CARRIAGE OF MULTIPLE ONE-WAY AND INTERACTIVE SERVICE ON CATV NETWORKS

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The concept of the wired city is based upon the facility and capacity of the CATV network. The original concept envisioned "everything for everybody" but progress has been retarded by the lack of economically viable services. Over the years individual stand alone services have been developed as income producers with some degree of success. Addressable control of premium television has been the most successful and profitable and is now being augumented by home security, utility meter reading and pay-per-event TV. The future promises the addition of more sophisticated services including videotex, interactive home shopping and personal computer interfacing plus banking. These business ventures are being fine tuned to be good revenue producers so that indeed the wired city concept is coming into much sharper focus.

With the economic driving forces building, and in some cases firmly in place, it is well to review the technical approach for delivery of these services on the CATV network. Typically, services of this sort are implemented on a stand-alone basis. Manufacturers and program suppliers, experts in their areas, have devised and configured transmission systems including headend subscriber equipment to provide efficient and economical delivery of each individual service. This has resulted in optimization of stand-alone services which in turn has resulted in deficiencies and complexities when multiple interactive services are implemented on a single cable system. The following discussion cites the need for and proposes a multiple service system for CATV carriage of subscriber services.

STAND-ALONE COMMUNICATION SYSTEMS

Let us examine the headend or central control requirement for typical services. Generally speaking each specific service requires some sort of computer to control delivery of status, information or control to and from the subscribers. For instance, in a one-way addressable premium television system it is necessary that the headend computer keep track of the addresses and messages to the subscribers, handle channel authorizations and changes, produce billing information and perhaps prepare the actual billing documents. In a stand-alone system much of the work normally associated with the cable system billing computer is performed by the pay TV control computer. When and if two-way, pay-per-event is instituted, additional control and bookkeeping must be done. Since the control computer for the pay television service is required to control the communications functions, it is necessary that the control computer be on the cable system (usually at the headend) or that high speed data lines be run from the headend to the remotely located control computer. This is a cumbersome situation at best, particularly since system diagnostics are performed at the control computer which should be based conveniently on the cable system for use by the cable technicians.

Should this same cable system desire to offer home security, the classic approach is to add a stand-alone security system which again is controlled by its individual computer. The format of the data transmission is usually unique. The same general restraints apply as in the pay TV system in that network control must be implemented in a convenient place on the cable system while the security central station may well be at some other location. The central station computer, which is associated with the security alarms and the customer data base, is often forced into a location on the cable system rather than being placed advantageously within the community. Some cable operators have chosen to operate their own exclusive security service while others are interested in serving other security operators within the community or even a combination of the two. In the case of multiple security operators, the additional restraints of such a stand-alone security system become obvious.

Due to various economic factors, utility meter reading via cable is gaining new support. If meter reading can be sold to a local utility(s) the cable operator has the distinct advantage of a drop in every home in town. For utility meter reading a headend communications control computer is again required plus a communications link to the utility's billing computer at some location remote to the cable system headend (it is doubtful that the cable company will issue utility bills).

Looking further into the future, the development of profit making banking and shopping services can be predicted. Whereas the services may start locally they can certainly be expected to develop into regional or nationwide ventures. In such a case, a major part of the data base will definitely not be local but will be accessed through satellite, telephone or other communication links. Under these conditions it is likely that a computer will still be necessary for control of the local communication. Situations similar to the above will be encountered in the majority of existing and future cable carried services.

Let us turn our attention to maintenance services which are desirable in the CATV network. Cable system status monitoring has met with varying degrees of acceptance and is certainly desirable if implemented effectively and economically. There has been a great deal of talk about bridger and feeder switching to control the summation of noise in larger systems. Many have concluded that the system architecture can, in most cases, be designed so that the number of subscribers in any section need not be large enough to require feeder switches to reduce excess noise. Noise summation, however, is not the only factor to be considered. In the tree type structure found in most cable networks it is extremely difficult to locate the source of ingress when it does occur. Even though an interfering signal can be seen on the spectrum analyzer at the hub or headend, there is generally little indication as to where the ingress is occurring. If the ingress happens to be at a frequency and amplitude which interferes with one or more of the upstream signal paths, an entire service may be disrupted. It is therefore necessary to have the ability to isolate sections of the system by remotely controlled feeder switches in order to turn off the ingress and allow the remainder of the system to operate properly until repairs may be made.

In a cable system installation where there are several simultaneous stand-alone subscriber services the presence of ingress may have varying effects on each of the services due to their frequency relationship to the interfering signal. When such a condition is encountered on one or more of the services it becomes necessary for the serving organization to refer the problem to the cable system operator who in turn must seek the cause. If the location of the ingress is implemented with feeder switches, it is then necessary to utilize yet another communication system (the feeder switch control system). Since the feeder switch control is not synchronized with the simultaneously operating stand-alone server systems, the process of isolation will cause disruption in all other services even though the ingress does not directly affect them. Of course, if feeder switches are also required to control noise summation, their employment can create intolerable problems due to lack of synchronization so that services are contending with each other to access various sections of the CATV network. In multiservice implementations on CATV the configuration of the subscriber equipment is of great import. In virtually all services subscriber terminal equipment includes special purpose hardware to perform the specific service; security panels, sensors, videotex/terminals, (etc.). On the other hand, in a collection of stand-alone services, a unique modem is required in each home for each service in order to receive and transmit the required information and control functions. The modem function is thereby duplicated for each service. In some services the modems may well be inefficient in use of spectrum, provide poor noise immunity, etc., while in other services higher speed, more expensive units may be required. This diversity is another source of non-uniformity and overall increased cost.

Figure 1 illustrates a typical headend representation of several stand-alone CATV services.

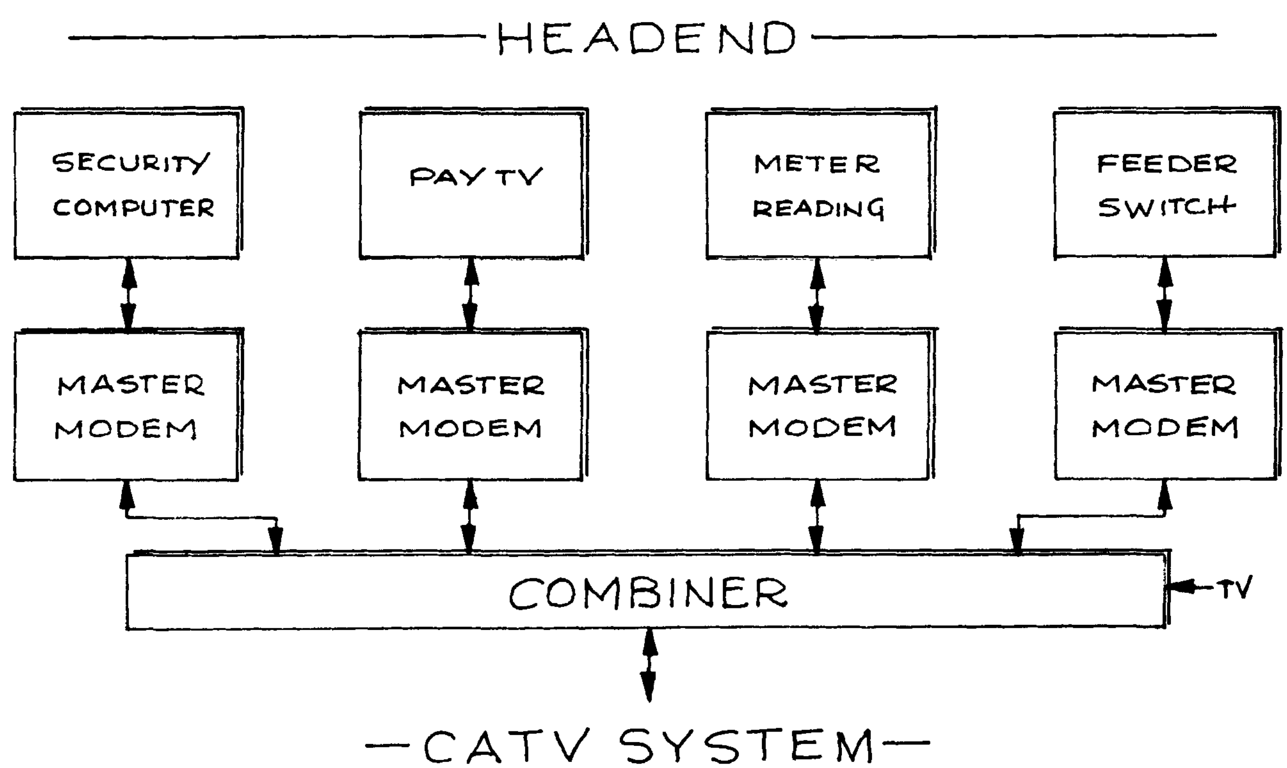
In general it may be said that the stand-alone implementation of multiple CATV services is costly, inefficient and often conflicting in operational requirements.

MULTIPLE SERVICE COMMUNICATION SYSTEMS

Due to the various problems discussed above, a new concept for the delivery of multiple CATV services has been developed. Simply stated, the need is for a "Multiple Service Communications System" (MSCS) which can simultaneously carry many diverse CATV services. The concept reduces duplication, lowers costs, increases capacity and allows for expansion into yet undefined new services.

An MSCS has a single computer which is the "master controller" so to speak, for all service delivery. This computer or System Communications Controller (SCC) transmits to and receives from the remote locations via a built-in master modem. Polling is employed as the system protocol since all control and information passes through this one common point. The SCC does not, however, attempt to perform the various status, control or information functions associated with the individual services. Instead, the SCC is configured with appropriate communications ports which are connected to the specific server computers whether local or remote to the SCC. These ports are normally configured per RS-232, however, virtually any interface, data rate and protocol may be employed. Communication to server computers may be done by wire, telephone circuits, cable carried data circuits, satellite links, etc.

The SCC is arranged to sort and store data as required for each service. In addition, each port is programmed to be protocol compatable with its respective server computer. The only data passed between the SCC and any server computer is that which is required to implement the service but not that required to control communication on the CATV network. In this way data transmission between SCC and server computer takes place at considerably reduced rates compared to the data flow on the CATV system. In addition, there is no interaction between server computers, thereby providing totally independent operation of the services.



SERVER COMPUTERS CONSTRAINED TO HEADEND RATHER THAN MORE CONVENIENT LOCATIONS

FIGURE ONE: TYPICAL CATV HEADEND FOR MULTIPLE STANDALONE SERVICES

On the CATV system the MSCS utilizes high speed data streams both to and from subscriber locations to implement all services as well as to monitor and control system operation. Since the data rate must be high to encompass multiple services, the cost of the remote modems could be undesirably increased. For other reasons the MSCS employs a communications sub-controller between the SCC and the subscriber modems. This unit has been labelled the Area Control Unit (ACU). The ACU carries on simultaneous communication with the SCC on one side and several hundred customer modems on the other. The communication circuit to the customer modems is also polled but at a much lower rate than the SCC link thereby reducing subscriber modem cost and complexity. The ACU keeps track of status of the customer modems and handles control and information traffic between customer modems and the SCC. Notice that the ACU reports status and alarm functions by exception, i.e.; when there is no trouble and no alarms only a short "all is well" message need be sent to the SCC. The ACU also provides buffering for traffic in order that messages may be properly interleaved in the polled data streams. Since the ACU is a very intelligent communication controller in itself it may, in certain cases, be employed on a stand-alone basis in small systems.

In the MSCS the customer modems assume several forms and, it is well to note that since many simultaneous services may be handled on the system, each service modem requires interface with the same radio frequency data channel thereby utilizing the same data transmission and reception hardware. Interfacing to a variety of individual services requires widely differing connections, formats and functions. In the case of security, medical, fire and other alarm and command requirements, simple on/off inputs and outputs are required. These inputs and outputs can also be programmed to read utility meters. This particular configuration is known as the Customer Service Module (CSM). Installation of the CSM for one of the above functions provides for all of these functions limited only by the actual number of input and output circuits. For these services the SCC is ported to security, fire, medical and utility monitors and computers which supervise their respective services.

Figure 2 illustrates an MSCS CATV implementation.

Home computer and videotex applications for CATV are developing. Interfaces to personal computers and videotex terminals are usually made at RS-232 level. This provides a convenient standard and is quite functional. In these cases the applicable modem is the Videotex/Data Interface (VDI). The same r.f. section is employed as in the CSM, however, the focus is now on the serial transmission of data to and from the computer or videotex terminal. Buffering is required to interface between the polled data to and from the ACU and the specific data rate of the user terminal.

Both upstream and downstream buffers are supplied so that the data stream to and from the computer or terminal appear to be real time rather than polled. SCC porting to VIDEOTEX and other data bases allows an extremely wide variety of important information and functions to be additionally provided.

Other important services can be implemented on the MSCS. Control of premium television viewing with the MSCS is an important application. In order to increase the security, reduce the cost and allow the use of non-addressable converters the Television Control Module (TCM) is mounted outside the residence and employs jamming techniques to control viewing. Jamming signals are applied under SCC control via the ACU to deny viewing of unauthorized channels on a drop by drop basis. The jamming signals are applied in a manner such that trapping is virtually impossible. Since this function occurs outside of the residence, tampering is extremely difficult. The TCM replaces the traditional subscriber multitap and draws power from the distribution cable. The cable system billing computer is connected to an SCC port to input subscriber viewing authorizations. The TCM also provides a remote T.V. disconnect switch for each drop but allows passage of messages between the ACU and customer modems within the residence thereby allowing services such as security and meter reading to function even though TV service may be shut off.

While the TCM module provides control for any premium TV delivery, pay-per-event service may be instituted by use of the Keypad Unit (KPU). The KPU interfaces with the drop within the residence and includes a display and controls for selection of pay TV channel, opinion polling, data base access, etc. If the subscriber desires a remote control for the KPU, it is provided by a wireless link to the hand held unit. The remote unit may be sold to the customer (and permanently retained by the customer) if so desired since its functions do not allow him to defeat the premium product billing. The KPU communicates with the ACU which in turn forwards billing information to the SCC. With this system it is virtually impossible to view the premium TV product and escape the billing function. The KPU may also be used to add the pay-per-event feature with one-way addressable converters thereby avoiding an additional converter changeout. Simultaneous CATV system control and status monitoring are uniquely fitted to the MSCS. In the matter of bridger or feeder switches, control is excercised simply by short commands embedded in the unified data stream. Such commands are absolutely synchronized with the system operation and service functions thereby adding minimum overhead and causing no conflict between services. Status monitoring of CATV parameters such as transmission levels may be performed in spec-

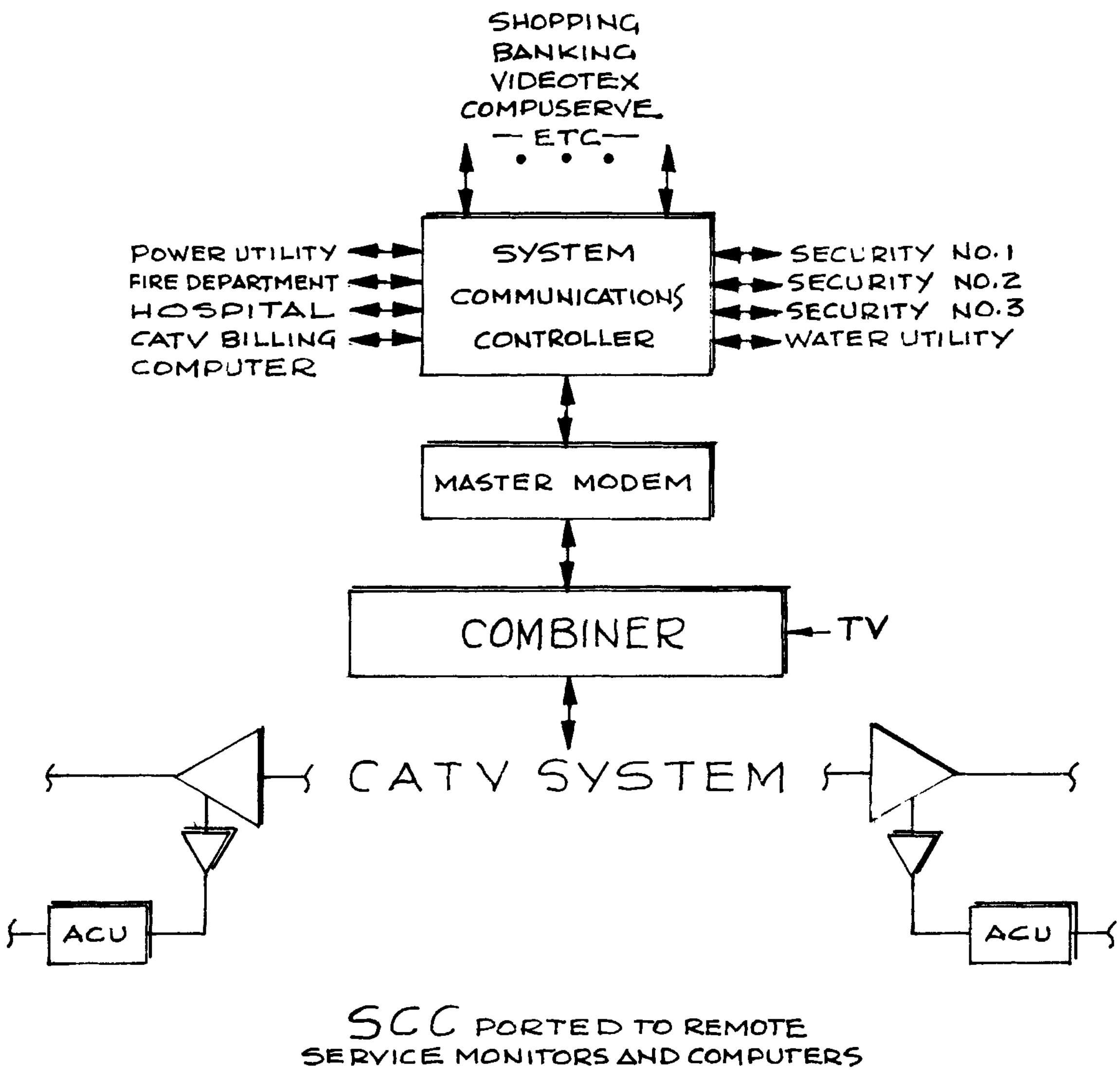


FIGURE TWO: MULTIPLE SERVICE COMMUNICATIONS SYSTEM FOR CATV SERVICES ially designed modules strategically distributed throughout the CATV network. Measurement of voltages, currents, etc. within trunk and distribution amplifiers may be handled in a similar manner; the greatest problem being access to these variables which are not usually available outside of the amplifier housing.

CONCLUSIONS

The MSCS offers many advantages in functionality and cost. Due to the concentration of intelligence in the ACU and the reduction of data rates to the customer modems, the cost of these high quantity items is dramatically reduced. In the provision of simultaneous multiple services the MSCS utilizes appropriate customer modems mixed within the system without penalty. The MSCS may be implemented initially for a single service and later expanded with additional cost savings over stand-alone systems. New services of the future will be implemented with similar, low cost modems as required. Simple services such as security, utility meter reading and pay TV control may be offered to hundreds of thousands of subscribers on a single MSCS channel. Since the MSCS size is limited by the total data throughput, requirements exceeding the systems data rate or expansion of the number of subscribers served may be achieved by utilization of multiple RF channels. This expansion again may be achieved on a minimum cost basis without the requirement for service calls to existing subscribers.

At this critical time in the history of cable television the door is opening for ever increasing revenues from non-TV subscriber services. The ultimate content and form of these services is still unclear. Transmission of these services via a Multiple Service Communications System requires minimum upfront cost and provides maximum effectiveness and performance plus the important ability to encompass new and developing services without conflict, equipment duplication or obsolescence.