Progress in time sync standardization in Q13/15: G.8271/G.8271.x

WSTS– 2014, San Jose

Stefano Ruffini, Ericsson,
ITU-T Q13/15 Associate Rapporteur

TIME SYNC: Q13/15 RECOMMENDATIONS

ERICSSON

- Analysis of Time/phase synchronization in Q13/15:
  - G.8260 (definitions related to timing over packet networks)
  - G.827x series
  - Both G.8271 Amd1 and G.8271.1 (incl. Amd) approved. New work item on G.8271.2

	Frequency	Phase/Time	
General/Network Requirements	G.8261	G.8271	
	G.8261.1	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		

G.8271: TIME AND PHASE SYNCHRONIZATION ASPECTS OF PACKET NETWORKS

ERICSSON

- G.8271 provides the basic requirements and framework
  - Target requirements
  - Noise sources
  - Time sync interface
- Updated version last year
  - Details on the time synchronization interface
  - Details on time-stamping granularity (characteristics of the noise sources)
  - Details on the time error accumulations
  - General improvements and alignment with the new G.8271.1
- Time sync interface details moved into G.703

TARGET APPLICATIONS

ERICSSON

Level of Accuracy	Time Error Requirement (with respect to an ideal reference)	Typical Applications
1	500 ms	Billing, Alarms
2	100 μs	IP Delay monitoring
3	5 μs	LTE TDD (cell >3km)
4	1.5 μs	UTRA-TDD, LTE-TDD (cell ≤ 3Km) Wimax-TDD (some configurations)
5	1 μs	Wimax-TDD (some configurations)
6	< x ns (x ffs)	Location Based services and some LTE-A features (Under Study)

Small cells coordination features generally addressed by Class 4 !

TIME SYNC INTERFACE: G.703/G.8271

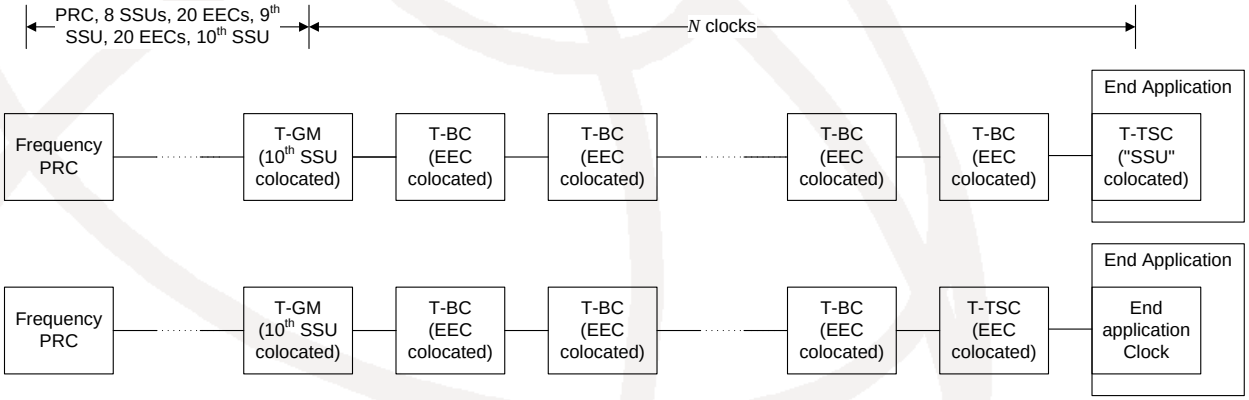
ERICSSON

- G.8271 introduces the functional aspects of a 1PPS time sync interface
  - Typically used for test measurement (output port). V.11/RJ45 also for possible time sync input (e.g. from GPS)
  - ToD protocol details associated to the 1PPS phase and time synchronization interface specification are under study
- New clause in G.703 on Time synchronization interfaces
  - V.11 1PPS
  - 1PPS 50 phase synchronization measurement interface
- G.703 specifies:
  - Pulse characteristics
  - perfomance objectives and, in case of V.11, Pin Out

PIN	Signal name	Signal definition
1	Reserved	FFS
2	Reserved	FFS
3	**1PPS_OUT-**	Tx 1PPS negative voltage
4	GND	V.11 signal ground
5	GND (Note 1)	V.11 signal ground
6	**1PPS_OUT+**	Tx 1PPS positive voltage
7	**TX-**	Tx TOD time message negative voltage
8	**TX+**	Tx TOD time message positive voltage

FULL TIMING SUPPORT VS. PARTIAL TIMING SUPPORT

- Recommended architecture with «PTP support» in every node (currently a chain of BCs has been considered)
  - Analysis similar to traditional «TDM» studies (PLL in every equipment, etc.)



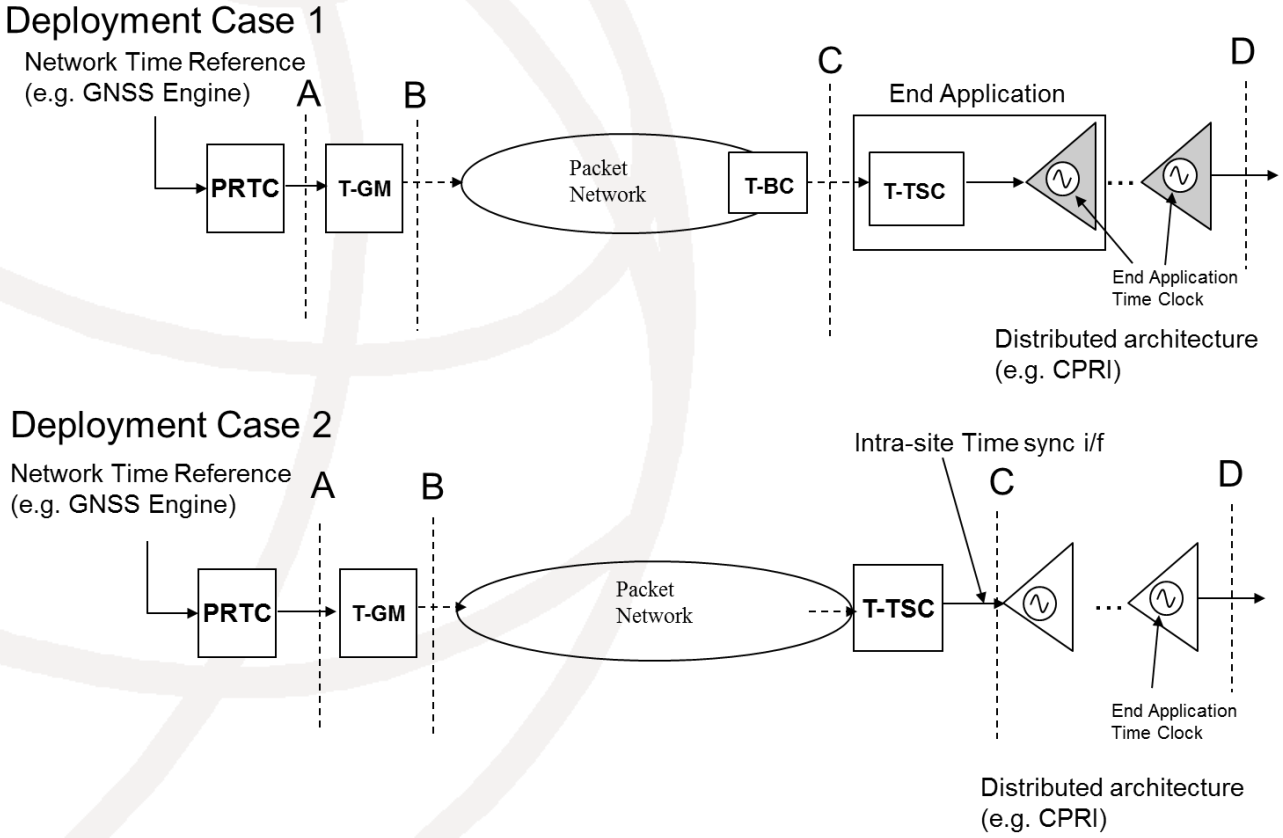
- In order to address specific needs, and already deployed network, «partial timing support» networks are being considered as well
  - Nodes not supporting PTP in the sync distribution chain
  - Different issues in defining network limits, etc.
  - PDV will be a relevant parameter
  - Asymmetry created also by different traffic loads
  - Complex task. First step is the «Assisted Partial Timing support»

TIME SYNC NETWORK LIMITS FOR FULL TIMING SUPPORT

ERICSSON

- Reference networks (HRMs)
- Metrics
- Noise components
- Failure conditions

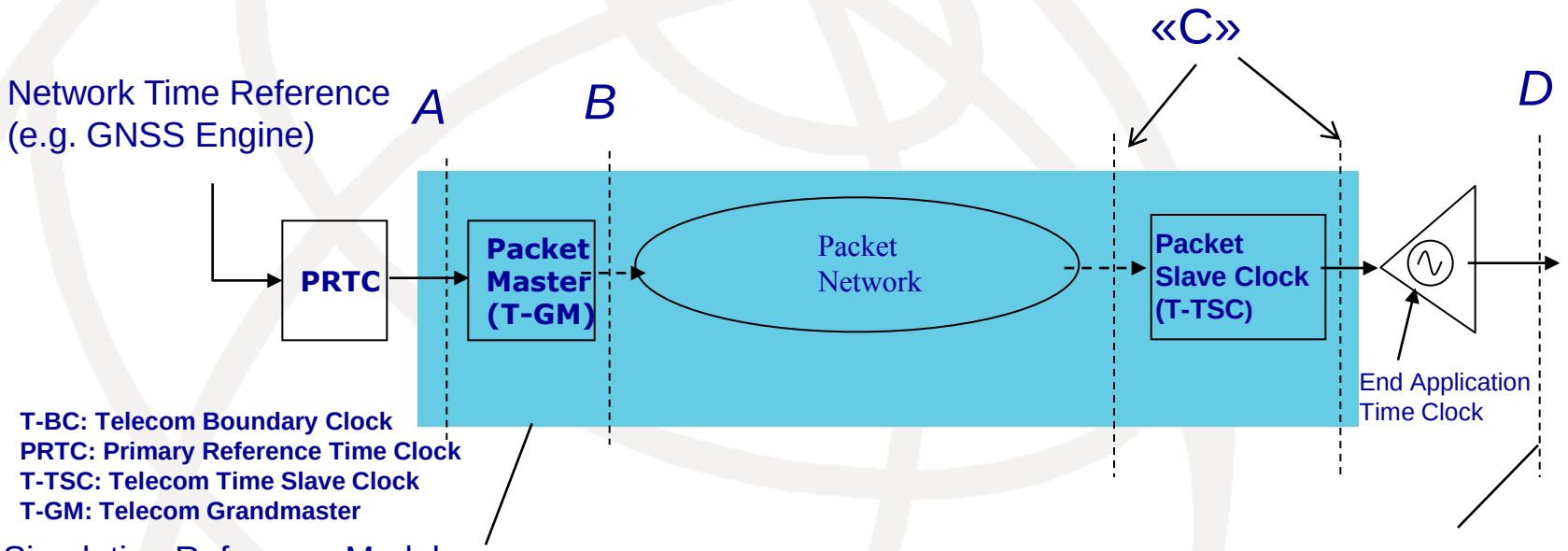
Deployment cases



REFERENCE NETWORK

ERICSSON

N — Common Time Reference (e.g. GPS time)



Simulation Reference Model:

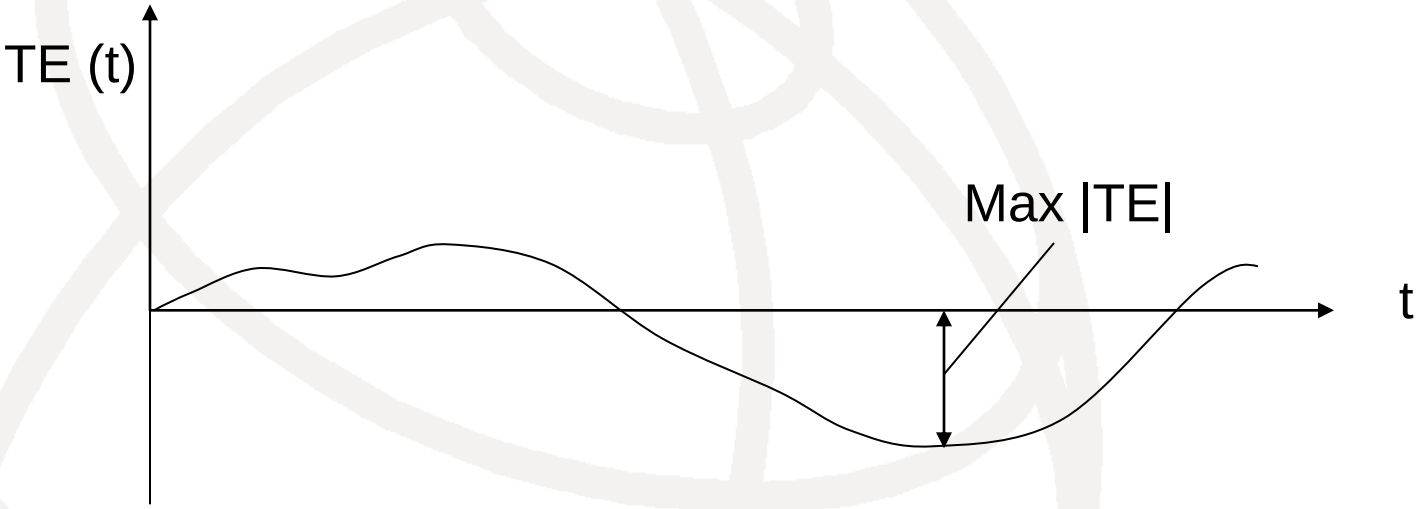
- chain of T-GM, 10/20 T-BCs, T-TSC
- with and without SyncE support

Typical Target Requirement in D < 1.5 μs in terms of max |TE|

Same limit applicable at the input and output of the T-TSC (note, limits at the output applicable only in case of external Packet Slave Clock)

METRICS

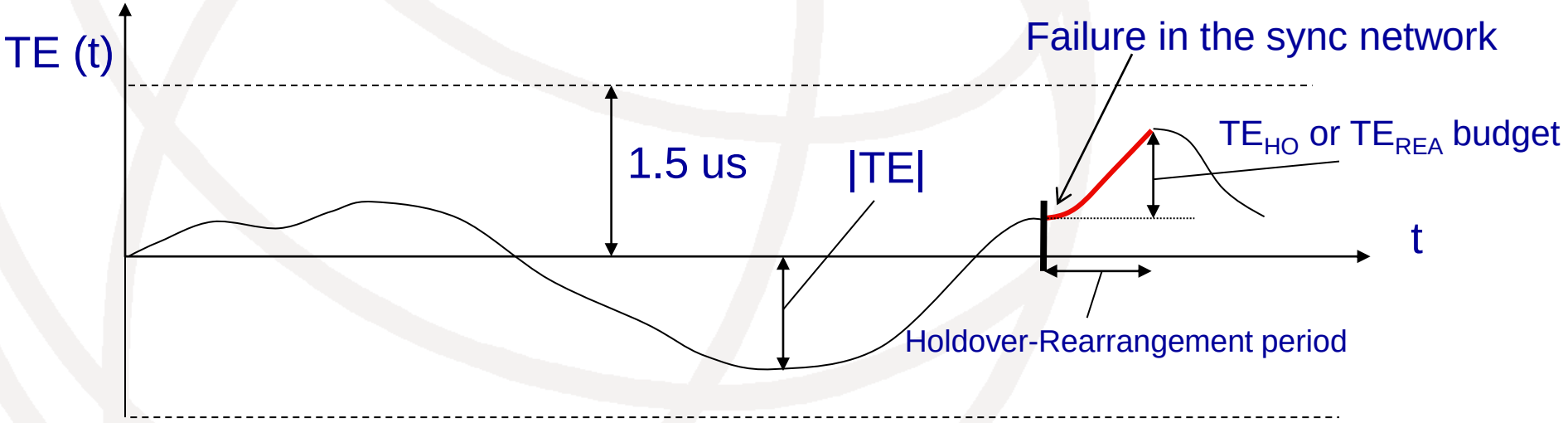
- Main Focus is Max absolute Time Error (Max |TE|) (based on requirements on the radio interface for mobile applications)



- Stability aspects also important
  - MTIE and TDEV
  - Related to End Application tolerance
- Same limits irrespectively if time sync is distributed with SyncE support or not ?
  - Probably yes, as the same overall objective applies

REARRANGEMENTS AND HOLDOVER

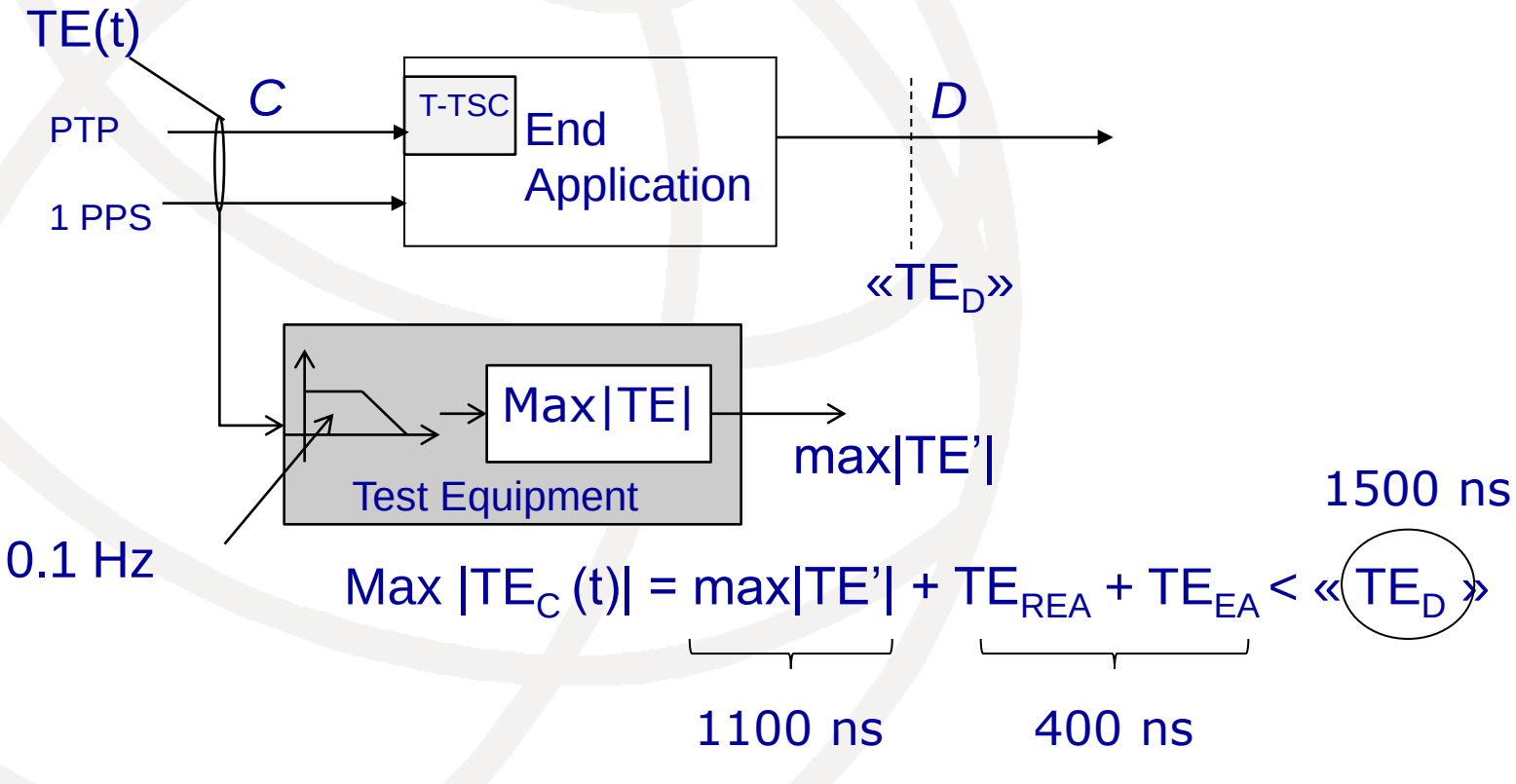
- The analysis of time error budgeting includes also allocating a suitable budget to a term modelling *Holdover and Rearrangements*
- Time Sync Holdover Scenarios
  - PTP traceability is lost and and the End Application or the PRTC enters "*time holdover*" using SyncE or a local oscillator
- PTP Master Rearrangement Scenarios
  - PTP traceability to the primary master is lost; the T-BC *or* the End Application *switches* to a backup PTP reference



TE_{HO} applicable to the network (End Application continues to be locked to the external reference)
TE_{REA} applicable to the End Application (End Application handles short rearrangement periods)

G.8271.1: TIME SYNC LIMITS, MAX |TE|

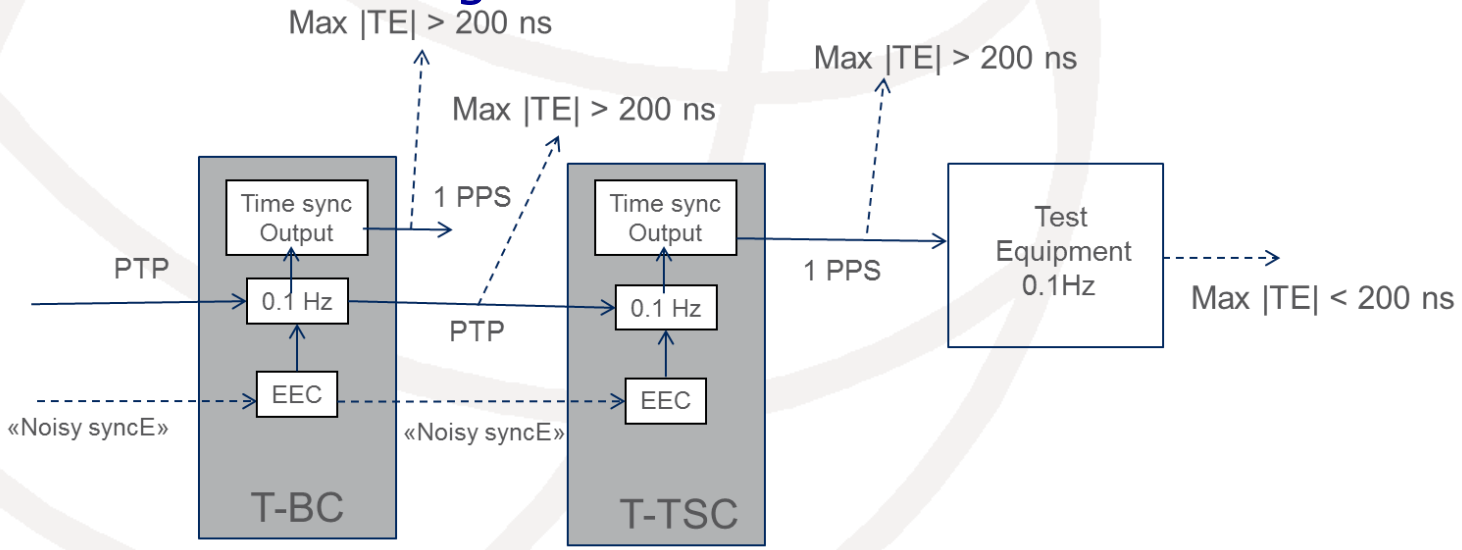
- Max $|TE_C| < 1.1$ us
- There might be some high frequency noise above 1.1 us
- End Application is only required to support short rearrangements (e.g. a few minutes)



NEED FOR FILTERING IN TEST EQUIPMENT

ERICSSON

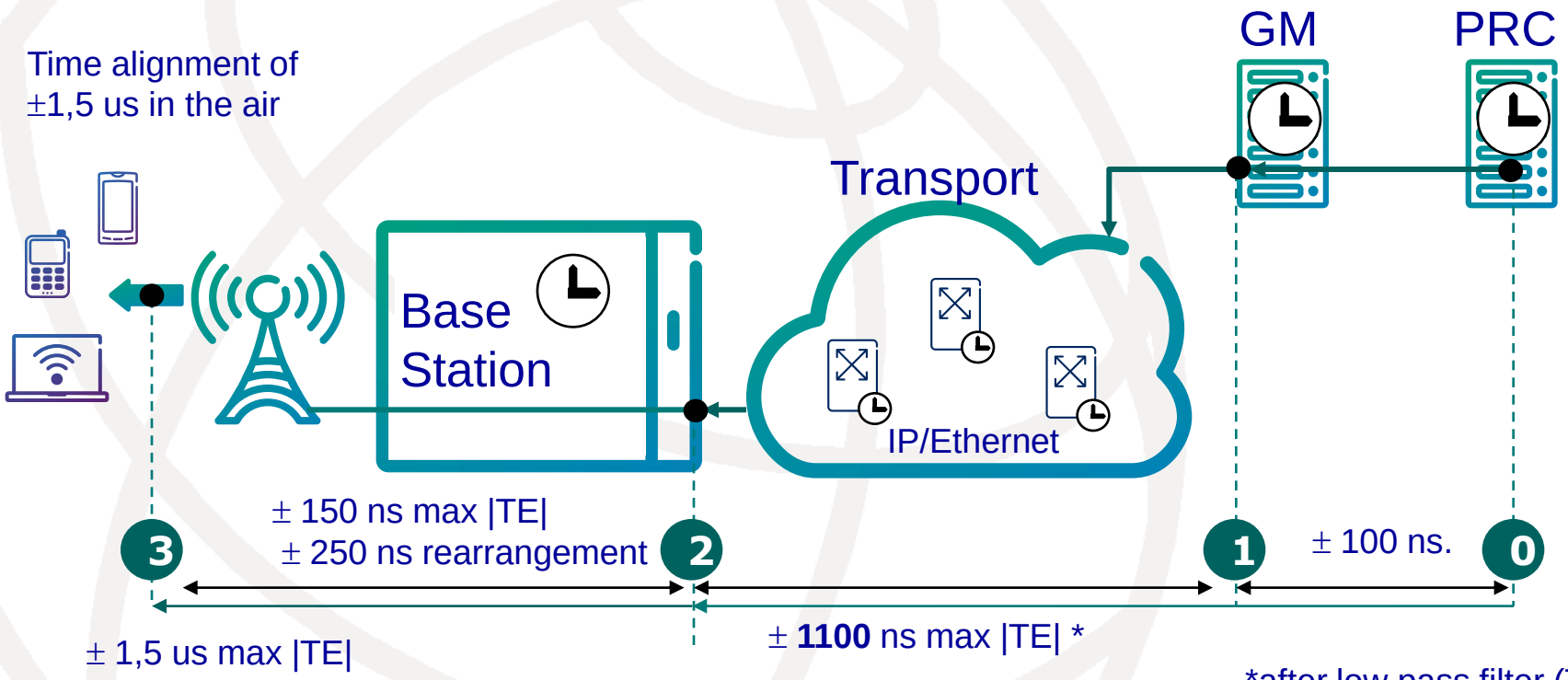
- «Time Wander» region: < 0.1 Hz
  - 200 ns allocated to dynamic noise:
    - Clocks in time sync chain with 0.1 Hz BW; higher frequency noise is filtered by the End Application
    - Simulations resulted in higher noise at higher frequencies
    - To get consistent results, test equipment performs 0.1 Hz filtering



TIME SYNC BUDGETING: MAIN CASE

ERICSSON

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

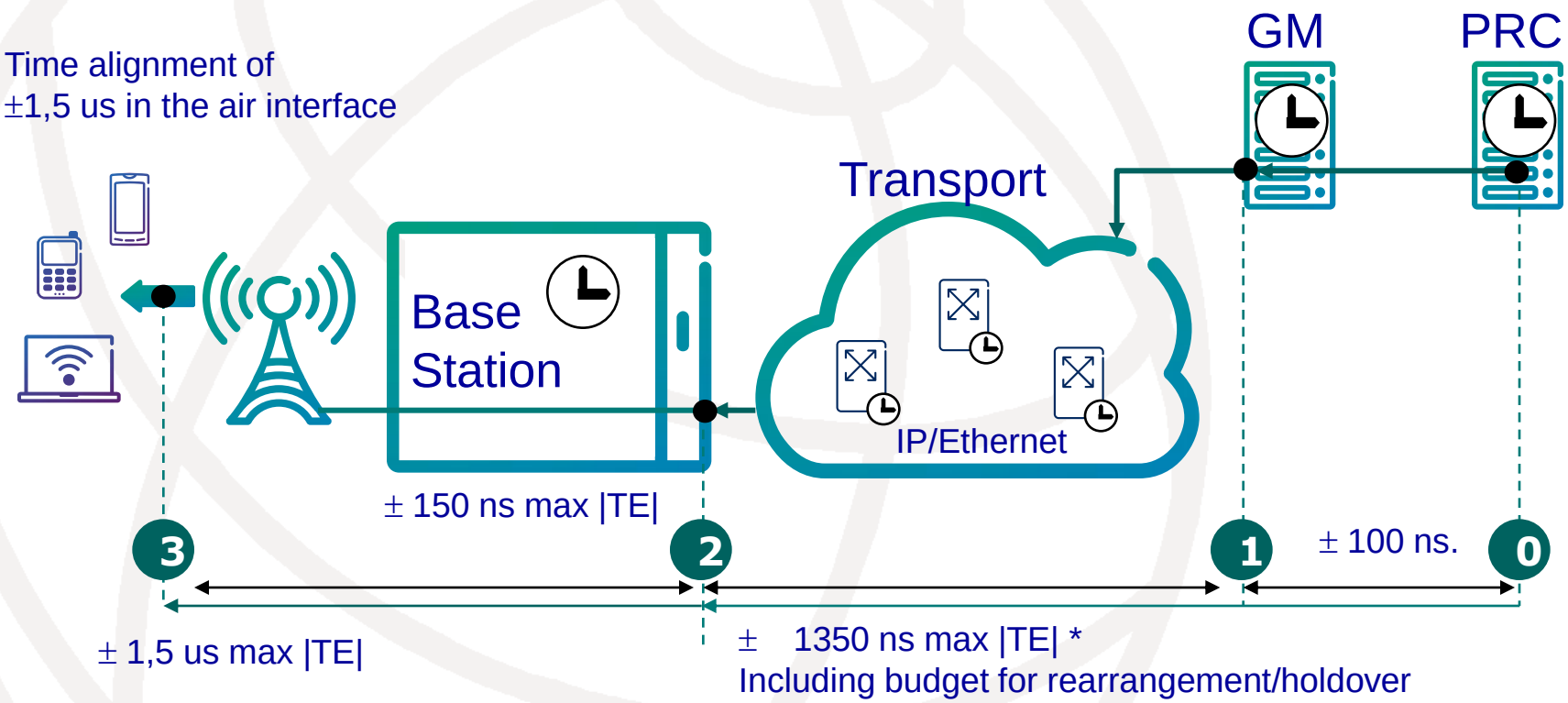


*after low pass filter (TBD);

ADDITIONAL EXAMPLE: REARRANGEMENTS HANDLED BY THE NETWORK

ERICSSON

Base Station continuously locked to the incoming PTP reference

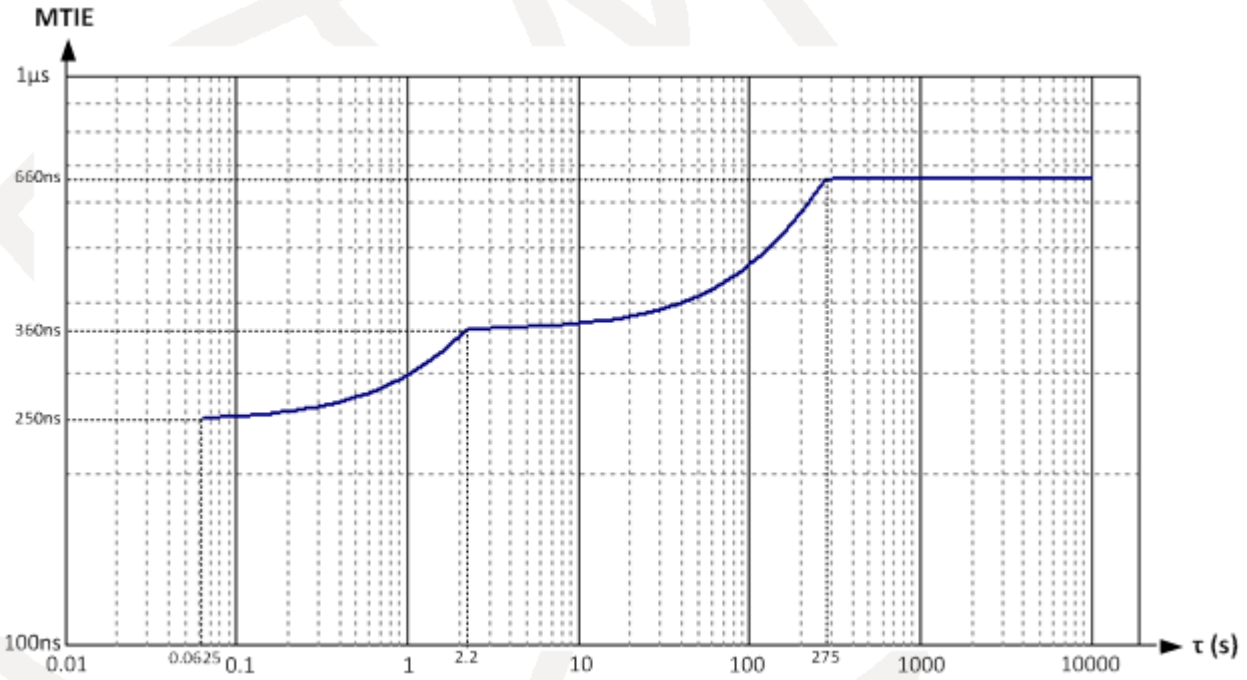


*after low pass filter (TBD)

DYNAMIC TIME ERROR: MTIE, TDEV, JITTER

ERICSSON

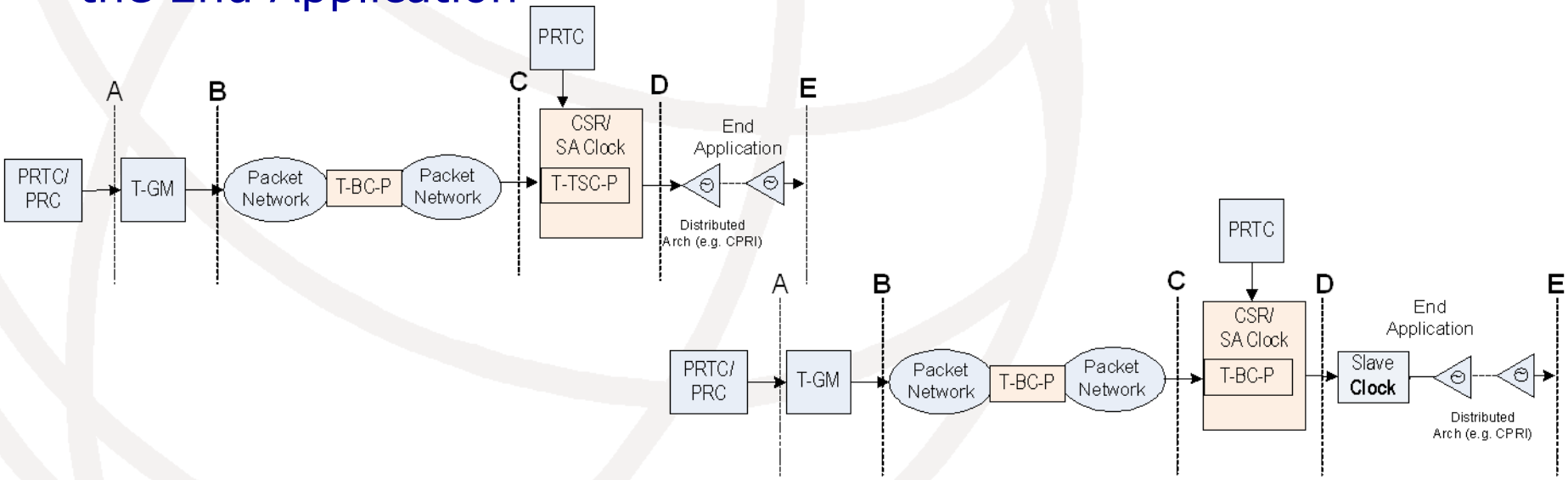
- MTIE mask has been defined based on the worst case:
  - Congruent scenario , with SyncE ring rearrangements



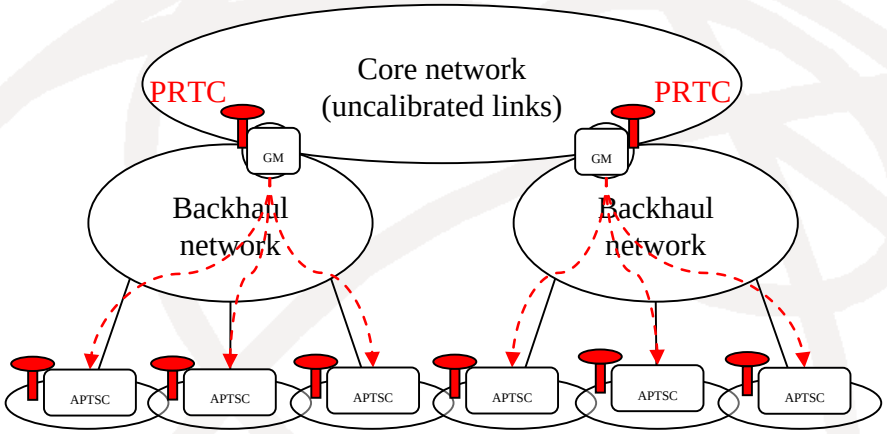
- This mask defines dynamic noise in the «time wander» region
- Jitter still to be defined

PARTIAL TIMING SUPPORT

- Initial focus on a special case: «Assisted Partial Timing Support» (APTS)
- PTP is used only as back up to GNSS
  - Increased concerns with GNSS vulnerability
  - Frequency reference may be sufficient
- Network limits to be defined in G.8271.2
- Two main deployment cases to start with: PTP or 1 PPS to the End Application

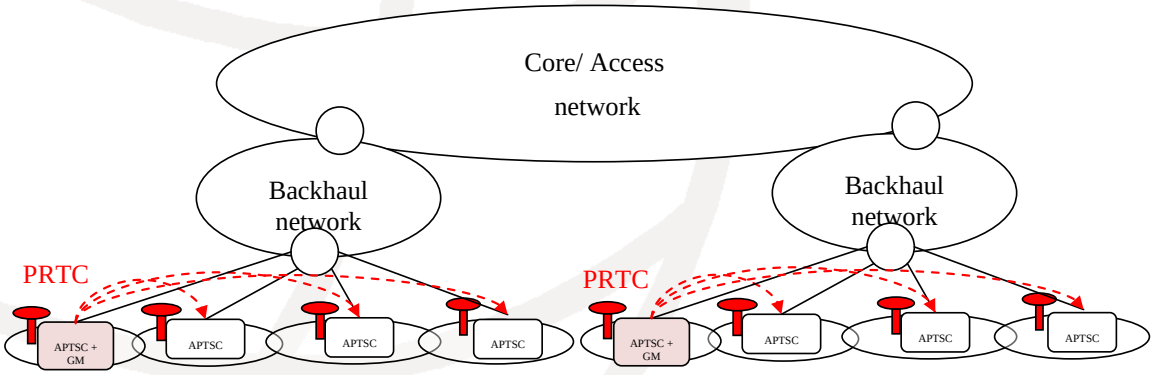


APTS ARCHITECTURES



Note: T-GM are connected to the PRTC in this architecture

Backup



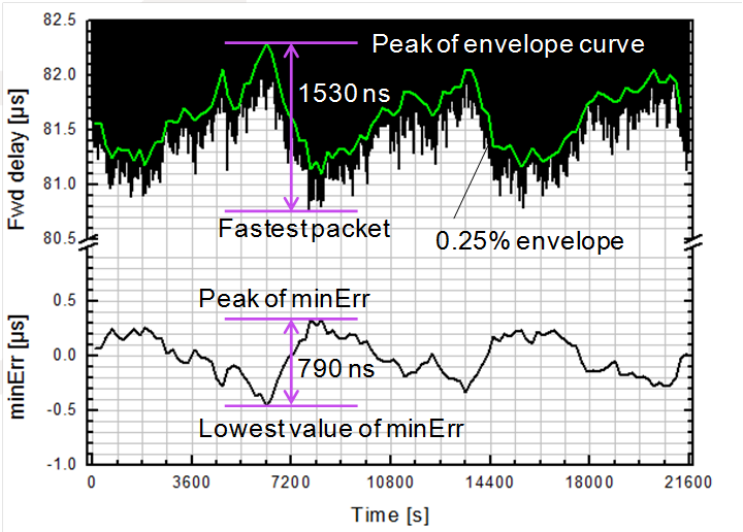
Backup : PRTC+GM A via Backhaul network to all APTSC's

APTS: STATUS ON NETWORK LIMITS

ERICSSON

- Focus on Slave node (BC in the future)
- Profile based on G.8265.1, but to cover time sync
- Clock characteristics, (e.g. "PDV tolerance") and Network Limits under discussion:
  - Need for an accurate metric (FPP may be too conservative)
  - Constant offset/Asymmetry is not an issue (frequency may be sufficient)
  - Packet selection is a key aspect
  - Variation of «minErr» and time dispersion prediction have been proposed

From WD65 (Sunnyvale 2014)



SUMMARY

ERICSSON

- G.8271.1 finalized (almost)
  - Max |TE| and MTIE time sync limits have been defined (full timing support)
- Some important topics to be completed:
  - Stability requirements (TDEV and high frequency noise)
- G.8271 and G.8271.1 provide the basis for other relevant recommendations
  - G.8272 PRTC), G.8273.2 (T-BC)
  - G.8273.3 (T-TC): under development
- Ongoing study on partial timing support
  - APTS as first application