FTTH: Low Noise AND High Bandwidth Make the Difference

Once customers get FTTH service, just about the only reason they give it up is that they have to move. Churn rates are that low. Here's why.

By Joe Savage ■ *FTTH Council*

Service providers are hotly competing for your voice, data and video service subscriptions. To deliver all three services, most are building new broadband access networks or upgrading those already in place. These next-generation broadband networks provide the bandwidth that supports delivery of these services. But the deal is not a simple one. Competition for your subscription dollars is centering on the bundled price for the package of all three services. Therefore a successful service provider must deliver a superior product for all three parts of the "triple play" package to succeed:

- For data service, or high-speed Internet, competition is about the raw downstream bandwidth provided to the subscriber, and more recently about the upstream bandwidth provided to the network. The more throughput, the better the service.
- For voice service, competition is about quality and reliability; the clearer the conversation, the better the service.
- For video service, competition centers on the breadth of channels offered, the quality of the picture on the screen, and the amount of high-definition programming. The better the image and the more video choice, the better the service.

Market share will be gained and subscribers retained by the access network that provides superior transport of all the elements of the service bundle. An access network using optical fiber all the way to the business or residence has clear advantages, especially when it comes to providing better services as perceived by subscribers.

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Broadband Access Networks: Pro and Con

Optical fiber cables provide much higher information transmission capability – more bandwidth over longer distances – than copper wires. And optical fiber cables operate at much lower levels of noise and interference. That is why high-speed long distance and local trunk networks use optical fiber almost exclusively. Therefore, all methods of increasing the broadband capability in subscriber access networks make use of optical fibers in those access networks – some partway to the subscriber, some all the way to the subscriber. The closer the optical fiber is to the subscriber, the more investment is required by the service provider – and the more capacity and reliability offered. Listed below are quick descriptions of the most common:

Hybrid Fiber-Coax: Cable television operators such as Comcast and Time Warner use an access network called Hybrid Fiber-Coax (HFC), in which optical fiber delivers the signal to a nearby transition point in your neighborhood called a node. Copper coaxial cable takes the signal the final distance from the transition node to you and up to about 500 other homes served off the same node. The advantage to this access architecture is that it allows re-using much of the existing coaxial cables in neighborhoods.

Fiber to the Node: Some telephone companies, such as AT&T and Bell Canada, are starting to use an access network called fiber to the node (FTTN). Others like BellSouth (now part of AT&T) use fiber to the curb (FTTC), in which optical fiber delivers the signal to a nearby point in your neighborhood. In both cases, copper twisted-pair telephone cables take the signal the final distance

Network Type	High-Speed Data	Voice Service Delivery	Video Service Delivery	Noise Susceptibility	High-Definition Video Capability
HFC	Highly asymmetric	VoIP	RF broadcast (analog and digital)	Medium	Limited MPEG-4 needed
FTTN/C	Asymmetric	PSTN & VoIP	IPTV only	Higher	Restricted MPEG-4 required
FTTH	Symmetric or asymmetric	PSTN & VoIP	RF broadcast and IPTV	Low	Open MPEG-2 or 4 optional, or signal can be uncompressed

Table 1 - Broadband Access Network Characteristics

to you and other homes served off the node. FTTN nodes typically serve about 500 customers; FTTC varies from that number to smaller numbers depending on household density. The advantage is, again, re-use of much of the existing twisted-pair cables.

Fiber to the Home: Other telephone companies, such as Verizon and GVTC, use an access technology called fiber to the home (FTTH), in which the optical fiber path is delivered all the way to your residence and all your neighbors' residences. The advantage is delivery of almost unlimited bandwidth, with minimal interference or error in the signal.

Noise and Interference – So What, and How Does It Affect My Competitive Position?

Broadband access networks differ in the amount of outside noise and interference that gets into the signal. (Noise comes from other circuits in the twisted-pair cable, as well as from microwave ovens, ham radios, power lines, small motors, electric razors, lightning strikes, lamp dimmers and so forth.) The following discussion is simplified a bit so that non-experts can easily follow.

Twisted copper pairs are most susceptible to noise entering the signal path, coaxial cable is somewhat better, and optical fiber is far superior. The more noise, the more the signal, and the service, is degraded. But the three services that make up the triple play bundle are affected differently by this outside noise and interference. Table 1 above lists some of the access network characteristics important to this discussion of perceived triple play quality.

Figure 1. Highly compressed video – typical of fast-moving HDTV sports broadcasts – is easily disrupted by noise. Old-timers will remember the days of rabbit-ear antennas and crude vacuum-tube TVs. Picture courtesy of IneoQuest, which sells network control software and hardware to reduce such problems.

Noise and High-Speed Data Services

A subscriber paying for higher-speed

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service may have a high bit rate, but will not see increased performance if the circuit is noisy. Why? Most high-speed data is carried over the Internet and uses a protocol called TCP/IP. Noise introduces digital errors into the IP packets, reducing throughput because of retransmission of corrupted packets. One error in the packet and the whole packet is retransmitted. Since most Internet traffic is not time-sensitive, the reduced speed is usually not noticed by the subscriber. However, gaps and stops in streaming video coming from the Internet are noticeable and annoying.

Hard-core online gamers are most affected by delays in high-speed data service; as their click stream to the gaming Web site slows, their team is disadvantaged relative to their opponents.

Noise and Voice Services

In FTTN/C networks, voice is carried in the traditional way, referred to as PSTN, for public switched telephone network. When analog voice (PSTN) is degraded by noise, clicks, pops and hissing are heard in the received signal.

In HFC and FTTH networks, a new technique is used. The voice signal is placed into IP packets and the packets are sent using a portion of the high-speed data bandwidth. For this Voice-over-IP service, or VoIP, the Internet's TCP/IP protocol is used, with the voice signal broken up and transported in IP packets. Noise corrupts the packets, just as with the HSD service, causing packet retransmission. But voice calls are time sensitive, so packet delays are very noticeable. Voice gaps and garble occur and, in very noisy circuits, the call is

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terminated. That's why VoIP calls sometime seem like cellular phone calls in quality and reliability. Noise and delay dramatically impacts VoIP calls.

Noise and Video Services

In FTTN/C networks, video is delivered, again, as IP packets using the TCP/IP protocols – hence the term IPTV. In HFC networks, video signals are delivered using the traditional radio frequency (RF) analog signals. FTTH networks can use either or both methods, IPTV and RF analog signals. (Some FTTH operators use only IPTV, others use only RF and other combine RF for broadcast channels and IPTV for the video-on-demand services.)

For RF video, noise appears as blips and blurring on the screen. For IPTV, noise shows up as action-stops and pixelization of the picture, as missing packets are retransmitted. In very noisy networks, the set-top box cannot synchronize with either the RF analog signal or the IPTV signal and a loss-of-signal is reported on the screen.

As one would expect, all three of the competitive triple play services benefit (in different ways) from operating over a low-noise network. Satisfaction surveys have shown subscribers are most sensitive to video picture quality in their satisfaction evaluations. Most are willing to change service providers to get better picture quality. And, of the three services, video is the most difficult to deliver. This emphasizes the competitive edge of FTTH as the access network technology of choice for video service.

Video Compression Magnifies the Impact of Noise

Access networks other than FTTH must rely on compression of the video signal to fit sufficient video channels into the bandwidth they are capable of delivering to the customer. The industry-standard form of compression is called MPEG-2 (Motion Picture Expert Group, Version 2) and is being used in most set-top boxes in the market today. It can deliver DVD-quality video.

Most FTTH networks use MPEG-2 compression because existing set-top boxes that are needed to receive digital TV signals also expect to receive compressed video signals. A newer, more efficient form of compression, known as MPEG-4, is needed to fit IPTV signals into the available FTTN/C bandwidth. CATV networks will shift to the newer MPEG-4 in their future set-top boxes in order to compete in delivery of more high-definition programs.

As the video signals are compressed into smaller and smaller amounts of bandwidth, surprisingly little picture quality degradation is seen – if the environment is truly noise-free. To squeeze the last iota of compression out of the TV signal, longer and longer frames and frame sequences are used. That is, each packet of video information is very large, and many, many video frames are sent without resending a "key frame" that contains all the video information.

An error in the frame results in a frame reset, or retransmission of that longer frame. Unfortunately, the relatively limited bandwidth delivered by HFC and FTTN/C networks is combined with higher levels of noise. And the more elegant and efficient the video signal compression scheme, the more impact a retransmitted IP packet, or a lost frame, has on the picture displayed on the TV screen. This impact is further exacerbated on high-definition TV signals because high-definition signal content requires more bandwidth, more compression and even more IP packets to deliver the image.

The lower-noise environment of the FTTH network contributes to providing a steady, high-quality image on the subscriber's flat screen HDTV set. This is quickly recognized by subscribers and leads to higher satisfaction scores.

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FTTH, Market Share and Satisfied Subscribers

Because of the bandwidth and noise performance of FTTH networks, superior performance is seen in all three services in the triple play bundle. Surveys of FTTH subscribers show consistently higher levels of satisfaction than subscribers to DSL, cable modem or other forms of broadband access. Market share for the hundreds of rural FTTH deployments averages above 50 percent and is growing over time.

So operators are faced with a decision – defensive tactics to forestall erosion of their customer base, or initiation of deployment of FTTH to compete effectively. In any case, because of its superior characteristics, FTTH will be their network in the long run anyway. Why not start now? **BBP**

About the Author

Joe Savage is President of the FTTH Council in Washington, DC. For more information, see www.FTTHCouncil.org.