

Widening Systems Engineering Borders (WiSEB) – 2nd edition

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Abstract—This paper summarizes three contributions in the session of the second edition of the Special Track “Widening Systems Engineering Borders”. The research work deals with the following key issues of this track:

- **Innovative concepts to introduce systems engineering best practices in the development process;**
- **A capability-based approach to design;**
- **Internet of Things (IoT) increased security for Near Field Communication (NFC);**
- **Cyber-Physical Systems (CPS) solutions in a process-centric organization and Digital Twin (DT) technology.**

This publication shows that the contributions in this track address research questions that are of high importance for industrial practice as well as current research directions.

Keywords: systems engineering, internet of things, cyber-physical systems, model-based systems engineering, near field communication, digital twin, ontology, IoT, MBSE, NFC.

I. INTRODUCTION

Products and systems are getting increasingly connected and complex as part of larger Systems-of-Systems (SoS). Our expectations of the performance, reliability, safety, security, and cost-effectiveness related to SoS are increasingly high.

So, why do we need to extend systems engineering adoption? Isn't it enough?

Systems Engineering is needed more than ever as our world is becoming more and more connected at all levels of society across all demographics. The speed of technology change is ever increasing, showing the criticality introduced by interoperability, interdependencies, vulnerability, ownership and safety. Complex interacting systems are part of our daily life, therefore complexity is no longer seen as a risk to be managed but a means to enhance the quality of life and the ability for industry/services to generate value.

Systems engineering is promoting a holistic approach by definition; how can we push forward its concepts and have a wider adoption of its fundamentals?

WiSEB goal is to focus on how systems engineering is fruitfully applied in different fields, even traditionally reserved to non-engineers, the issues related to such extension and the blockers related to its broader adoption.

Defense, automotive, Internet of Things (IoT) and medical industries are keen to systems engineering practices, but with different levels of adoption depending on company population and range of action; business development, sales and customer service are usually not involved in systems engineering practice, as an example. We set the goal to expand the benefits of systems engineering to new professionals, enriching the practice with cross-fertilization.

Moreover, complex systems have no-longer strict sector boundaries and crossing those boundaries (e.g., openness to civil society, social-technical involvement, etc.) opens the doors to a wide range of opportunities and new challenges that we would like to address.

II. SUBMISSIONS

WiSEB 2021 enlists three contributions:

- «A Capability Based Approach for Warship Design» presented by Prof. Paola Gualeni (DITEN – University of Genoa, Italy), Lucio Tirone, Maria Giovanna Scognamiglio and Paola Bonofiglio (Fincantieri S.p.A. - Genoa, Italy)
- «Chaotic based Security for Near Field Communication in Internet of Things devices» presented by Colin Sokol Kuka, James Chandler and Mohammed Alkahtani (University of York, The City of Liverpool College – UK)
- «Enabling Business Analysts to implement Cyber-Physical Systems (CPS) solutions using a Model Based approach» presented by Tommaso Panetti (Tor Vergata University – Rome, Italy), Ivan Famoso, Giulio Telleschi (AISE INCOSE Italy), Prof. Andrea D’Ambrogio (Tor Vergata University – Rome, Italy)

The paper about «A Capability Based Approach for Warship Design» [1] moves from the evidence that

traditional Naval Warship design is based on a rather sharp separation between two domains: the Platform and the Combat System. Naval engineers are primarily concerned with the Platform, with tight interaction with other disciplines such as mechanical and electrical engineers. On the other hand, Combat Systems engineers are more concerned with the technological component of the Warship, working in tight coordination with electronic, software or telecommunications engineers. The resulting system (the Warship) is often closer to a Federation of Systems, with more or less controlled interactions among each other, rather than to a truly integrated system. The focus of this paper is to present a novel approach to the design of a Warship that avoids the a-priori distinction between Platform and Combat System, but considers the Warship as a single, coherent whole. Thus, the approach shifts the focus on the level of the whole warship's capabilities, and its related measures of effectiveness and performance, rather than on its components and subsystems. The aim of such effort is to increase the mutual awareness of the problems specific of each of its components among the entire range of teams called to design, develop, produce, integrate, test and maintain a system as complex as a modern Warship.

The paper about «Chaotic based Security for Near Field Communication in Internet of Things devices» [2] starts with the concern on the security of wireless systems has become a growing challenge resulting from the expansion of the Internet of Things (IoT) into everyday life. Despite the many advantages driving the adoption of IoT devices, their proliferation increases the surface susceptible to advanced attacks that aim to misuse their resources and cause interruptions, delays, losses and degradation of the offered services in IoT. This paper introduces a chaotic transmission for Near Field Communication (NFC) Topology, based on the Wireless Power Transfer (WPT) systems. Traditional WPT circuits are based on inverters to create an oscillation for the transmitter coil. This results in systems relying only on software security. Therefore, we have introduced this topology which adopts chaotic encryption for NFC security. Furthermore, the proposed system is immune to man-in-the-middle (MitM) attacks. The simulation results and tests prove the functionality of the chaotic WPT based on the Chua's diode and their synchronisation between transmitter and receiver. The chaos generated is sampled by an electronic board and can be used for cryptography coding based on Python. The application for this system is a new NFC digital code for accessing the IoT services.

The contribution «Enabling Business Analysts to implement Cyber-Physical Systems (CPS) solutions using a Model Based approach» [3] recalls that it is widely perceived that Cyber-Physical Systems (CPS) solutions still have to provide their peak in terms of social and market benefits. In

addition, market available solutions do not allow business analysts to evaluate easy to understand process descriptions at design time, before committing the resources for process implementation.

In such context, the vision behind the contribution consists in enabling Business Analysts to implement CPS solutions using a Model Based approach and increase the level of automation through model transformations.

III. CONCLUSION

WiSEB 2021 collected contributions from a wide range of points of view, such as:

- Topic – IoT, MBSE, processes and security;
- Application – industrial product, research topic and application to R&D/production;
- Provenience – academia (University of Genoa, University of York, Tor Vergata University and The City of Liverpool College), industry (Fincantieri) and systems engineering association (INCOSE Italy).

It is a pleasure to highlight that all contributions come from cross-fertilization between mixed teams, as all systems engineering activities are expected to be. The research community as a whole will be able to get positive responses to key questions with a mix of practical and theoretical approaches that are part of all the contributions.

IV. ACKNOWLEDGMENT

My great thanks go to ICONS 2021 organizers for the confirmation of this special track in the conference for the second year. This includes the considerable administrative effort, due to the extra effort required to manage a conference during the pandemics.

Special thanks go to ICONS Steering Committee, which I take part for the first time, for creating a stimulating environment and setting up a conference with many interesting contributions.

Without the authors this track would not exist. Deep thanks for the very interesting contributions and the willingness to publish and present them.

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