

The logo consists of the letters 'UT' in a bold, white, sans-serif font, centered within a red circle. The background of the slide is a dynamic, abstract composition of blue and orange light streaks, suggesting motion and technology.

UT

Addressing synchronization challenges in modern mobile networks

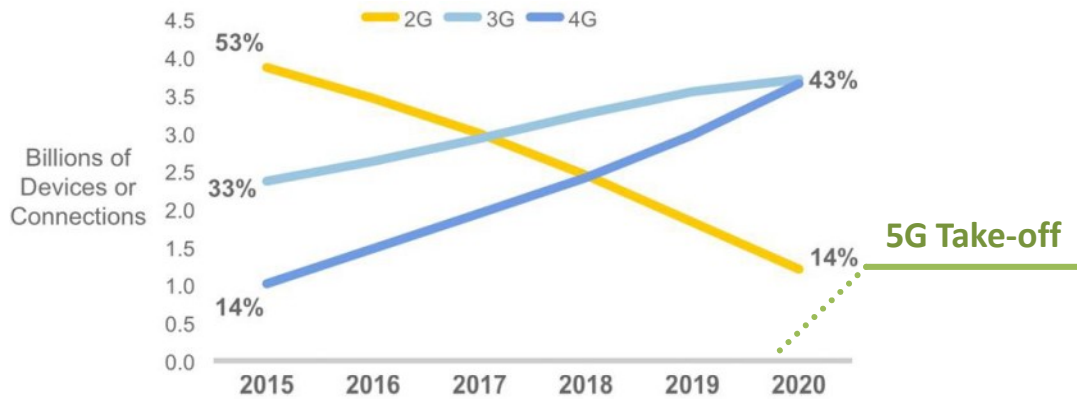
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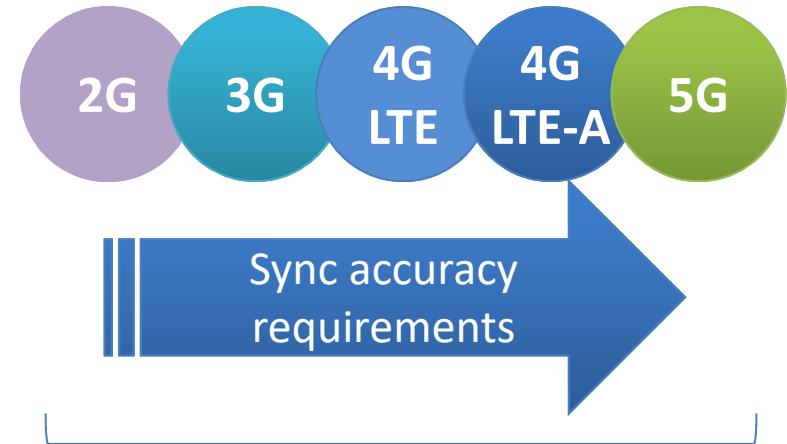


Synchronization requirements in mobile networks



Global Mobile Devices (Excluding M2M) by 2G, 3G, and 4G*

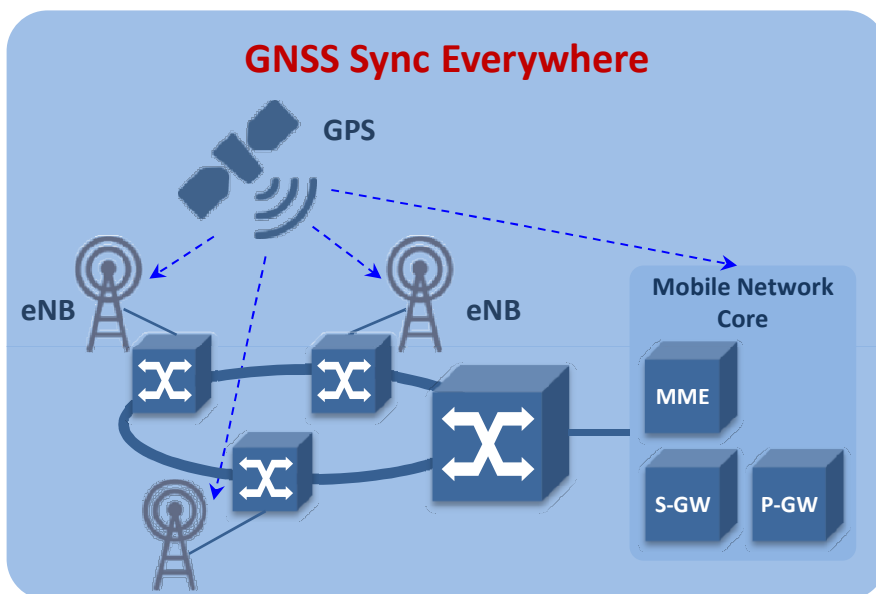
* Source: Cisco VNI Mobile, 2016



A mix of different requirements coexists

Standard	Frequency Sync	Phase/Time Sync
GSM	Radio Interface: ±50ppb (Wide area BS) ±100ppb (Local area BS) ±250ppb (Home BS). BS backhaul interface: ±16ppb	N/A
TD-CDMA, CDMA2000		±1.5µs
LTE-FDD		N/A
LTE-TDD		±1.5µs (small cell R<3km), ±5µs (large cell R>3km)
LTE-A		±0.5 to ±1.5µs
5G		±260ns to ±1.5µs

Traditional synchronization based on GNSS



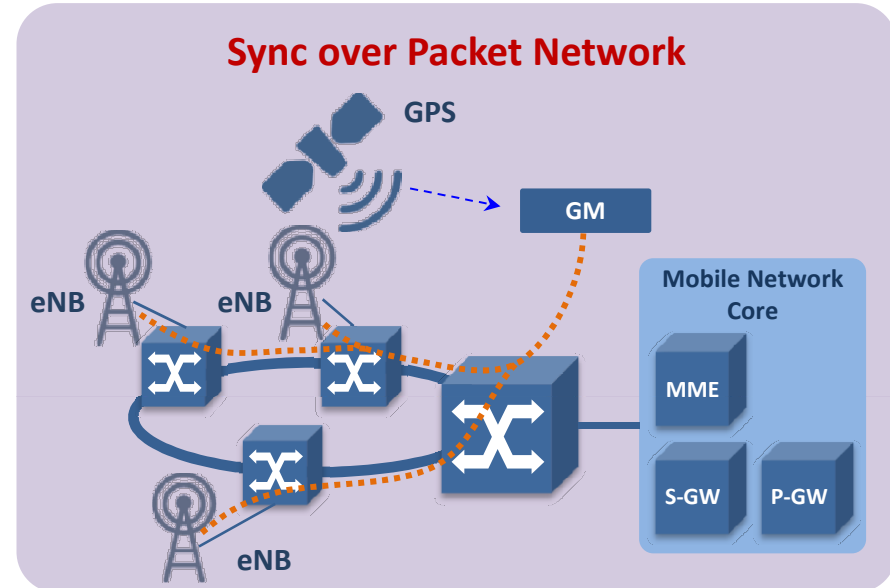
- Each cell site receives clock from GNSS - independently
- Accurate frequency and phase synchronization

BUT

- High cost of installation and maintenance
- No centralized management
- No protection, longer time to restore
- GNSS installation and signal reception in dense urban environment or indoors can be problematic
- Availability issues – antenna/cable vulnerabilities, lack of redundancy, GNSS jamming, GNSS spoofing

Centralized timing architecture

- Each eNodeB receives clock via packet data network
- Accurate frequency and phase/time synchronization between eNodeB and an external reference source
- Can be combined with backhaul network – low additional cost on sync
- Centralized management for all components



SyncE

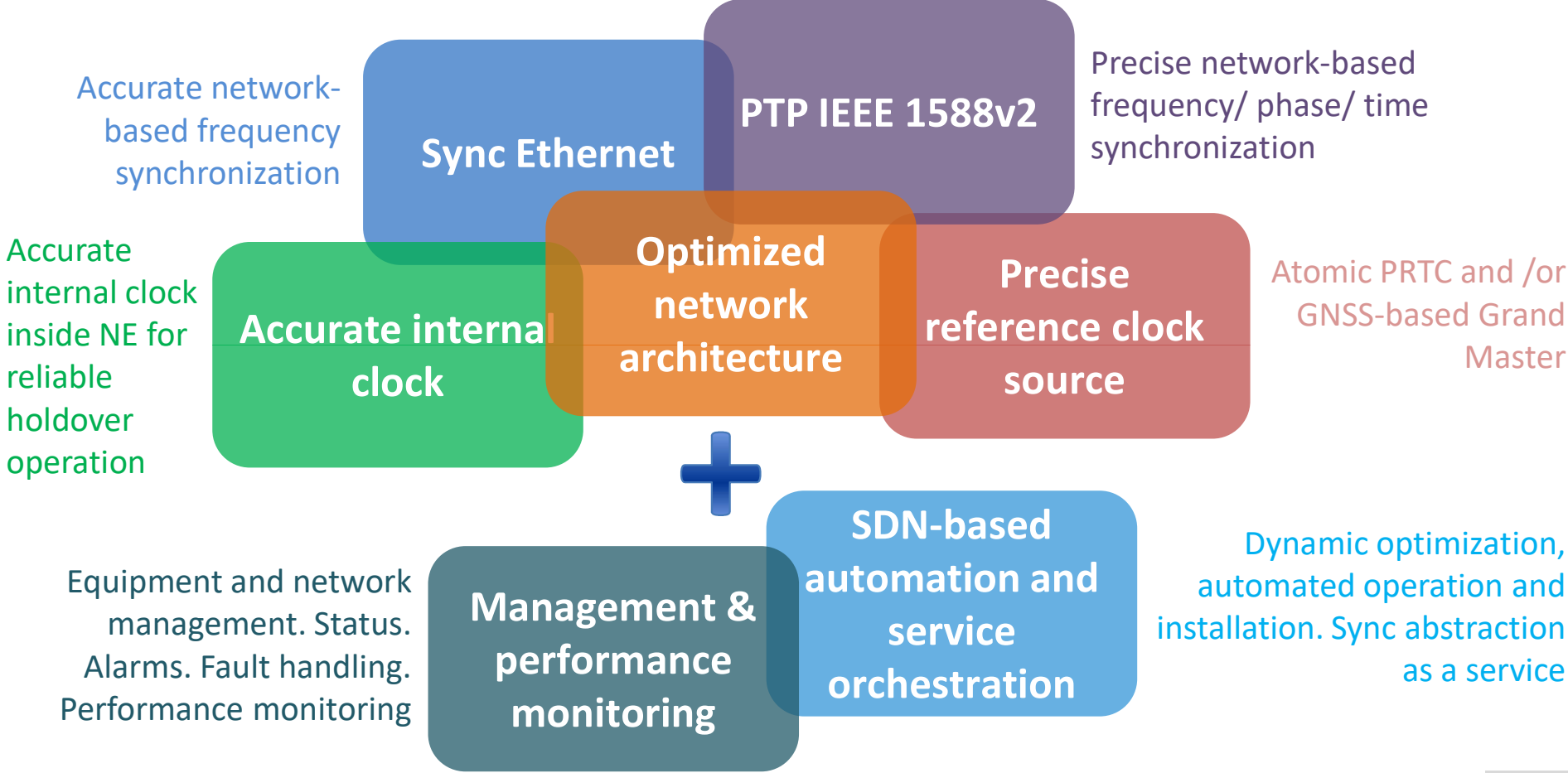
- Frequency sync
- Physical layer
- All network nodes must support SyncE
- G.8261/ G.8262/ G.8264



PTP / IEEE1588v2

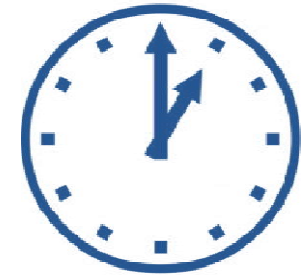
- Frequency and time sync
- L2/L3
- Full or partial network support
- Profiles G.8275.1, G.8275.2; T-GM, T-BC, T-TSC

Optimized “Sync over Packet Network”



Sync over packet networks: Challenges

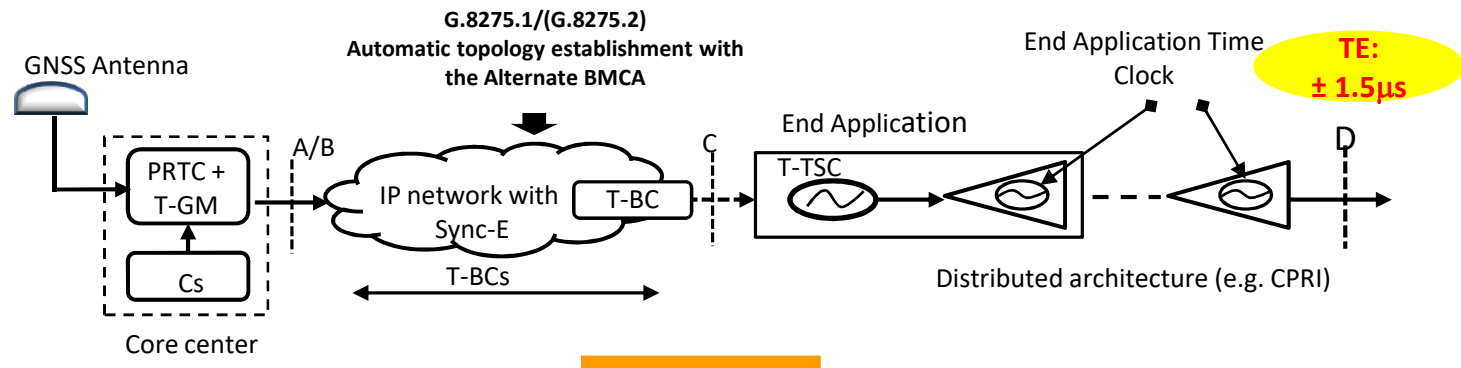
- Provide required sync accuracy
 - Heterogeneous networks, different performance of network devices, different technologies – complex to guarantee consistent sync performance
 - The best performance is while using on-path sync support in every node (TC/BC) – not always the case
 - Limitations of PHY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



Evolution for PTP Sync Network Architecture

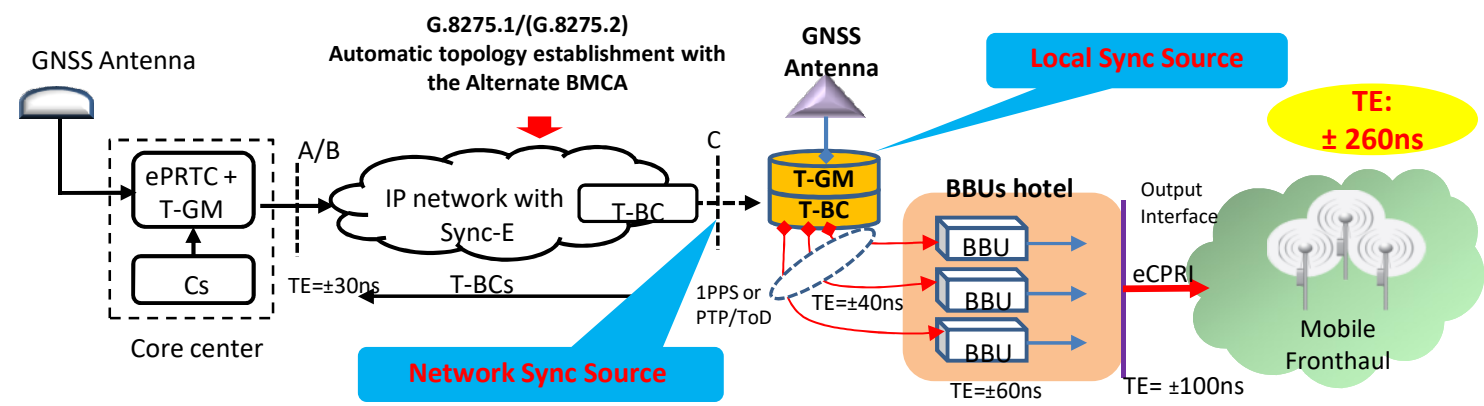


AS IS
Centralized Timing Architecture



Evolution

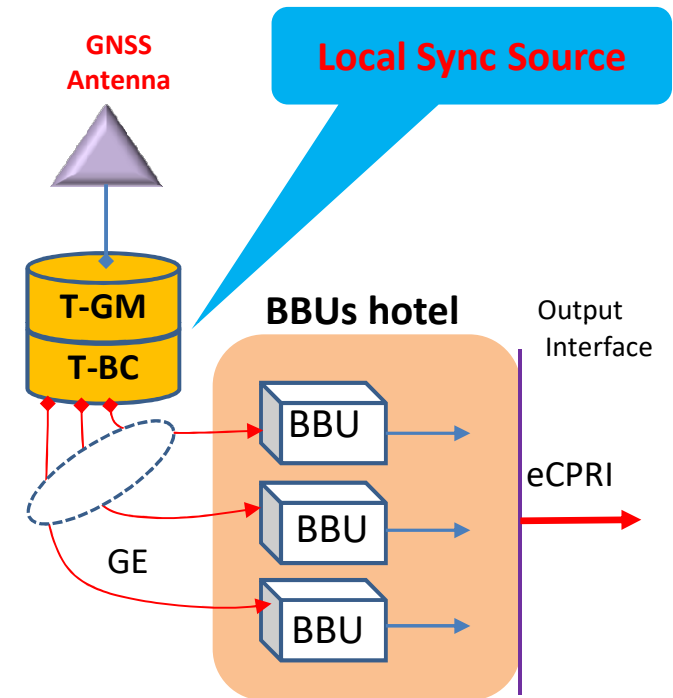
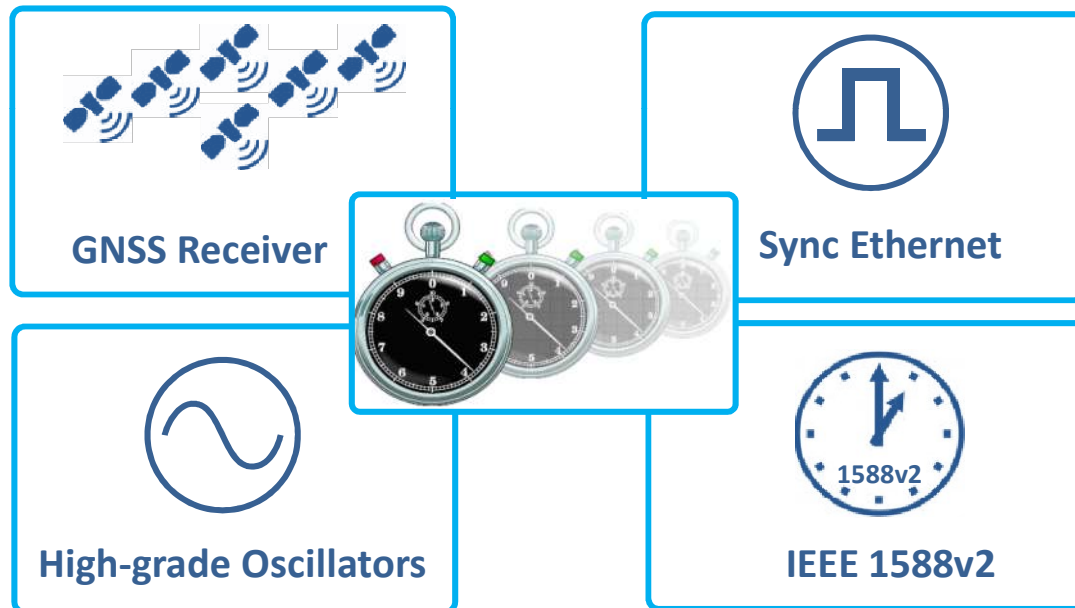
Future
Protected Timing Architecture w/ local sync source



Distributed Sync Scenario

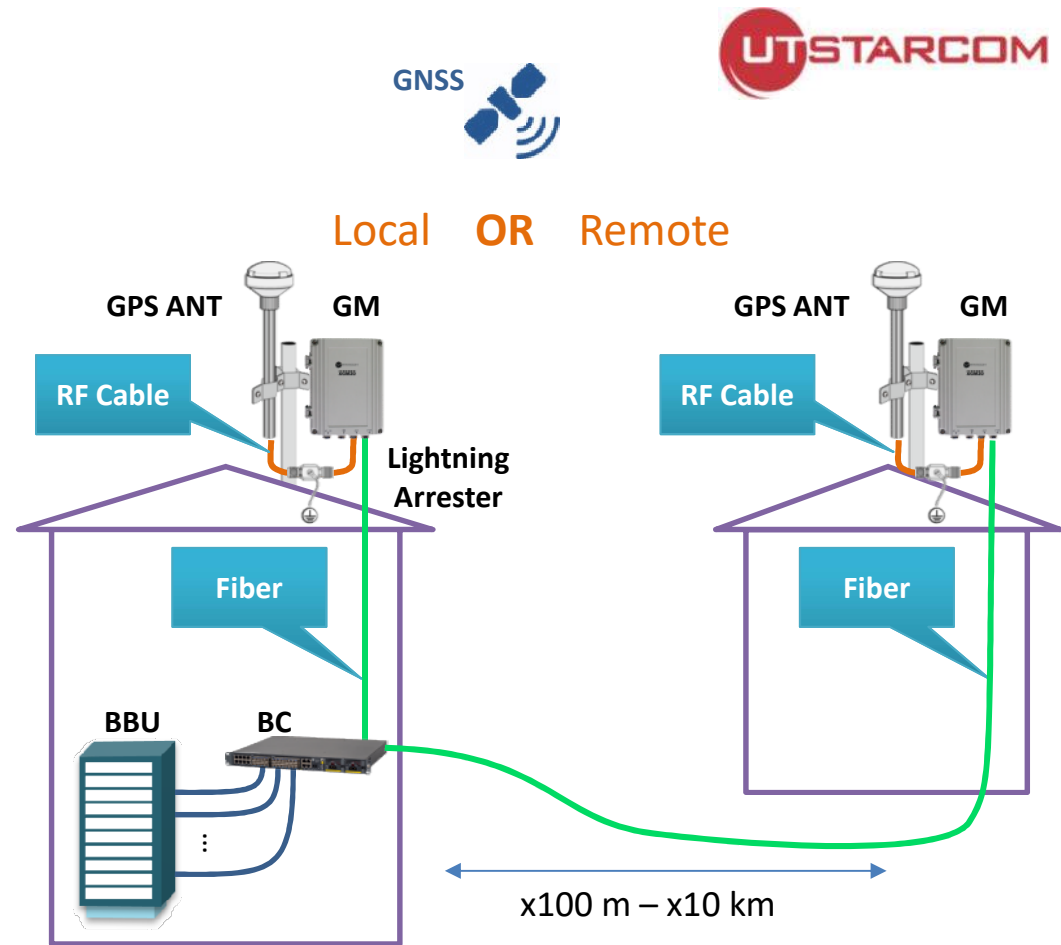
High performance local sync source

- T-GM receive GNSS signal and convert to SyncE +PTP
- T-BC duplicate to multiple 1588v2/PTP feed to BBUs
- T-GM+T-BC with integrated or separated design



Outdoor Design Grand Master

- Designed for distributed sync scenario
- Resolves issues of RF cable
- Short RF cable, predictable performance, easy delay compensation
- Easier site acquisition
- Great flexibility in deployment options
- Reduced risks of damaging indoor equipment due to a lightning strike



Case Study: Commercial Deployment



- Deployment of distributed sync scenario for LTE mobile network
- One of largest mobile network operators(MNO) in Japan
- Hundreds of sets GM and BC to serve thousands of BBIs
- Enables instant implementation of precise clock/time solution
- Deployment flexibility due to separate BC & outdoor GM
- Centralized network management system (NMS)
- Customer satisfied with clock accuracy and operation experience
- Early adopter



Future Improvements



GNSS Antenna

Core center

ePRTC w/ multiple Cs

IP network with Sync-E

T-BC

T-BCs

FTS w/ T-BC Class C

GLONASS BeiDou GPS Galileo

T-GM

Multi-/Single- GNSS

FPGA

FPGA Assisted 1588v2 PTP/WR Implementation

FPGA

Bi-Directional Optical transceiver supports 2 directions over single fiber

BiDi SFP/SFP+/XFP

High Grade OCXO with Double Oven

OCXO HQ

High Frequency accuracy for Best-in-class Rubidium Clock

Rb Clock

Master Time Slave Time

Sync (t₁)

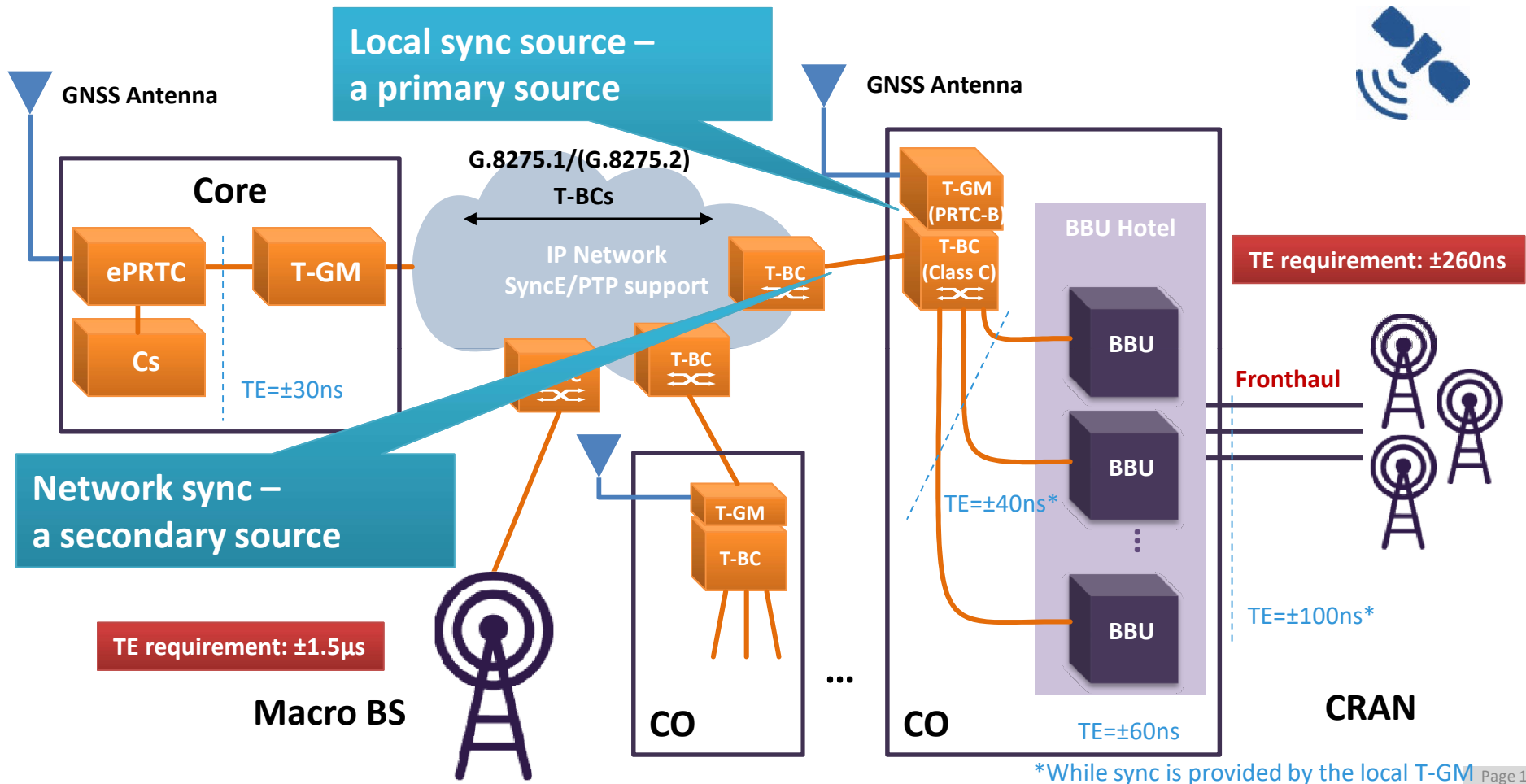
Delay_Req (t₂)

Delay_Resp (t₃)

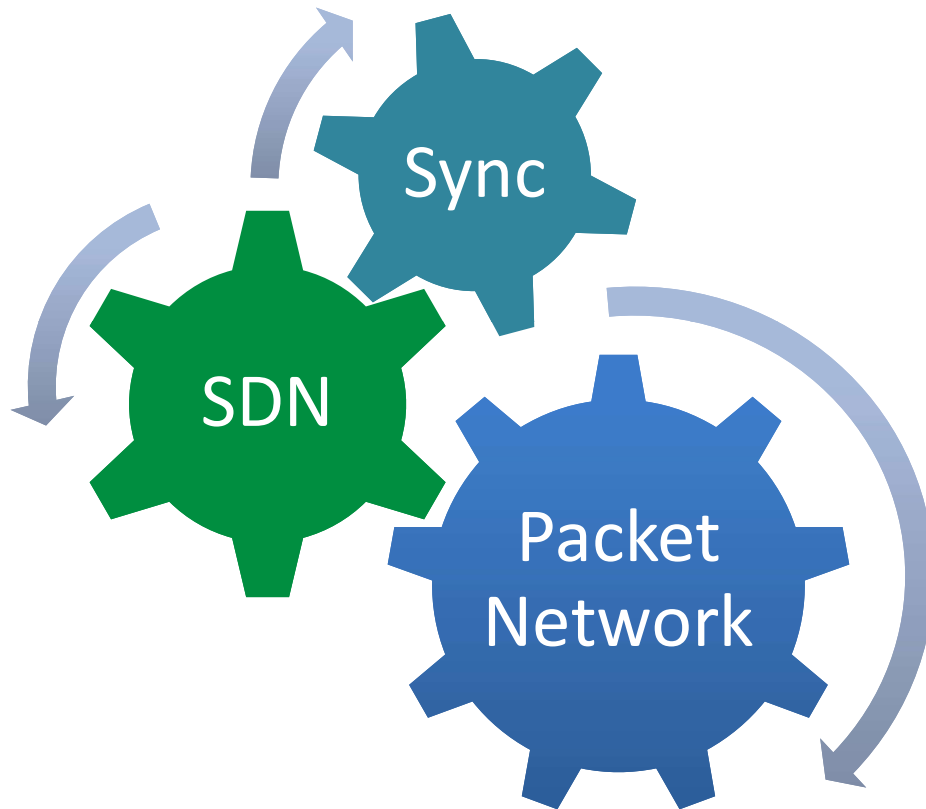
- cTE: Calibrate automatically
- Dynamic TE: Cancel out each other

TE Control

High-accuracy architecture for 5G evolution



Metro Network Ecosystem for sync support and network evolution



Metro network: Packet Network

- Based on MPLS-TP/Carrier Ethernet/SR
- GE/XGE/100GE support, great scalability
- Sub-50ms resiliency, OAM
- Embedded PTP & SyncE support
- High quality OCXO

Distributed Synchronization: SyncRing

- Very high accuracy for 4/5G networks
- PTP & SyncE
- Outdoor GM +T-BC
- Flexible deployment

Software Defined Network: SOO Network

- Optimized for metro networks
- Service and operation automation
- Dynamic services

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



Thank you!

