



CREATING THE LIVING NETWORK™

Fronthaul and Backhaul for 5G and Beyond

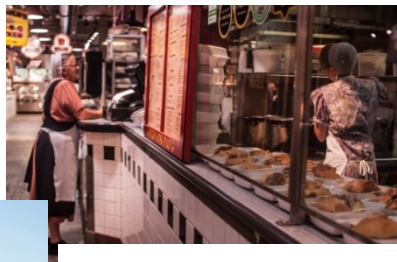
Alain Mourad

COST IRACON, Durham, October 2016

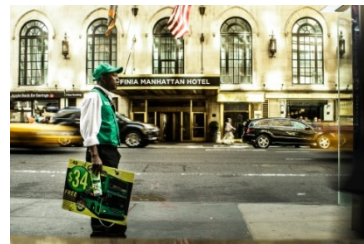


A Presence Focused on the World's Wireless Centers

INTERDIGITAL



INTERDIGITAL
PHILADELPHIA



INTERDIGITAL
NEW YORK

INTERDIGITAL
MONTREAL



INTERDIGITAL
SAN DIEGO



INTERDIGITAL
WASHINGTON, DC



INTERDIGITAL
Asia, Seoul



INTERDIGITAL
LONDON

INTERDIGITAL

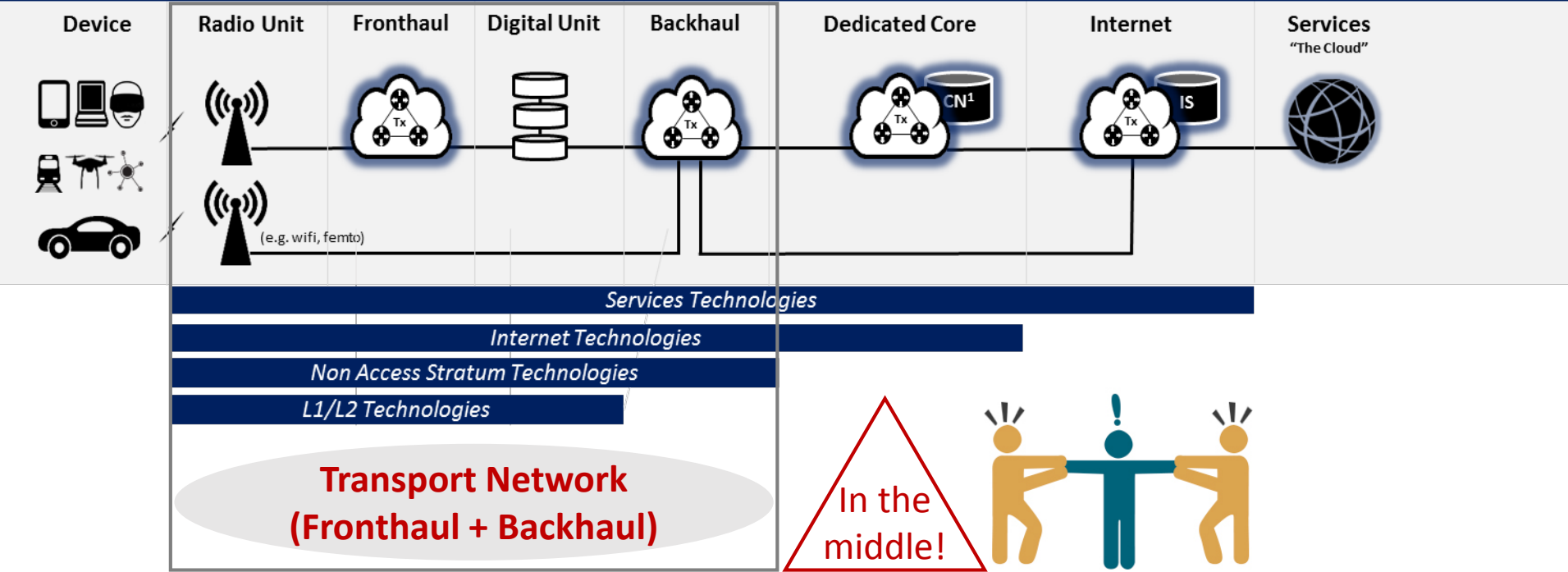


Part 1 – The path to next
generation (5G+) transport
*An Integrated Fronthaul and
Backhaul*



Transport Network in the E2E Picture

Transport == Interconnection of Mobile Network PoA, RAN (C-RAN), CN...Internet / Services



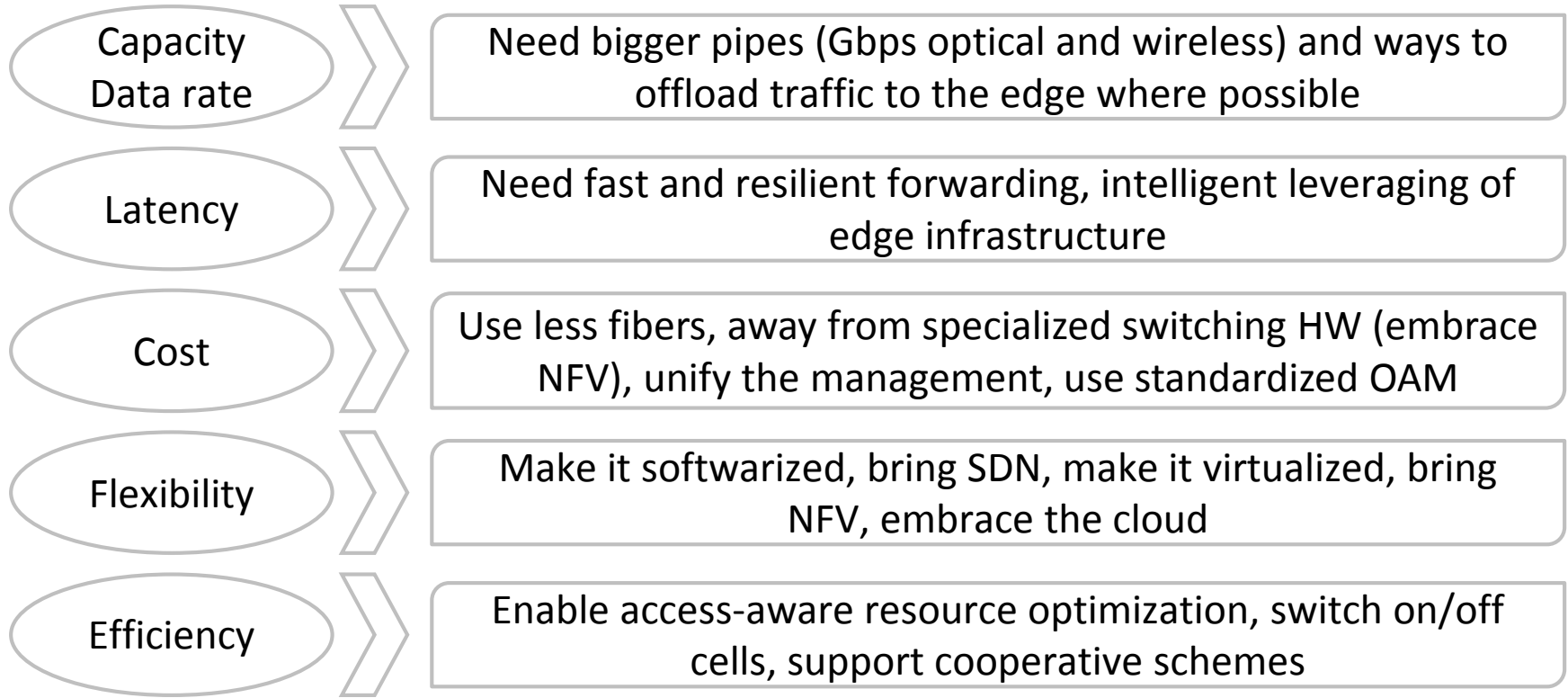
5G(+) Key Performance Indicators

- ✓ 1,000 X in **mobile data volume** per geographical area reaching a target $\geq 10 \text{ Tb/s/km}^2$
- ✓ 1,000 X in **number of connected devices** reaching a density $\geq 1\text{M terminals/km}^2$
- ✓ 100 X in **user data rate** reaching a peak terminal data rate $\geq 10\text{Gb/s}$
- ✓ 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 and radio link latency reaching a target $\leq 1 \text{ ms}$ for e.g. V2V communication
- ✓ 1/5 X in network management **OPEX**
- ✓ 1/1,000 X in **service deployment time** reaching a complete deployment in ≤ 90 minutes

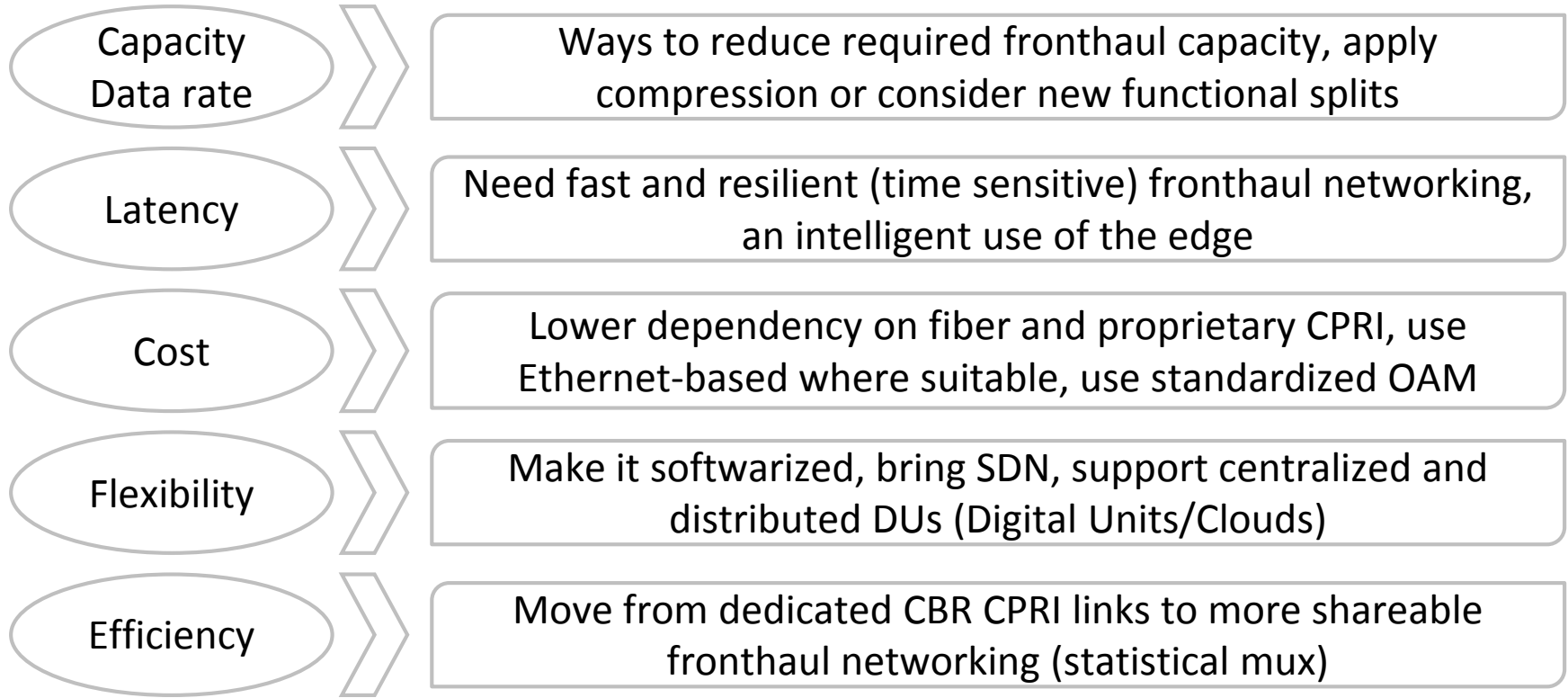
Vision

A unified programmable and shareable infrastructure that can deliver **flexibly, speedily and efficiently** all the diverse services envisioned

Mapping the 5G(+) KPIs on the Backhaul

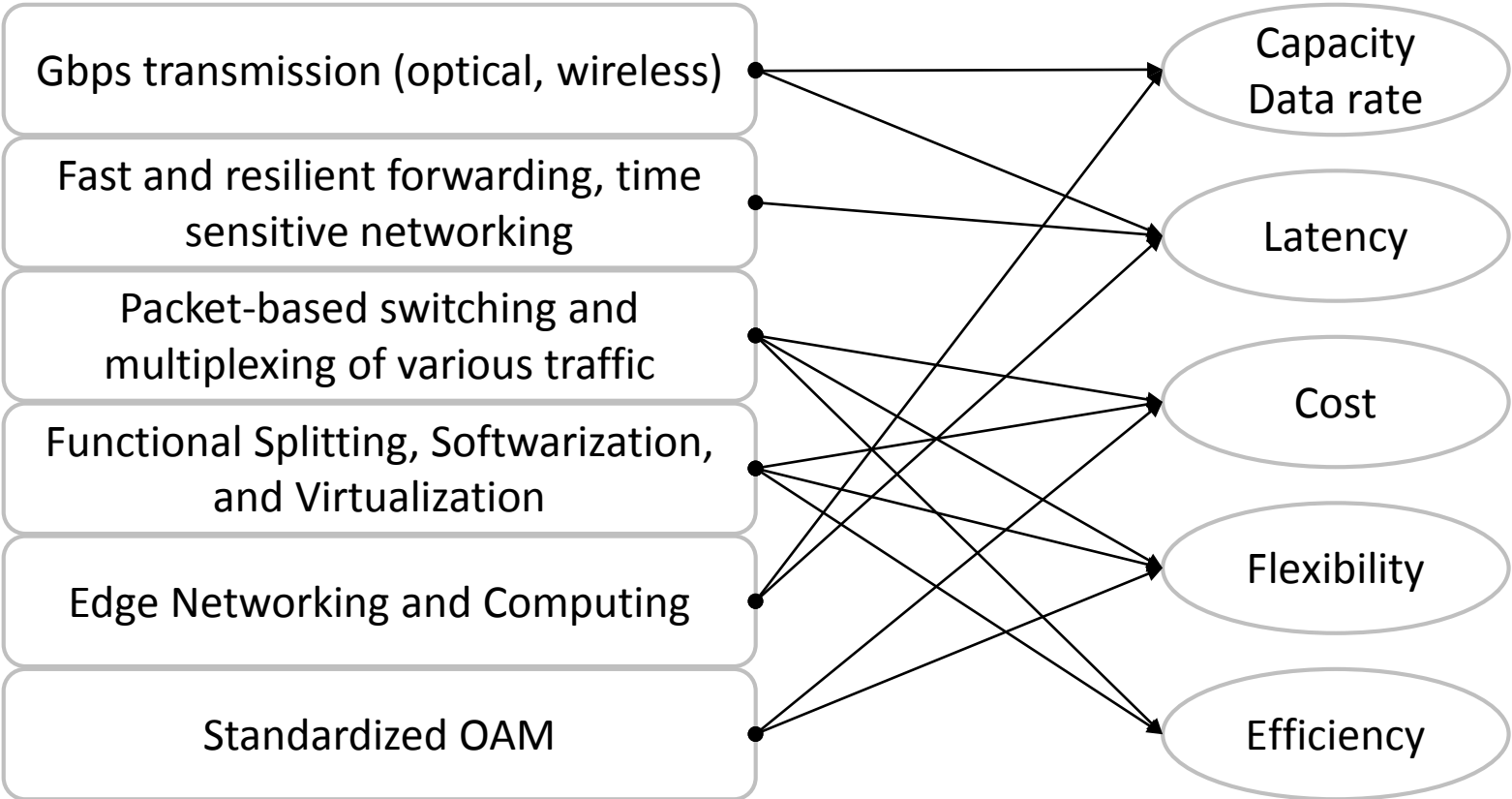


Mapping the 5G(+) KPIs on the Fronthaul



Recipe for 5G(+) Backhaul and Fronthaul

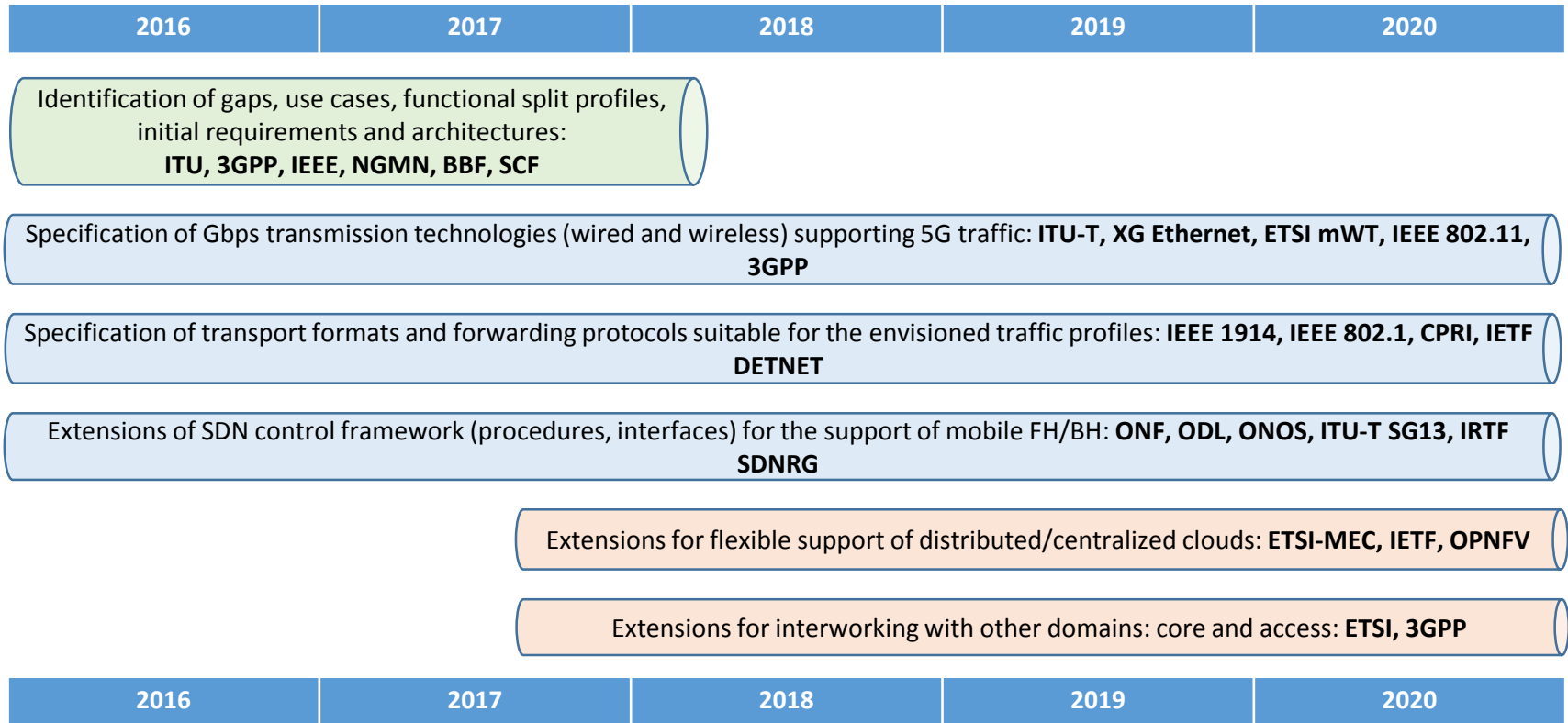
Integrated Backhaul and Fronthaul



What is being done where?

- **Use cases, gaps, requirements, architectures**
 - NGMN, ITU-T 2020 FG, ITU-R WP5D, 3GPP
- **Gbps transmission technology**
 - Wired: ITU-T SG15, NG-PON2, FSAN
 - Wireless: ETSI mWT, IEEE 802.11ay
- **Wireless access protocol functional splits**
 - 3GPP, IEEE 802.11, SCF
- **FH/BH traffic packetization (formatting)**
 - Fronthaul: CPRI/eCPRI, NGFI (IEEE 1914.1)
 - Backhaul: VLAN (IEEE 802.1Q), MPLS
- **FH/BH switching protocols**
 - IEEE 802.1CM TSN, IETF DETNET
- **SDN control**
 - ONF, OpenDayLight, ONOS, IRTF SDNRG, ITU-T SG13, IEEE 802.1CF
- **NFV-based management**
 - ETSI NFV, IRTF NFVRG, OPNFV, OpenStack
- **Edge networking and computing**
 - ETSI MEC

Standardization Roadmap



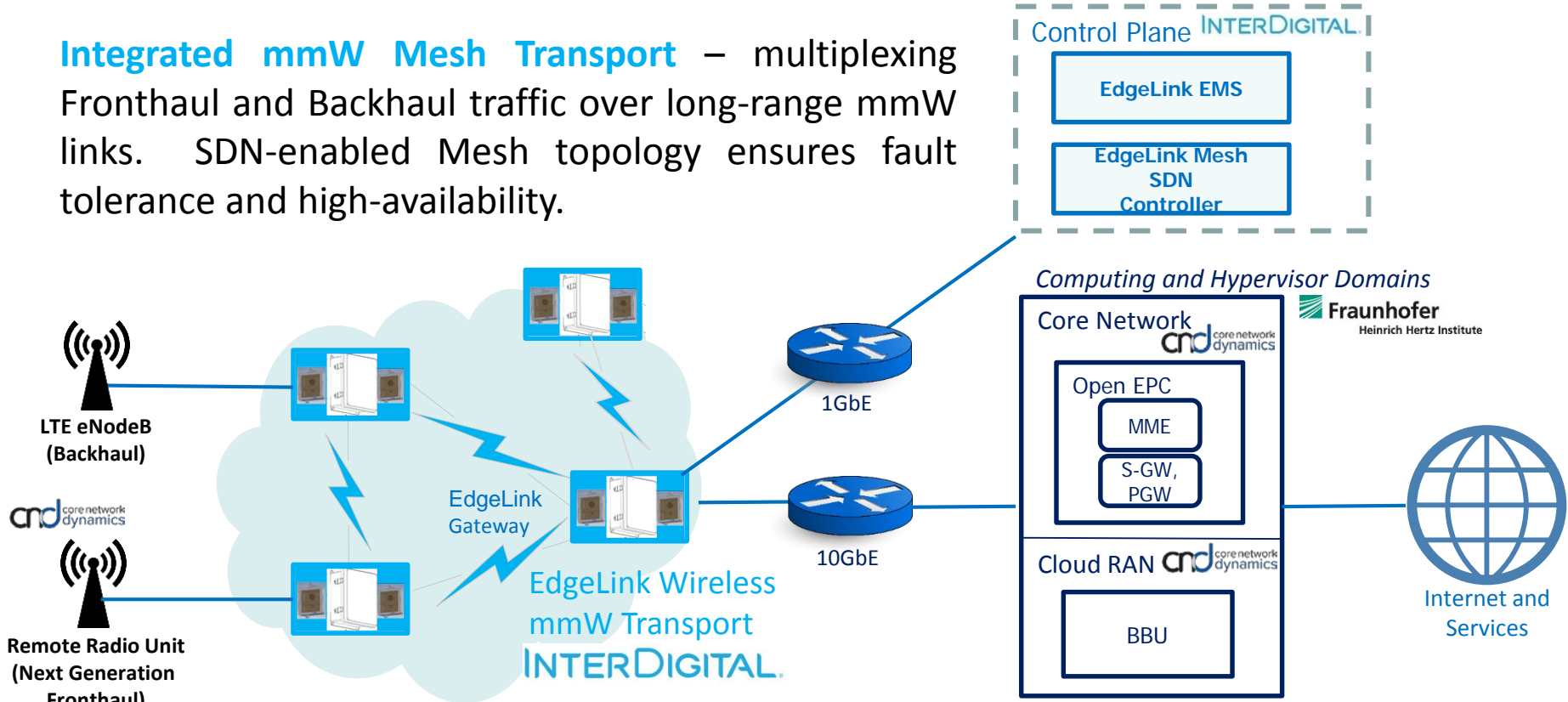
Part 2 – Testbed Trials

First trials of new FH and BH multiplexed over mmW

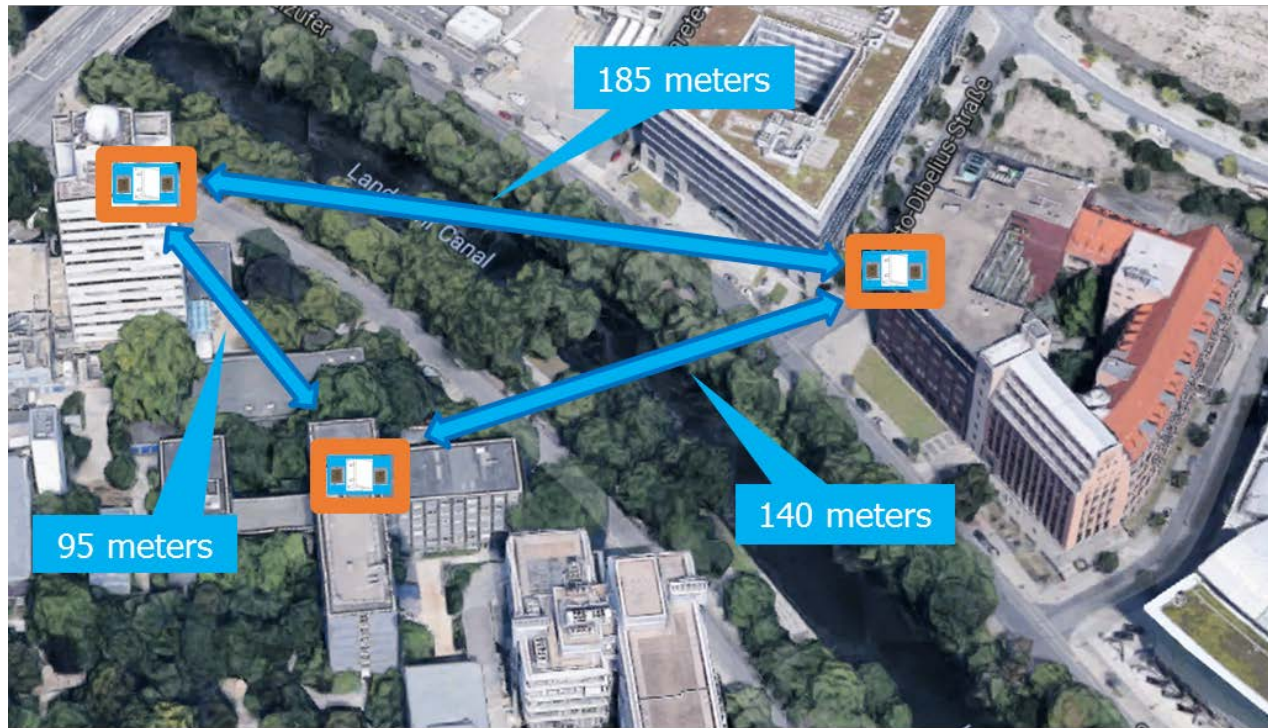


5G-Berlin Testbed Trials 2016

Integrated mmW Mesh Transport – multiplexing Fronthaul and Backhaul traffic over long-range mmW links. SDN-enabled Mesh topology ensures fault tolerance and high-availability.



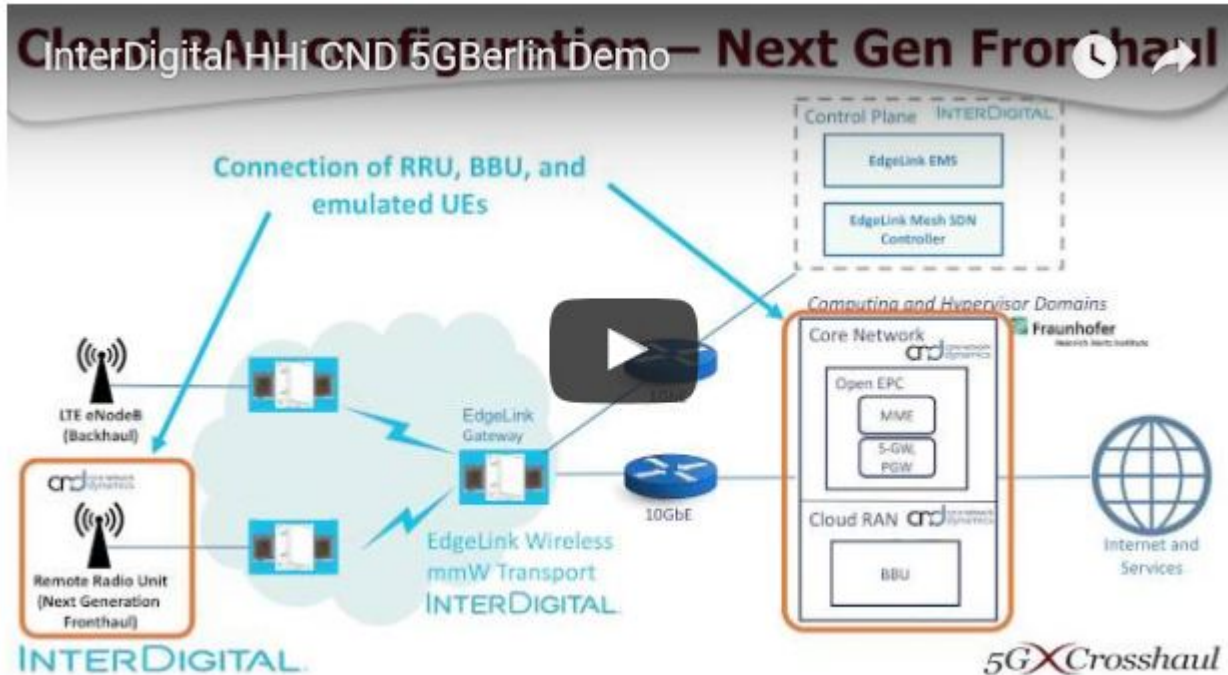
Physical Deployment Outdoor



Testbed spans three buildings across the HHI and Berlin Technical University Campus connected via EdgeLink mmW transport links

Demonstration September 2016

<http://5g-crosshaul.eu/5g-crosshaul-demonstrates-integrated-fronthaul-and-backhaul-over-millimeter-wave-system/>



A long range mmWave mesh able to multiplex packet-based new Fronthaul and Backhaul and to recover eventual link blockages by means of SDN

Take-Away

- Most of the key technology pillars envisaged in 5G core and access, such as **SDN, NFV, MEC and mmWave**, find their use too in defining the next generation transport network
- The fronthaul is moving from complex and rigid CPRI to more relaxed (backhaul-lean) **eCPRI/NGFI** with new functional splits
- Fronthaul and Backhaul are **converging** into a common **Crosshaul** packet-switching network with unified control and data planes
- **Several gaps** remain before the next generation transport is ready, and COST IRACON may contribute to address some of these gaps
 - In particular, mmWave transmission of fronthaul/backhaul including at very high frequencies (up to 300 GHz) could be particularly relevant to COST IRACON from a radio channel modelling perspective (Ref. ETSI mWT ISG)

Thank You!



INTERDIGITAL.
EUROPE

Alain MOURAD, PhD

Senior Manager – 5G RAN

InterDigital Europe, Ltd.

64 Great Eastern Street

London, EC2A 3QR

+44 7920 798 685

Alain.Mourad@InterDigital.com

Acknowledgement to the 5G-CROSSHAUL Project

Partners (21)



21 Multi-sector
Partners

2.5
YEAR PROJECT

\$8.9m
Total cost

www.5g-crosshaul.eu

Field Trial Planned in Berlin Q3/2016

Started
1st July 2015

100% Funded by
H2020