

# 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<sup>dB</sup> 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, to be included in Clause 30 of IEEE Std 802.3, 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
- 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:**

- SerDes rates on both switch ASICs and server network interface cards are expected to move to 100 Gb/s per lane in the next few years.
- The trends of increasing switch radix and decreasing server count-per-rack combine to favor architectures connecting servers to switches across multiple racks, requiring longer reaches over optical fiber (tens of meters) than can be supported by passive copper cables (< 2m), for 100 Gb/s lanes.
- Short reach, lower cost optical modules based on 100G wavelengths can serve as low cost interconnects between servers and switches over tens of meters in cloud datacenters, AI/machine learning clusters, high-performance computing applications, and in large enterprise and carrier datacenters. Implementations could be developed to support breakout topologies.
- Short reach, lower cost optical modules based on 100G wavelengths can also serve as low cost interconnects for a significant portion of switch-to-switch links in cloud datacenters in China, for example.

- **Multiple vendors and numerous users:**

- 55 individuals from 38 companies were Supporters for “Lower cost, short reach, optical PHYs using 100 Gb/s wavelengths” Call For Interest (CFI), including cloud and enterprise end-users. 65 participants attended the CFI consensus presentation. 55 participants voted in favor of forming a Study Group. 22 individuals from 18 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**

- 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 100 Gb/s(, 200 Gb/s,) and 400 Gb/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 maximum compatibility with the installed base of Ethernet nodes.

# Distinct Identity

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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 over multimode fiber physical media using 100 Gb/s wavelengths.

# 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.
- IEEE 802.3 has already established 100 Gb/s, 200 Gb/s, and 400 Gb/s MAC specifications suitable for 100 Gb/s per wavelength PHY operation in IEEE Std 802.3bs-2017 and IEEE Std 802.3cd2018.
  - The principle of supporting different PMD types from a common MAC specification has been amply demonstrated in IEEE 802.3.
  - 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
    - VCSEL-MMF links using 50 Gb/s (25 Gbaud PAM4 signaling) were developed in IEEE P802.3cd & P802.3cm, and 8-lane specifications for 400 Gb/s over parallel MMF were developed.
    - Individuals affiliated with component vendors have presented simulations & data demonstrating the feasibility of 100G (50 Gbaud PAM4) VCSEL-based multimode links.
  - 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 optical fiber media types.**
  - **The historical low cost & low power advantages associated with VCSEL-MMF link are expected to be preserved when increasing the optical lane rate from 50 to 100 Gb/s**
  - **Higher speed 100Gb/s wavelengths lead to reduced lane counts, reduced fiber & component counts, reduced complexity, and lower cost than previously standardized PMDs based on 50Gb/s wavelengths**
  - **Use of PMDs developed in this project in switch-to-switch links will promote re-use of the installed based of MMF cabling.**
  - **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.**



# 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.
- 
- **The definition of protocol independent managed objects, to be included in Clause 30 of IEEE Std 802.3, will be part of this project.**
  - cm: The definition of protocol independent managed objects will be part of this project.
  - ck: The project includes a protocol independent specification of managed objects.
  - cu: The definition of protocol independent managed objects, to be included in Clause 30 of IEEE Std 802.3, will be part of this project.
  - cn: The definition of protocol independent managed objects, to be included in Clause 30 of IEEE Std 802.3, will be part of this project.
  - ct: The definition of protocol independent managed objects, to be included in Clause 30 of IEEE Std 802.3, will be part of this 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.
- P802.3db
  - Broad Sets of Applicability:
    - SerDes rates on both switch ASICs and server network interface cards are expected to move to 100 Gb/s per lane in the next few years.
    - The trends of increasing switch radix and decreasing server count-per-rack combine to favor architectures connecting servers to switches across multiple racks, requiring longer reaches over optical fiber (tens of meters) than can be supported by passive copper cables (< 2m), for 100 Gb/s lanes.
    - Short-reach, lower cost optical modules based on 100G wavelengths will provide the lowest cost interconnects between servers and switches in cloud datacenters, AI/machine learning clusters, high-performance computing applications, and in large enterprise and carrier datacenters. Implementations could be developed to support breakout topologies.
    - Shorter reach, lower cost optical modules based on 100G wavelengths will also provide the lowest cost interconnects for a significant portion of switch-to-switch links in cloud datacenters in China.
  - Multiple vendors and numerous users:
    - 55 individuals from 38 companies were Supporters for “Lower cost, short reach, optical PHYs using 100 Gb/s wavelengths” Call For Interest (CFI), including cloud and enterprise end-users. 65 participants attended the CFI consensus presentation. 55 participants voted in favor of forming a Study Group. 22 individuals from 18 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.

# 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.
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- cm:
- 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.

# Broad Market Potential

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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.

- ck:
- Internet, cloud, and higher performance computing applications, along with advances in processors, server virtualization and converged networking, are driving the need for higher bandwidth switch connections e.g., in data centers, enterprises and campus networks. Increasing the electrical signaling data rate to 100 Gb/s provides cost effective 100 Gb/s, 200 Gb/s and 400 Gb/s Ethernet solutions that are required to maintain pace with new demands.
- These target markets offer significant market potential for 100 Gb/s, 200 Gb/s and 400 Gb/s Ethernet electrical PHYs and interfaces that optimize the total cost of ownership.
- 143 participants attended the “100 Gb/s per Lane Electrical Interfaces and PHYs” Call-ForInterest. 137 participants voted in favor of forming the Study Group. At least 80 participants affiliated with at least 45 companies indicated that they would support the standardization process. Study Group participation is consistent with these numbers.
- There is sufficient participation to effectively complete the standardization process including participants from end-users, equipment manufacturers and component suppliers.

# Broad Market Potential

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

- a) Broad sets of applicability.
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- CU:
- Ethernet is widely deployed in telecom client interconnects and in switch-to-switch applications in hyperscale and enterprise data centers where these 100 Gb/s and 400 Gb/s interconnects are expected to be widely utilized.
- The opportunity to have common 100 Gb/s per wavelength technology building blocks across all required SMF reaches in these applications enables solutions with reduced component count, increased density, and lower costs.
- Alignment of optical interface signaling rates with the anticipated transition on electrical interface SERDES signaling rates being defined in the IEEE P802.3ck project will be required to support cost effective solutions for all SMF reaches
- 90 participants attended the “100 Gb/s Per Lane Optical PHYs for 2 km and 10 km for 100 GbE and 400 GbE” Call-For-Interest consensus presentation. 80 participants voted in favor of forming a Study Group. At least 55 individuals affiliated with at least 43 companies indicated that they would support the standardization process. It is anticipated that there will be sufficient participation to complete the standardization process including individuals affiliated from end-users, equipment manufacturers and component suppliers.

# 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.

- cd:
- Ethernet is widely deployed for server and switch applications in data centers. Ethernet data rates of 50 Gb/s, 100 Gb/s and 200 Gb/s enable a variety of cost effective interconnect solutions for server and switch solutions. based on 50 Gb/s serial I/O technology.
- Internet, cloud, and higher performance computing applications, along with advances in processors, server virtualization and converged networking, are driving the need for higher bandwidth switch connections e.g., in data centers, enterprises and campus networks. Increasing the signaling data rate to either 50 Gb/s or 100 Gb/s, depending on the application, provides cost effective 50 Gb/s, 100 Gb/s and 200 Gb/s Ethernet solutions that are required to maintain pace with new demands.
- These target markets offer significant market potential for 50 Gb/s, 100 Gb/s and 200 Gb/s Ethernet interfaces that optimize the total cost of ownership.
- 134 participants attended the “50 Gb/s Ethernet Over a Single Lane and Next Generation 100 Gb/s & 200 Gb/s Ethernet” Call-For-Interest. 127 participants voted in favor of forming the “50 Gb/s over a Single Lane” Study Group and 124 participants voted in favor of forming the “Next Generation 100 Gb/s and 200 Gb/s Ethernet” Study Group. At least 102 individuals representing at least 66 companies indicated that they would support the standardization process. Study Group participation is consistent with these numbers.
- 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**

- **P802.3db:**
- **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 100 Gb/s(, 200 Gb/s,) and 400 Gb/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 maximum compatibility with the installed base of Ethernet nodes.**

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- As was the case in previous IEEE Std 802.3 amendments, new physical layers will be defined for 100 Gb/s(, 200 Gb/s,) and 400 Gb/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 maximum compatibility with the installed base of Ethernet nodes.



# Distinct Identity

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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.**

- P802.3db:
- The proposed amendment will be the first IEEE 802.3 standard defining operation over multimode fiber physical media using 100 Gb/s wavelengths.
- The proposed amendment will be the first IEEE 802.3 standard defining operation at 200 Gb/s using 100 Gb/s wavelengths over optical fiber physical media.

# Distinct Identity

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**Substantially different from other IEEE 802.3 specifications / solutions.**

- cm:
- 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.

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**Substantially different from other IEEE 802.3 specifications / solutions.**

- CU:
- IEEE P802.3bs and P802.3cd projects defined PHYs based on 100 Gb/s per optical lane over 500 m of SMF. The proposed 100 Gb/s and 400 Gb/s PHYs are focused on longer reaches of 2 km and 10 km which are not currently defined in IEEE Std 802.3.
- The proposed amendment to the existing IEEE 802.3 standard will be formatted as a collection of new clauses and modifications to existing clauses, making it easy for the reader to select the relevant specification.

# Distinct Identity

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**Substantially different from other IEEE 802.3 specifications / solutions.**

- cd:
- The proposed amendment will be the first IEEE 802.3 standard operating at a 50 Gb/s MAC rate.
- While the IEEE P802.3bs project is expected to introduce 200 Gb/s, it does not address the specification of 200 Gb/s Ethernet PHYs for backplanes, twin-axial copper cables and MMF.
- The proposed 100 Gb/s PHY(s), based on two 50 Gb/s electrical or optical signals electrical or optical signaling rates higher than 25 Gb/s in each direction, are not currently defined in IEEE Std 802.3
- The proposed amendment to the existing IEEE 802.3 standard will be formatted as a collection of new clauses, making it easy for the reader to select the relevant specification.

# Distinct Identity

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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.**

- ck:
- There are no existing standards or projects addressing the specification of 100 Gb/s, 200 Gb/s, or 400 Gb/s Ethernet electrical PHYs or electrical interfaces based on 100 Gb/s signaling.

# 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.

- 802.3db
- IEEE 802.3 has already established 100 Gb/s, 200 Gb/s, and 400 Gb/s MAC specifications suitable for 100 Gb/s per wavelength PHY operation in IEEE Std 802.3bs-2017 and IEEE Std 802.3cd2018.
- The principle of supporting different PMD types from a common MAC specification has been amply demonstrated in IEEE 802.3.
- 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
  - VCSEL-MMF links using 50 Gb/s (25 Gbaud PAM4 signaling) were developed in IEEE P802.3cm.
  - Individuals affiliated component vendors have presented data demonstrating the feasibility of 100G (50 GBaud PAM4) VCSEL-based multimode links.
  - Individuals affiliated component vendors have presented data on the feasibility of the necessary components for 100 Gb/s, 200 Gb/s, and 400 Gb/s solutions. Supporting material, which either leverages existing technologies or employs new technologies, has been provided.
  - Component technology for 100 Gb/s optical serial rates over SMF have already been development for other Ethernet projects (IEEE P802.3bs, cd, cu) or working implementations have been demonstrated.
- The reliability of Ethernet components and systems has been established in the target environments with a high degree of confidence.

# 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.
- cm:
  - 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.

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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.**
- ck:
  - 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.
    - Individuals affiliated with component vendors have presented data on the feasibility of the necessary components for 100 Gb/s electrical signaling for various internal system applications and 2 m copper cable. Proposals, which either leverage existing technologies or employ new technologies, have been provided.
    - Component technology based on 100 Gb/s electrical signaling rates is either under development or has been demonstrated.
  - The principle of scaling the IEEE 802.3 electrical PHYs and interfaces to different speeds has been well established by previous work within the IEEE 802.3 Working Group.
  - The reliability of Ethernet components and systems has been established in the target environments with a high degree of confidence.



# 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.

- CU:
- IEEE 802.3 has already established 100 Gb/s and 400 Gb/s MAC specifications suitable for 100 Gb/s per wavelength PHY operation in IEEE Std 802.3bs-2017 and IEEE Std 802.3cd2018.
- The principle of supporting different PMD types from a common MAC specification has been amply demonstrated in IEEE 802.3.
- 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 have presented data on the feasibility of the necessary components for 100 Gb/s and 400 Gb/s solutions. Supporting material, which either leverages existing technologies or employs new technologies, has been provided.
  - Component technology for 100 Gb/s optical serial rates, are already either under development for other Ethernet projects (IEEE P802.3bs & P802.3cd) or working implementations have been demonstrated.
- The reliability of Ethernet components and systems has been established in the target environments with a high degree of confidence.

# 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.
- cd:
  - The principle of scaling the IEEE 802.3 MAC to different speeds has been well established by previous work within the IEEE 802.3 Working Group.
  - 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 have presented data on the feasibility of the necessary components for 50 Gb/s, 100 Gb/s, and 200 Gb/s solutions. Proposals, which either leverage existing technologies or employ new technologies, have been provided. –
    - Component technology atfor 50 Gb/s (electrical and optical) and 100 Gb/s (optical) serial rates, are already either under development for other Ethernet projects (IEEE P802.3bs) or working implementations have been demonstrated.
  - The reliability of Ethernet components and systems has been established 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.**
- **802.3db**
  - **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 optical fiber media types.**
  - **The historical low cost & low power advantages associated with VCSEL-MMF link are expected to be preserved when increasing the optical lane rate from 50 to 100 Gb/s**
  - **Higher speed 100Gb/s wavelengths lead to reduced lane counts, reduced fiber & component counts, reduced complexity, and lower cost than previously standardized PMDs based on 50Gb/s wavelengths**
  - **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.**

# 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.**
- cm:
  - 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.

# 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.
- ck:
  - Electrical PHYs and interfaces based on 100 Gb/s electrical signaling can enable higher bandwidth switches, reducing the overall data center costs compared to those employing 50 Gb/s technology.
  - A 100 Gb/s, 200 Gb/s or 400 Gb/s Ethernet link based on 100 Gb/s electrical signaling will maintain favorable cost for server-to-switch and switch-to-switch applications.
  - The cost factors for Ethernet components and systems are well known.
  - In consideration of installation costs, the project is expected to use proven and familiar media.
  - In consideration of operational costs, the project is expected to maintain the current or better level of operational costs.
  - Network design, installation and maintenance costs are minimized by preserving network architecture, management, and software.
  - Possible use of common 100 Gb/s components and technologies to support 100 Gb/s, 200 Gb/s and 400 Gb/s electrical PHYs and interfaces would allow economies of scale to reduce cost for all implementations.

# 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.**
- CU:
  - The cost factors for Ethernet components and systems are well known and the 100 Gb/s and 400 Gb/s Ethernet interfaces will maintain a favorable cost balance for the targeted switch-to-switch applications
  - Reasonable cost for the resulting performance will be achieved in this project as established by prior experience in the development of:
    - Ethernet optical specifications based on 100 Gb/s per wavelength PMDs including 400GBASE-DR4 and 100GBASE-DR.
    - Industry optical specifications for 2 km and 10 km SMF reaches at 100 Gb/s and 400 Gb/s.
    - Alignment of electrical and optical interface widths.
  - In consideration of installation costs, the project is expected to use proven and familiar media consistent with industry deployments, namely single-mode fiber.
  - Network design, installation and maintenance costs are minimized by preserving network architecture, management, and software.
  - 100 Gb/s per wavelength PMDs reduce the number of optical transmit/receive components by up to 4 times compared to 25 Gb/s and 50 Gb/s per wavelength solutions leading to lowered overall network power consumption. For 100 Gb/s the elimination of the optical mux/demux components further reduces cost and power consumption of these PMDs.

# 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.
- cd:
  - The cost factors for Ethernet components and systems are well known.
  - Possible use of common components and technologies to support 50 Gb/s, 100 Gb/s, and 200 Gb/s, and 400 Gb/s Ethernet would allow economies of scale to reduce cost for all implementations.
  - Experience in the development of higher-speed 50 Gb/s technologies for Ethernet establishes that the new specifications developed by this project will entail a reasonable cost for the resulting performance.
  - In consideration of installation costs, the project is expected to use proven and familiar media.
  - Network design, installation and maintenance costs are minimized by preserving network architecture, management, and software.
  - A The 50 Gb/s, 100 Gb/s and 200 Gb/s Ethernet interfaces will maintain a favorable cost balance for the targeted server-to-switch and/or switch-to-switch applications.
  - Energy Efficient Ethernet will reduce the operational costs and the environmental footprint.