EVALUATION CRITERIA BEYOND OBJECTIVES

Mark Laubach, Ed Boyd, Thomas Kolze, Richard Prodan

INTRODUCTION

- **The Study Group approved draft Objectives that are proceeding through the approval process**
- **When approved, they become part of the evaluation criteria for technology selection**
- **There are additional fundamental protocol, system, and complexity items to consider as part of our evaluation criteria.**
  - System performance criteria from other organizations
  - Impact on EPON / EPoC system performance
  - Relative complexity impact tradeoffs of different proposals
  - Etc.

NOTE: This is an informational contribution for this meeting.

ADDITIONAL EVALUATION CRITERIA

- **CLT<>CNU PHY Layer delay**
- **Delay, Delay-Variation**
- **Discovery, Auto-negotiation, Re-Negotiation**
- **Relative Cost and Complexity of the CNU**
- **Support for higher layer functions in IEEE 802.3**
  - E.g. 1588v2/802.1af, power saving functions, EEE

SYSTEM PERFORMANCE EXPECTATIONS

- **EPON meets other industry Ethernet service and high speed data specifications**
  - Most often used as the basis for Service Level Agreements (SLAs)
- **For example, Metro Ethernet Forum for Carrier Class Ethernet service**
  - The Study Group adopted objectives for error rate and performance, however EPoC needs to provide capability for fiber competitive MEF (Metro Ethernet Forum) 23.1 [1] services and mobile backhaul services
    - E.g., if it can be run on EPON, it should run on EPoC (as capacity permits)
    - "MEF 23.1 is particularly important to MEF 22.1 Mobile Backhaul Phase 2 IA"
      - From: http://www.metroethernetforum.org/PPT_Documents/Reference-Presentations/Overview-of-MEF_23_Phase_II-Mar-12-2012.ppt
- **Cable industry service requirements are needed**
  - Service requirements for voice, video, data for both business and residential
- **Other uses, e.g. Cellular backhaul (MEF 22.1), etc.**

[1]: http://metroethernetforum.org/PDF_Documents/technical-specifications/MEF_23.1.pdf

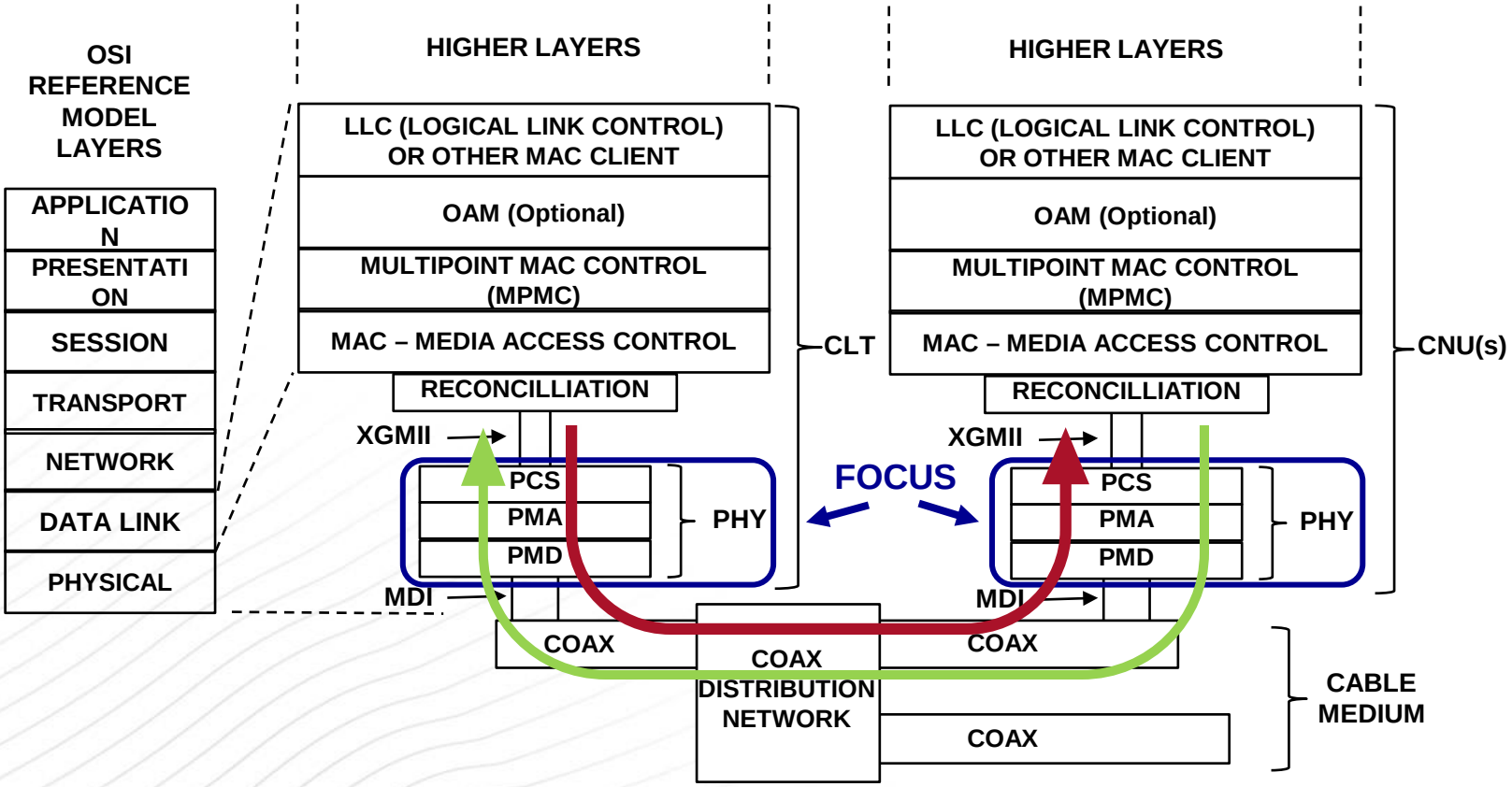
CLT<>CNU PHY DELAY TIME

CLT<>CNU PHY DELAY TIME

- **The system PHY Delay Time (PDT) needs to be bounded in order to assure compatibility with EPON scheduling up to 10Gb/s speeds**
- **PDT does not include scheduling delays**
- **PDT does include known fixed delays and cable network propagation delays. For example:**
  - Two-way coaxial cable network propagation
  - FEC, Interleaver pipe-line through encoder and decoder
  - TX and RX processing, including framing/mapping
  - Packet buffers
- **Ideal is that it is fixed for a given operational configuration**
  - This should be a TF requirement….\
- **The Task Force will need to specify the PDT budget**
  - and the reference points for measurement of PDT, e.g. XGMII sublayer <> RC sublayer interface or RC sublayer <> MAC layer service interface, etc.

CLT<>CNU PHY DELAY TIME

- **EPoC Layer Diagram**



CLT – COAX LINE TERMINAL
CNU – COAX NETWORK UNIT
MDI – MEDIUM DEPENDENT INTERFACE
OAM – OPERATIONS, ADMINISTRATION, & MAINTENANCE

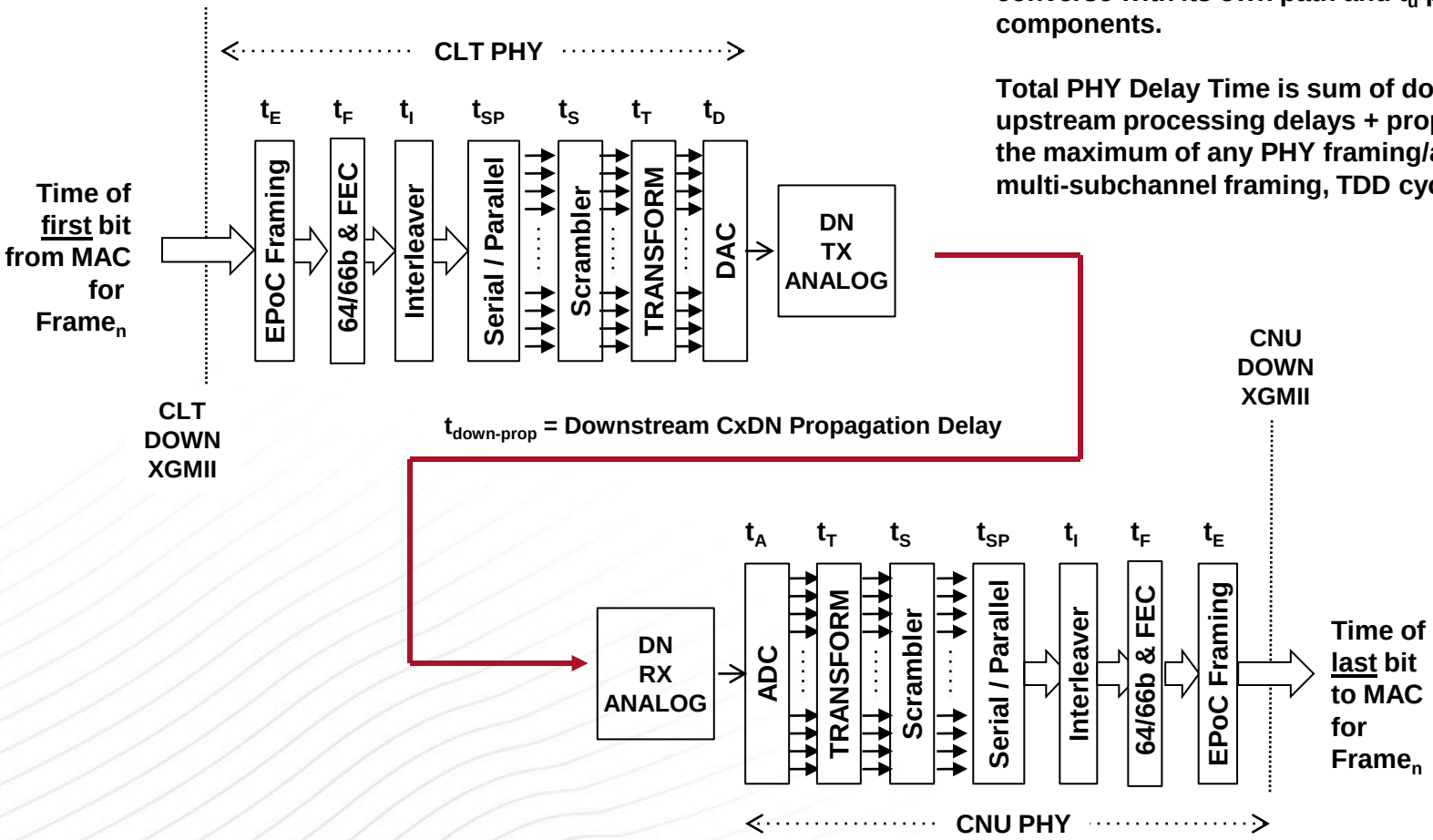
PCS – PHYSICAL CODING SUBLAYER
PHY – PHYSICAL LAYER DEVICE
PMA – PHYSICAL MEDIUM ATTACHMENT
PMD – PHYSICAL MEDIUM DEPENDENT
XGMII – GIGABIT MEDIA INDEPENDENT INTERFACE

CLT<>CNU PHY DELAY TIME

EXAMPLE

Downstream is illustrated. Upstream would be converse with its own path and t_u processing delay components.

Total PHY Delay Time is sum of downstream and upstream processing delays + propagation delays + the maximum of any PHY framing/access delays; e.g. multi-subchannel framing, TDD cycles, etc.



NOTE: The Signal-Processing sequence (path) will be determined by the Task Force. This is just an example to illustrate possible areas of fixed processing delay and propagation delay to raise awareness for future evaluation and consideration.

CLT<>CNU PHY DELAY TIME

continued

- **PDT will be in "trade off" with or have impact on:**
  - Amount and type of error protection
    - TF will need to evaluate complex tradeoffs of channel environment, required error protection, distance, and impact on PDT
  - Maximum distance between CLT (OLT) and CNU
- **TF will need to add a PDT budget "worksheet" to account for all delays**
  - PDT will impact EPON RTT
  - Need to clearly specify any timing reference points
- **Future TF contributions asking for technology evaluation or selection that impacts PDT need to be detailed (!) on budget impact**
  - And tradeoffs, if needed
- **Can PDT ever be exceeded?**
  - For normal operation, goal should be "no"
  - For unusual provisioning needs, cable operator should be aware of tradeoffs with any performance impact Need to state clearly

DELAY AND DELAY VARIATION

DELAY AND DELAY VARIATION

- **Metro Ethernet Forum performance for Carrier Ethernet**
  - Performance Tier 1 (Metro PT)
    - Subset of information in Table 6 “PT1 (Metro PT) CPOs”, Page 42 of [1]
    - Equations begin in Chapter 8 of [1]
  - Access plant (“Service”) limits for UNI – UNI frame transport
    - EPON, EPoC are the access plant
    - Must be able to meet MEF 23.1 COS H, M, L

PT1 Performance Metric (subset)	COS Label		
	H	M	L
Frame delay (ms)	≤ 10	≤ 20	≤ 37
Inter-Frame Delay Variation (ms)	≤ 3	≤ 10	N/S
Frame Loss Ratio	≤ .01% i.e. 10^{-4}	≤ .01% i.e. 10^{-4}	≤ .1% i.e. 10^{-3}

- **For explaining some acronyms and reference points, from [1]: Frame Delay: The time required to transmit a Service or ENNI Frame from ingress EI to egress EI. ENNI: External Network Network Interface. An interface used to interconnect two MEN Operators, EI: External Interface, MEN: The Operator’s or Service Provider’s network providing Ethernet services. Synonymous with Carrier Ethernet Network (CEN)**

DELAY AND DELAY VARIATION

continued

- **Similar paths that include EPoC should also be able to meet MEF 23.1 COS H, M, and L.**
- **For EPOC, impact is PDT plus any scheduling delays**
- **Future TF contributions asking for technology evaluation or selection that impacts delay and delay variation need to be detailed on impact**

DELAY AND DELAY VARIATION

continued

- **Operation observation**
- **Regardless of implementation, the DBA in the OLT/CLT is scheduling upstream traffic:**
  - As transmissions are to be received by the MAC
    - Time or arrival and order of arrival
  - To avoid collisions
  - To meet higher level system service objectives
    - E.g. SLA's, service flows
    - Service provider provisioning objectives
- **EPON assumes the PHY is a slave to the MAC with fixed delay**
  - Fixed delays with known (tight) variation excursions (jitter)
    - With EPoC, for a given provisioned configuration; e.g., error protection configuration, bandwidth configuration, PHY framing configuration, etc.
  - Necessary for accurate (and stable) RTT determination for each CNU/ONU

DISCOVERY, AUTO-NEGOTIATION, RE-NEGOTIATION

DISCOVERY, AUTO-NEGOTIATION, RE-NEGOTIATION

- **Bringing "new" and offline CNUs online will require following a well defined process that is to-be-specified**
  - Likely similar to procedures in DOCSIS ®
  - Future devices built to this standard should be able to work "out of box"
- **Overview of an example CNU process after POST:**
  - Channel "hunt" – locate downstream EPoC channel in RF
  - Decode configuration information, including upstream channel information
  - At proper time, attempt to inform CLT – be "discovered"
  - Be "discovered" by CLT – initial identifier assignment
  - Be managed by CLT – frequency, range, power, link rates, etc.
  - Be released by CLT to "LINKED" state
    - Auto-negotiation is finished, link/channel rates are known
    - Then made available to MAC layer - connected
- **Discovery and auto-negotiation MUST be accomplished without interfering with other operational CNUs**

continued

- **Re-negotiation, includes**
  - Periodic adjustment – frequency, range, power, etc.
  - Changing downstream channel parameters
  - Changing upstream channel parameters
- **No impact to the CNU MAC operation during renegotiation**
- **There is a high desire that re-negotiation of one CNU not interfere with other operating CNUs and**
- **The TF will need to develop expectations on "time to complete" and impact on overall performance**
  - For population sizes of a single CNU up to maximum number of CNUs
- **Future TF contributions asking for technology evaluation or selection that impacts areas of discovery, auto-negotiation, and on re-negotiation need to be detailed on impact**

RELATIVE COST AND COMPLEXITY OF THE CNU

RELATIVE COMPLEXITY IMPACT ON THE CNU

- **Comparing relative complexity impact of different proposals will be a part of the selection process**
- **Impact areas:**
  - FEC memory requirements
  - Packet buffering (e.g. for staging, access delay accomodation, etc.)
  - Tx and Rx processing (serial <> parallel conversion)
  - High parallelization
  - Clock synchronization
  - Transmit power
  - Analog RF performance
  - Etc.
- **Future TF contributions should be sufficiently “well understood” for the selection process -> “impact aware consensus”**

SUPPORT FOR HIGHER LAYER FUNCTIONS IN IEEE 802.3

SUPPORT FOR HIGHER LAYER FUNCTIONS IN IEEE 802.3

- **If EPON supports it, then so likely should EPoC**
- **Functions / Services:**
  - IEEE 1588-2008 (1588v2) “IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems”
    - achieves clock accuracy in the sub-microsecond range
  - IEEE 802.1AS-2011 - IEEE Standard for Local and Metropolitan Area Networks - Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks
  - IEEE 802.3az-2010 Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment 5: Media Access Control Parameters, Physical Layers, and Management Parameters for Energy-Efficient Ethernet
    - Are there any EEE options for EPoC?
    - Other power-saving functions?
  - What else?

SUMMARY

SUMMARY

- **There are additional fundamental protocol, system, and complexity items to consider as part of our evaluation criteria.**
  - This contribution summarizes some necessary criteria for evaluating technology proposals
  - The TF should adopt additional criteria to supplement the Objectives
- **The TF has been given an aggressive schedule**
  - The amount of detail in contributions directly impacts keeping to schedule
  - Helps work stay focused
- **Technology selection moves more efficiently when contributions have sufficient <u>appropriate</u> detail**
  - All contribution authors are aware of the evaluation criteria
    - Avoids “we weren’t aware that was needed”, etc.
  - Supports an “impact aware” consensus process

Thank you