

Feasibility of Simple Superframe Structure for EPoC Upstream

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Problem in Focus

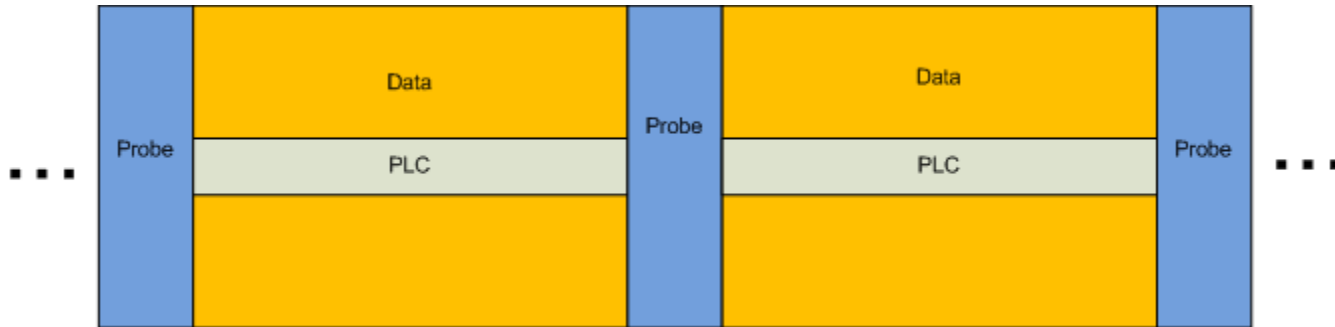
- Two proposals of superframe structure
 - Configurable superframe: varied for initial ranging, fine ranging. Varied data rate
 - One uniform superframe: constant data rate
- Two design philosophies
 - OFDM(A) technology
 - Dynamic rate adaptation
 - 2D resource allocation.
 - Optimize system capacity and utilization of resources
 - Ethernet (EPON)
 - Uni-directional layered structure, no handshaking between MAC and PHY
 - Data rate stays constant with infrequent reconfiguration
 - Extremely low jitter
- Our goal is Ethernet (EPON) MAC + OFDM(A) PHY
 - No cross-layer feedback.
 - Very limited rate adaptation and 1D channel allocation
 - Have to use more overhead to trade off flexibility

EPoC Design Methodology

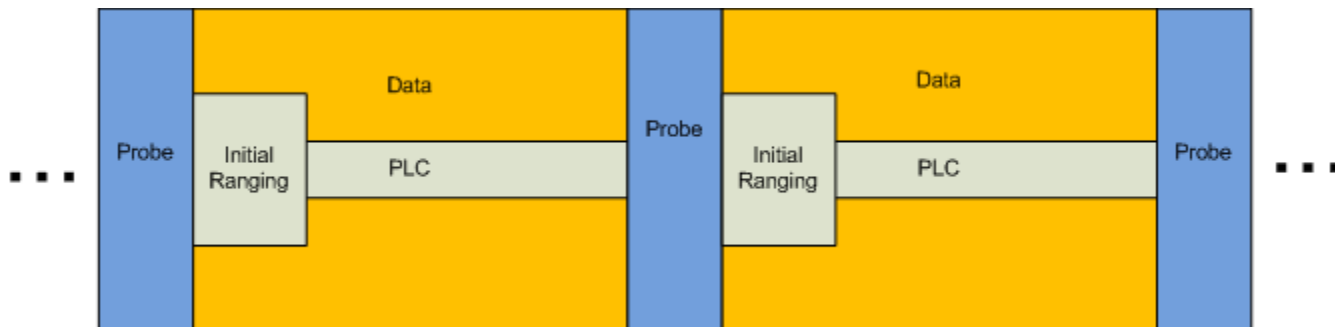
- The goal is to use EPON MAC + OFDM(A) PHY
- EPoC should adopt a hybrid design methodology
 - Static configuration for limited number of parameters.
 - Constant data rate when configuration is completed.
 - Zero or extremely low nominal jitter
- Therefore, EPoC Upstream superframe needs to deliver constant data rate
 - Static superframe structure is desired.

Example of Static Superframe Structures

Example 1: No dedicated area for ranging (Preferred superframe)



Example 2: Dedicated area for ranging



Key Elements for Superframe Structure

- Static overhead area
 - Probe symbols
 - PLC
- Initial and fine ranging areas are non-persistent.
- Can we fit initial and fine ranging into the persistent areas?

What does PHY Ranging Do?

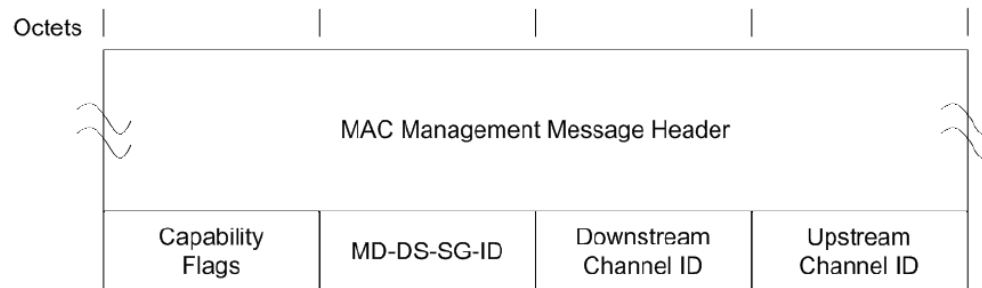
- Adjust CNU transmit timing and power.
- Allow for basic information exchange
 - MAC address, CNU_ID
 - Channel bonding?
- Most PHY parameter exchange through PLC after ranging
- Registration of new CNU into network should be done through MAC discovery process
- We should keep the ranging message as short as possible.

Current Ranging Parameters

- Assume that CNU has max RTT difference 200us.
- Initial ranging
 - 32 subcarriers: residual timing offset $\sim 0.625\mu\text{s}$ or 128 sample (worst case, actual implementation may have better numbers)
 - Preamble: 128 bit PRBS sequence, 4 slots or 8 symbols
 - Payload:
 - MAC address: 48 bits
 - Channel ID: 1 byte???
 - For channel bonding? In D3.1, this is associated with both PHY and MAC. How do we use this in EPoC?
 - FEC: 24 bit CRC + (128,80) LDPC

Current Ranging Parameters -- II

- Fine ranging
 - 128 subcarrier: residual timing offset $\sim 0.156\mu\text{s}$
 - Preamble: 128 bit PRBS, 1 slot (2 symbols)
 - Payload:
 - 34 bytes??? This is the length of B-INIT-RNG-REQ MAC management message in D3.1.



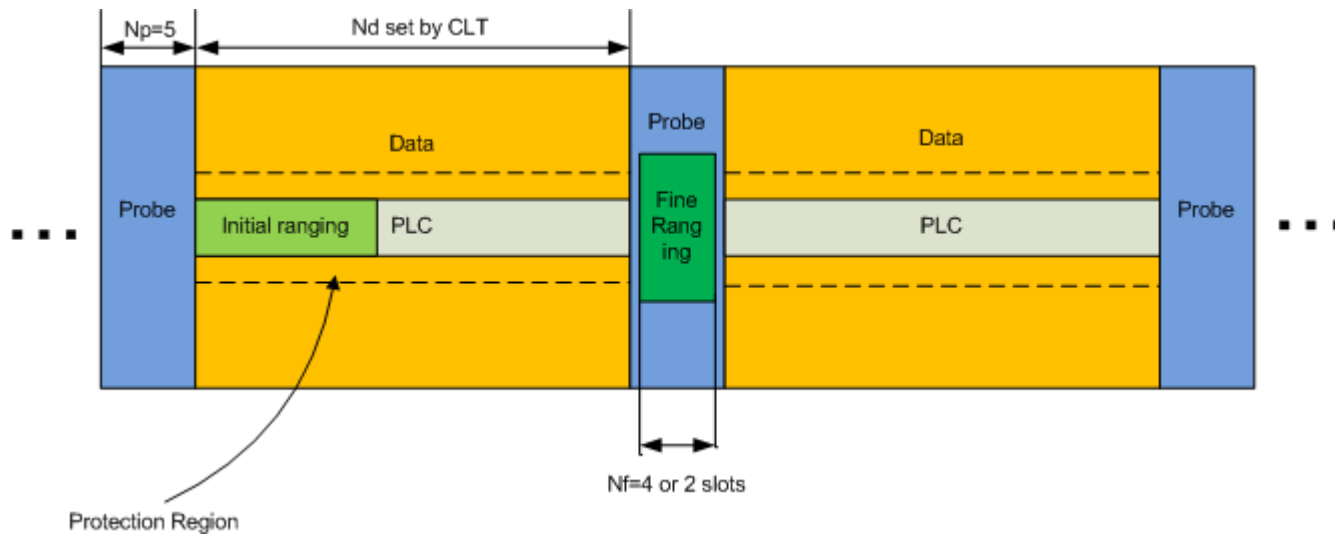
Idea for Ranging Parameters

- Initial ranging is to reduce the huge RTT difference (200u) down to a value that works for fine ranging.
- The final residual timing offset is determined by fine ranging.
- Fine ranging may also be divided in multiple steps.
- The payload message of fine ranging may need to be redefined and may be short.

Example of Initial Ranging Parameters for Static Superframe

- Initial ranging:
 - 8 subcarriers as PLC, residual RTT timing offset 2.5us or 512 samples.
 - Preamble: 32 bits PRBS sequence, 4 slots (8 symbols)
 - Only need $1e^{-3}$ detection error rate for SNR=2dB
 - Payload: 128 bits, 16 slots (32 symbols)
 - Total length: 40 OFDM Symbols
- Fine ranging parameters need to cover 2.5us RTT ambiguity as well as fine ranging payload.
 - 128 subcarriers, residual RTT timing
 - Preamble: 128 bits PRBS sequence, 1 slot (2 symbols)
 - Payload: 128 bits BPSK, 1 slot (2 symbols)
 - Total 4 OFDM symbols fit into a 5 OFDM symbol probing area

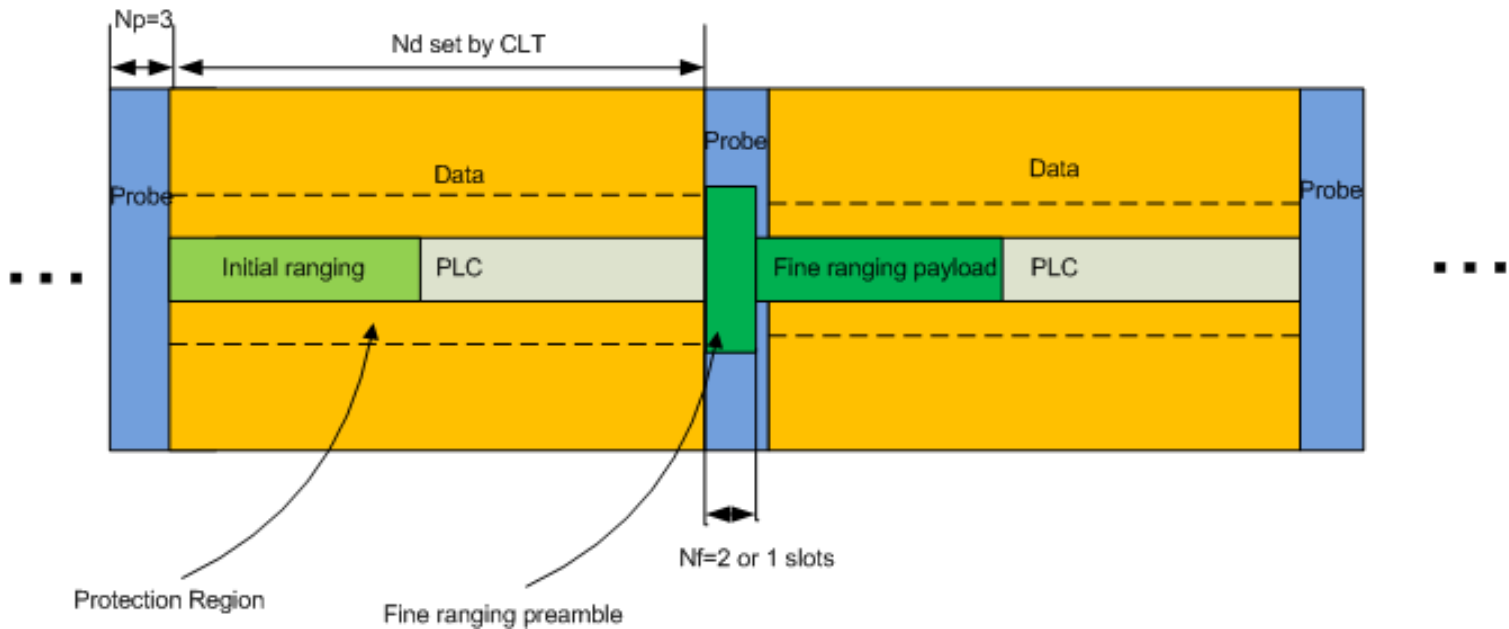
Example of Ranging Area for Static Superframe Structure



Another Example of Placement of Fine Ranging

- Fine ranging payload does not need to cover all the frequencies as for preamble
- Fine ranging payload can use PLC just like initial ranging.
 - Preamble: 128 subcarriers, 128 bit PRBS, 1 slot or 2 OFDM symbols
 - Payload: 8 subcarriers, 128 bit, 16 slots or 32 OFDM symbols
 - 2-symbol Preamble can fit in 3 symbol probe area.

Another Example of Placement of Fine Ranging



Summary

- A constant number of bits in a superframe is key to maintain a constant rate between PMA and PCS.
- Without constant bit rate, the jitter of gate and report message in MPCP will be out of control and violate the principle of MPCP.
- It is feasible to achieve a constant number of bits within superframe.
- The main purpose of this talk is to show the feasibility. The particular values of examples are not final.