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Large-Scale Complex IT Systems

Development, Operation and Management

17th Monterey Workshop 2012
Oxford, UK, March 19-21, 2012
Revised Selected Papers

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Preface

It is a great pleasure to introduce the proceedings of the 17th Monterey Workshop, held in Oxford, UK, during March 19–21, 2012. Attended by leading researchers from academia and industry, the workshop explored the challenges associated with the development, operation, and management of large-scale complex IT systems.

Large-scale complex IT systems underpin key critical applications in domains ranging from health care and financial markets to manufacturing and defence. Such systems are created and evolved dynamically through the integration of independently built and controlled heterogeneous components. As a result, traditional techniques, which assume complete control over the parts of a system, are inadequate in supporting the dependable engineering of important safety-, security-, and business-critical requirements.

The revised and significantly extended papers included in this volume incorporate the insights gained from the productive and lively discussions at the workshop, and the feedback from the post-workshop peer reviews. The volume has three parts. Part I focuses on identifying the challenges and risks faced by the developers, operators, and users of large-scale complex IT systems. The papers in this part examine the current and envisaged use of such systems in domains including cyber-physical systems, global financial markets, health care, teams of autonomous vehicles, and air traffic control.

Part II of the volume covers the model-based engineering of different aspects of large-scale complex IT systems. The papers included in this part explore a broad range of approaches to addressing the uncertainty, continual change, large scale, security concerns, and compositional and distributed nature that characterize these systems. Multi-view, multi-disciplinary, domain-specific, security, and multi-agent responsibility modelling approaches are identified as promising in handling such hard problems, and research agendas for turning them into fully fledged solutions are laid out by these papers.

Finally, Part III explores avenues for extending the use of formal specification, analysis, and verification to large-scale complex IT systems. The approaches envisaged to help achieve this ambitious objective include formal techniques that are incremental, modular, compositional, or which exploit extreme symmetries, quantitative steering, and independent viewpoint implementability.

We would like to thank UK's national research and training initiative in the science and engineering of Large-Scale Complex IT Systems (LSCITS) and its Director, Dave Cliff, for their generous sponsorship of the workshop. We are also grateful to the General Chairs, Luqi and Bill Roscoe, for their support in the organization and smooth running of a very successful workshop.

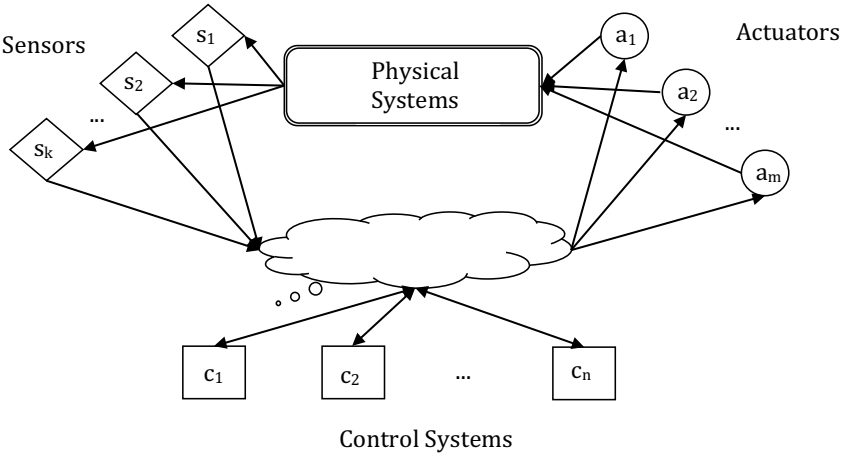
July 2012

Radu Calinescu
David Garlan

Message from the Monterey Workshop General Chairs

Oxford, in Strachey, Hoare and others, has an outstanding history in advancing programming language semantics, program verification, and the theory of concurrent computing. It maintains its strength in these areas and newer ones such as security and information systems, all of which made it natural to hold the 17th Monterey Workshop there between 19th and 21st March 2012.

Awareness of the importance of system integration has spread, and the economy and society of our interconnected world has become increasingly dependent on complex interacting systems. Such systems may incorporate networked multitudes of people, information services, physical components, sensors, software controllers, and actuators that affect the physical components. Examples of sectors relying on such systems include energy, transportation, manufacturing, defense, and medicine.



Cyber Physical Systems (CPS) are engineered systems comprising interacting physical and computational components [1]. Emerging CPS will be coordinated, distributed, and connected, and must be robust and responsive [2]. Potential applications span an amazing variety of contexts, from swarms of nano quadrotors to robotic surgery. Many of these applications impact the safety and well-being of societies and individuals. Therefore high integrity, predictable operation, compositional and iterative verification, and complex systems in the cloud are all relevant.

The need for dependable operation of systems that integrate heterogeneous components, continuously evolve, and have decentralized ownership and control has expanded yet again the challenges that the field of software engineering must address, introducing connections to subjects beyond its traditional scope, such as complexity in organizations, socio-technical engineering, and cyber-security.

The workshop itself was held in the Randolph Hotel, the setting of numerous episodes of Inspector Morse. It brought together a wide range of research relevant to complex heterogeneous systems, including approaches to developing them, securing them, verifying them, and taming their complexity. Others dealt with design and specification of systems with respect to multiple viewpoints, and how to combine these. It was natural that several of the papers addressed healthcare issues since healthcare IT provides some of the most complex and important examples of cyber-physical systems and complex distributed information systems.

It was wonderful to see the interactions and integration of advances from software engineering and many related fields coming together, following the culture and tradition of the Monterey Workshop series. We thank the program committee chairs Radu Calinescu from York and David Garlan from CMU for putting together a fascinating workshop program. Janos Sztipanovits initiated CPS as the workshop topic, Fabrice Kordon produced the beautiful website and years of collectable posters, and the Oxford hosts handled innumerable details.

The Monterey Workshop steering committee would like to thank the sponsors for their support of the Monterey Workshops, with special thanks to the UK's national research and training initiative in the science and engineering of Large-Scale Complex IT Systems (LSCITS) and its Director, Dave Cliff, for making this 17th Monterey Workshop possible. Many of the Monterey Workshop themes in the last two decades have subsequently blossomed into major research initiatives and widespread applications:

0th: Research Review on Formal Methods in Software Engineering: Concurrent and Real-time Systems, Monterey, California, 1991
1st: Computer-Aided Prototyping: CAPSTAG, Monterey, California, 1992
2nd: Software Slicing, Merging and Integration, Monterey, California, 1993
3rd: Software Evolution, Monterey, California, 1994
4th: Specification Based Software Architectures, Monterey, California, 1995
5th: Requirements Targeting Software and Systems Engineering, Bernried, Germany, 1997
6th: Engineering Automation for Computer Based Systems, Monterey, California, 1998
7th: Modeling Software and System Structure in a Fast Moving Scenario, Santa Margherita Ligure, Italy, 2000
8th: Engineering Automation for Software Intensive System Integration, Monterey, California, 2001
9th: Radical Innovations of Software and Systems Engineering in the Future, Venice, Italy, 2002
10th: Software Engineering for Embedded Systems: From Requirements to Implementation, Chicago, Illinois, 2003
11th: Software Engineering Tools: Compatibility and Integration, Vienna, Austria, 2004
12th: Realization of Reliable Systems on Top of Unreliable Networked Platforms, Irvine, California, 2005
13th: Composition of Embedded Systems: Scientific and Industrial Issues, Paris, France, 2006

14th: Innovations for Requirement Analysis: From Stakeholders' Needs to Formal Designs, Monterey, California, 2007
15th: Foundations of Computer Software, Future Trends and Techniques for Development, Budapest, Hungary, 2008
16th: Modeling, Development and Verification of Adaptive Systems, Redmond, Washington, 2010
17th: Development, Operation and Management of Large-Scale Complex IT Systems, Oxford, UK, 2012
18th: Cyber Intelligence and Security, Washington DC, 2013

The coming 18th Monterey Workshop will discuss challenges associated with the modeling, design, evaluation, and monitoring of cyber and cyber-physical systems, assess engineering techniques, and explore future research topics. Cyber- is a prefix derived from "cybernetic," which comes from the Greek adjective $\kappa\upsilon\beta\varepsilon\rho\nu\eta\tau\iota\kappa\acute{o}\varsigma$ meaning skilled in steering or governing [3]. Cyber and cyber-physical systems are being networked to perform critical functions and to evolve into the global superstructure:

- Accurately modeling the cyber-social context is a prerequisite for systems aimed at gathering, processing, storing, analyzing and using cyber data intelligently to support decisions.
- Document processing and data synchronization are needed to derive real-time intelligence from ongoing events in complex networked systems.
- Secure architecture and firm technical foundations are necessary to enable such systems to adapt to a changing world while maintaining reliable operation.
- Establishing abstractions to understand, predict, and build systems with optimized security and real-time intelligence should facilitate security and reliability of cyber and cyber-physical systems.

Prof. Sadie Creese, Director of the Oxford Cyber Security Center, and Dr. Doug Lange will be the program committee chairs of the 18th Monterey Workshop on Cyber Intelligence and Security in 2013.

July 2012 Luqi & Bill Roscoe

References

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2. Cyber-Physical Systems, National Science Foundation, USA
3. http://en.wikipedia.org/wiki/Internet-related_prefixes

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