Foreword to the Proceedings of the 6th International Conference on Information Society and Technology

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I. INTRODUCTION

Another successful edition of ICIST conference series has been organized at Kopaonik winter resort, on February 28th – March 2nd, 2016. ICIST is one of the most influential ICT events in the region with a long tradition of academic and industrial participation. Besides provided networking opportunities, in the past few editions it significantly boosted the quality of the presented work, with the outputs to the reputable journals.

In this Foreword, we present the highlights of the recent ICIST edition and introduce a reader to the content of the book of proceedings. Finally, we provide the discussion on the current state of the play in this year's focal area of the ICIST conference. As it was the case last year, the book of proceedings is organized in two volumes. Volume 1 chapters are the papers that have been accepted for presentation in the regular sessions. Volume 2 chapters are the papers that have been presented at the poster sessions.

II. OPEN AND BIG DATA

According to IBM assertions, we create 2.5 quintillion bytes of data per day and as of 2020 we shall reach the total amount of 44 zetabytes. 44 zetabytes is estimated to be almost 60 times the amount of all the grains of sand on all the beaches on earth. Individuals, various organizations, and governments produce huge amounts of data as part of their everyday activity/work – data related to environment, public-transport, health, education, etc. This data is used by governments to improve public-services, by companies to improve businesses, and by individual(s) to improve her/his status. General opinion is that there are many opportunities to use such data beyond the purpose it was originally collected. This is the driving force behind Big Data and Open Data movements.

Gartner IT Glossary[1] defines Big Data as follows: "Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation." The Open Definition[2] provided by Open Knowledge[3] sets out principles that define "openness" in relation to data and content. The definition defines "open" by the statement: "Open means anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness)". "Open data" is defined by the statement: "Open data and content can be freely used, modified, and shared by anyone for any purpose".

According to "Open Data Barometer Global Report - Second Edition"[4] a global movement to make government "open by default" gained momentum in 2013, when the G8 leaders signed the Open Data Charter[5]. This was followed in 2014 by the G20 largest industrial economies pledging to advance open data as a weapon against corruption, and in 2015 by proposal of the International Open Data Charter[6], which is signed by 19 national, state and city governments worldwide.

There are a number of organization and groups that are driving Big Data, Open Data and Open Government Data (OGD) research, best practice and technologies. Without an ambition to be exhaustive we shall list some of them here. European Commission (Communication on the data-driven economy[7]), United Nations (Global Pulse[8]), many national (The US Big Data Research and Development initiative[9], the Australian Government

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[1] http://www.gartner.com/it-glossary/big-data/
[2] http://opendefinition.org/
[3] The Open Knowledge Foundation, trading as Open Knowledge, is a not-for-profit organization. It is incorporated in England & Wales as a company limited by guarantee.
[4] http://opendatabarometer.org/assets/downloads/Open Data Barometer - Global Report - 2nd Edition - PRINT.pdf
[5] UK Cabinet Office, (June 18th 2013) G8 Open Data Charter and Technical Annex, https://www.gov.uk/government/publications/open-data-charter
[6] http://opendatacharter.net/wp-content/uploads/2015/10/opendatacharter-charter_F.pdf
[7] http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=6210;
http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=6216
[8] http://www.unglobalpulse.org/
[9] https://www.whitehouse.gov/sites/default/files/microsites/ostp/big_data_press_release_final_2.pdf

Public Service Big Data Strategy[10], the UK ESRC Big Data Network[11]) and local governments/agencies, universities across the Globe, the Insight Centre for Data Analytics[12], Govlab[13], the Omidyar Network[14], the Open Data Institute[15], the Open Data Research Network[16], the Open Government Partnership[17], the Open Knowledge Foundation[18], the Sunlight Foundation[19], W3C[20], the World Bank[21], and the World Wide Web Foundation[22] exhibit internationally recognized activities and results in Big Data, Open Data and Open Government Data. Open Government Data in Serbia is still at infancy stage. Directorate for eGovernment of the Ministry of State Administration and Local Self-Government is in charge with Open Government Data in Serbia.

One of the most consequent (with respect to "openness") initiatives related to Open Data and Open Government Data, which is extremely valuable for underdeveloped countries such as Serbia, comes from Sir Tim Berners-Lee. The World Wide Web Foundation established by Sir Tim Berners-Lee in 2009 and the Open Data Institute jointly initiated research called 'Open Data Barometer'. The Barometer was supported by the Open Data for Development (OD4D) program, a partnership funded by Canada's International Development Research Centre (IDRC), the World Bank, United Kingdom's Department for International Development (DFID), and Global Affairs Canada (GAC). Within the 'Open Data Barometer'[23] framework, three documents are created so far containing a comprehensive job already done: 'Open Data Barometer - 2013 Global Report', 'Open Data Barometer Global Report - Second Edition', and 'Open Data Barometer - ODB Global Report 3rd Edition'. As declared by the authors in the document 'Open Data Barometer - 2013 Global Report': "Above all, the Open Data Barometer is a piece of open research. All the data gathered to create the Barometer will be published under an open license, and we have sought to set out our methodology clearly, allowing others to build upon, remix and reinterpret the data we offer. Data collected for the Barometer is the start, rather than the end, of a research process and exploration."

As confirmation of being "a piece of open research", all three reports expose the research methodology in detail, all the collected data, and all the results of the analyses for 77, 86 and 92 countries worldwide. All reports, in addition to an exhaustive analysis, contain a ranking of the countries on open data readiness, implementation, and impact as well as key findings for the observed timeframes (years 2013, 2014, and 2015). Just to mention

that of all Ex-Yugoslavia countries only Macedonia was included in the third report.

Yet another initiative, directly bringing valuable results to underdeveloped countries including Serbia, is the World Bank's project ODRA (Open Data Readiness Assessment). The World Bank's Open Government Data Working Group has prepared and published a revised draft 'Open Data Readiness Assessment Tool'[24] aimed to assist in diagnosing what actions a government could consider in order to establish an Open Data initiative. The latest version of ODRA consists of two documents the 'User Guide'[25] and the 'Methodology'[26]. The approach proposed by World Bank was applied so far to 10 countries including Serbia. The assessment for Serbia, which was published in December 2015[27], contains both the overall assessment and suggested list of actions. The action plan was focused on integrating actions at the top, middle and bottom, including the active involvement of civil society and the business community. A first focus of those actions is making open data available where that is easy to do so, and to form pilot groups of government agencies, civil society, business and developers to quickly create a few practical examples of the usage of open data, which can serve as example for further extension of the open data program. It is recognized that for a sustainable and integrated role of open data as part of public service delivery however, the problems with retaining skilled staff and maintaining a sufficient level of IT knowledge across government are a significant obstacle. Nevertheless, by the end of February 2016 several governmental institutions joined the ODG initiative and open some of their data sets (see Table 1). All these datasets can be accessed via eGovernment portal of the Republic of Serbia, link http://data.gov.rs/.

In July 2014, the European Commission outlined a new strategy on Big Data, supporting and accelerating the transition towards a data-driven economy in Europe. The IDC study[28] predicted the Big Data technology and services market to grow worldwide from $3.2 billion in 2010 to $16.9 billion in 2015. Wikibon[29] claims that the overall Big Data market grew from $18.3 billion in 2014 to $22.6 billion in 2015. The study 'Big Data Analytics: An assessment of demand for labor and skills, 2012-2017'[30] predicts that in the UK alone, the number of big data staff specialist working in large firms will increase by more than 240% over the next five years. There are also several studies that have investigated the value of the Open Data economy. Graham Vickery[31] estimated that EU27 direct public sector information (PSI)[32] re-use

[10] https://www.aiia.com.au/documents/policy-submissions/policies-and-submissions/2013/the_australian_public_service_big_data_strategy_04_07_2013.pdf
[11] http://www.esrc.ac.uk/research/our-research/big-data-network/
[12] https://www.insight-centre.org/
[13] http://www.thegovlab.org/
[14] https://www.omidyar.com/
[15] http://theodi.org/
[16] http://www.opendataresearch.org/
[17] http://www.opengovpartnership.org/
[18] https://okfn.org/
[19] http://sunlightfoundation.com/
[20] https://www.w3.org/
[21] http://www.worldbank.org/en/about
[22] webfoundation.org
[23] http://opendatabarometer.org/

[24] http://opendatatoolkit.worldbank.org/docs/odra/odra_v2-en.pdf
[25] http://opendatatoolkit.worldbank.org/docs/odra/odra_v3.1_userguide-en.pdf
[26] http://opendatatoolkit.worldbank.org/docs/odra/odra_v3.1_methodology-en.pdf
[27] http://www.rs.undp.org/content/serbia/sr/home/library/democratic_governance/ocena-spremnosti-za-otvaranje-podataka/
[28] http://ec.europa.eu/digital-single-market/news-redirect/17072
[29] http://siliconangle.com/blog/2016/03/30/wikibon-names-ibm-as-1-big-data-vendor-by-revenue/
[30] http://ec.europa.eu/digital-single-market/news-redirect/17072
[31] Vickery, G. (2011). Review of Recent Studies on PSI Re-use and Related Market Developments, Information Economics, Paris
[32] Directive 2003/98/EC on the re-use of public sector information5 (the PSI Directive); Directive 2013/37/EU, amending Directive 2003/98/EC

market was of the order of EUR 32 billion in 2010. The aggregate direct and indirect economic impacts from PSI applications and use across the whole EU27 economy are estimated to be of the order of EUR 140 billion annually.

Table 1. Serbian governmental institutions that open datasets by the end of February 2016.

Institution	Available formats	Accessibility restriction
Office of The Commissioner for Information of Public Importance and Personal Data Protection	csv	None
Ministry of Education Science and Technological Development	html, json, csv, xls	None
Ministry of Interior Affairs/None	csv, xls	None
Public Procurement Agency/None	csv	None
Environment protection Agency/None	csv	None
Medicines and Medical Devices Agency of Serbia	csv	Governmental institutions only

The above estimates of direct and indirect PSI re-use are based on business as usual, but other analysis suggests that if PSI policies were open, with easy access for free or marginal cost of distribution, direct PSI use and re-use activities could increase by up to EUR 40 billion for the EU27.

In McKinsey's 2013 report 'Open data: Unlocking innovation and performance with liquid information'[33] authors state: "An estimated $3 trillion in annual economic potential could be unlocked across seven domains. These benefits include increased efficiency, development of new products and services, and consumer surplus (cost savings, convenience, better-quality products). We consider societal benefits, but these are not quantified. For example, we estimate the economic impact of improved education (higher wages), but not the benefits that society derives from having well-educated citizens. We estimate that the potential value would be divided roughly between the United States ($1.1 trillion), Europe ($900 billion) and the rest of the world ($1.7 trillion)".

According to the FP7 project BYTE (Big data roadmap and cross-disciplinarY community for addressing socieTal Externalities)[34], from the beginning of the millennium every three years a new wave of Big Data technologies has been building up: 1) The "batch" wave characterized by distributed file systems and parallel computing, 2) the "ad-hoc" wave of NewSQL characterized by underlying distributed data structures and distributed computing paradigm, and 3) the "real-time" wave, which enables insights in milliseconds through distributed stream processing. Even if it is quite clear what is expected from the Big Data technology today (cope with volume, variety, and velocity), there is neither a single tool nor choice of a platform that could satisfy these expectations. Current solutions are mainly concerned with high-volume and high-velocity issues with two architectural patterns passable: well-known Schema on Read[35] and Lambda Architecture[36] that appeared in 2013 and is considered a kind of consolidation of the Big Data technology stack. A key is that lambda architectural style recognizes the very different challenges of volume and velocity. Hence, this pattern splits data handling into three layers: fast layer for real-time processing of streaming data, the batch layer for cost-efficient persistent storage and batch processing, and the serving layer that enables different views for data usage. Even with these two patterns well established, the third dimension of Big Data, variety, remains unresolved as well as many other challenges such as veracity, actionability, and privacy. These are up-and-coming subjects of Big Data research and development today.

The ultimate vision of Open Government Data heavily relies upon Linked Data because efficient utilization of such data calls for intelligent automated access to globally distributed, heterogeneous data. Hence, the Open Government Data technology basically corresponds to the Linked Data technology, i.e. two technologies that are fundamental to the Web, URIs and HTTP, supplemented by RDF technology, RDFS, and OWL. Unfortunately, current Open Government Data deployments are commonly only isolated, internally linked islands of datasets provided in CSV or spreadsheet formats. We have selected the article "Linked Open Government Data: Lessons from Data.gov.uk"[37] for comments here because it addresses issues that are, by our opinion, of crucial importance for the future OGD. In this paper authors opt for the use of Semantic Web standards in OGD referring to this vision as the Linked-Data Web (LDW). Thereby, they emphasized four research challenges as relevant for representing OGD in RDF: discovering appropriate datasets for applications; integrating OGD into the LDW; understanding the best join points (the points of reference the databases share) for diverse datasets; building client applications to consume the data. As a conclusion, they exposed the lessons learned addressing governments, technical community and citizens as well as the list of bottlenecks in exporting OGD to the LDW. In addition to the unwillingness of public service providers to surrender control of their data, the issues related to discovery of OGD, ontological alignment, interfaces, and consumption are recognized as bottlenecks and, consequently, candidates for future research.

[33] Manyika, J. Chui, M. Groves, P. Farrell, D. Van Kuiken, S. and Doshi, E, A. (2013). Open data: Unlocking innovation and performance with liquid information, McKinsey Global Institute, New York.

[34] http://byte-project.eu/

[35] https://www.techopedia.com/definition/30153/schema-on-read

[36] Marz, Nathan, "Big Data – Principles and best practices of scalable realtime data systems", Manning MEAP Early Access Program, Version 17, no date. http://manning.com/marz/BDmeapch1.pdf

[37] Shadbolt, Nigel, O'Hara, Kieron, Berners-Lee, Tim, Gibbins, Nicholas, Glaser, Hugh, Hall, Wendy and schraefel, m.c. (2012) Linked open government data: lessons from Data.gov.uk. *IEEE Intelligent Systems*, 27, (3), Spring Issue, 16-24. (doi:10.1109/MIS.2012.23).

III. ICIST 2016 KEY FIGURES

In the ICIST event preparation phase, 63 of the distinguished researchers in the field from 18 countries have accepted the invitation to participate in the work of the International Programme Committee (IPC).
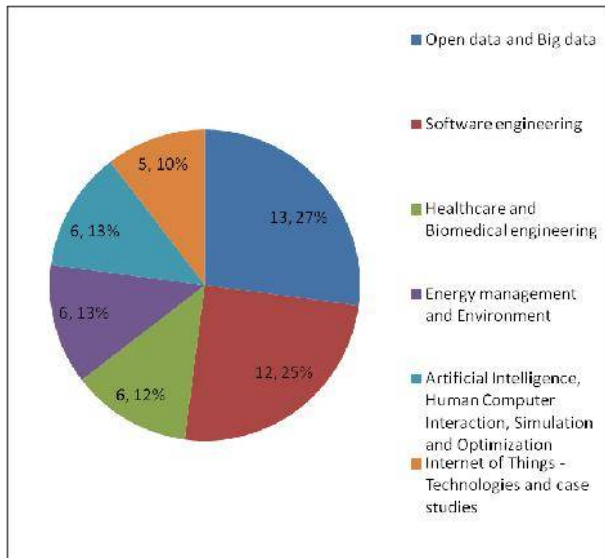

Fig. 1. Distribution of regular papers among main topics

This year, 80 papers were submitted to the conference, out of which the authors of 72 papers were invited to present their research work in regular and poster sessions. Thus, overall acceptance rate was 90%. Based on the reviewers' comments, the IPC has found that 48 papers show higher relevance and the level of scientific contribution, appropriate for presentation at the regular sessions, resulting with the regular paper acceptance rate of 60%. 220 researchers from 20 countries contributed as authors or co-authors to the submitted papers, making this event truly international.

Based on the works presented in the accepted regular papers, the following main topics and corresponding session distribution has been adopted by the IPC co-chairs: Open data and Big data; Software engineering; Healthcare and Biomedical engineering; Energy management and Environment; Artificial intelligent, HCI, Simulation; and Optimization and Internet of Things – Technologies and case studies. The distribution of regular papers among main topics is illustrated on Fig.1.

To the large extent, this distribution corresponds to the topics addressed by the previous three ICIST editions, and it clearly demonstrates the selection of topics of the major interest in the Serbian research community, as it is the most present in the conference series.

IV. SCIENTIFIC PROGRAMME

Since Open data and Big data was previously selected by the co-chairs as the focal topic of this year's ICIST, the largest number of papers addressing this area was submitted. The diverse topics addressed included but weren't restricted to government initiatives and their assessments, open data use in judicial systems, metadata management, transformation and analysis of linked data, social networks data analysis, etc. The scientific programme was complemented with the special round table discussion on the use of open government data in Serbia and presentation of the existing data sets.

The topic of software engineering was addressed mostly in the field of model-based software engineering, demonstrating very large interest of the local scientific community in this area.

Second year in a row, Healthcare and Biomedical Engineering becomes one of the most visited sessions, thanks to highly international participation and two very successful, nationally funded projects in this area. This year's edition addressed the potential of use of the ICT for the resolution of the specific health-related challenges, such as vertigo disorders, imaging issues, information extraction from EHR, implant material selection, and others.

The session related to the topic of energy management and environment dealt with the issues of energy management in multiple carrier infrastructures, energy management in neighborhoods, integration of network analysis system with GIS and tools for urban air quality studies.

Internet of Things remains the topic of high interest. This year's session addressed real-time biofeedback systems, RFID supported healthcare information systems, cloud-based IoT platforms and IoT demonstrations in the domains of agriculture, aquaculture and tourism.

Last, but not the least, one dedicated session presented 6 papers with the recent results of the research in the domains of simulation and optimization, human-machine interaction and artificial intelligence.

A. Poster sessions

Traditionally, the poster sessions are venues with the most interesting discussions that take place in less formal environment. The participating authors have presented a number of high-quality technical solutions and methodologies for solving different technical and societal problems.

V. ACKNOWLEDGEMENT