PAY PER VIEW, SECURITY, AND ENERGY CONTROLS VIA CABLE: THE RIPPLING RIVER PROJECT

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Abstract.

Control of Pay Channels, Security Systems, Energy Controls, and Meter Reading have been talked about or demonstrated on an experimental basis. This paper describes the implementation of an actual CATV system located in Wemme, Oregon to begin operation in early 1979. The system will utilize two-way data communications on the cable to offer each resident a choice of Cable, Premium TV, Security, and Energy Control systems. Metering and load shape reading will be demonstrated in conjunction with the local power company.

Security, Energy, and Pay Per View Services offered to Two-way cable subscribers.

A small planned community in Oregon will soon be the site of a test of on-line security and energy control services in addition to the entertainment services normally provided by cable. The system is the first test nationally to utilize a controller designed by C.B. Schrock and Associates, Inc. of Aloha, Oregon. The first system serves to demonstrate the versatility of the universal data handling system that the Company has developed.

The home unit called a Universal Addressable Data Terminal (UADT) is a microprocessor based controller that converts the cable to a data bus and then reads the bus back into the cable. Functional modules containing a minimum of hardware are then plugged onto the UADT "bus". Modules in production today include CATV and Pay, Security, and Energy. The capability for any other services such as polling of subscribers, utility demand reading, status monitoring, and sophisticated data services such as credit card verification and point of sale terminals are all easily accommodated with speciality modules.

Headend control and protocol (or language) of the system is also very basic. A major design goal was to provide a simple system so that a typical system operator could use and change operation easily, without hiring an expensive computer programmer. The ASCII standard found on most teletype and home computers is used for all commands. To interrogated a box in the system, four ASCII characters selects any box, two more select the module, and a question mark (?)or (ENQ) interrogates the status of the box. The sub-modules are also controlled (such as turning off lights or a furnance) with two characters per module.

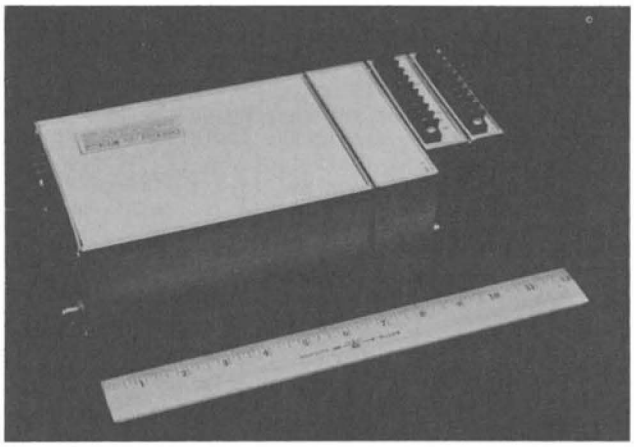

Figure 1. Universal Addressable Data Terminal for cable television systems is shown with a cable and preimium control, a security and alarm, and energy modules installed. Unit is mounted in any protected area and the house drop is looped through the unit.

Advantages over other systems.

A number of systems have been proposed or are in use that use single direction or the bi-directional capability of the cable for alarms, tap control, subscriber polling, energy controls, and TV selection or rating.

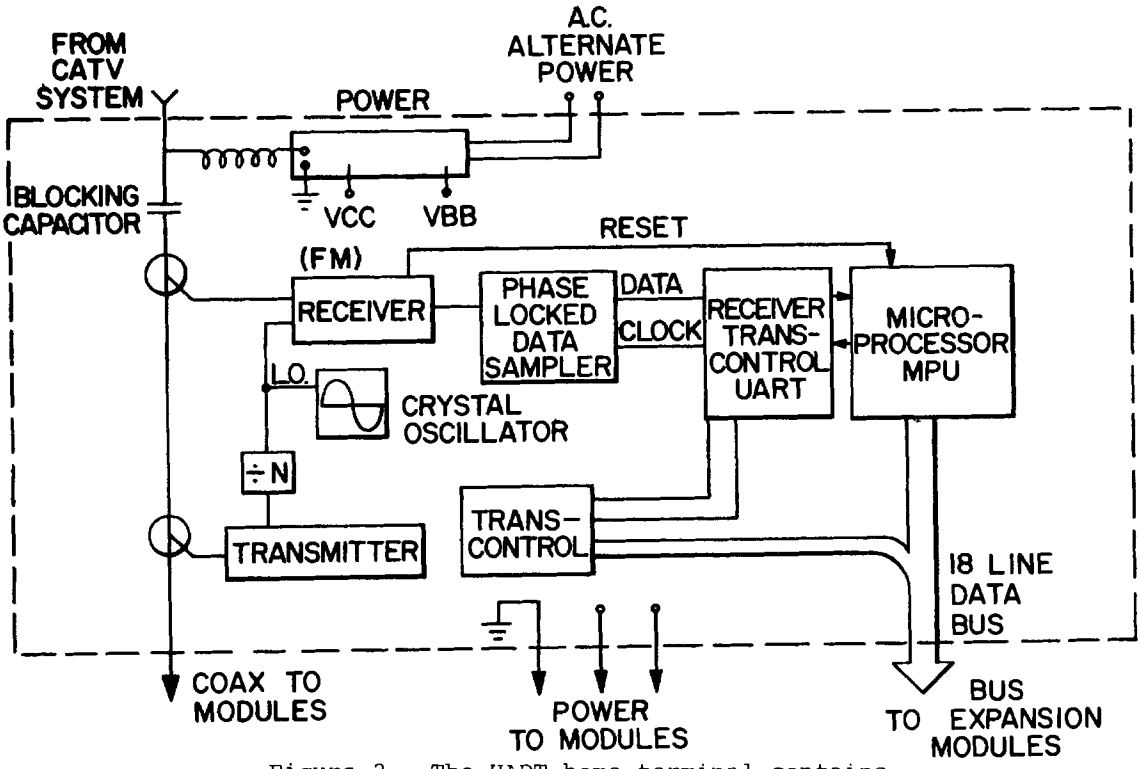

Figure 2. The UADT home terminal contains a receiver, transmitter, power supply, and a microprocessor controlled data converter. The receiver and transmitter share the same crystal oscillator.

Each home or remote terminal usually houses what is felt to be an optimum configuration for the speciality service desired and the data transmission format is chosen for the job. These systems are then polled or updated by a central computer.

The present approaches, however, cause a number of problems. The hardware and the data length are fixed at the time of manufacture inhibiting the capability for services which may not of been envisioned. The concept of polling individual subscribers in a rapid fashion necessary to detect changes (such as an alarm) is very wasteful of the data transmission medium, especially when the probability of an alarm is very low.

The present two-way service devices in-mass also raise another major problem, that is the need for multiple headend computers, carrier frequencies, data formats, all of which are incompatible with each other.

The new system offers both hardware and software expandibility. Virtually all cable Blue Sky Services are data services so the Company has produced an efficient data handler. A mix and match system using one of the international data standards is considered to be the only approach that will not be obsolete before it is installed.

Accordingly, the microprocessor based controller uses a fast, but accurate data format, and has a number of operating modes including a Simple mode for home alarms, a Complex mode for data services, and a All Call or Service request mode for alarms and interrupts. All modes are available in each controller and can co-exist on the same system carrier.

The Central Headend Computer.

A central processor or computer is located at the headend or any other single location within the system. The interface unit provided by the company consists of data storage, serial to parallel converters, and the necessary RF transmitter and receiver to interface to the system. A single parallel standard plug (Centronics Standard) is chosen depending upon the number of subscribers and the task. Anything from a simple TTY or home computer, to a complex commerical million dollar unit can be connected. This flexibility allows an operator to start small, possibly experiment, then upgrade without having to buy new home terminals or a new headend interface.

The computer controller is outfitted with peripheral off the shelf devices such as remote printers (possibly located in a fire, police, or dispatch location). For larger systems additional memory in the form of large core, disc, or tape can be connected so that information can be obtained "on line" to aid in the dispatching of fire, police, energy and the non-specified functions.

Interconnection capability from the computer is provided to external sources or computers such as banks, utility company computers, information sources, as deemed desirable by the CATV system so that data originating in the CATV system, or desired in the system, can be freely transmitted bidirectionally from external sources to or from any point in the system.

The entire headend interface "modem" is housed in a single rack width 3-1/2 inch high unit. It is supplied complete with a 24 hour real-time clock, audible alarm and external outputs, and an RS-232 interface for remote or local printer use. Priced at $2000, the unit provides all headend functions except for the actual computer. With the present home computers that are available, the entire headend for a small control system could be implemented for under $4000.

Technical Details of the System.

Serial Data Signals on a FM carrier along with CATV television signals enter the UADT data through a coax connector (74 or 118-136 MHz). An inductor taps the incoming RF line connecting to the powering compartment in so that cable powering of the device can be accomplished if desired. A blocking capacitor isolates cable powering and an MOV device protects the box from transients, passing only RF signals. An RF stripline on the motherboard contains directional complers for the receiver and transmitter.

The receiver combines many special features to provide accurate data handling capability and reliability with low cost. The receiver is a crystal controlled, super-hetrodyne FM design using very low parts count. The receiver consists of an input preselector, J-FET mixer--amplifier, single crystal oscillator, and a ceramic filter IF. A single IC is the IF, detector, and audio amplifier. A simple comparitor and DC restore circuit provide clean data for the MPU board.

The heart of the UADT is a microprocessor (MPU) using a propriatary program, the microprocessor locks onto the incoming data stream and generates synchronous clocking. The header and address of incoming signals are compared to a diode matrix on the motherboard until the address of the location is recognized. The MPU then latches the sub-address and message to the output bus of the data terminals. If commanded to read, the same sub-address and output bus is strobed in reverse, and the data is regenerated in a serial sequence and transmitted to the central controller.

The entire digital function of the UADT is performed using a single chip MPU located on one circuit card that plugs onto the motherboard. Two data speeds are being offered; an extremely low cost 2400 baud unit, or a 30K baud standard MPU.

The transmitter is a simple keyed CW design using existing state of the art design followed by a harmonic L.P. filter. The transmitter has four failsafe systems to prevent accidental runaway, since this single defect could lockup the systems. The safeties are: MPU data checks to guard against continuous data being fed to the transmitter, power supply pulldown in event of continuous transmission, and an R.F. monitor point that is checked by the MPU. In event of all three failures, the UADT can, on command, blow a fusable link powering the transmitter.

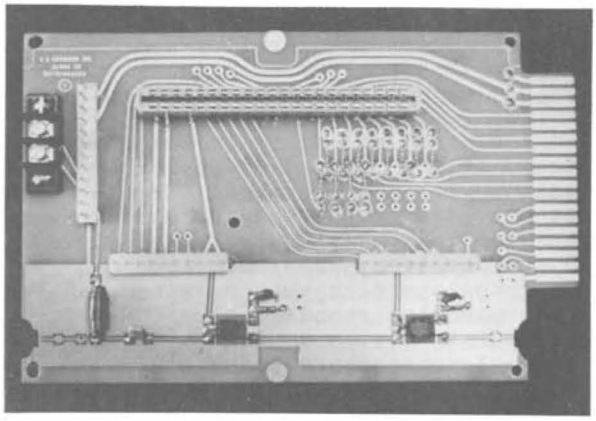

Figure 3. Motherboard contains RF couplers for the receiver and transmitter (lower edge) and primary address coding (right center).

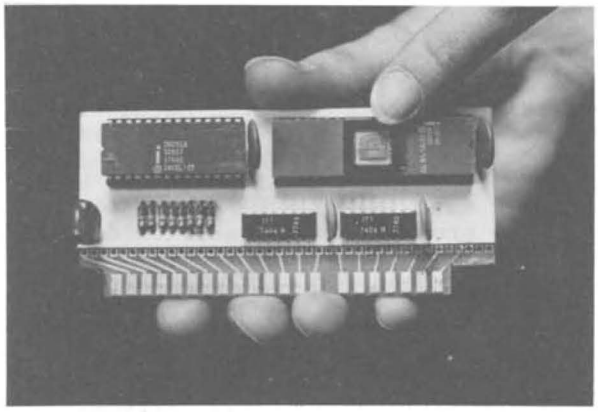

Figure 4. A prototype of the high speed (30 kB) MPU is shown. A single chip microcomputer (Intel 8048) performs all address recognition, formatting, supervision, and self test of the home unit.

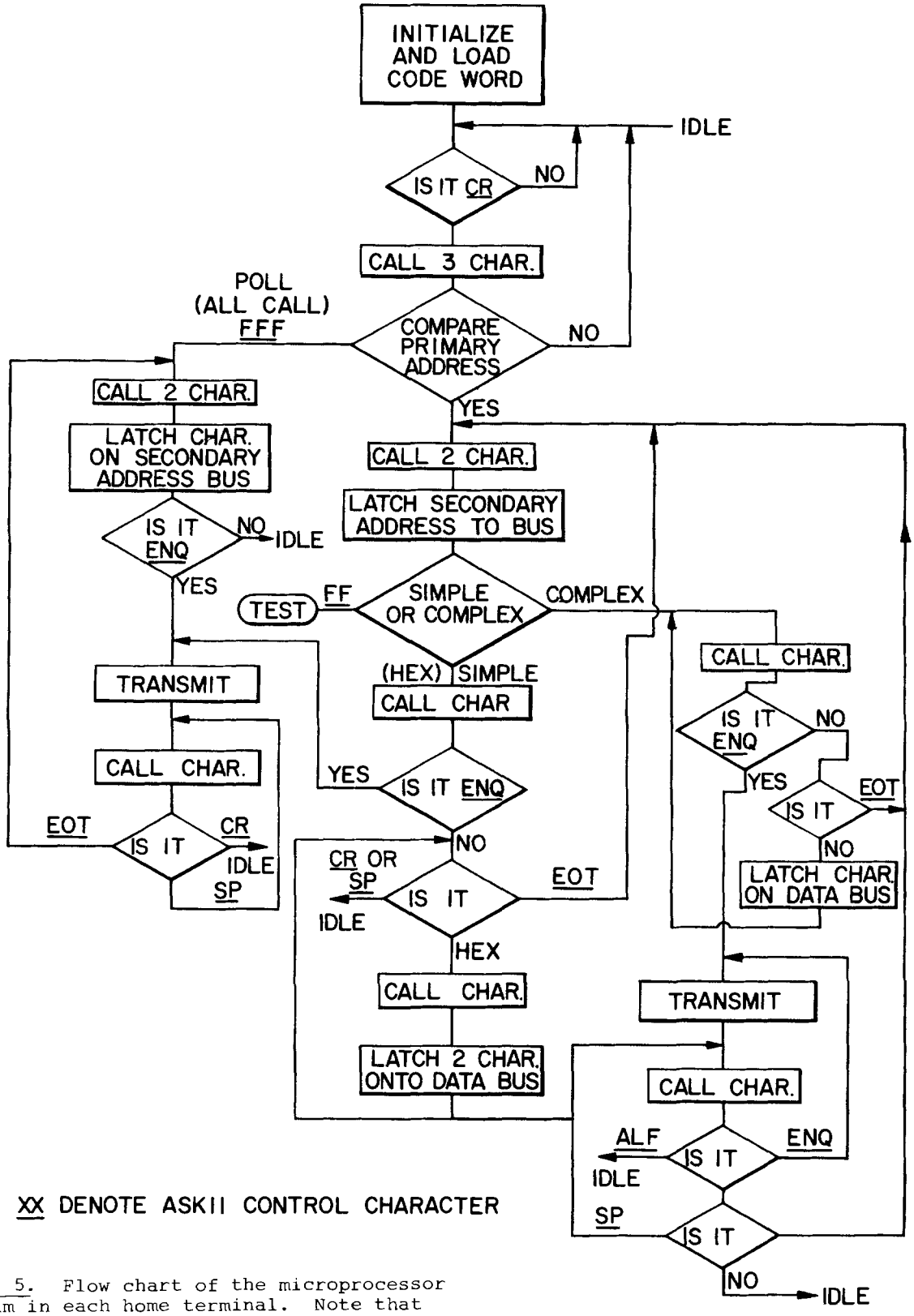

Figure 5. Flow chart of the microprocessor program in each home terminal. Note that three control modes are available: Simple Complex, and the All Call. Modes are automatically selected by downstream data.

A unique feature of the receiver system is the clock regenerator. Rather than encode clock onto the data stream which requires additional bandwidth, the system idles between transmissions with a half-rate clock signals. All messages are sent synchronously without header information on each bit. The clock is extracted directly from the data using a phase lock loop sample and hold regenerator. The circuit consists of an edge finder, driving an error amplifier. Whenever a data transition occurs, it is compared to the internal, free running clock. If an error exists, a sample and hold voltage is applied to the oscillator. Because data or "idle" clock is continuously present, long time constants are chosen so that it takes many clock transitions to either drift or correct an error. This has proven to be effective for reliable data transmission.

Expandability is provided by establishing the intermediate bus. The bus consists of 8 data lines and 8 address lines, as well as read, write, and simple control lines. Powering is also available on the bus. A push on R.F., coax connector is also a part of this bus. The bus was established to permit external modularity and expandability. Simple decoding to the bus for low cost services can be accomplished with a handful of parts. However, the design permits complex, or large numbers, or both to be accommodated. The R.F. portion of the bus can be continued for functions such as CATV switching. Using a narrower module that only fits over the data bus, functions such as alarms or energy controls not requiring R.F. can be accommodated.

The protocal of the system has a number of special features to allow for simple low cost operation, with expandability to complex operations. Each UADT terminal has the capability of 256 function modules. However, in the SIMPLE mode, determined automatically by the commands received, each home box is simplified to handle seven modules, which is adequate for most residences. For larger installations, such as apartments or businesses, the COMPLEX mode can be software selected, and allows up to 256 modules or functions at each UADT. The COMPLEX mode also can handle serial data transmission. Mass interrogation of critical functions such as alarms is accomplished using a binary tree sequence. Since most alarm functions occur only occasionally during the year, continual interrogation is felt to be inefficient. Test routines are built into the system to allow for: Parity and checksum on data as necessary, command control and shut-down of transmitter, continual verification of the status of all terminals, transmitter, receiver, and power supply status of terminals. A distress signal will be sent to the central computer by a box in event of tampering, power failure, or other problems within the home unit.

Cost reduction in design.

Some of the features that achieved the low terminal cost are the use of a simple receiver. The FM receiver uses minimum parts count, a ceramic IF filter and a single FM chip IF discriminator. Receiver and transmitter can share a common crystal oscillator. An AM return channel transmission scheme is used for simplicity in the transmitter design, as well as decreasing the acquire time at the central receiver location.

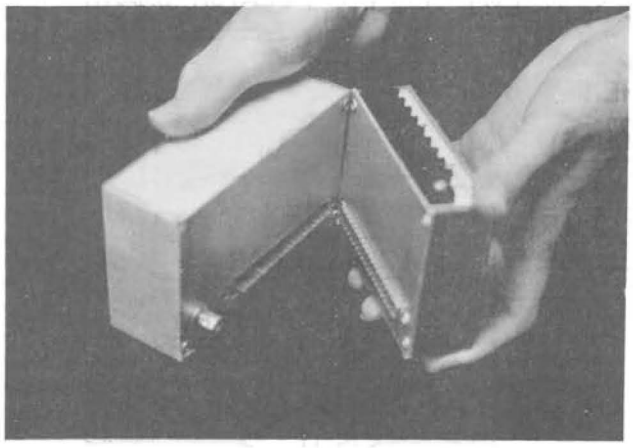

Figure 6. The bus extends through each specialty module. Up to 256 specialty modules could theoretically be stacked onto one UADT.

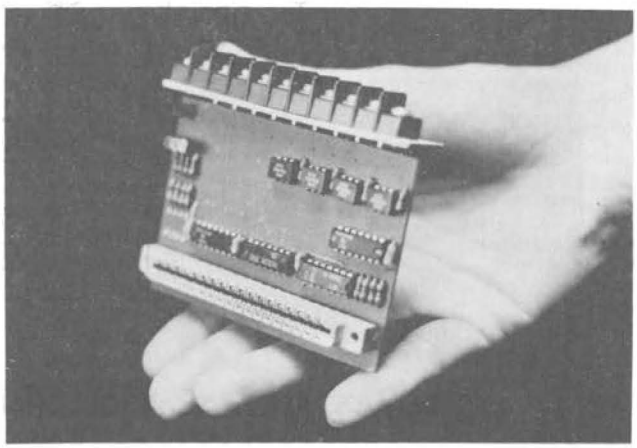

Figure 7. Each specialty module contains this master decode board. Depending upon the functions required, the board can be loaded with input-output drivers and isolators. A 4-input module is shown.

However, the biggest cost reduction is due to the use of the single chip microcomputer. A crude version of the box was executed a few years ago requiring over 50 TTL packages but was not cost effective. The real breakthough in design cost and flexibility, however, came with the introduction of the single chip microcomputer. The basic home controller has been designed around the Intel 8048 chip.

An entire home system fully loaded with four modules (TV and Pay TV, Security, Energy, and Meter Reading) can be installed for as little as $700 including all the hardware and labor. The cost of the system can be added to the price of a new home. Older homes can be easily retro-fitted for various services due to a unique kit approach to the energy and alarm controls. The Company feels that existing CATV installers could be adapted to perform the additional installations for the extra services.

The first system.

The first commercial installation of the system is in Rippling River, a planned community and convention center in Oregon that will eventually have 980 residential units. The homes will each have their own controller (UADT) while the condominium-type dwellings will be served, four or eight units per controller. All homeowners will have the choice of Cable TV, movies from a satellite receive station, alarm service, energy conservation, and meter reading (paid by the utility company). In addition, extra functions have been provided in the form of a message light system and TV theft alarm for all rentable units. The system will be in operation in mid-summer of 1979.

The developers of the planned community feel that the biggest advantage of this system over stand-alone home computers is the central reporting function. A large data base and computer can be located in the lodge and office facility. Alarms, for instance, will be dispatched to the appropriate agency with complete information such as the location within the home, nearest fire hydrant, name of insurance company, and any medical problems noted for the resident.

Energy controls are much more sophisticated than a stand-alone system since the central computer can factor weather forecasts, ground moisture, outside temperature, and total energy demand.

The Rippling River's CATV system will include the following system:

- Television and FM service — 5 local off-air TV stations, message channel, weather channel, and Channel 17 (via satellite).
- Premium Movie Service— Pay per view (via satellite).
- Security — Entry alarms, fire alarms, emergency alert panel (Fire, Police, Medic), and a light cycling outlet. $400 installation and $11 per month.
- Energy Conservation — Termperature turndown, waterheater control, outside lighting control, sprinkler controls and load leveling. $200 installation, $6 per month.

Other services at the community utilizing the coax cable will be a message light system for rentable rooms, a TV theft alarm, holding tank alarms, and an extensive CCTV system covering the golf courses, tennis courts, swimming pools, and night parking areas.

The data headend contains a dual DEC PDP-11-32 controller with remote printing terminals in the convention center and dispatch location: The entire CATV system, headend, and home terminals will have a minimum of four hours stand-by power.