5GXCrosshaul

5G-Crosshaul

A 5G integrated backhaul and fronthaul flexible transport network

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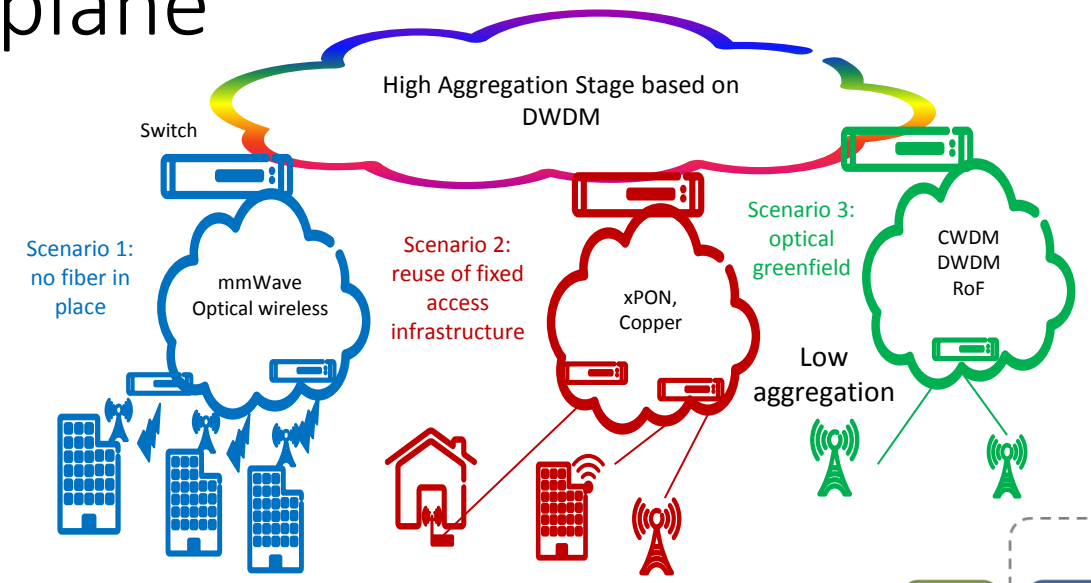
Outline

- How 5G-Crosshaul addresses the 5G KPIs
- 5G-Crosshaul technologies and data plane
- Use cases and technologies mapping
- The multi-layer switch
- Deterministic delay multiplexing
- Packet based multiplexing, Mac-in-Mac
- The protocol agnostic South Bound Interface

How 5G-Crosshaul addresses the 5G KPIs

- 1000x capacity: multi-layer switch at different levels of granularity, from Mbit/s to Tbit/s
- Very dense deployment thanks to any kind of medium: fiber, copper for indoor small cells, wireless for reaching locations with no installed cables
- Reliable Internet with zero-perceived downtime: fast reroute of channel paths in case of failure or QoS degradation, at the circuit, time-slot and packet switching granularity
- Reduction of energy consumption: centralization and concurrent optimization of computational and transport bandwidth resources.
- EU competitive industrial offer, leverage effect of EU funding, reach a global market share for 5G: member industries and telcos are European and world market leaders (and eager to remain so)
- New services of high societal value: programmable, multi-layer transport platform highly suitable to serve differentiated services with different requirements
- 5G skills development curricula: a holistic view is required encompassing radio protocols, optical and wireless transmission, switching, protection and restoration, fixed access, etc.
- SME participation of 20%: innovative SMEs are very active in the project

5G-Crosshaul technologies and data plane

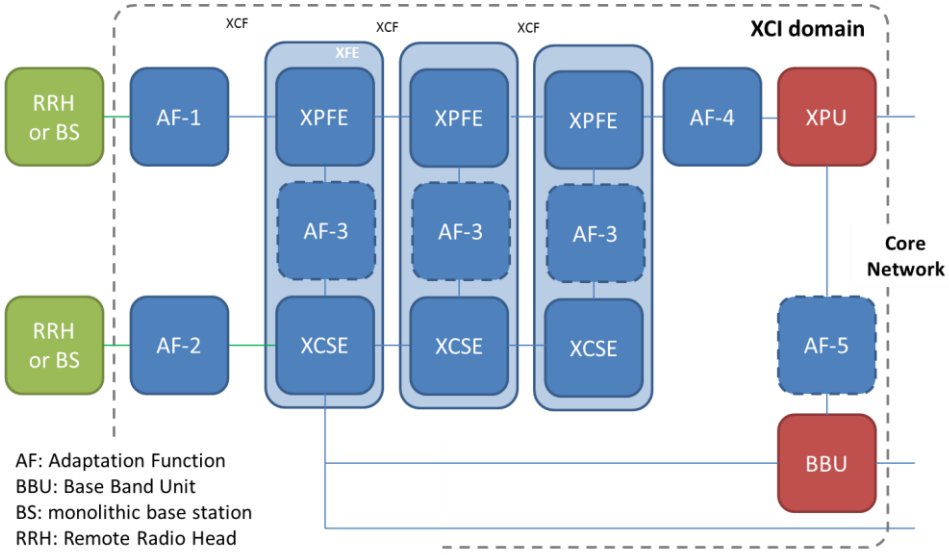


Programmable baseband and transport bandwidth resources

SDN control to hide unnecessary technology details and ensure e2e QoS

Any medium
Any topology
Any protocol split*

*including CPRI



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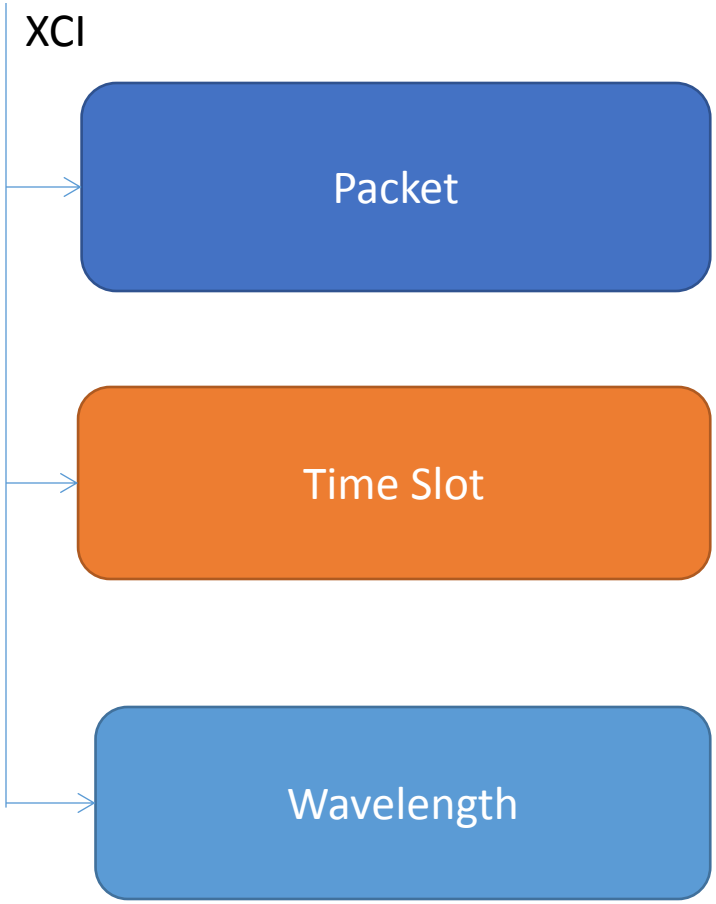
Use cases and technologies mapping

	wireless technologies			Access technologies		Optical technologies		
Technology	**Millimetre wave small cells backhaul spectrum range 50-90 GHz**	**Microwave and millimetre wave fronthaul**	**Optical Wireless Technologies**	**Technologies working on optical fixed access infrastructure**	**Technologies working on copper fixed access infrastructure**	**Passive multiplexing solutions based on CWDM**	**DWDM metro networks**	**Radio over Fibre technologies**
UC1 - vehicle mobility	Good for monitoring physical parameters. Possibility to remotely switch on/off devices. Energy efficient.	Poor due in particular to limited distances	Good due to negligible impact of doppler effect limited distances otherwise	Good for the bandwidth, in particular NG-PON and excellent for distance.	Good for the bandwidth for ETH, sufficient DSL. Improbable access to copper nearby streets or railways	Good for the bandwidth and for the limited cost. Excellent performance (latency)	Excellent for the bandwidth and performance (latency)	Excellent for its deplyment in tunnels
UC2 -media distribution: CDN and broadcast	Poor due to the low bandwidth per user (about 7 Mbit/s)	Poor due to the low bandwidth per user (about 8 Mbit/s)	Poor the LED solution. Good the LASER one	Good for the bandwidth, in particular NG-PON and excellent for distance.	Good for the bandwidth, in particular NG-PON and excellent for distance.	Good for bandwidth, excellent for cost	Excellent for bandwidth, good for cost	Good for bandwidth, excellent for cost
UC3 - Dense urban society	Excellent for indoor, even if limited bandwidth per area should be considered in the open air.	Excellent for indoor, even if limited bandwidth per area should be considered in the open air.	Good for Small cell backhaul, Excellent for indoor with LOS, where radio is not allowed, LED more affordable then LASER	Good.High density may imply that it is impossible to reach high bitrate in compressed space	Good.High density may imply that it is impossible to reach high bitrate in compressed space	Good. Even if high density may imply high denity of fibre deployment	Good. Even if high density may imply high denity of fibre deployment and for DWDM implies high costs	Good. Even if high density may imply high denity of fibre deployment

The multi-layer switch



- Packetized fronthaul
- Backhaul

- low latency frronthaul
- CPRI
- GbE backhaul

- CPRI
- 10GbE backhaul

Packet

- Statistical multiplexing gain o deal with big 5G traffic load
- High BW efficiency
- Possible delay and jitter issues

Time Slot

- Pre assigned time-slots
- Moderate BW efficiency
- Deterministic Latency and low jitter

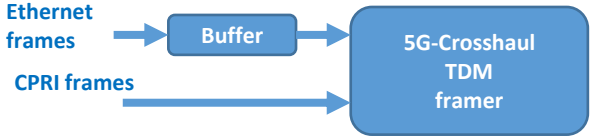
Wavelength

- Traffic with different requirements (FH, MH, BH) segregated on different wavelengths
- BW inefficient
- Low latency, no Jitter

- The switch is modular: some layers could be skipped depending on use case, operator requirements, target performance, etc.
- A common control is necessary to properly map the client signals into the three layers
  - Example: routing packets to the circuit switch for avoiding congestion (offload) or when latecy requirements are tight

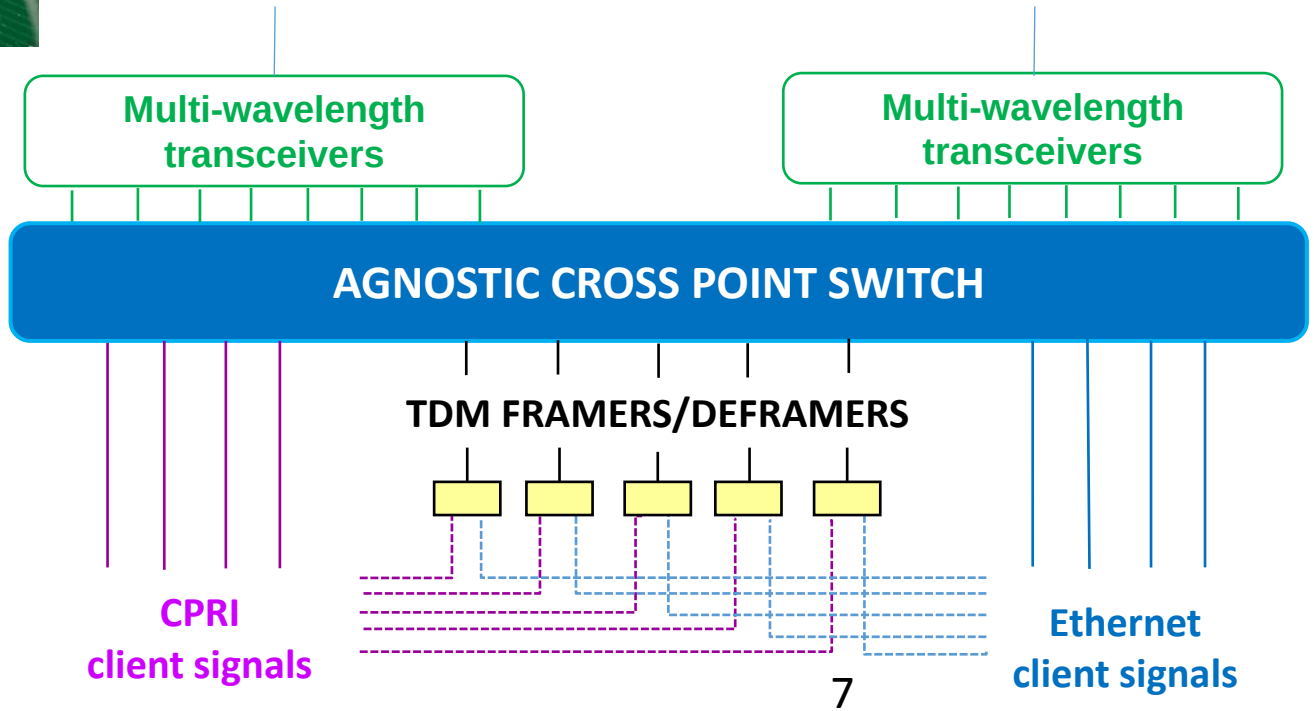
Deterministic delay multiplexing

Mini-ROADM



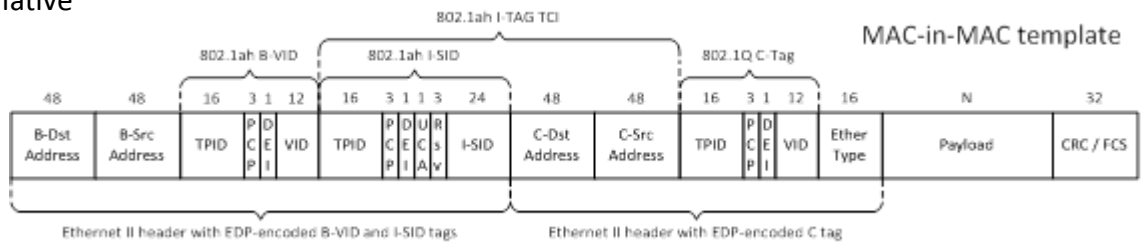
Deterministic delay framing

Circuit Switch



Packet based multiplexing

- Support multiple functional splits
  - Statistical multiplexing gain
- Multi-tenancy
  - One tenant shall not impact the QoS of other tenants
  - Guaranteed privacy among tenants
  - Different forwarding policies
- Compatibility with legacy Ethernet switches
- Compatibility with IEEE 1588v2 or IEEE 802.1AS
- Class of service differentiation (e.g. to manage different latency requirements)
- In band OAM
- Multi-media support, e.g. compatibility with 802.11ad
- To better support multi-tenancy MAC-in-MAC was chosen as frame format
  - MPLS-TP is also a viable alternative



The protocol agnostic South Bound Interface

- Modelling based on a protocol agnostic set of parameters for configuration, monitoring and inventory
- Enable applications, such as optimization of resource allocation and energy, running over the whole network infrastructure.
- The choice of the parameters sets was careful, neither too small to inhibit some applications nor too wide to negatively affect solution cost and scalability.
- The needed protocol extensions were analyzed taking as Open Flow, as a relevant example of protocol stack used in SDN and to facilitate the adoption of standardized and widely adopted solutions.