ITRI
Industrial Technology
Research Institute

H2020: Future Internet Program ITRI’s Participation

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ICL/ITRI

3GPP Summit
Standards Timeline for 5G

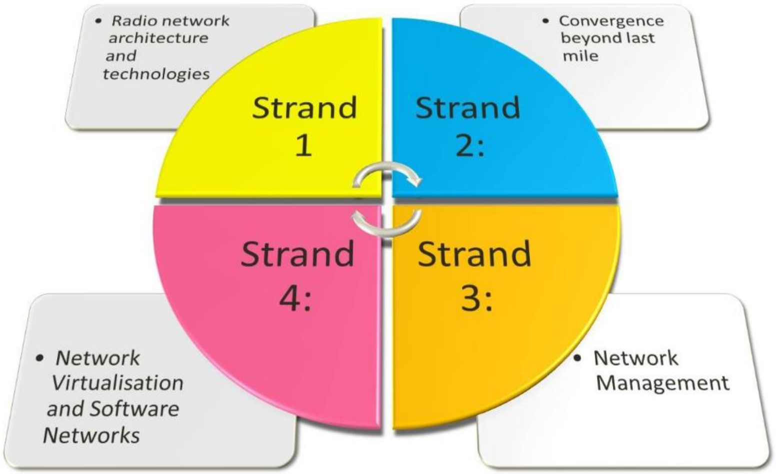
GIS MOTC Convention Center
Taipei, Taiwan, 24 November 2015

ICT 14 in H2020

Three pillars in H2020

Excellent Science Base	Industrial Leadership	Societal Challenges
• **ERC:** Excellent basic research • **Marie Curie:** Excellent training and mobility • **Future Emerging Technologies** • **Research Infrastructure**	• ICT • Nanotechnologies • Biotechnologies • Space • Advanced manufacturing and processing • Advanced materials	• Health and demographic change • Sustainable agriculture and bio-economy • Clean energy • Transport • Climate Action & Ressource efficiency • Inklusive, innovative und reflective societies • Secure societies

ICT 14 call



ICT 14 call: 4 strands

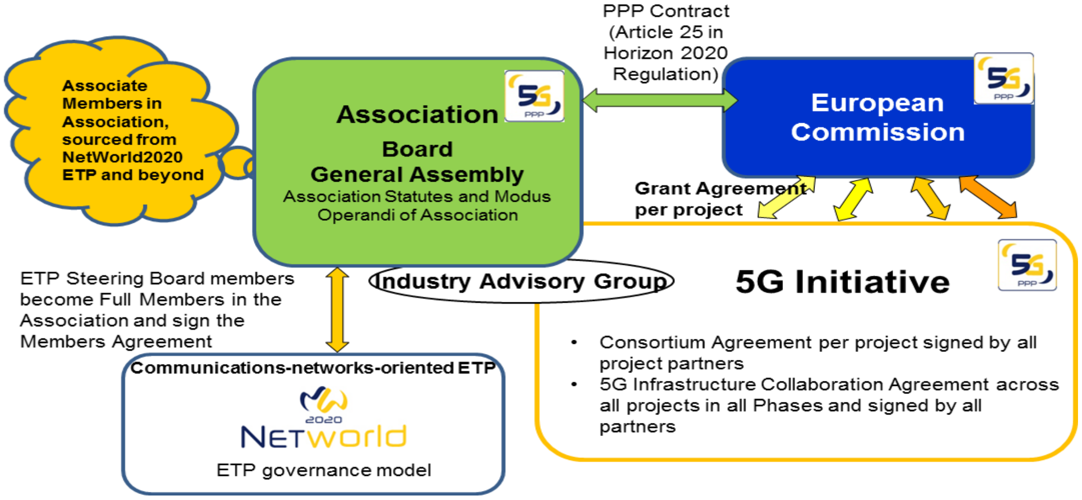
Strand 1: Radio network architecture & technologies
Strand 2: Convergence beyond last mile
Strand 3: Network management
Strand 4 : Network Virtualization and Software Networks

Source:5GPPP, EC H2020 5G Infrastructure PPP Pre-structuring Model RTD & INNO Strands (Version 2.0).

5GPPP In H2020 ICT14

- 5G PPP is a research program in Horizon 2020 of the EU dedicated to 5G system research
- Set up pre-structuring model in response to ICT14 call
- 5G Infrastructure Association vision paper published at MWC 2015

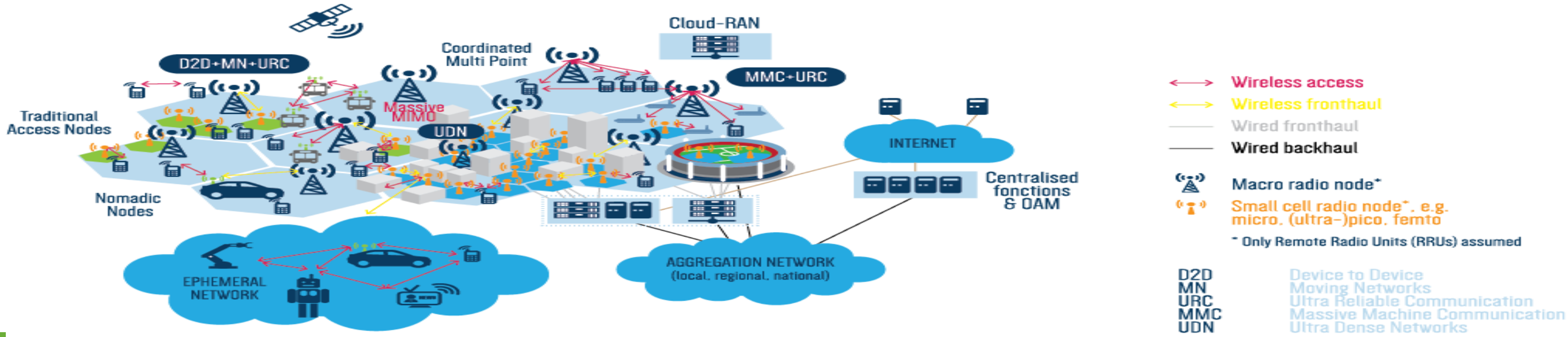
http://5g-ppp.eu/wp-content/uploads/2015/02/5G-Vision-Brochi



Source: 5GPPP, 5G Infrastructure PPP Information Day April 28, 2014 – Paris

Key Requirements & Network Architecture

- 1,000 X in mobile data volume per geographical area, target ≥ 10 $Tb/s/km^2$
- 1,000 X number of connected devices, density ≥ 1M $terminals/km^2$
- 100 X in user data rate, peak terminal data rate ≥ 10Gb/s
- Guaranteed user data rate >50Mb/s
- 1/10 X in energy consumption compared to 2010
- 1/5 X in end-to-end latency reaching 5 ms for e.g. tactile Internet & radio link latency target ≤ 1 ms for e.g. Vehicle to Vehicle coms.
- 1/5 X in network management OPEX
- 1/1,000 X in service deployment time reaching a complete deployment in ≤ 90 minutes
- Mobility support : speed up to 500km/h for ground transportation
- Accuracy of outdoor terminal location ≤ 1m



Source: http://5g-ppp.eu/wp-content/uploads/2015/02/5G-Vision-Brochure-v1.pdf

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5G PPP Phase I Projects

3GPP A GLOBAL INITIATIVE

5G Crosshaul the integrated fronthaul/backhaul
METIS II
sonata
FANTASTIC 5G
5G-XHaul
mmMAGIC
5G NORMA
Selfnet
VIRTUWIND
EURO 5G
Speed5G
CHARISMA
5GEx
Coherent
SESAME
CogNet
5G-Ensure
SUPERFLUIDITY

July 2015 ~ Dec 2017

METIS-II Objectives & Partners

1 — Develop the overall 5G radio access network design

2 — Provide the 5G collaboration framework within 5G-PPP for a common evaluation of 5G radio access network concepts

3 — Prepare concerted action towards regulatory and standardisation bodies

https://metis-ii.5g-ppp.eu

19 Partners:

- Operators: NTT Docomo, Orange, DTAG, Telefonica, Telecom Italia
- Vendors: Ericsson, Nokia, Huawei, ALU, Samsung, Intel
- Academia (in Europe): KTH, Uni Valencia, Uni Kaiserslautern
- SMEs: iDate, Janmedia
- Non-European partners: NYU, Winlab, ITRI

Project coordinator: Ericsson

Technical manager: Nokia

METIS-II RAN Design

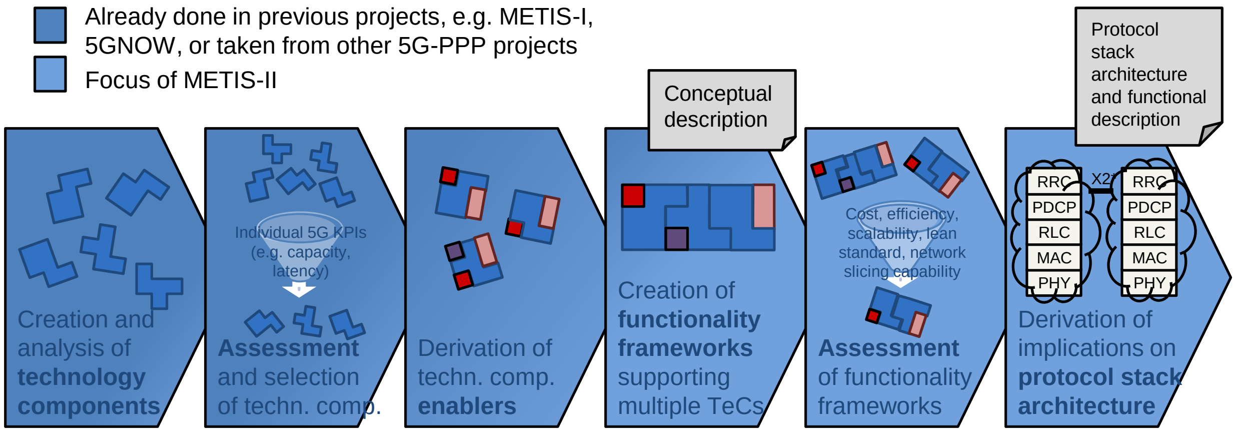
The METIS-II 5G RAN design will comprise

•the potential **spectrum usage** foreseen for 5G

•the **air interface variants** expected to be introduced in 5G or evolved from legacy

•**descr. how air interface variants (LTE/5G) will be integrated** (extend of harmonization, protocol level of aggregation etc.)

•a **comprehensive control and user plane design** of a 5G RAN, to the level of detail of "technology readiness level 2"



Protocol layers in focus:
•PHY investigated from harmonization / integration perspective
•MAC, RLC, PDCP, RRC (or 5G equiv.) designed in detail

The **protocol stack architecture and functional description** are expected to be the most suitable format to feed into standardization

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Holistic Air Interface Harmonization Framework

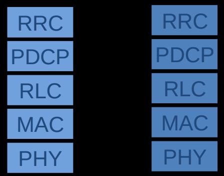
Protocol stack examples only!

Key problems to be addressed:

- Selection of air interface (AI) variants incl. evolved legacy to cover overall 5G requirements space
- Harmonization and integration of AI variants for the sake of a lean standard, efficient implementation, and as enabler for the other innovation pillars

Legacy (or unfortunate 5G outcome):

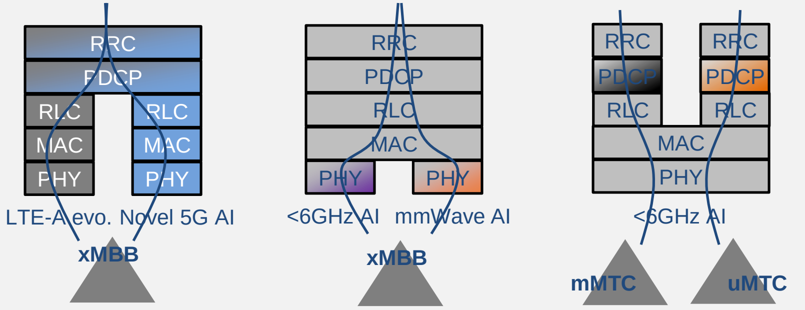
Air interface variants tailored towards different services, cell types, frequency bands, spectrum usages etc.



Legacy examples could be LTE-A, Wi-Fi, LORA etc.

Targeted 5G System

Maximum extent of harmonization and integration of AI variants (without performance sacrifice) to jointly cover all 5G services



Example: xMBB served via LTE-A and a novel 5G AI in dual connectivity

Example: xMBB served via co-located wide area and mmWave AIs with carrier aggregation

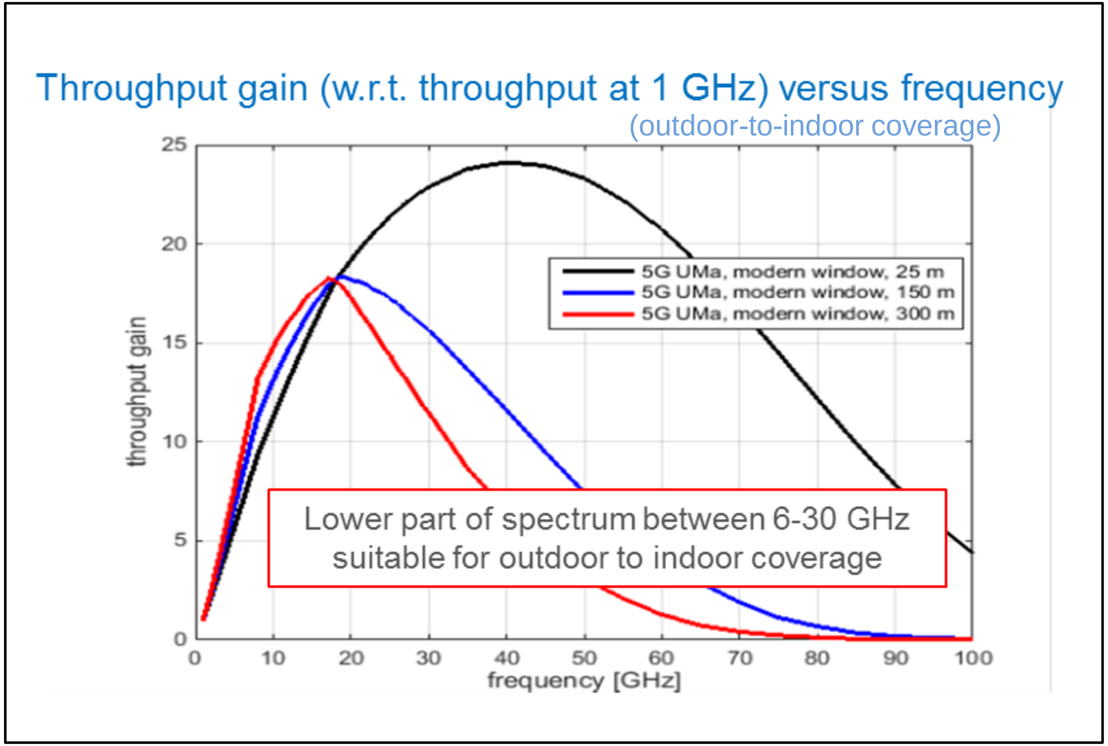
Example: uMTC and mMTC served by the same MAC/PHY (but different PDCP flavors)

Please note that:

- Suitable extent of harmonization and integration to be researched in METIS-II
- METIS-II takes orientation in 3GPP protocol names, but does not exclude changes
- Key research in METIS-II is to see how Network Slicing is reflected in RAN design

5G RAN Design Criteria Identification: Spectrum Considerations

Conclusions from report R 3.1, publicly available on https://metis-ii.5g-ppp.eu/

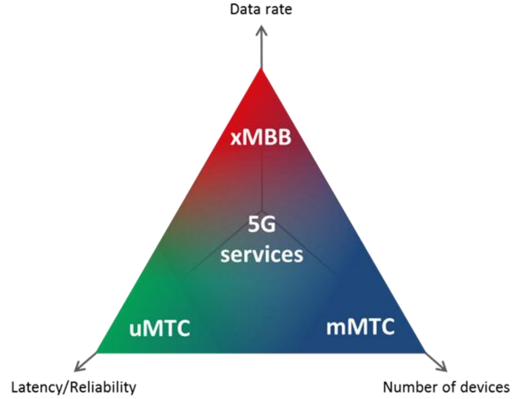


Additional spectrum bands are needed to satisfy all 5G use cases, and the whole range 6-100 GHz needs to be studied

5G success depends on the access to contiguous, wide and globally harmonized new frequency bands

5G services and use cases in METIS-II

Both extreme high data rates and low-latency communications, and extreme coverage



Ultra-reliable low-latency and/or resilient communication links for network services

Wireless connectivity for tens of billions of network-enabled devices

Use Case Set

- METIS-I
- ITU-R
- 3GPP
- NGMN
- Other EU projects

5G Use Cases in METIS-II

Service type	Use case	Scope of Requirements (Network/User Perspective)	Scope of Services (Service Perspective)
xMBB, mMTC	Dense Urban Information Society	Experienced user data rate / Traffic vol. per subscriber / Nb. of users & devices / Energy efficiency	Broad range of communication services covering needs related to both indoor and outdoor urban daily life (excl. office and factory)
xMBB	Virtual Reality Office	Experienced user data rate/Traffic volume per subscriber/ Latency	Broad range of communication services in in the (indoor) office context
xMBB	Broadband Access Everywhere	Experienced user data rate / Availability / Mobility / Energy efficiency	Full coverage topic addressing outdoor/indoor communication needs especially in rural areas
mMTC	Massive Distribution of Sensors and Actuators	Availability / Number of devices / Energy efficiency	Broadest range of IoT services covered
xMBB, uMTC	Connected cars	Latency/ Reliability / Mobility	Strong expectation from the (automotive) industry Belong to the first uMTC services expected to be commercialized

With these five use cases, all three generic services (xMBB, uMTC, mMTC) are being addressed.

5G-Crosshaul Objectives & Partners

1 developing an adaptive, sharable, cost-efficient 5G transport network solution integrating the fronthaul and backhaul segments of the network

2 flexibly interconnect distributed 5G radio access and core network functions

3 enable system-wide optimisation of QoS and energy usage as well as network-aware application development

www.5g-crosshaul.eu

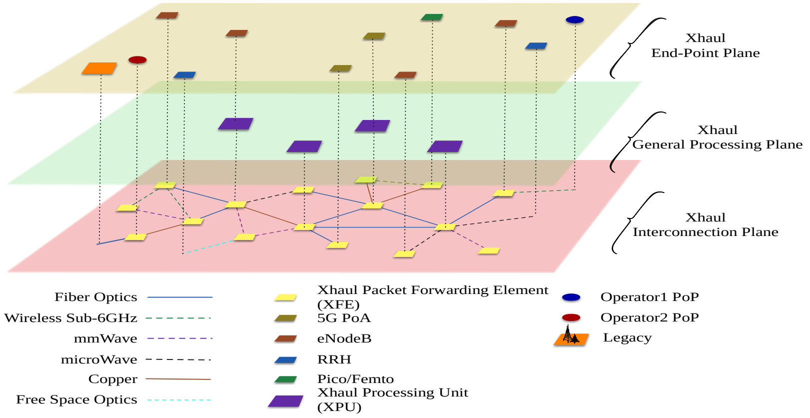
21 Partners:

- Operators: Orange, Telefonica, Telecom Italia
- Vendors: Ericsson AB, Ericsson TI, Nokia, NEC Europe, ATOS, Interdigital Europe
- Academia (in Europe): UC3M, FhG-HHI, Lunds University, CTTC, CREATE-NET, POLITO
- SMEs: CND, Telnet, EBlink, Visiona IP, Nextworks
- Non-European partners: ITRI

Project coordinator: UC3M

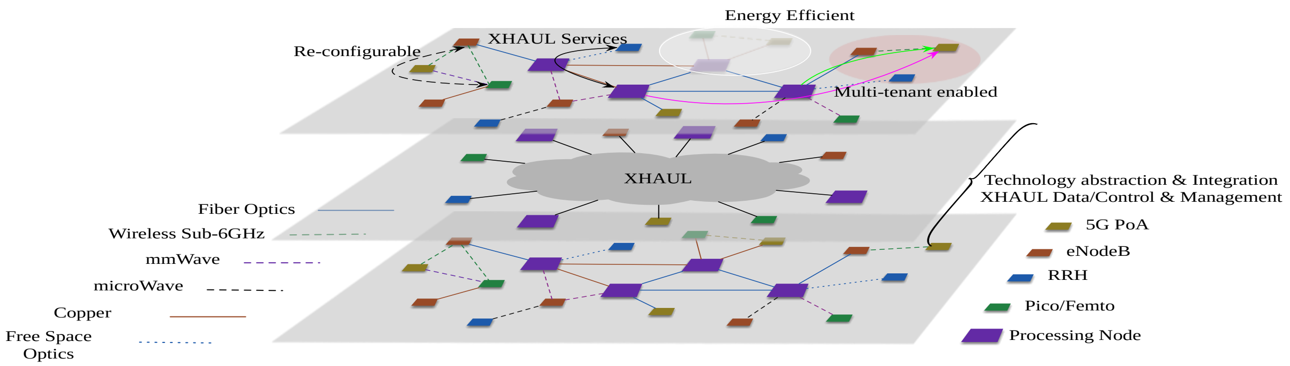
Technical manager: NEC

Physical Infrastructure of 5G-Crosshaul



- The "Interconnection Plane" makes use of **5G-Crosshaul Packet Forwarding Elements (XFE)** to **interconnect a broad set of novel technologies to create a packet-based network** that can meet the demands of 5G networks.
- The "5G-Crosshaul General Processing Plane" shows the different 5G-Crosshaul Processing Units (XPUs) that carry out the bulk of the operations in the 5G-Crosshaul.
- The different functional distributions between 5GPoA and XPU relation and the different services that can be hosted in the XPUs are represented by the different connection options between the uppermost ("End-Point Plane") and the middle layer.

Functional Architecture of 5G-Crosshaul



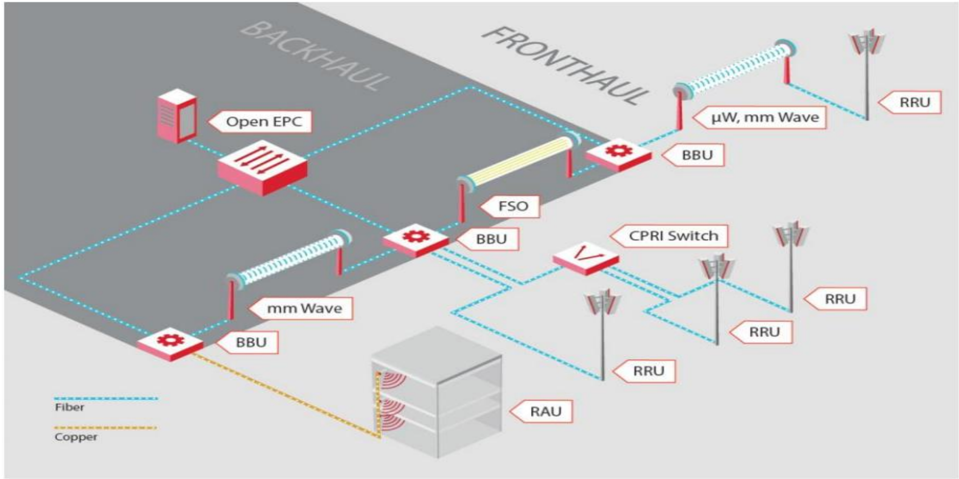
- The middle layer represents one of the key concepts associated to 5G-Crosshaul: the integration of the different technologies (including **fronthaul and backhaul**) in a common packet network based on **technology abstraction, unified framing and common data, control and management planes**.
- Finally, the upper layer presents a selection of the features offered by the 5G-Crosshaul infrastructure

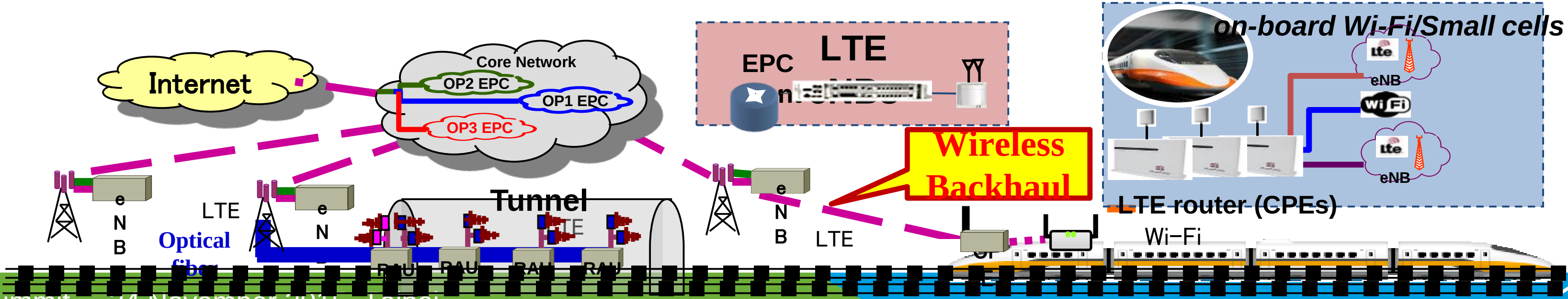
5G-Crosshaul Applications

- Multi-tenancy
- Network (re)configuration
- Infrastructure planning (capacity dimensioning) and provisioning
- Mobility management
- Energy management and monitoring
- RAN-aware Crosshaul resource management
- Virtual Infrastructure manager
- Content delivery networks
- TV broadcasting/multicasting

5G-Crosshaul Test Beds

- FhF-HHI in Berlin
  - A real world end to end network for early evaluation of 5G-Crosshaul concepts.
- HSR Test Bed in Taiwan
  - Evalutation of 5G-Crosshau Mobility





5G PPP Phase II Call

Work Programme 2016-17, 5G PPP Support lines

-154 M€ for 5G R&I and Innovation projects

-More focus on proof of concepts, experiments

-Close links to standards/spectrum expected

-International cooperation

- *EU-Japan joint call, radio access and virtualisation (€3M)*
- *EU-Korea joint call, interop framework (€3M)*
- **EU-Taiwan targeted opening, access testbeds (€5M)**

-Submission November 2016 for EU-TW proposals

EU-Taiwan Cooperation on 5G

- ICT-08-2017 (part b) : 5G PPP Convergent Technologies
- Scope : Cooperation in access convergence

This activity takes advantage of the supporting 5G research and demonstration facilities offered by Taiwan towards collaborative 5G research with the EU, and aims at developing and demonstrating an integrated convergent access across different air interface technologies and the fronthaul/backhaul/core network. Test beds making use of facilities offered by Taiwanese partners are targeted. It demonstrates the capabilities of new spectrum access schemes, including for co-working with the network. A system demonstrator showing applications potential is thus favoured, e.g. for high speed moving vehicles.

- Type of funding : Research and Innovation Actions (RIA)
- Level of Funding : €5 million

ICT-08-2017 Call Information

- Call Opens : 10 May 2016
- Call Closes : 08 November 2016
- Team composition:
  - At least 3 organizations from different EU member states
  - At least 1 participant from Taiwan and is funded by the Taiwan government
  - Industry driven activity considered as key
- Proposal evaluation : two evaluators each from EU and Taiwan
- Number of projects expected : 2

Possible Topics for EU-Taiwan Collaboration (1)

1. **5G Network Planning Tool for High Frequency Bands**
   – Use channel measurements and ray tracing-based models to implement and evaluate the effectiveness of a 5G RRH deployment tool
2. **Highly Coordinated Ultra Dense Network**
   – Efficient implementation techniques of applying network MIMO to a large number of small cell base stations
3. **Mobile Edge Networking for 5G Communications**
   – Network-driven D2D, edge computing, moving networks, and front-haul/back-haul network integration
4. **Scalable M2M Communications for IoT**
   – Random access enhancement, reduced signaling access, flexible air interface and network orchestration, and eDRX configuration optimization
5. **5G Convergence of 5G/ITS-G5 for the SeaPort of Things**
   - Mobility for the SeaPort Of Things (MobySPOT), for touristic and industrial applications. Testbeds in Livorno and Valencia

Possible Topics for EU-Taiwan Collaboration (2)

6. **Network Function Virtualization Infrastructure (NFVI)**
   - to develop a low-latency, real-time, and fault-tolerant virtualization infrastructure that is able to support NFV applications more effectively than general-purpose virtualization infrastructures, which are designed mostly for best-effort, highly-available, and throughput-oriented computing.
   - More specifically, the proposed NFV infrastructure is geared towards VM groups, each of which corresponds to a distinct virtualized network function, and is designed to run on a cellular communication system's core network as well as cloud-based RANs.
   - Looking for partners that are interested in and have expertise in building the core technologies in the proposed virtualization infrastructure as well as developing and testing novel virtualized network functions on this infrastructure.

Thank you