Virtualized Converged Cable Access Platform (CCAP) Operation

Learn how CommScope's vCCAP Evo™ solution can optimize your next-generation HFC and DAA network deployments.

Each new iteration of DOCSIS® standards has improved HFC access network performance while expanding the bandwidth spectrums available for network operation. These improvements, in turn, have led to newer and better consumer service offerings, supported by ever-increasing throughput speeds and network capacities. But even as HFC access networks have evolved in parallel with DOCSIS standards, so too have the demands and requirements placed on inside and outside plant architectures. These fall into two categories: on one hand, supporting expanded spectrums, throughput speeds, and increased traffic as the network evolves and services (and subscribers) are added; on the other, replacing, updating, and/or modifying the equipment deployed in the network to support the new DOCSIS standards and requirements that make improved network performance possible.

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SOLUTION BRIEF

The Challenge

In the headend, the incremental expansion of HFC access networks, and the resulting pressures placed on operational efficiencies, has resulted in increased Converged Cable Access Platform (CCAP) densities.[1] Today, as many cable operators optimize their networks for full DOCSIS 3.1 operation, these densities are quickly approaching critical mass. Expanding chassis capacity, powering and maintenance requirements, and the slow and cumbersome process of adding and provisioning new equipment not only pose logistical problems—what to do, for example, when the headend location runs out of space—they also hamper an operator's ability to scale their headend architecture quickly, efficiently, and seamlessly. And that's before the cost considerations. Simply put, scaling a hardware-based CCAP architecture to support DOCSIS 3.1 densities—the common approach taken by cable operators to support previous iterations of DOCSIS— is no longer practical.

Cable operators can address these issues in one of two ways. CommScope's DOCSIS 3.1*Enhanced* (D3.1*E*) supports expanded OFDM downstream channels in DOCSIS 3.1 mid-split or high-split networks; operators who wish to extend the life of their physical E6000® or C100G chassis, and who don't have any immediate plans to transition to a DOCSIS 4.0 network, can support D3.1*E* operation with chassis software and mid-split or high-split plant upgrades.[2] For cable operators already contemplating a transition to DOCSIS 4.0, however, now is a good time to consider an alternative to traditional, hardware-based CCAP architectures.

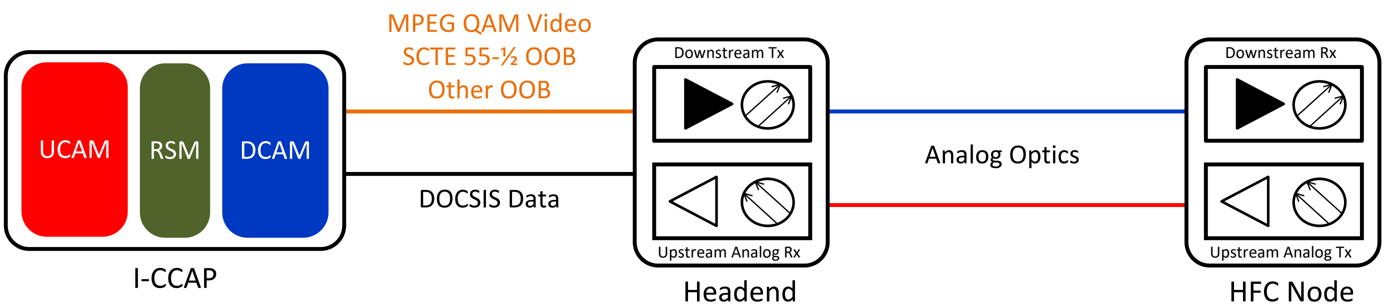

Figure 1. Basic Hardware-based CCAP Architecture

Revolutionary technologies such as Distributed Access Architecture (DAA) and Node PON address many of the challenges operators may encounter with end-of-life CCAP technology by pushing the edge of the network from the headend into fielded nodes, eliminating the need for many hardware components associated with physical CCAP cores. While many cable operators have either adopted these technologies already or plan to do so soon, most of these current deployments have been made in select portions of their networks—typically, but not exclusively, limited to high density, high traffic areas—leaving large areas of the network to operate as before.

Practically, this means cable operators will continue to utilize traditional HFC access networks, in some capacity, for the foreseeable future. Doing so, however, requires a solution that eliminates the scaling, space, and powering issues that arise as networks expand and grow while also maximizing the efficiencies and useability of existing equipment. Future-proofing the headend by establishing a foundation for full DOCSIS 4.0 operation is also a consideration. Thus, cable operators should consider a headend solution that:

- Leverages existing CCAP architectures, while also supporting incremental upgrades and improvements over time at whatever pace and budget the business can support
- Supports both virtualized DAA and Node PON operation and traditional HFC access network delivery of content
- Supports all common, current CCAP architectures and the rapid adoption of new headend technologies as they reach market
- Pivots quickly and seamlessly to support evolutionary and revolutionary network technologies
- Scales quickly and cost-effectively to support evolving density, throughput, and efficiency requirements

Virtualizing the headend supports all these requirements, while also providing a flexible, economical foundation for supporting DOCSIS 3.1*E* and DOCSIS 4.0 network improvements.

1 CCAP platforms differ from Cable Modem Termination System (CMTS) platforms in that they combine Edge QAM and CMTS functionality, which allows the CCAP to deliver both data and video to subscribers.
2 Beginning with Software Release 13, CommScope's Gen 2 E6000 CER will support D3.1E functionality; C40G and C100G I-CCAPs will support D3.1E functionality beginning with Software Release 8.12.

Reaching for the Cloud: Virtualized CCAP Operation

"Flexibility" is a byword for virtualized headend operation. Its appeal lies in the variety of approaches cable operators can adopt to transform their headend architectures. While a fully virtualized headend architecture encompasses virtual management, video, control, and data planes, cable operators can choose to virtualize all of these planes—or subsets of them—based on their network design, content delivery requirements, and traffic management needs.

Similarly, cable operators can choose from several incremental approaches to virtualizing CCAP operation based on how well their current CCAP architecture supports the demands and stresses placed on their networks, their immediate plans for optimizing and evolving their network architectures, and their long-term plans for supporting multi-gigabit service tiers. Because of these varied approaches, cable operators can choose to:

- Enhance a hardware-based CCAP core while supporting D3.1*E*
- Transition from a hardware-based CCAP core while moving the PHY layer to a remote PHY shelf and retaining analog optics in their node population (an approach that's typically used in MDU deployments)
- Transition from a hardware-based CCAP core while moving the PHY layer to a node-based Remote PHY Device (RPD) and replacing analog cabling with digital fiber to the node. The RPD extends the PHY layer from the CCAP core to the edge of the network

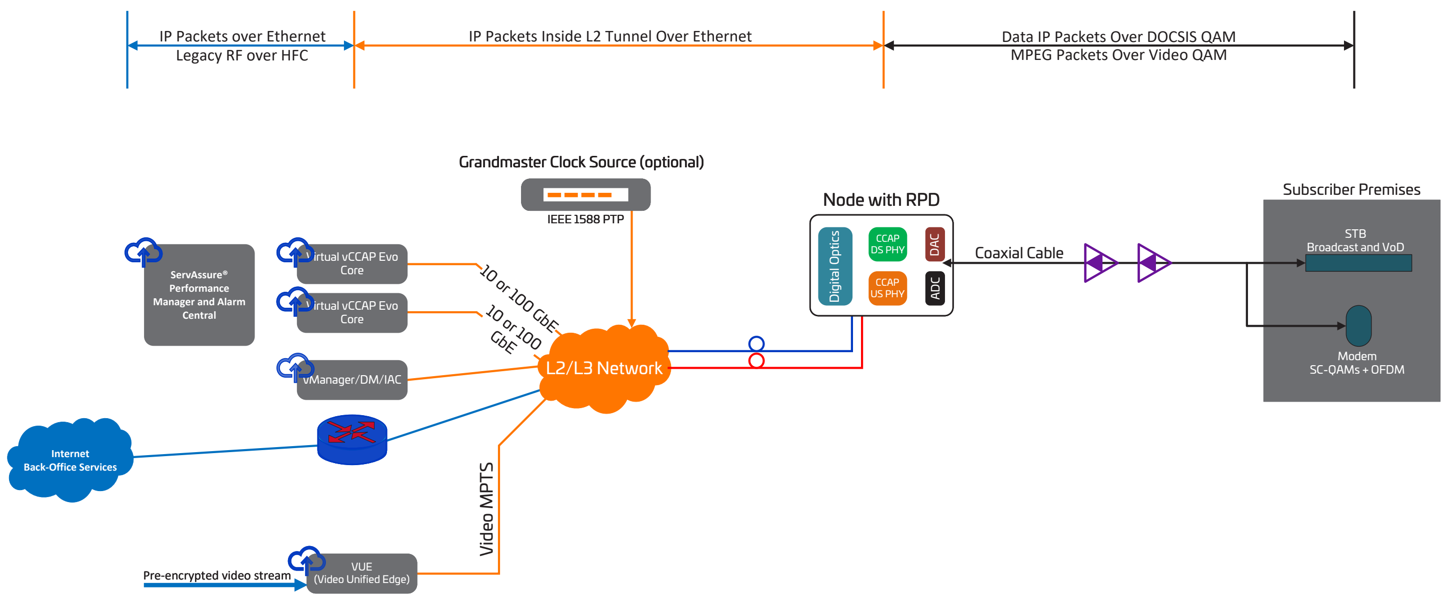

Figure 2. Basic Virtualized CCAP Architecture in a DAA Network

These options are not mutually exclusive, nor do they preclude cable operators from starting with one option and evolving to another—for example, beginning with virtualized HFC cable access network operation and transitioning to a node-based RPD approach in the future, as dictated by their business needs and goals.

With so many options available for partially or fully virtualizing the CCAP core, cable operators can easily scale their headend architectures as dictated by their business plans to expand their network capacity, roll out new service offerings, and/or address aging plants. This scalability also ensures that, as networks evolve and traditional HFC networks are transformed by revolutionary new technologies over the next decade, the virtual CCAP core can quickly and efficiently support the transition from standard DOCSIS 3.1 or D3.1*E* operation to DOCSIS 4.0 operation.

vCCAP Evo™: Virtualizing DAA Operation

CommScope's vCCAP Evo solution supports Remote PHY operation with a virtualized CCAP core. It's based on proven, field-hardened technology that's been in service for over 20 years, leveraging CommScope's robust, feature rich CCAP MAC and application software to easily port across all common CCAP and DOCSIS architectures. Additionally, by using common MAC software and common routing software, the vCCAP Evo solution supports the deployment of common features across both hardware- and cloud-based architectures.

The vCCAP Evo solution virtualizes CCAP management by utilizing a cloud-native architecture that is based on CommScope's C100G I-CCAP core DOCSIS and routing software. It has both immediate and future benefits: first, as a key component in overcoming the density and scaling limitations of currently evolving DOCSIS 3.1 networks, and second as a first step towards fully supporting next-generation DAA operation in both current DOCSIS 3.1 and D3.1*E* architectures and future DOCSIS 4.0 network deployments.

The vCCAP Evo solution's high scalability is especially useful in DAA architectures, as it supports higher scales of RPD devices per server clusters over time; the vCCAP Evo solution can support very large numbers of service groups per host server cluster (the architecture of which is discussed in more detail below, and which is subject to redundancy and how an operator engineers traffic on the network). The management plane utilizes both a Command Line Interface (CLI) and netconf/YANG Application Programming Interface (API) to receive and execute commands from the common core, Simple Network Management Protocol (SNMP) to manage devices on the network, syslog to log and analyze messages, and Internet Protocol Detail Record (IPDR) to collect and record statistics on data traffic and consumption from CPE devices in the network. The vCCAP Evo solution also supports telemetry streaming, which simplifies the management and visibility of both the vCCAP Evo core and active RPDs in the field.

The sections that follow describe the vCCAP Evo solution in greater detail.

vCCAP Evo Hardware Architecture

Components of the Connected Interface Network (CIN)—which connect the headend and data center to the HFC or DAA access network—are hardware based and independent of the vCCAP Evo solution.

The vCCAP Evo solution supports flexible deployment options, beginning with a cluster of two servers to support the control and DOCSIS data planes; this architecture also supports 1+1 redundancy. Using this basic deployment as a foundation, operators can then add additional data plane servers as needed to support additional throughput requirements; typically, a two-server data plane cluster can support as many as ~120 x 250 service groups with high availability. As new data plane servers are added, the redundancy for them becomes N + M, in which N indicates active servers and M indicates backup servers. Operators who don't require redundancy have the option of running the vCCAP Evo solution from a single data plane server.

vCCAP Evo host server specifications are shown in Figure 3.

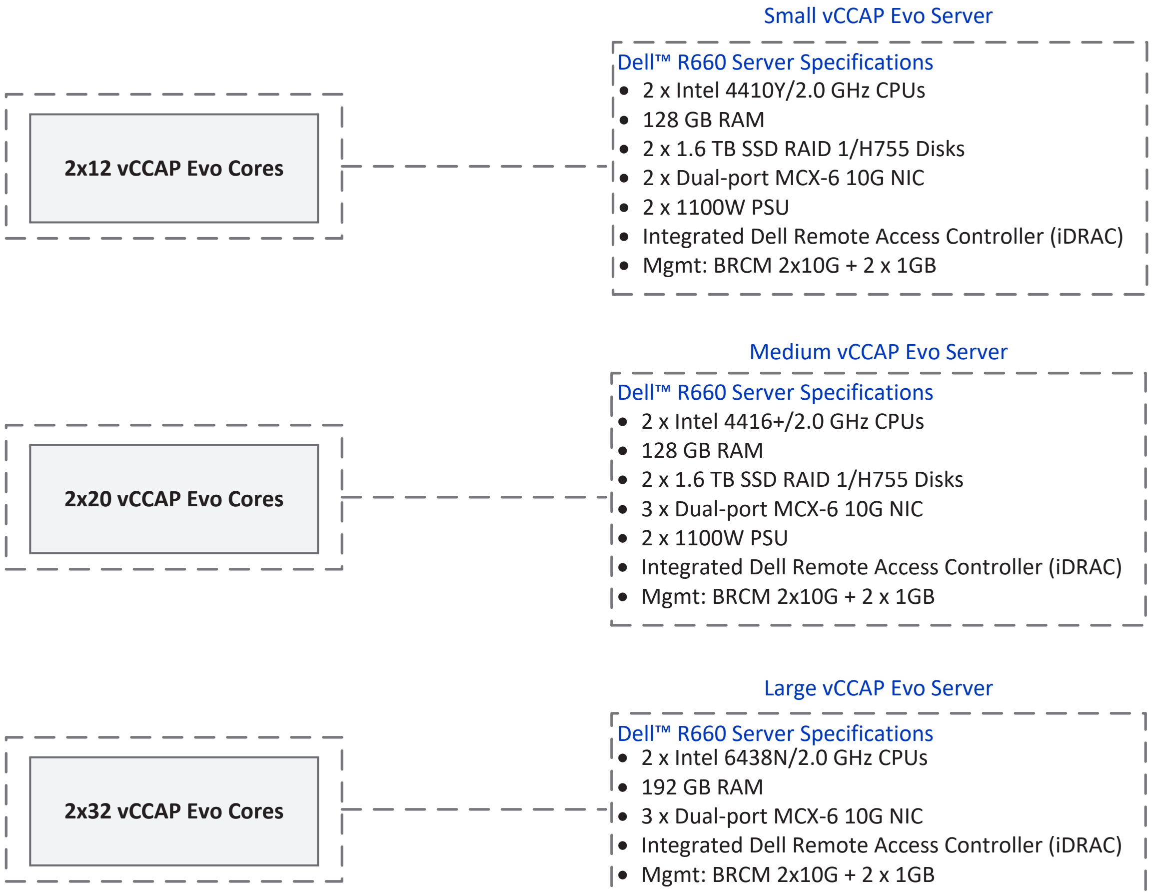

Figure 3. vCCAP Evo Server Specifications

The vCCAP Evo solution utilizes a Domain Manager or Intelligent Access Controller (IAC) cluster that manages all vCCAP Evo cores. A Domain Manager/IAC cluster does not have to be co-located with the core; the two can occupy different geographic locations. Each Domain Manager/IAC platform supports the on-boarding, configuration, operation, and management of fielded RPD devices to greatly simplify network expansion and scaling.

Figure 4 shows the Host Server and Domain Manager architecture.

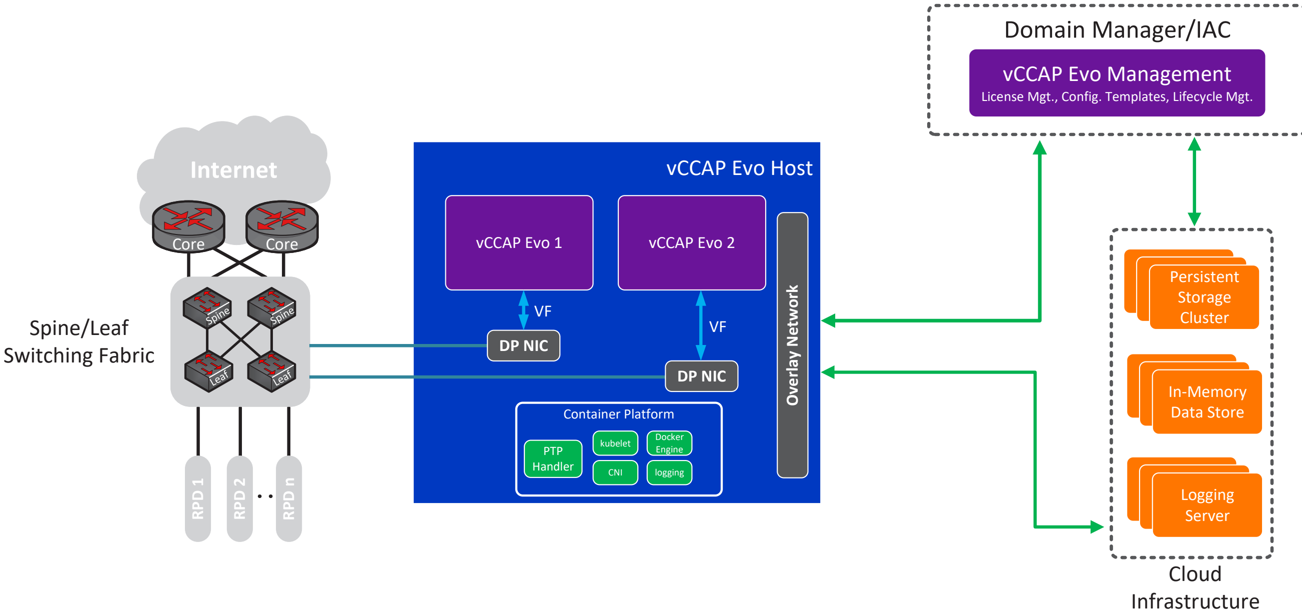

Figure 4. Host Server and Domain Manager Architecture

Domain Manager is RPD-vendor agnostic; although it is optimized for CommScope DAA and PON devices, the Domain Manager can manage hardware from any vendor. It supports both direct and pre-programmed control of crucial network elements. This enables service providers to migrate from hardware-based I-CCAP to DAA or PON operation quickly and cost-effectively, while leveraging Domain Manager's automated features to minimize service interruptions and reduce maintenance costs. Crucially, this simplifies operation by providing a common, centralized view of the network across multiple access networks—HFC, DAA, and PON—and hardware platforms.

Addendum: Virtualizing the Video Plane

While vCCAP Evo supports legacy broadcast and VOD video, more advanced features are available with CommScope's Video Unified Edge (VUE). Video and data services scale differently and are typically managed separately, so de-coupling the video core and allowing it and data to run independently of each other eliminates the risk of one impacting the other.

Video Unified Edge (VUE)

VUE is a suite of modular software functions that virtualizes—and thus simplifies— legacy, hardware-based QAM video networks. VUE, which supports the video data plane and video control plane, operates as an auxiliary video core in a DAA network to enable the delivery of video content to RxD devices. The VUE auxiliary core control plane (ACCP) communicates with RxDs to configure them for video services and to collect video-relevant telemetry. For the data plane, VUE ingests broadcast, narrowcast VOD, and SDV encrypted video MPEG transport streams, multiplexes them into operator-configured output transport streams, and encapsulates the transport stream video multiplexes into DEPI tunnels for delivery to RxDs.

The VUE solution can be easily scaled up, as required, by simply adding additional server resources to accommodate more transport stream capacity and/or to manage a growing population of RxD devices for video services. Operators can also configure VUE to encapsulate SCTE 55-1 out-of-band (OOB) multiplexer streams sourced from the CommScope OM2000 into a DEPI tunnel; alternatively, VUE can fully replace the functions performed by the OM2000. Operators can also configure VUE to receive upstream SCTE 55-1 directly from RxDs via R-UEPI and act as a virtual ARPD.

Video Topology Manager (VTM)

The Video Topology Manager (VTM) is a high-level DAA video management solution that can manage multiple VUE video core systems. The VTM provides automation capabilities that enable operators to configure and/or modify configurations of RxDs in mass. Channel frequency changes, for example, can be propagated out to all RxDs in a particular region in a few simple steps. For operators that use the CommScope DAC, the VTM can automate the creation of the DAA device population(s) frequency plans from the DAC's existing channel maps.

The VTM aggregates metrics and alarms from all the VUE Systems (including DAA device related alarms generated by the VUE) and provides filtering capabilities to isolate alarms when necessary. The VTM also provides graphical displays of each RxD packet/channel metrics—for example, Dropped Ingress Packets, which is the ratio of the DEPI frames received in the last sampling interval over the number of frames transmitted by the VUE—to assist in troubleshooting.

Operators' existing back-office systems can use the VTM's API, or operators can use the VTM GUI to manage the all the VUE systems. The VTM provides a central dashboard GUI that allows operators to manage RxDs, narrowcast service groups, and broadcast service groups in real time.

Conclusion

Virtualized CCAP operation has many operational benefits—including scalability, reduced power consumption, and space savings—that are applicable across a wide range of cable network architectures. While perhaps the greatest benefits of virtualized CCAP operation are realized in DAA and Node PON deployments, cable operators need not commit to these next-generation technologies to improve the management, configuration, and maintenance tasks required to operate and grow their current networks. Since virtualization isn't an "all or nothing" approach, cable operators can virtualize their CCAP architectures in stages—perhaps in parallel with outside plant improvements—to fit their own upgrade plans and budgets.

CommScope's vCCAP Evo is an ideal solution for virtualizing CCAP operation in today's evolving HFC cable access networks and a first step towards tomorrow's revolutionary DOCSIS 4.0 network architectures. The vCCAP Evo, in conjunction with Domain Manager or IAC, solution fully optimizes DAA and Node PON operation by supporting the independent scaling and modification of new and current RPD service groups via cloud-based core management, control plane, and data plane functions. It is a truly versatile option for whatever path cable operators choose to go down—now and in the future.

CommScope offers a full, end-to-end portfolio of DOCSIS 3.1, D3.1E, and DOCSIS 4.0 products and solutions for inside and outside plant operation. For further information about the vCCAP Evo Solution, contact your CommScope Sales Representative.

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