ICT Beyond 5G Cluster: Seven H2020 for future 5G

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***Abstract*—This paper presents a wide international initiative for the joint dissemination and exploitation of the results of seven European Commission Horizon 2020 projects, funded in the call ICT-09-2017 and joint Eu-Japan. The aim of the Beyond 5G Cluster is to offer a response to new challenges of future networks with above state of the art technologies covering all the major communication area from Gb/s to Tb/s.**

Keywords—ICT, H2020, 5G, millimeter waves, THz, Tb.

I. INTRODUCTION

While 5G networks has an established roadmap towards technology validation, specifications and tests by industry, outstanding new scientific opportunities are blooming in the field of networking research, with the objective of bringing little explored technologies and system concepts closer to exploitation. The challenge is to support European scientific excellence across a range of related domains and to bring the most promising long term research coming from the labs closer to fruition. This includes perspectives for the full exploitation of the spectrum potential, notably above 90 GHz, with new waves of technologies and knowledge, bringing wireless systems to the speed of optical technologies, opening opportunities for new applications. It includes interaction with photonic systems as well as new cooperation in networking and protocols, notably in the mobility context.

Development and exploitation of academic research through transfer and innovation towards industry with a particular focus on SMEs is an integral part of the challenge. These seven H2020 projects have agreed to form an unofficial cluster in order to try to coordinate dissemination activities to maximise the impact of the projects.

II. THE PROJECTS IN THE ICT BEYOND 5G CLUSTER

A. *DREAM – D-band Radio solution Enabling up to 100 Gbps reconfigurable Approach for Meshed beyond 5G networks*

The DREAM project [1], through the exploitation of the radio spectrum in D-band (130-174.8 GHz) with beam steering functionality will enable wireless links with data rate exceeding current V-band and E-band wireless backhaul solutions by at least a factor of 10 and thus, it will bring wireless systems to the speed of optical systems. The DREAM project vision and objectives rely on a power efficient and silicon based BiCMOS transceiver analog front end, operating in D-band and enabling cost efficient deployment of meshed networks with seamless fiber performance. A beam steering integrated antenna array using an intelligent low-cost packaging technology prototype will be developed for the implementation of the beyond 5G network proof of concept in a realistic environment.

B. *EPIC – Enabling Practical Wireless Tb/s Communications with Next Generation Channel Coding*

EPIC [2] aims to develop a new generation of Forward-Error-Correction (FEC) codes to enable practical wireless Tb/s link technology—corresponding to a 10x–100x throughput improvement over the SoA. The EPIC concept and methodology are shaped by the key finding that routine progress in silicon technology in the next decade will not be sufficient to allow FEC implementations to break the Tb/s barrier; Tb/s FEC will require not only help from silicon technology but also major innovations in FEC algorithm design and implementation domains. A key EPIC objective is therefore to develop and utilize a disruptive FEC design framework that considers the FEC algorithm design and corresponding silicon implementation architectures in a unified fashion. Through such an integrated approach, EPIC aims to advance state-of-the-art FEC schemes (mainly Turbo, LDPC and Polar codes) to obtain the principal channel codes for beyond-5G (B5G) use-cases. Top-performing solutions developed under EPIC will be validated by virtual silicon tape-out implementations, thus providing first-in-class FEC blocks of wireless Tb/s technology.

C. *TERAPOD – Terahertz based Ultra High Bandwidth Wireless Access Networks*

The aim of TERAPOD [3] is to investigate and demonstrate the feasibility of ultra-high bandwidth wireless access networks operating in the terahertz band. The project will focus on an end-to-end demonstration of THz wireless links within a data centre proof of concept deployment, while also investigating other use cases applicable to beyond 5G such as wireless personal area networks, wireless local area networks and high bandwidth broadcasting. The project seeks to bring THz communication closer to industry uptake through leveraging recent advances in

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THz components, a thorough measurement and characterization study of components and devices, coupled with specification and validation of higher layer communication protocol specification.

D. *TERRANOVA – Terabit/s Wireless Connectivity by TeraHertz innovative technologies to deliver Optical Network Quality of Experience in Systems beyond 5G*

TERRANOVA [4] aims to provide ultra-high data rates combined with agility, reliability and almost-zero response time, leveraging THz communication technology advances. Target scenarios include the use of wireless THz links as: (i) backhaul extension of the optical fibre and (ii) connectivity solutions for the increasing number of devices in the communication to or between cell towers (backhaul) as well as between remote radio heads and centralised baseband units (fronthaul). In all these beyond 5G scenarios, THz communications are expected to play a decisive role and TERRANOVA aspires to contribute to the definition of the system concept/architecture, the design of enabling technologies, as well as the evaluation and validation of the proposed innovations. To this end, TERRANOVA focuses on:

- The validation of disruptive concepts, namely the co-design of optical and wireless, backhaul and access; the co-design of channel models and waveforms, signals and coding, pencil beam-patterns and medium access control schemes.
- Proof of applicability of new spectrum regions, by validating cost efficient silicon technologies and DSP.
- Advances in signal processing, including the development of DSP algorithms for combined fibre-optic and THz links.
- The development of two proof-of-concept demonstrators, namely a THz Beamforming and a THz High-capacity Demonstrator, to validate TERRANOVA solutions for HF-frontend, MAC, PHY and combined optical-THz system.

E. *ThoR: TeraHertz end-to-end wireless systems supporting ultra high data Rate applications*

ThoR [5] is a joint EU-Japan project (H2020-NICT) which will provide technical solutions for the backhauling and fronthauling of data traffic at the novel spectrum range near 300 GHz, which is able to cover the data rates of 200+ Gbps required for B5G systems. Fibre optic networks cannot provide connections to the hugely increased number of nodes due to the prohibitive costs. Therefore, the use of currently unused spectrum for wireless links operating at disruptive bandwidths of several 10's of GHz beyond 252 GHz, will be a critical key enabler for the introduction of B5G networks. ThoR will make this happen by demonstrating that such a solution is technically possible and by actively supporting the corresponding spectrum identification for land mobile and fixed services at the World Radio Conference (WRC) 2019.

F. *ULTRAWAVE Ultra capacity wireless layer beyond 100 GHz based on millimeter wave Traveling Wave Tubes*

ULTRAWAVE [6] aims to build a ultracapacity layer with more than 100 Gb/s/km^2 to support the increasing request of high data rate backhaul networks For the first time a point to multipoint coverage at D-band (141 – 148.5 GHz) will be deployed by a number of area sectors fed by high data rate link (about 30Gb/s) at G-band (275-305 GHz). D-band transmission hub and terminals are in design and fabrication phase. Traveling wave tubes are the enabling devices for providing transmission power to overcome the high atmosphere and rain attenuation above 100 GHz. The complete MMIC chip set, antennas, synthesiser and subassembly are in progress. The G-band front end includes an optical transmitter to generate the data rate and is powered by a novel traveling wave tube.

G. *WORTECS – Wireless Optical/Radio TErabit CommunicationS*

WORTECS [7] aims to offer:

- Optical Wireless Communication (OWC), Fiber Wireless Fiber (FWF) and radio over 90 GHz Proof of Concept (PoC) with several Gigabit per second (Gbps) throughput: innovation on antenna, coding and other PHY/MAC improvements.
- Heterogeneous wireless Network architecture (HetNet) studies with new architectures and protocols for routing, latency and caching.

Last but not least, the customer views will be taken into account through interviews, questionnaires and field tests. The purpose is to provide a Virtual Reality user-friendly interface with a homogeneous solution including several Gbps data rate, reduced latency and multi-user environment associated with an accurate tracking.

III. Dissemination Strategy

The seven projects described above are funded through the EU's Horizon 2020 funding mechanism (and ThoR is jointly supported by the Japanese NICT). Since the objectives are overlapping and the research areas are inter-linked, the projects have independently agreed to form a cluster in order to more effectively share and disseminate information among themselves and to a wider audience. The participation to this session is one of a number of joint events and publications: see https://terapod-project.eu/links/ict-09-2017-cluster for more information.

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