Universitatea
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HABILITATION THESIS

SUMMARY

Title: Research on the Integration of Computing and Communication Systems

Domain: Electronic Engineering, Telecommunications and Information Technologies

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BRAŞOV, 2023

The habilitation thesis entitled "*Research on the Integration of Computing and Communication Systems*" presents the scientific achievements of the author after obtaining the scientific title of PhD in the field of electronic engineering and telecommunications (2011) focusing on the research elements implemented during the period when the author worked at the Faculty of Electrical Engineering and Computer Science.

In part (B-i), the habilitation thesis addresses a research topic in the field of Electronic Engineering, Telecommunications and Information Technologies that refers to the integration between computing and communication systems. Since the first GSM telecommunications networks, with the help of the unifying element represented by packet switching ("all-IP"), systems have evolved towards complex, distributed integrated platforms with high mobility needs, capable of serving a wide range of communication services. The evolution of complexity and types of communication services, based on new technologies, has also implied the implementation of new methods for mobility management, for automated orchestration of real/virtualized/emulated infrastructure and testing/instrumentation elements, as well as ways for creating and integrating communication services. The integration at the level of generic hardware-software platforms, the evolution of virtualization technologies and the migration to Cloud and network functions implemented in software have brought new challenges and requirements at the level of cyber security solutions. Another development of computing and communication systems is represented by the introduction of machine learning algorithms, with roles ranging from automation / orchestration, decision support, behavioral analysis methods, to complex artificial intelligence algorithms.

The scientific achievements covered by the habilitation thesis were published in 11 ISI journal articles (of which 8 in Q1 and Q2), 25 ISI indexed articles and 12 articles in other recognized international databases.

Chapter 1, entitled *"Solutions for computing and communication systems integration",* is dedicated to the integrative element with the greatest impact: software orientation of solutions and services. That is why technologies considered disruptive in the area of integration between computing and communication elements are called "*software-defined", (*where the term "defined" includes the meanings *"created, configured, modeled, orchestrated*") and next to them join terms defining the network area where software technologies are applied:

1. For the Radio *Access* area we have the concept of Software Defined *Radio* (SDR)
2. For the *Core* Network area we have the concept of Software Defined *Network* (SDN)

"Software defined" means reconfigurable, easy to integrate and deploy in virtualized systems and in the Cloud, easy to migrate and scale, often using open APIs, thus encouraging innovation and large-scale testing. Thus, two subchapters presenting research in the field are pursued: one dedicated to the core network that includes SDN concepts and one dedicated to the access network that includes SDR concepts.

Chapter 2, entitled "*Cyber Security of Computing and Communication Solutions and Services*" presents cyber security solutions from two perspectives of the author's professional activity: first, the didactic and continuous development perspective presents a series of contributions from the role of founder and coordinator of the master's program "Cybersecurity", which also includes the stages of building a reconfigurable and versatile cybersecurity lab, as well as the coagulation of a local technology hub initiative called "Brasov CyberHub", second, the perspective of implementing innovative solutions for securing computing and communication solutions and services – which represent a series of HW / SW implementations, some of them based on open source solutions. The chapter presents a series of contributions following the principles of the concept of "Defence in Depth", which aims to apply security methods at different levels, from enduser and terminal to communication elements and peripheral network. The solutions presented also include various

methods of assessing/auditing the vulnerabilities of a system, preventing possible cyberattacks, managing and responding to cyber security incidents, as well as forensic investigation of incidents.

Chapter 3, entitled *"Integration of artificial intelligence elements into computing and communication systems*", presents implementations with contribution of artificial intelligence that produce evolution for computing and communications systems with increased complexity, meeting high demands of processing and security. Artificial intelligence can be integrated at various decision-making levels in computing and communication systems, observing over time the migration of processing power from centralized models (Cloud) to elements at the edge (Edge) or to the support of distributed IoT elements.
Thus, the chapter begins with the description of an implementation carried out within the European project H2020 SARMENTI, aiming to integrate IoT communication and intelligence elements for eAgriculture or assisted agriculture, focusing on the implementation area of the analysis and decision support system.
Artificial intelligence ensures process optimization and can make an essential contribution to streamlining critical and emergency services, such as 112 systems. Such an implementation is the one from the ODIN112 project financed through the UEFISCDI Solutions mechanism, whose implementation details are presented.
Another research describes the implementation of a system that identifies modulation of complex radio signals. This is achieved using an artificial intelligence model developed, trained and integrated into the Microsoft Azure Cloud.
The case study on a complex instrumental configuration around a diesel engine test bench shows asmart device dashing based *on state control*, extended to ECUs (Electronic Control Units) equipped with *real-time* diagnostic capabilities and *optimal decision-making. Parameterization* (instantiation) can be *adaptive* (especially through ANN), and all transitions required for state control (at the level of algorithmic state machines, ASM – Algorithmic State Machine) can be decided with *classifiers* and other means of artificial intelligence.

Part (B-ii) presents the evolution and professional achievements of the author (academic, didactic and research and development) and the professional academic development plan, with the definition of research objectives in the field of communications and cyber security and didactic objectives.