5G RRH Phase Synchronization Challenges

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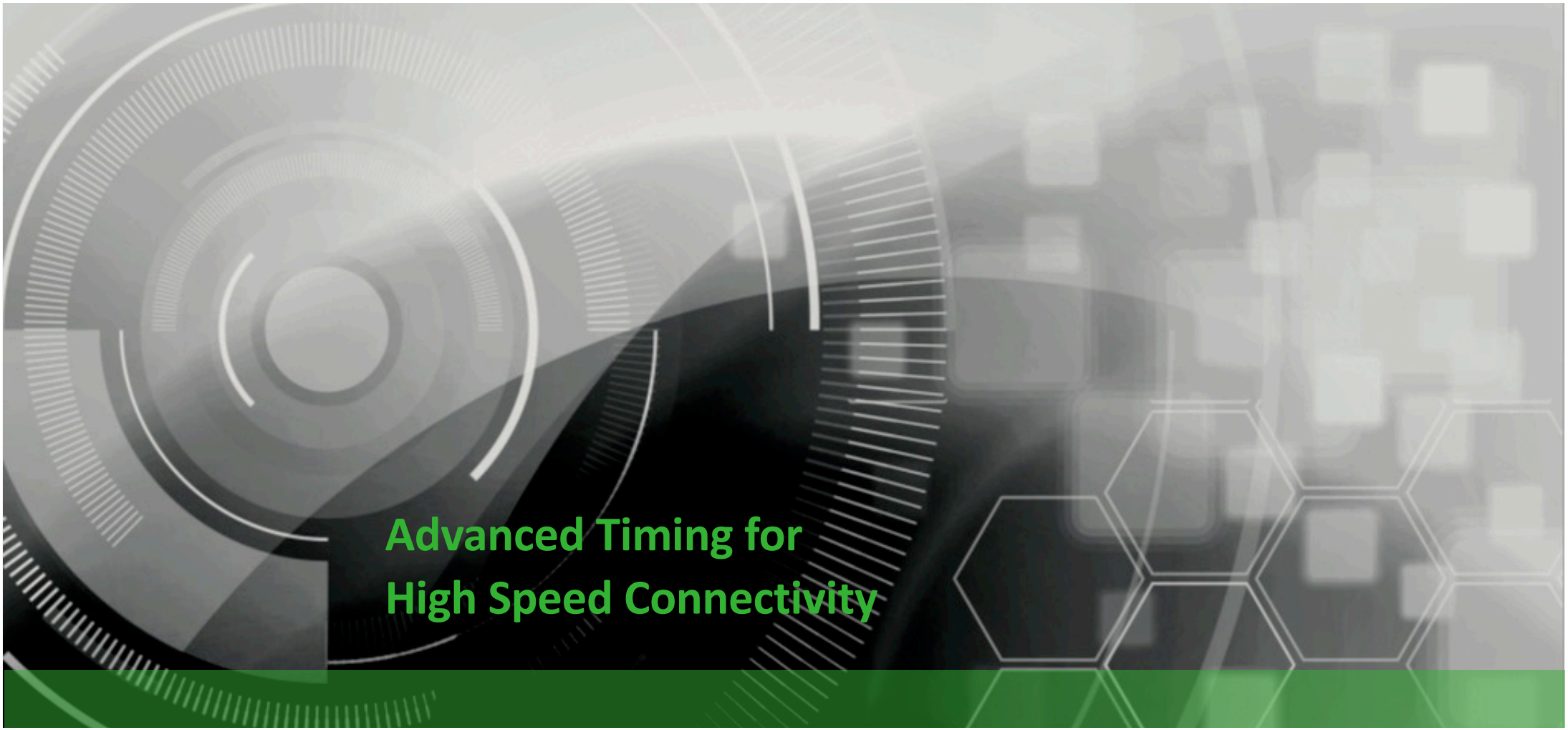
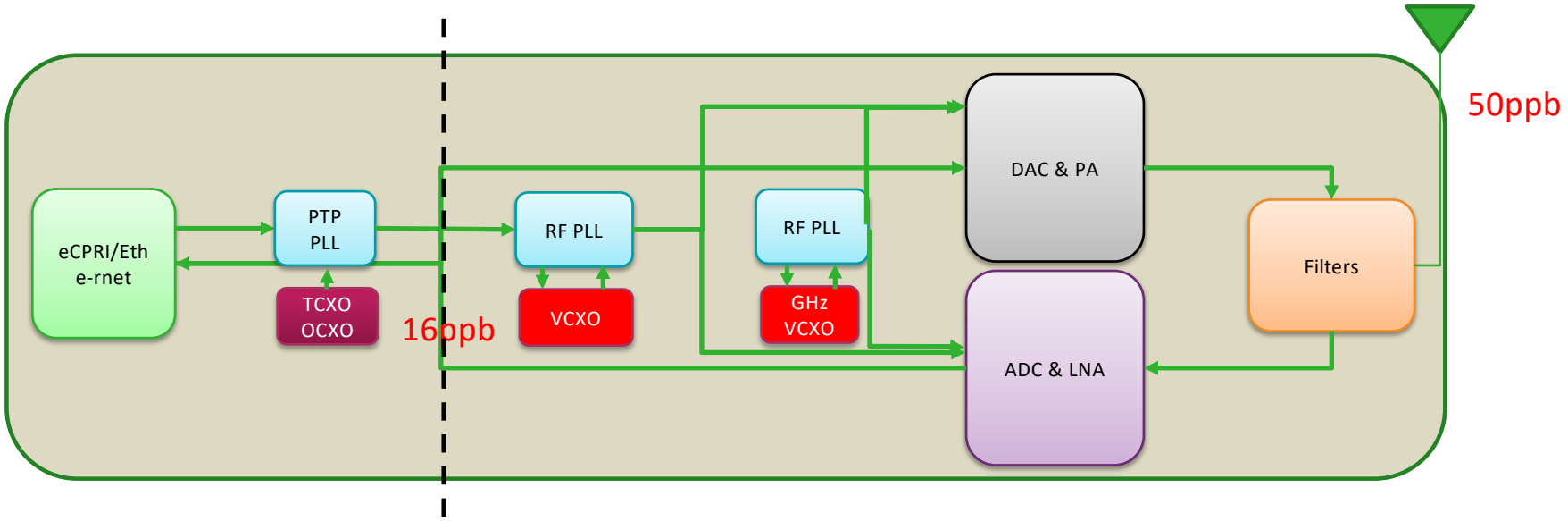


Agenda

- 5G RRH requirements
- 5G front-haul configurations
- Additional filtering on RRH
- Oscillator requirements
- Network configurations and oscillators

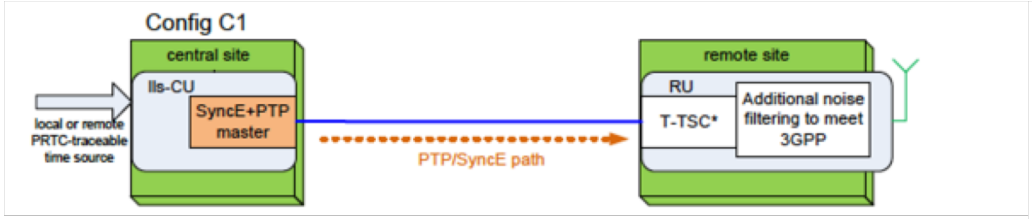
Overall & Synchronizer output requirements

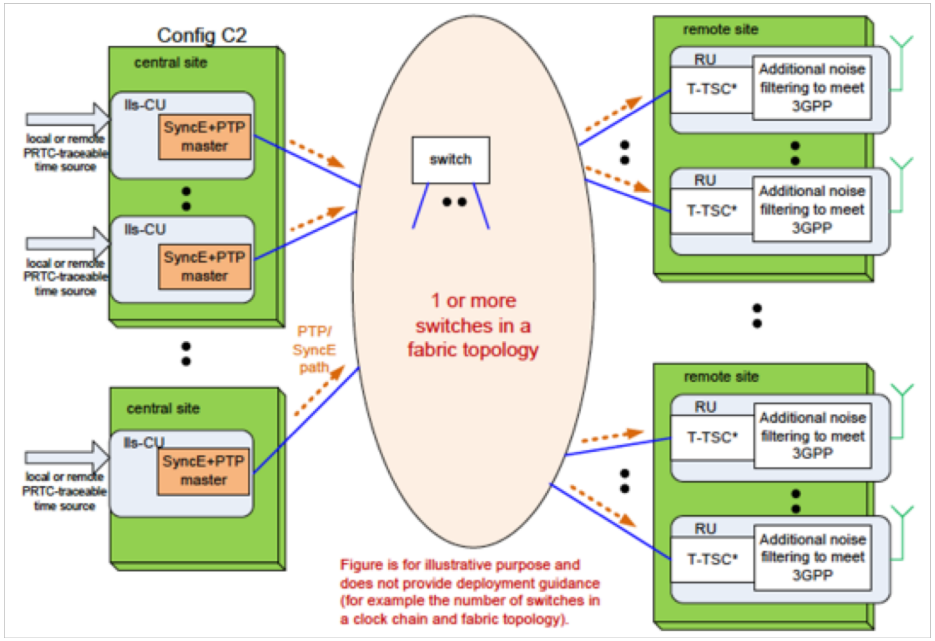


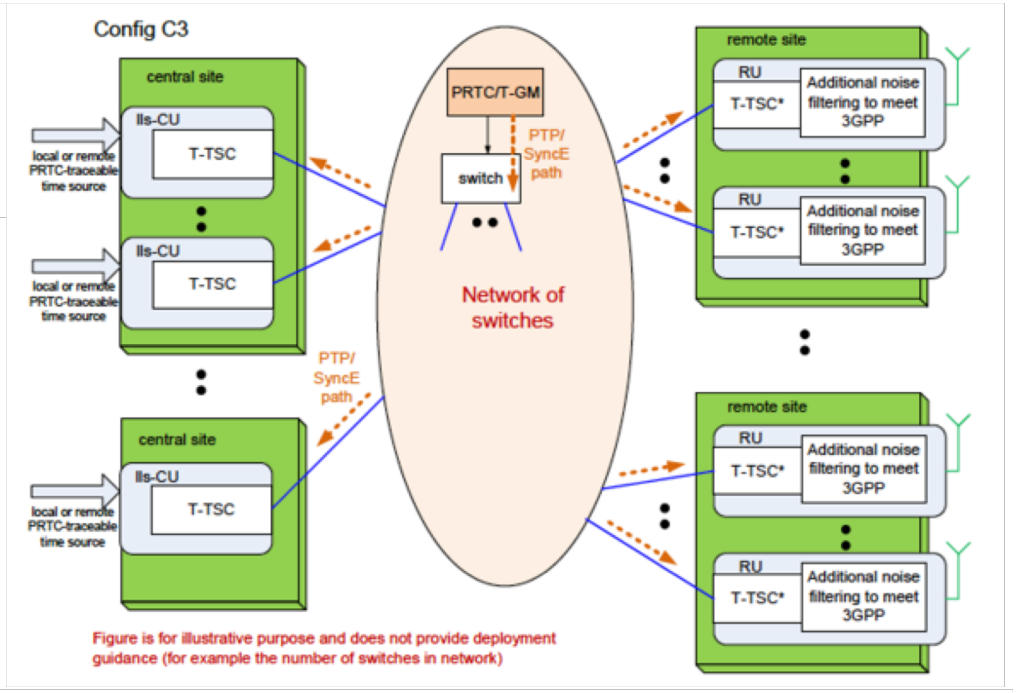
- **Synchronizer output**
  - 16ppb / 1ms
  - 10ns (Cluster)
  - 200ns (End to End)

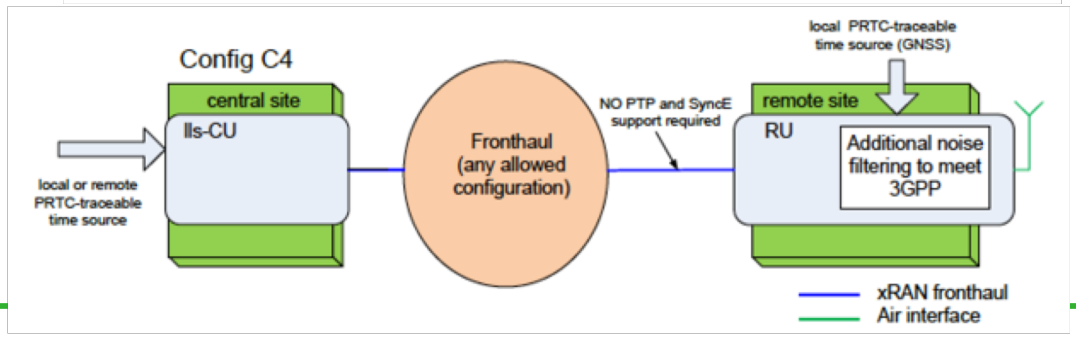
- **Radio**
  - 50ppb / 1ms
  - 65ns (Cluster)
  - 1.5uS (end to end)

RRH network deployment scenarios (XRAN)









CU/DU - RRH Summary of Network Scenarios

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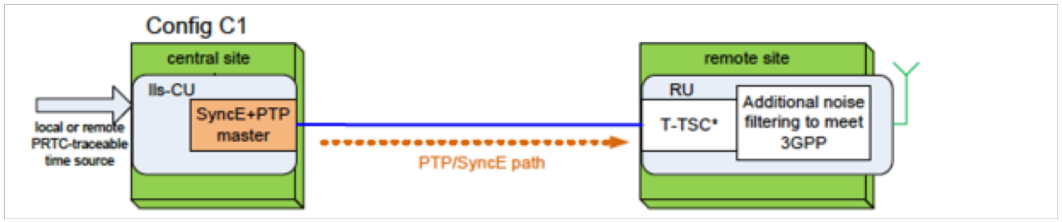
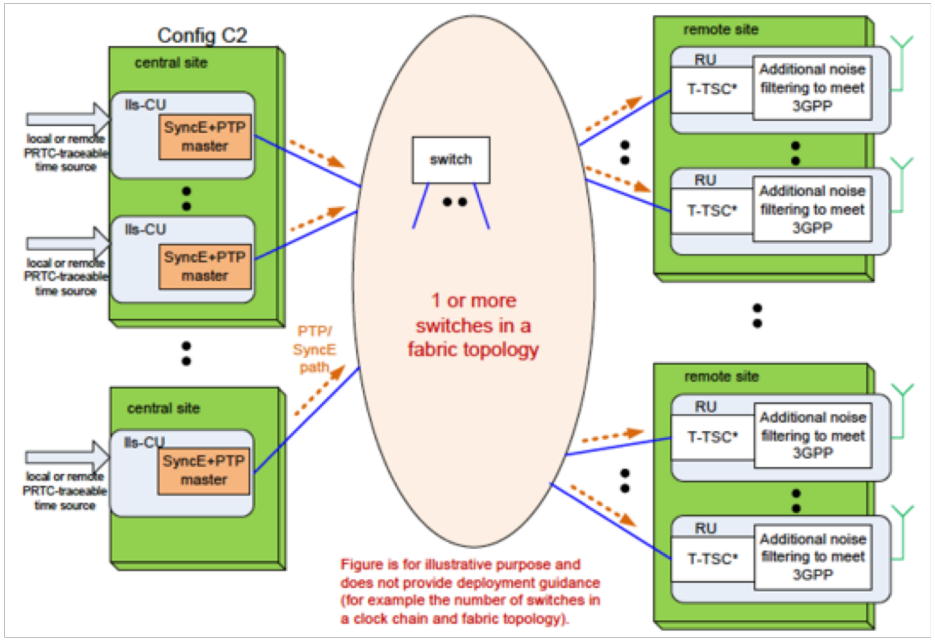
- #1 Point to Point
- #2 G.8273.2 A/B/C/D with n hops
- #3 PTP-GM on front-haul, n hops on each sides to CU/DU and RRH
- #4 Full chain of EEC
- #5 Cases #1-#4 with eEEC
- #6 PTP-GM on the RRH

- Cases #1-#3 with no SyncE support

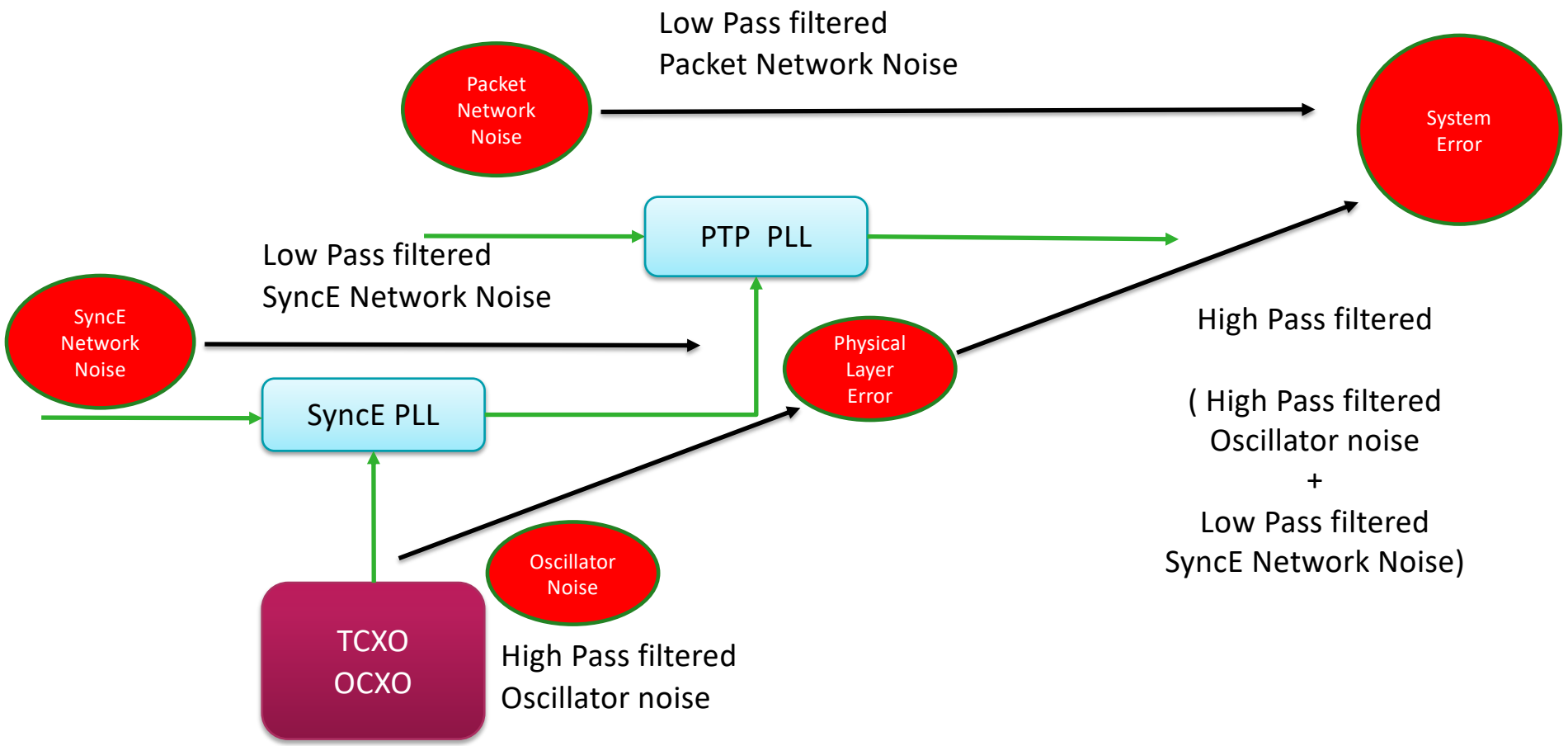
- At Constant temperature
- All cases with temperature variation

Commonly used scenarios





Synchronizer: Error inputs & Output Errors



Noise at the input

Network Limit of G.8262/G.8262.1 from G.8261

Table 4 – Network limit for wander at EEC-Option 1 interfaces expressed in MTIE

Observation interval τ (s)	MTIE requirement (ns)
$0.1 < \tau \leq 2.5$	250
$2.5 < \tau \leq 20$	100 τ
$20 < \tau \leq 2000$	2000
$\tau > 2000$	$433\ \tau^{0.2} + 0.01\ \tau$

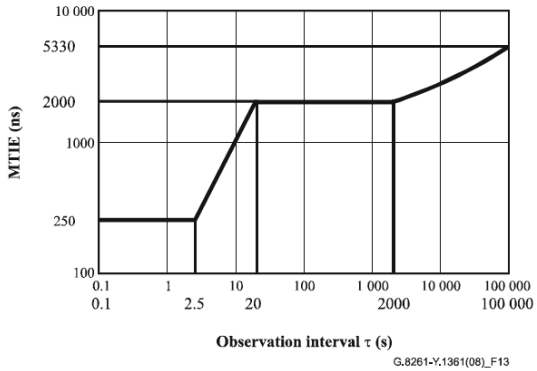


Figure 13 – Network limit for wander (MTIE) at EEC-Option 1 interfaces

- ***G.8262.1 may have a reduced network limit**

Requirements

- To get a 16ppb ffo at the synchronizer output

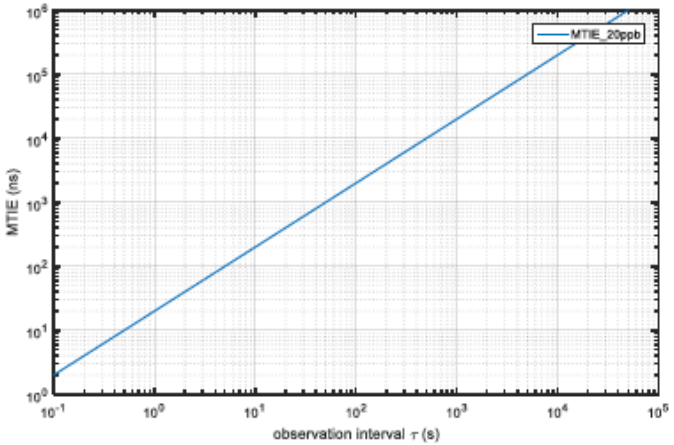


Figure 2 Additional MTIE requirements for SyncE layer

Generalized approach

- **Frequency offset = A * 2 * pi * f_{bw}**

Table 4 – Network limit for wander at EEC-Option 1 interfaces expressed in MTIE

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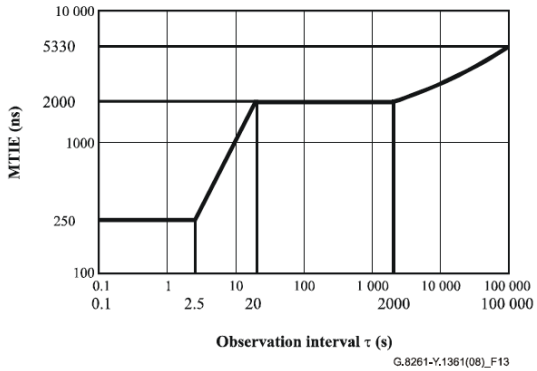


Figure 13 – Network limit for wander (MTIE) at EEC-Option 1 interfaces

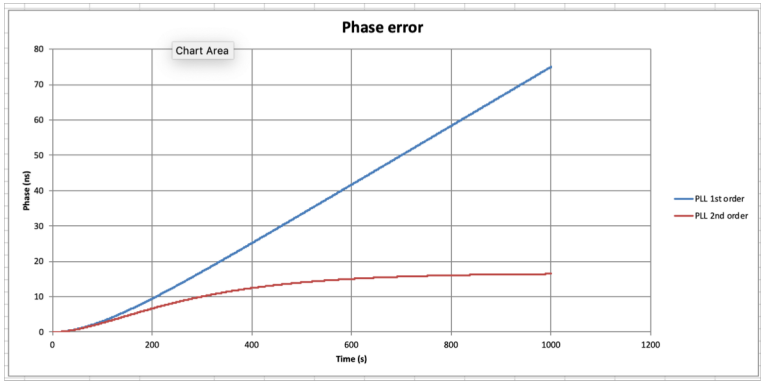
- **The filter value needs to be 10mHz**
- **If network limit to be 1/5 for new networks**
  - Filter value to be 50mHz

Phase Error across temperature - 10mHz

Assumptions :

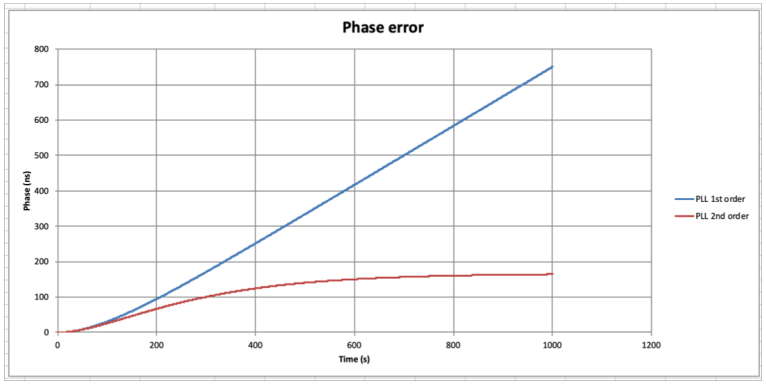
- Wander generation with ideal input case
- The radio may see a full range of temperature variations – 0.5degC/min
- Various Oscillator sensitivities

With 0.1ppb/degC



<20ns

With 1ppb/degC



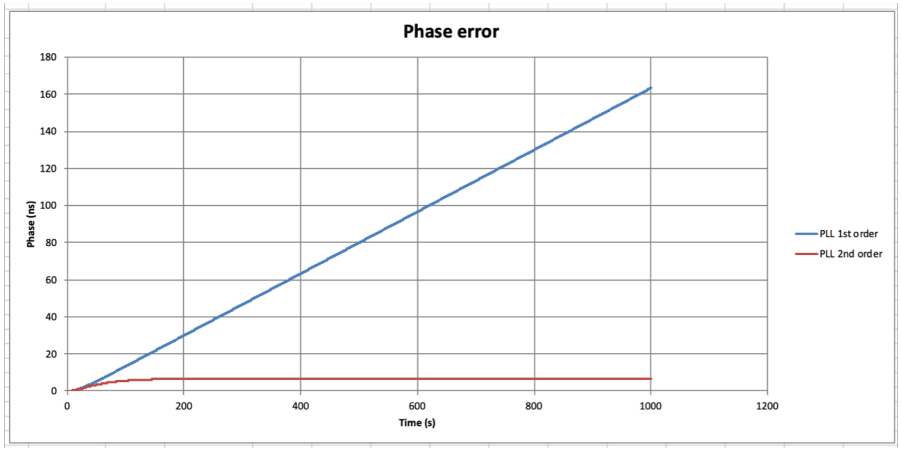
100+ns

Phase Error across temperature - 50mHz

Assumptions :

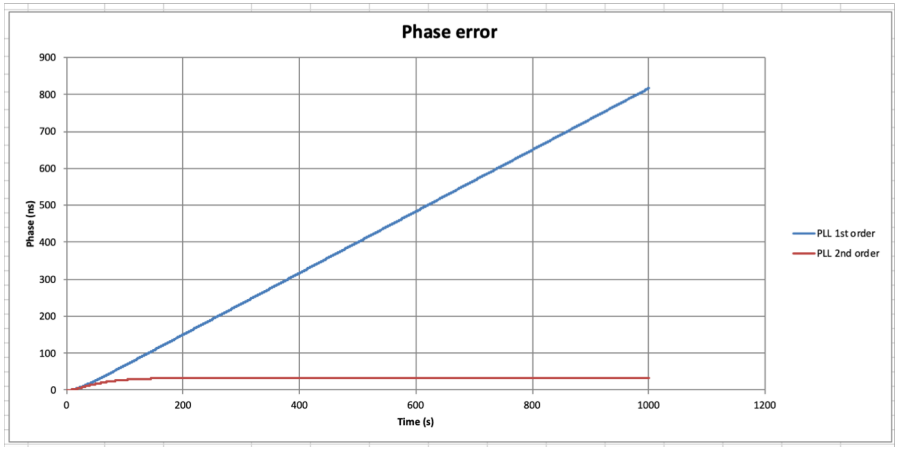
- Wander generation with ideal input case
- The radio may see a full range of temperature variations – 0.5degC/min
- Various Oscillator sensitivities

With 1ppb/degC



<20ns

With 5ppb/degC



>30ns

Slope requirements Vs network Scenarios

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Sl No	Description	Network Error	Slope	Output Performance
1	Traditional Networks	G.8262	0.1ppb/Deg C	<20ns
2	New Networks	G.8262.1	1ppb/deg C	<20ns
3	Point to point	G.8262.1 Wander	5ppb/degC	<20ns

Oscillators for RRH

	Post compensated TCXO	Miniature OCXO
Slope	1-5ppb/℃	0.1ppb/℃
Frequency Vs Temp Performance	30ppb (-40℃ to 85℃)	20ppb (-40℃ to 85℃)
Size	7mmx5mm, 5mmx3.2mm	7mmx5mm
Network Support	New Networks	Traditional Networks
Power	30mW	300mW
Warm up	100ms	3min

Summary

- **5G RRH deployment scenarios and fronthaul configurations vary**
  - Thus the network noise in to the RRH
- **Network noise and reference clock impairments contribute to phase errors**
  - Selection of loop bandwidth and refence clock plays key role

- **Network structure has a major impact and selection of oscillators for Remote Radio Heads**
- **There are number of possible solutions available on the reference clocks**

Thank you