VECIMA

Advantages of a Multi-Vendor Next Generation Access Ecosystem

in collaboration with BROADBAND SUCCESS PARTNERS

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From Connectors to Digital Interfaces – How Cable Evolved

Cable operators are not normally known for building networks based on standards, however if one looks into what has been built, it becomes clear that operators have been building standards-based networks for some time – it is just that the standards evolved organically. For example, cable operators have used the "F" connector since the 1960s, but it was not until 2015 that SCTE/ISBE actually formalized the standard specifications for an "F" connector with ANSI. SCTE/ISBE has indeed formalized many of the interfaces cable operators take for granted into real international standards.

Organizations that emerged from the telephony space, in contrast, create entire worlds of standards well before implementation in the field. Some standards, such as TR-069, established many years ago for management of remote devices, are in popular use today by both cable and telco operators.

If we look beyond service provider networks, the Ethernet standard has been adopted worldwide and is the basis for virtually all data networks deployed today. Ethernet, like the "F" connector, was also introduced commercially before it was standardized, however the gap between these milestones was three years versus five decades.

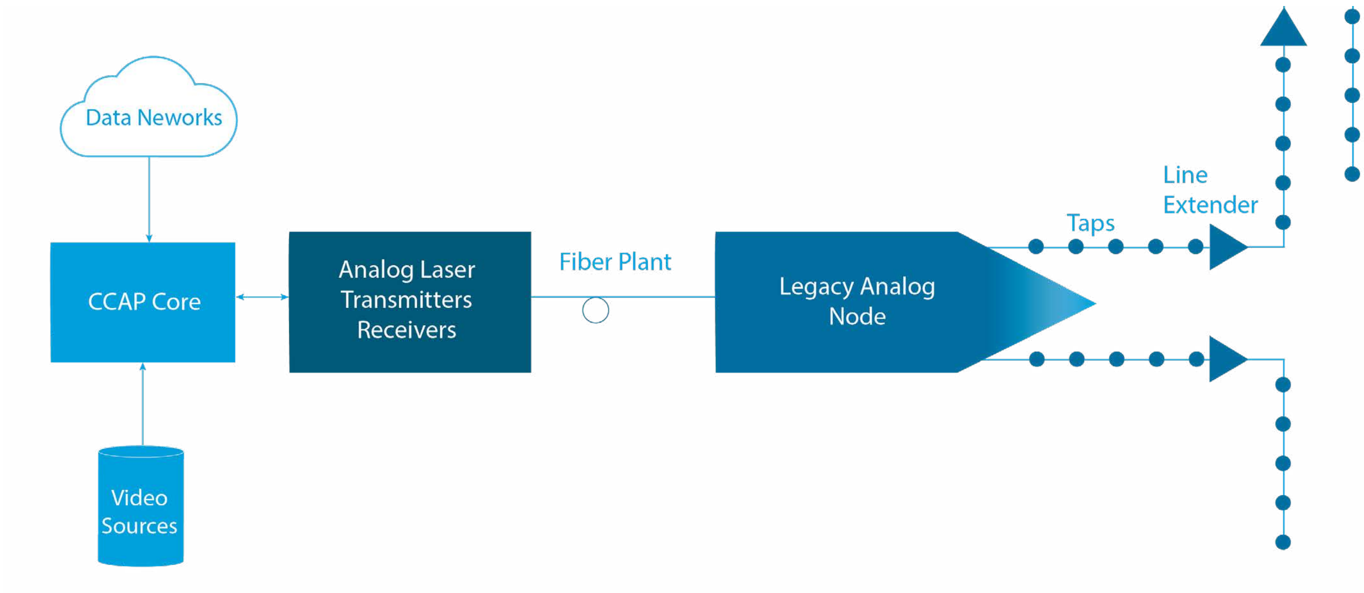
When networks are built on standard interfaces, not only does the network operator know that they can mix and match vendor equipment, they can test their networks using standardized test equipment, and ensure that their network meets standard specifications. While most analog RF interfaces used by cable can be reliably connected to one another without regard for vendor, the same is not true for many of the digital interfaces used to connect RF devices.

New standards, such as the R-DEPI (Remote Downstream External PHY Interface) and R-UEPI (Remote Upstream External PHY Interface) specifications from CableLabs™, are required in order to permit interoperability of sophisticated digital RF equipment.

Legacy Analog HFC

In a modern analog HFC network, the Cable Modem Termination System (CMTS) or Converged Cable Access Platform (CCAP) core (along with Quadrature Amplitude Modulation (QAM) modulators for video signals) generates RF that feeds analog laser transmitters. Fiber cables transport the optical signals out to nodes located in the outside plant, and at the nodes the RF modulated on the optical signals is extracted and amplified. The analog RF feeds the downstream coaxial plant. This arrangement is generally vendor-neutral. Any transmitter can feed any node.

An operator is free to find the best CMTS or CCAP solution for their situation, and can find the best node to be used with it. Should a problem happen in the supply chain, they can substitute another model or indeed another vendor. This is important because plant equipment typically has a much longer service life than headend equipment, and requires expensive field work should it need to be changed.

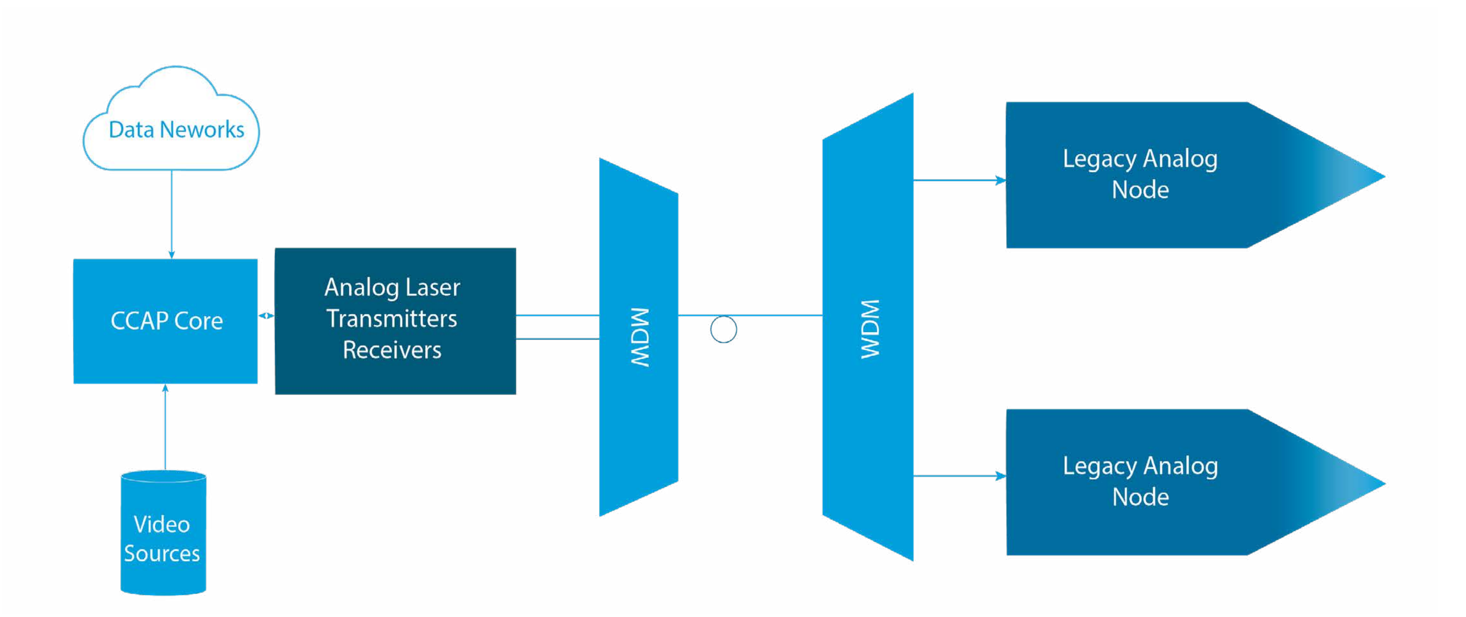


WDM **Additions**

As the need to feed more devices with limited available fiber developed, operators began to use Wavelength Division Multiplexing (WDM). At first, just two wavelengths, 1310 and 1550 nm were used with passive filters. This was fairly simple and interoperable.

Some node vendors have created 2x2 and 4x4 systems, where multiple nodes worth of electronics can be co-located in the same outside plant housing. This permits the operators to segment their network into smaller service groups, either upon initial installation or later on. This flexibility helps keep the network profitable, as upgrades to alleviate bandwidth constraints can be accomplished cost effectively. 2-wavelength WDM was commonly used when feeding 2x2 nodes, and Coarse Wavelength Division Multiplexing (CWDM), with the capability of up to 8 or 16 possible wavelengths, was frequently employed for 4x4 nodes.

As operators and vendors started experimenting with additional wavelengths, the International Telecommunications Union (ITU) created a standard plan for Dense Wavelength Division Multiplex (DWDM) wavelengths, which includes 72 unique channels. Due to various technical and commercial reasons, vendors of lasers, optical multiplexers/demultiplexers, and analog HFC have not all chosen the same wavelengths from that grid. As DWDM solutions were deployed, care had to be taken to make certain that the wavelength plans of both the transmitters and multiplexers matched, but analog interoperability was maintained.



As operators need to feed more nodes with a limited number of access fibers, they will require many wavelengths on the transport plant. Analog systems operating at multiple wavelengths are susceptible to interference from mixing and crosstalk, due to phenomena known as Four-Wave Mixing (FWM) and Stimulated Raman Scattering (SRS). These conditions can result in impaired transmission and has forced vendors to exclude certain wavelengths from the operator's optical channel plan. Analog optics are also based on fixed-mounted laser modules that are part of the vendor's transmitter. Fixed in frequency, inventories of specific wavelength modules could be a required part of the operator's spare kit.

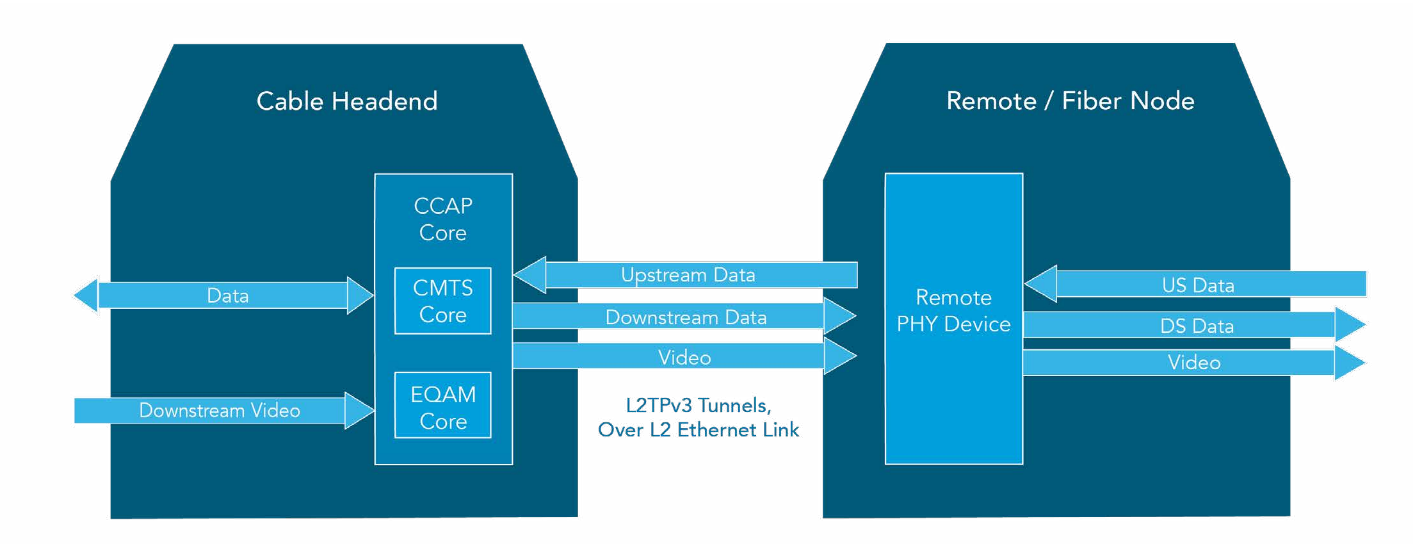
Using WDM in analog HFC did provide cost savings versus constructing additional transport fiber plant, but when considering a large expansion in the number of nodes as would be required with Node + 0, or any substantial cascade reduction, practical application of analog WDM is very difficult.

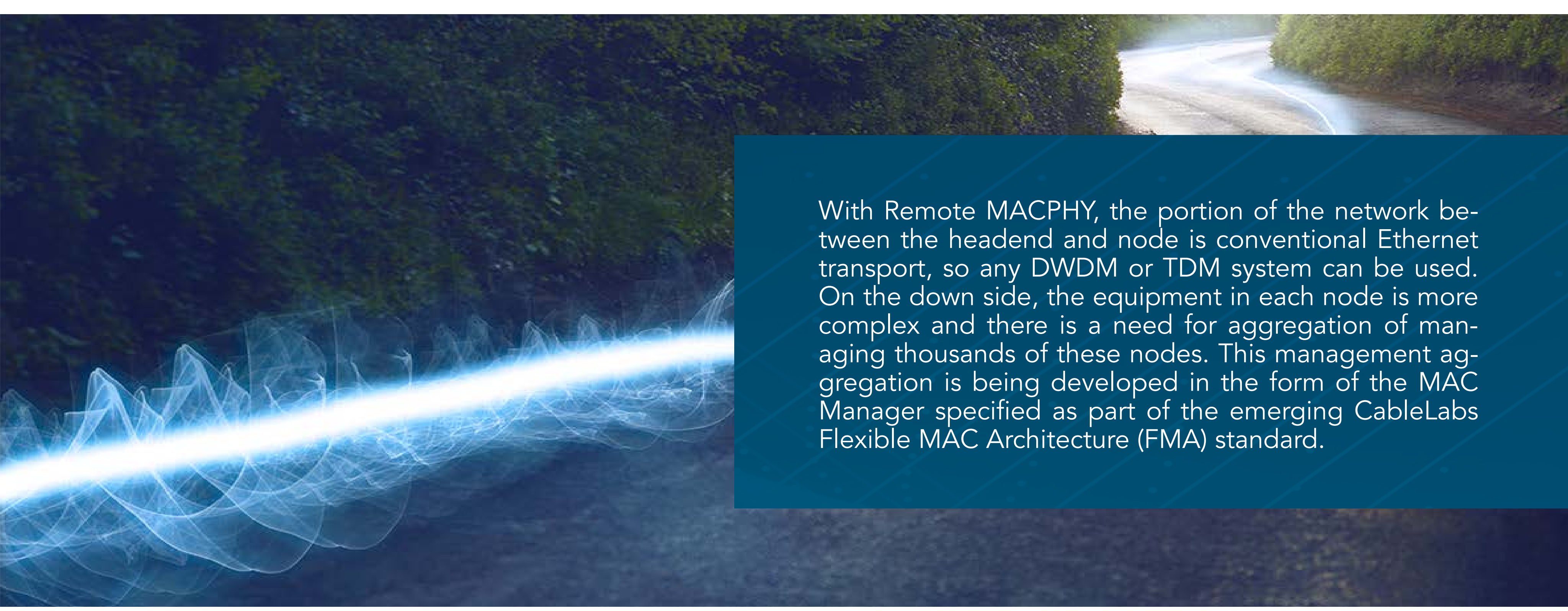
Distributed Access Architecture

With DAA, portions of the CMTS or CCAP system are moved out into the field. In **Remote PHY**, the RF portion of the network is moved from the CCAP to a Remote PHY Device (RPD) in the remote node, and with **Remote MACPHY**, the DOCSIS MAC Layer 2 digital portion, many control plane functions, and the RF portion are relocated to a Remote MAC Device (RMD) in the remote node. These methods have their own advantages and disadvantages.

Digital **WDM**

Both Remote PHY and Remote MACPHY use Ethernet transport instead of traditional analog modulated RF signals over the fiber between hub and node. Digital transmission is much less susceptible to interference caused by the phenomena described early and has no wavelength exclusion requirement. Digital optics are available in pluggable SFP+ form, and the pluggable modules may also be obtained in wavelength-tunable versions. This lowers both capital and operating expense.

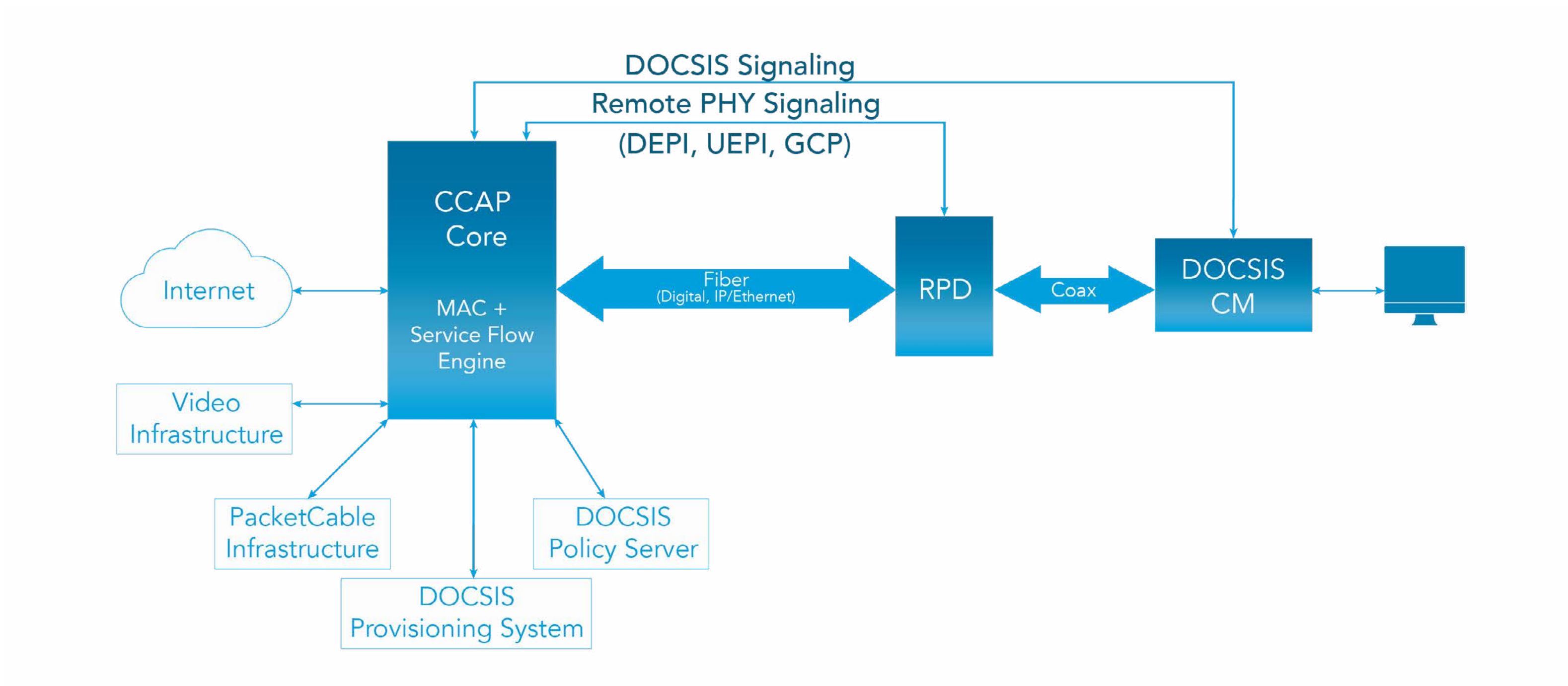




With Remote MACPHY, the portion of the network between the headend and node is conventional Ethernet transport, so any DWDM or TDM system can be used. On the down side, the equipment in each node is more complex and there is a need for aggregation of managing thousands of these nodes. This management aggregation is being developed in the form of the MAC Manager specified as part of the emerging CableLabs Flexible MAC Architecture (FMA) standard.

REMOTE-PHY **Interoperability**

With Remote PHY, major CMTS functions remain in the headend and only the RF portion is moved to the remote node. Early efforts at Remote PHY relied upon proprietary transport between the CCAP Core and RPD. While this appeared to support a faster development of the solution, it also eliminated the possibility of choosing different CCAP Core and RPD vendors as had always been done with analog nodes.



In 2015, CableLabs published its Remote PHY Family of Specifications. Specifications include system, configuration, and timing specifications as well as the R-DEPI and R-UEPI specifications. In addition, the GCP specification defines a protocol used for configuration and monitoring of RPDs. Since 2015 these specifications have continued to evolve.

With the Remote PHY specifications, vendors can create equipment that can interoperate. CCAP Core / RPD interoperability built on DAA standards allows 3rd-Party vendors to create new products, giving operators innovative capabilities and flexibility. Interoperability and independence also avoid lock-in of CCAP Core and RPD from a single vendor and allows operators to adapt to changes in the vendor ecosystem; both the CCAP Core and RPD can be swapped out at any time.

Robust interoperability continues to be proven in several "interop events" conducted by CableLabs, as well as several operators in real-world field deployments.

All major CCAP vendors, including Cisco, ARRIS, Casa, and Harmonic have embraced a standards-based implementation, to varying degrees, across their CCAP cores and RPDs. Because the RF component of the CCAP core is now moved to the field with R-PHY, some vendors are also developing virtual CCAP cores which use Commercial Off The Shelf (COTS) server hardware versus proprietary chassis based hardware. COTS server hardware provides for a lower cost hardware implementation, which is more flexible to scale up and down with demand. These deployments can also be used for multiple applications now or in the future. Additionally, standard server hardware can be maintained by traditional datacenter resources and operations teams versus proprietary, cable operator specific systems.

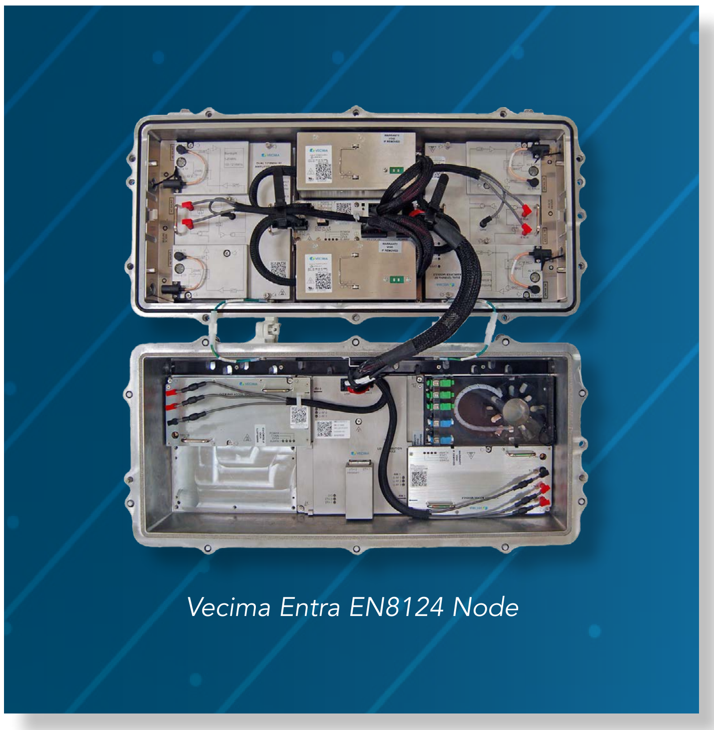
To the betterment of the industry, vendors will continue to implement the standards provided through a productive industry collaboration of operators and vendors with CableLabs.

The Vecima Entra Portfolio

ENTRA **Node**

Vecima has created its Entra node family to address the need for an interoperable and flexible RPD built from the ground up as an Ethernet-based distributed access node. Not only has interoperability with major CCAP Core vendors been demonstrated, but the node has features not found in many of the competitors' nodes, including:

- Low power consumption
- Segmentable with both 2x2 and 2x4 capability
- Lower cost
- Available in sub, mid, and high split configurations



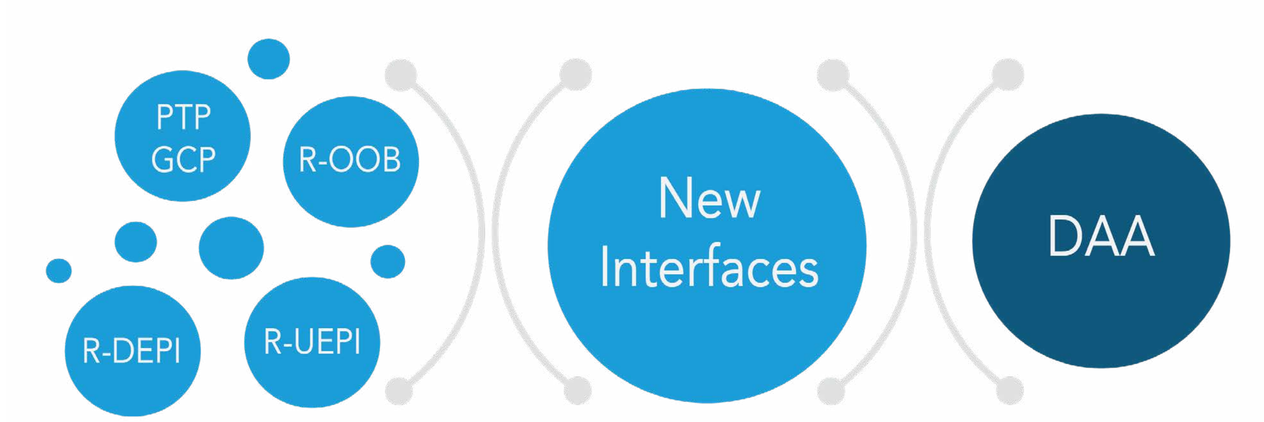
Vecima Entra EN8124 Node

With Entra's adherence to CableLabs standards and demonstrated interoperability, operators can enjoy the same flexibility they had with analog nodes while enjoying all of the advantages that DAA has to offer. They use standardized SFP+ pluggable optical modules, which enable the operator to reduce capital and operating expense.

ENTRA **Remote PHY Monitor**

The advent of DAA has introduced several new interfaces to the cable provider lexicon. Ensuring PTP, GCP, DEPI, and more are all functioning properly is critical moving forward. These are the interfaces driving the new multi-vendor ecosystem.

The Vecima Entra Remote PHY Monitor collects, stores, and presents RPD configuration and operational data in a simplified, clear, and consistent way providing operators with actionable insight into their RPD deployments. Consolidating RPD monitoring capabilities into a vendor-agnostic system drives smoother DAA rollouts, reduced operational expenses, and assurance the cable access network is operating at peak capacity.



Evolution to a Distributed Access Architecture is on the horizon for many cable operators. Why not leverage standards to make that transition easier, and be better prepared for any changes that may happen in the future?

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