COMMSCOPE®

Power Broadband for Everyone with Next Gen DAA PON

The recent public health emergency has shone a harsh light on the substantial disparity in broadband access, particularly as broadband has become recognized as an essential utility worldwide. This has led governments to substantially increase funding to promote broadband equity, by subsidizing access and providing funding to expand access to underserved areas. This added to a massive increase in broadband consumption, driven by existing but also new services that are taking hold in the home, such as telehealth, work from home and other, and the general digitization of services and business models.

Today, there is a unique opportunity to deliver broadband for everyone and to refresh access network deployment technologies and architectures. Cable operators have a leading role to play in this important endeavor, but they are not alone. The massive government subsidies, combined with growing market demand, are driving fierce competition; telecom operators are investing in fiber deployments, but also overbuilders and new entrants, including municipalities, are tapping into government funding to add capacity and serve growing demand. These developments are happening with a backdrop of highly disrupted supply chains, tight labor markets and highly dynamic market currents. These multi-faceted drivers are leading cable operators to explore many options to remain competitive, including brownfield overbuilding to enable higher tiers of service, deployments in greenfield areas, and everything in between. They will need technologies and solutions that integrate in their existing environment, that are capex and opex efficient, and that enable them to grow and evolve to meet market needs.

Drivers for cable access transformation

The last mile is undergoing a profound transformation. Government investment is leading to broadband penetration expanding to previously unserved or underserved areas, and consumption is fueled by the continuing worldwide digitization.

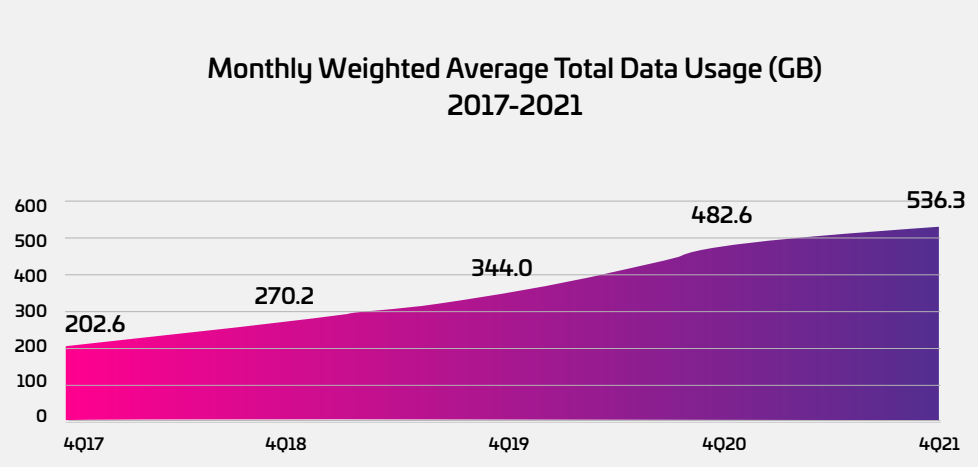


Figure 1 Source: OVBI Broadband Insights Report 4Q2

Governments are investing massively to promote broadband equity. For example, in the US the federal government is making significant funding available for infrastructure expansion particularly in under privileged and rural areas. Part of this funding is the recent allotment of $65 billion for continued broadband adoption and deployment as part of the infrastructure bill, passed in November 2021; this substantial funding comes after the relatively recent Universal Service Fund's allotment of $20.4 billion in a bid to improve quality of life for rural communities, under the FCC's Rural Digital Opportunity Fund (RDOF).

In Europe, €809 billion have been allocated to fund the Regional Development Fund program, which allocates funding for a very high-capacity infrastructure.

Funding in the US, Europe and other parts of the world will lead to a significant increase in FTTH passings:

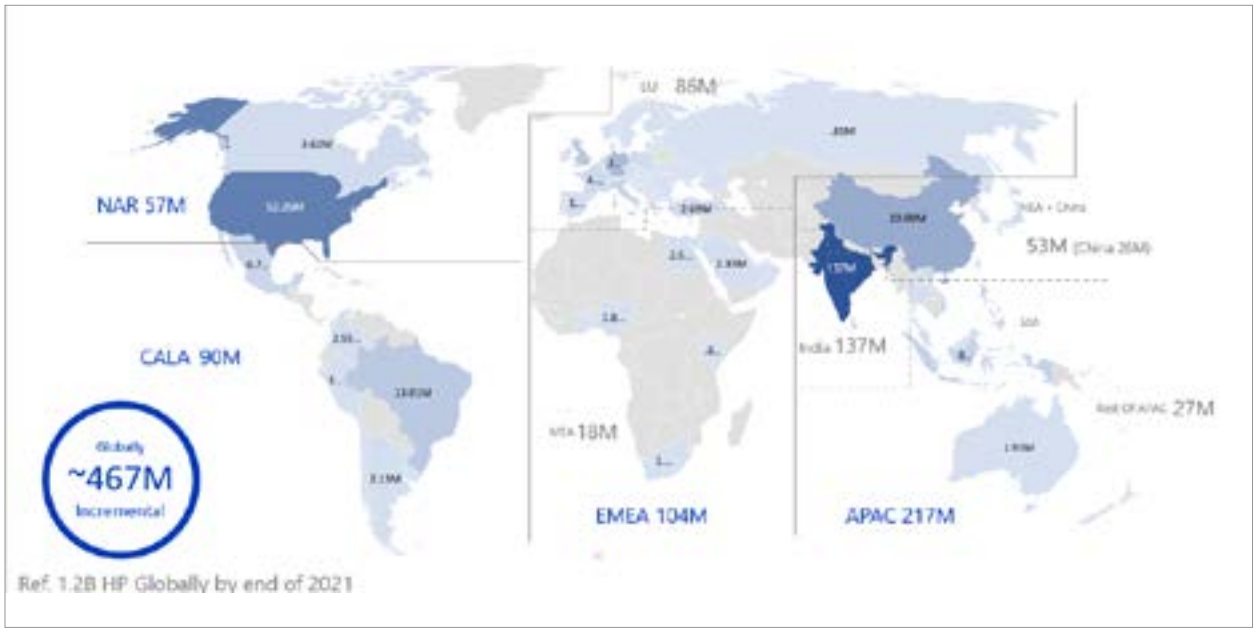


Figure 2 Change to: Global FTTH deployment status (source: CommScope)

At the same time, broadband consumption continues to increase as more services are delivered in the home (for example home healthcare, work from home), and digital services continue to grow. Emerging paradigms such as the metaverse will lead to an exponential growth in bandwidth consumption.

Government funding and demand growth are driving incumbents and entrants to build capacity in new areas and densify existing areas. Many technologies are being used in these deployments, including HFC, fiber, fixed wireless and other. However, fiber is emerging as the technology of choice. And, cable operators with ongoing expansions are choosing PON solutions that are uniquely suited for their network topology and build on their existing assets and network management.

Considerations for access network evolution

There are many scenarios for access network upgrades. Selecting a common technology to enable those scenarios that is compatible with the current operating environment is the best way forward.

Access network expansion scenarios

Cable operators have primarily four scenarios for expanding their last mile, driven by market conditions.

- **Greenfield** deployments, particularly driven by the RDOF broadband initiative. Includes MDUs.
- **Greenfield footprint expansion** into adjacent areas that leverage the existing plant to enable more home passings.
- **Success based deployments** – for example MDUs, developers demanding fiber builds, SOHO and other subscribers demanding gigabit symmetric services and businesses requiring increased SLAs. For such deployments, operators can use a bandwidth shedding strategy where they use PON to selectively serve customers who pay for a higher tier of service.
- **Brownfield and overbuild** – capacity additions in existing footprint, particularly in the upstream for symmetric services, and for meeting competitive pressure.

Considerations for selecting a technology for access network evolution

Most cable operators will have most of these deployment scenarios in some parts of their footprint. Therefore, as they expand the access network, it is essential for them to select a technology that:

- Delivers capacity on par with what competitors (for example telcos) are offering and that aligns with cable's 10G initiative.
- Presents significant commonality across all deployment scenarios.
- Is compatible with their existing topology; can be housed in nodes and cabinets, which are common in the cable outside plant and leverage the power supply infrastructure already present in the cable network.
- Has a common management environment with their existing HFC infrastructure, which is software based and cloud-native and that uses modern technologies such as YANG and NETCONF.
- Is relatively easy to operate
- Can be deployed and operated by the existing workforce who is knowledgeable about DAA and who can be upskilled to learn the newer technology.
- Presents a solid upgrade pathway for years to come.
- Has been adopted by CableLabs and is based on open standards to insure broad industry acceptance and interoperability.
- Optimizes capex and opex and is sustainable today and going forward
- Is field proven with a track record.

DAA PON delivers the benefits of PON without the challenges

Cable operators have solutions and strategies to expand the access network. Certainly, the traditional methodologies, such as node splits, continue to be viable for adding capacity. However, given the scale and scope of the network expansions underway and planned, and given the intense competitive environment, where telcos and many entrants are deploying fiber, a fiber-based technology will enable them to be more competitive and to best meet market need.

However, the fiber network needs to be compatible with their existing infrastructures and operating environments and must meet their current and future needs.

PON technology is emerging as the optimal technology for these expansions. It can deliver symmetric bandwidth up to 10 Gbps with a roadmap to 25 or even 50 Gbps, making it future ready. XGS-PON, which offers symmetrical 10 Gbps fiber to the home capability, is the technology of choice in areas where demand for gigabit services is expected. In addition to residential services, XGS-PON is well suited to power business services and 5G wireless backhaul.

Challenges of PON deployments

Deploying traditional PON technologies has some challenges, including:

- High cost of pulling fiber all the way, often to the subscriber, ahead of demand, so revenue is not guaranteed.
- Long lead times for permitting, to pull fiber all the way to the node.
- Lack of skilled labor, which has become more acute in recent months.
- For operators who have an existing HFC network, deploying an overlay PON network adds significant operational complexity as they would have to operate two networks.

However, operators who operate an HFC network can leverage that infrastructure to introduce PON at much-reduced deployment and operating costs and faster time to market, while enabling success-based deployments. In fact, the PON technology they deploy must align with the modern cable network architecture and cloud-native network and performance management environment, which will deliver the maximum benefits of delivering gigabit capacity with a fraction of the deployment costs.

This PON technology is DAA PON.

DAA PON is the optimal PON solution for cable operators

DAA PON leverages the inherent capabilities of distributed access architectures to move the move physical layer close to the subscriber, provides operators with the flexibility to deploy capacity where, when, and how it aligns with demand, and enables the delivery of 10G capacity.

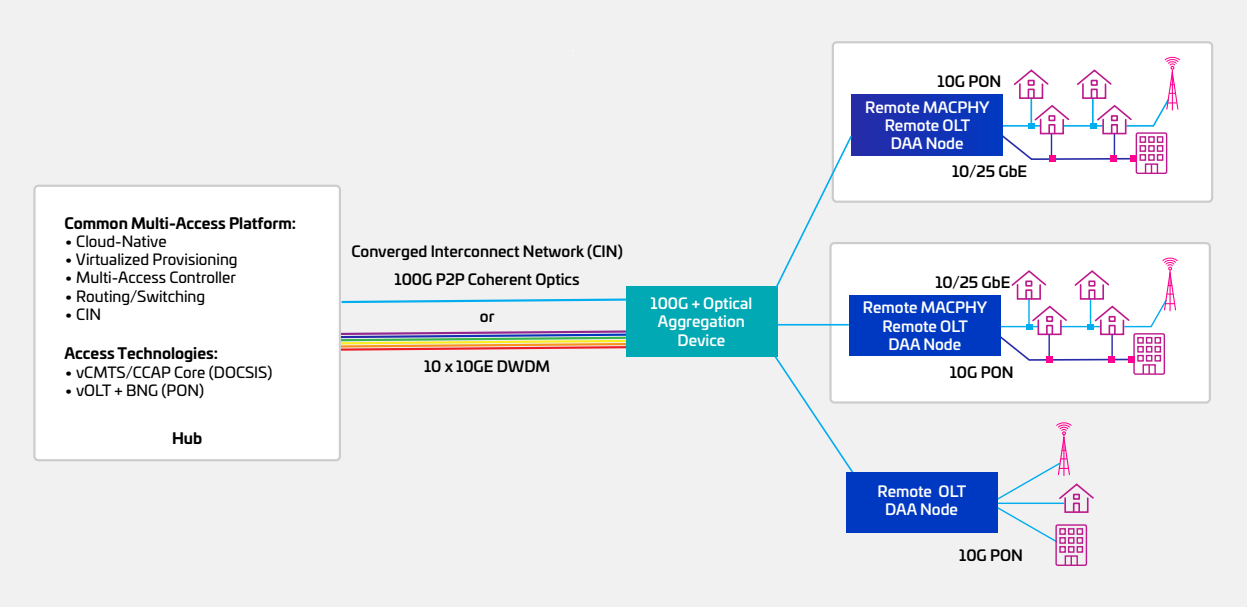


Figure 3 Leverage DAA to deploy FTTH gradually and selectively (source: CableLabs)

DAA PON is not a new concept. It was introduced by CommScope (formerly Arris) in 2016[1] , has been broadly adopted by CableLabs, and has been evolved and optimized over the past years to deliver capacity cost effectively by leveraging cable operators' deployed assets. CommScope has a long history of innovating with PON, which it brings to bear in its DAA PON solution.

Figure 4 PON Innovation (source: CommScope)

Major benefits of DAA PON:

- Provides up to 10 GB symmetric bandwidth, with the ability to go to 25 GB and beyond.
- Is purpose built for cable MSOs. It can be housed in a cable node or cabinet, which can be linked together using DWDM.
- Supports service convergence to an IP only network (the Converged Interconnect network), which is easier and more cost effective to operate, and enables operators to leverage more widely available network equipment and talent and that is more suitable for enabling digital services.
- The control plane is disaggregated from the hardware: the SDN, cloud native, management plane is separated from physical network elements.
- Active network elements are moved to the outside plant close to subscribers
- Has a common network management /performance management software across DAA technologies
- Has a centralized YANG management engine with extensible NB & SB interfaces
- Compatible with open standards (IEEE EPON and ITU XGS-PON)
- Has lower maintenance cost than RF, and overall requires less labor to install and operate.
- Is suitable to deliver residential and business services.

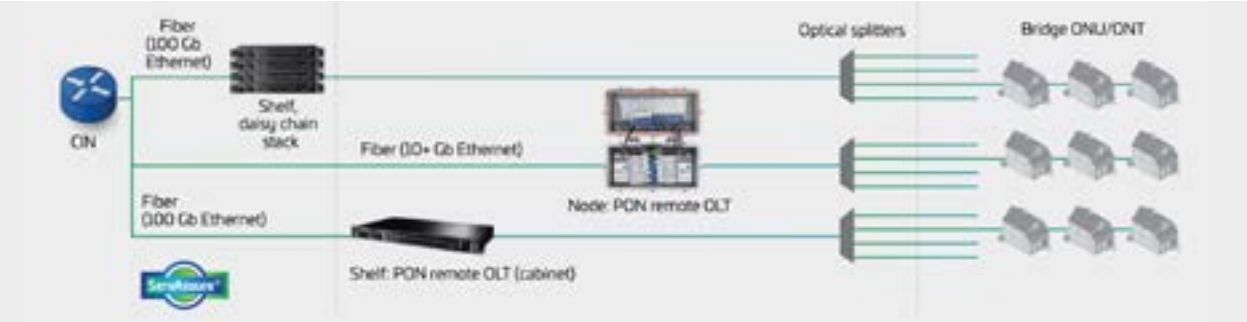


Figure 5 DAA PON enables multiple deployment scenarios

[1] https://www.nctatechnicalpapers.com/Paper/2016/2016-a-comparison-of-centralized-vs-distributed-access

DAA PON leverages HFC for capacity expansion

Maximize the use of existing infrastructure

PONs often require that active OLTs be located near power and cooling[2]. These capabilities are not always readily available and can be very expensive to build to support the density and distance requirements of PON architectures.

Similarly, PON deployments depend on the availability of fiber. Fiber runs, particularly between central facilities and remote locations are extremely costly, and often must run over long distances, incurring very high costs, long before demand has materialized. Furthermore, such fiber runs require rights of way, which have long lead times and expensive. On the other hand, fiber from the OLT to the customer premises is much shorter, and often can be deployed when there is a high likelihood of end user demand. PON architecture requires an Optical Line Terminals (OLTs) to be deployed in the network, typically close to end users. However, building new facilities to host active electronics is expensive[3]. Therefore, it is essential to use as many existing points of presence as possible to host the OLTs.

Fortunately, operators who have deployed an HFC network often have a fiber network up to the node. This fiber network can be leveraged for PON networks, resulting in lower costs and faster time to market.

Hybrid node solution for footprint expansions

The use of the HFC infrastructure for PON deployment is made possible by CommScope's innovative Node-OLT solution. Essentially, a R-OLT module is inserted into an existing node, enabling the operator to leverage the fiber run between the headend and the node. Furthermore, locating the OLT in the node provides the necessary power to the OLT.

The CommScope 10G Node-based R-OLT platform is a purpose built, hardened remote OLT, designed for Cable operators, allowing 10G EPON to be deployed seamlessly in their networks. It provides a migration strategy to 10G for MSOs brownfield deployments and simplifies PON greenfield network deployments. The CommScope R-OLT aligns with cable operators' evolution to Distributed Access Architectures enabling them to leverage their existing network assets to provide greater bandwidth and service offerings to their customers. It supports the disaggregation strategies of operator networks.

Adding a PON extension has no impact on the forward optical budget or performance and has minimal impact on the return optical budget.

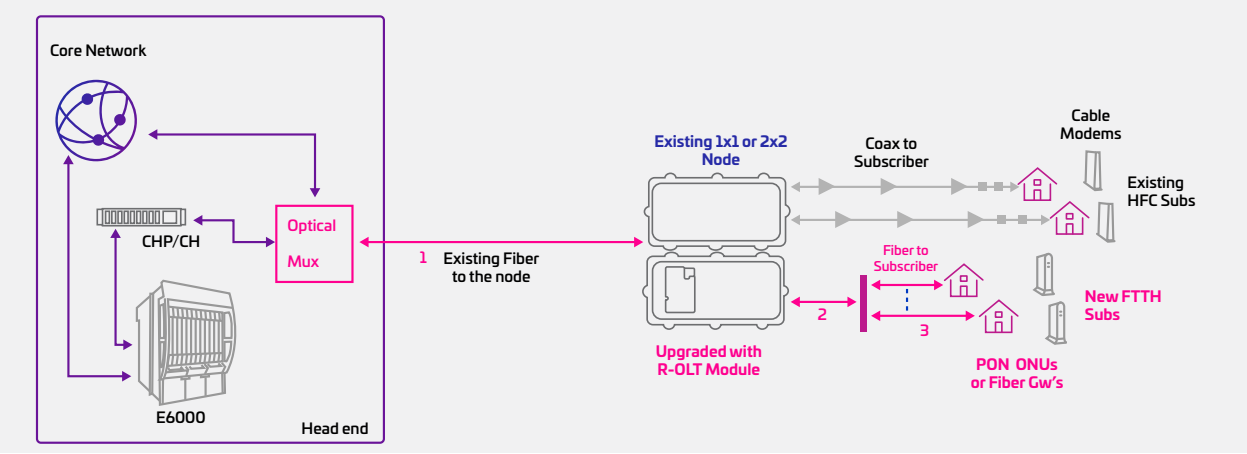


Figure 6 Node with R-OLT (source: CommScope)

A benefit of this architecture is that it enables the operator to start with PON – HFC co-existence and migrate to a PON only infrastructure over time, using the same enclosures.

[2] https://www.commscope.com/globalassets/digizuite/937376-pon-solution-ebook-ch-eb-116253-en.pdf

[3] https://www.commscope.com/blog/2021/future-ready-next-gen-pon-architectures-it-all-starts-with-sound-hardware-decisions/

Remote-OLT for PON-only greenfield deployments

The Remote-OLT solution is also suitable for greenfield deployments.

While ample government funding is available for deployment in low density areas, cable operators still need to demonstrate the financial viability of these deployments, particularly as government funding is typically contingent on meeting financial milestones. PON has traditionally been optimized for deployments in high density areas; therefore, operators must optimize multiple parameters as they plan for greenfield deployments; these include physical facilities, hardware utilization, power requirements, outside plant topologies, and management and operations resources[4].

Physical facilities: In rural areas, it is cost prohibitive to serve each subscriber using centralized physical assets. Therefore, operators must move the OLT to the edge of the network by using a remote OLT (R-OLT) solution, which dramatically reduces the time and cost of reaching rural subscribers. CommScope's DAA PON solution is ideally suited for this use case.

Hardware utilization: In new, low-density area, it is essential to not deploy capex before demand materializes. Therefore, operators can select a PON solution with an OLT that can be initially deployed with a low port counts and high split ratios (1:128), and that can be scaled up by adding ports and moving to a lower split ratio (1:64) when more capacity is needed. A cabinet-based remote OLT provides this flexibility to deploy capex in line with growing demand. A DAA PON is the right solution to optimize capex.

Management and Operating costs: Deploying a Remote-OLT solution, which uses the same cloud-based, multi-domain management and control solution cable operators use to manage their HFC infrastructure will significantly lower operating costs and lead to improvements in service quality and customer satisfaction.

Topologies: Selecting the right topology and technology in the outside plant has inherent implications for cost efficiencies. Using Remote-OLTs reduces the fiber count, resulting in fiber efficiencies, which has profound implications on costs (permitting, digging, etc.); it also places the last active device much closer to the subscriber, leading to improved optical budgets and makes connecting subscribers more cost effective.

Common, cloud-based, multi-domain, management, and control

DAA PON is a new domain for the common management solution

On-boarding and administering OLTs can be a tedious and time-consuming process, particularly when the OLT's control plane software resides on the device itself; in that case, the technician must be on-site and to bring each new device online, including initial software updates, system checks and other start-up tasks. This adds significant time to PON rollouts and increases demand for specialized technical staff.

For faster and easier PON onboarding, a software-defined network (SDN) architecture built on modern microservices provides a key advantage. In an SDN environment, the domain controller remotely recognizes a new OLT device as soon as it is powered up in the field. It then uses automation to bring the OLT online quickly, and without the need for a highly

[4] https://www.commscope.com/globalassets/digizuite/937376-pon-solution-ebook-ch-eb-116253-en.pdf

skilled network engineer. This hands-free onboarding makes OLT deployment a routine task and reduces the operational impact of PON rollouts[5].

Beyond onboarding, adding capacity to an OLT can also be done remotely, when control plane resources such as compute and memory are in the cloud, where they are easy and cost-effective to scale; operations personnel can scale the system simply by provisioning compute resources, configuring a virtual machine and installing the software, all remotely and easily. The same cloud-based solution is optimal for ongoing management and monitoring of the OLT network.

A multi-domain environment

Today's network needs a software-based management environment. DAA PON must be managed by the solution that also manages HFC, and other domains.

CommScope's ServAssure® Domain Manager is a powerful cloud-ready platform that manages network elements in DAA and PON deployments[6]; it provides onboarding, policy, license and firmware management, and telemetry. For an operator who is deploying DAA, the ServAssure domain manager provides a ready capability to manage the new PON using the same management environment, further simplifying the deployment and operation of the new network and reducing operating costs since the operator does not need to develop extensive new methods and procedures, incur extensive training, hire new, hard to find skillset and other.

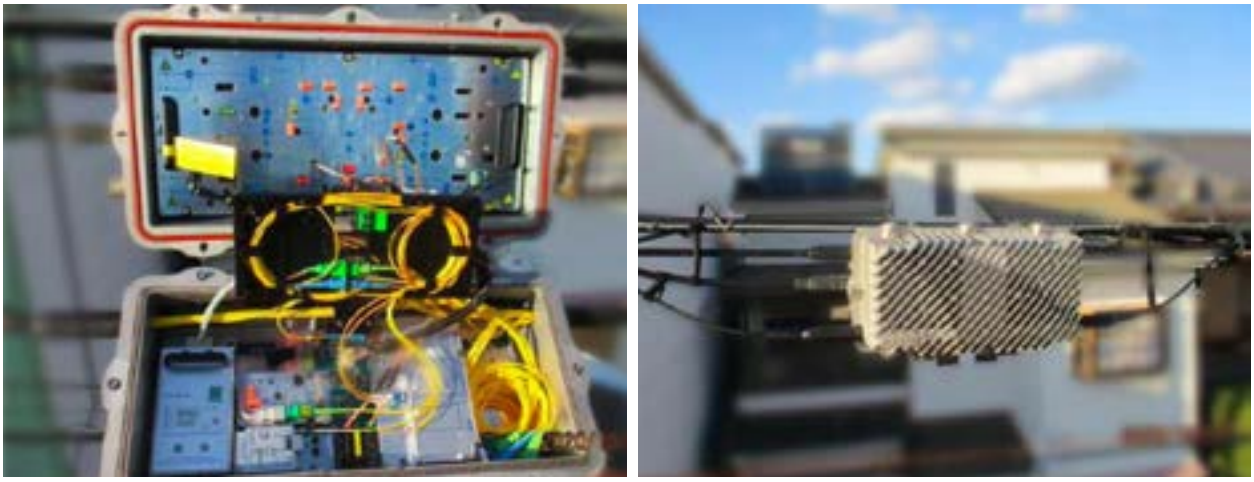
Furthermore, ServAssure has open APIs, allowing for integration with third party performance management solutions and element management systems.

DAA PON used by JCOM for brownfield, selective overbuild deployments

JCOM Co., Ltd (J:COM), Japan's leading cable broadband and multichannel video provider was facing stiff competition, particularly in its highly competitive Kansai region. J:COM's competitors were offering 5Gb/s and even 10 Gb/s high speed service. J:COM wanted to deliver 10 Gbps broadband to residential and business customers in that region.

J:COM wanted to deploy 10G EPON with Remote OLTs, and to leverage its existing HFC network and fiber nodes in order to deliver 10 Gbps symmetrical speeds. The company selected CommScope's 10G-EPON Remote OLT fiber node module for a large-scale deployment starting in the Kansai region, then expanding across Japan.

After initial trials, the deployment proceeded quickly. Today, there are over few thousand R-OLTs (nodes) deployed, serving PON and HFC subscribers simultaneously.



Hybrid HFC/PON node at J:COM (Source: CommScope)

[5] https://www.commscope.com/globalassets/digizuite/937376-pon-solution-ebook-ch-eb-116253-en.pdf

[6] https://www.commscope.com/product-type/broadband-access-network-systems/cmts-ccap/virtualized-systems/sa-domain-manager/

Conclusion

As broadband becomes the runtime of the world, garnering significant investments from governments and ever increased consumption, cable operators can seize the moment and capitalize on this market opportunity. But they cannot do that with yesterday's technology. They need solutions that are adapted to their environment, that enable them to deliver what the market needs today and in the future cost effectively. PON is the right technology for this undertaking, but it must be a "made for cable" PON that aligns with the distributed access architectures that operators are deploying, and with the cloud native network management solutions they are deploying. Operators have many deployment scenarios to plan for and have many parameters to consider as they decide on the right strategy for every deployment scenario. They need to work with a partner who has the breadth of solutions they need, a strong track record and deep and broad resources for support.

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