UPSTREAM RANGING PROPOSAL

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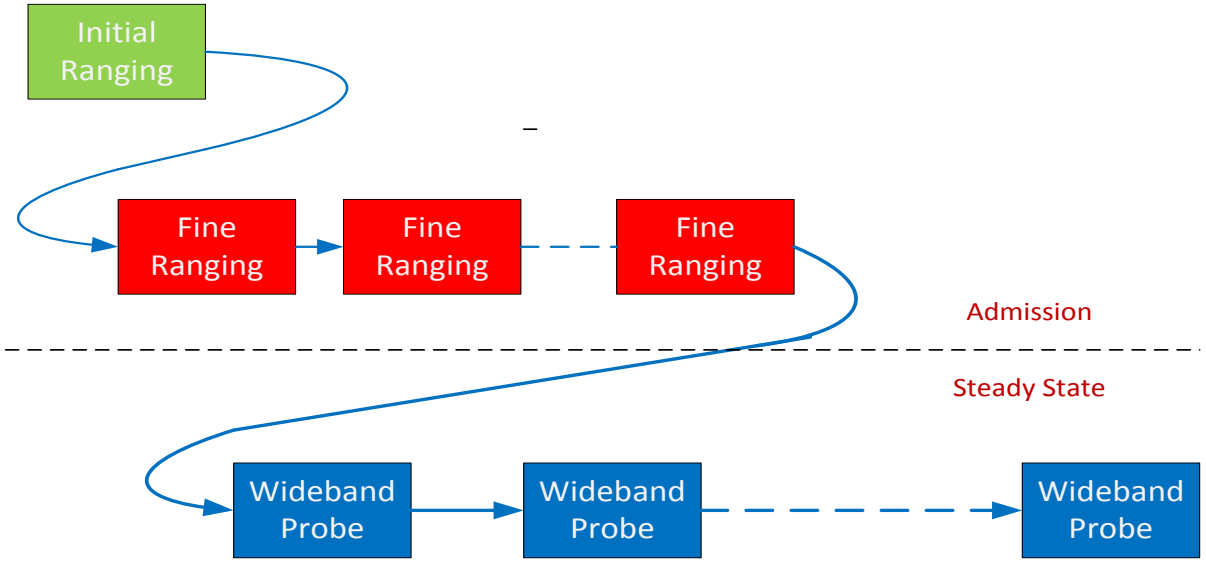
Ranging Proposal for EPoC

- Ranging has three stages
  - New CNU admission, CNU not yet known to the CLT
  - New CNY admission, CNU known to CLT and initially ranged
  - Steady state ranging
- The presentation proposes Ranging signals for the three Ranging stages
- Outline of presentation
  - Ranging Signals
  - Initial Ranging
  - Fine Ranging
  - Wideband Probes
  - Probe Sequence

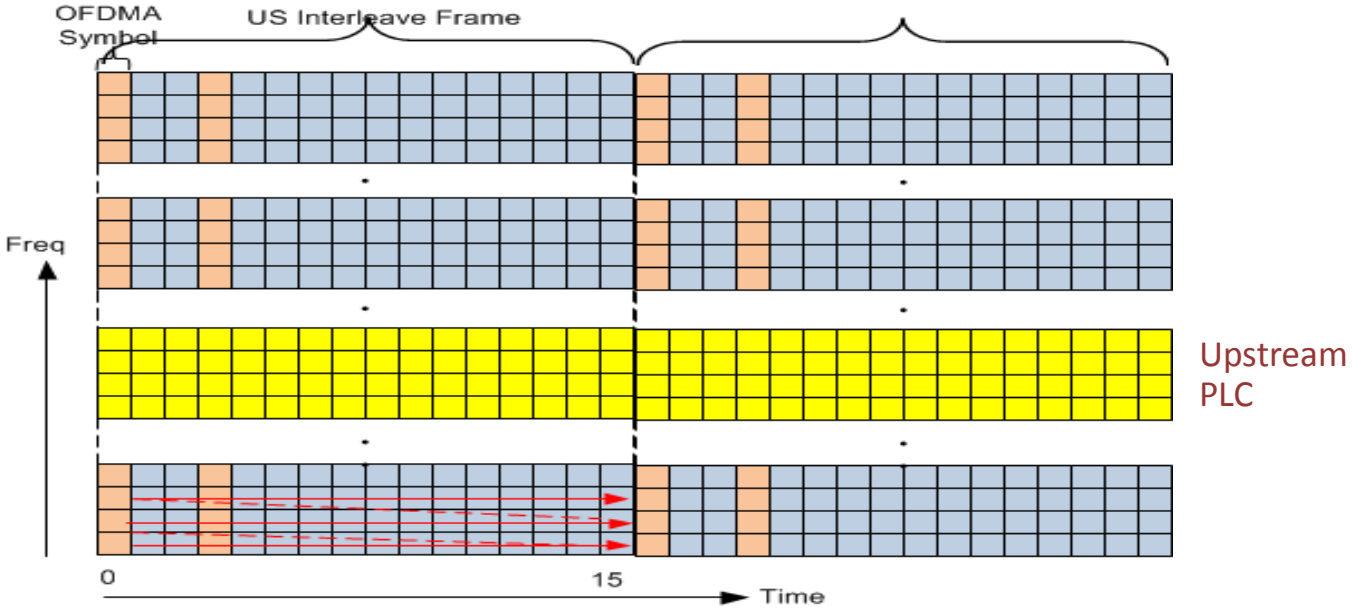
Three Ranging Signals

- Initial Ranging
  - Used by the CLT to identify a new admitting node and for coarse power and timing ranging
- Fine Ranging
  - Used for the 2nd stage of admission, after Initial Ranging received correctly
- Wideband Probes
  - Used during steady state for periodic ranging and periodic channel estimations



Narrowband Initial Ranging

- Round-trip delay of the HFC plant can be as large as 1.6ms to cover 100-mile plant
- With OFDMA, allocating wideband Initial Ranging TX opportunity can be wasteful
- The upstream PLC provides a narrowband signal that can be used for initial ranging.
- The upstream PLC can be enabled or disabled by the downstream PLC
  - Upstream PLC will span over successive OFDMA frames when enabled



Initial Ranging (1)

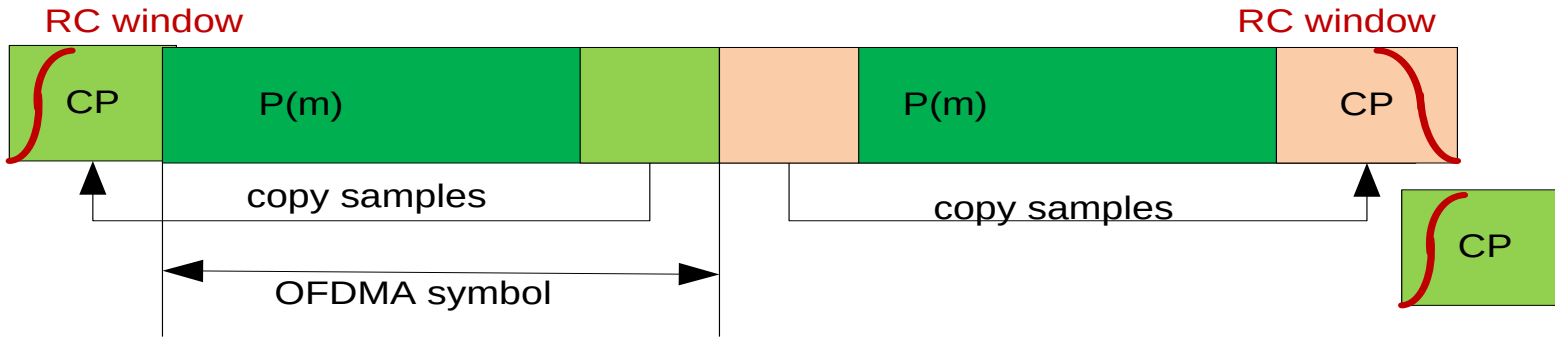
- Uses Upstream PLC
- Upstream PLC is configurable by the CLT
  - A single configuration for all CNUs
  - Width: Number of subcarriers (including guardband)
  - TX power: Max TX Power Limitation is configured but the Downstream PLC from the CLT PHY.
- Initial Ranging Signal structure
  - Comprised of a Preamble and a Unique ID

Initial Ranging Signal (2)

- Preamble
  - Preamble is a sequence of Admission Slots with different BPSK code sequence
  - Number of Admission Slots in a Preamble – configured by the CLT
  - Maximal number of Admission Slots is fixed in the spec (TBD)
  - Number of subcarriers is configured by the CLT
  - Maximal number of subcarriers is fixed in the spec (TBD)
- Unique ID
  - An ID (mostly like the CNUs MAC Address) plus CRC bits FEC decoded

INITIAL RANGING: ADMISSION SLOT

- A unit of repetition in Initial Ranging signal follows the “duplication rule”
- An Admission Slot is a two OFDMA symbol structure
- OFDMA symbol size and CP size are determined by the CLT
- P(m) is a BPSK code
- Every Admission Slot will have its own P(m) sequence
- TX window should be applied on the start and end of the Admission Slot



Initial Ranging Sequence requirements

- Robust, good performance in noise and interference
- Low CNU & CLT implementation complexity
- Low interference with adjacent subcarriers
- Ability to range to up to 1.6 mSec of round-trip propagation delay
- Sequence must carry Unique ID

Initial Ranging Scheduling

- The Downstream PLC will trigger an initial ranging for CNU PHYs that aren't linked.

Fine Ranging Signal

- Used for power and time adjustments during second stage of a new CNU admission
- BPSK sequence
  - Can use the same code sequence and signal structure as the Initial Ranging
- Unicast (no contention)
- Narrowband
  - Uses upstream PLC
  - Fixed size and configuration from CLT PHY

Wideband Probes

- Used for Power and time adjustments, pre-equalization, SNR measurements, etc…
- Wideband PRBS sequence transmitted over all available subcarriers in allocated OFDMA Frames
- Use several symbols per Probe to improve SNR of measurement
  - Also provides better protection against burst noise
- Staggered and non-staggered probe structures may be supported
- Configured in the CLT (See joint Qualcomm/Broadcom Presentation on Probes)

Probe Sequence

- BPSK PRBS sequence
  - Suitable for power adjustments, pre-equalizer coefficient calculations, periodic ranging (time adjustments)
- Simple generation and detection
  - TX : same process as Pilot generation
  - RX : same process as Channel Estimation