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Virtualizing the cable headend

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Abstract

As service providers continue to evolve their networks to support the ever-growing demand for content, and as video delivery shifts from broadcast technologies (QAM) to IP, solutions are needed for flexible and adaptable network deployments. CommScope's extensive portfolio, flexible architecture, and professional services capabilities enable service providers to optimally evolve their broadband networks. Built upon 20+ years of field hardened code and a vast installed base, CommScope's Virtualization platform is specially optimized for broadband and video service delivery. Flexible and elastic, this virtual platform is designed with growth and scalability in mind. CommScope's solution is comprehensive as it enables the virtualization of the management & control plane, the video plane and the data plane. Each of these solutions is best-in-class in the industry and taken together provide the most optimal end-to-end solution. However, operators do not need to embark on a forklift upgrade, but rather benefit from CommScope's deep expertise and extensive support to implement a gradual migration to virtualization; CommScope's professional services team works with every operator to design the virtualization roadmap that is best suited to its current network, operational environment and business goals.

Introduction

Bandwidth consumption continues to skyrocket. The Covid-19 pandemic brought increased urgency to the importance of broadband networks and led to a sudden step-function consumption increase, beyond the normal growth trajectory that the industry has traditionally seen.

Indeed, within the space of a few days, the patterns of bandwidth consumption have markedly changed, driven by the sudden adoption of applications such as video conferencing and telehealth on a massive scale.

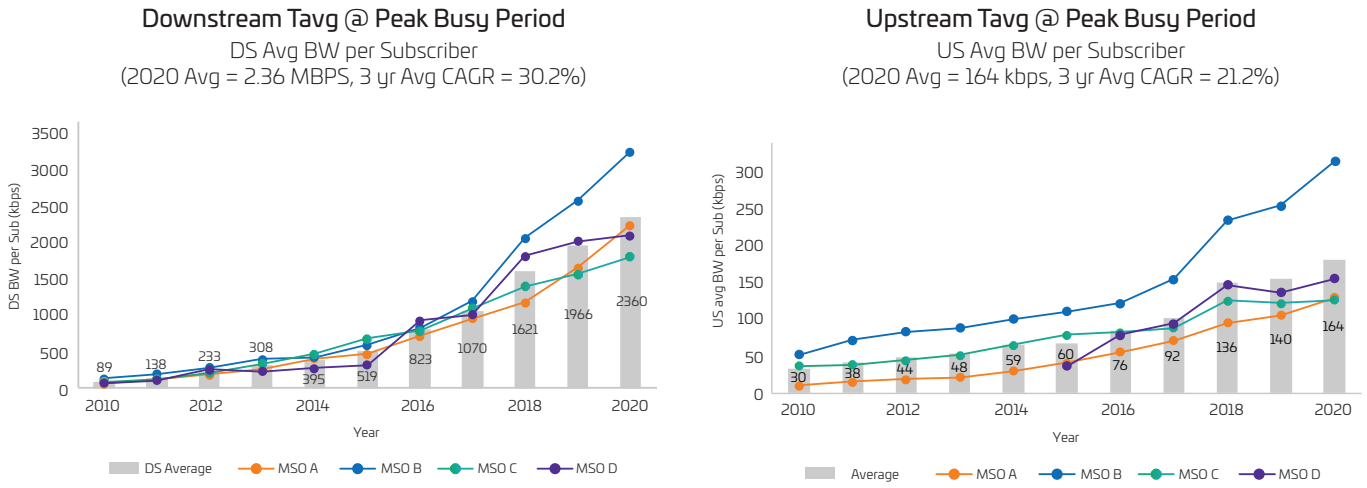

Figure 1. Bandwidth consumption trends (source: CommScope)

While the sudden increase in bandwidth consumption may somewhat taper off when lockdowns end, a notable portion of virtual engagement will become a long-term trend, requiring increased levels of network capacity, beyond what operators had originally planned.

Within this landscape, cable operators have continued to add capacity at an unprecedented rate. However, the massive and continuously growing demand requires a new playbook that enables them to optimize their network resources while simultaneously staying ahead of end user demand. Furthermore, in an increasingly dynamic market environment, operators need the ability to dynamically scale to meet demand, and to significantly increase service and feature velocity.

The Cable Access Evolution Trajectory

The access edge has evolved significantly over the past 20 years. In 2001, operators were deploying DOCSIS 1.1, and CommScope (back then Arris)'s C4 CMTS chassis delivered 1Dx8U (One Downstream and 8 Upstream Channels) per card, and a total of 16 cards for a total of 16Dx128U per chassis. The density and number of cards per chassis has steadily increased, in support of evolving versions of DOCSIS. Fast forward to 2015, when CommScope's E6000® Converged Edge Router (CER) (E6000) delivered 5376Dx1440U per chassis, supporting DOCSIS 3.1. More recently, the E6000 added support for OFDM and OFDMA.

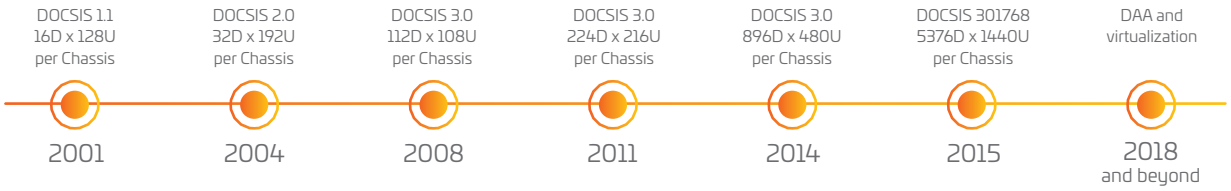

Figure 2. Evolution of access edge over the past 20 years

The capacity improvements needed going forward, will continue to require increased throughput and efficiency in the implementation of the CMTS. However, in some areas of high demand, the headends and hubs are becoming crowded, making adding more chassis a less than ideal situation, and relying on a hardware solution is no longer commensurate with the need for flexibility and agility.

These demands for improved efficiency and flexibility are why new technologies are needed to enable the continued modernization of the cable access edge. The move to distributed access architecture (DAA) solutions, along with virtualization, can address these needs and will underpin the industry's evolution for years to come.

The Distributed Access Architecture (DAA) and Virtualization

The DAA seeks to alleviate crowding in headends and hubs by moving some functionality to the edge of the network, typically the access nodes. There are a number of DAA variations:

- **For HFC:**

  Remote PHY – the PHY layer is moved to the access node, or to a Remote PHY shelf, while the MAC is retained in the hub or head end.

  Remote MACPHY – both the MAC and the PHY layers are moved to the access node.

- **For PON:**

  Remote OLT – the MAC and PHY layers are moved to the Optical Line Terminal (OLT), while the MAC management capability remains in the headend.

Until recently, the industry was consumed with debates about the relative merits of each of these approaches, with some vendors adopting one approach for their DAA solutions. As the industry evolved and as operators gained a better understanding of the tradeoffs of these variations, it became clear that operators needed different technologies in different parts of their footprints based on local parameters and requirements. Therefore, it is an imperative for vendors to offer an array of solutions, and operators need indeed to select a vendor that offers a continuum of technologies to meet their current and evolving needs.

In addition to alleviating the need for capacity in the headends, DAA involves removing the PHY layer from the CCAP, thereby paving the road to virtualization in the headend.

Virtualizing the Cable Headend

DAA is an important step in modernizing the cable headend; but to unlock the benefits of elasticity and agility, operators need to also migrate over time to a virtualized environment.

In a fully virtualized headend, the management plane, video plane and data plane are virtualized:

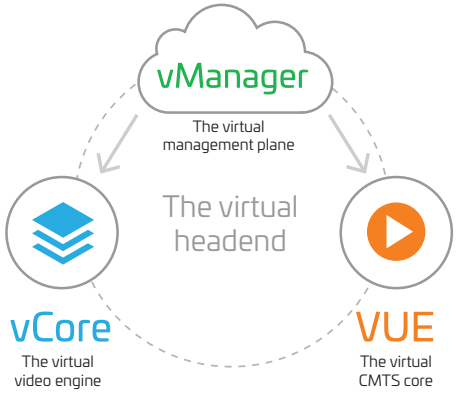

Figure 3. The virtual headend

It is recommended for operators to proceed deliberately and in steps as they embark on the virtualization journey. While there are significant benefits from operating in a fully virtualized environment, important gains can be realized over the course of a well-thought-out journey; indeed, a gradual approach enables the operator to realize benefits while at the same time mitigating potential risks associated with a complete overhaul.

Operators have a number of alternatives as they plan to introduce virtualization into their operating infrastructure. There is no one right solution, but each operator should consider its operating environment, its existing infrastructure, its business needs, and should identify the approach that best satisfies its unique parameters. What is also important to stress is that virtualization is not an all or nothing proposition; on the contrary, operators can derive significant value by introducing virtualization judiciously where it is most needed. Some approaches operators might consider, as explained in this blog :

- Operators who do not see a need to replace the hardware based I-CCAP can retain that network element, while virtualizing the management and control planes, which can result in significant benefits.
- Operators can virtualize the CMTS Core and move the PHY layer to a Remote PHY shelf. This approach enables the MSO to derive virtualization benefits while preserving analog optics.

[1] https://www.multichannel.com/blog/riding-virtualization-wave-guest-blog

- Virtualize the CMTS Core and move to a Remote PHY architecture by moving PHY layer to a Remote PHY device (RPD), which is housed in the access node. In this case, traffic out of the headend is carried over digital fiber, rather than analog, improving signal quality and extending the distance between the headend and the node.
- Evolve to a Remote MACPHY architecture, where the MAC and PHY layers are moved to the node, and a Remote MACPHY device (RMD) is housed in the node and performs the CMTS core capability.

Comprehensive Solution for the Virtual Headend

The right virtual headend solution should encompass the three major elements: data plane, video plane and management plane, and each solution should offer best in class capability, while enabling a clear evolution pathway.

The virtual CMTS Core - vCore

A key element of the DAA is the CMTS Core, which handles DOCSIS processing. Virtualizing the CMTS Core is fundamental to a fully virtualized architecture, because of the cost efficiencies, agility and velocity it enables. CommScope's vCore solution brings unique advantages, and builds on CommScope's extensive and successful track record with the C4 CMTS and the E6000 CCAP.

vCore overview

vCore is a cloud-native implementation of the CMTS Core; it leverages the cloud-computing delivery model. In this model, applications are packaged in separate containers, which are dynamically orchestrated to optimize resource utilization. These apps are loosely coupled and independent of infrastructure, enabling them to be modified or scaled independently of one another. This capability is fundamental to enabling a Continuous Integration / Continuous Development (CI/CD) environment, which is essential to service and feature velocity and dynamic scaling, providing to the operator the agility to respond to shifting market conditions. Cloud-native does not necessarily mean the applications are running in the cloud; they can run in the headend, in a dedicated data center, in the cloud, or in another location. This flexibility is one of the major benefits of virtualization.

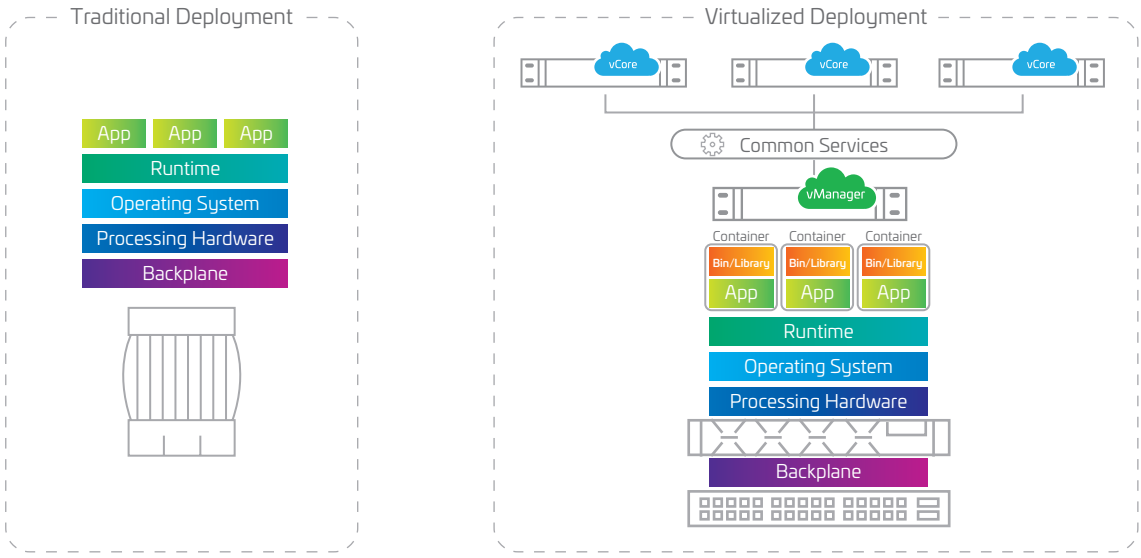

Figure 4 - Comparing the Hardware solution to the virtualized solution

vCore unique attributes

vCore benefits from CommScope's substantial track record in field deployments, and from the latest innovations in cloud native technology.

Field hardened, feature rich

vCore was not built completely from scratch; some of the capabilities in the widely deployed C4 and E6000 have been refactored (essentially repackaged) as microservices to run in the containerized environment. This enables vCore to leverage the extensive features set, and the substantial field hardening that these network elements have garnered from to their massive field deployments.

Industry leading data processing throughput

The data-plane, which handles the traffic transmission, has been completely re-architected in vCore, significantly increasing service group density, and resulting in industry leading data processing throughput. It runs on Common Off the Shelf (COTS) hardware, enabling it to benefit from Moore's Law for increasing processing cycles.

Unique 3D scaling

The 3D scaling model inherent to vCore enables service providers to optimize their network design to achieve their QoE objectives while minimizing spend on server and switching infrastructure. vCore is optimized to use the smallest number of COTS servers, resulting in reduced space, power and cost. It also has a highly efficient utilization of leaf/spine switch ports. It is a Layer 3 aware solution, providing improved real-world usability.

The three elements of vCore scaling:

1. Scaling with processor core count improvements; this is inherent to all virtualized solution architectures and enables them to take advantage of the continued march of Moore's Law.
2. MAC domain scaling, which enables native support for multiple service groups per vCore instance.
3. Throughput scaling using a mesh compute architecture. This increases the throughput of each vCore instance, enabling operators to optimize their server footprint.

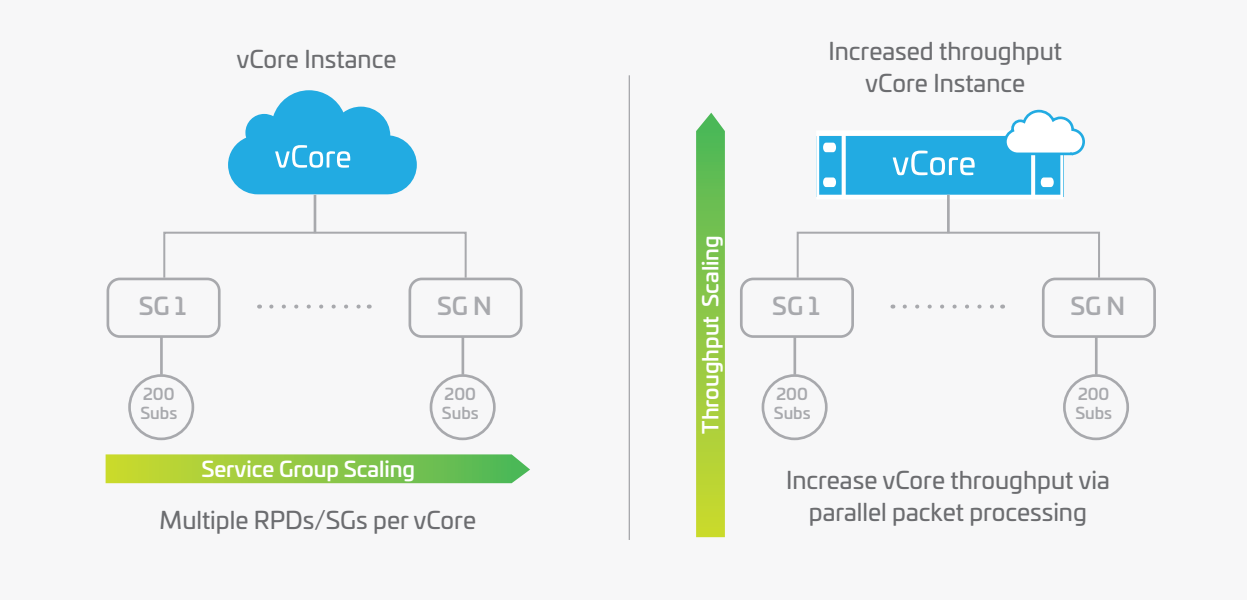

Figure 5 – CommScope vCore 3D scaling

Every operator has a unique combination of service group sizes, billboard speeds, and usage patterns. CommScope has proprietary traffic modeling tools built on a deep understanding of traffic engineering for access networks. These tools can be used in conjunction with the 3D scaling architecture to enable deployment plans to be "right-sized" for each operator's unique circumstances rather than using a one size fits all architecture.

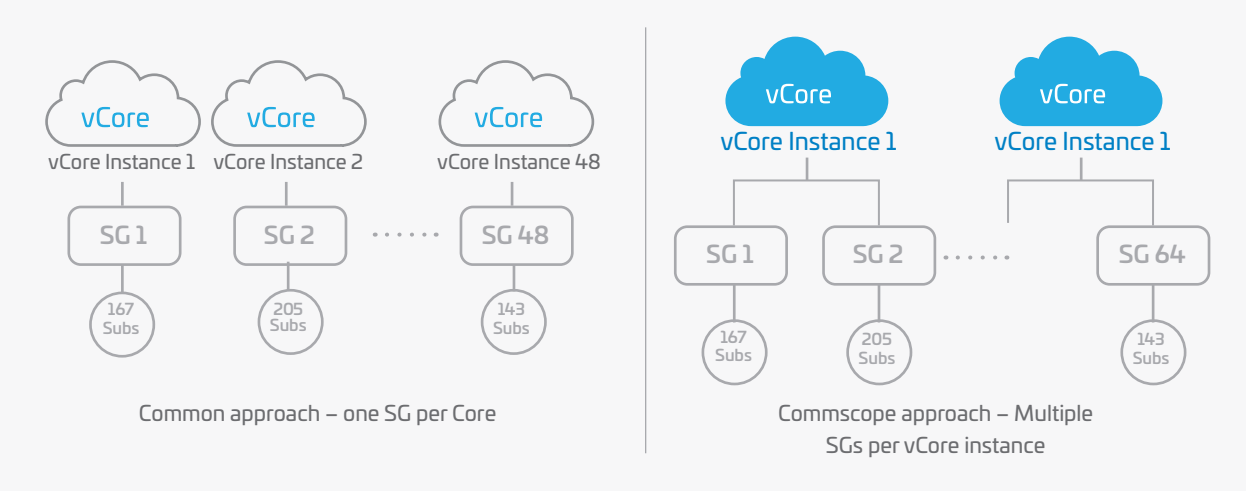

Figure 6 - Optimizing server resource deployment with the CommScope solution

The high throughput and efficient scaling of vCore, combined with the DAA, drive significant space (and associated cost) savings in the headends.

Hardened for field deployment

vCore benefits from CommScope's extensive testing capabilities, where the solution is stress tested in labs with tens of thousands of modems and eMTA's, not just with simulators. Such deep and broad testing capabilities are unique to CommScope and have been developed over many years of deploying robust solutions that have established the company as the market leader in cable industry solutions.

vCore also has a number of field deployment options that include high availability with hitless failover that again leverages learnings and approaches from the E6000 platform.

The virtual video engine - Video Unified Edge

The CommScope Video Unified Edge (VUE) is a suite of modular software functions deployable in the operator's cloud environment that virtualize the legacy video delivery infrastructure and functions as the Video Core in Remote PHY and Remote MACPHY architectures, supporting both video data plane and video control plane, as well as SCTE 55-1. It virtualizes EQAM functions by handling the packet processing, while RF modulation is done in Remote PHY or Remote MACPHY nodes.

Furthermore, in combination with CommScope's Vertasent virtualized control plane portfolio and the vManager VTM module, VUE can enable an entire video service lineup to be delivered with 32 QAM's (192 MHz) or even less, freeing up significant plant bandwidth for the continued expansion of DOCSIS service offerings.

The virtual cable access orchestrator – vManager

vManager facilitates deployment, configuration and management

vManager's suite of microservices facilitates deployment configuration and management of DAA networks, by providing the capability to manage each of the elements of this complex architecture, while offering a cohesive, comprehensive management layer.

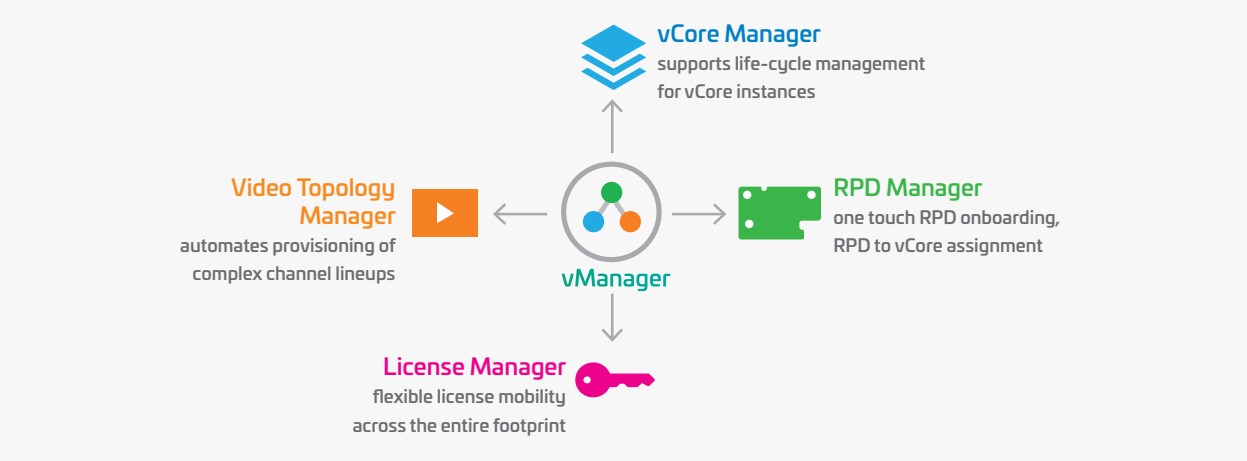

Figure 7 - vManager enables end-to-end management

vManager provides both human (GUI) and machine (API) interfaces for key installation and operation activities. It also integrates with the CommScope ServAssure NXT platform for richer DOCSIS performance management, optimization and analytics features.

Introducing virtualization in the headend

Below is a network architecture that shows how virtualization and DAA can be introduced, while supporting all legacy services, and preserving analog optics where needed:

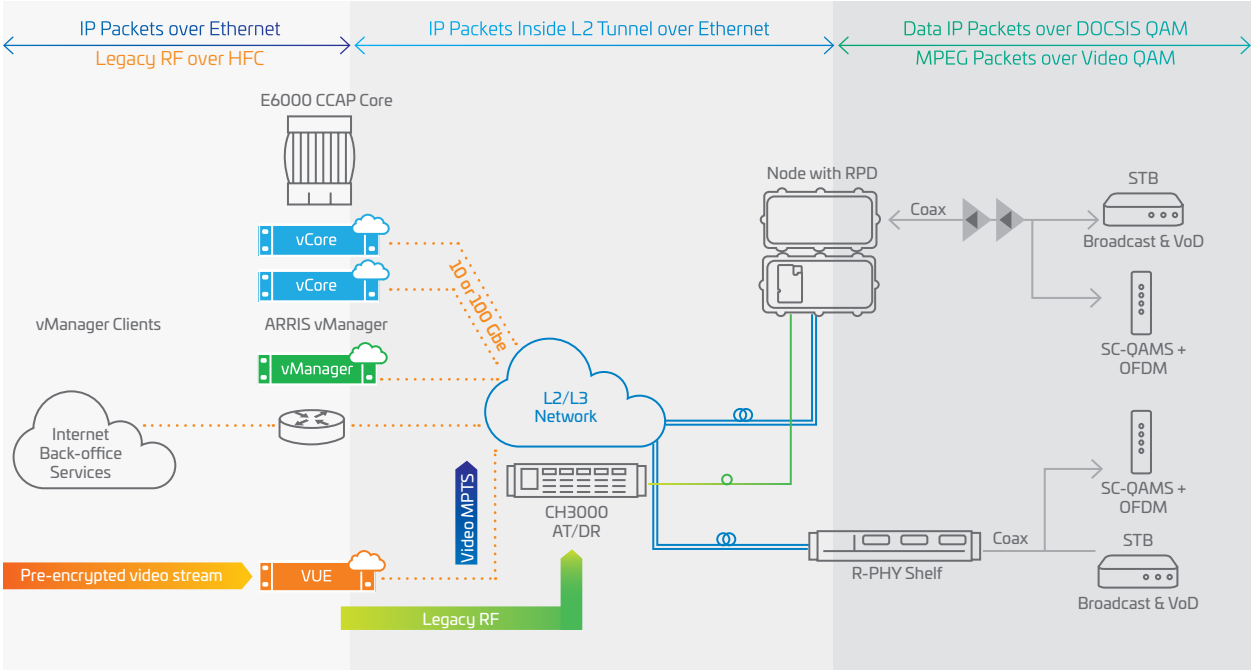

Figure 8 - Network Architecture with virtualization and DAA

Professional Services

The legacy cable environment was anything but simple, and indeed providing the right level of support has always been an essential differentiator for a major vendor. The new environment is far more complex: for example, while a chassis based product had a couple of connections to the Internet, the new environment has many more; the backplane is performed by a Converged Interconnect Network which needs to be configured; the old analog nodes are replaced by digital nodes that host Remote PHY or Remote MACPHY devices. Therefore, it is more essential than ever to work with a vendor that has deep and broad levels of support.

The CommScope Professional Services team helps audit the operator's infrastructure and assess its readiness for virtualization; it can recommend the best path forward, develop custom software to virtualize key network functions across both CommScope and other vendors' products, and assist in managing and executing the transition to a virtualized environment.

Selecting the Right Virtualized Solution

Virtualizing the headend is the best way for operators to meet the evolving market needs and to remain competitive. However, to achieve the best outcomes, it is important to select the right solution, that will meet the operator's needs today but will also grow to meet future needs. The key parameters to consider as the operator evaluates virtualized solutions are:

Performance

As demand for bandwidth continues to grow unabated, without a commensurate increase in revenue, operators need solutions that deliver the best performance per server, with cost efficient and flexible scaling. CommScope's vCore solution is the industry's highest performance solution today, with pathways to even higher throughput; its unique 3D scaling architecture enables operators to right-size their compute and switching investments, providing unparalleled flexibility and cost efficiencies.

Deployability

The virtual headend is a complex environment and requires new skillset, methods and procedures, and a new operating framework. Therefore, it is essential that the solution be complemented by a comprehensive management capability that provides a holistic view of data and video services with headend to home coverage. Furthermore, it is important to work with a vendor with an established track record of deploying complex solutions in the networks of operators of all sizes across the globe.

Support

It is hard to under-estimate the importance of a deep and broad level of support for these complex solutions that rely on new technologies and have profound differences from the traditional solutions operators have deployed.

CONCLUSION

The evolution of the cable plant has markedly accelerated in recent years in order to keep up with fast growing demand for bandwidth and dynamic market needs. The playbook that has been used to date to add capacity is quickly running its course in some of the areas with fast growing bandwidth needs and intense competition. Virtualization delivers the flexibility, agility, velocity and cost efficiency that operators need. However, virtualization is not an all or nothing value proposition, and indeed significant benefits can be reaped from virtualizing the control plane, even when the legacy network elements are still in place. Additional benefits are derived when the video plane is virtualized, and for this step, the CommScope VUE combined with SDV provide an optimal solution. The ultimate step is to virtualize the CMTS Core; CommScope's vCore is the industry leading CMTS Core solution; it is field hardened with the best performance, with flexible scaling and the highest throughput in the industry. As the operator proceeds along this intricate roadmap, it is crucial to work with the right vendor who brings field proven solutions, combined with deep levels of customer support.

CommScope pushes the boundaries of communications technology with game-changing ideas and ground-breaking discoveries that spark profound human achievement. We collaborate with our customers and partners to design, create and build the world's most advanced networks. It is our passion and commitment to identify the next opportunity and realize a better tomorrow. Discover more at commscope.com

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