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Suzana Loshkovska
Saso Koceski *Editors*

ICT Innovations 2015

Emerging Technologies for Better Living

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Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, Poland
e-mail: kacprzyk@ibspan.waw.pl

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Editors
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Faculty of Computer Science
Ss. Cyril and Methodious University
Skopje
Macedonia

Saso Koceski
Faculty of Computer Science
University Goce Delcev
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Macedonia

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Preface

The ICT Innovations conference is a framework where academics, professionals, and practitioners interact and share their latest results and interests related to basic and applied research in ICT. The conference is organized by the Association for Information and Communication Technologies (ICT-ACT), which supports the development of information and communication technologies in Macedonia, the Balkan region and beyond.

The 7th ICT Innovations 2015 conference gathered 316 authors from 36 countries reporting their scientific work and novel solutions. Only 26 papers were selected for this edition by the international program committee consisting of 215 members from 55 countries, chosen for their scientific excellence in their specific fields.

ICT Innovations 2015 was held in Ohrid, Macedonia during October 1–4, 2015. The special conference topic was "Emerging Technologies for Better Living" and it was mainly focused on scientific topics and technologies that have transformed the working and the living environments making them safer, more convenient, and more connected. The conference gave an overview of the emerging technologies, systems, applications, and standardization activities for better living, and identified their opportunities and challenges. The conference also focused on variety of ICT fields: Enhanced living environments, Data Mining & Information Retrieval, Bioinformatics & Biomedical Engineering, Connected Health Technologies, Digital Signal & Image Processing, Artificial Intelligence, Internet & Web Applications, Distributed & Parallel Processing, Internet of things, Robotics & Automation, Pattern Recognition, Assistive technologies, E-health, Context-aware Systems, Pervasive Technologies, Ambient Intelligence, Ubiquitous Computing, Embedded Systems, Innovative Media and Tools.

We would like to express sincere gratitude to the authors for submitting their contributions to this conference and to the reviewers for sharing their experience in the selection process. Special thanks to Katarina Trojacanec and Ivan Kitanovski for their technical support in the preparation of the conference proceedings.

September 2015

Suzana Loshkovska
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ICT Innovations 2015 was organized by the Macedonian Society of Information and Communication Technologies (ICT-ACT).

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Research and Innovation in ICT

With Examples in the Field of eHealth and Wellbeing

Andrej Kos, Urban Sedlar, Matevz Pustišek

University of Ljubljana, Faculty of electrical Engineering
{andrej.kos, urban.sedlar, matevz.pustisek}@fe.uni-lj.si

Abstract. The ICT environment has changed drastically in last 5 years. The paper describes the challenges of enabling critical mass of knowledge for multidisciplinary research and innovation in the current field of ICT. In introduction we describe our team, the importance of ICT and particular broadband internet access. Internet of things is also described, bringing great diversity of new domains the ICT has to encompass and support. The main part of the article addresses the ICT environment changes and different approaches towards research and innovation adaptation detailed with examples. As the research and innovation environment changes, we as a team have to adapt. The challenges and solutions are presented, based on concrete examples from the field of eHealth and wellbeing.

Keywords: Research, Innovation, ICT, Approaches, Ecosystem of talents

1 Introduction

The importance of research and innovation in ICT to support growth of all industry sectors is mentioned in many strategic documents. In the article we look behind the stage and present the complexity of the ecosystem of talents. We pay special attention to issues and solutions of conducting research and innovation in the broad field of ICT enabled Internet of things, taking into account type of research, type of funding, team members, critical mass knowledge and the actual university-industry environment.

1.1 Our team

The Laboratory for telecommunications (LTFE) and Laboratory for Multimedia (LMMFE) team's mission is: (i) excellence in research and industry cooperation, (ii) educating young talents and professionals, (iii) developing cool ideas and new knowledge and (iv) innovation for life and business.

There are 50 members in the LTFE and LMMFE team, not counting graduate and undergraduate students. About 50% of our budget is based on direct industry projects,

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15% from university for academic pedagogical activities and 35% from national and mostly European projects.

Our main teaching, research and development directions are communication networks and services - with focus on network operator grade systems, multimedia - including development of applications for smart and digital television and user experience evaluations, and various web and mobile applications in the domain of eLearning, eHealth and wellbeing.

In addition, we strongly aim to extend our research innovation beyond the obvious scope of an academic research group. We primarily exercise research innovation at university level (teaching, projects, Makerlab [1], Demola [2]) and entrepreneurship level (LUI [3], Hekovnik [4]), but also build the innovation ecosystem around secondary level schools (Openlab [5]) and around primary level schools (ZOTKS [6]). We act as research, development and training institution for local industry (ICT Academy [7]), and as ICT innovation center in Slovenia, having strong national and regional linkages. In this term we are unique in the region and often cited as best practice example [8,9].

1.2 Broadband networks

ICT has become the key element for growth in almost every industry sector. Therefore broadband communications technologies and services, including Internet, today play a similar role as roads and railways in the previous century and broadband has strong positive effects on the increase in GDP and job creation. A 10% increase in broadband penetration results in a 1-1.5% increase in the GDP annually and 1.5% labor productivity gains. There are many socio-economic benefits from high speed networks. To be able to fully exploit the potential of high speed broadband i.e. the increased innovation, improved welfare, customer benefits, new jobs, reduced environmental impact, better demography trends, increased productivity and increased GDP, new services, education of users and demand stimulation is need [10,11].

The Digital Agenda for Europe (DAE) [12] aims to help Europe's citizens and businesses to get the most out of digital technologies. It is the first of seven flagships initiatives under Europe 2020, the EU's strategy to deliver smart sustainable and inclusive growth. Launched in May 2010, the DAE contains 101 actions, grouped around seven priority areas. The goals connected to broadband and the use of digital technologies were set as stated below:

- the entire EU to be covered by broadband internet access by 2013,
- the entire EU to be covered by broadband internet access above 30 Mbps by 2020,
- 50 % of the EU to subscribe to broadband internet access above100 Mbps by 2020.

1.3 Internet of Things

Internet of Things (IoT) is an ecosystem where the virtual world integrates seamlessly with the real world of things. The IoT enables applications with high social and business impact, and once the enabling technologies are stable, it is expected new ones will emerge as well. Businesswise, the most important aspect is creation of value-added services that are enabled by interconnection of things, machines, and smart objects and can be integrated with current and future business development process. IoT as part of broader ICT has become part of practically all domains i.e. buildings, energy, entertainment, healthcare, wellbeing, lifestyle, industrial, transportation, retail, security and public safety and other.

2 ICT environment change

In last five years the ICT innovation and research area has changed drastically. Ten years ago, the ICT research was focused on communication networks on one side, and information technology support on the other side. During this time classical communication and information technologies and services, i.e. networks, protocol, connectivity, have become a commodity. Broadband networks, wired and wireless, as well as databases with open data accessible via open APIs are expected to be available all the time and everywhere, similar as 230V plugs in the wall.
There is of course still plenty of basic research and innovation within core ICT domains, however it is present in fewer areas, i.e. mobile, quality of experience, software defined networking/radio, security, etc. The majority of research has moved to applicative, interdisciplinary areas, where ICT plays just a part of the solution, as shown in Figure 1.

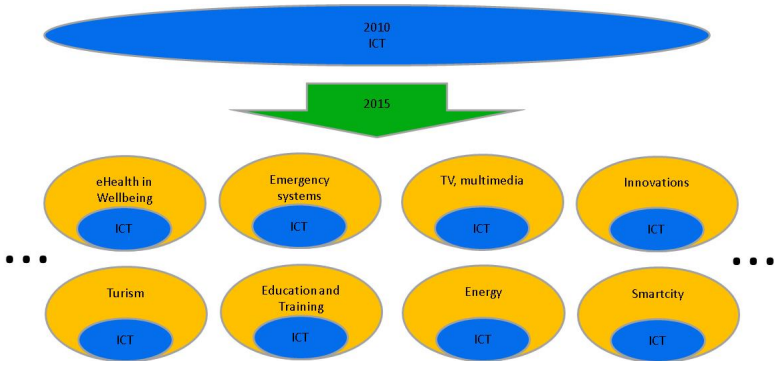

Fig. 1. ICT environment change in last five years

Conducting research and innovation, where ICT has the role of supporting service, means that researches have to acquire domain specific knowledge from a/many different domain/s.

The solution is to focus on just one or a few domains and build long-term critical mass of research and innovation expertize and financing. There are time, money and competence needed to adapt and there are many possible focuses to choose from. The chances to be successful in proposals for national or European project funding are on average 10% and falling. Adding to this less research and innovation funds, many research groups have decided to apply for projects in many/more fields/domains. Such amount of proposals causes tremendous stress for researches and evaluators. The outcome is also that the research might be determined by projects that a group wins, not the focus the group has set.

Taking these facts into account, the internal organization was adapted order to follow the above mentioned trend and to achieve results mentioned above.

3 Approaches to research

There is basic and applicative research in the field of ICT. With ICT being a support service to almost all other industries, the research is becoming more and more applicative.

The question that arises is, how to finance the research. The first option is to "apply for national and European project", hope for best results, and perform and hopefully continue the research already being "in the club" and having big projects. This type of research is excellent for long-term planning and stability of a research group. However, the efforts to get and run the project and tackle all the formal details, makes the group conducting the actual research less sharp and innovative, possibly going into doing "research projects" for salary.

Another option is "let's just do research". This approach brings in lots of motivation and focus, high innovation potential and much quicker results as just the research is in focus and all the other burdens do not exist (except for long term stability and financing). Students are mostly involved in this type of research. This approach is sustainable only if the researches/students are fluctuating and there exist funds for mentoring support. The limiting factor can be need for new equipment (not already existing) and nevertheless at least small source of funds that normally comes from other projects. Innovators and entrepreneurs involved in and motivated for this kind of research are highly searched for at start-ups, companies, and even universities.

Next option is "let's do research, if industry pays for it". Lately, with decreasing budgetary research funds, a common suggestion is to increase the industry funded research. This approach is excellent, if there are companies able to absorb the research, if both parties really want and need the research, and if there is an established culture of research for industry. There are cases where companies see this kind of cooperation just as "low cost development" (however it really isn't) or "with a contract I pay for development and get also the research and IPR". This issue is also strategically important for the universities as a whole.

Another option is “PhD positions paid from budget”, which is typically long term on one hand and formally very restrictive in terms of candidates and mentors on the other hand. PhD positions are typically won on tenders. So the available position cannot be planed more than a few months in advance., therefore we often cannot promptly respond to emerging research challenges, because timing is mostly dictated by formal procedures of official funding entities. Within this timing it is also hard to find a winning combination of a candidate, mentor and topic. We see that there is less and less candidates willing to go through the process of PhD, however, they would indeed perform the quality research.

4 Examples of ICT supported research and innovation in the field of eHealth and wellbeing

4.1 Stress measurements and sensing

Stress is a physiological, psychological and behavioral response to every change people must adapt to. ICT enables new options to monitor and prevent stress. For a thorough and more reliable identification of chronic stress the measurements need to be conducted continuously, throughout a longer time period. This can be done with the use of different electronic measurement devices that periodically, based on physiological indicators, can evaluate the current level of stress. Such indicators (markers) include: electro-dermal activity (EDA), various pulse samples, blood pressure and respiration activity. On today’s market, we can already find small sensor devices that allow these types of measurements.

We built a presence based context-aware chronic stress recognition system. It obtains contextual data from various mobile sensors and other external sources in order to calculate the impact of ongoing stress. By identifying and visualizing ongoing stress situations of an individual user, he/she is able to modify his/her behavior in order to successfully avoid them. Clinical evaluation of the proposed methodology has been made in parallel by using electro-dermal activity sensor.[13]

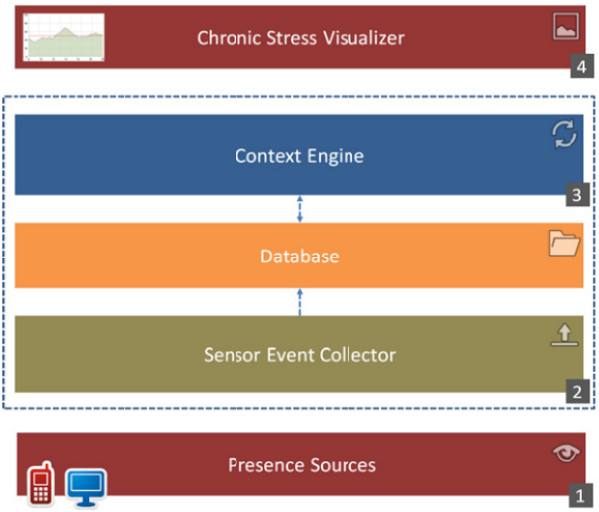

Fig. 2. Context-aware chronic stress recognition system

The sensor classification and presence based context-aware chronic stress recognition system were developed within the scope of young researcher program financed by Slovenian Research Agency. We had problems finding appropriate candidate for this position even when the research grant had been already assured. In the end we acquired and excellent foreign student. Because of very strict execution timeframe, which does not efficiently considers some facts that are out of the control of the researcher and his mentors (e.g. duration of peer review process for journal publications required for Ph.D. candidates [14]), student was left with very little time to get accustomed to new living and working environment.

4.2 DeSA

DeSA [15] is a healthy lifestyle mobile application for bio-sensing and healthy lifestyle management for diabetes patients and for other users that want to monitor their lifestyle. It allows users to track multiple health and fitness parameters, with special focus on diabetes management. It was tested in a pilot trial conducted in Norway hospital with diabetes patients, including the security features of the application i.e. secure sending of data to the physician and sending to an electronic health record (EHR).

The application can be installed on any iOS mobile device (iPhone, iPod, iPad). Glucose measurements can be performed by using the 2in1 smart glucometer, which utilizes the headphones connector to establish connectivity with the smartphone. The small portable glucometer makes mobility easier for diabetes patients. Since the glucometer does not need an additional power source, the users do not need to worry about batteries. The measured data are automatically stored into the local database and can be immediately presented in multiple charts or in the text format logbook.

Similar logging is also implemented for weight, insulin, stress, and food intake. The food logging feature is also useful for monitoring and storing different parameters e.g. carbohydrates, fat, sugar, protein, calories and water. A simple pie chart represents the daily food log and helps users find the desired balance between the intakes of different nutrients. DeSA activity tracking uses the in-built iPhone sensors to monitor steps, while Fitbit cloud synchronization. The application helps users reach their daily activity goals, which are set according to predefined settings or user ages.

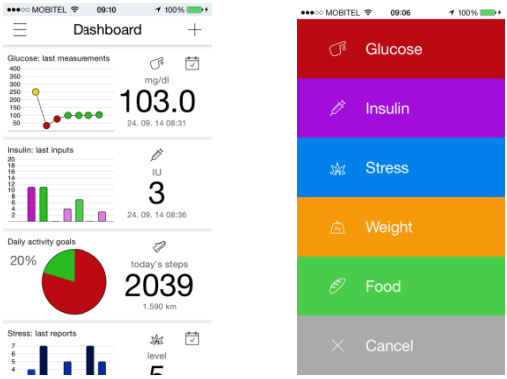

Fig. 3. DeSA application

The application was developed within the scope of EU 7. FW project Future Internet Social and Technological Alignment Research - FI-STAR, grant FP7-604691. Research conducted within a large EU funded project enabled deep and long-term (three years) involvement of several research fellows in the selected research domain. But the scope of our work was strongly directed by project objectives and sometimes unforeseen developments in the enabling technologies and principles, and thus to some extent limiting flexibility in following new research opportunities.

4.3 Welly

Welly is a well-being application, developed with the purpose of motivating users (especially younger population) to get involved in more physical activity. Application depends on the gamification effects for source of motivation to adapt to new and healthier lifestyle in real world. In order to use the application, the user needs to connect a Fitbit sensor, which is tracking user's activity by counting the number of steps the user has taken. The Fitbit sensor periodically sends the data about user's activity to the Fitbit cloud. As soon as the new data appears in the Fitbit cloud, a notification is sent to the importer, which generates an event on the platform. The received data then propagates through the platform and is stored in the database. The final visualization of user's activity progress is implemented as a mobile (iOS)

application, which features a cartoon-like graphical avatar named Welly. Each step the user makes is reflected on Welly's progress, and by gathering steps the user can help the cute stranded alien travel around the world in search of his home. The more active the user is, the faster Welly progresses through levels. Users can compare their progress with other players and post their results to Facebook and Twitter, further amplifying the gamification effect. A screenshot of the Welly application and the Fitbit sensor is presented Figure 4 [16].

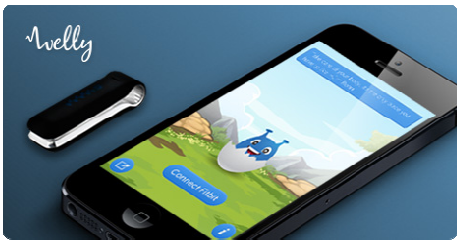

Fig. 4. Welly application screenshot and Fitbit sensor

The Welly application was developed within the scope of UL FE innovation environment (Makerlab). It was a response to an emerged innovation challenge that rapidly resulted in a small prototype solution. However, without a broader research or business backup it remained in this prototype phase.

4.4 Froc

Froc is a high chair for toddlers and kids. It is designed as an adjustable high chair for playful kids and their frisky parents. It's characterized by smart features, superior stability and natural materials. It was developed with parents in mind, who want to ensure a completely safe, yet relaxed and carefree childhood for their kids. It is based on rethinking the concept of wooden high chair for children. Majority of wooden highchairs are either Tripp Trapp or its clones, based on 40 years old design. Froc chair wants to be unique, practical and attractive, more suitable for modern style of living.

The Froc 2.0 chair version, currently being developed and tested, is equipped with the Internet of things electronic and communications system for measuring the weight of the child. It allows to link with a smartphone via Bluetooth 4.0 protocol. The applications open a great variety of additional features, such as child growth monitoring, food intake monitoring, healthy sitting positions, etc.

Fig. 5. Smart Froc – The world's first smart chair for kids

Froc is a product of Slovenian company Rimarket [17]. Internet of things electronic and communications subsystem is designed, integrated and developed by UL FE (Makerlab). Kickstarter campaign is being prepared for fund raising.

5 Conclusion

We presented the challenges and some of our solutions when conductions the research and innovation in ICT with examples in the field of eHealth and wellbeing. Having a relatively large research and innovation group in a small national environment and bigger EU environment poses many challenges in terms of research type, funding and IPR, personal growth and focus.

We came to the conclusion that the solution to sustain and grow the LTFE and LMMFE team and critical mass of knowledge is the combination of all mentioned approaches. That enables us to (i) be focused enough to be competitive on the national and EU research market, (ii) be flexible enough to be able to pivot in the fast changing ICT research and innovation area with (iii) the ability to support the industry.

Going more focused is the mission of start-ups, going more general would make the team noncompetitive on the research market. The biggest challenge we face is the personal growth of each team member and the integration of all mentioned (sometimes conflicting) research and innovation approaches.

The key element of success is to establish and sustain an ecosystem of talents, with young motivated researches and innovators (students) entering and the start-ups exiting and later cooperating. We presented cases of four very distinct approaches towards research and innovation. But in our experience, the innovativeness of the results is more dependent on the talents and motivation, rather than on form of research organization and its' financing. So a right mix of industry, national and EU projects with project based learning, on top of every day hard work is of most importance.

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Semantic Policy Information Point – preliminary considerations

Michał Drozdowicz[1], Maria Ganzha[1,2], Marcin Paprzycki[1]

[1] Systems Research Institute Polish Academy of Science, Warsaw, Poland
{michał.drozdowicz, maria.ganzha, marcin.paprzyck}@ibspan.waw.pl
[2] Department of Mathematics and Information Sciences,
Technical University of Warsaw, Warsaw, Poland

Abstract. Internet of Things (IoT), as a new paradigm for information management requires a number of novel solutions. The aim of this note is to consider methods and approaches needed to facilitate autonomous resource access. The access policies have not only to become capable of dealing with device-to-device interactions, but have to be flexible enough to deal with enormous heterogeneity of entities that are to interact in the IoT. Specifically, we will briefly summarize the existing approaches to access management and outline our approach to provisioning of the needed functionality.

1 Introduction

With the rising prevalence of connected devices, including networks of sensors, there is a growing interest in providing solutions for capturing, storing and processing the vast amounts of collected data. In this context, topics such as interoperability within the Internet of Things (IoT) also gained a lot of attention. A different issue that remains open, and at the same time growing in significance, is that of privacy and security of the data; on all levels of this fast growing ecosystem.

As what concerns regulation of access to the data and operations (services) exposed by the elements of the IoT, there are many similarities with the typical Web resources and services. There is an "entity," possibly described with several assigned attributes or roles, that requests access to "collected data" and/or physical or virtual resource(s) (or specific "services" available within such resources). In response, based on some declarative or imperative rules, such request is granted (or denied). Observe an important difference between the "standard web-provided" resources and such resources materializing in the IoT context. In the first case, typically, human-computer interactions are the core use-case. In the latter, the focus is on device-to-device interactions. Note also that in the case of the IoT, there are multiple reasons why the simple approaches, such as attribute or role based access control methods, may not scale well-enough and use of other solutions may be required.

The main aspects that make the IoT unique, when comparing to typical resources and services accessible in the Web, are:

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- Huge number of resources / producers ([8, 9])
- Fast growing number of consumers ([10, 13, 23])
- Enormous heterogeneity of data and service formats and descriptions ([6, 7, 11, 14])
- Unprecedented dynamics of (often short-lived) interactions between constantly changing parties ([17, 18, 22])
- Machine-machine interactions – especially on the "lower level" where, typically, one device "consuming" data produced by another device, while the role of the "human" is almost completely marginalized.

The aim of this note is to briefly summarize most common approaches of dealing with the aforementioned challenges and to introduce a semantically enriched access control policy system. To this effect, in the next sections we summarize: (i) policy-based access control, (ii) XACML language, (iii) semantic approaches to access control and (iv) semantic extensions to the XACML. We follow with an outline of the proposed approach to the (re)design of the *Policy Information Point*.

2 Policy based access control

Study of pertinent literature reveals the, in many cases, access control is embedded into the logic of the service or the resource provider, and intertwined with the business logic. However, in an environment consisting of a very large number of different services, such approach leads to an unmaintainable, inconsistent set of rules. In other words, it is rather difficult to be able to understand what policies do exist in the system (they are "hidden" within the devices) and how they relate to each other (e.g. [9, 17, 22]).

A better approach would be to move access control decisions outside of the services and devices, e.g. into a centralized authorization component or a set of such components. One way to design such a subsystem would be to use an "engine" that uses declarative policies, specifying the conditions under which a given request is accepted, or when access is denied. Obviously, such approach would have to face the problem of having a "centralized" solution (i.e. potential bottleneck of a large-scale distributed system). However, this problem is in many ways mainly a technical one. As soon as we separate the logic and authorization rules from the logic of the applications, we can see them as being a common part of all (sub)systems within the IoT. In this case, the analysis of a specific request can be "scaled down" to the devices (note that, in this case, all devices would subscribe to the common rules – or a part of these rules that they need to operate). This, in turn, makes the problem technically solvable (using existing techniques; e.g. from the fields of Grid / P2P computing [16].

3 XACML

Let us now consider ways of "representing" rules defining access policies. Currently, one of the most common policy specification languages is the eXtensible