802.3bn Link Ad Hoc

Status Update

Ed Boyd, Broadcom

OVERVIEW & TOPICS

Overview

- Objective
  - Define the process for the CLT PHY to connect to CNU PHY before the MAC is enabled.
  - Define any re-negotiation or PHY parameter procedure.
  - Define the PHY parameters to be configured over MDIO & Auto-Negotiation
  - What happens after CLT PHY & CNU PHY power up?
  - What parameters are PHY? (others are MAC)

- Output of the Ad Hoc
  - Baseline proposal
    - A single agreed solution is best.
    - Two or more options with pros and cons is the other option.
  - Joint Presentation for next meeting

Link Topics

- Link Transport Methods
  - Upstream
  - Downstream
  - e.g. Time Inserted or Frequency Inserted, or other
  - Protocol
- Auto-negotiation-Link state machine
  - Finding the Downstream
  - Speeding up the process
  - Initial Upstream
- Message Format & Addressing
  - e.g. Address + Register Pages
- Protocol
  - Dynamic or Static: Master or Slave, who makes change
  - e.g. Echo Protocol
- Parameters and Status Indicators
- MAC Discovery Compatibility

Parameters & Status Indicators

System Wide Possible

- TDD or FDD
- Power management control
- Note: Probing of the entire data channel would be handled in the MAC channel and not PHY link channel

Downstream Definition Possible List

- Number of Downstream OFDM channels
- 192MHz OFDM Channels Characteristics
  - Center Frequency, ~~Cyclic Prefix~~, FEC, Interleaver type/depth, ~~symbol length~~
- 192MHz OFDM Channels: Available Sub-Carrier (Frequency allocation)
- 192MHz OFDM Channels: Sub-Carrier Modulation Order

Upstream Definition Possible List

- Upstream PHY Link Channel frequency
- Number of Upstream OFDM channels
- 192MHz OFDM Channels Characteristics
  - Center Frequency, Cyclic Prefix, FEC, Interleaver type/depth, symbol length
- 192MHz OFDM Channels: Available Sub-Carrier (Frequency allocation)
- 192MHz OFDM Channels: Sub-Carrier Modulation Order
- Transmit Power Level
- Transmit Offset

Does not carry MAC Layer or above Frames (Configuration for upper layers could be carried)

Start Up Time Budget

- Finding the Downstream Channel
  - Hunt frequency and find preamble(Estimate at 2 seconds)

- Configuration for Downstream MAC channel
  - 1 second to transfer sub-carrier configuration

Evaluation Criteria

- Link establishment time.
- Simplicity
- Must work all of the time
- Must work below the MAC
- Bandwidth used

Definitions

- PLC – PHY Link Channel

LINK TRANSPORT

Link Transport Notes

- How many CNUs are supported?
  - In general, this is a design specification issue but we need to size fields.
  - Fields should be 15 bits to match LLID size.
  - Practical Numbers for analysis: 256 CNU PHYs per CLT PHY. (8 LLIDs per CNU, what does really mean to the PHY?)
- Do we need a Link configuration on the CLT PHY for every CNU PHY?
  - Some parameters will be common but others will be unique.
  - If we have to specify transmit power, delay offset, etc; they would be unique.
- How wide is the frequency transport?
  - Broadcom Proposal: 32x50KHz = 1600KHz
  - …
- How fast does it need to be? What is the data rate?
- How is the initial contention handled?
  - Broadcom Proposal: Random Symbol Offset or backoff a number of slot opportunities
- Do we need to detect collisions or just provide avoidance?
  - Broadcom Proposal: Avoidance
- How do we find the initial downstream channel?
  - Broadcom Proposal: Stored from previous position. Hunt based on 6MHz and/or 8MHz center frequencies.
- Do we need to acknowledge information from CLT PHY to CNU PHY?
- How fast do things change in the Network?
  - Updates in minutes.

Link Transport Notes

- How do we handle ingress noise on PHY link channel?
  - Double the channel
  - Move the channel
  - Avoid placing it on top of ingress, use clean spectrum, low modulation order. Only move if required.
- Do we define a grid position for the PHY link channel to simplify searching?
  - One location in a 24MHz channel? (Centered or first carriers or last carriers?)
  - One location in 6MHz and/or 8MHz channel grid? (Centered or first carriers or last carriers?)
  - One location in 2MHz channel grid? (Centered or first carriers or last carriers?)
- We need to define a fixed pattern (preamble) in the downstream PHY link channel
  - Can we use a CP instead of a preamble?
  - Fixed period?
- How do we transport multiple profile configurations if needed?
  - Option 1: Carry base profile in PHY link channel and bring up MAC with it. Use OAM to configure additional profiles.
  - Option 2: Configure all profiles in the PHY link channel.

Link Transport – Downstream Channel

- Two Options
  - Dedicated Subset of Carriers, Continuous
  - Subset of Carriers, periodic block of PHY link data
    - Spread out
    - Clumped
  - Symbol on all carriers
- How many PHY link channels do you need in the downstream?
  - 1 per 192 MHz
  - 1 for entire downstream
- How much data is needed in the channel?
- What is the modulation order for the PHY Link Data?
  - 16QAM is the most likely choice
- How much preamble is needed in the channel?
  - 1 symbol might work with auto-correlation
  - 2 symbols is simpler
- How many sub-carriers to make detection stable?
  - Channel model needed to be sure.
  - We can make a choice now but we will need to revisit
- We need to define a fixed pattern (preamble) in the downstream PHY link channel
  - Can we use a CP instead of a preamble?
  - Fixed period?

Link Transport – Downstream Data Rate

- Determine the required rate
  - Guessing the bandwidth of configuration of the modulation [channel worst case]
    - 4 channels (of 192MHz) x 16K carriers per block x byte per carrier = 64K Bytes
    - If initial configuration time of 1 second is required, then 64K Bytes needs 512Kbps
    - Double this so 1Mbps.
    - 1Mbps @ 16QAM is 256KHz
      - without overhead, 5 carriers at 4K FFT, 50KHz
      - 1% at 24MHz
    - Duane to expand on the analysis

Link Transport – # of Channels

- Do we want 1 PHY link of 1Mbps per 192 MHz channel downstream?
  - Is it a unique channel or just a duplicate if isolated channels?
  - Option 1: downstream is unique per 192MHz but upstream information would be the same if sharing the same upstream channel. All center Freq of downstream 192MHz blocks
  - Option 2: Duplicate entire PHY link so a multiple channel only needs to listen to 1 for all information
  - Option 3: Single PHY Link channel. Any lower capabilities CNU must listen to common channel that carries the PHY Link channel.
  - The decision for 1 per 192MHz or 1 per downstream can be linked to the decision on required CNU channel support. The PLC must follow this decision.
- Do we want 1 PHY link of ?Mbps per ? MHz channel upstream?
  - For TDD, upstream and downstream channel count would likely be the same.
  - Multiple PHY Link channels will use 2 transmitters out of the limit
  - Number of transmitters limit will grow as channel size increases?

Straw Poll #1

- Should the downstream PHY link channel be a fixed modulation order (e.g. QPSK, 16QAM, 64QAM)?

- Y: 27
- N: 1
- Abstain: 7

Straw Poll #2

- The PHY Link Channel should use 16QAM Modulation order?

- Y: 11
- N: 0
- Abstain: 0

Straw Poll #3

- The PHY Link Channel should use the same CP size and symbol duration as the data channel?

- Y: 11
- N: 0
- Abstain: 0

Straw Poll #4

- The downstream PHY Link Channel must detect [Not provisioned at CNU] the CP size and sub-carrier spacing (symbol size)?

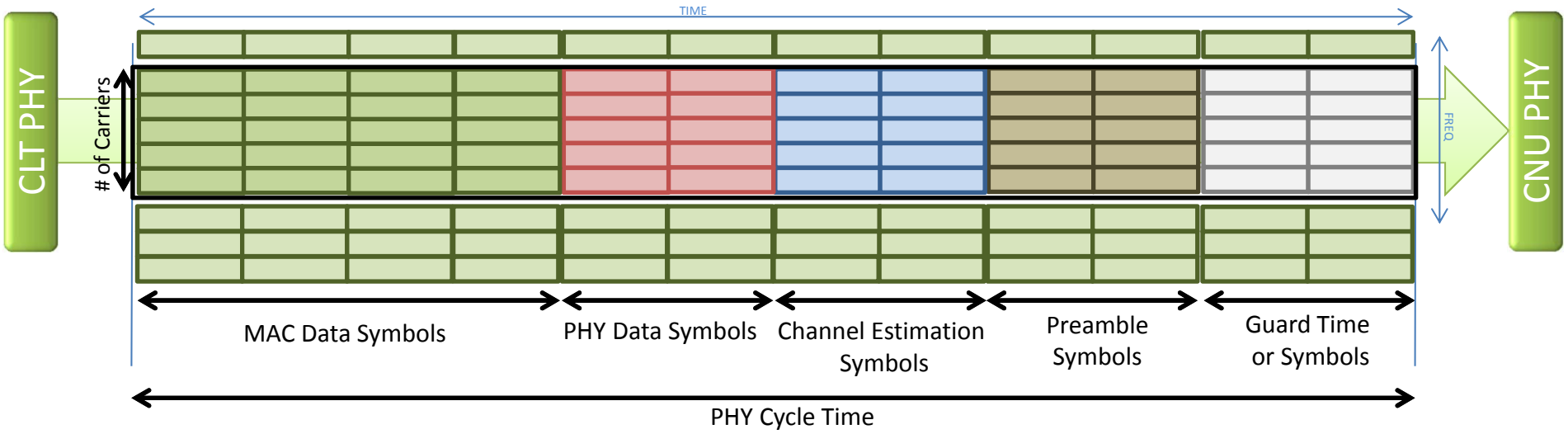
- Y:
- N:
- Abstain:

Straw Poll #5

- The downstream PHY link channel should be a dedicated set of carriers?

- Y:
- N:
- Abstain:

Downstream PHY Link Channel



	Bounds	Option 1 - FDD	Option 2 - FDD	Option 1 - TDD	Option 2 - TDD
PHY Link Channel Width (# of Carriers x carrier width)	1 to	300KHz	400KHz (easier to find)		
Guard Time/Symbols	0 to	0	0 to X	RTT+SwitchTime + up-cycle	?
Preamble Symbols	1 to	2	4		
Channel Estimation Symbols	0 to	?	?		
PHY Data Symbols	1 to	?	1 to Z		
MAC Data Symbols	0 to	0	>0		
PHY Data Rate	>0				

Downstream PHY Link Channel

- Number of preambles of symbols?
  - Fixed pattern, BPSK, PN sequence is an example
  - 2 symbols is used in LTE
  - 2 maybe difficult to detect in bad SNR, 8 would be able to support bad SNR
  - Avi simulation results show 8 symbols has high detection rate
  - Avi will show presentation on results at the next meeting

- How often should preamble be repeated?
  - Every 128 symbols, 8 preamble symbols (1/16th of PHY link channel) [Avi]
  - Every

- Channel Width
  - 400KHz gives more room for overhead

- Sharing the PHY link carrier with the MAC layer Data
  - Wider Channel can be used if MAC data is included.
  - Wider Channel is better against fading
  - PHY link alone doesn't restrict the MAC data channel
  - Slightly variable on the MAC data channel with the gap
  - Simpler to have an isolated channel

Downstream PHY Link Channel

- Do we need to detect symbol size (sub-carrier spacing) and CP size of PHY Link Channel?
  - Fixed is simpler but is it too restrictive and should be same.
  - It is not desirable for the data and the PLC to have different symbol size. Same FFT.
  - The PHY link CP and symbol size should be detected.
  - If we have 2 symbol sizes supported in the data channel, the PHY link channel will have 2 possible sizes.
    - The size of the PLC is constant (e.g. 400KHz)
    - 400KHz would be 8x50KHz carriers
    - 400KHz would be 16x25KHz carriers