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## Introduction to the CONASENSE 2022 Symposium

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### Abstract

This report provides an overview on CONASENSE 2022 international symposium, held in Munich on 27<sup>th</sup> and 28<sup>th</sup> June 2022, having been jointly organised by fortiss and CGC, Aarhus University. CONASENSE 2022 counted with 25 international speakers, presentations of papers, presentations of next generation projects, and also with a co-located Hackathon focused on next generation mobile IoT applications across multiple domains. The event counted with an international audience of 90 participants, where 40 were in Munich. The overall event, including the peer-reviewed papers, and abstracts of talks are summarised in this report, which corresponds to the proceedings of CONASENSE 2022.

## Contents

1. Introduction.....	2
1.1. Symposium Objectives.....	2
1.2. Format and Expected Outcome.....	3
1.3. Symposium Topics.....	4
1.4. Committees.....	5
1.4.1. General Chairs.....	5
1.4.2. Publicity Chair and Treasurer:.....	5
1.4.3. Student Forum Chairs:.....	5
1.4.4. EU-IoT/EFPP Hackathon Chairs.....	5
1.4.5. Technical Programme Committee.....	5
1.5. Symposium Agenda.....	6
1.6. Awards.....	10
1.7. Proceedings Structure.....	11

## 1. INTRODUCTION

6G is currently under definition, being often addressed from a plain telecommunications perspective, as an evolutionary paradigm that represents an extension of 5G. Having as horizon 2030, 6G initiatives are being deployed across the globe, to further ignite the development of 6G services. In its philosophy core, 6G embodies the “human in the loop” principle. The research effort being developed towards 6G requires an interdisciplinary approach that ignites discussion across different key technological sectors, ranging from communications until services and business cases.

In the context of 6G, the CONASENSE2022 provided an interdisciplinary view on latest trends in 6G communications, sensing, services and sustainability aspects based on the *CONASENSE (Communications, Navigation, Sensing, Services)* community vision.

The event corresponds to a 12<sup>th</sup> edition of former CONASENSE workshops, and has been based on a symposium format, including invited talks from industry; sessions for the presentation of peer-reviewed papers in selected topics; invited talks focusing on the presentation of next generation Internet of Things (IoT) projects; a Hackathon, with focus on the development of mobile, sustainable IoT applications.

The 2022 CONASENSE International Symposium has been jointly organised in hybrid mode by fortiss and CGC, Aarhus University within the context of a research partnership established between the two institutions in 2021. In total, per day, the symposium counted with 90 participants, of which 40 attended in person in Munich.

### 1.1. *Symposium Objectives*

The key objectives established for the 2022 symposium were:

- To further expand the CONASENSE community, integrating peer-reviewed research work from younger researchers.
- To ignite discussion focused on the development of the 6G paradigm based on an interdisciplinary methodology.
- To provide a balanced overview on today’s advancements in relevant 6G areas, e.g., IoT, AI, telecommunications, by bringing together experts developing scientific work, research and development projects, and developers and students more focused on the application of open-source solutions.

### ***1.2. Format and Expected Outcome***

As part of the symposium organization, the CONASENSE community Website<sup>1</sup> has been updated with the proposed agenda and with the talks provided by the speakers, upon prior consent. Moreover, partners CGC and fortiss 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 a hybrid event, but motivating speakers and main authors of papers to attend in Munich.

The event had an attendance of 90 participants (25 speakers), where 40 participants (including speakers) were in Munich. The remote participation has been supported by fortiss via Web conferencing.

In Munich, the event has been organised by fortiss in the Munich Highlight Towers, having the support of IBM, C4AI joint cooperation between fortiss and IBM.

The overall expertise of the participants related with research, innovation. A few participants concerned technology management, standardisation.

The event started on June 27<sup>th</sup> 2022 with a welcoming round provided by the organizers and has then proceeded to the keynote session , where experts from IBM, Infineon, Eclipse Foundation, and UnternhemerTUM gave input to relevant products and services.

The next sessions related with the presentation of full peer-reviewed technical papers, followed by invited talks with focus on 6G wireless changes, and a session on next generation IoT projects.

The event proceeded with additional invited talks focusing on 6G business models and use-cases.

For the second day, the event started with sessions focusing on the presentations of both full and short papers, followed by a session focusing on cooperation opportunities towards 6G IoT in Brazil, and then by a session of invited talks on advanced visions towards 6G.

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<sup>1</sup> <https://www.conasense.org>

The Hackathon was developed in parallel. The Hackathon started in the afternoon of the first day of CONASENSE 2022. Several meetups with mentors have been set, given that the participants were in hybrid mode.

The event closed with a final session, where awards to the best paper, best presentation and Hackathon awards have been provided.

The symposium derived the following outcome:

- These proceedings.
- A book based on selected invited talks, edited by River Publishers, under the “CONASENSE series”<sup>2</sup>.
- A Future MDPI special issue based on selected papers<sup>3</sup>.
- A River Journal of Mobile Multimedia (JMM) special issue, based on selected papers.

### 1.3. *Symposium Topics*



The theme of the symposium concerned “6G communications, services, and sustainability”. The main topics of the symposium concerned the following areas:

- **Communications:** Unified architectural communications involving ground to spaceborne infrastructures; quantum communications and their role and challenges in 6G; Machine-to-machine and device-to-device communication aspects; security aspects in 6G, including mitigation of attacks and architectural challenges; network architectures and protocols for 6G;
- **Navigation and Satellite Integration:** AR/VR advanced navigation approaches, considering both indoor and outdoor scenarios; new navigation

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[https://www.riverpublishers.com/series\\_search.php?val=+conasense+&search=Search](https://www.riverpublishers.com/series_search.php?val=+conasense+&search=Search)

<sup>3</sup> [https://www.mdpi.com/journal/futureinternet/special\\_issues/\\_CONASENSE](https://www.mdpi.com/journal/futureinternet/special_issues/_CONASENSE)

applications, e.g., navigation systems for visually impaired people; navigation based on wireless systems; the role of satellite systems and space communications in supporting future IoT systems; geolocalization services and challenges; Data verification, data curation aspects, data privacy aspects.

- **Sensing:** Internet of Things and its integration in different vertical markets; Internet of Everything and AIoT; Interfacing to the real world, in particular tactile interfacing, user-centric, context-aware man-machine interfacing.
- **Services:** The role of the Metaverse, AR/VR development towards 6G; Semantic technologies and their role in the development of a 6G unified architectural communications vision; ML application, in particular federated learning and decentralised learning approaches (e.g., swarm, hybrid federated learning approaches) required to support 6G services; new services and use-cases, e.g., emergency services, remote surgery, smart manufacturing, space exploration, underwater communications; New Edge-based services and the role of Edge computing
- **Sustainability and Greenness:** methodological analysis and research focused on automated evaluation of sustainable solutions towards 6G; analysis of 6G business advantages, proposal of business models and green business frameworks, etc.

## 2. COMMITTEES

### 2.1. *General Chairs*

Rute C. Sofia, fortiss GmbH, Munich, Germany

Ramjee Prasad, CGC, Aarhus University, Denmark

### 2.2. *Publicity Chair and Treasurer:*

Paulo Rufino, CGC, Aarhus University, Denmark

### 2.3. *Student Forum Chairs:*

Ernestina Cianca, University of Rome, Italy

Manel Khelifi, fortiss GmbH, Munich, Germany

### 2.4. *EU-IoT/EFPP Hackathon Chairs*

Mitula Donga, fortiss GmbH, Munich, Germany

Rute C. Sofia, fortiss GmbH, Munich, Germany

### 2.5. *Technical Programme Committee*

- Alben Mihovksa, CGC, Aarhus University, Denmark (Chair)

- Ernestina Cianca, University of Rome, Italy
- Tomaso de Cola, DLR, Germany
- Eduardo Cerqueira, UFPA, Brazil
- Augusto Casaca, INESC-ID, Portugal
- Elefteris Mamathas, Democritus University, Greece
- Henning Schulzrinne, Columbia University, USA
- Anand Prasad, Deloitte, Japan
- Valeria Loscri, INRIA, France
- Eirini Eleni Tsiropoulo, University of New Mexico, USA
- Diego Lopez, Telefonica, Spain
- Jonathan Fürst, NEC, Germany
- Simone Morosi, University of Florence, Italy
- Pedro Sebastião, ISCTE-IUL, Portugal
- Xiaoming Fu, University of Göttingen, Germany
- Maria Papadopouli, FORTH, Greece
- John Soldatos, Intrasoft, Luxembourg
- Jorge Sá Silva, University of Coimbra, Portugal
- Vassilis Tsaoussidis, Democritus University, Greece
- Artur Hecker, Huawei, Germany
- Marica Amadeo, University Mediterranea of Reggio Calabria, Italy
- Laura Feeney, Uppsala University, Sweden
- Ignacio Lacalle, Universitat Politècnica de Valencia, Spain
- Dianne Medeiros, Universidade Federal Fluminense, Brazil
- Evsen Yanmaz, Ozyegin University, Turkey
- Huiling Zhu, University of Kent, United Kingdom
- Jose Sallent, Universitat Politècnica de Madrid
- Anna Triantafyllou, University of Western Macedonia, Greece
- David Jimenez, Universidad Politécnica de Madrid, Spain
- Carlos Raniery Paula Dos Santos, Federal University of Santa Maria, Brazil
- Arne Bröring, Siemens AG, Germany

### 3. SYMPOSIUM AGENDA

The symposium has been organized in June 27<sup>th</sup>-June 28<sup>th</sup> 2022, with a co-located Hackathon. The agenda is presented in Tables Table 1 and Table 2.

**Table 1: CONASENSE 2022 Symposium, Agenda Day 1, 27th June 2022.**

Time (CET)	Sessions	
8:30-9:30	Registration period – Highlight towers, groundfloor	
9:00-09:30	<b>Welcoming Session</b> <i>CONASENSE welcome</i> , Rute Sofia, Ramjee Prasad <i>IBM Welcome</i> , Felizitas Müller, IBM <i>fortiss Welcome</i> , Harald Rueß, fortiss	
09:30-10:30	<b>Keynote Session – 21<sup>st</sup> floor, room Yorktown South</b> Chair: Paulo Rufino , Aarhus University  <i>IBM Innovation Studio Munich</i> , Felizitas Müller, IBM UnternehmerTUM - We turn visions into value , Florian Küster, Unternehmer TUM Makerspace <i>The EU platform for IoT and Edge must be open source!</i> ,Gael Blondelle, Eclipse (remote) <i>AI based sensing for IoT Building Applications</i> , Avik Santra, Infineon	
10:30-11:00	<b>Coffee-break</b> - 21 <sup>st</sup> floor, Yorktown South	
11:00-12:00	<b>Hackathon session 1</b> 20 <sup>th</sup> floor, Large Board room	<b>11:00-12:00 Technical session - Full paper session 1 (20m plus 10m)</b> Chair: Manel Khelifi, fortiss  <i>GDOP Optimised LEO Constellation for Positioning</i> , Harshal More, Mauro de Sanctis, Ernestina Cianca, Cosimo Stallo  <i>Achievable Bandwidth of Reconfigurable Intelligent Surfaces (RIS) Concepts Towards 6G Communications</i> , <i>Werner Mohr</i>
12:00-12:30	Hackathon session 1 (cont)	Invited Talks Track: 6G Wireless Challenges part I (15m plus 5m) Chair: Paulo Rufino, Aarhus University  <i>Cybersecurity in the Era of Next Generation Wireless Networks</i> , Milica Pejanović-Djurišić, University of Montenegro
13:00-14:30	<b>Lunch Break</b> – 21 <sup>st</sup> floor, Yorktown South	
14:30-16.15	Hackathon Session 2 14:30-15:30 – mentor get	<b>Project Presentation Session: Next Generation IoT Projects- Yorktown South</b> Chair: Victor Banos, fortiss

Time (CET)	Sessions	
	together	ASSIST-IoT, Ignacio Lacalle Ubela, Universidad Politecnica di Valencia (remote) IntellIoT, Arne Bröring, Siemens AG (remote) iGENIOUS, Giacomo Bernini and Erin Seder, Nextworks (remote) 'TERMINET: nexT gEncRation sMart INterconnectEd IoT', Panagiotis Sariagiannidis, University Western Macedonia (remote) VEDL-IoT, Jens Hagemeyer, University of Bielefeld IOT-NGIN, Jonathan Klimt, RWTH, Aachen EFPF, Usman Wajid, Information Catalyst
16:15-16:30	Coffee-break	
16:30-18:00	Hackathon Session 3	16:30-18:00 Invited Talks Track (15m plus 5 for questions): Business Models and Use-cases for 6G <i>Chair: Rute C. Sofia, fortiss</i> <i>Challenges in the design of a holographic telepresence system – the current outcomes from the implementation of a use case scenario</i> , Vladimir Poulkov, Technical University of Sofia, Bulgaria <i>6G - An Ecosystem for Technology and Market Opportunities</i> , Martjin Kuipers, University Lusiada/ INESC-INOV, Portugal <i>Green Business Model 6G Services: A new perspective with Internet of Things connected Green Business Models empowered with Artificial Intelligence</i> , Per Valter, Aarhus University <i>Green Business Models and Use-cases for 6G</i> , Peter Lindgren, vice-president CGC, Aarhus University, Denmark
18:00-18:30	Hackathon Mentors' get-together	

**Table 2: CONASENSE Symposium Agenda, Day 2, 28th June 2022.**



Time (CET)	Tracks	
09:30-10:30	Hackathon session 4	<p><b>Technical session - Full paper session 2 ((20m plus 10m) Chair: Manel Khelifi, fortiss</b></p> <p>Catarinha Castanheira, Rita Almeida, Duarte Marques, Guilherme Firmino, Luis Elvas, Joao C. Ferreira, <i>How tourists move in a city.</i></p> <p>Susmita Paul, <i>Intrusion Detection System in IoT to Prevent Cyber-Attacks in Organization</i></p>
10:30-11:00	Coffee-break	
11:00-12:00	Hackathon Session 5	<p><b>Short paper session (20m plus 10m)</b></p> <p>Chair: Albena Mihovska, Aarhus University</p> <p>Savita Sthawarmarth, Eric Renault, <i>Stateless Paradigm for Resiliency in Beyond 5G Networks</i></p> <p>Nidhi, Bahram Khan, Albena Mihovska, Ramjee Prasad, Vladimir Poulkov, Fernando J Velez. <i>Dynamic Resource Block Allocation in Network Slicing</i></p>
12:00-12:20		<p>Invited Talks Track: 6G Wireless Challenges part II (15m plus 5m)</p> <p>Chair: Paulo Rufino, Aarhus University</p> <p><i>Green OFDM Transmission: An optimal Signal Design Approach</i>, Hoomayoun Nikookar, Defence Academy, Netherlands</p>
12:30-14:30	Lunch Break	
14:30-15:30		<p>Invited Talks Track 2: IoT Cooperation Opportunities towards Brazil (15m plus 5m)</p> <p>Chair: Paulo Rufino, Aarhus University</p> <p><a href="#"><i>Information Technology courses in large scale to supply national demands</i></a>, Rodolfo Azevedo,</p>

	President of UNIVESP, Brazil Sergio Paulo Gaulindo, President of Brasscom, Brazil <a href="#"><i>IoT in Brazil understanding challenges and opportunities</i></a> , Paulo José Spaccaquerche, President of ABINC (Brazilian Association of IoT)	
15:30-16:00	Coffee-break	
16:00-17:00	Hackathon pitching	Invited Talks Track 3: Advanced Visions Towards 6G Chair: Rute C. Sofia, fortiss  <i>Machine Learning Enables Radio Resource Utilization of uRLLC</i> , Kwan-Cheng Chen, University of Florida  <i>Reaching out to billions of client devices: Challenges and opportunities in very dense wireless networks</i> , Jean-Paul Linnartz, Signify, Philips Lighting, Netherlands  <i>Polyphase Channelizers in Modern Communication Systems</i> , Fred Harris, University of San Diego
17:00-17:30	Hackathon Juri meeting	Break
17:30-18:00	Awards Session, Closure and announcement of next event	

#### 4. AWARDS

The Symposium has provided the following awards:

- Best paper award has been provided by the general chairs to the paper entitled “Achievable Bandwidth of Reconfigurable Intelligent Surfaces (RIS) Concepts Towards 6G Communications”, by *Werner Mohr*.
- Best presentation award, sponsored by Future Internet MDPI in 200CH, has

been provided to the talk “*Machine Learning Enables Radio Resource Utilization of uRLLC*”, by Kwan-Cheng Chen, University of Florida

Hackathon awards, sponsored by several Hackathon sponsors: Infineon, H2020 EU-IoT and H2020 EFPF projects (rf. To Part VIII) were provided by the Hackathon jury to the following Hackathon teams:

1. First Place, *Sustainable Irrigation*, skills training project by Team 4, Cassio Dias, Felipe da Silva Braz, Gabriel Negri, Jose Angelo de Oliveira, UNIVESP, Brazil.
- Second place, *Anomaly Detection*, by Team 2: Sudhir Kshirsagar, University of Illinois at Urbana-Champaign, USA
  - Third place, *Green Backup*, by Team 3: Bruno Lowczy, UNIVESP, Brazil

## 5. SYMPOSIUM HIGHLIGHTS



*Figure 1: CONASENSE2022 Closure Session.*



*Figure 2: Closure session, Best Presentation Award.*



*Figure 3: Awards' ceremony.*

## **6. PROCEEDINGS STRUCTURE**

The proceedings count with 10 parts, that have been organized as follows:

- **Part I – Introduction.**
- **Part II - Scientific papers.** This part covers the peer-reviewed scientific papers accepted in the symposium. The papers have been reviewed by the TPC members. Each paper had a minimum of three individual reviews. The conference management and peer-reviewing process has been developed via EDAS<sup>4</sup>.
- **Part III – Keynote Speeches.** This part provides an overview (title, abstract, bio and photo) for the keynote speeches.
- **Part IV – Invited Talks, Advanced 6G Visions.** This part provides an overview (title, abstract, bio and photo) for the invited talks concerning the symposium session “advanced 6G visions”.
- **Part V – Invited Talks, 6G Business Models, Use-cases towards Sustainability.** This part provides an overview (title, abstract, bio and photo) for the invited talks concerning the symposium session “6G technical and business challenges”.
- **Part VI – Invited Talks, 6G IoT Cooperation Opportunities towards Brazil.** This part provides an overview (title, abstract, bio and photo) for the invited talks concerning the symposium session “6G IoT cooperation opportunities towards Brazil”.
- **Part VII, Next Generation IoT Project Talks.** Covers next generation IoT project presentations, providing an overview towards innovative and active projects in the field, under development in Europe, with focus on IoT and Edge computing.
- **Part VIII, EU-IoT/EFPP Hackathon Summary.** Covers the event main goals, development, and outcome.
- **Part IX – Acknowledgements to the Symposium Sponsors, Promoters and Committees.**

### Author Biographies



**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

<sup>4</sup> <https://edas.info>

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



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, 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.



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 corporate 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.