SCTE·ISBE CABLE-TEC EXPO 2019 | NEW ORLEANS, LA SEPT. 30-OCT. 3

2019 Fall Technical Forum
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DAA, GAP, and Cloud Compute....the Network of the Future

A Technical Paper prepared for SCTE•ISBE by

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Table of Contents

List of Figures

Introduction

The coming combination of Distributed Access Architecture, Cloud Compute and the Generic Access Platform offer much promise to the network operator. However, the radical changes in the way distribution networks are built and managed will require new ways of envisioning the network and its capabilities. The new network is ripe with the potential of new revenue generating services and at the same time, fraught with the new engineering and operations issues that operators will have to overcome. This paper will discuss the engineering challenges of pushing equipment and services out to the edge, all the way to the strand, and provide an outline of how manufacturers are working to overcome the space and power constraints that come from moving transmission and compute equipment out of the head end and out into the edge of the network. It will also discuss the operations considerations such as training and tooling field staff to be prepared to manage this increasingly complex network. Lastly, it will offer some forward-looking proposals of future revenue generating services that the converged, intelligent, edge network of the future will support

Content

After nearly 30 years of working in the telecommunications industry, one thing that I have found to be consistently true is you can never have enough bandwidth. No matter how much is enough to support today's use cases, there will be a new use case or application tomorrow that will require more bandwidth. In 1998 Jakob Nielson created Nielson's Law of Internet Bandwidth that states; "A high-end user's connection speed grows by 50% per year."[1] Nielson was able to demonstrate at the time that bandwidth had grown from 300 bits per second modems to ISDN speeds between 1983 and 1998. He later amended his blog post on the subject to demonstrate that in the ten years since he had written Nielson's law that his Internet bandwidth had continued to increase to 300 megabits per second.

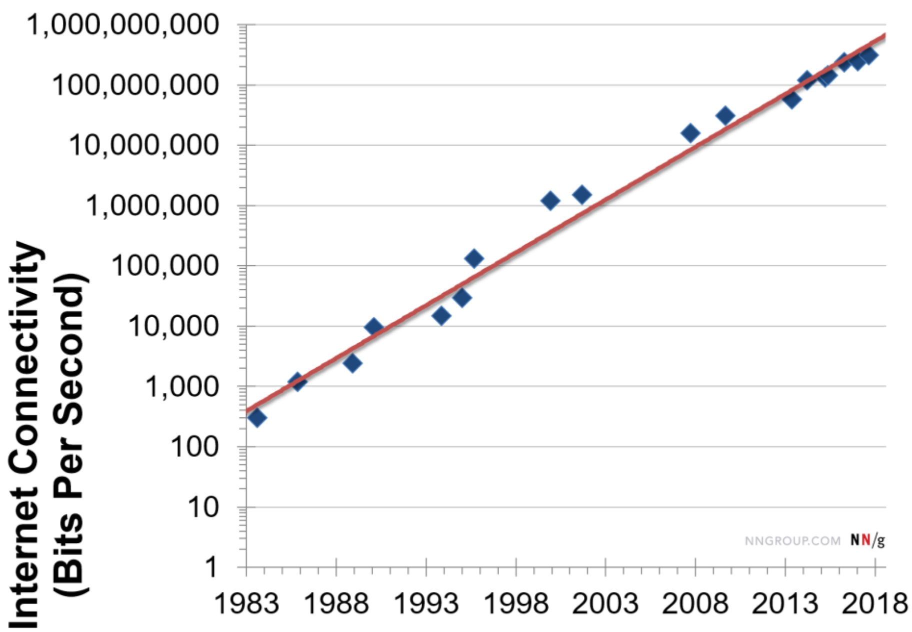

Figure 1 - Nielson's Law of Internet Bandwidth showing increases over time

This double-digit annual growth rate and the equipment additions to support it has nearly every operator running low on the space, power and cooling capacity they need to maintain and operate traditional transmission equipment. Additionally, as service providers evolve their networks to satisfy their customers with those all-important new services—IP/4K video, business services, IoT, 5G, and cloud/fog computing—transport networks are pushed to breaking point in the struggle to deliver more bandwidth and lower latency that customers demand to support the applications they use..

Providers in the MSO space have begun responding to these bandwidth, space and power challenges by evolving to what has been termed the "Distributed Access Architecture" or DAA, whereby the operator pushes the digital portion of the headend equipment closer to the edge of the network. One of the first use cases for DAA is "Remote PHY" which replaces traditional analog lasers and hybrid-fiber-coax (HFC) nodes with digital optics, usually 10 gigabit Ethernet, that allow placement of the CMTS or CCAP physical interfaces at the edge of the network and closer to the customer. This not only helps increase the amount of bandwidth going to each subscriber, but by moving the physical interfaces out to the edge, frees up precious space and power in the head ends and hub sites.

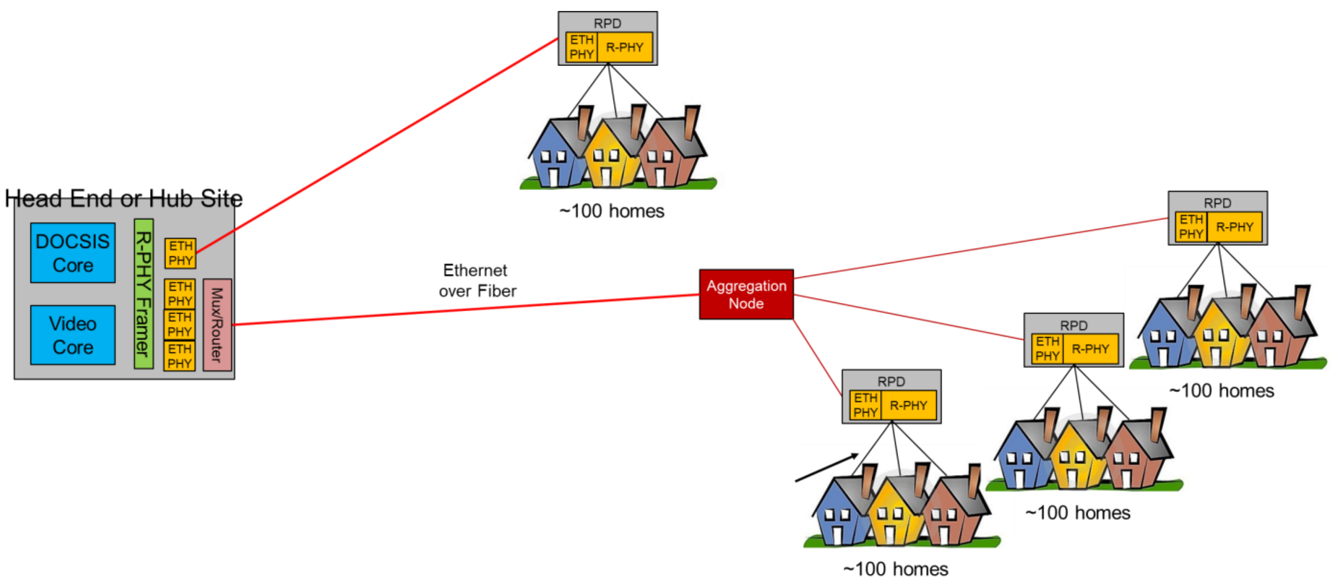

Figure 2 - Remote PHY Transport Architecture

While the primary driver for DAA today is to support Remote PHY, long term this architecture will evolve into a multi-service architecture. The other services supported will include remote CMTS and PON, Business Services transport, Wi-Fi backhaul, 4G/5G xHaul and Edge or Fog computing.

While it has much promise in increasing the amount of bandwidth and lowering latency for subscriber services, this new network architecture introduces its own set of unique operational challenges that now need their own unique solutions. One of the side effects of pushing so many physical interfaces out to the edge is a problem that has been termed "strand bloat." As remote PHY devices, wireless radio heads, small cells, business services aggregation and other new technologies join existing HFC nodes and amplifiers, the number of devices mounted on the strand begins to explode exponentially. This occurs in part because there is currently no standard definition for a strand-mount housing, requiring equipment manufacturers to build custom housing for each new technology.

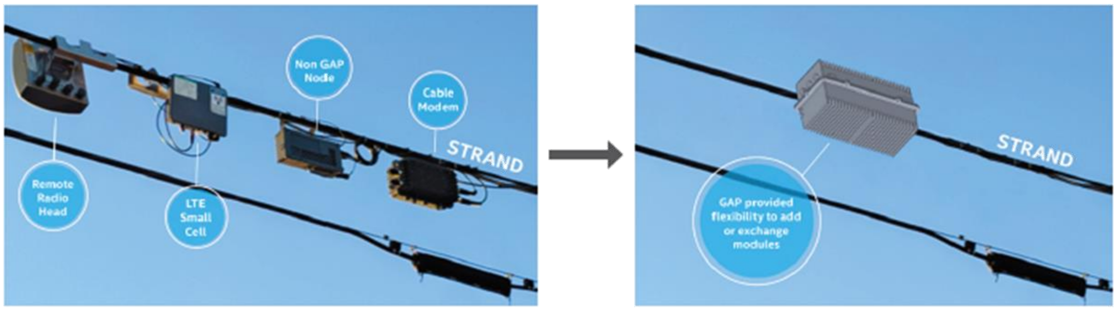

Figure 3 - Strand Bloat from multiple devices compared to GAP enclosure concept

In response to this issue, Charter, Cox and the SCTE last year created a new SCTE working group to develop a standard known as Generic Access Platform or GAP. The goal of the working group has been to develop a standard definition of size, power, and thermals for an outdoor housing that can be strand-mounted like a traditional HFC node, and that can accept modules to support services such as remote PHY or wireless radios. This will allow manufacturers to focus on building standardized modules to provide specific functionally.

The team of MSO and industry representatives working on the GAP specification started their efforts by attempting to envision the use cases that could a standard installation delivering multi services from the same enclosure could support. Some of the use cases envisioned for delivery via a GAP module would support current transport services such as HFC nodes, amps, Remote PHY and MAC/PHY devices, Remote PON, and Commercial Ethernet Aggregation. In addition, contributors to the GAP specification are considering the ability to support future use cases such as CBRS or 5G small cells and Edge compute.

Strand mounted edge compute is an interesting new use case that will provide not only the capabilities to support compute resources for customers for use in such solutions such as autonomous automobiles, IoT, content delivery and gaming but it will also open up the opportunity to drive network applications out from the head end to the edge. As an example, a virtual CCAP instance could be moved to compute in the GAP node to serve a remote PHY device. Another potential use would be the virtualization of the virtual radio access network and/or virtual baseband unit compute portions of 5G at the edge next to the small cell remote radio head. Distributing the compute and storage closer to the edge is commonly called "Fog Computing" The concept is that, like the cloud, the compute is distributed but as fog is a cloud close to the ground, fog computing is closer to the user.

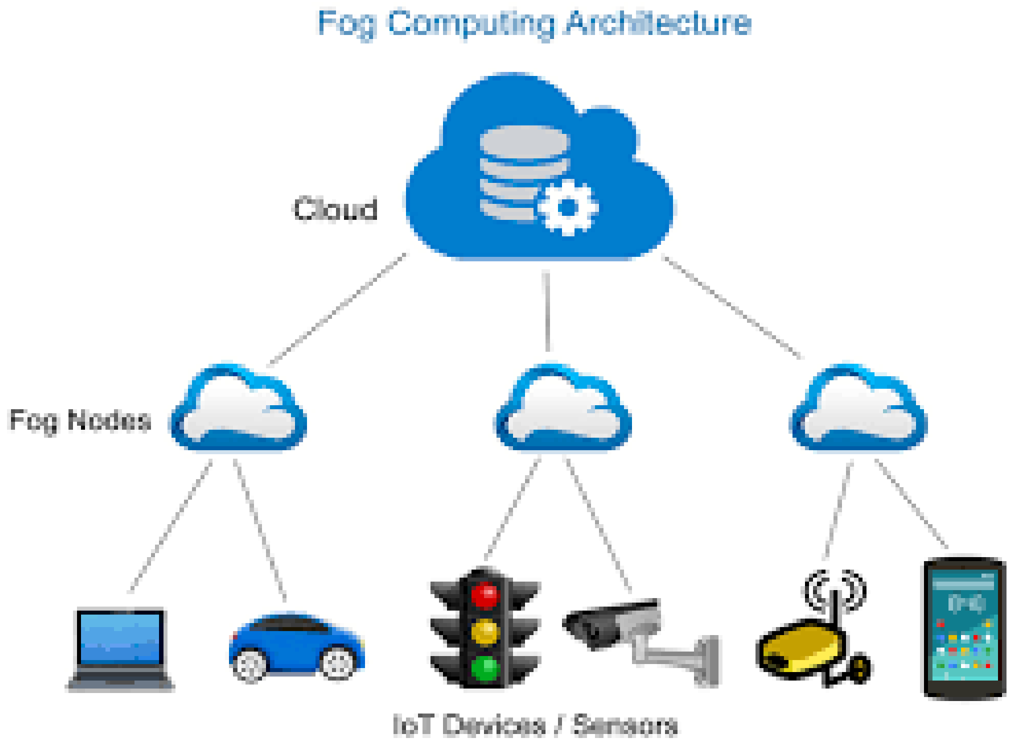

Figure 4 - Fog Computing Architecture

Much like cloud computing created new service and solution opportunities because of its ability to increase the velocity and flexibility with which applications are delivered, fog computing will add additional opportunities due to its decreased latency from close proximity to the user.
As DAA continues to push interfaces ever closer to the customer and GAP attempts to consolidate multiple edge systems into as few housings as possible, there is the opportunity to consolidate both multiple services but also the management of the services provided.

Another change in the way networks are built and managed that will come from the use of these new architectures is the collapsing of disparate networks used today to deliver multiple services. Traditionally networks were purpose built based on the specific requirements of their product use cases. Today we have HFC networks for residential and best effort commercial voice, video and data. We have fiber networks for high value commercial services and carrier xHaul. There are also separate fiber networks for providing video transport between head end and hub site locations. Commonly these networks are built and managed independently of each other. Most MSOs have a group managing their metro networks, another managing the backbone and yet another managing the core aggregation infrastructure for commercial services. There is also likely yet another separate group managing the CMTS, CCAP and other HFC based infrastructure.

Having separately managed and segregated networks was ideal when the services had no method nor reason to co-exist. Thirty years ago, there was not a compelling reason to merge the HFC video network with the business services network delivering a T1 to a commercial customer. However today, voice video and data services are being delivered using Internet Protocols as the common transport. Additionally, as customers continue to use these services ubiquitously across a variety of devices such as computers, smart TVs, tablets, etc., there is no longer a compelling reason to expend the capital and operating expense to manage the networks separately. In fact, there are disadvantages of segregating networks, especially as traffic begins to traverse between those networks in order to support customer use cases.

Lower operational effort means not only reduced cost but improved customer experience. By consolidating the management of multiple networks, the ability to have a comprehensive end-to-end view becomes possible. This will allow technicians to more quickly resolve issues, as they no longer have to mentally “glue” the flow of information across multiple networks.

DAA and GAP will drive not only network convergence, but also will create new opportunities as the industry begins to introduce new capabilities to the edge access network. By adding wireless to traditional fixed access and by providing edge compute capabilities use cases that require mobility, high bandwidth and low latency such as autonomous automobiles, IoT, and AR/VR gaming, new service revenue streams inevitably will be created.

Conclusion

As DAA continues to push digital interfaces used to deliver services further to the edge and as the SCTE works to create physical commonality through the GAP standard it is inevitable that both the physical networks and how they are managed will converge. While we are still a long way away from “one network to rule them all” we are starting to see engineering and operations consider how they can deliver a consolidated service delivery network. This will ultimately create opportunities to reduce capex and opex spend but more importantly create new service capabilities that will drive product innovation and revenue.

Abbreviations

IoT	Internet of things
HFC	hybrid fiber-coax
CMTS	cable modem termination system
CCAP	converged cable access platform
PON	passive optical network
MAC/PHY	media access control layer/physical layer
CBRS	citizens broadband radio service
T1	Transmission System 1
AR/VR	augmented reality/virtual reality
capex	capital expense
opex	operating expense

Bibliography & References

1. Nielson’s Law of Internet Bandwidth https://www.nngroup.com/articles/law-of-bandwidth/