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Cable Network Transformation Focused on Exceeding Customer Expectations

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Our industry is in a period of intensive change, not just technological, but also from the customers' experience. Since the inception of broadband service over cable, the charge has been for higher and higher speeds. Today, the customer expects much more: higher speeds, yes, but also high reliability, tight security, and low latency. These are the pillars of the 10G Network. Operators have a variety of tools at their disposal as they build out next-generation networks. As the HFC network is being readied for the launch of DOCSIS® 4.0 services, some of these tools are the distributed access architecture, band splits, smart amplifiers, and Artificial Intelligence.

Coming out of Cable Tec Expo

Network Transformation took center stage at this year's Cable Tec Expo, held October 16th to 19th in Denver, Colorado. One hundred two peer-reviewed papers were presented, covering transformational themes such as "Data Driven: Optimizing and Running HFC and Fiber Networks, End to End," "Know Before You Go: Everything You Need to Know About Moving to the Cloud," and "Spectrum Horizons: Navigating the Future of Connectivity and Communication." All Expo papers and slide materials, not just from Expo 2023 but also from Expos dating back to 2013, are available for download at www.scte.org/expo-papers/search.

Network Transformation

According to Merriam-Webster, "transform" means to "make a thorough or dramatic change in the form, appearance, or character." This characterizes what is happening today with cable networks. Networks are constantly evolving to support increasing customer expectations. Cable operators have many "tools in their toolkit" to evolve and transform networks, and this article will cover four of them. Other tools will be covered in later articles.

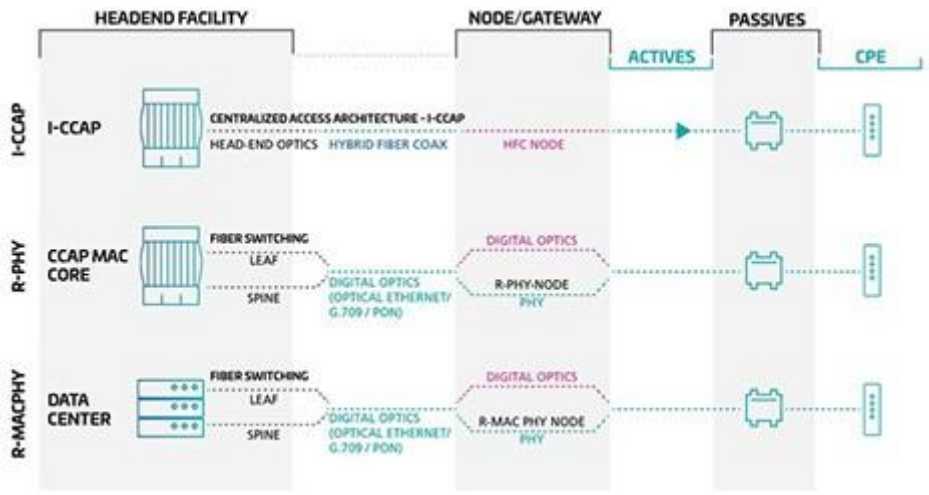

Figure 1: Comparison of integrated, pre-DAA, Remote PHY, and Remote MACPHY Source: CommScope

Technology Advancements Benefiting the Network

1. Distributed Access Architecture

The Distributed Access Architecture (DAA) is specified by CableLabs® and has been widely adopted by the cable industry. Multiple vendors are selling DAA equipment, and multiple operators have deployed it at scale in their access networks. We like to refer to this by saying the technology has a healthy ecosystem. DAA moves network functionality out of the hub sites and closer to the subscribers (See Figures 1 and 2 on next page), resulting in several benefits:

- Reducing space, power, and HVAC demand in the hub sites.
- Moving the physical (PHY) layer closer to the home results in better network performance – higher signal-to-noise ratio, higher modulation, more peak capacity, and higher speed service tiers.
- Moving the PHY layer closer to the home can result in lower latency, especially important for applications such as gaming.
- Digitizing the optics between the hub and the node, resulting in greater reliability.
- Lower operational expenses associated with alignment and maintenance.
- Improved network visibility due to the distributed functionality. The intelligent network elements, deep in the network, are reporting back real-time performance telemetry.
- Providing a standardized node in the last mile not only supports HFC but can support *multi-access* technologies in the future. Modules for PON, Wi-Fi, and cellular can all be developed and housed in the DAA node.

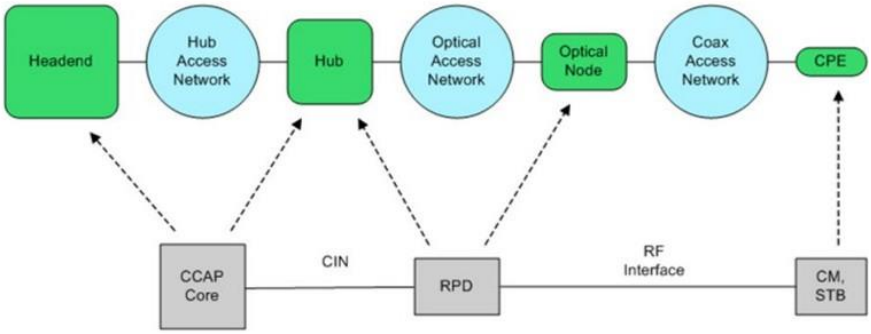

Figure 2: Diagram of the Remote PHY version of DAASource: CableLabs

2. Band splits: sub-; mid-; and high-split

An HFC network's capacity is driven by its frequency spectrum. In older networks, the spectrum started at 5 MHz and progressively ran up to 550, 750, and 860 MHz. Today's networks extend up to 1 or 1.2 GHz (Figure 3 on next page). With DOCSIS® 4.0support, extended-spectrum networks will run up to 1.8 GHz. Continued technological innovation may extend HFC networks to even higher frequencies. "Support" translates into all equipment along the HFC path, including the CMTS, fiber nodes, amplifiers, splitters, and CPE. The "band split" refers to where in the spectrum the downstream (hub to home) and upstream (home to hub) frequencies are assigned. Before two-way cable plants, there was no split, as all frequencies were dedicated to hub-to-home transmission. With the advent of interactive video and data over cable, spectrum needed to be reserved for upstream transmission. Five to 42 MHz was originally reserved for this purpose, with the downstream spectrum then starting at 54MHz (with a diplex filter in between to adequately partition the directional signals). As customer demands on the upstream have increased, the cable industry has looked for ways to assign more spectrum to the upstream. In the "mid-split" design, the upstream spectrum increases to 85 MHz, while in the "high-split" design, the spectrum increases to 204 MHz. DOCSIS® 4.0 will add other "ultra-split" options with the upstream band growing to 300 MHz, 396 MHz, 492 MHz, and 684 MHz. Gigabit per second upstream speeds per modem are now supported with these expanded spectral allocations. Many operators are now in the process of upgrading their networks to the mid-split and high-split designs.

3. Smart amplifiers

In access networks, amplifiers are electronic devices that increase the amplitude of electronic signals. Historically, the amplified levels were set by the technician at the time of installation. Periodically, a truck roll was needed to reset these levels (aka balancing the network). The smart amplifier is being specified and standardized by CableLabs & SCTE to eliminate these truck rolls. The amplifier will be network addressable, and standard functionality will include a YANG communications model for use between the amplifier and network operations center. Since the amplifier will be remotely accessible, remote configuration management (ability to remotely configure the device), performance management (telemetry on key metrics), and fault management (detection and isolation of device faults) will be supported. The SCTE Smart Amplifier Working Group meets bi-weekly on this program to complete the standardization process, now focused on the transponder to these amps, as vendors prepare to manufacture the devices.

4. Applying Artificial Intelligence to transformational projects

Artificial intelligence has jumped to the forefront of technology discussions around the world. The popularity of ChatGPT has brought these talks into the mainstream media. In the sphere of cable network transformation, operators have spun up their own AI/ML development teams and are busy applying artificial intelligence to all facets of the access network lifecycle: planning; construction; engineering; maintenance; and decommissioning. The SCTE Artificial Intelligence and Machine Learning Working Group meets on a bi-weekly basis and invites operators and vendors to share their AI/ML project status for the benefit of the overall industry. In the past year, a sampling of the projects presented within the group and at Expo presentations include node mapping, traffic forecasting, real-time impairment detection, continuous network health monitoring, extended reality services, voice-activated services, data lake capabilities, video transcoding, and video piracy.

SCTE is currently working on a project with Charter and AWS to apply a large language model (LLM) based chat interface to the data store of SCTE standards, technical papers, and presentations available on the SCTE website. The preliminary results look very encouraging to optimize the user-content interface versus today's hunt-and-seek search methods.

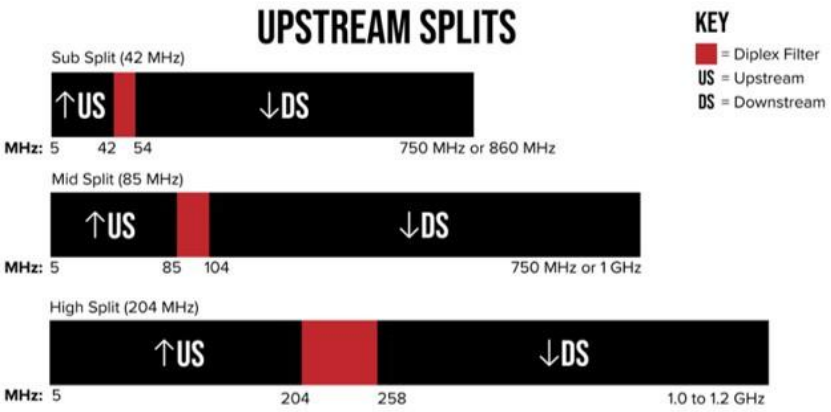

Figure 3: Band splits leading up to DOCSIS® 4.0 Source: CableLab

All four of these tools, DAA, band splits, smart amplifiers, and AI are directly transforming today's networks to create a better experience for our customers.

Focus on the Customer Experience

Cable operators are the leading provider of broadband services in the U.S. They have a long history of revenue growth and investing those earnings in improving their networks. Network upgrade programs are not done in a vacuum; they are performed to increase the level of customer satisfaction (and to provide a return on investment to the shareholders). In concert with network transformation, the customer journey also needs to be transformed. An April 2023 McKinsey report indicates that while the cable industry is positioned well with its network scale and capacity, investments must also be made to provide customers with a seamless experience such as they receive from streaming services, online merchants, and financial institutions.

When a network upgrade is performed, there must be minimal disruption to the customer. Communication with the customer should be timely and transparent. The benefits of said network upgrade should be readily apparent. While this article is focused on the network, the same applies to billing and provisioning upgrades. The expectation is that the digital experience is end-to-end, capturing the strengths of the network as well as back-office services. Customer experience, capturing both fact and perception, needs to be measured. While cable industry Net Promoter Scores are increasing, there is room for improvement. Network transformation is hand-in-glove related to online digital transformation. Technology is transforming the way people live, work, learn, and play, and network connectivity plays a huge role in that experience.

Charging into 2024

Network Transformation, especially as it impacts the customer experience, will continue to be a "hot topic" for years to come. SCTE is currently starting to plan which topics will take center stage for Cable Tec Expo 2024, which will be held next September 23-26 in Atlanta. The Expo program committee is being formed, and technology tracks will be selected that will capture the near future's transformational path. If you are a technology innovator or leader in this space, please consider submitting an abstract through the Expo 2024 Call for Papers, which will open in February at expo.scte.org.