EFM Copper

EFM_{Cu} Link Control

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Topics

- Recap of previous link control discussion
- MIB, the MDIO and PHY parameters
- Link initiation, handshake, G.994
- Next steps

Topics from the past:

- **Link Control needed for EFM**
  - **Band plan, bits/Hz, TX power, interleaver depth, etc**
- **Control of remote PHY**
  - **NT (CPE) device always acts as a slave to the LT (Concentrator)**
- **Primitive start-up mode**
  - **Link is initially established with a robust, common set of PMD parameters**
- **PHY parameters and the MIB. . .**
- **Bandplan flexibility**

Simple Example

1. **Host (DSLAM, switch, etc. . .) configured for various "profiles"**

   Each profile contains link settings for a particular environment. EXAMPLES:

   PROFILE A: long reach, low bit rate (small band, sparse constellation)

   PROFILE B: short reach, noise immune (large band, sparse constellation, deep interleaver, higher TX power)

2. **Host sets each LT port PMD parameters to primitive mode via MDIO**

   Link established with NT in primitive mode

3. **Host downloads profile settings to NT using OAM channel**

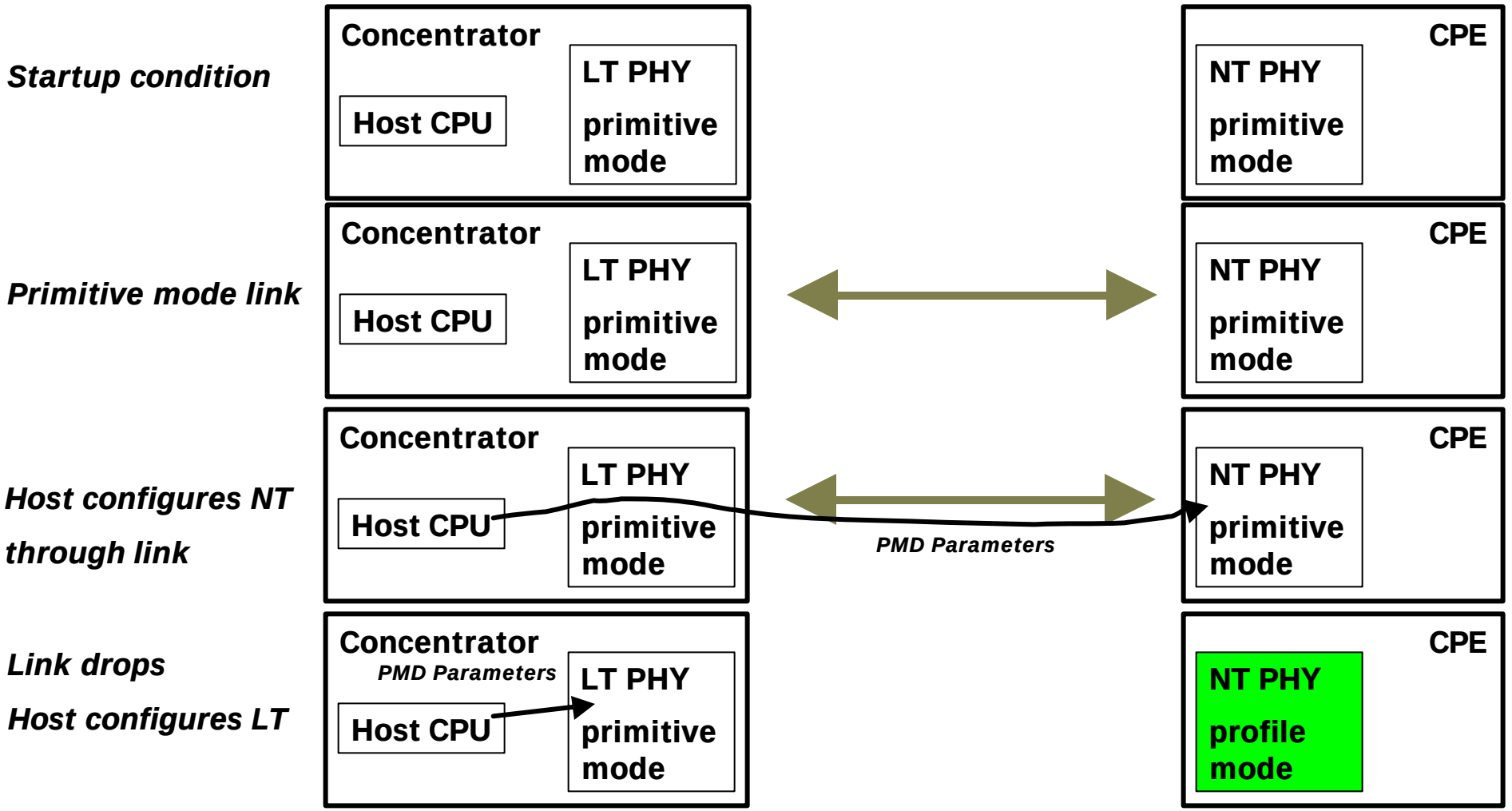
   Host instructs NT to switch to profile mode

4. **Host sets LT PMD settings to profile mode**

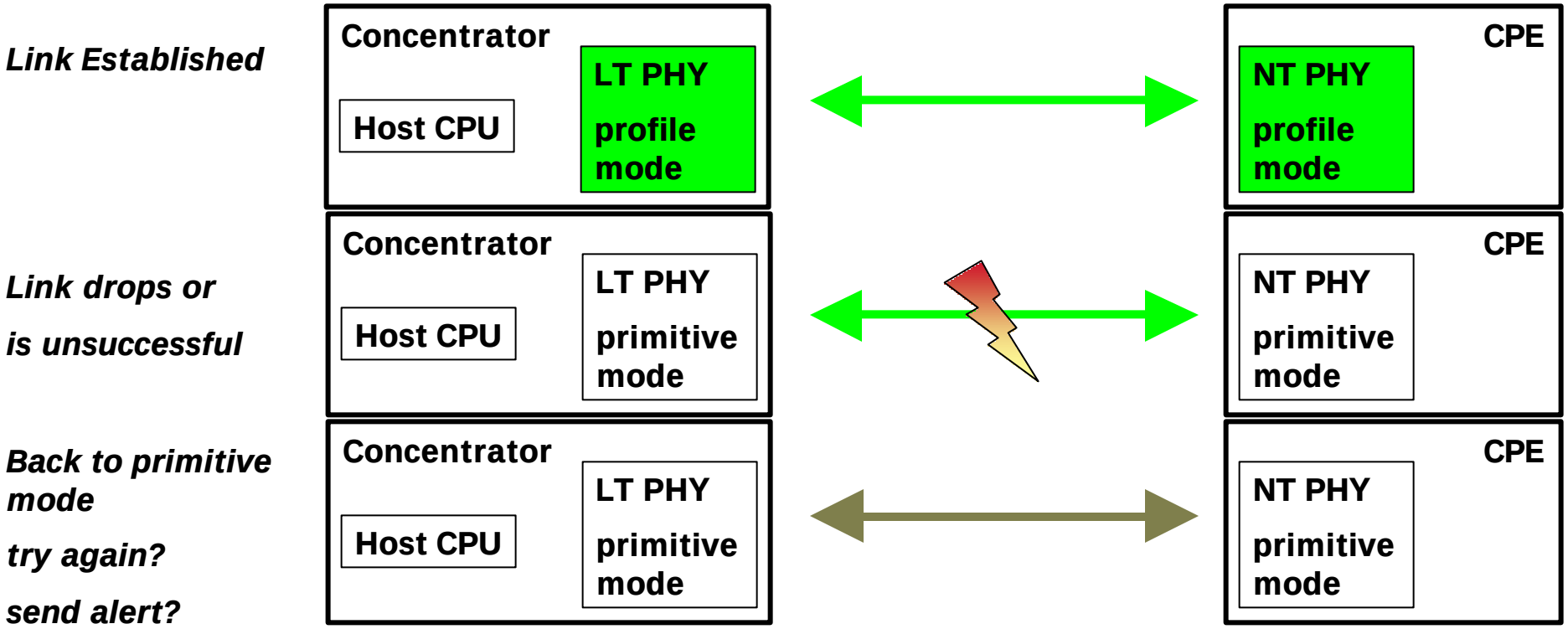
   Link established in new mode

5. **If link goes down, each side reverts to primitive mode and waits for link**

Simple Example



Simple Example



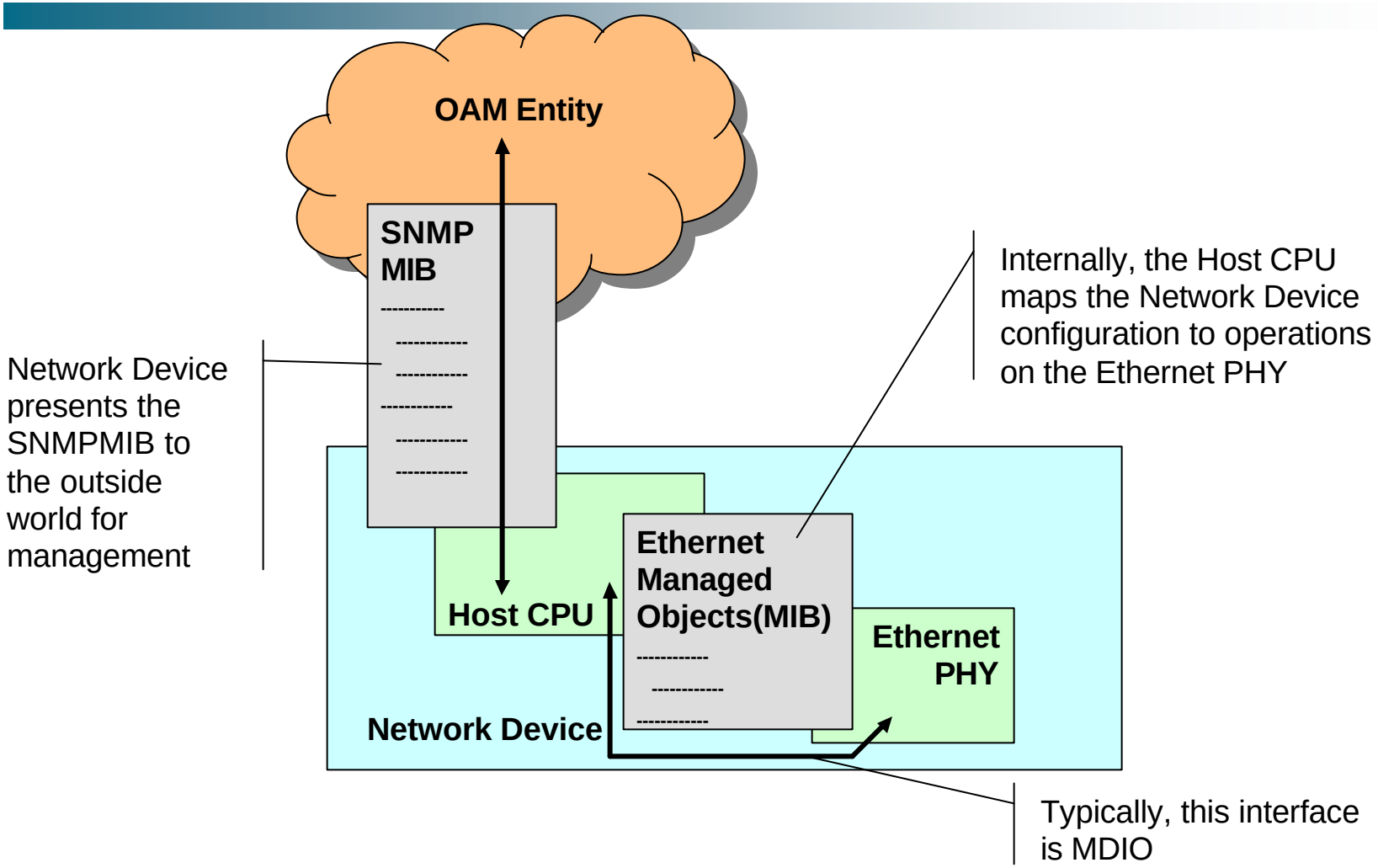
Ethernet Management 101

- **802.3 Clauses 5, 30 define manageable objects for Ethernet**
  - **misnomered "Ethernet MIB", but really protocol independent**
  - **these objects are mapped to GDMO and SNMP MIBs by Annex 30, IETF.**
  - **see *law_1_0901.pdf***
- **The Ethernet MIB is a list that describes the state objects on an Ethernet PHY**
  - **Manageables and Observables**
  - **Closely related to PHY registers**
  - **Objects must not be derived from other objects**
- **This is completely separate from the well-known SNMP MIB that a device presents to the outside world**

Ethernet Management 102

- 802.3 already has a MIB, which contains PHY and MAC control
- 802.3ah$_{Cu}$ will need to define extensions to this MIB that pertain to our specific functionality
  - PMD parameters, link aggregation, etc.
  - include management of LT and NT
- These manageable objects can be accessed through an arbitrary “management interface”
  - 802.3 typically uses MDIO
  - We propose using the 802.3ae Clause 45 MDIO extension to provide enough register space and addressing capability (see *turner_1_0901.pdf*)

System Management Example



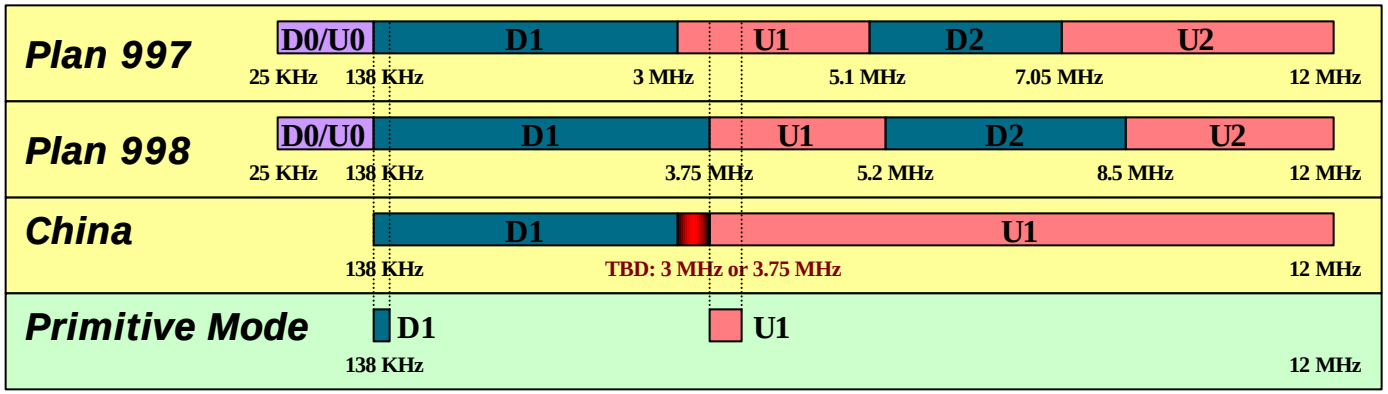
Control of remote PMD

- All PMD parameters on NT controlled from LT host
  - Uses OAM channel (VOC/EOC)
- LT host has total control of PMD algorithms
  - Plug-n-play CPEs
  - No need to restrict handshake or algorithms
  - CPE can be made as simple as possible
- Remote PMD parameters appear in local MIB
  - Accessible through MDIO

“Primitive” start-up mode

- All NT & LT devices start in primitive mode
  - Subset of operational modes,
  - Only the control channel is required, the data channel is optional
- Primitive mode should always make link
  - Narrow spectrum (universal spectral compatibility)
  - Lowest bits/hertz
  - i.e., very high noise margin
- Once link is established, host controls PMDs
  - Host can interrogate CPE capabilities then initiates normal operation in “Full” functionality mode
  - Change local & remote according to regional regulations
- Timeout falls back to primitive mode
  - If full link won’t come up or if link is lost

What does Primitive Mode look like?



- **Mini, subset bandplan**
  - **Always spectrally compliant**
  - **Most robust set of frequencies**
  - **Most robust constellation**

Primitive Mode and G.994

- **G.994 is not required for this scheme**
  - **Standard can explicitly specify primitive mode parameters and the host takes over from there**
- **Proposal does not preclude use of G.994**
- **G.994 can be used to establish initial primitive mode link**
  - **We'll need to identify code points and carrier sets for EFM Cu**
- **G.994 can carry capabilities and parameters over the VOC/EOC**
- **G.994 is not complete**

More on Remote PMD Control

- **Need to decide how much functionality is left up to the CPE PHY and how much is controlled by the Host**
- **Goals:**

  Keep CPE as simple as possible

  Allow Host system (LT) flexibility and control

  Ensure interoperability

  Avoid excessive management of the CPE

  DMT Example: The target band plan and bit rates might be controlled by the Host, but the NT decides on its own what sub-carriers have poor SNR.

- **Key Point: Whatever is NOT under the control of the Host system (LT) must be FULLY SPECIFIED by 802.3ah$_{Cu}$ to insure interoperability and forwards/backwards compatibility**

Basic Rate Adaptive Example

Same mechanisms as simple example. Only host behavior changes:

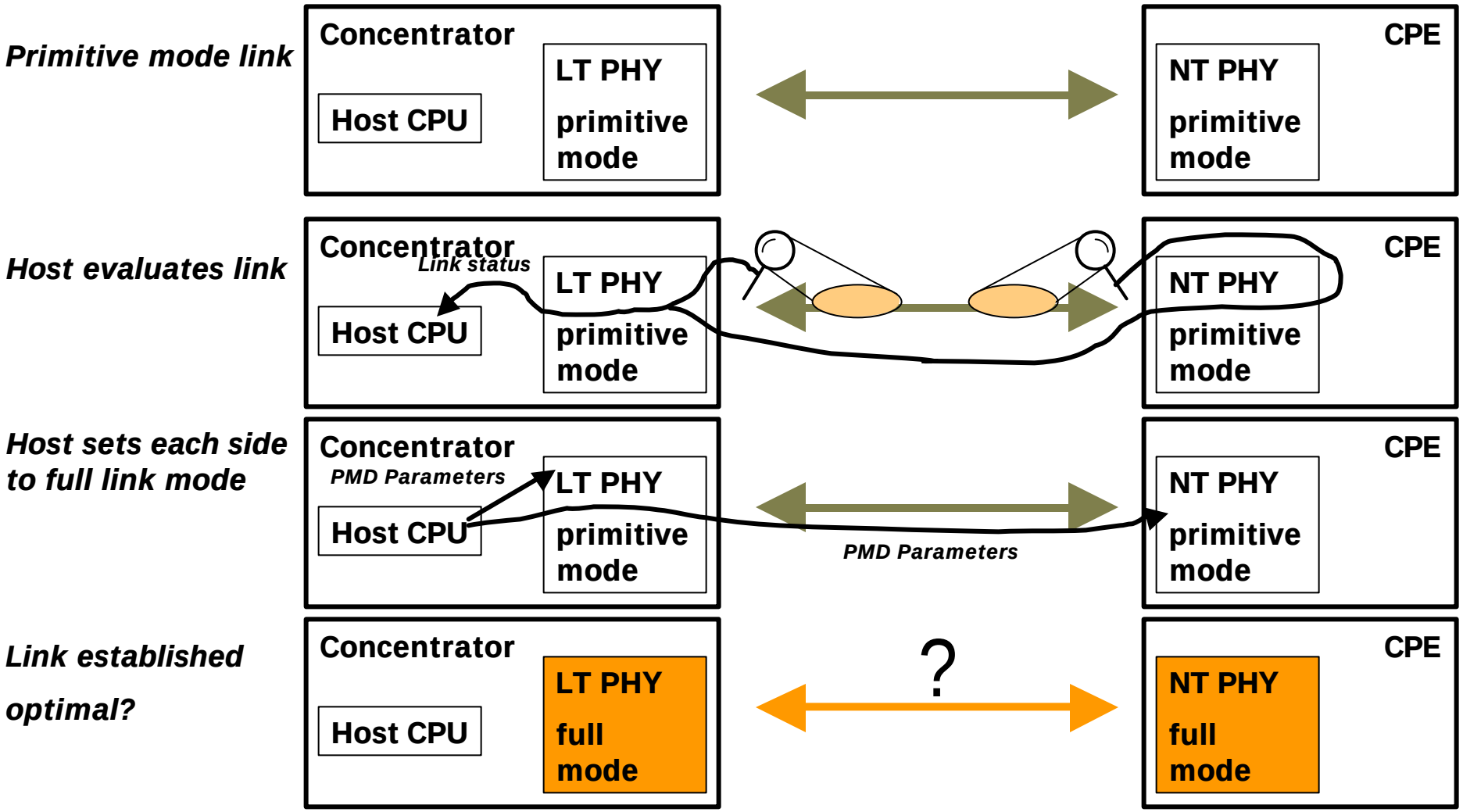
1. **LT and NT link in primitive mode**
2. **Host evaluates line condition based on parameters reported by PHY (SNR, RS errors, etc. . .)**
3. **Host sets NT PHY to a some configuration**

   might be best guess or optimized by steps below
4. **Host sets LT PHY to complementary configuration.**
5. **Link established?**

   NO: Host adapts parameters for better margin. Go to step 1

   YES: Host continues to evaluate line condition, may update parameters to optimize rate, reach, or latency. Back to step 3

Basic Adaptive Example



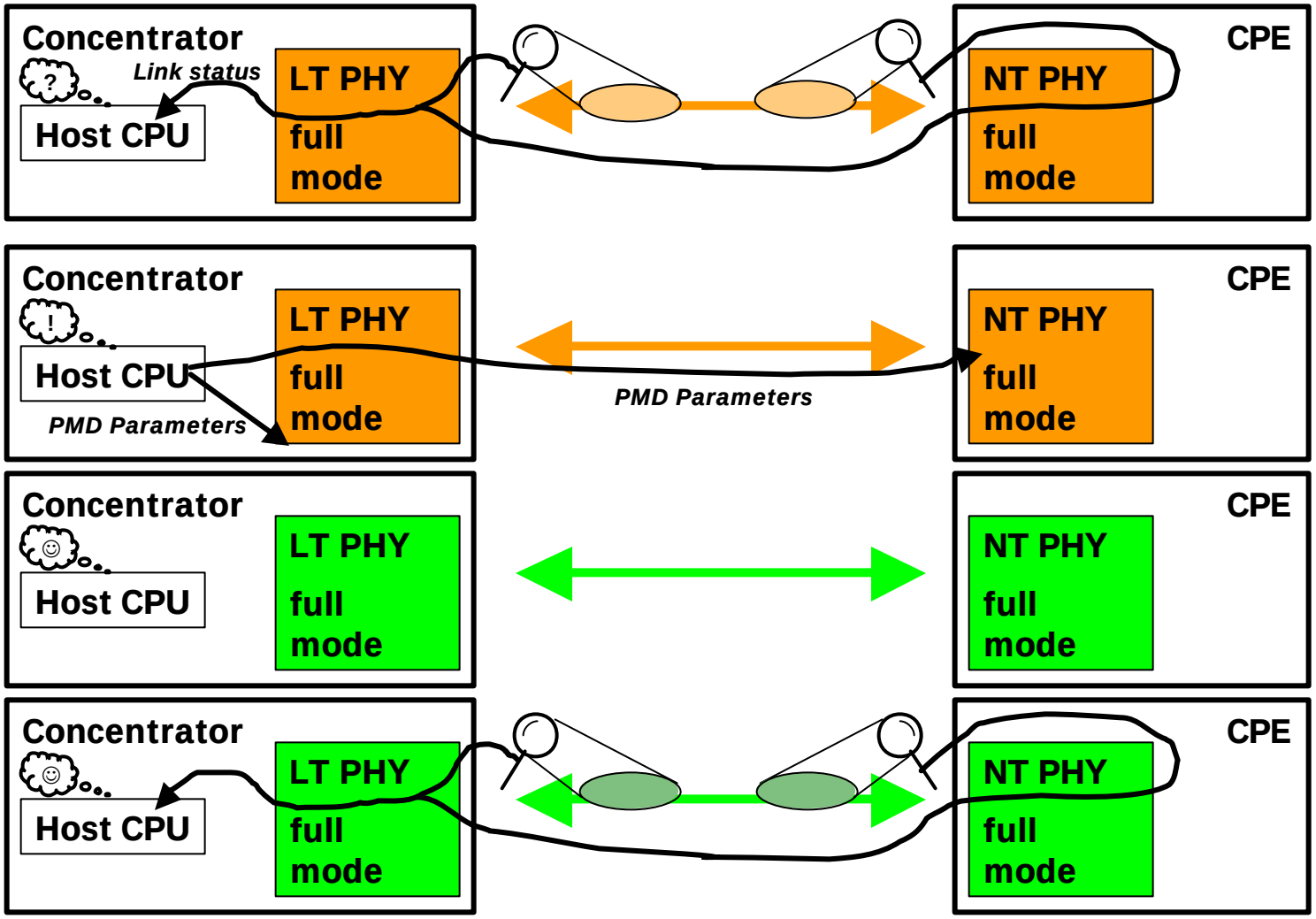
Basic Adaptive Example

Host continually evaluates link

Host applies optimized settings

Full optimized link established

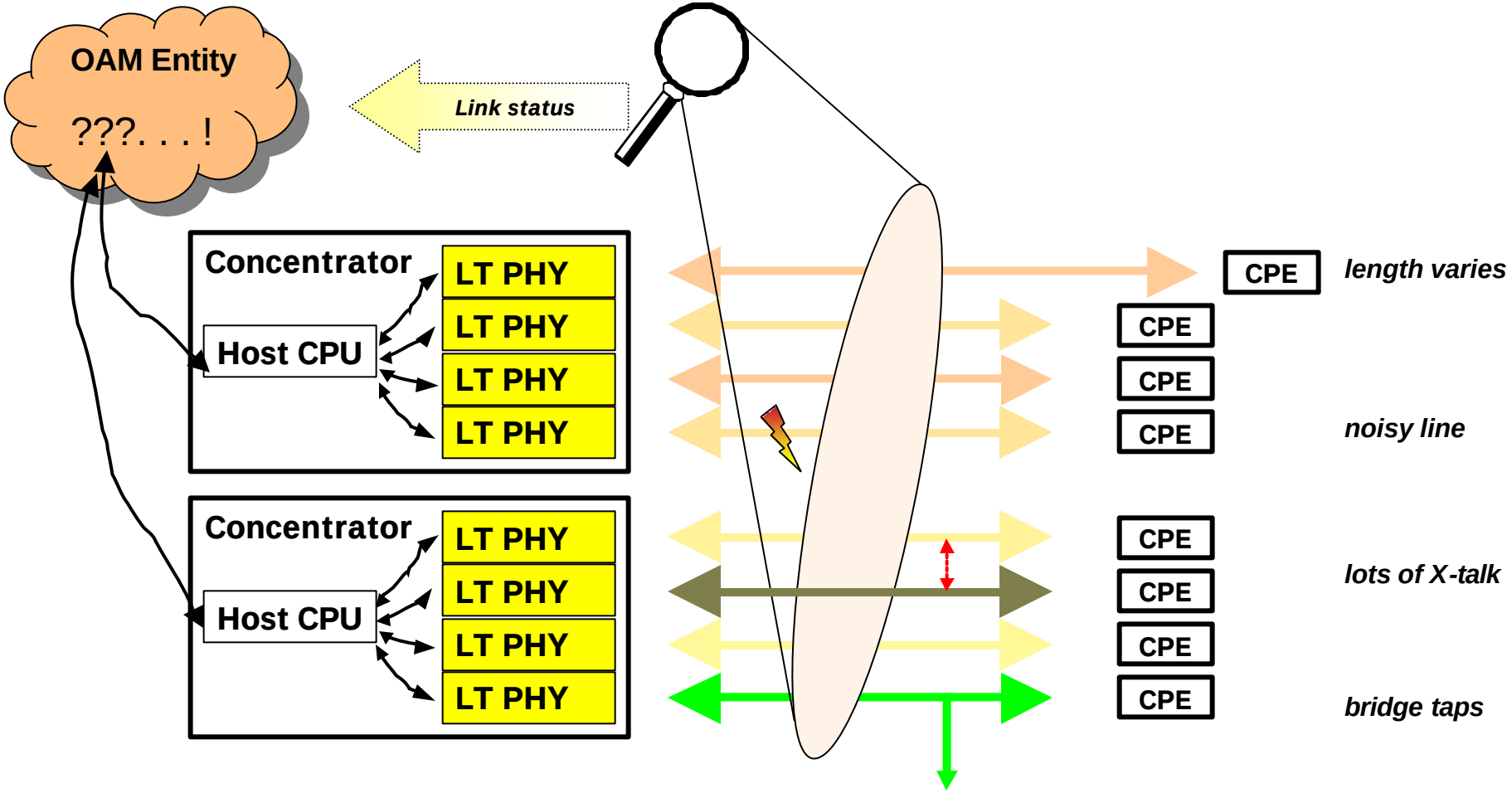
Host continues to monitor link for possible optimizations



System-level Adaptive Example

- **High-level OAM entity maintains multiple ports to decide PMD parameters**
- **Looks at all lines in an installation**
- **Can operate on a single host or across multiple hosts**
- **Examples:**
  - **create a “zipper” of DMT tones on FE/NEXTing ports**
  - **tweak transmit based on site cabling properties (bridge taps, attenuation)**
- **More stable than port-level adaptive methods**
  - **the system intelligence can prevent race conditions when 2+ ports try to optimize against each other**

System-level Adaptive Example



Summary

- **PMD control minimizes PHY state complexity**
  - **Complexity moved to host, amortized over n-ports on concentrator**
  - **No need to fix PMD algorithms in standard**
  - **Easier to allow regional variation & regulation**
- **PMD control through MIB and MDIO true to Ethernet.**
  - **PHYs integrate with current model easily**
- **LT host control of NT PMD simplifies interoperability**
  - **Different vendors' proprietary features operate with any brand of CPE**
  - **No handshaking or negotiating required at PHY level**
  - **Lowers CPE complexity**
- **Primitive mode is common baseline for advanced functionality**

Next Steps

- Define EFM_{Cu} managed objects
- Define PMD control registers
- Define primitive mode values
- Define primitive mode link acquisition sequence
  - If using G.994: code points and carrier sets