EFM Copper

Ethernet and PMD Control

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Topics

- PMD Control needed for EFM
- PMD parameters in the MIB
- Control of remote PMD
- Primitive start-up mode

PMD control needed for EFM

- **Bits/Hertz**
  - Governed by SNR
- **Band allocation**
  - According to spectral management …
  - … or to optimize rate/reach
  - Either number of tones or carrier center and width
- **Transmit power**
  - For power back-off or optimization
- **Interleaver depth**
  - Latency vs. noise immunity

PMD parameters in the MIB

- PHYs have hooks for PMD parameters, all control lies in the host
- Put all PMD control parameters in the MIB
  - Alongside all statistics/counters etc.
- Accessible through MDIO
  - Defined register locations, values, formats
- Algorithms to control PMD reside in host
  - Including band plans for spectral compatibility
  - Optimization or rate adaptation
- If we are making an Ethernet PHY, it should be controllable like one

Control of remote PMD

- **All PMD parameters on NT controlled from LT host**
  - **Uses OAM channel (EOC/VOC)**
- **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
- **Primitive mode should always make link**
  - Narrow spectrum (universal spectral compatibility)
  - Lowest bits/hertz
  - i.e., best 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 local regulations
- **Timeout falls back to primitive mode**
  - If full link won’t come up or if link is lost

Simple Example

1. Host (DSLAM, switch, etc. . .) configured for various “profiles”

   Each profile contains PMD 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

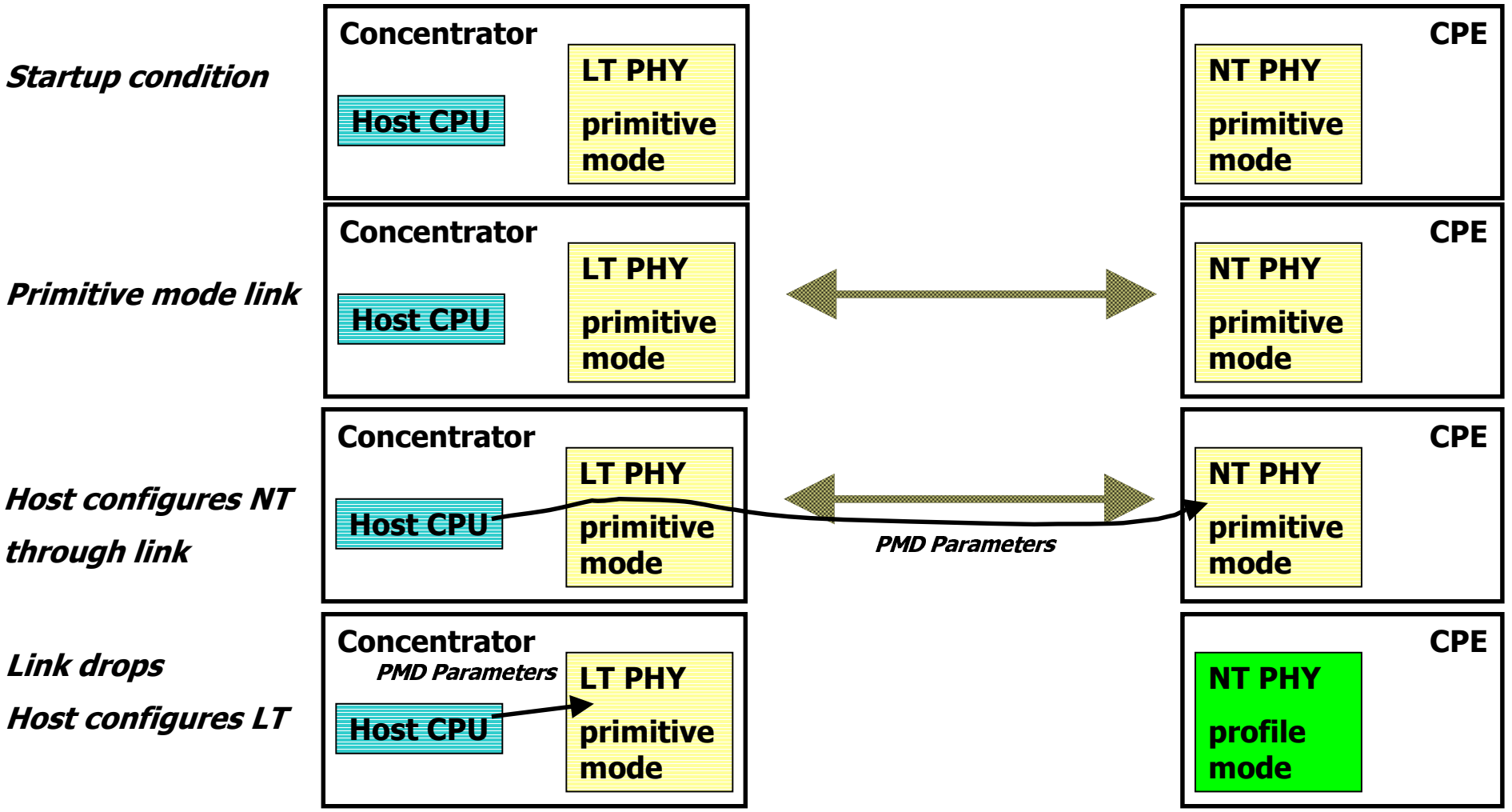
   Host instructs NT to switch to full mode

4. Host sets LT PMD settings to full mode

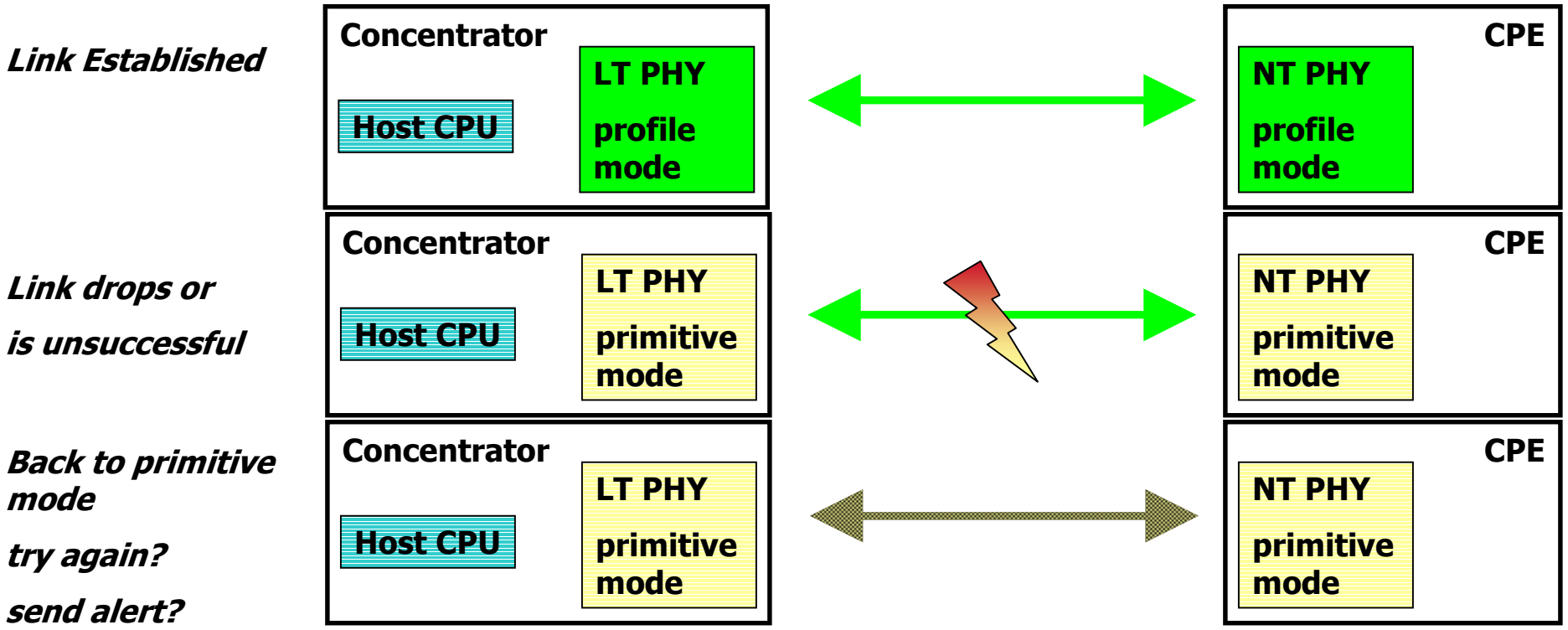
   Link established in new mode

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

Simple Example



Simple Example



Basic Rate Adaptive Example

Same mechanisms as simple example. Only host behavior changes:

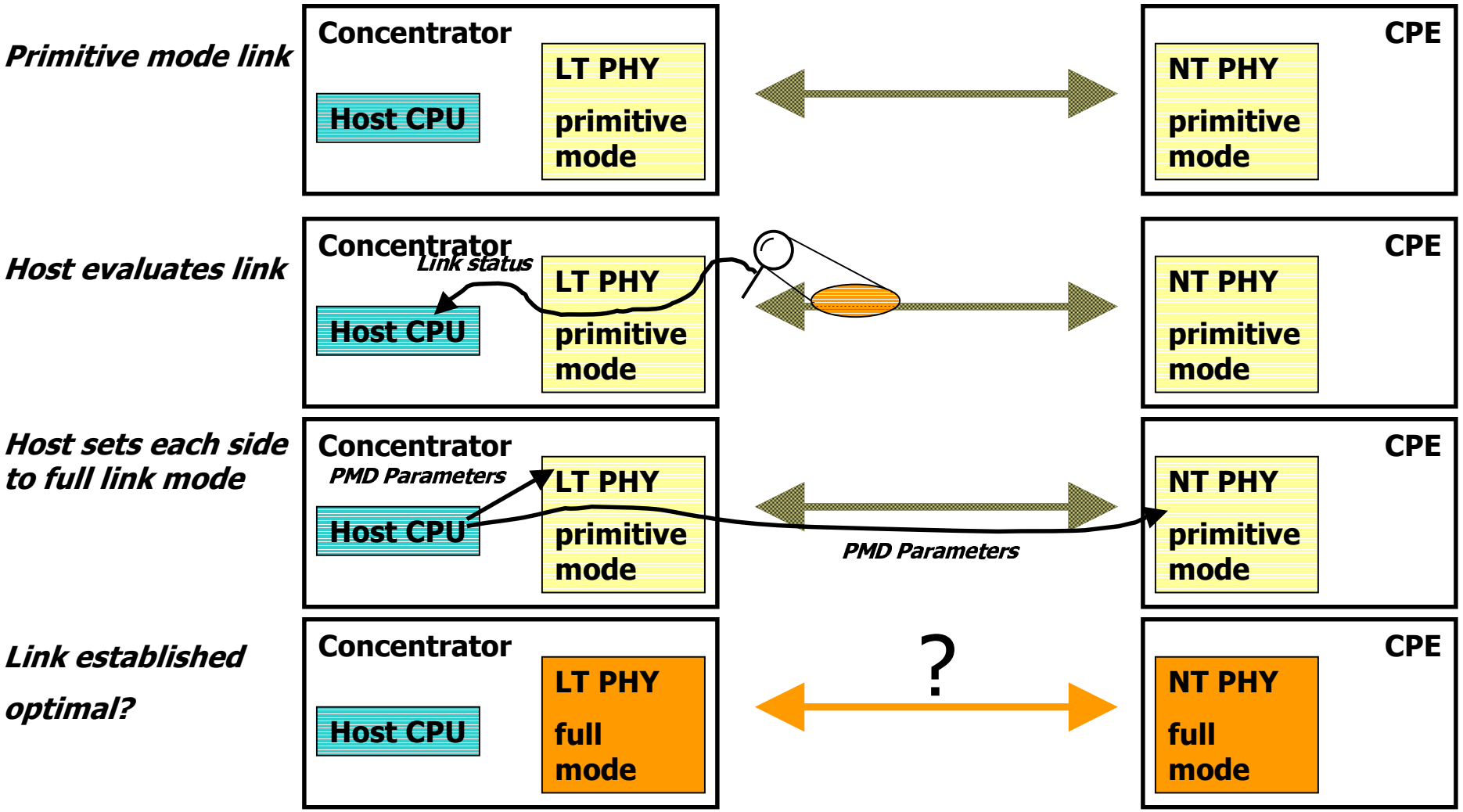
1. LT and NT link in primitive mode
2. Host evaluates line condition based on parameters reported by PHY (SNR, RS errors, etc. . .)
3. Host sets NT PHY to a some configuration

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

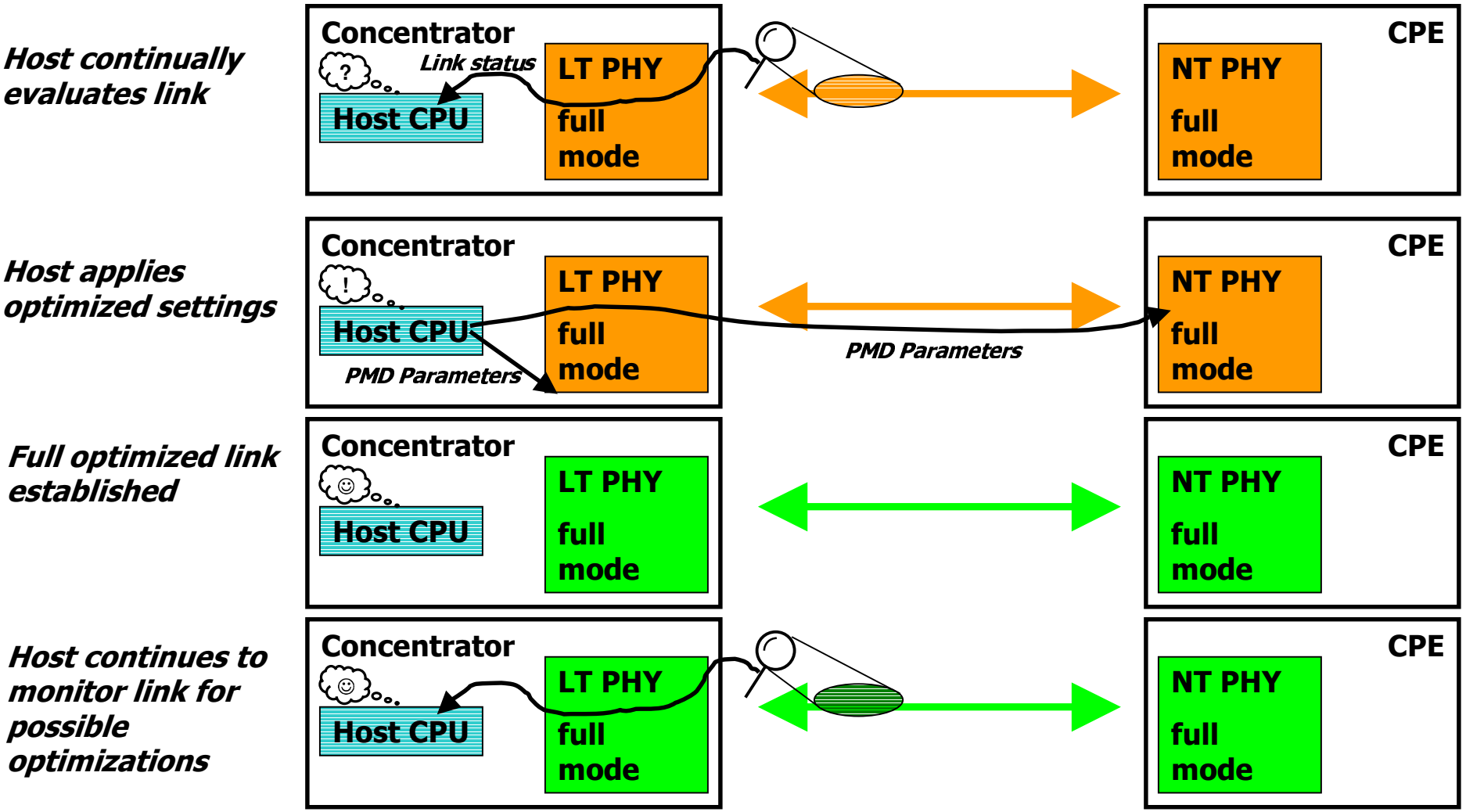
   NO: Host adapts parameters for better margin. Go to step 1

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

Basic Adaptive Example



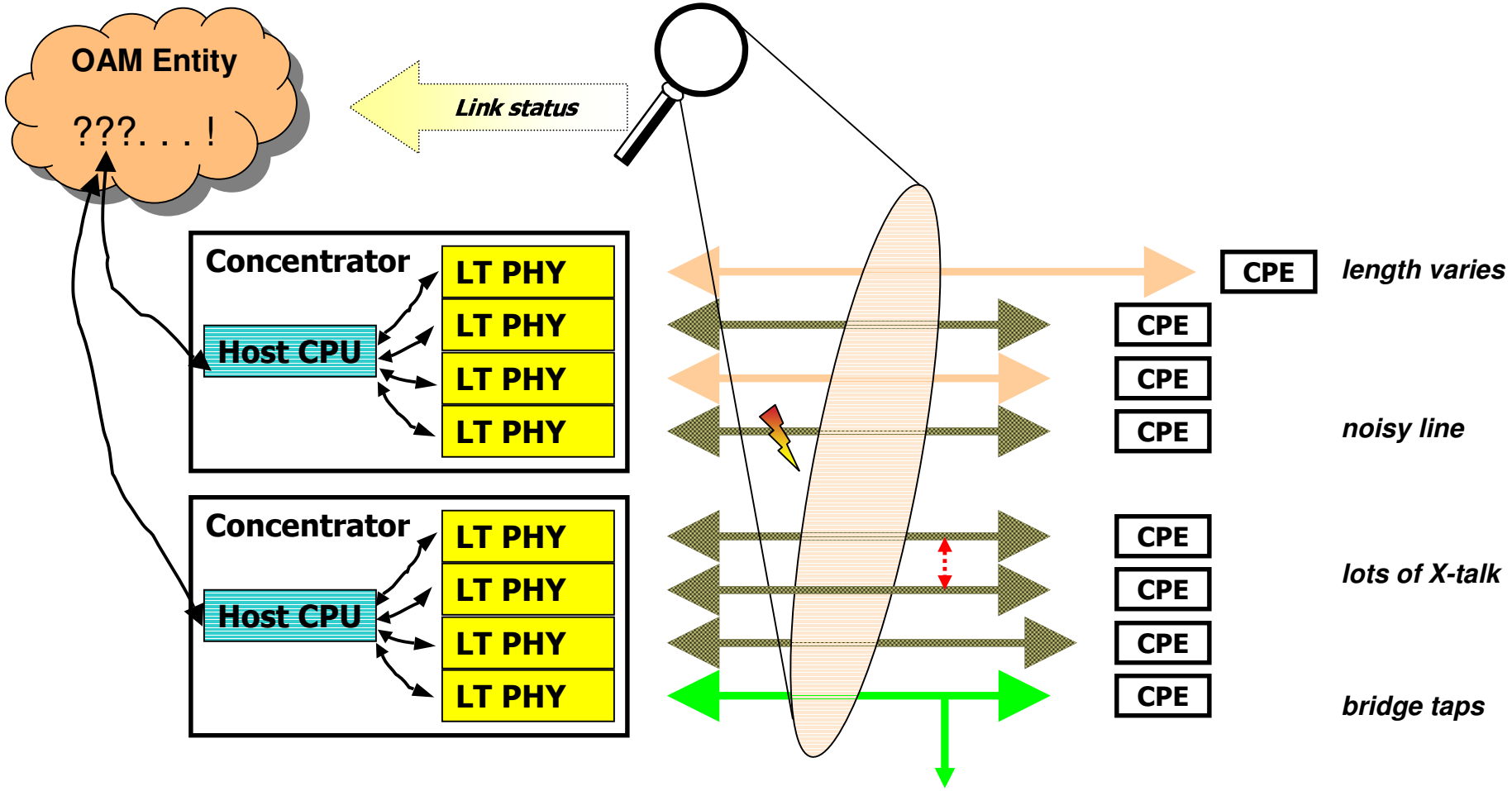
Basic Adaptive Example



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



In conclusion

- **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 local 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**