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TITLE: TV on the Internet: Dawn of a New Era?

SOURCE: Television Quarterly v30 no3 p31-47 Wint 2000

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Television pioneer Ralph Baruch knew the newly invented medium of television would exert a profound influence on society when, half a century ago, he saw a crowd gathered in front of a Manhattan storefront watching a test pattern, and three hours later, after Baruch had enjoyed dinner in a midtown restaurant, the crowd was still there, still watching. What Baruch couldn't have known then was how television and the more recently invented Internet would converge a half-century later. Today, anyone with a high-speed connection to the Internet (what is called broadband) will find television (or at least video and audio programming) increasingly integrated into their online experience. As digital television and broadband services roll out over the next decade, this integration will become increasingly seamless and ubiquitous.

Many television stations and all major networks maintain a site on the World Wide Web. Some of them provide at least some of their programming via the Web. A small but growing number of these and other programmers (such as CNN as well as some Internet-originals) provide near-broadcast quality programming via the Web, and some of it on demand. Audience members can view this programming at near-broadcast quality as long as they have a broadband Internet connection. What does this mean, exactly?

DELIVERING TV VIA THE INTERNET

Let's start with an example. KRON in San Francisco, the local NBC affiliate station, is one of a small but growing number of stations providing programming, in real-time or on-demand, via the Internet (www.kron.com). Viewers can go to the station's web site and select from a variety of news and information options, including stories reported in text, audio or video format, what we might call "television," although this is an inadequate term to accurately describe the video programming accessed via the Internet.

One of the new twists to emerge in this "television on the Internet," Columbia University journalism professor Steve Ross points out, is that much of the video KRON puts online is really "tv news without the b-roll." B-roll, the video material used in television news to provide background or context for a current news report, is replaced online with more efficient text content that can not only provide the same information as in the b-roll, but can do so in even more depth, yet is not necessarily forced upon all viewers, whether they need or want that additional background. Ross, who has teamed up for five years with communications professional Don Middleberg on the definitive study of online media, the annual "Media in Cyberspace" study, in August offered the author a preview of the 1999 edition of the study focussing for the first time on the use of the Internet among broadcast news operations. The study, which is targeted for late 1999 release, surveyed more than 1,200 television news stations across the nation, and found that some 400 now maintain web sites. Although a great many of them provide online video, most of that is largely promotional material. Only 32 (or less than 3%), as of August, 1999, actually delivered ondemand video news content online.

Many stations are offering their programming via Internet-webcaster Broadcast.com, or directly via their own "servers" using RealPlayer or Windows Media Player software. KRON uses RealPlayer. Broadcast.com provides the necessary server hardware and software (the equivalent in the traditional broadcast television world of the transmission

tower and frequency), and the station provides the digital content, audio and video. Depending on the audience member's technical setup (i.e., what kind of computer, software and network connection, or speed, aka bandwidth), he or she can connect to a live or a recorded program and begin watching and listening via computer. There are two basic ways s/he can access the program via the Internet. One can download the program, which means transferring the entire audio/video file, storing it on a local computer storage device, and then watching it whenever one likes, as often as one likes. Because video files can be very big (depending on the compression algorithm, a minute of video can take 10-100 megabytes of storage), downloading can be very slow, even with a broadband connection. That's why DVD is more popular for entire digital movies.

A second option is to stream the file of audio/video, also known as the television program. In the case of streaming video, a software program known as a codec (compression/decompression) buffers a few seconds of the video, and then the program begins playing on the client's (audience member's) computer, with a few more seconds of material continually being sent via the Internet. The viewer doesn't need to wait to view the program this way, but can't necessarily view the program again on demand unless s/he connects to the Internet and to the television station's web site. If there's a great deal of demand on the server or the network, streaming may not always provide an uninterrupted video flow in today's network. As the network improves, as consumers get access to more bandwidth, streaming media will continue to improve in quality and reliability (one good source of news about streaming media is the Streaming Media Newsletter, available at <http://www.streamingmedia.com>). On today's Internet, streaming media are the more common alternative for delivering "tv" via the Web. Most of the video, or "tv," streamed via the Internet today is fairly poor quality. It is often fuzzy, only a few frames per second, and only a few inches in image size, and often breaks up or is interrupted by "network congestion."

COSTS AND BENEFITS OF ONLINE TV

One of the major reasons many stations have lagged behind in developing television on the Internet is cost. Jim Topping, former general manager of KGO-TV (KRON's ABC-owned competition in San Francisco) and now senior vice president at ABC Owned TV Stations, notes that the installation of a powerful video server cost KGO-TV some \$9 million. Other technology to help the station go digital cost another \$12-14 million. Although this investment has established KGO-TV as probably the most state-of-the-art television station in the nation, with the capability to deliver any of its programming at high quality and ondemand via the Internet or other broadband media (e.g., asynchronous transfer mode, or ATM, is an alternative high-speed communications service capable of delivering broadcast quality video), it's also demonstrated the financial challenge faced by other stations in the process of going digital and going online with their video content. Of course, a \$9 million investment is the high-end approach, and is not necessary to start transmitting digital video on the Internet. Many operations have launched their efforts for far less, with perhaps \$100,000 for equipment and that much more for the technical staff to run the server. This low-cost approach is what has opened the door to many independent producers who are now transmitting television-like programming on the Internet, a subject that will be examined in detail later in this article.

One technology that is redefining the cost structure of digital programming is nicknamed "MP3," which refers to MPEG-1 Audio Layer III (MPEG stands for Moving Picture Experts Group), and is known colloquially as the compressed-file format for near-CD quality music delivered via the Internet. It is also known as the format for

pirated music, and has been a thorn in the side of the established recording industry for more than two years. This technology emerged as part of the MPEG compression standard (for digital video and audio) originally developed under the leadership of Leonardo Chiariglione, the Italian new-media guru. Chiariglione, who heads the Multimedia Services and Technologies division of CSELT, the research arm of the Telecom Italia group, also heads FIPA, the Foundation for Intelligent Physical Agents, and was named the executive director of the Secure Digital Music Initiative (SDMI) in the spring of 1999.

Launched by the Recording Industry Association of America (RIAA), SDMI is a non-profit organization of more than 130 companies and organizations covering a wide industry spectrum: recording industry companies, information technology companies, web companies, telecommunications, etc. Some might say Chiariglione's task is to put the genie back in the bottle. Another way to look at it, however, and perhaps a more accurate way, is that SDMI is designed to add a layer of intellectual-property protection, sort of a digital wrapper, to the content contained in the compression layer called MP3. Importantly, this wrapper can be extended to protect all online digital content, including video.

MP3 compresses audio files (whether music or any other audio) at high quality (near CD quality, but close enough for most human ears). College students, and many other young people, typically have a computer and Internet access, and a love for music. The one thing they lack is a lot of money (at least for now). MP3 offers a perfect solution to the college student dilemma—how to get all the music they want at the quality they want without paying much money for it. MP3 music files are relatively small, a couple megabytes, which can be downloaded quickly, or streamed almost instantly and very reliably, and played back either on a computer or a portable MP3 player, such as the popular Diamond Rio. Established recording companies, especially the major studios, have vehemently objected to MP3, because it provides a means of infinite duplication and dissemination of music, sometimes at no cost, and thereby undermines the existing business model for recorded music distribution.

People can transmit files easily and perfectly, contributing to what is called "piracy," costing the studios a great deal of revenue (although some contend that MP3 will help the overall recording industry grow, and despite some piracy, even more profits will result). In addition, many artists, including everyone from rapper Chuck D. of Public Enemy to Peter Cetera of Chicago to Alanis Morissette have all signed on with MP3, not just because they are drawn to the technology for its own sake, but because the revenue split is much more favorable to the recording artist. MP3 offers musicians the ability to take in 50% of the gross revenue for their music, compared to the standard 10% offered in recording industry contracts. Today, SDMI promises to offer a viable competitor to MP3 that the major labels will find acceptable. Ultimately, however, the question may be whether the consumer sees value in a technology (SDMI) that can insure the quality, authenticity and ownership of the programming they receive online.

The growth of MP3 suggests that Internet delivered programming may be a viable business; it also charts a possible course for TV on the Internet. Chiariglione argues persuasively, however, that the MP3 phenomenon does not demonstrate the viability of an Internet delivered programming business model. "The way I see the prevailing use of MP3 is the following," he explains.

"There is a wealth of assets that history has made openly available and that now technology allows people to take away for free. Exploiting those assets, people, not the legitimate owners, are making money. To me this looks like 16th-century Rome, where the Popes plundered the remains of imperial Rome to build their palaces: quod non fecerunt barbari fecerunt Barberini (what barbarians did not do, Barberinis—a family that provided some Popes—did)."

Those who are feeling an immediate MP3-class piracy threat are the major movie studios. They have traditionally made their money from a business model not that different from the music recording industry. Consumers pay for their own copies of the program, or pay to view/listen to a performance or exhibition (e.g., in a theater or at a concert). Pirated copies of movies or music threaten this business model.

Commercial broadcast television typically practices a different business model. Programs are usually offered at no cost to viewers with revenues coming from program sponsors or advertisers. Subscription television or fixed media (e.g., DVD, videotape) TV are much more akin to film and music. Pirated first-run movies are already being distributed via the Internet. College students and other young people have already obtained or produced digital copies of *The Phantom Menace* and begun sending them illegally via the Internet. Concerns about intellectual-property theft as well as unwanted competition have limited some programmers' forays online. Also, existing distribution agreements with traditional television programmers have also limited some online video transmission.

ON-LINE PROGRAM GUIDE BENEFITS EVERYONE

One area where everyone benefits from the development of TV on the Internet at virtually no cost is the introduction of the online programming guide (similar to what are called Electronic Program Guides, EPGs, in digital television or video). As the "million channel universe" rapidly replaces John Malone's antiquated "500 channel universe," the online program guide is more than a luxury, however; it is a necessity. Leading the way in the online program guides today is tvguide.com, the online version of TV Guide. [Tvguide.com](http://tvguide.com) offers viewers a fully interactive and keyword searchable guide to the coming week's programming on broadcast (whether delivered terrestrially, via satellite or the Internet) and cable television.

In addition, the articles and other content of the weekly magazine are posted online at no cost to the viewer. The site also features daily news about television and other media, a database on more than 40,000 movies, and digital video. One thing tvguide.com doesn't provide is a comprehensive listing on Internet-original online tv programming. Some regional and online programming guides are attempting to do this. One of the best is [FastTV](http://www.fastv.com) (www.fastv.com), which offers both an online video program guide (categories include news, sports, business, entertainment and lifestyles) as well as a keyword search engine (i.e., type in what you're looking for, and it will find online video that matches your search; I searched for Serena Williams and got 12 clips from the U.S. Tennis Open Championship and more). The site offers a variety of intriguing digital video tools, including fast forwarding through a clip, a clickable scene change frame bar, and a full-text transcript of each video clip.

Thanks to the tiny southwest Pacific Ocean island nation of Tuvalu (part of an archipelago in eastern Micronesia), one issue that may soon get much simpler is finding television content on the Internet. Because of the spelling of its name, Tuvalu has been assigned the new .TV top-level Internet domain name (TLD). The .TV domain name functions just as other Internet domains such as .COM, .NET and .ORG. The .TV Corporation (internet.tv) of Toronto, Canada is the exclusive worldwide registrar for the .TV top-level domain (TLD), under an agreement signed last year by Tuvalu's Prime Minister Bikenibeu Paeniu. Now, any program provider anywhere in the world can purchase a .TV domain name for its site, making it considerably easier for those interested in Internet TV to find online video programming. The initial price to register a .TV domain name is US\$1,000 for the first year with a \$500 annual renewal fee, although companies competing for names may bid up the price. "The majority of revenues from the .TV domain registry are used to help develop Tuvalu," the .TV Corporation reports.

PROGRAMMING ONLINE

The development of television programming on the Internet has given rise to at least three types of online programming (see Table 1). First is the transfer of off-line television programming to digital format served up directly and on-demand via the Internet. This type of programming is perhaps most common, although there is no definitive study yet available to test this hypothesis. There are examples from virtually every type of programming category on traditional, or classic television (over-the-air, cable, or direct-to-home satellite), ranging from news (regional, national and international), to sports, to entertainment, but among the most frequently encountered "television" programming of this type is promotional.

Whether they are transmitting movie trailers, soap opera clips or sitcom excerpts, many stations and other program providers have put short segments of their upcoming television programs online to promote viewer interest. A good example is Warner Bros. (www.warnerbros.com) with video clips from a variety of television series, including Seinfeld, and Babylon 5 and other WB programs. Warner Bros.' forthcoming new online programming channel, Entertaimdom (<http://www.entertaimdom.com/flash2.html>), promises extensive original online video programming, however, with Superman and at least five other TV series slated to run on its Multi-path Movie Channel (www.variety.com). Clips from NBC TV series, including an archive of video clips from 1998's Saturday Night Live season, are also available online (www.videoseeker.com).

The most common type of non-promotional programming thus far from over-the-air television stations is news and public affairs. CNN.com, MSNBC.com, CBS News, ABC News and NBC News are among the leaders in providing online video news, with the CBS Boston affiliate WBZ providing exceptional regional online video news, as well as Seattle CBS affiliate KIRO also a leader. A notable feature of CNN.com's online video offerings has included an advanced digital video search tool from "Virage," which enables the viewer to search through a video based on keywords in the audio transcript of a video, instantly accessing and playing the relevant video segment.

Last September ABCNews.com launched the first regularly scheduled network television-quality live Internet-only video news program. The 15-minute show is anchored by veteran journalist Sam Donaldson and airs on Mondays, Wednesdays and Fridays at 12:30 p.m. EST. The program offers news reports on a range of topics "from politics to business, special features, debate, analysis and occasional newsmaker interviews," says ABC News. The debut Webcast featured FCC Chairman Bill Kennard, and Rob Glaser, founder and CEO of RealNetworks, a leading provider of streaming media on the Internet (<http://www.realnetworks.com/>). The show also offers real-time chat with Donaldson or his guests (i.e., you can submit questions via e-mail).

NBC San Francisco affiliate KRON is another outstanding regional online video news provider. A third regional star is the Tribune Company, whose flagship newspaper The Chicago Tribune and flagship television station WGN are part of a converged news operation providing considerable quality online video news. A leading provider of international video news online is the BBC World Service, which provides live video news feeds online. Video news from other parts of the world is also available, including Japan, where Tokyo Broadcasting and Web Gendai are among the leaders in a country with fairly advanced digital and high-definition television programming. Other specialized business and technology video news is provided online by Bloomberg, ZDTV and PC Week. Online sports video leaders, especially sports news, including CNN.com, ESPN.com, CBSsportsline.com and Fox Sports. The online video entertainment arena is led by a variety of internet-originals, who are discussed later in the article. Most traditional television entertainment programmers prefer to provide only online promotional video feeds, as is the case with HBO. One

exception is Comedy Central, which provides much of its television programming online on-demand. Some educational video content is provided online, as well, with WGBH of Boston providing live video feeds and other video programming online. The Weather Channel is the premier provider of online video weather reporting, with live and on-demand (recorded) programs available. Music videos, including live and recorded performances are also available online, including from Sonicnet.com and others.

The recently announced merger of Viacom and CBS is likely to open up much greater opportunities for television, or video, on the Internet, although there has been no such official announcement of such possibilities from Viacom or CBS yet in this regard. With its new Internet division, MTVi, including both MTV and VH1, as well as its recently acquired SonicNet (a premier provider of online music), Viacom CBS is positioned well to provide not only online music but also online music video. Its Nickelodeon, already one of the most popular children's destination on the Web with 2.4 million registered users (The Industry Standard, www.thestandard.com), also is well positioned to bring more online video. Combined with CBS video news strength, the Viacom CBS empire is poised to take a leadership position on many online television fronts. Competition is coming in many areas, including (<http://jamtv.tunes.com/>) which offers more than 12,000 music video clips, music news and features via the Internet.

The second broad category of online video programming is Internet original programming. This began with so-called "web-cams," which have enjoyed enormous popularity around the world (literally thousands of web-cams have provided typically live feeds of everything from a coffee pot at Oxford to a seemingly endless series of web-cams observing people's private lives uncensored). This early experimentation, however, has given rise to much more serious online-original video programming in recent months.

Television programming has traditionally been provided to the public by a limited set of program providers. They have made their programming available on a scheduled basis, packaged for mass audiences and broadcast according to a controlled schedule. Just as MP3 opens the music recording industry to potentially thousands of new artists (i.e., program providers), the Internet opens the TV business to thousands, perhaps millions, of new TV program providers. These providers might be the traditional providers of TV programming, or they might be everyone from content providers from other media, such as radio or newspapers who wish to expand their programming into the multimedia realm, to not-for-profit or commercial institutions that wish to produce and distribute their own programming. Programmers could range from The Freedom Forum, a large media-oriented foundation that now produces extensive content delivered via its Web site, Free!. to such specialized industry-specific technical content providers (e.g., in health care, insurance) and adult-oriented content providers (e.g., the pornography industry, which has found a ready, willing and lucrative market online with an insatiable appetite for video delivered on-demand), to programming produced by individuals who yearn for self-expression and have finally found their own, nearly free, global medium.

The types of specialization of Internet TV go even beyond these, however. Perhaps most interesting is the rise of online TV shows unique to the Internet—programs produced for the Internet and available online. One of the most interesting examples is Pseudo TV (www.pseudo.com), a leading source of live and on-demand (accessed from digital archives over the Internet) Internet-TV programming about the world of Internet technology. Founded by Josh Harris, Pseudo offers a variety of some 55 programs, including Biztech TV (www.biztechtv.com) and Jason Calacanis' Silicon Alley Reporter TV show (www.siliconalleyreporter.com), which focuses on the social, cultural and economic impact of new media technology.

With a talk-show format, the Calacanis' weekly program features guests from New York's Silicon Alley and draws an increasingly global audience numbering in the thousands. This may be small by conventional broadcast TV standards, but is not so different from TV in the late 1940s, when TV was a new medium, and signals the coming specialization of TV online. Moreover, programs like the Silicon Alley Reporter TV show draw sponsors to support free programming, and offer viewers online participation through chat services. This is a model very similar to that already under development for WebTV. A June 1999 Arbitron NewMedia Internet study shows that almost three-quarters of Internet users in the U.S. spend up to 30 minutes a week watching streaming video. Nearly half plan to watch more streaming video in the future. The survey was conducted by Northstar Interactive, an Arbitron NewMedia company and based on Web-based interviews with 1,527 Internet Webcast users through random intercepts at the broadcast.com and Vtuner.com web sites.

Foreigntv.com is another fascinating Internet TV original. Foreigntv.com offers its online viewers an expanding slate of programming from around the world, beginning with cultural programming (such as documentaries independently produced about life in Cuba) and now expanding into news and public affairs, much of it with a distinctly non-U.S. point of view. One of the reasons foreigntv.com has captured a great deal of mainstream media attention is that one of the founders is Peter Arnett, a former CNN correspondent who made his fame during the Persian Gulf War as the only U.S. correspondent to report from Baghdad. Another online-only TV venture was also founded by a former CNN correspondent and celebrity. Lou Dobbs, known for his business reporting acumen, recently founded space.com, whose programming features original reporting about developments in space. Also entering the marketplace are universities (both traditional, such as Columbia University, and virtual, such as International University), which are not only bringing video programming into their distance-learning efforts but also delivering video via the web to general audiences with an interest in the intellectual life of the world's great centers of learning and knowledge.

One of the most innovative developers of quality programming in the online arena is also one of the best independent program producers in the off-line television world. The Broadcast News Network, or BNN, is a 15-year-old company with roots in so-called "old media" but embraces a philosophy that is much more tightly in tune with the redefined rulebook of new media. Founder and BNN executive producer Steven Rosenbaum says, "Old rules had the power in the hands of the content distributors—because distribution was the bottleneck. Today, with digital cameras making broadcast TV pictures for less than \$4,000.00, and web server technology and pipe (see section below on "broadband") growing each day—the pivot is changing. Quality content will rule—and by quality I mean content that users/viewers want and engage."

Since its founding, BNN has grown with network clients including CBS News' 48 Hours, A&E's Investigative Reports, Court TV, The Sci-Fi Channel, the History Channel, MTV, Fox Family, MetroChannels and VH1. BNN's objective is (www.BNNTV.com), Rosenbaum explains, "to empower viewers to make television, and act as an agent to package and polish this content to enhance value." Hence MTV Unfiltered—which BNN helped launch in 1996—"was slightly ahead of its time. We had viewers call in, request cameras, and shoot their own stories. The results were extraordinary. We believe that user content will demand stations to rethink the broadcast paradigm. With projects like CameraPlanet (www.camera-planet.com) we're creating new communities around digital video and storytelling. We'll let the audience tell us if that's what they want." Rosenbaum believes this new mode of "participatory

programming” will expand far beyond news and information. “We’re now in the pilot phase of a daily entertainment/comedy program in which viewers will get to script the lines of one of the main characters in real-time.”

Another online original program provider generating considerable attention in the online world is the Digital Entertainment Network (DEN, at www.den.net). DEN introduced its first slate of online video programs May 10, 1999, including 30 interactive television pilots. DEN’s programming is available via RealPlayer, Windows Media Player and QuickTime. As of August 1999, its shows included a slate of 11 programs streamed online, including Hip Hop Missive (an original production on hip hop culture), Rated DG (a movie review program), Exoticom (a travel show) and Royal Standard (a serial set in the 21st century, where “the descendants of the Titans go head to head with the incarnation of immortal evil...but Evil has gone Corporate”). With programming that brings to mind the WB, DEN has clearly targeted the under 35 generation. DEN has also captured two charter-member advertising sponsors, Pepsi and Ford.

A third online original program provider generating considerable buzz is ON2 (on2.com). Unfortunately, at this writing, the site had not yet actually put any of its content online. But promises to offer “a revolutionary network of web channels developed exclusively for the growing number of broadband-connected Web users. On2.com provides (or promises to) full-motion, television-quality video; incredible-sounding audio; plus the informative, interactive content that you expect from the Web.”

Reflecting the growing abundance on original online video entertainment, [wirebreak.com](http://ww1.wirebreak.com/home/index.html) is an interesting provider of offbeat comedy fare (<http://ww1.wirebreak.com/home/index.html>). Among wirebreak’s offerings are a series of short video programs, typically in three- to five-minute segments accessed on demand and run via RealPlayer G2 at network speeds of 56k, 100k or 300k; the faster the speed of the network connection for the user (or the greater the bandwidth), the better the quality of the video. Running at 300k, the video shown in a small window is quite good, with crisp resolution and about 15 frames per second, and the audio is very good; at full screen, there is some pixelation in the video. Typical original programs include Girls Locker Room Talk, featuring women talking frankly mostly about sex. It’s reminiscent of HBO’s *Sex in the City*.” A show I found myself watching and interacting with at some length was *Welcome to Venice*, a comedy set in California, not Italy. The segment I saw opened with about a three-minute clip, followed by a choice for the viewer, either (a), to train in the martial arts with “Barry,” or (b), to train with master “Bruce Levi.” I tried, and enjoyed, both options. More viewer options were available at the conclusion of these clips. Accompanying the video programming was an interactive, animated advertisement from Gillette Mach 3 that ran as the video program was loading.

An interesting government provider of online video is NASA, whose NASA.gov site offers live video web casts of various NASA missions. In fact, these live video feeds have become increasingly valuable in both education and journalism. Dan Dubno, producer and technologist for CBS News Special Events, reports that, “For a journalist who is used to watching live NASA feeds via satellite, it is now even easier to watch the live feeds on my desktop via the Internet.”

THE IMPORTANCE OF SPORTS ONLINE

Sports is an important entertainment area where online video is taking off. On September 26, 1999, NFL.com began live transmission of video of selected games in progress (including the matchup of the Green Bay Packers and the Minnesota Vikings)

to three locations outside the U.S. Online fans with high-bandwidth Internet access could watch NFL games live via the Internet in the Netherlands and Austria, and on a two-day delayed basis in Singapore. The video feeds are available to subscribers to "chello broadband," Europe's first broadband internet service provider, and SingTel Magix, a digital subscriber line service in Singapore.

More venues are likely soon. Not to be outdone, on November 2, 1999, coinciding with the start of the National Basketball Association season, the NBA launched its own online television network via the Internet. Commissioner David Stern says, "NBA.com TV represents the convergence of the Internet, television and basketball. By combining the immediacy and depth of information from NBA.com with current and historical television programming from the NBA, NBA.com TV will offer our fans complete, round-the-clock coverage of the league." NBA.com TV provides live game "look-ins" (brief video of games in progress), studio shows, archival video on demand and more. The 24-hour sports video network will initially be available only on DirecTV, the direct-to-home satellite television and Internet service provider (http://www.nba.com/news/nbacom_tv_launch.html).

One site that is something of a hybrid of original Internet video programming and an aggregator of digital video originally aired on television is the Alternative Entertainment Network TV (AENTV, <http://www.aentv.com/>). Los Angeles-based AENTV was named one of the "10 Great Video Sites on the Internet" by Broadcasting & Cable magazine (the others are all discussed elsewhere in this article; see <http://www.broadcastingcable.com/search/article.asp?articleID=692233997> for the full list). AENTV owns or has aggregated hundreds of hours of programming of a diverse range of TV talent, including Sonny & Cher, the Smothers Brothers, the Academy Awards archive library and television classics from the "Golden Age," such as the Burns and Allen show, the Frank Sinatra Show (I enjoyed watching and listening to Frank sing Cole Porter's classic, "I've got you under my skin") and the \$64,000 Question. The shows are all available on-demand for watching at no cost to the viewer. The site is advertising sponsored. iNEXTV Corporation, a wholly-owned subsidiary of Ampex Corporation, recently acquired a majority interest in AENTV.

One extensive area of online video that won't get much exposure here (because it is so vast it warrants an entire article itself) is sexually explicit, erotic or pornographic programming. Adult sites have been heavily involved in online video probably as long or longer than any other area of online programming, and have been doing so profitably. Their users have a high demand for online video, on-demand, live and interactive. If you're interested in viewing any of this content, some of it is available free, but it is increasingly available on a pay-per-view or members-only subscription basis. It's easy to find; simply do a keyword search under any of a variety of terms (which you can easily figure out) using any of the standard search tools or directories (e.g., Yahoo!, Google.com, lycos.com). Just be careful: once you visit one of these sites, you're likely to start receiving unexpected e-mail from a wide range of commercial interests.

DIRECTIONS IN ONLINE TV

Three developments suggest where television on the Internet is headed. The first is the advent of the next generation of streaming media products. Second is improved video compression technology. Third is the coming widespread rollout of broadband communication services.

Streaming media have been delivering poor quality video, and reasonably good quality audio, for some two years. But the introduction of Apple's Quicktime 4.0 and Digital Bitcasting's thinned MPEG dramatically transforms the quality of streaming

video. Apple's Quicktime 4.0 is already fairly widely known and used. Building on earlier versions, QT 4.0 delivers high quality video and audio via the Internet. It's nothing like the small video windows most computer users are used to seeing when watching Internet TV. The most dramatic use of QT 4.0 to date was not for television; rather George Lucas used QT 4.0 to deliver the trailers for his eagerly awaited Star Wars prequel, *The Phantom Menace*, to millions of eagerly awaiting fans in the Spring of 1999. The video was available in either streaming or downloadable format, for either Apple or Windows computer users. Depending on one's Internet connection, one could view the trailers in high resolution, 24 frames per second video windows as large as 8 x 4.5 inches (approximately the 16:9 aspect ratio of film). Moreover, the audio was of very high quality, using the MP3 technology to deliver near-CD quality stereo sound. Watching the trailer via a 12-year-old friend's computer equipped with Dolby sound, the author can attest, was very near the theatrical experience (at least compared to some of the multiplex cinema's I've sat in), and certainly as good as watching on a regular TV set. And watching the trailers for *South Park* was even better than in a theater, because I could easily turn it off.

Digital Bitcasting's thinned MPEG video format offers a second glimpse into the future of TV on the Internet. MPEG-2 is the compression format for delivering broadcast-quality video, and is what is used for DVD and direct-to-home satellite broadcasting, and will be the format for terrestrially delivered digital video broadcasts. Although MPEG is technically not quite the equal to MPEG-2, it is a close second, at least to the untrained eye. Digital Bitcasting's thinned MPEG is a technical solution for delivering MPEG quality video over the Internet today, and provides a natural upgrade path from MPEG1 to MPEG2 or MPEG4 as bandwidth improves in the next five to ten years.

"The Bitcasting thinned MPEG solution is being deployed right now by high-speed cable providers like Comcast and RoadRunner and DSL service providers like France Telcom and Hong Kong Telcom," reports Bitcasting's president, Peter Dougherty. If one has an Internet connection of at least 300 kilobits per second, thinned MPEG can deliver full-screen, 30 frames per second, high resolution video, as well as streamed MP3 audio. The key difference between streamed MPEG and QT 4.0 is the size of the video window. To the viewer at home, who may be used to watching video on a 13-inch screen delivered via either a roof-top antenna or via a standard analog cable system, the difference in quality between Internet-delivered video and over-the-air TV may be imperceptible. There will, of course, be a substantial difference in video quality between Internet TV and HDTV, but it will be many years before most viewers are able to view HDTV in their homes. Moreover, the on-demand, interactive nature of Internet TV are added values simply not possible via conventionally broadcast TV

Both QT 4.0 and Digital Bitcasting's players are downloadable free to the end user, although not to the program broadcaster. The Bitcasting server is sold as an upgrade to Real Player G2, an emerging platform for streaming media. Windows Media Player also incorporates its own full-screen video viewer, with MP3 sound, and thus offers a third alternative for near broadcast quality programming. Pixelon.com is a new fourth option.

Broadband Internet refers to high-bandwidth, or high-speed, communication services such as the cable modem or the telephone companies' T1 and Digital Subscriber Line (DSL is the general name of the technology to digitize the telephone subscriber line; xDSL refers to Asymmetric DSL, or ADSL, and Very High Bitrate DSL, or VDSL, which are even faster than basic DSL). Classic analog television and radio services are broadband, but they are not interactive. Bandwidth available for Internet service has traditionally been narrowband, or slow via dial-up modems typically delivering anywhere

from 28 kilobits to 56 kilobits per second. Video at these narrowband rates is very limited, usually a small window of jerky motion, low resolution imagery and marginally better sound (which requires less bandwidth).

ALL THIS IS SET TO CHANGE

All this is set to change as low-cost bandwidth begins to roll-out nationwide and low-cost digital consumer access devices roll out ubiquitously. Broadcast.com among others is already testing broadband content delivery via cable modems. Cable modems are roughly 174 times faster (about 10 megabits per second) than 56k modems. The early winner in the bandwidth battle may be the cable companies that are rolling out nationwide their digital set-top boxes and modems. Cable programmers such as HBO have launched a major initiative (March 6, 1999) with a regular schedule of movies in HDTV.

These companies are in a strong position to deliver low-cost broadband services and digital programming to the home. @Home, Time Warner's RoadRunner and Cablevision's Optimum TV are already delivering high-speed Internet access and broadband DTV services in a growing number of markets. Road Runner, the high-speed online service jointly owned by MediaOne Group, Time Warner, Microsoft Corp., Compaq Corp., and Advance/Newhouse, has more than 100,000 customers in fourteen states served by Time Warner Cable and MediaOne (www.timewarner.com, March 4, 1999). Optimum TV serves 15 markets, including parts of New York City, Long Island, and Cleveland, Ohio (www.cablevision.com) and @Home, a derivative of cable giant TCI, mainly serves suburban Denver, Colorado. AT&T has acquired TCI for \$48 billion, breaking the barrier between voice and video services.

Telephone companies have lagged somewhat behind in their delivery of high speed Internet and broadband digital video services to the home, with the most promising technology, Digital Subscriber Line (DSL), available in only a handful of markets. Leading Regional Bell Operating Companies (RBOCs) rolling out DSL and xDSL services include Bell Atlantic (<http://www.bellatlantic.com/>), Southwestern Bell (<http://www.swbell.com/>), US West (www.uswest.com) and others. Top DSL speeds are somewhat slower than the top cable modem bit rates, with high-end speeds for DSL some 25-50 times faster (about 2 megabits per second) than typical dial-up modems (56k). The major problem with cable modems is that the bandwidth is shared among users, so that if there is a large number of subscribers in a given area, the actual bandwidth available to any one user can be significantly reduced. In contrast, DSL is not shared; it operates over the switched telephone network, so the subscriber always has the maximum bandwidth available. Thus, in the short-run, cable modems may do quite well, but over time, as more subscribers sign up, and network congestion increases, DSL subscribers may have an advantage.

Both cable modems and DSL services can be left on continuously, so customers don't have to dial in every time they want to send or receive e-mail, surf the Web, or order on-demand digital video. This capacity is central to the development of broadband Internet service devices as "information and entertainment appliances." Conversely, leaving one's computer connected to the Internet raises new security considerations never an issue before for most home Internet users. When continuously connected, the user's computer is subject to the same type of hacker or cracker attacks that sometimes plague office and other institutional users. When one dials up, your computer is assigned a new "IP" address (the Internet protocol address) each time. This makes it much harder for hackers to break into your computer. Plus, hackers sometimes work at odd hours, when many home users might not even be logged on. Once on a dedicated line, however, your computer becomes more vulnerable to attack.

Table 2 summarizes the broadband services in North America and world-wide for selected services. DirecTV's PC product, DirecPC, delivers high-speed Internet access (for downloading content) via direct broadcast satellite at 400Kbps, three times the speed of ISDN, but several times slower than DSL and cable modem service; cable modems and xDSL, the accelerated digital subscriber line from the phone company, both deliver roughly 10 megabits per second. DirecPC provides upstream communications via a standard modem connection, which means upstream bandwidth is whatever the speed of the modem is (i.e., the consumer can't webcast high quality video). Broadcast.com has worked with DirecPC on trials of delivering digital video via the Hughes satellite system. Interactive Week (www.interactive-week.com, March 22, 1999) notes that negotiations are underway to deliver on-demand, customized digital video programming and interactive programming on a regular basis over the two-way satellite system. Cable modems and xDSL both provide upstream capability of roughly one megabit per second.

Wireless broadband services are also on the horizon in what is sometimes referred to as the third generation of wireless technology (3G). A number of players are planning broadband 3G services (two megabits per second or faster), including Qualcomm's CDMA (Code Division Multiple Access) 2000, the Universal Wireless Communications Consortium and the Global System for Mobile Communications (GSM).

One of the most interesting options for wireless broadband is via low-earth orbital (LEO) satellite (DBS is in a higher orbit), perhaps through the coming launch of Teledesic, the Gates-McCaw LEO satellite constellation designed to bring ubiquitous, low-cost broadband wireless services around the world by 2006. Another proposed system is the high-speed satellite data network dubbed Spaceway from Hughes Electronics, of El Segundo, CA, a \$1.4 billion plan for a North American satellite network to offer high-speed bandwidth for data, Internet access, videoconferencing, and other applications on demand. The rollout is planned for 2002 and will be the first step in Hughes' plan for a global broadband satellite network. The recent bankruptcy of Iridium, the proposed Motorola satellite system, may signal more than a bump in the road, however.

A competing interactive, high-bandwidth satellite system called SkyBridge is also planned (http://www.alcatel.com/press/current/1998/06_02.htm) for operation by 2001. SkyBridge Limited Partnership is a multinational collaboration whose general partner is Alcatel. The Alcatel web site reports the other partners include: Loral Space & Communications of the United States; Toshiba Corporation, Mitsubishi Electric Corporation and Sharp Corporation of Japan; SPAR Aerospace Limited of Canada; Aerospatiale and CNES of France, and SRIW, a Belgian investment entity. Alcatel intends to use a constellation of 80 LEO satellites, to deliver global connectivity to business and residential users worldwide with performance comparable to that of future terrestrial broadband technologies. Downstream speeds will be up to 10 Mbps and upstream speeds will be up to 2 Mbps. SkyBridge LP predicts 20 million users worldwide in its first year of operation, and 400 million by 2005. Whether they achieve this goal may depend largely on the successful launch of the necessary rockets bringing the satellites into orbit—a number of recent commercial launch attempts have failed, signaling trouble in the industry.

The development of a widespread, affordable broadband Internet infrastructure does more than bring commercial television online for consumers. It presents new opportunities to restructure the television industry and how programs are produced. Consider one company's foray into the fray. Javu Technologies is introducing a new Internet-based approach to non-linear video editing on the web. Most television

program producers are used to working with nonlinear video editing systems such as the Avid Media Composer, or the popular software-based non-linear video editor, Adobe Premiere. These systems permit the human video editor to sit down at a workstation and edit digitized video in a non-linear fashion, much as one might use a word processor to edit words “non-linearly” on a computer, cutting and pasting content (words or video) anywhere in a file for later linear consumption (by the reader or the viewer).

Javu’s non-linear video editor for the web permits this same functionality but via the Internet. In other words, the digital video is placed on a server, and then an editor, who might be anywhere in the world, can edit that video. As Javu’s web site reports, the implications are dramatic: “as footage is stored and edited on remote servers, individuals will not have to invest in state-of-the-art hardware or worry about clogging their hard drives with megabytes of video footage. In addition, the editing technology has been developed with user-friendly graphic user interfaces, allowing even the newest of computer users to easily store, edit and enhance their own video footage, pictures and music.” Of course, the technology today is still quite limited and slow, and it may take years before the commercial use of this technology is viable.

TRANSFORMING TELEVISION

Television on the Internet is not just television anymore. Via the Internet is not only a new way to deliver television programming; it begins to change fundamentally what we know as television. Moreover, it raises the question of just what constitutes television. Prior to today, understanding television was fairly straightforward. In fact, most four- year-olds could probably tell you what television was, at least in the common vernacular. Television can be described in many ways, but perhaps most relevant to a discussion of TV on the Internet is the view that TV is the audio and video programming delivered to a device typically equipped with a cathode ray tube, although increasingly with flat screen or projection devices, and a mono or stereophonic sound system. This programming has come in either of two basic options: 1) transmitted electronically either through wireless (terrestrially over the air or satellite) or wired (mainly via cable, although in some places via telephone lines); 2) delivered on fixed media (including optical digital versatile/video disk or DVD), or on magnetic tape (i.e., videotape, typically VHS format).

The Internet also brings the possibility of new video formats. Traditional video is based on a visual paradigm dating to at least the 1890’s work of American Thomas Edison and the French Lumiere brothers, who developed motion-picture cameras that captured images in a narrow field of view and made possible sequential narrative on film. Today’s digital video technologies, available for viewing via the Internet and in other digital media, offer the possibility of unusually large fields of view, up to 360 degrees, much like the panoramic paintings and photographs of the late 18th and 19th centuries.

Digital video can also offer what is called synchronized multimedia, or non-linear multimedia content that is embedded within a linear video. For example, imagine viewing a crime-scene video recorded in 360 degree format. As you use the mouse, or even voice command, to pan, tilt or zoom anywhere in the 360 degree view, you see what appears to be a damaged portion of a wall. You zoom in and click on the damaged area, and a message appears, explaining that you are viewing one of the bullet holes left behind by the police when they opened fire on the suspect. Does this sound impossible? It’s already been done in a collaborative project between the New York City crime news service, APBnews and the Center for New Media at Columbia University’s Graduate School of Journalism. Visit APBnews.com to explore the

collaborative video reporting about the 1999 slaying of west African immigrant Amadou Diallo by four undercover police officers in the Bronx. APBnews also offers a video center with extensive video and audio online reporting about a variety of crime reports, from a police pull-over for a speeding arrest that got out of hand to a drug investigation that began on the Web and lead to a real-world arrest. Full-motion 360 degree video is also available on the Web today. A growing number of companies are providing the necessary technology, including BeHere, which has an operational system delivering 360 degree motion video via the Real Player. See www.behere.com for a live or recorded sample in which you can use a mouse to pan, tilt, zoom throughout a 360 degree motion video (at the time of this writing a 360 degree motion video was available from ESPN.com of "aggressive in-line skating"). Tools from companies such as Veon (www.veon.com) and Virage (www.virage.com) add a variety of other functions to Internet video, including "hypervideo," or interactive links from video (including 360 degree video), and powerful video search capabilities (including real-time indexing, search and retrieval of video).

Digital video can also be viewed using a variety of alternative displays connected to the Internet. One intriguing device is the headworn display, which allows the wearer to be completely immersed in a three-dimensional video environment. Once the domain of games and virtual reality, head-worn displays have increased enormously in quality, dropped in price and now represent a viable means of delivering video news and other TV programming via the Internet.

All of this threatens the demise of local programming produced by traditional television stations. In its place we are witnessing the rise of specialized programming produced for national and international audiences. It is a process somewhat akin to the specialization of magazines in the 1950s and '60s. But there are three important differences: 1) the content of Internet TV is available on demand; 2) it is interactive and available in new formats; and 3) it is frequently free (ad and partner supported).

With the coming of broadband connectivity for the mass public, these developments will not only continue but increase. The falling cost of the technology needed to produce broadcast-quality programming will contribute to the increasing diversity and specialization of programming on the Internet. However, the creative talent needed to produce quality programming will still be expensive. But, as with MP3, there are thousands, perhaps millions, of young, and perhaps not so young, people with talent and a camera and computer eager to program for a niche audience on a global stage. Moreover, established program providers will find opportunities in the Internet environment. They can repurpose their existing products. The international market is opening up. There are new, credible entrants joining the fray, as well. Public radio stations are starting to produce television for the Internet, independent producers are designing quality, interactive programs. Television on the Internet is rapidly becoming video programming for a networked world.

ADDED MATERIAL

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Table 1 Selected Online Video Program Providers(FN*)

Online Programmer	Programming	URL (Web address)
AENTV	Aggregator, some original	www.aentv.com
NBA.com TV	Sports: Basketball	www.nba.com
NFL.com	Sports: Football	www.nfl.com
NASA	Original space science	www.nasa.gov
Wirebreak	Original Entertainment, adult comedy	www.wirebreak.com
Digital Entertainment Network	Original Entertainment, arts, culture	www.den.com

Pseudo TV	Original programming, entertainment, news, culture	www.pseudo.com
MTVi	Music video, music news	www.mtvi.com
Tunes.com	Music video, music news	http://jamtv.tunes.com/
Broadcast News Network	Original programming	www.cameraplanet.com; www.bnntv.com
CNN (including CNNsi)	Original and repackaged cable news	www.cnn.com
MSNBC	Original and repackaged cable news	www.msnbc.com
NBC (and selected affiliates)	Original and repackaged TV programming	www.videoseeker.com
Warner Bros.	Repackaged TV programming, movie trailers	www.warnerbros.com
ABC (and selected affiliates)	Original and repackaged TV programming, news	www.abc.com
CBS (and selected affiliates)	Original and repackaged TV programming, news	www.cbs.com
FasTV	Online video aggregator, directory, search engine	www.fastv.com
Space.com	Original programming on space news, features	www.space.com
ForeignTV.com	Aggregator, some original international news and features	www.foriegnv.com

FOOTNOTE

* Note: Not every site mentioned in the article is included in this table.

Table 2 Broadband Alternatives

Broadband Services	1998 Subscribers	1999 Subscribers	Homes Passed
DSL North America	439,000	748,000	34.7 million
Cable Modem/total	535,000	1.5 million	22 million
@Home (TCL/ATT)	330,000	850,000	
Road Runner (TW)	180,000	550,000	
Other	25,000	100,000	
Satellite			Universal
Home DirecPC	90,000	300,000	
Business VSAT	220,000	400,000	

Sources: Telechoice (<http://www.telechoice.com>); DirecPC (<http://www.direcpc.com/>), company information; Kinetic Research; Satellite Industry Association; Interactive Week, March 8, "US West Readies Video-On-Demand", page 12; "Telecentury Transitions: Wireless Telephony, Electronic Commerce, and Digital Television in the Global Marketplace," A Publication of the Japan-U.S. Telecommunications Research Institute, San Diego State University, San Diego, CA, 1999: 100.