Sync Architecture Evolution for 5GNR

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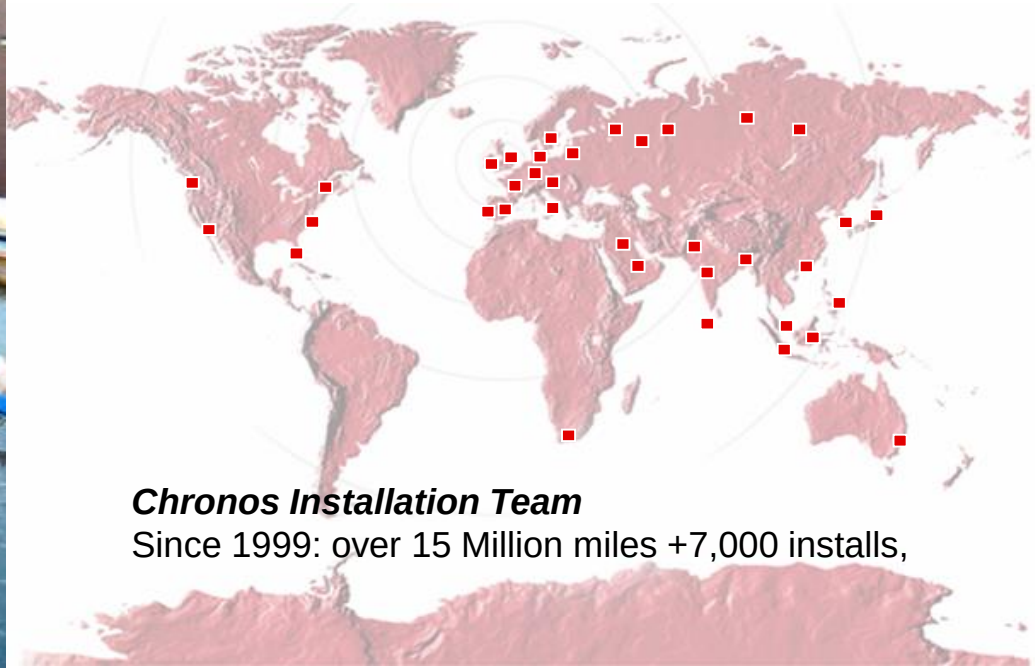
- Global reach – installations + support
- ***Extensive experience of how GNSS timing systems behave in the real world***



Chronos Installation Team
Since 1999: over 15 Million miles +7,000 installs,

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- GNSS interference detection systems

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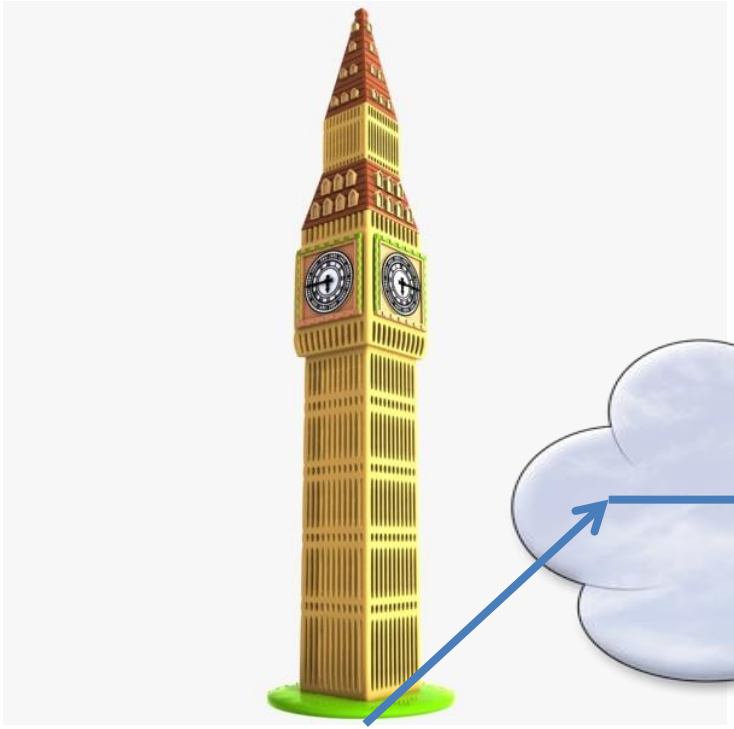
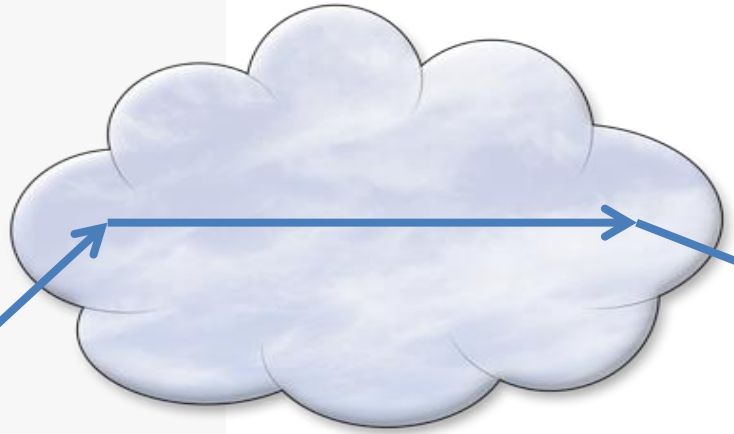
Back to basics





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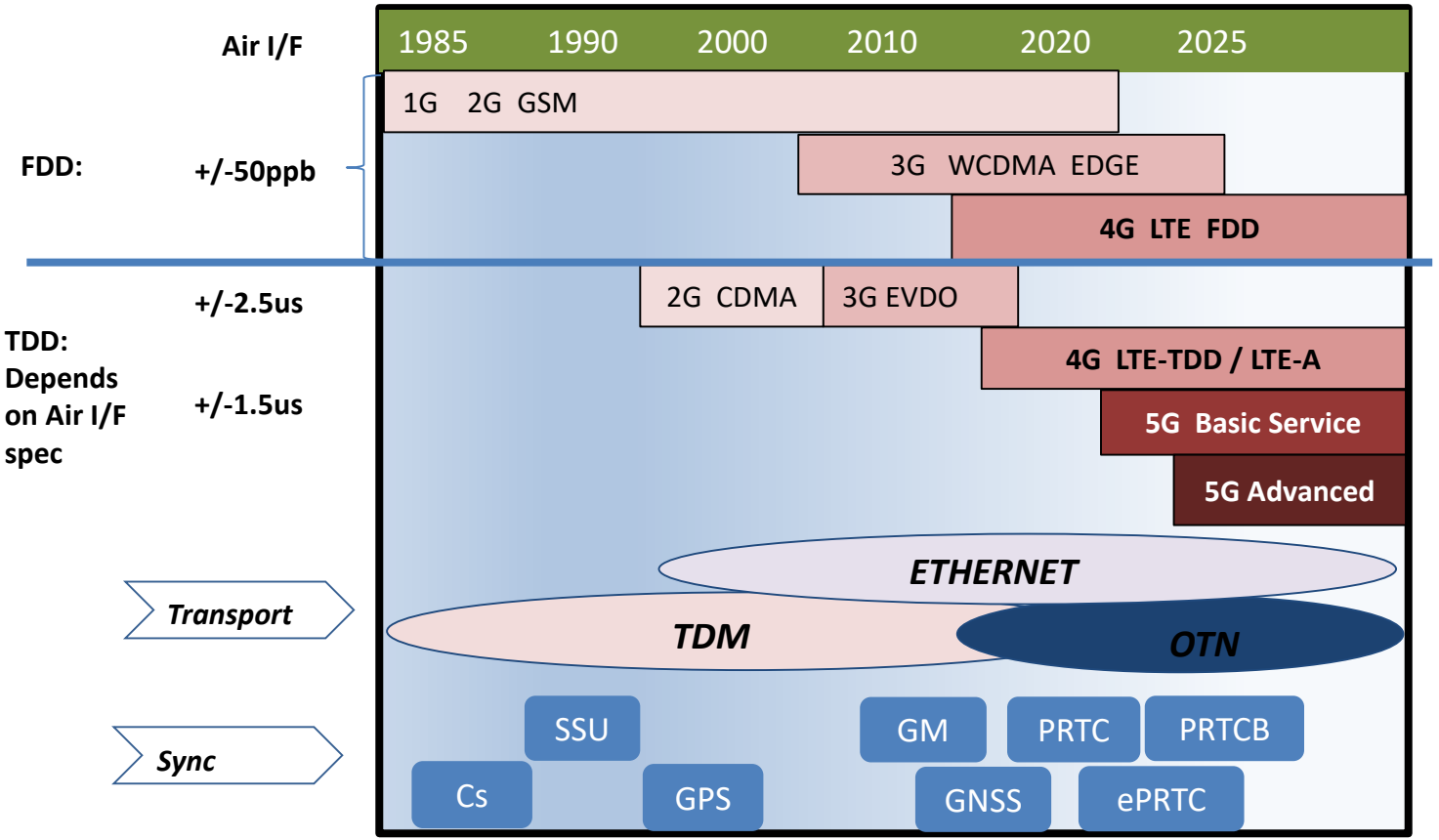
Evolution of Sync Requirements & Architectures



Faster Wireless connections **require & rely on** changes in network transport and in synchronization architectures in the Core and at the Mobile Edge

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New specs, new clocks

- PRC to PRTC
  - No longer just stable & accurate frequency
  - Adds time/phase
- ePRC/ePRTC
  - Even better performance
  - PRTC-B
- GM to T-GM
  - ITU interpretation of IEEE1588-2008 (PTPv2) GM
- BC to T-BC
  - Class A/B/C/D
- GPS to GNSS
  - + GNSS firewalls

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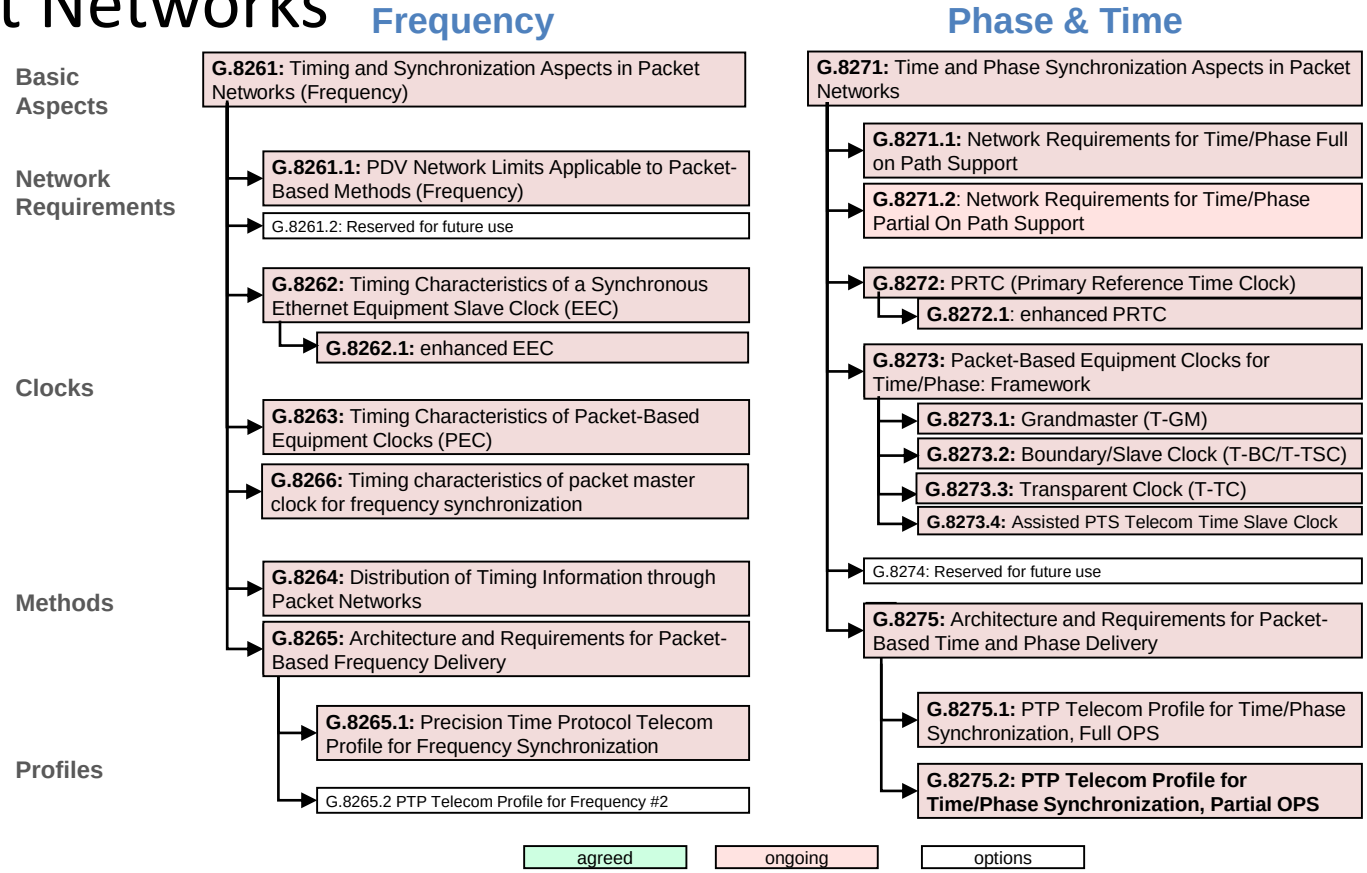
ITU-T Recommendations for Synchronization in Packet Networks



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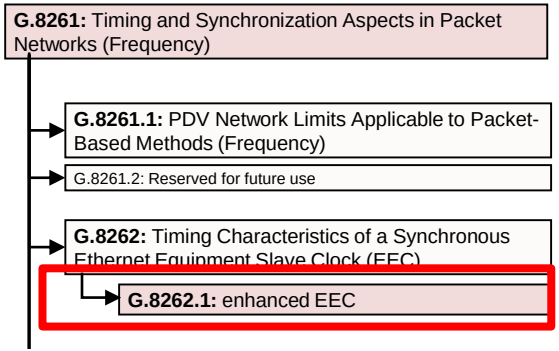
ITU-T Recommendations for Synchronization in Packet Networks

Frequency



Now Consented

eEEC **better noise control**

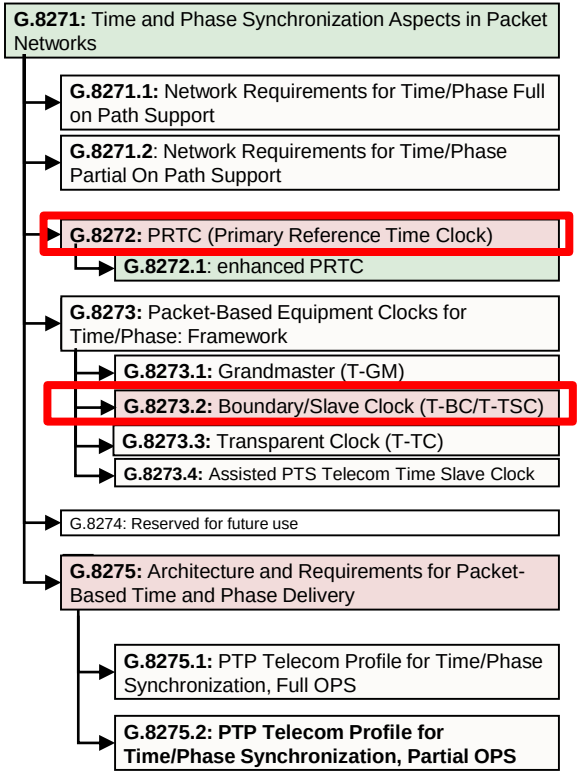
PRTC-B **+/-40nsec max Time Error**

BC Class C **+/-10nsec max Time Error**

WIP

BC Class D **+/- 5nsec max Time Error**

Phase & Time



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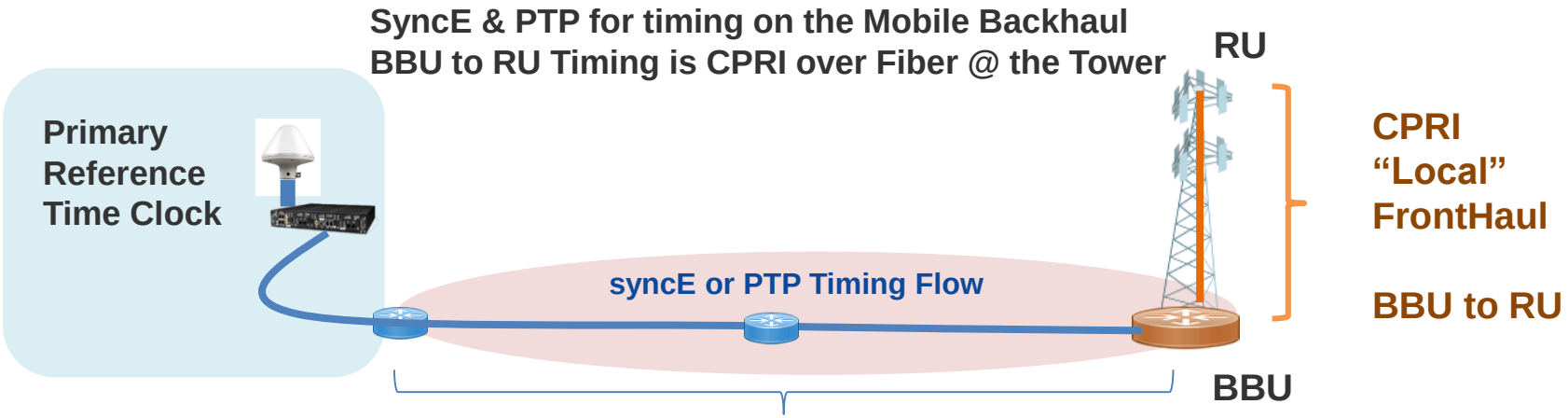
4G Time Error:
Mobile Backhaul/Local Fronthaul



PRTC +/-100ns	Transport +/-1us	BBU to RU ±400ns

End to End Time Error Budget = +/- 1.5usec

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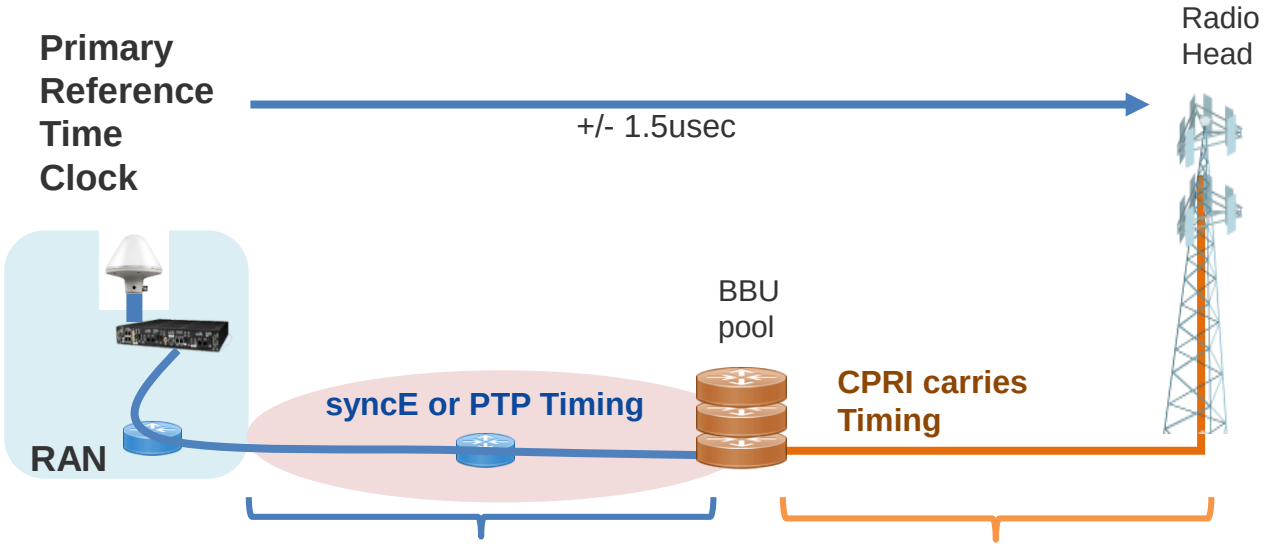
4G cRAN:
CPRI over Fiber Fronthaul/BBU Aggregation



PRTC +/-100ns	Transport +/-1us	CPRI Fronthaul to RU ±400ns

End to End Time Error Budget = +/- 1.5usec

Issues with CPRI

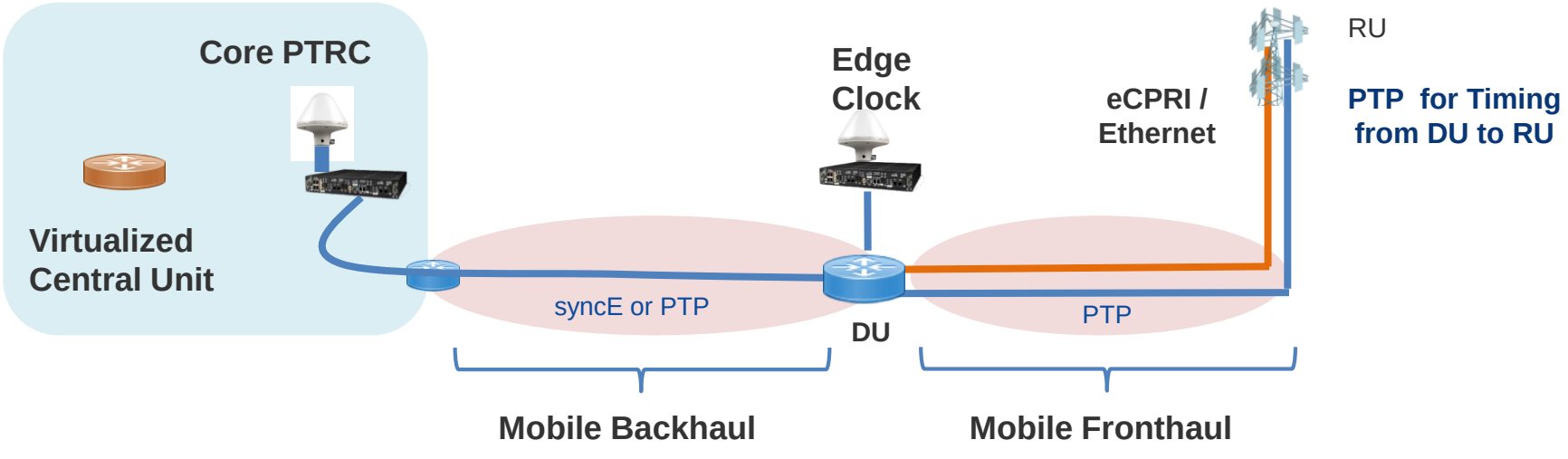
Power hungry
Proprietary
Expensive
Requires many BBU

Fronthaul TE budget still +/-400 nsec

CPRI cannot deliver 5G bandwidth to the UE

5G Advanced Services:
PTP Replaces CPRI for Timing

Centralized Unit (CU) and Distributed Unit (DU)
Fronthaul TE Budget reduced from +/-400 to +/- 130 nsec to enable Advanced Services



PRTC +/-100ns	Backhaul Transport +/-1.27us	5G Fronthaul +/- 130nsec

End to End Time Error Budget +/-1.5usec

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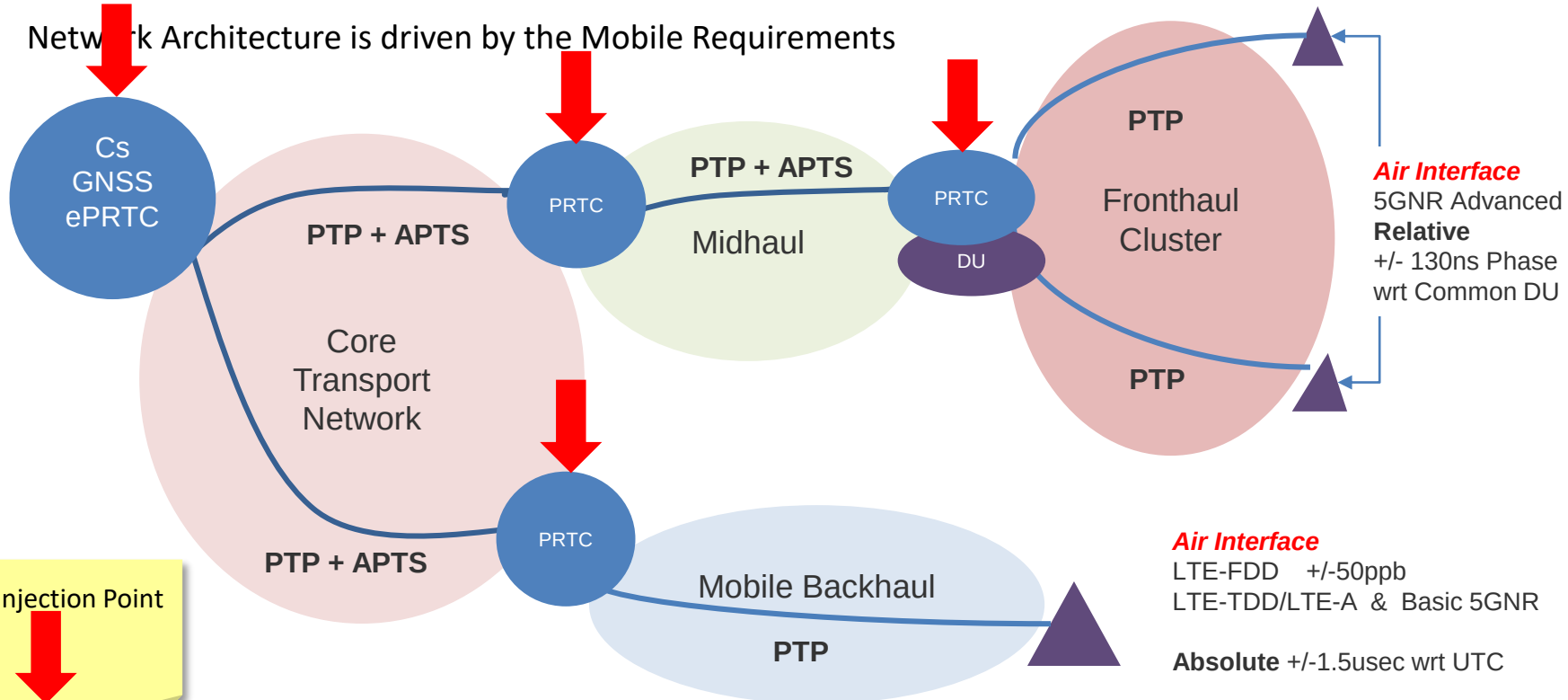
4G & 5G Synchronization Architecture:

High Precision Core Clocks for Holdover, Distributed PRTC for Phase at the Network Edge



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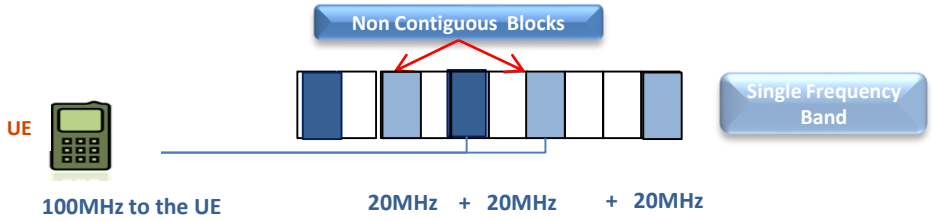
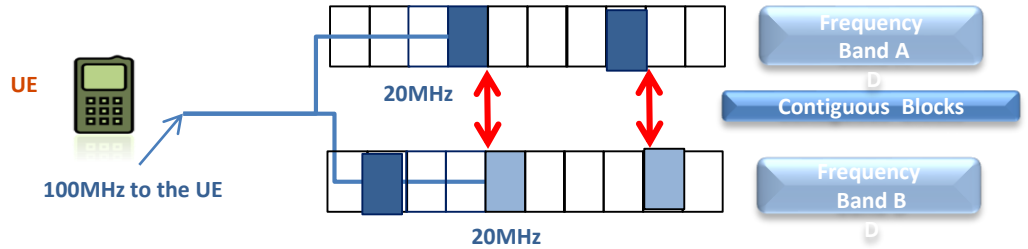
5GNR: Advanced Carrier Aggregation Services, wideband to the UE requires stringent TAE control to mitigate CoChan Interference

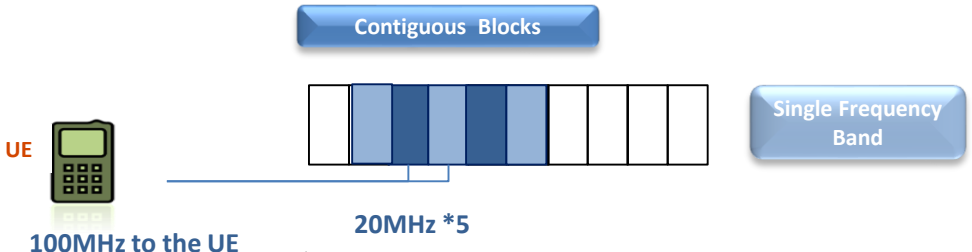
Intra-Band Non-Contiguous CA: +/-260ns



Inter-Band Contiguous CA: +/- 260ns



Intra-Band Contiguous CA: +/- 130ns



Physical realisation

- Massive (Magic) MIMO
  - 64T64R – space division multiple access
- Complexity of Antenna design means electronics and (high) power consumption now right at the top of the mast
- Oscillators more exposed to extremes of temperature compared to typical cabinet housing

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Summary

- Delivery of freq/phase/time is fundamental to 5GNR reliable & efficient operation
- Network architecture revolution presents challenges:
  - “Sync Injection points” have increased dramatically, new clock types means there’s no “one size fits all” solution
  - Many more clock types
    - GNSS/T-GM/PRTC/T-BC/edge clocks

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Thank you

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Chronos PhaseReady Event: The 5G Field of Dreams

3 OCTOBER 2019, KINGS PLACE, LONDON

As all UK networks roll out their initial 5G coverage, what does that mean for customers? What do…

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