# The High Speed Data Race

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 This article is about speed, the speed of data communications for the home and small-and-medium-business markets. The contestants we’re discussing are the cable guys, with their DOCSIS 3.0 cable modems, and the FTTH gang with fiber all the way to the home. A more complete discussion of the subject appears on our web site at www.enablence.com [1].

The bottom line is that nothing, and I mean nothing, can beat a fiber connection, not now and not in the foreseeable future. Fiber offers the highest speeds you can achieve, not to mention its other advantages such as extremely low operational costs and versatile high quality transmission. DOCSIS over a cable TV operator’s HFC (hybrid fiber-coax) comes second, but it is a fairly distant second. The cable TV industry is aggressively promoting DOCSIS 3.0, the fourth and latest incarnation of the DOCSIS standard. It does offer some improvements over earlier versions of DOCSIS, and it may keep HFC competitive for a few years. But in the end, the greater speed of FTTH, along with its other advantages, will win.

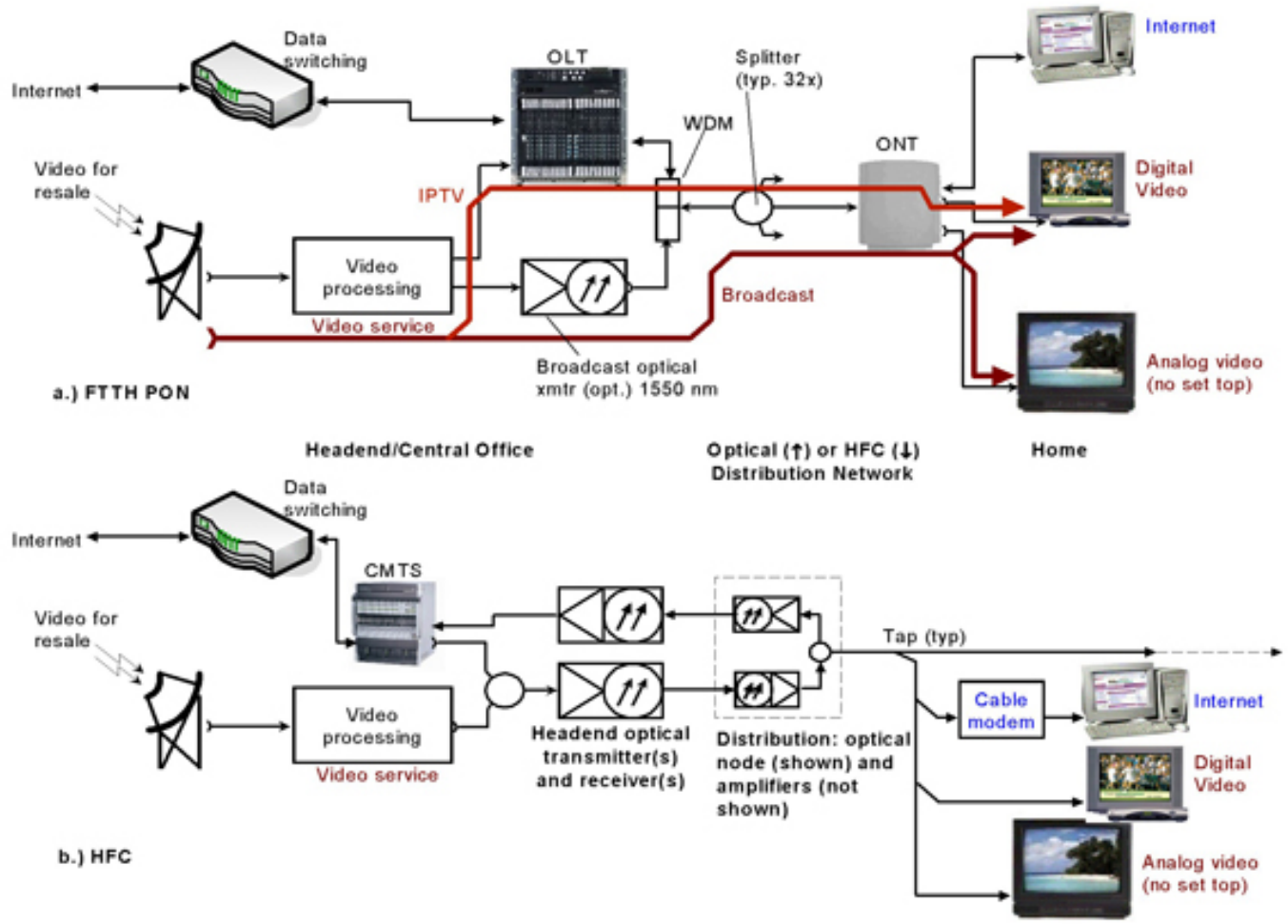


**Figure 1. Carriage of Signals in HFC and FTTH**

Figure 1 illustrates how signals are carried in the two systems. For HFC, all of the downstream signals are carried in 6 MHz wide channels. Most channels are used for video, but some must be reserved for data. The numbers work out such that any one 6 MHz wide channel can transport roughly 38 Mb/s of payload data. This channel may be used for a number of different services:
- 1 analog TV program
- About 10 standard definition digital programs
- About 2 high definition programs
- About 38 Mb/s of DOCSIS data

In the upstream direction, there is even more difference between FTTH and DOCSIS. FTTH can transport at least 1 Gb/s upstream from 32 subscribers. DOCSIS has a number of options for transporting upstream data, trading off bandwidth and robustness of modulation. Typically today, one 6.4 MHz wide upstream channel carries a wire rate of about 10 Mb/s, payload of about 8 Mb/s, using 16-QAM modulation. If the upstream RF path is suitable (meaning primarily that it is noise-free), higher orders of modulation may be used, resulting in higher data rates. The problem is that, in the real world, this portion of the spectrum tends to be relatively noise-prone, with noise from electrical appliances, short wave radio, and other sources invading the spectrum.

DOCSIS 3.0 added the feature of channel bonding, which is directly analogous to pair bonding in DSL, resulting in a higher bandwidth data service using multiple channels. It is physically possible to get up to four upstream DOCSIS channels in the bandwidth available, and this is optimistically called a 120 Mb/s service. However, in order to get this, a node must have at least 25 MHz of very noise-free spectrum in the upstream direction. While this is certainly possible to demonstrate in the laboratory, and may occasionally obtain in the field, the more common situation is that there is enough noise in the upstream direction that some of the channels must use lower-order modulation methods, costing more in data speed.

What is this bandwidth needed for? If you’re not using IPTV, not much today. But the history of telecommunications is that there is never enough bandwidth for long. Today DOCSIS can offer the speed needed, but already we are seeing applications that tax DOCSIS, and the bandwidth demands are going to keep going up. The way to get in front of them is FTTH, which even at today’s data rates, is using an infinitesimal portion of the bandwidth of which the fiber is capable.



**Links:**
[1] http://www.enablence.com