COSMOTE
our world is you

5G-XHaul – Dynamic Reconfigurable Optical-Wireless Backhaul / Fronthaul for 5G Small Cells and Cloud-RANs

Presenter:

Konstantinos Filis, Ph.D.

R&D Senior Engineer

2/11/2016

OTE
GROUP OF COMPANIES

5G-Xhaul Partners, Funding and Duration

12 PARTNERS

- **IHP – Innovations for High Performance Microelectronics – Germany**
- i2CAT Foundation - Spain
- Telefonica I+D - Spain
- University of Thessaly - Greece
- University of Bristol - UK
- Blu Wireless Technology - UK
- TES Electronic Solutions - Germany
- COSMOTE – Greece
- TU Dresden – Germany
- Airrays - Germany
- Huawei Technologies Düsseldorf GmbH - Germany
- ADVA Optical Networking - Germany

FUNDING: 7.3M € (H2020)

DURATION: 36 MONTHS (7/15 – 6/18)

H2020 5G-PPP

Grant Agreement No. 671551

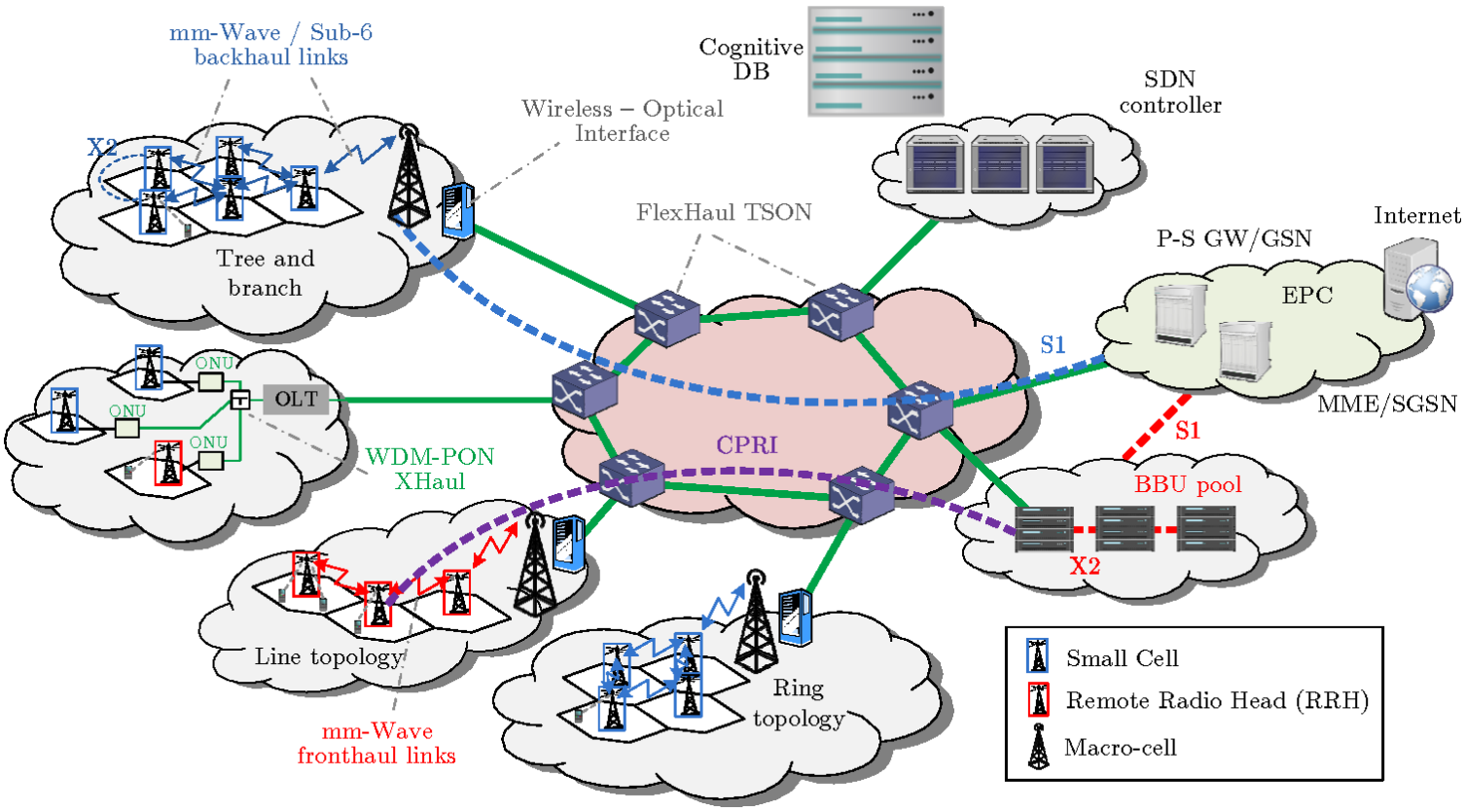
5G-XHaul Aim and Key Concepts

- 5G-XHaul aims at a converged optical and wireless network solution, relying on flexible infrastructure able to support Backhaul (BH) & Fronthaul (FH) networks required to cope with future challenges imposed by 5G Radio Access Networks (RANs).

***Key concepts*:**

- Programmable optical/wireless network elements, enabling tight control of transport network.
- Software Defined Network (SDN) architecture (control plane decoupled from individual transport network elements & logically centralized to achieve a holistic network view).
- Cognitive control plane, able to measure/forecast spatio-temporal demand variations and configure transport network elements accordingly.

5G-XHaul Architecture



Optical Technologies

- Time-Shared Optical Network (TSON)
- Wavelength Division Multiplexing-Passive Optical Networks (WDM-PON)

Wireless Technologies

- Point-to-Multipoint (P2MP) mmWave (60 GHz)
- Sub-6 GHz connectivity for users, backhaul and fronthaul

Deployment Overview: Data Plane

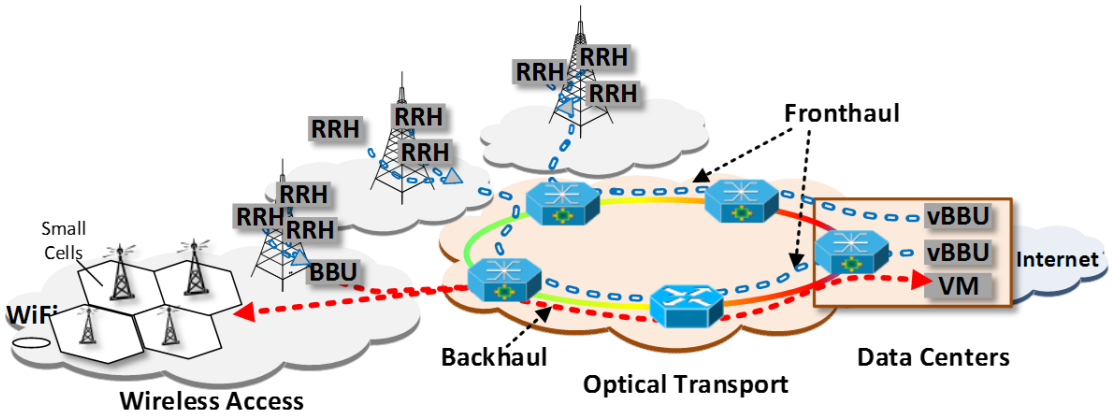
- Dense layer of small cells (complemented by macro cells) located 50-200m apart
  - Macro cell sites 500m apart
  - Small cells:
    - wirelessly backhauled to macro cell sites (mm-Wave + sub 6 GHz) or
    - directly connected to central office node through WDM-PON
- Remote Radio Heads (RRHs) connected to BaseBand Unit (BBU) pools via high bandwidth transport links (FH)
  - stringent delay & synchronization requirements
- TSON to demonstrate advanced BH capabilities (dynamic connectivity with fine bandwidth granularity)
  - supports sub-wavelegth switching, flexible frame lengths (64ns-25.6μs), variable bit rates (30 Mbps-6 Gbps)

Deployment Overview: Control Plane

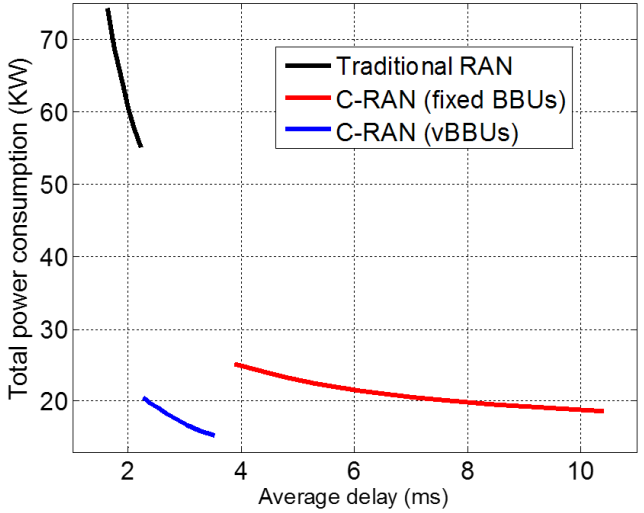
- Network slicing to support heterogeneous networks (2G/3G/4G, Wi-Fi, etc.).
- SDN to manage control plane, individually, by a logically centralized controller.
- Network Function Virtualisation (NFV) to execute network functions on commodity hardware.

Technical Innovations: Converged Architectures

- Define functional and physical transport architectures addressing the 5G design principles
- Define analytical frameworks to evaluate proposed architectures in terms of:
  - Network costs: including network and compute resources
  - Benefits of resource pooling (FH/BH, vBBUs)
  - Benefits of flexible functional splits



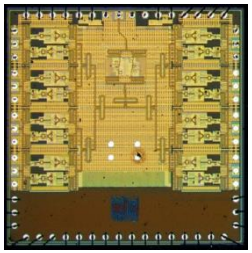
Pareto Front* of different converged architectures



*Pareto Front: The set of optimal outcomes in a Pareto optimization procedure - an area of multiple criteria decision making

Technical Innovations: Wireless

- mmWave (60GHz) Front End design
  - Antenna & BFIC
- mmWave Base Band design:
  - MIMO/Beam alignment and tracking/P2MP
  - Channel modelling
- Synchronization in wireless backhaul: IEEE 1588v2
- Functional splits for 5G-RANs:
  - Impact on transport requirements
  - Specific development for Massive MIMO
- Self-backhauling: Joint access and backhaul



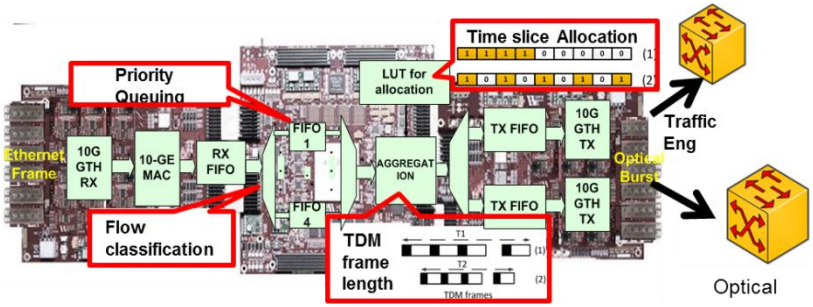
5G-XHaul mmWave BFIC

5G-XHaul mmWave nodes

Massive MIMO array supporting 5G-XHaul functional split

Technical Innovations: Optical

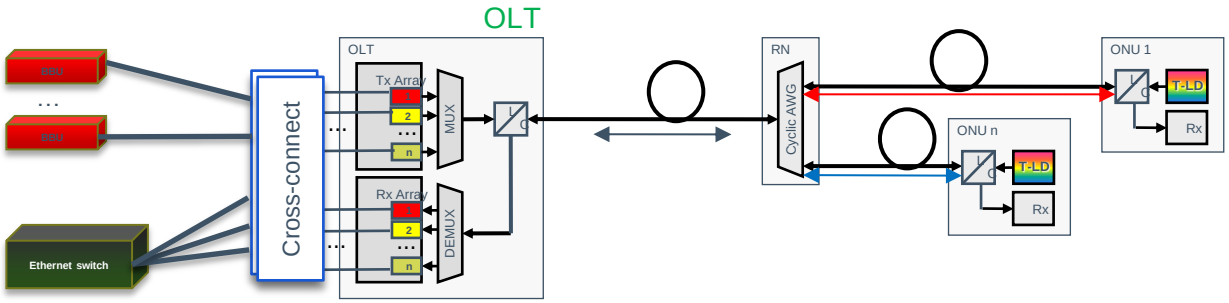
- Time Shared Optical Networks (TSON)
  - Elastic BW allocation (time slices)
  - Extensions for elastic grid
  - Native mapping of Ethernet and CPRI
  - Synchronization



Sub wavelength FPGA at edge

TSON FPGA implementation

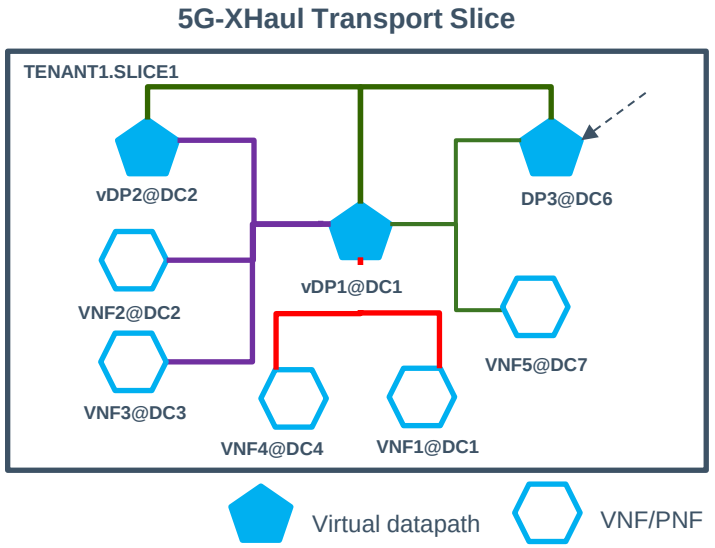
- Optical joint FH/BH enabled by flexible WDM-PON
  - 10-25 Gbps/λ, 20-40 Km
  - Color-less ONUs (out-of-band mgmt)
  - Switch off ONUs for energy saving
  - Flexible assignment BBU-RRH



5G-XHaul WDM-PON architecture

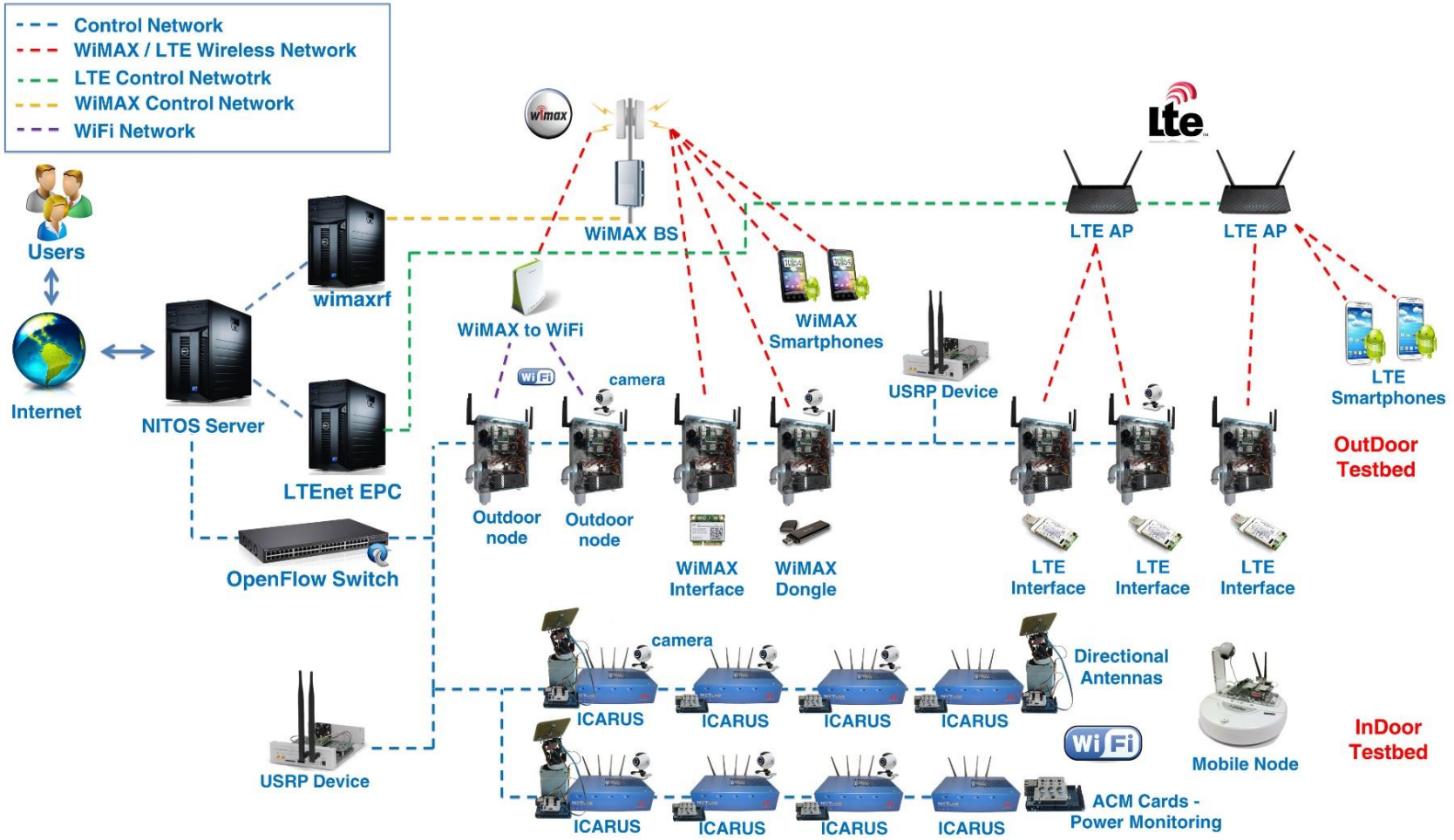
Technical Innovations: Control Plane

- Unified control for heterogeneous transport network
- SDN control plane scalability
  - Dynamic Flow Rules / Flow caching
- Virtualization/Slicing
- Spatially aware control plane:
  - Exploit data available from RANs to improve control/management in the transport
- Traffic engineering for joint mmWave/Sub6 wireless backhaul



Planned Experimentation

- NITOS, hosted by UTH in Volos, Greece -> Validate control plane



Final Demonstrator

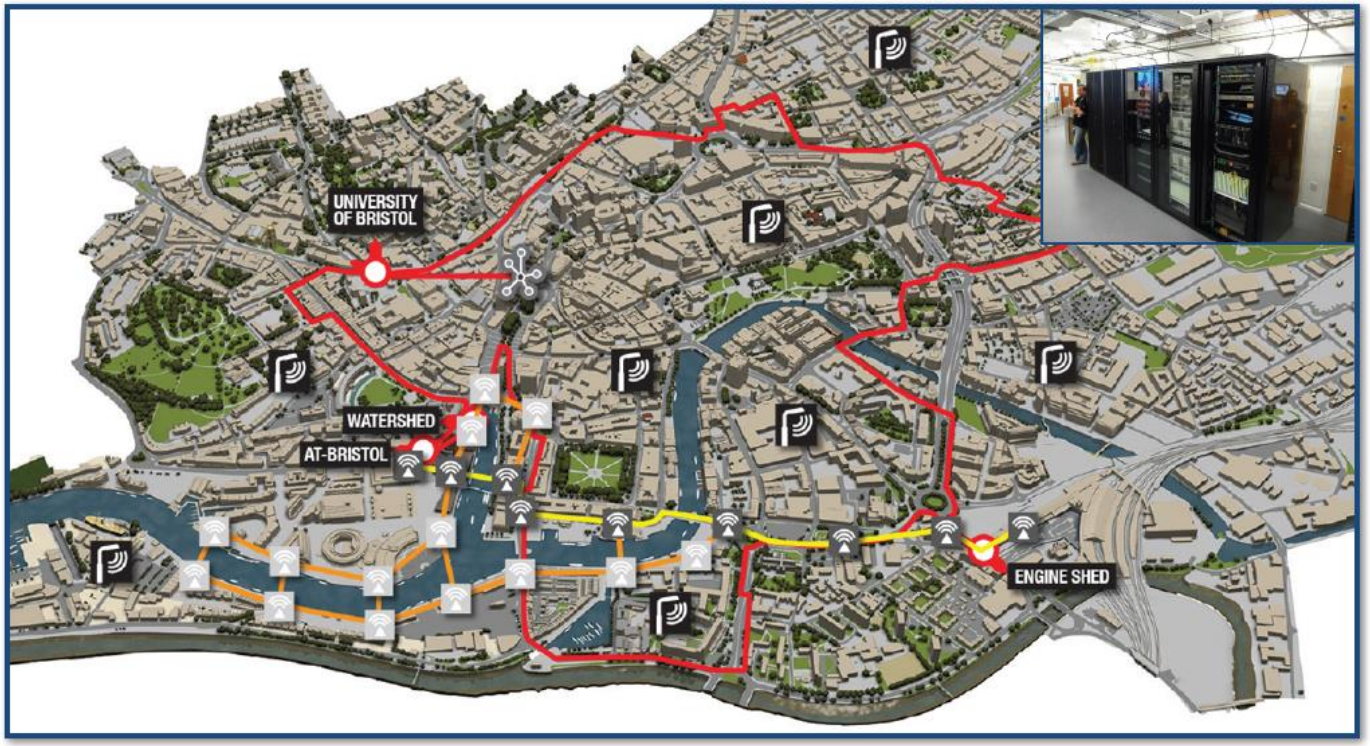
- "Bristol is Open (BiO)", Bristol, UK -> Validate 5G-XHaul architecture

Optical Network
144-fiber core network connecting 4 nodes

Wireless Network
1Gbps access network
Wi-Fi, LTE, LTE-A, 60Ghz, Massive MIMO

IoT Network
54 Fiber-connected lampposts
Clusters & 1,500 sensors

Cloud Infrastructure
HPC, commodity compute and storage (centralised & edge)



Thank You