DigiPoints

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Electronic Program Guides

Interactive systems that provide on-screen TV program listings are fast becoming a necessary part of the consumer viewing experience. Electronic Program Guides (EPGs) offer easy access to literally hundreds of different programs available over various platforms. EPGs not only tell the viewer what program is playing on a given channel at a particular time, but also they can provide detailed information about individual shows, listing actors' names, subject genres, plot descriptions, original release dates, and content ratings. Most EPGs offer touch-of-a-button VCR programming up to a week before a show is to appear, and some add on-screen text news, weather and sports services. This issue of *DigiPoints* explains how EPGs work and introduces the new A/65 PSIP standard that governs carriage of EPG data in MPEG-2 digital video in the United States. Typical EPG features and functions are demonstrated by an example EPG. In addition, some troubleshooting tips are reviewed.

Because of the abundance of programming selections in modern cable systems (especially those carrying digital video), the electronic

program guide is one of the most important software applications in a set-top terminal, helping every viewer to quickly determine:

- What's on now
- What's on next
- What's on in the next few days or weeks (usually sorted by favorite channels or genres)

All this program information must be presented in a straightforward manner, and it must accurately reflect the channel line-up of the system that carries it.

EPG Vendors

On-screen program guides are composed of two major parts: 1) the application software (often called the EPG presentation engine) that runs in the set-top terminal (or TV or VCR), and 2) the data that the application software receives and formats for display. Program guide scheduling data is available from several TV scheduling data vendors, such as TVData, Queensbury, NY; Tribune Media Services, Glens Falls, NY; Prevue Interactive, Tulsa, OK; and JDTV, Arlington, TX. EPG application software is available either from the set-top manufacturer (set-top manufacturers call their included EPG a "native" guide) or it can be purchased from a third-party vendor, such as StarSight Telecast, Freemont, CA, or Prevue Interactive's Greenwood Village, CO, office.

The EPG-equipped set-top must be frequently updated with scheduling data, usually distributed via an out-of-band data carrier or a VBI data insertion system[1]. The set-top terminal extracts the program guide data, stores it in its memory (DRAM) and keeps it for display on-screen as either a full-screen grid guide or as an overlay to active video. Periodically, the system updates or "refreshes" the guide. The amount of time a guide can look forward is determined by the amount of DRAM storage available in the set-top terminal.

Program guide information is locale-sensitive. An on-screen program guide must show local time as well as local broadcast channels. It must reflect the system's unique cable channel lineup, including pay-per-view (PPV), near video on demand (NVOD), and video on demand (VOD) offerings, as well as any barker channels. Thus, nearly every cable system's EPG must be customized for its unique needs. Aside from these local system requirements, the task of collecting program schedule data by the TV schedule data vendors is daunting. Program information from over 1100 VHF and UHF broadcasters must be combined with satellite programming schedules and distributed to many hundreds of cable systems. The world of digital broadcasting carries with it the flexibility (and complication) that stations may offer several choices: a single channel of high-definition programming, multiple channels of

1 Although digital EPG data could be carried in the same MPEG-2 multiplex stream as the program data, most U.S. Digital broadcasting networks have elected to use an out-of-band carrier. The reasons are dicussed later.

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standard-definition TV (SDTV) programming, or even combinations of the two—all within a single program time slot.

EPG Standards for MPEG-2

For digital video, the MPEG-2 standard has a mechanism for private data broadcast (program-specific private table) that is used to carry EPG data. However, the MPEG-2 standard does not define the format of the data carried. In the United States, the Advanced Television Systems Committee (ATSC) has recently issued a standard titled *ATSC A/65 Program and System Information Protocol (PSIP) for Terrestrial Broadcast and Cable.* It defines how EPG data is to be carried in MPEG-2 data streams. This EPG specification is mandatory for all U.S. MPEG-2 digital video broadcast systems. In Europe, the European Telecommunications Standards Institute's Digital Video Broadcast (DVB) standard is used to carry EPG data in MPEG-2 digital video streams. The ATSC and DVB groups issue their own TV system standards documents that build on the MPEG-2 standard to create a system standard that defines how ancillary features, such as encryption, pay-per-view TV services, transport over the RF spectrum and EPGs, are implemented. In the U.S. cable TV industry, the SCTE DVS group standards are the defining guidelines. The SCTE DVS group references or adopts existing standards, when appropriate.

For EPGs, these standards define how the program producers put program descriptions into the digital video stream, following the PSIP (in the United States) or DVB protocols (in Europe). The intent of the standards is to enable receivers built by different manufacturers to use the same data to build comprehensive EPGs.

Similar to the relationship between other standards that have been developed for the European and U.S. markets, PSIP and DVB are not interoperable. Since EPG data is only between 0.5 percent and 3 percent of the total digital content of a program, it is conceivable that an MPEG-2 stream could carry both ATSC and DVB program guide data. In actual practice, this is usually not done. A cable system may carry dozens of independent MPEG-2 data streams, and real-time gathering of program descriptions broadcast in MPEG-2 System Information (SI) tables can be rather slow and system-dependent. As indicated earlier, this is the reason most digital broadcasting networks in the United States use a separate out-of-band data carrier to transport EPG data to the set-top. Local storage of the program guide in the set-top DRAM isolates the consumer from any transport delays, and the on-screen guide, therefore, offers instant access to program schedules and descriptions from its descriptor records.

EPG for Analog and Off-Air TV Systems

Because consumers had been interacting with analog EPGs before digital technology became available, we will first discuss these incumbent systems. It should be noted that most currently deployed cable TV set-top EPG systems are proprietary, not interoperable and not standards-based. This is partly due to the fact that the technology was first deployed by

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manufacturers of set-top terminals whose main concern for their products was signal security. Integrating the EPGs with the access control system worked against the development of open standards. Today, new products by several manufacturers of televisions and VCRs include a built-in EPG that is standards-based. The standard that these systems use is an extension to the EIA-608A Vertical Blanking Interval data standard, called EIA-752, which defines a 16-bit analog Transmission Signal ID (TSID).[2] One example of an EPG system, albeit an off-air rather than cable system, is the Guide Plus+™ Gold EPG that RCA includes with its high-end television sets.

The Guide Plus+™ Gold-equipped TV has a vertical blanking interval (VBI) data stripper included and automatically tunes to the local channel that carries the EPG data, extracts it, and stores the data in the TV's memory. This EPG allows the user to browse the guide while watching a program in a window in the guide. It can sort movies by genre or Motion Picture Association of America (MPAA) rating. It can even be programmed to always tune to a particular program and activate a connected VCR (via a tethered infra-red "blaster" transmitter placed in front of the VCR) so that subscribers can always be sure that they won't miss their favorite programs.

VCR manufacturers are also offering EPGs as a means to simplify VCR programming. For example, with Mitsubishi's VCR Plus+® programming, the VCR is instructed to record by entering special codes that represent each TV program. These code numbers can be found in many TV listing guides. When the code number is entered, the VCR automatically knows the time, channel and duration of the program.

In most cable systems, especially those carrying premium pay-per-view analog channels and digital video, content and RF frequency are not coupled. Indeed, apart from certain "must carry" channels, cable systems have the freedom to define channel numbers independently of the RF frequency used to carry the TV signal. In digital video systems, the problem of channel identification is even more complex since multiple programs can be carried on a single RF channel.

Off-air broadcast EPG is simpler to implement than cable-based systems since the frequency of the off-air broadcast signal defines the station and, therefore, the programming content. However, vendor design creativity can make the whole problem transparent to the consumer. For example, with the VCR Plus+ Gold, the VCR automatically sets channels in memory. This feature sets the time and synchronizes the cable network numbers in line with the on-air network numbers. Channels are mapped by the entry of the user's zip code, and complete setup of the VCR is accomplished automatically.

A typical signal flow is illustrated by another example of an analog video EPG system configuration, the EPG that is available with the General Instrument CFT 2200. In this system,

2 See *DigiPoints* Volume 3, Issue 1 for a discussion of data carriage via the vertical blanking interval.

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the set-top terminal is equipped with EPG software and receives program-listing updates via an out-of-band data carrier. The data carrier is a 14 Kbps frequency shift keyed (FSK)-modulated RF carrier placed at a selected frequency in the system bandpass (typically, 106.5, 108.5 or 97.5 MHz). A third-party data provider, such as Prevue or Tribune, provides the program listing data. The third-party data provider's server transmits the program listings database via a modem connection to a Data Provider Translator (DPT) located at the cable system headend. The DPT uses the UNIX operating system and has a graphical user interface. The DPT serves multiple functions:

- Collects the information from the third-party data provider
- Combines it with local formatting (such as cable system logos)
- Combines it with local information such as NVOD schedules
- Stores remote control I/R blaster control codes
- Stores the Music Choice lineup
- Provides an interface to the access control computer
- Provides an interface to a VBI data inserter
- Supports operator-configured pricing on pay-per-view
- Supports definition of different channel lineups for different regions within a system

The access control computer forwards the DPT file to the set-tops either out-of-band or in-band via a data insertion unit. The DPT allows the program information to be sent either as a full file or as an abbreviated file that contains the same information as the full file with the exception of NVOD data and program content descriptions. Because the abbreviated file can be downloaded at a faster rate, set-tops can have a partial data set available for quick updates.

The DPT maintains a database of infrared (IR) codes for VCRs that can be downloaded to the set-top and used by the EPG to automate VCR control via a tethered IR blaster. These IR control codes are formatted and transmitted to a headend data insertion unit that puts the data into the VBI for transmission to the set-tops. (See Figure 1 for a block diagram of the data paths an EPG system can take to an analog set-top terminal.)

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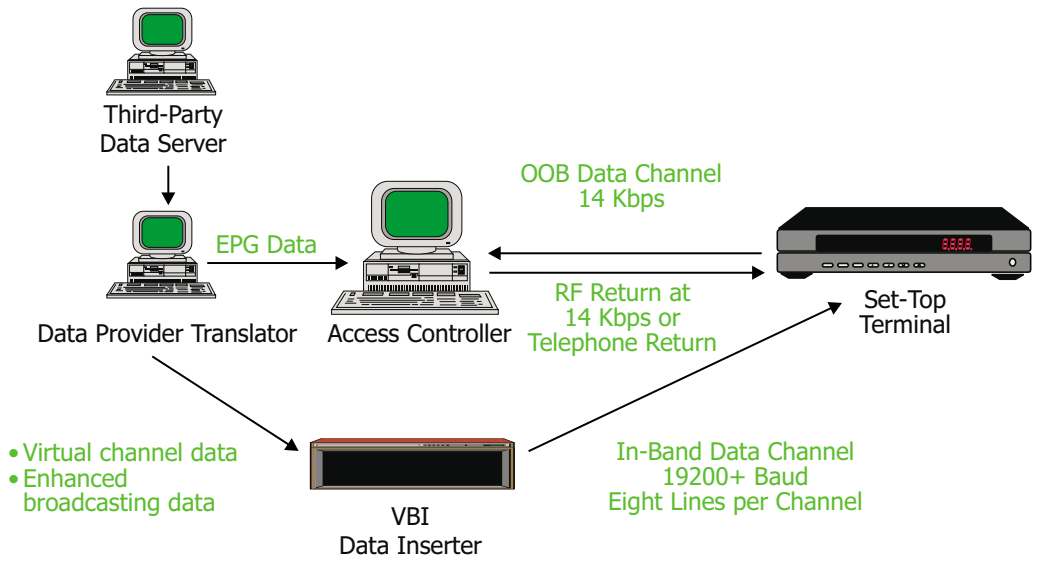

Figure 1: Analog Set-Top Data Paths

The ATSC Standard for EPGs

For U.S. MPEG-2 digital video systems, the *ATSC A/65 Program and System Information Protocol (PSIP) for Terrestrial Broadcast and Cable* standard addresses the issue of multiple programs on a single RF channel via the concept of virtual channels. Virtual channels are channels that appear to the user as ordinary channels, but are not carried at the frequency that is defined by the FCC for that channel number. For example, the FCC defines the 66-to-72-MHz band as channel 4. A virtual channel 4 would appear to the user as channel number 4 on the set-top display, but may in fact be carried at another frequency and is given definition as channel 4 by a data structure called a Virtual Channel Table (VCT). The definition of the channel as given in the VCT includes its frequency, method of modulation, a text name, channel type (analog audio/video, digital a/v, audio only, data) and the channel number the user may use to access it.

The A/65 protocol introduces a new navigational concept, the “two-part” channel number. Broadcasters consider their channel number an investment in brand recognition, so they usually include their number in their logo. Virtual channels allow broadcasters to have their secondary channels appear as part of their primary channel. For broadcasters, the first part of the two-part channel number (called the “major” channel number) is required to be the same as the EIA/FCC channel number already in use for the analog channel. The second part of the number (called the “minor” channel number) identifies one service within the group of channels defined by the major number. From the point of view of the user, where before there was just channel 4, there may also be 4.1, 4.2, 4.3, and so on.

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The A/65 protocol also standardizes a digital equivalent of the V-chip parental advisory data now included in analog broadcasts. Analog broadcasts carry this rating information as defined in the EIA standard EIA-608A. The A/65 standard includes a Rating Region Table (RRT) that defines a content advisory system for a specific region (country) and a Content Advisory Descriptor that can be used to associate specific program events with rating levels defined in the RRT. This way the system can carry different standards for different regions.

The A/65 PSIP standard is basically a method for delivering the data that a digital TV or cable set-top needs to support navigation among the digital services. Direct entry of the channel number must be supported, as well as tuning to a channel from the on-screen EPG. EPG data specified by A/65 may, therefore, also be used for navigation without an on-screen EPG. For example, it can identify what channel is currently being watched as well as what channel comes on next when the CHANNEL UP button on the remote is pushed.

The A/65 Program and System Information Protocol (PSIP) consists of six different data tables. These tables are used by the receiving EPG software to create the on-screen display. The six tables are:

- The Master Guide Table (MGT)
- The System Time Table (STT)
- The Virtual Channel Table (VCT)
- The Rating Region Table (RRT)
- The Event Information Table (EIT)
- The Extended Text Table (ETT)

The VCT has two sub-types, called the Terrestrial Virtual Channel Table (TVCT) and the Cable Virtual Channel Table (CVCT).

All PSIP tables follow the same basic structure for data transport defined in the MPEG-2 Program Specific Information (PSI) private data format. The “long form” syntax provides sectioning and versioning information as well as 32-bit CRC for robust error detection. In MPEG-2 PSI data streams, sectioning information is used to improve error resilience; if a data packet is lost from a long table, the corrupted packet doesn’t disturb the entire table. Such a disturbance would potentially cause the receiver to wait for the beginning of the table and to restart the data decoding process. The versioning information allows the receiver to be notified that the data being transmitted has been changed (it has a new version number). It is also important to note that the A/65 PSIP is designed to be extensible so that new descriptors for future services can be added as needed.

With ATSC’s acceptance of the A/65 PSIP standard, all ATSC-compatible digital broadcast television multiplexes, at a minimum, must carry the following instances of PSIP tables at these repetition rates:

- The Master Guide Table, repeated at a minimum of once every 150 msec
- The Terrestrial Virtual Channel Table, repeated at a minimum of once every 400 msec

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- The System Time Table, repeated at the rate of once per second
- The Rating Region Table, repeated at the rate of once per minute
- The first four Event Information Tables, representing 12 hours of program schedules

Figure 2 shows the relationship of the tables to each other.

The Master Guide Table provides three important functions in PSIP. For each type of PSIP table, the MGT provides the location in the Transport stream, the current version of the table and the length in bytes. When an EPG monitors the MGT it can see if any updates are available to any table it may have stored. The MGT also indicates the amount of memory required to store the updated table. It is extensible so that in the future additional tables may be added if the standard is changed. For example, a Data Information Table is proposed to support data events that are analogous to program events found in the EIT.

The Virtual Channel Table consists of virtual channel definitions where each channel is characterized by:

- the two-part (major.minor) channel number for access to the service
- its text name (up to seven characters, but extensible via a VCT descriptor)
- how the service is physically delivered (carrier frequency and modulation mode)
- its MPEG-2 program_number
- its “source ID” (referencing a unique name in a national database for program sources)
- the type of service (analog TV, digital TV, audio only or data)

The “source ID” given in the Virtual Channel Table is a nationally coordinated database set up by programmers to carry information about programs that can be carried as-is in all systems. Program title and schedule data are tagged with source ID that is then linked to whatever the VCT defines as services available to the receiver.

Other types of data specific to each Terrestrial Virtual Channel include a flag that tells whether the service is access-controlled or not, and an indication as to whether or not “extended text” is available to provide a text description of the service.

The Cable Virtual Channel is identical to the terrestrial version except that it defines a few extra bit fields for features that are unique to cable systems. For example, a cable channel can be hidden from user set-tops and accessible only to test equipment. A Cable Virtual Channel can even define a service that is physically carried on an out-of-band carrier.

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The Event Information Table (EIT) is the PSIP table that carries program schedule information for each virtual channel. Each instance of an EIT covers a three-hour time span and provides the following information for each programming source:

- Event start time
- Event duration
- Event title
- Pointer to optional additional descriptive text (synopsis, cast, director, etc.)
- Program content advisory data (optional)
- Caption service data (optional)
- Audio service descriptor, which can list available languages (optional)

Note that the descriptive text is not included in the EIT, but is instead delivered in a separate data structure, the Extended Text Table. Separating the text from the scheduling data allows the operator to send the descriptive text separately at a slower rate, if desired, to make more efficient use of bandwidth.

Each instance of the Extended Text Table carries one text block. Multiple languages are supported. Fields in the EIT and VCT link a program event or virtual channel to an EIT instance.

The System Time Table (STT) is the simplest and smallest of the PSIP tables. It provides receivers with a reference for the time of day and daylight savings time information. The STT bases its reference for time on the Global Positioning Satellite (GPS) time, which is measured in seconds since the first week of January 1980. This count increments without variation, and hence can be used as a reliable and predictable time base for specification of future times of action. To derive Universal Coordinated Time (UTC), a receiver also needs the current count of leap days (in seconds) that have occurred since the beginning of GPS time. These leap seconds account for the difference between GPS time (based on atomic clocks) and the time based on the earth's rotation. The STT also provides daylight savings time information (whether or not it is in effect), and it indicates the month and hour that the next transition will occur.

To track local time, a receiver also needs to know the local offset in hours from Universal Coordinated Time and whether or not daylight savings time is locally observed. The consumer can input this information directly via a setup screen, or the cable operator can deliver the information to the set-top via the set-top terminal communication channel. Typically this information is provided to the set-top by the system operator; however, because digital satellite receivers can be installed in recreational vehicles that can travel between time zones, provision had to be made for local time updates by the consumer.

The last type of PSIP table is the Rating Region Table (RRT). This table defines a "rating system" for a given region, characterized by a number of *rating dimensions*. Each dimension is composed of two or more *rating levels*. An example of a typical rating dimension used on cable is the Motion Picture Association of America (MPAA) system. The levels within the MPAA dimension include "G," "PG," "PG-13," "R," and "NC-17."

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The table structure in PSIP allows one or more instances of the RRT to be sent, as needed, where each instance defines one region. This feature allows separate rating systems to be sent with video that is broadcast near border regions and is received in two separate countries.

Figure 2 shows a simplified view of how the PSIP tables work together to deliver EPG data. The tables are transported in the "base PID," 0x1FFB. The Master Guide Table points to the PID, version and length of all the tables except the System Time Table. In the example, Event Information Tables are transported in PIDs 0x3E00 and 0x3E01. The example shows that the Virtual Channel Table defines a set of services, including those on the Transport Stream carrying the Virtual Channel Table itself. Two channels, named KVGN-S and KVGN-M, are shown. The Virtual Channel Table gives the channel numbers associated with the channels (10.1 and 10.2), the MPEG-2 program numbers the receiver needs to extract the elementary stream from the multiplex, and the source ID values for each channel.

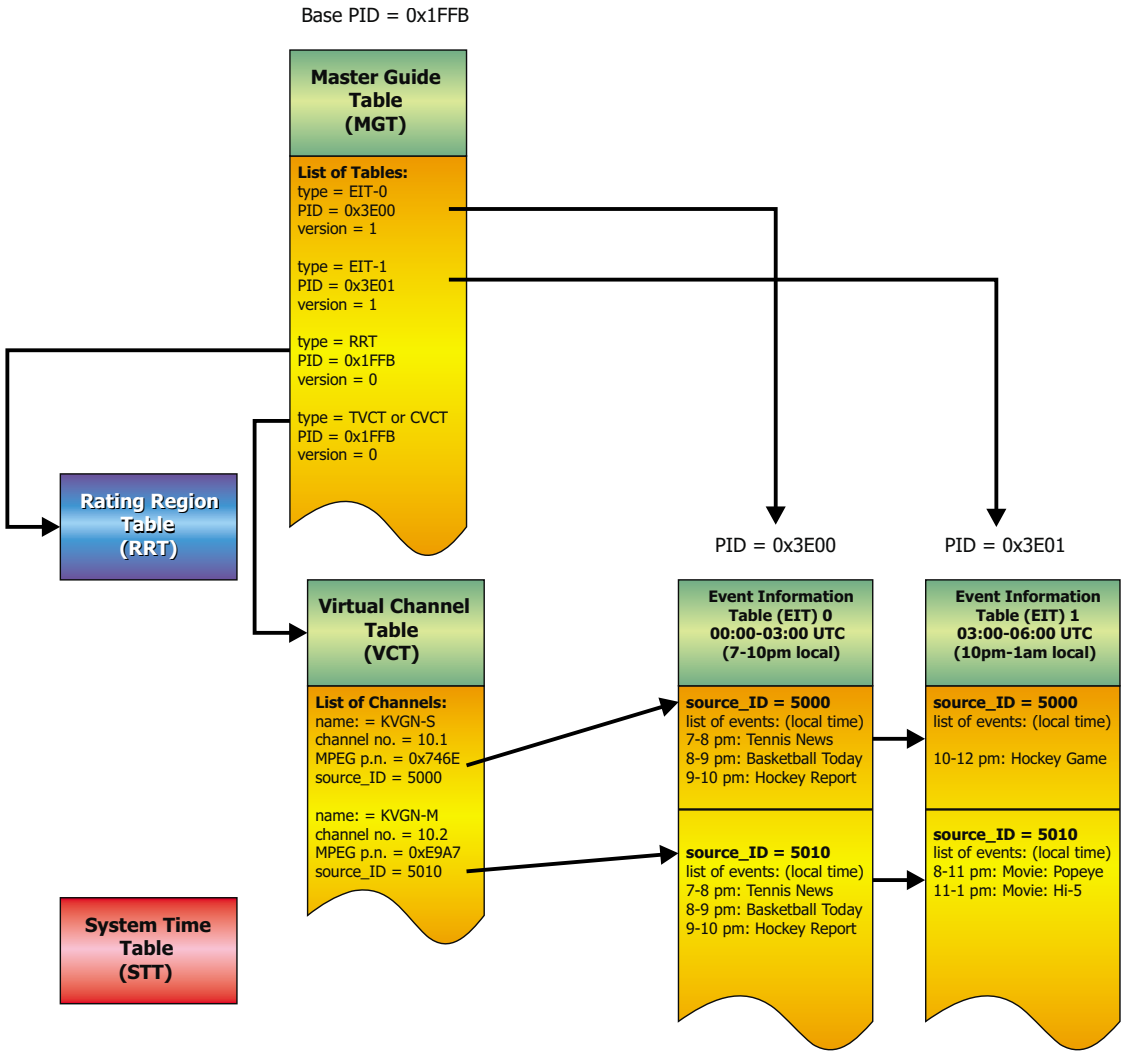

Figure 2: Relationship between PSIP Tables

The A/65 PSIP includes two methods of text compression, one for the title text that often includes capitalization, and the other for event description text. The method of text compression is a type of Huffman coding that assigns shorter codes for the characters that appear more frequently[3]. This compression technique approaches a 2:1 compression efficiency over straight ASCII coding.

Example EPG

EPGs are designed to work with a special remote control that includes functions for the EPG. The EPG remote is equipped with special keys related to EPG functions, such as INFO, FAV, GUIDE, SELECT and HELP. The set-top terminal equipped with an EPG may be configured to present a main menu when it is powered on, or the main menu may be called up with a MENU key on the remote control. Figure 3 shows an example EPG Main Menu with the Messages bar highlighted. The Messages selection accesses messages from the cable system operator. These may be a broadcast message sent to all subscribers, such as the announcement of a new service. They may also be messages sent to a particular group of subscribers defined by the system operator, such as a notice sent to all digital subscribers or groups living in a particular neighborhood. In some cases, the message may even be directed to a particular subscriber; for example, a reminder that the cable bill is overdue or a request to confirm that a service is scheduled.

3 Huffman coding is discussed in detail in Chapter 8 of *DigiPoints, Volume One*, by Justin J. Junkus and Michael J. Sawyer.

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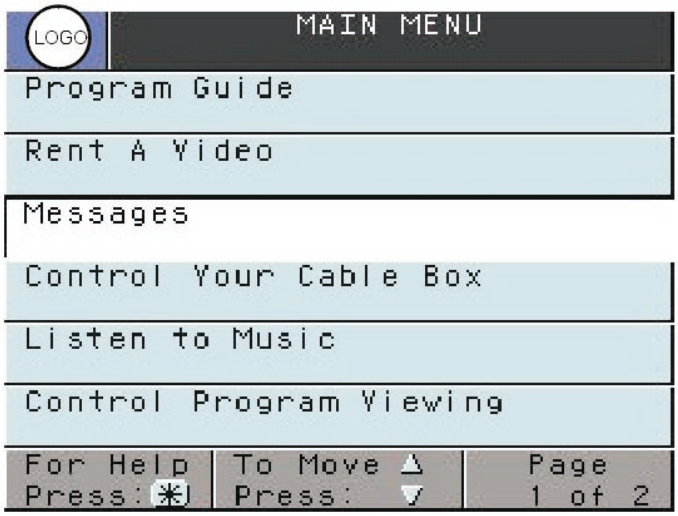

Figure 3: Main Menu

Figure 4 shows a typical Help screen. Help screens are included with EPGs to guide the novice EPG user and may be updated as needed if new features or functions are downloaded. Help screens can be used to identify the keys on the remote control, as well as to explain how to use particular features, such as the IR blaster control of the VCR.

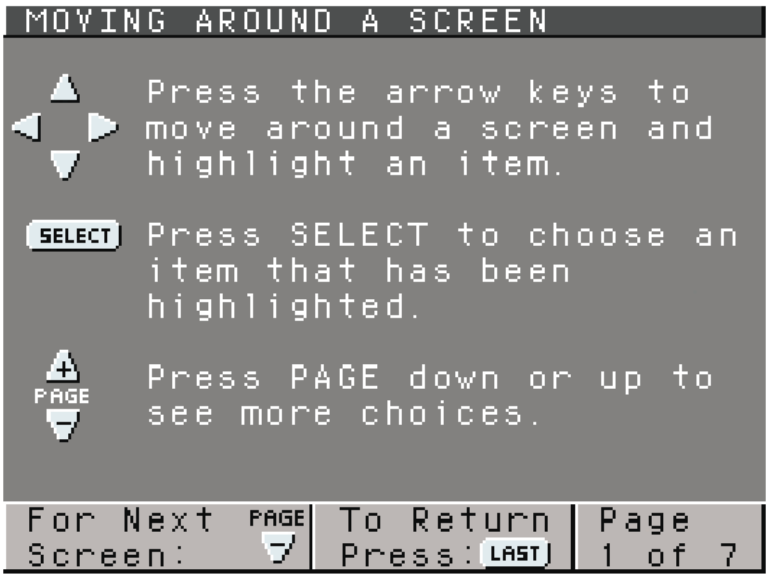

Figure 4: Help Screen

Figure 5 shows a Control Programming screen that allows the user to activate features such as Set Spending Limit or Activate Parental Control. Parental control allows parents to control their children's exposure to adult programming by requiring that a password be inputted before adult programming can be viewed.

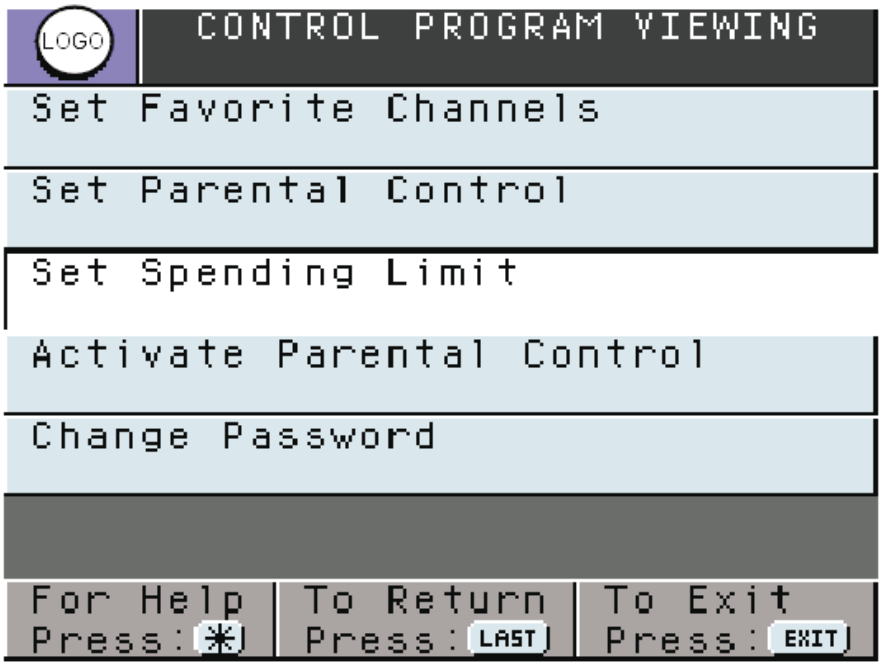

Figure 5: Control Program Viewing

Figure 6 shows the Program Grid Guide, the central feature of the EPG. It enables the user to quickly determine what's on and what's on next. The arrow keys on the remote allow the guide to be scrolled *down* through the channels and *across* through the time of day. How far the schedule extends into the future is determined by available set-top memory and the amount of data purchased from the program guide scheduling vendor.

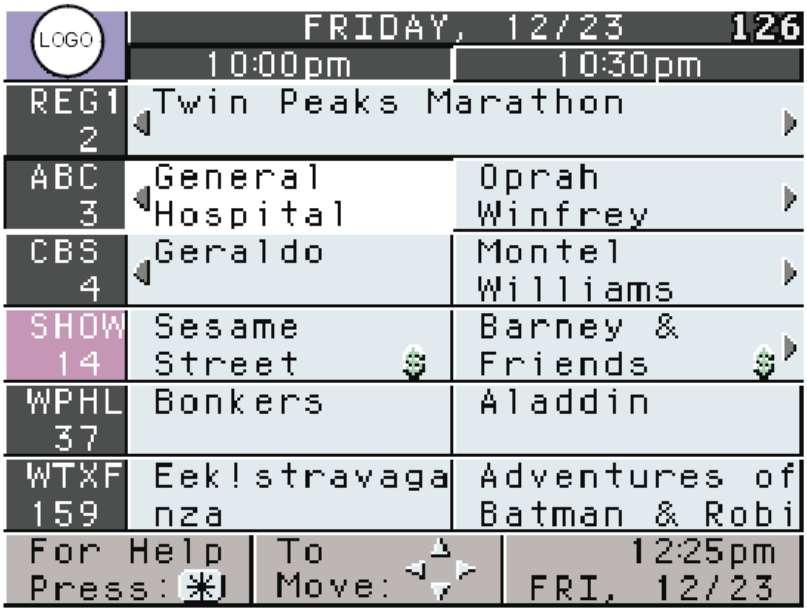

Figure 6: Program Grid Guide

Figure 7 shows how the INFO key gives access to descriptive text listing information about the cast, director, year the program was made, and its price. The availability of this information depends upon whether it was provided by the source of the program guide data. When the information is available, the grid guide screen will indicate that fact.

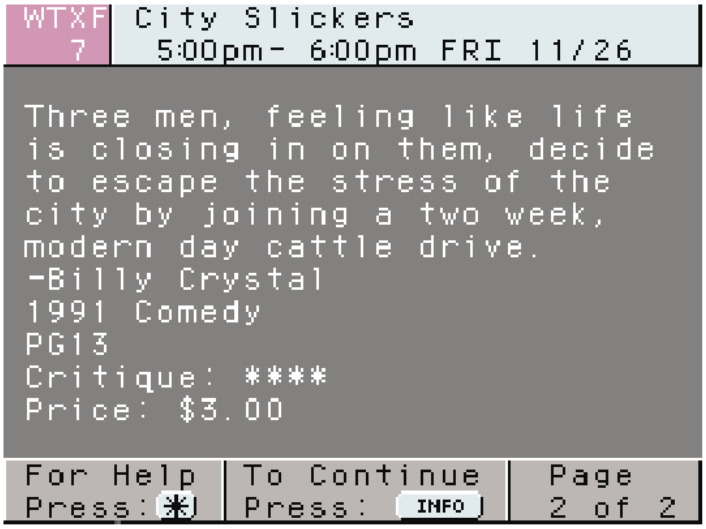

Figure 7: Program Information Accessed via the INFO Key on the Remote

The Browser feature shown in Figure 8 allows the viewer to call up a mini-screen that occupies only a small portion of the TV screen and answers the questions: What am I watching?, How much time is left?, What's coming next?, and What's on other channels?

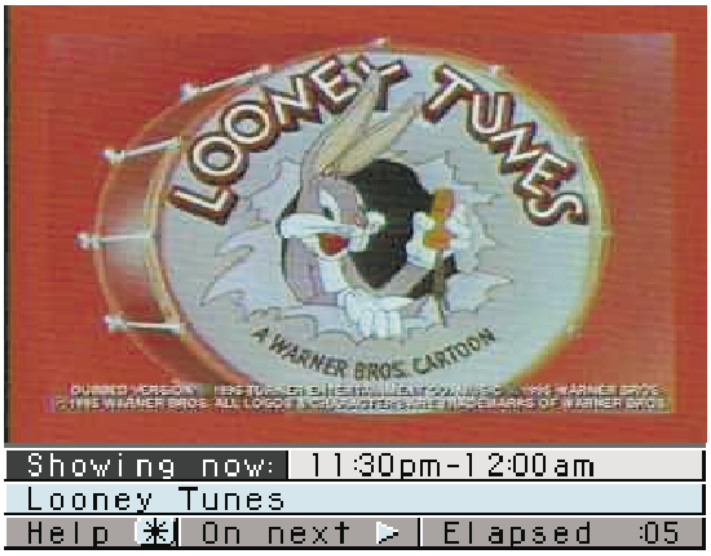

Figure 8: Browser

Figure 9, the Set Favorite Channels screen, allows the viewer to edit the EPG to show only those channels that are of interest. This feature speeds up the sorting process by allowing the viewer to create a personalized guide that shows only favorite channels.

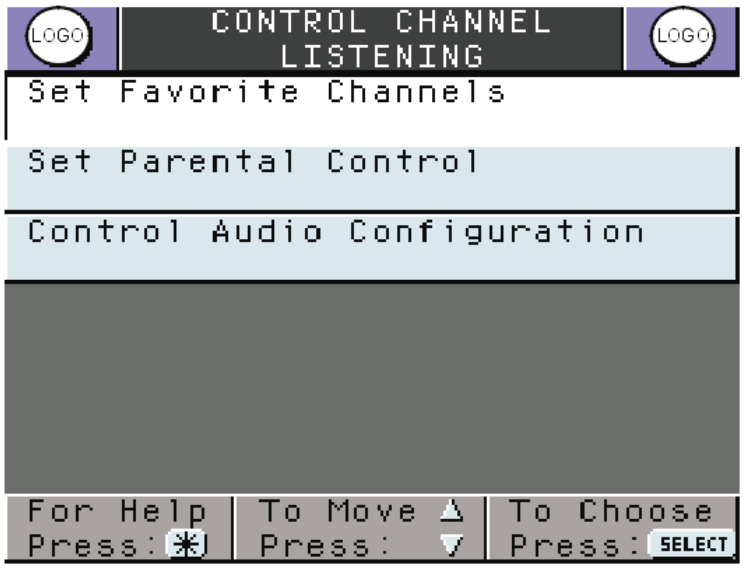

Figure 9: Set Favorite Channels/Parental Control/Audio Preferences

Figure 10 shows a typical channel lineup accessed by depressing the FAV key.

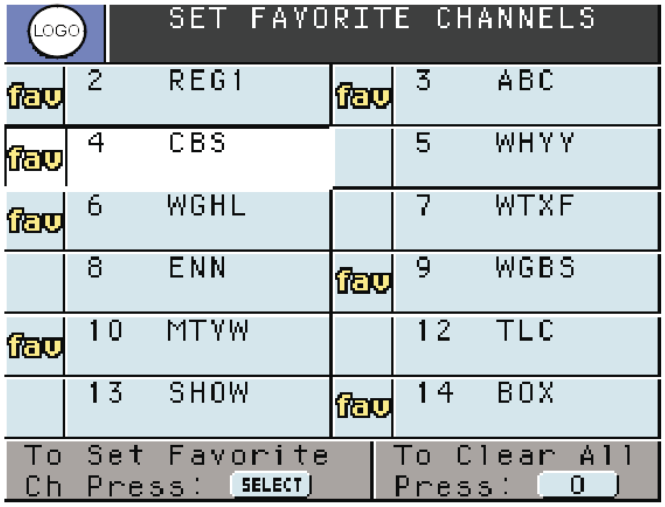

Figure 10: Favorite Channels

Figure 11 shows the EPG Parental Control screen. It allows parents to restrict access to programming by time of day, channel, MPAA rating ("PG," "R," etc.), and price ceiling. Access to restricted programming is "locked" and requires a password in order to tune to the channel. If the access code is lost or forgotten, the code can be reset from the headend. This feature requires that the parents contact the system operator by phone and provide a piece of information such as a driver's license or credit card number. The customer service representative will access their account file to verify authorization and reset the parental control password. New control data is then transmitted to the set-top, and in minutes the customer can access the locked programming.

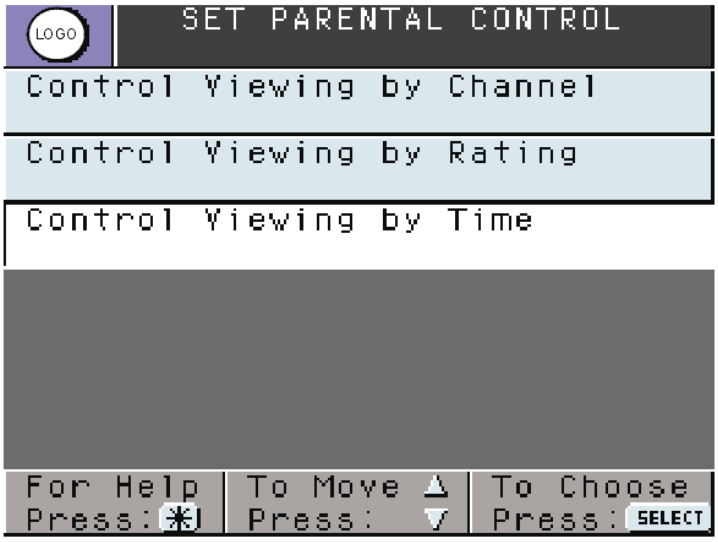

Figure 11: Parental Control

Figure 12 shows the Set-Top Terminal Setup screen. This screen allows the user to configure the set-top timers and defaults, such as display background colors. The setup screen is especially useful for installation technicians. They can use the setup screen to check system configuration information, such as:

- the model name of the terminal
- the current version of the guide in the terminal
- if the terminal is currently receiving data
- the presence of any error codes
- the state of the A/B switch
- the terminal output channel (3 or 4)
- the terminal multicast group
- terminal ID
- disconnect status (if terminal is receiving RF signal)
- whether the terminal is impulse pay-per-view capable
- whether the terminal is stereo-capable; whether the terminal has an IR blaster installed
- the current firmware version
- if the output video format is NTSC or PAL

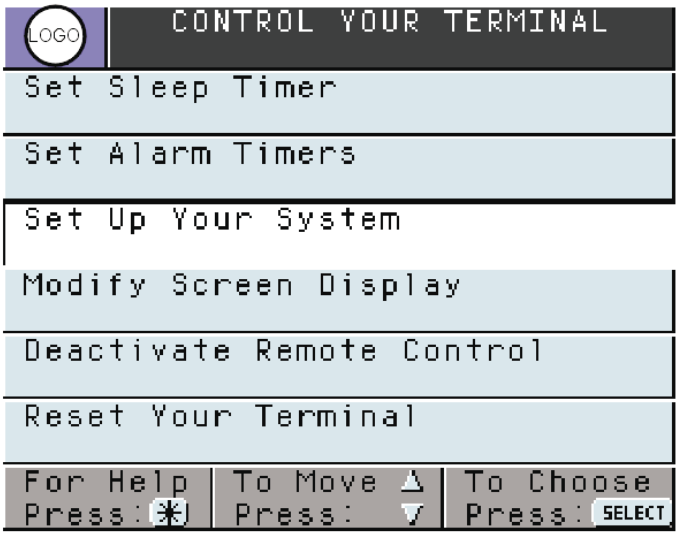

Figure 12: Set-Top Terminal Controls

Figure 13 shows the Sleep Timer screen. This feature allows those viewers who are in the habit of watching TV in bed to set up their set-top to turn itself and the TV off via a convenience outlet, after a set amount of time.

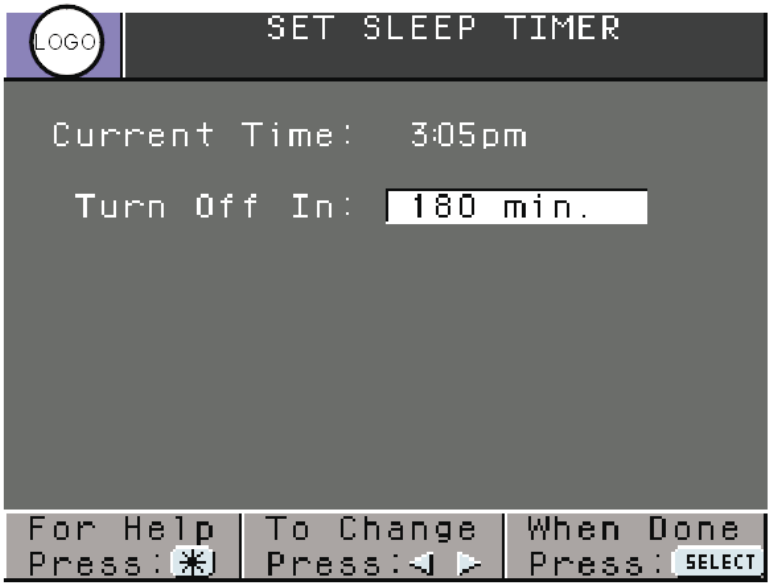

Figure 13: Sleep Timer

Figure 14 shows the Alarm Timers screen, which allows the user to set up his or her TV as a wake-up alarm, or as an intruder deterrent while away from home.

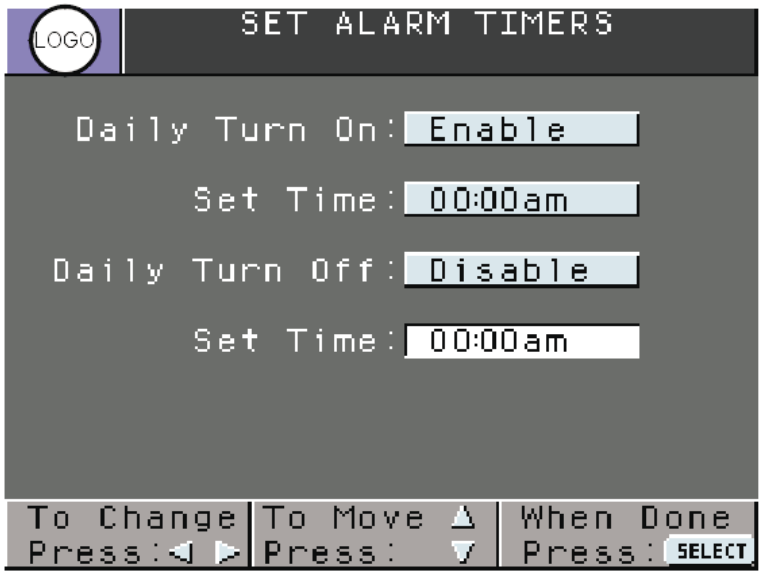

Figure 14: Alarm Timers

Figure 15 shows one of the most popular EPG features, VCR Control. This eliminates manual VCR programming by sending VCR control signals to a tethered IR blaster transmitter that is positioned in front of the VCR. When a program is selected for recording, the set-top turns on

the VCR, starts recording and then stops recording at the appropriate time. Because each brand and model of VCR has a unique set of IR codes, the correct brand and model of VCR must be entered in a setup screen. The IR codes are then downloaded from the system headend.

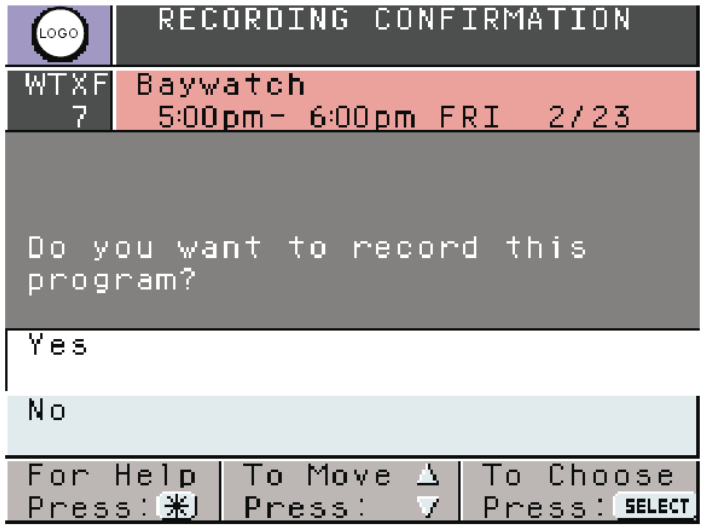

Figure 15: VCR Control – Recording Confirmation

Figure 16 shows the Pay-Per-View Access screen. EPGs, by their convenience and user-friendliness, facilitate impulse buying. Such purchases can substantially add to system revenue, but only if the subscriber is comfortable with the EPG and the associated remote control. Subscriber education at installation of the EPG is a big part of capturing this revenue.

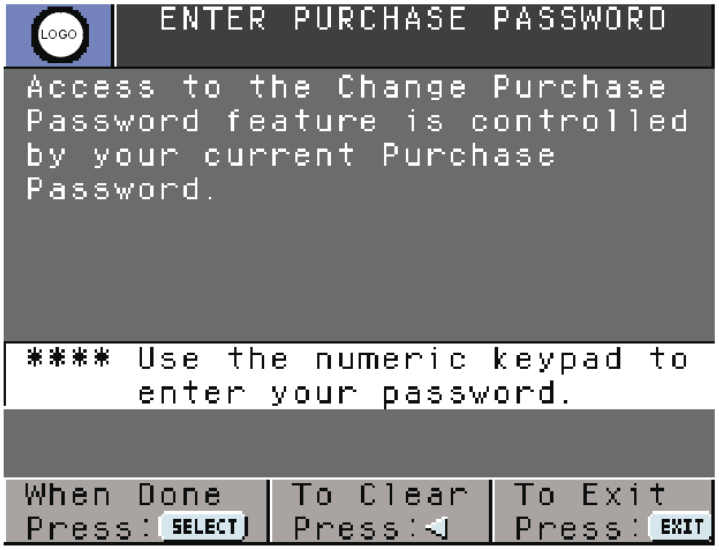

Figure 16: Pay-Per-View Access

The Pay-Per-View Confirmation screen in Figure 17 allows users to change their minds or cancel if the selection was made by accident. This feature provides a positive means of assuring that the purchase was made deliberately.

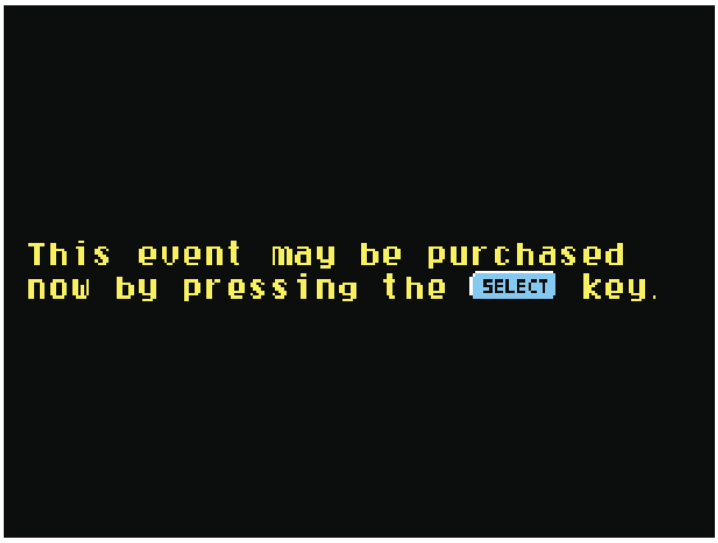

Figure 17: Pay-Per-View Confirmation

Figure 18 shows how an EPG's function may be integrated with audio channels and with text messaging that describes music channel offerings. This information is combined with the TV schedule data in the headend at the DPT computer.

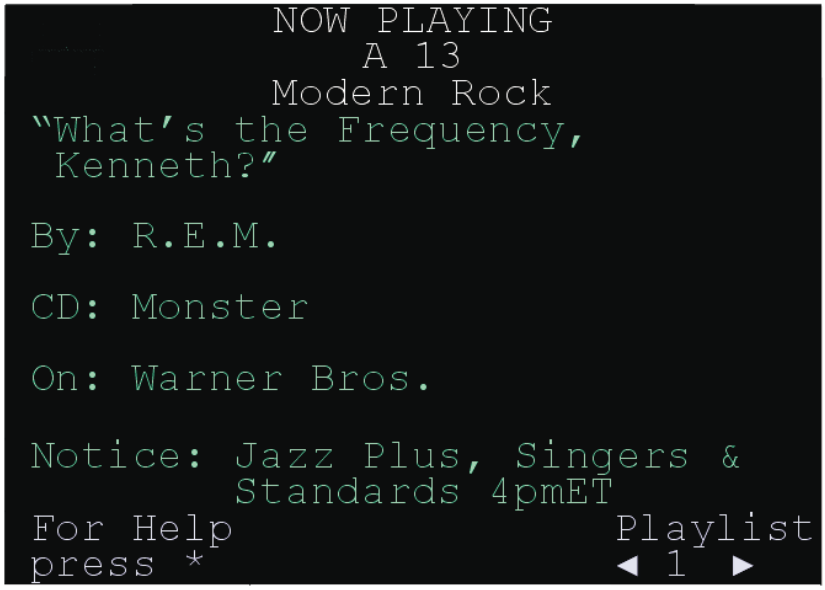

Figure 18: Audio Channels

Figure 19 shows how the EPG can be used to access interactive services that are delivered with the rest of the system's services. Linkage between interactive services and the EPG allows quick, easy access. Programs that are "enriched" by interactive content can be so indicated by the EPG.

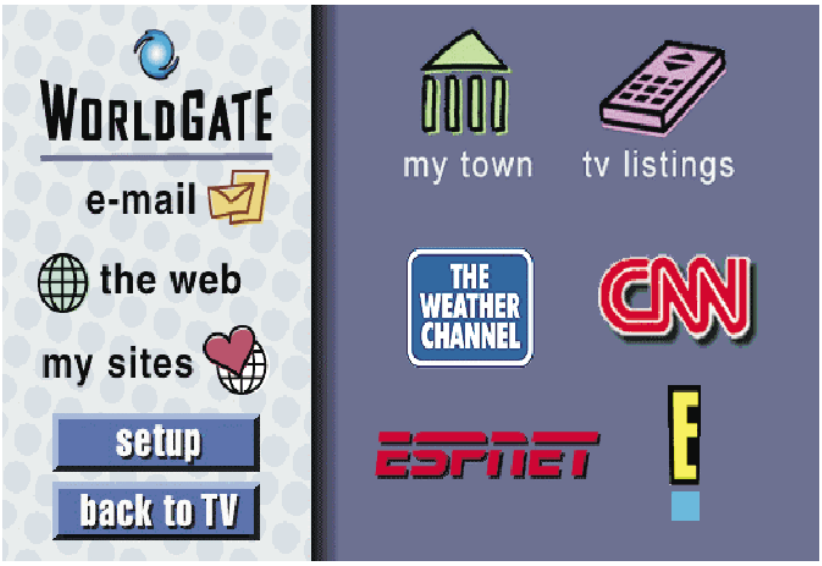

Figure 19: Interactive Access

Troubleshooting Tips

There are several common problems that may occur during setup of an EPG. Before we discuss troubleshooting techniques, some background information is helpful.

Because the data path to an analog set-top is typically narrow (14 Kbps) and shared by a large number of terminals, the available data rate for a particular set-top is usually quite small. For this reason set-tops are loaded with data off-line, prior to installation. By loading the data prior to installation, the installer is able to check the box immediately after installation and does not have to wait for downloads from a central source.

Typically this "off-line loading" is done with a computer set up for that purpose at the cable system's warehouse. Data is loaded into flash RAM memory that, once loaded, holds its contents even if power is disconnected. Flash RAM thus allows certain items such as descrambling codes, parental controls, pay-per-view purchase records, favorite channels or sleep timers to be held even if power is lost or the box is unplugged. Other information such as the program grid guide may be lost when the box is unplugged and may take 15 minutes or more to reload.

The process whereby data is distributed to set-tops is sometimes called *multicast*. Multicasting is data broadcast to groups of set-tops that have access to groups of services or programming *tiers*.

It is possible that through a setup error, a set-top may be accidentally assigned to the wrong group and therefore may receive the wrong EPG data.

Some set-tops are equipped with an internal RF Bypass Switch that allows the entire RF spectrum to be passed through the box, if desired. This allows RF signals to be passed to a second cable-ready TV or VCR for viewing non-scrambled channels. An A/B Switch may also be included so that a second, non-cable RF source may be selected for viewing.

Table 1 includes procedures for clearing several problem conditions.

Problem	Solution/Explanation
There are no listings in the guide.	This can happen if there has been a power failure or if the set-top has been unplugged. Make sure that everything is plugged in and running and wait 15 minutes. The grid guide should begin to fill in, and within 30 minutes, 12 hours of schedule should be available. If the problem persists, the set-top may need to be swapped out. If the problem is widespread and persists, there may be a problem with the headend data transmitting equipment or guide formatting computer.
EPG displays wrong data, channel map, times or incomplete information.	The set-top may have been assigned the wrong multicast address and is receiving data that is targeted to terminals in a different region. Select the setup option and confirm that the terminal is assigned to the correct multicast group.
Nothing happens when the MENU button on the remote is pushed.	If the set-top terminal was just installed, wait 15 minutes and see if the guide has been loaded. If this doesn't work, try unplugging the terminal and waiting another 15 minutes. If this doesn't work, swap out the terminal[4].
The guide has "locked up" and no keys on the remote will work, nor will the keys on the terminal.	Try unplugging the terminal and then plugging it back in. This will cause the scheduling information stored in the terminal to be lost, so it will take 15 minutes for the information to be reloaded. The terminal controls and channel up and down keys should work immediately. If not, swap out the box.

4 This troubleshooting step would probably be used by a customer service representative working with a customer over the phone. It would be most unusual (we hope!) for an installer to wait around for 30 minutes to verify a troubleshooting procedure.

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Cannot record programs from EPG.	Check software version on setup screen. Some software versions do not support VCR control.
Cannot see the edges of EPG screen.	Select Adjust Screen Position from the Video Setup screen and press arrow keys until the arrows on the screen are centered.
Cannot purchase pay-per-view event.	Check the viewer's credit limit on the setup screen and see if the purchase limit has been reached. Check to see if the terminal is on the list of non-responding terminals on the Terminal Diagnostics screen.
No stereo, or the sound is bad, or no surround sound.	Check the Audio Setup screen to make sure the terminal setup is appropriate for the customer's equipment. Make sure the stereo-enable setting is turned on in the Configuration Review screen. If the TV controls the sound, make sure the optimal stereo setting is selected.

Table 1: Example Troubleshooting Guide

Intelligent EPG Systems

Digital television is changing the way we watch TV, and when combined with the anticipated Intelligent EPG, the change will be profound. Without automatic sorting capability, the growing number of programs requires increasing amounts of time to sift through the available choices. Sorting can become discouraging as a subscriber scans through copious listings that hold little interest. For the discriminating viewer, it can seem like a search for a needle in a haystack.

An Intelligent EPG integrated with a digital VCR can be designed to perform advanced sorting. TV viewing is enhanced because the EPG presents the viewer only those offerings that meet personal interest criteria. Everything that is presented is immediately available for viewing from the digital VCR.

The Intelligent EPG, like a normal EPG, is a software program that runs in the set-top and is set up or programmed by the viewer. However, it is different from the average EPG in that it includes a database of information about user interests. It can be programmed to maintain separate listings for each member of the household.

For setup, the Intelligent EPG presents the user with a set of query screens that allow selections regarding favorite actors, directors, themes, sports teams or players, key words or other search or rejection criteria. For example, a Civil War buff who is also a Chicago Bears fan whose favorite actor is Clint Eastwood happens to be an avid birdwatcher. This subscriber can set up the Intelligent EPG to record all listings that mention the Civil War, all Bears games or sports talk shows that include a reference to the Bears, all Clint Eastwood movies (except those the

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subscriber has already seen three times), and all nature shows whose listings includes the key word *bird*. Then, the EPG automatically tunes to and records all programs that meet these criteria.

When this viewer sits down to watch TV, he or she checks the listings and finds *Gone with the Wind*, a show on yellow-bellied sap suckers, *Dirty Harry* and the latest Bears game. Since all these selections have been recorded by the EPG on a digital VCR, when the viewer selects *Gone with the Wind* from the EPG listing, the digital VCR starts the movie instantly and allows all the VCR features to be used.

This *timeshifting* feature allows a subscriber to watch favorite programs when convenient and to easily fast-forward through commercials. The ability to change both viewing time and remove commercial messages from content has been the subject of several discussions between programmers and companies like TiVo and Replay that provide personal viewing services. Programmers are concerned because timeshifting and commercial removal make it difficult to guarantee the value of a particular program timeslot to an advertiser.

Besides sorting through the broadcast listings using the criteria that a subscriber has selected, the Intelligent EPG will also track viewing habits and make suggestions based on shows selected by the subscriber from broadcast listings. For example, if the subscriber watched a new movie that did not meet any of the pre-selected criteria, the Intelligent EPG could note the director and actors in the starring roles and offer other movies featuring those stars or that director.

In addition, if the subscriber is an interactive TV viewer or has an internet-enabled set-top, the EPG and internet browser could be set up to share search criteria. For example, if an eighth-grade student performed a series of internet browser searches of the key words *supernova* and *astronomy*, the browser could forward these key words to the Intelligent EPG, and the EPG could search TV listings that might cause the recording of a Carl Sagan special on astronomy.

Summary

Electronic Program Guides are no longer just alternatives to printed media program guides. Especially with digital technology, an EPG provides a way to gain detailed program information, sort through viewing choices, and even record a personal selection of viewing alternatives. Personal viewing services that couple EPG technology with digital video recorders further enhance the possibilities for truly personal television.

The technician who installs or services the cable operator's offerings has tremendous influence in getting the consumer to use an EPG to its full potential. A subscriber's initial comfort level with a new remote and EPG is largely determined by the training he or she receives when the service is installed. In order to train the subscriber, the technician or installer needs to understand the various screens and their relationship to the remote control and needs to communicate their functions to the subscriber.

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Learning Just Enough to be Dangerous: Glossary

ATSC – Advanced Television Systems Committee. A U.S. standards organization commissioned by the FCC to issue system standards that build on the MPEG-2 digital video standard.

DVB – Digital Video Broadcast. A European standards organization that issues system standards that build on the MPEG-2 digital video standard.

EIT – Event Information Table. The PSIP table that carries program schedule information for each virtual channel.

ETT – Extended Text Table. The PSIP table that includes descriptive text not included in the EIT, but instead delivered in a separate data structure to conserve data bandwidth.

MGT – Master Guide Table. For each type of PSIP table, the MGT provides the location in the Transport stream, the current version of the table and the length in bytes.

MPAA – Motion Picture Association of America.

Multicast – Data broadcast to groups of set-tops that have access to groups of services or programming *tiers*.

PSIP – Acronym for the standard *ATSC A/65 Program and System Information Protocol (PSIP) for Terrestrial Broadcast and Cable,* which defines how EPG data is to be carried in MPEG-2 data streams in the United States.

RRT – Rating Region Table. Defines a *rating system* for a given region characterized by a number of *rating dimensions*, each of which is composed of two or more *rating levels*.

STT – System Time Table. Provides a reference for the time-of-day to receivers.

TSID – The U.S. standard governing EPG data carriage in analog video (EIA-752). It defines a 16-bit long analog Transmission Signal ID. An extension to the Vertical Blanking Interval data standard EIA-608A.

VCT – Virtual Channel Table. Consists of virtual channel definitions where each channel is characterized by the two-part channel number that the user will use to access the service, its text name, how the service is physically delivered, its MPEG-2 program_number, its “source ID” and the type of service.

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Virtual Channels – A virtual channel appears to the user as an ordinary channel, but may in fact be carried at a frequency other than that defined by the FCC. A virtual channel is given its channel number by a data structure called a Virtual Channel Table (VCT). This definition includes its frequency, method of modulation, a text name, channel type (analog audio/video, digital a/v, audio only, data) and the channel number the user may use to access it.

Testing Your Knowledge

1. What transmission methods are used to transport EPG data to set-top terminals?

2. What are the competing standards for carrying EPG data in MPEG-2 digital video?

3. What standards govern the carriage of EPG data in NTSC analog video?

4. Name two vendors of EGP application software.

5. Name three vendors of TV scheduling data.

6. How does an EPG control a VCR?

7. Explain the purpose of MPEG-2 Program Specific Information (PSI) Sectioning and Versioning.

8. What is Huffman coding?

9. What determines how far forward in time an EPG can look?

10. What features typify an Intelligent EPG?

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Answers to Issue 3-5 Questions

1. What data rates are supported by IEEE 1394 multimedia bus?

   The IEEE 1394 bus has scalable performance with speeds of 100, 200 and 400 Mbps supported. The next version, IEEE 1394B (backward compatible), will support a higher throughput, including 800 Mbps, 1.6 Gbps, and 3.2 Gbps.

2. What features enhance its ease of use?

   IEEE 1394 is "hot-plugable"; that is, devices need not be powered down to be added or removed from the bus. It is a "plug and play" interface; that is, it is self-configuring and self-managing, requiring no intervention from a host CPU.

3. What are the two types of transactions supported by FireWire?

   FireWire supports both isochronous and asynchronous data transactions.

4. How many nodes can be supported by an unbridged bus? A bridged bus?

   64-node addresses (0 to 63) are available on a single serial bus with address 63 reserved as a broadcast address that all nodes recognize. Therefore, the total number of addresses available for active devices is 63. Bus bridges allow as many as 1,024 busses to be connected, allowing for a maximum of 64,512 devices to be connected.

5. What is the maximum cable distance between two adjacent nodes? What is the maximum distance in a single unbridged network?

   4.5 meters (approximately 15 feet) between two nodes and 283.5 meters (945 feet) from end-to-end in a single network.

6. What techniques are available for exceeding the maximum cable distance, and how far can these techniques extend the bus?

   FireWire infrared repeaters are available that can transmit up to 30 meters, and plastic optical fiber transmitters are available for distances up to 200 meters. Also, non-standard cabling is available for cable lengths up to 10 meters.

7. How many types of standard cable are available, and what are the functions of the conductors?

   There is a six-conductor cable and a four-conductor cable. The six-conductor version has two conductors for data, two for strobe, and two for bus power. The four-conductor cable omits the power conductors.

8. What is fair arbitration?

   Devices on the IEEE 1394 bus follow a set of rules that allow all to get an opportunity to transmit data. Isochronous applications are guaranteed a constant bus bandwidth, while asynchronous applications are permitted access based on a fairness algorithm.

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