Timestamp Format

Richard Tse and Raz Gabe

Dec 15, 2015

Background

- ❑ The current draft of 1904.3 defines the timestamp as follows:
  - The timestamp is 32 bits in size and in units of nanoseconds
  - The timestamp field is encoded as a 32 bit sliding window capable of representing ~2 seconds worth of time
  - This implies the timestamp field is capable of encoding a presentation time maximum ~1 second in the future

- ❑ The time-of-day for an RoE system will be distributed using IEEE 1588 and GNSS:
  - IEEE 1588 would be used alone or as a backup for GNSS
  - IEEE 1588 uses a timestamp[79:0] and time counter that has:
    - 48-bits of integer seconds
    - 32-bits of nanoseconds (of which only bits [29:0] are used to count up to 999,999,999ns before rollover)
    - Up to 16-bits of fractional nanoseconds
  - GNSS uses 1pps events:
    - Gives the year, day, hour, minute, and second that corresponds to the 1pps

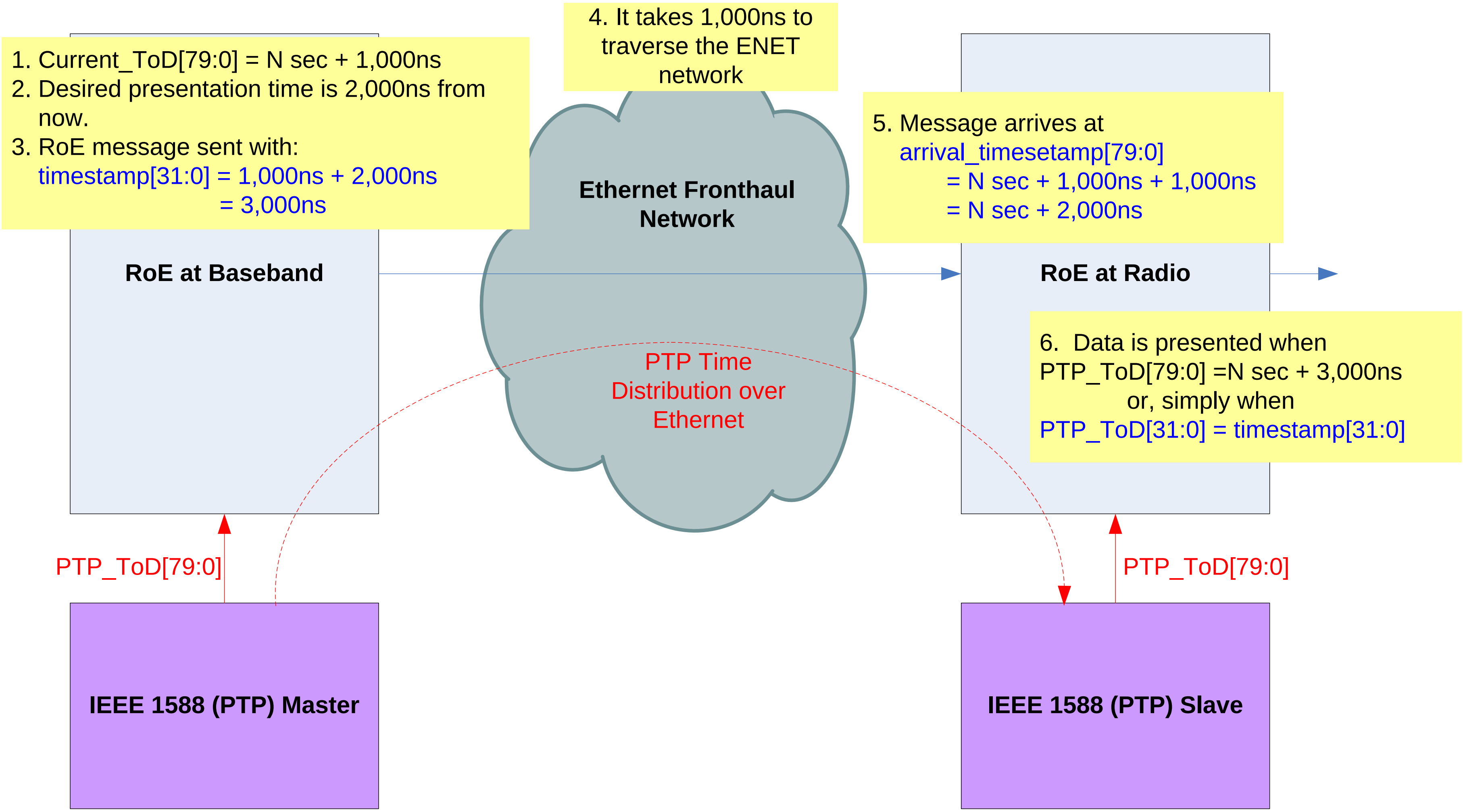
Description of Proposal

- Define our timestamp so it can be used with a IEEE 1588/GNSS time counter without conversion:
  - ~~Option 1: simplest~~
    - ~~Limits the presentation time to 1 second in the future~~
    - ~~Timestamp[31:30] = `b00~~
    - ~~Timestamp[29:0] counts from 0 to 999,999,999ns~~
  - Option 2: best resolution ← Selected at 11/24/2015 meeting
    - Limits the presentation time to 1 second in the future
    - Timestamp[31:2] counts in steps of 1ns
      range from 0 to 999,999,999ns
    - Timestamp[1:0] counts in steps of 0.25ns
  - ~~Option 3: allow a later presentation time~~
    - ~~Limits the presentation time to 2 seconds in the future~~
    - ~~Timestamp[31] counts from 0 to 1 seconds~~
    - ~~Timestamp[30:1] counts from 0 to 999,999,999ns~~
    - ~~Timestamp[0] counts in steps of 0.5ns~~

Benefits of Proposal

- ❑ Directly compatible with time-counters used by existing time synch protocols:
  - IEEE 1588 and GNSS equipment use time counters with 1 second time boundaries, not binary nanosecond time boundaries
- ❑ Determining the presentation time is simple (for brevity, example shown is for option 1 and bit 31 is the most significant bit):
  - If timestamp[31:0] > arrival_timestamp[31:0]
    - Presentation_time = arrival_timestamp[79:32] seconds + timestamp[31:0] nanoseconds
  - Else (rollover case)
    - Presentation_time = (arrival_timestamp[79:32] + 1) sec + timestamp[31:0] nanoseconds
- ❑ Future timestamp formats could be accommodated by using new PKT_TYPEs
  - Not likely to be needed for a long time

Example #1: no rollover



1. Current_ToD[79:0] = N sec + 1,000ns
2. Desired presentation time is 2,000ns from now.
3. RoE message sent with:
   timestamp[31:0] = 1,000ns + 2,000ns
   = 3,000ns

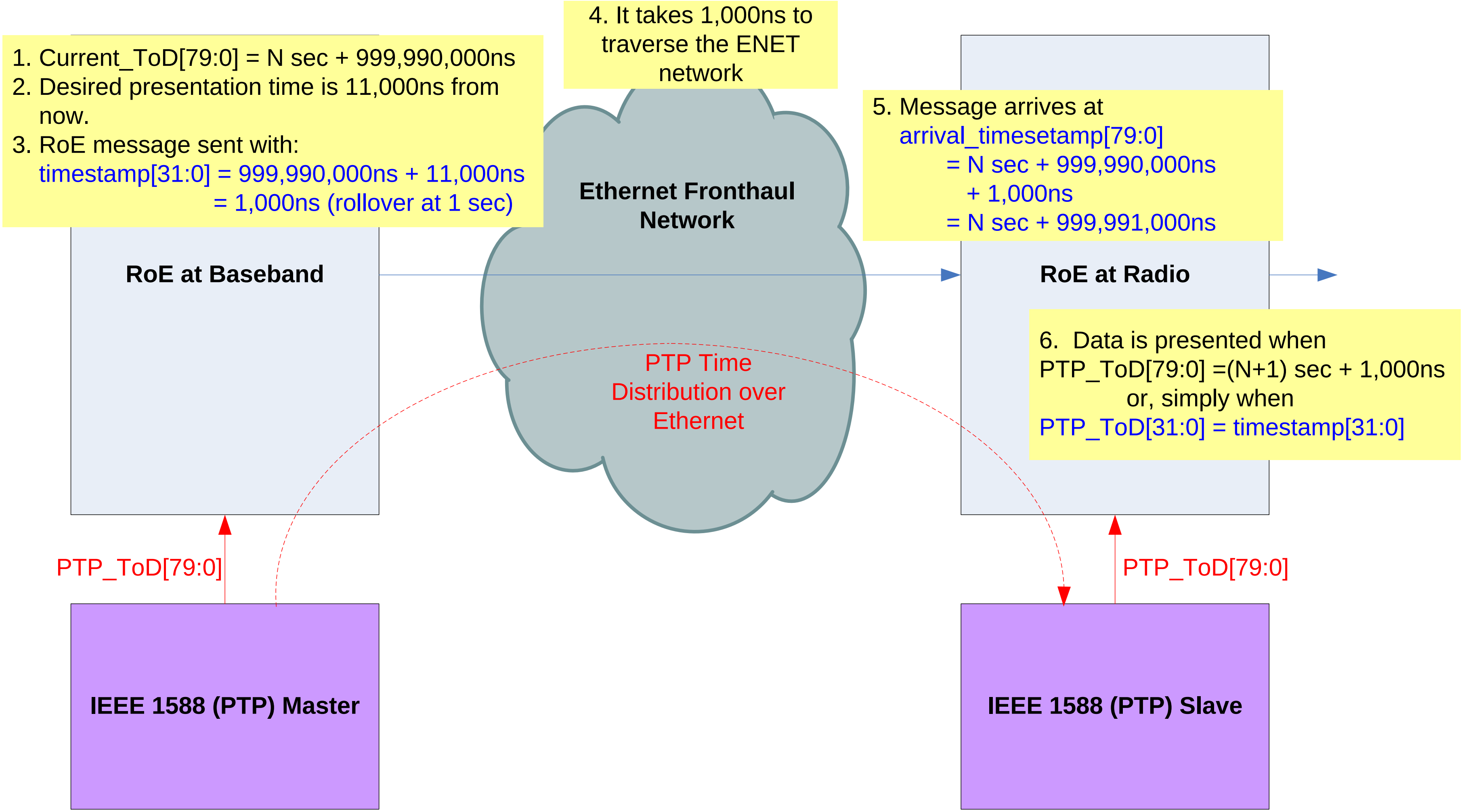
4. It takes 1,000ns to traverse the ENET network

5. Message arrives at
   arrival_timesetamp[79:0]
   = N sec + 1,000ns + 1,000ns
   = N sec + 2,000ns

6. Data is presented when
PTP_ToD[79:0] =N sec + 3,000ns
or, simply when
PTP_ToD[31:0] = timestamp[31:0]

Example #2: rollover case A

timestamp rolls over, arrival time does not



1. Current_ToD[79:0] = N sec + 999,990,000ns
2. Desired presentation time is 11,000ns from now.
3. RoE message sent with:
   timestamp[31:0] = 999,990,000ns + 11,000ns
   = 1,000ns (rollover at 1 sec)

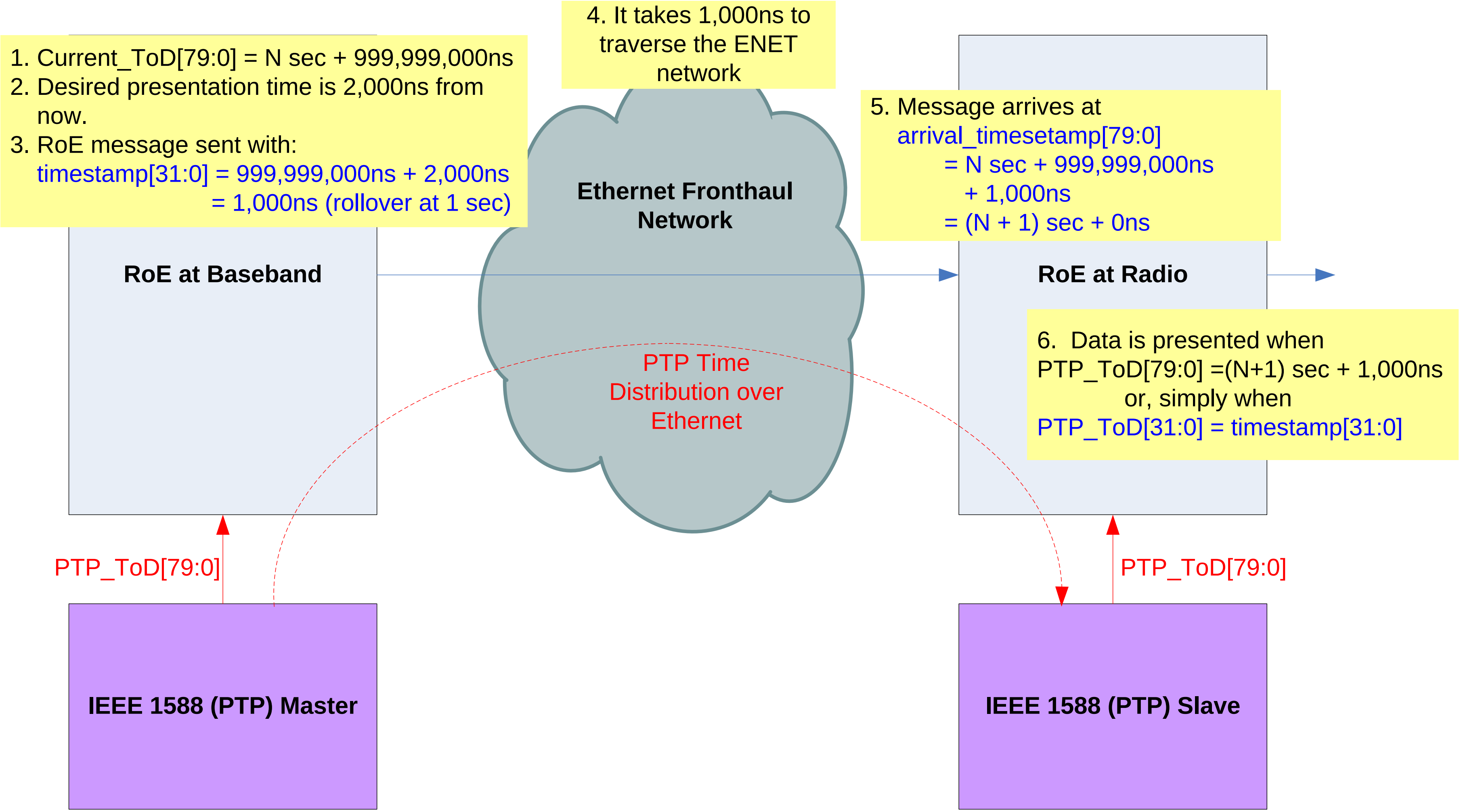
4. It takes 1,000ns to traverse the ENET network

5. Message arrives at
   arrival_timesetamp[79:0]
   = N sec + 999,990,000ns
   + 1,000ns
   = N sec + 999,991,000ns

6. Data is presented when
   PTP_ToD[79:0] =(N+1) sec + 1,000ns
   or, simply when
   PTP_ToD[31:0] = timestamp[31:0]

Example #3: rollover case B

timestamp and arrival time both roll over



1. Current_ToD[79:0] = N sec + 999,999,000ns
2. Desired presentation time is 2,000ns from now.
3. RoE message sent with:
   timestamp[31:0] = 999,999,000ns + 2,000ns
   = 1,000ns (rollover at 1 sec)

4. It takes 1,000ns to traverse the ENET network

5. Message arrives at
   arrival_timesetamp[79:0]
   = N sec + 999,999,000ns
   + 1,000ns
   = (N + 1) sec + 0ns

6. Data is presented when
PTP_ToD[79:0] =(N+1) sec + 1,000ns
or, simply when
PTP_ToD[31:0] = timestamp[31:0]

RoE at Baseband

Ethernet Fronthaul Network

RoE at Radio

PTP Time Distribution over Ethernet

PTP_ToD[79:0]

PTP_ToD[79:0]

IEEE 1588 (PTP) Master

IEEE 1588 (PTP) Slave

Proposal

- Redefine the timestamp as follows (for option 2):
  - The timestamp expresses the absolute time for presentation, relative to a defined reference plane, at the receiving endpoint of the RoE packet.
  - The timestamp is 32 bits in size. The most significant 30 bits is in units of ns and the least significant 2 bits is in units of 0.25ns.
  - The timestamp value ranges from 0.00ns to 999,999,999.75ns and is thus capable of expressing a presentation time up to 1 second in the future.
  - Both the sending and receiving endpoints of the RoE packet must account for rollover of this field after 999,999,999.75ns.
  - Both endpoints shall share the same understanding of the Time of Day (ToD). (unchanged from original definition)
- Change Annex B to show how to convert between the full presentation time and the newly defined timestamp value.