

# IEEE 802.3 Next-Gen 200 Gb/s & 400 Gb/s Multimode Fiber PHYs Study Group Closing Report

Robert Lingle Jr  
OFS  
Rosemont, Illinois  
March 8, 2018

# IEEE 802.3 NGMMF Study Group Information

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## Study Group Organization

Robert Lingle Jr, IEEE 802.3 NGMMF Study Group Chair

Mabud Choudhury, IEEE 802.3 NGMMF Study Group Secretary

**Study Group charter:** to develop a PAR and CSD responses for "Next-generation 200 Gb/s and 400 Gb/s PHYs over fewer MMF pairs than in existing Ethernet projects and standards."

## Study Group web and reflector information

Reflector: <http://www.ieee802.org/3/NGMMF/reflector.html>

Home page: <http://ieee802.org/3/NGMMF/index.html>

PAR: <https://mentor.ieee.org/802-ec/dcn/18/ec-18-0017-01-00EC-ieee-p802-3cm-draft-par.pdf>

CSD: <https://mentor.ieee.org/802-ec/dcn/18/ec-18-0018-02-00EC-ieee-p802-3cm-draft-csd.pdf>

Objectives: [http://ieee802.org/3/NGMMF/Adopted\\_Objectives\\_NGMMF\\_01\\_23jan18.pdf](http://ieee802.org/3/NGMMF/Adopted_Objectives_NGMMF_01_23jan18.pdf)

# Study Group Report for Rosemont

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- Average attendance of 66 in two sessions
- Reviewed 3 contributions supporting DI & simultaneous BMP of 4-pair & 8-pair objectives for 400 Gb/s over MMF
  - Large cloud end-users find both 4-pair and 8-pair MMF solutions at 400 Gb/s well-suited to their differing architectures. Two solutions to two problems.
  - It is important to support the installed base of 4-pair cabling and its associated architectural choices.
  - There exists strong market interest in developing high density solutions for speeds specified in 802.3cd, in octal form factors, and being able to also use these for 400 Gb/s Ethernet.
- Reviewed 4 contributions supporting BMP and TF of a 1-pair objective for 200 Gb/s over MMF in the Large Enterprise space
  - Contributions listed experts from Large Enterprise data center space requesting standardization of 200 Gb/s over 1-pair MMF and asserted TF of 100m over OM4 MMF.
  - Motion #3 failed for 200 Gb/s over 1-pair MMF: Yes-37, No-22, Abs-14 (76 in room)
- Responded to comments from EC members on pre-submitted 400 Gb/s CSD responses. There were not comments on the PAR.
  - Motion #4 passed to approve the modified CSD responses: Yes-20, No-0, Abs-2 (24 in room)

# Objectives Previously Adopted by SG\*

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1. Support full-duplex operation only
2. Preserve the Ethernet frame format utilizing the Ethernet MAC
3. Preserve the minimum and Maximum FrameSize of current Ethernet standard
4. Provide appropriate support for OTN
5. Specify optional Energy Efficient Ethernet (EEE) capability
6. Support a BER of better than or equal to  $10^{-13}$  at the MAC/PLS service interface (or the frame loss ratio equivalent)
7. Support a MAC data rate of 400 Gb/s
8. Define a physical layer specification that supports 400 Gb/s operation over 8 pairs of MMF with lengths up to at least 100m
9. Define a physical layer specification that supports 400 Gb/s operation over 4 pairs of MMF with lengths up to at least 100m

\*Note: objectives have not yet been approved by 802.3 WG vote

## Motion #\_\_\_\_\_

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Move that Move that the IEEE 802.3 Working Group approve the IEEE P802.3cm 400 Gb/s over Multimode Fiber objectives, as per slide 4 of 0318\_NG\_MMF\_close\_report.pdf

Moved by: Robert Lingle Jr.

Second: Mike Dudek

Technical :  $\geq 75\%$

Results: Yes:    No:    Abstain:

## Motion #\_\_\_\_\_

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Move that the IEEE 802.3 Working Group approve the IEEE P802.3cm 400 Gb/s over Multimode Fiber PAR, in <https://mentor.ieee.org/802-ec/dcn/18/ec-18-0017-01-00EC-ieee-p802-3cm-draft-par.pdf>

Moved by: Robert Lingle Jr.

Second: Mike Dudek

Technical :  $\geq 75\%$

Results: Yes: 84 No: 0 Abstain: 0

# 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 7.2 ‘Five Criteria’ of the ‘Operating Rules of IEEE Project 802 Working Group 802.3, CSMA/CD LANs’.

The following are the CSD Responses in relation to the IEEE P802.3 **cm Standard for Ethernet Amendment: Physical Layer and Management Parameters for 400 Gb/s over Multimode Fiber**  
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

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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.
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- The definition of protocol independent managed objects will be part of this project.



# Coexistence

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**A WG proposing a wireless project shall demonstrate coexistence through the preparation of a Coexistence Assurance (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?
  - b) If not, explain why the CA document is not applicable
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- 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.

## Broad Sets of Applicability:

The rate of deployment of multimode fiber (MMF) continues to grow both globally and in North America, adding to a substantial installed base of both OM3 & OM4 1-pair and 4-pair cable.

Recent market evidence shows that higher speeds over both duplex and parallel MMF cable have been needed in the first year that new switch speeds enter the market, including the rapid uptake of 100GBASE-SR4 in Quad Small Form-factor Pluggable (QSFP).

Market applications for low-cost, high density, short-reach MMF links at higher speeds include switch-to-switch, server-to-switch and switch-to-router connections in cloud and large enterprise data centers and central office transformation at service providers. Implementations could be developed to support breakout topologies.

It has been shown that the electrical specifications for 50 Gb/s lanes from 802.3bs can be re-used, such that Physical Medium Dependents (PMDs) from this project can share the same ports.

Standardizing lower cost applications for MMF facilitates upgrades and enlarges Ethernet market.

## Multiple vendors and numerous users:

55 individuals from 38 companies were Supporters for Call For Interest (CFI), including cloud and enterprise end-users. At the CFI, 56 individuals from 24 companies indicated participation in this project.

It is anticipated that there will be sufficient participation to effectively complete the standardization process including representatives from end-users, equipment manufacturers and component suppliers.

# 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**
- e) **Managed object definitions compatible with SNMP**

- As a PHY amendment to IEEE Std 802.3, the proposed project will remain in conformance 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 400 Gb/s operation.
- The proposed amendment will conform to the full-duplex operating mode of the IEEE 802.3 MAC.
- The project will include a protocol independent specification of managed objects.

# 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 operation at 400 Gb/s over fewer than 16 pairs of multimode fiber physical media.
- There are no existing standards, or projects developing standards, addressing the specification of 400 Gb/s over:
  - 4 pairs of multimode fiber, supporting existing parallel multimode fiber topologies and installed base deployments;
  - 8 pairs of multimode fiber, offering maximum flexibility for breakout topologies.

# 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 building equipment that supports IEEE 802.3 networks operating at different Ethernet rates has been amply demonstrated by a broad set of product offerings.
  - The proposed project will build on the array of Ethernet component and system design experience, and the broad knowledge base of Ethernet network operation
    - Component vendors, including PHY vendors, cabling vendors and systems vendors have presented data on the feasibility of the necessary components for this project. Proposals which leverage existing technologies have been provided.
    - Electrical interfaces sufficient to support this project have already been standardized in IEEE P802.3bs.
    - Single-lane 50 Gb/s PHY for operation over MMF are under development for other Ethernet projects (IEEE P802.3cd) and technical feasibility has been established at 850 nm.
    - Technical feasibility has been demonstrated up to a reach of at least 100 m.
    - Multiple experimental demonstrations of technical feasibility of combining wavelength division multiplexing with 50 Gb/s 4-level pulse amplitude modulation (PAM4) over MMF can be found in published literature. Both 40 Gb/s & 100 Gb/s vertical-cavity surface-emitting laser (VCSEL) modules based on both two and four wavelengths are in production.
  - The reliability of Ethernet components and systems 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) **Balanced costs (infrastructure versus attached stations).**
  - b) **Known cost factors.**
  - c) **Consideration of installation costs.**
  - d) **Consideration of operational costs (e.g., energy consumption).**
  - e) **Other areas, as appropriate.**
- The cost factors for Ethernet components and systems are well known. Re-use of common technologies from prior Ethernet projects will allow economies of scale to reduce cost.
  - In consideration of installation costs, the project is expected to use proven and familiar MMF media.
  - In consideration of balancing costs, it is anticipated the project will examine alternatives that trade off between PMD complexity and the number of fibers in order to maintain a reasonable balance between these two costs.
    - One or more PHYs will be specified which operate over fewer fiber pairs than currently defined in IEEE 802.3 standards and projects for the same speed(s), reducing infrastructure costs.
    - One or more PHYs will be specified which enable operation over MMF cables in the installed base.
    - Adding wavelengths & PAM4 to MMF modules preserves the historical low cost & low power advantages associated with VCSEL-based technology.
  - Network design, installation and maintenance costs are minimized by preserving network architecture, management, and software.
  - Energy Efficient Ethernet will reduce the operational costs and the environmental footprint.

## Motion #\_\_\_\_\_

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Move that the IEEE 802.3 Working Group approve the IEEE P802.3cm 400 Gb/s over Multimode Fiber 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/18/ec-18-0018-02-00EC-ieee-p802-3cm-draft-csd.pdf>

Moved by: Mabud Choudhury

Second: James Young

Technical :  $\geq 75\%$

Results: Yes: 77 No: 0 Abstain: 0

## Motion #\_\_\_\_\_

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Move that the IEEE 802.3 Working Group request the re-chartering of the “Next-generation 200 Gb/s and 400 Gb/s PHYs over fewer MMF pairs than in existing Ethernet projects and standards” Study Group.

Moved by: Robert Lingle Jr.

Second: Jon Lewis

> 50%

Results: Yes: 79 No: 0 Abstain: 0



Questions?

Thank you!