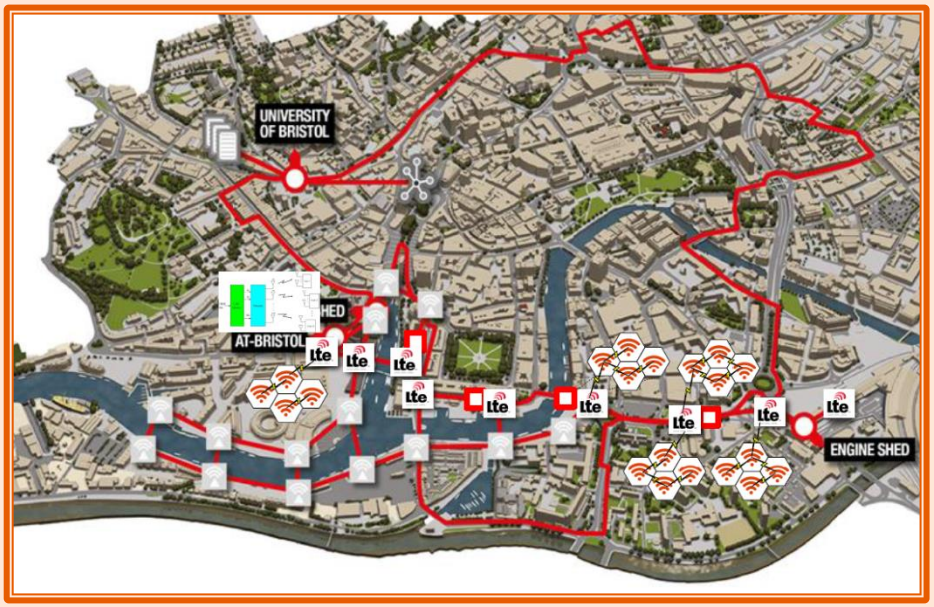
INTRODUCING THE 5G-PPP 5G-XHAUL PROJECT

Anna Tzanakaki (University of Bristol, NKUA)



Bristol 5G city testbed with 5G-XHaul extensions

European Commission
Horizon 2020
European Union funding
for Research & Innovation

1. CONSORTIUM OVERVIEW

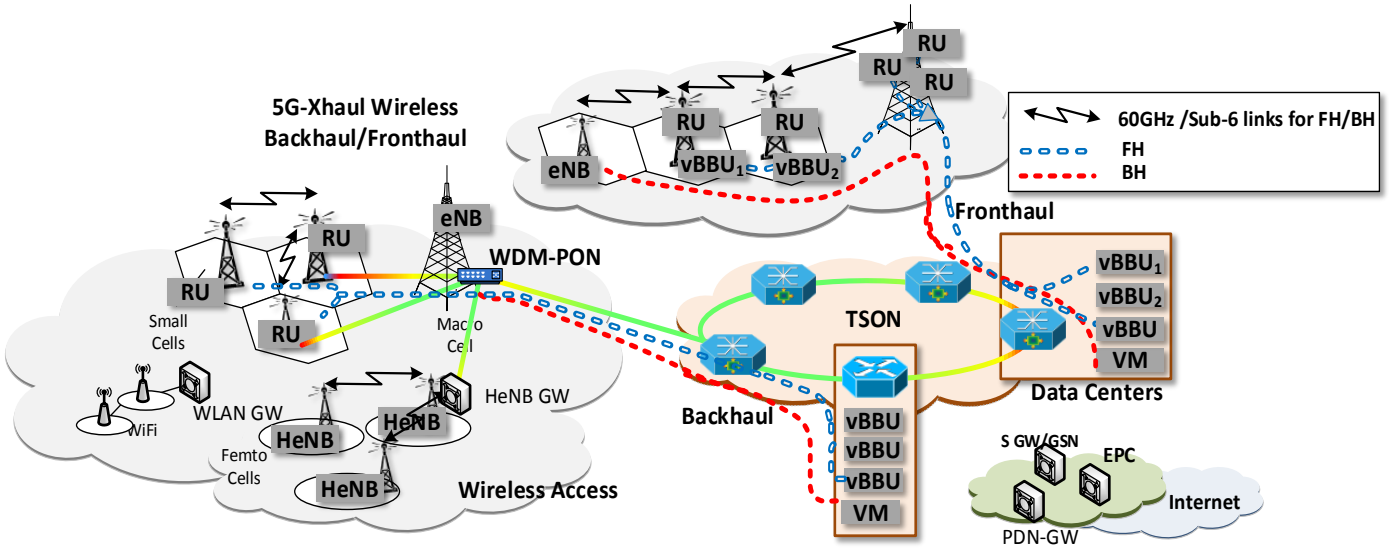
5G-XHaul

- IHP GmbH (Coordinator)
- ADVA Optical Networkin
- Airrays GmbH
- Blu Wireless Technology
- COSMOTE
- Fundació i2CAT
- Huawei Technologies
- TU Dresden
- Telefónica I+D
- TES Electronic Solutions
- University of Bristol
- University of Thessaly

- Universities (3x), Research Institutes (2x), SMEs (2x), Operators (2x), Industry partners (3x)

- 3 years duration
- Started: 01/07/2015
- 7.2 million euro EU funding

5G-XHaul Physical infrastructure



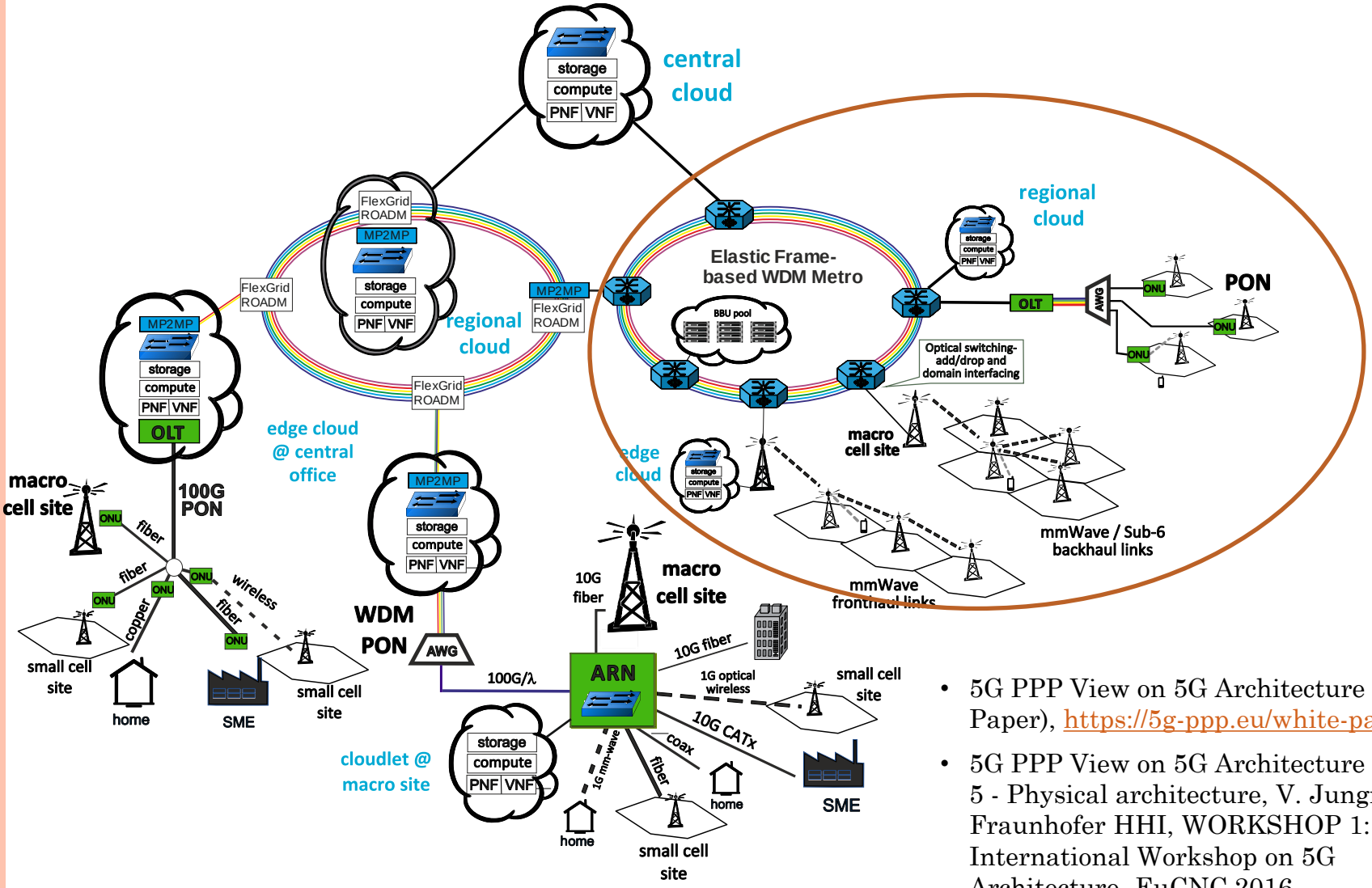
HeNB: Home eNodeB
VM: Virtual Machine
GW: Gateway

vBBU: Virtual Base Band Unit
RU: Remote Unit
PDN-GW: Packet Data Network GateWay

EPC: Evolved Packet Core
S GW: Serving GateWay

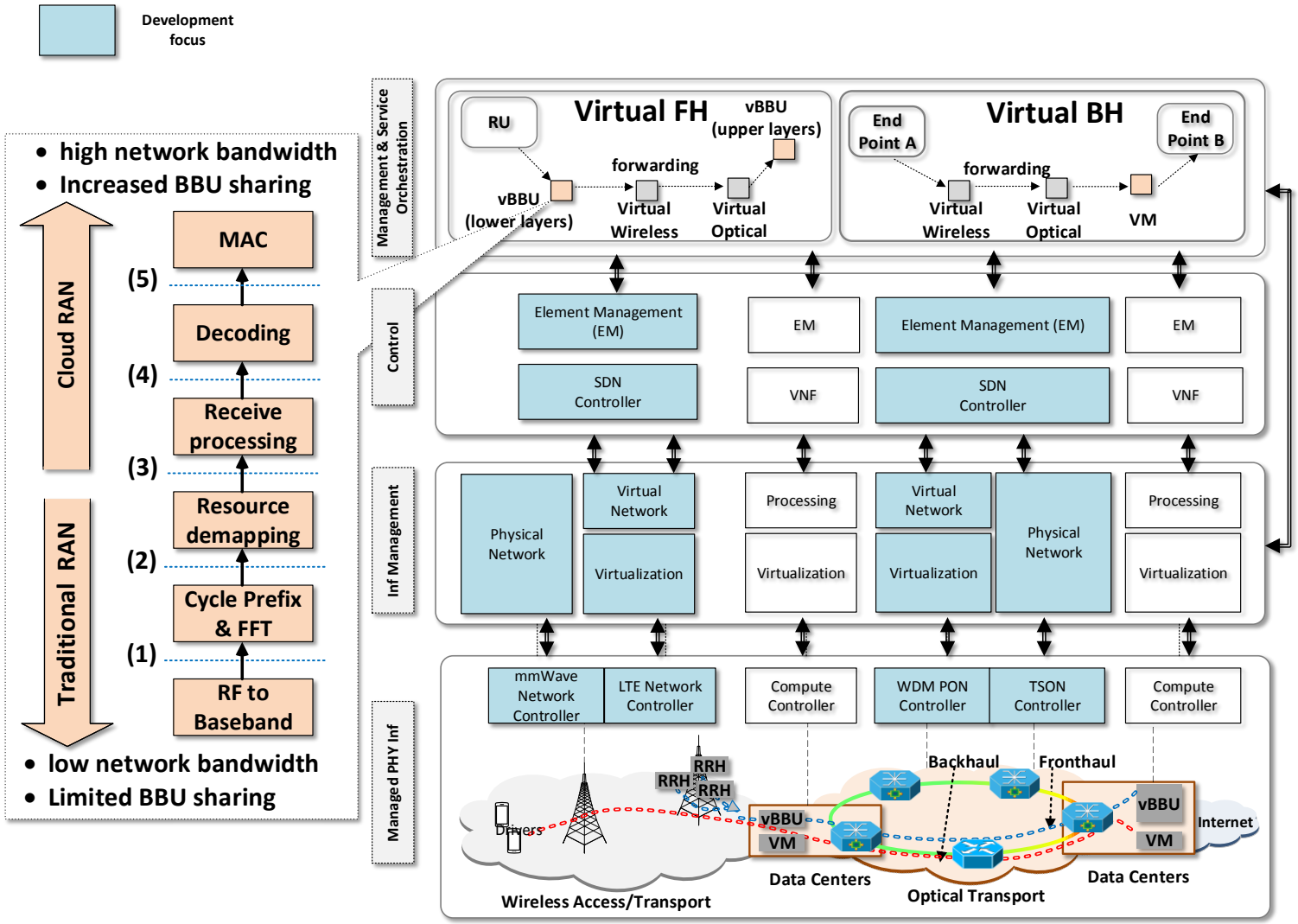
- The 5G-XHaul data plane considers an integrated optical and wireless network infrastructure for transport and access.
- The wireless domain comprises small cells complemented by macro cells.
- Fronthaul and backhauli can be supported through mmWave and Sub-6 wireless technologies or using a hybrid optical network platform combining both passive and active optical technologies.

5G-XHAUL INPUT TO THE 5G PPP VIEW ON 5G ARCHITECTURE



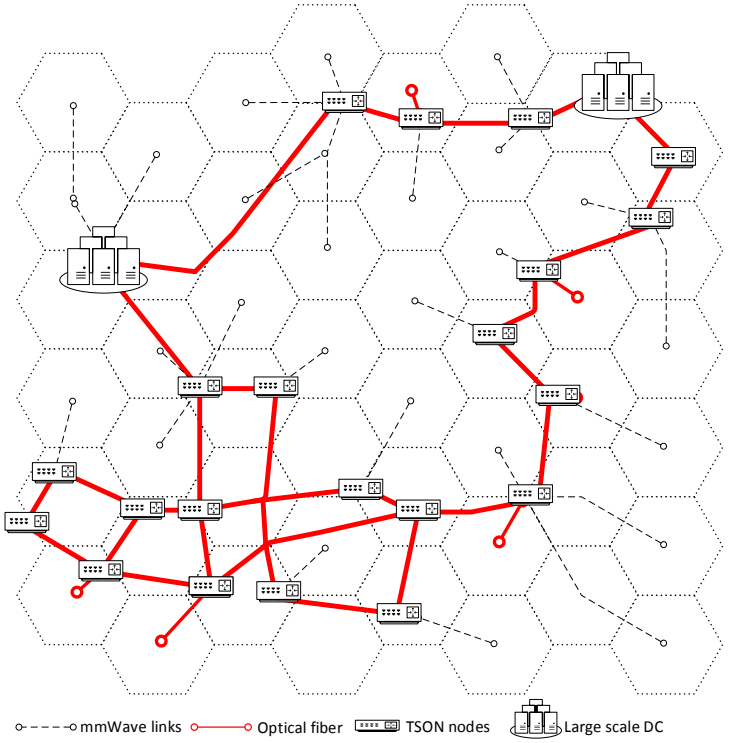
- 5G PPP View on 5G Architecture – (White Paper), https://5g-ppp.eu/white-papers/
- 5G PPP View on 5G Architecture - Section 5 - Physical architecture, V. Jungnickel, Fraunhofer HHI, WORKSHOP 1: International Workshop on 5G Architecture, EuCNC 2016

5G-XHaul Overarching Layered Architecture

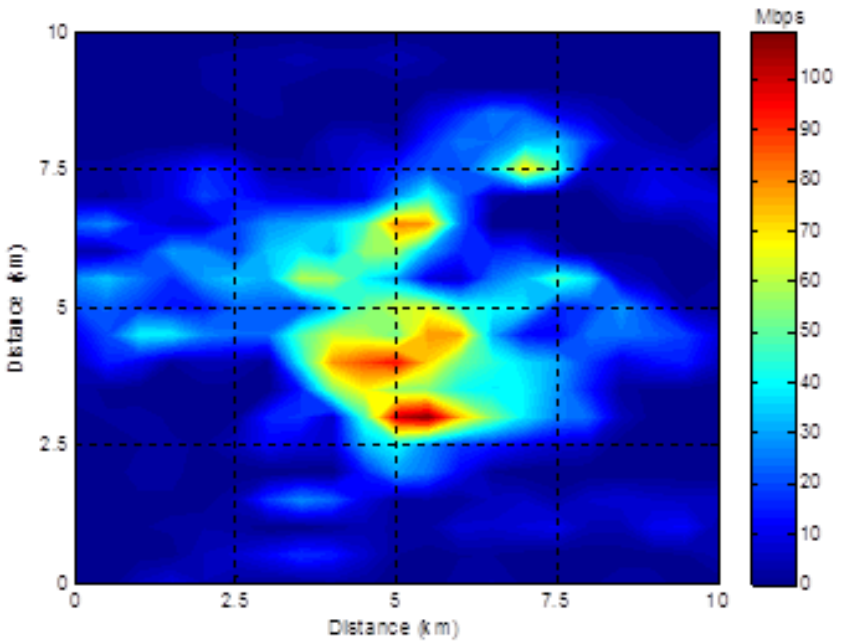


A. Tzanakaki et al., "5G infrastructures supporting end-user and operational services: The 5G-XHaul architectural perspective," 2016 IEEE International Conference on Communications Workshops (ICC), Kuala Lumpur, Malaysia, 2016, pp. 57-62

Architecture Performance Evaluation



Bristol 5G city network topology with mmWave backhauling



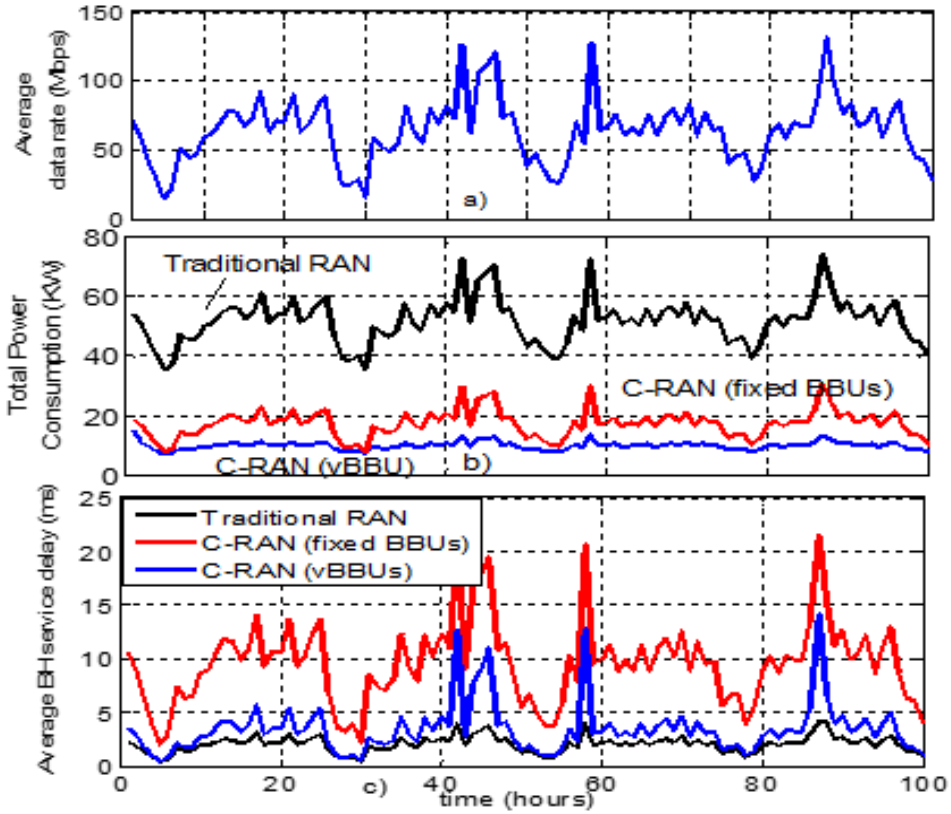
Snapshot of spatial traffic load

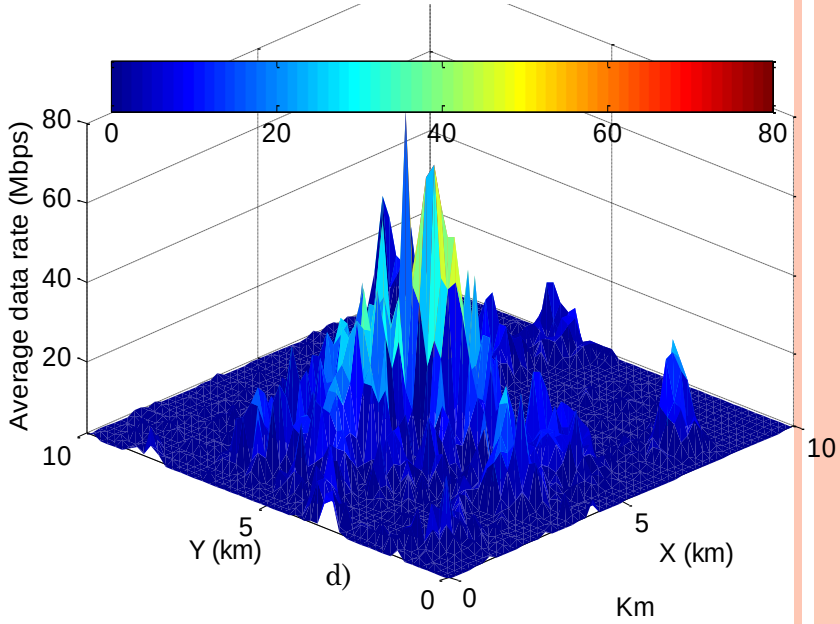
Mullti-objevctive optimisation model aims to identify the optimal resources and policies that can support the required services in terms of both topology and resources.

Optimal FH and BH service provisioning, with the overall objective to maximise the energy efficiency of the infrastructure and minimize end-to-end service delays.

A. Tzanakaki et all, “Wireless-Optical Network Convergence: Enabling the 5G Architecture to Support Operational and End-User Services“ IEEE Comms Magazine, August 2017

Numerical results: Energy-delay

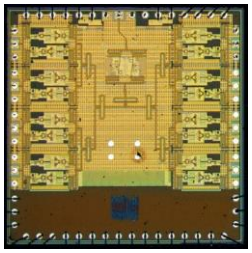




- Figs a) and d): average traffic per BS and spatial traffic distribution for the wireless access domain
- The C-RAN approach offers significant energy savings (60-75%) (Fig. b)
- Overloading of network resources to support FH, the C-RAN case increases the end-to-end service delay in the BH (Fig. c), which remains below 20ms for a 100 Mbps flow request
- The BH service delay for C-RAN vBBU is lower compared to the delay for the C-RAN fixed BBU case

DATA-PLANE: WIRELESS

- mmWave (60GHz) Front End design
  - Antenna & BFIC



5G-XHaul mmWave BFIC

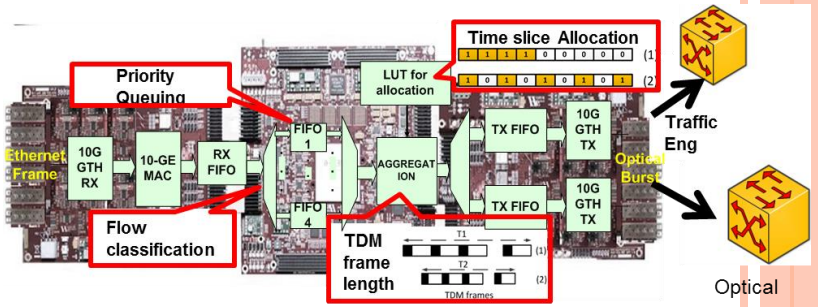
5G-XHaul mmWave nodes

- mmWave Base Band design
  - MIMO/Beam alignment and tracking/P2MP
  - Channel modelling
- Synchronization in wireless backhaul: 1588v2, ToF based
- Functional splits for 5G-RANs (NGFI):
  - Impact on transport requirements
  - Specific development for Massive MIMO
- Self-backhauling: Joint access and backhaul

Massive MIMO array supporting 5G-XHaul functional split

DATA-PLANE: OPTICAL

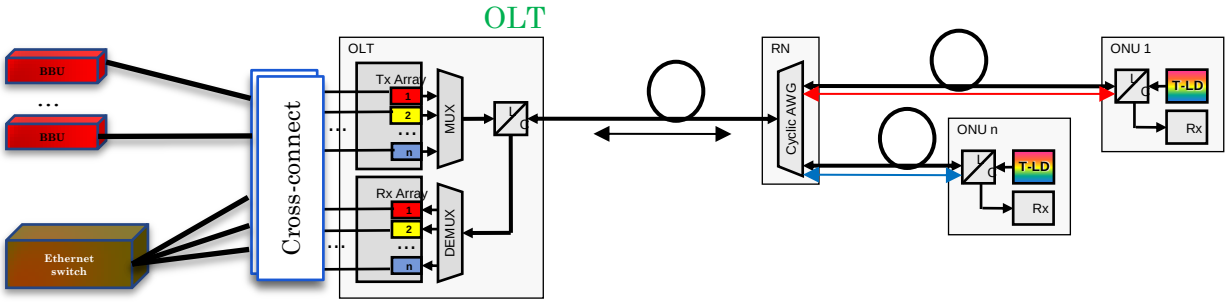
- Hybrid passive/active optical network solution supporting joint FH & BH
- Active: Time Shared Optical Networks (TSON)
  - Elastic BW allocation (time slices)
  - Extensions for elastic grid
  - Native mapping of Ethernet and CPRI
  - Synchronization



Sub wavelength FPGA at edge

TSON FPGA implementation

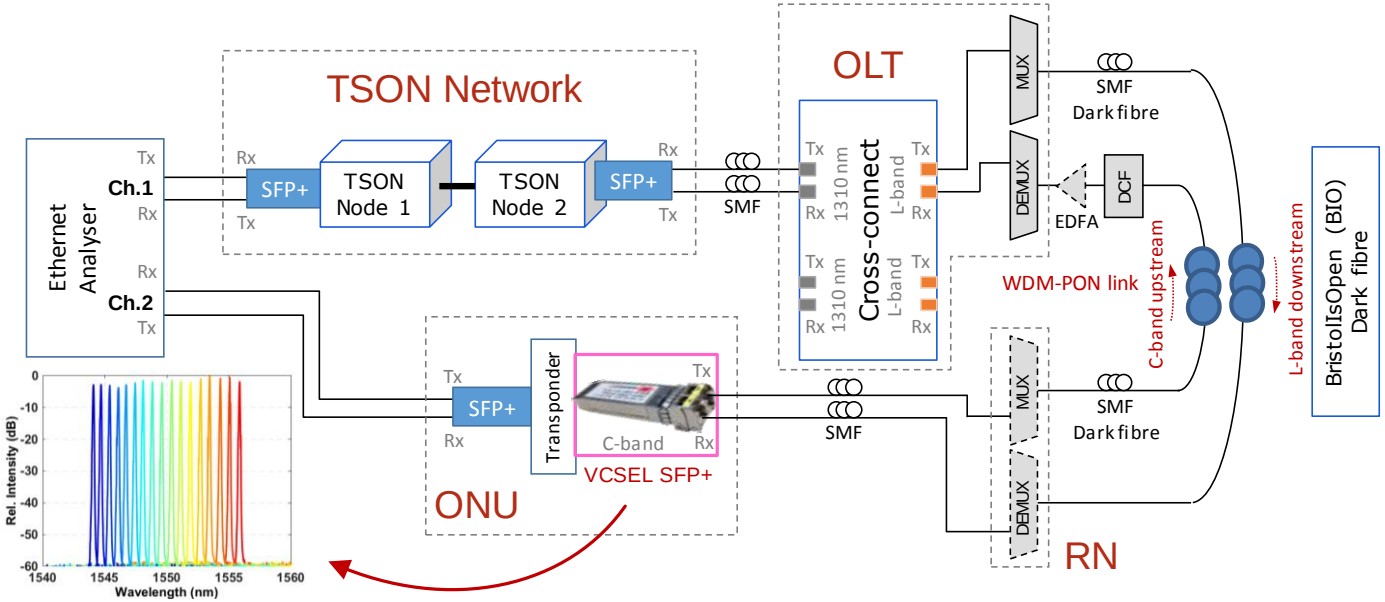
- Passive: flexible WDM-PON
  - 40λs, 10-25 Gbps/λ, 20-40 Km
  - Color-less ONUs (out-of-band mgmt)
  - Switch off ONUs for energy saving
  - Flexible assignment BBU-RRH

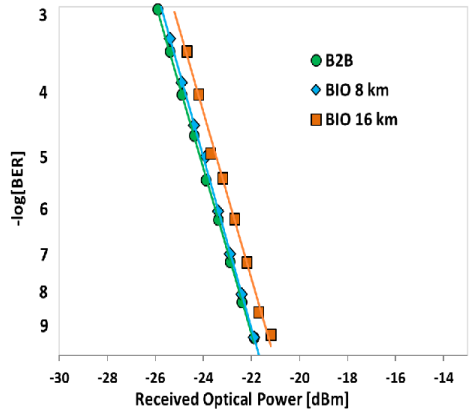


5G-XHaul WDM-PON architecture

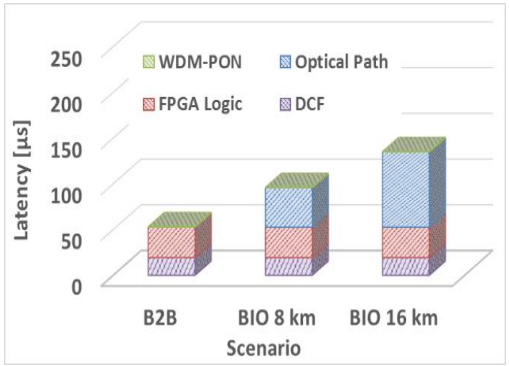
DATA-PLANE: WDM-PON & TSON INTEGRATION

- Testbed configuration of TSON and WDM-PON
  - Integration using BIO dark fiber

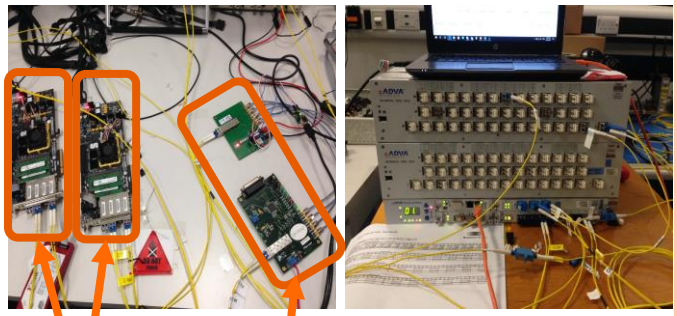




Downstream



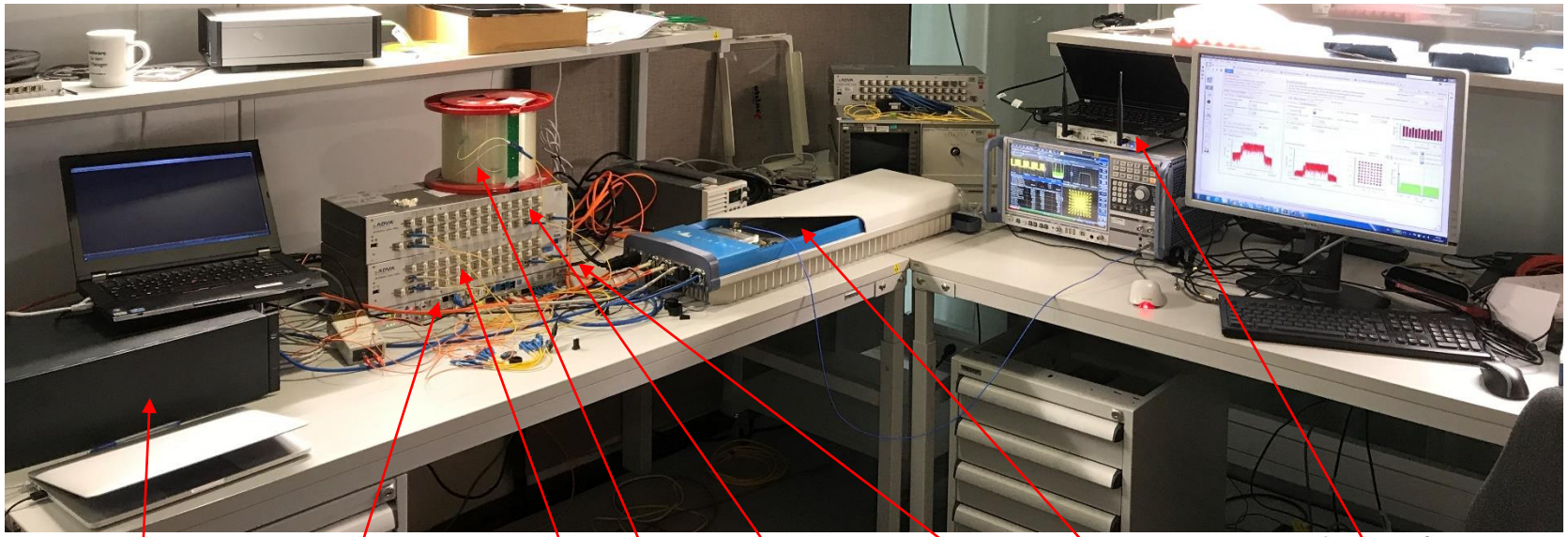
Latency

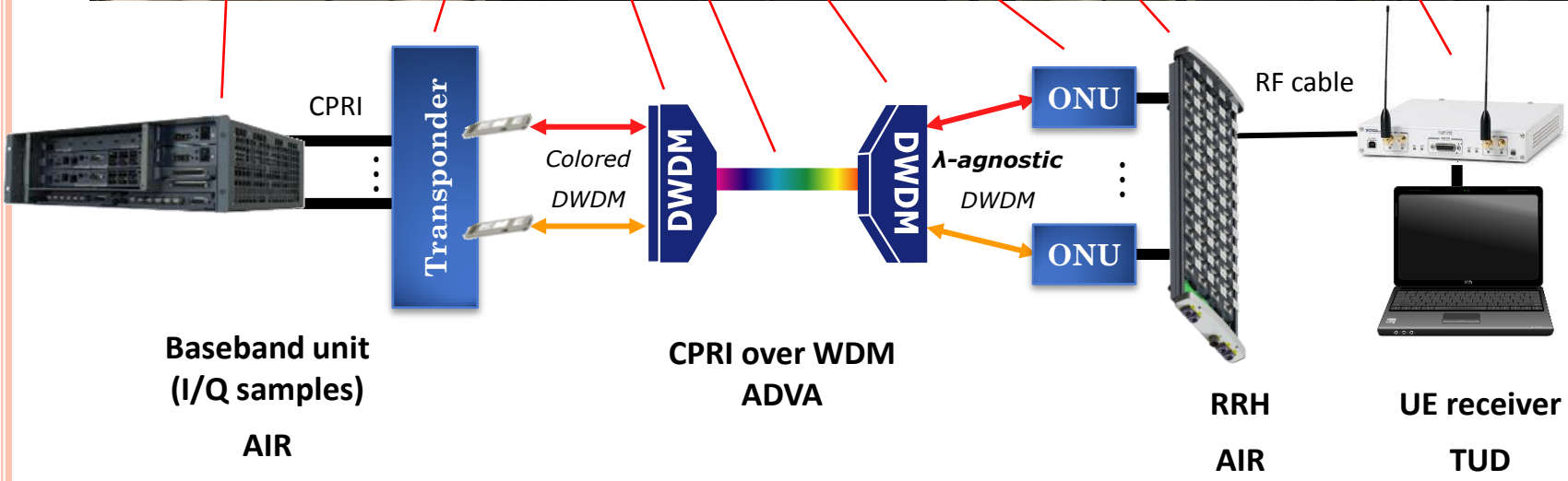


TSON Node 1&2 ONU

OLT side

DATA-PLANE: MASSIVE MIMO FH OVER WDM-PON





CITY-TRIALS: BIO INFRASTRUCTURE

5G-XHaul

Optical Network

144-fiber core network connecting 4 active nodes, full optical switching, flexi optical

Wireless & Mobile Net.

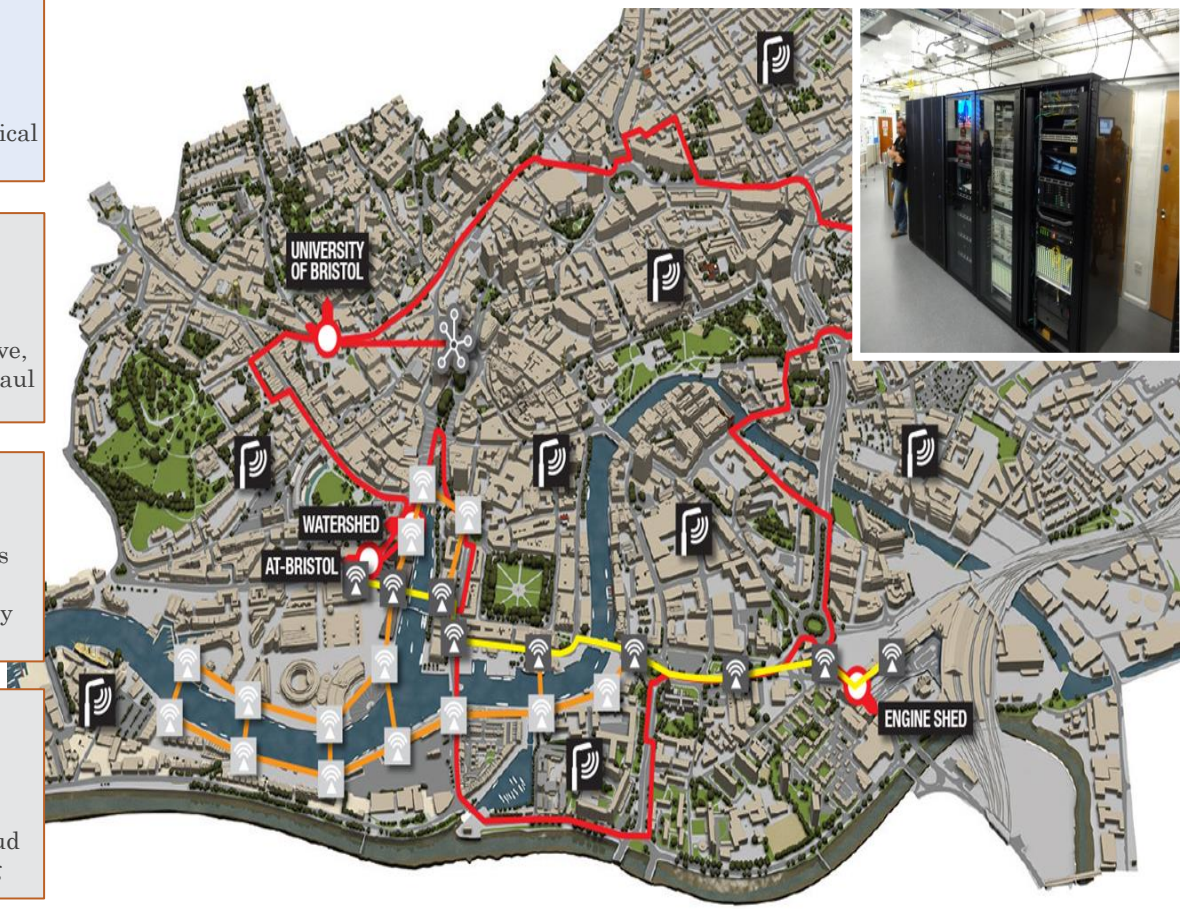
Wi-Fi 802.11ac, LTE, mmWave, Massive MIMO, 60GHz backhaul

RF Mesh Network

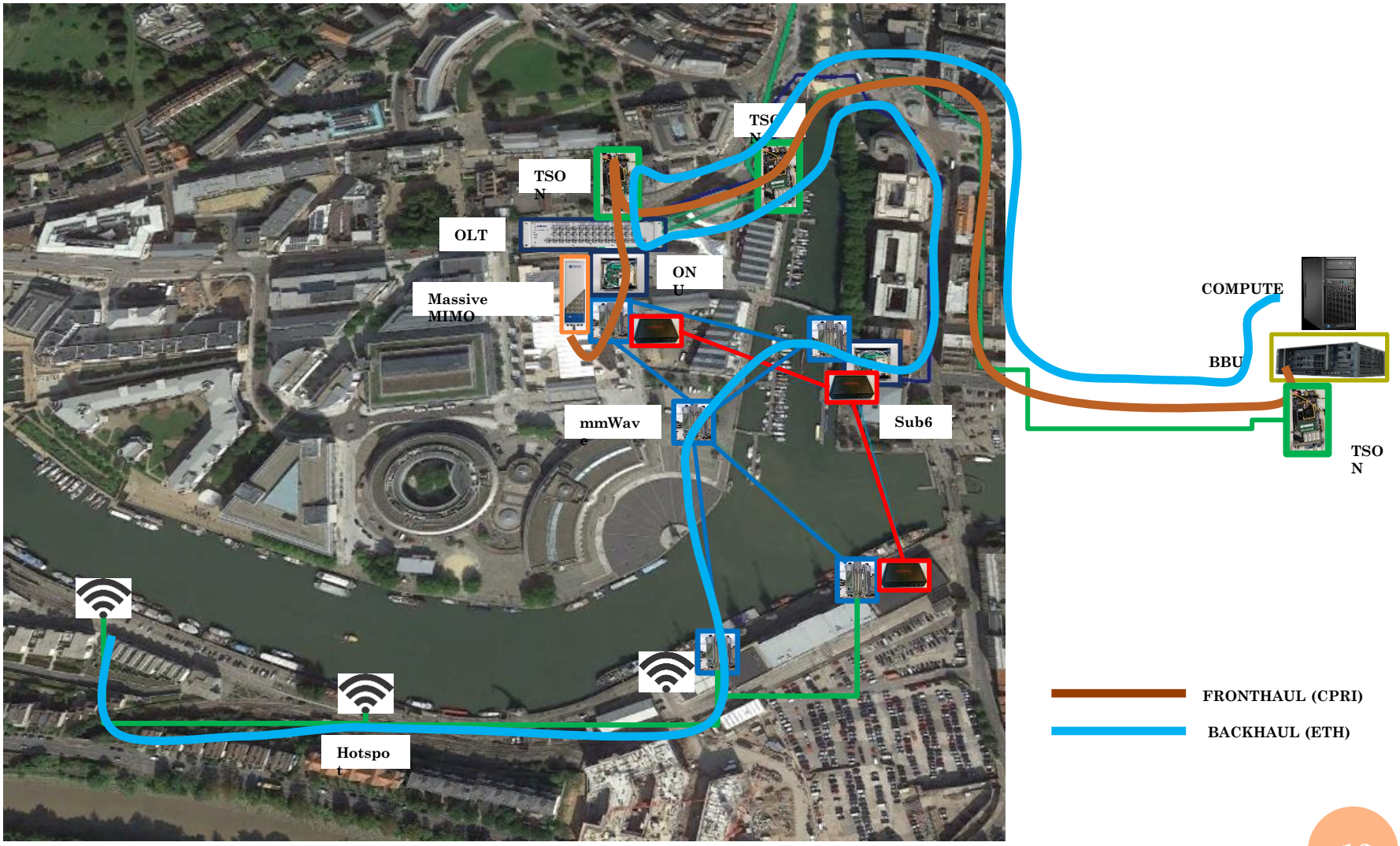
8 Fiber-connected lampposts with 1,500 photocells and any-sensor hosting capability

Computing Infrastructure

HPC facility, commodity compute/storage, private cloud and edge mobile computing



SAMPLE OF PLANNED DEMONSTRATION IN BRISTOL (JUNE'18)



5G-XHaul

Thanks for your attention!

Questions?

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