

## FROM 20 YEARS TO THE NEXT

L'Aquila, November 16<sup>th</sup>, 2022

### ***A FORMAL APPROACH FOR RAILWAYS INTERLOCKING APPLICATIONS***

**ABSTRACT:** Many railways interlocking systems are still based on electromechanical solutions. They are hard to understand and costly to modify and can be considered legacy systems. In this talk I will present the research underlying a novel process for the development of interlocking applications. The proposed methodology is able on one side to analyze and reverse-engineer legacy relay-based interlocking systems, and on the other to support the specification and verification of interlocking procedures by means of a model-based methodology. Research challenges range from modeling and verification of continuous-time, real-valued transition systems, automated abstraction for reverse engineering and specification mining, automated test generation, and parameterized verification.

**BIO:** ALESSANDRO CIMATTI is the director of the FBK Center for Digital Industry. A researcher since 1990 with ITC-Irst, from 2006 to 2020 he has been the head of the ICT Center's Embedded Systems (ES) research unit at FBK. Author of 220 papers in the fields of formal methods and artificial intelligence, for his fundamental works on Bounded Model Checking and on Satisfiability Modulo Theories, Cimatti has received the TACAS 2014 Most Influential Paper award, the ETAPS 2017 Test of Time award and the CAV Award in 2018 and 2021. He has been the leader of several technology transfer projects, including research projects funded by the European Union, the European Space Agency and the European Railway Agency, as well as of industrial collaborations with RFI, SAIPEM and Boeing.

### ***FRACTIONAL STOCHASTIC DIFFERENTIAL MODELS OF GLUCOSE CONTROL***

**ABSTRACT:** Fractional differential equations may be used to summarize, with an order that can in principle be estimated from data, different (presumably integer-order) interacting controls or influences upon the observed variable of interest, especially if the information content of the observations is relatively small compared to the complexity of the system of interacting variables. This is the case, for example, of transcutaneously measured glycemia, where besides glycemia itself (possibly decaying by first-order elimination) also unobserved factors (insulinemia, other hormones) may exert higher order effects. The problem is complicated by the fact that random events (food intake, exercise, emotions) may affect glycemia as well, leading to the formalization of the problem as a Fractional Stochastic Differential Equation (FSDE). We exemplify the use of simple FSDE models of glycemic control and undertake model parameter estimation in this framework. The difficulties in dealing with a numerically daunting task, while attempting to adhere to a physiological interpretation of the available data, are described.

**BIO:** ANDREA DE GAETANO is a biomathematician with Director of Research (full professor) tenure with CNR since 2001, currently working as Director of the CNR Institute for Biomedical Research and Innovation. A certified emergency surgeon by training (Italy), he attained both M.Sc. (USA) and Ph.D. (France) degrees in Applied Mathematics, is a J.D. with Italian Bar license and Doctor Honoris Causa (Statistics). He is Adjunct Professor of Mathematical Statistics, Mahidol University Dept. of Mathematics, Bangkok Thailand and Distinguished Professor (Full Professor with research endowment) with Obuda University, Budapest. His research interests focus on the mathematical modelling of physiological systems with ODEs, Stochastic and Fractional differential equations, and on the attending estimation of the model parameters from experimental observations. He has published so far over 200 full-length papers on international peer-reviewed journals, largely on the mathematical modelling of energy metabolism (Google Scholar metrics: 250 documents, 10125 citations, h-index 44). He has taught Mathematical Statistics at the Universities of Urbino,

Copenhagen and Mahidol Bangkok. He has obtained approx 5.1 MEuro funding for research through a series of EC-financed FP and H2020 projects, foreign financed grants and several Italian projects (Ministry of Research, Ministry of Defense). He has been president of the European Society for Mathematical and Theoretical Biology, as well as Italian National Academic delegate at the NATO Scientific and Technical Organization, Human Factors and Medicine Panel and at the European Defense Agency, Captech Simulation.

### **ADDRESSING COMPLEXITY IN CONTEMPORARY CONTROL APPLICATIONS VIA DATA-DRIVEN AND DISTRIBUTED OPTIMIZATION**

*ABSTRACT:* Motivated by applications in the energy domain, we shall discuss the key role of data-driven and distributed optimization in addressing the challenges posed by the presence of uncertainty and the large-scale structure of the involved systems. In particular, we shall present recent results on stochastic control with probabilistic constraints and decision making for multi-agent systems characterized by both discrete and continuous decision variables.

*BIO:* MARIA PRANDINI received the laurea degree in Electrical Engineering, summa cum laude, from the Politecnico di Milano in 1994, and the Ph.D. degree in Information Technology from the University of Brescia in 1998. She was a postdoctoral researcher at the University of California at Berkeley from 1998 to 2000. She also held visiting positions at Delft University of Technology (1998), Cambridge University (2000), UC Berkeley (2005), and ETH Zurich (2006).

In 2002, she joined the Department of Electronics, Information and Bioengineering at the Politecnico di Milano, where she is Full Professor since 2018. She is currently Chair of the Automation and Control Engineering Program.

She was elected Fellow of the IEEE in 2020 and IEEE Control Systems Society Distinguished Member in 2018. Since January 2022, she is Visiting Professor in Engineering at the University of Oxford for a period of 3 years. She is and has been active in the IEEE Control Systems Society (CSS), the International Federation of Automatic Control (IFAC), and the Association for Computing Machinery (ACM), contributing to their activities in different roles. She is currently IFAC Vice-President Conferences for the triennium 2020-23. In 2022, she has been elected IFAC President for the triennium 2026-2029.

Her research interests include stochastic hybrid systems, randomized algorithms, distributed and data-driven optimization, multi-agent systems, and the application of control theory to transportation and energy systems.

### **EDGE CLOUD COMPUTING IN TELCO NETWORKS**

*ABSTRACT:* The presentation analyzes the main Telco domestic networks' objectives and issues related to the application services performance (or technical quality) and the economic sustainability of the Ultra Broad Band (UBB) and Very High Capacity (VHC) networks. Application services are managed end-to-end between the end-user devices and the servers/clouds, that provide the services. Then the services performance depends on two Internet segments: Telco domestic networks and Over the Top (OTT) networks/clouds.

OTTs can manage effectively and efficiently the application services technical Quality of Experience (QoE) and have economic sustainability. On the contrary, Telcos had severe difficulties with application services quality and economic sustainability since the advent of UBB services. In many cases, Telco networks limit the applications quality. An example: video streaming provided by OTTs (e.g., Netflix, Amazon Prime, and DAZN) to the Telcos has different resolutions from lower than standard definition (SD) to higher than full high definition (full HD) and up to full 4K ultra-high definition (full UHD). However, only a 'small' number of Telcos' end-users today experience full HD quality.

OTTs are focused on application services, Telcos are mainly focused on network services, i.e. on the transport of IP packets. Moreover, Telcos obtain performance improvement by traffic management techniques (QoS-

based), such as bandwidth reservation and packet prioritization, that work at Layers 2 and 3 of the IP-IETF protocol stack. However, as shown by the multiyear experience of OTTs, this approach is not effective to improve application performance. Layer 4 techniques and Edge Cloud Computing (ECC) can

- provide much better services performance
- reduce, in many cases, network costs significantly
- enable UBB/VHC monetization.

Application performance is limited by the minimum between

- the available Bit Rate (BR, is the speed, in Mbit/s, of the communication channel and is the upper value for the Through, TH. TH is the speed of the application)
- the 'distance' end-to-end (from the end user device to the server) measured by network KPIs (such as Round Trip Time, RTT, and Packet Loss, PL)

To guarantee the services quality requirements the available BR has not to be the 'bottleneck', and, in many cases, the 'distance' must be reduced. The ECC reduces the 'distance' by distributing (on mini/micro data centers) the applications (part of the applications) closer to the end users.

Some Telcos started changing the network architectures, although the massive transformation has still to begin, and the TLC Regulation Authorities have not yet fully supported the transformation based on ECC architecture.

The speech presents:

- 'why' ECC platforms must be deployed in Telco Networks
- some comments and case studies on
  - the mathematical models
    - to evaluate applications performance improvement
    - to evaluate the conditions for and the network cost savings
    - to solve the ECC location problem, i.e. to define, given the services and saving trade off requirements, 'where' to deploy the ECC platforms
  - the impact of ECC on the economic sustainability for the Telco's UBB/VHC networks

*BIO:* GIANFRANCO CICCARELLA received the University Degree in electrical engineering at the University of L'Aquila, carried out research and teaching at the University of L'Aquila and worked in the telecommunications and information technology (ICT) sector in companies of the Telecom Italia Group, with technical and managerial responsibilities. Since January 2016, he started a consultancy activity in the ICT sector (definition of strategies, business positioning, evolution of architectures and services for Ultra Broad Band and Very High-Capacity networks). In the Telecom Italia Group, he held positions and responsibilities, including Corporate CTO for Telecom Argentina and TIM Brazil Companies, Vice President for Next Generation Access Networks (NGAN) and Partnerships at the Strategy Department of Telecom Italia, and Telecom Italia Sparkle CTO and CIO with responsibilities to drive the design, deployment, and operations of the Telecom Italia International Wholesale Services and Network. He was a member of the Board of Directors, the CEO, and the Chairman for companies within the Telecom Italia Group and a member of the Akamai Advisory Board. He was the Director of the Post Graduate Training and Technical Department, "Scuola Superiore Guglielmo Reiss Romoli," L'Aquila, Italy, did research and teaching at the EE Department, University of L'Aquila, Italy (where he became an Associate Professor), and was an Adjunct Associate Professor at New York Polytechnic University, NY, USA. He has authored several ten articles and was invited many times to deliver speeches to international conferences and round tables.