The Death of the Cable Modem

Could emerging fiber-to-the-home innovations such as 10 Gbps and 25 Gbps PON finally make copper-based coax cabling as antiquated as the Wright Flyer?

By Mark Scifres / *Pavlov Media*

Technological revolutions don't happen all at once. It often takes the combination of several distinct and separate advancements to cause permanent disruptions in the marketplace.

Consider the evolution of commercial flight. In 1903, the Wright brothers relied on wooden frames and propellers, hardly suitable for mainstream commercial flights as people know them today. Throughout World Wars I and II, metal frames slowly replaced wooden frames, but jet engines remained uncommon until the early 1950s. Only when jet engines were combined with the improved metal frames did the high-volume, commercial airline industry take off. Once the new jetliners became commonplace, the old metal frame propeller planes disappeared quickly from the market.

This type of transformation is about to happen to the telecommunications industry when it comes to data services. Over the next decade, the preferred, dominant internet delivery product to the home will be 10 Gbps fiber to the home (FTTH) with standardization of 25 Gbps within three years. Put it another way: Copper-based coax cabling is on its way to becoming as antiquated as the Wright Flyer.

A FAMILIAR TRANSITION

The impending obsolescence of copper-based coax and hybrid fiber coax (HFC) should be easy to spot for anyone who knows telecom history. Twisted pair type-2 phone wires and dial-up modems were the most common way to connect to the internet from home until copper-based coax wiped them out. The same fate now awaits coax-copper and HFC copper connections thanks to advances in fiber delivery technologies.

The costs for copper are higher than fiber in any new municipal construction, city, business or multiple-dwelling-unit (MDU) property. Fiber is more resilient to the elements, reducing the costs to repair and replace damaged lines. Copper will be relegated to simply powering devices in homes. But most important, physics dictates that copper wires can't keep up with fiber when fiber's full potential is unleashed.

CAN FIBER GET ANY BETTER?

It is becoming common knowledge that fiber has more capacity than copper lines, but just how much better can fiber get? The maximum capacity of fiber optics today is 319 Tbps on one strand with four cores and 552 wavelengths per core. Akamai, the world's largest and most sophisticated edge platform, has 300-plus taps worldwide and capacity across 4,100 locations. That means, all things being equal, all hosted Akamai content could be connected on one strand of fiber instead of across those 4,100 locations.

The big, Tier-1, long-haul carriers and major content providers, such as Google, Facebook and Akamai, are driving investments in long-haul fiber capacity because of how disruptive it is to long-haul operations and content hosting. This will have positive effects on reducing the amount of power it takes to run the internet – in the Akamai example, imagine going from powering 4,100 locations to one.

HFC HITS SPECTRUM LIMITS

All networks are built upon physics, and physics is ultimately what drives the economic

SPECIFICATION	SPECTRUM RANGE	MAXIMUM DOWN	ACTUAL DOWN	PROBLEM
DOCSIS 3.1	0 to 1.2 Gigahertz	10 Gigabit	~ 5 Gigabit	Not enough spectrum available for data channels vs. users per node.
DOCSIS 4.0	0 to 1.8 Gigahertz	10 Gigabit	~ 8 Gigabit	More spectrum, new amplifiers, and taps are needed for new electronics. Not faster down.

Cable Modem Download Speeds

SPECIFICATION	UPPER FREQUENCY	MAXIMUM UPLOAD	ACTUAL DOWN	PROBLEM
DOCSIS 3.1	1.2 Gigahertz	2 Gigabit	~1 Gigabit	Not enough spectrum available for data channels vs. users per node.
DOCSIS 4.0	1.8 Gigahertz	6 Gigabit	~ 3 Gigabit	More spectrum, new amplifiers and taps are needed new electronics. Not much faster up.

Cable Modem Upload Speeds

decisions of which products grow in the marketplace and which products go the way of the dodo bird. Coax amplifiers are limited by cost to less than 2 GHz because of a need for rare Earth materials to support reasonable performance above 2 GHz. Cable companies have tried to go higher, but it is too much work and too expensive to keep the signals "clean" in the real world.

The result: Cable companies are trying to "make do" in their technical specifications by increasing compression, which causes higher latency in devices (makes them slower) relative to fiber. That is primarily why there is a maximum down vs. actual down speed. Table 1 shows the current DOCSIS 3.1 spec and future DOCSIS 4.0 spec. Games such as this existed before – there was no effective increase in performance with DSL services over telephone lines near the end of their useful lives.

Cable companies are adding spectrum to try to have faster uploads. With fiber GPON, it's possible to simply use a different color of light for upload vs. download and have as much performance as desired without any resistance or compression. The fiber splitters are cheaper and require no maintenance or power.

TECHNOLOGY REPLACING CABLE MODEMS

Three technologies could make trouble for the future of cable modem technology:

- **25GS-PON Standard and New ASIC Chipsets:** Hardware manufacturers agree with strategies that play to fiber's strengths and have shown that support by ratifying the 25GS-PON standard, rated at 25 Gbps down and 25 Gbps up. This specific capacity was chosen because the data center teams at Google, Facebook and Amazon pushed their hardware teams for a faster ASIC designed for 28 Gbps SERDES so their data centers could reduce the number of computers needed. This saves power. SERDES ASIC chips take parallel data and serialize it onto a network and deserialize it back into parallel data for the server or switch memory. They interleave four 28-gigabit SERDES of these chips into one 100-gigabit Ethernet port on modern data-center switches that can plug into a server. Leveraging these high-production ASICS and optics for 25GS-PON saves a lot of money.
- **Switches:** Data-center and hardware teams also have been innovating packet processors, a segment long dominated by Broadcom. Nvidia, Marvel, Innovium, Intel and others are working on or already shipping CPU/DPU/FPGA and ASIC solutions to build new network switches that can process 100, 200, 400 and 800-gigabit speeds per port.
- **Customer Premise Equipment (CPE):** The CPE market is also racing forward. Comcast and a consortium of companies put together an open-source software initiative called RDK – a Linux build with specialty controls for network providers to manage devices, such as gateways, IPTV set-top boxes and mesh access points. Sharing code between hardware vendors should help keep the costs

down for the hardware and help mitigate future software security risks because network operators can patch the code if needed, unlike closed source code. These new devices are being designed for 10-gigabit XGS-PON today and likely will be ported to 25GS-PON within the next few years now that the protocol has been ratified. They will have 10-gigabit Ethernet in the home and, hopefully, some 25-gigabit Ethernet ports as well.

IS COPPER OBSOLETE?

Physics, adjacent technological innovations and a public hungry for fiber will eventually bring about the end of copper-based coax, but fiber optic ISPs can do some things to help realize this future quickly. ISPs should publicly support new standards that seek to maximize the potential of fiber, such as the 25GS-PON hardware standard.

The broadband industry should push Ethernet switch vendors harder on LAN considerations, particularly when it comes to CPE. The mass production of 10-gigabit copper mini switches is long overdue. Unfortunately, it is easier and cheaper to support USB 3.1 connectivity in the home at 20 gigabits per second, soon to be 40 gigabits per second, than to get reasonably priced managed ASIC mini switch chips for 10-gigabit Ethernet. As an industry, ISPs need to push manufacturers to build these products for homes to break past the limits of copper cable modems.

The fiber broadband industry must play to its infrastructure's strengths (higher peak speeds, more reliability, lower latency) and deliver products traditional copper infrastructure providers or wireless providers, both cellular and space-based, cannot match. Fiber operators should take more market share; depreciate electronics over a longer depreciation cycle; reduce operating costs for churn, network utilization and replacement costs; and invent new revenue streams that can take advantage of fiber's increased network capacities.

In short, the industry should sell 10-gigabit services to homes immediately and price them for consumers as entry-level products – at these speeds, there is no cable competition. There's plenty of upside in the fiber future for upsells above that speed – cable companies, cellular and the space industries do not have that advantage. Let's visit them in a museum along with some propeller airplanes. ❖

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