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Semantic Web as an Enabling Technology for Better e-Services Addoption

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***Abstract*—**E-services have significantly changed the way of doing business in recent years. We can, however, observe poor use of these services. There is a large gap between supply and actual e-services usage. This is why we started a project to provide an environment that will encourage the use of e-services. We believe that only providing e-service does not automatically mean consumers would use them. This paper shows the origins of our project and its current position. We discuss the decision of using semantic web technologies and their potential to improve e-services usage. We also present current knowledge base and its real-world classification. In the paper, we discuss further work to be done in the project. Current state of the project is promising.

***Keywords*—**E-Services, E-Services Repository, Ontologies, Semantic Web

I. Introduction

E-SERVICES (IT-supported services, e-services are typically available via a computer network) market has grown considerably. In the case of the Republic of Slovenia, this is also clearly stated in European Commission report for digital economy i2010 [1]. Although the report is limited to e-government services, it also gives a good insight into the whole area of e-services. E-services selection is satisfactory to both businesses consumers and individuals. However, we can observe poor use of these services: e-services are used in less than three quarters of businesses consumers and only little over quarter of individual users [1].

Obviously, there is a large gap between supply and actual e-services usage. This is why we started the project "Ontology-based E-Services Adoption Improvement". Its aim is to provide an environment that will encourage the use of e-services. We believe that only providing e-service does not automatically mean consumers would use them. To use e-services effectively, users should primarily be aware of an e-service existence, or they should be able to find them easily. Furthermore, users should know how to use e-services easily or how to connect them in a logical sequence. In real life situations it is very rarely that we encounter situations that can be supported only with one e-service. The project is primarily focusing on e-services that are addressing individuals. However, the project results are expected to be directly useful for business users also.

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In order to reduce the gap between supply and use of e-services, we are proposing an appropriate method of formal presentation of knowledge about e-services and applications on this basis. We believe that formal notation is necessary to improve the use of e-services significantly. At the same time, we will ensure that the new notation will not demand any additional activities of e-services users or providers. To enable our methodology, we have built a prototype platform. It allows users to use advanced components, such as intelligent proposing component to discover appropriate e-service or combination of them. System will also allow verification, if there is any alternative e-service or a collection of e-services to be selected.

This paper is presenting current state of the semantic web-enabled platform, its core structure and the potential for improving e-services adoption. The current e-services set, collected in the Republic of Slovenia, is also presented.

II. Related Work

The gap between the high level of offering and low level of e-services usage has been detected and tried to be addressed by many authors. The problem is not local, since it is observed throughout the European Union and in other IT developed countries.

[2] notes that despite the high presence and the high growth of companies and individuals on the Internet (almost 90% of businesses and a slightly less number of households) and high availability of e-services (at the European Union level there are as many as 60% of all government services available as e-services), the usage is lagging behind: 80% of the companies still have not received any orders over the Internet or used e-services in another way; in addition only less than 7% of companies are realizing at least 10% of their business through the use of e-services. Author is deriving from the thesis that two main reasons for that situation are poor quality of e-services and their poor acceptance among users. On this basis the author is proposing appropriate guidelines to increase the quality and acceptance of e-services.

[3] is proposing a strategy on how to raise the level of e-services in the European Union by 2012, as this is also one of the priorities of the European Union. Author explores the area of how to increase the usage of e-services through legal means. The governments are trying to impose certain e-services in the form of legal requirements. The author notes that in most cases the use of e-services is still a matter of a user decision.

[4] is proposing the use of specific vocabulary, based on ontologies, which allows intelligent search and automatic

integration of services on the Internet. The author is limited only to online services in the technical sense ("pure" Web services with software interface and without user interface).

Certain authors have already partially addressed the search of the e-services. [5] are exposing that just indexing keywords cannot serve for searching the appropriate e-services. Therefore they propose the statistical ontological matching of e-services. This could have been a basis of intelligent e-services inquiries. The study is interesting because the authors are not limited to Web services, but to e-services as a whole. However, they request a specific e-Service interface (OWL-S).

There are also more tries of using ontologies as a helping tool. For example article [6], which proposed the ontological description of Web services. For each domain it suggests its own ontology, which provides a basis for Web agent's search for appropriate e-services. Thus, accumulated knowledge can be used to facilitate the search of e-services. Author addresses only the collection of data about services in certain domains, and does not address the search of e-services.

III. E-Services Representation With Ontologies And Semantic Web Technologies

In philosophy, ontologies allow inter-linking and formal description of concepts in any area of human involvement. In computer science, the term ontology has much narrower meaning. With the help of ontologies, we can do advanced classification of individual information elements. We can also interconnect them and create an arbitrary metadata system [7].

The term ontology is mainly used in the field of knowledge management - specifically for classification of individual information objects. There are also simpler and less capable classification methods (e.g. controlled vocabulary, taxonomy, and dictionary). Ontologies not only allow hierarchical and network links between information objects, but also allow specification of axioms, rules and other restrictions for specific information object. One of the most important capabilities of ontologies is the ability of interconnecting objects with arbitrary relations. They allow ontology to formally describe knowledge.

The main advantages of using ontologies are as follows:

- Ontology based formal descriptions are easily processed by a computer and are thus suitable for automated processing.
- Transformation of mathematical notation to a user friendly output is easy to achieve.
- Semantic Web technologies, as a technological foundation for ontologies, are standardized and the adaptation rate is increasing rapidly.
- Knowledge sharing from a technical viewpoint as well as from a conceptual viewpoint is basically achieved automatically.
- Ontology based data is distributed by default.
- There is a wide range of tools that are supporting technologies from the Semantic Web stack.

Ontology as a conceptual foundation in the project has been chosen upon following reasons:

- We want to achieve greater degree of connectivity with existing formal notations and other solutions.
- We want to establish extensible and standard design for intelligent solutions.
- We want to establish a simple mechanism for capturing expert knowledge.
- We want to establish a simple data transformation mechanism.
- Notation and the platform should support automatic exchange of knowledge.
- They allow relative simple machine processing of knowledge.
- We want to support existing formal notations for representing knowledge about e-services.

Semantic web techonologies, which are supervised by the W3C consortium [8], are represented as a stack of standards which allow use of ontologies from a technical viepoint. One of the core components is RDF (Resource Description Framework), which is based on the markup language XML (eXtensible Markup Language). Concepts in RDF are denoted by URIs (Uniform Resource Identifier - another W3C standard, which is designed for globally unique naming). RDF allows the construction of a data model for resources and the relationships between them. Unified naming on URI is not enough for use of knowledge in intelligent agents. Ontologies fill this gap. There are several languages available for constructing ontologies. OWL (Web Ontology Language) is most widely used one and is also recommended by W3C. The whole stack of semantic technologies is available on the Web pages of W3C consortium [8].

The core of our ontology is shown in Figure 1. We have classified services to be simple services, not supported by ICT at all, or e-services. We also manage services, which are composed with several services. Ontology also covers special e-services, supported by web applications or exposed with web services. Ontology enables capturing several service providers. They can also be classified using taxonomies and folksonomies. Please note that Figure 1 gives only basic insight on some classes and their relations in larger ontology.

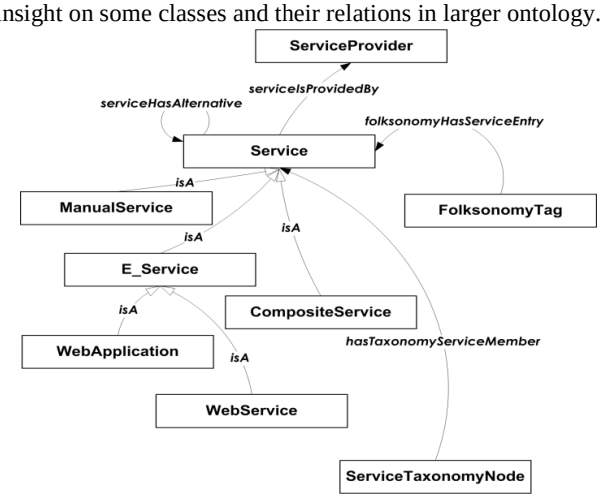

Fig. 1 Core of defined ontology

IV. Current State Of The Platform

The prototype platform enables hosting of intelligent services, which will empower use of e-services. The platform will also be available through application programming interfaces (API), in this manner the prototype itself will be an e-service available for reuse in third party applications. The prototype is implemented using open-source and freely available software. The base of the platform is semantic web technologies. The platform itself allows knowledge integration from distributed data sources (catalogues of e-services, World Wide Web, etc.) and management of the gathered knowledge. Additionally, the platform also:

- enables providers and users of e-services annotation of services with additional knowledge,
- integrates data from the World Wide Web, and from additional data sources,
- transforms data encoded in RDF language to a user-friendly format,
- manages index of words, which were used in the platform and additional data sources in order to enable searching based on keywords,
- provides all the data in raw RDF format, which will in turn enable newly built components to easily reuse information,
- manages a collection of real-world examples.

At the moment, the prototype implementation contains 3 services, which runs on the presented platform:

- full text search (data is not indexed only from local sources but also from external sources, e.g. World Wide Web),
- proposition of e-services or collection of e-services by using questions and answers approach,
- search for alternative e-services or alternative collections of services.

One of the key components, supported by the ontology is "e-service proposing component". Knowledge that is required by proposing component is consistent with ontology, presented in platform (see Figure 2). We introduce concept of Solution. Solution class is represented with Service class in Figure 1. Since we include possibility of related solutions at platform level, proposing component is able to propose not only potentially interesting solutions, but also solutions that can be related to proposed one.

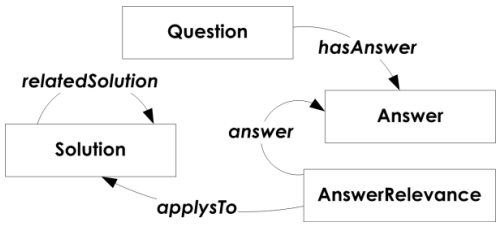

Fig. 2 Ontology structure, expected by the platform

Furthermore, the user knowledge aspect is also supported by the presented ontology in quite straightforward way. Users can provide experiences (knowledge) in question-answer pairs, which enables them to capture their implicit knowledge. Not only users can give experiences to tell which service is used in a particular situation ("Question" class), they can also specify more possible services to a situation ("Answer") with specified probability ("AnswerRelevance"). This value ranges from 0% to 100% and tells the user how likely it is that their particular candidate ("Solution") is used when the answer to a given question is confirmed as positive. Answers and possible candidates can easily be updated or added to questions at any time with the aid of a rich user-friendly web interface.

V. Current Data In The Ontology

At the moment, we are testing core functionalities of the platform. Users have entered 549 e-services so far at this phase. They have also classified them in the means of different providers, interaction types, economy activities, domains, types etc. They were actively involved in defining taxonomy also. Taxonomy itself is not closed and final but can, on the other hand, be altered at any time.

Based on that 549 e-services, we can get quite good first insight in the state of e-services in the Republic of Slovenia. The data might, however, be interesting for international audience also:

- majority of collected e-services is provided by private enterprises (see Figure 3),
- services are mainly oriented in business-to-customer manner (see figure 4),
- users discovered mainly services form the area of vehicle trade, finance and insurance economy activities (Figure 5),
- test users mainly discovered e-services from the domains of traffic, education and culture (if we ignore unclassified services) – see Figure 6.

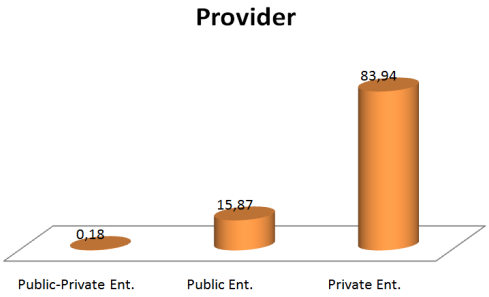

Fig 3 Current e-Services procentage by provider

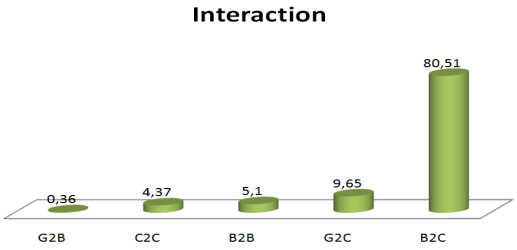

Fig 4 Current e-Services procentage by interaction type

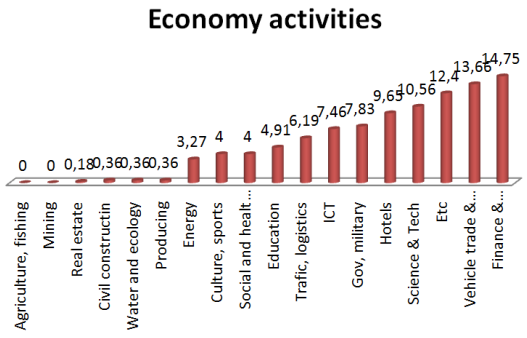

Fig 5 Current e-Services procentage by economy activities

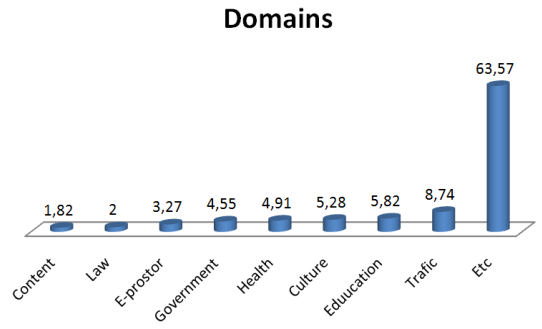

Fig 6 Current e-Services procentage by domains

VI. Further Work

It is our goal, that we will provide an e-services management methodology at the end of the project. It will in addition to e-services repository management also allow advanced, easy to use mechanisms for search and proposal of e-services. The project outcomes will allow user collaboration and linking of e-services. At the moment, platform itself is almost complete, so we can really focus on research on its benefits.

Firstly, the methodology approaches and the platform will be demonstrated in real life. We will address e-services that are targeted at student population.

The work on the project will be verified using established scientific research methods. In the final stages of the project, we will conduct a controlled experiment and a large number of surveys on the test population. In this manner, we will determine whether and to what degree our approach helps promoting the use of e-services. At this time, out platform will go public.

VII. Conclusions

In this paper we presented a gap between supply and actual e-services usage. This is why we started a project to provide an environment that will encourage the use of e-services. This paper showed the origins of our project and its current position. We discussed the decision of using semantic web technologies and their potential to improve using of e-services. We also presented current knowledge base and its real-world classification and further work to be done in the project.

Based on the research of existing formal representations, and based on the research of ontologies and Semantic Web technologies, we have presented our own approach for describing knowledge about e-services. Our own knowledge representation technique may be seen as a necessary extension, which allows greater search capabilities and higher grade of use of e–services.

At the end of the project we will provide an e-services management methodology, which will in addition to e-services repository management also allow advanced, easy to use mechanisms for search and proposal of e-services to be used. The project outcomes will allow user collaboration and linking of e-services. Platform itself is almost complete.

At the moment, the project can serve with some original contributions. The most important are:

- the ontology-based method for describing e-services and knowledge about them,
- the holistic methodology, which cover capturing, management and using knowledge about e-services,
- the semantic web-based prototype platform for hosting intelligent components based on knowledge about e-services,
- collected knowledge about ready-to-use e-services.

At the moment of testing we can summarize that even at this stage, the outcomes of the project are promising.

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