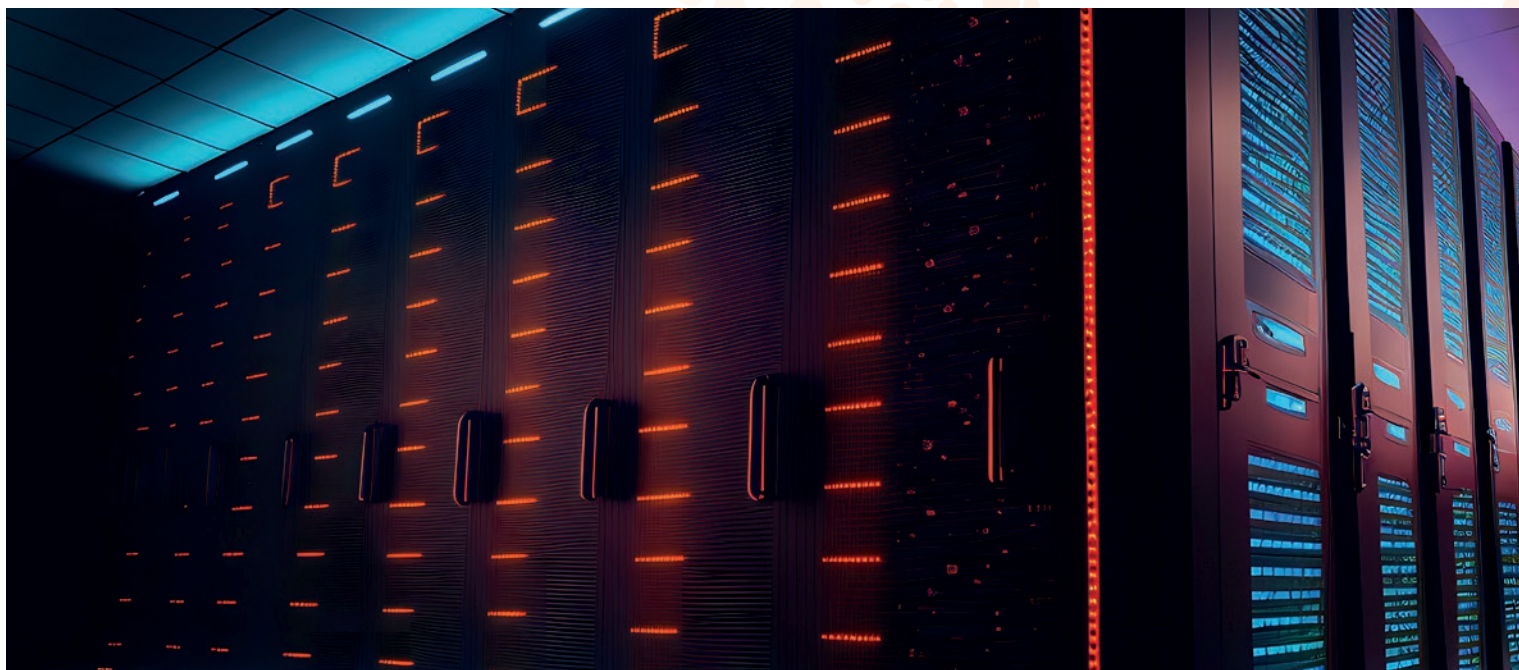




How Harmonic's COS PLATFORM REINVENTS NEXT-GEN BROADBAND ACCESS FOR UNIFIED DOCSIS AND PON

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CONSOLIDATING LAST MILE TECHNOLOGIES BY DISAGGREGATING THE ACCESS NETWORK

MSO's are experiencing increased demand for expansion into new markets and are starting to require higher capacity in their access networks. The shift has accelerated a transition to Distributed Access Architecture (DAA) that enables MSO's to innovate with higher capacity access networks.

The DAA requires disaggregation of physical and logical network functions. Disaggregation of the access node allows the simplification and miniaturisation of the physical network devices.

It also enables centralisation of software-based functions. This architecture drives the need for additional compute resources in the core and requires a new method to orchestrate these functions and resources.

Harmonic's cOS™ Pebble R-PHY and Fin OLT Plug (OEM from Ciena) supporting

IEEE 10G-EPON and ITU-T XGS-PON, are co-located in the same HFC node enclosure, while DOCSIS MAC and OLT Controller functions run at the head-end under Harmonic's cOS cloud-native core platform powered by Intel® Xeon® CPUs.

This paper covers this unique combination which enables MSO's to leverage the next generation of access network technology, while extending the longevity of their existing network infrastructure without wholesale changes.

INTRODUCTION

Many MSOs are enhancing their services portfolio by deploying Passive Optical Networks (PON), focused mainly on greenfield residential applications and business services. In the near-term PON can also be used to extend the value of existing DOCSIS network infrastructure



through innovative solutions involving DOCSIS and PON access technologies co-located on the same edge access node. This combination is part of a DAA that hosts most network functions running in software at the MSO headend. Utilising this architecture provides a unified platform capable of providing both DOCSIS and PON with multiple benefits including a reduced time to market as operations and support teams do not have to be trained on multiple systems.

With the exception of the PHY layer, the building blocks of DOCSIS and PON are very similar. This results in a unified software solution for DOCSIS and PON network access technologies.

DISAGGREGATION AND THE DISTRIBUTED ACCESS ARCHITECTURE

OVERVIEW

The standardisation of a DAA has triggered a major transformation in DOCSIS networks in recent years. The main variants of DAA and Remote-PHY, are shown in figure 1.

For the R-PHY variant, DOCSIS MAC and PHY components are deployed separately on the access network head-end and node respectively.

This architecture enables the transition to software-based network functions on generic compute platforms which eases the introduction of PON to augment DOCSIS Networks. The link between head-end and node is now digital. The digital link allows adding software at the head-end, which can forward traffic by standard ethernet to be delivered from the access node over PON as well as DOCSIS. This was not possible in the past because the reach would have been too long for a PON network.

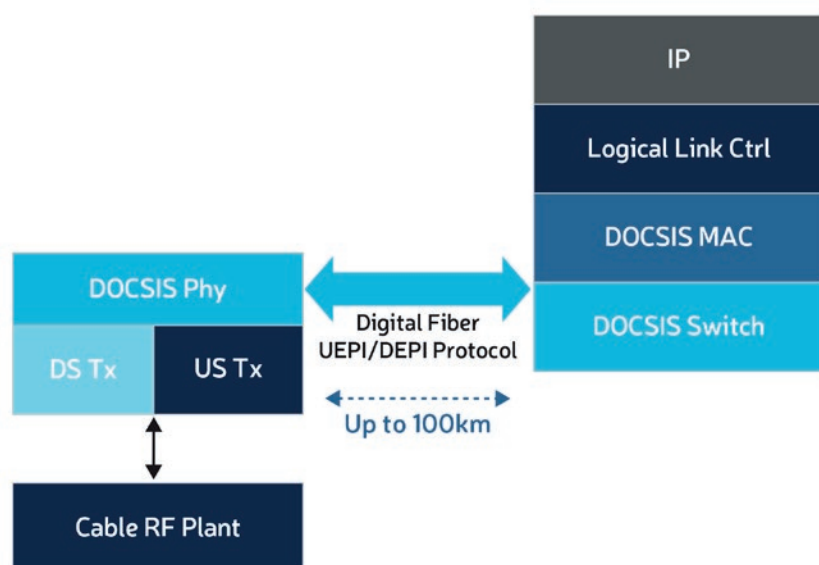
UNDERSTANDING DISAGGREGATED HARDWARE

Networking functions that were traditionally performed by an integrated CMTS, a chassis based DPoE system, or a BNG+OLT PON system are now distributed across multiple components in the network which perform more specialised functions.

Three main areas for disaggregation have been identified:

- **ROUTING ENGINE:** Performs all advanced routing functions, including IGP and EGP routing, VXLAN management, tunneling and L3 forwarding. This functionality is usually handed off to a dense, high performance L3 switch, or it can be also virtualised.
- **CLOUD-NATIVE ACCESS PLATFORM:** Responsible for all subscriber QoS, filtering and classification, FCAPS functions, and MAC (in case of R-PHY). This functionality has become a prime candidate for virtualisation, it can run in off the shelf x86 high performance server clusters. Moreover, additional disaggregation could be possible by disaggregating management from the data plane. Much of the subscriber management functionality shares the same architecture for both DOCSIS and PON.
- **PHYSICAL LAYER:** Low powered devices that convert traffic into RF or light for last mile access.

REMOTE PHY ARCHITECTURE



DAA facilitates PON in DOCSIS Networks

Figure 1: Distributed Access Architecture Variants

DEPLOYING DISAGGREGATED SOFTWARE

The advent of software containerisation has enabled the development of more flexible and resilient solutions. Rather than having a single, monolithic software platform, a disaggregated software

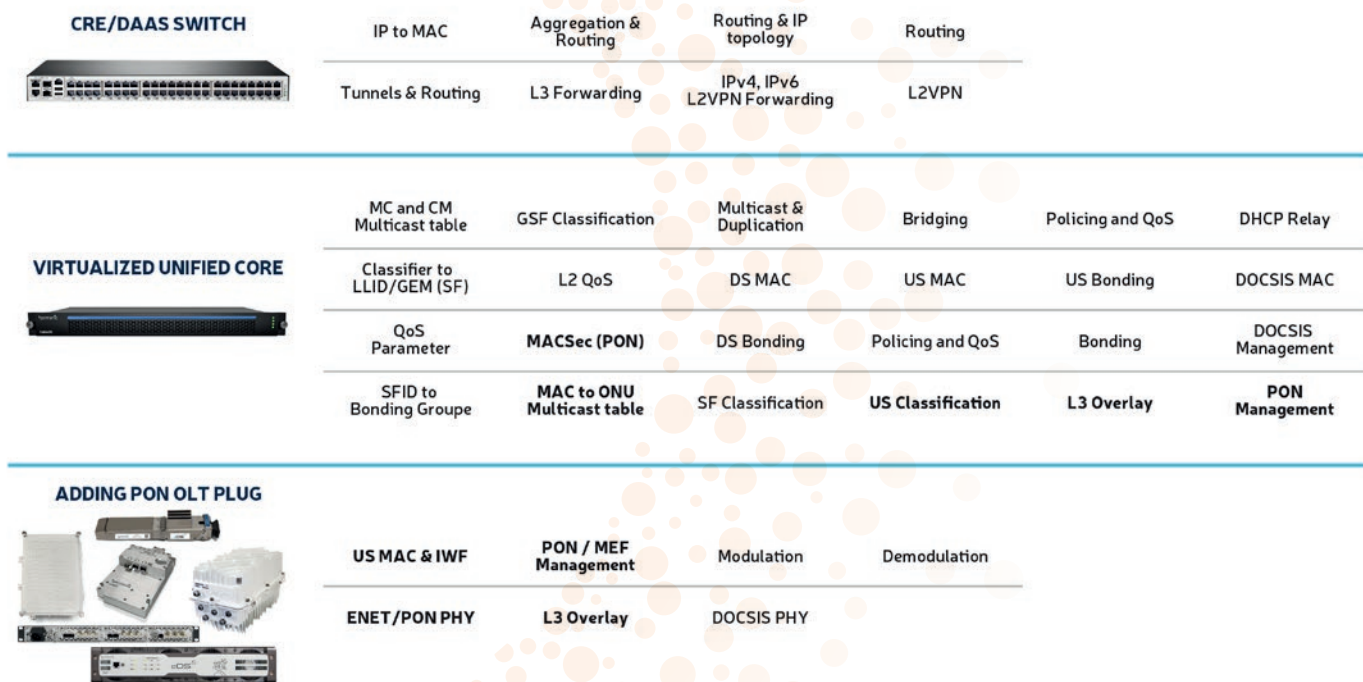


Figure 2. Disaggregated Hardware Functions

solution separates specialised software functions into their own containers that work together seamlessly but can also be managed independently.

Access platforms that host multitenant applications are excellent candidates for disaggregation, as components that are common to a virtualised CMTS and a virtualised PON solution could be reused across elements that manage both access networks. These elements can operate concurrently under the same compute module, offering a unified access platform.

DAA AND ENABLING TECHNOLOGIES

WHY PON?

Due to competitive pressure, or in order to offer a broader service portfolio, or just to future proof their access networks, many cable operators have already deployed a version of a PON solution for residential and/or business applications.

PON can offer faster bandwidth and higher reliability, but today, use of PON is ideal for greenfield solutions.

Having the ability to co-locate a PON OLT plug within the same Remote-PHY or Remote MAC Device opens up new revenue possibilities to the MSOs, as they can now offer PON service into targeted

brownfield areas that might require higher bandwidth capacity, or simply to offload business or high usage customers from DOCSIS to PON.

Also, the distributed hardware and software architecture results in a unified platform capable of providing both DOCSIS and PON, resulting in less time to market as operations and support teams do not have to be trained on two separate systems.

THE ROLE OF NFV AND CLOUD-NATIVE

Network Function Virtualisation (NFV) and cloud-native concepts have driven a transformation of both wireless and wireline access network infrastructure to more software-centric architectures with cloud-like capabilities.

Shown in Figure 4 is a high-level view of wireline and wireless network infrastructure, showing virtualised network functions such as virtualised CMTS (Cable Modem Termination System), virtualised BNG (Broadband Network Gateway) and 5G virtualised UPF (User Plane Function) which are now deployed in software on generic compute platforms powered by Intel Xeon CPUs.

Virtualising network functions in order to decouple and abstract them from hardware is a well-established approach and is quickly moving to the next phase of cloud-native deployments. This is driving adoption of cloud principles such

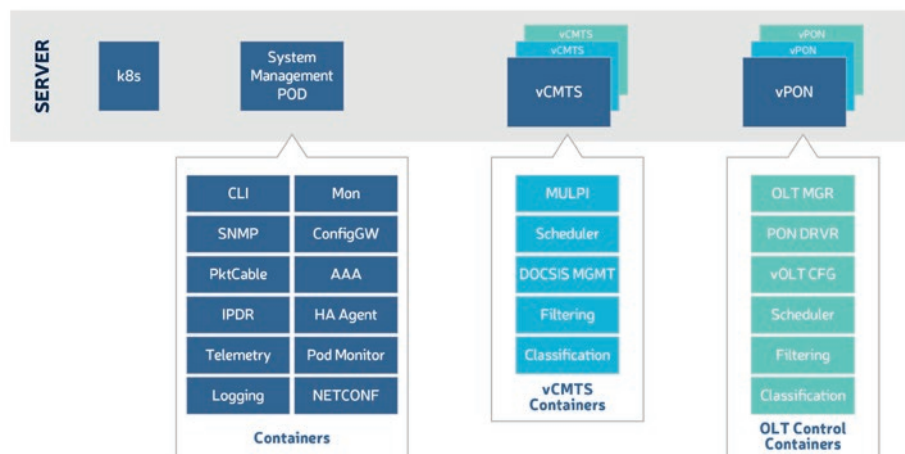


Figure 3. Disaggregated Software Functions

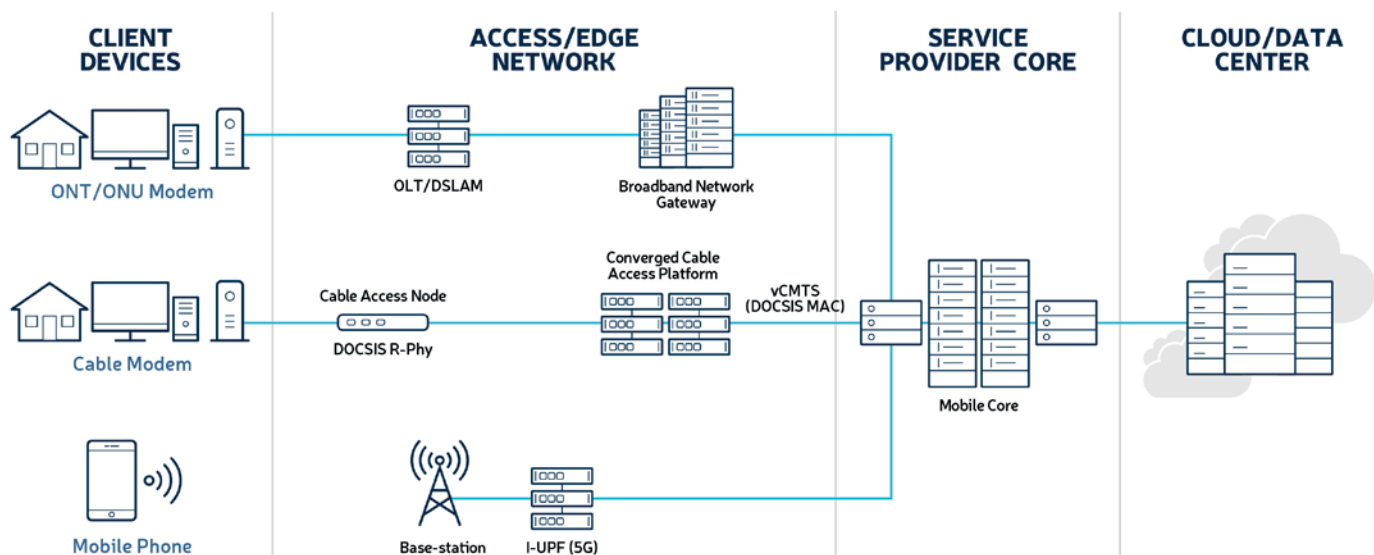


Figure 4. Software Network Functions in Wireline and Wireless Networks

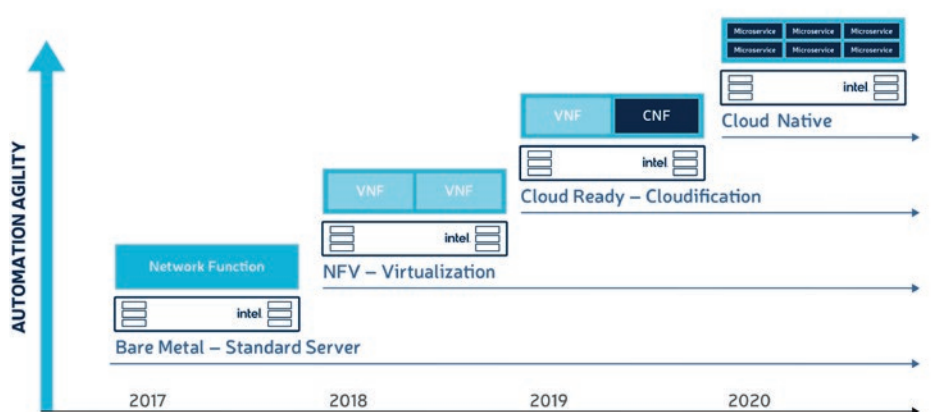


Figure 5. The Network Platform Transformation Journey

as containerisation with Kubernetes orchestration in a micro-services architecture.

This network transformation journey, shown in Figure 4 below, has enabled adoption of a spectrum of deployment models and evolving technologies. MSO's can now benefit from improved efficiency with reduction of space and lower power consumption, as well as easier maintenance and upgrades with granular scalability.

The flexibility of a cloud-native NFV deployment also helps consolidate software solutions with co-located network functions.

A UNIFIED APPROACH TO DOCSIS AND PON

Since DAA facilitates the meshing together of DOCSIS and PON to provide

a better overall service to meet subscriber data bandwidth needs, cable operators can gain a competitive advantage.

Figure 6 below shows a specific example where dominant traffic streams are from a small number of subscribers. This small group of users is responsible for the majority of the traffic in a service group. This small group of users is responsible for consuming the majority of the data bandwidth available to the service group, thus limiting the amount of bandwidth available to other users. This is typically addressed by splitting a fibre node, which carries additional expense to the operator.

In some cases this approach may also fail to address the problem as the heavy users are still present in the newly split node.

The DOCSIS to PON offload methodology illustrated in Figure 6 provides a very good way of resolving the dilemma of managing

such heavy data bandwidth users for cable service providers.

Once the heavy users on a DOCSIS R-PHY device are identified, a Harmonic Fin OLT Plug SFP+ can be installed in one of the Harmonic node's Ethernet ports. This simple approach allows the MSO to convert their existing R-PHY nodes into a PON OLT without the need of additional equipment installation, greatly reducing the barrier of entry to PON in a brownfield deployment. As the highest consumers of data bandwidth are slowly transferred to a PON fibre network, that newly installed fibre now passes additional homes and businesses, further expanding the potential customer base for PON services.

The DOCSIS to PON offload may be controlled in software at the head-end with minimal change to the existing platform which is already providing the vCMTS function in software. Cable providers can now solve the data bandwidth problem by guaranteeing higher bandwidth for their top users while actually improving access for the other subscribers in their area.

This approach also has the significant advantage of extending the longevity of the existing DOCSIS network infrastructure without wholesale changes.

The PON offload is essentially made possible by adding OLT forwarding and control software on the Intel-powered MSO head end servers and inserting the Fin OLT Plug in one of the Harmonic cOS Pebble R-PHY Ethernet ports which is in turn connected by optical fibre to the home of targeted subscribers.

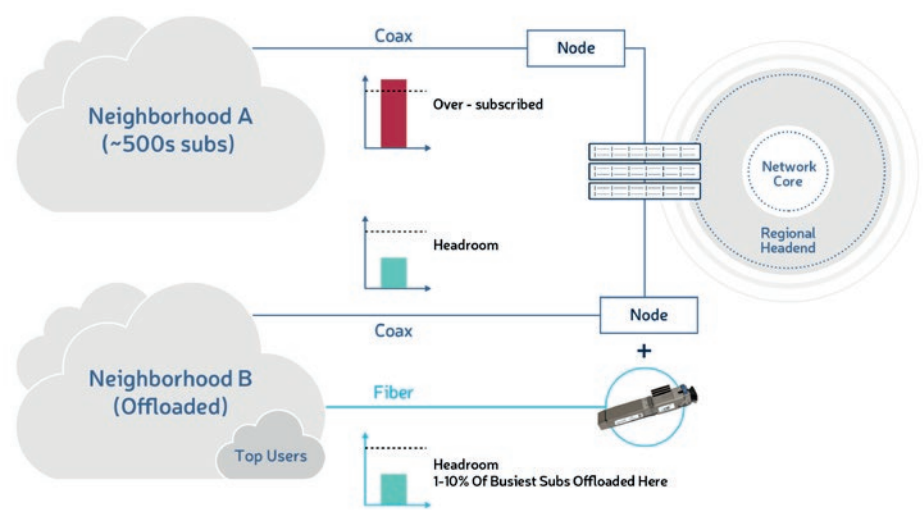


Figure 6. Unified DOCSIS - PON Overview

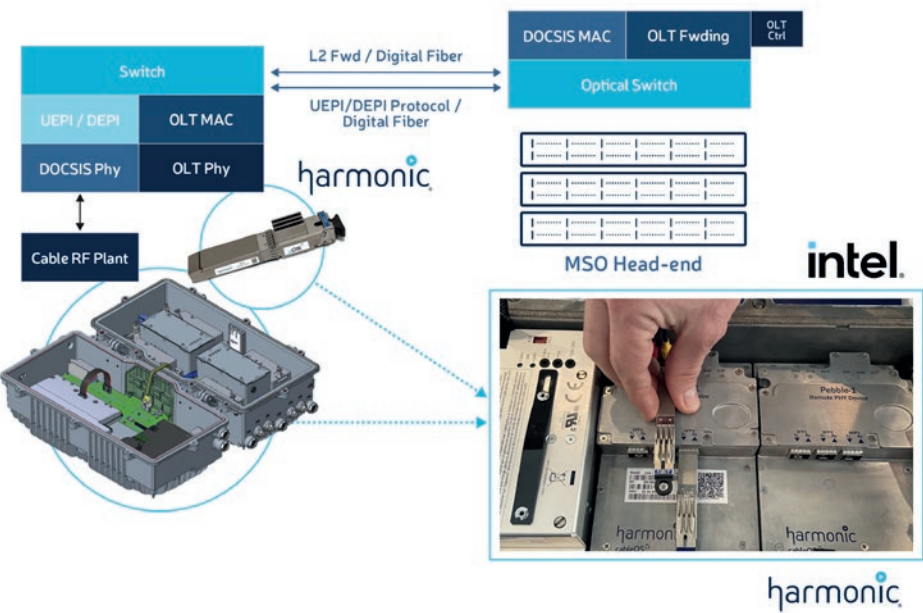


Figure 7. DOCSIS to PON offload using Harmonic cOS R-PHY and Fin OLT Plug

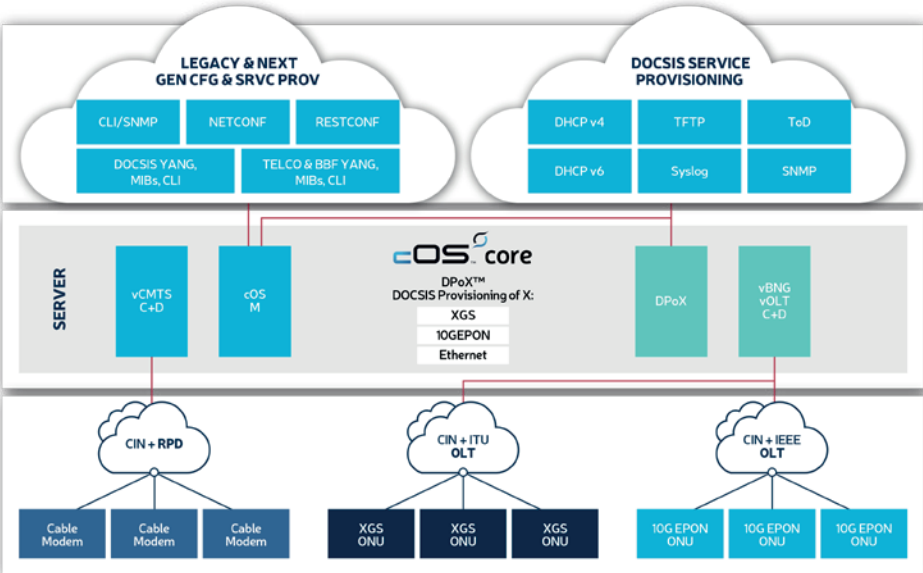


Figure 8. Uniform Provisioning for DOCSIS and PON (DPoX)

The Harmonic Pebble R-PHY device is already equipped with a switch for daisy chaining to other nodes so these ethernet ports can be used for this solution. Note that the link between MSO head-end and node may be upgraded to two wavelengths if bandwidth requirements are within the existing Lambda bandwidth capabilities.

Figure 8 shows how this solution looks with real hardware from Harmonic (cOS Pebble R-PHY with Fin OLT Plug). These are controlled by Intel-powered servers at the MSO head-end.

From this practical example we can see how DOCSIS and PON access technologies can co-exist and complement each other, providing the additional traffic bandwidth benefits of PON as well as extending the longevity of existing cable network infrastructure.

Another very important part of a unified solution for PON and DOCSIS is the integration to the provisioning system and back-office. DOCSIS Provisioning of X (DPoX) enables operators to use their existing Cable Modem provisioning system to also provision ONUs (XGS or 10GEPON). That also enables a unified IP addressing management across the PON and DOCSIS network.

A UNIFIED DOCSIS AND PON SOLUTION THAT ENABLES BUSINESS AGILITY

The Distributed Access Architecture allows the MSO to seamlessly expand their access networks beyond DOCSIS. The Fin OLT plug allows Harmonic's Pebble R-PHY nodes to also become PON OLTs, all managed under a single cOS platform powered by Intel® Xeon® processors.

Brownfield areas that were previously out of reach to PON networks can now be easily served out of an existing node while reusing trunk fibre. Greenfield deployments also benefit from a faster time to market due to the use of a common platform for DOCSIS and PON, which minimises training and back office integration.

Going forward, disaggregation will also allow additional unification of access technologies, like Ethernet and Wireless managed under a common cloud solution.