Security Command, Control, and Display Systems Development Status

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ABSTRACT

Sandia National Laboratories has developed a variety of command, control, and display systems for a broad spectrum of users. This paper briefly describes the latest systems developed for the Department of Energy (DOE), the Department of Defense (DoD), and the Department of State (DOS) applications. Applications covered vary from relatively small facilities to large complex sites.

INTRODUCTION

Sandia National Laboratories has, as the lead DOE physical security laboratory, developed a variety of command, control, and display systems for DOE facilities as well as for DOS and DoD applications. This paper will first discuss the general functions of such systems then briefly describe some of the systems developed and conclude with a discussion of technology relevant to those currently considering designing, developing, implementing, or procuring such a system.

FUNCTIONS

The role of these systems is to gather and present information to an operator to accomplish command and control functions for security systems. All functions between sensors and the display operator are included in the command, control, and display system and include data communication, data processing, information presentation, and operator interaction.

Data Communications - Polled/ multiplexed techniques predominate at the sensor level. Sensor data is usually concentrated via multiplexing for efficient use by the data processor(s).

Data Processing - Raw data is characterized, prioritized, and packaged for efficient presentation to the operator. Redundant processing is often employed to maximize information availability even under adverse conditions.

Information Presentation - The goal is to present only the necessary information in an efficient manner. The presentation techniques range from simple indicators and text to sophisticated graphics systems.

Operator Interaction - Reaction to the information presented should be facilitated by natural, easy responses on the part of the operator. Communication to a response force should be immediately available. Commands to the display system should be straightforward.

System considerations such as speed of operation (time from sensor initiation to display), maintainability, and reliability are also very important factors.

DOE APPLICATIONS

Sandia has developed many systems for DOE applications. Two "standard" systems have evolved - the Safeguards Control and Communication System (SCCS) and Security Alarm Control System (SACS), plus three systems that are in development as part of a continuing evolutionary effort, will be discussed here. Software for these two systems can be made available to interested parties.

The SCCS[1] is operational at three DOE sites and is being implemented at two others. The hardware configuration, shown in Figure 1, runs on two host computers which generate operator displays and execute operator commands. The computers run functionally identical software and communicate with each other via a network interface. The primary console is the focus for alarm assessment. The alternate console is responsible for overseeing the actions of the primary operator and is capable of assuming primary responsibilities. Each of the operator consoles includes two color graphics display terminals. Touch panels are used for command entry. Black and white television monitors are used for viewing live

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video coverage and recorded alarm scenes. Data and graphics interfaces provide the capability to modify the system database without modifying code.

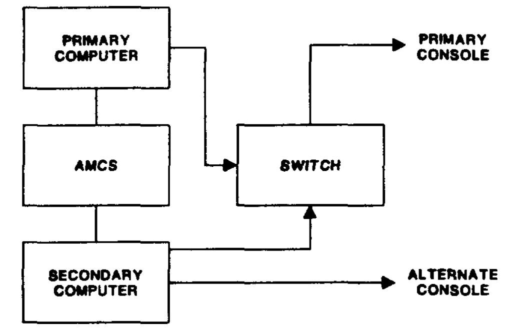

Figure 1 Basic Hardware Configuration

The SCCS uses the Alarm Multiplexer Communication System (AMCS)[2] to collect and report sensor status to the host computers. It utilizes a dual loop multiplexed configuration consisting of "paired" multiplexer control units (MCUs) that monitor a series of multiplexers. This configuration minimizes the impact of single-point failures and provides capability for easily adding or removing sensors from the system. AMCS consists of field-proven hardware which is vendor-supplied and maintained.

The SACS, shown in Figure 2, is operational at two DOE facilities. It

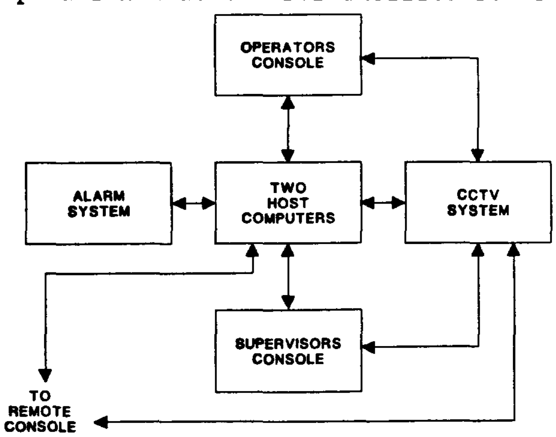

Figure 2 SACS Block Diagram

uses similar hardware and accomplishes functions similar to the SCCS. The alarm system is a commercial system. SACS has a single console since the secondary console function is accomplished at a remote site. The redundant computer runs in hot standby. The Supervisor's Console is unique to SACS. It allows the supervisor to monitor current site status and permits authorized, nontechnical personnel to make site-specific changes to the system. This capability not only prevents system obsolescence but also substantially reduces development and long-term maintenance costs.

The Site Independent Configurable Alarm Display System (SICADS)[3] is in the final development stages and is being prepared for installation at a DOE site. The goal of SICADS is to shorten software development time while providing the flexibility and functionality available in SCCS and SACS. SICADS supports multiple redundant CPU systems, multiple consoles which incorporate color displays and touch panels, and interfaces to AMCS. SICADS can run on VAX or MicroVAX computers. It also supports two types of consoles, a manager's station for report generation and system configuration and consoles used to assess alarms. To use SICADS, the system designer specifies site layout and site specific information at the manager's station. This information is used by the SICADS builder program to generate a VAXELN runtime system. Figure 3 illustrates the steps in using SICADS to build a runtime system.

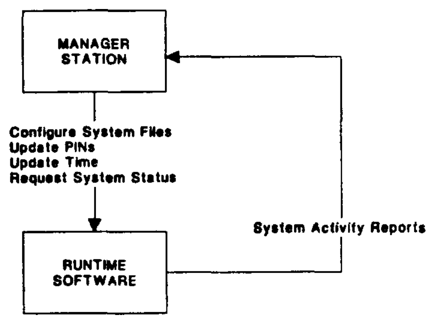

Figure 3 Overview of Software Architecture

The system to be implemented consists of three remotely networked microVAXs; two operator stations with two touch/display consoles; four operator stations each containing one touch/display. AMCS, video equipment and switching of station control between CPUs is also supported.

The Advanced Small Site Program (ASSP) is developing a system to meet the requirement for a low-cost small to medium sized security system. It retains most of the functional capabilities of the larger systems as shown in Figure 4. The system employs fiber optics for video and data transmission. This enhances security, reduces false alarms, and decreases installation or retro-fitting costs. The use of modular subsystems promotes distributed processing and provides a high degree of adaptability to meet site-specific requirements. The star network and the use of commercial equipment aid in quick and efficient modular replacement maintenance. Elimination of critical moving parts from the subsystems increases the mean time between failures. The system is created or modified using a configuration data file which informs each subsystem as to their specific functions. The file includes 1) map layout, 2) authorized operator functions, 3) camera coverage associated with each area, 4) operator command functions, 5) equipment designations, 6) sensor descriptions, 7) sensor priorities, and 8) sensor thresholds. The advanced small site program's flexibility presents a cost-effective solution to many sites' security problems and concerns.

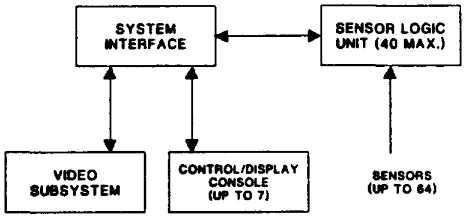

Figure 4 ASSP Block Diagram

The Modular Adaptable Network for Alarm Reporting (MANAR) system is currently under development. It is directed toward using PC technology to provide a versatile system with applicability to many types of facilities. The network example shown in Figure 5 illustrates the capability and configurability of the system. Each node can be multiple or single PCs which each have a specific function. The network architecture is based on the Intel Bit Bus and provides the ability to survive physical attacks at any line or node network location without loss of information from the rest of the network. Sandia has provided some special hardware to accomplish this since such a network is not commercially available. The bit bus operates in a polled mode with one CPU on the network assuming the responsibility of master. Each CPU is dedicated to its specific function thus providing true modularity of both hardware and software. The CCTV node is a PC with Sandia-developed routing switcher and character annotator boards. The alternate master provides for redundancy to ensure uninterrupted operation. Each other node can be duplicated if this level of redundancy is required. The network structure and the use of PC technology is expected to provide the functionality needed for a broad variety of applications in a cost-effective but reliable manner.

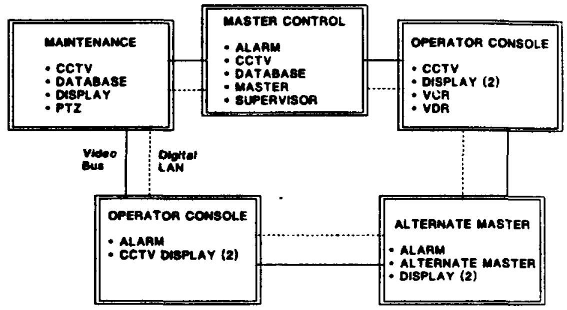

Figure 5 Example MANAR Configuration

DOD APPLICATIONS

In a synergistic effort with the DOE, Sandia has supported a number of DoD applications. Historically, the Small Permanent Communication and Display Segment (SPCDS) has been a mainstay of high security applications for the Air Force for over a decade. Other Air Force applications, and work for the Navy, focused on use of commercially-available systems, while support of the Army was provided by an adaptation of early DOE systems. In cooperation with our DoD sponsor - the Physical Security Systems Directorate, Electronic Systems Division, Hanscom AFB, MA - Sandia continues to support these activities. Although SPCDS is still in use today, new applications are utilizing current state-of-the-art computer-based technologies such as in the ongoing "Interim Annunciator" (IA) program.

Although much technology has been interchanged between the DOE and the DoD programs, significant differences exist in DoD applications such as 1) worldwide remote locations which may require off-site maintenance, 2) the temporary nature of operators and maintainers, and 3) the need for standard systems. These differences suggest that DoD systems must exhibit high reliability, minimum complexity, and flexible modularity. These goals were achieved in the IA by utilizing commercially-available components and subsystems. This approach results in lower cost and shorter into-use-time.

System Description - The IA, shown in Figure 6, uses a scaled-down version of the DOE AMCS communication system to collect alarms. It only uses a single master but can support a large number of sensors and has immunity to most single point failures.

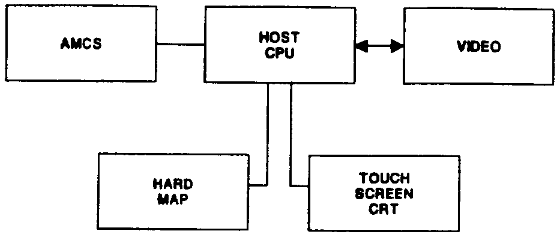

Figure 6 Interim Annunciator

The IA uses a single Motorola 68020 VME-bus CPU to a) control display of alarms to the operator via a color CRT and LED-based wall mounted graphics map, b) receive his commands via a touchscreen mounted over the CRT, c) control the automatic switching of video and character insertion from the sectors in alarm, and d) maintain a historical database of all system activity for post event analysis and periodic maintenance diagnostics. It utilizes memory-resident software, eliminating the need for floppy or hard disks. The system does not employ an on-line printer. Instead, it downloads the historical database onto a separate PC and uses a common database program with several pre-programmed reports to allow the user to perform an off-line review of system activity. The PC also provides a means for distributing upgraded versions of software to the VME CPU.

The IA operator interface design was based on lessons learned from early DOE work and provide a user-friendly display. The operator is presented with only the information he needs to perform an immediate assessment of an alarm. The data is presented in priority order with different levels of detail, size, color of blocks, and blinking dependent upon priority and current status of the alarm handling sequence. A major difference between the IA and most other DOE systems is the lack of CRT-based graphic maps. This allows a smaller footprint and lower cost (a one-bay versus two-bay console typical of DOE systems) since only one CRT monitor is used. Major cost savings occur by eliminating the extra support equipment which would be required for easy user modification of CRT-based graphics. The IA allows the user to modify the site configuration with the off-line PC without requiring factory or field reprogramming of EPROMS.

DOS APPLICATIONS

A next-generation security command, control, and display system for DOS foreign posts has been the objective of the Marine Automated Security Console (MASC) System Development Program. Although the MASC System has benefited from the experience of the DOE and DoD programs, unique requirements have warranted additional development. Some of the salient features provided by the system are 1) functionality and complexity compatible with world-wide foreign post requirements and technical support capabilities, 2) automation of frequently performed administrative tasks, 3) crisis management for alarm and non-alarm related situations, 4) remote operation for a variety of activated delay devices, 5) interfaces to installed equipment, 6) field configurability, and 7) ruggedized equipment.

System Description - The system consists of four independent yet integratable building blocks - the Information Management Block (IMB), the Drawing Display Block (DDB), the Text Display and Control Block (TDCB), and the Graphics Display and Control Block (GDCB). The IMB automates administrative tasks such as controlling keys and badges and displaying and recording of crucial information. Operations are facilitated with menus and most functions are handled with four function keys but a keyboard is available for text manipulation. The DDB provides a continuous display of the complete facility, security equipment locations, and alarm status. A writing surface overlay enables easily erasable notations for tracking events. The TDCB provides text display of equipment status and centralized control of security equipment. Four control/display modes are provided: 1) emergency device control, 2) alarm display, 3) access control, and 4) alarm mode select. The GDCB provides detailed control and display but has not been fully implemented. When all four blocks are integrated, they satisfy the needs of the largest posts. Since the blocks are independent, they can also be used individually to add functionality to any sized post.

TECHNOLOGY STATUS

This section provides a discussion of the technology options available to those considering designing, developing, implementing, or procuring such a system. There are systems other than those discussed above being developed within the government complex and private industry also offers systems which accomplish similar functions. The commercially-available systems lean toward a medium security system or attempt to address such a broad range of applications that the efficiency for handling security problems is degraded. Government-developed systems are for specific higher security applications. In both cases, however, the general technology is similar. Major elements for which technology will be discussed are data communications, data security, data processing, displays, and operator interaction techniques.

Data Communications - The sensor output switch state is usually transmitted as a simple binary signal in real time to a data collection unit. In multiplexed/polled systems, this information for several sensors is combined together and transmitted over a high speed data bus to the host processor. With the continuing evolution of powerful, small, economical processors it is feasible to locally enhance sensor data such as is done in the ASSP sensor logic unit.

Data Security - It is generally desired to protect data from intercept by outsiders and compromise by insiders. TEMPEST techniques are available to protect against outsiders but most facilities do not deem this to be necessary because of normal standoff distances and access restrictions. Insider protection is usually provided by line supervision on sensor communication and digital encoding on databases. Access controls and tamper indicators limit access to processors and displays. There are some capabilities for encryption available and more will become available as the need for more security increases. Some newer systems are using DES encoding schemes for data bus communications. Replacement of line supervision with an encoding scheme will probably cause significant cost increases in security systems.

Data Processing - The increasing processor capability should allow a broad variety of system capabilities and configurations in the future. Artificial intelligence techniques promise to provide a more efficient processing approach.

Displays - Selection and use of displays is primarily driven by considerations of amounts of data to be handled, ease of use, effectiveness of the interface, and cost. The systems available to the community include almost any approach a user might desire. The challenge is to select what is most appropriate and cost effective for the application.

Operator Interaction - Many of the comments in the preceding display section also apply here. Commercial interfaces are available to support a keyboard, mouse, or touch panel in these applications.

CONCLUSION

Development activities and the rapid evolution of the computers over the last decade have resulted in a broad variety of capabilities to support most security system command, control, and display needs. The major task in selecting a system is to become familiar with these capabilities and find the best match to a specific need.

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