PROVIDING LIFE, PROPERTY, AND FIRE PROTECTION THROUGH CABLE TELEVISION: NEW SERVICES THROUGH ADVANCED TECHNIQUES

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The paper suggests that the provision of security/alarm services by cable television operators might be used to: 1) generate additional revenue for the cable television operator; 2) increase CATV penetration levels in urban areas; 3) effectively utilize some of the extra bandwidth available on urban cable systems; and 4) provide field experience with the implementation and marketing of two-way services.

I. INTRODUCTION

In recent years, the cable issue has evoked considerable controversy, as urban centers throughout the country examine its various facets, in determining its application to their needs.

For many years, the cable was the sole means by which television was introduced in those areas which, for various reasons, could not bring in over-the-air signals. Thus, it served as an entertainment media, and virtually nothing more. Now, after a prolonged infancy, the cable industry has finally grown up; and far-sighted operators throughout the country are beginning to ask if and how the cable can assist them in better serving their subscribers; and , of course, how they, the operators, will be affected. How does the operator go about providing two-way cable to subscribers, particularly those in urban areas? And last, but certainly not least, will a two-way communications system prove economically feasible? These are but a few of the areas we will explore.

The possibilities are endless; the future, challenging. As the demand for services increases, we must look to modern technology to satisfy these needs. Thus, the operator can no longer be content to simply provide cable television to his subscribers. To remain competitive, it is imperative that he look to new areas that he can explore, new services he can provide.

We can now wire up entire areas, urban and suburban, for a two-way communications system that can satisfy the needs of today's society, making it possible for the operator to realize more revenues as he provides more services. In this way, we can give the cable industry the impetus it has long needed to move forward. The cable industry -- any industry -- can ill afford to become stagnated. Progress is essential for survival.

In this discussion, we will take a look -- a long, serious look -- at the various aspects of two-way communications: what can be accomplished in the field; how it can be done. Bear in mind, however, that this is only the beginning of a new era; we have only "touched the tip of the iceberg."

II. INTERACTIVE CABLE SERVICES: KEY TO THE URBAN MARKET

Perhaps the area that evokes the most interest from the most people, both potential urban and suburban subscribers, is that of public safety. As we all know, the burglar and, particularly, the fire alarms, have come into more prominence, as the news media daily recounts tragic incidents involving loss of human life, particularly through fire. Many, perhaps we should say most, of these lives would not have been lost had the victims had the protection of an alarm system which could simultaneously alert the subscriber and the proper authorities to an impending danger before it becomes life-threatening. Upon alert, the authorities could immediately dispatch the proper assistance, with virtually no loss of time. In situations where time is of the essence, this could mean the difference between life and death.

Because the public has become increasingly aware of the need for adequate protection,security alarms have realized a surge in popularity, with many selling at a brisk pace, regardless of the expense involved or their degree of effectiveness. The demand is particularly acute in urban areas, where the need becomes increasingly apparent. This is where the two-way cable comes in. Through the use of the two-way cable, the operator can provide subscribers with an alarm service which would not only be low in cost, but which would employ the latest in technology, to give it the greatest degree of effectiveness. This, in turn, would make it attractive to the potential subscriber and, subsequently, more lucrative for the operator.

Apart from provisions for security as part of the urban cable package, the number of other applications for interactive cable in metropolitan areas is almost limitless.

Such areas as utility monitoring, traffic control, visual monitoring of high-crime areas, pollution monitoring, power load monitoring and meter reading -- all these areas could be well served through two-way monitoring via cable. In addition to this, a tie-in with colleges and with other learning centers could provide at-home instruction for those unable to attend formal classes. Through use of the two-way cable, the public spirited citizen could actually "sit in" on and even actively participate in public hearings, legislative sessions, etc.

All of this is now possible. The time has come when pulbic services can and should be made readily available to all; and this can be done through the implementation of a highly sophisticated, technologically advanced telecommunications system. The urban centers, with their high density population, are prime areas for implementing such a system. This could be a boon to the cities, as they would become more attractive to the people, while permitting the operator to realize ample profit, both by reason of the high penetration possible and because of the appeal to the potential subscribers of the many and varied services he could offer.

The wideband width inherent in broadband communications makes such systems veritable superhighways for transportation of multiple audio, video and data channels. Thus, the multichannel capacity of a two-way broadband system allows for a diversity of offerings to the sophisticated urban subscriber that cannot be duplicated, or offered as inexpensively, by conventional communications systems, such as those of Bell Telephone. It is this fact which makes two-way telecommunications such a viable source of revenue for the urban cable operator.

How does the cable operator go about utilizing the cable, so that it is attractive to the potential subscriber and, thus, lucrative to him? Obviously, the first step would be to implement a city-wide system with a two-way capability. This would enable the operator to provide cable television immediately, and then to offer additional services, such as security alarms first on a limited basis to designated area, and then city-wide, on demand, at intervals compatible with the rate of financial return and public acceptance of the new services offered.

New services, by definition, will provide new experiences for the public which may well be attractive enough by themselves to gain widespread acceptance of interactive CATV.

The technical feasibility of such interactive systems has been demonstrated through comprehensive testing in El Sequndo, California, by Theta-Com, and in ToCom II's computer-controlled broadband system in Woodlands, Texas.

At some point after implementation of interactive services, it is more than possible that many existing services could be diverted from their traditional manner of function to cable. An excellent example of this is data processing, now handled by the telephone company. This area is easily adaptable to cable.

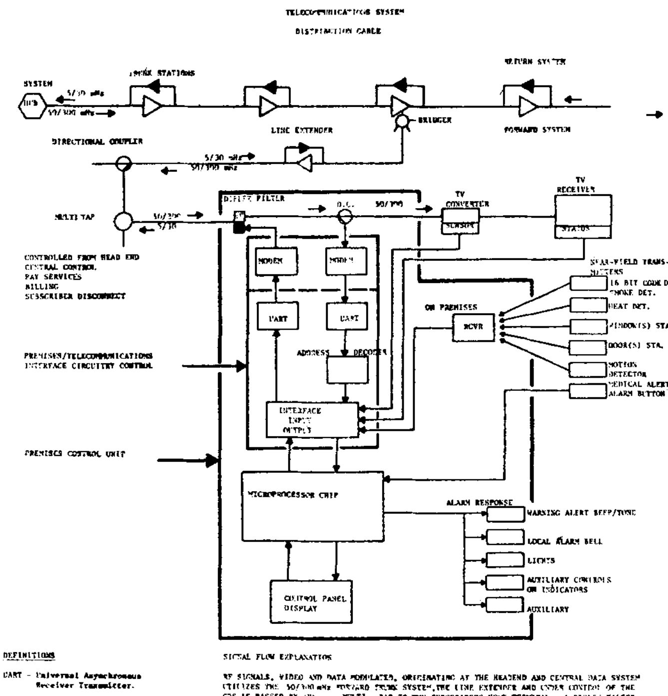
Once there has been significant acceptance of some of the services offered, as has been demonstrated in Woodlands, it becomes easy for the operator to justify added investment in the system, based on potential revenues.

III. ELEMENTS OF INTERACTIVE BURGLAR/FIRE SECURITY SYSTEM

The telecommunications system, as heretofore described (See Figure #1), consists of five primary elements, which may be defined as follows:

1. Computer-controlled Central Data System(CDS);
2. Multiple Headend Hub and Interconnection (Transportation) System;
3. Bi-directional Cable Distribution Network;
4. Interactive Home Terminal Units (H.T.):
5. Wireless Sensor Alarm Systems.

The Central Data System is comprised of a central computer with bulk memory, a hard-wire control and computer display console, data transmitters, data receivers, modems, teleprinters and other associated peripheral devices. Located at the headend, the CDS is capable of interrogating, receiving responses and acting on those responses, from >60,000 home terminal (microcomputer) units every six seconds.



DEFINITIONS

UART - Universal Asynchronous Receiver Transmitter.

It is used for serial to parallel data conversion and vice versa.

MODEM - Acronym for Modulator - Demodulator.

It is used for converting RF to data and vice versa.

SIGNAL FLOW EXPLANATION

RF SIGNALS, VIDEO AND DATA MODULATED, ORIGINATING AT THE HEADEND AND CENTRAL DATA SYSTEM UTILIZES THE 50/300 MHz FORWARD TRUNK SYSTEM, THE LINE EXTENDER AND UNDER CONTROL OF THE CDS IS PASSED BY THE MULTI TAP TO THE SUBSCRIBERS HOME TERMINAL. A DIPLEX FILTER IN THE HOME TERMINAL SEPARATES THE FORWARD AND 5/30 MHz RETURN SIGNALS; THE FORWARD SIGNALS VIDEO AND DATA ARE THEN SPLIT BY A DIRECTIONAL COUPLER BETWEEN THE SUBSCRIBERS CONVERTER AND TV AND THE INTERFACE CONTROL CIRCUITRY. THE MODEM DEMODULATES THE DATA AND THE UART CONVERTS THE DETECTED SERIAL DATA TO PARALLEL DATA AND WITH THE RIGHT DIGITAL CODE ADDRESSES THE DECODER AND OPENS UP THE PREMISES CONTROL UNIT AT THE HOME TERMINAL FOR INTERROGATION BY THE CDS AT THE HEADEND. THE PROGRAMMING, BUILT INTO THE MICROPROCESSOR CHIP, INTERROGATES THE PREMISES ALARM SYSTEM AND "ANSWERS BACK" TO THE CENTRAL DATA SYSTEM THE INTEGRITY OF EACH OF THE SECURITY SENSORS ON THE PREMISES VIA THE RETURN OR ANSWERING UART WHICH CONVERTS PARALLEL DATA TO SERIAL DATA FOR INITIATION OF THE RETURN MODEM WHICH DIGITALLY MODULATES A RF CARRIER OR OSCILLATOR FOR TRANSMISSION BACK TO THE CENTRAL DATA SYSTEM VIA THE 5/30 MHz CABLE RETURN SYSTEM.

Figure #1

The Multiple Headend and Interconnection System consists of three hubs, one of which will be designated as a Master Headend. These hubs are to be interconnected by trunk cables or AML microwave links.

The Master Headend includes a nearby array of VHF and UHF atennae, the electronic control center for amplifying the broadcast signals received from the antennae and the Central Data System (CDS). The broadcast signals of UHF frequencies will be converted to VHF frequencies in the master headend's electronic control center and then transmitted throughout the cable distribution system.

The Transportation System, which interconnects the master headend/hub with its two "slave" hubs, provides channel space for the transmission of signals from the master headend to each of the sub-headends. In addition, these interconnections permit the exchange of video signals, using a two-way video channel from each sub-headend to the master headend.

The Distribution System distributes the combined signals from the multiple headend/hub interconnection (transportation) system and the Central Data System to the subscriber, within the frequency spectrum of 50 MHz to 300 MHz.

The Home Terminal Unit (H.T.) is located in the subscriber's home, and has its own unique identification. There are individual identification codes for each home terminal. The home terminal responds with a digitally encoded signal when interrogated by the CDS.

The Wireless Sensor Alarm System consists of varied numbered miniature radio sender modules, which may be located at door locks, windows, or other openings. It also incorporates other detection devices; such as, ultrasonic motion sensors and fire detectors.

IV. SYSTEM DESCRIPTION AND DESIGN

Probably the single most important effort in our development of an economically feasible, centrally-controlled alarm system is the design of a low-cost microprocessor.

Various corporations have indicated an interest in producing a microprocessor chip that would include all parameters needed. At least one company has developed, within a single chip, a microcomputer containing a clock, 1,000 words of read-only memory, 65 words of random access memory, a program counter, an accumulator and several other housekeeping registers, as well as output latches for both addressing purposes and for an off-board digital display. The quoted price for this microcomputer is approximately $3.10, in quantities of 50,000 pieces.

The microcomputer (See Figure #2) has the capacity to keep track of up to 32 sensors in the home, including windows, intrusion centers, switch mats, etc. It can thus alert the occupant of any unsecured condition, such as an open window, for example. The user subsequently has the option of either closing the window or leaving it open. The computer automatically adapts, at the time of the alarm, to the best remaining conditions, in the event of a possible intrusion or in case of fire.

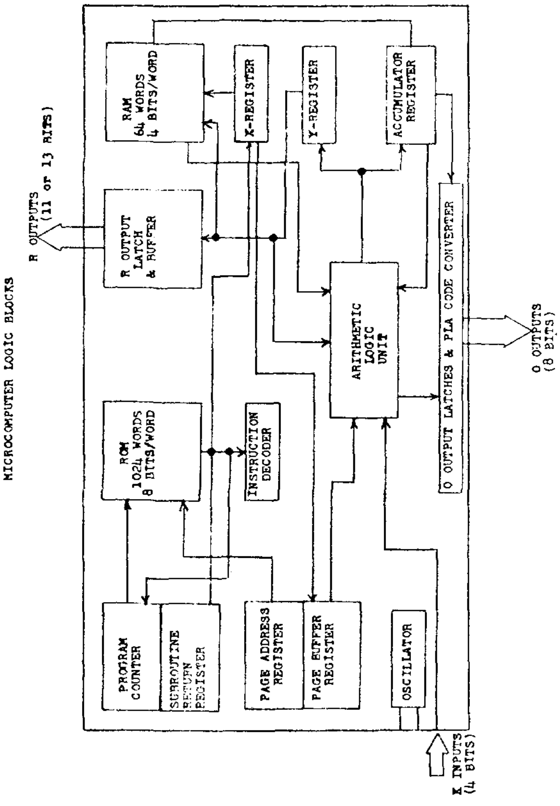


Figure #2

In addition to providing security alarms, the microcomputer has many more functions. Perhaps one of the most important is its capability to summon emergency medical assistance. Should a medical emergency arise, a medical alert button initiates a message to the Central Data System, which, in turn, informs the proper emergency unit.

Note: The microcomputer may also be used to track auxiliary inputs, in which capacity it can serve to notify the user of such existing conditions as freezer failure, a stove which has been left on, or a garage door open, etc. While the auxiliary inputs do not cause an alarm, they can send the information to the central processor, which, in turn, sends it back to the user on demand.

The subscriber's home terminal unit houses three distinct elements: a microcomputer; a multi-channel receiver; and a front control panel. The latter consists of a medical alert button, a 5-position key switch, a fire alarm reset button, and a single character light-emitting diode display (LED), whose function is the identification of each remote sensor by an assigned panel number.

The home terminal is the interface between the Central Data System, the CATV System, and the remote sensor in the subscriber's home. This can best be explained by describing the specific functions of the various controls on the front panel of the home terminal.

The five key switch positions on the home terminal unit may be defined as follows:

1. Normal - This position arms the system for interactive response with the Central Data System, and is the position which must be assumed for normal day-to-day system functions.

2. Full Test - In this test position, a calculator-type keyboard, depressed by the subscriber, instructs the microprocessor to initiate a full test of the subscriber's alarm system. All sensor system functions will perform normally as described in Position 1 (fire, burglar and medic alert), and notification of the "Full Test" condition will be included in the home terminal response to the interrogation by the Central Data System.

3. Local Test - This test position notifies the Central Data System that the home sensor is undergoing local tests.All sensor system functions will perform normally, but the return modem will be inhibited, so that no alarm message will be transmitted back to the CDS. The front panel display will indicate results of the local test.

4. Memorize - This position allows the system operator to set the user's home terminal code for various services, at the request of the subscriber. For instance, should the subscriber's system contain a fire alarm code and he requests one for burglar detection, the system operator can code the new data into the microcomputer. This can also be done should subscriber later request a medical alert or any other available code.

The system identification numbers are inserted into the microcomputer's memory by the system operator, for easy recognition by the Central Data Ssytem. This is accomplished through a calculator-type keyboard, located on the control panel. The system operator will assign channel numbers to his sensors during initial system installation, or subsequent to the addition of new sensors, at the subscriber's discretion. This data is inserted by the system operator, by a single triggering of the desired sensor. When loading is complete, the sensor will "beep", signalling the end of "Memorize" operation. The switch should then be returned to "Normal" position.

5. Channel Select - Switching between "Memorize" position and this one increments the channel number currently being displayed. Thus, the desired channel can be selected before activating a sensor to record its identification code. Once this has been done, the system operator returns the switch to the "Normal" position, which arms the home terminal for normal operation.

The sensor display, located on the home terminal unit, displays various information and has, as its prime function, the indication of sensor activation, for the subscriber's information.

Each individual display represents a distinct channel, corresponding to a specific sensor category. The categories of sensor channels include boundary sensors, internal sensors, emergency sensors, fire sensors, auxiliary emergency sensors, auxiliary control sensors and arming/disarming sensors. Thus, when the user locks or unlocks his front door, the particular channel to which the door's sensor has been assigned will display for a short time at the home terminal. During an actual alarm, the channel initiating the alarm will be displayed.

In addition to the above functions, a seven-segment display will flash for twenty seconds, thereby disclosing any sensor with an unsecured condition, such as an open door, once the door has been closed and the system subsequently armed. Accompanying this will be an audio alert, a "beep", that will inform the resident of the unsecured condition and its location.

Eight available codes are included in the system. These include individual numbers for fire/smoke, burglary emergency, auxiliary emergency , radio frequency interference, a battery sensor and low voltage monitor, an auxiliary control channel, and incorporation of two additional auxiliary control functions. Each of these will automatically send a digital message over the coaxial cable to the Central Data System.

New home terminal techniques and refinement of logic arrangements are being explored, to reduce the probability of user-caused false alarms. It has been determined that optimum results could be achieved should the user be given a single control, to be activated by the user in a way relevant to and compatible with his normal living routine.

V. THE WIRELESS SENSOR ALARM SYSTEM

It is an accepted fact that installation costs account for a probable 50% of the total cost of a fire and burglar alarm system. This is primarily due to the expense involved in running wires from the sensors to the home terminals. For this reason, it becomes apparent that the obvious choice for installation in an existing structure is a wireless alarm system, with its inherent low cost. A wireless technique can, without a doubt, significantly reduce the cost of an alarm system, making it more attractive to the cable operator.

There are many miniature wireless alarm systems currently on the market. For the most part, the reliability of these systems hinges on the very low market penetration which now exists for these items. The cost, while not prohibitive, is not at this time sufficiently low to warrant any foreseen flooding of the market. Consequently, it is unlikely that more than one system would lie within detection distance of another. It is anticipated, however, that should a low-cost, reliable system be made available, a significant market penetration would result. It is likely that this dense alarm population would result in a great deal of cross-talk between these wireless systems, and this could further aggravate an already serious false-alarm problem.

Therefore, means must be sought to minimize cross-talk between radio systems operating within close proximity, as for example, in an apartment complex, where up to 50 or more sensor transmitters might be operating on the same frequency, within a 200 ft. distance of each home terminal.

To accomplish this, we have investigated two basic approaches:

1. A digital coded technique, providing up to 32,000 different codes;
2. Use of a limited-distance transmitter, which exploits near-field radiation phenomenon.

Mathematical expressions define this latter phenomenon and reveal that within the near-field, certain terms in the radiation equation drop off very rapdily, and with distance, as compared with the so-called far-field term normally employed in radio communications systems. Furthermore, in the near-field, these fast-dropping terms are substantially GREATER in strength than are the far-field terms. Therefore, one obtains a high energy RF volume immediately surrounding the transmitter element, but this rapidly drops off with distance. By proper choice of radio frequency, one can take advantage of the near-field effect to limit the radiation distance within a prescribed volume.

"An experiment was done by the Aerospace Corproation in Washington, D. C. in which the equipment was constructed and tested (See Figure #3), utilizing both the digital coded technique and the near-field idea. Both were successful. In the case of the near-field device, the probability of detection in excess of 95% was achieved at a distance of 35-40 feet. But this probability reduces to near zero at a distance of 60 feet, as desired. Using conventional radio techniques as employed today, the probability of signal detection falls off more slowly. For example, a 95% probability at 40 feet might only reduce to approximately 85% at 60 feet, and such a system would, consequently, suffer more interference due to the other transmitting devices in the vicinity. Either the near-field or the digital, or both together, are promising for further application."[1]

The wireless sensor alarm system includes up to 32 miniature radio sender modules, which may be located at door locks, windows, or other openings. It can also incorporate other detection devices, such as ultrasonic motion sensors or fire detectors. The home terminal, incorporating a microprocessor and radio receiver for detection of the radio module output message, will accomplish a prescribed logic sequence, generating signals to the Central Data System.

Each radio sender module transmits a unique 15-bit permanent identification code and a 1-bit status message as a binary sequence (16 bits total). The microprocessor in the home terminal will recognize the identification code of each sender module associated with its system. Subsequently, the triggering of any radio sender module will be detected by any alarm receiver lying within a distance of 40-50 feet from the sender. However, the receiver programmed for this particular sender code is the only one that will react to this transmission.

There exist at least 32,000 sender code combinations. Therefore, the probability that more than one alarm system will respond to any specific radio module sender is negligible.

[1] Aerospace Corporation.

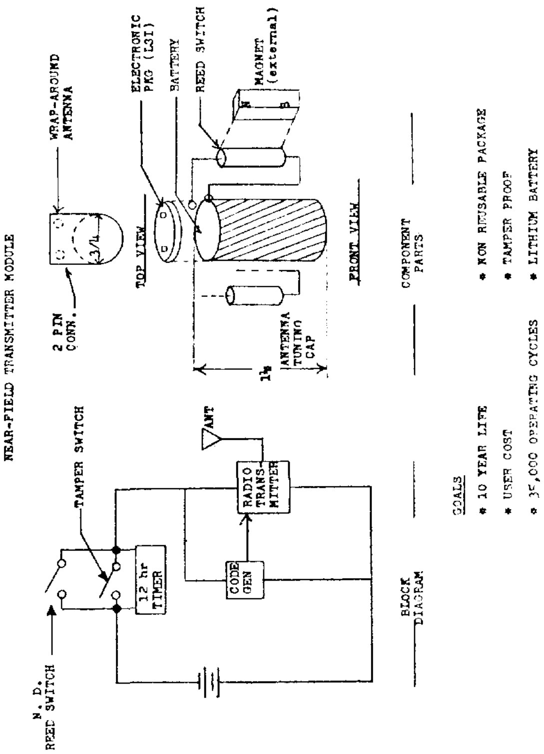


Figure #3

VI. CONCLUSION

The interactive, two-way cable concept, as outlined in this discussion and demonstrated so effectively in Woodlands, Texas, serves to reinforce and emphasize the fact that the cable can and ultimately will prove the most economical and technically sound means of accommodating the demand for public safety, health care, and at-home services.

As an increasing number of our major cities search for ways to halt the on-going exodus to suburbia, it becomes evident that the cities must have more to offer -- more services, adequate protection -- to make them attractive to the people. The cable, with its easy adaptability and proven feasibility, can provide these services, via a sophisticated telecommunications system. In this way, will our cities come alive again, as they once more become the hubs of activity.

For the private cable operator with the foresight to act on this coming demand, broadband telecommunications offers a vast frontier for economic development.

*Information for this paper supplied by the ToCom Company and the Aerospace Corporation.