SYNC OVER PACKET FOR 5G ERA

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UTSTARCOM – A GLOBAL TELECOM INFRASTRUCTURE PROVIDER

- Founded in 1991, started trading on NASDAQ in 2000 (UTSI)
- Operating entities in Hong Kong; Tokyo, Japan; San Jose, USA; Delhi and Bangalore, India; Hangzhou, China
- Strong customer base, multiple deployments for tier 1 operators worldwide

Focus on delivering innovative cutting-edge, packet optical transport, synchronization, wireless and fixed broadband access products and solutions coupled with carrier grade Software Defined Networking (SDN) platform

5G SYNC REQUIREMENTS

UTSTARCOM®

3GPP TS 38.133 V15.3.0 (2018-10):

Cell phase synchronization accuracy	**3 µs → ±1.5µs**

At antenna/ TAB port

3GPP TS 38.104 V15.3.0 (2018-10):

Synchronization applications	**TAE per BS Type**			
	1-C (FR1)	**1-H (FR1)**	**1-O (FR1)**	**2-O (FR2)**
MIMO or TX diversity transmissions, at each carrier frequency	65 ns	65ns	65ns	65ns
Intra-band contiguous carrier aggregation	**260ns**	**260ns**	**260ns**	**130ns**
Intra-band non-contiguous carrier aggregation	**3µs**	**3µs**	**3µs**	**3µs**
Inter-band carrier aggregation	**3µs**	**3µs**	**3µs**	**3µs**

TBD:

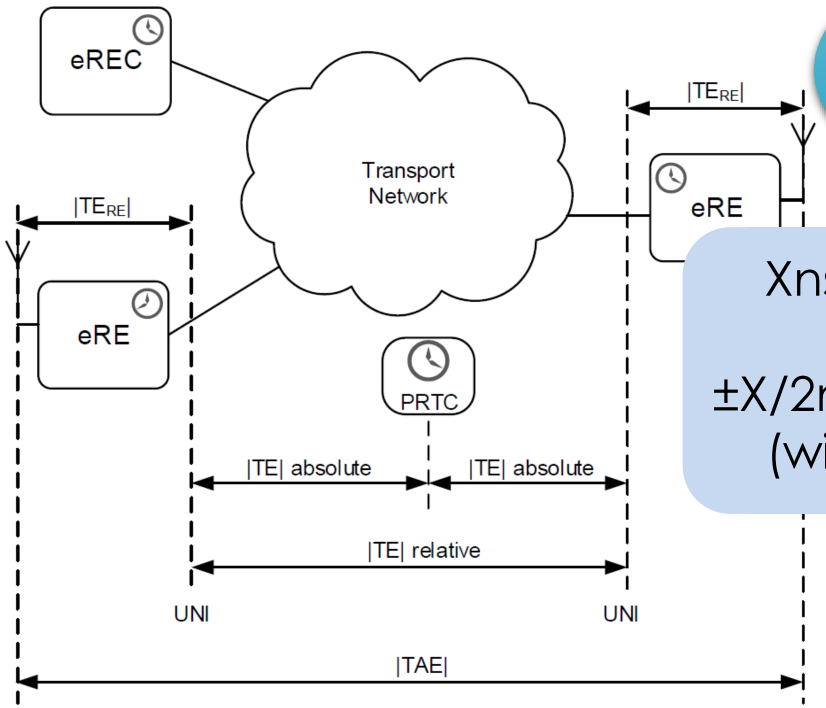
Synchronization accuracy requirements for CoMP, positioning, supplementary uplink etc. - TDB

ITU-T Transport network support of IMT-2020/5G GSTR-TN5G (2018-02):

…studies are ongoing on the feasibility of solutions targeting end-to-end time synchronization requirements (absolute or relative) on the order of **+/- 100 ns to +/- 300 ns** to address specific applications or potential future requirements…

5G TRANSPORT SYNC REQUIREMENTS
(Just an example)

eCPRI Transport Network V1.2 (2018-06-25):



At Network Interface

Xns relative
OR
±X/2ns absolute
(with PRTC)

Category (note 1)	Time error requirements at UNI, |TE|			3GPP Time alignment error (TAE) requirements at antenna ports
	Case 1 (note 2)		Case 2 (note 3)	
	Case 1.1 (note 4)	Case 1.2 (note 5)		
A+	N.A.	N.A.	20 ns (relative)	65 ns (note 6)
A	N.A.	60 ns (relative) (note 7)	70 ns (relative)	130 ns (note 6)
B	100ns (relative) (note 7)	190 ns (relative) (note 7)	200 ns (relative)	260 ns (note 6)
C (note 8)	1100 ns (absolute) (note 9)		1100 ns (absolute) (note 9)	3 us (note 6) (note 10)

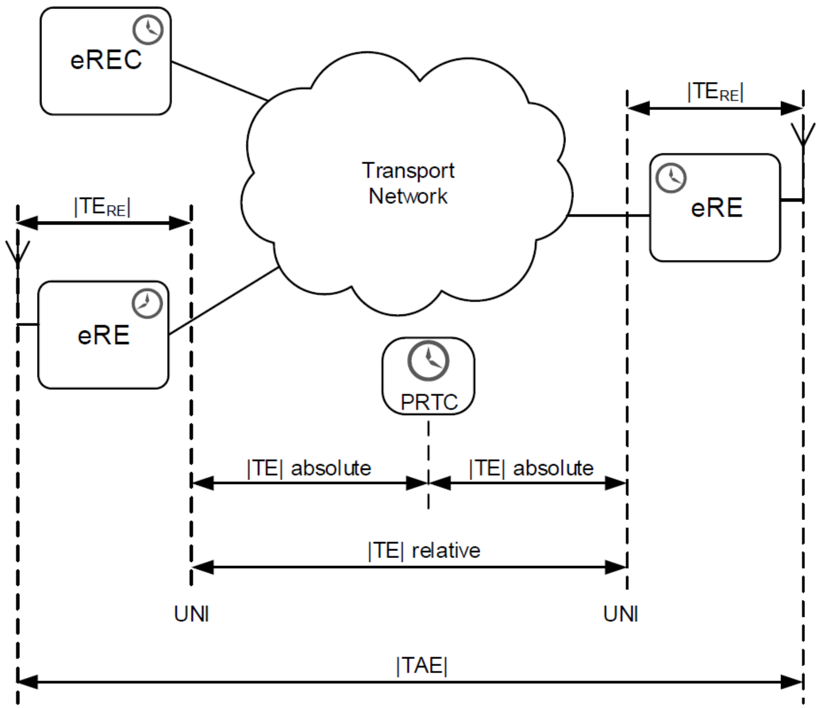
Per G.8271.1at the reference point C max|TE|≤1100ns, or TE ≤±1100ns

T-TSC is integrated into eRE

T-TSC is not integrated into eRE

5G TRANSPORT SYNC REQUIREMENTS
(Just an example)

eCPRI Transport Network V1.2 (2018-06-25):



3GPP feature	RAN	
	LTE	NR
MIMO or TX-diversity transmission	Category A+	Category A+
Intra-band contiguous carrier aggregation	Category A	BS Type 1: Category B BS Type 2: Category A
Intra-band non-contiguous carrier aggregation	Category B	Category C
Inter-band carrier aggregation	Category B	Category C
TDD	Category C	Category C
Dual Connectivity	Category C	Category C
COMP	Not specified in 3GPP	Not ready in 3GPP
Supplementary Uplink	Not applicable for LTE	Not ready in 3GPP
In-band Spectrum Sharing	Not ready in 3GPP	Not ready in 3GPP
Positioning	Not specified in 3GPP	Not ready in 3GPP
MBSFN	Not specified in 3GPP	Not ready in 3GPP

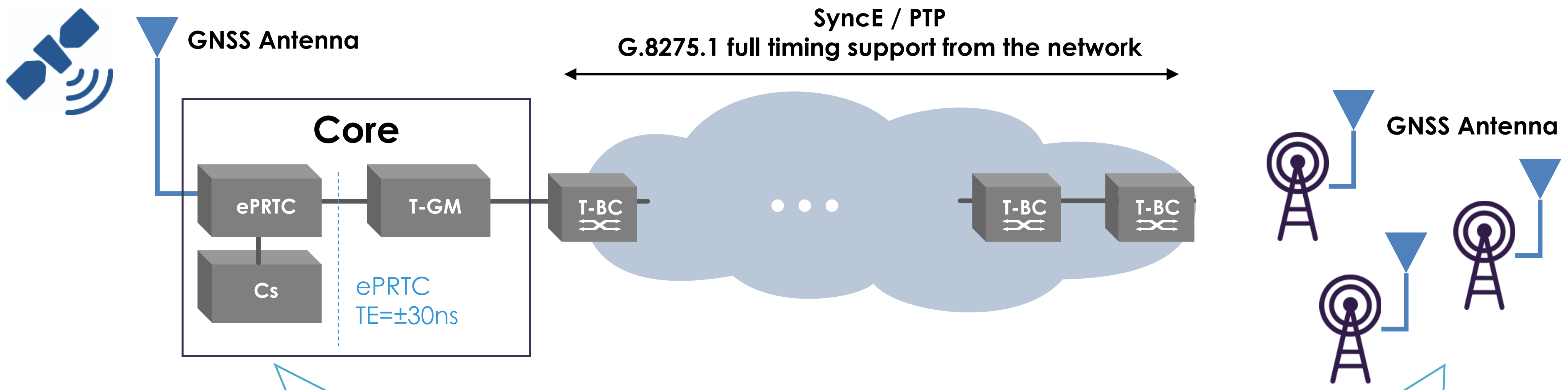
SYNCHRONIZATION CHALLENGES

- **Provide required sync accuracy**
  - Heterogeneous networks, different performance of network devices, different technologies, complex to guarantee consistent sync performance
  - The best performance is while using on-path sync support in every node (TC/BC) – not always the case
- **Provide it cost efficiently**
- **Guarantee high availability**
- **Meet different sync requirements from vertical applications**
- **Align with other trends in modern and emerging networks including 5G (network slicing, virtualization, XaaS etc.)**




TIMING ARCHITECTURE

Traditional architecture for 3G/4G



Central ePRTC –
a primary timing source

- Requires full on-path support from the network with T-BC Class C (?)
- Limited number of hops
- Transport network complexity

OR

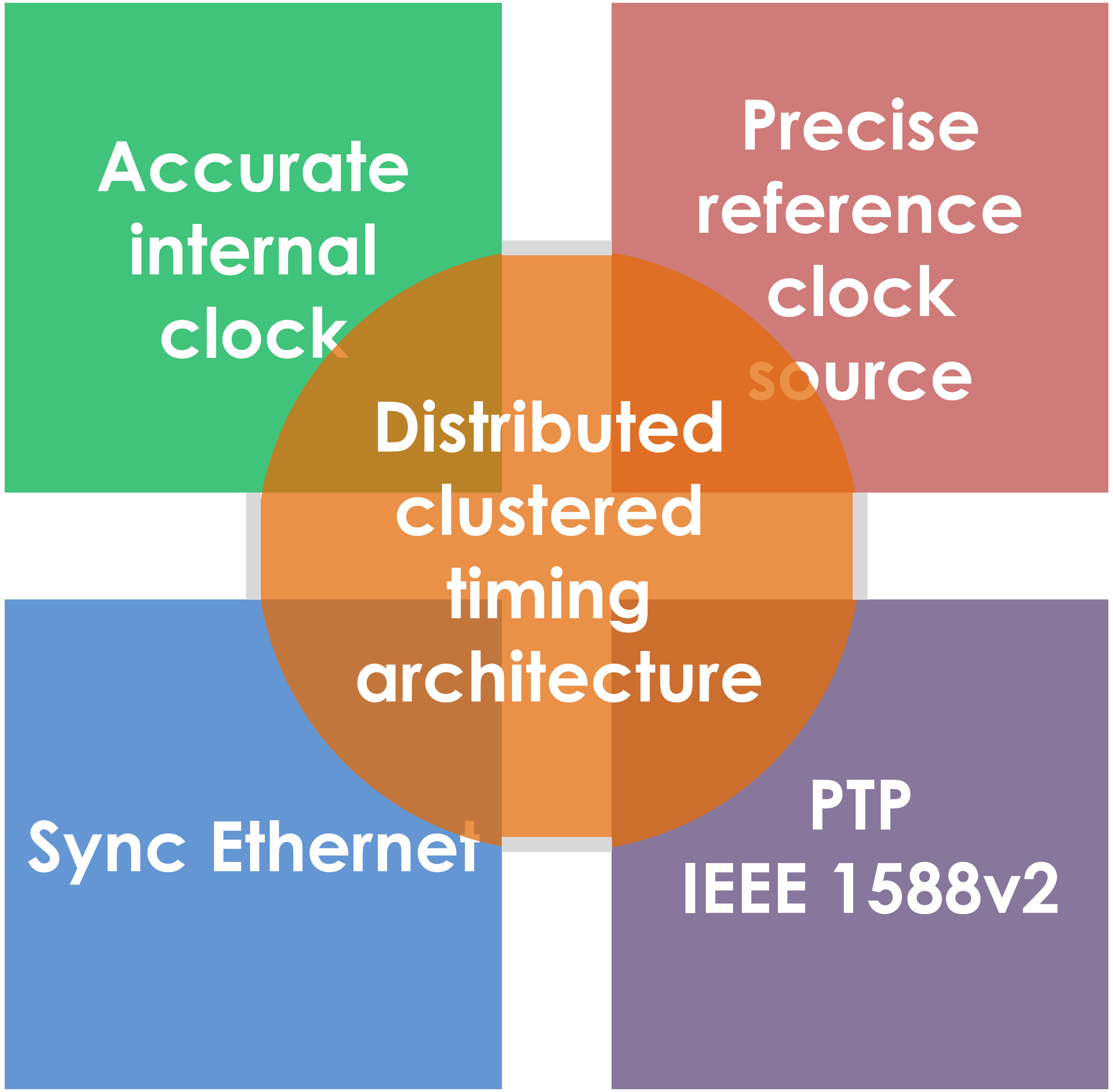
Distributed –
GNSS receiver @ every BS

- Small cell challenge
- High cost
- Limits site acquisition options
- Adds to installation and maintenance complexity

BUILDING BLOCKS

Accurate internal clock for reliable holdover operation

GNSS feeding a Grand Master, Atomic PRC/PRS

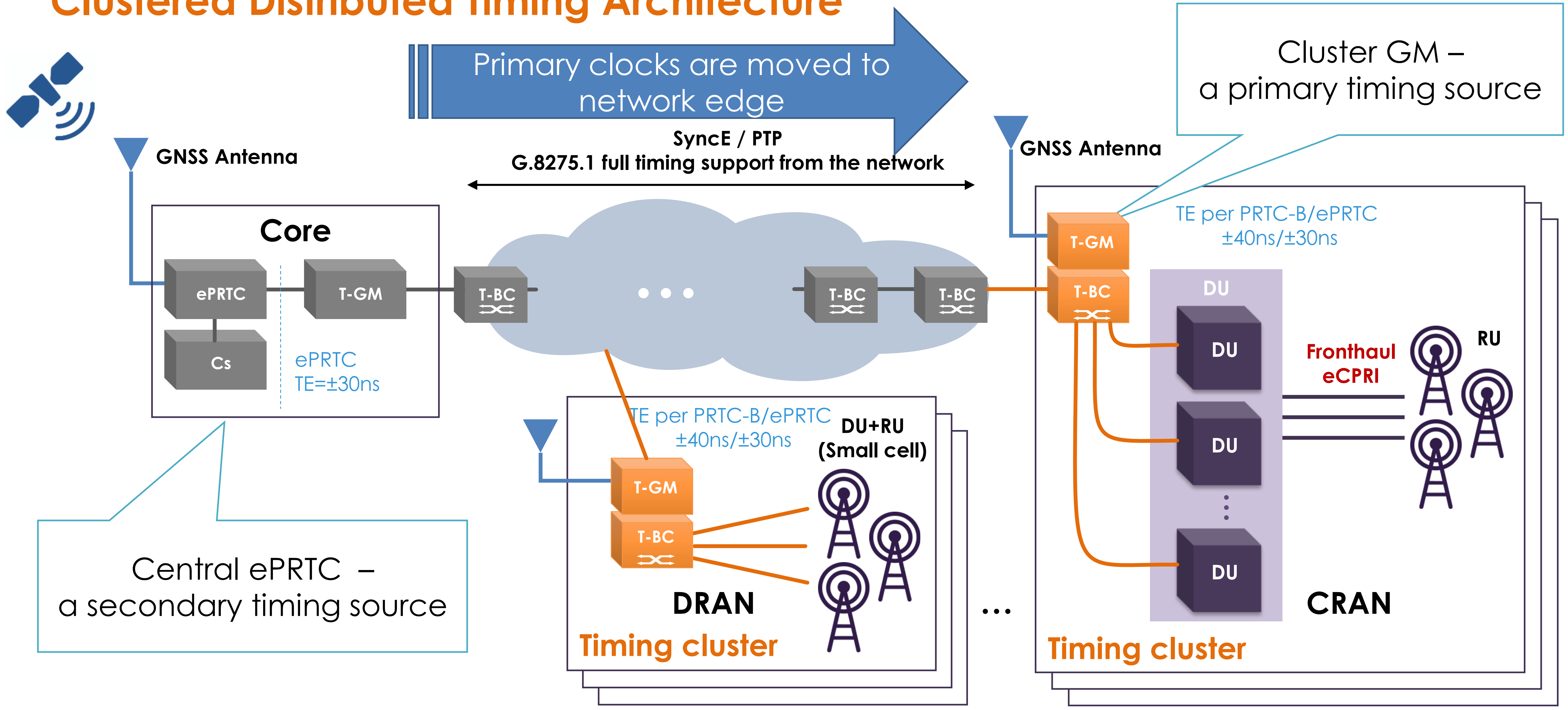


Accurate network-based frequency synchronization

Precise network-based frequency/ phase/ time synchronization

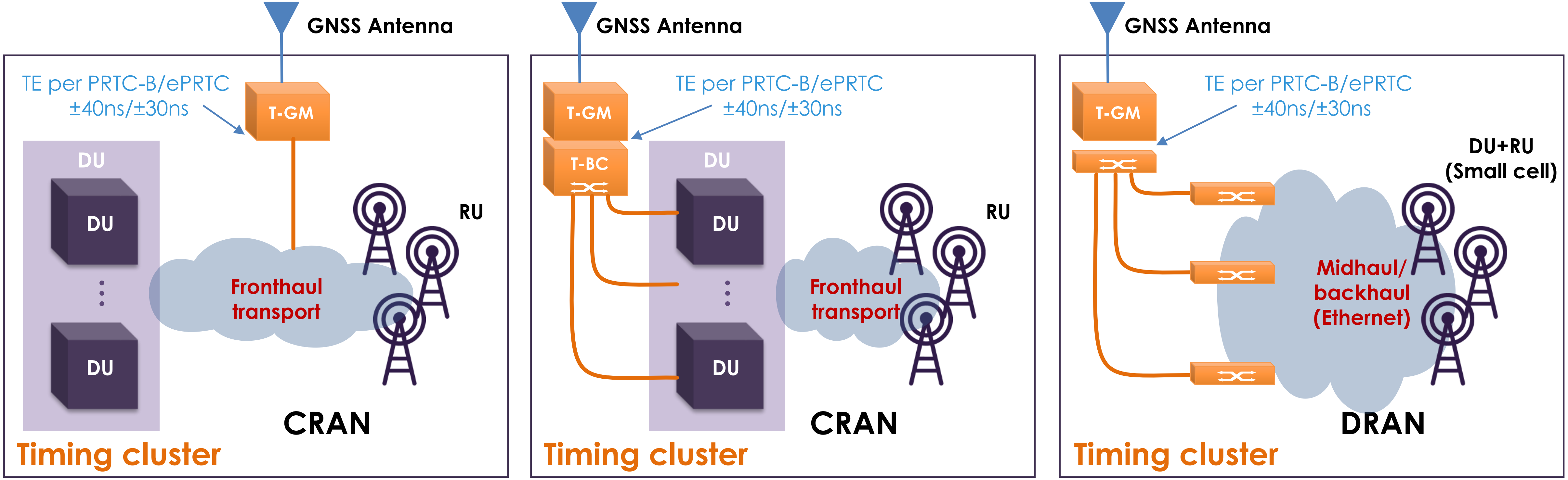
TIMING ARCHITECTURE

Clustered Distributed Timing Architecture



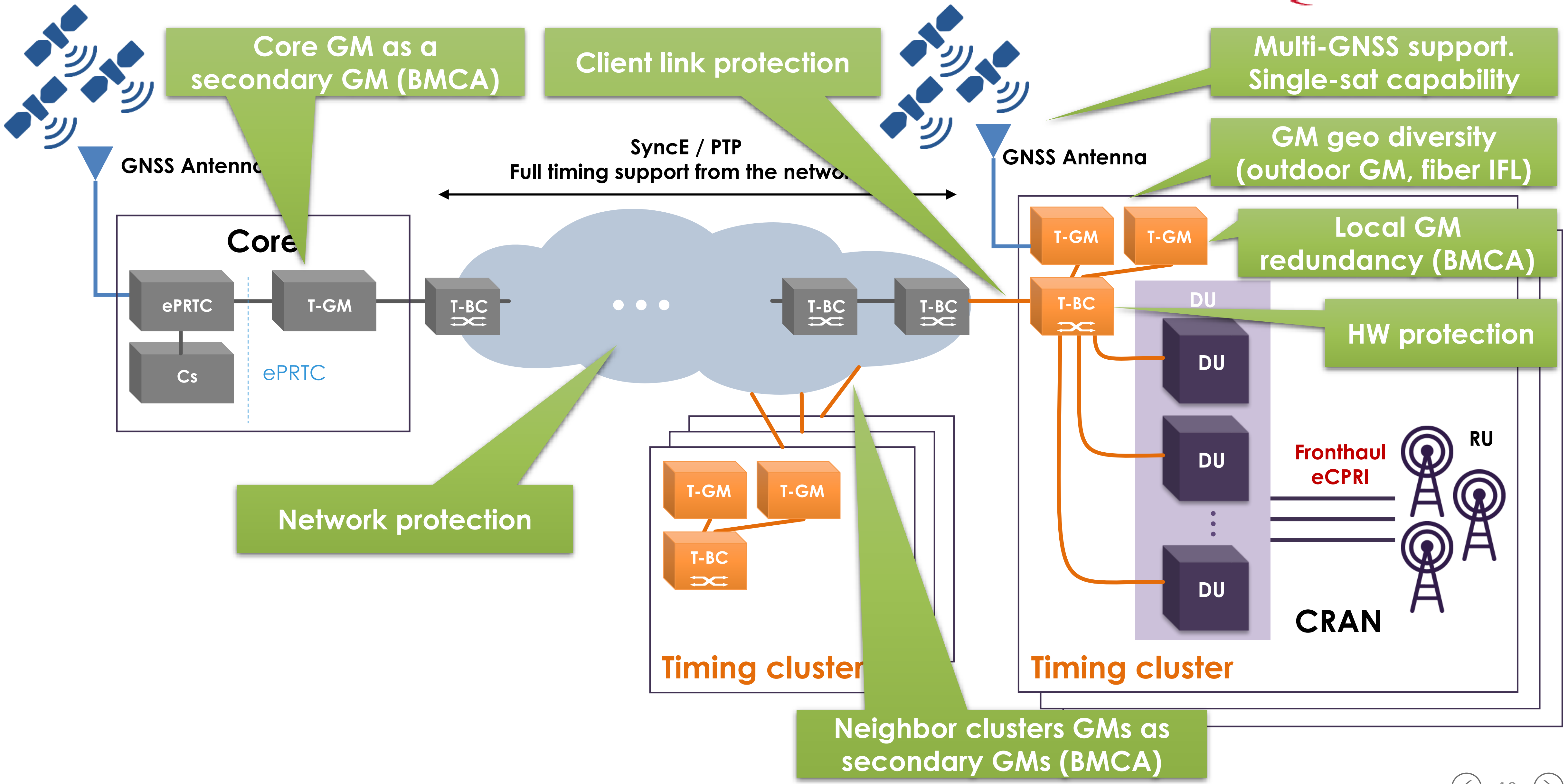
TIMING ARCHITECTURE

Clustered Distributed Timing Architecture – Some scenarios



- Max accuracy (x10-x100ns)
- Very high accuracy (x100ns)
- High accuracy (x100ns…<±1.5μs)
- High cost efficiency
- Mass small cell deployment

HIGH SYNC AVAILABILITY



GM FOR CLUSTERED DISTRIBUTED ARCH.

- **High accuracy (TE) of GM at network edge <u>is important</u>** to achieve the performance and spectrum efficiency of 5G network, i.e. TE per PRTC-B/ePRTC
- **Extra high holdover performance** (e.g. ePRTC level: ±100ns within 14-day period) normally **<u>will not be required</u>** at network edge:
  1. Clustered distributed architecture provides very high availability of accurate clock. Probability of holdover operation gets low.
  2. Sync accuracy better than ±1.5µs (e.g. 260ns) is required for certain scenarios and extended features (CA, etc.). So, if holdover mode can provide accuracy within ±1.5µs at BS antenna ports, it should be enough to ensure basic 5G network operation during holdover.
- **Also**: Cost efficiency, deployment flexibility, performance monitoring, management, etc.

TE (locked): ≤ ±30ns/40ns

Holdover: ± 1.1us/24h

GM FOR CLUSTERED DISTRIBUTED ARCH.

Concurrent GNSS multi-system / multi-frequency

High-grade OCXO

Sync Ethernet

PTP IEEE 1588v2

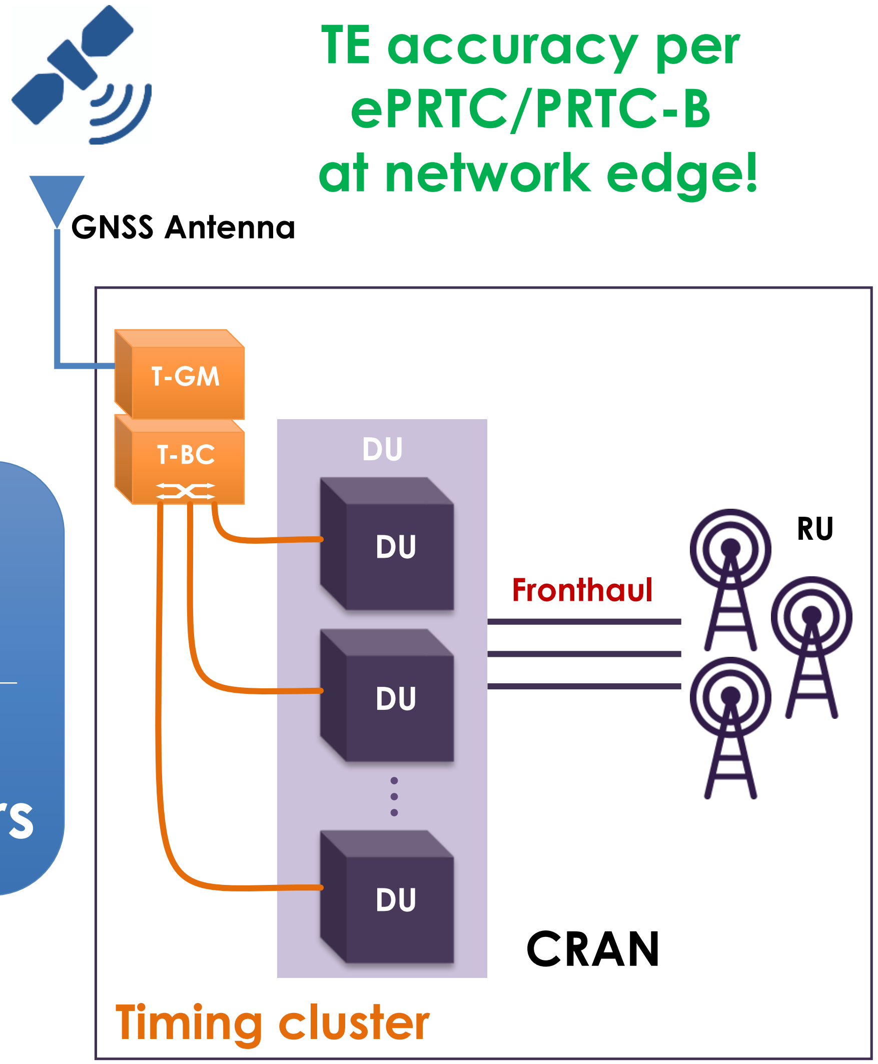
Outdoor deployment

Performance monitoring and management

TE (locked): ≤ ±30ns/40ns

Holdover: ± 1.1us/24hours

TE accuracy per ePRTC/PRTC-B at network edge!



GM FOR CLUSTERED DISTRIBUTED ARCH.

UTSTARCOM®

Concurrent GNSS multi-system / multi-frequency

High-grade OCXO

Concurrent Multi-system GNSS Receiver

- E.g. GPS, GLONASS, BDS, Galileo, QZSS
- Supports several systems concurrently
- Multiple frequency bands concurrently
- Operates with as few as a single satellite

ADVANTAGES:

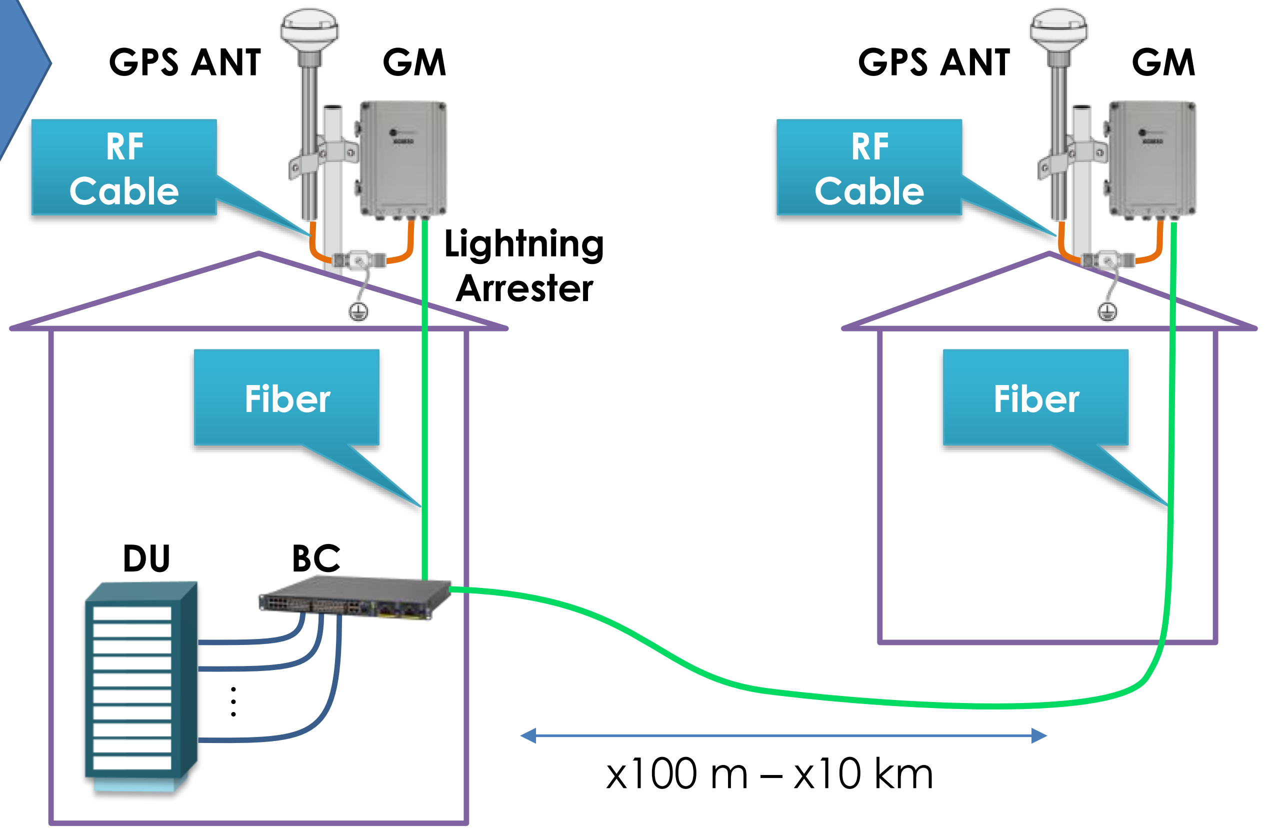
- ✓ Achieves higher timing accuracy with increased number of available satellites (compared to a GPS-only receiver)
- ✓ Improves success rate of timing locking
- ✓ Better stability and reliability in a complex electromagnetic environment
- ✓ Better protection against GNSS signal spoofing
- ✓ Reliable timing with limited sky view (down to 1 sat operation)
- ✓ Improved overall availability

OUTDOOR DESIGN GRAND MASTER

ADVANTAGES:

- ✓ Resolves issues and limitations of RF cable
- ✓ Short RF cable, predictable performance, easy delay compensation
- ✓ Easier site acquisition with fiber IFL
- ✓ Great flexibility in deployment options
- ✓ Reduced risks of damaging indoor equipment due to a lightning strike thanks to fiber IFL
- ✓ Improved availability with geographically distributed main and redundant GM

Local **OR** Remote
(OR both for redundancy)



Outdoor deployment

Performance monitoring and management

UTSTARCOM®

Thank you !