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Guest Editorial: software architecture for the web of things (SAWoT)

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Introduction

The Web is evolving into a platform where physical and virtual worlds meet. Within the next ten years it will be supposition that literally everything is connected and online. Cheap connectivity technologies foster this shift. Being constantly online is already true for most people due to the emerging online socializing and collaboration services. Now, the cheap connectivity technologies foster this evolution for other services. The emerging Web-based services are extending human abilities for socializing and collaboration. From a software development perspective, the world of computing is shifting from the era of single device computing to a new era where literally everything is interconnected, online, and programmable. Due to this shift, the single device computing era is coming to an end, and a new era where literally everything is interconnected and online is beginning.

This Special Issue includes research papers focused on two themes: Engineering the Internet of Things (IoT) from the perspective of the Web, and user experience from the perspective of multi-device software engineering.

Web of Things is the general term used for describing all the approaches of connecting physical objects to the World Wide Web. In the new era of computing the development is evolving from traditional client-server architectures to decentralized multi-device architectures in which people use various types of Web-enabled client devices, and data are stored simultaneously in numerous devices and cloud-based services. This new era will dramatically raise the expectations for device interoperability, implying significant changes for software architecture as well.

Liquid software refers to the approaches in which applications and data can seamlessly flow from one device to another, allowing the users to roam freely across all the computing devices that they have. The goal is that users of liquid software do not need to worry about data copying, manual synchronization of device settings, application installation, or other burdensome device management tasks. Rather, things should work with minimal effort. From the software development perspective, liquid software should dynamically adapt to the set of devices that are available to run it, as opposed to responsive software, which adapts to different devices, under the assumption that only one device at a time is used to run the application.

Papers in the special issue

The majority of the manuscripts are extended versions of selected papers from the Joint Workshop on Engineering the Web of Things (EnWoT) and Liquid Multi-Device Software. The workshop was held on 5th June 2017 in conjunction with the 17th International Conference on Web Engineering (ICWE 2017) in Rome, Italy. As the name suggests, the joint workshop focused on two themes: Engineering the Web of Things (WoT), and user experience from the perspective of multi-device software engineering.

The seven selected articles in this Special Issue include a review article about Architecting the Web of Things for the Fog Computing Era and case studies, as well as works that focus more on the design, implementation and testing of Web of Things Systems.

Mäkitalo *et al.* present a review about the current technological space for architecting Web technology based IoT software in the coming era of Fog Computing. The authors focus on fundamental research challenges and discuss the emerging issues.

Jacob *et al*. propose a software architecture pattern selection model which can be followed in designing IoT systems. Non-functional requirements such as scalability, availability, reliability, security, and heterogeneity determines the decision-making of our proposed model. Analytical results proves that this model can be used as a reference model for IoT developers in choosing a suitable software architecture pattern for their IoT system.

Bourahla *et al.* propose vagueness description with meta level logic programming to describe vague ontologies. These vagueness descriptions are inputs to vagueness reasoning procedure implemented at meta level, which is based on an extended Tableau algorithm. The extended Tableau algorithm is intended to answer queries even with the presence of imprecise information.

Luoto *et al.* show how systems designed with RESTful architecture can be implemented by using an IoT-specific technology called MQTT.

De Venuto *et al.* present a P300-based Brain-Computer Interface for mechatronic device driving, i.e. without need of any physical control. The technique is based on a machine learning algorithm, which exploits a spatiotemporal characterization of the P300, analyses all the binary discrimination scenarios, and pipes them into a multiclass classification problem.

Within healthcare, Buono *et al.* propose a system composed of a mobile application and an IoT device used as a pill reminder that aids patients to correctly take their prescribed drugs.

Leotta *et al.* propose an approach for acceptance testing of IoT-systems adopting graphical user interfaces as principal way of interaction. As case study, the authors selected a mobile health IoT-system for diabetes management composed of local sensors/actuators, smartphones, and a remote cloud-based system.

Guest Editors Biographies

Marina Mongiello

Marina Mongiello is an Assistant Professor at Politecnico di Bari, since 2002. Her recent research interests include: Software Engineering and Software Architecture, Formal methods, and model checking, Mobile and distributed reasoning and applications, software architecture for self-adaptive and context-aware software. She is Associate Editor of the IET *Software and* she has served in both organizing and in the Program Committee of several International conferences and workshops.

Francesco Nocera

Francesco Nocera is a Ph.D. Candidate at Polytechnic University of Bari with particular interests in Software Engineering and Artificial Intelligence fields. Main research topics are: Information Flow Processing (IFP) Systems, Knowledge Representation and description logics, Knowledge Representation Systems and Applications for the Semantic Web, Self-adaptive Systems, and software architecture design. He holds a Master's degree in Computer Engineering from Polytechnic University of Bari. He has taken part in the organization and in the Program Committees of conferences and workshops. He has served as a reviewer for different scientific journals.

Eugenio Di Sciascio

Eugenio Di Sciascio received a Master's degree with honours from the University of Bari, Italy, and a Ph.D. degree from the Polytechnic University of Bari in 1988 and 1994 respectively. He is currently a Full Professor of information systems at the Polytechnic University of Bari, where he is serving as Rector. He leads the research group of the Information Systems Laboratory. Formerly, he has been an Assistant Professor at the University of Lecce and an Associate Professor at the Polytechnic University of Bari. His research interests include multimedia information retrieval, knowledge representation, and e-commerce. He is involved in several national and European research projects related to his research interests.

Tommaso Di Noia

Tommaso Di Noia is a Full Professor of Information Technology Engineering with the Polytechnic University of Bari, Italy. He has authored several papers in international journals and prominent conferences in his research areas. His current research interests include knowledge representation and automated reasoning, semantic Web technologies, mobile and ubiquitous computing, personalized information access, and linked data.

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