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# DIGITAL BROADCAST TELEVISION TRANSITION

## Estimated Cost of Supporting Set-Top Boxes to Help Advance the DTV Transition

Statement of Mark L. Goldstein, Director  
Physical Infrastructure Issues





Highlights of [GAO-05-258T](#), a testimony before the Subcommittee on Telecommunications and the Internet, Committee on Energy and Commerce, House of Representatives

## Why GAO Did This Study

The digital television (DTV) transition offers the promise of enhanced television services. At the end of the transition, radiofrequency spectrum used for analog broadcast television will be used for other wireless services and for critical public safety services. To spur the digital transition, some industry participants and experts have suggested that the government may choose to provide a subsidy for set-top boxes, which can receive digital broadcast television signals and convert them into analog signals so that they can be displayed on *existing* television sets. This testimony provides information on (1) the current distribution of American households by television viewing methods and whether there are demographic differences among these groups; (2) the equipment required for households to receive digital broadcast signals; and (3) the estimated cost to the federal government, under various scenarios, of providing a subsidy for set-top boxes that would enable households to view digital broadcast signals.

We developed estimates of the cost of a subsidy for set-top boxes using data on household television characteristics, expected set-top box costs, and varied assumptions about how certain key regulatory issues will be decided.

[www.gao.gov/cgi-bin/getrpt?GAO-05-258T](http://www.gao.gov/cgi-bin/getrpt?GAO-05-258T).

To view the full product, including the scope and methodology, click on the link above. For more information, contact Mark L. Goldstein, (202) 512-2834, [goldsteinm@gao.gov](mailto:goldsteinm@gao.gov).

# DIGITAL BROADCAST TELEVISION TRANSITION

## Estimated Cost of Supporting Set-Top Boxes to Help Advance the DTV Transition

### What GAO Found

The three primary means through which Americans view television signals are over the air, cable, and direct broadcast satellite (DBS). GAO found that 19 percent, or roughly 21 million American households, rely exclusively on free over-the-air television; 57 percent, or nearly 64 million households, view television via a cable service; and 19 percent, or about 22 million households, have a subscription to a direct broadcast satellite (DBS) service. On average, over-the-air households are more likely to have lower incomes compared to cable and DBS households. While 48 percent of over-the-air households have incomes under \$30,000, roughly 29 percent of cable and DBS households have incomes less than that level. Also, 6 percent of over-the-air households have incomes over \$100,000, while about 13 percent of cable and DBS households have incomes exceeding \$100,000.

The specific equipment that each household needs to transition to DTV—that is, to be able to view digital broadcast signals—depends on the method through which the household watches television, whether the household has already upgraded its television equipment to be compatible with DTV, and the resolution of certain key regulatory issues. GAO examined two key cases regarding the regulatory issues. The assumption for case one is that cable and DBS providers would continue providing broadcasters' signals as they currently do, thus eliminating the need for their subscribers to acquire new equipment. In this case, only households viewing television using only an over-the-air antenna would need to take action to be able to view broadcasters' digital signals. The assumption for the second case is that cable and DBS providers would be required to provide broadcasters' digital signals to subscribers in substantially the same format as broadcasters transmitted those signals. This would require cable and DBS subscribers, in addition to over-the-air households, to have equipment in place to be able to receive their providers' high-definition digital signals.

If a subsidy for set-top boxes is only needed for over-the-air households (case one), GAO estimates that its cost could range from about \$460 million to about \$2 billion, depending on the price of the set-top boxes and whether a means test—which would limit eligibility to only those households with incomes lower than some specified limit—is employed. If cable and satellite subscribers also need new equipment (case two), the cost of providing the subsidy could range from about \$1.8 billion to approximately \$10.6 billion.

We provided a draft of this testimony to the Federal Communications Commission (FCC) for their review and comment. FCC staff provided technical comments that we incorporated where appropriate.

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Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to report on our work on the potential cost of providing a subsidy to consumers for the purchase of set-top boxes in order to accelerate the transition from analog to digital broadcast television. This transition—known as the DTV transition—offers the promise of more programming options, interactive services, and high-definition television (HDTV). Moreover, the return of radiofrequency spectrum used for analog broadcast television at the end of the transition will provide many benefits to society, such as easing the spectrum scarcity facing public safety first responders, engendering economic growth and consumer value from spectrum redeployed to wireless services, and affording the federal government revenues from the proceeds of a spectrum auction. To facilitate the transition, the Congress and the Federal Communications Commission (FCC) temporarily provided television stations nationwide with additional spectrum so that stations could simultaneously broadcast both an analog and a digital signal. Stations' analog licenses are mandated to terminate in December 2006, or when 85 percent of households in each market can receive digital broadcast signals, whichever is later.<sup>1</sup> While the purchase of digital televisions is steadily increasing, it nevertheless appears unlikely that a sufficient proportion of households will have digital television equipment in place by the end of 2006.

In order to spur households' adoption of the digital equipment necessary for the transition, some have suggested that the government provide a subsidy to certain households to purchase a device, known as a set-top box, that can receive digital broadcast television signals and convert them into analog signals so that they can be displayed on *existing* television sets. This device would enable the household to view digital broadcast signals without purchasing a digital television set; such sets currently sell at considerably higher prices than traditional analog television sets. Aiding in the deployment of set-top boxes may enable the transition to end sooner than it might otherwise by increasing the number of households that can view digital broadcast signals.

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<sup>1</sup>Additional requirements include (1) television stations affiliated with the four largest national networks (ABC, CBS, Fox, and NBC) are broadcasting a DTV signal and (2) the technology to convert a digital signal for use on an analog television set is generally available.

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At the request of this subcommittee, we have examined (1) the current distribution of American households by television viewing methods and whether there are demographic differences among these groups; (2) the equipment required for households to receive digital broadcast signals; and (3) the estimated cost to the federal government, under various scenarios, of providing a subsidy for set-top boxes that would enable households to view digital broadcast signals. In addition to information provided in this testimony, we are conducting additional work on the DTV transition, subsidy options, and administrative approaches for implementing a subsidy program, and will provide a more detailed study for the Committee and the Subcommittee later this year.

While a subsidy for set-top boxes may be one policy option to spur the transition, there are other policies that might do so as well. In our statement today, we provide cost estimates for a possible subsidy program under various scenarios. We note, however, that in providing these cost estimates, GAO is taking no position on this policy option. We are merely providing, as requested by the Committee and the Subcommittee, cost estimates for such a program.

To address the issues we will discuss today, we purchased data from Knowledge Networks, a survey research firm that had conducted a consumer survey on household television characteristics. The survey provided the responses of 2,471 randomly selected American households and covers such topics as the method each household uses to view television (e.g., cable, over the air), how many television sets they have, and whether they have set-top boxes for digital cable service. The survey also provides information on an array of demographic characteristics for each household. These data were collected between February and April 2004. The response rate for Knowledge Network's survey was 47 percent. The relevance of the response rate for the study's findings is discussed in appendix I.<sup>2</sup> Using a 95 percent confidence interval, all percentage estimates from the survey have margins of error of plus or minus 6 percentage points or less, and all cost estimates based on the survey data have margins of error of plus or minus 16 percent or less. To assess the reliability of these survey data, we reviewed documentation of survey

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<sup>2</sup>Because we did not have information on those contacted who chose not to participate in the survey, we could not estimate the impact of the nonresponse on our results. However, distributions of selected household characteristics (including presence of children, race, and household income) for the sample and the U.S. Census estimate of households show a similar pattern.

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procedures provided by Knowledge Networks and questioned knowledgeable officials about the survey process and resulting data. We determined that the data were sufficiently reliable for the purposes of this testimony. We also contracted with Knowledge Networks to recontact some of respondents to its survey to ask additional questions that GAO developed.<sup>3</sup> Because the number of recontacted households for the additional questions requested by GAO was small, the findings for these questions are not generalizable to a larger population. To gather information about the likely costs of set-top boxes, we interviewed several consumer electronics firms and experts.

The estimate of the potential cost of a subsidy that we are providing should not be interpreted as the cost of a government program. In preparing these estimates we discussed the nature of our work with Congressional Budget Office (CBO). If the Congress considers legislation for a set-top box subsidy program, the CBO will, based on the specifics of the law, prepare an estimate of the cost of the program. We conducted our work from August 2004 to January 2005 in accordance with generally accepted government auditing standards.

We provided a draft of this testimony to the Federal Communications Commission (FCC) for their review and comment. FCC staff provided technical comments that we incorporated where appropriate.

In summary:

- The three primary means through which Americans view television signals are over the air, cable, and direct broadcast satellite (DBS). We found that 19 percent, or roughly 21 million American households, rely exclusively on over-the-air transmissions for their television viewing; 57 percent, or nearly 64 million American households, view television via a cable service; and about 19 percent, or about 22 million American households, have a subscription to a DBS service.<sup>4</sup> We recognize that others have estimated a

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<sup>3</sup>The additional questions were related to why the household chose to view television as they currently do and whether they are likely to make changes in the viewing methods in the near future.

<sup>4</sup>These percentages do not add up to 100 percent because (1) between 1 and 2 percent of American households do not have a television, (2) about 1 percent of households receive television service through other means, such as a wireless cable system, and (3) the numbers reported here do not include close to 3 percent of households that reported having a subscription to both cable and DBS.

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lower value for the percent of households relying on over the air television.<sup>5</sup> Our results were derived from a survey of over 2,400 households, from which we estimated with 95 percent certainty that between 17 and 21 percent of households rely on over the air television. On average, over-the-air households are more likely to have lower incomes compared to cable or DBS households. While 48 percent of over-the-air households have incomes under \$30,000,<sup>6</sup> roughly 29 percent of both cable and satellite homes had household incomes less than or equal to that level. Also, only 6 percent of over-the-air households had incomes over \$100,000, while about 13 percent of cable and satellite households had incomes exceeding \$100,000. Additionally, non-white and Hispanic households are more likely to rely on over-the-air television than are white and non-Hispanic households.

- The specific equipment needs for each household to transition to DTV—that is, to be able to view broadcast digital signals—depends on certain key factors. First, the method through which a household watches television and whether it has already upgraded its television equipment to be compatible with digital television, will factor into the equipment needs of the household. Additionally, certain regulatory decisions yet to be made by FCC will play a role in determining some consumers’ equipment needs. We examined two key cases regarding the regulatory decisions.
- In case one, we assume that cable and DBS providers would continue providing broadcasters’ signals as they currently do, thus eliminating any need for their subscribers to acquire new equipment. That is, cable providers would initially “downconvert”<sup>7</sup> broadcasters’ high-definition digital signals to an analog format before they are transmitted to their subscribers. Similarly, DBS providers would initially downconvert broadcasters’ high-definition digital signals to a standard-definition digital format before they are transmitted to their subscribers. This enables the signals to be viewed on subscribers’ existing televisions

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<sup>5</sup>In its most recent report on video competition, FCC found that number of households subscribing to a multichannel video provider, such as a cable or DBS company, was approximately 85 percent of television households, thus implying that about 15 percent of television households rely on over-the-air television. The methodology employed by FCC differed from the household survey used to prepare our estimate.

<sup>6</sup>For a family of four, the poverty level is just under \$19,000, so the \$30,000 income level would correspond to about 160 percent of the 2004 poverty level for a family of four. The cutoff for eligibility for food stamps is 175 percent of the poverty level.

<sup>7</sup>The word “downconvert” means to take a signal in a given format and transform it into a lower-resolution format.

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sets. In this case, only households viewing television using only an over-the-air antenna must take action to be able to view broadcasters' digital signals.

- In case two, we assume that cable and DBS providers would be required to provide broadcasters' digital signals to subscribers in substantially the same format as broadcasters transmitted those signals. Because some of the broadcasters' digital transmissions are in a high-definition digital format, the second case would require cable and DBS providers to transmit the signals in this format to their subscribers. To be able to view these signals, cable and DBS subscribers would need to have equipment in place, or to acquire new equipment, that can receive their providers' *high-definition* digital signals. The second case would also require, as does case one, all over-the-air households to acquire new equipment.
- If a subsidy for set-top boxes were needed only for over-the-air households, we estimate that its cost could range from about \$460 million to about \$2 billion. The subsidy cost varies depending on the price of the set-top boxes and whether a means test—which would limit eligibility for the subsidy to only those households with incomes lower than some specified limit—were employed. However, if cable and satellite subscribers also needed new equipment and the subsidy provides some support for these households as well, the overall cost of the program would grow. We estimate that in this case, the cost of providing the subsidy could range from about \$1.8 billion to over \$10 billion, depending, again, on the price of the set-top boxes and whether a means test were employed.

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## Background

The United States is currently undergoing a transition from analog to digital broadcast television. With traditional analog technology, pictures and sounds are converted into “waveform” electrical signals for transmission through the radiofrequency spectrum, while digital technology converts these pictures and sounds into a stream of digits consisting of zeros and ones for transmission. Digital transmission of television signals provides several advantages compared to analog transmission, such as enabling better quality picture and sound reception as well as using the radiofrequency spectrum more efficiently than analog transmission. This increased efficiency makes multicasting—where several digital television signals are transmitted in the same amount of

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spectrum necessary for one analog television signal—and HDTV<sup>8</sup> services possible.

A primary goal of the DTV transition is for the federal government to reclaim spectrum that broadcasters currently use to provide analog television signals. The radiofrequency spectrum is a medium that enables many forms of wireless communications, such as mobile telephone, paging, broadcast television and radio, private radio systems, and satellite services. Because of the virtual explosion of wireless applications in recent years, there is considerable concern that future spectrum needs—both for commercial as well as government purposes—will not be met. The spectrum that will be cleared at the end of the DTV transition is considered highly valuable spectrum because of its particular technical properties. In all, the DTV transition will clear 108 megahertz of spectrum—a fairly significant amount. In the Balanced Budget Act of 1997, the Congress directed FCC to reallocate 24 MHz of the reclaimed spectrum to public safety uses. Since the terrorist attacks of September 11, 2001, there has been a greater sense of urgency to free spectrum for public safety purposes. The remaining returned spectrum will be auctioned for use in advanced wireless services, such as wireless high-speed Internet access.<sup>9</sup>

To implement the DTV transition, television stations must provide a digital signal, which requires them to upgrade their transmission facilities, such as transmission lines, antennas, and digital transmitters and encoders. Depending on individual station's tower configuration, the digital conversion may require new towers or upgrades to existing towers. Most television stations throughout the country are now providing a digital broadcast signal in addition to their analog signal. After 2006, the transition will end in each market—that is, analog signals will no longer be provided—when at least 85 percent of households have the ability to receive digital broadcast signals.

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<sup>8</sup>HD television provides roughly twice as many lines of resolution, creating a television picture that is much sharper than traditional analog television pictures. HD television can also provide CD-quality sound and is in “widescreen” format, with display screen ratios similar to a movie theater.

<sup>9</sup>Some of this spectrum—24 MHz—has already been auctioned.



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## Americans Watch Television through Three Primary Modes

The three primary means through which Americans view television signals are over the air, cable, and direct broadcast satellite (DBS). Over-the-air broadcast television, which began around 1940, uses radiofrequencies to transmit television signals from stations' television towers to households' television antennas mounted on rooftops, in attics, or directly on television sets. Over-the-air television is a free service. Cable television service, a pay television service, emerged in the late 1940s to fill a need for television service in areas with poor over-the-air reception, such as mountainous or remote areas. Cable providers run localized networks of cable lines that deliver television signals from cable facilities to subscribers' homes.<sup>10</sup> Cable operators provide their subscribers with, on average, approximately 73 analog television channels and 150 digital television channels. In 1994, a third primary means of providing television emerged: direct broadcast satellite (DBS). Subscribers to DBS service use small reception dishes that can be mounted on rooftops or windowsills to receive television programming beamed down from satellites that orbit over the equator. Like cable, DBS service is a subscription television service that provides consumers with many channels of programming. When the Congress enacted the Satellite Home Viewer Improvement Act of 1999, it allowed DBS carriers to provide local broadcast signals—such as the local affiliate of ABC or NBC—which they had previously not generally been able to provide.

**Over-the-Air Households.** We found that 19 percent, or 20.8 million American households, rely exclusively on over-the-air transmissions for their television viewing. We recognize that others have estimated a lower value for the percent of households relying on over the air television. Our results were derived from a survey of over 2,400 households, from which we estimated with 95 percent certainty that between 17 and 21 percent of households rely on over the air television. Compared to households that purchase a subscription to cable or DBS service, we found that exclusive over-the-air viewers are somewhat different demographically. Overall, over-the-air households are more likely to have lower incomes than cable or satellite households. Approximately 48 percent of exclusive over-the-air viewers have household incomes less than \$30,000, and 6 percent have household incomes over \$100,000. Additionally, nonwhite and Hispanic households are more likely to rely on over-the-air television than are white

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<sup>10</sup>When cable service first emerged, it was simply a service that provided a wire-based delivery of broadcast, or traditional television stations' signals, but by the late 1970s, cable operators began to provide new networks that were only available through a pay television service, such as HBO, Showtime, and ESPN.

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and non-Hispanic households; over 23 percent of non-white households rely on over-the-air television compared to less than 16 percent of white households, and about 28 percent of Hispanic households rely on over-the-air television compared to about 17 percent of non-Hispanic households. Finally, we found that, on average, exclusive over-the-air households have 2.1 televisions, which is lower than the average for cable and satellite households.

We asked the survey research firm to recontact approximately 100 of the respondents who exclusively watch television through over-the-air transmission to ask additional questions, including the primary reason the household does not purchase a subscription video service.<sup>11</sup> Forty-one of these respondents said that it was too costly for them to purchase a subscription video service, and 44 said that they do not watch enough television to warrant paying for television service. Most of the recontacted households seemed unlikely to purchase a subscription service in the near future. Only 18 of the recontacted households said that they would be likely to purchase a subscription video service in the near future, and another 10 said that they might do so.

**Cable Households.** We found that 57 percent, or 63.7 million American households, view television through a cable service. On average, cable households have 2.7 television sets. Sixteen percent of cable households have at least one television set in the home that is not connected to cable but instead receives only over-the-air television signals. Of the cable households surveyed, roughly 29 percent had household incomes of less than or equal to \$30,000, and about 13 percent had incomes exceeding \$100,000. We also found that 44 percent of the cable homes have at least one set-top box. Of those cable subscribers with a set-top box, about 67 percent reported that their box is capable of viewing channels the cable system sells on “digital cable tiers,” meaning that the channels are transmitted by their cable provider in a digital format. A subset of these “digital cable” customers have a special set-top box capable of receiving their providers’ transmission of *high-definition* digital signals.

Because the existence of a set-top box in the home may be relevant for determining what equipment households would need to view broadcast digital television signals, we asked the survey research firm to recontact approximately 100 cable households that *do not have a set-top box* to ask

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<sup>11</sup>The actual recontacted number was 102.

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questions about their likely purchase of digital cable tiers—which require a set-top box—in the near future.<sup>12</sup> First, we asked the primary reason why the household did not currently purchase any cable digital tiers of programming. Fifty-one of the recontacted respondents said that they did not want to bear the extra expense of digital tiers of cable programming, and 33 said that they did not watch enough television to justify purchasing digital cable service. Only 9 of the recontacted respondents said that they would be likely to purchase digital cable service in the near future, and another 9 said that they might purchase such service in the near future. Finally, we asked these respondents whether they would be reluctant to change their service in any way that would require them to use a set-top box. Of the recontacted respondents, 37 said they would be very reluctant to change their service in a way that would require them to use a set-top box, and another 38 said that they would be somewhat reluctant to do so.

**DBS Households.** We found that about 19 percent, or 21.7 million American households, have a subscription to a DBS service. These households have, on average, 2.7 television sets. About one-third of these households have at least one television set that is not hooked to their DBS dish and only receives over-the-air television signals. In terms of income, 29 percent of DBS subscribers have incomes less than or equal to \$30,000, and 13 percent have incomes exceeding \$100,000.

One important difference between cable and DBS service is that not all DBS subscribers have the option of viewing local broadcast signals through their DBS provider.<sup>13</sup> Although the DBS providers have been rolling out local broadcast stations in many markets around the country in the past few years, not all markets are served. DBS subscribers in markets without local broadcast signals available through their DBS provider usually obtain their local broadcast signals through an over-the-air antenna, or through a cable connection. This is important to the DTV transition because how households with DBS service view their local broadcast channels will play into the determination of their requirements to transition to broadcast DTV. We therefore requested that the survey research firm recontact approximately 100 DBS customers to ask how

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<sup>12</sup>The firm actually recontacted 102 such households.

<sup>13</sup>While cable providers are generally required to provide the local broadcast signals in each market, DBS providers are required to provide *all* local broadcast stations in markets where they provide any of those stations.

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they receive their local broadcast channels.<sup>14</sup> We found that when local channels are available to DBS subscribers, they are very likely to purchase those channels. Well more than half of the DBS subscribers who were recontacted viewed their local broadcast channels through their DBS service. Nearly one-fourth of the recontacted DBS subscribers view their local broadcast channels through free over-the-air television. As DBS providers continue to roll out local channels to more markets, the percentage of DBS subscribers relying on over-the-air transmissions to view local signals will likely decline.

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## Households' Equipment Needs for DTV Transition Will Depend on their Mode of Television Viewing and Current Equipment Status, and Will Also Be Affected by Regulatory Decisions

The specific equipment needs for each household to transition to DTV—that is, to be able to view broadcast digital signals—depends on certain key factors: the method through which a household watches television, the television equipment the household currently has, and certain critical regulatory decisions yet to be made. In this section we discuss two cases regarding a key regulatory decision that will need to be made and the implications that decision will have on households' DTV equipment needs.

Before turning to the two cases, a key assumption underlying this analysis must be discussed. Currently, broadcasters have a right to insist that cable providers carry their analog television signals. This is known as the “must carry” rule, and dates to the Cable Television Consumer Protection and Competition Act of 1992. FCC made a determination that these must carry rules will apply to the digital local broadcast signals once a station is no longer transmitting an analog signal. In our analysis, we assume that the must carry right applies to broadcasters' digital signals, and as such, cable providers are generally carrying those signals. DBS providers face some must carry rules as well, although they are different in some key respects from the requirements that apply to cable providers. For the purposes of this analysis, we assume that to the extent that DBS providers face must carry requirements, those requirements apply to the digital broadcast signals.

For nearly all cable subscribers, and more than half of the DBS subscribers, local broadcast analog signals are provided by their subscription television provider. This means that these providers capture the broadcasters' signals through an antenna or a wire and retransmit those signals by cable or DBS to subscribers. We make two disparate

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<sup>14</sup>They actually recontacted 102 such households.

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assumptions, which we call case one and case two, about how cable and DBS providers might provide digital broadcast signals to subscribers. We do not suggest that these are the only two possibilities regarding how the requirements for carriage of broadcast signals might ultimately be decided—these are simply two possible scenarios.

**Case One.** In this case, we assume that cable and DBS providers will continue providing broadcasters' signals as they currently do. This assumption would be realized if cable and DBS providers initially downconvert broadcasters' digital signals at the *providers' facilities*, which may require legislative or regulatory action. That is, cable providers would initially downconvert broadcasters' high-definition digital signals to an analog format before they are transmitted to their subscribers. Similarly, DBS providers would initially downconvert broadcasters' high-definition digital signals to a standard-definition digital format before they are transmitted to their subscribers. In this case, there would be no need for cable and DBS subscribers to acquire new equipment; only households viewing television using only an over-the-air antenna must take action to be able to view broadcasters' digital signals. This case shares many attributes with the recently-completed DTV transition in Berlin, Germany.

All over-the-air households—which account for approximately 21 million households in the United States—must do one of two things to be able to view digital broadcast signals.<sup>15</sup> First, they could purchase a digital television set that includes a tuner capable of receiving, processing, and displaying a digital signal. The survey data we used indicated that only about 1 percent of over-the-air viewers have, as of now, purchased a digital television that contains a tuner. However, some large televisions sold today are required to include such a tuner and by July 2007, all television sets larger than 13 inches are required to include a tuner. After that time, consumers who purchase new television sets will automatically have the capability of viewing digital signals. Approximately 25 to 30 million new television sets are purchased each year in the United States. The second option available to over-the-air households is to purchase a digital-to-analog set-top box. That is, for those households that have not purchased a new television set, the set-top box will convert the digital broadcast signals to analog so that they can be viewed on an existing analog television set. Viewers with digital-to-analog set-top boxes would

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<sup>15</sup> Additionally, these households could also choose to subscribe to cable or DBS service to eliminate the need to acquire additional equipment to view a television signal over the air.

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not actually see the broadcast digital signal in a digital format, but would be viewing that signal after it has been downconverted, by the set-top box, to be compatible with their existing analog television set. Currently, simple set-top boxes that only have the function of downconverting digital signals to analog are not on the market. More complex boxes that include a variety of functions and features, including digital to analog downconversion, are available, but at a substantial cost. However, manufacturers told us that simple, and less expensive, set-top boxes would come to the market when a demand for them develops.

**Case Two.** In the second case, we assume that cable and DBS companies would be required to provide the broadcasters' signals to their subscribers in substantially the same format as it was received from the broadcasters. Because some of the broadcasters' signals are in a high-definition digital format, cable and DBS subscribers—just like over-the-air households—would need to have the equipment in place to be able to receive high-definition digital signals. There are several ways these subscribers could view these signals:

- Cable or DBS subscribers would be able to view digital broadcast television if they have purchased a digital television set with an over-the-air digital tuner. They would then have the capability of viewing local digital broadcast stations through a traditional television antenna—just like an over-the-air viewer. However, many cable and DBS households may want to continue to view broadcast television signals through their cable or DBS provider.
- Cable or DBS subscribers could purchase a digital television with a “cable card” slot. By inserting a “card” provided by the cable company into such a television, subscribers can receive and display the digital content transmitted by the cable provider. Only very recently, however, have cable-ready digital television sets—which allow cable subscribers to receive their providers' digital signals directly into the television set—come to the market. Similar televisions sets with built-in tuners for satellite digital signals are not currently on the market.
- To view the high-definition signals transmitted by their subscription provider, the other possibility for cable and DBS households would be to have a set-top box that downconverts the signals so that they can be displayed on their existing analog television sets. That is, any downconversion in this scenario takes place at the *subscribers' household*, as opposed to the subscription television providers' facilities, as in case one. While all DBS subscribers and about a third of cable subscribers have set-top boxes that enable a digital signal from their provider to be

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converted to an analog signal for display on existing television sets, few of these set-top boxes are designed for handling *high-definition* digital signals. As such, if broadcasters' signals are transmitted by cable and DBS providers in a high-definition format, not all cable and satellite subscribers would need new equipment, although most would. In case two, as in case one, all exclusively over-the-air households need a digital television set or a set-top box.

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## Cost of Federal Subsidy for Set-Top Boxes Varies Considerably, Depending on Several Factors

In this section we present the estimated cost of providing a subsidy to consumers for the purchase of a set-top box that would be designed to advance the digital television transition. The estimated subsidy costs presented here vary based on (1) the two cases discussed above about whether cable and DBS providers initially downconvert broadcasters' digital signals at their facilities before transmitting them to subscribers; (2) varied assumptions about whether a means test is imposed and, if so, at what level; and (3) the expected cost of a simple digital-to-analog set-top box. All of the estimates presented here assume that only one television set is subsidized in each household that is determined to be eligible for the subsidy.<sup>16</sup>

**Means test.** Imposing a means test would limit the subsidy to only those households determined to be in financial need of a subsidy. A means test would limit eligibility for the subsidy to only those households with incomes lower than some specified limit. We employed two different levels of means tests. The scenarios with means tests are roughly based on 200 percent and 300 percent of the poverty level<sup>17</sup> as the income threshold under which a household's income must lie to be eligible for the subsidy. The poverty level is determined based on both income and the number of persons living in the household; for a family of four the official federal poverty level in 2004 was \$18,850.

**Set-top boxes.** We provide estimates based on two possible price levels for the boxes: \$50 and \$100. This range is based on conversations we had with consumer electronics manufacturers who will likely produce set-top boxes in the future. Set-top boxes for cable and DBS are often rented by

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<sup>16</sup>In our final report that will be issued later this year, we will also present scenarios under which more than one television set per household is subsidized.

<sup>17</sup>See appendix I for a methodological discussion and assumptions surrounding our determination of thresholds used to approximate the poverty level.

subscribers, rather than purchased. Nevertheless, in cases where cable and DBS subscribers need new equipment, we assume that the financial support provided to them would be equivalent to that provided to over-the-air households.

Table 1 provides the cost of a subsidy program under the assumption that cable and DBS providers downconvert broadcasters' signals at their facilities in a manner that enables them to continue to transmit those signals to subscribers as they currently transmit broadcasters' signals. In this case, cable or DBS subscribers do not require any new equipment, so only over-the-air households—approximately 21 million American households—would need new equipment. As shown in table 1, there is considerable variation in the cost of the subsidy program depending on the level of a means test and the price of the set-top box.

**Table 1: Estimated Cost of Set-Top Box Subsidy, Assuming Cable and DBS Downconversion, only Over-the-Air Households Are Subsidized**

Assumption about means test	Percent of over-the-air households eligible	Number of households subsidized (in millions)	Cost of subsidy, by estimated cost of set-top box (dollars in millions)	
			\$50 set-top box	\$100 set-top box
Means test at 200% of poverty level	50% of over-the-air households	9.3 (7.8 - 10.7)	\$463 (\$391 - \$534)	\$925 (\$782 - \$1,068)
Means test at 300% of poverty level	67 % of over-the-air households	12.5 (10.9 - 14.1)	\$626 (\$545 - \$707)	\$1,252 (\$1,090 - \$1,415)
No means test	All over-the-air households	20.8 (19.1 - 22.6)	\$1,042 (\$954 - \$1,130)	\$2,083 (\$1,907 - \$2,259)

Source: GAO.

Notes: Ninety-five percent confidence intervals in parentheses.

Analysis based on the status of television households in 2004.

Table 2 provides the cost of a subsidy program under the assumption that cable and DBS providers are required to transmit broadcasters' digital signals in the same format as they are received. Under this scenario, nearly all over-the-air households and most cable and DBS subscribers will not have the equipment in place to view high-definition digital broadcast signals. Although subscribers typically rent, rather than purchase, set-top boxes, we assume that the same level of subsidy is provided to these



households as is provided to over-the-air households to defray the cost of having to obtain a new or upgraded set-top box from their provider.

**Table 2: Estimated Cost of Set-Top Box Subsidy, No Cable or DBS Downconversion, Subsidy Provided to Over-the-Air and Cable and DBS Households**

Assumption about means test	Percent of U.S. households eligible	Number of households subsidized (in millions)	Cost of subsidy, by estimated cost of set-top box (dollars in millions)	
			\$50 set-top box	\$100 set-top box
Means test at 200% of poverty level	31% of households	35.1 (32.7 - 37.5)	\$1,753 (\$1,633 - \$1,873)	\$3,506 (\$3,266 - \$3,745)
Means test at 300% of poverty level	50% of households	55.5 (52.9 - 58.1)	\$2,775 (\$2,646 - \$2,904)	\$5,551 (\$5,293 - \$5,809)
No means test	Nearly all households	106.2 (105.1 - 107.3)	\$5,312 (\$5,257 - \$5,367)	\$10,624 (\$10,514 - \$10,734)

Source: GAO.

Notes: Ninety-five percent confidence intervals in parentheses.

Analysis based on the status of television households in 2004.

There are two issues that stand as important caveats to the analyses we have presented on estimated set-top box subsidy costs. The first is that we based the majority of the analyses on survey results that provide information on the status of American television households as of early 2004. Over the next several years, new households will be established, some households might change the means through which they watch television, televisions sets with integrated digital over-the-air tuners as well as digital cable compatibility will be purchased, and some cable and DBS households will have obtained set-top boxes capable of receiving high-definition digital signals from their providers. Households' purchase of certain new equipment could obviate the need for a subsidy for new television equipment. For example, some households may purchase a digital television set with an over-the-air tuner and begin to view digital broadcast signals in this manner; some large televisions sold today are required to include such a tuner and by July 2007, all television sets larger than 13 inches are required to include a tuner. In time, these factors could

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have the effect of reducing the cost of a set-top box subsidy because fewer households would need to be subsidized.<sup>18</sup>

The second caveat to these analyses is that these subsidy estimates do not include any costs associated with *implementing* a subsidy program. If the federal government determines that it would be worthwhile to provide this subsidy, the subsidy would need to be administered in some fashion, such as through a voucher system, a tax credit, a mail-in rebate, government distribution of equipment, or some other means. Any of these methods would impose costs that could be significant for the federal government and any other entities involved in administering the program. Such costs would be difficult to estimate until a host of decisions are made about how a subsidy program would be administered.

As I mentioned earlier, our work on the DTV transition continues, and we will provide more information in a report later this year. We will discuss various ways that a subsidy program might be administered and provide some analysis of the benefits and drawbacks of these various methods. We will also provide a discussion of how information regarding the DTV transition and any associated subsidy program might best be provided to the American people.

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Mr. Chairman, this concludes my prepared statement. I would be happy to respond to any questions you or other Members of the Committee may have at this time.

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## Contact and Acknowledgments

For questions regarding this testimony, please contact Mark L. Goldstein on (202) 512-2834 or [goldsteinm@gao.gov](mailto:goldsteinm@gao.gov). Individuals making key contributions to this testimony included Amy Abramowitz, Dennis Amari, Michael Clements, Andy Clinton, Michele Fejfar, Simon Galed, Eric

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<sup>18</sup>As we mentioned above, if at a later date the Congress considers legislation for a set-top box subsidy program, the CBO will, based on the specifics of the law, prepare an estimate of the cost of the program.

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Hudson, Catherine Hurley, Bert Japikse, Sally Moino, Karen O’Conor, and  
Madhav Panwar.

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# Appendix I: Methodology for Use of Survey Data Regarding Television Viewing

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To obtain information on the types of television service and equipment used by U.S. households, we purchased existing survey data from Knowledge Networks Statistical Research. Their survey was completed with 2,375 of the estimated 5,075 eligible sampled individuals for a response rate of 47 percent; partial interviews were conducted with an additional 96 people, for a total of 2,471 individuals completing some of the survey questions. The survey was conducted between February 23 and April 25, 2004.

The study procedures yielded a sample of members of telephone households in the continental United States using a national random-digit dialing method. Survey Sampling Inc. (SSI) provided the sample of telephone numbers, which included both listed and unlisted numbers and excluded blocks of telephone numbers determined to be nonworking or business-only. At least five calls were made to each telephone number in the sample to attempt to interview a responsible person in the household. Special attempts were made to contact refusals and convert them into interviews; refusals were sent a letter explaining the purpose of the study and an incentive. Data were obtained from telephone households and are weighted by the number of household telephone numbers.

As with all sample surveys, this survey is subject to both sampling and nonsampling errors. The effect of sampling errors due to the selection of a sample from a larger population can be expressed as a confidence interval based on statistical theory. The effects of nonsampling errors, such as nonresponse and errors in measurement, may be of greater or lesser significance but cannot be quantified on the basis of available data.

Sampling errors arise because of the use of a sample of individuals to draw conclusions about a much larger population. The study's sample of telephone numbers is based on a probability selection procedure. As a result, the sample was only one of a large number of samples that might have been drawn from the total telephone exchanges from throughout the country. If a different sample had been taken, the results might have been different. To recognize the possibility that other samples might have yielded other results, we express our confidence in the precision of our particular sample's results as a 95 percent confidence interval. We are 95 percent confident that when only sampling errors are considered each of the confidence intervals in this report will include the true values in the study population. All percentage estimates from the survey have margins of error of plus or minus 6 percentage points or less, unless otherwise noted.

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In addition to the reported sampling errors, the practical difficulties of conducting any survey introduce other types of errors, commonly referred to as nonsampling errors. For example, questions may be misinterpreted, some types of people may be more likely to be excluded from the study, errors could be made in recording the questionnaire responses into the computer-assisted telephone interview software, and the respondents' answers may differ from those who did not respond. Knowledge Networks has been fielding versions of this survey for over 20 years. In addition, to reduce measurement error, Knowledge Networks employs interviewer training, supervision, and monitoring, as well as computer-assisted interviewing to reduce error in following skip patterns.

For this survey, the 47 percent response rate is a potential source of nonsampling error; we do not know if the respondents' answers are different from the 53 percent who did not respond. Knowledge Networks took steps to maximize the response rate—the questionnaire was carefully designed and tested through deployments over many years, at least five telephone calls were made at varied time periods to try to contact each telephone number, the interview period extended over about 8 weeks, and attempts were made to contact refusals and convert them into interviews.

Because we did not have information on those contacted who chose not to participate in the survey, we could not estimate the impact of the nonresponse on our results. Our findings will be biased to the extent that the people at the 53 percent of the telephone numbers that did not yield an interview have different experiences with television service or equipment than did the 47 percent of our sample who responded. However, distributions of selected household characteristics (including presence of children, race, and household income) for the sample and the U.S. Census estimate of households show a similar pattern.

To assess the reliability of these survey data, we reviewed documentation of survey procedures provided by Knowledge Networks, interviewed knowledgeable officials about the survey process and resulting data, and performed electronic testing of the data elements used in the report. We determined that the data were sufficiently reliable for the purposes of this report.

Due to limitations in the data collected, we made several assumptions in the analysis. Number of televisions and number of people in the household were reported up to five; households exceeding four for either variable were all included in the category of five or more. For the purposes of our analyses, we assumed that households had no more than five televisions

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that would need to be transitioned and no more than five people. Number of people in the household was only used in calculating poverty, but may result in an underestimate of those households in poverty.

Calculations of poverty were based on the 2004 Poverty Guidelines for the 48 contiguous states and the District of Columbia, published by the Department of Health and Human Services. We determined whether or not each responding household would be considered poor at roughly 200 percent and 300 percent of the poverty guidelines. Income data were reported in categories so the determination of whether or not a household met the 200 percent or 300 percent threshold required approximation, and for some cases this approximation may have resulted in an overestimate of the number of poor households. In addition, income data were missing for 24 percent of the respondents. To conduct the analyses involving poverty, we assumed that the distribution of those in varying poverty status was the same for those reporting and not reporting income data. Comparisons of those reporting and not reporting income data show some possible differences on variables examined for this report; however, the income distribution is very close to the 2003 income estimates published by the U.S. Census Bureau.

To determine total numbers of U.S. households affected by the transition and total cost estimates for various transition scenarios, we used the U.S. Census Bureau's Current Population Survey estimate of the total number of households in the United States as of March 2004. To derive the total number of households covered by the various scenarios, we multiplied this estimate by the proportions of households covered by the scenarios derived from the survey data. The standard error for the total number of U.S. households was provided by the Census Bureau, and the standard errors of the total number of households covered by the scenarios take into account the variances of both the proportions from the survey data and the total household estimate. All cost estimates based on the survey data have margins of error of plus or minus 16 percent or less.

In addition, we contracted with Knowledge Networks to recontact a sample of their original 2004 survey respondents in October 2004. Households were randomly selected from each of three groups: broadcast-only television reception, cable television service without a set-top box, and satellite television service. For each group, 102 interviews were completed, yielding 306 total respondents (for a 63 percent response rate). To reduce measurement error, the survey was pretested with nine respondents, and Knowledge Networks employed interviewer training, supervision, and monitoring, as well as computer-assisted interviewing, to

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reduce error in following skip patterns. Due to the small sample size, the findings of these questions are not generalizable to a larger population.

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