APPLICATIONS AND DESIGN OPTIONS FOR AN IN-HOME CABLE TV DIGITAL CONSUMER TERMINAL

Daniel E. Sutorius
Jerrold, General Instrument

Abstract

No longer are we in the cable TV industry focusing our discussions on whether there is a technology available to do digital compression of video for our applications. The technology has been proven, products for satellite transmission exist, and products for cable TV are not far behind. The focus now is more on how the cable TV industry may best optimize the deployment of digital compression. This paper presents various applications for in-home digital consumer terminals along with a discussion of related design options.

APPLICATIONS

What are some of the primary applications that will be enhanced and/or enabled by digital compression? My list would include the following:

* NVOD
* Cable On Demand
* Home Theater
* Multimedia
* HDTV

NVOD

Near video on demand (NVOD) trials have already been performed by Time-Warner in New York (Quantum) and as part of the TCI (VCTV) test in Denver. Both of these activities were done using good old analog video, as will the Viacom - Castro Valley system to be launched later in 1993.

The use of digital compression will significantly reduce the amount of raw bandwidth required for the transmission of the movies to be carried in NVOD applications. If we take for example 10 hit movies (2 hours in duration each) and assume repeated one-half hour start times, the total bandwidth required would be 40 times 6 MHz, or 240 MHz (40 NTSC channels). Utilizing digital compression at a ratio of 10-to-one (achievable for film sourced material), only four 6 MHz channels would be required, or 24 MHz.

The in-home consumer terminal will require the digital transmission and processing circuitry as well as some form of consumer friendly NVOD ordering system. A menu-driven NVOD system will offer movie selection through various database trails, including by genre, start time and titles as well as offer functionality familiar to today's video rental consumers such as pause, fast-forward and rewind.

If an operator wished to modify the menus, an amount of downloadable memory will be required to expand the code in ROM.. Options in this area include battery-backed SRAM (maybe in either 8k Bytes or 32k Bytes increments depending upon the desired flexibility). These options would allow for some

degree of menu/screen customization, additional basic functions (akin to favorite channel) along with other potential look-and-feel enhancements.

Cable-On-Demand

As the cable TV industry moves towards providing a greater selection of on-demand services, the segmentation of cable systems into fiber optic nodes serving 500 to 2,000 homes will be prevalent. In a cable-on-demand application, smaller fiber optic node sizes can be used to offset contention issues of anticipated on-demand services. The smaller the number of homes per fiber optic node, the less likely will be the probability of more subscribers wanting access to the cable system than the amount of available channels to that particular node at any given time. Digital compression also can be used to increase the effective bandwidth to each node and thereby alleviate contention issues.

For cable-on-demand, the in-home consumer terminal would need similar functionality as that required for NVOD applications with the possibility of increased bandwidth requirements due to the increased variety of personalized programming options (which could be offset by smaller nodes as mentioned above). It appears likely that the digital consumer terminals will often use 1 GHz tuners to allow for maximum future flexibility

Return path capability may play a more important role as upstream commands will need to be sent real-time in order to interact with switching processing upstream. Both RF and telephone return paths already are offered as options for today's analog systems. The extensive use of fiber optics in cable plant rebuilds has enabled the increased use of RF return paths due to the homerun nature of fiber optic return (node to headend) which simplifies maintenance and enhances performance.

Home Theater

Almost all advertisements for today's premium TV sets include a statement highlighting an S-Video input. Since the digital decompression process utilizes a component signal, it is relatively straight forward to supply an S-Video (Y/C) output on the digital consumer terminal (See Figure 1). Baseband video outputs are expected to be a standard feature.

The quality of the video will be excellent for the digital programs/movies. The digital compression algorithms available today can reproduce pictures at receive locations throughout the cable plant that are subjectively equivalent to the quality provided to the digital encoder. The digital picture quality will not degrade as the receive site is distanced from the headend, as opposed to the typical degradation associated with analog video (i.e. no visible noise or distortion created in the picture due to transmission).

Audio quality will be equally as impressive. CD quality transmission is possible with the proposed digital systems. An issue will exist with regards to the consistency of stereo sound between the RF and component outputs (baseband or S-video) of the digital and analog programs. The analog signals can be transmitted down the cable plant encoded in BTSC. These signals will be

provided to the digital terminals' RF output ports for decoding within today's stereo TV sets to provide Left/Right stereo sound. Without a BTSC decoder in the digital consumer terminal, the baseband output of the analog programs can only be monaural.

For the digital programs the reverse is true. The digital programs will be transmitted through the cable plant in Dolby® AC-2 or other similar formats. They will be decoded in the digital consumer terminals and therefore be provided in L/R format to the baseband ports. The digital signals will not be encoded in BTSC and therefore will only provide monaural sound to the RF port.

If the cable operator wishes to provide consistent stereo sound for both analog and digital programs at the baseband ports of the digital terminal, a BTSC decoder for the analog programs will be required. A BTSC encoder will be required for the digital programs if the operator wished to provide stereo for both the analog and digital programs at the RF port.

As with today's analog converters, if certain operators desired to only use the digital consumer terminal for the digital and scrambled analog programs, an RF bypass switch could be utilized. This option would allow the unscrambled analog programs to bypass the terminal and provide RF input to cable ready TVs (provided the TV tuner has adequate performance and bandwidth capability). It should be noted that the consumer would have to go into non-RF bypass mode if they wished to utilize the anticipated on-screen-displays (OSD) and electronic program guides (EPG) to be provided with digital consumer terminals.

Multimedia

Multimedia is an often used term in the trade press and shows. It's used so often and in so many different contexts that I wouldn't be surprised if many are somewhat confused about what it is. Depending upon the perspective of the person describing the term, multimedia is something involved with computers, consumer electronics, public utilities or cable TV. In fact multimedia could be key to all the above and more.

Before the term multimedia appeared a different moniker was used to describe many of the services now included under the multimedia umbrella. The term frequently used was interactivity. While the promise of interactive services always seemed around the corner, the fulfillment of that promise was not fully met for many of the proposed applications.

The cable TV converter provided the possibility of having one device that could act as the controlling interface for much of the functionality promised under interactivity. Current analog converters already perform varied functions such as that of a clock, switched electrical outlet, phone modem and messaging device.

While much is already possible with today's converters, tomorrow's digital consumer terminals will go much further towards enabling multimedia/interactive services. In a digital video environment, the digital data streams transmitting the signals from uplink through headend to the in-home consumer terminal will have the capability to carry data along with or

instead of the video/audio services. Over the cable plant, the data can be carried within the video multiplex data stream or out-of-band. One of the limitations of transporting the data in the video multiplex is that the data must be associated with the tuning of a video service. Out-of-band transmission allows for continual reception of the data stream by the receivers in the in-home terminals. Typically today's analog converters contain out-of-band receivers capable of ten(s) of kbps. Due to the anticipated higher volumes of data coming over the out-of-band path, optional receivers up to 1.5 Mbps are planned. The information coming down the out-of-band path will include access control and EPG. Depending upon the processing capabilities within the consumer terminal, the received data can either be processed internally or passed out of the terminal through a port to other devices/modules.

At cable TV shows in 1992 computer software manufacturers provided a glimpse of the possibilities of multimedia. Icon-based operating systems facilitated access to programming and/or information services. These types of operating systems will typically require processing capability and memory beyond that usually found in today's cable TV converters or even that which will be required for baseline functionality in digital consumer terminals.

To provide for ROM and RAM expansion capability, access to the digital terminal's primary microprocessor bus is offered through external ports or internal connectors (processor interface, "PI" port, in Figure 1). Internal connectors allow for the insertion of computer-like modules. These modules could contain state-of-the-art microprocessors, operating systems, user interfaces and memory that would allow for the upgrade of the basic digital terminals. This would allow the cable TV operators to make the upgrade investment only in the cable systems and subscribers' homes where this functionality would have economic justification.

A key component to any multimedia scenario is having the right architecture and tools to enable various third party programmers to be able to create attractive new programs to run on these computer-like converter platforms. Without these programs there will be little incentive for consumers to pay the envisioned premiums for the hardware and services.

What are some of the examples of how a multimedia environment may add value to the cable subscriber? One way could be associated with the watching of music videos. The data sent to the terminal could include the lyrics of the songs being played, information about the artist, ticket information for their next concert and potentially the ability to order the related CD. If a subscriber is watching a baseball game, information about a specific team and/or player could be viewed while watching the game as well as the ability to switch between various camera angles or replays.

Digital compression and processing may not be the technology that makes interactivity a successful business for cable TV, but it should certainly help enable a more accurate determination of consumer preferences/demand.

HDTV

The Federal Communications Commission's high definition TV (HDTV) standard selection process is well underway and has focused on digital techniques. Until the final decisions are made regarding a standard, a likely plan for digital consumer terminals is that they output the decrypted digital signals associated with a particular HDTV program out a port capable of data rates of ten(s) of Mbps. This data would then be delivered to an appropriate digital interface to a digital HDTV television.

SUMMARY

The future is not now, it is already behind us (at least with regards to cable TV's technical capabilities). The challenge ahead is to apply cable's cutting edge technologies like digital compression in a way that optimizes value to cable TV subscribers of today and tomorrow.

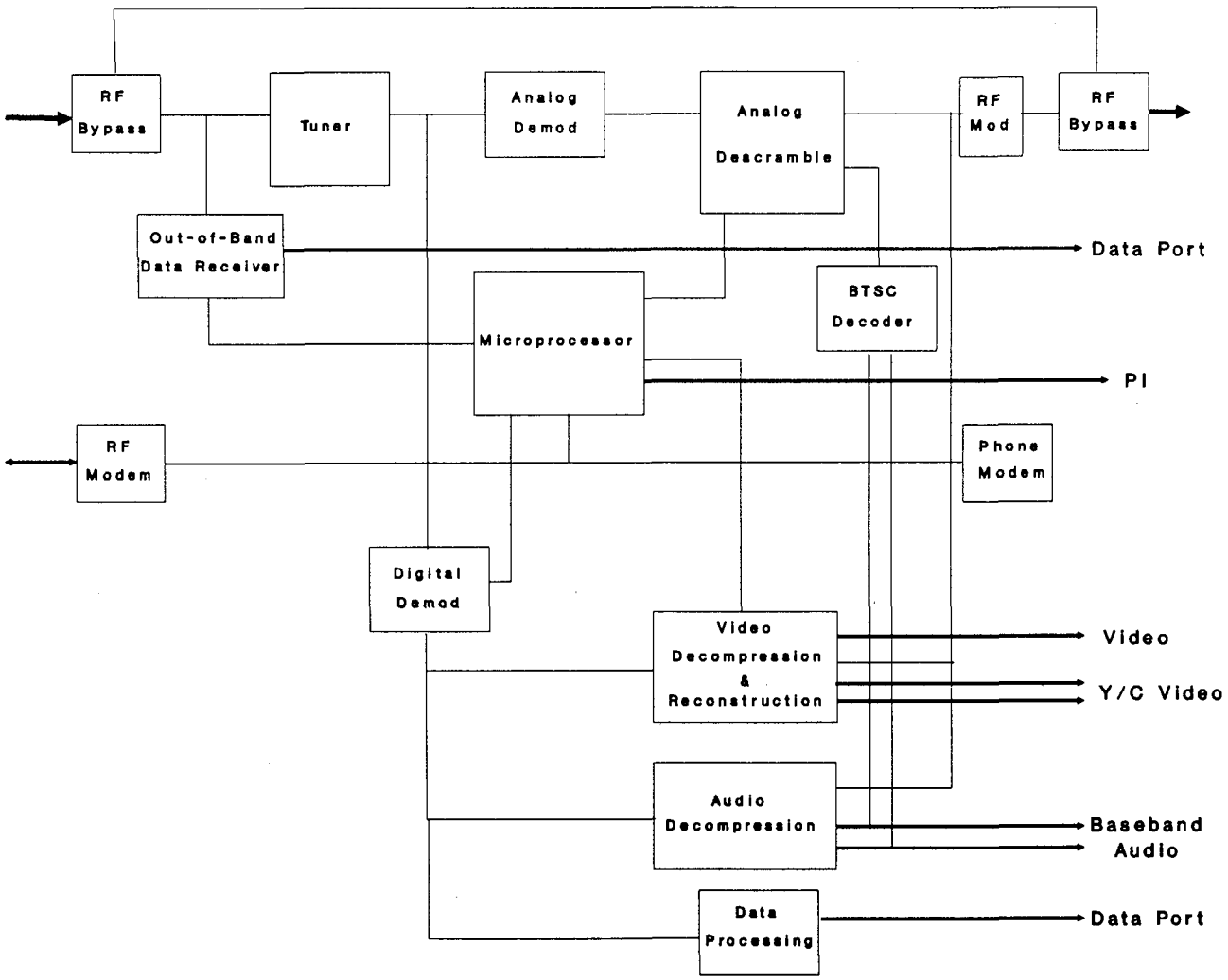

Figure 1 - Digital Consumer Terminal Functional Diagram