IEEE 802.3
Beyond 400 Gb/s Ethernet Study Group

Objectives – Past / Future and Their Form

John D'Ambrosia
Chair, IEEE 802.3 Beyond 400 Gb/s Ethernet SG
18 Jan 2021 Teleconference

Foreword

- **My responsibility as chair:**
  - **to produce a draft standard, recommended practice, or guideline in a reasonable amount of time for review and approval by the WG.**

- **Nothing in this presentation should be interpreted as an endorsement by its mention.**
- **Material presented is for Study Group participants reference.**

Introduction

▣ **This presentation reviews objectives and their form.**

▣ **Past "new speed" projects going back to 802.3ba are considered**

– **802.3ba – 40GbE / 100 GbE**

▪ **https://www.ieee802.org/3/ba/PAR/P802.3ba_Objectives_0709.pdf**

– **802.3bs – 200 GbE / 400 GbE**

▪ **https://www.ieee802.org/3/bs/Objectives_16_0317.pdf**

– **802.3by – 25 GbE**

▪ **https://www.ieee802.org/3/by/P802_3by_Objectives.pdf**

– **802.3cd – 50 GbE**

▪ **https://www.ieee802.org/3/cd/P802d3cd_objectives_v4.pdf**

▣ **Other projects targeting specific PHY types are also reviewed.**

▣ **Wording of objectives presented for reference and lessons learned.**

Objective – New Rate

◙ **Historical Perspective**
- **802.3ba**
  - **Support a MAC data rate of 40 Gb/s**
  - **Support a MAC data rate of 100 Gb/s**
- **802.3bs**
  - **Support a MAC data rate of 200 Gb/s**
  - **Support a MAC data rate of 400 Gb/s**
- **802.3by**
  - **Support a MAC data rate of 25 Gb/s**
- **802.3cd**
  - **Support a MAC data rate of 50 Gb/s and 100 Gb/s**

◙ **Very similar wording from prior projects –**
- **Support a MAC data rate of ____ Gb/s**

"Apple Pie" Objectives Wording

|	802.3ba	802.3bs	802.3by	802.3cd
Support full-duplex operation only	✓	✓	✓	✓
1. Preserve the 802.3 / Ethernet frame format utilizing the 802.3 MAC	✓			
2. Preserve the Ethernet frame format utilizing the Ethernet MAC		✓	✓	✓
1. Preserve minimum and maximum FrameSize of current 802.3 standard	✓			
2. Preserve minimum and maximum FrameSize of current Ethernet standard		✓		
3. Preserve minimum and maximum FrameSize of current IEEE 802.3 standard			✓	✓
Provide appropriate support for OTN	✓	✓	✓	✓
1. Specify optional Energy Efficient Ethernet (EEE) capability	n/a	✓		
2. Support optional Energy-Efficient Ethernet operation			✓	✓
1. Support a BER better than or equal to 10-12 at the MAC/PLS service interface	✓			
2. Support a BER of better than or equal to 10-13 at the MAC/PLS service interface (or the frame loss ratio equivalent)		✓		
3. Support a BER of beLer than or equal to 10-12 at the MAC/PLS service interface (or the frame loss ratio equivalent)			✓	
4. Support a BER of better than or equal to 10-12 at the MAC/PLS service interface (or the frame loss ratio equivalent) for 50 Gb/s and 100 Gb/s operation				✓
5. Support a BER of better than or equal to 10-13 at the MAC/PLS service interface (or the frame loss ratio equivalent) for 200 Gb/s operation				✓

Observation – wording of objectives tends to improve with successive iterations

The Following Pages

- **Reviews wording for potential objectives, leveraging previous projects**
- **This is only for reference of potential wording for objectives and should not be construed as support for any potential objectives shown**

Physical Layer Specifications or PHYs?

- **This effort needs to focus on the development of physical layer specifications**
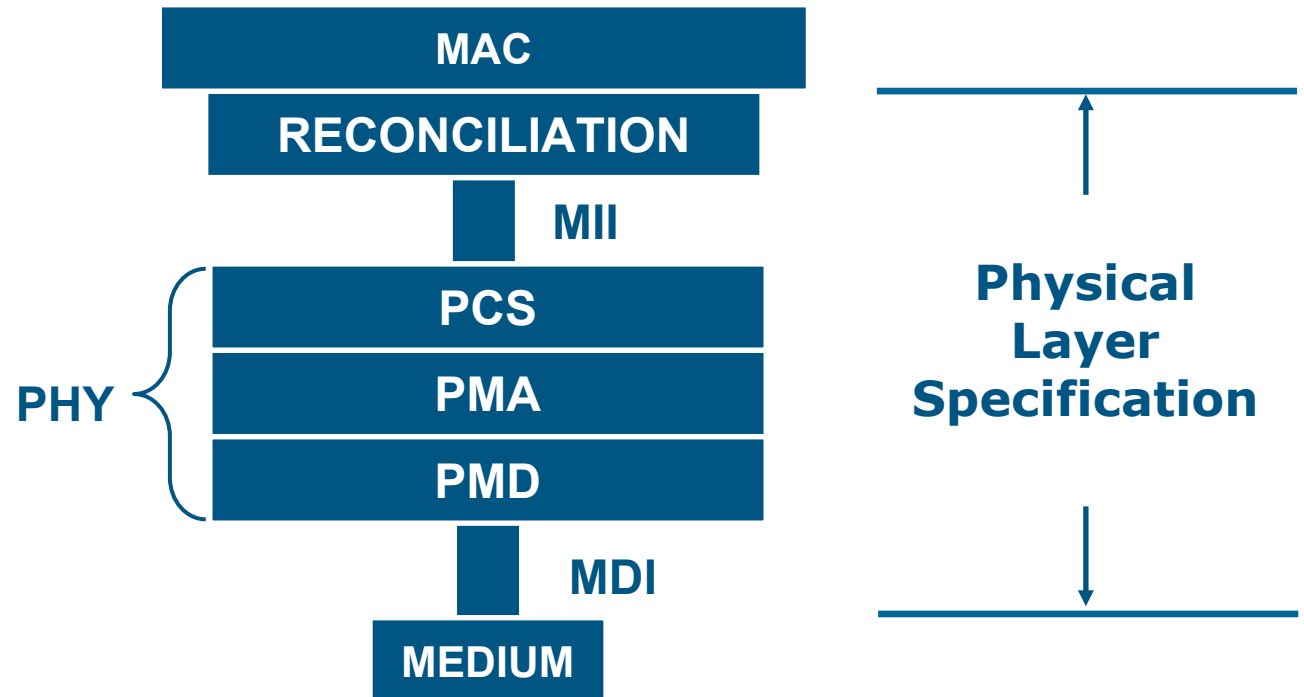
List of Electrical Interfaces & PMD Types

- **Electrical Interfaces (AUI)**
  - **Chip-to-chip**
  - **Chip-to-module**
- **PMD Types**
  - **Backplane**
  - **Twin-Ax**
  - **MMF (current trend up to 100m)**
  - **SMF - parallel fiber approach (current trend up to 500m)**
  - **SMF –duplex fiber approach (2km to 40km)**
  - **DWDM Systems**

Examples – Prior AUI Objectives

- **From IEEE P802.3bs**
  - **Support optional Attachment Unit Interfaces for chip-to-chip and chip-to-module applications**
- **From IEEE P802.3ck** (**https://www.ieee802.org/3/ck/P802_3ck_Objectives_2018mar.pdf**)
  - **Single Lane**
    - **Define a single-lane 100 Gb/s Attachment Unit interface (AUI) for chip-to-module applications, compatible with PMDs based on 100 Gb/s per lane optical signaling**
    - **Define a single-lane 100 Gb/s Attachment Unit Interface (AUI) for chip-to-chip applications**
  - **Multi-Lane**
    - **Define a four-lane 400 Gb/s Attachment Unit interface (AUI) for chip-to-module applications, compatible with PMDs based on 100 Gb/s per lane optical signaling.**
    - **Define a four-lane 400 Gb/s Attachment Unit Interface (AUI) for chip-to-chip applications.**

- **Observations**
  - **An AUI can be an electrical interface between PHY Sublayers or part of an MII Extender Sublayer. Both are part of the physical sublayer. Not all projects have specified AUI objectives (.3ba/ .3by / .3cd)**
  - **Number of lanes of AUI may or may not be specified**

Examples – Prior Backplane Objectives

▪ **From IEEE P802.3ck**

- **Single Lane**

  ▪ **Define a single-lane 100 Gb/s PHY for operation over electrical backplanes supporting an insertion loss ≤ 28 dB at 26.56 GHz.**

- **Multi-lane**

  ▪ **Define a four-lane 400 Gb/s PHY for operation over electrical backplanes supporting an insertion loss ≤ 28 dB at 26.56 GHz.**

Examples – Prior Twin-Ax Objectives

- **From IEEE P802.3ck**
  - **Single Lane**
    - **Define a single-lane 100 Gb/s PHY for operation over twin-axial copper cables with lengths up to at least 2 m.**
  - **Multi-lane**
    - **Define a four-lane 400 Gb/s PHY for operation over twin-axial copper cables with lengths up to at least 2 m.**

- **Observations**
  - **Number of lanes may not need to be specified**
  - **Note language "… up to at least" – means it has to support all reaches up to at least the stated reach**
    - **Some may interpret "at least" to mean that it just needs to support the stated reach and not all reaches up to the stated reach number**
    - **IMO – Not meeting everything up to a stated reach is a broad market potential issue**

Example – Prior MMF Objectives

- **From IEEE P802.3db (https://www.ieee802.org/3/db/P802d3db_Updated_Objectives_Approved_November_2020.pdf)**
  - **Single Lane**
    - **Define a physical layer specification that supports 100 Gb/s operation over 1 pair of MMF with lengths up to at least 100 m**
  - **Multi-Lane**
    - **.Define a physical layer specification that supports 400 Gb/s operation over 4 pairs of MMF with lengths up to at least 100 m**

- **Observation – specific type of MMF not noted**

Example – Prior Objective – PSM Approach

- **From IEEE P802.3bs**
  - **Provide physical layer specifications which support 200 Gb/s operation over:**
    - **At least 500 m of 4-lane parallel SMF**
  - **Provide physical layer specifications which support 400 Gb/s operation over:**
    - **At least 500 m of SMF**

- **Observation – at 400 Gb/s the number of lanes was not specified**

Example – SMF Fiber Approach

- **From IEEE P802.3bs**
  - **Provide physical layer specifications which support 400 Gb/s operation over:**
    - **At least 10 km of SMF**
- **From IEEE P802.3cu** (**https://www.ieee802.org/3/cu/Objectives_Approved_Sept_2019.pdf**)
  - **Define a four-wavelength 400 Gb/s PHY for operation over SMF with lengths up to at least 2 km**
- **Observations**
  - **Number of wavelengths may or may not be specified**
  - **Note use of "…up to at least…"**

Example – Over DWDM Systems

- **From IEEE P802.3ct (https://www.ieee802.org/3/ct/ProjDoc/3ct_Objectives_190911.pdf)**
  - **Provide a physical layer specification supporting 100 Gb/s operation on a single wavelength capable of at least 80 km over a DWDM system.**

- **Observation – in the .3ct project the lack of ".. Up to at least.." contributed to a comment being submitted against the BMP of the draft**

Conclusions

▫ **This presentation reviews past objectives and their form.**

▫ **Advice – leverage what has been demonstrated to work on the path to success. Learn from what has caused issues.**

THANK YOU!