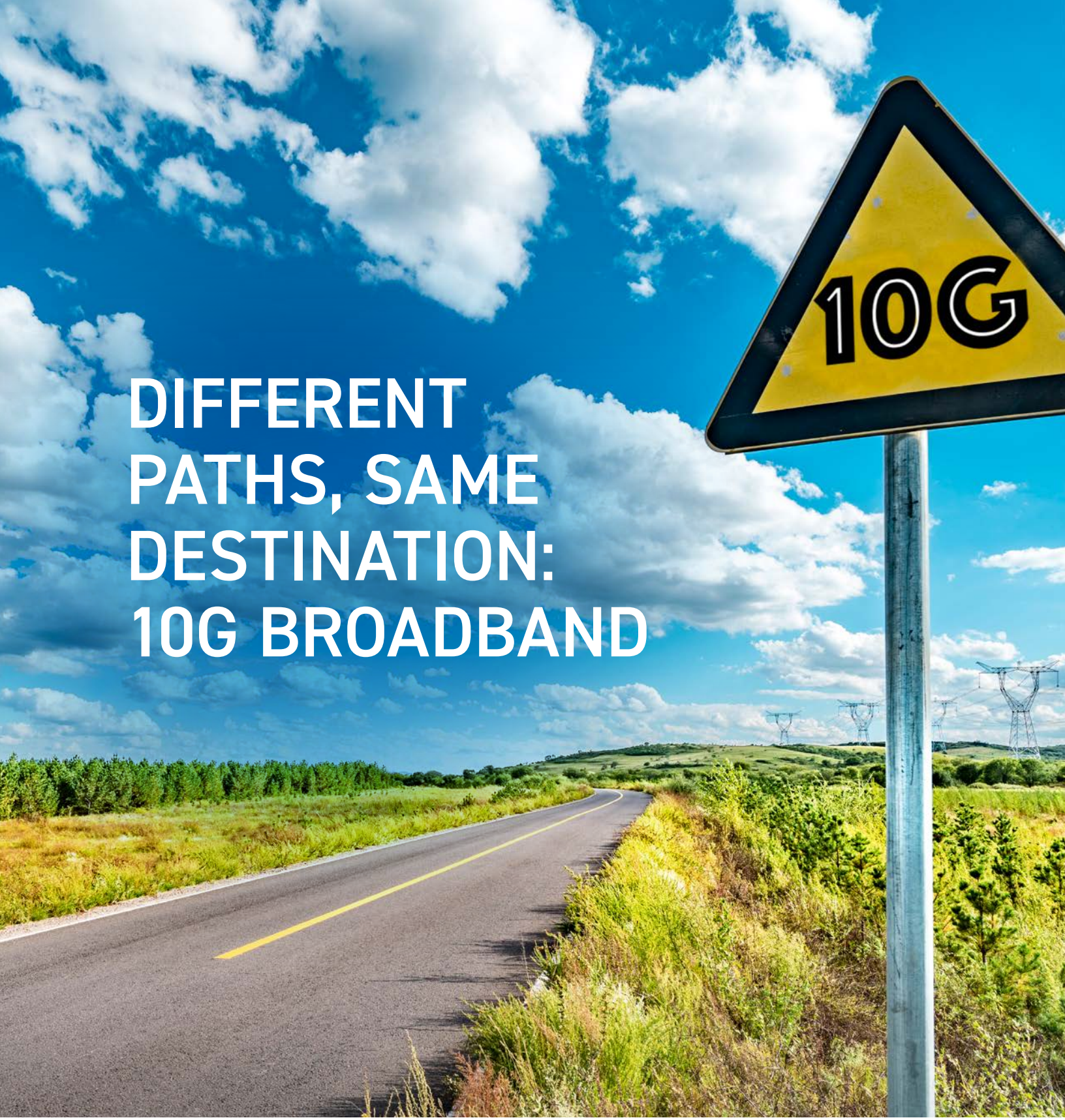

DIFFERENT PATHS, SAME DESTINATION: 10G BROADBAND

FINLEY

INTRODUCTION

Broadband providers are getting serious about offering multigigabit service to residential and small business customers, as well as to wireless carriers needing backhaul connectivity. Telecom providers, cable operators and others are upgrading or making plans to upgrade their existing network infrastructure to support speeds approaching 10 Gbps.

In this white paper, we explore 10G options, including options based on using fiber-to-the-premises (FTTP) passive optical network (PON) infrastructure deployed primarily by telecom companies and some others, as well as options based on using hybrid fiber coax (HFC) DOCSIS infrastructure deployed primarily by cable operators.

We also look at the status of 10G deployments and we touch on the next generation of broadband infrastructure supporting 25G.

The total capacity of some of the 10G technologies we will discuss is somewhat less than 10 Gbps because of overhead. It's also important to note that capacity is typically 10 Gbps for an entire neighborhood, but network operators will use the technology to deliver multigigabit service to some individual customers. They can do this because not all customers will be online at the same time, and for a large part of customers' time online, the customers will not need the full capacity of the connection. Operators also may offer lower-speed tiers at lower cost that represent a large portion of the total customer base.

FIBER BROADBAND OPTIONS

The two primary alternatives for providing multigigabit service using FTTH/PON infrastructure are XGS-PON and NG-PON2.

Both options conform to the basic PON architecture, in which a single high-speed optical source located in the service provider's facility, be it a central office, remote hut, cabinet, or even a self-contained strand/pole mounted node; feeds a neighborhood-based splitter serving multiple end-user locations, each with its own fiber. The optical source is known as an optical line terminal (OLT), while the devices at each customer location are known as the optical network terminal (ONT) or optical network unit (ONU). The IEEE 802.11 FTTH standard uses the ONU designation, while the ITU GPON standard uses the ONT designation.

Total capacity for XGS-PON is 10 Gbps upstream and downstream, an improvement over widely deployed GPON, which has 2.5 Gbps capacity downstream and 1.25 Gbps upstream.

Unlike GPON and XGS-PON, which are single-wavelength systems, NG-PON2 uses four wavelengths, each with 10 Gbps symmetrical capacity, for total capacity of 40 Gbps bi-directionally.

By using four wavelengths, NG-PON2 also supports capabilities such as failover, load balancing and bonding. The latter enables multiple wavelengths to be combined to support speeds above 10 Gbps. Network operators also have the option of putting mobile, business and residential services onto different wavelengths.

Additionally, the NG-PON2 standard calls for the technology to support eight wavelengths in the future for total capacity of 80 Gbps bi-directionally.

The added capabilities of NG-PON2 come at a higher cost, however, because of the tunable lasers that support the technology.

Both XGS-PON and NG-PON2 can be deployed as upgrades to existing GPON infrastructure.

10G CABLE BROADBAND

Traditional cable networks use hybrid fiber coax architecture in which fiber is extended from the cable company headend to a neighborhood node from which coaxial cables deliver video services to individual customers using radio frequency communications. Data Over Cable Service Interface Specification (DOCSIS) standards define the technology added to this infrastructure to support data services, traditionally consisting of a cable modem deployed at the customer premises and a cable modem termination system (CMTS) deployed at the cable company headend.

CableLabs, the primary research and development laboratory for the cable industry, refers to its 10G initiative as a “combination of technologies” that include, but are not limited to, the latest versions of the DOCSIS standard known as DOCSIS 3.1 and DOCSIS 4.0. In addition to supporting faster speeds, CableLabs’ 10G initiatives include developments designed to support lower-latency service and enhance reliability and security.

Both DOCSIS 4.0 and DOCSIS 3.1 provide 10 Gbps capacity in the downstream direction. DOCSIS 3.1 provides 1-2 Gbps of upstream capacity. DOCSIS 4.0 improves on that considerably, boosting upstream speeds to 6 Gbps. DOCSIS 4.0 also is designed to support symmetrical speeds not traditionally offered by cable operators.

The DOCSIS 4.0 standard expands frequencies used up to 1.8 GHz, provided that the operator has moved video programming out of that portion of the RF band.

To obtain maximum speeds with DOCSIS 4.0 requires reducing the number of customers served from a network node. Operators can accomplish this by moving to a distributed access architecture (DAA) that involves splitting nodes or taking fiber deeper into the network. This approach also involves decentralizing CMTS capability and virtualizing it by distributing it to remote PHY or remote MACPHY nodes deployed throughout the network.

For greenfield builds, cable operators often deploy PON as an alternative to HFC. And some operators are opting to overbuild existing HFC networks with PON rather than upgrade their HFC infrastructure to support higher speeds, at least in certain areas.

STATE OF DEPLOYMENT

Of the two 10G PON technologies, XGS-PON currently is more popular, measured by the number of operators choosing the technology.

Among the major telecom companies, AT&T, Consolidated and Frontier have begun deploying XGS-PON. Other companies that have deployed or plan to deploy XGS-PON are Sonic, Empire Access, Ritter Communications, TruVista, TEC, Lumos, Hotwire, and 4-County Electric Power Association.

The company with the biggest plans for NG-PON2 is Verizon. A company executive in 2018 said the company's network roadmap is focused on using NG-PON2 as an access method for wireless, residential and business services.

Smaller providers that have deployed NG-PON2 include Inyo Networks and electric cooperative OzarksGo.

Cable 10G is still evolving and cable company 10G initiatives to date have consisted primarily of lab and field trials.

In October 2020, Comcast achieved symmetrical speeds of 1.25 Gbps on a live production network in Jacksonville, Florida using remote PHY nodes and a virtualized CMTS (vCMTS). In April 2021, the operator said it achieved symmetrical 4 Gbps speeds in a lab test using DOCSIS 4.0. Comcast also has said that it eventually expects to move to a DAA approach systemwide.

In September 2021, a Charter executive said the company planned to expand the spectrum available for DOCSIS 3.1 broadband prior to deploying DOCSIS 4.0. At that time, the executive also said there may be parts of the network where it makes sense to do a fiber overlay.

More recently, in January 2022, Charter demonstrated speeds exceeding 8.5 Gbps downstream and 6 Gbps upstream using a remote MACPHY approach.

Some of the second- and third-tier cable companies are more aggressive about fiber broadband in comparison with the larger providers.

Midco has announced a significant investment in fiber broadband to support 10G symmetrically and has said that as of 2022, it will no longer build HFC networks; instead, all new broadband deployments will use XGS-PON. Altice has said it will deploy FTTH throughout the footprint it acquired when it purchased Cablevision and for a large part of its Suddenlink footprint. Armstrong also has deployed fiber broadband.

LOOKING AHEAD TO 25G

Although 10G broadband is still in its infancy, standards bodies already have defined technology to support 25G speeds.

25GS-PON was developed by a group of vendors and operators that formed the 25GS-PON Multi-Source Agreement (MSA). It is designed to be an upgrade to GPON or XGS-PON. Bell Canada and Frontier already have trialed the technology and Hotwire is deploying it.

Alternatively, the IEEE has defined a 25G/50G-EPON standard that can be deployed as an upgrade to earlier-generation EPON networks. The standard allows for symmetric or asymmetric operation with downstream speeds of 25 Gbps or 50 Gbps, and upstream speeds of 10 Gbps, 25 Gbps, or 50 Gbps.

At least one equipment manufacturer already has 25G PON equipment on the market, although it is basically proprietary and not tied to any standard. The same vendor also has stated that it plans to offer 40G PON in the near future.

Broadband traffic growth shows no signs of slowing down. Indeed, whenever additional bandwidth becomes available, creative minds quickly develop new ways to use it, and end users quickly make these new applications an important part of their lives.

In addition to making plans to continually boost broadband speeds, service providers also must ensure that they can maximize revenues and operate most efficiently by maximizing the number of subscribers that can be served from a single OLT port.

Clearly, multi-gigabit speeds are the future and any service providers that haven't already begun offering multi-gigabit speeds should be making plans now for offering them.

FOR MORE INFORMATION ON THIS TOPIC AND OTHER SERVICES, CONTACT FINLEY ENGINEERING AT 417-682-5531 OR VISIT FINLEYUSA.COM.

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