

# Unlocking the potential of Remote MACPHY



## Abstract

Distributed access architectures (DAAs) were developed by the cable industry as a set of optimal network architectures to enable cable operators to deliver 10G services to meet the ever-growing demand for bandwidth and to deliver the services of the future. However, despite their significant promise, DAA deployments have been slower than expected. This is because some early solutions were proprietary and because operators thus far had to choose from a plethora of options, including the Integrated Converged Cable Access Platform (I-CCAP) or one of the modes of the DAA. In fact, operators had to commit to a DAA mode, namely Remote PHY (R-PHY) or Remote MACPHY (R-MACPHY), long before their requirements were well defined—and without an easy migration path if their needs changed. Furthermore, the significant and sudden demands the pandemic placed on operators' networks, particularly in the upstream, led them to use well-tested methodologies largely based on centralized architectures (I-CCAP), to increase capacity to meet demand, rather than consider new architectures such as DAAs.

The recent introduction of the innovative RD2322 by CommScope, helps solve these challenges for operators. The CommScope RD2322 is an RxD solution, which can be deployed as an R-PHY device (RPD) or an R-MACPHY device (RMD) (thus the RxD name) and can be changed from one mode to the other in the field with a simple software upgrade, which can be done remotely. The RD2322 is the industry's most flexible node-based device for DAA evolution. It is a 2x2 RxD, meaning it can support up to two downstream service groups (DS-SGs) and up to two upstream service groups (US-SGs) in most of the supported node housings, while also feeding all four ports available in these housings. The RD2322 can be configured and deployed in 1x1, 1x2, and 2x2 DS-SGxUS-SG configurations and remotely configured and licensed in a pay-as-you-grow fashion—enabling virtual service group splits. Furthermore, even when the RD2322 is configured in RMD mode, its power consumption is well within what is typically acceptable in the outside plant, and the hardware module and supported node housings are able to sustain the heat dissipation. Such innovations were made possible thanks to the significant investments CommScope has made in research and development on various cable access, CMTS, and CCAP technologies.

The RD2322 could not have come at a more opportune time. It provides a flexible upgrade path toward DAA solutions—essential to realizing the industry's 10G goal—to meet the market need for broadband and new services and to enable a forward-looking, software-based network infrastructure. The RD2322 also unlocks the benefits of R-MACPHY, including simplicity (all in one box), more capacity (without straining the headends and hubs), speed, low latency, cost and space efficiency, and flexibility, while enabling virtualization. By obviating the need to commit to an architecture upfront, the RD2322 will enable operators to accelerate the adoption of DAA, and sets the industry on a forward path. The time for DAA solutions has arrived.

## Introduction

Broadband consumption had been growing at a fast clip before the pandemic, but its growth accelerated over the past year as most everyday life activities moved online and became more dispersed—making it harder to concentrate capacity in certain geographic areas.

As part of its ongoing tracking of bandwidth utilization over the past 12 years, CommScope has been assessing the average peak-time busy-hour bandwidth consumption across four North American MSOs. During this extended period, CommScope has found that average peak-time busy-hour bandwidth consumption (Tavg) downstream (DS) increased 32.5 percent in January 2021 versus January 2020—and, for the same period, Tavg for upstream (US) utilization increased a significant 57 percent. Notably, US CAGR is coming closer in line with DS CAGR (24 percent over the past three years), and the DS:US ratio is trending downward toward 12:1.

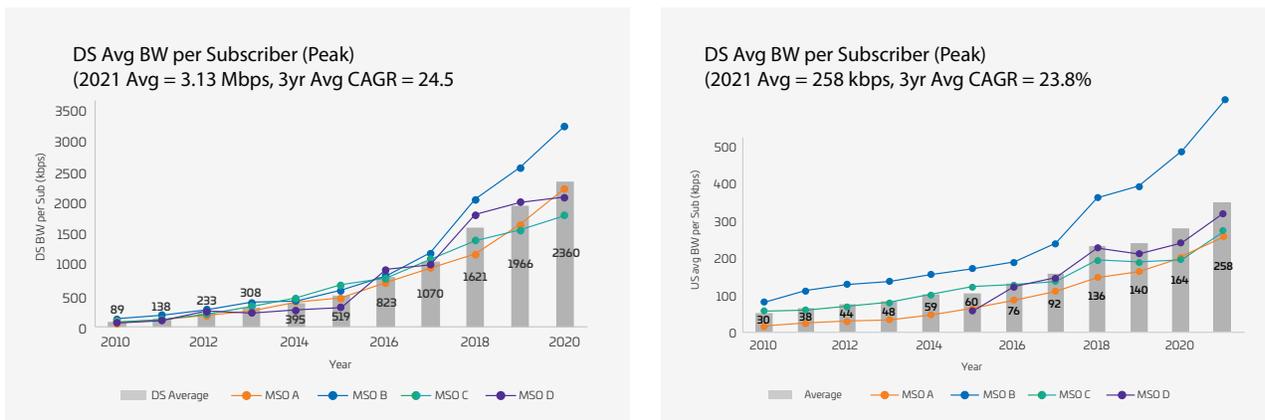


Figure 1: Bandwidth consumption trends<sup>1</sup>

It is widely expected that broadband consumption growth will continue as some of the shifts hastily adopted during the pandemic will evolve into long-term patterns. Examples of these shifts include work from home, remote learning, telehealth, ecommerce, streaming and gaming.

The notable and expected continued increase in US bandwidth consumption is particularly challenging for operators. Most of their tools have been designed to increase DS capacity. Many operators are now exploring increasing upstream capacity by augmenting upstream spectrum, from 42 MHz (low-split) in the US, 65 MHz (low-split in some markets) to 85 MHz (mid-split) and even 204 MHz (high-split).

While broadband service providers raced to meet the near-term demand for capacity primarily using established methodologies such as node splits, operators are now looking for a distributed access architecture (DAA) such as Remote PHY or Remote MACPHY to complement their typical I-CCAP deployments. While I-CCAP products have largely been able to keep up with operator needs in supporting subscriber bandwidth growth, DAA solutions enable operators to break beyond the current headend and hub site real estate footprints and migrate from analog to digital optics—reducing noise and enabling a more efficient use of bandwidth with DOCSIS 3.1 and beyond.

DAA solutions enable the evolution of cable networks to meet the increasing market demands by decentralizing the headend and virtualizing network functions. While accepted as the right architecture for many access networks to migrate to going forward, field deployments have been somewhat slower than expected because operators have been faced with a plethora of options and with the need to commit to network topologies before they had a full grasp of their long-term needs. This has recently changed thanks to innovations by industry leader CommScope.

<sup>1</sup> <https://www.commscope.com/blog/2021/tracking-bandwidth-consumption-start-of-the-roaring-20s/>

# R-MACPHY BECOMES THE PREFERRED ALTERNATIVE TO I-CCAP

## Distributed access architecture solutions

DAA solutions enable operators to extend the digital part of the plant to the access node—using digital fiber Ethernet links to replace analog optics between the headend and the node. This leads to increased throughput, improved resiliency, lower latency and lower cost. It also supports operators’ goals of pushing fiber deeper, and ultimately enables a virtualized operating environment.

There are two major DAA alternatives for an HFC network:

- **Remote PHY (R-PHY)** — the PHY layer is moved to the access node or to an R-PHY shelf, while the MAC layer is retained in the hub or headend.
- **Remote MACPHY (R-MACPHY)** — both the MAC and the PHY layers are moved to the access node. The CCAP Core function (which handles DOCSIS processing) is in the R-MACPHY device (RMD), which now resides in the fiber-optic node, and the digital/RF interface (PHY layer) is also placed at the optical/coaxial boundary.

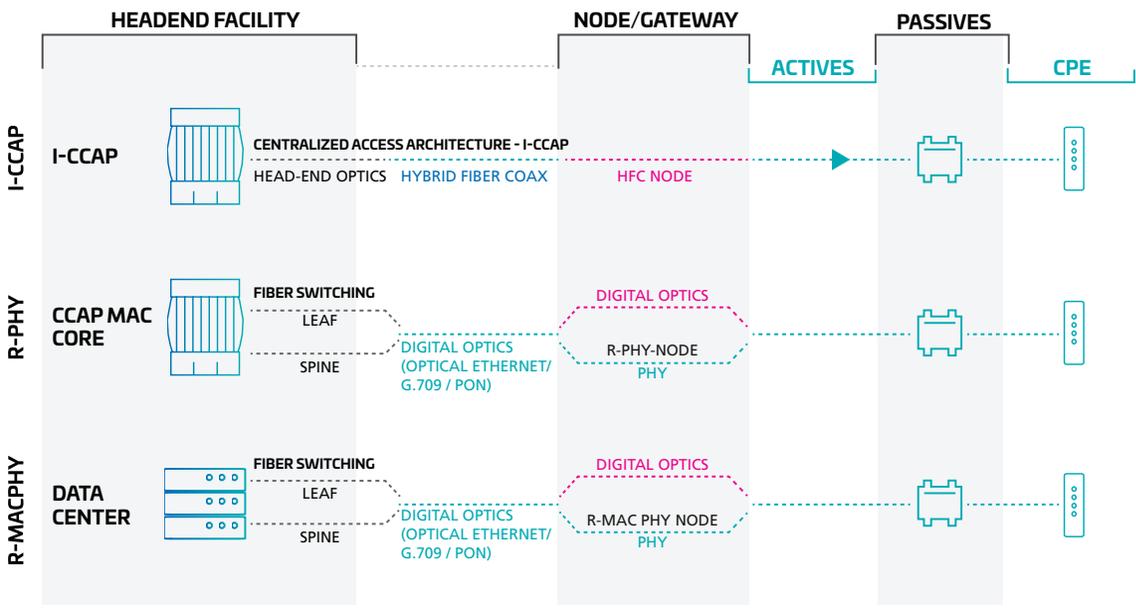


Figure 2: The two major DAA modes compared with I-CCAP

The two modes have some similarities, but also have different characteristics, pros and cons. Some highlights:

- Both solutions are compatible with existing Video and OOB Auxiliary (Aux) Cores and can make use of cloud computing via a virtualized control and management plane and video plane.
- **R-PHY** enables the reuse of the pCore/vCore and has lower power consumption in the optical node (but requires higher power and more rack space in the headend). Its cost is lower in the optical node but higher in the headend. However, it imposes more operational complexity, requires a grand master clock, and has higher transport latency (because the MAC and the PHY are separated). It also imposes some limitations on the distance between the hub and the node and does not enable fog computing.
- **R-MACPHY** is a simpler, all-in-one-box architecture. It does not require a CCAP Core and can be deployed without (or with) a grand master clock. This architecture provides the lowest latency—making it more appropriate for edge computing (in addition to cloud computing) and for applications with low latency tolerance. It has the lowest power consumption in the headend, but adds a small amount of power in the node due to the inclusion of the MAC.

R-MACPHY generally presents a better alternative to increase capacity, particularly in the upstream—enabling low-latency applications, streamlining operations, and paving the way to a virtualized operating environment, thus enabling service velocity and elasticity.

While some operators have already made a commitment to a DAA solution, many have preferred to have more flexibility, or found that adopting one solution did not meet their network evolution needs. Operators desired more flexibility—a solution that could grow with them as they evolved their architecture and outside plant requirements in different parts of their footprints.

Today, operators have that flexibility thanks to innovations and significant investments from market leader CommScope.

### CommScope paves the way for wide R-MACPHY market adoption

The RD2322 Remote PHY/MACPHY Device (RxD) (RD2322), supports operation either as an RPD or an RMD (thus the RxD designation)—allowing the flexibility of a software-only upgrade to switch operation modes. In the RPD mode, the RD2322 performs the PHY layer functionality, leading to alleviated demand in terms of density and power consumption in the headends. In the RMD mode, the RD2322 provides a simple, all-in-one-box distributed CMTS solution that moves both the MAC and PHY layer functions out of the headend/hub to a fiber-optic node. Both solutions place the digital/RF interface (i.e., the PHY layer) at the optical/coaxial boundary. The RD2322 also supports all upstream spectrum allocations, including 42 MHz (low-split), 65 MHz (low-split for some markets), 85 MHz (mid-split) and 204 MHz (high-split).

There are many benefits to this solution, including deployment flexibility, increased bandwidth capacity, improved fiber efficiencies, simplified plant operations with digital optics, decreased loads on headend facility space and power systems, scalable functionality with reduced multi-touch deployment cost, and directional alignment with NFV/SDN/FTTx systems of the future.



Figure 3: The CommScope RD2322 RxD

<sup>2</sup> 65 MHz split for Annex A operation is a committed future release feature

## Optimizing the CMTS for the Access Edge

CommScope's significant investment in the C4® CMTS, and later the E6000® Converged Edge Router (CER) over many years—plus its market leadership position and broad field deployments of these solutions along with Access Technology Solutions, such as fiber nodes—were brought to bear in the development of the RD2322. CommScope DAA solutions leverage the many innovations and significant investments CommScope has made in the E6000® CER over many years, including power optimization, a robust set of features, and field hardening.

CommScope's commitment to R-MACPHY is not new. In fact, as far back as 2015, the company started working on an R-MACPHY solution. At the time, the amount of processing needed for the MAC could not comfortably fit in the power and cooling footprint of fiber nodes given the technology available at the time. This effort was restarted in earnest several years ago, and the massive investment in optimizing the E6000 CER, along with the know-how the company gained about R-MACPHY, came together—enabling the MAC to be deployed on a device, the RD2322, with power consumption acceptable in the outside plant, while at the same time being feature rich and field hardened. The reduction in power consumption of the RMD and improved heat dissipation of the fiber nodes also improves sustainability.

## Delivering DAA flexibility

Until very recently, cable operators had to choose upfront between R-PHY and R-MACPHY as they planned their DAA solutions. This drove operators to either choose a solution that may not be optimal in the long term or to postpone the network evolution decision altogether. Many operators' footprints are anything but homogeneous, and some architectures may be suitable in some topologies more than others. Add to this dilemma criteria such as service uptake, density, economics, and market trends, and it becomes obvious why operators have been deliberate in their DAA network evolution plans.

This will change with CommScope's introduction of the RD2322, as it provides the operator with the flexibility of switching between R-PHY and R-MACPHY with a simple software upgrade. The RD2322 can be configured as an RPD or RMD: Essentially, the operator can leverage the same RD2322 hardware to easily migrate from having the MAC in the headend in a R-PHY deployment to a R-MACPHY deployment with the MAC in the node.

This flexibility is essential for operators who may want to deploy with R-PHY but may want to be able to easily migrate to R-MACPHY in the future. It will encourage them to commit to adopting DAA without having to make specific R-PHY/R-MACPHY decisions. It will also help operators future-proof their deployments and optimize total cost of ownership, since the same hardware (RxD) is used, the same node is retained, and no truck roll is required. This solution also delivers deployment benefits because it is operationally simpler, requires less skilled labor, and minimizes migration cost over the long term. This should lead to a faster market adoption of an architecture that is increasingly becoming essential to meeting market need and to long-term competitiveness.

## Enabling a cost-effective upgrade path

For operators who have deployed flagship node products from CommScope, such as the NC4000™ Series and the Opti Max™ OM41x0 series of optical fiber nodes, CommScope provides operators a straightforward and efficient upgrade path to DAA RxD. Furthermore, operators can retain the existing video core infrastructure, resulting in a reduced total cost of ownership and an improved ROI. The end-to-end solution is also highly scalable, enabling operators to grow their deployments in alignment with market need without stranding capital.

## Optimizing the operational environment

The CommScope DAA RxD solution is complemented by a cohesive, comprehensive, microservices-based management layer. CommScope's Virtualized Management Suite enables operators to deploy, configure and manage RxDs and to make the transition from RPDs to RMDs with a simple software upgrade. It connects to the operators' existing management platforms to help unify operations for mixed I-CCAP and DAA environments. It also simplifies license management and provides data analytics for a truly powerful integrated management capability. The Virtual Management Suite also provides the capability to manage DAA deployments at high scale. This is essential in a DAA environment. Unlike the I-CCAP solution, which typically supports 96 service groups, the RMD supports up to two service groups each—leading to increased management complexity. CommScope's Virtualized Management Suite provides this capability and interconnects with operators' existing operational/management environment.

## Providing business flexibility

The technological innovations and operational flexibility brought forward by CommScope enable operators to easily migrate from an I-CCAP or RPD-based environment to the new RMD-based environment—further removing impediments to committing to DAA deployments.

## THE R-MACPHY ADVANTAGE

There are numerous benefits to Remote MACPHY:

- By moving the PHY and the MAC to the node, what remains are management and control plane functions. These functions lend themselves to virtualization, and use components that are generally available rather than cable plant specific. Furthermore, these capabilities can reside in a data center, further simplifying the network infrastructure and leading to cost savings.
- Moving the MAC to the access network reduces latency since media processing is happening close to the subscriber. Low latency is increasingly essential not only for gamers, but for mission-critical applications (e.g., healthcare) that are moving to the home. Furthermore, enabling processing at the edge paves the way for edge computing.
- Reducing space and power consumption in headends and hubs, while at the same time enabling operators to add capacity to meet exponential bandwidth consumption.
- Simplifying operations—Remote MACPHY is an all-in-one-box solution, which simplifies plant operations, leading to cost efficiencies. It is also particularly attractive in areas with skilled labor shortages because of the simplicity of maintenance and operations.
- Improving fiber efficiencies; R-MACPHY uses digital fiber, which is cheaper and more reliable than analog optics. Furthermore, R-MACPHY allows for longer fiber reach—bringing fiber further from the headends/hubs and deeper into the subscriber network.
- Directional alignment with NFV/SDN/FTTx.
- Savings costs on long-term deployment (reduced transition costs from R-PHY to R-MACPHY).

## A FLEXIBLE PATHWAY TO THE FUTURE

CableLabs® has recently released the Flexible MAC Architecture (FMA) suite of specifications, which provides a framework for disaggregating the CCAP management, control and data planes, and supports the 10G platform. CommScope's RD2322 and management solutions provide a pathway for operators to migrate gradually toward FMA. CommScope's Virtualized Management Suite uses software-defined networking and network function virtualization principles—bringing the operating environment closer to NETCONF, YANG, streaming telemetry, and other methodologies that will become essential in the operators' environment in the near future. Furthermore, DAA solutions enable operators to incrementally add DOCSIS 4.0 capabilities to their networks.

## THE COMMSCOPE ADVANTAGE

The innovation, scalability and flexibility CommScope introduced with the RD2322 are complemented by the full capabilities of a leading and committed world leader that brings perspective and resources and that partners with operators throughout the transformation journey.

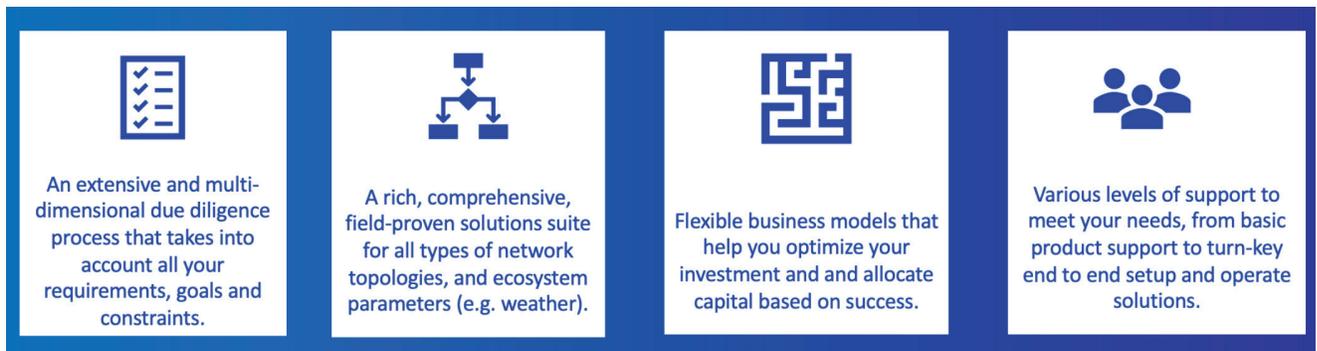


Figure 4: End-to-end deep capabilities

As unique as the RD2322 solution is, it is part of a broad continuum of solutions that address operators' needs and continue to evolve as these needs change. These solutions are complemented by rich professional services and field application engineering capabilities.

- The field application engineering organization works with customers to identify product solutions for their application that provide short- and long-term value. It includes technical pre- and post-sales support and provides all that is needed for a successful field implementation.
- The professional services organization has more than 1,300 experienced service professionals in 30 countries with diverse skillsets, processes and facilities that cost-effectively help network operators achieve their desired outcomes in the shortest timeframe.

## CONCLUSION

Since its inception, R-MACPHY has been recognized as a very attractive, flexible and efficient DAA alternative. With the RD2322, CommScope has addressed the challenges that had prevented R-MACPHY from being a broadly deployed solution. Not only does the RD2322 resolve the power constraints that had held the technology back, it also provides the flexibility that operators need to switch between RPD and RMD modes with a simple software change. Leveraging CommScope's rich I-CCAP legacy, the RD2322 is also a feature-rich, field-hardened product that provides the operational framework to make the solution deployable and scalable, and the business flexibility needed to make R-MACPHY a market reality. These innovations could not come at a more opportune time. Tremendous demand for bandwidth has led operators to consider more modern alternatives to the traditional hardware-based node splits and other methodologies; at the same time, the recent focus on expanding broadband availability to currently underserved areas can be more easily met with R-MACPHY. The time is ripe for R-MACPHY to gain market traction and for operators to benefit from the investments and innovations toward increased bandwidth and lower latency. The transition to DAA starts now and, with CommScope's support, operators can unlock the potential of Remote MACPHY!

<sup>3</sup> <https://www.cablelabs.com/on-the-path-to-10g-cablelabs-publishes-flexible-mac-architecture-specification>

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