SPECIAL REPORT

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Ramp Begins for 10 Gbps as Broadband Access Network Backbone

By Stephen Hardy

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Ramp Begins for 10 Gbps as Broadband Access Network Backbone

Many cable operators have begun to offer gigabit broadband services to residences and businesses as a way of trumping – or at least maintaining pace with – the competition. Some have leveraged bonded DOCSIS 3.0 channels or an all-fiber approach such as RF over glass (RFoG), EPON or GPON for this purpose.

The advent of DOCSIS 3.1 promises an efficient way of providing gigabit services over existing hybrid fiber/coax (HFC) plant while providing an upgrade path to services with even greater speeds. The 10-Gbps downstream capacity DOCSIS 3.1 holds the key to gigabit now and higher-rate services later. Several operators have embarked on DOCSIS 3.1 rollouts for just this reason. Yet DOCSIS 3.1 is not the only transmission technology that offers 10 Gbps capabilities. Operators therefore have a choice of how to meet their gigabit-and-beyond requirements as they upgrade their infrastructures with 10 Gbps (and greater) capacity in mind.

DOCSIS 3.1 in the Spotlight

DOCSIS 3.1 has rightfully taken center stage as operators upgrade their HFC networks to meet gigabit and eventual multi-gigabit

Many cable operators are looking at 10-Gbps architectures for their access networks to ensure gigabit services now and multi-gigabits later.

requirements. The technology, in its currently fielded incarnation, offers 10 Gbps downstream and approximately 1 Gbps upstream.

The use of orthogonal frequency division multiplexing (OFDM) represents one of the key building blocks of the technology. OFDM involves the transmission of multiple subcarriers in a relatively small window of spectrum. The DOCSIS 3.1 specifications call for spectrum windows from 24 MHz to 192 MHz wide, in

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which subcarriers 25 kHz or 50 kHz wide may be transmitted. The resulting spectral efficiency is impressive; a 192-MHz OFDM channel can contain as many as 7,680 subcarriers of 25 kHz or 3,840 subcarriers of 50 kHz.

OFDM combines with error correction via Low Density Parity Check (LDCP) and the use of frequency and time interleaving to ensure the network delivers such high capacity reliably. Operators whose DOCSIS 3.0 networks support 256-QAMwill be able to support 1024-QAM via DOCSIS 3.1. The technology also is expected to support 2048-QAM and 4096-QAM as well. The ability to establish multiple profiles also enables operators to set the optimal transmission scheme for a given set of line conditions.

DOCSIS 3.1 provides a 10-Gbps pipeline to serve residential and business customers.

As noted, current DOCSIS 3.1 doesn't offer 10 Gbps upstream. While it does feature a new modulation format for upstream, orthogonal frequency division multiple access (OFDMA), early deployments haven't used this capability, sources in the vendor community indicate. Regardless of the modulation format used upstream, this capacity limitation makes it challenging to offer symmetrical gigabit services across an extensive footprint — but hasn't slowed deployments.

In the United States, those deployments began with Comcast, which launched field trials in 2015 and began rolling out the technology in earnest last year. Such deployments continue this year, with rollouts in Colorado, Oregon and southwest Washington region, and suburban Kansas City, MO, and Olathe, KS, the most recently announced. The company also has leveraged the technology to offer business services, with the U.S. Northeast and Mid-Atlantic regions being the latest additions to its DOCSIS 3.1 enabled business services footprint.

Rogers Communications in Canada is another major North American operator who has deployed DOCSIS 3.1. However, Tier 2 and 3 operators in the U.S and Canada have taken up the DOCSIS 3.1 mantle most enthusiastically. Service providers such as Atlantic Broadband, Grande, MaxxSouth, Mediacom, Midco, Packerland Broadband, RCN, Videotron and WOW! have deployed the technology in their networks. Meanwhile, Charter and Cox have yet to publicly step to the plate. The common explanation in the former case is that Charter's focus lies on integrating its newly acquired Bright House Networks and Time Warner Cable assets, while Cox has indicated an interest in

deploying DOCSIS 3.1, but has yet to publicly announce doing so.

Altice USA, meanwhile, has announced it will focus on an all-fiber approach toward gigabit services delivery. So far, the operator is the only cable operator of note to turn its back on DOCSIS 3.1, although Altice USA mentioned in its most recent fiber deployment update that that it "continues to roll out enhanced services to its customers via its existing HFC network."

But while the approximately 1-Gbps upstream transmission rate hasn't yet proven a problem, operators wisely recognize that symmetrical capabilities will be necessary in the future. Hence CableLabs announced in 2016 its intention to develop Full Duplex DOCSIS 3.1, which will address the lack of symmetry. As the name implies, Full Duplex will involve simultaneous transmission of upstream and downstream signals. CableLabs has been closed mouthed about details of its work, although it's known that Cisco has contributed a silicon reference design that offers an approach to interference and echo cancellation at the Remote PHY node. Press reports suggest CableLabs could announce the specification before the end of the year.

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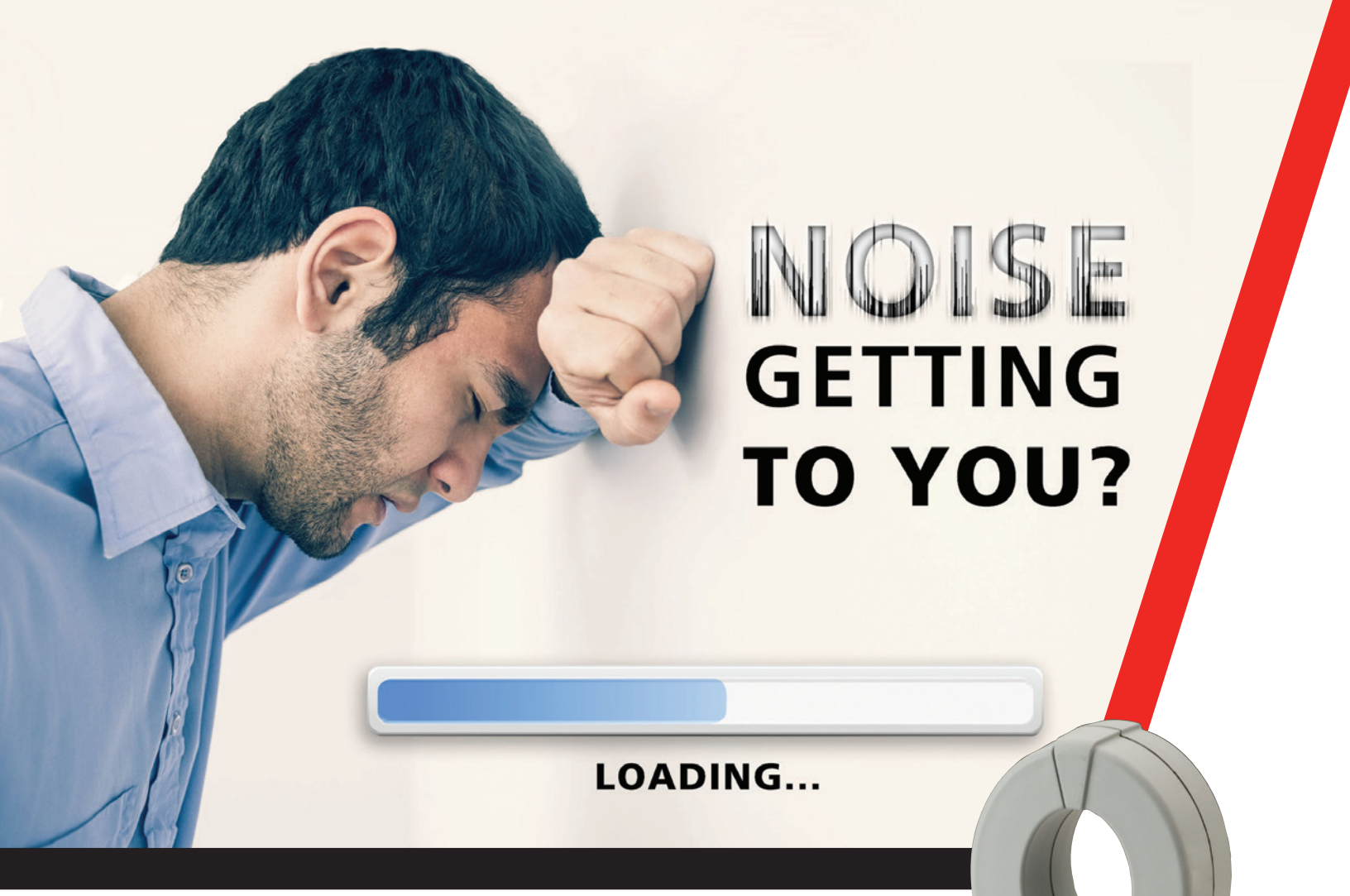
What Happened to 10G-EPON?

DOCSIS 3.1 wasn't the first 10-Gbps transmission technology available to cable operators. That distinction belongs to 10G-EPON, enhanced via DOCSIS Provisioning of EPON (DPoE) capabilities.

As the technology's name states, 10G-EPON offers 10 Gbps of capacity in the downstream. It also can offer either 1 or 10 Gbps of upstream capacity, depending upon the variant employed. The approach was expected to become popular for the provision of business services, alongside residential offerings in fiber to the building applications. However, after early deployments by such operators as Bright House Networks, as well as a number of systems vendors announcing 10G-EPON platforms over the past couple of years, use of the technology appears to have stalled, judging from the lack of recent deployment announcements. The advent of DOCSIS 3.1 undoubtedly has had a dampening effect on the demand for 10G-EPON, as well as the success of more conventional, DWDM-based approaches to business services provision.

Nevertheless, as the IEEE launches work on specifications for EPON technology for transmission rates greater than 10 Gbps, and the cable industry is playing a lead role. The current effort, under the auspices of the IEEE P802.3ca 100G-EPON Task Force, is developing the parameters of 25-Gbps, 50-Gbps and 100-Gbps versions of EPON, with work ongoing in single-wavelength and multi-wavelength approaches depending upon the transmission



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rate under consideration. Baseline proposals for the variants are scheduled to be selected by the end of the first quarter of next year. The Task Force hopes its work will achieve standards status in 2020. And how do we know cable operators are interested? Curtis Knittle of CableLabs serves as the Task Force Chair.

Two Options for 10-Gbps GPON

Meanwhile, cable operators who opted for GPON in their fiber to the premises deployments will soon have two options available for support of 10-Gbps capabilities. XGS-PON offers a direct approach to symmetrical, single-wavelength 10-Gbps service provision. NG-PON2 promises to support multiple wavelengths of 10 Gbps on a single fiber – if a few transceiver details can be worked out.

NG-PON2 is the more flexible, if more complicated, 10-Gbps pathway. The ITU-T standard enables the transmission of as many as eight wavelengths of 10 Gbps per fiber, although initial systems support only four. The multi-wavelength capability offers several potential benefits, including incremental capacity expansion, separate transmission of business and residential services on the same fiber, and rapid restoration of service in the face of outages by moving affected services from one wavelength to another. Verizon, which has spearheaded development of the technology through an RFP and which hopes to begin deploying the technology next year, has experimented with wavelength bonding to enable provision of greater than 10 Gbps to a single location as well.

All-fiber options promise to support not only 10 Gbps but higher capacities as well.

The key to these benefits is a tunable transceiver at the customer premises that can determine which wavelengths it's supposed to transmit and receive, particularly in scenarios where those wavelengths may change. Tunable transceivers have become mainstays of many service provider networks; however, the current generation of tunable modules doesn't meet the cost points of access networks.

At the NGPON2 Forum meeting held this past June during the Fiber Broadband Association's Fiber Connect event, speakers offered opinions on how such price points might be reached (including, privately, getting Verizon to relax

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its insistence that the transceivers support symmetrical 10-Gbps operation right off the bat). While a speaker from one young European company promised to have a tunable transceiver in production this year, Verizon Director of Network Planning Vincent O'Byrne acknowledged that the idea that he would see tunable transceivers at his desired price points in time to meet his stated deployment target was more an act of faith than certainty.

Keeping the Options Open

Cable operators have a variety of options at their disposal when it comes to enabling 10-Gbps capabilities in their broadband access networks. DOCSIS 3.1, alongside its eventual Full Duplex variant, provides a straightforward approach to boosting HFC capacity to such rates. However, all-fiber options in both EPON and GPON flavors will soon outstrip the capabilities of DOCSIS 3.1, leaving HFC in catch-up mode again once capacities greater than 10 Gbps become necessary.

Such a time isn't likely to arrive soon – although vendors are already positioning technologies such as NG-PON2 as a viable approach for such near-term emerging requirements as 5G fronthaul and backhaul. It's likely that many operators, as is currently the case, will use a mix of technologies to meet the needs of their varied applications.

Stephen Hardy *is editorial director of Broadband Technology Report.*

Learn What to Consider as You Plan Your DOCSIS 3.1 Deployments

You can now view on-demand the August 2017 SCTE·ISBE LiveLearning Webinars™ for Professionals webcast, produced by BTR, "Considerations in DOCSIS 3.1 Deployments." The webcast speakers discuss strategies for ensuring successful rollouts, including how to address the ground element balancing challenges DOCSIS 3.1 presents to headends and hubs, as well as the DOCSIS 3.1 measurements that will be key to troubleshooting deployment issues. Register for the webinar and view it now!