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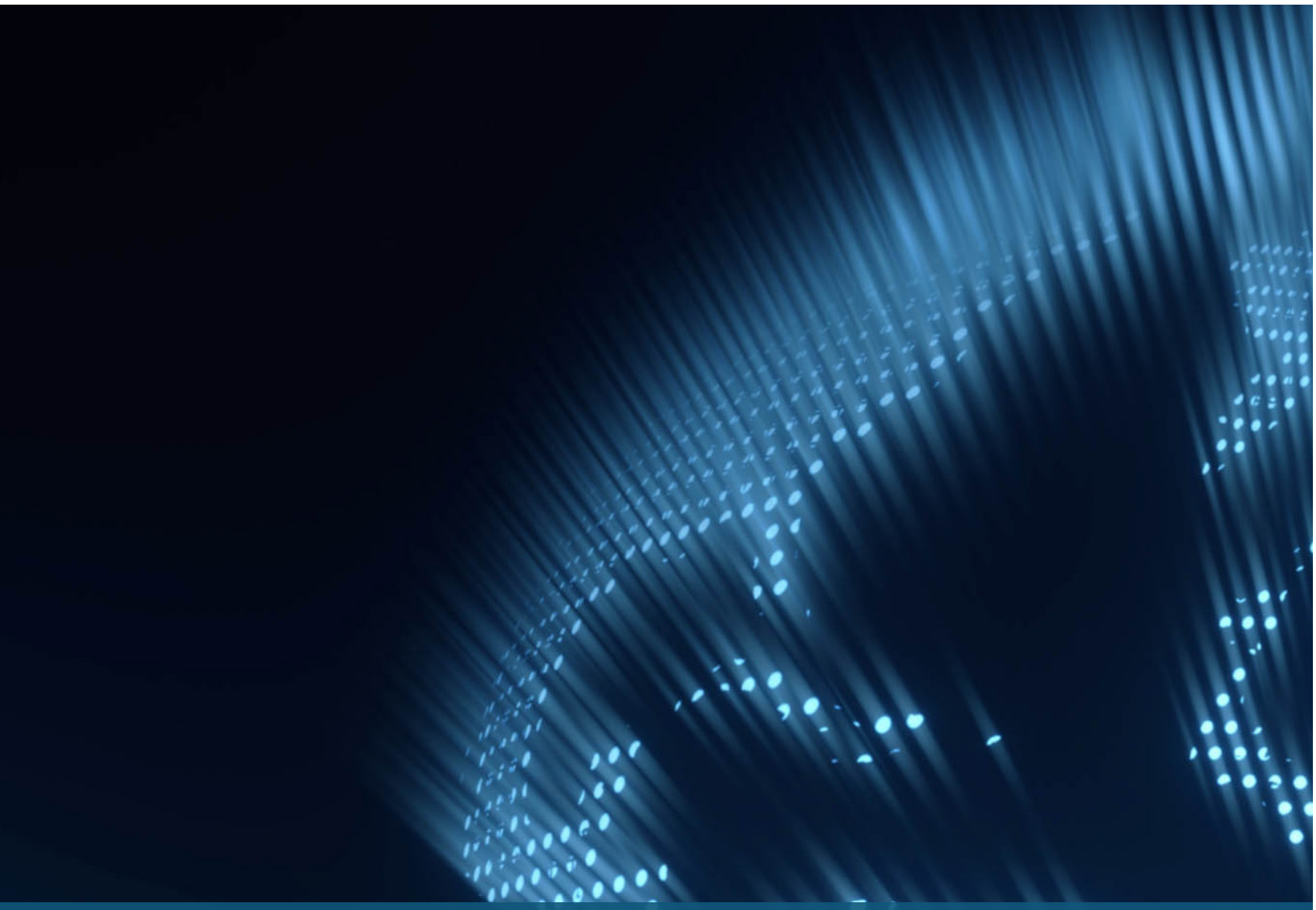

Making Sense of Node Segmentation in a Distributed Access World

in collaboration with BROADBAND SUCCESS PARTNERS

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In the beginning, there was HFC.

For many years, Cable Operators have been running Hybrid-Fiber-Coax (HFC) networks capable of efficient transmission of video, voice, and data services for both residential and business customers.

Residential customers are consuming more and more video content over their broadband connections, and this will dramatically increase as content moves to 4K or perhaps beyond. Businesses are relying upon cloud-based services rather than on-site servers, increasing their bandwidth needs. Add in the demands of automated device backup, home security cameras, and online gaming, and today's HFC could come up short. These factors have produced an industry-wide consensus that upgrades will be required.

Legacy HFC networks running DOCSIS data services have boundaries. Analog optics followed by analog amplifiers produces an overall signal-to-noise which limits the order of modulation that may be used. That, coupled with bandwidth limitations, can restrict the maximum speeds that the network is capable of achieving.

Operators are faced with many choices once they decide to upgrade their HFC networks. The operator could deploy "Next-Generation Hybrid Fiber Coax" (NG HFC), which includes Distributed Access Architecture (DAA), Node + 0, Full Duplex Data Over Cable Service Interface Specification (FDX DOCSIS), and Extended Spectrum DOCSIS (ESD). These choices could be used individually or in combination. Let us examine these choices.

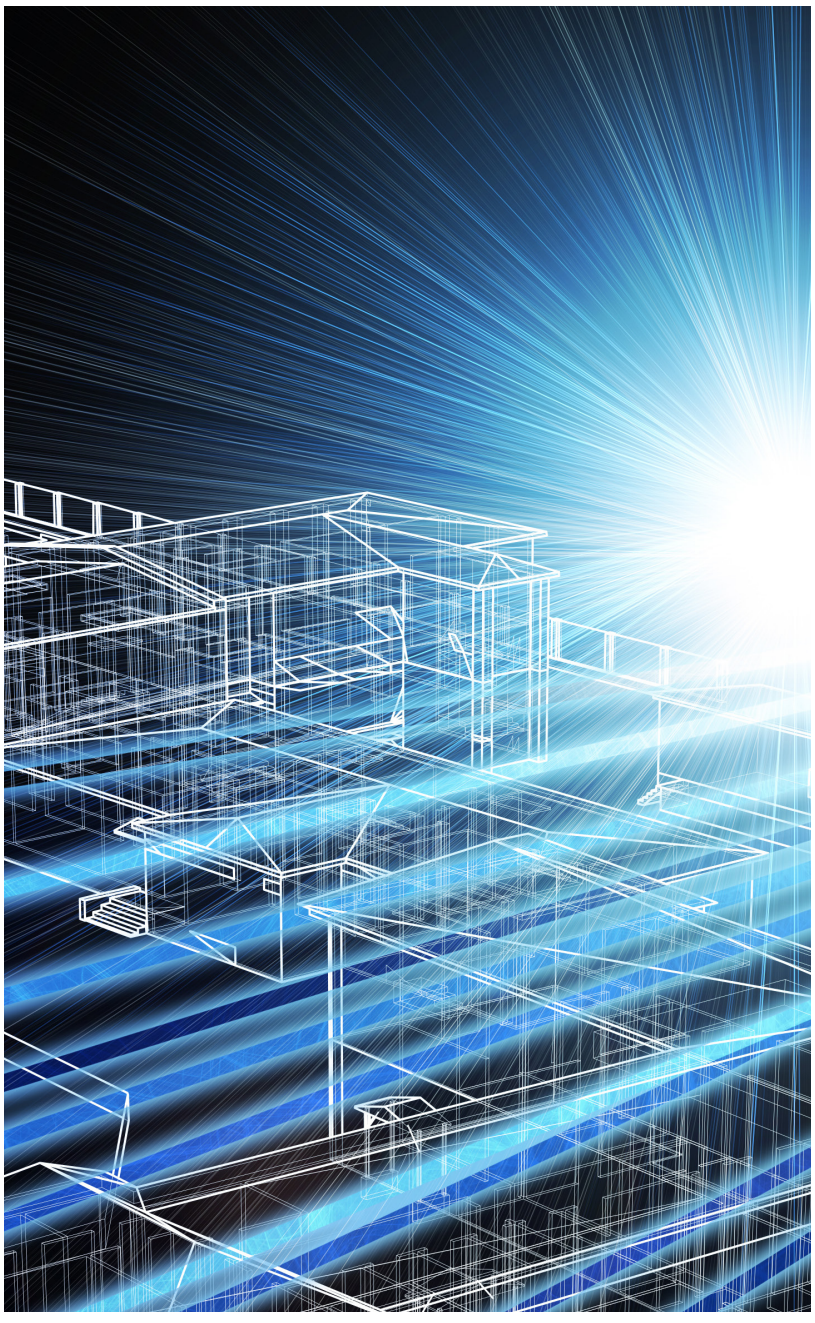
Distributed Access Architecture **DAA**

In the analog HFC world, Cable Modem Termination Systems (CMTSs) and QAM video modulators take digital inputs from routers and switches. The RF carriers generated are fed to purpose built, application specific analog laser transmitters, which are carried by the outside plant to nodes in the field where light is converted back to RF.

With DAA, major portions of the cable headend are moved out into the plant. The switches and routers connect directly to DAA nodes using inexpensive digital optics common across a variety of IP networking architectures. At the DAA node, the functions of the QAM modulators and CMTSs are replicated and the RF is generated, without any analog optical transmission.

FIBER DEEP

Node + 0, or Fiber Deep, has been a goal considered by many service providers. By taking the actives out of the plant, not only is reliability increased but the potential for higher transmission speeds may be achieved. Node + 0 also makes Full Duplex DOCSIS (FDX) possible.



By removing all existing amplifiers and installing DAA nodes close to the last amplifier location, the service group size is cut dramatically. A node that once served 500 homes is replaced by many nodes that serve perhaps 50-75 homes each. This allows the served homes (and businesses) to achieve their maximum offered speed with little regard for contention.

With no amplifiers, the signal-to-noise ratio present at the node is available to every home fed. With this improvement, the order of modulation can be increased, for example, from 1024 QAM to 4096 QAM, with commensurate throughput increases.

The amount of bandwidth available for upstream signals can be increased through Full Duplex DOCSIS (FDX). Here, a portion of the traditionally downstream spectrum is used for transmissions in both downstream and upstream directions through echo cancellation. With current technology, this requires Node + 0 architecture – the echo cancellation will only work in a passive coaxial area. This could enable symmetric 1 Gbps service to be offered over HFC, and perhaps even higher speeds if coupled with extending the plant bandwidth.

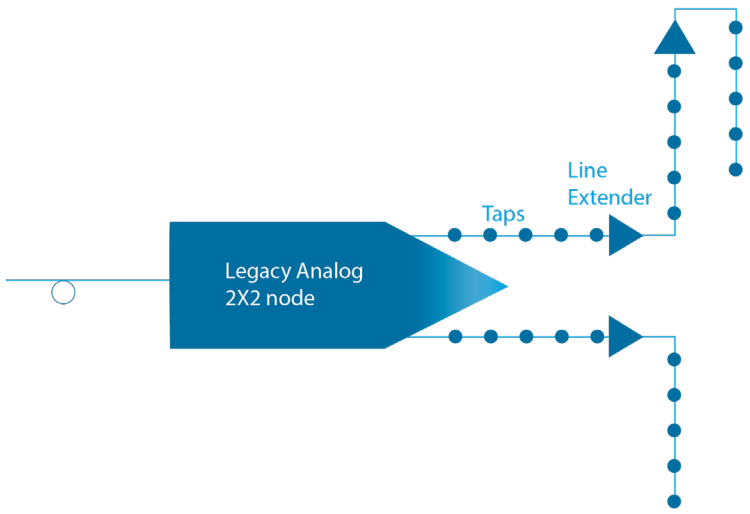
FDX may require that the operator shift the customer connection from a plant-extension architecture, where the spectrum on the network is distributed throughout each home to a gateway architecture, and service is terminated at a single device. That gateway, in turn, feeds the customer's in-home equipment.

As good as Node + 0 is, it is expensive both in terms of monetary cost and service disruption. Operators will want to find ways to enjoy increased service speeds while maintaining profitability.

Another consideration is that in less dense areas, the number of homes per node in a legacy plant might already be low enough to not be of concern in terms of service group size. Improving from, for example, a legacy node serving 100 homes to eight new DAA nodes serving 13 homes each could be very costly and inefficient.

DAA Without Fiber Deep

Replacing analog nodes with digital ones has many advantages. For one, the signal-to-noise ratio is improved by eliminating the analog impairments to transmission over fiber. In addition, simpler digital fiber multiplication equipment (Dense Wavelength Division Multiplexing) may be used reducing the cost and complexity of operating new nodes in a fiber-limited plant.



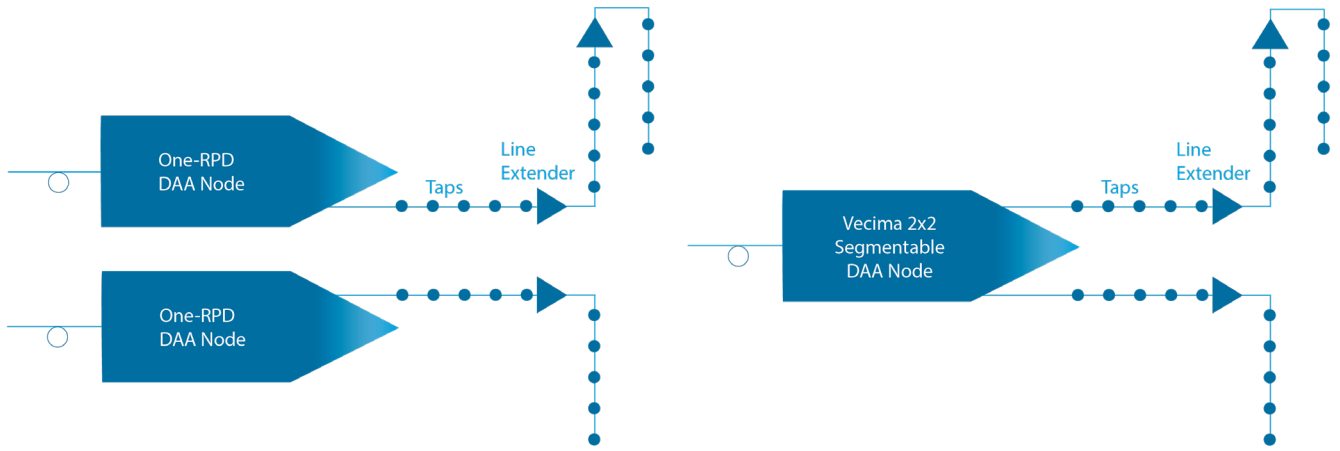
Another factor to consider is what DAA can mean when considering a DOCSIS 3.1 (or DOCSIS 4.0) upgrade. If a large number of CMTSs or CCAP devices are involved, the cost for upgraded line cards or purchasing new chassis may be significant. It might be better to consider moving to a Virtual CCAP architecture where many of the CMTS functions would be performed by the DAA node.

If existing analog nodes are simply replaced by DAA digital nodes, the size of each service group does not change. If the old node fed 500 homes, so would the new one. The same level of contention for available bandwidth would continue. How does this help increase speeds? Higher order modulation may be used, and the available amount of spectrum may be increased, if the downstream amplifiers are capable of that enhancement.

Reduction in service group size is always the reason for a "node split". This could be in response to congestion detected by a network monitoring system, or in anticipation of growth in terms of number of customers, consuming applications (e.g. new IPTV service) or required speeds. Just as with their analog counterparts, operators may decide at a future date that the DAA node warrants segmentation.

NODE SEGMENTATION

If new DAA nodes with a 2x2 capability are installed during a DAA upgrade, the operator can, at a later date, split a 500-home service area in two. While this seldom results in an equal split, the new smaller service groups can relieve contention for bandwidth.



Many analog nodes are capable of supporting multiple service groups. With DAA, the same capability would be desired in order to be able to split an existing, single service group into new service groups, rather than only one downstream and, perhaps, two upstream service groups.

If more new service groups than the existing node can support are required, the only choice is to add new separate nodes. When an additional separate node is required, there are increased capital costs beyond the cost of the new node itself. The new node housing must be placed in the plant, requiring additional design and construction efforts, including both coaxial cable and fiber extensions. A simple table showing various capital expenses for these items and relative spend is included below.

CAPITAL EXPENSE	RELATIVE SPEND
Node Redesign Work	$
Permitting	$
Pole Loading Analysis	$
Network Repowering & Upgrades	$$
Additional Node Cost	$$
Coaxial and Fiber Construction	$$$

Examining the Operating Costs

Running a new physical node requires additional power and maintenance activity. Each node is a potential site for water intrusion or signal leakage, and if network status monitoring is used, another site that must be monitored.

The Alternative: When a DAA node is selected, make sure it has the capability to be segmented to match any future requirements for splitting.

One Tier-1 US MSO indicated that over 75% of their analog node locations have already been segmented into two or more service groups. Another large MSO replaced 85% of their original nodes with segmentable ones between 2004 and 2010. Of those, almost half have subsequently had their second segment activated.

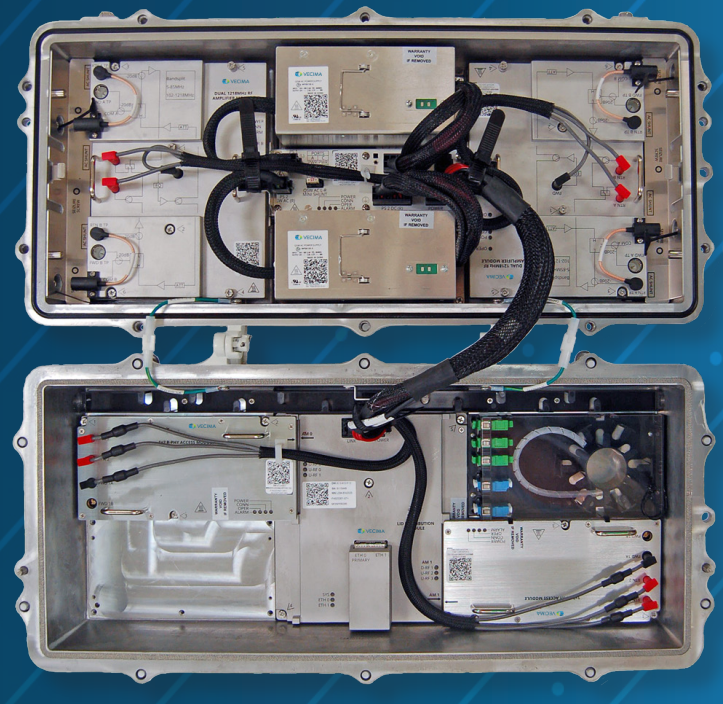
When you consider that a large service provider may have tens of thousands of analog nodes, the scope of the challenge of node segmentation and re-architecting the plant for Fiber Deep becomes clearer. Even a mid-sized service provider could easily have over 5,000 existing node locations.

The Vecima Entra Node

The Vecima Entra node is a standards-based device compatible with major vendor distributed access architecture systems. Unlike DAA nodes offered by others, the Entra node is capable of providing full spectrum service to up to two downstream service areas (or groups) and 4 upstream service areas.

With 2x4 segmentation, node splits dividing an existing service area into two new downstream and four new upstream service areas could be accomplished without hanging new physical node housings and without all of the commensurate increased construction and operating costs.

Other vendors typically require service providers to accept tradeoffs to enable segmentability in their DAA nodes. An example of this is limiting channel capacity, which effectively renders moot one primary benefit of segmenting. The Vecima Entra node also leverages common network interfaces and management processing for multiple RPDs, which reduces power consumption while still providing plenty of connectivity back to the headend.



Vecima Entra EN8124 Node

Entra Node **Portfolio**

The Vecima node was built with DAA as the assumed starting point: the legacy baggage inherent to other vendor's platforms, which commonly leverage analog nodes upgraded to DAA, doesn't limit a service provider's potential.

- The Entra node is available in 1x1, 1x2, 2x2, and 2x4 configurations for initial deployment.
- Kits are available to easily upgrade from single RPD functionality, as a 1x1 or 1x2, to dual RPD functionality as a 2x2 or 2x4. The kit consists of an additional RPD module that is field deployable in less than 5 minutes.
- If the Entra node is initially deployed in a 2x2 configuration, it is a trivial matter to add new upstream service groups and convert to 2x4 operation. This is enabled through a simple software operation.

In summary, the Vecima Entra node gives operators the flexibility required to reconfigure the network service groups while maintaining an open, interoperable approach to other vendors' CCAP platforms.

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