

5G: an IP Engineer Perspective

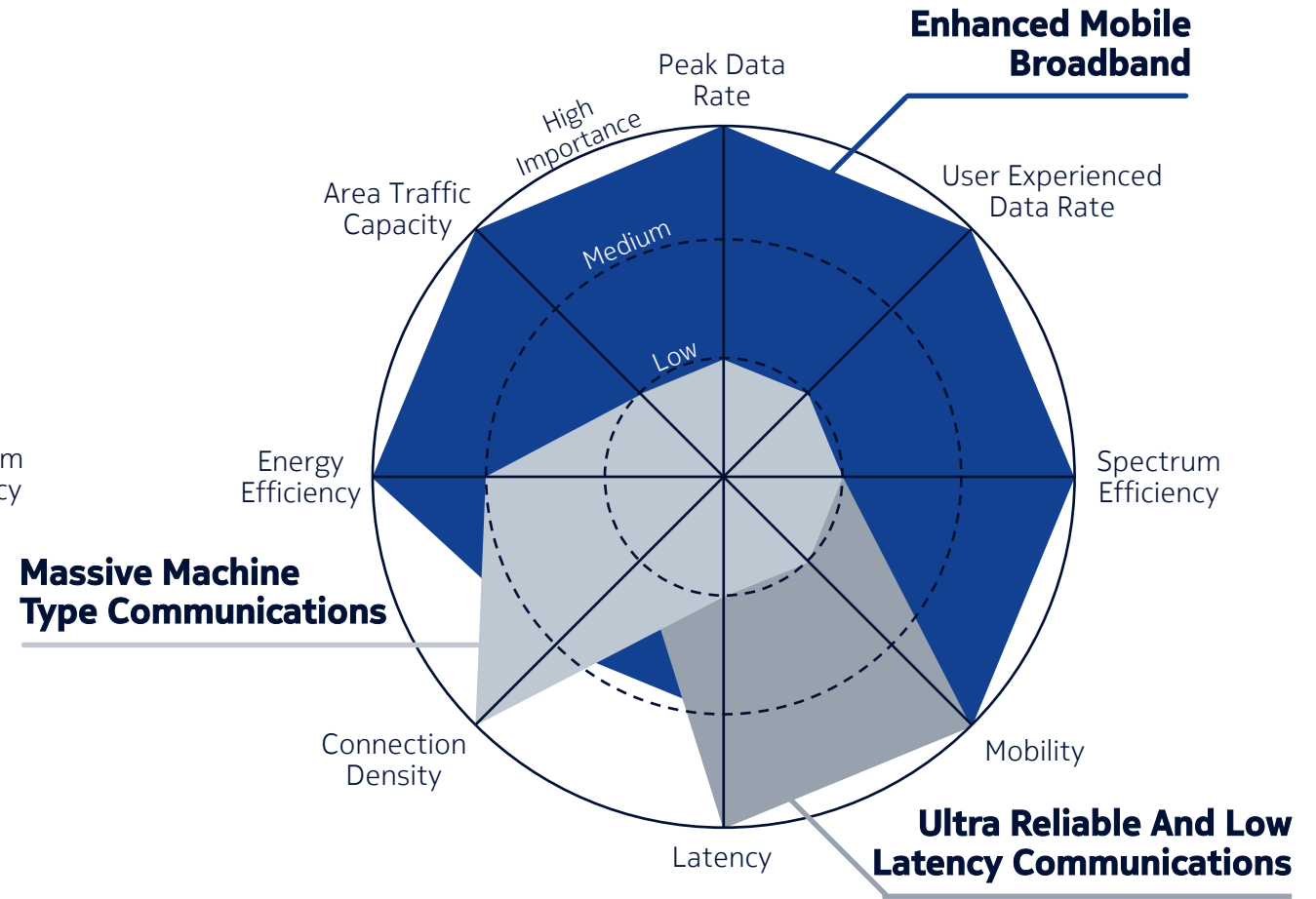
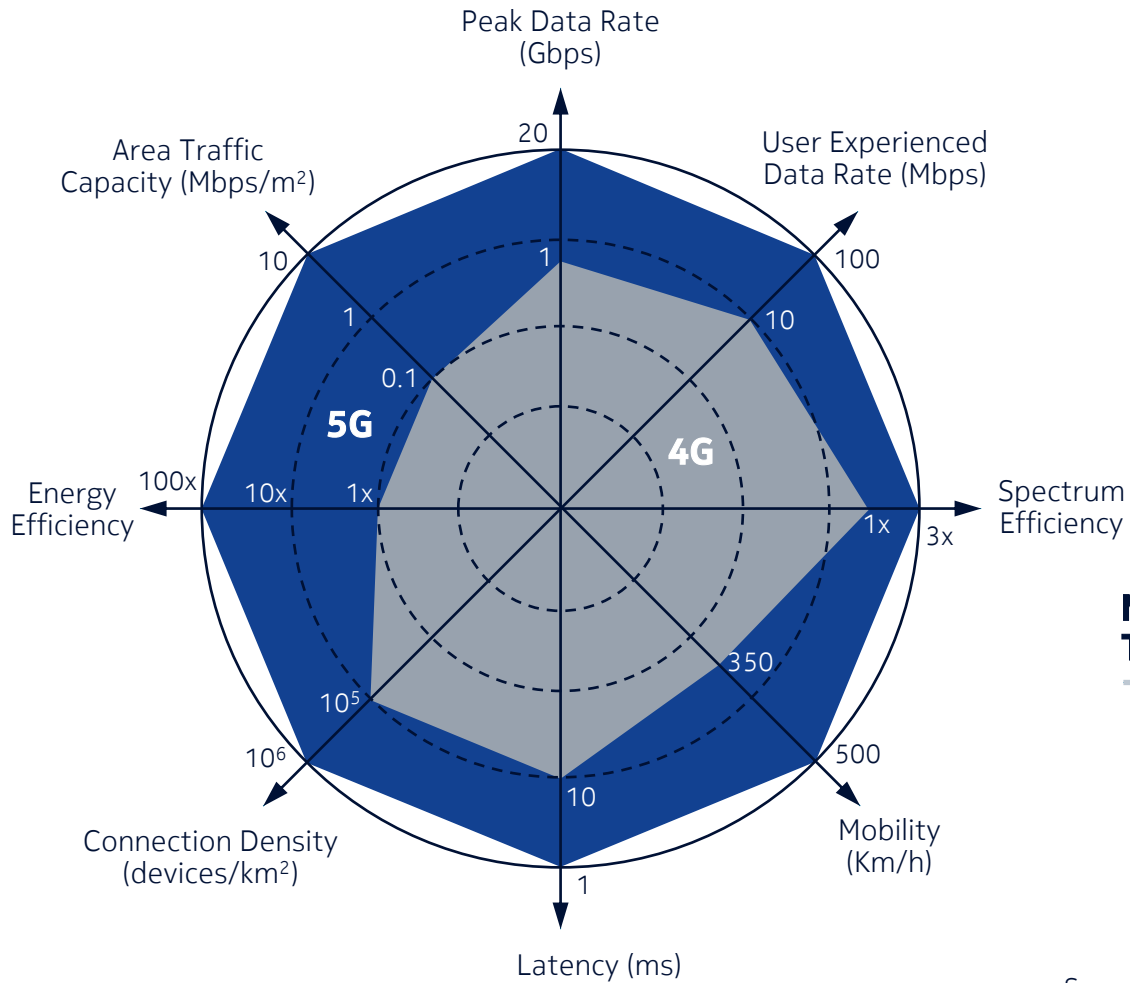
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What Is 5G?

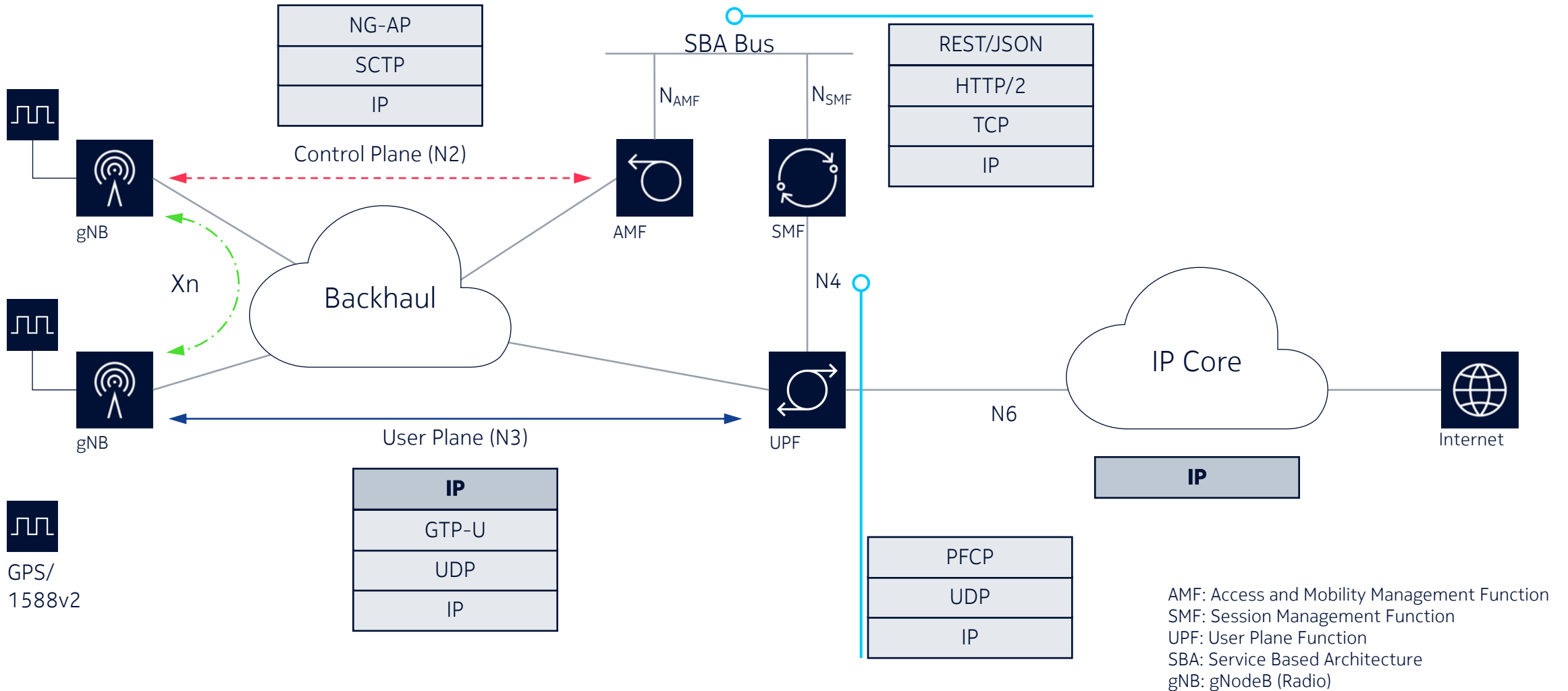
ITU-R IMT-2020 performance goals



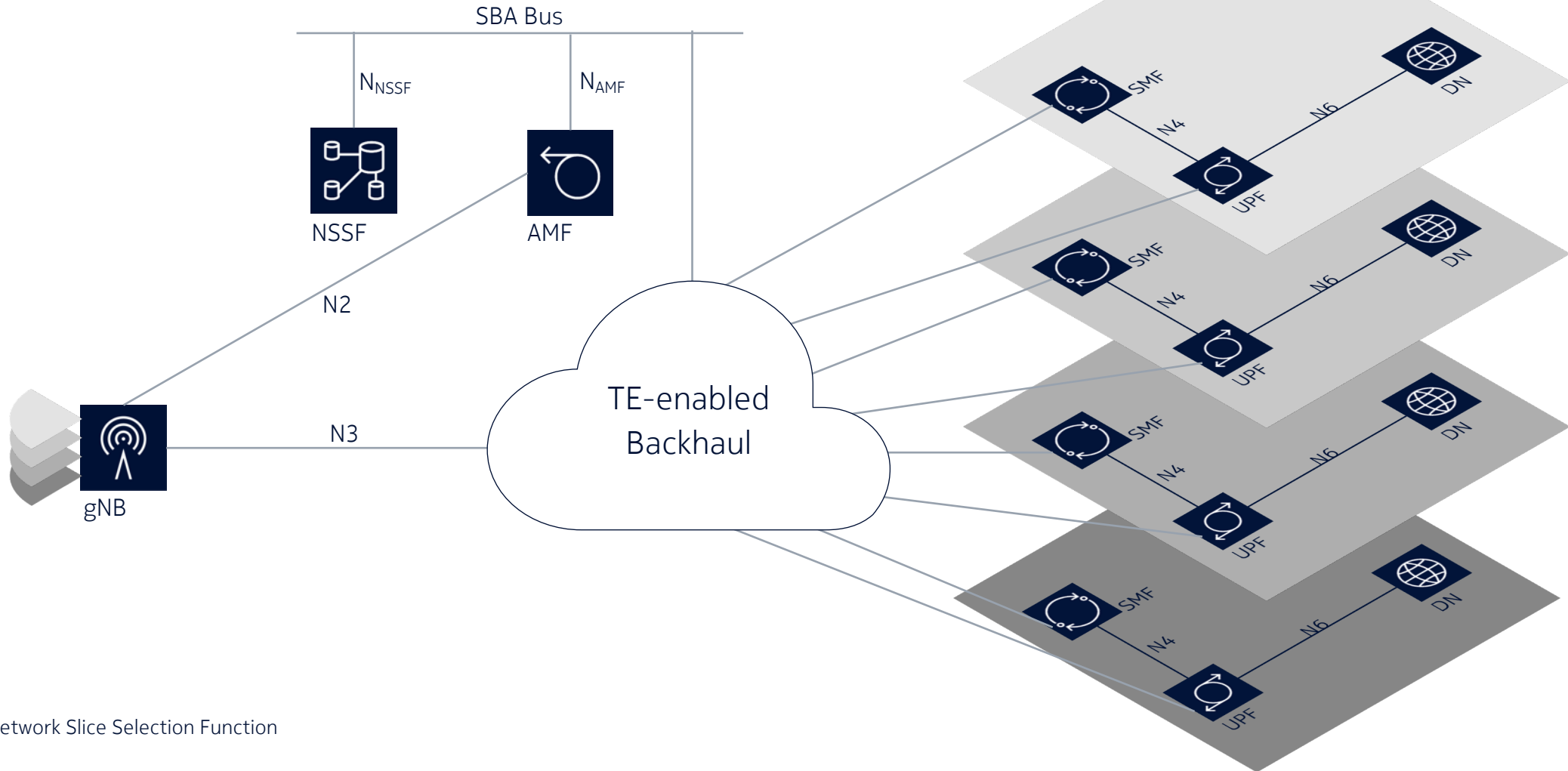
Source: ITU-R M.2038.0

5G Architecture and Traffic Flows

Same backhaul protocol stack as 4G



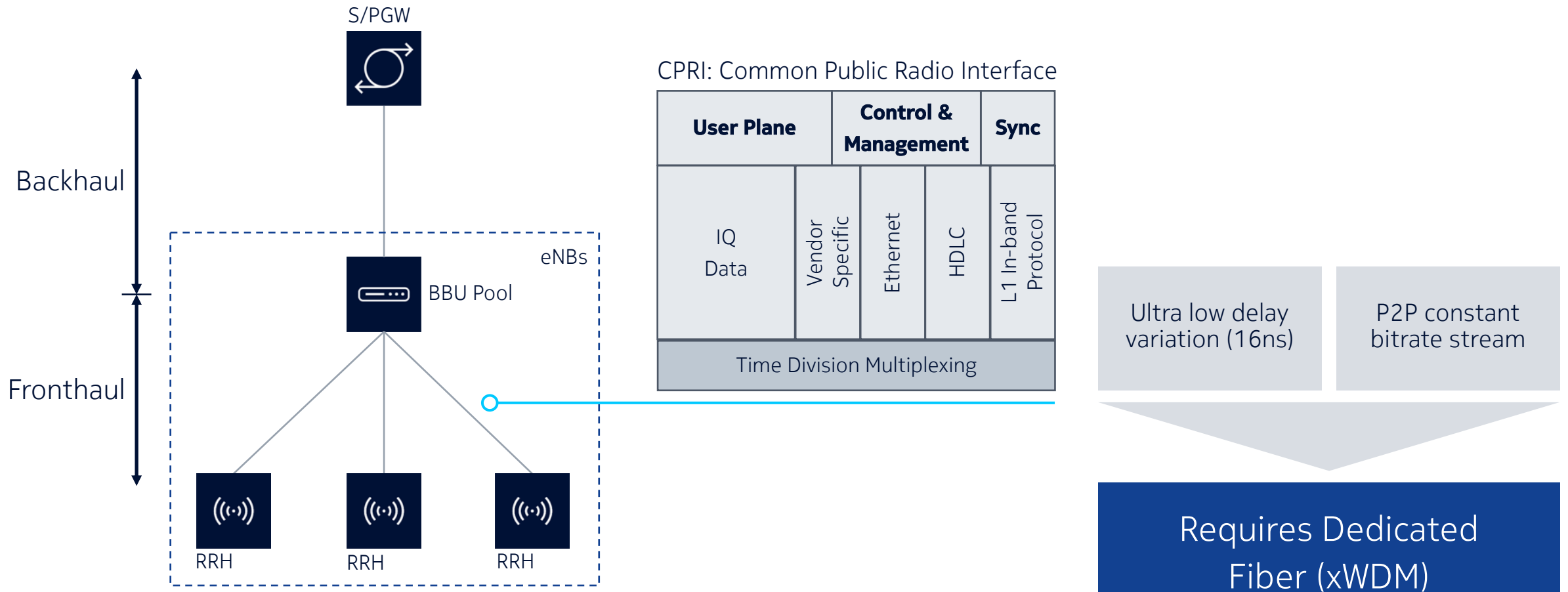
5G Network Slicing for “Network as a Service” Requires a service-aware backhaul network



NSSF: Network Slice Selection Function

RAN Densification: Searching for Better Radio Coordination

4G CRAN architecture introduces CPRI for the Fronthaul network



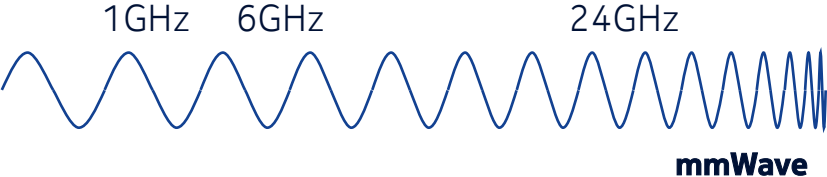
EPC: Evolved Packet Core
 RRH: Remote Radio Head
 BBU: Baseband Unit

Centralized RAN

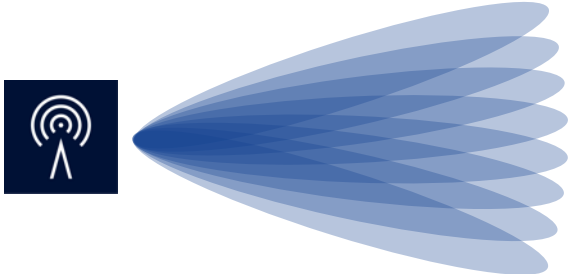
5G New Radio Main Technology Innovations

Targeting a 10X increase in throughput

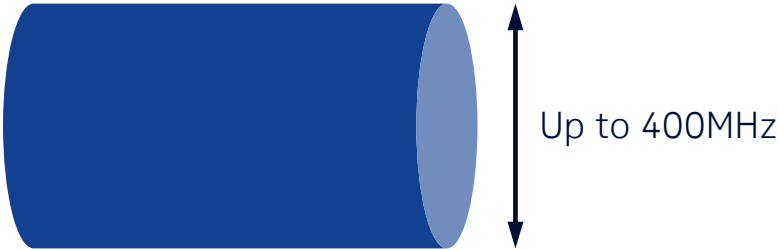
New Spectrum Options



Massive MIMO

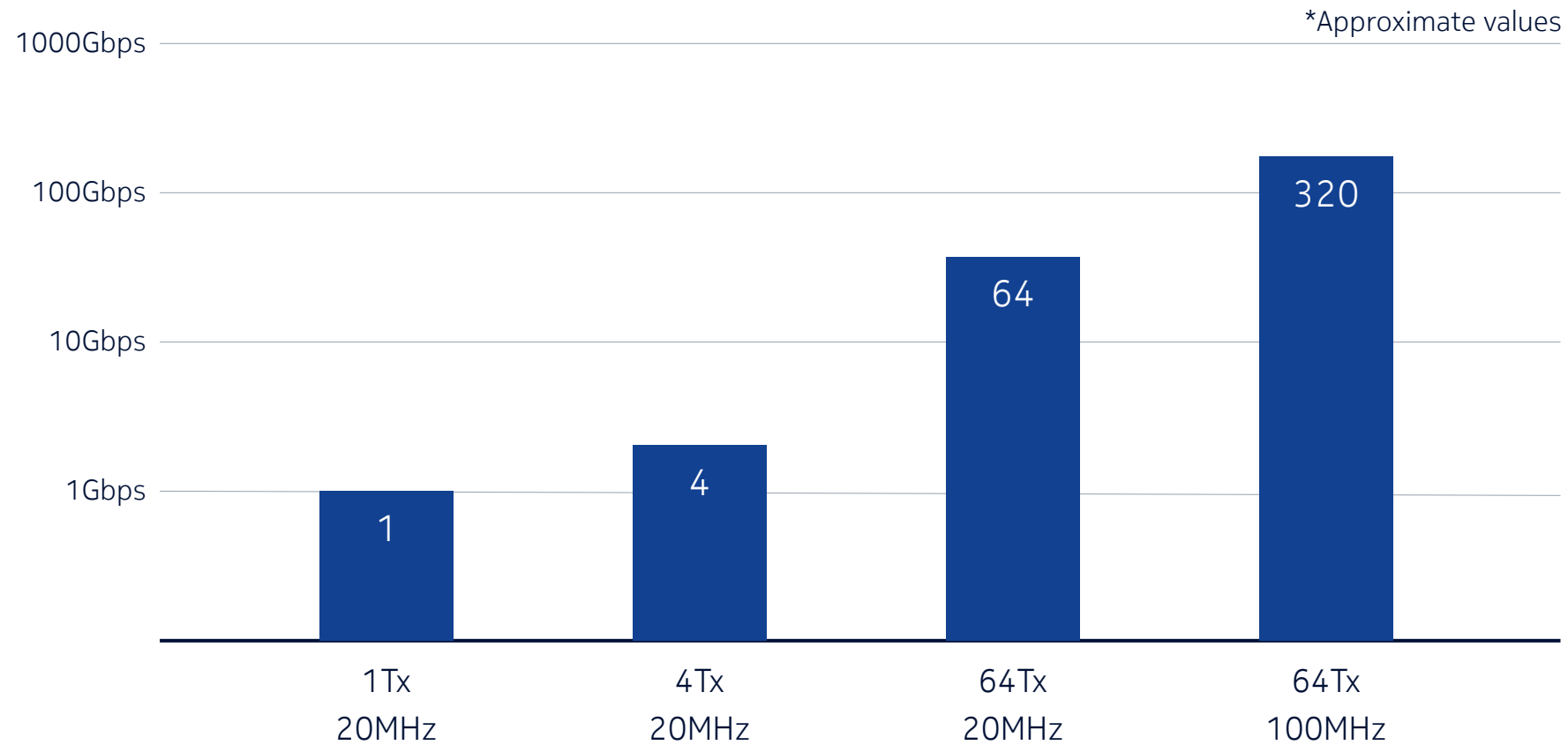


Larger Radio Channels



Current 4G CRAN Architecture Unfit for 5G Deployments

CPRI bandwidth explosion with massive MIMO



5G Standards Development Initiatives

Transport related standards bodies



Main 5G standards (release 15):

- Overall architecture
- Radio
- Core



Ethernet forwarding standards:

- 802.1CM – Time Sensitive Networks
- NGFI – Next Generation Fronthaul Interface
 - 1914.1 – Packet Based Fronthaul
 - 1914.3 – Radio over Ethernet

CPRI
Common Public Radio Interface

Fronthaul protocols:

- CPRI v7.0 (2015)
- eCPRI v1.2 (2018)



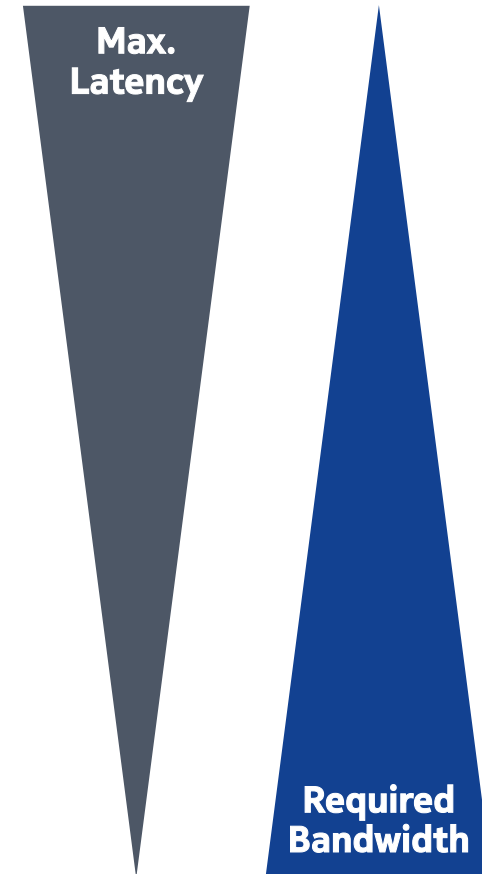
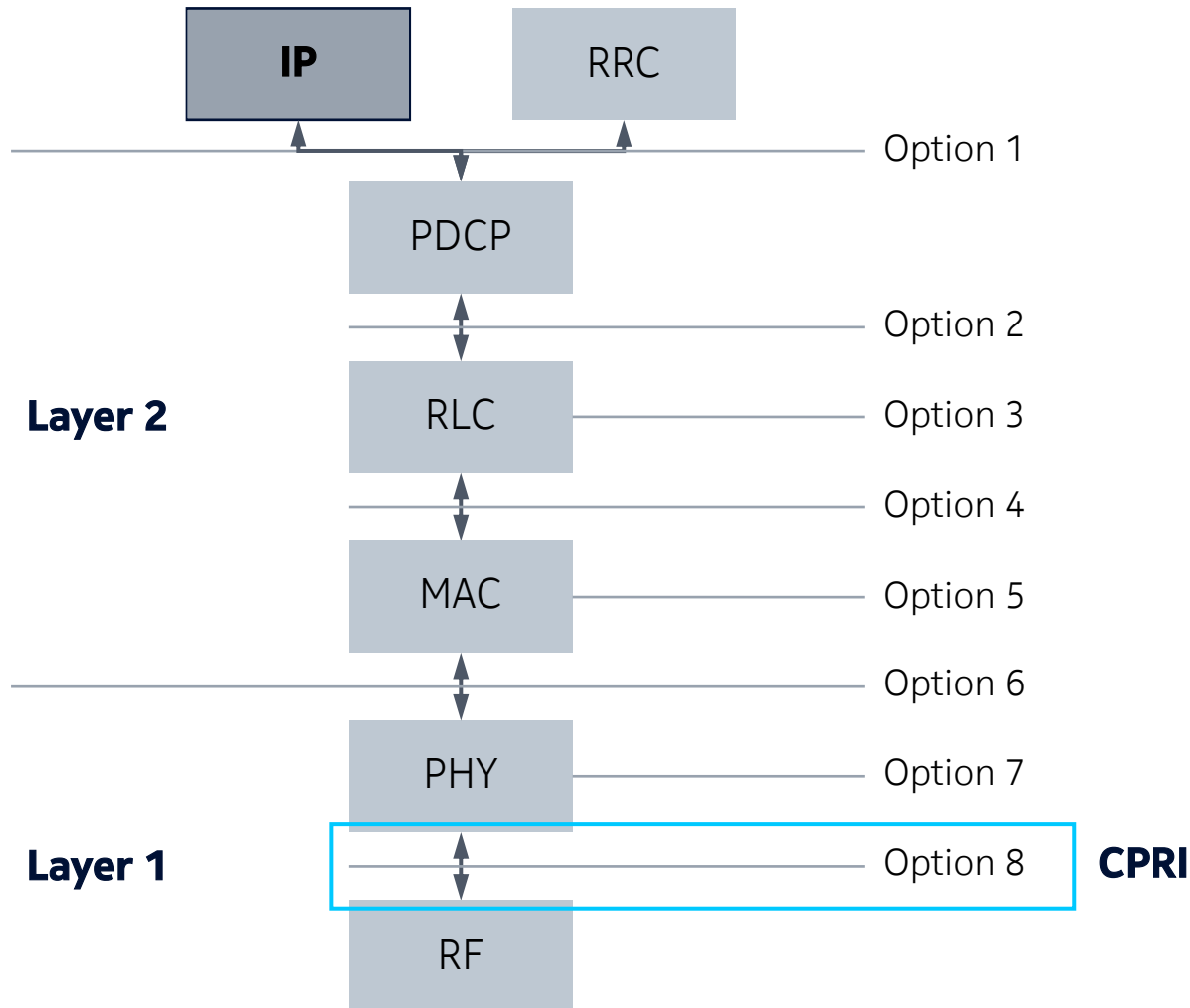
Fronthaul transport services specification:

- MEF 22.3
- MEF 22.3.1

Additional initiatives exist to address other areas of 5G standards (O-RAN, Small Cell Forum, etc.)

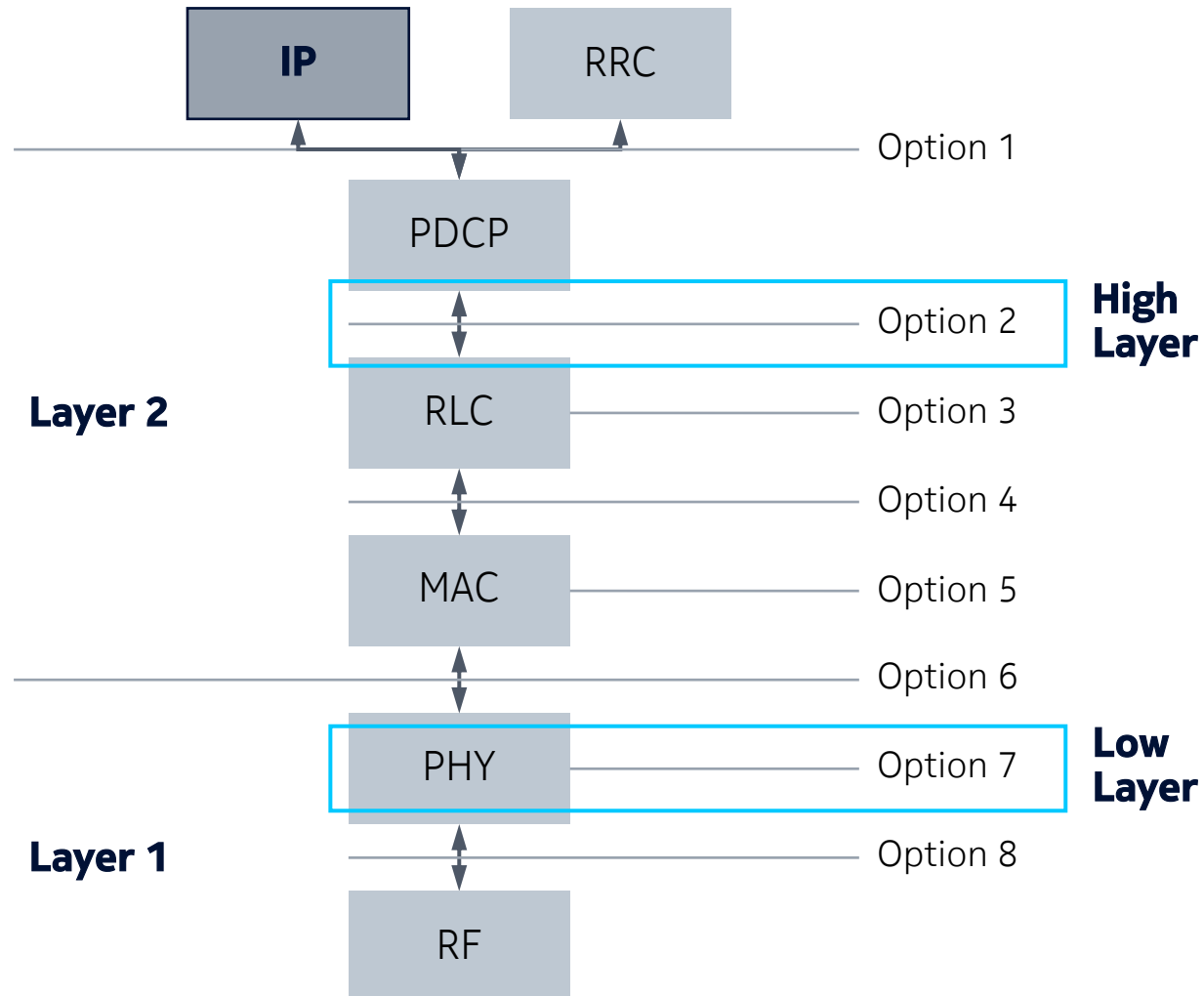
4G RAN Protocol Split

High bandwidth and strict latency



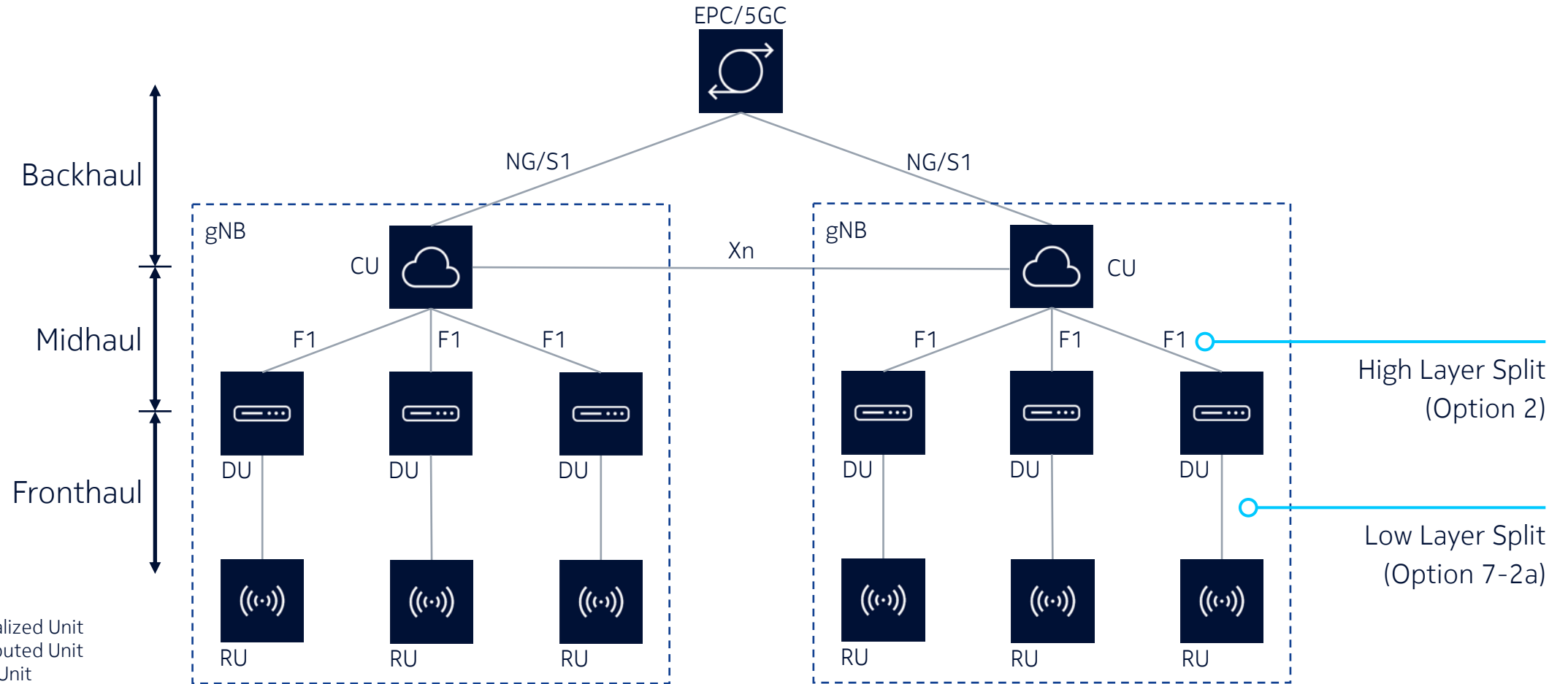
5G RAN Protocol Split

Dual split options to enable Cloud RAN



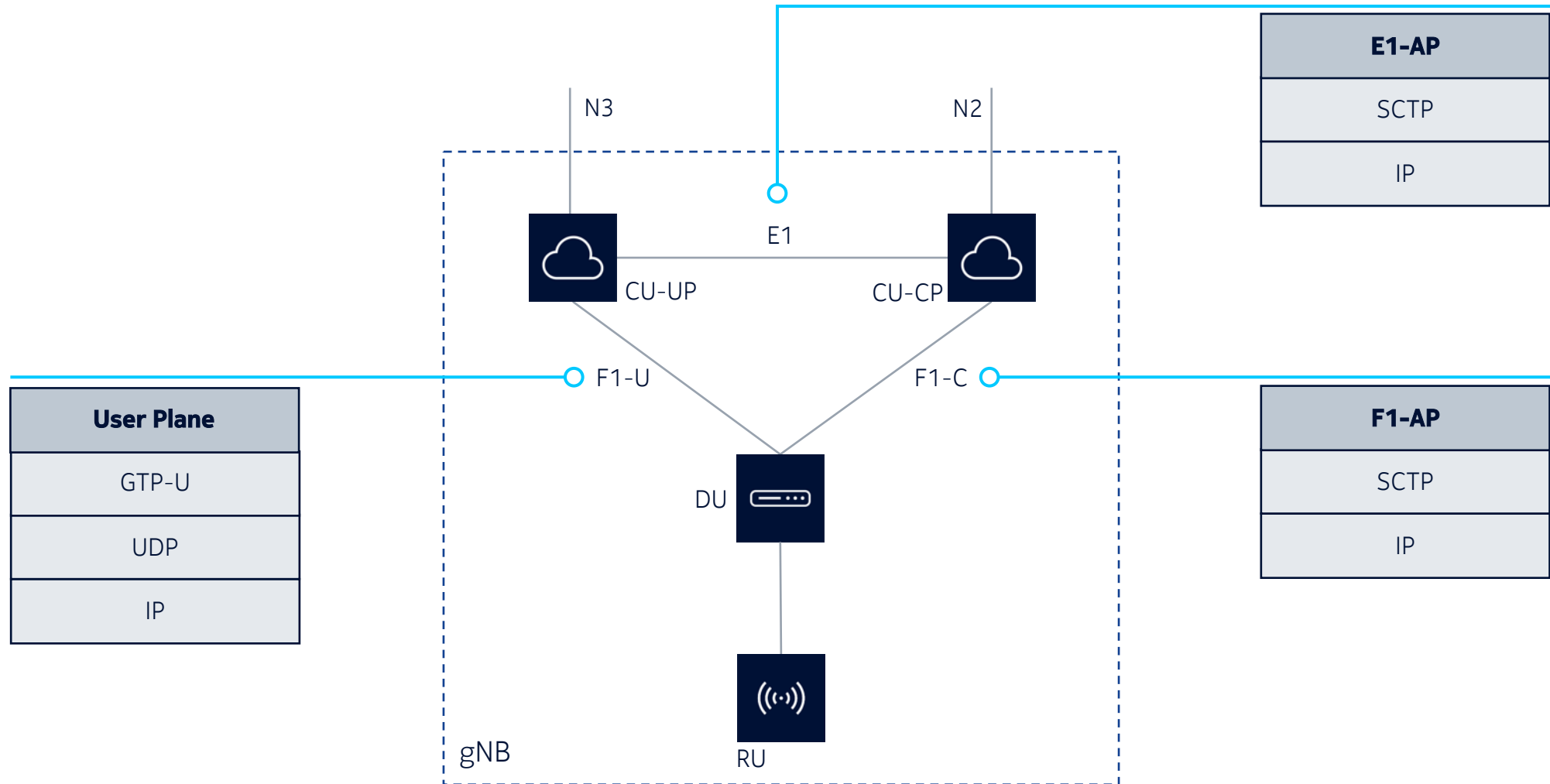
5G NR Introduces a New RAN Architecture

Cloud RAN with packet-based transport



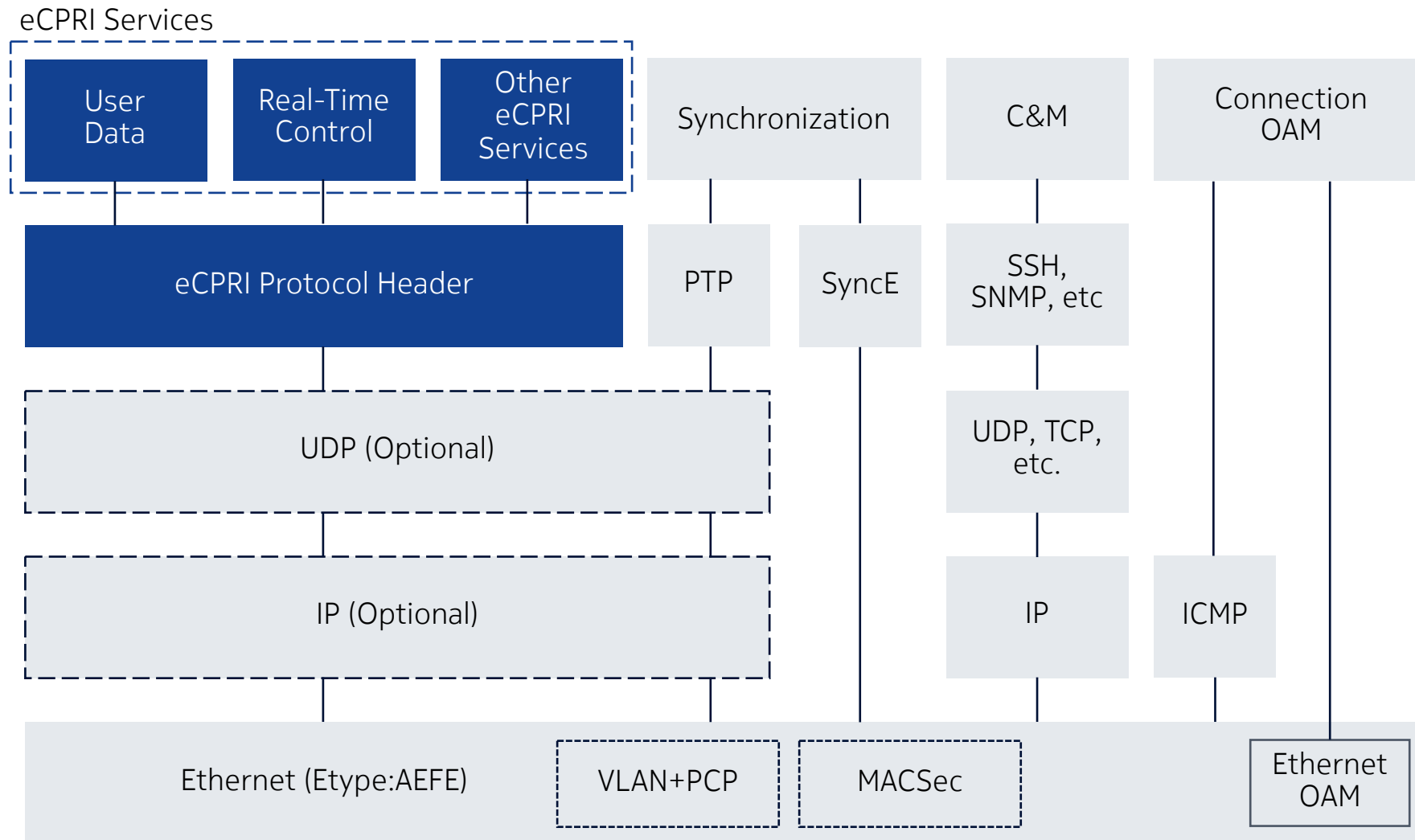
New Midhaul Interfaces: E1 and F1

Similar to current backhaul protocol stack



eCPRI: Fronthaul Transport over Ethernet

Designed for packet-based networks



eCPRI Fronthaul Bandwidth Estimations

Savings of 10x compared to CPRI

Basic Assumptions:

100MHz

8x4 MIMO (w/ 2 streams per uplink layer)

64 Antennas

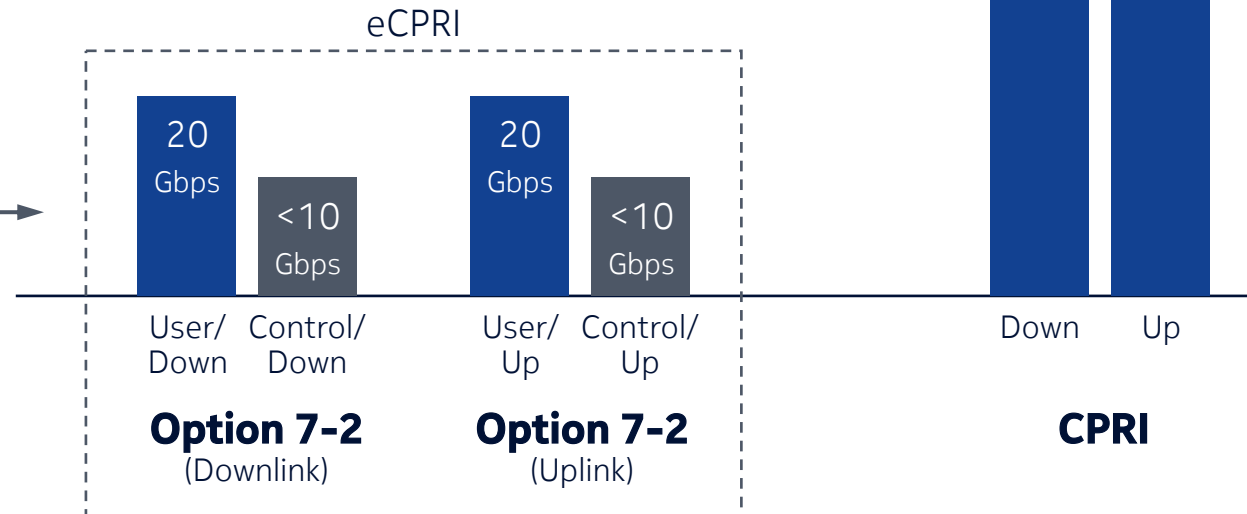
TTI: 1ms

Modulation: 256QAM

*3Gbps downlink from MAC layer

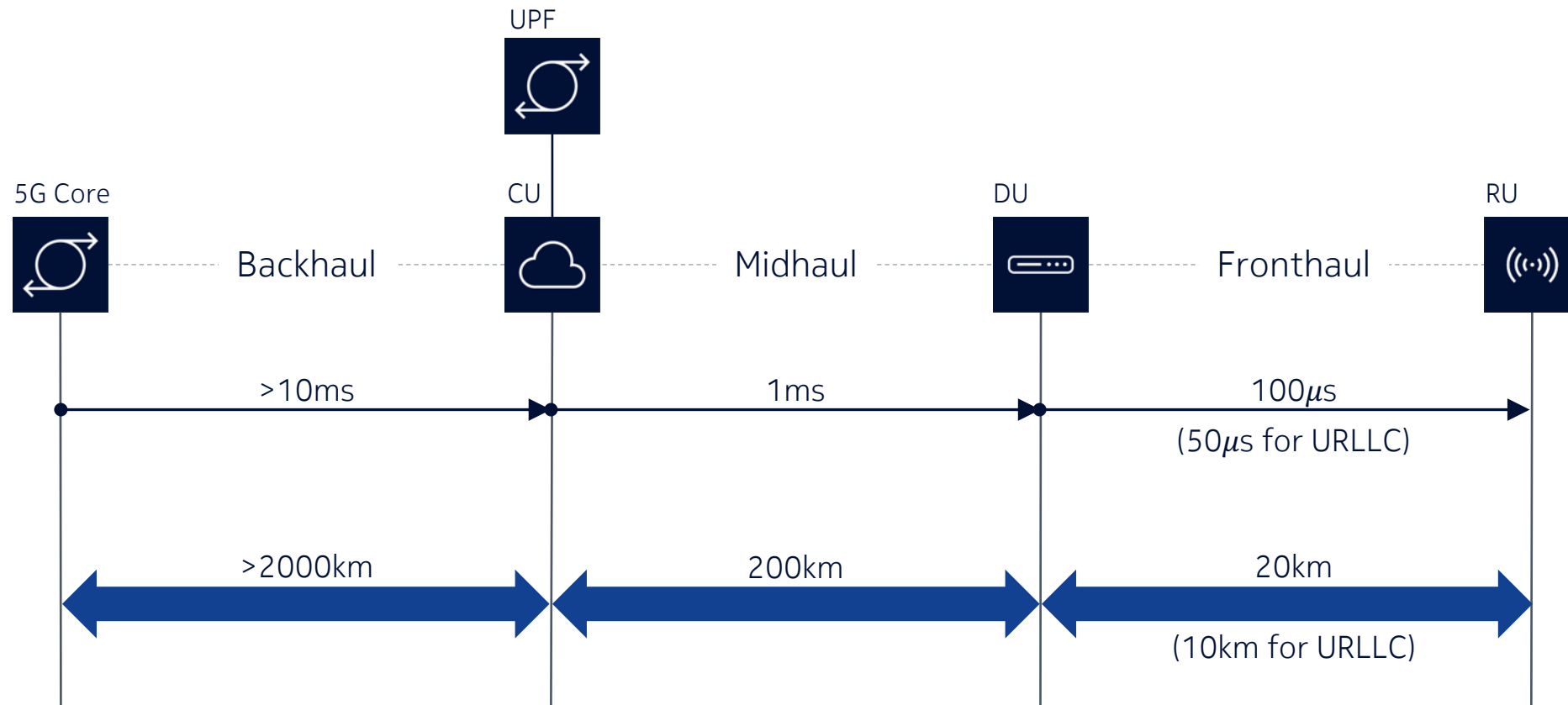
*1.5Gbps uplink to MAC layer

Drives 25GE
interfaces



IEEE1914.1 & eCPRI Recommended One-Way Latency

Direct implication on inter-node distances

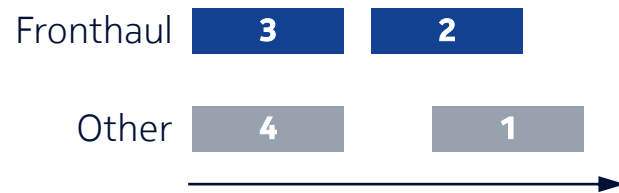


Fiber Latency=5μs/km

IEEE 802.1CM – Time Sensitive Networks

QoS for mixing Fronthaul with other traffic flows

Ingress traffic



Profile A: Strict Priority

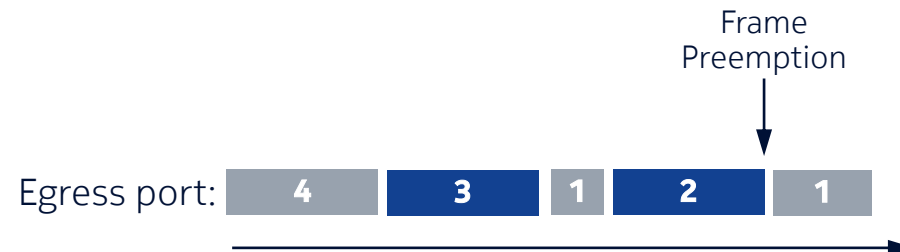
Fronthaul: High Priority
Other: Low Priority



Supported Today

Profile B: Frame Preemption (<10GE only)

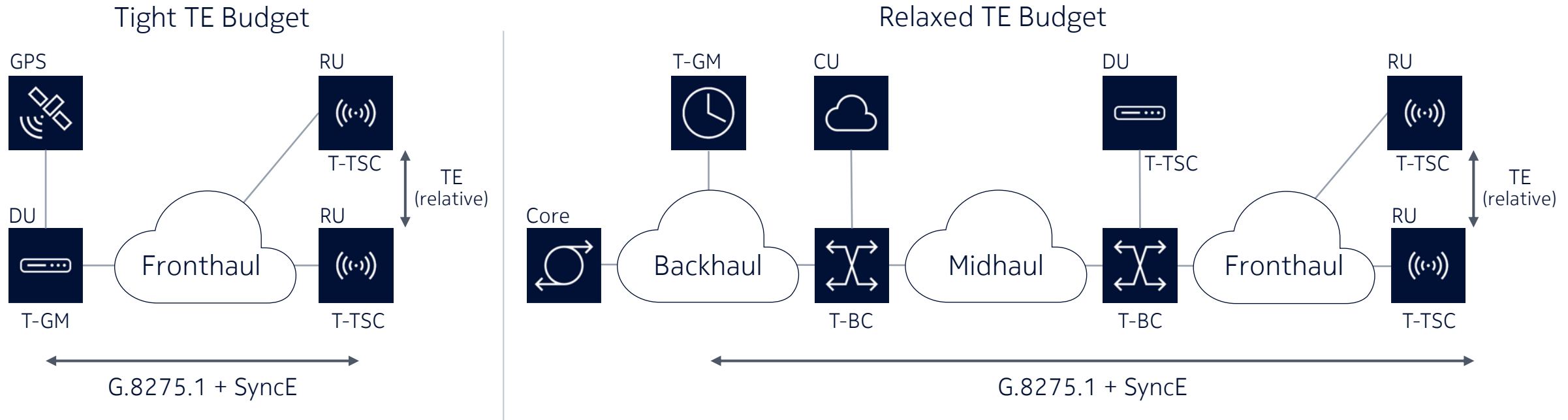
Fronthaul: Express Traffic
Other: Preemptable Traffic



**Requires MAC Change
(mated boxes on a link)**

eCPRI Depends on External Synchronization

Timing architecture driven by RAN features and TE budget



Router TE classes (G.8273.2)

Class	Constant TE (ns)
A	±50
B	±20
C	±10

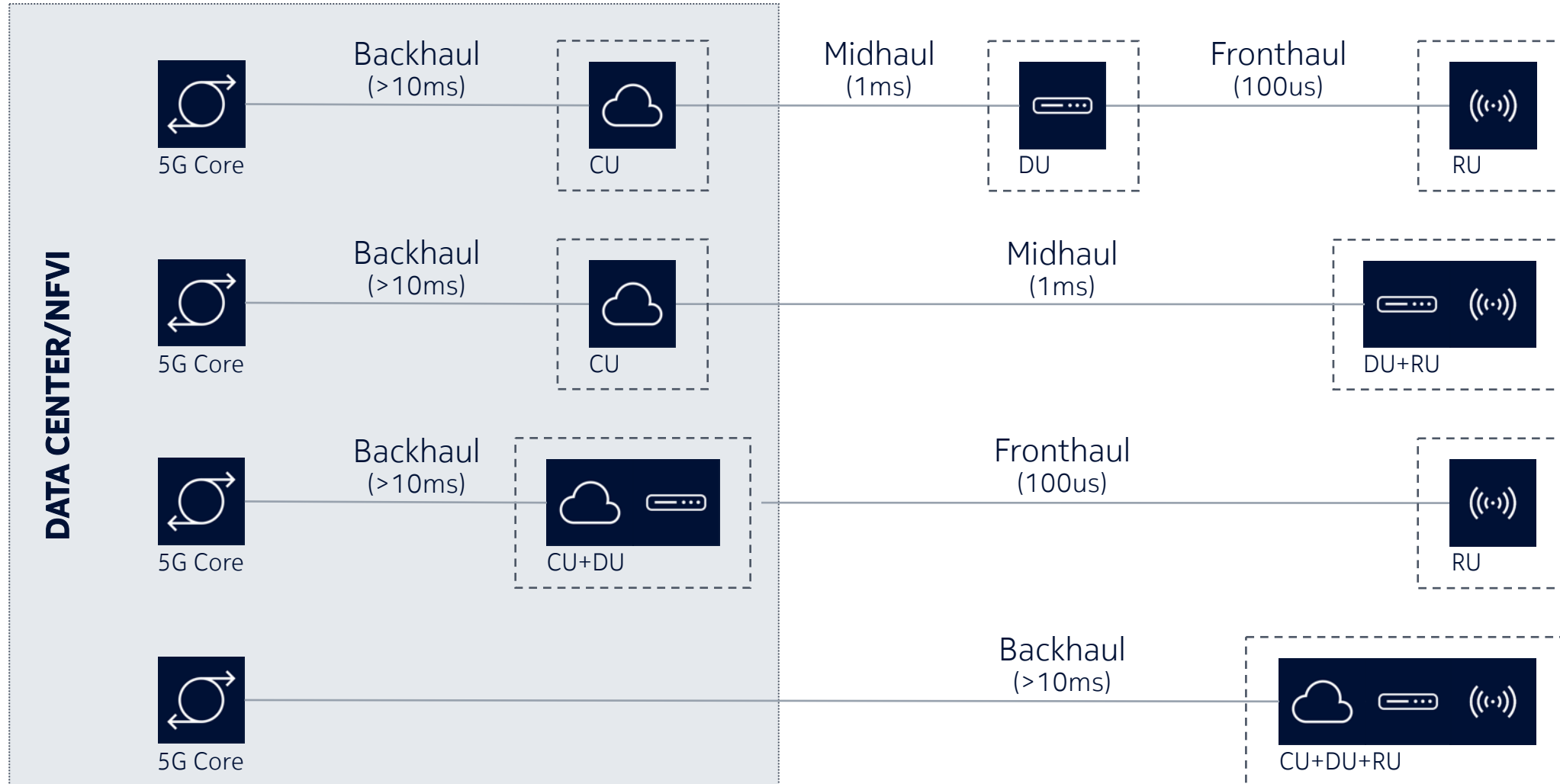
Inter-RU Timing Requirements

Category	Max TE (ns)*	RAN features
A+	±20 (relative)	MIMO, Tx-diversity
A	±70 (relative)	Intra-band CA
B	±200 (relative)	Inter-band CA
C	±1100 (absolute)	Basic TDD, LTE CoMP/eICIC

*Note: Time error figures are between any two given RUs in the network, except for Category C which is an absolute value from the timing source (T-GM).

Summary: No One-Size Fits-All Solution

Radio and IP/Transport planning must be done together



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Thank You!

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