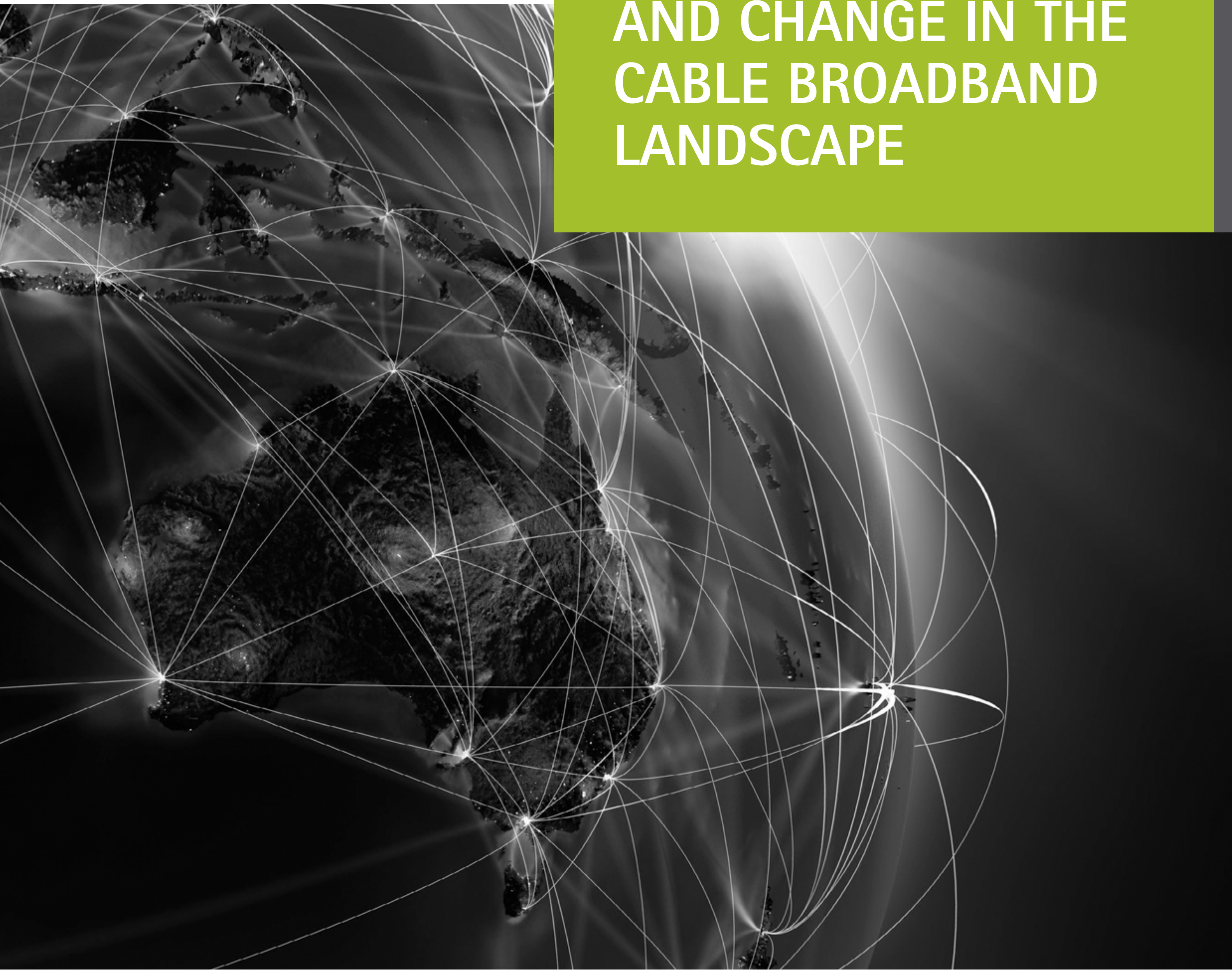
YOUR GUIDE TO UNDERSTANDING

THE RAPID UPHEAVAL AND CHANGE IN THE CABLE BROADBAND LANDSCAPE



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Engineering Tomorrows Networks

GIGABIT BROADBAND SERVICES HAVE WELL AND TRULY ARRIVED

As you read this, cable operators around the world are preparing to roll out the industry's new DOCSIS 3.1 specifications.

That means they'll have the technical ability to offer downstream data speeds as high as 10 Gbit/s and upstream speeds of 1 or 10 Gbit/s.

In other words, we're on the cusp of a step-change in connectivity and user experience.

But to actually deliver that performance to customers, cable providers will need much higher bandwidth capacity, more processing power and greater operating efficiencies.

IP video is a key driver of this step-change.

Because as cable operators start to shift more and more of their video services to IP delivery, they will need more capacity to carry the unicast signals to subscribers and simulcast their programming over both QAM and IP channels.

This will naturally demand more storage and processing closer to the network edge.

Space constraints in cable headends and hub sites are another major business driver.

With headends and hub sites getting more and more congested with bulky equipment, cable providers need to spread the load through their access networks.

Providers are also looking for ways to reduce the number of hub sites to optimise both capital expenditure and opex.

Besides clearing space in headends and reducing the number of hub sites, cable operators are seeking to push capacity to demand epi-centres such as multiple dwelling units (MDUs) and hotels.

They're taking a more granular approach than before.

They are also seeking to shift network capacity to existing and potential revenue hotspots—such as the business segment.

The cable network has no equivalent of the mobile network distributed antenna system (DAS) or small cell, no equivalent of the Wi-Fi Vantage hotspot.

So some form of DAA makes perfect sense.

We predict that the launch of Ultra HD (4K TV) services and the emergence of the Internet of Things (IoT) will add significantly to the cable capacity crunch.

In the case of bandwidth-heavy Ultra HD, for instance, it's estimated that a single channel will require 15 to 20 Mbit/s line speeds to deliver to a subscriber TV, set-top box, tablet or other viewing device.

That's a huge step up for cable operators.

One more potential driver for the migration to distributed CCAP is integrated CCAP technology.

By combining the traditional data processing functions of the CMTS and video processing functions of the edgeQAM modulator in one dense, centralised device in the headend, integrated CCAP makes it easier for cable operators to look at splitting up those functions into different modular components.

That should make it easier for operators to virtualise the equipment and shift some or all of the components into the network.

The cable industry is entering a period of great technological upheaval and change.

Because both the technology and the user demand for fast, high quality connectivity are growing developing faster than ever before.

So as a cable operator, how will you respond?

The next section lays out the main options that cable technologists are exploring right now…

DAA—
THE BENEFITS

Cable technologists are examining and debating various options for relieving the growing strain on the cable infrastructure.

The idea is to shift at least some of the central headend equipment and functions to the access networks and virtualise them in the cloud.

DAA, known as Distributed Access Architecture, promises several major benefits for cable broadband network operators.

One critical advantage is that DAA keeps the cable data and video signals in digital format as long as possible, extending the digital signals beyond the headend deep into the network node before converting them to analogue.

The distributed approach accomplishes this feat by replacing the analogue forward link between the headend and the access network with a more advanced digital forward, or "digital fibre," connection.

This switch to digital optics produces signals with a higher signal-to-noise ratio, meaning less signal interference.

Such enhancements are especially essential for the rollout of DOCSIS 3.1 and its much higher data speeds.

Another benefit of DAA is improved reliability of the optical link between the headend and network.

While analogue optical links can be hurt by environmental conditions and require periodic maintenance, Ethernet optical links are far more durable and require much less maintenance.

DAA also enables cable network operators to leverage longer distances between the headend and the node.

That's because digital interfaces operate over much longer distances than their analogue counterparts.

Cable operators can take advantage of these longer distances to move key functions and services deeper into their networks, freeing up space in the headend.

In the process, cable network operators can use the new digital forward links to drive Ethernet much deeper into their networks.

As a result, they can use IP-based technology to deliver data, video and potentially other services all the way to the node, rather than just to the headend.

The new digital fibre link can support more wavelengths than the old analogue connection.

That means it can help cable operators upgrade to a more "fibre deep" architecture.

They can set up more fibre nodes and create smaller service groups. In turn, this will make it easier for cable operators to make the eventual migration to all fibre networks.

Finally, DAA allows cable operators to start virtualising different headend and network functions and placing them in the cloud.

DAA could become the cornerstone of the industry's emerging network functions virtualisation (NFV) strategy, enabling further reductions in capex, space and power requirements.

It should also make it easier and more efficient for cable operators to deploy such advanced broadband specs as DOCSIS 3.1.

Cable technologists agree that a DAA approach makes the most sense for the industry's future.

Remote PHY is the leading documented option right now. Another option is Remote MACPHY that moves both the PHY and DOCSIS processing (MAC) to the access node.

Adopting both options gives you the agility to deploy the right approach for each service group.

Under this next generation architecture, the PHY layer of the integrated CCAP device (or CMTS and edgeQAM) is split off from the CCAP core (or CMTS core and edgeQAM core) chassis in the headend and shifted to a new Remote PHY Device (RPD) at the optical node in the network.

As defined by CableLabs in a recently issued series of specs, Remote PHY represents an evolution of the Modular Headend Architecture specs originally issued for the modular CMTS (M-CMTS).

Consisting mainly of PHY-related circuitry, such as downstream QAM and OFDM modulators and upstream QAM and OFDM demodulators, the RPD is a PHY device that converts downstream DOCSIS data, MPEG video and out-of-band (OOB) signals from digital to analogue one way and upstream data, video and OOB signals from analogue to digital the other way.

The technology uses pseudowires between the headend and the network node to connect the RFP devices to the CCAP core.

	Remote PHY	Remote MACPHY
Remote Node	PHY Device PHY Only	Remote CCAP, MAC & PHY
Core	CCAP Core (CMTS Core & EdgeQAM Core)	Controller, Router, OLT/Ethernet
Digital Fibre Link	Supported	Supported
Standards (open standard)	Specified by CableLabs	Technical report issued by CableLabs

Table 1: Compare the Options

Virtualisation is Coming

Software-defined networking (SDN) and network functions virtualisation (NFV) are gaining traction as cable operators pursue innovative ways to meet growing bandwidth demands, boost service delivery and performance, slash operating costs and bring new products, services and features to market faster.

Virtualisation provides the opportunity to re-architect networks to achieve not only cost savings, but also service agility and network convergence.

Most industry leaders agreed that implementation of new virtualised functions will require a step-wise approach that establishes a common framework allowing legacy systems and virtualised systems to work together. Cable operators will not rip and replace existing gear or legacy management software, so there needs to be an industry-wide understanding of how new technology can operate within existing systems.

CableLabs has an initiative called the SDN/NFV Application Development Platform and Stack project, or SNAPS designed to accelerate the adoption of network virtualisation for cable providers. CableLabs successfully deployed a virtual CCAP (converged cable access platform) core on OpenStack. Casa and Intel provided hardware and Casa Systems provided the Virtualised Network Function (VNFs) that ran on the SNAPS platform. The virtual CCAP core controls the cable plant and moves every packet to and from the customer.

Casa's vCCAP is CableLabs compliant and provides full CCAP functionality: DOCSIS core, video core, routing, subscriber management, and provisioning functions. Casa's vCCAP is enabled in Casa's Axyom Software framework which is an open standards based NFVI architecture.

Convergence

The convergence of cable and wireless represents a new area of opportunity.

The co-existence and increasing interworking between licensed and unlicensed spectrum technologies will drive considerable change. The cable industry is likely to be a significant part of 5G networks for mobile services, backhaul, and MEC locations. [Multi-access Edge Computing (MEC) initiative is an Industry Specification Group (ISG) within ETSI.]

Casa's solutions ultimately enable an access agnostic multi-services core, converged transport, and SDN-controlled, orchestrated services across fixed, unlicensed and licensed wireless access types.

Casa has demonstrated VoWi-Fi and VoWi-Fi to VoLTE calling leveraging Casa's cable and LTE-EPC wireless access and core VNFs running at the edge in a common software framework, OpenStack-based environment.

THE KEY FACTORS YOU MUST KNOW FOR THE DAA ERA

Cable operators should consider the cost of both deploying and managing the distributed solution.

Total cost of ownership (TCO) should take into account not just the physical equipment needed for the remote nodes, but also all costs associated with the replacement of any required management tools.

By evaluating TCO, not just the costs of equipment deployment, cable operators can understand their combined capital and operating expenses.

Without such an evaluation, you'll struggle to budget and plan effectively.

The TCO should also highlight the substantial gaps compared to the legacy architecture underscoring WHY the legacy architecture should be placed in to maintenance mode sooner rather than later.

Cable providers should also look at the new revenue stream that the distributed approach could generate for them—like being able to offer ultra fast broadband services for high value customers.

By assessing the potential revenue gained, they can gain a strong sense of what the return on their investment will be and shape their expectations accordingly.

In other words, we recommend doing in-depth research into the financial benefits and costs that come with this new generation of technology.

Be careful. Avoid unintended indirect costs such as unplanned network architecture design work and extra hardware for poor end-to-end solution integration.

C-COR Broadband provides ongoing maintenance and support for all equipment it installs for clients…

C-COR Broadband will seek to work with its clients to provide a full and transparent overview of these potential costs and benefits.

That way, they will be in a much better position to assess the investment.

Third, cable operators should examine the upheaval factor.

This means looking at how much change will be required to carry out the network transformation and whether their company is ready to make that kind of change.

An example being the new skills required for the field technicians and training centre resources across the disparate geographic markets.

Another key factor is keeping an eye toward future scalability of the cable network.

The Remote PHY approach should minimise the need to replace the remote nodes in the network as capacity demands continue to mount.

Plus, since there are many more remote nodes than headends, operators will want to keep the power consumption down.

This approach follows other access technology evolution paths—such as mobile edge and Wi-Fi Vantage—that have tended to keep the edge devices simple as access densification evolves.

In addition, cable providers should consider the path to virtualisation.

Factor	Considerations
Time to Market	Has CableLabs already issued specifications for the architecture? Does the approach use existing or planned cable devices (cable modems and STBs)?
Cost	Does the DAA solution reduce equipment, power and space requirements in headends and hubs, thus cutting both opex and capital expenditure? What are the hidden costs of retraining staff to use new configuration and management tools and update customer premises equipment (CPE)? Will the approach boost opex or generate more frequent truck rolls (e.g., for upgrades)?
Scalability	Will the DAA solution enable targeted scaling of capacity where needed? Will the solution reduce the need to replace remote nodes as more capacity is needed?
Path to Virtualisation	Are layer functions presently candidates for virtualisation per CableLabs specifications? Are layer functions more software-centric, enabling an easier shift toward virtualisation? Will keeping more complex functions centralised right now make the ultimate virtualisation path smoother?
Inter-operability	Are there already any cross-vendor interoperability specifications for the DAA solution? Do specs define inter-operability between remote nodes and CCAP cores, enabling greater flexibility?
Security	How secure are the physical locations for the complicated electronics? How secure is the connection between the remote node and the core/ data centre via IPsec? How great is the management control to guard against man in the middle attacks?

Table 2: Key considerations

WHY CHOOSE REMOTE PHY?

DAA has some major benefits.

These include keeping the cable data and video signals in digital format as long as possible, enabling higher QAM modulation rates, packing more bits per hertz into the network, boosting the reliability of the optical link between the headend and network, driving Ethernet much deeper into the networks and supporting more wavelengths.

But many leading cable technologists believe that Remote PHY stands out as the distributed access option of choice, at least as the first step in the network transformation process.

They provide several reasons to support their position:

Remote PHY offers a standards-based approach to going the distributed route, thanks to the family of seven specifications and two technical reports that CableLabs approved for the architecture and updated as recently at May 2017.

Among other things, these specs define interoperability between different CCAP core chasses and Remote PHY vendor solutions without requiring specialised development or upgrades of back-office systems.

The Remote PHY node devices, as defined in the CCAP spec, can support all of the current CCAP services.

This means cable providers can introduce these new devices into their access networks without needing to make any further changes to their cable modems or set-top boxes.

The Remote PHY approach shall be highly manageable.

But watch out for the emerging CableLabs technical report for Remote MACPHY as a complementary option for DAA. Key to it gaining consensus shall be agreement on just how to deliver video from two competing options.

Remote PHY devices can be presented as extensions of the CCAP core and then collectively managed as if they actually formed one single giant CMTS chassis.

By retaining the MAC functions in the headend, the Remote PHY architecture reduces the potential complexity and costs of the optical node in the network.

Such reduced complexity will translate into fewer operational failures and, thus, fewer truck rolls for cable operators to carry out.

The Remote PHY approach has significantly lower power requirements than a legacy architecture.

Remote PHY maintains security because it has the least amount of equipment. In the Remote PHY architecture, all encryption/decryption and key management is performed in the headend or node.

Remote PHY can easily support networks with different sized DOCSIS and video-on-demand (VoD) service groups.

Remote PHY keeps the MAC functions centralised in the headend. This centralisation should pave the way for the eventual virtualisation of these functions, just as the development of the integrated CCAP chassis has done for the basic CCAP functions, commencing early 2018.

Factor	Considerations
Time to Market	CableLabs specifications have already been issued for Remote PHY but not yet for other DAA approaches. Remote PHY method uses existing/planned devices (cable modems and STBs).
Cost	Hidden costs from retraining personnel to carry out rival approaches could increase operating expenses, at least in the short term. Large numbers of remote nodes required by Remote MAC/PHY could lead to increased operating expenses if those nodes are power hungry or require frequent truck rolls (e.g., for upgrades).
Scalability	Remote PHY enables targeted scaling of capacity where needed. Remote PHY reduces the need to replace remote nodes for additional capacity.
Path to Virtualisation	PHY layer functions are not candidates now for virtualisation per CableLabs specifications. MAC layer functions are more software-centric already, enabling easier gravitation toward virtualisation. Keeping more complex functions centralized until they are virtualized may make the virtualisation path more straightforward.
Inter-operability	CableLabs' Remote PHY specifications already define cross-vendor interoperability between remote nodes and CCAP cores. Remote MAC/PHY specifications have not yet been defined, leaving its interoperability potential open to question.
Security	Remote nodes are less likely to be situated in highly secure physical locations, making Remote MAC/PHY more of a potential security risk. Remote PHY would secure the link between the remote node and the core/data centre via IPsec and boost management control of the remote node.

Table 3: Why deploy Remote PHY now

Consider the following migration scenario involving Casa's Remote CCAP Node (RCN) and the corresponding CCAP Services Card (CSC) in the headend that aggregates the remote nodes.

A single hybrid fibre coaxial (HFC) node can changed over very simply to an RCN (presuming the RCN is already positioned and the corresponding CSC card is already in the CCAP core) by upgrading the fibre cable in the headend and at the node. Then, if needed, more RCNs can be added to reduce service group sizes within a cluster.

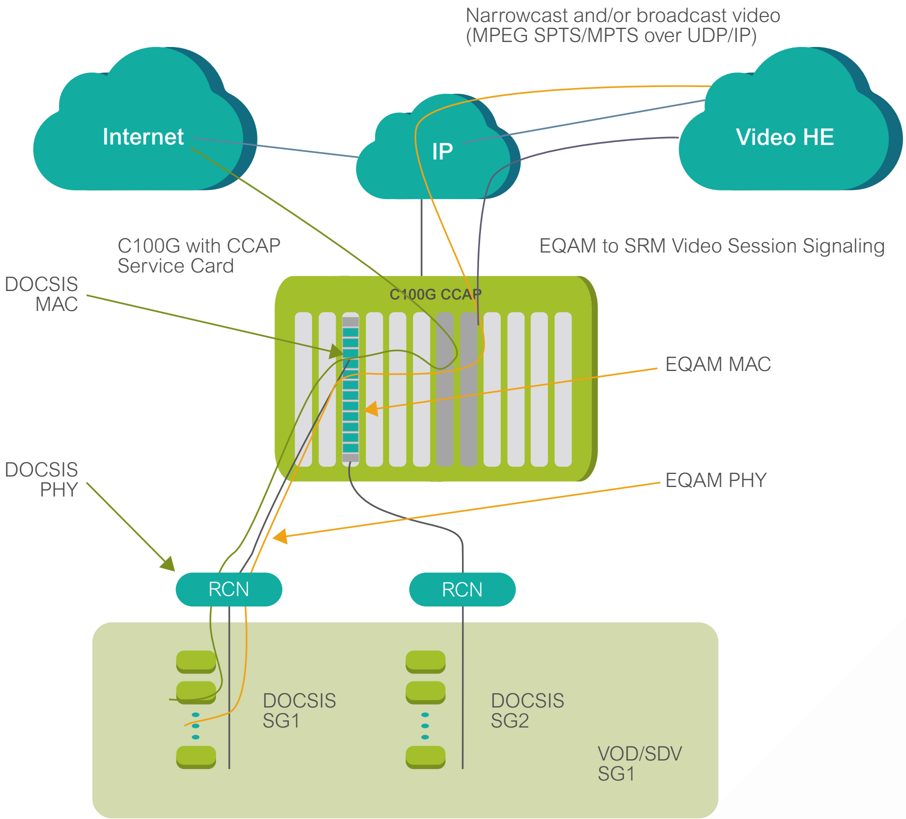

Figure 1: Casa Systems Remote PHY Architecture

CONCLUSION—POWERFUL NEW TECHNOLOGY FOR AN EXCITING NEW ERA IN BROADBAND

Demand for bandwidth is surging.

Looming capacity problems won't solve themselves.

As the introduction of gigabit service, the growing adoption of IP video, the increasingly rapid rollout of Wi-Fi Vantage, the steady growth of business market segment and wholesale segment for 5G and IoT services and the upcoming launch of Ultra HD or 4K services places a greater strain on their access architectures, cable operators will need to find ways to make their networks carry more traffic and run more efficiently.

Cable providers will also need to spread the load around as their already congested headends threaten to become even more packed with large chassis and other equipment.

Distributed Access Architecture (DAA) solutions offer salvation for bandwidth-pressed cable providers.

This technology is your greatest tool for dealing with this step-change in demand and capability.

By shifting some or all of your traditional headend equipment and functions to the network node and cloud, you can free up space in your crowded head-ends, boost the capacity of their networks, make those networks run more smoothly and more efficiently, and cut power consumption and costs.

DAA also offers other potential benefits, including higher signal quality, greater reliability of the links between the headend and network, improved network performance and, ultimately, a better customer experience.

Like many leading cable technologists, C-COR and its strategic partner—Casa Systems—argues that Remote PHY offers the best bang for the buck right now because of its unique advantages.

These advantages include a standards-based approach fully defined by CableLabs specs, support for all CCAP functions and services, greater manageability, less network complexity, lower operational costs and greater security.

In addition, Remote PHY offers a clear path to further virtualisation of the access network.

DAA is clearly a concept whose time has come for cable.

Now the big question is not whether to distribute the access architecture at all, but how best to distribute it.

C-COR believes that Remote PHY makes sense as the first step down this much-anticipated virtualisation path. By late 2018, Remote MACPHY shall be a credible complementary option for DAA.

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