Time sync standardization: The importance of defining "Network Limits"

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Contents

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- The importance of defining network limits
- Network limits for full timing support: done?
- Limits for partial timing support: what are the challenges?
- Conclusions

Network Limits?

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- ITU-T recc. G.8271.1 specifies
  - maximum *network limits* of phase and time error that shall not be exceeded
  - *minimum equipment tolerance* to phase and time error at phase and time synchronization interfaces.
- Why:
  - to ensure interoperability of equipment produced by different manufacturers and a satisfactory network performance
  - Operator perspective: Reference Network
  - Equipment perspective: NEs noise generation/tolerance

Time Sync Network Limits:

Q13/15 Recommendations

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- Analysis of Time/phase synchronization in Q13/15:
  - G.8260 (definitions related to timing over packet networks)
  - G.827x series

	Frequency	Phase/Time	
General/Network Requirements	G.8261	G.8271	2015 ?
	G.8261.1	2013/14 G.8271.1,	G.8271.2
Architecture and Methods	G.8264	G.8275	
	G.8265		
PTP Profile	G.8265.1	G.8275.1, G.8275.2	
Clocks	G.8266	G.8272	
	G.8262	G.8273,.1,.2,.3, 4	
	G.8263		

Full Timing Support vs. Partial Timing Support

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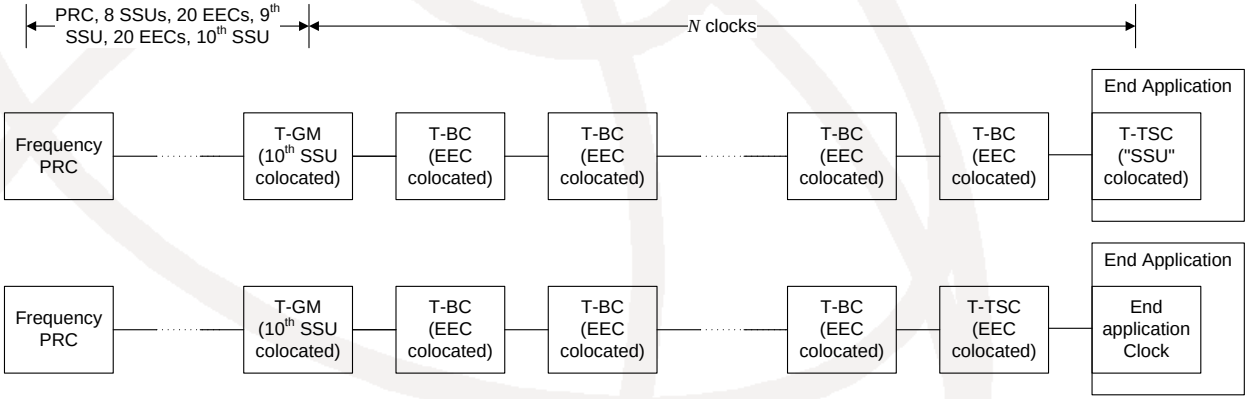
- Recommended architecture with «PTP support» in every node (currently BCs-based); N=10 or 20; different T-BC classes
  - Analysis similar to traditional «TDM» studies (PLL in every equipment, etc.)



- In order to address specific needs, and already deployed networks, «partial timing support» networks are being considered as well
  - Nodes not supporting PTP in the sync distribution chain
  - Different issues in defining network limits, etc.
  - PDV, Asymmetry created by traffic load, etc.
  - Complex task. First step is the «Assisted Partial Timing support»; a second simplied scenario has also been proposed

G.8271.1: limits in full Timing support

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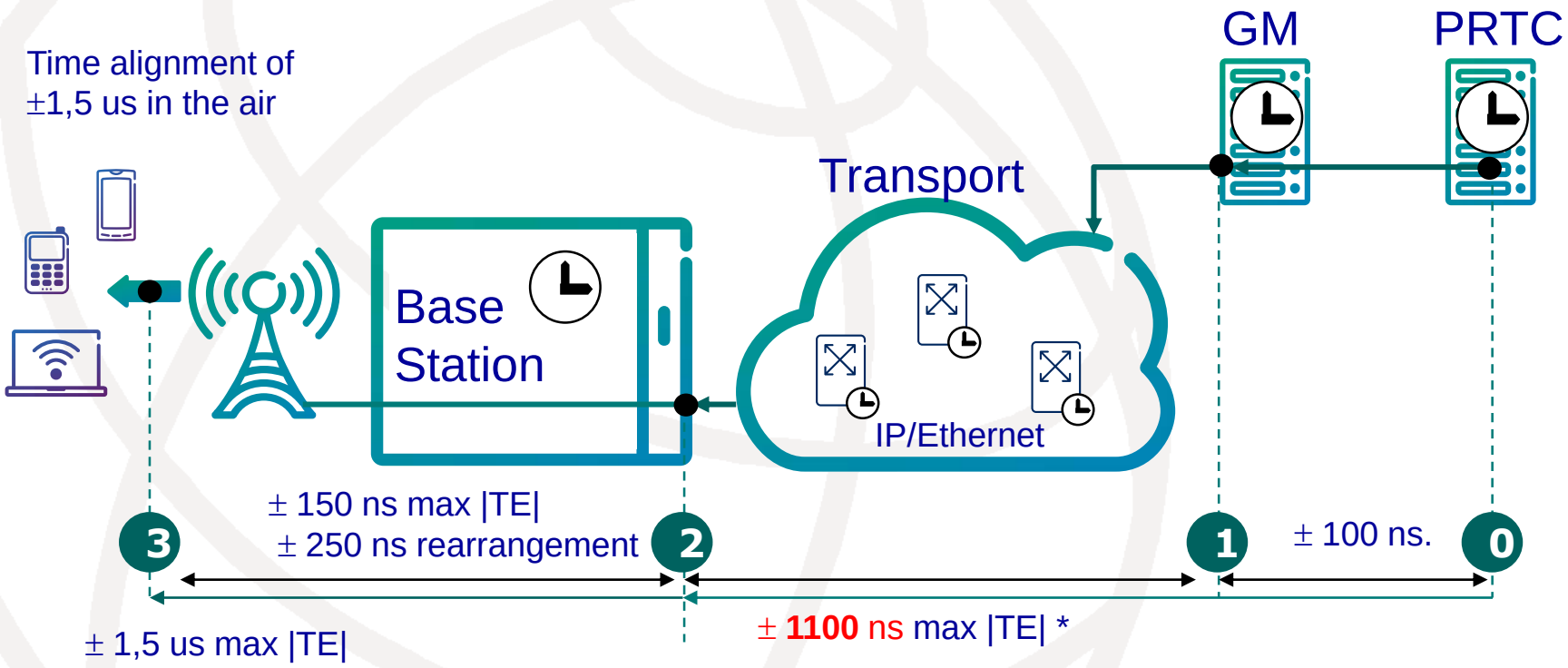
- Various parameters have been considered:
  - Contant vs. Dynamic TE
- max |TE| to limit constant error (actually including both *dynamic* and *constant* error)
  - Easy to compare with the 3GPP requirements: +/- 1.5 us
  - Budget for the End application and for failure conditions
- *Dynamic part* of the TE noise based on simulations analysis:
  - Ring rearrangements and combination of SyncE/PTP noise
  - MTIE mask defined (noise components < 0.1 Hz)
  - High frequency noise (noise components > 0.1HZ)

Time sync Budgeting (max |TE|):

Main case

Rearrangements handled by the end application (e.g. Base Station)



*after low pass filter (0.1 Hz);

Max |TE|Time Error Budgeting Examples

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Max|TE|

Budget Component	Failure scenario a)	Failure scenario b)	Long Holdover periods (e.g. 1 day)
PRTC (ce_{ref})	100 ns	100 ns	100 ns
Holdover and Rearrangements in the network (TE_{HO})	**NA**	**400 ns**	**2400 ns**
Random and error due to synchronous Ethernet rearrangements (dTE')	200 ns	200 ns	200 ns
Node Constant including intrasite (ce_{ptp_clock})	550 ns (Note 1)	550 ns (Note 1)	550 ns (Note 1)
	420 ns (Note 2)	420 ns (Note 2)	420 ns (Note 2)
Link Asymmetries (ce_{link_asym}) (Note 3)	250 ns	100 ns	100 ns
	380 ns	230 ns	230 ns
Rearrangements and short Holdover in the End Application (TE_{REA})	250 ns	**NA**	NA
End application (TE_{EA})	150 ns	150 ns	**150 ns**
Total (TE_D)	**1500 ns**	**1500 ns**	**3500 ns (Note 4)**

Max |TE| Additional example: Rearrangements handled by the network

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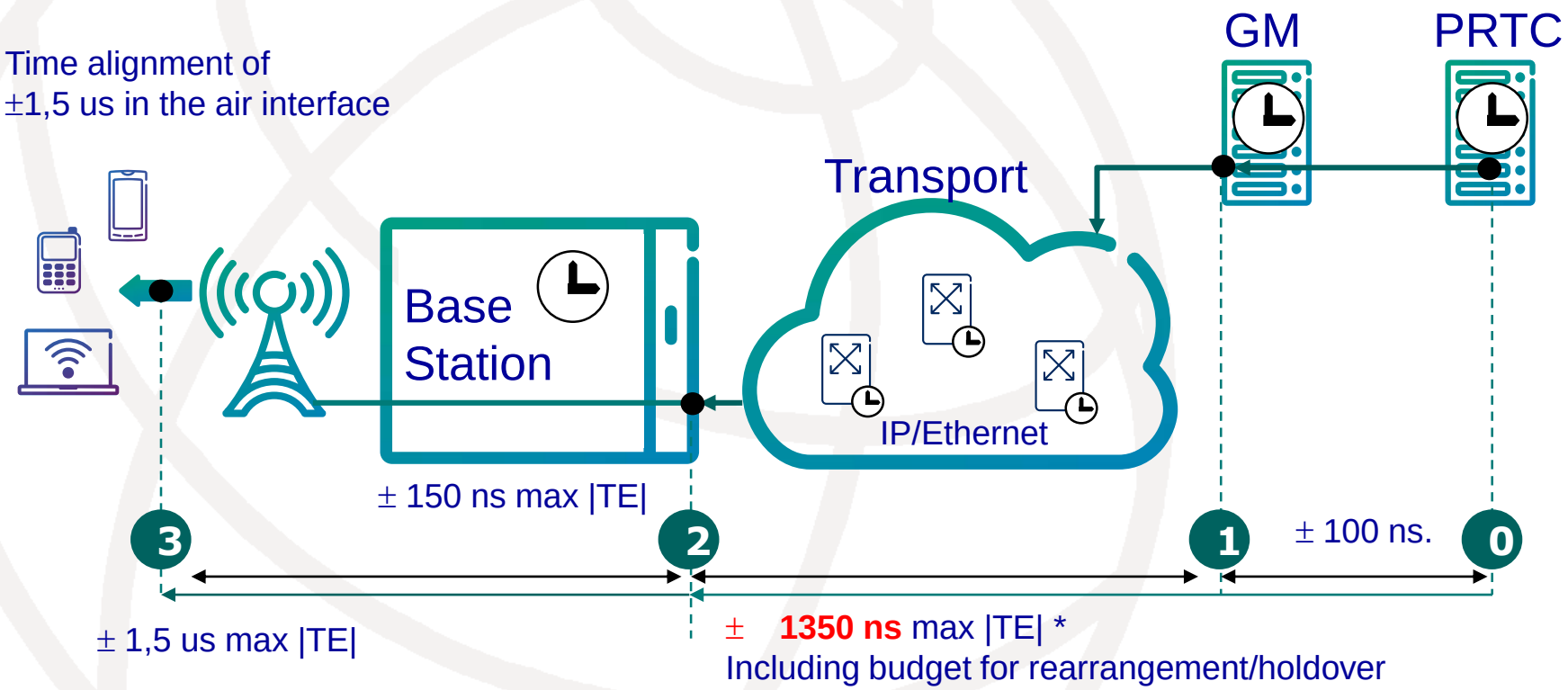
Base Station continuously locked to the incoming PTP reference

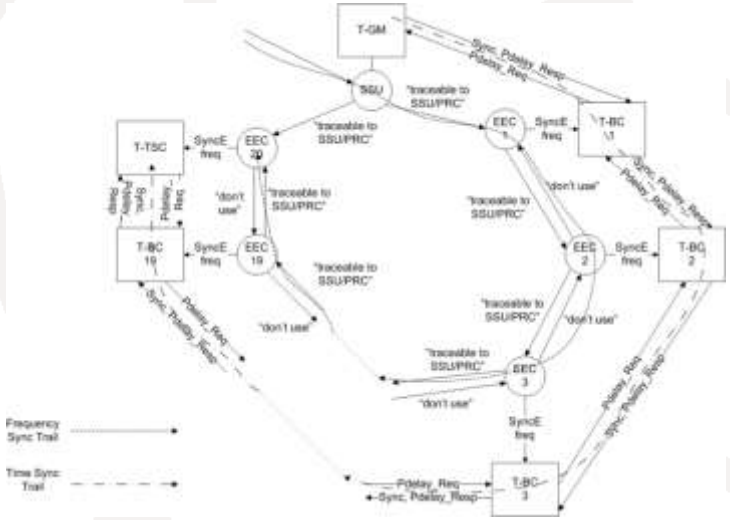


*after low pass filter (0.1 Hz)

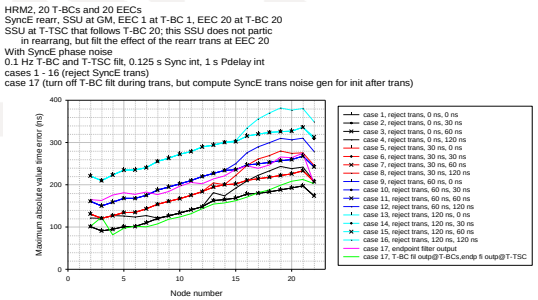
Dynamic Time Error:

MTIE, TDEV, «Jitter»

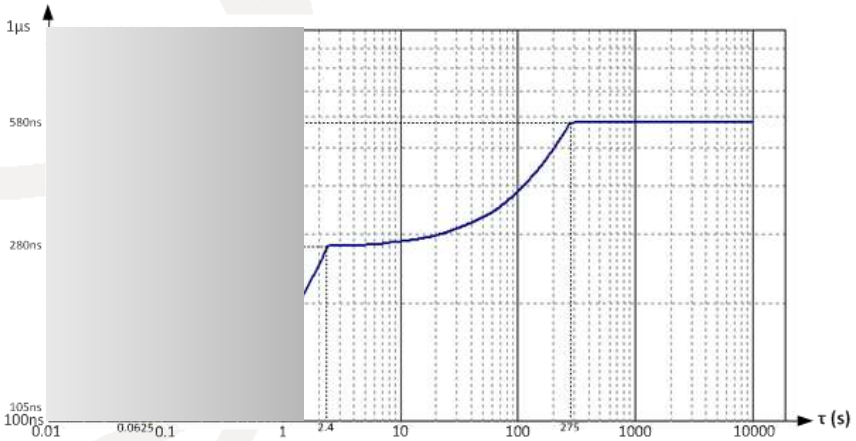
- MTIE mask has been defined based on the worst case:
  - Congruent scenario , with SyncE ring rearrangements



From WD30, (Boulder, March 2012)



From C238, (July 2013)



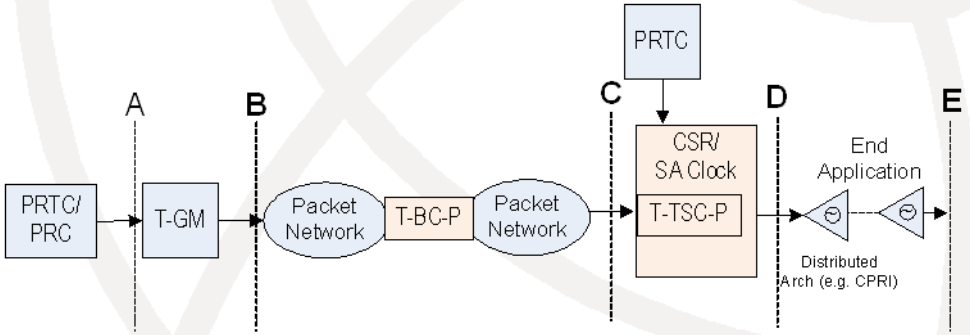
- This mask defines dynamic noise in the «time wander» region (< 0.1 Hz)
- High frequency noise (> 0.1 Hz): < 200 ns p-t-p

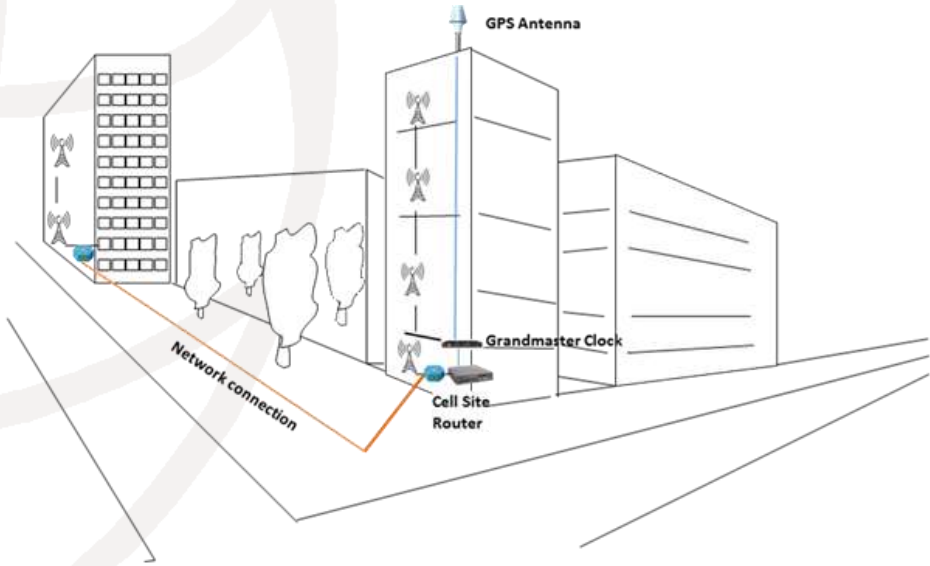
Completed ?

- TDEV ?
  - To verify if the T-BC spectral noise currently defined (TDEV <4 ns) is consistent with the overall network limits
- Assumption based on SyncE support
  - Pros:
    - Stable frequency reference
    - Holdover capability
  - Cons
    - Noisy SyncE (in theory)
- Plan to also address PTP T-BC clock with no-SyncE assistance:
  - Is this use case relevant ?
  - Any difference from network limits perspective?
    - Max |TE| should be the same (to meet +/- 1.5 us)
    - Dynamic noise in principle could be different; but End application is not able to distinguish if PTP is carried in a SyncE or no-SyncE capable network: *Same MTIE?*

Partial Timing Support

- Two main scenarios as a first step
  - APTS (Assisted Partial Timing Support)
  - Pure PTS (for small cells)



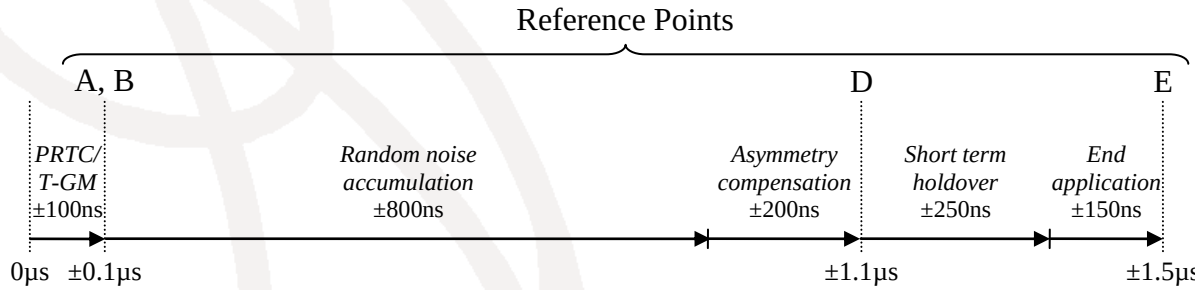


From WD20 (Sophia Antipolis 2014)

Limits for APTS

- Basic Approach:
  - Unknown HRM / no simulations required
- Budget:

From WD14, (Dec 2013, Copenaghen)



- Frequency sync sufficient
  - 1-way or 2-way stability metrics
- FPP (floor packet percentage) too conservative.
  - General agreement to use a more accurate metric; current proposals:
    - «Min Err» (*Peak to peak Average Time Error*)
    - «pktFilteredMTIE »

Limits for PTS (Small cells)

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- Still to be discussed. Some initial thoughts
- HRM may be defined (3 hops);
  - How to model a packet node? (same problem for 8265.1)
  - What Simulations ?
- Budget: no need to allocate 200 ns to GPS
  - 1 us ?
- 2-way stability metrics is needed (time sync is necessary)
- Asymmetry is also important

Summary

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- G.8271.1 finalized (almost)
  - Max |TE|, MTIE and "jitter" time sync limits
- What is missing?
  - TDEV , Pure PTP (is it relevant?)
- G.8271.1 provide the basis for other relevant recommendations
  - G.8272 PRTC), G.8273.2 (T-BC/T-TSC), G.8273.3 (T-TC)
- Ongoing study on partial timing support
  - APTS as first application
  - Simplified «PTS» for small cells applications as second step
  - More complex than full timing support?