# ITSF - TIMING FOR 5G

## SYNCHRONISATION REQUIREMENTS FOR 5G

# Agenda

- LTE A-PRO
- What defines 5G
- 5G use cases
- Use cases mapped to capabilities
- Network Slicing
- 5G New Radio timeline
- 5G new interfaces & RAN functional Splits
- Timing Requirements
- Summary

# What defines 5G?
# LTE A-Pro

## LTE A-Pro

- 3GPP releases 13 & 14
- Data speeds >3Gbps (LTE-A 1Gbps)
- 640MHz of carrier bandwidth (LTE-A 100MHz)
- Latency 2ms (LTE-A 10ms)
- NB-IOT


5G

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# What defines 5G?
# Perception of infinite capacity and always connected.

## 5G goals

- Higher peak and average data rates
  - Peak 20Gbps down (10Gbps up), average user experience of 100Mbps (50Mbps up)
- Massive traffic density
  - nx10k users per stadium at 10s Mbit/s each
  - nx10 users per office floor at 1Gb/s each
- Massive connectivity
  - 1M connections per square km


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# What defines 5G?
# Step change in key performance characteristics

## 5G goals

- Ultra-low latency
  - 1mS for URLLC, 4mS for eMBB (one way)
- Ultra reliable network
  - Available at all times, in all places
- Spectrum efficiency
  - Minimum downlink peak 30bit/s/Hz
  - Much more efficient use of spectrum than we have today


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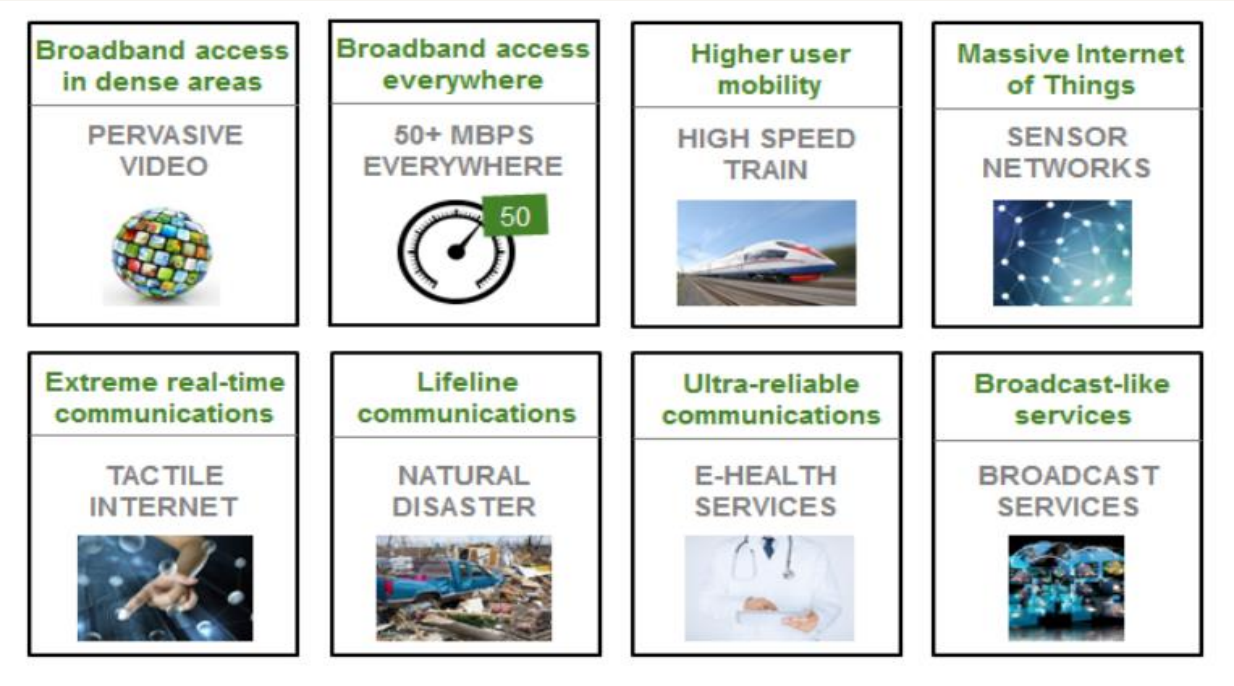
# 5G use cases

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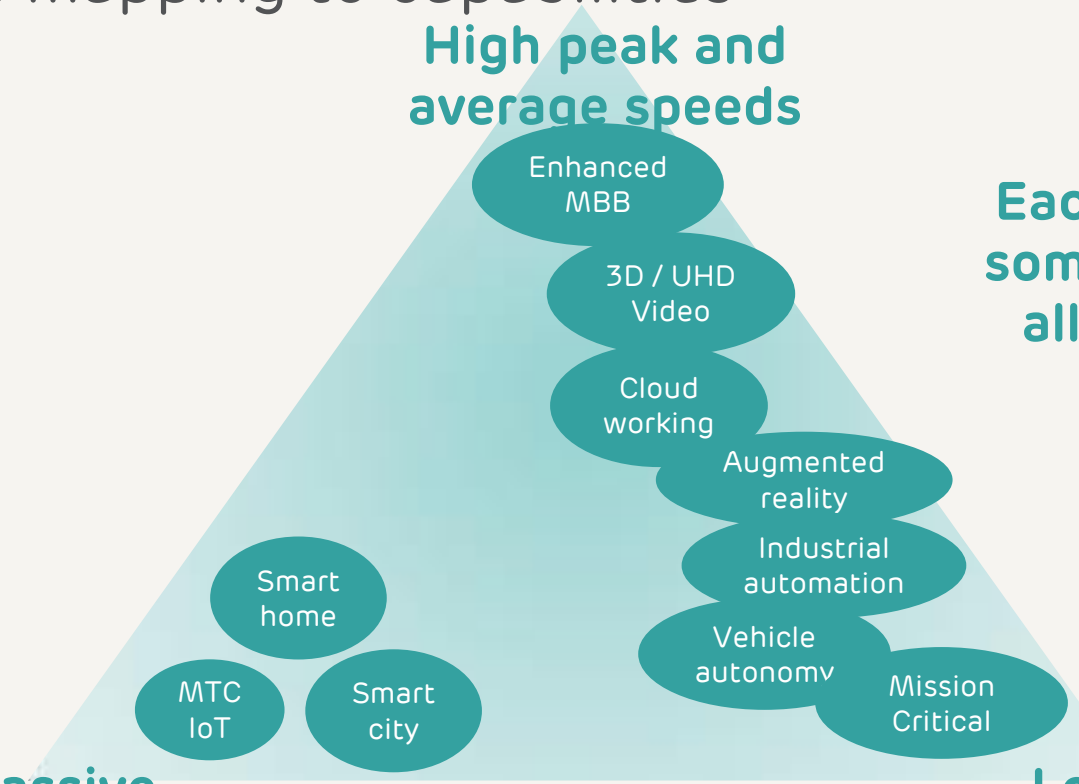
**Some 5G Characteristics are key to each use case.**

Source: https://www.ngmn.org/uploads/media/NGMN_5G_White_Paper_V1_0.pdf

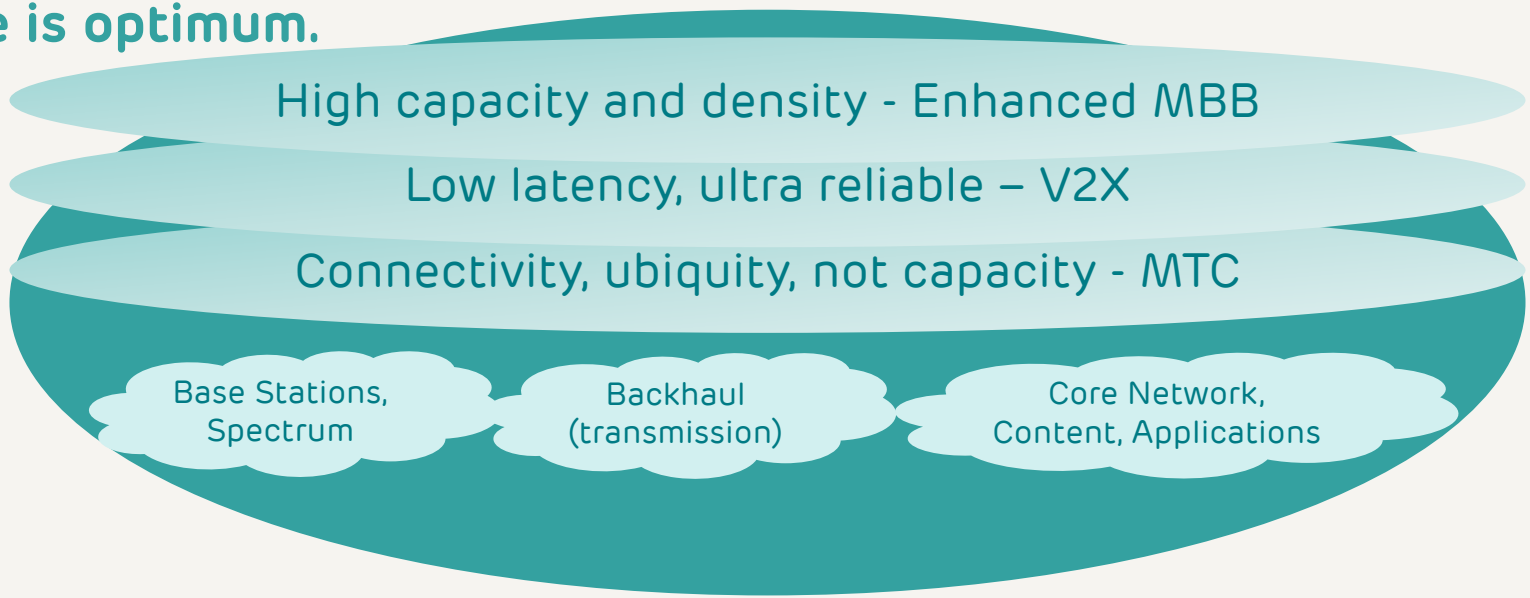
# Use case mapping to capabilities




**Each use case needs some (but usually not all) 5G capabilities**

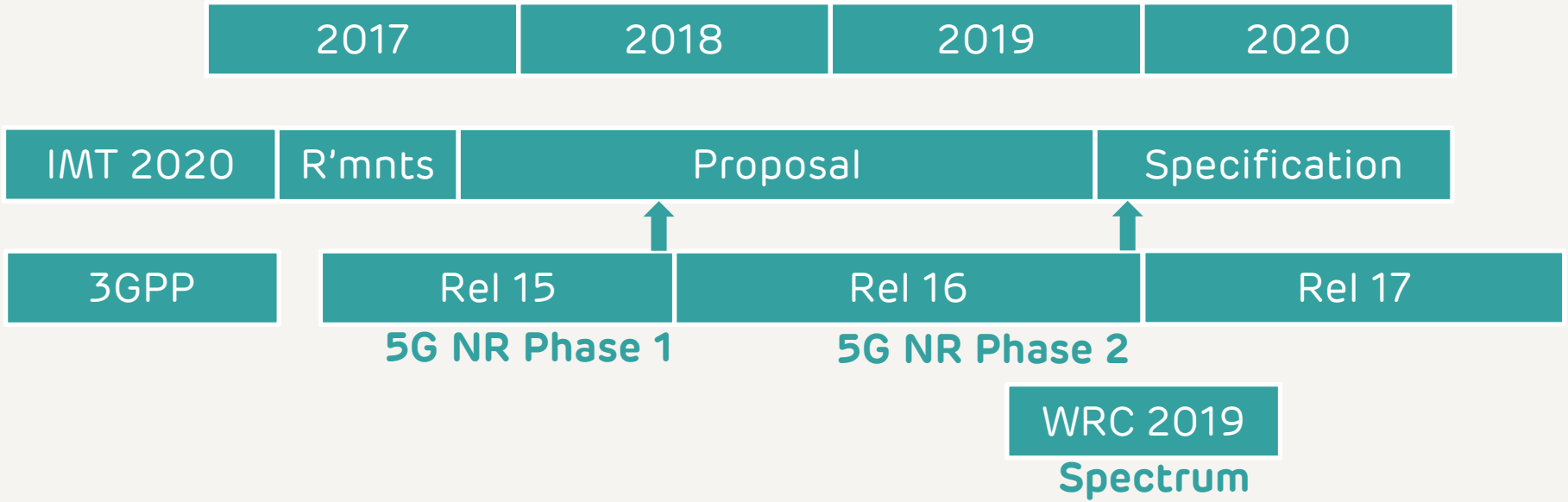
# One network to serve them all – Network Slicing

**Providing all 5G capabilities for every use case, or separate networks with only the required capabilities, will drive cost. One network which can allocate appropriate capabilities to each use case is optimum.**



# 5G NR (New Radio) Timeline

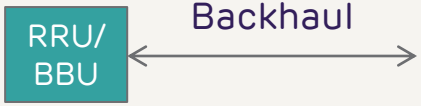
**5G requires a new radio air interface. Currently under study in 3GPP, this will be proposed in to ITU IMT 2020 in two phases. LTE-Advanced Pro (Rel 13) delivers some near 5G capabilities and will co-exist with tight integration. Equipment makers are demonstrating pre-standards 5G NR now.**

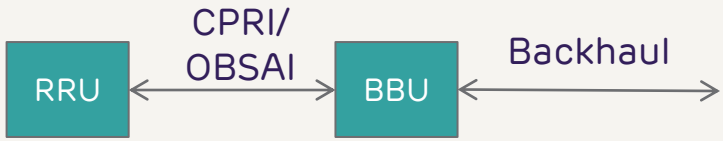


# 5G NR (New Radio) – new base station architecture

## LTE

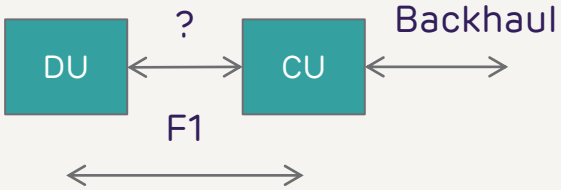
- **Single Node with Radio Unit and Baseband Unit, or Remote Radio Unit using CPRI up a mast**

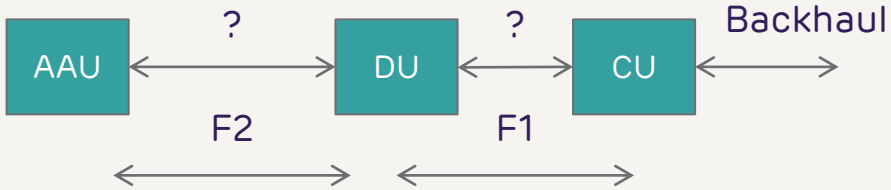


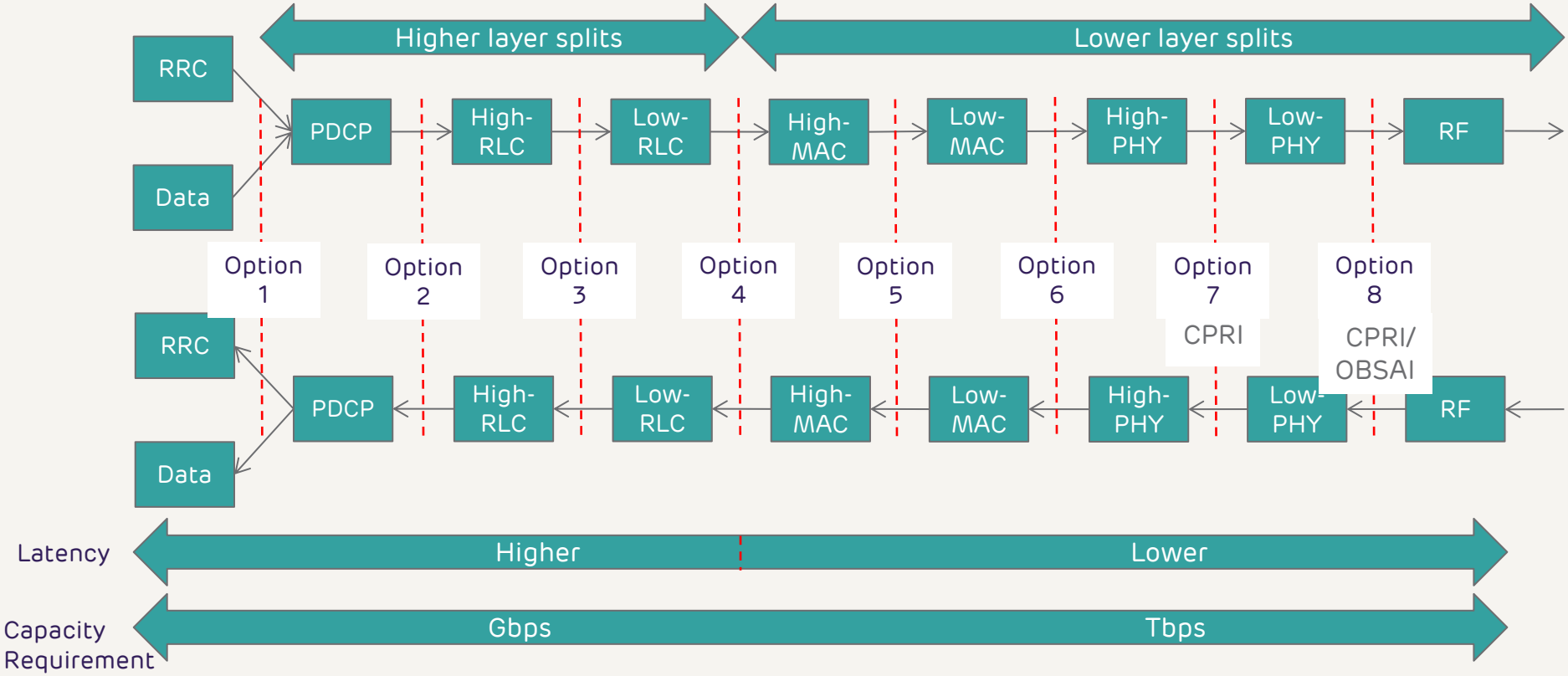

## 5G New Radio

- **Radio and Baseband effectively split into a Distributed Unit and a Central Unit, but what protocol runs between them. It also now has a name - F1 interface & F2 for DU to Active Antenna Unit**



# RAN functional splits and timing requirement



# 5G New Radio

## Functional Splits

**Option 2 - High Level Split - similar to LTE – little change 3uS relative**

- **Current LTE macro network of sites and backhaul may make a good starting point for 5G**

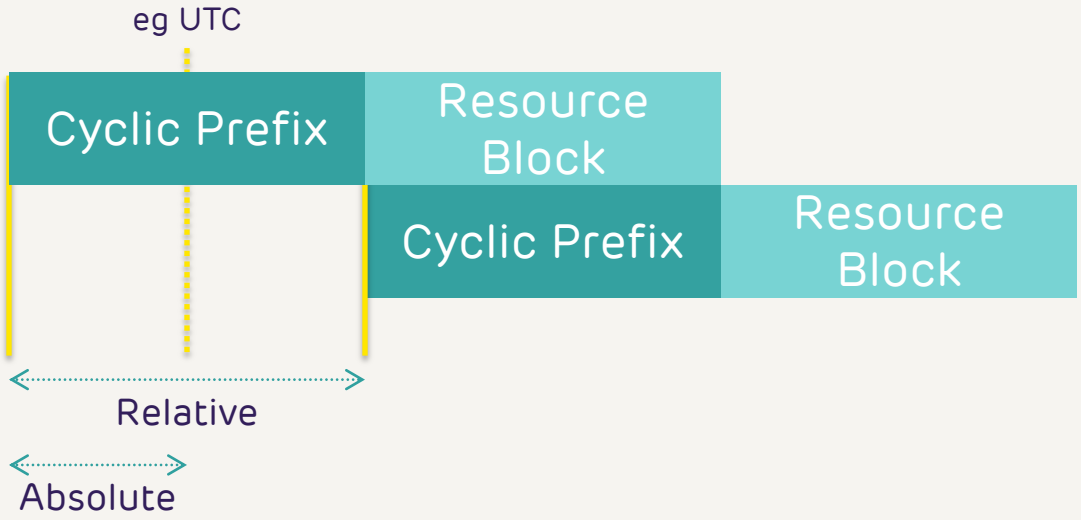
**Option 7 – Low level Split - eCPRI?**

- **Relative TAE becomes more important, especially with more interference and more beamforming with AAUs**
- **Also as Ethernet based CPRI, does this mean we need Ethernet type sync technology – ie PTP, etc**

# Timing Requirements

**Time Alignment Error –the time difference between significant instants of 2 signals – LTE A Pro – relative 3us – 1.5us absolute**

**The use of base stations using the same carriers and massive MIMO drives these figures, and relative TAE between base stations will be critical to achieve spectral efficiency**



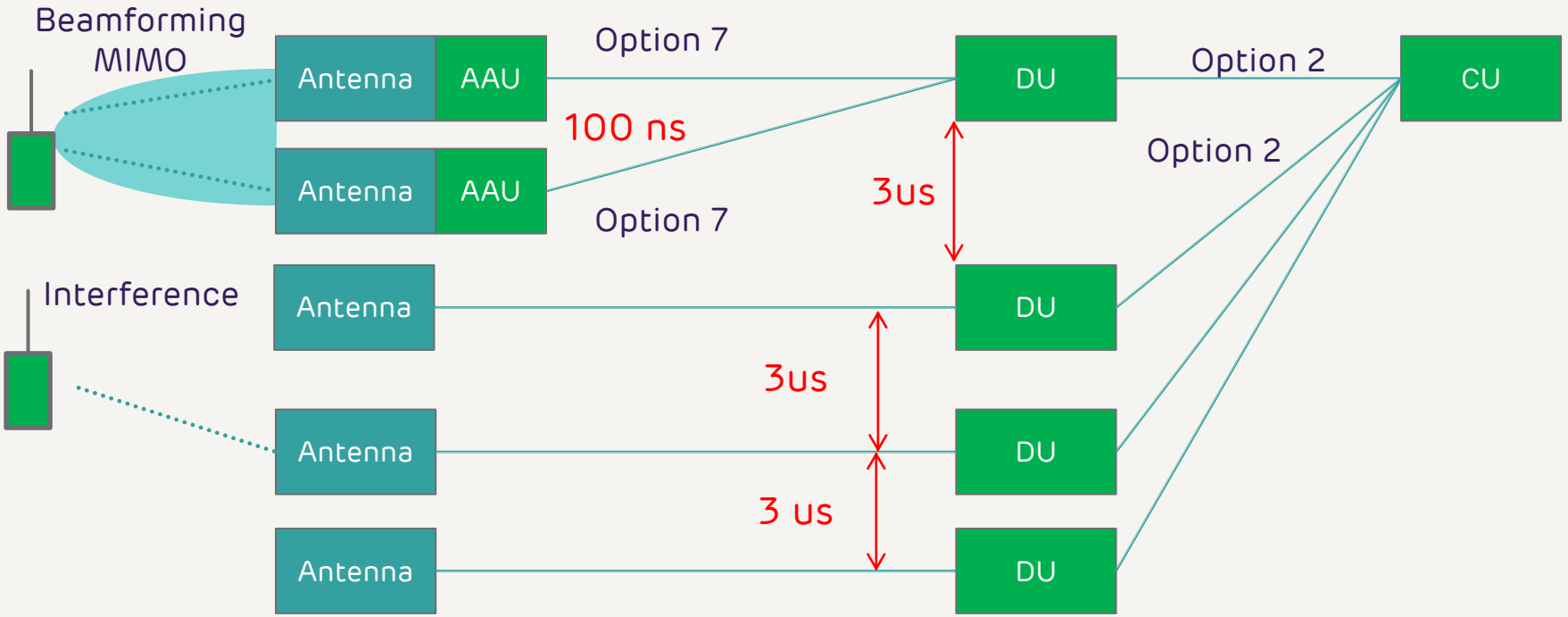
# Timing Requirements from 3GPP LTE-A via G.8271 5GNR will be the same or tighter.

**Table II.2 – Other time and phase requirements**

| Typical applications (for information) | Synchronization requirements | Specification |
|---|---|---|
| Asynchronous dual connectivity (note, applicable only for FDD-FDD inter-band dual connectivity) | 500 µs (Note 4) | [b-3GPP TS 36.133] |
| Synchronous dual connectivity (note, applicable only for TDD-TDD and FDD-FDD inter-band dual connectivity) | 33 µs (Note 4) | [b-3GPP TS 36.133] section 7.13 and 7.15.2 |
| Intra-band non-contiguous carrier aggregation with or without MIMO or TX diversity, and inter-band carrier aggregation with or without MIMO or TX diversity | 260 ns (Note 3) | [b-3GPP TS 36.104] section 6.5.3.1 |
| Intra-band contiguous carrier aggregation, with or without MIMO or TX diversity | 130 ns (Note 3) | [b-3GPP TS 36.104] section 6.5.3.1 |
| Location Based Services using OTDOA (Note 2) | 100 ns | |
| MIMO or TX diversity transmissions, at each carrier frequency | 65 ns (Note 3) | [b-3GPP TS 36.104] section 6.5.3.1 |
| More emerging LTE-A features that require multiple antenna co-operation within a cluster. | x ns (Note 1) (Note 3) | |

# Timing Requirements

## Diagram of splits and timing requirements



# Summary

- 5G New Radio creates new demands for synchronisation
- In most cases in line with requirements for LTE A Pro
- Demands on the air interface with massive MIMO and large spectral efficiency demands will drive relative sync requirements down to 100s of ns between AAUs
- Different slices may have different requirements.
- One network – many services

# THANK YOU