IEEE 802 EC review draft

IEEE P802.3df™ Defines ~~a Holistic Architectural Approach~~Architecture Holistically to Achieve 800 G~~B~~b/s and 1.6 Tb/s Ethernet

Ethernet networking technology has come a long way since 1985 when the seminal Ethernet standard IEEE 802.3™ was published, providing for packet-based data transfer at 10 Mb/s. Since then Ethernet speeds have increased exponentially to 400 Gb/s, and Ethernet has both driven and benefitted from the growth of information and computing technologies.

While users typically connect to the internet wirelessly, the data from wireless devices and access points ultimately must connect to a wired network for cost-effective, high-speed, and reliable data transmission. That wired network is usually Ethernet because it is ubiquitous, sits in the background, and works unobtrusively and reliably.

In fact, by driving the importance of networking, the COVID-19 pandemic has served to highlight just how critical Ethernet has become to our increasingly online and connected world, because the remote and virtual activities which have increased dramatically on a global basis since the start of the pandemic would not be possible without Ethernet.

Soaring Ethernet Bandwidth Needs Worldwide

The coming years will continue to see a veritable explosion in demands for more bandwidth on Ethernet networks, driven by multiple simultaneous trends. These include growing user numbers, more devices coming online, faster access speeds, higher peak bandwidth demands on networks, and a constant stream of new online services and bandwidth-generating applications in mobile, video, artificial intelligence, augmented/virtual reality, and other areas.

The recently published IEEE 802.3 Ethernet Bandwidth Assessment (BWA) Report, based on a year-long study of global bandwidth usage and trends, projected that from 2017 to 2022 the number of internet users would increase from 3.4 billion to 4.8 billion. Internet connections would go from 18 billion to 28.5 billion, and average traffic per user per month would rise from 29 GB to 85 GB. Relative to observed traffic in 2017, the submitted data to the 2020 Ethernet BWA indicates a broad diversity in the bandwidth growth rates of the various applications explored, ranging in 2025 from 2.3× to 55.4× the traffic levels of 2017

The bandwidth assessment was conducted prior to the pandemic, and it was observed after the completion of the report that significant growth occurred during the initial stages of COVID-19 in 2020.

IEEE P802.3df™ Explores 800 Gb/s and 1.6 Tb/s Ethernet

With the explosive bandwidth demand growing across all areas of Ethernet connectivity globally, the IEEE P802.3df™ Task Force was recently formed to define an amendment to IEEE 802.3 that encompass Media Access Control (MAC) parameters, physical layers, and management

parameters for the transfer of Ethernet format frames at 800 Gb/s and 1.6 Tb/s over copper and single- or multi-mode fiber.

This standards project also will be used to define derivative physical layer specifications and management parameters for the transfer of Ethernet frames at 200 Gb/s and 400 Gb/s.

Data-transfer rates of 800 Gb/s and 1.6 Tb/s have been chosen because they will meet all likely Ethernet requirements over the next decade, but an optimal solution requires a holistic architectural approach that allows Ethernet networks to be flexible and grow with technology.

Extensive technology reuse as bandwidth requirements grow will allow the Task Force to quickly define a multitude of different technical specifications. It enables multiple types of applications to make use of the various physical layer specifications defined for this project, and supports compatibility across generations of Ethernet technology.

Technology reuse also reduces the time needed to develop multiple Ethernet specifications, along with the cost and time needed for product development. It increases the potential for long-term use of equipment ports, helps the return on investment (ROI) of component and system suppliers, and enables users to extend the life of their equipment.

Developing New Signaling Approaches Across Ethernet Rates

While the IEEE P802.3df Task Force hasn't defined a final path, the use of both 100 Gb/s and 200 Gb/s signaling to enable future Ethernet systems is anticipated. Both signaling rates can be leveraged to a number of areas, such as the electrical interfaces inside a system box that are used to connect semiconductors, optical modules and backplane connections, as well as to copper and optical interfaces. Because 100 Gb/s exists today, it will help to quickly deliver various 800 Gb/s standards; 200 Gb/s then will be developed and will allow for narrower solutions for 200/400/800 Gb/s and 1.6Tb/s.

By increasing the signaling rate to 200 Gb/s, the number of input/output (I/O) pins per port can be reduced from 2 to 1, which is more cost-effective and will enable higher-density systems with greater capabilities.

In addition, all of these specifications will likely incorporate forward error correction (FEC) to provide coding gain. It is necessary to consider the coding gain needed by each specification to ensure interoperability, given the presence of 100 Gb/s and 200 Gb/s electrical interfaces in different system boxes. This requires a holistic approach.

One of the trends identified by the IEEE 802.3 Beyond 400 Gb/s Ethernet Study Group, which preceded the formation of the IEEE P802.3df Task Force, is the shift of a majority of ports to a "x8" architecture. This means that interconnection between devices, and between devices and optical modules, will have eight lanes, or signaling paths, in each direction (i.e., for both transmitting and receiving).

This will provide system flexibility, because ports then could be designed with x1, x2, x4, and x8 implementations that would support an Ethernet data-transfer rate based on lane width x signaling rate. For example, one 100 Gb/s lane would provide 100 Gb Ethernet, two 100 Gb/s lanes would provide 200 Gb Ethernet, and so forth.

It is also applicable to the physical interconnections between systems. By developing 200 Gb/s signaling for a x8 port - a 1.6 Tb/s capacity port can be developed, which could support dual 800 Gb/s Ethernet ports or a single 1.6 Tb/s Ethernet port.

Addressing multiple physical layer objectives holistically from the outset like this, rather than sequentially over time, is different from what has been done previously. It will benefit users and producers of systems and components for high-bandwidth applications 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, among others.

Get Involved in IEEE P802.3df

Spanning multiple Ethernet rates, signaling rates per lane, lane widths, and media types, IEEE P802.3df is a leading-edge standards project that will develop an Ethernet architecture from a holistic approach. The Task Force welcomes any interested stakeholders to join this important effort as bandwidth needs continue to grow and expand in the future.

Get involved with IEEE P802.3df, or explore other IEEE 802 activities.