Addressing the Sync Accuracy Challenges of 5G RAN

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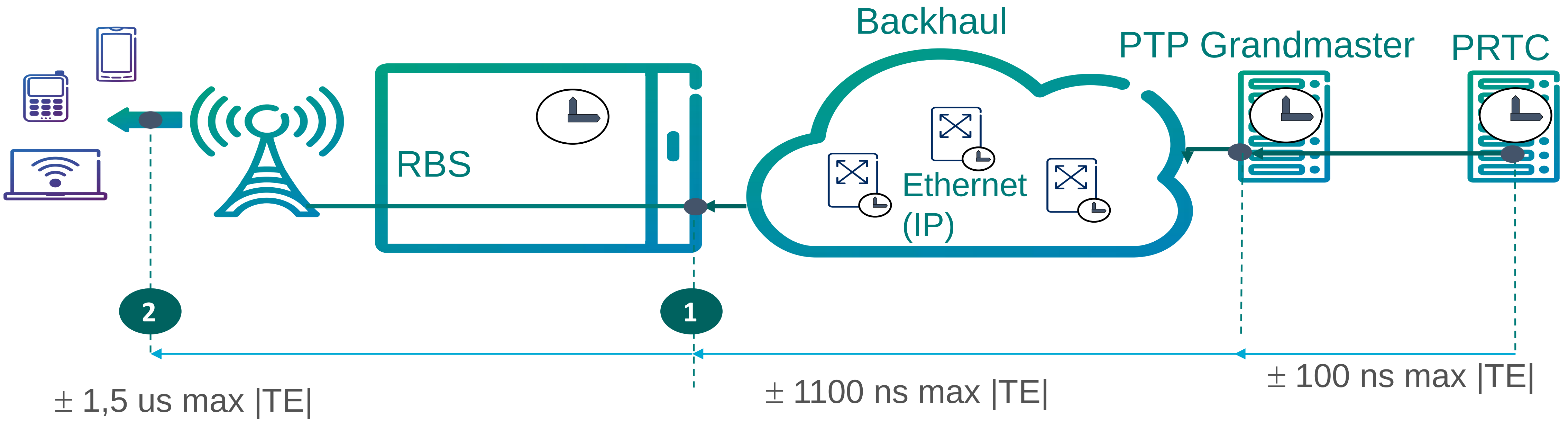
RBS Synchronization System Responsible

ERICSSON

Baseline - Challenges

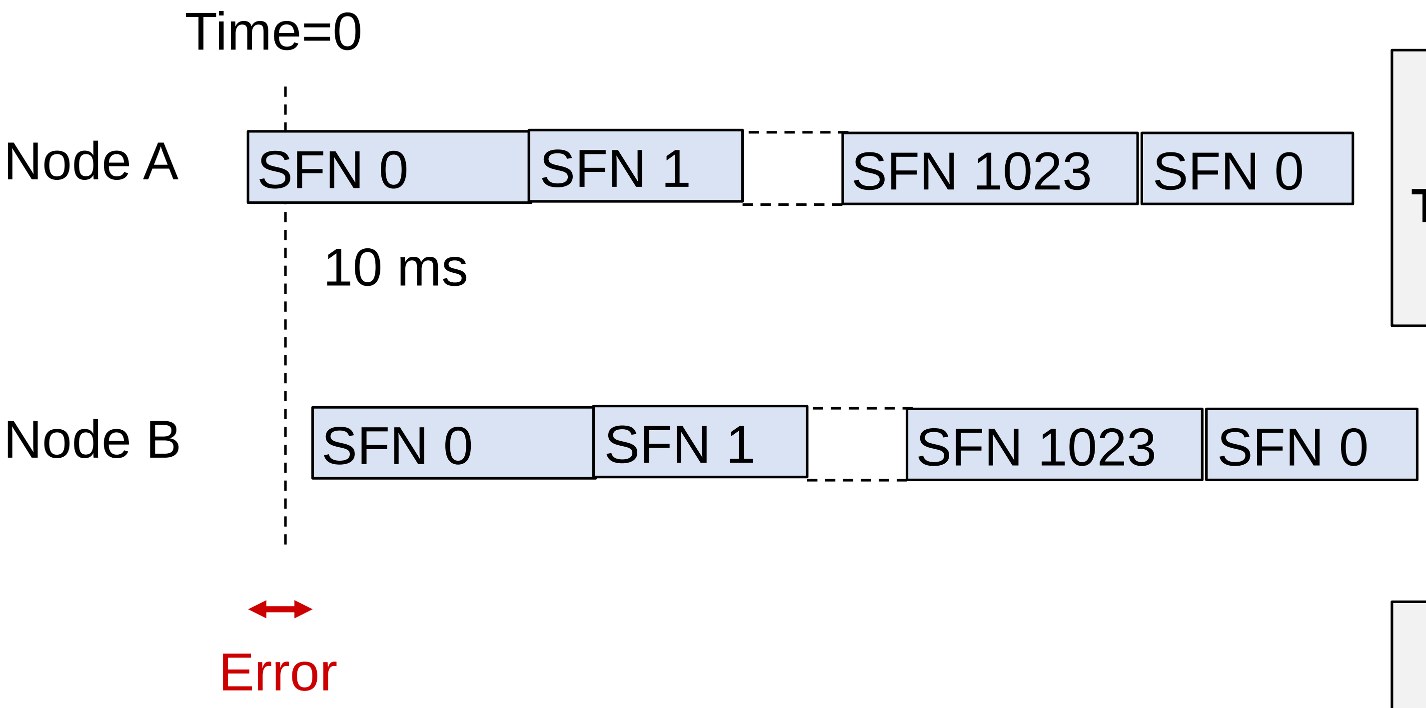


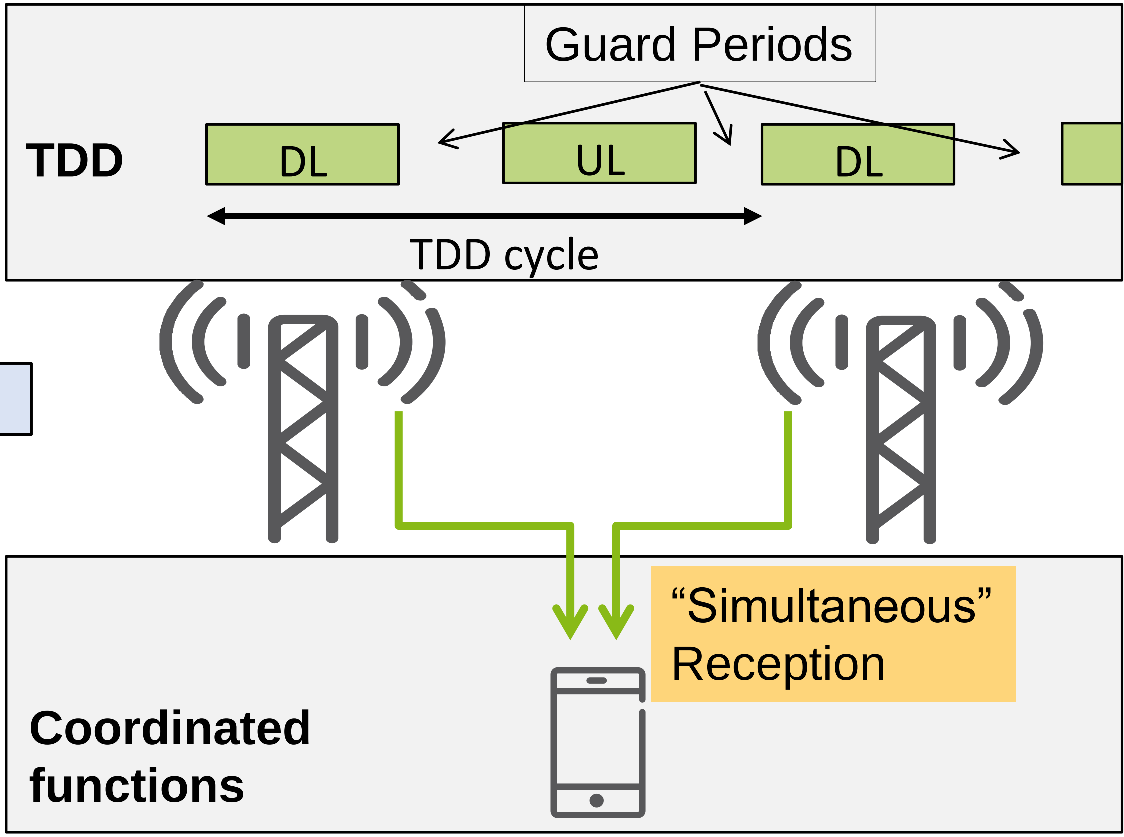
Baseline: ITU-T reference path allocates 400 ns to the BS (G.8271.1&2)

Challanges:

- Industrial IOT: High Accuracy Time transparency required across 5G NW including the UE(s)
- Integrated Access and Backhaul: RAN faces the same accuracy budget problem as PTP
- UE Positioning: Unrealistic expectations on Synchronization accuracy.

Synchronization – of what?

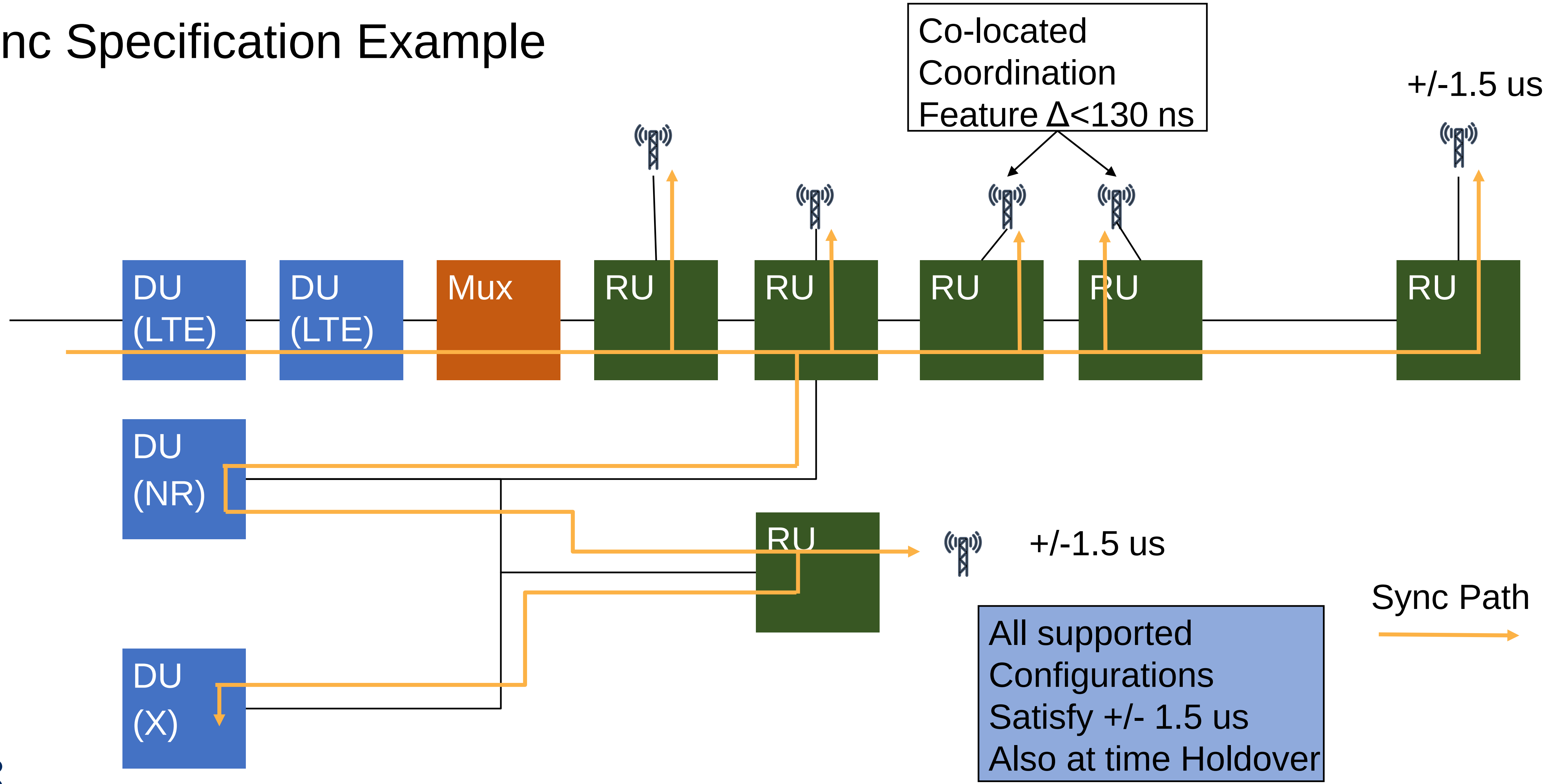




Max Error between non-colocated antennas for NR TDD according to 3GPP: 3 us

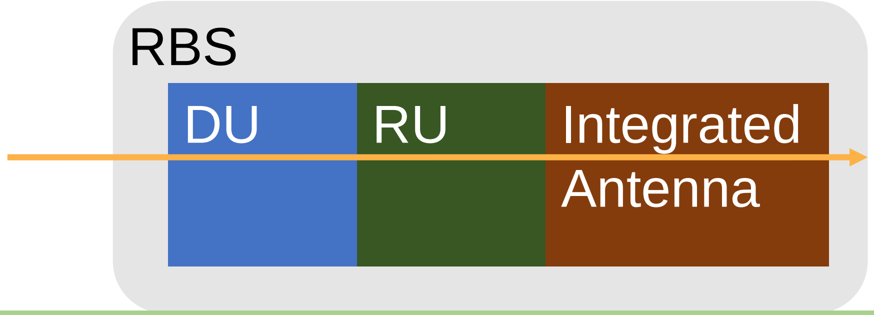
What is an RBS?

Sync Specification Example



Improved accuracy of the RBS?

With a completely Integrated RBS/RU,
you get best possible accuracy

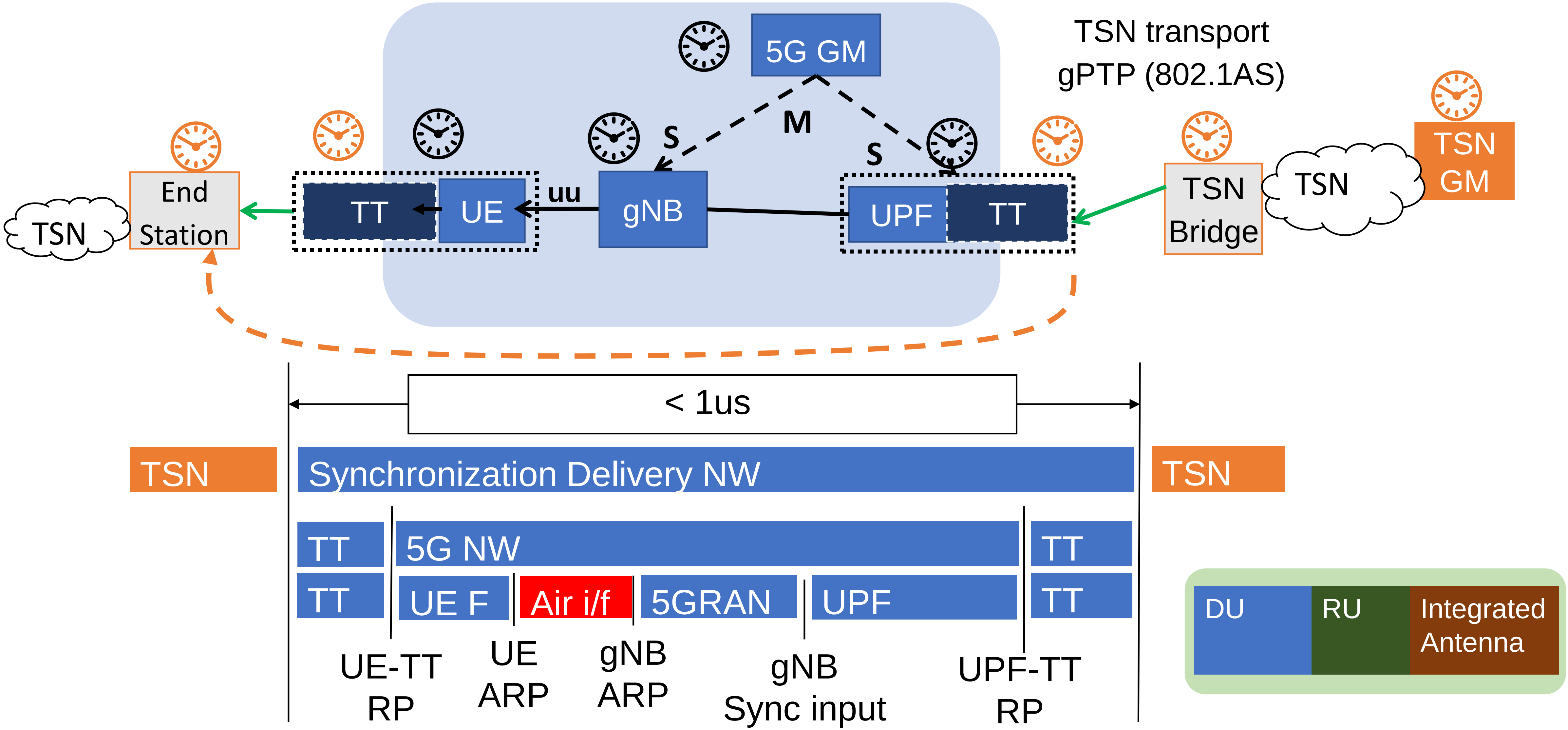


Bottlenecks

- PTP or GNSS accuracy.
- Holdover margin for GNSS outage.
- Radio signal Filters.
  - E.g Cavity filters. Even when compensated have a large temperature dependent group delay.

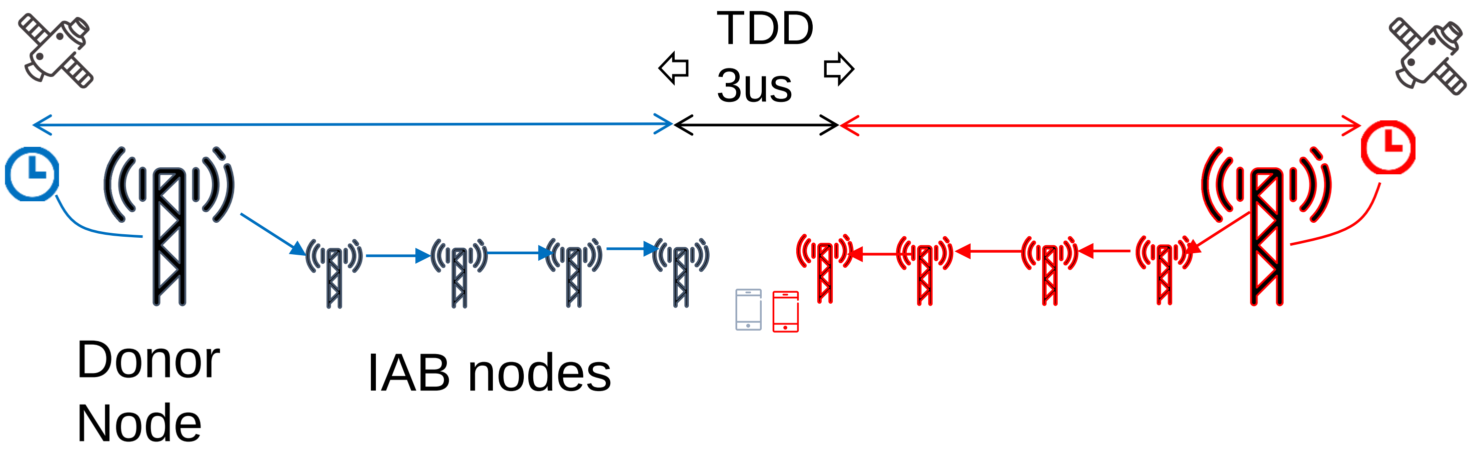
Applications requiring much higher accuracy require special RBS designs and special Sync distribution design

Industrial IoT challenge



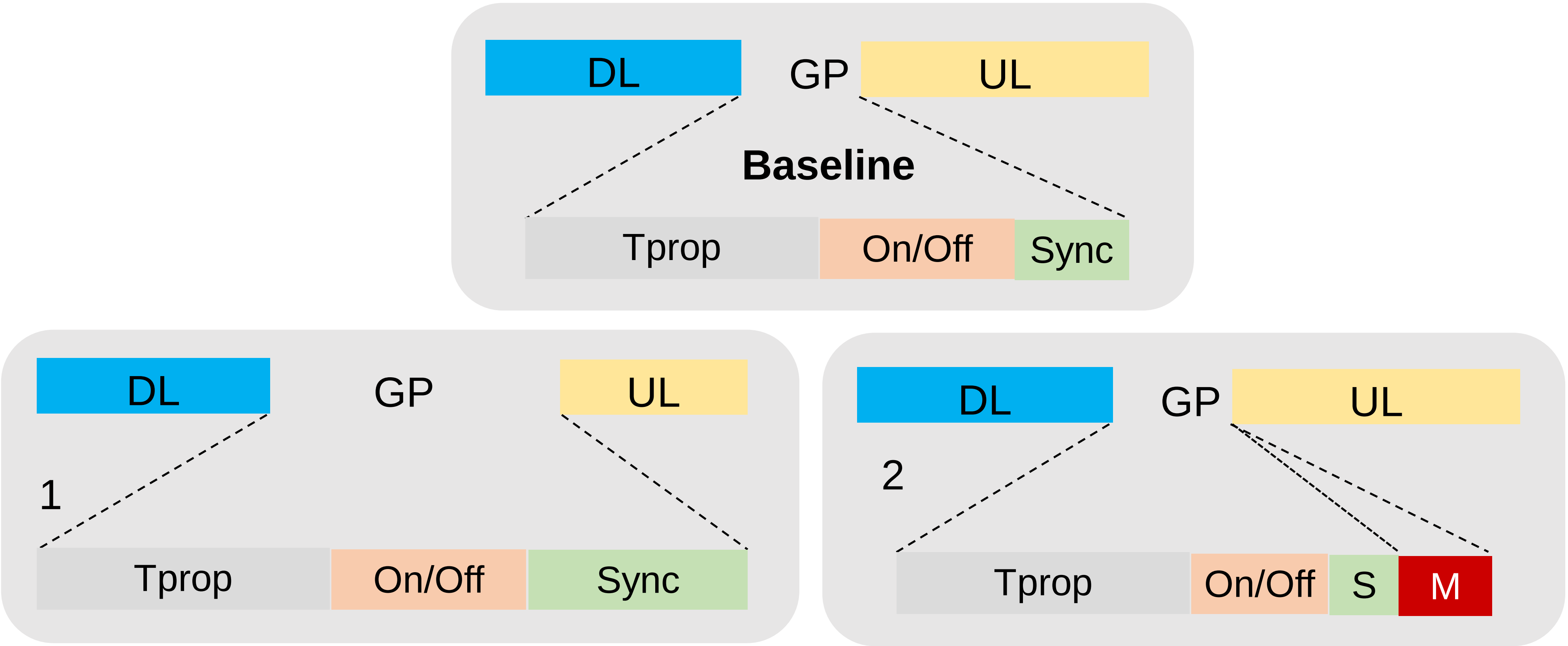
IAB

Integrated Access and Backhaul



- IAB nodes have no fixed line transmission. Only the ordinary Radio Access Interface (Same as UE)
- It is TDD. (Nodes send and receive on the same frequency)
- Synchronization options:
  - GNSS.
    No Challenge. Legacy requirements and solutions apply.
  - Over The Air (Radio interface)
    Legacy Time budget is not sufficient.
    Holdover not required at IAB nodes. (But at Donor node)

IAB options



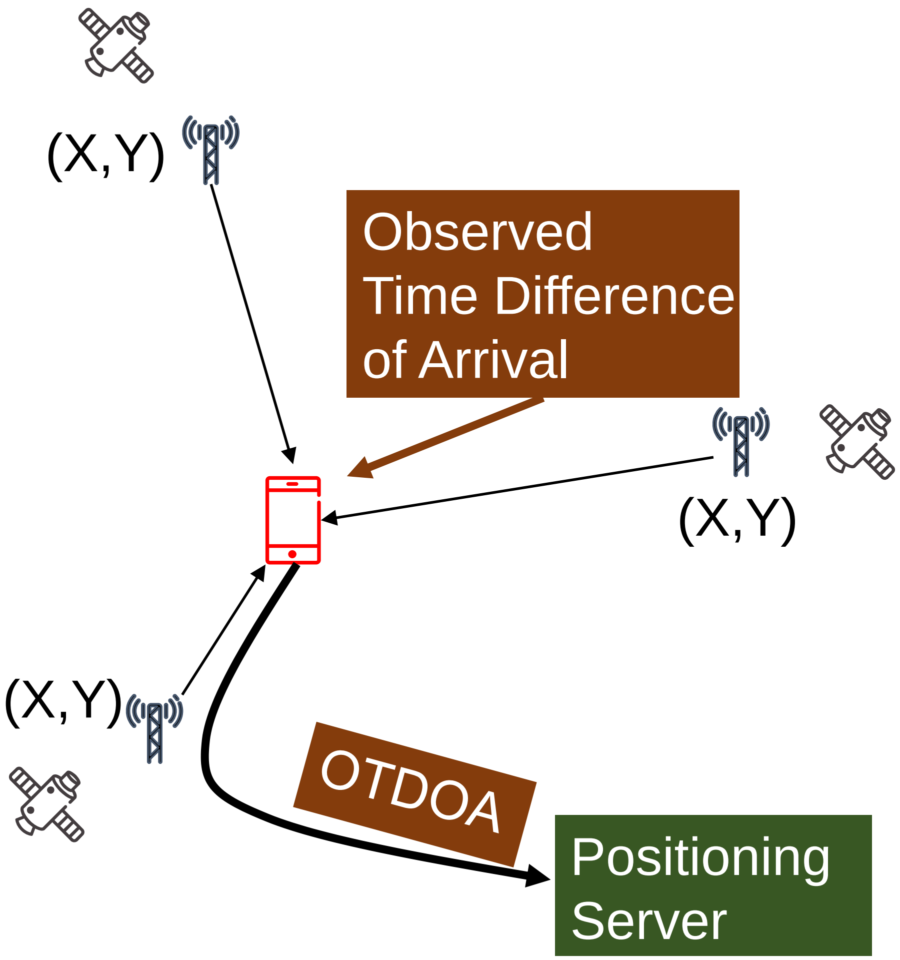
Requires GNSS
Sacrifice Holdover?

Multi hop allocation

Time budget for IAB can be obtained from following:

1. Additional Guard Period symbols. Ample margins. Takes capacity.
2. Better than standard IAB nodes. Increases Cost. Reduces Availability

UE Positioning



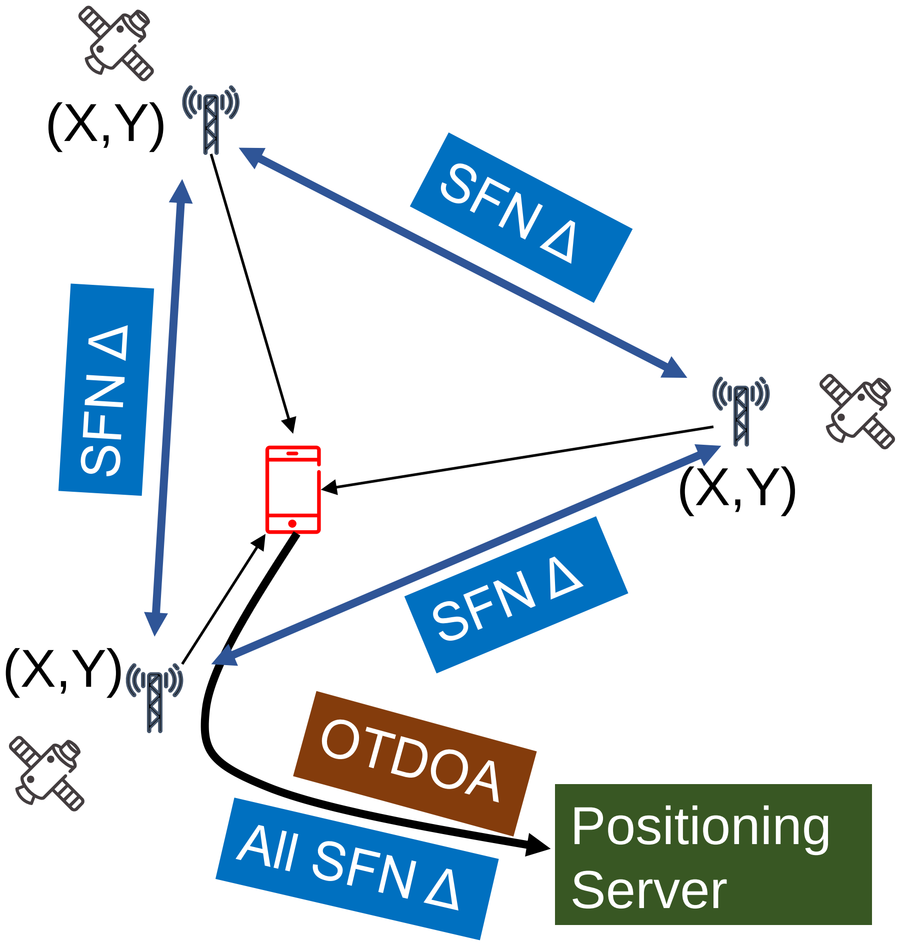
All ranges of positioning accuracy are discussed.
From 100 m to a few cm.

Some methods rely on accurate Synchronization.
But far from all.

Round trip time measurement to the UE would
Remove requirement for Sync.
Heuristic methods like Fingerprinting etc.

- ALI Accuracy Standards: The FCC adopted the following revised standards for Phase II location accuracy and reliability:
  - For handset-based solutions: 50 meters for 67 percent of calls, 150 meters for 95 percent of calls;
  - For network-based solutions: 100 meters for 67 percent of calls, 300 meters for 95 percent of calls.

Positioning by sync – How to improve



Measure the SFN Δ between all RBSes over the radio interface.

Correct the triangulation calculation with deltas

More accurate since measurements of SFN Δ is made close to the radio interface

Mainly applicable to TDD. RBS can send and receive on same frequency.
More Complex for FDD.
Still limited by antenna feeder accuracy and Radio filter accuracy
Radio parameters like receiver noise and multi-path poses problems.

Conclusions

A modular and complex RBS can meet the 3GPP requirement of +/- 1.5 us,
But the 400 ns allocated by ITU-T is used up by components and time holdover.

A fully integrated RBS could provide better accuracy for IoT, IAB, and Positioning.
But are vendors and operators willing to pay the extra cost?

Restricted deployments for industrial IoT,
More margin for Sync through added Guard slots for IAB,
Non Sync dependent or SFN Δ measurements can be applied for UE positioning

Can reduce synchronization accuracy requirements
Which will reduce cost of deployment