Panel proposal, coming from the proposal of the workshop "1st Workshop on Economics and Adoption of Millimeter Wave Technology in Future Networks" transformed into a Special Session Workshop.

Title of the panel
Economics and Adoption of Millimeter Wave Technology in Future Networks

1. **Names, addresses, and a short biography of the organizers**

- Valerio Frascolla, Intel, am Campeon 10-12, Neubiberg, Germany, valerio.frascolla@intel.com
- Claudio Paoloni, Lancaster University, Lancaster, UK, c.paoloni@lancaster.ac.uk

Dr. Valerio Frascolla is Director of Research and Innovation at Intel Deutschland. He obtained the MSc and the PhD in electrical engineering from Ancona University, Italy. Since 2006 in Germany, he has been working in different roles for Comneon, Infineon and finally Intel.

Dr. Frascolla has expertise in mobile platforms concept engineering, system architecture and requirements management, standard bodies attendance (3GPP) and innovation program management, using lean and agile methodologies. He won and run several panels, workshops, special sessions and special tracks at international conferences (VTC, WCNC, EuCAP, ISWCS, EuMW, EUCNC, EUSIPCO) and has been contributing in different roles to several national and EU-funded research projects (EASY-C, PMSE-xG, ADEL, MiWaveS, SPEED-5G, mmMAGIC, FUTEBOL, 5G-MiEdge, 5G Champion). His research interests are Multi-access Edge Computing and 5G systems design.

Claudio Paoloni is Head of Engineering Department at Lancaster University and Professor of Electronics. He is author of more than 180 articles in international journals and conference proceedings in the field of high frequency electronics, vacuum electronics and wireless communications. He holds four patents.

He is Coordinator of the Horizon 2020 project TWEETHER "Travelling wave tube based w-band wireless networks with high data rate distribution, spectrum & energy efficiency" and of the H2020 ULTRAWAVE "Ultra capacity wireless layer beyond 100 GHz based on millimeter wave Traveling Wave Tubes".

He served as Local Organization Chair of IEEE International Vacuum Electronic Conference 2009 (IVEC 2009) and as Conference Chair of UK/Europe China Millimeter Wave and THz Technology Workshop 2013 (UCMMT2013) held in Rome.

He is Chair of the IEEE Electron Devices Society Vacuum Devices Technical Committee.

He was Guest Editor for the Special Issue of Transaction on Electron Devices on Vacuum Electronics (June 2014). He was Chair of the Technical Programme Committee of the International Vacuum Electronics Conference 2017 (IVEC) held in London.

2. A brief description (1 page max) of the technical/industry issues that the panel will address, emphasizing its timeliness

Future rentable 5G network deployments are tightly linked to the affordable availability of a set of new technology enablers. Among the most important ones, Millimeter Wave (mmW) technology is for sure a pillar of future wireless networks, both for access and for backhaul connections.

Backhaul enhancements are desperately needed to cope with the management of a skyrocketing number of devices (order of several billions according to the IoT paradigm) that will connect to future smart networks and grids, within bigger and bigger (smart) city conglomerates. Backhaul advancements are also needed to handle the huge amount of additional data exchanged by new wireless moving sources, e.g. the booming self- and automated-driving vehicles, each one expected to create gigabyte of data per Km.

Access enhancements are needed as well, as the forthcoming 5G system, and its successors, will have to provide users at the same time with smooth, reliable and high bandwidth connections, leveraging on a set of different access technologies. Legacy system will be enhanced via aggressive carrier aggregation schemes, meanwhile new radio technologies will leverage the consistent additional new spectrum bands, mainly in the mmW regions, being allocated for wireless access.

As an example of deployment issues the ecosystem is going to face for backhaul, enhancements are needed w.r.t. several technologies related to affordable and capillary backhaul to feed tens or hundreds of small cells per kilometre square. But if the technology for high capacity small cells at sub-6GHz frequency is available and well tested, the backhaul part is still an open question. The cost of sites, in urban environment, risks to be predominant on the cost of equipment and maintenance. Solutions for low footprint, reduced environmental impact, easy installations, fiber free backhaul have to be sought to stimulate operators to move toward a full and affordable 5G deployment.

This panel focus the attention to aspects not yet touched when discussing a broad deployment of a new technology, bringing to the next level the mmW adoption, especially when one coniders to trespass the 100 GHz threshold.

The panel aims at extending and enlarging the ecosystem discussion to aspects mainly non related to pure technical topics, which are supposed to impact in a broad sense the economics of the whole society:
- Socio-cultural hurdles for a broad adoption of mmW links
- Business innovation needed for a smooth adoption of new technologies
- Return on Investment of mmW deployment for backhaul and access networks
- New technologies that synergize and facilitate the adoption of mmW technology
- Breakthrough innovations in the mmW domain
- WiGig, WiFi and cellular mmW access: potential synergies and ROI differences
- Standardization status of mmW deployment
- Regulatory aspects of mmW deployment
- New business opportunities for mmW adoptions with focus on SMEs

3. Names, addresses, and a short biography of proposed 3-5 panellists (it is highly recommended that the proposed panellists represent both academia and industry.)

The proposers of the panel approached several personal well-known-in-the-field contacts to cover different aspects of the societal and economic impact of mmW technology.

Research centers (CTTC, CEA), member of the Catalan government, Industry (Huawei, Intel) and academia panelists will provide interesting and different views to the issues in focus.

- **Christos Verikoukis, Fellow researcher at CTTC, ES**

  Dr. Christos Verikoukis got his Ph.D. from the Technical University of Catalonia (UPC) in 2000. He is currently a Fellow Researcher at CTTC (Head of the SMARTECH department) and an adjunct professor at Barcelona University (Electronics Department). He has published 116 journal papers and over 180 conference papers. He is also co-author in 3 books, 16 chapters in different books and he has filled 3 patents. He has supervised 12 Ph.D. Thesis (10 on going PhD Students) and 5 Post Doc researchers since 2004. Dr.Verikoukis has participated in more than 35 competitive projects (technical manager in 4 of them) while he has served as the Principal investigator in national projects in Greece and Spain. Dr.Verikoukis received the best paper award of the Communication QoS, Reliability &Modeling Symposium (CQRM) symposium in the IEEE ICC 2011 & ICC 2014 conference, of the Selected Areas in Communications Symposium in the IEEE GLOBECOM 2014 conference, of the EUCNC 2016 conference and the EURASIP 2013 Best Paper Award for the Journal on Advances in Signal Processing. He was the general Chair of the 17th, 18th, 19th and 22th IEEE CAMAD, and the TPC Co-Chair of the 15th IEEE International Conference on eHealth Networking, Application & Services (Healthcom) and the 7th IEEE Latincom Conference. He has also served as the symposium co-chair of the CQRM symposium in the IEEE ICC 2015, 2016 & 2018 and IEEE Globecom 2017 conference. He is currently the Chair of the IEEE ComSoc Technical Committee on Communication Systems Integration and Modeling (CSIM).

- **Mr. Xavier Flores , member of the Catalan Government Unit "Secretary of Telecommunications, Cybersecurity and Digital Society" local government in Barcelona, ES**

  Mr. Flores is a consultant of the public company CTTI (Telecommunications and Information Technologies of Catalonia, like myself) working at the Secretary of Telecommunications, Cybersecurity and Digital Society at the Government of Catalonia deploying and coordinating wireless projects area.

- **Emilio Calvanese Strinati, Head of wireless research and strategy at CEA-Leti, FR**

  Emilio Calvanese Strinati obtained his Masters degree in 2001 from the University of Rome "La Sapienza" and his Ph.D in Engineering Science in 2005 on Radio link control for improving the QoS of wireless packet transmission. He started working at Motorola Labs in Paris in 2002. Then in 2006 he joints the Centre for Atomic Energy (CEA) in Grenoble as a research engineer. Since 2004 Emilio Calvanese Strinati is giving lectures at ENST, the University of Rome "La Sapienza" and, INPG-Grenoble on physical and MAC layer topics. Its main research topics are information theory, advanced coding schemes, cooperative communications, scheduling, resources allocation and green ICT for wireless mobile networks. From 2007, he becomes a PhD supervisor. Emilio Calvanese Strinati has published around 70 papers in international conferences and books chapters, and is the main inventor or co-inventor of more than 20 patents. Currently he is Smart Devices & Telecommunications Strategy Program Director for International Research Programs in CEA.

- **Renato Lombardi, Huawei, Italy**

  Renato Lombardi is the Director of Huawei's Research Centre in Milan, Italy. He oversees the development of microwave technologies and the implementation of innovative mobile broadband backhauling networks across Europe. Mr. Lombardi graduated from the Politecnico di Milano. He previously led the Microwave Technical Sales Department for Siemens in Germany and was later appointed to Head of Research & Development. As a result of the Siemens and Nokia joint venture in 2006, Mr. Lombardi became a member of the integration team and later Head of Product Management of the Microwave Business Line. Renato joined Huawei in 2008 and was responsible for establishing the microwave division of R&D in Milan. In 2011, he was awarded the title of 'Fellow of Huawei'

- We intend to invite a second person (in addition to Prof. Paoloni) to represent the academia, and for that purpose we have contacted several people we know, also personally, that would perfectly play that role, e.g.
  - Maziar Nekovee, Professor at Sussex University, UK,
  - Mehrdad Dianati, Professor at University of Warwick, UK
  - Tommy Swenson, Professor at Chalmers, SE
  When we will be told about the acceptance of the panel, we will finalize and decide for one among them.

4. **Planned format of the panel, such as planned presenters, topics, etc.**
   - Welcome, introduction of the panellists and of the SSW (10 m)
   - First round of questions with focus on mmW opening new markets and creating new business cases (15 min)
   - Interaction with public and open questions (15 min)
   - Second round of questions with focus on hurdles for mmW deployment (15 min)
   - Interaction with public and open questions (15 min)
   - Wrap up (10 min)

The panel organizers assume a duration of 80 minutes, if less time is planned the panel can be easily shrink to 1h. If more time is given (say 2hours) it would be worth organizing a World-Café' of the duration of 30-45 minutes. The panel organizers already run a very successfully workshop containing a World-Café' session at EuMW 2016 in London, which was very much appreciated by the audience.

Notes on the World-Café':
- The World Café is an effective modality of information sharing for engaging participants in an interactive discussion, to exchange ideas and clarify concepts within a large group, leveraging on the "collective intelligence" in the room. Participants move among a series of small groups/tables where they continue the discussion in response to a set of key questions previously distributed, focusing on the specific goals of the workshop.
- The questions will be prepared beforehand by the World-Café' organizers and will be complemented by potential additional new questions generated during the panel. Each small group in which the audience is split will have a leader that will collect the common view of the group and will report to the overall audience in the final wrap up session.

- The final outcome of the World-Café' will be elaborated by the panel proposers and will be disseminated in the websites of the co-organizing funded projects.

5. Questions to be addressed to the panellists

In the following a superset of the possible questions is provided.

Together with the panellists, the panel organizers will focus on the most interesting subset of them.

- What are the main socio-economic hurdles for a broad deployment of mmW?
- Return on Investment of mmW deployment for backhaul and access networks
- Is mmW access really needed to make 5G deployment rentable?
- What are the most promising use cases for the first mmW deployment?
- What are the main cost factors that hinder mmW support, both from backhaul and for access?
- What are the still open main technology issues that might slow down mmW adoption?
- What are the new business cases that mmW deployment will add to the existing 5G ecosystem?
- What are the new business opportunities for mmW adoptions with focus on SMEs?
- Wireless networks are at microwave. Will mmW be the microwave of the future?
- Which are the implications if mmW will not be implemented, in the access, and in the backhaul?
- Are standards and regulatory bodies ready for finalizing the mmW deployment?