



# 5G Transport Networking

## Requirement, Reference & New Business

CTO Office, Enterprise Business Group  
July, 2019

**LEADING NEW ICT**



# Topics today

**01**

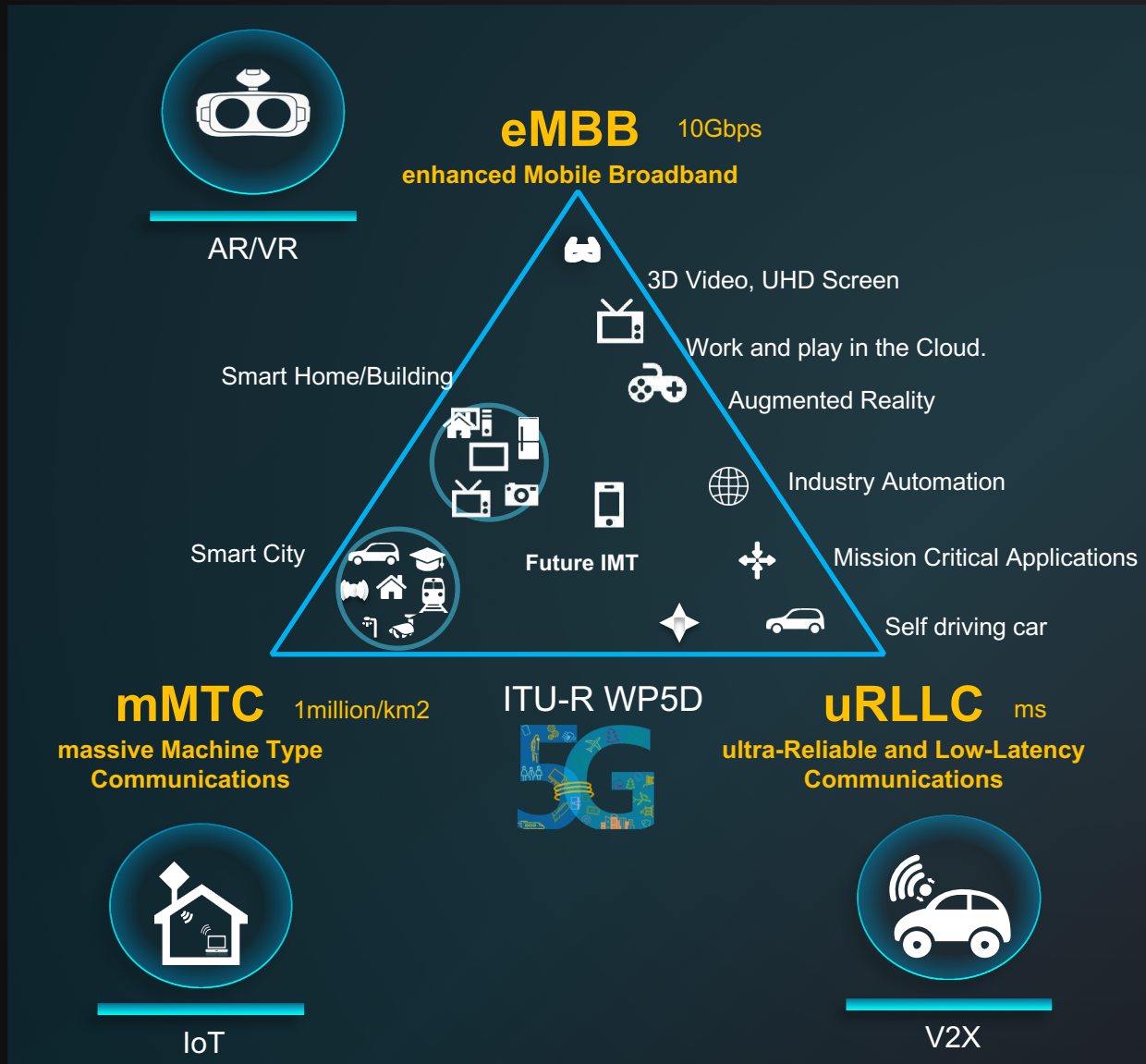
**5G Transport Network Requirement**

**02**

**5G Carrier of Carrier Business Opportunity**



# New Challenges for 5G Transport Network



## New transport network requirements

1. SLA Changes for New APPS
2. Architecture Changes
3. Traffic Model
4. Bandwidth Projection
5. Latency per Segment
6. Clock Synchronization
7. Network Slicing

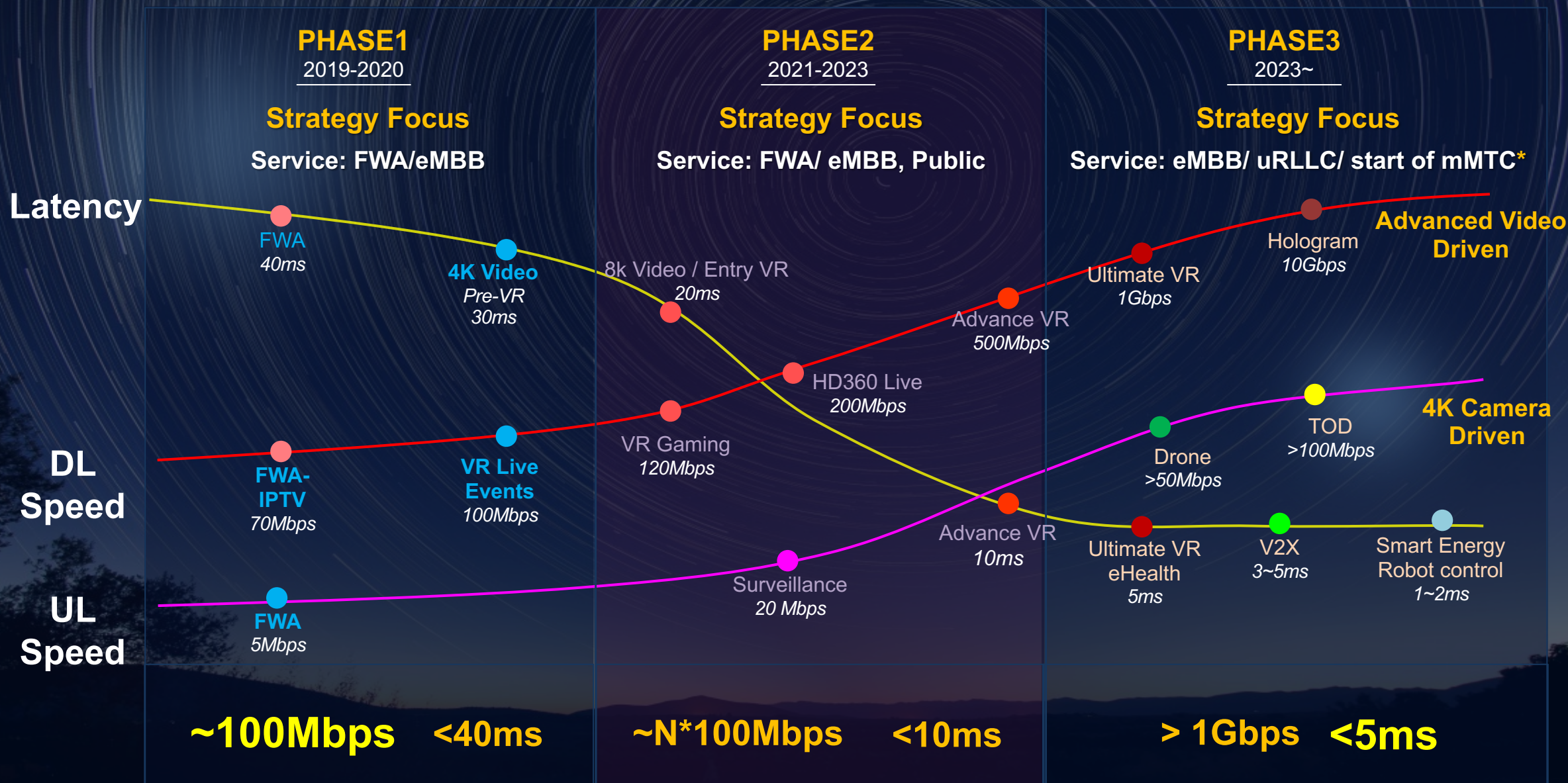
Plus traditional transport requirements,

e.g.:

- 50-ms Protection Switching
- End-to-end OAM



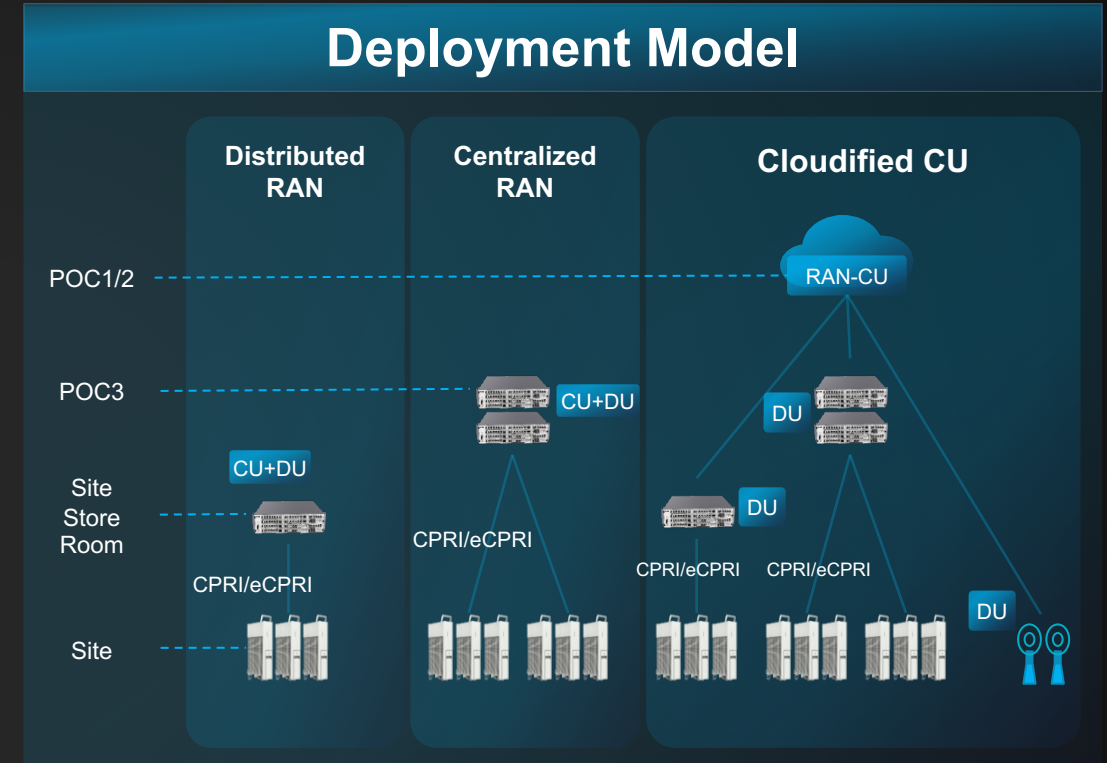
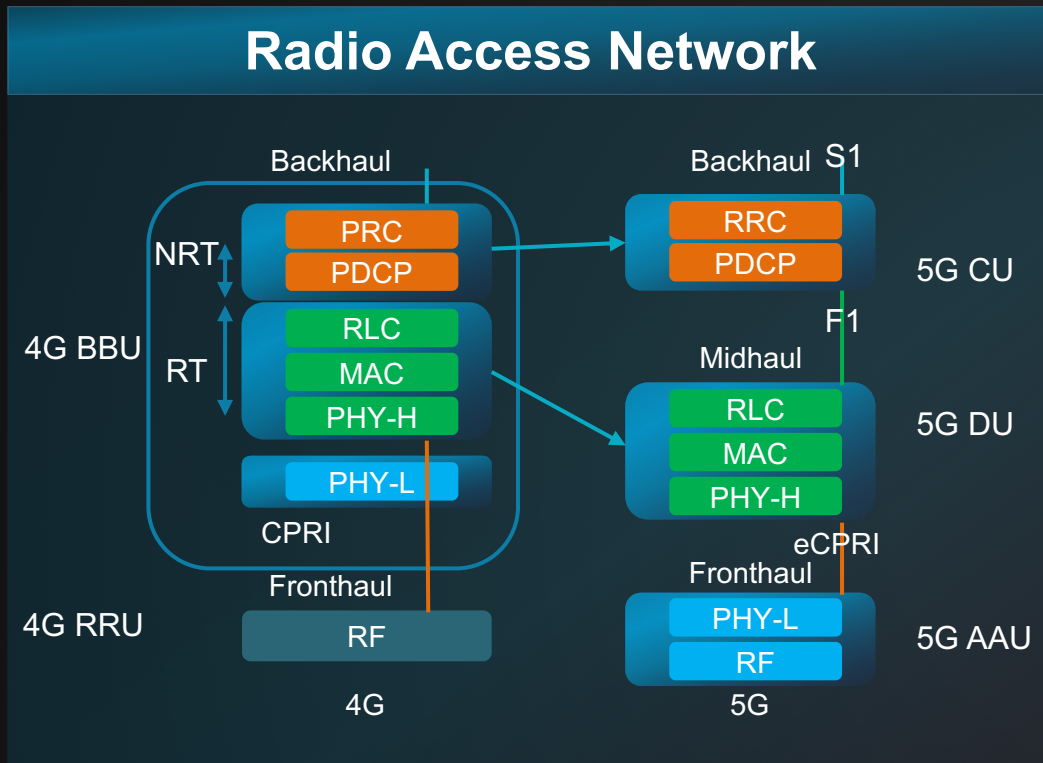
# 1. Services Requirement Projection



\*mMTC use case not included



## 2.1 Architecture Changes/Access Network

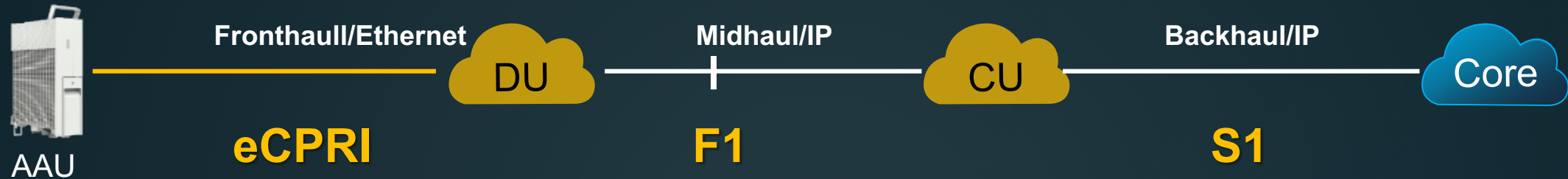


## Summary

- From 2-Layer BBU/RRU to 3-Layer CU/DU/AAU
- CU/DU split for flexible deployment model & implementation model
- Latency sensitive functions on DU
- Backhaul, Midhaul & Fronthaul interface defined
- eCPRI interface: new interface defined to significantly lower the bandwidth requirement



## 2.1 Architecture Changes/Access Network



- Bit base -> Ethernet Frame base
- 10/25GE defined
- High latency requirement(e.g. HARQ): 100us
- Point-to-point
- Distance: <10Km
- Bandwidth required varies (e.g. High or Low Frequency, No. of Cells, MIMO types, Over Subscription Ratio, etc.)
- Statistical multiplexing not recommended
- Typical Interface: 3x10GE or 3x25GE

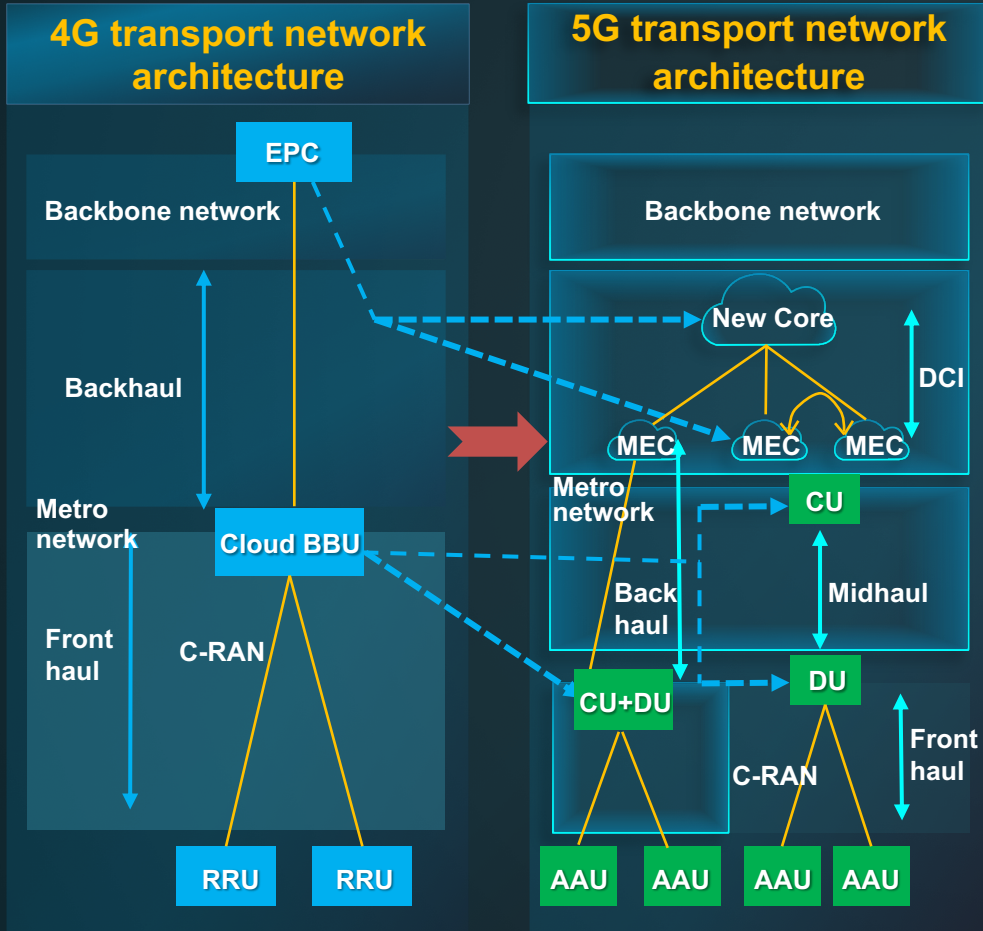
- Bandwidth (different projection)
- Average 3-7Gbps
- Statistical multiplexing can be used
- Point-to-point or Point to Multi-point
- Distance: Around 40km~80km
- Latency: Control Plane Bounded.  
<10ms (Recommended). 20ms (max).

- Bandwidth (different projection)
- Average 3-7Gbps
- Statistical multiplexing can be used
- Multi-Point-to-multi-point
- Distance: Under 200km
- Latency: Service Bounded

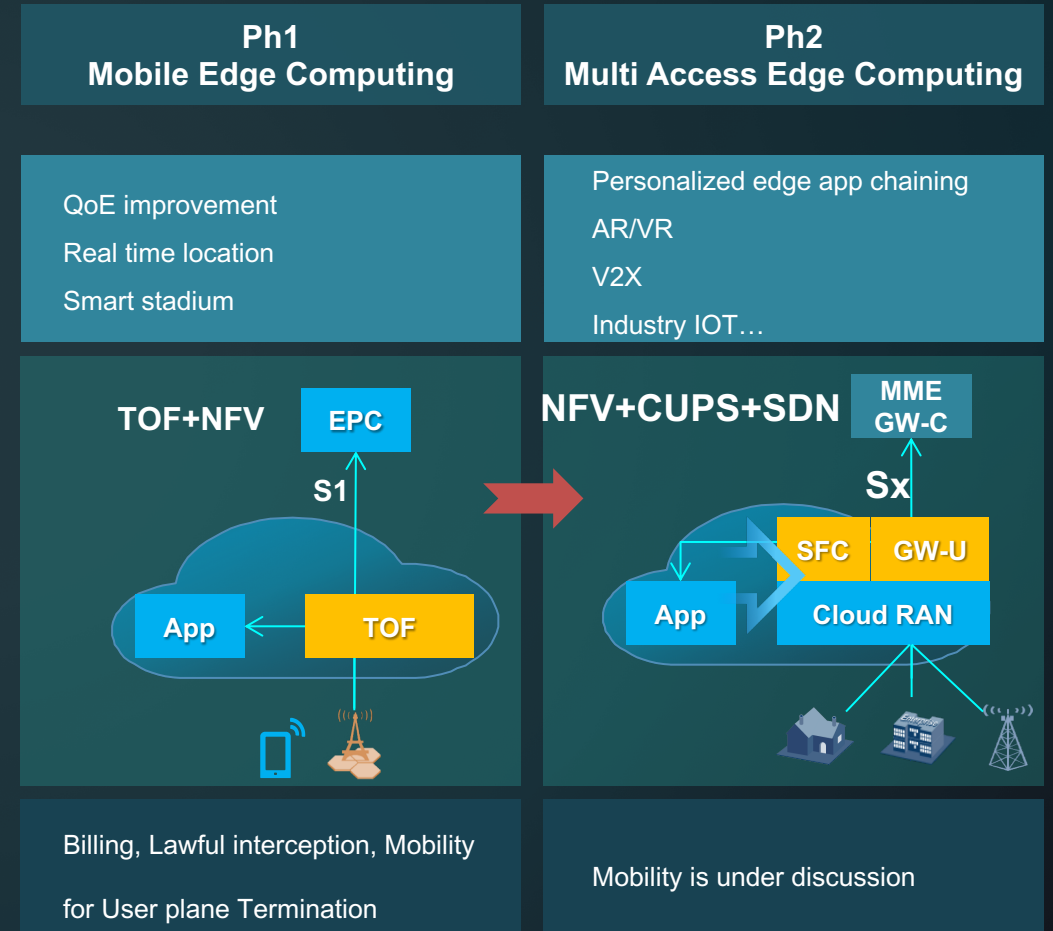


## 2.2 Architecture Changes/Core

### Deployment Model Transition

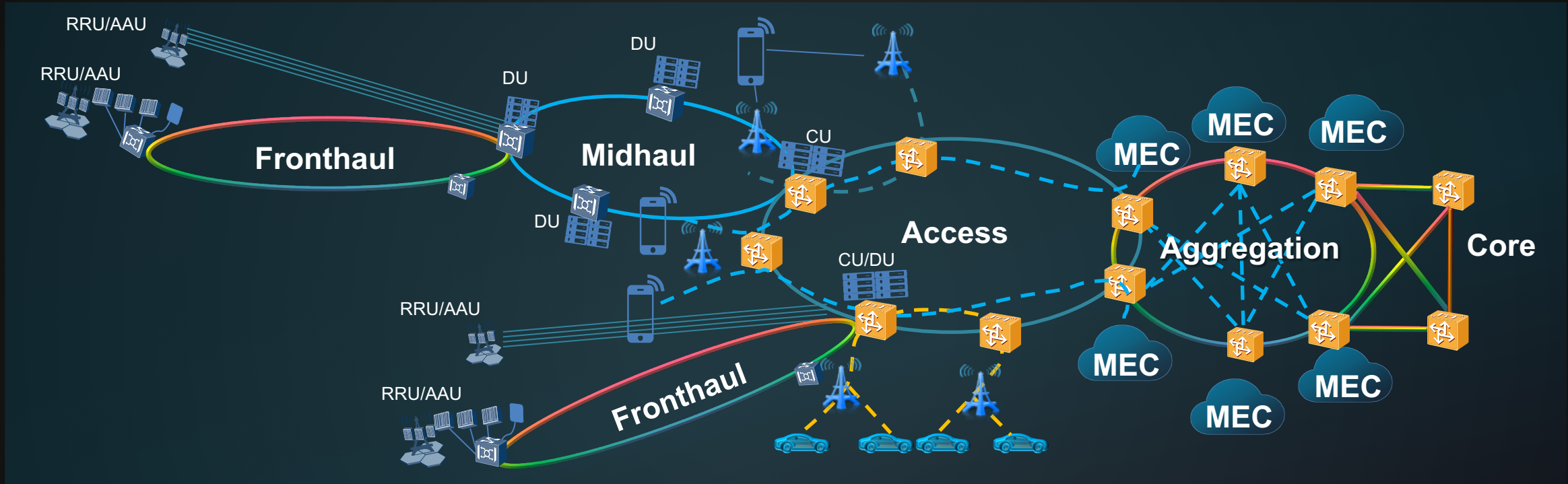


### MEC Development





### 3. Change in Traffic Model



#### Changes

- EPC -> MEC. Cross-MEC East-West traffic flow increasing dramatically
- eX2 traffic among base stations are increased (20% estimated)
- L3 Extended from Core to Aggregation or even Access is necessary.
- IP network restructure is one of the major design areas for 4G->5G



## 4. Bandwidth

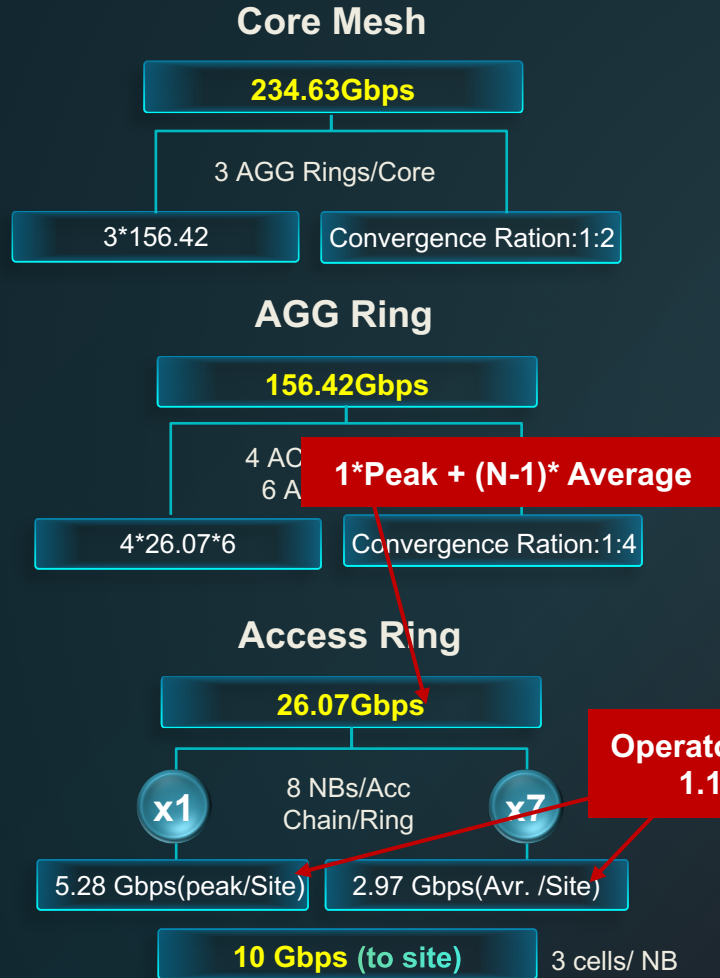
5G One Site Bandwidth requirement (Model used by Mobile Operator A: Large Scale)

	5G Low Frequency (C-Band)	5G High Frequency (mmWave)
Spectrum	3.4Ghz ~ 3.5Ghz resources Spectrum: 100Mhz	Above 28Ghz Spectrum: 800Mhz
configuration	3 cells, 64T64R	3 cells, 2T2R
	Peak: 40bit/hz; average: 10bit/hz	Peak: 20bit/hz; average: 5bit/hz
	10% encapsulation expense, 1:3TDD over subscription; 20%*p traffic	10% encapsulation expense, 1:3TDD over subscription
Peak of Sector	$40\text{bit/hz} \times 100\text{Mhz} \times 1.1 \times 0.75 = 3.3\text{G}$	$20\text{bit/hz} \times 800\text{Mhz} \times 1.1 \times 0.75 = 13.2\text{G}$
Average of Sector	$10\text{bit/hz} \times 100\text{Mhz} \times 1.1 \times 0.75 \times 1.2 = 0.99\text{G}$	$5\text{bit/hz} \times 800\text{Mhz} \times 1.1 \times 0.75 = 3.3\text{G}$
Peak/Site	$3.3\text{G} + 2 \times 0.99\text{G} = 5.28\text{G}$	$13.2\text{G} + 2 \times 3.3\text{G} = 19.8\text{G}$
Average/Site	$3 \times 0.99\text{G} = 2.97\text{G}$	$3 \times 3.3\text{G} = 9.9\text{G}$

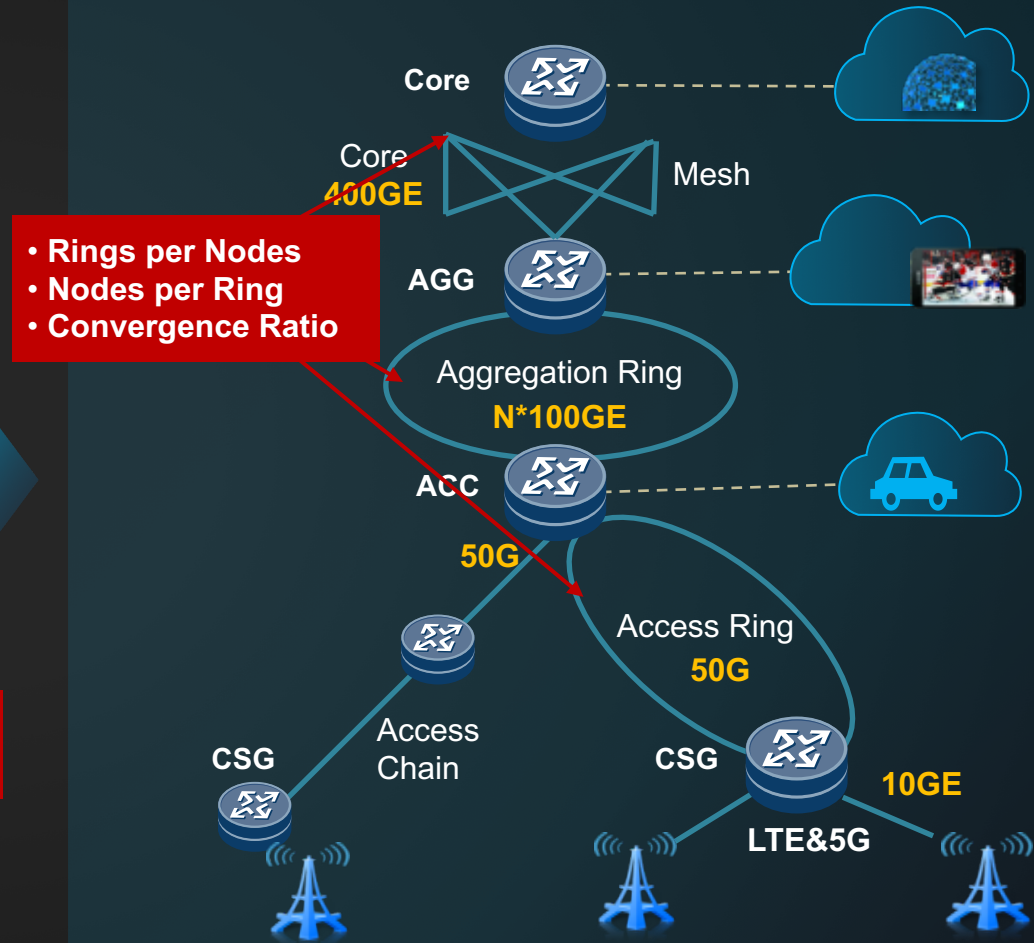


# 4. Bandwidth

## From Bandwidth



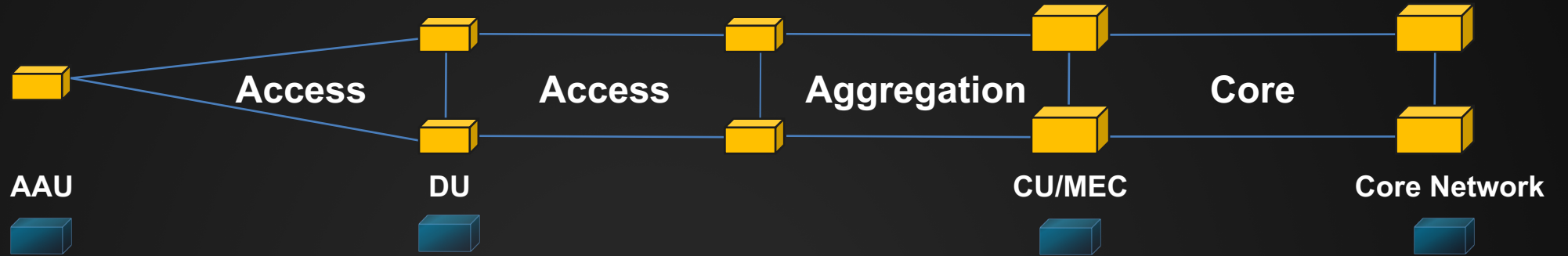
## To Topology



➤ To meet the bandwidth requirement, 10G-PON UL/DL Split Ratio should be 1:1. 25G-PON Standard canceled, 50G-PON standard under development



# 5. Latency per Segment

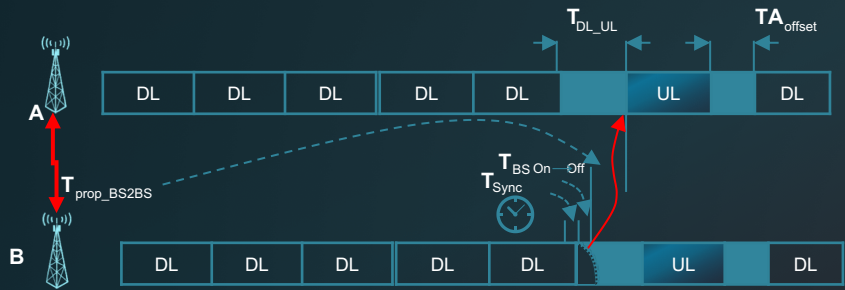


Network	Transport	Fronthaul		Middlehaul+Backhaul		
	Latency	<100us		<0.5ms		Service requires
	Distance	1~10km		5~50km		20~300km
	Hops	~8hops		~15hops		~8hops
Services	uRLLC ev2x	1ms				eV2X<1ms, end to end Fronthaul + backhaul <1ms
	eMBB VR/AR	5ms~40ms				

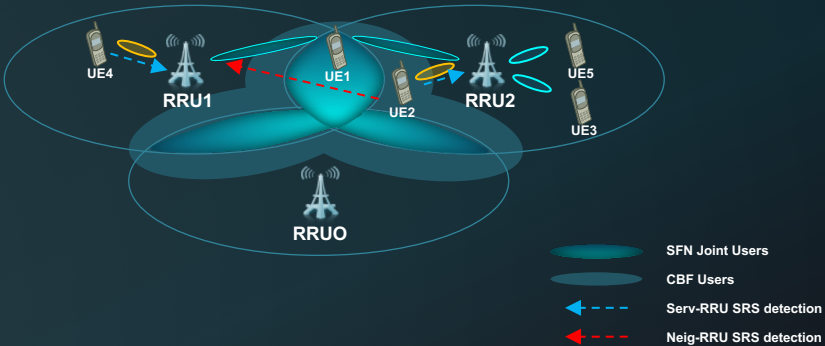
# 6. Time Sync Requirement

## High-Precision Clock Synchronization in 5G Era: $\pm 200\text{ns}$

5G NR Ultra-short Frame  
✓ "Guard Period" becomes shorter



CoMP/SFN requirement:  
✓ Get 5-30% bandwidth gain



5G NR/Comp/SFN requirements for time synchronization

Scenario	4G services	Timing/Freq. Requirement	Impacts
4G	Basic FDD service	$\pm 0.05\text{ppm}$	Inter-Basestation switching failure
4.5G	FDD/TDD UL CoMP function	$< \pm 1.5\mu\text{s}$	Zero gain for CoMP



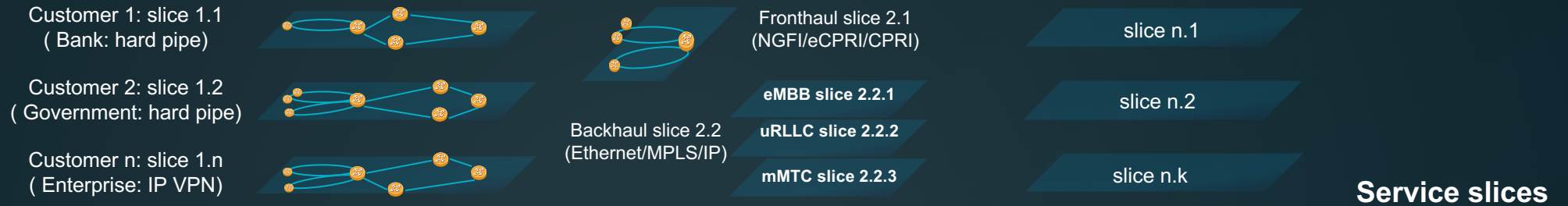
5G Services	Scenario	Timing Requirement	Impacts
Basic 5G service (TDD)	5G Low frequency(sub-6G) and High frequency(above-6G)	$< \pm 1.5\mu\text{s}$	Low Precision of Sync will cause the basic 5G service failure
Collaborate services (CoMP/SFN)	5G Low frequency (sub-6G)	$< \pm 200\text{ns}$	Performance declines or no gain

From: 3GPP TS36.133, 36.922

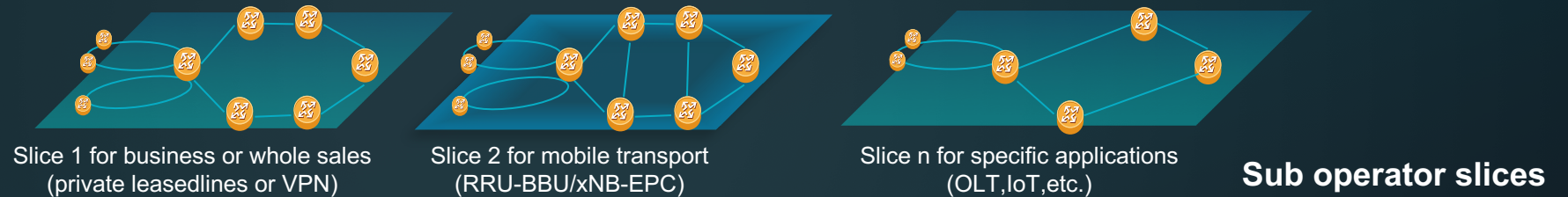


# 7. Network Slicing for Upcoming Latency Sensitive Service, e.g. URLLC

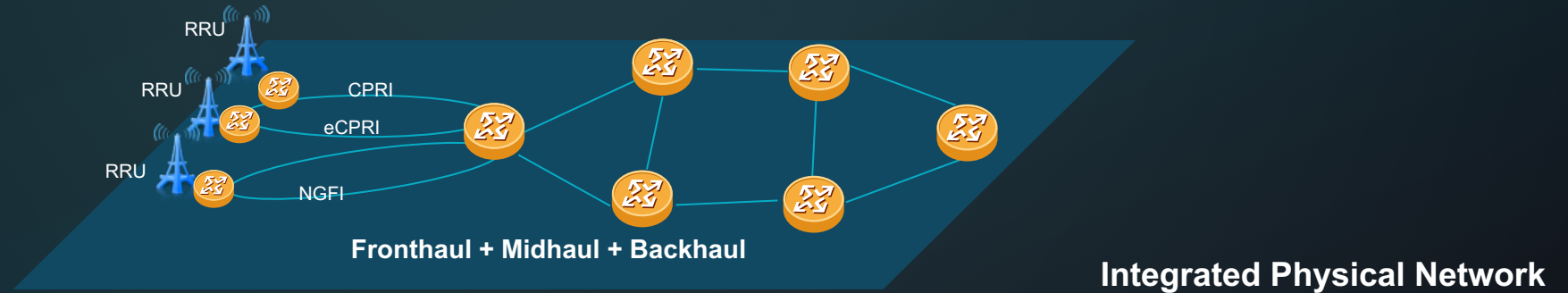
## SDN control



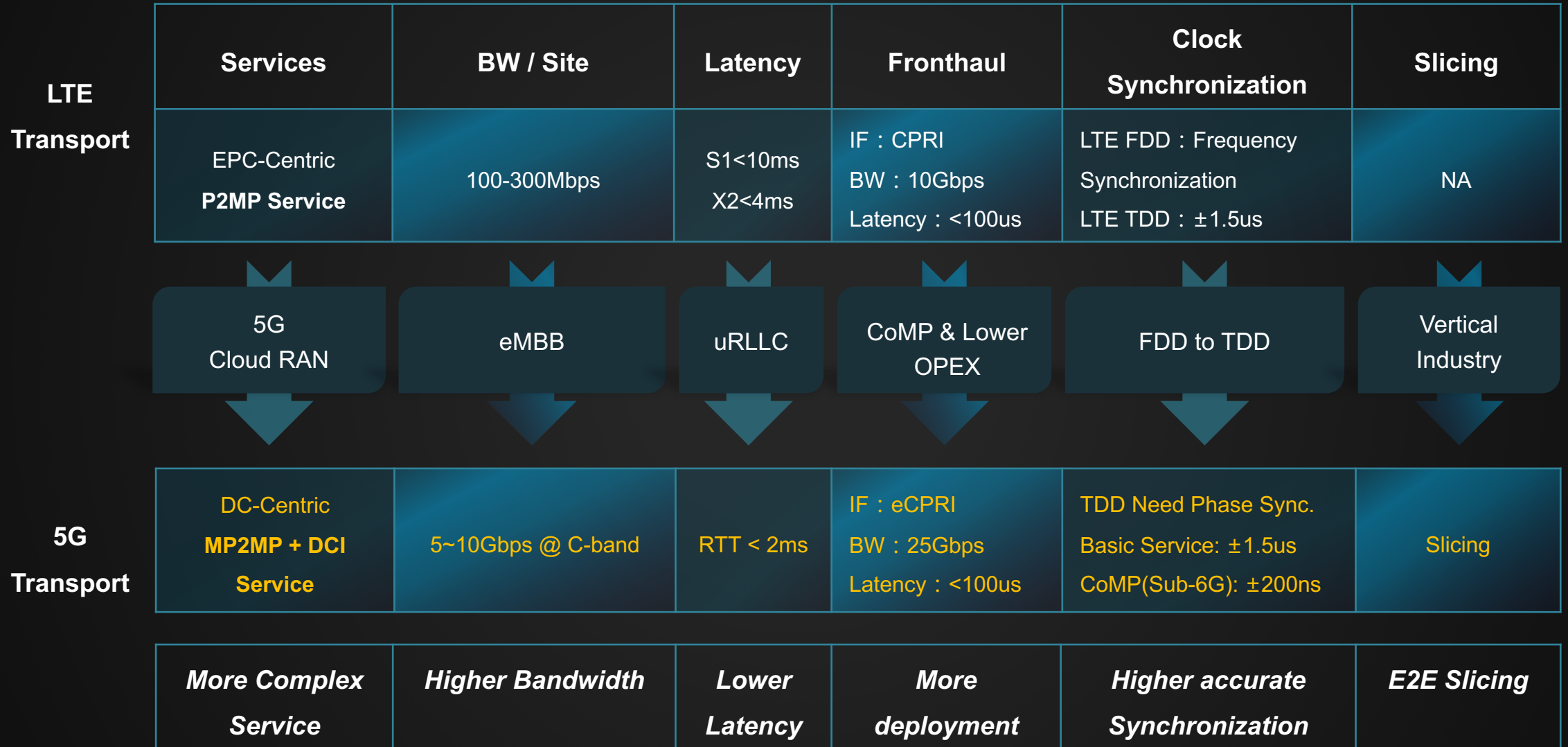
## SDN control



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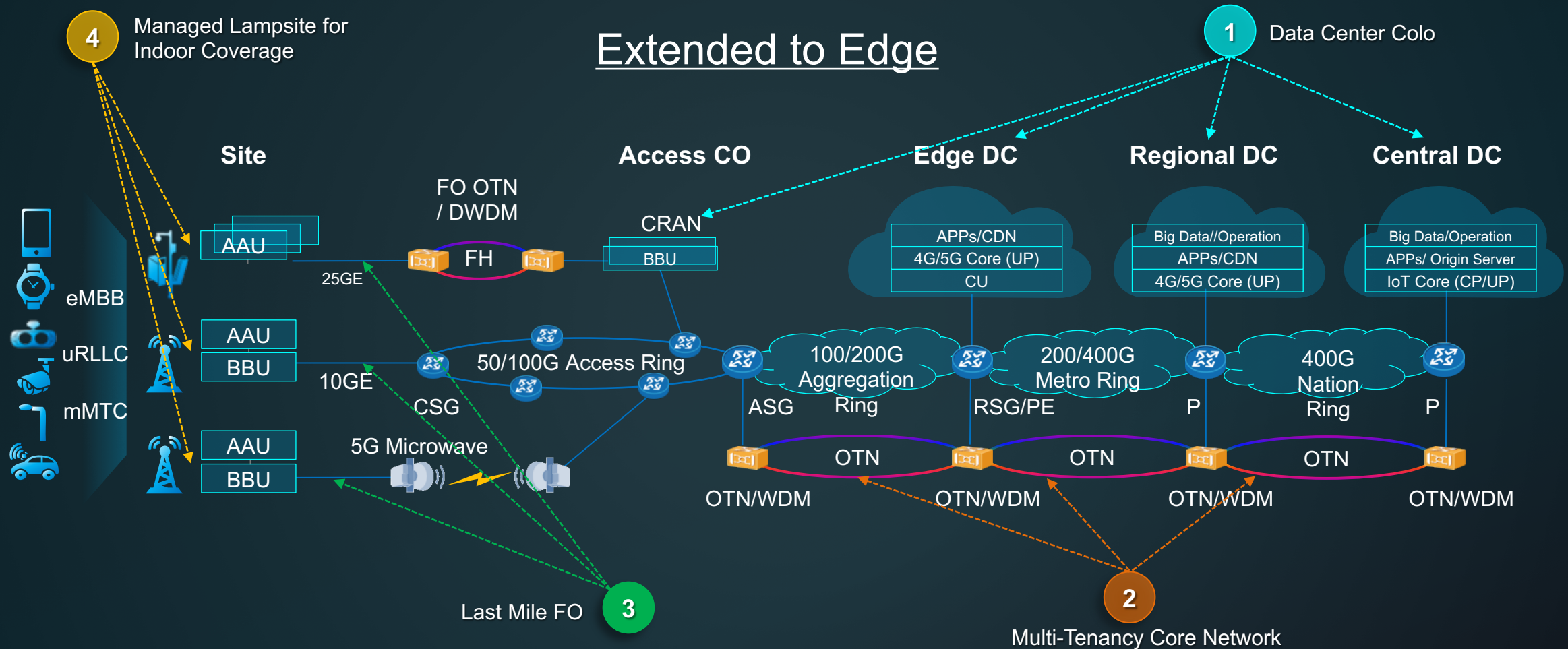
# Summary: Challenges and Requirements from 4G to 5G transport





# 5G Carrier of Carrier Opportunity

## Extended to Edge



## 5G Backbone End-to-End Architecture

# 5G Carrier of Carrier. Same & Difference?

## Same

Services Requirement?

Architecture Changes?

Traffic Model?

Bandwidth?

Latency?

Time Synchronization?

## Difference

### Multi-Tenancy

- Multiple Clock Sources
- Clock Synchronization
- Multi-Level Management
- Management Transparency
- Optical vs. IP Core

**Deep-Dive Workshop  
Available**



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# THANK YOU

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