Fear Not FTTH: Alternatives to Complex HFC Upgrades

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Introduction

Cable operators have a long history with Hybrid Fiber Coax (HFC) infrastructure. Increasing bandwidth is a never-ending process, but the HFC is reaching the ceiling for simple upgrade procedures. Next-generation access alternatives are beginning to be adopted in order to keep pace with future bandwidth demand. As these changes are made, it's important to keep provisioning and other back-office systems consistent with existing ones.

Broadband Success Partners interviewed several MSO executives on the topic of how their next generation of upgrades will be accomplished, and also reviewed a 2018 study conducted by Calix on the subject.

MSO Legacy Architecture and Upgrades

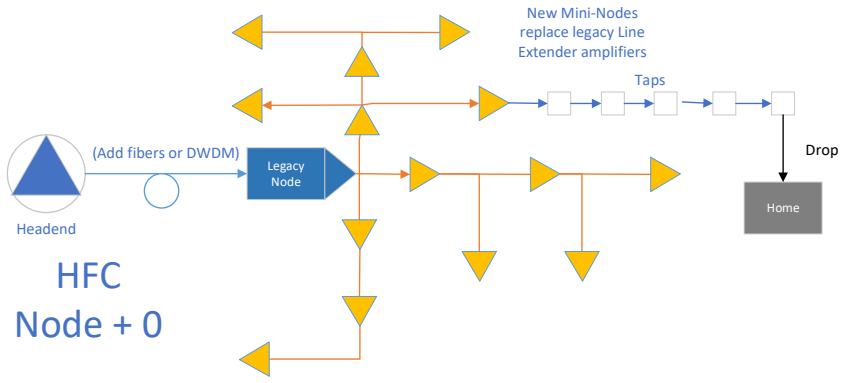
Most MSOs have an HFC infrastructure consisting of 500-homes per node today. Maximum amplifier cascades range from 3-6 amplifiers beyond the node. Operators divide node serving areas into smaller ones as needed to meet the bandwidth demands of their customers.

This approach has served operators well over the past twenty years, but anticipated growth in the demand for bandwidth will eventually make this technique obsolete. Operators now look to "Node + 0 and Distributed Access Architecture" or "Fiber-to-the-Home" (FTTH), or a combination, as the long-term solutions.

Cable operators are comfortable with DOCSIS provisioning and all of its related systems. They know that new HFC technologies will be compatible with DOCSIS, but are not sure about FTTH. Modern virtualized provisioning and management systems can address this challenge – more about this later.

Node + 0 and Distributed Access Architecture

MSOs have been considering Node + 0, or "Fiber Deep", in order to address the expected bandwidth crunch. Eliminating active devices beyond the node makes for very small service groups (usually 64 homes or fewer), enabling very high sustained bandwidth for each customer.



Adding all of the new nodes required for Node + 0 will require a commensurate increase in CMTS (or CCAP or vCCAP) devices in the headend. Already taxed by demand-generated node splits, space and power in the headend is limited.

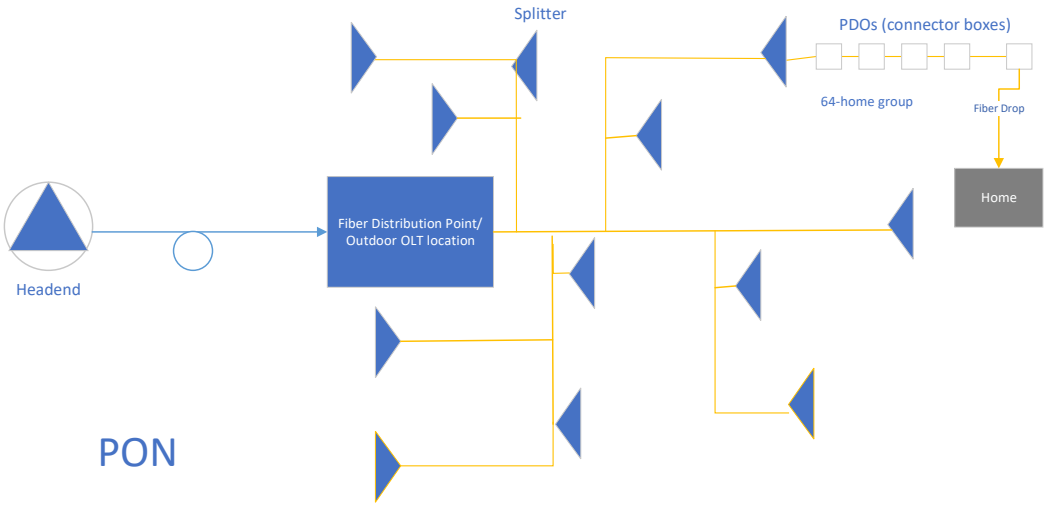
Distributed Access Architecture (DAA) solves this problem by separating the RF and digital portions of the headend process. Remote PHY puts the RF generation at the node location while leaving all other CMTS processing in the headend. Remote MAC-PHY puts the bulk of CMTS functionality out in the node.

By putting the bulk of the headend equipment into the field, space and power in the headend become available for other purposes. By cutting the amplifier cascades to zero, Full Duplex DOCSIS operation also becomes possible. Full Duplex DOCSIS (FDD) will permit the upstream speeds to rise to 1 Gb/s for symmetrical service and beyond.

Extended Spectrum DOCSIS (ESD) is seen as an alternative to FDD. By using a high split for upstream, operators extend the top end of the system to recover the lost downstream spectrum and perhaps add more.

FTTH

A passive optical network consisting of Optical Line Terminals feeding clusters of 32 or 64 homes via splitters is the foundation of most modern FTTH networks.



PONs have many operational advantages over HFC networks, including minimal maintenance and power requirements. One CTO reported, “All RF plant issues, such as signal leakage, no longer exist with FTTH. This enables a far more reliable network with less maintenance activities.” And, “…reduced maintenance and powering saved $2.6 million per year”.

Despite the advantages of Fiber to the Home, almost all major MSOs in the United States have not yet embraced it. Why is this?

Construction Cost

Building FTTH requires not only replacement of all Outside Plant (OSP) coaxial cable with fiber cable, but also replacement of cable drops to each home with fiber drops. Inside the home, fiber must be brought to the optical terminal equipment location, and that location requires power and access to any in-home wiring required to service the devices.

Lack of DOCSIS infrastructure

Bringing an ONT online via established "telco" methods often involves procedures that are foreign to most cable operators. Passive Optical Network (PON) systems originally required that a specific ONT be brought online ONLY when that home is tied to an account and given some level of service. Replacing an ONT might require that the unit be provisioned BEFORE it is connected to the plant. By contrast, many MSOs allow any DOCSIS modem to be connected and automatically be brought online in a "walled-garden" state. That modem can then be attached to an account and provided with Internet service by direct interaction with the walled-garden servers.

DOCSIS infrastructure also allows all of the housekeeping necessary for a cable modem service, including CALEA/Lawful Intercept of data and voice, encryption and privacy of data, DNS, TOD, etc. While Telco techniques can also take care of these items, DOCSIS has them handled in one consistent way.

Differences between PON and DOCSIS have added a level of uncertainty as to how an operator would bring FTTH into their legacy operational systems and procedures.

Equipment Replacement

When an optical system replaces DOCSIS over coax, a new termination device is required between the Outside Plant and the Router. The ONT replaces the cable modem and has a cost associated with it. If legacy video service over coax was present, set-top boxes would need to be replaced by IPTV boxes, as MPEG video over RF channels is no longer possible.

(Hybrid RF-overlay approaches do enable preservation of RF STBs in a PON, however this adds cost and complexity.)

An IPTV system must be present to feed the video service on the optical network. This service can be provided by the operator or a third-party IPTV provider.

On the plus side, "Smart TVs" can take a data feed directly, and with appropriate software decode and display an operator's IPTV service.

In the next section, we will examine how all of these concerns can be addressed through a hybrid network approach.

Network Evolution – Comparing HFC Coaxial and FTTH Alternatives

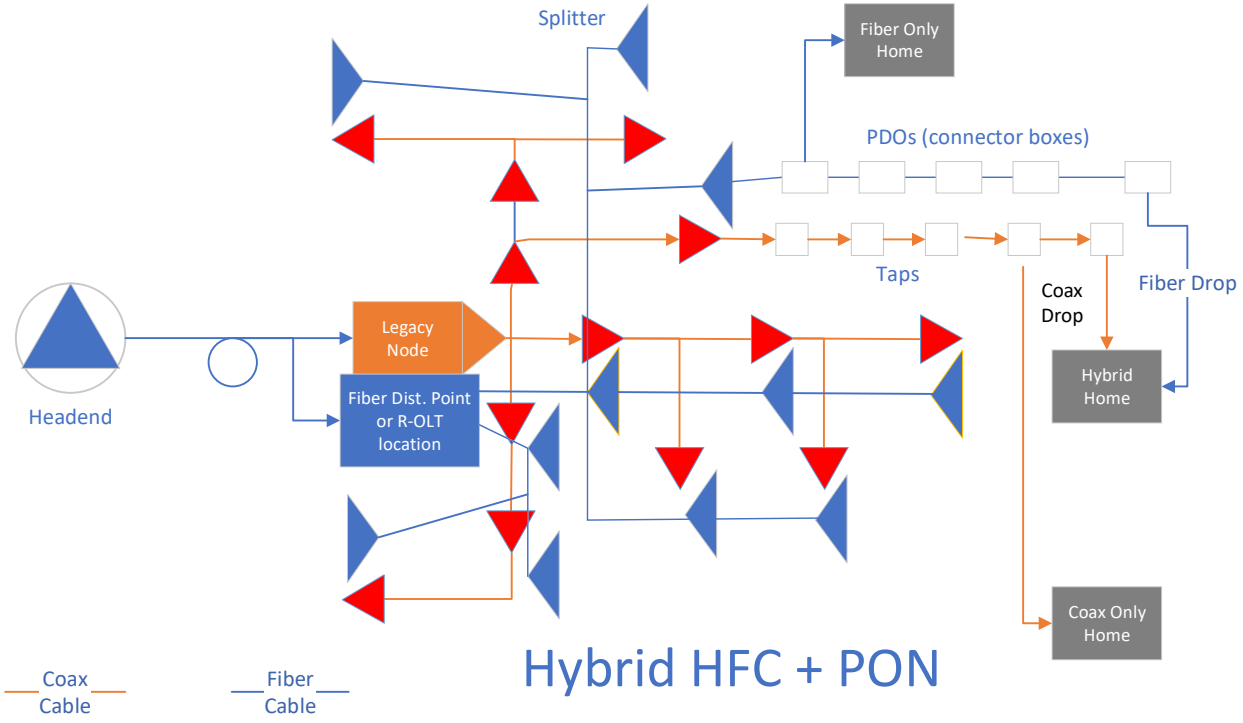
In 2018, Calix released the study, "Rethinking Cable Network Evolution – a comparison of Node + 0 and FTTH". In this report, the costs of upgrading a typical Node + 6 HFC network to Node + 0 or to FTTH was considered for low, medium and high-density operating areas. The conclusions of the report were this:

- In low density areas, FTTH had a 19% lower CAPEX and lower OPEX.
- In medium density areas, Node + 0 and FTTH had similar CAPEX, while FTTH had lower OPEX
- In high density areas, Node+0 had 36% lower CAPEX, however FTTH would still have lower OPEX and greater capacity

These results align with the expectations of most operators, and can be considered as a source of reasons why Tier 2 and Tier 3 cable operators have embraced FTTH far more readily than Tier 1 MSOs.

Later, Calix produced the report, "Lower cost alternatives to Fiber Deep with PON". This built on the 2018 study and added consideration of a combination approach: The FTTH system would be overlaid on top of the existing Node + 6 HFC system (as would have been the case for an FTTH upgrade before.) However, the HFC system would continue to operate and feed most existing customers, as follows:

- The Hybrid approach would overlay FTTH to opportunistically serve customers requiring high bandwidth
- Customers not requiring high bandwidth would remain on the non-upgraded HFC network, which would no longer require an upgrade
- A non-gateway architecture would continue to be used for the HFC network customer access equipment



By following this combination approach, operators would incur the operating expense of running two networks, however the capital cost would be much lower than either converting to a Node + 0 HFC network or moving all of the customers to an FTTH network. This was true for low, medium, and high subscriber density plant. One large MSO CTO said, "Legacy networks stick around a long time. There is no direct reason to prompt collapsing them."

Today, we can look at these studies and draw the same conclusions. However, there are some new and important factors to consider:

- Operators are seriously considering extended bandwidth improvements, including FDD (Full Duplex DOCSIS) and ESD (Extended Spectrum DOCSIS) along with their upgrades.
- If FDD is used, that requires the adoption of Node + 0 with present amplifier technology.
- If ESD is used, replacement of amplifiers with extended bandwidth amplifiers and new diplex filters is a minimum requirement. Replacement of tap plates, or entire taps, with units that can accommodate the top frequency of 1.6 GHz, 1.8 GHz, or beyond is also required.

Why would an operator consider ESD in place of FDD? One reason is that when upstream is transmitted on spectrum previously reserved for downstream signals (FDD), legacy devices could receive interference. If these legacy devices are in the home receiving the new service, a change to a gateway architecture and/or legacy equipment replacement can eliminate that possibility. In an adjacent home, however, we are relying upon tap port-to-port isolation and there might still be a problem.

ESD is compatible with Node + n operation, while FDD requires Node + 0. Several Tier 1 operators are actively working on ESD-based DAA solutions while not deploying Node + 0. ESD and FDD need not be considered in the combination HFC/FTTH approach at all – the HFC network would not be upgraded.

For rural operators, Node + 0 is very expensive on a per-home-passed basis. According to several Tier 2 MSO executives, their sparsely populated node service group sizes are already small enough.

Putting all of this together: HFC upgrades to Node + 0 will cost more than was anticipated in the study.

Creating a Compatible Provisioning Environment

Now that we have shown that FTTH is worth considering, either as a stand-alone network or in combination with a legacy HFC network, it's important to maintain a consistent approach to provisioning and back-office operations. The FTTH Provisioning Environment can now be virtualized, and integration into the DOCSIS world is easier than ever.

Many of the MSO executives we recently interviewed indicated a desire for different types of functionality in a FTTH management system. While some are happy to create their own adapters to a previously telco-friendly PON system, others would prefer to treat the PON system as if it were a CMTS. Additionally, DOCSIS is generally considered to be a Layer 3 (routed) network, however most PON systems operate at Layer 2.

PON vendors have addressed these concerns by developing advanced software tools. For example, in Calix's Intelligent Access Edge, individual software modules can be added or removed to allow operating in whichever environment the operator is most comfortable with. Details can be found in the "Intelligent Access Edge Solution Brief".

The platform provides the connectors to back office subscriber management systems, DOCSIS provisioning connector, and diagnostic tools to enable co-existence with a legacy DOCSIS network and minimal adaptation of existing systems.

DOCSIS functions are available in the Subscriber Management module. These handle Authentication, authorization, and accounting (AAA), Address assignment, Policy management, and Lawful Intercept (LI).

The choice of operating at Layer 2 or Layer 3 is then left to the operator.

Remote OLTs – Handled

One of the realities operators face is the lack of fibers to transport signals from the headend or hub to the access neighborhoods. This shortage applies equally to Node + 0 and PON situations. With DAA, operators can use DWDM (Dense Wavelength Division Multiplexing) to multiply the capability of the transport fibers.

FTTH PON networks can use the same DWDM systems to feed a remote OLT platform which generates and receives the PON wavelengths out in the field. The Calix Intelligent Access Edge system can centralize subscriber management, aggregation, and lawful intercept in one platform, and feed remote platforms which function as remote Layer 2 OLTs.

Conclusion

When comparing the costs of upgrading an existing network to Next-Generation HFC or FTTH, many factors must be considered. The ultimate long-term operating cost, however, will determine if the decision to go FTTH was a wise one. While the capex costs to build FTTH may exceed those for many DOCSIS network upgrades, operating cost differences should make up the differences over time. It is much less expensive to operate an FTTH network versus a copper or coax one. One MSO executive reported that operating costs for FTTH networks were one-tenth that of the coaxial networks they replaced. In an urban environment, another executive said, "we have 1,000-unit MDUs that generate no trouble calls, where we used to have a technician dedicated to the building."

A rural operator VP of Engineering commented, "We looked at the costs of DAA and DOCSIS 3.1, and deploying PON was much less expensive in our geography. FTTH is the end-game, so why invest in a technology that will be obsolete in a short time?"

The VP of Engineering for a large MSO that has mostly urban and suburban systems said, "Both (FTTH and HFC) have their place. There are economic reasons why DAA is the correct answer today, and there are places where Fiber is the correct answer today. We will be in a mixed mode for a long time to come.

By using a hybrid FTTH overlay/Legacy HFC network approach, operators can dramatically reduce their CAPEX while receiving all of the benefits of FTTH. They avoid the 'experimental' nature of FDD, and the anticipated extensive service disruptions associated with tap replacement.

While the costs of building FTTH are significant, and next-generation DOCSIS is a viable alternative, advanced PON management systems can take concerns about provisioning and back-office operations off the table.

Links

"Rethinking Cable Network Evolution – a comparison of Node + 0 and FTTH"
https://go.pardot.com/l/2172/2018-06-18/3t9c4g

"Lower cost alternatives to Fiber Deep with PON"
https://go.pardot.com/l/2172/2019-05-22/44vbcj

"Intelligent Action Solution Brief"
https://www.calix.com/solutions/intelligent_access_edge.html