CHAPTER 9

NAVAL TACTICAL DATA SYSTEM (NTDS)

INTRODUCTION TO NTDS/WDS

In recent years the nature of naval warfare has been radically altered with the introduction of new, ultra-complex, and tremendously effective combat weapons. The sophisticated weapons systems which have evolved to control these combat weapons have not, however, solved or eased the basic combat command direction problems that confront the U.S. Navy. In combat a fleet will continue to be involved in close-range offense and defense, regardless of its super-offensive and super-defensive capability. During such close-range combat, the shipboard Combat Information Center (CIC), nucleus of fleet combat decisions, is subjected to extremely complex tactical situations. These require a multitude of intelligent and highly significant decisions, each to be made in a very short period of time. The speed at which these combat situations will be concluded is inconceivable to someone thinking in terms of typical CIC operations of the World War II or Korean era.

There are four distinct ways in which increased stresses are placed on the personnel and machines necessary to handle information associated with combat direction:

1. Load stress—Increasing volume of tactical data imposes a heavy processing and handling load.

2. Time stress—Tactical situations develop and terminate in extremely short periods of time.

3. Speed stress—High speed data processing and handling is required due to the high rate and volume at which tactical data is generated.

4. Coordination stress—Rapid determination and effective assignment of fleet weapons require high speed exchange of situation, decision, and status information between fleet elements. To compound this already complex situation, fleet defense is less than ever a proposition wherein each ship fends for itself. That is, for a modern fleet to effectively defend itself, defensive capabilities of all ships in the fleet must be pooled and assigned from this pool on the basis of threats posed to the individual ships comprising the fleet.

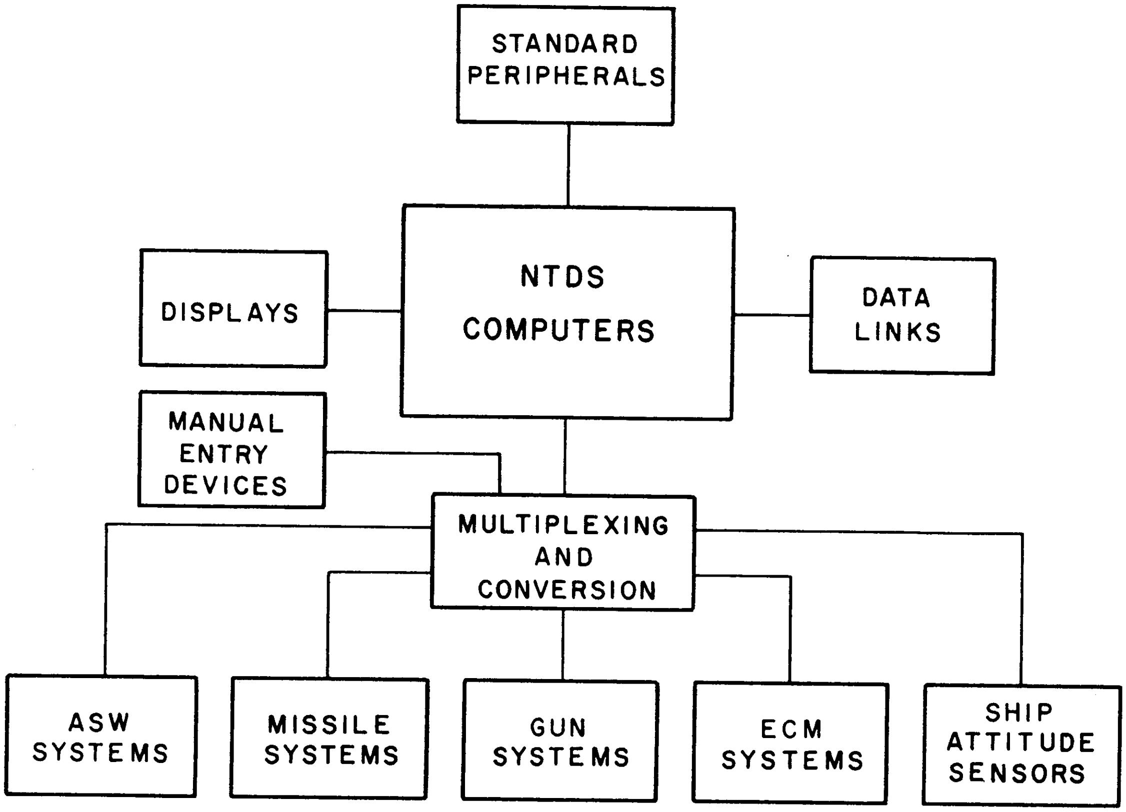
The first practical approach to the most effective utilization of full fleet capabilities is NTDS. Integrated design and major components of NTDS were developed to provide the fleet with automated data handling capabilities.

NTDS OVERVIEW

Operationally, this computer-centered control system performs the following (figures 9-1 and 9-2):

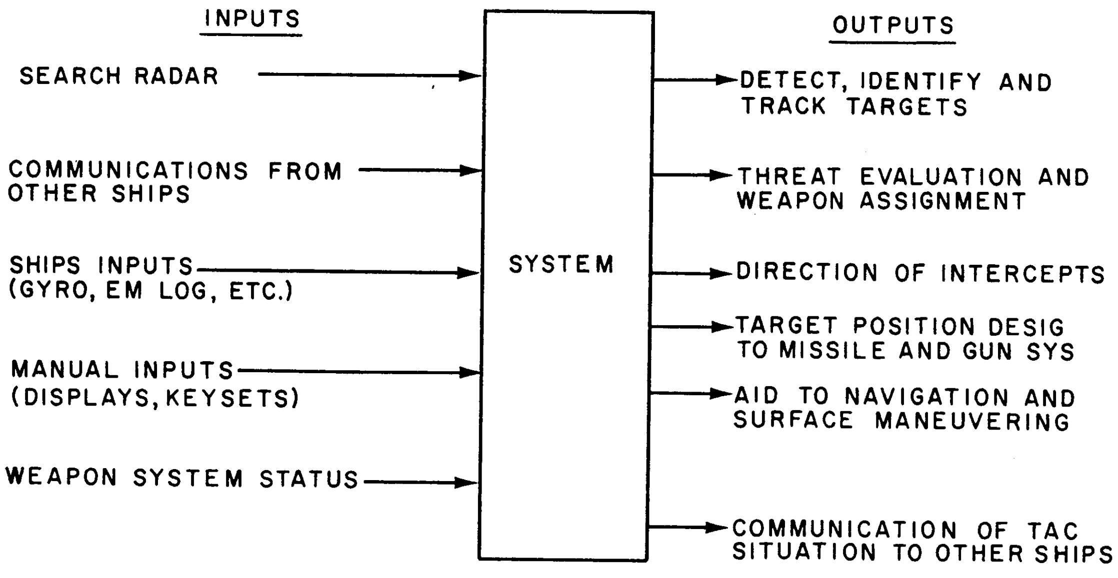
1. Coordinates the collection of data from the ship's sensors (radar, sonar, navigation inputs, and the like), and from external sources via communications links
2. Correlates the data to obtain a clear picture of the tactical situation
3. Processes the data required for decision making
4. Communicates the decision for action to the weapons systems selected

Rapid exchange of tactical information between ships and units of the fleet not only permits a high degree of task force integration and



245.85

Figure 9-1.—NTDS Equipment Grouping.



245.86

Figure 9-2.—System Inputs/outputs.

coordination, but tremendously increases the ability of individual ships to perform their separate tasks. Computers communicate with each other automatically at extremely high speeds via tactical data communication nets. The computers function to present tactical information to, as well as accept tactical information from, operators via display and push-button media. However, NTDS provides much more than data exchange facilities. NTDS permits the execution of programmed functions at computer speeds and the solution by computers of problems which are currently handled by voice communication and/or manual means. Combat effectiveness is increased by NTDS in the following ways:

1. Increases the capability of individual ships to process and evaluate automatically tactical data collected by the ships themselves
2. Automatically gives each ship immediate access to evaluated tactical information held by other ships in the formation
3. Permits various levels of command to appraise more realistically the current tactical situation in its entirety (by providing common access to the total tactical information accumulated by other ships in the tactical situation)
4. Increases effectiveness in executing orders (such as, vectoring orders for interceptors which are provided automatically)

Refer to figure 9-1 for a diagram of a typical NTDS equipment grouping.

DEVELOPMENT OF NAVAL TACTICAL DATA SYSTEM

The Naval Tactical Data System (NTDS) was developed by the U.S. Navy as a new command tool for implementing tactical combat direction in task forces. It includes as components a variety of electronic equipment:

1. High-speed, general-purpose, stored-program digital computers
2. High-speed automatic digital-data communications facilities
3. Multi-purpose digital/analog displays
4. Radar video processors
5. Readout devices
6. Magnetic storage disks
7. Magnetic tape handlers
8. Manual data entry devices
9. Analog-to-digital converters
10. Multiplex and interface functions

In addition to the NTDS equipment, there is a wide variety of other electronic equipment which comprises the system environment. Realtime inputs are inserted into the system from sensors and other systems. Realtime outputs are provided to other systems internal and external to the ship. In addition to equipment, the system includes computer programs which control the operation of the equipment. The NTDS shipboard equipment requirements vary with each ship type and the ship's combat characteristics and mission. However, standard equipment capable of handling every element of tactical combat direction is common to all. Thus, NTDS is used to describe any of a number of shipboard systems, each with differing capabilities and composed of different quantities of modular equipment and various computer programs.

The two essential and related elements of the NTDS complex are personnel and machines. The object of this relationship is to remove from the operators, to the maximum practicable extent, the performance of tiring and repetitive operations which are now imposed upon them. This conserves their efforts for functions of decision making by which they can best contribute to the system. Thus, the net effect of automatic equipment is not to reduce the number of personnel and displays in the system, but to minimize the burden placed on operators by permitting concentration of operator efforts in areas requiring human decisions. The contribution of each operator in NTDS is thereby increased over that in manual systems, and total system capability is greatly increased.

NTDS OBJECTIVE

NTDS is a human/machine interface coordinating fleet air defense, antisubmarine warfare, and surface defense operations. The objective of NTDS is to provide those in command of forces ashore and afloat with a broad picture of the current tactical situation and to assist in directing their operations in time to intercept and destroy all potential enemy threats. This is achieved by automating, to a high degree, the collecting, processing, exchanging, and evaluating of large quantities of data through the use of digital computers and digital data processing techniques. In effect, NTDS reduces reaction time and acts as a Force effectiveness multiplier.

NTDS SYSTEM OVERVIEW

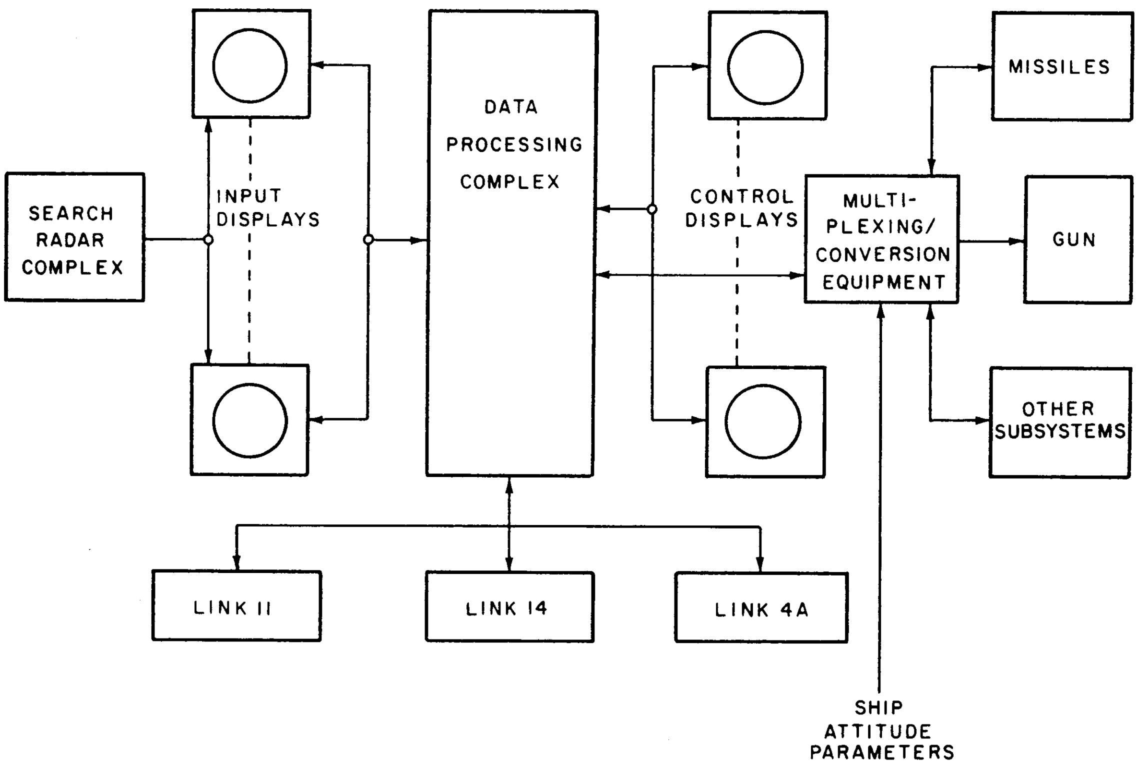
NTDS accomplishes its objectives in realtime. Data is received by the system from various sensing devices which are in continuous contact with the outside environment. The data is used by the system to evaluate an event as it happens. The rate of sampling of each sensing device is determined by how frequently data is needed to update the system. Fundamental to the design philosophy of NTDS is the unit computer concept. The unit computer concept is based on the use of standard computers operating in conjunction to obtain increased capacity and functional capability. Refer to figure 9-3 for a diagram of a simplified NTDS system.

NTDS SYSTEM CONFIGURATION

To accomplish the numerous and varied tasks required of NTDS, the system is divided into three major subsystems:

1. Data Processing Subsystem
2. Data Display Subsystem
3. Data Transmission Subsystems

Each of these subsystems is an integral part of the NTDS system configuration. The data these subsystems generate and feed back to the central data processing subsystem is stored, processed, and distributed by the Operational



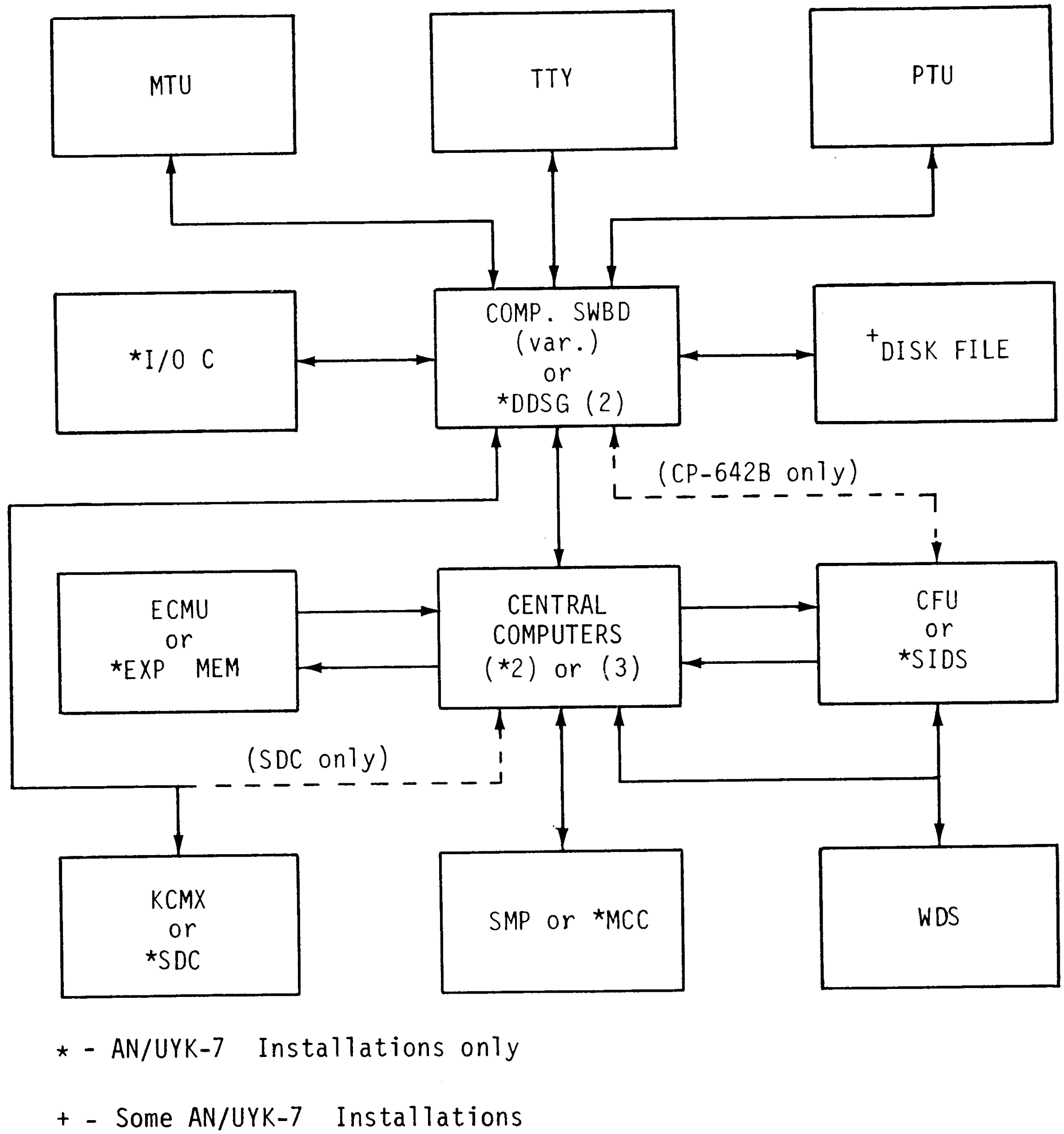
245.87

Figure 9-3.—Simplified System Diagram.

Program to provide usable output data for the other subsystems. In the following paragraphs, these subsystems will be explained. Although some sections of these subsystems can operate independently from the NTDS data processing subsystems, the goal of NTDS is that they operate in conjunction with each other. This provides for maximum, coherent flow of data for use in making and executing command-level decisions.

NTDS DATA PROCESSING SUBSYSTEM (DPS)

The NTDS Data Processing Subsystem (DPS) (fig. 9-4) is the heart of the NTDS. The



245.88

Figure 9-4.—NTDS Data Processing Subsystem (DPS).

DPS consists of a computer group, peripheral devices for data input/output, and interface buffer devices to interface and provide switching for the DPS. The following paragraphs describe each of the primary equipment units or equipment groups that comprise the NTDS data processing system.

DPS Computer Group

The DPS computer group is composed of the central computer, an Extended Core Memory Unit (ECMU) or Expanded Memory (EXP MEM), a Control Formatting Unit (CFU) or Sensor Interface Data Subsystem (SIDS) Computer, and a Systems Monitoring Panel (SMP) or Monitor and Control Console (MCC). These devices process, store, control and route data in a realtime mode of operation.

CENTRAL COMPUTER.—The central computers used in the NTDS DPS are either CP-642B/USQ-20(U) or AN/UYK-7(V) general purpose, stored program, digital data computers. The type of central computers used varies with the ship class in which they are installed. They provide control and process digital data for the entire NTDS installation.

ECMU/EXP MEM.—The ECMU and EXP MEM provide additional core memory storage for the Operational Program (OP) modules and maintenance programs. The ECMU, MU-602(V)1/UYK, is used with the CP-642 computer installations, while the Expanded Memory is used in AN/UYK-7(V) installations.

CFU.—The CFU computer, CP-789/UYK, is used in CP-642B installations. It provides interface between the central computers and gun, missile or underwater fire control system computers. The CFU computer also provides an interface path for automatic digital tracking (ADT) devices and the central computers.

SIDS.—The SIDS computer, AN/UYK-7(V), is used in AN/UYK-7 shipboard installations. It provides an interface path to the central computers for data from the ADT devices. It is also used to operate the Video Signal Simulator (VSS) on ships equipped with this training device.

SMP.—The SMP provides a method of monitoring and controlling program operation. It can be used to load, initiate and modify program operation. It produces alarm readouts which can be interpreted by an experienced operator to determine system operations. Any irregularities in the operation of a peripheral device or subsystem will cause an octal alarm code to be indicated on that computer channel of the SMP readout. The SMP being used (at this writing) with the CP-642B installations is the C-3675A/USQ-20(V).

MCC.—The MCC provides a greater capability to monitor system operation than does the SMP. It provides the operator with a direct readout of program conditions, and status of all subsystems and peripherals, and can be used to initiate four levels of system testing. The MCC is a crt readout device with both fixed-function and variable-function keys. All alarms are alphanumerics and do not require a code list to determine the cause of the alarm as is the case in the SMP. The MCC currently used with the AN/UYK-7(V) computer installations is either the OJ-200/UYA-4, or the AN/UYA-6.

PERIPHERAL GROUP.—The Peripheral Group of the DPS is composed of magnetic tape units (MTU), paper tape units (PTU) and teletypes (tty), Input/Output Consoles (I/OC), or disk files. The quantity and type of equipment varies with the class of ship.

MTU.—The MTUs provide a means of loading and extracting program data. The RD-243/USQ-20(V) is the most common MTU used in a CP-642B computer installation. This unit is being replaced by the RD-358/UUQ MTUs.

PTU.—The PTUs provide a means of loading program modifications, maintenance programs, or program parameters via the paper tape reader (PTR). The PTR is the input portion of the PTU. Data can be extracted from the OP or can be dumped from the main computer memory by means of the high speed punch (HSP) portion of the PTU. The HSP is the output portion of the PTU. The RD-231/USQ-20(V) is the PTU most commonly used with CP-642B computer installations.

TTY.—The tty consists of a keyboard, a page printer, a reperforator, and a transmitter-distributor (TD). The keyboard and TD provide a means of entering data in the OP or modifying program operation. The page printer and the reperforator provide a means of producing output data from the program in either a printed form or as a paper tape. The most common tty used with the CP-642B computer installations is the OJ-212(V1)/UYK.

Disk File.—The disk file provides a means of loading program data and extracting program data. The disk file is much faster than a MTU and is now being used in more NTDS installations. The RD-281(V)3/UYK is the disk file used with some AN/UYK-7(V) installations.

I/O C.—The I/O C or, as it is sometimes termed, DEAC (Data Exchange Auxiliary Console,) is a composite device containing two magnetic tape transports, a page printer, a paper tape reader, and a high speed punch. The OJ-172/UYK I/O C is currently being used in AN/UYK-7(V) installations and replaces the PTU, MTU and tty's.

INTERFACE BUFFER GROUP.—The interface buffer consists of the Computer Switchboards or Digital Data Switch Groups (DDSG), Weapons Designation System, and the Keyset Central Multiplexer (KCMX) or Signal Data Converter (SDC). These devices provide switching for the various peripheral equipment, conversion from an analog format to a digital format, and interface between analog or digital fire control systems and the central computers.

Computer Switchboard.—The computer switchboard provides a method of switching peripheral devices from one computer to another. The SB-1299/USQ-20(V) is a manual switch device presently used with the CP-642B installations.

DDSG.—The Digital Data Switch Group (DDSG) is a remotely controlled switching device which provides the same functions as the computer switchboard mentioned in the previous paragraph. The DDSG currently in use with AN/UYK-7(V) installations is the AN/UYA-14A.

KCMX-Keyset Central Multiplexer.—The KCMX provides the means of exchanging data, control, and status information with either one or two computers, a variety of input/output devices and a control system. The KCMX currently used with the CP-642B installations is the CV-2036/USQ-20(V).

SDC.—The Signal Data Converter (SDC) provides functions similar to the KCMX. It is a buffer and conversion device which routes status, control and data from other subsystems to the control computers. The SDC currently used with some of the AN/UYK-7(V) installations is the Mk 70 MOD 11 or MOD 12.

WDS.—The Weapons Direction System (WDS) is an interface device between NTDS and various weapons systems. It generates control signals which are sent to various weapons systems and receives status signals which inform the operator of system status. The WDS Mk 11 MOD 4 is currently used with most of the CP-642B installations. The WDS Mk 13 MOD 0 is used with the majority of AN/UYK-7(V) installations.

NTDS DISPLAY SYSTEM COMPONENTS

NTDS display components are discussed in the following paragraphs and are illustrated in figure 9-5.

NTDS Display Consoles

The primary units of the Data Display Group are the ppi Display Consoles. The ppi Display Console is a multipurpose console which displays digital radar data and computer-generated symbols to present to the operator a complete and current picture of the tactical situation. The console also provides the capability for data entry into the Operational Program by the operator.

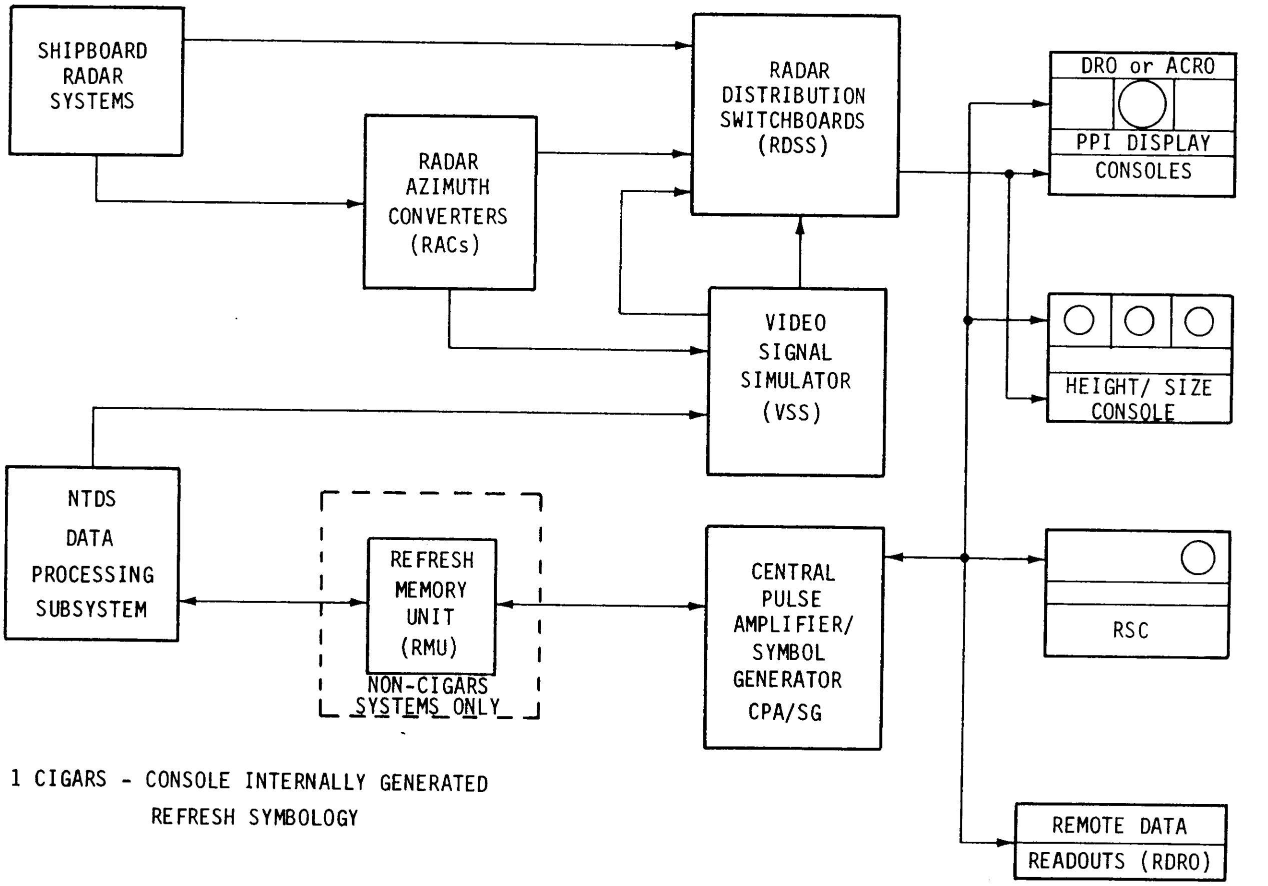


Figure 9-5.—NTDS Display Group Subsystem.

All displayed data is supplied to the consoles by the Operational Program, the radar systems, or the video simulator. The Operational Program stores display data and performs the calculations necessary to perform target tracking, compute trial intercepts, convert coordinates, pair selected tracks, and assist in navigation.

The ppi console provides four distinct types of display: sweep (radar), symbols, alerts, and auxiliary readouts. Auxiliary readouts include Data Readouts (DRO) and Auxiliary Console Readouts (ACRO). Radar analog signals are applied to an analog-to-digital converter where they are converted to digital signals for use by the ppi console. Digital sweep and sweep timing signals from the radar converter are then sent to the ppi console from the distribution switchboard. The console then applies the sweep and timing signals to the display as radar sweep and range marks on the crt. Symbol data in the form of digital messages is sent from the computer via the RMU to the CPA/SG. Here the messages are assigned symbology and sent to the ppi console for display. The RMU provides symbol waveform messages to the CPA/SG at a nominal rate of 15 times per second providing a flicker-free presentation. Computer output data also provides display alerts and readouts at the display console.

Display controls permit the operator to select various range scales, radars and video sources, Selective Identification Features (SIF) and special classifications of track presentation.

Voice communication capabilities provided at the ppi console include radio communication with remote units and sound-powered circuits for communication with ownship console operators.

Operation Summary Console (OSC)

The Operation Summary Console is a large-face crt display console. It is designed to provide an enlarged presentation of the tactical situation with NTDS display symbology. This is its only mode of operation and it does not provide inputs to the system.

The OSC is installed only aboard ships that have the operational need for this type of display and the space to accomodate it.

Symbols

The symbols used in the Display Group of the NTDS are generated in the Symbol Generator group as controlled by the Operational Program in the computers. Descriptive data on detected tracks is entered into computer memory by display console operators. The computer Operational Program causes messages to be sent periodically to the display console groups. These messages are decoded to determine symbol type and other descriptive information. The symbols are then presented on the ppi indicating position, velocity, description, and tactical status concerning selected tracks.

Computer-stored target information is displayed on the crt as symbols (target markers) and lines that are superimposed upon the video display. The position of a symbol represents the position of a target. Ideally, the dot of the symbol coincides with the center of the video for the target. There are also symbols that do not represent targets and for which there is no video. These include reference points, combat air patrol sections and so forth, which are located at certain geographic positions and have tactical or operational significance.

The shape of the symbol and the special markings associated with it indicate category, identification, class and tactical status. Category classifies a track as air, surface or subsurface. Identification indicates whether the track is unknown, friendly, or hostile. Class signifies interceptor, carrier, helicopter, ownship, missile site, sonobuoy ownship picket, and so on. Tactical sidemark information is added as FCS number, engaged or missile in flight symbol, and so forth.

Three operation symbols are used for the operation of the ppi consoles. These are: the hook, to illustrate the target in close control; the ball tab, to designate a geographic point or a target; and the pointer, to designate a target when in communication with another console over the NTDS intercommunication system.

Some tracks are not completely distinguished from other tracks by symbol shape alone. Panel controls permit the operator to distinguish different kinds of tracks that have the same symbol shape, by allowing the operator to cause the symbol to blink, to enlarge, or to be changed to a dot only. For example, remotely tracked targets (that is, targets that are being tracked by other NTDS-equipped ships) may be distinguished from locally tracked targets by displaying the remote tracks as dots, or vice-versa.

Height/Size Console

The OA-7980/UYA-4 Height/Size (H/S) Console is used to measure the height and raid size of selected aircraft tracks being processed by the data display group.

The H/S Console height displays operate with the standard height-finding radar. The size display is capable of operating with any search type radar. Height and raid size are determined by the operator in conjunction with the display and are entered into the computer associated with the data display group for use throughout the system.

The H/S Console is divided functionally into six major areas: input data processing, height displays (RHI display), size displays (SAI display), output data, auxiliary readouts, and power supplies.

Radar Set Console, RSC

The OA-7032/SPS-48(V) Radar Set Console (RSC) is a centralized operating console containing a Range Height Indicator (RHI), and controls and indicators for operating the radar set and interfaces with NTDS equipment. It is used in conjunction with ppi's in the NTDS installation to provide control and height data for the NTDS Display System. This console is a component of the AN/SPS-48C Radar Set. It is covered at this time to simplify its relationship to the NTDS Display Group.

Remote Data Readout

Many ships are equipped with a OA-8337/UYA-4 data readout commonly known as Remote Data Readout (Remote DRO). This unit serves two purposes: it provides a means of displaying additional information for console modes for which the normal display console DRO is inadequate; and provides Command and Control information to stations not part of CIC.

Displays on the Remote DRO are a one-way communication controlled by the Operational Program. The Operational Program computer uses the same procedures to display data on the Remote DRO as for the DROs which are physically a part of the display consoles.

Central Pulse Amplifier/ Symbol Generator

The Central Pulse Amplifier/Symbol Generator (CPA/SG) functions as a pulse amplifier, symbol generator, and Test Message Generator (TMG). These functions provide the following system capabilities:

1. Amplification and distribution of computer input and output data between the display groups and the computers
2. Generation of symbol waveform and timing signals for display on the display consoles
3. Generation of simulated computer output data for testing and troubleshooting the display groups
4. Provision of system configuration switching

Central Pulse Amplifier

The Central Pulse Amplifier (CPA) is a power amplifying and gating device by which the display consoles communicate with the NTDS computer. In the Model 4 system the interface is normally between the Refresh Memory Unit (RMU) rather than directly with the computers, although the RMU does provide a bypass operation option. The CPA is a two channel (two input, two output) unit with each channel capable of handling a 15 display console group and each group capable of being switched with either computer I/O link. The CPA has three functions: input data, output data, and control functions.

1. Input Data

The CPA input data function receives computer output data, data acknowledge, and external function signals from the control function. The input data function amplifies and distributes signals received to the display groups and the symbol generator. Selection of data to be distributed is controlled by the data source control signals. Since the dual CPA/SG contains two input data functions, two computers can communicate with two display groups. Either computer can communicate with either or both display groups.

2. Output Data

The CPA output data function receives computer input data, input data requests, and data enable signals from each console in the display groups. It also receives data source control signals from the control function.

3. Control

The CPA control function receives output data requests from the symbol generator and input data requests from the output data function. The control function generates data source control signals to control data flow to and from the computers. It also amplifies and distributes data request signals to the computers.

Distribution of computer input data from the display groups to the computers is controlled by the data source control signals from the control function. The output data function amplifies computer input data and input data requests, then distributes them to the computers when data enable is received from the display groups.

Symbol Generator

The purpose of the Symbol Generator (SG) is to produce the waveforms needed at the ppi console to display desired symbols.

The symbol generator develops symbol waveforms, unblanking, sidemark, master clock, and counter enable signals from computer output and data acknowledge signals received from the computers via the central pulse amplifier. The symbol generator also generates a computer control signal (output data request) which is sent to the computers via the central pulse amplifier and RMU.

The symbol generator has six major functions: input, timing, waveform generation, waveform control, unblanking, and output.

1. Input

The input function stores and decodes computer output data which defines (1) the symbols and sidemarks to be generated, and (2) the external function and data acknowledge signals received from the pulse amplifier. The input function produces symbol category and subcategory data from the decoded computer output data.

Category and subcategory data defining the symbol or sidemark to be generated are sent to the waveform generation, waveform control, and unblanking functions. The input function also generates counter enable signals to synchronize the timing function and the display groups (via the output function). It clears stored computer output data on receipt of timing functions and generates output data requests. Output data requests are sent to the computers via the pulse amplifier and inform the computers that the CPA/SG and display group are ready for new data. The external function signal is received from the computers to reset the output data request signal if it is not reset automatically.

2. Timing

The timing function receives counter enable signals from the input function and generates master clock and timing signals. The master clock synchronizes the display consoles with the symbol generator, and timing signals control the internal timing of the symbol generator.

3. Waveform Generation

Waveform controls, in conjunction with category and subcategory data, control analog waveform generation. The waveform generation function produces analog waveforms (sine, triangle, and trapezoid) that are sent back to the waveform control function. Symbol waveforms are amplified by the CPA and sent to the display groups via the output function.

Radar Azimuth Converter

Since NTDS data display consoles present digital sweeps, it is necessary to convert radar range and azimuth information from analog form to digital form for use in digital deflection sweep circuits of ppi consoles. The translation of radar synchro or analog signals is accomplished by a Radar Azimuth Converter (RAC) CV-2095/UYA-4 associated with each radar. The digital azimuth information and sweep pulse trains from each RAC in a system are sent to a Radar Distribution Switchboard for distribution to all consoles. The RACs also generate the range marks used by the consoles.

Sensor signals indicating sweep angular position and timing are sent to converters where this information is transformed into signals to drive the sweep display on the display consoles.

The RAC receives a master trigger from a radar, indicating the start of a radar sweep. The RAC then generates an end-of-sweep signal, which is delayed from the master trigger by an amount determined by the setting of a range selector on the azimuth converter. Range marks are generated during the interval between the master trigger and the end-of-sweep signal. The range marks and end-of-sweep signal are sent to the display console from the RAC.

Radar Distribution Switchboards

The Radar Distribution Switchboards (RDS) provide distribution of radar system generated synchro, digital, and video signals to the data display group units and the various shipboard radar indicator facilities. Two types of RDSs are used, the SB-2780/UYA-4(V) and the SB-1109/SP.

Video Signal Simulator

The SM-441/UYA-4 Video Signal Simulator (VSS) develops simulated radar video and sweep signals for use with UYA-4 display group testing, troubleshooting, and operator training. Simulated video signals consist of simulated track video combined with either simulated receiver noise and sea clutter, or live radar video. Simulated azimuth and sweep timing signals consist of simulated variable speed antenna synchro and sine/cosine signals, master trigger, and early trigger.

The VSS receives output data from the Operational Program which defines the range, azimuth, azimuth beamwidth, video duration, intensity, noise source selection, and the like, of a simulated track. This data is stored and compared with digital azimuth and sweep data from the data switchboard. When computer data and radar data coincide, simulated video signals are generated and sent through the data switchboard to the display consoles. Either simulated receiver noise and sea clutter or live video may also be added to the simulated video signals to form the VSS output. Digital azimuth and sweep data are fed back into the data switchboard for access by any display console connected to the data switchboard.

Digital azimuth and sweep data enter the VSS from a data converter via the data switchboard. Switchboard controls select the source of the radar video, digital azimuth, and sweep data. The data may be from any one of the operating radars connected to the data switchboard.

Inputs to the data converter are normally from an operating radar system. If an operating radar system is not available, the VSS provides radar signals (simulated azimuth and triggers) which simulate an operating radar system. These simulated radar signals may be switched into the data converter by the Radar Simulator selector switch to replace the operating radar azimuth and triggers.

NTDS DATA TRANSMISSION SUBSYSTEMS

NTDS utilizes three separate data transmission links to maintain tactical data communications with other tactical units. (See figure 9-6.) Each of these links provides a unique capability to transfer data rapidly to other ships, aircraft and shore facilities without the delay of human interface (excepting Link 14 receive). The data processing subsystem formats the messages for each of the data links based on shipboard inputs from the display subsystem, sensor inputs, and other data link inputs.

Link 11

The automatic data communication links provide the operational commander with a high speed, accurate mode of tactical communication. Link 11 (figure 9-6a) provides high speed computer-to-computer transfer of tactical environment information, command orders, and participating unit status to all other tactical data systems with a nominal 300-mile radius. Tactical information currently transferred is surface, subsurface, air, and ECM track information on friendly, hostile, and unknown identity tracks. The responsibility for track reporting is determined by the Operational Program on the basis of a quality-of-tracking figure calculated for each local track and broadcast as part of the track information. In the case of ECM tracks, a bearing line is presented that originates from the reporting ship. Whenever the program detects the intersection of two bearing lines having similar ''fingerprints,'' an ECM fix is automatically displayed at ownship and broadcast to the other ships of the force. As a part of each report, the track's course, speed, altitude/depth, relative threat, weapons inventory, identity parameters, and engagement status are broadcast. The commands to engage (specifying the type of weapon), break engage, cease fire, interceptor hand-over, and maneuvering orders can be broadcast when originated through console button actions by the appropriate console modes.

Link 14

Link 14 provides a means of transmitting track information, identity, engagement status,

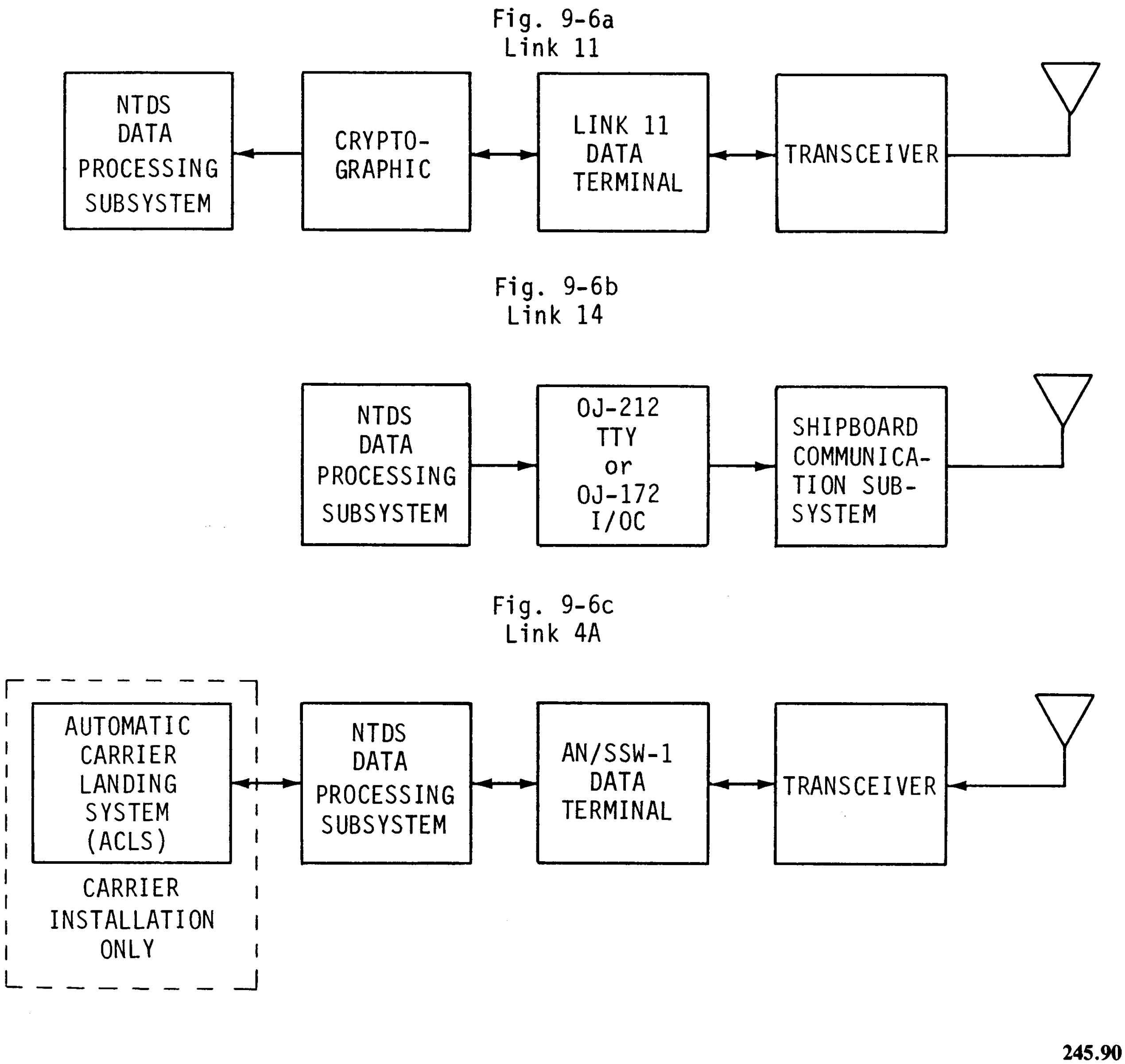
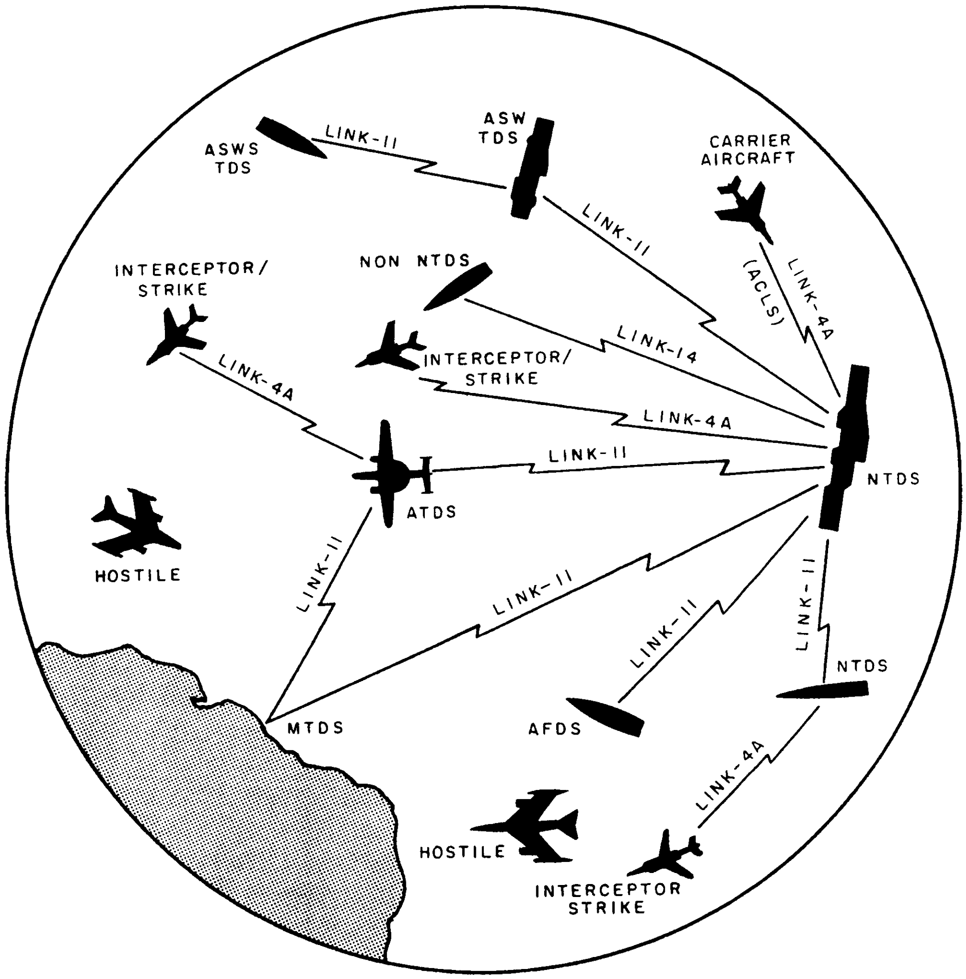


Figure 9-6.—NTDS Communication Links.

drop track reports, and gridlock information to those units not capable of participating in the Link 11 net (fig. 9-6b).

Link 4A

Link 4A enables the Operational Program to take control of the autopilot in a suitably equipped aircraft to control land/launch, pursue or follow collision intercept geometry. It may control a flight out to a strike area and return it to base without the requirements for pilot action. The pilot has the option of going fully automatic, utilizing the visual display to aid in interpreting the intercept controller's dialog, or totally ignoring the Link 4A transmission (fig. 9-6c). Refer to figure 9-7 for an Intersystem Communications Employment diagram.



245.91

Figure 9-7.—Intersystem Communications Employment.

COMMAND AND CONTROL

The generalized basic system discussed previously in this section can now be further defined in terms of the functions performed by a Command and Control System: detect data, operate on data, and use data. Each gross function can be further delineated: the detection function involves the processes of detection, display, tracking, and identification; the operation functions performed are processing and evaluation; the use functions include dissemination, designation, and control.

Each of these functions has certain unique characteristics and interfaces with other system functions in a certain way, as is discussed in systems operations manuals for ship classes. Within the framework of the general functions defined here however, some final points can be noted which further characterize Command and Control Systems:

- They are realtime. The data received from an environment must be processed and used fast enough to affect that environment.

- The processing of many inputs occurring in realtime usually requires the storage of data for purposes of correlation and prediction; this in turn necessitates large storage (memory) capacities in the digital processing subsystem.

- The correlation and prediction operations noted above, in addition to other processing functions such as threat evaluation, and the like, dictate the need for a digital processing system which has a powerful arithmetic capability. This is typically found in large, fast, computers with a large word size.

- The processing of great quantities of input data in realtime (in which arithmetic operations are performed) is a characteristic of the command portion of a Command and Control System.

- The utilization of the processed data typically involves the control of subsystems, such as weapons and communications, which require information in a specific format, both electrically and in terms of content. The digital processing which is performed is primarily the conversion, scheduling, and routing of data for these subsystems. This function is a characteristic of the control portion of the Command and Control System.