Consultant's Report

EPCOT / WORLD SHOWCASE

SPECIAL EVENTS CONTROL SYSTEM

Preliminary Design Phase

Presented January 26, 1981

By

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This work is performed under WED
Work Authorization # 97D-80-1.

INTRODUCTION

The **SPECIAL EVENTS CONTROL SYSTEM** (SECS) will control entertainment equipment throughout EPCOT and World Showcase. It has been conceived to be as flexible as possible to allow for expansion and unforseen functional needs which will develop in the future of the park. Great care has been given to design a system that will perform with the utmost reliability.

Redundant main computers form the hub of the dual MinnieNET communications network which provide links to the Remote Interface Cabinets (RICs) located in the Pavilions of World Showcase.

Each RIC directly controls lighting and special functions, collects inputs and function verification and sends control data to audio control equipment in its pavilion's control area. As more Pavilions are added in World Showcase the increased count of RICs will expand the control capabilities of the SECS.

The SECS interacts with other computer systems in EPCOT (SMACS, Park Function Controller and Audio Control Equipment) to provide functions associated with park maintenance as well as entertainment events such as pageants and courtyard shows.

This report defines the SECS' purpose and requirements and describes how the architecture of the computer system fulfill s these.

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SECS CENTRAL SITE DESCRIPTION

The hub of the EPCOT Special Events Control System will be located at EPCOT Central. The portion of this equipment designed by E.T.C. will include:

- -The System Operator's Console
- -Remote Programming Console
- -The System's SECS Computers
- -Computer Communication Equipment
- -The Back-up Systems
- -Remote Interface Cabinet (RIC)

The SECS equipment at the Communicore will include two identical Computers. The SECS Computers will serve as the hub of the SECS network. They will be responsible for cue editing, storage and event control. It will be responsible for generating commands for the Park Function Controller, the Audio Routing Switcher, the audio sources and the lighting and audio functions associated with all the RICs. The second , or Back-up, Computer will be responsible for maintaining back-up copies of all SECS cue files and will be capable of feeding these files back to the Main Computer in the event of a failure of the Main Computer's file storage device.

The Back-up Computer will also serve to run periodic diagnostics on the entire SECS system and inform the operator of any system failures. In the event of a failure in the communications link between the Main Computer and any of the RICs, the Back-up Computer will provide an alternate path for communication. In the event of a failure of the Main Computer the Back-up Computer will be capable of taking over all the SECS functions mentioned above.

During normal system operation the Back-up Computer will be available for use by programmers to modify SECS programs or develop new programs. This facility will be available to personnel at Communicore or at a remote site via a phone line.

I Communicore Operator's Console

A) Operator Controls and Display Descriptions

The Communicore Operator's Console is the main human interface to the Special Events Control System. The Console is to be part of the 'Show' in Communicore and therefore, the appearance of the console is a major design consideration. The actual enclosure design will be executed by WED based on spacial requirements provided by This Report. The major components of the console will be:

- -Operator's dedicated function keyboard used to:
  - -edit cues and initiate actions live.

- control Color Graphics Display and monochrome CRTs.

- Color Graphics Display of SECS status.
  - makes all SECS status information available in graphic form
- Three monochrome alpha-numeric displays.
  - Cue Edit Display
    - Light Status Display
    - Sound Status Display
    - Transmitter Position Display
  - System Maintenance Display
  - Daily Log Display/System Status Display
- Alpha-numeric Data Entry Keyboard.
  - Entries into Daily Log
  - Messages to Local Status Displays
  - Communication to Data Entry Terminal in Entertainment Director's Office.
- System Maintenance Console.
  - Local Status Display selection controls.
  - Reset functions for Remote Interface Cabinets.
- Audio Monitoring panel.
  - monitor of audio sources routed to pageant route.
- Intercom Control panel.
  - Intercom channel selection.
- Microprocessor Card Racks and associated electronics.
  - control of panel functions.
  - communication with SECS Computers
  - monochrome CRT drivers.
- Color Graphics Display Driver.
  - MiniComputer controlled Color CRT driver.

Additional controls that are covered by and referred to in this section serve as parallel access terminals and back-up equipment to the Console. They are:

- Alpha-numeric CRT terminal in the Entertainment Director's office for entry of event programming.
- Remote Programming Console used to back-up Console.

B) Console Architecture

The console is to be operationally similiar to the Mickey-Track system now employed at Disneyland. Externally the most dramatic difference will be the spectacular Color Graphics Display. Internally there will be many differences. Due to the magnitude of the SECS system, minicomputers will be employed for the central processor instead of microprocessors.

The most direct method of interfacing the console would be to connect all the operator controls and displays directly to the main computer. This technique has several drawbacks. First, a large number of cables would be required to connect the console's many features to the computer. Second, a great demand would be placed on the main computer to service both the console and the network of RICs in real-time. Third, the task of backing-up the console in the event of a failure is made quite complicated. Fourth, in the event of a main computer failure the console would need to be switched to the back-up computer, a task made difficult by the large number of cables involved.

There is a simple solution that has several additional benefits. A micro-processor system will be installed in the console and it, rather than the main computer, will be interfaced directly to the operator controls and displays. In this way the main computer is freed from the task of servicing the controls and displays directly and the link between the console and main computer can be reduced to one high speed serial line. A second serial line will be used to interface the console to the back-up computer eliminating the need for any hardware switching of the console. The architecture of this microprocessor system will be similar to that used in the RICs (see drawing 2), and the serial line protocol for the console to SECS Computers interface will be the same as that used by the RICs. In this way the console can be configured as a node in the network rather than existing as a unique peripheral of the main computer.

The benefits of this approach are; a reduction in the number of cables required to interface the Console to the system, a reduction in the cost of the Console control and display interfaces, a standardization of communication protocol that will allow the Remote Programming Console to easily replace the Operator's Console, a standardization of system hardware that will reduce the variety of circuit cards in the system, a reduced load on the SECS Computers and a method of interfacing to the back-up system that is not dependent on hardware switching.

Due to the extremely large demands for processor time and mass storage, the Color Graphics Display will require a dedicated microcomputer. In order to facilitate program development this microcomputer will be of the same "family" as the main computer so that the same development software can be used for both systems. The Color Graphics Display system will have its own controls to allow the operator to select the system's mode of operation and choose what information is displayed. The Color Graphics Display and system controls will be contained within the console while the microcomputer and its disk will be separate. The color graphics system will be linked to the console's microprocessor system via a high speed serial line.

C) Cue Editing Console

The **Cue Editing Console** provides the operator with the ability to enter, record, edit and execute cues in the Special Events Control System.

The console will be comprised of one of the monochrome CRT displays as well as the Color Graphics Display which will be mounted in the center section of the Communicore Console. All functions and controls for the Cue Editing Console, its display and the Color Graphics Display, will be in the Dedicated Function Panel located in the table area of the Console immediately in front of the two displays.

This console, as currently planned, will be very similar in function to the Disneyland Parade Controller. Cues will be organized on a Transmitter#/Receiver# basis and will consist of a block of English-like text which has proven to be successful in the present system. Cues are 'written' by the operator much as he would coverse with the use of Verb switches and numerical information added with the use of a keyboard. Planned improvements include:

-Operator-definable names which appear in display references to specific transmitter numbers and receiver locations (e.g. German Bandleader/Pageant Entrance 1). These names will be entered by using the Data Entry Keyboard in the Communicore Console.

-A more complete Event Timing Log (see System Status Diplay) will be produced during each event, including a sequential list of everything that occurred during that event such as system malfunctions, operator comments, transmitter arrival times, etc. This will aid greatly when editing cues as it will be displayed on the System Status Display and can be accessed simultaneously.

-Back-up copies of the cues will be kept on the disks in the SECS Computers. This will be useful if changes are made to an event's cues which are not satisfactory, it will be easy to return to the original cues.

-There will be an Immediate Execute

function, where a cue or verb can be initiated live by the operator.

-The addition of a Help function which will provide information to the operator on the function and purpose of the controls in the SECS.

The display formats for the Cue Editing Console will show essentially all information pertinent to the entry and editing of cues, the execution of events and transmitter location, lighting and sound output status and the like.

The display modes will include:

1. The Cue Edit Display will contain information regarding the cue that is selected by the Dedicated Function Panel at the time. Information to be displayed will include:

-Event title.
-Last date cue was modified.
-Cue number by Transmitter # /Receiver #.
-Name of Transmitter and Receiver.
-Cue sequence displayed as English-type text. The length of a cue can be greatly expanded from the Disneyland Parade Controller due to the increase in display density.

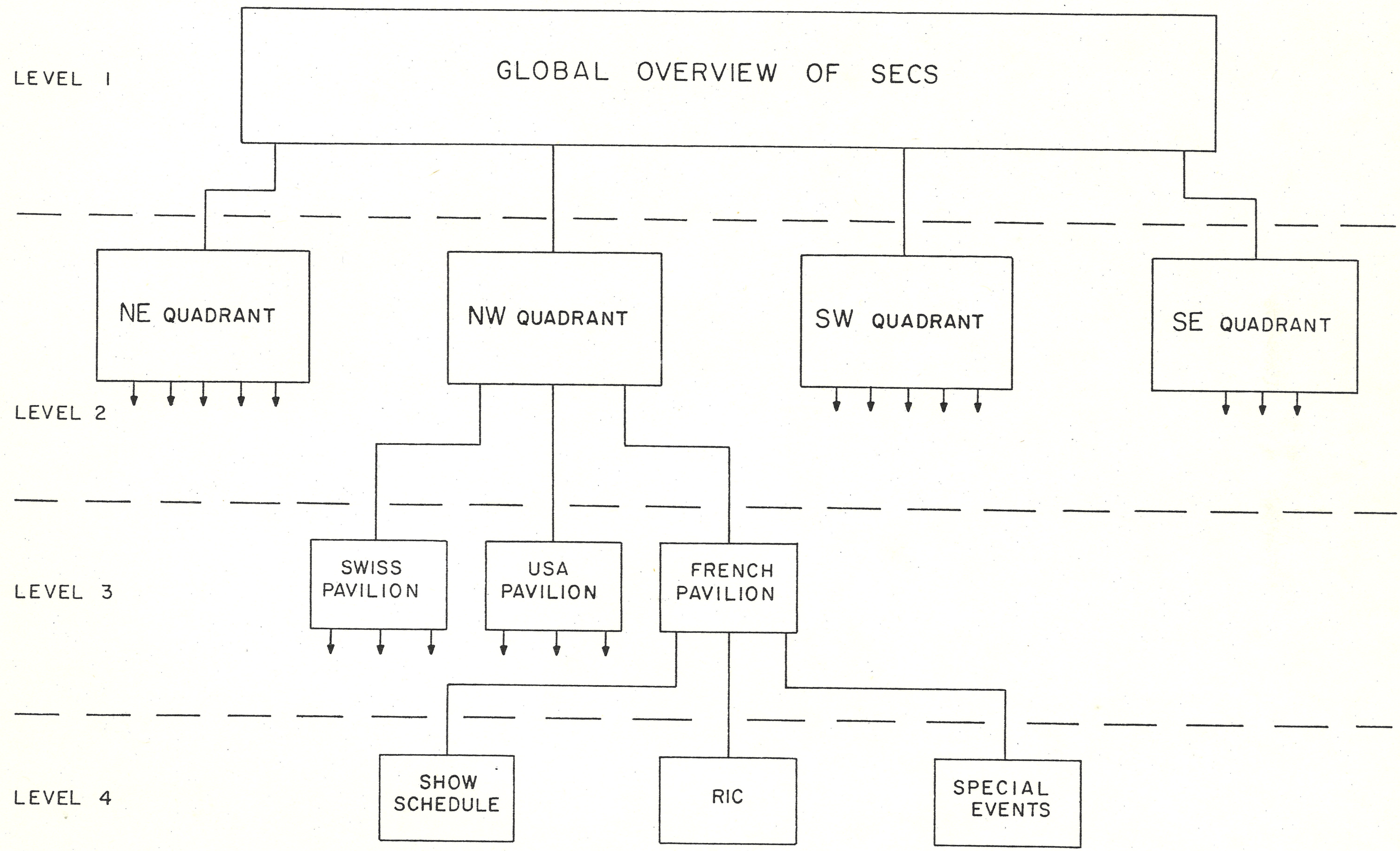
D) Color Graphics Display

1) Considerations of Color Graphics Hardware

In addition to the 3 monochrome video monitors, a color video display with sophisticated graphics capability shall be incorporated into the console. The purpose of the color display is to provide a fast and powerful interface to the MinnnieNET and associated devices. The color display should be interactive to provide for easy use and sophisticated monitoring the SECS. Typical color displays include:

-An overview of the entire system with any selected sub-system enhanced
-An overview of a specific pavilion
-A graphic representation of any Remote Interface Cabinet
-A menu of operations and displays

Careful consideration must be given to the hardware chosen for the color driver and monitor since it will ultimately set the limitations on the system's



SECS TREE AS ORGANIZED BY THE COLOR GRAPHICS DRIVER

FIGURE 1

capabilities. There are several technologies available which essentially fall into 3 basic catagories:

-Direct Storage
-Vector Refresh
-Raster Scan

With a direct storage device the CRT contains a charge storage screen. The CRT itself stores the video image. The advantages to this type of display are that minimal CPU time is required and that very high resolution displays can be generated. The disadvantage is the incapability to selectively modify discrete portions of the display. This makes interactive and dynamic graphics somewhat difficult to produce.

The other two approaches to computer graphics, vector refresh and raster scan, involve continuously updating a screen with a very short persistence phosphor. Both require special hardware to update the display. The information needed for this operation is derived from a dedicated random access memory which contains a digital representation of the displayed image. In the vector refresh case this information is in the form of a list of vectors to be drawn on the screen. Altering the display is effected by suitable manipulation of this list. In raster scan graphics, there is a direct correspondence between bits stored in memory and points on the video display. The points are called pixels and a pixel is defined to be the smallest resolveable area on the screen. The simplest example is a monochrome display in which each bit can be either on or off corresponding to a pixel being black or white. To implement color more bits are required to define the state of each pixel.

Each of the refresh approaches has some advantages over the others. Drawing three dimensional pictures and performing rotations is more easily accomplished with vector refresh. Vector refresh is however not suited for generating color displays and few manufacturers have opted to produce color terminals using this technology. Drawing large and finely detailed images and performing operations such as zooming and panning are best handled by the raster scan techniques. Raster scan is also best for the creation and editing of graphic displays. To facilitate this a device called a frame grabber exists that produces a digital representation of a television picture from the composite video signal.

2) Graphics Driver Architecture

Current computer graphics raster scan technology provides a powerful tool for display of information. The addition of color to graphics displays enhances the ability of the computer to convey greater densities of information in a manner which is humanly digestable. A color terminal also contributes to the entertainment aspect of the console. Hence, a high resolution raster scan color graphics display will be incorporated into the console.

The full exploitation of color graphics requires a significant amount of processor time and resources. Therefore, in order to avoid making excessive demands on the SECS Computers, the color graphics will be driven by a separate, dedicated microcomputer. This dedicated processor, henceforth referred to as the graphics driver, will be a slave to the SECS Computers. In view of this relationship, the graphics driver should be a close relative of the main processor in order to simplify hardware and software maintenance. One advantage of using a dedicated proccessor for graphics control is that system development of graphics hardware and software can occur independently and in parallel with the remaining system. Being a separate entity, the integrity of the graphics driver will not affect the functioning of the remainder of the system. It can be shut down without disturbing the operation of SECS.

The graphics driver will have access to status information indirectly through the console microprocessor via a high speed serial link. In addition, there will be a set of operator controls on the dedicated function panel that are interfaced directly to the graphics driver. The purpose of these controls is to control the display mode and display parameters. A direct line will link the graphics driver with a private disk which stores digitally encoded representations of the SECS in varying degrees of detail. The graphics driver will enable the operator to view the status of any portion of the SECS in a wide range of detail. The operator shall have the capability of homing in on any subsystem and interrogating the status of that subsystem.

The graphics driver will organize the digital representation of the SECS into a tree pattern (see figure 1). The highest level in the tree corresponds to a global overview of the entire system. While at this level, a computer generated picture of SECS will be displayed on the color terminal. Moving one layer deeper into the tree brings the graphics driver to a particular quadrant of the network and invokes the driver to display a corresponding view of the quadrant in greater detail. The graphics driver will obtain real time information to complete the display from the

SECS Computers.

There will be two separate modes of operation in which the graphics driver can be used; Normal mode and Scan mode. In the Normal mode the operator will be able to specify and instantly access any level in the tree and its corresponding status information. The display screen will show a graphic picture of the level and update status information in real time. The status information will be in the form of color encoding or a superimposed alphanumeric display or a combination thereof. At certain levels in the tree, the operator can enable or disable the display of an overlay of various subsystems. For example, at the highest tree level, a picture of the lighting levels or current float positions can be superimposed on the display.

The Scan mode provides a more sophisticated method of transporting oneself around the SECS tree. By using a trackball, the operator will be able to guide the graphics driver from its present location to any other connected location on the tree. For example, starting at the overview level, one can pan over a quadrant, zoom in on a pavilion area, enter the pavilion and inspect the status of the local remote interface cabinet. The operator can then back out of the pavilion enter the quadrant overview, and inspect another nearby pavilion.

3) Color Graphics Display Layout

The Color Graphics Display (CGD) will reside in the center of the operator's console. Near the display will be a keyswitch to turn the graphics display power on and off. If a remote color monitor is included in the system then a switch will be included to enable the remote display.

4) Color Graphics Display Controls

The dedicated function panel will include push-buttons and a trackball for controlling the CGD. The function of the trackball will depend on the current mode of the CGD. In the Normal mode the trackball will be used as a cursor controller. The operator will select a function from a list or "menu" by spinning the trackball to position the cursor over the desired function. The function will then be executed by pressing the "INITIATE" button. Alternately the operator may wish to read a description of the function selected. In this case the "HELP" button will be pressed and the graphics driver will display text explaining the entry chosen. The "HOME" button permits the operator to return the CGD to its overview state, in which the basic menu is displayed. Two buttons, NORMAL and SCAN, control the mode of the graphics driver.

In the "SCAN" mode the trackball will control the portion of the SECS displayed. Two other buttons, "ZOOM IN" and "ZOOM OUT", will be used in "SCAN" mode to select the amount of detail displayed from a SECS overview (level 1) to a detail of one pavilion (level 4) (See figure 1).

E) System Maintenance Console

The System Maintenance Console is located to the operators right in the SECS Console. The primary responsibilities of this console are to display the operational status of every component in the SECS, initiate diagnostic programs in the system and to instigate corrective measures in the case of a detected failure. The Intercom Control Panel should be located close to this console to allow the SECS operator to communicate easily with maintenance personnel in the field.

The System Maintenance Console will be comprised of one monochrome CRT display in the Communicore Console as well as certain switches and controls which are associated with the Dedicated Function Control Panel.

1) Local Status Display Select.

These rear illuminated switches (1 for each possible RIC + the Console) are located under the CRT and their position corresponds to the location of the Remote Reset switches above. The selection of one of these switches results in the duplication of that RIC's Local Status Display on the CRT in the System Maintenance Console.

In addition to the Reset All RICs function there is an Entire System switch that displays a block diagram of the SECS with status and error messages for each sub-system.

Switches will also be provided to show a status display of both of the SECS Computers as well as the Color Graphics Display System.

2) Diagnostic Program Select

This section of the Dedicated Function Panel is a series of switches used to select and execute hardware diagnostic routines in any of the sub-systems of the

SECS. The selected routines will be executed on the sub-system that is selected and displayed on the System Maintenance Display CRT, where the results will be displayed.

There will be a Diagnostic Enable keyswitch that will disable those diagnostic routines that should be used only when the park is closed such as audio and lighting output tests. This enable switch will have an associated indicator lamp.

Since the available diagnostic routines will vary for each type of device in SECS and will depend on the state of the Diagnostic Enable keyswitch, the possible selections will be displayed as a menu on the CRT and will be selected by Cursor controls on the System Maintenance Console. Once a routine has been selected in this manner, it can be executed by the depression of the Execute switch.

Certain diagnostic routines will call for operator involvement (to verify if outputs responded correctly and then request status log entry of results for example). The operator will be prompted by the CRT display and will respond by depressing either the YES or NO switch.

The operator can also receive instructional help on the use of this console by depressing the Help switch. This will display text describing whatever function/diagnostic is selected at the time.

3) Remote Reset Control Functions

These functions will be located on the System Maintenance Console above the CRT, since they are a secondary control function they will not be in a central position on the console. There will be a hard-wired Remote Reset Enable keyswitch and indicator lamp to prevent accidental or improper resetting of a RIC which would cause an interruption in the output for that system.

There will be one backlit reset pushbutton for each RIC in the SECS. The buttons will normally be illuminated at low intensity. Should the Main SECS Computer not be able to communicate with a given RIC, it will flash the appropriate Remote Reset Switch. The switch will flash from OFF to ON in conjunction with an audio alert buzzer to indicate that the SECS Computers request the operator to perform a reset function. Operator intervention is required here to make the determination as to whether it might be better to leave the RIC in the mode of failure rather than reset the RIC. The resetting of a RIC will re-initialize the CPU in the RIC resulting in all outputs being set to an OFF state. This output status will remain until the first transmission from the SECS Computers is completed, setting the outputs to the selected states.

Upon SECS initialization, all Remote Reset indicators will illuminate temporarily indicating that the RICs on MinnieNET have been reset by a command from the SECS Computers. This reset will be a 'soft reset' or a command sent over the serial links instructing the remote processors to re-initialize their operating programs and to turn off all control signals. It differs from the Remote Reset function in that it does not reset the electronics, only the software.

Additional Remote Reset functions on this console include:

- -Reset All RICs Provides similar hardware resets for all RICs simultaneously.
- -Reset Main Computer Hardware reset for Main Computer.
- -Reset Back-up Computer Hardware reset for Back-up Computer.
- -Reset Console Hardware reset for Console MPU.
- -Reset Color Graphics Display System

F) System Status Display Console

The System Status Display Console is located in the SECS console on Communicore. It is located to the operator's left and is comprised of the third monochrome CRT display, an alpha-numeric data entry keyboard and some dedicated function switches.

The purpose of this console is to enter and display the System Log which contains records of the Events controlled by the SECS, error messages, system messages (transmitted to LSDs in the RICs) and event programming.

The System Status Display can be addressed by the Remote Data Entry Terminal in the Entertainment Director's office as well as from this Console.

The contents of the System Status Display can be printed by the printer in Communicore.

1) System Status Summaries

The Main Computer will maintain a log of the status of each production and of the status of the system. At the end of each production a summary will be printed that describes the production as it was designed and as it actually occurred. The production summary will include items such as:

- -Time production started
- -Time of arrival of floats
- -Time of execution of cues
- -Time and type of operator interactions
- -Time production completed
- -Delays and errors in the production
- -System failures
- -Operator comments

At the end of each day a summary will be printed that will include:

- -a list of the day's productions
- -a list of the productions created or modified
- -a summary of the park function activity
- -a summary of system errors
- -a description of modifications or repairs made on the system.

2) Dedicated Function Controls

There will be dedicated function switches which provide the following functions:

- terminal enable keyswitches with indicator lamps to :
  - enable Remote Data Entry Terminal in Entertainment Director's office
  - enable local programming console input
  - enable System Software Maintenance Terminal
- "SCREEN PRINT" switch which outputs System Status Display to printer

G) Remote Programming Console

The Remote Programming Console (RPC) serves two purposes. The first is to allow pageant/festival cues to be entered from remote locations throughout the World Showcase where the timing can be observed live. The second purpose is to serve as a Back-up system for the SECS Console in Communicore. Both of these functions require the access to all display modes of the Cue Editing Console as well as the function control contained therein.

The RPC architecture will be similar to that of the SECS console with the exception that the RPC will have only one CRT display. The RPC will connect to MinnieNET through any of the RICs via a high-speed serial link. The CRT display update needs are the main reason for the high MinnieNET transmission rate requirements.

The RPC will resemble a data entry terminal in physical terms although it will have a dedicated function control panel rather than a typewriter keyboard. Since this unit must be portable and can expect to encounter some physical abuse, rugged construction must be of prime concern in it's design. The RPC might also be exposed to inclement weather so thougt should also be given to this in it's packaging design.There will be no need to store information permantly within the RPC so there should be few mechanical parts to malfunction (i.e. no disk storage).

At least two of these units should be included in the SECS, with one permanently located in Communicore to serve as an emergency back-up to the SECS Console and one for remote cue entry use.

H) Communication with other Systems

1) Voice

The Operator's Console will include an intercom to allow the operator to communicate with other Disney personnel. Additional intercoms should be located at the RICs, convenient locations in the pavilions, service buildings and on other system consoles (SMACS system).

2) Electronic Mail

In addition to the intercom a system could be installed that would allow text messages to be transmitted between system consoles containing computer terminals. This type of system would allow an operator to send a message even when the recipient is away from the console or busy. It would also allow messages to be logged on the system disk and printed on the line printer.

II Main Computer

A) Functional Requirements

1) Cue and Program Storage

The Main Computer must have on-line mass storage for SECS programs, lighting and audio cues and any system buffers too large for storage in the computer's memory. There must also be the facility for off-line or library storage and inherent in this, the capacity to transport data between the SECS computer and others. A quantitative evaluation of these requirements must take into account an estimate of the size of the system programs, the method of storing cues and the number of cues on-line at one time, the need for additional buffer space and the maximum amount of time allowable for the finding and reading or writing of on-line data. An evaluation of these requirements yields the volume, access time and transfer rate parameters required of the mass storage devices in the system.

An additional requirement of the system's mass storage devices (and all other system components!) is high reliability. Since the mass storage devices are partly mechanical they are typically among the least reliable components in a computer system. Therefore they must be chosen from a proven technology with maintenance and replacement available from several, major sources.

2) Processing Console Commands

The main computer will be responsible for processing all commands entered on the SECS operator's console. This will include commands typed on the data entry keyboard, cue commands entered on the console's dedicated function panel and commands entered on the LSD selection panel. Commands will be encoded by the console's microprocessor system and sent to the main computer as a data packet via MinnieNET lines. The main computer will receive a packet, interpret the command, evaluate the appropriateness of the command and respond accordingly. The main computer's response to a command will be one or more of the following:

- send a packet of status information to the console's System Status Display
- send a packet of status information to the console's Color Graphics Display
- initiate a programming operation
- enter cue information into a file
- initiate the execution of a program
- send a packet of cue information to a RIC
- send a packet containing a message to a remote terminal
- generate a printed report
- initiate a diagnostic procedure
- etc.

3) Processing Status Information from Remote Interface Cabinets

Information regarding the status of all lifts, contactors, transmitter locations, event initiation switches, park lighting switches etc. will be sent from each RIC to the main computer as a data packet on the network lines. The main computer will be responsible for maintaining tables of current status information. The SECS Computer will periodically poll the RICs requesting status information and will update the status tables accordingly. In addition to operational information the polling procedure will serve a diagnostic function and will allow the main computer to obtain information regarding the functional status of the RICs and the communication network. In this way the system operator will be made aware of any malfunctions in the RICs.

In addition to the maintenance of status tables within the SECS Computers status information will be encoded by the SECS Computers and sent to the console so that the System Status Display and the Color Graphics Display can be kept current. Depending on the amount of status information and the available memory in the Console microcomputer system this Console updating procedure may occur whenever the SECS Computers receive a status packet from a RIC or only when the status packet would update a current display. In other words, if the Console microcomputer system contains sufficient memory it would be convenient for it to maintain a duplicate copy of the status tables.

4) Generating Control Information to send to Remote Interface Cabinets

The Remote Interface Cabinets will not act independantly to control lifts, lights or audio switches but instead will act under the direct control of the SECS Computers. If the system operator wishes to manually operate a light or any function of the SECS network he will press the appropriate buttons on the console's dedicated function panel. This action will be interpreted by the SECS Computers and a data packet will be generated and sent to the appropriate RIC via the MinnieNET link.

When a production is initiated by the SECS Computers a sequence of cues will be read from the Computer's disk for each RIC involved in the production and downline loaded into each RIC. The Main Computer will coordinate the production by monitoring all appropriate switches, transmitter ID sensors, contactors, timers etc. and sending commands to the RICs to execute the previously loaded cues. The RIC software will maintain a pointer to the next cue to be executed. The commands from the SECS Computers will be sent via the MinnieNET links and will tell the RIC to execute the next cue, move the cue pointer or alter the list of cues. In this way all cues are transferred to the RICs prior to their execution and execution of any cue is invoked by a common, brief command. Thus even a complicated cue can be invoked without encountering a delay due to the time required to transfer the cue information on the MinnieNET.

This method of controlling SECS functions will apply, not only to entertainment productions, but to the park functions, audio matrices and any other devices on the MinnieNET system.

5) Software Development and Maintenance

The facility must exist for the development and maintenance of the extensive SECS software. The SECS Computers will be supplied with all system utility programs required to generate, modify, compile, assemble, link, debug, etc. the SECS software. A terminal will exist at a separate location in Commu-nicore for the purpose of software maintenance. This terminal will be able to be connected to either of the SECS Computers (Main or Back-up). In addition to this terminal a remote terminal will be able to communicate with the SECS Computers via a telephone line. The Back-up computer will be operated in a multi-task mode with two jobs allowed to execute simultaneously. The jobs will be prioritized as follows;

High priority - interrupt driven job consisting of back-up of cue files and periodic execution of network diagnostics

Low priority - software maintenance job allowing a programmer to develop or modify SECS software.

B) Options in Regard To System Architecture.

1) CPU

The choice of CPU determines, to a large extent, the magnitude and cost of the Main Computer system. The range of possibilities extends from a single 8-bit microprocessor to a main-frame computer. At the low end, one reasonable option would be to base the SECS Computers on the same microprocessors as those used in the RICs to achieve an inexpensive system with a minimum number of unique components. In a system of this type the main computer and the RICs could use identical software modules for system communications. A single set of utility programs and language processors could be used to develop the software for the entire system. The speed of the main computers would be severely limited, however, as would the availability of peripheral devices and powerful system development software.

The power of a main-frame computer far exceeds the requirements of the SECS network and the cost is prohibitively high. The solution lies in finding a CPU with sufficient speed that will support the necessary peripherals and is supported by excellent system and utility software. In addition to this the entire system must be able to fit in the rack space allocated!

2) Mass Storage Devices

The SECS Computer s must have mass storage of sufficient speed and capacity to store the SECS programs, store and access the cue files and the system development programs. The devices available for mass storage include flexible disks, Winchester disks, cartridge disks, fixed media disks and magnetic tape drives. At the low end of the range of available devices the Main computer could be configured with two flexible disk drives. Flexible disk drives offer the outstanding advantage of being inexpensive and having an easily transportable medium. Though this system could be made to work, development would be slow and programmers would quickly demand a faster system. In addition to the speed limitation of flexible disks the relatively small capacity would necessitate frequent swapping of the disks during program development and system operation. The media affording the largest data capacity is magnetic tape. This form of mass storage also affords a very high rate of data transfer but due to the solely sequential mode of access magnetic tape is not a practical medium for system programs which typically require large amounts of random access. The requirements for cue file and program storage do not approach the capacity of magnetic tape. Thus the devices most suited to the application as the SECS Computers' mass storage device are the Winchester, cartridge and fixed media disks.

3) Printers

The considerations for selecting a printer for the system are quite simple; one must consider the speed and the quality of print required. The lowest cost option is a dot-matrix character printer. These printers are available in a range of speeds from 30-300 characters per second. In approximately the same price range, printers are available that produce letter quality type at rates from 10-100 characters per second. The fastest printers are also the most expensive with print rates in the hundreds of lines per minute and prices up to ten times that of character printers.

C) System Description

In consideration of the functional requirements and available technology the SECS Computer s will consist of a 16-bit micro or mini-computer made by a major manufacturer with components available from multiple sources. The system will include;

- -16-bit CPU
- -64k RAM Memory
- -10Mb Fixed Media Moving Head Disk
- -Dual 8" Flexible Disks
- -Real Time Clock
- -300 CPS Dot-Matrix Character Printer Interfaces

This CPU was selected because 16-bit machines are available with sufficient speed and development software to support the SECS requirements. The mathematical processing power and additional capabilities of larger CPUs are far in excess of what is needed.

64k of memory was selected because it is the maximum number of bytes directly addressable by 16 bits of addressing and the cost of RAM is quite low. This will ensure that adequate space is available for development programs, SECS programs and SECS buffers.

The 10Mb disk has been specified to allow all system programs and utilities to reside in the system at one time thus eliminating the need for media swapping during software development. The speed of such a device will further facilitate program development and ensure that SECS operation can proceed without delays caused by slow disk accesses.

A system with fixed media disks alone lacks any means of transporting and storing programs or files off-line. In consideration of this requirement the system will include a dual 8" flexible disk drive. The flexible disks will provide a low cost means of allowing programs developed on other machines to be installed on the SECS computers. The flexible disks will also allow programs and cue files to be stored in a library for back-up and archival purposes.

The Real-Time Clock is an essential component for event scheduling and production status generation.

The system's printer will not be required to produce large quantities of output or letter quality documents. Thus it is adequate to include a printer that can produce the required output without lengthy delays. The production status reports and daily status reports will average only a few pages each. A printer generating text at 300 CPS (a common speed) will suffice.

The Main Computer will require interfaces to the peripheral devices, MinnieNET and Back-up Computer system. The interfaces required are:

- -Disk Controller
- -Flexible Disk Controller
- -Line Printer Controller
- -Synchronous Serial Line Controller
- -DMA Synchronous Serial Line Controller

The functions of the peripheral device controllers are selfexplanatory. The Synchronous Serial Line will be used to interface the SECS Computers to the MinnieNET multiplexer (see drawing 4). This interface will provide the means to transfer data between the SECS Computers and the RICs. The DMA Serial Line will serve as the interface between the Main Computer and the Back-up Computer.

III. Communications Gear

A) Functional Requirements

1) Inter-CPU Link

The link between the Main Computer and the Back-up Computer serves two primary functions. It serves as a path for cue files to be transferred and as an alternate path for Communicore to Pavilion data communication.

The first function consists of two parts. During cue editing cue files are stored on the Main Computer's mass storage device. As a precaution a copy of the cue file is sent to the Back-up Computer via the Inter-CPU link and is stored in the Back-up Computer's mass storage device. If the Main Computer is incapable of accessing a cue file on its mass storage device the back-up copy can be returned to the SECS Computers via the Inter-CPU link.

In the event of a breakdown on the primary data path (Main Computer's MinnieNET) between Communicore and a RIC the system will automatically attempt to use an alternate route. This route will consist of the Inter-CPU link, the Back-up Computer, the Back-up multiplexer and the Back-up data lines to the RICs.

It is essential that this link operate at a high speed so that operations using the link are not unduly slowed. To achieve a balance between the disk transfer times and the link transfer times during file back-up operations the link speed should be comparable to the disk transfer rate. A second consideration is that cues invoked via the back-up path should not be noticeably delayed.

Data transferred on this link is critical to the operation of the system and the method of transfer employed should include the capability to detect and correct any data transfer errors on the link.

2) Central Site - RIC Links

The RICs will be connected to the computers in Communicore with a twisted-pair Common User Lines. All communication between the SECS Computers and the RICs will be via this cable. Signals on this cable will include:

RIC Remote Reset Lines
RIC Power Monitors
Serial Data to RICs
Serial Data from RICs
Back-up Data to RICs
Back-up Data from RICs

Status information regarding lift contactors, transmitter locations, RIC status etc. will be encoded by the RIC microprocessor systems and transferred to Communicore via the Data lines. Likewise lighting and audio cues will be encoded by the SECS Main computers and transferred to the RICs via the Data lines. The rate that data is transferred on these links must be sufficiently high so that no noticeable delay is induced in the programmed or manual execution of cues. Data transferred on these links is critical to the operation of SECS and the method of transfer must include the capabilities for error detection and correction.

The links will employ modern computer network technology with an average data rate greater than 100k bits per second.

B) Options

1) Inter-CPU Link

The inter-CPU link could be one of several types of links depending primarily on the data transfer rate requirement. The links available and their associated maximum rates are the following:

-RS232 Serial line	19.2kbps
-Synchronous Serial line	300kbps
-DMA Serial line	1Mbps

2) Central Site - RIC Links

a) Network configurations

The SECS network has a key feature that determines to a large part what types of network designs can be employed. This feature is the existence of a clearly defined central site. Communications on the network is limited to the exchange of data between the central site and the nodes, data is not transferred from one RIC to another. For this type of network two types of design are commonly employed. The most common is the ring or multi-drop architecture. The ring network consists of a single cable or pair of cables with each node interfaced to the network via a tee tap. Ring networks are economical in their use of cable and coax is generally employed with data rates up to 1Mbps being attained. A disadvantage of the ring structure is the need for a complex algorithm for dealing with contention for the common line.

The other common design for networks with a clearly defined central site is the star or spoke network. In this type of design, lines radiate from the central site with a unique line dedicated to linking each node with the central site. The star configuration requires more cable than the ring but features an elimination of the line contention problem and a total data rate potentially equal to the sum of the rates on all lines operated concurrently.

b) Communications protocols

Several computer network protocols are currently in use in the computer industry. These range from the relatively low level protocols such as BiSync and HDLC to the more complex networks such as Xerox's Ethernet. Most of the industry's networks employ coax cables with a baseband technique such as Manchester encoding. Some use modulation techniques with an RF carrier. Since the modulation techniques require a high bandwidth they are applicable only to networks employing coax cable. Since most of the existing networks employ multi-drop lines their protocols contain the facility to specify the destination of a data packet transmitted on the line. The majority of the current networks are designed to allow hundreds or even thousands of nodes to be placed on the network. These networks operate with data rates of one or two million bits per second over distances up to one mile.

The SECS requirements differ in several ways from those of most computer networks. The SECS MinnieNET has relatively few nodes, it is not constrained by the need to economize on cable and it does not employ coaxial cable. It has an unusually high demand for transmission speed since lengthly delays in Remote Programming Console display updating and cue execution cannot be tolerated. The types of data are few, primarily consisting of RIC input status and cues.

C) MinnieNET System Description

The specifications of the MinnieNET system are intended to satisfy the requirements of the Communicore computers to RICs links using the 25 twisted pair Common User Lines. The twisted pair cable limits the types of communication possible to the baseband techniques with a maximum rate on the order of 100kbps. Since cable is provided between Communicore and each of the pavilions the star configuration (see drawing 3) will be employed eliminating the line contention and destination addressing problems of multidrop networks. Either a synchronous, externally clocked technique or a self-clocking technique (phase-encoded) will be employed depending on the results of tests on the cable. The digital signals placed on the cable will conform to standard RS422 and differential drivers and receivers will be employed to obtain the best possible immunity to noise. The signals on the cable will be optically isolated from the bulk of the elecronics in Communicore and the pavilions. Only the line drivers and receivers and their unique power supplies will not be isolated from the cable. The power supplies for the line circuits will be isolated from AC power and ground by isolation transformers (See Drawing 4).

MinnieNET is a data aquisition and process control network and as such it differs radically from the typical, general purpose computer network. The number of types of interactions on the network is limited and a simple protocol is sufficient to take care of all the possibilities. Several restrictions can be imposed that make the task of managing the network relatively simple.

The following rules will apply to MinnieNET:

Only one computer - RIC interaction can take place at any given time.

The lines will be operated in half duplex mode.

Only the Main or Back-up computer can initiate an interaction, a RIC can not.

The SECS Computers will obtain status information from the RICs by periodically polling the network, requesting updates to the status tables maintained by the SECS Computers. The SECS Computers will send cues to the RICs by selecting the appropriate MinnieNET line and sending the data in a point to point fashion.

To ensure that erroneous actions are never taken, MinnieNET will employ an error correcting protocol. This protocol is implemented in software and consists of five hierarchical levels:

Application level - transfer a logical data set such as a cue list or status message between the computer (Main or Back-up) and a RIC

Datagram level - transfer a block of data, with error correction, between the computer and a RIC

Block level - transfer a block of data, with error detection, between the computer and a RIC

Byte level - transmit or receive a single byte of data

Bit level - electrical specifications for data on MinnieNET lines

IV Back-up System

A) Functional Requirements

1) General

The ideal system of back-up is one that would detect a malfunction and be able to take over the responsibilities of the failed components in such a way that the task in progress could proceed without error.

2) Cue and Program Storage Back-up

The Main Computer in Communicore will include a mass storage device responsible for the storage of SECS programs and special event cues. In the event of a loss of any of this data or a failure of the mass storage device itself the SECS computers must be able to retrieve the files from a secondary, or Back-up, source.

3) Computer Back-up

The Main Computer in Communicore is an essential element in the SECS system. In the event of a failure of any part of the Main Computer an alternative system must be available to take over the responsibilities of the faulty component.

4) MinnieNET Lines Back-up

In the event of a breakdown in the data path between the Main Computer and a RIC an alternative path for the transfer of data must be available.

5) Operator's Console Back-up

In the event of a failure of the operator's console an alternate means must be provided for control of essential components of the SECS. Some of the features of the console are not essential to control of the SECS. These features, including the system maintenance console and the color graphics display, need not be available on the back-up system.

6) Automatic Back-up Capability

In the event of either a mass storage failure, a Main Computer failure or a MinnieNET line failure the SECS system must be able to automatically invoke the appropriate Back-up system in such a way as to avoid loss of the affected function. The system must also advise the operator of the malfunction and indicate the appropriate diagnostic and/or corrective measures to be taken.

B) Optional Configurations

1) Mass Storage Back-up

The simplest way to Back-up the programs and cue files of the Main Computer is to include a duplicate mass storage device on the Main Computer itself. With this configuration the creation and subsequent retrieval of back-up files is as simple as the creation and accessing of the primary files. This method suffers from a serious flaw, in the event of a failure of the Main Computer neither copy of any file may be accessed. A possible solution to this problem is to design the system so that the Main Computer's mass storage devices are accessible by another computer. In this way the alternate computer can access the mass storage device in the event of a Main Computer failure. This method also suffers from a serious flaw. Since both computers access the same device a mode of failure of this device can easily occur that would cause both computers to crash! This possibility is due to the existence of a point of intersection of the system and it's back-up.

Another method of backing-up the system's mass storage device is to employ an independent computer to maintain copies of all system files.

2) Main Computer Back-up

As with the mass storage back-up the most direct method of providing a back-up for the Main Computer's CPU is to include a duplicate CPU in the Main Computer system. If this configuration were employed the Main Computer's bus architecture would need to have multi-processing capability. The spare CPU could periodically execute a diagnostic routine and determine if the main CPU is functioning properly. If the diagnostic shows a failure of the main CPU the spare would take over. This scheme will only satisfy a limited range of CPU failures. In order for the spare CPU to succeed in taking control of the computer the failed CPU must fail in a mode where it is capable of relinquishing control of the computer's bus.

In the event of a transient power loss the Main Computer is likely to lose the contents of memory. If this were to occur during a production the computer would lose track of the state of all lights, audio routers, lifts, etc. and would also lose track of all cues to be executed. If a few seconds of emergency power are provided the computer would be able to store the contents of memory on it's disk and recover from the power loss gracefully.

If the contents of memory were to be lost due to a failure other than a power loss it would be essential to have a back-up copy of pertinent SECS status tables. This could be accomplished by continuously maintaining a copy of the status tables on the SECS Computers' disks or on an independent storage device.

Another mode of failure is a failure of a SECS Computers' component, CPU, peripheral, memory or other, that forces an error to persist on the computer's bus. In this event the Main Computer can not be made to operate until the faulty component is removed. This and other unrecoverable Main Computer failures can only be dealt with by an independent back-up computer.

3) Communications Equipment Back-up

The data paths between the SECS Computers and the RICs can breakdown at any point. If a failure of the MinnieNET multiplexer were to occur a spare multiplexer could be switched into the system. Similarly a faulty line could be replaced by an electronic switch and a spare line. Alternately two ports, two multiplexers and two sets of lines could be permanently interfaced to the Main Computer. This method appears to have the advantage of avoiding any hardware switching while still providing an alternate data path. On closer examination, however, one realizes that in the event of a Main Computer failure the Back-up Computer must have access to the MinnieNET lines so that either switching needs to exist at this point or another set of MinnieNET lines must be dedicated to the Back-up Computer.

4) Console Back-up

Obviously, no amount of electronic switching or spare circuitry can replace a broken keypad or burnt out video display. A replacement for the essential features of the operator's console must be provided. This could take the form of a special, back-up panel on the console or a computer terminal could be employed to replace the console's status display and control functions. A duplicate of the operator's console could be constructed at another location or the remote programming console could be used as a back-up.

5) Emergency Back-up AC Power Supply

The entire SECS Communicore system (including the RIC) is supplied from a conditioned supply from the Florida Power Bus. In addition, it is supplied with a five minute emergency power supply in case of a power interruption on the primary supply. This will allow the SECS Computers to perform a controlled shutdown of the SECS should there be an interruption of that power that lasts for more than three minutes. It should be noted, however, that the RICs do not have the emergency power available to them which will limit the effectiveness of this feature.

C) System Design Principles

The back-up system was designed using the following principles:

-A fully functional model of the SECS system was designed first without any back-up features. The primary consideration in this design was the reliability of the system.

-In the addition of the back-up system the primary consideration was avoiding disturbing the integrity of the previously designed system. In other words the addition of the back-up system should not reduce the reliability of the primary system.

-The back-up system should be able to replace all primary system functions automatically without causing an error in the task in progress.

In consideration of the second principle above the back-up system was designed without any hardware switching since the addition of a switch introduces a potential point of failure for both the primary system and the back-up.

In further consideration of this principle the number of points of contact between the primary and back-up systems is minimized and the nature of these points is chosen to minimize the possibility that a failure of one system can cause a failure in the other.

D) System Description

The back-up system will consist of a duplicate of the Main Computer without the flexible disks or printer plus a duplicate of the MinnieNET multiplexer and RIC interface lines. A high speed link will connect the main and back-up computers. The console will include a microprocessor system similar to that used in the RICs and it will have two serial interfaces. One will be connected to a MinnieNET line to the Main Computer and the other will be connected to a MinnieNET line to the Back-up Computer. Similarly the RICs will each have two serial interfaces, one to each computer.

The system will provide for the maintenance of back-up copies of all SECS files, will provide an alternate path for communication between the Main Computer and all RICs, will provide a replacement for the Main Computer, and will allow the use of the remote programming console to substitute for the operator's console.

During cue editing operations cue files will be sent to the back-up computer via the high speed link and stored on the back-up computer's disk. In the event of a loss of file or a failure of the main computer's disk the back-up copy can be retrieved.

If the Main Computer is unable to communicate with a RIC via the primary channel the Main Computer will open the back-up channel and communicate via the high speed link, Back-up Computer, back-up multiplexer and back-up MinnieNET lines.

During normal operation the Main Computer will send SECS status information to the Back-up Computer. The back-up computer will be responsible for maintaining a duplicate copy of the SECS status tables. If the Main Computer should have a transient failure resulting in a loss of memory it could retrieve the SECS status tables from the Back-up Computer and continue to operate. If an unrecoverable failure of the Main Computer occurs the Back-up Computer would open all back-up channels and take over the responsibilities of the Main Computer.

In the event of a failure of the operator's console the remote programming console could be plugged into the Communicore RIC and used to control the SECS.

Remote Interface Cabinets

I RIC General Description

A) Functional Description

The Remote Interface Cabinets (RIC) provide the majority of the input, output and remote monitoring functions for the Special Events Control System. There will be one RIC located in the Electronic Equipment Room of each of the pavilions in World Showcase as well as one in Communicore. From a system architecture point of view, the RICs are located at the points of the MinnieNET 'star' and are comprised of an 8-bit microprocessor bus system which contains the necessary interface components for each application.

An RIC communicates with the SECS Computers using the high speed protocol described in the MinnieNET section above. As cues or specific actions are initiated by the SECS, commands to turn on or off lights, to control lifts and special functions and to start sound fades are downloaded to the RIC. These actions are either executed by the input/output section of the RIC or passed through to the Audio Processing Control Cabinet using the WED designed protocol. Verification of certain functions is sent back to the SECS Computers to keep the operator informed of malfunctions in the system.

The interface and control requirements of the RICS include:

- -control signals to Pageant Lighting Contactors
- -control signals to Pageant Lighting Lifts etc.
- -special functions (e.g. fountains etc.)
- -verification inputs of contactor closures, lift position, event initiation switches, worklight key switches, etc.
- -control signals to Pageant Route Lighting dimmers
- -possible future control of inter-pavilion show lighting.
- -Transmitter I.D. receivers and interface components
- -Local Status Display CRT.
- -serial links with SECS Computers via MinnieNET.
- -interface between MinnieNET and Remote Programming Console
- -communications between MinnieNET and the Audio Processing Control Cabinet
- -Remote Reset Function.
- -Power Supply Monitor.

The use of a modular microprocessor bus systems and diagnostic software routines in the RICs provide advantages in maintenence, cost and system reliability. Since the interface requiremnts of each RIC differs, the individual cabinets can be configured in the most economical manner, using common components, which reduces back-up inventory requirements. With the aid of diagnostic software and the local CRTs, routine maintenance and critical repairs can be performed quickly by technicians with an intermediate level of training.

B) The Transmitter I.D. System

The purpose of the Transmitter I.D. system is to inform the SECS computer network of the presence of a given Transmitter or handheld transmitter/modulator at various points along the pageant route in World Showcase.

The pageant route has been divided into 22 audio and lighting zones, the boundaries of which are marked by antennas (sensors), for the Transmitter I.D. system (WED drwg.1239). In addition to the sensors at the boundaries of these zones, additional sensors have been placed at five primary Parade Access routes from the perimeter road which enables the SECS Computers to determine the direction of a pageant as it enters the route.

As a Transmitter approaches a sensor, the identification number is received by equipment located in the RIC of a nearby Pavilion where the location of that Transmitter is sent to the SECS Computers over MinnieNET. The progress of Transmitters is used by the SECS to initiate lighting and sound cues in World Showcase.

The system will be an upgraded version of the Float I.D. system presently in use in Disneyland. Principal enhancements include:

1) Unitized construction of the Transmitter I.D. modulator, radio transmitter and battery pack. This will be especially important to the EPCOT system since the majority of the radio transmitters will be handheld or carried as part of a costume. Some interaction will be necessary between the manufacturers of the I.D. modulator and the radio transmitters to insure miniaturization of the unit, obtain FCC approval for the final assemblies, etc.

2) Consistent use of +5v. TTL levels for digital transmission of the Transmitter I.D. signals in place of the low-level analog signals used in the Disneyland system. Digital transmission of the Transmitter I.D. information will be designed into the system instead of added as an afterthought.

3) The use of a Cyclic Redundancy Check (CRC) or similar redundancy check to reduce the probability of Transmitter misidentification due to the presence of two Transmitter signals at the same sensor at the same time. This was occasionally observed in the Disneyland system when marginally de-tuned transmitter/receiver pairs caused signal skips and two float modulation signals "collided" to produce a third signal for an incorrect float number. This failure mode can be effectively eliminated.

4) Increased rate of Transmitter I.D. transmissions. The principal cause of sensor misses in the Disneyland system

was the excessively short duration of signal presence when a transmitter transmitted weakly or did not pass directly over the buried antenna. An increase in I.D. transmission rate from ~10 hz. to ~100 hz., together with the redundancy provisions of 3), should permit a relatively brief burst of clear transmission to be used as a valid Transmitter I.D. hit.

5) Computer access to both of the digital signal strength indications from the radio receivers. The H.M.E. receivers used in the Disneyland system have two signal strength LED indicators: the first (green) one indicated the presence of a signal which was above threshold at any given moment, and the second one went on when the signal was present for the last few seconds. Because of the time lag involved in the response of this second signal, the float was often nearly gone by the time that the delayed signal became active, so that most of the float I.D. transmission was wasted. By providing the processor in the remote interface cabinet, direct access to the two LED signals as well as the demodulated Transmitter I.D. signal, programs could be developed which should be much more successful at separating 'noise hits' from valid Transmitter I.D. receptions.

6. An analog signal strength meter brought out from the Transmitter I.D. receiver that can be digitized in the RIC and displayed in bargraph form on the Local Status Display and on the SECS console in Communicore. This signal can be used to form a more sophisticated signal strength alogorithm. In addition the display will be useful as a monitor of the transmitter strength and to differentiate between digital problems in the system and those that are radio related.

7. The ability to digitally 'tune' the sensitivity of each Transmitter I.D. input card to require some number of correct transmissions before accepting a Transmitter I.D. 'hit'. This could be accomplished either via a thumbwheel switch on each receiver input card or through software intervention from the main control console in Communicore. Thus antenna/ receiver combinations which are prone to signal skips could be required to have a valid signal present longer than antenna/receivers which have a tendency to miss Transmitters. This sensitivity adjustment is similar to the delay time adjustment on the HME receiver, except that the timing requirement is on the signal <u>quality</u> instead of the signal <u>strength</u>.

8. Extensive hardware & software diagnostic aids for debugging and tuning the Transmitter I.D. System components, including:

a) Portable (ideally handheld) receiver with indicator for 'signal present' and a 7-segment display of Transmitter number. This could be used for checkout of floats, costumes, etc. which would contain the I.D. transmitters.

b) Display on the LSD as well as in Communicore of the status of each of the receiver inputs, including both signal strength indicators and the receiver Transmitter number (if any). These displays will be extremely useful when replacing or adjusting receivers. Since the signals will be displayed in a 'stand alone' mode on the Local Status Display a substantial amount of debugging of the radio equipment could take place independently of the SECS Console in Communicore.

c) When a Transmitter I.D. 'hit' occurs, a message will be sent to the SECS computer via MinnieNET and that computer will return an acknowledgement to the RIC. A message of "Acknowledged" or "Not Acknowledged" on the Local Status Display will indicate the status of this handshake and inform the observer of the RIC that a complete end-to-end check of the Transmitter I.D. system has been performed.

d) It was observed in the Disneyland installation that simply walking into the room containing the float I.D. receivers with a hand-held transmitter/modulator was enough to activate all receivers. A dedicated local transmitter (broadcasting a special diagnostic "Transmitter number") which would be activated and modulated under software control could perform a simple go/no-go check of the receivers in each RIC prior to each event.

C) Local Status Display

The Local Status Display will be a CRT contained in the RIC used to indicate the status of input and output channels, diagnostic results, system configuration and messages from the SECS operator. The purpose of this display is to aid in the maintenance and repair of RIC equipment. The information contained in this display will be available to the SECS operator in Communicore as well.

The display format will consist of a series of boxes on the CRT, each of which represents a modular card on the microprocessor bus. The display will reflect the individual RIC system configuration with each box containing the following information:

- The type of card installed.
- The results of the diagnostic checks which are being performed periodically on the given card. These will vary from simple information that the card exists,to complicated routines such as memory diagnostics.

- The state of all input and/or output channels for the card.

The System Message Line will be displayed constantly. This line is for messages from the SECS operator regarding instructions for maintenance personnel, event status, time of day, etc.

Since the amount of information will be too great to display on one CRT page, the Local Status Display will constantly be scrolled. This scrolling can be suspended by the maintenance technician, by the depression of a switch on the CRT driver card, at the time when the appropriate information is displayed.

D) Examples of Local Status Display Modes

system message from SECS console

```
******************************************
*   MIKE SOMMER CALL HOME IMMEDIATELY    *
******************************************
```

Title comes from SECS main CPU

```
        **  JAPAN PAVILION **

STARTUP: time 13:21:20    SYSTEM: time 12:42:30
         date  11/15/81           date 11/24/81
```

Status entry flashes each time diagnostic routine is run.

CARDS INSTALLED	STATUS
CPU (EPROM version 1.4)	OK
CRT DRIVER	OK
MEMORY CARD	OK
SERIAL LINK #1 to SECS MAIN CPU to AUDIO PROCESSOR BOX	 OK OK
SERIAL LINK #2 to SECS BACKUP CPU to REMOTE PROG. CONSOLE	 OK DISCONNECTED
INPUT CARDS CHANNELS 1-32	OK
OUTPUT CARDS CHANNELS 01-32 CHANNELS 33-64	OK OK
RADIO RECEIVER INPUTS #1 #2	OK -- Transmitter #31

```
*****************************************************
*      ANOTHER IMPORTANT  SYSTEM MESSAGE            *
*****************************************************
```

CPU CARD STATUS OK

EPROM	version 1.4	
	release date 11/22/81	
	CHECKSUM TEST	OK
CPU INSTRUCTION TEST		OK
CPU RAM TEST		OK
CLOCK FREQUENCY TEST		OK

CRT DRIVER CARD STATUS OK

CRT MEMORY CHECK	OK
CRT CHARACTER GENERATOR CHECK:	OK

```
ABCDEFGHIJKLMNOPQRSTUVWXYZ 0123456789
    !@#$%^&*()_-+=][|\"':;}{?/>.<,
```

MEMORY BOARD STATUS **ERROR**

TEST RESULTS SINCE POWER-UP:
SUCCESSFUL TESTS: 10241
FAILURES RECORDED: 1

map of IC failures on memory

16-K RAM CHIPS								
	o k	o k	o k	o k	o k	* *	o k	o k
	o k	o k	o k	o k	o k	o k	o k	o k

SERIAL LINK #1

MAIN CPU LINK:	OK	
LINK ESTABLISHED:	13:21:20	11/15/81
LAST TRANSMISSION:	12:42:30	11/24/81
CRC ERRORS:	TOTAL:	3
	LAST 24 HRS:	0

```
AUDIO CONTROL LINK:                OK
     LINK ESTABLISHED:  13:21:30  11/15/81
     LAST TRANSMISSIONS:
      BGM 2 to 50%      12:25:15  11/24/81
      PAG 3 to 75%      12:25:30  11/24/81
*************************************************
* WINDOW LOUVRES NOT FUNCTIONING IN JAPAN TOWER *
*************************************************
```

INPUT CARD CHANNELS 1-32 OK

	0	1	2	3	4	5	6	7	8	9
0	ON							ON		
1				ON						
2		ON							ON	
3										

RADIO RECEIVER INPUTS 1-4
#1 - PARADE ACCESS TUNNEL SENSOR SIGNAL STRENGTH: 7 XXXXXXX # TRANSMISSIONS: 5 XXXXX
#2 - ZONE 1 PARADE ENTRANCE SIGNAL STRENGTH: 0 # TRANSMISSIONS: 0
#3 - ZONES 1/2 BOUNDARY SIGNAL STRENGTH: 0 # TRANSMISSIONS: 0
#4 - ZONES 2/3 BOUNDARY SIGNAL STRENGTH: 0 # TRANSMISSIONS: 0

OK

title from SECS Main CPU Link

Transmitter #31 acknowledged SECS control

E) **RIC Modular Hardware and Software Description**

1) Hardware Description

The RIC will have a microprocessor bus architecture which will provide all input/output functions on modular cards. This is dictated first, by the fact that each RIC has different input/output requirements and must offer room for future expansion.

Secondly, a great importance must be put on the maintenance and reliability aspects of the SECS, downtime for any single function in the system must be reduced if not prevented entirely and the modular approach to the architecture offers several advantages:

-Since each separate type I/O function is contained on a different card, a failure or damage from an outside source is not likely to propagate through the entire RIC.

-If a fault occurs on a card it is easily replaced in the field which greatly reduces the time required to put the system back on line. To replace a component, it is necessary only to duplicate the address jumpering of that card on the replacement and insert the new card into the rack.

-The use of common components in RICs and the Communicore Console reduces the spare parts inventory significantly and will allow the field repair technician to carry a complete set of replacement cards at all times.

The last consideration is the cost saving advantage in this modular approach. The selection of the proper industry standard bus will offer a wide selection of components produced by several companies. This fact will provide for more competitive bidding, an increased number of available features and the advantages of second sourcing. Also, since the requirements of RICs differ at this point, and future expansion of the system is likely, a modular approach allows new features to be added easily in the future without significant modification to the system.

2) Software Description

The software in the Remote Interface Cabinet will reside in EPROM and will be as nearly identical as possible in all RICs. The software will automatically reconfigure itself for whatever I/O cards are installed in each RIC and will display the configuration status both on the Local Status Display and (upon operator request) on the SECS Console.

F) Example of Interactive Maintenance Procedure

With this design philosophy and the use of a Local Status Display CRT, one can build up an RIC from scratch as follows:

Starting from a minimal system consisting of one CPU card and one CRT driver card, one can verify that the software initializes and that self-diagnostic programs in the EPROM execute properly. This minimal two-card system could be used to check out each of the card positions in the RIC's card rack.

The RIC could then be upgraded by powering down, adding any of the I/O cards, and powering up the system. Example: If the card which was added was an RS-232 link to the Audio Processing Control Cabinet, the software would identify the card and perform a diagnostic sequence to attempt to establish communication with that device. The results of this procedure will be reflected on the Configuration Status Display of the Local Status Display CRT.

In a similar manner all of the I/O cards needed for the given RIC installation could be added, one by one if necessary, to the card rack. In each case the CRT display would reflect the functionality of each of the cards installed and any bad cards could be rapidly identified.

When the RIC system appears to be operational in the stand-alone mode, the addition of the serial link to MinnieNET will enable the RIC to accept commands from the SECS Console. Since 'handshake' messages will be exchanged regularly between the RIC and the Main and Backup CPUs, the status of the MinnieNET communications links will be continually updated on the Local Status Display CRT display.

In addition to power-up initiated diagnostic routines, periodic diagnostic routines will be executed to determine and display the RIC configuration and operational status. For example, should the backup serial link to the MinnieNET be severed by the foot of an errant maintenance technician, he would see the serial link disappear from the Configuration Status Display. Then, after warming up his soldering iron and repairing the damage, he could watch the backup serial link re-appear on the display within a few seconds. His blunder, as well as the time taken to repair it, will be recorded on the daily log of system malfunctions and downtime.

G) RIC Specifications

1) Electrical Specifications

The following specifications outline the maximum input/output requirements for the RICs located in pavilions. The RIC located in Communicore is a special case in that it is the interface point between the SECS Computers and the Power Supply Monitors from the individual RICs. These special inputs will, however, be of the same types as those specified below. (See Part II, Section II for details on the Communicore RIC).

Some general specifications apply to the equipment interfaced to the RICs. These include:

- -lightning protection devices on all control/feedback wiring that leaves the immediate building that houses the RIC.
- -opto-isolation on all serial links to the RIC.
- -all serial transmissions will contain Cyclical Redundancy Checks (CRC).
- -the interfacing of equipment and special functions (such as fireworks) to the SECS **must** be done with the utmost regard to safety.

Types and Specifications of Input/Output Signals

a) AC power requirements;
   1. The RICs will receive four 20 Amp single phase circuits.
   2. The power will be supplied from a conditioned supply off of the Florida Power Distribution Buss.

b) Digital outputs (lighting contactors, lift actuators, special functions).
   1. Outputs are current sinking.
   2. 48VDC at < 200mA per channel.
   3. 32 control channels per modular card.

c) Digital inputs (contactor closure verifications, lift position indicators, power supply monitors, worklight key switches, etc.).
   1. Inputs sense switch closure to system supplied common, which will be earth grounded in the RIC.
   2. 32 channels per modular card.

d) Analog outputs (Pageant route dimmers, possible control of inter-pavilion show lighting).
   1. 8-bit level information (255 discrete levels).
   2. 0-10VDC analog range at 3mA per channel.
   3. 32 channels per modular card.
   4. RIC systems will be able to support 160 dimmer channels

e) Analog inputs (for possible entering of level information from inter-pavilion show lighting consoles).
   1. 8-bit level information.
   2. 0-10VDC analog range.
   3. 32 channels per modular card.
   4. Feature initially not installed in system, although system should be able to support 160 dimmer channels.

f) Transmitter I.D receiver interface.
   1. Inputs for 5 receivers.
   2. 5VDC TTL input with Transmitter I.D. protocol.

3. Will contain all logic necessary to interrupt Transmitter I.D. input signal.

g) Local Status Display CRT interface.
 1. RS 170 composite video output.
 2. Alpha-numeric and limited graphics capability.
 3. Monochromatic output.
 4. One switch input for display freeze.

h) Serial interface (primary link with SECS Computer and link with Remote Programming Console).
 1. Both ports are high speed (> 100K BPS).
 2. Both ports are synchronous.

i) Serial interface (Back-up link with SECS Computer and link with Audio Processing Control Cabinet).
 1. Port that links to SECS Computer is high speed (100K BPS) and is synchronous.
 2. Port that links to APCC is RS 232 compatible with communication protocol defined by WED Dept. 510.

j) Remote Reset (from SECS Console in Communicore).
 1. This input resets the CPU in the RIC to re-initialiaze the system should the SECS not be able to communicate with the RIC.
 2. Switch signal uses 1 pair of the common user lines between EER and Epcot Central.
 3. See Section II.A.3.a.iii. for details on Communicore console control.

k) Power Supply Monitor.
 An optically isolated AC line monitor and a 5Vdc power monitor that send their outputs to the RIC in EPCOT Central to monitor the power supplies.

2) Physical Specifications

Each RIC will be housed in 1 72" E.I.A. equipment rack manufactured by EMCORE PRODUCTS, Rochester, MN. Which is to be supplied by the purchaser. Components contained in this rack will include:

a) Microprocessor Bus Card rack
 1. All wiring from interface cards to ELCO 8016 type connectors included.
 2. All address jumper information will be displayed on inside of front door.
 3. Card rack will be accessible from front of rack with ELCO connectors accessible from rear.
 4. Cables from Card rack will be brought out to Wire-wrap terminals within the RIC.
 5. A local reset switch will be provided and be accessible from the front of the RIC.

b) Lightning Protection and Control Breakout Boxes
 1. Lightning Protection devices and Control Breakout

Boxes will be mounted on the walls of the EER and are not considered as part of This Report.
2. Wiring from these boxes to the RIC is not part of This Report.

c) Local Status Display CRT
1. 9 inch (diagonal) monochrome CRT monitor in Rack-mount configuration.
2. Power switch and CRT controls will be accessible from the front of the RIC.

d) Transmitter I.D. Receivers
1. Units mounted in side by side fashion similar to installation at Disneyland.
2. Receiver face panels accessible from the front of the RIC with Heliax cables and output connectors accessible from the rear of the cabinet.
3. Output wiring from receivers routed through Wire-Wrap terminal blocks from CPU card rack.
4. Maximum number of 6 receivers will be accommodated.

e) Power Supplies
1. DC power supplies for CPU card rack will be modular, and if possible utilize card rack mounting configuration.
2. All circuit overload protection devices will be accessible from the front of the RIC.
3. A DC power supply monitor plug will be provided on the front of the unit to permit rapid measurement of the supply voltages.
4. All AC power supply circuit overload protection devices will be accessible from the front of the RIC.
5. AC Power indicator lights will be on the front of the RIC.

II RIC in Communicore

The RIC located in Communicore will be similar to the other RICs, but shall have additional responsibilities to the SECS. As well as pageant related functions, this RIC will be the interface point of local Power Supply Monitors from the RICs located through the SECS network. These inputs will be interfaced through standard modular components used in the systems, and the physical requirements are otherwise the same as above.

The electrical specifications that differ from the norm are:

A) Digital input
1) Digital signals from AC Power Supply Monitors in each of the RICs in on the MinnieNET.
-25 possible inputs.
2) The Remote Power Supply Monitor inputs will be transmitted on the common user lines from each pavilion. The individual lines will be terminated at the terminal blocks in the Communicore RIC and then brought into its CPU card rack.

B) Serial Interfaces:

1) Two high-speed serial links to MinnieNET.
2) One high-speed serial link to Remote Programming Console.

3) RS232 serial links to:
   - Park Function Controller.
   - Audio Routing Switcher.
   - Pageant Route Audio Processor Control Cabinet.
   - Remote Data Entry Terminal in Entertainment Director's office.

C) Emergency Power

This cabinet will be on the same five minute emergency power supply from the Florida Power bus that the SECS Computers in Communicore draw from. The purpose of this is to allow the SECS system to perform a controlled shutdown/restore process should it detect a major power failure on the network.