

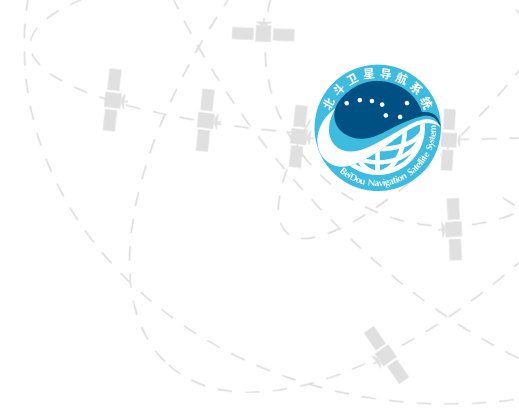
BEIDOU application in Telecom network

13th Meeting of the International Committee on
Global Navigation Satellite Systems

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- 02 GNSS application in Telecom synchronization solutions
- 03 BeiDou use case in Telecom network



01

Synchronization requirements in Telecom

- Basic Concepts
- Telecom network synchronization solutions

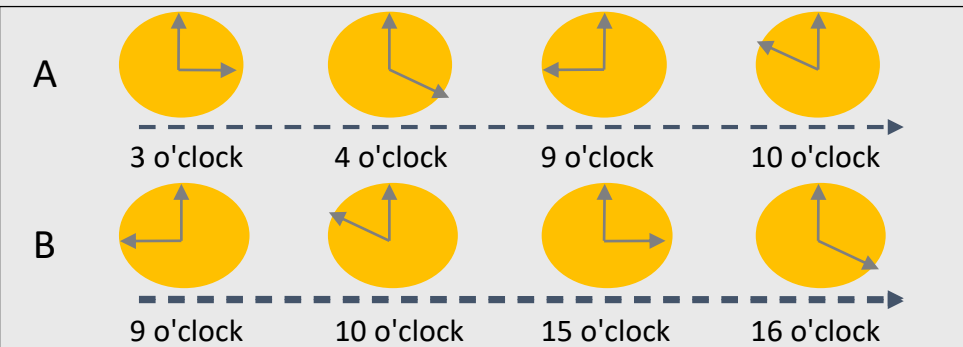
01 Synchronization requirements in Telecom/Basic Concepts

What's synchronization mean in Telecom network?

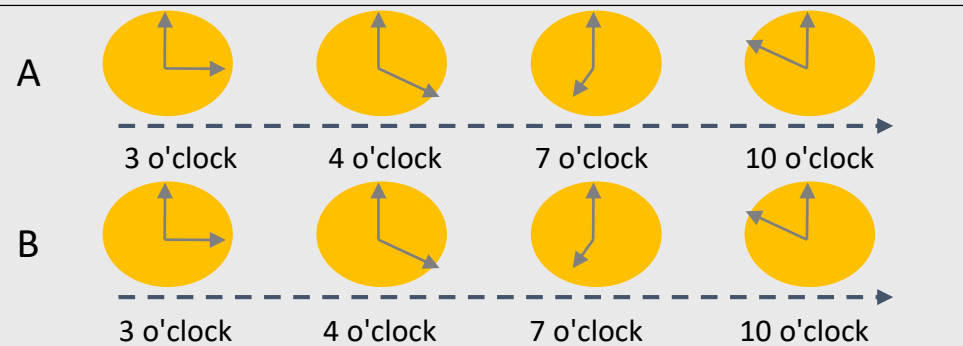
The Synchronization ensures that the frequency, phase and/or time differences among systems are within a tolerable range, so that the data can be correctly transmitted and processed, and the operation can be correctly executed.

there mainly are there different synchronizations: **Frequency** , **time** synchronization

Frequency synchronization



Time synchronization :



Base station synchronization requirement

Base station system		Frequency Synchronization	Frequency Synchronization
2G	GSM	√	×
	CDMA	√	√
3G	WCDMA	√	×
	CDMA2000	√	√
	TDS-CDMA	√	√
4G	LTE TDD	√	√
	LTE FDD	√	×
	LTE-A	√	√
5G	NR(TDD)	√	√

01 Synchronization requirements in Telecom/Basic Concepts

Base station Time synchronization requirement

Level of accuracy	Time error requirements (Note 1)	Typical applications (for information)
1	500 ms	Billing, alarms
2	100 μ s	IP Delay monitoring
3	5 μ s	LTE TDD (large cell)
4	1.5 μ s	UTRA-TDD, LTE-TDD (small cell) Wimax-TDD (some configurations)
5	1 μ s	Wimax-TDD (some configurations)
6	x ns (Note 3)	Various applications, including Location based services and some LTE-A features (Note 2)

NOTE 1 – The requirement is expressed in terms of error with respect to a common reference.

NOTE 2 – The performance requirements of the LTE-A features are under study. For information purposes only, **values between 500 ns and 1.5 μ s** have been mentioned for some LTE-A features. Depending on the final specifications developed by 3GPP, LTE-A applications may be handled in a different level of accuracy.

NOTE 3 – For the value x, refer to Table 2 below and Table II.2 of Appendix II.

Le-vel of accuracy	MaxRelative TE (Note 1)	Typical applications (for information)
6A	260ns	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
6B	130ns	Intra-band contiguous carrier aggregation, with or without MIMO or TX diversity
6C	65 ns	MIMO or TX diversity transmissions, at each carrier frequency

NOTE 1 – The maximum relative time error requirements represent the peak-to-peak time difference measured between the elements in the cluster only.

In 3GPP terminology this is equivalent to time alignment error (TAE), which is defined as the largest timing difference between any two signals.

Tables from G.8271

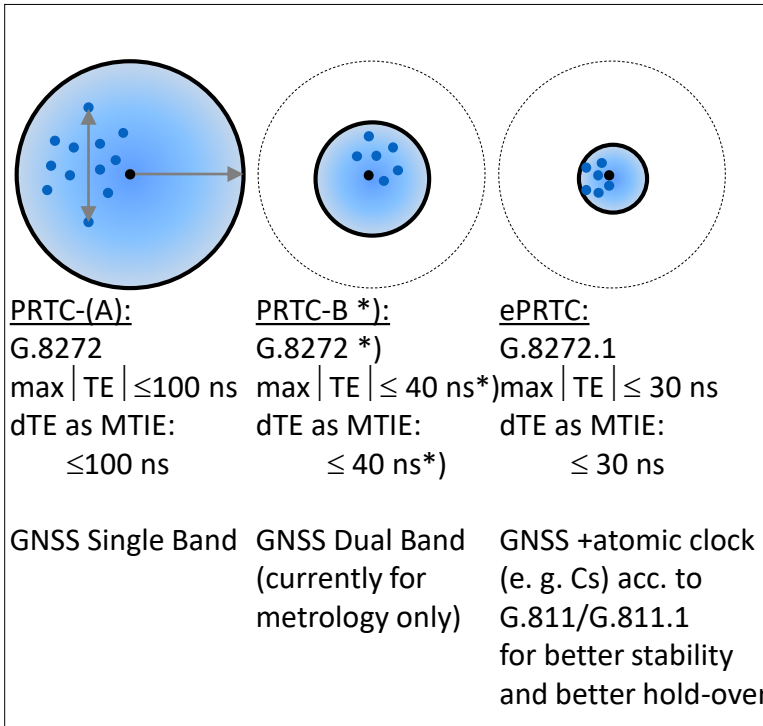
Application:

- Current ITU-T clock specifications are related to G.8271 accuracy level 4
- Level 5 and 6 require better clocks

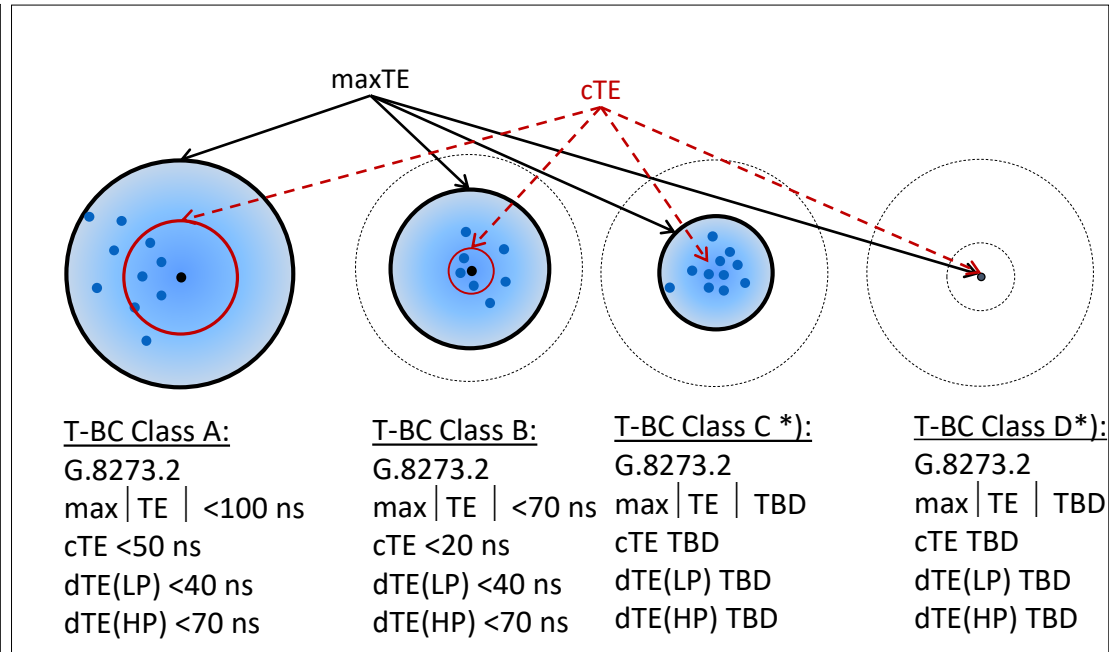
01 Synchronization requirements in Telecom/Basic Concepts

Fixed network Time synchronization requirement

Primary Reference Time Clock functions:
UTC related



Dissemination equipment, output values related to input signal:
used in synchronization chains with cTE and noise accumulation

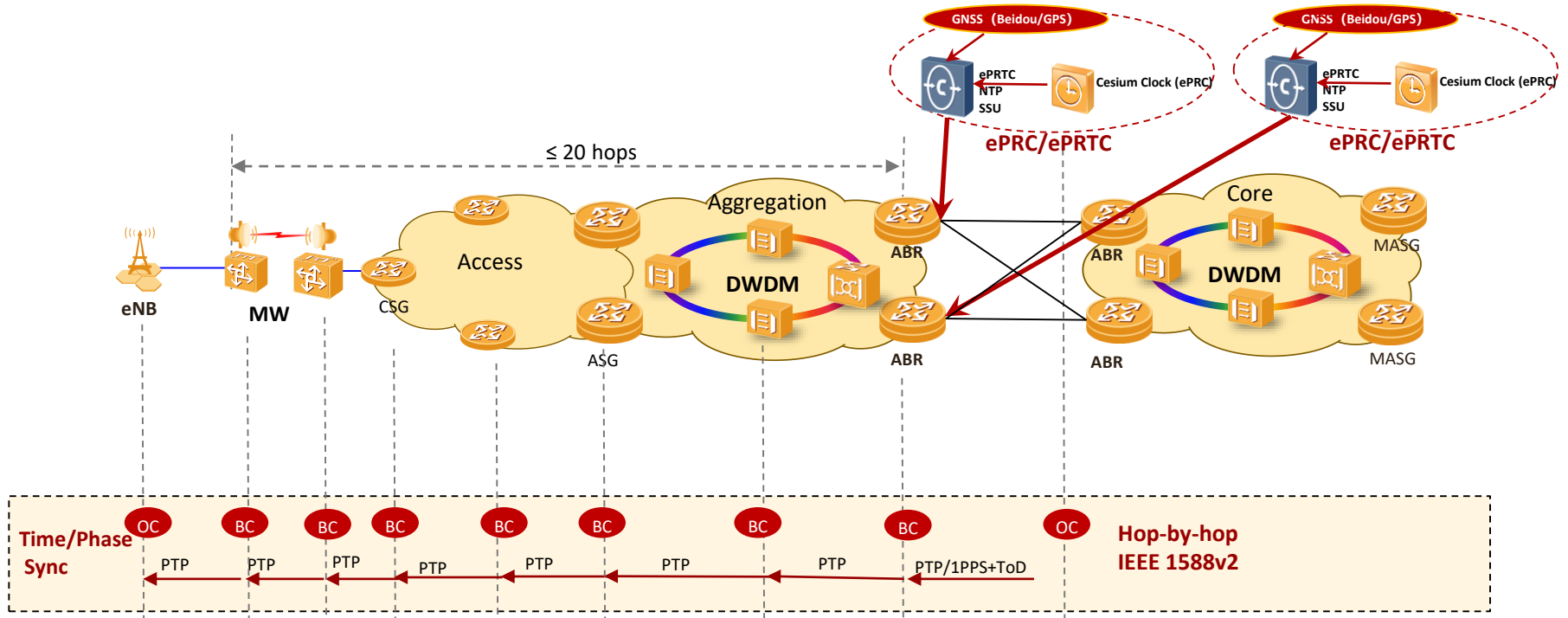


*) Not specified or not fully specified by ITU-T

Application:

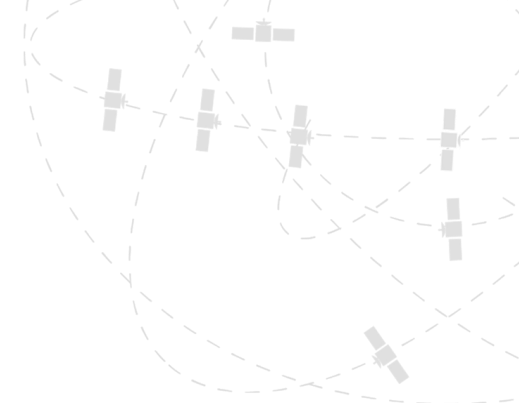
- Current ITU-T clock specifications are related to G.8272 PRTC-A and G.8273.2 Class A/B
- G.8272 PRTC-B、 G.8272.1 ePRTC、 G.8273.2 Class C/D require better clocks

01 Synchronization requirements in Telecom/Solution



- ePRC/ePRTC: **deploy two sets of master and slave sync source equipment** at the metro layer and ensure that the E2E clock link connected to the source equipment must not exceed 20 hops.
- **Each set of sync source equipment include one Cesium clock (act as ePRC), and one Clock server (ePRTC/NTP/SSU/GNSS all in one).**
- Time synchronization: deploy IEEE 1588v2 (G.8275.1/IEEE 1588) hop by hop and configure microwave and WDM NEs as BCs. It is advised to configure IEEE 1588v2 to the DELAY mode.

02

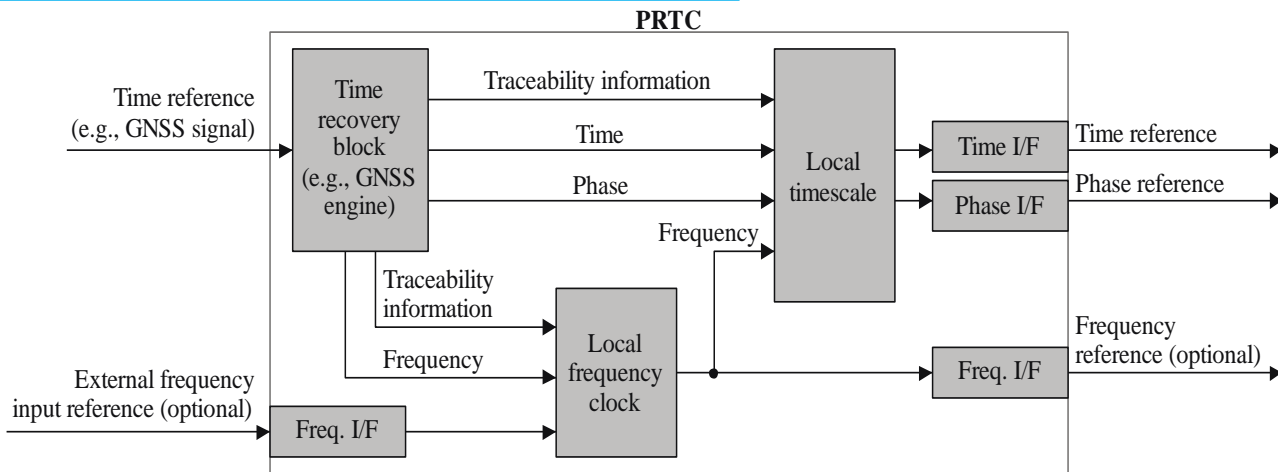


GNSS application in Telecom synchronization solutions

- PRTC-A/PRTC-B
- ePRTC/cnPRTC

GNSS application in Telecom synchronization solutions/ PTRC-A&PTRC-B

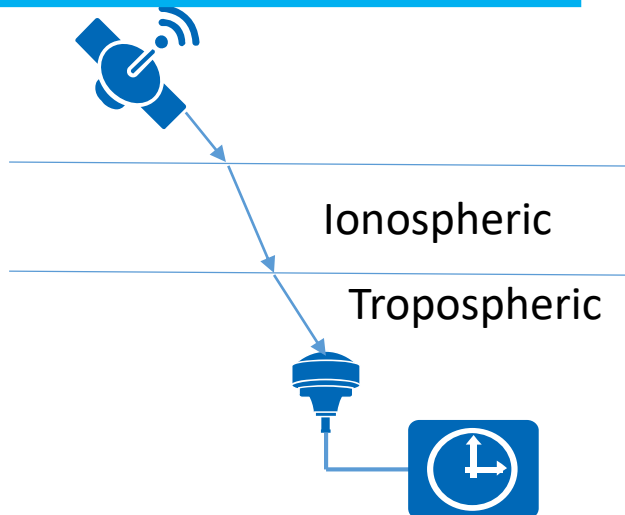
PTRC-A&PTRC-B logical architecture



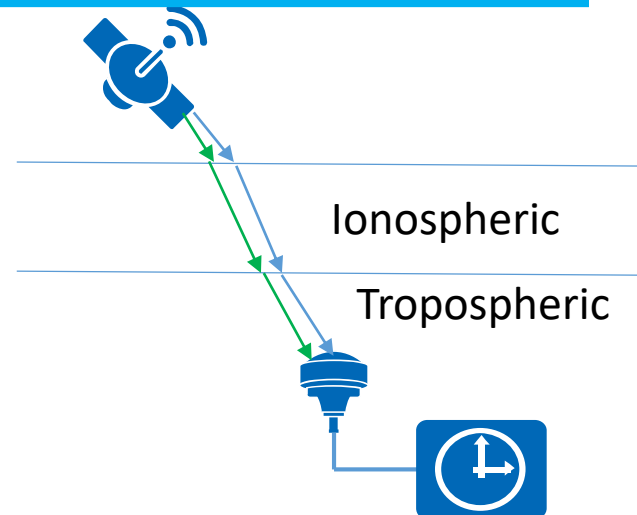
G.8272-Y.1367(12)_Fil.1

- PTRC-A & PTRC-B share the same Logical architecture except time reference.
- The PTRC-A time source is Single Band GNSS
- The PTRC-B time source is Dual Band GNSS

PTRC-A: 100ns time accuracy

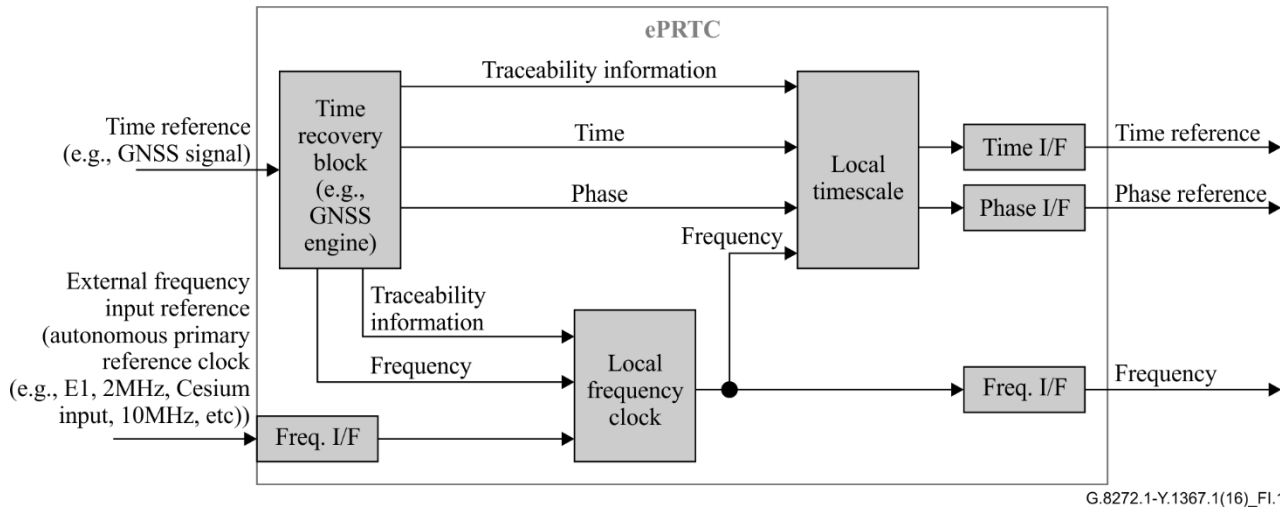


PTRC-B: 40ns time accuracy



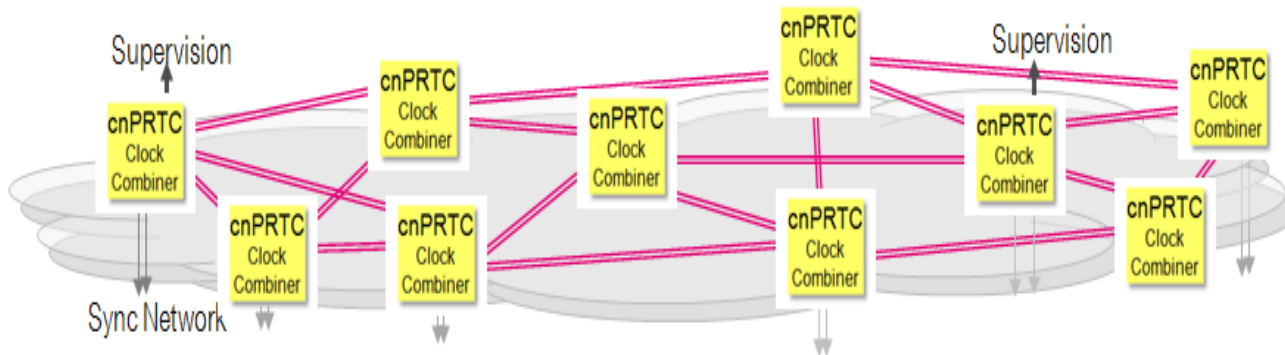
GNSS application in Telecom synchronization solutions/ ePRTC&cnPRTC

ePRTC: 30ns time accuracy



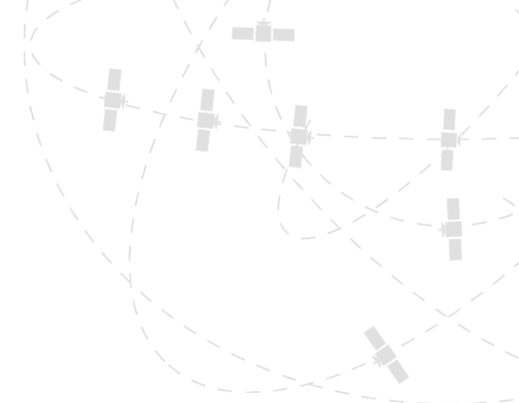
- The ePRTC time source is Single Band or Dual Band GNSS
- The ePRTC have an external frequency better than G.811 or G.811.1

cnPRTC: High reliability and accuracy for further study



- The cnPRTC time source is Single Band or Dual Band GNSS
- The cnPRTC Satellite common-view or other way to do group synchronize
- The cnPRTC have a High reliability and accuracy

03

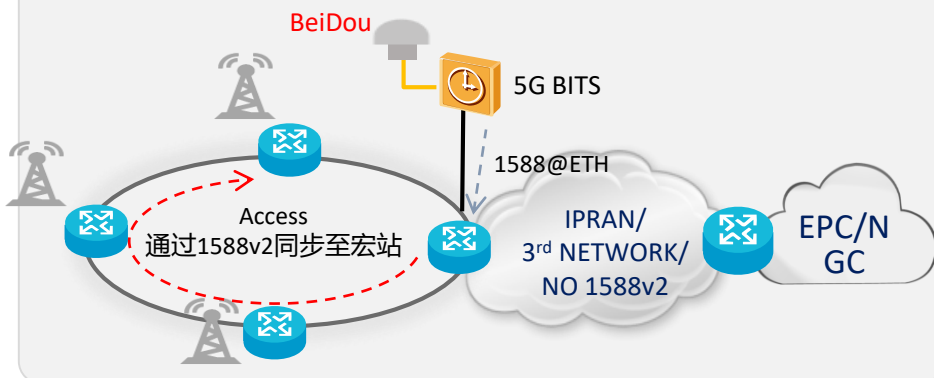


BeiDou use case in Telecom network

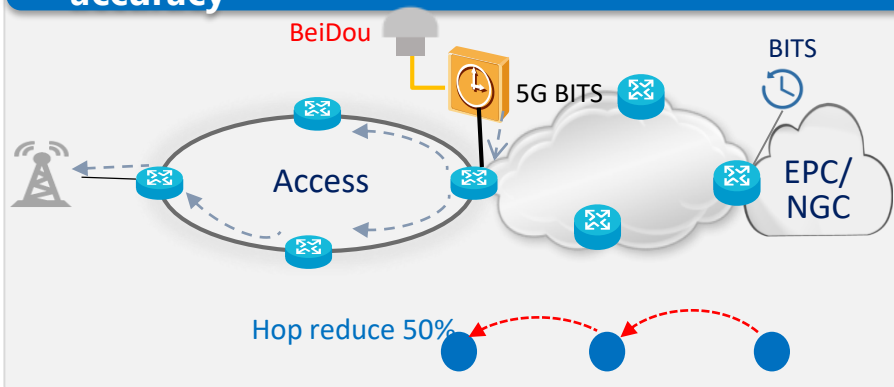
- Scenario
- Product

BeiDou use case in Telecom network/ Scenario

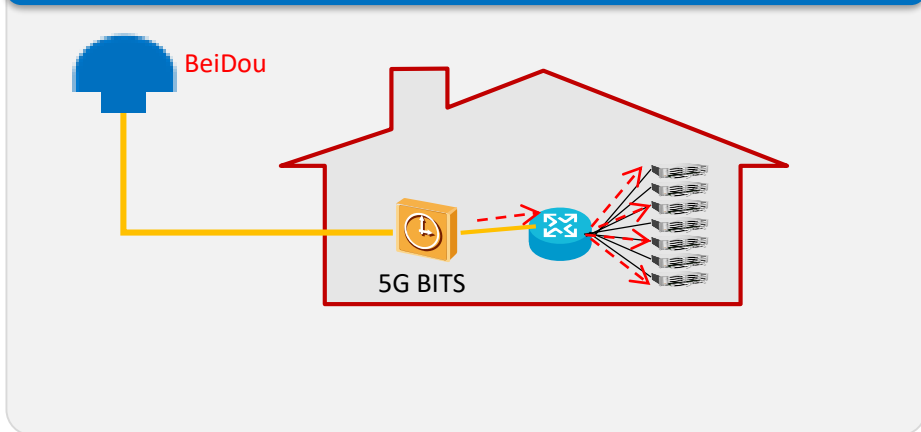
① Time Isolated island, BITS down to Access Ring



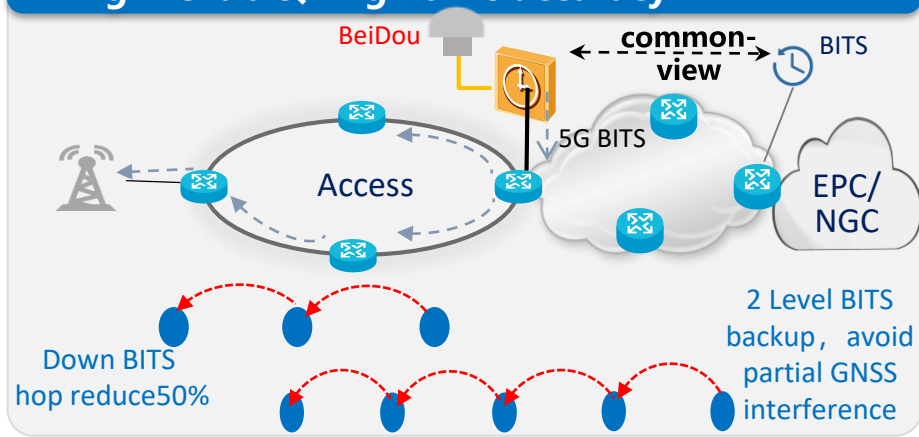
③ BITS down to Access, reduce hop, high time accuracy



② reduce GNSS cable, BITS supply clock source for CO

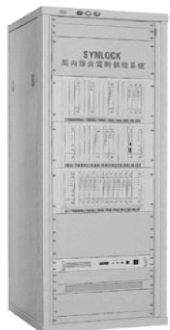


④ 2 Level BITS common-view, easy to maintain, high reliable, high time accuracy



BeiDou use case in Telecom network/ Product

Telecom Sync Source Products evolution(HW as a example)



1993~

Legacy Frequency

- 1993: C&C08 SPC exchange clock module
- 1995.12: Synlock V1 debut
- 1997.08: Synlock V2 debut
- 1999.04: GPS & GLONASS dual mode receiver module



2002~

Multi-Function

- 2002.10
Synlock V3 debut
GPS module
- 2004.8
Synlock V3 NTP



2005~

Mini Size

- 2005.08
Synlock V5 debut
GPS module
- 2007.12
Synlock T5030 debut
(power grid version)



2009~

IP Sync

- 2009.07
Synlock T6020 debut
BeiDou Model
- 2011.10
Synlock V3 1588v2 &
SyncE
- 2014.6
Synlock V3/T6020
1588ACR
BeiDou II Model



2018~

5G Sync

- 2018.12
Synlock T8010 II debut
Dual-band GNSS
BeiDou II Model
- 2019.12
Synlock T8010 I debut

THANK YOU!

13th Meeting of the International Committee on
Global Navigation Satellite Systems





References

- [1] ITU-T Recommendation G.8273.2
- [2] ITU-T Recommendation G.8272
- [3] ITU-T Recommendation G.8272.1
- [4] ITU-T Recommendation G.8271

