Getting Ready for 10G in Cable Networks

The operational simplicity of capacity upgrades becomes increasingly important as bandwidth explodes.

By Teresa Monteiro and Jon Baldry / *Infinera*

Bandwidth is rapidly growing in almost all types of access networks. Just stop for a moment and think about your own experiences at home, in the office and on the move. What kind of connectivity did you have five, 10, or maybe 20 years ago? How did your home and work lives change over time as you gradually gained access to more bandwidth?

The cable industry is embarking on its next change in access bandwidth by introducing the 10G initiative, which will deliver up to 10G per user over the cable access network. 10G represents an order of magnitude increase in headline download speeds. To put this in perspective, a decade ago, the cable industry was on the cusp of taking customers from 50 Mbps to 100 Mbps, and a decade before that, 1 Mbps was considered industry-leading. A launch point for the 10G initiative is ensuring that the current 1G technology is widely available to potential customers. According to CableLabs analysis, the percentage of U.S. households with access to 1G services rose from just 4 percent in 2016 to 80 percent by the end of 2018, and the infrastructure used for these services will provide the springboard to 10G.

WHAT IS 10G?

The 10G initiative is not a single technology but a platform upgrade that not only increases access speeds but also reduces latency and increases reliability and security. The platform uses the existing DOCSIS-based hybrid fiber coax (HFC) in the last mile and pushes optical networking technology deeper into the access network, utilizing the distributed access architecture and converged interconnect network initiatives that are underway or in planning to enable higher capacity over the HFC access infrastructure.

Overall, 10G is intended to keep cable networks at the leading edge of the residential and business services market with leading performance. Currently the 10G platform is working its way through the standardization process and early field trials of the technology, with services anticipated to get underway soon.

WHAT HAPPENS DEEPER IN THE NETWORK?

As capacity grows in access networks, naturally the level of traffic in the corresponding aggregation and backhaul networks needs to increase by a similar amount. In these networks, the "unit of bandwidth currency" is multiples of 100 Gbps carried over coherent optics, as the interfaces between optical systems and their client routers/switches typically operate at 100G. For many years, 200 Gbps coherent optics were the benchmark in backhaul and long-distance networks. 400 Gbps optics were also available, but with reach limited to shorter distances of just a few hundred kilometers, they mainly were used in shorter data center interconnect projects.

In 2018–2019, 600 Gbps coherent technology that similarly supported its headline rate of 600 Gbps over very short distances but pushed

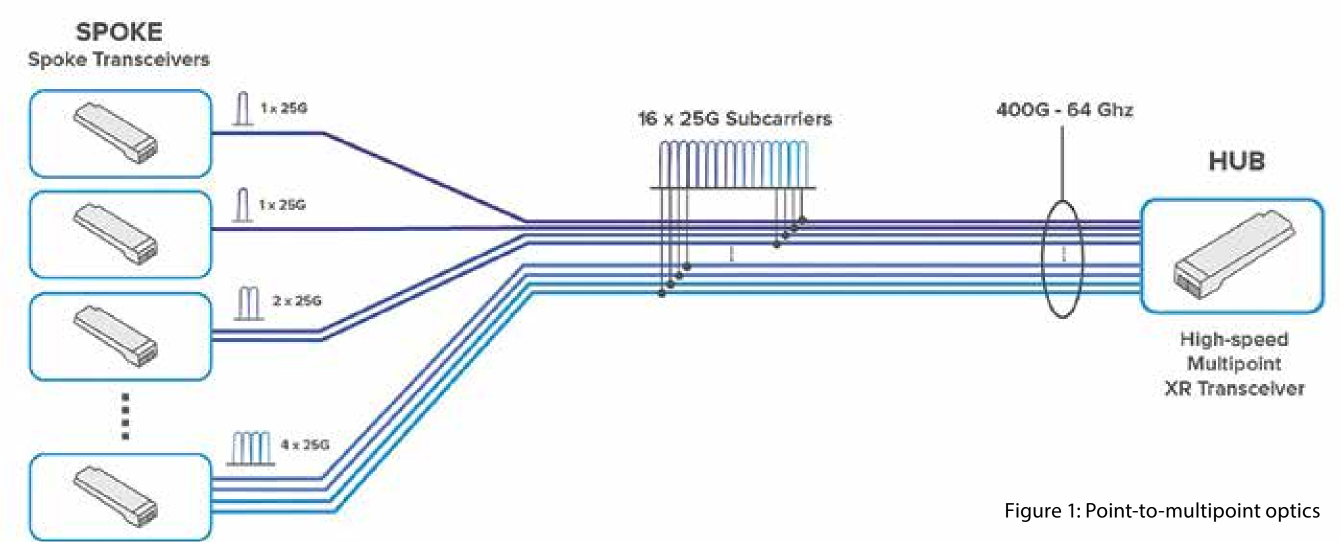

Figure 1: Point-to-multipoint optics

400G performance to a much more usable 2,000-plus km became available, enabling the technology to be used in a wide range of cable backhaul applications. Now in the second half of 2020, 800 Gbps coherent technology is starting to become available. In a break with recent tradition, 800 Gbps coherent technology can achieve its headline speed over significantly greater distances than initial 400 Gbps and 600 Gbps solutions, with initial solutions able to achieve distances of up to approximately 950 km (see www.infinera.com/white-paper/maximizing-the-capacity-reach-of-800g-generation and www.infinera.com/wp-content/uploads/XR-Optics-SB-0217-RevC-0820.pdf).

This technology therefore can also support many backhaul applications and will ramp up over the next year or so to become mainstream. In parallel to this, client interfaces between optical systems and routers/switches are starting to migrate to 400 Gbps Ethernet interfaces for the most demanding applications, although 100 Gbps still dominates.

Optical technology is evolving rapidly to higher and higher headline speeds to enable the cost-effective transport of ever-growing access bandwidth. But operationally, the process of adding chunks of capacity to backhaul networks needs to be simplified, because it is becoming a more common task as access bandwidth continues to accelerate exponentially.

SOFTWARE-BASED HARDWARE OPTIONS TO REDUCE COMPLEXITY

Luckily, there are solutions to this problem. Optical networking hardware can provide options that make the task of adding significant chunks of backhaul capacity much simpler, quicker and cheaper. The first of these is software-defined capacity, which takes advantage of the large-scale integration of optical components into a single device to create a pool of bandwidth that can be simply managed with the click of a mouse on a management system. Andres Madero recently wrote an article in the May/June 2020 edition of this magazine that describes the use of software-defined capacity in the management of networks through the COVID-19 pandemic (see: “Software-Defined Capacity Enables Providers to Overcome COVID-19 Traffic Spike Issues”: https://tinyurl.com/yxln4o2u). In summary, this approach enables the engineering, provisioning, and transfer of capacity in a network via software, with minimal or even no physical intervention. This simplifies bandwidth growth and enables more flexibility in overall network capacity.

Another recent innovation in optical networking that has the potential to radically simplify the addition of high-capacity backhaul to support access network growth is the creation of point-to-multipoint optics.

These optics break the 50-year-old paradigm of point-to-point optics, with the same speed laser at each end of a fiber, through the use of modulated Nyquist subcarriers within a traditional DWDM wavelength (see: www.infinera.com/white-paper/The-Ultimate-Guide-to-Nyquist-Subcarriers). In a cable aggregation and backhaul network, this technology can enable a higher-speed optic, initially a 400G optic, to communicate with up to 16 variable-speed optics that support 25 to 100 Gbps, simply by allocating between one and four subcarriers to this optic. Furthermore, these upgrades in speed are handled smoothly through a software automation application that is, in practice, transparent to the operator. This approach can both drastically reduce the cost of the aggregation network by eliminating redundant optics modules and intermediate aggregation switches and greatly simplify the process of adding capacity to the network.

INCREASED OPERATIONAL SIMPLICITY THROUGH AUTOMATION

Both innovations outlined above can enable a network that is more dynamic and software-centric. But how can the industry take advantage of automation software to further simplify the process of facilitating bandwidth growth?

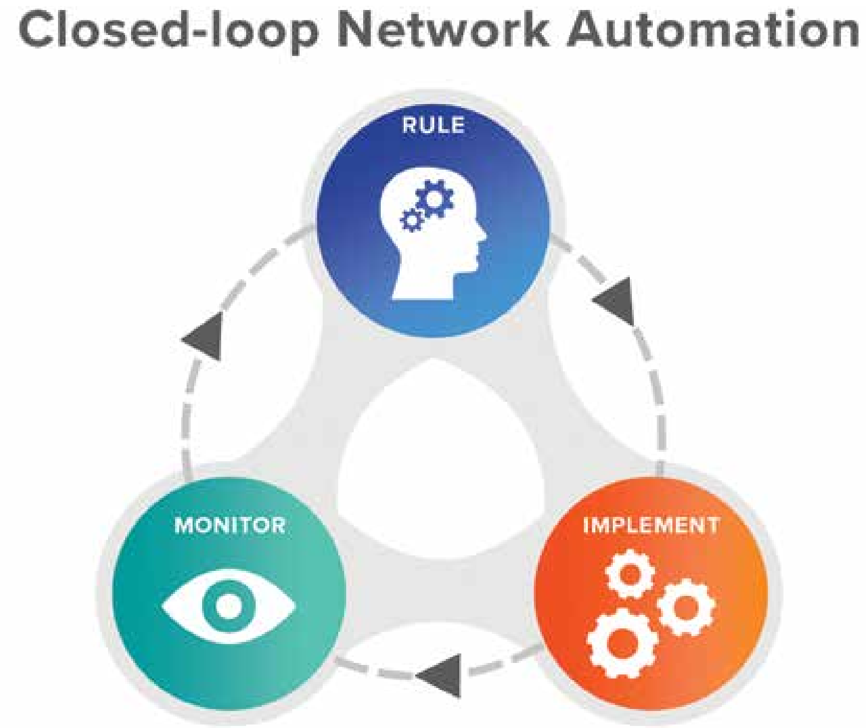

Figure 2: Closed-loop network automation

Today, capacity additions typically are planned offline, with each network layer planned independently by a technology expert. The outcomes are configured manually in the network, usually with the use of configuration scripts or via the user interfaces of the management systems affected network domain. This is inefficient – in terms of people and effort involved, service activation speed and network resource utilization when compared with an integrated multilayer, multidomain planning and provisioning approach.

A centralized network control software solution, spanning different technologies and domains, provides full network visibility and exposes machine-to-machine open application programming interfaces, enabling automation applications to act intelligently and effectively on the network.

A workflow engine application, for example, can perform fast, optimized, real-time end-to-end capacity planning and zero-touch provisioning across the network. The automation can be further extended to test and verify that the new bandwidth demand was properly set up before final acceptance.

Another type of application that can simplify procedures for bandwidth growth is closed-loop automation. The closed-loop network automation process consists of continuously monitoring network status, checking network data against predefined rules, implementing the resulting actions in the network and continuing to monitor the network afterward.

Closed-loop automation applications can be as simple as collecting link load data, and once a certain threshold is crossed, sending an alert to an operator that new capacity may be needed soon. But closed-loop automation applications can shine when combined with the use of more sophisticated networking technologies, such as those described above.

With more and more network devices able to stream (i.e., push) a variety of telemetry data into a software control system, these large quantities of information can be stored in a data lake and subjected to big-data analytics and machine-learning techniques for pattern and trend finding, as well as prediction (extrapolation) of future network behavior.

Traffic increase predictions can be used by closed-loop engines to issue improved recommendations for network augmentations well ahead of time or, in more evolved systems, perform capacity adds autonomously with automated end-to-end routing and provisioning. Note that this self-adapting behavior is particularly interesting in scenarios in which capacity can be added to the network without any field intervention. One example is in networks in which the optics' speed can be increased via the allocation of additional subcarriers, as described above.

Another relevant application of closed-loop automation in the scope of bandwidth growth is dynamic resource usage optimization, in which hidden capacity is freed, for example, through selected reroutings, maximizing the deployment investment.

CONCLUSION

10G is coming and will have an enormous impact on the experience of both residential and business users through increased capacity, lower latency, and higher levels of security. This will result in significant bandwidth growth throughout the transport network and will drive the need for more efficient high-speed optics and more sophisticated automation software that will minimalize the operational aspects of backhaul capacity growth.

The optical networking industry is innovating with ever-higher speeds in coherent transport, software-defined capacity, point-to-multipoint optics, advanced management and orchestration software and advanced workflow automation software to meet this challenge. ❖

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