STORE AND FORWARD IPPV VIA THE TELEPHONE RETURN PATH

by

Dennis R. Clark

GENERAL INSTRUMENT CORPORATION

ABSTRACT

Utilizing the public switched telephone network for Impulse Pay-Per-View (IPPV) is an appealing alternative to building and maintaining a two-way cable plant. The telephone system provides a reliable means of communication for both voice and data. What will happen when it is subjected to concentrated peak loads for Impulse Pay-Per-View purchases? The 'store and forward' IPPV system provides a method to eliminate peak loads. The subscriber terminal must be a 'smart' addressable unit with non-volatile memory and auto-dial modem capability. The terminal stores the purchased event service code and time of purchase. At a later time the terminals are commanded to call, in organized 'calling groups', to report their stored purchases. This paper examines the operation of a hybrid cable/telephone IPPV system and how it will work in a real cable system environment.

INTRODUCTION

In order to demonstrate the potential use of a hybrid cable/telephone IPPV operation the entire system will be examined from the scheduling of events to the impulse purchase or "store" to the data collection or "forward" process. The telephone specific considerations will then be examined to show the practical application of the automatic dial modem (terminal) in the subscriber's home. A successful operation will require not only that the data collection process is reliable, but also that it does not interfere with the subscriber's use of the telephone. From the cable operator's point of view the terminals should be relatively easy to install, the system should be automated to avoid billing errors, and it should be easy to maintain.

Some commonly asked questions are :

- What equipment is required for data collection ?
- How are the events scheduled for purchase ?
- What is the maximum rate of collection possible ?
- How many phones/terminals can be installed in a home ?
- Will there be contention with the subscriber's telephone ?
- What is the Installation time required?
- What are the FCC regulations and requirements ?
- How much security is required ?

The answers to these questions and others are the topic of this paper.

TELEPHONE IPPV HARDWARE AND SYSTEM ARCHITECTURE

The telephone IPPV system looks much like the traditional addressable cable system with a few minor additions. One or more incoming telephone lines are installed and attached to as many auto-answer modems. If more than one incoming line is needed a rotary or 'hunting' configuration is installed by the telephone company in the central office so that one telephone number can be used for multiple lines. The auto-answer modems are normally 300 baud since the transaction time is short and this is the most reliable form of data communication over the public switched network. The modems are connected to a telephone controller where the incoming data is collected for later transfer to the billing system. The addressable controller actually has the job of assigning the 'calling groups' for a controlled sequence of data collection with minimum telephone usage and maximum throughput. The telephone controller may actually be part of the addressable controller in smaller systems, or systems with few event offerings.

The home terminal consists of a 'smart' addressable converter with an auto-dial modem and non-volatile memory for storage of the purchase information (data). It is capable of 2-way communication over the telephone and must be registered by the FCC under part 68. It must be capable of distinguishing the event being shown, allow the subscriber to purchase it, keep track of credit usage, and return this data back to the telephone controller on command. Besides being able to dial and communicate, it must also allow the subscriber to have priority use of the telephone.

The rest of the system is likely to be the same as an existing addressable control system with the possible exception of the schedule driven scrambler/encoders. The encoders will store a sequence of event schedules and automatically switch on the exact time to the next control setting in its memory. Each encoder has its own time clock and non-volatile memory storage so that it can survive a power outage and return to its scheduled settings. These time clocks are synchronized by the addressable controller and keep accurate time even with loss of power. This fail-safe method can ensure the maximum protection against lost revenue due to computer down time and power outages. This aspect becomes especially important when offering high-priced blockbusters on a regular basis.

The complete system diagram would be as shown in Figure 1, which shows all of the basic components in a telephone IPPV system.

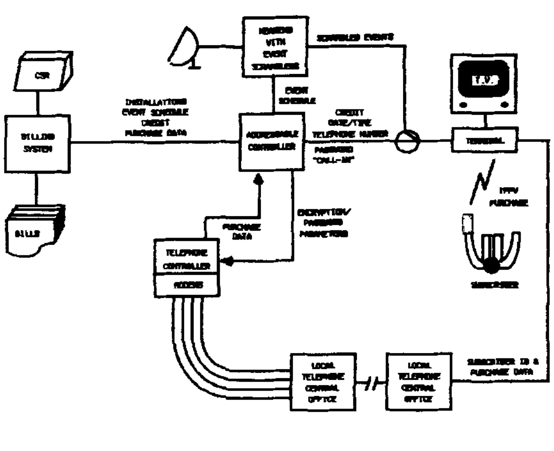

FIGURE 1: I.P.P.V. SYSTEM WITH TELEPHONE RETURN PATH

EVENT SCHEDULING

The source of the IPPV system is the programming material which the cable operator supplies on one or more channels. The event schedule supplied with this programming must be entered into the billing system, the addressable controller, and the headend scramblers/encoders. This schedule consists of a 'service code' for each event with a given 'preview time', 'purchase time', and 'no-purchase time'. The service code is transmitted (in-band) with the scrambled program to identify the purchased event.

The 'preview time' allows the viewer who has not yet purchased to watch a preview segment of the upcoming event with the option to purchase at this time. The 'purchase time' is when the event is no longer viewable by subscribers who have not yet purchased it, and therefore must be purchased to continue viewing. After a predetermined time into the event the 'no-purchase' option may be used to avoid a mistaken purchase for the following event during the end of the current event (see figure 2).

Both the service code and the time of purchase are used to identify a purchased event, so the service code may be re-used at a later time.

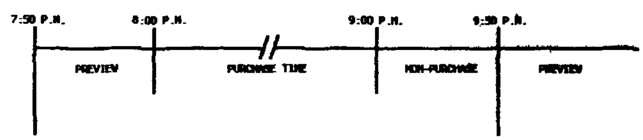

FIGURE 2: EVENT SCHEDULE

IMPULSE PURCHASE OR STORE

The 'store' operation occurs when the subscriber tunes to an event channel and initiates a key sequence to buy the event. Recent studies indicate that subscribers will use this method four times as often as subscribers who must initiate a telephone call to the cable office for the same services.

If the home terminal is 'allowed' to purchase, the event is simply descrambled and the transaction is stored in non-volatile memory. The terminal must verify the following before allowing the purchase:

- Purchase code (PIN) was entered correctly.
- Credit limit is not exceeded.
- Current date and time is known.
- Channel is not parentally controlled.
- Event program is in 'preview' or 'purchase' time.

To help the subscriber and/or cable operator to identify a problem with purchasing, an informative message should be displayed on the terminal. Normally this process is successful and will subsequently appear to the subscriber as an instantaneous authorization by the cable operator to the requested purchase. The terminal will store the following information to log the purchase for collection at a later time :

- Event service code.
- Date and time of purchase.
- Status information (valid, collected, etc.).

DATA COLLECTION OR 'RETURN' PATH

Any two-way IPPV system requires a reliable and effective method to collect purchase transactions for billing. The subscriber must be aware that it is impossible to steal service or avoid the billing process.

The collection process may vary a great deal depending on the number of subscribers, the number of events offered, and the penetration rate of the events. The system design must accomodate a data collection process capable of collecting the data :

1. Within the established billing cycle
2. Before the terminal runs out of storage.
3. Before the terminal security disable.

Since many systems use multiple billing cycles, special considerations may be needed to ensure the timely collection of transactions. If many different events are offered it may be necessary to perform a 'skimming' operation to collect data from the heavy users. Certain security aspects must also be considered in the terminal to ensure that the purchase data is collected within a given timeframe.

When examining the efficiency of data collections in a telephone return path it is obvious that the number of incoming lines should be directly proportional to the amount of data that can be collected in a given period of time. There are many other opportunities to maximize the system throughput which may not be quite as obvious. Among these methods are :

- Require only terminals with purchases to call-in.
- Provide a 'skimming' operation (call-in if > N purchases).
- Overlap calling groups (eliminate dial & connect time).
- Allow for maximizing the usage of incoming lines by providing retries after a busy signal.

These methods can be used to 'tune' the collection process depending on the system size and event penetration.

In actual operation there are several situations that hamper data collection. These are :

- Subscriber's phone is in use.
- Terminal is unplugged from AC power.
- Telephone connection is unplugged or faulty.
- Only one terminal in the home can call-in at a given time.

The system must allow for these conditions by providing multiple (time-shifted) collections and a method to identify the faulty terminals. Additional consideration may be needed to determine the number of phone calls generated from the subscriber's home, especially if they are toll calls.

SYSTEM THROUGHPUT EXAMPLE

It is reasonable to assume that a successful IPPV operation may be running 12 events per day on two channels. It is unlikely that a subscriber would purchase all 24 events in a given day since he can only watch one channel at a time for a period of less than 24 hours. Since the events are reshown it is more likely to assume that an average viewer will purchase two events per week. If the terminal can store 16 events it will then be necessary to collect the transactions for the average subscriber at least once within an eight week period. Assuming that we will collect transactions once a week (8 times more often) and the data collection time is 15 seconds, the following shows the theoretical limit for system throughput with one incoming line :

```
15 sec/box     =      4 boxes / minute
               =    240 boxes / hour
               =  5,760 boxes / day
               = 40,320 boxes / week
```

With 10 incoming lines :

```
               =  57,600 boxes / day
               = 403,200 boxes / week
```

The total I/O processing power in the latter case is 3 KBaud continuously (10 lines x 300 Baud) with the ability to store 1.3 transactions/second (10 lines x 2 transactions / 15 seconds). This is a moderate job for today's microcomputer with a hard disk. Of course the total load on the telephone system is only 10 to 30 calls continuously.

Since it is impractical to use theoretical limits in real life, system throughput should be cut by the expected inefficiencies. For example:

- 12 hour/day data collection.	50%
- Non-maximized incoming line usage.	5%
- Second pass and special collections.	5%
- Computer or cable system down time.	1%

Keep in mind that the percentage of inefficiency is not always additive and the efficiency of this example would most likely be represented as:

(100 - 50) x 0.95 x 0.95 - 1 = 44.125 %

57,600 boxes/day x 44.125 % = 25,416 boxes/day

If the system size increases beyond the limits of the equipment, another telephone controller can be added in parallel. If it has the same number of incoming lines, the throughput will double.

TERMINAL CALL-IN SEQUENCE

When a terminal is commanded to call-in to report transactions to the cable office it first must determine if it has anything to report. If not, then no attempt to call is made. If so, the terminal must be sure that :

1. The phone is not already in use (either off-hook or dialing).
2. The phone is not ringing.

After determining that the phone is free to use, the following sequence occurs:

1. Take the phone off-hook.
2. Wait for the dial tone.
3. Dial the (downloaded) phone number.
4. Wait for pickup and carrier detect.
5. Receive first command (encrypted).
6. Respond and continue dialogue.
7. Hang up.

This complete process takes approximately 35 seconds under typical circumstances and is illustrated in Figure 3. Ideally the terminal should be capable of relinquishing the line to the subscriber at any time to avoid a conflict. Also, the terminal should be capable of hanging up and redialing after a given period of time if the correct signals were not present the first time (ie. busy signal). The number of retries should be a downloadable parameter.

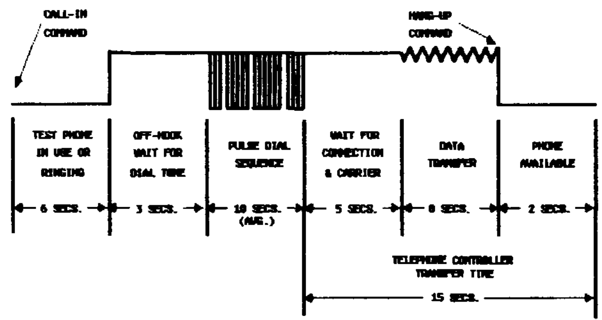

FIGURE 3: CALL-IN AND DATA TRANSFER SEQUENCE

PULSE DIALING AND RINGING

Pulse dialing is normally selected since it is universally available throughout the United States. The dial sequence consists of a series of 100 millisecond 'breaks' and 'makes' for each digit, with a 0.8 second inter-digit gap (see Figure 4). Using these values the time for each digit is:

1 = 0.9 sec	6 = 1.4 sec
2 = 1.0 sec	7 = 1.5 sec
3 = 1.1 sec	8 = 1.6 sec
4 = 1.2 sec	9 = 1.7 sec
5 = 1.3 sec	0 = 1.8 sec

It is easy to see that a telephone number with more 1's than 0's is faster to dial. Some sample numbers are:

123-4567	8.4 sec
555-9000	11.0 sec
1-800-123-4567	14.5 sec

The ringing pulse is an AC signal superimposed on a DC biased level. The ringer frequency, duration, and voltage can vary widely as shown in Figure 5. The terminal must wait up to 6 seconds to determine if the phone is ringing before going off-hook to dial.

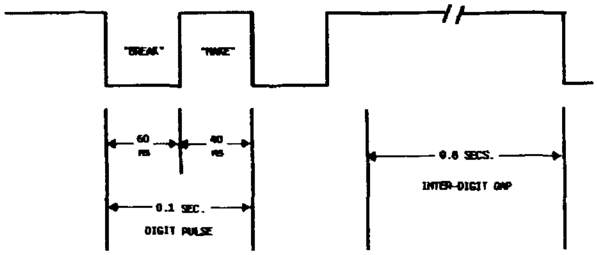

FIGURE 4: DIAL PULSES

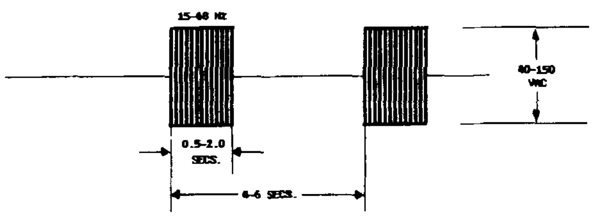

FIGURE 5: RINGER SIGNAL

DATA SECURITY

Since the telephone is widely used by computer hobbyists or 'hackers' it is advisable to add some security to the data transmission. Encryption methods can be used to stifle any attempts at breaking into the data collection scheme. Also both the terminal and the headend should hang-up if the wrong data sequence is received.

Anyone attempting to steal event services by unplugging the telephone connection may find that they will lose their complete service when the terminal realizes that it is unable to communicate. If no events are stored, the terminal will function properly without the telephone connection. If an event is purchased and the terminal fails to call-in after multiple data collection cycles, the security timer will eventually timeout and cause a loss of service until the situation is corrected.

INSTALLATION AND MAINTENANCE

The connection of equipment to the telephone network requires additional training, special tools, and additional hook-up equipment. Although the installation of an extension phone is similar to that of a cable outlet, the system is entirely different in nature and therefore requires some basic knowledge. A simple phone system uses 2 wires called 'tip' and 'ring' to carry the signals for off-hook, dial, ringer, and voice or modem signals. These signals have certain constraints and should be well understood by the installer/troubleshooter. A maximum of five ringer loads (REN) may be connected to a given phone line. Any device registered by the FCC has a REN number listed on the FCC label. Certain voltages are allowable for on-hook and off-hook but these can vary with humidity and may affect the terminal operation. DC voltages can change polarity to indicate toll calls.

A telephone installer will require a voltmeter, a handset ($300.00), and a crimper ($75.00) at a minimum. Recent experience has shown that it is rare to find a telephone jack in close proximity to the television. The additional time required for the telephone installation is roughly estimated at 45 minutes, with most installations requiring wall or carpet fishing. Some good aspects are that the phone connections already exist in the home and the telephone is traditionally reliable.

CONCLUSION

It is easy to conclude that the store and forward IPPV concept, used in conjunction with the telephone return path, represents a realistic and workable approach to the Pay-Per-View business. As with any Pay-Per-View system it is complex and should be well understood by the operating personnel. The system is structured for mostly automated operation with no loading of the telephone network. The processing power has been distributed to the ends of the system where it works best, allowing for instant purchases and minimal processing power at the collection end. The telephone system is reliable and is maintained night and day by the local telephone office. A test market can be created easily and without great expense. If the market exists the system can be expanded to cover virtually any system size.

REFERENCES

1. Electronic Industries Recommended Standard RS-496, Interface between Data Circuit-Terminating Equipment (DCE) and the Public Switched Telephone Network (PSTN)", EIA Engineering Subcommittee TR-30.3.

2. "Reference Manual for Telecommunications Engineering", R. Freeman, John Wiley and Sons, 1985.