Enablence

THE FLAVORS OF VIDEO: BROADCAST OR IP?

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THERE CERTAINLY IS A LOT OF TALK ABOUT HOW TO DELIVER VIDEO ON FIBER-TO-THE-HOME (FTTH) SYSTEMS TODAY. THIS PAPER IS A LIGHT, LOW-TECH LOOK AT THE ISSUES, WITH THE SERIOUS INTENT TO HELP YOU SORT OUT THE OPTIONS IN VIDEO DELIVERY.

PROLOGUE

Television has taken the U.S. and much of the developed (and developing) world by storm in the last 60 years or so. No other entertainment medium has been embraced so completely by the masses. Dating ourselves, we remember the first TV station in our area coming on the air. And we remember our first TV, a used DuMont 21 inch console. That DuMont didn't prove too reliable, and Dad somehow managed to trade up to a used 21 inch RCA. All black-and-white back then; color was in committee being negotiated. TVs came in two sizes: 17 and 21 inches. Then shortly thereafter, manufacturers started putting out gigantic, premium 24 inch sets.

A young boy used to sit for hours in front of that RCA set, fine tuning the test pattern coming from WSUN TV-38 ("You've got a date, on 38") before it went on-the-air in the afternoon. Our area was unusual in that we got a UHF station before we got VHF. If you were anybody at the elementary school, you were clued in on what happened the previous afternoon on Captain Mac's Adventure Trails. Then there was the news block: 15 minutes of a talking head from the local station followed by 15 minutes of network news, sometimes with film clips from Washington or some other mysterious place. After that was some programming for adults, but once a week Disney had a TV program with a Disneyland theme, and there were Lassie and some really great westerns. And Saturday mornings: ah, a kid's dream come true. Cartoons, Howdy Doody, Rin Tin Tin, Flash Gordon, and always a western or two.

THE PRESENT

Fast-forward to today and look at the differences. Yesteryear was "57 channels and nothing's on." Now it's hundreds of channels and nothing's on. It's video-on-demand when you want it, and it's video where you want it. It's not even "all channels" any more. Want last night's episode on your computer? "No problem, mon." Want video on your phone? Not my thing, but it's yours if you want it. Not all the video is from the big guys to us little guys, either. You can find thousands of short videos on the web, produced by individuals. I watched some the other day. I soon got bored, but judging by the comments people had posted, and by the number of times some had been viewed, my tastes must not jibe with those of the modern generation (which I pretty well knew already).

We have morphed from a few national suppliers of video, with video fanning out from one to all, to hundreds of suppliers of video for profit (they hope), and millions of hobbyists feeding their own video to anyone who will watch, with a whole spectrum (pun intended) of video in between.

What does all of this have do with fiber-to-the-home? A lot. All this video needs what we've got: bandwidth. Bandwidth *is* the killer application we've all been looking for. I've been trying in vain to promote Farmer's law as my claim to fame. It's not working, but I keep trying: *No matter how much bandwidth you provide, some clown is going to come along with an application that needs more*. And today no application needs more bandwidth than video. And no technology has more bandwidth than FTTH. By a lot.

BROADCAST?

For our competition, bandwidth come in only one flavor, but for us, it comes in multiple flavors, and we have more of it than anyone else. First is the bandwidth you get from a broadcast tier. "Broadcast," you say? "Man, that's so, well, nineties. Today it's IPTV." Yeah, I know about IPTV, and I'll get to it in a minute. But don't sell the old guy short, either. How would you like to have a 6.8 Gb/s downstream pipe into each and every home you serve – enough capacity to send almost 1700 TV programs with today's technology, more tomorrow. That's in addition to your data, of course. All the infrastructure pieces you need are in place and mature. Well, 6.8 Gb/s is about the theoretical capacity of a broadcast tier that goes out to 1,000 MHz. For video only, you actually get a bit more (it's a matter of the protocols used and how much bandwidth they take). If you used all that bandwidth for TV, you could get up to about 1570 standard definition (SD) TV channels, or 470 high definition (HD) channels, or some combination thereof.

Not that you would use the broadcast tier that way - that bandwidth is very versatile - but it illustrates what can be done. No, you would probably do what most people do today: plodding old analog TV for the first 78 or so channels – after all, about 2/3 of the population still get their TV that way, at least on some TVs in their homes. And you can hook directly into those TVs without a box. Sure, you can transmit digital and get more capacity, and some day all TVs will tune the digital signals directly. But you're going to buy a lot of set top boxes in the meantime.

The rest of the spectrum you can use for digital TV, modulated onto RF carriers. There's enough space left for maybe 750 SD programs – more tomorrow with MPEG-4. And you have the ability to ride on the backs of the cable TV industry, which has very sophisticated and reliable set top boxes available, along with all the back-office support you can think of. The boxes are two-way (supported on all Enablence's FTTH platforms), you can get them for multi-room service, and with PVRs. High definition is mature and works very well. There is advertising insertion hardware to let you add your own ads, there are lots of choices in video-on-demand servers, caller ID on the TV, games, and web surfing (which, BTW, doesn't work all that well on TV, but you can do it if you want to).

So what FTTH systems support broadcast? All of them. With both GPON[1] and EPON[1] you have a few small hurdles to get over that two-wavelength systems don't have, but Enablence can help you jump those hurdles without trouble. The biggest deal is to keep idle codes out of the video, and Enablence has countermeasures to make that happens. Sometimes when you run high transmit power, you have a little bit more to look at, but nothing that can't be handled. Of course, to use cable TV set top boxes, you have to support getting their return signals to the headend (CO if you're a telephone guy). Enablence has you covered here too. [1]

[1] Gigabit Passive Optical Network – the current ITU FTTH standard

[1] Ethernet Passive Optical Network. Also known as GEPON – the IEEE standard. A PON is the most common form of FTTH, with optical splitting used to share central facilities with many subscribers. There are also point-to-point networks that don't share central facilities.

[1] Patent issued and pending

IPTV?

OK, I said I'd get to the modern age and talk about TV over IP, IPTV. That's the buzz word these days. A lot of the promotion of IPTV has been done by the DSL folks. Simple reason for their excitement: DSL people don't have a choice. It's IPTV or out of the game. And out of the game means not having triple play, and not having the one service that folks are willing to pay real money for. Us FTTH guys, we're different: we have a choice. And we don't even have to make that choice. We can do both: broadcast where it makes sense, and IPTV where that makes sense.

Now don't get me wrong. I like IPTV, and think it has a great future. But I'm also a realist, and having been burned more than a few times, I'm aware of the issues before the industry. Let's spend the rest of this time talking about when you would do one or the other.

DEFINING THE TERMS

First, let's try as best we can to define the terms. Broadcast is pretty straightforward: you take one or (in the case of digital) more TV programs and put them on an RF carrier. You then combine all of the RF carriers and shoot the whole bunch to a 1550 nm optical transmitter. This optical signal goes down your FTTH plant to the home, where it is converted back to the same RF that cable TV uses. Well, there is a little difference: if you design your FTTH system correctly, the quality you deliver will be better than that on cable TV. But otherwise, it looks just like cable TV.

IPTV starts the same way from the originator. It's converted to a particular type of packet stream called a "single program MPEG transport stream." This transport stream is put in IP packets, and the packets are lumped with all the other data going to subscribers. No difference.

Naw, that's not right. They used to say, "a bit is a bit is a bit," meaning that all bits, regardless of what they carry, can be treated the same way. Not so: if you want the kind of video you get over the Internet now, go ahead and treat them all the same way. But the first time your video freezes on your subscriber's TV is the last time you'll serve him video: that doesn't (or shouldn't) happen on cable or satellite. This means that you have to support quality of service (QoS) parameters, a task Enablence can help you get right.

THE BIG BOX

For IPTV, you're committed to a box on almost every TV in the home, and you will be for a long time. Yeah, you will see a few TV manufacturers putting IPTV inputs on a few TVs starting about now, but remember that a TV lives for an average of 15 years, and few TVs today can accept the IP input. Also, it's not just a matter of tuning in the broadcast. How are you going to control premium programming, so it is only received by the right people? Lots and lots of issues here. You better believe Hollywood is going to have its say. So you're in for a lot of boxes.

The cable TV industry is in about the same boat on digital broadcast. A few TVs now tune digital cable broadcasts directly, but most do not. Because of the longevity of TVs, combined with the few that tune digital, cable is finding it impossible to consider turning off the analog channels (though there is talk — not action — of reducing the number of analog channels).

The good old boys at the FCC have mandated that every TV sold in the U.S. have an off-air digital tuner. A lot of them have tuners for cable digital TV (off-air and cable digital are similar, but not quite the same). Some tune satellite broadcasts. So far we've only seen a very limited number of sets that can "tune" IPTV.

A new FCC mandate scheduled to go into effect a few months after this is written requires that set tops have "removable security," meaning a device called a CableCard®, which allows the subscriber to buy his or her own box and just get the security element from the cable supplier. Some TVs also support the CableCard. Problem is, today's CableCards don't support the advanced two-way features that today's set top boxes support.

GETTING AROUND HOME

The next issue with IPTV is that you have to get it to the TV in the home. Most homes now have coaxial cable (coax) running to the TV, for either satellite or cable TV service. If you go broadcast, you can use this coax directly. But if you use IPTV, your set top is going to want an Ethernet connection, and that requires a different kind of cable. You can install the cable to every TV, but that takes time, which equals money. And it's disruptive to the subscriber. Or you can use one of several methods of getting the IPTV over the coax. That's going to cost you for equipment on each end of the coax, but it will let you get away with not putting in new cable. You'll have to do the cost tradeoff. See the companion Enablence White Paper, *In-Home Wiring*, Publication number 990-00003.

COST/QUALITY/BANDWIDTH

There are some program supply issues with IPTV, but these are getting solved. You have to get the encoded video from somewhere. There are folks in the business of selling you pre-encoded video, but you have to get it from their location to yours. Or you could encode it yourself, and the cost depends on quality and how many channels you get already in suitable digital format and how many you have to put in that format. The one thing we can say with some certainty is that for the next few years, if you want your video in the more bandwidth-efficient MPEG-4 AVC format (as opposed to today's universal MPEG-2), be prepared to shell out big bucks for processing or transport. Fortunately, as an FTTH guy, you are not as bandwidth-constrained as are the DSL guys, so you can live with MPEG-2 until encoding/transcoding prices come down.

IPTV HALLOWEEN

FINGERS IN THE PIE

Now here's something to scare you about IPTV. With broadcast, either the TV or the set top box is provided by one manufacturer, and typically that manufacturer is responsible for, and has provided himself, every piece of hardware and software in the box. So box operation is pretty straightforward. With IPTV, for a variety of reasons a lot of different manufacturers touch the video: one guy builds the hardware. Another guy makes the operating system it uses. Another guy makes the middleware that handles the video, and another guy makes the digital rights management (DRM) software, which controls how the picture is presented. And someone else may have done the program guide. If you buy the set top from its manufacturer, he may take responsibility for the integration. But we can tell you from talking to them, that they have only a partial picture of what is going on in the software.

STANDARDS, WHAT STANDARDS?

Standards for IPTV are incomplete. This was addressed in a recent article in *EE Times* Magazine.[1] Some selected quotes from the article:

> "The slow pace of IPTV rollouts and proprietary nature of the systems are leading the International Telecommunications Union to step in and coordinate standards efforts, but the idea of such a move has been met with mixed reactions … Some Asian operators and vendors … have complained about a lack of cohesive IPTV standards that encompass the technical gear, billing systems, and middleware… "Standards would be helpful in terms of ensuring device interoperability, but there is still a lot of fine-tuning that needs to happen to optimize multimedia over telecom networks," said Ted Hsiung, of Cascade Ltd … Although vendors … are teaming up in loose partnerships to ease the rollout process, simplicity is a long way off … "There is not one vendor out there in the world that does everything from the headend over to the DRM system to the middleware. The maturity of the products is not there," said Josef Lorenz, … Siemens Multimedia."

A recent article in Forbes Magazine[1] lamented the slow progress of IPTV, particularly in the U.S. It tends to lag other parts of the world partially due to the more intense competitive environment here, and the relative lack of cable TV infrastructure elsewhere:

> "Sometimes I think I'm going to die before it [IPTV] is a reality in North America," says Lo {CEO, Ruckus Wireless}. "I'm not happy at all with the speed of deployment, but it is happening." . . .

[1] Mike Clendenin, *ITU Volunteers to Unsnarl IPTV Standards*, EE Times Magazine, May 29, 2006, page 21.
[1] Stephanie Mehta, *Watching TV Anywhere and Everywhere*, Forbes Magazine, Feb. 22, 2007

The biggest proponent of IPTV in the U.S, AT&T, is in just a dozen or so markets in the U.S. There are many reasons for the slow deployment of telco TV in the U.S., ranging from technology issues to regulatory hurdles.

Recently a number of companies in the telecommunications and consumer electronics fields have formed an organization, the Open IPTV Forum, to address the standards issue.[1] Hopefully this activity or some other will successfully be able to fill in the dots for IPTV.

WHO LEFT THE SET TOP ON?

A problem plaguing IPTV and broadcast SDV (see below) is the propensity of some subscribers (your writer included) to leave the set top turned on when they finish watching a program. We miscreants turn off the TV, but don't bother with the set top. No big deal in broadcast, but in IPTV, this means that a program stream will stay on the network forever, even though no one is watching it. Say you have an extreme case: 32 subscribers on a PON, three TVs each, 4 Mb/s per video stream. Do the math: if all set tops are left on at night, your network will be streaming 384 Mb/s for no purpose whatsoever.

The folks experimenting with SDV on broadcast have the same problem. An early proposal to counter it is to wait, say, four hours after the last set top interaction (channel change, volume change, etc.). Then put a sign up saying, "to continue watching this program, press the enter key." If someone presses the enter key, then the set top is good for another four hours. If no one presses the enter key, the program is shut off. Better than nothing, I guess. But what about the guy who leaves the TV on all day for his dog? (Fiber-to-the-dog? Hey, we hear it happens – please don't suggest it to my wife for her cats.) Or the Old Timer who leaves the set top on to tape a program early in the morning?

TUNING

With broadcast, when your subscriber tunes from one channel to another, his or her TV or set top does all the work and you don't even know about the tuning. But with IPTV, tuning involves your network. All the guys who have something in the set top play a roll in getting a new program. And gear from several companies is involved in your network. Yep, your network gets involved every time a subscriber tunes to another channel.

There are at least two ways IPTV signal transmission can get set up. One is called "unicast," and is most commonly used when a program is intended for one and only one subscriber. A unique program stream is generated for that subscriber, starting where the program stream originates, and going all the way to the subscriber. Obviously this can burn a lot of bandwidth in your network prior to and in the FTTH portion.

The other way is more efficient: if the program is sent using "multicast" then it only goes through your plant once when several subscribers are getting the signal at the same time. This take less bandwidth on your network, both before you get to the FTTH part and usually in the FTTH portion, too, depending on where the subscribers are located. But it means that your network is involved in each and every tuning event from every subscriber. One manufacturer of set top boxes told us recently that he counted up to 14 different vendors involved in every channel change!

We've done a good bit of testing, and it is possible to make all this work, but there remain some questions about scaling: what happens when tens of thousands of subscribers on high-speed connections channel surf at the same time when a big game goes to commercial? There are a couple of big IPTV installations overseas, so they know something about this. But the installations are primarily on DSL, not faster FTTH. And viewing habits seem to be different in North America.

OK, now that we've established some fundamentals of broadcast and IPTV, what makes sense? Well, as any good consultant will tell you, "it depends." It depends on what services you are supplying, and it depends on your competitive situation.

ADVANTAGE: BROADCAST

First, start with a conventional model that we've spent the last 60 years teaching people to use: broadcast. Deliver the same program at the same time to all the subscribers. Hands down, broadcast wins the efficiency race when this is what you want to do: it's simple, well-understood, leaves your network alone, and is low in cost – basic services don't even require a set top. We could say the same thing for downloading programs to personal video recorders (PVRs). If someone wants to download a program to his PVR, you really want to broadcast that program, and let the subscriber set his PVR to record it when you broadcast it. Everyone records the program at the same time. You only tie up bandwidth once, not every time any Joe Sixpack wants to record it. That's the way all PVRs are set up today (except for those in IPTV set tops): they are designed to let the subscriber pick out a broadcast program and record it.

The cable industry has developed good business models and equipment for video-on-demand (VOD), advertising insertion, and other services using broadcast, and you can ride piggy-back on these models if you go broadcast. They have even developed a variant of the IPTV theme called *switched digital video* (SDV) useful for less-watched programming.

ADVANTAGE: IPTV

Now we start considering a number of methods of program distribution where either IPTV is going to win the efficiency contest, or the deliver technology is of little concern. Let's take the simple case of video-on-demand (VOD). VOD is one of the hottest things going in the cable TV space right now; it's something cable TV can do that satellite can't do.[1] You can do VOD on broadcast, which is what cable TV is doing now.

But it is more efficient on IP if you have the right network ("right network" meaning FTTH). By definition, VOD is one-to-one programming: you have to send out a separate program stream to each subscriber. Each subscriber will start the program at a different time, and may want to pause or rewind the program at different times. This is the definition of VOD. (If you are going to sent the program to all subscribers at the same time, and expect them to buy it when you send it, it's called "pay per view.")

It turns out that the way you configure a network for broadcast has, for the most part, the same set of signals going to each and every home in a neighborhood of hundreds or thousands of homes. So to send VOD to one subscriber, you tie up a channel (or, more properly, part of a channel) to each and every subscriber in the neighborhood. Not very efficient. Sure, you can segment your network to different neighborhoods and re-use the channels, and this is what cable TV does. But that costs money for more optical transmitters, and takes physical re-cabling each time you do it. With IP, you already have an efficient path that ties up bandwidth to only one PON (32 to 64 subscribers typically) to reach one subscriber. Thus, while you can do VOD on broadcast, and this may make sense in the early days, IPTV is more efficient in the long run.

Next, we turn to a similar service that some cable guys are experimenting with, called the "network PVR." Basically, you use a server at the headend (CO to you telephone folks) to capture video, and the server plays out the program to the subscriber when he wants it. This is an experimental service at the moment, with technical, cost, and legal issues that have yet to be sorted out. You could, in some scenarios, watch last night's program if there was talk about it at the office, and you wish you'd either seen it or at least had the foresight to PVR it. Other cable operators are experimenting with letting the subscriber use the network PVR just as he would a PVR at his home (though this experiment has at least temporarily been shut down due to legal issues). Another idea is to let the subscriber start a program over if he missed the first few minutes. However it is used, as far as the network is concerned, this is just like the VOD case (point-to-point), and is more efficiently done on IPTV, though it can be (and is being) done on broadcast.

CHALLENGE: IPTV

We're fans of IPTV where it makes sense, and it make sense for certain applications (such as VOD), which are growing in importance. But we caution that IPTV does have certain obstacles yet to overcome. A case in point in an article on *cnet*,[1] talking about AT&T's imminent rollout of IPTV (mostly via DSL at first):

> "Initially, most of the companies supplying gear and services have focused on simply getting the technology to work. As a result, early deployments, including AT&T's, will look very much like what's already available from cable and satellite operators today. Early on, the battle for new customers will be won based on pricing. But in the long run, IPTV providers need to convince customers that they offer features that are different from what's already available from the traditional television providers."

The last place that anyone wants to play is to differentiate only on pricing. That's a loosing strategy. We are fans of IPTV for certain applications because it makes sense from an efficiency standpoint, and we believe efficiency will ultimate lower cost of delivering the service. But these are the early days, and the technology is not that mature yet. So in competitive situations, you would have to compete on price until novel applications become practical, assuming they emerge.

Some service providers operating IPTV systems are having problems with customer retention. While technically the systems are working fine, the fact that the subscriber experience is different from what people are accustomed to on cable or satellite has caused some IPTV providers to loose subscribers back to cable. This is particularly applicable to more mature subscribers who are accustomed only to basic service and maybe one or two pay channels, with no cable box.

ADVANTAGE: FTTH

Now we talk about other IP-based video services that are a bit different. You carry them, but you don't directly make revenue from them. You make some dough just by carrying the program, and as such, an FTTH system with it's record-smashing bandwidth is the best way in the world to carry the programs. But you are only the pipe – this is video service, but it is not *your* video service.

At least today, the programs go to a computer, not to TV. TV is a "lean back" experience, where you are there just to watch. Computer is a "lean forward" service, in which you expect to participate. Sure, you can watch TV on your computer, but is that where you really want to lean back and relax (nerds excluded)?

Want the last episode of *Survivor 243* or *American Idol 867*? No problem: the TV network will let you have it for free with commercials or with no commercials for a "slight extra fee." Or some such: I get confused as to the models folks are using, and as a guy who watches an hour of TV a week at most (CNN excepted), I don't really follow the models that closely. But I know this is making the network affiliates mad.

Clearly, watching a rerun on demand is more efficient when done on IPTV: it's a one-to-one service. Now the bad news: you as the telecom provider don't take part in this activity anyway. You are merely the conduit. No revenue for your here.

SLINGSHOT VIDEO

Kind of related to this is another personal video service that only works on IP: you know you can "time shift" video with a PVR (or even a VCR if you can program it). You can also "place shift" your video by having it sent from your home to another location. A company called Sling (we hear others are getting into the act, too) produces a box you hook to your cable or set top, and you can call up video from it to wherever you are, so long as you have a decent Internet connection. Neat idea from a consumer's viewpoint: you're traveling and want to catch up with the news back home, or you want to see what your kids are watching? Pull it up on your computer.

[1] Marguerite Reardon, *IPTV Prepares for Prime Time*, cnet NEWS.COM, June 5, 2006. The content of the article remains valid as this is written.

Our radio money-and-practical-living guru, Clark Howard, sings the praises of the Slingbox. He points out that you might now take cable (or satellite, or FTTH video) service at your home, and not at your vacation home. You simply use the Slingbox to send programs from your home to your vacation spot. Not good for you. Well, even though I'm not big on TV, I ordered a Slingbox a few months ago because a customer sang it's praises. It is a good product, but with all due respect, Clark, you either haven't used one or else you are as undiscriminating in your video as you are in other things you buy on the cheap without considering quality. The box is made to get signals through pipes that are too small for entertainment quality video. On my home computer, networked to the box with a 10/100Base-T network, video is decent on the computer monitor, but I would not be happy with it on a big screen TV. And over today's "high speed" connections, the signal is just short of awful. It's not Sling's fault: you just can't encode video well enough to get it through the tiny upstream pipes that cable or DSL provide, if you want a decent picture and consumer costs.

So here, score a big one for FTTH: we, and we alone, have a big enough upstream pipe to let Slingbox and friends do what they can do. So while Sling (and any other place-shifting box) involves video that we have nothing to do with, our big fat upstream pipe can let us differentiate ourselves vs. the other guys. Then the problem becomes how to make the Internet handle all that bandwidth with decent QoS, and how to pay for it. But that's a subject for another time.

YET MORE VIDEO

Now we come to one of the biggest subjects of discussion today: downloading videos onto iPODs, Zunes and such. Now I am not qualified to discuss the merits of this application, so we'll just assume that some characters want video downloaded to portable devices. Looks as if my opinion doesn't count here. Anyway, this is a classic IP download issue, and since it doesn't involve real-time display of video, QoS is a non-issue. Anybody can handle this video service, which, again, can best be done in IP. We still have the advantage of the fattest pipe: you can download five or ten videos on FTTH in the time it would take you to download one with the next best technology. But it's not video in the traditional video entertainment sense. If you tried to display the video on a TV, you would be one disappointed kid. The quality is just not there: no need for 56 inch quality on a two inch screen.

Next, here is the service that I really don't understand: uploading your videos to the Internet. We watched some the other day, and found that it gives new meaning to TV's vast wasteland (apologies to, I think it was former FCC Commish Newton Minnow who coined that phrase, back in the three-network days). But OK, so I'm just a Jurassic engineer unworthy of the 21st century. Here we have another example of where our superior upstream bandwidth really shines: you can upload more than 10 senseless videos using FTTH in the time it would take to upload one senseless video using other technology. You just provide the pipe. This is not your video service, even though it is video.

It's just a matter of time before someone with more time and money than good sense decides to program his own Internet TV station: You get a big server and a static IP address, and video of whatever quality, and voila, you're a TV station. Go peddle your videos to anyone who will watch. Try to make money if you can. Again, good for FTTH – it needs that big pipe of ours. But again, this is not a TV service you're delivering – you are just providing your high-speed pipe. Bandwidth *is* the killer application.
A lot of these applications are going to the computer and not to the TV. I guess the market for watching video on your computer has kind of been proven, or at least is getting proven. But we contend that TV on the computer is not TV for the average Joe Sixpack. He might watch it, but the video that people watch most is on the TV, which is on in the typical American home for over 8 hours a day. And that is where we think of video going when we talk about a video service over FTTH (or cable, or satellite, or even over, ugh, DSL).

HIGH DEFINITION

According to an article in *USA Today*,[1] for the first time in 2006, consumers bought more HDTV sets than traditional ones. So clearly the demand for HD is taking off, and you have to provide it. With traditional MPEG-2 video, HD requires something on the order of 12-15 Mb/s (the 19.2 Mb/s number often quoted is really the bit rate at which broadcasters deliver data after certain overhead, and is not the same as what it takes to deliver HDTV). Tough for DSL folks to swallow, especially when you consider that they have to deliver programs for about three TVs, in addition to other data. No problem for FTTH, though. MPEG-4 AVC is said to deliver similar HDTV performance at maybe 8-10 Mb/s. At that data rate, DSL is still in trouble, just not quite as much. You still have the fact that MPEG-4 AVC encoders are not yet common, and are priced accordingly – there is a whale of a lot more computation to do encoding MPEG-4 than there is for MPEG-2. And HD is just now launching in MPEG-4.

By the way, when you're ready to put HDTV on IPTV (after the DSL folks have suffered through all the rollout pains), you'll be able to do it better than anyone else. FTTH wins again!

The article in *USA Today* says satellite is in a better position than cable when it comes to HD. The logic is a bit twisted, but there could be some truth to portions of it. Satellite has to launch more satellites to support more HD, not a cheap proposition. Satellite is looking at MPEG-4 AVC, too, but they have to buy new set tops for all of their subscribers if they go to AVC. That's not cheap either. But with better bandwidth efficiency, AVC can save satellites.

Cable is in a good news, bad news situation. Good news is that they have years of experience transporting HD on broadcast (MPEG-2), and all the pieces for a good subscriber experience are there. Your good news is that you can ride their coattails. Bad news for cable is that they don't have the spectrum to transmit all that HDTV. That's why the article says HDTV is tough for them to swallow.

[1] David Leiberman, *Cable Operators find it Tough to Swallow HDTV*, USA Today, June 5, 2006, available at their web site

Most cable TV networks in North America were rebuilt in the late 90s/early 00s. They were built mainly to 750 MHz (starting at 54 MHz), limiting their bandwidth. Furthermore, that bandwidth is shared between TV, data, and voice. Advantage as usual, FTTH: RF systems on FTTH can cover up to about 1 GHz, yielding 35% more spectrum than cable has. And you don't have to share your expanded bandwidth with data or voice: you have a whole separate wavelength for these services (including IPTV). So you ride on cable's coattails, and turn their problem into your advantage.

If you look up the *USA Today* article, you'll also see the reference to CableCards®, developed to reduce the need for set top boxes. CableCards have been a less-than-revolutionary new development in cable, but to the extent they play a roll, you can use them too, if you have a broadcast tier. They were an industry-sponsored, government-mandated idea to reduce the needs for set tops, and to an extent they do that. They were also intended to allow subscribers to buy set tops at retail, a market that has yet to materialize. But for several reasons CableCards have not taken off very well. And in our opinion, the future does not bode all that well for them.

IPTV HALLOWEEN - REPRISE

Now let me give you one other frightening scenario that is going to happen sooner or later with IP set top boxes: they are connected to the Internet like any other computer, right? And what does the Internet sometimes deliver to computers? Viruses, trojans, and other mal-ware. What is to stop the same thing from affecting your set top boxes? Beats me. A broadcast box, because it can only be communicated with over the broadcast network, is reasonably immune to such problems – there is an isolation point at the headend. But how do you stop miscreants from using your IP set top? What if someone can break into a set top and reprogram it to take in an encrypted program and put it back out unencrypted for the world to take? Can't very well happen with decent quality today, with the limited upstream bandwidth of today's technology. But could happen with FTTH. (When you think about it, this is pretty much what a slingbox plus a set top box can do, though Sling is not built to complement FTTH's wide bandwidth. This has the digital rights management folks all uppity, even though you and only you can access your slingbox. And only one person at a time can watch a slingbox.)

Carrying the scenario a bit further, what happens if someone gets in your IP set top boxes and jiggers them to receive Internet video from somewhere else, bypassing the programming you provide? What would you do about it? Should you do anything about it? If you are getting paid for the box and the Internet connection, do you care where video comes from? But what happens to the commercials you sell on that video? Is someone else selling commercials your subscribers are seeing? Is the program supplier (your business partner) getting the audience he expects from you? Can you even talk to your own box to shut off service if you need to? Who gets the blame when something doesn't work right? Beats me, but sometimes I kind of like to play a little FTTH Stephen King.

UNIQUE TO IPTV?

A lot of IPTV advocates talk about all the unique services they can provide that the broadcast folks cannot provide. Sounds great until you take a look at what the broadcast folks have done and are doing. Then some of the IPTV gurus look as if they don't understand the competition (which they don't). Here we summarize some of the advantages claimed for IPTV, and put them in perspective with what the broadcast (cable, satellite) folks are already doing. From our position of neutrality in the debate (Enablence does both IPTV and broadcast, in both EPON and GPON), we can be objective about the issue. Some services are more efficiently done on IPTV, but services can be done either way. We present this list in order to get the industry's collective creative juices flowing to come up with truly unique differentiators.

Remember that most digital broadcast set tops today have two-way out-of-band communications with the headend, and they use this communications to advantage to do pretty much everything that the IPTV folks have thought about doing. Those two-way communications channels can be carried on FTTH. Downstream is just part of the broadcast offering – no different. Upstream requires digitizing the RF signal and getting it back to the headend in a usable form, but good FTTH systems can do that with no problem – Enablence supports all standard upstream communications protocols.

PAY-PER-VIEW (PPV)

This is a service that provides a fixed set of movies (or other programming) with staggered start times. You can start the movie at 8:00, 8:30, or 9:00, your choice. A few IPTV advocates have claimed uniqueness here, yet this has been a mainstay service on broadcast TV (both cable and satellite) for a number of years. What the cable and satellite broadcasters do is to treat each move and each start time as a separate channel. Maybe the 8:00 start time is on channel 630, the 8:30 start time is on channel 631, and the 9:00 start time is on 632. This is invisible to the subscriber thanks to intelligence in the set top. The set top displays only one channel number, and does not necessarily tell you what channel you are actually watching. Sure this ties up spectrum, but it is deemed a good use of that spectrum. Viewing is reported to the headend after-the-fact, for billing purposes.

VIDEO-ON-DEMAND (VOD)

VOD is a service whereby you can choose your movie from a large menu, and watch it when you want to, just like you'd do with a DVD. You can pause and resume the movie, you can rewind, and you can fast forward. The movie is actually being served from a video file server in the headend, and you are given your own channel on which to watch. This is starting to be a big money-maker for broadcast-based cable TV. Satellite has a bit more of a bother, because their satellite footprints are so wide. But they can pre-load your PVR with encrypted movies. You only get the decryption key when you buy the movie. Sure, you tie up spectrum, but again, this service is deemed a good use of that spectrum.

Cable TV systems are divided into *nodes*, which serve anywhere from maybe 100 to 2,000 subscribers, depending on when the node was constructed. The same RF spectrum can be re-used from node to node, so that you can send different programming to different subscribers on the same RF frequency, so long as they reside in different nodes. This is the magic that lets cable TV provide a good VOD service. If a node serves 500 homes, then you tie up spectrum to 500 homes in order to serve one. But statistics allow you to do this satisfactorily. Experience so far indicates that capacity for a simultaneous usage rate of 5 to 10% of the subscriber base prevents problems. So if you have a 500 home node and go to the top end, you need 50 program channels, about five RF channels (out of typically about 110 RF channels available). Thus, about 4.5% of available bandwidth is tied up for VOD.

IPTV, though, is more efficient. If you have a PON that serves, say, 32 homes, then you only tie up bandwidth to 32 subscribers to reach one. By the same ratios as above, you will need three streams of video to provide VOD service. With MPEG-2 SD, this is about 12 Mb/s of bandwidth. Out of 1 Gb/s, this is 1.2% of bandwidth. Thus, while you can do VOD on broadcast, IPTV wins on efficiency.

By the way, we talk in terms of PONs, but the situation is no different if you are operating a point-to-point network. They have limitations folks don't like to talk about: the limitations apply to the network side of that point-to-point switch. The capacity numbers usually work out about the same for PONs and point-to-point networks.

CALLER ID ON TV

The idea is that when someone calls your home phone, the caller's identification pops up on the TV. This service is often cited as a unique service that IPTV can provide. But you can buy commercial systems today that do this on broadcast. A computer monitors the VoIP softswitch (or whatever system is being used for voice), and when a call is placed, sends an out-of-band signal to the appropriate set top box, which uses its internal character generator to display the caller ID.

"INFINITE" SPECTRUM

It is true that with IPTV you can offer unlimited channels, because you are only sending out channels being watched, whereas with traditional broadcast you are sending out everything, to the point where you run out of bandwidth to send more. The cable folks are now starting to use a service they call *switched digital video* (SDV), in which they transfer their less-watched programs to a PPV-like service. Popular channels remain on broadcast for the sake of economy. When an SDV program is requested by a set top, if someone on that node is already watching that program, the set top is commanded to tune to the frequency already in use for the program. If no one is watching the program at that time, then it is assigned a frequency, and the requesting set top is commanded to tune to that frequency. Early studies have suggested about 60% bandwidth savings using this technique.

FAST CHANNEL CHANGE

By now just about everyone knows that channel change times are longer with digital video than with analog, and this gets in the way of channel surfing. Now I can argue this one either way: channel surfing is dead because of the large number of channels to choose from, forcing the subscriber to resort to a program guide. Or I can argue that a subscriber will simply program his own limited selection of favorite channels, and surf them. (It is known that no one subscriber watches more than 15 or 20 channels regularly. But each person watches a different set of channels.) In any case, there are several reasons why channel change time is longer with digital than with analog.

There may be some truth to the argument that you can do better with IPTV, but the cost of the most widely-proposed system for doing so is likely to be prohibitive for nearly all operators, even the largest ones. It involves large farms of video servers each holding the most recent *I-frame* of video (the frame you need to start displaying a picture) of each and every program out there. For broadcast switched digital video, the broadcast folks have developed a system that feeds out the newly-requested stream quickly, solving a narrower problem more economically.

Enablence employs a technique in our PON systems called fast join and leave. It helps the channel change issue to an extent, but channel change is not going to be a fast with digital as it is with analog.

VIDEO PROGRAM GUIDE

Rather than looking through a text-based program guide, the subscriber sees a screen of small moving pictures. He highlights the one he wants then selects it. Broadcast does this by encoding the small picture tiles at the headend and putting them on an available channel. The set top generates the screen text and blends in the video tiles from the headend. At least two systems are being rolled out.

Typically the video program guide is being done by genre: you can take a look at all the news shows on, all the children's shows, all the movies, and so on. But score one for IPTV here: it is not yet feasible to allow the broadcast subscriber to choose which program tiles he sees; the cable operator does that for him. In IPTV one could conceivably allow the subscriber to set up his own favorite channels to put in the tiles. (Note that headend equipment to implement this service in IPTV is not known to us at this time, but it is theoretically possible.)

NETWORK-BASED PVR

Rather than having each subscriber with his own PVR, the operator has the PVR function at the headend (in a special-purpose video file server), and the subscriber controls it. This is being done now in a limited fashion on broadcast, by operating the headend PVR output on a unique channel, treating the service just like a VOD session. The limitations to network-based PVR services are more based on legal and economic considerations than on technical considerations. But score another small one for IPTV: as with any video destined for one subscriber and one subscriber only, IPTV is more efficient, as we argued above.

In the cable TV space, one company is using a service whereby if you tune in to a program late, you can start it over at the beginning so long as you start it over before it ends. Another experiment had the program saved at the headend and played back later by the subscriber. The first service has not been challenged in court, whereas the second has been ruled illegal. Hey, doesn't make sense to me either, but I'm just telling you what has happened. Point is, cable TV has been working in this area for some time now.

GATHERING STATISTICS ON TV VIEWING

Groan, this is one of those ideas that pops it's head up every few years, only to have it whacked off by reality. We used to think we were going to put Neilson out of business with broadcast set tops: we had two-way communications, we let them report what they were tuned to, and we have one-upped the world. And what a great new revenue stream! "Not so fast" the experts said. How do you know who is watching the program: the whole family, or the dog? How do you know anyone is watching? Is the TV even turned on? There's a lot more to gathering viewing statistics than just what program is tuned. If a method of using the set top for collecting viewer stats is developed, both IPTV and broadcast will be able to participate.

HYBRID TV

There are some ways folks are talking about today that use both RF broadcast and IPTV to their fullest. These offer the best of both worlds and can prove very economical. Among the variations:

- Analog broadcast, plus all digital services on IPTV: You can even use old trap technology (ca 1975) to offer one or two premium subscription services to analog subscribers. Allows you to offer basic service, including limited subscription premiums (HBO, Showtime, etc.) without a set top. You have a service that doesn't require set tops, but you also can boast an "all digital" service. You will want to duplicate all shows on IPTV in order to let customers with set tops have all features.
- Analog and basic digital broadcast (including premium subscription) on broadcast, other services (such as VOD) on IPTV: you can offer a more complete package using the most basic digital set tops. You have a service that doesn't require set tops, but you also can boast an "all digital" service.
- Analog and basic digital broadcast (including premium subscription), plus PPV on broadcast, video-on-demand on IPTV. This lets you maximize use of existing signals and equipment, while being able to offer unlimited personal programming to IPTV subscribers.

CONCLUSION

IPTV is all the DSL guys can muster, so they are pumping it as hard as they can. It's going to be a good and useful tool, but it is still immature. To start, you are better off going with the tried and proven (75 million or so) deployed digital broadcast set-tops that support all the latest features - - HDTV, DVR, multi-room DVR, VOD, etc - - with the comfort of knowing other companies have done the heavy lifting for you.

There are some things that broadcast does most efficiently, and some that IPTV does most efficiently. But there is little that one can do that the other cannot do, at least so far as *your* video service is concerned. A lot of the new "services" people talk about on IPTV are not really your video anyway – they are video riding over your network, but you are not selling those video services. You don't make revenue from them. Such services include TV networks selling (or giving away) old shows on the Internet, and personal video sites. These are all IPTV services, sometimes called "over the top" video.

FTTH people like broadcast for its maturity, ease of connecting TVs, subscriber familiarity, and the ability to piggy-back advances in the cable TV business. They like IPTV for the ability to *not* need a broadcast overlay, and the essentially infinite number of channels you can offer. Plus IPTV is the current buzzword.

To sum it up, broadcast video still has life left in it for a lot of reasons, and IPTV is here to stay. A good solution is to start with broadcast today, and add IPTV when it, and you, are ready. Sure, some folks are providing all-IPTV today, but they are missing some opportunities, and taking the pioneer's grief. Those providing only broadcast and not looking at adding IPTV in the future are also missing something. The future has a place for it all. And guess which one technology is uniquely poised to deliver on that future in all its forms!

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