THE 2019 FIBRE CHANNEL ROADMAP

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When companies invest in a technology, they want to know that they will get a return on their investment for years to come. Fibre Channel has had a very accurate roadmap for over a decade, showing the past, present and future of the Fibre Channel physical layer. Fibre Channel has been progressing since 1996 by doubling the data rate every few years and the roadmap shows the progression will continue far into the future. Fibre Channel continues to outpace other physical layer technologies like Ethernet and will continue to surpass them in speed.

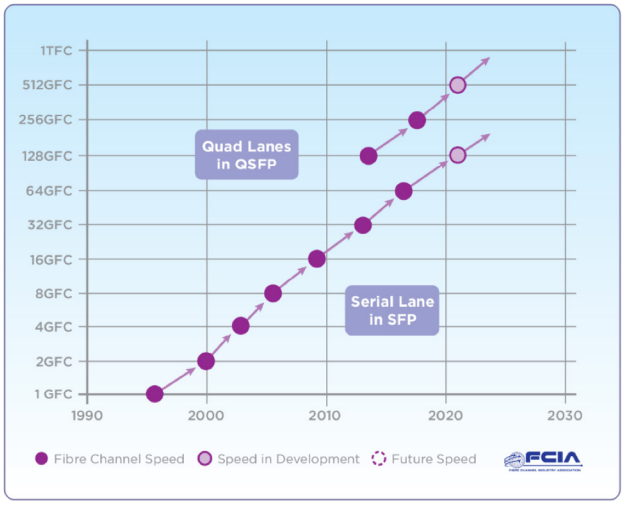
The ANSI INCITS T11.2 Task Group (T11.2), the standards body that defines Fibre Channel speeds, finished 64GFC in 2018. 64GFC runs 9% faster than 50GbE and has been defined for a Bit Error Ratio (BER) of 1E-15 that is 1,000 times better than Ethernet that has a 1W-12 BER. 64GFC products are expected to ship in 2019/2020. T11.2 is also working on 128GFC that runs 9% faster than 100GbE. 128GFC is expected to be completed in 2021 with products shipping in 2022. The Fibre Channel physical layer will continue to leverage the developments in the Ethernet physical layer and exceed them.

An accurate roadmap provides a reliable guide for suppliers, manufacturers and distributors of products to plan their product development and release cycles. The features and timing of the technology migration reflected in the roadmap are based on open standards that are technically stable and complete. Some technology developments outlined in reliable roadmaps are required building blocks for product development. For example, lasers in optical modules need to be developed before transceiver modules used in a switch or host bus adapter. With a solid roadmap and standards, multiple companies can develop products in parallel that will eventually interoperate when they reach the market.

FCIA's Roadmap Committee produces the FCIA Speedmap in concert with T11.2. The resulting roadmap is the refined product of an intense iterative process that pinpoints highly attractive market propositions balanced with sound engineering feasibility. It becomes the official FCIA Speedmap and MRDs (Marketing Requirement Documents) for T11.2's map of speeds and timelines. The MRDs define sets of features and benefits that are not only feasible within the Speedmap timelines, but also result in actual products delivered in the prescribed timeframe that realize massive market success.

FCIA's roadmap has helped the industry see the future of Fibre Channel for over 15 years. Fibre Channel has always had a clear road ahead where the link speeds double every 3-4 years when the speeds can be cost-effectively doubled. Figure 1 shows the history of Fibre Channel speeds and future speeds after 2020.

Figure 1: Fibre Channel Speeds



[1]*At the time of this article, the exact 128GFC design parameters have not been finalized and may change.*

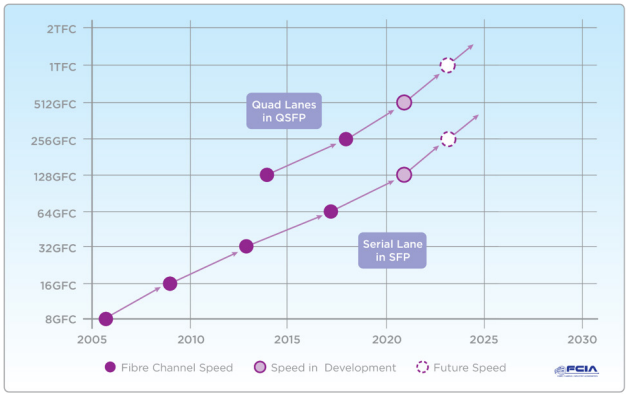
Figure 1 also shows how Fibre Channel initially used only serial speeds for the first five generations. These serial speeds have used the venerable Small Form Factor Pluggable (SFP) module. The sixth generation of Fibre Channel, known as Gen6 Fibre Channel, uses the SFP28 (an SFP that runs at 28Gb/s) for 32GFC as well as the Quad Small Form Factor Pluggable (QSFP28) module for 128GFC. T11.2 just finished the seventh generation of Fibre Channel speeds that will continue this tradition with 64GFC in an SFP and 256GFC in a QSFP. The project for the eighth generation of Fibre Channel that supports 128GFC in the SFP is underway and is keeping pace with 100 Gigabit Ethernet (100GbE) in an SFP module.

The Fibre Channel Roadmap doesn't stop there. In Figure 2, the roadmap extends to Terabit Fibre Channel (1TFC) – that's almost 1,000 Gigabits of data per second. Following the 1X/4X lane paradigm, Fibre Channel and Ethernet plan to double individual lane speeds repeatedly over the next decade. With Fibre Channel's focus on storage in the data center, Fibre Channel will continue to standardize speeds at approximately the same time as Ethernet, but Fibre Channel speeds will be 9% faster. While Fibre Channel doubled speeds from 28Gb/s to 56Gb/s in 2017, Ethernet plans to double 25Gb/s to 50Gb/s in 2018. The trend will continue with Fibre Channel lanes doubling to 112Gb/s and then 224Gb/s. When 4 lanes of these speeds are aggregated, the combined speeds will deliver almost a terabit/second of data for what will be known as Terabit Fibre Channel (1TFC).

While Fibre Channel standards are completed in advance of products being released by at least a year, some Ethernet products are released before the Ethernet standard is ratified. This means that Ethernet products of similar speeds are released at about the same time as similar speed Fibre Channel products. For example, 50GbE products running at 53.125Gb/s and 64GFC products running at 57.8Gb/s are both expected to be widely available in 2019/2020 for the first time. High-speed Ethernet and Fibre Channel products are basically running on similar physical layers.

The physical layers of Fibre Channel and Ethernet are marching at a similar pace now. While Fibre Channel has continuously doubled speeds from generation to generation, Ethernet used to grow by a factor or 10 until 40GbE came along. 40GbE, which is based on 4 lanes of 10G technology, broke

Figure 2: Future Speeds for Fibre Channel



the 10X paradigm and opened the door to more moderate steps in speed. Similar to technology progressions like Moore's Law and storage capacity, doubling of lane rates is the new norm. Individual lanes can then be grouped together to form new speeds. While Ethernet continues to use up to 16 lanes for 400GbE router applications, only 1X and 4X lanes are shown in the Fibre Channel Roadmap because these are the only relevant speeds for storage area networks (SANs).

The Fibre Channel Roadmap has been printed as a physical, folding roadmap and an electronic version can be downloaded at: https://fibrechannel.org/roadmap/. The backside of the map shows how Fibre Channel is used in data centers around to world to store and replicate data. Fibre Channel continues to grow and provide the most cost-effective and reliable links for SANs.

Besides the roadmap, the FCIA Roadmap subcommittee develops the MRD for new speeds like 128GFC. Important elements defined in the MRD include backward compatibility with previous speeds. For instance, just like 1/2/8/16GFC, and 32GFC edge connectivity, 64GFC and 128GFC are required to be backward compatible at least two generations. These speeds are auto-negotiated with no user intervention required, - i.e., 32GFC ports will automatically run at 8GFC and 16GFC, while 64GFC will automatically run at 32GFC and 16GFC. 128GFC continues Fibre Channel's long history of ensuring total backward compatibility by also operating at 32GFC or 64GFC. This important level of backward compatibility has been and will continue to be a major benefit in Fibre Channel's continued success.