



Data Path vs Control Path for Timing of Radio Data

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History from 2/16 Plenary

- ❑ Definition of a data packet type with both seqnum and timestamp was rejected
 - This packet type supports radio timescales (e.g. CPRI frequency) that are different from the Ethernet network timescale (e.g. IEEE 1588)
 - Use of more pkt_types was not desired
- ❑ A control packet sub-type was defined with both seqnum and timestamp
 - This control packet also periodically provides the relationship between the radio timescale and the Ethernet network timescale using seqnum and timestamp

Goals of this Presentation

- ❑ Show the operation of the data path and the control path options
- ❑ List the benefits and the issues of the two options
- ❑ Confirm the use of the control path option or switch to the data path option

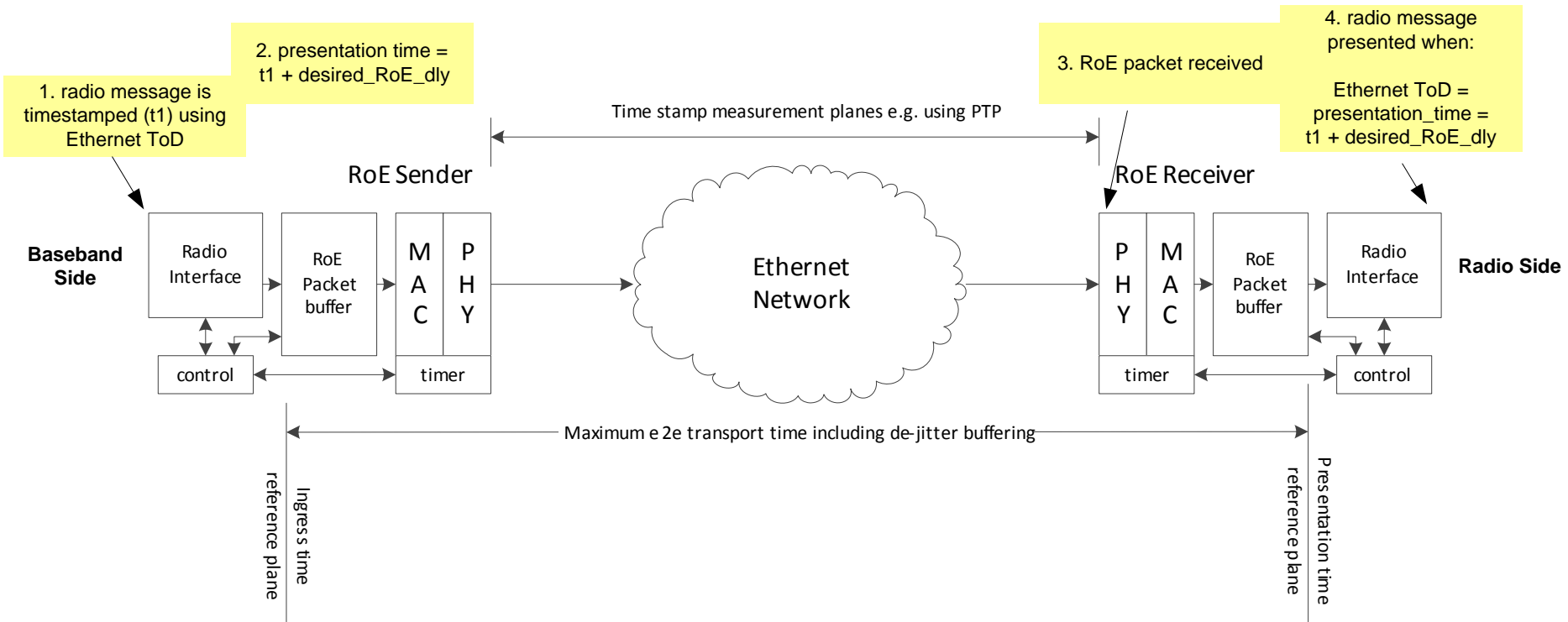
□ Timescale:

- A linear measure of time (e.g. the definition of 1 second)
- Domains with different timescales have “1 second intervals” that are different from each other. For example:
 - 1s in domain A’s timescale domain =
1s + 1ns in domain B’s timescale

Example 1: Data Path Option

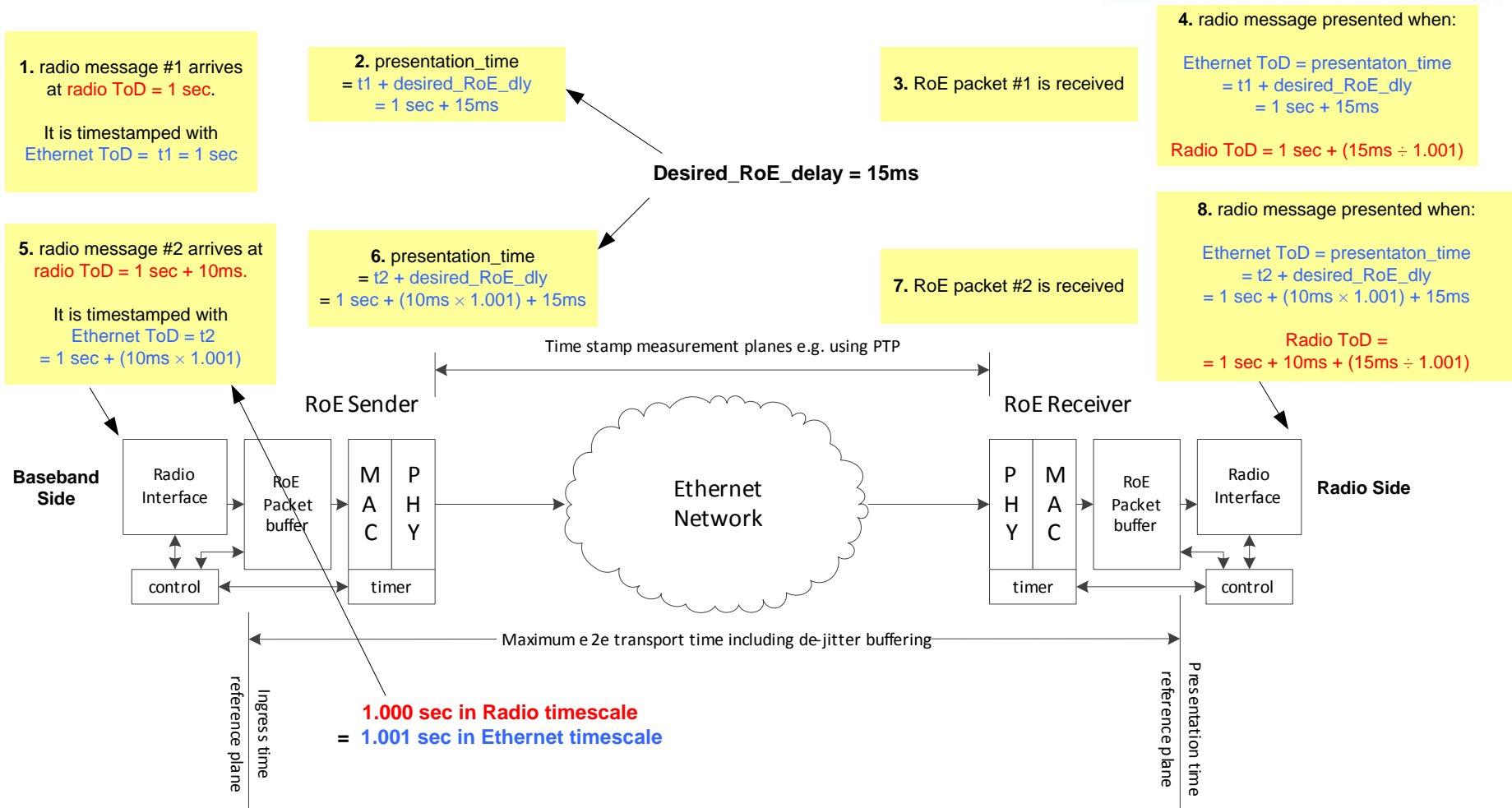
- ❑ Data path packets all have timestamps
 - For simplicity, timestamp field is not limited to 999,999,999.75ns in this example
 - Seqnum is used only for reordering or detection of missing packets
- ❑ Desired RoE network delay is set to 15ms
- ❑ The radio and the Ethernet network (PTP) have different timescales
 - 1.000 sec for the radio = 1.001 sec for PTP
 - This timescale offset is HUGE and is used for example purposes only
- ❑ Radio timescale values are shown in red
- ❑ Ethernet timescale values are shown in blue

Reminder: Basics of Data Path Timestamping



- ❑ All timestamping is done in the domain of the Ethernet timescale (PTP, for this example)

Example 1: Data Path Timestamping with Frequency Transparency



- ❑ The radio's timescale is preserved at destination
- ❑ The difference in timescales only affects the network delay
 - Network delay and timescale offsets are expected to be small so net error is small (e.g. $200\mu\text{s} \times 50\text{ppb} = 0.01\text{ns}$)

Benefits: Data Path Option

- ❑ Presentation time generation is easy
 - Just add the desired network delay to the timestamp
- ❑ Presentation time usage is easy
 - Just wait for the Ethernet ToD to equal the presentation time
- ❑ Radio client frequency preservation is easy
 - Radio client frequency is naturally preserved if its data is presented at the specified presentation time
- ❑ Effect of different radio and Ethernet timescales is negligible
 - Very small effect on the overall delay of every packet
- ❑ If timestamps are on every packet, seqnum function is simplified
 - Just used for reordering and missing packet detection

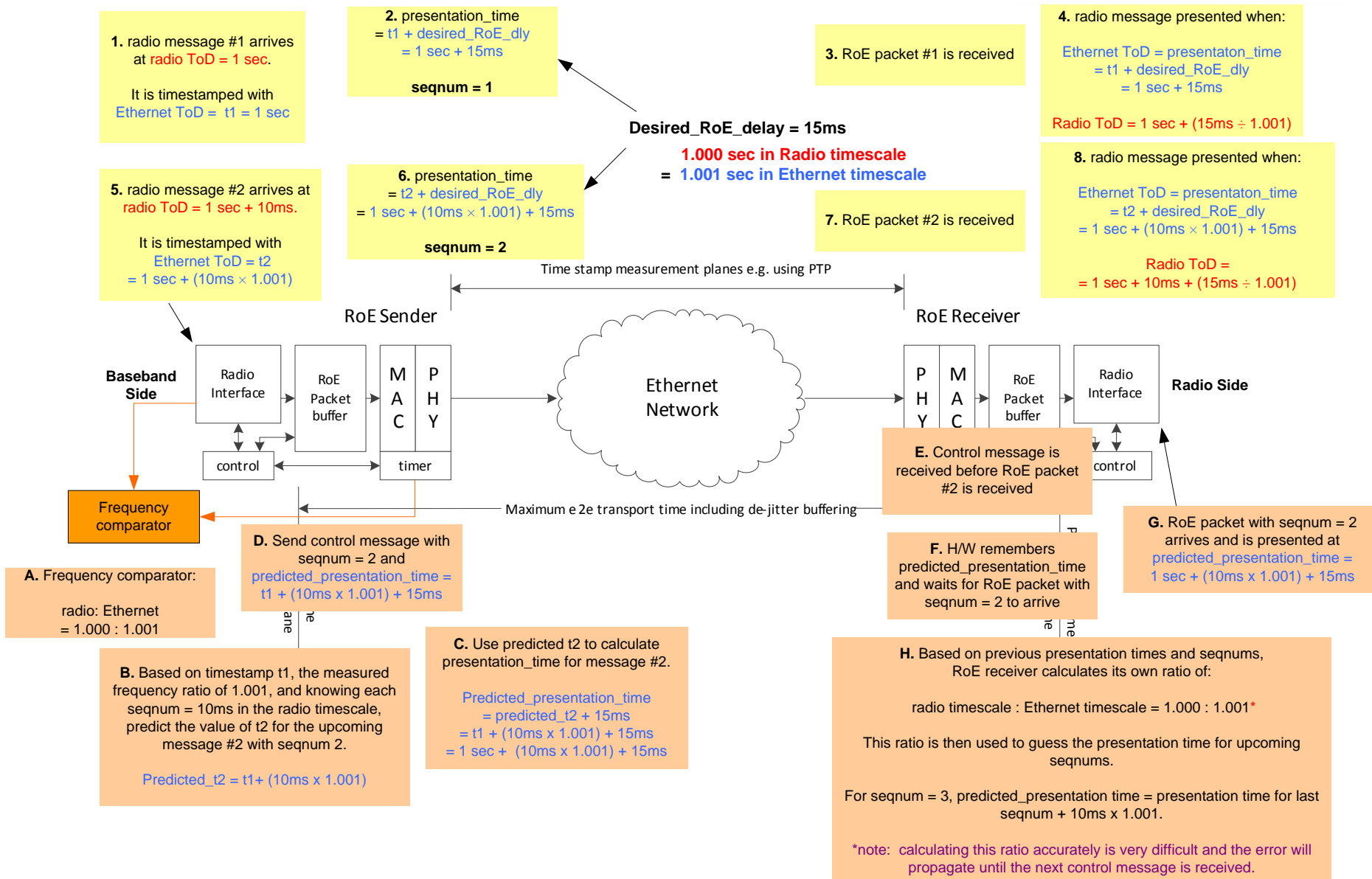
Issues: Data Path Option

- ❑ More pkt_types are consumed if we have packets with just the seqnum and packets with both seqnum and timestamp
- ❑ Bandwidth efficiency is reduced if seqnum and timestamp both exist on *every* data packet

Example 2: Control Path

- ❑ Control packets are used to communicate relationship between timestamp and seqnum
 - Simple incrementing seqnum is used for this example, where each increment is equivalent to 10ms of radio time
 - For simplicity, timestamp field is not limited to 999,999,999.75ns in this example
- ❑ Desired RoE network delay is set to 15ms
- ❑ The radio and the Ethernet network (PTP) have different timescales
 - 1.000 sec for the radio = 1.001 sec for PTP
 - This timescale offset is HUGE and is used for example purposes only
- ❑ For reference and for comparison purposes, the data path timestamp operations from last the example are shown again
- ❑ Radio timescale values are shown in red
- ❑ Ethernet timescale values are shown in blue

Example 2: Control Path with Frequency Transparency



Benefits: Control Path Option

- ☐ No additional pkt_type is used
- ☐ Bandwidth usage should be less
- ☐ Is there a less complicated way to do this with control packets?

Issues: Control Path Option

- ❑ Low latency is required for control packets
 - Control packets must get to the destination *and* be processed before the corresponding data message arrives
 - Network latency must be small
 - Processing delay must be small
- ❑ Prediction of future events is required
 - Accurate prediction is difficult and the error grows linearly with:
 - the time between control packets
 - the time between the prediction and the actual event
 - IEEE 1914.1 mechanisms may not have continuous radio data, thus prediction may not even be possible
 - Floating point math is necessary to maintain accuracy
- ❑ More control packet bandwidth is required

Conclusions and Proposals

□ Conclusion:

- Data Path option has better performance, a simpler implementation, and fewer system restrictions

□ Proposals:

- Use the data path instead of the control path for these timing operations
- Define a `pkt_type` with both timestamp and `seqnum`