10 Gigabits: The Next Frontier

Over the last year, several network providers have launched 10 Gbps residential Internet services. But that's just the first sign of a much larger network transformation.

By Masha Zager / *Broadband Communities*

The first announcement came in December 2014: US Internet, a small competitive ISP, revealed that it was launching 10 gigabits per second residential Internet service in Minneapolis. The idea seemed improbable. Ten gigabits – when most consumers hadn't even heard of a gigabit? Who would pay $300 a month for Internet service, anyway?

A year later, enough fiber-to-the-home providers have followed suit that 10 Gbps can legitimately be called a trend. VTel, a small incumbent telco in Vermont, introduced 10 gigabit speeds in June. Salisbury, N.C., became the first 10 gigabit city when its municipal provider, Fibrant, made 10 Gbps service available anywhere in the city. EPB Fiber Optics in Chattanooga – which had laid claim to being the first gigabit city in 2010 – quickly introduced NextNet, its new 10 gig Internet service. Rocket Fiber, a brash startup launched by Detroit businessman Dan Gilbert, made its debut in November with residential speeds up to 10 Gbps. Other providers have said they will start offering 10 Gbps speeds in 2016.

Why are they doing it? How are they doing it? And when will your customers and residents start asking for 10 Gbps speeds?

MAKING A SPLASH

Residential customers are not asking for 10 Gbps speeds today. Most of their devices and home networks can't handle that speed, and no consumer applications are available for which 10 Gbps would make a difference. The fact that service providers are pricing the 10 Gbps tier at $300 or more per month indicates that they don't expect it to be a true consumer product.

That doesn't mean no one will purchase the service. A few days after EPB Fiber Optics launched NextNet, it announced its first 10 Gbps customer: Dr. Jim Busch, a radiologist and entrepreneur in Chattanooga. He downloads and uploads massive diagnostic image files at his home office, and high-speed fiber optic Internet is critical for him. "I've had a great experience every time EPB upped their Internet speeds," Busch said at the time. "You don't know how big a difference it's going to make until you have it in place." He added, "In my field, fiber optic speeds save lives."

Harold DePriest, EPB's president and CEO, said he expected other Chattanooga residents to use the 10 Gbps service "to push the boundaries in ventures ranging from health care and 3D printing to film production and software development."

Serving the few home-based businesses that will benefit from 10 Gbps speeds doesn't warrant major technology investments or press conferences. However, service providers do have two good reasons to offer 10 Gbps: competitive positioning and preparation for future demand.

US Internet launched its 10 Gbps service in Minneapolis only four months after CenturyLink announced 1 Gbps service there. Neither deployment is citywide, but the two providers may compete head-to-head soon, if they aren't doing so already. A top speed of 10 Gbps sets US Internet apart from other local providers. (US Internet has since added 2.5 Gbps and 5 Gbps speed tiers.)

Similarly, EPB Fiber Optics made its 10 Gbps move six months after Comcast announced 2 Gbps services in Chattanooga. Comcast said it would offer 2 Gbps for up to 200,000 Chattanooga customers – in a city of only about 70,000 households. Comcast's 2 Gbps service wasn't priced to sell and didn't pose any serious threat, but EPB Fiber Optics wasn't about to be trumped in its own hometown.

Fibrant had no gigabit competition, but it had a marketing problem. Its takeup is only about three-quarters of what had been projected, and after six years, many Salisbury residents and businesses were still unaware of what fiber meant for them. The 10 Gbps announcement brought Fibrant a new wave of publicity and helped generate economic development buzz for Salisbury.

In short, offering 10 Gbps Internet speed positions an FTTH provider as bold, unbeatable and forward-looking.

POINT-TO-POINT CONNECTIONS

Today, the simplest way for an operator to offer 10 Gbps Internet to a residential user is to employ the kind of connection typically provided to business users: a point-to-point Ethernet connection. Some operators, such as US Internet and VTel, already use point-to-point Ethernet in residential neighborhoods; for them, providing 10 Gbps service to a home can be as easy as plugging a 10 GbE–capable transceiver into the port that terminates the fiber in the central office and perhaps replacing the optical network terminal (ONT) at the customer premises.

Most operators serve residential areas with point-to-multipoint fiber (passive optical networks, or PONs) rather than point-to-point. For them, upgrading isn't quite as simple, but they can still run point-to-point fiber to any household that orders 10 Gbps service. This is Fibrant's plan for the immediate future. The approach makes sense as long as few residential users demand 10 Gbps connections.

MEETING FUTURE DEMAND

Some providers are already taking steps to upgrade their passive optical networks rather than offer point-to-point 10 Gbps connections for residential use. The first U.S. provider to announce that it would upgrade its PON was EPB Fiber Optics. In adopting Alcatel-Lucent's next-generation broadband technology, EPB illustrates how 10 Gbps service is related to preparing for future 1 Gbps demand.

> Though there is little residential demand for 10 Gbps, it allows operators to prepare for the future and make a splash today.

With a direct, point-to-point connection, a gigabit subscriber can get a full gigabit at any time because no one else is using the fiber. On a PON, however, multiple users share a fiber. A 1 Gbps (EPON) or 2.4 Gbps (GPON) port in a central office may serve as many as 32 users. This means residential gigabit subscribers could potentially get much less than a gigabit during peak periods, in the same way that cable speeds slow down in the afternoon when kids come home from school.

In reality, this doesn't happen today. Residential broadband traffic still isn't heavy enough to congest a gigabit EPON or GPON network. Sixteen or even 32 gigabit households can easily share a central-office port without noticing any interference. That's because most residential usage doesn't occupy anything like a full gigabit; for example, streaming a 4K (ultra-high-definition) video at Netflix's highest quality setting occupies only 15 Mbps, less than 2 percent of a gigabit. When data does flow at gigabit speed, it doesn't do so for long. Downloading an entire movie at 1 Gbps, for example, takes only about two minutes.

However, as data traffic continues to grow – it has grown between 40 and 50 percent per year, year in and year out – congestion will inevitably occur. To guarantee residential gigabit subscribers their full 1 Gbps, providers will eventually need to buy the next generation of PON equipment, which is capable of 10 Gbps per wavelength. Many providers (including Fibrant) are already testing this equipment for residential use.

Stefaan Vanhastel, who leads global marketing for Alcatel-Lucent, says, "When we first announced [next-generation PON] about a year ago, we really expected that the main applications would be business services and mobile backhaul. We're a bit surprised that residential turns out to be one of the main applications."

Even providers that delay upgrades will likely move to next-generation PON by the early 2020s, says David Russell, solutions marketing director at FTTH equipment vendor Calix. Five to 10 years from now, GPON will "run out of gas" in single-family neighborhoods, Russell says, and the next generation of equipment will become a necessity.

Thus, for EPB Fiber Optics, upgrading to the next generation of PON both maintains the future integrity of its 1 Gbps service offering and allows it to provide 10 gigabit service to anyone who needs it.

THE EVOLUTION OF 10G-PON

Delivering 10 Gbps service over PON has been possible – though not economically attractive – for several years. The 10G-EPON standard was adopted in 2009, and equipment for it was available as early as 2010. It has been deployed in some Chinese cities, usually with large split ratios – some equipment supports 256-way splits. However, falling prices for 1 Gbps EPON equipment and the adequacy of that equipment to meet existing bandwidth demand limited the market for 10G-EPON equipment.

In the United States, GPON is much more widely used than EPON. GPON, part of the International

Eventually, 10G-PON will be needed to serve residential users, and multiwavelength options will offer new options for business users.

Telecommunication Union (ITU) family of standards, began evolving toward 10G in 2010 when the ITU adopted XG-PON1, which supported 10 Gbps downstream and 2.5 Gbps upstream. Carriers tested XG-PON1 but did not deploy it in any volume.

Russell explains, "The XG-PON1 standard really didn't address the applications people wanted 10G for." At that time, he says, 10 Gbps was of interest mainly to businesses, and businesses needed symmetrical bandwidth. "Because 10 Gbps/2.5 Gbps wasn't useful, the ITU immediately embarked on developing a new, better standard," Russell says.

In 2015, the ITU adopted that new, better standard – NG-PON2, which supports both 10 Gbps symmetrical and 10 Gbps/2.5 Gbps over each of eight pairs of wavelengths, for a total potential 80 Gbps. (Equipment produced today uses only four of the eight wavelength pairs.) NG-PON2 is the first FTTH standard to allocate multiple wavelengths for data. It uses both time-division multiplexing and wavelength-division multiplexing, meaning that multiple users can share one wavelength or one user can combine multiple wavelengths. This architecture is called TWDM-PON.

LIMITATIONS OF NG-PON2

NG-PON2 didn't solve every problem. One issue is that supporting multiple wavelengths at a single customer premises is expensive because, as Russell puts it, "The optics vendors aren't ready for an affordable, tunable solution."

Tunable optics handle multiple wavelengths by filtering incoming signals into a separate stream for each wavelength and directing outgoing signals to the right wavelength. Low-cost, tunable ONTs for customer premises will probably not be available until 2017.

Though businesses might be able to afford tunable optics today, they have the less-expensive option of using fixed-wavelength, point-to-point connections. Residential services might choose the 10 Gbps/2.5 Gbps option rather than 10 Gbps symmetrical, because the optics are less expensive for the lower speeds. Ana Peskovic, product marketing manager for Alcatel-Lucent, says, "The market trends that we see from Sandvine and others are showing that residential traffic is very asymmetrical, so 10 Gbps/2.5 Gbps is a perfect fit. Upstream bandwidth needs to be increased [from today's levels], but there's really no need to go for symmetrical bandwidth."

Another limitation of NG-PON2 is that it does not support RF video (which runs over a separate wavelength on GPON). An operator that wants both 10 Gbps capacity and RF video has to go back to the XG-PON1 standard – and if it wants *symmetrical* 10 Gbps capacity and RF video, it will have to wait for the XGS-PON standard, which the ITU is now developing. XGS-PON, which is expected to be ratified in 2016, will support symmetrical 10 Gbps speeds over a fixed wavelength, and it will also support RF video. Though it will require specialized ONTs, it will still be less expensive than NG-PON2 until low-cost, tunable ONTs are available.

CONVERGING THE PLATFORM

All these types of networks can run over the same fiber at the same time, enabling operators to serve different customers with different technologies. Currently, a single fiber can carry data over 36 wavelengths in the access network (18 upstream and 18 downstream): two for GPON, two for XG-PON1 or XGS-PON, 16 for NG-PON2 and 16 for point-to-point.

According to FTTH equipment vendor ADTRAN, a common access platform that makes it easy to operate NG-PON2 alongside other networks will accelerate the deployment of NG-PON2. ADTRAN's NG-PON2 platform uses a flexible optics approach that allows NG-PON2 to interoperate with multiple optical transceivers to maximize economic flexibility. Existing residential FTTH customers and early business adopters of 10 Gbps technology can be supported on a single, common access architecture.

ADTRAN's NG-PON2 platform, currently in field trials, supports 10 Gbps GPON (XG-PON1 or XGS-PON, fixed wavelength), TWDM-PON (NG-PON2, multiwavelength), DWDM point-to-point fiber (multiwavelength), 10 Gbps EPON and traditional GPON. It handles provisioning through open APIs, using management systems based on software-defined networking.

With this "pay as you grow" approach, service providers can align optics costs with target applications, starting with low-cost 10 Gbps deployments and growing to multiwavelength capabilities.

FIXED-WAVELENGTH APPLICATIONS

Kurt Raaflaub, ADTRAN's senior manager for carrier networks product marketing, explains that fixed-wavelength 10 Gbps ONTs in residences and small businesses may never have to be replaced by tunable optics. A single wavelength is probably all these premises will need for the foreseeable future. Raaflaub adds that small-cell sites and cell towers are also plausible candidates for fixed-wavelength deployments.

In multifamily housing, deploying 10 Gbps to the building – for example, NG-PON2 to the basement and G.fast to the unit – can ensure gigabit speeds for individual users without running fiber to individual units. Calix's Russell calls this combination"very powerful" for brownfield multiple-dwelling units (MDUs) that are costly to rewire.

In greenfield MDUs, fiber can be delivered to each floor or each unit. Raaflaub says, "The building becomes a point of presence – you're treating it like its own little town." A small MDU, he says, might have passive components in the basement, and a large MDU might have an optical line terminal in the basement. Either solution would be less expensive than running point-to-point fiber to the basement, today's preferred solution.

Vanhastel mentions a clever approach to deploying 10 Gbps in a residential neighborhood or an MDU: Place a 1:2 splitter at the optical line terminal and use a 1:32 split in the field. (An existing GPON deployment would already have a 1:32 split in the field.) This splits the 10 Gbps 64 ways. As bandwidth demand grows, the 1:2 splitter can be removed, doubling capacity without having to change the outside plant.

THE MULTIWAVE FUTURE

Once prices for tunable optics fall, serving large businesses via PON will become less expensive than serving them over point-to-point fiber. At that point, in addition to offering businesses speeds up to 80 Gbps – or else highly secure, dedicated wavelengths – operators will be able to develop new business models and offer new, revenue-producing applications.

For example, Russell says, a business customer might want to be able to switch automatically from one wavelength to another, using the secondary lightpath as a backup. Multiple wavelengths on NG-PON2 might also be useful on open-access networks; if each service provider is assigned a separate wavelength, providers can't interfere with one another's traffic.

Vanhastel says network operators will be able to easily unbundle their networks by renting entire wavelengths to other service providers. Or two operators could coinvest in fiber, one building in one city and the other in another city, and trade wavelengths so each could have a presence in both cities. Both models are beginning to emerge in Europe.

Industry analyst Ovum has great hopes for NG-PON2 as a driver for fast FTTx network monetization. In a recent report, Ovum concludes, "TWDM-PON allows support for higher [average revenue per user] subscribers such as enterprises, leading to faster [return on investment] while enabling pay-as-you-grow network deployment options. TWDM-PON will surpass XG-PON1 as the next-gen GPON architecture of choice." ❖

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