CONASENSE 2021 Symposium Report

VENUE: Hybrid, fortiss, Research Institute of the Free State of Bavaria, Germany, Guerickestr. 25
80805 Munich, Germany

DATE: October 4th – 5th, 2021

Organised by
CGC, CTIF Global Capsule, Aarhus University, Herning, Denmark
Fortiss GmbH, Munich, Germany

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Executive Summary

This report provides an overview on the talks and discussions held during the 2021 CONASENSE 2021 international symposium, 4th-5th October 2021. Jointly organised in hybrid mode by CGC, Aarhus University and fortiss GmbH, in Munich, Germany, the CONASENSE 2021 symposium had as main purpose to ignite discussion on 6G challenges, based on the CONASENSE interdisciplinary vision. For that purpose, the symposium counted with 25 invited talks and multiple panel discussions, which are summarised in this report.

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List of Acronyms

Acronym	Meaning
AI	Artificial Intelligence
AP	Access Point
eVTOL	Electrical Vertical Take-Off and Landing
IIoT	Industrial IoT
LiFi	Light Fidelity
ML	Machine Learning
NTN	Non Terrestrial Networks
PaaS	Platform as a Service
RAN	Radio Access Network
SDN	Software Defined Networking
SDR	Software Defined Radio
THZ	Teraherz
Wi-Fi	Wireless Fidelity
WLAN	Wireless Local Area Network

Acknowledgements

We would like to thank all the external speakers and participants who contributed to the event and who are listed in Annex II.

We would also like to thank the fortiss and CTIF teams that have participated in the organization of the event.

1. Symposium Overview and Objectives

The 2021 CONASENSE International Symposium has been jointly organised in hybrid mode by CTIF and fortiss within the context of a recently established research partnership between the two institutions.

The aim of the 11th edition of CONASENSE was to bring together academia, business sectors, government, and standardization organizations to present their techno-business solutions and approaches, having as basis the following areas:

- **Communications:** This research area focuses on an intelligent network that optimizes data transmission, along with energy efficiency, and cutting-Edge data compression, and robust protocols for a decentralized, complex, and heterogeneous network that can be combined with fixed, wireless, and optical wireless communications (OWC). Finally, security is also considered for improvement, including blockchain communications and quantum communications based on quantum key distribution.
    - **Main topics of interests:** Terahertz communications, 6G Networks, Open-RAN, Optical Wireless Communications, Machine-to-machine communications, Quantum Communications, IIoT, Cyber Security.
- **Navigation & Satellites:** future networks and high precision, smart sensors, coupled with Machine Learning, bring in the possibility to address precise positioning indoor, outdoor, in scarce and densely covered areas. Expectations are that future navigation systems will be able to handle exact positioning, in time a space, down to a centimetre level to all network nodes.
    - **Main Areas of interests:** autonomous indoor navigation systems; augmented reality indoor navigation; outdoor navigation systems based on Global Navigation Satellite Systems; applications in different vertical sectors, from autonomous vehicles to drones to unmanned spaceships to nanotechnologies applied in the medical field; navigation systems for e.g., visually impaired people; navigation systems based on wireless technology (e.g., NFC, Wi-Fi/GPS).
- **Sensing:** Sensing relates with the efficient and smart integration of (IoT) devices within diverse scenarios related with the societal lifecycles. The increasing number of sensors on IoT implies an increase in data exchange, and a change of roles, leading to service decentralisation and having the user (citizen) as a prosumer.
    - **Main topics of interests:** IoT and its integration in different vertical markets (e.g., IoT for Health, Industrial IoT); IoT services supported by satellite systems and space communications; semantic technologies and interoperability; crowd-based sensing; swarming; behaviour learning and inference, federated and other decentralised learning approaches.
- **Services:** There are several services to benefit from it, in all vertical industries and to mention just a few services.
    - **Main topics of interests:** multi-sensors data fusion, machine learning for autonomous systems, human-centered engineering, man-machine interfaces, edge-cloud services, Industrial Internet of Things (IIoT), AI, Machine Learning for Robotic guidance, smart cities, smart vehicles, autonomous vehicles, flying cars, drones, Internet of Nano Things (INoT), emergency services, remote surgery, smart manufacturing, smart logistics, smart meters, smart antennas, space explorations, communication services, and underwater communications.

The key objectives established for the 2021 symposium were:

- To ignite discussion focused on the development of the 6G paradigm based on an interdisciplinary methodology.
- To further develop the CONASENSE vision towards 6G.
- To further strengthen the cooperation established between fortiss and CTIF.

2. Format and Expected Outcome

As part of the symposium organization, the CONASENSE Website[1] has been updated with the proposed agenda and with the talks provided by the speakers, upon prior consent. Moreover, partners CTIF and fortiss[2] have developed also specific Webpages for the event and announced the event broadly via their channels.

The organizing committee has decided to, due to COVID-19, **organize an event based upon invited talks only, free of registration and with a limited audience**. The symposium agenda is provided in Annex I, while the speaker biographies and summary of talks are provided in Annex II.

The event has been supported by fortiss in hybrid mode. A total of 25 invited speakers has participated in the event, being 15 experts face-to-face in fortiss, Munich, Germany. The overall audience consisted of the speakers and of an invited audience in a total of 50 participants. The remote participation has been supported by fortiss via Web conferencing. The overall expertise of the participants was very broad starting from research, system and solution engineering, innovation and technology management, standardisation, strategic product management and marketing.

The proposed outcome of the symposium was:

- A book edited by River publishers[3] in 2022, based upon extended papers derived from a selection of invited talks.
- A special issue on a magazine (2022), based upon invited papers, derived from a selection of invited talks.

The event started on October 4th with a welcoming round provided by the organizers and has then proceeded with a keynote speech by Dr. Anand Prasad[4] with a talk about the evolution of different Cloud services and security issues, highlighting the need to address data privacy in 6G services.

The CONASENSE vision has then been introduced by Prof. Dr. Ramjee Prasad (CTIF president), followed by a presentation on the fortiss vision by Dr. Harald Rueß (Scientific Manager of fortiss), focus on software engineering and the role of autonomous systems, security and trustworthiness.

After this introductory round, a first keynote speeches session took place (Session I, chaired by Dr. Rute C. Sofia). After the lunch break, the technical sessions have been started.

The technical sessions have been organized accordingly with the CONASENSE areas (Communications, Navigation and Satellites; Sensing; Services). Each session has been developed with a similar format, covering 4 to 6 invited talks, followed by a panel involving all speakers and the audience, to ignite discussion on 6G key research challenges for the specific area, having in mind the 2030 horizon.

After the Communications session, a second keynote speech session has been provided to accommodate the speakers on the Americas (USA and Brazil).The first day closed at 18:00, followed by a social dinner.

The second day of the event (5th October 2021) was dedicated to the subsequent technical sessions and panel discussion. The second day was closed at 18:00, by the organizers (Ramjee Prasad and Rute C. Sofia).

3. Keynote Sessions

The CONASENSE2021 Symposium counted with 2 Keynote sessions both held on October 4th, 2021, to accommodate speakers from different regions of the globe.

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[1] https://www.conasense.org

[2] https://www.fortiss.org/termine/conasense-internationales-symposium-2021

[3] https://www.riverpublishers.com

[4] Due to COVID-19 and to the fact that the invited speakers were remotely presenting on different regions of the globe, a few changes to the agenda have been done to accommodate requests by the speakers.

Keynote session I, chaired by Rute C. Sofia, started with the talk „*Connected Smart Lighting to provide IoT Connectivity, Sensing and Positioning*" by Dr. Jean-Paul Linnartz, Signify, Netherlands. Jean-Paul debated on LiFi, the support of communication via light, sensing and localization possibilities, having in mind different use-cases that are relevant in the context of 6G, e.g., use-cases in Health, Manufacturing, Building Management for LiFi and the role of LiFi to accommodate a people-centric automated behaviour in the adaptation of the environment to the user mood, surroundings, context.

The second talk, "*The Green Wall*", has been provided by Prof. Dr. Peter Lindgren. The talk provided a view on sustainability and on how to truly reach sustainable businesses. Its key focus related with a sustainability business model innovation debate, alerting to the need to circumvent focus just on environmental issues as such limited focus makes it hard to reach green business models. Peter alerted that most available sustainability analysis is focusing on technological "greenness"

A second keynote session took place in the afternoon of October 4th chaired by Paulo Rufino. The session started with the talk "*An Engineering Perspective on the Quantum Optical Communications and Sensing*" by Prof. Dr. Kwang-Cheng Chen, University of Florida, USA. Kwang-Cheng debated on the current development of Quantum communications, alerting to the fact that we are possibly close to seeing the first commercial quantum computers (horizon of 5 years), and a key challenge that needs to be tackled relates with how classical computers can interoperate with quantum computers. For the longer term perspective, Kwang-Cheng alerted to the need to further focus on applications, and to take into consideration the fact that channel modelling is quite different than the modelling available today.

Prof. Dr. Rodolfo Azevedo (UNIVESP, Brazil) has next provided the talk "*How to keep the academic and scientific distance learning for students during the Coronavirus Pandemic*", presentation of UNIVESP on the remote education platform and statistics about the students during COVID-19

4. CONASENSE Area I: Communications

The communications session and panel has been chaired by Rute C. Sofia (replacing Peter Lindgren) and counted with talks from Dr. Werner Mohr, Dr. Kaneshawaran Govindasamy, Prof. Dr. Vladimir Poulkov, Dr. Valerio Frascola, Dr. Martjin Kuipers, Dr. Stefan Wevering.

Dr. Werner Mohr (Consultant, Germany) provided the talk „*Basic considerations on Terahertz communication systems*", providing an overview on terahertz systems and near vs. far field problems, alerting to the key challenges of attenuation and radiation dangers when considering the human-in-the-loop factor.

The second talk, "Global 5G Evolution for CONASENSE", Kaneshwaran Govindasamy, Global 5G Evolution, has been focused on 5G innovation incubator and accelerator, focus on students' projects and student development.

Prof. Dr Vladimir Poulkov, Technical University of Sofia, Bulgaria, then presented "*The Evolution of the Radio Access Network towards 6G*, focusing on Open RAN overview and opportunities.

The next speaker, Dr. Valerio Frascola (Intel, Germany), presented "*Wi-Fi evolution: towards Wi-Fi 7*", *an overview on* Overview on the evolution of the latest developments on Wi-Fi, IEEE 802.11ax, IEEE 802.11.be.

Dr. Martjin Kuipers (INESC-INOV, Portugal) presented "*The case for 6G*" focusing on the possible impact of 6G in terms of incumbent/telco ownership; the role of virtualization and possible 6G business models.

A final talk on "*The security architecture of 5G networks and how it could evolve towards 6G*", by Dr Stefan Wevering, Nokia, Germany, addressed the role of openness and network softwarization to adequately support security and data privacy aspects in 6G services and the challenges thereof.

4.1 Communication Research Challenges towards 2030

The aspects discussed can be categorized into the following aspects:

- Terahertz (THZ) integration in 6G and challenges to near, far field.
- Role of virtualization, softwarization and the need to open the RAN.
- The need for slicing, service automation and diversification support.
- The role of ML in the protection and attack of 6G architectures.

4.1.1 Terahertz Integration Aspects

About Terahertz integration, there are technical challenges that hint that THZ communication will be used in a scoped manner only (near field). In manufacturing, there may be use-cases that are relevant. As for the relevancy of free space optics, there are challenges to be addressed due to environmental aspects, e.g., fog.

Sensing may be a relevant area to apply THZ. While communications will be scoped, THZ is interesting regarding sensing applications.

4.1.2 6G and Beyond 5G evolution:

- 6G does not exist but we know we need to go beyond 5G / the same occurs with any technology and we need to define it now, at least 10 years before.
- 6G should be able to provide us with a platform for testing that can support the development of new (envisioned) services.
- There is the need to focus on use-cases for 6G but also how to open the platform so that it can be used universally (to bootstrap new use-cases and allow a fast development of new services).

4.1.3 Openness

- Software Defined Radio (SDR) and Open RAN: not really a need to open more SDR, softwarization seems enough.
- The openness requirement is driven by applications, so future research should consider this aspect.
- Regarding energy efficiency, an issue seems to relate with downlink vs. uplink power control. Most apps and use-cases required downlink control, but in the future health requires uplink control, for instance.
- In comparison to 5G and openness, there is the need to develop a full open ecosystem to increase development of new use-cases (Platform as a Service, PaaS).
- Open RAN fosters competition within vendors but we need openness in the core domain to foster 3rd party development (open to programmes).
- Hyperscalers already addressing quantum in hardware.

4.1.4 ML and 6G communications

- Key aspects discussed related with the use of ML not just to prevent cyberattacks but also as a tool to estimate the future impact of attacks.
- Data curation, data unification requires trustworthy ML.

5. CONASENSE Area II: Satellites and Navigation

The satellites and navigation session and respective panel has been chaired by Rute C. Sofia and counted with talks by Dr Maria Gupta (ESA, Germany); Dr Paulo Mendes (Airbus, Germany); Dr. Tomaso de Cola (DLR, Germany); Prof. Dr. Homayoun Nikookar, faculty of Military Sciences of the Netherlands Defence Academy, Netherlands.

Dr. Maria Gupta opened the session with the talk "*From 5G to 6G: space connecting planet earth for a sustainable future*", providing an overview the future research directions for satellites in 6G. Key research areas discussed concerned air interfaces and spectrum; onboard Edge computing; sensing; dynamic routing and AI; unified data architectures (e.g., data-centric networking) to support data curation; sustainable mobility. Use-cases debated related with agriculture, fintech, health, manufacturing, with a remark on also the need to investigate broadband services.

The session continued with the talk provided by Dr. Paulo Mendes (Airbus), "*Cognitive networking as instant primer of large-scale satellite networks*". Dr. Mendes focused on the need to handle spaceborne communications as an autonomous system, and to the need for packet switching in space communications. He proposed an interdisciplinary approach for cognitive, smart satellites, the 4C approach, integrating communication, computing, caching, cognition. He mentioned also that there is already an alignment towards 6G, debating on research directions and the role of service function chaining vs. SDN.

Dr. Tomaso de Cola (DLR) presented "*Non-terrestrial Networks (NTN): Boosting 6G from the Sky*", focusing on NTN and their integration beyond 5G; the current 6G vision and services and addressing key research areas of NTN for 6G.

Prof. Dr. Nikookar followed with "*A Risk Analysis of CONASENSE Satellite Systems Threat*", providing an overview on risks and threats to smart constellations (CONASENSE satellites), and on the need of AI to mitigate attacks and risks, and to estimate the impact and severity level of future attacks.

5.1 Satellite/Navigation Research Challenges towards 2030

Overall, the key research challenges discussed in the panel were:

- Smart satellites and their role in 6G.
- The need to support research via experimental facilities.
- The need for unified architectures across terrestrial and NTN, and how to achieve this vision.

5.1.1 Key Technological Priorities for Reaching a 4C Vision

- Satellite-based communications need to be seen in an integrated way to 6G
  o For point-to-point communication support, rates are low in comparison to 5G
  o Assuming smart constellation models (e.g., Starlink) rates will be higher
  o There is the need to assess which throughput can really be offered to individual users
- Discussion on satellites vs. 5G is being wrongly directed; smart satellite constellations are seen as extensions of terrestrial communications, as aggregators or interconnection of private terrestrial networks, for instance, and not as a competitor to 5G and beyond 5G communications.
- To reach a 4C vision, we have the technical blocks already, e.g., SDN, SDR, virtualization, but not a unified architectural vision.
- Satellite network can be extended to new services but not replace the current terrestrial system (they will complement each other).
- Different business models are possible. For instance, Starlink wants to compete with other ISPs. Autonomous mobility can be a niche where satellites can be used.

5.1.2 Experimentation Facilities Aspects

- Europe is building testbeds for experimentation for example in Germany Fraunhofer and DLR. There are plans to create Hubs and test centres with equipment for companies and small players to test their products.
- Channel emulators available.
- Some testbeds, but in specific industry sectors.

- A needed next step is cooperative experimentation, where it is important to involve MNOs.

5.1.3 New Use-cases and New Services

- Satellite support in logistics and IoT have been mentioned by most speakers.
- There is the need to understand capacity support, but this is not a blocker for new services.
- Research on sustainability and business models for satellite integration in 6G is required, looking into the possibility to deploy new services (e.g. flexible payload approaches, integration of analytics in the satellite payloads.
- Health, satellite constellations are seen as interconnection of different private Clouds/Edges.
- IoT as a clear application across different European competitiveness domains.
- Autonomous vehicles, air or ground also seen as a relevant application.
- Any service concerning earth observation, navigation aspects is relevant.
- Support of broadcasting services / China as mentioned example.
- Could satellite constellations be seen as TIER-1 infrastructures?

5.1.4 A Unified Architecture Vision

- The design of such unified architecture is still missing and not fully addressed by the community.
- There are existing technologies that can be utilized for the purpose of designing the unified architecture; however, this will require more players to be involved.
- Edge computing seems to be a key enabler for the development of new services.
- Current approaches, e.g., Amazon, Microsoft, is placed on the development of private infrastructures to support earth to space communications / this approach does not scale and increases silos, preventing the development of adequate support for end-to-end services.
- The question is whether we will be able to truly achieve a distributed system behaviour with smart satellite constellations.
- Satellites are usually discussed/seen as fronthaul for communications: the discussion should be steered towards backhaul support.

5.1.5 Reliability and Resilience of the Infrastructure

- Physically, satellites are remote and not directly accessible.
- Orchestration and networking need to be worked together.
- Free space optical links are useful in this case, to provide communication resilience between satellites.
- Mesh of networks in the sky is considered also.
- Reconfigurable payloads are the basis for autonomous orchestration.
- Today satellite constellations have backup - belts of satellites are usually deployed having backups on space and ready to be sent from the ground.

6. CONASENSE Area III: Sensing

The sensing session has been chaired by Prof. Dr. *Milica* Pejanović-Djurišić and counted with the following speakers: Prof. Dr. Ernestina Cianca, University of Rome; Prof. Dr. João Ferreira, ISCTE-IUL; Marcos A. Salvador, Polytechnique Montreal, Canada.

Prof. Dr. Enerstina Cianca, University of Rome, started with the talk "*Geolocalization of low complexity and low power consumption IoRT terminals*", dedicated to a debate on challenges concerning the role of IoRT in geolocalization. The talk addressed aspects such as the role of 5G NR-RL17, and the use of satellite communications, as well as on the state-of-the-art discussion of algorithms for geolocation and accuracy.

The session then continued with Prof. Dr. João Ferreira providing the talk "Social Media Insights about COVID-19 in Portugal: a social sensing approach", focused on another type of sensing: social sensing

and challenges during COVID-19. The talk focused on the role of misinformation in social media, as a key challenge for sensing; challenges for data mining and data collecting via social media; how context-awareness can assist in reducing the impact of misinformation.

The third talk provided by Marcos Salvador was entitled "*Challenges of machine learning in eVTOL aircraft systems reliability and safety*". The talk focused on the role of ML on the development of eVTOL services; security measures to make them commercially available and full compliance to safety measures; dependency on non-terrestrial and terrestrial networks; and the maturity level of eVTOL technology.

6.1 Sensing Research Challenges towards 2030

6.1.1 Sensing Directions in 6G

- The talks provided show the high degree of variability in the interpretation of sensing services, and the different, heterogeneous applications that sensing has, being a key area to address in 6G.
- Sensing research should be targeted to understand the impact in local vs. global services in 6G.
- Satellite support today is still costly and time-wise it still creates a problem for sensing.
- Remote sensing requires lower latency, and less costly infrastructures.
- Edge computing can help in reducing costs required, by bringing data processing to the Edge (thus supporting sensing in a local scope).

6.1.2 Role of Heterogeneous Communications in Sensing

- We had talks on very different aspects of sensing, supported by satellites (IoTRT), by D2D or direct (point-to-Cloud) communications. The evolution and the role of heterogeneous communications in this context is still in an early stage.
- However, sensing will be supported by local communications and terrestrial wireless, long-range, e.g., LoRa/LoRaWAN. The types of data generated; the interconnection aspects need to be addressed.
- Heterogeneous communications will be a key part of sensing, with very diverse requirements (from a PHY, MAC, IP perspective). Cross-layer approaches need to be researched.

6.1.3 Sustainability and Energy Efficiency Aspects

- Sensing provides the data to assist estimations that can provides sustainability, greenness and reliability.
- Sensing provides the basis for reaching completely automated systems, and green levels are achievable with automated behaviour.
- Sensing is the basis for measurement and continuous measurement is essential to provide sustainability.
- Large-scale problems such as climate changes are better addressed by large-scale, satellite based sensing.

6.1.4 Disinformation, Data Curation and Sensing

- Disinformation is hard to detect, ML is highly relevant in the context of data curation and validation.
- Possibility to ack "good feedback" and "bad feedback", to detect misinformation.
- Social sensing as relevant, for instance, in emergency communications.

7. CONASENSE AREA IV: Services

The session on services has been chaired by Paulo Rufino and counted with invited talks by: Prof. Dr. Albena Mihovska, Aarhus University, Denmark; Prof. Dr. Milica Pejanović-Djurišić, University of Montenegro; Dr. Navin Kumar; Prof. Dr. Per Valter, CGC, Aarhus University.

Prof. Dr. Albena Mihovska, Aarhus University, Denmark, provided the talk "*AI and AR-enabled Next Generation Applications and Service*s", addressing universal and metaverse communications. Albena debated on the role of AI and the relevancy in data processing and context extraction, and on performance and cost efficiency. As use-cases, the debate revolved on AR, MR, XR, Digital Twins new types of users. .Albena is managing the cube environment for holographic communications including all sensors for digital avatar.

Prof. Dr. Milica Pejanović-Djurišić, University of Montenegro, provided the talk "*Building an Agile Co-Innovation Framework for Addressing Emerging Technological Challenges*", debating on cyberconvergence as the new norm, and on the need to increase human mobility safety via pervasive technologies. She mentioned that security threats are one of the biggest challenges on applied technologies and debated on the current ICT responses to tackle these challenges, along with the efforts on building effective partnerships like government, regulatory and authority (UN, ITU, World Economic Forum). Milica debated on the current roadmap for digital cooperation (UN roadmap) and on the challenges for the 21st Century require common understanding and a shared vision of the future.

Dr. Navin Kumar presented "*System Working Principles and Use Cases of Railway Mobile Communication System towards 5G and Beyond*", focusing on operational needs of the railway communications infrastructure and current undertakings.

Prof. Dr. Per Valter, CGC, Aarhus, presented "*Green business model ecosystem perspective on complex real-time systems within the transportation sector*", addressing the need to focus on business model ecosystem optimization to truly reach sustainable services in 6G and alerting that most issues of green energy relate with workload optimization.

7.1 6G Services Research Challenges towards 2030

Key topics discussed towards 6G services success were:

- A holistic perspective considering computation/communications but also sustainability and ethics
- Education must be integrated as a key service in the context of 6G.
- A solution may be the development of a core innovation framework that is relevant to industry, to education, to the different countries.
- R&D needs to be driven also by applicability.
- 2030 is around the corner and too soon.

7.1.1 KPIs for Greenness and Sustainability

- Define services that can be autonomously used by entities, to optimize the business processes; combine with IoT sensing devices, e.g., cameras to detect empty spaces in trucks and ML to detect occupancy.
- Sensing services are key to greenness as they are the basis for self-organizing optimization.
- 5G had a few KPIs but we started transmitting more data.

7.1.2 AR/VR/Hologram Applications Needs

- Decentralised Edge computing/split computing could improve the need to transmit large data sets
- Joint computation and communication initiatives is imperative
- Encoding is an aspect that can assist, but will not suffice to allow for new types of avatars to emerge, e.g., smell, etc.
- Quantum communications may be an answer for this but what we need is a holistic approach to 6G: integration of computation, communication, sustainability (greenness and economic).

7.1.3 Human in the Loop: 6G People-centric Services

- There is a mismatch between societal relevancy and technology development.
- Technology should be applied to solve real problems, in addition to scientific development
- There is not a specific SDG for ICT, but now ICT is specifically being addressed in each SDG.
- CONASENSE can also provide suggestions on how to best integrate societal impact and create an evolution for technology aligned with the evolution of society.

8. Summary & Conclusion

The CONASENSE 2021 symposium has been organised based on an invited talk and invited participation format, involving 25 speakers and an audience of 50 participants. The invited talks are the basis to further develop the expected outcome (book and special issue focusing on 6G services).

The audience seemed quite interested in the presented topics and most have actively participated by questions or comments during both the talks and during the panels. The informal feedback about the workshop provided by participants and contributors after the event was quite positive. We would like to thank again all contributors to the workshop who made the event a success.

Annex I: Agenda

Agenda:

Day 1, October 4th, 2021 (9.30 CET to 17.30 CET)

Time (CET)	Topic	Attendance
9:00-9:30	*Registration period*	
9:30-9:45	*Welcome and programme presentation*, **Rute C. Sofia** (fortiss), **Ramjee Prasad** (CGC)	In person
9:45-10:15	*The CONASENSE Vision*, **Ramjee Prasad**, CGC, Aarhus University	In person
10:15-10:30	**Harald Rueß**, *introduction to fortiss, fortiss*	In person
10:30-10:50	**Coffee-break**	
Keynote Session I *Chair: Rute Sofia*		
10:50-11:10	*Connected Smart Lighting to provide IoT Connectivity, Sensing and Positioning*, **Jean-Paul Linnartz**, Signify	remote, NL
11:10-11:30	*The Green Wall*, **Peter Lindgren**, CGC, Aarhus University	In person
11:30-11:50	*From Cloud-native 5G to 6G Security*, **Anand Prasad**, Wenovator	remote, JP
11:50-13:30	**Lunch Break**	
13:30-15:20	**Session I - Communications** *Chair: Peter Lindgren*	
13:30-13:50	*Basic considerations on Terahertz communication systems*, **Werner Mohr**, consultant	In person
13:50-14:20	*Global 5G Evolution for CONASENSE*, **Kaneshwaran Govindasamy**, Global 5G Evolution	remote, Malaysia
14:20-14:40	*The Evolution of the Radio Access Network towards 6G*, **Vladimir Poulkov**, Technical University of Sofia, Bulgaria	In person
14:40-15:00	*Wi-Fi evolution: towards Wi-Fi 7*, **Valerio Frascola**, Intel labs, Germany	remote, DE
15:00-15:20	*The case for 6G*, **Martijn Kuipers**, INESC-INOV, Portugal	Remote, PT
15:20-15:40	*The security architecture of 5G networks and how it could evolve towards 6G*, **Stefan Wevering**, Nokia, Germany	In person
15:40-15:50	**Coffee Break**	
15:50-16:50	*Panel I: Communications horizon 2030: key research challenges*, Chair: Session chair All Invited speakers of Session I	In person/remote

16:50.-17:30	**Keynote Session II** *Chair: Paulo Rufino*	
16:50-17:10	*An Engineering Perspective on the Quantum Optical Communications and Sensing,* **Kwang-Cheng Chen**, *University of Florida, USA*	Remote, USA
17:10-17.30	*How to keep the academic and scientific distance learning for students during the Coronavirus Pandemic*, **Rodolfo Azevedo**, *UNICAMP, Brazil*	Remote, Brazil
17.30-17:45	*Day 1 Closure*, **Rute Sofia** and **Ramjee Prasad**	In person
19:00	*Social Event Dinner (19:00 CET)*	

Day 2: October 5th, 2021, 9.30-18:30

Time (CET)	Topic	Attendance
9:30-11:30	**Session 2: Navigation & Satellites** *Chair: Rute C. Sofia*	
9:30-9:50	From 5G to 6G: Space Connecting Planet Earth for a Sustainable Future, **Maria Gupta**, ESA	In person
9:50-10:10	*Cognitive networking as instant primer of large-scale satellite networks*, **Paulo Mendes**, Airbus	In person
10:10-10:30	*Non-terrestrial Networks (NTN): Boosting 6G from the Sky*, **Tomaso de Cola**, DLR	In person
10:30-10:40	**Coffee Break**	
10:40-11:00	*A Risk Analysis of CONASENSE Satellite Systems Threats*, **Homayoun Nikookar**, *faculty of Military Sciences of the Netherlands Defence Academy, Netherlands*	In person
11:00-12:00	*Panel discussion: Satellites in 6G, key research challenges* *Chair: Session II chair* *All Invited speakers of Session II*	In person
12:00-13:30	**Lunch Break**	
13:30-14:30	**Session III: Sensing** *Chair: Milica Pejanović-Djurišić*	
13:30-13:50	*Geolocalization of low complexity and low power consumption IoRT terminals*, **Ernestina Cianca**, *Univ Rome*	In person
13:50-14:10	*Social Media Insights about COVID-19 in Portugal: a social sensing approach*, **Joao Ferreira**, *ISCTE-IUL*	remote, PT
14:10-14:30	*Challenges of machine learning in eVTOL aircraft systems reliability and safety*, **Marcos A Salvador**, *Polytechnique Montréal, Canada*	Remote, Canada
14:30-15:30	Panel Discussion: Sensing key research challenges Chair: Session III chair All Invited speakers of Session III	
15:30-15:40	**Coffee Break**	
15:40-16:20	**Session IV: Services** *Chair: Paulo Rufino*	

15:40-16:00	*Applications of AI and AR in the context of Next Generation Communications and Services,* **Albena Mihovska,** *Aarhus University, Denmark*	In person
16:00-16:20	*Building an Agile Co-Innovation Framework for Addressing Emerging Technological Challenges,* **Milica Pejanović-Djurišić***, University of Montenegro*	Remote, Montenegro
16:20-16:40	*System Working Principles and Use Cases of Railway Mobile Communication System towards 5G and Beyond,* **Navin Kumar**	remote, India
16:40-17:40	*Panel discussion: Services and key aspects to handle* Chair: Session IV chair All Invited speakers of Session IV	
17:40-18:00	**Closing Session**, **Ramjee Prasad and Rute Sofia**	

Annex II: Bios and Talks

Introduction to fortiss, Harald Rueß, Scientific Manager, fortiss

After studying mathematics in Ulm, Germany, and computer science in San Diego, California, Harald Rueß earned a doctorate from the University of Ulm. He worked at SRI International in Menlo Park, California between 1995 and 2005, first as an international fellow, then since 1998 as a staff researcher in SRI's computer science lab, including stints as a visiting professor in Mannheim in 2001 and longer research assignments in Cambridge in 1999 and Manchester in 2005. His research interests encompass the fields of dependable and safe embedded systems, symbolic analysis and synthesis, as well as decision processes. He worked as a systems consultant and program manager in the automotive and aerospace industries in southern Germany between 2006 and 2008. Harald Rueß has been scientific managing director at fortiss - the research institute of the Free State of Bavaria for software-intensive systems and services – since 2009.

Connected Smart Lighting to provide IoT Connectivity, Sensing and Positioning, Jean-Paul Linnartz, Signify

Jean-Paul M. G. Linnartz (Fellow, IEEE) currently is a Research Fellow with Signify (Philips Lighting) Research, and a Part-time Professor with TU Eindhoven, addressing Personalized Human Centric Lighting and optical wireless communication. His inventions led to more than 75 granted patent families and have been a basis for three ventures. From 1992 to 1995, he was an Assistant Professor with the University of California, Berkeley, CA, USA. In 1994, he was an Associate Professor with TU Delft. From 1988 to 1991, he was an Assistant Professor with the TU Delft. He was Senior Director with Philips Research, Eindhoven, The Netherlands, where he headed Security, Connectivity, and IC Design Research Groups.

Abstract: The transition from incandescent to LED lighting has "digitized" lighting, lighting control and the lighting IoT infrastructure. To enhance comfort, wellness and productivity, the trend towards personalized Human Centric Lighting calls not only for dimming and colour control of (usually many) light sources but also for the real-time connectivity of many sensors. Similarly, rooms inside buildings can be used more efficiently if sensor data is collected about occupancy, people traffic flow or asset location. This can save energy, control ventilation, air purification, UV virus disinfection, or can schedule maintenance and cleaning more efficiently. The central point in the ceiling, traditionally occupied by an only one large light bulb, now increasingly becomes a key point in the IoT infrastructure. It is a suitable sensor location. If used for advanced wireless communication with adaptive beam steering, it allows the definition of atto cells that can re-use the available radio spectrum every few meters. In fact, wireless communication has shown a constant densification. From Marconi crossing oceans, to having one global user per frequency, to co-channel planning of radio stations, to cellular reuse densified into micro and pico cells, to potentially the footprint of a communication signal shrinking to the width of a laser beam. In that migration from massive, phased arrays to RF MIMO to targeting a light beam can simplify wireless technology and can reduce power consumption. In other words, the ceiling central point not only becomes an IoT end-point but also a vital communications hub towards human users and IoT devices. In this presentation, Jean-Paul Linnartz sketches the convergence of Communication, Navigation, Sensing, and Services from the perspective of Signify (Philips Lighting), the world's leading light company. Indoor positioning with centimetre accuracy by using light sources as beacons was commercially rolled out about a decade ago. Today, we see an uptake of indoor wireless communication light, predominantly because directed light gives interference-free, thus guaranteed low latencies, as demanded in virtual reality and autonomous industrial machines and vehicle. As the technical leader of the EU project Enhanced Lighting for the Internet of Things, he reports on distributed MIMO to ensure reliable blockage-free coverage, and a fibre fronthaul network to ceiling access points. The vision of a convergence of sensing, communication and positioning is embodied by Signify in the Interact portfolio of connected lighting software applications for the IoT. While Jean-Paul will focus on indoor application, outdoors, the ubiquitous presence of light poles gives another opportunity to leverage the presence of a connected lighting infrastructure.

The Green Wall, Peter Lindgren, Aarhus University and Vice President of CTIF Global Capsule (CGC)

 Peter Lindgren holds a full Professorship in Multi business model and Technology innovation at Aarhus University, Denmark – Business development and technology innovation and is Vice President of CTIF Global Capsule (CGC) www.ctifglobalcapsule.org. He is founder of the Multi Business Model Innovation Approach. He is Director of CTIF Global Capsule/MBIT Research Center at Aarhus University – Business Development and Technology and is member of Research Committee at Aarhus University – BSS. He is cofounder of five start-up businesses amongst others - www.thebeebusiness.com , www.thedigibusiness.com, www.vdmbee.com

Abstract: SENSEMI is contemplated as a novel aggregation of technical methods to transform business models into competent businesses in a "never before seen" way to Greener, Sustainable and Tangible economies. A promising business must have a robust business model, which is a defined way of modelling the business by resolving challenges and enhancing the value creations into well-demarcated dimensions, such as value propositions, competencies, value formula, etc. By assimilating the "Artificial Intelligence Sensing" dimension in the business modelling process it involves developing the sensing, transmission, reception, and recreation of the information beyond the present state-of the-art technologies (audio and video) by involving other forms of sensing such as touch, taste, and smell, and bind them with the Business Model Process. Hence, the talk put forward an innovative and tangible feedback and dissemination approach to cascaded BMI processes.

From Cloud-native 5G to 6G Security, Anand Prasad, Deloitte Tohmatsu Cyber

Dr. Anand R. Prasad, Partner at Deloitte Tohmatsu Cyber (DTCY) where he leads connectivity security. Prior to DTCY Anand was Founder & CEO, Wenovator LLC that now forms part of Deloitte and Senior Security Advisor, NTT DOCOMO. He was CISO, Board Member, of Rakuten Mobile, where he led all aspects of enterprise and mobile network security (4G, 5G, IoT, Cloud, device, IT, SOC, GRC, assurance etc.) from design, deployment to operations. Anand was Chairman of 3GPP SA3 where, among others, he led the standardization of 5G security. He is also advisor to several organizations such as CTIF Global Capsule, Guardrails and German Entrepreneurship Asia. Anand is an innovator with 50+ patents, a recognized keynote speaker (RSA, MWC etc.), and a prolific writer with 6 books and 50+ publications. He is a Fellow of IET and IETE.

Abstract: In this talk, we will a dive into cloud-native security aspects of 5G. With that as base, we will discuss security aspects for next steps of mobile communications system in the form of 6G.

Basic considerations on Terahertz communication systems, Werner Mohr, consultant

Werner Mohr graduated from the University of Hannover, Germany, with the master's degree in electrical engineering in 1981 and with the Ph.D. degree in 1987. Dr. Werner Mohr joined Siemens AG, Mobile Network Division in Munich, Germany in 1991. He was involved in several EU funded projects and ETSI standardization groups on UMTS and systems beyond 3G. Werner Mohr coordinated several EU and Eureka Celtic funded projects on 3G (FRAMES project), LTE and IMT-Advanced radio interface (WINNER I, II and WINNER+ projects), which developed the basic concepts for future radio standards. Since April 2007 he was with Nokia Solutions and Networks (now Nokia) in Munich Germany, where he was Head of Research Alliances. In addition, he was chairperson of the NetWorld2020 European Technology Platform until December 2016. Werner Mohr was Chair of the Board of the 5G Infrastructure Association in 5G PPP of the EU Commission from its launch until December 2016. He was chair of the "Wireless World Research Forum – WWRF" from its launch in August 2001 up to December 2003. He was member of the board of ITG in VDE from 2006 to 2014. He is co-author of a book on "Third Generation Mobile Communication Systems" a book on "Radio Technologies and Concepts for IMT-Advanced" and a book "Mobile and Wireless Communications for IMT-Advanced and Beyond". In December 2016 Werner Mohr received the IEEE Communications Society Award for Public Service in the Field of Telecommunications and in November 2018 he received the VDE ITG Fellowship 2018. In May 2019 Werner Mohr received the WWRF Fellowship. In March 2021 he retired from Nokia and is now active as consultant.

Abstract: Discussions on research directions towards systems beyond 5G/6G have started. One of the potential elements of future mobile and wireless systems are new radio systems in the (sub)-Terahertz domain. These are new frequency ranges for mobile and wireless systems to support very high throughput data links and the huge growth of data traffic in the coming years. The main purpose of this paper is to get an understanding from a system perspective of the relation between achievable data throughput versus range and system bandwidth for different propagation conditions, carrier frequency ranges and to investigate basic physical limits. Radiation limits of electromagnetic power with respect to effects on the human body are considered. Compared to the currently used frequency bands below 10 GHz additional effects like rain, atmospheric and foliage attenuation must be considered in the (sub)-Terahertz frequency range, which have a significant impact on system performance. The possible throughput is dropping very fast with range. Therefore, wideband Terahertz systems are only applicable for short range communication especially if radiation limits need to be respected to avoid effects of electromagnetic radiation on the human body. Especially point-to-point links could be applied for backhaul connections and to replace optical fibres in data centres. This investigation does only provide basic ideas, which need further research. However, it shows that there is a reasonable potential for system implementation and deployment.

Global 5G Evolution for CONASENSE, Kaneshwaran Govindasamy, Global 5G Evolution

Kaneshwaran Govindasamy is the Founder of Global 5G Evolution, a platform & community providing millions of engineers & university students with informative content to help them innovate in the 5G technology domain. This allow the reach of engineers and University students to enable state of art technologies and allowing to engage conversations that would help them with knowledge for their research and engineering. He has 23 years' experience in the Telecommunications field in Key Account Management, Business Development & Commercial Management in Vendor & ICT Consulting Environment for Telco Operators in Asia, Enterprise market & Government agencies including MINDEF. Areas of expertise include 5G, IoT, Analytics, Cyber Security, Cloud, OSS/BSS, Power BI, LTE, Core Networks, Transmission & Transport Networks, Radio Microwave & Radio Base Stations. Kanesh forte is being in leading company, Ericsson Malaysia for

12 years in Key Account Management role. Kanesh was an apprentice to Professor Tharek Abdul Rahman in Wireless Microwave 28GHz Research & Development in 1998-2000. Kanesh qualifications are MBA (Victoria University, Melbourne, AU, 2009-2010) and BEng (Notingham Trent University, UK, 1996-1997).

Abstract: Global 5G Evolution, a platform & community providing millions of engineers with informative content to help them innovate in the 5G technology domain. We surpassed 120 speakers/5G experts from 35 countries worldwide on board with us; with 18 sessions. This YouTube community driven project, Global 5G Evolution reaches millions of engineers with information about state of the art technology and engaging conversations that enable them to stay up to date, and find knowledge during research, engineering, architecture and design. We would like to further explain further how this 5G Community platform will transform the Businesses including SMEs, Enterprises and Start-ups in this huge 5G ecosystem which includes Internet of Things, Digital Twin, Computer Vision, 3D Modelling, Drones, AR VR, Coding, AI, Robotics, Holographic and Machine Learning. We would love to encourage more Tech Youtubers targeting Gen Z Content Creators to participate where we can help to host them to the International scene.

The Evolution of the Radio Access Network towards 6G, Vladimir Poulkov, Technical University of Sofia, Bulgaria

Professor Vladimir Poulkov has received the M.Sc. and Ph.D. degrees from the Technical University of Sofia (TUS), Sofia, Bulgaria. He has more than 30 years of teaching, research, and industrial experience in the field of telecommunications. He has successfully managed numerous industrial, engineering, R&D and educational projects. He has been Dean of the Faculty of the Telecommunications at TUS and Vice Chairman of the General Assembly of the European Telecommunications Standardization Institute (ETSI). Currently he is Head of the Tele infrastructure R&D Laboratory at TUS and Chairman of the Cluster for Digital Transformation and Innovation, Bulgaria. He is Fellow of the European Alliance for Innovation; Senior IEEE Member. He has authored many scientific publications and is tutoring BSc, MSc, and PhD courses in the field of Information Transmission Theory and Wireless Access Networks.

Abstract: Like any radio, the cellular Base Stations (BSs) have a Radio Frequency (RF) and a Baseband (BB) part. For many years the RF part and the BB part of these major components of the Radio Access Networks (RANs) infrastructure have been tightly integrated. At these times connecting the RRUs of one vendor to the BBU of another vendor usually could not be possible due to the propriety of the solutions. In the last few decades, RANs have significantly evolved from analog to digital signal processing units, where hardware components are being replaced with flexible and reusable software-defined functions allowing the RRU and BBU of cellular BSs to be independent the implementation of advanced access architectures. Following these driving forces the BS architecture has evolved considerably over the last few years towards the so-called "Open RAN". The main behind opening the RAN is to disaggregate the elements of the BS and to develop open standards for the interfaces and interaction procedures between them. Currently service providers worldwide are driving adoption of "Open RAN for 5G". At the same time researchers consider implementing open source in the next generation RAN architecture to be an indispensable constituent of 6G ecosystems. This talk presents an overview of the evolution of RAN technologies and the latest trends towards virtualized, open and intelligent Next Generation RAN (NG-RAN).

Wi-Fi evolution: towards Wi-Fi 7, Valerio Frascola, Intel labs, Germany

Valerio Frascolla (MSc and PhD in Electronic Engineering) is Director of Research and Innovation at Intel and had been working at Ancona University, Comneon, Infineon, and as reviewer for the European Commission. He serves as chairman of several workgroups in European associations and is board of directors' member of the BDVA association. He has expertise in wireless systems architecture and protocols, requirements management, and standardization, his main research interest being 5G and beyond system design, with focus on spectrum management, AI, and edge technologies. He is author of 70+ publications, reviewer for 30+ journals, has participated in the TPC of 75+ conferences.

Abstract: The talk will focus on the Wi-Fi technology, elaborating the evolution of the Wi-Fi generations in the last 10 years and summarizing the main expected features of the forthcoming Wi-Fi 7, touching on its planned beneficial impact on the Industrial Internet of Things (IIoT) domain.

The case for 6G, Martijn Kuipers, INESC-INOV, Portugal

Berend Willem Martijn Kuipers received a B.Sc. from the Rijswijk University of Technology, the Netherlands, in computer science in 1996. In 1999, he received his M.Sc. in telecommunications from the Delft University of Technology in the Netherlands. He received his Ph.D. in telecommunications from Aalborg University, Denmark in 2005. During his Ph.D. he has developed a novel multicarrier access scheme for 4G systems. Currently he is employed by INOV-INESC Inovação in Lisbon, where is involved in the application of artificial intelligence algorithms for data analysis, such as clustering algorithms, seasonal ARIMA forecasting and machine learning. He has supervised more than 30 M.Sc. students and was involved with courses on telecommunications and computer networks, artificial intelligence and data structures. He has taken part in National and European projects, like Monitor-BT,E-Balance, TRILLION, ROCSAFE, FASTER e PERSONA and has publications in channel modelling, access techniques

and IP networking. He is also professor and coordinator at the bachelor's degree in Computer Science and Engineering at the Lusíada University of Lisbon, where he is responsible for the courses on artificial intelligence, data structures and computer networking.

Abstract: In 6G, the communication architecture is moving away from a pure cellular deployment and will see the formation of networks as a service (NAAS). This requires a complex technology, which will drastically change their operation. MNOs and MVNOs, must devise new business models and deployment strategies to be able to have any chance on recuperating their investments as the classical "overprovisioning" method is no longer a viable solution in 6G. 6G relies on virtualization of the network, which will use resource provisioning mechanisms based on self-managed reliable and trustworthy AI algorithm. Networks need to adapt dynamically to the required demand and requirements and must do so without interrupting the service. This creates new opportunities for existing players but will also open the market for new operators. Even though 6G is still being defined, it is of the utmost importance to understand the new dynamics, models and opportunities that it will bring us.

The security architecture of 5G networks and how it could evolve towards 6G, Stefan Wevering, Nokia, Germany

With more than 20 years of experience in the telecommunications industry, Stefan has a very broad knowledge of various technologies and network architectures. However, he also held different positions in various job functions that enabled him to identify and evaluate the business challenges facing the telecommunications ecosystem. After completing his PhD studies in Applied Optics at University of Osnabrück, he began his professional career in 2001 at Siemens ICN in the Advanced Technologies group for DWDM networks. He then worked in systems engineering, in various pre-sales positions and most recently as a technology consultant at Nokia for various European communication service providers, for Deutsche Telekom. He is particularly interested in studying the benefits of 5G technology for the telecommunications ecosystem, always keeping in mind that something else will come after 5G.

Abstract: 5G technology aims to realise new use cases in telecommunication networks to enable additional business opportunities in vertical markets, for example in industrial IoT. This is due to new capabilities being defined by 3GPP, especially around use cases in the context of enhanced mobile broadband (eMBB), ultra-reliable and low latency communications (URLLC), and massive machine-type communications (mMTC). There are several technological enablers involved, but the most important is the evolution towards a Software-centric network architecture where the defined virtual network functions can run on any Hardware infrastructure, also including any kind of cloud platform (even public clouds). On the other hand, this openness also means that a solid security architecture is becoming a necessity in 5G networks. In this work the basic security concepts and enhancements of 5G, being specified by standardisation, are outlined and explained. Additionally, as the world will still be becoming more and more open (and therefore more complex as well), there will also be a short outlook to potential security mechanisms required in 6G networks.

An Engineering Perspective on the Quantum Optical Communications and Sensing, Kwang-Cheng Chen, University of Florida, USA

Kwang-Cheng Chen has been a Professor at the Department of Electrical Engineering, University of South Florida, since 2016. From 1987 to 2016, Dr. Chen worked with SSE, Communications Satellite Corp., IBM Thomas J. Watson Research Center, National Tsing Hua University, HP Labs., and National Taiwan University in mobile communications and networks. He visited TU Delft (1998), Aalborg University (2008), Sungkyunkwan University (2013), and Massachusetts Institute of Technology (2012-2013, 2015-2016). He founded a wireless IC design company in 2001, which was acquired by MediaTek Inc. in 2004. He has been actively involving in the organization of various IEEE conferences and serving editorships with a few IEEE journals (most recently as a series editor on Data Science and AI for Communications in the IEEE Communications Magazine), together with various IEEE volunteer services to the IEEE, Communications Society, Vehicular Technology Society, and Signal Processing Society, such as founding the Technical Committee on Social Networks in the IEEE Communications Society. Dr. Chen also has contributed essential technology to various international standards, namely IEEE 802 wireless LANs, Bluetooth, LTE and LTE-A, 5G-NR, and ITU-T FG ML5G. He has authored and co-authored over 300 IEEE publications, 4 books published by Wiley and River (most recently, Artificial Intelligence in Wireless Robotics, 2019), and more than 23 granted US patents. Dr. Chen is an IEEE Fellow and has received several awards including 2011 IEEE COMSOC WTC Recognition Award, 2014 IEEE Jack Neubauer Memorial Award, 2014 IEEE COMSOC AP Outstanding Paper Award. Dr. Chen's current research interests include wireless networks, quantum communications and computing, cybersecurity, artificial intelligence and machine learning, IoT/CPS, and social networks.

Abstract: After Bell resolved the famous discussions between A. Einstein and Copenhagen school about quantum entanglement, R. Feynman suggested the potential of quantum computing, which was first realized by the quantum key distribution serving an example simultaneously for quantum computing, quantum communication, and quantum cryptography. Following the brilliant efforts in physics, engineering implementation of quantum optical communications has been examined, while both alternatives of quantum-classic communication and quantum-entangled communication are taken into consideration. Further applications in quantum networking and quantum sensing are explored.

How to keep the academic and scientific distance learning for students during the Coronavirus Pandemic, Rodolfo Azevedo, UNICAMP, Brazil

Rodolfo Azevedo is an associate professor at University of Campinas (UNICAMP) and President of the São Paulo Virtual University (UNIVESP). He received his PhD in Computer Science from University of Campinas (UNICAMP) in 2002 and is a member of the Computer Science graduate program where he advises master and PhD students. He got four best papers in conferences (SBAC-PAD 2004, SBAC-PAD 2008, 2018, and WSCAD-SSC 2012). In 2012 he received the Zeferino Vaz Academic Award and the newly created UNICAMP Teaching Award. He has been honoured 8 times in the Computer Science and Computer Engineering graduations. He was Director of the Institute of Computing from 2017-2019.

Abstract: The coronavirus pandemic is challenging many areas of education, including Distance Learning. Although a hybrid approach by nature, Distance Learning also suffers from the impacts of the pandemic, whether due to the impossibility of in-person tests, the lack of a physical place for studies and exchange of experiences, or even the dropout caused by other correlated factors, such as unemployment, difficulty in accessing the internet or even students' lack of motivation in this new reality. This presentation will address the experience of the São Paulo Virtual University (Univesp)/Brazil in such a scenario including the impact of the pandemic on student retention, strategies adopted, and solutions used to improve the quality of education.

Vision and business perspectives for Non-Terrestrial-Networks, Maria Gupta, ESA

Maria Gupta is Senior Telecommunication Systems Engineer in the Strategic Programme Line 5G/6G, Directorate of Telecommunications & Integrated Applications in the European Space Agency (ESA), https://artes.esa.int/space-5g-6g. She prepares and implements initiatives for 5G/6G satellite solutions fostering the integration of satellite and terrestrial solutions within the 5G and for various verticals. Interfaces with external stakeholders - space and non-space organisations, national space agencies and EU to develop common understanding for the requirements for 5G/6G satellite networks. She has more than 20 years of experience in satcom field. In her previous positions, she was with Eutelsat in the Systems Studies Division and the Space Engineering SpA in the Telecom Programmes Division.

Abstract: A new era of digitalisation and connectivity, between everything and everyone, has the potential to change the fundamentals of human existence: the way we interact, produce, live and work. New connectivity networks will be designed to be environmentally sustainable. The new and emerging applications and services enabled by seamless global connectivity offered by Non-Terrestrial /Satellite Networks will be pursued and commercialized to support a circular economy and climate neutrality. The potential contribution that 5G/6G satellite networks can make to sustainability spans across all Sustainable Development Goals (SDGs) and, to Zero Hunger (2), Good Health and Well-Being (3), Quality Education (4), Affordable and Clean Energy (7), Decent Work and Economic Growth (8), Reduced Inequalities (10), Sustainable Cities and Communities (11), Climate Action (13), Life on Land (15), among others. Space has an invaluable role to play in the 5G/6G ecosystem in support of a myriad of current and future use cases. 5G and 6G have a potential global economic impact which is staggering, with the satellite connectivity share very compelling. Satellites can extend coverage, enhance performance, and provide reliability and security to 5G/6G, helping to deliver its promise of global, ubiquitous connectivity. Main objective of the presentation is to highlight the main business and technological challenges and opportunities for NTN networks in the 5G/6G ecosystem and the prevailing verticals.

Cognitive networking as instant primer of large-scale satellite networks, Paulo Mendes, Airbus

PAULO MENDES is Expert in Network Architectures and Protocols at Airbus central research and technology in Munich, Germany. His research interests include self-organized wireless networking, information and service-centric networking, and quantum networking. Paulo is also an invited associate professor at University Lusófona, where he was associate professor from 2010 to 2019. Before joining Airbus, Paulo co-founded the COPELABS research center (2010), the Senception start-up (2014), and the Internet architectures and networking research group at INESCTEC laboratory (2007). From 2003 to 2007 Paulo was senior researcher at NTT Docomo Euro-labs. In 2004, Paulo Mendes got his Ph.D. degree (summa cum laude) in informatics engineering from the University of Coimbra, while being a visiting scholar at Columbia University, New York, from 2000 to 2004. He is an IEEE senior member and an ACM member.

Abstract: Driven by the vision of a pervasive Internet able to support emergency autonomic systems, such as autonomous vehicles and satellite constellations, there is the need to support a more flexible, scalable and low cost management of such networks. In this context, further work is needed to devise a suitable management framework able to sustain large scale networks (e.g. LEO constellations) while still following the network automation path that has been tackled in 5G networks and by Internet Service providers. Such a management framework will allow future mobile networks (e.g. cellular, vehicular, satellite) to become cognitive by observing and acting autonomously to optimize their performance. Cognitive mobile networks will enable full automation of network management and configuration tasks, allowing operations and maintenance personnel to supervise the network. Besides the usage of AI to furnish the needed automation and prediction, the envisioned management plan needs to be able to interact with a variety of network technologies, such as network slicing, software defined network and

network function virtualization, which need to be combined to create more flexible services. However, it will be difficult to manage flexible and fine-grained services with the current architecture of mobile networks, such as 5G. In the future the architecture of a mobile network should be redesigned to achieve a powerful, flexible and intelligent networking experience. This talk aims to provide a brief analysis about the integration of such cognitive service architecture with large scale satellite systems.

Non-terrestrial Networks (NTN): Boosting 6G from the Sky, Tomaso de Cola, DLR

Tomaso de Cola received the master's degree (with honours) in telecommunication engineering, in 2001, the Qualification degree as Professional Engineer in 2002 and the Ph. D. degree in Electronic and Computer Engineering, Robotics and Telecommunications in 2010 from the University of Genoa, Italy. From 2002 until 2007, he worked with the Italian Consortium of Telecommunications (CNIT), University of Genoa Research Unit, as scientist researcher. Since 2008, he has been with the German Aerospace Center (DLR), where he has been involved in several projects funded by EU and ESA programs, focusing on different aspects of DVB standards, CCSDS protocols, emergency communications, and testbed design. He has been taking part of different standardization activities within ETSI, IETF, DVB, and CCSDS, where he serves as area director of the Space Internetworking Services (SIS). He is co-author of more than 100 papers, including international conferences and journals. His main research activity concerns: TCP/IP protocols, satellite networks, transport protocols for wireless links, interplanetary networks as well as delay tolerant networks, and communications strategies for emergency applications. Dr. de Cola served on the Technical Program Committee at many IEEE International Conferences and as TPC chair for the satellite track in many ICC and Globecom editions. He has also been guest editor for IEEE JSAC, IEEE Wireless Communication Magazine, and IEEE Network; he is currently serving as associate editor for IEEE Communication Letters, IEEE Wireless Communication Letters, IEEE Systems Journal, and IEEE Transactions on Vehicular Technology. He is also serving as associate editor for Elsevier Computer Networks Journal. Finally, he was the chair of the Satellite and Space Communications (SSC) technical Committee (TC) within ComSoc from 2017 to 2020. He is currently serving as chair of the SatCom working group with the EU Networld2020 ETP.

Abstract: Satellite communications (SatCom) and non-terrestrial networks (NTN) in a broader sense are experiencing a new hype thanks to their emergence as one of the technology champions in the 5G-3GPP standardisation, the renewed interest towards satellite constellations, and new attractive technology advancements in the development of satellite payloads. In this light, NTNs are expected to play a key role in the overall 6G definition roadmap, by taking advantage of a multi-folded space ecosystem, expected to complement the capabilities of 6G terrestrial networks and then eventually provide users with unprecedented QoE. This talk overviews some of the key technology advances in SatCom from a research perspective and outlooks the role that these can have in the full integration of NTNs within the 6G ecosystem.

A Risk Analysis of CONASENSE Satellite Systems Threats, Homayoun Nikookar, faculty of Military Sciences of the Netherlands Defence Academy, Netherlands

Homayoun Nikookar received his Ph.D. in Electrical Engineering from Delft University of Technology in 1995. He is an Associate Professor at the Faculty of Military Sciences of the Netherlands Defence Academy. Dr Nikookar has published 150 papers in the peer reviewed international technical journals and conferences, 15 book chapters and is author of two books: Introduction to Ultra-Wideband for Wireless Communications, Springer, 2009 and Wavelet Radio: Adaptive and Reconfigurable Wireless Systems based on Wavelets , Cambridge University Press, 2013.

Abstract: The use of space systems to support Communication Navigation Sensing and Services (CONASENSE) activities has increased exponentially since their first application in 1965 with the Initial Defense Satellite Communications System. Although the first major application was for communications services, space-based capabilities have now expanded to provide a wide range of other types of services. Today these applications include navigation, targeting, mapping, remote sensing, surveillance and meteorological tracking, prediction and other services. Currently space is seen as a new war frontier in which satellites play a major role. Given the importance of CONASENSE satellite services in today's life and the huge amounts of financial resources and the state-of-the-art technological capabilities that are necessary to realize this kind of technology, it makes a satellite system a realistic target for threats. Also, the fact that a damaged or destroyed satellite cannot be replaced within a short time, makes threats more serious to satellites. Furthermore, currently cyber threats are becoming the most obvious recourses to take hostile action against CONASENSE satellites. In addition to that the ground control station and antennas will also be vulnerable to cyber threats and conventional threats as well. In this paper the threats of CONASENSE satellites are studied and a risk analysis of the relevant threats is provided. The influence of artificial intelligence (AI) technology and the role it can possibly play in protective measures are also included.

Geolocalization of low complexity and low power consumption IoRT terminals, Ernestina Cianca, Univ Rome

Ernestina Cianca is Assistant Professor at the Dept. of Electronic Engineering of the University of Rome Tor Vergata, where she teaches Digital Communications and ICT Infrastructure and Applications (WSN, Smart Grid, ITS etc.). She is the Director of the II Level master's in engineering and International Space Law in Satellite systems for Communication, Navigation and Sensing. She is vice-director of the interdepartmental Center CTIF-Italy. She has worked on wireless access technologies (CDMA, OFDM) and in the waveforms design, optimization and performance analysis of radio interfaces both for terrestrial and satellite communications. An important part of her research has focused on the use of EHF bands (Q/V band, W band) for satellite communications and on the integration of satellite/terrestrial/HAP (High altitude Platforms) systems. Currently her main research interests are in the use of radio-frequency signals (opportunistic signals such as Wi-Fi or specifically designed signals) for sensing purposes, and. Device-free RF-based activity recognition/crowd counting/density estimation and localization; UWB radar imaging (i.e., stroke detection). She has been the coordinator of the activities of the Interdepartmental Center CTIF for the Italian Space Agency project "Sviluppo Terminale EGNSS multifunzionale e riconfigurabile (TESEI)", on the development of a GNSS multifunctional terminal. She has been principal investigator of the ASI project WAVEA2, phase 2 study for two demonstrators and two pre-operative missions for satellite communications in W band. Responsible for the University of Rome Tor Vergata activities for the several ASI-ESA projects. She is Associate Editor for the journal Wireless Communication and Mobile Computing (Hindawi). She is author of more than 150 papers published on international journal and conference proceedings.

Abstract: In the context of Internet of Remote Things (IoRT), small, low cost, low complexity and low power consumption terminals are connected to the network via satellite. The knowledge of the position of the IoRT terminal is important for current and future location-based applications. However, the knowledge of the position of the IoRT terminal is crucial also to ease the integration with 5G and overcome some challenges of the communications with LEO fast-moving satellites such as long and variable delays and high Doppler shifts. A device may use its location information in combination with satellite ephemeris data to support mobility, compensate for Doppler effects, and achieve time and frequency synchronization. As a matter of fact, 3GPP has agreed to assume that User Equipments (UEs) will be equipped with a Global Navigation Satellite System (GNSS) receiver. This assumption appears unrealistic in a IoT scenario where low consumption and low complexity terminals are involved. Therefore, different solutions must be investigated. Therefore, this talk will make an overview on geolocalization techniques of IoT terminals from one single satellite, showing achievable performance and outlining challenges and research directions.

Social Media Insights about COVID-19 in Portugal: a social sensing approach, Joao Ferreira, ISCTE-IUL

João C. Ferreira is Assistant Professor with habitation at ISCTE-IUL. He graduated in Physics from the Technical University of Lisbon (UTL / IST), Portugal, received an MSc in Telecommunications and a PhD in Computer Engineering from UTL / IST and a second PhD in Industrial Engineering at the University of Minho. His research interests are in: data science, Text Mining, IoT, AI, IoT and AI application health, energy, transportation, security networks, Blockchain, Electric Vehicle, Intelligent Transportation Systems (ITS) and sustainable mobility systems. He has authored more than 250 papers in computer science. He has executed more than 30 projects (6 as PI), more than 180 scientific paper reviews and more than 25 scientific project evaluation. IEEE CIS Chair 2016-2018 and main organizer of international conferences such as: OAIR 2013, INTSYS 2018, INTSYS 2019 and INTSYS2020. IEEE senior member since 2015. Guest Editor and topic editor of MDPI in the topics of energies, electronics and Sensors. President of the IEEE CIS in PT (2017-2018). Author of a patent around Edge Computer in a monitoring system for fishing vessels. Coordinator of the Master of Decision Support Systems and of the summer schools (smart cities) and winter schools (IoT and blockchain systems) 2019 and 2020. He is participating in the following projects - H2020 Infrastress, Sparta, ENSURECEC and MARISA, ANDANTE, Interreg Block4Coop, BALCAT, AIM Health, PT2020 Monitoring persistent track and Multicam and the Digital Demo

Abstract: The rapid spread of COVID-19 around the world had a significant impact on daily life. As in other countries, measures were taken in Portugal to combat the spread. The objective of this paper is to attain a perception of the reality concerning the COVID-19. With topic modelling and sentiment analysis, the adopted approach was validated within the context of Portugal, covering data over a period of one year, but it can equally be employed in similar situations and other countries. For this purpose, data was extracted from three sources (Twitter, Reddit and Publico). These data were prepared for application of natural language processing (NLP) tools specific to the Portuguese language. Then, a dashboard was built, and evaluated by experts in medical care, who highlighted the potential of the results obtained, concluding that the information extracted reflects the events related to the pandemic. All data will be made available upon request.

Challenges of machine learning in eVTOL aircraft systems reliability and safety, Marcos A Salvador, Polytechnique Montréal, Canada

Marcos Salvador is an engineer with more than 12 years of experience in the aerospace industry, currently pursuing his M.Sc. in the department of Industrial Engineering and Applied Mathematics, at École Polytechnique de Montréal (Canada). He holds a B.Sc. in Electronic Engineering from the Faculty of Engineering São Paulo, Brazil (2005). His work in the field of RAMS has focused on critical systems safety analysis and risk analysis and management. His research interests are Condition-Based Maintenance, Machine Learning and Pattern Recognition, Data Analytics, Industry 4.0, Autonomous and Interoperable Flight.

Abstract: The increasing number of requests for type certification received by the European Union Safety Agency on Vertical Take-off and Landing (VTOL) aircraft attests to the expansion of frontiers in Urban Air Mobility (UAM). In addition, it has revealed the interest of traditional airplanes and helicopters manufacture, and the emergence of new players, all developing their respective versions of electric powered VTOLs (eVTOL). The perspective of eVTOL entering service in the coming years to serve the transport of passengers, also brings the concern to ensure the reliability and safety aspects of those aircraft systems that will be flying under new operational missions, which differs from current fixed wing and rotorcraft aircraft. Moreover, the evolution of aircraft systems monitoring technology makes possible to acquire increasing amounts of data. In the event of system failures, the high complexity of new systems combined with the huge amount of data provided, it makes the decision-making process more difficult. Machine learning allows to evaluate this data and improve reliability and safety. Even as the number of aeronautical accidents has decreased over the last years, 60-80% of those accidents are result of human-failure. In an initial implementation and operation stages machine learning (ML) can support pilot by using aircraft data to predict system failures and contribute to improve reliability and safety. Then, at an advanced stage, ML may support to reduce the human interaction with eVTOL opening the possibilities for an autonomous aircraft. This paper addresses the main challenges for the incorporation of ML in the upcoming eVTOL fleet and its potential contribution to aircraft systems reliability and safety.

Applications of AI and AR in the context of Next Generation Communications and Services, Albena Mihovska, Aarhus University, Denmark

Albena Mihovska is a Senior Academic and Research Professional, currently an Associate Professor at the Dept of Business Development and Technology, at Aarhus University, Denmark. She is leading the 6G Knowledge Research Lab at the CTIF Global Capsule (CGC) research group at the Dept as well as several EU-funded projects in Beyond 5G networks.

Abstract: Applications that take advantage of wireless communications are expanding from connecting humans to connecting various things. Wireless communication has been more and more complemented by the exponential growth of advanced technologies such as artificial intelligence (AI), augmented and extended reality (AR and XR) and is causing a revolutionary shift in the traditional wireless communication networks with the potential for an increased contribution to achieving social goals. The talk will focus on novel applications and services and the open technological and social barriers to be overcome for the full adoption of AI and AR and XR technologies.

Building an Agile Co-Innovation Framework for Addressing Emerging Technological Challenges,   Milica Pejanović-Djurišić, University of Montenegro

Milica Pejanović-Djurišić is full professor in Telecommunications and Wireless Communications at the Faculty of Electrical Engineering, University of Montenegro, founder and director of its Research Centre for ICT. Prof. Pejanović-Djurišić has been cooperating with numerous universities, research centres, international and think tank organizations worldwide as a visiting researcher and lecturer. In her research work she is focused on various aspects of wireless communications and networks, where she has achieved notable results that were published in several hundred scientific papers in international journals and international conferences, scientific and professional papers in domestic journals and conferences, as well as in several books and other publications.

Abstract: The world is in the middle of an unprecedented technological revolution, one that is already demonstrating far-reaching social, economic, and geostrategic consequences. In such circumstances, countries around the world increasingly recognize that they must lead in tech based innovation if they are to be prosperous and secure today and in the future. In our societies activities of political, economic, social and cultural life already depend to a large degree on digital connectivity. As cyberspace is the technical foundation on which the world is increasingly relying to exchange information, cyber readiness and resilience is becoming the norm. Cybercrimes and threats undermine not just the safety of network users but disrupt economical and commercial activities all the way to influencing the level of accepting new solutions offered through advancements in communications, networking, sensing…That calls for a change towards adjusting research focus — to go stronger towards innovating and implementing new solutions, together with building new capabilities and capacities. Such change will not be possible without effective coordinated partnerships with diverse stakeholders: governments (local and national), entrepreneurs, venture capitalists, incubators and accelerators. Thus, the coordinated wide innovation system will be

able to provide necessary change of the technical architecture and underpinnings for defending against cyberattacks, so that networks would be defended, mission-critical networks ensured, high-quality cyberspace situational awareness provided, policies designed and practical tools created to integrate particular cyber effects, in the situation when existing trusted platforms have been found to have backdoor access and mobility continually challenges the definition of securing to "the edge". In this contribution, building of such innovation framework will be discussed, taking into consideration the importance of understanding the challenges inherent to innovating for the contemporary security environment and a level of related uncertainty, so that the research would be able to provide rapidly adaptable solutions based upon timely reassessments of the changing conditions.

System Working Principles and Use Cases of Railway Mobile Communication System towards 5G and Beyond, Navin Kumar

Dr Navin Kumar has over 24 years of working experience in Government, Industry and academia in IT and Telecommunication area. He has over 10 years of overseas experience in teaching, research and development. Currently, he is working as Assoc. Professor and chairman ECE Dept. in Amrita Vishwa Vidyapeetham (University), Bangalore campus. Dr. Navin has around 100 publications in peer reviewed international journals and IEEE conference proceedings. In addition, he has also authored and edited books and book chapters. Dr. Navin has been awarded the Fraunhofer Challenge award in academic year 2010-2011 for the best PhD thesis work. He also received research grant from foundation of science and technology (FCT) Govt. of Portugal towards his PhD research work. He is the recipient of Gowri Memorial award, India in year 2009 for the best journal paper. Many of his papers adjudged as best paper awards at International IEEE conferences outside India. He is Sr Member of IEEE, AIENG (HK), Life member of IETE and Fellow IE(India). He is very active IEEE volunteer. He is secretary in Bangalore Section. He served as Chair of IEEE ComSoc Bangalore Chapter (2017-18), Chair VTS Bangalore and, Student Branch Counsellor of Amrita School of engineering. He is also associated with IEEE Photonics, ITS, VTS, Consumer Electronics and Sensor council. Dr. Navin has been giving tutorial at IEEE flagship conferences like ICC, WCNC. He regularly speaks and delivers talk as keynote, invited speakers in conferences and workshops. His research area includes, 5G (mmWave and Massive MIMO), Visible Light Communication, Optical Wireless Communication, IoT and Intelligent Transportation Systems, He is also the part of IEEE 5G and Future Network Initiative.

Abstract: The use cases, applications and promises of 5G and beyond is still to be explored. The support of this emerging technology for railway mobile communication (RMCS) is yet to be witnessed and experienced. The RMCS envisioned large use cases of very high-speed data transfer, very low latency and even massive connectivity to support railway users. 3GPP Rel 17 has been discussing on this vertical. It eventually will resemble GSM-R and will additionally provide communication capabilities beyond what GSM-R has been able to. It will provide higher data rates, lower data latencies, multimedia communication, and improved communication reliability. In this talk, we will highlight the transition requirements from legacy communication systems (e.g. GSM) to future RMCS (FRMCS), interworking requirements between legacy communication systems and FRMCS as being discussed in Rel17.

Organizers' Bios

Ramjee Prasad,

President, CTIF Global Capsule, Professor,

Department of Business Development and Technology, Aarhus University, Herning, Denmark

Ramjee Prasad, Fellow IEEE, IET, IETE, and WWRF, is a Professor of Future Technologies for Business Ecosystem Innovation (FT4BI) in the Department of Business Development and Technology Aarhus University, Herning, Denmark. He is the Founder President of the CTIF Global Capsule (CGC). He is also the Founder Chairman of the Global ICT Standardization Forum for India, established in 2009. He has been honoured by the University of Rome "Tor Vergata", Italy as a Distinguished Professor of the Department of Clinical Sciences and Translational Medicine on March 15, 2016. He is an Honorary Professor of the University of Cape Town, South Africa, and the University of KwaZulu-Natal, South Africa. He has received the Ridderkorset of Dannebrogordenen (Knight of the Dannebrog) in 2010 from the Danish Queen for the internationalization of top-class telecommunication research and education. He has received several international awards such as IEEE Communications Society Wireless Communications Technical Committee Recognition Award in 2003 for making a contribution in the field of "Personal, Wireless and Mobile Systems and Networks", Telenor's Research Award in 2005 for impressive merits, both academic and organizational within the field of wireless and personal communication, 2014 IEEE AESS Outstanding Organizational Leadership Award for: "Organizational Leadership in developing and globalizing the CTIF (Center for TeleInFrastruktur) Research Network", and so on. He has been the Project Coordinator of several EC projects, namely, MAGNET, MAGNET Beyond, eWALL. He has published more than 50 books, 1000 plus journal and conference publications,

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more than 15 patents, over 140 Ph.D. Graduates and a larger number of Masters (over 250). Several of his students are today worldwide telecommunication leaders themselves.

Rute C. Sofia
Industrial IoT Head

Fortiss, Munich, Germany

Rute C. Sofia (PhD 2004) is the Industrial IoT Head at fortiss - research institute of the Free State of Bavaria for software intensive services and systems in Munich, Germany. She is also an Invited Associate Professor of University Lusófona de Humanidades e Tecnologias, and an Associate Researcher at ISTAR, Instituto Universitário de Lisboa. Rute's research background has been developed on industrial and on academic context, and she has co-founded COPELABS (2012-2019, Lisbon, Portugal), research unit which she also steered between 2013-2017. and where she was a Senior Researcher until 2019. She has co-founded Senception Lda (2013), a start-up focused on personal communication platforms. Her current research interests are: network architectures and protocols; IoT; edge computing; in-network computation; network mining. Rute holds over 60 peer-reviewed publications in her fields of expertise, and 9 patents.

She is an ACM Senior member and an IEEE Senior Member, and an ACM Europe Councillor. She is also an N2Women Awards Co-chair. Before COPELABS/ULHT, she was a senior researcher at INESC TEC (07-10, Porto, Portugal), where she steered the "Internet Architectures and Networking" area of UTM, team dedicated to wireless/cellular networking architectures and to user-centric networking paradigms. She was (04-07, Munich, Germany) a senior research scientist in Siemens AG and Nokia-Siemens Networks GmbH, focusing on aspects such as: fixed-mobile convergence; carrier-grade Ethernet; QoS; IPv6 interoperability. Rute holds a BEng in Informatics Engineering by Universidade de Coimbra (1995); M.Sc. (1999) and Ph.D. (2004) in Informatics by Universidade de Lisboa. During her PhD studies, she was a visiting scholar (2000-2003) at Northwestern University (ICAIR) and at University of Pennsylvania. The PhD degree has been awarded by University of Lisbon, "Summa cum Laude". The PhD studies took place (Visiting scholar) at ICAIR, Northwestern University (2000) and University of Pennsylvania (2000-2003).

Paulo Sergio Rufino Henrique

Spideo, France

CGC, Aarhus University

Paulo S. Rufino Henrique holds more than 20 years of experience working in telecommunications. His career began as a field engineer at UNISYS in Brazil, where he was born. There, Paulo worked for almost nine years in the Service Operations, repairing and installing corporative servers and networks before joining British Telecom (BT) Brazil. Paulo worked five years at BT Brazil managing MPLS networks, satellites (V-SAT), IP-Telephony for Tier 1 network operations. He became the Global Service Operations Manager during that period overseeing BT operations in EMEA, Americas, India, South Korea, South African, and China. After a successful career in Brazil, Paulo got transferred to the BT headquarters in London, where he worked for six and a half years as a service manager for Consumers Broadband in the UK and IPTV Ops manager for BT TV Sports channel. Additionally, during his tenure as IPTV Ops manager for BT, Paulo also participated in the BT project of launching the first UHD (4K) TV channel in the UK. He then joined Vodafone UK as a Quality Manager for Consumers Broadband Services and OTT platforms, and he worked in that capacity for almost two years. During his stay in London, Paulo completed a Post-graduation Degree at Brunel London University. His thesis was entitled 'TV Everywhere and the Streaming of UHD TV over 5G Networks & Performance Analysis'. Presently, Paulo Henrique holds the Head of Delivery and Operations position at Spideo, Paris, France. He is also a Ph.D. candidate under Professor Ramjee Prasad's supervision at Global CTIF Capsule, Department of Business, Aarhus University, Denmark. His research field is 6G Networks - Performance Analysis for Mobile Multimedia Services for the Future Wireless Technologies.