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ADVANCED SMALL SITE PROGRAM

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ABSTRACT

Development of the Advanced Small Site Program (ASSP) will satisfy the requirement for a small to medium sized security system. This system uses commercially available, low cost, state-of-the-art technology to enhance its performance. The system addresses all aspects of technical security. These aspects include control and display; perimeter and interior sensors; data and video transmissions; video assessment; reduced installation, operation, and maintenance costs. Major system features include use of multi-level graphics with touchscreen inputs to control all sensor and video functions. An optional feature allows the use of fiber optics for data or video transmissions. Integration of functional components into modular sub-systems eases the task of expanding, maintaining, and operating the system. The system's automatic restart function permits a fully loaded system to configure itself in less than ten minutes. Site personnel will be able to create and modify a configuration data file of the site. The ASSP software uses this file data to run its programs. The configuration file contains the number of sensors, sectors, buildings, cameras, sensor thresholds, sensor priorities, and other site specific information. An off-line program obtains this information through a series of queries to the site personnel. This information is written to a data configuration file. This paper describes the functions and integration of this system.

INTRODUCTION

In the past, the Department of Energy (DOE) community has used large integrated security systems for protection. These systems do alarm reporting and video recording of perimeter and interior areas. The use of redundant alarm processors, bit map graphics monitors, and large scale mini-computers (to drive the control and display consoles) make these systems extremely expensive. The cost of these systems did not change significantly when using a small number of sensors. A system with close to the same functions, developed using today's new technology, is more cost effective.

Such a system is modular so each site can tailor the system according to the site's requirements. The cost of a system is reduced for a site with fewer requirements, sensors, or cameras. This system is adaptable so that expansion (sensors, cameras, etc.) would not require software changes in most cases. There is a wide selection of available functions to accommodate a particular site's requirements. The site personnel can change the system setup parameters via a map builder program. This would eliminate a third party having to change maps, sensor tables, camera assignments, and function command selections each time a site changed configurations.

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SYSTEM DESCRIPTION

This modular system can service up to 2500 sensors; 1000 sectors or rooms; 1000 video inputs; and 7 control and display consoles. The modular configuration permits redundancy of alarm processors, communication links, and video sub-systems. The configuration of the above system would be equivalent to the large systems already in use and their price. This ASSP system is not intended for a first-time installation of this magnitude. Although, as time passes and security requirements change, a medium sized site is able to expand to this large capacity. The ASSP system is designed to incorporate many functions that are found in larger systems, while being able to perform at a smaller site at an economical price. This system is designed for a configuration containing a few sectors (small) to a configuration containing many buildings and several sectors (medium).

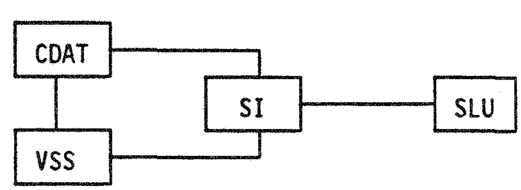

Figure 1. System Block Diagram

Four major sub-systems (Figure 1) compose the modular building blocks of the distributed processed ASSP system. These are the Control and

Display-AT (CDAT), the System Interface (SI), the Video Sub-System (VSS), and the Sensor Logic Unit (SLU).

The CDAT is the operator's interface to the system, therefore at least one must be in the system. Six additional CDAT's can be in the configuration which allows secondary control at different locations, but one CDAT must be primary.

The SI controls error recovery and the message traffic of the system. The SI is necessary only if the system contains multiple VSS's, CDAT's, or SLU's. The maximum configuration of a SI is capable of controlling two VSS's, an alternate SI, 7 CDAT's and up to 40 SLU's.

The VSS handles all video commands and information. The VSS sub-system can have one duplicate VSS in the system for backup capability. The VSS is not required for all site applications. For example, when a site does not use closed circuit TV (CCTV). The elimination of the VSS would reduce the system costs and could be added later if the site desired video coverage.

The SLU interfaces to the sensors with a maximum of 64 sensors per SLU. Multiple SLU's are used to increase the sensor capacity to meet the site's requirements.

Although sounding like a roomful of equipment, these subsystems can be mounted in a four bay console (Figure 2). Inside a typical four bay console is the capacity to check and control 64 video sources via fiber optics, record 128 video events in solid state memory, and archive any channel of video on a VCR. The video switcher has the capacity to support video outputs for one local and one remote secondary console. This four bay console setup could process sensor data from up to 40 SLU nodes.

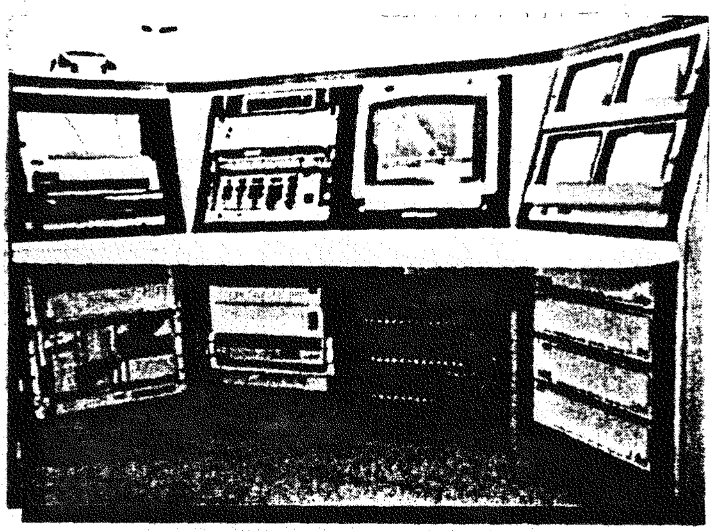

Figure 2. Typical Four Bay Console

DESCRIPTION OF SUB-SYSTEMS
Control and Display-AT (CDAT)

The CDAT (Figure 3) is a PC-AT compatible processor that controls the display for and input from the operator. It is an industrial PC chassis with a passive backplane. The chassis houses a 80286 processor card, a standard disk controller card, and an EGA monitor controller. Additional cards in the chassis are an eight port serial card and a high speed graphics card. These cards support the communications and graphics task of the CDAT.

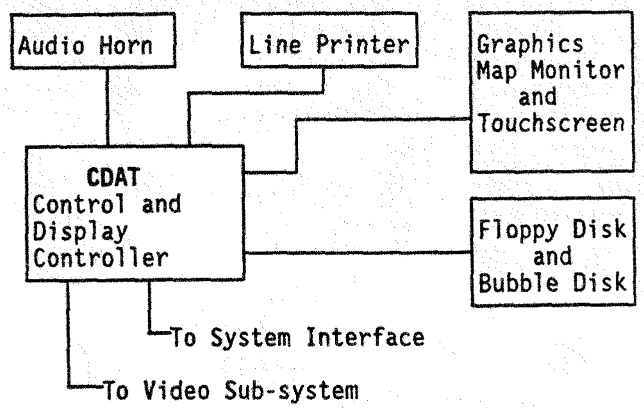

Figure 3 Control and Display Block Diagram

The disk controller handles a 1.2 mega-byte floppy and a 1 mega-byte bubble memory pack. The serial card handles the multiple serial communications to the sub-components and sub-systems connected to the CDAT. The graphics are generated by a high speed co-processor and graphics card set.

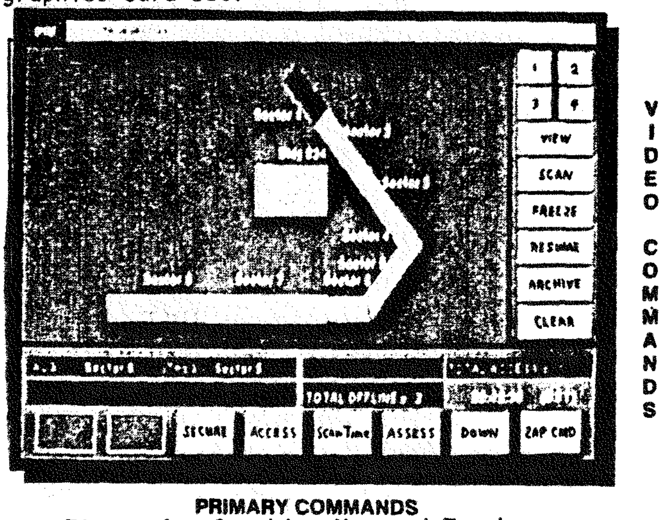

Figure 4. Graphics Map and Touchscreen

This card set frees the 80286 processor from the computationally intense task of drawing the graphics. The graphics card set draws the graphic images from the configuration data file information according to the site (x,y) coordinates. Using these coordinates increases the memory usage, map storage capacity of the disk, and the near real-time response to changes on the graphics monitor. This is an immense cost savings over the use of stored bit maps, using a large high resolution stand-alone graphics monitor, to display the graphic image. This card set has two serial ports which handle the primary communications to the SI or SLU in the system.

The operator input is managed by a touchscreen controller. This controller transmits information to the CDAT processor when the operator touches the front of the graphics monitor (Figure 4). A single touch or a sequence of touches to the graphics screen form a command. This command is formatted in the ASSP protocol and sent to the appropriate sub-system. Multiple CDAT's allow for primary and secondary control with a duress capability to alert the other display consoles. Automatic switching from secondary to primary can occur when the primary is under duress or fails to act on an event.

Each CDAT, as shown in Figure 3, costs approximately fifteen thousand dollars.

System Interface (SI)

The system interface acts as message traffic cop for all the sub-systems. The SI (Figure 5) is responsible for sub-system error recovery, system time, sector-to-sector priority algorithm, message logging, and internal security code checking. This system uses a VME based 68020 processor card. Additional VME cards support communications to all the sub-systems and the status log function.

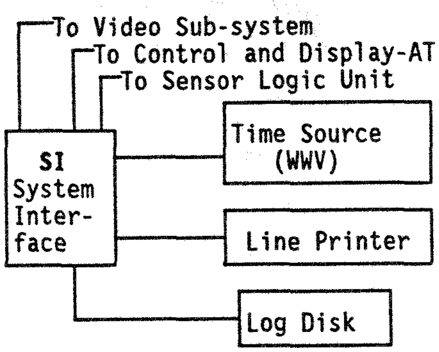

Figure 5. System Interface Diagram

Sub-system error recovery involves several facets of the system. These facets are the detection of off-line communications channels, component failures reported by the sub-system controllers, and maintaining multiple CDAT's in the system in the correct configuration.

System time is broadcasted from the SI to synchronize all sub-systems. The system time comes from a WWV time source unit and is capable of being adjusted for each site's time zone.

The priority scheme used in the ASSP makes use of three priority levels. The priority in the system ranges from three being the lowest to one being the highest. A priority three indicates a probable false alarm and a priority one would indicate a probable intrusion. Initial prioritization occurs at the SLU level. Each site assigns the priority to the sensors to reflect this philosophy. The SI is responsible for recognizing all of the sector boundaries according to the information in the configuration data file. If there is an adjacent sector already in alarm the SI will adjust the priority of the adjacent sector. This adjusted message is sent to all on-line control and display consoles.

All messages in the system, except state-of-health messages, are logged on a hard disk in the system interface. If this disk is full or not working the log function is lost, but the system continues to function.

All sub-system controllers contain a hardware identification for their hardware and a software identification to create an internal security check. The SI changes the software codes at random, thus each message changes over the course of time. This constantly changing code creates a security check for counterfeit messages.

The price of the SI, shown in Figure 5, can range from fifteen to twenty-five thousand dollars. The cost is dependent on the number of sub-systems in the system configuration.

Video Sub-system (VSS)

The Video Sub-System (VSS) manages all of the video in the system. The VSS (Figure 6) is responsible for all the solid state recording, archiving, scanning, switching, and presence detection of the video inputs. This sub-system also uses a VME based processor card and support card to accomplish it functions.

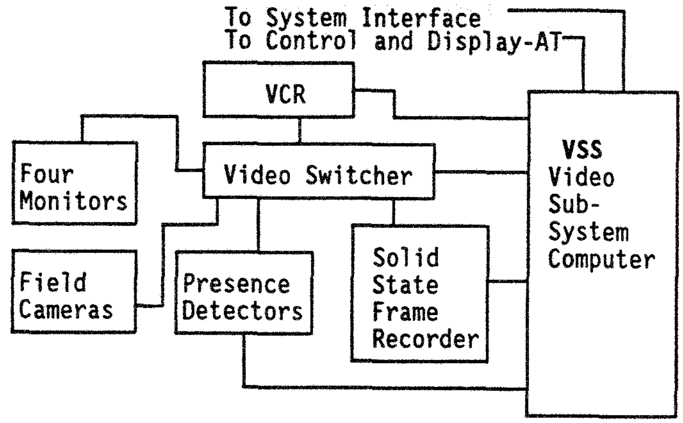

Figure 6. Video Sub-System Block Diagram

Eight asynchronous video inputs can be recorded in solid state memory in less than one second from the time of notification. A two field record technique (Figure 7) is used to emphasize motion. This technique records one field at the time of the event, then delays half a second and records the other field. This implies that the first field of the first eight simultaneous events are recorded in the first half-second. The second eight fields are then recorded in the second half-second. This recording is then played back to the operator at one-second intervals between the two fields.

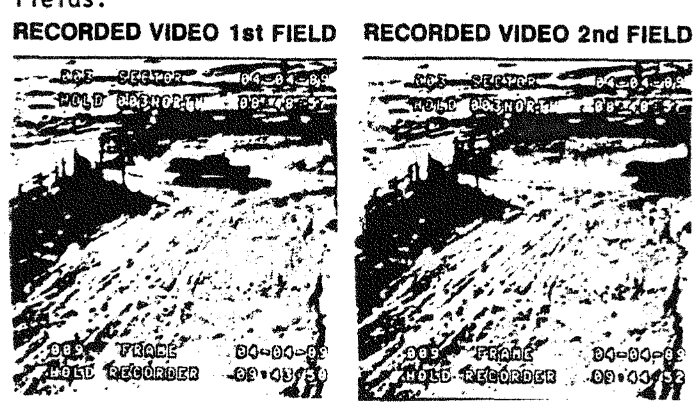

Figure 7. Two Field Record

This motion permits the operator to make a swift and accurate assessment of the event. The playback can be frozen by the operator command to examine each field of the video images and then resumed the toggle motion at the operators request. The solid state recorder can record 128 of these events.

All the video in the system can be recorded on command to a VHS type tape recorder. This recording length is determined by the site operating procedures. The recording can then be removed for playback by another recorder.

A video scan function permits the operator to selectively scan video inputs or to scan all available video inputs. The selective scan would be used to focus the attention of the operator on a certain area of concern for the day, such as a new construction area. The operator can adjust the frequency of the scan by a set scan time function. The capability to stop and re-start this scan is provided to the operator through a menu selection.

All video is available to the operator when designated in the configuration file and the video input image is determined to have a good video signal. Video inputs can be designated to be exclusive, meaning the video is not available to the operator unless an event has occurred in that camera's coverage area. Maintenance or a supervisor can override this function when entering their mode of operation.

All video in the system is constantly checked against a high and low threshold, set by the site personnel. If a video input signal is outside of this range, the video input is declared bad and will be reported to the operator. An alternate camera would be selected if one was made in the map builder program. A bad camera message would alert the solid state recorder so it's video image would not be recorded. Bad camera status is summarized in a table for display at the operators console.

The cost of the VSS, shown in Figure 6, varies from forty to one hundred and fifty thousand dollars. Cost is a function of the switcher size, the solid state recorder size, the amount of fiber optics, and the number of control and display consoles supporting video.

Sensor Logic Unit (SLU)

The Sensor Logic Unit (SLU) performs all the sensor input processing (Figure 8).

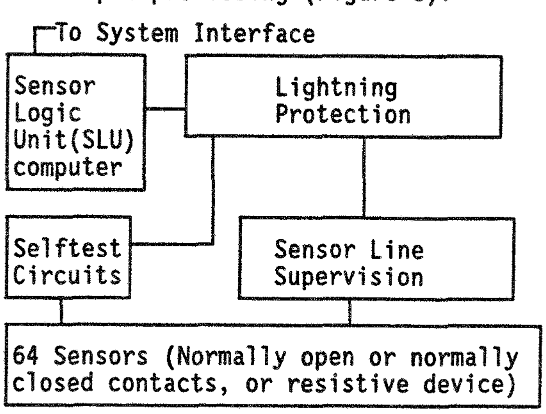

Figure 8. Sensor Logic Unit Block Diagram

It controls the access, offline, self-test and mask conditions of each of the sensor inputs. This system is a VME based processor card with two support cards. The support cards provide an analog to digital (A/D) conversion of the sensor inputs and a relay output card to provide a means to self-test the sensors. The SLU is usually located in a field junction box (Figure 9).

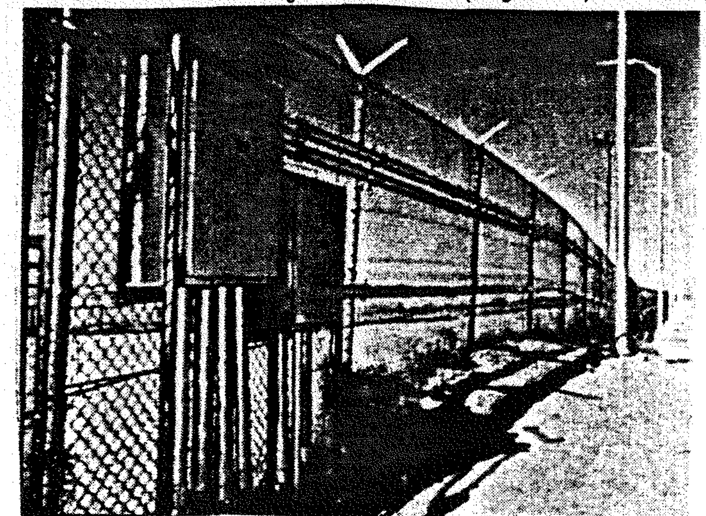

Figure 9 Field J-Box and SLU

If the status of a sensor changes, this is detected by the SLU and an appropriate message is generated taking into account the static and/or dynamic priority conditions of the sensors. The static priority is the level of importance that the site permanently assigns a sensor input. The dynamic priority uses the static priority information of the sensors, according to the number of sensors in a sector that are alarming, to create a new priority. This new priority is reported to the control and display consoles. This system uses three levels of priority, where priority one is the highest level and priority three is the lowest.

All threshold levels for the sensors are sent from a configuration data file to reside in the SLU. This allows the sensor inputs to be normally open or closed relay contacts, or any resistive analog device. Resistive devices are possible because the A/D conversions take place at the SLU. The sensor input is Direct Current (DC) line supervised to detect the various conditions of the sensor and the sensor cable. The sensor can be secure, offline, accessed or in one of three event states. These event states consist of alarm and two tamper conditions. The tamper condition can detect an open or shorted circuit. The accessed condition does not report (masks) the alarm state, but reports both tamper conditions. Offline permits authorized personnel to remove the sensor for repair, because both the alarm and tamper states are not reported.

The SLU has a set of relay contacts for testing each sensor. This test forces the sensor to the alarm state actively testing the sensor operation. This is done randomly at least once every eight hours. Any self-test failure is reported to the operator so it can checked.

Each sensor logic unit manages up to 64 sensor inputs. These can be grouped in blocks of 16, 32, or 64 inputs. Each sensor input input line can be protected against lightning strikes with optional hardware. Messages are generated and sent Rs-232 protocol via fiber optics through a primary and a secondary serial port.

The SLU, shown in Figure 8, costs between six to eight thousand dollars. It's cost depends on the number of inputs and whether there is any lightning protection of the external channels.

DATA and VIDEO TRANSMISSION

The transmission of data and video information in the ASSP system is via fiber optic cable. This cable does not emanate electro-magnetic radiation (EMR) nor is it susceptible to electro-magnetic interference (EMI). This creates a highly secure transmission medium. The size of the cable also promotes retro-fitting, since cable can be run in existing conduit. Standard video cable require lightning protection circuits, equalizers, clampers, and hum transformers to protect and restore the video image to an acceptable level. Fiber optic cable does not need these devices. Transmission via wires of RS-232 data signals to a distance of two kilometers requires modems. Using fiber optics, these signals can easily be transmitted this distance.

OPERATION
CONTROL AND DISPLAY

The control and display AT is the operators interface to the system. The touchscreen is a point and touch system of interaction with the operator. This point and touch technique aids in quick training. System operation does not require keyboard skills.

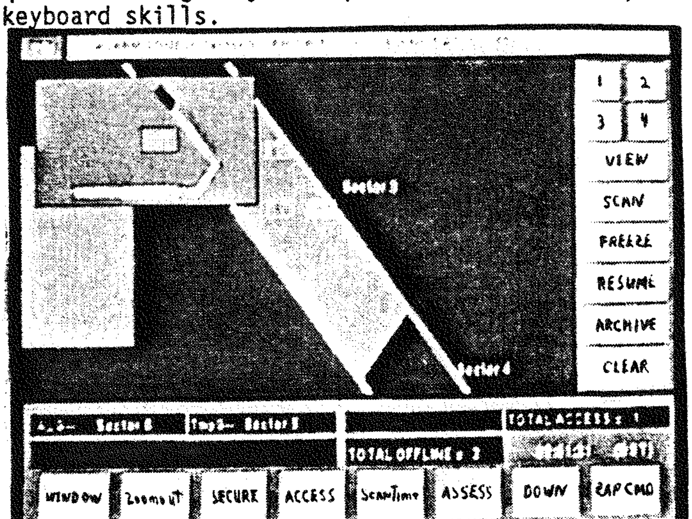

Figure 10. Sector Details and Site Status

The CDAT sorts the events by priority and time received. If the operator makes an assessment of the event the CDAT will automatically present the next highest priority event to the operator. The operator can select any event out-of-order by command. If video is configured in the system, then the video monitors will track the graphics map indications as the operator selects different events. Any time the operator is observing the details (zoomed-in) of a sector (Figure 10) or building a graphic world icon of the sites overall status is available by a single touch. Therefore, the operator is always informed about the site's status.

The operator can have four monitors of video information to view, see Figure 11. This small number of monitors keeps the operators attention focused to important events occurring at the site. The upper monitors present the live and recorded information that the operator is zoomed-in on from the graphics map. The lower left monitor allows the viewing of the live video of the next highest priority event. The last monitor is used only by the operator. With the video tracking the graphics map all of the information is presented to the operator so a quick and accurate evaluation of the situation can be made.

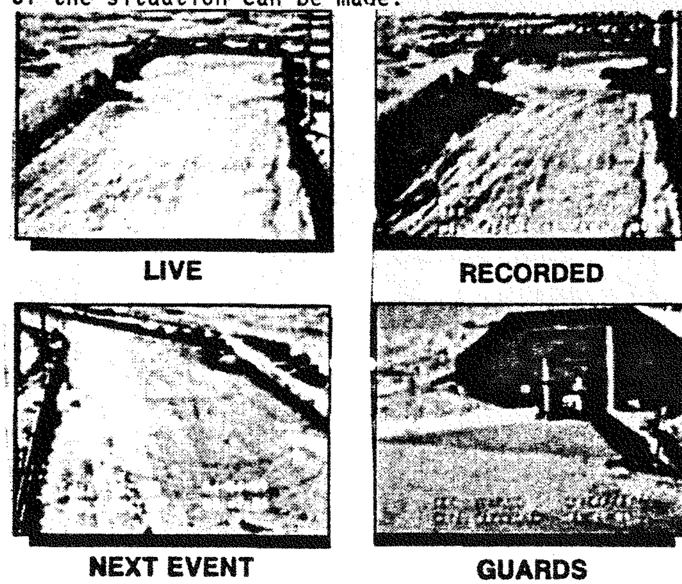

Figure 11. Video Assessment Monitors

Alarm assessment is completed in this system by identifying the cause of the alarm. If the alarm is still active then the event cannot be assessed because it would immediately generate another event. If video is recorded (Figure 6) this identification can be made rapidly. If video is not present the operator must wait for the roving patrol to report the reason of the alarm. This is entered in the system with the assessment menu, which is set by information in the configuration file from the map builder program. A accurate assessment without immediate video recording is unconfirmed at best. Each video alarm scene can be recorded on a VCR tape (VHS) for permanent storage. The length of the recording is up to the operator and the site's standard procedures. Once the assessment is made then the recording is erased and the next event is presented to the operator until all events are assessed.

COST CONSIDERATIONS
INSTALLATION

Construction and installation is always a significant cost factor of any system. Some of the considerations to reduce costs are fiber optic cable using existing conduits and terrain following sensors for minimal perimeter preparation. The ability of the transmission cables to mix with power cables allows a lower trenching or conduit use to install the system. The equipment can be mounted in the four bay console doing away with an equipment room. The equipment can be mounted in many different fashions depending on the site requirements

MAINTENANCE and OPERATION

The operation and maintenance of a system is the long term cost of any system. Maintenance can be as simple as sub-system exchange with a working spare or as complex as troubleshooting the individual failed component on a circuit card. The maintenance philosophy for the ASSP system can range anywhere between these two extremes and is dependent on the site's technical capability.

The ASSP system is a star type communications network instead of loop multiplexed, which makes it easier to isolate a sub-system communication failures. As an added feature each board has a certain amount of self-diagnostics and indicates a failure mode through a front panel indicator. Several of the sub-systems also use the same VME cards which promotes a smaller spare parts inventory to cover all the system functions.

Critical moving parts have been removed from the system except for cooling fans. Therefore diminishing periodic replacement of moving parts, thus reducing the maintenance cost. The status log hard disk and the VCR have moving parts, but there performance does not effect the ability of the system to be in an operational state.

SITE CONFIGURATION AND SETUP MAP BUILDER

The map builder program gives the site the capability to setup or change the system parameters to meet the new site requirements.
The map builder is an offline program that runs on an IBM PC-AT compatible computer. It must have an EGA adapter card, a 1.2 Mbyte floppy, and at least 640 KBytes of RAM. The map builder program will create a file that the ASSP system reads to setup all of the hardware in all the sub-systems. The information for the file is input from a person answering the questions asked by the map builder program.

The map builder program obtains information on the number of sensors and their static priority. This priority is the relative importance that a site assigns each sensor. Other information on the sensors are the threshold settings, access timeout period, and the amount of tolerance around the secure threshold. All this information informs the SLU how to report the sensor status. Sector information tells the SLU what groups of sensors are in a sector and what groups of sensors are in each dynamic priority groups. The dynamic priority group determines how the SLU treats multiple alarms in a sector. The information on the sector for the CDAT, VSS, and SI would inform these systems how to draw the sector, the label information for the video coverage, the labels for the sensors and the sector.

Other information would define communication channels to use, how many times to repeat a message and the amount of time to allow before re-transmitting a message. All the information that the sub-systems need is requested by the map builder program. After all the information is input to the program, the program will output two reports. One report gives the rough inter-system connection of the components and sub-systems. The second gives the approximate equipment and cost list of the system components. This list with the documentation of the system would allow the site to install, operate, and maintain their own system.

The map builder gets information for exterior and interior applications. The maximum limits of the system currently are 1000 sector descriptions. A sector can be described as a room in a building or a section (sector) in a perimeter. The system can define a maximum of 25 floors in a building and 25 buildings maximum with a sum of 100 floors for all buildings. Therefore, if there were 4 buildings with 25 floors each with 10 rooms this would be the maximum amount of space that can currently be programed.

The map builder program is intended to be run by the site personnel who has knowledge of the sites layout. This information may have to come from several sources therefore the program allows the original creation of the sites information and an editing capability to continue to make changes in the configuration. The program is user-friendly, but some working knowledge of computers, x-y coordinate system, and typing would make entry of the sites information a quicker process.

Project Status

The ASSP project is still in prototype development with a one-year expected completion date. The software is seventy percent written with fifty percent of that debugged. The error recovery features have been designed, but are not coded. Documentation has started, but will not be finished until the design and final coding have been completed. Although the hardware is only a preliminary selection, most functions in the system are being tested at an active exterior and interior test bed area. In the near future, access control for personnel identification will be designed into the overall system. Another feature for future enhancement is to have a hot standby (redundant) system interface for total sub-system backup capability. When completed the ASSP system will be an ideal solution for small to meduim sized sites requiring security.