EXTENDED SERVICES IN A DIGITAL COMPRESSION SYSTEM

Jeffrey Cox, Manager, Digital Compressed TV
Gojo Strkic, Senior Software Engineer
Philips Broadband Networks, Inc.

Abstract

The coming of digitally compressed video opens the door to a variety of new services that up to now were either impossible or impractical to deliver over broadband RF systems.

The data stream of digitally compressed signals that delivers high quality video and audio services is equally at ease delivering any number of additional services, such as interactive video guides, multiple promotional channels, and sophisticated advertising and shopping services.
The cable system operator can now offer these services because digital compression makes it possible to send still frame images, low bit rate video, and teletext within a single stream.

This paper explores how digital compression makes the expansion of the services possible.

INTRODUCTION

Digital compression allows not only more of the traditional video and audio services, but also opens up the possibility of new services never before feasible.

These new capabilities also add new complexities. The use of the new features requires a system design that is both flexible and easy to use. Logical grouping of related services is needed. Higher levels of automation in both playout and generation of playout schedules are required.

In this paper, we will first look at some new services that are possible with state-of-the-art compression systems being developed to meet the emerging MPEG2 standard. We will then explore some tools and techniques needed to implement these new services. At the end we will illustrate how these techniques can be utilized to build the hypothetical shop at home service.

Digital delivery systems offer a wide range of features that can extend the impact of a conventional television signal:

any number of different audio languages can be sent with a given video service,

a large number of high speed teletext services can be supported,

auxiliary data services can be associated with a video channel, providing interactive on-screen displays, and

wide screen(16x9) pictures are possible, with the decoder cropping the picture to 4x3 format under the direction of commands embedded in the digital bit stream.

Also, many new features can be offered that were previously not practical:

the ability to receive and display single frame images accommodates many new or extended services, such as shop at home, classified ads, and electronic "yellow pages." The digital system provides a major extension of the current classified channel. In current systems, the user is at the mercy of the single, fixed rotation of slides. The user has no control over what is seen and may have to wait many minutes to see something of interest. Digital technology provides the opportunity to transmit a catalog of pictures and text, allowing the user to select items of interest.

For example, as many as 100 or more high quality full screen still frames per second can be transmitted, along with associated text, providing an on-line catalog of advertisements.

Interactive, user friendly program guides will incorporate still frame images or even short, low-resolution video clips. (As many as 50 short video clips could be run in parallel in a 6 MHz band, each using 1/9 of the screen.) Teletext overlays can prompt the viewer for selection of specific clips and display of explanatory text. Work on interactive text-oriented program guides is under way at many companies. Using these techniques they can be extended to be multimedia guides.

Video games can be downloaded, similar to a previous system in which games were downloaded from the cable into commercially available video game decks.

Encyclopedias and other references may be kept on-line for ready access. Pictures and text can be mixed into a common interactive data stream. This allows reference materials to be kept current, where CD-ROMs and books run the risk of becoming obsolete. Services can charge on a pay-as-you-go basis, making the service much more affordable than the purchase of an entire encyclopedia. This opens up a much wider customer base than would be otherwise available. More information can be found in Reference 2.

Of course, in a two-way system, all of these features can become interactive. In a one-way system all information needs to be sent repeatedly, since the source has no way of knowing what information the users may want to look at. In a two-way system, with even a very slow return channel, such as a 1200 baud asynchronous link, the information provider can determine what information is requested at any time, filling the data channel with only information that is likely to be needed.

While the advent of digital video systems opens the door to a number of new and exciting opportunities, it also presents a number of new challenges to the system operator. With new capabilities come new complexities. Figuring out how to make the best use of the huge available bandwidth will not be a trivial task.

For example, instead of transmitting up to 70 or so video services, the system of the future will be able to carry several hundred channels. The method of selecting a channel is no longer so straight forward, either. For the most part, channel assignments are standardized. Channel 42 is almost always found at 331.25 MHz. These standards are no longer relevant in a digital video system. The system needs to provide more than just an indication as to what frequency each channel is; it also needs to assist in allocating the resources within each carrier.

Most systems that transport subscriber video services offer a limited number of options for configuration of the video service. For instance, BTSC stereo allows the operator to transmit one stereo audio channel and a single, mono, secondary audio. Satellite systems such as D2-MAC and B-MAC offer a wider, but still limited set of options. Digital systems will allow a virtually unlimited set of options. The operator can decide how many audio services to attach to a single video service. Each audio service can have its own characteristics. It is also possible to turn the tables and attach a single audio service to a number of video or teletext services. The channel usage can be optimized by sending the unique components once and sharing them among different services. The digital system must provide the tools necessary to create this array of service packages efficiently.

The digital video system will also be dynamic in nature. Specialized services will come and go on a regular basis. The concept of "virtual channels" will become widespread. The services accessed by a specific channel can change frequently, allocating resources where they are needed most. The digital video system must have the capability of tracking these changes transparently. The subscribers should never know they are no longer watching the same electronic signal from one moment to the next.

One of the required tools in the digital video "toolkit" is a flexible channel mapping system. It must allow the operator access to the flexibility of the digital system while limiting the complexities of using the system.

CHANNEL MAPPING

Let us introduce several terms we use in the following text: a datastream file, a map, and a table.

A datastream file is a sequence of bytes that is transmitted repeatedly as a sequence of packets on a single Service Identifier (SID).

A map is used to describe the structure of the whole transport system (Global Channel Map) or structure of one band (Band Channel Map). Each map is subdivided into groups of related entities which are called tables (Channel Map Table, Service Map Table). Each map is transmitted under one SID and usually contains more than one table.
There are two channel maps that are transmitted separately in two datastream files: the Global Channel Map and the Band Channel Map.

To make our explanation simpler, we will associate the Global Channel Map with one satellite and Band Channel Map with one transponder. In real satellite implementation that may be the case, but the digital transport system can be implemented in several different ways. Similarly, the global map may be an entire cable bandwidth and the band map represents a 6 Mhz band.

The Global Channel Map is a master directory for the entire system. It provides a reference that the receiver can access at any time to find out where services are located.

The Global Channel Map is transmitted as a single datastream file. It consists of a numbers of tables, transmitted in order: a single Band Map Table, followed by a single Channel Map Table, followed by

multiple Service Map Tables, as shown in Figure 1.
Note that we need only one Global Channel Map per system. (For example, if we have two systems on one satellite we would have two Global Channel Maps).

The Band Map Table indicates how to find a particular frequency band, without providing any specifics about the services it carries. The Band Map Table contains one entry for each band on the transport system. In our example of the satellite system, each entry in the Band Map Table contains one entry for one transponder.

The Channel Map Table describes each of the available, user identifiable, entertainment or information channels. The receiver can store as much or as little of the channel map information as desired. Any information not stored can be retrieved at any time from the data streams. The equipment can trade off the cost of additional memory against the added channel acquisition time that might be incurred.

The Service Map Table describes a set of services that together comprise a particular channel.

There are many different service types that can be described by the Service Map Table. Some of the more conventional types are video with audio, video with stereo or second sound, audio only, and teletext. A single video service can be matched with any number of audio services, allowing multiple languages for a single video source. We can also conceive of a single audio track shared among multiple video signals. This can be useful, for example, if different views of an event are provided for the viewers to select. The ability to define new service types and send them out via service maps allows the system to evolve and grow as new requirements and new services are designed.

Each band has a system channel which is used to carry the Band Channel Map. The Band Channel Map is a subset of the Global Channel Map. It has the same structure as the Global Channel Map, but it is smaller since it relates to only one band. In our example, we can say it covers only one transponder. The SID for the Band Channel Map is unique.

MAP UPDATES

The large number of possible services can generate a dynamic system, with services coming and going on a regular basis. Changes to the system configuration need to be handled cleanly and communicated to the entire system.

The Global Channel Map Updates are carried as a separate datastream file on the system channel, using a unique SID. The idea is to convey the changes in the system to the receiver. The datastream file structure is almost identical to the Global Channel Map file shown in Figure 1, but with the addition at the beginning of the file of the header information shown in Figure 2. The structure of the Band Map Table, Channel Map Table, and Service Map Tables stays the same, keeping in mind the following. If no updates are to be made, the Band Map Table will be empty (Number of Bands = 0), the Channel Map Table will be empty (Number of channels =0), and the service map tables are omitted.

Band Map Table

Band Data (Id etc.)	Frequency	FEC Data	Satellite Data

Channel Map Table

Channel Data (Id etc.)	Band	Alternate Channel	Access Control

Service Map Table

Service Data	Access Control Data

Figure 1. The Global Channel Map consists of band, channel, and service map tables.

Map Updates

Time Stamp	Band and Channel Map Data

Figure 2. Header Information is the crucial part in updating the maps.

CONDITIONAL ACCESS

Besides the techniques of channel mapping digital compression system can also provide secure Conditional Access to services, so that viewers receive only the services for which they have paid. Recent advances in microcomputer technology and cryptology make reliable Conditional Access possible.

Conditional Access is a broad topic. We will briefly outline three major functions that conditional Access serves in a digitally compressed system:
Scrambling/Descrambling, Entitlement Control, and Entitlement Management.

The Scrambling/Descrambling function makes a program comprehensible only to viewers who subscribe for it. Every component of the program (service, in our terminology) can be scrambled separately. The descrambling is done in the receiver and is based on a secret parameter called the Control Word (CW).

The Entitlement Control Function provides the information about conditions required to access the program and accompanies the encrypted secret parameters. This information is packed in dedicated messages called Entitlement Control Messages (ECMs).

The Entitlement Management Function distributes the entitlement to the receivers.

The Scrambling/Descrambling function is usually done in hardware. Since Control and Management functions require use of complex cryptographic algorithms, they are done using a Smart Card . The Smart Card is detachable microcomputer the size of a credit card.

SHOPPING

The channel mapping system provides a tool kit that can be used to build the advanced user features we have already looked at. For example, we can build a hypothetical shop at home service.
Such a service might use a combination of many of the service types that have been described. The shopping service is accessed by selecting a particular channel number, just the same as selecting a conventional television channel. Our service will be assigned to channel 200, the CAble SHopping channel (CASH).

We will define channel 200 as a teletext channel. When channel 200 is selected, a text/graphics screen is displayed welcoming the user to the system and providing an index of available departments within the cable "store." Each department is represented by a channel number. For example, Sporting Goods can be viewed by selecting channel 210. Channel 210 lists a directory of categories within sporting goods, such as Baseball or Skiing. The contents of the selected category can vary from channel to channel and also with time on a specific channel. The Skiing channel, for example, might have a short clip of full motion video, showing a skier going down the slopes. This might be followed by still frame pictures of various pieces of ski equipment, one at a time, with a prompt to purchase the displayed merchandise. Once the user reaches this level of specialization within the shopping system, the system returns to a sequential access to views of a limited number of related items available for purchase. Ordering can occur by telephone, as it is today, or by entering a sequence on the keypad, similar to ordering an impulse pay-per-view event.

Impulse purchases would be collected by a store and forward technique, in most cases. With careful manipulation of the channel map, each category of merchandise can be allocated a time slot of active video to be intermixed with text and still frame screens. A single service channel can be used for several full motion video clips. The channel map control system allocates the single video source to several different channel numbers. For example, a single video might be shared between all categories within the sporting goods department. Each of nine categories might be allocated one minute time slots on a rotating basis. Alternatively, a single service could use most of the available video time to demonstrate the main sales item, similar to the current shopping shows. Other categories would still be available for inspection and purchase, using the still frame and teletext modes.

This method places a heavy burden on the channel mapping system. The channel map might be updated every minute. It is critical that the changes be performed cleanly. The network does have the luxury of maintaining complete control over how the switches are made. This provides an opportunity to use fade to black to mask any disruptions in the video display. This is an application where sending repeated "I" frames will provide real benefits.
The delay for displaying the newly selected video service will be only as long as the time needed to receive and decode a single frame. In this example, the security system does not pose a problem for rapid channel switching, since all of these activities fall within a single service. If any security is required, the same scrambling control can be used for the entire service.

CONCLUSION

The digital video system of the future affords the possibility of a whole new range of video and audio related services. The CASH shopping channel is just one of many examples of how this new technology can be put to work. With this increased capability comes increased complexity. Careful design of the implementation tools for the digital video system will provide the operator access to the capabilities of the system without making it so complex the features will never be used.

As standards for the compression and transport of video and audio signals fall into place, attention needs to focus on establishing a set of conventions for the configuration and operation of these systems.

ACKNOWLEDGEMENT

Special thanks to J. Wendorf of Philips Laboratories Briarcliff for discussions and sharing some of his ideas with us.

REFERENCES

[1] *"Philips Digital Video Compression System,"* System Specification

[2] J.Wendorf and H. Strubbe, *"Fast Digital Data Channels Enable New Cable Services,"* in 1992 NCTA Technical Papers pp 173-178