BOOK OF ABSTRACTS

IEEE HPSR®
IEEE International Conference on High Performance Switching and Routing
7-10 June 2021 // Paris, France // Hybrid On-line Conference

June 2021

PARIS, FRANCE
Message from the Conference General Chair and Conference General Co-Chair

On behalf of all HPSR committee members, we welcome you to IEEE HPSR 2021, 22nd Conference on High Performance Switching and Routing held in Paris from 7th to 10th of June 2021. This hybrid (in person and virtual) HPSR conference is sponsored by the IEEE Communications Society.

This edition focuses on the new trends of the new generation networks and telecommunication and addresses numerous challenges in these areas driven by cloudification, virtualization, softwarization, Internet of things and data science. HPSR focuses on how smart communications and cloud application impact not only on network technologies (protocols, equipment, algorithms, power, MANET, VANET, etc.), but also on creating collective and individual awareness about the multiple sustainability threats which our society is facing nowadays at social, environmental and political levels, considering a wide family of applications (healthcare, underwater, vehicular, robotic, economics, ...). These are only some of the factors that are driving the demand for switching and routing capabilities that are more intelligent, efficient, and reliable than ever before.

Therefore, a major outcome of this conference is to provide researchers and designers a better understanding of real-world challenges for new communication technologies and enable them to develop innovative solutions to address such challenges. As part of the technical program, the conference has 3 Keynote speakers, 2 invited sessions with 8 invited speakers, 1 panel session, 7 technical sessions, 2 Short track sessions, 3 Workshops, and 2 Tutorials.

We would also like to thank all the authors, keynote speakers, panelists for making great effort of sharing innovative minds and research results, industry trends and to all the participants, the academic and industry communities. In the meantime, we would like to express many sincere and special thanks to the HPSR 2021 Organizing Committee, Technical Program Committee, Operations Committee and all volunteers for their devotion, vision, courage, passion, and constant effort to make this conference a success.

Last, but not the least, many special thanks for sponsoring and supporting the HPSR 2021 Conference go to the conference partners: Huawei, Futurewei, UPEC, UPEC/EPISEN/IT4H (ITS), ESME SUDRIA and TincNET/LISSI.

We hope that the HPSR 21 conference provided an interesting and up-to-date scientific program. We also hope that all participants enjoyed this exciting in person and online event, the French hospitality and the beautiful city of Paris, even the situation, due to COVID context, imposes to us a lot of hard constraints.

Together, we make this HPSR 2021 Conference a successful event!

Sincerely,

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Pr. Abdelhamid Mellouk
UPEC, France

General Co-Chair

Dr. Abdulhalim Dandoush
ESME-Sudria Paris, France
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IEEE HPSR’21 Conference Program

Day 1: Monday, June 7 - Location: 34 rue de Fleurus, 75006 Paris

Technical Program: 09:15-19:30

HPSR Opening: 09:15-09:30

Abdelhamid Mellouk (Université Paris-Est Créteil, France)
Abdulhalim Dandoush (Esme Sudria, France)
Hassine Moungla (Université Paris, France)
Thiago Abreu (Université Paris-Est Créteil, France)
Scott Fowler (University Linkoping, Sweden)

Keynote: 09:30 – 10:30

Keynote Presentation: Merouane DEBBAH, Huawei France
Title: “From Connected Things to Connected Intelligence”
Session Chair: Abdelhamid Mellouk (UPEC, France)

The standardization for 5G wireless systems is maturing and researchers around the world have already started to look beyond the 5G systems. Although the next G gossip is at a premature stage, this talk aims to provide an overview of the vision, challenges and key enabling technologies envisioned by the wireless community. The talk will mostly focus on the fundamental technologies and will discuss potential research directions to meet the requirements of next generation wireless systems.

Bio: Mérouane Debbah received the M.Sc. and Ph.D. degrees from the Ecole Normale Supérieure Paris-Saclay, France. He was with Motorola Labs, Saclay, France, from 1999 to 2002, and also with the Vienna Research Center for Telecommunications, Vienna, Austria, until 2003. From 2003 to 2007, he was an Assistant Professor with the Mobile Communications Department, Institut Eurecom, Sophia Antipolis, France. In 2007, he was appointed Full Professor at CentraleSupelec, Gif-sur-Yvette, France. From 2007 to 2014, he was the Director of the Alcatel-Lucent Chair on Flexible Radio. Since 2014, he has been Vice-President of the Huawei France Research Center. He is jointly the director of the Mathematical and Algorithmic Sciences Lab as well as the director of the Lagrange Mathematical and Computing Research Center. He has managed 8 EU projects and more than 24 national and international projects. His research interests lie in fundamental mathematics, algorithms, statistics, information, and communication sciences research. He is an IEEE Fellow, a WWRF Fellow, a Eurasip Fellow, an Institut Louis Bachelier Fellow and a Membre émérite SEE. He was a recipient of the ERC Grant MORE (Advanced Mathematical Tools for Complex Network Engineering) from 2012 to 2017. He was a recipient of the Mario Boella Award in 2005, the IEEE Glavieux Prize Award in 2011, the Qualcomm Innovation Prize Award in 2012, the 2019 IEEE Radio Communications Committee Technical Recognition Award and the 2020 SEE Blondel Medal.
He received more than 20 best paper awards, among which the 2007 IEEE GLOBECOM Best Paper Award, the Wi-Opt 2009 Best Paper Award, the 2010 Newcom++ Best Paper Award, the WUN CogCom Best Paper 2012 and 2013 Award, the 2014 WCNC Best Paper Award, the 2015 ICC Best Paper Award, the 2015 IEEE Communications Society Leonard G. Abraham Prize, the 2015 IEEE Communications Society Fred W. Ellersick Prize, the 2016 IEEE Communications Society Best Tutorial Paper Award, the 2016 European Wireless Best Paper Award, the 2017 Eurasip Best Paper Award, the 2018 IEEE Marconi Prize Paper Award, the 2019 IEEE Communications Society Young Author Best Paper Award, the 2021 Eurasip Best Paper Award, the 2021 IEEE Marconi Prize Paper Award as well as the Valuetools 2007, Valuetools 2008, CrownCom 2009, Valuetools 2012, SAM 2014, and 2017 IEEE Sweden VT-COM-IT Joint Chapter best student paper awards. He is an Associate Editor-in-Chief of the journal Random Matrix: Theory and Applications. He was an Associate Area Editor and Senior Area Editor of the IEEE TRANSACTIONS ON SIGNAL PROCESSING from 2011 to 2013 and from 2013 to 2014, respectively. From 2021 to 2022, he serves as an IEEE Signal Processing Society Distinguished Industry Speaker.

Coffee break: 10:30-10:50

Technical Session 1: Next Generation Networks - 10:50 – 12:30

Session Chair: Hassine Moungla, University of Paris, France

1- InterS: Towards Inter-Slice Bandwidth Resource Sharing
Authors: Mohammed Chahbar (L2TI - Université Paris 13, France); Gladys Diaz (Sorbonne Paris Nord University, France & L2TI, Institut Galilee, France); Abdullhalim Dandoush (ESME Sudria, France)
Presenter: Abdullhalim Dandoush

2- A Two-Tiered Caching Scheme for Information-Centric Networks
Authors: Kelvin H. T. Chiu (Hong Kong University of Science and Technology, Hong Kong); Jason Min Wang (The Hong Kong University of Science and Technology, Hong Kong); Ahmed M. Abdelmoniem (Assiut University & KAUST); Brahim Bensaou (The Hong Kong University of Science and Technology, Hong Kong)
Presenter: Kelvin Chiu

3- SDN-Based Link Recovery Scheme for Large-Scale Internet of Things
Authors: Nurzaman Ahmed and Arijit Roy (Indian Institute of Technology, Kharagpur, India); Ayan Mondal (Univ Rennes, Inria, CNRS, IRISA, France); Sudip Misra (Indian Institute of Technology-Kharagpur, India)
Presenter: Nurzaman Ahmed

4- Next Generation Intra-Vehicle Backbone Network Architectures
Authors: Onur Alparslan, Shin'ichi Arakawa and Masayuki Murata (Osaka University, Japan)
Presenter: Onur Alparslan

5- Towards Multi-Criteria Heuristic Optimization for Computational Offloading in Multi-Access Edge Computing
Authors: Raghubir Singh and Simon Armour (University of Bristol, United Kingdom (Great Britain)); Afsh Khan (Toshiba Europe Ltd., United Kingdom (Great Britain)); Mahesh Soriyaybandara (Toshiba Research Europe Limited, United Kingdom (Great Britain)); George Oikonomou (University of Bristol, United Kingdom (Great Britain))
Presenter: Raghubir Singh

6- A Joint Computer Vision and Reconfigurable Intelligent Meta-Surface Approach for Interference Reduction in Beyond 5G Networks
Authors: Valeria Loscri (Inria Lille-Nord Europe, France); Anna Maria Vegni (Roma Tre University, Italy); Eros Innocenti and Romeo Giuliano (Università degli Studi Guglielmo Marconi, Italy); Marco Mazzenga (Università di Roma Tor Vergata, Italy)
Presenter: Valeria Loscri

Lunch break: 12:30 – 14:00
Technical Session 2: Routing / Security - 14:00 – 15:40
Session Chair: Thiago Abreu, University Paris-Est Créteil, France

7- Prediction Augmented Segment Routing
Authors: Murali Kodialam (Nokia Bell Labs, USA); T. V Lakshman (Bell Labs, Nokia, USA)
Presenter: Murali Kodialam

8- CP-Trie: Cumulative PopCount Based Trie for IPv6 Routing Table Lookup in Software and ASIC
Authors: MD Iftakharul Islam and Javed Khan (Kent State University, USA)
Presenter: MD Islam

9- C2RTL: A High-Level Synthesis System for IP Lookup and Packet Classification
Authors: MD Iftakharul Islam and Javed Khan (Kent State University, USA)
Presenter: MD Islam

10- Scalability Analysis of a Blockchain-Based Security Strategy for Complex IoT Systems
Authors: Eva Marín-Tordera (Technical University of Catalonia UPC, Spain)
Presenter: Eva Marín-Tordera

11- A Technique to Monitor Threats in SDN Data Plane Computation
Authors: Loïc Desgeorges and Jean-Philippe Georges (University of Lorraine, France); Thierry Divoux (University of Lorraine, CRAN, France)
Presenter: Loïc Desgeorges

12- A Bandwidth Balance Routing Approach for Saving Network Capacity in Static Elastic Optical Networks
Authors: Jorge Alberto Bermúdez Cedeño (Universidad Técnica Federico Santa María, Chile); Reinaldo Vallejos and Nicolás Jara (Universidad Tecnica Federico Santa Maria, Chile)
Presenter: Jorge Bermúdez Cedeño

Coffee break: 15:40 – 16:00

Technical Session 3: Next Generation Networks - 16:00 – 17:40
Session Chair: Aude Herry, ESME-Sudria Paris, France

Authors: Ouassim Karrakchou, Nancy Samaan and Ahmed Karmouch (University of Ottawa, Canada)
Presenter: Ouassim Karrakchou

14- RAFALE: smaRt and Scalable orchestration System for virtuAL Network seRvices
Authors: Laaziz Lahlou (Ecole de Technologie Supérieure & University of Quebec, Canada); Amina Bounas and Houssem Eddine Mohamadi (Ecole de Technologie Supérieure, University of Quebec, Canada); Nadjia Kara (Ecole de Technologie Supérieure, Canada)
Presenter: Laaziz Lahlou

15- Revenue Optimization and Protection with Network Slicing over a Physical Optical Substrate
Authors: Kacius Assis (Federal University of Bahia, Brazil); Raul C. Almeida, Jr (Federal University of Pernambuco, Brazil); Helio Waldman (Universidade Estadual de Campinas (Unicamp) & Federal University of ABC (UFABC), Brazil)
Presenter: Helio Waldman

16- A Reinforcement Learning-Based Solution for Intra-Domain Egress Selection
Authors: Duc-Huy Le and Hai Anh Tran (Hanoi University of Science and Technology, Vietnam); Sami Souhi (University Paris Est UPEC, France)
Presenter: Duc-Huy Le

17- Qualitative Communications for Augmented Reality and Virtual Reality
Authors: Cedric Westphal (Huawei Innovation Center, USA); Dongbao He (Tsinghua University, China); Kiran Makhijani and Richard Li (Futurewei Technologies, USA)
Presenter: Cedric Westphal
Coffee break: 15:40 – 16:00

Technical Session 4: Next Generation Networks - 16:00 – 17:40

Session Chair: Sami Souihi, University Paris-Est Créteil, France

18- Cross-Layer Loss Discrimination Algorithms for MEC in 4G Networks
Authors: Mamoutou Diarra (Inria & Ekinops, France); Walid Dabbous (INRIA, France); Amine Ismail (Ekinops, France); Thierry Turletti (INRIA & Université Côte d'Azur, France)
Presenter: Mamoutou Diarra

19- Mobile Traffic Forecasting Using a Combined FFT/LSTM Strategy in SDN Networks
Authors: Mohammed Lotfi Hachemi (University of Oran1, Algeria); Abdelghani Ghomari (University of Oran1 Ahmed Ben Bella, Algeria); Yassine Hadjadj-Aoual (University of Rennes 1, France); Gerardo Rubino (INRIA, France)
Presenter: Mohammed Lotfi Hachemi

20- A Recurrent Neural Network Based Approach for Coordinating Radio and Computing Resources Allocation in Cloud-RAN
Authors: Mahdi Sharara (Université Paris Saclay, France); Sahar Hoteit (University of Paris Sud & Centrale-Supelec, France); Véronique Vèque (University Paris-Saclay, France)
Presenter: Mahdi Sharara

21- From Cloud-Native to 5G-Ready Vertical Applications: An Industry 4.0 Use Case
Authors: Chiara Lombardo (University of Genoa & CNIT- Research Unit of the University of Genoa, Italy)
Presenter: Chiara Lombardo

22- Slicing-Based Offloading in Vehicular Edge Computing
Authors: Sara Berri (ETIS, CY Cergy Paris University, ENSEA, CNRS, France); Khaled Hejja (INFRES, Telecom Paris, Institute Polytechnic of Paris, Palaiseau, France); Houda Labiod (Telecom ParisTech, France)
Presenter: Sara Berri

23- 5G and Edge Computing Enabling Experience Delivery Network (XCDN) for Immersive Media
Authors: Gang Shen (Intel, USA); Lei Zhai and Jianhui Dai (Intel Corporation, China); Hassnaa Moustafa (Intel Corporation, USA)
Presenter: Gang Shen; Jianhui Dai

WELCOME RECEPTION: 19:30 – 20:30
Keynote Presentation: Imed Lassoued (Ekinops, France) and Amine Ismail (Ekinops, France)
Title: “Virtualization impact on the telecommunication industry: Current trends and perspectives.”
Session Chair: Abdulhalim Dandoush, ESME-Sudria Paris, France

Emerging concepts such as Software Defined Networking (SDN) and Network Function Virtualization (NFV) have been revolutionizing the telecommunication industry. These technologies have been pushing new and flexible ways for service providers to manage their networks through standardization, softwarization and automation. Thus, allowing a faster deployment of new services while optimizing the capital and operational expenses. In this presentation, we review the latest evolutions in the virtualization domain and how these new technologies have been adopted by Ekinops to push innovative services toward service providers. A live deployment scenario of a virtualized network service will be demonstrated using the complete Ekinops NFV solution.

Bio:
Amine Ismail is a telecommunication network and software development expert. He is leading the study and research activities at Ekinops. His main research topics cover the optical transport, SDN&NFV, SDWAN and congestion control algorithms for xG networks. Prior to this position Amine was a technology advisor attached to the CTO office and has been leading the architecture activities related to the Ekinops NFV and SDWAN solutions. Amine Ismail holds a PhD in computer science from University of Nice, a master degree from Telecom-ParisTech as well as an engineering degree from INSAT.

Imed Lassoued holds the position of Field Technical Expert (FTE) at Ekinops and plays tow-fold role: providing technical expertise and sales support to global account teams for a broad range of products (NFV, SD-WAN, routing, …) and work with PLM, architects and R&D in defining and developing products features. He has also worked as a technical presales engineer, R&D engineer and product manager. He holds a PhD from the University of Nice Sophia Antipolis, graduated with a Master degree from Telecom Bretagne and Engineering degree from ENSI.
Recent technological trends such as Industry 4.0 introduced new challenges that push the limit of current computer and networking architectures. It demands the connection of thousands, if not millions, of sensors and mobile devices coupled with optimized operations to automate various operations inside factories. This led to the new era of Internet of Things (IoTs) where lightweight (possibly mobile) devices are envisaged to send vital information to cloud data centres (mobile and fixed infrastructure) for further processing and decision making.

Current cloud computing systems, however, are not able to efficiently digest and process collected information from IoT devices with strict response requests for two main reasons: (1) the round trip delay between IoT devices to the processing engines of cloud could exceed an application's threshold, and (2) network links to cloud resources could be clogged when IoT devices flush data in an uncoordinated fashion. Fog and Edge Computing are two solutions to address both of the previous problems. Though designed to alleviate the same problem, they have fundamental differences that make adopting one more applicable than the other.

This talk will overview the practical concerns of exploiting Edge Computing to realize today’s IoT implementations through tackling the most important obstacles that hinder their adoption. First, production of applicable network (fixed and mobile) latency models to capture all elements of IoT platforms. Second, building a holistic Edge ecosystem to orchestrate various inter-related layers of IoT platforms, including connectivity, big-data analytics, and workload optimization. Third, proposing viable solutions that can actually be implemented in IoT-based applications, such as, vehicular networks, preventative maintenance, health, energy, to name a few.

**Bio:** Albert Y. ZOMAYA is Chair Professor of High-Performance Computing & Networking in the School of Computer Science and Director of the Centre for Distributed and High-Performance Computing at the University of Sydney. To date, he has published > 600 scientific papers and articles and is (co-)author/editor of >30 books. A sought-after speaker, he has delivered >250 keynote addresses, invited seminars, and media briefings. His research interests span several areas in parallel and distributed computing and complex systems. He is currently the Editor in Chief of the ACM Computing Surveys and served in the past as Editor in Chief of the IEEE Transactions on Computers (2010-2014) and the Founding Editor in Chief of the IEEE Transactions on Sustainable Computing (2016-2020).

Professor Zomaya is a decorated scholar with numerous accolades including Fellowship of the IEEE, the American Association for the Advancement of Science, and the Institution of Engineering and Technology (UK). Also, he is an Elected Fellow of the Royal Society of New South Wales and an Elected Foreign Member of Academia Europaea. He is the recipient of the 1997 Edgeworth David Medal from the Royal Society of New South Wales for outstanding contributions to Australian Science, the IEEE Technical Committee on Parallel Processing Outstanding Service Award (2011), IEEE Technical Committee on Scalable Computing Medal for Excellence in Scalable Computing (2011), IEEE Computer Society Technical Achievement Award (2014), ACM MSWIM Reginald A. Fessenden Award (2017), and the New South Wales Premier’s Prize of Excellence in Engineering and Information and Communications Technology (2019).
Coffee break: 10:30-10:50

Technical Session 5: Processing for Emerging Networks - 16:00 – 17:40

Session Chair: Yann Labit, Université de Toulouse, France

24- A Multi-Objective Routing Scheme for Deterministic Network
Authors: Yutao Xia and Bing Hu (Zhejiang University, China)
Presenter: Yutao Xia

25- Increasing Vehicles Perception Using Cooperative Relaying and Priority-Based Beaconing
Authors: Sanaullah Faiz (Universite Sorbonne Paris Nord, France); Nadjib Achir (University Sorbonne Paris Nord, France); Khhaled Boussetta (Universite Sorbonne Paris Nord, France)
Presenter: Sanaullah Faiz

26- High-Speed Connection Tracking in Modern Servers
Authors: Massimo Girondi, Marco Chiesa and Tom Barbette (KTH Royal Institute of Technology, Sweden)
Presenter: Massimo Girondi

27- Run-To-Completion Versus Pipelined: The Case of 100 Gbps Packet Parsing
Authors: Hesam Zolfaghari, Haseeb Mustafa and Jari Nurmi (Tampere University, Finland)
Presenter: Hesam Zolfaghari

28- Delay-Aware Backup Resource Allocation with Probabilistic Protection for Network Services
Authors: Shinya Horimoto, Fujun He and Eiji Oki (Kyoto University, Japan)
Presenter: Shinya Horimoto

29- Service Chain Provisioning Model Considering Traffic Amount Changed by Virtualized Network Functions
Authors: Shintaro Ozaki, Takehiro Sato and Eiji Oki (Kyoto University, Japan)
Presenter: Shintaro Ozaki

Lunch break: 12:30 – 14:00

Technical Session 6: Applications of Machine Learning - 14:00 – 15:40

Session Chair: Lamine Amour, ESME-Sudria Paris, France

30- Identity Management with Hybrid Blockchain Approach: A Deliberate Extension with Federated-Inverse-Reinforcement Learning
Authors: Soumya Banerjee (Trasna-Solutions, Ireland); Samia Bouzefrane (Conservatoire National des Arts et Métiers, France); Amar Abane (Inria, France)
Presenter: Soumya Banerjee

31- Learned Bloom Filters in Adversarial Environments: A Malicious URL Detection Use-Case
Authors: Pedro Reviriego (University Carlos III of Madrid, Spain); José Alberto Hernández (Universidad Carlos III de Madrid, Spain); Zhenwei Dai and Anshumali Shrivastava (Rice University, USA)
Presenter: Pedro Reviriego

32- Foresighted Resource Provisioning for Network Slicing
Authors: Quang-Trung Luu (Nokia Bell-Labs, Université Paris-Saclay); Sylvaine Kerboeuf (Nokia Bell Labs, France); Michel Kieffer (CentraleSupelec, France)
Presenter: Quang-Trung Luu
33- High Performance Network Metadata Extraction Using P4 for ML-Based Intrusion Detection Systems  
Authors: Nicholas Gray (University of Wuerzburg, Germany); Katharina Dietz, Michael Seufert and Tobias Hoßfeld (University of Würzburg, Germany)  
Presenter: Nicholas Gray

34- Reinforcement Learning Based Approach for Virtualized Face Detection at the Edge  
Authors: Selma Khebbache (IRT-SystemX, France); Makhlouf Hadji (IRT System X, France); Mohamed Idriss Khaledi (IRT SystemX, France)  
Presenter: Makhlouf Hadji

35- ML-Based Incast Performance Optimization in Software-Defined Data Centers  
Authors: Kokouvi Benoit Nougnanke (LAAS-CNRS & Univ de Toulouse, France); Yann Labit (LAAS-CNRS, Université de Toulouse, France); Marc Bruyere (IIJ Innovation Institute & The University of Tokyo, Japan)  
Presenter: Yann Labit

Coffee break: 15:40-16:00

Short-Track Session 1: Security & IoT and Smart Applications (16:00-17:40)  
Session Chair: Thierry Divoux, University of Lorraine, CRAN, France

36- Energy Efficient and High Performance Modified Mesh Based 2-D NoC Architecture  
Authors: B. Naresh Kumar Reddy (IIT Delhi, India); Subrat Kar (IITD, India)  
Presenter: B. Naresh Reddy

37- Secure Multipath Routing in Heterogenous Low Power and Lossy Networks in the Internet of Things  
Authors: Somia Sahraoui and Nabil Henni (University of Biskra, Algeria)  
Presenter:

38- A Self Organizing OneM2M IoT Network  
Authors: Mouna Ben Mabrouk (Altran, France); Jean-Paul Garandeau, Thibault Tabani and Martine Gateau (Altran Connected Solutions, France)  
Presenter: Mouna Ben Mabrouk

39- A Novel Blockchain Secure to Routing Protocol in WSN  
Authors: Wassim Jerbi (National Engineering School of Sfax, Tunisia); Abderrahmen Guermazi (CES Laboratory, Tunisia); Omar Cheikhrouhou (College of CIT, Tunisia); Hafedh Trabelsi (University of Sfax, Ecole Nationale d'Ingénieur de Sfax, Tunisia); Atef Boubaker (ISET Sfax, Tunisia)  
Presenter: Wassim Jerbi

40- Verification of Cloud Security Policies  
Authors: Loïc Miller (University of Strasbourg, France); Pascal Mérindol (Université de Strasbourg, France); Antoine Gallais (Polytechnic University Hauts-de-France, France); Cristel Pelsser (University of Strasbourg, France)  
Presenter: Loïc Miller

41- Towards Secure and Leak-Free Workflows Using Microservice Isolation  
Authors: Loïc Miller (University of Strasbourg, France); Pascal Mérindol (Université de Strasbourg, France); Antoine Gallais (Polytechnic University Hauts-de-France, France); Cristel Pelsser (University of Strasbourg, France)  
Presenter: Loïc Miller

Coffee break: 17:40-18:00
Short-Track Session 2: Next Generation Networks (18:00-19:20)
Session Chair: Michel Kieffer (CentraleSupelec, France)

Authors: Hedi Hamdi (Jouf University, College of Computer and Information Sciences, Saudi Arabia); Imen Soud (University of Carthage, Tunisia); Randa Jabeur Ben Chikha (Jouf University, Saudi Arabia)
Presenter: Hedi Hamdi

43- A Low-Cost IP-To-NDN Translation Gateway
Authors: Feri Fahrianto (Universitas Islam Negeri Syarif Hidayatullah, Indonesia); Noriaki Kamiyama (Ritsumeikan University, Japan)
Presenter: Feri Fahrianto

44- Intelligent Routing Approach Based on Machine Learning and SDN for Heterogeneous IoTs
Authors: Dyhia Rehoune, Mouna Ben Mabrouk and Azadé Fotouhi (Altran, France)
Presenter: Mouna Ben Mabrouk

45- Towards a Crowdsourced Network Measurements Analyzer (CNMA) for the Streaming Service
Authors: Lamine Amour and Abdulhalim Dandoush (ESME Sudria, France)
Presenter: Lamine Amour

46- Simulated Annealing-Based Beam Management for 5G Vehicular Networks
Authors: Rima Benelmir and Salim Bitam (University of Biskra & LESIA Laboratory, Algeria); Abdelhamid Mellouk (UPEC, University Paris-Est Creteil Val de Marne, France)
Presenter: Rima Benelmir; Salim Bitam; Abdelhamid Mellouk

47- A New Control Algorithms for Simultaneous Connections Routing in Elastic Optical Networks
Authors: Enass Abuelela and Mariusz Zal (Poznan University of Technology, Poland)
Presenter: Enass Abuelela
Day 3: Wednesday, June 9 - Location: 34 rue de Fleurus, 75006 Paris

Panel: 09:00 – 10:30

Panel Speakers:
Renaud Lifchitz (Holiseum)
Sylvain Cariou (Crystalchain)
Sara Tucci-Piergiovanni (CEA LIST)
Matthieu Quiniou (Chaire ITEN/UNESCO)

Title: “Blockchain, What’s Next?”
Moderator: Yackolley Amoussou-Guenou (CEA List, France)

Coffee break: 10:30-10:50

Technical Session 7: IoT and Smart Applications - 10:50 – 12:30

Session Chair: Dr. Makhlouf Hadji (IRT System X, France)

48- On the Use of Machine Learning and Network Tomography for Network Slices Monitoring
Authors: Anouar Rkhami (Inria, Univ Rennes, CNRS, IRISA, France); Yassine Hadjadji-Aoul (University of Rennes 1, France); Gerardo Rubino (INRIA, France); Abdelkader Outtagarts (Nokia Bell Labs France, France)
Presenter: Anouar Rkhami

49- DC Building Management System with IEEE 802.3bt Standard
Authors: Kareem Hafsi (LCIS Laboratory, France); Denis Genon-Catalot (University Grenoble Alpes - Grenoble INP & LCIS, France); Jean-Marc Thiriet (Université Grenoble Alpes, France); Olivier Lefevre (UBIANT, France)
Presenter: Kareem Hafsi; Jean-Marc Thiriet; Denis Genon-Catalot; Olivier Lefevre

50- CAE Adaptive Compression, Transmission Energy and Cost Optimization for m-Health Systems
Authors: Abeer Al-Marridi and Amr Mohamed (Qatar University, Qatar); Aiman Erbad (Hamad Bin Khalifa University, Qatar); Mohsen Guizani (Qatar University, Qatar)
Presenter: Abeer Al-Marridi

51- An Analytical Model of Bluetooth Performance Considering Physical and MAC Layers’ Effects
Authors: M. Shabbir Ali and Julian Garbiso (VEDECOM, France); Jun Zhang and Houda Labiod (Telecom Paris, France); Oyunchimeg Shagdard and Mohamed Hadded (VEDECOM, France)
Presenter: M. Shabbir Ali

52- Privacy-Aware Ant Routing for Wireless Multimedia Sensor Networks in Healthcare
Authors: Yasmine N. Saleh (Arab Academy for Science, Technology and Maritime Transport, Egypt); Claude C. Chibelsish (Semantics 21 Ltd, United Kingdom (Great Britain) & University of Warwick, United Kingdom (Great Britain)); Ayman A. Abdel-Hamid (Arab Academy For Science, Technology, and Maritime Transport, Egypt); Abdel-Hamid Soliman (Staffordshire University, United Kingdom (Great Britain))
Presenter: Yasmine Saleh

53- Toward an Autonomous Smart Home: A Three-Layer Edge-Fog-Cloud Architecture with Latency Analysis
Authors: Hussein Chour (CentraleSupelec & Lebanese University, France); Djamel Eddine Kouicem, Azadé Fotouhi and Mouna Ben Mabrouk (Altran, France)
Presenter: Hussein Chour
Lunch break: 12:30 – 14:00

Technical Session 8: Invited sessions on New IP, session I - 14:00 – 15:40

**Session Chair: Lijun Dong (futurewei, US)**

**54- The Future of Media Streaming Systems: Transferring Video over New IP**
Authors: Stuart Clayman (University College London (UCL), United Kingdom (Great Britain)); Mustafa Tuker, Halil Arasan and Muge Sayi (Ege University, Turkey)
Presenter: Stuart Clayman

**55- Computing Power Network an Interworking Architecture of Computing and Network Based on IP Extension**
Authors: Bo Lei and Qianying Zhao (Beijing Research Institute China Telcom Beijing, China); Jie Mei (Beijing University of Posts and Telecommunications, China)
Presenter: Bo Lei

**56- High-Precision Accounting for High-Precision Networking Services**
Authors: Alexander Clemm (Futurewei Technologies, USA); John Strassner (Huawei, USA)
Presenter: Alexander Clemm

**57- A Proof of Optimality on EDF Scheduling in Sink-Tree Packetized Networks**
Authors: Xuan Liu (Network Technology Lab, Huawei & Beijing University of Posts and Telecommunications, China); Bingyang Liu (Huawei, China); Shoushou Ren (Huawei Technologies Co., Ltd., China)
Presenter: Xuan Liu

Coffee break: 15:40-16:00

Technical Session 8: Invited sessions on New IP, session II - 16:00 – 17:40

**Session Chair: Lijun Dong (futurewei, US)**

**58- Indirect Line-Of-Sight Free-Space Optical Communications Using Diffuse Reflection**
Authors: Roberto Rojas-Cessa (New Jersey Institute of Technology, USA)
Presenter: Roberto Rojas-Cessa

**59- Multi-Path Transmission Scheme Based on Segment Control in Low-Earth-Orbit Satellite Network**
Authors: Man Ouyang (Beijing University of Posts and Telecommunications, China); Xuefei Duan (Guangdong Communication & Network Institute, China); Jiang Liu, Ran Zhang and Tao Huang (Beijing University of Posts and Telecommunications, China); Hua Lu (Guangdong Communication & Network Institute, China)
Presenter: Jiang Liu

**60- Asymmetric Addressing Structures in Limited Domain Networks**
Authors: Kiran Makhijani and Lijun Dong (Futurewei Technologies, USA)
Presenter: Kiran Makhijani

**61- On Control and Data Plane Programmability for Data-Driven Networking**
Authors: Alessio Sacco (Politecnico di Torino, Italy); Flavio Esposito (Saint Louis University, USA); Guido Marchetto (Politecnico di Torino, Italy)
Presenter: Alessio Sacco

Close Ceremony: 17:40 – 18:00

Social Event: 19:00 – 22:00
Day 4: Thursday, June 10 - Location: 34 rue de Fleurus, 75006 Paris

WORKSHOP

SARNET-21: Semantic Addressing and Routing for Future Networks: 09:00 – 19:20

SARNET Opening - 09:00 – 09:10

David Lou (Huawei Technologies, Germany)

Keynote: 09:10 – 10:10

Keynote Presentation: Olivier Bonaventure (UC Louvain, Belgium)
Title: “The Routing Challenges for Future Networks”
Session Chair: …. 

Abstract ???

Bio:…..

Coffee break: 10:10-10:20
SARNET- Technical Session 1: Semantic Addressing- 10:20-11:20
Moderator: Rui Aguiar (University of Aveiro, Portugal)

1- QoS-Enabled Semantic Routing for Industry 4.0 Based on SDN and MOM Integration
Authors: Paolo Bellavista (University of Bologna, Italy); Mattia Fogli (University of Ferrara, Italy); Luca Foschini (University of Bologna, Italy); Carlo Giannelli (University of Ferrara, Italy); Lorenzo Patera (University of Bologna, Italy); Cesare Stefanelli (University of Ferrara, Italy)
Presenter: Lorenzo Patera

2- Dyncast: Use Dynamic Anycast to Facilitate Service Semantics Embedded in IP Address
Authors: Yizhou Li (Huawei, China); Zifa Han (Huawei Technologies, China); Shuheng Gu and Guanhua Zhuang (Huawei, China); Feng Li (Huawei Technologies)
Presenter: Yizhou Li

3- Virtual Data-Plane Addressing for SDN-Based Space and Terrestrial Network Integration
Authors: Gao Zheng, Ning Wang and Rahim Tafazolli (University of Surrey, United Kingdom (Great Britain)); XinPeng Wei and Jinze Yang (Huawei Technologies, China)
Presenter: Gao Zheng

Coffee break: 11:20-11:30

SARNET- Technical Session 2: Routing, Forwarding and Performance- 11:30-12:30
Moderator: Adrian Farrel (Old Dog Consulting, UK)

4- A Vision to Software-Centric Cloud Native Network Functions: Achievements and Challenges
Authors: Ryota Kawashima (Nagoya Institute of Technology, Japan)
Presenter: Ryota Kawashima

5- Service-Based Forwarding via Programmable Dataplanes
Authors: René Glebke (RWTH Aachen University, Germany); Dirk Trossen (Huawei Technologies Düsseldorf GmbH, Germany); Ike Kunze (RWTH Aachen University, Germany); Zhe Lou (Huawei Technologies European Research Center, Germany); Jan Rüth, Mirko Stoffers and Klaus Wehrle (RWTH Aachen University, Germany)
Presenter: René Glebke

6- Towards Real-Time Routing Optimization with Deep Reinforcement Learning: Open Challenges
Authors: Paul Almasan and José Suárez-Varela (Barcelona Neural Networking Center, Universitat Politècnica de Catalunya, Spain); Bo Wu and Shihan Xiao (Huawei Technologies, China); Pere Barlet-Ros and Albert Cabellos-Aparicio (Barcelona Neural Networking Center, Universitat Politècnica de Catalunya)
Presenter: Paul Almasan

Lunch break: 12:30 – 14:00
SARNET - Technical Session 3: Semantic Routing, Framework and Security - 14:00-15:20

Moderator: Mohamed Faten Zhani (ETS, Canada)

7- Flexible Semantic-Based Data Networking for IoT Domains
Authors: Mays F AL-Naday (University of Essex, United Kingdom (Great Britain)); Irene Macaluso (Trinity College Dublin, Ireland)
Presenter: Mays AL-Naday

8- Securing Named Data Networking Routing Using Decentralized Identifiers
Authors: Nikos Fotiou (Athens University of Economics and Business, Greece); Yannis Thomas (Athens University of Economics and Business (AUEB), Greece); Vasilios A. Siris, George Xylomenos and George C. Polyzos (Athens University of Economics and Business, Greece)
Presenter: Nikos Fotiou

9- Private Routing in the Internet
Authors: Francesco Tusa, David Griffin and Miguel Rio (University College London, United Kingdom (Great Britain))
Presenter: Francesco Tusa

10- A Structured Approach to Routing in the Internet
Authors: Nirmala Shenoy, Shreyas Chandraiah and Peter Willis (Rochester Institute of Technology, USA)
Presenter: Nirmala Shenoy

Coffee break: 15:20-15:30

Panel: 15:30 – 16:50

Panel Speakers:
- Christian Jacquenet (Orange, France)
- Rui Aguiar (University of Aveiro, Portugal)
- Adrian Farrel (Old Dog Consulting, UK)
- Mohamed Faten Zhani (ETS, Canada)
Title: “Semantic Addressing and Routing Impact on Future Networks”
Moderator: Alex Galis (University College London, UK)

SARNET Closing: 16:50 – 17:00

Alex Galis (University College London, UK)
VNI-21: Virtualization for Enabling Next-Generation IoT Networks – 08h50-13h00

VNI Opening – 08h50 – 09h00

Ayan Mondal (University of Rennes, France)

Keynote: 09h00 – 09h45

Keynote Presentation: Sudip Misra (IIT Kharagpur, India)
Title: “Synergizing IoT with Next Generation Networks through Virtualization”

Invited Talk: 09:45 – 10:30

Rajiv Ranjan (Newcastle University, UK)

Coffee break: 10:30-10:50

VNI - Technical Session 1: Virtualization for Enabling Next-Generation IoT Networks – 10:50-11:50

Moderator: Arijit Roy (SensorDrops Networks Pvt. Ltd., India)

1- Seamless Multi-Access Edge Computing Application Handover Experiments
Authors: Pablo Fondo-Ferreiro, Alberto Estévez-Caldas and Rubén Pérez-Vaz (Universidade de Vigo, Spain); Felipe Gil-Castiñeira (University of Vigo, Spain); Francisco J. González-Castaño (Universidad de Vigo, Spain); Santiago Rodríguez-Garcia and Xosé Ramón Sousa-Vázquez (Optare Solutions SL., Spain); Diego Lopez (Telefónica I+D, Spain); Carmen Guerrero (University Carlos III of Madrid, Spain)
Presenter: Pablo Fondo-Ferreiro

2- I2UTS: An IoT Based Intelligent Urban Traffic System
Authors: Vejey Pradeep Suresh Achari (Thapar Institute of Engineering and Technology, Deemed to be University, Patiala, India); Zeba Khanam, Amit Singh and Anish Jindal (University of Essex, United Kingdom (Great Britain)); Alok Prakash (Nanyang Technological University, Singapore); Neeraj Kumar (Thapar University Patiala, India)
Presenter: Vejey Pradeep Suresh Achari

3- Application of IoT in Smart Epidemic Management (in Context of Covid-19)
Authors: Sajoy Datta and Monideepa Roy (KIIT University, India); Pushpendu Kar (University of Nottingham Ningbo China, China)
Presenter: Sajoy Datta
Panel: 11:50 – 12:50

Panel Speakers:
Guillaume Pierre (University of Rennes, France)
Paolo Bellavista (University of Bologna, Italy)
Malamati Louta (University of Western Macedonia, Greece)

Title: “Future of Next Generation Networks for IoT”
Moderator: Arijit Roy (SensorDrops Networks Pvt. Ltd., India) and Ayan Mondal (IRISA, France)

VNI Closing: 12:50 – 13:00

Arijit Roy (SensorDrops Networks Pvt. Ltd., India)
SCCRM-21: Supply Chain Cybersecurity and Risk Management - 08:50-13:00

SCCRM Opening – 08:50 – 09:00

Eva Marin (UPC, Spain) and Panos Trakadas (NKUA, Greece)

Keynote: 09:00 – 09:30

Keynote Presentation: Jürgen Neises (Fujitsu, Germany)
Title: “Supply Chain Resilience in Industry 4.0 – Views on the role of Policies and Trustworthiness”

SCCRM - Technical Session 1: Cybersecurity in Supply Chains – 09:30-10:50

Moderator: Henrique Santos (University of Minho, Portugal)

1- Farm to Fork: Securing a Supply Chain with Direct Impact on Food Security
Authors: Helen C. Leligou (Synelixis Solutions, Greece); Panagiotis Karkazis (University of West Attika, Greece); Panagiotis Trakadas (University of Athens, Greece); Anthony Gonos (OPTIMUM SA, Greece); Theodore Zahariadis (University of Athens & Synelixis Solutions S.A., Greece)
Presenter: Helen Leligou

2- Challenges in the Automotive Software Supply Chain, Connected CAR
Authors: Jose Soriano and Guillermo Jiménez Prieto (Capgemini Engineering, Spain); Ernesto Correa (Consultant/Engineer & Capgemini Engineering, Spain); Noel Ruiz (Capgemini Engineering, Spain)
Presenter: Guillermo Jiménez Prieto

3- The Role of Intent-Based Networking in ICT Supply Chains
Authors: Mounir Bensalem (TU Braunschweig, Germany); Jasenka Dizdarević and Francisco Carpio (Technische Universität Braunschweig, Germany); Admela Jukan (Technische Universität Caroli-Wilhelmina zu Braunschweig, Germany)
Presenter: Mounir Bensalem

Coffee break: 10:50-11:10
Keynote: 11:10 – 11:30

Keynote Presentation: Martin Ubelhor (EC)
Title: “Cybersecurity for industry/supply point of view from the EC”

Invited Talk: 11:30 – 12:00

Fabio Martinelli (CNR, Italy)
Title: “Cybersecurity trust and resilience in Industry”

Panel: 12:00 – 12:50

Panel Speakers:
Fidel Santiago (European Commission, H1)
Haris Mouratidis
(University of Brighton, member of the advisory board of FISHY, UK)
Nineta Polemi (CYRENE project, Greece)
Roberto Cascella (ECSO, Belgium)

Title: “Future of Next Generation Networks for IoT”
Moderator: José Francisco Ruiz (ATOS, Spain)

SCCRM Closing: 12:50 – 13:00

Panos Trakadas (NKUA, Greece)
Abstract: Often computer/mobile users call everything that disturbs/corrupts their system a VIRUS without being aware of what it means or accomplishes. This tutorial systematically introduces the different malware varieties, their distinctive properties, different methods of analyzing the malware, and their detection techniques.

Today computing devices like laptops, mobile phones, smart devices, etc., have penetrated very deep into our modern society and have become an integral part of our daily lives. Currently, more than half of the world’s population uses computers/mobile devices for their professional/personal needs. However, these computing devices are targeted by malware designers encouraged by profits/gains associated with the attack. According to a recent report, monetary losses due to cybercrime are expected to reach 10 trillion dollars annually by 2025. The primary role in providing defense against malware attacks is designed and developed by the anti-malware community (researchers and anti-virus industry). Traditionally anti-viruses are based on the signature, heuristic, and behavior based detection engines. However, these engines are unable to detect next-generation polymorphic and metamorphic malware. Thus researchers have started developing malware detection engines based on machine learning to complement the existing anti-virus engines. However, there are many open research challenges in these models like adversarial robustness, explainability, fairness, etc., which we are going to discuss in detail during the workshop.

This workshop will cover fundamental techniques, limitations, open research problems and future directions in the field of malware analysis and detection. Following are the three specific learning outcomes:
1. Audiences will get familiarity with different types of malware and their detection techniques.
2. Applications of classification and clustering based frameworks for malware detection.
3. Overview of significant research problems in the area of malware analysis and detection, results and conclusions from the recent research papers.

Bio:
Ashu Sharma is currently working as a senior malware analyst at WatchGuard, India. He has more than three years of industrial experience in malware analysis and more than two years of teaching experience. He has completed his Ph.D. in static malware analysis from BITS Pilani, India, and post-doctoral in malware identification via dynamic analysis under Prof. Sandeep Shukla (IIT Kanpur, India). He was the speaker at many reputed conferences/workshops and had many publications in reputed conferences/journals.

Hemant Rathore is currently working as Assistant Professor at the Department of CS and IS at BITS Pilani, Goa Campus, India. Before joining academics, he was working in the area of computer security for three years at Symantec, India. His Ph.D. is on the topic of Adversarial Robustness and Explainability in Malware Detection Models. His research interests are in the area of Malware Analysis, Network Security, Machine Learning, and Operating Systems. He has guided several undergraduate and postgraduate students in their independent research projects and published many research papers in reputed journals/conferences.
Abstract: The need for clean energy has become crucial with population growth, the abundant demand in traditional energy resources and the need for the decarbonization of economy to curb climate change. The solution ahead is to shift to and integrate more renewable and clean sources of energy with the existing conventional energy infrastructure as well as offer end-users a more active role in the integrated management of their energy resources (grid, loads, storage, microgeneration). Energy trading platforms are mechanisms used to attain increased energy demands while meeting participants’ satisfaction (i.e., consumers, prosumers, and utility grids). Participant satisfaction is driven by two main factors: stable coverage of energy demand and profit maximization, which can be fostered by demand response programs. Peer-to-Peer (P2P) energy trading platforms should find a win-win balance, where all participants are able to make some profit and meet their energy demand under any circumstances.

In this context, intelligent communications, as well as decentralized technologies, have emerged as a solution to these issues. For instance, blockchain technology, deep and reinforcement learning coupled with fast and reliable communication infrastructures such as 5G, provide great opportunities to improve the way energy prosumers and consumers communicate with the grid. A decentralized energy management system takes advantage of various technologies, and effective communication is used to ensure optimal utilization of the available resources. Incorporation of advanced technologies such as blockchain, distributed intelligence, and federated learning can considerably overcome the technical challenges and reduce market barriers, which in essence would attract the adoption of this disruptive technology.

This tutorial aims to present recent advances on the applications of blockchain technology in energy management systems, especially in peer-to-peer energy trading.

Bio: Dr. Moayad Aloqaily (S’12, M’17) received the M.Sc. degree in electrical and computer engineering from Concordia University, Montreal, QC, Canada, in 2012, and the Ph.D. degree in electrical and computer engineering from the University of Ottawa, Ottawa, ON, in 2016. He was an instructor in the Systems and Computer Engineering Department at Carleton University, Ottawa, Canada, in 2017. He has been working with Gnowit Inc. as a Senior Researcher and Data Scientist since 2016. He is also the managing director of xAnalytics Inc., Ottawa, ON, Canada, 2019. Currently, he is with the Faculty of Engineering, Al Ain University, United Arab Emirates. His current research interests include the applications of AI and ML, Connected and Autonomous Vehicles, Blockchain Solutions, and Sustainable Energy and Data Management. He was the recipient of many honors and awards. He received the 2020 best paper award from Ad Hoc Networks Journal. He has chaired and co-chaired many IEEE conferences and workshops including BCCA2020, AdHocNets2020, PEDISWESA-ISCC2020, ITCVT-NOMS2020, E2NoT-IWC2020, ICCN-INFOCOM19, AICSSA19, and BATFMEC19-20. He has served as a guest editor in many journals including IEEE Wireless Communications Magazine. He started his own Special Interest Group (SIG) on Blockchain and Application as well as Internet of Unmanned Aerial Networks. He is an IEEE member, ACM Member, and a Professional Engineer Ontario (P.Eng.).
Conference abstracts

Technical Session 1: Next Generation Networks

1- InterS: Towards Inter-Slice Bandwidth Resource Sharing
Authors: Mohammed Chahbar (L2TI - Université Paris 13, France); Gladys Diaz (Sorbonne Paris Nord University, France & L2TI, Institut Galilée, France); Abdulhalim Dandoush (ESME Sudria, France)

A network slice (NS) is an isolated end-to-end (E2E) virtual and logical network created upon a customer request to fulfill the diverse requirements of a specific business use case. A fundamental issue in network slicing is the efficient share of the underlying physical network resources between network slices. This paper presents a proof of concept (PoC) of the inter-slice bandwidth resources sharing approach initially introduced by the IETF COMS information model. To the best of our knowledge, our PoC, so-called InterS, is the first to implement the data model and evaluate the performance of the concept via realistic intensive experiments in a Software Defined Network (SDN). Thus, InterS allows a congested NS to acquire temporary the free bandwidth resources of a neighbor slice and use them to serve its own traffic. Experiments have shown that InterS can significantly improve the operator's network bandwidth usage as well as the flow acceptance rates under some specific network conditions.

2- A Two-Tiered Caching Scheme for Information-Centric Networks
Authors: Kelvin H. T. Chiu (Hong Kong University of Science and Technology, Hong Kong); Jason Min Wang (The Hong Kong University of Science and Technology, Hong Kong); Ahmed M. Abdelmoniem (Assiut University & KAUST); Brahim Bensaou (The Hong Kong University of Science and Technology, Hong Kong)

In information centric networking (ICN), by default, forwarder nodes along the paths from content producers to consumers, cache and reuse content chunks ubiquitously, invoking the Least Recently Used (LRU) replacement policy when needed. Due to the cache filtering effect, this ubiquitous-LRU strategy is inefficient: popular contents that are cached a few hops away from the edge are of little utility. Most alternative proposals adopt unified on-path schemes that rely on popularity statistics or other global state information to improve the performance. In the Internet, it is difficult to imagine different administrative-entities exposing such information to each other, and so we argue that such schemes are not realistic; and secondly, a unified caching scheme across the network ignores the administrative autonomy, which is one of the tenets of the Internet. In this paper we argue for a two-tiered caching scheme that maintains an on-path caching scheme (e.g., Ubiquitous-LRU), yet embraces AS-autonomy by adding within the AS an off-path cooperative-caching and redundancy elimination, to make better use of caches in the edge where they are most valuable. We describe the implementation of our scheme and highlight the design choices to make the system practical. Our evaluation results show that our scheme can reduce cache misses and upstream traffic by up to 15% compared to the state-of-the-art.
3- SDN-Based Link Recovery Scheme for Large-Scale Internet of Things
Authors: Nurzaman Ahmed and Arijit Roy (Indian Institute of Technology, Kharagpur, India); Ayan Mondal (Univ Rennes, Inria, CNRS, IRISA, France); Sudip Misra (Indian Institute of Technology-Kharagpur, India)

In this paper, we propose SD-Reco, a Software-Defined Network (SDN)-based centralized AP and relay node re-configuration scheme for link recovery in IEEE 802.11ah networks. The proposed scheme identifies the overlapping regions and congestion of a network and re-configures Relays, APs, and SDN core nodes for reliable data transmission. Taking advantage of redundant links, the SDN controller triggers a node to receive/transmit frames using the best relay/AP for reliable and low latency delivery. The stations use redundant available links to relay/AP for any failure, not meeting the Quality of Service (QoS) requirement and congestion. Our solution use a relay placement scheme to know topology of the network for centralized controlling. An AP node determines the congestion status of each relay and itself and updates the same to the SDN controller. Accordingly, the controller selects an AP/relay and places flow-rules from overlapping regions for forwarding the traffic dynamically. SD-Reco improves packet delivery ratio up to 18.7% and latency up to 33.3%, compared to the existing state-of-the-art.

4- Next Generation Intra-Vehicle Backbone Network Architectures
Authors: Onur Alparslan, Shin'ichi Arakawa and Masayuki Murata (Osaka University, Japan)

Increasing bandwidth requirements in vehicles are pushing the backbone architectures to use faster switching technologies like Ethernet. However, the traditional Ethernet cannot satisfy the strict latency requirements in a vehicle. As a solution, switched Ethernet variants like Time-Sensitive Networking (TSN) and Audio Video Bridging (AVB) are being standardized for automotive Ethernet. Moreover, it is expected that the intra-vehicle backbone architectures will shift to a zonal architecture for more centralizing the processing and decreasing the costs. In this paper, we present the recent trends, advances and challenges in intra-vehicle backbone networks. Moreover, we compare a TSN+AVB Ethernet backbone architecture with an alternative cut-through switching optical backbone network architecture by simulation and show that the cut-through switching optical architecture may achieve lower latency.

5- Towards Multi-Criteria Heuristic Optimization for Computational Offloading in Multi-Access Edge Computing
Authors: Raghubir Singh and Simon Armour (University of Bristol, United Kingdom (Great Britain)); Aftab Khan (Toshiba Europe Ltd., United Kingdom (Great Britain)); Mahesh Sooriyabandara (Toshiba Research Europe Limited, United Kingdom (Great Britain)); George Oikonomou (University of Bristol, United Kingdom (Great Britain))

In recent years, there has been considerable interest in computational offloading algorithms. The interest is mainly driven by the potential savings that offloading offers in task completion time and mobile device energy consumption. This paper builds on authors' previous work on computational offloading and describes a multi-objective optimization model that optimizes time and energy in a network with multiple Multi-Access Edge Computing servers (MECs) and Mobile Devices (MDs). Each MD has multiple computational jobs to process, and each task can be processed locally or offloaded to one of the MEC servers. Several heuristic offloading policies are proposed and tested with an objective function with a range of weightings for optimizing time and energy. The approaches are illustrated with the help of three test cases of varying complexity. The objective function shows a continuous variation as the emphasis is placed on either time or energy saving by the weighting factors. The numerical tests demonstrate that the proposed heuristic algorithms produce near-optimal computational offloading solutions while considering a combined weighted score for schedule task completion time and energy.
6- A Joint Computer Vision and Reconfigurable Intelligent Meta-Surface Approach for Interference Reduction in Beyond 5G Networks

Authors: Valeria Loscri (Inria Lille-Nord Europe, France); Anna Maria Vegni (Roma Tre University, Italy); Eros Innocenti and Romeo Giuliano (Università degli Studi Guglielmo Marconi, Italy); Franco Mazzenga (Università di Roma Tor Vergata, Italy)

Reconfigurable Intelligent Meta-surfaces (RIMs) are particular devices able to control and manipulate radio frequency wireless signals. This promising technology allows to improve the reliability of wireless networks, thanks to the capacity of reflecting the desired signals through appropriate phase shifts. The joint use of RIMs together with Computer Vision (CV) technology is the main objective of this paper. This synergistic approach is used to correctly identify the specific configuration of a radiation pattern, to be used as input for computing optimal coding sequences of the RIM. Indeed, by the means of a CV algorithm it is possible to infer a connectivity graph related to a real scenario, where people is moving. The information about network nodes such as their distance, their position, etc. is used for feeding an intelligent logic, able to compute the optimal configuration for re-directing the signals towards a given target node. The main rationale behind the use of CV to infer these information is that in a high dynamic context, it can be necessary to update information about the network configuration several times, and this can be expensive in terms of energy and computation cost. The usage of CV will allow to send a "picture" of the current environment as a graph, each time a new configuration is required. Numerical results show the huge potentiality of this combined approach in terms of interference reduction. It has been observed that for high traffic load, it is possible to reduce the average interference. Furthermore, an analysis including the positioning estimation error of the CV algorithm has been addressed, in order to consider how it affects the interference reduction. Results show that, even though there is an increasing effect of interference, when the error is accounted, the interference reduction impact is still important.
Technical Session 2: Routing / Security

7- Prediction Augmented Segment Routing
Authors: Murali Kodialam (Nokia Bell Labs, USA); T. V Lakshman (Bell Labs, Nokia, USA)

With the increasing success of machine learning based approaches for prediction problems, there has been recent effort in improving the performance of online algorithms by augmenting them with machine learning predictions. Since machine learning predictions typically do not offer any performance guarantees, the new approach has to take into consideration the possibility that the machine learning prediction can be inaccurate. The idea is to develop approaches that give good results when the prediction is accurate (consistency) while ensuring that the performance is still acceptable in the worst case, when the prediction is not accurate (robustness). Segment routing is now being widely deployed and used for traffic engineering in IP networks. The key idea in segment routing is to break up the routing path into segments to better control routing paths and improve network utilization. We consider the problem of designing the segments in a network to minimize congestion. This is typically done for a predicted traffic matrix. We use the ideas of consistency and robustness to design a parametrized algorithm that gives good performance when the actual traffic matrix is exactly the predicted traffic matrix (consistency) while giving good performance in the worst case if the actual traffic matrix deviates significantly from the predicted traffic matrix (robustness).

8- CP-Trie: Cumulative PopCount Based Trie for IPv6 Routing Table Lookup in Software and ASIC
Authors: MD Iftakharul Islam and Javed Khan (Kent State University, USA)

Routing table lookup is a key function of a router. It involves performing the longest prefix match (LPM) of an IP address. Poptrie, the state-of-the-art trie based routing table lookup, encodes nodes using population counting bitmap. Poptrie uses PopCount CPU instruction which can process only 64 bits at a time. This is why, Poptrie uses 6-bit stride ($2^6 = 64$). This paper presents an extension of Poptrie named CP-Trie (stands for Cumulative PopCount based Trie) where it stores cumulative PopCount along with population counting bitmap. This enables CP-Trie to process longer stride (e.g. 8-16 bits) at each step. This reduces the number of steps and the number of memory access needed for an IP lookup. The fewer number of steps results in faster lookup. It also results in less power consumption in ASIC. Fewer memory accesses indicate that it requires fewer SRAM blocks in ASIC which results in lower area. This is why, CP-Trie is a more practical solution for pipelined ASIC compared to Poptrie. Our experiments with routing tables from real core routers show that CP-Trie achieves up to 1.43X lookup throughput on a general purpose CPU, but consumes 1.36-1.47X memory compared to Poptrie. We also implemented Poptrie and CP-Trie in a 1 GHz pipelined ASIC. Our physical synthesis report shows that CP-Trie consumes 0.86X power and 0.79X area compared to Poptrie in ASIC.

9- C2RTL: A High-Level Synthesis System for IP Lookup and Packet Classification
Authors: MD Iftakharul Islam and Javed Khan (Kent State University, USA)

IP lookup and packet classification are two core functions of a router. IP lookup involves performing the longest prefix match (LPM) of the destination IP address. Packet classification involves finding the best match in a multi-field ruleset where each field needs an exact or prefix match. ASIC based IP lookup and packet classification are traditionally designed in a register transfer level (RTL) hardware description language (HDL) such as Verilog or VHDL. However, manually writing hardware logic is notoriously complicated and painful. This paper presents a High Level Synthesis (HLS) system named C2RTL. C2RTL generates hardware logic in Verilog RTL directly from IP lookup or packet classification algorithm implemented in C. C2RTL is implemented as a plugin of GCC compiler. It takes an IP lookup or packet classification algorithm (in C) as an input and generates corresponding synthesizable Verilog RTL code for pipelined ASIC. We developed several IP lookup and packet classification algorithms in C2RTL and generated corresponding Verilog RTL. We evaluated the resulting RTL code with OpenROAD EDA.
10- **Scalability Analysis of a Blockchain-Based Security Strategy for Complex IoT Systems**  
Authors: Eva Marín-Tordera (Technical University of Catalonia UPC, Spain)  
Supply chains constitute a type of a IoT system that is becoming increasingly complex today. Providing supply chains with cyber-security guarantees is becoming a highly topic in current research. This interest is mainly rooted on the fact that supply chains may include different vulnerable components, such as those residing in factories, distribution centres, logistics, or transportation, just to name a few. Moreover, most of these components are controlled by different IoT devices, such sensors and actuators, also becoming well-known sources of vulnerabilities easing attackers to get access to the whole system. In this scenario, cyber-attacks that use this weak link in a supply chain are increasing in the last years, as it has been largely reported in the literature. In this heterogeneous scenario, the key trend to facilitate cybersecurity provision sits on guaranteeing cybersecurity in the entire supply chain be it handled as a whole, that is, not separately for each individual component of the chain. In this paper, we propose an authentication/access mechanism for the weaker elements in supply chains, i.e., the IoT devices, leveraging blockchain as the baseline technology, that is based on considering the generation of temporal tokens to have a higher access control.

11- **A Technique to Monitor Threats in SDN Data Plane Computation**  
Authors: Loïc Desgeorges and Jean-Philippe Georges (University of Lorraine, France); Thierry Divoux (University of Lorraine, CRAN, France)  
Software Defined Networking (SDN) is a networking paradigm which proposed to decouple the forwarding and the control planes. Security and safety threat challenges at the control level are divided into the reinforcement of the controller, whatever the reason. This work aims to consider both threats and pave the way for a multi-controller architecture without East-West interface. Considering one nominal controller in charge of the data plane computation, we designed a second one in order to control the consistency of the decisions made by the controller, i.e. only through observing the activity of the command (i.e. the management traffic). Compared to related works, no direct exchanges between the controllers are required. The detection logic is introduced theoretically and it mainly relies on two phases: the learning of the decisions and the verification that each decision taken fits with the data plane estimate. The algorithm, implemented on ONOS, is discussed in a case study.

12- **A Bandwidth Balance Routing Approach for Saving Network Capacity in Static Elastic Optical Networks**  
Authors: Jorge Alberto Bermúdez Cedeño (Universidad Técnica Federico Santa María, Chile); Reinaldo Vallejos and Nicolás Jara (Universidad Técnica Federico Santa Maria, Chile)  
Nowadays, most optical network planning strategies route the users by the shortest paths. However, balancing the network paths may achieve remarkable savings by using network resources as even as possible. In this work, we propose a balancing routing strategy for elastic optical networks (EON) architectures with static network operation, called Bandwidth-Balanced (BB). We compute the connection paths balancing the number of FSUs demanded in all network links, contrary to the users balancing strategies found in the literature. To evaluate our proposal, we perform the Routing, Modulation Level, and Spectrum Assignment problems (RMLSA), taking into account physical-layer impairments (PLI) found in optical communications. Experimental results show that the BB strategy outperforms commonly used strategies in capacity savings and spectral fragmentation.
Technical Session 3: Next Generation Networks

Authors: Ouassim Karrakchou, Nancy Samaan and Ahmed Karmouch (University of Ottawa, Canada)

Fast and customizable programmable data planes (PDPs) implementing new services such as multi-flow synchronization, on- and in-time delivery, and in-network caching and compression are key enablers to future applications (e.g., streamed holograms, telesurgery, and autonomous industrial systems). This paper outlines the design principles of EP4, an application-aware extended P4-based network architecture that offers hosted applications an extensible catalog of services through its control plane. The latter configures a PDP that can achieve minimal parsing and processing for fast-tracked packets as well as customized processing and forwarding for other packets. An extended parser (eParser) performs the first task, which reduces the necessary latency experienced by packets. Alternatively, adaptive processing is achieved using an enhanced processor (eProcessor) that optionally parses customized headers using just-in-time programmable parsers. It then executes selected P4 packet processing pipelines implementing different services. These programs are installed at runtime without impacting other switch functionalities. Experimental results demonstrate the architecture’s enhanced performance compared to current solutions.

14- RAFALE: smaRt and Scalable orchestrAtion System for virtuAL Network sErVICES
Authors: Laaziz Lahlou (École de Technologie Supérieure & University of Quebec, Canada); Amina Bounas and Houssem Eddine Mohamadi (École de Technologie Supérieure, University of Quebec, Canada); Nadjia Kara (École de Technologie Supérieure, Canada)

Time-efficient and scalable mechanisms have a significant role in aiding cloud providers to deploy their increasingly complex virtual network services in a seamless manner thanks to Network Function Virtualization (NFV) and Software Defined Networking (SDN) paradigms. Unfortunately, existing state-of-the-art techniques suffer from non-scalability aptitude and often do not converge rapidly towards feasible solutions, although they provide competitive solutions in acceptable execution time for small-scale scenarios. In this paper, we propose RAFALE, a novel approach that formulates the orchestration problem as a graph matching problem and solves it using two exact algorithms. To the best of our knowledge, this is the first work that attempts to tackle the placement and chaining of the VNFs from a different perspective. Experimental results indicate that RAFALE outperforms, in terms of scalability and time-complexity, the well-known VF2 graph matching algorithm and two existing heuristic-based approaches for the placement and chaining of the VNFs.

15- Revenue Optimization and Protection with Network Slicing over a Physical Optical Substrate
Authors: Karcius Assis (Federal University of Bahia, Brazil); Raul C. Almeida, Jr (Federal University of Pernambuco, Brazil); Helio Waldman (Universidade Estadual de Campinas (Unicamp) & Federal University of ABC (UFABC), Brazil)

Network protection is a key solution and an important component in the requirements of virtualization over elastic optical networks (EONs). In this paper, we examine the significance of network virtualization with survivability design against single-link failures and shared risk link groups (SRLG) under dedicated protection and bandwidth squeezing schemes. We study an optimization version of the routing, modulation and spectrum allocation (RMSA) problem with the goal of maximizing the revenue from the accommodated requests of the virtual optical networks (VONs) or slices. We present a Mixed Integer Linear Programming (MILP) formulation for the problem and evaluate some numerical results. We suggest a heuristic that utilizes techniques of decomposition of the problem, which can be employed to obtain a near optimal solution that has a per instance guarantee on the closeness to the optimal solution.
16 - A Reinforcement Learning-Based Solution for Intra-Domain Egress Selection
Authors: Duc-Huy Le and Hai Anh Tran (Hanoi University of Science and Technology, Vietnam); Sami Souhi (University Paris Est UPEC, France)
In a large network, an ingress router often has multiple potential egress points where it can transmit traffic to external networks. The traditional solution is choosing the closest node (with shortest path) to the ingress node. In this paper, we claim the drawbacks of this approach in flexible network system and introduce our proposal called MAB-based Egress Selection. Our approach uses several Reinforcement Learning techniques, which are commonly used to resolve Multi Armed Bandit (MAB) problem, to allow the ingress router to periodically re-pick egress point, hence optimize long-term performance of traffic transmission. To formalize the egress selection process as an MAB problem, we use a combined score of delay and loss representing link status as reward. However, capturing those network metrics encounters some issues due to the distributed control and restricted local view of network nodes. For this purpose, a centralized control architecture, e.g., Software-defined Network (SDN), is a promising candidate. We applied four common algorithms, $\epsilon$-greedy, Softmax, UCB1 and Single Pull UCB2 (SP-UCB2) for egress selection process. The models are evaluated in two simulated network topologies with different scenarios of network traffic condition. The experimental results show that the UCB algorithms produce the best performance, especially in busy network.

17 - Qualitative Communications for Augmented Reality and Virtual Reality
Authors: Cedric Westphal (Huawei Innovation Center, USA); Dongbiao He (Tsinghua University, China); Kiran Makhijani and Richard Li (Futurewei Technologies, USA)
Qualitative Communication has been proposed to increase the responsiveness of a network due to packet loss. The basic idea is to allow the network to drop part of the payload to preserve the integrity of the session (as opposed to dropping whole packets as in TCP). We consider this idea in the context of AR/VR and see how selectively dropping payload naturally fits with such an application where the data can be easily split within some critical and non-critical data. We present basic mechanism to leverage qualitative communications in 360 degree video streaming, as well as a pre-fetching scheme. We evaluate this proposal on actual 360 video traces and show the significant improvement of our proposal versus a vanilla transmission mechanisms.
Technical Session 4: Next Generation Networks

18- Cross-Layer Loss Discrimination Algorithms for MEC in 4G Networks
Authors: Mamoutou Diarra (Inria & Ekinops, France); Walid Dabbous (INRIA, France); Amine Ismail (Ekinops, France); Thierry Turletti (INRIA & Université Côte d'Azur, France)

Traditional loss-based Congestion Control Algorithms (CCAs) suffer from performance issues over wireless networks mostly due to their inability to distinguish wireless random losses from congestion losses. Different loss discrimination algorithms have been proposed to tackle this issue but they are not efficient for 4G networks since they do not consider the impact of various link layer mechanisms such as adaptive modulation and coding and retransmission techniques on congestion in LTE Radio Access Networks (RANs). We propose MELD (MEC-based Edge Loss Discrimination), a novel server-side loss discrimination mechanism that leverages recent advancements in Multi-access Edge Computing (MEC) services to discriminate packet losses based on real-time RAN statistics. Our approach collects the relevant radio information via MEC’s Radio Network Information Service and uses it to correctly distinguish random losses from congestion losses. Our experimental study made with the QUIC transport protocol shows over 80% higher goodput when MELD is used with NewReno and 8% higher goodput when used with Cubic.

19- Mobile Traffic Forecasting Using a Combined FFT/LSTM Strategy in SDN Networks
Authors: Mohammed Lotfi Hachemi (University of Oran1, Algeria); Abdelghani Ghomari (University of Oran1 Ahmed Ben Bella, Algeria); Yassine Hadjadji-Aoul (University of Rennes 1, France); Gerardo Rubino (INRIA, France)

Over the last few years, networks' infrastructures are experiencing a profound change initiated by Software Defined Networking (SDN) and Network Function Virtualization (NFV). In such networks, avoiding the risk of service degradation increasingly involves predicting the evolution of metrics impacting the Quality of Service (QoS), in order to implement appropriate preventive actions. Recurrent neural networks, in particular Long Short Term Memory (LSTM) networks, already demonstrated their efficiency in predicting time series, in particular in networking, thanks to their ability to memorize long sequences of data. In this paper, we propose an improvement that increases their accuracy by combining them with filters, especially the Fast Fourier Transform (FFT), in order to better extract the characteristics of the time series to be predicted. The proposed approach allows improving prediction performance significantly, while presenting an extremely low computational complexity at run-time compared to classical techniques such as Auto-Regressive Integrated Moving Average (ARIMA), which requires costly online operations.

20- A Recurrent Neural Network Based Approach for Coordinating Radio and Computing Resources Allocation in Cloud-RAN
Authors: Mahdi Sharara (Université Paris Saclay, France); Sahar Hoteit (University of Paris Sud & Centrale-Supelec, France); Véronique Vèque (University Paris-Saclay, France)

Cloud Radio Access Network (Cloud-RAN) is a novel architecture that aims at centralizing the baseband processing of base stations. This architecture opens paths for joint, flexible, and optimal management of radio and computing resources. To increase the benefit from this architecture, efficient resource management algorithms need to be devised. In this paper, we consider a coordinated allocation of radio and computing resources to mobile users. Optimal resource allocation that respects the Hybrid-Automatic-Repeat-Request deadline may require formulating high-complexity and resource-heavy algorithms. We consider two Integer Linear Programming problems (ILP) that implement a coordinated allocation of radio and computing resources with the objectives of maximizing throughput and maximizing users' satisfaction, respectively. Since solving these highly-complex problems requires a high execution time, we investigate low-complexity alternatives based on machine learning models; more precisely on Recurrent Neural Networks (RNN). These RNN models aim to depict the performance of the ILP problems with a much lower execution time. Our simulation results demonstrate the great ability of RNN models to perform very closely to the ILP problems while being able to reduce the execution time by up to 99.65%.
21- From Cloud-Native to 5G-Ready Vertical Applications: An Industry 4.0 Use Case

Authors: Chiara Lombardo (University of Genoa & CNIT- Research Unit of the University of Genoa, Italy)

This paper aims to showcase the ability of the MATILDA Platform to enable vertical applications fully utilizing the capabilities offered by the fifth generation of mobile networks (5G). Although 5G, powered by network slicing and edge computing, promises to flexibly support radically new and extremely heterogeneous vertical applications, vertical stakeholders generally lack both the skills to exploit the full potentials of 5G networks and the vision of the underlying resources, owned by Telecom providers that are reluctant to expose them in an unmediated way. The MATILDA platform bridges the gap between the vertical application and the network service domains. This paper presents the case of an Industry 4.0 application, and highlights the role played by the MATILDA solution in its successful deployment and orchestration.

22- Slicing-Based Offloading in Vehicular Edge Computing

Authors: Sara Berri (ETIS, CY Cergy Paris University, ENSEA, CNRS, France); Khaled Hejja (INFRES, Telecom Paris, Institute Polytechnic of Paris, Palaiseau, France); Houda Labiod (Telecom ParisTech, France)

Vehicular edge computing (VEC) provides an environment for offloading tasks from vehicles. Indeed, the advantage through VEC is to push power computational and storage capacities at the edge nodes near the vehicles to handle the enormous resources required by some applications. On the other hand, in order to manage efficiently these resources, it would be necessary to partition them into several parts, each dedicated to a specific service. Thus, integrating network slicing in VEC appears to be relevant. Therefore, in this paper we study the task offloading problem from vehicles to wireless 5G new generation nodes (gNBs) and road side units (RSUs) hosting sliced edge computing servers. We formulate the problem as an integer linear programming problem and propose a new algorithm, which follows a centralized control strategy to holistically view and manage the whole network, and the sliced edge nodes. In addition, it follows network function virtualization framework to separate the logical network from the physical resources. The simulation results show that, in terms of acceptance ratio, the proposed algorithm provides very close results to the optimal solution, and when compared to state-of-art algorithm, integrating slicing is better when there is enough resources on the hosting nodes, but it still guarantees the differentiation among services.

23- 5G and Edge Computing Enabling Experience Delivery Network (XCDN) for Immersive Media

Authors: Gang Shen (Intel, USA); Lei Zhai and Jianhui Dai (Intel Corporation, China); Hassnaa Moustafa (Intel Corporation, USA)

With 5G and Edge Computing, media services observe a very big revolution nowadays. LTE led to media services evolution through enabling video streaming anytime, anywhere, and to any connected mobile device. CDN offered HTTP-based solutions for media streaming services, however real-time communication (RTC) and interactive traffic are not fully supported. 5G and Edge Computing are now enabling new experience through an Experience Delivery Network (XDN) enabling 360 immersive media, where content creation is in real-time, on the fly and equally uses upstream and downstream links. Real-time Communication (RTC) with 5G and Edge Computing allows negligible latency between the communicating parties and is promising not only for immersive media, but also for Cloud Gaming and Tele-health applications. In this paper, we present a 360 Immersive Media solution using Intel WebRTC Tool Kit (OWT) and edge computing platforms allowing media ingestion over 5G networks from multiple cameras, media control and 360 media distribution over 5G networks. Microservices architecture is used for media ingestion, control, and distribution functions, allowing the solution deployment across multiple edge computing clusters and sites. We implemented a prototype for our presented solution and we present a first performance evaluation.
Technical Session 5: Processing for Emerging Networks

24- A Multi-Objective Routing Scheme for Deterministic Network
Authors: Yutao Xia and Bing Hu (Zhejiang University, China)

The problem discussed and solved in this paper is the multi-objective routing problem for Deterministic Network. The technical requirements of resource allocation in the Deterministic Network implementation technology require us to reserve corresponding resources for deterministic flows to be transmitted in the network, which introduces a new constraint of bandwidth competition, making the existing multi-objective routing schemes unable to provide effective solutions. In order to solve this problem, we firstly establish a mathematical model and solve it with optimization methods. Then we propose a multi-objective routing scheme based on genetic algorithm. On the basis of satisfying delay and bandwidth constraints, good results are obtained. In order to test the scalability of the scheme, it was tested in network after adding packet loss constraint and the network of larger scales, which all achieved good results. By comparing the performance of our scheme with that of mathematical modeling optimization, it is found that our scheme has a significant and substantial improvement in efficiency at the cost of relaxing constraints. It is concluded that the multi-objective routing scheme based on genetic algorithm proposed in this paper is an effective scheme to solve the multi-objective problem for Deterministic Network.

25- Increasing Vehicles Perception Using Cooperative Relaying and Priority-Based Beaconing
Authors: Sanaullah Faiz (Universite Sorbonne Paris Nord, France); Nadjib Achair (University Sorbonne Paris Nord, France); Khaled Boussetta (Universite Sorbonne Paris Nord, France)

The use of vehicle's on-board sensors in increasing the perception of cooperative vehicles is becoming prevailing and essential for the road safety. However trusting only on the on-board sensors could limit the perception of the cooperative vehicles for example an object/vehicle can not be detected if it is impeded by some obstruction. The perception efficiency of vehicles can be increased beyond their field of view (FoV) by exchanging the sensor detected information through V2X communication. The perception of vehicles can be more accurate as much as frequent share the information. However by transmitting numerous messages could saturate the communication channel and deteriorate the perception improvement specially in the dense circumstances. In this paper we address both these issues and propose two different schemes, (i) an information propagating mechanism to increase the cooperative vehicle's perception above their FoV and (ii) an optimal dynamic cooperative priority based beaconing model to coup with the channel congestion. By using the information propagation mechanism we can increase the perception of cooperative vehicles up to their maximum communication range and on the other end probability based dynamic cooperative priority beaconing scheme selects the most suitable cooperative vehicle to transmit based on its on-board sensor facility. These proposed mechanisms immensely decrease the contention on the channel while extend the perception beyond the FoV. We evaluate both the mechanisms for the performance in terms of vehicles awareness, channel load and communication range through simulations for several vehicle densities. The simulation results show that these proposals provide better performance compare to the classical beaconing schemes.

26- High-Speed Connection Tracking in Modern Servers
Authors: Massimo Girondi, Marco Chiesa and Tom Barbette (KTH Royal Institute of Technology, Sweden)

The rise of commodity servers equipped with high-speed network interface cards poses increasing demands on the efficient implementation of connection tracking, i.e., the task of associating the connection identifier of an incoming packet to the state stored for that connection. In this work, we thoroughly investigate and compare the performance obtainable by different implementations of connection tracking using high-speed real traffic traces. Based on a load balancer use case, our results show that connection tracking is an expensive operation, achieving at most 24 Gbps on a single core. Core-sharding and lock-free hash tables emerge as the only suitable multi-thread approaches for enabling 100 Gbps packet processing. In contrast to recent beliefs, we observe that newly proposed techniques to "lazily" delete connection states are not more effective than properly tuned traditional deletion techniques based on timer wheels.
27- Run-To-Completion Versus Pipelined: The Case of 100 Gbps Packet Parsing
Authors: Hesam Zolfaghari, Haseeb Mustafa and Jari Nurmi (Tampere University, Finland)
Packet parsing is the initial step in processing of network packets. It is encountered in any environment in which packets must be processed. Examples include switches, routers, firewalls, and kernel of operating system. In recent years, there has been focus on programmable and protocol-independent packet processing hardware. The two main hardware architectures for packet processing are run-to-completion and pipelined organization of functional units. This applies to packet parsing as well. Both run-to-completion and pipelined organization have pros and cons and the debate as to which provides greater overall benefit is endless. In this paper, we consider this problem from the perspective of programmable 100 Gbps packet parsing. We will see that the pipelined parser provides 40x throughput compared to the run-to-completion architecture despite running at the same operating frequency and using the same functional units in each pipeline stage.

28- Delay-Aware Backup Resource Allocation with Probabilistic Protection for Network Services
Authors: Shinya Horimoto, Fujun He and Eiji Oki (Kyoto University, Japan)
This paper proposes a backup resource allocation model for virtual network functions (VNFs) to minimize the total required backup computing capacity with considering the service delay. If random failures occur to primary hosts, the VNFs in failed hosts are recovered by backup hosts, where the allocation is determined in advance. We introduce the probabilistic protection, where the probability that the protection provided by a backup host fails is limited within a given value; it allows backup resource sharing to reduce the total required computing capacity. The previous work formulated the backup resource allocation problem without considering the service delay as a mixed integer linear programming (MILP) problem by adopting the robust optimization. We consider the delay of services, which consists of networking delay between hosts and processing delay in each requested VNF. The probability that the total delay of a service exceeds its threshold is constrained within a given value. To solve the problem with the delay constraint, we introduce an algorithm with two methods to make the MILP problem be aware of the service delay. The results observe that, compared to the baseline, the proposed model can reduce the total required backup capacity of computing resource.

29- Service Chain Provisioning Model Considering Traffic Amount Changed by Virtualized Network Functions
Authors: Shintaro Ozaki, Takehiro Sato and Eiji Oki (Kyoto University, Japan)
This paper proposes a service chain provisioning model considering traffic changing effects of virtualized network functions (VNFs) while determining the VNF visit order of each request, routes of requests, and VNF placement. The service chain provisioning problem is formulated as an integer linear programming (ILP) problem. Three methods of limiting the number of VNF visit order patterns considered in the ILP problem are introduced in order to shorten the computation time. These methods select visit order patterns so as to suppress the sum of the traffic amount reserved by each request on its route. Numerical results show that the consumption of network and computation resources becomes more efficient by considering traffic amount changed by VNFs than the case assuming the traffic amount of each request to be constant end-to-end. The results also show that the computation time can be shortened in our examined scenarios while we obtain the objective value larger by at most 0.4% than the optimal value by limiting the number of visit order patterns.
Technical Session 6: Applications of Machine Learning

30- Identity Management with Hybrid Blockchain Approach: A Deliberate Extension with Federated-Inverse-Reinforcement Learning

Authors: Soumya Banerjee (Trasna-Solutions, Ireland); Samia Bouzefrane (Conservatoire National des Arts et Métiers, France); Amar Abane (Inria, France)

The widespread Decentralized applications (DApps) and Blockchain components significantly boost the security frameworks in many vertical applications and use-cases including different secured payment methods and in smart contracts. The primary theme of Blockchain is to create decentralized control across the target network. Formally, a blockchain is essentially a state machine driven by transactions, and the system state \( s \in S \) is a collection of stored data states. However, there are couple of instances, where proof of consensus does not support the theme of complete decentralization. For example, under PoS (Proof of Stake), it is believed that nodes with the largest numbers stakes (e.g. currencies) would be less likely to be attacked. Thus, they will dominate the network and here it becomes centralized and contradicts with the theme of Blockchain. Similar behavior is observed in case of PoA (Proof of Authority). This bottleneck and trade-off behavior opens up following possibilities: firstly, to investigate certain optimal combinations of proofs which could consolidate security and privacy without being decentralized. Secondly, as the distributed data acquisition methods across the networks cannot resolve the statistical challenges posed by heterogeneous local datasets. Since different users have different device usage patterns, the data samples and labels located on any individual device may follow a different distribution, which cannot represent the global data distribution. Therefore, the proposed method could be bi-focal to compensate the gap. Hence, this papers coins the approach of the presenting hybridizing the consensus whereas to initiate a machine learning mechanism to collect the local data globally through a permission driven and federated approach. The paper introduces Federated Reinforcement learning to be improvised for distributed independent data as policy of consortium while binding the proof of consensus more centrally authenticated.

31- Learned Bloom Filters in Adversarial Environments: A Malicious URL Detection Use-Case

Authors: Pedro Reviriego (University Carlos III of Madrid, Spain); José Alberto Hernández (Universidad Carlos III de Madrid, Spain); Zhenwei Dai and Anshumali Shrivastava (Rice University, USA)

Learned Bloom Filters (LBFs) have been recently proposed as an alternative to traditional Bloom filters that can reduce the amount of memory needed to achieve a target false positive probability when representing a given set of elements. LBFs rely on Machine Learning models combined with traditional Bloom filters. However, if LBFs are going to be used as an alternative to Bloom filters, their security must be also be considered. In this paper, the security of LBFs is studied for the first time and a vulnerability different from those of traditional Bloom filters is uncovered. In more detail, an attacker can easily create a set of elements that are not in the filter with a much larger false positive probability than the target for which the filter has been designed. The constructed attack set can then be used to for example launch a denial of service attack against the system that uses the LBF. A malicious URL case study is used to illustrate the proposed attacks and show their effectiveness in increasing the false positive probability of LBFs. The dataset under consideration includes nearly 485K URLs where 16.47% of them are malicious URLs. Unfortunately, it seems that mitigating this vulnerability is not straightforward.
32- **Foresighted Resource Provisioning for Network Slicing**  
Authors: Quang-Trung Luu (Nokia Bell-Labs, Université Paris-Saclay); Sylvaine Kerboeuf (Nokia Bell Labs, France); Michel Kieffer (CentraleSupelec, France)

Network slicing has emerged as a pivotal concept in 5G systems, allowing mobile operators to build isolated logical networks (slices) on top of shared infrastructure networks. Within a network slice, several Service Function Chains are usually deployed on a best-effort premise. Nevertheless, this approach does not guarantee the availability of enough infrastructure resources to accommodate the uncertain and time-varying slice resource demands. This paper investigates two adaptive slice resource provisioning methods accounting for the evolution with time of the slice resource demands. A probabilistic guarantee of meeting the slice resource requirements can be obtained, while being robust against uncertainties. The myopic approach accounts for the past demands when provisioning the current demands, while the foresighted approach accounts for both past and future demands. These two methods lead to MILP problems. Their performance is compared with a quasi-static method, where provisioning is agnostic of the past and future demands.

33- **High Performance Network Metadata Extraction Using P4 for ML-Based Intrusion Detection Systems**  
Authors: Nicholas Gray (University of Wuerzburg, Germany); Katharina Dietz, Michael Seufert and Tobias Hoßfeld (University of Würzburg, Germany)

Today's communication networks process an increasing amount of traffic, while simultaneously providing services to a larger and more diverse quantity of devices. This enhances the complexity of the network and imposes a larger attack space, impacting network management and security efforts. Deployed hardware middle-boxes, like firewalls and Intrusion Detection Systems (IDSs) often lack the flexibility to adapt to this dynamic environment, which Network Function Virtualization (NFV) addresses by implementing these services in software. Yet, this may impose a bottleneck, due to the absence of hardware acceleration. To mitigate this drawback, the functionality can be offloaded to programmable hardware, using P4. In this work we implement an IDS, capable of operating in core and backbone networks up to 100Gbps. This is achieved by using the hardware acceleration of P4-enabled Intel Tofino switches for high performance metadata extraction, in order to train an ML-based detection engine. The system is evaluated regarding its throughput and obtainable aggregation levels as well as its accuracy for detecting a variety of network attacks.

34- **Reinforcement Learning Based Approach for Virtualized Face Detection at the Edge**  
Authors: Selma Khebbache (IRT-SystemX, France); Makhlouf Hadji (IRT System X, France); Mohamed Idriss Khaledi (IRT SystemX, France)

Real-time requirements in video streaming and processing are increasing and represent one of the major issues in industry 4.0 domains. In particular, Face Detection (FD) use-case has attracted the interest of industrial and academia researchers for various applications such as cyber-physical security, fault detection, predictive maintenance, etc. To ensure applications with real time performance, Edge Computing is a good approach which consists in bringing resources and intelligence closer to connected devices and hence, it can be used to cope with strong latency and throughput expectations. In this paper, we consider optimal routing, placement and scaling of virtualized face detection services at the edge. We propose an edge networking approach based on Integer Linear formulation to cope with small problem instances. A reinforcement learning solution is proposed to address larger problem sizes and scalability issues. We assess the performance of our proposed approaches through simulations and show advantages of the reinforcement learning approach to converge towards near-optimal solutions in negligible time.
35- ML-Based Incast Performance Optimization in Software-Defined Data Centers
Authors: Kokouvi Benoit Nougnanke (LAAS-CNRS & Univ de Toulouse, France); Yann Labit (LAAS-CNRS, Université de Toulouse, France); Marc Bruyere (IIJ Innovation Institute & The University of Tokyo, Japan)

Traffic optimization is fundamental to achieve both great application performance and resource efficiency in data centers with heterogeneous workloads, including incast. However, general performance models, providing insights on how various factors affect a certain performance metric used in the network optimization process, are missing. For the special case of incast, the existing models are analytical models, either tightly coupled with a particular protocol version or specific to certain empirical data. This paper proposes an SDN-enabled machine-learning-based optimization framework for incast performance optimization in data center networks that leverages learning-based performance modeling. Evaluations based on intensive NS-3 simulations show that we can achieve accurate performance predictions that enable finding the efficient switch buffer space to achieve optimal incast completion time in different configurations. We expect this framework to be a building block for autonomous data center network management.

Short-Track Session 1: Security & IoT and Smart Applications

36- Energy Efficient and High Performance Modified Mesh Based 2-D NoC Architecture
Authors: B. Naresh Kumar Reddy (IIT Delhi, India); Subrat Kar (IITD, India)

System-on-chip (SoC) has migrated from single core to multi core architectures to adapt the expanding intricacy of real time applications. Network-on-chip (NoC) is appeared as an alternative to deal with the communication issues in embedded system-on-chip architectures. In network-on-chip (NoC) design, application mapping plays a significant role i.e. responsible for mapping an application on the NoC platform, because the application mapping on a mesh based NoC platform is NP-hard. In this research paper, a modified 2-D mesh NoC architecture is introduced. Every core is associated with the two routers. An effective mapping algorithm which maps the cores in the modified NoC architecture is also illustrated based on a CER region to enhance the processor performance and reduces the communication energy. The outcomes of the simulation illustrate that the proposed strategy is outperformed comparing with the other mapping techniques in terms of communication energy and performance. Moreover, the proposed algorithm is relevant to both random and distributed core graphs.

37- Secure Multipath Routing in Heterogenous Low Power and Lossy Networks in the Internet of Things
Authors: Somia Sahraoui and Nabil Henni (University of Biskra, Algeria)

The Internet of Things (IoT) is made up of huge sets of networked low-power devices. Those devices are generally tasked to provide highly important services that can be reached out through the internet. Communications with IoT networks cannot be achieved without the support of efficient underlying routing schemes. However, the constraints related to scarce resources, as well as the wireless and lossy nature of the IoT’s networks, may tremendously affect the communications reliability. Moreover, the exposure to cyber-attacks, especially those that threaten data and service availability, complicates even further the routing and security missions in such a constrained context. In this paper, we propose an efficient solution that enhances both the communications reliability and security in the IoT-enabled Low power and Lossy Networks (LLNs). The solution relies on novel, adaptive and secure multipath routing scheme for the IPv6 routing protocol for LLNs (RPL). The initial assessment results confirm the effectiveness of the proposal.
38- **A Self Organizing OneM2M IoT Network**  
Authors: Mouna Ben Mabrouk (Altran, France); Jean-Paul Garandeau, Thibault Tabani and Martine Gateau (Altran Connected Solutions, France)

In IoT, there is a huge diversity in types of devices, protocols and mechanisms that must be supported. 'IoTification' helps these objects to communicate with each other, exchange information in order to have a better connected and managed system. In order to reduce the number of errors during manual maintenance interventions on the IoT network infrastructure and to improve the efficiency of reconfiguration actions by automatic mechanisms, a self-organizing network (SON)-based architecture is proposed for a oneM2M IoT network. This makes it possible to take into account the heterogeneity of IoT subnets and to reduce the costs related to network infrastructure extensions. The proposed approach is implemented and evaluated according to the ACS quality management system.

39- **A Novel Blockchain Secure to Routing Protocol in WSN**  
Authors: Wassim Jerbi (National Engineering School of Sfax, Tunisia); Abderrahmen Guermazi (CES Laboratory, Tunisia); Omar Cheikhrouhou (College of CIT, Tunisia); Hafedh Trabelsi (University of Sfax, Ecole Nationale d'Ingénieur de Sfax, Tunisia); Atef Boubaker (ISET Sfax, Tunisia)

A blockchain is a database that contains the history of all exchanges made between its users since its creation. A blockchain is a distributed and secure ledger of all transactions made since the start of the distributed system. It is a technology for storing and transmitting information, transparent, secure, and operating without a central control body. Our paper studies a new device authentication for mobile sensor node to prove its authenticity to unknown network manager. To solve the authentication of sensor among multiple networks, our proposal a blockchain scheme where the transaction specifies the authentication of given cluster head CH. As we claim, a blockchain guarantees an integrity and availability of message under assumption that every node has some public and private key pairs. However, it does not provide any authentication mechanism for symmetric key. Hence, the proposed scheme is secure as we claim. More concretely, in the protocol proposed Blockchain Security IoT (BSI) is to provide authentication between the mobile base station (BS), the cluster head and the member nodes for wireless sensor networks (WSN). Our protocol BSI protocol makes it possible to put the necessary keys of the networks at the level of each sensor for the different scenarios carried out, BS mobile node and migration node. We evaluate the performance of our protocol with simulations using MATLAB. The results confirm that the BSI protocol is robust and efficient, provides lower power consumption and fast computing time.

40- **Verification of Cloud Security Policies**  
Authors: Loïc Miller (University of Strasbourg, France); Pascal Méridol (Université de Strasbourg, France); Antoine Gallais (Polytechnic University Hauts-de-France, France); Cristel Pelsser (University of Strasbourg, France)

Companies like Netflix increasingly use the cloud to deploy their business processes. Those processes often involve partnerships with other companies, and can be modeled as workflows where the owner of the data at risk interacts with contractors to realize a sequence of tasks on the data to be secured. In practice, access control is an essential building block to deploy these secured workflows. This component is generally managed by administrators using high-level policies meant to represent the requirements and restrictions put on the workflow. Handling access control with a high-level scheme comes with the benefit of separating the problem of specification, i.e. defining the desired behavior of the system, from the problem of implementation, i.e. enforcing this desired behavior. However, translating such high-level policies into a deployed implementation can be error-prone. Even though semi-automatic and automatic tools have been proposed to assist this translation, policy verification remains highly challenging in practice. In this paper, our aim is to define and propose structures assisting the checking and correction of potential errors introduced on the ground due to a faulty translation or corrupted deployments. In particular, we investigate structures with formal foundations able to naturally model policies. Metagraphs, a generalized graph theoretic structure, fulfill those requirements: their usage enables to compare high-level policies to their implementation. In practice, we consider Rego, a language used by companies like Netflix and Plex for their release process, as a valuable representative of most common policy languages. We propose a suite of tools transforming and checking policies as metagraphs, and use them in a global framework to show how policy verification can be achieved with such structures. Finally, we evaluate the performance of our verification method.
41 - Towards Secure and Leak-Free Workflows Using Microservice Isolation

Authors: Loïc Miller (University of Strasbourg, France); Pascal Méringol (Université de Strasbourg, France); Antoine Gallais (Polytechnic University Hauts-de-France, France); Cristel Pelsser (University of Strasbourg, France)

Companies like Netflix increasingly use the cloud to deploy their business processes. Those processes often involve partnerships with other companies, and can be modeled as workflows. This shift towards the cloud environment has led to more and more data leaks and breaches, resulting in huge losses of money for businesses like the movie industry, as well as a loss of user privacy for businesses dealing with user data like the pharmaceutical industry. In this paper, we show how those workflows can be enforced while preventing data exposure. Following the principles of zero-trust, we develop an infrastructure using the isolation provided by a microservice architecture, to enforce owner policy. We show that our infrastructure is resilient to the set of attacks considered in our security model. We implement a simple, yet realistic, workflow with our infrastructure in a publicly available proof of concept. We then verify that the specified policy is correctly enforced by testing the deployment for policy violations, and estimate the overhead cost of authorization.

Short-Track Session 2: Next Generation Networks


Authors: Hedi Hamdi (Jouf University, College of Computer and Information Sciences, Saudi Arabia); Imen Souid (University of Carthage, Tunisia); Randa Jabeur Ben Chikha (Jouf University, Saudi Arabia)

Wireless sensor networks (WSNs) are one of the most widely recognized dynamic systems used for monitoring and tracking. Cognitive radio technology has been incorporated into wireless sensors to meet the frequency requirements of WSN-based systems such as the Internet of Things (IoT) and vehicular networks. As a matter of fact, data routing has a great impact on self-organized networks. We therefore introduce a cognitive dynamic low energy adaptive clustering hierarchy (CDLEACH) protocol dedicated to cognitive WSNs. CDLEACH is based on a dynamic cognitive clustering approach. In fact, the number of cluster heads (CH) should be adjusted over the network lifetime based on the number of alive sensor nodes (SNs). In addition, SNs with the highest observed idle channels are selected as CHs. In order to test the proposed data routing algorithm under realistic circumstances, we derive the analytical energy model in which the energy-sensing range of the consumed SNs is taken into account. The simulation results show that CDLEACH provides a significant reduction of the energy consumption of SNs. Consequently, a good enhancement in terms of network lifetime is shown in addition to an increase of the amount of transmitted data.

43 - A Low-Cost IP-To-NDN Translation Gateway

Authors: Feri Fahrianto (Universitas Islam Negeri Syarif Hidayatullah, Indonesia); Noriaki Kamiyama (Ritsumeikan University, Japan)

A low-cost migration from IP-to-NDN is one of the most critical challenges that should be answered before the NDN protocol replacing the IP protocol on the Internet. A translation approach is considered as the practical and economical approach for IP to NDN migration. This paper proposes a lightweight translation method between IP and NDN by utilizing the data payload for bridging the semantic protocol gap in some possible producer and consumer scenarios. We evaluate the packet throughput, latency, and processing load to clarify the gateway effectiveness using a computer emulator.
Short-Track Session 2: New IP-2

44- Intelligent Routing Approach Based on Machine Learning and SDN for Heterogeneous IoTs
Authors: Dyhia Rehoune, Mouna Ben Mabrouk and Azadé Fotouhi (Altran, France)

Internet of things (IoT) is a network of billions of objects connected through heterogeneous communication technologies such as Ethernet, WiFi, Bluetooth, ZigBee, etc. The diversity of communication technologies is a significant barrier preventing the management, the control and more specifically the interoperability using a unified interface. In this paper, the SDN layer, which aims at ensuring a universal management of the IoT heterogeneous network, is to develop a Machine Learning algorithm that allows the classification of IoTs according to the data, this algorithm allows the COBOX to find the object that will be interested in the data sent by other IoT, finally integrate this algorithm in the SDN network. The proposed solution enables the building of a middleware that supports interoperability between heterogeneous devices.

45- Towards a Crowdsourced Network Measurements Analyzer (CNMA) for the Streaming Service
Authors: Lamine Amour and Abdulhalim Dandoush (ESME Sudria, France)

This exploratory work introduces a new data analyzer system, called CNMA (Crowdsourced Network Measurements Analyzer). CNMA aims at addressing the root cause of the bad performance of typical internet applications such as video on demand streaming and web search considering the 3G/4G radio access network. In particular, we study the related physical radio access parameters to the timeout status of transport connections and application throughput using the "5Gmark" crowdsourcing full tests. Thus, we consider dataset of LTE technology collected via measurements from one of the major French mobile operators in Ile-de-France region. To perform the analysis, CNMA is composed of three different modules. The first one is the storage module for storing the Crowdsourced Network Measurements (CNMs) raw data of "5Gmark" tool. The second module is the batch unit. The last module consists on the visualization (dashboard) one for plotting and reporting the analysis results. The main expected outcome of CNMA is the impact of the bit rate combined with other parameters of the physical layer such as the Received Signal Strength and the Reference Signal Received Quality (RSRQ) on the application throughput and their correlation to the connection timeout phenomena.

46- Simulated Annealing-Based Beam Management for 5G Vehicular Networks
Authors: Rima Benelmir and Salim Bitam (University of Biskra & LESIA Laboratory, Algeria); Abdelhamid Mellouk (UPEC, University Paris-Est Créteil Val de Marne, France)

Despite the huge development in the fifth generation (5G) vehicular networks, the data transmission is still suffering from the signal attenuation, especially when vehicles move. It is due to the limited 5G connectivity range where the frequency waves, named mmWaves, are only able to cross a short distance and are interrupted by physical obstacles like buildings, trees, and walls. These obstacles can obstruct, disrupt or absorb a part of the transmitted signal. To overcome this drawback, a various beam management approaches were proposed in the literature to find the best transmission beam that increases the performance of 5G vehicular networks. In this paper, we propose a new simulated annealing algorithm that adjusts dynamically the direction of the beam according to the connected vehicle positioning, where the mmWave base station selects for each vehicle position the optimal angle that maximizes the Signalto-Interference-plus-Noise Ratio (SINR) of the received signal. The results obtained showed the effectiveness of this proposal to establish an efficient communication between the mmWave BS and the connected vehicle compared to conventional method.
47- A New Control Algorithms for Simultaneous Connections Routing in Elastic Optical Networks
Authors: Enass Abuelela and Mariusz Zal (Poznan University of Technology, Poland)

This paper presents novel six rearrangeable control algorithms suitable for Elastic Optical Network (EON). The proposed algorithms are based on simultaneous routing and matrix decomposition. We investigated the wavelength-space-wavelength switching fabrics, known as the WSW1, for previously developed three-stage architecture. In our proposal, we develop these algorithms for the four inputs/outputs WSW1 switching fabrics. The three-stage architecture of WSW1 was intensively considered only for a smaller number of inputs/outputs. We were able to achieve better results than previously proposed algorithms considering the same number of inputs/outputs. The switching fabric working under the proposed algorithms offers a smaller construction cost than the switching fabric controlled by previously known algorithms. This is expressed by the number of wavelength converters.

Technical Session 7: IoT and Smart Applications
48- On the Use of Machine Learning and Network Tomography for Network Slices Monitoring
Authors: Anouar Rkhami (Inria, Univ Rennes, CNRS, IRISA, France); Yassine Hadjadji-Aoul (University of Rennes 1, France); Gerardo Rubino (INRIA, France); Abdelkader Outtagarts (Nokia Bell Labs France, France)

Network Slicing (NS) is a key technology that enables network operators to accommodate different types of services with varying needs on a single physical infrastructure. Despite the advantages it brings, NS raises some technical challenges, mainly ensuring the Service Level Agreements (SLA) for each slice. Hence, monitoring the state of these slices will be a priority for ISPs. However, due to the high measurements overhead, it is generally forbidden to directly measure the performance of all of these slices. To overcome this limitation, network tomography is a promising solution, consisting of a set of methods of inferring unmeasured network metrics using end-to-end measurements between monitors. In this work, we focus on inferring the additive metrics of slices such as delays or logarithms of loss rates. We model the inference task as a regression problem that we solve using neural networks. In our approach, we train the model on an artificial dataset. This not only avoids the costly process of collecting a large set of labeled data but has also a nice covering property useful for the procedure's accuracy. Moreover, to handle a change on the topology or the slices we monitor, we propose a solution based on transfer learning in order to find a trade-off between the quality of the solution and the cost to get it. Simulation results with both, emulated and simulated traffic show the efficiency of our method compared to existing ones in terms of both accuracy and computation time.

49- DC Building Management System with IEEE 802.3bt Standard
Authors: Karem Hafsi (LCIS Laboratory, France); Denis Genon-Catalot (University Grenoble Alpes - Grenoble INP & LCIS, France); Jean-Marc Thiriet (Université Grenoble Alpes, France); Olivier Lefèvre (UBIANT, France)

We present the results for a new building supply and communication architecture based on Power Over Ethernet (PoE) with the IEEE 802.3bt standard. Driven by technological advances like photovoltaic production, LED lighting terminals, computer terminals, tablets, screens and the advancement of power electronics that allow more and more conversions with very high efficiency, direct current in buildings might be the right solution to reduce energy consumption and go towards positive energy buildings. With the new IEEE 802.3bt PoE standard which allows 99 W and with the increasing demand for new services in smart buildings and the emerging of IoT devices, we propose a communication and supply architecture completely based on the IP protocol. This paper presents feedback of the first deployment of a smart building totally powered by PoE devices, we analyse the power supply architecture and the application communication protocol that we have used which is MQTT (Message Queuing Telemetry Transport).
50- **CAE Adaptive Compression, Transmission Energy and Cost Optimization for m-Health Systems**
Authors: Abeer Al-Marridi and Amr Mohamed (Qatar University, Qatar); Aiman Erbad (Hamad Bin Khalifa University, Qatar); Mohsen Guizani (Qatar University, Qatar)

The rapid increase in the number of patients requiring constant monitoring inspires researchers to investigate the area of mobile health (m-Health) systems for intelligent and sustainable remote healthcare applications. Extensive real-time medical data transmission using battery-constrained devices is challenging due to the dynamic network and the medical system constraints. Such requirements include end-to-end delay, bandwidth, transmission energy consumption, and application-level Quality of Services (QoS) requirements. As a result, adaptive data compression based on network and application resources before data transmission would be beneficial. A minimal distortion can be assured by applying Convolutional Auto-encoder (CAE) compression approach. This paper proposes a cross-layer framework that considers the patients' movement while compressing and transmitting EEG data over heterogeneous wireless environments. The main objective of the framework is to minimize the trade-off between the transmission energy consumption along with the distortion ratio and monetary costs. Simulation results show that an optimal trade-off between the optimization objectives is achieved considering networks and application QoS requirements for m-Health systems.

51- **An Analytical Model of Bluetooth Performance Considering Physical and MAC Layers' Effects**
Authors: M. Shabbir Ali and Julian Garbiso (VEDECOM, France); Jun Zhang and Houda Labiod (Telecom Paris, France); Oyunchimeg Shagdar and Mohamed Hadded (VEDECOM, France)

This paper presents an analytical model for the average Packet Error Rate (PER) of Bluetooth in Basic Rate (BR) mode. The effects of the physical layer and the MAC layer are taken into account. A Nakagami-m block fading is considered to take into account the effects of wireless channel fading. A Gaussian Frequency Shift Keying (GFSK) modulation scheme is used. Also, Forward Error Control (FEC) coding effects are taken into account. The interference between the different piconets is captured by a simple Medium Access Control (MAC) layer collision model. An approximation of instantaneous PER is obtained as a first result. Then, a closed-form expression is derived for the PER at the physical layer of Bluetooth. Finally, the overall average PER at the physical and MAC layer of Bluetooth is computed. Extensive simulations are performed to show the accuracy of the obtained results.
52- **Privacy-Aware Ant Routing for Wireless Multimedia Sensor Networks in Healthcare**

Authors: Yasmine N. Saleh (Arab Academy for Science, Technology and Maritime Transport, Egypt); Claude C. Chibelushi (Semantics 21 Ltd, United Kingdom (Great Britain) & University of Warwick, United Kingdom (Great Britain)); Ayman A. Abdel-Hamid (Arab Academy For Science, Technology, and Maritime Transport, Egypt); Abdel-Hamid Soliman (Staffordshire University, United Kingdom (Great Britain))

Although the importance of privacy is well-acknowledged for sensitive healthcare data, significant research efforts are still needed to develop robust privacy protection solutions for Wireless Multimedia Sensor Networks (WMSNs) used in the context of healthcare. The aim of this paper is to investigate privacy-preserving mechanisms for WMSNs for use in healthcare, to ensure privacy-aware transmission (from sensors to the base station) of multimedia data. The AntSensNet is a WMSN-based routing protocol, which combines the basics of the ant colony optimization-based routing with the hierarchical structure of the network, to provide QoS and power efficient multipath multimedia packet scheduling.

In this paper, the AntSensNet routing protocol was extended by adding to it privacy-preserving mechanisms, towards achieving unlinkability, anonymity / pseudonymity and location privacy. The standard AntSensNet routing protocol is vulnerable to privacy threats. Consequently, the following privacy attacks' countermeasures were incorporated: (i) size correlation and encryption of scalar and multimedia data transmitted through a WMSN, and size correlation and encryption of ants, to achieve unlinkability and location privacy; (ii) fake traffic injection, to achieve anonymity, source location and base station location privacy, as well as unlinkability; (iii) pseudonyms, to achieve unlinkability. To assess the impact of such countermeasures, a quantitative performance analysis was conducted through simulation to gauge the overhead of the added privacy countermeasures. It can be concluded that the added privacy measures have enhanced privacy but at the expense of extra delay and multimedia jitter.

The sources and the volumes of fake traffic must be carefully studied depending on the health condition of a patient to determine what vitals need to be monitored, whether video and audio monitoring is required or not versus the required level of privacy.

53- **Toward an Autonomous Smart Home: A Three-Layer Edge-Fog-Cloud Architecture with Latency Analysis**

Authors: Hussein Chour (CentraleSupelec & Lebanese University, France); Djamel Eddine Kouicem, Azadé Fotouhi and Mouna Ben Mabrouk (Altran, France)

Due to the rapid evolution of smart devices, recently, the smart home (SH) sector has attracted attention and faced a fast expansion. However, the current cloud-based SH architecture and the ever-growth of the smart-things number and applications have brought several challenges to SH like the user-dependent automation tasks, the user-dependent SH management system, and the relatively large delay response time. These challenges create a gap between the actual SH and the envisioned autonomous SH that can control the SH objects independently and automate the home intelligently. Reducing this gap became the main target of the current SH research works. This paper builds on the network softwarization and virtualization techniques along with the edge, fog, and cloud computing to propose a three-layer Edge-Fog-Cloud SH (EFC-SH) intelligence architecture that can enable the autonomous SH. Then, it derives the optimal trade-off between the workload and the latency at each layer. Simulation results show that the proposed EFC-SH architecture achieves lower latency compared to the cloud-only or fog-only architectures.
Invited sessions on New IP, session I

54- The Future of Media Streaming Systems: Transferring Video over New IP
Authors: Stuart Clayman (University College London (UCL), United Kingdom (Great Britain)); Mustafa Tuker, Halil Arasan and Muge Sayit (Ege University, Turkey)

Big Packet Protocol (BPP), which is part of New IP, was designed to transfer packets for future networking applications, and aims to overcome obstacles within current networks for high precision services. One of the most important advantages of New IP is that it allows changes to packets during transmission. The strategy of BPP is to reduce the packet size by eliminating specific chunks, cutting out segments from the transferred video, rather than dropping or retransmitting packets. This provides an effective mechanism to enhance the performance of video streaming applications, by obtaining continuous delivery and minimum guaranteed quality at the receiver. In order to make video transmission over BPP effective, we need to select a video codec that can do multiple encodings for the same region, such as scalable video coding (SVC). To support such functionality, we have augmented the BPP packet structure in order to transfer video data. This paper describes the use of BPP for carrying video from servers to clients, and defines the packet structure for this purpose, plus the extensions needed to support SVC encoded video. To evaluate the proposed approach, we use SDN to facilitate BPP operations, with results showing a successful implementation of a system using these combined techniques.

55- Computing Power Network an Interworking Architecture of Computing and Network Based on IP Extension
Authors: Bo Lei and Qianying Zhao (Beijing Research Institute China Telecom Beijing, China); Jie Mei (Beijing University of Posts and Telecommunications, China)

The introduction of edge computing has brought new changes in network traffic model. From the perspective of users, resources in different locations are not equal. For providing users with a better service experience, the distance between users and resources (different latency), network conditions, as well as charging and many other factors are needed to be considered. This paper considering various resources proposes an interworking architecture of computing and network based on IP extension: Computing power network. It is a new type of network that realizes the best resource allocation, by distributing computing, storage, algorithm and other resource information of service nodes through network control plane (such as centralized controller, distributed routing protocol, etc.). It combines network context and user requirements to provide the optimal distribution, association, transaction and scheduling of computation storage and network resources.

56- High-Precision Accounting for High-Precision Networking Services
Authors: Alexander Clemm (Futurewei Technologies, USA); John Strassner (Huawei, USA)

The networking landscape is expected to undergo profound changes over the coming years, with new applications emerging that depend on the ability of networks to provide high-precision services with stringent service-level guarantees. To enable and incentivize network providers to deploy and deliver such services will also require advances in the way such services can be accounted for. At its core, this will require support for high-precision metering that allows to generate custom accounting records that can be custom tailored towards specific service offerings and service level agreements. This paper presents a framework to enable such metering.
57- A Proof of Optimality on EDF Scheduling in Sink-Tree Packetized Networks
Authors: Xuan Liu (Network Technology Lab, Huawei & Beijing University of Posts and Telecommunications, China); Bingyang Liu (Huawei, China); Shoushou Ren (Huawei Technologies Co., Ltd., China)

Earliest Deadline First (EDF) scheduling, is known to obtain the optimality of deterministic delay performance upon the single link. However, due to the generality of the network with multiple nodes and multiple flows transmitted within it, the optimal online scheduling is impossible. In this paper, we prove that EDF can still provide the optimal delay performance in a class of practical multiple-nodes-and-multiple-flows network scenarios, such as 5G Cloud VR/AR applications in up-link cases, namely in sink-tree networks multiple flows sharing the root node as the same destination node. The proof uses the delay-based schedulability region to quantify the performance of different scheduling policies. Finally, the proof indicates that EDF can achieve the largest schedulability region in sink-tree networks.

Invited sessions on New IP, session II

58- Indirect Line-Of-Sight Free-Space Optical Communications Using Diffuse Reflection
Authors: Roberto Rojas-Cessa (New Jersey Institute of Technology, USA)

Free-space optical communications (FSOC) has been proved to achieve the highest data-rate communications, and yet, its long-time adoption remains reserved to very selective applications. A culprit of the limited adoption of FSOC is its point-to-point link application that is the result of the required a) the direct Line-of-Sight (LoS) between transmitter and receiver, and b) the needed fine alignment of the transceivers of the communicating stations. Indirect LoS FSOC (ID-FSOC) is an alternative to FSOC where transmitter and receiver might not be in LoS of each other but to a diffuse reflector. Such a reflector not only helps to cover out-of-sight areas but also converts the optical link onto a broadcast channel where one station may communicate with all other stations that may have LoS to the reflector. Here, we discuss some of the properties of this novel paradigm and argue that it may represent a new facet of free space of optical communications that provides a great range of applications for high-speed data communications.

59- Multi-Path Transmission Scheme Based on Segment Control in Low-Earth-Orbit Satellite Network
Authors: Man Ouyang (Beijing University of Posts and Telecommunications, China); Xuefei Duan (Guangdong Communication & Network Institute, China); Jiang Liu, Ran Zhang and Tao Huang (Beijing University of Posts and Telecommunications, China); Hua Lu (Guangdong Communication & Network Institute, China)

Because of the challenges brought by the high dynamic topology of satellite networks to the transport layer, this paper is mainly devoted to a multi-path transmission control protocol (MPTCP) path selection scheme based on segment control technology and software-defined networking (SDN). We describe the signaling interaction mode of MPTCP and the process of segment control technology applied in the satellite network. According to the requirements of real-time and accuracy of data transmission, we consider the link delay, stability, and packet loss rate, and construct the scheme as a maximum-flow minimum-cost problem. The experimental results show that the proposed scheme can meet the low delay requirements of delay-sensitive traffic flow, improve bandwidth utilization, and ensure more efficient and reliable data transmission.
60- Asymmetric Addressing Structures in Limited Domain Networks
Authors: Kiran Makhijani and Lijun Dong (Futurewei Technologies, USA)

Different industry verticals require their network domains to describe their optimized application control and behavior through custom protocols. Such local protocols are necessary because adapting specific behaviors using current general-purpose network paradigms often leads to constrained design decisions since the IP does not provide necessary customization with its existing format. At the same time, with the growth in Industrial Internet and IoT, there is a need for convergence between the standard Internet and proprietary protocols. In this regard, network addresses are key to representing application semantics or a device's capability, but the current IP address structure does not sufficiently capture these artifacts. We propose the use of New IP shipping specification to accommodate a diverse set of local protocol requirements in a well-structured user-defined address scheme and its effective integration and adaptation to the IP for opaque connectivity over the Internet.

61- On Control and Data Plane Programmability for Data-Driven Networking
Authors: Alessio Sacco (Politecnico di Torino, Italy); Flavio Esposito (Saint Louis University, USA); Guido Marchetto (Politecnico di Torino, Italy)

The soaring complexity of networks has led to more and more complex methods to manage and orchestrate efficiently the multitude of network environments. Several solutions exist, such as OpenFlow, NetConf, P4, DPDK, etc., that allow network programmability at both control and data plane level, driving innovation in many focused high-performance networked applications. However, with the increase of strict requirements in critical applications, also the networking architecture and its operations should be redesigned. In particular, recent advances in machine learning have opened new opportunities to the automation of network management, exploiting existing advances in software-defined infrastructures. We argue that the design of effective data-driven network management solutions needs to collect, merge, and process states from both data and control planes. This paper sheds light upon the benefits of utilizing such an approach to support feature extraction and data collection for network automation.
Workshop abstracts

SARNET- Technical Session 1: Semantic Addressing

1- QoS-Enabled Semantic Routing for Industry 4.0 Based on SDN and MOM Integration
Authors: Paolo Bellavista (University of Bologna, Italy); Mattia Fogli (University of Ferrara, Italy); Luca Foschini (University of Bologna, Italy); Carlo Giannelli (University of Ferrara, Italy); Lorenzo Patera (University of Bologna, Italy); Cesare Stefanelli (University of Ferrara, Italy)

Industry 4.0 environments pose unique challenges for the realization of the communication substrate at the shop floor, due to the strict Quality of Service (QoS) requirements, the high heterogeneity of the employed data exchange protocols, and the different network technologies and addressing schema toward the machines. To address those issues, the paper proposes a distributed support based on a Message Oriented Middleware (MOM) and a Software Defined Network (SDN) control plane that coordinate to enable semantic routing by also allowing traffic differentiation as well as in-network processing at intermediate network nodes. Seminal results, collected in realistic industrial settings, confirm the feasibility of our proposal.

2- Dyncast: Use Dynamic Anycast to Facilitate Service Semantics Embedded in IP Address
Authors: Yizhou Li (Huawei, China); Zifa Han (Huawei Technologies, China); Shuheng Gu and Guanhua Zhuang (Huawei, China); Feng Li (Huawei Technologies)

Edge computing services are deployed at edge sites that are closer to users compare to the central cloud. There are quite a number of edge sites in a city hosting those service instances. The user's request is normally served by the geographically closest one in order to get faster response. However the shortest distance does not necessarily mean the lowest latency from the user's experience. With increasing number of edge sites, computing capacity and load, and network path status rather than geographical location, are playing key roles in determining the best edge site or service instance to handle the user's request to achieve the optimal overall load balance and user experience. In this paper, we propose a dynamic anycast (Dyncast) networking architecture to optimally route the computing request to the most appropriate service instance by considering the real time computing loads and the network status simultaneously. The field testbed experiments demonstrate the effectiveness of the proposed dyncast architecture. Dyncast shows 9.5% to 159.9% improvement in terms of job completion time (JCT) over traditional scheduling strategy under different computing load and network status scenarios.

3- Virtual Data-Plane Addressing for SDN-Based Space and Terrestrial Network Integration
Authors: Gao Zheng, Ning Wang and Rahim Tafazolli (University of Surrey, United Kingdom (Great Britain)); XinPeng Wei and Jinze Yang (Huawei Technologies, China)

Integrating Low Earth Orbit (LEO) satellites with terrestrial network infrastructures to support ubiquitous Internet service coverage has recently received increasing research momentum. One distinct challenge is the frequent topology change caused by the constellation behaviour of LEO satellites. In the context of software defined networking (SDN), the controller function that is originally required to control the conventional data plane fulfilled by terrestrial SDN switches will need to expand its responsibility to cover their counterparts in the space, namely LEO satellites that are used for data forwarding. As such, seamless integration of the fixed control plane on the ground and the mobile data plane fulfilled by constellation LEO satellites will become a distinct challenge. In this paper, we propose the Virtual Data-Plane Addressing (VDPA) Scheme by leveraging semantic IP addresses to represent virtual switches at the fixed space locations which are periodically instantiated by the nested LEO satellites traversing them in a predictable manner. With such a scheme the changing data-plane network topology incurred by LEO satellite constellation can be made completely agnostic to the control plane on the ground, thus enabling a native approach to supporting seamless communication between the two planes. Our testbed-based experiment results prove the technical feasibility of the proposed VDPA-based flow rule manipulation mechanism in terms of data plane performance.
4- A Vision to Software-Centric Cloud Native Network Functions: Achievements and Challenges

Authors: Ryota Kawashima (Nagoya Institute of Technology, Japan)

Network slicing qualitatively transforms network infrastructures such that they have maximum flexibility in the context of ever-changing service requirements. While the agility of cloud native network functions (CNFs) demonstrates significant promise, virtualization and softwarization severely degrade the performance of such network functions. Considerable efforts were expended to improve the performance of virtualized systems, and at this stage 10 Gbps throughput is a real target even for container/VM-based applications. Nonetheless, the current performance of CNFs with state-of-the-art enhancements does not meet the performance requirements of next-generation 6G networks that aim for terabit-class throughput. The present pace of performance enhancements in hardware indicates that straightforward optimization of existing system components has limited possibility of filling the performance gap. As it would be reasonable to expect a single silver-bullet technology to dramatically enhance the ability of CNFs, an organic integration of various data-plane technologies with a comprehensive vision is a potential approach. In this paper, we propose a practical method to design terabit-class CNFs based on effective harmonization of the technologies within the wide range of network systems consisting of commodity hardware devices. We focus not only on the performance aspect of CNFs but also other pragmatic aspects such as interoperability with the current environment (not clean slate). Additionally, we highlight the remaining missing-link technologies revealed by the goal-oriented approach.

5- Service-Based Forwarding via Programmable Dataplanes

Authors: René Glebke (RWTH Aachen University, Germany); Dirk Trossen (Huawei Technologies Düsseldorf GmbH, Germany); Ike Kunze (RWTH Aachen University, Germany); Zhe Lou (Huawei Technologies European Research Center, Germany); Jan Rüth, Mirko Stoffers and Klaus Wehrle (RWTH Aachen University, Germany)

Access to networks for purposes of executing remote services has become a dominant form of communication, while virtualization has enabled the flexible and fast deployment of those services across distributed locations. This seems at odds with the design that drives the network layer of the Internet. Our paper presents an approach to flexibly deploy a network layer solution for optimizing service access within a single domain, while retaining full connectivity to Internet-based services. We discuss design considerations and the resulting design. We analyze expected gains from our solution.

6- Towards Real-Time Routing Optimization with Deep Reinforcement Learning: Open Challenges

Authors: Paul Almasan and José Suárez-Varela (Barcelona Neural Networking Center, Universitat Politècnica de Catalunya, Spain); Bo Wu and Shihan Xiao (Huawei Technologies, China); Pere Barlet-Ros and Albert Cabellos-Aparicio (Barcelona Neural Networking Center, Universitat Politècnica de Catalunya)

The digital transformation is pushing the existing network technologies towards new horizons, enabling new applications (e.g., vehicular networks). As a result, the networking community has seen a noticeable increase in the requirements of emerging network applications. One main open challenge is the need to accommodate control systems to highly dynamic network scenarios. Nowadays, existing network optimization technologies do not meet the needed requirements to effectively operate in real time. Some of them are based on hand-crafted heuristics with limited performance and adaptability, while some technologies use optimizers which are often too time-consuming. Recent advances in Deep Reinforcement Learning (DRL) have shown a dramatic improvement in decision-making and automated control problems. Consequently, DRL represents a promising technique to efficiently solve a variety of relevant network optimization problems, such as online routing. In this paper, we explore the use of state-of-the-art DRL technologies for real-time routing optimization and outline some relevant open challenges to achieve production-ready DRL-based solutions.
7- Flexible Semantic-Based Data Networking for IoT Domains
Authors: Mays F AL-Naday (University of Essex, United Kingdom (Great Britain)); Irene Macaluso (Trinity College Dublin, Ireland)

The rapid adoption of the Internet of Things (IoT) as a means for digital transformation is sketching a new landscape of heterogeneous data and distributed, machine learning-based, applications. The intertwine of the two combined with the varying availability of data, generated in different parts of the domain, raises the need to exchange bulks of relevant data on demand across application(s) points. Data relevance escalates the role of semantics in identifying and locating suitable data; particularly at the network layer, to provide efficient mapping of data supply and demand. This paper proposes a semantic-based data networking framework, for managed IoT domains, embracing principles of information-centric networking without restrictions on the routing function. Managed semantics are used to provide flexible (label-based) data addressing scheme and a scalable semantic locator function, designed as an overlay network of distributed instances that can be realized on top of any routing or forwarding solution. Nonetheless, we outline different routing solutions and their suitability to such scenarios, to then draw a recommendation of the most suitable underlying routing fabric. We evaluate our framework over an example IoT domain of the Pervasive Nation (PN), Ireland national IoT network. Through our example, we show that the number of managed semantics in such a domain can be vastly smaller than that expected on an Internet scale. We analyze our semantic aggregation scheme over the example PN network, and show the high flexibility in mapping data while maintaining a small state in the semantic locator function.

8- Securing Named Data Networking Routing Using Decentralized Identifiers
Authors: Nikos Fotiou (Athens University of Economics and Business, Greece); Yannis Thomas (Athens University of Economics and Business (AUEB), Greece); Vasilios A. Siris, George Xylomenos and George C. Polyzos (Athens University of Economics and Business, Greece)

Named Data Networking (NDN) is a realization of the Information-Centric Networking (ICN) paradigm, where routing is based on content identifiers rather than on network location identifiers. The routing state in NDN can grow exponentially, not only due to the huge number of content identifiers (as opposed to network addresses) but also because it is difficult to detect "fake" routing advertisements. For example, in contrast to IP-based routing, a potentially valid routing entry in NDN can be advertised from multiple network locations, making NDN susceptible to Denial-of-Service attacks at the routing layer. In this paper, we leverage Decentralized Identifiers (DIDs) to build self-verifiable "content advertisements." With our solution, any router can verify that a content advertisement originates from an "authorized" entity, without requiring any trusted third party. We implement our solution and we evaluate it in a scenario where filtering is implemented by the edge routers. We show that our solution reduces fake routing advertisements with minimal computational overhead.

9- Private Routing in the Internet
Authors: Francesco Tusa, David Griffin and Miguel Rio (University College London, United Kingdom (Great Britain))

Despite the breakthroughs in end-to-end encryption that keeps the content of Internet data confidential, the fact that packet headers contain source and IP addresses remains a strong violation of users' privacy. This paper describes a routing mechanism that allows for connections to be established where no provider, including the final destination, knows who is connecting to whom. The system makes use of inter-domain source routing with public key cryptography to establish connections and simple private symmetric encryption in the data path that allows for fully stateless packet transmission. We discuss the potential implications of real deployment of our routing mechanism in the Internet.

10- A Structured Approach to Routing in the Internet
Authors: Nirmala Shenoy, Shreyas Chandraiah and Peter Willis (Rochester Institute of Technology, USA)
Advent of new content delivery models and proliferation of applications such as IoT, machine-to-machine communications and industry automation are placing new demands on the Internet for improved service-specific support. This calls for change in either the Internet routing or addressing schemes or both. Given the wide deployment of the Internet protocol (IP) and its routing protocols, such as the Border Gateway Protocol (BGP) and Open Shortest Path First (OSPF), modifying and/or substituting these protocols would face severe challenges. We decided instead, to investigate an IP-agnostic solution called the Expedited Internet Bypass Protocol (EIBP) to work in parallel with IP while operating entirely independent of Layer 3 protocols. EIBP uses network structures (physical or virtual) to automate assigning of routable addresses to Internet routers and thus voids the need for a routing protocol; this applies to both inter and intra-AS routing. EIBP can be used to expedite specific traffic flows as we bypasses all traffic in Layer 3. EIBP was coded and prototype tested on routers from the Global Environment for Network Innovation (GENI) testbed for intra-AS routing. In this article, we highlight the significant performance improvements achieved with EIBP compared to IP with OSPF or BGP. We describe one approach to extend EIBP for inter-AS routing and highlight the benefits. EIBP can also support virtual mobility domains to handle mobile users.

VINI - Technical Session 1: Virtualization for Enabling Next-Generation IoT Networks

1- Seamless Multi-Access Edge Computing Application Handover Experiments
Authors: Pablo Fondo-Ferreiro, Alberto Estévez-Caldas and Rubén Pérez-Vaz (Universidade de Vigo, Spain); Felipe Gil-Castiñeira (University of Vigo, Spain); Francisco J. González-Castañó (Universidad de Vigo, Spain); Santiago Rodriguez-Garcia and Xosé Ramón Sousa-Vázquez (Optare Solutions SL, Spain); Diego Lopez (Telefonica I+D, Spain); Carmen Guerrero (University Carlos III of Madrid, Spain)

Multi-Access Edge Computing (MEC) is one of the fundamental technologies committed to satisfy the requirements targeted by 5G and beyond networks, such as low latency and massive communications. Nevertheless, deploying a large-scale MEC infrastructure will require a huge investment that should be minimized by optimizing the resources at edge locations, and to use centralized datacenters when possible. Thus, automated orchestration is essential for implementing mechanisms that deploy applications at the best location and even that relocate them, when necessary, to satisfy the Quality of Service (QoS) requirements. In this paper we describe an architecture for this purpose, which we have implemented in an experiment that demonstrates how Open Source MANO (OSM) can automate the relocation of a video processing application that helps drivers to remember the latest traffic sign viewed. Our proposal also includes two new components: the first one maintains the state of the applications when they are deployed at a new location, and the second one allows OSM managing the Open Network Edge Services Software (OpenNESS) edge platform. Finally, we elaborate on open challenges in MEC platforms.

2- I2UTS: An IoT Based Intelligent Urban Traffic System
Authors: Vejey Pradeep Suresh Achari (Thapar Institute of Engineering and Technology, Deemed to be University, Patiala, India); Zeba Khanam, Amit Singh and Anish Jindal (University of Essex, United Kingdom (Great Britain)); Alok Prakash (Nanyang Technological University, Singapore); Neeraj Kumar (Thapar University Patiala, India)

Growing population and migration to cities have given birth to multiple urban issues. Traffic congestion is one of the most prominent ones with severe side effects like fuel wastage, loss of lives, and slow productivity. The traditional traffic control system deploys programming logic control (PLC) which uses round-robin scheduling algorithm. However, few recent works have proposed IoT-based framework which requires the deployment of a series of sensors. In this paper, we propose an IoT-based framework that uses the existing network of CCTV cameras at the junction. An edge device is used to estimate the traffic density and detect emergency vehicles using YOLO v3 -Efficient Net. These two parameters are used as an input to a novel traffic control algorithm. The performance of the proposed framework has been evaluated by analyzing its properties using the UA-DETRAC dataset. The proposed framework achieves 68.10% vehicle detection accuracy.
3- Application of IoT in Smart Epidemic Management (in Context of Covid-19)
Authors: Sujoy Datta and Monideepa Roy (KIIT University, India); Pushpendu Kar (University of Nottingham Ningbo China, China)

The main reason which makes epidemics so dangerous and difficult to contain is their highly infectious nature. In the case of Covid 19 also, data shows that its contagious nature is increasing along with its various mutant strains. One of the primary methods adopted to fight the pandemic has been to break the infection chain and thus reduce the rate of persons getting infected every day, through lockdowns, self-isolation, social distancing, and other measures. But although there are already many existing epidemic models, to predict and track the spread of the disease, it is evident from the difference in the rates of infection and fatalities in different countries, that a uniform set of parameters is not sufficient to accurately predict the curves. In this paper, we have suggested some additional benchmarks that could be considered and at a higher granularity for more accurate predictions at more local levels. We also propose an IoT-based framework for the collection of such types of data through smartphones for more consolidated information to be made available to the authorities, for the effective management of epidemics. The framework also issues warnings to other users through smartphones if the app detects the presence of a potentially infected person within close range.

SCCRM- Technical Session 1: Cybersecurity in Supply Chains

1- Farm to Fork: Securing a Supply Chain with Direct Impact on Food Security
Authors: Helen C. Leligou (Synelixis Solutions, Greece); Panagiotis Karkazis (University of West Attika, Greece); Panagiotis Trakadas (University of Athens, Greece); Anthony Gonos (OPTIMUM SA, Greece); Theodore Zahariadis (University of Athens & Synelixis Solutions S.A., Greece)

Food security is currently considered a huge societal challenge which technology providers, technology adopters, policy makers and consumers altogether are facing. A first step towards more secure and safe food has been attempted through the deployment mainly of Internet of Things based solutions and applications that gather information and provide it to the users. However, these systems are susceptible to attacks e.g. data leakage and information modification, keeping our societies away from the target of secure food. This paper explores the requirements of the farm to fork supply chain with respect to security and proposes a platform that aims at alleviating and mitigating a wide set of attacks.

2- Challenges in the Automotive Software Supply Chain, Connected CAR
Authors: Jose Soriano and Guillermo Jiménez Prieto (Capgemini Engineering, Spain); Ernesto Correa (Consultant/Engineer & Capgemini Engineering, Spain); Noel Ruiz (Capgemini Engineering, Spain)

Car Manufacturer has to address today growing threats, cars have been incrementally becoming more complex with more code and on the other hand they have to maintain its components during extended life spans of several years compared with other industries. This, together with the increasing connectivity thanks to the connected car and 5G, is becoming a major concern for the industry. FISHY offers a prime opportunity to address some of these challenges since it will offer a homogenous way to tackle some of the threats. The focus of this document is to describe how the supply chain for its IOT components, that are part of the ECU, can be secured to maintain security over time, all using surveillance techniques such as continuous vulnerability management or firmware and software updates using out-of-band channels. Finally, we will discuss the importance of security maintainability as a key enabler for long-term crypto-based protection.

3- The Role of Intent-Based Networking in ICT Supply Chains
Authors: Mounir Bensalem (TU Braunschweig, Germany); Jasenka Dizdarević and Francisco Carpio (Technische Universität Braunschweig, Germany); Admela Jukan (Technische Universität Carolo-Wilhelmina zu Braunschweig, Germany)

The evolution towards Industry 4.0 is driving the need for innovative solutions in the area of network management, considering the complex, dynamic and heterogeneous nature of ICT supply chains. To this end, Intent-Based networking (IBN) which is already proven to evolve how network management is driven today, can be implemented as a solution to facilitate the management of large ICT supply chains. In this paper, we first present a comparison of the main architectural components of typical IBN systems and, then, we study the key engineering requirements when integrating IBN with ICT supply chain network systems while considering AI methods. We also propose a general architecture design that enables intent translation of ICT supply chain specifications into lower level policies, to finally show an example of how the access control is performed in a modeled ICT supply chain system.