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Dear Reader,

Applied Internet and Information Technologies today are horizontal technologies that have an impact on the overall human existence and application in all spheres of the functioning of modern societies. Without exaggeration, we can conclude that there is no profession that is not affected by the Internet and information technologies. Whether it's transportation, banking, medicine, education, tourism, entertainment, sports ... to religion, internet-based tools and information technologies are used every day.

However, although Applied Internet and Information Technologies are deeply involved in all spheres of society, we are still at the beginning. The time to come will mean the integration of the virtual/digital and the real. Technologies such as artificial intelligence, machine learning, virtual and augmented reality, internet of things, robotics, autonomous vehicles, etc. are in a relative start, but the scenarios for their integration into human existence are already visible. What is yet to come from the development of these technologies is difficult to predict, but surely the progress will be dramatic, and therefore the need for quality research and education in the field of information and communication technologies.

International conference on Applied Internet and Information Technologies is an essential segment of the scientific work of the Faculty of Information and Communication Technologies - Bitola. I hope that the papers presented in October 2018 in Bitola, although only a drop in the ocean of information and communication technologies, opened many new possibilities and opportunities for cooperation among the participants of the conference. In that context, I will conclude with a proverb of Mother Teresa: "We ourselves feel that what we are doing is just a drop in the ocean. But the ocean would be less because of that missing drop."

Enjoy in the reading of the papers published in this proceedings.

Conference Chairman,

Prof. Igor Nedelkovski

Dean of Faculty of Information and Communication Technologies - Bitola

University "St. Kliment Ohridski" - Bitola

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Connected Health Technologies for the Support of Chronic Patients: Challenges and Opportunities

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ABSTRACT

Connected health technologies enable health actors to make better decisions for health and care, via design of devices, services or interventions around the patient's needs, sharing of health related data and proactive care. These aspects, i.e. data sharing and patient centred approaches, along with the temporal and organizational continuum via new care and business models, are also central in integrated care approaches.

In this respect, the use of cloud based systems is further discussed, as regards a) Chronic disease management, b) Health Behavior Change, and c) Independent Living.

In the former case where the need for mature and robust ICT technology is highlighted, along with interoperability and standardisation among services/devices. This will later create a stable environment that will leverage medical knowledge and allow the transition from observation via connected health, to decisions and interventions.

In the latter case of Health Behavior Support, or Independent Living Support, deployed as a home based service, CH consumer electronics are central and their role in changing the health landscape is recognized. The value of data is highlighted, that can lead to personalised models of behavior, status and needs. However, they way to connect such services with care and with community services is not trivial.

In all these cases for elder care and self-management, the common technological components are a cloud platform, along with wearables and sensors, and mobile computing.

Moving beyond these examples, when the cloud-based PHR becomes the central point around which the services are organized, one may recognize health challenges related to the different cultures and values of health and social care services, and how to balance their priorities in a common framework. Connected Health Services can be built around the PHR following a loosely connected scheme. This will require to technically allow for an ecosystem of services and analytics, and to investigate models for organisational integration. The main directions to achieve this goal are:

a) To integrate and liberate the data: a PHR can play a role in this, and bridge social service, primary care services, and even consumer health services

b) To connect the personal health data to an ecosystem of services: this can be built on top of a PHR , with adequate security. Blockchain technologies can play a role

c) To show the value of personal health data analytics: develop a culture of data driven research and AI services

d) To enable the assessment of CH impact that will allow the scaling up of CH services.

Thus, leveraging the PHR to become the core of an ecosystem of connected health services can bear promises for a new era in digital health and integrated, even cross-border, care.

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Applicability Issues in Security Requirements Engineering for Agile Development

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Abstract – Cyberattackers present a real threat to software systems, which is why organizations are requiring software vendors to produce secure software. During the past decade, many software vendors have started expanding their development process to include activities that increase the security of the software. Furthermore, both the industrial and the scientific literature has presented dozens of different secure software development methods. Despite this effort and an explicit requirement, secure development practices are still not widely adopted.

In this paper, we present insight into why this is the case. We examine issues that limit the adoption of security requirements engineering practices in agile development. Furthermore, we analyze the proposed security analysis techniques designed to identify security requirements and increase the security posture of software products developed following the Scrum framework and examine how they address the discovered issues. From this research, we derive a set of recommendations for improving security requirements engineering practices for the agile development context.

I. INTRODUCTION

Over the last two decades, the omnipresence of the Internet has ushered in a new digital age. While its benefits are undeniable, recent years have shown the dangers of moving business dealings, commerce, and sensitive data processing to the web. These digital assets, valuable to individuals, organizations, and governments, have become a prime target for cybercriminals and other threat agents.

The threat of cybercrime has become so severe, that the US President signed into law the Cybersecurity Enhancement Act of 2014. This resulted in the creation of the Federal Cybersecurity Research and Development Strategic Plan, a document which highlights the current state of cybersecurity, as well as research and development goals for the next 15 years [1]. According to the plan, systems need to deter attackers and protect from, detect and adapt to malicious cyber activities.

An essential aspect of any modern system is the software it uses. Software, especially Internet-facing applications, such as websites and public services, presents an often-targeted attack surface [2][3]. To combat this, organizations are requesting built-in security from their software suppliers [4]. This is achieved by integrating various security activities throughout the software development lifecycle (SDLC).

A. The Security Development Lifecycle

The Security Development Lifecycle (SDL) is a business process that defines a set of practices that augment the SDLC to produce demonstrably more secure software. It permeates the whole SDLC, expanding each phase of software development with certain practices whose purpose is to:

- Discover threats to the software system;
- Analyze the attacks that can realize them;
- Identify software vulnerabilities that enable the identified attacks;
- Specify countermeasure requirements.

The listed steps make up the security analysis process, which can be practiced at the software design level, where architecture and software design is examined, or it can be applied to the code level, where low-level design and actual code is reviewed.

Several papers explored and compared different processes for constructing secure software. In [6] the authors compare OWASP CLASP (which has since evolved into the OWASP Software Assurance Maturity Model Project [7]), Cigital's Touchpoints (which has since developed into the Building Security-In Maturity Model [8]), and Microsoft's SDL. They break down the three major secure development processes of the time into practices, providing an extensive catalog of 45 security practices. A similar study was conducted in [9], where the authors cataloged and compared activities found in Microsoft's SDL, Cigital's Touchpoints and the Common Criteria [10] security engineering processes. Recently, an industry standard was issued by IEC, which specifies process requirements for the secure development of hardware and software products used in industrial automation and control systems [11].

B. SDL and Agile

Despite a significant number of SDL initiatives found in literature, as well as the explicit requirement for secure software, adoption rates of the security development lifecycle are still low. A survey conducted by Errata Security in 2010 shows that, out of 46 organizations, only 30% use a formal SDL methodology in their workflow, while 43% do not use any SDL methodology, formal or otherwise [12]. More recently, a study was conducted in Malaysia that interviewed software development

practitioners about security [13]. The study concluded that, while practitioners are becoming more aware of the importance of security, the SDL practices are immature, and a notable percent of practitioners (19.4%) never receive any security-related training.

The lack of SDL adoption can be explained, in part, due to the nature of state-of-the-art software development practices. Specifically, agile software development [14] defines the development workflow of many software vendors today. This set of development methodologies has been criticized for neglecting security requirements [15][16]. The first instances of the SDL [5][17] were initially designed for the waterfall development model, though since then several adaptations of this process have been created for agile development methodologies [9][18][19]. However, the traditional practices that compose the SDL are challenging to integrate into agile development and are often inefficiently practiced [9][18][20].

In this paper, we focus on a subset of SDL activities concerned with security requirements engineering (SRE) in the context of agile development. SRE entails the software security analysis at both the design and code level to derive security requirements based on the needs of the software context. We focus on the Scrum framework [21], as the most wide-spread agile methodology. We analyze the challenges of integrating SRE activities into the Scrum workflow and identify critical factors that raise applicability issues. We then examine the literature for SRE approaches and determine how well each method resolves the identified problems.

The rest of the paper is organized as follows: In Section 2 we provide a brief overview of the Scrum framework to provide the necessary background. Section 3 analyzes the literature for identified problems related to SRE in agile. In Section 4, we examine to what extent different Scrum SRE methods resolve the identified issues. Section 5 summarizes our findings and discusses the results. From these findings, we derive recommendations for developing SRE methods that apply to the Scrum framework. Section 6 concludes our work and offers further research opportunities.

II. Agile Software Development

In this section, we briefly describe the Scrum framework to supply the reader with an understanding of the terminology used in later chapters.

Agile software development has emerged as a practice that emphasizes adaption to changing software requirements. Developers produce constant increments of running, tested software features and continuously collaborate with the customer, to make sure the correct requirements are met [22].

Out of all agile development approaches, the Scrum framework is by far the most widespread. According to the annual State of Agile survey [23], Scrum is applied by 56% of software vendors that practice agile development. When considering hybrid methods that rely on Scrum (e.g., Scrum with Kanban), this number goes up to 70%.

A. Scrum Team

Scrum is a lightweight framework for team collaboration on complex products. It introduces roles, events, artifacts, and rules that bind them together while leaving plenty of room for self-organizing to deal with unpredictable and difficult problems [21]. The Scrum team consists of several roles, which include the product owner, the Scrum master, and the development team.

The product owner is responsible for determining and prioritizing user requirements, by interfacing both with the developers and the customer. The product owner maintains the product backlog, which is a document that contains software requirements. While not mandatory, the most common way to express these requirements is through user stories. A user story is a brief statement of intent that describes what the software needs to do for the user. They are a mechanism for describing features provided by the software system, which bring value to the user and the business [24].

The Scrum master assists the team in practicing Scrum, by facilitating a dynamic that optimizes the performance of the team. He or she is responsible for organizing the Scrum workflow, helping with user story analysis and workload management. While this role was traditionally included in all Scrum teams, the high adoption of agile has made it superfluous in mature organizations [21].

The development team includes coders and testers that write and test the software described through user stories. While the size of the team varies, usually it spans from four to seven members. Optimal team size is small enough to remain nimble and large enough to complete significant work [21].

B. Workflow

The Scrum team constructs software iteratively, by producing sets of functionalities in short intervals (usually two to four weeks), called sprints. At the beginning of the sprint is the sprint planning event, where the team determines which user stories from the product backlog shall be implemented during this sprint. The result of this activity is the construction of the sprint backlog that defines the goal for this sprint [21].

From the sprint backlog, members of the development team implement user stories until there are no more stories or the sprint is complete. During this time user stories are decomposed, understood, implemented, and tested. The user story is finished when the acceptance criteria are fulfilled [21]. While the acceptance criteria are story-specific, the definition of done is an artifact that lists additional acceptance criteria for all user stories. This artifact lists tasks that need to be completed to maintain the quality of the product (e.g., regression testing completed, user documentation updated to reflect the new story, and the performance testing benchmark achieved). The definition of done contains business-facing tests that provide quality control [25].

Near the end of the sprint is the review, where the team and stakeholders collaborate about what was done in the sprint. At the end of the iteration, a demo of the working, integrated software is held for all interested stakeholders.

During this time each story is presented, where the product owner accepts stories that are deemed finished while returning incomplete ones to the backlog [21].

The final activity is the retrospective, where the team takes the time to reflect on and assess the results of the sprint. During this time the team determines what went well in the sprint, what could be improved, and what will be improved in the next sprint.

III. Applicability Issues of SRE in Agile

In this section, we identify issues that limit the adoption of security requirements engineering practices in agile development.

The traditional SDLs were constructed following the waterfall development model. Since then, software vendors have, for the most part, reorganized their development business processes to follow various agile development methodologies [26]. As the SDL is defined as a set of security practices, applying the waterfall-based SDLs to the agile development environment calls for the redistribution of security practices, with or without modification, to the agile workflow.

Microsoft has adapted their original SDL for to the agile context [27]. Their agile SDL contains the same security practices as in the waterfall SDL model, distributed in three categories, which include one-time practices (conducted at the start of a project), every-sprint practices (performed in every sprint), bucket practices (completed periodically, spread across multiple sprints during the project lifetime).

However, it seems that merely redistributing practices designed for the waterfall development model to the agile development model is not enough. In [9], the authors applied practices from Microsoft's SDL to an agile development process practiced in Ericsson AB. They conducted interviews with personnel involved in software development to assess the applicability and effectiveness of the different security practices. The discussions concluded that Microsoft's SDL had the most significant adverse effect on the agile development process, criticizing practices such as threat modeling for being too costly to conduct. Similar conclusions were presented in [18], where Microsoft's Agile SDL was criticized for being too unwieldy for the agile context.

The finding in [9] contradicts the primary goal of threat modeling, as this practice is meant to find security issues early in the SDLC before the code is written when they are uncostly to fix [28]. One reason for this outcome is the lack of proper training, as threat modeling is often described as challenging to learn, as well as teach [29][30]. Based on this, we identify the first applicability issue:

1. Complexity – If the security analysis technique introduces new types of documentation, additional job roles, or requires a lot of training to practice effectively it works against agility and therefore cannot complement agile development.

Poller et al. identified a different set of problems with security engineering processes such as Microsoft's SDL and Cigital's Touchpoints, concerning agile development [19]. The authors conducted a long-term empirical study in which they examined the organizational impact that a security consultation had on a large, multinational software vendors' development process. While the security assessment and workshops conducted by the consultants resulted in an initial rise of awareness and enthusiasm for developing secure software, after two months most of the initiative has faded, and no lasting consequences of the security consultation were observed. The authors identified several key factors that influenced the outcome, two of which are relevant applicability issues for our context:

2. Unaccountability – If security is intangible and not part of the binding agreement between the managers and development teams it will not be done as it cannot be accounted for;
3. Lack of Guidance – Security engineering processes, such as Microsoft's SDL and Citigtal's Touchpoints, do not offer appropriate guidance for organizations and developers on how to adapt the different practices to their workflow.

IV. Agile SRE Method Assessment

In this section, we examine the scientific literature of the past decade for security analysis techniques designed to identify security requirements and increase the security posture of software products developed following the Scrum framework.

We analyze a recent systematic mapping study on the topic of security in agile requirements engineering [31], from which we extract methods applicable to the Scrum framework, excluding other agile development techniques. We further examine the literature for any additional relevant methodologies.

We analyze each method to determine the extent to which it has issues of Complexity, Unaccountability, and Lack of Guidance. We do this by rating each technique on how well it fulfills the following requirements:

1. Simplicity – The security analysis technique should not mandate the introduction of additional types of documentation or job roles. Additionally, the method should require as little training as possible to practice effectively. This requirement answers the Complexity issue.
2. Accountability – The security analysis technique should be integrated into the standard agile development workflow and produce visible and quantifiable action items. This requirement answers the Unaccountability issue.
3. Guidance – The security analysis technique should be fully documented, offering illustrative examples of its use, as well as advice for integration into different real-world contexts. This requirement addresses the Lack of Guidance issue and partially Unaccountability, as the execution of ambiguous methods cannot be sufficiently accounted for.

A. SRE Methods

In [32], the author introduces the concept of abuser stories – a user story that describes how a threat agent can achieve a goal that compromises the system or its assets. Abuser stories represent a skeleton for the threat model, but lack adequate requirement traceability to provide security assurance.

Regarding *Simplicity*, abuser stories introduce a simple and intuitive artifact, while not requiring any new roles. Training needs are not discussed. *Accountability* is not addressed, as it is both unclear when sufficient abuser stories have been defined and what development work needs to be done to resolve the abuser story. While the original paper is concise and does not offer much regarding *Guidance*, abuser stories have been around for over a decade, and several papers have utilized this concept and offered some illustrative examples [33][34].

In [35], the authors present an extended Security-Enhanced Agile Software Development Process (SEAP), which was practiced in Ericsson AB. The method introduces four roles in the agile development process, including the security manager, security architect, security master, and penetration tester. Activities conducted by the penetration tester are out of the scope of our context.

Regarding *Simplicity*, SEAP mandates the introduction of several new roles to the organization, most prominently the security master who expands the Scrum team. As a result, the development team does not require any training, as the security master performs the security assessment. The paper does not discuss the documentation resulting from the analysis. Regarding *Accountability*, the process outlines the activities that need to be conducted by the development team. Finally, regarding *Guidance*, the only resources provided by the authors is the paper that documents the SEAP flow, practiced in Ericsson AB, which lists roles and their responsibilities in the process. No examples of use or tailoring guidelines are presented.

In [36], the authors present Secure Scrum, where they expand user stories with S-Tags – descriptions of security concerns related to one or more backlog items. S-Tags represent security-related effort (e.g., in the form of additional user stories, specialized testing, research, etc.). During the implementation of a user story, all related S-Tags need to be present in the sprint backlog, where the definition of done states that verification needs to make sure that all present S-Tags are resolved.

Regarding *Simplicity*, Secure Scrum defines an additional, although simple, documentation type and no new roles. Training requirements are not discussed. Placing security-related effort in the backlog in the form of an S-Tag helps achieve *Accountability*. Regarding *Guidance*, it is unclear how to implement Secure Scrum in an organization efficiently. For example, the generalized nature of S-Tags as "anything security-related" is susceptible to threat explosion [37], where developers can virtually indefinitely populate the backlog with new S-Tags. This raises an issue with *Accountability* as well, as no guidance is given on how to identify S-Tags, and therefore determine when this activity is complete. Finally, there is no guidance on how to tailor the process for different contexts, as well as no illustrative examples to show the process in action.

In [38], the authors introduce a security analysis process for agile development based around a new document, the security backlog. The security backlog is managed by a new role, the security master, who processes the product backlog to identify security concerns with user stories, which are then entered into the security backlog.

Regarding *Simplicity*, the security backlog approach introduces a new document structure, a new role, as well as a process which is disjoint from the development process. As the security master manages the security backlog, the development team does not require additional training. *Accountability* is achieved as the security master processes security-related concerns into user stories, where the developers are required to perform only development tasks. Regarding *Guidance*, while the general flow of the security backlog management process is present, the details are not documented. In a later paper [39], the authors showcase an illustrative example of the method used on an industry-based case study. There is no process tailoring guidance.

In [40], the authors present S-Scrum, an expansion to the Scrum framework that introduces three types of security-related research spikes. The first type of research spike is conducted after release planning, where a security analysis is performed on the backlog, potentially introducing new items into the backlog. Then, the next spike is issued for security modeling, to incorporate the results of the security analysis into the software design. The final type of research spike entails a detailed security analysis for each sprint.

Regarding *Simplicity*, the method does not introduce new documents or roles, while training needs are not discussed. However, S-Scrum offers little regarding *Accountability*, as it is unclear when the proposed research spikes are considered done. Furthermore, there is very little *Guidance* provided by the paper, as the research spikes are vague in their purpose and offer no detailed description of how to efficiently conduct them. Additionally, the article provides no illustrative examples and no tailoring guidance.

In [41], the author presents the Agile Security Framework. This framework is presented as an end-to-end security development lifecycle for agile development, covering SRE, as well as penetration testing. We focus on the SRE activities, where abuser stories, attack trees, and threat modeling is utilized to discover threats and attacks, and form requirements which mitigate them.

Regarding *Simplicity*, the method introduces several artifacts (e.g., abuser stories, attack trees) and mentions a new role (i.e., security expert). The authors recommend dedicated security training. *Accountability* is achieved through a method that decomposes abuser stories to make sure that relevant threats are identified, and appropriate mitigations are planned, which results in the construction of acceptance tests. *Guidance* is partially achieved, as the paper presents an extensive description of the method, coupled with illustrative examples of use, but no guidance is provided for tailoring the technique to different contexts.

In [42] and [43], the authors examine security assurance cases and present an expansion to the agile development

process that entails the construction of these documents. Security assurance cases present structures that provide evidence that the developed software is acceptably secure and constructing such a body of evidence requires appropriate threat modeling and security requirement analysis. It should be noted that the papers place greater emphasis on the end product of SRE (i.e., the security assurance case) and not the SRE method itself.

Regarding *Simplicity*, the paper introduces a new document type that needs to be constructed, reviewed, and maintained. Furthermore, the article mentions the security expert role during the process of creating the security assurance case and notes that security training is required for developers. Concerning *Accountability*, the security assurance case is a well-structured body of evidence that can be directly mapped to work that needs to be realized. Finally, enough *Guidance* is given for executing all the tasks related to security assurance case construction, and two illustrative examples are presented in the papers. No tailoring guidance is offered.

In [44], the authors present an expanded Scrum framework (called VAHTI-Scrum) that is meant to be compliant with the Finnish security standard collection (VAHTI). As such, it is concerned with security throughout the whole software development lifecycle, where we once again focus on the SRE activities.

Regarding *Simplicity*, VAHTI-Scrum introduces a new role to each Scrum team, the security developer, responsible for security reviews, security test cases, etc. The Scrum master is required to have substantial security knowledge. The method introduces threat modeling and application risk analysis, although it is unclear when these activities should be conducted. The process is further expanded by adding "sprint zero" for security analysis and periodic hardening sprints to enhance the security of the software. The method addresses *Accountability* by relying on the expertise of the security developer when completing well-known tasks such as threat modeling. While the paper explains the roles and responsibilities, it offers only minor tailoring *Guidance* and does not present any illustrative examples.

V. Discussion

Table I summarizes the extent to which each SRE method has achieved the goals of Simplicity, Accountability, and Guidance, as defined in Section IV. A grade of 1 means that the requirement is insufficiently addressed, 2 is given for techniques that partially fulfill the requirement, while 3 means that a method is fully compliant with the requirement.

From these results, we draw several conclusions:

- *Guidance* is insufficiently addressed. Three methods are presented in a single paper and offer little more than basic illustrative examples. No paper provides sufficient guidelines for tailoring the technique to different organizational contexts.
- Full *Accountability* is only achieved when a dedicated security expert exists in the process. However, most such methods are too complicated and fail to address the *Simplicity* requirement.
- Methods that fulfill the *Simplicity* requirement do not offer stopping conditions for security analysis activities, which is why they can only partially satisfy the *Accountability* requirement. Furthermore, simple methods often lack proper *Guidance*, hinting at their lack of maturity.

TABLE I. Agile SRE Methods in Relation to Simplicity, Accountability, and Guidance

Method	Applicability requirements		
	Simplicity	***Accountability***	***Guidance***
Abuser Cases [32]	3	2	2
SEAP [35]	2	3	1
Secure Scrum [36]	3	2	1
Security Backlog [38]	1	3	2
S-Scrum [40]	3	1	1
Agile Security Framework [41]	1	3	2
Sec. assurance case [43]	1	3	2
VAHTI-Scrum [44]	1	3	2

Based on these conclusions, we derive several recommendations for developing SRE methods applicable to the Scrum framework:

- High complexity contradicts agile development principles, limiting the adoption of the SRE method in organizations that favor agility.
- To achieve *Accountability* of security analysis work, some security expertise is required. Dedicated personnel or training for the Scrum team is mandated. Furthermore, security analysis must be timeslotted to provide a stopping condition.
- Organizations need *Guidance* to adopt an SRE method. This includes a detailed explanation of the technique, illustrative examples of its use, and tailoring guidance for adapting the SRE.

VI. Conclusion

In this paper, we examined issues that limit the adoption of security requirements engineering practices in agile development, specifically the Scrum framework. Furthermore, we analyzed the SRE methods proposed in the literature and examined how they approach the discovered issues. We investigated how each technique addressed the Simplicity, Accountability, and Guidance requirement (as defined in Section IV). From the results, we derived a set of recommendations for developing SRE practices applicable to the agile development context.

As a continuation of this work, we plan to design and implement an SRE method that addresses the Simplicity, Accountability, and Guidance requirement.

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Web Application for Art Gallery Management Support

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Abstract – This paper presents a software solution for art gallery management support, implemented in "UK Ecka", City gallery of Zrenjanin, Serbia. It enables better organization of work in the field of cultural heritage and art work management, with systematic recording of data and monitoring the state of art work, as well as and digital presentation supported by information technologies. Process of software development is presented, as well as similar solutions for art gallery management support.

I. INTRODUCTION

Better organization of work in the field of cultural values cultivation can be reached by systematic recording and monitoring of the state and the location of the art work, supported by information technologies.

The paper [1] describes the problems and the results of software development, which enables the cultural heritage pieces management, primarily works of art. Implemented solution was used to monitor the status of the artwork from initial reception and accommodation, renting, the final write-off and discharge. This software was implemented and used at the contemporary gallery "UK Ecka", which represents one of the Institutions of culture in the Zrenjanin city. Since 2002, the desktop software version was used to record data about the entire gallery art collection (2480 artworks), which mostly consists of art paintings.

II. RELATED WORK

The research in the field of information systems for supporting the record of art works is given below.

The entities in the cultural heritage sector, their interdependence and the corresponding business processes that link them use modern information and communication technologies [2]. In [3], an initiative for the integration of the information system of the library, archives and museums is described for the purpose of unified search and resource use. An open-source system was created that enables interoperability of data between different departments and organizations. Collective data access has enabled an integrated platform for system users. Paper [4] describes the importance of standardization in the field of digital resource record keeping, especially in the field of recording data about works of art. For the above reasons, the need for design of metadata that would enable the collection, classification, organization and exchange of data, especially digital forms of works of art, as well as video materials, is emphasized. In the paper [5], an initiative has been described for creating a unique prescriptive framework, which would provide the basis for the development of websites related to content in the context of cultural heritage. This development framework was formulated on the basis of the need to create unique e-Government services that would enable the integration and exchange of data between primarily the websites of the Ministries of Culture of the countries of the European Union. Compatibility of data on these sites is necessary due to dynamic content exchange, and is defined in this paper by the development framework for their creation and integration. The guidelines for digitalization have been defined within the Minerva project [6], which was created by the ministries of the European Union countries in order to cooperate and harmonize the activities of digitalization of cultural and scientific contents. This project proposes the application of ISO 21127. The basic role of this standard is to provide a conceptual basis for the information exchange between organizations whose activity relates to cultural heritage, such as museums, libraries and archives. Based on the analysis of various forms of cultural contents data recording, a categorization of data to be recorded was performed:

- Basic data on the registration: identification data, classification, physical form, condition, and geographical location, date of origin, applicability, characteristics, and relationship to other objects.
- Administrative data relating to the management of relevant facilities where art collections may belong. This information is a prerequisite for management and documentation relating to objects belonging to collections in cultural institutions.
- Documentation information on digital products and processes. These data categories are metadata related to the processes of digitization, identification, quality and thematic content of digitized material.
- Data on the conservation (restoration and conservation) of cultural objects. This data also applies to meta-data on long-term (long-term) techniques for the preservation of cultural objects as well as digitized material.

- Data on publishing cultural content. Digitized material can be published on the Internet and can be stored on optical media (CD-ROMs, DVDs). The contents that are prepared for displaying can be specially selected and prepared for specific user profiles, e.g. for editing purposes or to have multilingual support.

In the paper [7], the need for the application of Big Data technologies in processing large amounts of data in the field of public cultural services is emphasized. In this paper, a platform for collecting data from public cultural institutions and data analysis based on model-based algorithms is proposed. By applying the proposed approach, better access to data by users of public service providers' services is enabled.

In Nozaki et al. [8] the system that uses data from the multimedia database and allows setting queries based on work impressions is described. The recording includes the data about the image itself and the accompanying documentation, as well as the location data. The system enables recording information about image impressions with descriptive words of image quality. The given descriptive ratings are used to help with new search and display of image data.

III. Software Solutions

Software solutions for managing art works of the contemporary gallery are available in the form of commercial software, websites, and as mobile applications intended for the wide market. Below are listed some of these solutions.

Art gallery management software Artsystems [9] is implemented as a desktop, web and mobile application, which uses a local database and supports data storage in the Cloud system, as well as work in the computer network. It supports recording of artworks data related to basic data, value and costs data, artwork-related transactions (primarily related to the sale and exhibition of artworks), the status of work and the history of changes in work, as well as the change of art work locations. It also provides a record of the contact information of all participants in various processes related to the art work. It contains a module for processing a digital photograph of an art work and a reporting module.

A similar solution is software that enables the recording of art works data, which enables management of various activities like exhibitions and sales, as well as reports generating. This software is intended for art galleries, artists and collectors [10]. This solution is web-based, with support for mobile devices. Data is stored on servers provided by the company that has developed this solution.

The solution [11] was implemented primarily for the record keeping of art work in the form of data warehouse and it also contains an auction support module that can be online.

The solution [12] supports the record of art works using cloud archiving, implemented as a web solution and a mobile solution. Functionally, it supports the record of artworks, artists, as well as the creation of electronic exhibitions and catalogs, sales and rentals. It supports various types of search and reports.

The solution [13] offers contact logs, a warehouse of art work, sales and support for marketing events (e.g. exhibitions), with attendance records and event logs.

Another solution is primarily intended for storing data using cloud and presenting art works and supporting sales and customer records, along with all supporting documents. [14]

Software solutions in Serbia are also presented below in this section.

The solution [15] is a web site, which is created by the gallery “White Angel” from Belgrade, which gives the opportunity to display biographies of all painters who sell paintings in this gallery and download the PDF catalog, as well as the web form on which contact information and message can be entered. Several static images of artistic images of a fixed rectangular display format are also shown.

The solution [16] is another example of a web site which is created by the previously mentioned gallery of “White Angel”. This website provides an overview of new artworks images, in aim to offer these artworks for sale. A separate section shows an alphabetically-sorted display of biographies of painters who sell their paintings in this gallery. Separate sections divide old and contemporary paintings (i.e. paintings from contemporary painters). A special section of this website provides list of paintings that are offered with reduced price. There is a link that leads to a special website for the purchase of paintings photos [17].

The solution [18] is a website for free advertising of artworks sales. It is possible to register users as sellers and to post ads on the sale of artwork, which include artwork images, their characteristics, contact details of the seller and selling prices. Artwork images are shown in categories: new, popular and by categories based on image creation techniques.

The solution [19] is a web site created with purpose of advertising artworks and marketing events (combine presentation and sale of art works). Information about artists is displayed on this site (contact details and photographs of artist's paintings). All photographs of artists' works are displayed in a fixed square form as a diminished whole photograph or as part of an art image. A special section of this site gives an overview of the pictures of various authors, filtered according to the production technique - paintings, drawings, photographs, sculptures, handicrafts. Artists have the opportunity to pay for the presentation of their biography and work. As part of the presentation of the work, a special section of the website gives an overview of the collection, the latest works and artworks with price discount. Also, on this website there is an offer of service for making various art objects for personal use or interior design and decoration.

IV. Web Application Development

Web application for art gallery organization support is developed as an improved version of previous solution [1]

that was developed in 2002. Previous version was implemented as a Windows desktop application based on relational database, that runs only on one computer.

The process of implementing the new solution can be divided into two phases. First phase is collecting and analyzing user's requirements and the first software solution, a desktop application that handles data in relational database with reports that supports few basic business processes. This solution includes basic functionality and data related to the artwork and core of the business process life cycle workflows. The second phase of development is programming web version of software and transforming the old database (filled with data for more than ten years) into a new database management system without losing any data. This new solution was designed to support all functions and data of the desktop version, but also to support extensions in data recording, in alignment with the requirements of the Ministry of Culture.

Within the implementation of the first phase, the collection of documentation is realized, as well as snapshot of the current status and specifications of the user's requirements. This model has been created using the method of the system structural analysis. Primitive processes from the process tree are assigned to software functions. Based on the data dictionary, a conceptual and relational data model is created, and then a database was created.

The desktop application was implemented using Visual Basic programming language, Microsoft Access database, and Crystal Report generator. The first version of the program was developed in 2001, implemented and used since January 2002. During the maintenance period of the initial function software, solution is expanded with the capabilities of searching, editing, additional reports, and some automation. Also, in the period of maintenance and improvement of the software, a part of the desktop application, which refers to the adaptive displaying of artworks digital photographs, was implemented.

A. Client Requirements

During 2017, activities on improving the solution have been initiated. The following user requirements are specified as needed to be implemented with the new version of the software:

- Software should enable network data entry by multiple employees.
- Extended data coverage - introduction of more detailed records in some segments, as well as verification of compliance with recent versions of the Law on Cultural Property of the Republic of Serbia [20] and harmonization with the Guidelines of the Ministry of Culture and Information of the Republic of Serbia for the Digitalization of Cultural Heritage in the Republic of Serbia [21].
- Digital image display in reduced form and form of original high-resolution dimensions.
- The software should have the same structure and functionality as the desktop version of the application, with minimal extensions in terms of the coverage of new features and data.

As the most suitable technology for implementing new software version, web technology was selected, according to [3], with PHP programming language, HTML/ CSS/JavaScript user interface, Apache web server and MySQL database management system. This technology has been selected because it is suitable for light edits and extensions, even by Gallery staff, and also because it is common in the implementation of web sites, which would allow subsequent integration with the existing gallery site. Also, modern web application solutions allow displaying on mobile devices, so the public availability of content related to cultural goods is further enhanced.

Within development planning, the possibilities for continuing development after the second phase have been defined. The existing "UK Ecka" gallery website [22] could be improved by integrating it with the second phase results. This way, integration with gallery website will allow the input and dynamic display of data at the gallery website.

B. Business Processes Model

The business process that is analyzed presents activities related to works of art, particularly in the Gallery of contemporary arts "UK Ecka Zrenjanin". The following business processes were identified:

- The artworks are received in the gallery from the artwork authors, via gifts or redemption. The artwork is evaluated in relation to the condition and value; it is introduced into the inventory and stored in a place of accommodation.
- Institutitons (clients, users from other institutions) may request the gallery service of renting the artwork, in aim to have them presented in the workspace of these insitutions. On the basis of requests and data on issued works, document named "Revers" is formed. After returning the work to the Gallery, the document named "Returns" is created.
- If necessary, the process of restoration of artwork is carried out. It includes reparation of the artworks with damaged parts.
- Once a year, inventory of the works is carried out by commission members, where the status, value and location of all artworks in the Gallery are determined, as well as the need to write off the work (if it cannot be restored) or restoration (if the damage is partial).

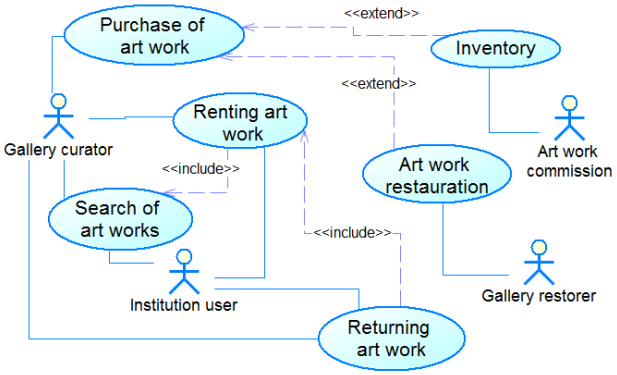

Figure 1. Main software functions and users

All of these business processes are implemented within the gallery. Communication with the environment refers to the exchange of information with the author of the work on reception, as well as the exchange of information with the clients (institutions or individuals) who rent art works.

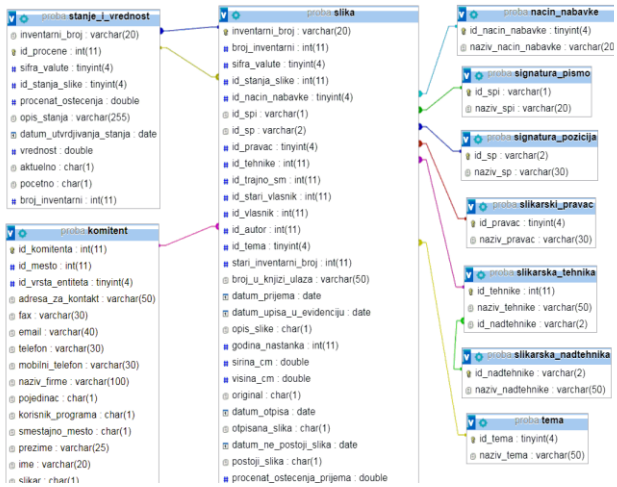

Figure 2. Relational database schema

New user requirements and needs are:

- Expanding the capabilities of software features, such as adding new automations, queries, and reports.
- Extending the functions of the existing software to support data records on artwork restoration.
- Forming a network software solution (LAN).
- Connecting user interface with the Internet presentation of the gallery [22], to display the artistic fund on the web.

Use case diagram presented on figure 1. displays developed software functions.

C. *Database Model*

Database design is based on client requirements specification, but also on the old database tables and objects, and on created new business processes. Relational database schema presented on figure 2. is just a part of whole database which has 30 tables. It was created in as a MySQL database within PHP MyAdmin software for database administration. The largest table is "Painting" with about 40 attributes presenting art work features. The whole database is generated by executing a set of SQL data definition language commands with table definitions, reference constrains, and defined referential integrity for every relationship.

D. *Software Functions, Forms, Pages and User Interface*

Software functions can generally be divided into basic data pages and support for records that accompany business processes. The main software functions and users of this web application are shown by the use case diagram on figure 1.

The structure of the application menu is organized in such a way that it segregates the part of the encoders, while separates the part related to business processes (processing). Also, parts for adjusting print parameters and printing of reports are especially highlighted. Particularly, the query section enables presenting data that re the most frequently needed. Menus, shown on figure 4,

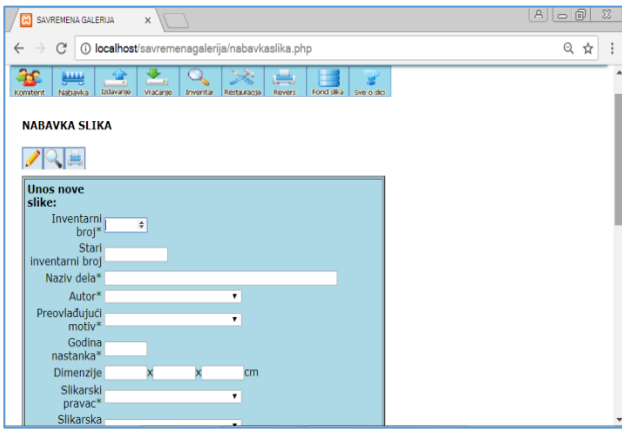

Figure 3. Web page for art work purchase

are organized as drop-down menus and graphical button menu, that highlights the most important software functions.

Each form for entering basic data and art work processing (i.e. business process support) is organized using "cards" – adding new data, searching for data and printing (figures 3 and 4).

Within the desktop version of the software, only one user profile (administrator) was defined with ability to enter and change artworks data, as well as finding and printing all necessary reports. In web application we defined four user profiles: gallery curator, art work commission members, gallery restorer, and an institution representative user (i.e. user that is employed in an institution that aims to rent artwork to be presented in the institution).

Dropdown menus have the following menu items:

- Basic data: City, Country, Workplace, Employees, Customer type, Customer, Art work theme, Art work direction, Painting

technics, Signature position, Signature letter, Way of purchasing art work.

- Processing: Purchasing, Renting, Returning, Inventory, and Restauration (figure 1).
- Reports: About the fund (all art works, purchased in the period, certain categories), Revers, Returned art works, Inventory lists.
- Fund search: All art work information, the total fund of all images, search for painters and pictures.

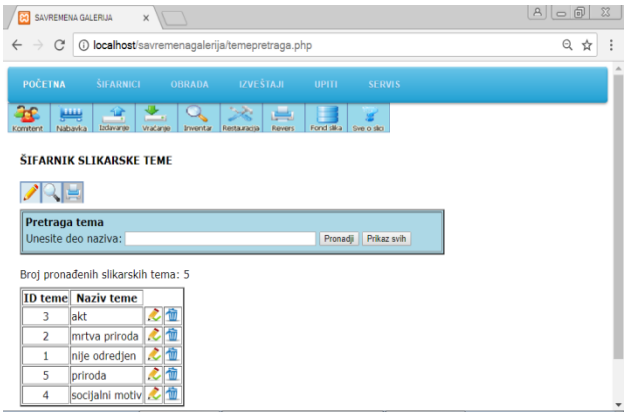

Figure 4. Web application search form example – paintings theme

V. CONCLUSION

Based on the available data on existing software solutions, which would support life cycle records in digital art work, it can be concluded:

- Each of the software solutions analyzed (English and Serbian versions) are incomplete i.e. do not support data recording during the entire artwork life cycle.
- All analyzed English solutions are oriented towards the sale of artworks and partly cover the life cycle of the work. Available software solutions in the Serbian language are actually websites for the sale of works of art within a specific gallery of images or through public free advertising for sales. The Serbian solutions do not provide the possibility of monitoring the life cycle of the artwork.
- English solutions comparing to Serbian solutions differ in the comprehensiveness of the application of modern software development technologies (desktop, web, cloud, mobile applications).
- The graphic representation of artworks in English or Serbian software versions do not adapt to the dimensions of the digital record of the artwork. The artwork digital photo presenting is supported within fixed frames, where art is displayed - either as reduced or as partial representations (segments) of works of art.

The web-based software presented in this paper provides a significant contribution in this area. It could be concluded that this application will help to improve management of cultural heritage and artwork, with comprehensive set of software functions. As a web solution, it provides increase of public availability of data records on cultural heritage.

ACKNOWLEDGMENT

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Development of PHP application for City Archive Library Records

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Abstract – The significance of the realization information system of the library is reflected in the support of material records and ease of use by users and librarians. The problem of registering the library material of the archives of the city of Zrenjanin was that the books were kept using Word documents. The application is of great importance for library material for this reason because it enables easier data organization, because all data is in one place. In consultation with employees from the library of the archive of the city of Zrenjanin, a web application for the record keeping of library materials was realized.

I. INTRODUCTION

The significance of the implementing library information system is reflected in the support of library material data records and ease of use by users and librarians. In this paper, a snapshot of the status and specifications of the user's requests was made in relation to the library of the Archives of the city of Zrenjanin. A universal model of business processes and software design that could be applied to any library has been developed. The proposed general model and design has been implemented with more specific details within implementation of the web application to support The City Archive library of Zrenjanin. Previously, in the Archives of the city of Zrenjanin Library, the information about the books were kept by using Word documents. There were too many Word documents, making is difficult to find information.

This paper deals with the problem of developing the information system of the library. Existing solutions were explored, followed by a model and implementation of a web application for the support of library records. The application is of great importance for library material for this reason because it enables easier data organization, because all data is in one place. This application makes it easier to enter information about books. After starting web application, unregistered user gets a tabular display of entered books with the ability to filter according to three parameters: Book title, Author and Signature. The "administrator", after authentication, can enter, edit, and delete data about books. In addition, there is a possibility of parametric printing, according to the same parameters as the tabular filter, extended with storage location as a filtering parameter.

II. RELATED WORK

Libraries store many data. It is therefore necessary to digitize the books and archive the data about them, so that future generations could use these books. The importance of introducing information technology into libraries is indisputable. The availability of information on library material is thus greater. Library users can get the necessary information in a quick and easy way, even with the possibility that they do not come to the library at all, and library workers can quickly provide the information they are looking for, or they can get the information they need more quickly with library material [1].

Web applications are software solutions that are accessed through web browsers by users over a network such as the internet or an intranet. The use of development environments in web applications can reduce the number of errors in the program, and thus the code is simpler and allows one team to concentrate on the development environment, while the other focuses on certain cases of use [2].

There are many library materials. The Library of "Matica srpska" is the oldest Serbian library of national importance and the first public scientific library in Serbia. It was founded in 1826. in Pest, with the founding of "Matica srpska" [3].

The electronic catalog of the National Library of Serbia is one of the largest electronic catalogs in Serbia. It contains about 820 000 bibliographic records, which include all types of material [4].

BISIS (Library information system) in the case of a single prefix search, it can be searched: by author, by title, by keyword. Advanced search is used to search for multiple prefixes including logical operators [5].

Regarding archival and records management considerations in the application of information technology the Electronic Records Management

Branch (ERM) provides advice and technical support, training, and guidance to state and local government agencies. The Branch assists, and tries to ensure that aware of archival and records management requirements as they relate to information resources planning, management, and appropriations [6].

College Records Management Program administers the Simmons College Archives. To the systematic and consistent management of all records, regardless format policy outlines the obligations of Simmons staff, faculty, and administrators. Retention Schedules for all College Records has developed the College Archives. The College Archives services provides include ensuring long-term preservation of historical records [7].

Sheffield City Archives & Local Studies have countless hundreds of thousands of items which amount to almost 10 kilometers of books and documents [8].

Digital imaging use government agencies to enhance productivity, provide greater access to certain types of information, and as a preservation option. Many advantages offer digital imaging, including: improved distribution and publication, increased access, streamlined workflows, and a greatly reduced need for physical storage space. Government agencies digital files made available over the web allow to provide information to partners or the public quickly and efficiently [9].

The Center for digitalization of the City Library "Vladislav Petkovic Dis" was founded in early 2008, as the first among the public libraries of Serbia. In this way, the institutionalization of the work on the digitization of native material, which has been implemented in the City Library Cacak since 2006, is institutionalized. The Center is responsible for designing, organizing, leading and proposing all activities related to the digitization of materials, its long-term preservation, protection and use by employees and users. In addition, the Center for Digitization maintains all the web presentations of the Library, provides technical and information support to employees and users in the field of computer and information technologies, proposes and implements automation solutions for the institution's operations and the application of information technologies in the work of the Library [10].

III. DEVELOPMENT MODEL

Development model that presents the basis for the implementation of the web application is presented with UML Use case diagram (presenting software functions) and CDM – conceptual data model that is a basis for the relational database creation.

The use case diagram (Fig. 1) explains in more detail each of the functions an application can perform. This diagram is the best-defined interaction between participants in working with the application. The use case ellipsis diagram defines the functions that the application performs at the request of the participants. Functions connect either to the participant or to other functions, which depends on the course in which the application goes.

The physical data model is relational database basis and it was obtained by Power Designer automated generating based on CDM (Fig. 2). This way, CDM represents a logical design for relational database creating.

IV. THE SOLUTION

The selected technology for implementation of the web application is PHP programming language, with supporting tools: Notepad++ to write code, web server Apache, DBMS server MySQL. Web server and DBMS were used as parts of XAMPP. Version XAMPP 3.2.1. was installed at the City Archive Library office, to enable running of the web application.

A book entry page allows data about books to be entered into the database through the HTML-based PHP page form. The required field is Book title and Language. Everything else is not required to be entered. If it is not entered in place of an empty place, it is entered "-", and for the year "0". When entering the necessary data for a book, it is necessary to click on the Record (SAVE) button (Fig. 3).

The search option is provided for an anonymous user at the starting page of the application, above the tabular presentation of data. The filtering is enabled according to three parameters. Parameters are Book name, Author and Signature (Fig. 4). For example, when the Book title is entered, you need to click on the Filter button to do the search. After you return to the initial tab, click the All button. Filtering can be done for all three parameters individually.

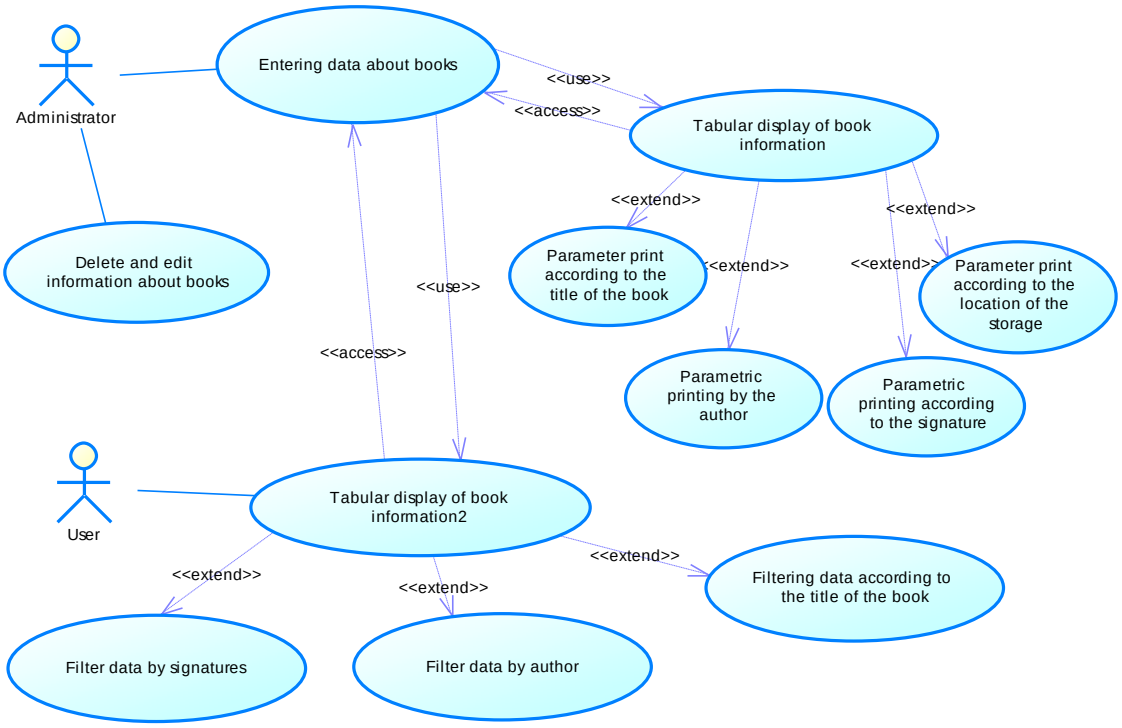

Figure 1. Use case diagram with software functions of application

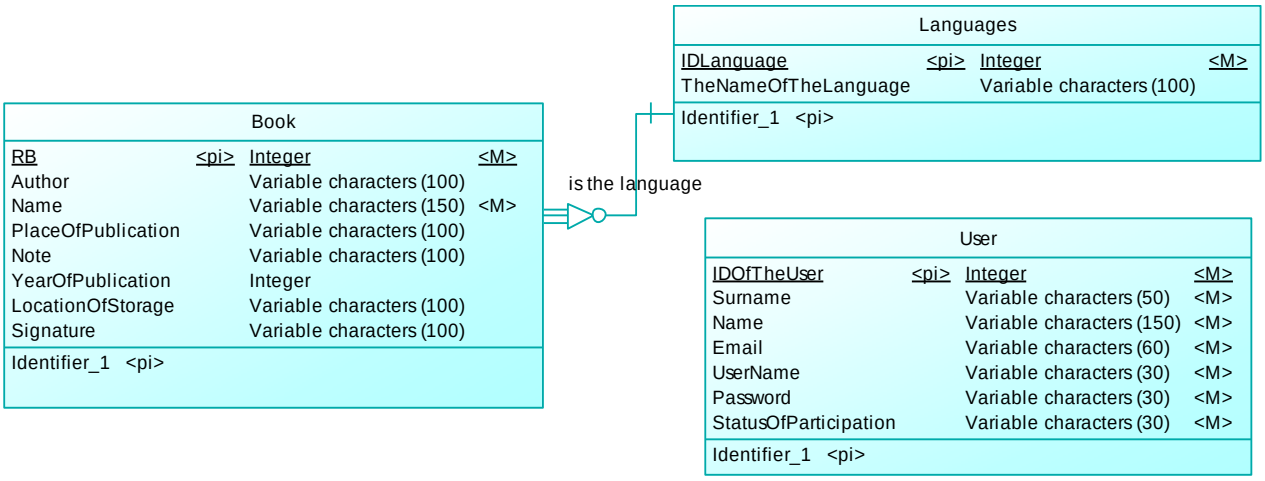

Figure 2. CDM data model for the application

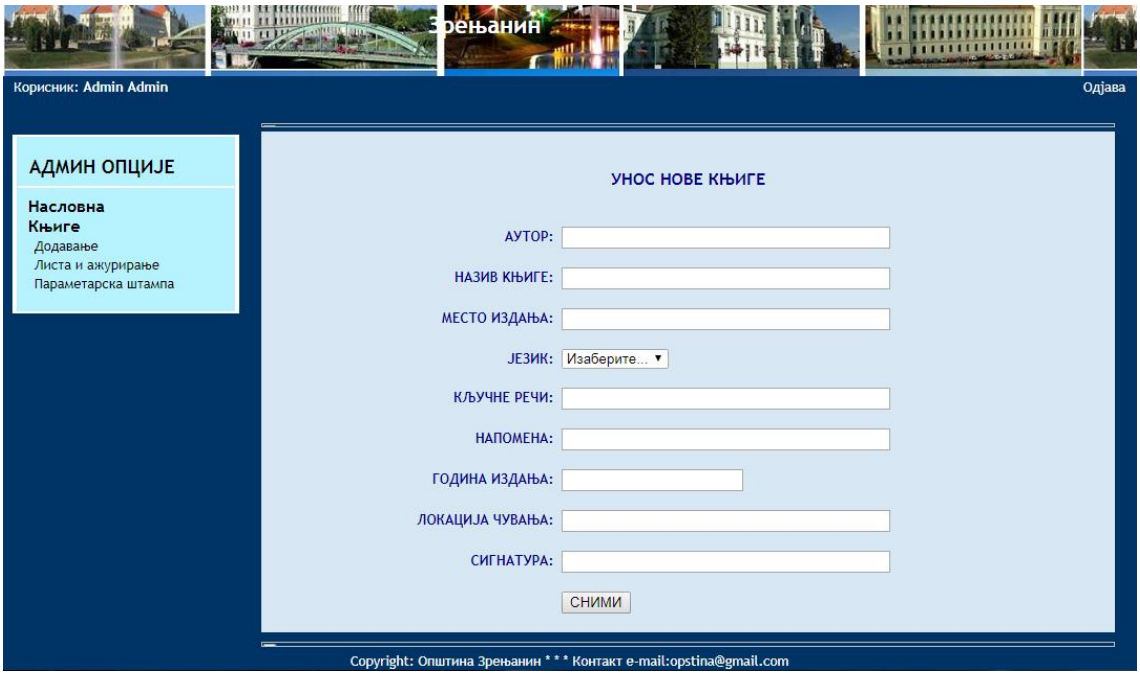

Figure 3. View page for book entry

АУТОР	НАЗИВ КЊИГЕ	МЕСТО ИЗДАЊА	ЈЕЗИК	КЉУЧНЕ РЕЧИ	НАПОМЕНА	ГОДИНА ИЗДАЊА	ЛОКАЦИЈА ЧУВАЊА	СИГНАТУРА
Agata Kristi	Beskrajna noć	London	Srpski	Noć, mrak, ljubav	Dešava se	2005	Orman 2	Signatura 359
Ivo Andrić	Na Drini ćuprija	Beograd	Srpski	Drina, reka, most	Radi se o	1980	Orman 1	Signatura 355
Ivo Andrić	Prokleta avlija	Novi Sad	Nije određen	Prokleta, avlija, dvorište	Dešava se	1954	Orman 1	Signatura 355
Tomas Man	Vizija	Berlin	Engleski	Misao, razmišljanje, budućnost	Radi se o	1893	Orman 3	Signatura 365

Figure 4. Filter page view

V. CONCLUSION

In consultation with employees from the library of the archive of the city of Zrenjanin, a web application for the record keeping of library materials was implemented. Comparing to other similar solutions, this web application fit to the particular needs of the city archive library, regarding specific database structure and search options. The current application is valid and can be used, but it could be improved with some other options.

Further improvement of the application for the needs of the library of the archives of the city of Zrenjanin should enable the record of issuing and returning books, whereby the recors should contain the information to which the book was issued, which institution requires the publication of the book (or where the user is employed), the purpose of issuing, etc. Additional features should be implemented in the following version: import data from Word documents (a list of all books that have been entered manually so far). In addition, the ability to export

data from a database to Excel or to XML should be done.

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Cloud-Based Electronic Health Record for Health Data Exchange

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Abstract – This paper proposes a model for an Electronic Health Record for Health Data Exchange based on a SaaS (Software as a service) service model developed on top of cloud computing technology. Service oriented architecture (SOA) and SaaS enable establishment of service model by leveraging the benefits of both. In the proposed model EHRs are stored in the cloud, and can be accessed through a web portal or background web services through SOA. The system is using Health Level Seven International (HL7) standard and is capable of storing information on: healthcare processes, resources, users and authorization, also capable of recording of all data on the patient history, diagnostic test data, therapy, decisions request for further investigations, and treatment. The system is set up to support the use of technologies, decision support and management plans. Owners of EHRs are responsible for generating access policies based on the attributes of authorized healthcare providers, encrypting EHRs and uploading encrypted EHRs, digital signing of all request for getting data and digital signing of response into the cloud. EHRs is organized into a hierarchical data structure, which give possibilities to share different parts of the EHR making our model more flexible.

I. INTRODUCTION

The development in the area of information and communication technologies and progress in medical sciences, together with related technologies, has led to a strong need for exchange health information across institutional borders. New information and communication technologies have the potential to revolutionize healthcare and health systems and contribute to their future sustainability. Many IT systems have been developed and implemented in attempts to improve healthcare protection. Some of these systems include simple electronic health records (EHR) or electronic medical records (EMR) that replace paper records for information storage and retrieval [1]. Walji et al. [2] recommend the usage of a multi method approach when testing the usability of health information technology.

Health information technologies (HIT) represent one of the most promising ways to modernize and improve health care delivery. Usage of HIT provides timely access to patient health information and evidence-based decision support thus reducing medical errors and enhance clinical decision making [3]. Electronic health record (EHR), electronic patient record (EPR), electronic medical record (EMR), Healthcare Information Systems and the exchange of healthcare data are essential components of the IT infrastructure in healthcare. The same are often crucial elements in providing the support for health care reforms. EHR describes the concept of a comprehensive, institutional, and longitudinal collection of a patient's health and healthcare data. According to the definition from ISO/TR 20514 standard [4] EHR is defined as: 'a repository of information regarding the health status of a subject of care in computer process able form, stored and transmitted securely, and accessible by multiple authorized users'. EHR has a standardized or commonly agreed logical model of information which is independent of EHR systems. The main purpose of EHR is the support of continuing, efficient and quality integrated healthcare.

EHR includes both medical and non-traditional health and lifestyle-related information, with the consumer as the focus around which the information is recorded. Different health care professionals and administrative staff are using the EHR: physicians, nurses, pharmacists, laboratory technicians and other healthcare employees.

EMR systems manage electronic health records, so they can be created, gathered, and managed by authorized healthcare providers within healthcare organizations. Data entered into the computer (e.g. X-ray, pathology and pharmacy data) which can be integrated into the record are called electronic medical record. In some situation, there may be paper back up. EMR may be characterized as a partial health record under the hat of a healthcare provider that holds a portion of the relevant health information about a person over their lifetime.

An EPR is a sub-type of an EHR, used in a specific hospital or healthcare organization. According to the ISO/DTR 20514:2005 standard [4] it's defined as 'a repository of patient data in digital form, stored and exchanged securely and accessible by multiple authorized users'.

EHRs differ from EMRs and PHRs most notably on the basis of the completeness of the information the record contains and the designated custodian of the information. A PHR is often described as a complete or partial health record under the custodian of a person(s) that holds all or a portion of the relevant health information about that person over their lifetime.

Interoperability in healthcare refers to the possibility of exchanging health data between two or more interconnected systems. The exchange information should be interpreted and understood in the same way for all the interconnected systems. To reduce costs and improve

quality of healthcare, cooperation and collaboration of healthcare units from different locations is required.

The introduction of national platforms for managing of EHR can be treated as a new health information system. This paper describes a cloud-based model of EHR for healthcare organizations, adapted to the needs of health data exchange.

Description of the cloud based HER model is presented in the next section of this paper. Discussion and challenges are presented in section three, while the last, fourth section concludes the paper.

II. CLOUD BASED EHR

A. *Different EHR models*

Today, in many healthcare systems, data are still stored in human readable formats only. Although, data like laboratory results and medical findings are measured and calculated digitally, final reports are often printed and transmitted to the physician. In the modern healthcare systems, data are being stored and transmitted in computer's readable data formats.

Currently, there is a strong push in these healthcare systems for establishment and increase of the use of EHR in the delivery of health care.

Models of EHR are often discussed in literature in terms of degree of centralization or distribution. In general, according to the architecture of EHR, there is a separation of basic and universal model of EHR [5]. The universal EHR architecture has two categories, it may be a centralized system or a distributed system. The basic model of EHR is built inside one organization (hospital or clinic) and connected to all hospital/clinic IT systems. The basic EHR type is centralized and collects data from all operating healthcare systems in the hospitals, clinics or general practitioners. EPR and EMR can be considered as different kind of basic architecture models of EHR.

In centralized EHR patient data are collected and stored in a single repository or location. Individual healthcare providers or health professionals maintain the full details for individuals (patients) in their own EPR or EMR, which are subsets of the EHR.

In the distributed model of EHR, there is no location that is considered as a primary repository of information. Instead, the EHR is physically distributed across several locations. Users create their own view or record by accessing the data from these locations. In this model of EHR each healthcare organization has its own EHR with its own data model and with its own terminology standards.

In many healthcare systems, EHR's data are currently distributed in the different IT systems in private and public healthcare institutions. It is unclear how much of these data are relevant and enough for clinical research and which data elements are relevant for feasibility analyses. Structured data must be documented during patient care through the use of national or international sets or terminologies.

Most of the laboratories have special laboratory information systems, so they have started structuring their data very early. But, there is still need for all laboratories to use standard terminologies and put their data with EHRs.

B. *Best practices of EHR's implementations and adequate technologies*

In some healthcare systems, EHR's data are distributed in the different IT systems in private and public healthcare institutions in a form of non-necessarily standardized EHR, EMR or EPR. The data exchange between IT systems designed in this way, is very difficult. Hence, the introduction of standards in the design of the new model of EHR is needed, the design of collaborative model of EHR based on new technologies should be considered.

There are different health informatics standards that are currently used to define domain models of EHR: ISO HL7 21731 'Health informatics – HL7 version 3 Reference Information Model' (RIM) [6], ISO EN 13606 'Health Informatics – EHR communication' [7], Open - EHR Reference Model [8], etc. On the other hand, International Statistical Classification of Diseases 10th revision (ICD10) is used in most European EHRs.

Design of health information systems, especially their underlying business and informational models which describe basic concepts, business and relation networks, have to be based on standards. Lopez and Blobel [9] present a method and the necessary tool for reusing standard of healthcare information models, for supporting the development of semantically interoperable systems and components.

The results of the Häyrinen et al. [1] literature reviews show that the challenge for ongoing national EHR projects, in the most of the countries, is to take into account all the different types of EHRs and the needs and requirements of different healthcare professionals and consumers in the development of EHRs. Additional challenge is the use of international terminology and sets in order to achieve semantic interoperability.

The EHR contains valuable information entered by physicians and clinicians. Besides its immediate clinical use at the point of care, the EHR provides rich data that can be analyzed and mined for clinical research (when EHR is treated as a repository of medical information across many patients).

Patient notes, in particular, convey an abundance of information about the patient's treatments and medical history, signs and symptoms, which often are not nested in the structured part of the EHR. Notes' information can be found in the form of narrative and semi-structured format through lists or templates with free-text fields [10].

So, generally the new EHR model:

- must be capable of containing information on: healthcare processes, healthcare requests, healthcare characteristics, activities, medical problem, resources, users and authorization;
- must allow for the recording of all data on the patient history, physical examination, diagnostic test, and therapeutic interventions to support patient care;
- must allow for the recording of observations, interpretations, decisions request for further investigations, and treatment; and

- should support the use of technologies, decision support and management plans.

Health Information Exchanges (HIE) is complex as the healthcare landscape is a complex network of varied stakeholders. At the center of this healthcare network is the patient. As the patient moves through the healthcare labyrinth, each stakeholder captures a slice of patient data or records a healthcare transaction pertaining to that patient. According to Metzger et al.[11], the interoperability of health information system is defined as: 'the capability of heterogeneous systems to interchange data in a way that the data from one can be recognized, interpreted, used and processed by other systems.'

Many countries have implemented a network of interoperable EHR. Among these countries is Canada with its so called "Canada Health Infoway"[12]. According to Canadian model of interoperability, EHR solutions link clinics, hospitals, pharmacies and other healthcare providers. The vision of "Canada Health Infoway" is to provide a secure and private EHR lifetime record of health and healthcare history and care within the healthcare system, available to authorized healthcare providers, medical staff and individuals.

Following the "Canada Health Infoway", we can define interoperability infrastructure for the case of EHR. In our case EHR should be host on back-end of central healthcare information system. The main question is how these services will be exposed to the client consumers (primary, secondary and tertiary healthcare providers, and patients)?

According to Lomotey and Deters [13], two types of architectural designs from Web services have been embraced in the medical system design: SOA (Service-oriented Architecture) and ROA (Resource Oriented Architecture). SOA is an architectural style whose goal is to achieve loose coupling among interacting services. It has become an extremely popular paradigm. An enterprise service bus (ESB) is one of the main technologies that enables implementation of service-oriented architecture (SOA). As most appropriate, in our cases we use SOA.

Cloud computing (CC) technology offers cost-effective services (including simple data management and storage, cheap computer resources) and features (portability, reliability, scalability, and elasticity). Cloud computing can be used as platform to implement electronic health records (EHRs) systems because it offers great potential for quick access to healthcare information and other information concerning health. IT infrastructure in the healthcare is very complex and sensitive and must be taken additional measures to protect the patient's private data. Maintaining reliability and integrity of information stored in cloud computing, and providing data backup and recovery processes in extreme cases are very important in healthcare area.

Cloud computing can offer patients access to their medical data anytime and anywhere in the world. The cloud technology, becomes compelling for deploying EHR systems because it provides flexible, wide-area mobile access increasingly needed in the modern world. However, before cloud-based EHR systems can become a reality, issues of data security, access control, patient privacy, and overall performance of the whole system must be addressed.

EHR can serve for multiple purposes including medical communication, legal documentation, financial transaction, research and analytics.

Electronic signatures attached to entries in EHRs have different logical and legal meanings for different users in the healthcare system. Some of these are stamps from historic paper formats that require reconsideration. Traditionally accepted functions of signatures, such as identity verification, consent, authorization and non-repudiation can become unclear in the context of computer-based workflow processes that incorporate functions like logins, auto-fill and audit trails.

The digital signature is a very useful mechanism that provides authenticity mechanisms in complex IT systems. With this security mechanism, the authenticity of the digital record is guaranteed and it will be sufficiently to deploy this kind of system in the Healthcare Cloud in order to avoid false data transactions. The digital signature gives the receiver the reassurance that a message or data are valid and trustworthy.

C. Proposed EHR model for health data exchange

The proposed model will be based on SaaS (Software as a service) service model developed on top of cloud computing technology for healthcare domain [14]. Service oriented architecture (SOA) and SaaS enable establishment of service model by leveraging the benefits of both. In the proposed model EHRs are stored in the cloud, and can be accessed through a web portal or background web services through SOA (see figure 1). Owners of EHRs are responsible for generating access policies based on the attributes of authorized healthcare providers, encrypting EHRs and uploading encrypted EHRs, digital signing of all request for getting data and digital signing of response into the cloud. EHRs is organized into a hierarchical data structure, which give possibilities to share different parts of the EHR making our model more flexible.

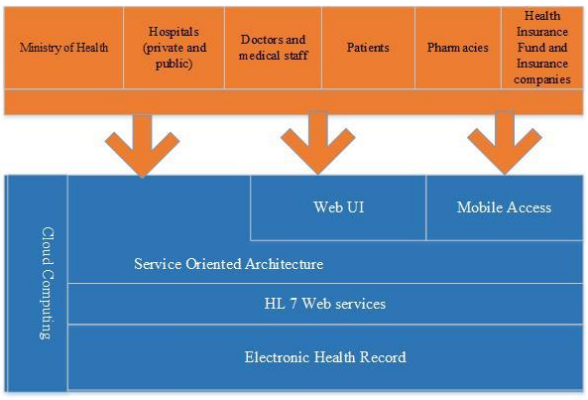

Figure 1. Model of Cloud Based EHR

Direct call to web services is a type of access that can be used by the organizations that already have applications related to the health record and need to integrate those systems with the cloud based EHR. Access to the EHR through the web application can be used by healthcare organizations and providers that do not have EHR's application. The new EHR can be accessed through mobile

application. This is very convenient for the physicians and patients because they can use the application anytime and anywhere through their mobile devices.

For the data exchange between the entities involved in ours cloud based model of EHR, we proposed the use of Health Level Seven International (HL7) standard. Through the HL7 web services layer, each entity performs data exchange using HL7 message format.

Detail architecture of the proposed collaborative model of EHR based on cloud computing technology is shown on Figure 2. For the model description, we will use the feature unification of cloud computing where CC brings together all the disciplines, technologies (Web services, virtualization, SOA, etc.) and business models used to deliver IT capabilities (software, platforms, hardware) as a service request, scalable and elastic.

The main components of cloud computing EHR architecture are:

SaaS layer – consisting of interface, security access and business sublayers. The interface sublayer allows different forms of access to the cloud HER, the security access sublayer provides the entry point to the entire infrastructure and implements all the low-level requirements of Authentication and Access Control. Finally, the business sublayer implements all EHR SOA services.

PaaS layer – implements agnostic services that can be used by the upper SaaS services, one of which is the interoperability based on HL7 web services.

IaaS layer - provide computational resources to all the above layers and modules. The client maintains the applications, runtimes, SOA integration, databases, server software while the supplier maintains the Cloud virtualization, hardware server, storage, networks [14]. This layer, according to CC features, provides platform for Business Continuity and Disaster Recovery functionalities.

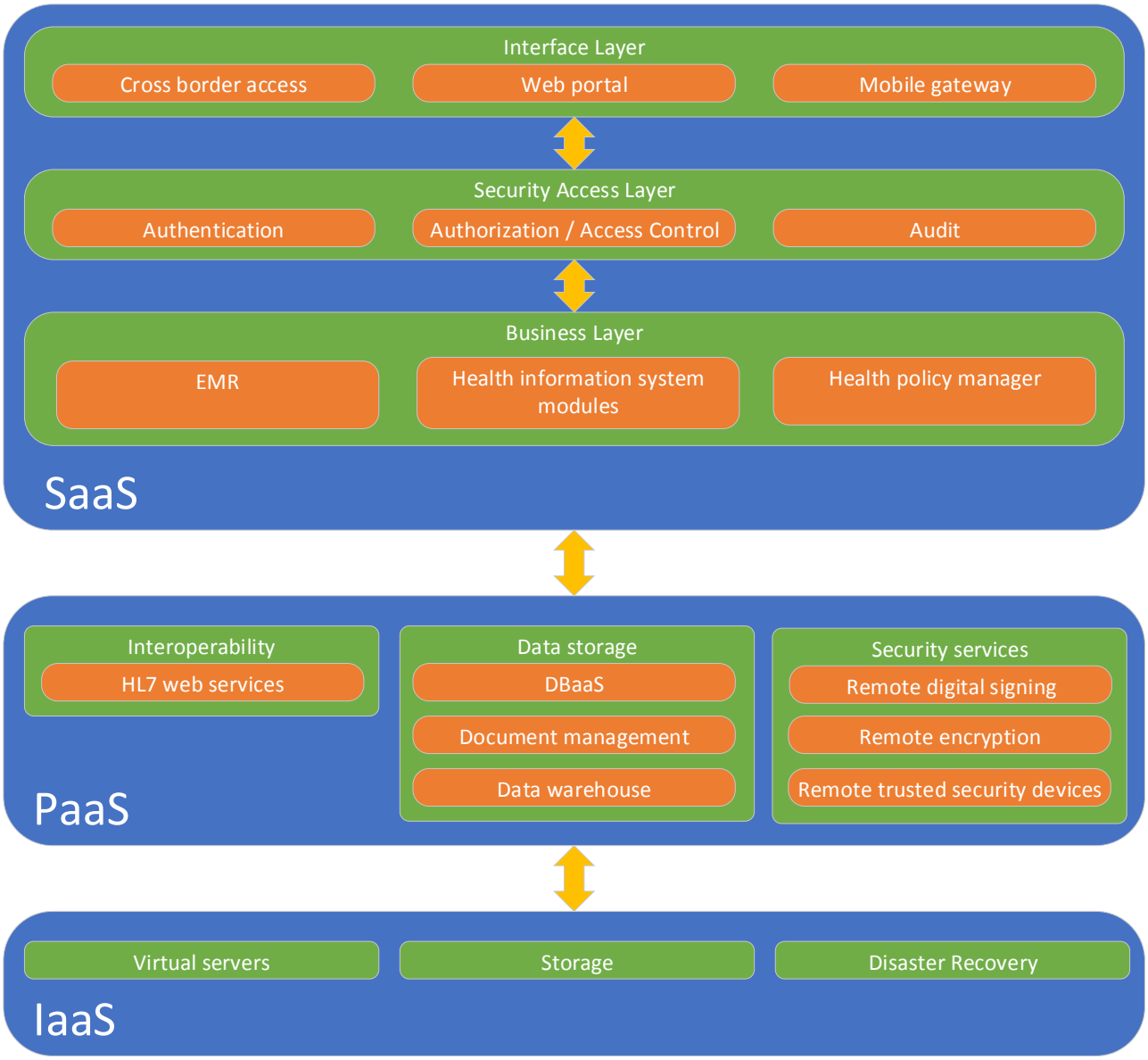

Figure 2. Architecture of cloud based EHR

The Interface sublayer implement all the user and service interfaces for interacting with the EHR's data and the overall platform. It consists of three modules: web portal, mobile access gateway and cross border access.

The Security access sublayer represents the entry point to the EHR. Security access layer consists of three modules: Authentication module - authenticates users so only legitimate users can access the system; Access Control module - controls users' access to EHRs from all the actors authorized to access the data: patient/citizen, health workers, administrative staff; and Audit module - maintains all system logs and controls the access to the health data contained within the EHR. This layer will be used for implementation of cross-border federation of identity providers for the cross-border scenarios.

The main role of the Business sublayer is to implement the business services allowing the implementation of cloud EHR. One important part of the Business sublayer is the health policy management module that supports all the health, healthcare, insurance and administrative activities performed on EHR's platform by the authorized users.

The web portal has three different views according to users' identities:

- healthcare practitioners are able to discover a patient with at least one identification. By selecting the desired patient, they can submit the patient's EHRs access request. Based on the authorization result and allowed access by the patient, the request is either allowed or denied;
- patients are able to view their EHRs from particular healthcare providers they are associated with or the composite EHRs aggregated from all healthcare providers they obtained services from; and
- administrators have the capability to manage all users, healthcare providers and other registered institutions, insurance companies, registered in the whole system.

The interoperability module integrates the proposed EHR system with all external EHR subsystems, EMR, EPR, Health and Healthcare information system, Insurance company's IT systems. Also, this module provides integration's services with epSOS (Smart Open Services for European Patients) through NCP (National Contact Points) [15].

Hosting and disaster recovery module is for supporting and interacting with the cloud computing platform. Open data module is responsible for open data exchange with external users while Business module defines business rules and content data of EHR.

Data management layer have two system modules: Health Identification module and Data storage module.

Health Policy Manager module represents the central place for controlling the access to the sensitive medical and administrative information. It consists of two sub-modules:

Health Access Policy manager sub-module provides capability for patients to specify their access control policies; and

Health Policy Enforcement sub-module enforces corresponding policies when receiving EHRs access requests from users and generates authorization results to Access Control module.

The Health Policy Manager fulfil the security requirements such as Confidentiality, Integrity, Authenticity, Authorization and Accountability.

The usage of security model follows the principles of the WS Security standard. The requirement of Confidentiality is achieved through the use of an encrypted patient identifier in order to keep personal data separate from healthcare information through the secure exchange message. Moreover, the access to data is controlled by the use of Access Control (AC). Access control policies are stored as records in a policy storage database as a part of database in data storage module. All actions about creation of new data in the database are tracking by the appropriate database event manager.

The Data storage module consists of two submodules: Database with Document Management System (DDMS) submodule and Data Warehouse submodule (DW). The DDMS is a submodule that manage a vast variety of data collected within the EHR, including raw data, formatted documents, image files and so on. It represents an interface between data and the front-end application. This sub-modul contains central RDBMS compliant with SQL standards and NoSQL Database Management System instance for supporting unstructured data.

The DW sub-module is intended to supporting the information extraction from the system. It contains a copy of source data structured according to a single global schema.

Parts of SaaS layer are:

- the Health and Healthcare Information system module. It manages the services of business processes and guarantee full support for creating modular software;
- the EMR module- manages with medical records and feeds the EHR module. It manages the collection of medical data from other systems.

III. Discussion

Migrating of EHR to the Cloud may represent a great step in the digitalization of medical data. Cloud based model of EHR, like the model described in this paper, will increase the access to the personal and medical data of patients. Some advantages like scalability, costs, and involving the patient as an active part of the health information management process may represent a step forward in healthcare improvement.

Our proposed Cloud-Based EHR provides integration of all medical data for citizens collected in health care facilities and the administrative data. All data from EHR will be enrolled in a central location which would be available to all health care workers and institutions according to their access privileges.

The introduction of electronic services has a positive impact on improving health care. The implementation of

our model of EHR, as electronic service, will greatly increase the quality of health care as can be seen from the comparison of data from the two IT systems in the case of the Macedonian healthcare information system [16] [17].

There are many challenges fostering the new collaborative model of cloud computing in healthcare. Several requirements and conditions must be taken into account when sensitive medical and private administrative data are migrating to the cloud based HER [18]. In order to make this process easier, healthcare providers, or healthcare authorities, must inform their patients of the change and how their data will be managed and stored. Legislative mechanisms regarding the security and privacy of data are important [19]. The strategic planning is necessary to examine staffing, budget, organizational culture, technologies in the health sector, and government regulations that may affect it, assess its capabilities to achieve the goal, and identify strategies designed to move forward [20].

The modular approach of the EHR's implementation represents a guarantee of scalability of the cloud computing platform in terms of computational resources and upgrade of the specific modules.

IV. CONCLUSION

Using cloud computing technology in healthcare may considerably improve the access to healthcare information. The collaboration between healthcare providers is the additional opportunity offered by cloud computing. With this technology we can check the availability of a physician, a medical specialist, a product or a service at different times and in different cases.

Patients can be guided by appropriate persons or in appropriate units where they can find what they need. This is a great benefit for patients and health professionals because it increases the quality of the healthcare service.

The use of cloud computing and common international healthcare standards in the EHR design enables integration among many types of healthcare organizations whether they already have application or want to develop a new one. It also reduces complex business processes by automating the manual processes.

The use of cloud based EHR system will enable data sharing, analysis tools, and infrastructure that can speed up many research, especially in healthcare services, by enabling new insights and enhancing efficiency.

ACKNOWLEDGMENT

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IoT project in agriculture

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ABSTRACT

The exclusion of a man from permanent, routine tasks is the goal of automation. Irrigation is one of the activities that can be automated in a simple and inexpensive way. One possible solution for automatic irrigation of plant crops is shown in this paper (for tomatoes, but the solution is also applicable for cultivation of all other plants, maintenance of lawns, irrigation of orchards, etc.). The solution is realised on Raspberry Pi 3 Rev B platform with connected sensors for temperature and humidity measurement DHT22, temperature sensor DS18b20, soil humidity sensor and 8 relay board. The irrigation management is based on requirements of the technological production of the quantity of the needed water for tomatoes, according to the formed table for each day of the plant's growth and based on the measured soil moisture. All data is recorded in the MySQL database in order to be analyzed and to enable the correction of irrigation norms.

Based on the competed experiment results have shown that the external appearance, quality and yield of tomatoes is excellent, as the plants always have optimal soil moisture. Additionally, this is a cheap solution for almost completely autonomous system. The system can be managed via Internet (SSH), as the current state can be controlled via WWW. Only requests are that the Apache server is previously installed and the existence of the wireless connection on Raspberry.

Keywords: Raspberry, IoT, irrigation, tomato

I. INTRODUCTION

Irrigation, as an agro-technical activity, is the first time mentioned about 3000 years BC. The area that was irrigated is Mesopotamia (between the rivers Tigris and Euphrates), and the records were written in cuneiform script invented by the Sumerians. The cuneiform script is the oldest known system of writing, and irrigation had certainly been done earlier, only there is no written evidence.

Today, intensive agricultural production cannot be imagined without irrigation. Only the irrigation system can provide stable and high yields of crops, which is the goal of the agricultural production.

In Serbia, only 3% of arable land is irrigated, while 17% is irrigated in the world [1]. There are many reasons for this, starting from the standings of the agriculture in the country, small investments in this sector, up to the need for big investments, big start-up costs, expensive equipment maintenance, etc.

The irrigated crops must be carefully selected to justify the high economic investments. On the larger farms, the most common crops are various types of seeds, and on the smaller ones usually vegetable crops.

The choice of the type of irrigation system must satisfy the economic criteria (system price, cost of exploitation, life expectancy of the system), but also to be adapted to the irrigated crop. Cheaper systems per hectare of area (e.g. rain wings) are unsuitable for irrigation of vegetable crops, because they can cause diseases (blight, septoria leaf spot, etc.) and require additional chemical protection measures (and costs).

The irrigation process usually comes down to manually setting the watering parameters (the amount of water in mm/m^2), by adjusting the frequency and the quantity of the watering determined by the responsible person. Physical presence of a human is essential here.

The paper proposes a cheap alternative to the classical irrigation, with elements of automatic operating, complete control and recording of the entire process without the presence of a man.

II. IRRIGATION SYSTEM FOR TOMATOES

For the realization of the project, tomatoes were selected as one of the most sensitive plants to the lack of water, and especially sensitive to moistening of the leaves during irrigation. An identical solution is applicable to other vegetable crops, even to the arable crops.

The chosen type of the irrigation is the irrigation in furrows. The drip irrigation system, or some other one, can also be used (which is not crucial for this paper).

The implemented irrigation system consists of:

- hydraulic part, a pump, hose system, water exchanger, etc.,
- hardware device that controls the system and is physically connected to other components, relays, sensors, soil moisture meters, etc., and
- software part which manages the entire irrigation process and which turns irrigation on and off, calculates the irrigation intensity, irrigation time, records all the data, etc.

The land area used on this project is a part of the $40m^2$ garden, where 120 tomatoes seedlings are densely planted. The density of planting is chosen with the aim of the area conservation and it involves compacting two rows with one passage space. The two rows therefore occupy 40 cm, and the passage occupy 60 cm, while the distance between the plants is always 50 cm.

A. Hydraulic part

An electric well pump at a depth of 18m delivers 1200l/hour of water that is distributed to the piping system. The diameter of the pipe, the length of the pipe and the amount of water must be calculated for each individual case, whereby the manufacturer's instructions must be

followed (e.g. the minimum pressure for the good functioning of the drop by drop is 0.7 bar and the maximum permissible pressure is 1.2 bar).

For research purpose, a garden hose of ½" and ¾" is chosen, but a cheaper and long-term solution is the purchase of a rounded hose (the price is about 0.15 Euro/m^1).

The distributive T pieces are placed at 1m distance, since the canal around the plant was not formed. In the case of the existence of a canal, the distance is supposed to be greater.

The distribution system is based on the fishbone system, where at the end of each row there is a cover that equalizes the hydraulic pressure inside of the system (Figure 1).

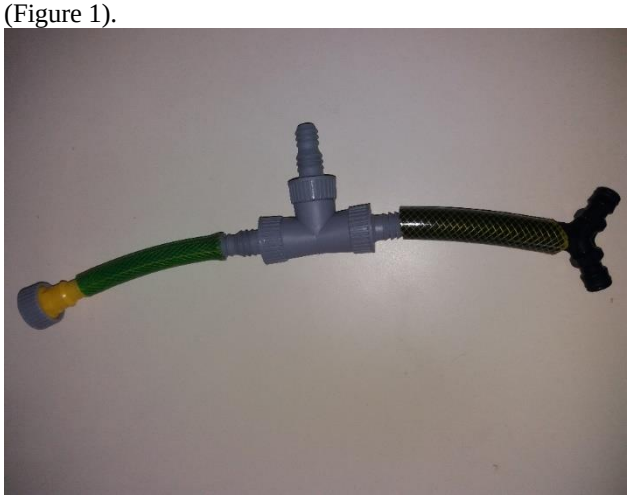

Figure 1. Hydraulic components of the irrigation system

The amount of water for irrigation is calculated based on the soil moisture and daily requirements of water for the plant. For tomatoes this is 3-4 mm of water per day if the plant is in the fruiting phase. The water excess is very undesirable, as it causes fruit tearing, increased evaporation of water from the soil and the occurrence of diseases.

B. Hardware part

In the last few years, the usage of the Internet technology for practical everyday tasks with new approaches is immense. The emergence of various forms of automation in everyday life greatly facilitates the functioning of the community, freeing a man from routine daily tasks. Benefits of the Internet technologies reflect not only in the improvement in the quality of the tasks completion, but also in the energy savings and the increase of the living comfort by availability through 24/7 from any spot in the globe, requiring only internet access. Turning the heating on over the Internet half an hour before returning home and turning the lights on and off using our voice may seem unnecessary, but monitoring cameras at our home while we are away can be very significant.

For all of these and many other situations, there are professional solutions that may require engagement of different companies and significant investments. The quality of the solution is not always guaranteed, and it depends on the knowledge and the abilities of the company. There are certainly no solutions for all the requirements, and that means planning and meeting demands from the beginning gives the lead as whole process requires time, money and more difficult corrections of the implemented system.

The autonomous realization of such projects until recently included knowledge of electronics, printed board design, the purchase of electronic parts, soldering, programming, and for this, the vast majority of those interested lack both knowledge and skill.

PC as a component is a good basis for the realization of such projects. Population of those that know at least one programming language is growing, but the insurmountable obstacle is the inability to manage external devices via PC. Older generation of PCs had a serial and parallel port, and that was all. The newer generations only have a USB port, but a digital connection with, for example, 8 channels is simply too expensive.

The term IoT was created in 2008 and since then the market value has grown at a rate of 31% year-over-year to 8.4 billion in 2017. [3] and it is estimated that there will be 30 billion devices by 2020. [4]. Global market value of IoT is projected to reach $ 7.1 trillion by 2020. [5].

With the emergence of a single board computer the size of a credit card, the basis for computer communication with the environment in a very simple way is set. In addition to the far lower price than PCs, since the beginning the single board computers had a communication port that other digital or analog devices could be attached to and controlled. Of course, the microprocessor is far weaker than the one in the PC, but such processing power is not necessary at all.

Few dozens of the suitable single board computers can be purchased on the market and it is a real challenge to choose one (Table 1) [6]. Even though they all meet the requirements of the project, Raspberry Pi was chosen since it is the most popular (12.5 million copies sold in various versions), easily accessible, and the third best selling general purpose computer ever (behind Apple Macintosh and Microsoft Windows PC).

Raspberry Pi 3 B has all the necessary features to be the hardware basis of the project. It has (Figure 2) a sufficiently powerful processor, 1GB of RAM which is enough, Linux operating system on the SD card, an internet socket and WIFI. Another important quality is a low price.

The temperature sensor DS18B20 is the standard sensor of the manufacturer Dallas Semiconductor, widely distributed primarily because of its reliability and low price.

The DHT22 is a basic digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin, no analog input pins needed.

8-channel low level trigger relay (by Songle) can be applied to Arduino and Raspberry Pi projects. Relays are suitable for driving high power electronic devices such as lights, electric fans air condition and pumps. A relay can be used to control low and high voltages devices.

Soil moisture sensor measure the volumetric water content in soil indirectly by using some other property of the soil, such as electrical resistance, dielectric constant. The relation between the measured property and soil moisture must be calibrated (Figure 3).

Table 1. Raspberry Pi alternatives with main characteristics

Model	Processor	GPU	Memory	Price
Raspberry Pi 3 Model B	Quad Core 1.2GHz Broadcom BCM2837 64bit CPU	Broadcom VideoCore IV	1GB LPDDR2 (900 MHz)	$35
Arduino Mega 2560	ATmega2560	n/a	256KB Flash ROM	$38
Asus Tinker Board S	Rockchip RK3288 (4x Cortex-A17 @ 1.8GHz)	Mali-T760	2GB LPDDR3 RAM	$89
Banana Pi M64	Allwinner A64 (4x Cortex-A53 @ 1.2GHz)	Mali-400 MP2	2GB DDR3 RAM eMMC	$60
BBC micro:bit	ARM Cortex-M0	n/a	256KB Flash ROM, 16KB RAM	$16
Huawei HiKey 960	Kirin 960 (4 x 2.3GHz ARM A73 cores, and 4 x 1.8GHz ARM A53 cores)	ARM Mali G71 MP8	3GB LPDDR4 SDRAM	$239
LattePanda	Intel Cherry Trail Z8350 Quad Core 1.8GHz	Intel HD Graphics	2GB DDR3L	$119
Le Potato	Amlogic S905X (4x Cortex-A53 @ up to 2GHz)	Mali-450 MP2	1GB DDR3 RAM eMMC	$35
NanoPC-T3 Plus	Samsung S5P6818 (8x Cortex-A53 @ 400MHz to 1.4GHz)	Mali-400 MP	2GB DDR3 RAM eMMC	$75
Odroid-C2	Amlogic S905 (4x Cortex-53 @ up to 1.5GHz)	Mali-450 MP2	2GB DDR3 RAM eMMC	$46
Odroid-XU4	Samsung Exynos5422 (4x Cortex-A15 @ 2.0GHz and 4x Cortex-A7 @ 1.4GHz)	Mali-T628 MP6	2GB LPDDR3 RAM eMMC	$59
Orange Pi Plus2	Allwinner H3 (4x Cortex-A7 @ 1.6GHz)	Mali-400 MP2	2GB DDR3 RAM; 8GB eMMC	$50
Pine A64-LTS	Allwinner R18 (4x Cortex-A53 cores @ 1.2GHz)	Mali-400 MP2	2GB DDR3 RAM eMMC	$32
PocketBeagle	Octavo Systems OSD335x SiP with TI Sitara AM3358 (1x Cortex-A8 @ 1GHz)	PowerVR SGX530	512MB RAM	$25
Raspberry Pi Zero W	Broadcom BCM2835 (1x ARM1176JZFS core @ 1GHz)	VideoCore IV dual-core	512MB SDRAM	$10
Rock64 Media Board	Rockchip RK3328 (4x Cortex-A53 @ 1.5GHz)	Mali-450 MP	1GB DDR3L; empty eMMC slot	$24.95

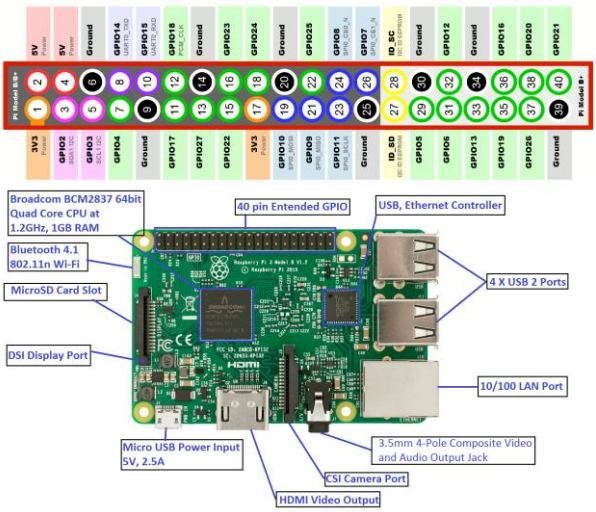

Figure 2. Raspberry Pi 3 Model B

C. Software part

The operating system is Linux Raspbian, which is located on the 16GB SD card. Additionally, the LAMP software package (Linux, Apache Web server, MySQL database and PHP MyAdmin) was also installed.

Communication with Raspberry is via the Putty program (SSH via port 22) and Team Viewer, because Raspberry is physically located in the garden without a monitor, a keyboard or a mouse. The installed ApacheWeb server provides all the necessary information about the history of activities and the current state, also it is updated every minute via the CRON function of Linux.

Figure 3. Used hardware components

Complete communication with connected components and management is realized in the programming language C, and a version in the Python programming language, which is currently a very popular language that is experiencing great expansion, as it has been developing gradually.

The DS18b20 shielded sensor is a single wire temperature sensor with a unique 64bit address that allows multiple sensors to be connected to the same bus (same pin). A single resistor of 4.7 or 10 KΩ is needed on one main bus, and the temperature range from -55 to +125°C can be read, with a ±0.5°C fault and precision of 9-12 bits (the smallest division of 0.125°C was used). The sensor is used to measure the temperature of the water in a well because of a large difference in temperature (more than 10°C) between the outside temperature and the water temperature that is harmful to the plant. That is why most of the irrigation cycles perform during the night, while the most convenient part of the day is in the early morning.

The DHT22 is a sensor with digital and calibrated output signal. In this project the version with integrated resistors in the circuit was used. Only one DHT22 sensor can be connected on one pin. Communication is significantly slower, so the safe reading interval is greater than 2 seconds (5 second refreshing was used). Data is being read in an array of 40 bits (air humidity + temperature + control bits). It is possible to read the temperature from -40 to +80°C (±0.5°C tolerance, 0.1°C resolution) and humidity from 0 to 100% (±2% tolerance, 0.1% resolution).

A bank of 8 relays was used for the possibility of expanding the use of the system. For this project, a single relay is used that turns the well pump on and off. The relay's characteristic is that it is designed for 10A, DC 30V or 10A, AC 250V. Each relay can be set to the initial state NO (*normally open*) and NC (*normally closed*).

The soil humidity sensor is designed to measure and control the current humidity. The potentiometer is used to set the soil moisture on which the signal is sent to the Raspberry Pi device.

Three tables were created using MySQL:

- The table of work history and system settings. This table contains date and time, all measured parameters (air temperature, humidity, water temperature), pump status, and soil moisture status. The interval of measuring and writing all of the states to the database is every 20 minutes and is realized by the CRON function of Linux.
- The table of specified parameters. This table contains the parameters to be respected by the system. When the operating mode changes (e.g. the humidity of the soil decreases below the tolerance limit), this table receives new states and these are the conditions of the desired operating mode. The second method of management is setting the parameters in advance for a specific time and date, which is most commonly used.
- The table of current parameters contains the current operating mode. This table is compared to the table of specified parameters each minute using the CRON function in Linux. In the case of no modification the operating mode stays unchanged. On the other hand, the system parameters are change, the pump is turned on or off, value of outside temperature or humidity changes, etc.

The system functioning algorithm consists of comparing the given parameters with the current operating mode. This comparison is made every minute.

If some other preconditions are met (the difference in water and air temperature is less than 10°C, the humidity of the soil is insufficient, etc.) Raspberry sends the signal to the relay, the relay closes the contact and the well pump is turned on.

The amount of water supplied is calculated based on the flow through the pump, the plant's need for water which depends on the current stage of the development of the plant and the type of soil. This is the most sensitive part of the entire project, and the amount of water is calculated for each day throughout the vegetative period of the plant, respecting the technology of tomato production. The biggest challenge was to estimate water evaporation during the sunny days in order not to produce excess moisture in the soil. The data collected and the corrections that have been made will be the basis for the next year's irrigation table.

The read data (Figure 4) is refreshed every 5 seconds and is used to control the functioning of the system.

```
pi@raspberrypi:~/Desktop/main
Prethodni status cirkulacione pumpe u bazi = 0
DHT22: Vlaznost vazduha = 65.10 %, a temperatura = 25.80 *C
DS18B20: Temperatura = 26.00 *C
Novi status cirkulacione pumpe = 0
Iskljucen
MySQL Tables in mysql database:
1  2018-06-19 16:38:27  25.7  25.79  65.09
Novi sadrzaj tabele "stanja"
1  2018-06-19 16:38:40  25.7  25.79  65.09
pi@raspberrypi:~/Desktop/
```

Figure 4: Irrigation status and current parameters

III. CONCLUSION

In its philosophy, IoT requires an interdisciplinary approach. This means that for the realization of the project it is necessary to bring together experts in different fields (in this case experts in vegetable farming, tomato production technology, hardware, sensors, databases, the Internet, etc.), because it is unrealistic to expect all of that from just one person. Many unsuccessful projects have been well thought-out, professionally realized, technically perfect, but useless in practice because they were done by IT specialists for non-IT purposes.

This paper presents a problem oriented approach in agriculture where the technology of tomato production in real conditions is respected. All production parameters are exceptionally good, from the yield, health and condition of the plant, to the quality of the fruit. The production and modification technology itself is not described in detail because it comes out of the IoT focus.

The proposed solution is inexpensive (Raspberry with the necessary components costs about $50), reliable and above all, flexible. It can also be used for all other plants, whereby it is necessary to adjust the table of plant's need for water, and it is a cheap alternative to automatic watering of the lawn. For managing the irrigation of dozens of plant species, one such system is sufficient (the system shown can manage 8 irrigation systems).

Further improvements of this solution are headed from linking rainfall gauges, automatic addition of fertilizers to irrigation (where it is necessary to do a chemical soil analysis and determine how many of the micro and macro elements should be added and in which stage of the plant development), but this will be the topic of some other paper.

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Business Intelligence in Power Distribution System

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Abstract - The power distribution companies have large amount of information about their consumers and other numerical information about consumers' consumption. Big part in manipulation, receiving, changing and using big amount of information in power distribution companies now has Business Intelligence system. Business Intelligence is group of software tools and methods which make possible using information from data warehouse. The main goal of Business Intelligence is to develop and support procedures for making business decisions. This text shows some aspects of use Business Intelligence in Power Distribution Information system.

I. INTRODUCTION

Making good business decisions is very important in monitoring and satisfying demanding market. In order to make the right business decisions, it is necessary to have knowledge about the company itself and about the environment in which the company operates. To gain knowledge, it is necessary to have appropriate information based on different sources. Gathering data and obtaining necessary information from these data have to be in a short time. It is necessary to pay attention to the quality of the data, because reliable data can be obtained on the basis of quality data, on the basis of which the correct business decisions can be made.

In order to get quality information from various data, we use data warehouse. Data Warehouse (DW) is used to collect the necessary data in order to obtain quality information and acquire the necessary business knowledge through which can be made right business decisions.

Distribution system is part of power system which distributes electrical power for local use. In order to improve the general business of the company, as well as to provide reliable and high quality consumers' supplies, it is necessary to have a modern, fully implemented integrated information system. The introduction of modern information technologies into everyday business practice enables significant improvement of performance permissions, as well as a reduction in the total cost of exploitation of the system.

This paper briefly explains an approach to design data warehouse and business intelligence system for power distribution company.

Since the enormous amount of data is stored in database of the billing system, it is very useful to make statistical comparison of some data. In the next chapter, it will be shown how we can compare some data statistically using data warehouse.

II. BUSINESS INTELLIGENCE AND DATA WAREHOUSE

The term "Business Intelligence (BI)" first used by Howard Dresner in 1988. Dresner defined Business Intelligence as the "concepts and methods to improve business decision making by using fact-based support systems." Business Intelligence (BI) can be defined as the process of turning data into information and then into knowledge. Knowledge is typically obtained about customer needs, customer decision making processes, the competition, conditions in the industry, and general economic, technological, and cultural trends [1]. Basic mission of business intelligence is the support and development of procedures of making business decisions. Making of business intelligence dictates establishment of coherent approach in management of information and development of unique attitude depending on their role and importance in the organization, company or institution [2].

Creating business intelligence requires establishment of a coherent approach to data management of a unique attitude towards their role and importance in an organization, enterprise or institution [3]. Buseness Intelligence consists of:

- ETL (Extracting Transformation Loading)
- Data Warehouse
- OLAP (On Line Analytic Processing)
- Data presenting to users

Data warehouse (DW) is a subject oriented, nonvolatile, integrated, time variant collection of data in support of management's decisions [4]. Data Warehouse is used to support systems of Business Intelligence. In early days of data warehousing the only way for creating interface between operational environment and data warehouse was writing programms. With technology evolution, appears ETL software that automaticaly create interfaces required for transforming data into data warehouse.

The Extract, Transform, Load (ETL) process involves fetching data from transactional systems, cleaning the data, transforming data into appropriate formats and loading the

result to a warehouse [5]. In the ETL process, data from data sources is extracted by extraction routines. Data are then propagated to the Data Staging area where they are transformed and cleaned before being loaded to the data warehouse [6]. ETL process includes:

- Extraction (allow user to choose relevant data from database that will be placed into Data Warehouse)
- Transforming (transforming data into suitable format for Data Warehouse) - It takes up 80% of the time of the whole process
- Loading (initial loading, incremental loading).

Data marts are small data warehouses that contain only a subset of the Data Warehouse. The data mart provides the platform for Online Analytical Processing (OLAP) analysis. Therefore, OLAP is a natural extension of the DW. The results from OLAP analysis can be presented visually, which enables improved comprehension [7].

Management in the power energy systems are coming across the need of mastering an ever growing quantity of information, as well as the need for answers and questions which for a transaction orientated relational data base (OLTP-On Line Transaction Processing) is not an easy task. The relational model is represented by a set of tables (relation). Tables represent object types, and columns represent object attributes. Rows represent the appearance of objects - connections. One or more table attributes uniquely identify one row of table and this attribute is called the primary key of relation. SQL (Structured Query Languague) is the standard database language. It defines the structure of the relational model (a set of tables and their attributes, keys, etc.), a set of attribute limit values and dynamic integrity rules. The simplicity of the relational model structure (a set of flat tables) and the simple language for manipulating them made the relational model the most popular implementation model of the database. Problems that appear in reporting for a relational transactional model are the following:

- It takes a lot of time to join tables
- Queries burden the transaction system
- Users are constantly looking for new reports with new data

Dimensional modeling is a logical design technique with the aim of presenting data in a form that ensures high performance of the system in order to perform data analysis. The dimensional model solves three problems listed above in the following way:

- It has measures and dimensions
- It has a separate database
- The user can create reports as he wants

The multidimensional model views data as consisting of facts linked to several dimensions. A fact represents a focus of analysis and typically includes attributes called measures. Measures are usually numeric values that allow quantitative evaluation of various aspects of an organization to be performed [8]. Multidimensional data analysis or On-line Analytical Processing (OLAP) offers a single subject-oriented source for analyzing summary data based on various dimensions [9]. Dimensions are standard business parameters that define each transaction. Each dimension table has its primary key, and all these primary keys participate in creating a primary key of the fact table. Such models are called star schemes. The fact tables contain information that is, usually, of a numeric type and can contain a large number of records.

Details of dimensional base can be imagined in a shape of a cube, (Fig.1). Many authors call dimensional base a cube. Technically speaking that is an n-cube as it can have more than three dimensions.

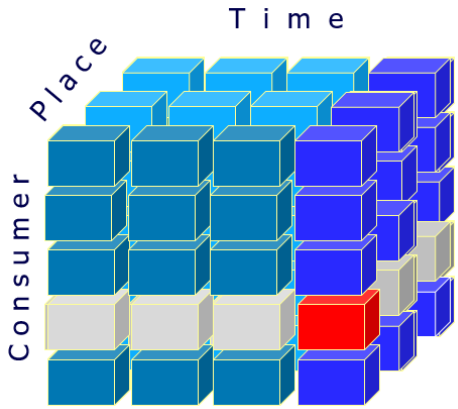

Figure 1. Cube in Business Intelligence

Data warehouses can be distinguished by the type of architecture. Bill Inmon [4], [10] proposed the CIF (Corporate Information Factory) as an integrated data warehouse, i.e. database in the third normal form (3NF), from which multidimensional data marts are to be derived. The second option is bus architecture, defined by Ralph Kimball [11], [12], where a data warehouse is just a collection of data marts with conformant dimensions. Data Warehousing 2.0 (DW 2.0) is a second-generation attempt to define a standard Data Warehouse architecture. One of the advantages introduced in DW 2.0 is its ability to support changes of data over time [10].

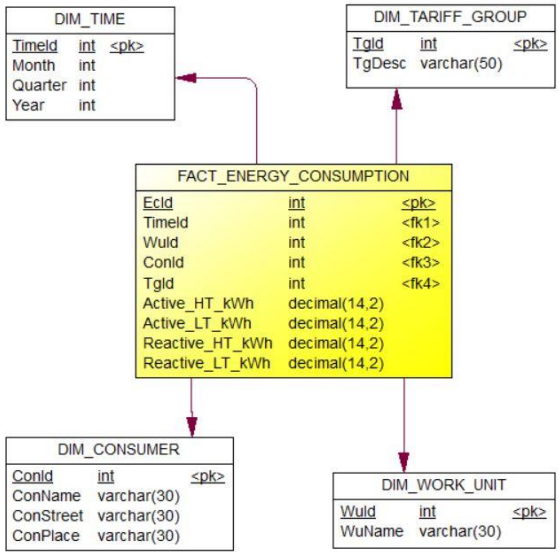

Figure 2. Example of Star schema in Power Distribution System

The figure 2. shows the part of a dimensional database defined with one table of facts and several dimension tables that can be used in realisation of Business Intelligence in Power Distribution System. Dimension tables are: Consumer, Tariff group, Work unit and Time. The fact table is Energy consumption. The fact table consists of numerical data about energy consumption. The other group of attributs in fact table are foreign keys that are used to join fact table with dimension tables.

The figure shows star schema that consists of one fact table and several domension tables. Dimension tables are not joined with some others dimension tables. Sometimes, it can be useful to separate one dimesion in several relations. It is the case of snowflake schema. OLAP performs multidimensional analysis of business data and provides the capability for complex calculations.

III. An Approach to Data Mart Design in Power Distribution System

A. *Business Intelligence Technology*

For the realization of the system, we selected Microsoft technology in accordance with the Gartner Magic Quadrant (Figure 3).

Figure 3. Gartner Magic Quadrant for Analytics and Business Intelligence Platform (source: Gartner, February 2018)

Microsoft continue to lead business intelligence and analytics vendors in delivering easy-to-use tools that support a full range of analytic workflow capabilities. For 11 consecutive years, Microsoft is positioned in the Leaders quadrant in the Gartner Magic Quadrant for Analytics and Business Intelligence Platforms 2018 edition [13].

B. *Architecture of System*

This chapter shows practical realisation of data warehouse. For system realisation we have chosen Data Mart BUS arhitecture represented by Ralph Kimball.

TABLE I. Matrix of BUS Architecture

	Dimensions				
Business process	Tariff group	Work unit	Consumer	Supplier	Quarter
Distribution	X	X	X		X
Supply		X		X	X
Maintenance		X			X
Finance	X	X	X	X	X

Overview of the general Data Warehouse structure is realised through matrix of BUS architecture (TABLE I) that displays Data Marts (or business processes) in rows and conformed dimesions in columns. According to Kimball, dimension is compatibile if it has unique attribute names, consistent keys and if the attributs have the same values. Compatibile dimensions should be defined in the company and it can appears as dimesional table in several data marts.

The next Figure shows the Data Warehouse atchitecture. Data Warehouse architecture means definitions of the main Data Warehouse elements and describes how these elements are built and connected.

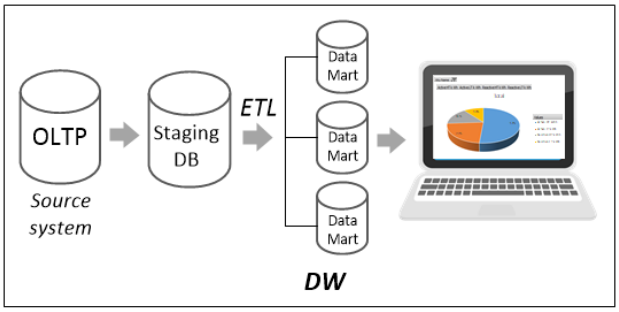

Figure 4. Data Warehouse Architecture

The main elements of the Data Warehouse are:

- In this case, data source consists of internal data that are generated from transactional system based on Oracle 11g DBMS.
- Staging database based on Microsoft SQL Server 2016 DBMS that is created during data transformation. Staging databases are commonly used when we have large amount of data.
- ETL/ELT process involves retrieving data of transactional systems, transforming data into an appropriate format and loading data into Data Warehouse
- Data Warehouse, which is based on MSSQL Server 2016 DBMS in this case, implies data storage with integrated data of the company.
- Data Mart is a way of data storage that contains summarized data of some organizational units or of a particular group of buseness processes.
- Data Access Tools. They allow users to have different views on data. In this case, we use Microsoft Excel 2016.

Data Mart is realised according to physical model on Figure 2 with dimension tables and a measure table. After creating staging database and data warehouse and after generating tables for data mart, it started integration, extraction, transformation and data loading from, in this case, transactional database based on Oracle 11g DBMS. Data Integration has been done by Microsoft SQL Server Integration Service (SSIS) as part of SQL Server Data Tools 2015 environment. The next activity is building a cube with Microsoft SQL Server Analysis Services (SSAS) whict is also part of the SQL Server Data Tools 2015 environment.

Integration Services is a set of graphical tools and programmable objects for moving, copying, and transforming data. It also includes the Data Quality Services (DQS) component for Integration Services. Analysis Services includes the tools for creating and managing online analytical processing (OLAP) and data mining applications [14].

For the users, it is acceptable to use some of the tools for analysing OLAP cube for reading data from created cube. The following example shows a report in Microsoft Office Excel 2016. Microsoft Excel is an application that most users already use in everyday work. Excel 2016 features related to SQL Server Analysys Service, are perfected at the highest level, which makes data collection and analysis simplier and with more options. A set of all listed features makes Excel the most desirable access tool in use of analytical models and data.

C. Example of the Business Intelligence Analysis

In this section is described an example of analysis of the trend of electricity consumption in a given work unit.

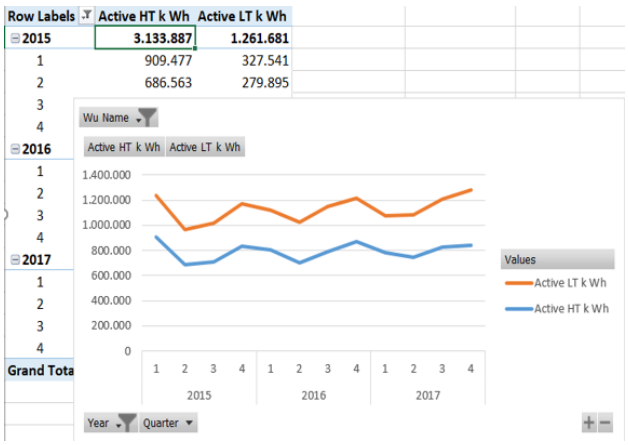

Figure 5. Example of trend analysis of energy consumption

The particular benefit of using OLAP tool is to provide trend analysis that provides predicting business events using business results in a given period. After obtaining the results of electricity consumption for the current period and in order to predict consumption for the next period, we started analysing electricity consumption. To obtain this report, the next dimensions were needed: year and quarter, active electricity of higher tariffs (HT) and lower tariffs (LT), filtered by a specific work unit.

The results of the trend analysis are displayed on the Figure 5. Trend line has a direction of growth, so management can predict the growth of electricity consumption in the certain quarters of the business year for a apecific business unit and plan the appriopriate system loading. In addition to the chart, it is also possible to display real number quantitative indicators.

IV. CONCLUSION

Business Intelligence is an area in expansion. Business Intelligence realisation on Power Distribution System provides easy and simply access of data and their statistical processing. This is very important for people using the software and for their clients, too.

Power Distribution System has enormous amount of data. It is very important to collect, organize and present that data on the proper way in order to improve and facilitate the company's business. Business Intelligence is the key step in that process.

By implementing Business Intelligence system, the management of the power distribution company has got a powerful tool for launching various business analysis and the posibility to create various business reports in order to make faster and better business decisions.

Key words: Data warehouse, Business intelligence, Business decisions, Power Distribution System

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Analysis of Accessibility of the e-Learning Platforms According to the WCAG 2.0 Standard Compliance

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Abstract - Access to information and communication for people with disabilities through modern technology is an important requirement for their social inclusion in the institutions of every country, European Union and other international organizations. Learning management systems (LMSs) have to be accessible in order to enable people with disabilities to take part in the educational and learning processes. Although the accessibility of the learning management systems is improving, they still possess significant challenges for users with disabilities. This paper analyzes the accessibility of the latest public version of the respective LMSs such as Moodle, Eliademy, Docebo, Sakai and ATutor for people with disabilities. The considered criteria are with different levels of compliance in accordance with the Web Content Accessibility Guidelines (WCAG) 2.0. The goal of this analysis is not to rate or rank these LMSs for accessibility, but to highlight some points about how the presence or absence of certain key usability/accessibility features can significantly impact users' experience. The analysis covered the following types of impairments: visual, hearing and motor impairments. Recommendations derived from the practical use of these systems will be used to support decision-making in the project activities of CROSS4ALL IPA2 for selecting a suitable e-learning platform to increase the digital literacy for e-health of the population of the border area for whom this project is intended.

I. INTRODUCTION

Many EU activities in the last decade have been associated to improve the living conditions of the EU population in general, with an emphasis on the older population, young children and people with disabilities. The trend of aging of the population in Europe and the application of the principles of "equal treatment for all people" regardless of the problems they live in, on which location and in which country, showed that not everywhere the living conditions of the entire population, and especially the vulnerable categories as older people, children and people with disabilities are equal. When it comes to these vulnerable groups, in some countries the standards set are satisfied, while in others are still not. In order to improve the living conditions of these vulnerable categories of citizens, the EU, in large percentage, directs its project activities towards these vulnerable groups, i.e. funds projects aimed at raising people's knowledge about the needs and opportunities of vulnerable categories of people, improving health and social services, and applying IT technologies to lighten the lives of older people, children and the disadvantaged population. In this context, one of the conditions to take advantage of the opportunities offered by IT is remote (distance) learning, which has long been a world trend, but now, by applying standards for learning systems that provide accessibility for all citizens, regardless of whether they are older people, children or citizens with a disability. The requirements of the project activities of EU projects are focused towards creation of affordable e-learning systems that are made according to the WCAG 2.0 and W3C standards which provide "accessibility of the website or the system for all". Particularly important is their application in the improvement of health and social services to a broad population that can significantly contribute to raise digital e-health literacy.

Due to the importance of the concept, this article is devoted to the analysis of several reputable e-learning systems in terms of their accessibility and convenience for use by vulnerable groups. Because typically e-learning systems are put on the web, the W3C's Web Accessibility principles are applied. Accessibility is defined by the ISO 9241-171:2008 standard and according this standard it can be said that an online educational environment is accessible, when everyone, despite its personal characteristics and environment type is capable to access the information provided via the learning objects [1]. Consideration has been given to the four principles i.e. Perceivable, Operable, Understandable and Robust that should provide the basics of web accessibility with 12 guidelines for the authors [1]. For each guideline, criteria for success for testing according to WCAG 2.0 are defined. In order to meet the needs of different groups and different situations, three levels of compliance are defined: A (lowest), AA and AAA (highest) [2]. Successful and advisory techniques that create the level of accessibility are given. According to the mentioned principles, the special guidelines have been developed by the W3C community to help developers and web content creators to create content on the web that will comply with the WCAG 2.0 standards.

European Unified Approach for Accessible Lifelong Learning (EU4ALL) by proposing the concept of accessible lifelong learning, endeavors the elimination of obstacles to the interlinked worlds of education by using suitable technologies [3].

This paper takes into consideration the five e-learning platforms that are most used by the community according to Gartner, which does not mean that they are the best for all e-learning areas. The aim is to analyze the accessibility of LMSs for people with disabilities considering the criteria with different levels of compliance in accordance with the Web Content Accessibility Guidelines (WCAG) 2.0. Given the limited space that we have and the extensive material intended for this research, only the final results of the research are given, without detailing the synthesized data. The explanations for each data in the table are not included in the paper and it is planned to be published later.

The paper is structured as follows. After the introduction, considerations related to the topic, the opinions of other authors and their experiences so far have been taken into consideration. The focus is also on exploring e-learning platforms intended for e-health considering our project focus. The next section is devoted to explaining the applied methodology and the principles underlying the analysis. The analysis of the platforms according to WCAG 2.0 principles and access levels follows. It is planned that the recommendations given in this paper will be used to support decision-making in the project activities of CROSS4ALL IPA2 for selecting an e-learning platform to increase the digital literacy for e-health of the population of the cross border area for which the project is intended. Last section provides concluding remarks and directions for further work.

II. Related Works

Many authors consider LMSs and their accessibility from different points of view. When the accessibility in context of e-learning is considered, many authors highlighted that there is a need to define criteria for instructors, authors of the contents and e-learning specialist that create and run activities on the web. When somebody talks for inclusion and accessibility, it is necessary to have some generally accepted definition that will be uniquely defined and will clarify which are those common visual, verbal and kinetic dysfunctions that affect the style of learning and according to which it is necessary to design content accessible to everyone [4]. According to Oxford dictionary, accessibility and inclusion are defined as "typical physical and mental conditions that limit the movement, sensitivity or personality activities". In this context, the authors argue that for blind people or people with visual impairments [5], a text or audio alternative for graphics can be provided by text-to-speech technology or Screen reader technologies that are achieved by applying software like JAWS [6], Windows Eyes [7], NDVA [8], and Voice over Mac [9], ORCA (Linux) [10] and Android Trackback [11]. Certainly, keyboard accessibility should be considered instead of using the mouse and multimedia contents. Audio description is of significant importance in multimedia content. For people with reduced visual capability, this means an opportunity to increase the screen or to use a Browser with Zoom features. For individuals with hearing disabilities, titles, transcripts, graphics matching, and visual presentations should be defined.

People with significant motor impairment generally face barriers related to the using of a mouse or aspects of a keyboard to access web content. This group will often rely on various keyboard technologies to access web content, including a “large key” keyboard, an onscreen keyboard, or a scanning keyboard that is operated with a single switch or head mouse [4].

Other aspects of disability consider some cognitive impairments and learning disabilities [12]. There is a reference to material consistency, predictability, complexity, and memory, that the ability to understand and match the materials is of particular importance [4].

It is also important that the material itself has to be adapted to the personality and provide a framework for problem solving. The users have to have the ability to remember and recognize, but also dedicate the task that has to be solved. They conclude that in order to achieve all this, it is necessary the material to be written in a simple language, without sarcasm, idioms, metaphors, and other risky forms that lead to ambiguity. Therefore, all these learning systems should follow the standards and specifications of WCAG 2.0 [12], [4], ATAG 2.0 [13], ARIA 1.0 [14] and be accessible to all (APIP) [15]. The AChecker Web Accessibility Checker [16] evaluates the accessibility of e-learning and other web content. It provides a list of known, likely and potential accessibility issues, as well as detailed description of potential strategies to improve issues.

In [12] authors take into consideration holistic model of e-learning accessibility which considers learners’ needs. There are also efforts to specify some e-learning critical success factors (CSFs) as perceived by university students [17]. CSFs were grouped into 4 categories including several measures.

Acosta and Lujan-Mora in [18] had made a comparative study of three Learning Management Systems (LMSs), Moodle, Sakai and system named ABC, developed in Ecuador in order to evaluate the levels of accessibility according to the needs of users. They analyzed and compared the selected LMSs according to accessibility criteria, considering functional tasks in scale with 6 levels of accessibilities which can be used for decision making and selection of LMS from the teachers’ and students’ aspects.

Aldheleai et al. considered the concept of cloud computing as a new inspiration for creative learning environment which provides a high level of accessibility, solving the problems with hardware and software [19]. They reviewed the usability of cloud technology for third world countries like Yemen, trying to give brief introduction to cloud computing and cloud-based LMSs and summarize the main advantages and drawbacks of using them for online learning. They compare services offered in each layer and concept of the cloud computing with traditional IT, taking into consideration some well-known cloud e-learning platforms, regarding the benefits of using cloud based LMSs, risks and disadvantages. They conclude that

these platforms save a lot of efforts of organizations as well as learners and enable people living in underdeveloped countries to come over all LMS obstacles as soon as they get internet connections [19]. According to [20] the cloud concept implies opportunities for the inclusion of new technologies as Internet of Things (IoT) and Ambient Assisted Living and increasingly changes the manner of living today, especially when some vulnerable groups are taken into consideration. This is especially important when some e-leaning systems for these vulnerable groups (as elderly people, children, and people with disabilities) have to be created [20].

Półjanowicz et al. in [21] had made analysis of e-learning platform at the Faculty of Health Sciences, Medical University of Bialystok on 90 students and they found that some students who have achieved a poor result due to blindness or inability to attend to the classes, have achieved significant success with this platform because they have freedom for the timing of learning, learning time, increased opportunities for improvement and enrichment of syllabuses and additional materials for learning with which students show an enviable result in e-exams. The effects of applying this system are highly appreciated by students and professors [21].

Komenda et al. described OPTIMED Platform suitable for e-learning systems for effective harmonization of medical and healthcare curriculum [22], allowing access to necessary meta information for the courses as well as all learning courses for the students. In this case, extreme programming for creating OPTIMED Platform is used for conceptual data model and the fundamental attribute in all phases. The platform is suitable for higher education institutions and aims to improve the medical and healthcare courses and remove duplicate contents. They state that the accessibility is in very high level regarding the students' ability and accessibility [22].

However, in order to detect the crucial accessibility problems in the current LMSs, a combination of accessibility expert and end-user evaluation is exceptionally beneficent [23].

III. Methodology used for Analysis of E-Learning Platforms through WCAG 2.0

The accessibility testing and evaluation using an analytical method was performed on the latest public version of the respective Learning management systems (LMSs) such as Moodle [24], Eliademy [25], Docebo [26], Sakai [27] and ATutor [28]. Accessibility testing was performed using same criteria for the mentioned LMSs. The goal of this evaluation is not to rate or rank these LMSs for accessibility but to educate the public about how the presence or absence of certain key usability/accessibility features can significantly impact users' experience. The analysis covered the following types of impairments: visual, hearing and motor impairments.

Table I shows the features and tests relating to some of the common assistive technologies (ATs). For the purpose of Screen reader criterion, the software Thunder [29] is installed and features like Screen Reader accessible player, Listing headings of a page, Accessing bypass links which people with visual disabilities can use are tested for the given platforms. With the second feature Keyboard accessibility it was examined whether the user can navigate only by using the keyboard, for example, via shortcuts or pressing tab button. The third feature Audio description examines whether the user can add an audio file as an alternative to the video. Using the browser's zoom feature it is verified that all content and not only parts of it can be resized and the feature Screen magnification is established.

People with hearing impairments experience fewer barriers in accessing web content than people with vision impairments. Using feature Captions (transcript) it is examined whether the platform offers a way to add captions/transcript (either to upload file with captions or to enter captions manually).

People with significant motor impairment generally face barriers associated with using a mouse or aspects of a keyboard to access web content. Windows Speech Recognition is used to navigate and use the platform (access various menus, links, scroll down/up, add assignments, access calendar and edit events etc.).

The established criteria from Level A (must haves) and Level AA (should haves) that affect the functional availability of the five learning management systems are in accordance with Web Content Accessibility Guidelines (WCAG) 2.0 through the World Wide Web Consortium (W3C) and they are shown in Table II and Table III, respectively.

Table IV provides an analysis of criteria with varying degrees of compliance in order to gain a better understanding of the accessibility of each listed platform.

IV. Analysis of selected E-Learning Platforms according to WCAG 2.0 Compliance

The analysis was performed on the latest public version of the respective Learning management systems (LMSs) such as Moodle, Eliademy, Docebo, Sakai and ATutor, considering the WCAG 2.0 standards and criteria.

Moodle is one of the most popular open source LMS options available today. It features dashboards, learner tracking, and multimedia support. This open source Learning Management System also gives the ability to create mobile-friendly online courses integrating third-party add-ons. One of the standouts of this tool is the user community.

Eliademy is completely free for educators and eLearning facilitators. It features eLearning course catalogs, eLearning assessment tools, and even a mobile Android application for educators who wish to develop mobile learning modules for their on-the-go audiences.

Docebo is a cloud-based LMS solution to provide training programs for employees, partners and customers. Docebo's various features and applications can be enabled or disabled based on the company's

needs. Users can deliver content, manage training, track certifications and reward learners through the platform. It provides unlimited storage, courses, bandwidth and admins. The system can be integrated with third-party applications as well.

Sakai is a free open source LMS that gives community members it serves the license to change and tweak its structure to better suit their needs. The program boasts of extreme flexibility and wide variety of features, making it the top LMSs of choice by a number of the world's leading colleges and universities as well as nonprofit organizations that promote education. Sakai continues to improve as members of its community strive to create the perfect learning experience for anyone and make Sakai the ultimate learning management system capable of supporting various teaching methodologies.

ATutor as an open source LMS boasts a variety of useful features, ranging from e-mail notifications to file storage. One of the most notable highlights of ATutor is that it is user-friendly and easily accessible, which makes it an ideal match for those who may be new to the world of e-learning design and development. It also offers a wide variety of themes to speed up the e-learning course development process, as well as e-learning assessment tools, file backups, analytics and poll integration.

The analysed features related to assistive technologies are given in Table I, while Table II, III and IV show the criteria according to the WCAG 2.0 standard.

TABLE I. ANALYZED FEATURES RELATED TO ASSISTIVE TECHNOLOGIES

	Moodle	**Eliademy**	**Docebo**	**Sakai**	**ATutor**
Visual Impairment					
Screen reader	Yes[i]	Yes	Yes	Yes	Yes
Keyboard accessibility	Yes	Yes	Yes	Yes	Yes
Audio description	Yes	Yes	No	Yes	Yes
Screen magnification	Yes	Yes	Yes	Yes	Yes
Hearing Impairment					
Captions (transcript)	Yes	No	Yes	No	Yes
Motor Impairments					
Speech recognition	Yes	Yes	Yes	Yes	Yes

TABLE II. CRITERIA FOR LEVEL A OF COMPLIANCE (MUST HAVES)

	Moodle	**Eliademy**	**Docebo**	**Sakai**	**ATutor**
Add text alternatives for images, video, audio	Yes	Yes	Yes	Yes	Yes
Create document structure through headings, lists, and table headers.	Yes	Yes	Yes	Yes	Yes
Generate valid HTML markup	Yes	Yes	Yes	Yes	Yes
Help authors avoid and correct mistakes and Document the user interface, including all accessibility features (Undo/Redo, Save/Cancel, Restore default, Leave Page/Stay on Page, Auto-Save Option)	Yes	Yes	Partial[ii]	Yes	Yes

TABLE III. CRITERIA FOR LEVEL AA OF COMPLIANCE (SHOULD HAVES)

	Moodle	**Eliademy**	**Docebo**	**Sakai**	**ATutor**
Provides adequate documentation on accessibility features	Yes	No	No	Yes	Yes
Makes the most accessible authoring options the default	Yes	No	No	Partial	Yes
Prompts content authors for accessibility information when it has not been provided	Yes	No	No	No	Yes
Offers accessibility checking and repair functions	Yes	No	No	Yes	Yes

[i] also provides Screen reader helper

[ii] does not preserve the existing content that has been edited and does not provide Auto-Save Option if the user made mistake and left the page

TABLE IV. ADDITIONAL CRITERIA FOR ACCESSIBILITY

	Moodle	Eliademy	Docebo	Sakai	ATutor
Keyboard Access	Yes	Yes	Yes	Yes	Yes
Skip to main content link	Yes	No	No	Yes	Yes
Within-Page Navigation					
HTML Heading Markup	Yes	Yes	Yes	Yes	Yes
ARIA landmarks	Yes	No	No	Yes	Yes
Logical Tab Order	Yes	Yes	Partial	Yes	Yes
Visible Focus	Partial	Partial	Partial	Yes	Yes
Labelled Forms with Instructions					
Use of HTML Label element	Yes	No	Yes	Yes	Yes
Use of title attribute	No	No	No	No	Yes
Accessible (ARIA-enabled) feedback	Yes	Yes	No	No	No
Personal Preferences					
Font types and sizes	No	No	No	No	Yes
Font color and background color	No	No	Yes	No	Yes
Navigation elements (breadcrumbs, links, table of content)	No	No	Yes	No	Yes
Topic numbering to organize content numerically	No	No	No	No	No
Choice of themes	Yes	No	Yes	No	Yes[iii]
Preferred content Type	No	No	No	No	Yes
Accessible Authoring					
Visual editor is keyboard accessible[iv]	Partial	Partial	Partial	Partial	Partial
Alert for no text alternative for an image	Yes	No	No	No	Yes
Math equations	TeX	TeX	No	No	LaTeX
The cursor get trapped inside the editor	No	Yes	No	No	No
Accessibility check is provided by editor tool	Yes	No	No	Yes	Yes
Timing					
Session timeout alert and extension option	No	No	No	Yes	Yes

Table I shows that Moodle and ATutor support all analyzed features related to assistive technologies (ATs). The other LMSs lack support for only one feature i.e Eliademy and Sakai Captions (transcript), while Docebo - audio description. The advantage of Moodle in terms of ATs is that is supports Screen reader helper, found in the visual editor.

To evaluate LMSs' ability to create accessible e-learning content it is necessary for the system to satisfy the criteria according to WCAG 2.0 standards. Some criteria required for Level A are given in Table II. In this context all LMSs except Docebo meet the analyzed criteria. The only criterion which it does not fully satisfy is Help authors avoid and correct mistakes and Document the user interface. We evaluated this criterion as Partial because Docebo does not preserve the existing content that has been edited and does not provide Auto-Save Option if the user made mistake and left the page.

Table III gives an overview of some criteria recommended to meet Level AA of compliance. In terms of these criteria, there are significant differences. Moodle and ATutor fulfill the established criteria, while Eliademy and Docebo do not. For Sakai the criteria Makes the most accessible authoring option the default and Prompts content authors for accessibility information when it has not been provided are evaluated as Partial and No respectively because no math equations and no alert for lack of alternative for an image are provided.

We want to emphasize some criteria that have a significant impact on e-learning for people with disabilities as shown in Table IV. Criteria Skip to main content link (which becomes visible after pressing tab button), ARIA landmarks and Accessibility check is provided by editor tool are fulfilled by three of the analyzed systems i.e. Moodle, Sakai and ATutor. The only criteria that are satisfied by all systems are Keyboard Access and HTML Heading Markup. In terms of LMS Accessibility, ATutor has vital advantages, as it is the only analyzed system that satisfies the criteria Use of title attribute and Preferred content type. The last mentioned criterion is crucial because it enables people with different disabilities to choose alternative for textual, visual and audio content, suitable to users' needs. The criterion Visible Focus is fully satisfied only by Sakai and ATutor, while in the other three systems it is evaluated as Partial. It needs some improvement in order to make it easily visible for people with low vision. Only two of the analyzed systems (Docebo and ATutor) provide users with the option to choose desired colors and satisfy the criterion Font color and background color.

V. CONCLUDING REMARKS

Each of analyzed LMSs presents a different learning platform with unique features. Although the

[iii] themes need to be downloaded

[iv] partial means that the visual editor supports shortcuts, but not tab navigation

accessibility of learning management systems is improving there are still significant challenges for people with disabilities. For people experiencing disability, some aspects of the LMS may present difficulties. Each LMS has core features that cannot be modified and variable features which can be adapted for the specific accessibility requirements of people with disabilities. According to the CROSS4ALL requirements, the criteria from WCAG 2.0 Level AA compliance need to be satisfied.

These analyses are made in real environment, on public accessible e-learning systems, evaluating the criteria needed for the standard as well as necessary features. Perceptions from the practical use of the LMSs given in this paper will be used to support decision-making in the project activities of CROSS4ALL IPA2 for choosing an appropriate e-learning system to increase the digital literacy for e-health of the population of the cross border area for which the project is intended.

The final purpose is to provide website with e-leaning system that will increase e-health and medical digital literacy for the cross border region, including all partners' contribution for cross border population with special focus on the elderly people, people with disabilities and children.

Our further testing will continue with evaluation of the criteria of Level AAA for Moodle and ATutor, as these two systems are particularly prominent in terms of availability for people with disabilities.

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Web-based assessment tool for Teachers Digital Competency

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Abstract - Even though there are several different frameworks and standards for proving the digital competencies expected from teachers, there is a need for a Web-based assessment tools that allow real, dependable and valid assessment of these competencies. This paper addresses the design challenges related to a software solution for self- and peer-assessment of teachers' digital competencies. In this system the competencies are assessed by a teacher his/her-self or by her/his peers using the performance indicators that are based on the competency model for Teachers.

Keywords: *Teachers digital competencies, Web-based assessment tool*

I. INTRODUCTION

We are part of the digital age, where the majority of artifacts produced by us at the workplace and at home are digital and accessible over the Internet. Desktop computers are not anymore the leading hardware devices for accessing the Internet as our mobile phones, TV sets, office and home appliances turn digital and get online. Schools have to handle the situation where children are in many ways more capable of handling these new digital tools than teachers.

Numerous international initiatives are aiming at developing more relevant digital competency frameworks for teachers. In this study, we define competency as an integrated set of personal characteristics (e.g. skills, knowledge, attitudes, social capital, experiences) that an individual possesses or needs to develop in order to perform an activity within a specific work-related context. Teachers' digital capabilities are hereby used as a synonym for educational technology competencies: these are the competencies that are expected from teachers in the digital age, in order to facilitate efficient and creative learning of their students, but also to coordinate their own sustainable professional development in the context where the pace of technological innovation is only increasing. While many teachers have been part of the professional development courses on using educational technology, there is little consciousness of educational technology competencies. In order to plan teachers' professional development and training needs, it is necessary to measure their level of educational technology competencies [2]. One option to assess the educational technology competencies is to use a Web-based assessment tool. On the other hand, ETCM contains complex performance indicators that cannot be assessed using simple mechanical tests. Other evaluation methods such as self- or peer assessment are needed to assess these competencies. This paper addresses the following research problem: to what extent could be teachers' educational technology competencies assessed using a Web-based tool. Based on the proposed assessment method we discuss the design and development of a Web-based assessment tool [3].

II. DIGITAL COMPETENCY FOR TEACHERS

There are a number of initiatives and approaches aiming at developing standards, which can act as a basis for measuring teachers' educational technology competencies [4]. In this section, we will shortly discuss them.

- One of the most general digital competency standards, the International Computer Driving License (ICDL) started as a European initiative but has currently extended to 148 countries. ICDL certifies that the owner has knowledge of basic concepts of Information Technology (IT), technically it should be accepted in any field or occupation. Modules like the concept of ICT, using personal computer and managing files, word processing, spreadsheets, databases, presentations, and communication have to be accomplished in order to achieve the basic level of digital literacy, but the ICDL framework is neglecting dimensions, which are pedagogically important and is leaving out important background information [5].

- UNESCO ICT Competency Framework for Teachers (ICT-CFT) aims at improving teachers' practice of using ICT in professional activities by providing a set of guidelines for creating national-level competency models. The framework addresses six sub-domains of the teachers' work: policy and vision, curriculum and assessment, pedagogy, ICT, organization and administration, and teacher professional development [6].

- National Educational Technology Standards for Teachers (NETS-T) is a competency model developed in 2008 by the International Society for Technology in Education (ISTE). ISTE NETS-T aims to make teachers act as role models for students with regard to digital age knowledge work skills. The main advantage of ISTE NETS-T is to maintain for standards-based performance assessment in the same way for teachers, school administrators, and students. ISTE NETS-T acknowledges the importance of developing and accessing competencies in the valid context of teachers' work [7].

Each of the above-mentioned competency frameworks have their benefits in a specific framework. ICDL provides globally acknowledged and easy-to-implement generic ICT skill tests for professionals in a variety of fields, whereas UNESCO and ISTE have more contextualized, competency- and performance-based approach. Our model aims at in-service teachers' competency development in the World Wide Web primary, secondary, professional and higher education level. The model consists of five core capabilities:

1.Comfort and inspire student learning and creativity

2.Design and develop digital-age learning experiences and assessments

3.Model digital age work and learning

4.Support and model digital-age social responsibility

5.Engage in professional growth and leadership

III. MEASURING DIGITAL COMPETENCIES

Measuring digital competencies is a difficult task, which is seen in some attempts to develop frameworks and models. Evaluation methodology and instruments must be reliable, valid, flexible, but also affordable with respect to time and costs. The methodology together with the assessment instrument must make sure that assessment decisions involve the evaluation of adequate evidence to judge the level of competency of the teacher. The methodology must express similar outcomes for teachers with equal competency at different times or places. Validity, on the other hand, focuses on whether an assessment methodology and its instrument actually succeed in evaluating the competencies that it is designed to evaluate. Validity refers to the degree to which the explanation and use of an assessment outcome can be supported by confirmation [8]. In order to assess whether a teacher is competent, the judgement is made alongside competency standards developed by a group of experts. A competency standard is comprised of individual units of competency that include the essential information needed to assess a teacher. However, there is a question of what sort of evidence needs to be collected in order to assess and make judgments on the benchmark level a teacher meets.
For example, Miller has developed a pyramid of clinical competencies, which is a simple theoretical model exactness the issues involved when analyzing validity [9].

The pyramid consists of four levels:
1.knows—basic facts about the World Wide Web
2.knows how—applied knowledge
3.shows how—performance assessment in vitro
4.does—performance assessment in vivo

This kind of conceptual model also has a potential in the context of teacher education and their educational technology competencies. Taking the model as a basis and looking at the ways of how educational technology competencies have been assessed, the literature overview shows that the majority of assessment models and tests focus on the first basic level— assessing a pure technological knowledge and skills with basic computer-based multiple-choice tests. Developing such tests is rather time-consuming, but they guarantee high reliability because of a large number of items that can be easily tested and marked. The main drawback of these tests is seen in their de-contextualization, lack of authenticity in tasks and assessment of the most trivial parts of knowledge. For assessing educational technology competency advancement such an approach has some limitations and has led to an increasing focus on more sophisticated assessment methods such as testing "knows how"—i.e., the assessment of knowledge as applied to problem-solving or educational technology reasoning and decision-making in specific contexts. Thus, the test items must be problem-based and situated in authentic context. Level 3, "shows how" in Miller's pyramid, can be assessed by practical examinations, observed long or short cases. The only way to assess level 4, "does", is to observe the person at work in the real world. As the levels 3 and 4 are difficult to perform in an online environment, our focus is on level 2: "knows how". Difficulties in setting up " know how" tests involve combining the application of knowledge with the large range of problems. Digital competencies cannot be divided from the practical contexts in which they are acquired and applied.
We acknowledged 5 levels of performance for each competency in ETCM and created an assessment rubric, which provides "knows how" performance criteria for each level. The main difference in comparison to the previous competency models is the emphasis of our assessment rubric on facilitating and supporting learners to use technology for developing their creativity, personal learning environment, learning habits and skills, but also in contextualizing the performance indicators in real-life situations, digital-age teachers are facing today. We also try to create a set of problem-based cases anchored in authentic settings of teachers' work and related self-test questions that allow automatic feedback from the E-digi tool. The subsequent design challenge for this project is to define methodologically sound self- and peer assessment test items for each performance indicator, that enable the measurement of each competency using a valid and consistent method [10].

IV. METHODOLOGY

The design challenge is to enable teachers to evaluate their educational technology competencies. The following phase of a research-based design process is participatory design, involving potential users of the system in design sessions. In order to communicate the design ideas with, we need simple and non-technical communication tools [11]. At first we remodeled the system architecture with UML Component Diagrams.
The main concepts of our system are Competency Test, where registered teachers or members take the competency test, which can be taken several times to measure the advancement. There would be large number of tasks (20 competencies, 5 levels). It can be saved and continued later

and the test starts with self-evaluation. The test has 3 types of tasks: automatically self-test items, peer assessment tasks and self-reflection tasks. Peer assessment requires blind review from a user in the same or higher level. After the test is taken a Competency profile is established where the level of competencies is displayed as a diagram, users can compare their average with the average level of various groups. After the competency profile is created, groups can be formed based on teacher's location and level of competency. Anybody can create their own groups and they can be public or private. Competency requirements are created by groups owners and teacher trainer, so that the classification of members is done more easily.

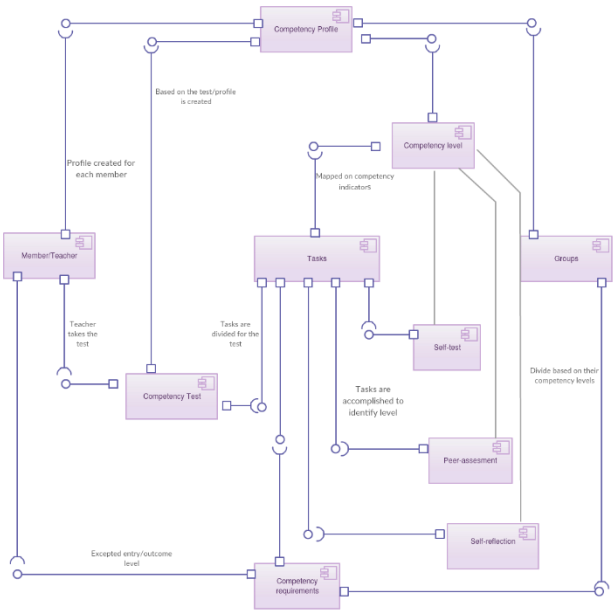

Figure 1. UML Component Diagram

Afterwards we used the scenario-based design where typical use cases are described as simple stories of people and their activities. These stories can be used in a participatory design session to evoke ideas and discussion. We prepared four main scenarios that directly addressed the above-mentioned design challenges [12].

A. Competency test

The central feature of the system is a competency test that is taken by the users. One of the usability issues with competency test is a large number of tasks. There are 20 competencies in 5 groups. Each competency is assessed on a 5-point scale. We have taken several steps to solve this issue. Before starting the competency test users can pre-evaluate their competency level in 5 competency groups. When taking the test, they will receive tasks at the specified competency level. Also, it is possible to save the test and continue answering later. Competency test can be taken several times to measure the advancement in educational technology competencies. All results can be compared with the earlier results.

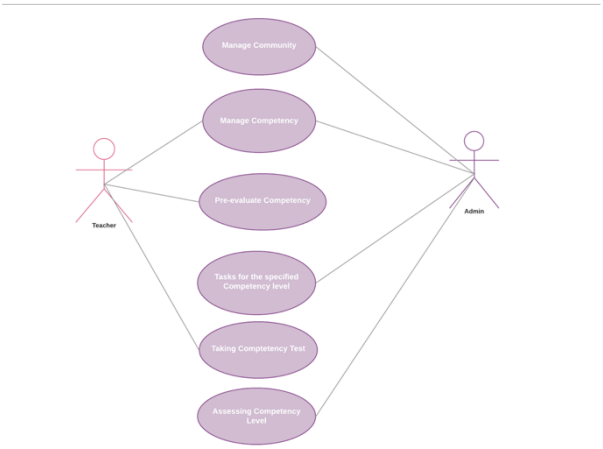

Figure 2. Competency Test Use Case Scenario

B. Tasks

The competency test contains tasks that are mapped to performance indicators. These performance indicators are specified with the assessment rubric. The tasks are divided into three types according to the assessment method: (1) automatically assessed self-test items, (2) peer- assessment tasks and (3) self-reflection tasks. Whenever possible, we tried to compose a self- test item for each competency, but often it would have compromised the authenticity of the tasks, so we had to create either peer-assessment or self-reflection task instead. An example of a self-test task could be a multiple-response item based on a screencast that shows how a teacher is publishing a learning object into a repository while making several small mistakes in the process. An example of a peer-assessment task expects the teacher to adopt a given study guide to her own working context (age range, subject area, software). An adapted study guide will be submitted for qualitative peer-assessment procedure by another teacher. An example of a self-reflection task expects the teacher to reflect on the process and results of her experience in creating digital learning resources based on one real-life example [13]. Peer-assessed tasks are typically used in higher competency levels where the user has to write a solution to an authentic problem. In that case, the answer has to be evaluated by another user with the same or higher competency level. In case of teacher students and novice teachers, this can be one of their group members [14].

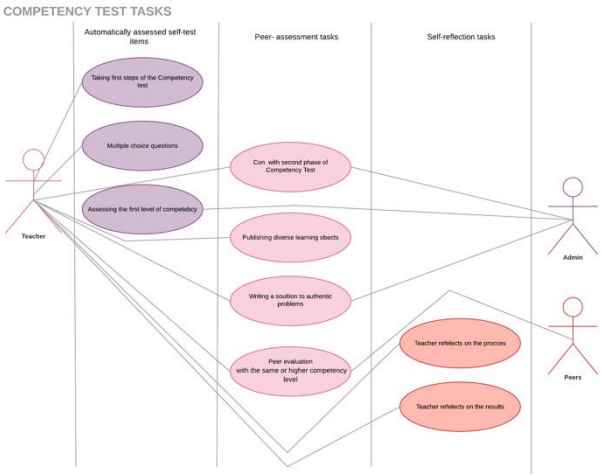

Figure 3. Competency Test Tasks Use Case Scenario

C. Competency profile

When the user has completed all the tasks the system will display her competency profile. This includes a diagram that displays her competency level in all 20 competencies. In the competency profile, it is possible to compare the achieved competency levels with the average competency level of various groups (other novice teachers, other teachers in the school, other teachers for the course, all users, etc.). It is possible to make the competency profile public or share it with selected people [15].

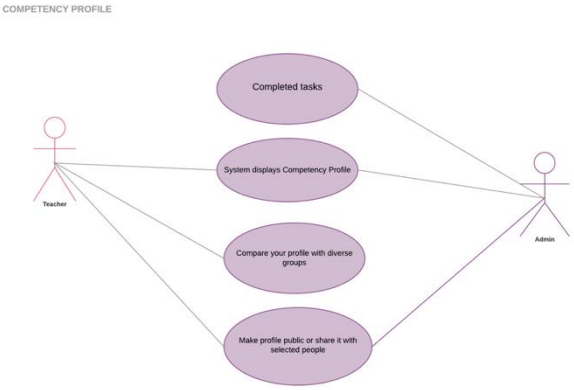

Figure 4. Competency Profile Use Case Scenario

D. Group

In order to connect teacher students from the same course or teachers from the same school, it is possible to create groups. The creator of the group (typical facilitator of the course or educational technologist of the school) is able to see the competency profiles of other group members and various statistics about the competencies. In a school setting, this system can be used to find out teachers' training needs in educational technology.

Figure 5. Creating Groups Use Case Scenario

V. CONCLUSIONS AND FUTURE WORK

Digital competency frameworks play an important role in systematic support of teachers' professional development. This paper analyzed the design for Web-based assessment of teachers' digital competencies and presented the conceptual design of a Web-based competency assessment tool.

We hope this tool will not be a monolithic Web application, but as one component in a larger digital ecosystem of distributed tools that teachers are using in their everyday work in the digital age. Teachers' competency profiles created can be linked and embedded in other social media systems. In addition to supporting teachers' professional development, the system will be used for collecting valuable data for further research on teachers' professional development. We foresee that this software can be also used as a generic competency assessment tool. By using the crowd sourcing and self-assessment approach, we believe that we have managed to create not only digital competency self-assessment tool, but provide a platform for sharing good practices of using digital tools in education adopted to the teachers with different levels of digital competences. By using the crowd sourcing and self-assessment approach, we believe that we have managed to create not only digital competency self-assessment tool, but provide a platform for sharing good practices of using digital tools in education adopted to the teachers with different levels of digital competences.

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Visualization of Big Digital Data with Zeppelin

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Abstract - The Big Digital Data (BDD) concepts deserve attention nowadays because of the need of analysis of data models they use, their usage from the customers with various levels of IT knowledge and the need for different analysis of big data in time and space. The huge amount of data and objects collected from different sources are flowing in databases with heterogeneous data with purpose of efficient visual data analysis. For this purpose, as emerging trend, visualization of big digital data is very important and has to be taken into consideration from methodology and practical aspects. The methodology used for visualization of BDD usually demands usage of a model for big data. The practical aspect demands data science knowledge and specific tools capable to deal with big data for different purposes. Zeppelin software tools for problems of visual data analysis of big digital data are used in this paper.

I. INTRODUCTION

Big Data become emerging technological trend as a part of Data Science. A big data solution is different in all aspects from a traditional business inteligence solution. Companies are deriving significant insights by analyzing big data that gives a combined view of both structured and unstructured customer data as well as seeing increased customer satisfaction, loyalty, and revenue [1]. Big data are not focused only on the unique market, but are combination of technologies for data management that are evolving in time. Big Data provide storing, managing, manipulation with a huge amount of data with a high accuracy and speed in precise time, enabling accurate and valuable information and knowledge. The key for big data understanding is the fact that big data have to be managed to meet the business requirements and design the solution [2]. As companies begin to evaluate new types of big data solutions, they are able to monitor data coming from machine sensors to predict a catastrophic event. Retailers can monitor data in real time to upsell customers' related products as they are executing a transaction. Big data solutions can also be used in healthcare to determine the cause of an illness and provide a physician with guidance on treatment options [3].

Dealing with this problems demands usage of some predefined patterns that are suitable for visualization of big digital data as Mashup View Pattern [2], Compression Pattern, Zoning Pattern, First Glimpse Pattern, Exploder Pattern, Portal Pattern and Service Facilitator Pattern [1]. For these patterns knowledge of the applied model is needed (Fig.1). Commercial tools that appear on the market promise higher productivity for big digital data analysis and provide specific business visualizations. Tools as QlikView [4], TIBCO Spotfire, SAS RA [5], Tableau and Zeppelin [6] can be mentioned. They also can be used in combination for gaining BDD visualization.

Apache Zeppelin [7, 8] is multipurpose software for data ingestion, research, analysis, visualization and collaboration. It supports more than 20 backend systems, including Apache Spark, Apache Flank, Apache Hive, Python, R, and JDBC (Java Database Connectivity) [1, 9]. It is easy to deploy, built on top of modern web technologies (provides built-in Apache Spark integration, eliminates the need to build a special module, plug, or library), incorporates visualizations and dynamic forms [10, 11]. Apache Zeppelin is flexible, allows users to mix different languages, exchange data between backends, as well as customization of appearance [10, 12]. Hardware and software components for interpreter, authentication and visualization can be included. Its advanced features provide interaction between custom visualizations and a group of resources [13].

Apache Zeppelin is open source web based software that performs interactive data analysis with possibilities of data capture, research, sharing, visualization and collaboration with Hadoop and Spark [14]. Zeppelin is a tool that enables engineers, analysts and data scientists to be more effective and productive through development, organizing, sharing and code exchange as well as data visualization, in a huge interactive work processes and projects [15, 16]. There are many available Spark software tools. Zeppelin supports Python, as well as a long list of programming languages such as Shell and Markdown [9, 10]. In fact, Zeppelin supports multiple language backends which has support for a growing ecosystem of data sources. It provides interactive "snippet-at-time" experience for Data scientists. The collaborative data analyses with Zeppelin and data visualization capability make them easy for data manipulation for research, visualization, sharing and collaboration, using Apache Flink [17], Apache Hadoop, and Apache Spark [14] as some of the Big Data platforms. With Apache Zeppelin, a wide range of users can make excellent visualizations that can be used for analysis of collaborative documents with SQL, Scala or other tools. Zeppelin is used in many companies as Amazon Web Services, Hortonworks, JuJu and Twitter [1, 4].

The paper will be organized as follows. First section describes some visualization possibilities using Zeppelin. The second section considers creating visualization with local databases and SQL statements with examples as well as examples for mathematical

function visualization. The practical usage for sharing the gained visualizations on the extended screens and copying the paragraphs with links follows. Concluding remarks highlight the main contribution of the paper and propose some logical conclusions.

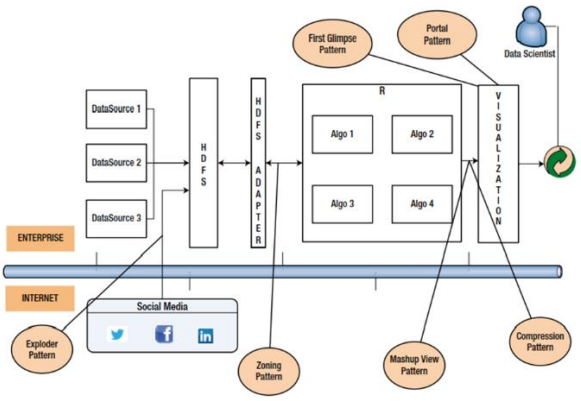

Figure 1. Big data analysis and visualization patterns [3]

II. VISUALIZATION WITH ZEPPELIN

Zeppelin can help to create big digital data (BDD) visualizations analyzing whole data with diagrams from Zeppelin's library [10]. The analyst can have the general data overview, gaining all data from big data repository in the same screen online from some cloud based platform or gain some snippet-at-time saved locally. As an example, we provide visualization of extracted data from big data repository, named cars, transformed as .csv file (Fig.3). For this purpose, we wrote the Scala code shown in Fig.2.

```
      def dataTable():String={
          var str=""
          //Load csv file
          Val
csv=scala.io.Source.fromFile("D:/Downloads/weather/cars.csv")
          for(line <- csv.getLines){
              val cols=line.split(",").map(_.trim)
              str=str+cols.mkString("\t")
              str=str+"\n"
          }
          csv.close
          return str
      }
      //To display the charts
      println("%table "+dataTable())
```

Figure 2. Scala code for creating visualization

	mpg,cylinders,engine,horsepower,weight,acceleration,year,origin,name
2	18,8,307,130,3504,12,70,American,chevrolet chevelle malibu
3	15,8,350,165,3693,11.5,70,American,buick skylark 320
4	18,8,318,150,3436,11,70,American,plymouth satellite
5	16,8,304,150,3433,12,70,American,amc rebel sst
6	17,8,302,140,3449,10.5,70,American,ford torino
7	15,8,429,198,4341,10,70,American,ford galaxie 500
8	14,8,454,220,4354,9,70,American,chevrolet impala
9	14,8,440,215,4312,8.5,70,American,plymouth fury iii
10	14,8,455,225,4425,10,70,American,pontiac catalina
11	15,8,390,190,3850,8.5,70,American,amc ambassador dpl
12	0,8,350,165,4142,11.5,70,American,chevrolet chevelle concours (sw)
13	0,8,351,153,4034,11,70,American,ford torino (sw)
14	0,8,383,175,4166,10.5,70,American,plymouth satellite (sw)
15	0,8,360,175,3850,11,70,American,amc rebel sst (sw)
16	15,8,383,170,3563,10,70,American,dodge challenger se
17	14,8,340,160,3609,8,70,American,plymouth cuda 340
18	0,8,302,140,3353,8,70,American,ford mustang boss 302
19	15,8,400,150,3761,9.5,70,American,chevrolet monte carlo
20	14,8,455,225,3086,10,70,American,buick estate wagon (sw)
21	22,6,198,95,2833,15.5,70,American,plymouth duster
22	18,6,199,97,2774,15.5,70,American,amc hornet
23	21,6,200,85,2587,16,70,American,ford maverick

cars

Figure 3. Cars.csv database shown in Excel

Using the code from Fig.2, the database is loaded in .csv file, the table with the source of Zeppelin is created and then the data are visualized. The main comparative advantage of Zeppelin is the ability of direct instantaneous visualizations results of data with all data files from database. With a simple drag and drop of data that have to be visualized, Zeppelin aggregates all data values and shows in a graphical way, using red color for files and green for data that have to be visualized. The three areas where data can be dragged and dropped are Keys, Groups and Values. In the Key area, the key files that have to be visualized are entered. The area Groups contains the files that have to be grouped according to some criteria. The last area, Values, contains the files that have to be aggregated, necessary to create sum, count, average, min, max or other functions.

First visualization shows the diagram of year of production of cars compared with each car's acceleration (0 to 100 km/h), grouped according to production country (origin by America, EU, Japan) – Fig.4. In this visualization, some results are obvious, as the year of production of cars, shown on the X axis. Y axis shows the acceleration rate in seconds (from 0 to 100 km/h) of the fastest accelerating car produced in the given years. All cars are grouped according the Origin shown on the upper right corner in Fig. 4.

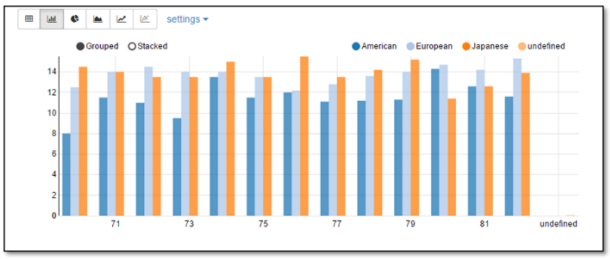

Figure 4. Visualization of the year of production related to minimal acceleration grouped by cars production origin

Fig.5 presents magnification of the Fig.4 gained with selection of the desired data column. We can see that the fastest accelerating car is produced in America in 1970 and can achieve acceleration from 0 to 100 km/h in 8 seconds.

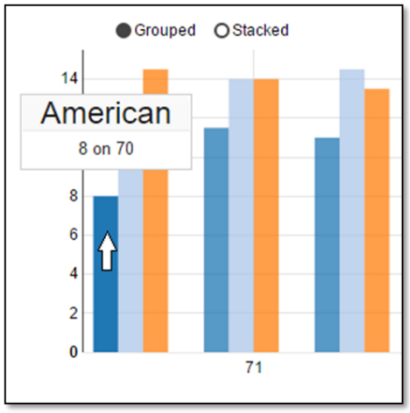

Figure 5. Details about selection in Fig.4

The second visualization shows diagram of cars' motor power in relation with minimal acceleration from

0 to 100 km/h, grouped by year of cars' production. X axis shows engine volume of old-timers in cubic inch. Y axis presents summed acceleration for the fastest cars and year of car's production (Fig.6).

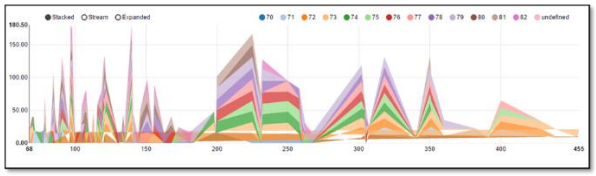

Figure 6. Visualization of the motor power related to min acceleration and year of production of the cars

Detail overview of all cars from database cars.csv with motor volume bigger than 250 cubic inches or 3.2 liters is shown on Fig.7. To obtain the details we can point with the mouse over the year of production for all years in the database. Right of the years of production (70, 71 and 72) the values for acceleration in seconds are shown, grouped by year of production.

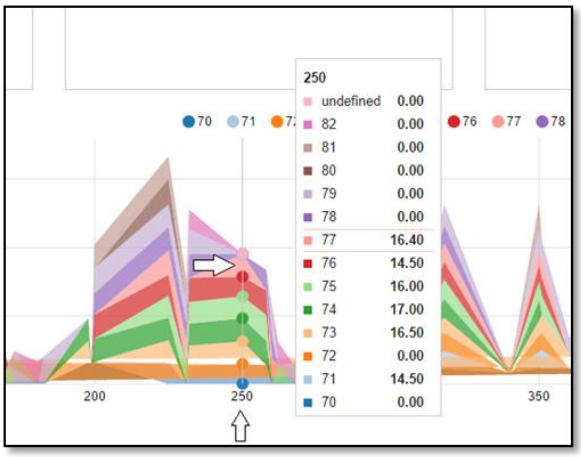

Figure 7. Detail overview of cars from cars.csv database

Zeppelin has an option to include or exclude only the data that needs to be visualized by simply clicking the buttons in the data grouping section. The example shown on Fig.8 will present only the data from 74, 78, 79, 80 and 82 (Fig.9).

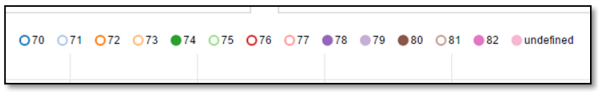

Figure 8. Controlling the grouped data that have to be shown

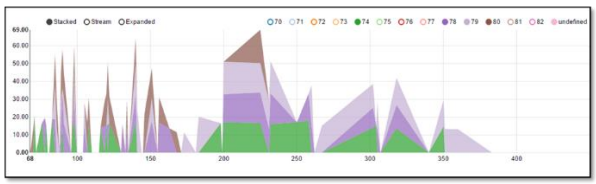

Figure 9. Filtered data for year of production - selected in Fig.8

Visualization on Fig.10 in which the number of cylinders, the number of horsepower and motor volume, is related with the cars' weight aims to show how we can put more data in the Keys, Groups and Values areas.

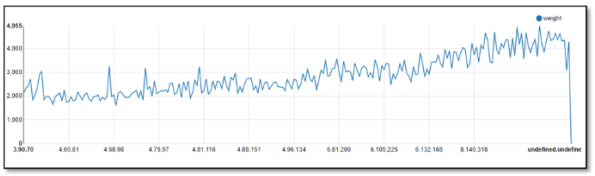

Figure 10 Visualization of numbers of cylinders, horsepower and motor volume related with cars' weight

Fig. 11 shows an example of detailed overview of all cars in cars.csv. X axis represents the three values (separated with commas): numbers of cylinders, horsepower and motor volume, sorted by the number of cylinders for each car. Y axis shows the car's weight. Pointing the value, we can see toolip (Number of cylinders is 4, horsepower 70 hp, motor volume 79 cubic inches and car's weight 2074 lbs or 940 kg).

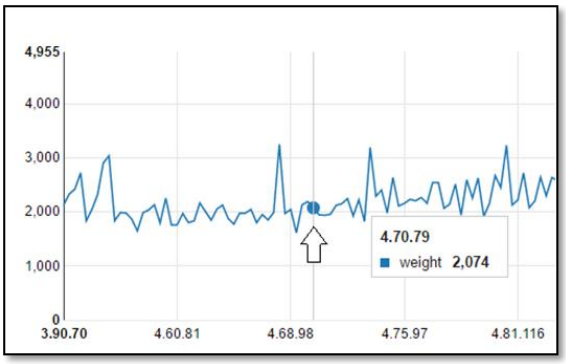

Figure 11. Detail overview of all cars with tooltip for the selected cars

III. Creating Visualization on Local Databases with SQL Statements

In order to visualize data with Zeppelin, extracted from a huge big data set and store in local database, containing 45 212 data rows, with a huge amount of columns with variate data is used, named bank.csv. It is also snippet-at-time of big data repository. The data have to be transformed from CSV file to RDD (Resilient Distributed Datasets that is the main Spark structure) and for that reason it is necessary to create the script file, shown on Fig.12. When the transformation is done, header will be removed from file by means of filter option.

```
val bankText = sc.textFile("D:/Downloads/bank/bank-full.csv")

case class Bank(age:Integer, job:String, marital : String, education : String,
balance : Integer)

// split each line, filter out header (starts with "age"), and map it into Bank
case class
val bank = bankText.map(s=>s.split(";")).filter(s=>s(0)!="\"age\"").map(
    s=>Bank(s(0).toInt,
            s(1).replaceAll("\"", ""),
            s(2).replaceAll("\"", ""),
            s(3).replaceAll("\"", ""),
            s(5).replace All("\"", "").toInt
        )
)

// convert to DataFrame and create temporal table
bank.toDF().registerTempTable("bank")
```

Figure 12. Script file - create RDD from bank.csv

After loading the database, it is converted into a table which can be used to perform certain analyzes and visualizations by writing SQL commands. In this example, they are used to filter the column "age", to display values that are less than 30. (Fig. 13).

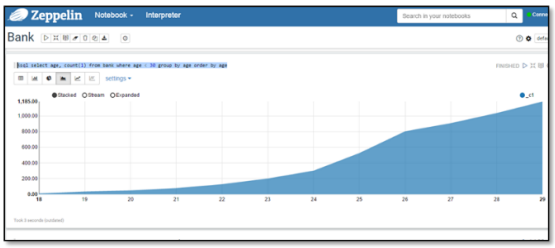

Figure 13. Area chart with condition "age" column < 30

If the data that have to be analyzed and visualized are variable and it is necessary to obtain different visualizations depending on the values, a field, in which the user inputs a value himself is used by implementing SQL code. The values that are entered in the field are executed instantaneously, so that immediately new visualization is obtained in relation to the entered value in the field. This is one of the main advantages of Zeppelin compared with other big data analysis tools. There is also possibility to index data from different columns and make new insight with some optimization tools.

Mathematical data visualization with Zeppelin can be created using Scala programing language. Fig.14 shows example of visualization for the function y=sin(x), using Scala code. First X and Y axes are created, then the cycle from 0 to 360 degree is run and finally sin(x) is calculated. Visualization of data is shown on Fig.15.

```
println("%table\nx\ty")
(1 to 360).map(i=>i.toDouble / 50).map(x=>(x,
Math.sin(x))).foreach{case (x,y) => println(x + "\t" + y)}
```

Figure 14. Scala code for y=sin(x) function visualization

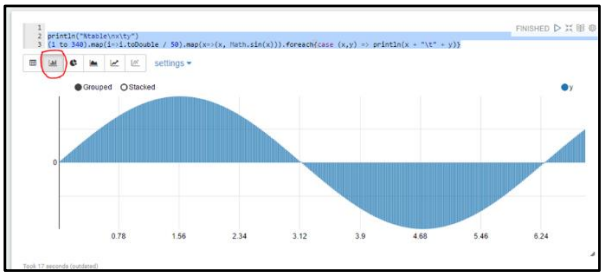

Figure 15. Mathematical visualization of sin(x) using Zeppelin

IV. Practical Usage of Sharing the Gained Visualization on the Extended Screens and Copying the Paragraphs with Links

Apache Zeppelin has the capability to share the working screen of data visualization with web socket or URL address. Visualizations can be changed interactively enabling all working addresses instantly to see the changed data. To share the screen the teams and users working on Zeppelin, just have to copy the URL address that is in the upper part of the browser (Fig. 16).

Figure 16. URL address shared with Zeppelin

The option for screen sharing is shown on Fig.17. The advantage of this option provides the easiest access to codes and visualizations on the distance locations between teams and users online.

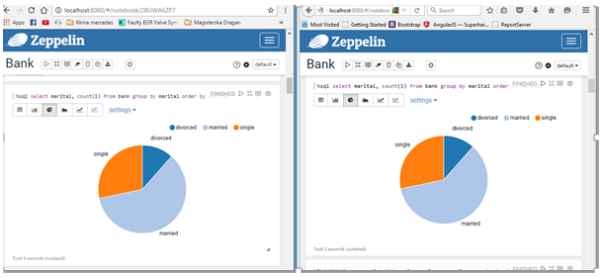

Figure 17. Sharing screen with Zeppelin

Zeppelin also gives the possibility to copy paragraphs with links. In this case, the link from the paragraph is copied and the result is published in a new window in the browser, as shown in Fig.18. If that paragraph needs to be opened in another browser, it is necessary to copy the URL and use it to access.

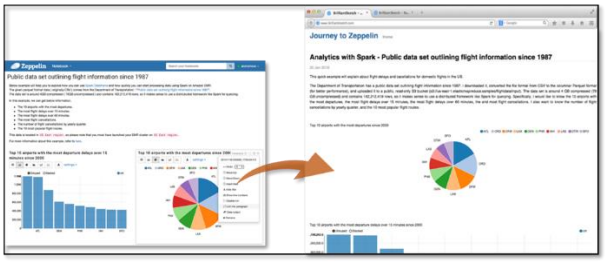

Figure 18. Copying the paragraph in visualization

As conclusion, Apache Zeppelin has many advantages and possibilities which simplify the team work, offering a wide range of programming languages with embedded possibilities using Interpreter menu. It can work online on cloud and with databases extracted from big digital data unlike some other tools. Also variable database formats with a wide range of visualization possibilities, enabling easy data analysis, taking into consideration the huge amount of data that can be supported. The SQL statements which Zeppelin has in disposal can help in decision-making processes with easy sorting, extracting and data filtering.

V. Concluding Remarks

The paper considers patterns and concept for dialing with BDD visualization. Some general problems with BDD visualization are considered in order to highlight some patterns and methods for BDD visualization [18]. The huge amount of unstructured, variable data and their dynamic nature bring unique challenges for data scientists to create specific valuable and imaginative visualizations online or prepared locally [1]. For this reason, the paper considers software solution for solving some of these challenges about BDD. Some basic concepts help to create the best data visualizations and practices offline. But, first of all, the data that need to be visualized have to be understood, regarding their volume, variety, variability and velocity [18]. Next aspect is how the data have to be presented and what information they contain [19]. The knowledge of the audience is very important in order to have a clear

understanding what they want from the data and in what form [20, 21].

For effective BDD visualization, Zeppelin is used as an open-source, web-based tool that enables interactive data analytics and collaborative documents. It allows making meaningful, data-driven, interactive documents with SQL, Scala, R, or Python right in the browser. Zeppelin Interpreter is the plug-in which enables users to use a specific language/data-processing-backend [12]. Currently Zeppelin supports many interpreters such as Scala (with Apache Spark), Python (with Apache Spark), SparkSQL, Hive, Markdown and Shell. Interactive interface allows users to instantly see the results of the analytics and have an immediate connection with their creation.

Apache Zeppelin is used by organizations as Amazon Web Services, Hortonworks, JuJu and Twitter. They analyze their BDD with some advanced visualization methods in Zeppelin, gaining more insights in data and making decisions with diagrams created with Zeppelin.

In this paper our practical experience with Zeppelin was related to gaining visual BDD analysis, starting from extracting data from big digital data repository, data preparation and data visualization. With the created visualizations, we can highlight that the whole BDD concept of data analysis is based on visualization techniques and models, with software tools which bring competitive advantages to users and companies. For online usage, they demand a huge hardware resources, high transmission speed and time.

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Performance Evaluation of Clustered Web Servers Using the Round Robin Scheme

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Abstract - Contemporary e-Commerce systems are constantly facing huge and bursty workloads. Continuous performance evaluation of Web server clusters is a cornerstone of capacity planning methodology, whilst their performance modeling and simulation strives to foresee the system's behavior under various scenarios. In this paper, we present a simulation model of a generic e-Commerce Web server cluster, consisting of a variable number of Web servers, using the class of Generalized Stochastic Petri Nets (GSPNs). The model also implements one of the basic static load balancing algorithms, the Round Robin algorithm, for equal distribution of incoming HTTP requests across the cluster's Web servers. We convey a steady-state and a transient analysis of the GSPN model by numerical simulations using dedicated software, TimeNET, and present the obtained results. This way, we accomplish a threefold aim, (1) to establish a modeling framework suitable for performance analysis of arbitrary e-Commerce Web server cluster; (2) to get valuable insights into the dynamics and behavior of such systems; (3) to demonstrate the modeling and evaluation power of TimeNET regarding the performance analysis of arbitrary Discrete-Event Dynamic Systems (DEDSs).

I. INTRODUCTION

As e-Commerce paradigm became mainstream worldwide during the mid-1990s, e-Commerce Websites began to cope with a heavily increased traffic. As a result, single Web servers started reaching their capacity limits to effectively handle the ever-increasing workload. Soon e-Commerce Websites needed inclusion of additional Web servers to successfully handle the incoming Internet traffic generated by e-Customers, which easily outreached tens of millions of HTTP requests per day. This phenomenon has led to the emergence of Web clusters, a locally distributed Web system that is "… an architecture consisting of multiple Web servers and mechanisms to route incoming requests among several server nodes in a user-transparent way" [1]. As a result, a multi-tiered Web architecture for e-Commerce has emerged (Fig. 1). Cluster computing appears in several varieties, each offering different advantages, like high availability, load balancing, high-performance computing, and grid computing [2]. In such architectures, it is of an utmost importance to split the workload as much as equally across the Web servers (i.e. to balance the workload), in order to preserve the general availability and high responsiveness of the whole system.

Load balancing refers to "the process of distributing the load among various nodes of a distributed system to improve both job response time and resource utilization while also avoiding a situation where some of the nodes are heavily loaded while other nodes are idle or lightly loaded" [3]. The load distributing policy aims to maximize the throughput of a distributed system as a whole.

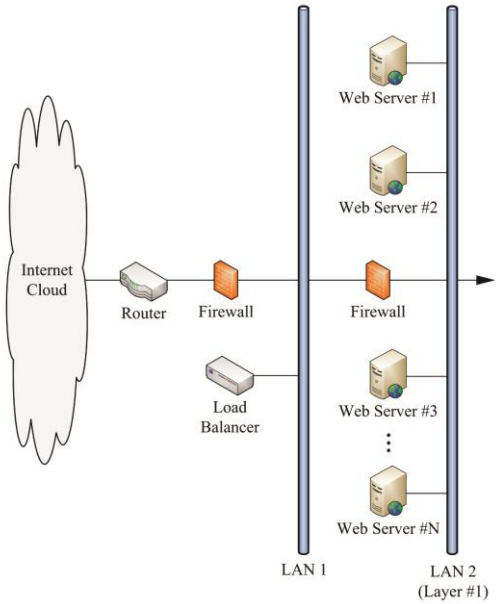

Figure 1. Schematic representation of the first tier of a generic multi-tiered e-Commerce Website architecture, portraying the load balancer and a cluster comprised of a number of Web servers

Efficient load balancing is based on the utilization of appropriate algorithms, known as load-scheduling or load-balancing methods/schemes. They are used by load balancers to determine the next Web server to send an HTTP request to. These can be roughly categorized into three major categories: static, dynamic, and hybrid [4].

Whilst in dynamic load balancing the workload is distributed across the Web servers in a non-deterministic way, based on the feedback information from Web servers during runtime, in static load balancing the workload is distributed across Web servers in accordance with a pre-determined scheme that does not depend on any feedback information from the Web servers. Static load balancing is independent regarding the current system state; it does not depend on the time instances when decisions are made. It

should be notified that, in general, dynamic and hybrid algorithms deliver better results than static algorithms [4].

Because of its intrinsic simplicity, and the ability to be represented by stochastic Petri nets, in this paper we use the Round Robin (RR) static load balancing scheme, which is being widely used both in practice and theory. The RR scheme is easy to be implemented; it is a starvation-free algorithm since it presents a circular queueing process. Theoretically, it assumes that all Web servers are identical machines, exhibiting identical performances. In addition, it does not require any inter-process communication. However, the RR scheme cannot provide good results in a general case, and/or when jobs are unequal (i.e. it provides the best performance only for special purpose applications). Besides, it does not support the prioritization of more important tasks. In this particular case, we do not use time-slicing RR scheme on queued jobs (HTTP requests) in the load balancer, but rather we assume that complete jobs (e.g. equally sized HTTP requests) are being distributed towards Web servers in the cluster.

The paper is organized as follows. In Section 2 some of the most recent research closely related to the subject has been elaborated. Section 3 briefly introduces the class of Generalized Stochastic Petri Nets (GSPNs) that has been used as a modeling formalism in building the proposed performance evaluation model. The modeling framework has been described in Section 4. Section 5 presents the simulation results in two subsections. Section 6 concludes.

II. Related Research

During the recent three decades, an abundance of research has been done vis-à-vis the performance evaluation of Web server clusters, the efficiency of load balancing algorithms, or both. Here we present some of the most recent and relevant research.

Reference [5] focuses on the simulation of four static load balancing algorithms that have been carried out in order to compare their performances. Performance evaluation and a proposed dynamic architecture of Web server farms have been studied in [6]. Reference [7] deals with the evaluation of two performance measures (i.e. the mean response time and the utilization of Web servers) using a software simulator that implements the algorithms of several load balancing schemes, including the RR scheme. Performance evaluation of distributed Web server architectures under e-Commerce workloads has been treated in [8]. The RR scheme has been subject to analysis in [9] and [10]. A comparison of load balancing algorithms for clustered Web servers has been carried out in [11].

III. Generalized Stochastic Petri Nets (GSPNs)

Initially been proposed by Marsan, Balbo, and Conte in 1984, the class of Generalized Stochastic Petri Nets (GSPNs) is now recognized as a widely-known tool for performance analysis of distributed systems, which utilizes the graphical notation introduced by ordinary Petri Nets (PNs) [12-13]. In GSPNs some transitions are timed, whilst others are immediate. Random, exponentially distributed firing delays are associated with timed transitions, whereas the firing of immediate transitions takes place in zero time, with priority over timed transitions. In addition, the selection among several possibly conflicting enabled immediate transitions is made by utilizing their corresponding firing probabilities. In general, immediate transitions are used for modeling instantaneous actions or logical actions (typically choices), whilst timed transitions with an exponentially distributed delays are used for modeling the duration of activities (events) within the GSPN model.

The analysis of a GSPN model can be two-fold: (1) qualitative: performed by studying the structural characteristics of the underlying Petri Net; (2) quantitative: performed by computing the steady-state (stationary) and/or the transient (time-dependent) probability distributions of the associated stochastic model (process), equivalent to a GSPN model. GSPNs are isomorphic to semi-Markov processes, i.e. their quantitative analysis can be performed on a reduced Embedded CTMC (Embedded Markov Chain, EMC), defined solely on a set of tangible states, or by reducing the GSPN to an equivalent Stochastic Petri Net (SPN) [13]. The stationary distribution of the underlying stochastic process is usually a basis for obtaining a plethora of performance metrics, like calculating the probabilities of specific state conditions, resource utilization, expected throughputs, expected number of clients (active resources), expected waiting times, etc. On the other hand, transient analysis is a basis for investigating the system behavior over time, i.e. it describes the evolution of the observed system up to a given time and thus it can be used for obtaining specific performance metrics such as probabilities of reaching particular states and probabilities of satisfying assigned deadlines [13].

IV. The Modeling Framework

For demonstration purposes, we come up with a series of GSPN models of clusters comprised of a different number of Web servers that implement the RR load balancing algorithm (Fig. 2). The modeling has been carried out using TimeNET®, a dedicated tool for modeling and simulation of several classes of Stochastic Petri Nets, including GSPNs [14-16].

All developed GSPN models are based on the existence of a single load balancer (a place named *P_LB*) and a cluster of an arbitrary number of Web servers ($N = 2 \ldots 5$), that belong to the first tier of a typical e-Commerce Website architecture. The workload posed to the load balancer has an intensity of λ [HTTP requests/s], represented by a flow of tokens coming from the place named *P_HTTPs* at random time instances that follow the Poisson distribution, after the exponential transition *T_HTTPs* fires at a rate of $\lambda = 1/arrival_time$. The variable *arrival_time* [s] denotes the mean inter-arrival time of HTTP requests. All incoming HTTP requests are presented by individual tokens, one per a request, residing in the place *P_LB* (i.e. the load balancer).

The GSPN substructure, comprised of both the places *P_choose_WS*(*i*) and immediate transitions

T_send_to_WS(*i*) (*i* = 2 … 5), along with the place *P_LB*, implements the load balancer that distributes the tokens from the place *P_LB* (i.e. the HTTP requests) across the clustered Web servers according to the RR scheme.

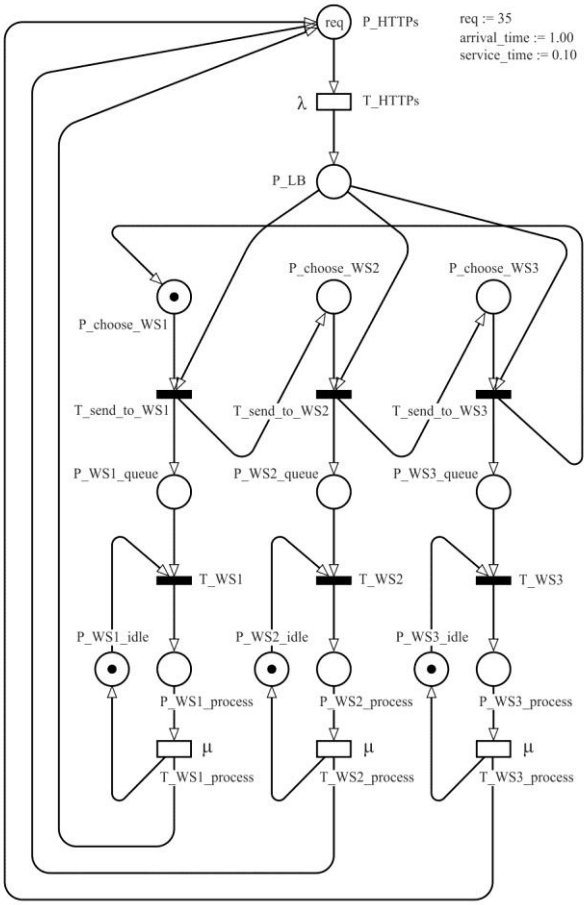

Figure 2. GSPN model of a Web cluster comprised of N = 3 Web servers and a load balancer that distributes the incoming HTTP requests according to the Round Robin algorithm

As long as there is a token in the place *P_LB* and a token in the place *P_choose_WS*(*i*), the immediate transition *T_send_to_WS*(*i*) becomes enabled and fires, such that a single token is being removed from the places *P_LB* and *P_choose_WS*(*i*), and a single token is being put to the place *P_WS*(*i*)*_queue* (*i* = 2 … 5). This means that an HTTP request has been sent from the load balancer to the corresponding Web server. At the same time, the firing of the transition *T_send_to_WS*(*i*) also puts a token in the place *P_choose_WS*(*i*+1), to point out the next Web server an HTTP request should be sent to. The firing of the last transition *T_send_to_WS*(*N*) puts a token back to the place *P_choose_WS1*, such that a circle becomes closed.

During the execution, places *P_WS*(*i*)*_queue* (*i* = 2 … 5) contain an arbitrary number of tokens, resembling HTTP requests waiting in a buffer queue to be processed by particular Web servers, *WS*(*i*). Whenever the place *P_WS*(*i*)*_idle* contains a token (i.e. the corresponding Web server is idle), the immediate transition *T_WS*(*i*) becomes enabled and fires, taking away a single token from the place *P_WS*(*i*)*_queue* and putting it into the place *P_WS*(*i*)*_process*. In such a way, the exponential transition *T_WS*(*i*)*_process* becomes enabled; it fires after a mean time delay *service_time* [s], such that the service rate μ = 1/*service_time* [HTTP requests/s].

For simplicity reasons, it is assumed that each of the Web servers processes HTTP requests at a constant service rate of μ [HTTP requests/s], i.e. all of them represent identical machines exhibiting an identical individual performance, which is often referred to as a horizontal scaling. In practice, however, it is more likely that Web servers are going to be different machines that would process the HTTP requests at rather different service rates.

Concurrent firings of the exponential transitions *T_WS*(*i*)*_process* put a single token back in places *P_WS*(*i*)*_idle* (to denote that the Web server is ready to process the next HTTP request in the queue), and also put a token back to the place *P_HTTPs*, in order to preserve the initial number of tokens in the model and make its state-space a finite one. A finite state-space is necessary for the simulation model to be computationally tractable.

The whole modeled system is equivalent to an M/M/*N*/*req* queuing system, i.e. a multi-server, finite-capacity system with maximum *N* servers and *req* customers, where the HTTP requests arrive according to a Poisson process with a rate of λ (i.e. the inter-arrival times are independent, exponentially distributed random variables with parameter λ), whilst the service times are also assumed to be independent and exponentially distributed with parameter μ [17].

V. Simulation Results

Given that the service rate μ has a fixed value of 10 [HTTP requests/s], we have altered the arrival rate λ, so it took its values from the interval [1 … 35] [HTTP requests/s], with a step of 2. Thus, the resulting ratio ρ = λ/μ ranges from 0.1 to 3.5, with a step of 0.2. It should be notified that such values have been deliberately chosen to investigate the system behavior when ρ ≈ 1 and ρ > 1.

All simulations have been carried out with a finite initial number of tokens in the place *P_HTTPs*, *req* = 35 [HTTP requests]. Further increasing of the value of variable *req*, and/or the value *N* representing the number of Web servers in the cluster has led to computationally intractable simulation models, because of the state-state explosion (e.g. for *N* = 4 and *req* = 35, the GSPN model has 326,340 tangible markings, whilst for *N* = 5 and *req* = 35, the GSPN model has 3,247,860 tangible markings!).

The specification of the corresponding reward measures (performance metrics) for the Web server WS1 is presented in Table 1. The corresponding reward measures have been defined for all other Web servers included in the GSPN models, as well. However, since the distribution of tokens (i.e. HTTP requests) across the places *P_WS*(*i*)*_queue*, *i* = 2 … 5 (i.e. Web servers) has been done using the RR scheme, and since all tokens are mutually equal, the obtained results (i.e. the values of the reward measures) for all Web servers are identical, i.e. the RR scheme assures that all modeled Web servers in the cluster are equally loaded.

TABLE I. DEFINED REWARD MEASURES

Measure	TimeNET v4.4 Definition
utilization_WS1	(#P_WS1_proc > 0)
queue_length_WS1	(#P_WS1_queue)
waiting_time_WS1	((#P_WS1_queue) - (#P_WS1_queue > 0)) * arrival_time
Prob_0_requests	(#P_WS1_queue == 0)
Prob_*x*_requests (*x* = 1 … 5)	(#P_WS1_queue == *x*)
Prob_*x*_and_more_ requests (*x* = 0 … 5)	(#P_WS1_queue >= *x*)
Prob_*x*_and_less_ requests (*x* = 1 … 5)	(#P_WS1_queue <= *x*)

A. *Steady-state analysis*

The steady-state (stationary) analysis has been done using the Stationary Analysis module, which computes the steady-state solution of the model with continuous time, by solving the corresponding Embedded Markov Chain (EMC) [15].

The functional dependency of the Web server utilization vis-à-vis the arrival rate λ, for a various number of Web servers in the cluster, is depicted in Fig. 3.

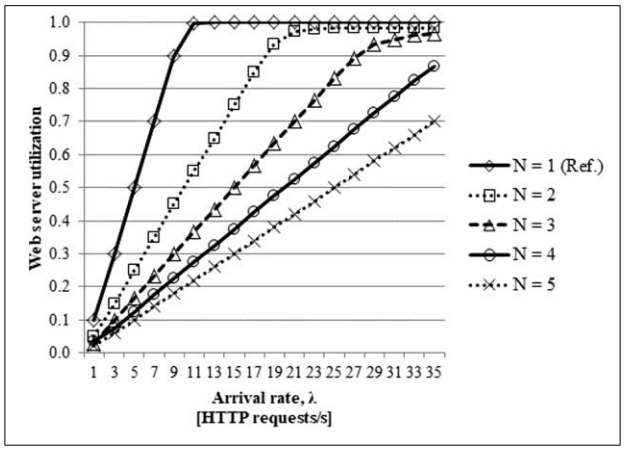

Figure 3. Web server utilization as a function of the HTTP requests' arrival rate, λ, for different number of Web servers, given that the service rate μ equals 10 [s^{-1}]

Simulations show that, for all values of the arrival rate λ (i.e. $0 < \lambda \leq 9$) that precede Web server saturation (i.e. high levels of utilization, greater than 0.90), adding a second identical Web server reduces the utilization by half (50%), adding a third Web server reduces their utilization by 67%, adding a fourth Web server reduces their utilization by 75% and adding a fifth Web server reduces their utilization by 80%, relative to the utilization levels gained in the reference case (i.e. when a single Web server is used).

Fig. 4 depicts the average queue length at Web servers vis-à-vis the arrival rate λ, for a various number of Web servers in the cluster. Simulation results show that for all values of the arrival rate λ (i.e. $\lambda \geq 29$) that follow Web server saturation (i.e. high levels of average queue length, generally greater than 33.5), adding a second identical Web server reduces the average queue length at Web servers by more than a half (approximately by 53%).

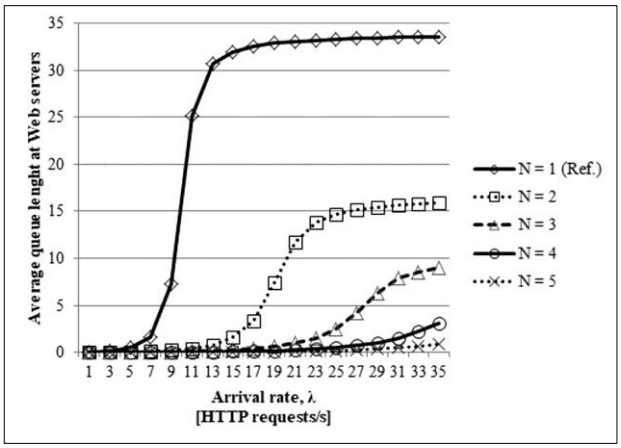

Figure 4. Average queue length at Web servers as a function of the HTTP requests' arrival rate, λ, for different number of Web servers, given that the service rate μ equals 10 [s^{-1}]

Further significant reductions of average queue length at Web servers are evident by adding a third (approximately by 75%), fourth, and a fifth Web server to the cluster, relative to the average queue length gained in the reference case (i.e. when a single Web server is used).

The average waiting time of HTTP requests in Web server queues vis-à-vis the arrival rate λ, for a various number of Web servers in the cluster, is depicted in Fig. 5.

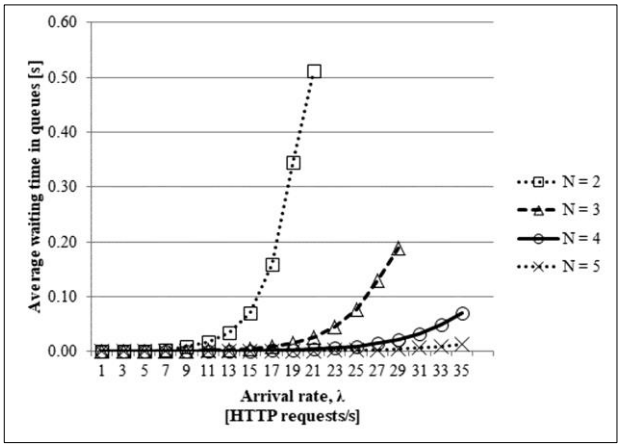

Figure 5. Average waiting time at Web server queues as a function of the HTTP requests' arrival rate, λ, for different number of Web servers, given that the service rate μ equals 10 [s^{-1}]

According to the simulations, adding a third, fourth and fifth Web server in the cluster reduces the average waiting time of HTTP requests in Web server queues at least by 91%, 83%, and 76%, respectively, and relative to each other.

A 3D view of the probability that Web servers are idle (i.e. there are no HTTP requests waiting in Web server queues) is shown in Fig. 6. It is obvious that as the ratio $\rho = \lambda/\mu$ rises, the probability $P(r = 0)$ of having zero HTTP requests in Web servers' queues drops down. However,

such decrease slows down as the number of Web servers in the cluster, N, increases. In other words, the probability $P(r = 0)$ that the Web servers would be idle rises as their number in the cluster increases.

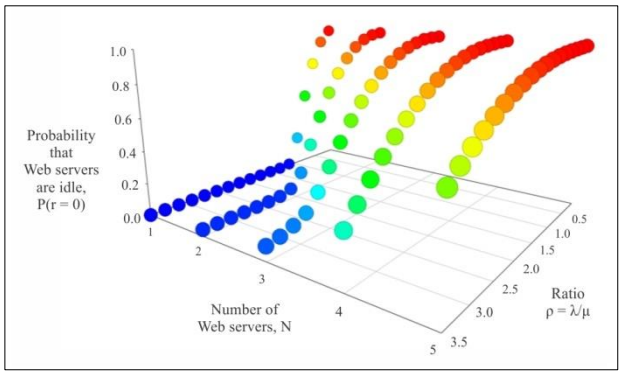

Figure 6. Probability $P(r = 0)$ that Web servers are idle, as a function of the ratio λ/μ, and different number of Web servers, given that the service rate μ equals 10 [s^{-1}]

The probability that exactly R HTTP requests are present in Web server queues, $P(r = R)$, is portrayed in Fig. 7.

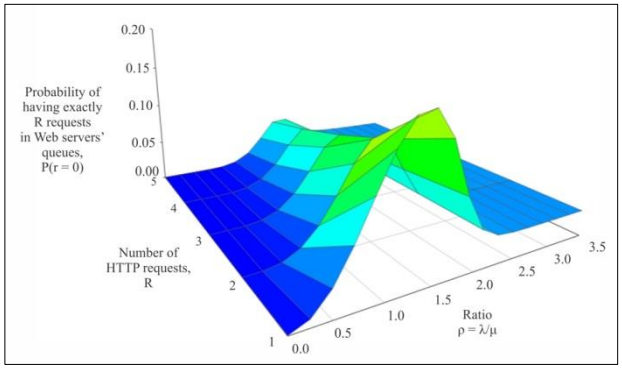

Figure 7. Probability $P(r = R)$ that there are exactly R HTTP requests waiting in Web server queues, as a function of the ratio λ/μ, given that the service rate μ equals 10 [s^{-1}], for $N = 2$ Web servers in the cluster

Such probability gets its maximum for $R = 1$ HTTP request and continually decreases as the value of R grows. For $N = 2$ Web servers in the cluster, the probability approximates $P(r = 1) = 0.16396418$ for $\lambda/\mu = 1.5$ (i.e. for $\lambda = 15$ [HTTP requests/s] and $\mu = 10$ [HTTP requests/s]).

The probability $P(r \geq R)$ that at least R HTTP requests are waiting in Web server queues is depicted in Fig. 8. Obviously, as the ratio $\rho = \lambda/\mu$ increases, such probability rises from values near to 0 to values near to 1. However, the increase becomes more severe as the reference number of HTTP requests in the queues, R, rises, such that $P(r \geq 1) = 0.95882778$, whilst $P(r \geq 5) = 0.84179076$, for $\lambda = 35$.

Finally, we also assess the probability $P(r \leq R)$ that at most R HTTP requests are waiting in Web server queues, graphically depicted in Fig. 9. In this case, the probability decreases as the ratio $\rho = \lambda/\mu$ increases and/or the reference number of HTTP requests in the queues, R, decreases, such that $P(r \leq 1) = 0.06956791$, whilst $P(r \leq 5) = 0.18810534$, for $\lambda = 35$ [HTTP requests/s].

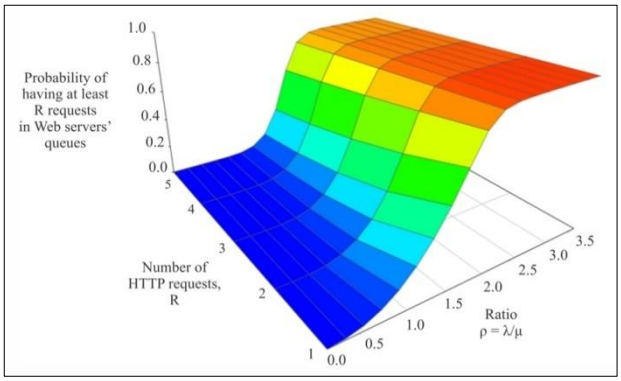

Figure 8. Probability $P(r \geq R)$ that there are at least R HTTP requests waiting in Web server queues, as a function of the ratio λ/μ, given that the service rate μ equals 10 [s^{-1}], for $N = 2$ Web servers in the cluster

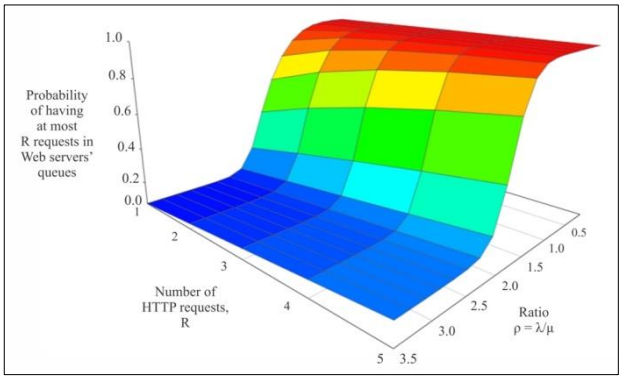

Figure 9. Probability $P(r \leq R)$ that there are at most R HTTP requests waiting in Web server queues, as a function of the ratio λ/μ, given that the service rate μ equals 10 [s^{-1}], for $N = 2$ Web servers in the cluster

B. *Transient analysis*

Transient (time-dependent) analysis has been done using the Transient Simulation module. It estimates the system's behavior until a given time point, but it is restricted solely to the assessment of basic reward measures (e.g. excluding the assessment of the waiting time in Web server queues) [15]. The transient analysis has been carried out in the case when the Web server cluster consists of $N = 3$ Web servers, given that the maximum number of HTTP requests in the system is $req = 35$, the arrival rate $\lambda = 17$ [HTTP requests/s], and $\mu = 10$ [HTTP requests/s].

The evolution of the Web server utilization in the cluster is presented in Fig. 10.

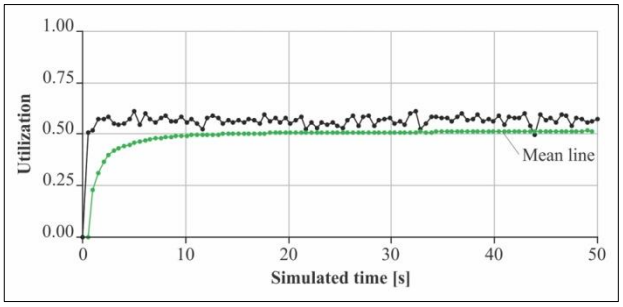

Figure 10. Transient behavior of the Web server utilization

The transient analysis of Web server queue length is depicted in Fig. 11.

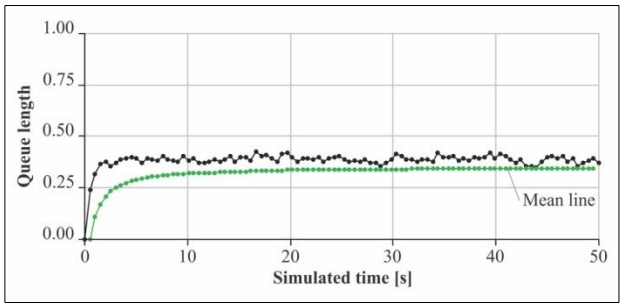

Figure 11. Transient behavior of the Web server queue length

Finally, the transient behavior of the probability P(r = 0) that there are no HTTP requests waiting in Web server queues is shown in Fig. 12.

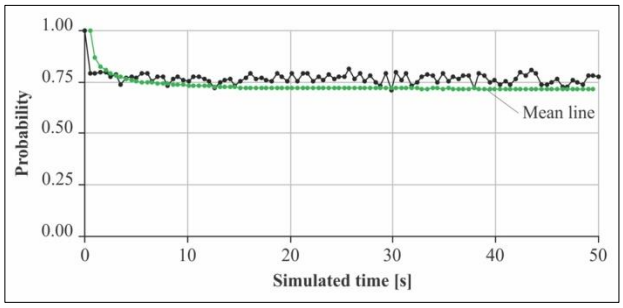

Figure 12. Transient behavior of the probability P(r = 0) that there are no HTTP requests waiting in Web server queues

VI. Conclusion

Since the Internet traffic increases dramatically on a daily basis, especially the one being generated by e-Customers, e-Commerce Websites are facing the challenges of high availability and high responsiveness of their Web servers more than ever before. The results of this study have shown undoubtedly that by the appliance of the horizontal scaling approach, i.e. by increasing the number of Web servers in the first hierarchical tier, and by organizing them logically into a cluster, significant gains in terms of performance can be achieved.

Such GSPN-based approach has few limitations, including (1) the inability to model HTTP requests with variable size (i.e. all tokens are mutually equal, meaning that the HTTP requests they present have the same/similar size); and (2) the inability to model other, more efficient, dynamic schemes of load balancing (i.e. the Round Robin algorithm is suitable/efficient for load balancing in a case when the incoming HTTP requests do not differ significantly from each other vis-à-vis the service demands they pose to Web servers, like in this particular case). In addition, TimeNET® as a software tool also exhibits a number of limitations, like (1) the inability to convey simulations for bigger number of Web servers in the cluster and/or bigger number of HTTP requests in the GSPN-based model (i.e. for larger GSPN models), due to a state-space explosion and a lack of main memory to handle the computation; (2) the limitation to deal with finite state-spaces only; (3) the inability to compute other relevant performance metrics, like the average time tokens need to proceed from one place to another, distant one.

Future research includes utilization of the class of Colored Stochastic Petri Nets (CSPNs) to take into account variable-sized HTTP requests, conducting performance analyses, and carrying out mutual comparisons of the results with those obtained by this study.

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Model of software development using RAD methods and standard ISO/IEC 12207

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Abstract - The software/system engineering standard aim to govern the quality of system development life cycle processes of the software. It can be found as ISO/EIC (IEEE) 12207 standard (System and Software Engineering: 2008). The standard has to establish a framework with defined processes, activities and tasks that can be used in the process of creating or software product and service, as well as in the processes of software supply, development, operation, maintenance and disposal [1]. The main version of this standard can be found as ISO/IEC 12207: 2008. Later, this version is updated according to the needs of software engineering development processes. The recent changes can be found under the code AS/NZS ISO/IEC 12207: 2013. In this moment, the standard can be described as a common language with couple of different processes with purpose to provide a common structure, suitable for many software development companies, suppliers, maintainers, operators, managers, and technicians that are involved in the software development processes. The standard structure is with flexible design, and can be used with many life cycle development methods. In this paper, we will propose model of the standard, taking into consideration agile development methods and two basic principles: modularity and responsibility. The model validation is done on the practical software process development according to this standard and principles.

I. INTRODUCTION

Nowadays, software development processes can be very complex because of huge amount of software development tools, as well as, many emerging technologies that are used in the information systems (IS) development process. Today's IS need to satisfy very complex and costly business demands. All these demands request very large pallet of methods, tools and processes that have to be standardized. The standard is a document with technical specifications and criteria aiming to ensure standardized and consistently software development processes which will meet users' demands and increase their satisfaction. The main goals of standardization in software development life cycle (SDLC) are to define a common framework, enabling to developers involved to "speak the same language", providing a basis for communication between the IS's modules, preconditions for joint different parties participation in projects and framework for software with defined quality. But, the standard does not prescribe a specific model of life cycle of software or methods development nor activities and processes that have to be joined to the selected model and methods. They only help organizations to meet the current demands for quality processes given the framework for software product improvements and software process implementation. When organization is not using this ISO standard, is likely to have a chaotic way of producing software and dissatisfied customers.

For this reason, we propose a model of information system for company management according to software engineering standard ISO/IEC 12207:2013 with the waterfall model of SDLC. The paper is organized as follows. Section 2 provide some agile development methods improvement, as RAD, that have to be standardized. Section 3 describe the different model that can be used with the standard and the waterfall model development processes according to the Standard recommendations. Next section explains the practical implementation of the proposed model and their processes. Finally, the concluding remark for the paper highlighted some benefits form the model.

II. AGILE DEVELOPMENT AND ISO/IEC 12207 STANDARD

Because of the high modularity of the standard, it provides a framework that can help address the various factors that affect software development such as complexity, schedule, cost, etc. [2] In addition, ISO/IEC 12207 can act as an inventory of processes, which gives different perspectives to particular parts of the software life cycle process.

ISO 12207 can be implemented in an agile context i.e. agile methodologies can be implemented or extended in such a way that they conform to ISO 12207 but still remain their agile characteristics. The agile principle of stressing the development of working software rather than huge volumes of documentation need not be a rejection of producing documentation per se. Rather, it represents a shift of focus to what software development really is all about – the production of software. Agile methods actually can be applied within a variety of models. While Agile methods are common in executing an evolutionary lifecycle model, they can be used in other lifecycle models at various stages. What the methods have in common is an emphasis on continuous inspection and collaboration in the rapid production of working

software in an environment where changes, including changes to requirements, are expected.

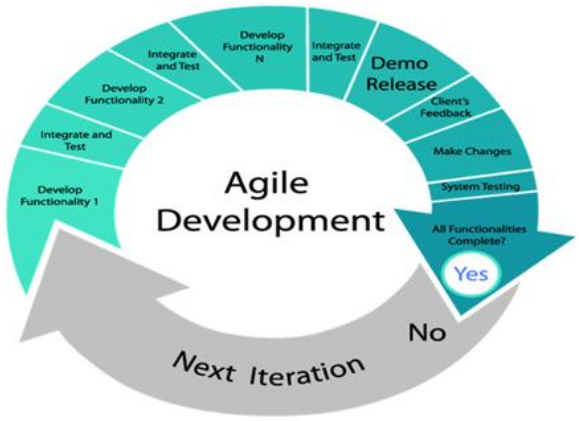

Figure 1. Agile application development [3]

This standard can be also implemented in rapid application development (RAD) [4] - a software development methodology that uses minimal planning in favor of rapid prototyping. The RAD model focuses on iterative and incremental delivery of working models to the customer. This results in rapid delivery to the customer and customer involvement during the complete development cycle of product reducing the risk of non-conformance with the actual user requirements.

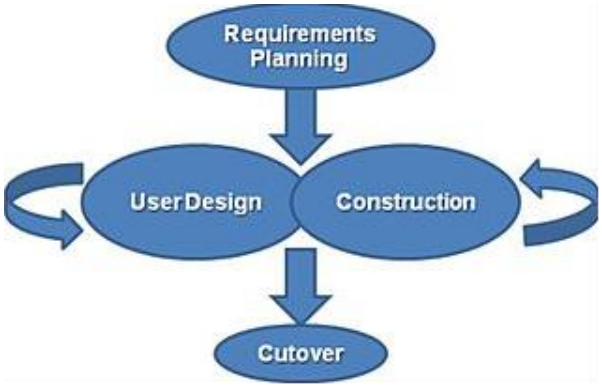

Figure 2. Rapid application development model [5]

ISO 12207 should be used in medium to large project teams (20+ people) or when it is mandated (e.g. by government) to follow this approach. This is standard is mostly used by outsourcing companies. This standard enables both clients and contractors to clearly understand how a software product should be managed, developed, supplied, deployed, and maintained. ISO 12207 is a commonly accepted fundamental international standard for business arrangements related to software products.

III. The Waterfall Model and ISO/IEC 12207 Standard

There are various software development life cycle models defined and designed which are followed during the software development process. These models are also referred to as Software Development Process Models. Each process model follows a series of steps unique to its type to ensure success in the process of software development. Every software developed is different and requires a suitable SDLC approach to be followed based on the internal and external factors. This International Standard describes the architecture of the software life cycle processes but does not specify the details of how to implement or perform the activities and tasks included in the processes [6]. The waterfall model [7] identifies system requirements, software requirements, analysis, program design, coding, testing and operations as the primary processes. This model was the first to be used widely in Software Engineering to ensure success of the project. In "The Waterfall" approach, the whole process of software development is divided into separate phases. In this Waterfall model, typically, the outcome of one phase acts as the input for the next phase sequentially. This model allows departmentalization and control, it is simple and easy to understand and use and it has clearly defined stages. It is easy to manage due to the rigidity of the model. Each phase has specific deliverables and a review process. A schedule can be set with deadlines for each stage of development and a product can proceed through the development process model phases one by one. An example of the waterfall model with its sequential phases is shown in the Fig. 3.

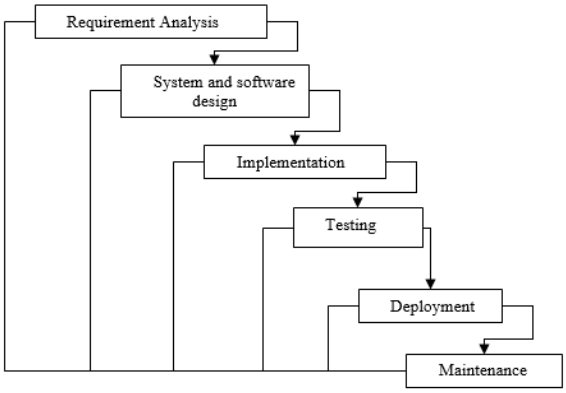

Figure 2. Waterfall model

The Waterfall Model was the first Process Model to be introduced. It is also referred to as a linear-sequential life cycle model. The waterfall Model illustrates the software development process in a linear sequential flow. This means that any phase in the development process begins only if the previous phase is complete [8].

The waterfall model splits complex tasks into smaller, easily manageable subprojects that deliver an outcome that can be inspected. The product of the previous step needs to be inspected and verified and each step must be flawless. Unfortunately, this model is too naive. In practice steps overlap each other: during the design phase, problems of specification are identified, during the implementation phase problems of design are identified and thus the waterfall model is not as streamlined as one would wish.

Because the ISO/IEC 12207 covers the entire life cycle from conceptualization of ideas through retirement, it has to be considered as the software life cycle from different levels of abstraction. We will follow the highest level of the processes as shown in Figure 4. There are different categories of processes that have to be identified [9].

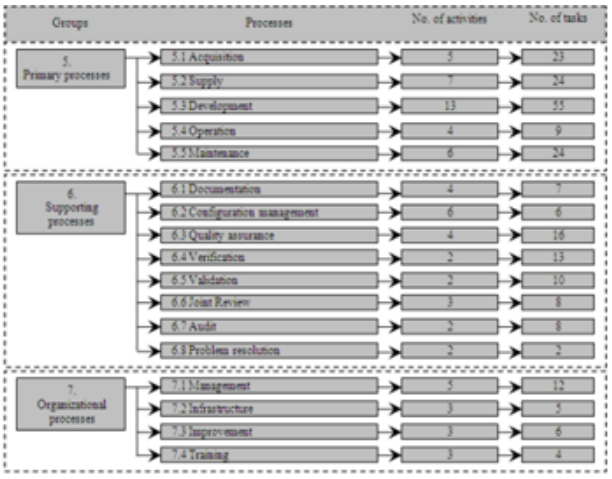

Figure 4. The structure of the International Standard ISO 12207 [9]

For model validation, the explanation of the waterfall model is given, taking into consideration the practical example of software development using RAD methods and standard ISO/IEC 12207 with online store. The walk through of the phases of RAD and explanation of their implementation are given bellow.

-Requirement Gathering and analysis − During this initial stage all involved parties (designers, developers and users) come to a rough agreement on the scope of the project and application requirements, so that future stages with developing can begin. This phase is a combination of system planning and system analysis in the process of SDLC. In this phase are captured all the requirements of the software that is going to be developed and also in this phase are documented all the software requirement specifications (SRS). This documentation should not specify how the software should be done, but how the software should work. The stage of requirement analysis is the most important stage of the process – communication is the key for good further development of the software.

In this phase are indicated all the characteristics of the software - that it will be of public character; products, prices and quantities will be visible to all users of the online store; all the users can leave feedback on the store regarding the products/services; the software will keep data about the product delivery status; the administrators can add, edit or delete products from the store at any time.

-System Design − Based on the specifications of the first phase, the design of the software is prepared in the design phase. This system design helps in specifying hardware and system requirements and helps in defining the overall system architecture. User feedback is gathered with heavy emphasis on determining the system architecture. This allows initial modeling and versions to be created. This step is repeated as often as necessary until an ultimate solution is reached.

The online store will have some performance requirements to satisfy the needs of the users. A large number of users will be able to search and buy products from the store at the same time – the software needs to have an acceptable speed and stable server connections so it can get better performance at peak time. In this phase what should be taken into consideration are the reliability, sustainability, compatibility, portability and other requirements of the software. The store must support hardware and software requirements. In this moment, the capabilities of the platform should also be taken into consideration. The database design also should be created in this stage.

-Implementation − After the system design has begun, the implementation phase is the moment when the most of the actual application coding, testing, and integration take place. Along with system design, the implementation phase is repeated as often as necessary, when a new components are required or alterations are made to meet the software needs. According to system design inputs, the system is developed first in a small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality [10].

The actual process of developing the online store in this phase is happening. The store consists of two components – back end and front end system and it needs to be successfully loaded on the Internet.

-Integration and Testing − All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.

After the coding process has been completed, the next step is testing. Here are implemented different kinds of testing on the store: unit testing, integration testing and validation testing - all this to ensure that the software will work just as it was previously specified.

-Deployment of system − Once the functional and non-functional testing is done; the product is deployed in the customer environment or released into the market. With the other words, the online store is going into production (live) and is available to all the potential users.

-Maintenance − There are some issues which come up in the client environment. To fix those issues, patches are released. Also to enhance the product some better versions are released. Maintenance is done to deliver these changes in the customer environment. Online store is easy to maintain, it just needs a large safety implementation of the users data that is entered in the database, so it can provide security at the highest level.

All these phases are cascaded to each other in which progress is seen as flowing steadily downwards (like a waterfall) through the phases. The next phase is started only after the defined set of goals are achieved

for previous phase and it is signed off, so the name "Waterfall Model". In this model, phases do not overlap

IV. CONCLUDING REMARKS

The standard for software engineering ISO/IEC 12207:2013 usage can bring many potential benefits, especially for software companies any organizations. These improvements are mainly in the software development management processes as well as in certification visibility that can attract a new customers and partners. Some benefits are connected with enhancing partnerships and co-development in a today's global environment. Taking into consideration the standard implementation in agile development processes, they can gain more benefits connected with object oriented programming practices. Also, some benefits come with encapsulation of best practice, avoiding some common past mistakes, establishing a framework for quality assurance process, providing continuity etc.

This paper consider implementation of ISO/IEC 12207 with a Waterfall model with agile development method and explain how the standard can be used with this model, explaining the processes that have to be employed in order to give a suitable framework for manage, engineer, use, and improve software engineering processes in its lifecycle. They have to be managed by carefully selected steps in each phase, defining the processes, activities and tasks that have to be undertaken to successful project implementation [11]. Some other models also have to be analyzed in order to gain a validation of usage of standard of others agile development methods for SDLC.

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Dropout Regularization in Deep Neural Networks Used in Atomic Simulations

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Abstract - Recently deep learning has received significant attention in the research community. That implies the fast development of improved deep learning concepts, which can be applied in variety of domains. In most of the domains the problem of regularization arise. This paper aims to give a breakthrough in understanding the importance of dropout, as an adaptive regularizer that can control the overfitting in deep neural networks. Several aspects of the dropout regularization are discussed. We try to solve the problem of correlation between the adjacent units and propose a new method for regularization of deep neural network designed for atomic simulations, actually for predicting of the energies of small molecules. Also, a theoretical framework of the proposed method is given, followed by the experiments on molecular dynamics dataset. The main contribution of this paper is improving on state-of-the-art results of energy prediction using the equilibrium energies as well as molecular dynamics trajectory on the benchmark dataset.

Key words: dropout, regularization, deep learning, atomic simulations

I. INTRODUCTION

Recently, many real-world data science problems face the difficulty of many factors of variations of influence on every single piece of data we are able to observe. This difficulty can be efficiently solved using a deep neural network. Deep neural networks, as improved concept of standard artificial neural networks, have achieved great success in various domains, such as object recognition and action recognition or automatic colorization in image processing [1],[2]; real-time analysis on behavior in video processing [3]; automatic text and handwritten generation in natural language processing or in machine translation [4]; life sciences, medicine, and health care as an industry [5]; self-driving cars and robotics; voice search and voice-activated assistants in advertising; predicting earthquakes or energy market price forecasting etc. Deep learning can be defined as hierarchical feature learning because of the ability to extract a feature from raw data [6]. Deep learning methods effectively exploit complex, compositional nonlinear functions, learn distributed and hierarchical feature representations, and make effective use of both labeled and unlabeled data [7]. Flexibility of deep learning is based on ability to represent the world as nested hierarchy of concepts, with each concept defined in relation to simpler concepts, and more abstract representations computed in terms of less abstract ones [8]. Also, deep learning can be viewed as scalable learning across the domains, and this refers to the concept of processing in depth. The processing in-depth means that this technique scales with data and model size. [9] Increasing the complexity of the model usually means stacking many hidden layers and over-parameterization. Over-parameterization of deep neural networks has the most influence to the reasons that lead to overfitting. Network with millions of parameters can be easily over fit. The problem also occurs in the case of insufficiency of training data. Overfitting refers to decreasing the ability of generalization of the network. Good generalization mean that the deep neural network has the ability to perform well not just on the training data, but also on new inputs or unseen data. In order to be solved the problem of overfitting different strategies of regularization can be used. The concept of regularization is not so new and works well not only on neural networks but also on linear or logistic regression. Very effective regularization approaches are: regularization by adding parameter norm penalties - *L_2 regularization*, also known Tikhonov regularization, and *L_1regularization*; *data set augmentation* - working new data or injecting noise, *early stopping, parameter tuning or parameter sharing*, and *dropout* [10].

The focus of this paper is on dropout, as an adaptive regularizer for generalized models [11]. The main contribution of this paper is improving on state-of-the-art results on the benchmark data set. In the second section are presented the main concepts of the dropout with some theoretical background. Discussion on some interesting properties is included in this part. The third section describe the methods that are used. The experiments with the obtained results are given in the fourth section. Next is the discussion on the results followed by conclusions and the open issues as a future research directions are also included.

II. BACKGROUND

In general, the regularization mean modification to learning algorithm in order to decrease the generalization error but not its training error. The regularization process deal with the problem of poor prediction performance. Standard regularization strategies include *putting extra constraints* on model, in form of adding restrictions on the parameter values or penalties that express a generic preference; or *design of ensemble methods*, in which combination of multiple hypotheses is done in order to

explain the training data. Deep learning requires a strongly defined estimator for regularization that makes a trade of bias and variance. Dropout, as a regularization method, especially refers to artificial neural networks.

One of the key idea of this paper is to understand why and under what conditions dropout helps in training. Dropout, method introduced by Srivastava and Hinton [10] for solving the problem of overfitting, become very popular since its effectiveness. The contribution of dropout should be in direction of developing flexible solution for high capacity deep neural network. Dropout provides an inexpensive approximation to training and evaluating a bagged ensemble of exponentially many neural networks. [8] That mean, this method includes creating a set of models, or set of fully connected neural networks. The essence of the dropout is bagging approach, introduced by Breiman [12]. Bagging create a set of models that are trained on different subsets of the same training set and the improvement of the performance is done by averaging the prediction results of each model. The difference from bagging is in that each model is trained for only one step and all of the models share parameters. This is very useful in the cases when we work with very big architecture and when we face with the problem of finding optimal hyper parameters values. Dropout regularization is done by combining many different networks by randomly dropping units with a probability p for each training case. Here should be emphasized that, dropping the unit is temporarily removing from the network along with all its incoming and outgoing connections [10], such as activation functions. The removing is done randomly. Fig.1 The idea of dropping out is - every hidden unit to create useful features on its own, without relying on other hidden units to correct its mistakes. Also, dropout strategy can be viewed as putting binary mask on the deep neural network in order to include/exclude some part of it. Dropout is generally viewed as an indiscriminately applicable tool that reliably yields a modest improvement in performance when applied to almost any model. [13] Dropout is most effective when taking relatively large steps in parameter space. One of the most interesting characteristics of the dropout is that allows one to exploit properties of the data (e.g., minimum entry in the diagonal of the Hessian) to ensure robustness and consistency [14].

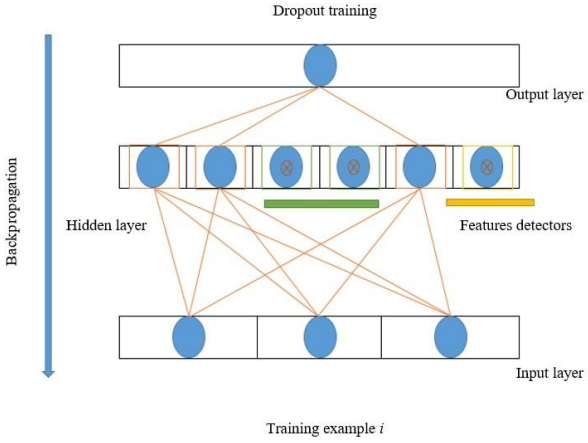

Figure 1. Dropout – removing the hydden units

In [15] dropout is viewed in context of adding a regularization penalty term that grows exponentially with the depth of the network when the more traditional weight decay penalty grows polynomially. Also the authors in [15] proved that the dropout penalty can drive a learning algorithm to use negative weights even when trained with monotone training data. Dropout training is a variant of stochastic gradient descent (SGD) [10] where, as each example is processed, the network is temporarily perturbed by randomly "dropping out" nodes of the network.

III. METHODS

A. Motivation

The dropout procedure usually is viewed as introducing noise or putting mask on each input. That is actually for each new training case, during the forward pass, randomly zeroing each dimension of the network layer with probability p_d, where p_d is the dropout rate. Standard dropout use fixed probability for omitting a unit.

In atomic simulations the dependencies between the molecular dynamics descriptors are too complex and the fixed probability may cause excluding the influence of some relationship between the descriptors. The motivation is using deep learning to achieve good predicting performance followed by obtaining quantum-chemical insights that are results of the interactions. The insights are out of the scope of this paper, but are analyzed in details in [23, 24, and 25]. The aim is to expand the possibilities of deep neural networks with new way of regularization using dropout, in atomic simulations.

Since data augmentation, as a regularization technique, is not feasible to be done in the case of molecular dynamic simulations, improved dropout is promising technique. Several improvements of dropout are realized in [13], [16], [17], [18], [19], [20] but application in domain of atomic simulation is missing, since the specific adjustment that should be done.

B. Proposed approach

The proposed approach differs from standard dropout in assigning not a constant probability of omitting hidden units in the training. The hidden units are divided according to the group of atomic descriptors. Since, each group of hidden units has different contribution to the network performance, different probability for each group is assigned. The need of different probability is implied by possible losing information for specific relationship between the descriptors, if we exclude unit with a high activation value. Usually high activation value indicates important feature. The probability of dropping out units depend on the molecular energy rang. Another difference is related to the behavior of hidden nodes that are organized in feature maps. In feature maps all units share the same set of weights in order to extract a certain feature by performing the same operation on all different parts of the input. The strong correlation between the adjacent units is avoided although there is exist a correlation between the feature maps. Each feature map is related to the group of

the molecular descriptor. Feature detectors are created by the different probability p_{di}. The index i of the probability refers to group of descriptor.

On Fig. 2 is presented the architecture of the deep tensor neural network [23] for predicting the energies. Each atom type corresponds to a vector of coefficients $\boldsymbol{c_i^{(0)}}$, which is repeatedly refined by interactions $\boldsymbol{v_{ij}}$. The interactions depend on the current representation $\boldsymbol{c_j^{(t)}}$, as well as the distance D_{ij} to an atom j. After T iterations, an energy contribution E_i is predicted for the final coefficient vector $\boldsymbol{c_i^{(T)}}$.

Our model contains of two components. The first component in which is included the proposed dropout approach is training, and the second is inference with dropout.

Training the model begins by selecting an example from the training set and extracting features from that example. These features are input to dropout layer where a mask matrix is drown from *multinomial* distribution with different probabilities for different units. This is one specification of the proposed approach, since usually dropping out is done using the *Bernoulli* distribution. Multinomial distribution allows fast training, which is one of the advantage of our method. Network training, as a dynamic process, requires not a fixed probability of retaining a neuron, not only since the dependency of molecular energy rang, but also since treating the negative co-adaptations phenomenon.

C. Data

This data set consists of molecular dynamics trajectories of 113 randomly selected $C_7O_2H_{10}$ isomers [21]. First the encoding of the molecules is done in order to be eligible for the input of the neural network. The input vector includes molecular geometries as *xyz* trajectories, and energies valence densities, additional - consistent energy calculations of all isomers in equilibrium are included. All trajectories are calculated at a temperature of 500 K and a resolution of 0.5 fs. The molecules have different sizes and the molecular potential energy surface exhibit different levels of complexity. In order to avoid problem of data incompleteness standard preprocessing techniques are performed.

D. Experiments

We evaluate proposed approach with benchmark of quantum-machine dataset. The dataset is obtained from the repository [21]. The experiments are conducted using Keras – the Python deep learning library [22], because it is minimalistic, modular, and awesome for rapid experimentation. We do not use additional regularization technique. That can be a future research work, in order to be done the comparative analysis between the different types of regularization. In order to obtain stable results, we train four independent networks, and report 95% confidence interval values.

E. Results

In the Tab.1 are given the results obtained from the experiments. As a performance measure it is used mean absolute error. From the Tab.1 we can see that, deep neural network with the proposed dropout approach (*dropAD)* offer a higher accuracy performance. The good accuracy performance is due to including the relationship between the descriptors, forming groups of it. We can see that the mean absolute error for energy prediction is decreased using dropAD method. The difference between the compared models is in the range from 0.1 to 1.9. Even this small improvements has big contribution especially in molecular dynamics simulations.

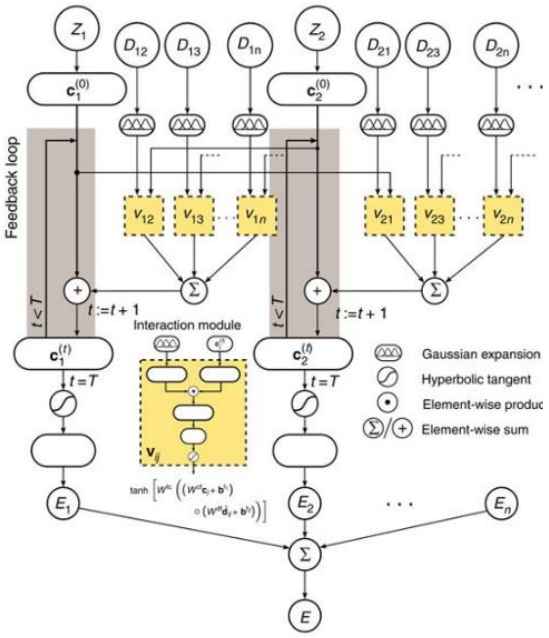

Figure 2. Deep network architecture [23]

IV. Conclusion

In this paper is given a breakthrough in understanding the importance of dropout, as an adaptive regularizer that can control the overfitting in deep neural networks. Basic features of dropout are discussed, with recalling the related work to it. The motivation of the proposed approach, that introduce different way of regularization using dropout method, is applying deep learning to achieve good predicting performance in obtaining quantum-chemical insights of the interactions on atomic level. The insights are out of the scope of this paper. The aim is to expand the possibilities of deep neural networks with new way of regularization using dropout, in atomic simulations. In this work is present different dropout approach. The experiments show that the proposed approach result with better prediction performance in predicting the isomer energies. Open issues for the research work presented here are strong mathematical justification of the method, and optimization of hyper-parameters values through validation process.

TABLE I. Mean absolute errors (in meV) for energy prediction

	Benzen	Saliylic acid	Malonaldehyde	Toluene
DTNN [23]	1.7	21.7	8.2	7.8
dropAD	1.5	19.8	8.1	6.4

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E-health, Need, Reality or Mith for R.of Macedonia

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Abstract – The constant unstoppable trend of outpouring of medical staff in R. of Macedonia reduces the quality of public health service, especially in areas with a small number of inhabitants and people with disabilities. For this reason, the paper analyzes the current situation and proposes some possible improvements in actual healthcare system with usage of IT, using e-health concepts, also supported by CROSS4ALL IPA2 Project. The project's outcomes do not tend to be connected at this moment with state healthcare system, nor to enrich the state health care information system, but they give some possibilities for improvement of the model and add a new possible enrichments in the three levels of healthcare systems in R. of Macedonia, easy applicable in the other countries, especially in cross border areas. The proposed model includes integration of data in the base level.

I. INTRODUCTION

The trend of reducing the number of medical personnel in the R. of Macedonia, especially medical practitioners and specialists, demands some strategic thinking about the medical healthcare system and treatments that are offered in the R. of Macedonia in the future. The constant unstoppable trend of the outpouring of young doctors and experienced public health specialists constantly reduces the absorption factor of hospitals, the quality of services for citizens and the satisfaction of medical workers, primarily for doctors. Computerization of administrative matters for general practitioners and specialists did not bring any drastic improvements although the Health Strategy envisaged obtaining a more efficient public health service in Macedonian case. The responsibilities of general practitioners and specialists have increased as a result of extensive administration procedures and because of the incompatibility of all health information systems at the three levels: primary, secondary and tertiary. Such a constellation and relationships as well as populist campaigns, where the whole system is not taken into consideration, with great support from information services and some journalists, have led to great dissatisfaction among healthcare workers who have been constantly under the public pressures and attacks, shifting all health problems to the ultimate participants without arguments, so as not to pinpoint the main culprit (tricks) for the situation in health service in R. of Macedonia that is continually getting worse and worse [19]. If we add to these facts the low income of medical staff who, as a drop of overflow, affect the constant outflow of doctors from R. of Macedonia. All mentioned facts contributed to the great dissatisfaction and lack of motivation of the medical staff in the R. of Macedonia and their employment in countries with higher incomes and absorption power of medical professionals.

As actually there is no improvement in health conditions and already existing staff in healthcare institutions is constantly decreasing both because of the outflow of staff and because of its aging and retirement, we should be thinking how to improve the healthcare, health protection of the population through the introduction of emerging technologies such as e-health services.

The term e-health or e-healthcare covers a wide range of opportunities for citizens using IT technologies. However, the implementation of such technologies requires an educated population that will have a higher level of health literacy and awareness of the opportunities offered by IT technologies for healthcare [18]. The concept itself includes distance treatment (e-telemedicine, e-health, m-health), contacts between patients and doctors through collaborative technologies for remote patients, measurement of patient's vital parameters through appliances that are connectible and compatible, and store the measured data results in databases, available for their general practitioners that can use them for e-prescribing of drugs, issuing e-referrals, creating electronic records for patients and many other services. These activities called e-health, e-telemedicine services or "medicine at a distance" can increase the quality of life of the people, especially those with disabilities, elderly people or children. There have been many EU activities in the last decade that tent to improve the living conditions of the population in general, accenting older population, children and people with disabilities. This is because of the aging of population as well as the application of the "equal treatment for all people" principle, which prefers implementation of some EU standards for living conditions improvement. For this reason, applying of IT technologies in the living condition improvement and implementing of some improvements in health services as e-health is very important and desired nowadays.

Because of the importance of the concept of e-health, this paper analyzes the situation in R. of Macedonia, proposing some solutions for the problems. The paper is structured as follows. After the introduction, some issues related to the current needs and running project outcomes are taken into consideration. The next section is dedicated to

explanation of the project plan and suggests some improvements with the project activities and the proposed e-health model. Some recommendations are given in this paper for connecting the CROSS4ALL IPA2 project activities with the state healthcare system. Finally, the project influence and concluding remarks are given.

II. RELATED WORKS

Many authors consider e-health systems as needed help for many areas where the people do not have access to suitable healthcare institutions as well as quality of healthcare systems [2, 5, 6, 17]. This is especially the case in rural, mountain and inaccessible areas that cannot be covered by appropriate healthcare systems [11, 12].

Many authors explain some improvements of healthcare system with usage of emerging IT technology [8, 9] providing telemedicine in the different areas as psychology, cardiology, radiology, surgery with robots on distance etc. [12]. The trend of growing needs for appliances for many vital issues, brings a huge industry of such devices [4], some of them being approved by the Federal Drug Association (FDA) and some not [14]. The next emerging trend is how these appliances should be connected to mobile phones and provide information for medical staff in order to increase the patient satisfaction and to unlock the ability of medical workers to help patients remotely [13].

Some authors consider e-health from holistic point of view and highlight the need of education for e-health and healthcare literacy [15]. There are also efforts to specify what the patients have to know and where this knowledge can be found [1].

Some concepts include usage of Cloud [10] that implies the opportunities for usage of new technologies as Internet of Things (IoT) and Ambient Assisted Living [2]. These concepts increasingly change the living conditions. This is very important when the vulnerable groups are taken into consideration [15].

There are a lot of papers connected with assisted ambient living connected with e-health. They state that the accessibility is in very high level taking into consideration the people with disabilities, elderly people and children in the distant location from cities and urban zones [10, 2].

III. ANALYSIS OF THE REALISTIC NEEDS AND PROJECT OUTCOMES

Many citizens and inhabitants live in rural areas without a good health treatment and incidentally do not have access to general practitioners and specialists. They have indeed a need of some e-health capabilities [2] as well as some people with disabilities [15].

The mentioned Cross4all project [13] is actually based on this issue and tend to improve some health inequality in the cross border area. One of the objectives of the project is to design innovative practices to improve access to vulnerable groups and establish mechanisms focused on home counseling and offer innovative tools and services for better management in health, as tools for e-health services, e-referral, e-prescription etc. The project includes multidisciplinary teams of experts who will be trained and equipped with kits (sets of wireless and smart devices) in order to make a diagnostic pre-assessment, e-prescription, e-referrals and the needed reports. The project provides an opportunity for implementation and evaluation of mobile-based healthcare and propose further modifications in the development of the project "My Term" [16], developed by the Ministry of Health of the Republic of Macedonia.

How is all this conceived and how should it be done?

In the beginning, mobile sets will be set up in selected vulnerable groups of patients, in rural areas where the situation is lack of patients' access to health institutions. The sets will be made by the devices for measurement of blood pressure, glycaemia, blood oxygen and single-channel ECG devices for monitoring of cardiac arrest - acceleration or slowing down of the heart as well as irregular heart rhythm. After 5-7 days, mobile team will visit these patients again and maybe will acquire the data on the mobile device - tablet, (if there is not direct link with cloud) and transfer the data in the form suitable for accepting from the created Cloud platform for this project. All devices for measuring vital parameters will be FDA approved or cleared.

Fig.1 Patient with measurement instrument, optionally mobile device or tablet, optionally connected on Cloud

IV. PROJECT PLANN AND SUGSTED IMPROVEMENTS

Taking into consideration project's activities, each patient who wants to participate in the CROSS4ALL project, has to sign a consent for participation for the project, gaining ID that will be used for all patient's reports, stored data retrieval, data for all consumed drugs in the period and for the project purpose, lab results and other methods made by them as Rtg, EHO, CT and etc., during the project duration. The experts will download cloud data and based on them will further recommendations, advice, referral or prescription will be given. (Fig.2).

Fig.2 Relations between physicians and patient

The first phase in e-health services introduction is certainly education of the population in the area, taking

into consideration the possibilities that e-health services can provide. The education of the population can be done through usage of web site intended for this project. This web site has to be accessible for all people in the area, and according to standards taking into consideration elderly people, children and people with disabilities.

The next important factor for e-health improvement is educating health professionals about the possibilities of new technologies and improving their accessibility through their education for the use of new technologies. The mobilization of medical staff with purpose of increasing their effectiveness and efficiency should be linked to their motivation to use e-health services and to think how to serve patients in the fastest and most appropriate way.

One of the most important factors (maybe the most important one) is the involvement of the Ministry of Health and the Health Insurance Fund in these processes through the introduction of e-government's e-health services and their conditional integration with all health systems in order to avoid the hinder of the processes of introducing e- health in the R. of Macedonia.

Of course, some prerequisites for introducing e-health services are required. First of all, the secure Internet access is required for all general practitioners and specialists, institutions as well as patients. Telecommunications need to connect all devices from vital signs measurement kits (measuring apparatus, devices and laboratories), the devices from the health institutions, as the kits from devices given to the patients as well as kits from the mobile teams. All patient data should be acquired and stored in some cloud location in order to ensure that security standards will be satisfied and the patient data are protected from unwanted access or patient data stealing.

V. Analysis of "My Term" IS and Possible Improvements with Project Activities

We are convinced that the project will be successfully implemented and the results will be presented to the authorities responsible in the Ministry of Health and we believe that it should produce some changes and improvements to the actual state healthcare system "My Term". In this system, the primary and secondary or tertiary health systems are separated. Their functionality is as follow:

In the Primary healthcare system, there are records with personal data, records with data for given therapy (for acute and chronic diseases) and possibility for printing mentioned documents. There is also possibility for e-referral to specialists and labs and printing of mentioned referral document (Figure 3). Prescribing drags is also one of the possibility of this part of healthcare system.

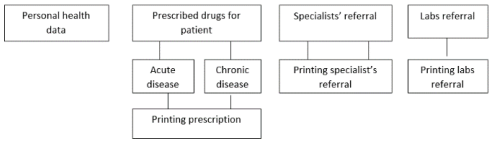

Fig. 3 Primary healthcare system functions

In the Secondary healthcare system, there is personal data that can be reviewed by the specialist for acute and chronic diseases therapy, but there is no possibility for printing. Also, there are possibility for gaining reports and reviewing the reports from specialists, diagnostic, laboratory and hospital reports and creating a new referral to other departments or labs (Fig. 4).

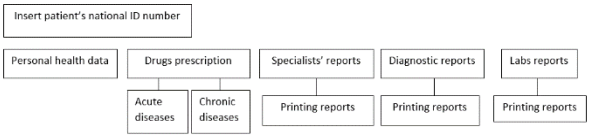

Fig.4 Secondary healthcare system functions

The current setting and system arrangement is connected with institution and patients cannot get their data. The records exist, but there is no permission for state authorities or law for using the data from patient's side. The proposed model has to be changed in order for the healthcare to be compliant with the EU standards for healthcare and to have possibility for the patient to have his own Electronic Personal Health Record (EPHR) at disposal. This concept has to be supported by Macedonian authorities in healthcare, taking into consideration the strong security standards in the direction of developing the black chain technology. If the concept is acceptable for Macedonian healthcare authorities according to EU standards and law, some privilege for accessing healthcare data from the patients should be allowed in order to have access to their own data. In our case with CROSS4ALL activities, the patient can give the permission to the selected appropriate healthcare practitioner to use their data for this purpose and to store them on CROSS4ALL Cloud.

The medical practitioners who will be hired on the e-health project, would return the reports, recipes, referrals and advice to the patients through the cloud platform (Fig. 5) as e-referral and e-prescription. The final model is shown on Fig.6.

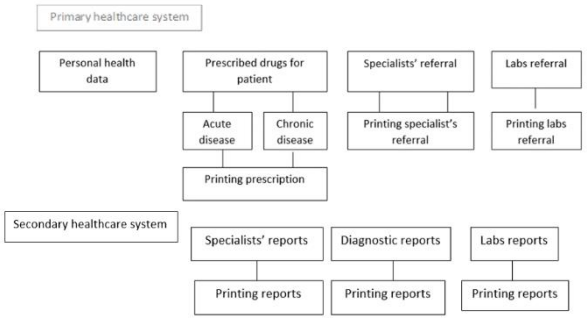

Fig.5 Integrated team for e-health

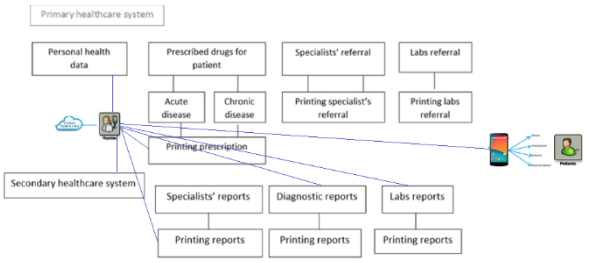

Fig.6 The final proposed model for state health (and e-health) system

VI. Concluding Remarks

The paper aims to highlight some aspects of usage of e-health system in the R. of Macedonia taking into consideration the actual Macedonian healthcare system and the running IPA 2 project CROSS4ALL that is also included in the Greek healthcare systems [3]. The project intends to increase the usage of e-health and digital literacy in R. of Macedonia as well as in cross border area. Also, the planned activities have to provide a real base for usage of some e-health concepts in the area. The usage of e-health in the region aims to prove that in the R. of Macedonia it is possible to implement some e-health element as vital sign measurement instrument kits for remote area citizens in order to increase the access to healthcare and medical services for some vulnerable groups of people as elderly people, children or people with disabilities.

There is a growing need for education of population in the area for e-health possibilities as usage of mobile devices in the patient's homes. The owners of these devices would send this data on Cloud platform, and a team of doctors will review these data and give some recommendations and reports for further treatment of the patients. E-prescription has to be the next step which has to be provided through this platform and will enable for the patient therapy to be printed at home. Also, e-referrals will be the next step of improvement of this e-healthcare system. The problem with the eventual charging of the services (co-payments) can be solved with usage of system that will use a credit or debit card.

Taking into consideration the actual activities on the three layers' Macedonian information system, the model of integration of project activities with state healthcare information system are proposed.

The final consideration has to be done by the Ministry of Health, which can provide the institutional training for the general practitioners, specialists of the secondary or tertiary healthcare system and specialized teams that have to support the implementation of the proposed model.

Taking into consideration CROSS4ALL planned activities, and influence which it needs to have of the healthcare system in the Republic of Macedonia, e-health can be very well used, and certainly satisfaction would be double-sided - both for the doctors and for patients.

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Virtualization in e-Government

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Abstract: This paper explains the business model of e-Government which is based on the technology of data virtualization. The methods by which this technology can be realized are also presented, as well as the way in which it can be applied. From the perspective of security, general advantages and disadvantages of virtualization technology have been presented. The paper also provides an overview of some of the most common software solutions for virtualization, where VMware software is presented in more detail.

Key words: e-government, virtualization, modern technologies, safety, software, VMware

I. INTRODUCTION

Sharing the data in the State Government Sector is not a new topic, but in the modern era of networking, smart devices and technologies that enable huge data warehouses, this problem requires new and different solutions. For these reasons, data sharing model based on data virtualization technology has been developed in a State Government Sector. Data sharing is the ability of two or more programs, workstations, or users to access the same data. It can be consecutive or simultaneous access to data. From the data sharing model in the State Government Sector is expected to enable the sharing of information of public importance, the sharing of open data, and the sharing of other important data to G2G (Government to Government), G2B (Government to Business) or B2B (Business to Business) relations.

In recent years, virtualization has been present in the implementation of various computer systems, and the State Data Center in the Republic of Serbia also applies virtualization technology in carrying out its business activities. State Data Center in the Republic of Serbia is a physical and virtual infrastructure whose purpose is to store computers, servers, network and security systems necessary for the functioning of e-government. [1]

II. VIRTUALIZATION

A. *What is Virtualization?*

In a broad sense, virtualization is a concept which describes techniques and methods for abstracting computer resources. Virtualization of computer resources provides us the ability to have multiple virtual servers on one physical server, and also to merge several different physical resources into one logical (virtual) whole. It is achieved by installing virtualization software (hypervisor) on the physical computer (server).

The idea of the implementation of data sharing model in State Government Sector is that all state authorities can offer their data sources, which will be integrated into a single, virtual data source. This model offers a simpler way to set up the query criteria and manipulate Data in databases, because the process of abstraction identify only important aspects of a resource and ignores the technical details about it.

Essential characteristics of virtualization:

- an abstract layer between the hardware and the applications that are being used,
- reducing the price and complexity of the system,
- isolation of computer resources in order to increase security and reliability,
- removing redundancy (removing unnecessary hardware) and optimizing the use of IT infrastructure.

B. *Virtual Machine*

At the lowest level of virtual machines, there are hardware, and above hardware is the VMM (Virtual Machine Monitor), also known as a hypervisor. A Virtual Machine Monitor is a specific virtualization software that is responsible for managing hardware resources and arbitration of the operating system requirements or the applications that are running on them. A VMM ensures that each of these operating systems has the impression that it has its own memory, hard drive, processor, and other important resources. The concept of arbitration means that a hypervisor manages resources and cares that there is no interference between operating systems.

There are two basic types of virtualization which depend on how the hypervisor is implemented: type 1 (Bare-Metal Architecture) and type 2 (Hosted Architecture).

Type 2 Virtualization (Hosted Architecture (Fig. 1)) requires that the operating system must be installed on computers, and the virtualization software (hypervisor) is installed on operating system. This type of architecture requires that each virtual machine creates a special virtual environment, which requires allocating pre-defined amount of memory and hard disk space for each VM.

Type 1 Virtualization (Bare-Metal Architecture (Fig. 2) is advanced type of this technology in which the hypervisor is located as a layer between hardware and the operating system. In this case, a hypervisor creates partitions, where on each partition it is possible to install different operating system that accesses physical hardware through a hypervisor. In this way, resources are allocated dynamically depending on the needs of virtual machines.

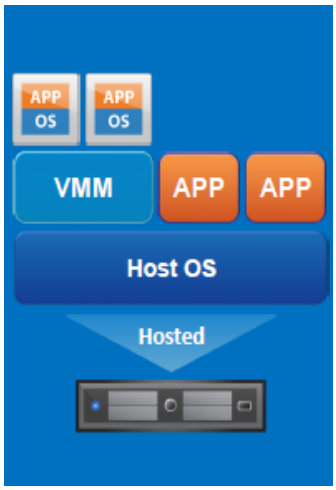

FIGURE 1. HOSTED ARCHITECTURE

C. An Overview of Virtualization Techniques

- Full virtualization – it is possible to install several different virtual operating systems on the physical server. They are separated from the physical host layer by hypervisor layer.
- Hardware-assisted virtualization – this virtualization technique improves the efficiency of complete virtualization by introducing processors, memory and other hardware components that are specially designed and modified to ensure maximum performance in virtual environments.
- Paravirtualization – virtual environments communicate with the host operating system through the hypervisor. The host operating system provides hardware information to virtual environments. An virtual operating system drivers and hypervisor drivers are interconnected to allow virtual operating system to have access to the hardware. With this virtualization technique, the simulation of the complete hardware is not necessary, so the performance is better.
- Operating system-level virtualization – it is possible to install multiple virtual operating systems on a single host. It is important that the operating systems are the same.
- Application Virtualization – an emulator is a software layer located between applications and the operating system which provides an emulated environment. Successful execution of applications may depend on the operating system on which it is executed and its components. Therefore, there may be mismatches and problems in execution of application, and in this case, the emulated environment is a protective interface that solves the problem of incompatibility of applications with the operating system.
- Desktop Virtualization – a physical machine is virtualized through a client / server model, where almost all processes are executed on a server with powerful hardware, so for a client is enough to have cheap computer to access to server from the client side.

FIGURE 2. BARE-METAL ARCHITECTURE

- Network Virtualization – allows the virtualization of a physical network to get more virtual networks or merging multiple physical resources into one virtual network.
- Memory Virtualization – this technique allows to reserve memory on the hard disk that the operating system can use as additional RAM. When the physical RAM resources are used up, it switches to the use of reserved memory as RAM.
- Data Virtualization – it is possible to access to logical or physically data sources located in different locations, in such a way that the user has the impression that all data is stored in one location.

- Storage Virtualization – data storage devices on multiple physical locations are viewed as a unique storage location.

D. *The Advantages and Disadvantages of Virtualization*

The advantages of switching to a virtual environment are plentiful [2]:

- Reducing costs. More efficient use of computer resources leads to a significant reduction in costs.
- A simpler way to backup. It is possible to back up the entire server, also backups of individual operating systems on the server. The recovery is much faster and simpler.
- Reducing heating. By virtualization it is achieved that fewer physically present servers run the same number of services. In this way, the problem of heat generation is solved.
- The safe way to testing. It is possible to test the most risky procedures and make critical mistakes without any consequences.

Virtualization also has some disadvantages:

- In the event of a fault or malfunction on a server, all virtual machines become inaccessible.
- Virtualization requires powerful servers that support virtualization technology, which creates additional costs, but it is also cost-effective when looking at the long-term.
- For new technologies we need professionals who understand this, so we need to provide education for IT staff, which will prevent, minimise and eliminate any system downtime.
- It may also be a problem when the number of servers can be higher than the number of administrators who maintain them.

III. OVERVIEW OF MOST POPULAR VIRTUALIZATION PLATFORMS

- Oracle VM VirtualBox is a freeware and open-source hypervisor software for x86 virtualization. Additional guest operating systems can be installed on this platform, each in its own virtual environment that is independent of other.
- Microsoft Virtual Server 2005 R2 provides a virtual operating system that allows to increase hardware utilization and quickly configure and run virtual machines.
- The standalone Microsoft Hyper-V Server 2008 variant does not require an operating system. The main advantages of this software are reliability, cost-effectiveness and optimized virtualization solutions that help organizations to improve server utilization and reduce costs.
- XenServer is a freeware and open source hypervisor software. XenServer is a bare-metal hypervisor that does not require an operating system on the host. More specifically, when XenServer is installed on a computer without an operating system, it becomes a host operating system on which virtual machines will be installed.

IV. VMWARE

An overview of existing VMware products:

- VMware Workstation allows users to run multiple virtual machines with x86-x64 operating systems on a single physical computer. It is most popular VMware software and it is not free (it can be used for free for 30 days during the trial period).
- VMware Player is software for non-commercial (personal) use. It is free and available online for download.
- VMware GSX Server is a free product. A host operating system is required for its installation. It has fewer options than VMware Workstation, but that's because it's available for free..
- VMware ESXi is a bare-metal hypervisor that installs directly onto a physical server. ESXi is not a software application that is installed on an operating system, instead, it includes and integrates vital operating system components. With direct access to and control of underlying resources, ESXi is more efficient than hosted architectures and can effectively partition hardware to increase consolidation ratios and cut costs for users. The main advantage is that minimizes hardware resources needed to run hypervisor for cost savings and more efficient utilization.

V. CONCLUSION

The e-Government development in many countries are at different stages, which depends on the state budget, but also on the willingness of citizens and employees in state organizations, enterprises, etc. to accept modern technologies as part of everyday life.

Virtualization technology as a business model of e-Government, provide the opportunity for better resource utilization and low-cost ways to improve business operations. This will reduce costs and increase the efficiency and user satisfaction. Also the importance of benefits such as data integrity, acceleration of processes and the flexibility of these technologies should not be ignored. The most common question, which relates to business using ICT technology, is security, therefore, there is a need to create new laws and regulations in data transfer field..

Considering the benefits of virtualization this technology are currently the best options for e-Government.

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Development of a component-based, media data processing and classifying system powered by Artificial Intelligence, accessible via Web API

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Natural Language Processing (NLP) is a route for computers to examine, comprehend, analyze and get significance from human language in a smart and valuable way. By using NLP, engineers can compose and structure information to perform tasks like sentiment analysis, translation, speech recognition, named entity recognition, topic segmentation and automatic summarization. NLP is described as a difficult issue in software engineering. Human dialect is rarely exact, or evidently spoken. To comprehend human language is to understand the words, as well as the ideas and how they're connected together to make meaning. Despite language being one of the most effortless things for people to take in, the uncertainty of it is the thing that makes regular dialect handling a troublesome issue for computers to ace. NLP is utilized to analyze content, enabling machines to comprehend how humans talk. This human-PC association empowers genuine applications like sentiment analysis, stemming, relationship and topic extraction, summarization, parts-of-speech tagging, named entity recognition and more. NLP is ordinarily utilized for content mining, automated question answering, and machine translation.

I. INTRODUCTION

Natural Language Processing (NLP) is a tract of Artificial Intelligence and Linguistics, gave to put forth computers to comprehend the expressions or words written in human dialects. Natural language processing appeared to facilitate the client's work and to fulfill the desire to speak with the computers in normal natural language. Since every one of the clients may not be knowledgeable in machine particular languages, NLP caters those clients who don't have enough time to learn those languages. [1]

A language can be characterized as an arrangement of principles or set of symbols. The symbols are joined and utilized for passing on data or broadcasting the information. Natural Language Processing essentially can be divided into two sections i.e. Natural Language Understanding and Natural Language Generation which develops the task to comprehend and create the content.

This paper presents the processes and the methodologies used in the development of a component-based system for processing and classifying media data, with utilization of Artificial Intelligence methods such as Naive Bayes Classification and TF-IDF methodology.

II. NATURAL LANGUAGE PROCESSING

Linguistics is the study of language which incorporates Phonology that alludes to sound, Morphology word arrangement, Syntax sentence structure, Semantics syntax and Pragmatics which alludes to comprehension.

The grammar can be extensively categorized in two levels: Higher Level which incorporates speech recognition and Lower Level which relates to natural language. A couple of the researched assignments of NLP are Discourse Analysis, Co-Reference Resolution, Named Entity Recognition, Automatic Summarization, Optical Character Recognition, Machine Translation and so forth. A portion of these tasks have coordinate true applications, for example, Named entity recognition, Optical character recognition, Machine translation and so on. Automatic summarization delivers a justifiable summary of an arrangement of content and gives summaries or detailed data of content of a known type. Co-reference resolution alludes to a sentence or bigger set of content that figures out which word alludes to the same object. Discourse analysis alludes to the task of distinguishing the discourse structure of associated content. Machine translation alludes to automatic translation of content starting with one human language onto another. Morphological segmentation alludes to the partition of an offered word to its individual morphemes and recognizing the class of the morphemes. Named entity recognition portrays a stream of content and figures out which items in the content identify with legitimate names. Optical character recognition (OCR) gives an image representing printed content, which helps in determining the related content. Part of speech tagging depicts a sentence and determines the grammatical part of speech for each word. A portion of the assignments, for example, co-reference analysis, automatic summarization etc. are used as subtasks that are utilized in solving larger tasks.

The objective of Natural Language Processing is to suit at least one strengths of an algorithm or system. The metric of NLP on an algorithmic framework takes into account the incorporation of language understanding and language generation. It is even utilized in multilingual event identification system for cross-lingual event extraction for English, Dutch and Italian texts by utilizing distinctive pipelines for various languages. The system joins a particular arrangement of premier multilingual Natural

Language Processing (NLP) tools. The pipeline incorporates modules for essential NLP processing and in addition further developed tasks, for example, cross-lingual named entity linking, semantic role labelling and time standardization. Subsequently, the cross-lingual system takes into account the interpretation of events, members, areas and time, and also the relations between them. The yield of these individual pipelines is expected to be utilized as an input for a framework that generates event centric knowledge graphs. All modules behave like UNIX pipes: they all take standard input to do some annotation, and create standard output which thusly is the input for the following module pipelines. Every one of them are built with an information driven design so modules can be adjusted and replaced. Besides, modular architecture takes into consideration distinctive configurations and dynamic distribution.

A. Levels of NLP

The 'levels of language' is a standout amongst the most informative techniques for speaking to the Natural Language Processing which produces the NLP content by acknowledging Content and Sentence planning and Surface Realization stages.

Linguistic is the science which includes significance of language, dialect context and different types of the language. The different critical terminologies of Natural Language Processing are:

1) Phonology

Phonology is the part of Linguistics which alludes to the systematic course of sound. The term phonology originates from Ancient Greek, the term phono- meaning voice or sound, and the suffix –logy alluding to word or speech. Phonology incorporates semantic utilization of sound to encode significance of any human language.

2) Morphology

The diverse parts of the word that represent the smallest units of importance are known as Morphemes. Morphology which includes Nature of words, is initiated by morphemes. A case of a Morpheme could be the word pre-cancellation which can be morphologically examined into three separate morphemes: the prefix pre-, the root cancella, and the postfix -tion. The understanding of a morpheme remains the same over every one of the words. To comprehend the significance, people can break any obscure word into morphemes. For instance, including the addition –ed to a verb, passes on that the action of the verb took place in the past. The words that can't be partitioned and have importance independent from anyone else are called Lexical morphemes (e.g.: table, seat). The words (eg. -ed, -ing, -est, -ly, -ful) that are joined with the lexical morpheme are known as Linguistic morphemes (eg. Worked, Counseling, Smallest, Likely). Those grammatical morphemes that happen in blend are called bound morphemes (eg. -ed, -ing). Syntactic morphemes can be isolated into bound morphemes and derivational morphemes.

3) Lexical analysis

In the Lexical analysis, people, and additionally NLP frameworks, interpret the importance of individual words. Different kinds of handling present to word-level comprehension – the first of these being a part-of-speech tag to each word. In this processing, words that can act as more than one part-of-speech form are doled out the to the most plausible part-of-speech tag, based on the context in which they occur. At the lexical level, Semantic representations can be supplanted by the words that have only one meaning.

4) Syntactic level

This level underscores to examine the words in a sentence in order to reveal the grammatical structure of the sentence. Both punctuation and grammar are required in this level. The output of this level of handling is portrayal of the sentence that contains the basic structural connections between the words. Not all NLP applications require a full parse of sentences. Syntax structure passes on importance in many languages since order and reliance add to meaning. For instance, the two sentences: 'The cat chased the mouse.' and 'The mouse chased the cat.' vary just regarding language structure, yet pass on very unique and different implications.

5) Semantic analysis

In semantic analysis, most people believe that in it, the meaning of the words is resolved. Be that as it may, it isn't. It is every one of the levels that pass on the importance. Semantic processing decides the conceivable implications of a sentence by turning on the associations among word-level implications in the sentence. This level of processing can consolidate the semantic disambiguation of words with numerous implications. For instance, among different implications, 'file' as a noun can mean either a cover for papers, a device to frame one's fingernails, or a line of people in a queue. The semantic level examines the words for their lexicon explanation. Most words have more than one meaning, yet we can detect the suitable one by taking a look at the rest of the sentence.

6) Discourse

While syntax and semantics manage sentence-length units, the discourse level of NLP manages units of content longer than a sentence i.e., it doesn't decipher multi sentence messages as simply grouping sentences, each of which can be explained independently. Rather, discourse centers around the properties of the content overall that pass on importance by making associations between part sentences. One of the most widely used techniques is the Anaphora Resolution - the replacing of words, for example, pronouns, which are semantically stranded, with the relevant substance to which they allude.

7) Pragmatics

Pragmatics is concerned with the firm utilization of language and uses stub well beyond the stub of the content for understanding the objective and to clarify how additional significance is perused into writings without truly being encoded in them. This requires much world information, including the comprehension of expectations and intentions, plans and objectives. [2]

III. NAIVE BAYES CLASSIFIERS

Naive Bayes Classifiers are a set of classification algorithms in view of Bayes' Hypothesis. It's not just a single algorithm, but a group of algorithms in which all offer a unique guideline, i.e. each pair of features being classified is autonomous of one another.

For a some kinds of probability models, Naive Bayes Classifiers can be trained proficiently in a supervised learning setting. In numerous applications, parameter estimation for Naive Bayes Models utilizes the technique for greatest probability; as it were, one can work with the Naive Bayes Model without tolerating Bayesian probability or utilizing any Bayesian methods. [3]

As expressed in [4], the fundamental Naive Bayes supposition is that each element makes an independent and equivalent commitment to the result. We accept that no combine of highlights are reliant to one another. The features are thought to be autonomous. Also, each component is given a similar weight (or significance). None of the qualities is insignificant and is thought to contribute equally to the result.

The Naive Bayes presumption says that the probabilities of the diverse event (i.e. predictors attributes) are totally autonomous given the class value. (i.e. knowing the estimation of one property says nothing in regards to the estimation of another if the class is known). [5]

A. Bayes' Theorem

Bayes' Theorem finds the likelihood of an event happening, given the likelihood of another event that has already happened. Bayes' theorem is expressed numerically as the following equation:

$$P(A|B) = \frac{P(B|A)\,P(A)}{P(B)} \tag{1}$$

where A and B are events and P(B) ? 0.

B Essentially, we are endeavoring to discover likelihood of event A, given the event B is valid. Event B is additionally named as evidence.

P(A) is the priori of A (the prior probability, i.e. likelihood of event before evidence is seen). The proof or the evidence is a characteristic estimation of an obscure occurrence (here, it is event B).

P(A|B) is a posteriori probability of B, i.e. likelihood of event after proof is seen.

Now, we can apply Bayes' theorem in the following way:

$$P(y|X) = \frac{P(X|y)\,P(y)}{P(X)} \tag{2}$$

where, y is class variable and X is a dependent element vector (of size n) where:

$$X = (x_1, x_2, x_3, \ldots, x_n) \tag{3}$$

B. Naive assumption

Now, it's an ideal opportunity to put naive assumption to the Bayes' theorem, which is, autonomy among the features. So now, we split evidence into the free parts.

Now, if any two occasions A and B are independent, at that point,

$$P(A, B) = P(A)\,P(B) \tag{4}$$

Consequently, we reach to the outcome:

$$P(y|x_1, \ldots, x_n) = \frac{P(x_1|y)\,P(x_2|y)\,\ldots\,P(x_n|y)\,P(y)}{P(x_1)\,P(x_2)\,\ldots\,P(x_n)} \tag{5}$$

which can be expressed as:

$$P(y|x_1, \ldots, x_n) = \frac{P(y)\,\prod_{i=1}^{n} P(x_i|y)}{P(x_i)\,P(x_2)\,\ldots P(x_n)} \tag{6}$$

At this point, as the denominator stays consistent for a given input, we can expel that term:

$$P(y|x_1, \ldots, x_n) \propto \mathrm{P(y)} \prod_{i=1}^{n} P(x_i|y) \tag{7}$$

Now, we have to make a classifier model. For this, we discover the probability of given arrangement of inputs for every single conceivable value of the class variable y and get the yield with greatest likelihood. This can be expressed numerically as:

$$y = argmax_y\, P(y) \prod_{i=1}^{n} P(x_i|y) \tag{8}$$

Along these lines, at last, we are left with the task of calculating P(y) and $P(x_i \mid y)$. P(y) is likewise called class probability and $P(x_i \mid y)$ is called conditional probability. The distinctive Naive Bayes Classifiers contrast for the most part by the suspicions they make with respect to the distribution of $P(x_i \mid y)$. [6]

IV. TF-IDF

TF-IDF (Term Frequency-Inverse Document Frequency) is a content mining system used to categorize documents. The contrasts between TF-IDF and sentiment analysis is significant.

Despite the fact that both could be considered classification content strategies, their objectives are distinct. From one viewpoint, sentiment analysis expects to classify reports into opinions, for example, 'positive' and 'negative'. Then again, TF-IDF classifies reports and documents into classes inside the records themselves.

This would give understanding about what the audits are about, as opposed to if the creator was happy or unhappy. In the event that we examine item survey information from an e-commerce webpage offering

computer parts, we would wind up with groups of archives about 'laptop', 'mouse', 'keyboard', and so on.

We would pick up a lot of information about the kinds of reviews that have been composed, yet we would not get the hang of anything about what the clients thought of those items. In spite of the fact that the calculations are comparable with respect to the way that they classify text, the consequences of every one give us exceptional and unique bits of knowledge.

A. *Applications of TF-IDF*

This algorithm is valuable when we have a record set, especially an expansive one, which should be categorized. It is particularly clever in light of the fact that we don't have to prepare a model early and it will naturally represent contrasts in lengths of reports.

We should envision a huge corporate site with a huge number of client contributed blog entries. Contingent upon the tags connected to each blog entry, the item will show up on posting pages on different parts of the website. In spite of the fact that the creators could tag the items manually when they composed the content, as a rule they decided not to, and in this manner many blog entries are not categorized.

Empirics demonstrate that just a little division of clients will set aside the opportunity to manually include tags and help with classification of posts and reviews, making deliberate association unsustainable. Such a record set is a great utilize case for TF-IDF since it can create tags for the blog entries and help us show them in the correct zones of our website. A quick run of the algorithm would experience the record set and deal with every one of the entries, eliminating of a lot of issues.

B. *The math*

TF-IDF computes a weight which represents the significance of a term inside a document. This is done by looking at the recurrence of use inside an individual record as opposed to the whole data set (a collection of documents).

The significance expands proportionally to the occasions a word shows up in the individual record itself - this is called Term Frequency. Be that as it may, if numerous records contain the same word many times, at that point we keep running into an issue. That is the reason TF-IDF likewise balances and offsets this value by the frequency of the term in the whole document set, a value called Inverse Document Frequency.

```
TF(t) = (Number of times term t appears in a doc)
/ (Total number of terms in the document)

IDF(t) = log_e(Total number of documents
/ Number of documents with term t in it).

Value = TF * IDF
```

TF-IDF is computed for each term in each report. Commonly, we will be intrigued either in one term specifically (like a web search engine), or we would be interested in the terms with the highest TF-IDF in a specific document or record, (for example, generating tags for blog entries). [7]

V. THE SYSTEM

In the following section the development of a component-based, media data processing and classifying system powered by Artificial Intelligence, accessible via Web API will be described, as well as we will see the way that the system works and what is the standard procedure for managing the system's components and modules.

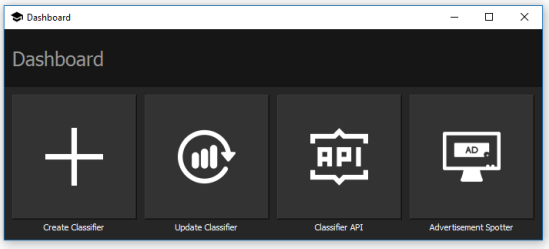

Figure 1 - Dashboard

A. *Dashboard*

Dashboard *(Figure 1)* is the main application from which the corresponding components and modules are started. The user interface is pretty intuitive and easy to use. It is consisted of 4 buttons that represent the four different modules out of which the two components are built from. The first three buttons correspond with the modules of the first component, and the fourth button is the module of the second component. By clicking on any of the buttons, the corresponding module window opens.

B. *Component 1: Component for Text Articles Classification*

1) *Module 1: Create Classifier*

This module *(Figure 2)*, serves to create a classifier, which later will be used as a service called through API. By clicking the Browse Dataset button, a window opens in which we select a JSON file with the data that needs to be processed.

Considering the fact that the data file can be too big, the program offers the option to specify the number of different tags on which the neural network will be trained. There is an option to set the number of data units in the whole set, as well as the number of data units in the training set, while the number of data units in the testing set is calculated automatically.

By clicking the Train Classifier button, the training of the neural network begins. First, the values of the number of data units in the whole set, the training set and the testing set are taken, and the corresponding program parameters are set. The neural network is trained with Naive Bayes Classifier and the accuracy is checked with the testing set. When the neural network training is completed, the program offers the option to save the trained neural network by clicking the Save Classifier button. In that case, a window opens in which we need to enter the name of the neural network and the location of the file in the system.

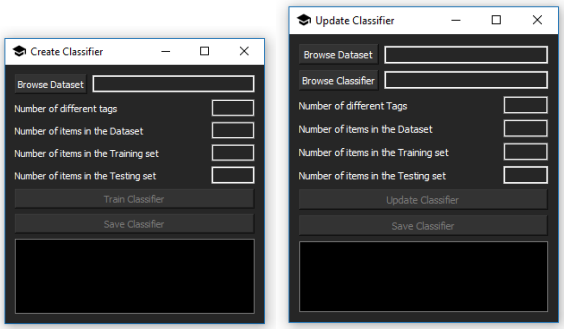

Figure 2 - Create Classifier and Update Classifier

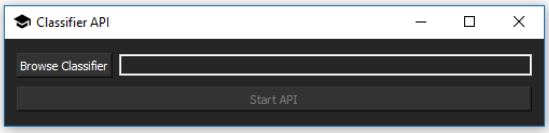

Figure 3 - Classifier API

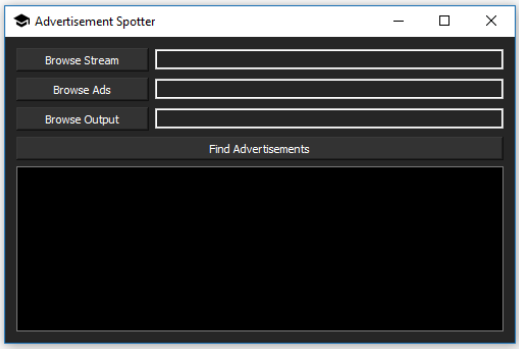

Figure 4 - Advertisement Spotter

2) *Module 2: Update Classifier*

With the help of this module *(Figure 2)*, we can update the neural network with new data. The user selects the dataset by clicking the Browse Dataset button, and by clicking the Browse Classifier button, it reads the already created neural network that we want to update with new data. The numbers of different tags, data units of the whole set and the training set are entered. The number of data units in the testing set is automatically calculated by the system.

When the user enters all the required parameters, by clicking the Update Classifier button, the program updates the already created neural network with new data. On the window console, the new accuracy of the neural network is written, according to the testing with the testing set. If we are satisfied with the accuracy, by clicking the Save Classifier button, we can save the neural network on the local file system. Just as the first module, apart from the saving the neural network, this module also automatically generates files with tags and a TF-IDF file.

3) *Module 3: Classifier API*

The third module *(Figure 3)* has the task to create a web server to which, through Web API, requests will be sent for the processing of a certain text, and an answer will be created in a form of a JSON, which will be sent to the client.

In the window of this module, we should select a path to the neural network that we want to use, which is created through Module 1 or updated through Module 2. By clicking the Start API button, the server starts to work and awaits user requests that need to be processed.

C. *Component 2: Component for Advertisement Spotting*

1) *Module 4: Advertisement Spotter*

The fourth module *(Figure 4)* is used to find advertisements in a given video stream. The interface of this module is pretty simple. It consists of three buttons, through which the user chooses the file location with paths to the video streams, the file location with paths to the advertisements that we want to find, and the location where we want to save the generated report. By clicking the Find Advertisements button, the program begins to work, finds the advertisements in the video streams, generates a report, saves it in the corresponding location and automatically opens it when the program is finished processing.

VI. CONCLUSION

Natural language processing (NLP) has recently increased much attention for analyzing and dissecting the human language computationally. It has spread its applications in different fields, for example, email spam detection, summarization, medicine, automatic question answering, machine translation, information extraction and so on. The paper is presenting the various applications of NLP and the current trends and challenges, as well as the use of Artificial Intelligence, Machine Learning, Neural Networks and Multimedia Processing as part of a custom-built, component-based system accessible via Web API.

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Designing Intelligent Tutoring System Based on Bayesian Network

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Abstract— Nowadays, the educational system in each country is facing new challenges and recent IT innovations, which are the key factors for the success and quality of education that will result in a more efficient and effective knowledge transfer. Intelligent tutoring systems - ITS are a perfect IT solution that can contribute to overcome the restrictions imposed by the traditional teaching and improve the educational process. Guided by the need to improve education, the main purpose of this paper is to offer a model of architecture of an ITS for learning C# programing language – CPLITS. The system is intelligent because it has implemented an artificial technique called Bayesian Networks in its architecture. The aim of CPLITS is to adapt to the different needs of different categories of students through a mechanism that enables them support in the navigation through the online learning materials, support for delivering effective and efficient pedagogical instructions in the learning process while solving a particular problem as well as structuring of the teaching curriculum based on the student's profile.

Keywords— intelligent tutoring systems, model of intelligent tutoring systems, Bayesian network

I. Introduction

Studies of student learning have long shown that learning can be more effective if it is performed through private tutoring rather than teaching in a classroom [1]. In classroom teaching, all the students have to listen to the same lectures regardless of the knowledge that they have and theirs learning preferences. It is not possible for the teacher to deliver a lecture that is customized to each student's existing knowledge. An Intelligent Tutoring System (ITS) can address this problem. The ITS will enable the student to learn the material at their own learning speed, and can teach the materials that are relevant to the students' current knowledge and provide help that is specific to the students' problem [2]. By its nature, ITS can be defined as computer software systems that try to mimic the methods and dialogs of natural human tutors, to generate teaching activities in real time or at the request of different categories of students [3]. Over the years, ITS have been a subject of continuous changes and improvements evolving from computer aided instruction into intelligent computer aided instruction, today known as ITS, using various AI techniques such as: Bayesian networks, intelligent agents, fuzzy logic, neural networks, ontologies and many more that makes this system intelligent and more sophisticated.

The main goal of this paper is to present a design approach of an intelligent tutoring system that will adapt to the different needs of different categories of students through a mechanism that enables them support in the navigation through the online learning materials, support for delivering effective and efficient pedagogical instructions as well as structuring of the teaching curriculum based on the student's profile. The rests of this paper is organized as follows. Design approach of intelligent tutoring system known as CPLITS is discussed in Section 2. Section 3 gives an overview of the proposed architecture of CPLITS with brief description of its components, as well as structuring of the Bayesian Network implanted in the system. The last section provides concluding remarks and future directions for our work.

II. Design approach of an intelligent tutoring system

Intelligent tutoring systems are designed in a way that in their structure incorporate techniques of the Artificial Intelligence - AI in order to provide tutors who will know how to teach, what to teach and how to adequately make knowledge transfer to the student. Examples of ITSs [4], [5], [6], [7], [8] present various ways of dealing with the problem of tutoring using the computer, suggesting different approaches. The main characteristic that increases effectiveness to the task of teaching with an ITS, is system adaptability to the student. Assessing the user state of knowledge and profile requires uncertainty reasoning [4]. Each student has their own characteristic which influences their understanding to interpret learning material. Students receive knowledge in different ways, including hearing and seeing; by reflecting and acting; reasoning either logically or intuitively; by memorizing or visualizing and drawing analogies; and, either steadily or in small bits and large pieces [9]. So, the students must be provided with material models that meet with their personality and their previous knowledge.

Several researchers have tried to show the power of adaptability of the system [10], [11]. For example, a student in an adaptive educational system will be given a presentation that is adapted to his knowledge of the subject, and a suggested set of most relevant links to proceed further [12].

Taking everything mentioned above into consideration, we are proposing a model of intelligent tutoring system – CPLITS. CPLITS is intended for students who want to start learning the key concepts of the C# programming language. The architecture of the proposed model, including its main components and sub-components, as well as modeling the Bayesian Network that will be implemented in

system's architecture. The proposed system is a web-based system.

III. Architecture of CPLITS

Intelligent tutoring systems are characterized by the fact that they store three basic kinds of knowledge: domain knowledge, knowledge about learners and pedagogical knowledge. This knowledge types define the main modules of the system's architecture: the domain knowledge module, the student knowledge module and the pedagogical module. So, the architecture of the proposed system is composed of the following modules: (1) student module; (2) knowledge base module; (3) teaching module; and two additional modules: (4) user interface module that act as a communication bridge between the system and the student; (5) Bayesian Network module; each of which is decomposed to submodules. The architecture of CPLITS is a client-server architecture. The system is web-based and can be accessed from anywhere, at any time using any of the popular web-browsers. The client part contains the user interface for establishing interaction between the student and the system while the server part contains the remaining modules of the system. Figure 1. Shows the full representation of the architecture.

The student module accumulates all of the relevant data related to the student and it contains several submodules: student profile; database with personal information storage; knowledge mastery values/learning style and activity recorder. The student's profile is the main figure that has function to accumulate all the necessary information obtained from the other submodules so that the final result would be creating report for the student with records such as personality information, progression of the student as he\she manages through the learning materials, learning style, overall time spent on the topic, test results and so on. Each generated profile is unique and features a different learning style defined by Felder-Silverman model [9] for categorizing students based on their learning style.

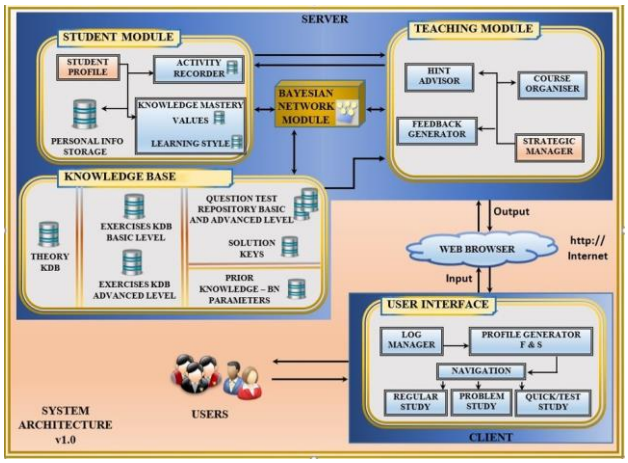

Fig. 1. Representation of the general architecture of CPLITS with their modules and submodules

The knowledge base module covers the key basic concepts needed for understanding the bases of C# programming language regarding the console application. The student will have chance to get introduction in the programming language, data types, operators, variables, control structures, functions, complex data structures and classes. This module is divided into: theoretical materials of various visual formats like text documents, presentations, videos; practical assignments both basic and advanced level; question test repository with different difficulty level of questions; solution keys and prior knowledge that is a base for initializing the parameters in the Bayesian Network.

The teaching module is in charge of leading the student through the learning process and deciding what materials to present to the student regarding the generated learning style. This module contains: strategic manager; feedback generator; hint advisor and organizer of the teaching curriculum. The strategic manager is the main component that coordinate others submodules with function to analyze the structure of the content of each learning concept by establishing communication with the knowledge base, providing helpful instructions and recommendations in solving a particular problem. It also provides up-to-date feedback and as well as generating tests from the test database, organizing the theory and the practical assessments.

The user interface module is the communication bridge between the student and the system. Potential users in the system are: students and administrator. The administrator has full control of the system and is responsible for maintaining the system, creating learning materials, defining the parameters of the Bayesian Network from previous experiences that the students have shown during the study of the matter. On the other hand, when the students get in touch with the system it needs to make signing with user account through the log manager in order to create its own profile. Afterwards learning style is required to be created by answering the questions proposed in the Felder-Silverman test in order to make categorization of students in one of the learning style regarding the organizing of theory materials [13] as shown in Table 1.

Table 1. Different categories of learning styles

Category	Learning style	Preferred format
1	Reflective, visual and sequential	Multimedia lectures
2	Reflective, intuitive and verbal	Theoretical lectures - text
3	Active, sensing and global	Case study with practical tasks

After defining the learning style the student can proceed with learning a particular concept through navigation of the learning materials. Each concept represents a learning package consisted of theory part, practical assignments and test. In other word the student will need to pass three stages of the learning process: (1) regular study that covers the theory, (2) problem study that covers the practical part with different level of difficulty and (3) quick test study that covers evaluation of student's knowledge by answering questions in generated test with different difficulty level regarding the student's knowledge. By the end of each stage the system will present to the student two options before he can continue to next concept: 1- understand the concept, 2-don't understand, repeated. Additionally, it will present some recommendations in order to improve the learning process for the future concepts.

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The Bayesian Network module is consisted of Bayesian model for organizing and navigating through learning materials represented as nodes and arc between nodes.

A. Application of Bayesian Networks in CPLITS

Bayesian Networks - BN are graphical models i.e. directed acyclic graphs for reasoning under uncertainty. As a graphical model of probability, it represents casual relationships of probability between set of random variables and their conditional dependencies.

BN as AI technique in ITS are used for various purposes such as modeling the student's module in order to help students in personalized learning environment, for structuring teaching strategies in order to provide effective and efficient pedagogical guidance for the student in the learning process, structuring of teaching materials for more flexible and easier access, monitoring, evaluating and updating the level of student's knowledge and preferences. BN in CPLITS are used for structuring of the problem from a particular domain, for tracking student's knowledge and guiding the student how to learn and what to learn next. The proposed model of BN for CPLITS it's shown in Figure 2 and it's developed in GeNIe Modeler, software solution for representing BN.

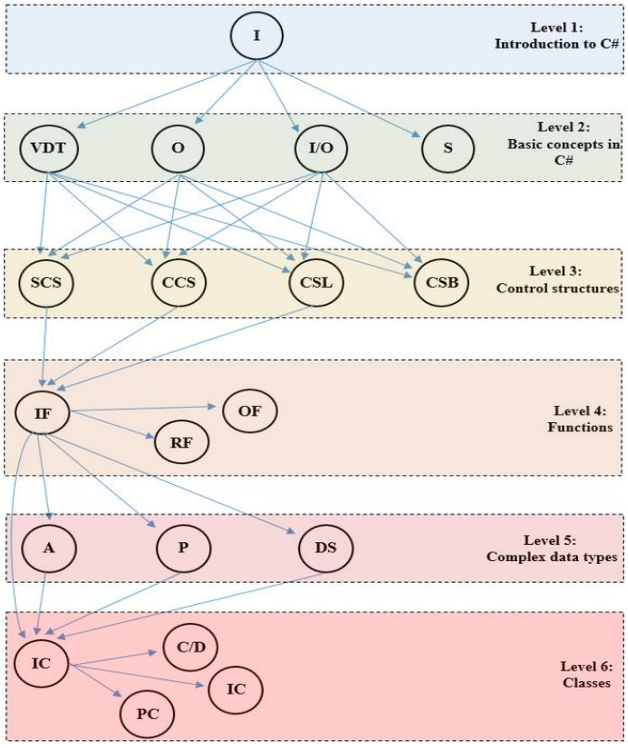

Fig. 2. Full representation of 6-th level BN for navigation

The structure of the Bayesian network consists of nodes and connections that represent the interdependences between. The total number of nodes in the network is 19 nodes with 31 connections between the nodes. Adding the directed arc from one node to another is done in order to determine whether the knowledge of the previous concept is a prerequisite for learning the next concept. The nodes in the BN are organized in six levels depending on the contents of the materials that the student will learn: (1) Introduction in programming, (2) Basic concepts in C#, (3) Control structures, (4) Functions, (5) Complex data structures and (6) Classes. Because of this organization, the BN can be known as 6-th level BN for navigation through learning materials of the C# programming language. Each of these levels corresponds to one of the knowledge mastery values. First and second level correspond to beginner with some knowledge in the area, third and fourth correspond to intermediate level of knowing the area, and the last two levels correspond to advanced level of knowing the area. After defining the structure of the BN next step is to calculate the conditional probabilities between the nodes in the network. For that purpose, it is required to create conditional probability tables - CPT that shows the probability for two or more conditionally dependent nodes – events. The formula of Bayes' Theorem for updating of the values in the network is going to be used for calculating the probabilities.

Considering that the nodes in the network are defined and the conditional probability tables are fulfilled from the parameters from the prior knowledge database, the network can be updated in situation where no observations are made of any event, i.e. the nodes takes the initial values of probabilities they have. Each node has their own probability and the occurrence state of every node can be "mastered" and "not mastered" that refers to the concept. To make it easier for the student to navigate through the materials, CPLITS marks the learning concepts with appropriate colors and signs in terms of which concepts are learned and which are not learned. Such material markings are generated from the BN in the system and can be categorized according to the three criteria: (1) mastered concepts, (2) concepts that can be learned and (3) concepts that are not available for learning. The markings for the concepts can be of the following character: green color with tinted sign, blue color with unlocked padlock and grey color with locked padlock appropriately for mastered concepts, concepts that can be learned and concepts that are not available for learning. This marking is done in order to help the student to gain an insight for the current knowledge level of each concepts and guidance for what he\she can learn further. Furthermore, a concept can be categorized as mastered only if the BN show that the probability value P (concept = mastered | evidence) is greater or equal to 0.7, where evidence is a variable for the student's knowledge of the previous learning concept. A concept can be categorized as concept that can be learned only in situation where all previous concepts of the previous level are marked as mastered concepts with probability greater or equal to 0.7. Finally, a concept can be categorized as concept not available for learning only in situation when there is at least one prerequisite concept that is not mastered.

After everything is defined we can calculate the probability that the student has mastered the concept - variables and data types before any evidence is observed i.e. prior probability. For that purpose, CPTs are presented in Table 2 and Table 3.

Table 2. Given CPT for introduction in programming and variables and data types

Introduction in programming - I	
Mastered	0.71
not mastered	0.29

Table 3. Given CPT for introduction in programming and variables and data types

	Introduction in programming - I	mastered	not mastered
Variables and data types - VDT	mastered	0.72	0.21
	not mastered	0.28	0.79

Based on the above data from the CPTs we can calculate the probability for variables and data types such as:

$$P[VDT = mastered] = P[VDT = mastered \mid I = mastered] * P(I = matered)$$

$$+ P(VDT = mastered \mid I = not\ mastered) * P(I = not\ mastered)$$

$$= 0.72 * 0.71 + 0.21 * 0.29 = 0.57 * 100 = 57\% \quad (1)$$

The obtained results show that 57% or 0.57 is the probability that the student is prepared to master the concept variables and data types. The calculated results for the rest nodes in the network are shown in Figure 3.

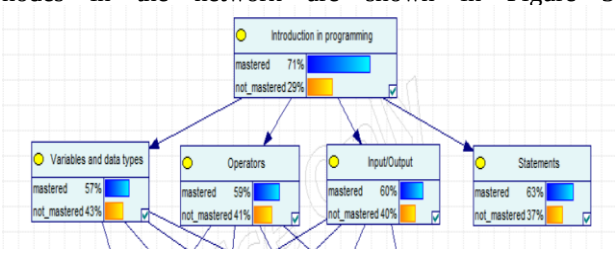

Fig. 3. Updated values of probabilities in BN without observing any evidence

In the same way the posterior probability can be calculated i.e. probability after certain nodes-evidences are observed. For the abovementioned example, we can calculate the probability that the student has mastered variables and data types after mastering the concept introduction to programming. The formula has the following form:

$$P[VDT|I] = \frac{P[VDT, I]}{P[I]}$$

$$= \frac{P[VDT = mastered|I = mastered]P[I = masterd]}{P(I = masted)}$$

$$= \frac{0.72*0.71}{0.17} = \frac{0.5112}{0.71} = 0.72 * 100 = 72\% \quad (2)$$

The results for the computed posterior probabilities are shown in Figure 4.

It can be concluded that 72% is the probability that the student masters the concept variables and data types by previously mastering introduction to programming.

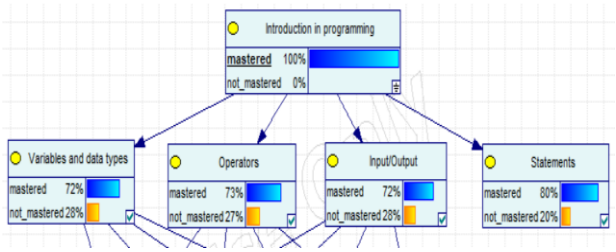

Fig. 4. Updated values of probabilities in BN with observing evidence

In the same way, the probabilities can be computed for the rest of the nodes. By using GeNIe Modeler these computations can be done automatically.

IV. Conclusion

Nowadays the effectivity of the education is mostly due to the development of information and communication technologies in order to improve the knowledge transfer to students. ITS as one link from the chain of information technologies have found adequate application in education. In this paper it has been developed a model of ITS that will aid student to better understand the concepts of C# programming language by giving them support in the navigation through learning materials how to learn and what to learn in the upcoming concepts. The beneficiaries of using this system will allow to student to learn at a distance with time and costs savings. It also provides them much more personalization and adaptability, user-friendly interface that follow the concept one-size fits all and the most important thing increase the level of effective and efficient motivation in the learning process. In the future, the efforts would be concentrated on implementing the system in a final software solution by writing code, updating the model in terms of expanding the system's functionalities, adding new learning concepts and implementing the Bayesian Network via the SMILE platform offered by BAYES FUSION, an independent library based on C #, Java, .NET and Python.

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Trends in software maintenance support tasks: A study in a micro software company

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Abstract - Support tasks in software maintenance relates to tasks that help in ensuring proper functioning of software applications without modifying them. These tasks include training, consultation, clients' data management, installation and configuration of software applications. The aim of this study is to investigate trends in support maintenance tasks performed in a micro software company. Tasks' related data are extracted from the company internal repository of tasks. Trend analysis is based on descriptive statistical methods and proposed support task typology that reflects the real maintenance practice in the company. The analysis relates to trends in working hours spent by programmers on solving support tasks and distribution of tasks among senior and junior programmers. The results of trend analysis are useful for planning and decision-making activities in the selected company. Benefits for the company, limitations of the study, and research implications are outlined.

I. INTRODUCTION

Software maintenance is the costliest part of software life cycle, consuming over 50% of all costs [1,2,3,4]. Even more, maintenance costs for software systems being used for long time greatly exceed software development costs [5]. Although software maintenance has been recognized as very important for productivity and efficiency of software organizations [6], maintenance tasks are treated as short term tasks that should be completed as fast as possible [3]. In addition, maintenance tasks are considered among software engineers as less interesting and boring comparing to software development tasks, which often causes avoidance of these tasks [7].

Software maintenance has been researched over 40 years. In this period, several classifications and typologies of maintenance types have been proposed in software engineering literature. The first and the most influential typology in software maintenance is defined in 1976 by Swanson [8]. It includes corrective, adaptive and perfective tasks. This typology is extended with preventive maintenance in Standard for Software Engineering-Software Maintenance, ISO/IEC 14764 [9]. Chapin et al. [10] proposed more detailed classification of maintenance tasks based on the modifications implemented on software applications (software, code, customer-experienced function). This extended typology includes 12 types of tasks grouped in 4 clusters: support interface, documentation, software properties, and business rules. Support interface includes tasks such as trainings, consultations and evaluations of software systems. Due to the high importance of software modifications in software maintenance (software properties and business rules clusters), support interface is categorized as less important, and therefore much less researched segment of software maintenance practice. Regardless of the maintenance task type, software maintenance tasks should have minimal impact on clients' business performance [11].

In the book *Software Engineering Best Practices* [12] Jonas identified customer support as one of the main cost drivers in software life cycle since it is highly labor intensive and generally unsatisfactory. Kitchenham et al. [13] proposed a maintenance ontology aimed at identifying factors that influence software maintenance, according to which software organizations should organize and manage support activities into well-defined roles performed by skilled staff. This ontology proposes organization of maintenance support in the following three levels: (1) Non-technical help desk staff engaged for logging problems and providing the first assistance to software users, (2) Technical support that communicate with end users, understand their problems and can suggest some quick solutions, and (3) Maintenance (software) engineers that do modifications on software products.

Software maintenance management requires careful and on time management activities to reduce errors and ensure software usefulness for end users[14]. One of the most reliable ways to detect problems and potential improvements in software maintenance is to collect data in a real industrial setting and conduct data analysis to identify trends in everyday maintenance practice. Efficient and reliable trend analysis in software maintenance is based on [15]: (1) well defined software maintenance processes, (2) tracking of software maintenance requests on daily basis, (3) precisely defined procedures for collecting relevant data, and (4) validated data that are extracted for the proposed measurement goals.

Based on the above discussion, investigation of support tasks trends in software maintenance is proposed as the aim of this study. The rest of the paper is organized as follows. Related work section outlines studies related to trends in software maintenance and justifies the need for researching support maintenance tasks in industrial practice. The third section presents the study aimed at investigating trends in maintenance support tasks in a local micro software company in Serbia. The fourth section presents discussion of benefits for the company, limitations of the study, and research implications for industry practitioners and researchers. The last section contains concluding remarks and brief reference to future research directions.

II. RELATED WORK

Trend analysis in software maintenance is used for detecting issues in everyday industrial practice. It requires collecting reliable data in an appropriate period, which are suitable for achieving proposed research goals and are aligned with the goals of organization involved in the research [16]. However, the use of traditional management techniques is not completely applicable in software maintenance due to specific internal organization of software companies and non-material nature of software products. This section outlines some empirical studies dealing with trend analysis in software maintenance and justifies the need for inquiring trends in software maintenance support tasks.

Kenmei et al. [17] organized an empirical study aimed at investigating trends of change requests based on time series. Data were extracted from version control and bug tracking systems for open source software projects Eclipse, JBoss and Mozilla. Created model enables prediction of number of change requests to be received in next 2 to 6 weeks, which is important for project staffing and planning.

April [15] presented an empirical study with trend analysis of supply and demand of software maintenance services. Maintenance demand is defined as a total of all received maintenance requests, while supply is total of all services given to customers. The study was conducted in Integratik, an ERP development firm in Canada, as a part of software process improvement project. The aim of a developed trend model is to help in managing customer expectations from software maintenance. Trend analysis is performed in a way that enable identification of trends related to personnel workload and trends for delivered software systems.

Bando and Tanaka [18] presented trend analysis of accidents occurred in financial information systems. Data collection included several sources: newspapers, news release on websites, magazines and books. Trend analysis of accidents was performed according to type, severity and faults. Trend analysis identified the following types of accidents: service related, processing related, information related, and cybercrime related. The results of trend analysis revealed that human made faults are increasing more than physical faults. Based on results, the authors proposed several priority issues for dependability improvements of cases such as repeated accidents, frequent accidents, human-made mistakes, or software quality.

Trend analysis aimed at identifying trends in maintenance request processing in a very small software company is presented in [19]. Trend analysis is used within software process improvement project, with the main objective to identify segments of maintenance practice that should be improved. Data analysis was used for identifying monthly trends for number of maintenance requests, number of spent working hours on solving requests, distribution of requests per maintenance types (tasks). For data analysis is used maintenance task typology developed in the company. As one of the results of maintenance processes improvement project, a new task typology was developed by considering the context in the company and relevant scientific literature [20]. Trend analysis aimed at investigating distribution of maintenance tasks among programmers according to a newly proposed typology is presented in [20].

Aggarwal et al. [21] conducted a study aimed at investigating trends for Chromium Browser Project. The trends relate to bugs extracted from Issue Tracking Systems (ITS) for the selected software. Each bug report contains the following fields: Priority(Pri), Category(Cr), Operating System(OS), Milestone(M) and Type. Trends are used for discovering topics in bug descriptions that mostly attract developers, which enables discovering of duplicated bugs and reopened bugs. The results of trend analysis are useful for expertise modeling, resource allocation and knowledge management.

This short literature review revealed that trend analysis is used for investigating software maintenance practice. The common objectives are to identify trends in the selected segment of practice and to propose improvements or to estimate future trends. Presented studies deal with business software applications purposely developed for specific group of clients [15,18,19,20] or with open source software projects [17,21], considering general maintenance trends or trends related to corrective tasks. However, there are no identified studies dedicated to support tasks in software maintenance. The study presented in this paper aims at filling this gap in research literature and contributing to empirical knowledge base in the field of software maintenance.

III. CASE STUDY

The study was carried out in an indigenous software company focused on producing business software applications for local clients in Serbia. According to *User guide to the SME Definition* published by European Commission [22], the company can be classified as a micro enterprise since it has 7 employees (6 programmers and 1 technical secretary). In total, 48 software applications are used by over 100 clients in Serbia. The study objective is to identify trends in supportive maintenance performed in the company and based on the results to propose directions for improving everyday practice.

A. Software maintenance trends

Data extracted from the company internal repository of tasks were used for data analysis. The data were extracted from the repository by using SQL scripts, and after that they are imported in MS Excel for further processing and analysis. Analyzing trends requires data collected from a longer period, which ensures identification of trends relevant for the practice to be investigated [23]. Data analysis is based on 2293 software maintenance tasks performed in the period of 19 months, starting from February 2013. According to detailed investigation of maintenance tasks' trends [20], 2036 tasks were classified as maintenance tasks, which is 88.79% of all tasks.

Classification of maintenance tasks was performed based on a new typology introduced in [20]. The following types of maintenance tasks were included in the typology: adaptation, correction, enhancement, preventive, and support. Based on the data analysis presented in [20], 467 support tasks were identified, which is 22.94% of all maintenance tasks. Since support tasks relates to providing

direct assistance to software users in using and operating software in appropriate manner, or solving problematic issues, it is very important to identify trends in everyday practice related to software maintenance support tasks.

Task realization is recorded by the number of working hours (WH) that assigned programmer spend on solving all task related issues, which includes: working hours in the company (WHC), working hours spent on Internet for accessing client's information system (WHI), and working hours in the client's company or at the client side (WHCS). Total number of working hours per each task (WHT) is the sum of WHC, WHI and WHCS.

B. Software maintenance support tasks subtypes

Support tasks relate to providing support to users of software applications. These maintenance tasks might include modifications of software application's data (without modifying code of a software application), but in many cases, they do not require any activity that is implemented on software application. The examples of support tasks are administrative tasks on hardware infrastructure or training organized for software users in client companies.

Based on data analysis of support tasks, a new typology of support tasks is proposed. This typology is introduced to enable more reliable and fine-grained classification and management of support tasks. The new typology introduces the following subtypes of support tasks:

- *Administration*. These tasks include installation and configuration of software applications, software modules and necessary hardware and communication equipment. In addition, this subtype includes administration of software users and solving administrative and organizational issues related to client's organization.
- *Consultancies*. This subtype relates to consultancy services related to giving oral explanations, preparation of the appropriate documentation or monitoring the realization of certain activities in software use in a client's organization.
- *Data management*. These tasks relate to various activities aimed at sustaining clients' data operable for them. Data migration, backup and data transformation are common tasks in this category.
- *Training*. These tasks aim at preparing software users for using software applications or specific modules. They are mostly organized in clients' companies.

Detailed preliminary analysis of tasks' descriptions revealed that some tasks have elements that enable classifying them in more than one category. For example, training activities are usually organized after installation and configuring tasks, which is in several cases joined in one larger task. Nevertheless, each task is classified in one of the proposed subtype classes based on subjective judgement of the engaged programmer(s).

C. Trends in supportive maintenance tasks

The simplest descriptive statistical analysis includes identification of trends for each specific subtype of support tasks. In Table I a distribution of support tasks per introduced subtypes is presented. Presented data revealed that most of the tasks are classified in Data management subtype category (37.26%), while trainings are the last represented in the practice (6.21%).

TABLE I. DISTRIBUTION OF SOFTWARE MAINTENANCE TASKS ON SOFTWARE MAINTENANCE SUPPORT SUBTYPES

Task subtype	No of tasks	Share [%]
Administration	133	28.48
Consultancies	131	28.05
Data management	174	37.26
Training	29	6.21
TOTAL	**467**	**100.00**

Descriptive statistics, that includes average number of working hours and total number of working hours for each task subtype, as well the share of each task subtype in total support maintenance is presented in Table II.

TABLE II. WORKING HOUR TRENDS FOR SOFTWARE MAINTENANCE SUPPORT SUBTYPES

Support subtype	Average WH	Total WH	WH Share [%]
Administration	1.55	206	25.42
Consultancies	1.63	214	26.40
Data management	1.93	335	41.33
Training	1.91	55.5	6.85
TOTAL	**1.76**	**810.5**	**100.00**

Data presented in Table II revealed the following interesting trends: (1) The majority of time spent on support tasks is spent on data management tasks (41.33%), while trainings consume the least time (6.85%), (2) average time spent on training and data management tasks is similar (1.91 and 1.93 respectively), and (3) administrative tasks are the shortest at average (1.55). Regarding the average number of working hours all average values are very close, and since working hours are recorded with the values of 0.5 hours, there is no significant difference in time consumption for different subtypes of support tasks.

In the company work 6 programmers, 3 seniors and 3 juniors. Table III presents distribution of support maintenance tasks on these two groups of programmers.

TABLE III. DISTRIBUTION OF SUPPORT TASKS ON JUNIOR AND SENIOR PROGRAMMERS

	Juniors	Seniors
Administration	73	60
Consultancies	56	75
Data management	79	95
Training	10	19
TOTAL	218	249
Share [%]	46.68	53.32

These data revealed that senior programmers solved more maintenance support task than junior programmers in total. The only segment of support practice in which junior programmers solved more tasks are administrative tasks related to installing and configuring software and hardware systems and administering software systems and users.

IV. DISCUSSION

A. Benefits for the company

The results of the presented study revealed several benefits for the company in which the study was performed. These benefits are briefly discussed in this subsection.

The first benefit for the selected company is introduction of a fine-grained classification of support maintenance tasks based on introduced support subtypes. Support tasks' subtypes reflect the real practice in software maintenance, which is the basis for more detailed analysis of tasks and further improvements in their processing. Based on that classification, the programmers can better classify their work and estimate working hours for future tasks.

Insight into distribution of support tasks among programmers can be used for improving scheduling of tasks in future, which will result with more balanced workload of programmers and faster processing of maintenance requests to which tasks are associated.

Finally, observed drawbacks in the extracted data records (quality, accuracy and consistency) from the company repository influence results of this study, which will be used as a guideline for improving task management software system in the company. This improvement will lead to recording more accurate data in the task repository, followed with more reliable data analysis and estimations of task processing.

B. Limitations and validity

The most critical limitation for the results of the study is the quality of the data extracted from the company repository of tasks. Another limitation influencing the study results is proper treatment of data that significantly deviate from typical data (outliers) [24,25]. These limitations will be addressed in future research and improvements of the practice in the company. The focus of improvements will be on defining and implementing more precise data recording procedures.

Reliability and quality of empirical studies is usually judged in terms of internal and external validity [26]. The main threat to internal validity relates to confidence towards completeness and accuracy of data extracted from the company repository. Proper treatment of this threat to validity requires systematic and accurate recording of all tasks in the company, which is the subject for further process improvement initiatives in the company.

External validity relates to generalizability of the study results, which is quite problematic in any empirical study conducted in a specific organizational context [27]. However, generalizability can be observed from the perspective of used research methods and study design, which can be repeated or adapted to other software organizations.

C. Implications

Presented study has significant benefits for software engineering practice in the selected company, but also has implications and can be of benefits to other software companies and software engineering research community. The benefits for the selected company are discussed in the subsection *Benefits for the company*.

Other software companies can find useful lessons how to organize investigation of their practice in the cooperation with researchers from academia. These lessons include selection of data sources and appropriate methods for data analysis, as well as consulting relevant literature for positioning specific segments of the practice against the best practice stated in literature.

This study contributes to empirical knowledge base in software engineering field in many ways. Since there is a lack of studies dealing with supportive maintenance, this study can be used as a starting point for selecting methods for empirical data analysis based on analyzing trends in empirical data. Further, selection of appropriate data sets for empirical analysis, and their treatment with adequate research methods is also important issue discussed in this study. And finally, the study design can be adjusted to other industrial settings by considering their specificity.

V. CONCLUSIONS

The importance of software maintenance practice for the overall business performance in the selected company is evident from the data extracted from its repository of tasks. Since supportive maintenance tasks have direct impact on clients' satisfaction with software applications and provided services, investigation of trends related to support tasks is highly important for the practice assessment and identification of further possible improvements. Trends identified in empirical data indicate distribution of tasks per introduced support subtypes and distribution of tasks per junior and senior programmers, which are important findings for improvements of task scheduling and management of programmers' workload in the company.

Several future research directions arise from this study. The first relates to proposals of tasks scheduling improvements based on the identified trends, which may require both technical (internal software for tracking tasks) and organizational changes in the company (changes in organizing people and their activities). The second direction relates to using trend analysis for investigating other segments of practice in the selected company, which will result with complete insight into the practice in the company (not only maintenance tasks). The third research direction relates to development of models for estimating costs (time, resources, money) based on task description and complexity. Finally, implementations of the proposed trend analysis approach in other software companies will provide clearer picture about the usefulness of this approach to trend analysis and helps in identifying improvements in the presented trend analysis approach.

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Chatbots in online business

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Abstact: This paper explains use of chatbots in online business. What are benefits and how you can emprove your buisiness, sales by using chabot as your personal asistent. The paper also provides the results of statistical analyses of research.The results of a given study are based on data obitained from a companies that implemented chatbots in their business.

Key words: chatbot, online, business, marketing, sales, customer service.

1. Introduction

As consumers today become exposed to an increasing number of advertisers both on the Internet and in the real world, the big challenge is directly attracting customers who are faced with both big and small businesses and online businesses. By combining the intelligence of machine learning and artificial intelligence with interaction with the user through the messaging platforms [1], chatbots have a huge potential to be the best way to get direct access to consumers soon.

Chatbots have huge usage as instant messaging applications, through which they can play the role of an operator, ie completely replace the human factor in order to allow users to get information, but also to realize specific needs, such as orders and the like. They are programmed to communicate with site visitors by guiding them through the whole communication and providing them with information about products and services, up to the purchase, ordering of a service or product. [2]

Thanks to chatroulette sites, retail businesses can be in contact with future customers and loyal customers 24 hours a day, 7 days a week, but also more. Although smooth communication does not guarantee the quality of the service, chatroulette bots offer entrepreneurs a personalized approach. [7]

When it comes to chat bots, it's not a mistake to say that electronic commerce is the biggest gain. Entrepreneurs in this industry are expected to stay in daily contact with their customers, and the primary purpose of chatting bots is precisely that - to provide unhindered communication in real time. [7]

2. Theoretical considerations

Chatbot is an algorithm, a programming script that is designed to give users the ability to communicate online and interact with it in order to accomplish a specific task, without any engagement of the human factor. This means that a user can realize his or her needs on a particular site, without the participation and activities of people who would otherwise have to wait 24/7, thus fully automating the whole process. Many bots are already integrated into the framework of individual online communications applications, such as Facebook Messenger, where it is possible to talk to them, without knowingthat you are talking to a computer program, not with the right person. A special category is Chatbots that have developed Ai (Artificial Intelligence), so they can solve even more complicated tasks than those that are basic, and special emphasis is placed on individuals who can already learn (Machine learning). Machine learning is realized in such a way that the algorithm is so written that it can change when it is exposed to new data or variables that are not present in their system. [6]

Chatbots are robots programmed to respond as humans. According to Boris's definition: *"Chatbot is a computer game that is capable of having a human conversation with the user by receiving and sending text messages for the purpose of automating the business process"*. They start from simple to advanced. On the one hand, we have simple chatbots that act according to the pre-defined rules and in this way give answers to users. They are less useful in

consumer computing because they require a specific input and are programmed to generate a certain output, so there is not much room for different conversation styles. On the other hand, we have advanced chatobots based on artificial intelligence, able to understand conversational phrases and are programmed to actively learn from previous conversations in order to be able to constantly develop. Exactly advanced chatbots represent a huge benefit in today's business. [4]

3. Benefits business using chatbot

Certain communication tasks will probably always require a „human touch“, such as marketing, PR services, sales, advanced customer service, and so on. Where chetbots are most useful, at least for now, these are basic interactions that do not require a lot of skills in dealing with the issue. In practical terms, this allows for increased efficiency and cost savings in reducing staff recurring processes that require employees to support users, which is the biggest advantage of chat bots. [4]

Fgure 1. Ilustration of chatbot

3.1. Better experience in using social networks

Social networks provide small businesses with a unique opportunity - to build an army of faithful followers around their brand, products and services, while taking advantage of all the benefits that social networking offers, the benefits that companies need to raise interest and stimulate interactions. The world we live in is moving very fast, so customers also demand quick answers to their questions. [5]

Chat bots provide a practical solution to this challenge. An excellent example of this is the chat bot made by Snatchbot company. Their platform allows businesses to create custom bots, even when a person in charge does not have any technological knowledge or previous experience in the field of software robotics. [5]

When on your social networking profiles you install a new, customized bots, which is a very fast and simple process, users are given to interact with it 24 hours a day, 7 days a week, and get instant answers to your questions from it . With this kind of user experience, you will satisfy both current and potential customers, and thus establish better relationships with their customer base. [5]

3.2. Improved customer service

Social networks are not the only communication channel that chat bots can cover - this solution is suitable for all channels, so the way it's used completely depends on the needs and preferences of your comany.

You can install chat bots on your official website as a live chat option, or you can integrate it with your favorite messaging application, which is used by the staff of your customer service.

Chat bots are the product of artificial intelligence and machine learning. Through the word recognition technique, a chat bot can teach you a large number of answers to the questions that your customers most often ask.

Small businesses are not in a position to invest a lot of money in customer support, but the chat bot can still help them reduce the number of user requests. In the beginning, they answer simple questions, but the chat bot eventually learns to deal with more complex queries.

For example, you can learn a chat bot to give users instructions for installing and configuring your digital services. You can also use the bots to quickly troubleshoot the use of your products.

Solving user requests of any kind with the help of chat bot technology is quite simple, which is sure to testify about the efficiency of your company with customers.

3.3. Reduced costs

The services that a chat bot can provide to your users does not require a major investment. Once you install them once on the selected customer service channel, be it social networking or live

chat options on your website, chatroulette bots continue to cut costs even though their effectiveness remains the same from the first day of implementation.

Bots can serve a larger number of users and potential customers at the same time and answer questions without any help from superior agents. Given this high level of efficiency and different uses, small companies that adopt the chat bots as a solution have a significant advantage over their competition.

If you compare their price with the cost of other methods to improve user experience, you will find that chat bots are the cheapest solution. Since the fully automated, chat bot technology does not require any additional maintenance costs.

3.4.Increased sales

Sales teams rely on CRM systems to provide them with all the necessary information about their customers. In this way, small extensions approach each customer as an individual, and thus achieve strong and long lasting relationships with their clientele. Chat bots do this without any help from the CRM system. They learn in every interaction with potential customers, so they personalize their services very quickly.

Bots "remember" the previous conversations, the dilemmas of individual customers and their decisions, which allows them to completely individuate a consumer trip, from beginning to end, for each custters omer individually.

It is equally important that thanks to the history of interactions that they keep in the chat bots system, potential customers can offer just those products and services for which they as individuals would be very interested. Interactions with them are more and more like interactions with customer service staff or sales professionals, so small businesses can use them to send offers and messages to future customers. Instead of email, coupons and special discounts to customers, you can submit by any chanel managed by chat bot.

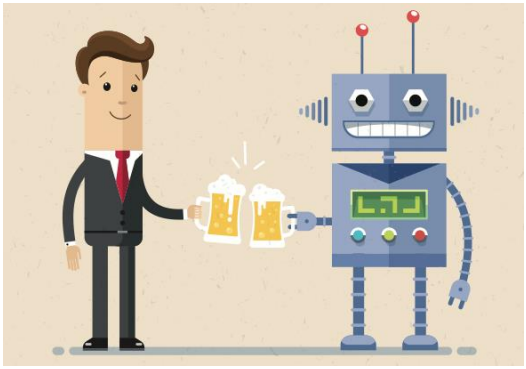


Figure 2. Increased sales ilustration

3.5. Consumer experience

When it comes to implementing new technology in small businesses, it all comes down to raising user interest in brand, products, and services. In order to do this, companies generally use a number of different marketing methods.

If you have a chat bots that are ready to serve visitors to your website, users of your application for messaging or tracking your profiles on social networks, expensive marketing methods you do not need. By itself, the chat bot increases your chances of being first noticed, and then leave a powerful first impression.

Chat bot technology is mobile, which means your customers with the bot can interact with their smart devices from anywhere. In addition, the functionality of the chat bots does not depend on the device that the customer uses, making them valuable helpers for your team.

The previous reasons are just some of the arguments in favor of implementing a chat bot technology in small businesses, but they are certainly enough to convince you that the bots are worth every investment. In the end, chat bots are the cheapest solution for providing quick answers and a positive consumer experience.

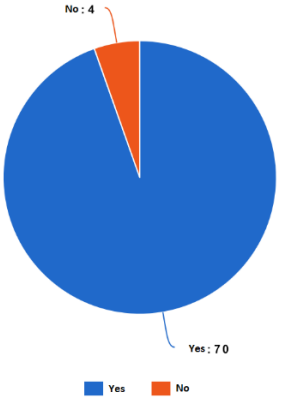
4. Research results

The main objective of this research is to examine employees in workplaces: Marketing Manager, Business Planning Manager and Public Relations, to determine their concern for the use

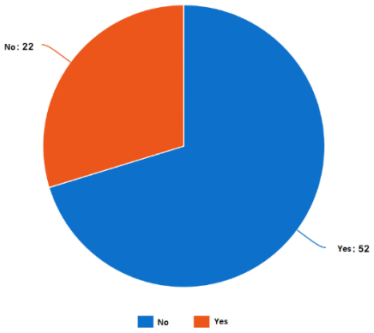
of chatbots in the business and the application of the same, as well as identifying all the benefits of doing business using chatbots.

The survey was conducted in January 2018 within five highly successful marketing companies on a sample of 74 employees in jobs closely related to Internet marketing and online advertising.

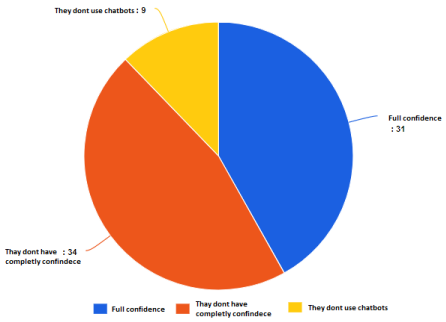
1. Are you familiar with the term "chatbot"?



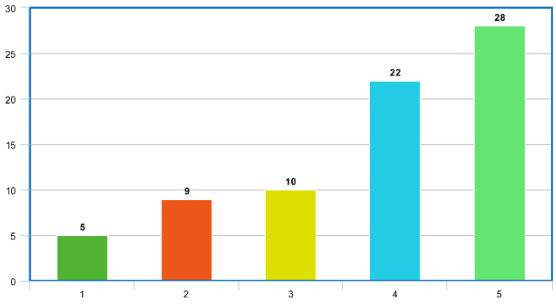
2. Does the company in which you are employed use chatbots as personal assistants?



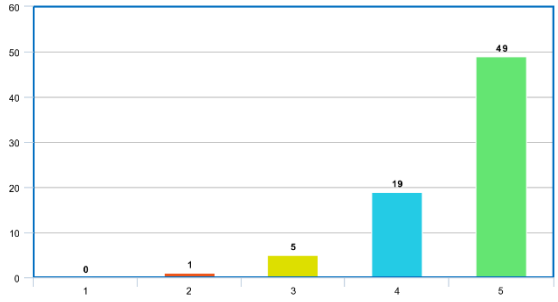
3. To what extent do your clients have confidence in communicating with chatbots?



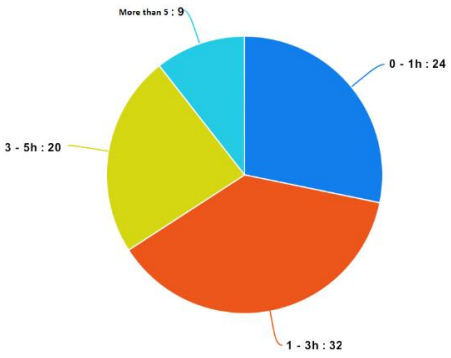
4. To what extent do your chatbots reduce the time spent on answering common customer issues?



5. To what extent do you smarten that chat rooms will replace a person in the role of a customer service in the near future? (Optional)



6. How much time chatbot save you per week?



5. Conclusion

An efficient online service is a critical component of online shopping experience. As the online market comes to saturate a large number of online consumers, see great benefit in quick and efficient responses and it is highly likely that some consumers will leave online shopping if they can not quickly find answers to their questions. However, the satisfaction offered by chatbots in digital marketing and online sales has great potential and ability to improve. In order to rebuild online services to clients, internet business professionals should further approach to chatbots and a large number of consumers who have no experience with using innovative advances in information technology. Chatbot technology in the role of personal assistants or virtual agents is still developing with great integration opportunities with businesses. Virtual agents offer attractive business opportunities, including improving customer experience, up to 24-hour customer accessibility, cost-cutting while the company develops parallel in other directions to achieve the best possible results.

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Model of architecture for cooperation and exchange data between Higher Education Institutions and Public Institutions in Republic of Macedonia through Web services technology

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Abstract

Today, the process of exchange information between internal business units, customers, partners and applications is extremely important for success, yet most organizations use applications that differ from each other and work with different data format, which makes it difficult for establishing impeccable, productive communication. Web services have evolved as technology that make the exchange of data to be universal even between critical applications over operating system, platform, and language barriers. This paper introduces the concept of Web services and identifies the benefits and challenges associated with their implementation into model of architecture for exchanging data between the Higher Education Institutions, more precisely the Faculty of Information and Communication Technologies and the Public Institutions in Macedonia. Web services are defined generally, the required data to be exchanged are highlighted, the model of architecture is illustrated and in the end it is covered in detail the section on security protocols and the safety of data transmission.

Keywords: web services, data exchange, web security

I. INTRODUCTION

Web Services have received a lot of press, and with that comes a great deal of confusion over what they really are. Suppose you were making an application that you wanted other applications to be able to communicate with, for example Java application which makes stock information update every 10 minutes and you would like other applications to be able to use the data. There are a couple of different scenarios that you can use in this case, but every one of them requires considerable research to get the other applications to a working state considering there are applications coded in different programming languages than Java.

The solution to this problem is to send a standard file format, a format that any application can use, regardless of the data being transported. Web services let any application communicate with any other application without having to consider the language it was developed in or the format of the data [3]. .

At the simplest level, web services can be seen as a specialized web application that differs mainly at the presentation tier level. While web applications are typically HTML-based, web services are XML-based. Interactive users for B2C (Business to Costumers) transactions normally access web applications, while web services are employed as building blocks by other web applications for forming B2B (Business to Business) chains using the so-called SOA model.

Web services typically present a public functional interface, callable in a programmatic fashion, while web applications tend to deal with a richer set of features and are content-driven in most cases.

II. BASIC TERMS RELATED TO THE WEB SERVICES

The Web service can be defined as a set of protocols and standards that are used to exchange data between applications or systems. Software applications written in different programming languages operating on different system platforms can use Web services to exchange data over computer networks [1]. Web services are XML-based information exchange systems that use the Internet for direct application-to-application interaction. These systems can include programs, objects, messages, or documents.

The basic web services platform is XML + HTTP. All the standard web services work using the following components:

- *SOAP (Simple Object Access Protocol),* a protocol describing the way an application needs to communicate with the web service. SOAP enables the use of web services for financial transactions on the Internet, such as for example authorization of credit cards.
- *UDDI (Universal Description Discovery and Integration),* a system similar to the "yellow pages" system that lists web services, which allows software

applications to "view" the available Web services and the way they can be " attach "to them;

- *WSDL (Web services description language)* is a language that serves to define individual Web services. The WSDL language describes all kinds of activities that a web service can do.

A. Web services characteristics

The approach to the web services is done through a web server. Technically: The Web Service is a distributed software system whose components can be developed and performed on physically different devices [2].

An HTTP request comes, by definition, from the client to the server, while the HTTP response comes from the server to the client. For Web services that use HTTP for transmission, HTTP messages are an infrastructure and they can be combined into basic patterns that are characteristic of Web services.

These forms are, the Request / response where the conversation begins with an HTTP request and an HTTP response is expected, and the Solicit / response where the conversation starts with an HTTP message from the server and an HTTP message is expected from the client. Richer conversational forms can be obtained by combining two forms. And they themselves comprise the basic forms:

- One-way - client-to-server message, no response.
- Notification - a message from the server to the client, with no response to the client.

Web services tend to have a simple architecture. The previous four forms represent the bulk of modern Web services, and the dominant one is the request / response form.

B. Web Services Security

Due to the extensiveness, consideration of the security issue of Web services is usually divided into three parts [4]:

- *Transport-level security* - represents the first or primary level of security in the Web services. It is composed of core protocols covering the communication between the Web services and their clients. Security at this level is provided on three sides.

First, the client and the service during the transport they need conviction that they communicate with one another, not with an attacker.

Secondly, data sent from one side to another must be well-encrypted, encrypted so that the interpreter can not decipher and thus access sensitive information.

Thirdly, on each side there is evidence that the received message is the same as the sent message.

- *User authentication and authorization* - Web services provide customers with access to specific resources. If the resource is secured, in that case the client needs appropriate credentials to gain access to them. The letters of credit are presented and confirmed through a process that usually has two phases.

Namely, in the first phase, the client, ie the user, sends information such as a user name together with the credentials, such as the code. If the credentials are not accepted, the request for access to the resources will be rejected.

This phase is known as User Authentication. The second, optional, phase consists of fine settings and the right of access to an authenticated user. This phase is known as authorization.

- *WS Security* - the security of Web services or WSS is a set of protocols that determine how many different security levels can be applied to the SOAP infrastructure before a particular transport, HTTPS, or through a specific service container, Tomcat.

WSS should provide strong end-to-end security regardless of the transport and container that serves the service. The term "end-to-end" is used for a complete, complete transfer from the client to the service or vice versa.

The threat to Web services includes a threat to the system itself, the applications, and the full network infrastructure. To protect Web services, a wide range of security mechanisms is needed to solve the problem of authentication, access control and security policy distribution.

Some of the XML-based security measures include also XML digital signature, XML encryption, XML Key Management Specification, Security Assertion Markup Language, Web Services Security and ebXML Message Service. An excellent presentation and definition of the security measures is presented in [5].

III. DATA EXCHANGE PROTOCOL BETWEEN WEB SERVICES

First, the system can be based on frequent high-frequency messages (relatively short communication-executing radius). This can always be mitigated by increasing the scope of the service to reduce the frequency of communication.

Secondly, the service may perform data exchange in rare cases, but still be better served and supported by a more appropriate protocol, e.g. large database transfer requires a high-performance service that will need to use another protocol besides SOAP through HTTP for quality data transmission, although SOAP can also be used in this case as the basis for placing the call to the other service (FTP).

Third, a single system can already have an inherited distributed object that uses a protocol like CORBA IIOP. Direct support within the WSDL for this protocol is currently not available and should be developed. Meanwhile, protocol bridges between SOAP and IIOP are a fairly simple solution.

A. Data streaming library between web services

Often, when it comes to data transfer by means of web services, two entities are mentioned, a page that produces data and a page that receives those data. An approach that allows the data-producing side to transmit data to the "consumer" side is the development of a data transfer library that can take advantage of all available data transfer protocols, including those of web services.

When developing a data transfer library to work in a network environment, the following issues need to be considered:

- *Authentication* of entities for data production and consumption (reception) of data. Authentication plays a key role in data transfer because it provides "sensitive" data to fail in the wrong hands.
- *Reliable data transfer*, as the databases become more and more complex, there must be a way to ensure that a large amount of data is reaching their destination, and the underlying transmission mechanism will be able to deal with wrong or noisy channels.
- *Full utilization of the bandwidth*. Usually, the network environment is characterized by high-speed channels, a function that needs to be fully exploited if one wants to use the processing power offered by such a distributed environment.
- *Secure data transfer*. In addition to fast and reliable data transfer, the data transfer mechanisms (protocols) should also provide a high level of privacy. The channel that transmits data must be provided with data encoding mechanisms.

In Fig. 1 are shown the steps for establishing a streaming between two Web services and this process includes the following:

- The Web Services Controller sets the desired connection and application options (or web service) that "generates" data by updating the characteristics of the resources of the web services.
- When the corresponding settings are transferred from the Web Services Controller to the Web Services template, the controller sends a message that the initialization process on the data production page can begin. This means that the background application is configured to start generating data and the server connects to the application to retrieve that data. The server also initiates the connection process according to the characteristics set by the Web Services Controller (which protocol will be used, which port, etc.).
- The Web Service (or Application) that produces applications notifies the controller that the initialization process on the home page is complete and is now in order that the data receiving page is initialized to start operating according to the desired and already set features, again with the update the characteristics of the resources of the web services. (WS Resource Properties)
- When the other party for receiving the data has been successfully initialized and completed, the controller is informed that both parties (either applications or both web services) are ready to start transmitting and receiving data.
- The initial message is sent to both web services. The data server accepts the connection from the client, and the shared authentication takes place.
- If the authentication succeeds, then the data production application begins to transfer the data to the server that it uses as a connection to send it to the client (the one requesting the data). The client reads the data from his connection to the server and transfers them to the application that needs to receive these data. This data flow is shown in a picture in the line with a cross-section.
- When the transfer is completed, the controller is notified to be able to stop the server and turn off the application or continue and initiate the process again depending on the application requirements of the client side.

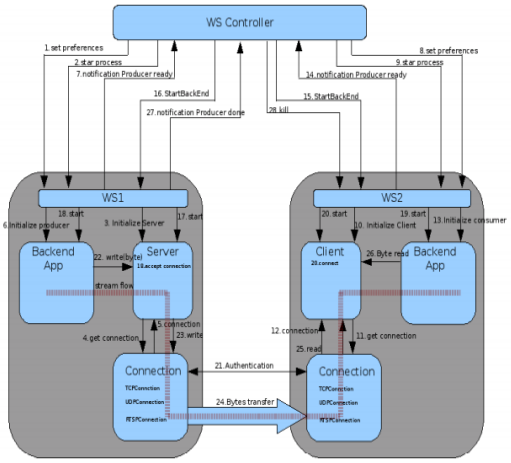

Figure 1. Design of a streaming library and web services for producing / receiving data. Dashed line indicates the flow of data from the production site to the background application that receives data

IV. DEFINING E-COOPERATION BETWEEN FICT AND PUBLIC INSTITUTIONS

This paper refers precisely to the creation of a model of architecture that will illustrate how the communication and collaboration at the application level will take place and which will enable the exchange of data using the technology of web services specifically between the Faculty of Information and Communication Technologies (FICT) at the University St. Kliment Ohridski in Bitola and the public institutions in the Republic of Macedonia, in particular the Ministry of Education and Science (MES), the Health Insurance Fund of the Republic of Macedonia (FZOM), the Pension and Disability Insurance Fund of the Republic of Macedonia (PIOM), the Employment Agency of the Republic of Macedonia (EARM), the Public Revenue Office (PRO) of the Republic of Macedonia, the Embassies of the other countries in the Republic of Macedonia.

Common data forms for the following documents will be created, which FICT and the mentioned public institutions would exchange through the Internet, i.e. through the technology of web services without the help of students or employees in both institutions such as a Certificate for a full-time student, a Certificate for passed student exams, a University diploma, access to student records, a database of graduates, Study programs.

A. Creating a format of data to be exchanged

Web Service Definition Language (WSDL) is an XML format for describing web services as a collection of communication endpoints that allow messaging. In this case, these messages transmit messages for collaboration between public institutions and .

A very important aspect of data exchange is the selection of unique identifiers for objects that are managed inside the system. For some objects, the choice is easy because they have natural unique identifiers, others require a common agreement because each institution probably has its own set of values for object identifiers.

The most important objects to be identified in this case are as a HEI (High Educational Institution) that would have its own identifier or ID = FICT on the one hand and Public Institutions (PI) on the other. In addition, each public institution, having in mind the need to access different data, would have its own identifier (e.g. Ministry of Education with *ID = MON*, Public Revenue Office with *ID = UJP*, further Health Insurance Fund with *ID = FZOM*, Pension Fund with *ID = PIOM*, Employment Agency with *ID = AV*RM, Embassies that would sign a cooperation agreement such as the German Embassy also with a unique identifier *ID = DEAMB* etc.)

The proposed set of web services for this project covers the following methods (the arguments are left out):

- *sendHEIData (), getHEIData ()* - official information about and the public institution is the basis for further electronic processing of the necessary documentation. An agreement that is once signed is likely to continue over the years, but it is good sometimes to upgrade the basic information, because from year to year the study programs, courses, study conditions, etc.
- *sendCFRS (), getCFRS ()* - Certificate For Regular Student or confirmation for a full-time student is one of the inevitable documents, the most requested by the public institutions can be said for further processing and processing of documents. What is included in the certificate for a full-time student are personal data of the student that appear as char, int or other types of variables, for example: name, surname, embg, placeofbirth, as well as student / student enrollment functions in summer / winter semester determined or current year;
- *send ToR (), getToR ()* - Transcript of Records or Certificate of Examination which invokes the study program functions of the student, subjects selected by the student during the semester, the grades received by the student in the subjects and the total average of all grades. Of course, these functions already exist and function greatly in the program used by the Student Affairs Service, public institutions will only have to access to download the data;
- *sendDBoGS (), getDBoGS ()* - Database of Graduated Students, this data may be needed by ESA to upgrade their database with students who have already graduated and should pass under their responsibility;
- *validateUID ()* - this is as an auxiliary function for validating a person or the identifier of both institutions to ensure the accuracy of the data transmitted.

In most cases, symmetric functions such as send () for sending data to the partner institution and get () for downloading data from the partner institution are represented, in this case the collaboration is one-way, i.e. only the public institutions have the opportunity to access the database of FICT to retrieve data, and FICT can only send data to the server of the public institutions.

V. MODEL OF ARCHITECTURE FOR EXCHANGE DATA BETWEEN FICT AND PI THROUGH WEB SERVICES

In Fig.2 is shown a general overview of the project for cooperation between FICT and the public institutions via web services as a prototype of the architecture of the model that will be functional for this purpose. The overall system is a multi-network network composed of the following components:

- UDDI
- Web server built into the application server. and any public institution participating in the project should have their own Web server and WSDL, not all Web services must be implemented in each node.
- Web client embedded in the same application server that is required in general for the purpose of testing and during the initialization phase. It can help test the links between system elements and data forms at different stages of the project.
- An application server on which a user interface application is built regardless of the programming language that will allow the client to display a user level to start the functions that will then proceed through the web services or the application level.

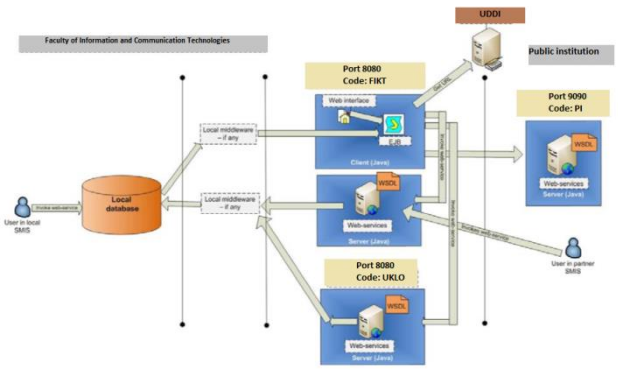

Figure 2: Test model of the set prototype of data exchange via web services

The interface for calling web services should be integrated with the local student information management system. From the perspective of the database, two technologies can be used for the implementation of the data exchange and that would be:

- *Web service called by a local user.*

For the send () method - based on the context, the data is selected from the database, the XML message is

formulated, and entered into the *Advanced Message Queue for outgoing messages*. The answer was read by the *Advanced Message Queue for incoming messages* [6].

For the get () method - the message is constructed and entered into the Advanced Message Queue for outgoing messages, the answer is read by the Advanced Message Queue for incoming messages and is displayed in Oracle, where it can be viewed or deleted.

- *Web service called by a remote user.*

For the send() method - the sent records are stored in the Oracle XML buffer database, special processing is performed to select messages that match specific web methods and can be displayed in Oracle forms, can be searched , read, deleted.

For the get () method, a data request initiates a procedure call from the Oracle package that selects the data from the database and sends it to the caller.

A. Web services security standard

When it comes to data transactions that are executed online, the biggest issue that needs to be addressed is transmission security. Information transmitted over the Internet can be easily intercepted. Web as a technology is invented to share information, so security was not a key issue for developing HTTP technology.

The *WSS standard* itself deals with several core security areas, leaving many details to so-called profile documents. The core areas, broadly defined by the standard, are ways to add security headers (WSSE Header) to SOAP Envelopes, attachment of security tokens and credentials to the message, inserting a timestamp, signing the message, encrypting the message, extensibility.

The primary goal of the WSS standard is providing tools for message-level communication protection, whereas each message represents an isolated piece of information, carrying enough security data to verify all important message properties, such as: authenticity, integrity, freshness, and to initiate decryption of any encrypted message parts. WSS security specification deals with two distinct types of data: security information, which includes security tokens, signatures, digests, etc; and message data, i.e. everything else that is passed in the SOAP message [3].

Web Services are still experiencing a lot of turbulence with their immaturity of the used standards, performance, complexity and interoperability, but as a technology that is growing, defects are improving each day.

B. Performance evaluation of the model architecture

When a FICT server gets a get () method by the server of one of the public institutions that is sent by pressing the button, of course here it is a work through the user interface by the remote administrative user of their local SMIS, for sending a set of data for students who need to meet a particular requirement, the employee of student questions corresponds to the request and sends the data. In a few days some corrections may be required.

Firstly, it is asked whether the entire list of student data should be re-sent or only upgraded. Definitely for each data or document being sent, a timestamp should be attached so that the recipient can sort it chronologically.

Secondly, the public institution has already received the response to the request and received the documents it needs, they do not know that some changes have been made in the meantime, so in this case FICT should have the right to call the send () method so that it can send an upgraded version of the document or it is better to wait for the next get () method from the partner site?

Thirdly, one of the public institutions may ask for documents that are still in the drafting phase of the FICT, so the get () method cannot have a return response at the moment.

Web services may be symmetrical in the sense that the same set of functions can be called from any of the partners, but it seems that the data exchanged is more in line with the exchange of data in real life situations.

VI. CONCLUSION

Correct e-communication between higher education institutions (faculties, universities) and public institutions is a cooperation that every country desires.

If it was done as it should, that collaboration would reduce the number of documents, emails, letters, fax documents that the two parties exchange in case of need would save the time spent by students for collecting copies of documents related to their faculty file that the faculty keeps on their servers in an electronic version would avoid harassment for personal delivery of them and reduce the misunderstandings in the transmission and handover of documents regardless of the direction in which it is lecture (whether from faculties to public institutions or vice versa).

In the time of the huge rise of the Internet and internet technologies used, web services and digital signatures, universities and their units, the faculties keep data for students and study programs in electronic form but still exchange them on paper. What does it take to change how the information will be processed? Applications can transfer data electronically through the architecture of web services, and if they need commonly accepted data formats, even those that refer to the collaboration between them.

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A Comparison of Introductory Programming Courses between Portugal and Serbia

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Abstract - The goal of the study was to learn more about differences in academic performance, teaching, and assessment between introductory programming courses in Portugal and Serbia. Data about a selection of higher education courses were compiled and a comparison of student performance and methods employed in the classroom was performed. The obtained results are expected to serve as a basis for subsequent research on how to improve the current teaching practice in the two countries.

I. INTRODUCTION

Basic programming education has become ubiquitous in higher education all over the world and it is now a common part of various study programmes in science, technology, engineering, and other areas. As programming is being taught to a large number of students, there is a great pressure to provide satisfactory education. This in turn is expected to facilitate wider application of information and communications technology (ICT), which should bring various benefits to the society. Nonetheless, programming is usually considered to be a complex skill and many higher education institutions (HEIs) are faced with the problem of students struggling to complete their courses on introductory programming.

Any novel teaching method or technique that aims to improve learning of programming would be more valued if it could be successfully applied in different courses and across multiple countries. However, each course is unique in terms of its students, teachers, and the overall educational context in which it is organized. In addition to national regulations and HEI policies, teacher's decisions and sometimes even those of students may affect the structure, requirements, and outcomes of a course. Still, course comparison, which may not be an easy task even for two courses on the same subject, could provide useful information when devising improvements in teaching. If an improvement is to be generally applicable, it would need to be evaluated in different environments that have already been studied and sufficiently understood

In the present study, we examine and compare two groups of courses in higher education that are devoted to introductory programming, a group of courses from HEIs in Portugal and a group of courses from an HEI in Serbia. This study represents an initial phase of a bilateral research project whose aim is to propose improvements to information technology (IT) teaching practice in Portugal and Serbia. In this initial phase, we are concerned with collecting anonymised data about selected courses on introductory programming, processing the data to obtain comparable data sets, exploring and contrasting the data sets, and discovering more about potential challenges in course execution in particular countries. Once the critical areas of improvement are identified, we may design concrete interventions and perform evaluation, which is the subject of subsequent phases of our project.

II. RELATED WORK

Portugal and Serbia are European countries of comparable size and population. Unlike Portugal, Serbia is not part of the European Union (EU), but it has entered the negotiation process to become a member. Nevertheless, the use of ICT in enterprises in Serbia is comparable to the corresponding level in the EU and, for some indicators, above the EU average [1].

Both countries are part of the Bologna process and are full members of the European Higher Education Area (EHEA) [2]. As a result, in these countries, the higher education systems are organized around the three-cycle format (bachelor's, master's, and doctoral degrees). Moreover, science, technology, and engineering appear to be prominent areas of higher education in the two countries. In Portugal, the annual number of students who completed their studies in areas related to science and engineering has exhibited a relatively positive trend over the past few years [3]. In Serbia, the official policies have been supportive of higher education in engineering and natural sciences [4].

Despite the fact that programming is currently a lucrative skill that can be acquired at a great number of HEIs, students tend to associate the process of learning to program with various difficulties. Based on responses from five different European countries, it may be inferred that students who learn to program overestimate their understanding and that more attention should be given to

certain programming topics [5]. Moreover, in a different study, it was observed that two introductory programming courses in Portugal and the United Kingdom had some common issues during course execution, including poor lecture attendance and problems in laboratory classes [6].

Difficulties in introductory programming courses have been categorized as being related to the nature of programming, teaching methods, study methods, student abilities and attitudes, or psychological challenges faced by students [7]. For instance, in a survey of students in Portugal, lack of effort or personal persistence and lack of motivation were some of the common reported reasons for learning difficulties [8]. In other studies involving students from Portugal, it was noted that final marks in an introductory programming course were positively correlated with final marks in some mathematics courses [9] and that students who failed an introductory programming course also had weak understanding of basic mathematical concepts and struggled with problem solving [10].

According to the reports in numerous studies, some of which have been mentioned in this section, it is evident that introductory programming is demanding and that students and teachers may face a varied set of issues in programming education. Before intervening in a course, it is appropriate to first compile and analyse data about concrete courses and then to identify issues in the courses.

III. Data and Methods

For the purpose of our study, we collected and used anonymised data about a selection of introductory programming courses in higher education in Portugal and Serbia. Student identifiers were not part of the collected data. We analysed a period spanning academic years from 2013/2014 to 2016/2017. We have collected data for two institutions in Portugal, coded as PI-A and PI-B, and one institution in Serbia, coded as SI-A. In the context of our study, the term institution was used to denote an HEI at the level of a university or an institute.

We analysed the following courses:

- courses PC-A1 through PC-A7 – seven courses from the institution PI-A that belong to four different study programmes in total;
- courses PC-B1 through PC-B5 – five courses from the institution PI-B that belong to three different study programmes in total; and
- courses SC-A1 through SC-A3 – three courses from the institution SI-A that belong to three different study programmes in total.

For each execution of an analysed course, we recorded academic year, course code, institution code, programming language taught in the course, number of registered students, values of three indicators of student performance, and teaching and assessment methods that were predominantly used in the course.

The three indicators of student performance were:

- Passed/Assessed – the pass rate when considering only assessed students, i.e., a ratio of the number of students who passed the course and the number of students who were assessed in the course;
- Passed/Registered – the pass rate when considering all students, i.e., a ratio of the number of students who passed the course and the number of students who registered for the course; and
- Assessed/Registered – the assessment rate, i.e., a ratio of the number of students who were assessed in the course and the number of students who registered for the course.

The same three indicators were used in a different study as metrics to assess the student performance in Portugal across consecutive academic years [11]. The definition of the state of being assessed actually differed between the two countries. For the analysed courses in Serbia, i.e., courses SC-A1 through SC-A3, a student was considered assessed only if the student had earned more than zero points in at least two different assessments. This definition was adopted because courses SC-A1 through SC-A3 had multiple ordinary pre-exam assessments throughout the term, unlike the analysed courses in Portugal. Due to limitations of the available data about the selected courses in Serbia, the values of the three performance indicators had to be calculated differently for the courses SC-A1 through SC-A3, i.e., only the students who were enrolled in the course for the first time were considered and the values of the indicators relying on the number of assessed students had to be based on certain estimates.

We considered the following teaching methods:

- 1 – doing paper-based exercises, i.e., students do not solve exercises by using computers, but by using pencil and paper;
- 2 – doing computer-based exercises, i.e., students use computers to solve exercises, either by using an editor and a command line compiler or by using an integrated development environment (IDE);
- 3 – project-based learning (PBL), i.e., projects are developed during the programming classes and programming concepts are introduced when needed in the project;
- 4 – using learning management systems (LMS), i.e., a software platform is used to manage classes and work outside the classroom;
- 5 – using syntax-oriented editors, i.e., syntax-oriented editors are used when programming in the classroom; and
- 6 – using debuggers, i.e., debuggers are used when programming in the classroom.

We considered the following assessment methods:

- 1 – project-based assessment, i.e., students produce some code to solve a problem and then send or present the code to the teacher;
- 2 – individual work, i.e., code is produced by just one student and there is not any group work;

- 3 – midterm assessment with paper-based exercises, i.e., assessment at the middle of the academic term when students use pencil and paper to solve exercises;
- 4 – midterm assessment with computer-based exercises, i.e., assessment at the middle of the academic term when students write programs on computers in the classroom;
- 5 – exam assessment, i.e., students do an exam at the end of the academic term, either by using computers or by pencil and paper;
- 6 – automated assessment, i.e., the teacher uses a special tool to automatically assess student code;
- 7 – peer assessment, i.e., student's code is assessed by other students; and
- 8 – multiple assessments, i.e., students have multiple assessments throughout the academic term.

Multiple teaching and multiple assessment methods may be applied during the same course execution.

IV. Results and Discussion

In Table 1, there are some basic data about each selected course, most notably the programming language taught and employed teaching and assessment methods. The dominant programming language is C, followed by Haskell and MATLAB. The dominance of the C language in programming courses coincides with the findings of other researchers. In a separate study of programming courses in the European higher education, it was concluded that C is the language most often taught, with strong advantage over the other languages especially in the first term [12]. In general, the preference for C in programming education is typical of Serbia, but, in Portugal, Java and Python are actually used more often than C to teach programming [12].

In both countries, teaching methods involved computer-based exercises and, to a lesser degree, usage of syntax-oriented editors. Another commonality is that paper-based exercises were not used in teaching, i.e., this traditional method has been abandoned in practice. However, for the analysed courses, it may be also noticed that some new trends, such as learning management systems, peer assessment, and even fully automated assessment of student code, have not been adopted yet.

In general, student project work has become more common in higher education, especially in engineering and science studies. In the context of the considered courses, project-based learning and project-based assessment were applied only at one institution in Portugal, i.e., solely within the courses at the institution PI-A. We may only hypothesise that the absence of project-based assessment at the other two institutions is related to the insufficient number of academic staff members needed for such a demanding task.

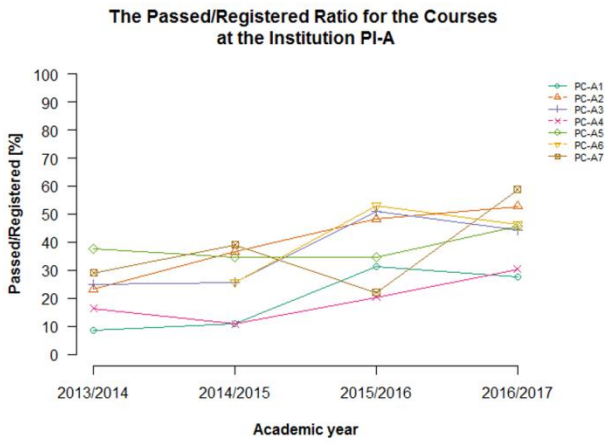
TABLE I. Overview of Courses

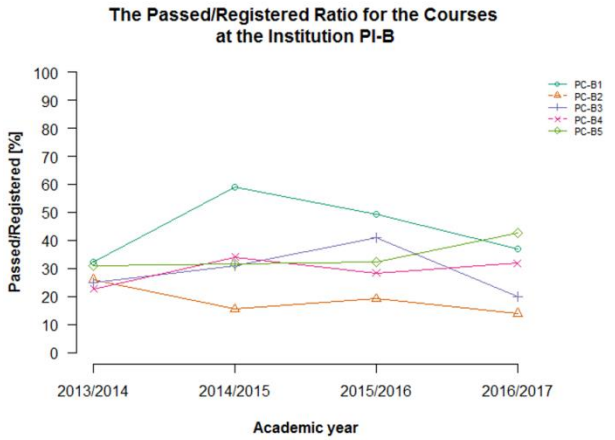
Institution code	Course code	Language taught	Teaching methods	Assessment methods
PI-A	PC-A1	Haskell	2, 3	1, 3, 4, 5
PI-A	PC-A2	Haskell	2, 3	1, 3, 4, 5
PI-A	PC-A3	Haskell	2, 3	1, 3, 4, 5
PI-A	PC-A4	C	2, 3	1, 3, 4, 5
PI-A	PC-A5	C	2, 3	1, 3, 4, 5
PI-A	PC-A6	C	2, 3	1, 3, 4, 5
PI-A	PC-A7	C	2, 3	1, 2, 5
PI-B	PC-B1	C	2, 5	3, 4, 5
PI-B	PC-B2	C	2, 5	3, 4, 5
PI-B	PC-B3	C	2, 5, 6	3, 4, 5
PI-B	PC-B4	C	2, 5	3, 5
PI-B	PC-B5	MATLAB	2, 5	3, 4, 5
SI-A	SC-A1	C	2, 5	2, 5, 8
SI-A	SC-A2	C	2, 5	2, 5, 8
SI-A	SC-A3	C	2, 5	2, 5, 8

There was also some variation between the choices of other assessment methods. There was an exam assessment in both countries, but the execution of assessment throughout the term differed. In Portugal, there was almost always some form of midterm assessment, while, in Serbia, there were only multiple assessments organized throughout the term.

In Fig. 1, the values of the Passed/Registered ratio are given across the examined academic years for all the considered courses. The top and middle chart in Fig. 1 show that the two institutions in Portugal have similar pass rates, which could be classified as low to moderate. On the other hand, the Passed/Registered ratio is generally better in courses in Serbia and the pass rates there could be regarded as high. As the compiled data do not include assessment scores and final grades of students, we could not speculate if the higher pass rates were the result of potentially better student knowledge of programming in Serbia. In a global survey of pass and failure rates in introductory programming courses, the reported average pass rate was 72% when all the courses were weighted equally [13]. With respect to this value, the pass rates could be considered above average for the institution in Serbia and below average for the institutions in Portugal.

At least some portion of the difference in pass rates between Portugal and Serbia could be attributed to the fact that all the performance ratios for the courses in Serbia were calculated only for the students who were registered for the course for the first time in a particular year. Nonetheless, based on the knowledge of past course executions in Serbia, it may be supposed that, even if all the registered students were considered, the pass rates in Serbia would on average still be higher than in Portugal. In this other scenario, the pass rates in Serbia would probably move towards the moderate to high category.





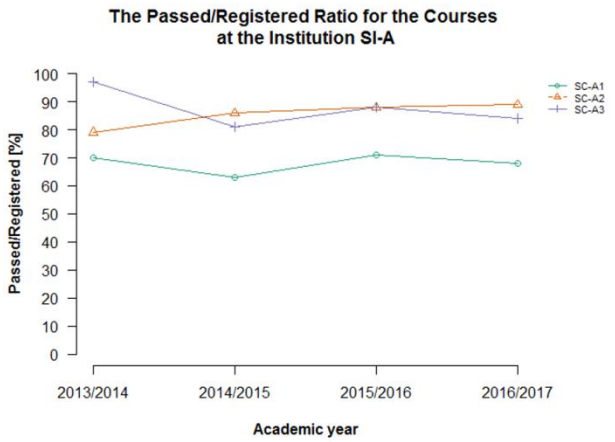
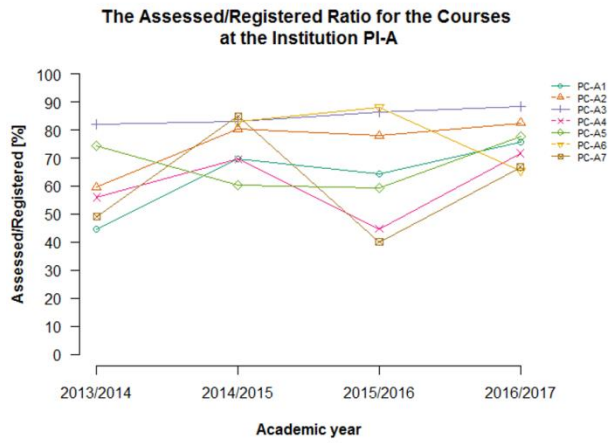
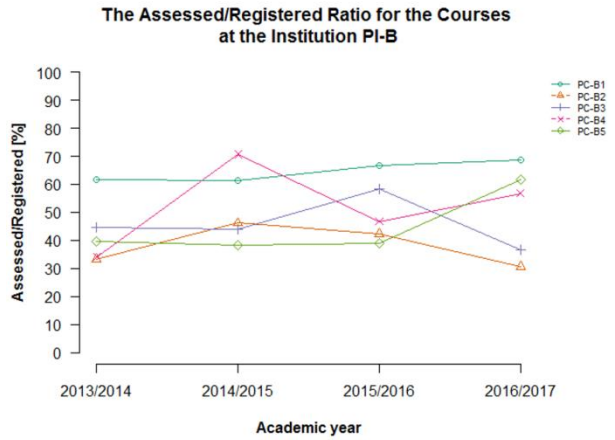


Figure 1. The Passed/Registered indicator values for different institutions: PI-A (top), PI-B (middle), and SI-A (bottom)





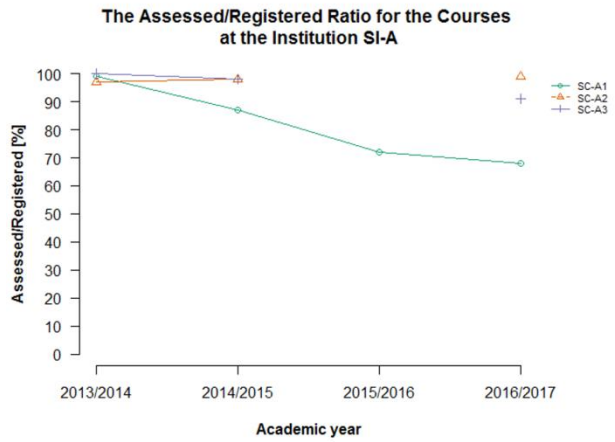


Figure 2. The Assessed/Registered indicator values for diffierent institutions: PI-A (top), PI-B (middle), and SI-A (bottom)

In Fig. 2, the values of the Assessed/Registered ratio are shown. As expected, the values of the Assessed/Registered ratio are somewhat higher than the corresponding values of the Passed/Registered ratio. The differences in the Assessed/Registered ratio between the institutions in Portugal and Serbia are less pronounced than for the Passed/Registered ratio. However, these differences are still noticeable and the institution in Serbia exhibits higher assessment rates. The previous commentary regarding the influence of sample construction on the Passed/Registered values may also apply to the case of interpreting the Assessed/Registered values.

The greatest difference between the Passed/Registered and Assessed/Registered values may be observed for the institution PI-A, which is located in Portugal. Such a difference may be more easily observed in Fig. 3, where the values of the Passed/Assessed ratio are presented. Based on these values, it may be presumed that the Passed/Assessed ratio is noticeably higher in Serbia as opposed to Portugal.

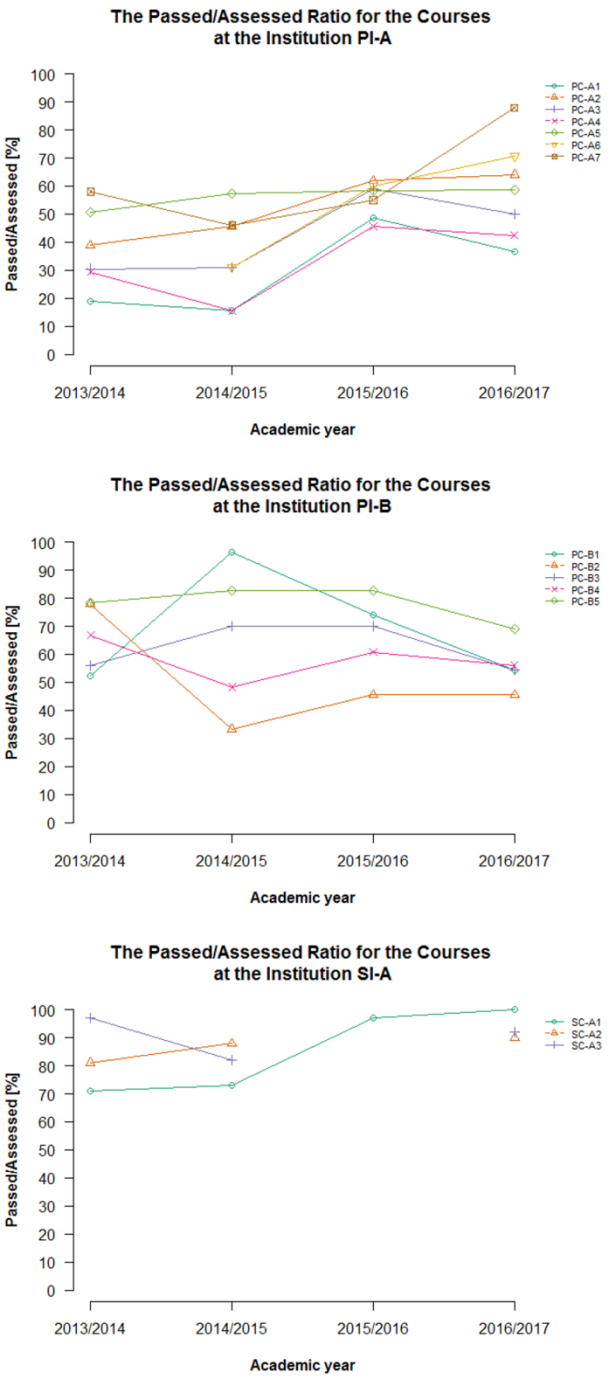


Figure 3. The Passed/Assessed indicator values for different institutions: PI-A (top), PI-B (middle), and SI-A (bottom)

V. Conclusion

We collected and analysed anonymised data about selected introductory programming courses at HEIs in Portugal and Serbia. The main findings of the comparative analysis of the courses in the two countries include:

- the C language is the main choice for introductory programming courses in both Portugal and Serbia;
- teaching methods differ between the countries – computer-based exercises are used in both countries, but PBL is applied only in Portugal;
- assessment methods differ between the countries – exams were applied in both countries, but midterm assessment is usually preferred in Portugal and multiple assessments throughout the term are preferred in Serbia;
- assessment rates are higher in Serbia; and
- pass rates are higher in Serbia, even when only the assessed students are considered.

The most prominent distinction between the courses in the two countries is the difference in both the pass rates and the assessment rates. Potential causes might include differences in teaching methods and course requirements, as well as disparities in motivation and attitudes of students. Another factor might be the lack of previous education in computing and the absence of prerequisite skills. However, the introduction of computer science into basic education [14] could contribute to better preparedness of future students, which may reduce the present problems. Since we are interested in improving current IT teaching practice, we are planning to look more closely into the identified issues.

Acknowledgment

The research was conducted as part of the project *Data mining based evaluation of IT teaching practice in Portugal and Serbia* within the Programme of Scientific and Technological Cooperation between the Government of the Portuguese Republic and the Government of the Republic of Serbia, and also supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia under Grant III-44010.

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Mobile Applications for Recording Road Traffic Noise

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Abstract - We are witnessing numerous discussions that are conducted in order to define the optimal routes of significant transport corridors in Bosnia and Herzegovina, especially in the segment where the issues of their location are discussed in the vicinity of large city cores, hospitals and cultural monuments. There are various software solutions for measuring noise near traffic routes using mobile devices. The aim of the study is to measure the noise level on the main road near the hospital complex of the city of Doboj based on the noise measurements performed by the mobile application, and analyze the relationship between the level of traffic noise and the traffic flow frequency.

Key words – Road traffic noise, traffic flow frequency, Sound Meter (SM).

I. INTRODUCTION

Environmental noise pollution refers to sound levels in human environments that are higher than acceptable levels caused by traffic, construction, industrial, and individual recreational activities. Noise can have serious direct or indirect consequences on human health, such as hearing loss or sleep disturbance. Noise, like unwanted sound, causes various interruptions during work and rest, impedes voice communication and affects the general and working behavior of a person, and at strong levels can have pathological effects. Noise can endanger human health, leading to disturbance sleep and rest, increased fatigue and decreased ability to work, and not rarely damage to the organism [1]. Over time, it can lead to an increase in blood pressure and to mental disorders. The effects of noise can activate the premature development of the disease, and in extreme cases even death. Exposure to noise during the night can be significantly different from the effects during the day.

II. TYPES OF NOISE AND APPLICATIONS FOR NOISE MEASUREMENT

Activities carried out across Europe in order to reduce noise in the environment have a different priority compared to environmental issues such as air and water pollution, often because such issues were considered to be best addressed at national or local level. Republic of Srpska regulated noise protection measures with the "Environmental Protection Act" [2]. In the initial stages, EU noise regulation was based on internal market goals and in most cases focused on harmonizing allowed noise values created by certain devices (motor vehicles, home appliances, etc.). As time information on the impact of noise on human health became more and more available, there was a need for a higher level of protection for EU citizens.

A. Noise and environment

Noise appears as a significant problem in the human environment in most urban areas. Still, this problem is still not considered important, and therefore it is not paid enough attention despite the fact that it significantly affects the quality of life of the vulnerable population. The reason for this approach can be sought in the definition of noise and its perception as a subjective experience of certain external events, its specific character, and the difficulty in linking causes to effects on human health [3]. Every sound phenomenon (noise, magnification, speech, etc.) that hinders work or rest is noise. In order for some sound to be called a noise, it must be strong enough, that we can distinguish it from other sounds and hear it well. When it comes to endangering the living and working environment, it is certain that, in addition to various types of harmfulness, the noise is most often mentioned.

B. Road traffic noise

Noise in the environment is defined as the sound created by all sources that occur in the human environment. One of these sources of sound can be traffic, and this kind of noise is called traffic noise. We distinguish several types of traffic noise according to the types of roads:

- traffic noise on motorways,
- urban roads,
- roads and
- roads for special purposes.

The latest problem is traffic noise on urban roads because such roads pass through urban settlements, near hospitals, schools and monuments of culture. The European Union, by the directive of 2002, defined the term "environmental noise" and refers to unwanted and harmful external influences generated by human activity, including the noise generated by transport (road, rail and air) and the exposure of the population to noise in cities [4].

High traffic noise values in such environments may have a bad impact on people's lives [5]. Traffic noise is a major environmental and health problem in modern cities.

The European Environment Agency published a report according to which about 125 million people were affected by road traffic noise levels above 55 dB daily, causing 10,000 cases of premature death, nervousness and anxiety in almost 20 million adult inhabitants, and 8 million a year had a disorder sleeping. Over 900,000 cases of hypertension and 43,000 hospitalized per year have been reported [6].

There are numerous projects in Europe dealing with noise reduction in urban areas. One of them is SYLVIE (SYstematisch Lärmsanierung von innerstädtischen WohnVIErteln) [7].

By rapidly increasing the traffic flow frequency, traffic noise is becoming more and more intense. Previously, under the noise of the vehicle, only the noise of the engine, of its exhaust system. Today, it is known that there are other noise sources of vehicles that are no less important than the noise of the engine, which are:

- transmission,
- tire noise due to rolling and
- noise of parts of the superstructure, which comes under the influence of resonances.

Road vehicles produce two basic and independent noise sources and come from the drive system and tire contact with the road surface. On the drive system, noise is mainly generated by engine operation, in suction, blowing and cooling. For trucks and buses, the noise is stronger due to the stronger propulsion system and the characteristic adhesion of the vehicles on the road, therefore, their percentage distribution in the traffic flow is of great importance. In passenger and freight vehicles, the sound pressure level largely depends on the engine operation, the speed of the rpm, and they are different for different speeds [8]. Road traffic noise (cars, buses, trucks and motorcycles) is the most common source of noise in cities and is the primary cause of interfering with human activities. Long-term exposure to high noise levels has far-reaching negative impacts on human well-being and health, with measurable economic consequences: treatment costs, decline in work activity and productivity, increased mortality, a decline in the market value of buildings in excessive noise zones [9].

When considering traffic noise, the analysis of the noise characteristics of isolated vehicles, passenger vehicles, motorcycles and heavy vehicles should first begin, and then analyze the traffic noise, especially in the urban environment, where there are interrupted and uninterrupted traffic flows.

In order to better understand the effects of traffic noise on man, considerations of the basic sources of traffic noise are necessary. Noise sources are present in both road and rail and air traffic [10].

C. Mobile applications for environmental noise measurement

There are different applications for mobile devices that measure environmental noise in decibels (dB). Mobile applications for noise measurement substantially similar in architecture and can:

- indicates decibel,
- display the current noise,
- display average decibel values,
- display decibel by graph,
- calibrate for each device.

Different applications for measuring environmental noise made by the redeemed or different operating systems. They can be installed on Android, ISO, Linux and Windows operating systems. The most popular mobile applications for measuring environmental noise are:

- *Sound Meter.*
- *Decibel Meter.*
- *Sound Meter & Noise Detector.*
- *Decibel X.*

Sound Meter

Sound meter is mobile application (app) which shows a decibel values by measure the environmental noise. Microphones in most Android mobile devices are designed to measure environmental noise. Microphone detects and displays in decibels (dB) as max, average and min sound level. The maximum values are limited by the device. The mobile application Sound Meter has the ability to recognize the type of noise based on measured noise in (dB), Figure 2. In a study to measure road traffic noise used mobile application Sound Meter because it is free, allows calibrate for each device and "friendly" for use.

Decibel Meter

Decibel Meter mobile app uses the built-in microphone to determine the level of sound it detects, and displays this in decibels (dB) as max, average and min sound pressure level. With this app, the level of noise from the environment can be easily measured. All microphone audio data are used to calculate (dB) reading to the user.

Sound Meter & Noise Detector

Sound Meter is also known as sound level meter, decibel meter (dB), noise meter, sound pressure level meter (SPL meter). This app will use the phone microphone to measure environmental noise decibels (dB) and show a value for reference. The biggest advantage is the ease of use.

Decibel X

"Decibel X" or Professional dBA Noise Meter is one of the few sound meter mobile apps that has highly reliable, pre-calibrated measurements and supports frequency weightings: ITU-R 468, A and C. It converts the mobile into a professional noise meter, precisely measures the sound pressure level (SPL).

III. MATERIAL AND METHODS

This paper presents the results of the study of the level of traffic noise and the traffic flow frequency in the area of Doboj. The research is based on the collection, statistical processing and recording of the value of road traffic noise (Lsm) expressed in (dB) and traffic flow frequency (N) expressed in (vph). The aim of the research is to determine the existence of a mathematical dependence between the stated quantities.

A. Location of measuring

In the focus of observation is the location marked with the number (1-red) in Figure 1. The location marked with (1-red) represents the intersection crossroads from the direction of Doboj and M17 road from the direction of Modrica. The location (1-red) was selected due to the traffic peak in the morning and the end of the working day. For this reason, police often regulate traffic at the location of the designated site. The measuring point is located 4 m from the road, in the middle of the marked island and at a height of 1.5 m [11]. It should be pointed out that the location of the measurements is located in a 20 m radius from the city settlement "Old Town" (2-yellow) and 200 m from the hospital "Holy Apostle Luka" (3- yellow).

Figure 1. Location of measurements in relation to housing settlement and hospital. Measurement location (1-red), housing estate "Stari grad" (2-yellow) and hospital (3-yellow).

B. Measuring of traffic noise

Measuring the value of road traffic noise (Lsm) was done in June 2018 by a smart phone using the Sound Meter application that is intended for the Android platform. The Lsm variable represents the noise level recorded by the Sound Meter app (Figure 2).

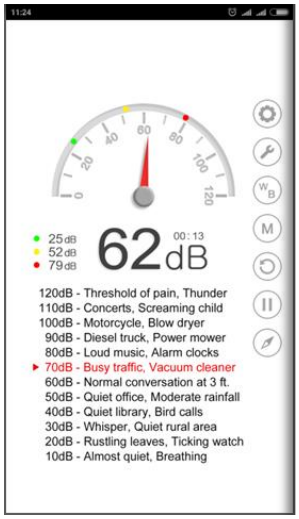

Figure 2. Mobile App Sound Meter for measuring traffic noise.

Seven measurements were made, and each metric implies morning, afternoon and night time. Each term consists of three fifteen-minute intervals within an hour, and these are:

- Morning intensity (traffic peak) between 6:30 a.m. and 7:30 a.m.
- Afternoon intensity (traffic peak) between 2:30 p.m. and 3:30 p.m.
- Night intensity (traffic peak) between 10:30 p.m. and 11:30 p.m.

The measurements were performed in approximately equal conditions with respect to climatic data. The following climatic data were recorded:

- the weather,
- the air temperature,
- the velocity and direction of wind,
- the atmospheric (barometric) pressure.

Climate data is also collected and stored using a smartphone.

IV. RESULTS AND DISSCUSION

Correlation between the average values of road traffic noise (measured using the Sound Meter application) or Lsm in (dB) and the average traffic flow frequency N u (vph) is shown in Table 1.

TABLE I. THE CORRELATION MATRIX OF (LSM) AND (N).

Time	Morning		Afternoon		Night	
Measurement	L_{sm} (dB)	N (vph)	L_{sm} (dB)	N (vph)	L_{sm} (dB)	N (vph)
1	62	190	61	160	53	51
2	58	161	61	236	51	48
3	60	192	60	207	51	52
4	63	306	65	320	56	99
5	60	283	62	300	54	90
6	62	216	61	220	56	99
7	65	247	62	238	57	78

The results of the average values of road traffic noise and average traffic flow frequency at intervals of fifteen minutes in the morning, noon and evening are shown in Figure 3.

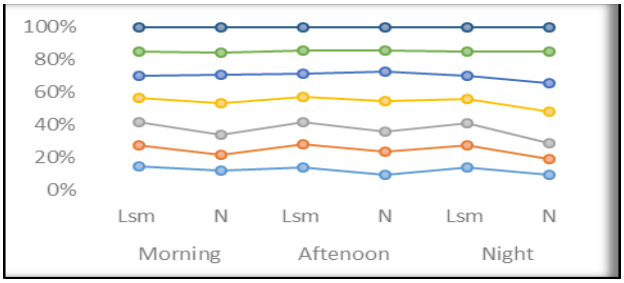

Figure 3. Road traffic noise Lsm and traffic flow frecuency N values in day time.

By the method of mathematical regression, a form of function describing the dependence of the average value of road traffic noise Lsm from traffic flow frequency N was obtained (Figure 4). Nonlinear cubic regression was used.

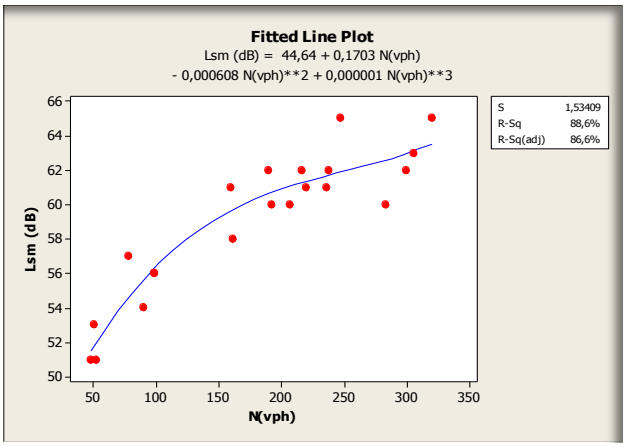

Figure 4. Dependence of the average value of road traffic noise Lsm from traffic flow frequency N.

The third-degree function with an 88.6% determination coefficient was described by formula (1):

$$Lsm = 44.64 + 0.1703N - 0.000608N^2 + 0.000001N^3 \quad (1)$$

N is a causal variable and L is a consequential variable. Determination coefficient shows what percentage of the variability of the dependent (consequential) variable explained by variability of the independent (causal) variable. The quadratic function has a coefficient of determination of 87.9% which is smaller in relation to the function represented by the equation (1). The value of the determination coefficient for a linear function has a value of 81.5%.

V. CONCLUSION

Road traffic noise greatly affects the quality of life of people who for a long time or temporarily stay in the vicinity of roads. Traffic flow affects the road traffic noise that has been proven in this paper. It is important that the traffic noise is rapidly and accurately recorded due to the speed of traffic flow frequency. Mobile devices allow recording the level of traffic noise and traffic flow. Mobile applications for recording traffic noise represent a fast and efficient way of recording noise with the aim of alarming at not allowed noise values. In this case, competent authorities can react quickly to alleviate the disadvantage of the state for the quality of people's lives. In case of noise alarm based on the traffic flow frequency, it is possible to seek quick and efficient solutions in the form of air barriers, noise reduction at source, reduction of noise distribution, protection against noise in the place of emission, and altering the route of the roads. Mobile noise measurement applications take precedence over classical noise meters because they are adaptable to a variety of portable devices (smart phones, tablets, notebooks, etc.) and different operating systems (Android, ISO, Windows, etc.). The applications are cheap, reliable and portable, which in certain noise measurement situations is necessary.

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Software Solution for the Calculation of Critical Load Points for Special Consignments

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Abstract - The calculation of critical points of special consignments during transport in most cases is counted manually. Usually it is a job that requires several hours, in some cases even days of work. In order to simplify and shorten this long- and long-term work, the software solution "Calculate critical points" is proposed for the calculation of the critical points of the shipments.

Key words - Subscribe consignments, transport of special consignments, critical point of the load, software solution.

I. INTRODUCTION

Safe railway transport means safe passage of traffic composition under overpasses, tunnels, etc. This situation requires accurate and fast calculation of the critical load points of special consignments. Critical load points for special consignments are still counted manually at ŽRS A.D. Doboj, and according to their findings, it takes several hours. This is the job of the Construction Service, which belongs to the Construction Department. The time required by that service to examine the possibility of transporting special consignment ranges from 5 to 20 days. Time depends on the complexity of the consignment. Such a long period of time required to examine the possibilities of transporting the railway becomes uncompetitive on the market, because it becomes unacceptable for the user to wait 10-30 days (in exceptional cases) for the transport.

A. Special consignments

Special consignments include vehicles whose loading, transport, transshipment, unloading, causes difficulties with respect to installations or railway means of transport, and which can be received for transport only under special technical and operational conditions. Special consignments can be grouped into 9 groups, as follows:

- special consignments exceeding the factory profile,
- special consignments exceeding the allowed load,
- on-wagon consignments without the RIV mark, as well as new vehicles not yet fitted into the rolling stock of a railway,
- goods that require special measures due to the position of the center of gravity,
- freight rail and steel or concrete structures over 36m long,
- wagons with more than 8 axles,
- special consignments of goods loaded on two or more wagons,
- Individual items whose weight is over 25t.

All consignments that must be transported under special technical or exploitation conditions shall also be included in the special consignment.

II. TESTING THE POSSIBILITY OF TRANSPORT OF SPECIAL CONSIGNMENT

In the case of local traffic, the examination of the possibilities for the transport of a special consignment is performed by the railway transport company (RTC) on whose territory the consignment is transported. Within the ŽRS A.D Doboj, the exploitation sector (transport and transport service and technical service), the construction sector, the electro technical sector and the traction sector are engaged. The request comes first to the exploitation sector (transport and transport service) where its processing and recording is done. After that, it is handed over to the department for jobs (civil service), which is conducting additional tests. In practice, the electrical and technical services sector is engaged as needed. The results of the tests carried out in these sectors (services) are returned to the TTS (Traffic and Transport Services) sector. The TTS prescribes the necessary traffic and technical measures of conditions, and based on them, the economic conditions (price) are required from the sector for railway commercial operations. After that, the TTS informs interested units on the field.

Examination of the possibility of transporting a particular consignment is carried out in several stages:

- choice of wagon,
- check of allowed load,
- determining the center of gravity of cargo on the wagon,
- determining critical points for consignments that engulf the free profile,

- detection of safety distances,
- determining the transport route,
- additional checks (checking the ability of bridges and so on).

III. DETERMINATION OF CRITICAL POINTS OF LOADS OF SPECIFIC CONSIGNMENTS

Determination of the position of the points that exceed the factory profile is made in relation to the two normal levels:

- Vertical plane is flat in which the axis of the track gauge,
- horizontal plane is determined by the upper edges of the track gauge.

Critical points for exceeding the load profile are the furthest points on the consignment measured from the vertical or horizontal plane. The calculated distance is added so that the wagon with a special consignment can safely pass in the least favorable place of transport. This distance consists of:

- accessories for direction and curvature,
- second addition,
- safety distance.

Figure 1 displays the required distance for the safe transportation of consignments.

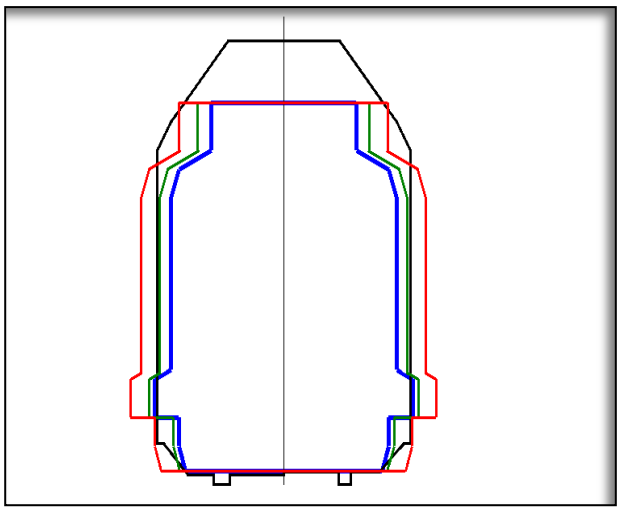

Figure 1. Display of critical points

The profile of the ŽRS (Railway of the Republic of Srpska) is shown in black, the blue is profile of the load, the green color is the addition of the rocking and the red color is additive for the curve and direction. On this view we can see the exact point where the special consignment exceeds load profile of ŽRS.

IV. METHODS

The time required to investigate the possibility of transporting specific consignments ranges from 5 to 20 days. Calculating the critical points of the load lasts for several days, depending on the complexity of the consignment. In order to simplify and accelerate this long and lasting job, the software solution "Proračun kritičnih tačaka" was proposed.

The C # programming language and development environment was used to create software "Proračun kritičnih tačaka". C # is chosen as a software solution because object-oriented programming language engineered for the .NET platform also has the efficiency, a high level of security, garbage cleaning mechanism, and the speed of application development.

When creating an application, the following features have been considered:

- Works like other Windows applications because of using the module "Windows Forms", which has a library controls such as buttons, toolbars etc.
- Works with Web applications.
- Works with Web services.
- Works with databases, ADO.NET part of the .NET platform.

V. DISSCUSION

The "Proračun kritičnih tačaka" application is designed specifically for calculating critical load points. Critical points of the goods are calculated on the basis of the dimensions of the special consignment. The calculated points are used for the selection of the transport route. Then, appropriate protective measures for the execution of transport are determined. Transport protection measures include primarily limitations of maximum speed and speed over the crossbar, determining the tracks through which the train can be driven with a special consignment, grounding of the cargo, disassembly of parts of the contact network. The program "Proračun kritičnih tačaka" consists of 2 forms. The first form consists of the several units as it can be seen at Figure.

Figure 2. Form for entering dimensions of loads and additional parameters

Railway information - relevant track information is entered here. For this calculation, only the radius of curvature (R) is required, but there is a possibility, when the need for additional tasks of this program appears, to add the necessary data subsequently.

Wagon data - here you enter the spacing of the axles in the stand (a) and the spacing of the shaft or the distance between the stand stops (r). These data are expressed in meters (m).

If the item is located inside the cradle hub, then it is not necessary to manually enter it, but the column is not automatically populated by one click on the "Popuni Ni" button. Otherwise, the Na column will be filled manually.

Table for entering the dimensions of the cargo and the distance between the inner and the outer points from the nearest headquarters. The first two columns represent columns for entering the width of the load from the axis of the track - left and right. The values in the third and fourth columns, for a given width, represent the starting and ending points of expansion of this width. If you enter a value only in the column "Visina iznad GIŠ-a 1", then the program will automatically fill in the column "Visina iznad GIŠ-a 2" with the same value. The fifth column (Ni), as already mentioned, is automatically filled by clicking the button. This button is used for critical loads.

Two buttons, "Izračunaj" and "Iscrtaj". The "Izračunaj" button is used to calculate the necessary additions for that special consignment. The "Iscrtaj" button is inactive when launching the application. It becomes active only after calculating the add-ons (after using the "Calculate" button).

By pressing the "Izračunaj" button, a new form appears on the graphic display of the drawn profiles:

- ŽRS profile (according to UIC-506, three types of free profiles: GA, GB and GC),
- profile of special consignment,
- profile of special consignment with the addition of swings,
- profile of special consignment with the addition of a swing and a curve fitting.

If you have not entered all the required dimensions of the special consignment, either the width or the height, the message "Unesite širinu (levu ili desnu) od sredine kola" appears on the screen (Figure 3), or "Unesite visinu" (Figure 4).

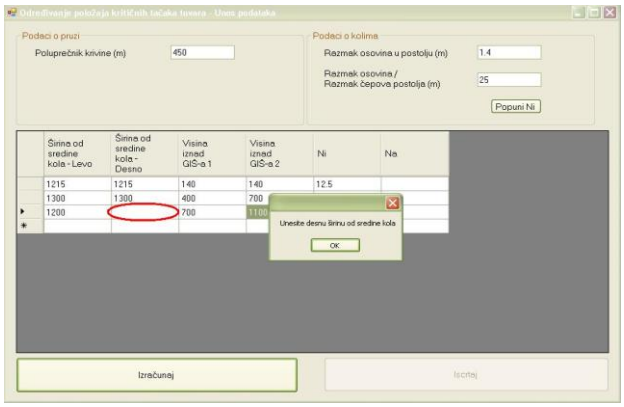

Figure 3. Message „Unesite desnu širinu od sredine kola“

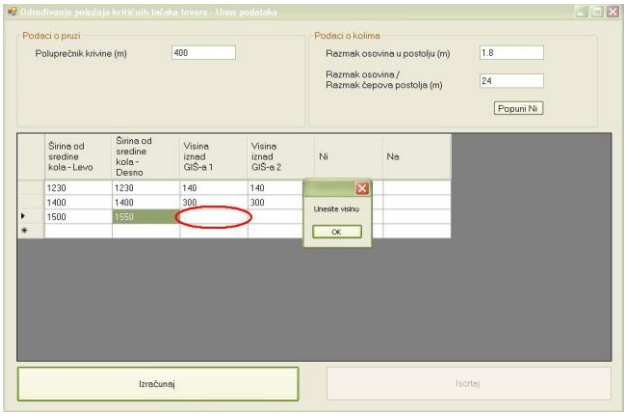

Figure 4. Message „Unesite visinu“

When all data is entered, with one click on the "Izračunaj" button, we get two more columns with the calculated add-ons (Figure 5), and the "Iscrtaj" button becomes active:

- Swinging attachment - "Moguće pomeranje".
- Curvature and directional attachment - "Dodatak za krivine".

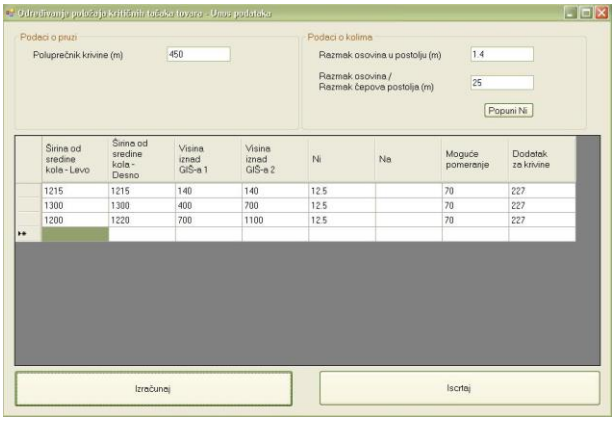

Figure 5. Correctly filled form

By clicking the "Iscrtaj" button, another form will be opened, showing the required distance for the safe transport of the special consignment (Figure 1.).

VI. CONCLUSION

Using the proposed software solution "Proračun kritičnih tačaka", critical points are obtained immediately after entering the dimensions of special consignment by one click on the given button. We can develop this software solution in several directions. By adding a freight wagon database that is capable of transporting special consignments would allow the supply of wagon data with a simple selection of the appropriate wagon. Adding a database of critical points on the ŽRS A.D Doboj network (tunnels, bridges, overpasses, objects that engulf the profile, etc.) is also useful. This would allow direct connection with the obtained critical point display, which would result in precise critical sites on the line and concrete measures to be taken by comparing the required and available distance. By linking the Sectors within the

RTC, the necessary data is currently delivered. This would reduce the time needed to examine the transport possibilities to a minimum.

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Defining a feature-rich end-to-end augmented reality platform for spatial exploration

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Abstract - This paper defines an augmented reality end-to-end platform for spatial exploration with the time as an added component. The platform will be defined for exploring the past and future of houses or buildings that are recognised by the natural features extracted from a photo of their facades. We compare the fiducial marker to natural features and explore the natural feature tracking available with ARToolKit. The paper goes in-depth with generating markers and provides guidelines for the size of the photo, the level of extraction of features and the minimal and maximal resolution. Our primary focus is on setting up the communication of a smartphone and a server including the filtering of markers and display objects. We also discuss the need for calibration of the camera and the methods used for calibrating and delivering the calibration file to the end user.

I. INTRODUCTION

Augmented reality is used in many categories such as product visualisation, entertainment, marketing, military, medicine, industrial design, tourism and education. Most of the available products, apps and solutions are intended for indoor usage. This is especially the case with the introduction of ARKit and ARCore. Analyzing the category for tourism and exploring the past or future state of outdoor objects we found some specific apps that explore the history of certain houses and buildings or locations. Also, there are end-to-end platforms available where users without technical knowledge can create markers and add display objects. Since there isn't a platform that includes the time factor as a way to explore certain object and have rich multimedia and text we propose our platform.

II. RELATED WORK

There are multiple applications and research that address the use of augmented reality for displaying the history of a certain object or a location. These allow for displaying historical events, archaeological information's and present the culturally historical heritage of a location but rarely focus on the time dimension.

Apps that are close to our platform are dARsein [1], an iPhone app that explores the house of the famous Austrian architect Josef Maria Obrich, timetraveler berlin wall [2], an Android app that displays historical events around the Berlin wall, Paris, Then and Now Guide [3], an Android app with 2000 spots in Paris with photos up to 100 years from the past, London History AR [4] that uses a card as a marker, AR MApp [5]that uses a map of the city of Barcelona and others.

Arth, Pircheim, Ventyra, Schmalsties and Lepetit [6] worked on a method for tracking the camera on non-textured 2.5 dimensional maps, where the height of the object is added to the 2 dimensions. McClean [7] proposed a platform for urban environments that extrudes the flat surfaces/facades of objects thus eliminating the need for 3D scene reconstruction after which the flat surfaces are used to determine the pose of the camera and the pose of the displayed object. Cavallo, Rhodes and Forbes [8] showed how a combination of the classical markerless approach together with internal sensors and geolocation could be used to display 2D objects.

III. DEFINING THE PLATFORM

Our goal was to create a platform that will contain different time points for objects; so the end user can explore the state of the object in different periods. The platform will be able to display the past of objects with rich history or locations that are in development. When used in development locations it can display the future progress in real time and how the finished object will look like when finished.

Since ARToolKit does not support cloud recognition we created a platform that consists of an app executed on a smartphone and a server. The goal is to develop a platform available to as many users as possible.

All of the recognition data and display data is stored on a server. The addition of markers can be done on a web browser or the mobile app. The process of adding markers and display objects such as a picture, audio, video, 3D model and text or a link needs to be simple so users without technical skills can use the platform. The platform needs to support adding various time intervals containing multimedia or textual data so users can explore how an object used to look like in the past or how it could look in the future. The content creator will have the ability to add display data in the future. The platform needs to have an administrator user that has access to all the added data that after reviewing, can approve or disapprove. This puts a filter, so end users receive only the approved content.

The mobile app should be available to as many users as possible starting with low-end devices. This translates to Android phones that have low specifications. Each

Android phone is equipped with a camera and GPS, but low-end phones are usually lacking some or many of the internal sensors. That is why the filtering of the data needs to be done by using the location of the phone and have only optical recognition by using only the camera. Filtering the data helps by narrowing down the radius of the objects that are near the user.

A few years ago, fast 4G network communication was reserved only for high-end phones. Today nearly all of the phones support 4G so all of the users can benefit from fast transfers of the recognition and display data.

The mobile app fist sends the location to the server which filters the objects surrounding the user and selects only the approved ones that are sent back to the user. Having a slider is key for easy navigation when there is data for multiple time points. The initial recognition of an object displays the default data together with a bottom-placed slider.

Another key aspect is changing the pose (position and orientation) of the displayed multimedia, so it is placed right where the recognised object is. This process is best done with the mobile app so the displayed multimedia can be positioned in real time.

A. *Hardware*

There are multiple hardware offerings specific to augmented reality. These include Google Glass, Tango phones, HoloLens, Meta, ODG, Magic Leap and others. All of these devices have their advantages, but by defining the platform to be available to as many devices as possible, we chose smartphones.

B. *Software*

In order to choose the software to develop the mobile app, there are a couple of characteristics that can be observed such as the type of the license, the supported platforms, the support for smart glasses, local and/or cloud recognition, 3D recognition, SLAM support and UNITY support. There are many available SDK's such as Kudan, Wikitude, ARToolKit, EasyAR, MAXST, XZIMG and others. ARToolKit is open source and best suited for academic purposes.

IV. FIDUCIAL MARKERS VS NATURAL FEATURES

The recognition of the objects (houses, buildings) can be done by using fiducial markers "Fig.1" or by recognising the natural features "Fig. 2" of the facades or doors. The usage of fiducial markers has three main advantages [9] over natural features:

- they enable for a highly dynamical environment in which the angles of the marker reflect the movement
- they are practical in situations where there is a monolithic environment lacking textures
- the lighting of the environment has a minimal effect due to the contrast in the marker

Althought the recognition and tracking of fiducial markers are faster compared to natural features. This type of scenario would mean putting physical markers in the environment. Having a platform with multiple objects makes it unpractical from an economic, legal and logistical standpoint.

We have to note the need for the platform to recognise houses, buildings etc. therefore using the natural features makes the objects much larger markers compared to fiducial markers. It also enables the phone to recognise the objects from much greater distances without physically placing fiducial markers that would occlude the objects.

Another difficulty with using fiducial markers is the recognition of objects from multiple sides. Instead of placing physical markers the use of natural features allows for the objects to be recognised by additional software data.

Figure 1. Fiducial marker

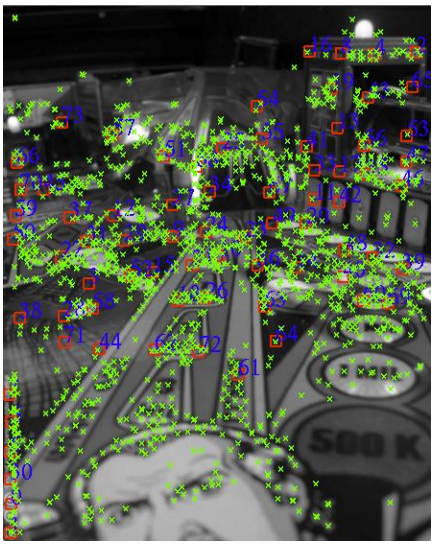

Figure 2. Natural features

V. NATURAL FEATURE TACKING

The ability to recognise natural features is part of ARToolKit, the SDK we used in creating the platform. The recognition of natural features is aimed at photos and documents, but our goal is to recognise outdoor objects. Extracting the features requires that the surface is flat and that the photo contains many details. The need for details is because the platform needs to train with a photo of the current condition (look) of the object so it can later be recognised and tracked in real time.

Before training with a photo, some rules need to be followed:

- the surface needs to be in a rectangular image
- the image needs to be in jpeg format
- the surfaces need to have texture and a larger number of fine details and sharp edges

Training with photos that have large areas with single colour or don't contain enough details can lead to difficulties when locating the natural features and the created marker not being recognised or tracked well.

Before extracting the natural features, the photo is converted to grayscale. That means that the contrast in the grayscale photo is key for extracting natural features. There are some cases when a colour photo seems to look like it has good contrast, but the converted grayscale does not make it suitable for recognition and tracking.

Bigger photos with large resolutions enable for extraction of a larger number of features. This enables for better tracking when the user is closer to the object and in cases when a higher resolution camera is used. Choosing the optimal resolution of the photos used to create markers is significant because using a photo with a too large resolution creates larger files and uses more RAM, storage and CPU. Another potential drawback is that from a more detailed photo the extracted features can't be seen from the smartphone when using a lower resolution on the mobile app. On the other hand, using a too low resolution will extract much fewer details that are not enough for recognition when the user is too close or too far from the marker.

When recognising the marker, the natural features need to keep their geometric relation. Photos of objects that have the same elements such as reiterating windows or balconies are not guaranteed to be tracked well.

Before the extraction of features, the photo is resized to multiple photos with different sizes. In some cases, an object can have some details such as text that can be used when the user is near the object and use the features from the resized smaller photos when the user is far from the object and the text or small details are not visible.

The physical size of the houses or buildings allows for them to take a large portion of the camera preview and to be recognisable from a larger distance making them good markers. Here we must note the importance of having a real-world analysis of the surroundings of the object that is used as a marker. This means to take into consideration the physical location of where the user is expected to explore the object. In some cases, objects will not fit in the camera preview, so we have to use parts from the object.

VI. GENERATING MARKERS - GENTEXDATA

genTexData is an app used for extracting the features where beside the photo of the objects to be used as a marker we need to specify the following parameters:

- Extraction level for tracking features, 0 for few, 4 for many, 2 for default
- Extraction level for initialising features, 0 for few, 3 for many, 1 for default
- Minimum image resolution in DPI (depending on the photo size)
- Maximum image resolution in DPI (depending on the photo size)

The speed and stability of the recognition and the tracking is in direct correlation with the parameters specified during the extraction of features.

Before training with a photo of a house "Fig. 3" we removed the background elements not needed for tracking. The photo has 800*450 pixels and is 107KB in size. In order to look and compare the differences with different parameters, we made 3 pieces of training. In all of the cases, we used 10dpi for minimum resolution and 72dpi for maximal.

Figure 3. Photo of a house used for extracting features

In the first training "Fig. 4" we used the lowest settings 0/4 for initialising and 0/3 for tracking features. In the second training "Fig. 5"we used the default settings 2/4 and 1/3 and in the last one "Fig. 6" we used the highest settings 4/4 and 3/3.We used the app dispFeatureSet for displaying the features of each of the generated markers.

Completing the training process results with 3 new files: .iset containing pyramids of compressed images, .fset with the tracking features and .fset3 with the initialising features. dispImageSet is the app used to display the compressed images.

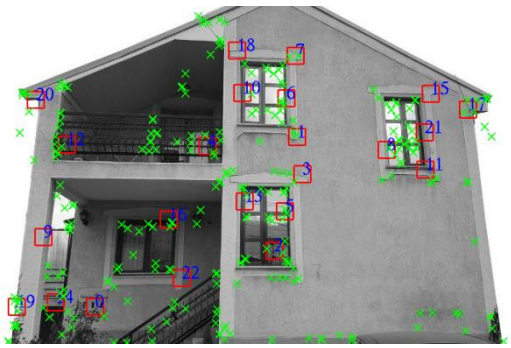

Figure 4. Extracted features with the lowest settings

× initialising features

□ tracking features

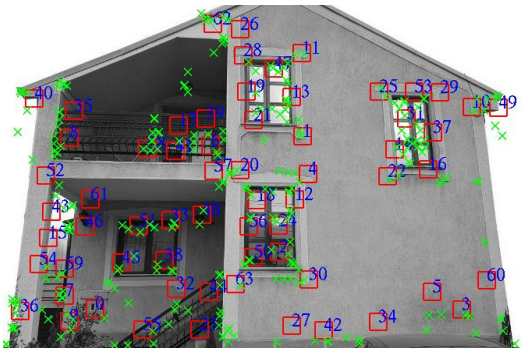

Figure 5. Extracted features with the default settings

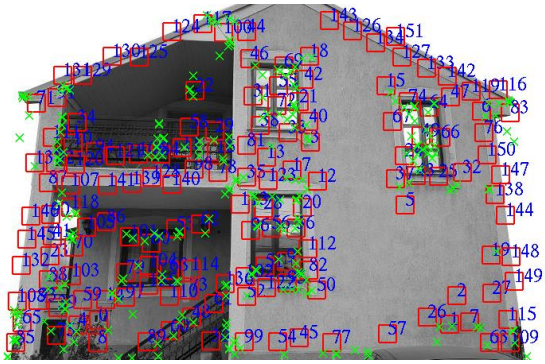

Figure 6. Extracted features with the highest settings

In all of the three cases we got the same .iset file (49KB) containing 10 images with the following DPI:
72.000000[dpi] image. Size = (800,450)
63.496048[dpi] image. Size = (706,397)
50.396847[dpi] image. Size = (560,315)
40.000004[dpi] image. Size = (444,250)
31.748024[dpi] image. Size = (353,198)
25.198423[dpi] image. Size = (280,157)
20.000002[dpi] image. Size = (222,125)
15.874011[dpi] image. Size = (176,99)
12.599211[dpi] image. Size = (140,79)
10.000000[dpi] image. Size = (111,63)

In all three cases, we got the same .fset3 file (265KB) with the same number of initialising features. The differences are in the number of tracking features.

TABLE I. THE NUMBER OF EXTRACTED INITIALIZING AND TRACKING FEATURES

IMAGE	I	TRACKING FEATURES		
		A Fig 4. (2KB)	B Fig 5. (5KB)	C Fig 6. (10KB)
72.000000[dpi] Size = (800,450)	337	23	64	152
63.496048[dpi] Size = (706,397)	328	22	52	112
50.396847[dpi] Size = (560,315)	467	13	35	75
40.000004[dpi] Size = (444,250)	287	7	22	47
31.748024[dpi] Size = (353,198)	211	5	13	29
25.198423[dpi] Size = (280,157)	173	4	10	19
20.000002[dpi] Size = (222,125)	110	3	5	11
15.874011[dpi] Size = (176,99)	66	1	4	6
12.599211[dpi] Size = (140,79)	43	1	2	4
10.000000[dpi] Size = (111,63)	29	1	2	2

I = initialising features

The reason for having the same number of initialising features is that up to version 5.2 ARToolKit used SURF as a feature extractor. Version 5.3 uses FREAK and the genTexData app not being updated does not support setting the level for initialising features so it gives the same result no matter the given parameters [10].

Using a photo of a façade to create a marker and visually inspecting the features we can conclude that: features are extracted where there are edges and details, surfaces without details do not provide features and surfaces with details with low contrast and not good for tracking.

Although generating markers is technically possible it is not practical such as the case where generating a marker on Samsung S5 took up to 25 minutes [11].

VII. USER KEY

The addition of user key eliminates the need for users to register and log in and enables for:

- Adding markers
- Review the users existing markers
- Changing the display objects (adding and deleting)
- Changing the display parameters (size, position and orientation)

At start up the app checks if it has user key and if it does not it sends a request to the server to generate a new key. The generated key is checked if it is already in use and if the key is unique it is sent back to the user. The user key is used as a permission barrier for adding new markers, reviewing the existing ones and changing the objects.

VIII. ADDING MARKERS

Adding markers is done via the mobile app or the site of the server. When adding markers via the mobile app, the user key is used to identify and add a new record to the database so the user can later edit the display objects. When accessing the website, the user logs in only by typing in the user key which can be viewed in the mobile app.

When adding a new marker, the user first selects the photo from which the marker will be generated. This photo needs to be in jpeg format. If the photo has geolocation data, the location fields are automatically completed by using a JavaScript library [12]. If the photo does not contain geolocation or the user has the need, the geolocation can be manually changed.

Together with the photo and the geolocation the user adds the display objects. These objects can be images, sounds, videos or 3D models. An image or 3D model can be combined with audio.

For all the display objects the user enters a label that is used when there are multiple display objects from different time periods. In such cases, the user can select a default object to be displayed when the marker is recognised.

Each of the objects can be complemented with a link that will be opened with the WebView component. The

link can be a web page on the server with text and multimedia or can be a link from sites such as Wikipedia.

At the end of this process when the user selects to create a marker, he receives a message that the added marker and display objects will be available to other users when they are allowed by the administrator.

On the server side, first a new id is created in the database. The parameters with the photo, the geolocation and the display objects are put in the database with the new ID.

Before generating the marker, we reduce the size of the photo, so the larger size is 1000 pixels. The resizing of the photo is done so we end up with smaller file sizes of the iset, fset and fset3 files needed for recognising and tracking the marker. Smaller marker and display files are faster to transfer, faster to load and take less storage on the smartphones. This is key when aiming at low-end devices that have less RAM and storage. Also, the very process of generating the marker is much faster when using resized photos.

The generating of the marker with genTexData is called with the following parameters: level 2 for the extraction of tracking features, level 1 for the extraction of initialising features, min_dpi 10 for the minimum resolution and max_dpi 80 for the maximal resolution. Having max_dpi at 80 is suitable for the resolution of 1000 pixels and the min_dpi at 10 because there are usually a low number of features at that resolution.

Until the generation of the marker is completed all of the display objects are kept in the memory, and when the generating is completed, the marker and display objects are put in a folder named with the new ID.

IX. CAMERA CALIBRATION

Smartphone cameras have lenses that create distortion. That is because the focal length or the distance between the lens and the sensor is less than 35mm, making them wide angle cameras. The smaller is the focal length; the larger is the field of view (FOV) and vice versa. In these cases where the camera sensor is smaller than the FOV leads to squeezing the photo, so it fits the sensor “Fig. 7”. This leads to positive radial distortion also known as barrel distortion [13].

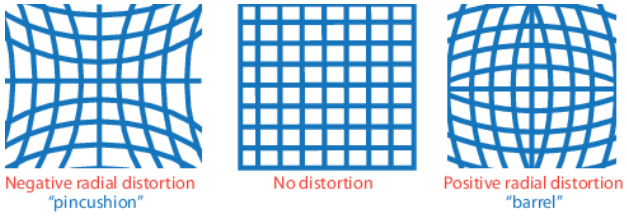

Figure 7. Visualization of negative radial, no distortion and positive radial distortion

When using an augmented reality app on a smartphone where there are optical recognition and tracking of markers, an uncalibrated camera can make for imprecise tracking. When looking for natural features besides matching the features the algorithms also have to match their geometry, so having a distorted camera views means the features are viewed at a different position [14].

In the case of ARToolKit the standard camera parameters are provided in a camera_para.dat file. This file is read at starting the app and contains good enough parameters for various phones.

In order to eliminate the camera distortion and thus get much better recognition and tracking, we need to make camera calibration for specific phones. To make the calibration, there is the ARToolKit6 Camera Calibration app available GitHub [15]. When calibrating the camera the following document [16]“Fig. 8” is printed on an A4 format.

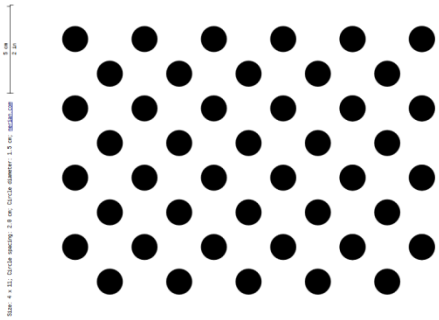

Figure 8. A pattern for calibrating the camera

The calibration app offers multiple resolutions for calibrating. Since smartphones use various camera sensors, we had to choose a resolution available for most of them, and that is 640x480 (VGA) that has 4:3 ratio. When first designing the app we testes with 850x450 because it has a 16:9 ratio but real-world testing showed that the VGA resolution is most versatile and best used in our use case.

Calibrating the camera for all of the available and future devices is a logistical challenge. That is why we have to note that the aspect ratio of the resolution is much more important than the resolution itself. Having a VGA calibration with a 4:3 aspect ratio can be used for all 4:3 resolutions. This allows for 2-3 calibrations per device: 4:3 and either 16:9 or 18:9 depending on the ratio of the device's display.

There are two methods for calibrating the camera: a manual and a guided one “Fig. 9”. On the manual method, the user calibrates the camera by taking multiple photos of the pattern. This method can be done with at least 5 photos but taking more photos from multiple angles makes for better calibration. On the guided method the user follows a guide to position the phone at a certain position and angle and once the FOV matches the pattern the camera automatically takes a photo.

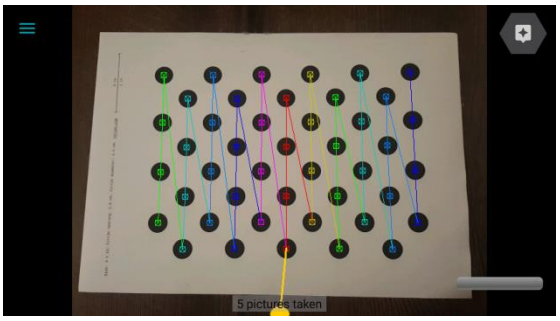

Figure 9. Guided camera calibration

When using the guided method, the app recognises the circles that are 1.5cm large and distanced 2cm each. On "Fig. 9" we have the 5th step of 8 steps in total. A good practice is to move and change the angle of the device rather than moving the pattern.

In the results of a completed calibration "Fig. 10" the values in each of the columns represent the deviation in each of the guided photo in pixels. The goal is to generate a calibration where all of the values are smaller than 1 pixel. The generated calibration file is named with the manufacturer of the device, the model and the used resolution and is stored on the server.

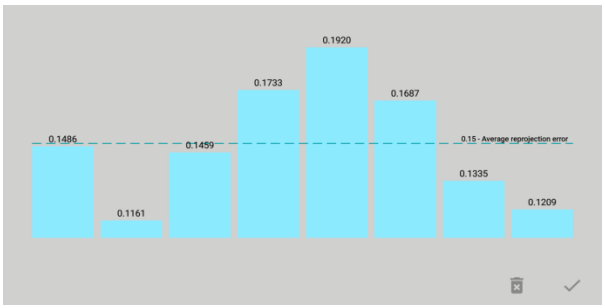

Figure 10. Display of camera calibration results

A small file size that is usually less than 1KB allows us to send the calibration file to the users' phone when delivering the markers and display objects. On request the server checks for the specific model and resolution used and if there is a match it is sent to the user; otherwise the mobile app uses the generic calibration.

ARToolKit 6 includes a server [17] that enables a distributed approach at delivering the calibration file. In our case using this server would mean an additional web service, and that is why we implemented the functionality in our server.

X. CONCLUSION AND FUTURE WORK

In this paper, we proposed an end-to-end augmented reality platform with the goal of spatial exploration of objects that can be used to display their past form or potential future. We defined the hardware and software needed for the platform for wide usage. Despite the fast recognition of fiducial markers, the use of natural features has obvious advantages in our scenario.

We addressed the creation of markers with natural features and the optimal parameters for fast recognition and tracking. Adding a user key makes it easy for users to authenticate when adding new markers and display objects. Also we explained the process of adding markers. In the end, we addressed the importance, the process and the delivery of camera calibration files.

In the future we need to develop the aspects of the mobile app such as the display of photo, video, 3D model and the playback of audio and display of hyperlinks, the changing of the position and orientation of the displayed objects so they overlap the objects, the role of the focus of the camera, the resolution of the camera, the camera ratio, the screen orientation, the tacking stability, changing the perspective of the displaying photos and the factors that can have an effect on the user experience.

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Fog Computing for Personal Health Principles

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Abstract: Ambient Assisted Living (AAL) environments rely on ambient sensing and environment control to enable elderly people to continue to live in their preferred environments. Unlike smart homes where the target audience is usually a family unit, AAL goal is to be able to interact with care receivers and care providers. This provides possibility in case of home based AAL, the care recipient not to be under constant monitoring by the care providers which reduces care costs and increases care efficiency. Cloud paradigm and fog computing fits well for this scenario as data from homes can be aggregated and analyzed in a centralized location. An interface for the care providers can be provided from the cloud using web and mobile devices.

In this article, we describe principles for AAL based on fog computing. The edge nodes process and detect local activities of daily living (ADL) events, and have direct control of the local environment. The fog nodes further process and transmit data. The cloud is used for data computation that requires greater resources.

1. INTRODUCTION

Technology for monitoring, assisting and improving personal health has improved considerably with the advancements in affordable wearable and environmental sensors, improved Internet connectivity and the advances in the field of cloud computing. The presence and rapid growth of Internet of Things (IoT) has also impacted how people monitor their health [1]. Wearable devices monitor heart rate and physical activity [2]. More appliances come with internet connection capability and smart sensors are becoming common. The sensor and usage data can paint a more detailed picture about health and personal habits [3].

For elderly and disabled people technology has direct impact on their ability to remain at home and live more independent lives [4]. A rich research filed of Ambient Assisted Living (AAL) is improving the means and methods for improving the health of the elderly and disabled. AAL is also facing different challenges [5]. Enhanced Living Environment (ELE) is field that provides resources for personal health for the general population [6]. AAL and ELE address different target audience but both fields benefit from similar technology [7].

A single device, individual or group of sensors, both wearable or environmental, present in the ELE can provide input on limited set of health aspects. Smart watches and health trackers can track body temperature, hearth rate, walking, or running, environmental sensors can detect temperature, humidity, can perform fall detection and movement within the home. To get even more out of these devices and sensors we connect them to the cloud where all the data is analyzed for a more holistic picture. Having data from many users, machine learning (ML) algorithms can learn and predict health hazards and find correlations between the environment and human health [8].

While the benefits of IoT cloud computing are visible both in research and daily use, when it comes to personal health there are many drawbacks. News about lack of security of IoT devices and bad practices of certain corporations that gather and abuse personal data from owners of connected devices have made consumers wary of the technology and more proactive in protecting their personal data [9,10]. There is a potential of targeted advertisement to identify personal health details, future employers might refuse potential employees because of their health risks or personal habits, and insurance companies can purchase personal data and use it to deny coverage or increase premiums. Protections against these practices vary and can be loose in some jurisdictions. Even when such protections exist the legal expenses can be high and the case can be difficult to prove. Fog computing can have a role in data protection by moving some data analysis to the edge nodes and anonymizing the data that is sent to the cloud [11].

Personal healthcare and AAL can generate a significant quantity of data and for some scenarios, such as fall detection, the requirement is to have immediate reaction of the system by triggering alarm to the care provider. Data pre-processing on edge nodes can significantly reduce the bandwidth requirement and the need for real time cloud communication [12].

Cloud downtime or connectivity issues can be a problem in the case of AAL. While many of the large cloud providers have multiple availability zones, the cost of having high availability of the cloud is higher. Edge nodes can more easily be clustered allowing for high availability of the fog computing.

2. FOG BASED ARCHITECTURE

Fog computing adds an extra layer to the cloud computing architecture but it is not merely an extension of the cloud. Fog computing has the following characteristics: it spans to adjacent physical locations; has support of on-line analytics; the service is provided by smart but not powerful devices; supports various communications networks; and is distribute computing [13]. There are four logical layers as shown in figure 1.

On the first layer the data is generated by sensors that can be wearable or body sensors, and peripheral or environmental sensors. Data can also be generated from external sources such are: social networks, clinical center information systems or medical databases. Data collected by the sensors can include: vital signs, personal habits, or environmental factors. External data sources can provide different information including: medical check results, medical databases for diagnostics.

The fog layer gathers the sensor data and process them and passes either processed or some raw data to the cloud. The devices directly connected to the sensors are called edge nodes and aside from collecting data they can take actions with the user. Each LAN environment can have one or more edge nodes, depending on the application requirements and scale. In cases of elderly care facilities data for multiple tenants could be processes on the same edge nodes. These actions can include providing feedback to the person to take their medicine or to start exercise, and can provide direct interaction with the environment such as activating the humidifier or regulating the room temperature, control electrical appliances and emergency cut-off for water, gas and electricity. The fog network usually has more limited capacity than the cloud for data computation and is not able to do complex machine learning and feature extraction. However, for nodes could be able to run algorithms developed by machine learning. As the machine learning system improved and evolves regular updated could be pushed down to the fog network to improve detecting patterns in the sensor data. Using this methodology ADL detecting ML could receive continuous data and improve the detection rate. Events that take brief time, such as when person falls, can be detected by the nodes in the fog using the latest ML model improved in the cloud.

The cloud layer collects data from multiple sources and process the data. Machine learning and feature extraction is done at this layer. Data from the fog and from external sources is collected by the global data fusion component, this data is processed. The could can process data from multiple locations and create a machine learning models. The output is continuously improved knowledge base. This knowledge base in turn is used by the service layer.

The service layer is the product of the system. Knowledge obtained by analyzing the data is used for services including creating customized recommendations for diet and exercise, improve diagnostics systems, provide updates to the health providers, and add additional information in medical databases.

A. Smart e-health gateway

In fog computing the nodes closest to the devices or things are called edge nodes. In healthcare systems, these nodes can be smart e-health gateways. The gateway serves as a bridge for medical sensors and home/hospital building automation appliances to IP based networks and cloud computing platforms. The main requirement of a gateway is to support various wireless protocols and inter-device communication. Its role can be extended to support several features such as acting as repository to temporarily store sensors' and users' information, and bringing intelligence by enhancing with data fusion, aggregation, and interpretation techniques, essential to provide preliminary local processing of sensors' data, becoming thus a Smart e-health gateway. Smart e-health gateway can tackle many challenges in ubiquitous healthcare systems such as energy efficiency, scalability, interoperability, and reliability issues [14].

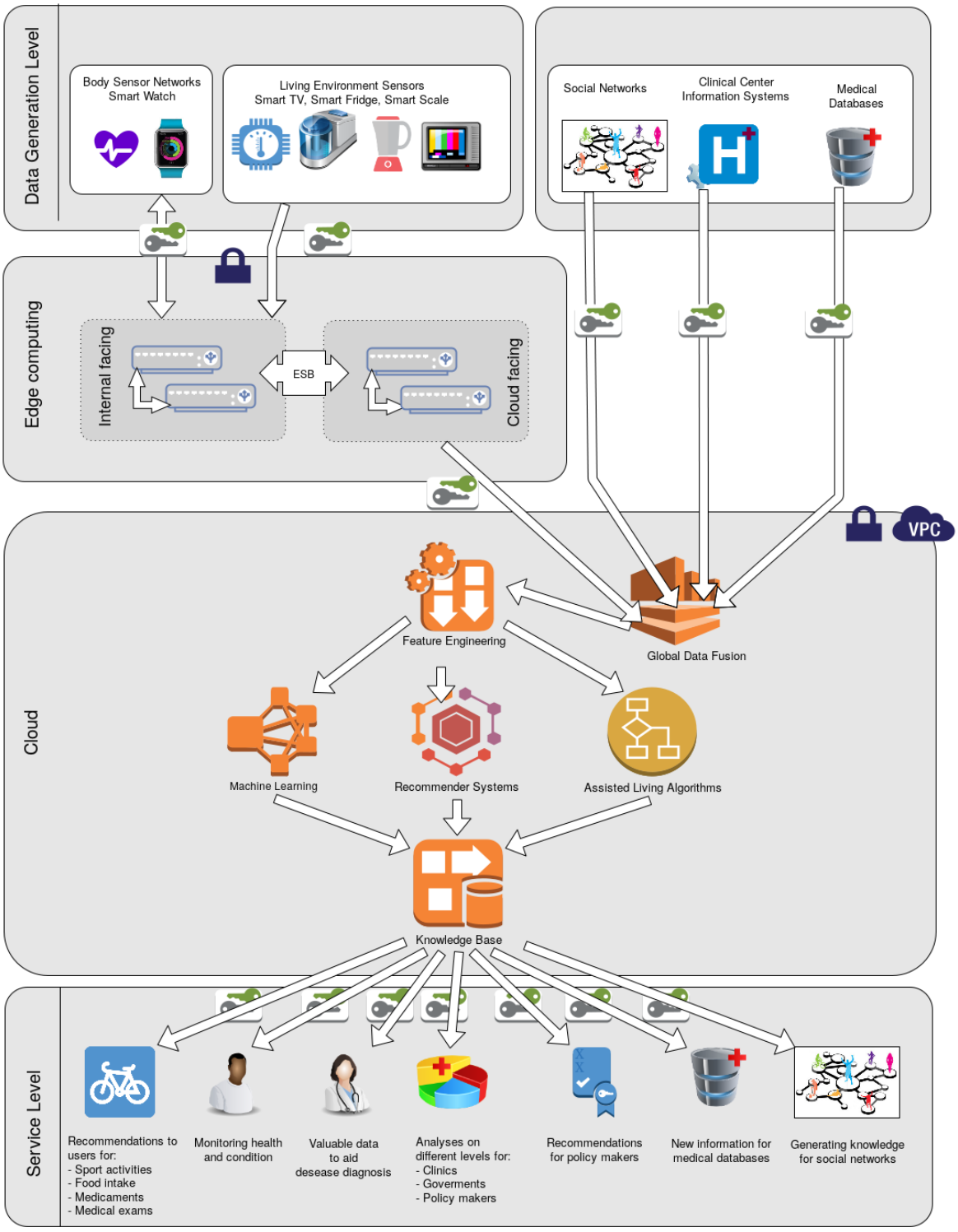

Figure 1: Architecture for fog computing for personal health

3. INTEROPERABILITY

There are many frameworks proposed in the literature and numerous studies have explained the importance and proposed solutions to achieve connected interoperable systems [15]. However, interoperability is only accomplished within individual frameworks and only for subset of considered devices, sensors or modules. A major obstacle of system integration with the cloud is to make all things connected and operating in a way that data can be collected and used in consistent manner across all devices. For example, a kitchen appliance may send its usage data to the cloud on events it is being used, body sensor might be sampled at high rate while environmental sensor at a much slower rate, and yet another device might have an API but would require external script to pull the data. Collecting metrics in a flexible way that would allow even more devices with different properties to be added at any point in the system can become hard to implement in a typical cloud scenario.

An AAL solution is an integrated system-of-systems composed of systems, subsystems and components, providing a part of the overall AAL system and its services [7]. In a fog computing scenario integration can be cascade in nature, some processing nodes will deal with components based on one framework while other nodes will provide multi-framework integration. The fog nodes interfacing with the cloud would have unified presentation for the data they transport. Application-level interoperability benefits from Web technologies, such as the RESTful architecture, that provide an elevated level of interoperability. Using these technologies, an abundance of programming APIs can be distributed across entire fog domains and utilized to increase the flexibility of loosely coupled management. [16]

Interoperability for personal health devices has many aspects. One aspect is the physical layer. Various sensors can generate different signal. In the case of video or Laser Radar (LADAR) or other sensors that generate massive data sets they might be above the bandwidth limits to be uploaded to the cloud. Other devices such as temperature sensors are periodically sampled and generate only few bytes. Sensors can also generate analog and digital signals. Analog signals must be converted to digital to be processed. Some analog devices might have different working voltage and the readings would have to be scaled properly. In the proposed fog computing AAL architecture this will be handled transiently so all data is preprocessed by the time it reaches the cloud.

At the edge node or the smart gateway node interoperability requires that the gateway supports most of the common communication standards, both wired and wireless. A gateway with good connectivity allows the sensor network to be easily expanded and upgraded.

4. DATA FLOW

Having in mind the privacy concerns as well as the technical aspects for scalability and interoperability, it is important to identify and trace the data flow in the system. Sensor data originates when sensors acquire measurement from the physical world. This measurement is represented by electrical signal that is transferred to a controller that would interpret the signal. Some sensors are manufactured to include the electronic circuits to digitalize the reading and some are even Internet connected enabling them to directly upload the data to a remote system. The sensor data is then passed to the local processing nodes. These nodes are part of the fog and can communicate to other layers of the fog. The data on these edge nodes is processed for local events detection.

Only the edge nodes or smart e-health gateways should be able to get unfiltered raw sensor data. The data that is passed on to other layers of the fog is pre-processed. From this point, the data can be split to multiple paths depending on the desired function as shown on figure 2. Data that has personal identifiable data can only be passed to the areas of the fog used for healthcare provider retrieval that is certified to be compliant with local regulations for handling medical data. Data used for science research can also contain medical data but personal identifiers should be stripped or hashed. Other service types might require aggregated data that doesn't expose user medical conditions. This, for example, can include the average time spent outdoor. Such data can be correlated with local weather to determine the best time to organize group activities for the senior members of the community. Some data might be of the type that the person would like to share on social media or other platforms. This might include exercise data such as walking, hiking or riding a bike.

Each of the services dealing with user data are logically independent and can be hosted on separate cloud platforms. The health provider service is independent from the social media or from research medical databases. The separation of the cloud can be implemented by separation on any level in the fog network.

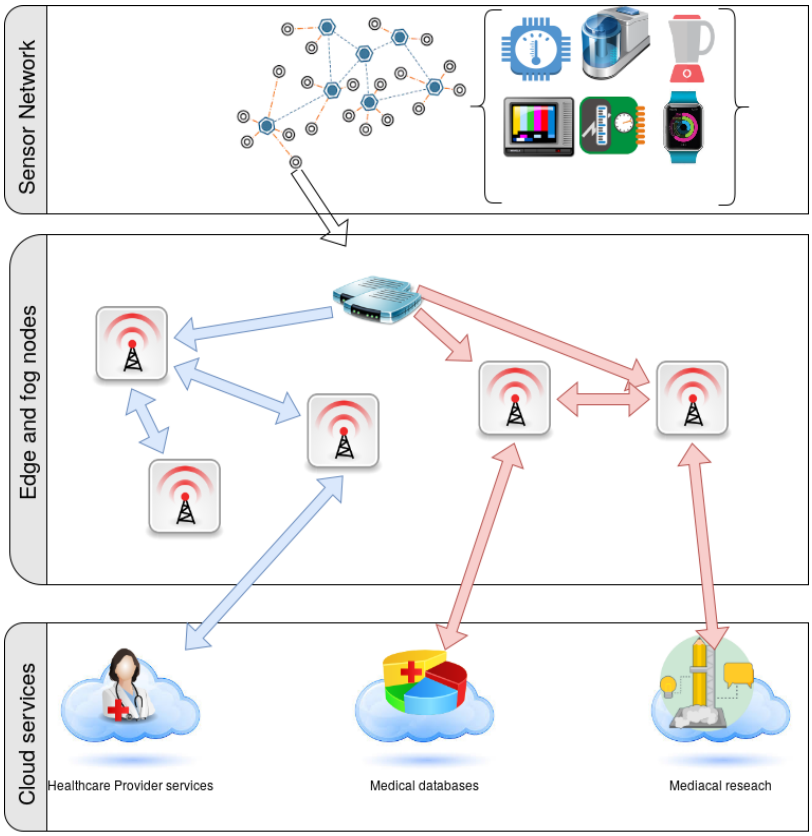

Figure 2. Data flow in Fog architecture for personal health

5. Conclusion

As personal health become more pervasive and part of daily live, and as the data generated by it increases in volume, a fog computing offers solution for many issues that would arise. The added flexibility of the fog architecture enables better placement of computing and network resources. Smarter data flow could protect personal data, bandwidth cost could be reduced and more scalable, secure and interoperable systems can be designed.

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Methodology for Bluetooth Low Energy Performance Analyses Based on Open-source Hardware

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Abstract – Considering the growing appliance of the wireless personal area network (WPAN) technologies and their rapid development, the importance of finding the reliable methodology for their performance analyses and testing becomes very important. The WPAN technologies can be used in the variety of indoor-based applications, such as home automation, indoor localization, and positioning, etc. In this paper is presented the methodology for testing Bluetooth Low Energy modules with open-source hardware-based platform. Furthermore, the methodology framework is described, together with measurements results analyses and the results as well.

I. INTRODUCTION

The rapid growth and deployment of wireless personal area network (WPAN) technologies represent one of the recognizable trends in ICT world in the past decade. There is a variety of WPAN technologies, but according to the market, Bluetooth, Bluetooth Low Energy, ZigBee [1] and 6LoWPAN [2] have the special place in this group. WPAN represent the group of short-range technologies with preferably indoor utilization. The scope of their appliance is wide, and in recent years the extensive usage of those technologies in home automation [3] and indoor localization and positioning systems [4] is evident. In this paper, the methodology for the testing Bluetooth Low Energy (BLE) for possible application in indoor systems for home automation and indoor positioning, based on open-source hardware is presented. The methodology is based on long-term experience on similar technology performance analyses presented in previous researches [5-8].

This paper describes the approach similar to previous researches, with the difference of applying different technology (Bluetooth Low Energy) and multiple Transmitting (Tx) and one Receiving (Rx) station (the measurement device). This paper is structured as follows. After the introduction section, the brief presentation of related work is given. The methodology section explains Bluetooth Low Energy basics and methodology framework. The Results section shows measurement results with visualized data and Result analyses section gives analyses and discussion. Conclusion section is giving concluding remarks, experiences learned from the test and possible directions of further work on this topic.

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II. RELATED WORK

Bluetooth and Bluetooth Low Energy technology can be used for the variety of indoor applications. One of the examples is the utilization of these technologies for tracking humans in an indoor environment (shopping mall) [9]. Another positioning system based on BLE is presented in [10]. Bluetooth can be very effective in home automation systems and some examples are given in [11, 12]. Also, the same technology is highly applicable to the Internet of Things (IoT) systems as well [13]. With the widely spread appliance of this technology, the issue of its performance analyses is important as well. One example of performance analysis of Bluetooth Low Energy (BLE) networks is presented in [14].

III. METHODOLOGY

The Bluetooth technology was developed at Ericsson labs (Sweden) in 1994. Special Interest Group (SIG) is a not-for-profit association that was founded in February 1998 by the five founding members: Ericsson, Intel, IBM, Nokia, and Toshiba. Bluetooth SIG does not make, manufacture, or sell Bluetooth products. Originally Bluetooth supported a maximum data rate of 721 kbps and this standard specification is referred as Basic Rate (BR). The next specification, Bluetooth 2.0+EDR (Enhanced Data Rate) added support for higher data rates up to 2.1 Mbps. The Bluetooth 3.0+HS (High Speed) specification improved the data rate up to 24 Mbps [1, 15].

The Bluetooth technology uses the license-free ISM band (Industrial, Scientific, and Medical) in the range starting from 2400 MHz to 2483.5 MHz. This band is unlicensed all over the world and can be used in any country without prior permissions. Since this band is unlicensed, it is used by other devices including Wi-Fi, ZigBee, 6LoWPAN devices, remote control toys, and

even some home appliances as microwaves. So, the interference may appear. Bluetooth uses a Frequency Hopping Spread Spectrum (FHSS) to avoid utilization of the single frequency to send and receive data. Instead, the Bluetooth devices use a set of frequencies and hop rapidly from one frequency to another using a pseudo-random pattern. These hops occur 1600 times per second across 79 RF channels, spaced by 1 MHz. Bluetooth uses Gaussian Frequency Shift Keying (GFSK) modulation, maximum output power ranges from 1 mW to 100 mW, and transmit power goes up to 20 dBm. Receiver sensitivity is generally -70 dBm at 0.1% Bit Error Rate and the typical transmission range is from 10 m to 100 m. Bluetooth devices are organized in the piconet (ad-hoc network) with up to 8 devices with one master and up to seven slave devices. Two or more piconets can be connected in one scatternet. Data are encrypted with a 128-bit authentication key [1, 15].

The significant advance in technology development is made with Bluetooth 4.0 specification and the issue of older and newer device compatibility becomes important. Nowadays, there are three types of devices. Devices that support earlier specifications are referred as BR/EDR. BR stands for previously mentioned Basic Rate indicating that the device can support up to a maximum data rate of 721 kbps and EDR stands for Enhanced Data Rate indicating that the device can support up to a maximum data rate of 2.1 Mbps. [15]

LE systems represent the second device types which conform to 4.0 (or higher) Bluetooth specifications. These systems have lower complexity and lower cost compared to BR/EDR systems, and the throughput of these devices is significantly lower. LE devices utilize only 40 channels spaced by 2 MHz each. The channels are numbered from 0 to 39 starting at 2402 MHz. Data transmissions are on channels 0 to 36 and advertisements are on channels 37, 38, and 39. The maximum throughput is about 305 kbps for 4.0 compliant devices and 800 Kbps for 4.2 compliant devices. [15]

The third type of devices supports both BR/EDR and LE specifications which is also referred as BR/EDR/LE or dual-mode devices.

The platform for the experiment described in this paper is based on open source hardware. The central unit of the platform is microcontroller board Arduino/Genuino UNO Rev3. This microcontroller is connected to Bluetooth Low Energy communication module AT-09 based on Texas Instruments CC2541 chip with the receiver sensitivity of -90 dBm for 2 Mbps GFSK and -94 dBm for 1 Mbps GFSK respectively [16]. The CC2541 is BLE communication chip used in a variety of applications [17, 18, 19]. The wiring between Arduino/Genuino is simple with four wires (AT-09 GND – Arduino Uno GND pin, AT-09 VCC - Arduino 5V or 3.3V pin, AT-09 Tx – Arduino Uno Rx pin 0 and AT-09 Rx pin – Arduino Uno Tx pin 0). The BLE stations were battery powered.

Table I. The BLE station data

Station Name	ID	Dist. (m)	Avg. RSSI (dBm)	St. Dev	Pkts. Rcvd.
IV Flavia	QFL	8.8	-85.0405	8.212026	247
XX Valeria	VVV	4	-81.1572	6.766878	299
XII Fulminata	DFU	15.65	-89.0563	3.73997	213
VII Claudia	SCP	16.42	-91.0504	2.372315	139
VI Ferrata	SFR	19.71	-86.7351	3.385924	302

There are five stations with BLE modules configured as BLE master devices. Those stations have station names and station IDs as it is listed in Table I in the first two columns. In this table, the BLE station data, such as station name and ID, distance in meters from measuring location, average RSSI in dBm of received packets, the standard deviation of RSSI in dBm and the number of packets received is given.

The RSSI signal is measured with Android smartphone and BLE scanning and logging application. The smartphone is located at the location L_m shown in Fig. 1. The measurements are made with five BLE stations simultaneously.

IV. Experiment

The experiment is made in institutional building on the 2nd floor. The layout of the 2nd floor is shown in Fig. 1. The positions of BLE stations are shown in Fig. 1 and distances from L_m locations are given in Table I. The communication paths between BLE stations and smartphone at position L_m are represented with the dashed lines and the obstacles between BLE stations and measuring device are visible in Fig. 1 as well.

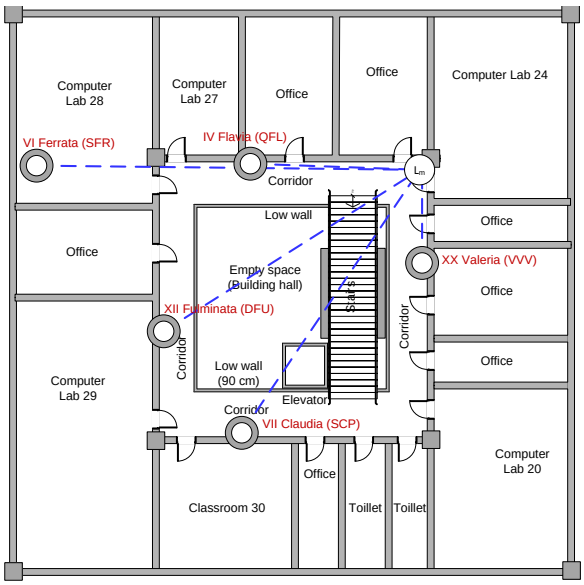

Figure 1. The layout of the institutional building 2nd floor where the experiment took place

BLE stations were configured as master devices and during the test constantly advertised themselves. The Android smartphone is used to log RSSI of the packets sent from BLE stations, together with other information such as BLE station MAC address, receiving time, etc. The logged files are used for further processing on PC. For the purpose of log file processing the Python script was developed. The Python script parses the log files and generates statistics. It calculates the number of packets received per BLE station, mean, minimum and maximum RSSI values, generates the graph of RSSI packet distribution per BLE station and graph of RSSI value variations during the test period. The script also creates a database stored in CSV format for further processing and gives the graphical comparison of measured values

compared to values calculated by ITU indoor propagation model [20, 21].

V. RESULTS

The test results are presented in this section. The packet RSSI distribution for BLE station IV Flavia (QFL) is shown in Fig. 2. The RSSI of the packets is presented on an x-axis and the number of packets is presented on the y-axis. The blue vertical dashed line shows the mean packet RSSI calculated value.

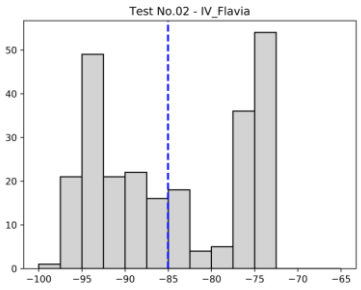

Figure 2. Packet RSSI distribution for BLE station IV Flavia (QFL)

The packet RSSI distributions for BLE stations VI Ferrata (SFR), VII Claudia (SCP), XII Fulminata (DFU) and XX Valeria (VVV) are shown in Fig. 3, Fig. 4, Fig. 5 and Fig. 6 respectively.

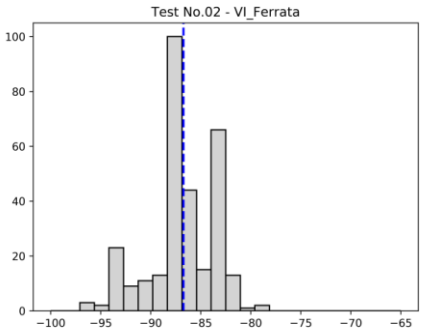

Figure 3. Packet RSSI distribution for BLE station VI Ferrata (SFR)

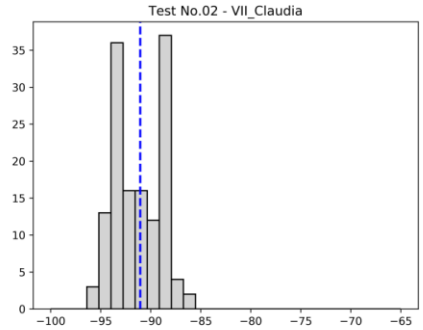

Figure 4. Packet RSSI distribution for BLE station VII Claudia (SCP)

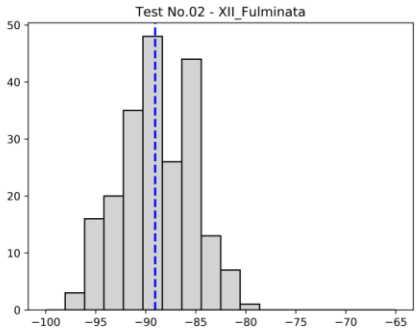

Figure 5. Packet RSSI distribution for BLE station XII Fulminata (DFU)

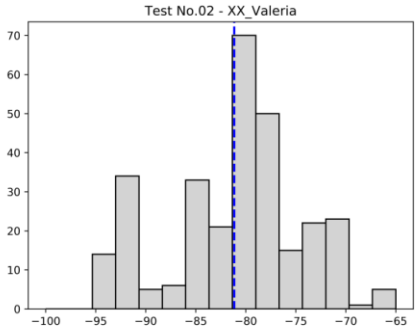

Figure 6. Packet RSSI distribution for BLE station XX Valeria (VVV)

The comparison of measured values compared to values calculated by the ITU indoor propagation model [20, 21] is shown in Fig. 7. Here, the ITU propagation model is used with values of 50, 55, 60 and 65 for *N*, instead of recommended 18 (for corridors with channeled energy), 20 (similar to free space environment), 33 (office areas) and 40 (long paths with reflections). *N* is the distance power loss coefficient. Horizontal lines represent Texas Instruments CC2541 receiver sensitivity of -90 dBm for 2 Mbps GFSK and -94 dBm for 1 Mbps GFSK respectively [16].

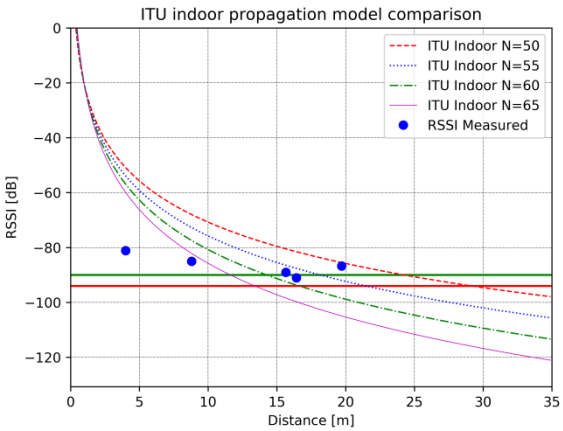

Figure 7. Comparison of measured RSSI values with ITU indoor propagation model

The Fig. 7 clearly shows that ITU indoor propagation model doesn't fit well with measured results. The ITU

model has low accuracy at shortest distances (below 10 m) and better accuracy with distances between 15m and 20m with distance power loss coefficient *N*=55.

ITU model low accuracy in this experiment can be the good foundation for further research. The future work may include a comparison of measured results with other popular indoor RF models used for calculation of the expected signal strength such as one-slope model and log-distance model [20, 21-24]. This research can be extended with the goal to find a suitable propagation model for better prediction of BLE modules performance used in this experiment.

The variations of packet RSSI values are shown in Fig. 8 for the BLE station with the best performance (VI Ferrata) and in Fig. 9 for the BLE station with the worst performance (VII Claudia).

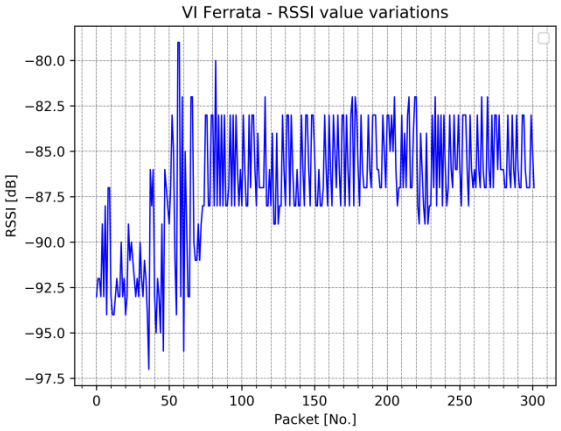

Figure 8. Packet RSSI value variations of BLE station VI Ferrata (SFR)

VI. Result Analyses

The results show that open-source hardware platform can be effectively used for BLE module performance analyses. The BLE modules which are used in experiment show good indoor coverage up to 20m. It is highly possible that BLE modules can reach longer distances and this will be also included in future experiments.

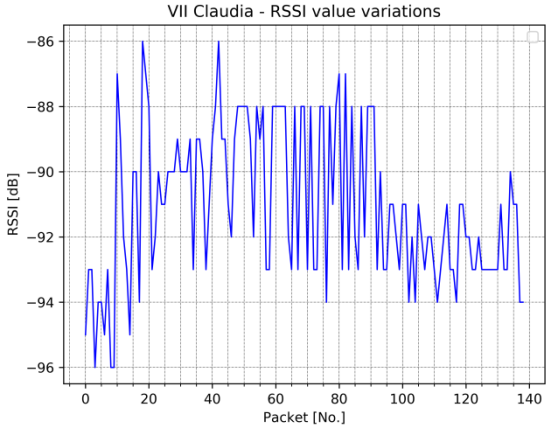

Figure 9. Packet RSSI value variations of BLE station VII Claudia (SCP)

The BLE station performance is analyzed with the two main criteria: the number of received packets and mean RSSI values. The best performance has XX Valeria BLE station positioned at the shortest distance from measuring location L_m (Table I and Fig. 1). Also, there are no obstacles between these two locations.

Next two BLE stations with the best performance are IV Flavia (at the distance of 8.8 m) and VI Ferrata (at the distance of 19.1 m). IV Flavia is at the shorter distance with no obstacles, and VI Ferrata is at approximately twice longer distance with the wooden padded door as the obstacle. IV Flavia received 55 packets less, which might be caused with its location very close to the wall.

BLE station XII Fulminata has much lower performance, and VII Claudia has the worst performance. These two poor performances are easy to explain since these BLE stations are located behind large obstacles. These obstacles are very wide concrete stairs that partially cover XII Fulminata and fully cover VI Claudia. The last BLE Station (VI Claudia) also has the elevator made of metal and glass as the obstacle that fully cover BLE station.

VII. Conclusion

In this paper, the methodology for Bluetooth Low Energy (BLE) performance analyses is presented. This methodology is built upon an open-source hardware platform based on Arduino/Genuino UNO Rev3 microcontroller board. The BLE modules with TI CC2541 chip are used. The experiment used five BLE stations configured as master devices and deployed on the same floor in the institutional building. The RSSI of the packets are logged with the smartphone Android application. The measurement results are parsed with developed Python application and visualized for the performance analyses. During the experiment, no major difficulties are experienced, and the test platform worked like it was planned.

The analyses show that performance varied depending on distance and even more depending on obstacles. Also, the analyses show that BLE modules can be used at the distances up to 20m. The maximum operating distance should be explored in future experiments. According to the experiment results and experiences, the proposed BLE performance testing platform proved to be effective for its purpose.

The further research should include measuring with the larger number of locations in the same building or elsewhere in order to explore the maximal range of BLE modules and factors affecting the BLE module performance. The logged results from the larger number of locations should be used for finding accurate BLE indoor propagation loss model. Finally, the proposed open-source based platform should be used as a test-bed for the development of BLE based application for home automation or indoor positioning.

Acknowledgment

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Challenges in Mushroom Classification Using Image Recognition Technology

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Abstract – In the age of technology, the competitive nature of software development could lead to the release of potentially dangerous applications. Mushroom identification applications using image recognition technology are becoming increasingly common, yet their proclaimed accuracies have not been independently ascertained. This study strives to compare the prediction accuracy of the most highly-rated mushroom identification Android applications. It was observed that the accuracy in classifying the correct mushroom species ranged from twenty to fifty percent, depending on the number of images per species provided to the application. This was far below the accuracies declared by the developers. The danger in this discrepancy is that mushroom pickers who are amateur taxonomists could mistake a poisonous species for an edible one, leading to deadly consequences. It is therefore recommended that app developers include scientific-based taxonomic methods during software development and also increase the number of images available for image classification since this greatly improves accuracy.

Keywords - image recognition, machine learning, mushroom classification, taxonomy.

I. INTRODUCTION

Machine learning has infiltrated all aspects of human life. Image recognition has considerably advanced the field of machine learning; yet its full capacity has yet to be exploited in specific fields [1]. Mycology, for instance, was expected to greatly benefit from this technology but no attempts have been successful so far.

Mycology involves the study of fungi. The identification of fungal species is crucial to experts and amateurs alike [2]. Mushroom pickers must correctly distinguish edible and poisonous species, for errors are potentially fatal. Thus, they would greatly benefit from the image-based classification of fungi.

In spite of significant advancements in mycology and machine learning, there have been no improvements in mushroom identification datasets since the introduction of the fungal dichotomous key in 1987 [3].

Due to the lethal repercussions of fungal misclassification, image recognition must be very accurate and precise. This technology has proven to be highly useful in face and pattern recognition, for example [4].

The push for the mass production of new software by innovation-based economies is rarely backed by proper quality checks. This is further exacerbated by the lack of openness about the data and technology used to build this shoddy software. Recent media reports have highlighted mobile applications aimed at mushroom identification that are extremely inaccurate and likely deadly [5] [6].

In this paper, we have compared three of the most highly rated and frequently used mobile applications for mushroom identification to ascertain if their accuracy is as purported [7] [8] [9].

II. METHODOLOGY

The most widely used Android applications for mushroom identification that were selected for comparison are as seen in Table 1 below.

TABLE I. ANDROID APPLICATIONS SELECTED FOR COMPARISON

Label	*App 1*	*App 2*	*App 3*
Application name	Mushroom Identify - Automatic picture recognition	Mushrooms app	Mushroom identification from photos
Developer	Knitting Mushroom	Vocom	Dominik Steinhauser
Current Version	v2.26	v27	v2.5.7
Released	September 2015	June 2017	July 2015
Updated	July 2018	September 2018	July 2018
Number of downloads	500.000+	100.000+	100.000+

The dataset that was used for testing the accuracy of the apps contains triplicate photos of the following mushroom species: *Amanita cesarea*, *Coprinus picaceus*, *Daedalea quercina*, *Grifola frondosa*, *Hypholoma fasciculare*, *Macrolepiota excoriata*, *Phellinus igniarius*, *Polyporus squamosus*, *Trametes hirsuta*, and *Xerula radicata*. Pictures from 1 to 10 represent part of the used dataset.

Picture 1. *Amanita cesarea*

Picture 2. *Coprinus picaceus*

Picture 3. *Daedalea quercina*

Picture 4. *Grifola frondosa*

Picture 5. *Hypholoma fasciculare*

Picture 6. *Macrolepiota excoriata*

Picture 7. *Phellinus igniarius*

Picture 8. *Polyporus squamosus*

Picture 9. *Trametes hirsuta*

Picture 10. *Xerula radicata*

For a given image, each of the applications displays at least 5 mushroom species and their percentage values. These values represent the application's certainty in identifying the correct mushroom species. Percentage values are sorted in a decreasing order, whereby the top value represents the most probable species.

Accuracy predictions were based upon the app's ability to correctly identify the mushroom species from three different photos.

III. Results & Discussion

The results generated by the apps are as visualized in Table 2.

TABLE II. ACCURACY OF SPECIES IDENTIFICATION USING ANDROID APPLICATIONS

Label	*App 1*	*App 2*	*App 3*	**App 3+*
Amanita cesarea	Correct	Correct	Correct	Correct
Coprinus picaceus	Correct	Wrong	Top 5	Correct
Daedalea quercina	Top 5	Correct	Wrong	Wrong
Grifola frondosa	Wrong	Wrong	Wrong	Wrong
Hypholoma fasciculare	Wrong	Top 5	Correct	Correct
Macrolepiota excoriata	Wrong	Wrong	Wrong	Wrong
Phellinus igniarius	Top 5	Correct	Top 5	Correct
Polyporus squamosus	Wrong	Correct	Wrong	Wrong
Trametes hirsuta	Wrong	Wrong	Wrong	Wrong
Xerula radicata	Correct	Wrong	Wrong	Wrong
Correct / top 5 / wrong	**3 / 2 / 5**	**4 / 1 / 5**	**2 / 2 / 6**	**4 / 0 / 6**

*App 3+ is App 3 with the added ability to process three different images of the same fungal species simultaneously enabling more accurate predictions with a guaranteed accuracy 90%.

According to Table 2 above, the "Correct" value indicates when the application correctly identified the mushroom species based on its highest probability value. App 1 accurately identified the species forty percent of the time, while App 2 and App 3 produced accuracy values of thirty and twenty percent respectively.

The "Top 5" value indicates correct species identification by using the second to fifth highest probability values. In this case, the application delivered an approximate result but it was still the wrong species that was identified overall. When the Top 5 value was taken into consideration, the accuracy values of App 1 and App 2 improved to fifty percent while App 3 rose to forty percent.

App 3+ had an accuracy of forty percent due to its ability to accept multiple input images.

In addition, App 3+ has proven that providing multiple images per species improves the accuracy of the identification. Until the identification accuracy is enhanced for single images, multiple images covering several features of each species are essential.

The accuracies of all the tested applications are far from that which was proclaimed by the developers. This is partly due to a lack of transparency regarding the dataset that was used to achieve this accuracy.

This discrepancy is potentially dangerous for they are unable to discern between edible and poisonous mushroom species. Nevertheless, each app issues a warning stating that the results should not be used independently but in conjunction with additional mushroom identification methods, such as a dichotomous key.

IV. Conclusion

The aforementioned apps provide additional habitat information about the different fungal species, yet the fungal identification via image recognition is in the beta mode and poses a real danger when released to the public.

In order to improve the accuracy, stringent scientific-based identification procedures should be implemented, as well as openly available datasets and more prudent accuracy predictions.

Considering the importance of high accuracy, taxonomical methods should be utilized alongside image identification to increase precision and accuracy.

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Modeling of unmanned aircraft management software

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Abstract: This paper contains example for modeling of drone control software. The paper provides an overview of some key methods in drone control software modeling. The paper also provides basic explanation about drone physics.

Key words: drone, software, modeling.

I. Introduction

Drone is an unmanned aerial vehicle (UAV), an aircraft that does not need to have pilot aboard and can be controlled remotely by a human.

Depending on criteria there are different classifications of drones. Main classification of drones would be the one based on the type of aerial platform that it uses. There are:

- Single rotor drones
- Multi rotor drones
- Fixed wing drones

Most used type of drone is quadcopter, a multi rotor drone with for motors powered by electric battery.

In comparison with standard manned aerial vehicles controlled by a pilot in the cockpit, drone has some advantages:

- It can be lighter and can be in smaller size
- Drone production can be simpler, faster and cheaper
- Use and maintenance costs are lesser
- Drone operator is never endangered
- It can easily access to the places that are hardy accessible for men

Because of many advantages that it offers and thanks to technology development, with time drone is finding more uses for different jobs and tasks that would be otherwise too slow, difficult or impossible if done by a human.

Drone has its use in agriculture, videography, transportation, medicine but regardless to its purpose and its hardware, key part in every use is drone control software. [1][2]

Picture 1: Quadcopter

Drone control software needs to be reliable and to have high quality what acquires a lot of time to be invested in modelling and design of the software. In this text will be described a basic object model of the software with the help of UML and implementation of some methods.

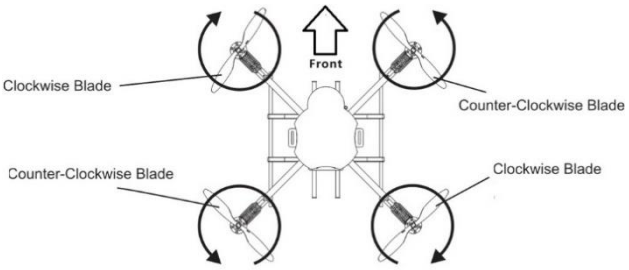
II. Drones physics

In order to approach the modeling and design of a drone control software firstly it is needed to understand how that hardware works.

Quadcopter has four motors which rotate four propellers. Rotating propellers produce force proportional to the speed of rotation and opposite to the force of gravity. If the force produced by propellers is large enough, quadcopter can hover in air and by increasing and decreasing the speed of propeller rotation quadcopter will ascend and descend.

Every rotating propeller beside force produces angular momentum proportional to its angular velocity.
Angular momentum of quadcopter is equal to sum of

angular momenta of all four propellers. If all propeller would rotate in same direction the resulting angular momentum of quadcopter would not be equal to zero and quadcopter would be rotating in opposite direction. To stop this unwanted rotation propellers are set to rotate in different directions like it is shown on picture 2. One pair is set to rotate clockwise while the other pair is set to rotate counterclockwise. This way, if rotation speed of every propeller is the same, rotating pairs cancel each other's angular momentum and there is no unwanted rotation of quadcopter[3]



Picture 2- Drone's physics

If rotation speed of one pair of propellers is reduced and at the same time rotation speed of other pair is increased as much then quadcopter will stay at the same level but angular momentum will not be equal to zero and quadcopter will rotate.

If rotation speed of front propellers is reduced and at the same time rotation speed of rear propellers is increased then the quadcopter will stay at the same level bit it will start to tilt and move forward.[4]

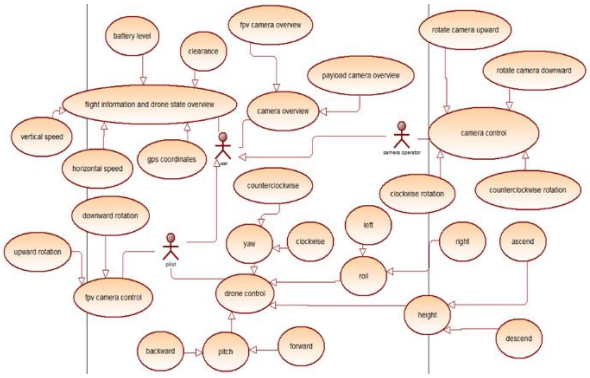
A. *Description of drone for which software is bieng modelled*

Drone that is being used for this example is quadcopter. It has first person view camera and second camera as a payload. To fully operate drone one operater is needed to control flight and fpv camra while another one is needed to operate payload camera. More detailed description is given in the use case diagram (picture 3.).

III. Key object oriented model diagrams

A. Use case diagram

In the given diagram (*Picture 3.*) primary actor (user) has options to view information about flight and current state of drone (battery level, gps coordinates, clearance etc.) and also to view both cameras. User is generalization of actors 'pilot' and 'camera operator'. Beside options inherited from actor 'user', pilot has additional options to control drone during its flight and to control fpv camera while camera operator has options to control second camera.



Picture 3. Use case diagram

B. Class diagram

Diagram (picture 4.) consists of next classes:

- Drone
- Motor
- Fpv camera
- Camera
- Pilot
- Camera operator
- User

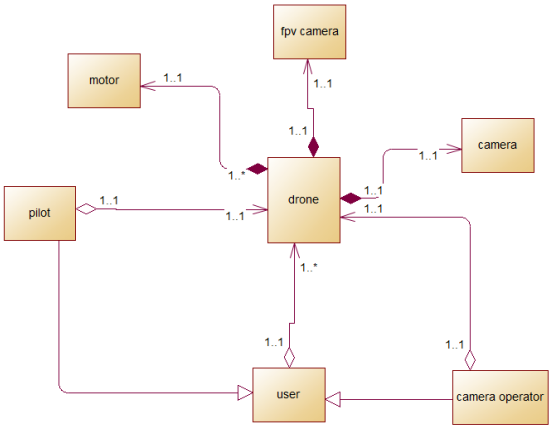
Class drone is a composition of classes motor, fpv camera, camera and it has attributes that are instances of those classes. It contains attributes that represent battery level, gpscoordinates and clearance and it contains getter methods for those attributes and methods for altering drones state and maneuvering.

Class user contains methods for viewing the drone cameras, clearance, and gps coordinates. Class user is inhertied by classes pilot and camera operator.

Class pilot contains methods for drone maneuvering which as a parameter accept an instance of class drone.

Class camera operator containt methods for camera control which as a parameter also accept an instance of class drone.

Class motor contains methods for increasing and decreasing speed of propeller rotation.



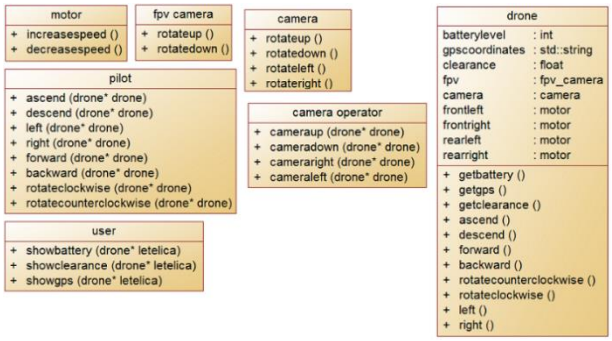
Picture 4. Class diagram

IV. Implementation of key methods

To rotate quadcopter clockwise firstly it is needed to call methot rotateclockwise() from the class pilot which as a parameter accepts instance of class drone. This method in its definition contains call of method rotateclockwise() from class drone. Method rotateclockwise() from class drone in its definition contains calls of methods increasespeed() and decreasesspeed() for all four motors of drone. Method decreasespeed() is called for frontleft and rearright motor and increasespeed() is called for frontright and rearleft motor.

To ascend quadcopter it is needed to call method ascend() from class pilot which as a parameter accepts instance of class drone. In its definition this method contains call of method ascend() from class drone. Method ascend() from class drone contains in its definition contains calls of methods increasespeed() for all four motors.

To move quadcopter forward it is needed to call method forward() from class pilot which accepts as a parameter instance of class drone. This method contains in its definition call of method forward() of class drone. Method forward() from class drone in its definition contains calls of methods increasespeed() for rear motors and decreasespeed() for front motors.



Picture 5. Main classes

V. Conclusion

Described model covers only basic software specifications for drone control software. Althou model is based on quadcopter it would not differ too much from models based on other types of multirotor drones.

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A Review on Smart Home based on Ambient Intelligence in healthcare

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Abstract - Ambient Intelligence is an innovative concept that is used to mark intelligent computing systems that allow people and devices to interact with each other, as well as with the environment. The development of the Ambient Intelligence should contribute to the further progress of human society. One of the ways in which this can be achieved is by applying these systems in the field of healthcare, because healthy people, or healthy nations, are one of the prerequisites for further progress. In this paper, the concept of the Smart Home system will be presented which can contribute to the preservation or improvement of the health of the person.

I. INTRODUCTION

Today healthcare is facing new approaches and technologies and represent an area that is constantly innovating, improving and developing. Care for the preservation of one's own health or the health of the patient does not represent an easy task. In the implementation of health care, healthcare institutions are obliged to apply scientifically proven, verified and safe health technologies. The development of microprocessors has contributed to the development of Ambient Intelligent Technology. Ambient Intelligence is finding its increasing application in the field of healthcare and is a challenge not only for engineers who need to implement new solutions, but also for health workers who need new solutions to benefit their patients.

II. AMBIENT INTELLIGENCE

The European Commission's Information Society Technologies Advisory Group (ISTAG) first introduced the Ambient Intelligence (AmI) concept [1]. The idea originated in the 1990s, and it is anticipated that AmI technology will reach its usable goal by 2020.

Ambient Intelligence is a new paradigm for environments that respond to the presence of people [2]. The main goal is to strengthen people's abilities by means of an environment that responds and adapts to human needs, habits, gestures or emotions. In this paradigm, there are no conventional input and output devices, but their role is taken by sensors and processors embedded in objects that are used on a daily basis. By interpreting the information collected from the sensors, it is possible to adapt the environment according to the needs of its users [3]. This seemingly futuristic vision of everyday environments enables innovative interactions between people and between humans and machines, characterized by ubiquitous and unobtrusive communication. AmI paradigm is a combination of omnipresent digital data processing, i.e. Ubiquitous Computing and Human-Centric Computer Interaction Design. There are also numerous other explanations and definitions of the Ambient Intelligence in the literature. However, one of the "most beautiful" definitions says that Ambient Intelligence is a future in which we will be surrounded by intelligent objects, in which the environment will be able to recognize our presence and respond to it in an uncomplicated way [4].

Smartphones, navigation devices, tablets, sensors and other portable devices that are now used contribute to achievement the above mentioned vision and enable further development of the Ambient Intelligence. Ambient intelligence can still be defined as a digital environment that supports people in their day-to-day activities helping them in an incomprehensible way, and to make it possible the system must be intelligent.

Ambient Intelligence refers to systems that are sensitive to the presence of people and "behave" properly. Also, it seems that they exist almost everywhere around us, because sensors and computer systems are embedded in our everyday environment [5]. Ambient Intelligence proposes new ways of interaction between people and technology which is adapted to the needs of people and the surrounding environment [1]. AmI systems are systems sensitive to context, adapted to the needs of their users, and thanks to the ability to anticipate user actions and to adapt to them, they are both anticipatory and adaptive [6]. AmI technology is therefore an ideal candidate for the development of different solutions in various fields, including healthcare. Observed in the context of healthcare, this is essentially the way nurses help patients: they intervene if necessary and they stop interruptions when they are no longer necessary.

Ambient Intelligence includes many areas of computing: artificial intelligence, human-computer interaction, sensors, ubiquitous computing, computer networks. In addition, Ambient Intelligence should not be identified with any of the mentioned areas, since none of them conceptually covers the Ambient Intelligence completely. AmI practically relying on all these areas together in order to create better and more intelligent services for their users [1]. When it comes to Ambient Intelligence, in the future, there is a growing demand for services and applications for

people with chronic diseases, i.e. those who need continual care or monitoring, such as diabetics, heart patients, people with arthritis, Alzheimer's disease or dementia. The goal of the Ambient Intelligence is to develop intelligent and intuitive systems and interfaces that are capable of recognizing and responding to the needs of users, providing communication and focusing on people by creating complex environments in the home as well as in other places like health facilities.

Instances of Ambient Intelligence are sensory networks such as the Body Area Network or the Smart Home. The idea of smart homes has been around for quite a long time, and its popularity has come with the help of the development of personal computers and the fact that many home-based processes can be automated. In essence, the purpose of this house is not different from the purpose of an ordinary house, but is therefore infrastructurally different. Smart homes have an infrastructure that allows communication between different devices, and the ultimate goal is to make life easier for the householder. Smart homes have great applications in health care but also in other areas.

III. SMART HOME

Smart Home Systems are one of the most common instances of Ambient Intelligence. They are designed and created to make the living space more pleasant and simpler to use and people's lives. Thanks to integrated wireless sensors, these systems are adapting the entire infrastructure of the smart home to the current situation, interacting with users in a residential environment in a timely manner, with the aim of supplementing and enriching the usual activities with minimal involvement or effort of man [7].

Control of lighting, multimedia devices, air conditioning, heating, video surveillance, alarm systems, even control of beds, wardrobes, stoves, bathrooms are some of the features that are easy to manage. All this does not require a technical pre-knowledge [8]. However, people's attitudes towards smart homes are different. Some people do not want their life to be so dependent on technology, care for safety or for a price. Unlike them, many look at the smart house as the place where technology is applied that makes life easier and which can save time in favor of doing the activities that bring the greatest satisfaction. It provides comfort and overcomes the shortcomings of current houses, assuming unwanted obligations [2]. Life in a smart home should take place in a way that its inhabitants do their everyday activities without having the impression that they live in a laboratory. An example of a smart home is given in Figure 1.

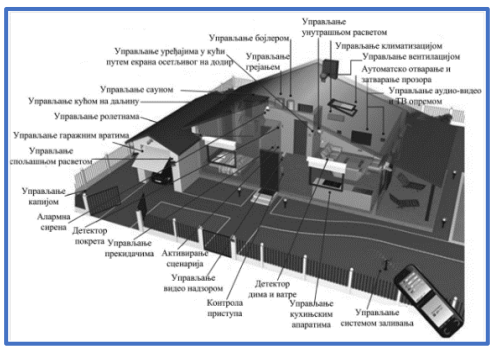

Figure 1. Smart home, downloaded from: www.elab.rs

IV. AMBIENT INTELLIGENCE HEALTHCARE

An intelligent environment can be used both for monitoring the health status of patients as well as for automating various medical services. AmI is an area of great potential for health services. One example is which hospitals can increase the efficiency of their services by monitoring the patient's health by automatically analyzing the activities he performs in his room. This reduces the need for more health workers, while at the same time increasing the patient's independence [9]. The need for health workers is just one of the challenges that healthcare faces today.

Smart home technology combined with healthcare technology can be a substitute for nursing homes [10]. By developing home automation and optimizing communication between devices in the home environment and for the benefit of its residents, solutions have been created to allow elderly people to live independently to their deep age [5]. While this is primarily important for the elderly, it is also important for injuries and chronic illnesses as the intention is to provide such individuals with greater independence and better health status. Doctors naturally try to provide as much support as possible to patients living in their homes, however the number of nurses is often insufficient financial resources. Therefore, carers, with sensors placed in the house, can have an insight into the condition of their patients and, based on that, decide how often and when to visit and provide adequate care.

When it comes to adopting technology, generally older people have more problems to accept and adopt new technology than younger people due to lack of experience and their reduced physical and physiological abilities. Barriers that prevent faster adoption or implementation of monitoring technologies include questions about the privacy and unwillingness of people (mostly elderly) to accept new technology. Acceptance depends not only on the person's health status, but also on the perception of need or personal goal [10]. However, home automation is the first form of aid that the older population slowly adopts in the developed countries of the world [5]. Machiko Tomita cites an example of an increase in the number of elderly people in the United States, as this leads to an increase in the incidence and prevalence of chronic diseases, which entails increased health care costs. As already mentioned, with this problem, the developed and underdeveloped parts of the world are also encountered, and this problem is unavoidable even for our country where the average age of the population is increasing from year to year.

V. ADVANTAGES OF SMART HOME

There are numerous advantages of using smart houses: automating various processes, facilitating everyday tasks, increasing comfort and energy savings, or helping older

and sick people. Smart Home technology allows patients to be tracked in their homes, and their nurses receive information about their health status, which enables them to respond in a timely manner. This concept has been implemented in many advanced smart homes that have a health monitoring system. Smart Home with healthcare technology can also be used for home therapy after surgery in order to improve safety and improve the physical and cognitive activities of users. The system should also be able to inform both the user and the caregiver when necessary [10]. Smart Home systems can be used for:

- Prevention and detection of patient falls - Sensors can detect that a patient's movement has occurred /did not occur and inform about that. Also, patients themselves can activate alerts.
- Automatic control - Water / ambient temperature control, heaters or stoves, lighting, security doors and windows, visitor identification. It is also possible to record the opening of the refrigerator door.
- Monitoring of health status - Use of sensors placed below the bed for the detection of sleep patterns, reminder for taking medication or examinations with a doctor. Health monitoring systems include often checking vital signs such as: blood sugar levels, blood pressure, body temperature, pulse, cholesterol levels, body weight, adherence therapy, and the perception of drug interactions. The detected changes serve as a basis for creating alerts.

- Monitoring physical activity - It is realized using cameras or carrying devices.

Ambient Intelligent Systems are invisibly embedded in the environment but have a direct impact on the lives of their users. If the system functions ideally, the user's life will be improved. However, the problem is that the system rarely works perfectly and problems are possible with regard to privacy and security, but also the price and ease of use.expression, An example in Serbia: Emergency Center in Novi Sad opened in 2010 is the first smart hospital built in the Republic of Serbia. The construction of this "hospital on the button" lasted four years. The new center extends over 9,000 square meters and is built according to the latest standards. In one place there is the best medical equipment, and operations are similar to those in Europe and America. The building is completely computerized and represents the first building of its kind in our country. From the control room of the Emergency Center, at every moment, the condition and movement of patients and employees is monitored. In addition, the building is energy efficient. Heating and cooling systems use solar energy, so the costs are reduced to a minimum. At its level of energy efficiency and automation, it belongs to the world's top in terms of hospitals [11, 12].

VI. CONCLUSION

In the last few decades we witness the development of technologies such as mobile telephony or broadband wireless communication. According to data from www.independent.co.uk, the number of mobile phones in 2014 exceeded the total number of inhabitants of the planet Earth. The constant and rapid development of technology has not only brought a lot of new devices into our lives, it has changed, but it continues to change the way in which people observe and use different technological products. We should not forget that the price of these devices is getting smaller, and their performance and application capabilities in different areas are getting bigger. Basically, Ambient Intelligence systems are based on the use of devices that can somewhat resemble a human being or help a person, but they are still under human control. AmI technology is designed to be inconspicuous for the user, but users must have the ability to interact with devices, i.e. and the system must be able to address the user if there is a need for this: for example, if there is a physical fall of the AmI system user.

Although Ambient Intelligence in Health is becoming more and more subject of researchers worldwide, its application has not yet reached its full maturity, although it is expected in the near future. The reasons for the difficulties that currently exist in the work are the necessity of cooperation of experts from different fields. Also, work in the field of health means work where mistakes are unwanted, and often not allowed.

Observing the situation in our country, it can be concluded that this is a technology that brings with it a great number of new terms unknown to both experts and ordinary people. Ambient Intelligence slowly but "shy" comes to us. Through interviews with medical experts, the impression is that larger hospitals and clinics in our country have at least one or more smart devices, as well as that it is in the plan of purchasing new equipment.

In front of the Ambient Intelligence, new challenges will arise in the future, whose solutions will help to anticipate and meet the needs of the users, or improve the quality of people's lives.

In the end, when everything is overlooked, it comes to the conclusion that despite the problems that accompany the Smart Home system, there are more advantages and it is worth investing in this technology.

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Web service protection

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***Abstract*: Web services are the product of a new way of designing information systems. The spread of the idea of distributed data processing and the sharing of functionality with other organizations has led to the accelerated development of the web itself. Namely, organizations are no longer focused exclusively on the development of their own applications in order to promote or improve their own business. With a new methodology of development, those particular parts of their business open up the community and make it available to the general public.**

Web services have become a compulsory part of the business of almost every organization. However, the sharing of functionality means sharing its vulnerabilities and disadvantages. More specifically, the security vulnerabilities of a single service now have an impact on the operations of the organizations that use the service.

Increasing the use of web services in everyday business increases the need for concrete methodologies for testing their security. There is currently no single methodology for testing the security of a web service that includes all possible scenarios, but there are certain suggested methodologies and recommended steps that facilitate the procedure of testing the service.

Key words: Web services, XML, Security specification

I. Introduction

Web services represent the technology for the implementation of network and distributed applications. Web services are modular, self-describing, self-sustaining applications that can be published, locate and invite via the Internet. Based on open standards, web services enable the deployment of web-based applications using any platform, object model, and arbitrary programming language, i.e. web services allow any software to communicate using a standardized XML message system. Applications are implemented using web services from different sources, regardless of where they are located or how they are implemented.

The underlying problem of even faster acceptance of web service technology is security. Security was not one of the basic requirements for developing a web service. To overcome this problem, a number of security specifications for web site security have been developed. The most important issues to be solved are: the secrecy of the messages being transmitted, the integrity of the data being transmitted, the authentication of the client and the server, and non-authenticity. [1]

II. Web service security

Thanks to the dynamic development of web technology, computing-based services have experienced rapid development. Web services become part of everyday users. Organizations offered most of their business to users in the form of various web services. For example, for a long time, banks have been able to pay via internet banking or through mobile applications. How web services do not have a unique interface but can be used on all platforms are suitable for separating functionality. Namely, when paying via internet banking or mobile applications, one and the same web services are used. Thus, web services have become the target of malicious attacks on information systems. Successful execution of an attack on a web service can be disrupted by a whole series of other subsystems that use or depend on this service. For example, a DoS - Denial of Service attack on an online account checking service can cause a drop in all systems using that service. Users who want to inspect their accounts via Internet banking will not be able to review. Also, users who want to check the account balance on mobile devices will be deprived of service declines. There is a greater danger of such infrastructure. If the vulnerability of a web service is detected that can achieve a certain benefit, there are almost unlimited sources of attack. Mobile users, as well as those who use web applications for Internet banking, could use the same vulnerability.

When web services are considered from the point of view of security, there are two points of source of vulnerability. These points are a communication channel through which messages and service domains are exchanged. Securing the confidentiality of information when transmitting messages via an insecure network is one of the basic security problems of the Internet. Thanks to the development of web technologies, this security problem has been solved by the introduction of cryptographic procedures for secrecy and user authentication. [1]

The second security problem is the service domain of the web service, and is closely related to authentication. Namely, it is necessary to ensure that the user is indeed entitled to perform certain operations. This is usually done through an Access Control List (ACL) linking users, resources, and permitted operations. This is often not enough, and additional monitoring measures are being used. For critical web services, such as money transactions, each user's step is recorded. This would make it easier to reconstruct malicious work in the event of an attack and sanction it appropriately.

III. Safety requirements

The importance of security does not need to be specifically emphasized, especially when it comes to the exchange of sensitive data in distributed computer systems, primarily to the Internet. In order for a web service to be safe, it is necessary that at least the following four requirements be met: authentication, confidentiality, integrity and non-integrity.

A. Authentication and authorization

Authentication implies the identification of parties in communication. The recipient of the message must be sure that the message was received from the person who presented himself as a sender. Endpoints must identify the identity of service users in order to prevent access and use of services by unauthorized and malicious users.

Authentication is a process in which a user or source of information proves that they are what they are representing - in other words, the process of identifying the identity of a user trying to access the system. Authentication implies the use of any technique that allows the receiver to automatically identify and reject messages that have been intentionally altered or have been modified due to channel errors. In addition, it can be used to ensure the positive authentication of the sender of the message, although it is possible to use algorithms with a secret (symmetric) key, for some kind of authentication, before any secrets are split between the parties exchanging messages.

The general definition of authorization is that it is a process that pertains to checking that the individual or organization that requested the action has the right to do so. The second definition, in the narrow sense, refers to a computer-based approach: Authorization is the process of granting or denying access to users to a secure system. There are several ways to authorize.

B. Cryptography

Cryptography is a science that deals with methods of keeping the information secret. When personal, financial, military or national security information is transferred from one location to another, they become vulnerable to eavesdropping. Such problems can be avoided by encrypting (encrypting) information that makes them unusable in case of compromise. Basic elements of cryptography:

- Encryption - the process of transforming the readable text into a form that is unreadable to the one to whom this text is not intended.
- Decryption - the procedure for restoring the encrypted text into a legible form.
- Key - the initial value of the encryption algorithm.

Cryptography can be symmetric, asymmetric and Hash functions.

C. Hesh functions, symmetric and asymmetric encryption

Hash functions are not used for encryption. They have suitable properties that are used to achieve cryptographic functionality related to the integrity of the transferred data, the authentication of the participants in the communication, the integrity of transactions, and the like. In encryption, the most common encryption size corresponds to the size of the message.

The basic idea of a hash function is to serve as a compact representative image (digital imprint) of input logging and cannot be obtained by any other input value. The Hash function (in the widest sense) is a function h, which satisfies the following two properties:

1. compression - to the input x of an arbitrary final length joins the output h (x) of the fixed length n.
2. simplicity of calculation - set h and input x, h (x) is easy to calculate. [2]

Unlike symmetric cryptography, asymmetric cryptography uses two keys - public and private. The principle is as follows: at the same time, a private and appropriate public key is being created. The public key is given to people who send encrypted data. With this person, they encrypt the message they want to send. When a recipient receives a code, he decrypts it using his private key. In this way, each recipient has its own private key and public can be given to anyone, since it is used only for encryption, and not decryption.

D. Digital signature and digital certificate

A digital certificate is an electronic document issued by the Certification Authority (CA). A digital certificate can be understood as a digital ID card, as it contains information about the user of the certificate and information about the digital certificate issuer. It is a certificate that confirms the connection between the data for the verification of the digital signature and the identity of the signatory, which is issued by an accredited certification body. Within the digital certificate issued to the user, there is, among other things, the user's public key, which is a pair of his secret cryptographic key (Private Key).

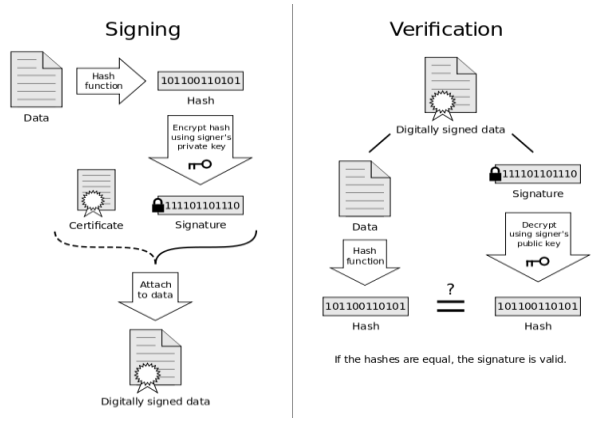

Diagram 1. A diagram showing how a digital signature is applied and then verified.

The digital signature is an electronic analogue of the actual signature by hand. Similar to handwriting, a digital signature must be counterfeit, the recipient must be able to verify it, and the sender, i.e. the one who signs, cannot later be able to deny it, i.e. The digital signature also ensures the non-validity of the message. The main difference between handwritten signature and digital signature is that a digital signature cannot be a constant, but must be a function of the whole document it appears. If a digital signature would not be a function of the whole document it appears, then it could be copied and added to any other document. It is most often created by the fact that a digital summary is encrypted by the sender's secret key. On the receiving side, a digital summary is obtained by decryption by the sender's public key.

The digital signature has the following features:

- Authenticity - confirming the identity of the signatory
- Integrity - which confirms that the content of the document is not changed after being authenticated by a digital signature
- Irreversibility - the sender cannot deny that he has sent a particular message he has signed with his secret key

E. XML Firewall

XML Firewall processes XML requests and replies through HTTP or HTTPS protocols. It uses one protocol and contains a processing policy with a set of requests, responses, two-way rules, and error rules.

Although XML Firewall processes XML documents of all kinds, including messages created in SOAP, it can accept unprocessed (text or binary) documents. Through the processing policy, XML Firewall can apply all different processing methods to the request and response message, regardless of the format. Processing can include AAA, transformation, validation scheme, recording and cryptographic operations. [3]

The XML firewall can be configured on the remote service proxy. However, one of the more important features of the XML firewall is to define the configuration as a backlinks service. As a backlinks, the remote server is not defined. In this case, the service itself generates a response to the client handling the request. This feature is useful when developing, testing and debugging services when a remote server is not available.

The XML firewall implements practical XML practices for the location. The basic XML Firewall can be configured in minutes, but complex security practices that use full XML Firewall power can be defined. [3]

IV. Web service protection levels (SSL protocol)

The protection of the web service can be done on two levels:

- Transport-level security
- Application-level protection, or message-level security,

Secure Sockets Layer (SSL) is a secure messaging (communication) protocol over the Internet that allows you to send confidential information (such as a credit card number) over the Internet in encrypted and secure form. The SSL protocol provides a special communication layer, which is placed on a trusted transport layer (e.g. TCP / IP), while the application layer is placed on SSL. It receives the message from the application layer, disassembles it into smaller parts suitable for encryption, adds a control number, encrypts, possibly compresses, and then sends those parts. The recipient receives parts, decompresses, decrypts, checks the control numbers, composes parts of the message, and submits them to the application layer. In this way, a secure channel of transmission through the network is realized through SSL. If the client and the server are inactive for a long time or conversation with the same security attribute takes too long, the attributes change.

SSL provides the following:

- Authentication-communication is established between the two trusted parties.
- Data confidentiality - data exchange is encrypted.

- Integrity of the message - is checked for corruption.
- Securing the exchange of keys between the client and the server. [4]

SOAP is a simple protocol for changing information in a decentralized, distributed environment. It's an XML-based protocol. The main risk factors of the SOAP and the basic WS security issues are that SOAP does not provide: authentication, integrity protection, confidentiality detection, redundant message detection, robust mechanism for authentication of the registry entry, resistance to DoS attacks, etc. [5]

The growth and popularity of SSL applications points to the danger of detecting and exploiting security holes in the protocol that could endanger the security of data being protected. The popularity of the Internet, and its users is growing every day, and the number of users using electronic transactions is rising too. SSL is very cheap for deployment, and has been developed as a fast solution for security in web applications that work with confidential data. This explains the more implementation of this protocol on the Internet. However, like any other system, SSL is not completely secure.

V. IBM DataPower Gateway

Gateway is a device located in a computer network node, it serves to communicate with another network that uses a different network protocol. The computer can also have a gateway role.

IBM DataPower Gateway is a multi-channel gateway that provides security, control, integration, and optimized access to a wide range of mobile, web, API (Application Programming Interface), SOA (Service-Oriented Architecture), B2B (business to business), and cloud processes.

Advantages of IBM DataPower Gateway:

- Provides a mobile gateway solution to protect, integrate, control and optimize access to the web, home and hybrid mobile applications.
- Provides a highly secure API gateway that allows you to provide, control, publish, monitor, and manage the API.
- Provides, manages and integrates SOA processes into DMZ (demilitarized zones) and security zones.
- Enhances web protection. Controls and accelerates traffic of intranets and intranet applications.
- Provides native support for JSON, SOAP / XML and other standards based on these formats.

The IBM DataPower Gateway provides the same features both as a physical and a virtual gateway. Virus Edition can be used on virtual machines, public clauses or platforms such as Microsoft Azure, Docker, Amazon EC2 ... Physical and virtual gateways can be combined to achieve maximum flexibility. [6]

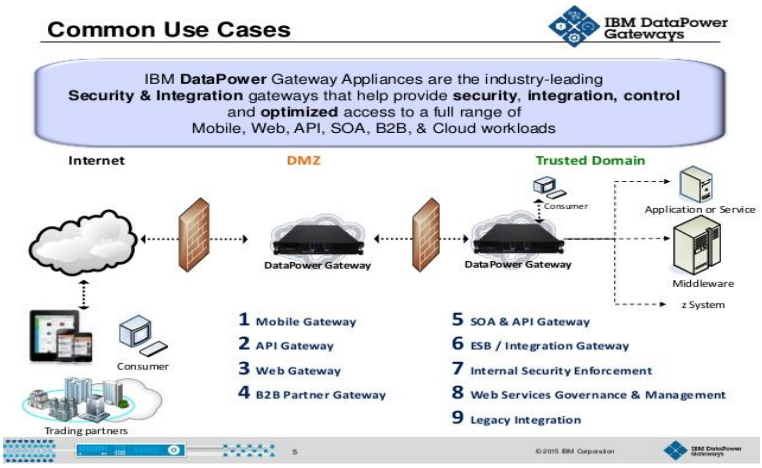

Figure 5. IBM DataPower Common Use

VI. Conclusion

Web service is a technology that enables easy data exchange and better coordination between business entities. As such, it is very interesting for use in e-commerce. However, the first implementation did not appear immediately after the emergence of technology, but the security problem was awaiting.

Basic security requirements: secrecy, authentication, integrity and non-compliance, which must be met in order to be considered secure by the web service, can be met using digital signatures and digital certificates.
The fact that all business processes do not require equally strong security mechanisms does not change the fact that any security requirements of a business process must be covered, or web services as technology cannot be applied at all. There is no security that we can judge as a semi-obscure. Either the application is safe enough or not. Between it does not exist.

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Architecture for Multimedia Learning System With Social Networking Features

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Abstract - **Multimedia support for education and learning has been proven to be quite fruitful in multiple contexts. Students augment their cognitive abilities, accelerate their memorization and learning, and abstract entities become easily understandable. But, multimedia learning is not a paradigm that can be easily implemented. It requires modern equipment and infrastructure, as well as multimedia content specifically crated for the referred lectures and distributed in a user friendly manner. This paper addresses the key features of some related systems, their applicability for multimedia learning, customized to the requirements of the primary and secondary school system in R. Macedonia, and proposes an architecture for multimedia learning specifically tailored to the requirements of the aforementioned educational system. Besides the possibilities for creation and sharing of multimedia content, the proposed architecture is designed to provide some social networking services, in order to motivate students to use the system more frequently.**

Keywords: Multimedia learning, Social networking, System architecture design

I. INTRODUCTION

Learning by the aid of multimedia is a paradigm that in the last several decades has been proven to be highly advantageous to the educational systems, providing improvement to students' learning. The explosive development of Internet and multimedia technologies brought vast possibilities to implement multimedia learning in all levels of education. Worldwide research shows that implementing multimedia in education fosters enhancements in many different aspects, such as furtherance of cognitive abilities, acceleration of memorization and learning and easement of understanding of abstract, micro and macro entities.

As an example, Lee et al. [1], as pioneers in the field of implementing multimedia in education, reported that this method of instruction demonstrates great capacity to enhance traditional teaching methods. They also show that, when applied correctly, it can bring breadth and depth to the subject, render efficient use of class time, create flexibility in teaching, and, enhance students' learning. Mayer [2], as one of the greatest researches in the field, also concluded that, under some conditions, multimedia learning can lead to substantial improvements in learning, and that students are better able to make sense of scientific or mathematical explanations when they are able to hold relevant visual and verbal representations in working memory at the same time. Garcia et al. [3] showed that, in some specific case of descriptive geometry, the use of flash animations accelerates the development of students' spatial perception. Lin et al. [4] investigated the potential benefits of using animation, visual cueing, and their combination in a multimedia environment designed to support learners' acquisition and retention of scientific concepts and processes, concluding that participants provided with animations retained significantly more concepts than their colleague peers provided with static graphics. Kim et al. [5] explored the effects of gamification of learning and concluded that, after some period of adaptation, the learning curve is quite steeper that with regular learning. This list goes much further and similar conclusions are presented by many other researches, such as: Arcelli et al. [6], Mayer et al. [7], Milovanovic et al. [8], Pérez-López et al. [9], Barra et al. [10], Surjono et al. [11], Tibbitts et al. [12], Gilakjani [13], Kumar et al. [14], Bittman et al. [15], Mai et al. [16], Chen et al. [17], Marsono and Wu [18], Adesope et al. [19], Ocepek et al. [20], Danielson et al. [21], Leow et al. [22], Smith et al. [23], Mayer et al. [24], Jeong et al. [25], Scheiter et al. [26], Park et al. [27], Schweppe et al. [28], that undoubtedly prove the benefits of the implementation of multimedia technologies in education. In addition, the effort of Almara'beh et al. [29], that explored the effectiveness of multimedia learning, confirm that multimedia technology empowers the educational processes by means of increased interaction between students and teachers, makes learning more dynamic and longer lasting, and it is applicable in the world outside the classroom.

But, the first question that imposes is how to provide and distribute multimedia content to the learners involved. Second, are the concerned schools prepared with adequate equipment and infrastructure to implement multimedia learning in their educational processes? Regarding the second question, a recent research of Kotevski and Tasevska [30] conducted for the high school educational system in the city of Veles, R. Macedonia, confirmed that the referred high schools lack in classroom multimedia equipment and teachers' competencies to create multimedia content. It is quite understandable that teachers with various scientific backgrounds are not trained to produce multimedia learning materials. But the fact that the schools are not sufficiently equipped with proper assets to implement multimedia in the classrooms, imposed the need to search for a concept that will enable students to acquire adequate multimedia learning materials, and have

permanent access regardless whether they are in the classroom, at home or elsewhere. Considering this situation we were inspired to explore possible options for the provision of multimedia learning content to the students of primary and secondary schools in R. Macedonia.

The rest of this paper is organized as follows. Section 2 elaborates the functionalities of the existing Learning Management Systems (LMSs), and their applicability for customized multimedia learning. This section also provides an insight into some previously published designs of particular Multimedia Learning Systems (MLSs). In section 3 we present our architecture of a system for multimedia learning with an incorporated elements of social media networking and its incentives. Section 4 presents the concluding remarks and our intentions for future work in the subject.

II. Related Work and Motivation

One category of systems that offer certain possibilities for multimedia learning are the LMSs. Thus, we provide a review of some of the more popular LMSs with their functionalities and their applicability in multimedia learning. The reviewed LMSs are: Moodle, Blackboard Learn, Ilias, Edmodo, Canvas and Sakai.

Moodle [31] is a free and open-source LMS written in PHP and distributed under the GNU General Public License. Developed on pedagogical principles, Moodle is used for blended learning, distance education, flipped classroom and other e-learning projects in schools, universities, workplaces and other sectors. With customizable management features, it is used to create private websites with online courses for educators and trainers to achieve learning goals. Moodle (Modular Object-Oriented Dynamic Learning Environment) allows to extend and tailor learning environments using community sourced plugins. Moodle runs without modification on Unix, Linux, FreeBSD, Windows, OS X, NetWare and any other system that supports PHP and a database, including webhost providers. Moodle also has import features for use with other specific systems. In the higher education market in the United States, Moodle was for a time the second largest provider with 23% market share in 2013 (following Blackboard learn with 41%. However, by 2017 Moodle had dropped to the third largest provider, partly due to increased adoption of Instructure's Canvas platform. In March 2016 Blackboard became an official Moodle partner.

Blackboard Learn [32] is a virtual learning environment and course management system developed by Blackboard Inc. It is a Web-based server software, which features course management, customizable open architecture and scalable design that allows integration with student information systems and authentication protocols. It may be installed on local servers or hosted by Blackboard ASP Solutions. Its main purposes are to add online elements to courses traditionally delivered face-to-face and to develop completely online courses with a few or no face-to-face meetings. Blackboard Learn provides users with a platform for communication and sharing content. Regarding the communication, the system enables posting announcements for students, student's chats, discussions and email.

Ilias [33] was developed in 1998, and it is now supported by 11 premium partners and more than 40 institutional Ilias society members. It has thousands of active installations, and is being used by millions of users worldwide. It can be used as a simple course player, a complex authoring tool, a full-fledged collaboration platform, or all of these combined, without the need for licensing fees. Any special requirements can be implemented by the service providers. A voluntary membership to the Ilias society is inexpensive and grants the clients with a direct influence on the long-term development process. With Ilias, course management, learning modules, test & assessment, portfolios, surveys, wikis and blogs are easily achieved.

Edmodo [34] is an educational system that offers collaboration and coaching platform to schools and teachers. The Edmodo network enables teachers to share content, distribute quizzes, assignments, and manage communication with students, colleagues, and parents. Edmodo is very teacher-centric in their design and philosophy: students and parents can only join Edmodo if invited by a teacher. Teachers and students spend large amounts of time on the platform, both in and out of the classroom. As of July 2017 Edmodo claimed to have over 78 million users worldwide, and about half of those in the USA, with the rest being in 180 countries around the world. Significant Edmodo concentrations exist in Singapore, Indonesia, Uruguay and Italy.

Canvas LMS [35] is an online LMS that delivers a customizable design and architecture which enables users to educate or learn in a customized manner. The system provides communication between teachers and learners, making it possible for both parties to effortlessly collaborate in the learning process. Canvas LMS allows students to submit paperwork, obtain notifications, and interact with the learning materials given to them, on the devices they use. They can also merge their Canvas LMS account with their social media accounts on Twitter and Facebook. The app offers a platform that educators can use to create effective learning tools for learners. Instructors can provide feedback and integrate wikis, blogs, videos, and other mediums of education, and monitor the students' progress.

Sakai [36] educational software platform is designed to support teaching, research and collaboration. Sakai is developed by a community of academic institutions, commercial organizations and individuals and it is distributed under the Educational Community License (a type of open source license), with the first version released in March 2005. It is used by hundreds of institutions, mainly in the US, but also in Europe, Asia, Africa and Australia. Sakai was designed to be scalable, reliable, interoperable and extensible. Its largest installations handle over 100,000 users.

The list of similar systems can be further extended, including Litmos LMS, Schoology, Brightspace, Docebo, TalentLMS, OpenEDX and many more.

What is common for all the aforementioned LMSs is that they are mainly built as course management systems that offer some features for multimedia learning, but cannot be easily customized as systems for multimedia learning. The presented LMSs are not out of the box solutions and represent more of a course management systems. Their administration can sometimes be difficult and not very user friendly, especially if someone tries to implement a multimedia learning system over an LMS platform. The teacher cannot easily download an LMS and be up and running the next minute, with all the necessary preparations for multimedia learning.

Taking into account the aforementioned limitations of LMSs and the specific requirements for multimedia learning, many efforts present designs of specific multimedia learning systems. In this manner, Lock Yen Low et al. [37] in 2003 outline the details of the development and deployment of a novel MLS, starting from content development flow to the implementation stage. The project is launched at the Multimedia University (MMU) in Malaysia. One of the drawbacks from the current point of view is that Adobe (Macromedia) Dreamweaver and Flash were used to develop the interactive environment within two university campuses. Nusir et al. [38] designed an interactive MLS for the children of primary schools in Jordan. After implementation, the authors report improvement of students' abilities and their learning skills. Huang et al. [39] presented the design of an online MLS for improving students' perceptions of learning English. The system is constructed as a quiz offering video leaning content. The experimental results demonstrated that students had a positive view of the functions of the video supported quiz system.

On the other hand, if we direct our attention to the social networking services, we can easily conclude that such services are omnipresent and their usage becomes viral in every part of the world. According to Statista [40] the most famous social networking sites worldwide as of July 2018 are Facebook [41] with 2.196 billion users and Youtube [42] with 1.9 billion users, among which just above 60% of all users are under the age of 34. Furthermore, Statista reports that the average daily time spent on social media worldwide in 2017 is about 135 minutes. From a different perspective, in 2015 Perrin [Social Media Usage] reported that 90% of the population in the USA, aged between 18 and 29, are active users of social networking services. Today, it is very rare to find a person that doesn't use mobile or some other networking device, even a child. There are opposite opinions as well. We all witnessed the ban of using mobile phones in French schools for pupils up to the age of 15 that came into force in September this year. But, regardless of the fact that some communities consider the usage of mobile phones by children to be unnecessary and even disadvantageous, the commodity of mobile and social networking services is hardly to be put out of usage. We believe that, instead of restrictions, the more convenient way would be to make a considerable effort to redirect some of the time that young individuals spend on social networking communications toward using multimedia learning while being able to communicate with their friends.

Considering the previous elaboration, we decided to propose a network and service architecture for multimedia learning system, which would be customized to the existing primary and secondary educational systems in R. Macedonia. The system would be tailored to meet the specific requirements of the defined study programs for each subject and include social media communication and incentives. To achieve the goal we conducted a series of interviews with teachers in the domain of the secondary schools in the city of Bitola, R. Macedonia. As an outcome, we postulated the following 11 essential prerequisites that the proposed MLS should satisfy:

1. Tailored according to the requirements of the educational system of implementation.

2. Based on the official learning materials, issued by the government, for the students in each year of study.

3. Enable all users to create and share multimedia content and connect the content to a specific lecture, but the sharing should be approved by one of the teachers that teach the corresponding subject.

4. Incorporate communication and incentives similar to the ones offered by the contemporary social media, in order to provide the users some features that they are quite familiar with, and fond of as well.

5. Built simple, intuitive and user friendly

6. Designed with a clean interface, simple design and with as fewer options as possible.

7. Built with the latest web technologies, free and/or open source preferred, such as HTML5, CSS3, JavaScript, etc.

8. Video tutorials to use existing video sharing platforms (free or paid), sush as YouTube, Dailymotion, Mediafire, Vimeo, Metacafe, DTube, Vevo etc.

9. Interconnected with the most popular social media services, such as Facebook, Twitter etc.

10. Promote grading awards for the most productive students of multimedia content.

11. Easily searchable content.

III. ARCHITECTURE FOR MULTIMEDIA LEARNING SYSTEM

The main goal of this research is to propose a system for multimedia learning that is quite different from similar systems in the architectural approach that would be tailored to the specifics of the educational system to support, with special attention to the simplicity of usage. The proposed architecture allows each user to manage and augment the part of multimedia learning content, adding text, images, audio, video and animations. The systems is designed to enable social media like incentives for the most liked learning content, in quite similar manner the users are used to in social networking. The graphical presentation of the MLS architecture is presented in two layer concept, given in Fig. 1 and Fig. 2. The proposed system defines four user categories: (1) Top level Administrators, (2) Government officials, (3) School managers, (4) Teachers, (5) Students

and (6) Samaritans. Each category has its own permissions for applying changes to the system.

Top Level Administrators (TLAs) are IT personnel engaged by the Government officials in charge. Their privileges include administration of schools and teacher profiles and define data about the basic educational content for each distinctive combination of: year of study, year of content publication and name of the subject.

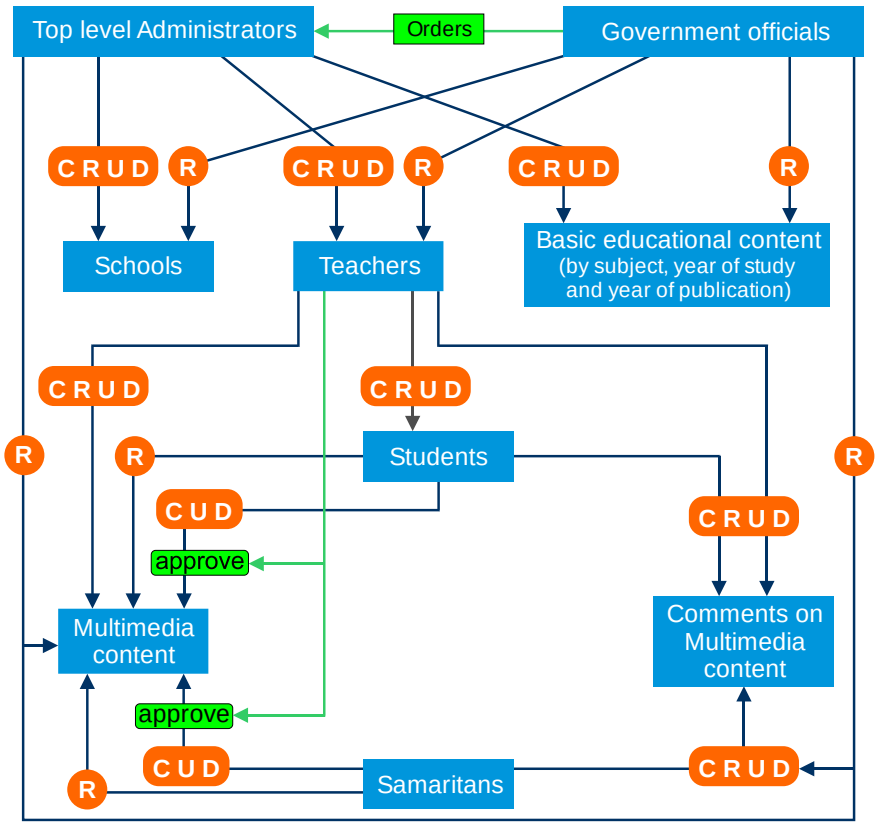

Figure 1. Architecture for Multimedia Learning System
(C R U D – Create, Read, Update, Delete)

Ministry officials (MOs) are privileged to view everything in the basic educational layer (BEL) of the MLS, but only limited content from the social networking layer (SNL). For example, personal messages exchanged between individuals are visible only to the parties involved in the conversation. Every change required in the system is ordered through the system to the responsible TLAs.
Schools managers (SMs) have similar privileges as the MOs, with the exclusion of the ordering privileges that are limited only to the school they manage.

Teachers have privileges to administer student profiles and create multimedia content, as well as to approve multimedia content created by their students for their subject of teaching. They have a view of all the materials in the system, just like any student.

Students can administer multimedia lectures they create and can view all multimedia content.

The Samaritan category is created for individuals or organizations (governmental or non-governmental) that do not belong to any of the other four categories, and would like to contribute to the system with creation of multimedia learning materials.

The social networking layer, presented in Fig. 2, is available to all users in the system. It features functionalities similar to the basic functions of the popular social networks, including inviting friends, posting messages to groups or individuals, sharing information about multimedia content and liking and rating multimedia lectures.

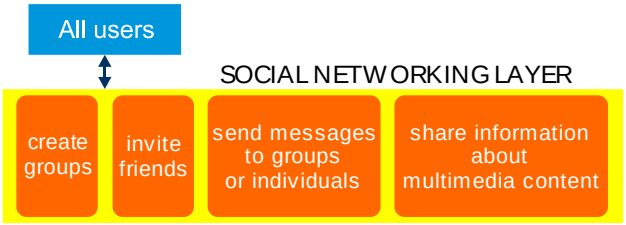

Figure 2. Social networking layer of the MLS

The whole solution is intended for learning purposes only, and does not cover exams. Additionally, we intend to include quiz module for learning purposes, but we are strongly determined to support the idea of separating the teacher from the examiner. When the teacher is granted with both roles, to teach and test, the teacher is put in a position of power and control. This long-standing approach leads to variety of grading criteria that can never guarantee equally graded students. Furthermore, it leads to uneven and unfair possibilities for high school graduates when they enroll for higher education.

CONCLUSION AND FUTURE WORK

Multimedia learning has been widely recognized to support educational processes and enhance learning. Multimedia accelerates students' memorization, their cognitive abilities and provides easier understanding of abstract entities. While the benefits are confirmed in many research efforts, the obstacles that multimedia learning is constantly facing is the creation of multimedia learning content, as well as its distribution. To address these issues, in this research we propose an architecture for multimedia learning system that incorporates some basic functionalities of social media. The system is intended to be built as an extension of an existing educational system (primary and secondary) with possibilities for each user to contribute to the creation of multimedia content. Additionally, our solution represents a green solution that enables preservation of substantial amount of printing paper and funds, since the system will carry all the official learning materials in electronic form. Our future work will include activities to acquire funds for planning, development and testing purposes and to analyze results after a certain period of usage. The planning phase will include deeper analysis of the current situation and interest of all the stakeholders. The idea is to achieve construction of a system in which every student is equal and every student can cooperate in order to facilitate and improve the effectiveness and efficiency of the teaching system. Our preliminary interviews with several teachers and students have shown that such system would cause greater interest and greater desire to learn, due to the multimedia context of learning. The system is intended to be used in all primary and secondary schools in the state, as a unified system where both teachers and student can enhance their knowledge and understanding, and share information with other colleagues.

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Application of Arduino Measurement Set for Experimental Evaluation of the Static Behavior of Continuous Systems

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Abstract – Application of an Arduino based measurement system, in experimental capture of the elastic line of statically loaded simple systems, is presented in this paper. For this purpose, an experimental set of console steel beams, loaded at the end with concentrated force, was developed. The experimental set was made to determine the displacements at characteristic points, separating the beam length at equal distances. Like any experimental study, the proposed one is preceded by the development of a theoretical model for analytically obtaining the expected results. The displacements of the characteristic points of the beam are calculated by Method of direct integration. Then it is performed manually measuring of the some displacements, using a simple caliper. The main measurement is made by an Arduino measurement system. The system consists of light sensors, connected to an Arduino board that converts the analog signal into digital and directs it to the computer. The digital signals are processed, scaled and displayed by a specially developed in the MATLAB environment program. The results are compared with the theoretical and the manual measurements results. The percentage error in the implementation of the alternative measurement system has been determined. The Arduino measurement system can also be used for beam vibrations at frequencies up to 3-4 Hz. The experimental configuration was developed in the Laboratory for Numerical and Experimental Dynamic Modeling at the University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria.

I. INTRODUCTION

Much of the equipment in many Bulgarian laboratories is from thirty-forty years - the time before the computer revolution in science, education and technology. The most outdated is the equipment in the various mechanical laboratories in the technical universities in Bulgaria. The main reason for this is the high prices of the modern mechanical equipment.

The main experimental studies in these labs are related to the measurement of real or relative displacements of characteristic points by the volume of large models of real constructions or details of them under different impacts. Based on these displacements are calculated the corresponding stress points and made the evaluation of static and dynamic behavior of structures. Measuring sensors that are connected to the points send analog signals to analogue measuring instruments. The information from the latter is counted and processed manually. It is possible after manually enter the information to use appropriate software for numerical processing of the results. The process of manually entering of the reported data, however, is rather lengthy and uniform.

In the scientific study in this report is proposed an alternative measurement system, directly connected to a computer configuration, provided with appropriate software. The measurement system is an Arduino based light resistor system. The software, chosen for processing, analysis and visualization of the results is the MATLAB program system. It is used licensed academic version of MATLAB/Simulink, owned by the Laboratory for Numerical and Experimental Dynamic Modeling.

The idea of the proposed alternative measurement system is the results cheaper and faster to reach the computer for easier processing, analysis and printing of the latter.

II. THEORETICAL MODEL AND ANALYTICAL CALCULATIONS

The theoretical model corresponds to a laboratory existing stand, used to study the stresses and deformations of a console steel beam. Picture of the stand is shown in “Fig. 1”, and the corresponding model in “Fig. 2”.

The measurement system, which is described below in

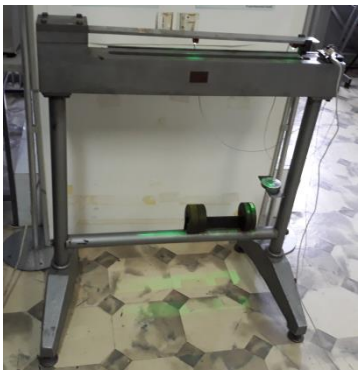

Figure 1. Stand for study the stresses and deformations of a console steel beam

the report, is intended to determine the absolute displacements of characteristic points. For this reason, analytical research on the basis of the theoretical model is also oriented to determine of such displacements.

The values of the characteristics of the theoretical model of "Fig. 2", correspond to the characteristics of experimental model of "Fig. 1" are given in the following table

TABLE I. CHARACTERISTICS OF THE MODELS

	Description	*Symbol*	*Dimension*	*Value*
1	Length of the beam	l_b	[cm]	67
2	Position of the concentrated force	l_f	[cm]	63
3	Position of characteristic points	l_1, l_2	[cm]	30, 60
4	Dimensions of the cross section of the beam	b/h	[cm]	5/0.8
5	Weight per Unit Volume	γ	[kN/cm^3]	78.5e-4
6	Module of Elasticity of used steel	E	[kN/cm^2]	20000
7	Concentrated force	F	[kN]	50
8	Dimention of the characteristic points	w_1, w_2	[cm]	

The analytical calculations follow the path, given in the Method of direct integration. The calculations are made separately for the load from own weight of the beam and from concentrated force, located at any point of the beam length.

First, the expressions in the bending moment at any section of the beam are calculated.

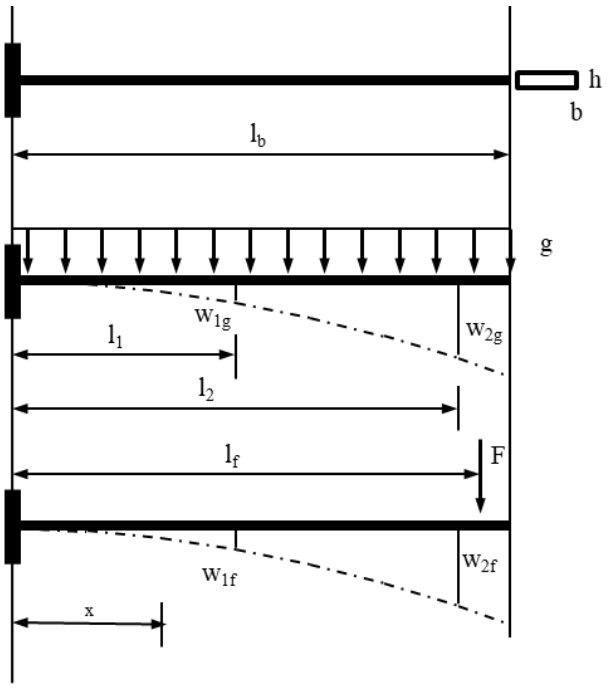

Figure 2. Theoretical model for study the deformations of a console steel beam

$$M_g = -g.\frac{x^2}{2} + g.l_b.x - \frac{g.l_b^{\,2}}{2}$$
$$M_F = F.x - F.l_f \quad (1)$$

It is known from the Strength of Materials theory that the expression of the second derivative of the displacements, multiplied by the bending stiffness, is equal of the expression of the bending moment, multiplied by -1 [1], [2].

$$EJw'' = -M \quad (2)$$

After integrating of (2) and calculating the integration constants from the boundary conditions, the expressions for the displacement of from the beam length are obtained.

$$EJw_g = -g.\frac{x^4}{24} + g.l_b.\frac{x^3}{6} - \frac{g.l_b^{\,2}}{2}.\frac{x^2}{2}$$
$$EJw_F = F.\frac{x^3}{6} - F.l_f.\frac{x^2}{2} \quad (3)$$

After replacing the table I values in formulas 3, the displacements of the characteristic points are obtained. The latter are given in the comparative table the end.

III. EXPERIMENTAL MODEL

The modified stand for study the stresses and deformations of a console steel beam, is used for experimental studies. Modification refers to the results reporting system.

As such, a system of light sources, resistors and controller is used. The scheme of the system is shown in "Fig. 3".

A system of light sources is attached to the bottom of the console beam. The system allows the supply of one to six lamps. Two light sources are used in the experiment, conducted in the present research. The latter are fixed at a distance of l_1 and l_2 from the beginning of the beam.

Vertical below them light resistors are attached on a fixed part of the stand. The number of the resistors is the

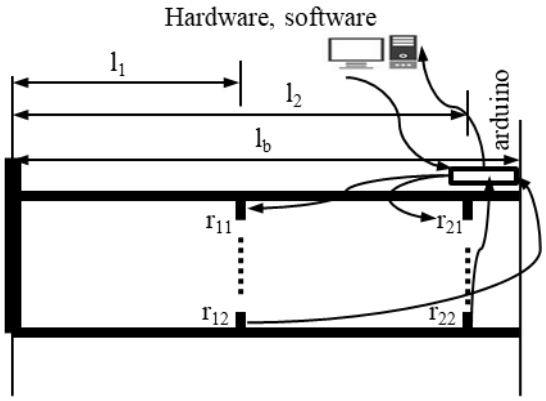

Figure 3. Sheme of the Arduino displacements measurement set

same us the number of the lamps.

Both groups - lamps and resistors are connected to an Arduino controller. The controller contains 6 inputs for connection with the lamps and 6 outputs that connect the controller and resistors.

The Arduino board connects to the computer with a standard printer cable. The controller and the lamps are powered by the cable. Along the same cable, the results are returned to the computer for processing, analysis and printing.

Photo of the Arduino displacements measurement set is shown in "Fig. 4".

A major part of the experimental configuration is the developed signal processing program. The program is composed in MATLAB environment program and has the following appearance.

```
clc
clear
sw1=arduino('COM5')
sw2=arduino('COM4')
interv=100;
% passo=1;
t1=1;
x1=0;x2=0;
while (t1<interv)
      b1=sw1.analogRead(0);
      b2=sw2.analogRead(0);
      x1=[x1,b1];
      x2=[x2,b2];
      subplot(2,1,1); plot(x1);
      axis([0, interv, 110, 130]);legend('end');
      grid
      subplot(2,1,2);  plot(x2,'r');
      axis([0, interv, 125, 145]);legend('middle');
      grid
      t1=t1+1;
      drawnow;
end
```

The signals from the resistor are the input data into the program. The signals are proportional to the distance between the resistor and the light source. The magnitude of the signals accumulates in real-time in resultant numerical vectors. The latter are displayed in graphical form.

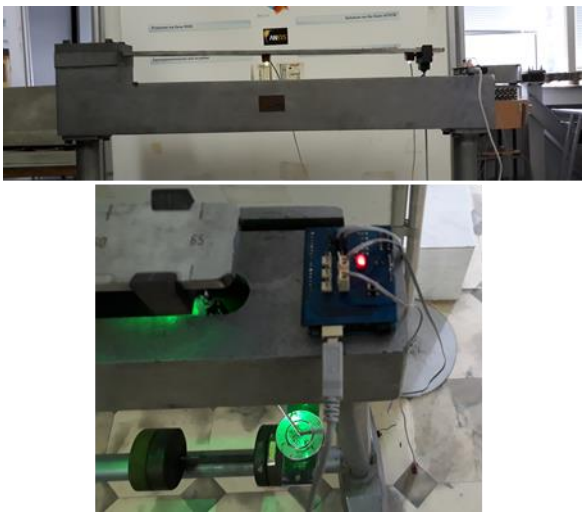

Figure 4. Photo of the Arduino displacements measurement set

IV. CONDUCTING OF THE EXPERIMENT

The using of the developed measurement system for determining the displacements of the console beam of "Fig. 4" is in the following sequence:

First, the relationship between the value of the signals and the distance between the resistor and the light source is determined. For this purpose, the two parts of the sensor are attached to two fixed points with a certain distance between them. Then the distance between them is changed with a value close to the expected beam displacements.

The relationship between the value of the signals and the distance, which is named factor of conformity, is determined by the ratio of the difference in signals to the change in distance.

$$\delta = \frac{d}{s_2 - s_1} \tag{4}$$

Then, the value of the signals in a horizontal undeformed beam is counted. In order to ensure the horizontal position of the beam, plastic blocks are placed at certain points with a height equal to the height in the bending. These signals serve as the beginning of the report of the changed signals that occurs when changing the distance.

After removing the supporting blocks, the beam takes a deformed position "Fig. 5 - up". The signals in both sensors are read in the new position. By the factor of conformity between the change of the signal and the displacement of the corresponding point, the last one is calculated.

Then it is starts loading of the beam at a distance 53 cm from the fixed point. Weights of 1.5 and 2 kg are added to reach the maximum displacement, allowing experimental configuration. Again, the signals from the two sensors are counted.

Figure 5. Photo of experimental set with unloaded and loaded beam

After multiplying the signal value by the factor of conformity, the displacements of two points are obtained.

Graphical results of the conducted experiment, obtained by the Arduino displacements measurement set, are shown in "Fig. 7".

V. RESULTS AND ANALYSIS

The results of the deformation of the beam at the middle and end point are obtained in four ways.

First, analytical results are obtained. After replacing of the data from Table 1 in Formulas 3 at x=30 cm and x=60 cm, the displacements from load of own weight and concentrated force are determined. Also it is calculated the total displacement as the sum of the two components.

Then a numerical determination of the composite and full shift was made. For this purpose a model based on FEM was developed, using the SAP2000 programm system. A picture of stressed and deformed state of gravity plus concentrated force is shown in "Fig. 6".

Experimental results were obtained twice:

First, manually using a precision caliper, the distance from the stationary part of the stand to the beam is measured. The measurement is made in horizontal, deformed by weight and concentration. Then, the absolute beam displacement at own weight and concentrated force is calculated.

The second experimental study is done with the Arduino displacements measurement set (ADS). The Arduino board signal is shown on the graph in "Fig. 7". At the start the signal at undeformed beam is observed. It follows the stage of a deformed beam of its own. The last part of the graph is the signal recording of a deformed beam from its own weight and concentrated force.

The waveform character of the signal around a certain average value is due to the influence of external light sources on the light resistor pair.

The authors are currently working to reduce signal distraction by placing the sensors in special dark tubes.

After reading the results, the change of the signal at first and second load conditions is calculated. Finally, by the factor of conformity of formula (4), the displacement at each of the loading states is determined.

The results obtained by each of the four methods are shown in Table II.

The percentage error for each of the methods is also calculated with respect to the theoretical results.

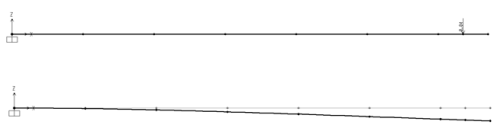

Figure 6. Numerical Reesults on the displacemenrs of characteristic points from the beam (SAP2000)

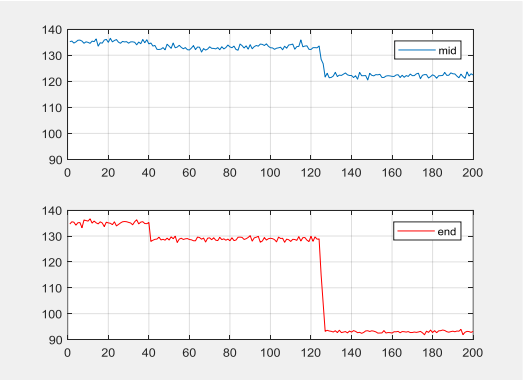

Figure 7. Graphival results on the displacemenrs of characteristic points from the beam

TABLE II. RESULTS

	Method	*Displacements [cm]*			*percent error*
		w_g*[cm]*	w_F *[cm]*	w_{g+F} *[cm]*	
1	Analytical results by Method of direct integration	0.054	0.280	0.334	0
		0.157	0.891	1.048	
2	Numerical results by SAP2000	0.052	0.281	0.334	0.19
		0.155	0.891	1.046	
3	Experimental results by precision caliper	0.050	0.28	0.330	1.19
		0.150	0.890	1.040	
4	Experimental results by ADS	0.047	0.272	0.319	4.70
		0.154	0.878	1.032	

VI. CONCLUSION

Based on the results, each user of similar cheaper measurement systems can judge when to use such and when expensive precision measurement systems.

The measurement system can to use for vibrations of such beams at vibration frequencies of up to 5 Hz.

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EXpencer - Application for Management with Costs Analysis

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Abstract - Anyone who works with supplies is in a situation where at the key moment there is a lack of certain material, damage to the equipment or defect of the technical means.

The process of defect compensation, equipment or supplies of consumables is obsolete, protracted, and sometimes due to poor communication is defective.

There are many methods that deal with cost management and procurement analysis. One method will be presented in this paper.

An application for cost management and analysis is designed to make an order quickly as possible, directly and without hindrance.

Keywords: application, costs, analysis

I. INTRODUCTION

In order to order, the user will log on to the eXpencer on the website, where he will request a particular service. The application is requested to immediately forward it to the responsible persons, who will then be appropriately processed by priority. The user will be informed that the person in charge has received a request and at the same moment fulfills it.

Figure 1. EXpencer homepage

II. LITERATURE REVIEW

There are many papers that deal with cost management and procurement analysis.

One part of this paper presents a mathematical model for a trading company's inventory management, which is done automatically by a commercial program package for inventory accounting. By using this application a company may make substantial savings. [1]

In the paper authors focus on a application of various models, including the "optimal inventory management" model, can significantly facilitate the decision-making process. The analysis in this paper focuses on the effects of the application of the EOQ model in supplies optimization of the company "XY". The analysis showed that there is an economic motivation to apply this model, since its implementation significantly reduces the inventory costs, which contributes to overall profitability. By applying this model in the case of the trading company "XY", the total inventory costs would be lower by 1.88%. Ordering costs would be reduced by 30%, the inventory holding costs would increase by 7.45%, but it would significantly reduce investment in inventories.[2]

In this paper the author is thinking about the efficiency analyzes of trading. The author reviews the cost categories and the basic functions in trading activity to find possible ways getting reliable information.[3]

In the study is emphasized that cost efficiency, cost reduction, and spend analytics continue to be among the top business priorities in supply chain management (SCM) and procurement. [4]

III. ENTITY – RELATIVE DIAGRAM AND DESCRIPTION OF DATA BASE RELATIONS

The database contains 9 entities. In USER will save the first and last name of the user, the email address that will serve the user as a user name and password that the user appoints from the administrator. The password will be encrypted according to the md5 standard in the database.

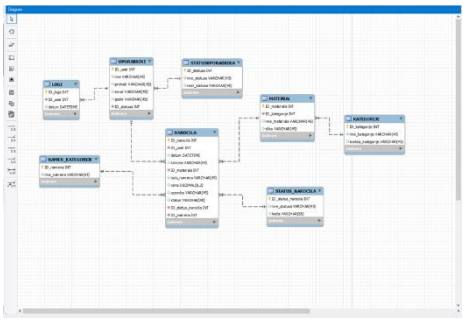


Figure 2. ER diagram of the eXpencer application

In the CATEGORY entity, will preserve the names of the categories (stationery, electronics ...) and their abbreviations.

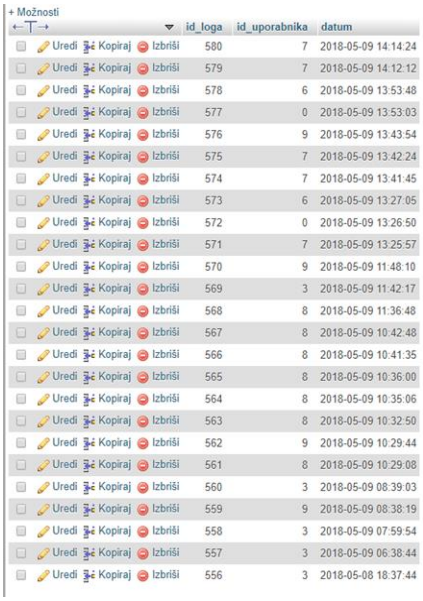
+ Možnosti

	ID_kategorije	ime_kategorije	kratice_kategorije
Uredi Kopiraj Izbriši	1	Pisarniški material	PM
Uredi Kopiraj Izbriši	2	Elektronika	EK
Uredi Kopiraj Izbriši	3	Programska oprema	OP
Uredi Kopiraj Izbriši	4	Materijalna sredstva	MS
Uredi Kopiraj Izbriši	10	Pisarniški material	PM
Uredi Kopiraj Izbriši	25	printer	pre

Označi vse Z označenim: Uredi Kopiraj Izbriši Izvozi

Figure 3. Entity category

The subject Logs will record the history of all announcements from the user's site. Serial number, user name and date of the event.



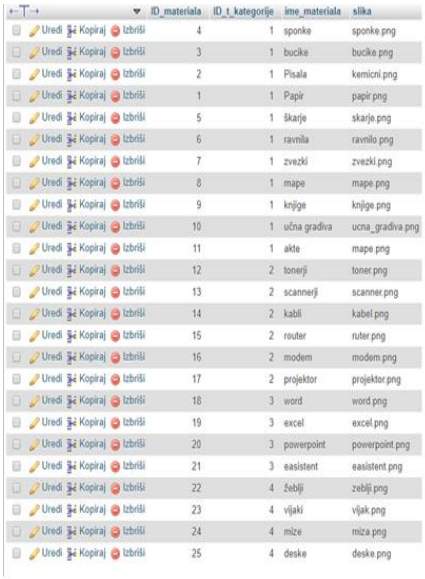
+ Možnosti

	id_loga	id_uporabnika	datum
Uredi Kopiraj Izbriši	580	7	2018-05-09 14:14:24
Uredi Kopiraj Izbriši	579	7	2018-05-09 14:12:12
Uredi Kopiraj Izbriši	578	6	2018-05-09 13:53:48
Uredi Kopiraj Izbriši	577	0	2018-05-09 13:53:03
Uredi Kopiraj Izbriši	576	9	2018-05-09 13:43:54
Uredi Kopiraj Izbriši	575	7	2018-05-09 13:42:24
Uredi Kopiraj Izbriši	574	7	2018-05-09 13:41:45
Uredi Kopiraj Izbriši	573	6	2018-05-09 13:27:05
Uredi Kopiraj Izbriši	572	0	2018-05-09 13:26:50
Uredi Kopiraj Izbriši	571	7	2018-05-09 13:25:57
Uredi Kopiraj Izbriši	570	9	2018-05-09 11:48:10
Uredi Kopiraj Izbriši	569	3	2018-05-09 11:42:17
Uredi Kopiraj Izbriši	568	8	2018-05-09 11:36:48
Uredi Kopiraj Izbriši	567	8	2018-05-09 10:42:48
Uredi Kopiraj Izbriši	566	8	2018-05-09 10:41:35
Uredi Kopiraj Izbriši	565	8	2018-05-09 10:36:00
Uredi Kopiraj Izbriši	564	8	2018-05-09 10:35:06
Uredi Kopiraj Izbriši	563	8	2018-05-09 10:32:50
Uredi Kopiraj Izbriši	562	9	2018-05-09 10:29:44
Uredi Kopiraj Izbriši	561	8	2018-05-09 10:29:08
Uredi Kopiraj Izbriši	560	3	2018-05-09 08:39:03
Uredi Kopiraj Izbriši	559	9	2018-05-09 08:38:19
Uredi Kopiraj Izbriši	558	3	2018-05-09 07:59:54
Uredi Kopiraj Izbriši	557	3	2018-05-09 06:38:44
Uredi Kopiraj Izbriši	556	3	2018-05-08 18:37:44

Figure 4. The information entered in the LOGI

The MATERIAL entity will contain the name of the material (for example, clips, paper, pens, etc.), and their images.

Name CATEGORIES has saved activity names (eg project, lesson, activity ...).



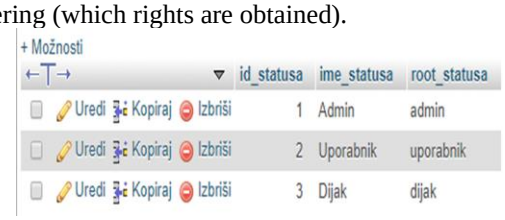
	ID_materiala	ID_t_kategorije	ime_materiala	slika
Uredi Kopiraj Izbriši	4	1	sponke	sponke.png
Uredi Kopiraj Izbriši	3	1	bucike	bucike.png
Uredi Kopiraj Izbriši	2	1	Pisala	kemicni.png
Uredi Kopiraj Izbriši	1	1	Papir	papir.png
Uredi Kopiraj Izbriši	5	1	škarje	skarje.png
Uredi Kopiraj Izbriši	6	1	ravnila	ravnilo.png
Uredi Kopiraj Izbriši	7	1	zvezki	zvezki.png
Uredi Kopiraj Izbriši	8	1	mape	mape.png
Uredi Kopiraj Izbriši	9	1	knjige	knjige.png
Uredi Kopiraj Izbriši	10	1	učna gradiva	ucna_gradiva.png
Uredi Kopiraj Izbriši	11	1	akte	mape.png
Uredi Kopiraj Izbriši	12	2	tonerji	toner.png
Uredi Kopiraj Izbriši	13	2	scannerji	scanner.png
Uredi Kopiraj Izbriši	14	2	kabli	kabel.png
Uredi Kopiraj Izbriši	15	2	router	ruter.png
Uredi Kopiraj Izbriši	16	2	modem	modem.png
Uredi Kopiraj Izbriši	17	2	projektor	projektor.png
Uredi Kopiraj Izbriši	18	3	word	word.png
Uredi Kopiraj Izbriši	19	3	excel	excel.png
Uredi Kopiraj Izbriši	20	3	powerpoint	powerpoint.png
Uredi Kopiraj Izbriši	21	3	easistent	easistent.png
Uredi Kopiraj Izbriši	22	4	žeblji	zeblji.png
Uredi Kopiraj Izbriši	23	4	vijaki	vijak.png
Uredi Kopiraj Izbriši	24	4	mize	miza.png
Uredi Kopiraj Izbriši	25	4	deske	deske.png

Figure 5. Table for displaying the material

The most important entities are CONTRACTS. When ordering with the help of a foreign key, we obtain the user (his user name), the date of the order, the quantity of the ordered material, the foreign key to the entity material (help to the user for the display of categories), the foreign key to the entity purpose (display of all categories) for material, note and foreign key to entity status (for displaying all statuses).

Figure 6. Contracts

From the STATUS BUILDER, will obtain the status name (admin, user, student) that will need when registering (which rights are obtained).



+ Možnosti

	id_statusa	ime_statusa	root_statusa
Uredi Kopiraj Izbriši	1	Admin	admin
Uredi Kopiraj Izbriši	2	Uporabnik	uporabnik
Uredi Kopiraj Izbriši	3	Dijak	dijak

Figure 7. Status Bulder

The STATUS CONTRACT entity has stored order status (rejected, on-waiting, closed).

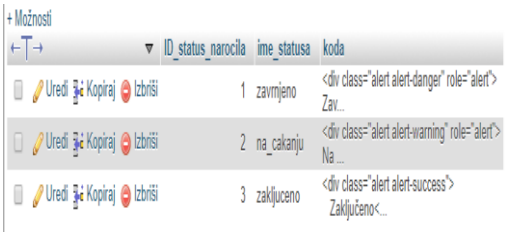


Figure 8. Status Contract

IV. APPLICATION OF THE USERS

Until we log into the system, we do not have many useful options. We can log in as a user or as an administrator. By logging in to the system, we identify with the username in the form of an e-mail and password, and the administrator automatically assigns us user rights. Password is encrypted with md5.

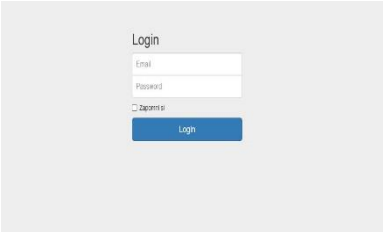


Figure 9. Application page for the application

When clicking on the login button, a function is started that first checks whether both fields are filled. If both fields are filled, the function checks if the user name matches the one that is stored in the database. Then it checks the password again, and if it matches it, it redirects us to the user's home page.

Figure 10. Session and user definition

V. SUPERVISION PANEL - ADMINISTRATOR

On the home page of the administrator, the page will appear in the form of a control panel. When a user is logged in, his user name appears in the top left corner. In the upper right corner you can see the "home" icons for the home page, the settings icon, the help icon and the logout for the currently logged in user.

The first window shows the total number of registered users. The following window is for settings (change of user name and password) - if we want to change the username or password, leave the second field blank. In the next window we find a description and information about the application itself. In the order window, we find all orders and their status (described in the following pages). In the statistics window, we can review the costs per users, by categories, as well as a review of monthly costs, as well as year-rounds. Under the last window, materials and categories see the lists of pre-prepared materials and categories of purpose.

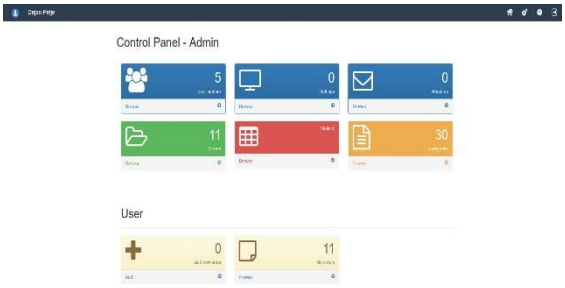


Figure 11. Administrator's Control Panel

VI. DOMESTIC PAGE - USER

The administrator has only two rights to the user when using the application - submitting orders and reviewing their own order history.

On the home page, finds two windows. The first one is for the submission of orders, while the second window is used to review its own order history.

Figure 12. User home page

VII. SHOWING OPERATION

The user on the home page chooses the "Submit new order" box. By clicking, we are redirected to a new page where we can select the desired material and fill in the required fields.

The first choice is a type of material where we can choose between different office materials, equipment, components and services. We continue with the choice of a category where we can choose between the categories "lessons", "project", "education", and other administrative services and activities.

In the next window, we type in the order of use, the used quantity, and we can also add various notes and additional requirements, which define the request more precisely.

In the "total price" box, enter the amount of the order, and if we do not know the price, enter the number 0.

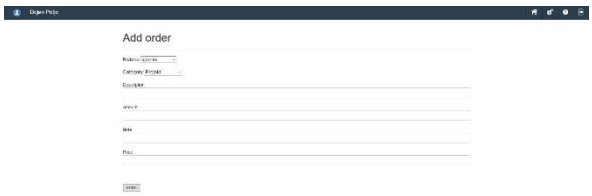


Figure 13. Submission of a new order

When a successful order is submitted, a confirmation "Contract successfully awarded!" Is displayed at the top of the page in the green box.

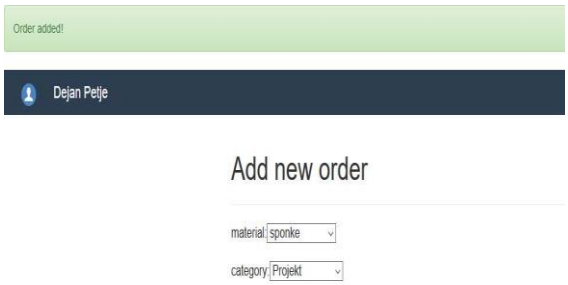


Figure 14. Notification of successful order

VIII. ORDERS

All orders from all users are visible under the order box. Each order specifies the user who sent the order and the date on which the order was submitted. The quantity, purpose, price, type of material and notes are also indicated. Submitted orders are pending until they are approved or rejected by the administrator.

Figure 15. Review orders

The administrator can approve or reject customer orders. Whether the order was approved or rejected is displayed on the far right of the box at each order separately.

Figure 16. Review of order status

IX. STATISTICS AND ANALYSIS OF COSTS

Under this box, a complete overview of costs is enabled, as well as the entire history of approved and / completed orders.

Costs can be reviewed in a number of different ways, e.g. costs for each user separately, costs by categories, costs for each month separately, and annual costs.

Figure 17. Overview of cost statistics

In the annual cost category, we find the total costs for each user individually, as well as information about the materials they ordered throughout the year.

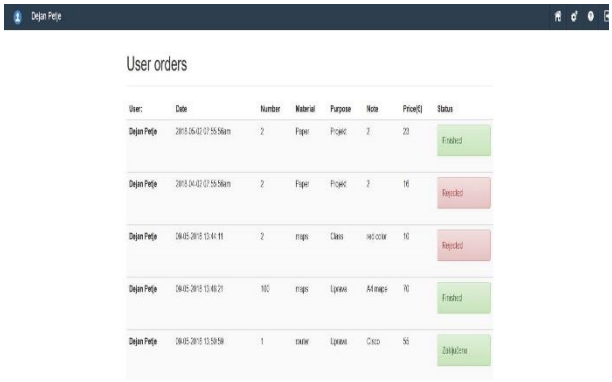


Figure 18. Annual costs for each user separately

For the cost category, we can see the total and combined costs of all users for a particular category (paper, pens, folders, cables, ...)

For purposes of use, however, we find information on the activity for which the materials were used (lessons, projects, other activities, administration)

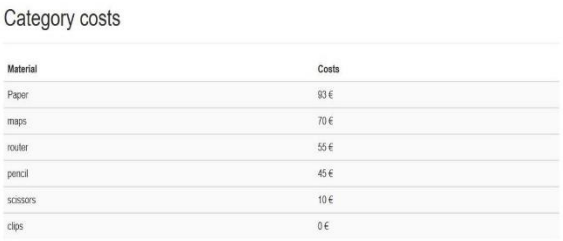


Figure 19. Costs by categories

As part of the review of the costs of the users themselves, we can see the orders for each user separately, the quantity and the total price of the ordered items.

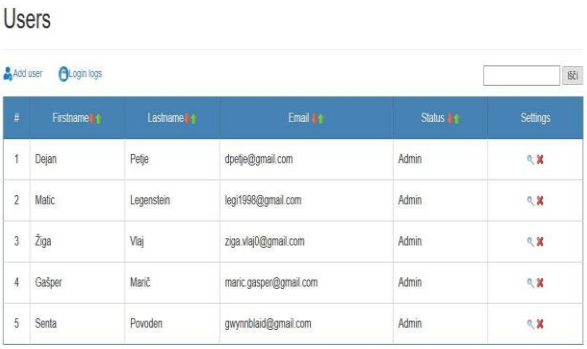


Figure 20. User overview

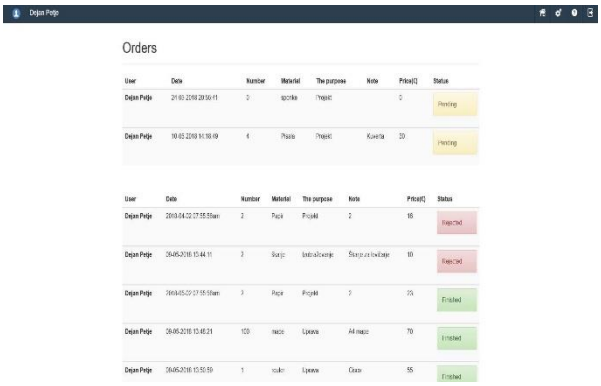


Figure 21. Review orders for the user

X. CONCLUSION

The application is designed in a transparent and easy manner, making it easier for the end user to handle it. It is useful for different areas and different categories, which the administrator, depending on the scope of the activity, organizes.

Because the application also enables the processing of statistical data by users and by material, with monthly and annual display, it is also suitable for analyzing and partially managing the costs of user material and for limiting uncontrolled costs in the consumption of consumables.

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Design of LoRa Service Infrastructure Solution for D2D Communication over Physical 433 MHz Wireless Link

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***Abstract* - In this work, we present results from wireless link performance evaluation of LoRa-based low-cost devices operating in the 433 MHz unlicensed band. Diffie Hellman key exchange method is used to allow two devices, having no prior knowledge of each other, to establish a shared secret key over an insecure channel. The proposed solution is tested in various conditions and channel states, showing acceptable performance, reliability and scalability to serve higher number of networked IoT devices, without running standardized protocol stack as LoRaWAN.**

I. INTRODUCTION

Nowadays, significant research and development efforts are undergoing by the academia and industry on the study, analysis and finding new solutions related to high-dense sensor networks as part of the IoT (Internet of Things) concept [1,2]. LoRa (Long Range) is a modulation technique that enables long-range transfer of information with a low transfer rate and high energy efficiency. LoRaWAN from the other side is a protocol stack (Fig. 1) designed on top of the LoRa physical layer by LoRa Alliance. It uses unlicensed radio spectrum in ISM bands to provide low power, wide area communication between remote sensors and gateways connected to the IoT network. It is obvious that the intention of such standards-based approach is efficient and faster set up of public or private IoT networks using hardware and software which is secure and interoperable. The end-devices and gateways are connected with links within ISM radio bands with single hop, while the gateways and network servers are connected using wired IP back-haul infrastructure or 3G/4G/5G wireless broadband connections. Nowadays, rapid development of mission-oriented IoT applications [3-9] is possible using affordable and easily accessible hardware platforms and development kits which do not employ standard-based protocol stacks. Moreover, the limited signal- and data processing resources of such development platforms, based on widely available microcontrollers such Arduino etc., make them unsuitable to process complex multi-layer protocol stacks.

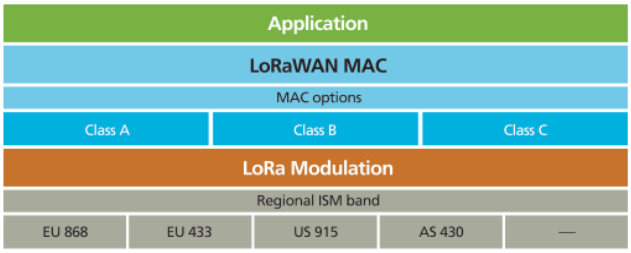

Fig. 1. LoRaWAN Protocol Stack

Naturally, a question arises from the above facts: "Is it possible to realize IoT infrastructure with similar LoRaWAN full stack functionality application with standard devices equipped with LoRa radio interface, with software-defined API-assisted upper layer functionalities, such MAC, device function classification security and scalability?". The results from practical system design, performance analyses and tests in various operational conditions in this work, prove that fully functional IoT service and node-gateway communication infrastructure could be successfully realized with low-cost devices and

carefully designed low-complex software functions, allowing real-time data exchange between resource-constrained IoT nodes.

II. Description of the LoRa Nodes

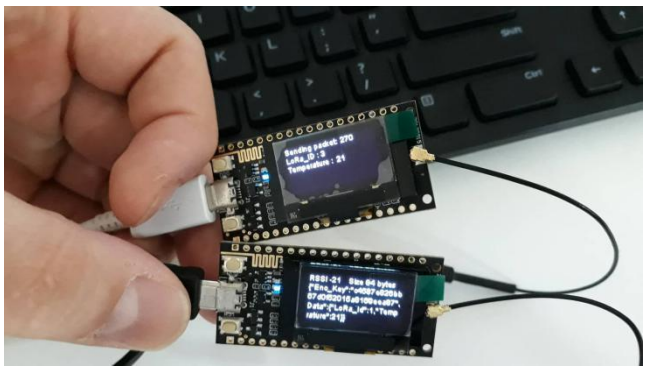

Fig. 2. LoRa devices used in the development

The IoT devices/nodes (Fig. 2) are equipped with SX1278 chip which is based on ESP32 for frequency of 433 MHz. The nodes have 16 MB on board flash memory and 0.96-inch blue OLED display, lithium battery, charging circuit, and highly-integrated CP2102 USB-to-UART bridge controller providing a simple solution for updating RS-232 designs to USB using a minimum components and PCB space. The CP2102 includes a USB 2.0 full-speed function controller, USB transceiver, oscillator, EEPROM, and asynchronous serial data bus (UART) with full modem control signals in a compact 5 x 5 mm MLP-28 package.

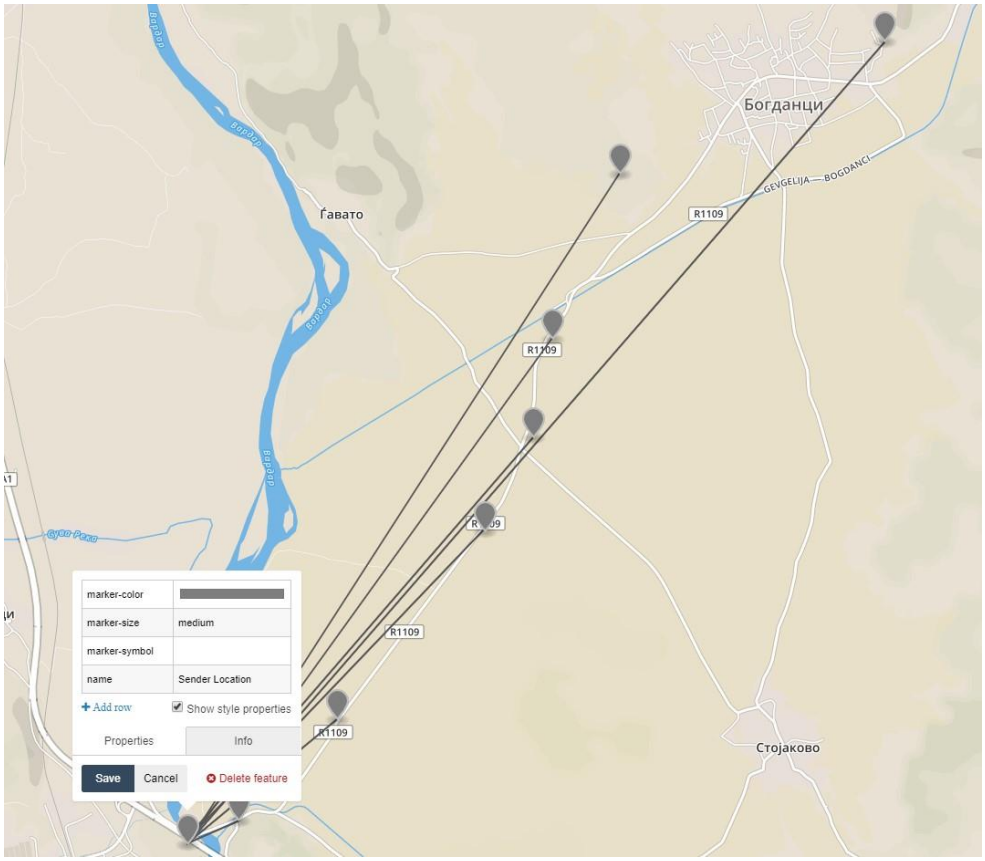

Fig. 3. Test results from non-urban environment

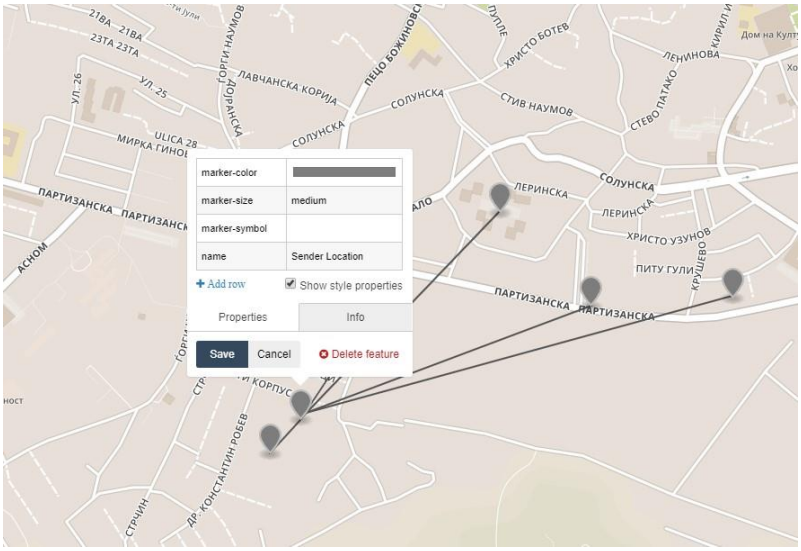

Fig. 4. Test result from urban environment

III. TESTBED

1. LoRa Sender – IoT device (Fig. 2) - get data from a sensor, generates Diffie-Hellman key, encapsulate packet and send packet over 433MHz D2D radio communication.

2. LoRa Reciever – IoT device (Fig. 2) that get data from 433MHz D2D radio communication, reads packet data and display on screen packet data and the current RSSI

3. Batteries – 3.7v 8800mAh to power LoRa devices

4. Battery Charger

5. Vehicle – To achieve desired distance

IV. DATA FLOW AND LORA ARCHITECTURE

The data flow architecture from the sender node to receiver node is designed as follows:

A. LoRa Sender

1. Generates Diffie-Hellman encryption key. Values used to generate this key are hardcoded into each device
2. Get the measured parameter from temperature sensor device (other sensors can be added easily). Constructs JSON string with hardcoded data like: LoRaID, measured temperature and the generated encryption key.
3. Send the data as JSON string via 433 MHz radio link.

This process is repeated on every sender device for n seconds that is hardcoded into each node. For synchronization, both (sender and receiver) devices use the previously defined sync word. This approach guarantee that receiver device will reject all of the packets not using identical sync word. This data later could be processed, visualized and analyzed from various aspects depending from the usage model.

B. LoRa Receiver

1. Receive the data packet
2. Read/Decode data packet
3. Measure RSSI
4. Display data and RSSI on screen

The communication between the sender and the receiver (gateway) is connectionless, similar to the concept of UDP-based communication where no acknowledge regarding the successfully received packet is sent back to the transmitter. For non-mission critical applications this approach is acceptable and in favor of bandwidth efficiency and energy conservation while in the same time support the scalability

of the solution when increasing the number of IoT devices using the service architecture proposed.

V. Wireless Link Performance Evaluation

For testing in non-urban environment, Vardarski Rid region was selected - close to the city of Gevgelija (municipality of Bogdanci). The road from Gevgelija to Bogdanci is almost a straight line, and Vardarski Rid is always in the line of sight, for any part of the road. The sender LoRa device was placed on the hill where it has the most beautiful field of vision all the way, more precisely in the coordinates of 41 ° 08 '57.0 "N 22 ° 31'17.6" E.
For testing in urban environment, we realized the measurements the city of Bitola. The sender device was placed coordinates 41 ° 01'15.4 "N 21 ° 19'24.2" E.

In an urban environment where large distortion of the signal is expected due to many obstacles, the most distant successful transfer achieved is 900 meters with the RSSI of -120. This result is very acceptable considering the environment in which the test was performed. In non-urban environment the longest distance achieved is 8800 meters with RSSI of -125.

VI. Conclusion

Considering the low-cost devices used, equipped with standard LoRa-based 433 MHz radio interface without higher-gain antenna configurations, the reliable application of such devices for non-mission-critical applications as transfer of sensor data is achievable. The functionalities of the upper layers as those in LoraWAN certified devices, for such applications could be replaced by simple software operating high on the application layer. With the data-flow architecture, proposed in this work, also the security expectations of the application are achieved, which is crucial for such non-standardized low-cost and low-complex development approach.

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Classification of Jamming Attacks and Detection and Prevention Techniques in Local Wireless Networks

Darko Pajkovski, Nikola Rendevski, Zoran Kotevski, Tome Dimovski

***Abstract*— This study focuses on the detection techniques and classification of jamming attacks in wireless networks. This is more difficult, because open nature of this medium leaves vulnerability to multiple threats. Jamming attacks often appear at physical and MAC layer but sometimes cross-layer and involves different methods and techniques. Some of these jamming techniques are surveyed to understand the problem of blocking legitimate communication by causing intentional interference in the network. In this case, there are two main aspects of jamming techniques in wireless network: types of jammers and placement of jammers for effective jamming. Various jamming detection, and localization mechanisms are studied towards detection and jamming classification. Basically, a jammer can be elementary or advanced depending by functionality. Both of these are divided into two sub-groups.**

Keywords: Jamming, wireless networks, placement of jammers, detection jammers, localizing jammers.

I. INTRODUCTION

With the rapid development of WLAN over the last decade WiFi technology and communications have evolved rapidly and have been widely deployed and utilized in both residential and enterprise networks. The growth of wireless technologies and networks over recent years have created more security vulnerabilities and resulted with more incidents and security attacks to both enterprise and customers. This type of various security threats such as jamming, flooding, collisions due to dynamic nature and node characteristics become critical issue [1]. While WiFi brings brilliant convenience to the social life, some kinds of criminal activities and attacks in wireless communication protocols and devices have significantly increased. The WiFi forensics technology has become a significant problem to be solved both in WiFi and in computer forensics.

Jamming attack is the most efficient way to stop services, disrupt the wireless communication and it is very difficult and complex to be appropriately detected. Any interferences at the transmissions on wireless networks are due to jamming attack. A jammer can easily listening the shared medium and transmitting in the same bandwidth as network, without particular hardware. Usually, attacks occur a physical layer such as radio jamming (RF) however at MAC layer; an attacker in 802.1x protocol manipulates with increasing the delay time or sending false data [2].

Jamming detection has become an important issue with main goal to improve security in wireless networks. Signal-to-noise ratio has been used to detect jamming. Jamming in wireless networks represents disruption of existing wireless communications with changing the intensity of the signal-to-noise ratio at receiver sides through the transmission of interfering wireless signals.

Figure 1 Example of wireless network

One of the key issues that make jamming a big threat is that they are easy to launch, but difficult to detect. In the case of WiFi even special devices not be needed as computers can be turned into jammers. There are several cases of jamming incidents that indicate the criticality of the issue like; cars parked near a store could not be unlocked remotely using key fobs, that showing presence of jammer attack that interrupted the key fob signals [3]. Another case involves an explosion of an oil pipeline, cyber-attacks that involved jamming of satellite communications to prevent transmission of alerts in Baku-Tbilisi. It appears that jamming will remain to be a major issue, with the growing up of the Internet of Things devices, the use of wireless communications is rapidly increasing in many fields and jamming attacks is becoming an important threat. Jamming can be done at different levels, from interfering transmission to blocking legitimate communications.

To understand how a jammer works and how to avoid jamming in wireless network, we will describe some different aspects of wireless network jamming. First, types of existing jammers and how network can be jammed in various ways using different types of jammers. We discuss in details different types of jammers, the optimal placements of jammers in order to achieve their affects. Then, it's necessary to use existing technologies to localize jammers in wireless networks. Finally, the most challenging issue is how to deal with the jamming attacks when we cannot know exactly when may start/end.

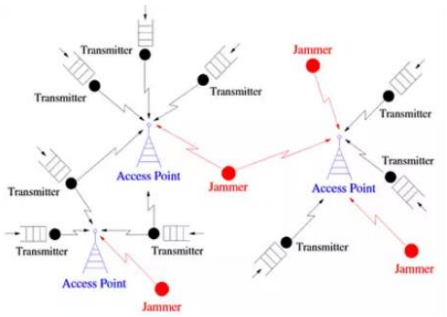

Figure 2 Jamming attacks on wireless network

In this paper we discuss for different types of jammers and their optimal placements also classification to identify the type of a particular jammer. This paper is organized as follows: Section 2 shows the security layer in wireless networks. In Section 3 we discuss different measurements that might be used to detect a radio interference attack. Section 4 describes the definition of jamming attacks and classifications of jammers. In Section 5 we give some details of how to localize jammers in wireless networks. Section 6 describes various protocols for detection and prevention of jamming attacks.

II. NETWORK LAYER IN WIRELESS NETWORKS

Network layer in wireless networks is divided into 5 layers as shown in Figure 3. Jammers launch attacks in both lower layer because it's easier to generate there, their characteristics and nature of wireless networks allow it. Characteristics are with open medium, dynamic topology and hidden terminal.

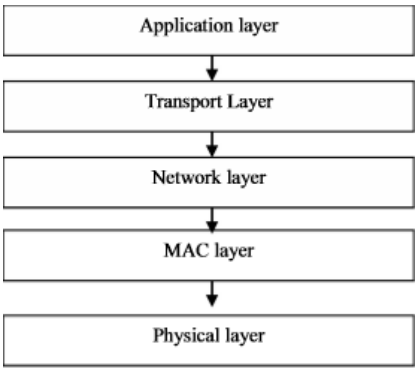

Figure 3 TCP/IP Stack

III. JAMMING CHARACTERISTICS AND METRICS

In this section, we define the characteristic of a jammer's behavior, and then we describe metrics that can be used to measure the effectiveness of a jamming attack. In this case, the metrics are strongly related to the ability of a radio device to either send or receive packets.

After numerous studies for jamming attacks, the exact definition of this type of attack remains unclear. A common conjecture is that a jammer continuously emits RF signals to fill a wireless channel, and legitimate traffic will be completely blocked [4, 5]. They may start interference as soon as it detect a transmission on the channel, and may remain quiet when the channel is idle. A jammer is purposefully trying to interfere with the physical transmission and reception of WiFi communications because all jamming attacks and their communications aren't compliant with MAC protocols. A jammer can achieve the main goal to interfere the legitimate WiFi communications by preventing a real traffic source from sending out packet, or by preventing the reception of packets. If X and Y is two legitimate participants, and Z denote a jammer, for many reasons X and Y may be unable to send out packets. One of them is that Z can continuously emit a signal on the channel so that X can never sense the channel as idle. The other one can be keep sending out packets from Z and force X to receive as junk all the time. If X successfully sends out packets to Y, but Z blast a radio transmission to corrupt the message that Y receives. The following metrics is to measure the effectiveness of a jammer:

- **Packet Send Ratio** (PSR): The ratio of packets that are successfully sent out by a legitimate traffic source to the total number of packets received. PSR is measured at the transmitter side. MAC sub-layer acts as an interface between two sides and some of the wireless networks employ some form of carrier-sensing multiple access control before transmission packets. That means that the channel must be sensed as being in an idle state for some random time before X can send out a packet. Different MAC protocols have different definitions on an idle channel, some of them compare the signal strength measured with fixed threshold, others may base threshold on the noise level on the channel. If we have many packets buffered in the MAC layer, the newly arrived must be dropped. Also, the time for staying in MAC layer is limited and packets that are too long will be discarded. If X intends to send out *n* messages but only *m* of them go through, the PSR is *m/n.*

- **Packet Delivery Ratio (PDR):** It is a ratio of packets that are successfully delivered compared to the number of packets that have been send out by the sender. We have unsuccessful delivery, if the packet that is send out by X, Y may not be able to decode it correctly. The PDR can be compute on multiple ways such as measuring at the receiver Y by calculating the radio of the number of packets that pass the CRC check with respect to the number of packets received. The other way to calculate at the sender X by having Y send back acknowledge packet. Also PDR is defined to be 0, if no packets are received.

- **Carrier sensing time:** The time a station has to wait for the channel to get idle and then start the transmission.

- **Signal strength:** The signal power that is measured on the receiver end and can be used as a detection parameter [6]. Also, there are two approaches that are used to characterize the variation in signal strength: 1) average value of signal strength in time window; 2) spectral discrimination technique.

IV. JAMMING TECHNIQUES AND FUNCTIONALITY

As we describe before, jamming attacks makes intentional radio interferences to harm WiFi communications in various ways like corrupting signal received at receivers, keeping communicating medium busy, causing a transmitter to back-off whenever it senses busy WiFi medium. Jamming attacks are mostly at the physical or MAC layer but sometimes cross-layer are possible too. In this section we describe various types of jammers and their functionality. Also, jamming effect of jammers depends on its radio transmitter power, location and influence on the network. The main goal of a jammer is to make the jamming as effective as possible. Basically, a jammer can be elementary or advanced depending upon its functionality. The elementary jammers are divided into two sub-groups: proactive and reactive. In other hand, advanced jammers are also classified into two sub-groups: function-specific and smart-hybrid.

A. Proactive jammer

There are three basic types of proactive jammers: constant jammer, deceptive jammer and random jammer. All of them transmits jamming signals all time whether or not there is data communication in WiFi network. They sends packets on the channel it is operating on or some random bits, putting all the others nodes on that channel in non-operating modes, because they doesn't switch channels, operates and performing jams on only one channel until its energy wasted.

1) Constant jammer: continuosly produces high-power noise that represents random bits without following CSMA (Carrier Sense Multiple Access) protocol. According to this mechanism, a legitimate node has to sense the status of the WiFi medium before transmitting. Specifically, the constant jammer doesn't wait for the channel to become idle before transmitting, because prevents legitimate nodes from communicating with each other by causing the WiFi media to be constantly busy. This type of attacks are easy to detect, easy to launch but can damage network commnunications to the point that no one can communicate at any time,

2) Deceptive jammer: continuosly send illegitimate packets so that the channel appears busy to the legitimate nodes. The difference between this jammer and a constant jammer is that a constant jammer sends random bits continuously while a deceptive jammer sends regular packets which appear legitimate to the receiver. The other advantage compared to a constant jammer it is more difficult to detect because it sends legitimate packets instead of random bits. Deceptive jammer is also energy inefficient due to the continuous transmission like constant jammer.

3) Random jammer: intermittenly sends either random bits or regular packets into WiFi networks. Opposite to the above constant jammer and deceptive jammer it aims at saving energy. It operates randomly in both sleep and jam intervals. It sleeps for a certain time of period and then becomes active for jamming, it acts as a constant or reactive jammer. The both sleeping and jamming time periods are either fixed or random. This jammer doesn't follow any MAC protocol. The PDR increases when the sleep interval increases and packet size decreases. The ratios between sleeping and jamming time can be manipulated to adjust tradeoff between efficiency and effectiveness.

B. Reactive jammer: The three models described above are active jammers and they try to block the channel irrespective of the traffic pattern on the channel. As we decribe before active jammers are usually effective and keep te channel busy all the time, but its also easy ti detect. An alternative approach to jamming WiFi communications is to employ reactive method. In this type of jammer is not necessary to jam the channel all time when nobody is communicating. In other words a jammer stays quiet when the channel is idle but starts transmitting radio signal when it sense activity on the channel. A reactive jammer targets on compromising the reception of a message. It is less energy efficient than random jammer because the jammer's radio must continuously be on in order to sense the channel. The primary advantage on reactive jammer is that it is much more difficult to detect than proactive jammer because the PDR cannot be determined accurately in practice. There are two different ways to implement a reactive jammer.

1) Reactive RTS/CST jammer: jams the WiFi network when it senses a request-to-send (RTS) message is received by receiver. RTS/CST jammer starts jamming the channel when RTS is sent. When the RTS message is sent from a sender, receiver will not send back clear-to-send (CST) reply because the RTS message is distorted. In this way, the sender will not send any packets beacause it belives the other side is busy with

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another transmission. In other way, the jammer can wait the CTS reply to be sent by the receiver and jams them. The result will also be the same because the sender not sending data and the receiver always waiting for data.

2) Reactive Data/ACK jammer: jams the WiFi network by corrupting the transmissions packets or acknowledgement (ACK) packets. This jammer starts jamming the channel when sense a data transmission at the transmitter end. In this case, the jammer can corrupt data packets, or it will waiting the data packets reach the receiver and then corrupt the acknowledgement packets. The result of both corruptions data transmissions and ACK messages will lead to re-trasnsmissions at the sender end. In the first way when the data packets are not received correctly at the receiver side, data packets have to be re-transmitted. In the second way, if the sender doesn't receive the ACK message it believes that something is wrong at the other side like buffer overflow and it will re-transmit the data packets.

C. Function-specific jammers

Function-specific jammers are implemented by having a pre-determined function. They can work as proactive and reactive jammers on a single channel to conserve energy or sometimes to jam multiple channels and maximize the jamming throughput irrespective of the energy usage. At one moment in time a jammer can jam a single channel not fixed to that channel, can change their channels according to their specific functionality. There are three basic types of specific-functionality jammers: follow-on jammer, channel-hopping jammer and pulsed-noise jammer.

1) Follow-on jammer: hops over all available channels very frequently about thousand times per second and jams all channels for a short period of time. The jammers in modern systems do not know the frequency of next hop. These jammers are able to follow even a pseudo-random frequency hopping sequence, because after the transmitter hops away from the previous frequency, the jammer scans the entire band in search for the new frequency and starts to jam there. Increases hopping rate doesn't change the bit-error-rate of the communications signal and that is an advantage on follow-on jammers. Due to its high frequency, hopping rate is more effective against same anti-jamming techniques.

2) Channel-hopping jammer: can listen to and jam a single channel at a time and hops between different channels proactively. The jammer can determine instantaneously when it has hopped to some channel on which legitimate communication exists and then immediately jams this channel. This type of jammer has directly accessed to channels by overriding the CSMA method provided by the MAC layer. Characteristically for this type of jammers is that it can jam multiple channels at the same time. The jammer can check j channels in time $t\,j$. If we have a total of L channels the probability that the jammer has hit the right pseudo-random sequence after checking j channels is j/L for all $0 \leq j \leq L$.

3) Pulsed-noise jammer: is similar to the elementary proactive random jammer because can switch channels and jam on different bandwidths at different periods of time. Another advantage and similarity with random jammer is saving energy by turning off/on according to the programmed schedule. This jammer just like previous one can attack multiple channels and it can be implemented to simultaneously jam them.

D. Smart-hybrid jammers

The main goal of these jammers is to expand their congestion effect in the network they mean to jam. The name smart-hybrid comes from their power efficient and effective jamming nature. They also pay attention of themselves by conserving their energy. Additionally, they spend significant energy in the right place to hinder the communication bandwidth for the complete network or a major part of network in enormous systems. Every of this kind of jammer can be implemented as both proactive and reactive jammers.

1) Control-channel jammers: work in multi-channel networks by targeting the control channel to coordinate network activity [6]. If the jammer captures the hopping sequence of a compromised node, then by design this node can be identified. In this case the effectiveness of a jammer who gets knowledge from compromised node becomes unique to the effectiveness of a jammer who hops randomly between channels. Furthermore, future control channel can be obtained from the compromised nodes.

2) Implicit jamming attacks: are used the rate adaptation algorithm in WiFi networks, where the AP (Access Point) worries to the weak node by reducing its rate. During to this process the current AP spends much more time communicating with this weak node than the other nodes. When the jammers of these types jams a node which is communicating with the AP, the focus from the rate adaptation effect falls down on the jammed node while causing other clients to wait and suffer.

3) Flow-jamming attacks: can involve several jammers throughout the network to jams packets with purpose to reduce traffic flow. These attacks are launched by using information from the network layer [7]. There are two jammer models with centralized control and non-centralized model. The

first model with centralized control, minimum power to jam a packet is computed then the jammer acts accordingly. The second model a non-centralized, where each jammer shares some information with neighbor jammers to increase efficiency. In Table 1 we summarize the features of all the above jamming technique. We represent every type of jammer in this table, is it a proactive or reactive, energy efficient or not, and their ability of jamming single or multiple channels. Also, there are some jamming approaches that combine multiple of these techniques such as implementation of a single-tone reactive jamming [8], using the variations of jammers to analyze the performance of the best jamming approach in 802.11 networks [9]. In other hand, the [10] are using combination od jammers (reactive/random and multi-channel/pulsed-noise) and resulted with obtaining interrupt jamming, pulse jamming and scan jamming.

Jammer	*Proactive*	*Reactive*	*Energy efficient*	*Single channel*	*Multiple channels*
Constant	×			×	
Deceptive	×			×	
Random	×		×	×	
RTS/CTS jammer		×		×	
Data/ACK jammer		×		×	
Follow-on	×		×	×	
Channel hopping		×		×	×
Pulsed noise	×			×	×
Control channel	×	×	×	×	
Implicit	×	×	×	×	
Flow-jamming	×	×	×	×	×

Table 1 Classification of jammers

V. LOCALIZING JAMMERS

In this section the focus falls down on localization approaches and positioning of jammers. The localization approaches are divided into two groups: range-based and range-free. There is few work in this area because is very difficult to locate a jammer. Current techniques are described below:

- **Centroid-based schemes** [11] estimate the position of a jammer by averaging the coordinates of the jammed nodes. If the jamming has been detected, all affected nodes are marked as jammed and these nodes have information about their coordinates. In distributed network, better estimation can be obtained with increasing the network density. In this case if we increase network density the most probably is that jammed nodes are evenly distributed around the jammer.

- **Virtual force iterative approach** starts with a coarse estimation build upon the centroid scheme [11] and then re-estimate the jammer's position until is closely to the true location by computing the push and pull virtual forces. The real jammed region contains all jammed nodes but none of the boundary nodes. The virtual-force iterative approach will stop computing when the estimated jammed region covers all jammed nodes and all boundary nodes fall outside of the region.

- **Geometry covering based localization** is similar to centroid approach because computes the convex hull instead of the centroid. Then, uses the computed geometry to estimate jammer location from the convex hull [12]. Technique of finding the smallest circle completely contains a set of points given by the convex hull is to approximate the location of the jammer with high accuracy.

- **Light weight jammer localization** is gradient-based scheme with computing the PDR value [13] of two sides (sender and receiver) as a product of probability. The first computed probability is that the sender sensing the medium idle, then second is probability that the receiver will receive the data sent to it, and the third is probability that the sender will receive the ACK message. All third probabilities are computed independently by sending messages to its neighbors in order to obtain PDR.

- **Exploiting neighbor changes** [14] are using the least-squares (LSQ)-based algorithm to locate the jammer. The jammer's location is computed from the initial hearing range of the node and changes of node's

hearing range. The assumption is that the initial value is known before the jammer starts computing. The equations of the algorithm are equal to the number of nodes whose hearing range changes and they are computed simultaneously.

VI. DETECTION AND PREVENTION OF JAMMING

Jamming is a very harmful and destructive attack, it is essential to have operative detection and recognition and necessary countermeasure against it. In this section we discuss some of existing schemes for detection and recognition jamming of basic types of jammers. For methods of detection and recognition we investigate the operational form specific, metric, overhead, charge, cost and implementation difficulty. Moreover, for this types of detection, countermeasure we examine the condition of network type and whether is knowledge required.

- **Ant system –** an evolutionary algorithm for recognition jamming [15] at the PHY layer and redirects communications to an appropriate destination node. It communicates a suggestion to test whether a DoS attack is true or not. By creating an agent traverse the network iteratively, the Ant system collects the information for multiple routes to a destination. The information collected is then stored in a list and will be used for redirection. Also, the information on energy and expanse are used to be sure of whether jamming is identified or not. The detection of jamming is true or not is based on checking the metrics like SNR, PDR, BER, energy, expanse, packet loss and putting them into a decision model. Then the system calculates the values between two given nodes and check probability is within a certain threshold, otherwise the network is jammed.

- **Channel searching and spatial retreat** provides migration to alternative channel when a jammer within range and lumps communication on a particular channel [16]. On other hand, spatial retreat moves mobile nodes from the location where they involve jamming to another safe location. The authors [16] investigate three situations: two-party communication, organization and networks. Here, the detection may be conducted at MAC layer using CSMA. On the validation of a jamming recognition channel changing or spatial retreat process is accomplished.

- **Hybrid system** is a mixture of anti-jamming defense techniques: base station repetition, base station evasion and multipath routing between origin paths [17]. The base station repetition implies that multiple simulated base stations are existed in the network. Evasion scheme denotes to the spatial retreat of a base station when jamming is detected. Multipath systems occur when there are multiple data paths between a node and a base station.

- **Game theoretic modeling** uses a clustering algorithm to recognize whether a node belongs to non-jammed cluster or jammed cluster based on the RTS, data, carrier sensing failure count or network allocator significance [18]. Game theory necessitates two players: the jammer and the display nodes. The determination of jammers is to maximize the denial of wireless channel to access the appropriate users while sincere nodes try to exploit their communication output. Display nodes use cross layer features for recognition of constant jammers by sensing the medium and for detecting of reactive jammers by typical retransmission rate of RTS/Data packets. This kind of nodes can act continuously or periodically.

- **Channel hopping** or switching from one station to another is the most popular countermeasure to jamming. Proactive channel hopping is the modest implementation. Multiple variations of channel hopping are present in [19]. The authors improve the effectiveness and efficiency of channel hopping by creating it sensitive, adaptive and code-controlled. In proactive channel hopping the present communication channel is altered after certain duration of time. This happens regardless of whether or not there is jamming.

- **Control channel attack prevention** in a wireless network manages channel custom where multiple channels are used to increase the network ability. To avoid jamming the authors in [6] purpose several bunch whereby each of them preserves its own control channel with a single hopping structure. At the advanced network level a jammer can jam the control channel by enchanting data from a compromised node about the protocol mechanism and cryptographic quantities. A jammer's capability to positively regulate the upcoming control channel from previously detected information is measured in evasion entropy.

- **Cross-layer jamming detection and migration –** can be completed either at the PHY layer or MAC layer; very infrequently it is done on the higher layers. There are certain circumstances where jamming detection is done using cross-layer approaches. The algorithm is created on PHY layer but usually uses the upper-layer security devices. A three-based approach is used to form the irregular hopping pattern. Any user can interpret the message the message transmitted by the sender using accurately one hopping pattern. When the jamming is detected the cover is detached and both the children of that root are added to the shield. The

detection of jamming will be done when the source uses additional test designs during its transmission.

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Security In Cloud-Based Systems

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Abstract - Cloud computing is amongst the most used computer architectures nowadays, cloud computing enables users, companies and every other entity to store data, process data, deliver software on demand, create new apps and services, stream audio and video and many more. However, there is a need for a high security standard that will prevent from security breaches and other types of malicious applications. For example, the data stored in the cloud needs to be secure and confidential also preserving integrity. In this paper we will present the issues and security problems that appear in this type of services and we will focus extensively on the security of the cloud services.

I. INTRODUCTION

These Cloud computing is amongst the most used services nowadays; many companies rely on the services provided by cloud computing architectures, many small and medium companies will start to adopt the cloud computing model in their companies in order to provide services such data storing and data management [1], most of the apps in some of the companies or small businesses run on the cloud, most of the users use the services provided by cloud computing architectures. The main target of the companies is maximizing their profit and focusing less on the IT infrastructure, this is a perfect example for the increased demand for the cloud computing. Cloud computing consist of many technologies like virtualization, web and many more. Cloud computing also provides efficient data retrieval. In this paper we will discuss the implementation of security architectures, services, methods and other data integrity techniques.

II. CLOUD SECURITY

Cloud computing provides a lot of benefits for the users as we previously mentioned in the introduction section of this paper, and that arises the question for the security of the cloud computing services. In cloud computing, security is a broad topic. Cloud computing security consists of many different architecture, services and types of data protection methods. To simplify the most critical issues in the security of the cloud computing are: data breaches, insecure interface, malicious API's, malicious insiders, DoS (Denial of Service) and DDoS (Distributed Denial of Service) attacks.

In the section below, we discuss several of the factors that were mentioned before in this paper:

A. Physical factors

Many companies nowadays rely on the cloud computing; however, we shouldn't eliminate the risks and hazards that can appear as results from natural disasters, there are several physical factors that may contribute to data loss, events like: fire, earthquake, floods [2].

B. Malicious Insider/s

Malicious insiders are people who work at a company who also have authorization to gain access to services as managing databases, administrators of the systems, partners that offer cloud computing services [3]. Companies or organizations cannot easily detect or prevent these scenarios from happening since it is hard to detect if the employee that has a certain access to critical data, however this can be improved by encrypting the critical data and by encrypting the data we somehow eliminate the risk of "malicious insiders".

C. Infected APIs

APIs enable the user to communicate with the user and APIs provide necessary tools which the clients or the users can communicate or manage data.

Many solutions proposed by CSA [4] to avoid insecure interfaces and APIs which include:

- Analyzing the security model for interfaces of the cloud provider.
- Making a strong access control and authentication when data is being transmitted.

D. Denial of Service

Number Every cloud computing has its own resources, there are specific companies that need the resources of their software or their product available at a specific time, the attacker might use all the available resources at that specific time and for the user that might present a problem since the speed and the responsiveness time will be significantly slower.

E. Hijacked account

The username and the password might get stolen or compromised by a misuse or a virus on the client side. The hacker or the hijacker might use the stolen username and password to change the data that are in cloud system or it may sell the information to others. To prevent this from happening it is recommended to use two factor authentications, to also monitor the activities, to implement effective security policies.

III. SECURITY METHODS

Another effective method is to use a Hardware Security Model, this module prevents both physical and logical attacks also the hardware is specialized to generate and perform cryptographic operations and keys. Cryptography is an essential tool in secure processing when we have and architecture that connects with other cloud architectures [12].

Data is often stored in the cloud, which is untrusted because it is in a domain where security is not managed by the data owner, in this case data security has to be given more attention. When more than one entity wants to share data, there has to be a mechanism to restrict who accesses the data [15]. Techniques were proposed to keep data content confidential and keep unauthorized personnel from accessing and disclosing the data by using access control while permitting many authorized entities to share data [4]. In this following part we have:

- Public Key Encryption

Public key encrypts data using public key. The owner of the private key or the person who has the private key can decrypt the data. Many issues that make this way hard to apply in the cloud when many people need to access those files.

- Identity-Based Encryption (IBE)

Identity-Based Encryption the owner of data can encrypt his data by specifying the identity of the authorized entity to decrypt it based on that entity's identity, which must match the one specified by the owner. Therefore, there is no key exchange [4].

- Attribute Based Encryption (ABE)

In attribute-based encryption, an identity of a user is identified by a set of attributes. This set of attributes generates the secret key. Also, it defines the access structure used for access control. This access control is using encryption to encrypt data for confidentiality and share it among group of users. It is a kind of integrating the encryption with the access control.

Cloud computing now is moving to multi-cloud computing because of security issues stemming from using a single cloud such data availability.

IV. DATA INTEGRITY

Another key aspect of cloud computing security is the data integrity. Checking the integrity of the data can be done either by the client or third parties [14]. One of the methods is to download the data and then check the hash value in this way, a message authentication code algorithm is used. The second one is to compute that hash value in the cloud by using a hash tree. In this technique, the hash tree is built from bottom to top where the leaves are the data and parents are also hashed together until the root is reached. The owner of data only stores the root. When the owner needs to check his data, he asks for just root value and compares it with the one he has [11].

A. Third Party Auditioning

Third Party Auditor (TPA) is a person that has skills and experience to carry out all auditing processes such as in the picture below. TPA scheme find great use for checking the data integrity.

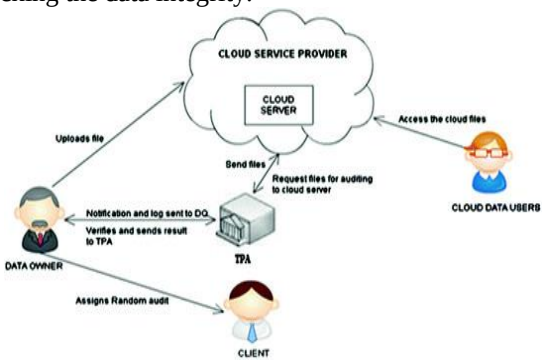

Figure 1. TPA illustration

The owner has information about all the data that are stored in the server. In the picture below is represented a scheme in which the data proofing is presented. This scheme includes the data owner in the auditing process. First, PA uses normal auditing processes. Once they discover any modification to the data, the owner is notified about those changes.

B. Proofing Retrievability

Proofing retrievability is a cryptographic method to check if data can be retrieved from the cloud. Method of proof of retrievability is done by taking the hash of block using a hash function. Owner of data has the hash values of the file by using keyed hash function. After the receiving of hash values, the owner of the data needs to keep the key and the hash values. the data owner sends the file to a remote server. When the data owner needs to check his data retrievability, he sends his key and asks the server to send the hash values by using his key in order to compare them with the hash values that data owner has.

V. SECURITY CLOUD SERVICES

Security Access Point - One of the components that is needed as an extension of the functional architecture is Security Access Point (SAP). SAP is a cloud server providing front-end security service. The first service, which is important before any access to a cloud is allowed, is authentication of users. Authentication must be based on open standards and without pre–arrangements (to be applicable in an open environment).

We used challenge-response authentication protocol based on the FIPS 196 standard [5]. The standard requires the use of public–key cryptography, therefore for the first, identification message in the FIPS 196 protocol, we use client's certificate. Public–key cryptographic operations on a client side are performed using PIV–compliant smart card, so client certificate is in fact stored in the card. The first component of the SAP is therefore Strong Authentication Server providing strong authentication service.

In addition to authentication between a client and the SAP server, we also use single sign–on protocol. The standard to be followed for this service is Secure Assertion Markup Language (SAML) [6]. Therefore, SAML Server and single sign–on authentication is the next component and single sign–on is the next service provided by the SAP server. SAML ticket is also stored in client's smart card.

Finally, after a client has been authenticated and SAML ticket has been issued, the final service before allowing the user to access any Application Servers is authorization. SAP must verify that a client and his/her request are authorized to access internal cloud resources. Authorization is based on the XACML standard [7]. The standard specifies two core components for enforcement of authorization policies: Policy Decision Point (PDP) and Policy Enforcement Point (PEP). Therefore, PEP Server and authorization enforcement is the final security service provided by the SAP server.

IDMS is X-500 compliant server that is used to store registration data for all local resources in a cloud. Data for users registered in the cloud is going to be stored in that server. In other case, user registration data may be stored in IDMS server which is located in users' home environments. In that case, those servers and security servers in the cloud must be federated. Federation will be accomplished as binding of X.500 directories, as Microsoft forest of domain servers (Active Directories), as distributed database, or using federation protocol for Web services. Since cloud should also support open access, even by users being registered in other clouds, binding between IDMS Servers located in cooperating clouds must be performed as a prerequisite for federated secure cloud architecture. Besides binding of IDMS servers, in case of multiple clouds, federation must also be established between authorization policies. In a single cloud PDP is the server maintaining XACML authorization policy and performing verification of access requests on behalf of a SAP server that acts as a PEP Server. So, in a federated environment, authorization policies maintained by individual PDP servers must be synchronized. Synchronization is performed using federation protocol and it covers both aspects – syntactic (dictionaries) and semantic (rules) synchronization.

Finally, CA is standard Certificate Authority Server. For the purpose of scaling, CA Server must be linked into a large–scale Public–Key Infrastructure (PKI).

Therefore, security components and architecture for cloud computing environments are shown in the picture below.

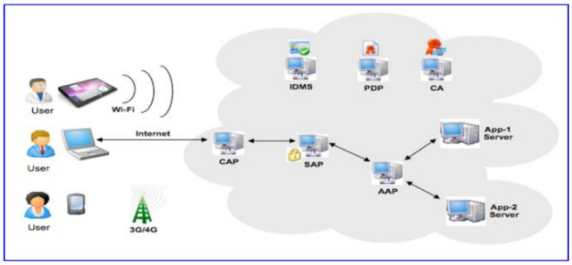

Figure 2. SAP illustration

VI. Conclusion

As we previously mentioned cloud servers and cloud services are more and more widely used amongst user, companies, etc. On daily basis there is more demand for cloud computing, cloud computing is unavoidable, it has also caught the attentions of many customers, businesses. Many of the businesses rely on cloud computing since cloud computing provides benefits, some of the benefits that cloud computing provides are: reduction of costs to run software, also companies spent less time in maintaining their software and it also enables the companies to focus on their business rather than spending time to maintain or create their services. Some of the users of the cloud computing services are skeptical about the security of the data that is stored on the cloud computing services, because of that security is amongst the most important aspects of cloud computing, companies should take seriously this aspect since the security of their data rely on the implementation and the good habits of creating and managing cloud servers and cloud services [10]. The aspects of encrypting the data and protecting the data from theft or corruption is amongst the most important aspects that the provider od the services must fulfill. In this paper we also covered some of the aspects that can be used to protect the data integrity and retrievability.

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Fundamental aspects of creating a predictive model - GIS in archeology

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Abstract –The application of geographic information systems in archeology is not a new issue in the archeology world. It has been used since the creation of the geographic information system. Predictive modeling of a new potential archeological site is the main focus of this research. Predictive modeling with the help of machine learning is the winning combination in this case. Geographic information system can also, find application in preserving cultural heritage, visualization, and mapping important historical information. In a world where ancient cities are destroyed from natural catastrophes or terrorist attracts the preservation is becoming more present. On the territory of the Republic of Macedonia, there are many archeological places, known and unknown. Our goal is to predict an archeological settlement from an ancient or Roman period between the cities Bitola and Ohrid, or where the road Via Egnatia used to be.

I. INTRODUCTION

Decisions based on the location are made all the time. From ancient history, people were deciding where to build their home. The location was crucial for their existence. Businesses now are making the same decisions such as where to build a new factory. The location is important in every aspect of our lives.

A geographic information system (GIS) is a system that deals with geographic data. With the help of tools, it can store, manipulate and analyze spatial data. GIS find their implementation almost in every discipline such as science, business, industry, health, climatology, natural resources, archaeology and many more.

The subject of this research is the application of GIS in archaeology. Archaeology is the study of the past human behavior. The usage of GIS in archaeology started with the development of the GIS. Archaeologists acknowledge the importance of GIS since its beginning.

The application of GIS in archaeology is in the following areas:

- Cultural resources management
- Excavation
- Environmental archaeology
- Computational archaeology

Predictive modeling is what it makes the archeology such an interesting subject. Finding new potential site locations is a dream of every archeologist. At the beginning, the scientists relied on the facts and on their intuition, but today they have various tools available. GIS is the most used system in the archeology, proving to be very useful. GIS allows organizing all the data and their visualization, and also, in combination with the right predictive model it can be a revolutionary method for discovering new sites. Predictive modeling in archeology means cutting the costs of the excavation to the minimum.

A. Cultural resources managment

Cultural resource management is the management of cultural resources such as heritage and the arts. But, it can go further and it can be involved in other areas such as languages in extinction, folklore, architecture, and archaeology. This terminology in the context of archaeology is often called rescue archaeology. This occurs when an archaeological site is about to be destroyed. Unexcavated sites are in danger, especially in urban areas. For that reason, archaeological pieces of evidence that are found in the ground should be represented on a map. Is very important even the smallest discovery to be acknowledged.

B. Excavation

This is a rather wide area. GIS in excavation can be implemented in different stages of the excavation process. The most important and used one is before the whole process of excavation even begins. Usually is used to confirm that in that area is indeed the targeted archaeological site. But can also be used during the whole process of excavation. It is used also for site analysis, recording, processing, and visualization of all data. It is very useful to put all gathered and processed data from the excavation into the GIS.

C. Enviromental archeology

Environmental archaeology is the science that studies the connection between the past societies and the environment they lived in. First, it tracks the changes that occurred in the environment during a long period of time. It is logical that the environment will not be the same thousand years later. Earthquakes, wars, droughts are changing the environment. All of these changes should be registered.

The other focus is on the use of past use of plants and animals. Using animal remains and macro-remains from the plants, these studies provide information about a past life. These include also a research of the resources that are

found at the archeological site. Wood, stone, clay, tools, soil and all natural resources that are found, provide useful details.

D. Computational archeology

Archaeologists work with a lot of data. It is difficult to manage all the information without using some help. That is why they started using software application. This term is mostly used for applying some mathematical methods in order to provide useful information. Computational archaeology can be used also to replicate an entire archaeological site. Computational archaeology includes GIS in spatial analysis. Scientists referred to computational archaeology as knowledge building.

II. PRACTICAL USE OF GIS IN ARCHEOLOGY

There are many examples of successful implementations of GIS in archaeology.

The multiplicity of applications of GIS in archaeology is due mainly to the growing interest of archaeologists in modern methodologies for archaeological data management, where research has been performed by topographic, photogrammetric and remote sensing techniques. GIS is becoming a fundamental tool for managing, sharing, analyzing and visualizing spatially referenced data and they are completely substituting the traditional techniques used by archaeologists, based upon filling out forms, graphics and other paper documents [1]. In the modern global society, where mass media such as the Internet is dominating, the issue of utilization is becoming very important, so, most of the recent GIS applications (Multimedia GIS, WebGIS) take this aspect into consideration.

Some of the scientists go even further talking about spatial thinking [2].

GIS in archeology can find a useful application in the following areas:

- Preserving cultural heritage, especially nowadays, when terrorists are destroying ancient cities and natural disasters are more present.
- Data management -dealing with a huge amount of data is possible only with a system that can easily organize them. Processing all the data and visualize important information was the first purpose of building a GIS just for the archeological purpose.
- Landscape studies - landscape change over time. Rivers, lakes, even seas or others bodies of water can disappear over time. The situation is the same with the quality of the soil, the urbanization. Keeping information and showing landscape changes on maps can provide useful information.
- Visualization and data representation. Sometimes just placing all useful information on a map gives a new perspective. All data in archeology have many attributes. That means a single spot on the map will have a lot more meaning than just a coordinate number. It can represent a settlement, a tomb, a religious building and a lot more. Also, they are divided by the century they represent. The place where they can be found can have a meaning, too. Whether it is located near a body of water, a river, a hill or a mountain, each can have a meaning, too. That is why it is important all of the characteristics to be represented on a map.
- Saving time and resources. Not only that all data can be found quickly, but also the information that is provided saves money and other resources.
- GIS also has the ability to predict potentially new archeological sites with a help of machine learning

A. Protecting archeological sites from an oil spill in Washington

There are 29 federally recognized tribes in Washington. Many of the archeological sites are located near the coast. To protect them from any potential damages such as the oil spill, the Washington State Department of Archeology and Historic Preservation created a GIS for this purpose. On a map, the location of the tribes is marked and there you can find information such as the contact from a tribal staff (Figure 1). So when the oil spill occurred, the map located all the tribes around the affected area and alarmed them. [3]

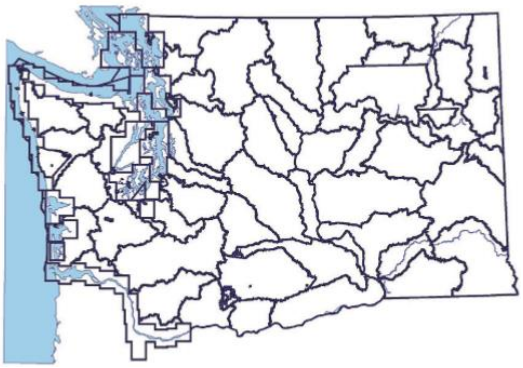

Figure 1. Image of a GIS layer of an oil spill response plan.

B. Predictive modeliing using GIS

Predicting a new potential ancient location is what archeologists want to do. Using their knowledge of a certain region, information and data they begin to explore the area. So to cut the expenses and to optimize the time and the effort archeologists turn to GIS.

The idea is new potential sites to be discovered by GIS with an application of intelligent agents. The machine learning uses training data to learn the behavior and discover new patterns. So that's what Bjoern Menze and Jason Ur did. [4] They recognized this potential.

Using satellite images of places that have archaeological sites and places that do not have sites they started the training. They concentrate the research on the Syrian sites. They trained a classifier to recognize the spectral signature assuming that the discovered archaeological sites have common features (Figure 2).

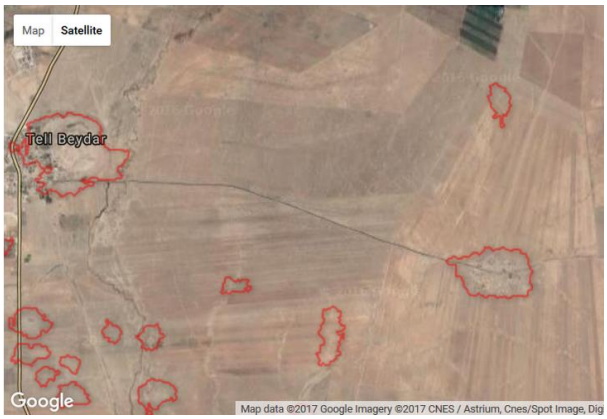

Figure 2. Image of a few potential sites represented on a map.

At the end, they correctly predicted 94% of the sites that have been identified. Also, they additionally predicted 14000 new potential places. Currently, the focus is to decrease the classifier's predictive errors.

C. Implementation of GIS in archeology in Macedonia

Republic of Macedonia is a country with a huge history. Unofficially it has nearly 5000 archeological areas. Officially it has more than 1000 registered archeological sites. For a small country that means it has an archeological areas almost everywhere.

Archeologists in Macedonia started using GIS very recently. They mostly used it to create maps, to preserve information and data and to classify archeological sites. But in terms of using predictive modeling we are still at the beginning.

This research, is a scientific and both practical effort to show how the predictive modeling can be used in the Republic of Macedonia. Using a preview of ArcGIS and working in Google Earth Pro we predicted a potential new site. [5]

D. Methodology implementation and discussion of the results

The practical research was done using Google Earth Pro where we entered spatial data. First, we choose a region. We wanted to know if we can find an archeological place in Pelagonia. Pelagonia is the name of a geographical region in Macedonia. It is located in the south-west and is the biggest structural basin in the whole country. We collected information about the already known archeological places in this region.

But, we had difficulties since there were too many of them. So, in order to narrow the choices we choose a period. We chose the ancient and Roman period. We find the coordinates of all archeological areas of this period using the website https://www.latlong.net/. Entering all the data into the map was easy but it takes a lot of time. By entering the coordinates and the name of the region, the archeological site appeared on the map.

When we put all archeological sites in this region we noticed that they all of them are near the path between Bitola and Ohrid. In this place was the road Via Egnatia.

Previous researches showed that ancient people build their homes near rivers or other bodies of water. Between Bitola and Ohrid, there is a river called Leva Reka (Figure 3). In this area, there are two archeological sites: StaroSelo and GornaCrkva. StaroSelo was a settlement from middle age. But, that period is out of our research focus. The other archeological site is not in the researched area where were found two pithos from the late antiquity. Pithos are big containers for bulk storage. People used them to store food, fluids or grains. This period is what we are looking for. The presence of the pithos shows that in this area there was a settlement or maybe even a larger city. This area was not researched because they stopped the excavation for financial reasons. The priority was on different places and there were no more resources for further excavation. But, looking from a different perspective now this place could hide more than it shows.

Another significant attribute of this place is that is surrounded by seven hills. People in the ancient period used hills as a protection of vandals. Also, this area has fertile soil, which is one more characteristic that there have been ancient settlements there.

Figure 3. Image of Leva Reka represented on a map.

Taking this into consideration we are confident that the future GIS that should be built for this purpose should recognize this area. Also, it would give a certain percent of error. Knowing the positive or the negative rate helps the scientists to make an informative decision. If we got a high percentage from the system archeologists can take further steps and start an excavation. Or, if the outcome of the research comes with a small percentage then it could be better to discuss further this. Taking into account that the excavation cost a lot of money it turns out that building a predictive model is becoming a useful tool for reducing the costs. Also, having a high percentage of possibility of having a settlement and being ready to start to excavate is attracting new potential investors. Although, it must be taken into consideration that no system can have a hundred percent certainty when human factor is in question. [6]

III. CONCLUSION

Building a GIS for the archeology in Macedonia would be a long process but on the long run it would pay off. In this case, the benefits will be bigger than the expenses.

IV. FURTHER REASEARCH

Predictive modeling with GIS has already showed to be useful. But, since the technology is improving every day the opportunities became endless. 3D GIS is the newest trend, ESRI already builds a 3D interactive web application [7]. 4D GIS is also an option, with the fourth dimension being time. 3D GIS are already used in many modern researches but archeologists are skeptical believing that 3D GIS will give the same results as 2D GIS. The main purpose of GIS in archeology is processing data and visualizing them in a way that they can be useful. Old school archeologists even go further saying that 3D takes the focus from the big picture. The studies so far show that 3D GIS are most useful in the representation of landscape changes.

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