The First Step in Cable Network Transformation: Digitization

Cable business transformation starts with the digitization of hybrid fiber-coaxial (HFC) cable plants.

Today, cable network operators maintain extensive networks that connect millions of subscribers to their services. Over time, service offerings from cable operators have evolved to accommodate customer needs. Cable access networks were initially deployed to deliver downstream linear video traffic. Then came innovations for supporting data and telephony. Now, most cable operators have become multiple system operators (MSOs), with millions of subscribers reliant on and driving the demand for broadband Internet access, voice services, business networking services, and more.

To deliver services such as linear video, video-on-demand (VoD), and IP traffic, cable operators have continuously built on top of their existing systems, which has led to a complex system of overlay networks. Managing and maintaining the services in these systems requires dedicated equipment, management, and operational expertise. Operations tend to be split across technologies and locations. Some applications run in data centers; others remain in headends and central offices. Nearly all of these services are delivered by inefficient legacy systems. As the industry has consolidated, cable operators also have found themselves managing multiple access networks that operate different technologies simultaneously, such as HFC, DSL, passive optical network (PON), and wireless. A typical cable access network is a hugely complex and unwieldy environment that needs to transform for it to keep up with increasing bandwidth and connectivity demands.

Benefits

- ·Operational Savings. Reduce the operating expenses for power, cooling, and space.
- ·Scalability. Dynamically control and target capacity for when and where it is needed.
- ·Interoperability. Cross-vendor interoperability Defined by CableLabs® Remote PHY specifications and built on OpenRPD open source software.
- ·Foundation for a distributed access architecture (DAA), enabling virtualization and overall network transformation.

Going from analog to digital

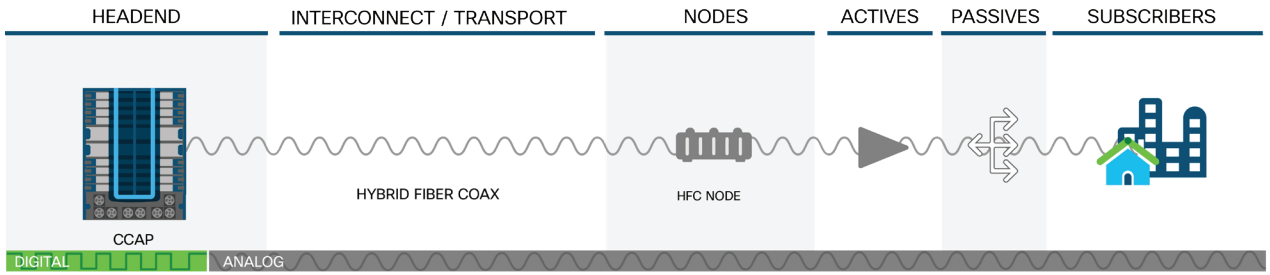
For most MSOs, the first stage of network transformation needs to be the digitization of their HFC cable plants. Fiber must be pushed deeper into the network by changing the existing HFC cable plant from analog to digital. Many solutions have been proposed for digitizing the HFC cable plant; however, the industry has been consolidating around Remote PHY technology. As a collaboratively defined, standards-based technology, Remote PHY is designed to upgrade or replace analog HFC fiber nodes by separating the PHY circuit from the headend and placing it in the node or shelf. Remote PHY serves as a foundation for a distributed access architecture (DAA). It extends your digital network deeper out to the fiber optic node, which moves the digital to RF interface from the headend the node or shelf.

With Remote PHY in place, you can begin leveraging the increased density and distance associated with digital optics. You also can begin to eliminate the analog fiber network that connects hubs to nodes and shelves. You can then replace that network with a more cost effective, easier to maintain, higher-quality Ethernet network. With Remote PHY, cable operators can more easily scale capacity and Gigabit service tiers to be on par with any pure-fiber competitor. And they can do it at a fraction of the cost of ripping and replacing their existing HFC plants.

Deploying Remote PHY

Many possible approaches exist for deploying Remote PHY in today's networks. Because no two networks are created the same, deployment strategies and architectural considerations vary. Fortunately, Remote PHY is a technology with agreed-upon standards and specifications. These standards ensure interoperability and compatibility, which helps ease the migration from analog to digital. Figure 1 shows a simplified cable access architecture deployment with a traditional converged cable access platform (CCAP) or cable modem termination system (CMTS) to analog optical transport and traditional HFC nodes.

Figure 1: Traditional architecture



Combining Remote PHY digitization upgrades with DOCSIS 3.1 readiness and enablement can alleviate cost issues.

Traditional HFC nodes used to be capable of providing services to thousands of homes, but they no longer can keep up with the increasing bandwidth and service demands. To meet demand, the solution has routinely been to add more equipment to supply and support the increased requirements. Multiplying the number of nodes in the network and doing node splits has always been a temporary solution. It provides increases in capacity at a cumulative cost of increased operating and capital expenses and complexity. The traditional HFC node that once supplied services to thousands of homes either has or is likely be split down to a number closer to 250 homes. With fewer subscribers per node, there is more available capacity per subscriber.

Upgrading the cable plant from DOCSIS 3.0 to DOCSIS 3.1 can help alleviate some of the HFC bottleneck with improved error correction and increases in useable upstream and downstream spectrums, orthogonal frequency-division multiplexing (OFDM), and orthogonal frequency division multiple access (OFDMA).

DOCSIS 3.1 is a tool available for MSOs to extend their network capacities. It can potentially reduce the number of required node splits and meet the offered traffic demand using existing infrastructure. However, DOCSIS 3.1 is only valuable if the network hardware is ready to support it. DOCSIS 3.1 does little to solve the management and maintenance overhead challenge, but Remote PHY and DOCSIS 3.1 shine together in this area. Combining Remote PHY digitization upgrades with DOCSIS 3.1 readiness and enablement can alleviate cost issues. It reverses the diseconomies of scale that rely on existing processes and analog technology—where MSOs attempt to keep up with subscriber demand by increasing the number of analog HFC network devices in the access that also require a corresponding increase in headend hardware needs. Remote PHY is key to economically unlocking major bandwidth increases in existing access networks while enabling fiber deep (N+0) architectures that push digital fiber out much closer to subscriber homes. Migrating from analog to digital with Remote PHY can also pave the way for next-generation DOCSIS known as Full Duplex DOCSIS (FDX), which supports symmetrical services and greater scalability.

Cisco provides a comprehensive portfolio for transitioning from analog to digital.

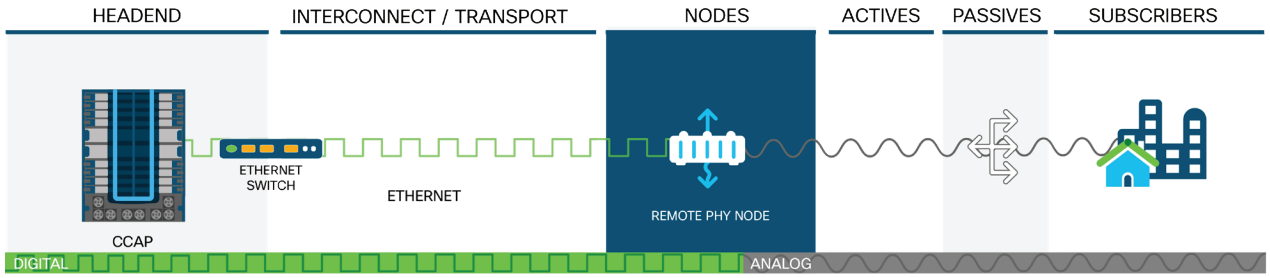
Limiting the disruption in the migration from analog to digital requires careful planning. A good approach is to take inventory and assess the RF active and passive devices. Then determine the areas with devices that require upgrades or replacements and whether the devices can support the additional capabilities and spectrum unlocked with DOCSIS 3.1 (beyond 1-GHz forward spectrum and 85-MHz return spectrum). Because DOCSIS 3.1 is backward-compatible with DOCSIS 3.0, the upgrades you make to your access network can be incremental.

Cisco provides a comprehensive portfolio for transitioning from analog to digital. The portfolio includes Remote PHY nodes, node upgrade modules, and Remote PHY shelves.

Digitizing with the Remote PHY Node

The use of Remote PHY nodes represents a significant evolution of the cable access architecture. It extends the digital fiber network (typically Ethernet) farther out in the field, going all the way to the node that is a few hundred feet from subscriber's home. And it replaces or upgrades current analog HFC nodes with a simplified Remote PHY device (RPD) that connects Ethernet on one side to HFC on the other. Although upgrading and or replacing entire nodes is a significant change, the benefits they deliver are even greater.

Figure 2: Digitizing with Remote PHY nodes



The Cisco cBR-8 CCAP is ready to support Remote PHY with a simple software upgrade and or begin your headend transformation with the Cisco Cloud Native Broadband Router (cnBR) and Remote PHY.

Beyond upgrading the physical node, the migration to Remote PHY also requires the headend to support it. Instead of requiring new headend hardware like some vendors, the Cisco cBR-8 CCAP is ready to support Remote PHY with a simple software upgrade. Alternatively, MSOs who are ready to scale beyond hardware and virtualize their headend functions can begin using the Cloud Native Broadband Router (cnBR) for their Remote PHY devices.

Table 1. Cisco GS7000 Series node compatibility for Remote PHY

Cisco GS7000 1 GHz High-Output 4-Way Segmentable Node	+	Optical interface board (OIB) Upgrade	+	Cisco Remote PHY 120 RPD	=	Remote PHY
Cisco GS7000 1 GHz 4-Way Segmentable Node	+	Optical interface board (OIB) Upgrade	+	Cisco Remote PHY 120 RPD		
Cisco GS7000 1.2 GHz Segmentable Node	+	Optical interface board (OIB) Upgrade	+	Cisco Remote PHY 120 RPD		
Cisco GS7000 1.2 GHz 4-Port Fiber Deep Node	+	Cisco Remote PHY 120 RPD				
Cisco GS7000 1.2 GHz Segmentable Node with Remote PHY	+	Cisco Remote PHY 120 RPD (included)				
Cisco GS7000 1.2 GHz Segmentable Node	+	Cisco Remote PHY 2x2 RPD				
Cisco GS7000 1218 MHz Fiber Deep Intelligent Node (iNode)	+	Cisco Remote PHY 120 RPD				
Cisco GS7000 Full Duplex DOCSIS Ready Intelligent Node (FDX)	+	Cisco Full Duplex DOCSIS RPD				

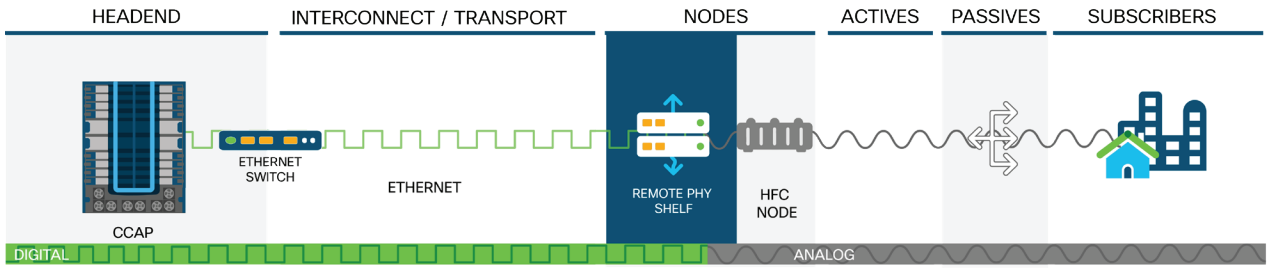
The Remote PHY shelf enables you to digitally extend features that were once tied to headend hardware, consolidating larger hubs to smaller sites.

Remote PHY nodes eliminate many of the inefficiencies of analog optics. Today, cable providers need racks of quadrature amplitude modulation (QAM) modulators stacked together, converting digital services for analog optical transmission. Analog optics have limitations. They can't transmit over long distances, and they generate significant "noise" in the network, reducing quality and limiting capacity. When you deploy RPDs close to customers, you can eliminate analog transmitters and receivers, and replace them with digital fiber connections, reducing the signal to noise ratio (SNR) in your access network. You can use higher-order modulation schemes to deliver much more bandwidth. You can scale from a maximum 256 QAM today to 1,024 or 4,096. Add it up, and you can boost data rates over existing HFC infrastructure by more than 50 percent.

Digitizing with the Remote PHY shelf

The Remote PHY shelf enables you to digitally extend features that were once tied to headend hardware, consolidating larger hubs to smaller sites. With Remote PHY shelves, you're simplifying network operations by eliminating the need for dedicated hardware-based platforms in many of your hub sites. Effectively, Remote PHY shelves become port extenders for a consolidated and more centralized CCAP core (see Figure 4 and Figure 5). You can continue to use much of your existing HFC plant while reducing the need for full-featured CCAP/CMTS platforms at smaller sites, which radically reduces space, power, and cooling requirements at those hub sites. Remote PHY shelves will also enable you to scale bandwidth without having to expand your equipment footprint in those hub sites. Compared to Remote PHY nodes, Remote PHY shelves are a not a direct replacement for your existing nodes because the PHY circuit is in the shelf and not in the node. Remote PHY shelves are designed to extend your investment in existing HFC nodes while digitally consolidating functions across hub sites. Remote PHY shelves are an attractive option for networks with small hub sites that serve smaller numbers of service groups, where space is limited and deploying a full CCAP headend would be cost prohibitive.

Figure 3: Digitizing with Remote PHY shelves

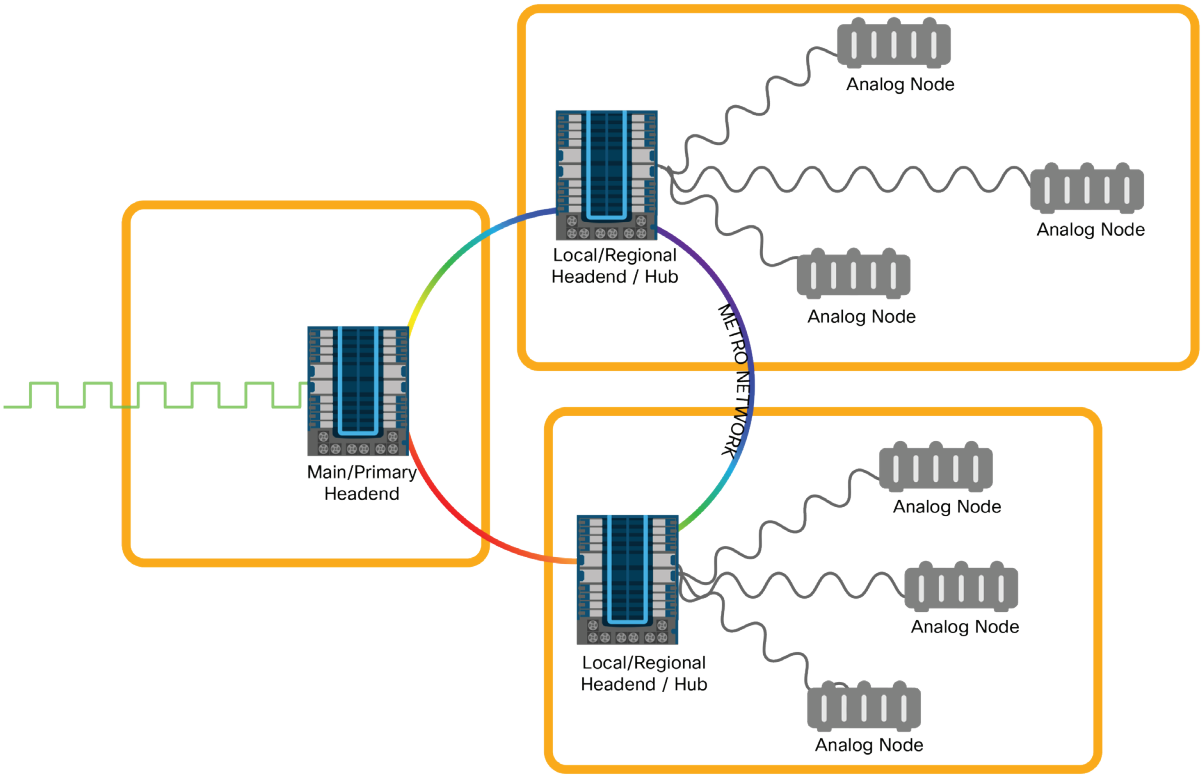


Consolidating hub sites with Remote PHY shelves can reduce costs because the architecture requires less power and less equipment management.

Hub site consolidation deployments

Consolidating hub sites with Remote PHY shelves can reduce costs because the architecture requires less power and less equipment management. For example, Figure 4 shows a simple cable access network architecture with three headends/hubs that each have a full stack of equipment in them to supply services to their respective customer regions.

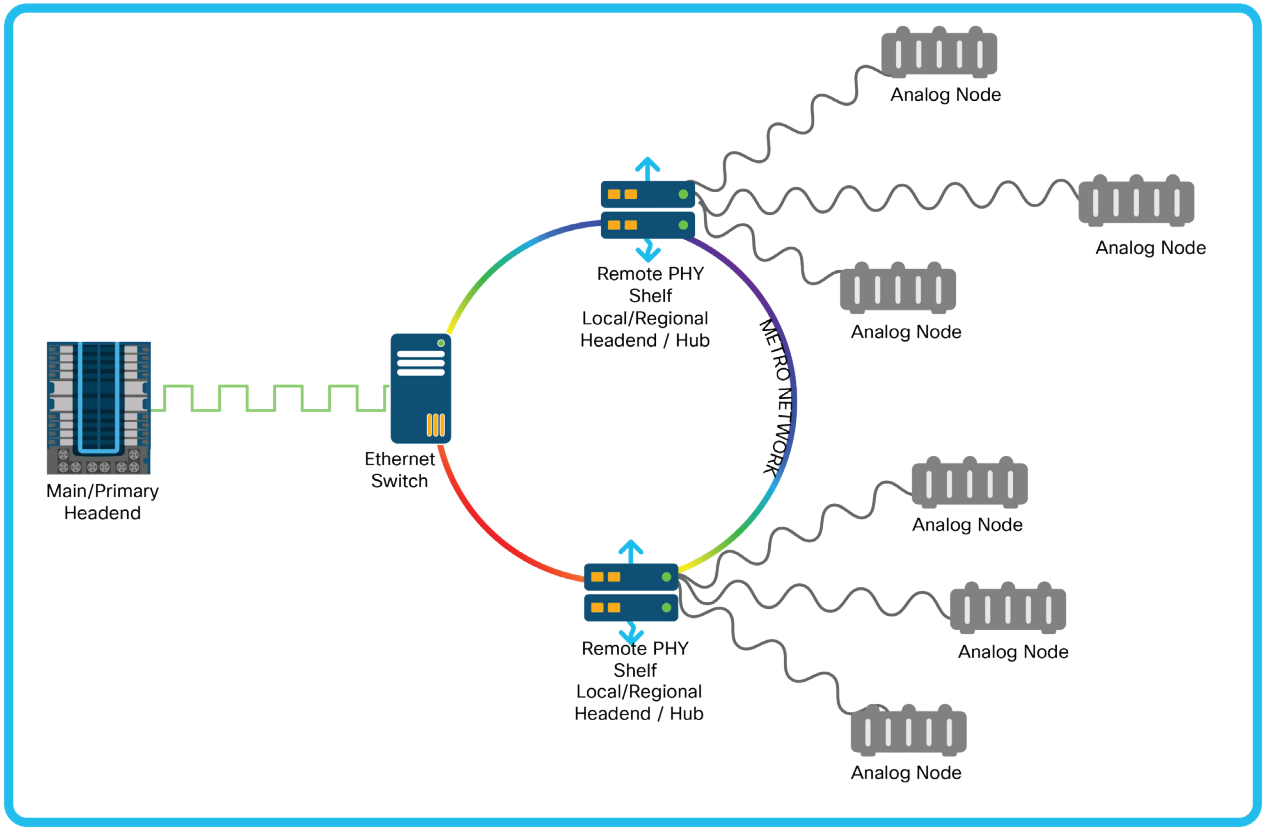
Figure 4. Traditional Hubsite/Headend architecture.



Using Remote PHY shelves, operators can effectively extend the logical and digital reach of the main headend and establish a single management domain.

The introduction of Remote PHY shelves enables cable operators to consolidate their regional/local headends/hubs, reducing the amount of traditional equipment in each (see Figure 5). Using Remote PHY shelves, operators can effectively extend the logical and digital reach of the main headend and establish a single management domain.

Figure 5. Hubsite/Headend consolidation with Remote PHY shelves.



Cisco Remote PHY shelves

Cisco offers three sizes of Remote PHY shelves for various types of deployments:

Cisco Remote PHY Shelf 300

- Supports up to three service groups
- Temperature hardened
- Ideal for outdoor cabinet placement and small hub site consolidation

Cisco Remote PHY Shelf 600

- Supports up to six service groups
- Temperature hardened
- Ideal for outdoor cabinet placement and small hub site consolidation

Cisco Remote PHY Shelf 7200

- Supports up to 72 service groups
- High availability
- Ideal for hub site consolidation

Why Cisco for Remote PHY?

Vendors are racing to bring Remote PHY solutions to market, often promising the same benefits. But as with any new technology, the devil is in the details. The Cisco Remote PHY approach incorporates a number of important features:

- Standards-based, open-source RPDs. At Cisco, we know that innovation comes when our customers can draw on open standards and open-source development from many vendors. That's why we submitted our Open-RPD software architecture to CableLabs® to become the basis for the new RPD industry standard. With Cisco Remote PHY, you can mix and match standards-based RPDs from multiple vendors and deploy them as plug-and-play solutions in your nodes.
- Lower CapEx. Both the Cisco Cloud Native Broadband Router (cnBR) and the Cisco cBR-8 CCAP are prepared to capitalize on Remote PHY. With Remote PHY and the cBR-8, you'll be able to double the number of service groups each chassis can support without adding any new hardware.
- Simple, streamlined migration. Remote PHY is a departure from current cable access architectures toward a distributed access architecture (DAA). With solutions from some vendors, those changes can be extremely disruptive. With our approach, you can migrate your current cBR-8 CCAP platforms to Remote PHY with a simple software upgrade and or begin transforming your headends by virtualizing with the Cloud Native Broadband Router (cnBR).
- Fast, simple installation. With thousands of hub sites and tens of thousands of nodes that need advanced onsite technical expertise, installing Remote PHY shelves or nodes can become costly. Our comprehensive orchestration tool makes it easy for field technicians to install Remote PHY. They scan a QR code, connect the device, and the orchestrator does the rest.

Financing to Help You Achieve Your Objectives

Cisco Capital can help you acquire the technology you need to achieve your objectives and stay competitive. We can help you reduce CapEx. Accelerate your growth. Optimize your investment dollars and ROI. Cisco Capital financing gives you flexibility in acquiring hardware, software, services, and complementary third-party equipment. And there's just one predictable payment. Cisco Capital is available in more than 100 countries. Learn more.

Learn more

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Remote PHY orchestration and automation

Pushing fiber out closer to subscribers delivers significant benefits, but migrating to a Distributed Access Architecture with Remote PHY can be a massive operational effort. For any MSO, the path to fiber deep (Node+0) can mean upwards of a 10x increase in the number of nodes. The total number can reach into hundreds of thousands of nodes each of which must be deployed, configured, and managed. This effort can entail dozens of manual steps for each new node. Because a typical region may include up to 500 Remote PHY devices (RPDs) per CMTS instance and a relative number of CMTSs, a deployment may require months of work before it becomes operational.

Cisco makes moving to Remote PHY and fiber-deep deployments much easier. Whether you're using a physical or virtual CMTS, you can automate the configuration of thousands of Remote PHY devices with Cisco's built-in tooling. The Cisco RPD automation tool encompasses:

- Deployment preparation. We provide a comprehensive inventory and planning interface that makes it easy to plan out how each CMTS will be configured and used. It shows the catalog of services each RPD will deliver and how new nodes will be assigned to a given service group or CMTS.
- Automated Configuration. The Cisco RPD automation tool automatically generates and publishes the relevant CLI commands needed to configure the CMTS to support the RPD.
- Field installation. Simplify and optimize your skilled technicians' time in the field. Technicians can now scan a QR code on RPDs that will then load the newly scanned RPDs into the system inventory. The system can then automatically pair the RPD with the appropriate CMTS and service group, push out the configuration, perform validation testing, and activate the new device
- Ongoing RPD and service monitoring. Once RPDs are deployed, you can use simple topology overlay and underlay views to monitor the real-time health of your RPD footprint, showing both the health status of services along with link status and utilization.

The RPD orchestration platform also provides a framework to automate incremental changes, including the ability to roll back any change to the previous good state without having to retrace each step manually. And, unlike other Remote PHY automation solutions that rely on closed, proprietary technologies, the Cisco solution is fully open and standards-based.