IEEE 802 Nov 2021
Electronic Plenary

IEEE 802.3 Ethernet WG
Closing Plenary
18 Nov 2021

IEEE 802.3
Beyond 400 Gb/s Ethernet SG
Closing Report

IEEE P802.3 B400G Study Group Project information

- **Study Group Organization**
  - **John D'Ambrosia, Study Group Chair**
  - **Tom Issenhuth, Study Group Recording Secretary**
- **Task force web and reflector information**
  - **Reflector information: https://www.ieee802.org/3/B400G/reflector.html**
  - **Home page: https://www.ieee802.org/3/B400G/index.html**

This Plenary's Accomplishments

- Reviewed comments submitted against project documentation
  - Summary / Response - https://www.ieee802.org/3/B400G/public/21_1116/dambrosia_b400g_03a_211116.pdf
  - Adopted updated PAR and BMP response – unanimous consent
- Liaison Responses Generated to:
  - From OIF regarding 800G Coherent Project
  - From ITU-T SG15 regarding OTN Support
- Approved requesting 3rd SG rechartering

- Updated PAR - https://mentor.ieee.org/802-ec/dcn/21/ec-21-0224-02-00EC-par-ieee-p802-3df.pdf
- Updated CSD - https://mentor.ieee.org/802-ec/dcn/21/ec-21-0225-01-00EC-csd-ieee-p802-3df.pdf

IEEE P802.3df OBJECTIVES

B400G Adopted Objectives

- **Non-Rate Specific**
  - Support full-duplex operation only
  - Preserve the Ethernet frame format utilizing the Ethernet MAC
  - Preserve minimum and maximum FrameSize of current IEEE 802.3 standard
  - Support a BER of better than or equal to 10 -13 at the MAC/PLS service interface (or the frame loss ratio equivalent)
  - Provide support to enable mapping over OTN
- **200 Gb/s Related**
  - Support a MAC data rate of 200 Gb/s
  - Support optional single-lane 200 Gb/s attachment unit interfaces for chip-to-module and chip-to-chip applications
  - Define a physical layer specification that supports 200 Gb/s operation:
    - over 1 pair of copper twin-axial cables in each direction with a reach of up to at least 1.0 meter
    - over 1 pair of SMF with lengths up to at least 500 m
    - over 1 pair of SMF with lengths up to at least 2 km
- **400 Gb/s Related**
  - Support a MAC data rate of 400 Gb/s
  - Support optional two-lane 400 Gb/s attachment unit interfaces for chip-to-module and chip-to-chip applications
  - Define a physical layer specification that supports 400 Gb/s operation:
    - over 2 pairs of copper twin-axial cables in each direction with a reach of up to at least 1.0 meter
    - over 2 pairs of SMF with lengths up to at least 500 m

B400G Adopted Objectives

- **800 Gb/s Related**
  - Support a MAC data rate of 800 Gb/s
  - Support optional eight-lane 800 Gb/s attachment unit interfaces for chip-to-module and chip-to-chip applications
  - Support optional four-lane 800 Gb/s attachment unit interfaces for chip-to-module and chip-to-chip applications
  - Define a physical layer specification that supports 800 Gb/s operation:
    - over 4 pairs of copper twin-axial cables in each direction with a reach of up to at least 1.0 meter
    - over eight lanes of twin axial copper cables with a reach up to at least 2 meters
    - over eight lanes over electrical backplanes supporting an insertion loss ≤ 28dB at 26.56GHz
    - over 8 pairs of MMF with lengths up to at least 50 m
    - over 8 pairs of MMF with lengths up to at least 100 m
    - over 8 pairs of SMF with lengths up to at least 500 m
    - over 8 pairs of SMF with lengths up to at least 2 km
    - over 4 pairs of SMF with lengths up to at least 500 m
    - over 4 pairs of SMF with lengths up to at least 2 km
    - over 4 wavelengths over a single SMF in each direction with lengths up to at least 2 km
    - over a single SMF in each direction with lengths up to at least 10 km
    - over a single SMF in each direction with lengths up to at least 40 km

B400G Adopted Objectives

- **1.6 Tb/s Related**
  - Support a MAC data rate of 1.6 Tb/s
  - Support optional sixteen-lane 1.6 Tb/s attachment unit interfaces for chip-to-module and chip-to-chip applications
  - Support optional eight-lane 1.6 Tb/s attachment unit interfaces for chip-to-module and chip-to-chip applications
  - Define a physical layer specification that supports 1.6 Tb/s operation:
    - over 8 pairs of copper twin-axial cables in each direction with a reach of up to at least 1.0 meter
    - over 8 pairs of SMF with lengths up to at least 500 m
    - over 8 pairs of SMF with lengths up to at least 2 km

WG Motion #1

- **Move that the IEEE 802.3 Working Group approve the IEEE P802.3df objectives, as per slides 5 - 7 of 1121_b400g_close_report.pdf**

- **M: John D'Ambrosia**
- **S: Mark Nowell**
- **(Technical ≥ 75%)**
- **Results 802.3 Y: / N: / A:**
- **Motion**

IEEE P802.3df CSD

CSD Changes Summary

- **Modification to Broad Market Potential Response (additional text highlighted)–**

  There has been wide attendance and participation in the study group by subject matter experts familiar with the needs of end users, equipment manufacturers and component suppliers. It is anticipated that there will be sufficient participation to effectively complete the standardization process.

IEEE 802.3 Criteria for Standards Development (CSD)

The IEEE 802 Criteria for Standards Development (CSD) are defined in Clause 14 of the IEEE 802 LAN/MAN Standards Committee (LMSC) Operations Manual. The criteria include project process requirements ("Managed Objects") and 5 Criteria (5C) requirements. The 5C are supplemented by subclause 4.5 'Criteria for Standards Development' of the 'IEEE 802.3 Ethernet Working Group Operations Manual'.

The following are the CSD Responses in relation to the IEEE P802.3df PAR

Items required by the IEEE 802 CSD are shown in Black text and supplementary items required by IEEE 802.3 are shown in **blue** text.

Managed Objects

Describe the plan for developing a definition of managed objects. The plan shall specify one of the following:

a) The definitions will be part of this project.
b) The definitions will be part of a different project and provide the plan for that project or anticipated future project.
c) The definitions will not be developed and explain why such definitions are not needed.

- The definition of protocol independent managed objects, to be included in Clause 30 of IEEE Std 802.3, will be part of this project.

Coexistence

A WG proposing a wireless project shall prepare a Coexistence Assessment (CA) document unless it is not applicable.

a) Will the WG create a CA document as part of the WG balloting process as described in Clause 13? (yes/no)

b) If not, explain why the CA document is not applicable.

- No. A CA document is not applicable because the proposed project is not a wireless project.

Broad Market Potential

Each proposed IEEE 802 LMSC standard shall have broad market potential. At a minimum, address the following areas:

a) Broad sets of applicability.

b) Multiple vendors and numerous users.

- The principle of building equipment that supports IEEE 802.3 networks operating at different Ethernet rates has been amply demonstrated by a broad set of product offerings.
- Per the IEEE 802.3 2020 Bandwidth Assessment Report, by 2025 the bandwidth requirements of various applications will grow between 2.3 to 55.4 times relative to their 2017 levels. The definition of 800 Gb/s and 1.6 Tb/s Ethernet will address the growing diverse bandwidth requirements and cost considerations for these key application areas: cloud-scale data centers, internet exchanges, co-location services, content-delivery networks, wireless infrastructure, service provider and operator networks, and video distribution infrastructure.
- Presentations have been submitted to the study group that illustrate the market adoption of Ethernet ports addressing multiple rates and medias for use with duplex and parallel infrastructures.
- Evolving needs of computing applications will be enabled by parallel solutions targeting noted high–bandwidth applications.
- There has been wide attendance and participation in the study group by subject matter experts familiar with the needs of end users, equipment manufacturers and component suppliers. It is anticipated that there will be sufficient participation to effectively complete the standardization process.

Compatibility

Each proposed IEEE 802 LMSC standard should be in conformance with IEEE Std 802, IEEE 802.1AC, and IEEE 802.1Q. If any variances in conformance emerge, they shall be thoroughly disclosed and reviewed with IEEE 802.1 WG prior to submitting a PAR to the Sponsor.

a) Will the proposed standard comply with IEEE Std 802, IEEE Std 802.1AC and IEEE Std 802.1Q?

b) If the answer to a) is "no", supply the response from the IEEE 802.1 WG.

c) Compatibility with IEEE Std 802.3

d) Conformance with the IEEE Std 802.3 MAC

- As an amendment to IEEE Std 802.3 the proposed project shall comply with IEEE Std 802, IEEE Std 802.1AC and IEEE Std 802.1Q.
- As was the case in previous IEEE Std 802.3 amendments, new physical layers will be defined for 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s operation.
- As an amendment to IEEE Std 802.3, the proposed project will conform to the full-duplex operating mode of the IEEE 802.3 MAC.
- By utilizing the existing IEEE Std 802.3 MAC protocol, this proposed amendment will maintain compatibility with the installed base of Ethernet nodes.
- The definition of protocol independent managed objects, to be included in Clause 30 of IEEE Std 802.3, will be part of this project.

Distinct Identity

Each proposed IEEE 802 LMSC standard shall provide evidence of a distinct identity. Identify standards and standards projects with similar scopes and for each one describe why the proposed project is substantially different.

Substantially different from other IEEE 802.3 specifications/solutions.

- The proposed amendment will be the first IEEE 802.3 standard defining 800 Gb/s and 1.6 Tb/s Ethernet, providing an upgrade path for IEEE 802.3 users from lower Ethernet rates, such as 200 Gb/s and 400 Gb/s Ethernet.
- The proposed amendment will define derivative physical layer specifications from those developed for 800 Gb/s and 1.6 Tb/s Ethernet to address copper, multi-mode fiber, and single-mode fiber specifications, based on a reduced number of physical lanes, for 200 Gb/s and 400 Gb/s Ethernet.

Technical Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence that the project is technically feasible within the time frame of the project. At a minimum, address the following items to demonstrate technical feasibility:

a) Demonstrated system feasibility.
b) Proven similar technology via testing, modeling, simulation, etc.
c) Confidence in reliability.

- The principle of scaling the IEEE 802.3 MAC to higher speeds has been well established by previous work within IEEE.
- The principle of building equipment that supports IEEE 802.3 networks operating at different Ethernet rates has been amply demonstrated by a broad set of product offerings.
- Systems with an aggregate bandwidth of greater than or equal to 1.6 Tb/s have been demonstrated and deployed in operational networks.
- The proposed project will build on the array of Ethernet component and system design experience, and the broad knowledge base of Ethernet network operation.
  - Contributions have been made that presented data on the feasibility of higher speed solutions. Proposals, which either leverage existing technologies or employ new technologies, have been provided.
  - The experience gained in the development and deployment of technologies since the start of the development of 40 Gigabit Ethernet and 100 Gigabit Ethernet (IEEE 802.3ba) starting in 2008, is applicable to the development of specifications for components at higher speeds. For example, some combination of the following approaches could be used to address 800 Gb/s and 1.6 Tb/s Ethernet, as well as to address reduced lane count solutions for 200 Gb/s and 400 Gb/s Ethernet: pulse-amplitude modulation, parallel transmission techniques, forward error correction, optical coherent signaling, and wavelength-division multiplexing
- Based on prior experience with developing higher speed solutions, the reliability of Ethernet components and systems is understood and can be projected in the target environments with a high degree of confidence.

Economic Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence of economic feasibility. Demonstrate, as far as can reasonably be estimated, the economic feasibility of the proposed project for its intended applications. Among the areas that may be addressed in the cost for performance analysis are the following:

a) Known cost factors.
b) Balanced cost factors.
c) Consideration of installation costs.
d) Consideration of operational costs (e.g., energy consumption).
e) Other areas, as appropriate.

- Prior experience scaling IEEE 802.3 indicates the cost distribution between servers, switches, routers, and the infrastructure will remain acceptably balanced for 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet.
- The cost factors for Ethernet components and systems are well known. The proposed project may introduce new cost factors which can be quantified.
- The deployment of 800 Gb/s and 1.6 Tb/s Ethernet standards and derivatives at 200 Gb/s and 400 Gb/s will allow economies of scale to reduce cost for all solutions.
- In consideration of installation costs, the project is expected to use proven and familiar media, including electrical backplanes, twin-axial copper cables, multi-mode optical fiber cabling, and single-mode optical fiber cabling.
- Network design, installation and maintenance costs are minimized by preserving network architecture, management, and software.
- In consideration of operational costs associated with power consumption, the project will examine alternatives that trade off PMD complexity, power, latency, and implementation constraints.

WG Motion #2

- **Move that the IEEE 802.3 Working Group approve the IEEE P802.3df CSD "Managed Objects", "Coexistence", "Broad Market Potential", "Compatibility", "Distinct Identity", "Technical Feasibility", and "Economic Feasibility" responses, as per https://mentor.ieee.org/802-ec/dcn/21/ec-21-0225-01-00EC-csd-ieee-p802-3df.pdf**

- **M: John D'Ambrosia**
- **S: Kent Lusted**
- **(Technical ≥ 75%)**
- **Results 802.3 Y: / N: / A:**
- **Motion**

IEEE P802.3df PAR

PAR Changes Summary

Modifications Highlighted

- **5.2.b. Scope of the project:** Define Ethernet ~~Media Access Control (~~MAC~~)~~ parameters, physical layer specifications~~;~~, ……
- **In 7.1** The Ethernet Technology Consortium released D1.~~0~~1 of "800G Specification" on ~~10 March 2020~~06 August 2021, which defined an 800G MAC and physical coding sub-layer (PCS).
- In **7.1.1 Project/Standard Date:** ~~10 Mar 2020~~06 Aug 2021

IEEE P802.3df PAR (1 of 3)

https://mentor.ieee.org/802-ec/dcn/21/ec-21-0224-02-00EC-par-ieee-p802-3df.pdf

- **2.1 Title: Standard for Ethernet:** Amendment: Media Access Control Parameters, Physical Layers and Management Parameters for 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Operation
- **5.2.b. Scope of the project:** Define Ethernet MAC parameters, physical layer specifications, and management parameters for the transfer of Ethernet format frames at 800 Gb/s and 1.6 Tb/s over copper, multi-mode fiber, and single-mode fiber, and use this work to define derivative physical layer specifications and management parameters for the transfer of Ethernet format frames at 200 Gb/s and 400 Gb/s.
- **5.5 Need for the Project:** The project is necessary to provide solutions to meet the growing bandwidth needs for computing and network interconnect application areas, such as cloud-scale data centers, internet exchanges, co-location services, content delivery networks, wireless infrastructure, service provider and operator networks, and video distribution infrastructure
- **5.6 Stakeholders for the Standard:** Stakeholders include users and producers of systems and components for high-bandwidth applications, such as cloud-scale data centers, internet exchanges, colocation services, content delivery networks, wireless infrastructure, service provider and operator networks, and video distribution infrastructure.

IEEE P802.3df PAR (2 of 3)

https://mentor.ieee.org/802-ec/dcn/21/ec-21-0224-02-00EC-par-ieee-p802-3df.pdf

- **7.1 Are there other standards or projects with a similar scope?:** Yes
- **If Yes please explain:**
- There are no other IEEE standards or projects with a completely similar scope. There are two other industry efforts outside of IEEE 802 that may partially overlap the 800 Gb/s Ethernet portion of the scope of the proposed project:

  The Ethernet Technology Consortium released D1.01 of "800G Specification" on 10 March 202006 August 2021, which defined an 800G MAC and physical coding sub-layer (PCS).

  The IEEE 802.3 Working Group received a liaison from the Optical Internetworking Forum (OIF), which communicated the start of the "800G Coherent Project." The project includes a campus objective that would define fixed wavelength unamplified 2-10km links that would support Ethernet clients up to 800G aggregate bandwidth, which may address some of the application spaces that the proposed project would address. The OIF 800G Coherent Project does not define 800 Gb/s Ethernet nor any of the related attachment unit interfaces.

  Stakeholders for the proposed project have expressed the desire for this effort to define the MAC parameters, physical layer specifications, and management parameters for 800 Gb/s Ethernet operation (as well as 200 Gb/s, 400 Gb/s, and 1.6 Tb/s Ethernet) that are consistent and completely integrated with existing IEEE 802.3 Ethernet specifications.

  and answer the following

  7.1.1 Standards Committee Organization: Ethernet Technology Consortium
  Project/Standard Number: N/A
  Project/Standard Date: 06 Aug 2021
  Project/Standard Title: 800G Specification

  7.1.2 Standards Committee Organization: Optical Internetworking Forum
  Project/Standard Number: N/A
  Project/Standard Date: 06 Nov 2020
  Project/Standard Title: 800G Coherent Project

WG Motion #3

- **Move that the IEEE 802.3 Working Group approve the IEEE P802.3df PAR, in https://mentor.ieee.org/802-ec/dcn/21/ec-21-0224-02-00EC-par-ieee-p802-3df.pdf**

- **M: John D'Ambrosia**
- **S: Dave Ofelt**
- **(Technical ≥ 75%)**
- **Results 802.3 Y: / N: / A:**
- **Motion**

LIAISONS

Liaisons

- **Proposed Response to OIF regarding 800G Coherent Project - https://www.ieee802.org/3/B400G/public/21_1116/IEEE_802d3_to_OIF_b400g_1121_draft_Redacted.pdf**
- **Proposed Response to ITU-T SG15 regarding OTN Support - https://www.ieee802.org/3/B400G/public/21_1116/IEEE_802d3_to_ITU_b400g_1121_draft%20_Redacted.pdf**

WG Motion #4

Move that the IEEE 802.3 Working Group approve:

- **IEEE_802d3_to_OIF_b400g_1121_draft_Redacted.pdf**
- **IEEE_802d3_to_ITU_b400g_1121_draft_Redacted.pdf**

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- **Technical (>=75%)**
- **M: D'Ambrosia**
- **S: Huber**
- **Results:**

WG Motion #5

- **Move:**
  - **The IEEE 802.3 Working Group requests the rechartering of the Beyond 400 Gb/s Ethernet Study Group**

- **M: J. D'Ambrosia**
- **S: M. Nowell**
- **> 50%**
- **Results 802.3: Y: / N: / A:**

Next Steps

- If approved by 802.3 / 802 EC then next approval is at IEEE SA Standards Board Meeting (week of 12/6).
  - Anticipated Approval Date – 12/9/21
- If approved by IEEE SA Standards Board:
  - A new Task Force web page will be set up.
  - A link to the new Task Force web page will be provided on the Study Group web page, and sent to the B400G and Dialog Reflectors.
- Task Force formation @ the IEEE 802.3 Jan 2021 Interim Meeting

THANK YOU!