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Malavolta, Ivano; Capilla, Rafael

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# Current Research Topics and Trends in the Software Architecture Community

## ICSA 2017 Workshops Summary

Ivano Malavolta

Vrije Universiteit Amsterdam  
Department of Computer Science  
Amsterdam, The Netherlands  
i.malavolta@vu.nl

Rafael Capilla

University Rey Juan Carlos  
Department of Informatics  
Madrid, Spain  
rafael.capilla@urjc.es

**Abstract**—This summary reports the workshops accepted in the 1<sup>st</sup> International Conference on Software Architecture (ICSA 2017), held by Chalmers University at Gothenburg (Sweden). We gather the description of current and new research trends in different software architecture topics to provide a wide view to researchers and practitioners about the current status and trends in the field. ICSA is a premier software architecture conference that encompasses WICSA and COMPARCH conferences in one single event.

**Keywords**—software architecture, IoT, micro-services, organizational dimensions, architectural knowledge, decision making, automotive systems.

### I. INTRODUCTION

Much research has been done over the past 15 years in the software architecture field. The major software architecture conferences (WICSA, ECSA, COMPARCH, QoSA) and related workshops have been leading the research trends in the software architecting practice. Nevertheless, there are few summaries reporting the workshops and topics in software architecture such as in [1]. Workshops provide a unique forum for researchers and practitioners to present and discuss the latest research and development results, experiences, trends, and challenges in the field of software architecture. We therefore summarize in the short reports not only the topics and the workshops accepted for ICSA 2017 but also the main research topics and trends since 2010.

### II. ICSA WORKSHOPS

#### A. *International Workshop on Engineering IoT Systems: Architectures, Services, Applications, and Platforms (IoT-ASAP)*

The Internet of Things (IoT) includes billions of heterogeneous, distributed, and intelligent things—both from the digital and the physical worlds—running applications and services from the Internet of Services (IoS). Things span, for instance, RFID tags, sensors, computers, plants, lamps, autonomous robots, and self-driving vehicles. Often, things are connected through heterogeneous platforms also providing support for, e.g., data collection, management, and applications

deployment. Additionally, things can offer their functionalities as (web) services facilitating their dynamic interaction. A key aspect of engineering IoT systems is their architecture and a wide range of challenges needs to be addressed both at design and run-time. For instance: heterogeneity, adaptability, reusability, interoperability, uncertainty, security, and privacy while also taking into account the human in the loop bringing needs on the systems' functionalities and qualities. Novel software architecture principles are needed to overcome these challenges for IoT systems. The objective of IoT-ASAP, International Workshop on Engineering IoT Systems: Architectures, Services, Applications, and Platforms, is to bring together researchers and practitioners from several areas (e.g., Architecture, Internet of Things (IoT), Service-Oriented Computing, Self-Adaptive Systems, Multi-Agent Systems, User Interaction and Experience) to investigate and discuss state-of-the-art, principles, challenges of, and (interdisciplinary) approaches for, engineering IoT systems. A representative example of the topics and themes discussed in the workshop can be found in [2].

The workshop organized by *Romina Spalazzese, Marie Christin Platenius, Steffen Becker and Gregor Engels* can be found at: <http://groups.uni-paderborn.de/swt/IoT-ASAP/>.

#### B. *International Workshop on Architecting with MicroServices (AMS)*

Inspired by Service Oriented Architecture (SOA), and from the convergence of Cloud Computing and Web 2.0, Micro-service Architecture (MSA) has recently emerged as an architectural style particularly suitable to the adoption of cloud technologies and infrastructures. Companies like Netflix, Amazon, and The Guardian have evolved their applications towards a micro-service architecture. The MSA style is an approach to developing a single application as a suite of small services, each running in its own process and communicating with lightweight mechanisms. Although the set of MSA principles aims for high degrees of flexibility, modularity and evolution, adopting MSA in the real world is a challenging task and a long process. Even though the design principles around the micro-service architectural style have been identified, many aspects are still unclear or unexplored. The goal of **AMS 2017** is to gather researchers and practitioners to share challenges,

solutions, and reflections on the frontiers of architecting with micro-services.

This first workshop will play the specific role of investigating the state of the art and the state of the practice with respect to architecting with micro-services. The main objectives the authors want to achieve by running this workshop are, among others, assess the state of the research and practice on architecting with micro-services, create links and synergies between tool vendors, researchers, and practitioners working on micro-service architectures, identify needs and gaps in the software architecture community with respect to micro-services, set the basis for having a set of shared (industrial) case studies and benchmarks for assessing solutions for architecting with micro-services. Some of the research topics of interest include: techniques and methodologies for designing MSA, architectural description of MSA designs, approaches for migrating existing applications towards MSA, industrial practices and tools supporting the adoption of MSA. A representative example of the topics and themes discussed in the workshop can be found in [3].

The workshop organized by *Patricia Lago and Joost Bosman* can be found at: <https://ams2017.github.io/>.

### C. *1<sup>st</sup> International Workshop on the Social and Organizational Dimensions of Software Architecting (SODA)*

The focus of the SODA workshop is on the “soft” side of software architecture, i.e., the non-technical issues faced when architecting a software system. More specifically, the organizers of the workshop focus more on the role of the architect, rather than on architecting activities or the process of architecting. The primary goal of the SODA workshop is to provide one venue for researchers, practitioners and educators from the software architecture domain to jointly discuss experiences, synergies, forge new collaborations, and explore innovative solutions that address the challenges related to the role of the architect. In detail, the main goals of the workshop are: (i) to provide an open forum for discussions, (ii) to share knowledge and experiences, and (iii) to build and grow a community.

The SODA workshop aims at offering a venue for researchers, practitioners and educators within the software architecture domain to jointly discuss experiences, forge new collaborations, and explore innovative solutions in this area. This initial edition of the workshop focuses on two aspects related to the role of the software architect: (i) tasks performed and skills required from architects; (ii) the wider social and organizational contexts of the architect.

The SODA workshop is characterized by a strong multidisciplinary nature, with focus on the following topics: skills of architects, including evidence for their relevance and impact on project success and product quality; the impact of experience on how architects perform tasks; the tasks and skills of architects and their relation to tasks and skills of other roles (e.g., developers); the role of the architect in highly iterative/incremental development (e.g., continuous delivery and DevOps); personality and personality traits of architects, in particular in their social and organizational context; socio-technical and organizational relationships of architects at the

crossroads of organization, architecture and social development networks; social and organizational pitfalls and conflicts of interests faced by architects (and how to handle them); community smells in organizational context; social-technical project cost and social debt; job performance of architects, evaluation and assessment of architects and their skills and skill level; implications of skills and social/organizational context on tertiary education/professional training and career paths of architects. A representative example of the topics and themes discussed in the workshop can be found in [4].

The workshop organized by *Matthias Galster, Rick Kazman and Damian A. Tamburri* can be found at: <https://sites.google.com/site/1stsoda2017/>.

### D. *2nd International Workshop on decision Making in Software ARCHitecture (MARCH)*

Traditionally, software architecture is perceived as the result of the software architecture design process, the solution, usually represented by a set of components and connectors. Recently, the “why” of the solution, the set of design decisions made by the software architect, is complementing or even replacing the solution-oriented definition of software architecture. Till now, most of the research around software architecture design decisions focused on capturing the design decisions. Typically, research papers focused on tracing, representing, capturing and modelling design decisions (see for example the proceedings of successive SHARK workshops).

The focus of the present workshop, MARCH, is on the process of making these design decisions. In this workshop, we seek to explore and understand the decision-making process, how different factors influence the quality of software architecture decisions, and ways to assure good software architecture decision making. Decision making research is an emerging field in software engineering and software architecture. Applicable research papers that explore how to study decision making are relevant in this workshop. Understanding decision making process can be based on multiple scientific disciplines such as work and organizational psychology, cognitive psychology, behavioral economics, and human computer interaction. Some of the research topics of major interest for this workshop are: Cognitive, behavioral, and social aspects of decision making, Group and collaborative decision making, Decision communication, Methods and tools for decision making, Knowledge needed or helpful for decision-making and Organizational aspects of decision making. A representative example of the topics and themes discussed in the workshop can be found in [5].

The workshop organized by *Maryam Razavian, Antony Tang, Hans van Vliet and Jan Carlson* can be found at: <http://is.ieis.tue.nl/research/bpm/MARCH16/>.

### E. *Workshop on Automotive System/Software Architectures (WASA)*

The WASA workshop focusses on the system and software architecture of automotive systems. Indeed, the always increasing use of software over the years, is introducing a paradigm shift by requiring automotive companies to develop their systems using architecture and model-based techniques. Although model-based techniques, for example by using

Simulink<sup>1</sup> or Stateflow<sup>2</sup>, are being accepted in the automotive industry as standard languages and tooling for developing automotive control software, the techniques for system and software architecture are still far from being widely accepted except from the AUTOSAR<sup>3</sup> standard, which is used to create the software for the ECUs.

Goal of the WASA workshop is to address issues related to the appropriate automotive system/software architecture and engineering techniques, which can be accepted by the automotive industry.

The topics of interest of the WASA workshop include: automotive system/software architecture (architecture description languages, experiences of applying AUTOSAR standard, integration of software and hardware components, communication infrastructures etc.); automotive software quality; automotive software safety; automotive component-based software engineering; model-based automotive software development; automotive software engineering techniques; automotive reverse engineering; software engineering techniques for autonomous driving vehicles (processing big data generated from all the sensors in the autonomous driving cars, ...); software engineering techniques for hybrid and fully electric vehicles; novel software engineering approaches in automotive SE (e.g. continuous integration, software ecosystems). A representative example of the topics and themes discussed in the workshop can be found in [6].

The workshop organized by Andreas Vogelsang, Harald Altinger, Mirosław Staron, Yanja Dajsuren and Yaping Luo can be found at: <http://www.win.tue.nl/wasa2017/>.

### III. EVOLUTION OF SOFTWARE ARCHITECTURE TRENDS

There have been many workshops organized in different software architecture conferences along the past years. Nevertheless, while some topics die very quick others have been adopted as mainstream topics in WICSA, ECSA, QoSA, COMPARCH and now ICSCA conferences. As new challenges arise for this community, new research trends and topics emerge too. In Table I we want to summarize and highlight the different research topics and trends around the workshops help since 2010 and independently of the conference supporting them, as a quick overview of what has been proposed and discussed and what new research directions are emerging.

TABLE I. SOFTWARE ARCHITECTURE WORKSHOPS

Workshop	Conference	Topic	Years
EcoSys	ECSA	Software Ecosystems	2010
IWSECO			2014
WEA			2015
			2016

MeSSa ISSA	ECSA	Security and safety in SA	2010 2014 2016
NW-MODE ACVI	ECSA WICSA	Model-driven Engineering	2010 2016
VARI-ARCH SAVA VARSA VAQUITA	ECSA WICSA/ECSA	Variability in SPL architectures Variability in SA Variabilities for qualities in SA	2010 2011 2012 2014 2015
WISAD FoSADA	ECSA QoSA	Imperfect information in SA design SA design assistants	2010 2015
TDSA	ECSA	Traceability and dependencies in SA	2011
SHARK APKDD SAADM QRASA MARCH	WICSA/ECSA ECSA WICSA	Reusing AK Architectures and platforms for knowledge discovery SA in decision making Reasoning in SA	2012 2015 2016 2017
AGSE	WICSA/ECSA	Architectures for global software engineering	2012
DAD	ECSA	DSL architecting	2014
SESoS	ECSA	Software engineering for systems of systems	2013 2014
ASDS SANCS	ECSA	Self-managing distributed systems Cyber-physical systems	2015
WESEE WSA SESAW SODA	ECSA	Enhancing software engineering education Women in SA Profession of software architect Social and organizational dimensions	2015 2016 2017
SAM SAEroCon	WICSA ECSA	Software architecture metrics	2014 2015

<sup>1</sup> <https://www.mathworks.com/products/simulink.html>

<sup>2</sup> <https://www.mathworks.com/products/stateflow.html>

<sup>3</sup> <http://www.autosar.org>

SaGRA		Architecture erosion Architecture sustainability	2016
WASA	WICSA/QoSA WICSA	Automotive SA	2015 2016 2017
CoBRA	QoSA	Component-based techniques	2015
ACCAS DaSCCA IoT-ASAP AMS	WICSA	Architecting cloud computing Dependable and secure architectures Architectures and services, micro-services	2011 2012 2017
ABA	WICSA	Architecting-based testing	2011
STDS	WICSA	Standards for software architecture	2011

We can consider workshop who have died or attracted less interest those which only 1 edition and those others with 2 editions before 2016. Workshops with 3 editions or more since 2010 are more popular. Hence, from our perspective, the most popular topics (some of them may have become mainstream topics in any of the software architecture conferences and are no longer organized or they appear with a different name) are:

- Software ecosystems
- Security and safety in software architecture
- Software variability
- Architecture knowledge
- Professional, organizational and social aspects
- Architecture metrics and sustainability
- Automotive in software architecture
- Cloud computing and service architectures

We are aware that some important topics like systems-of-systems and cyber-physical systems are important topics organized as workshops in other software engineering conferences. In addition to the analysis of the most popular topics in software architecture workshops, there are other interesting research issues and to the best of our knowledge, not organized before as a WICSA/ICSA/ECSA/COMPARCH/QoSA workshop. Among new hot research areas in software architecture we could cite: DevOps approaches, architectures for smart vehicles, Drones and swarm systems, blockchain-based systems, and context-aware architectures among others.

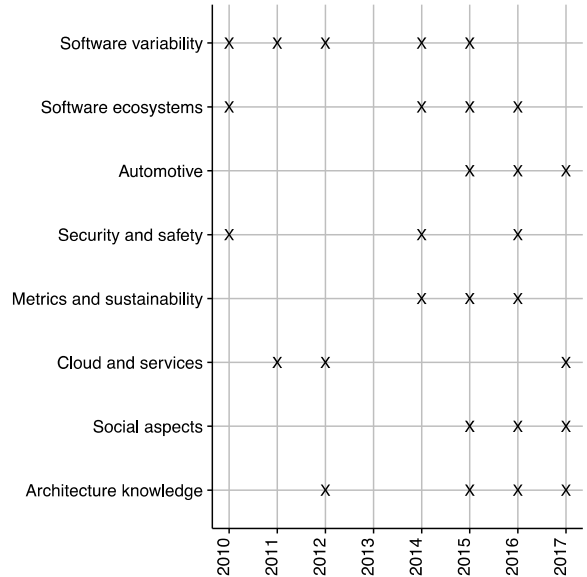


Fig 1. Trends of most popular software architecture topics.

We hope this summary has serve to report not only the summary of ICSA 2017 workshops accepted but also as an analysis of most popular research topics in software architecture since 2010 and to provide trends and new research paths for the future.

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