5G Communication with a Heterogeneous, Agile Mobile network in the Pyeongchang Winter Olympic competitioN

Grant agreement n. 723247

Deliverable D7.4
Status of standardization and dissemination and update of plan

Date of Delivery:	28 February 2018 (Contractual) 13 April 2018 (Actual)
Editor:	INTEL Deutschland GmbH – Germany
Associate Editors:	CEA
Authors:	Markus Mueck, Emilio Calvanese-Strinati, HyeonWoo Lee, Taesang Choi, Giuseppe Destino, Petri Uosukainen, Nicolas Chuberre, Antonio Clemente, Wouter Tavernier, Roc Maymo-Camps, Wilhelm Keusgen, Gosan Noh, Junhyeong Kim, Seok Ho Won, Heesang Chung, Ilgyu Kim
Dissemination Level:	PU
Security:	Public
Status:	Final
Version:	V1.0
File Name:	5GCHAMPION_D7.4_Final.pdf
Work Package:	WP7

	Title:	Deliverable D7.4: Status of standardization and dissemination and update of plan
	Date: 13-04-2018	**Status:** Final
	Security: PU	**Version:** V1.0

Abstract

In the first year of the 5G CHAMPION project, a first deliverable (D7.1) was issued addressing strategy and agreed actions in order to drive standardization, regulation and dissemination activities. A second deliverable (D7.2) was issued afterwards providing a status of respective actions after the first 9 months of the project. Following the organization of key events in top-notch conferences and in particular the participation of 5G CHAMPION to the Pyeongchang Winter Olympic Games with a Proof of Concept platform, this document provides a revised *Status of standardization and dissemination and update of plan.*

In this context, the current activities are analyzed and it is verified that the project is on track for meeting its objectives and obligations in the space of Standards Contributions, Regulation Contributions, Scientific Publications, Workshops/Tutorials and Interaction with Media.

Index terms

5G, 5G CHAMPION, Dissemination, Regulation, Standardization.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Contents

1 Introduction 5

2 Technology Directions and related Dissemination Strategy 6

3 Standards & Fora Strategy 7

3.1 3rd Generation Partnership Project (3GPP) 7

3.2 European Telecommunications Standards Institute (ETSI) 10

3.3 Institute of Electrical and Electronics Engineers (IEEE) 11

3.4 Internet Engineering Task Force (IETF) 12

3.5 Next Generation Mobile Networks (NGMN) 12

3.6 Small-cell Forum 13

3.7 ITU-T IMT-2020 Focus Group 13

4 Regulation Strategy 15

4.1 International Telecommunication Union (ITU) 15

4.2 European Conference of Postal and Telecommunications Administrations (CEPT) 15

4.3 Telecommunications Conformity Assessment and Market Surveillance Committee (TCAM) 15

5 Scientific Publication and Education Strategy 17

5.1 Scientific Conferences and Journals 17

5.2 Education – Teaching, Tutorials, etc. 17

6 Achieved Contributions 18

6.1 Standards Contributions Conference Publications 18

6.2 Scientific Conference Publications 20

6.3 Scientific Conference Presentation 22

6.4 Scientific Journal Publications 22

6.5 ETSI White Papers 23

6.6 Keynote Speeches 23

6.7 Invited Talks 23

6.8 Panels 23

6.9 Book Chapters 23

6.10 Books 24

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

6.11 Special Sessions 25
6.12 Workshops 28
6.13 Proof of Concept at K-ICT Square during the Winter Olympic Games 50
6.14 Press Releases, Press Interviews and articles, radio interview 70

7 5G CHAMPION Website 73
7.1 Website structure 73
7.2 Project 75
7.3 Results 75
7.4 Links 76
7.5 Contacts 76

8 Collaboration with other research projects 78

9 Cross Korean / European Collaboration Benefits 79

10 Corrective Actions 80

11 Conclusion 80

12 References 81

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

1 Introduction

In the second year of the project, the main effort of 5G CHAMPION was related to a successful participation to the Pyeongchang Winter Olympic Games with a Proof of Concept platform. This objective has been fully achieved and created tremendous visibility for the work of the consortium well beyond the expected level. A detailed report on the project's activities is available in sections 6.10 and 6.11 of the present document.

Despite of the strong focus on the Pyeongchang Winter Olympic Games preparations, the 5G CHAMPION consortium continued to invest substantial effort to create visibility and impact of the work through actions in Standards Bodies, the organization of Workshops and Special Sessions and the submission of scientific papers to key conferences and journals as well as co-authorship of a book chapter.

To further address the visibility of the project, 5G CHAMPION has successfully co-organized a highly visible and successful Workshop entitled "**INTERNATIONAL WORKSHOP ON 5G TEST-BEDS & TRIALS - LEARNINGS FROM IMPLEMENTING 5G (5G-TESTBED 2017)**" at the "IEEE Global Communications Conference (GLOBECOM)". Another exception example is the organization of the Industry Track on "5G and Wireless" at the **2017** IEEE 85th **Vehicular Technology Conference**: **VTC2017-Spring** 4–7 June **2017 in Sydney, Australia**. Also, 5G CHAMPION co-organized the ETSI supported Workshop on "*Multi-RAT and Network/Terminal Function Virtualization*" on 23rd February 2017 at Orange Gardens, Châtillon, France which was co-located with the ETSI RRS standardization meeting and with active participation by 5G CHAMPION leaders.

Furthermore, 5G CHAMPION partners substantially impacted standards and regulation activities. To give a few examples, ETSI RRS work progressed substantially in the field of Software Reconfiguration and active participation to TCAM SDR Subgroup activities in the same field supported the overall European Efforts in this space.

Overall, 5G CHAMPION has been highly active and achieved substantial success in terms of acceptance of a Workshop at one of the very best conferences in the field (such as IEEE Globecom and others), scientific publications, session organization, etc.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

2 Technology Directions and related Dissemination Strategy

Table 1 summarizes the 5G CHAMPION strategy for contribution to standards bodies and regulation bodies, to influence and educe the scientific community and to interact with media representatives in order to maximize the impact and visibility of the project. The overall plan is consistent with the initial project intentions and no changes were required during the lifetime of the project. The key technological directions of the 5G CHAMPION project are identified and mapped with respect to specific actions that are candidates over the lifetime of the project.

Table 1: Dissemination Strategy.

	Standards Contributions	**Regulation Contributions**	**Scientific Publications**	**Workshops/ Tutorials/ Tracks**	**Interaction with Media**
complex 5G set-up			Conference/ Journal contributions		TV interview, press releases
mmWave high capacity backhaul in 24-28 GHz using novel antenna arrays	IEEE & 3GPP	CEPT	Conference/ Journal contributions	Educational events	
virtualization through NFV/SDN in a secure backhaul architecture as well as a novel SDN-based IPsec tunnel architecture	ETSI		Conference/ Journal contributions	Educational events	
novel accurate positioning solutions (<1m accuracy) using mmWave combined with GNSS PPP	ETSI		Conference/ Journal contributions	Educational events	
direct UL/DL communication between satellites and 5G User Equipment			Conference/ Journal contributions	Educational events	
Software Reconfiguration	ETSI	TCAM SDR Working Group	Conference/ Journal contributions	Educational events	

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

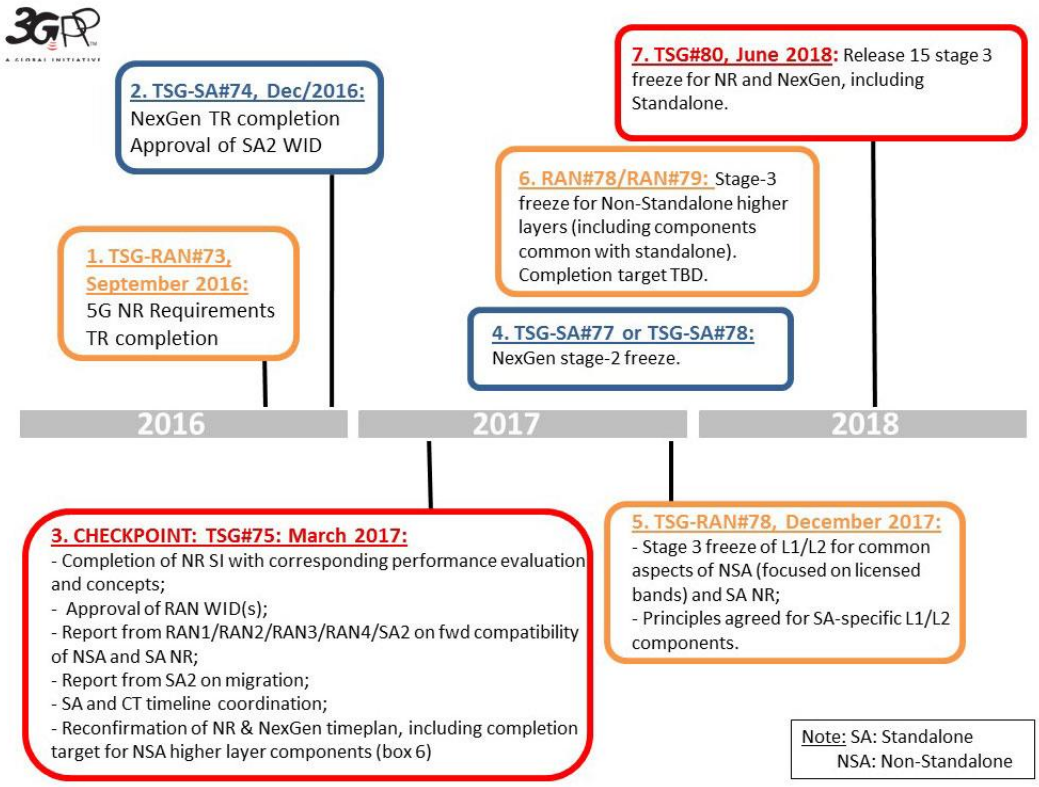
3 Standards & Fora Strategy

It is a key objective of the 5G CHAMPION consortium to influence most relevant standards and fora with the object to drive thought leadership and the 5G technology evolution across the entire eco-system. Similar to the upper planning, the overall schedule is considered to be well thought and relevant. This section outlines the consortium strategy for the most relevant bodies that are identified.

3.1 3rd Generation Partnership Project (3GPP)

The 3rd Generation Partnership Project (3GPP) is identified to be one of the key bodies for the definition of future 5G technology. The checkpoints to be met by the 5G CHAMPION consortium with respect to the 3GPP planning are indicated in Table 2.

Table 2: 3GPP 5G activities during 5G CHAMPION project (http://www.3gpp.org/images/articleimages/5g_timeline.jpg).



In order to cope with the 5G requirements, 3GPP initiated studies on use cases and new radio (NR) technologies for the 5G network in a 3GPP RAN Workshop held in Phoenix, AZ in Sep. 2015 [1]. At the workshop, there was a consensus that the new radio will cover three high level use cases:

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

- Enhanced Mobile Broadband;
- Massive Machine Type Communications;
- Ultra-reliable and Low Latency Communications.

3GPP has started the 5G standardization effort for developing the “New Radio” access technology in TSG RAN and the “Next Generation” core network in TSG SA. The New Radio will be non-backward compatible to the legacy LTE-Advanced technology, and will meet all the 5G requirements and use cases defined by the IMT-2020 [2]. The Next Generation core network will define new architecture to support diverse use cases and scenarios, and enable tight multi-RAT interworking. There are also under planning Standalone and Non-Standalone NR operations, where the latter one would have LTE as control plane anchor.

The study item (SI) on New Radio access technology approved in Mar. 2016 will cover initial evaluation of various new physical-layer techniques such as modulation, waveform, multiple access, channel coding, and MIMO for difference deployment scenarios [3]. Among those various 5G deployment scenarios, the high speed scenario focuses on providing continuous coverage along high speed train tracks using either 4 or 30 GHz frequency band [2]. The access link to the UE in the train is directly established for the 4 GHz band. For the 30 GHz band, the access link for the UE is established through a relay which is deployed outside of the train. During the project time frame, new Study and Work Items could be expected, especially one could target for items regarding physical layer measurements and procedures related to beamsteering and beamforming.

Indeed, 5G CHAMPION partners have already been contributing to the scenario and evaluation assumption descriptions for the 5G NR high speed scenario in 3GPP RAN1#84bis, RAN1#85, and RAN1#86 meetings. In addition, there have been partner contributions on the study of new radio technology standardization especially on the numerology, frame structure, channel structure, and MIMO-related topics. 5G CHAMPION partners are thus recognized by the community as key contributors and thought leaders and are perfectly positioned to further drive the technology evolution. 5G CHAMPION will keep seeking worldwide for solid partnership and support for better dissemination and great promotion of 5G CHAMPION standardization activities in 3GPP standard body by actively participating technical discussions and jointly generating contributions.

Hence, the technical solutions developed during the 5G CHAMPION project will significantly impact on the development of the NR access technology SI, especially on high speed scenario and beamforming related items.

The relevant 3GPP working groups for possible contribution from 5GCHAMPION are:

- SA1: Service aspects;
- SA2 : Architecture aspects;
- SA3: Security aspects;
- SA5 : Network management aspects;
- RAN1: Radio Layer 1;
- RAN2: Radio Layer 2 and Radio Layer 3.

In the framework of 5G CHAMPION, we have furthermore set the objective to determine the feasibility of **seamlessly integrating satellite communication in the 5G network infrastructure** to meet selected 5G Key Performance Indicators. In particular to define the technical enablers and configurations allowing operation of a 5G User Equipment via satellite for global service continuity beyond terrestrial network coverage.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

In terms of standardisation activity, this translates into the following ambitions:

- Ensure that the 3GPP Next Gen architecture will support satellite Radio Access Network as any other 3GPP defined RAN technologies;
- Define a future Uu interface which is satellite "friendly" for example in terms of latency and Doppler characteristics associated to the proposed space segment (whether NGSO or GSO);
- Define the high level architecture of the Satellite Radio Access Network.

Similar to the upper statements, 5G CHAMPION consortium partners have been actively contributing to 3GPP standardization in the field of satellite communication and have thus created a fruitful basis for future work to be performed in the framework of the consortium. Examples of specific past and planned future contributions are indicated in Table 3. The 5G CHAMPION consortium has been able to build on this basis and benefit from an established channel into the community which was established in an early phase of the project.

Table 3: Examples of contributions to 3GPP by 5G CHAMPION consortium members.

Reference	Document Title	Impact	Status
3GPP TR 22.891	Feasibility Study on New Services and Markets Technology Enablers; Stage 1 (Release 14)	Adding a use case "5G Connectivity Using Satellites" (clause 5.72)	Done in SA1
3GPP TS 22.261	Service requirements for next generation new services and markets [TBD]; Stage 1 (Release 15)	Add a new basic capability "Satellite Access" (Clause 6.3.2.3): *The 3GPP system shall be able to provide services using satellite access.* *The 3GPP system shall support service continuity between land based and satellite based access networks owned by the same operator or by an agreement between operators*	SA1#75 decision (August 2016)
3GPP TR 38.913	Study on Scenarios and Requirements for Next Generation Access Technologies; (Release 14)	Adding of a new deployment scenario "Satellite extension to Terrestrial" (Clause 6.1.12)	RAN#72 decision (June 2016)
3GPP TR 23.799	Study on Architecture for Next Generation System (Release 14)	Add an architectural requirement (Clause 4.1): *Satellite radio access network (3GPP and non 3GPP defined) shall be supported (for phase 2)*	SA2#116bis decision (September 2016

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

		Add a new key issue 22: Support of "5G connectivity via satellite" use case	
3GPP TR 38.912	Study on New Radio Access Technology (Release 14)	Add relevant information and parameters that would be needed to model a NextGen (5G) system with satellite access in order to evaluate the performance of 5G technologies over such a system	To be submitted in future RAN1 meetings

As a post-project follow-up, 5GCHAMPION consortium members will furthermore prepare inputs for several 3GPP SA and RAN WG preparation meetings for the possible contributions for actual SA and RAN WG Study or Work items, especially related to mmWave beamforming and/or steering and Satellite Technology. Gained hands-on experiences from 5GCHAMPION demonstration will be exploited internally for the future product releases in the 5G CHAMPION partner organizations.

3.2 European Telecommunications Standards Institute (ETSI)

ETSI is an independent, not-for-profit organization which provides a platform for all those who need to be involved in the standardization of telecommunications: ETSI creates standards via consensus and through the direct input of our members.

ETSI is working on key technologies which enable the future 5G Eco-System, including for example Mobile Edge Computing, Network Function Virtualization, Security solutions, Reconfigurable Radio Systems, Satellite Systems, etc.

In the context of the 5G CHAMPION project, the focus of the ETSI work was on the ETSI Satellite Earth Stations and Systems (ETSI TC SES) and ETSI Reconfigurable Radio Committee (ETSI TC RRS). The latter is chaired by Dr. Markus Mueck of INTEL. As a key enabler of future 5G systems, TC RRS develops solutions for software reconfigurability in alignment to article 3(3)(i) and 4 of the novel Radio Equipment Directive (RED) and thus supports related European Commission activities in the TCAM SDR (Software Defined Radio) WG (Working Group) which is currently in an early phase – the timing is thus perfect for 5G CHAMPION to influence the corresponding work of TC RRS and TCAM.

Furthermore, ETSI RRS recently started to develop a Radio Interface Engine. The committee is currently working on a corresponding Feasibility Study. With context information management being a key enabler in the future 5G eco-system, 5G CHAMPION has been contributing to this activity with submissions on context learning approaches.

In the field of virtualization, contributions were submitted to standards bodies in the field of MANO (Management and Orchestration). To give a specific example, 5G CHAMPION partner KT has tested a variety of 5G VNF solutions from global vendors. From the view point of service provider, KT has contributed to the definition of the requirements for 5G MANO.

In the context of Satellite systems handled in ETSI TC SES, a new work item referenced DTR/SES-00405 has been initiated. Entitled "Satellite Earth Stations and Systems (SES); Seamless integration of satellite and/or HAPS (High Altitude Platform Station) systems into 5G system;", it aims at identifying 5G systems architecture integrating satellite and/or HAPS

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

systems (communication and/or navigation) for relevant use cases. Contributions have been made in relation to relevant satellite (communication and/or navigation) technologies.

3.3 Institute of Electrical and Electronics Engineers (IEEE)

Within IEEE standards activities, the center of interest for 5G CHAMPION lies in the IEEE 802 family. It relates to IEEE standards, which deals with local area networks (LANs) and metropolitan area networks (MANs) and is maintained by the IEEE 802 LAN/MAN Standards Committee (LMSC). In the IEEE 802, there are several individual Working Groups (WGs) providing the focus for each area. Among them, ETRI has been participating in the IEEE 802.11, IEEE 802.15 and IEEE 802.16 WGs, and brief descriptions of which are given as follows:

- IEEE 802.11 WG: Wireless LAN WG developing a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands
- IEEE 802.15 WG: Wireless Personal Area Network (WPAN) WG focusing on the development of consensus standards for Personal Area Networks (PANs) or short distance wireless networks
- IEEE 802.16 WG: Broadband Wireless Access WG currently focusing on developing standards and recommended practices to support the development and deployment of broadband Wireless Metropolitan Area Networks

Recently, in order to offer a better mobile Internet service in high-speed environments, IEEE 802.15, a working group (WG) of the IEEE 802 standards committee, created an Interest Group High Rate Rail Communications (IG HRRC) in November 2014 [4], based on the proposal made by 5G CHAMPION partners [5]. The main objective of this group is to focus on standardization of a mobile wireless backhaul for user groups located in the fast moving vehicles, especially for high-speed railway. Before the proposal was approved by IEEE 802.15 WG, the proposal was initially presented in the IEEE 802.16 WGs. However due to lack of participants in the 16 WG, 5G CHAMPION partners realized that it is difficult to keep standardization activities in the group. That was the main reason why 5G CHAMPION partners and delegates from the 16 WG finally decided to propose it to the IEEE 802.15 WG. The IEEE 802.15 IG HRRC currently chaired by ETRI holds a joint meeting with the 802.16 WG. The group usually organizes the meeting during IEEE 802 plenary session, so there will be 3 meetings of IG HRRC in March, July and November each year. The main participants of the group include ETRI, IEEE 802.16 WG delegates as well as Beijing Jiaotong University (BJTU), China. They have already had 9 meetings so far and during the meetings, a wide range of frequency bands including millimeter-wave have been studied as a candidate for the broadband wireless backhaul links for the fast moving vehicles through ray-tracing channel modeling and system demonstration, showing its infinite feasibility and potentiality [6][7][8]. Besides, various technical challenges and key technologies have been discussed as well [9].

Recently, our main concern is considering the transition from the IG to Study Group (SG) when enough interest has been identified. Since the group is completely led by ETRI, as long as both Korean and European consortiums could be able to collaborate on driving on the IEEE 802.15 IG HRRC standardization activities, there would be a high possibility of the transition to the SG, even to Task Group (TG) that is responsible for developing the specification. At the stage of either SG or TG, it is would be a great chance for both Korean and European partners to closely work on specification development and include their key technologies to the specification, which will not only highly be beneficial to the project, but also create a long lasting synergy for 5G research, innovation and commercialization. Therefore, the main strategies for the IEEE

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

802.15 IG HRRC standardization activities are to invigorate the group with collaboration from European and other Korean partners, which will finally paved the way for transition to SG and TG. As a first step, 5G CHAMPION PARTNERS will distribute the call for participation document in order to give a comprehensive understanding of the IG status and to encourage European partners and other companies to participate in upcoming meetings scheduled as follows:

- IEEE 802 plenary session on November 6-11, 2016 (Grand Hyatt San Antonio, San Antonio, TX, USA);
- IEEE 802 plenary session on March 12-17, 2017 (Hyatt Regency Vancouver, 802 Plenary Session);
- IEEE 802 plenary session on July 9-14, 2017 (Estrel Hotel and Convention Center, Berlin, Germany);
- IEEE 802 plenary session on November 5-10, 2017 (Caribe Hotel and Convention Center, Orlando, FL, USA).

3.4 Internet Engineering Task Force (IETF)

The Internet Engineering Task Force (IETF) is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.

5GCHAMPION has been monitoring the IETF SFC working group, IRTF SDNRG and IRTF NFVRG as well as Operation & Maintenance activities (Transport Network Control and Management related solutions) which are expected to play a key role in future 5G systems.

The IETF Distributed Mobility Management (DMM) working group specifies solutions for IP networks so that traffic between mobile and correspondent nodes can take an optimal route. 5GCAHMPION is actively participating in this group to distribute and place IP anchoring functions over the network to address issues stemming from conventional centralized single anchoring architecture.

The Soongsil University in Team-GIST has proposed solutions about deployment models and anchoring in IETF DMM WG.

- Deployment models for distributed mobility management will provide available deployment models for distributed mobility management networks, consisted of mobility management functions: anchoring function, location management, and forwarding management functions.
- Enhanced mobility anchoring in distributed mobility management aims to identify what should be enhanced for mobility anchoring and to provide possible approaches for enhanced mobility anchoring over deployment models.

3.5 Next Generation Mobile Networks (NGMN)

The Next Generation Mobile Networks NGMN Alliance is an open forum to evaluate candidate technologies to develop a common view of solutions for the next generation of wireless networks. It was founded by major telecommunication corporates in 2006, and it is regarded as an association of mobile operators, vendors, manufacturers, and research institutes.

The main objective of NGMN is to provide a platform that facilitates the successful commercial launch of future mobile broadband technologies, thereafter, providing affordable broadband mobile services to the end-user. In more details the objectives are:

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

- expansion and evolution of mobile broad band with an especial focus on 5G
- setting clear goals and functionalities as well as basic requirements for deployment scenarios
- recommendations to equipment providers and standardization bodies, leading to cost-effective network evolution
- to facilitate the information flow among the industry partners on critical and immediate concerns and to share experiences, and
- stating and dealing with the spectrum necessities and supporting the foundation of a transparent and clear IPR regime.

The NGMN envisions 5G is an end-to-end platform that enables a fully mobile and connected world, which empowers value creation towards customers and partners.

5G CHAMPION partners were involved in NGMN activities on various levels, which are attending the internal meetings and organized public events, contributing to technical documents and white papers and showcasing technology at the NGMN exhibition. Current activities involve the attendance of the 5G Forum meeting in April and discussing the current status of 5G trials with partners, as well as the participation on the NGMN industry conference & exhibition in November. There will be a booth from Fraunhofer HHI among others, where the final results of 5GCHAMPION could be displayed.

3.6 Small-cell Forum

The Small-Cell Forum works to ensure the adoption of industry wide standards, a positive regulatory environment, common architectures and interoperability.

Small-cell network management will be a key component of future 5G systems. The activities in the forum are as in the following.

1. Standardization, regulation & interoperability: ensuring the adoption of industry wide standards, an effective regulatory structure, common architectures and interoperability.

2. Marketing, promotion & business case: promoting the value & potential of small cells across the industry and to press, analysts, regulators, and targeted interest groups and standards bodies.

5G CHAMPION partners have been reaching out to the small-cell forum for dissemination and standardization purposes.

3.7 ITU-T IMT-2020 Focus Group

In early 2012, ITU embarked on a programme on “International Mobile Telecommunications (IMT) for 2020 and beyond”, setting the stage for IMT-2020 research, development, and marketing activities around the world. ITU-T Study Group 13 is mandated to study the requirements, architectures, capabilities and mechanisms of future networks including mobile. There is a desire to establish an open platform for experts representing ITU members and non-members in order to gain deep understanding of the IMT-2020 agenda, from non-radio transmission related network perspective. Recognizing activities being undertaken around the world, it is necessary to identify the specific areas for ITU-T Study Group 13, in order for ITU-T Study Group 13 to make constructive contributions to IMT-2020, together with other standardization bodies. The outcomes of this Focus Group will consist of continuing to define the visions and objectives related to IMT-2020, in order to help progress and promote

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

standardization by ITU-T Study Group 13 and other SDOs on IMT-2020. With regard to specific tasks, the following areas have been identified as areas of study/activity:

- Explore demonstrations or prototyping with other groups, notably the open source community - this task investigates demonstration or prototyping various aspects of IMT-2020 networks;
- Enhance aspects related to Networks softwarization and ICN.

This work refines aspects related to network softwarization, building on, or refining the output from the first Focus Group. Softwarization of the network has been studied in academia, this work will help identify issues that may exist in translating this from theory to application. It also investigates the use of ICN approaches within the IMT-2020 goals. There is much academic and industrial work around ICN in the 5G context at this time. We will suggest experiments aimed at guiding the broader community in next steps that can help bridge the gap between the research and practical use of ICN in IMT-2020. The output of this work will be a document that describes those experiments and provides recommendations on how ICN can be adopted in IMT-2020.

- Continue to refine and develop the IMT-2020 network architecture;

The work produces base material for the development of draft Recommendations to be approved by SG13, based on the architecture work produced during the identification of standardization gaps as reported in the report of FG IMT-2020. The output of this work will be a document that describes in depth the network architecture needed to address identified architectural gaps.

- Continue the study of fixed mobile convergence aspects;

Recognizing that a connected society in the years beyond 2020 will need to accommodate a similar user experience for end-users regardless of whether they are on the move or stationary, the new 5G standards aim at maintaining high quality service at high mobility, enabling the successful deployment of applications on a moving platform, such as in cars or high-speed trains.

- Continue to study network slicing for the front haul/back haul network;

This work studies and defines the use of network slicing in the context of control of the front haul/back haul network. Note, that it is expected that the transport and equipment aspects of front haul and back haul networks will be performed by Study Group 15. The work of the Focus Group is limited to dealing only with control aspects.

- Continue to define new traffic models and associated QoS and OAM aspects applicable to IMT-2020 network

IMT-2020 is seen as enabling new applications not limited to requiring high bandwidth, low latency and diverse service requirements. This item will define new network management aspects for the IMT-2020 network, including any QoS or OAM aspects. The work will produce base material for the development of draft Recommendations to be approved by SG13.

Based on the objectives of this group, 5G CHAMPION has been contributing to items 1, 2, 3, and 6. Among these items, a phased approach was applied starting from architecture to demonstration & prototyping contributions. Especially, due to the objective of our project, demonstration & prototyping related contribution has had higher priority than other working items.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

4 Regulation Strategy

Government administrations and regulation bodies are currently in the process of defining the regulation framework of future 5G systems. 5G CHAMPION has identified key opportunities in this field and selectively provided contribution with the objective to maximize the project impact.

4.1 International Telecommunication Union (ITU)

ITU is a specialized agency of the United Nations (UN) that is responsible for issues that concern information and communication technologies.

In WP5D of ITU-R, 13 technical performance requirements, deployment scenarios, evaluation methodologies and circular letter for IMT-2020 have been intensively discussed and were finalized in June 2017. Since Dec. 2017, WP5D is receiving IMT-2020 proposals until June 2019.

In addition, spectrum requirements for IMT-2020, network model for sharing study with other services e.g. satellite, are under discussion in WP5D.

4.2 European Conference of Postal and Telecommunications Administrations (CEPT)

5G CHAMPION had identified an opportunity to address regulation decisions on mmWave Communication for ITS (Intelligent Transport Systems). Through suitable suggestions in ETSI ITS and ETSI BRAN, as well as CEPT, currently the re-allocation of the 63-64 GHz band in Europe is in progress. The final objective is to move this band to match with WiGig Channel 4 or 3 such that off-the-shelf equipment may be used for ITS applications.

4.3 Telecommunications Conformity Assessment and Market Surveillance Committee (TCAM)

The Telecommunications Conformity Assessment and Market Surveillance Committee (TCAM) is an advisory and regulatory committee that assist the European Commission in matters regarding conformity assessment and market surveillance. TCAM had created a Software Defined Radio (SDR) Working Group (WG) in order to discuss the implementation of software reconfiguration related articles 3(3)(i) and 4 of the Radio Equipment Directive (RED).

5G CHAMPION has influenced the corresponding discussions through its activities in ETSI TC RRS (Reconfigurable Radio Systems) on technology solutions in the field of software reconfigurations.

In particular, 5G CHAMPION partners have contributed to the below mentioned TCAM SDR Subgroup report (see overview page of the current draft below) and have submitted their candidature to the EC Expert Group on Reconfigurable Radio Systems.

This activity has finally lead to the creation of the EC Expert Group RRS (Reconfigurable Radio Systems), in which the consortium member Dr. Markus Mueck (INTEL) has been designated to be the official ETSI representative. Through the ETSI TC RRS committee, inputs have been orchestrated to this group.

In this context, 5G CHAMPION partners have substantially influenced Europe's discussions on Software Reconfiguration.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Ref TCAM WG(10)20, SDRsubgroup interim report

TABLE OF CONTENTS

1 INTRODUCTION 2

2 DEFINITION OF A COMBINATION OF RADIO EQUIPMENT AND SOFTWARE 4
2.1 Specific radio equipment definition 4
2.2 Classes and categories for A COMBINATION OF RADIO EQUIPMENT AND SOFTWARE 4
2.3 Open issues 5

3 PRACTICAL IMPLEMENTATION MEASURES 6
3.1 Identifying the responsible party 6
3.2 Mechanisms to ensure compliance 6
3.3 SPECIFIC OBLIGATIONS of the manufacturer 7
3.4 Technological aspects 8

4 CONCLUSIONS 9

ANNEX 1: TEXTS OF REFERENCE FOR THE SUB-WORKING GROUP 10

ANNEX 2: TERMS OF REFERENCE 12

ANNEX 3: LIST OF DOCUMENTS AND CONTRIBUTIONS 15

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

5 Scientific Publication and Education Strategy

5.1 Scientific Conferences and Journals

The 5GCHAMPION partners have generated a highly visible and impacting footprint of their research outcomes in the scientific community. The main KPI that the project is using to measure this impact are in the form of publications in journals and at best-in-class conferences, as well as through speeches, tutorials, etc.

The consortium has exceeded the initial plans of contributions to best-in-class conference papers and journals (initial target: 20 conference papers and highly visible journal publications).

5.2 Education – Teaching, Tutorials, etc.

Education and teaching has been an important target for the exploitation of 5G CHAMPION results. It is indeed of key importance to feed latest findings and progress beyond the state of the art into University programs in order to ensure teaching at the edge of the technology:

5G CHAMPION strategic directions have been implemented by consortium partner Universities into selected University programs. In particular master and high-quality PhD programs have been influenced by the 5G CHAMPION activities.

To give a specific example, 5G CHAMPION has established new teaching directions in the field of Software-Defined Networks, Service Orchestration and Programmable networks & service. The 5G CHAMPION related research in these fields is fully embedded, for example, in the different Flemish universities allowing a very efficient exploitation of knowledge by embedding this in the more advanced University courses. In this specific project, the research group IBCN (Internet Based Communication Networks and Services), part of Ghent University, was involved which has assimilated 5G CHAMPION results into advanced master courses on Future Internet and related high-quality PhD.

As part of the 5G CHAMPION platform development, selected contributions are open-sourced and as such available for the European research community. This involves 5G CHAMPION developments in orchestration components, monitoring components, and/or network functions.

Tutorials are useful tools to disseminate and share project results among a professional community. Typically, tutorials were organized in conjunction with major scientific conferences. Participants included academic, governmental and industrial representatives who wish to acquire knowledge in new field.

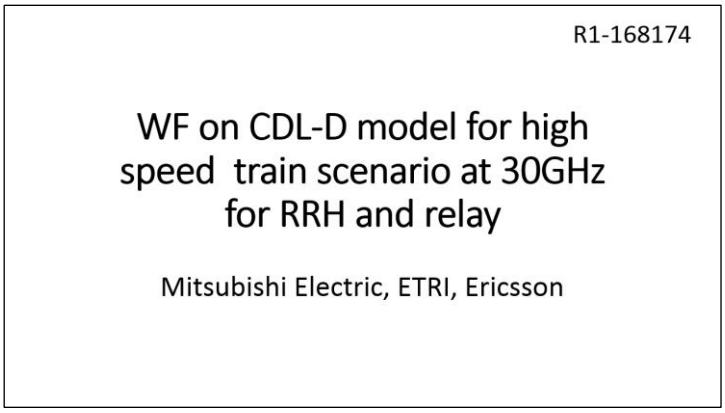
5G CHAMPION has thus not only promoted the project and its results through press releases and joint workshops, but also tutorials are a key outcome to address many of the major industrial stakeholders.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

6 Achieved Contributions

6.1 Standards Contributions Conference Publications

- **R1-168174, "WF on CDL-D model for high speed train scenario at 30GHz for RRH and relay"**: Agreed at 3GPP RAN1#86 meeting in Aug. 2016.
  - Source: Mitsubishi Electric, ETRI, Ericsson
  - Agreements were made on the angular spread-related parameters specific to high speed train scenario
  - The first page of the contribution is illustrated below:

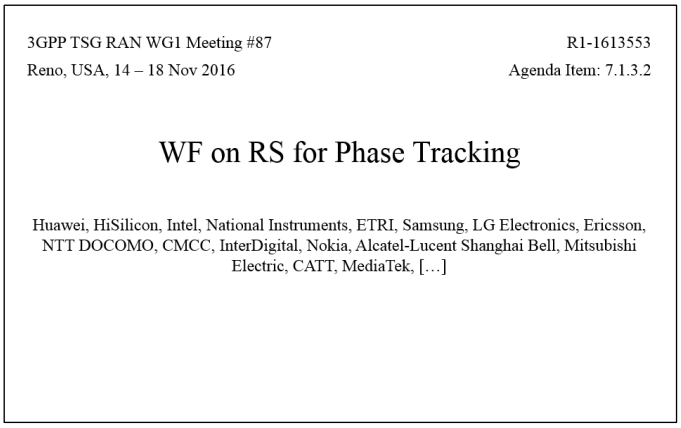

R1-168174

WF on CDL-D model for high speed train scenario at 30GHz for RRH and relay

Mitsubishi Electric, ETRI, Ericsson

Figure 1: Contribution to 3GPP RAN1#86/

- **R1-1613553, "WF on RS for Phase Tracking"**: Agreed at 3GPP RAN1#87 meeting in Nov. 2016.
  - Source: Huawei, HiSilicon, Intel, National Instruments, ETRI, Samsung, LG Electronics, Ericsson, NTT DOCOMO, CMCC, InterDigital, Nokia, Alcatel-Lucent Shanghai Bell, Mitsubishi Electric, CATT, MediaTek
  - Agreements were made on the design of phase tracking reference signal especially for mmWave-based transmission
  - The first page of the contribution is illustrated below:


3GPP TSG RAN WG1 Meeting #87 R1-1613553

Reno, USA, 14 – 18 Nov 2016 Agenda Item: 7.1.3.2

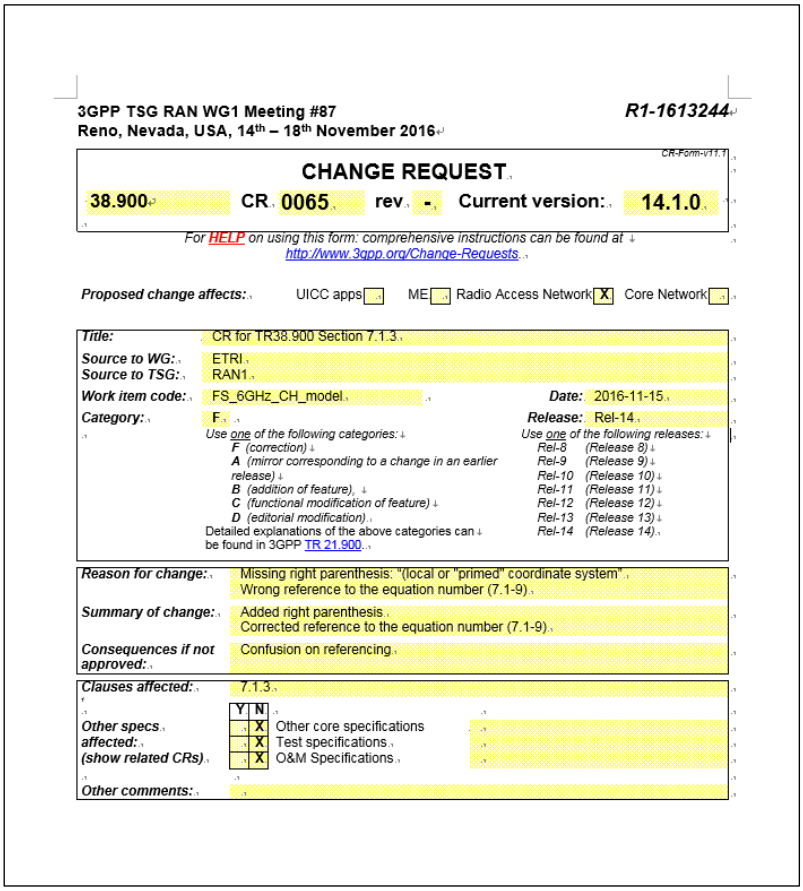
WF on RS for Phase Tracking

Huawei, HiSilicon, Intel, National Instruments, ETRI, Samsung, LG Electronics, Ericsson, NTT DOCOMO, CMCC, InterDigital, Nokia, Alcatel-Lucent Shanghai Bell, Mitsubishi Electric, CATT, MediaTek, […]

Figure 2: Contribution to 3GPP RAN1#87.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

- **R1-1613244, "CR for TR38.900 Section 7.1.3"**: Agreed at 3GPP RAN1#87 meeting in Nov. 2016.
  - Source: ETRI
  - Agreements were made on the correction of Section 7.1.3
  - The first page of the contribution is illustrated below:



3GPP TSG RAN WG1 Meeting #87 R1-1613244
Reno, Nevada, USA, 14th – 18th November 2016

CR-Form-v11.1

CHANGE REQUEST

38.900 CR 0065 rev - Current version: 14.1.0

For HELP on using this form: comprehensive instructions can be found at http://www.3gpp.org/Change-Requests

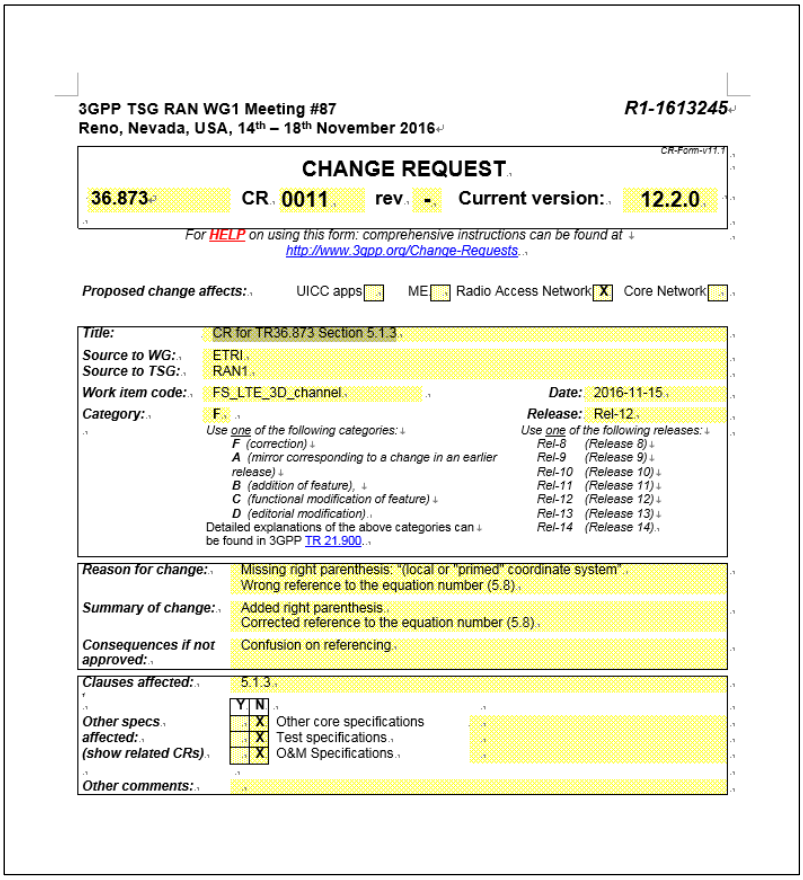
Proposed change affects: UICC apps [ ] ME [ ] Radio Access Network [X] Core Network [ ]

Title:	CR for TR38.900 Section 7.1.3
Source to WG:	ETRI
Source to TSG:	RAN1
Work item code:	FS_6GHz_CH_model — Date: 2016-11-15
Category:	F — Release: Rel-14
	Use one of the following categories: F (correction), A (mirror corresponding to a change in an earlier release), B (addition of feature), C (functional modification of feature), D (editorial modification). Detailed explanations of the above categories can be found in 3GPP TR 21.900. — Use one of the following releases: Rel-8 (Release 8), Rel-9 (Release 9), Rel-10 (Release 10), Rel-11 (Release 11), Rel-12 (Release 12), Rel-13 (Release 13), Rel-14 (Release 14)
Reason for change:	Missing right parenthesis: "(local or "primed" coordinate system". Wrong reference to the equation number (7.1-9)
Summary of change:	Added right parenthesis. Corrected reference to the equation number (7.1-9)
Consequences if not approved:	Confusion on referencing
Clauses affected:	7.1.3
Other specs affected: (show related CRs)	Y N: X Other core specifications; X Test specifications; X O&M Specifications
Other comments:	

Figure 3: Contribution to 3GPP RAN1#87.

- **R1-1613245, "CR for TR36.873 Section 5.1.3"**: Agreed at 3GPP RAN1#87 meeting in Nov. 2016.
  - Source: ETRI
  - Agreements were made on the correction of Section 5.1.3
  - The first page of the contribution is illustrated below:

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.



3GPP TSG RAN WG1 Meeting #87 R1-1613245
Reno, Nevada, USA, 14th – 18th November 2016

CR-Form-v11.1

CHANGE REQUEST

36.873 CR 0011 rev - Current version: 12.2.0

For HELP on using this form: comprehensive instructions can be found at http://www.3gpp.org/Change-Requests.

Proposed change affects: UICC apps [ ] ME [ ] Radio Access Network [X] Core Network [ ]

Title:	CR for TR36.873 Section 5.1.3
Source to WG:	ETRI
Source to TSG:	RAN1
Work item code:	FS_LTE_3D_channel — Date: 2016-11-15
Category:	F — Release: Rel-12
	Use one of the following categories: F (correction), A (mirror corresponding to a change in an earlier release), B (addition of feature), C (functional modification of feature), D (editorial modification). Detailed explanations of the above categories can be found in 3GPP TR 21.900. — Use one of the following releases: Rel-8 (Release 8), Rel-9 (Release 9), Rel-10 (Release 10), Rel-11 (Release 11), Rel-12 (Release 12), Rel-13 (Release 13), Rel-14 (Release 14)
Reason for change:	Missing right parenthesis: "(local or "primed" coordinate system". Wrong reference to the equation number (5.8)
Summary of change:	Added right parenthesis. Corrected reference to the equation number (5.8)
Consequences if not approved:	Confusion on referencing
Clauses affected:	5.1.3

Other specs affected: (show related CRs)	Y	N	
		X	Other core specifications
		X	Test specifications
		X	O&M Specifications

Other comments:

Figure 4: Contribution to 3GPP RAN1#87.

6.2 Scientific Conference Publications

[1] K. Sun and Y. Kim, "A Hierarchical Anchor Selection Scheme for Distributed Moble Network Architecture," *7th Conf. on Information Techn. Convergence*, (*ICTC 2016*), Jeju Island, Korea, 19-21 Oct. 2016.

[2] M. Mueck, E. Calvanese Strinati, I.-G. Kim, A. Clemente, J.-B. Doré, A. De Domenico, T. Kim, T. Choi, H. K. Chung, G. Destino, A. Pärssinen, A. Pouttu, M. Latva-aho4, N. Chuberre, M. Gineste, B. Vautherin, M. Monnerat, V. Frascolla, M. Fresia, W. Keusgen, T. Haustein, A. Korvala, M. Pettissalo, and O. Liinamaa, "5G CHAMPION - Rolling out 5G at 2018 Winter Olympic Games ," *IEEE Globecom 2016*, Washington DC, USA, 4-8 Dec. 2016.

[3] H. Yoon, S. Kim, T. Nam, and J. Kim, "Dynamic Flow Steering for IoT Monitoring Data in SDN-coordinated IoT-Cloud Services," *31st International Conf. on Information Networking*, (*ICOIN 2017*), Da Nang, Vietnam, 11-13 Jan. 2017.

[4] G. An, S. Han, and S. Lee, "Study of Distributed Wireless Access Point Controller," *31st International Conf. on Information Networking*, (*ICOIN 2017*), Da Nang, Vietnam, 11-13 Jan. 2017.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

[5] S. Koh and S. Lee, "A Proposal of OpenFlow Controller to improve Transfer Rate in Mesh Network," *31st International Conf. on Information Networking*, (*ICOIN 2A017*), Da Nang, Vietnam, 11-13 Jan. 2017.
[6] J. Kim, H.-S. Chung, S.-Wμ. Choi, I. Kim, and Y. Han, "Mobile Hotspot Network Enhancement System for High-Speed Railway Communication," *11st European Conf. on Antennas Propagat.,* (*EuCAP 2017*), Paris, France, 19-24 Mar. 2017.
[7] S. H. Won, M. Mueck, V. Frascolla, J. Kim, G. Destino, A. Pärssinen, M. Latva-aho, A. Korvala, A. Clemente, T. Kim, I. Kim, H. K. Chung, E. Calvanese Strinati, "Development of 5G CHAMPION testbeds for 5G services at the 2018 winter Olympic Games,' 18th IEEE *International Workshop on Signal Processing Advances in Wireless Communications (SPAWC 2017*), Sapporo, Japan, 3-6 Jul. 2017.
[8] M. Mueck, S. Choi, V. Ivanov, K. Kim, H. Ahn, T. Haustein, V. Frascolla, "Adaptive automitive communications solutions of 10 years lifetime enabled by ETSI RRS softaware reconfiguration technology," *Workshop on Prototyping 5th Generation Cellular Wireless Technology*, (*EuCNC 2017*), Oulu, Finland, 12-15 Jun. 2017.
[9] G. Destino, P. Marko, M. E. Leinonen, J. Haukipuro, O. Kursu, A. Pärssinen, and N. Cassiau, "Multiple antenna techniques for device pairing of a mmWave high capacity backhaul system," *Workshop on Prototyping 5th Generation Cellular Wireless Technology*, (*EuCNC 2017*), Oulu, Finland, 12-15 Jun. 2017.
[10] M. E. Leinonen, O. Kursu, G. Destino, S. Myllymäki, S. Tammelin, J. Haukipuro, N. Tervo, M. Sonkki, T. Rahnkonen, M. Latva-aho, A. Pärssinen, A. Korvala, and M. Pettissalo, "Proof of concept of mmWave high capacity backhaul: RF and antenna components," *Workshop on Prototyping 5th Generation Cellular Wireless Technology*, (*EuCNC 2017*), Oulu, Finland, 12-15 Jun. 2017.
[11] J. Saloranta, G. Destino and H. Wymeersch, "Comparison of different beamtraining strategies from a rate-positioning trade-off perspective," *European Conf. Networks Communications* (*EuCNC 2017*), Oulu, Finland, 12-15 Jun. 2017.
[12] G. Destino, O. Kursu, S. Tammelin, J. Haukipuro, M. Sonkki, T. Rahkonen, A. Pärssinen, M. Latva-aho, A. Korvala, and M. Pettissalo, "System analysis and design of mmW mobile backhaul transceiver at 28 GHz," *European Conf. Networks Communications* (*EuCNC 2017*), Oulu, Finland, 12-15 Jun. 2017.
[13] H. Chung, J. Kim, G. Noh, B. Hui, I. Kim, C. Choi, M. Lee, Y. Choi, and D. Kim, "From architecture to field trial: a millimeter wave based MHN system for HST communications toward 5G," *European Conf. Networks Communications*(*EuCNC 2017*), Oulu, Finland, 12-15 Jun. 2017.
[14] Y. Choi and J. H. Lee, "Pilot structure design to increase wireless channel capacity for High-Speed Railway," *uropean Conf. Networks Communications* (*EuCNC 2017*), Oulu, Finland, 12-15 Jun. 2017.
[15] T. Deleu, N. Chuberre, M. Gineste, and V. Frascolla, "Narrowband IoT service provision to 5G User Equipment via a satellite component," *Workshop on Prototyping 5th Generation Cellular Wireless Technology*, (*EuCNC 2017*), Oulu, Finland, 12-15 Jun. 2017.
[16] V. Ivanov, M. D. Mueck, Y. Jin, S. Choi, G. Destino, and V. Frascolla, "Highly efficient representation of reconfigurable code based on a Radio Virtual Machine: Optimization to any target platform," *25th Europen Signal Processing Conference*, Kos island, Greece, 28 Aug. - 2 Sep., 2017.
[17] J. Saloranta and G. Destino "Reconfiguration of 5G radio interface for positioning," *25th Europen Signal Processing Conference*, Kos island, Greece, 28 Aug. - 2 Sep., 2017.
[18] G. Noh, J. Kim, H. Chung, B. Hui, Y.-M. Choi, and I. Kim, "mmWave-based mobile backhaul transceiver for high speed train communication systems," *IEEE GLOBECOM 2017*

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Workshops: International Workshop on 5G Test-Beds & Trials - Learnings from implementing 5G (*5G-Testbed 2017*), 8 Dec. 2017.
[19] M. Mueck, S. Choi, P. Bender, V. Ivanov, Y. Jin, H. Ahn, K. Kim, and E. Dutkiewicz, "Radio Equipment Directive - A novel Software Reconfiguration Framework," *IEEE GLOBECOM 2017 Workshops: International Workshop on 5G Test-Beds & Trials - Learnings from implementing 5G* (*5G-Testbed 2017*), 8 Dec. 2017.
[20] M. Schmieder, M. Peter, R. Askar, I. Komsic, W. Keusgen, "Measurement and Characterization of 28 GHz High-Speed Train Backhaul Channels in Rural Propagation Scenarios", Convened session at *European Conference on Antennas and Propgation* (EuCAP 2018), London, UK, 9 - 13 Apr. 2018.
[21] R. Gerzaguet, S. Bicais, P. Rosson, J. Estavoyer, X. Popon, D. Dassonville, J.-B. Dore , B. Miscopein, M. Pezzin, D. Miras, and D. Ktenas, "5G Multi-Service Field Trials with BF-OFDM," *IEEE GLOBECOM 2017 Workshops: International Workshop on 5G Test-Beds & Trials - Learnings from implementing 5G* (*5G-Testbed 2017*), 8 Dec. 2017.

6.3 Scientific Conference Presentation

- IEEE PIMRC 2016, 5G CHAMPION: 5G, we will prove it works', Emilio Calvanese Strianti, CEA-LETI, France. At the panel on 'The Path to 5G Enhanced Mobile Broadband'.
- IEEE 5G Berlin Summit, "5G CHAMPION: 28 GHz 5G Proof-of-Concepts at 2018 Winter Olympic games", Dr. Emilio CalvaneseStrinati, CEA-LETI, France
- IEEE Globecom Conference, "5G CHAMPION: 28 GHz 5G Proof-of-Concepts at 2018 Winter Olympic games", Dr. Emilio CalvaneseStrinati, CEA-LETI, France at the industrial panel on '5G Networks Prototyping: Entering the Next phase of experimentation for future Radio Access Technologies.

6.4 Scientific Journal Publications

[1] G. Noh, H. Wang, C. Shin, S. Kim, Y. Jeon, H. Shin, J. Kim, and I. Kim, "Enabling Technologies Towards Fully LTE-Compatible Full-Duplex Radio," *IEEE Communications Magazine*, vol. 55, no.3, pp. 188-195, Mar. 2017.
[2] K. Sakaguchi, T. Haustein, S. Barbarossa, E. Calvanese Strinati, A. Clemente, G. Destino, A. Parssinen, I. Kim, H. Chung, J. Kim, I. W. Keusgen, R. J. Weiler, K. Takinami, E. Ceci, A. Sadri, L. Xian, A. Maltsev, G. Khanh Tran, H. Ogawa, K. Mahler, and R. W. Heath Jr. "Where, when, and how mmWave is used in 5G and beyond," *IEICE Trans. Electronics*, vol. E100.C, no. 10, pp. 790-808, Oct. 2017. (Invited paper)
[3] T.-X. Do and Y. Kim, "Control and data plane separation architecture for supporting multicast listeners over distributed mobility management," *ICT Express*, vol. 3, no. 2, pp. 90-95, Jun. 2017.
[4] E. Calvanese Strinati, M. Mueck, I. Kim, A. Clemente, J. Kim, G. Noh, H. Chung, T. Choi, G. Destino, A. Parssinen, N. Chuberre, B. Vautherin, and A. Korvala, "5G CHAMPION – Disruptive 5G Technologies for Roll-Out in 2018," *ETRI Journal*, vol. 40, no. 1, Feb. 2018.
[5] T. Choi, T. Kim, W. Tavernier, A. Korvala, and J. Pajunpaa, "Agile Management and Interoperability Testing of SDN/NFV-enriched 5G Core Networks," *ETRI Journal*, vol. 40, no. 1, Feb. 2018.
[6] M. E. Leinonen, G. Destino, O. Kursu, M. Sonkki, and A. Parssinen, "28 GHz wireless backhaul transceiver characterization and radio link budget," *ETRI Journal*, vol. 40, no. 1, Feb. 2018.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

[7] S. Shi and S. Choi, "Efficient and security enhanced evolved packet system authentication and key agreement protocol," *Journal of the Korea Society of Digital Industry and Information Management,* pp. 87-101, Mar. 2017.
[8] First intercontinental 5G trial begins at winter Olympics: the 5G Champion project shows off a 5G link between South Korea and Finland, IEEE Spectrum, 21 Feb. 2018.

6.5 ETSI White Papers

[1] M. Mueck (editor), F. Ambrosini, P. Bender, S. Cadzow, S. Choi, V. Ivanov, M. Pagnozzi, and I. Siaud, "Software radio reconfiguration: a highhly efficient and modular software reconfiguration approach for mobile devices," *ETSI White Paper*, no. 21, Oct. 2017.

6.6 Keynote Speeches

[1] Emilio Calvanese Strinati, "5G CHAMPION: Proofing 5G Wireless communications performance," VTC Spring'17 Industry Track on 5G and Wireless Communications, Sydney, Australia, June 2017.
[2] Hyun Kyu Chung, VTC Spring'17 Industry Track on 5G and Wireless Communications, Sydney, Australia, June 2017.
[3] Emilio Calvanese Strinati, "5G CHAMPION: Proofing 5G Wireless communications performance," 2nd EAI International Conference on 5G for Ubiquitous Connectivity, Melbourne, Australia, June 2017.

6.7 Invited Talks

[1] Emilio Calvanese Strinati "5G CHAMPION: 28 GHz 5G Proof-of-Concepts at 2018 Winter Olympic games", IEEE 5G SUMMIT Berlin 2016, Germany, November 2016.
[2] Valerio Frascolla, "Resource and spectrum management - an European research projects survey", International Conference on Advances in Cognitive Radio (COCORA), Venice, Italy, April 2017.

[3] Valerio Frascolla, "From concept to deployment: the visions of the 5GCHAMPION and 5G-MiEdge projects (Olympic games are coming ...)", Industrial Panel at the International Conference on Advances in Cognitive Radio (COCORA), Venice, Italy, April 2017.

[4] Valerio Frascolla, "5G use cases for Olympic games: The visions of the projects 5GCHAMPION and 5G-MiEdge", Industrial Panel of the "Workshop on Optical-Wireless Convergent Networks", Brasilia, Brazil, June 2017.

6.8 Panels

[1] 5G Networks Prototyping, Plenary industrial panel at IEEE Globecom 2016, Washington DC, USA, December 2016.

6.9 Book Chapters

- **"Spectrum Policy and Cognitive Radio Standards"** Section of the "Handbook of Cognitive Radio", to be published by Springer (49 pages)
- Authors: Dr. Markus Mueck
- 1st page of the chapter:

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

ETSI-RRS Reconfigurable Radio Systems Standards

Dr. Markus Mueck, INTEL Deutschland GmbH, Am Campeon 10-12, 85579 Neubiberg, Germany,
email: Markus.Dominik.Mueck@intel.com

Abstract: The evolution of classical, static Radio Systems towards Reconfigurable Radio Systems is a clear trend in the industry for several reasons – first, the lack of spectral resources forces manufacturer to exploit novel technological trends in order to meet 5G related promises in terms of Quality of Service, Latency, Reliability, etc. Second, the fast evolution and heterogeneous nature of the radio environment combined with an ever increasing computation power in mobile devices calls for new ways of ensuring that the diverse environment is exploited in the best possible way; software reconfigurability is the key to dynamically adapt any target device to the specific needs of its owner through installation of tailored and targeted software components. All this flexibility, however, is useless without access to real-time, reliable context information which feeds decision making entities in the network, in the mobile device or implemented in a distributed way such that the network as well as mobile devices participate in the decision making process. The European Commission has recognized this trend in an early stage and acted correspondingly. ETSI received EC Mandate M/512: "STANDARDISATION MANDATE TO CEN, CENELEC AND ETSI FOR RECONFIGURABLE RADIO SYSTEMS" which lead to the development of the Licensed Shared Access Spectrum Sharing solution in ETSI's Technical Committee Reconfigurable Radio Systems (TC RRS). Furthermore, the new Radio Equipment Directive creates a clear framework for Software Reconfigurable Radio Equipment in Europe. This section details the respective technical solutions and trends as they are currently being developed in ETSI standards.

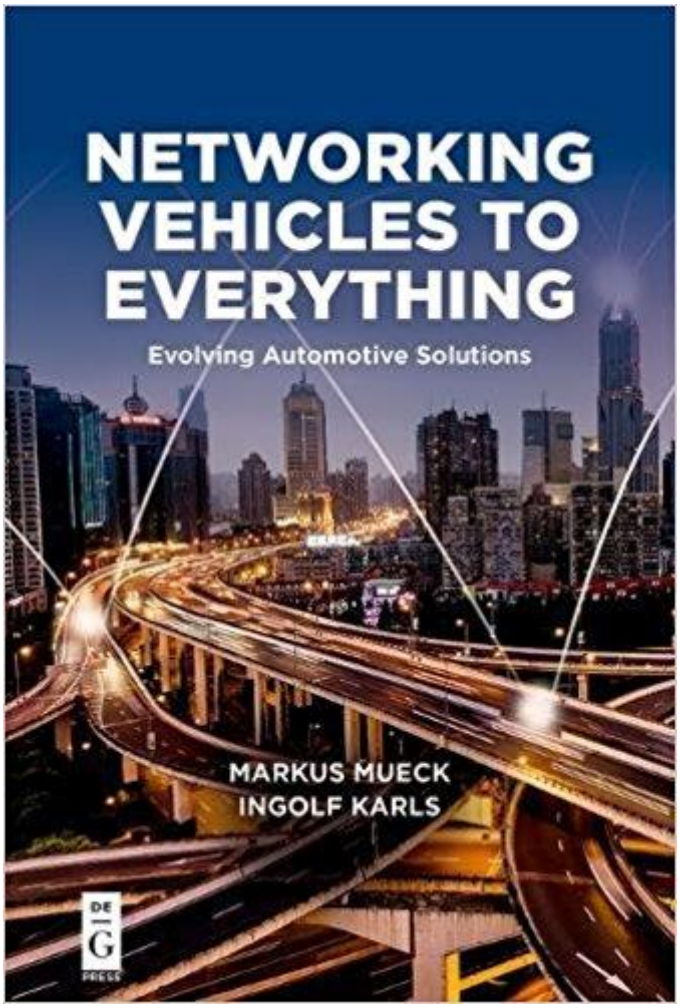
Keywords: Cognitive Radio Systems, ETSI, Reconfigurable Radio Systems, Software Reconfiguration, Spectrum Sharing

Figure 5: First page of the Book Chapter "Spectrum Policy and Cognitive Radio Standards".

6.10 Books

- **"Networking Vehicles to Everything: Evolving Automotive Solutions",** Book published by DeGruyter Editions in December 2017
- Authors: Dr. Markus Mueck, Dr. Ingolf Karls
- Cover:

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.



6.11 Special Sessions

- **"Software Reconfiguration enabling 5G"**: Accepted Special Session at The 2017 European Signal Processing Conference (EUSIPCO 2017)
  - Organizers: Dr. Markus Mueck (5G CHAMPION, INTEL), Prof. Seungwon Choi (5G CHAMPION, Hanyang University), Dr. Dr. Emilio Calvanese Strinati (5G CHAMPION, CEA)
  - **Scope**: The "Radio Equipment Directive (RED)" was recently published and replaces the previous "Radio and Telecommunication Terminal Equipment (R&TTE) Directive" which was in force since 1999. The RED creates a new regulation framework in Europe and includes in particular clear provisions in order to enable the introduction of software reconfiguration technology in the Single European Market. This Special Session will gather cross-regional experts, including Korean and European thought leaders, in order to address state of the art technological solutions enabling software reconfiguration in wireless radio

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

equipment. Furthermore, challenges in the field of security and certification will be discussed in order to provide the audience with a holistic picture on the multi-disciplinary challenge. This proposal is supported by the 5G CHAMPION consortium which is working towards a real-field PoC of 5G Networks capabilities at Peyong Olymic games in 2018.

- Structure of the Special Session – 5 invited Scientific Papers:
- ***Adaptive automotive communications solutions of 10 years lifetime enabled by ETSI RRS Software Reconfiguration technology;*** KIM Kyunghoon (Hanyang University, Korea), AHN Heungseop (Hanyang University, Korea), HAUSTEIN Thomas (HHI, Germany), FRASCOLLA Valerio (INTEL, Germany)
    - **Short Abstract:** ETSI RRS has recently published a set of standards for Client side Software Reconfiguration covering the technical, security and regulation vectors. It will be shown how the basic features for downloading and installation of software can be applied to a vehicular context. Furthermore, a novel highly efficient way of introducing generic reconfigurable code through a Radio Virtual Machine based representation will be considered for its applicability to the automotive context.
- ***Highly efficient representation of reconfigurable code based on a Radio Virtual Machine: Optimization to any target platform;*** IVANOV Vladimir (LG, Korea), JIN Yong (Hanyang University), DESTINO Guiseppe (University of Oulu, Finland)
    - **Short Abstract:** This paper introduces a novel way of adapting a Radio Virtual Machine (RVM) based code representation to any target platform. The approach indeed consists in reconstructing a generic RVM based code representation to the available resources of a target platform in order to enable efficient back-end compilation. Finally, highly efficient code is generated which is substantially superior to a middle-ware based code execution approach.
- ***An SDN/NFV evolved packet core approach enabling agile management of core network functionality and services***; CHOI TaeSang (ETRI, Korea), KIM TaeYeon (ETRI, Korea), CLEMENTE Antonio (CEA, France)
    - **Short Abstract:** Virtualization of major parts of the network in combination with Software Defined Networking are a clear trend in 5G Communications. This paper will discuss novel solutions combining SDN and NFV approach in order to enable an agile management of the infrastructure core network functionalities and related services.
- ***Reconfiguration of 5G radio interface for positioning:*** SALORANTA Jani and DESTINO Giuseppe (University of Oulu, Finland)
    - **Short Abstract:** In addition to high data-rate, mmWave technology has great potential to provide extremely high localization accuracy. In this paper, we outline the benefits of this technology for positioning and their main applications, which are no longer confined to services but also to improve communication. We shall focus on the reconfiguration mechanisms of the radio interface in order to achieve optimum trade-off with data communication.
- ***Radio Equipment Directive – A novel software reconfiguration framework:*** Markus Mueck (INTEL), Christoph Legutko (INTEL), Emilio Calvanese Strinati (CEA)
    - **Short Abstract:** The European Commission has recently replaced the R&TTE Directive – which was in force since 1999 – by the novel Radio Equipment Directive (RED). The RED represents the basic regulation framework for wireless equipment and includes novel provisions for software reconfigurability. This paper summarizes the novel rules and provides solutions which will enable

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

manufacturers to meet technical, security and certification requirements for 3rd party software reconfigurable equipment.

- First page of the submission:

Special Session Title: Software Reconfiguration enabling 5G

Short description of proposed field (one paragraph):

The "Radio Equipment Directive (RED)" was recently revised for the first time since 1999 and replaces the previous "Radio and Telecommunication Terminal Equipment (R&TTE) Directive". The RED creates a new regulation framework in Europe and includes in particular clear provisions in order to enable the introduction of software reconfiguration technology in the Single European Market. This Special Session will gather cross-regional experts, including Korean and European thought leaders, in order to address state of the art technological solutions enabling software reconfiguration in wireless radio equipment. Furthermore, challenges in the field of security and certification will be discussed in order to provide the audience with a holistic picture on the multi-disciplinary challenge.

This proposal is supported by the 5G CHAMPION consortium which is working towards a real-field PoC of 5G Networks capabilities at Peyong Olymic games in 2018.

Novelty and motivation (one to two paragraphs), including why this topic is of interest to the EUSIPCO community

Software Reconfigurability is going to be a substantial driver for future signal processing solutions, since it will make underlying radio platforms open and available for 3rd party components introducing new and competitive features across all layers – from the physical layer up to the application layer. The technology clearly is one of the focus topics of the EUSIPCO conference and of utmost interest to the community. In the context of future 5G systems, this technology will be a key enabler to allow for an adaptation of generic hardware platforms to the needs of specific vertical markets.

Talks on the opportunities and first generation solutions will be highly instructive and insightful to the audience. The corresponding exchange of views may indeed accelerate the overall European 5G effort and increase Europe's leading edge.

Short biography of the organizers

Dr. Markus Mueck oversees Intel's technology development, standardization and partnerships in the field of spectrum sharing. In this capacity, he has contributed to standardization and regulatory efforts on various topics including spectrum sharing within numerous industry standards/regulation bodies, including ETSI, 3GPP, IEEE, the Wireless Innovation Forum and CEPT. Dr. Mueck is an adjunct professor of engineering at University of Technology, Sydney, Australia and Macquarie University, Sydney, Australia, he acts as ETSI Board Member supported by INTEL and as general Chairman of ETSI RRS Technical Body (Software Radio and Cognitive Radio Standardization). He has earned engineering degrees from the University of Stuttgart, Germany and the Ecole Nationale Supérieure des Télécommunications (ENST) in Paris, France, as well as a doctorate degree of ENST in Communications.

Figure 6: Special Session at EuSIPCO 2017.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

6.12 Workshops

- "**Multi-RAT and Network/Terminal Function Virtualization**" **on 23rd February 2017 at Orange Gardens, Châtillon, France**" by Orange, b<>com and INTEL and co-located with ETSI RRS strandardization meeting and with active participation by 5G CHAMPION leaders:
    - See http://www.multi-rat--network-terminal-function-virtualization-02.webself.net/
    - **Scope**: "This full day workshop, within the framework of H2020 challenges, addresses multi-RAT architectures in conjunction with Network and Terminal Function Virtualization (NTFV). Network and terminal scalability in the 5G multi-RAT context, involves innovative RAT management and new virtualization functions for Software Designed Networking (SDN) and mobile device reconfiguration. The goal of this workshop is to provide recent trends in these research topics topics from a technical, security and regulation perspective with a focus on the future joint Multi-RAT and NTFV approach for 5G seamless access networks. The workshop includes oral presentations and exhibitions."

T

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

- **5G CHAMPION** Talk by Dr. Emilio Calvanese-Strinati: 5G CHAMPION – 28 GHz 5G Proof-of-Concept at 2018 Winter Olympic Games

- **5G CHAMPION** Talk by Dr. Markus Mueck (jointly with Francois Ambrosini of IBIT): Terminal Reconfigurability, Technical Solutions, Security and Regulation Aspects

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

General Program

9.00	Welcome to participants
9.30	Workshop opening, O. Simon, P. Cordier, I. Siaud, M. Mueck
10.00	Virtual RAN towards 5G, A. de Lannoy
10.30	Mobile Core Network Virtualization: Performances Analysis, I. Alawe
11.00	Coffee Break
11.15	Evolution of OAI Software for Data-Center Deployments, R. Knopp
11.45	Challenges in SON for 5G, S. Ben Jemaa
12.15	On convergent mm-MAGIC and ETSI-RRS multi-RAT architectures for 5G, I. Siaud
12.45	Lunch
14.00	Terminal reconfigurability, technical solutions , security and regulation aspects, M. Mueck, F. Ambrosini
14.30	5G Champion: 28 GHz 5G Proof-of-Concepts at 2018 Winter Olympic games, E. Calvanese Strinati
15.00	ETSI RRS –Radio Interface Engine Work Item, R. Raulefs, M. Mueck, I. Siaud
15.30	Flexible radio (hardware + software) under new RE-Directive: a compliance issue?, B. Smith
16.00	Workshop Conclusions
16.15	Coffee Break
16.30	Demos and Exibitions
19.30	Social Event, Bouillon Racine Restaurant

Démos and Exhibitions

16.30	5G — Connectivity as a service, Grégory AKPOLI-JOHNSON [Orange]
	5G — Visualizing the customer experience, Mohamad MAAZ [Orange]
	Green Multi-Technology Engineering platform and extensions, mm-MAGIC project, Anne-Marie Ulmer-Moll, Isabelle Siaud
to	[Orange], Angelos Goulianos, Evangelos Mellios [Univ. of Bristol]
	LTE TDD coexistence management (CXM) on FCC 3.5 GHz CBRS band, C. Le Thierry d'Ennequin, P.J. Muller [RED Technologies]
	EU FLEX-LSA project: multi-countries LSA experimentation on FLEX LTE testbeds, [RED Technologies, ALLBESMART]
18.00	Anticipatory video streaming for mobile networks, S. Valentin, S. Mekki [Huawei, Paris]

- Workshop at EuCNC 2017, Oulu, Finland on "**Prototyping 5th Generation Cellular Wireless Technology**"
  - A Workshop was organized with participation of multiple research projects:
    - 5G CHAMPION (**5G C**ommunication with a **H**eterogeneous**, A**gile **M**obile network in the **PyeongChang** w**I**nter **O**lympic competio**N**)
    - Flex5Gware: (**Flex**ible and efficient hardware/software platforms for **5G** network elements and devices)
    - 5G-MiEdge (**Mi**llimeter-wave **Edge** cloud as an enabler for **5G** ecosystem)
    - MiWaveS (Beyond 2020 Heterogeneous Wireless Networks with **Mi**llimeter-**Wave S**mall Cell Access and Backhauling)
  - The project flyer is available here:

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

EUCNC 2017 June 12-15

European Conference on Networks and Communications | Oulu, Finland

5G: European Roadmap, Global Impact

Tekes 12 - 15 June 2017 www.eucnc.eu

IEEE ComSoc EURASIP

Workshop Proposal

This document contains a template for all the information relevant to each Workshop to be organised within EuCNC 2017. The rules for organising and attending Workshops, as well as the items for the evaluation of proposals, are available at the conference website, under "Authors / Call for Workshops" (http://www.eucnc.eu/?q=node/60). If the proposal is accepted, this text (the public information in it) will be used to advertise the Workshop in the conference website.

The proposal should be submitted by the deadline, 2017 Feb. 06, to eucnc-workshop@ee.oulu.fi. The name of the file should be the Workshop title (abbreviated, if necessary).

Proposer's Name	Dr. Markus Mueck (5G CHAMPION), Michael Faerber (Flex5Gware), Dr. Valerio Frascolla (5G-MiEdge), Sylvie Mayrargue (MiWaveS) *Note: Since this proposal is a collaboration among four Horizon-2020 projects, we choose to provide a proposer's name for each of the projects.*
Proposer's Institution	INTEL Germany, CEA-Leti France
Proposer's Email	Markus.Dominik.Mueck@intel.com, Michael.Faerber@intel.com, Valerio.Frascolla@intel.com, Sylvie.Mayrargue@cea.fr.
Proposer's Phone Number	Dr. Markus Mueck: +49 (0)89 99 8853-63149, Michael Faerber: +49 (0)89 99 8853- 26912, Dr. Valerio Frascolla: +49 (0)151 12278516, Sylvie Mayrargue: +33 4 38 78 62 42

Figure 7: Special Session Proposal to EuCNC 2017.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

- The workshop program is as follows:

  - Keynote Speech by Jari Lehmusvuori (NOKIA) on The 5G Test Network in Finland (CONFIRMED)
  - Keynote speech by Sergio Barbarossa (Sapienza university of Rome, technical manager of the 5G-MiEdge project) on theBenefit of merging MEC and mmWave technologies (CONFIRMED
  - Narrowband IoT service provision to 5G User Equipment via a satellite component; DELEU Thibault (Thales Alenia Space, France), CHUBERRE Nicolas (Thales Alenia Space, France), GINESTE Mathieu (Thales Alenia Space, France), FRASCOLLA Valerio (INTEL, Germany)
  - Adaptive automotive communications solutions of 10 years lifetime enabled by ETSI RRS Software Reconfiguration technology; Markus Mueck (INTEL, Germany), Seungwon Choi (Hanyang University, Korea), Vladimir Ivanov (St Petersburg University, Russia), KIM Kyunghoon (Hanyang University, Korea), AHN Heungseop (Hanyang University, Korea), HAUSTEIN Thomas (HHI, Germany), FRASCOLLA Valerio (INTEL, Germany)
  - Proof of concept of mmWave high capacity backhaul: RF and antenna design, DESTINO Giuseppe (University of Oulu, Finland), CLEMENTE Antonio (CEA, France), PÄRSSINEN Aarno (University of Oulu, Finland), KURSU Olli (University of Oulu, Finland), KORVALA Aki (Nokia), Maciej Smierzchalski (CEA, France), Fatimata Diaby (CEA, France), KIM Il Gyu (ETRI, Korea), CHUNG Heesang (ETRI, Korea)
  - Multiple antenna techniques for device pairing of a mmWave high capacity backhaul system; DESTINO Giuseppe (University of Oulu, Finland), PETTISSALO Marko (Nokia), CLEMENTE Antonio (CEA)
  - Hardware-In-the-Loop Trials and Demonstrations for 5G mm-Wave Communications; a Waveform Study; Jafar Mohammadi (HHI, Germany), Jian Luo (Huawei, Germany), Valerio Frascolla (INTEL, Germany), Katsuo Yunoki (KDDI Research, Japan), Koji Takinami (Panasonic, Japan), Kei Sakaguchi (HHI, Germany), Khanh Tran Gia (Tokyo University), Sergio Barbarossa (Sapienza university of Rome)
  - Radio Frequency Enabling Technology – Session Chair: Valerio Frascolla, INTEL, Germany
  - Blocking and blockage scenarios with beamforming for 5G; Visvesh Saravanan (INTEL, Germany), Camila Priale (INTEL, Germany)
  - PA model including memory effects; Camila Priale (INTEL, Germany), Visvesh Saravanan (INTEL, Germany)
  - MiWaveS millimeter-wave antennas for 5G access and backhauling; T. T. Potelon (Université de Rennes 1, France), F. Foglia Manzillo

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

(Université de Rennes 1, France), M. Ettorre (Université de Rennes 1, France), R. Sauleau (Université de Rennes 1, France), J. Säily (VTT, Finland), A. Lamminen (VTT, Finland), M. Kaunisto (VTT, Finland), J. Aurinsalo (VTT, Finland), L. Marnat (CEA-LETI, France), L.Dussopt (CEA-LETI, France), S. Mayrargue (CEA-LETI, France)

- Some impressions of the workshop:

Figure 8: Keynote Speech by Jari Lehmusvuori (NOKIA).

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Figure 9: Dr. Guiseppe Destino presenting at the Workshop at EuCNC 2017.

- Workshop at IEEE Globecom 2017 on "**5G Test-Beds & Trials – Learnings from implementing 5G (5G-Testbed)**", 4-December-2017, Singapore. This Workshop is jointly organized by 5G CHAMPION and 5G Mi-Edge projects.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

IEEE GLOBECOM

Call for Papers

International Workshop on

5G Test-Beds & Trials – Learnings from implementing 5G (5G-Testbed)

In conjunction with Globecom 2017, 4-8 December 2017, Singapore

Scope and Objectives:

Early stage 5G prototyping and proof-of-concept has been successfully completed. First generation 5G technology is now moving towards productization. Test-bed experiments and trials are further pursued for three reasons: first, final fine-tuning of first stage products is performed with a focus on specific technical challenges; second, equipment in a pre-production stage is tested in massive deployment scenarios through suitable trials; and third, innovation continues towards second generation 5G features and corresponding new ideas are implemented and tested. The objective of this Workshop is to address the above mentioned challenges. 5G Experts will be to meet and exchange findings, views and opinions on current test-beds, trials, early phase products and next generation 5G features and functionalities. The key objective is to exchange learnings encountered during practical tests in order to understand where the real challenges, weaknesses but also strengths of 5G lie and how they can be addressed in the future evolution of the technology.

We solicit original submissions in the following areas:

- 5G applications, use cases and business models
- 5G test-beds and trials
- Prototyping of 5G evolution features
- Implementation and operation of mmWave technology
- Implementation and operation of heterogeneous technologies and networks
- Implementation and operation of vertical services including vehicular, medical, Internet-of-Things and Machine-to-Machine applications
- Implementation and operation of spectrum sharing, including Licensed Shared Access (LSA) and Spectrum Access System (SAS)
- Low latency strategies and related implementations
- Energy efficiency vs. QoS vs cost-efficiency trade-offs
- Architectural evolution of mobile networks
- Virtualization across the entire 5G ecosystem including backhaul and access network as well as user devices
- Network Function Virtualization (NFV) and related test-beds
- Mobile Edge Computing (MEC) and related test-beds
- Software Reconfiguration of radio features
- Lessons learned from 5G test-beds and trials, including required standards changes, gaps to be filled, etc.
- Regulation framework and required evolution

Important Dates:

Paper Submission: July 1, 2017
Acceptance Notification: September 1, 2017
Camera-Ready: October 1, 2017
Workshop: December 4, 2017

Submission Guidelines:

Papers need to be submitted using EDAS. The paper should be in English, not exceeding 5 two-column A4 pages, and should follow standard IEEE conference templates available here (*). Accepted papers will be published in IEEE Xplore. They will be presented either orally or by means of a poster.

Organising Committee:

General Chairs
- Markus Mueck (INTEL Germany)
- Taesang Choi (ETRI, Korea)
- Emilio Calvanese Strinati (CEA LETI, France)

TPC co-chairs
- Antonio Clemente (CEA, France)
- Kei Sakaguchi (Fraunhofer HHI, Germany)

Publicity chair
- Zdenek Becvar (Czech Technical University, Czech Republic)
- Eryk Dutkiewicz (University of Technology, Australia)
- Thomas Haustein (Fraunhofer HHI, Germany)

Technical Programme Committee:

DUTKIEWICZ, Eryk (UTS, Australia)
JAYAWICKRAMA, Heshanga Abeweardana (UTS, Australia)
HEIMLICH, Michael (Macquarie University, Australia)
SIAUD, Isabelle (b<>com, France)
FILIPPOU, Miltiadis (INTEL, Germany)
ROTH, Kilian (INTEL, Germany)
SCHULZ, Egon (Huawei, Germany)
SRIKANTESWARA, Srikathyayani (INTEL, US)
DEBBAH, Merouane (Huawei, France)
DEMESTICHAS, Panagiotis (University of Piraeus, Greece)
KIM, TaeYeon (ETRI, Korea)
LEE, HyeonWoo (Dankook University, Korea)
MAJEED, Erfan (Institut fuer Kommunikationstechnik, Germany)
YOUSSEF, Ziad (Institut fuer Kommunikationstechnik, Germany)
CHOI, Seungwon (Hanyang University, Korea)
FREDA, Martino (Interdigital, Canada)
BARBAROSSA, Sergio (Sapienza University of Rome, Italy)
TRAN, Khanh (Tokyo Tech, Japan)
DE DOMENICO, Antonio (CEA-LETI, France)
RAULEFS, Ronald (DLR, Germany)
DE MARI, Matthieu (University of Technology, Singapore)
PESCOSOLIDO, Loreto (National Research Council, Italy)
DENIS, Benoit (CEA LETI, France)

(*) http://www.ieee.org/conferences_events/conferences/publishing/templates.html

Figure 10: Workshop Proposal to IEEE Globecom 2017, 4-8 December, Singapore.

- The workshop program is as follows:

  - Keynote Speech by Dr. Geng Wu (INTEL, US) on "5G: from concepts to field testing"
  - Keynote Speech by Ian Wong (National Instruments, Germany) on "5G Theory to Practice: Lessons Learned from Massive MIMO and mmWave Early Trials"
  - “Impact of RAN virtualization on fronthaul latency budget: an experimental evaluation”, Francesco Giannone (Scuola Superiore Sant'Anna, Italy, Italy); Himank Gupta (Indian Institute of Technology, Hyderabad, India, India); Koteswararao Kondepu (Sculoa Superiore

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Sant'Anna, Italy, Italy); Antony Franklin A (Indian Institute of Technology Hyderabad, India, India); Piero Castoldi (Scuola Superiore Sant'Anna, Italy, Italy); Luca Valcarenghi (Scuola Superiore Sant'Anna, Italy, Italy); Damiano Manicone (Scuola Superiore Sant'Anna, Italy, Italy)

- "5G Multi-Service Field Trials with BF-OFDM", Robin Gerzaguet (University of Rennes 1, France, France); Simon Bicaïs (CEA, France, France); Patrick Rosson (Cea Leti Minatec, France, France); Jérémy Estavoyer (CEA-Leti, France, France); Xavier Popon (CEA-LETI, France, France); David Dassonville (Cea Leti Minatec, France, France); Jean-Baptiste Doré (CEA, France, France); Benoit Miscopein (CEA, France, France); Manuel Pezzin (CEA, France, France); David Miras (CEA-Leti Minatec, France, France); Dimitri Kténas (CEA, France, France)
- "mmWave-based Mobile Backhaul Transceiver for High Speed Train Communication Systems", Gosan Noh (Electronics and Telecommunications Research Institute, Korea, Korea); Junhyeong Kim (ETRI & KAIST, Korea, Korea); Hee Sang Chung (ETRI, Korea, Korea); Bing Hui (ETRI, Korea, Korea); Young Min Choi (Cleverlogic, Korea, Korea); Ilgyu Kim (ETRI of KOREA, Korea, Korea)
- "Turning the knobs on OpenFlow-based resiliency in mmWave small cell meshed networks", Ricardo Santos (Karlstad University, Sweden, Sweden); Hiroaki Ogawa (Tokyo Institute of Technology, Japan, Japan); Gia Khanh Tran (Tokyo Institute of Technology, Japan, Japan); Kei Sakaguchi (Tokyo Institute of Technology & Fraunhofer HHI, Japan, Japan); Andreas J. Kassler (Karlstad University, Sweden, Sweden)
- "Narrowband IoT service provision to 5G User Equipment via a satellite component", Mathieu Gineste (Thales Alenia Space, France, France); Thibault Deleu (Thales Alenia Space, France, France); Michel Cohen (Thales Alenias Space, France, France); Nicolas Chuberre (Thales Alenia Space, France, France); Visvesh Saravanan (INTEL, Germany, Germany); Valerio Frascolla (Intel Deutschland Gmbh, Germany, Germany); Markus Dominik Mueck (Intel Deutschland GmbH, Germany, Germany); Emilio Calvanese Strinati (CEA-LETI, France, France); Eryk Dutkiewicz (University of Technology Sydney, Australia, Australia)
- "Towards E2E Slicing in 5G: A Spectrum Slicing Testbed and its Extension to the Packet Core", Anteneh A. Gebremariam (University of Trento, Italy, Italy); Muhammad Usman (University of Trento, Italy, Italy); Ping Du (The University of Tokyo, Japan, Japan); Akihiro Nakao (University of Tokyo, Japan, Japan); Fabrizio Granelli (University of Trento, Italy, Italy)

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

- “A Flexible IoT RAN System Based on SDR with Optimal Antenna Distribution”, Hsun-Wei Cho (National Taiwan University, Taiwan, Taiwan); Hung-Yu Wei (National Taiwan University, Taiwan, Taiwan)
- "Radio Virtual Machine", Vladimir Ivanov (St. Petersburg State University of Aerospace Instrumentation, Russia, Russia); Markus Dominik Mueck (Intel Deutschland GmbH, Germany, Germany); SeungWon Choi (Hanyang University, Korea, Korea); Heungseop Ahn (Hanyang University, Korea, Korea); Kyunghoon Kim (Hanyang University, Korea, Korea); Emilio Calvanese Strinati (CEA-LETI, France, France)
- “Radio Equipment Directive - A novel Software Reconfiguration Framework”, Markus Dominik Mueck (Intel Deutschland GmbH, Germany, Germany); SeungWon Choi (Hanyang University, Korea, Korea); Paul Bender (BMWi, Germany, Germany); Vladimir Ivanov (St. Petersburg State University of Aerospace Instrumentation, Russia, Russia); Yong Jin (Hanyang University, Korea, Korea); Heungseop Ahn (Hanyang University, Korea, Korea); Kyunghoon Kim (Hanyang University, Korea, Korea); Eryk Dutkiewicz (University of Technology Sydney, Australia, Australia)

- Some impressions of the workshop:

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Figure 11: Dr. Emilio Calvanese-Strinati (CEA-LETI) presenting 5G CHAMPION.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Figure 12: Heungseop Ahn (Hanyang University, Korea) presenting the joint paper "Radio Equipment Directive - A novel Software Reconfiguration Framework".

- 5G CHAMPION partners have organized the **2017** IEEE 85th **Vehicular Technology Conference**: **VTC2017-Spring** (4–7 June **2017)** Industry Track on "*5G and Wireless*" with the following list of speakers:

- Adrian Scrase (ETSI, France)
- David Soldani (NOKIA, Germany)
- Takehiro Nakamura (NTT DoCoMo)
- Emilio Calvanese Strinati (CEA, France)
- Kyungwhoon Cheun (SAMSUNG)
- Huyn Kyu Chung (ETRI, Korea)
- David Cooper (ERICSSON, Australia)
- Ray Owen (NOKIA, Australia)
- Brian Hutson (Juniper Networks, Australia)
- Jeff Owen (Vodafone, Australia)
- Karl Nieman, National Instruments

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

- 5G CHAMPION talk by Dr. Emilio Calvanese Strinato (CEA, France):
  - Title: "**5G CHAMPION: 28 GHz 5G Proof-of-Concepts at 2018 Winter Olympic games**"
  - Abstract: 5G -Next Generation Communication Networks - will be a global game changer from a technological, economic, societal and environmental perspective. The 5G CHAMPION develops, prototype and trials key enabling technologies for a proof-of-concept environment to be showcased at the 2018 Winter Olympics in PyeongChang, Korea. This will allow maximum visibility for the available technology two years ahead of 2020, i.e. the official launch of 5G. Key enabling technologies included in the 5G PoC include i) a complex 5G set-up operating inside and close to the PyeongChang Olympic venue, addressing indoor and outdoor propagation channels in mmWave & below 6GHz spectrum; ii) high-speed broadband connection via mmWave high capacity backhaul in 24-28 GHz, using novel antenna arrays for wireless back/front-hauling, enabling the provision of >2Gbps; iii) advanced evolved

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

packet core solutions for efficient system management with virtualization through NFV/SDN in a secure backhaul architecture as well as a novel SDN-based IPsec tunnel architecture; iv) novel accurate positioning solutions (<1m accuracy) using mmWave combined with GNSS PPP; v) direct UL/DL communication between satellites and 5G User Equipment 'as is' – a corresponding first ever proof-of-concept will set-up; vi) better mobility support through a novel small cell architecture & hybrid adaptive beamforming. The overarching objective is to achieve a highly energy efficient system approach – which is a key requirement and challenge for 5G. Key novel 5G building blocks are under development and implementation into a new architectural approach providing an efficient end-to-end system performance encompassing cutting edge 5G radio-access, core-network and satellite technologies. 5G CHAMPION targets to validate in the PoC the following KPIs: 1) 20 Gbit/s maximum data-rate over a mmWave link, 2) 2.5 Gbit/s over a wireless mmWave backhaul link, 3) 100 Mbit/s of user-experience in moving hot-spots, 4) seamless access to satellite communications for 5G devices, 5) 1-2 ms latency over the 5G wireless backhaul link, 6) agile management of the core network functionality and services, 7) ubiquitous (indoor-outdoor) location accuracy < 1 m.

- 5G CHAMPION talk by Dr. Huyn Kyu Chung, ETRI, Korea
  - Title: "**Mobile Xhaul Network for 5G RAN evolution**"
  - Abstract: For 5G mobile communication services, it is expected that small cells will be more densely deployed and moving network could be a key feature to accommodate various 5G service requirements. Based on these technical trends, it is necessary to study technical solutions to support network mobility and to provide wireless connectivity to functional entities within radio access network (RAN) with scalable and flexible manner. In this talk, the Mobile Xhaul Network (MXN) will be introduced which is the ongoing research project as a way to provide wireless transport connectivity to 5G RAN including moving cell via Xhaul link consisting with front-haul, mid-haul and backhaul. Currently, the MXN project is focusing on network architecture and essential radio transmission technologies such as MIMO and beamforming with millimeter wave on 28GHz frequency band. In this talk, as a preliminary study of MXN, a wireless backhaul solution for moving network, called Mobile Hotspot Network (MHN) will be introduced, which is one of candidate technologies for mobile backhaul commercial solutions in the metro environment in Seoul, Korea.

- 5G CHAMPION talk by Dr. Markus Mueck:
  - Title: "**Enabling IoT for a multitude of vertical applications**"
  - Abstract: The market of IoT devices is expected to be vast – including diverse target applications related to metering, medical, sports, gaming, etc. It is obvious that a large number of different modem chipset features will be required addressing various application domains, form factors and user interfaces. This environment is a serious challenge for Chipset manufacturers since it will be impossible to serve each target use case with a tailored solution. Rather, a small number of generic components need to be designed which are finally reconfigured to optimally fit their market needs. This reconfiguration will rely in particular of software component provision – affecting radio parameters as will as higher layer functionalities. This talk will explain how a recent change

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

in European Regulation (the introduction of the Radio Equipment Directive) and related ETSI standards will address precisely this problem and provide an agreed technical approach to the problem.

- Some impressions of the event:

Figure 13: Dr. Markus Mueck (TPC Co-chair, 5G CHAMPION, INTEL), Dr. Javier Gozalvez (President of the IEEE Vehicular Technology Society (VTS).), Dr. Eryk Dutkiewicz (Chair VTC Spring'17), Dr. Xiaojing Huang (Technical Program Committee Chair), Dr. David Soldani (Industry Track Chair, NOKIA).

6.12.1 EU-Korean Symposium on 5G: "From the 5G challenge to 5G CHAMPION Trial at Winter Olympic Games"

On the 23rd of February 2018, the 5GCHAMPION Consortium has co-organized with IITP, the European Commission, the French Embassy to Korea and the Finish Embassy to Korea the first "From the 5G challenge to 5G CHAMPION Trials at Winter Olympic Games". The workshop toke place at the Conference Hall, Content Korea Lab CKL, K'OCCA

16th Fl, 40 Cheonggyecheon-ro, Jung-gu, Seoul. **More than 80 people** have attended the 23/02 symposium including the **French Ambassador to Korea**, the vice-president of IITP and the **Vice-Ambassador of Finland**. The participants have interacted, witness the achievements, and related Proof of Concepts of the 5GCHAMPION project and its consortium.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The program of the event is the following (also available on the 5GCHAMPION website):

Moderator: IITP (Kwang ho CHUN, khchun@iitp.kr***)***

Organizers:

French Embassy *(LEMAIRE Oriane,* Oriane.LEMAIRE@cea.fr*)*

CEA *(Emilio CALVANESE STRINATI,* emilio.calvanese-strinati@cea.fr***)***

ETRI *(Taesang CHOI,* choits@etri.re.kr*)*

09:00 - 09:20	**Opening of Registration**
09:20 – 9:30	**Opening address:** **5G CHAMPION EU / Korea coordinators (Dr. Emilio Calvanese Strinati, Dr. Hyun Kyu Chung)**
09:30 – 9:40	**Welcome address:** **Fabien Penone, French Ambassador to Korea**
9:40 – 09:50	**Speech of encouragement:** **Kim Gwangsu, Director General for Information and Communication Industry Policy, Korea's Ministry of Science and ICT**
9:50 – 10:00	**Time for celebratory photo**
Session 1	**5G CHAMPION Trials – Results, Lesson Learnt and Perspectives**

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

10:00 – 10:30	***5GCHAMPION: Challenges, Achievements and Perspectives*** **Dr. Emilio Calvanese Strinati, CEA-LETI, 5GCHAMPION EU Coordinator** **Dr. Hyun Kyu Chung, ETRI, 5GCHAMPION KR Coordinator**
10:30 – 11:00	***mmW Moving Hotspot Trial – Results and Lesson Learned*** **Prof. Jouko Niinimäki, Rector of the University of Oulu** **Dr. Giuseppe Destino, University Oulu, Dr. Ilgy Kim, ETRI**
11:00 – 11:30	***5G ready: Orchestration of 5G services – Core network aspects*** **Dr. TaeSang Choi, 5GCHAMPION Korean Technical Manager, ETRI**
11:30 – 12:00	***5GCHAMPION Trial at the Olympic Games Venue: Experience of immersive 5G services: Korea-Finland connected*** **Aki Korvala, Program Manager, Nokia**
12:00 – 13:00	**Lunch Break & Demos Exposition**
Session 2	**Industrial session : 5G Trials and Future of 5G Services**
13:00 – 13:30	***Global Trends of smart terminal for 5G service & Samsung's development Plan*** **Daegyun Kim, Sr. Director Samsung Electronics**
13:30 – 14:00	***Nokia 5G Communication System and Network Vision*** **Juha Pelkonen, Product Manager, Nokia**
14:00 – 14:30	***Status of KT's 5G pilot service at PyeongChang Winter Olympic Games*** **Jong-Sik Lee, Intra Research center of KT Director, KT**
14:30 – 15:00	***5G development status and plan of SKTelecom*** **Jong-Jwan Park, Future Technology Director, SKT**
15:00 – 15:30	***Orange: On the road to 5G~~5G technology and service plans of European carriers~~*** **Jean-Michel Serre, CEO, Orange Japan**

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Session 3	Panel discussion: Challenges for an Efficient Implementation of 5G Services
16:20 – 16:40	*Roadmap towards 5G testbeds in Europe* Bernard Barani Deputy Head of Unit, Future Connectivity Systems, European Commission
16:40 – 17:00	*Korea's roadmap towards 5G* Jaehak Yi, Mobile Communication PM, IITP
17:00 – 17:50	*Round table: The Importance of 5G Trials at Olympic Games – Today's Experience and Tomorrow's Perspectives and Open Challenges* Moderator: Dr. E. Calvanese Strinati, CEA-LETI Participants: Dr. H. Chung (ETRI), Daegyun Kim, Sr. Director Samsung Electronics , Jong-Sik Lee, Intra Research center of KT Director, (KT), Jean-Michel Serre, CEO, Orange Japan Jaehak Yi, Mobile Communication PM, IITP
17:50 – 18:00	Closing Remarks Ms. Anna Huovila, Deputy Head of Mission, Embassy of Finland in Korea
16:00 – 16:20	Coffee Break & Demos Exposition

This workshop has presented the **results of the 5GCHAMPION trials** started during the opening of Olympic Games but has also focused on **specific demonstrations** (including the **5Gb/s 28GHz mmW mobile hotspot link**) and the **intercontinental interactive experience between Oulu and the K-ICT Square demo area in Korea**.

The introduction speech has been given by the French Ambassador to Korea Mr. F. Penone, Dr. Kim Gwangsu, Director General for Information and Communication Industry Policy and

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

[Left] The French Ambassador to Korea (Mr. F. Penone)
[Centrer]: Dr. Kim Gwangsu, Director General for Information and Communication Industry Policy
[Right]: Ms. Anna Huovila, Deputy Head of Mission, Embassy of Finland in Korea

The participants have actively participated with questions during the presentations and the closing roundtable.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

During the symposium of the 23/02 participants had also visited our **dedicated 5GCHAMPION booth** where both **satellite link emulation testbed and a prototype** of **28GHz advanced electronically steerable transmit-array antenna** have been showcased and presented to the audience.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The day has been concluded with a **reception at the French Embassy** where the French Ambassador to Korea has delivered a very warm and supportive speech to 5GCHAMPION. Institutional, researchers and Industry have exchanges impression and future thoughts on 5G, their potential implications and, **collaborations between Europe and Korea** and follow up actions.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

6.13 Proof of Concept at K-ICT Square during the Winter Olympic Games

During the week of 19-22 of February 2018 the 5GCHAMPION consortium have deployed important resources to deliver a set of unique proof of Concepts at the K-ICT Square. While the details of the demonstrations are details in the related deliverables in WP6, hereafter we report some dissemination related events and some photos that witness the active presence of the consortium members and the interested experienced from the audience that had reached more than 4500 visitors at the 5GCHAMPION booth during the week of 19th of February 2018.

5GCHAMPION **trials** started during the opening of OG but has also focused on **specific demonstrations** (including the **5Gb/s 28GHz mmW mobile hotspot link**) and the **intercontinental interactive experience between Oulu and the K-ICT Square demo area in Korea**.
After a preparation day for setting up all the content and the demos,

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

ICT SQUARE

입주기업

• 노슨(NOHSN)주식회사 •
미래기술 예측을 통해 IT&NT&BT가 융합된 헬스케어 시스템 및 서비스개발 기업

• ㈜닷 •
장애인들이 더 나은 생활을 누리고 다양한 디지털 격차를 해소할 수 있도록 IoT기기를 개발하는 개발 전문 기업

• 댓츠잇 •
위치기반 서비스를 기반으로 지역 문화관광에 특화된 서비스 플랫폼을 개발하는 회사

• ㈜라이온시큐리티 •
사용자 본인의 지문과 정합 알고리즘이 탑재 된 지문인식 스마트 카드인 ASTO 카드를 보안, 핀테크, 물류 등의 분야에 활용하는 기술개발 기업

• ㈜룰루랩 •
데이터 기반으로 최적의 제품을 추천하는 인공지능 피부 분석 솔루션
대표번호 010-3130-3548

• ㈜모픽 •
세계 최초 무안경 3D커버 "Snap3D"와 3D 최적화 플레이어 "Mplayer 3D"를 독자적으로 개발

• 버넥트 •
증강현실(AR) 분야의 최고 전문가들이 주축이 되어 설립한 회사.
국내 최고의 증강현실(AR) 기술력 보유 기업

• ㈜브이컴 •
ICT/IOT 융합컨설팅 및 콘텐츠제작, 전문 기술과 풍부한 노하우를 기반으로 스마트우편함 기술 및 아직 경험해보지 못한 다음시대의 새로운 서비스로 시장의 변화를 주도하는 기업.

• ㈜스마트박스 •
세계 최초로 IoT(사물 인터넷)기술을 활용한 제품 및 시스템을 제조, 개발, 서비스 운영하는 기업

• ㈜쓰리디팩토리 •
국내 1위 VR 게임방 브랜드인 "Camp VR"을 보유하고 있으며, 차세대 3D 기술인 "홀로그램"과 "무안경 3D" 분야에서 국내 최고의 기술을 보유

• ㈜아이디로 •
세계최초 가시광 RFID를 중심으로 고성능 UHF RFID 장비와 시스템을 제공

• ㈜어거스트텐 •
세계최초의 디지털 이온자임 마스크를 개발/제조/판매

• 유퍼스트㈜ •
글로벌 의료 시장을 목표로 청각 장애와 난청을 해결할 수 있는 IoT 웨어러블 디바이스인 NUGUNA 솔루션을 개발

• 웰트 주식회사 •
세계 최초 벨트형 웨어러블을 출시한 헬스케어 IoT 기업

• 웹프라임 주식회사 •
다수의 GPU를 장착한 서버 한대로 다중 VR 게임을 지원할 수 있는 솔루션 개발 및 10만원이하의 보급형 저가 무선 HMD를 제조

• ㈜이너트론 ㈜보카프 •
국내외 신기술 획득과 품질, 가격경쟁력 확보를 통하여 세계 최고 기술을 보유한 수출형 강소기업으로 스마트 식품조리기기와 글로벌 가정대체식품(HMR) 간편식 플랫폼 제공

• 이노넷㈜ •
4차 산업혁명을 위한 인지무선 기술이 적용된 배낭형 이동기지국, TVWS Device 및 버스 공공 와이파이 전문기업

• 토도웍스㈜ •
휠체어를 사용하는 장애인들을 위한 기술을 개발하는 엔지니어링 회사입니다.
휠체어용 파워어시스트에 IoT기술을 접목시켜 사회적 약자가 당면하는 문제를 하나하나 해결해 나가는 소셜벤처기업.

• 하나마이크론㈜ •
IoT Wearable & Flexible 반도체 분야 글로벌 리더, IoT 서비스 플랫폼 및 IoT 융복합 디바이스 전문 기업

• ㈜후본 •
융복합 기술 기반 IoT 보안 시스템, AR/VR/360°Real Audio 기술적용 HMD, 융합 소재 3D프린터 솔루션을 개발

• GLS •
60 GHz 대역을 기반으로 한 근접거리 무선통신용 반도체 칩을 설계 및 제조하는 팹리스 업체

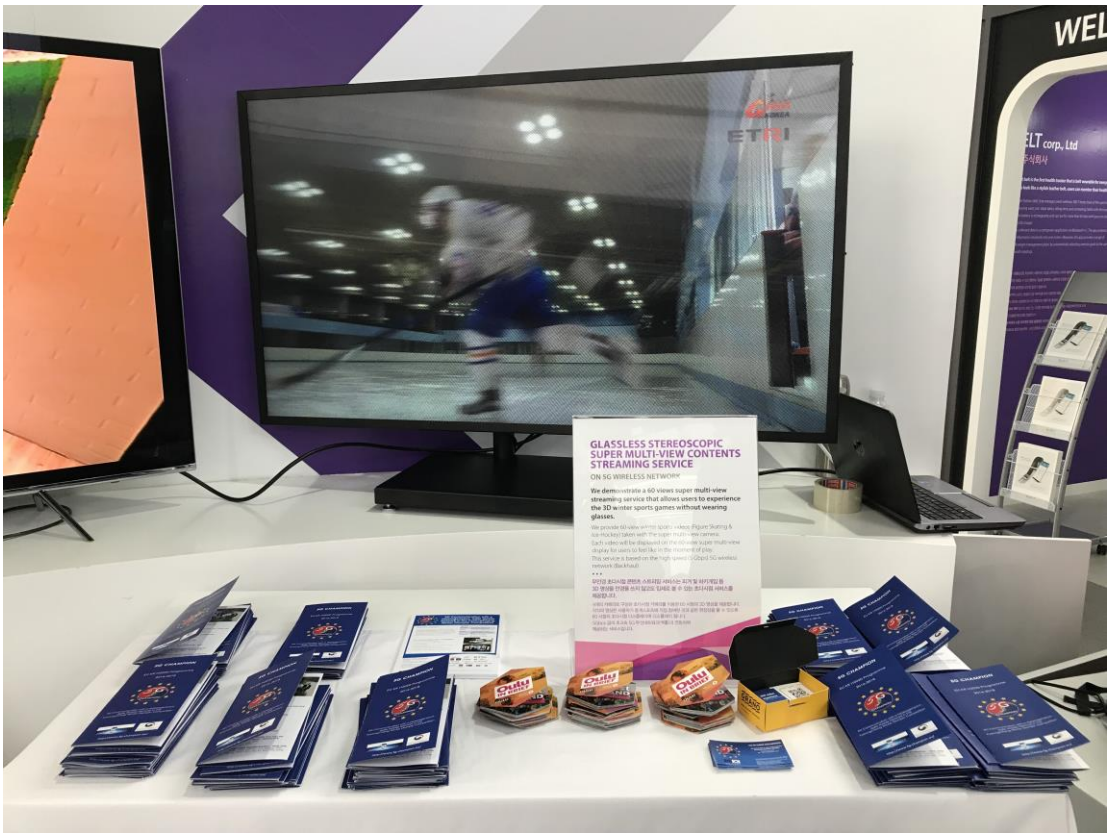
The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The 5GCHAMPION team was ready to present to the visitors the different 5GCHAMPION PoC.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.



The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

ENJOY ICT VR
WINTER SPORTS VR
CAMP VR POWDER ROOM

Among the 4500 visitors of the 19th of February week at the 5GCHAMPION booth we have been honored during the 20/02 to have the **visit of the Prime Minister of Finland, the Finish Ambassador to Korea and the Olympic.**

For this special occasion, the 5GCHAMPION consortium has prepares a specific and detailed oral presentation on 5GCHAMPION activities

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

And a very detailed visit of our demonstration booth and 5GCHAMPION bus.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Showing that we reached the 5Gb/s at a speed of 60 Km/h/

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

We also have been honored by the visit of IITP representatives.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

We have been also honored to have several people vising out boot and learning about 5G and our achievements.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

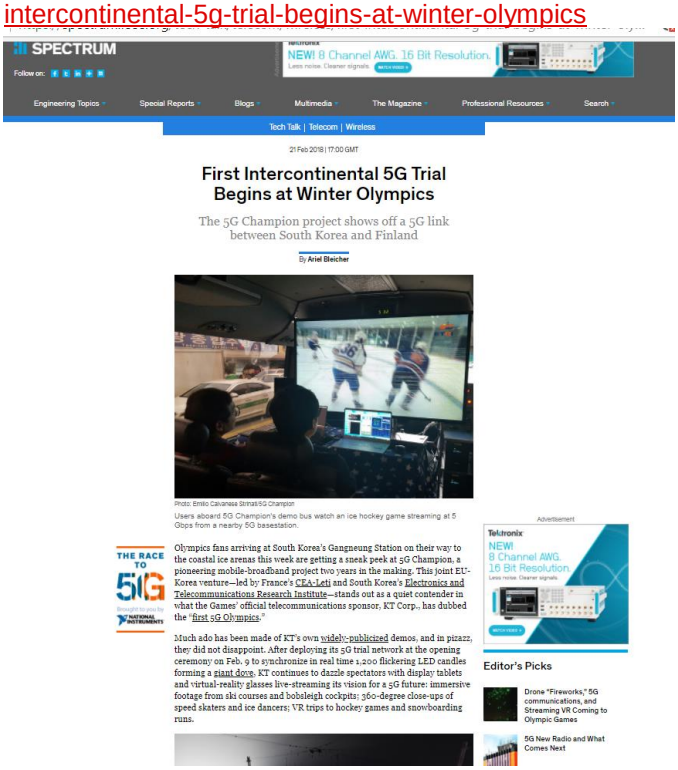
6.14 Press Releases, Press Interviews and articles, radio interview

During the last six months the 5GCHAMPION consortium has intensively disseminated in the international press its achievement and explained the next steps of the work needed to achieve immersive and reliable 5G survives. While the updates list of the more than 40 articles appeared on 5GCHAMPION, here after we present a short selection of them.

IEEE Spectrum (the most know journal of the IEEE engineering community) has published two articles on 5GCHAMPION. The first citing its work for demonstrating 5G at the Olympics and the second fully dedicated to 5GCHAMPION and its achievements ("First Intercontinental 5G Trial Begins at Winter Olympics - The 5G Champion project shows off a 5G link between South Korea and Finland") https://spectrum.ieee.org/tech-talk/telecom/wireless/first-

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

intercontinental-5g-trial-begins-at-winter-olympics .



Some other recent articles (this is not an exhaustive list) appeared on the international press are:

Microwave Journal

http://www.microwavejournal.com/articles/29801-eu-south-korean-project-will-demo-5g-system-prototype-at-2018-winter-games

5G Router – link to Microwave Journal article

http://www.5g-router.com/tag/5g-posts/page/3/

Telecoms Tech News

https://www.telecomstechnews.com/news/2018/feb/15/eu-and-south-korea-partner-champion-5g-winter-games/

Everything RF

https://www.everythingrf.com/News/details/5647-2-5-Gbps-Prototype-5G-System-to-be-Demonstrated-at-the-2018-Winter-Games-in-South-Korea

EE News Europe

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

http://www.eenewseurope.com/news/eu-south-korean-project-demonstrate-5g-system-2018-winter-games

Electronics Weekly

https://www.electronicsweekly.com/news/design/communications/5g-comms-prototype-2018-winter-olympics-2018-02/

Sensors Mag

https://www.sensorsmag.com/components/5g-prototype-debuts-at-2018-winter-games

Electronics Specifier Wireless

https://wireless.electronicspecifier.com/5g/5g-system-prototype-unveiled-at-2018-winter-games

Electronics 360

http://electronics360.globalspec.com/article/11149/at-the-2018-winter-olympics-eu-south-korean-project-to-demo-5g-system-prototype

Evaluation Engineering

https://www.evaluationengineering.com/consortium-demo-world%E2%80%99s-first-5g-platform-winter-games

Times Tech

http://www.timestech.info/2018/02/eu-south-korean-project-will-demonstrate-5g-system-prototype-2018-winter-games/

Components in Electronics

http://www.cieonline.co.uk/eu-south-korean-project-will-demonstrate-5g-system-prototype-at-2018-winter-games/

Nanotech Now

http://www.nanotech-now.com/news.cgi?story_id=54982

EDACafé

https://www10.EDACafe.com/nbc/articles/view_article.php?articleid=1565665

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

News Now – link to EE News Europe article
http://www.newsnow.co.uk/h/Technology/Internet/5G

7 5G CHAMPION Website

A 5G CHAMPION project website has been implemented at the following registered address: www.5g-champion.eu/. The objective of this website is to provide an international visibility on the project scope, consortium, scientific activities and contributions, and public results.

7.1 Website structure

The web site contains the following facilities:

- The website home page (Figure 14) with the project loge, name, objectives, consortium, and an overview technical key contributions,
- A menu bar with folding list giving direct access to all the others pages,
- Several static pages regularly updated by the Administrators (CEA): news, project, consortium, advisory board, results, links, and contact.

To help understand the usage of the website, the website was registered with the free Google Analytics facility. This will allow rich reports to be run on the website, giving a very clear picture of information such as:

- How many users are visiting the site,
- Where are visitors coming from geographically?

The 5G CHAMPION project website is hosted by the project coordinator, CEA, and is under its responsibility. The website will remain functional and updated at last one year after the end of the project. The project coordination team edits the site content and collects the necessary materials.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

Figure 14: 5G CHAMPION website home page.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

7.2 Project

The menu Project contains two different pages: project overview (Figure 15) and project structure. The first page presents briefly the project and the 5G CHAMPION system concept implementation. Instead, the page project structure presents in details the seven project work packages.

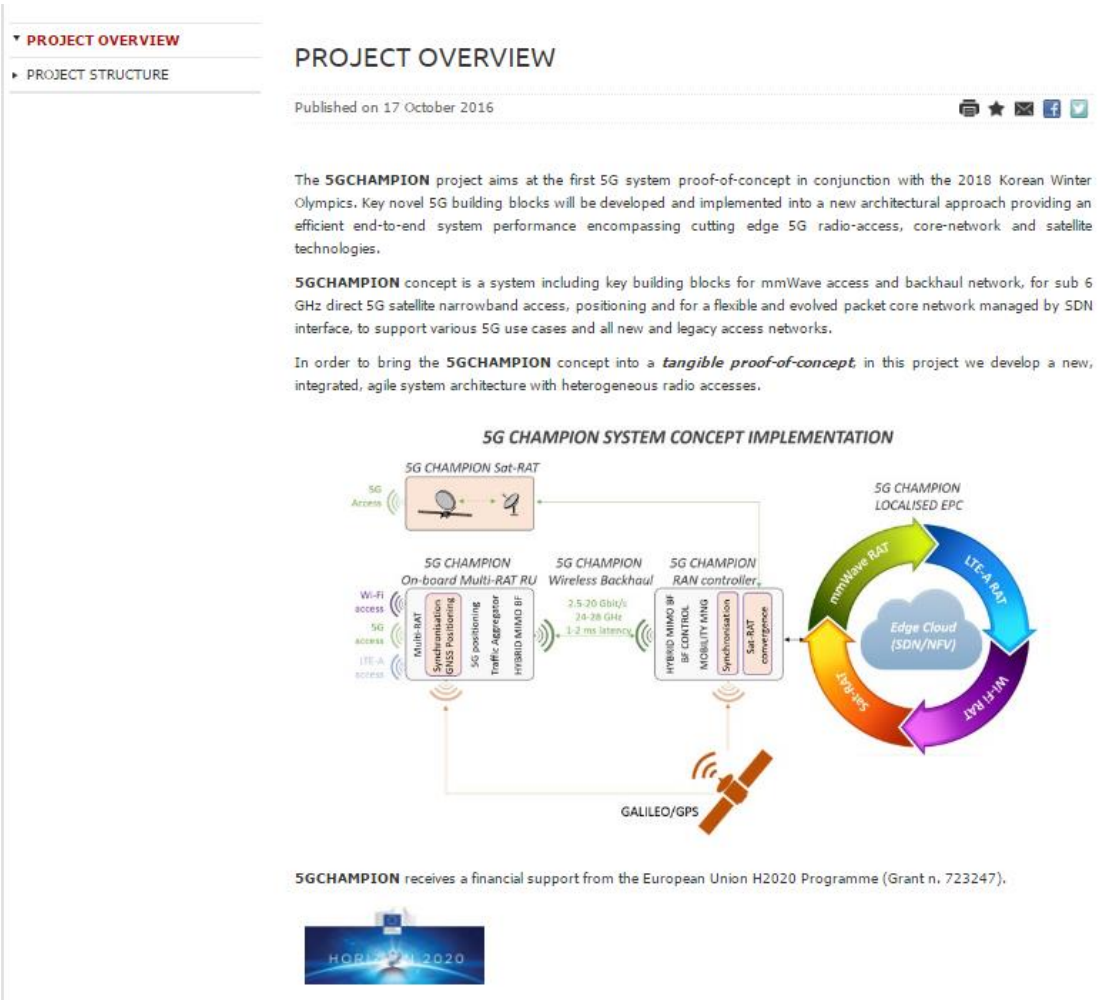


Figure 15: 5G CHAMPION website project structure page.

7.3 Results

The menu results (Figure 16) contains several web page resuming all the results of the 5G CHAMPION project: presentations, deliverables, publications, workshops, keynotes and invited talks, and demos.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

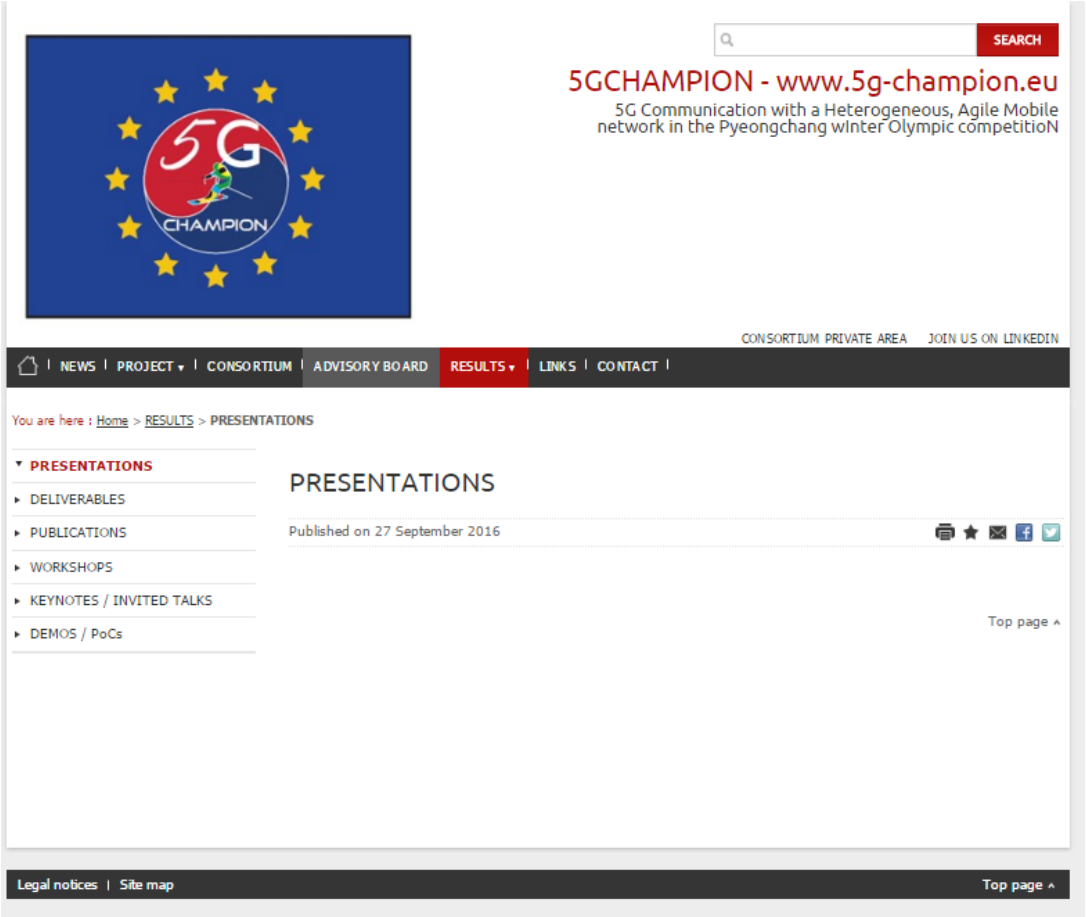


Figure 16: 5G CHAMPION website results page.

7.4 Links

This page lists links to other web sites of the related collaborative projects. These links will be checked periodically by the webmaster and updated if necessary.

7.5 Contacts

The page contacts (*Figure* 17) provides the contact information to the project coordinator and management team with workpackage leaders.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

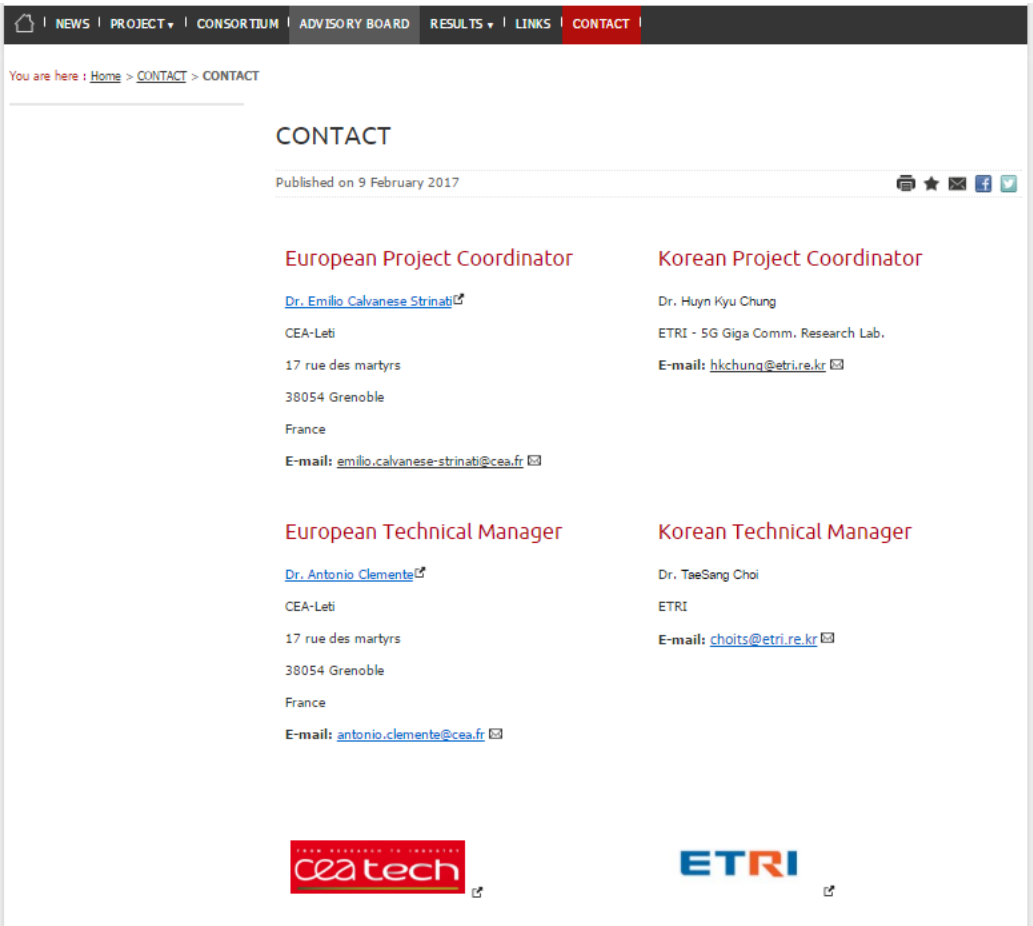


Figure 17: 5G CHAMPION website contacts page.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

8 Collaboration with other research projects

5G CHAMPION has been collaborating with other projects in order to extend 5G CHAMPION consortium collaboration to other European Commission projects in H2020. More precisely 5G CHAMPION has organized jointly with MiEdge project two major events in 2016 and 2017:

- '10th International Workshop on Evolutional Technologies & Ecosystems for 5G and Beyond (WDN-5G ICC2017)' that will be held in Mai 2017 at IEEE ICC conference, Paris (http://icc2017.ieee-icc.org/); (ii) The special session at 5G Berlin Summit 2016 on 'Joint 5G Projects and Trials' (http://www.5gsummit.org/berlin/).
- 5G CHAMPION has planned on 10-11/10/2016 a joint workshop (http://zzzdana.wixsite.com/ict-techday) in Seoul with WiseIoT and Basamati EU-KR projects.

5G CHAMPION has been discussing with mmMagic 5G PPP phase 1 project on network prototyping. A joint participation was organized to the IP9 industrial panel held at IEEE Globecom 2016 with title "5G Networks Prototyping: Entering the Next Phase of Experimentation for Future Radio Access Technologies" on 7th of December 2016.

Furthermore in order to maximize the European momentum towards, and benefits from, the future 5G integrated, ubiquitous and ultra-high capacity networks, 5G CHAMPION has been paving the way for collaborating with ongoing 5G PPP phase 1 projects and with the 5G-Infrastructure Association and the NetWorld2020 European Technology Platform.

5G CHAMPION has furthermore had an active collaboration and exchanges with 5G PPP phase 2 projects in the wireless strand.

Furthermore, 5G CHAMPION has been in discussion with the GK-5G project (Project Name: 5G mobile communication system development based on mmWave) and QK-5G project (Project Name: Development of 5G Mobile Communication Technologies for Hyper-connected smart services) in Korea. Technical discussions for the related issues and joint contributions for the IEEE and 3GPP standardizations have been finalized.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

9 Cross Korean / European Collaboration Benefits

5G is a ***global*** revolution and it requires cross-national validation and **cross-continental** interoperability and economical sustainability validation. Regulation on 5G spectrum is already globally discussed and indication on potential '*5G new bands'* has been indicated by the WRC'15 [10]. Final decision is expected by 2019 during the WRC'19. WRC'19 decision will be based on several parameters: political, economic and technical. Therefore 5G ecosystem cannot wait 2020 for a full scale validation of 5G technology and related services.

Industry, SMEs, Operators and academia from two of most active areas of the world on 5G revolutions - Korea and Europe - decided to federate in order to anticipate the validation of **potentials of on 5G** key enabling technologies **in 2018**, delivering a joint an unprecedented proof-of-concept show cased at the **2018 Winter Olympics** in PyeongChang, Korea.

5G CHAMPION started in July 2016 and since then bilateral benefits of Korean-European collaboration were showing a tremendous pay-off for 5G CHAMPION partners, Korean and European ecosystems. In a global scale, the worldwide 5G community benefits from active 5G CHAMPION dissemination activities.

The 5G CHAMPION consortium indeed sees specific benefits for:

- **Korean and European Consortium members** which can drive the development of a holistic and global fully integrated 5G system definition and solutions. This creates momentum for strengthening the cooperation between Europe and Korea for ***future research projects*** not only at the consortium scale but also between Korean and European future collaborations frameworks under discussion. Today, 5G partners experience that joining forces in such unique collaborative ecosystem give them an edge in the attempt to get ahead of the game in developing ultra-fast 5G wireless communications networks and preparing global standardization for it.
  Industry, service providers and operators have used practical feedback to improve reliability and performance of the newly developed products and related services from both Europe and Korean market players. Moreover, working together towards global standards for 5G, in support of ongoing standardization in relevant fora, such as 3GPP and ITU and indeed developing common interest in research activities and products ensuring global 5G interoperability. Specifically from satellite perspective and related service provisioning, Cooperation between Korea and Europe is spreading the usage of Galileo in Asia with win-win benefits.
- **5G Global Community** which benefits from a very vivid and active dissemination activity from 5G CHAMPION. 5G CHAMPION has produced common interest and forged a consensus on specific key 5G functionalities that have been proven in 2018. Europe, Korea and in a global scale many other countries in the world have demonstrated strong interest on 5G CHAMPION activities. For instance 5G CHAMPION has today a large community that follows actively 5G CHAMPION news and achievement. Today the 5G CHAMPION LinkedIn group accounts for about 350 members.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

10 Corrective Actions

The 5G CHAMPION consortium has been highly productive and successful in terms of standardization, regulation and dissemination activities throughout its lifetime. No corrective actions were required.

11 Conclusion

The 5G CHAMPION project has been a tremendously enriching experience for all participants from a technical, political and intercultural standpoint. The consortium partners have been able to foster new ties across the globe, establish new academic and industrial relationships and win new insights into the way of working in a different culture.

Overall, the project has fully met or exceeded its original objectives in terms of dissemination, influencing of standards bodies and regulation administrations, creation of new state of the art and knowledge in the field.

The key highlight of 5G CHAMPION was certainly the successful participation to the Pyeongchang Winter Olympic Games with a Proof of Concept platform. This objective has been fully achieved and created tremendous visibility for the work of the consortium well beyond the expected level.

We expect that those results and new relationships will outlast the lifetime of the project by far.

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.

12 References

[1] D. Flore, "RAN workshop on 5G: Chairman summary," RWS-150073, Sep. 2015. [Online]. Available: ftp://ftp.3gpp.org/workshop/2015-09-17_18_RAN_5G/Docs/RWS-150073.zip.

[2] 3GPP TR 38.913, "Study on Scenarios and Requirements for Next Generation Access Technologies," 2016.

[3] 3GPP TR 38.802, "Study on New Radio (NR) Access Technology Physical Layer Aspects," 2016.

[4] http://www.ieee802.org/15/

[5] Junhyeong Kim et al., "Mobile Wireless Backhaul for Fast Moving Cells", IEEE 802.15-14-0671-00-wng0, Nov. 2014

[6] Ke Guan et al., "Mobile Channel Characterization in Typical Subway Tunnels at 30 GHz", IEEE 802.15-15-0666-02-hrrc, Sep. 2015

[7] Ke Guan et al., "Ray-tracing based Study on Mobile Channel in Typical Urban Environment with Various Beamforming Strategies at 32 GHz", IEEE 802.15-15-0837-01-hrrc, Nov. 2015

[8] Sung-Woo Choi et al., "Performance Evaluation of Millimeter-wave-based Communication System in Subway Tunnels", IEEE 802.15-16-0185-01-hrrc, Mar. 2016

[9] https://mentor.ieee.org/802.15/documents

[10] World Radio Conference 2015, see http://www.itu.int/en/ITU-R/conferences/wrc/2015/Pages/default.aspx

[11] World Radio Conference 2019, see http://www.itu.int/en/ITU-R/conferences/wrc/2019/Pages/default.aspx

The information contained in this document is the property of the contractors. It cannot be reproduced or transmitted to thirds without the authorization of the contractors.