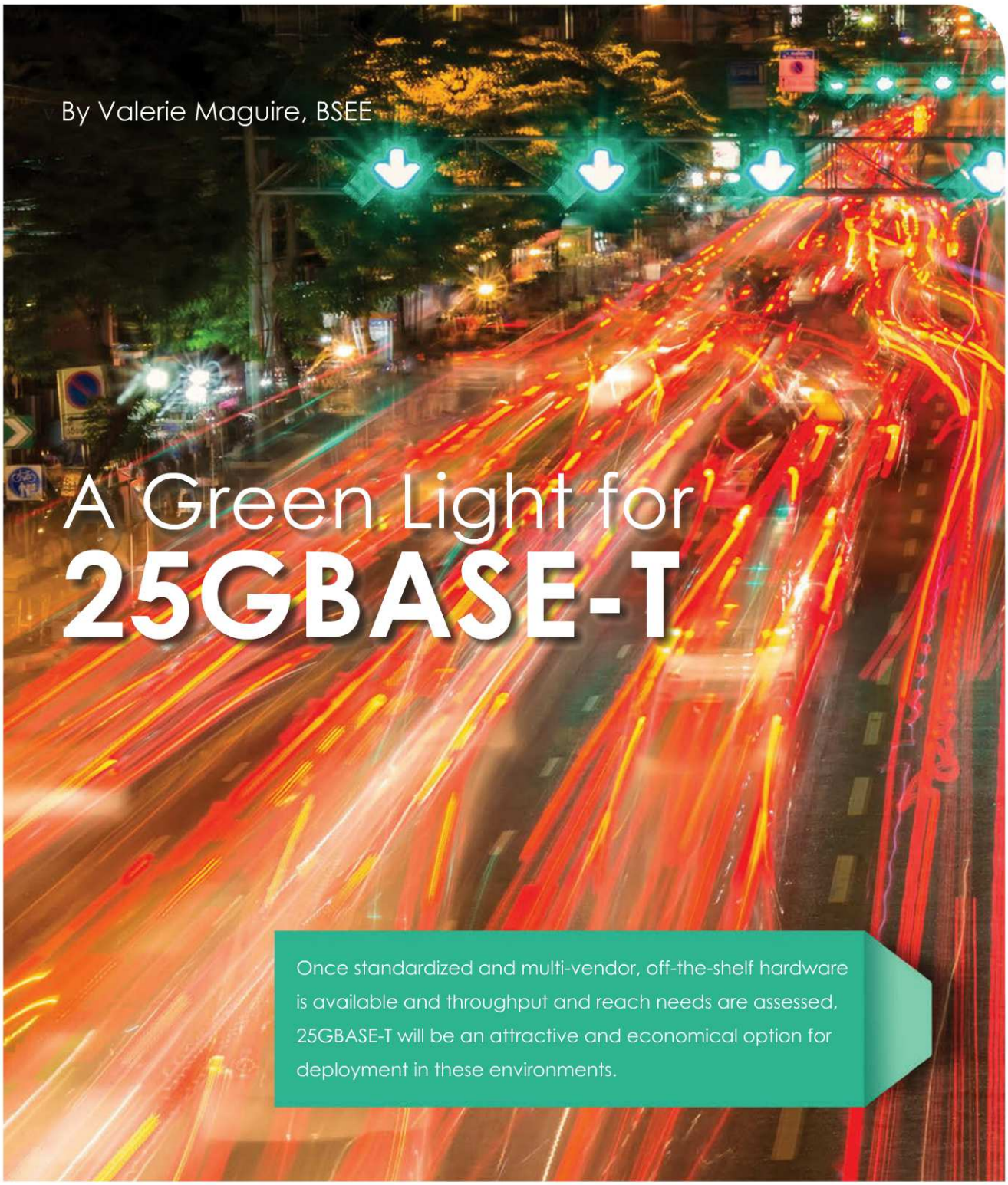

By Valerie Maguire, BSEE

A Green Light for 25GBASE-T

Once standardized and multi-vendor, off-the-shelf hardware is available and throughput and reach needs are assessed, 25GBASE-T will be an attractive and economical option for deployment in these environments.

25GBASE-T can enable optimized switch port usage over a broad range of server-to-switch architectures, enable large, modular switches and higher port counts and allow ports to be utilized that might otherwise be constrained by the 5 m reach limit of 25 Gb/s direct attach twinaxial solutions.

In November 2014 at the IEEE 802.3 Ethernet Working Group meeting in San Antonio, Texas, there was a call for interest (CFI) on 25 gigabit per second (Gb/s) Ethernet over balanced twisted-pair copper cabling. With 48 contributors and supporters, including representatives from Microsoft®, Intel®, Cisco® and Siemon®, the objective of the CFI was to gauge interest in forming a Study Group to investigate a 25GBASE-T project.

A combination of market drivers and technical feasibility prompted the consideration of this potential new Ethernet standard, and CFI participants thoroughly examined all of these factors. CFI attendees voted overwhelmingly in favor of the formation of a 25 Gb/s Study Group, with 37 individuals representing 25 companies volunteering to participate and pledging support. The motion to form the Study Group passed without objection at the Closing Plenary meeting.

This article offers a closer look at what led to this decision, which has paved the way for the work that has steadily progressed and brought us to the point where defined objectives for 25GBASE-T were approved at the IEEE 802.3 Closing Plenary meeting held during the week of March 9 in Berlin, Germany.

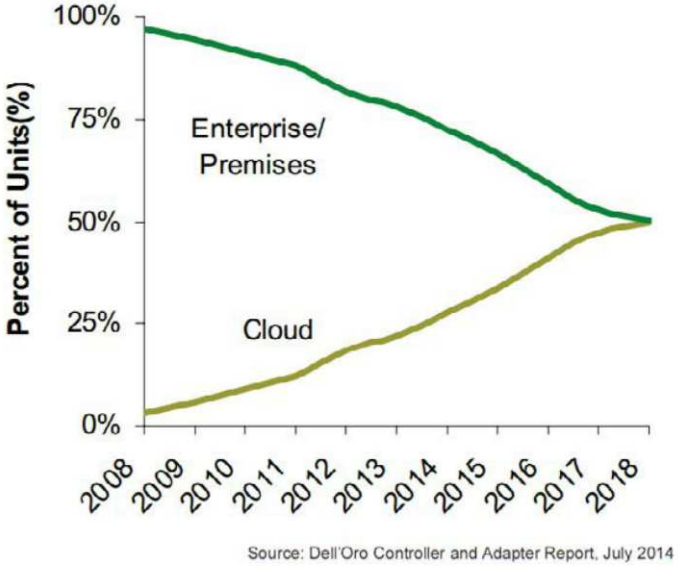

FIGURE 1: Cloud and enterprise server shipments are expected to equalize by 2018.

Plenty of Market Drivers

The deployment opportunity for 25GBASE-T is clearly defined as being in the 30 meter (m) reach zone, sitting between the existing 10GBASE-T standard as the top end of enterprise LAN requirements and the pending 40GBASE-T standard for data center applications. The market drivers considered included trends for cloud versus enterprise servers, the latest update on server port speed forecasts, the supporting media mix, potential topologies and cost optimization.

In predicting the future trend toward cloud server growth, the Dell'Oro Controller and Adapter Report of July 2014 forecast that cloud and enterprise server shipments will equalize in volume by 2018, with 25 percent of server units shipped in 2014 already destined for cloud deployment (Figure 1). The prediction is that cloud computing will grow fast before stabilizing, with a small number of entities comprising the majority of this market.

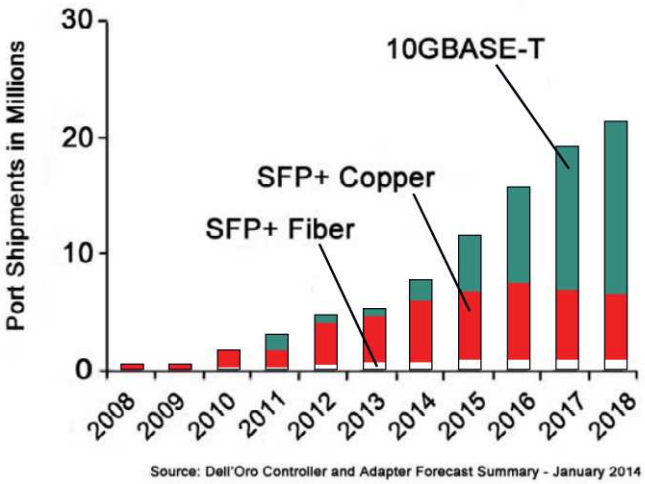

FIGURE 2: 10 gigabit port shipments per type of connection.

Market analysis of the speed of application and storage migration to cloud servers shows that transition to 10 Gb/s Ethernet speeds supported by optical fiber cabling, direct attach twinaxial and balanced twisted-pair copper cabling is nearly complete throughout data centers, and 40 Gb/s and 100 Gb/s optical fiber Ethernet deployments are becoming more common. In addition, the P802.3by 25 Gb/s Ethernet Task Force has successfully demonstrated the broad market potential for a 25 Gb/s Ethernet switch-to-server interconnect and is rapidly progressing with the development of a single-lane 25 Gb/s Ethernet specification for operation over up to at least a 5 m direct attach copper twinaxial assembly.

25GBASE-T will support the benefits of backwards-compatible BASE-T technology and is positioned as a cost-optimized step on the speed migration path to 40GBASE-T for support of data center edge connections over distances of up to 30 m (i.e., switch-to-server connections in row-based structured cabling or top of rack configurations). Meanwhile, on premise servers, 1000BASE-T is still predominant, with 10GBASE-T growing and 40GBASE-T predicted for significant future growth. Once standardized and multi-vendor, off-the-shelf hardware is available and throughput and reach needs are assessed, 25GBASE-T will be an attractive and economical option for deployment in these environments.

As shown in Figure 2, 10 Gb/s server port shipment forecasts by Dell'Oro show continued growth for 10GBASE-T as speeds increase from 1000 megabits per second (Mb/s) in the enterprise data center. While direct attach 10 Gb/s QSFP+ and SFP+ copper and optical fiber connections continue to have a place, growth forecasts suggest that 10GBASE-T supported by balanced twisted-pair copper cabling will continue to be the dominant 10 Gb/s server connection overall. The trend drives home the importance of having a full suite of BASE-T solutions available to support migration to 40 Gb/s with balanced twisted-pair copper cabling.

In considering data center topologies, it was acknowledged that there is no single end-all cabling configuration for every facility and the choice should be dictated by architectural options. Top of rack (ToR) switch-to-server connections may be right for some users; however, for many applications and facilities, middle of row (MoR) and end of row (EoR) switch-to-server connections enable improved cost efficiency, better space utilization and support for mixed applications. Compared to the direct attach twinaxial implementations typically used for ToR connections, a 25GBASE-T PHY will have the reach to support a much broader range of architectures to easily facilitate all types of cabinet-to-cabinet and row-based switch-to-server connections.

Cost optimization was a key point in the CFI discussion, and 25 Gb/s transmission was identified as a "sweet spot" to optimize both port count and total bandwidth for server interconnects. Furthermore, existing 10GBASE-T and emerging 40GBASE-T chip technology can easily be leveraged and optimized for 25GBASE-T support within transceiver equipment.

Summarizing the market drivers, the conclusion put forth at the IEEE 802.3 Closing Plenary meeting in November 2014 was that 25GBASE-T is a much needed point on the roadmap from 1 Gb/s to 10 Gb/s and

Parameter	10GBASE-T	40GBASE-T	25GBASE-T (example)
Channel	100 m link segment compliant to clause 55.7 of IEEE 802.3™-2012 (e.g., category 6A)	30 m link segment compliant to clause 98.7 of IEEE P802.3bq™/D1.0 (e.g., category 8)	30 m link segment compliant to clause 98.7 of IEEE P802.3bq™/D1.0 (e.g., category 8)
Baud (MHz)	800	3200	2000 (example)
RX_ENOB (bits)	9.5-10	7.8	6.5-7.5
Channel IL (dB, Nyquist)	46.9	29.4	22.6
Channel Round Trip (baud)	880	1056	660
Echo Cancellation (dB)	55	47 (-6 dB) to 55	43 (-12 dB) to 55
NEXT Cancellation (dB)	40	34 (-6 dB) to 40	28 (-12 dB) to 40
FEXT Cancellation (dB)	25	22 (-3 dB) to 25	19 (-6 dB) to 25
Relative SNR Margins (dB)	0 (ref)	+2.7 dB to 0.2 dB	+8.7 dB to +4 dB

TABLE 1: Example feasibility comparison (source: IEEE 802.3 Call For Interest - 25GBASE-T – November 2014 San Antonio)

ultimately 40 Gb/s on a compatible infrastructure. 25GBASE-T can enable optimized switch port usage over a broad range of server-to-switch architectures, enable large, modular switches and higher port counts and allow ports to be utilized that might otherwise be constrained by the 5 m reach limit of 25 Gb/s direct attach twinaxial solutions.

Technically Feasible

In considering the technical feasibility of 25GBASE-T, it was observed that the application could build on the existing and well-established 10GBASE-T technology that is evolving to support 40GBASE-T. An example comparison of 10GBASE-T , 40GBASE-T and likely 25GBASE-T transmission parameters, including baud rate, noise cancellation (i.e., echo, near-end crosstalk [NEXT] loss and far-end crosstalk [FEXT] loss) and relative signal-to-noise (SNR) margins demonstrated that the complexity of 25GBASE-T over 30 m of cabling is roughly the same as 10GBASE-T over 100 m of cabling using known capabilities (Table 1).

Following this convincing comparison, it was stated that the 25GBASE-T application would be intended for operation over the same two-connector ISO/IEC Class I/ Class II and TIA Category 8 channels and directly connected link segments currently defined in Draft 12.0 of the IEEE P802.3bq 40GBASE-T amendment. Presentations delivered to the IEEE P802.3bq Task Force have shown technical feasibility of 40GBASE-T using 10GBASE-T based signaling at a 3.2 gigahertz (GHz) symbol rate. Therefore, it is likely that 25GBASE-T will be supported using the same 10GBASE-T signaling at a symbol rate of approximately 2.0 GHz. In addition, the existing circuit to physical channel (i.e., PHY) models developed in IEEE P803.3bq for 40GBASE-T can be applied to estimate 25GBASE-T PHY

transmitter, receiver and cancellation parameters, SNR margins and power management.

Why Now?

This question is worthy of careful consideration. Responses heard at the CFI emphasized that 25GBASE-T was overlooked as a critical point on the migration roadmap to 40GBASE-T as enterprise data centers begin transitioning from 10GBASE-T to higher speeds. It is now known that 25GBASE-T will allow users to leverage capital investment and research and development resources in 10GBASE-T and 40GBASE-T technology, while optimizing deployment costs as servers and switches incrementally increase data speeds. With a twisted-pair structured cabling system, switches and servers can also take advantage of the BASE-T auto-negotiation feature, which allows switches to automatically and seamlessly transition between different speeds on individual ports depending on the connected equipment. This enables partial switch or server upgrades on an as-needed basis unlike optical fiber, QSFP+ and SFP+ Ethernet switches that require all connected devices to be transmitting at the same data rate, thereby requiring all equipment to be upgraded at one time.

A 25GBASE-T standard will positively fit within the successful balanced twisted-pair copper Ethernet ecosystem. It shares open and common specifications, ensures interoperability and provides security for those investing in development. Given the market drivers, technical feasibility and added value that 25GBASE-T could offer to the industry, it was not a surprise that the motion to form a 25GBASE-T Study Group was approved without objection.

The Road is Paved

Given the green light, the 25GBASE-T Study Group quickly determined objectives for a 25GBASE-T Ethernet application and the project was rolled into the existing IEEE P802.3bq 40GBASE-T project. The merged objectives were approved at the IEEE 802.3 Plenary meeting held during the week of March 9 in Berlin, Germany.

In addition to defining PHYs to support both 25 Gb/s and 40 Gb/s data rates, the objectives for both applications include support for full duplex operation, auto-negotiation and energy-efficient Ethernet. It is worth noting that both 25GBASE-T and 40GBASE-T are planned for operation over category 8 cabling and directly connected link segments. The development work on both applications also ties into recently published TIA TSB-5019 addressing High Performance Structured Cabling (HPSC), which suggests that 25GBASE-T and 40GBASE-T will work anywhere in the data center over up to 30 m of four-pair, balanced twisted-pair copper cabling, including fat tree, leaf and spine, interconnected fat tree fabrics and anywhere in a classic level 3 hierarchy, for full mesh, interconnected meshes and centralized switching.

Getting the green light for 25GBASE-T in addition to 40GBASE-T will provide even greater choice and flexibility for future data centers deployments. The road is paved, and with a target ratification date of March 2016, this will certainly be one journey to watch. ◀

AUTHOR BIOGRAPHY: Valerie Maguire, BSEE, is Director of Standards & Technology at Siemon. She is TIA TR-42 appointed liaison to IEEE 802.3, treasurer of the IEEE 802.3 Ethernet Working Group, clause editor for the P802.3bq 25G/40GBASE-T Task Force and has held leadership positions in the TIA TR-42 Telecommunications Cabling Systems Engineering Committee and TIA-TR42.7 Copper Cabling Subcommittee for eight two-year terms. Valerie has authored more than 45 technical articles and engineering papers, holds one United States patent and received the 2009 Harry J. Pfister Award for Excellence in Telecommunications. She can be reached at valerie.maguire@siemon.com.