

Increasing Bandwidth while Reducing Costs with the AOI Remote PHY Solution

Executive Summary

This paper introduces the concept a Remote PHY Device (RPD) in cable operator (MSO) networks and describes how Applied Optoelectronic Inc.'s (AOI) Remote PHY solution can help you increase bandwidth and reduce costs in your network.

Background

Remote PHY is a type of distributed access architecture (DAA) that moves the physical layer of the network (Layer 1) to the Node while maintaining higher network layer functions in the headend. Implementing Remote PHY allows you to add subscribers and capacity while reducing equipment and operational costs. Equipment cost savings result from eliminating things such as analog transmitters, analog receivers, RF combiners and QAMs in the headend. Operational cost savings come from reduced headend power consumption, maintenance, and space requirements in the headend. This is an overview of how the AOI Remote PHY solution is a key part in a cost effective network migration to provide additional bandwidth, reduce costs and prepares for future bandwidth growth.

Introduction

Bandwidth demand continues to grow due to several services such as high definition television, gaming, and internet video.

- *Globally, IP video traffic will be 82 percent of all IP traffic (both business and consumer) by 2021, up from 73 percent in 2016. Global IP video traffic will grow threefold from 2016 to 2021, a CAGR of 26 percent. Internet video traffic will grow fourfold from 2016 to 2021, a CAGR of 31 percent. (Source: Cisco-The Zettabyte Era: Trends and Analysis, June 7, 2017).*
- *Internet video to TV grew 50 percent in 2016. This traffic will continue to grow at a rapid pace, increasing 3.6-fold by 2021. Internet video to TV will be 26 percent of fixed consumer Internet video traffic in 2021. (Source: Cisco-The Zettabyte Era: Trends and Analysis, June 7, 2017).*
- *Internet gaming traffic will grow nearly tenfold from 2016 to 2021, a CAGR of 57 percent. Globally, Internet gaming traffic will be 4 percent of consumer Internet traffic in 2021, up from 1 percent in 2016. (Source: Cisco-The Zettabyte Era: Trends and Analysis, June 7, 2017).*

The growth in bandwidth demand has become the number one issue for MSOs. Short of building entirely new networks with the cost and complexity that would entail, operators need a way to meet the demand in a way that leverages their existing networks with an incremental and scalable solution. AOI's Remote PHY is a straightforward and cost effective solution to increase bandwidth while reducing operational costs and complexity of the network.

The Numbers Tell the Story

Nielsen's Law of Internet Bandwidth has accurately tracked internet connectivity over the past 36 years. As demand increases, the data rate available continues to increase. MSO's and equipment vendors have successfully provided improved data rates solutions to end users in the past and new technologies continue to enable this trend. Remote PHY is one of the new technologies enabling increased internet connectivity.

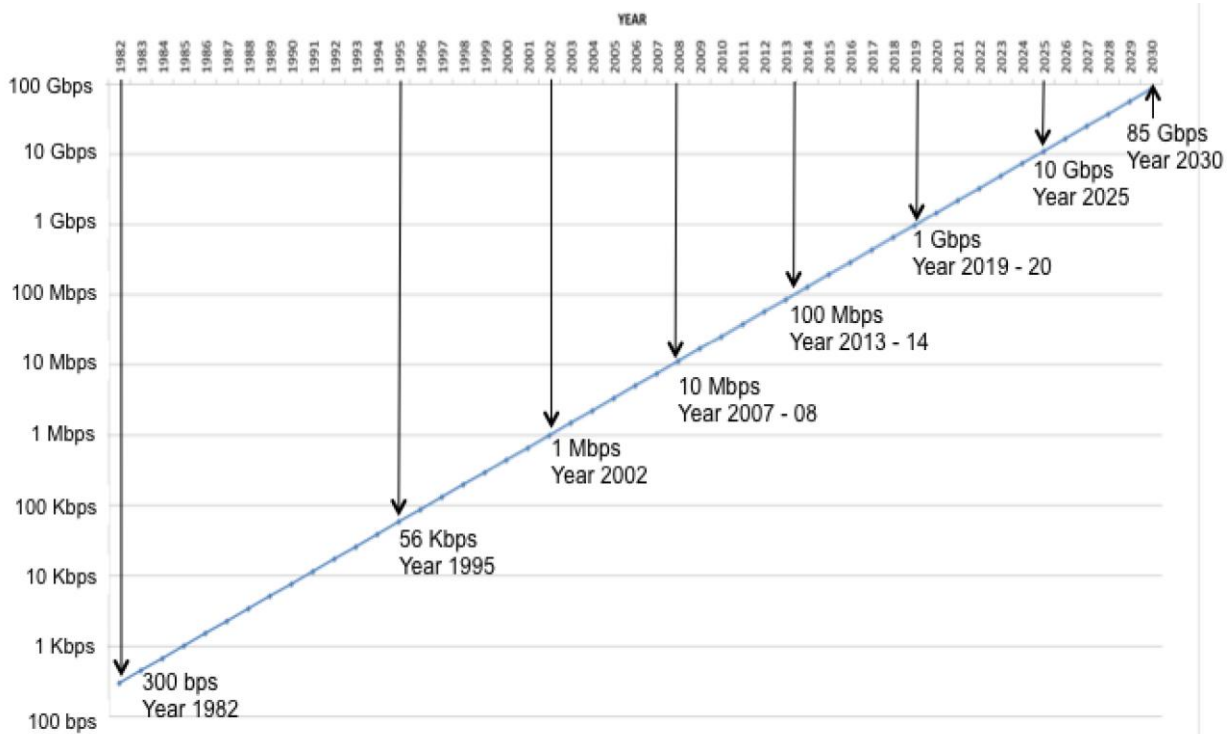


Figure 1. Nielsen's Law of Internet Bandwidth (<https://www.nngroup.com/articles/law-of-bandwidth/>)

Cable Networks Today

Most cable networks today use hybrid fiber coaxial (HFC) built on a centralized access architecture (CAA) model. These networks use a combination of optical and analog connections that are anchored by a headend containing cable modem termination systems (CMTS) to deliver broadband services (data and unicast traffic) and quadrature amplitude modulation (QAM) equipment to deliver narrowcast and broadcast video. Demand for increased data usage and higher speed Internet access (download/upload) have created unsustainable growth in the number of racks, which are required to house new equipment to meet this rising demand. Space is limited in the headend and maintaining, powering, and cooling large amounts of equipment is expensive. Converged cable access platform (CCAP), which combines the CMTS and QAM into one platform, is a step toward addressing the headend space issue by converging data and video into a single unit but projected future demand requires another leap forward.

Distributed Architecture is the Future

Distributed Access Architecture using a CCAP/CMTS and a digital link to RPD Nodes improves the network performance, when compared to CAA networks using analog fiber. Viable solutions to existing networks must consider the DAA solution in order to have a realistic chance of success. If DAA is the future for existing networks, the ideal solution is one that transforms a current, centralized, CATV network into one that is more distributed and modular, with all of the economic and scale advantages that brings.

Migrating to Remote PHY

AOI understands the HFC migration path, the latest technologies, and cost effective network solutions that meet network operator needs. AOI recognizes an optimal first phase in this HFC migration is upgrading DAA networks utilizing business as usual (BAU) Nodes with BAU RPD Nodes. This first step positions the network for an ease in transition to the next steps that include pushing RPD Nodes deeper in the network, removing actives after Nodes and creating Node+0 service groups (N+0) with fewer homes served per Node.

An approach in upgrading to a DAA network with CCAP/CMTS and using existing BAU Nodes with RPD's has several benefits as a migration path to service future increased data traffic demands.

- Reduction of headend equipment space & power consumption in the headend
- Digital optics from the headend to the Nodes improves network performance
- Ease of network setup using SFP+ transceivers vs. setup of analog Tx's and Rx's
- Upgrade BAU Nodes to BAU RPD Nodes has a minimal impact to the CATV plant
- Flexibility to implement BAU and Fiber Deep RPD Node solutions to meet a variation of network bandwidth demand

Separating the Physical Layer from the Headend

When the Physical Layer is moved from the headend to the Node, the analog transmitters, receivers and supporting RF combiners/splitters that connect the CMTS to the BAU Node are removed. The CAA CMTS is upgraded to a DAA CCAP/CMTS. Analog optics in a CAA network are replaced with transceivers that connect via Ethernet the DAA CCAP/CMTS to the BAU Remote PHY Nodes. The typical headend rack space savings is approximately a 4:1 ratio when transitioning from analog optics to digital optics. This results in cost savings at the headend in two ways. First is the cost reduction per square foot and secondly is reduced power consumption due to having less equipment in the headend. Once this new digital Ethernet architecture is in place, you can gradually upgrade the plant from BAU Remote PHY Nodes to Fiber Deep Remote PHY Nodes (N+ 0) and eventually to a full-duplex capable network.

Utilizing existing plant infrastructures and scaling to meet demand needs is a key benefit of DAA with Remote PHY. The DAA network enables flexibility by using BAU RPD Nodes where bandwidth demand can be supported by larger service groups and fiber deep RPD Nodes to satisfy higher bandwidth demands where smaller service groups are required.

Migrating the Outdoor Plant

In a DAA network with a CCAP/CMTS the first phase of migrating the outdoor plant is to either drop in replacement RPD BAU Nodes or upgrade existing Nodes to RPD BAU Nodes. The benefits of migrating the outside plant to BAU RPD Nodes include:

- **Better Network Performance**
 - Replacing analog optics with digital fiber connections eliminates the limitations of the analog optics, which cannot transmit over long distances without generating significant noise.
 - Digital optics allows for easier setup by eliminating complicated balancing of analog transmitters and receivers, further simplifying your network.
 - Using digital optics increases the available spectrum and allows for further segmentation of the Nodes, enabling more optical lambdas (wavelengths) per fiber.
- **Reduced Operating Costs**
 - Removing QAM modulators, analog transmitters, analog receivers and RF splitters/combiners from the headend reduces the required rack space, which lowers power and cooling costs.
 - Replacing analog HFC fiber Nodes with digital fiber Nodes allows you to replace the analog fiber network with a more cost effective Ethernet network delivering higher quality signals to the home (improved MER).
 - Deploying Remote PHY devices offers the cost savings of a “bolt on” solution instead of a costly “forklift” solution that building a pure fiber network would entail while offering the same capacity upgrades as pure fiber.
- **Modernized Access and Transport Architecture**
 - Replacing legacy network equipment in the network with newer and less expensive Ethernet networks offers performance that is equivalent to pure fiber networks with 10Gbps of IP traffic.
 - Building a modern network with new technologies enable the future virtualization of the CCAP/CMTS with distributed access architecture networks.
 - Implementing Remote PHY enables higher order of modulation that enables the ability to deliver more bandwidth (bits/Hz) and is an early step in the migration path to modernizing CATV networks.

AOI Remote PHY

The AOI Remote PHY Device (RPD) provides a cost-effective and standards-based solution for implementing distributed CCAP architecture with minimal disruption to your network. Our Remote PHY technology allows you to separate an integrated CCAP into two components, the CCAP Core and the RPD. This type of architectural change maintains the MAC functions in the CCAP core in the headend, while moving the physical layer out to the RPD in the Node. These changes in the headend and in the Node keep the network disruptions localized and enable reutilization of existing outdoor plant equipment with no required changes.

Increasing Bandwidth while Reducing Costs with the AOI Remote PHY Solution

The AOI 2x2 BAU RPD provides a straightforward approach for adding capacity with the following features and functionality:

- FPGA based design
- CableLabs OpenRPD standards compliant
- Dual downstream and upstream ports
- CableLabs DOCSIS 3.0 and 3.1 standards support
- Interfaces available for Node monitor and control features
- Memory allocated for customer specific software features
- Supports future features through remote software updates
- Flexible spectrum loading options that allows RPD power consumption to be optimized for actual requirements
- Spectrum Loading Plan available in the following defined plans or custom channel loading:
 - Second SFP+ that can be used for redundancy or daisy chain
 - Supports DOCSIS Annex A, B, and C
 - 2x2 and 1x2 configurations

The End Result – AOI's RPD is ready to support Increased Bandwidth

AOI's 2x2 BAU RPD is ready for deployment today. The RPD supports CATV networks migrating from CAA to DAA with minimal network disruptions, through the use of RPD lid upgrades to existing segmented and non-segmented Nodes with a CCAP supported CMTS. Deployment of AOI's 2x2 BAU RPD provides in improved efficiencies, greater bandwidths, and lower costs for CATV networks.

For more inquiries regarding this product and development, please contact sales@ao-inc.com.

About Applied Optoelectronics

Applied Optoelectronics Inc. (AOI) is a leading developer and manufacturer of advanced optical products, including components, modules and equipment. AOI's products are the building blocks for broadband fiber access networks around the world, where they are used in the internet datacenter, CATV broadband, telecom and FTTH markets. AOI supplies optical networking lasers, components and equipment to tier-1 customers in all four of these markets. In addition to its corporate headquarters, wafer fab and advanced engineering and production facilities in Sugar Land, TX, AOI has an R&D center in Atlanta, Georgia and engineering and manufacturing facilities in Taipei, Taiwan and Ningbo, China. For additional information, visit www.ao-inc.com.