5G mmWave Transport
and
5G-PPP 5G-Crosshaul project
The 5G Integrated fronthaul/backhaul

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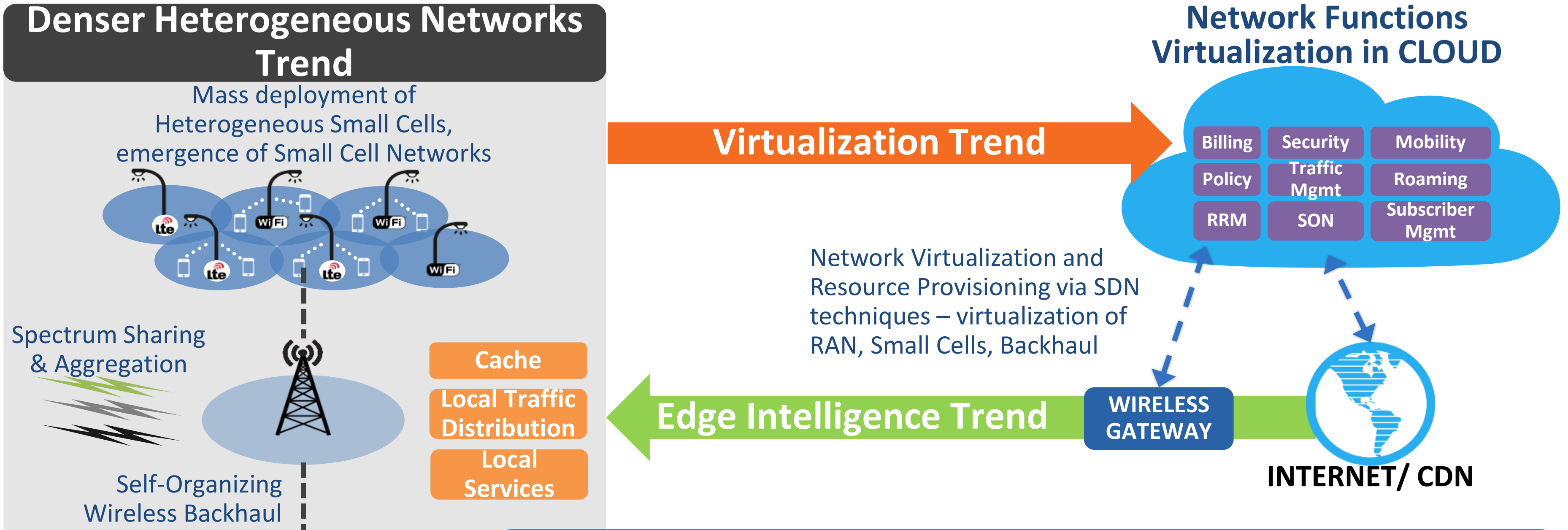
Agenda

- 5G Trends and Drivers
- High Capacity, Low-Latency Street Level Transport as a MEC enabler
- The 5G-PPP 5G-Crosshaul Project

5G Technology Trends and Drivers



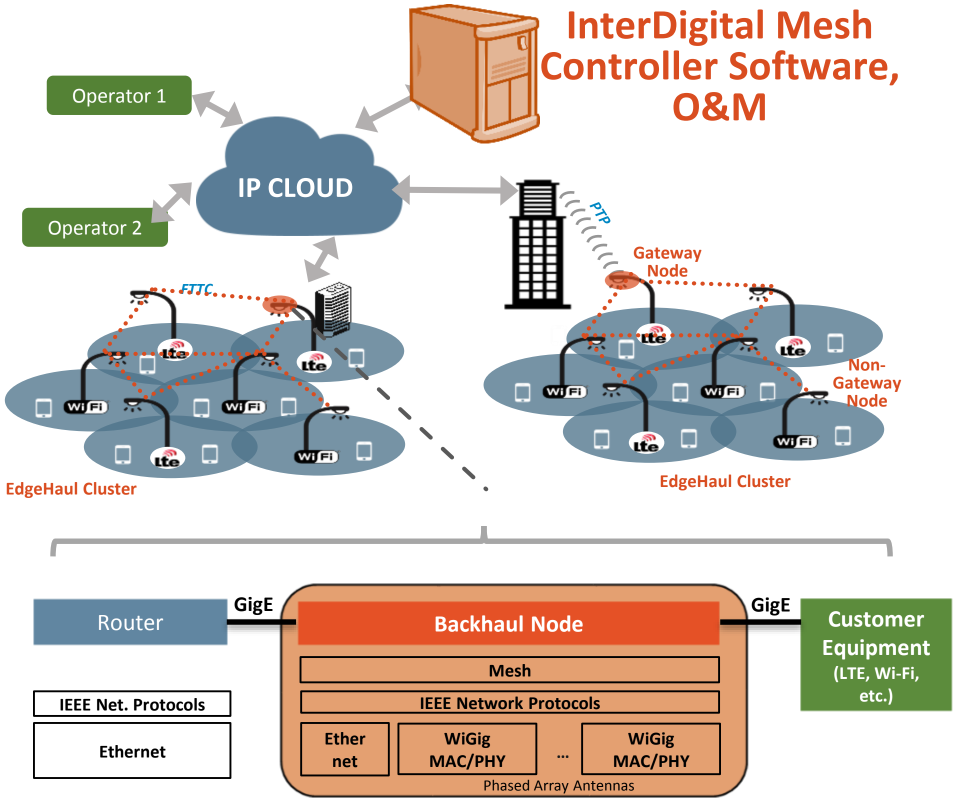
Millimeter Wave Transport is a MEC enabler…
- **Ideally suited for dense, shorter range networks**
- **High capacity at the edge for "last ¼-mile" exchange of data**

MWC2015 EdgeHaul™ Live Over-the-air Demo

- **Low-Cost, High Capacity**, Scalable design for today's Small Cell Backhaul and future 5G millimeter wave access
- 60GHz Phased Array with electronic beamsteering reduces installation cost an provides interference management
- WiGig (IEEE 802.11ad) based baseband chip enabling Gigabit data rates
- Three sectors, 270° coverage

EdgeHaul™ System Architecture

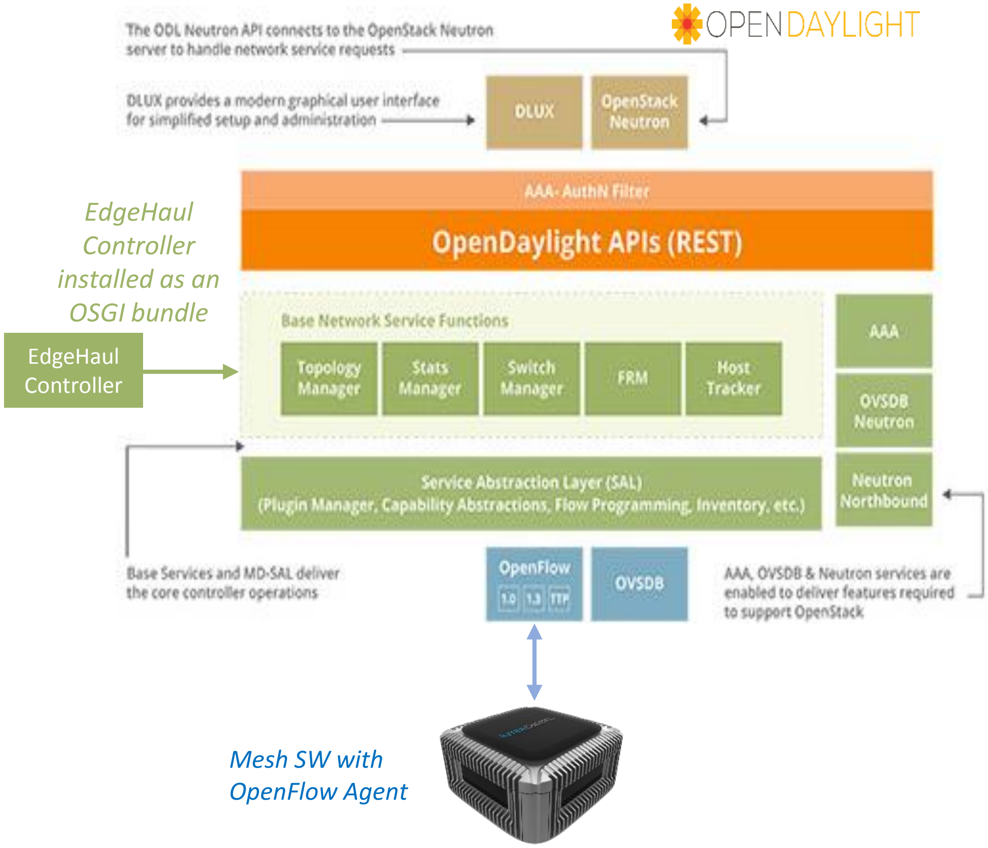
- EdgeHaul is a centrally controlled multi-hop mesh network of mmWave backhaul nodes
- Clusters of initially ~10 nodes each are connected by mesh to Gateway
- System scales by replicating clusters
- Key System Components
  - **EdgeHaul nodes** contain virtual switch (OpenVSwitch) and mmWave MAC/PHY/RF air interface
  - **Mesh Controller Software** built on SDN framework (OpenDayLight) for flexibility
  - **O&M Software** run on cloud server with a web-based interface for remote O&M



Intelligent software to build a Carrier Grade Edge Network from commercial WiGig hardware

SDN Implementation

- SDN provides flexibility to integrate with modern 5G multi-vendor heterogeneous networks
- Common platform for extensibility and leveraging open-source components
- EdgeHaul Use
  - Mesh Controller functions hosted by the OpenDaylight SDN Controller
  - Standardized OpenFlow protocol
    - Programming Mesh nodes with frame forwarding flow rules
    - Collect standardized network measurements from OpenFlow agents
  - Future Integration with existing community of OpenDaylight services and applications



5G Crosshaul

the integrated fronthaul/backhaul

The 5G Integrated Fronthaul/Backhaul

- 5G-Crosshaul - An **EU H2020 5G-PPP** collaborative project developing an integrated fronthaul and backhaul solution for 5G networks

Funding	Duration	Effort	Start	Consortium
~8 m€	30 Months	981 PMs	July 01, 2015	21 partners

- Partners in the consortium include **leading telecom industry** vendors, operators, SMEs, and research institutes
  - **Vendors and IT:** NEC (TM*), Ericsson, Nokia Networks, InterDigital, ATOS
  - **Operators:** Telecom Italia, Orange, Telefonica
  - **SMEs:** CoreNetwork Dynamics, Telnet, EBlink, Visiona IP, Nextworks
  - **Research institutes:** University Carlos III of Madrid (PC*), Fraunhoffer Heinrich Hertz Institute, CTTC, CREATE-NET, Politecnico di Torino, Lunds University, ITRI

*TM – Technical Manager; PC – Project Coordinator

The Context

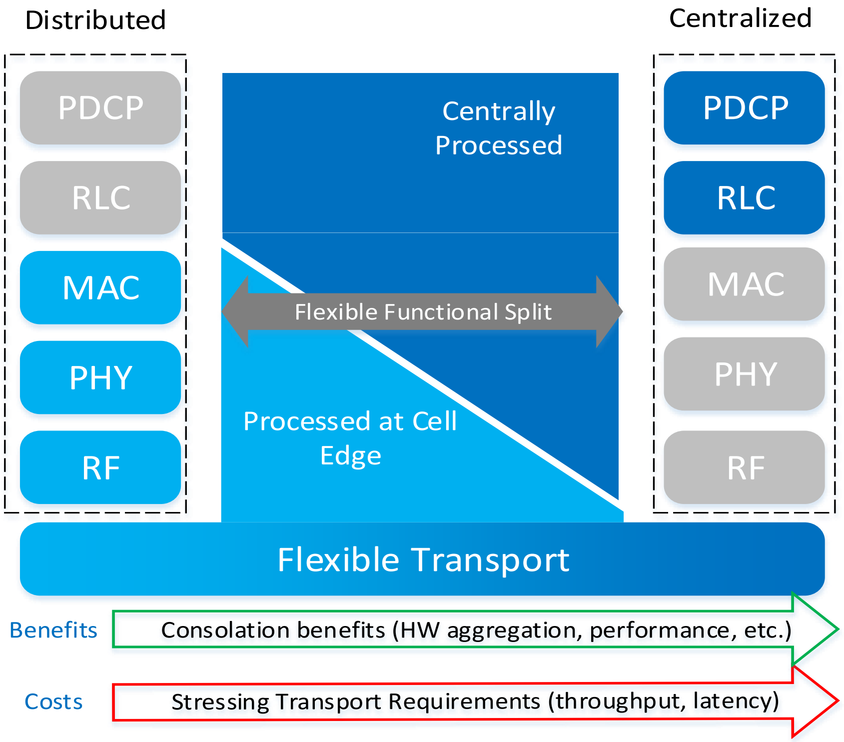
- **The drivers:** An ambitious set of 5G KPIs (e.g. capacity, latency, efficiency) at a time network operators are challenged to reduce costs (TCO) and expand their service offer!
- **SDN, NFV and the Cloud** are instrumental tools to help operators meet their 5G network requirements.
- However, these tools cannot be deployed independently, but rather **jointly in an optimized way** to meet the 5G network infrastructure needs at a given time and in a given service area.
- The **transport network** (interconnecting the access and the core) is a key part of the overall network infrastructure, and hence **shall evolve along with the access and the core to meet the 5G requirements.**

The Challenges

- High level of **densification** foreseen in 5G, raises the challenge of **small cell backhaul**, where fiber-like capacity over wireless is needed.
- **Macro backhaul** is (carrier-grade) packet-switching and embracing the SDN and NFV concepts to lower costs and improve flexibility.
- **Fronthaul** is evolving too, from fixed and costly CPRI PTP links to **Ethernet-switching** for scalability and lower cost, but not yet resolving the challenges of bandwidth and latency.
- The RAN is embracing virtualization too, with **new functional splits** (e.g. L1/L2) relaxing the bandwidth requirement of CPRI (and CPRI-like) fronthaul but not really the latency.
- This calls for a **unifying transport solution** that integrates the fronthaul and backhaul traffic mixture, in a common-haul packet switching under a common-haul SDN-based control. **This is the aim of the 5G-Crosshaul project!**

RAN Function Splits Challenge

- Centralization of RAN functions yield benefits from hardware consolidation and advanced signal processing (e.g. COMP)
- Cost and availability of transport (e.g. fiber) may prohibit full centralizations
- MEC is a part of optimizing
  - Flexibly choosing the functions to process at the edge
  - Edge servers provide equivalent to cloud functions



5GXCrosshaul

INTERDIGITAL.

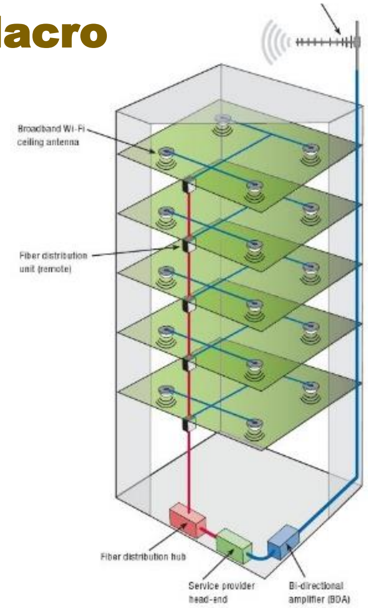
Example Motivation for Unifying Transport

- Diverse data transport systems exist at network edge, especially for indoor wireless
- Limitations
  - No common management system
  - No flexibility for evolving network architecture
- **Unified transport enables integration across diverse transport systems**
- Other cases
  - Multi-tenancy
  - Mobile Edge Computing
    - New applications with ultra-low latency
    - Network reconfiguration as local demands change

Indoor Small Cell

CPRI

Macro



Indoor DAS

WLAN

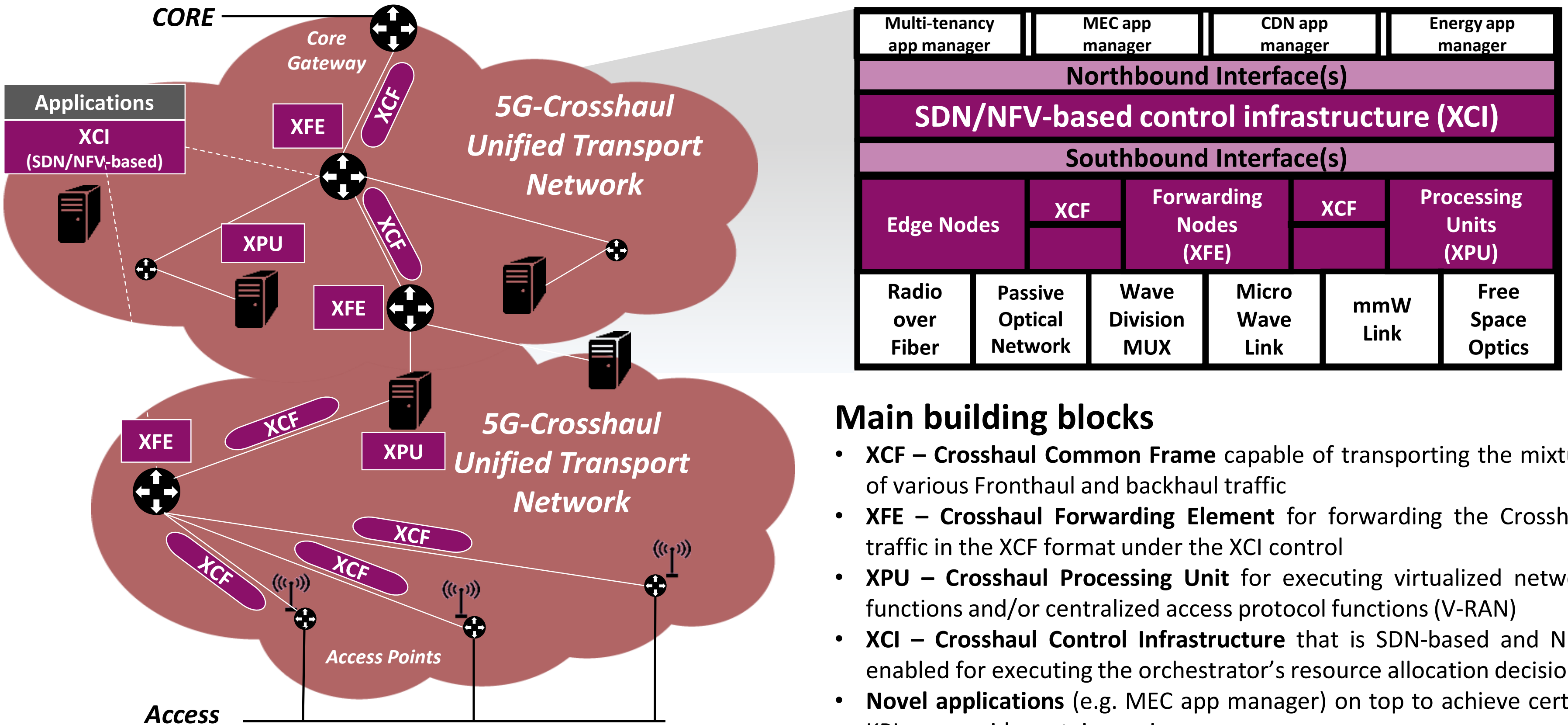
mmWave

Fiber

CAT-5

Cooper/RF

Simplified View of 5G-Crosshaul Architecture



Main building blocks

- **XCF – Crosshaul Common Frame** capable of transporting the mixture of various Fronthaul and backhaul traffic
- **XFE – Crosshaul Forwarding Element** for forwarding the Crosshaul traffic in the XCF format under the XCI control
- **XPU – Crosshaul Processing Unit** for executing virtualized network functions and/or centralized access protocol functions (V-RAN)
- **XCI – Crosshaul Control Infrastructure** that is SDN-based and NFV-enabled for executing the orchestrator’s resource allocation decisions
- **Novel applications** (e.g. MEC app manager) on top to achieve certain KPIs or provide certain services

MEC in 5G-Crosshaul

- 5G-Crosshaul project has set its focus on 5 key use cases, 3 verticals (High speed train, media distribution, dense urban society) and 2 horizontals (multi-tenancy, and **mobile edge computing**).
- MEC schemes are envisaged in the **application plane** of the 5G-Crosshaul infrastructure, with benefits to the end user (QoE) and operators (e.g. managed backhaul capacity, service differentiation)
- 5G-Crosshaul focus areas on MEC use case include:
  - Mobile edge computing in the architecture
  - MEC Requirements on the NBI/SBI
  - Optimization of network and computing resources

Thank you!

www.5g-crosshaul.eu