

# NETWORK SYNCHRONIZATION ARCHITECTURE DESIGN FOR 5G

VŨ XUÂN NHÀN

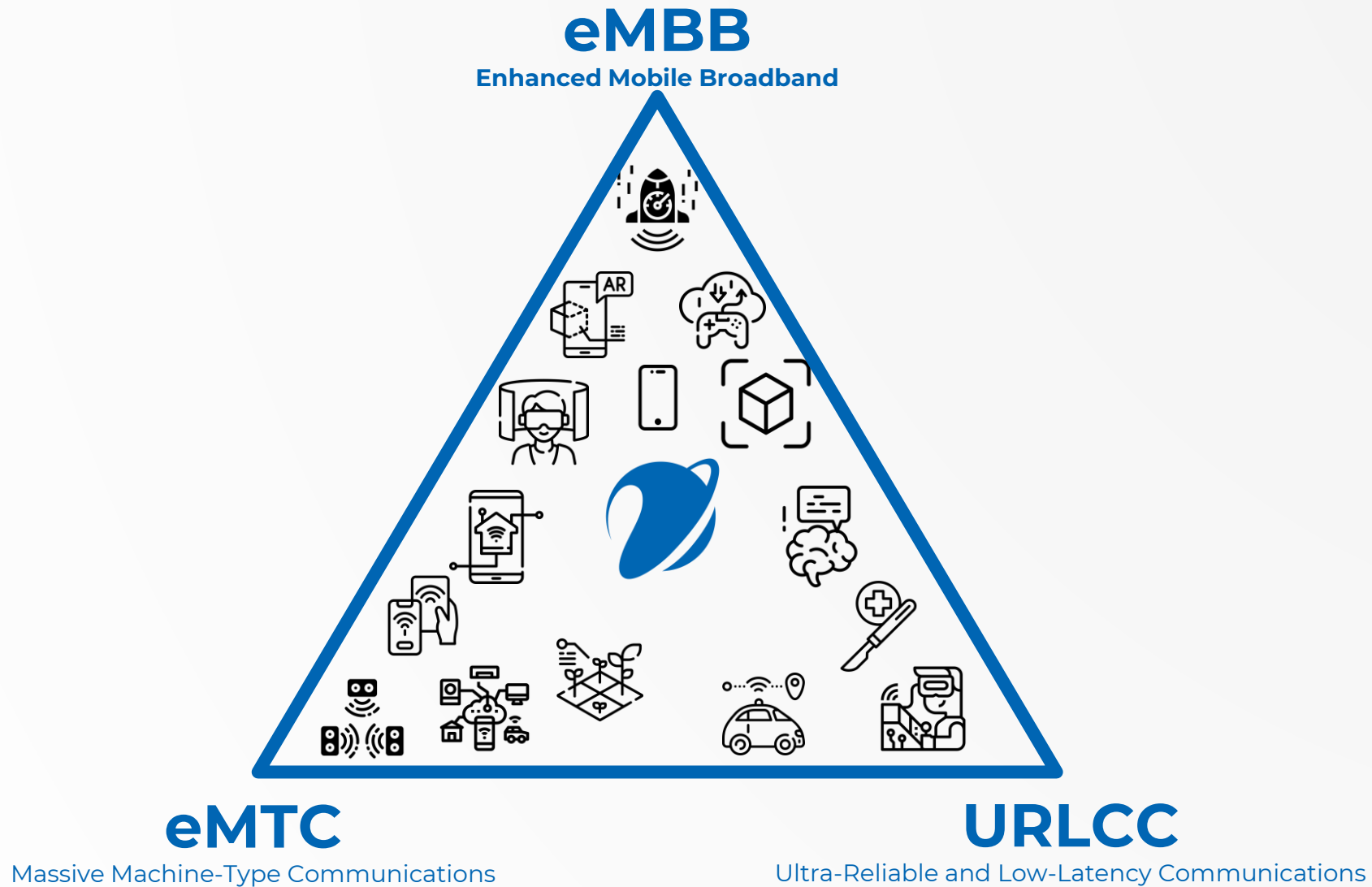
VNPT Net

Đà Lạt, tháng 10/2023

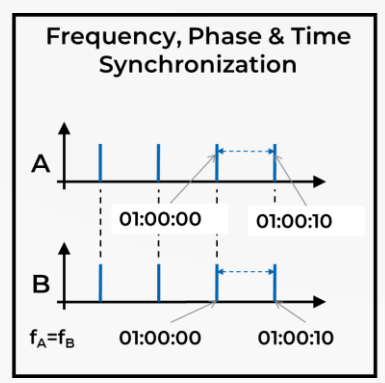
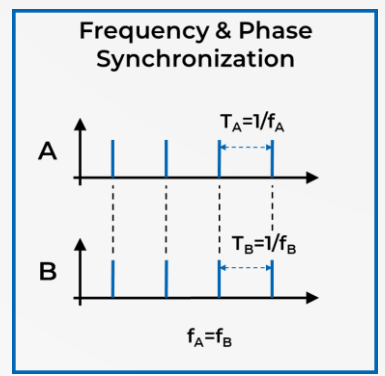
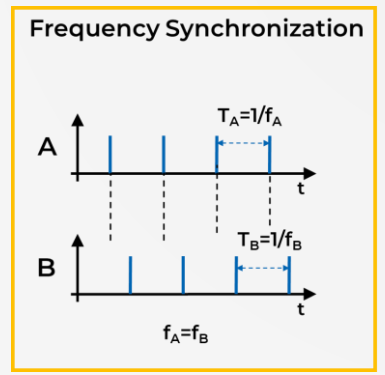
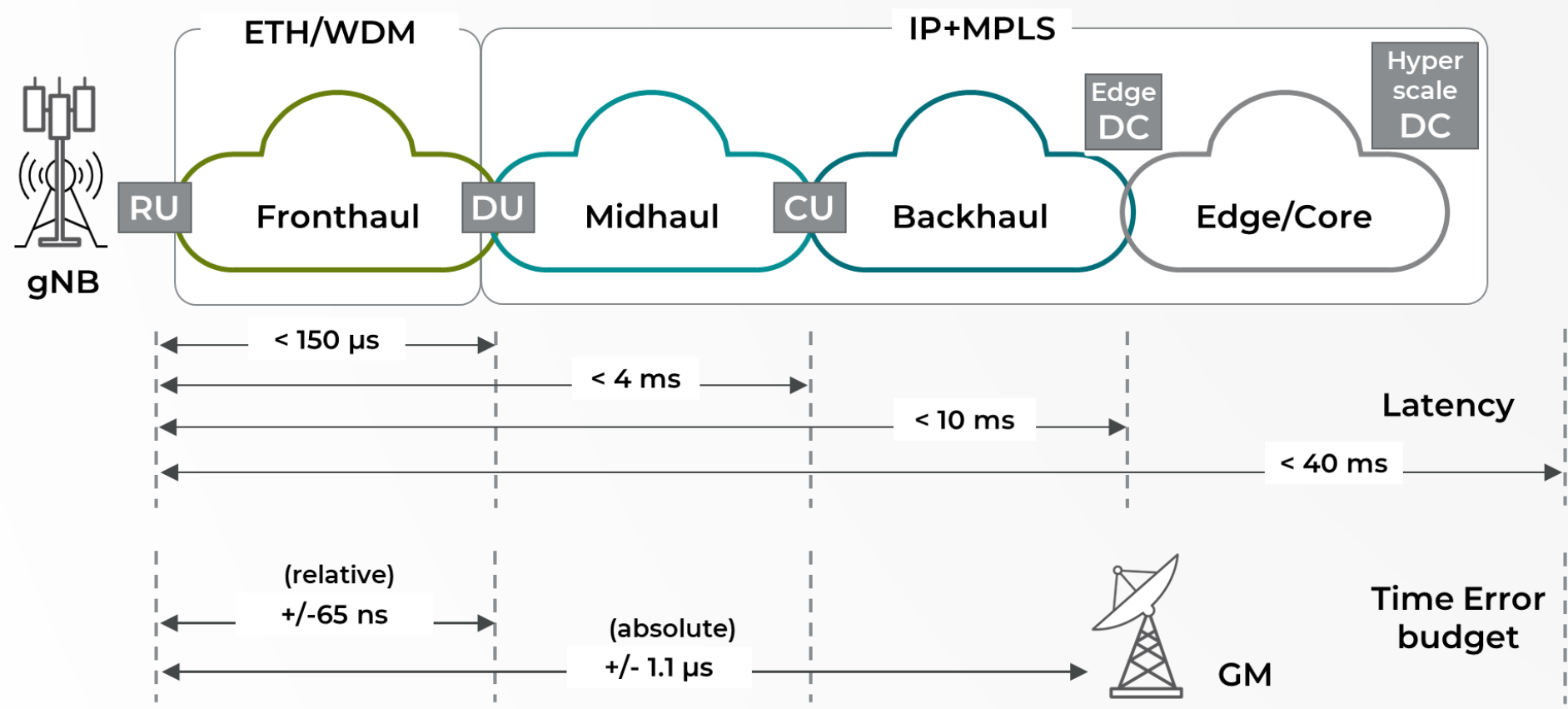
- Timing and Synchronization in the 5G era: the requirements
- Considerations
- Transmission network: the limitations
- Synchronization architecture models



# 5G: THE USE CASES



# FDD 50PPB IS NOT ENOUGH



TDD,  $\pm 1.5 \mu s$  for 5G general,  $\pm 1.1 \mu s$ , 16ppb for backhaul



# CONSIDERATIONS

FDD vs. TDD

$\pm 1.1 \mu s$   $\pm 1.5 \mu s$

Vulnerabilities

Centralized vs. Distributed

High Availability

Class A vs. B vs. C vs. D



FTS vs. PTS/A-PTS

PTP vs. Hybrid Sync-E/PTP

G.8275.1 vs. G.8275.2 vs...

Sync Sources

QoS, Network Slicing



Low bandwidth

High/Ultra high bandwidth

Better coverage

Poor coverage

# FDD

**Low band**  
(500MHz, 700MHz)

**Mid band**  
(2600MHz, 3700MHz)

**High band**  
(26000MHz)

50ppb

MIMO  
beamforming

UE timing: 10μs  
CA: 3-5μs  
TDD: 1.5μs  
CoMP: 1μs

# TDD

Dynamic bandwidth

2G, 3G, WCDMA  
LTE FDD, 5G FDD (Low band)

CDMA, LTE TDD  
5G TDD (Mid, High band)



# SYNC SOURCES AND PROTOCOLS

## NTP

- Not good for high precision timing use cases (TDD)

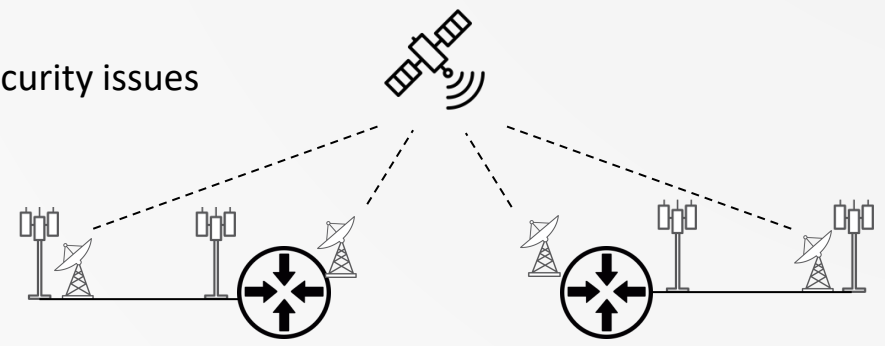
## SONET/SDH và Sync-E

- Not suitable for phase/time sync
- Timing support required for all network nodes

## GNSS

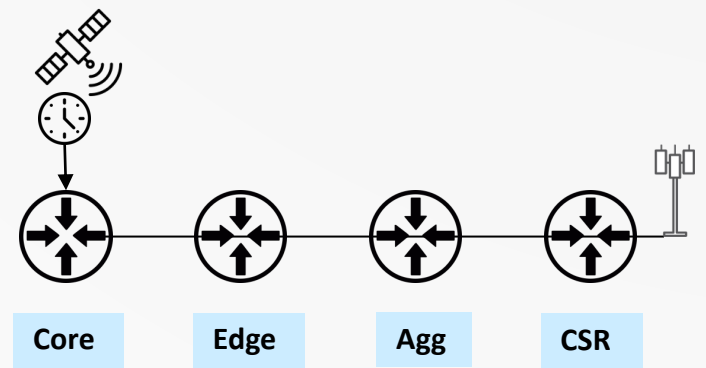


- Delivers frequency, phase and time
- Line of sight issues
- High CAPEX/OPEX
- Jamming, spoofing, security issues



## PTP

- Frequency, phase and time sync
- High precision





# G.8275.1 VS. G.8275.2

- Default PTP profile
- For easier deployment and interoperability

- All network devices must support timing packet termination and regeneration
- Ethernet multicast encapsulation

IEEE 1588v2

ITU-T G.8275.1 (FTS)

ITU-T G.8275.2 (A-PTS)

ITU-T G.8275.2 (PTS)

- Timing packet termination and regeneration capability is not required for all network nodes
- GNSS support at network edge
- Unicast encapsulation

- Timing packet termination and regeneration capability is not required for all network nodes
- Unicast encapsulation

## Phase synchronization:

- **G.8275.1** – PTP telecom profiles for phase/time synchronization with Full path Timing Support (FTS)
- **G.8275.2** – PTP telecom profiles for phase/time synchronization with Partial Timing Support (PTS) and Assisted PTS (APTS)
- **G.8273.2** – Timing characteristics of T-BC & T-TSC
- G.8273.3 – Timing characteristics of T-TC
- G.8273.4 – Timing characteristics of T-BC-A/P & T-TSC-A/P
- G.8271.1 – Network Limits for Time Synchronization with FTS
- G.8271.2 – Network Limits for Time Synchronization with (A-)PT

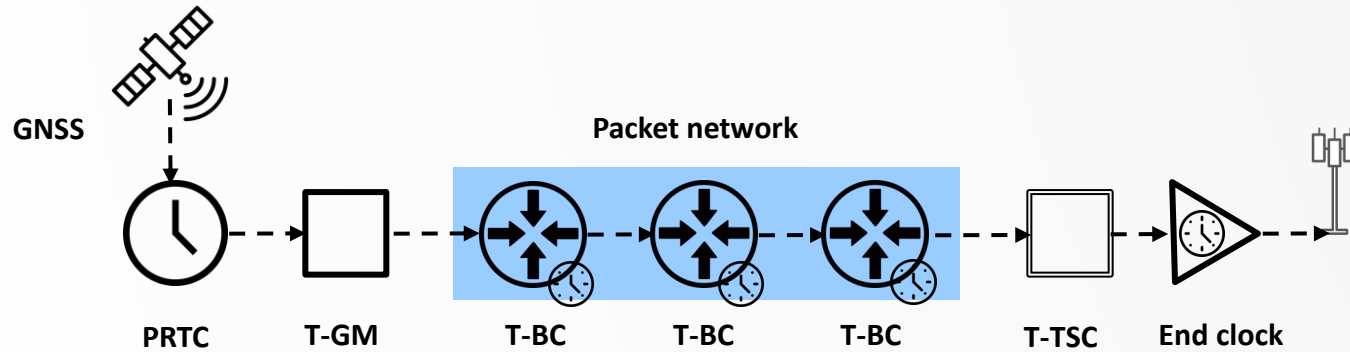
## Frequency synchronization:

- G.781, G.813 etc. – BITS/E1/T1
- G.8262 / G.8262.1 & G.8264 – Synchronous Ethernet
- G.8265.1 – PTP telecom profile for frequency synchronization



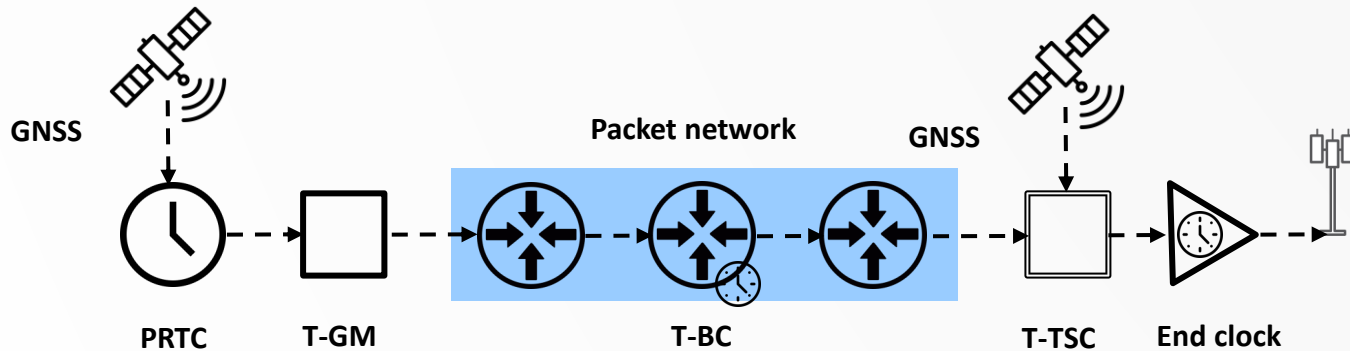


# FTS VS. PTS/A-PTS



## FTS (G.8275.1) Full Timing Support

- All network nodes between T-GM và T-TSC must have T-BC or T-TC function
- Hybrid Sync-E/PTP



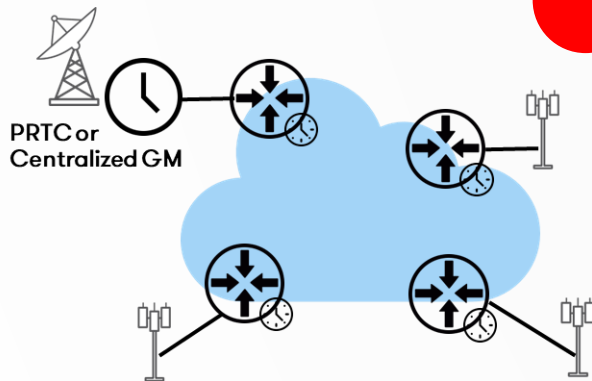
- Backup to GNSS
- PTP can maintain timebase when GNSS is out of service
- T-BC and T-TC function is not required for all network nodes

## PTS/A-PTS (G.8275.2) Partial Timing Support/Assisted Partial Timing Support

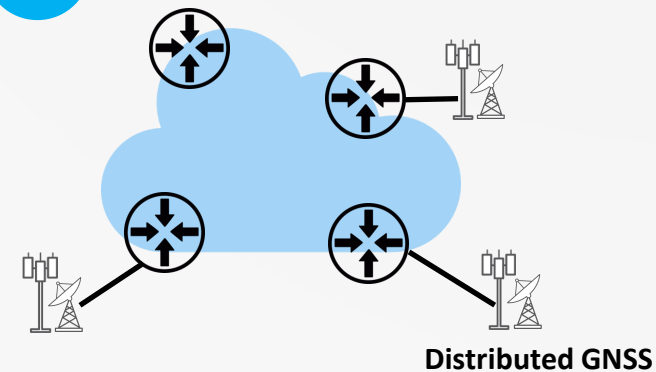
# Centralized

● Sync device OPEX, CAPEX ●

● Network transmission device CAPEX ●



● Scalability ●

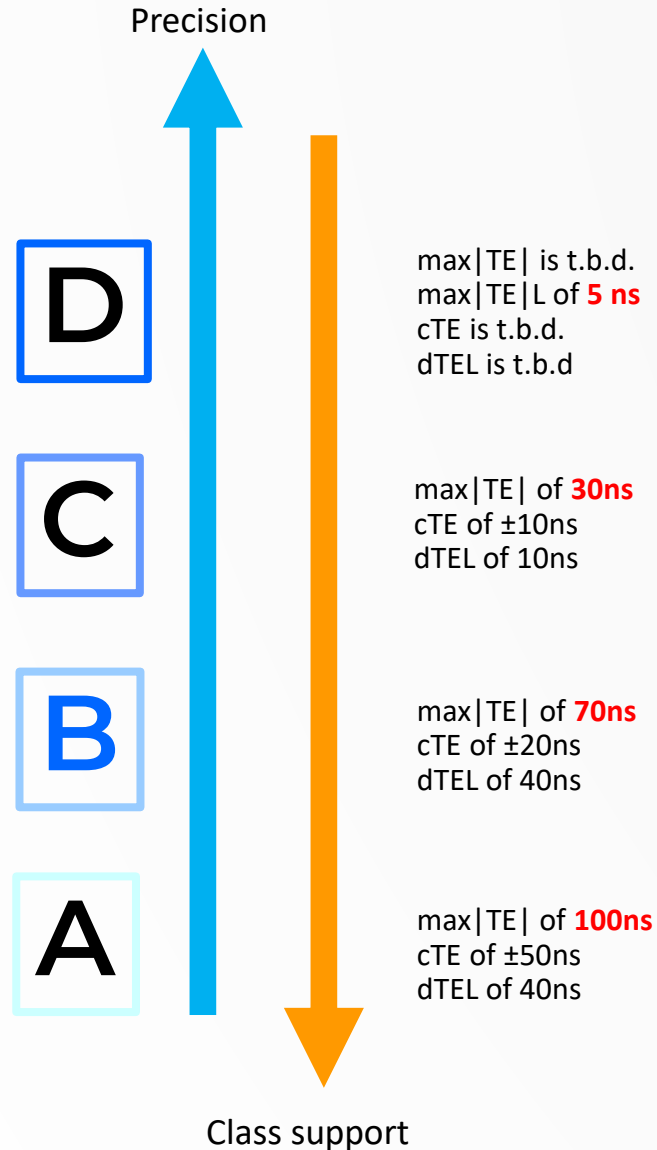


● High availability ●

# Distributed



# CLASS A, B, C, D



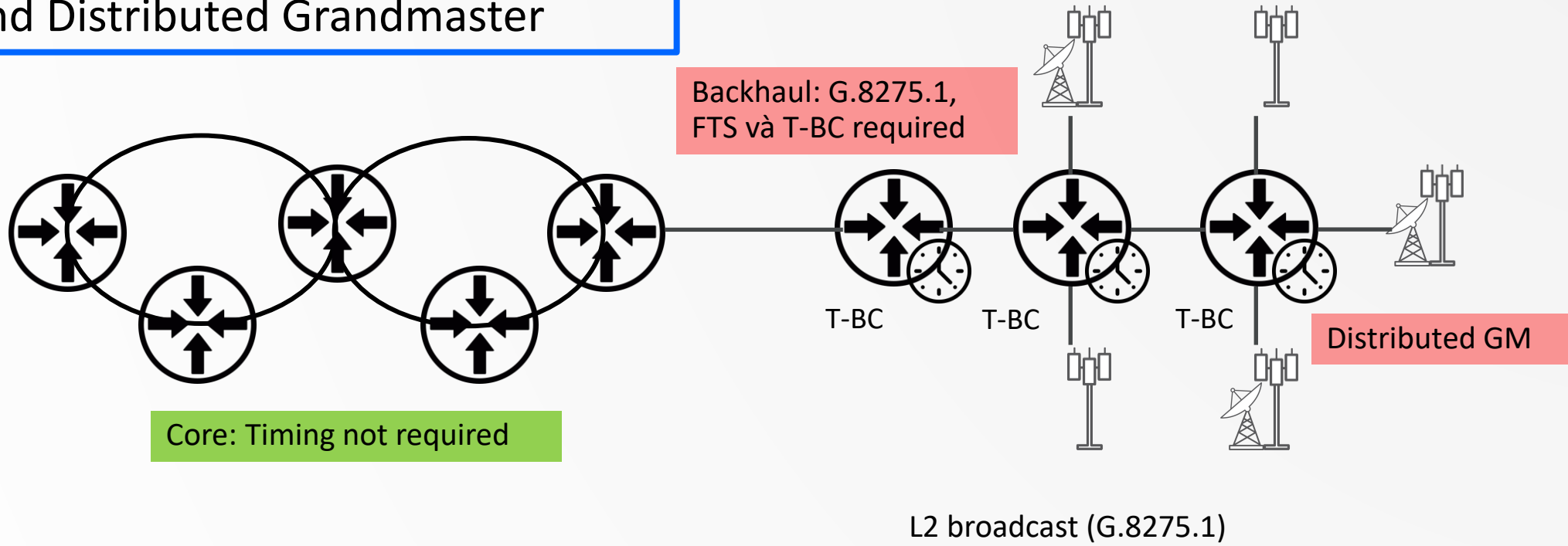
MPC type	MIC type / Ports	Time stamping	Profiles	Sync-E	Performance
MX80-P/T	1 and 10 ports	HW time-stamping + PDV comp. in PFE	IEEE1588	Yes	+/-100 ns (ideal) +/- 1 us (w.c.)
MPC1/2/3/4	1, 10, 40 and 100G	HW time-stamping + PDV comp. in PFE	IEEE1588	Yes	+/-100 ns (ideal) +/- 1 us (w.c.)
NG-MPC2/3	10x10GE, 2x10GE, 100G ports	FPGA time-stamping + PDV comp. in PFE	G.8275.1, G.8275.1 Enh, IEEE1588	Yes	+/-100 ns (ideal) +/- 1 us (w.c.)
NG-MPC2/3	20x1GE E/EH MIC	PHY time-stamping	G.8275.1, G.8275.1 Enh, IEEE1588	Yes	Class-B metrics
MPC5/6	10G and 100G ports, no support on 40G ports	PHY time-stamping	G.8275.1, G.8275.1 Enh, IEEE1588	Yes	Class-B metrics
MPC7/8/9	10G, 40G, 100G	MAC time-stamping	G.8275.1, G.8275.1 Enh, IEEE1588	Yes	Class-B metrics
MPC10	10G...400G	MAC time-stamping	Roadmap	Yes	Target Class-B
MX104	1 and 10 ports	PHY time-stamping	G.8275.1, G.8275.1 Enh, IEEE1588	Yes	Class-B metrics
MX204 & MX10003	10G, 40G, 100G	MAC time-stamping	G.8275.1, G.8275.1 Enh, IEEE1588	Yes	Class-B metrics
MX10K LC2101	1G, 10G, 40G and 100G	MAC time-stamping	G.8275.1, G.8275.1 Enh, IEEE1588 (all roadmap 1H20)	Yes	Target Class-B

Hardware	BITS/DTI (J.211)* 2 x RJ45	GPS: 10MHz(in/out), 1PPS (in/out**), TOD  ToD - RJ45; 1PPS & 10MHz - RF1.0/2.3	SyncE <i>cXR/eXR</i>	1588/PTP (Default & G.8265.1)  <i>cXR/eXR</i>	1588/PTP (G.8275.1 & G.8275.2)  <i>cXR/eXR</i>	1588/PTP G.8273.2  <i>cXR/eXR</i>
A9K-RSP440-TR/SE	FCS	FCS	4.3.4/-	4.3.4/-	-/-	-/-
ASR-9900-RP-TR/SE (RP1 for 9912/9922, 4.3.2)	FCS	FCS	4.3.4/-	4.3.4/-	-/-	-/-
A9K-RSP880-TR/SE	FCS	FCS	5.3.0/6.1.1	5.3.3/6.4.1	6.2.1/6.4.1	6.2.1/6.4.1
A9K-RSP880-LT-SE/TR	FCS	FCS	6.2.2/6.4.1	6.2.2/6.4.1	6.2.2/6.4.1	6.4.1/6.4.1
A99-RP2-TR/SE	FCS	FCS	5.3.0/6.4.1	5.3.0/6.4.1	6.2.1/6.4.1	-/-
A99-RP3-TR/SE	FCS	FCS	-/6.5.15	-/6.5.15	-/6.5.15	-/6.6.1



# SYNC ARCHITECTURE MODELS

## FTS and Distributed Grandmaster



GNSS jamming, line of sight issues  
GNSS CAPEX

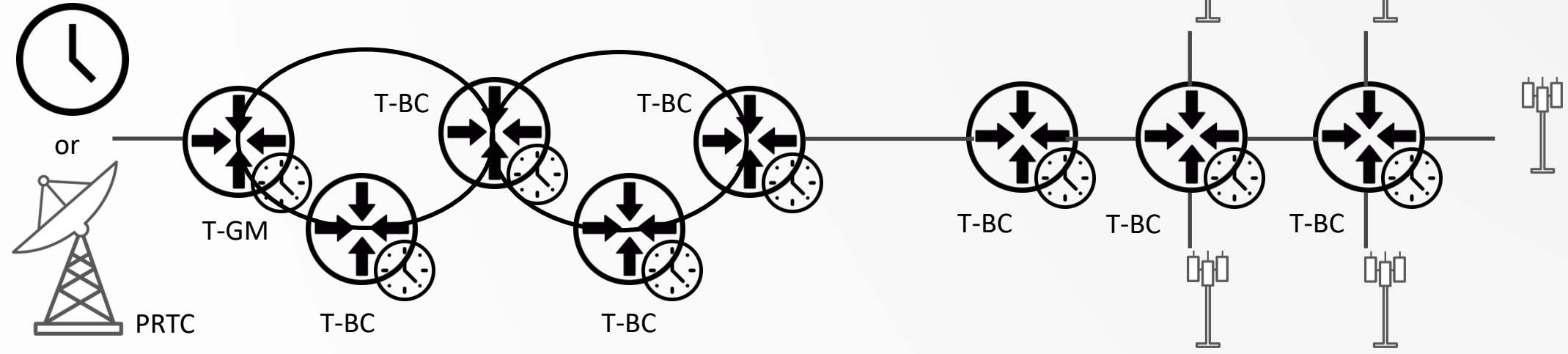
Option

1



No GNSS required at cell site

## FTS and Centralized Grandmaster



Centralized GM

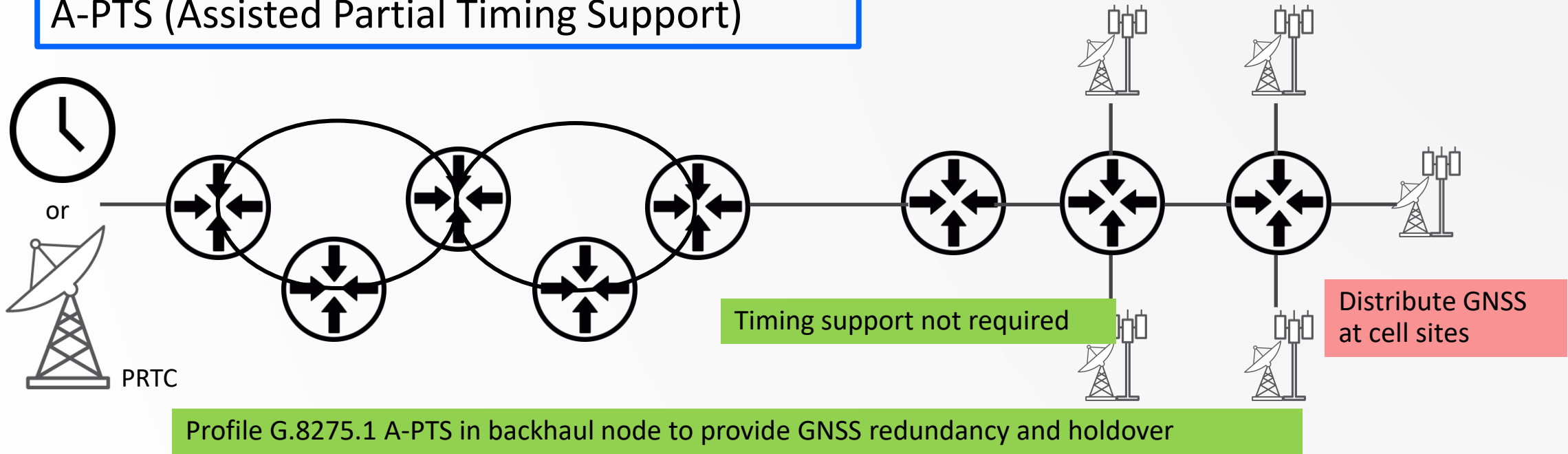
All network nodes must support G.8275.1 FTS và T-BC

Tech specs for Network devices

Option **2**



## A-PTS (Assisted Partial Timing Support)



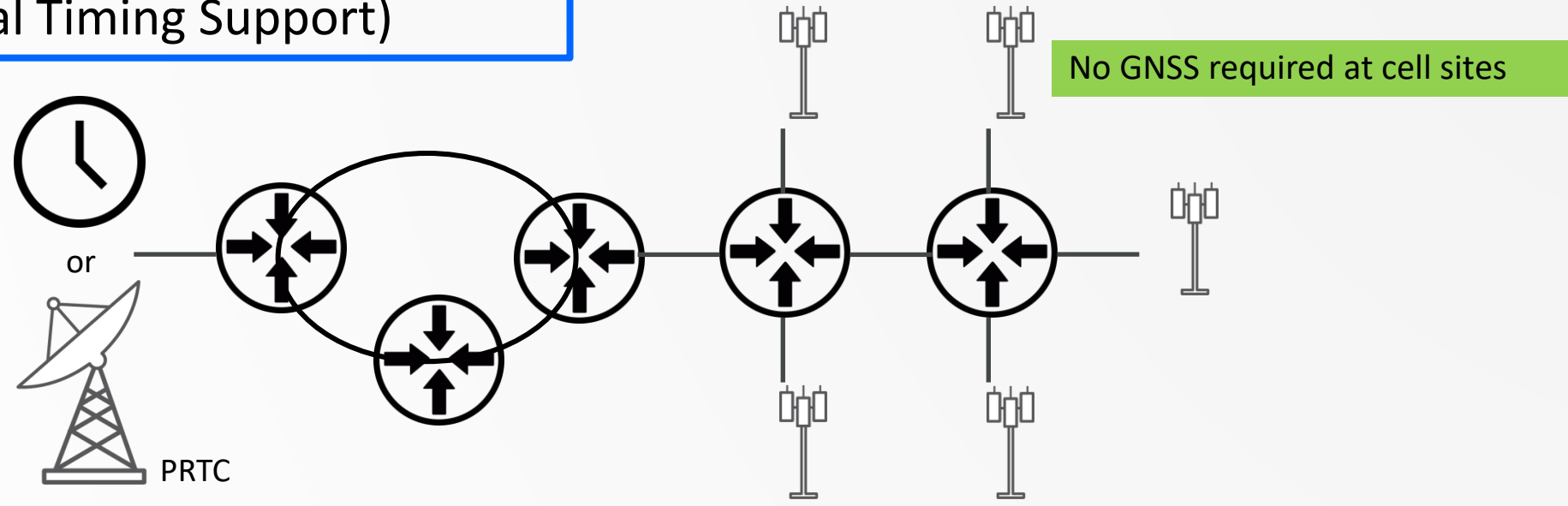
L3 Unicast (G.8275.2)

For GNSS redundancy and holdover

Option **3**



## PTS (Partial Timing Support)



Network devices without PTP support

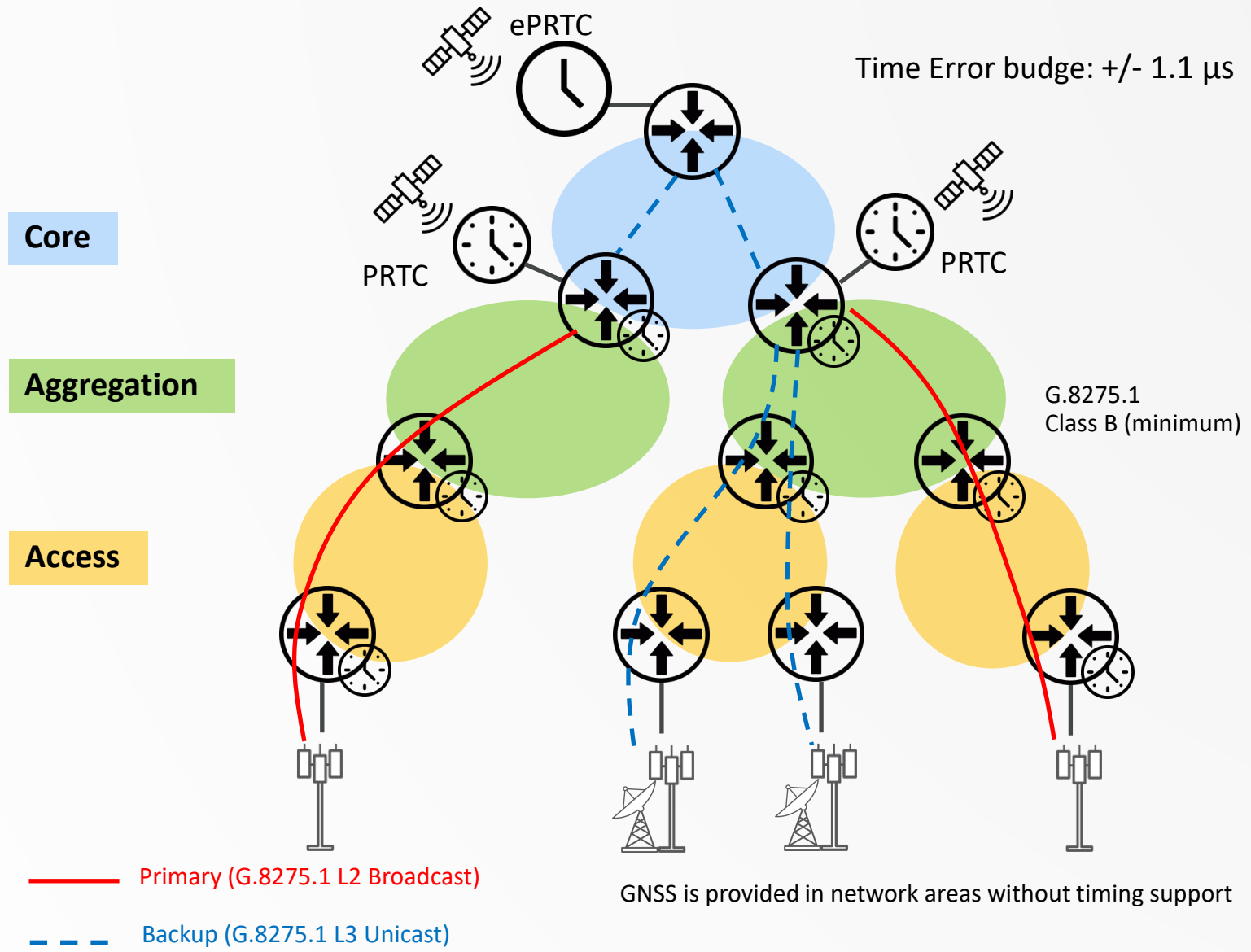
L3 Unicast (G.8275.2)

Limited number of hops

Option **4**



# VNPT'S MODEL





# Q & A