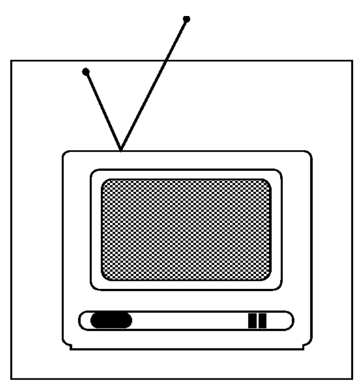
# Broadcast and High-Bandwidth Services 5

Wireless communication systems will play an increasingly important role in the delivery of a wide range of high-bandwidth entertainment, information, and communication services. Radio-based technologies have been used for decades to transmit one- and two-way communications in support of a wide variety of applications. Radio and television broadcasting, for example, have long been a staple of the nation's communication infrastructure, supplying information and entertainment to millions of Americans for over 50 years. Since the early 1970s other wireless systems—microwave networks and satellites, for example—have been providing high-capacity links primarily for large corporate, industrial, and government users (the only users with bandwidth requirements large enough, or who could aggregate enough traffic to need a high-capacity system). Today, as the demand increases for high-speed data, multimedia, and video communications, wireless systems are increasingly being designed to provide high-bandwidth capabilities directly to individual users and businesses. This chapter examines the role of new and existing wireless technologies in delivering broadcast programming, video, and other high-bandwidth services as part of the evolving National Information Infrastructure (NII).



## FINDINGS

- High-bandwidth radio technologies will play a somewhat paradoxical role in the NII. **At the local level, wireless systems will *compete* with established wireline and other wireless service providers.** From a national policy perspective, however, **wireless technologies will *complement* wire-based systems in extending video-based NII services to more**

**American citizens and businesses, and could be important in extending universal service to underserved populations.**

As a competitor, high-bandwidth wireless systems are expected to bring substantial benefits to consumers and businesses, including lower prices and more diverse services. Direct broadcast satellite (DBS) services, for example, and several new terrestrial wireless systems will compete with cable companies and broadcasters in the market for video programming. Satellite-based digital audio broadcasting (DAB) will compete with local broadcasters for radio listeners in cars. Terrestrial and satellite-based "bandwidth on demand" systems will compete with local telephone and cable companies to provide "last mile" NII connections to businesses and consumers who need high-bandwidth communication services capable of handling video communications, image transfer, high-speed data, and multimedia applications.

As a complement to wire-based systems, wireless systems have great potential for extending NII resources to rural or underserved populations. In particular, satellite-based systems may bring the full range of NII services and applications to more users because of their ubiquitous nationwide coverage. This single-source coverage also assures consistent services across different local areas for users with national communication needs —multiple services, whether wireline or wireless, will not have to be "stitched together." The architecture and cost structures of wireless technologies—terrestrial and satellite-based—may allow them to deliver NII services to some areas faster, and perhaps less expensively, than traditional wireline systems, especially in areas that are remote or undergoing new construction. High-bandwidth technologies may even be used by traditional wireline carriers to deliver services—at least one local telephone company has invested in a wireless video provider, and cable companies are actively involved in the DBS industry.

- Although it is too early to assess the general effect of competition on price because the systems are too new, many analysts and policymakers believe that competition will drive prices down or at least hold them steady.[1] **Because some of these technologies, markets, and industries are still in their infancy, it is difficult to determine how effective competition in new markets will be, which technologies will survive, and which companies will prosper. Similarly, claims about the benefits new wireless technologies can bring to the national economy must be regarded cautiously.[2]**

Each system has advantages and benefits that will be attractive to consumers and businesses, but that will also splinter markets and frustrate analysis and policymaking. As technology advances and demand sharpens, systems will become increasingly differen-

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[1] Some anecdotal and statistical evidence does exist, for example, that a second cable company in a given franchise area will reduce cable rates. See Federal Communications Commission, *Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, CS Docket 94-48, released Sept. 28, 1994, paragraphs 57-60 and 203. At least one MMDS provider claims similar reductions in cable rates as a result of its entry into the local market. Letter from Todd Rowley, Peoples' Choice TV to Andrew Kreig, Wireless Cable Association International, Jan. 16, 1995.

[2] The Federal Communications Commission noted this problem explicitly in an ongoing proceeding:

"...it must be noted that the proposals before us are largely that. There is little evidence in the record regarding the likely public interest benefits of the various proposals, including increased access to high-quality, affordable, and innovative services, and stimulation of economic growth through increased competition for existing services and introduction of new services that may be expected to stimulate demand and create jobs." Federal Communications Commission, *Rulemaking To Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band and To Establish Rules and Policies for Local Multipoint Distribution Service*, CC Docket 92-297, released Feb. 11, 1994, at para. 23.

tiated—not only in the products and services they offer, but in what they can actually deliver. The unique capabilities and disadvantages of wireless technologies, combined with changing consumer demand, will lead to markets that overlap for some services, but diverge for others provided by the same systems. Consumers will benefit from a wider range of services and competition among many different types of providers—both wireline and wireless. Assessments of the overall market will lose meaning as many smaller submarkets form. In addition, **the uncertainties of technology advances, consumer and business demand, and regulatory treatment make it difficult to judge their overall effects on the wireline portions of the NII.**

- **As technology advances and competition develops, the implementation of universal service (whatever its definition) and other public interest obligations becomes more problematic for both wireless and wireline carriers.**[3] Historically, universal service has been associated with the provision of basic telephone service (see chapter 9). Today, the development of new technologies, coupled with changing societal needs, is forcing the concept of universal service to evolve as well. In the future, universal service is likely to include a wide range of advanced communication and information applications, such as voice, data, and video services. Exactly what the new universal service will encompass is unclear, but because wireless providers are expected to be significant competitors in various markets, how these issues are resolved will directly affect their operations and economics.

  An evolving definition of universal service will pose serious challenges for policymakers regarding wireless services. First, if universal service comes to include access to high-bandwidth information and entertainment services—such as those offered by the wireless providers discussed below—new segments of the wireless industry will be subject to new regulations. Additionally, if universal service mandates two-way, broadband access to NII resources, the majority of wireless providers—those who cannot technically offer such services—could be put at a regulatory disadvantage. Mandating such a level of service for all telecommunications providers fails to account for legitimate technology differences and could penalize companies that made rational technology and business decisions in the past.

  A system of universal service based on designation of essential carriers—such as that envisioned in recent legislation—or a tiered system of universal service obligations based on technology and services delivered might represent a more flexible, and hence long-term, approach to setting universal service obligations and rights.[4] Such an approach would be consistent with current congressional initiatives for deregulation and belief in the market as the most efficient and effective means of delivering services to consumers. However, until decisions are made about what constitutes universal service, and what mechanism will be used to move its subsidies, evaluating the effects on providers of all sorts would be guesswork at best. Even when these fundamental decisions are made, more data will be needed on wireless system costs, wireline upgrade costs, and the extent of the universal service "problem" before these questions can be answered.

  Second, identifying the companies that will bear the cost of providing new levels of universal service, and those that will receive financial

[3] For more discussion of these issues, see Leland L. Johnson, *Toward Competition in Cable Television* (Cambridge, MA: The MIT Press, 1994).

[4] U.S. Congress, Senate, S. 652, *The Telecommunications Competition and Deregulation Act of 1995* (Washington, DC: U.S. Government Printing Office, June 15, 1995).

help in meeting these obligations have already become significant issues. Providers who have traditionally borne public service obligations will be increasingly subject to competition from newer providers who use different technologies and do not carry similar burdens. For example, broadcasters—in return for their free use of the public airwaves—have been subject to public service requirements, while Multichannel Multipoint Distribution System (MMDS) and DBS are not.[5] Cable television systems have been subjected to many types of franchising requirements in return for their use of public rights-of-way; MMDS and DBS are not because they do not use public rights-of-way per se.

From a competitive standpoint, such inequities may skew the ability of different firms to compete, although the extent of such inequities is unclear. For example, "[w]ere the wireless systems taxed and the proceeds used to benefit their wireline competitor in its high-cost area also served by the wireless systems, competition from these wireless systems might be weakened."[6] It may be possible to adopt a consistent set of regulations to guide competition. However, if attempts to reduce technical and regulatory inequities are too broad, they may not work because the inherent capabilities of the technologies are often quite different. Satellites, for example, inherently have national reach, but does that mean they should be subject to franchise fees in every local jurisdiction in the country? At least one analyst has proposed that extending license auctions to new video service providers might be one method for recovering value from the public use of spectrum—eliminating the need for franchise fees and public service obligations—while still allowing different technology systems to compete.[7]

- **In the emerging NII, the role and function of television broadcasters will have to evolve to fit new competitive models.** Broadcasters have played an important role in American life for 50 years. They were long the sole providers of video programming, and have had exclusive access to what has become a very sought-after portion of the radio frequency spectrum. Despite increasing competition from cable television and other smaller programming providers, television broadcasting has remained relatively strong. However, an uncertain regulatory future and new forms of competition from program distributors with far greater capacities have made the outlook for the industry increasingly unclear.

  Even with a conversion to digital technology and the capability to broadcast multiple channels of video and perhaps other (data) services, broadcasters' ability to compete with interactive cable television, telephone company services, DBS, and other wireless broadcasters is unknown. Broadcasters have several advantages in the emerging competitive environment—including programming resources, prime spectrum, local community ties, advertiser-supported free (to consumers) programming, and a broad base of political support. However, they also suffer some significant disadvantages, including a lack of channel capacity and an unfocused vision of what their new role is likely to be. In considering the future of broadcasters, a range of issues must be considered by both the industry and Congress that are beyond the scope of this report. These include national and local ownership rules, allowing

[5] DBS providers were included in a 5 to 7 percent channel capacity public interest set-aside included in the 1992 Cable Act, but that requirement is not being enforced pending court review. The FCC does have a rulemaking examining whether and how DBS should be subjected to programming obligations. Federal Communications Commission, *Implementation of Section 25 of the Cable Television Consumer Protections and Competition Act of 1992, Direct Broadcast Satellite Public Service Obligations*, MM Docket 93-25, 8 FCC Rcd. 1589, para 1 (1993).

[6] Ibid., p. 168.

[7] Johnson, op. cit., footnote 3.

broadcasters to provide nonbroadcast services, and what the impacts would be on viewers if broadcasters stopped broadcasting free over-the-air programming altogether.

## BACKGROUND

The technologies and systems discussed below share a number of important characteristics that will shape their contributions to the NII. First and foremost, the advent of digital technologies lies at the heart of many of the changes now taking place in radio communications. Each of the technologies discussed in this chapter is either in the process of converting to digital technology or is being designed from the outset to work digitally. This switch will fundamentally affect the services companies can offer and at what cost.

Second, many of the systems discussed below were originally designed to be one-way. Although two-way wireless systems are used—satellite networks, for example—and some wireless systems are supplemented by return communications supplied by the telephone network, most use of radio waves for high-bandwidth communications remains concentrated in a one-way broadcast or point-to-multipoint format. It is only recently that companies have begun to develop interactive, broadband wireless networks for the consumer and business markets.

Finally, many of these systems were designed to serve users at fixed sites. The ability to broadcast radio waves over a wide area has proven to be a remarkably efficient way to reach many people quickly, easily, and at relatively low cost. In the future, the low cost and ease of deployment of broadcast technologies will enable them to compete with wire-based alternatives in many markets, especially one-way entertainment programming.

## RADIO BROADCASTING

Radio broadcasting is one of most familiar wireless services. Commercial radio broadcasting began in 1921, and within 10 years, more than 50 percent of all American households had a radio receiver. In 20 years that figure climbed to 90 percent, and today, radio broadcasts blanket almost the entire nation and radio receivers are almost everywhere. The average American home has 5.6 radios, and it is almost impossible to buy a car without a radio—there are nearly 200 million radios in American cars and trucks.[8] People listen, on average, to a little more than three hours of radio per day, mostly while commuting or at work. However, although there are more than 11,000 radio stations operating in the United States today—almost evenly divided between AM and FM—many of these are concentrated in and around metropolitan areas, and the most rural areas of the country may have access to only one or two stations.

Radio broadcasters use a single high-powered transmitter, operating in either the AM or FM frequency band, and a tall antenna to beam programming—including music, local news and information, education, talk radio programs (mostly on AM stations), and emergency information—to listeners in a radius of approximately 25 miles.[9] Because of this relatively limited range, radio broadcasting traditionally has been closely linked to the communities in its broadcasting area. National radio networks also use satellites to share programming. For example, the 25 Native American radio stations use a satellite link provided by

[8] Radio Advertising Bureau, *Radio Marketing Guide and Fact Book for Advertisers 1993-1994*, Dallas, TX, 1994.

[9] Repeaters/translators are used to extend the broadcast signal and serve outlying areas. AM stations are capable of beaming programming over far longer distances at night. The differences between AM and FM radio are significant (see app. A). Amplitude modulation (AM) uses relatively little spectrum—each station needs only 10 kHz—but the signal is easily disrupted by noise and interference (the signal is lost under bridges, for example). Due to poor quality, many listeners have shifted over to FM radio, making it the dominant radio format. Frequency modulation (FM) is more resistant to noise and signal loss, but each station needs a wider range of frequencies (200 kHz) to operate. Although both formats are capable of carrying stereo signals, most FM stations broadcast in stereo and most AM stations do not, and the majority of existing radios are not compatible with AM stereo.

the National Public Radio satellite system toreceive programming through the American Indian Radio on Satellite (AIROS) project. Broadcasters are now trying to broaden their services to include low-speed data transmission that could provide local travel information, as well as supplementary information for advertising and audio programming (see chapter 4). In the future, radio broadcasters will switch to digital technology, and satellites may increasingly be used to deliver radio programming over wider areas.

## ■ Digital Audio Broadcasting (DAB)

The next generation of radio broadcasting will use digital transmission technologies. While no such services are operating yet, broadcasters and startup companies are developing systems that will replace traditional AM and FM modulation techniques with digital signals that will allow thereto broadcast compact disc (CD), or near CD-quality, programming that is more resistant to noise and interference. DAB may also enable new types of information services to be delivered. Consumers will have to replace their existing analog radios with new digital ones to receive the better sound and new information services.

CD RADIO, INC.

*Satellite radio receivers similar to this prototype will have three bands: AM, FM, and.satellite.*

Two types of DAB systems are being developed in the United States. Existing AM and FM radio broadcasters are planning to implement DAB technology using existing radio channels. The new digital signals will be sent simultaneously alongside the analog signals. Meanwhile, a small number of startup companies is developing satellite-based DAB systems that will use new frequencies recently allocated for this purpose.

This divided approach has slowed the development of DAB in the United States, as the two sides have battled bitterly before the Federal Communications Commission (FCC). The result is that in the United States-unlike in many other countries where integrated systems are being planned-digital radio services will likely be delivered by two different kinds of systems: existing broadcasters, who will have to upgrade their facilities, and satellite-based providers, who are building their systems from scratch.[10] The two systems will not be directly compatible, although future radio receivers probably will be able to receive both terrestrial and satellite-delivered DAB as well as existing AM/FM broadcasts. The FCC is still in the process of developing the rules for future DAB services.

### *Satellite DAB*

The idea of broadcasting radio programming directly from satellites dates back at least 45 years.[11] In the 1980s, a small number of companies around the world proposed satellite-based (formally known as Broadcast-Satellite Service-Sound, or BSS-Sound) systems that would use frequencies in the L-band (roughly 1.4-1.6 GHz) to transmit their programming. Because these types of systems would use frequencies other than the tradi-

[10] Some other countries are planning to use new internationally allocated frequencies in the L- or S-bands to deliver DAB services using both terrestrial and satellite transmitters working ma single system.

[11] The concept of using satellites to transmit programming was first described byArthur C. Clarke in 1945. Arthur C. Clarke,''ExtfS-Tenestrial Relays:" *Wireless World,* October 1945. More recently, satellite broadcasting was considered at international Conferences dating back to 1979.

tional AM/FM broadcasting bands, they are often referred to as “”out-of-band’’ or “new band” systems.[12]

The first U.S. out-of-band system was proposed by Satellite CD Radio, now CD Radio, in 1990, and in December 1992, five other companies submitted applications to the FCC to offer satellite radio services.[13] In January 1995, almost exactly three years since the frequencies were allocated internationally, the FCC formally allocated radio frequencies for satellite DAB in the United States.[14] Now the FCC must develop licensing and operating rules to govern the provision of satellite DAB services. The FCC anticipates that this process will last until the end of 1995, and that licenses will be granted shortly thereafter. Once applications are granted and licenses issued, proponents expect it will take about three years to construct and launch the satellites, making service available in roughly 1998-99. CD Radio is currently testing its system using two NASA satellites, and predicts a startup date of 1998.[15]

### Services

Proponents of satellite DAB are planning a variety of programming targeted to audiophiles, users with specific musical tastes, and groups with differing ethnic and cultural backgrounds. These small audiences may not be able to support a local radio station, but when aggregated across the country, make a national service possible. This “narrowcasting” concept is analogous to the programming philosophy of cable television. Satellite DAB may be especially popular in rural areas that lack access to the wide range of programming available in most metropolitan areas. The inherently national nature of the satellite technology, however, means that no locally originated programming—news, weather, or sports—can be transmitted. In addition, for technical reasons discussed below, satellite DAB is being developed primarily to serve radios in vehicles, although other markets are being considered. As currently planned, the CD Radio system would broadcast 30 commercial-free music channels to subscribers who would pay a $5 to $10 monthly fee. Other companies plan to offer some channels on a subscription basis, and others as advertiser-supported programming.

In addition to audio programming, the transmission of data services directly to users is also being explored. Proponents envision broadcasting data services to support educational needs, paging operations, and navigation and traffic management systems for the nation’s cars and highways. Up to 20 channels may be broadcast to support these services.

[12] Although out-of-band systems can technically be satellite or terrestrial, development of out-of-band systems has focused almost exclusively on satellite technologies in the United States. Other countries, including Mexico and Canada, are experimenting with out-of-band solutions using both terrestrial and satellite delivery.

[13] In addition to Satellite CD Radio, American Mobile Radio Corp., Digital Satellite Broadcasting Corp., Loral Aerospace Holdings, Inc., Primosphere Limited Partnership, and Sky-Highway Radio Corp. petitioned the FCC in 1992 to offer satellite DAB. Since then, Loral and Sky-Highway have merged with Satellite CD Radio, leaving a total of four applicants. Carol Horowitz, “DAB: Coming to a Car Near You?,” *Satellite Communications*, October 1994, pp. 38-40.

[14] The frequencies allocated were 2310-2360 MHz. This action was consistent with the position taken by the United States at the 1992 World Administrative Radio Conference. The United States and India are the only two countries to use these frequencies. Other frequencies to be used include 1452-1492 MHz (in Europe, South America, Africa, and, importantly, Canada and Mexico) and 2535-2655 MHz (including Russia, China, and Japan, among others). This means that no common radio broadcasting system will exist across the world as the AM and FM systems do now.

[15] CD Radio has petitioned the FCC for a 319d waiver, which would allow them to begin construction at their own risk prior to receiving a license from the FCC. This would allow CD Radio to begin operating sooner after receiving their license.


CD RADIO, INC.

*Satellite dishes such as these will beam digital quality radio programming up to satellites that will then retransmit it across the country*

## Technology

Satellite DAB systems are conceptually quite simple (figure 5-l). On the ground, large satellite dishes will beam programming up to one or two geosynchronous satellites that will then rebroadcast these signals nationwide. CD Radio, for example, plans to construct and deploy two satellites to be used to deliver its services. Other developers of satellite DAB systems plan to augment the satellites with terrestrial transmitters (so-called "gap fillers") that would improve reception in urban areas (e.g., between buildings and in tunnels). Satellite DAB systems will feature individually addressable radios that will require a signal from the system's operations center to be activated or deactivated. Receiving antennas are silver-dollar-sized discs built into a car's roof. Satellite DAB systems are likely to have difficulty serving radios in homes or offices because the frequencies involved will not penetrate buildings very well. Antennas could be mounted on roofs or windows, but additional wiring would be needed to connect to the radio.

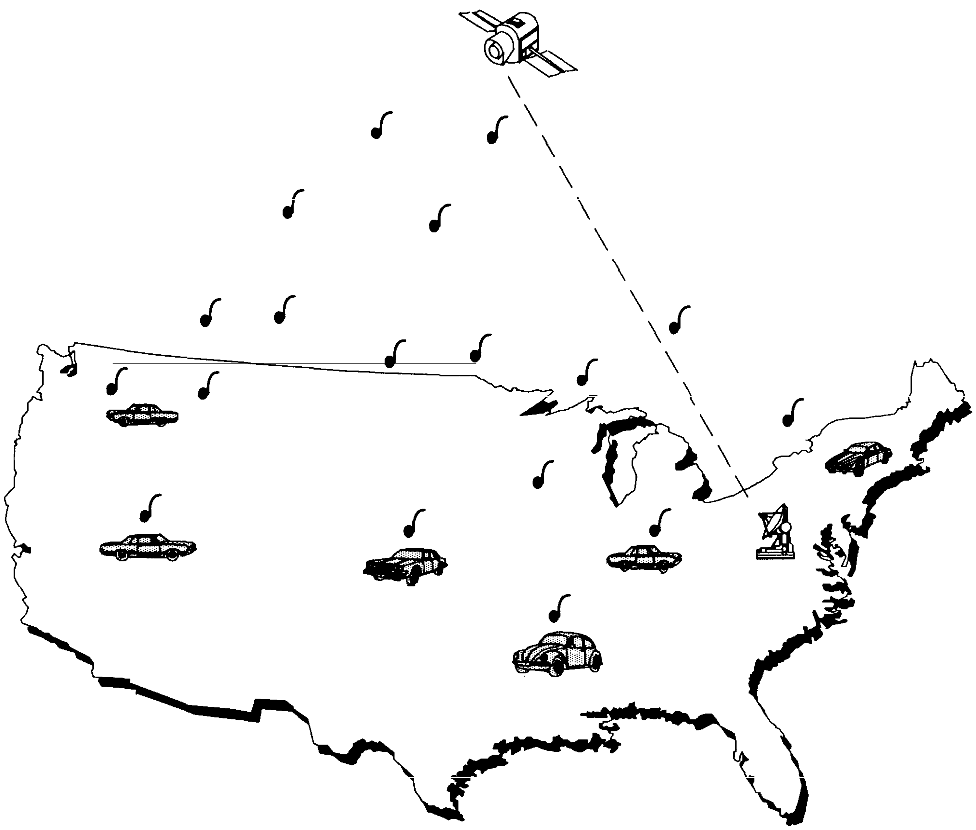
Because satellite DAB will be a new service--an additional choice for consumers rather than a replacement for their existing radios-there are no real transition problems to new satellite DAB technology. For listeners, the important point is that existing analog radios will not be able to receive the new programming; consumers will have to buy new radios if they want digital sound. CD Radio has demonstrated a new receiver that receives the AM, FM, and satellite bands, but this receiver is not yet commercially available.

### *Terrestrial* DAB

In response to local broadcasters' concerns about the transition to digital broadcasting technologies, competition from new satellite services, and the possible effects of these changes on smaller radio stations, several companies began developing digital technologies that would work "in-band" —using the same frequencies currently used by AM/FM stations. This approach would allow existing broadcasters to upgrade their facilities without bringing in new, unwanted competition.

Development of terrestrial DAB in the United States is now focused primarily on in-band, on-channel (IBOC) solutions that will allow a broadcaster to transmit its present analog signal simultaneously with a new digital signal without the two interfering (figure 5-2). No new spectrum is required. This development path indicates that terrestrial DAB is most likely to be treated as an extension or upgrade of existing radio services-better quality, some additional radio-related services and maybe data broadcasts-rather than as a new service like satellite DAB. IBOC will use existing broadcast facilities to a large extent, but will require new digital transmitters and radio receivers. The cost for a radio station to upgrade its facilities is somewhat unclear, but will depend on how advanced and up to date the station's existing equipment is. Estimates put the cost at approximately $50,000 to $150,000 per station; not prohibitive for large market stations, but potentially a

FIGURE 5-1: Satellite Digital Audio Broadcasting



SOURCE: Office of Technology Assessment, 1995

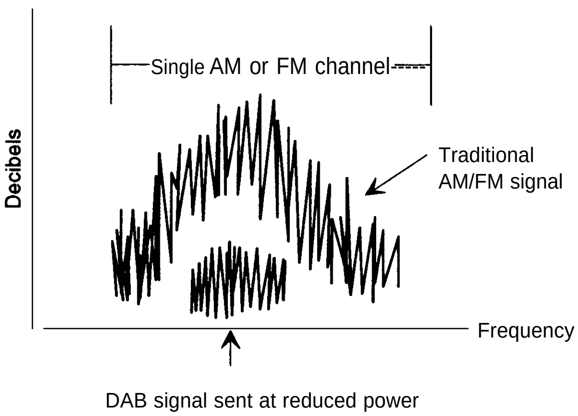
problem for smaller ones.[16] Consumer radios are expected to be expensive initially, but fall into the $50 to $350 range—about the price of current high-end radios-once they are produced in quantity.

Like satellite DAB, the transition to terrestrial DAB should be relatively easy for consumers. Those with older radios will continue to receive the existing analog signal, while newer radios will receive the new digital signal that is transmitted simultaneously. Past technical and institutional issues that divided the industry internally appear to have been largely resolved, and development of a terrestrial DAB standard is progressing. 17 While

[16] Bortz & Company, *Digital Audio Broadcasting: Phase I*, Mar. 4, 1993. Testimony of John R. Holmes, in Hearings before the Subcommittee on Telecommunications and Finance of the Committee on Energy and Commerce, House of Representatives, 102d Congress, Nov. 6, 1991, p. 9.

[17] The Electronic Industries Association (EIA) established a task group in August 1991 to develop a U.S. standard for terrestrial DAB. The group-composed of specific system proponents, manufacturers, and broadcasters—received 11 proposed standards, which were reduced to five by the end of 1992. Testing began in 1993, and EIA now expects to finish in mid-1995. The group will then forward its recommendation to the FCC for consideration as the final DAB rules are developed. Demonstrations of both AM and FM IBOC systems were held at the National Association of Broadcasters convention in April 1995.

FIGURE 5-2: In-Band, On-Channel Digital Audio Broadcasting Systems




SOURCE: Office of Technology Assessment, 1995.

there may be some economic dislocation caused by the switch to digital broadcasting technologies, OTA believes disruption to the industry will be minimal.

## Issues and Implications for the NII

The radio broadcasting industry is now at the beginning of a transition to digital technologies. It seems clear that two different DAB technologies will be deployed: satellite-delivered, out-of-band services and terrestrial systems using IBOC technology. Several regulatory and institutional issues remain unresolved, and competition from alternative programming providers is possible.

### *Demand and Competition*

The primary issue now consuming the DAB industry is the battle between traditional broadcasters and satellite DAB proponents. This conflict has been bitterly fought for the past five years and shows no signs of abating.[18] The conflict is based on different assessments of market demand-no one is really sure how consumers will react to these new services. Traditional broadcasters are concerned that satellite DAB will harm local broadcasters by taking significant audience share-and, hence, advertising dollars-from them and could cause some smaller (and more rural) stations to go out of business. Similar concerns have also been voiced by some FCC commissioners.[19]

Proponents of satellite DAB argue that the economic impacts of satellite systems will be minimal because the systems are expected to serve largely niche markets (audiophiles, special interest groups, and underserved customers). One report states that satellite DAB providers will achieve penetration rates of between 3 and 10 percent of the automobile market nationwide, while others put the figure at between 5 and 15 percent for all radios.[20] Further, some proponents of satellite DAB contend that the health of traditional broadcast radio stations should not be a factor in the FCC's consideration of satellite DAB service.[21]

This is not technically a "one or the other" choice; consumers who subscribe to DAB services will continue to listen to their local stations—just as they switch between AM and FM now. What is unclear is the *extent* to which consumers will treat satellite DAB as a substitute for local programming-the time that they will spend listening to satellite rather than local services. It is this time, translated into market share, that local broadcasters are afraid of losing because of the potential corresponding losses in advertising revenue. Comments filed before the FCC indicate that national advertising makes up only a small portion of a station's total advertising revenue, but it

[18] The National Association of Broadcasted, for example, has promised a "tough fight" against satellite DAB in the licensing and operating rules are developed at the FCC. "FCC Takes First Major Step Toward Satellite DAB *Service, ''Audio Week,* vol. 7, No. 3, Jan. 16, 1995, p. 1.

[19] Comments of Commissioners Ness and Barrett, reported in ibid.

[20] First numbers are from InContext, Inc., *Satellite Radio,* August 1994; second numbers are from Bortz & Company, Op. cit., footnote 16.

[21] "NAB Renews Attack on Satellite Digital Audio Radio," *Telecommunications Reports,* Jan. *9, 1995.*

may be that the loss of even that small amount could force some marginal broadcasters out of business.[22]

In addition to satellite providers, traditional radio broadcasters also face competition from local cable operators, many of whom now offer digital music services using existing cable television facilities.[23] Digital Music Express (DMX) and Digital Cable Radio now offer digital audio services to cable systems nationwide, and DMX is also being delivered via satellite as part of Hughes DirecTV programming (see below). Each offers about 30 channels (to be expanded to about 120 channels) of commercial-free music programming on a subscription basis, but no local or informational programming. Programming packages range from about $11 per month to $75 per month for business users. Although rollout of the service to providers has been relatively rapid, consumer acceptance has been slow. Total penetration rates are now expected to peak at between 5 and 10 percent of cable-served homes. Some analysts believe this may indicate low demand in general for radio services listeners have to pay for.

No firm conclusions can be reached about demand and competition at this time. Doing a prospective analysis of the economic impacts of a new technology is always difficult, and DAB is complicated by current uncertainties in demand and product/service acceptance. Using past technology diffusion and interaction patterns to determine future acceptance and demand—as some industry studies do—is not sufficient for policy purposes. The tradeoff for consumers will be between free local programming with commercials and commercial-free programming that they must pay for. Take-up of terrestrial DAB services may exceed that of satellite services, if only because they are more familiar and can be positioned as an extension of an existing service. Mass market data services may not do well in competition with many other data services (see chapter 4), but services narrowly tailored to radio listeners—auxiliary services like local travel information—may find acceptance.

### Policy Considerations

The deployment of terrestrial and satellite DAB raises some difficult questions for policymakers at the FCC. In the short term, the FCC is wrestling with questions about operating rules. In the longer term, more fundamental questions need to be considered. The most difficult long-term issue facing policymakers is how satellite and terrestrial DAB will affect the local, terrestrial broadcast industry. How can the traditional strength of the U.S. local broadcasting industry be complemented by the new technologies of satellite delivery? How can new forms of competition in radio services be promoted, while acknowledging (but not necessarily protecting) the role and investments of local broadcasters? What might the future structure of the U.S. broadcasting industry look like?

Satellite broadcasting, because it injects new competition into the whole radio industry (not just local competition), could dramatically reshape the broadcast industry in this country. Satellite services could complement local programming, be limited to serving niche markets, or emerge as a substantial competitor to local broadcasters. In some countries—Canada, for example—terrestrial and satellite DAB may develop as complementary parts of one broadcasting system. In the United States, however, it now seems likely that the two industries will remain separate—the established broadcast industry controlling terrestrial DAB, and the new startups controlling satellite services.

Given this context, it appears that satellite and terrestrial DAB will compete on the local level—

[22] See, for example, various comments of CD Radio and the National Association of Broadcasters, before the Federal Communications Commission, *Amendment of the Commission's Rules with Regard to the Establishment and Regulation of New Digital Audio Radio Services,* Docket 90-357.

[23] The information in this section comes from Bortz & Co., op. cit., footnote 16.

radio listening in vehicles—while complementing each other at a broader level—extending coverage, meeting unserved needs. It should be possible to set the rules for satellite and terrestrial DAB such that both industries can thrive. A possible analogy may be the dual nature of cable television—local television stations and cable channels exist alongside “superstations’’ and nationwide cable channels that cater to specific interests. Nationwide DAB services may be able to supplement existing local services in the same way and would also fill in gaps in coverage of various programming formats; not every person in America can get the kind of radio station he or she wants, and not every market has 10, 15, 20 or more stations with a variety of formats available. For a listener in a remote location who would like to hear classical music, a satellite-delivered service may be the only option.

The broadcast industry’s fears that nationwide satellite audio programming will force some radio stations out of business must be taken seriously. When satellite services start up, some smaller radio stations may not survive. On the other hand, satellite DAB proponents argue that development of satellite DAB technology will help the United States maintain its competitiveness in satellite and related broadcasting technologies.

For policymakers the issue is relatively simple, but difficult to solve: do the benefits of nationwide satellite radio services outweigh the loss of a number of smaller, likely rural, local radio stations? Relying on competitive forces is one way to approach the problem, but the social value of these stations may override the workings of the market. If a local station cannot compete, should it be allowed to go out of business, or do the benefits of local information and entertainment call for some kind of protection? Could other local stations (where they exist) take up the slack? The industry should be prepared to present a good case for preserving small stations based not on past history—there can be little doubt of the historical importance of local radio stations—but on the prospects for future performance. Society in the 1990s and beyond is changing rapidly, and the nation’s radio listeners are entitled to a radio system that best meets their needs. The public interest may need to be redefined to include not only local, but also national and international programming and services. Congress should be prepared to address the social value of local broadcasters, and whether that value may outweigh reliance on market-based outcomes alone.

## VIDEO PROGRAMMING SERVICES

Video entertainment programming, which began with broadcast television in the 1940s, has become a pervasive part of American life. In this industry, broadcast and cable television are the dominant suppliers—broadcast television is available to roughly 96 percent of the American public, with cable television passing roughly the same percentage of households, 63 percent of which subscribe. Today, however, a number of wireless systems, as well as telephone companies, are poised to compete directly with cable and, to a lesser extent, broadcasters.[24] A full assessment of the competitive market for video programming services, including smaller local competitors such

[24] FCC definitions specifically exclude current broadcast television companies from this market because they do not provide multichannel service or use a fee-for-service model. The FCC notes, however, that “for at least some viewers, broadcast television service satisfies their demand for video programming.” FCC, *Annual Assessment*, op. cit., footnote 1, para. 98. For purposes of this discussion, OTA takes the view that the aggregated channels provided by multiple local broadcasters essentially represent a multichannel service that does, in fact, compete with basic cable service. The future of multichannel individual broadcasters, as discussed above, also argues for including broadcasters in a future-oriented assessment of video programming services. In addition, by strict antitrust and economic definitions, competition with each of the wireless services discussed will be different because different technology systems offer slightly different packages of services. Because DBS, for example, cannot provide local broadcast programming, it is not a perfect substitute for local broadcast or cable service. DBS does, however, compete directly with the enhanced or premium services offered by cable companies. It is in this sense that competition (although not complete or perfect) is used throughout this section. This position is consistent with views taken by the Federal Communications Commission, *Reexamination of the Effective Competition Standard for the Regulation of Cable Television Basic Service Rates*, Report and Order and Second Notice of Proposed Rulemaking, 6 FCC Rcd 4552-53 (1991).

as low-power television and satellite master antenna television systems (SMATV), is beyond the scope of this report, but several analysts and the FCC have already examined these issues in greater detail.[25] Consequently, this section will focus on the wireless entrants in the video programming market, and assess the technical, economic, and regulatory issues they will face in the coming years.

## Broadcast Television

Broadcasting has been an important component of the nation's communications infrastructure for decades—bringing entertainment and information to millions of people, and having an undeniable impact on the nation's culture. In a sense, television was the first broadband communications service. By using the airwaves, it was possible to deliver hundreds of megahertz of video programming at a time when wired media could not. Today, however, several different technologies—including cable television, DBS, other wireless systems, the local phone companies, and even video rentals—are putting competitive pressure on broadcasters. Over the next decade, broadcasters face the difficult task of managing the transition to a new generation of digital technology.

### *Services*

In one sense, *broadcasting* is a technology—the use of the airwaves to distribute a high-powered video signal over a metropolitan area. But broadcasters do not simply provide a conduit to the home. Their real business is the selection of content for their channel and the sale of advertising time. The more viewers that a station can attract with its programming, the more advertisers will be willing to pay. The content used to attract viewers includes news, sports, and entertainment.

A station's programming can come from three main sources. Some of it, such as much of the station's news programming, is locally produced. If the station is affiliated with a network, the network programming usually arrives at the station over a satellite feed and is then rebroadcast. While it would be possible to distribute programming to stations over high-bandwidth fiber links, satellites are more cost-effective, given the large number of stations to which the programming is distributed and the inherent point-to-multipoint nature of satellite services. Finally, programming can be distributed to the station by independent programmers, who provide programs either on tape or via satellite.

The true value of broadcasting technology lies in its ability to provide universal access to video. Once the television station's tower is in place, almost everyone within the station's coverage area can receive the signal. It costs the station nothing to add additional viewers. By contrast, with wired broadband media, each new subdivision or subscriber requires additional expense. Even after the rapid build-out of cable systems over the past decades, over-the-air broadcasting is still the only universally available source of video programming. Nearly all U.S. households can receive at least one over-the-air broadcast television signal, and nearly 95 percent can receive more than five channels.[26]

The second hallmark of broadcast television is that the service is "free," once the viewer has purchased a television. This is not strictly a consequence of the use of wireless technology. Wireless technology makes it possible for every viewer in a city to receive a video signal; advertiser-supported programming makes the service free. This business model emerged in part because it was considered too difficult or expensive for each station to

[25] FCC, *Annual Assessment,* op. cit., footnote 1. Bruce L. Egan, "Economics of Wireless Communications Systems in the National Information Infrastructure (NII)," contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, November 1994. Johnson, op. cit., footnote 3, ch. 8.

[26] Federal Communications Commission, Office of Plans and Policy, "Broadcast Television in a Multichannel Marketplace," OPP Working Paper Series 26, June 1991, p. 18.

try to recover fees for the service directly from the viewer.[27] Whatever the origins of the business model, however, policymakers in the United States have long attached considerable value to the availability of a video service that is both universally available and free.

Because broadcast television is so ubiquitous and is perceived to have considerable influence on U.S. cultural and political life, policymakers have periodically tried to influence programming content. Efforts to influence what broadcasters show have focused on violence, children's programming, and balance in news reporting. The FCC has the authority to impose standards on broadcasters because the spectrum that broadcasters use is considered to belong to the public. The Commission, acting on behalf of the public, requires broadcasters to meet programming standards as a condition of licensing. The FCC has not imposed similar conditions on programmers who distribute their content through cable because they do not use the public airwaves.

Licensing decisions also focus on the degree to which broadcasters tailor their programming to the community in which they operate, particularly through news and public-affairs programming. The natural coverage area of a broadcaster's signal matches a typical metropolitan area, and "localism" has long been cited as one of the hallmarks of the U.S. broadcasting system. But in practice, broadcasters distribute a mix of local and national programming. Many stations are affiliated with national networks, who pay their local affiliates a fee to broadcast network programming in exchange for the right to sell some of the affiliates' advertising time to national advertisers.

## *Technology*

### Current television technology

Over-the-air television broadcasting was first authorized more than 50 years ago. On July 1, 1941, the FCC allocated spectrum for channels 1 to 13 in the so-called Very High Frequency (VHF) band.[28] Subsequently, a much larger band of frequencies, for channels 14 to 83,[29] was allocated in the Ultra High Frequency (UHF) band.[30] Each of these channels is 6 MHz wide.

Broadcasters transmit their signal from a single antenna on a tower several hundred feet tall. The power output necessary for good reception throughout the city depends on the antenna height, the terrain, and the frequency at which the broadcaster operates. The signal can usually be received upwards of 50 miles from the tower, depending on the type of antenna employed by the user. In part of the coverage area, it may be necessary to use an outdoor antenna to get good reception, but in other areas simple "rabbit ears" are sufficient.

The basic format for transmitting television signals in the United States is referred to as NTSC (National Television Systems Committee), named after the group that developed the system.[31] It was chosen by the FCC as the U.S. national standard in 1941 and has proven remarkably durable. In 1953, color was added to NTSC in a compatible way—old black and white receivers could still receive the new signal. Later,

[27] Ibid., p. 4.

[28] Channel 1 was later reassigned.

[29] Channels 70 to 83 were later reassigned to cellular telephony and other land mobile radio services.

[30] The "very high frequency" and "ultra high frequency" terminology reflects broadcasting's long history. With advances in radio technology, television's frequencies, the highest of which is 806 MHz, are now considered to be at the lower end of the usable spectrum. By contrast, the new PCS services will operate at 2000 MHz (2 GHz), and many other services operate at still higher frequencies.

[31] Two other formats are used for television transmission around the world: Phase Alternation Line (PAL), which is used in Germany and the rest of Europe, and Systeme Electronique Couleur avec Memoire (SECAM), which is used in France, Africa, and Russia, among other countries. The three standards are not compatible.

in 1984, a stereo sound capability was added to the standard. In addition, "subcarriers" within the signal have been exploited for the transmission of closed-captioning information and other services. While the standard has remained much the same for more than 50 years, better camera, production, and receiver technologies have considerably improved the quality of the picture seen in most households

As good as NTSC has been, however, it is highly inefficient in its use of the spectrum. Many of the radio frequencies that are allocated to television cannot actually be used because there would be unacceptable interference between channels. In the UHF band, for example, only nine out of the 55 channels can be used in any given city.[32] On several occasions, the FCC has tried to encourage development of a receiver that would allow use of the unallocated channels, referred to as taboo channels, but their efforts have been unsuccessful.[33] Problems with interference also require that channels not be reused in adjacent cities less than 150 miles away. Even if the station's signal is not strong enough to be received in the next city, it may be strong enough to cause interference.


High-definition television receivers will offer film-quality images, digital sound, and a wider aspect ratio to enhance the home theatre experience.

### Advanced television systems and high-definition television

**In** the mid-1980s, technology advances made it possible to develop a new television format that would offer significant improvements over NTSC. Japanese companies had begun to demonstrate a new high-definition television (HDTV) system that offered better resolution, a wider screen, and better sound. However, the Japanese system was not compatible with NTSC, and required more spectrum than a conventional television channel to deliver the extra information required for a sharper picture. Nonetheless, it was proposed for use in the United States, sparking a vigorous debate that was partly about industrial policy and partly about the future of over-the-air broadcasting.[34]

The FCC has played an active role in the development of HDTV technology. Fearing that the limited spectrum available in the broadcast band would make it impossible for them to compete with other media in the delivery of HDTV, broadcasters petitioned the FCC in 1987 to investigate the implications of HDTV. The FCC responded by opening a Notice of Inquiry,[35] and in November 1987 it established the Advisory Committee on Advanced Television Service (ACATS), which was charged with providing information to the Commission.

ACATS established a testing process to compare the candidate systems. Originally, the systems being proposed were based on analog technology; by 1990, however, new digital compression technologies allowed an HDTV signal to

[32] Federal Communications Commission, *Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service,* Notice of Inquiry, 2 FCC Rcd 5125,5126,5133 (1987).

[33] Ibid.

[34] "Super Television," *Business Week,* No. 3089, Jan. 30, 1989, pp. 56-63.

[35] Federal Communications Commission, *Advanced Television **Systems,*** op. cit., footnote *32.*

be squeezed into a standard 6 MHz NTSC channel, and also allowed use of the unused taboo channels.[36] The number of HDTV system candidates dwindled as proponents dropped out or merged their efforts to develop digital systems. At the end of the ACATS testing process in 1992, there were few differences among the four remaining systems, and the proponents were encouraged to combine their efforts. A "Grand Alliance" was subsequently formed in May 1993, and testing of the Grand Alliance system is scheduled to conclude in late 1995. Once the tests are completed, ACATS will recommend the system to the FCC as a U.S. national standard.

To smooth the transition to HDTV, the FCC has proposed a transition plan that would move the industry and consumers to HDTV over the span of several years.[37] The transition will begin when the FCC picks a standard and assigns HDTV channels to each city in a new *Table of Allotments*. According to current proposals, all current high-power television stations will be eligible for a second channel to be used for HDTV (their original channel will be returned at the end of the transition period). Broadcasters will have three years to apply for an HDTV channel, and by the end of the sixth year are required to be broadcasting in HDTV. After nine years, broadcasters are expected to be simulcasting, showing the same programs on both their NTSC and their HDTV channels. The purpose of the simulcasting provision is to prevent NTSC viewers from being deprived of the opportunity to see the same programming as HDTV viewers.[38] The HDTV and NTSC channels are currently not considered separate services. Before the ninth year, however, broadcasters will be permitted to show different programs on HDTV in an effort to experiment with the capabilities of the new medium or to use specialized programming to attract viewers to the new service. The FCC's preliminary decision is to require broadcasters to return their NTSC channel 15 years from the date that the transition to HDTV begins, but, as with the dates of all of these milestones, this will be reviewed at regular intervals during the transition process.

In part, the FCC schedule is designed to build momentum for HDTV. By specifying a date on which HDTV programming will begin, the Commission is hoping to encourage programmers and equipment manufacturers to invest in the development of the programs and receivers that will be needed for HDTV to be a success. The FCC is attempting to avoid a chicken-and-egg problem in which broadcasters do not begin HDTV broadcasts until sufficient receivers are available and manufacturers do not produce receivers until broadcasts begin. The FCC is using its jurisdiction over the broadcasters to position them as market leaders, hoping that receiver manufacturers, programmers, and other media will follow.[39]

In the past year, the debate over HDTV has shifted. Broadcasters have been quite reluctant to commit to HDTV in any meaningful way because they believe that viewers may not want it—or be willing to pay the thousands of dollars new HDTV sets are expected to cost. Instead, broadcasters have been pushing the more generic idea of digital

[36] By transmitting the video signal in digital rather than analog form, it is possible to do complex mathematical manipulations of the signal in order to reduce the bandwidth requirements. Federal Communications Commission, *Advanced Television Systems,* First Report and Order, 5 FCC Rcd 5627 (1990).

[37] Federal Communications Commission, *Advanced Television Systems*, Second Report and Order and Further Notice of Proposed Rulemaking, 7 FCC Rcd 3340.

[38] Federal Communications Commission, *Advanced Television Systems*, Memorandum Opinion and Order, Third Report and Order, and Third Further Notice of Proposed Rule Making, MM Docket No. 87-268, Sept. 17, 1992.

[39] "In addition, because over-the-air broadcasting reaches more than 98 percent of U.S. households, an ATV terrestrial broadcast system is the medium most likely to bring this technological advance to virtually all Americans. Consequently, it is the medium most likely to result in rapid penetration of ATV receivers and, hence, to contribute to higher sales volumes and eventually lower costs for these receivers." Federal Communications Commission, *Advanced Television Systems,* op. cit., footnote 37.

television (DTV) or advanced television (ATV). These concepts are designed to give broadcasters more flexibility to deliver different kinds of television services—depending on what viewers actually want and will pay for. For example, broadcasters could offer multiple channels of digital television at a level of quality that approximates the current NTSC system, or deliver one HDTV channel, and/or provide advanced information and data services. These issues are currently being discussed at the FCC and in Congress, where the terms and conditions of broadcasters' provision of data services is being debated.

## *Issues and Implications*

### Technology, standards, and spectrum

The main issue facing broadcasters is the transition to next-generation digital technology.[40] The FCC has not issued any rulings on HDTV since 1992, apparently waiting for ACATS to report its recommendation on the HDTV standard that has taken longer than expected to develop. Although the basic elements of a new digital television standard are in place, there are unresolved issues that will have to be addressed by the Commission. One issue is the question of interlace versus progressive scan. Traditionally, television receivers have used interlace scan, in which alternate lines are scanned in each frame, whereas computer monitors use progressive scan, in which all lines are scanned every frame. Because they believe that the distinctions between computers and televisions will blur, the computer industry has been pressuring ACATS to use progressive scan for HDTV. Currently, the Grand Alliance system offers both modes, but the FCC could impose policies that require broadcasters to transmit progressive scan material, to encourage the sale of computer-friendly progressive scan displays.

A second set of technology issues involves efficient use of the broadcast spectrum. From a spectrum management standpoint, there are good reasons to develop policies that would result in the adoption of modern technologies as soon as possible. As long as broadcasters are permitted to continue using NTSC, the broadcast allocation will be underutilized. But new digital television technology, combined with the requirement that NTSC broadcasting cease at some point in the future, would make it possible to use the spectrum more efficiently. It is possible that at the end of the transition process, the entire VHF band would be freed for other uses, such as mobile or new inbuilding communications technologies.

Another spectrum/technology concern involves system architecture—whether to use the traditional model of a single tower broadcasting a high-powered signal, or several smaller transmitters broadcasting at lower power. This latter scheme is sometimes referred to as "distributed transmission" or "cellular television" because each tower broadcasts to only part of the overall coverage area. One advantage of these "single frequency networks" is that towers can be located wherever necessary to tailor coverage; for example, filling in coverage in a valley.[41] But the main advantage of this approach is that it leads to more efficient spectrum use because the same channel can be used in adjacent cities.

Finally, the cost of upgrading to digital transmission technologies is an important issue for broadcasters. Although costs will vary depending on how much digital equipment a station already has (digital film storage and tape playback machines, for example), costs could be high, especially for smaller stations that do not have the

[40] HDTV was, until perhaps two years ago, the preferred acronym. Now, in trying to move toward a more flexible use of the new technologies, broadcasters coined the digital television (DTV) term. DTV is conceived to be broader and more inclusive than HDTV, which is being portrayed as an overly narrow technology mandate.

[41] One single frequency network technology is COFDM (coded orthogonal frequency division multiplexing). Its consideration was mentioned in the FCC's last Report and Order, op. cit., footnote 38, but it is not currently part of the Grand Alliance system.

advertising revenues of stations in larger markets. Broadcasters will have to buy new antennas, towers, and production equipment. The cost of adding basic HDTV capability—allowing a station to "pass through" network programming and add local commercials, but not originate any local programming—has been estimated to be between $1.3 million and $2.2 million per station.[42] The cost could be significantly higher for the estimated two-thirds of all stations that would need to build a new tower for HDTV broadcasting.[43] Stations will also incur higher costs to buy the production and studio equipment needed to originate programming in an HDTV format. However, the ability to pass through network programming will meet the FCC requirements outlined in its transition plan.

### Demand

In recent years, broadcasters have begun to question whether there is enough demand for HDTV to warrant the expensive technology upgrades that would be required to provide it. It is unclear how many viewers will be willing to pay the (initially) high cost of HDTV receivers to receive better pictures. The advantages of HDTV are most apparent on large screen displays, which are inherently more expensive. Because their service is not by subscription, broadcasters will be unable charge viewers extra for a premium HDTV service, as would a cable company. Nor will they capture any of the revenues from the sale of HDTV receivers. In the 1950s and 1960s, NBC used the transition to color in part to spur the sales of color receivers produced by its parent, RCA.

Faced with what they perceive to be high costs and low demand, many broadcasters are actively resisting the mandated transition to HDTV. Instead, they argue, they should be allowed to use the spectrum more flexibly to offer multiple digital channels (instead of just one HDTV channel) or even other services, such as data transmission. Such uses, industry representatives point out, could increase spectrum efficiency, enhance diversity, and provide a way to offset the cost of deploying any new technology the FCC requires. The debate over what the FCC should require now occupies center stage in the digital television/HDTV debate. There is concern that broadcasters are being forced by the FCC in a direction that consumers will not want to go—HDTV.[44]

The viability of HDTV is, in part, a separate issue from the question of whether the FCC should encourage broadcasters to adopt digital broadcast technology. If HDTV is not considered to be viable, one option is "multicasting," the use of the digital channel to broadcast multiple standard-definition channels (SDTV). The same technology that squeezes a high-definition signal into a single channel can also be used to transmit four or more standard-definition signals. Viewers could continue to use their existing television sets, but would need a set-top box to translate the digital signal into the NTSC format understood by their television. This box would be much less expensive than an HDTV receiver, most of whose cost is in the display, not the decoder. The additional channels could provide broadcasters with additional revenue sources (through subscriptions, perhaps) and provide an incentive to move to more

[42] National Association of Broadcasters, *NAB Guide to HDTV Implementation Costs* (Washington DC: NAB, 1993), p. 39.

[43] Ibid., p. A-7.

[44] "What also comes through in the industry's comments, however, is trepidation—and understandably so. After all, the Commission is *mandating* the development of this new technology in only one sector of the video marketplace: broadcast television. Other segments of the industry—program producers, film studios, cable programmers, DBS providers— can elect to watch from the box seats as the broadcasters enter the Colosseum. While shouldering only a fraction of the risk, they will have the luxury of awaiting the answers to the fundamental questions that broadcasters, and the Commission, must grapple with today: Will consumers rally around high-definition? Will compellingly crisp pictures and sound make HDTV indispensable to America's 90 million television households?" Statement of Commissioner Ervin S. Duggan, federal Communications Commission, *Advanced Television Systems,* op. cit., footnote 38.

efficient technology. This is, in fact, the strategy now being pursued by cable, wireless cable, and satellite companies (see below), that are converting to video distribution systems that use digital transmission technologies and set-top decoders to deliver services to current analog televisions. However, manufacturers who have invested in the development of HDTV receivers and production equipment are opposed to standard-definition multicasting. In addition, this strategy would perpetuate the use of NTSC's interlaced display technology, which is opposed by the computer industry.

In addition to multicasting more video programming, broadcasters are considering many other services that could be delivered over a high-bandwidth digital channel. These include data delivery or paging. As a wireless medium, broadcasters can quickly deliver services to locations that do not have wireline facilities and to mobile users. But because these services are not seen as being part of the broadcasters' traditional service, the ability to use spectrum in this way is seen by some as a windfall. The issue of "flexible use" of broadcast spectrum was debated in the last Congress, and in the current Congress, proposed legislation would give broadcasters the freedom to offer "ancillary and supplementary" data services, subject to certain restrictions. The meaning of "ancillary and supplementary services," however, will have to be defined by the FCC. Broadcasters would have to pay a fee for spectrum used for these services.

### Competition and the role of over-the-air broadcasting

Broadcasters' main business—programming a channel and selling advertising—is no longer completely tied to broadcast technology as its sole means of distribution. While over-the-air broadcasting made the television business possible, today more than 60 percent of households now receive broadcasters' programming over cable and some rural viewers receive programming directly from satellites.[45] While new cable programming competes with broadcasters for advertising dollars, cable technology is also an essential conduit for broadcasters to reach viewers. For this reason, the terms under which cable systems carry broadcast signals have been the subject of intense policy debates and negotiations between networks and cable providers.[46]

To some extent, the fate of broadcasters as programmers (creating and selling programming) may be separate from their role as program distributors. Whether or not over-the-air broadcast technology will continue to be a significant mode of distributing entertainment programming depends on a variety of factors. While wireless technology was a good way to deliver television service quickly to all of the people in a metropolitan area, there is a limit to the amount of available spectrum. By contrast, the cable and telephone companies are rapidly upgrading their distribution plant to deliver an even wider range of programming; over the past decade, there has been significant growth in the number of viewers preferring to receive programming using cable or other "multichannel" services such as DBS or wireless cable. In addition, many of these companies are proposing new interactive services that may attract even more subscribers. Even with digital compression and multicasting, it is unlikely that broadcasters will be able to match the number of channels or range of services these other providers will offer, unless more spectrum is made available to individual stations—an unlikely prospect.

Some have suggested that if other distribution media were to provide programmers with satisfac-

[45] Viewers can only receive network programming via satellite if they cannot get a broadcast signal or have not recently been a cable subscriber. For those viewers who qualify, packages of network programming are available to C-band system owners from NetLink and PrimeTime 24. DirecTV/USSB owners are subject to the same qualifications.

[46] See, for example, Federal Communications Commission, *Amendment of Part 76 of the Commission's Rules Concerning Carriage of Television Broadcast Signals by Cable Television Systems,* Report and Order, MM Docket No. 85-349, Nov. 28, 1986.

tory access to the viewing audience, it is conceivable that broadcasters could choose to stop distributing programming over the air altogether. If this were to occur, there would be difficult questions about the fate of remaining viewers who still relied on free over-the-air broadcasting. Currently, however, control over their own distribution medium provides broadcasters with significant advantages. They can sell advertisers access to the 40 percent of households that do not have cable, as well as to a significant number of second televisions in cable households that are not connected to cable. In addition, their status as broadcasters entitles them to carriage on cable systems by "must carry" regulations. Other programmers have to compete to be included as one of a cable system's channels.

## Alternative Video Service Providers

The market for video entertainment programming is becoming increasingly crowded and competitive. Broadcasters face competition not only from cable television providers, but also from a small—but growing—number of companies that use radio-based technologies to provide similar services. Recently launched DBS services bring hundreds of channels of premium and pay-per-view programming to subscribers, and terrestrial wireless systems promise similar, if fewer, services. Telephone companies are preparing to enter the video distribution market by upgrading their own wire-based networks, but also through the use of wireless.

The emergence of these new wireless distribution technologies is undercutting the traditional preeminence of the television networks and local broadcast stations, and could provide substantial competition for cable television as well. Wireless companies provide, or plan to provide, programming packages similar to those offered by cable television, and each of the alternatives has brought competition for viewers and advertising dollars. Some analysts expect new wireless services to be the main source of competition to cable television and broadcasters in the market for alternative video programming—not the local telephone companies that have been planning and fighting for the right to offer video programming for years.[47]

### *Multichannel Multipoint Distribution Service (MMDS)*

MMDS providers, commonly known as "wireless cable," offer entertainment programming services in competition with traditional cable television providers. To date, the industry has grown very slowly in the United States, amassing only 750,000 users—served by 175 systems—across the country.[48] In recent years, however, growth has picked up noticeably, and individual companies have been successful in some local markets. Industry representatives predict that by the end of 1995, the number of subscribers will more than double to 1.8 million viewers served by 200 systems, and by the year 2000 analysts expect wireless cable systems to be serving between 3.2 million and 4 million subscribers and earning between $1.5 billion and $2 billion in annual revenue.[49] Other countries are installing wireless cable systems instead of wired systems because of its lower costs and faster installation times.

MMDS providers use low-power microwave signals broadcast from a central tower to deliver their services. No local franchise is required. Programming packages typically include movie channels like HBO, premium programming (Disney channel), some local broadcast stations (and national "superstations"), and pay-per-view. Wireless cable providers, however, do not pro-

[47] Johnson, op. cit., footnote 3.

[48] Much of this paragraph is based on materials provided by the Wireless Cable Association International.

[49] Andrew Kreig, Wireless Cable Association International, personal communication, March 20, 1995; Louise Lee, "Wireless Cable-Television Sector Is on Acquisition Binge," *The Wall Street Journal*, June 8, 1994; Tom Kerver, "The Wild World of Wireless Video," *Cablevision*, May 23, 1994.

duce their own programming, such as local news or sports. To receive the MMDS signal, subscribers must purchase about $200 worth of equipment, including a rooftop antenna, signal converter, and a set-top box, and pay a monthly service fee roughly between $17 (basic package) and $25 (basic plus one premium channel).[50] The major advantage of MMDS over cable and DBS is the low initial construction costs-$1 million to $2 million for the tower and transmitting equipment—no expensive satellites to build and launch, and no expensive cable to lay. This lower cost structure is what allows MMDS providers to charge less for their services (although usually for fewer channels).

MMDS systems operate at 2.6 GHz, limiting them to line-of-sight delivery, and use analog transmission to deliver video to consumers.[51] The number of channels used (and offered to consumers) by individual MMDS providers varies. FCC rules allow MMDS companies to use up to 33 channels, but only 10 of these channels are dedicated to MMDS. Twenty of these channels are allocated to the Instructional Television Fixed Services (ITFS), and another three are allocated to the Private Operational Fixed Service. ITFS license-holders will often lease some or all of their capacity to a local MMDS provider, or the channels can be shared by time of day. Complex rules govern sharing between the three services, resulting in a situation where not all 33 channels are available to MMDS providers in all markets.[52] This is likely to hamper the ability of MMDS providers to compete effectively in some areas.


*"Wireless cable" systems will provide consumes with another choice in the increasingly competitive multi-channel video distribution market.*

Over the last several years, the MMDS industry has grown considerably and is now preparing for serious competition with other video service providers--- cable, DBS, and Local Multipoint Distribution System (LMDS) (see below). Rapid consolidation has taken place as companies seek to develop the economies of scale and cost advantages that will bolster the industry's competitive position.[53] Until three years ago, MMDS companies were often denied access to programming—or charged exorbitant rates-by many video programmers who were owned by or locked into contracts with cable television companies. In 1992, Congress passed the Cable Act, which pro-

[50] John Ramsey, "MMDS: The Advent of Latin American Pay TV," *Satellite Communications,* p. 17, August 1993; Kreig, op. cit., footnote 49.

[51] Specific frequencies are 2500-2655 Mhz and 2655-2690 MHz. Line-of-sight restrictions, including blockages by trees and buildings, may be overcome by technological advances that will allow the signals to be "bent" but to date they have limited MMDS to relatively flat topography. MMDS systems' range is about 30 miles.

[52] Bennett Z. Kobb, *Spectrum Guide:Radio Frequency Allocations in the United States,* 30 MHz-330 GHz (Falls Church, VA: New Signals Press, 1994), pp. 149-151.

[53] Lee, op. cit., footnote 49.

hibited video programmers from discriminating against program distributors like MMDS and DBS.[54] The Cable Act opened up access to programming that had been held back for many years, and allowed the wireless companies to compete more effectively and evenly on product and price.

In addition, the MMDS industry is now developing digital compression schemes that are expected to increase the number and variety of channel offerings, perhaps allowing providers to offer as many as 200 channels. A digital upgrade could also enable MMDS providers to offer interactive programming. Also, the ITFS service has channels specifically identified as "return" or "response" channels, allowing voice and data communications to be sent back to the broadcaster.

As a result, wireless cable has become a more attractive technology choice for both consumers and suppliers. Pacific Telesis recently announced plans to acquire a wireless cable company in Southern California, and Bell Atlantic/NYNEX will team up to invest in another MMDS provider.[55] These companies see wireless cable as a way to deliver advanced digital video services to their customers until they can upgrade their existing telephone systems to carry video signals. This allows them to enter the video programming distribution market significantly faster than waiting for new fiber optic systems to be installed. This strategy is a preemptive response to cable company provision of telephone services later in the decade.

## *Satellite Television Services*

Satellites have been an integral part of the communications infrastructure since the first communications satellite, Hughes' Early Bird, was launched in 1965. Early satellites transmitted telephone calls across the Atlantic Ocean, and were soon used to distribute television programming to network affiliates across the country. Today, satellites deliver video programming directly to over 5 million people.

### C-band and Ku-band satellites

C-band satellites have been carrying television programming for more than 20 years. These satellite systems were primarily designed to distribute programming from television networks to their local broadcast affiliates, and premium cable channels (HBO, Discovery, and Disney) and television "superstations" to cable television systems across the country. However, in the early 1980s consumers began putting up their own dishes—so-called backyard dishes—to receive the programming directly.[56] Today, satellite television services provide video, data, and music services, mostly to people in rural areas where broadcast and/or cable do not reach. By 1994, there were about 4.5 million backyard satellite dishes in use in the United States, roughly 3 million of which are in areas with access to cable television.[57]

C-band systems account for the bulk of consumer satellite TV systems.[58] Consumers use 7-to 10-foot-diameter dishes, costing from $2,000 to $3,000 installed, to receive analog video signals from geostationary satellites in orbit 22,300 miles above the Earth. C-band dish users can receive approximately 150 free, unscrambled signals and roughly another 100 scrambled channels, such as HBO, can be ordered through various program packagers for a monthly subscription fee. The

[54] The Cable Television Consumer Protection and Competition Act of 1992, Public Law No. 102-385, 106 Stat. 1460 and codified at 47 U.S.C. section 151.

[55] "PacTel To Buy Tiny Wireless-Cable Firm For $120 Million To Speed Video Project," *The Wall Street Journal*, Apr. 18, 1995, p. A4.

[56] These satellite receiving dishes are also referred to as "home satellite dishes" and "television receive-only dishes. At first, the programming transmitted over satellites was unscrambled and free to anyone with a receiving dish. Soon, however, programmers began scrambling their services and charging for use.

[57] Johnson, op. cit., footnote 3, pp. 115, 151.

[58] Most cable programming services still use C-band for program delivery.

number and types of programming packages available vary widely, but for about $25 a month, a subscriber can receive approximately 25 basic cable channels and eight movie channels, in addition to the 150 free channels. These systems also use subcarrier frequencies to offer multiple channels of audio, such as music and talk radio stations. C-band services also provide data services for an additional fee. By attaching a data terminal to their home equipment, customers can receive a host of information services, such as financial information, stock updates, and specialty services.[59]

Ku-band satellite services use higher frequencies that allow smaller dishes, and are used mostly by businesses, broadcast and cable companies, the government, and others to supply private communication networks. These networks often use very small aperture terminals (VSATs) to link far-flung company sites (see chapter 4). Ku-band satellites also provide commercial radio and television distribution, teleconferencing, private data networks (such as remote credit card verification), high-speed image transmission, distance learning, international and domestic long-distance telephone transmission, and other services. In addition, Ku-band satellites have helped establish telephone service for remote and/or less developed countries.

#### Direct broadcast satellite (DBS)

DBS systems represent the next evolution of satellite-delivered television.[60] DBS was originally conceived to serve households not passed by cable, but as that number shrank from 18 million in 1984 to approximately 4 million in 1992, services were targeted more directly at existing cable markets.[61]


DAVID WYE

*High-power DBS satellites allow receiving dishes, seen here on the corner of the garage roof, to be quite small.*

The FCC authorized DBS service in 1982, and established rules for the service that regulate it not as a broadcasting or common carrier service, but according to its own rules. Despite support from some large companies, all early attempts to establish a successful DBS venture failed. The satellites for the new service were very expensive to build and launch, premium programming was difficult for some providers to obtain, and consumer demand was low—the systems could only transmit a half dozen channels.

In the past four years, however, two new DBS systems have begun offering packages of video programming, as well as pay-per-view events, directly to consumers' homes. These new systems use high-power and digital technology to provide a wide selection of programs and CD-quality sound, using smaller dishes than traditional large-

[59] Hary Thibedeau, Satellite Broadcasting and Communications Association, personal communication, Jan. 20, 1995.

[60] Direct Broadcast Satellite (DBS) technically refers to a specific type of high-powered satellite operating in the 12.2-12.7 GHz(Ku)band. This was the way that most analysts and policymakers thought video programmming would be delivered directly to consumers when the service was established in 198l, and the name has gained widespread acceptance.Primestar, discussed below, is not technically a DBS system, because it uses a lower powered Ku-band satellite that operates according to the FCC's Fixed Satellite Service rules. For purposes of clarity, Primestar will be discussed in this section because it provides the same services historically ascribed to DBS.

[61] Johnson, op. cit., footnote 3.

dish satellite TV. Although the systems should appeal most to users who cannot receive cable television or have chosen not to subscribe, early indications are that the market for such services may be much broader. Initial sales of DBS services have exceeded expectations, with nearly 750,000 subscribers signing up in the first year of operation. Some DBS proponents have interpreted these figures to indicate consumer discontent with cable television providers. Various types of direct-to-home satellite services are being developed around the world.[62]

Conceptually, DBS systems are quite simple (figure 6-3). Programmers send their material to a central facility similar to a cable system's headend, where the programming is compressed and sent up to orbiting geosynchronous satellite(s). The signals are then broadcast over the United States for reception by the user's receiving dish. From the dish, a cable feeds the programming to the set-top receiver, which decodes the compressed programming and records billing information for pay-per-view (PPV) events. One system remotely polls the subscriber units each month (via phone-line connection) to collect the billing information.

Despite the advantages offered by DBS—including national coverage, high-quality sound, and wide selection—the systems suffer some competitive disadvantages as well. Perhaps the biggest is that the receiving dish must have a clear line-of-sight to the satellite in the southern sky with no obstructions such as tall trees, mountains, or buildings. Analysts estimate that 50 percent of all U.S. households, including apartment buildings, have this capability, meaning that the other 50 percent cannot receive DBS programming at all.[63] The other significant disadvantage, which some consumers are apparently still unaware of, is that the systems cannot carry local programs, and most DBS customers cannot get network programming (ABC, CBS, NBC, FOX, and PBS) at all. The Satellite Home Viewers Act of 1994 allows subscribers to receive network programming only if the consumer cannot receive it off the air, and if they have not subscribed to cable in the last 30 days.[64] Finally, the systems are not expected to be able to offer true video-on-demand services (in which the user can control "Stop," "Review," and "Search" functions) in the near future, although they do offer near video-on-demand in which movies begin every 15 minutes or so. The nature of the broadcast satellite beam combined with the large number of subscribers makes it currently infeasible to dedicate a single channel to an individual subscriber.[65]

Two systems offer direct-to-home services today—Primestar, owned by a consortia of cable companies and GE American Communications, Inc.; and Hughes' Communications Galaxy DirecTV/United States Satellite Broadcasting

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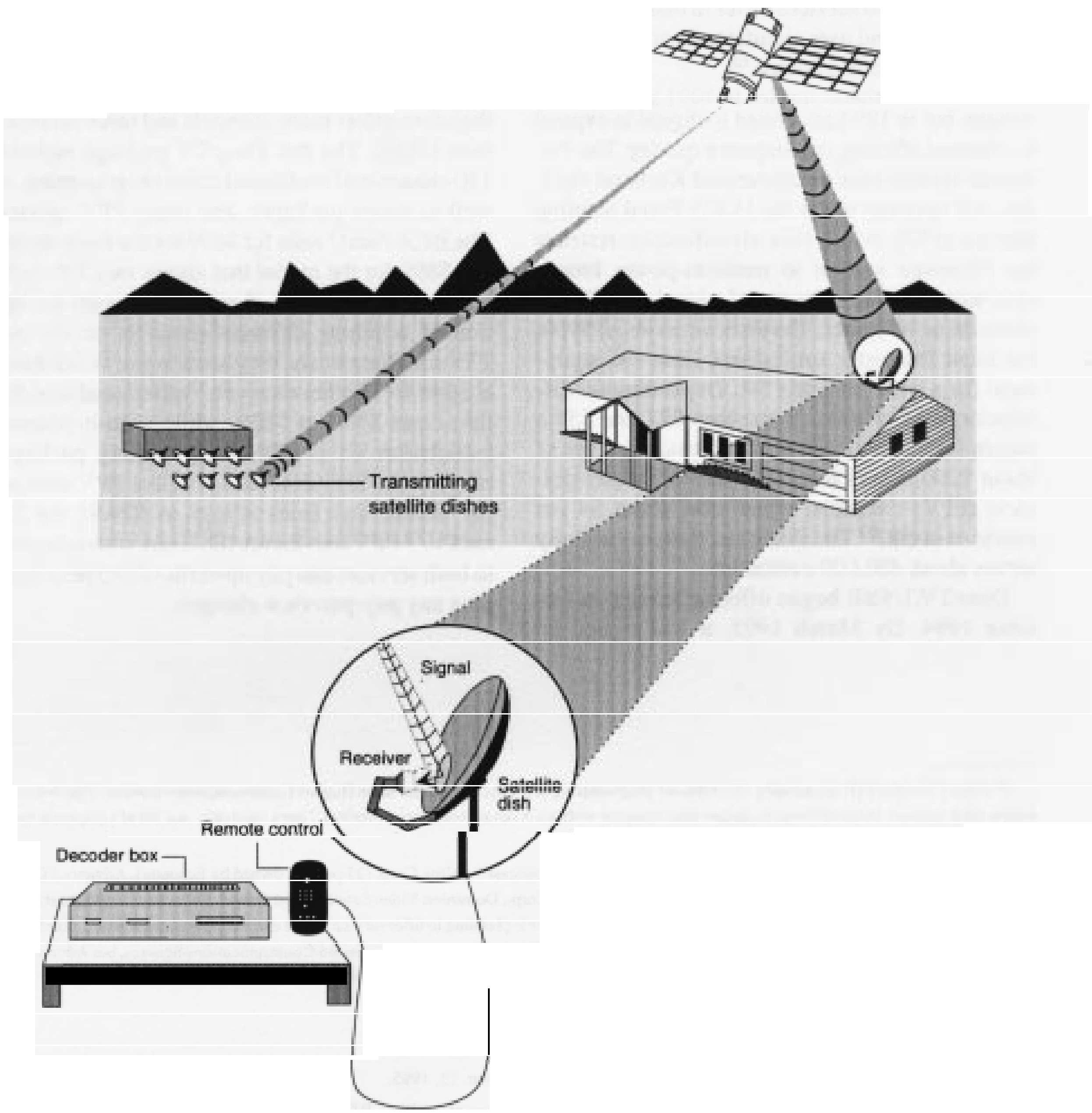
[62] For an overview of these activities, see Michael S. Alpert and Marcia L. De Sonne, *DBS: The Time is Now,* (Washington, DC: National Association of Broadcasters, 1994).

[63] Satellite Broadcasting and Communications Association, presentation to OTA staff, Apr. 7, 1994. The number of single-family homes affected is likely to be significantly lower.

[64] Satellite Home Viewer Act of 1994, Public Law 103-369, Oct. 18, 1994. Dawn Stover, "Little Dish TV," *Popular Science,* January 1995. One company, Local DBS, Inc., has proposed to use spot beams to relay local programming to viewers. See Alpert, op. cit., footnote 62.

[65] Johnson, op. cit., footnote 3.

[redacted]




SOURCE: Office of Technology Assessment, 1995.

(USSB), which uses RCA's Digital Satellite System (DSS).[66] Other companies have received licenses for DBS, but are not yet operating.[67] Although the two services differ in many respects, each is digital and uses significantly smaller sized dishes than C-band systems.[68]

Primestar initiated service in 1991 as an analog system, but in 1994 converted to digital to expand its channel offering and improve quality. The Primestar system uses a commercial Ku-band satellite, and operates under the FCC's Fixed Satellite Service (FSS) rules. This classification restricts the Primestar system to medium-power broadcast, which requires the use of a receiving dish of either 36 or 40 inches. The dishes cost about $900, but most Primestar subscribers lease the equipment for a small monthly fee. Depending on distributor, subscribers pay between $21 and $54 a month for 77 channels, plus an installation fee of about $200. Users receive a number of pay-per-view (PPV) channels, which cost about $4 per movie or event.[69] The Primestar system currently serves about 400,000 customers.

DirecTV/USSB began offering service in October 1994. By March 1995, it had signed up 500,000 customers, and expects 3 million by 1996 and 10 million by 2000.[70] The system uses two satellites in geosynchronous orbit, compared with Primestar's one,[71] and broadcasts at higher power, resulting in a smaller (18 inches) receiving dish.[72] DirecTV controls the majority of the capacity on the Hughes satellites (27 of 32 transponders), and therefore offers more channels and more diversity than USSB. The full DirecTV package includes 150 channels of traditional cable programming, as well as sports packages, and many PPV options. The RCA dish[73] sells for $699 for the basic model and $899 for the model that allows two TVs to be hooked up. However, if consumers want the option of watching different channels on the two TVs simultaneously, they need to pay an additional $649 for another receiver. Professional installation costs $150 to $200, while a do-it-yourself installation kit is $70. Programming packages range from $17.95 to $34.95, plus PPV charges for USSB, and from $21.95 to $29.95 for DirecTV.[74] PPV movies are $3. Users who subscribe to both services can pay upwards of $65 per month plus any pay-per-view charges.

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[66] DirecTV and USSB are actually two separate programming services, but use the same Hughes Communications satellite. The two companies offer services that complement, rather than compete with, each other (with some overlap). Users need only one set of equipment to receive both services, and many subscribe to both.

[67] Other potential DBS providers include: Echostar, Direct Broadcast Satellite Corp. (25 percent owned by Echostar), Advanced Communications Corp. (Tempo holds their license), Continental Satellite Corp., Dominion Video Satellite, and Tempo. Echostar is the furthest along—satellites are built and programming alliances are in place. Alphastar is planning to offer service by the end of 1995 using an AT&T fixed service satellite. Primestar was planning to transition to true DBS through Tempo's control of Advanced Communications licenses, but Advanced was turned down by the FCC for a license extension, putting Primestar's DBS plans in jeopardy.

[68] Stover, op. cit., footnote 64.

[69] Ibid.

[70] Eric Schine, "Digital TV: Advantage, Hughes," *Business Week*, Mar. 13, 1995.

[71] Due to differences in orbital spacing between these two classifications of satellites, BSS satellites are less susceptible to interference from adjacent satellites. This difference, along with their higher power, allows DSS systems to use smaller dishes.

[72] The Primestar system broadcasts at 45 watts, whereas the two DSS satellites broadcast at 120 watts.

[73] RCA has an exclusive license to manufacture the equipment for 18 months after the launch date or until one million units are sold, whichever comes first. After this point, Sony will enter the market with its dishes.

[74] In addition to the standard packages, DirecTV offers a $5.95-per-month package consisting of only one channel, but it allows subscribers to select the full complement of specialty sports packages and pay-per-view options. Some of the specialty sports packages offered by DirecTV are the Golf package, for $6.95 a month, the NFL season package for $119.95, and the NHL season package for $69.95.

## *Issues and Implications*

### Competition

The historic context for video programming services, and for the emerging NII specifically, is clearly based on competition. The video programming market is in its infancy, but already shows signs of becoming quite competitive.

> Any investigation of competition and public policy in such a dynamic arena [video programming] is handicapped by uncertainties about future technological advances and social needs. The only certainty is that surprises are in store. Before the end of the decade, we must anticipate achievements and disappointments going far beyond anything foreseeable in this monograph... Fortunately, these developments do not critically depend on the widespread deployment of any one technology or on the success of particular firms. The possibilities are so numerous, in terms of alternative technologies and the roles of diverse firms, that the public will benefit almost regardless of which path is taken through the maze. The challenge for public policy is to facilitate and to guide this dynamic process in ways that maximize these benefits.[75]

Congress demonstrated its commitment to competition in the 1992 Cable Act, where it expressed its preference for competition over rate regulation and its belief that the promotion of competition through new distribution technologies was critical.[76] The FCC has now taken over the congressional mandate to encourage competition in video services.[77] In September 1994, the FCC concluded that, despite substantial growth in alternative delivery systems, competition in multichannel video programming still did not exist for most Americans. Competing cable systems are still few in number, local telephone companies are only operating experimental video-delivery systems, and wireless competitors still do not have enough subscribers to make the market truly competitive.[78] The FCC further concluded that lowered entry barriers—to let more competitors enter the market—were likely to lead to significant benefits for consumers. Even if competitors do not actually enter the market, the threat of competition may provoke incumbents to improve services and cut costs.[79]

It now seems likely that, as the video programming market matures and technology continues to advance, services and providers will become increasingly differentiated. In part, this will be due to the different capacities and characteristics of the systems noted above. Provision of video programming packages may continue as the "core" market, but ancillary markets will form as well. Because the technology systems discussed above are not perfect substitutes for each other—some national, some local; some more interactive than others—they are likely to compete in the core market, but not necessarily in the splinter markets. The result will be that consumers will have a wider array of choices—that are more likely to match their needs more closely—than in the previous era of broadcast television's "one size fits all." It will be difficult to generalize policy nationally when competition will vary from location to location. Much more research will be needed to determine the nature and effectiveness of competition in these highly diversified markets.

The transition to future services, such as HDTV and interactive applications, will be a substantial

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[75] Johnson, op. cit., footnote 3, pp. 187, 179.

[76] The Cable Television Consumer Protection and Competition Act of 1992, Public Law No. 102-385.

[77] The Federal Communications Commission undertook several actions in response to congressional mandate in the act. See Federal Communications Commission, *Implementation of Sections 12 & 19 of the 1992 Cable Act—Development of Competition and Diversity in Video Programming Distribution and Carriage*, First Report and Order, MM Docket 92-265, adopted Apr. 1, 1993; FCC, *Annual Assessment*, op. cit., footnote 1.

[78] FCC, *Annual Assessment*, op. cit., footnote 1, at para 15.

[79] Glenn A. Woroch, "The Evolving Structure of the U.S. Wireless Communications Industry," contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, December 1994. Johnson, op. cit., footnote 3.

issue for alternative video providers. Satellite service providers have said they are capable of and will provide HDTV if demand warrants it. Like other video providers, however, they are not rushing to HDTV. From a consumer's standpoint, HDTV may be viewed not as revolutionary, but as an upgrade—like color television. Because demand for HDTV is so uncertain, some analysts have called on the FCC to rethink its policies toward it.[80]

Interactive services are also likely to pose a competitive challenge for the video providers discussed in this section. Today's companies are primarily one-way providers of entertainment programming. Cable companies, however, are rapidly positioning themselves as information service providers as well. For example, several offer Internet access—something one-way services cannot do. It seems likely that the market for multichannel video programming will splinter as different technology systems exploit their technology and regulatory status, but it is still unclear which of these providers might begin to offer interactive services and when.

### Technical constraints

Today, the primary technical challenge facing video service providers is the conversion to digital technology or the upgrading of digital capabilities to improve capacity and service. Because most systems are up and running (or are expected to be soon), technical concerns are not expected to substantially slow or stop the development of new services. Providers' use of different technologies, however, entail limitations or restrictions on what the systems can do and the services they can offer. Such differences are the basis of the competitive diversity of the industry.

As the industry matures, technical and regulatory differences will become more important. Programming limitations—due to lack of capacity or regulation—may hamper some providers' competitive positions. Satellite TV providers, for example, cannot deliver local programming because of technical limitations, are severely limited by regulations in the number of customers they can deliver network programming to, and will not likely be able to offer true video-on-demand due to capacity constraints. MMDS providers will likely continue to have fewer channels compared with their cable and satellite rivals. Individual broadcasters, too, will only be able to offer a limited number of video channels—even the aggregate of all local television stations' digital channels will be unable to match the hundreds of channels offered by cable and DBS.

Another technical constraint for MMDS, LMDS, and most satellite providers is the limitations of line-of-sight transmission. The number of people that can actually be served by wireless systems may be considerably less than first thought due to these physical constraints. Technology advances and better engineering are expected to alleviate some, but not all, of the limitations of line-of-sight systems.

Many alternative video programming providers are also affected by restrictions that have been placed on receiving antennas and dishes. Despite FCC regulations preempting local zoning ordinances and rules, many localities and homeowners associations continue to enact local regulations in violation of FCC rules.[81] Chapter 8 discusses these issues in more detail.

### Integration and concentration issues

The economics of the wireless video programming industry will not be fully discussed here. Rather, this section will identify some of the issues that may affect the industry as it matures. Policymakers are concerned about the extent to which the competition and the diversity it implies can be sustained over the long term. Because it is still a young industry—many services are not operating yet—it is difficult to determine what it will

[80] Johnson, op. cit., footnote 3.

[81] FCC, *Annual Assessment*, op. cit., footnote 1, para. 76.

look like in five or 10 years. Costs, revenues, and future plans generally are closely guarded secrets. As a result, even getting a baseline of data to work from is difficult.

During the next five to 10 years, it is likely that the industry will continue to grow, adding new entrants as new companies emerge. Beyond about five years, it also seems likely that consolidations and mergers among some industry players will increase. Consolidations already have been seen in the MMDS market, and analysts expect other industries to follow suit as they mature.[82] Mergers also are likely between various wireline and wireless carriers, if regulations permit, and wireline carriers are investing in MMDS providers.

Such combinations, however, may have both short- and long-term negative effects. In the short term, horizontal integration between directly competing firms, such as in the DBS industry, could reduce the level of competition in individual markets—whether or not this is harmful would be determined case-by-case. Because most markets do not have multiple providers of the same service—currently each area tends to have one cable service, one MMDS (if that), and several local broadcasters—the more important potential problem is mergers between indirectly competing firms, or firms that provide not the same service, but a close substitute. For example, cable and DBS, DBS and MMDS or LMDS, and telephone companies with any of these. Because of these concerns, cross-ownership restrictions currently exist between cable and MMDS (and SMATV) providers. However, no such restriction exists between cable and DBS, and the local telephone companies are reportedly interested in LMDS technology.

In the long term, the ultimate outcome and extent of this trend are unclear, as are the final impacts. It is conceivable that, if cross-ownership became widespread across the various segments of the video programming industry, both the diversity and quality of services could decline, and overall prices could rise. Policies that are procompetitive now—to allow wide latitude in mergers and acquisitions—could turn out to be anticompetitive in the long run. Again, the immature state of the industry makes analysis highly speculative. Firms will merge or not based on the economics of individual situations that have not yet developed.

### Interconnection issues

The extent to which the wireless video service providers discussed in this section will interconnect or interoperate with other parts of the NII will only be determined over time—absent government intervention to require specific levels and kinds of interoperability. The systems now function primarily as the final delivery (one-way) link to consumers and businesses. In this regard, their connections to the NII may be quite limited. The NII would serve as a resource base—or a backbone—for supplying the information or entertainment that is then sent on to customers. It seems likely that the cable/telephone networks will serve as an important way for video service providers to get programming in addition to the satellite delivery systems that already exist. Very little information if any is likely to travel back through the NII core from the users of these systems.

If these services become two-way or interactive, however, their integration with other networks is likely to be greater. One-way broadcasting systems, for example, may be relatively isolated from other communications systems now, but may link up with interactive programming provided by the Interactive Video Data Service (IVDS). DirecTV/USSB is also primarily one-way, but gathers billing data over phone lines. In the future, real-time interactive services may also be provided through such combinations. The next generation of DBS could add an element of interactivity by allowing users to download large amounts of information—mov-

[82] In the DBS industry, for example, one analyst believes that after four to five companies enter the market over the next three to five years, they will begin to consolidate. Michael Alpert, Alpert and Associates, personal communication, Mar. 23, 1995.

ies, for example—that they could then use as they wish. Such developments depend on continuing advances in memory technology (movies require large amounts of storage) and declining costs.

It is also conceivable that wireless programmers could eventually concentrate more on programming, and become less involved in the distribution side of the business. In the future, what are now wireless companies ironically may come to depend on the wire-based NII backbone to deliver some or all of their programming. In addition to their broadcast operations, for example, broadcasters could move their products over many competing delivery systems including cable, MMDS, and the public switched telephone network (PSTN).

## EMERGING HIGH-BANDWIDTH SERVICES

In addition to the services described above, a new class of entertainment/information service provider is emerging—one that is capable of delivering a wider range of high-bandwidth, even interactive, services. Only one of these services is operational, and all, in fact, are still vying for spectrum before the FCC. They represent a mix of local and national services targeted at both businesses and individuals.

### Local Multipoint Distribution Service (LMDS)

LMDS, also known as cellular television, is being developed primarily as another alternative to cable television, MMDS, and DBS services. In the future, LMDS technology may be able to deliver telephony and interactive data services as well. Proponents believe that the high-bandwidth capabilities of the system, combined with its interactive potential, make it a natural extension of the NII. Currently, only one provider, CellularVision of New York, is offering commercial video programming service, serving about 200 customers, but 12 other companies have received experimental licenses.[83]

LMDS proponents plan to use frequencies in the 27.5-29.5 GHz band (line-of-sight is required) and low-power transmitters in a cellular-like arrangement to deliver up to 50 channels of analog one-way video programming (figure 6-4).[84] For about $30 a month, customers can receive local broadcast stations, as well as popular enhanced programming, such as ESPN, movie channels, and pay-per-view channels.[85] A central tower uses an omnidirectional antenna to transmit programming to each individual cell site—between three and 12 miles in diameter—which then retransmits it to subscribers' homes. Thus, to cover a major metropolitan area of 1,000 to 2,000 square miles would take between 20 and 40 transmitter sites.[86] This configuration allows the provider to tailor the coverage areas of each transmitter to provide the best possible service. At the subscriber's home, a small antenna (there are several designs, including small dish antennas and 6.5-inch-square flat panels) on a windowsill or roof connects to the user's television.

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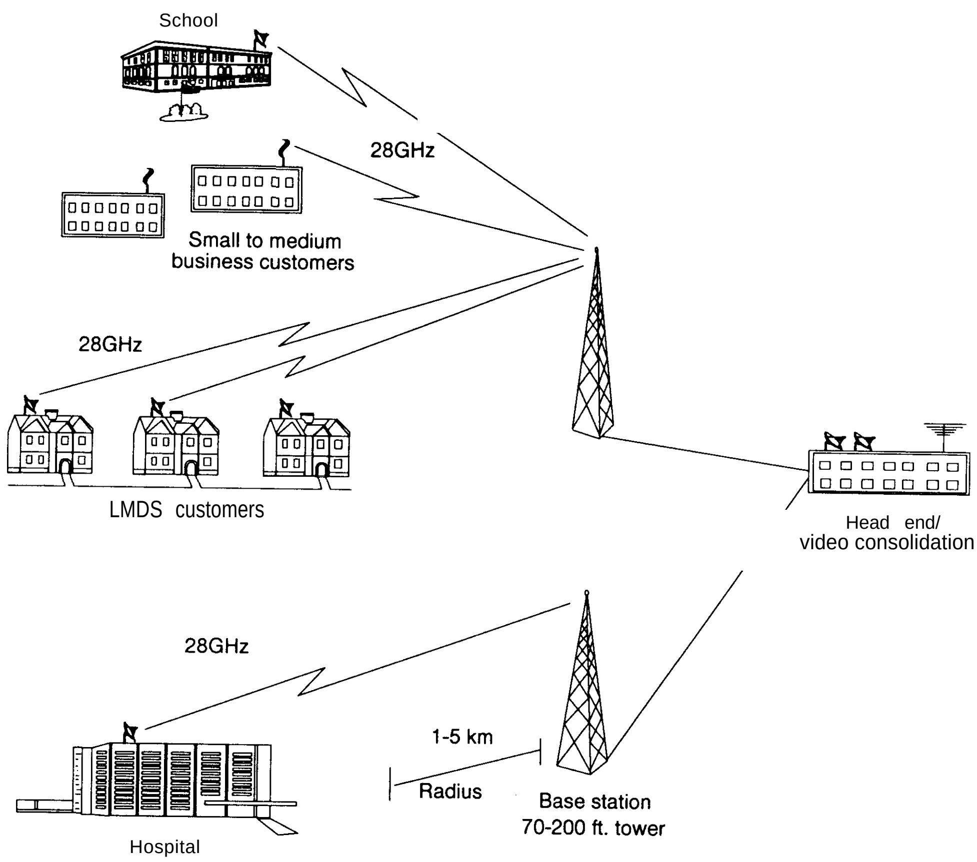
[83] In January 1991, the FCC granted Suite 12 Group (now CellularVision of New York) a license to provide LMDS service in the New York City metropolitan area. Service began in June 1992. Since that time, the FCC has received over 971 applications to build similar systems across the country.

[84] Each channel is very wide—20 MHz. Using a special transmission technique (opposite polarization of signals), proponents and the FCC believe that the number of channels can be doubled—each original channel matched by a new one. These new channels could be used to carry more video programming or interactive services.

[85] B.J. Catlin, ed., "Wireless Cable TV FAQ," unpublished paper, Colorado State University, Department of Computer Science, May 3, 1994 (rev.).

[86] Egan, op. cit. footnote 25, p. 37.

FIGURE 5-4: Local Multipoint Distribution Service System




SOURCE: Office of Technology Assessment, 1995.

In the future, proponents plan an even wider range of services, including more video channels, telephone services, and various interactive services.[87] System capacity could be at least doubled by using digital compression technology and different transmission schemes. This extra capacity would then be used for new channels or services. By combining the wide (20 MHz) LMDS channels with interactive capabilities (LMDS systems can offer interactivity by inserting return-path communication channels between the video channels),[88] LMDS proponents envision delivering applications such as video-on-demand, videoconferencing, telephone service, and various data services, including computer networking to homes and businesses.[89] These applications are

[87] Except where noted, the services and applications discussed in this paragraph are from the Federal Communications Commission, op. cit., footnote 2.

[88] Return channels will use opposite polarity signals to avoid interfering with the video programming.

[89] Texas Instruments presentation to OTA staff, Nov. 9, 1994.

expected to serve distance education, telemedicine, and a number of business communication needs. Providers of rural telephone and broadcasting services have also expressed an interest in LMDS as a way of serving remote customers. Proponents claim that the systems will be able to accommodate future digital communications advancements, including HDTV.

LMDS offers a number of potential advantages over competing video delivery systems, primarily stemming from its point-to-multipoint cellular architecture. First, construction costs are lower compared with satellite systems, and savings can be passed on to consumers in the form of lower monthly bills.[90] Costs can also be spread out over time as the system increases its service area (this is different from the PCS/cellular model where mobility requirements mean that broad coverage areas are much more important at system startup). Second, the cellular-like architecture allows the system to be built quickly and implemented in areas with the highest potential demand—sites can be added as needed. Finally, the cellular design makes the system very spectrum efficient because frequencies are reused in each cell. This reuse also increases the capacity of the systems, which is greater than MMDS but less than DBS. DBS, however, cannot match the interactive services provided by LMDS.

The rules and regulations that will govern LMDS are currently being determined at the FCC. The 28 GHz band being used by LMDS is currently allocated to FSS, and the satellite community would like to use the spectrum for a number of applications. To resolve the conflict, the FCC began a proceeding to consider redesignating the band for shared use by LMDS and satellite providers. As part of that process, the FCC convened a Negotiated Rulemaking Committee (NRMC), consisting of representatives from all interested parties, to develop consensus on the technical rules for sharing the 28 GHz band. The NRMC, after weeks of difficult debate, was unable to agree on a sharing plan, and some participants believe that sharing is impossible. The FCC will now make its own decision based on the information provided through the NRMC and the normal rulemaking process. A decision is expected sometime in late 1995.

## New Satellite Systems[91]

### *Spaceway*

Hughes' Spaceway system plans to offer high-speed, high-quality data, video-telephony, and voice services to fixed sites, including homes with personal computers, telecommuters, and businesses. Hughes predicts applications—including medical image transfer; connecting to online services, such as America On-Line and Prodigy; as well as personal video-telephony—will drive demand for their service. Spaceway will also be capable of providing basic voice service to remote regions on a global basis.

The Spaceway system ultimately will employ constellations of satellites in each of six orbital locations.[92] Its design will utilize intersatellite links to provide global communications, much as Iridium plans. Spaceway will use Ka-band frequencies to deliver these services, and Hughes

[90] Alpert and De Sonne, op. cit., footnote 65. This is true, of course, only on a local basis; to achieve comparable national coverage to a satellite system, costs would be substantially higher.

[91] Loral Corp. announced in May 1995 that it would be providing services similar to the systems described. The CyberStar system would use a single satellite to provide high-speed data communications to support video conferencing, computer networking, distance learning, and other applications. The system is estimated to cost $500 million, and company officials plan to begin service to all 50 states in 1998. Jeff Cole, "Loral Plans a Data Service Using Satellites," *The Wall Street Journal*, May 3, 1995, p. B5.

[92] Hughes plans to launch its Spaceway system in two phases. The initial phase will consist of nine satellites, two in each of the four orbital planes and one interconnection satellite between North America and Asia-Pacific. Hughes anticipates operation of the first phase by the year 2000. The second phase will introduce two additional satellites in the four orbital planes and keep just one interconnectional satellite between Asia-Pacific and North America.

will offer interconnection to the PSTN through terrestrial operations control centers. Users will have to purchase their own sending and receiving equipment.

### *Teledesic*

Teledesic's proposed system of low-Earth-orbit (LEO) satellites is singled out because it differs from the other "big" and "little" LEO systems in both scale and the services it hopes to deliver. In its original FCC application of March 21, 1994, Teledesic applied to provide fixed satellite services in the United States and abroad; in late 1994 the company amended the application to include mobile services provided outside the United States.[93] According to FCC regulations, Teledesic cannot provide mobile services in the United States in the bands it is currently seeking.

Teledesic plans to offer telephone, high-speed data, and video services in the United States to fixed users, and these same services to both fixed and mobile users outside of the United States. The company also expects to offer full interconnection to the PSTN with access to the various online services, such as Compuserve. Teledesic plans to market its network to other service providers in the United States, acting as a wholesaler of services rather than selling directly to the end-users.

The Teledesic system design calls for a constellation of 840 satellites in low earth orbit, roughly 621 miles above the earth. Satellites will use the internationally allocated Ka FSS band. The network will feature intersatellite links using fast packet switching technology, a ground component composed of end-user terminals, and gateway terminals serving groups of users. Teledesic plans to offer a variety of end-user terminals to accommodate various user needs, with the upper end allowing bit rates of 1.2 Gbps.[94]

### *Issues and Implications*

The primary issue facing the industry is the allocation of spectrum for the various service providers. Rules regarding what frequency bands the systems will use and how much bandwidth they will get are yet to be determined, and the FCC has delayed any decisions on operating rules until the spectrum issues are resolved.[95] LMDS proponents are fighting to gain full access to spectrum in the 28 GHz band, while various U.S. satellite service providers also want to use the band.[96] The National Aeronautics and Space Administration (NASA), for example, is currently using this band for its Advanced Communications Technology Satellite (ACTS) experiments, which it launched in 1993 at a reported cost of $1 billion. Other satellite providers, including Hughes and Teledesic, are developing satellite systems that would also use the band. Finally, several of the LEO satellite systems are supposed to use this band to provide mobile satellite services (see chapter 3). The technical, service, and other regulatory uncertainties that flow from this unknown outcome have seriously slowed LMDS development.

The FCC has indicated that it intends to allocate spectrum to all these potential services as part of its overall mission to encourage the development of competitive systems that will bring new services to the public as quickly as possible. It now appears, based on the conclusions of the

[93] Teledesic Corp., *Amendment of Application of Teledesic Corporation for Authority to Construct, Launch, and Operate a Low Earth Orbit Satellite System in the Domestic and International Fixed Satellite Service*, before the Federal Communications Commission, File No. 22-DSS-P/LA-94, Dec. 30, 1994.

[94] Teledesic Corp., *Application of Teledesic Corporation for a Low Earth Orbit Satellite System in the Domestic and International Fixed Satellite Service,* before the Federal Communications Commission, Washington, DC, Mar. 21, 1994.

[95] All other issues pertaining to establishment of LMDS will await development of frequency coordination and sharing criteria for space and terrestrial services and technical parameters for the service. Federal Communications Commission, op. cit., footnote 2.

[96] The band is currently allocated only to point-to-point services, but LMDS services have been operating in the band on a waiver of existing rules. For a summary discussion of the various satellite proposals, see Federal Communications Commission, op. cit., footnote 2.

NRMC, that sharing is not a viable option, given today's technology. LMDS systems would interfere with satellite systems and vice versa. Given these factors, the FCC has essentially three options: 1) divide the spectrum between the various systems; 2) move LMDS operators to another band; or 3) move satellite operations to another band. Existing use of the band by NASA's ACTS, and the varied uses of the band already proposed by satellite interests, appears to make the third option the least likely. Dividing the spectrum between the proponents probably could be done technically, but all future services likely would suffer from spectrum shortages and capacity constraints.[97] Systems may have to be reengineered. In addition, since the LMDS spectrum is to be auctioned, and the value of the licenses is closely tied to the amount to be offered, companies cannot plan auction strategies until such concerns are worked out.

Because only one operator is currently using the band—although there is more extensive experimental use—moving LMDS operations to another band also seems to be a viable option, and the 40 GHz band, which is now part of a reallocation proceeding at the FCC, is one possibility.[98] Other countries are developing systems similar to LMDS in these bands, although Latin American countries reportedly are experimenting in the 28 GHz band. If either group of users is forced to relocate to other frequencies, systems will have to be reengineered, increasing costs and time to market.[99]

Although these new systems have some way to go before they begin full-scale operation, they represent the best efforts to date to replicate the full range of services proposed for the NII. If such services eventually begin operation, they have the potential to meet the bandwidth requirements of many, if not most, users, and to extend the reach of high-bandwidth services to all areas of the country, regardless of location. The technical and regulatory hurdles that must be overcome, however, are substantial.

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[97] This conclusion is premised on today's technology. Future developments in compression technology and spectrum-sharing methods could make band segmentation and spectrum-sharing possible.

[98] Federal Communications Commission, *Amendment of Parts 2 and 15 of the Commission's Rules To Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications*, ET Docket 94-124, released Nov. 8, 1994.

[99] Although the band is currently lightly used for satellite services, the time and costs of relocating satellite operators is unknown, because many of the systems involved are still under development and costs are closely guarded. The record on whether such a move is feasible or practical for LMDS is similarly unclear, but generally seems to indicate that such a move is possible, if potentially costly. "Commenters Like FCC Proposals To Open Above-40 GHz Bands..." *Telecommunications Reports*, vol. 61, No. 5. pp.19-21, Feb. 6, 1995.