Priority Considerations for Fronthaul Traffic

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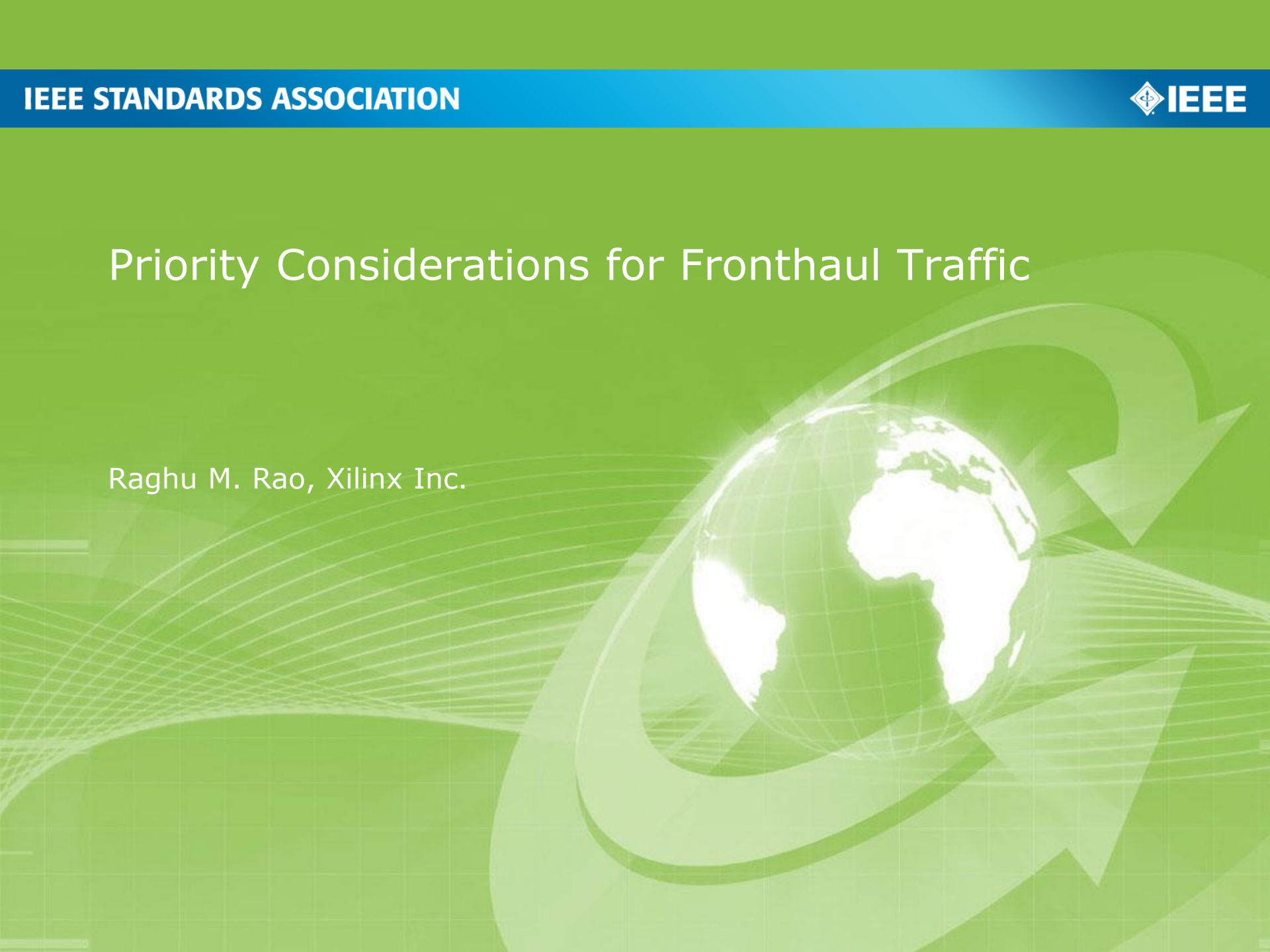

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IEEE 1914
Next Generation Fronthaul Interface (COM/SDB/NGFI)
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Acknowledgements

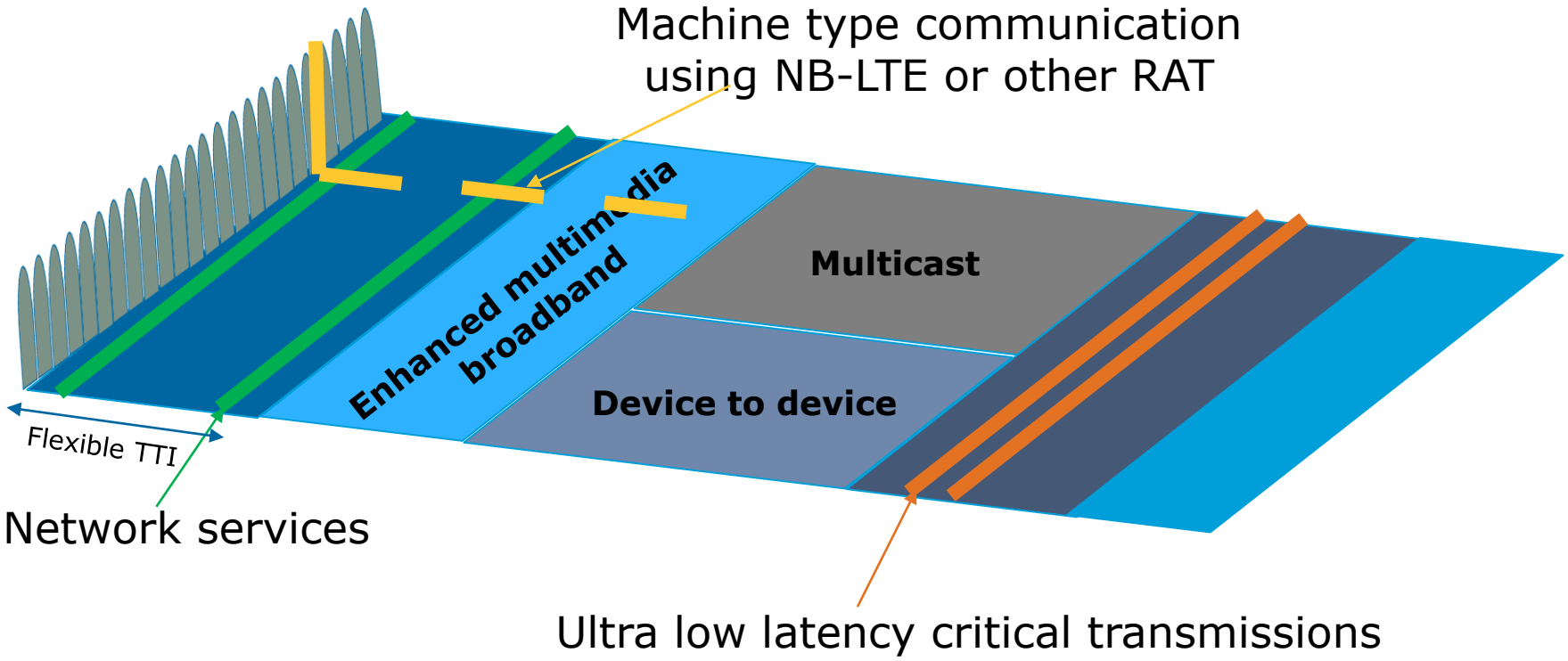
This presentation builds upon the many presentations on network slicing, functional splits and importantly the presentations in the Time Sensitive Networking (802.1 and 802.1CM) standardization body among others.

5G Traffic

- The four use-cases defined for 5G at this point are
  - Enhanced multimedia broadband which has high throughput requirement.
  - Ultra low latency critical communication which has lower throughput requirement but stringent timing requirements
  - Massive machine type communications that consist of short bursts of data that are not time critical
  - Network services which relate to communications required to manage the mobile network
- 5G also supports multiple radio access technologies (multi RATs)

- This presentation discusses the relative priorities between the various types of traffic.

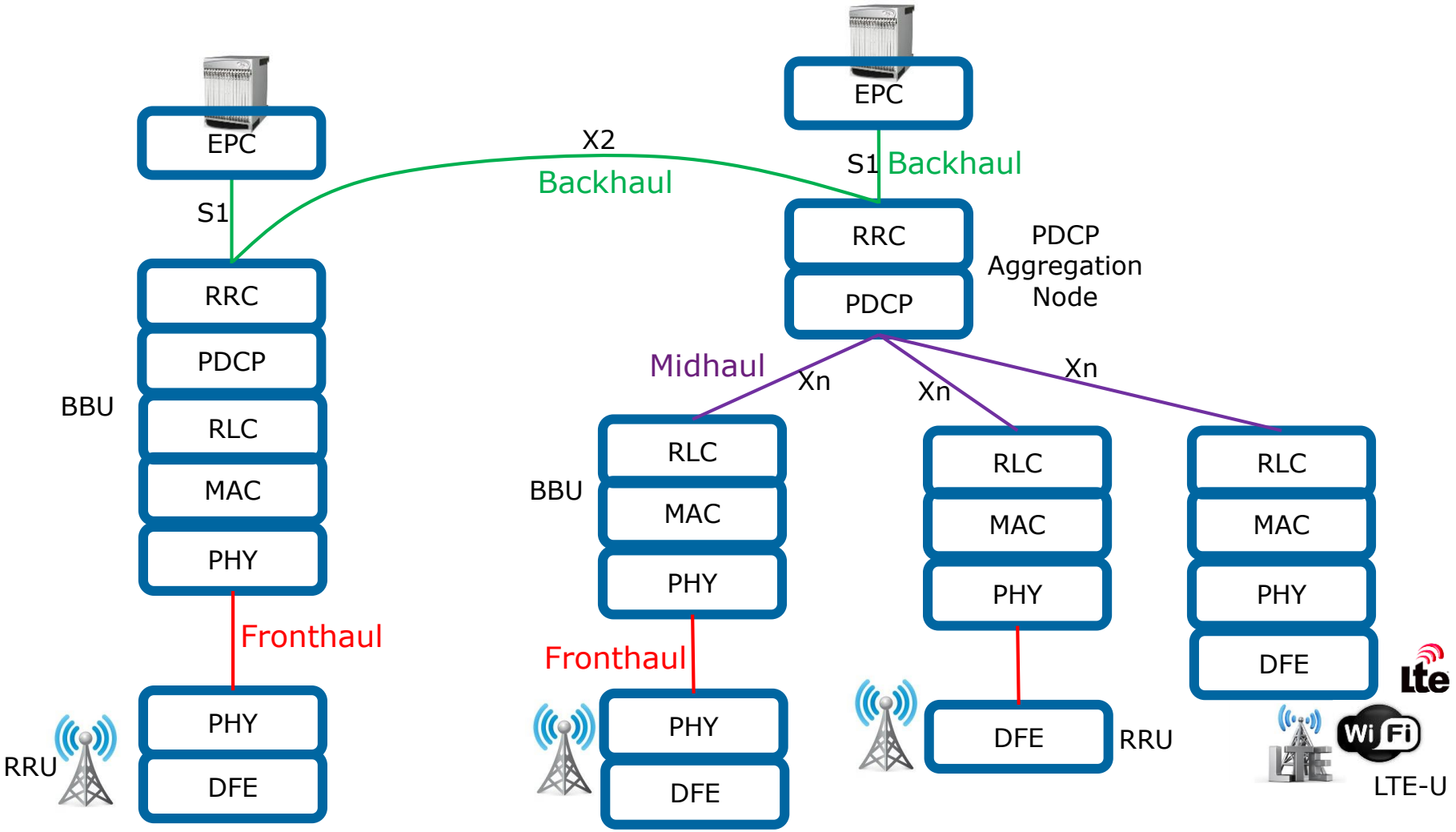
Network Slicing in 5G



Functional Splits

- There could be one split in the L1 between the baseband and the radio units which could transport I/Q data and this is called “fronthaul” and these have tight latency requirements.
- Other splits could be in the L2 or beyond and these transport IP or Ethernet frames and the throughput and latency requirements of these frames or packets are vastly different from that of fronthaul.
- There could also be multiple splits in the baseband one towards the radio and the other towards the packet core.
- The traffic towards the packet core is the “backhaul”.
- Other splits between the fronthaul and the backhaul are termed “Midhaul”, ex. Dual/multi connectivity.

Further Functional Splits



Prioritizing 5G Traffic

- What is the priority between different types of fronthaul and backhaul traffic?
- Is all fronthaul traffic identically high priority (relative to backhaul)?
  - Does the fronthaul traffic from bursty machine to machine communication get the same high priority as enhanced multimedia broadband?
  - What about priority between Control and I/Q data?
- Is all backhaul traffic identically low priority (relative to fronthaul)?
  - Does the backhaul traffic related to ultra low latency critical communication get a lower priority compared to eMBB fronthaul traffic?

Proposal for NGFI

- So far the discussion in the NGFI group has primarily been on functional splits.
- However, the focus of this group is also transport related items.

- We believe that the focus on prioritization of traffic based on 802.1CM considerations such as VLAN tags in the bridged fronthaul network and time aware and QoS aware traffic shaping is essential.

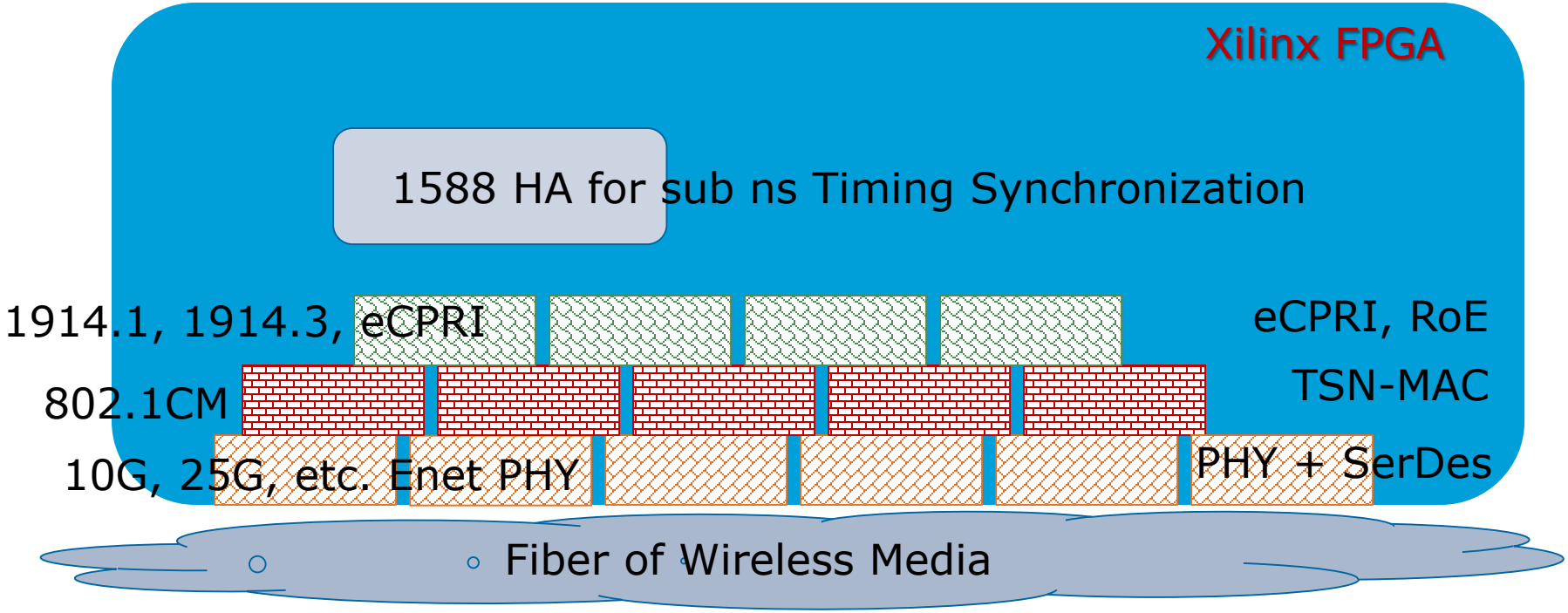
- The rest of the presentation discusses the various aspects of the fronthaul interface and the technologies under development to enable packet based fronthaul.

From Circuit Switched to Packet Switched

- Traditional fronthaul infrastructure to transport I/Q data encapsulated in CPRI frames is circuit switched
  - This has a dedicated path and bandwidth reserved for it
  - Might be overprovisioned and inflexible but there are no issues regarding delay and time synchronization
- The move to packet based fronthaul with Ethernet technology needs to address the issue of worst case delay
  - Ethernet is “best effort delivery”
  - Adaptive and robust but timing is very sloppy
- What is needed is bounded delay and accurate timing synchronization and these are the topics of Time Sensitive Networking (802.1CM)

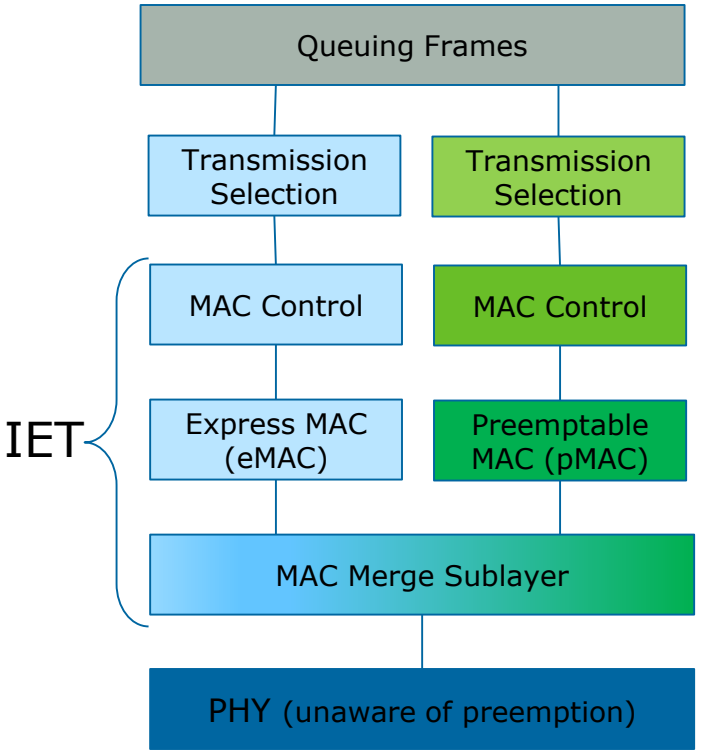
Bricks That Comprise The Transport Interface

- What are the underlying technologies related to packet based fronthaul?



Frame Preemption/ Interspersing Express Traffic

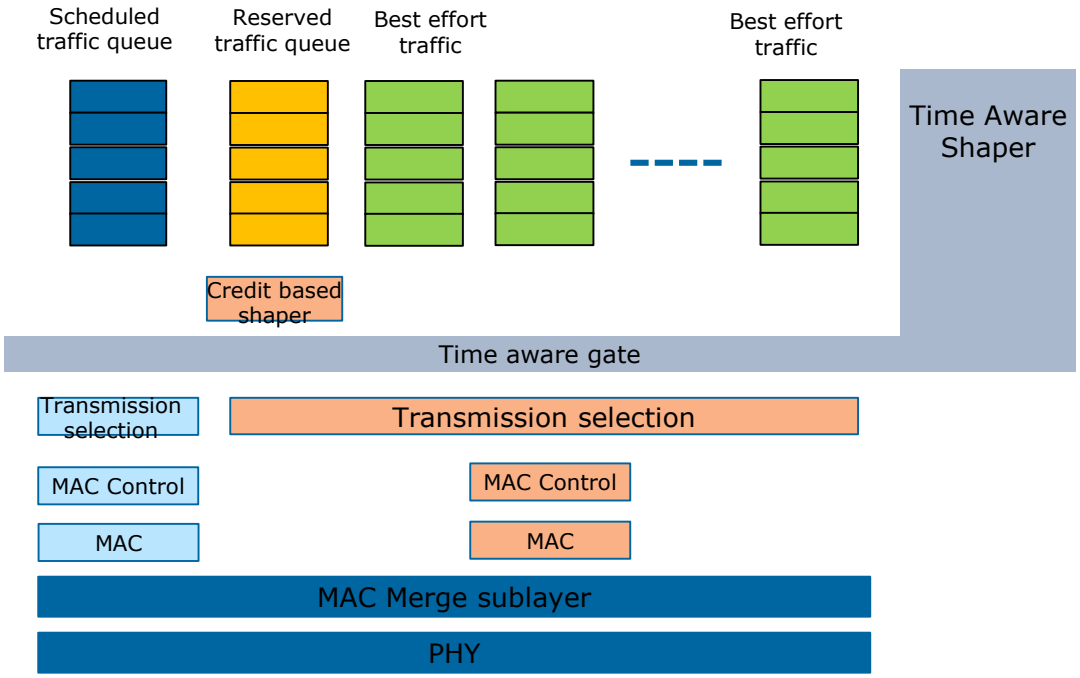
- Time-critical frames can suspend the transmission of non-time-critical frames.
- Specified by
  - 802.3br (Interspersing Express Traffic – (IET))
  - 802.1Qbu (Frame Preemption)
- Minimum fragment size if 64 bytes
- 802.1Qbu makes the adjustments needed in 802.1Q in order to support 802.3br such as assign a status for frame preemption, ex. Express or preemptable.



Source: Intro to IEEE 802.1CM by Janos Farkas

Scheduled Traffic

- To achieve Deterministic Ethernet we need a variety of queues enabled for express traffic and pre-emptable traffic.
- Traffic shaping based QoS criteria and time aware shaping enable bounded delays.
- This coupled with accurate (sub-ns) timing sync can enable packet based fronthaul.



The Other Parts of TSN

TSN for Audio-Video Bridging has made significant progress

TSN for Fronthaul (802.1CM) borrows many ideas from AVB but has profiles specifically for fronthaul

802.1Qbu/802.3br – Preemption and express traffic interspersing

802.1Qbv – Enhancements for scheduled traffic

802.1Qcc – Stream reservation protocol extended to support preemption, scheduling and centralized control

802.1Qav credit-based shapers

IEEE 1588-HA for sub-ns time synchronization

Priority Assignment

- Proposal for priority assignment based on VLAN tags and QoS criteria
- VLAN tags for the bridged fronthaul network that includes the RU and BBU
- As an example, QoS priorities for :

1. uLLTC, Fronthaul I/Q
2. uLLTC, Backhaul I/Q
3. uLLTC, Fronthaul C&M
4. eMBB (MIMO TX Diversity), Fronthaul I/Q
5. eMBB, Fronthaul I/Q
6. eMBB, Fronthaul C&M
7. eMBB, Midhaul, Backhaul
8. mMTC, Fronthaul
9. mMTC, Backhaul

Conclusion

- 5G supports 4 different types of usecases
- Each of these have varying throughput and latency requirements
- In a bridged Ethernet network, traffic could arrive at the bridge from multiple ports and essential (express) traffic could be queued up leading to excessive delays
- 802.1CM enables Time Sensitive Networking and a deterministic Ethernet for fronthaul

- IEEE 1914 could focus on prioritization of traffic and defining the fronthaul transport network along with encapsulation of IQ data.