X-Ethernet

Ethernet Everywhere

Network Technology Lab of 2012 Labs

BUILDING A BETTER CONNECTED WORLD

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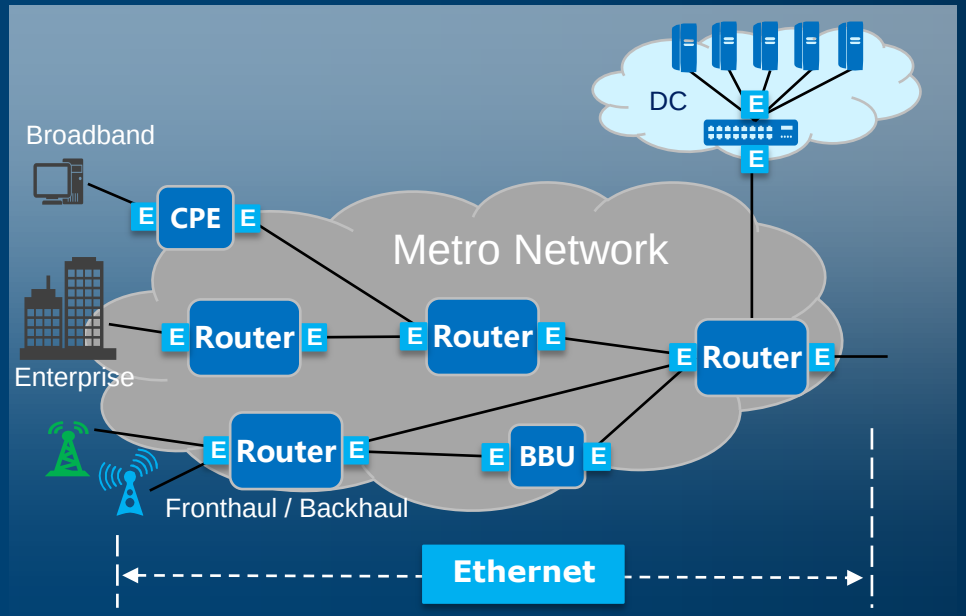
A Unified Ethernet Network – Ethernet Everywhere



Service	Latency	jitter
CPRI	<100us	+-8.138ns
Inter-site CoMP	250us	--
Smart Grid	<5ms (<500km)	+-10us
Industry4.0	ns ~ ms	Low jitter
Low latency S1	< 1ms	--

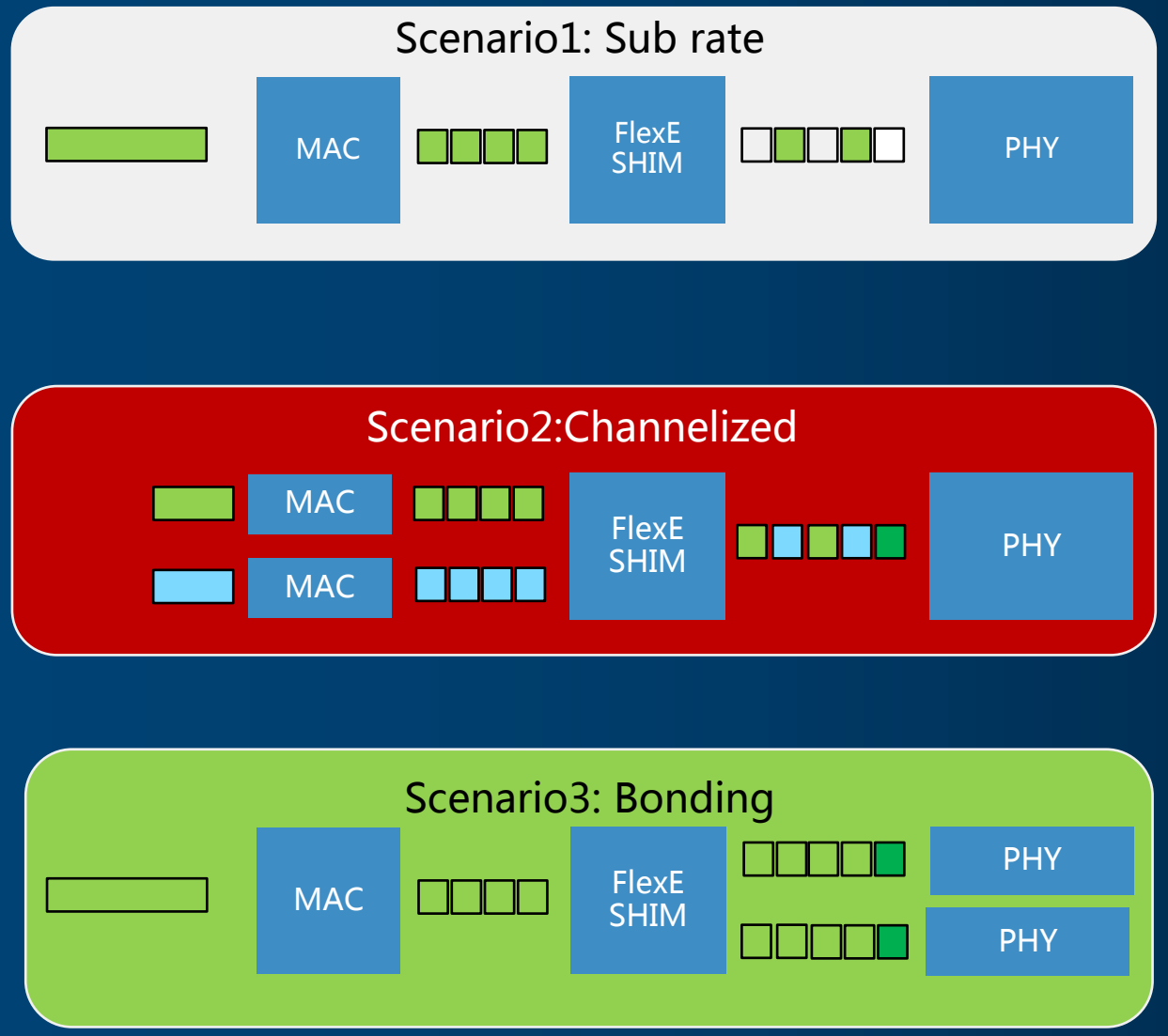
All Ethernet

- Standard, perfect interoperability
- Mature ecosystem, lost cost
- But difficult to support some new Apps

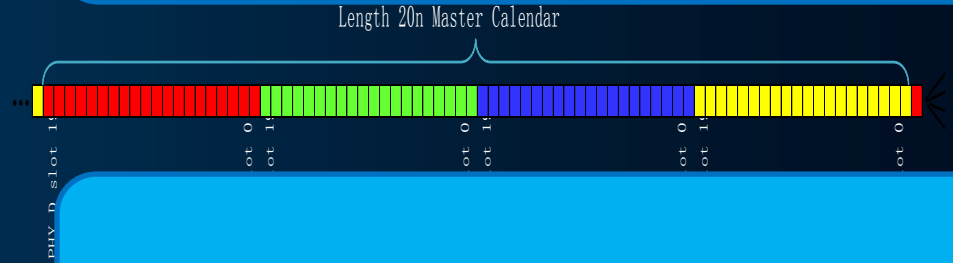
Ultra-Low Latency Requirement

- New emerging service
- Different level of latency requirement
- Beyond packet latency / jitter capability

FlexEthernet Use Cases



Programmability

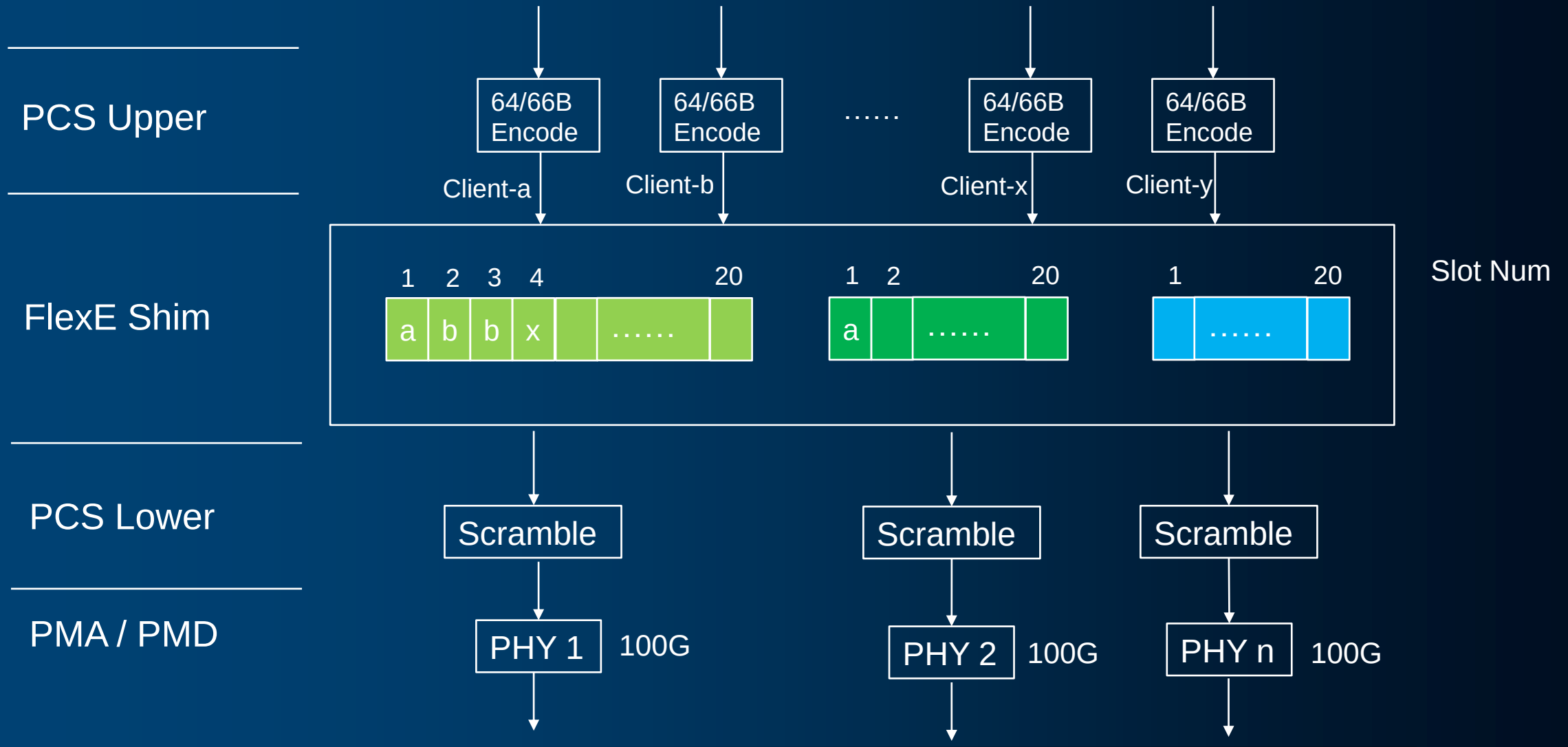


Isolation

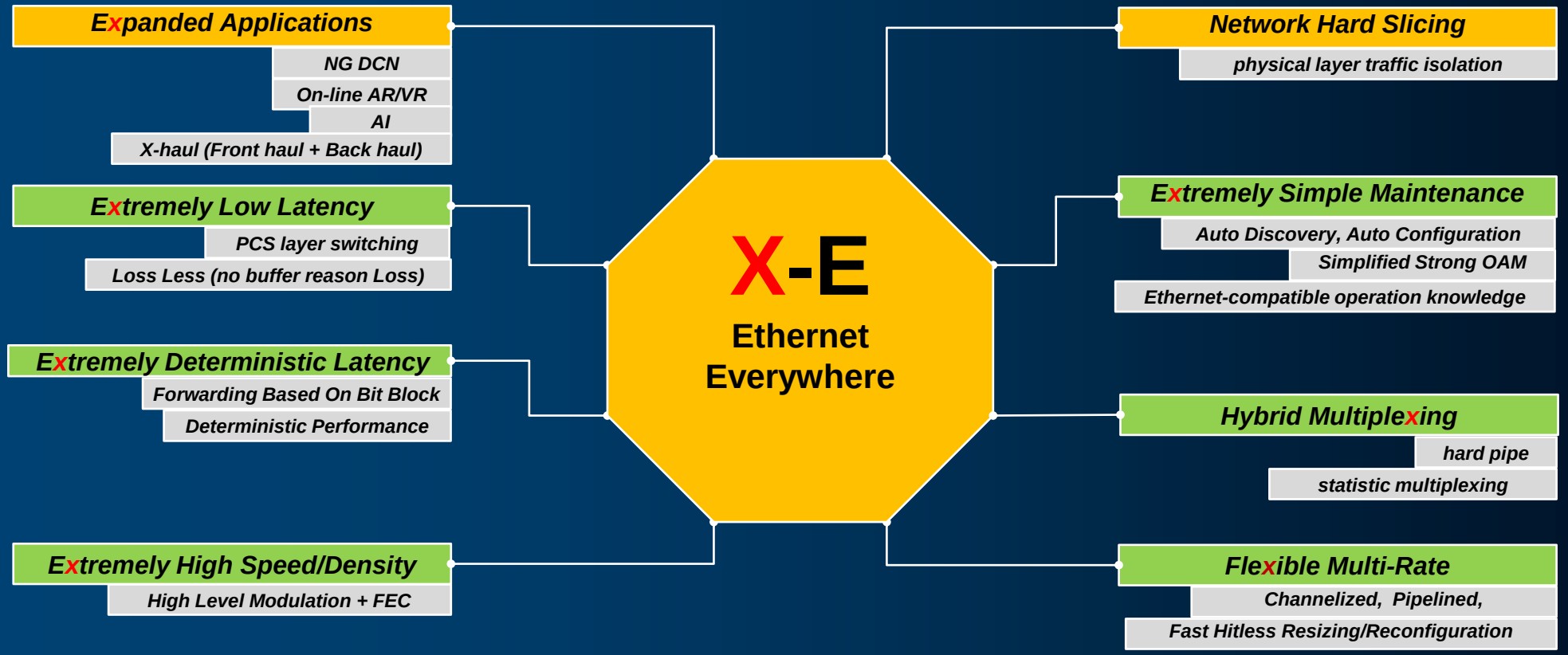
Each port has 20 channels at maximum.
Minimum channel band is 1/20 port band.

Flexibility

FlexEthernet Implementation

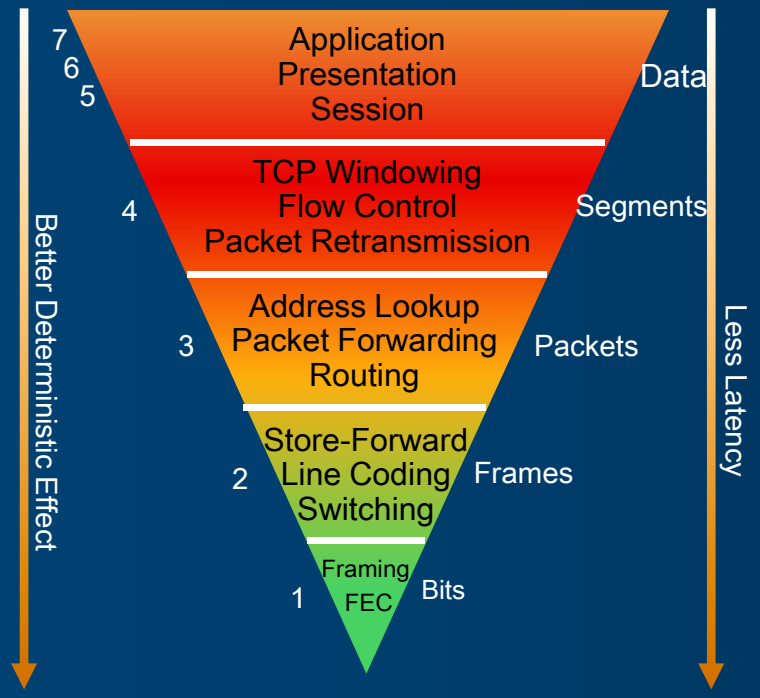


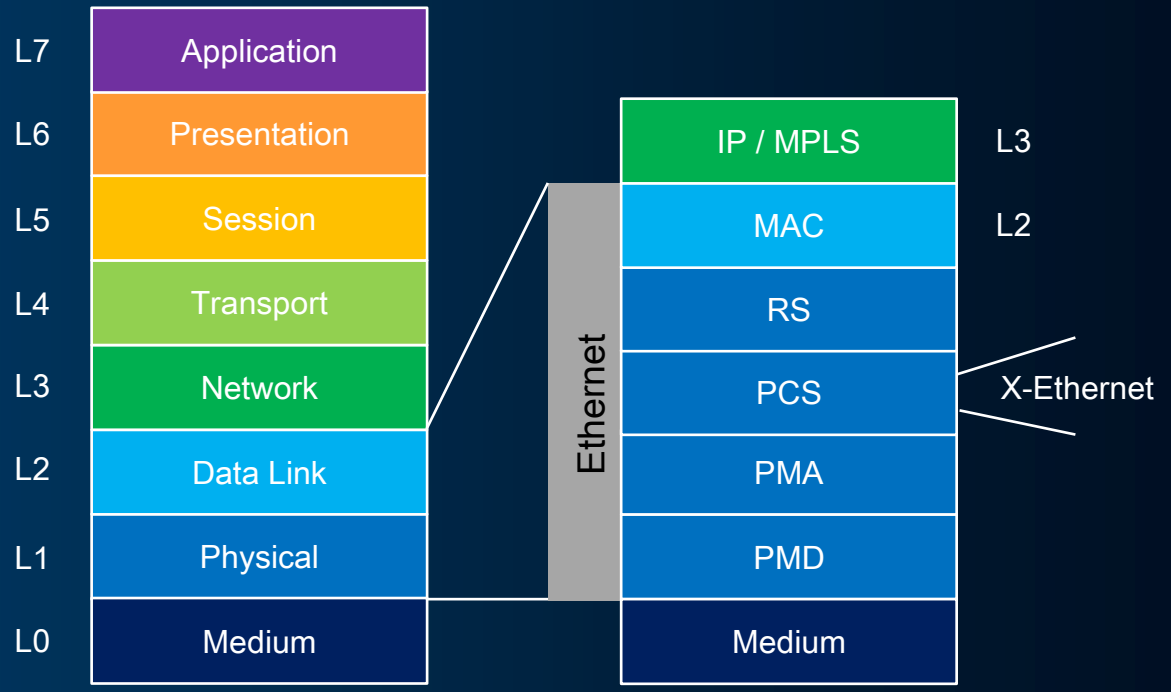
What is X-Ethernet



- X-Ethernet is a technology set we are engaged in;
- Main purpose of X-Ethernet is resolving deterministic ultra-low latency challenge;

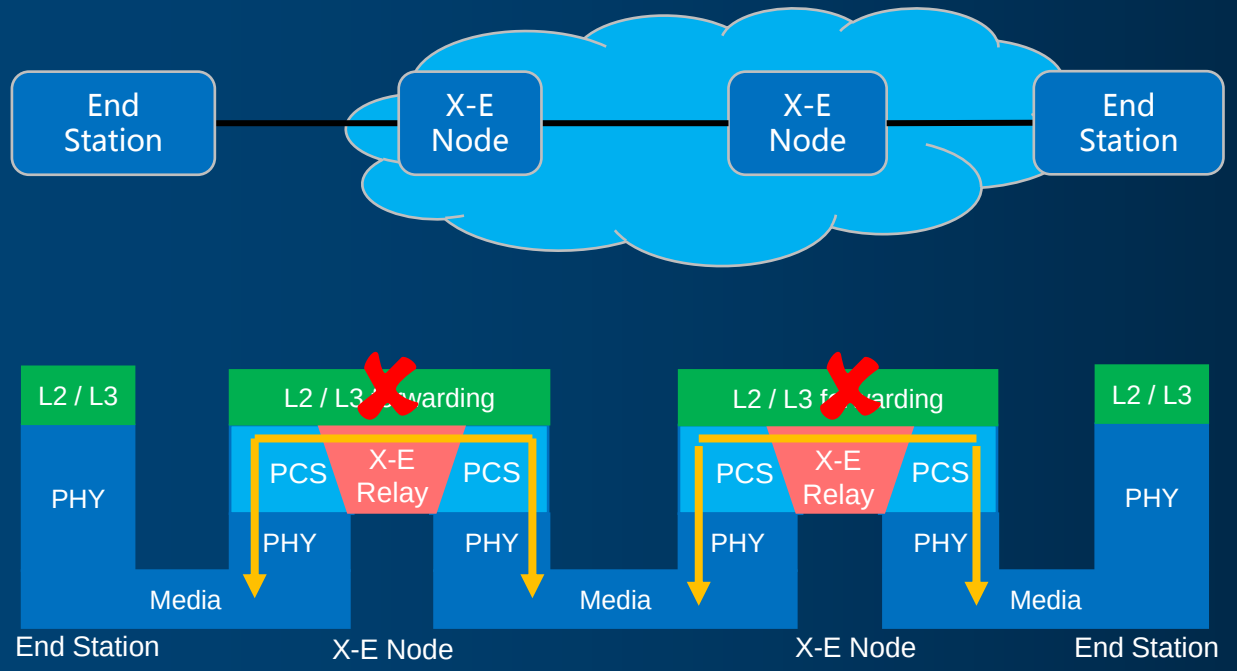
X-Ethernet Forwarding

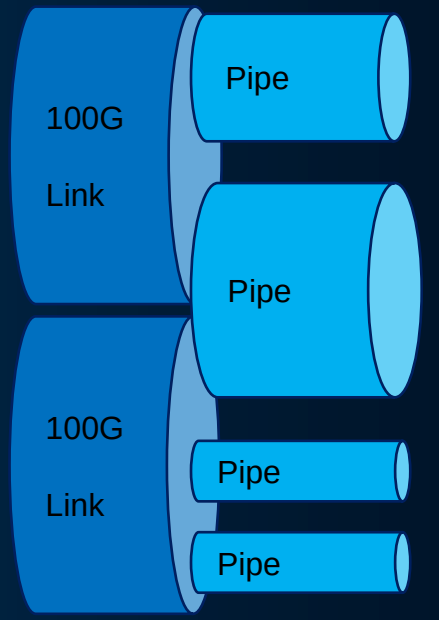




- Forwarding in lower layer can have lower latency
- X-Ethernet make use of Ethernet PCS layer code block forwarding

X-Ethernet E2E Hard Pipe



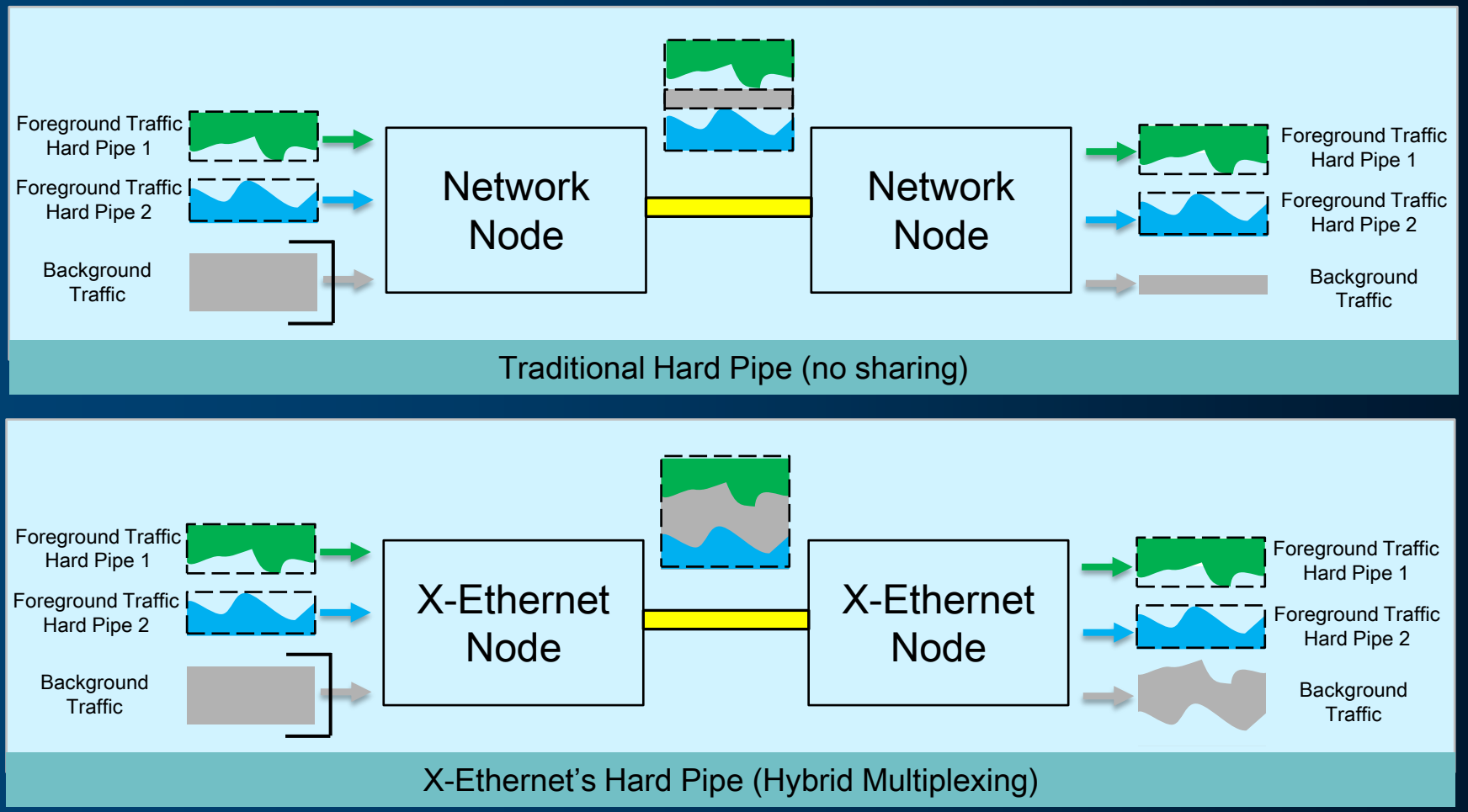


X-Ethernet can provide E2E hard pipes using PCS layer forwarding

Why low latency

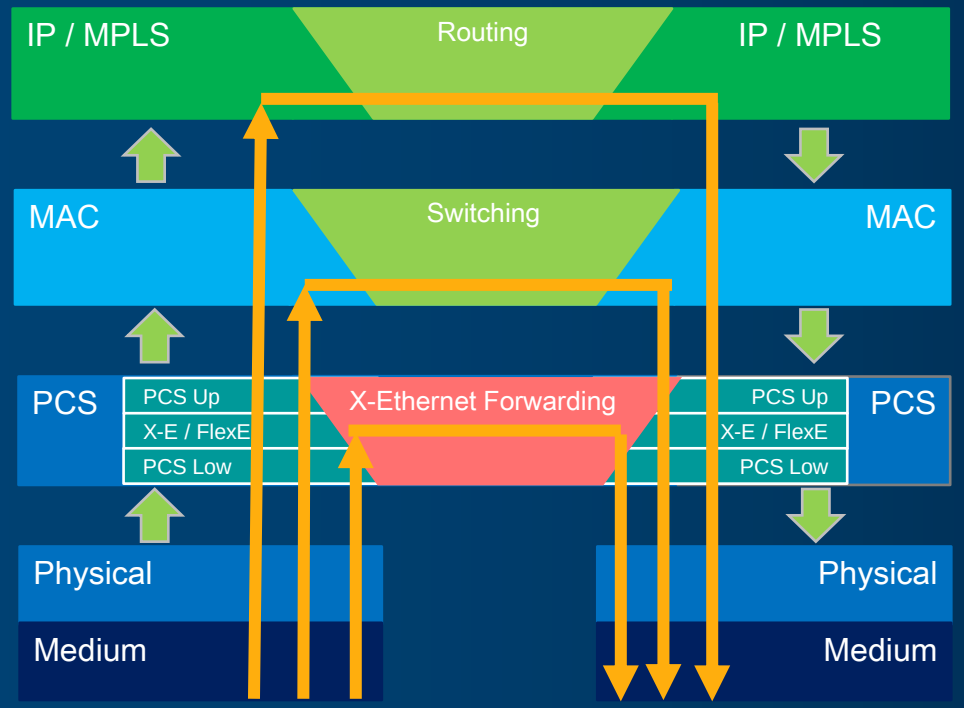
- No store-and-forward, no buffering
- No MAC/IP table lookup
- No scheduling / queuing, no congestion, no packet loss and retransmission

X-Ethernet Hybrid Multiplexing

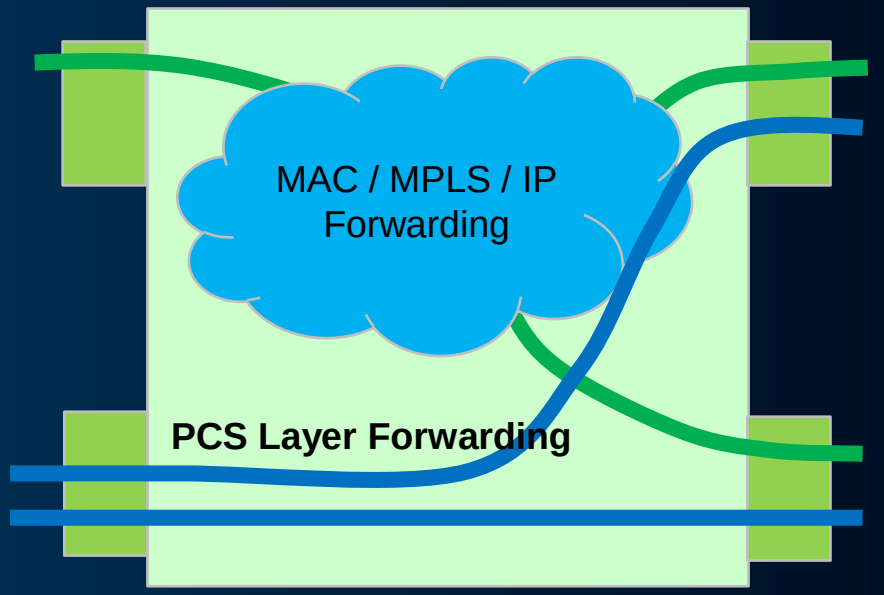


- X-E Hybrid Multiplexing supports sharing unused bandwidth of X-E hard pipes with background traffic to raise network utilization;

Multiple Forwarding Modes

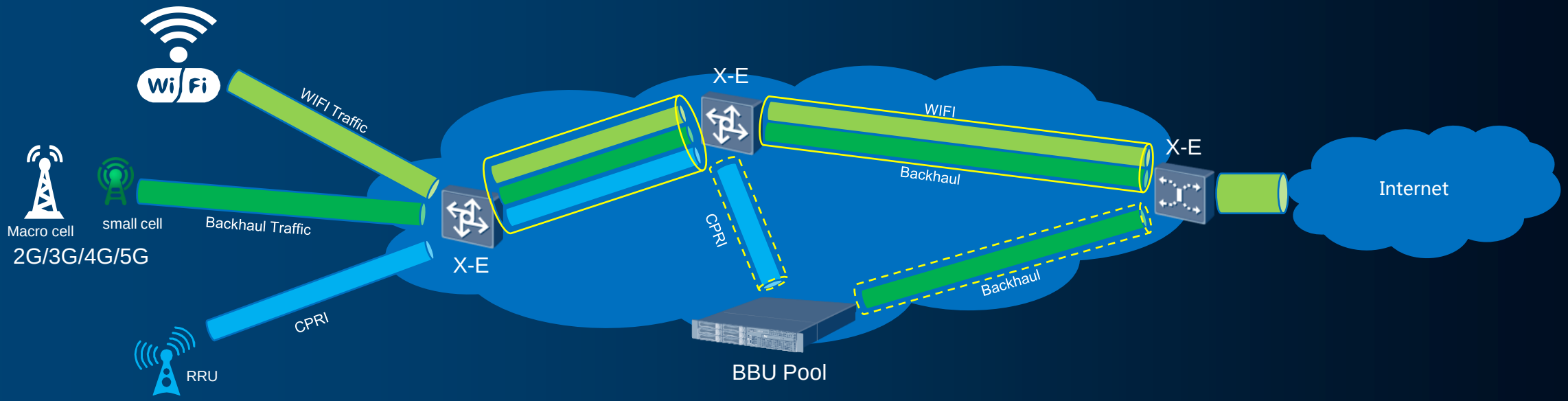


PCS Code Block / L2 / L3 forwarding capability



Multiple forwarding modes in parallel in a single device or even single link

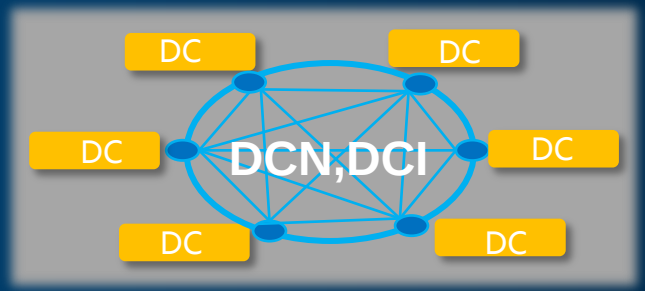
Multiple Modes for Various Services



- Multiple forwarding modes for various type of services respectively
- An Integrated network for multiple types of service

X-Ethernet Use Cases

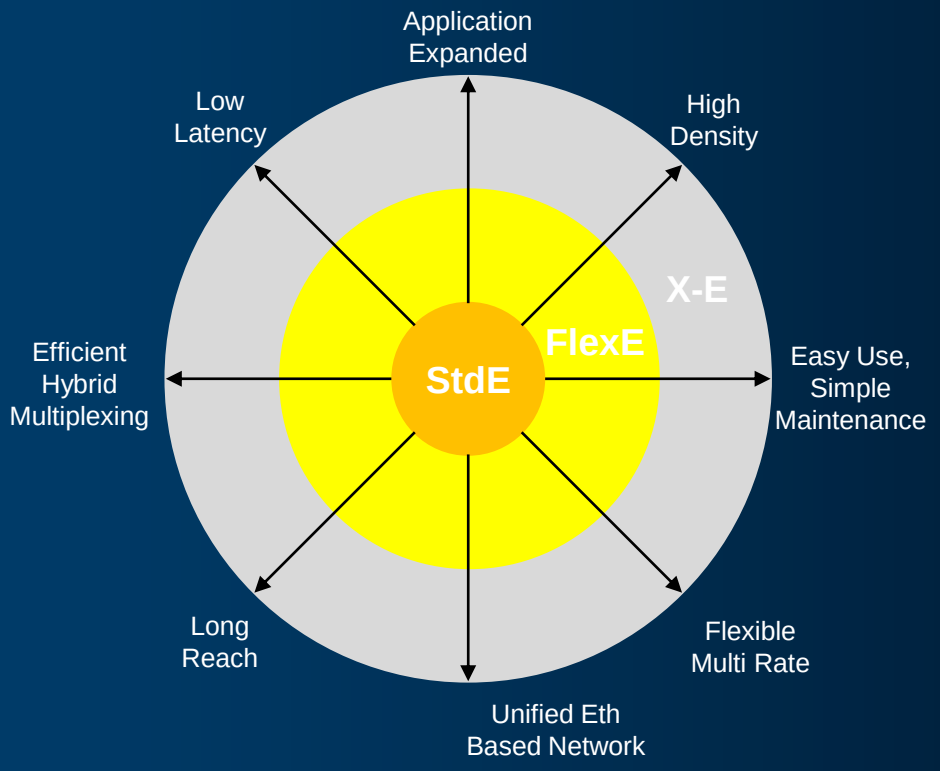
HFT: High Frequency Trading, Time is Money, Latency means profit loss



Network based AR/VR with 20ms Motion to Photons Latency/Round Trip Time; Latency Budget for Network is limited as 1~5ms

Cloud Service, Computation, CDN

Low end to end latency, High Throughput



5GXCrosshaul
the integrated fronthaul/backhaul
5G-XHaul
5G PPP
The 5G Infrastructure Public Private Partnership

Future Mobile Fronthaul and Backhaul
Low Latency and High Capacity/Density

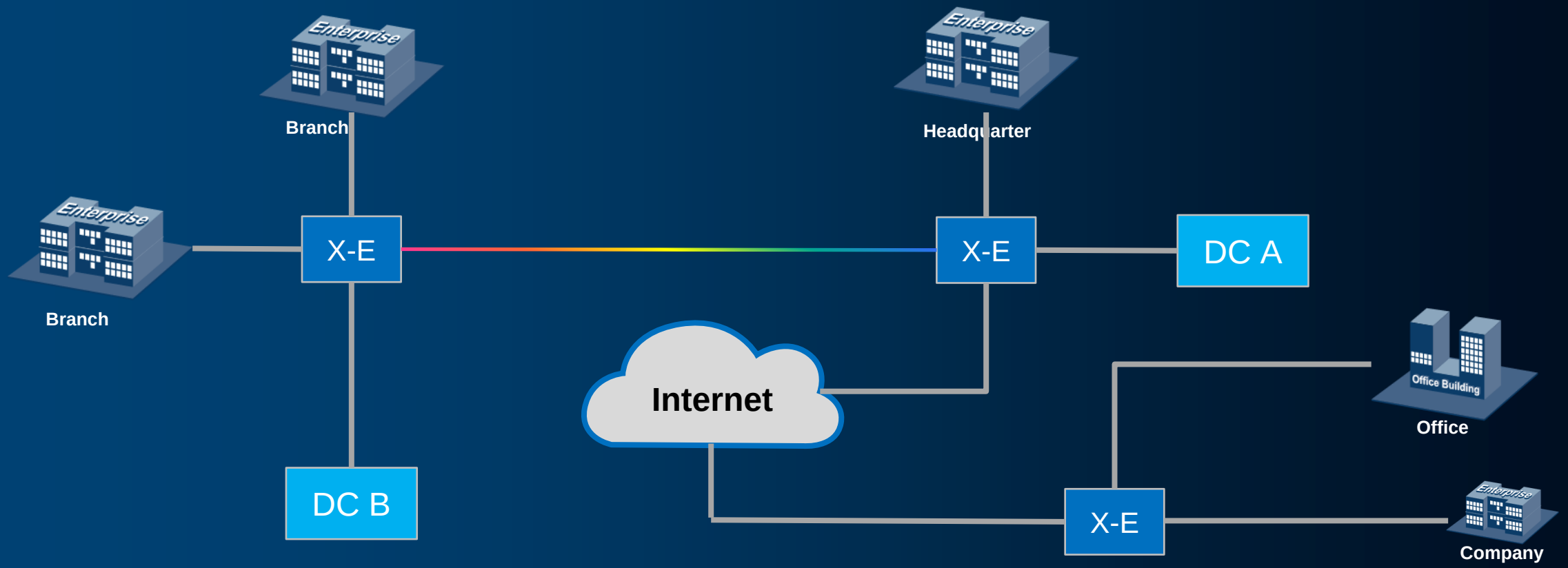
Industrial Networking 4.0

Low latency, Timing sensitive

Internet of Things

Low Latency, Vast Connectivity,

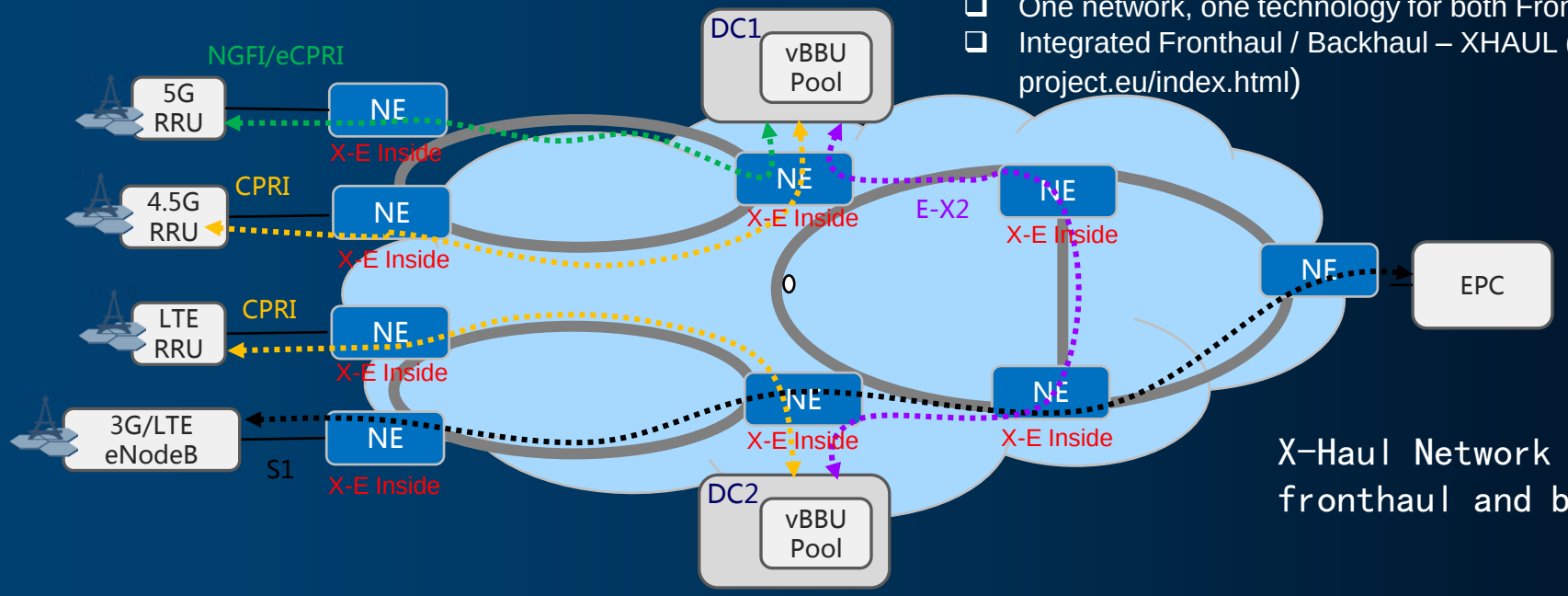
Use Case 1 – Ethernet Leased Line



- E2E hard pipe – fine granularity – 1G, N*1G, which is an enhancement to FlexE spec
- Security – physical layer traffic isolation
- QoS – Guaranteed bandwidth; very low latency; no packet loss
- Dynamic bandwidth adjustment

UseCase 2 : Xhaul - Converged Fronthaul/Backhaul

- One network, one technology for both Fronthaul and Backhaul
- Integrated Fronthaul / Backhaul – XHAUL (http://www.5g-xhaul-project.eu/index.html)



X-Haul Network for integrated fronthaul and backhaul

Deterministic Ultra-Low Latency

- Fronthaul（CPRI）: 100us(20km)/200us(40km);
- Backhaul :10us~1ms;
- Provide deterministic ultra-low latency closed to the physical limitation for wider Fronthaul scale;

One Network

- One Device，One interface，One Fiber for both Fronthaul and Backhaul traffic;
- Fronthaul/Backhaul On Demand;
- Hitless Bandwidth Adjustment
- High bandwidth utilization by creative hybrid multiplexing;

Based on Ethernet

- Achieve deterministic ultra-latency forwarding layer, based on Ethernet PHY Core;
- Leverage Ethernet mature ecosystem;

X-Ethernet Prototype

JOIN US IN

BUILDING A BETTER CONNECTED WORLD

THANK YOU

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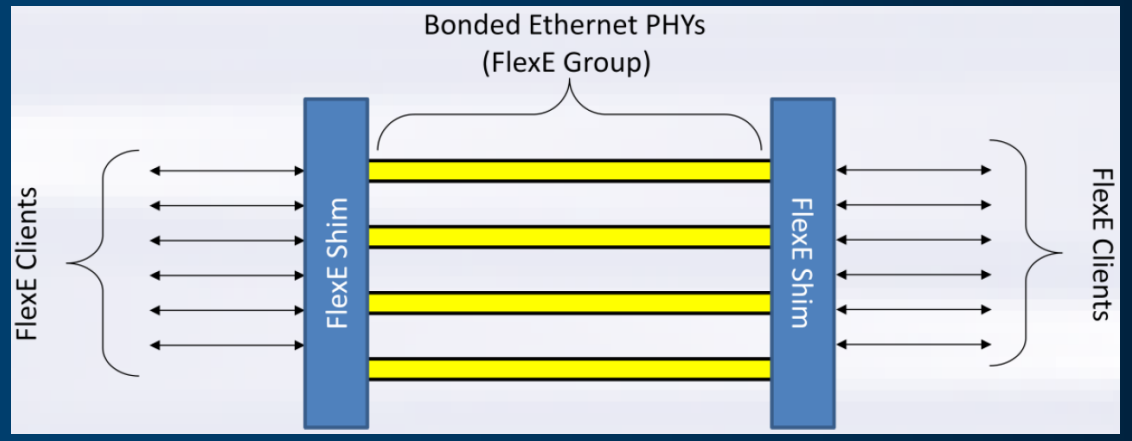
FlexE Architecture



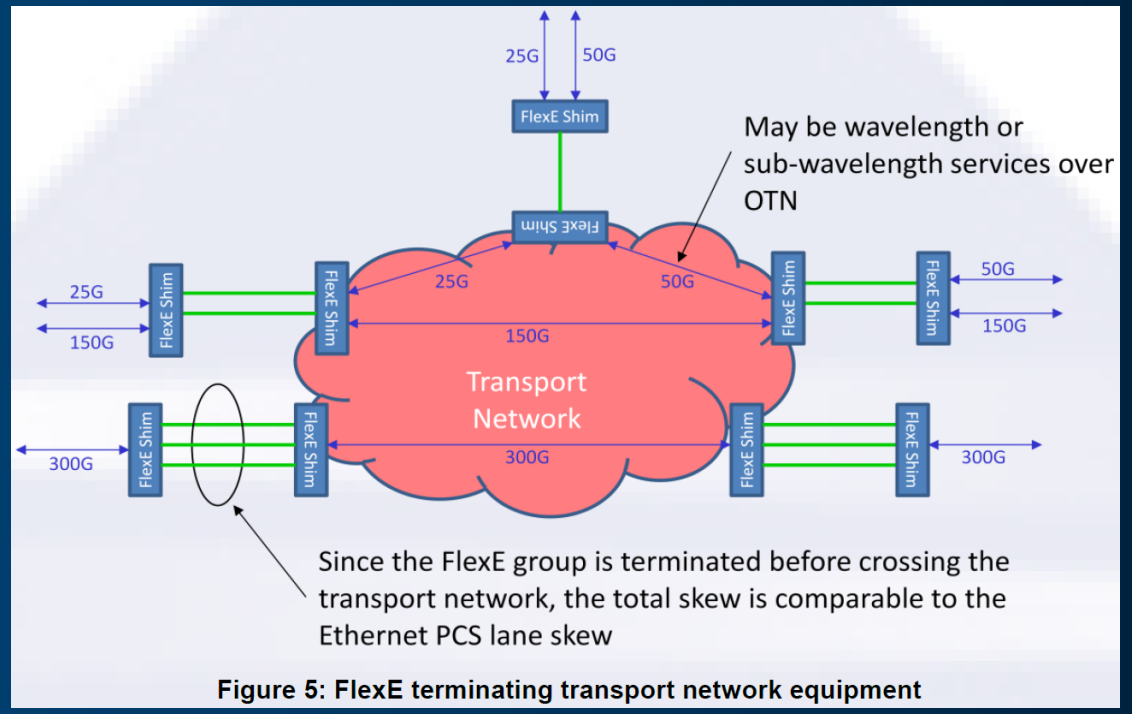
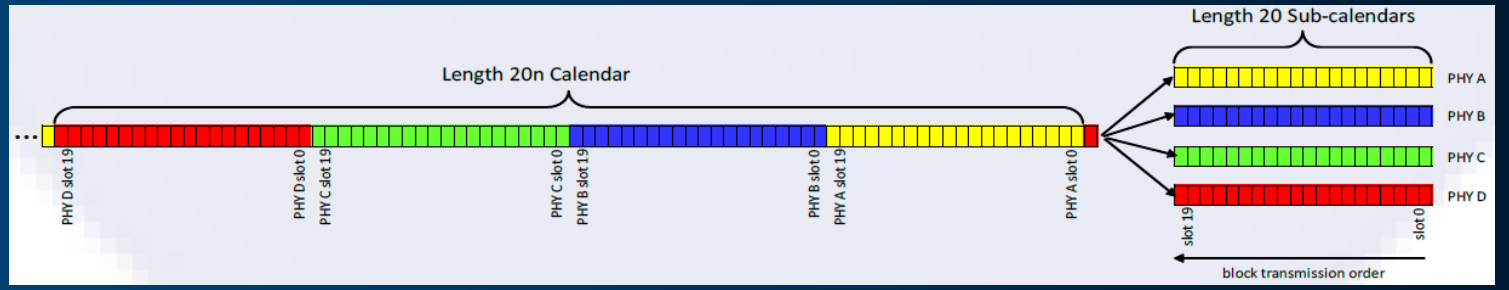
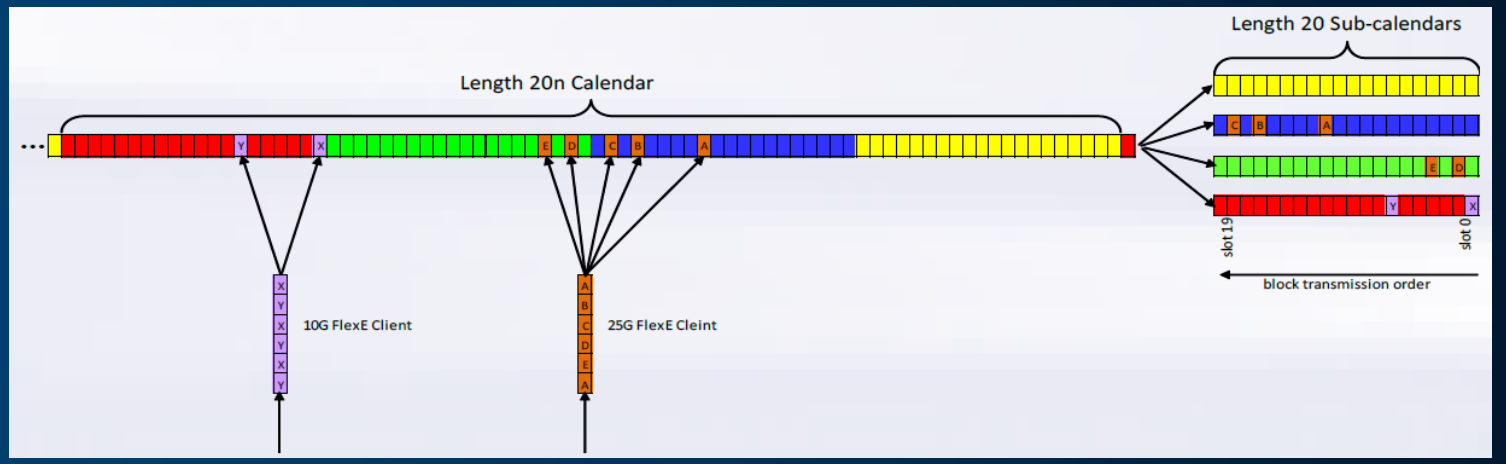
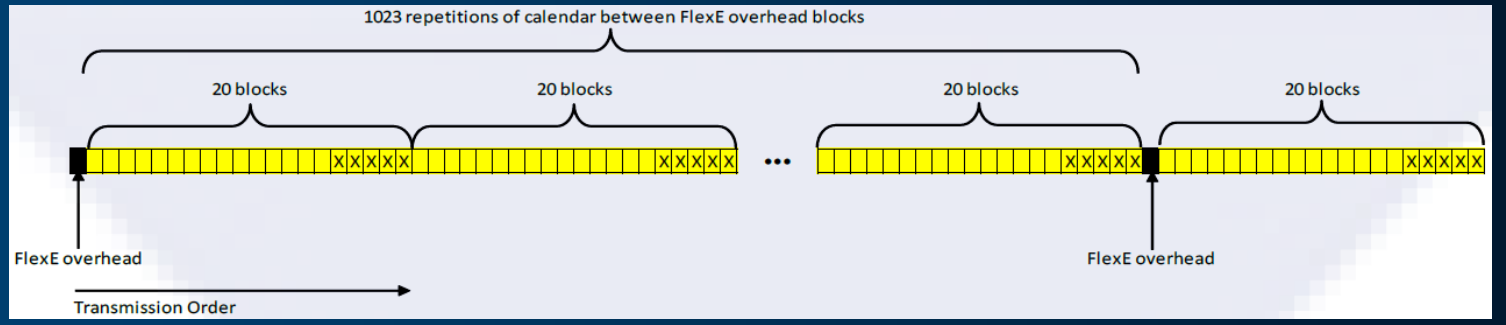


Figure 5: FlexE terminating transport network equipment

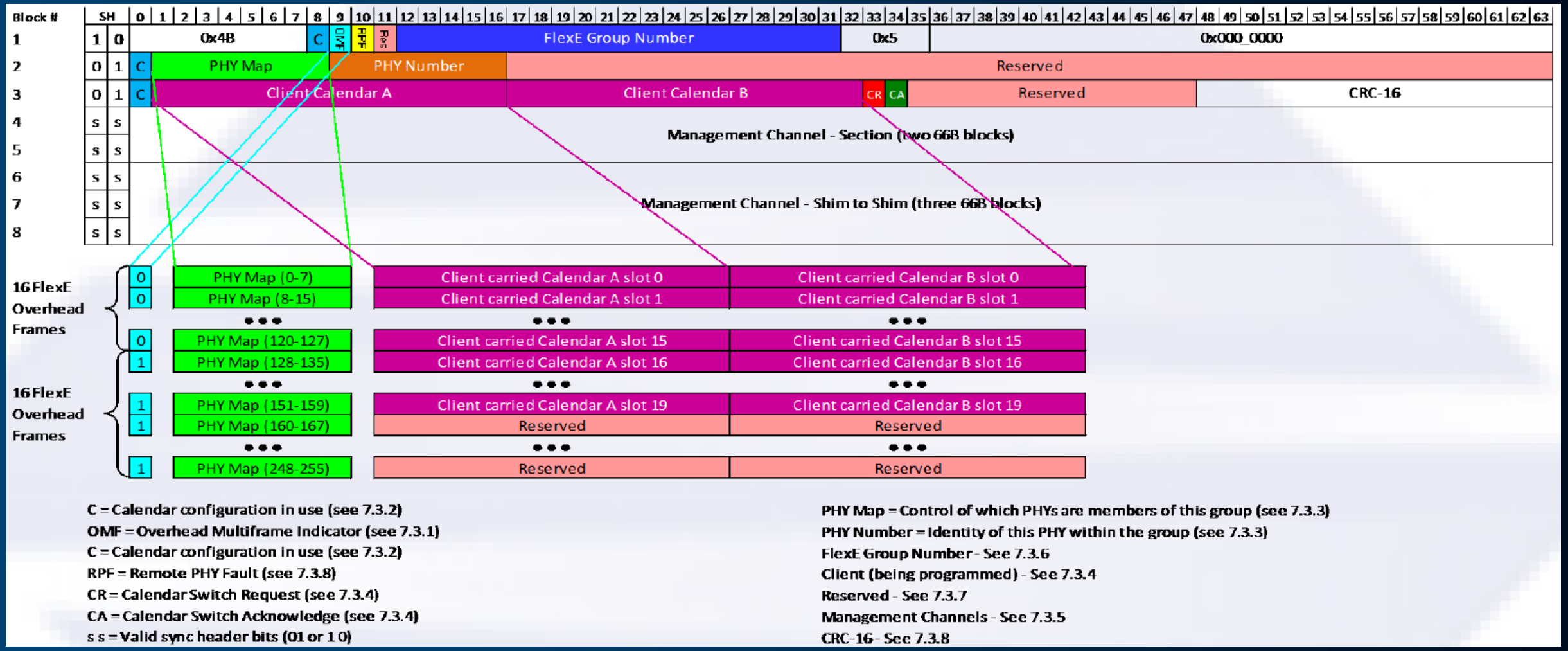
FlexE Calendar







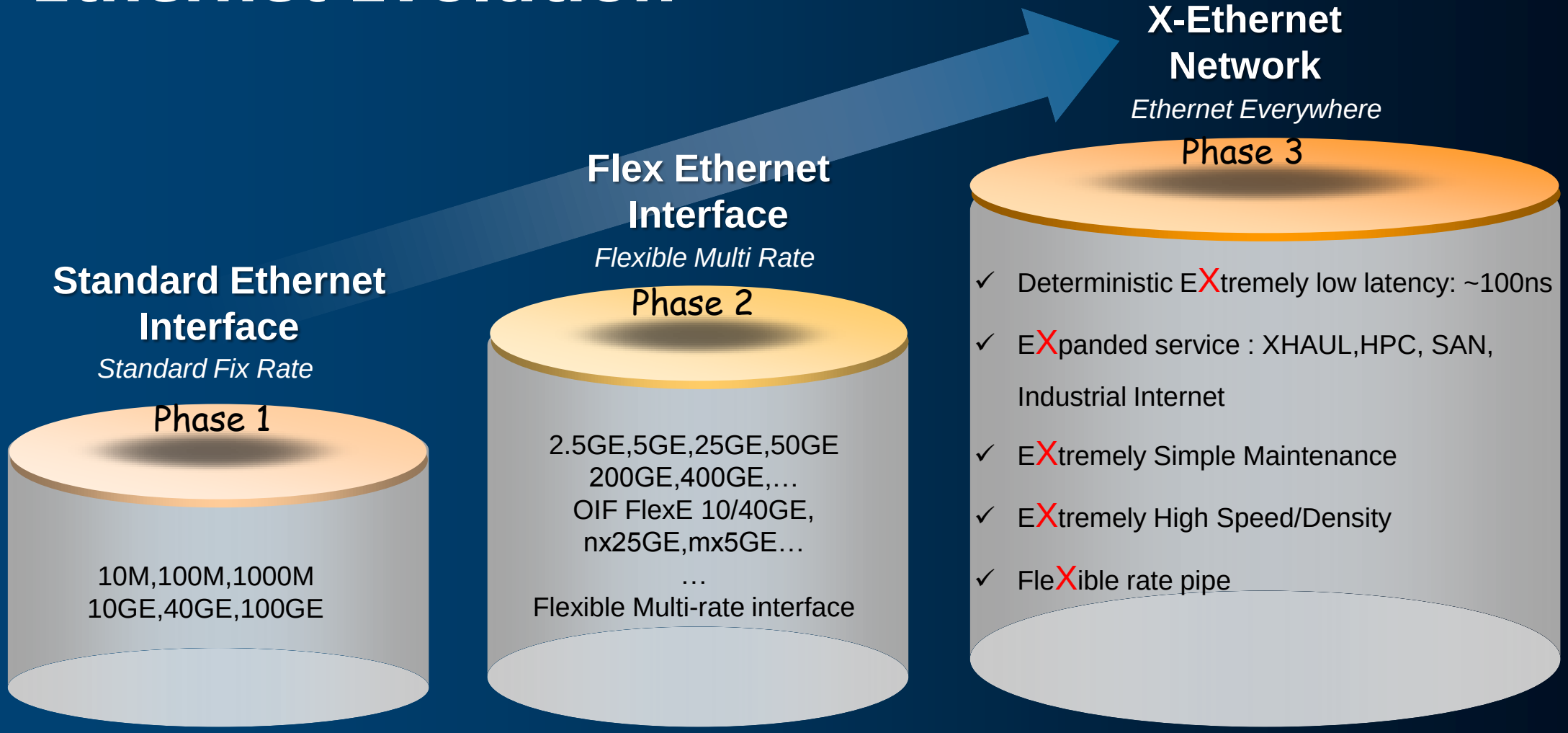
FlexE Overhead



C = Calendar configuration in use (see 7.3.2)
OMF = Overhead Multiframe Indicator (see 7.3.1)
C = Calendar configuration in use (see 7.3.2)
RPF = Remote PHY Fault (see 7.3.8)
CR = Calendar Switch Request (see 7.3.4)
CA = Calendar Switch Acknowledge (see 7.3.4)
s s = Valid sync header bits (01 or 1 0)

PHY Map = Control of which PHYs are members of this group (see 7.3.3)
PHY Number = Identity of this PHY within the group (see 7.3.3)
FlexE Group Number - See 7.3.6
Client (being programmed) - See 7.3.4
Reserved - See 7.3.7
Management Channels - See 7.3.5
CRC-16 - See 7.3.8

Ethernet Evolution



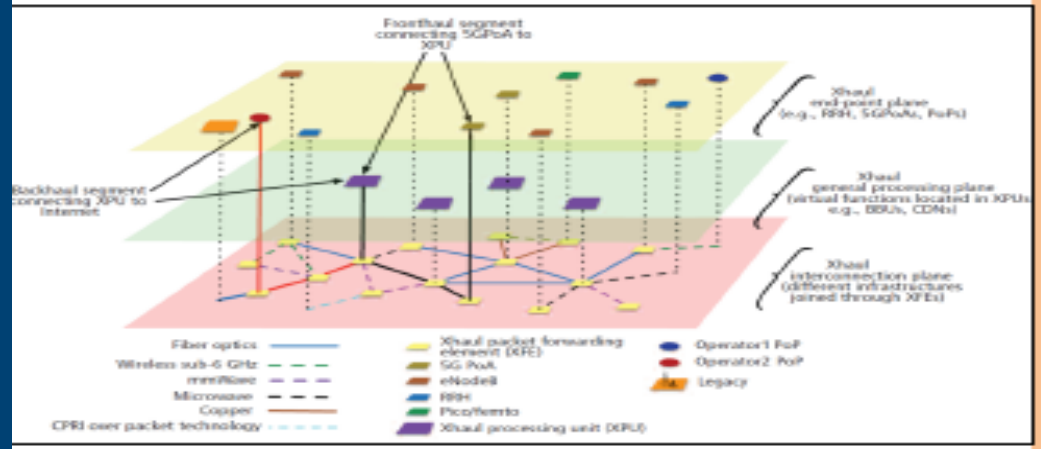
X-Ethernet will be the evolution direction of Ethernet

5G xHAUL vs Crosshaul

5GXCrosshaul
the integrated fronthaul/backhaul

5G-Crosshaul [Abstract]

The 5G Integrated Fronthaul/Backhaul Transport Network



5G-Crosshaul Focus areas

- Unified control plane for fronthaul/backhaul SDN/NFV-based (XCI)
- Unified data plane for fronthaul/backhaul technologies (XCF, XFE)
- 5G-enabling transm. techs, e.g., mmWave, uWave, optical and copper
- UCs: Dense Urban Society, Multi-Tenancy, Media Distr, MEC, Vehicular
- 5G demonstration testbeds in Berlin, Madrid, Barcelona, Taiwan

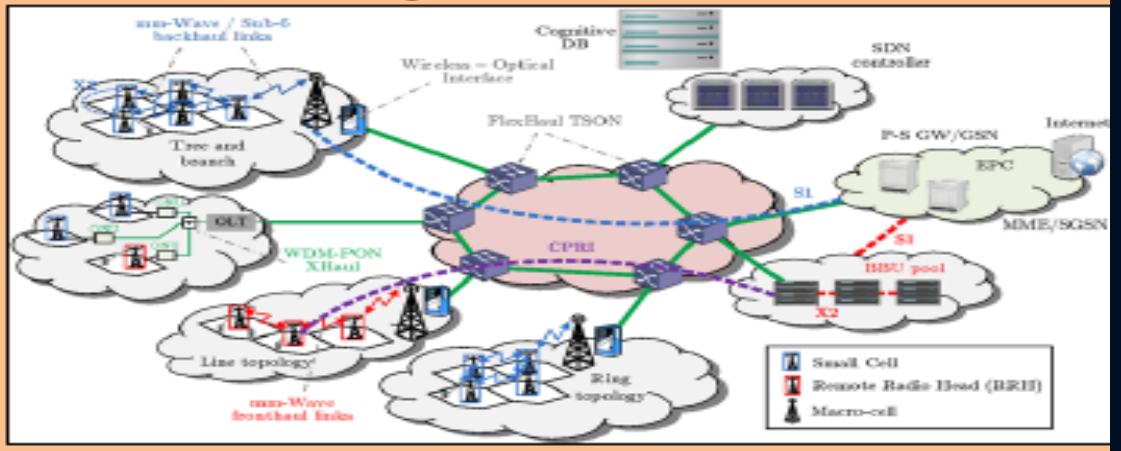
5G-Crosshaul Consortium

Operators – Orange, Telefonica, Telecom Italia
Vendors – ATOS, Ericsson, Interdigital, NEC, Nokia
Broadcaster/ Tech. Provider – Visiona, Telnet
SMEs – Eblink, Nextworks, CND,
R&D Centers – Create-net, CTTC, Fraunhofer HHI, ITRI
Universities – Univ. Carlos III, Univ. Lund, Pol.Univ. Torino
PM – Arturo Azcorra (UC3M)
TM - Xavier Costa (NEC)

5G-XHaul

5G-Xhaul [Abstract]

Dynamically Reconfigurable Optical-Wireless Backhaul/Fronthaul with Cognitive Control Plane for Small Cells and Cloud-RANs



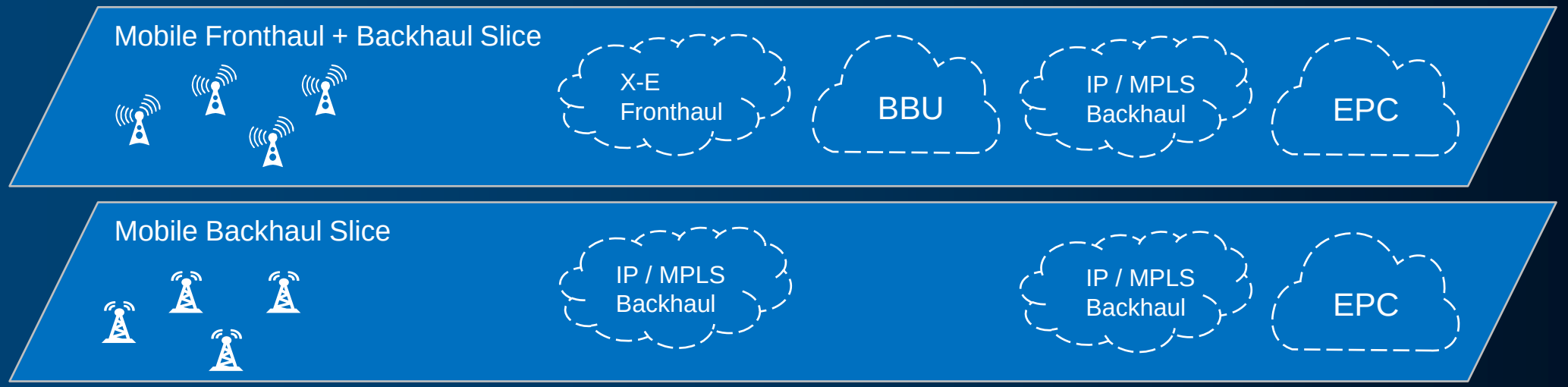
5G-XHaul Focus areas

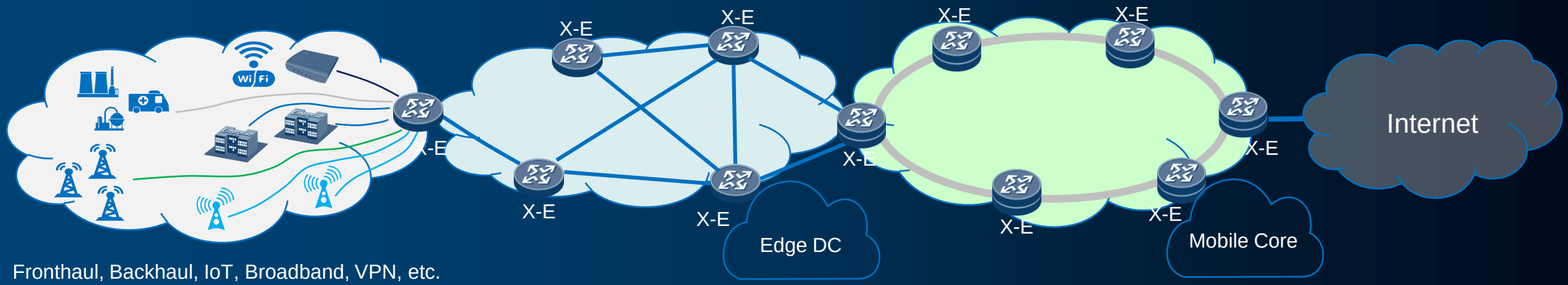
- Converged Wireless-Optical, Fronthaul-Backhaul Network Architecture
- Multi-technology wireless and optical programmable data plane
- Flexible wireless (60 GHz / Sub-6) transport
- Hybrid WDM optical transport: active/elastic TSON and PON
- Dense Urban Society (xMBB) use case
- 5G-XHaul Demonstrator in Bristol BIO

5G- Xhaul Consortium

Operators – Cosmote, Telefonica
Vendors – Adva, Bluwireless, Huawei, IHP
SMEs – Airrays, TES Electronic Solutions
R&D Center – i2cat
Universities – TU Dresden, Univ. Bristol, Univ. Thessaly
PM – Eckhard Grass (IHP)
TM - Daniel Camps (i2cat)

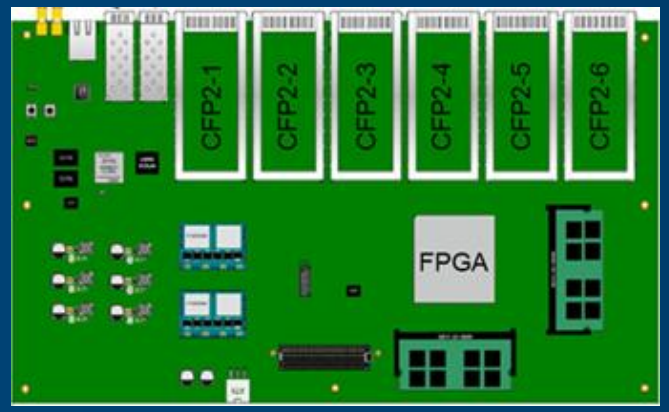
Use Case 2 – Xhaul – Integrated Fronthaul/Backhaul

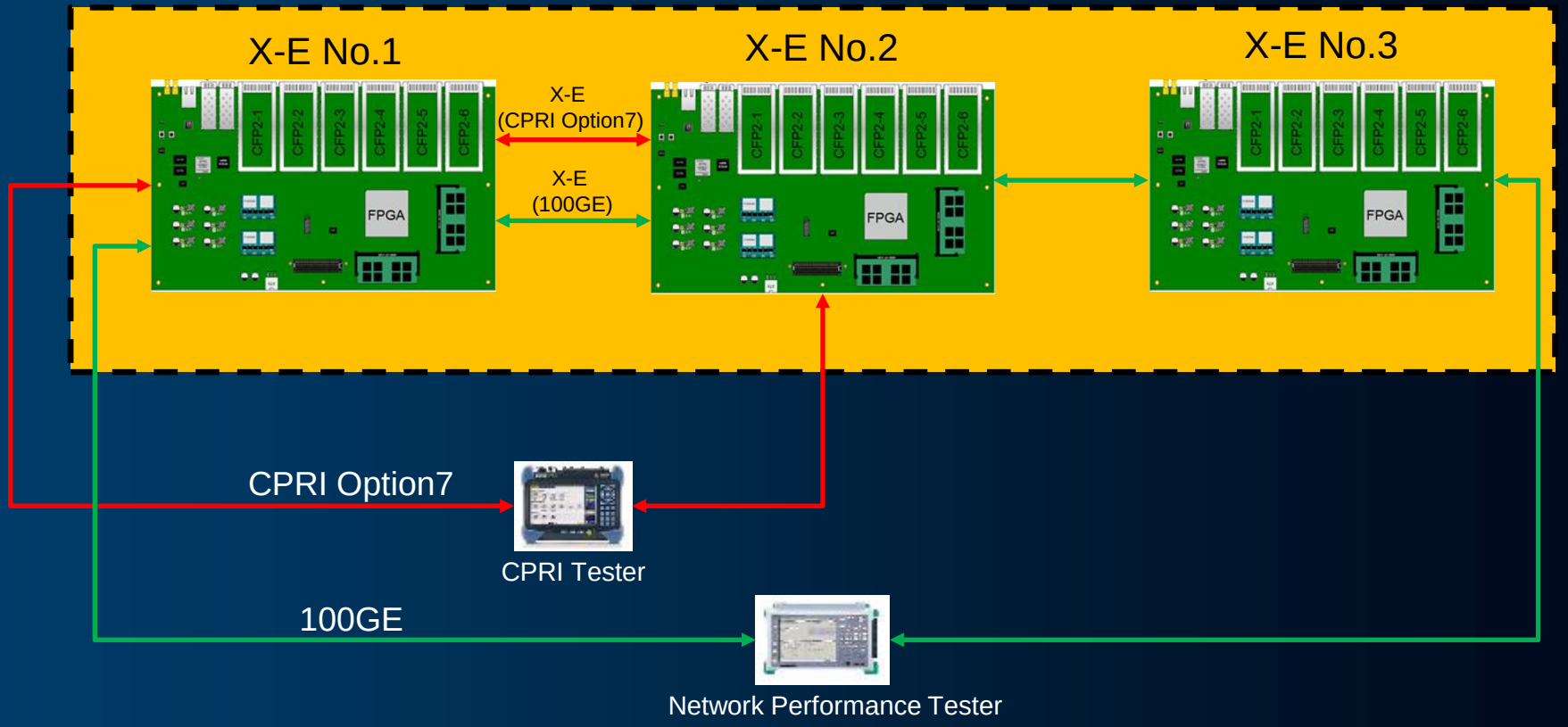




- One network, one technology for both Fronthaul and Backhaul
- Integrated Fronthaul / Backhaul – XHAUL (http://www.5g-xhaul-project.eu/index.html)

Progress of X-Ethernet Prototype





- Use FPGA to prove two key features:
  - 150/200ns single node Latency, 1ns jitter per 3 nodes
  - CPRI transparently transmission
- Two 10G ports support CPRI Option7 and Native 10GE. Six 100G ports support X-Ethernet and Native 100GE