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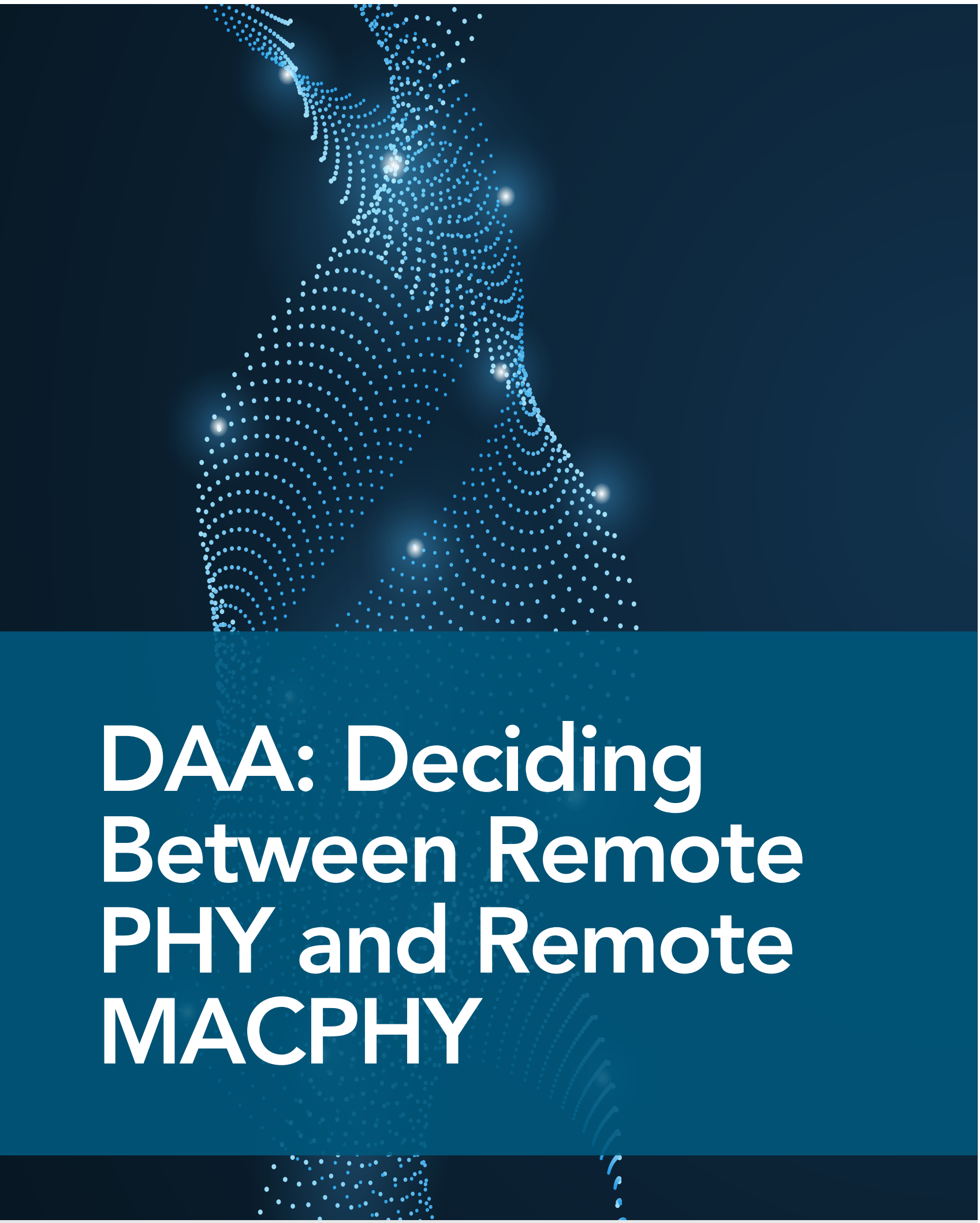

DAA: Deciding Between Remote PHY and Remote MACPHY

Traditional HFC Architecture Limits and DAA Benefits

As broadband demands on operator networks continue to grow, cable operators have come to realize that the traditional hybrid fiber coaxial (HFC) architecture – CCAP + analog optics + fiber nodes – is not sustainable. After decades building networks in this manner, operators are moving to a Distributed Access Architecture (DAA), pushing headend and hub functions to the node.

To understand why operators are turning to DAA, we must first consider why traditional cable network architecture is reaching the end of its road. There are several inherently limiting factors, including:

Limited capacity
Traditional integrated CCAPs, because they depend on analog optics, do not consistently support the higher orders of modulation used in DOCSIS 3.1 and required to meet today's network capacity requirements.

High capital expense
The specialized analog optics and fiber nodes used in traditional HFC networks are purchased only by cable operators. The low volume significantly drives up cost, and the limited production results in longer lead times.

High operating expense
Traditional HFC architectures and integrated CCAPs have very high space and power requirements, the latter not just to operate the equipment, but to keep it cool. These high-power requirements also work against the greener networks many operators are pursuing. Also, with many headends and hubs out of space, facility real estate expenses will increase.

Lower customer satisfaction
The analog optics used in traditional HFC networks significantly reduce the signal-to-noise ratio (SNR) and negatively impact service quality and the customer experience. The associated truck rolls also increase operating expenses.

DAA resolves the challenges of the traditional cable access architecture.

As noted above, DAA distributes the functions typically performed in the CCAP, moving some of them from the headend to the node. There are two main variants of DAA – Remote PHY (R-PHY) and Remote MACPHY (R-MACPHY).

The difference between the two variants is based on which CCAP functions get moved to the node:
- In R-PHY, only the DOCSIS PHY is relocated to the node
- In R-MACPHY, both the DOCSIS MAC and DOCSIS PHY are relocated

By distributing these functions, DAA resolves the challenges of the traditional cable access architecture. Pushing the DOCSIS PHY to the node digitizes the entire fiber transport network, eliminating the need for analog optics, reducing the overall capital expense and supporting more capacity via higher orders of modulation. Additionally, because RF signals now begin at the node instead of all the way back at the headend, DAA provides a much higher SNR, substantially boosting customers' quality of service. Finally, because less equipment is required in the headend and hub, especially in the case of R-MACPHY, there is a significant reduction in space and power requirements.

DISAPPEARING **Roadblocks**

Until recently, obstacles including lack of standardization, unproven interoperability, and few real-world deployments tempered operators' willingness to implement a DAA. However, as outlined in *Table 1: Disappearing Roadblocks* below, these barriers have been or are being eliminated.

Feature	R-PHY	R-MACPHY
Standardization	It took over six years to establish a standard for R-PHY. CCAP and Remote PHY Device (RPD) vendors had to work through a multitude of architectural challenges. With those issues resolved, the CableLabs Remote PHY standard has delivered stability and enabled multi-vendor, end-to-end R-PHY solutions.	The standard for R-MACPHY is CableLabs Flexible MAC Architecture (FMA). The critical FMA specifications are complete (See Vecima FMA Specification blog). Relying heavily on the path paved by R-PHY, R-MACPHY was comparatively easy to specify. As the inventor of R-MACPHY and main contributor to the FMA specification, we can confidently say that standardization is not a roadblock.
Interoperability	Deploying best-in-class CCAP cores and RPDs together has been a major hurdle for R-PHY, but many vendors have finally achieved interoperability. For instance, Vecima RPDs are fully interoperable with both physical and virtual CCAP cores from the industry's major vendors – Cisco, CommScope, Casa, and Harmonic. See Table 2, below, for details on Vecima RPD interoperability.	The same factors that expedited FMA standardization have facilitated R-MACPHY interoperability. The biggest challenge for R-PHY was DOCSIS PHY/MAC interop; Remote MACPHY Devices (RMDs) have no DOCSIS PHY/MAC interop requirement. Also, R-MACPHY uses the same standardized, proven video architecture as R-PHY. Furthermore, FMA uses automation and tools that reduce the interoperability effort.
Proof Cases	R-PHY has been deployed by operators of all sizes and in all regions of the world. With numerous reference deployments, operators can be confident in deploying R-PHY.	R-MACPHY has been deployed by operators of all sizes and in all regions of the world. With numerous reference deployments, operators can be confident in deploying R-MACPHY.

Table 1: Disappearing Roadblocks

Interoperability is an essential consideration for R-PHY deployments. To avoid finding themselves locked into a single vendor, book-ended solution, operators should plan to deploy networks using nodes sourced from different vendors than their CCAP core.

With the R-PHY specification in place, many vendors have successfully proven interoperability. For instance, Vecima has successfully established broad interoperability between its R-PHY nodes and CCAP cores from major vendors including Cisco, Casa, CommScope and Harmonic. In fact, as the only major supplier of DAA nodes that doesn't also sell a CCAP core, we're interop subject matter experts. *Table 2: Vecima RPD Interoperability* below details Vecima's interoperability success with these vendors.

Feature	Cisco	Casa	Casa	Arris
D3.0 Downstream	✓	✓	✓	✓
D3.0 Upstream	✓	✓	✓	✓
Downstream Bonding	✓	✓	✓	✓
Upstream Bonding	✓	✓	✓	✓
D3.1 Downstream	✓	✓	✓	✓
D3.1 Upstream	✓	✓	✓	✓
NDR/NDF	✓	✓	✓	✓
Viavi Integration	✓	✓	✓	✓

Table 2: Vecima RPD Interoperability

Complete & Validated

Complete

R-PHY vs. R-MACPHY Considerations

With the benefits of DAA well defined and established, and with the roadblocks – standards, interoperability and proof cases – knocked down, the question is no longer, "Should I implement a DAA?" but "What is the best approach for my network: Remote PHY or Remote MACPHY?"

An operator's decision will come down to two key considerations: 1) what are the key strategic and tactical benefits sought, and 2) which approach is better suited to their current network architecture and status?

Figure 1: Key Strategic and Tactical Goals for DAA

KEY CONSIDERATIONS **for DAA**

As shown in Figure 1: Key Strategic and Tactical Goals for DAA, there are four key strategic goals associated with DAA:

- Improving network flexibility
- Increasing service velocity
- Maximizing network ROI
- Future-proofing the network

However, the near-term driving factors to deploy DAA today are almost always focused on the tactical benefits of cost and capacity which translate into two primary goals:

- Increased HFC fidelity (providing additional capacity and better service quality)
- Greater headend density (enabling facility consolidation and reduced space and power)

R-PHY addresses the HFC fidelity issue by digitizing the network all the way to the neighborhood/node. R-MACPHY also addresses HFC fidelity, but additionally maximizes headend density by virtualizing the CCAP core, which in turn minimizes headend/hub space and power requirements.

When deciding between R-PHY and R-MACPHY, operators often take into consideration factors such as the degree of congestion in their headend/hub, available capacity (and therefore investment) in their existing CCAP devices, current power use in the outside plant, latency requirements, and their overall strategic network plan.

R-PHY **Advantages**

Using R-PHY nodes connectede to existing CCAP devices is a smaller DAA step than R-MACPHY. It has lower perceived risk and offers the following benefits:

Minimize operational change

- Takes advantage of existing headend infrastructure and architecture
- Operators convert existing CCAP devices to CCAP cores and replace analog optical nodes with RPDs, without changing anything upstream of the CCAP

Leverage CCAP capacity and video

- If an operator has significant capacity remaining in its CCAP devices, this capacity will not be left fallow.
- If an operator has already fully integrated video into the CCAP, they can continue to take advantage of this

Lower OSP power

- Today, an R-PHY node uses about 5% less power than an R-MACPHY node
- In most cases, this is not a decision point, but in an environment where power and space (size of node is dependent on power) in the outside plant are very limited, R-PHY is likely the better choice

Steppingstone to R-MACPHY or FTTH

- R-PHY serves as an excellent first step towards R-MACPHY or, ultimately, Fiber-to-the-Home (FTTH).

The near-term DAA drivers are typically focused on increased HFC fidelity and greater headend density.

R-MACPHY **Advantages**

R-MACPHY is a bigger step than R-PHY. It delivers almost all of the R-PHY benefits above, and in addition delivers:

Smallest Headend and Hub Footprint

- Eliminates existing and future headend and hub equipment
- Minimizes space requirements, allowing for facility reduction
- Minimizes power and cooling requirements (See *Figure 2: Comparing Space and Power Requirements for DAA Approaches*)

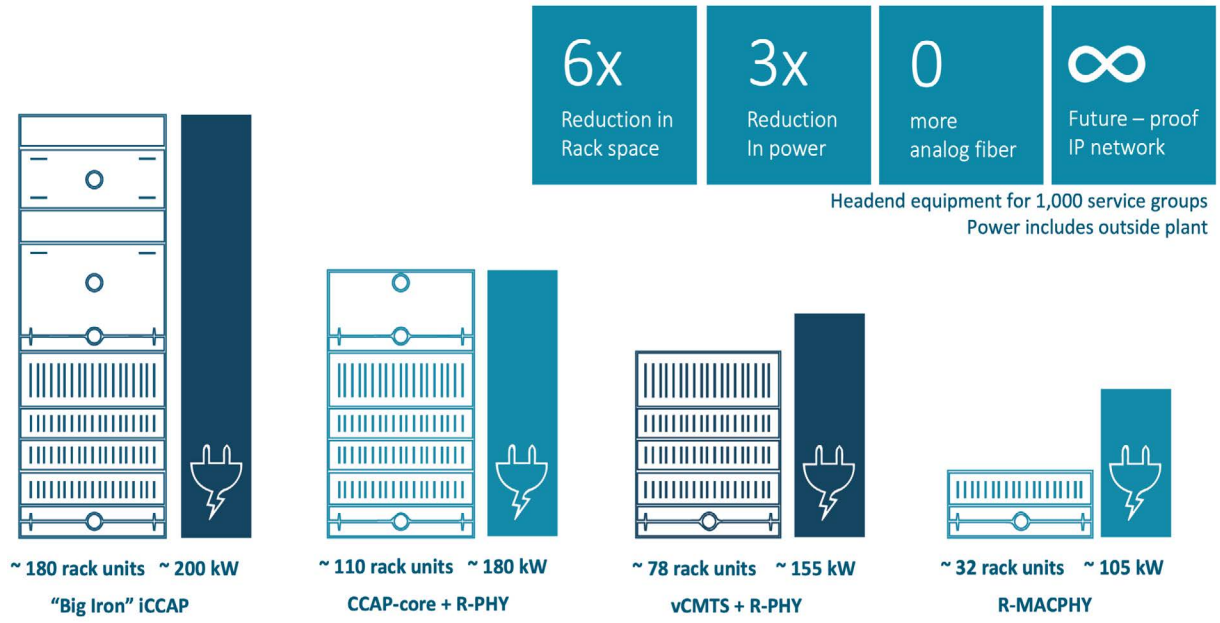

Figure 2: Comparing Space and Power Requirements for DAA Approaches

Lowest Latency (no distance limits)

- Ensures there are no latency issues in the network regardless of how far the node/neighborhood is from the headend
- Enables hub collapses and massive centralization

Greater Network Convergence

- Aligns all access technologies in the outside plant – DSL, DAA, FTTH, mobile – to the same IP architecture, enabling a Converged Interconnect Network (CIN) and unified control and management
- Simplifies the network architecture and allows it to flexibly align with the vision of a fully converged, multiservice access network

Steppingstone to FTTH

- R-MACPHY is a natural waypoint in the evolution to FTTH

If you're wondering, **"Can I Use R-PHY and R-MACPHY in the same network?"** the answer is, "Of course!" Some operators have even discussed using them in the same hub, using R-PHY to leverage existing CCAP investment, and then capping and growing the network with R-MACPHY. The two technologies are fully compatible and can be transported across the same CIN network.

Making the R-PHY and R-MACPHY Decision

So, how should an operator ultimately choose between R-PHY and R-MACPHY?

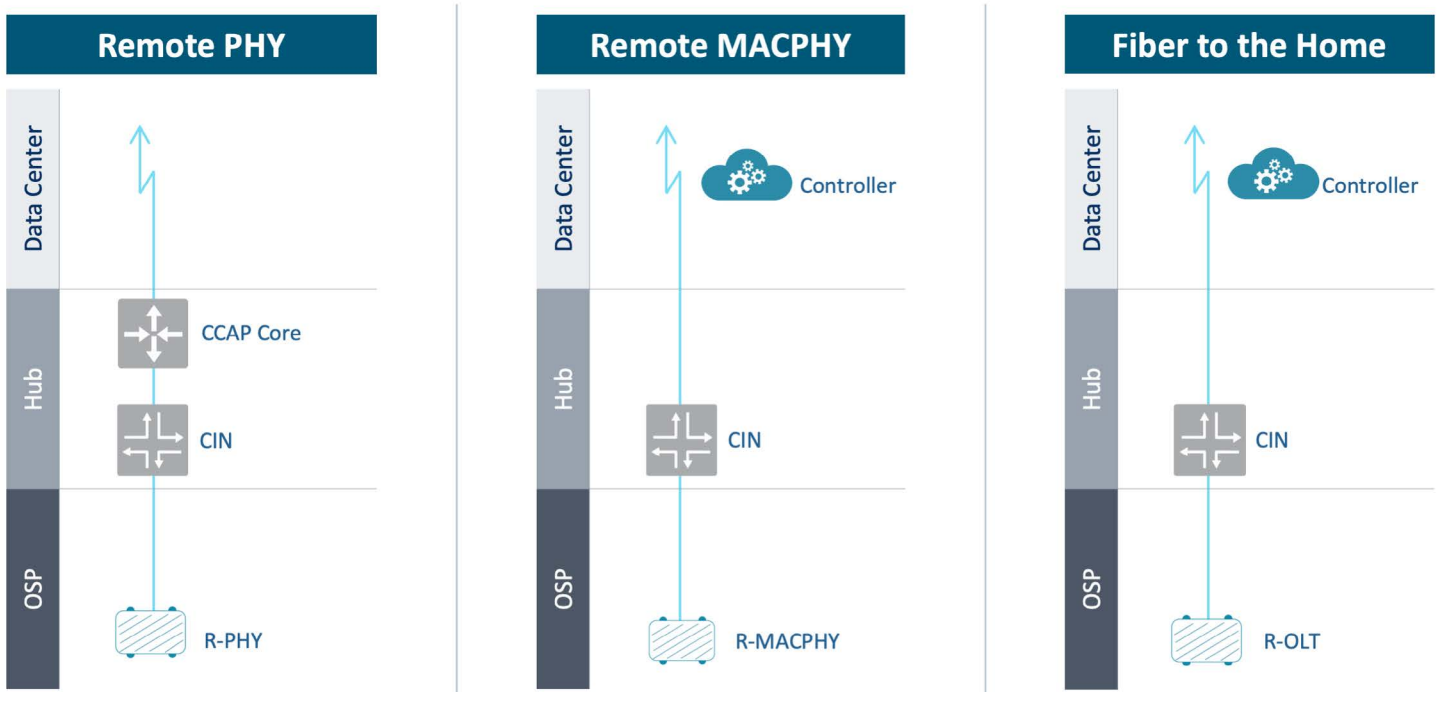

Figure 3: The Best Technology for Each Situation

It is obviously an involved decision, but to simplify things a bit:

R-MACPHY delivers greater financial and operational benefits, and it is a superior strategic solution.

R-PHY delivers significant benefits, requires a smaller step when deployed with an existing CCAP core and enables operators to take advantage of existing CCAP capacity.

So, we suggest operators choose R-MACPHY for its greater immediate benefits - HFC fidelity, space and power savings, low latency -- and its long-term advantages -- network flexibility.

If an operator is not ready for that big of a step or if they have significant existing capacity to leverage, we suggest they choose R-PHY, which still delivers strong benefits – higher fidelity HFC and denser headends – over the existing iCCAP architecture.

What about Fiber-to-the-Home (FTTH)? FTTH has its place as well, of course. Its role today is predominantly greenfield residential services and commercial services. FTTH has been hampered in brownfield deployments due to legacy video, but is growing as operators move to IP video. We will address FTTH in another whitepaper.

Both approaches deliver strong financial, operational and strategic benefits. If you are unsure which approach is the best fit for your network or specific network situation, Vecima is ready, willing and able to assist you in a full evaluation.

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