COMPARATIVE STUDY OF ONE-WAY DATA DELIVERY SYSTEMS

Gregory T. Woodsum

Zenith Electronics Corporation

ABSTRACT

One-way data delivery systems have been receiving more focus lately for data communications. One reason for this is that one-way data delivery systems use the same transmission principles that have made television and radio common communications tools which help minimize receiver costs. Also, the number of receivers in the field does not greatly influence the cost of delivering the information. Therefore, having more receivers in the field actually reduces the communications costs per receiver. The recent focus of one-way data communications has been at extending the use of satellite, radio, and television transmissions for data. The capabilities for each of these communication technologies to support data will be investigated.

INTRODUCTION

Nationwide data communication has been very successful over the past few years for private and in some cases public networks. As the cost of nationwide two-way data communications increases at a steady rate, more investigations and activity into one-way data delivery systems have begun. There have already been many successful systems for one-way data delivery using satellite transmissions directly to receive-only satellite antennas (dishes). Recently, more focus has been aimed on the use of the satellite as the national distribution of data but using alternative methods for the local distribution of the one-way data stream.

SATELLITE

Satellite communications is the focal point for all nationwide communication needs. Ample bandwidth is available for multiple uses of each of the transponders on any given satellite. However, there are some limitations and some complex issues regarding the use of C-Band and Ku-Band allocations for data communications. The major issue is dish size (which impacts the installation costs) versus acceptable Bit Error Rates (BERs).

The typical C-Band transponder available bandwidth with most satellite receivers is 27MHz. Much of the bandwidth is used for video but there is room for at least a half-a-dozen narrow band sub-carriers running at 19.2Kbps each. In order to actually use this capability with acceptable BERs requires a fairly large earth station and/or very expensive receivers. Alternatively, when a transponder is used only for data communications, smaller dishes can be used by using a technology called spread-spectrum. Using this technology, more bandwidth is used per bit but the system allows for the implementation of considerably smaller dish sizes. Spread-spectrum allows for approximately 100Kbps of data per transponder while using 2-foot receive-only dishes.

Low power Ku-Band satellites which allow the receiver to use the smaller dishes have significantly reduced the receiver costs but alternatively have problems with reception under adverse weather conditions. High power Ku-Band satellites, however, are expected to overcome some of these stumbling blocks but neither of these satellites are as available as their C-Band counterparts nor have as large of a footprint.

Another stumbling block in direct satellite distribution has been that each receiver must have its own dish. One effective implementation to get around this problem is to translate the received data into the FM band of a cable system and send it down the cable. This has been a very adequate solution for data communications at 19.2Kbps and below but does require the installation of extra hardware at the head end of a cable

system. The over-all costs for the distribution and receivers in this configuration is much more reasonable than with individual dishes.

Direct satellite communications however complex is well understood and can provide excellent bit error performance in a very simple national distribution chain.

RADIO

Radio is a good source of data communications primarily because the cost of the receiver is very inexpensive. Pocket radios are commonplace and the technology is well understood. There have been two major reasons why radio has not been a larger player in data communications:

1) There is no good way to tie the local radio stations into a nationwide network.

2) Previous FCC regulations allowed only one 9.6Kbps data channel.

Satellite communications have played a major role in removing the first stumbling block. Many radio stations have installed their own dishes to receive information on a national basis and this trend is expected to continue. The second hurdle was removed when the FCC deregulated the radio stations and allowed more bandwidth to be used for ancillary purposes such as data communications.

Technically, FM Radio Stations have always had a 200KHz wide bandwidth between carriers. This gives the station a baseband bandwidth of 99KHz which was expanded from 75KHz after FCC deregulation. The stereo audio portion of the bandwidth uses up the first 53KHz and allows the remaining 46KHz to be used for ancillary purposes. When the remaining bandwidth is used for data communications, slightly more than 38Kbps is available.

Hardware is beginning to appear in the radio stations to make use of the extra bandwidth for data communications. However, further testing is required to determine the BER using the expanded communication channels and the amount of Forward Error Correction (FEC) that is required. Also, because most of the local radio transmission stations are not manned, local insertion of specialized data is not anticipated.

TELEVISION VBI

Television is definitely an exploited communication medium. It is almost a universal language in itself and already has a national distribution network in-place. The primary reason the use of the television's Vertical Blanking Interval (VBI) has not had more wide-spread use as a data communication medium is because the VBI is very fragile. Less than 4% of the televsion signal can be used for data communication without affecting the normal video. In order to achieve the high data rates that the VBI can transmit, the realized BER is affected. There are essentially two reasons why the VBI is a fragile medium for data communications:

1) The data is tied directly to the video, therefore, when there is a loss of video (i.e., sync) the data is also lost.

2) The data is AM modulated, therefore, it is not immune to impulse noise.

Technology for stripping the data out of the video has improved tremendously over the past few years which has allowed for the improvement of the bit error performance. Unfortunately, the underlying causes for the errors still exist. The solution for making the VBI a viable communication medium has been to insert appropriate FEC codes to recover the data that is lost. By understanding the mechanism for how the data is lost, the FEC codes that have been implemented are beginning to prove that the VBI is a very viable data communications medium.

The VBI consists of approximately 10 lines onto which data can be inserted. The standard instantaneous data rate is 5.7272Mbps. This computes to be an aggregate data rate of 19.2Kbps per line when using both fields. If all 10 lines were to be used for data communications, the effective data rate would be 192Kbps. However, without an appropriate FEC code to permit an acceptable bit error performance, this data is not very useful. Inserting an FEC code and addressing information into the data stream decreases the aggregate data rate approximately 20% to around 15.5Kbps per line. This would still provide almost 155Kbps if all 10 VBI lines were used.

Similar to the radio networks, hardware using the improved FEC coding is beginning to become available. Performance testing is still a major issue because reception is varied across the nation and within different localities. These seem to be minor stumbling blocks because the majority of the receiving stations that have been tested have shown exceptionally low BER. Additionally, the national distribution of the signal is already in place.

The next step in VBI communications is to get more systems on line and more

local insertion of specialized data to augment the nationally delivered information. Even without local data insertion, the television's VBI is a viable data communication medium because no costs are involved in the local distribution of the data other than the delivery of the normal video to the subscriber.

CONCLUSION

One-way data communications is going to be more of a growth area over the next few years. This will happen through three different distribution media: satellite, radio, and television. Satellites will be the dominate national distribution medium with radio stations, television broadcast stations, and CATV operators becoming a larger part of the local distribution of one-way data. The technical considerations are better understood for this type of communication and the technology is available. The next major hurdle is to educate the marketplace so that they can make better use of their data information and the resources available to them.