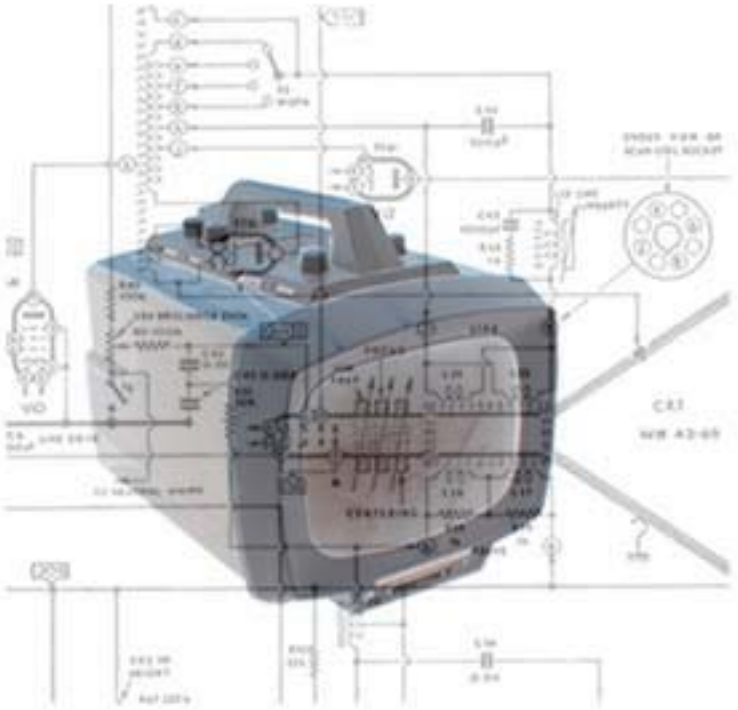
HOME ENTERTAINMENT NETWORKS

Forces Shaping the Home Network: Broadband Providers, Devices and Services



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INTRODUCTION

A battle is shaping up between Cable, DSL (Digital Subscriber Line) and Direct Broadcast Satellite (DBS) providers to provide the next generation of entertainment services to the home. These services will change home entertainment from a linear to a non-linear experience. TV shows will be available on-demand when the consumer has time to watch. TV programs will no longer be grouped by networks they will be grouped by the consumer's tastes. PVR (Personal Video Recorder) functionality and Video on Demand (VOD) will allow consumers to create their own channels around their choices and to view the programs at any time. Video will be just one of the entertainment options and will be mixed with other services including:

- Broadband Internet
- HDTV Service
- Pay Per View Video Services
- Music Services
- Online Gaming
- PVR Functionality
- Interactive TV
- Phone Service
- E-Mail

The intrusion of computer technology into the television environment has been tested many times in the past. An excellent historical perspective on Interactive TV was written by Tracy Swedlow and is available at ITVT.[1] A comprehensive analysis of past Interactive TV efforts is too much for this paper.

Digital Home Entertainment Devices will begin to replace the VCR. The quick acceptance of the DVD player will lead to numerous other devices such as digital set-top boxes and video storage devices such as the Tivo or Replay PVRs (Personal Video Recorder). Manufacturers will eventually try to merge many of these functions into a single box in order to simplify things for the consumer. Plugging these devices into the outside network (DSL, cable and DBS) as well as the inside network (Ethernet, 802.11b) will eventually lead to a completely networked Home Entertainment Network.

Outside networks will bring unprecedented services into the home. Video on Demand (VOD) and new Pay-Per-View services will make any movie available at the click of a button. Interactive TV (ITV) will provide additional information to the consumer to enhance their viewing experience. Whether ITV happens on the TV alone or on a combination of the TV and computer screen has yet to be determined. These services will combine with other services we more traditionally associate with the computer. In fact, the line between the computer and the set-top box will begin to blur.

These services are in the works. However, it is not at all clear who will bring these services to our homes. Will it be cable, DBS, or DSL? Who will create these next-

generation networked devices? Will it be electronic manufacturers, computer companies or traditionally manufacturers of set-top boxes?

In this paper we will examine the emerging home entertainment network including the service providers, the home network and the services they provide. We'll examine this emerging environment and look at who will be the winners and losers for the consumer's entertainment dollar.

SERVICE PROVIDERS

Establishing a digital broadband connection to the home is a first step in creating a viable home entertainment network. Currently DBS and cable systems are the early leaders in this field. DSL providers have moved quickly to establish broadband connections, but have been reluctant to add their own entertainment services after loosing billions on it in the early 1990s. Rupert Murdoch believes[2] that the battle will be between a DBS/PVR combo and cable companies providing VOD service.

The type of connection that enters the customer's house will play a large role in the type of home network and the services that are available. Let's look at the advantages and disadvantages of each system and see what services each can provide.

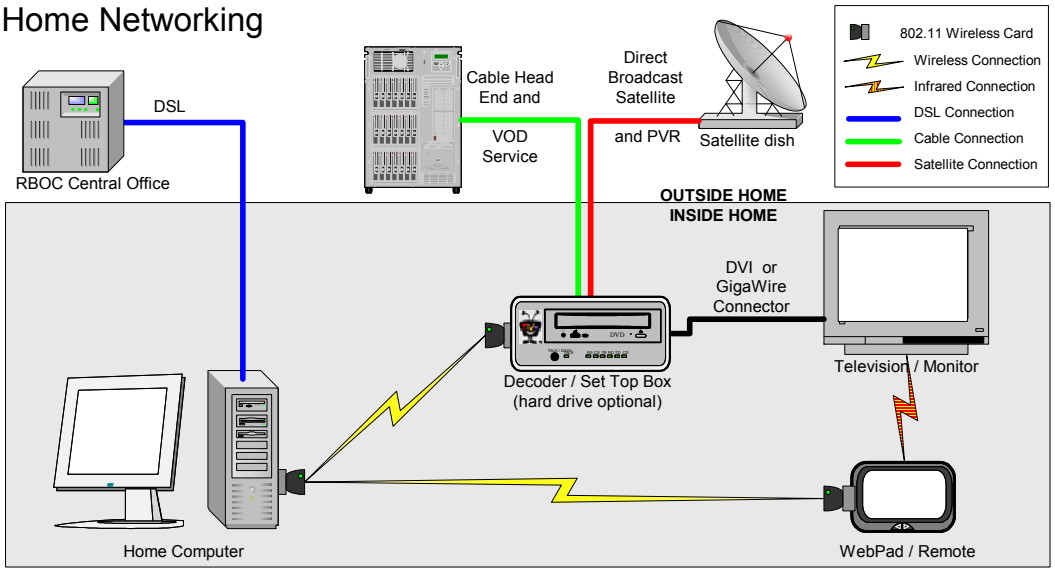

Figure 1: Home Network

The diagram above shows the most likely place that each type of connection (cable, DBS and DSL) would connect into the home. Notice that cable and DBS most often connect into a set-top box in the living room and then share their connection with the Home Computer. DSL providers generally almost always connect directly to the computer.

Satellite

DBS providers are the fastest growing provider of video services and broadband connections. The Yankee Group estimates that DBS will grow from 17.7 million customers in 2001 to over 27 million in 2005. Most of these customers will be taken from cable companies. New features such as local channels are making DBS an increasingly viable alternative to cable. Until now, DBS providers have differentiated themselves by providing more channels and innovative sports packages.

How can satellite maintain these adoption rates?

Satellite's main advantage is simple economics. It is cheaper to set up a digital satellite system than a digital cable system. Andersen Consulting discusses the economics in this report[3]. Infrastructure costs to enable a single customer are nearly 7 times great for digital cable than for DBS. Its no wonder that DBS companies can afford to sell PVR enabled set-top boxes at a reduced price. Even when DBS providers start using DSL instead of dial up as a back channel, the price is about half the cost of a digital cable upgrade.

Video-On-Demand services are often projected to be the most profitable of digital services. Recently released movies make up the majority of VOD services. Satellite providers can multicast these movies and have them stored in the consumer's PVR. Multicast is similar to broadcast, in that a single broadcast from a satellite could insert the movie on the PVR of every customer. Cable companies have to transfer the movie to EACH customer, making thousands of individual broadcasts. Once the movie is delivered to the PVR hard drive it can be purchased, unencrypted and viewed.

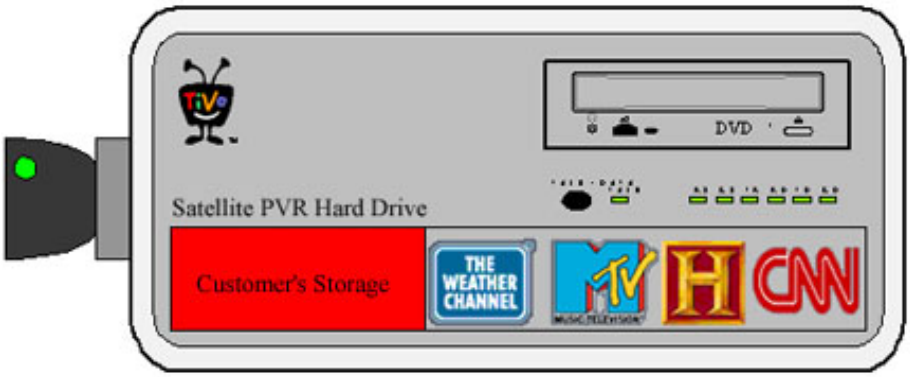

Figure 2: Set Top Box

DBS providers can make additional revenue by "renting" space on the PVR's hard drive to networks and to store commercials. (**See Figure 2**) The consumers retain use of a portion of the hard drive to store their own programming. Space

could also be leased to Music Services. Tivo and Real have conceived of just such as service.

The customer is not the only one to benefit from DBS. With EchoStar and DirectTV consolidating, DBS will be a single service with a nationwide footprint. A single service will eventually mean a single platform. This will attract networks that wish to start adding interactive content to their programming. Until now it had been cost prohibitive to develop unique ITV content for the variety of architectures at different MSO's (Multiple Systems Operators). DBS will be well suited to provide the first viable ITV experience in North America. Much as BSkyB has done in England. This additional service will allow Echostar raise its profile as a premium service and help differentiate it from cable.

Satellite also has a number of drawbacks. It is going up against cable, the entrenched standard. Cable providers have existing relationships with both networks and customers. Satellite providers must convince customers that they are a viable substitute for cable. Satellite is also limited by its current one-way infrastructure. Often the set-top box communicates customer responses through a dial-up connection that can be slow and unreliable. Satellite providers would be well served to strike up a relationship with DSL providers to supply the back channel. Direct TV has already moved in this direction with their Direct TV DSL service. Down the line satellite will also have trouble delivering the 100s of VOD movies that cable will eventually provide.

Cable

Cable systems are the incumbents in the delivery of video services. Cable is currently undergoing a massive infrastructure change from analog to digital networks. Digital networks create a huge advantage for cable as it can send more video down the same pipe using digital compression. At the end of 2001, about 11.7 million homes had digital cable. The number of homes with digital cable should surpass the total number of homes with DBS within the next year.

Cable delivers massive amounts of bandwidth to the home. A single analog channel takes up 6 MHz or about 30 Mb/s on a digital network. Once converted to digital, the channel itself can be compressed and the additional space used for more channels, higher quality video (HDTV) or other services.

The two-way connectivity of digital cable makes it a natural for interactive services. Satellite has to rely on a slow dial-up back channel to serve as a return path. Two-way service allows cable to offer services that satellite won't be able to deliver until two-way service goes into effect in the future. Real time services such as IP Telephony will also suffer on DBS because of time delays bouncing the signal off a satellite.

Cable companies believe that most VOD services will be provided in real time over the network. In this model, the movie resides at the MSO's head end server and is transmitted over the coax cable in real time to the customer. This consumes an enormous amount of bandwidth, especially if all customers are watching different programs starting at different times. Cable companies seem more reluctant to deploy PVRs into the homes. This may be due to the fact that cable set-top boxes are normally provided for free by the cable companies. Giving away a free PVR to all customers is an expensive proposition!

Cable is a mixed environment. No two cable systems are deploying the same infrastructure. This is particularly true for digital services. The variety of different platforms makes it very difficult/prohibitively expensive for outside companies to create applications for cable networks. Content providers such as networks, music services or third party application providers will have to rewrite their application for each major MSO!

This lack of standards will stall the creation of ITV content by the networks. Networks such as CNN, ESPN and Discovery are not going to write different applications for each MSO. At this point, the MSOs have made little effort to create a set of standards for Interactive TV on digital cable. In the short, term Interactive TV will remain experimental on cable services. The MSOs may even go as far to form Walled Gardens where their network and applications are entirely proprietary. Standards based ITV's brightest future in North America is on DBS.

Cable services are expensive. It is costly to lay new cable, it is expensive to dig up consumer's yards, and it is expensive to convert from analog to digital. Cable systems also make use of shared networks. The networks are great when the first few customers go online, but as more customers are added, the bandwidth decreases and the service becomes worse. Consumers will not accept a service that becomes worse with time. DSL is not a shared network and uses this to its advantage when advertising broadband Internet connections.

Cable companies will also run into a problem with competition. Cable companies will be providing broadband access to the Internet. This access will provide the customer with services that could be in competition with the services that the cable company provides. Cable companies will need to walk a fine line between revenue goals and appearing anti-competitive.

DSL

Broadband has been slower to role out than projected. There are about 11 million homes with broadband of which about 4 million are DSL. Unfortunately, the RBOCs (Regional Bell Operating Company) have spent most of their time driving the CLECs (Competitive Local Exchange Carrier) such as NorthPoint and Covad out of business rather than expanding their networks.

DSL's main advantage is that all home users started out connecting to the Internet through a dial-up modem. It is only natural that the consumers move to another product from the phone company. However, delays, poor marketing, old wiring and lack of understanding about DSL technical drawbacks have frustrated consumers. To this date the phone company cannot tell if your home can get DSL. Even if you are within the prescribed geographically distance from the Central Office the wiring may not handle your connection.

If we examine **Figure 1** you'll notice that DSL does not go into a cable box and then get split out to connect to a computer. It goes directly to the PC. The Phone companies didn't always see things this way. In the early 1990s the RBOCs tried delivering video services over DSL to a set-top box. They got burned to the tune of several billion dollars and now concentrate on networks, not content or applications. Being free of delivering content is not necessarily a bad thing. It leaves the DSL providers with the ability to team with third-party application providers. This frees the DSL companies of the massive costs of developing the infrastructure to deliver video. They simply act as a pipe and if they're smart, collect a tariff for creating preferred application partners. Since DSL is built on the open standards of the Internet the choices of application providers will be far more numerous. If cable companies allow third party Internet based services over the broadband connection they may cannibalize their own services.

Having the DSL line connected to the computer gives application services providers (ASP) a great deal of choice. The computer is considerably "smarter" than even the best set-top boxes and can provide services such as games that the set-top is poor at creating. We have seen the natural evolution of "Two Screen" Interactive TV (ITV) watch TV simultaneously as they browse the web. Often they are exploring ideas they have seen on TV. It is a great opportunity for the networks to push these viewers to their web properties. The computer is a natural device for "lean forward" experiences such as research, game playing, E-mail, even music. (**See Figure 3**) Computers for the foreseeable future are much better devices for organizing and managing services. We'll examine this in more depth later in the paper.

DSL has many drawbacks on the technical side that we discussed above. Additionally it is hard to install at the consumer's home and often requires a technician to come to the house. In the end DSL will most likely never reach the speeds of cable since it is a twisted pair copper wire going up against a broadband coaxial cable.

DEVICES

We've examined the many different ways that home entertainment services can arrive at the consumer's home.

So what will the Home Entertainment Network look like inside the home?

Inside the home people generally engage in two types of interactive activities. There is the *Lean Forward* experience and the *Lean Back* experience. The Lean Forward experience occurs when the activity requires heavy. It generally involves working a keyboard and mouse together and is best done on a computer at a desk. The Lean Back experience generally finds the consumer on a couch or chair watching TV. Interaction is minimal and is generally limited to input from a remote control operated by a few simple buttons and a basic menu system.

Lean Forward	Lean Back
Web Surfing	Watching TV
Gaming	PVR and Pay Per View
E-Mail	HDTV
Managing Files	Interactive TV

Music and IP Telephony could belong to either category

Figure 3 : Lean Back / Lean Forward

Steve Jobs hit on something designing the new iMac. He said, "Each element has to be true to itself". The Home Entertainment Network should behave the same way.

The Computer

The computer has a few essential functions.

- Storage
- Data Processing
- Comprehensive Interface – keyboard and mouse

The computer is a Lean Forward experience. With the computer already firmly entrenched in the North American home the question remains;

Does the home need a powerful entertainment set-top box?

The computer is always likely to have more storage capacity. Typical computers shipping today have at least 30-60 GB hard drives. The evolution of processors means that even the cheapest machines have a 1.2 GHz processor. The computer has the set-top box beaten for ability to input and manage data files. A keyboard/mouse combination is far more versatile than a simple remote control.

The computer in North American homes has become nearly as much a source of entertainment as the TV. Computers that are hooked in with a broadband connection already fulfill many of the services that are being proposed for the set-top box. The main service it currently doesn't provide is *video* based services.

If the computer is this versatile and powerful couldn't its power be extended to control the TV as another display?

This seemingly simple request is more difficult than it first appears. A typical GUI interface such as Apple's OS X or Windows is too complex to control with a simple remote control. Additionally the type and interface are made for viewing from 18" not from 10 feet. Normal television sets are also only made to display NTSC signals with a resolution of 486 lines. These limitations have made the TV unsuitable for displaying a computer interface.

The other problem arises in getting the video signal from the computer to the Television monitor when the devices are not in the same room. If we look at **Figure 1** we see that the video signal would have to travel over a wireless network to the set-top box, be decoded and displayed on the TV set. Current wireless technology simply isn't capable of transmitting the data rates needed, even by compressed high quality video. We'll delve into the wireless network and video later in the paper. See **Figures 7, 8 and 9**.

The WebPad

Microsoft is taking the most interesting approach to integrating the TV and PC. Microsoft is notorious for trying to cover all they're bases. They have learned from the relative failure of WebTV. Their latest attempt to own the living room is the well documented XBox platform with a possible follow up being the more general use Home Station[4]. Microsoft often gets things correct after a few attempts. If WebTV is the first attempt and Ultimate TV is the second then Microsoft may get it right with the next iteration.

However, Microsoft is also following their classic "*embrace and extend*" approach to owning the living room. They are launching a two-prong attack to make the PC extensible onto the Television monitor with technologies called Mira and Freestyle[5].

Figure 4: Webpad

MIRA

Mira is Windows CE .NET based device. Viewsonic is working on a prototype of this device. (**Figure 5**) It is essentially a flat screen LCD that has some independent processing capability, but is largely slaved to the PC via a wireless link.

This device can tap into the Broadband Internet connection through the computer as well as access all the files on the hard drive. It is small and light and can be carried around the house. This device is perfect for placing on your lap while watching TV. The consumer can then surf the web while watching TV. One element of Interactive TV that consumers find annoying is things popping up and interrupting the broadcast. With a second screen the user can "Opt-In" and decide when they want more information. Since the web pages are displayed in HTML format there is no need to reformat the web pages to display on the TV screen.

This will save networks the cost of repurposing their web content for a variety of Interactive TV platforms.

This technology would be particularly effective if the Mira WebPad could communicate with the TV. This would allow the WebPad to act as a sophisticated remote control for the TV and other consumer electronics. (**See Figure 1**) Additionally the TV should be able to pass web URLs to the WebPad so that consumers can find additional information on the show they are watching. This could be as simple and low bandwidth as a list of Bookmarks about a show. Current designs do not include this two-way communications ability with the TV.

Figure 5: Mira

MIRA would be used in larger homes where the computer and PC and separated by a significant distance. It is different from the Tablet PC in that it runs Windows CE .NET, it is slaved to the PC and only has minimal processing power and RAM onboard. A Tablet PC will be a full working PC running Windows XP.

Freestyle

Microsoft's second prong is simplifying the PC interface so that it can be displayed on a TV Screen and operated with a remote control. Freestyle isn't aimed at word processing, it's aimed at viewing pictures, watching video, recording video with Tivo like features, and listening to music. (**Figure 6**)

The interface is a simplified version of Windows XP and shares the designs look and feel. The interface is specifically designed for viewing at 10 feet from the TV Monitor and the fonts are clear and easily readable at this distance.

Figure 6: Freestyle

Both Mira and Freestyle are slated to ship by the end of the year. It is currently unclear if they will be bundled with Windows or sold separately. Both technologies hold great promise and represent a far simpler and evolutionary approach to bringing computing power to the TV.

The Set-top Box

When discussing the home computer we asked:

"Does the home need a powerful entertainment set-top box?"

Simple Set-top Box

Looking at Mira and Freestyle technologies from Microsoft indicates that Microsoft believes the PC is powerful enough to control the TV Monitor as well as the PC Monitor. Apple may have similar thoughts for their home electronics push.

However, we also need to remember that Microsoft is pumping billions into development of the XBox, Home Station and whatever grows from the wreckage of Ultimate TV and WebTV. In the *Set-Top-centric Microsoft worldview* they favor a smart set-top.

In the *PC-centric Microsoft worldview* the set-top box only needs to be a simple device capable of decoding video streams it receives from the PC via a wireless network. They would use the PC for processing and storage and the TV for display. Remember also that five chipmakers; Cirrus Logic Inc., ESS Technology Inc., LSI Logic Corp., STMicroelectronics and Zoran Corp. all said they will

support Windows Media in their next-generation DVD playback chips. Those companies made 90 percent of the DVD processors shipped last year. It's a small step to move that chip to a set-top box or create a combination DVD/Set-Top.

These simple set-top boxes would be relatively inexpensive once the video codecs are encoded to a chip.

A computer teamed with a simple set-top box would make a formidable opponent compared to the relatively expensive smart set-top box.

Smart Set-Top Box

Unlike Microsoft, companies such as Sony, AOL, DirectTV, Echostar, Motorola, Liberate, OpenTV and Moxi Media don't have a major desktop OS to extend to the TV. These companies will be pushing the set-top box as the device that can break Microsoft's monopoly on power by denying them control of the living room. If this device isn't powerful enough it will run into the same problem faced by WebTV. The device will be so weak compared to a PC that no one will buy it. The device must be able to do some things better than the PC. As the Tivo has showed, even a comparatively weak machine can do one thing better than the PC, process video. If these companies can build a device at relatively low or subsidized cost that does a number of things better than the PC then consumers may be willing to adopt it.

One strength of the set-top box is it physical closeness to the TV Monitor. The set-top also has access to the massive bandwidth available on cable networks. For high definition video services (anything over regular NTSC video) the decoder box must be located very close to the TV Monitor and physically connected. Once decompressed video signals take up huge amounts of bandwidth. (See **Figure 9**) Today's wireless networks are not capable of carrying HDTV (High Definition Television) even when compressed. Once video is decompressed even NTSC video can't travel via home networking wireless standards. We'll examine this more in the next section.

From this comparison it becomes apparent the set-top boxes that are slaved to a PC for processing and storage will be considerably cheaper to deploy. Companies in competition with Microsoft will need to subsidize their boxes in order to get them into the home. While this might seem like a money losing operation competitors such as Echostar have lead the challenge with cut rate PVR boxes while still maintaining revenue.

Wireless Home Network

In-home networks stand at 6% of U.S. households owning PCs. Consumers are not willing to string cables across there homes. They will not rip up walls and

they will not tear up carpets. Home Networking has to be wireless or use existing wiring in the house.

802.11b and other Home Standards

Of the existing home networking standards 802.11 has been the most successful. It is wireless, operates at maximum bandwidth of 11 Mb/s, is mostly compatible between different vendors, is relatively easy to install and is fairly cheap. It is not a perfect technology, but it is good enough to have beaten out wired solutions such as Home PNA (over phone lines) and the existing corporate standard, Ethernet. Intel's wireless standard Home RF has also not caught on due to its lower bandwidth, inability to communicate with other networks such as Ethernet and lack of broad industry support. Intel has recently moved to support 802.11b. Bluetooth is another emerging wireless standard that has been slow to take off. Its limit of 2Mb/s will most likely limit it to networking peripherals such as keyboard, printers and cell phones.

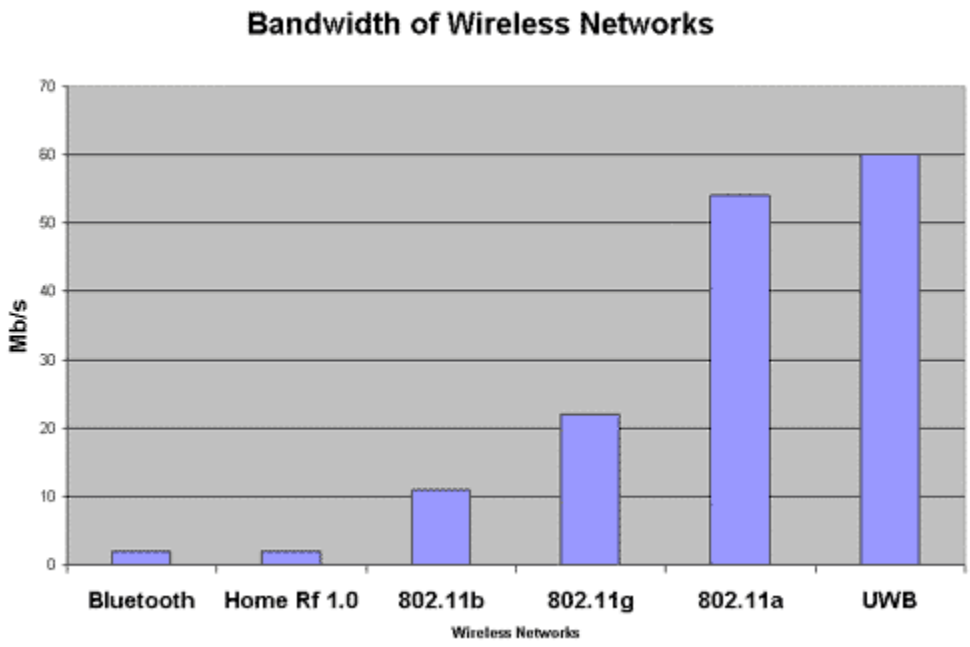

Figure 7

802.11b is a great technology for limited in-home services. It is very good at providing shared Broadband Internet connections to multiple computers. Moving non-video files around is also very fast and easy.

802.11e

802.11b was never meant to be a fault tolerant network connection for time sensitive data such as video. Streaming even a 500 Kb/s file over an 802.11b

network can cause buffering and poor video quality. An emerging standard to help quality and avoid interference is called 802.11e. The goal of 802.11e is to help wireless LANs handle interference and to provide better support for those big streaming multimedia files by using error-correction and better bandwidth management. This functionality adds multimedia and QoS support to the current IEEE 802.11 specification. The 802.11e specification can be applied to any 802.11 standard.

802.11a

802.11b is the first standard to get traction in the industry. However several other standards are emerging that will help home networks reach the point where they can move video at data rates that will support home video services. 802.11a at first seems like a great technology. It runs at 54 Mb/s and would appear to build on 802.11b. Until we find out it runs at a 5Ghz frequency, which is incompatible with 802.11b's 2.4Ghz frequency. Additionally, this higher frequency means that the range of "a" is limited to 60 ft where "b" will travel up to 300 ft. 802.11a may catch on in specialized functions, but most likely will not gain wide acceptance in the home

802.11g

802.11g is what 802.11a should have been. It exists on the same frequency and is compatible with 802.11b. It is an emerging standard, but should start at 22 Mb/s and grow to 54 Mb/s. 54Mb/s, as long as error correction and little interference is present, starts to get interesting for moving video around the home in a compressed format. (**See Figure 8**) With modern compression even an HDTV signal can be compressed to fit this bandwidth.

Ultra Wide Band (UWB)

UWB[6] has been in use by the government since the 1960's. UWB doesn't operate on a single frequency it hops between frequencies very quickly (a billionth of a second) and sends out a Morse code like message. The receiving end knows the pattern and listens on the different frequencies. Using multiple frequencies makes UWB ultra secure while giving the standard much greater potential bandwidth. Theoretically since UWB spends only a billionth of the second on any one frequency it does not disrupt other communications.

Expected to see UWB products toward the end of 2003. Once developed UWB will most likely start at 40-60 Mb/s and grow to 1 Gb/s.

The power of devices and wireless networking is growing daily, but simply having advanced devices isn't enough. The network and the devices must either be easy to use or leverage existing skills and metaphors.

SERVICES

We talked about DSL, cable and DBS's ability to bring content into our homes and the ability of devices and wireless networks to move that content around and play it back. In this section we'll talk about how these proposed services fit into our home entertainment network.

- Broadband Internet
- HDTV Service
- Pay Per View Video Services
- Music Services
- Online Gaming
- PVR (Personal Video Recorder) Functionality
- Interactive TV
- Phone Service
- E-Mail

Broadband Internet

Fast Internet connections are one of the first services that DSL, cable and DBS are bringing to the home. In many ways this one service is driving infrastructure upgrades, both by service providers and within the home. Sharing broadband connections between multiple computers in the home is driving home networking at this stage. Current home networks, especially 802.11b are more than capable of sharing Broadband connections.

The large telephone companies have been particularly effective (some might say ruthless) in keeping DSL start-ups (CLECs) from providing service. Through competition with satellite providers and cable companies the price point for broadband service has been established at between $39.95 and $59.95. This price in addition to regular services from these providers goes a long way toward achieving the industry revenue goal of $100 per month per subscriber.

HDTV

Bringing High Definition Television (HDTV) to North America has been a fiasco. The U.S. made the "ambitious" goal of moving to both Digital and High Definition at the same time. Many other countries, notably Europe and Japan chose to adopt each independently. The FCC also created a ruling that over the air broadcast television providers had to move to HDTV exclusively by 2006 provided that a certain penetration of HDTV capable TV sets had been reached. The mistake here is that the cable industry is not bound by similar legislation. Since cable is where most people in North America get their video this ruling made little sense. Additionally the Movie Studios, the easiest source of content for HDTV, has been slow to move to HDTV because of copyright issues.

A comprehensive understanding of HDTV is too much for this paper. For more information try this document[7] prepared by PBS.

Even with these problems, some progress has been made to get HDTV sets into consumer's homes. This had mainly been driven by the high-end consumer's desire to watch DVD movies on a sharper screen. DVD's are comparable to a medium resolution HDTV signal called SDTV 480i and look better on a HDTV set than on regular TV. Very view HDTV compatible sets actually have the ability to receive HDTV broadcasts over the air as a separate tuner must be purchased to receive the signals.

DTV Picture Formats

DTV Format	Picture Format	Aspect Ratio	Frame Rate
HDTV	1920 x 1080	16:9	30i, 30p, 24p
HDTV	1280 x 720	16:9	60p, 30p, 24p
SDTV	704 x 480	16:9	60p, 30i, 30p, 24p
SDTV	704 x 480	4:3	60p, 30i, 30p, 24p
SDTV	640 x 480	4:3	60p, 30i, 30p, 24p

(i) interlaced / (p) progressive

HDTV will not take off until cable and satellite providers start to carry the signals and the studios release movies in HDTV format. Satellite providers such as DirectTV and Dish Networks have moved forward with HDNet and HBO/Showtime respectively. Consolidation between Echostar and DirectTV will leave the new company with lots of excess capacity that could be used for HDTV services.

Currently very few cable providers are carrying HDTV signals over cable due to incompatible modulation between Broadcast TV and Cable TV. However, Time-Warner Cable is conducting tests in Manhattan and HBO recently signed a deal with Viacom to carry HDTV programming. Having HBO deliver HDTV may help the movie studios begin to convert their content to HDTV.

D-VHS and HD-DVD

The movie studios have recently realized that there is consumer demand for movies that take full advantage of the high resolution of HDTV compatible TV monitors. DVD is limited to 9 Mb/s and simply doesn't have the data rate or total storage to playback HDTV quality movies or TV. A new storage medium was needed. In February 2002, major movie studios and electronics companies agreed on a new standard HD-DVD that will provide 30 GB of storage and will support HDTV data rates. (**See Figure 8 and 9**). It will look like a traditional DVD, but will not play in old DVD players. If recent infighting on the backward

compatibility and laser color can be worked out this will be a compelling standard.

Another competing standard is D-VHS that comes in tape form. This medium holds 44 GB of data and is intended only for high-end videophiles. HD-DVD will become the mainstream video format for delivering pre-recorded HDTV.

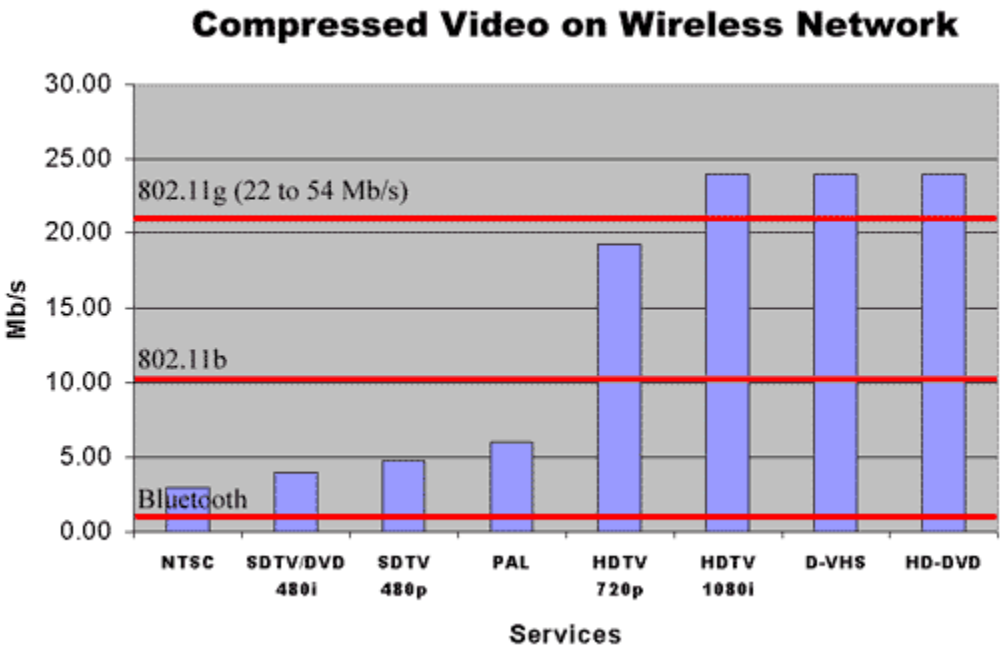

Figure 8

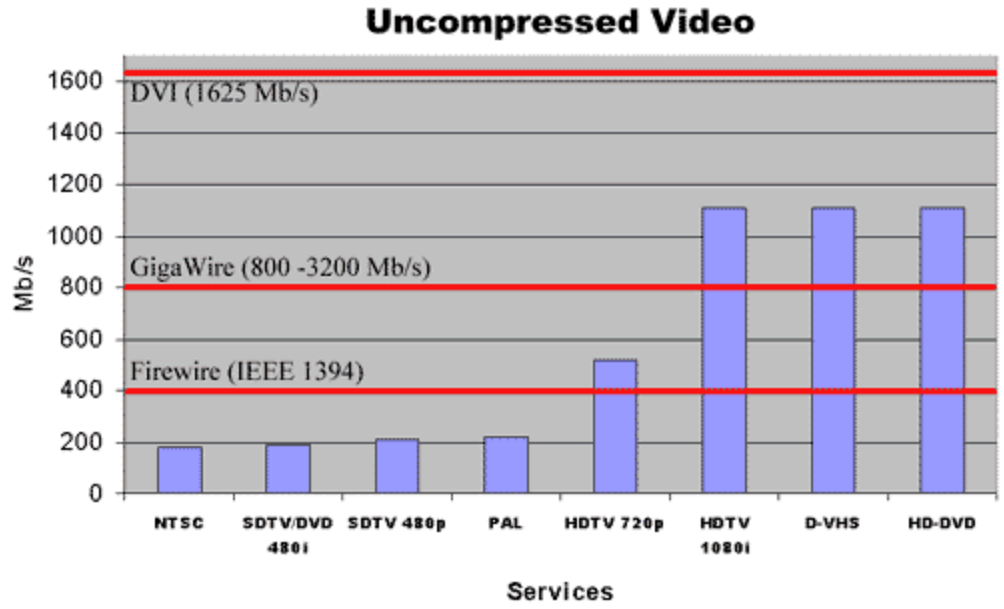

Figure 9

Pay-Per-View / VOD

VOD is expected to be the most lucrative of the video services. Cable and satellite providers would like to put Blockbuster out of business and help consumer's increase video consumption by avoiding the trip to the video store. Satellite providers should have the early lead in providing VOD to consumers with PVRs. First run movies are stored on the PVR and then unlocked for playback. The user will have full control over the movie to fast-forward, pause, and rewind. Additionally, the movie can be available for several showings during the day. Satellite providers will be limited by the size of the hard drive in the PVR. They will NOT be able to deliver hundreds of movies on demand. The role out of this service is also being delayed by the time involved in consolidating Echostar and DirectTV.

VOD is where cable will eventually excel. Cable providers can store the movies at the head end and deliver them at any time. Currently cable providers are struggling to make this form of delivery cost effective and reliable. Even delivering a NTSC broadcast requires at lease 2Mb/s. Each consumer watching the movie uses this amount of bandwidth. If this is true, what happens when a first run movie is released and 10% of the consumers on the network start watching it? Remember they all had different start times so that they cannot share streams. Also the consumer may pause the video. Either bandwidth is additive or immensely complicated algorithms must be used to share bandwidth.

Multicast via satellite is far more cost effective as a single broadcast can reach all homes in North America. However the satellite providers are limited by the size of the PVRs hard drive. Initially the satellite providers will enjoy an advantage as they build a homogeneous network. However, as cable fixes the bandwidth problem through better network architectures and build out the cable companies will win by providing far larger video libraries available on demand at any time.

DSL providers should not be ruled out. DSL's advantage is that they can choose from a huge variety of Video Service providers that are springing up on the Internet. With current technology high quality video can NOT be reliably streamed over a consumer grade DSL line in real time. However, if the consumer is willing to download the video in advance and then play it back for an encrypted file DSL isn't such a bad solution. (**See Figure 10**) DSL may be able to gain market share at the low end of the price range before cable and satellite can get their systems in place. However, in the long term DSL will be reliant on home networks to move video from the computer to the Television Monitor. Few people want to gather around the computer monitor to view a movie.

Let's do a few calculations that will describe the immense size of the video files that these companies are trying to squeeze through these connections.

Average movie on DVD 5 GB

5 GB (Gbytes) = 40 Gb (Gbits) (remember 8 bits = 1 byte)*

40 Gb = 40,000 Mb = 40,000,000 Kb

Consumer DSL maxes out at about 500 Kb/s

40,000,000 Kb divided by 500 Kb/s = 80,000 seconds to download

80,000 seconds = 22.2 hours

Bottom line: It takes 22 hours to download a DVD movie on DSL

*We use bytes to describe files on our hard drives, but use bits to describe bandwidth. It's all marketing. Describing a modem a 56Kb/s sounds better than 7KB/s

Figure 10: DVD Movie Download

Satellite providers and cable companies are counting on these new revenues to increase the dollars spent per customer WITHOUT reducing existing revenue streams. Recently an Echostar study reported that homes with PVR set-top boxes consume considerably fewer Pay-Per-View movies. The TV shows recorded to the PVR are chosen by the consumer and provide an acceptable substitute for Pay-Per-View movies, especially when the additional cost is factored in. Satellite and cable companies must by aware that not all new revenue is incremental; some may come through cannibalizing old revenue bases.

Music Services

Music services have attracted a lot of attention in light of Napster's emergence and subsequent decline. However, many other "free" music services have sprung up to take its place. MP3s have long been confined to the computer. This gives DSL providers an opportunity to form alliances with web based music services to provide the first music services. Cable providers will be slower to form these alliances since they see the music revenue as a service that they should control. DSL providers are not as interested in services and should be more willing to serve as the "pipe" for a variety of music service providers.

Pay music services will not succeed unless they have the same convenience and choice as free services such as Morpheus, WinMX, Aimster, Bearshare and Gnutella. Consumers must be able to store the music on their computers and burn the music to CD or download it to an MP3 player. If the consumer is not free to use music in this manner then music piracy will continue.

While the computer has been the home of MP3 playback for some time some providers think the PVR may also be a suitable home for music playback. The Series II models of the Tivo have Real Player built into them. The Series II can either dump music CDs to the Tivo's hard drive or download music from Real's Gold Pass service. Since the Tivo Series II is network connected the user would be able to move the music back to their computer to burn to CD. I would not expect services from cable or satellite to eat into the web-based music services business in the near future. More likely cable and satellite will be content to provide virtual "Radio Stations" for several music genres.

Online Gaming

It is unlikely that cable, DBS or DSL providers will recognize substantial revenue from online gaming. In this market they merely provide bandwidth for PC users and console gamers. Network providers will be best served through cooperative marketing and signing exclusive relationships with online gaming companies. The gaming industry was $8.2 billion in the US alone in 2001. Online gaming will not add much to this for many years. Jupiter Media Metrix reported in December of 2001 that online console games will total $250 million annually by 2006, compared with $1.5 billion for online PC games. About 12.3 million of the 79 million households with game consoles will have them connected to the Internet by 2006, according to the report.

The real players in this market will be the console developer's themselves. Console developers hold such sway over their game developers that they will be creating the online gaming services on their own platforms. Microsoft and Sony stand to capture the majority of online gaming console revenue. This differs from the PC environment where game developers often build their own online gaming environments.

Downloading games across the web to a console resident hard drive may also emerge as an interesting model.

Pace Micro, a major European set-top developer, has begun bundling older game systems such as Sega Dreamcast on its boxes. This will most likely prove a poor combination for the same reason WebTV failed. People, especially gamers, are not interested in old underpowered systems.

Interactive TV will also create a new venue for game developers. These games will not be "twitch" games such as Doom or Quake. They will be games appropriate to the lower powered set-top boxes; card and board games, arcade classics, gambling, and games that are TV Show specific. Bundling these games together at a reasonable incremental price could be a significant source of recurring revenue for satellite and cable companies.

PVR

Who can charge for the PVR?

The stand-alone PVR has not made significant inroads into the North American home. The market leader, Tivo, only had 380,000 boxes deployed by Jan 2002. Cable providers may not be able to sell the box as they have traditionally given away their cable boxes and recouped their costs by adding new services. Satellite providers have had more luck selling their set-top boxes, but have traditionally still heavily subsidized them. The PVR is a great feature, but its true value is only felt when it is combined in one box with other services such a Pay-Per-View, Music, and Interactive TV that take advantage of the its VCR like controls and its hard drive storage space.

Interactive TV

Interactive TV is a phrase that has become as all encompassing and therefore meaningless as "Multimedia". For the sake of discussion in this article it will include: EPGs, Onscreen Applications and Show Specific interactive elements.

With the merger of Echostar and DirectTV, the satellite platform has become very interesting for Interactive TV. A unified platform is very attractive for ITV applications. Satellite in the US may prove to be the leading edge, just as it was in the UK on the BSkyB platform. Satellite gained significant market share in the 1990s because it was able to differentiate itself from cable by offering far more channels. This advantage has largely been cancelled out by cable's expanding offerings. Satellite cannot maintain this strategy forever because only so many valuable channels exist. In order to be perceived as a premium service they must add other features that differentiate them from cable. Interactive TV can be such a service. Satellite providers would be smart to reach out to the networks with the promise of a stable unified platform for ITV. This would encourage the networks to create programming with ITV enhancement that could be viewed only on satellite. In this model the networks would also be able to tap into the consumer's PVR to make it easy for them to record programs, increasing the ratings for the network.

Satellite also has premium packages that lend themselves to interactive elements. Sports packages especially lend themselves to Interactive TV where consumers can pull up comprehensive statistics on their favorite teams and players. Real time fantasy leagues are another possible use.

Cable TV has been a long stream of abortive attempts to introduce ITV services. In the United States each cable system has a different infrastructure. This has frustrated attempts by the networks to launch ITV services since they are incompatible between MSOs. A similar metaphor would be to imagine each

cable system as a different Operating System. Thus an application written for Windows (AT&T) has to be rewritten for Macintosh (Comcast) or Unix (CableVision). The costs for the networks are prohibitive. The few ITV applications we see are network centric and created by the MSOs. These are generally Electronic Program Guides (EPG) that show what is on next. While these have value, they don't contribute to a consumer's desire to dig deeper on subject matter they see on TV.

With this diversity of infrastructures the proper course of action for the networks is to follow a *two-screen* approach. Cable companies can use their websites to aggregate web content, produced by the networks, so that it can be viewed simultaneously on the computer screen with the TV program. This leverages the substantial website infrastructure that many networks have put into place and contributes to website ad revenue. The cable firms will most likely want a piece of that revenue for users referred from the cable site. Cable companies will benefit through an increase in cable modem services, especially if the networks introduce broadband content and video previews.

Phone Service and E-Mail

Voice over IP (VoIP) is a service often touted by the Cable companies for their networks. However, with the exception of AT&T and Cox, high economic and operational barriers have dissuaded most cable companies from providing telephone service. Many cable networks were converted to IP to provide cable modem service they did not take telephony services into account at their cable head ends. Telephony services will require a further upgrade to the cable head ends to provide isochronous (time-sensitive) applications. A telephone call is a highly isochronous network application. If transmission delays greater than a few hundred milliseconds occur, telephone call quality suffers.

Billing is another issue. VoIP services already exist and a telephony application is built into newer versions of Windows. All these services require is a broadband connection that the cable company already provides. Why should the consumer buy from the cable company directly when they can chose between the many providers available on the Internet? For Cable companies to succeed in this area they will need to integrate services such as answering machines, fax and e-mail into a better user experience. Also their private networks will allow for better quality. Only when nearly free VoIP applications are not an acceptable substitute will Cable VoIP become a viable option.

Many people are skeptically that e-mail will ever become a mainstream application for the living room. E-mail is a lean forward experience. (**See Figure 3**) It needs a full keyboard, it needs to be sorted and placed in folders, it needs a lot of management to deal with the huge quantity of mail. E-Mail on the TV will most likely always be slaved to the computer. It may become a secondary method of sending e-mail, but the main repository for e-mail will remain the PC.

DSL providers suffer from many of the same problems as cable companies. In their case, however, they are not simply losing an incremental service they are losing their core service. Because of this I would expect the Telephone providers to make progress in this area before the Cable companies. Cable is more worried about rolling out new and more profitable services that fighting for the thin profit margins in this saturated market.

GLOSSARY

ASP – Application Service Provider

CLEC - Competitive Local Exchange Carrier

DBS – Direct Broadcast Satellite

DSL –Digital Subscriber Line

DVR - Digital Video Recorder

HDTV – High Definition Television

ITV – Interactive Television

MSO – Multiple Systems Operators

PVR – Personal Video Recorder

RBOC –Regional Bell Operating System

VOD – Video on Demand

URLS

1. http://www.itvt.com/etvwhitepaper.html
2. http://www.som.yale.edu/analystreports/reports/CableCompanies.pdf
3. http://www.andersen.com/resource2.nsf/vAttachLU/FastF_IDTV/$File/FastF_IDTV.pdf
4. http://www.pcformat.co.uk/news/detail.asp?id=30803
5. http://www.winsupersite.com/showcase/freestyle_mira.asp
6. http://www.pbs.org/cringely/pulpit/pulpit20020124.html
7. http://www.pbs.org/opb/crashcourse/tv_grows_up/