TSN Update and

The Use of TSN for Fronthaul

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Outline

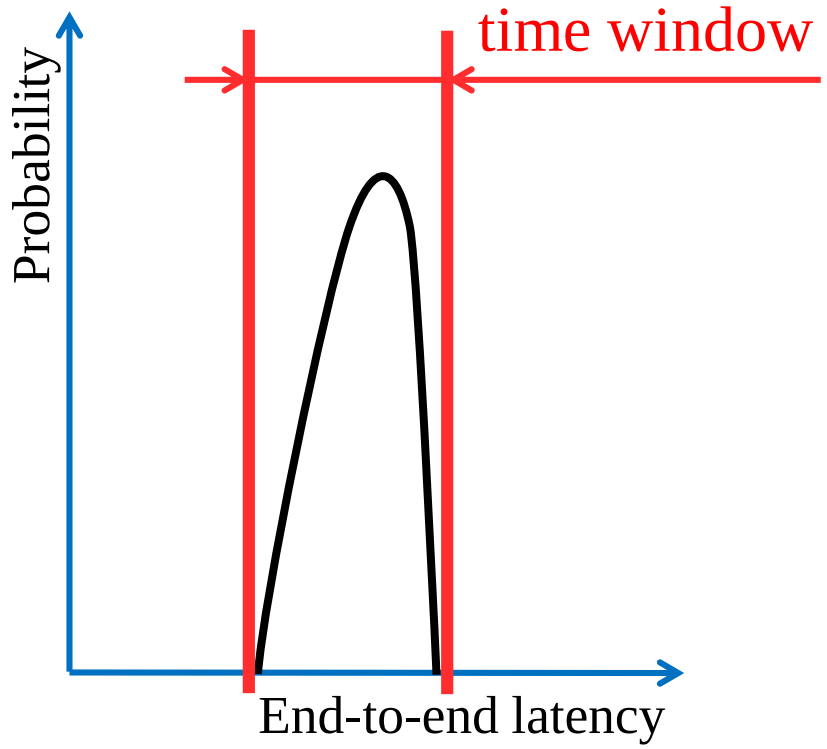
- Time-Sensitive Networking (TSN)
  - TSN tools
  - TSN profiles
- TSN for Fronthaul profile
  - Background
  - Overview
  - Updates via amendment
- Summary

What is TSN all about?

Time-Sensitive Networking (TSN) = the right packet at the right time

— Deterministic data packet delivery =

— Data packet delivery within a **time window** without loss or delay due to congestion or errors

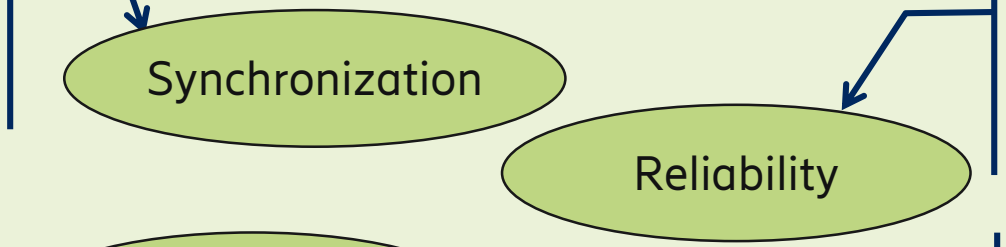


TSN Profiles (Selection and use of TSN tools)

Audio Video Bridging [802.1BA]	Fronthaul [802.1CM(de)]	Industrial Automation (IEC/IEEE P60802)	Automotive In-Vehicle (P802.1DG)	Service Provider (P802.1DF)

TSN Components

(Tools of the TSN toolbox)



Time synchronization:
Timing and Synchronization (802.1AS)
includes a profile of IEEE 1588
(revision: P802.1AS-Rev → 802.1AS-2020
at IEEE SA Standards Board for approval)

High Availability / Ultra reliability:
Frame Replication and Elimination (802.1CB)
Path Control and Reservation (802.1Qca)
Per-Stream Filtering and Policing (802.1Qci)
Reliability for time sync (802.1AS-2020)

Bounded low latency:
Credit Based Shaper (802.1Qav)
Frame preemption (802.3br & 802.1Qbu)
Scheduled Traffic (802.1Qbv)
Cyclic Queuing and Forwarding (802.1Qch)
Asynchronous Traffic Shaping (P802.1Qcr)
QoS Provisions (P802.1DC)

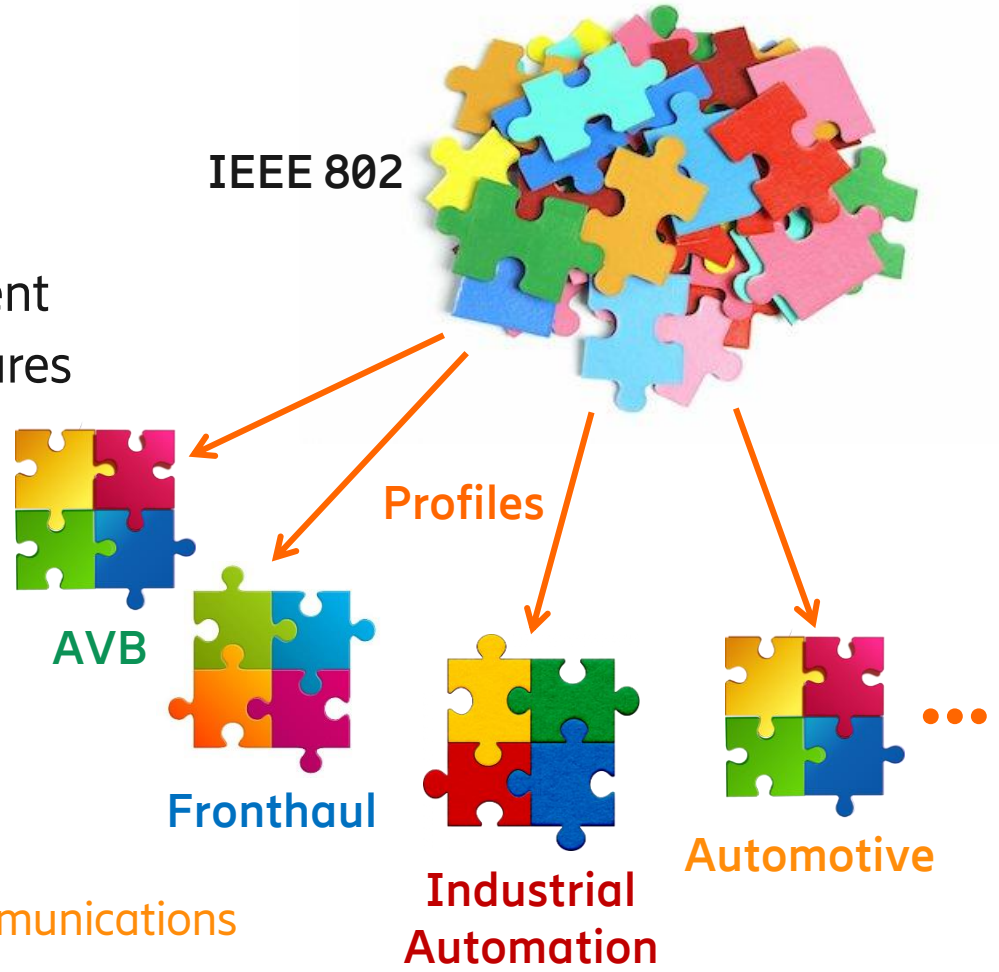
Zero congestion loss = Bounded latency

Dedicated resources & API
Stream Reservation Protocol (802.1Qat)
TSN configuration (802.1Qcc)
Basic YANG (802.1Qcp)
YANG for CFM (P802.1Qcx)
YANG for LLDP (P802.1ABcu)
YANG for Qbv, Qbu, and Qci (P802.1Qcw)
YANG & MIB for FRER (P802.1CBcv)
Extended Stream Identification (P802.1CBdb)
Link-local Registration Protocol (P802.1CS)
Resource Allocation Protocol (P802.1Qdd)
Configuration Enhancements (P802.1Qdj)
LLDPv2 (P802.1ABdh)

Note: P upfront of an ID indicates ongoing Project

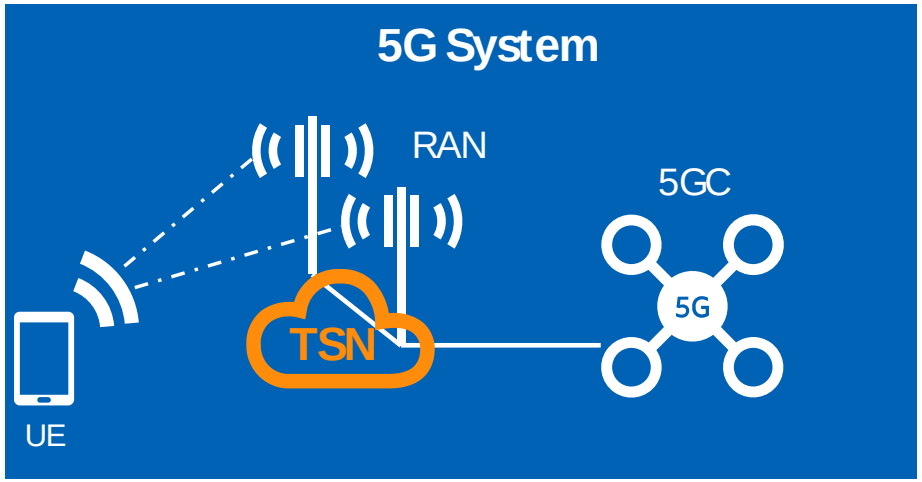
TSN Profiles

- Wide breadth of choices in IEEE 802 standards
- A TSN Profile
  - Narrows the focus ➔ ease interoperability and deployment
  - Selects features, options, defaults, protocols, and procedures
  - Describes how to build a network for a particular use
  - Provides configuration guideline if needed
- Published TSN profile standards:
  - IEEE Std 802.1BA for Audio-Video Bridging (AVB) networks
  - IEEE Std 802.1CM TSN for Fronthaul
- Ongoing TSN profile projects:
  - IEC/IEEE 60802 TSN Profile for Industrial Automation
  - P802.1DG TSN Profile for Automotive In-Vehicle Ethernet Communications
  - P802.1CMde Amendment (TSN for Fronthaul)
  - P802.1DF TSN Profile for Service Provider Networks

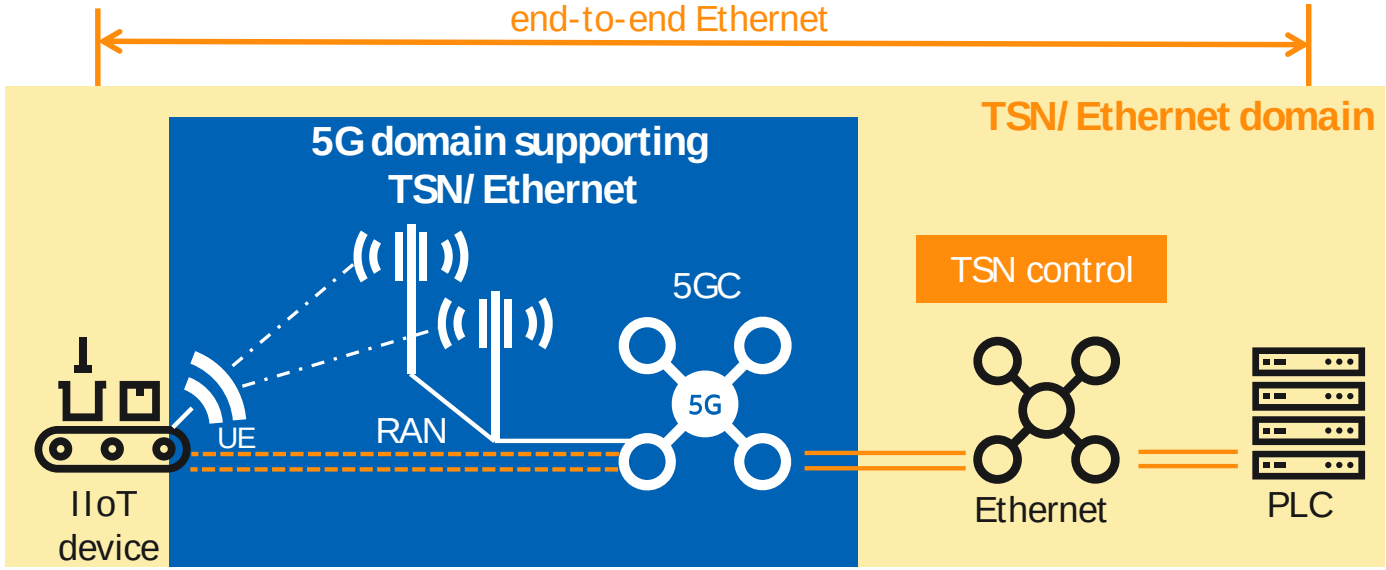


Relationship between TSN and 5G

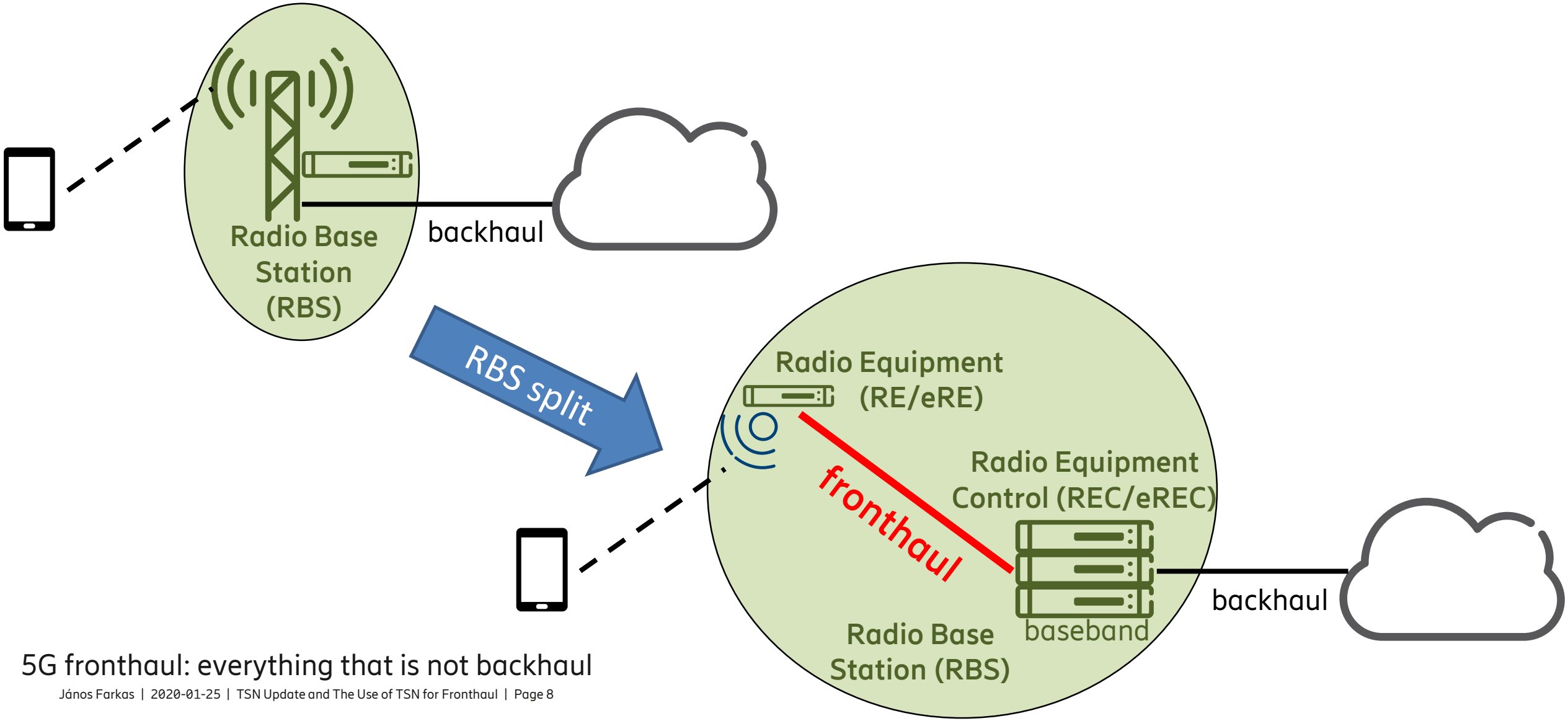
A) TSN as a building block of 5G



B) 5G interconnecting TSN devices

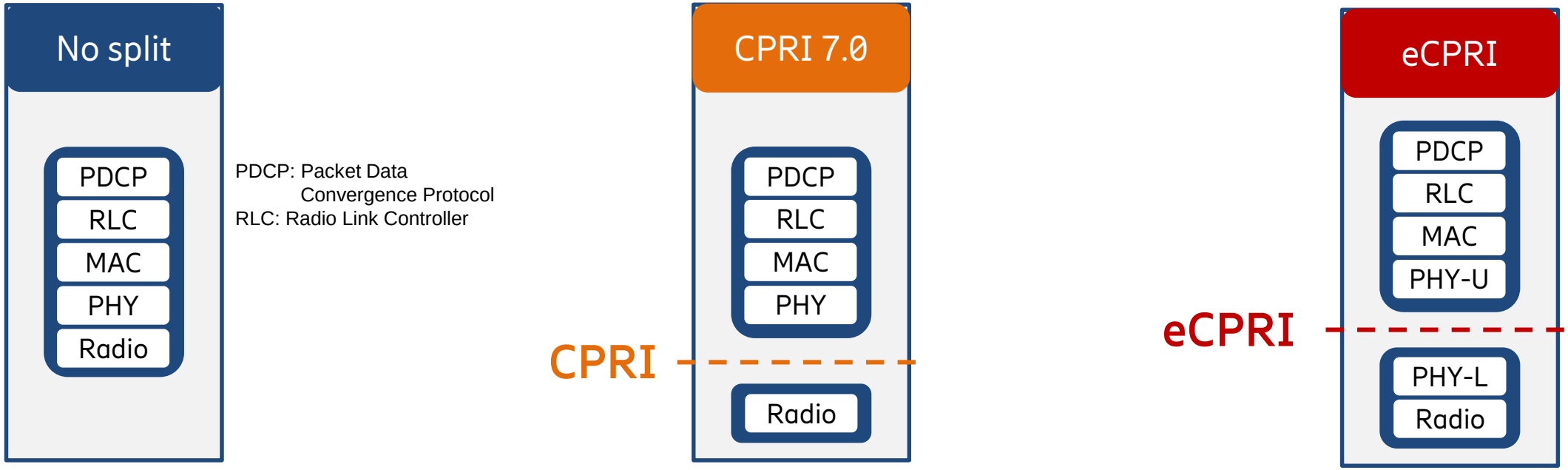


5G Fronthaul – Simplified Architecture



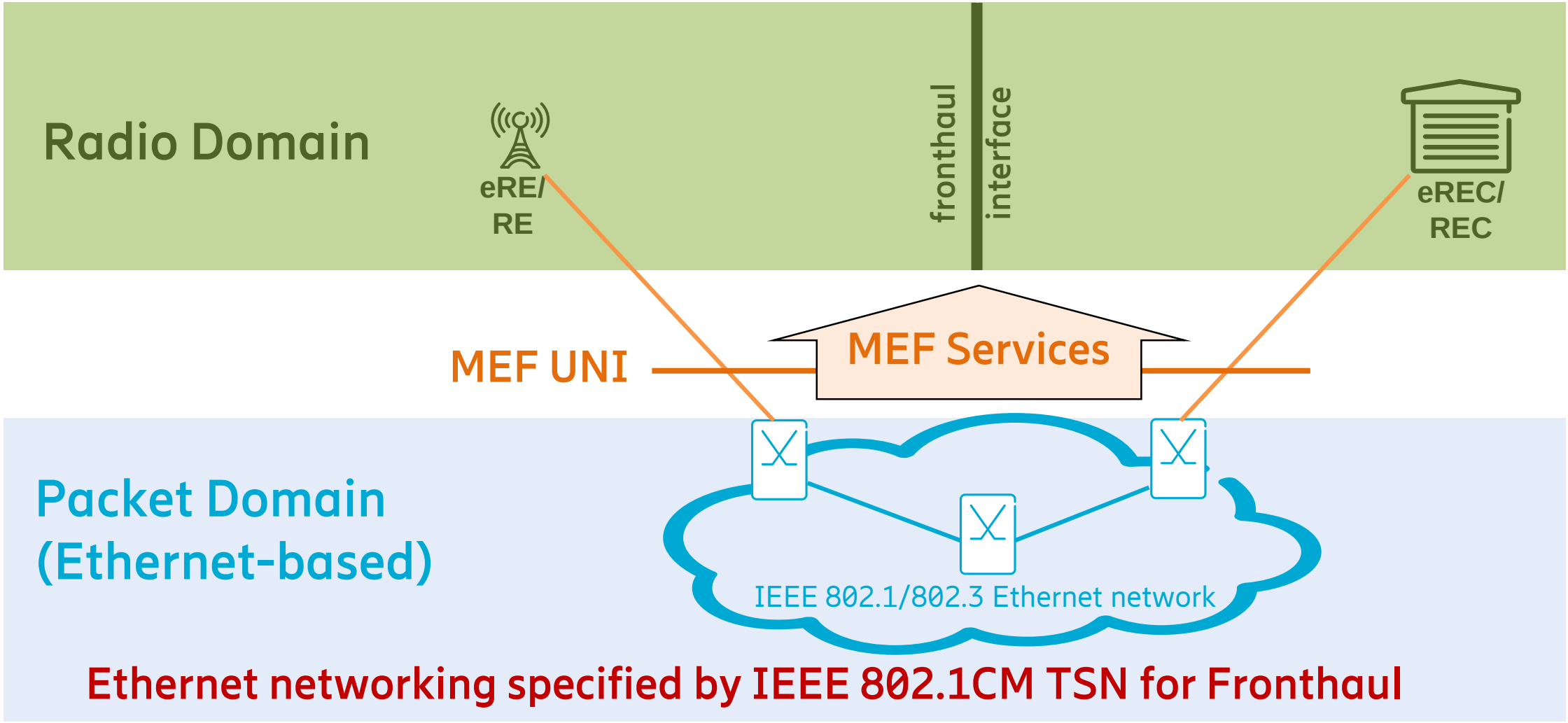
5G fronthaul: everything that is not backhaul

Radio Base Station Split

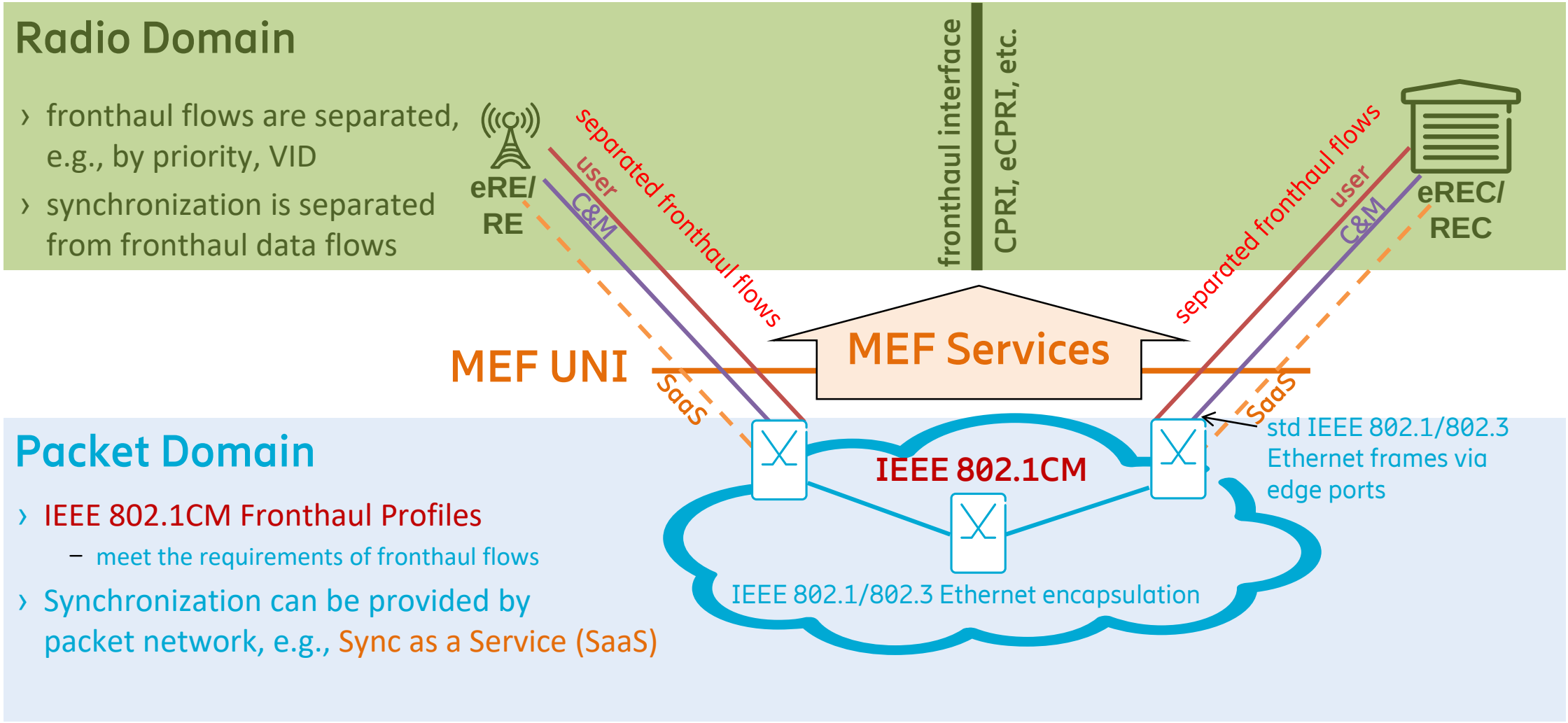


- These splits are in scope of IEEE Std 802.1CM-2018
- Further splits can be addressed by an amendment to 802.1CM

Ethernet-based Fronthaul Approach



Ethernet-based Fronthaul Details

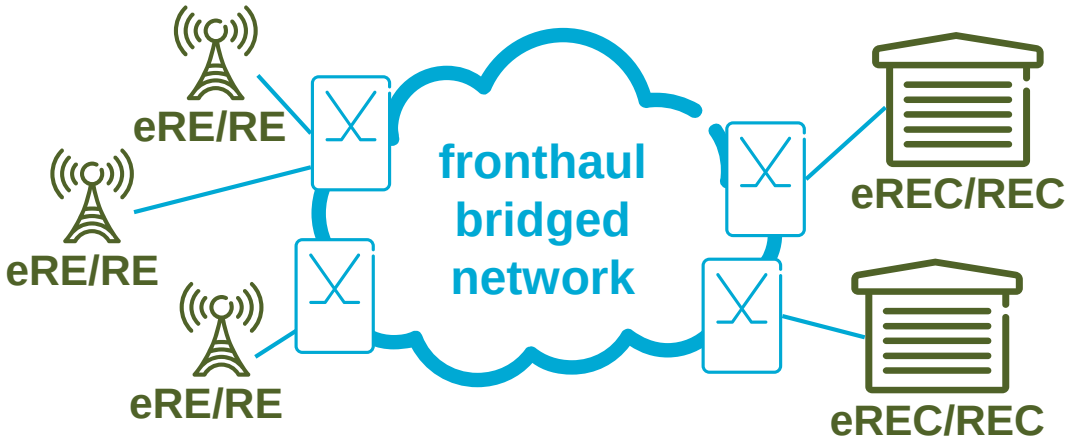


Fronthaul Profiles

- Profiles are engineered taking into account the worst-case
- The two 802.1CM Profiles are applicable to both CPRI and eCPRI
- **Profile A**
  - Keep it as simple as possible
  - Based on strict priority
    - User data (IQ data) → high priority traffic class
    - C&M data → lower priority traffic class
  - Max frame size for all traffic: 2000 octets (IEEE Std 802.3)
- **Profile B**
  - Leverage a TSN feature: frame preemption (802.3br & 802.1Qbu)
  - Strict priority + frame preemption
    - Fronthaul traffic → high priority traffic class; express traffic
    - Non-fronthaul traffic → lower priority traffic class; preemptable traffic
  - Frame size maximized for fronthaul traffic (2000 octets)
  - Frame size is flexible for non-fronthaul traffic
- **Synchronization solutions** (being extended by P802.1CMde, see next slide)

Amending the TSN for Fronthaul Profile Specification

- P802.1CMde amends IEEE Std 802.1CM-2018
  - P802.1CMde status: concluded initial SA ballot
- Enhanced synchronization features
  - ITU-T G.8262.1 Timing characteristics of an enhanced synchronous equipment slave clock
- Updates for 5G
- New annex for F1 fronthaul interface [3GPP TS 38.470]
- Updates addressing changes in cited references
- Updated references
- Clarifications



- *Note: The amendment does not change the profiles for data flows.*

Summary

- TSN is evolving
  - New tools being added to the toolbox
  - Profile specifications on the use of the TSN tools

- TSN for Fronthaul profile is being updated
  - IEEE Std 802.1CM-2018 and P802.1CMde
  - Developed via a collaborative effort
    - CPRI Cooperation
    - ITU Q13/15
    - IEEE 802.1
  - Two Fronthaul profiles for data flows
  - Synchronization solutions described
  - P802.1CMde amendment updates the Fronthaul profile specification

Thank you!