

PHY DISCOVERY

High Level Steps

- CNU finds DS PLC
- CNU collects
 - DS/US OFDM parameters
 - DS/US Channel parameters
 - US PHY-Link parameters
 - CNU waits for PHY Discovery Window
- CLT Opens PHY Discovery window (Ref kliger_3bn_01_0513)
 - need to define what this PHY Discovery is
- CNU Responds to PHY Discovery
 - With MAC address at a minimum
- CLT Updates CNU with
 - CNU ID (if not MAC address)
 - US OFDM Timing advance/offset
 - US Amplitude adjustment
- CLT / CNU perform US OFDM fine ranging
 - This would include initial channel estimation for the CNU requiring CNU to transmit probes for that purpose.
- Fine tuning iterated as necessary
- CLT declares Link Up
 - Hand-off CNU MAC address, range, link speed, etc

CNU finds DS PLC

- ID PHY-Link sub-carriers via correlation or other mechanism (exact method need not be specified). Preamble now defined (see motion #10 Geneva July 2013/TD76, montreuil_3bn_01_0713.pdf slides 2, 3, 12, and 13
 - FFT/Symbol size determined
 - CP determined
- Begin local OFDM clock synchronization (used for local time)
 - CNU OFDM clock must be synchronized before responding to a PHY Discovery window
- Begin Decode of DS PHY-Link
- Verify DS PLC/OFDM based on info in PHY-Link
 - PLC location/center frequency, Cycle time, guard times
 - FFT, Symbol and CP size

CNU collects from DS PHY Link

- DS/US OFDM Global parameters;
 - FDD/TDD ✓
 - Number of OFDM Channels
 - FFT Size ✓
 - Cyclic Prefix size ✓
 - Window Size ✓
 - Interleaver Depth ✓
 - OFDMA Frame size ✓
 - Resource Block duration
- DS/US OFDM per Channel parameters
 - Center Frequency of each DS/US Channel
 - Exclusion Bands
 - Resource Block spectrum
 - Continuous Pilot locations
- US PHY-Link parameters
 - Center Frequency ✓
 - Cycle Time ✓
- PHY Discovery parameters
 - Preamble bit sequence ✓
 - Discovery window duration ✓
- These parameters would be regularly transmitted to a Broadcast DA on the DS PHY Link

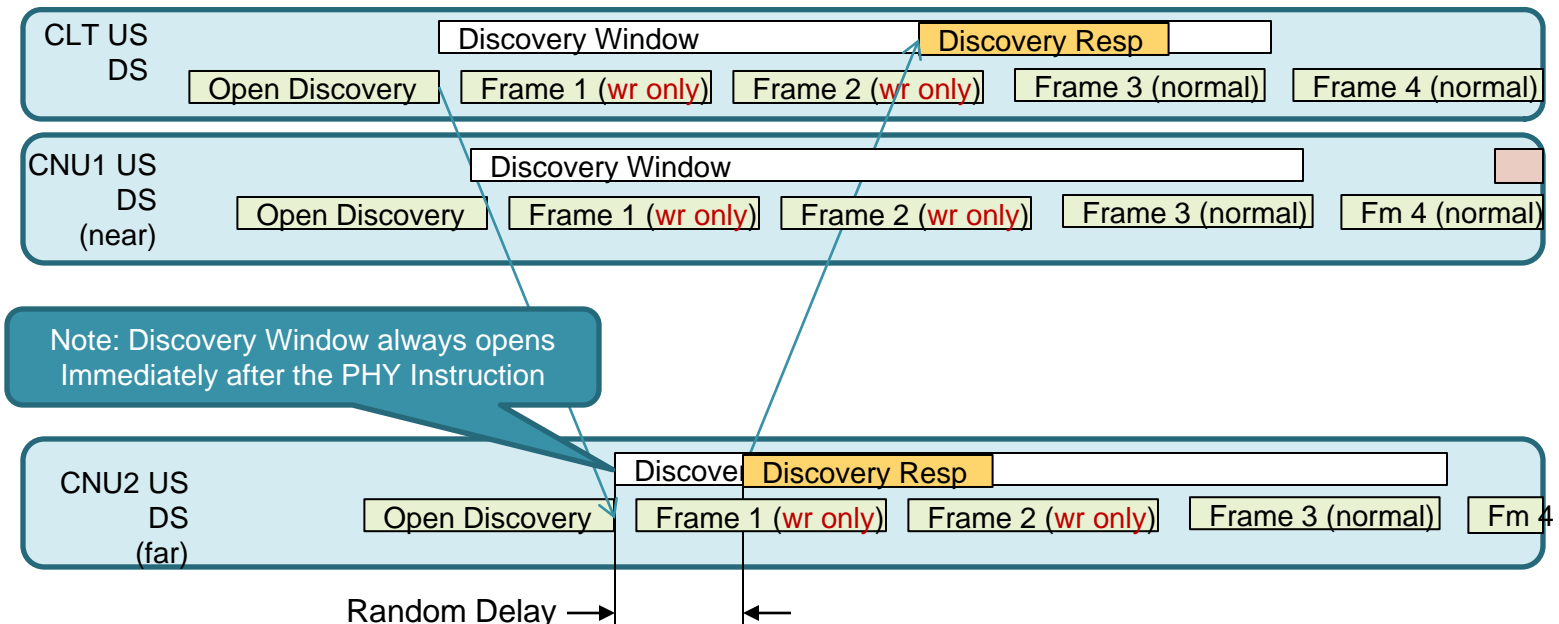
✓ Required parameter for Discovery Response
Others optional for Discovery but required before Link-Up

CLT Opens PHY Discovery window

- A PHY Discovery window would be initiated by a Write/Verify or a Read to a specific MDIO Register or Register Set.
 - Example
 - DA = Broadcast address +
 - Write Discovery Preamble
 - Read Frame ID and read Random Delay time +
 - Read MAC Address +
 - Write/Verify Discovery window duration
- Because the US Discovery Window opening would likely cover more than one PHY Link frame subsequent DS frames could only contain write instructions.

PHY Discovery Window

- Discovery Window overlapping subsequent frames
- Discovery Window always starts immediately after PHY Instruction and is NOT aligned to US PHY Frame



CNU Responds to PHY Discovery

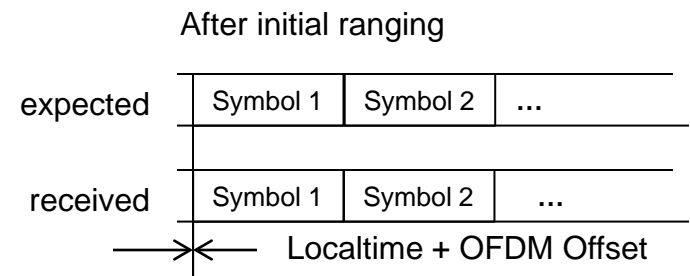
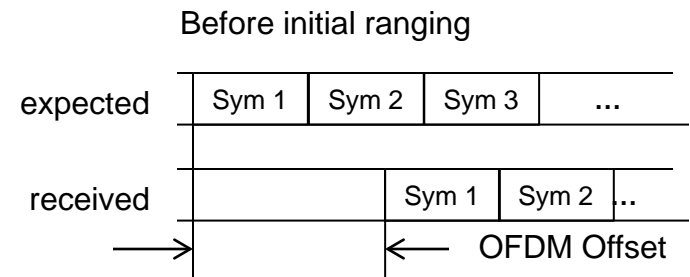
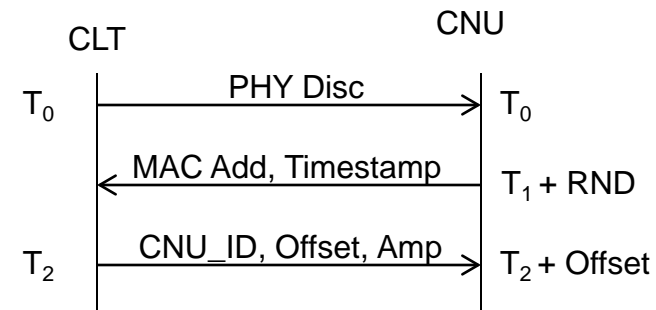
- OFDM Clock/Carrier Frequency must be locked
- CNU must implement a Random back-off algorithm to avoid contention
 - See rndDlyTmr in D0.10 for details of a similar function
 - May want to consider selecting a PHY Discovery opportunity at random rather than a time base back-off opportunity
- CNU Responds using default amplitude with
 - Preamble pattern as defined in PHY Discovery Instruction(s)
 - MAC Address
 - Timestamp, Frame ID and/or Random delay used
 - important, allows CLT to calculate Offset
 - Need to define default amplitude

CLT Updates CNU

- Assigns CNU_ID (omit if using MAC address)
- Sets Initial Timing advance/offset
 - A 16(?) bit offset from current local time
 - Allows ± 160 μ s adjustment in 4.88 ns increments to OFDM phase
 - 24 bits would allow ± 40.9 ms adjustment
- Sets Initial Amplitude per SC or RB

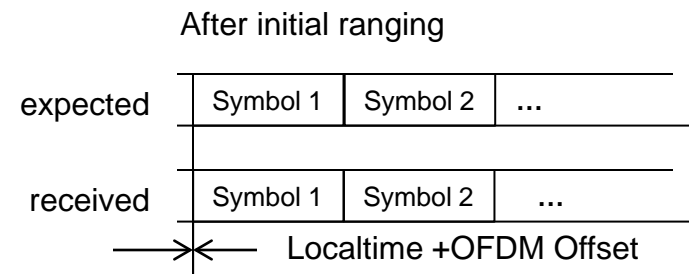
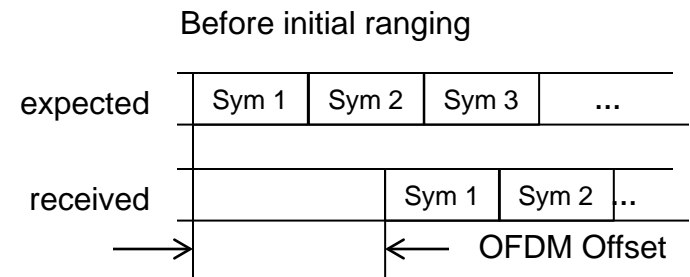
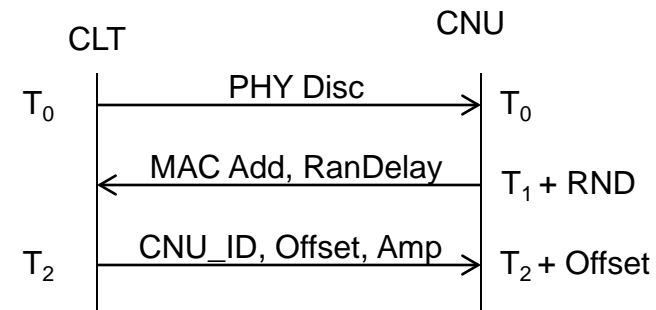
PHY Discovery – initial ranging with timestamp

- CLT sends a PHY Discovery window that starts in next US PHY Frame and extends for n PHY Frames
- CNU sets local time to Timestamp, waits until “next frame” + Random delay
- CNU sends
 - MAC Address
 - Timestamp (local time)
- CLT sends
 - OFDM Offset
 - 16 bits relative to Timestamp counter at 204.8 MHz clock
 - CNU_ID (optional), and Amplitude adjustment
- CNU sets local time to Timestamp + Offset
 - Updates OFDM Clock PLL on receipt of each DS PHY Link Frame



PHY Discovery – initial ranging without timestamp

- CLT sends a PHY Discovery window that starts in next US PHY Frame and extends for n PHY Frames
- CNU waits until “next Frame” + Random delay
- CNU sends
 - MAC Address
 - Random delay
- CLT sends
 - OFDM Offset
 - 16 bits relative to local time plus Random delay at 204.8 MHz clock
 - CNU_ID(Optional), and Amplitude adjustment
- CNU sets local time to local time + Offset
 - Updates local time PLL on subsequent updates



CLT / CNU perform US OFDM fine ranging

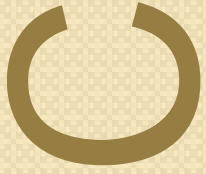
- CNU responds using updated Timing advance/offset
- CLT performs read or write/verify instructions to check tuning
 - Resets Amplitude per SC or RB as needed
 - Resets Timing advance/offset as needed
 - This may be iterated until CNU is within acceptable limits
 - What are these limits?
 - CNU timing within 1/10 CP duration (93.75 ns) has been mentioned in ad hoc calls
- Do we need to define a timeout period within which CNU is declared at fault (or start over)?

US OFDM fine ranging

- Initial Profile set-up
 - CNU should (must?) default to a null initial profile (all tones off)
 - CLT performs US Channel estimation using probes (*additional details needed from the “PHY Guys”*)
 - CLT programs initial profile for CNU to use and switches CNU to new profile using PHY_Config
- Alternatively PHY Link could broadcast a “default” profile and CNU switched to it

CLT declares Link Up

- Capabilities exchange
 - CLT queries CLT capabilities
- CLT declares “Link-Up”
 - First informs & confirms with CNU
 - Then informs local management of new CNU
 - This is probably accomplished by writing to some read only MDIO Register that the upper layers check periodically



Comments/Questions



THANK YOU

Nomenclature

PHY Discovery Window an opportunity for a new CNU to transmit in the PHY Link. Analogous to EPON Discovery. Nominations for better terms will be considered.

PHY Discovery Response The transmission in the PHY Link from a CNU that is trying to join the network.

OFDM Parameters includes; number of OFDM Channels, PFDM Duration/Size, CP size, Windowing, Interleaver, FEC in use, etc.

Channel Parameters includes; Center frequency, Exclusion bands, etc. for each OFDM channel.

From D0.10 draft

`rndDlyTmr`

This timer is used to measure a random delay inside the discovery window. The purpose of the delay is to a priori reduce the probability of transmission overlap during the registration process, and thus lowering the expectancy of registration time in the CCN.

VALUE: A random value less than the net discovery window size less the REGISTER_REQ MPCPDU frame size less the idle period and RF turn on and off delays less the preamble size less the IFG size. The timer value is set dynamically based on the parameters passed from the client.