Standardization Roadmap for the 5G Integrated Fronthaul and Backhaul

Alain Mourad and Jaehyun Ahn
InterDigital Europe Ltd

ETSI Workshop « 5G: From Research to Standardization »
Sophia-Antipolis, 11 May 2016
Outline

• Part 1: Setting the scene – The fronthaul and backhaul in the 5G picture
• Part 2: Introducing 5G-Crosshaul – The 5G integrated Fronthaul/Backhaul
• Part 3: Standardization Roadmap – as captured so far by the 5G-Crosshaul
Part 1: Setting the scene

The fronthaul and backhaul in the 5G picture
• **Vision**: A *unified programmable and shareable infrastructure that can deliver flexibly, speedily and efficiently all the 5G services envisioned*

• **Key Performance Indicators (KPIs):**
  
  – 1,000 X in **mobile data volume** per geographical area reaching a target ≥ 10 Tb/s/km²
  
  – 1,000 X in **number of connected devices** reaching a density ≥ 1M terminals/km²
  
  – 100 X in **user data rate** reaching a peak terminal data rate ≥ 10Gb/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 ≤ 1 ms for e.g. Vehicle to Vehicle communication
  
  – 1/5 X in network management **OPEX**
  
  – 1/1,000 X in **service deployment time** reaching a complete deployment in ≤ 90 minutes
Mapping the 5G KPIs on the backhaul

- **Capacity/Data rate**: Need bigger pipes (Gbps optical and wireless) and ways to offload traffic to the edge where possible.
- **Latency**: Need fast and resilient forwarding, intelligent leveraging of edge infrastructure.
- **Cost**: Use less fibers (e.g. DWDM and/or wireless), away from specialized switching HW (embrace NFV), unify the management, use standardized OAM.
- **Flexibility**: Make it softwarized, bring SDN, make it virtualized, bring NFV, embrace the cloud.
- **Efficiency**: Enable access-aware resource optimization, switch on/off cells, support cooperative schemes.
Mapping the 5G KPIs on the fronthaul

Capacity/Data rate: Ways to reduce required fronthaul capacity, apply compression or consider new functional splits.

Latency: Need fast and resilient (time sensitive) fronthaul networking, an intelligent use of the edge.

Cost: Need to lower dependency on fiber and proprietary CPRI, use Ethernet-based where possible, use standardized OAM for fronthaul switches.

Flexibility: Make it softwarized, bring SDN, support centralized and distributed clouds.

Efficiency: Move from dedicated CBR CPRI links to more shareable fronthaul networking (statistical mux).
Enablers for 5G integrated FH and BH

Gbps transmission technology, optical and wireless

Fast and resilient forwarding, time sensitive networking

Standardized OAM

Packet-based switching and multiplexing

Edge Networking

Softwarization

Functional splitting, virtualization, and orchestration

Capacity/Data rate

Latency

Cost

Flexibility

Efficiency
Part 2: Introducing 5G-Crosshaul

The 5G integrated fronthaul and backhaul
Unifying the transport of existing and new fronthaul and backhaul traffic into a 5G crosshaul SDN/NFV-based packet switching network, that supports 5G RAN architectures and KPIs

A high capacity low latency transport solution that lowers costs and guarantees flexibility and scalability

The target for this tech: Telcos & Switch Vendors
A holistic approach for converged Fronthaul and Backhaul under common SDN/NFV-based control, capable of supporting new 5G RAN architectures (V-RAN) and performance requirements

Main building blocks

XCF – Common Frame capable of transporting the mixture of Fronthaul and backhaul traffic

XFE – Forwarding Element for forwarding the traffic in the XCF format under the XCI control

XPU – Processing Unit for executing virtualized network functions (V-RAN)

XCI – Control Infrastructure that is SDN-based and NFV-enabled for executing the orchestrator’s resource allocation decisions

Novel network apps on top to achieve certain KPIs or services
Consortium and Project Traction

**Partners (21)**

- Atos
- NEC
- Nokia
- INTERDigital Europe
- Nextworks Engineering Forward
- EBlock
- Telecom Italia
- Core Network Dynamics
- TELNET
- Telefónica
- Telefónica I+D
- CREATE-NET
- Fraunhofer Heinrich Hertz Institute
- Visiona
- TTC
- ITRI
- Industrial Technology Research Institute
- Ericsson
- Orange

**Project Duration**
Jul 2015 – Dec 2017

**EU Funding**
7.95mio Euros

**Project Traction**
- Baseline architecture
- Common Frame Format
- First trials in Sep’16

[www.5g-crosshaul.eu](http://www.5g-crosshaul.eu)
Part 3: Standardization Roadmap

As captured by 5G-Crosshaul
Categorization of ongoing work

• Use cases, gaps, requirements, architectures
  – NGMN, ITU-T 2020 FG, ITU-R WP5D, 3GPP, BBF, SCF

• Gbps transmission technology (wired/wireless)
  – Wired: ITU-T SG15, NG-PON2, 100GE, CPRI
  – Wireless: ETSI mWT, IEEE 802.11ay

• Wireless access protocol functional splits
  – 3GPP, IEEE 802.11, SCF

• FH/BH traffic packetization (formatting)
  – Fronthaul: CPRI, NGFI (IEEE 1914.1 << 1904.3)
  – Backhaul: VLAN (IEEE 802.1Q), MPLS
Categorization of ongoing work (Cont’d)

• FH/BH traffic forwarding (switching protocols)
  – IEEE 802.1CM (Time Sensitive Networking), IETF DETNET (Deterministic Networking)

• SDN control
  – ONF (OpenFlow), OpenDayLight, ONOS, IRTF SDNRG, ITU-T SG13, IEEE 802.1CF

• NFV-based management and orchestration
  – ETSI NFV, IRTF NFVRG, OPNFV, OpenMANO, OpenStack

• Network applications and APIs
  – OMA, ETSI MEC
Standardization roadmap (by 2020)

### 2016
- Identification of gaps, use cases, functional split profiles, initial requirements and architectures: ITU-R/T, 3GPP, IEEE, NGMN, BBF, SCF

### 2017
- Specification of Gbps transmission technologies (wired and wireless) supporting 5G traffic: ITU-T SG15, XG Ethernet, ETSI mWT, IEEE 802.11

### 2018
- Specification of transport formats and forwarding protocols suitable for the envisioned traffic profiles: IEEE 1914, CPRI, IEEE 802.1CM, IETF DETNET

### 2019
- Extensions for flexible support of distributed/centralized clouds: ETSI? OPENSTACK?
- Extensions for interworking with other domains: core and access: ETSI? 3GPP? OPNFV? OPENMANO?
- APIs for the support of various transport network applications: ETSI? OMA?

### 2020
- Extensions for interworking with other domains: core and access: ETSI? 3GPP? OPNFV? OPENMANO?

© 2016 InterDigital, Inc. All Rights Reserved.
http://5g-ppp.eu

Thank you for your attention!