Can New PON Architectures Help Networks Close the Digital Gap?

The COVID pandemic did not create the broadband divide, but it did thrust the digital disparity between served and underserved communities into the global spotlight. With access to high-speed internet now considered a basic necessity, a significant portion of the world's population find themselves on the wrong side of the gap.

Globally, developed countries enjoy an 87 percent internet penetration rate, while only 47 percent of those in developing nations have access. That figure drops to just 19 percent in the least developed countries.[i]

In the U.S., 97 percent of urban areas have access to a high-speed, fixed service. In rural areas, that number falls to 65 percent and on tribal lands to 60 percent. In total, nearly 30 million Americans cannot fully benefit from the digital age.[ii]

> The world is blighted by a digital divide. In total, 3.7 billion people have no internet access. The majority are in low- or middle-income countries (LMICs). In the developed world, just 13 per cent of people lack a connection compared with 53 per cent in developing nations, and 81 per cent in the least developed countries.
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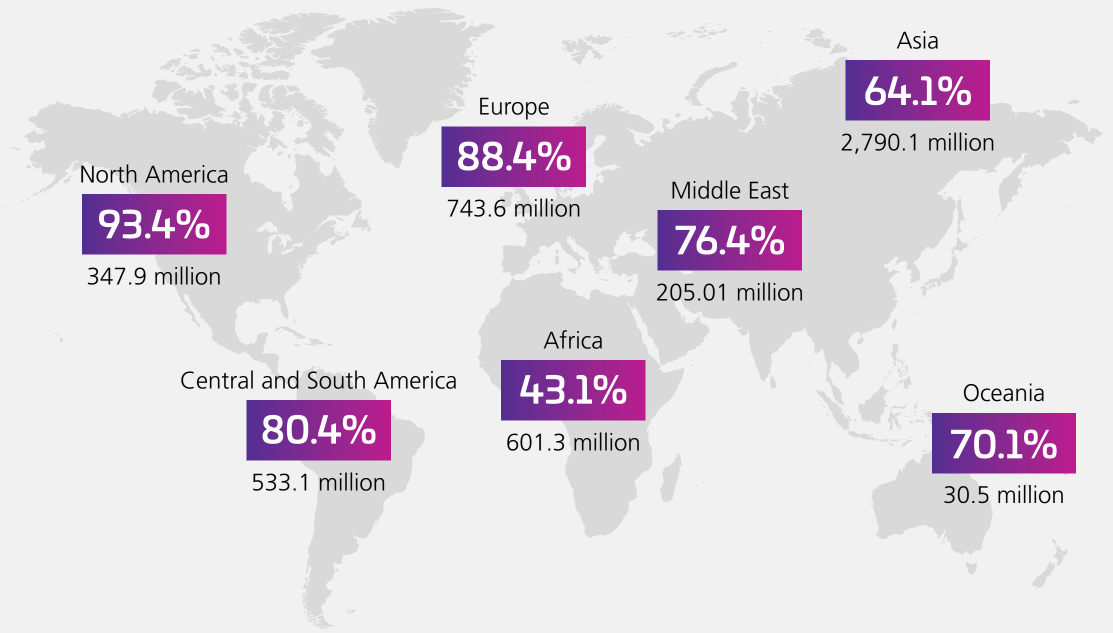
> **The Tony Blair Institute for Global Change, March 2, 2021**

The growing digital divide—and its cost in terms of equal access to education, job opportunities, healthcare and more—has received greater attention from the world's nations. Government investments include grants at the federal and state levels of multiple countries worldwide. It is estimated that as much as $200 billion in government stimulus funding is being made available around the world. But more is needed to close the gap. Recent estimates by the ITU suggest that at least $428 billion is required to reach universal broadband connectivity by 2030.[iii] Among other things, these investments would include mobile infrastructure, metro and backbone fiber networks.

Global internet penetration



Source: Internet Worldwide Stats, December 2021

Why closing the gap is such a heavy lift

For years, rolling out advanced broadband services in rural markets has been challenging due to the unique dynamics of these environments. Traditionally, service providers have found it difficult to justify the financial investments it takes to construct next-gen networks in areas where subscriber density is low and revenue opportunity can be less than it is in urban and suburban markets.

New public funding programs are helping to level the playing field—enabling a substantial opportunity for service providers of all sizes to build next-generation high-speed broadband networks in rural markets around the world. In the U.S., federal and state governments have committed over $140 billion to making robust broadband services available to every American. Meanwhile, the EU has taken a multi-layered approach that includes no fewer than four different investment models involving both public and private sectors as well as community residents. In all cases, the hope is that the initial investments will spur a surge in new private money to help networks and communities cross the finish line.

Even though funding is available, it is not guaranteed. Network operators and owners must still make a strong business case that balances community value (performance and reliability) and the overall cost to build and operate the network. In many cases, funds are awarded based on the service provider's ability to demonstrate the financial viability of their plan. In addition, speed of deployment is a chief concern. Public funding often comes with strings attached in the form of a set of milestones that must be achieved throughout the project lifespan. Many of those projects involve the use of passive optical network (PON) technology.

Increasing reliance on passive optical network (PON) technology

Globally, the GPON market size surpassed $10 billion in 2021 and is poised to grow at over 10% CAGR from 2022 to 2028. Global GPON product shipments exceeded 250 million units in 2021.[iv] Continuing developments in PON technology have not only improved optical reach and performance; they have also enabled MSOs and other service providers to address their networks' cost concerns.

For these reasons, in particular, it is critical for service providers to develop a 360-degree view of the time and cost factors of rural next-gen PON deployment. Several dynamics—physical facilities, hardware utilization, power requirements, outside plant topologies, management/operations resources—can have a substantial impact on PON deployment time and costs.

Recent advances in software-defined networking (SDN) and network disaggregation make possible a complete shift from traditional fully coupled and integrated platforms to disaggregated and open architectures. These new architectures will reduce capital and operational costs, accelerate time to market for new services, and pave the way for new "pay-for-use" models.

A key obstacle, however, is that many of today's PON solutions—and specifically the optical line terminals (OLTs)—have been developed and optimized for the deployment dynamics and economics of high-density environments. To use PON effectively in low-density rural areas, where it is desperately needed, operators and their OEM partners will need to adapt the technology and architectures for a new environment.

Benefits of a disaggregated PON architecture

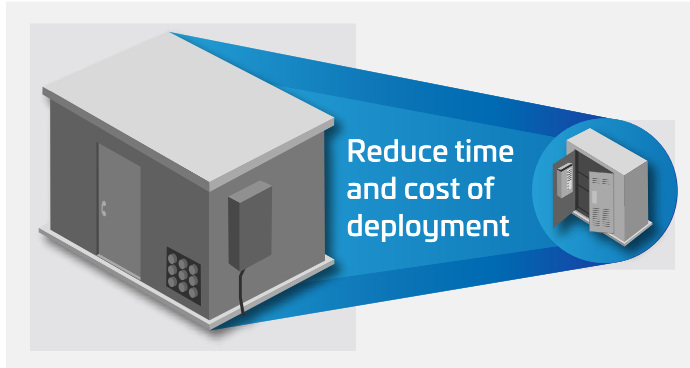
CommScope recently modeled installation and operating costs for a low-density (7.6 homes per mile, 4.7 homes per kilometer) rural PON deployment. The results of this exercise demonstrate how a disaggregated, software-driven PON network can significantly improve the business case for a successful rollout in rural markets.

Reducing physical facilities' costs and deployment time

One of the primary challenges of PON deployment in rural environments is the distance that often separates the service provider's existing hub or central office facilities from the end-user locations. In many greenfield deployments, service providers may not have these traditional facilities in place at all. Whether greenfield or brownfield, it is often impossible to serve every subscriber using centralized physical locations. In these cases, new facilities are needed—but the time and costs of constructing them can be prohibitive. In this traditional approach, permitting, site preparation, transportation, construction, point of presence (POP) and the procurement of equipment for a new walk-in facility or a mini hub can cost hundreds of thousands of dollars per site and take several months to complete from start to finish.

In the case of our modeled rural PON example, seven new facilities would be needed to reach every home—requiring significant time and substantial costs to construct. As each of these POPs would serve only a few hundred homes at best, this would drive up the cost per home to levels well above the industry average for denser areas. However, today, new options based on moving the OLT to the edge by using a Remote-OLT (R-OLT) are available at a fraction of the cost and time needed to deploy traditional facilities. These newer designs create a variety of cost-saving opportunities.

Replacing traditional facilities with outdoor cabinets with R-OLTs: Replacing conventional walk-in facilities with environmentally hardened R-OLT shelf devices in outdoor cabinets creates significant savings in time and cost. The data indicates a 40 to 80 percent savings on infrastructure cost depending on the situation and whether an existing cabinet and power are already available. We also found that deployment time can be reduced by 70 to 80 percent when compared to traditional facilities.



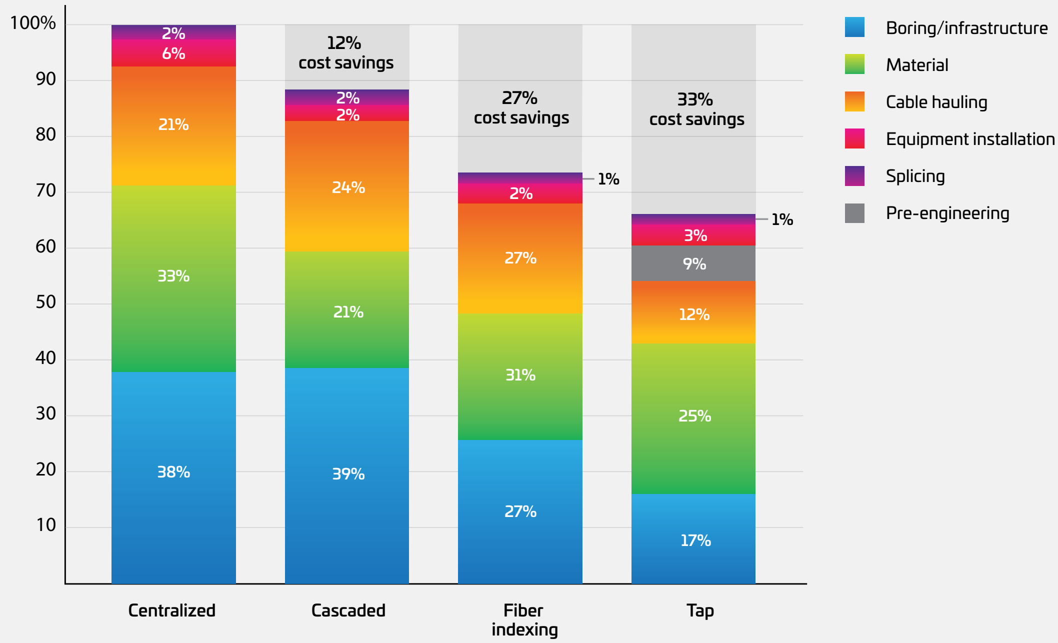
Increasing hardware utilization: As noted earlier, many of today's existing OLTs have been designed to meet the needs of high-density urban and suburban markets. Therefore, it can be difficult to maintain high hardware utilization in rural PON networks. One way to address this issue is by using OLTs that can be deployed initially with low port counts and high split ratios (1:128). The operator can then scale up—adding ports and reducing the split ratio (1:64) as capacity is needed. This enables better port utilization and higher CapEx efficiency. Our modeled data showed that using cabinet-based remote OLTs enabled the cost-effective deployment of infrastructure for very small serving areas and a seamless migration path toward future growth—all while keeping hardware utilization optimized for both cost and capacity.

Improving management and service efficiency: An additional dynamic we examined in this rural PON deployment was the management and service overhead required to operate the network and keep it growing. By deploying R-OLT and shelf OLT devices that leverage modern software rather than legacy OLTs in traditional facilities, the volume and complexity of annual truck rolls per site was shown to be reduced significantly. This is made possible by a range of advanced software capabilities that enable R-OLT to be deployed with zero-touch provisioning and managed remotely with automation.

Optimizing outside plant investments: In the rural environment we studied, we found multiple opportunities to reduce the costs of fiber deployment by carefully selecting fiber topologies and technologies. The first area of savings stemmed from the inherent fiber efficiency of Remote-OLTs, which reduce the fiber count requirements in the feeder network and place the last active device much closer to subscribers than is possible with centralized facilities. In addition to being cost effective, placing Remote-OLTs deep in the network improves optical budgets between the OLT and home, enables more choice in split ratios, helps extend service over long distances, and allows for the use of more connectorized solutions—which can facilitate and speed up the process of connecting new subscribers.

Additional savings were created using cascaded, tap, and indexing technologies. Despite the fact that these technologies can add incremental passive connectivity costs to PON deployments, they can significantly reduce the labor requirements and deployment time of running new fiber when compared to centralized architectures. This is due to the plug-and-play nature of connectors and their ability to reduce splicing, cable hauling, pre-engineering and other tasks.

Comparative cost analysis of topologies



A delicate network balancing act

As service providers begin planning, designing, and deploying next-gen PON networks, there is a lot to think about. There are often tradeoffs between near-term capital investments and long-term operational costs, and the two must be balanced in accordance with the service provider's unique business priorities. There are decisions to be made about how to evolve from existing technologies to what is next. There is a learning curve with next-gen technologies that needs to be considered in light of the advantages of going modern. And then, of course, there's speed. Service providers are wise to consider how quickly they can get their next-gen PON networks up and running and choose technologies that help them roll out new features and capabilities quickly and efficiently. In addition to measuring success by performance, QoS and network adaptability, operators must also view their next-gen PON planning through the lenses of cost and time to market.

Using a disaggregated architecture that leverages the benefits of R-OLTs, software-defined networking and automation is just one emerging solution that can help operators balance their various challenges. The industry will need even more weapons in our collective arsenal if we are to meaningfully address the global digital divide.

For more information on the latest strategies and solutions for fiber- and PON-based networks, visit commscope.com.

[i] Measuring digital development facts and figures 2019; International Telecommunications Union; 2019
[ii] COVID-19 exposed the digital divide. Here's how we can close it; World Economic Forum, Jan 27, 2021
[iii] People-Centred Approaches for Universal Broadband; ITU/UNESCO Broadband Commission; Sept 2021
[iv] GPON Competitive Market Share and Global Forecast – 2021 – 2028; Global Market Insights; January 2022

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