TA-ENG: SESC - FFG DIVISION

FFG COMBAT SYSTEM LEARNERS GUIDE

VERSION 2.01, DATED 10 Dec 2014

SECTION 3 – Command & Decision Systems

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Chapter 1. Introduction

1. The Command and Decision Systems (also known as C2 – Command & Control), facilitate steps three through seven of the Fourteen-step Engagement sequence. These functions contribute to Tactical Picture Compilation and Threat Evaluation & Weapon Assignment (TEWA).

2. The major systems covered in this section include:

   a. RIADT

   b. ADS

   c. TDL

   d. BVP

3. From the UWS, the SOC is technically a Command & Decision system, however it is covered in the sensors section of this learners guide in order to keep the UWS together in one place.

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Chapter 2. Radar Integrated Automatic Detection & Tracking (RIADT)

References:

- ABR 6509 FFG Combat System Manual
- ABR 6511 FFG Combat System Operators Manual
- ABR 6551 Maintenance Manual for Sensor Data Fusion System

General

1. Sometimes referred to as the Sensor Data Fusion System (SDFS), the RIADT performs the automatic detect and track function and data fusion of all three surveillance radars, both individually, and as a combined sensor. Digital and analog returns from SPS-49A, SPS-55, and Mk 92 radars are combined and processed to provide an integrated database of radar tracks to ADS. The RIADT also provides some radar controls to AD/T and Surface Operator roles at the C&Di consoles.

2. The RIADT is comprised of a video interface processor, two dual Radar Track Processors (RTPs), a Plot Fusion Processor (PFP) module, a Data Fusion Processor (DFP) module, a Multi-sensor Integrated Data-fusion Display System (MIDDS) and a Power Supply as depicted below.

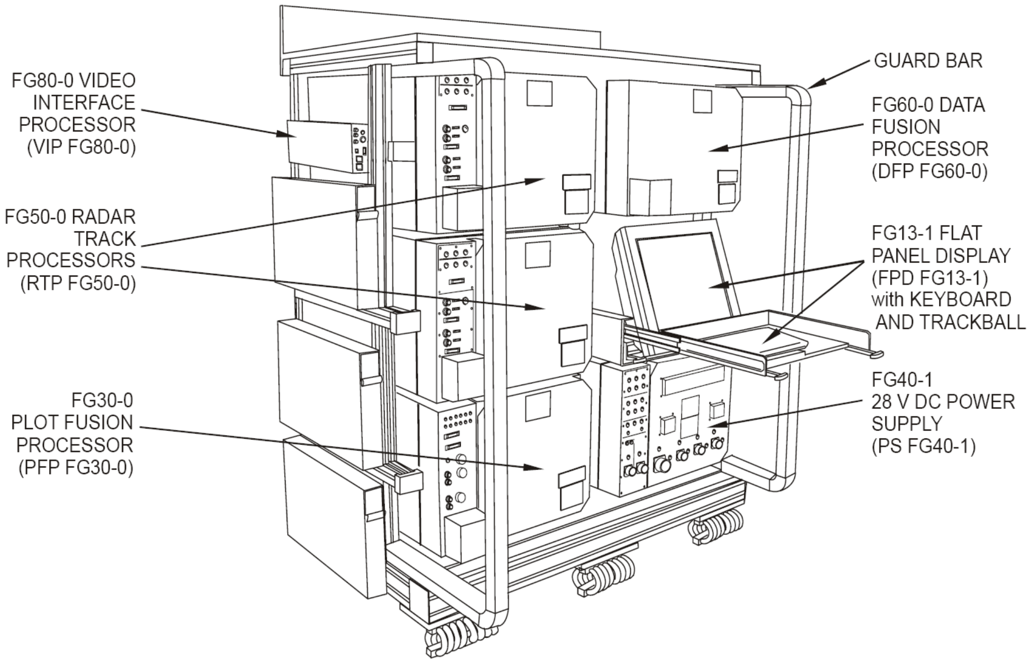

Figure 2-1: RIADT Physical Layout

3. The RIADT system accepts plots from the three fitted search radars and tracks from both track radars and manages the establishment and maintenance of tracks on contacts. It is able to track weak contacts by combining detection evidence from all radars in cases where a single radar tracker may be unable to declare a track due to a lack of evidence.

4. Track maintenance includes updating of existing tracks with new sensor data. It also produces kinematic estimates of contacts (position and velocity estimates) and provides external systems with estimates of the confidence of the track accuracy of each track. When either fire control channels FC-1 and FC-2 are tracking, the gate position of the tracker is provided to this function as an additional tracker source.

5. The RIADT function determines how many separate entities are being tracked by the ship's radars and how many tracks should be reported to the C2 system. This involves three distinct sub-functions:

   a. Determining if two tracks from separate sources are reports of different or the same entity (track correlation and merging);

   b. Determining if a single track with more than one reporting tracker in fact relates to two entities. This decision would result in a new track being created (track decorrelation and splitting); and

c. Optimum combination of all tracking sources for correlated tracks to produce the best estimate of target kinematics. Each track must be assessed for correlation and decorrelation on a regular basis. Correlated tracks produced by the single sensor and the multiple sensor tracking functions are consolidated by this function to produce a single track for each target entity regardless of the number of separate trackers that are reporting that entity.

6. In the event of a casualty, the RIADT is capable of operating as a stand alone system, providing fused track data display to the maintenance workstation in RICER.

System Inputs

a. 115V, 1ϕ, 60Hz

b. LP cooling water

c. Gyro

d. EM Log

e. MK 92 CAS search radar Plots to RTP FG50-0;

f. MK 92 CAS/STIR track radars and DSOT Plots to WIP FG70-0 (For radar video alignment only);

g. SPS49A(V)1 Radar Video & Plots to RTP FG50-0, via the VIP FG80-0;

h. SPS55 Radar Video to RTP FG50-0, via the VIP FG90-0 and FG92-0 IF Amplifier;

i. ADS radar control

j. Radar Signal Distribution Switchboard (SPS-55 only);

k. MIDDS (HMI)

System Outputs

a. Radar control

b. Track data to ADACS, WCP and MIDDS

c. Radar plots (MIDDS only)

Radar Track Processors

7. There are two dual RTPs housed in the RIADT mounting rack in RICER. One dual RTP processes SPS-49A and SPS-55 radars, the other processes CAS Search and contains one spare channel. The RTPs provide the following functions:

a. Remote control facilities to control the radars,

b. Video processing,

c. Land blanking,

d. CFAR,

e. Edge detection filtering,

f. Azimuth correlation filtering,

g. Generation of plot reports on target like objects,

h. Detection of tracks in operator defined acquisition zones,

i. Rejection of tracks in operator defined clutter zones,

j. Updating (tracking) of contacts,

k. Generation of up to 20 test targets.

SPS-49 RTP Plot Selection

8. The AN/SPS-49A(V)1 radar incorporates its own automatic detect and track (ADT) processing. The RTP associated with SPS-49 can either receive plots direct from SPS-49 ADT processing, or receive SPS-49 video only and conduct the ADT processing itself. This is determined by selections accessed via the SPS-49 RTP Control VAB on a C&Di console (See the SPS-49 RTP Control Window below). Using SPS-49's own processing, with MTI or NMTI selected for 'Plot Selection' (note that MTI & NMTI are functionally the same), allows SPS-49 to forward plots that it determines to be targets. These consist of **special alert tracks** (determined in a single scan with set criteria), **rapid promotion tracks** (which are determined by two successive scans of the radar), and **normal plots** (which may take four or more radar scans to be confirmed). If, in the SPS-49 RTP Control Window, 'Plot Selection' is set to 'RTP Video', the RTP will do all ADT processing and special alert / rapid promotion tracks will not be seen. 'RTP Video' should only be selected if SPS-49 processing is degraded/defective in such a way that its ADT processing is affected.

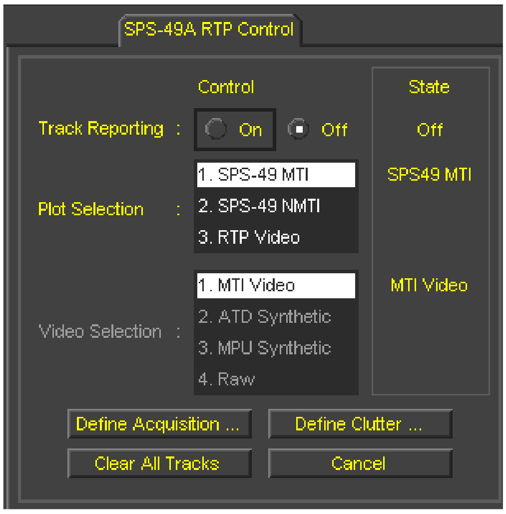

Figure 2-2: SPS-49 RTP Control Window on C&Di Console

Plot Fusion Processor Module

9. The PFP module processes the RTP plots to declare tracks. The PFP can process up to 100 tracks from each RTP.

10. A primarily air target specific ADT function is provided to operate with the track plots from all three surveillance radars to give the earliest track detection possible. This function is called the *Sparse Target Tracker (STT)*, and uses a multiple hypothesis process to declare tracks. Selecting STT Track Reporting 'On' and enabling which sensors are used for STT processing are the only operator selections available from the PFP Control menu.

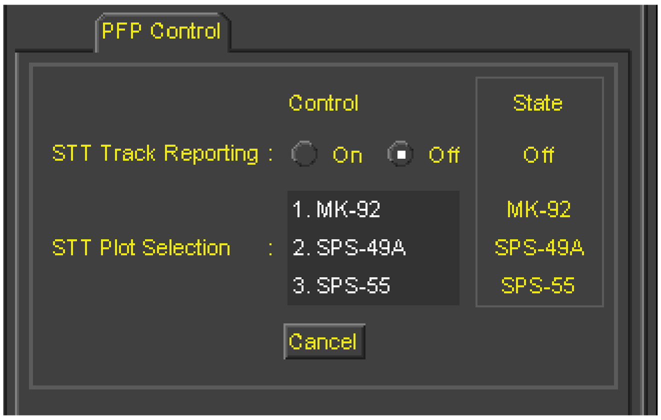

Figure 2-3: PFP Control Window

11. The STT will most likely produce the earliest track on a high-speed target within its processing range of 7 to 15 nm, but is also likely to produce the most false alarms. Track quality is generally not as high as for single radar specific trackers; where radar specific tracks exist, they will normally be selected in preference to STT tracks. Like the RTPs, the STT can detect and track up to 100 targets.

Data Fusion Processor Module

12. The DFP module is another dual processor component that correlates the tracks formed at the PFP to produce a single fused track for onward reporting to ADACS. Operators have the option of selecting which sensors input to the DFP. Generally, all for inputs below would be used, unless the STT is generating too many false alarms, in which case it can be deselected.

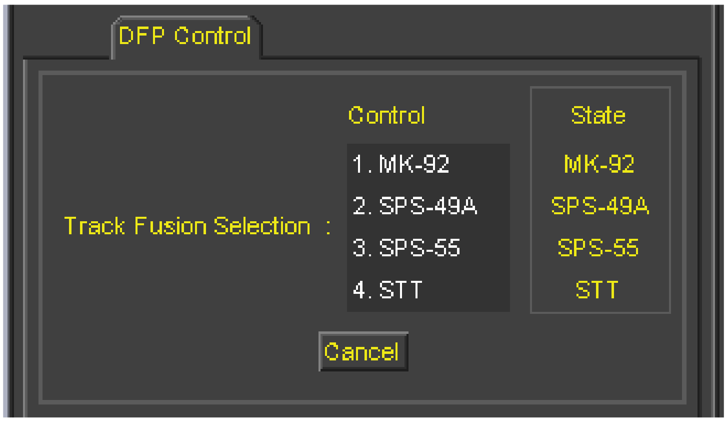

Figure 2-4: DFP Control Window

13. The DFP is the controlling system within the RIADT. Status request messages are sent from DFP to the PFP and RTPs, with the subsequent status responses used to update the DFP's oversight of the system parameter settings. ADACS interfaces with this unit.

14. As there are dual DFPs each one requires its own interface control peripherals. This is why there are two keyboards and two track balls, one for each DFP processor.

Multi-sensor Integrated Data-fusion Display System

15. MIDDS is the HMI software component of the RIADT that resides on the Data Fusion Processor. MIDDS is controlled from the flat display panel and trackball. This component, used for operation and maintenance, provides a real-time, multi-sensor data correlation system with a graphical display. MIDDS enables the output of data to the display panel and to ADACS.

16. The output of only one of the dual DFPs can be displayed on the MIDDS at any given time.

Figure 2-5: MIDDS Screen

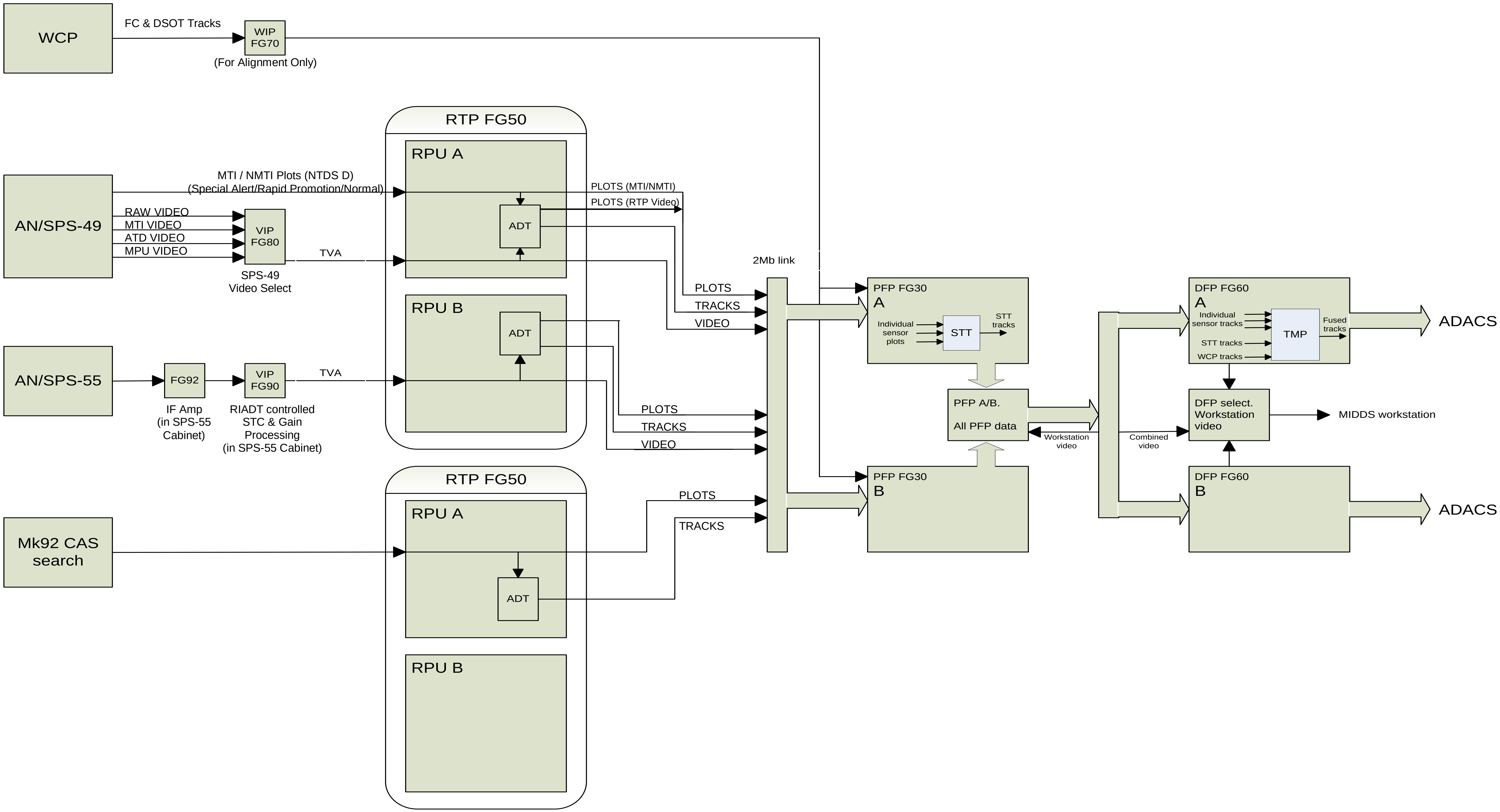

Figure 2-6: RIADT Block Diagram

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Chapter 3. Advanced Display System (ADS)

References:

- ABR 6509 FFGUP Combat System Manual
- ABR 6511 FFGUP Combat System Operator Manual
- ABR 6512 Maintenance Manual for Advanced Display System (ADS) Server
- ABR 6513 Maintenance Manual for Command and Decision (C&Di) Console

Introduction

1. The Advanced Display System together with ADACS software forms the heart of the Command and Control element within the FFG Combat System. It consists of a Local Area Network (LAN) based data management system which provides the capability to perform:

a. Tactical Picture Compilation

i. Track

ii. Sensor Correlate

iii. ID & Classify

b. Threat Evaluation & Weapon Assignment (TEWA)

i. Assess whether a track is a threat

ii. Facilitate weapon-to-threat-pairing

iii. Facilitate Orders for Engagement (Command Assignment)

Primary Components

Command and Decision (C&Di) Consoles

Reference: ABR 6511 Section 7, Chapter 2.

ADACS HMID 7.5

2. The ADS display console is the OJ-719(V)15/UYQ-70(V)2, Command and Decision (C&Di) Console. There are eight consoles installed in the Ops room to provide a display of combat system tactical information for missions such as AAW, ASuW, ASW and EW. The consoles receive computer-generated data, composite video analogue input and radar video and data to present a two dimensional picture of the tactical situation. The C&Di Console operator can select the desired data for display to perform the following functions:

a. Detect, track, identify and evaluate contacts;

b. Assign and control on-board weapons systems; and

c. Assign and control external weapons systems (such as interceptor aircraft) via radio and/or data link communications.

3. Each console can be configured to provide any of the possible ADACS operator roles.

4. The C&Di is a single display water cooled console with a VME (Versa Module Eurocard) bus architecture chassis that houses the Circuit Card Assemblies (CCA). The console frame is made of aluminium alloy with an injection moulded composite bull-nose. A hinged panel in the lower section of the console (under the bull-nose) is used to access the VME chassis and CCAs, mass media storage devices, power subsystem and the backup batteries. A control panel assembly and communications footswitch are also located in the lower section. The bull-nose section contains the keyboard and keyboard dimmer control, the trackball assembly, a landscape-oriented touch-sensitive X-Terminal, a communications alert (buzzer) assembly and buzzer DISABLE/RESET switch and console status indicators. The upper section of the console (above the bull-nose) contains a Flat Panel Display (FPD), a portrait-oriented touch-sensitive X-Terminal and a Console Intercommunication Station (CIS).

5. System Inputs:

a. 115V, 3ϕ, 400Hz

b. LP cooling water

c. LAN A

d. LAN B

e. MK 92 CAS search radar via RSDS;

f. SPS49A(V)1 Radar via RSDS;

g. SPS55 Radar via RSDS and RIADT;

h. IFF via RSDS and UPA-59

6. System Outputs:

a. Radar control

b. Track data to ADACS, WCP and MIDDS

c. C2 picture compilation

d. TADIL network operation and control functionality (Link 11/Link 16 HMI)

e. Operator communications

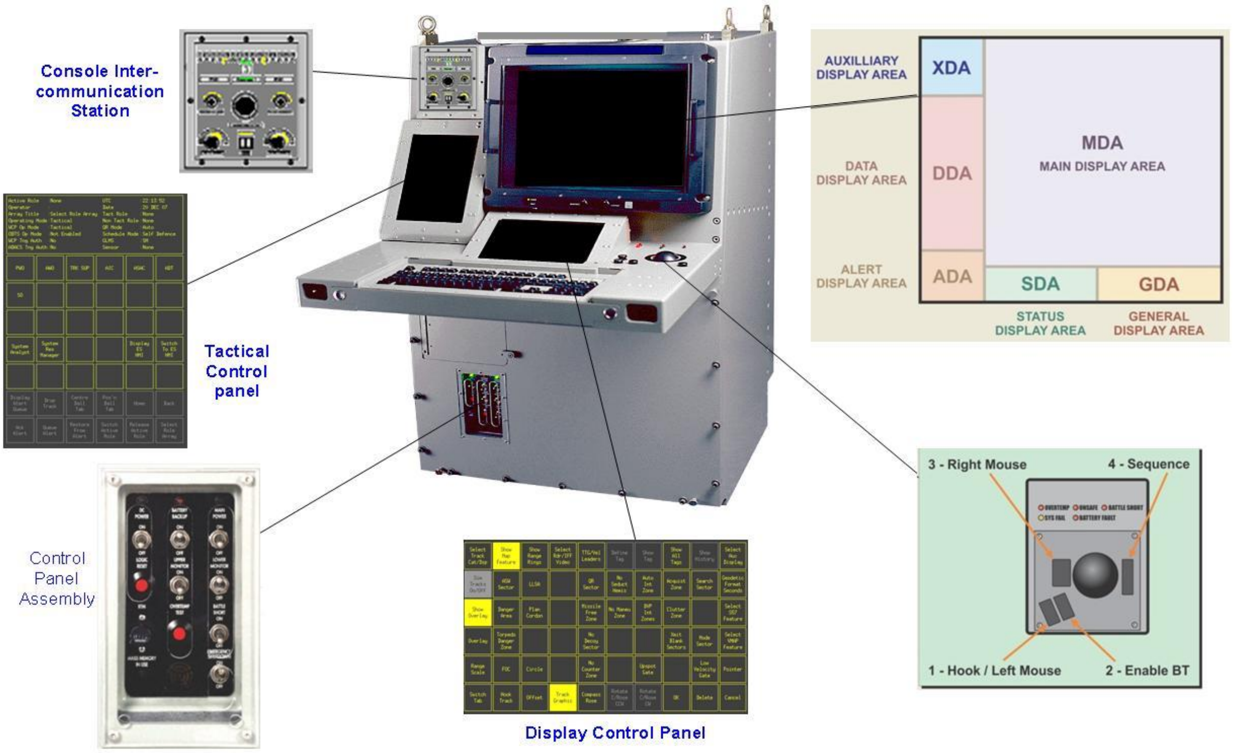

Figure 3-1: C&Di Console

7. The C&Di console contains temperature sensing circuits that shut down the main power in cases of high temperature. When the temperature inside the console reaches 57 °C, the OVERTEMP HIGH indicator on the Control Panel Assembly will illuminate blinking and the OVERTEMP alarm will sound, indicating the console is in danger of being shut down due to high temperature. When the temperature inside the console reaches 63 °C, the UNSAFE indicator will also illuminate, over-temperature horn will continue to sound, and the PTC CCA will initiate a Graceful Shutdown of the console, if the BATTLESHORT switch is in the OFF position.

8. The temperature interlock feature can be disabled by moving the BATTLESHORT switch to the ON position, preventing Graceful Shutdown, and allowing the server to operate until catastrophic failure occurs. The BATTLESHORT indicator will illuminate, indicating that the temperature interlock feature is disabled. Moving the BATTLESHORT switch to the OFF position extinguishes the indicator and returns the temperature interlock to its normal enabled state.

9. The C&Di console will enter battery backup in the event of AC power failure when in normal operation. In battery backup the console is provided with a minimum of eight minutes of DC power. Long enough for the operating system to be shut down without loss of data. This shut down is called a Graceful Shutdown and is defined as a self-initiated orderly termination of the ADACS software followed by console power off. Graceful Shutdown is designed to prevent damage to the server components in a non-critical situation. A Graceful Shutdown in Progress message will be displayed on the Landscape X-terminal at that time.

10. In normal operation, a Graceful Shutdown will be automatically initiated by the PTC module when an UNSAFE over-temperature condition arises or when an AC power failure occurs and the backup battery voltage drops below 44 VDC.

Human Machine Interface

11. The HMI is explained in depth in the ADACS Human Machine Interface Description (HMID), which is provided to ships is soft copy with delivery of every ADACS software upgrade.

12. The operator HMI interface is provided by an 18 inch flat panel liquid crystal display (Tactical Display), two electro-luminecent (EL) touch panels, a trackball, buzzer, and keyboard. One touch panel provides all the tactical controls required by specific operator roles; this is known as the Tactical Control Panel (TCP), whilst the other provides the display related controls used to tailor the display for particular situations; this one is called the Display Control Panel (DCP). Both use fixed action buttons (FABs) and variable action buttons (VABs), combined with trackball controls and dialogue windows in the flat panel display to tactically operate the console.

Tactical Display

13. The Tactical Display presents a variety of information required by the operators. It is divided into six functional areas comprising:

a. Main Display Area (MDA) – this presents the graphical display of radar, IFF, track symbology, maps and overlays (i.e. the equivalent of a PPI);

b. Auxiliary Display Area (XDA) – displays a wide area picture of the MDA, or one of two other video sources such as flight deck camera or EOTS;

c. Data Display Area (DDA) – provides data readouts and graphical user interfaces (GUIs) for most operator alphanumeric entries in tab window formats;

d. Alert Display Area (ADA) – displays the latest system alerts in priority order of critical, very important, important, and least important, as well as indicating the number of alerts queued;

e. Status display Area (SDA) – colour coded buttons indicating the status of prime combat system elements. Depressing a button provides a status readout in the DDA; and

f. General Display Area (GDA) – provides a continuous readout of general information such as ownship position, time (UTC), balltab position, and range scale of the MDA.

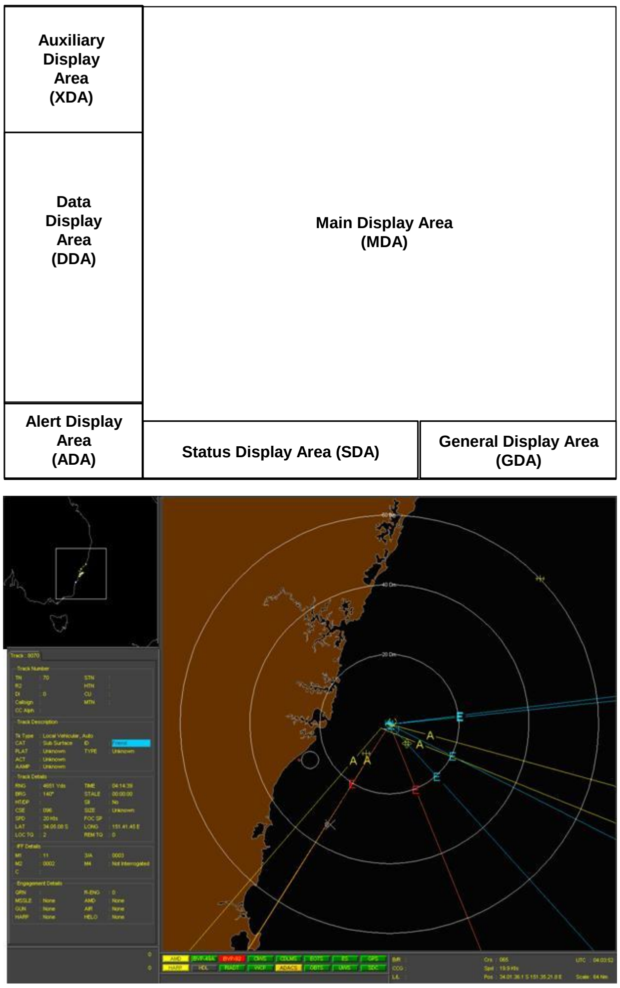

Figure 3-2: Tactical Display

Tactical Control Panel

14. The TCP displays 42 buttons arranged in 7 rows of 6 buttons each in a ‘portrait’ orientation. Primary system status details are displayed across the top of the TCP, including: current tactical and non-tactical selected roles, launcher priority, combat system mode (i.e. training or tactical), QR mode, selected radar, and date and time. The top three rows of buttons (1 to 18, numbered left to right, top to bottom) are allocated as low frequency of use, role specific VABs. The next two rows (buttons 19 to 30) are high frequency of use, role specific VABs. These include most of the primary track management and common VABs. The bottom two rows (buttons 31 to 42) are FABs. They are used to navigate the various arrays, and include buttons common to all roles. Refer to the latest version of the ADACS HMID for a description of each FAB and VAB.

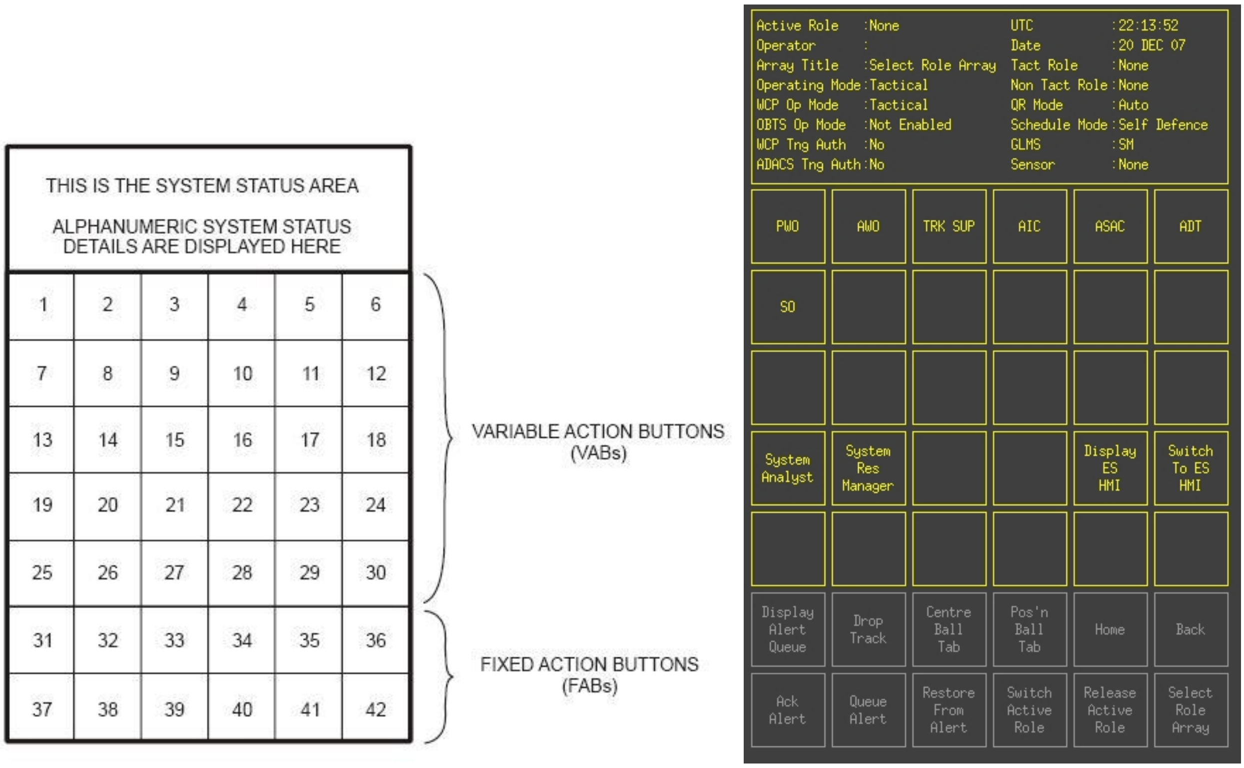

Figure 3-3: Tactical Control Panel

15. The system status area at the top of the TCP displays 7 lines of status information, including date and time in UTC, system and sub-system modes, the roles selected at the console, the name of the currently displayed TCP array, and the operators name and rank (when entered), and the radar selected for display on the MDA.

Display Control Panel

16. The DCP is oriented in ‘landscape’ and has 6 rows of 10 buttons; the outer border of 28 buttons are FABs, with the remaining 32 buttons as VABs (see Figure 2–5). There is one instance of the FABs changing, whenever data entry is required in alphanumeric characters. The DCP converts to a virtual ‘qwerty’ keyboard, using all 60 buttons, reverting to the normal DCP display when the data is accepted. The full keyboard incorporated in the bullnose is only used for the operation of x-term sessions such as ES HMI, and file housekeeping through the system resource manager role.

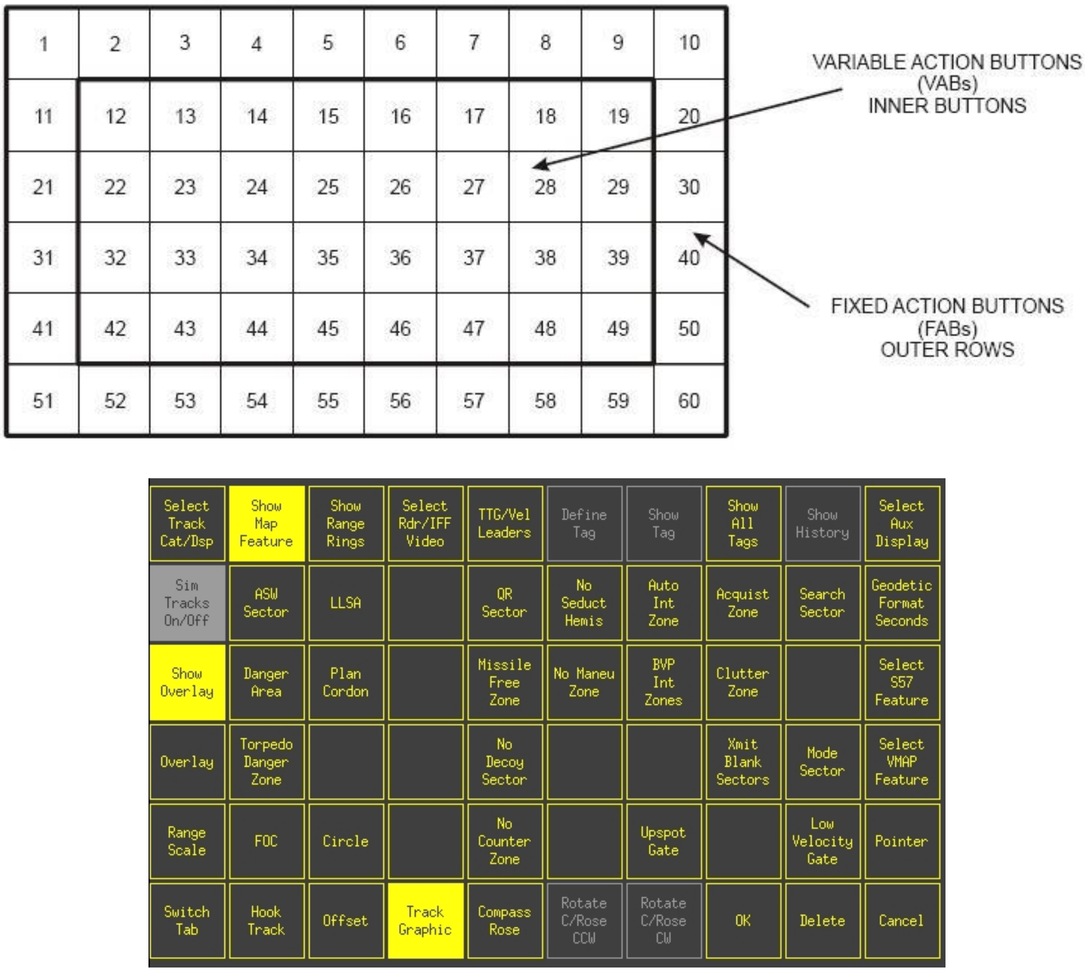

Figure 3-4: Display Control Panel

TRACKBALL ASSEMBLY

17. The trackball assembly consists of a rotating trackball and four push buttons. The trackball is used to move the cursor around the display, while the buttons are used to instigate actions according to their role and the position of the cursor.

18. Rotation of the trackball is translated into motion of the displayed cursor. When the trackball is rotated, the displayed cursor is moved in the direction of the trackball rotation. The speed of cursor movement is related to the speed of rotation of the trackball. The cursor can reach any part of the tactical display.

19. The shape of the cursor is dependent on its position in the display and the software application. The 'Balltab enabled' shape (a cross-hair) is only available when in the MDA part of the tactical display; if it is moved to any other display area, it reverts to the mouse pointer shape (an arrow). The balltab must be enabled again within the MDA using the trackball assembly balltab buttons.

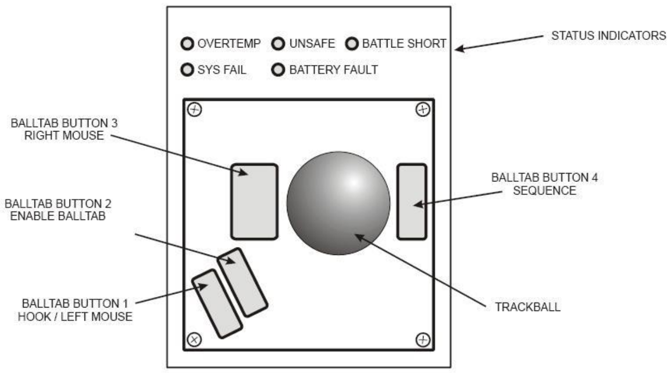

Figure 3-5: Track Ball Assembly

ALERTS

20. Alerts are messages sent to operators to highlight critical conditions that require operator attention or action. Alerts are sent to the C&Di console to which they are relevant, i.e. they are role and function dependent. A priority is appended to each alert based on the urgency of the message and the type of response required. There are four priority levels for ADS alerts, 1 to 4, with ‘1’ being the highest and ‘4’ the lowest.

Priority	Category	Description
1	critical	immediate response is required - these are in response to time critical threats to ownship, or critical system/sub-system status conditions
2	very important	generally in response to progress of engagements
3	important	these conditions require attention within approximately one minute
4	least important	these conditions are not time dependent, but require attention when available

Table 1: Alert Priorities

21. Audible and tactile cueing occur at the C&Di consoles to indicate to an operator that a new alert requires attention. A buzzer combined with a vibration on the right hand side of the bullnose in front of the trackball assembly activate to indicate alerts. The level of buzzing annoyance increases with alert priority.

22. Alerts are colour coded for visual recognition and cueing. Red is used to display priority 1 and 2 alerts, with priority 1 alerts distinguished by ‘flashing’. Important (priority 3) alerts are coloured yellow, whilst the lowest priority (priority 4) are white.

23. Acknowledgment of an alert can greatly effect the visual display of the C&Di console, as well as the control panels. Depending on the alert, tab windows and pop-up menus can be displayed, VAB arrays can change in preparation for an action, and the MDA can change to highlight the alert information. This can be a trap for operators that rapidly acknowledge alerts to clear the alert queue to stop the incessant buzzing. Operators can quickly revert to the function that was being conducted prior to the alert through FAB action.

ROLES AND FUNCTIONAL ARRAYS

24. The tactical functions of ADS rely on individual roles completing their allocated duties to produce a real time picture for display and appreciation. The specific roles are allocated arrays of VABs as the means to input, extract and analyse the data displayed in the tactical plot. Each operator selects the primary tactical role associated with their duties, and any non-tactical roles as required to supplement their tactical requirements. Each role is limited in the instances of use. Some, by virtue of their nature, are limited to single instances to maintain the command and control structure, particularly with respect to weapon engagement authorities and permissions. For a full description of functional arrays, refer to the latest ADACS HMID with additional advice in ABR 6511 Section 7, Chapter 2.

25. Any role can be selected from any of the eight C&Di consoles provided the number of instances have not been exceeded, however the ancillary equipment surrounding each console tends to dictate which roles are best suited to which position. The multi-functional design provides flexibility in the event of one or more console failures.

Role	Maximum Allowed Online
PWO	1
AWO	1
AIC	3
Trk Sup	1
ASAC	3
ES HMI (display)	1
SO	4
ADT	5
Sys Anal	1
Sys Resource Mgr	1

Table 2: ADS Role Restrictions

ADS Servers

26. The ADS server is based on the AN/UYQ-70 Console design with the major difference being it is air-cooled. It provides the interfaces between the ADS and other combat system sub-systems and is the platform on which the Input/Output (I/O) and centralised Track Management processing of components of ADACS executes. Each server requires 115V, 60Hz, 1Φ power.

27. Two identically configured ADS Servers are provided for each combat system. Functionality is typically duplicated on both servers with ADACS dynamically managing the interfaces and determining how the load is shared between the two servers. With the exception of one interface (BVP), full Combat System operation can be maintained when one server is off-line.

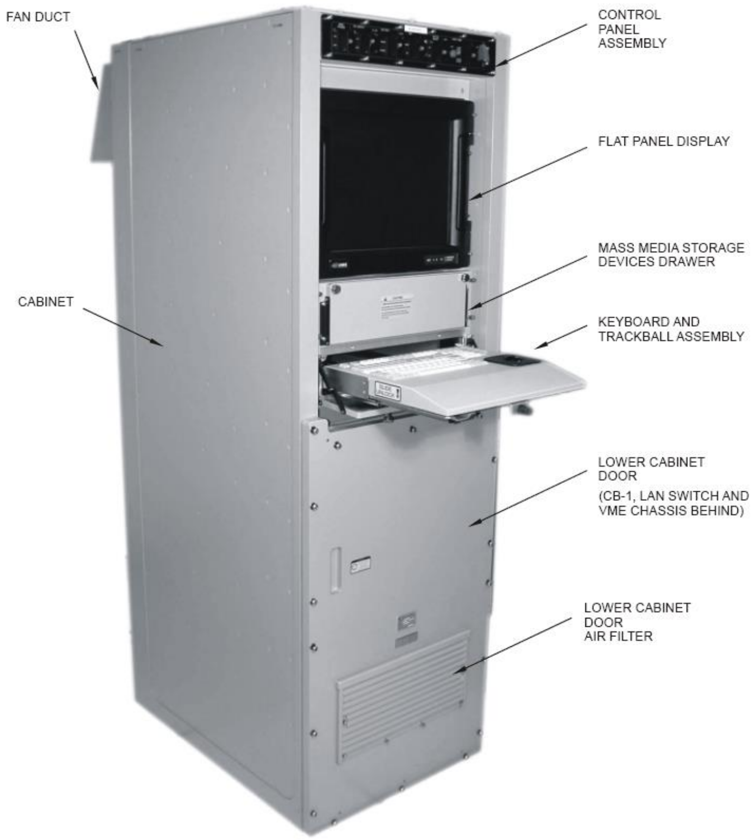

Figure 3-6: ADS Server

28. The UYQ-70 is an equipment cabinet with an open system architecture designed around the VME chassis. The components are mounted in an 1800 mm high vertical cabinet made of aluminium alloy. The cabinet is air cooled and has serviceable air filters in the lower cabinet door and the upper rear of the cabinet. The upper section of the cabinet contains the Control Panel Assembly, Flat Panel Display, a Mass Media Storage Device drawer and a retractable drawer containing a keyboard and trackball assembly. A hinged door in the lower section of the cabinet is used to access the main power Circuit Breaker (CB-1), the VME chassis and the LAN switch. Both servers are located in the Radar, IFF and CIC Equipment Room (RICER, 1-100-0-Q).

29. The server includes two removable hard disk drives for local data storage, a CD-ROM drive and a DAT drive for data loading and removal. The VME chassis houses two Intel Pentium III processor boards running the Solaris 8 Unix operating system. In the lower half of the server are the VME chassis and associated circuit cards, LAN Switch. Naval Tactical Data System (NTDS) and Serial interface cards are installed in the VME chassis to provide interfaces to combat system sub-systems. The LAN switch provides Fibre Distributed Data Interface (FDDI) and Ethernet interfaces to sub-systems as well as to the C&Di Consoles.

30. The ADS Servers provide management of the following combat system interfaces (also refer to the diagram on the following page):

a. Command and Decision (C&Di) Consoles (1 through 8);

b. Common Data Link Management System (CDLMS);

c. Beacon Video Processor (BVP) system;

d. Radar Integrated Automatic Detection Tracking (RIADT) system;

e. Underwater Weapon System (UWS);

f. Electro-Optical Tracking System (EOTS);

g. Electronic Warfare Support (ES) system;

h. Onboard Training System (OBTS);

i. Helicopter Data Link (HDL), via the Combat System Switchboard (CSSB);

j. Signal Data Converter (SDC), via the CSSB;

k. Global Positioning System (GPS);

l. Weapons Control Processor (WCP), via the CSSB;

m. Active Missile Defence (AMD) system, via the CSSB;

n. Harpoon Weapon Control Console (HWCC), via the CSSB;

o. WSN-7B Gyro;

p. Standard Missile Adjunct Processor (SMAP); and

q. RAN Standard Input/output Device (RANSID).

31. As with the C&Di console the ADS Server contains temperature sensing circuits that shut down the main power in cases of high temperature. When the temperature inside the console reaches 57 °C, the OVERTEMP HIGH indicator on the Control Panel Assembly will illuminate blinking and the OVERTEMP alarm will sound, indicating the server is in danger of being shut down due to high temperature. When the temperature inside the server reaches 63 °C, the UNSAFE indicator will also illuminate, over-temperature horn will continue to sound, and the PTC CCA will initiate a Graceful Shutdown of the server, if the BATTLESHORT switch is in the OFF position.

32. The temperature interlock feature can be disabled by moving the BATTLESHORT switch to the ON position, preventing Graceful Shutdown, and allowing the server to operate until catastrophic failure occurs. The BATTLESHORT indicator will illuminate, indicating that the temperature interlock feature is disabled. Moving the BATTLESHORT switch to the OFF position extinguishes the indicator and returns the temperature interlock to its normal enabled state.

33. The ADS Server will enter battery backup in the event of AC power failure when in normal operation. In battery backup the server is provided with a minimum of eight minutes of DC power. Long enough for the operating system to be shut down without loss of data. This shut down is called a Graceful Shutdown and is defined as a self-initiated orderly termination of the ADACS software followed by server power off. Graceful Shutdown is designed to prevent damage to the server components in a non-critical situation. A Graceful Shutdown in Progress message will be displayed on the FPD at that time.

34. In normal operation, a Graceful Shutdown will be automatically initiated by the PTC module when an UNSAFE over-temperature condition arises or when an AC power failure occurs and the backup battery voltage drops below 44 VDC.

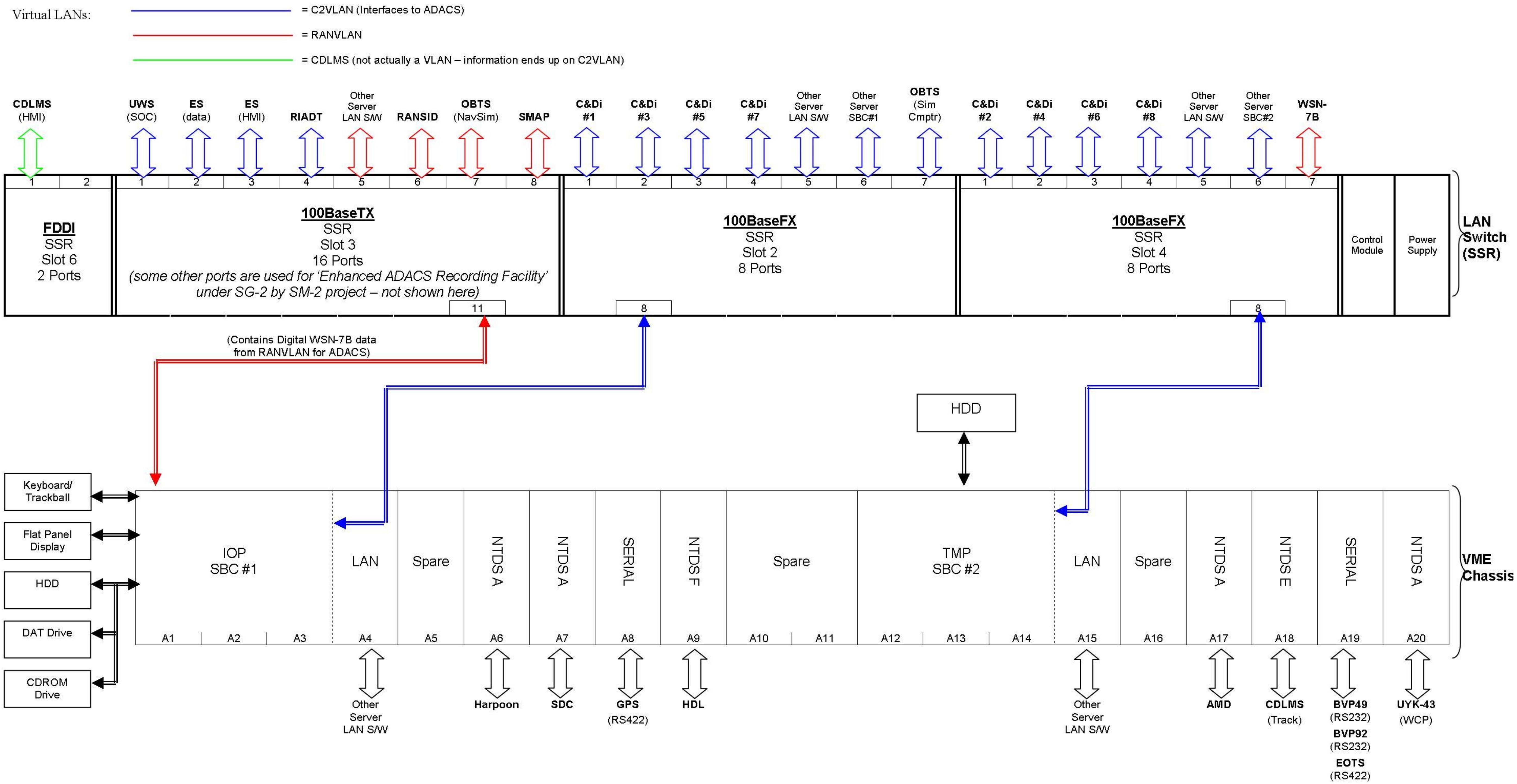

Figure 3-7: ADS Server External Interfaces

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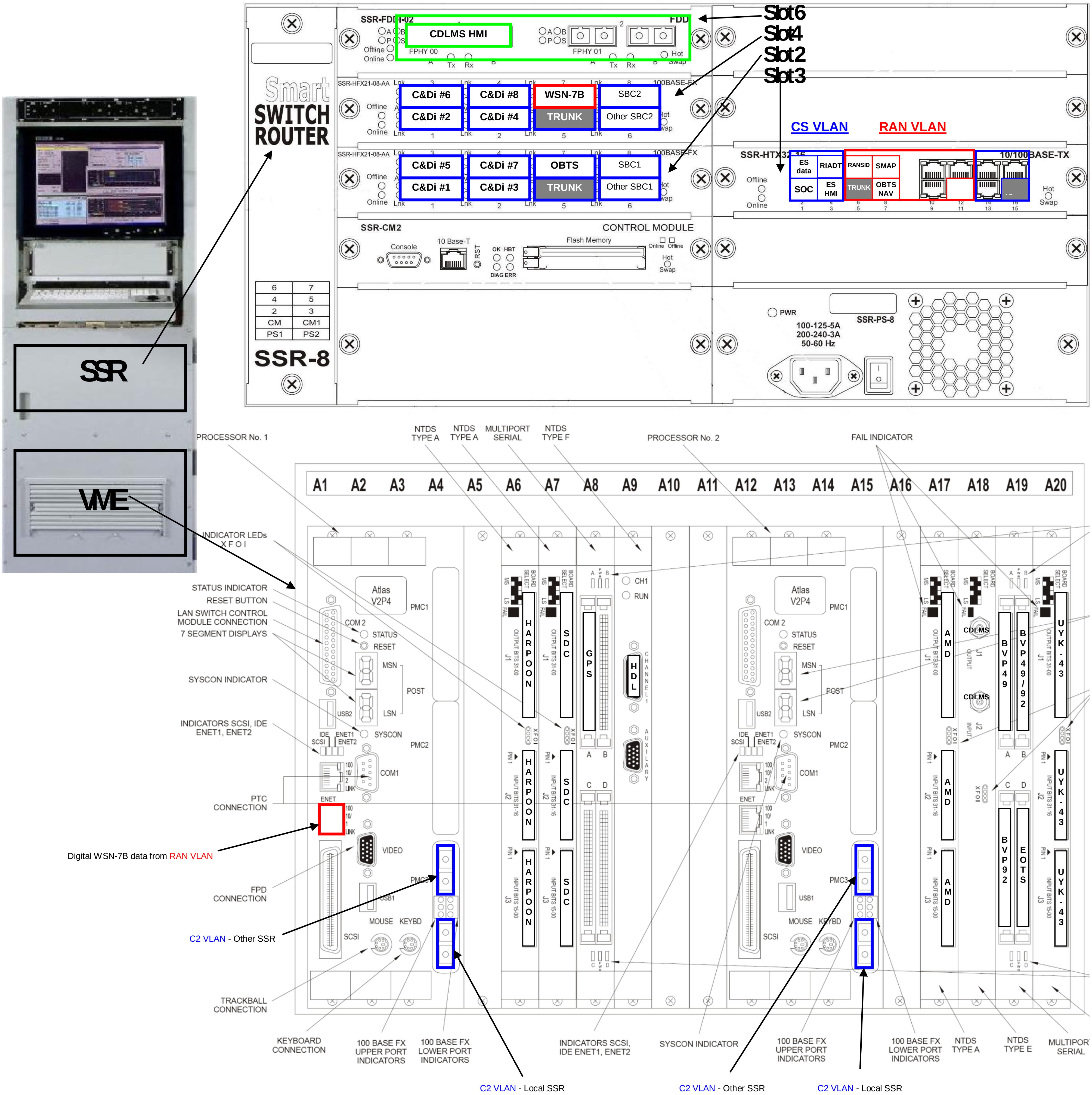

Figure 3-8: ADS Server External Interfaces (Physical Layout)

SSR Virtual LANs:

C2 VLAN				
Slot	**Port**	**Type**	**Equipment**	**IP Address**
2	1-4	100BaseFX	C&Di Consoles 1, 3, 5 & 7	
2	5	100BaseFX	SSR Trunk (to other ADS Server SSR Slot 2)	129.218.100.201
2	6	100BaseFX	Other ADACS AP-1 (Top Port) – links to other ADS Server VME SBC#1	
2	7	100BaseFX	OBTS Sim Computer	129.218.100.200
2	8	100BaseFX	Local ADACS AP-1 (Bottom Port) - links to local VME SBC#1	
3	1	100BaseTX	UWS (SOC)	129.218.100.10x (101 = Switch #1, 102 = Switch #2)
3	2	100BaseTX	ES (data)	129.218.100.61
3	3	100BaseTX	ES (HMI)	129.218.100.62
3	4	100BaseTX	RIADT	129.218.100.20x (207 = Switch #1, 208 = Switch #2)
4	1	100BaseFX	C&Di Consoles 2, 4, 6 & 8	
4	5	100BaseFX	SSR Trunk (to other ADS Server SSR Slot 4)	129.218.100.202
4	6	100BaseFX	Other ADACS AP-2 (Top Port) – links to other ADS Server VME SBC#2	
4	8	100BaseFX	Local ADACS AP-2 (Bottom Port) - links to .local VME SBC#2	

RAN VLAN				
Slot	**Port**	**Type**	**Equipment**	**IP Address**
3	5	100BaseTX	SSR Trunk (to other ADS Server SSR Slot 3)	129.218.99.10x (101 = Switch #1, 102 = Switch #2)
3	6	100BaseTX	RANSID	129.218.99.5x (51 = Port #1, 52 = Port #2)
3	7	100BaseTX	OBTS Nav Sim (controls WSN-7B Sim Mode)	129.218.99.72 (Dual Fail-Over)
3	8	100BaseTX	SMAP	129.218.99.55 (Dual Fail-Over)
3	11	100BaseTX	ADACS AP-1 (links RAN VLAN to VME SBC#1)	129.218.99.6x (61 = Server #1, 62 = Server #2)
4	7	100BaseFX	WSN-7B	129.218.99.71 (Dual Fail-Over)

Table 3: SSR Virtual LAN

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Australian Distributed Architecture Combat System (ADACS) Software

References:

- ADACS Human Machine Interface Description 7.5, 26 May 2011
- ADACS Software Design Description Issue 7.3, 12 Dec 07

Overview of the ADACS Program

35. The ADACS Computer Software Configuration Item (CSCI) is comprised of 10 Computer Software Components (CSCs). Each CSC is comprised of Computer Software Units (CSUs) or CSU groups.

CSC Name	Abbreviation
Picture Manager	PM
Tactical Applications	TA
Record and Replay	RR
Resource Management	RM
Software Load and Initialise	LI
Track Management	TM
Interface Management	IM
Alert Management	AM
Event Log	EL
Common Operating Environment	COE

Table 4: ADACS Computer Software Components

36. **Picture Manager** – is responsible for displaying and managing the Tactical Display Area of the ADACS Human Machine Interface (HMI). The Picture Manager provides a display of tactical track symbology, radar video, and map data on the ADACS console. The Picture Manager also manages the operator-input devices including the touch panel, track ball and keyboard and allows the operator to manipulate the main display through the Display Control Panel and Tactical Control Panels.

37. **Tactical Applications** - This CSC enables control of the tactical functions within the combat system. The primary purpose of the Tactical Applications CSC is to enable the replacement of the NCDS Tactical Control Panel HMI with the new ADACS Console HMI. Tactical Applications enables the operator to perform the tactical operations from an ADACS console by processing the tactical requests in a server process, and returning the results to the ADACS console, or by passing the tactical function requests to an appropriate CSC, such as Track Management, or to other subsystems.

38. **Record and Replay** - The Record and Replay CSC extracts data from ADACS and records the data on electronic media. This CSC provides recording functions such as start, pause, resume, and stop. Record and Replay will provide functions to replay the extracted data at real-time, slow and fast speeds.

39. **Resource Management** - This CSC constantly monitors and manages ADACS system resources. This includes status monitoring of local resources as well as system resources, which includes sub-system interface status. The Resource Management CSC reports the status of the system to the operator. This CSC also manages the failover function from the Primary ADACS Server to the Secondary.

40. **Software Load and Initialise** - The Software Load and Initialise CSC provides the functions to install the software onto the local disks of each of the ADACS processors. This CSC also enables the correct configuration of the ADACS software to be initialised on the ADACS Consoles and Servers upon power up of the ADACS hardware. This CSC also allows the operator to shutdown ADACS software on Consoles and Servers.

41. **Track Management** - This CSC provides the capability to manage the ADACS main track data store for airborne, surface and subsurface tracks and special points. The Track Management CSC provides correlation for various sensors as well as dissimilar sensor data fusion and track data distribution. This CSC distributes track data to the ADACS consoles as well as other subsystems requiring track data.

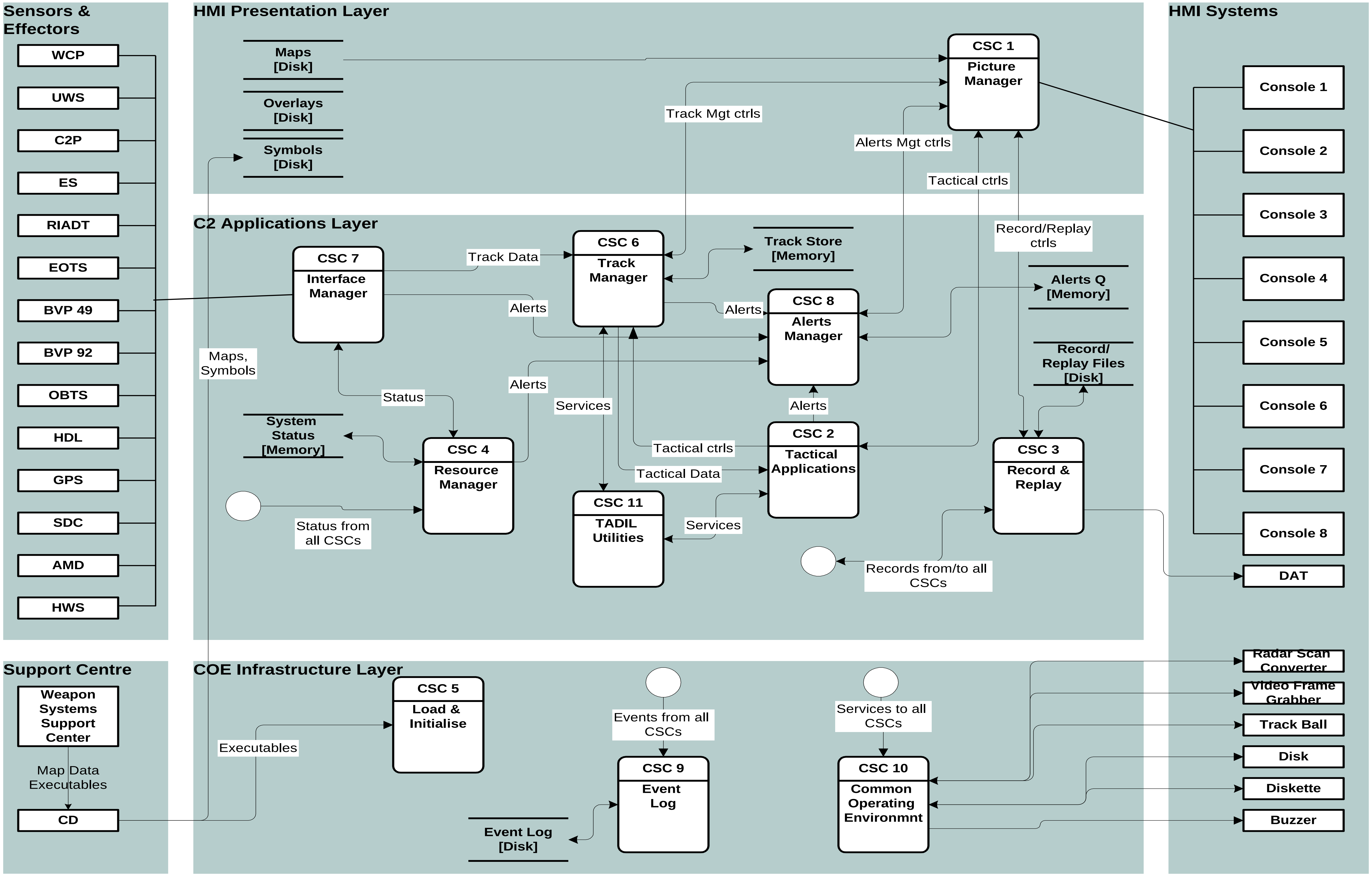

Figure 3-9: ADACS CSC Interconnection

42. **Interface Management -** The Interface Management CSC provides the interface between the various Sub-Systems and ADACS CSCs. Interface Management is responsible for handling the lower level communications protocols (e.g. NTDS and RS-422) of the various Sub-Systems so that this level of implementation is hidden from the other ADACS CSCs. Interface Management pipes the various messages between the Sub-System and the appropriate CSC for processing. This CSC also manages the distribution of own ship data such as heading, speed, pitch and roll as well as navigation data such as own ship position and time in UTC.

43. **Alert Management** - Alert Management allows for the receipt and processing of Alerts within ADACS. Alerts are held within a queue and displayed to the operator. The Alert Management CSC will allow alerts to be acknowledged by the operator and for associated processing of the alert to be performed. For a detailed description of the Alerts HMI refer to the ADACS HMID document.

44. **Event Log** - This CSC provides a mechanism for logging software events such as errors and debug statements. The logs stored on the server disc will be used for software debug and maintenance purposes, in particular during the development, integration and testing of ADACS.

45. **Common Operating Environment** - This CSC provides the functions to support the operation of the CSCs within the operating environment. This includes the operating system, functions for inter-process communications and memory management. It also provides general-purpose utilities that can be used by other CSCs. It also provides a single, common service set for time reference.

Operating Modes

46. The start-up of ADACS involves the transitioning of ADACS through the key Modes from POWER-OFF, through INITIALISATION, CONFIGURATION and TACTICAL Modes.

47. ADACS comprises 3 types of computers. Consoles, Track Management Servers and I/O Processors. Each starts-up independently of each other. The executable code for the operating system (CSC 10) software and all applications specific software are stored on the disk local to each processor. Therefore each processor may start-up independently of all other computers.

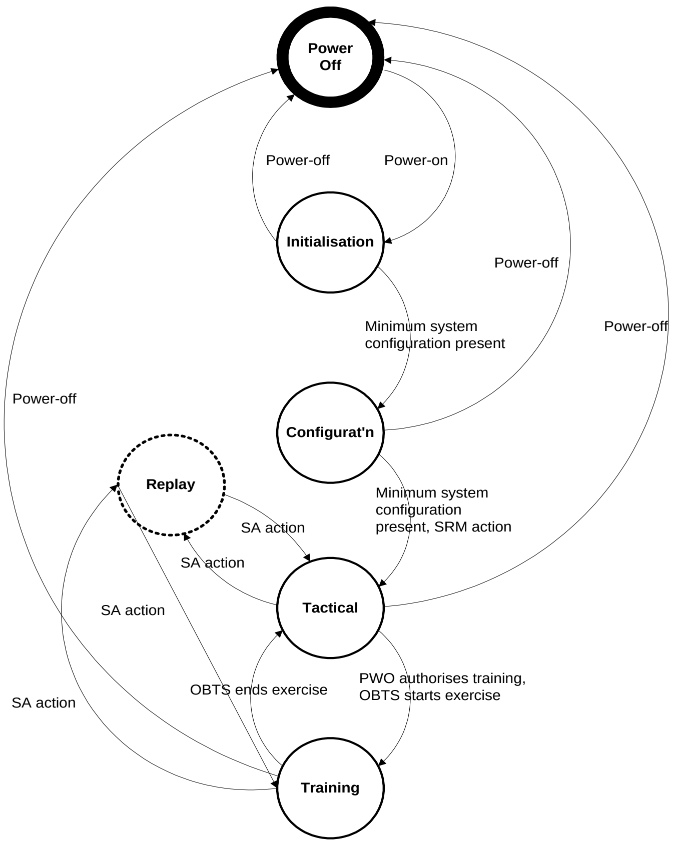

Figure 3-10: ADS States & Modes

Tactical Picture Compilation

48. The purpose of the picture compilation function is to present information to the command in real time within the C&Di system. Track data and the display of information are optimised for ready assimilation by the operator. The C&Di consoles display sensor and track data as selected by the operator.

49. The ADS provides the following Tactical Picture Compilation capabilities (which can be related back to steps one through five of the Fourteen Step Engagement Sequence:

a. Sensor control

b. Track Management

c. TADIL operation

d. Dissimilar sensor fusion

e. Identify & Classify Tracks

f. Display the real time tactical picture to the operators in an ‘intuitive’ presentation.

50. Track management may be performed by any, or all, of the following methods:

a. the C&Di picture compilation system;

b. the Sensor Data Fusion System (RIADT); and

c. dissimilar sensor fusion.

51. Track management provides the capability to manage the common track store for airborne, surface, sub-surface, space, and ground tracks and special points. The function provides correlation of reports from various sensors, sensor fusion and track distribution.

52. Primarily, target tracks will automatically be entered into ADS from one of the contributing sensors, and fused with other sensor information to provide a single, correlated track. C&Di console operators retain the ability to manually detect, enter and correlate ownship sensor targets with those received from external sources such as radio circuits and data links.

Tracking

53. Vehicular tracks, i.e. tracks with a course and speed component, can be considered realtime, nonrealtime, or non-TDS.

a. A realtime track is a track that has been, and is currently being, reported by a sensor. It has a track quality which degrades over a time based algorithm depending on update rates, and it can be either local or remote (Data Link);

b. A non-realtime track is one that was originally reported by a sensor but has become stale over time;

c. A non-TDS track is a track that is reported by another platform (a third party) over a communications circuit, such as a radio or a signal. While the track is held by the third party's sensors it is not held on ownship sensors or reported as a realtime track over a data link.

54. An **auto track** is a realtime local vehicular track which is being reported by at least one of the sensors. Auto tracks are updated (tracked) automatically by the sensor reports.

55. **Auto eligible tracks** are tracked by operators, but are eligible to become auto tracks should one of the sensors commence reporting it.

56. **Manual tracks** are local vehicular tracks which are tracked by operators, and ignored by the sensors. Even if a sensor were to detect the contact, it would continue to ignore it provided the manual tracking was sufficiently accurate to keep it within the sensor correlation parameters. If the contact and the track were outside the parameters, the sensor would report a new auto track. To make a track manual, the operator must use the Track Auto/Manual VAB.

57. **ES Tracks -** the ES system reports its 32 highest priority emitters to ADS for display via an EW Bearing Line. These bearings are not corrected for pitch and roll, thus a correction (quadrant error correction) must be performed by ADS. The ES system time stamps reports to provide an accurate time of detection, allowing ADS to calculate the correction.

58. **UWS Tracks -** The UWS can generate vehicular and bearing only tracks for reporting to ADS. Active HMS and MOAS tracks have range and bearing data appended, whereas passive tracks from HMS or the Towed Array (TA) are bearing only and therefore displayed as acoustic bearing lines.

59. **SDFS Tracks** - SDFS (RIADT) fuses the plots determined from individual search radars to pass a single track to ADS.

Automatic Tracking

60. The Sensor Data Fusion System (SDFS) used by the FFG to monitor surveillance radars to automatically detect and track targets is the Radar Integrated Automatic Detection and Tracking (RIADT) system. Detections from the three search radars are correlated within RIADT system and then fused with other sensor data within the ADACS program.

Manual Tracking

61. The Track Supervisor (Trk Sup) operator is responsible for the conflict resolution of all system tracks. Trk Sup responsibilities also include initiation, maintenance, and termination of Link-11/16 data link and establishment of gridlock for Link-11 and navigational accuracy for Link-16, to maintain track alignment between ownship and other data link participants.

62. There are two detector/tracker functions as follows:

a. a. Air Detector/Tracker (ADT). The ADT is responsible for detecting and entering all air tracks within ownship detection range and for updating the track position; and

b. b. Surface Operator (SO). The SO is responsible for detecting and entering short-range air and all surface tracks from ownship surface search radar video and for updating system tracks to radar video returns.

63. The position correction (POSCOR) function is used to enable the operators to update the speed, course, and position of a firm or tentative track by clicking on radar video on successive sweeps of the Radar. POSCOR allows the computer system to calculate a track course and rate, and automatically update the track position. Targets that were entered as tentative tracks become firm tracks after two POSCORs; the calculated speed used to determine whether the vehicular track is air or surface.

64. ADS aids the operator in manual tracking by periodically moving track symbols to a predicted position based on previous position, course, and speed.

Sensor Correlation

65. Sensor Correlation is the function of taking information from multiple sensors which may have detected the same target, and fusing this data to display a fused system track.

66. Fusion of multiple sensors provides:

a. improved track accuracy over that of any single sensor;

b. better track continuity especially in regions experiencing multi-path fades;

c. auto ID/classification by cueing of IFF; and

d. control of ship's sensors in response to operator requests.

67. There are two primary systems which perform Sensor Correlation:

a. The RIADT system performs Sensor Data Fusion of the three search radars.

b. ADACS performs “Dissimilar Sensor Fusion” of multiple ownship sensors (including the track data from RIADT) and from external sensor data provided by Data Links.

ADACS Dissimilar Sensor Fusion

68. The ADACS Dissimilar Sensor Fusion process merges track data from all contributing sources. The process assumes a fixed accuracy/quality ranking for each sensor in each fusible dimension. Fusion for all system tracks is attempted once per second.

69. The sensors which contribute to ADACS dissimilar sensor fusion function include:

a. search radars via RIADT:

i. AN/SPS-49 A(V)1,

ii. AN/SPS-55,

iii. Mk 92 CAS Search, and

iv. Sparse Target Tracker (STT) – a combination of radars;

b. fire control radars via WCP;

c. ES system;

d. IFF via Beacon Video Processors (BVP):

i. BVP-92, and

ii. BVP-49;

e. sonar via UWS:

i. ASW active (HMS),

ii. UWS passive (TA or HMS),

iii. UWS fused (held by more than one sensor), and

iv. MOAS;

f. EOTS; and

g. Data Links via CDLMS:

i. LINK-16

ii. LINK-11

Identification & Classification

70. There are five basic categories of identification available: air, surface, sub-surface, ground, and space. ADS operators do not have the controls to identify a track as a space track; space tracks are received via data link (Link-16). Each of the categories can then be appended with further identifying information, such as identity, activity, and type.

71. Of primary concern to efficient identification and classification, particularly in a rapidly developing situation, is the systematic use of established and recognised terminology. The introduction of Link-16 has enabled increased levels of identity to be afforded to tracks. Track identification and classification terminology is as follows:

a. **category** - defines the operational environment of the track as air, surface, sub-surface, ground or space;

b. **identity** - defines the real or potential threat of the track as pending, unknown, assumed friend, friend, neutral, suspect, hostile, joker or faker; (note that identifying a track as hostile is not necessarily a “threat evaluation” – threat evaluation is normally done after (or at the same time as) identifying a hostile target, the threat evaluation determines whether the hostile track is a threat to our mission, and therefore whether it should be engaged. There may be hostile tracks that are not a threat to our mission.

c. **platform** - defines the platform type of the track dependant on the category selected. For example, an air track could be identified as a fighter, helo or MPA aircraft platform; ground tracks could be identified as installations, command centres etc;

d. **platform activity** - appends an activity type to the track, such as training, reconnaissance, search and rescue; and

e. **specific type** - defines the specific version of the track, dependant on the category. By example, air tracks could be type defined as F-18, F-14, or P3.

72. The vehicular track symbol to be displayed at C&Di consoles depends on the identification and classification selections appended to it. The category and identity define the basic shape and colour of the symbol, whilst the platform further defines the symbol with letters and/or additional markings (IAW MIL-STD-2525). All identification levels can be viewed for a particular track via the track tab window displayed in the data display area of the console.

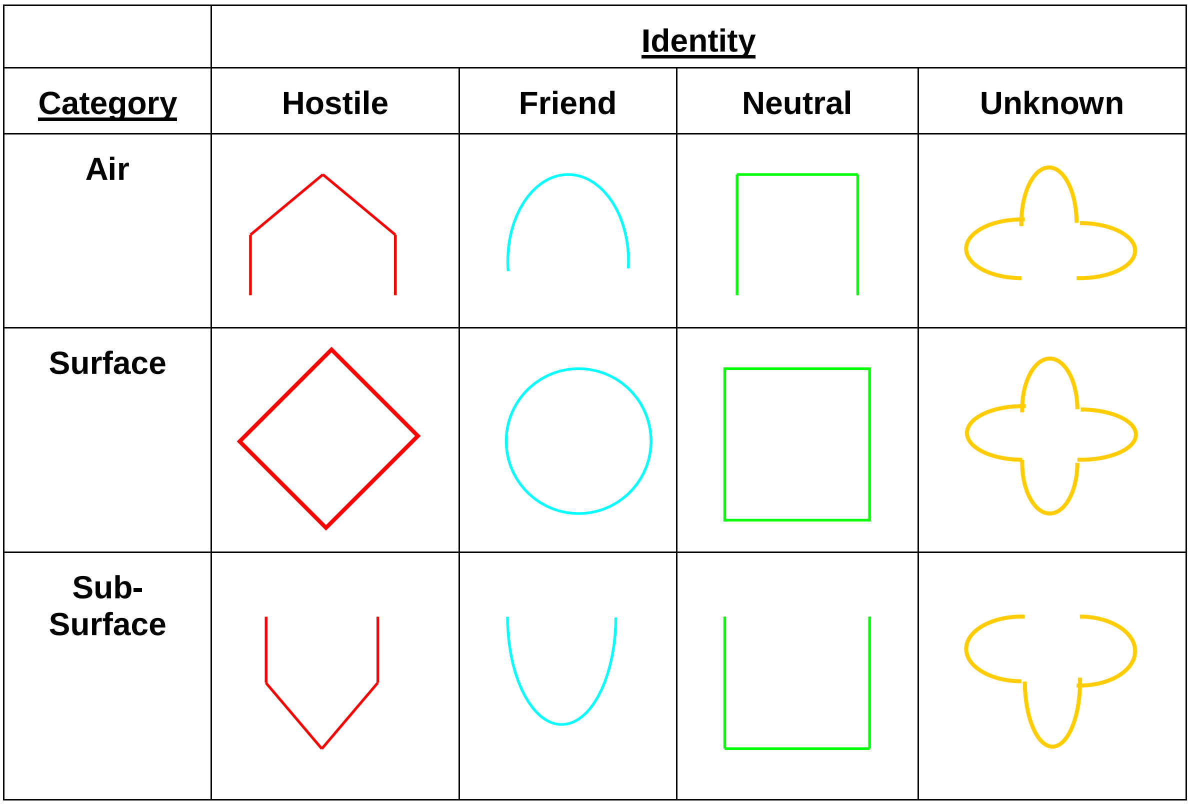

Figure 3-11: MIL-STD-2525 Basic Symbology

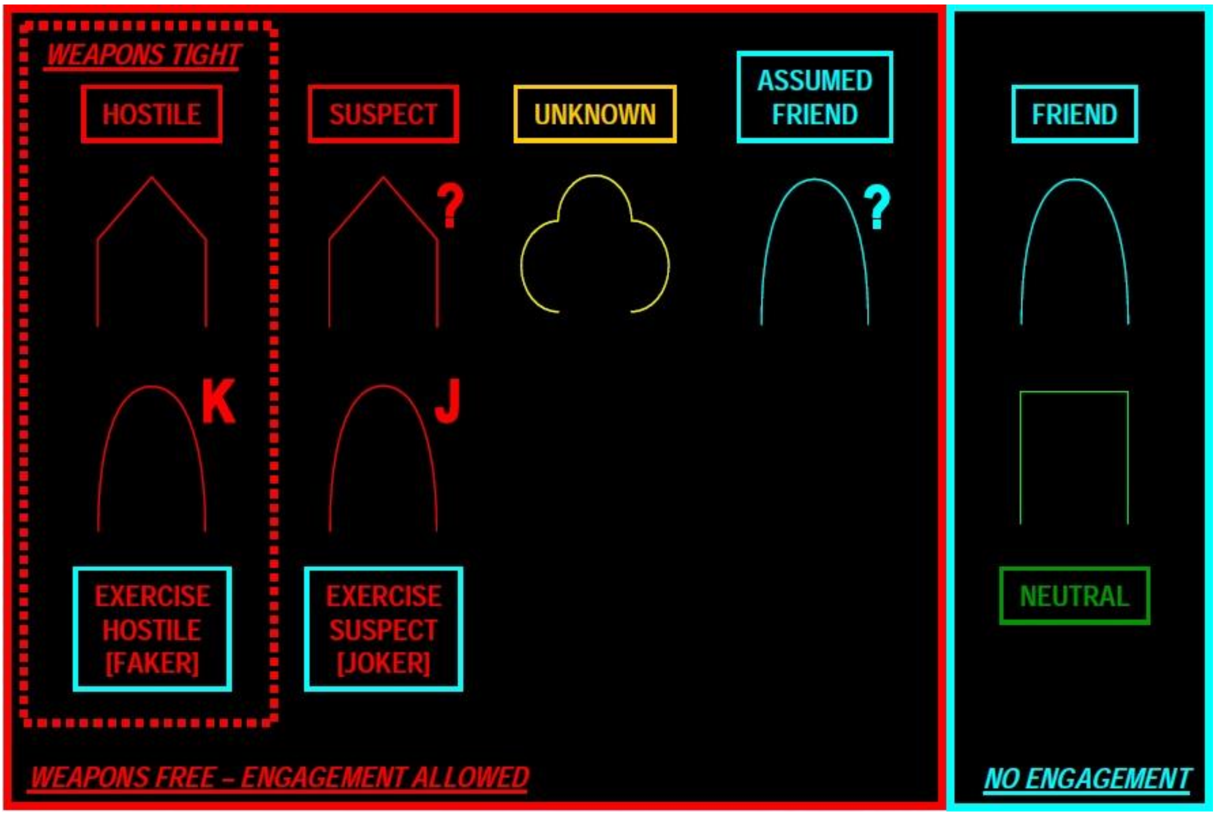

Figure 3-12: Engageability of Track Types

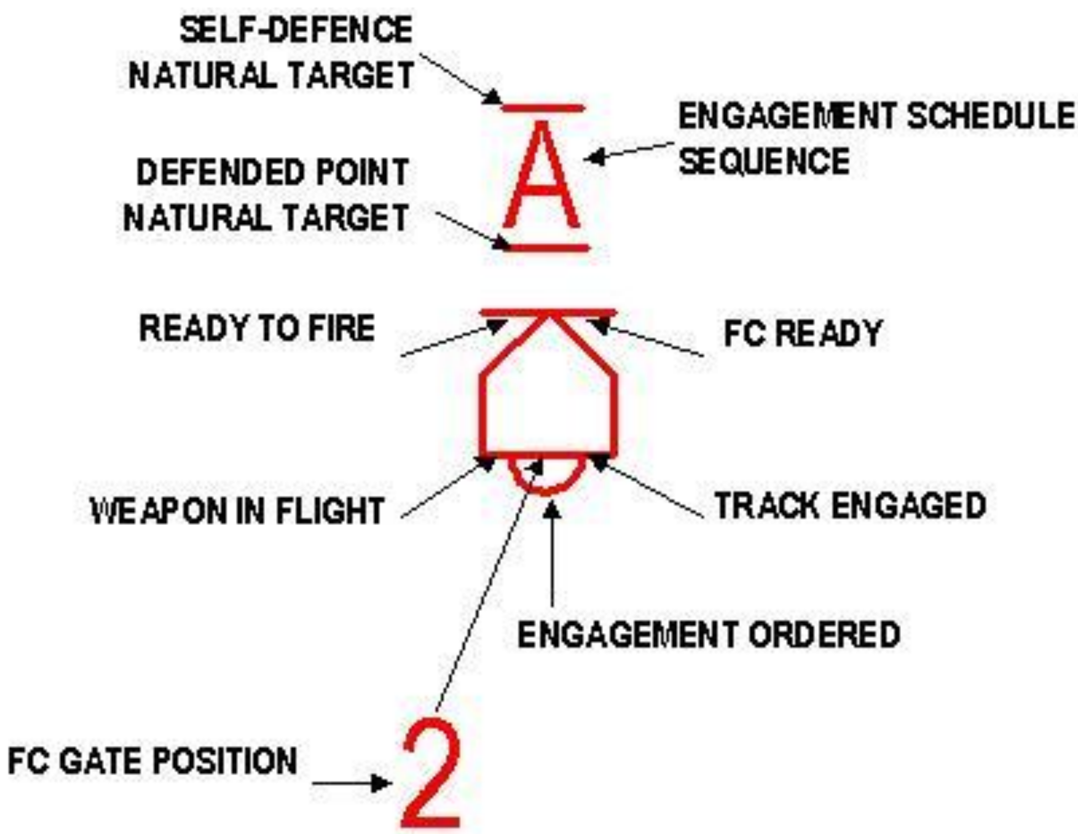

Figure 3-13: ADACS Target Symbology

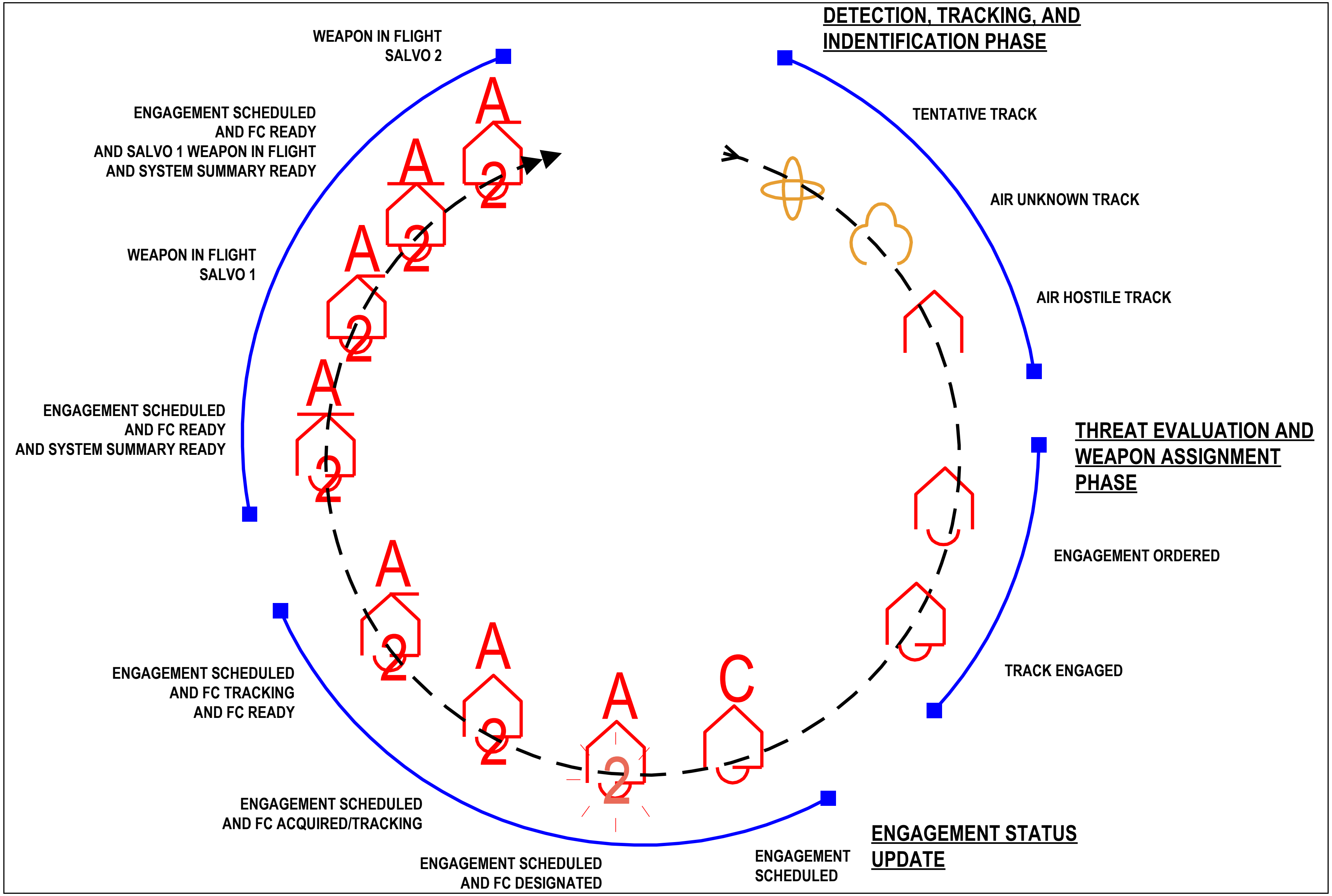

Figure 3-14: Progression of ADACS Engagement Symbology

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Threat Evaluation & Weapon Assignment (TEWA)

Threat Evaluation

73. The decision to engage tracks identified as hostile can be performed manually by the PWO and AWO, or automatically by the C2 system. The AWO and PWO are assisted in their evaluation of the tactical situation and optimal selection of defensive weapons by the computational display facilities of the C2 subsystem.

Threat Determination

74. Determining the degree of threat the track presents to a selected point, either own-ship or a defended point depending on the mission, is a process of evaluation based on the following:

a. threat position;

b. threat future position;

c. projected closest-point-of-approach (CPA);

d. identification;

e. category;

f. range of weapon delivery; and

g. time remaining to effectively engage.

75. There are several ‘automated’ tools provided by the Combat System to assist in threat determination. These include:

a. ADACS Quick Reaction (QR) Processing;

i. QR Semi-Auto;

ii. QR Auto;

b. Late Detect Processing

c. ES report of a threat missile emitter;

d. SPS-49A Special Alert Tracks; and

e. RIADT Sparse Target Tracker (STT) alert (via QR).

76. There are also several manual methods of threat Determination:

a. QR Manual mode;

b. WCC report of a missile detection via ‘ASM/SSM Alert’ pushbutton,

c. AWO use of QR Target VAB, or

d. AWO use of QRN VAB.

Quick Reaction (QR)

Reference: ABR 6511 Section 3, Chapter 2.

77. ADACS can perform automatic threat evaluation through QR processing. When the QR mode is either QR Auto or QR Semi-Auto, all non-friend (i.e. hostile, suspect, unknown, or pending) tracks are subject to QR processing. Track range, CPA, and speed are compared to AWO-modifiable predetermined criteria. Tracks meeting QR criteria are declared QR tracks and the AWO and PWO are notified by an alert.

78. The criteria for determining whether a track is a threat is covered in ABR 6511 Section 5, Chapter 2, Paragraph 2-3.

79. Friendly tracks are periodically checked against QR criteria. If ADS determines that a track identified as friendly meets QR criteria, AWO and PWO will receive a ‘friendly track meets QR’ alert.

80. In **QR Manual mode** AWO retains control for assignment of targets to missiles (SM-2, ESSM, or Harpoon) or gun. PWO retains control of the assignment of surface targets to missiles (Harpoon) or gun, and of subsurface targets to either own-ship torpedo tubes or assigned aircraft. For further detail, see ABR 6511 Section 5, Chapter 2, Paragraph 2-7.

81. The **QR Semi-Auto Mode** provides rapid response to threatening tracks while maintaining positive AWO control of engagements. Tracks assigned QR status causes the following events:

a. generation of a QR target alert at the AWO and PWO roles;

b. change of track identification to hostile;

c. transmission of an automatic engageability request message to the WCP; and

d. presentation of recommended engagement alert to the AWO.

82. The **QR Auto mode** provides the fastest response to threatening tracks and automatically authorises engagement (Command Assignment). Tracks meeting QR criteria cause the following events:

a. generation of a QR target alert at the AWO and PWO roles;

b. change of track identification;

c. transmission of an automatic engageability request message to the WCP; and

d. transmission of an automatic Engage Order.

83. QR Processing is dependant on the selected Scheduling Mode. The Scheduling Mode is selected by the AWO via VAB, and instructs the Weapons Control Program (WCP) running on the AN/UYK-43 (which is part of the fire control systems) how to priorities engagements that have been ordered. There are three Scheduling modes (which are described in more detail in Section 4 of this learner's guide, which is entitled: Fire Control Systems). These modes are:

a. Defended Point;

b. Self Defence; and

c. Area Defence.

84. When Defended Point schedule is selected, ADACS calculates QR against the Defended Point rather than ownship. This ensures QR and the schedule remain linked to the same threat determination source.

Late Detect Processing

85. ADACS attempts to determine the earliest detection and assessment of threats possible. To aid in rapid response to threats, fast moving, closing contacts detected at short range can be automatically identified as a threat. This is known as Late Detect. A target meeting Late Detect speed, range and course criteria will be automatically identified as hostile air, with an alert sent to AWO and TRKSUP to highlight the detection.

86. Unlike QR processing, the Late Detect criteria is always centred on own-ship, regardless of the scheduling mode selected.

87. Late Detect provides a self defence capability when the schedule mode is Defended Point, and so QR processing is occurring elsewhere.

AN/SPS-49A SPECIAL ALERT TRACKS

88. SPECIAL ALERT is a track promotion scheme bypassing the RIADT plot-to-track processes.

89. SPECIAL ALERT creates a track based on an SPS-49A single plot when the measured Doppler rate provides Time-to-Go less than a defined sector. The SPECIAL ALERT track will be radially inbound at the radial Doppler rate, which may be different to the actual track trajectory.

RIADT SPARSE TARGET TRACKER (STT)

90. Creates RIADT track based on multiple plots from disparate radars. STT only operates in annulus around ownship (30 km to 15 km). Its primary purpose is rapid track formation for ASMD. Tracks detected by the STT may not have been identified as a track on individual radars, and this detection allows threat determination to occur by either QR or late detect.

EW-FC DESIGNATION BEARING LINES

91. A usual response to an ES identification of an inbound ASM is to deploy soft-kill countermeasures, however an EW-FC bearing line provides a FCS ‘hard-kill’ capability against missile targets with bearing only sensor data. This type of threat determination operates on an EW PIDCH code generated by ES for a bearing line. ADACS translates PIDCH to EW-FC index for FCS designation with an appropriately selected scan pattern.

Weapon Assignment

92. If a track is determined to be a threat, the next decision in the TEWA process is to determine the most appropriate available effector to neutralise the threat. This assessment can be performed manually by the PWO / AWO using the data they have about the threatening track, and their knowledge of the effectors at their disposal.

93. If a QR target is identified as a threat, weapon-to-threat pairing and assignment occurs as a function of both ADACS and WCP and is described in ABR 6511:

a. Section 3, Chapter 2, paragraph 2-5;

b. Section 5, Chapter 2, paragraph 2-11 thru 2-13;

c. Section 5, Chapter 2, paragraph 2-19 thru 2-25 (note that references to SM-1 are out of date and SM-2 characteristics should be considered instead).

Command Assignment

94. Command Assignment is simply the decision to engage a target that has been identified as a threat in the TEWA evaluation process. Although the concept is simple, the CO retains vicarious liability[1] for this decision, even if he delegates it to his PWO, AWO or even to ADACS via activating QR-Auto mode. In making the decision, the CO must consider broader issues such as:

a. Rules Of Engagement (ROE);

b. National Intent;

c. Second/third order effects;

d. Tactics; and

e. Safety for non war-time engagements.

95. The decision to go ahead with the engagement is an ‘Order For Engagement’ (OFE). The word ‘order’ in this context means a direction or command, and not a prioritised list (that happens later).

[1] the responsibility of the superior for the acts of their subordinate or any third party that has the "right, ability or duty to control" the activities.

Manual OFE

96. An OFE may be passed manually to the Fire Control System by the PWO or AWO by pressing an OFE VAB. These include Engage Missile Orders (EMO) and Engage Gun Order (EGO). An EMO may define the type of missile of missile to use (Engage Missile SM or Engage Missile ESSM) or not (Engage Missile), in which case the decision of which missile to use must be made by the Fire Control System (this will be discussed later).

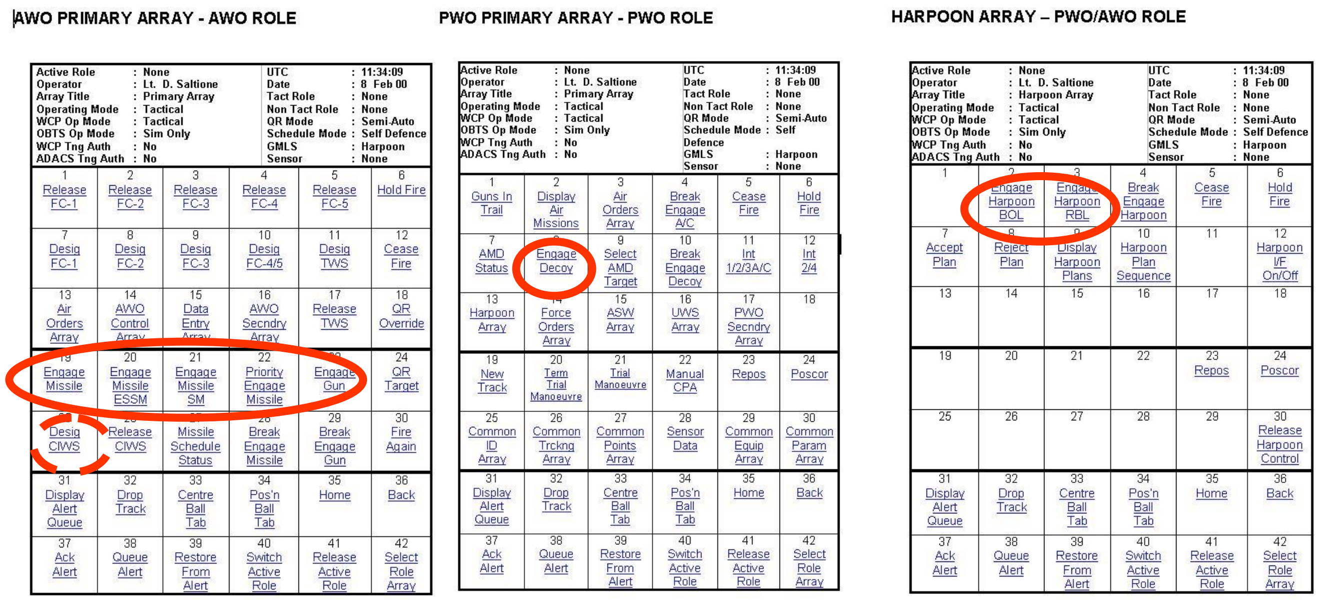

Figure 3-15: Examples of OFE VABs

97. Other manual methods for providing an OFE include:

a. Harpoon Plan Approval;

b. CIWS engagement order (via voice command);

c. Torpedo engagement order (via voice command); and

d. Helo engagement order (via voice or HDL).

Automatic OFE

98. An OFE can also be generated and passed to the Fire Control System automatically via QR-Auto Mode. In this case the CO has delegated the decision to engage a target that has been assessed as a threat, to ADACS. In QR-Auto mode, ADACS will provide an OFE on any engageable target that meets all QR criteria.

99. Auto Self Defence Mode (ASD) is the next logical step in automation after QR-Auto mode, however ASD mode is not a Command Assignment, rather it is a VLS scheduling function and is discussed in section five of this learners guide in the VLS chapter.

Record & Replay Functions

100. The ADACS Record and Replay CSC is responsible for extracting data and recording the data onto digital media. This data can then be used for the purposes of subsequent replay on the ADACS consoles or for analysis. The Record and Replay CSC is comprised of the following major CSUs:

a. Record and Replay HMI;
b. Record and Replay Server;
c. Record and Replay Data Store;
d. Data Extraction Points;
e. Data Extraction Client;
f. Data Replaying Client;
g. Record and Replay System Management;
h. Archive and Restore Server.

101. This CSC provides Record and Replay HMI controls to the operator such as:

a. Recording Extraction Setup;
b. Start/Stop Recording;
c. Pause/Resume Recording;
d. View Recordings list;
e. Initialise Replay Setup;
f. Start/Stop Replaying;
g. Pause/Resume Replaying;
h. Replay in synch with an OBTS scenario - this capability means that operators can 'play' an OBTS scenario, and then play back both their actions (ADACS recording) as well as see what they were reacting to (OBTS scenario);
i. Archive recorded data to external media;
j. Restore recorded data from external media.

102. The Data Extraction Points CSU provides the points in ADACS from where data can be extracted. The Data Extraction Points on the ADACS console are also used for replaying the previously extracted data. The Data Extraction Points CSU interfaces with the Data Extraction Client CSU and Data Replaying Client CSU to send extracted data to the Record and Replay Server CSU for storage, and retrieval of these events when replaying. The following events are capable of being recorded via an extraction point:

a. Trackball button actions;
b. Tactical Control Panel VAB/FAB actions;
c. Display Control Panel VAB/FAB actions;
d. Initial data displayed in windows of the Tactical Display;
e. Subsequent data entered into windows of the Tactical Display;
f. Track Update data;
g. Own-ship Update data;
h. Alert Updates;
i. Status Update data;
j. Data from external subsystems as a result of Subsystem Tactical Control Requests (E.g. RIADT, OBTS, ES, UWS etc.);

103. Note that Radar Video cannot be recorded as it doesn't go on the ADS LAN.

104. Data is recorded for all consoles so that the display events that occurred on every console can be reproduced. Recorded data is time stamped to enable replay to be specified at various time intervals. Recorded console data associated with a specific console also has the console ID recorded with it.

Chapter 4. Tactical Data Links

References:

- Mil-STD 6011 – Link 11 Message Standard
- Mil-STD 6016 – Link 16 Message Standard
- Understanding Link 11 Handbook
- Understanding Link 16 Handbook
- Joint Multi-TADIL Operating Procedures
- DI(G) OPS 10-3 Tactical Digital Information Link standards, implementation, interoperability, compatibility, configuration management, operational assurance, testing and training
- ADF Multi TDL Guide and SOPs.
- Intro to ADF TADILs student guide
- ABR 6511 Combat system Operators Manual Section 1 Chapter 3

Overview

1. DI(G) OPS 10-3 defines a TDL as:

"A Tactical Data Link (TDL) is defined as a communications system which supports the exchange of Near-Real-time tactical data between participants using a variety of free or fixed format messages, which are characterised by unique transmission characteristics, protocols and standardised message structure"

2. For the ADF the real-time communications architecture used to support this activity should have high capacity, security, interference resistance and survivability. This should be coupled with low data latency. There should be seamless connectivity from sensors to weapon systems, overlaid with C2 directives. Consequently TDLs have been designed for use in the exchange of real-time or near real-time tactical information between computerised Tactical Data Systems (TDS). A TDS is a mission system in an aircraft and command system in ships or in land HQs.

3. TDLs provide for the continuous exchange of information concerning space, air, land, surface and subsurface tracks, together with details about friendly units, the status of weapon engagements and other tactical data (including intelligence, Electronic Warfare (EW) information and network management).

4. Some TDLs also provide commanders with the capability to transmit certain commands to subordinate units and to send coordination requests to cooperating forces. As a result, TDLs allow cooperating forces at all echelons of military action a means to provide mutual support to coordinate action and to stop fratricide (blue on blue).

5. The RAN FFG TDL group provides secure tactical digital information links (TADILs) and the RAN unique helo data link (HDL) that can transfer, in real time, tactical data between ownship and other Australian Defence Force (ADF) and allied assets. TDL includes capabilities for TADIL A (Link-11) and TADIL J (Link-16) via the Common Data Link Management System (CDLMS), and the HDL through a separate data link modem (DLM). All three data links are controlled from ADS C&Di consoles; Link-11 and Link-16 are controlled by Track Supervisor via a remote 'x-window' session, and HDL is controlled by the ASAC using VABs.

Link 11

6. Mil STD 6011C - Section 4 defines Link 11 as:

"Link 11 is a high speed, HF/UHF, NATO, tactical data information link, employing netted communication techniques and standard message formats, for the exchange of digital information among airborne, land based and seaborne platforms. Operating in the HF spectrum (2-30 MHZ) the data link is designed to provide omnidirectional, gapless coverage over ranges up to 300 miles. Link 11 may also operate in the UHF frequency range from 225-400 MHZ."

7. Link 11 is predominantly a maritime data link utilising the M series message to pass data between participants. It is a relatively slow link, (rates of 2250 and 1364 bits per second) and normally operates in a polling mode, with a central Network Control Station (NCS) polling each participant. When polled by the NCS, the Participating Unit (PU) transmits all of its data to all other participants on the Link 11 Network. Link 11 can also operate in a broadcast mode in which a single unit broadcasts information to all other units. Link 11 is secure but not Electronic Counter Measures (ECM) resistant. Each PU uses a Data Terminal Set (DTS) that acts as a modem and provides low level network access and control functions.

8. The Link-11, or Tactical Digital Information Link "A" (TADIL-A) architecture, uses a standard message format – M series messages – to transfer data. It requires the formation of a structured data network within which information can be exchanged between all units participating in the net. The PUs can be shipborne, airborne or land-based. M-Series messages are defined in MIL-STD 6011 and are 48 bits long. There are 40,000 possible Data Identifiers.

9. Numbers are assigned to each Link 11 unit (via OPTASKLINK) with the range of PU numbers being 018- 768 (Octal). This means that a Link 11 net only supports 62 unique addresses. Each PU gathers tactical information from its own sensors, and transmits this data to all other PUs listening. Thus, each PU should have the tactical data for the entire net in real time. The simultaneous availability to a Task Group Commander of information from all the sensors of all PUs assists in the making of informed command decisions.

10. Information transmittable over Link-11 includes:

a. Own-ship position, course and speed.

b. Reported Track data (position, course, speed, height, ID, Category, etc.).

c. IFF/SIF.

d. EW information.

e. Engagement & Weapon Status.

f. ASW information (datum, sinkers etc.).

g. Emergency information (NAV HAZARD, Downed A/C, Man-In-Water, Surface Zero).

h. Special Points (CAP Station etc.).

i. Interceptor Handover Request/Instruction.

j. Force Orders.

Link 11 – Equipment

11. The Data Terminal Set (DTS) has two primary functions in the Link-11 net. First, the DTS controls all of the sequencing of events required to pass net transmission from one station to another. Second, the DTS accepts binary digital data from the computer and converts it to phase-modulated audio tones for the radio(s). The USQ- 125 can operate with up to four HF or UHF radios. For reception of information, audio tones from the radio are converted to binary data for the computer.

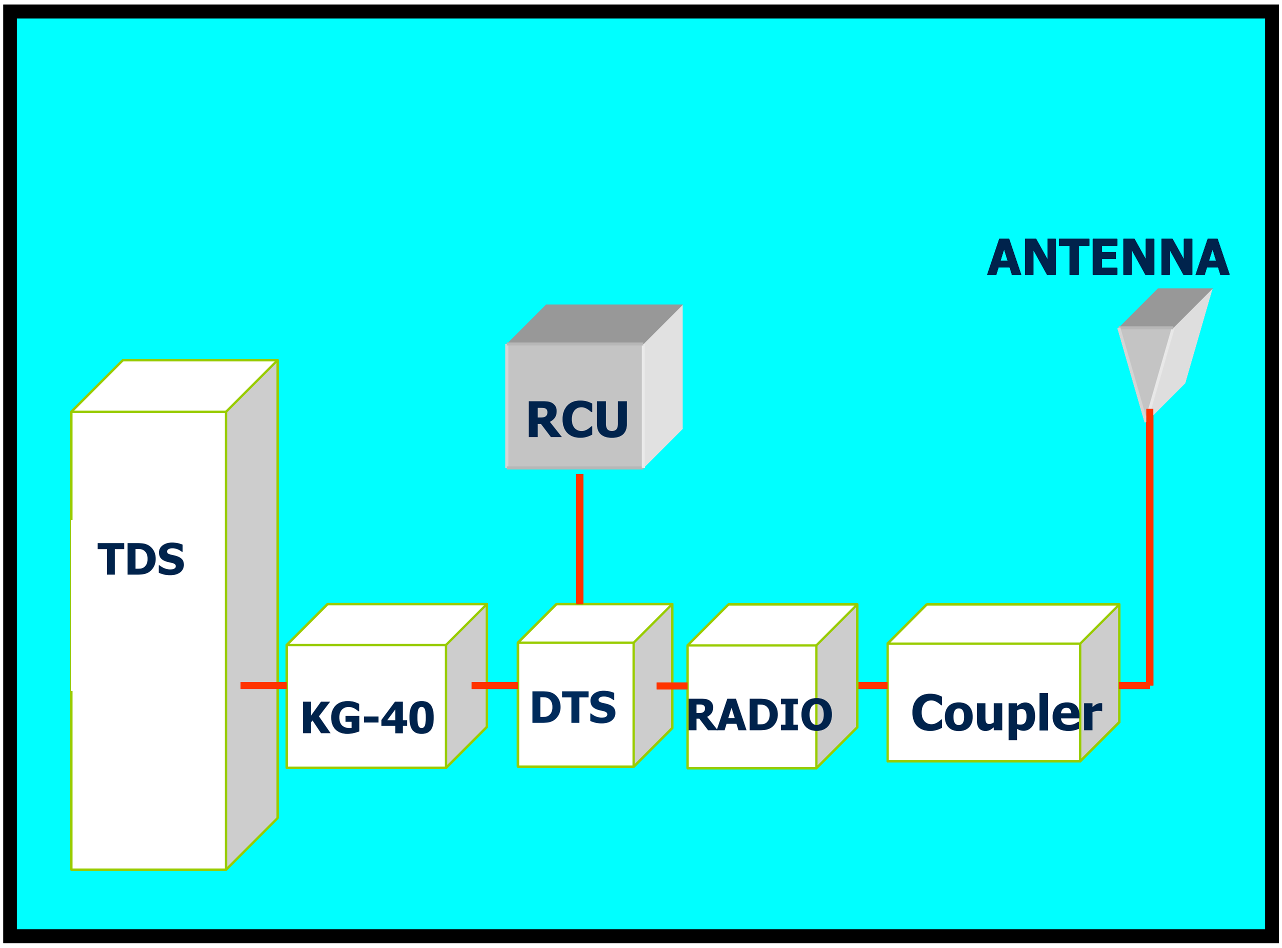

Figure 4-1: Link-11 Equipment Block Diagram

12. The Data Terminal Set (DTS) consists of two elements: a Data Terminal (DT) and a Remote Control Unit (RCU). The USQ- 125 is the data terminal while the Remote Control Unit was implemented by either a PC running the USQ- 125 remote control program or a UNIX workstation running a USQ- 125 remote control program. Post upgrade the CDLMS houses the DTS and performs the role of RCU.

13. Further detail on Link 11 equipment is provided later in the CDLMS section.

Link 11 – Operation

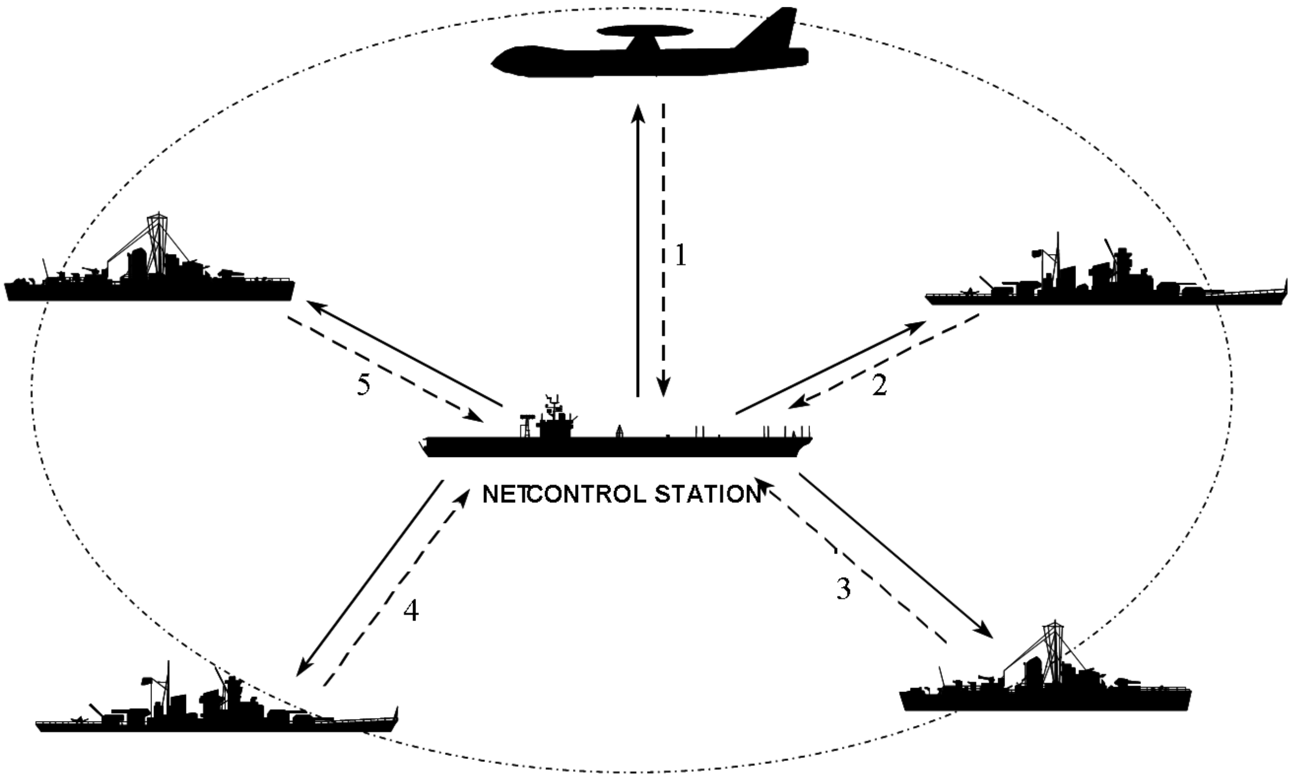

Figure 4-2: Basic Link 11 Operating Concept

14. Data Link Reference Point is a point on the surface of the earth, defined with latitude and longitude. All Link 11 participants must reference all of their geographic data to the DLRP.

15. Roll Call is the normal mode of operation for Link-11. In Roll Call, one unit is designated as the NCS. The remaining units serve as picket stations, or PUs.

16. The NCS' DTS controls the sequence in which the other PUs are polled. When polled by the NCS, each PU transmits its data.. During the remainder of the time, a PU is receiving reports from the other members of the Link 11 net. If a PU does not answer its call-up, the NCS will automatically poll that PU a second time. If the PU still does not respond, the NCS polls the next unit in the sequence.

17. Link 11 has a variable Net Cycle Time (NCT), which is the time that it takes for NCS to start with the first PU, go around to all of the PU's and then start over. As different PUs have different data to transmit – NCT varies. Figure 11 is a graphical representation of a polling sequence, using the conventional Link 11 waveform (CLEW). Each unit gets polled in a pre-determined sequence. If a unit does not reply to the poll (i.e. PU 64) the unit will get polled a second time.

18. NCS is responsible for entering and monitoring the PU polling sequence in Link 11. The PU list is entered into the Data Terminal Set (DTS). An advantage of the USQ- 125 is that all DTSs are capable to function as NCS. As described previously, in the event the NCS becomes unserviceable or destroyed, the duty of NCS will be promulgated within OPTASK LINK and the new NCS enters the list of PUs into their DTS and starts polling each in turn.

19. In order to effectively communicate track data, units need to operate in a common coordinate system. One of the dilemmas when converting track data between different combat systems is the potential to include positional errors so multiple participants may report the same real world object in slightly different positions. If the errors are great enough, they may end up creating multiple tracks upon Link 11 that don't really exist. To assist with accurate correlation Link 11 designates a Gridlock Reference Unit (GRU). Each PU uses tracks it holds in common with the GRU in order to align (in X and Y axis) its coordinate system to that of the GRU, hence minimising the chance of correlation errors.

20. The maximum distance a unit can be from DLRP is 512 Data Miles. That unit then can report a track up to 521 dm from its position giving a theoretical distance of 1024 dm's. A Data Mile is a unit of distance used in radar calibration. The data mile equals exactly 6000 ft or 1828.8 meters; this is equivalent to about 1.137 miles or 0.9875 nautical miles.

21. Link 11 uses a four-digit Track Number (TN) in the range 00018 to 77778, allowing 4,092 TNs on Link 11.

22. Link 11 operates in the Ultra High Frequency Band (225 - 245 MHz) which normally Line of Sight this gives Link 11 transmission ranges when using UHF:

a. Ship to Ship 25nm

b. Ship to Air 150nm, and

c. Air to Air 300nm.

23. Link 11 can operate on the High Frequency band (2 – 30 MHz) with coverage of 300nm+. Predominantly a ground wave is used transmit HF data Link 11 can also be sent via satellite using UHF Satellite Communications or via land line utilising STU-3/Speakeasy to encrypt the Link 11 information.

24. Although the definition states a high speed link, it is a relatively slow link compared to modern communications systems with data rates of 2250 and 1364 bits per second.

25. Link 11 has the following Limitations:

a. Link 11 operates upon a single carrier frequency whether UHF or HF. If an enemy can find that carrier frequency, they will have an opportunity to jam Link 11 (Electronic Attack).

b. Relatively slow data rate (1.3 / 2.2kbps) in comparison to newer TDLs..

c. Only supports a maximum of 62 participants – all rest of PUs to be RX Only.

d. No priority interrupts for emergency/Flash data. A PU has to wait until the polling cycle gets back to that PU to send emergency/flash data.

e. Variable Net Cycle Time – Dependent on No of PUs and/or the amount of Data passed.

f. Grid reporting system only supports local reporting area within a 2 Data Mile range and NCS needs to be centrally located

g. The nodal nature of Link 11, it makes it vulnerable to loss of the NCS. If the NCS becomes unserviceable or destroyed, there will be a certain mount of time where a Link11 network will cease to operate. A new NCS re-establishes the Link 11 Network. To change/take over this duty the OPTASK LINK will list the relevant standby duties and responsibilities.

26. Link 11 has the advantage of a “Beyond Line of Sight” (BLOS) capability when using HF (ground wave) to a theoretical range of 300 nm. It can also operate in the UHF band for Line-of-Sight (LOS) connectivity. Link 11 is relatively easy to setup and reconfigure as required unlike Link 16 which has a very substantial planning overhead, Link 11 can be coordinated very easily amongst Link 11 capable units.

Link 16

Overview

27. Link 16 is the designation given to a TDL that is being fully integrated into operations of the forces of NATO and other Allies including Australia. Mil-STD 6016 - defines Link 16 as:

"JTIDS/MIDS is a High-capacity, Digital information distribution system providing integrated Communications, Navigation and Identification capabilities. It provides Secure, Flexible, and Jam-resistant information transfer in Real time among the dispersed and mobile units."

28. Link 16 operates on 51 frequencies in the 960 to 1,215 MHz frequency band, sharing with TACAN but strictly avoiding the IFF transponder frequencies which are also in the band. The Link 16 TDMA scheme breaks up time into 7.8125 ms time slots and allocates these slots to users, based on projected traffic demand. Users employ their time slots to transmit while listening during all other times, thus enabling relays of opportunity, to maximise the probability of message reception. Participants routinely inject information into the network through their regular broadcast slots without necessarily knowing who needs the information, using a broadcast-oriented architecture. Each transmission consists of a pulse stream consisting of a synchronisation preamble, a header to define the type of message and the message itself. Both predefined messages and free format messages are permissible in the system. All users can continuously monitor the data available and retain information that they require. Typical Link 16 messages from data sources provide identity, location, altitude, speed and heading. Status messages provide such information as target acquisition, weapon or stores availability, fuel remaining and equipment status.

29. Link 16 is designed to survive the highest levels of enemy radio electronic combat. The links are encrypted with the latest approved crypto devices. Jam resistance is achieved by multiple techniques through fast hopping over all frequencies, direct sequence spread spectrum of the waveform and Reed-Solomon forward error correction. The result of the signal processing gains from this combination of techniques means that the Link 16 omnidirectional radiation pattern can offer as much signal improvement as if it were being transmitted by a highly directional antenna (such as parabolic dish), without the difficulties of beam pointing or the limitations of single path links.

Figure 4-3: Link 16 Network Concept

30. Link 16 utilises LOS UHF communications and Time Division Multiple Access (TDMA) to provide timeslots to Link 16 participants for transmission and/or reception of information from other Interface Units (IU) on a Link 16 Network. It has two range modes: Normal – 300 NM and Extended – 500 NM.

31. In a TDMA system each unit takes turns according to pre-allocated time slots IAW the network design. The TDMA architecture is based upon the 24 Hour day which is divided into 112 Epoch's. Each Epoch is divided into 64 (12 Second) Frames. The Frame is the basic recurring unit of time in the Link 16 TDMA Network.

32. This 12 second frame contains 1536 Time Slots (TS) of 7.8125 milliseconds. All the 1536 TS are explicitly defined into 3 separate Sets (Set A, B and C) of 512 TSs. These time slots are allocated during the Link 16 Network Design Phase.

33. The TDMA architecture of Link 16 provides for a highly accurate time synchronisation of the terminals which is used to support the position location function. JTIDS terminals receive messages within time slots and utilise the message to measure the Time of Arrival (TOA). This information is then combined with the terminal's estimate of position to form the pseudo-range observation for the terminal's Kalman filter. The filter processing of the sequence of pseudo-range observations from sources with superior position accuracy permits each terminal in the community to maximise navigation performance. The distribution of precise geodetic position data establishes a Link 16 geodetic community that is correlated to the best available geodetic position reference. This periodic reporting of secure position and identification also serves to identify Link 16 users to all other Link 16 elements, even elements which operate in a receive-only mode. Identification is not limited to Link 16 users. The identification and position of other units (friendly or enemy) can be fed into the Link 16 network by radar sites, intelligence posts and other participants.

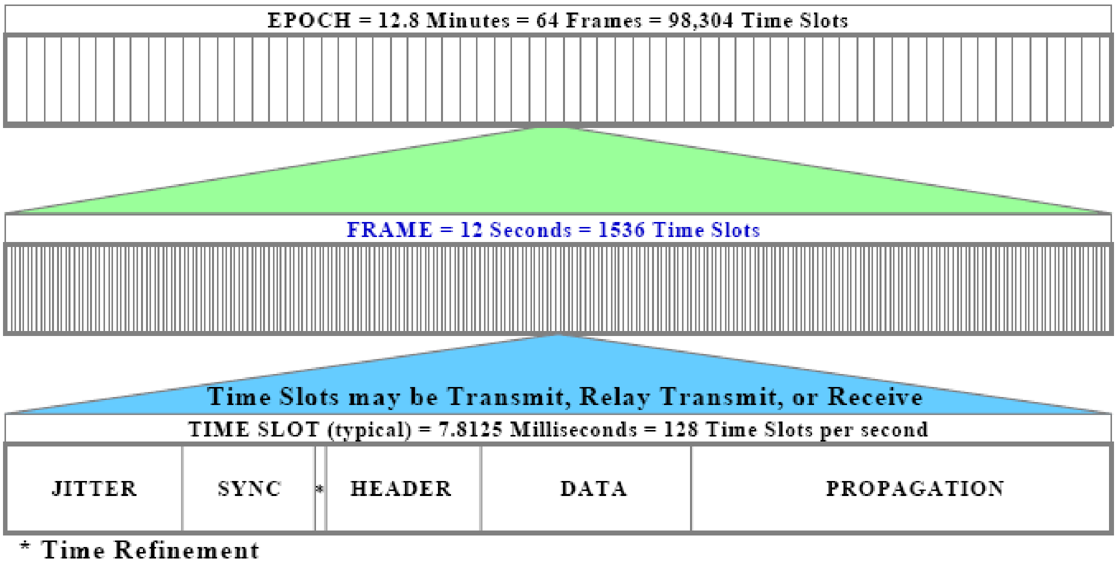

Figure 4-4: Link 16 TDMA Concept

34. Timeslots are the Basic unit of access in Link 16 TDMA. One timeslot is 7.8125milliseconds in duration. Timeslots are assigned to both the function they support and the participating platform. Each time slot contains the following information:

a. Jitter: Variable start interval, Jitter length is determined by the TSEC crypto not all packing structures have Jitter.

b. Synch: Synchronization preamble allows receiving terminal to ID message and precedes all Data.

c. Header: Address (Sync and Header contains 72 Pulses)

d. Data: Data (Either 285 or 444 Pulses – depending on the packing structure.) If the larger packing structure is used then the Jitter is removed.

e. Propagation: Remaining time in the TS allows for the lat pulse to propagate (or travel through the atmosphere). Propagation limit determines the maximum range for direct connectivity: 300NM in Normal range mode or 500NM in Extended range mode.

35. Link 16 data messages types include

a. Free text messages

b. Voice, imagery, alphanumeric free text, etc.

c. Fixed format messages:

d. Consists of between 1 an d 8 words:

e. Initial

f. Extension

g. Continuation words

36. Word length is fixed at 75 bits. This is comprised of:

a. 70 data bits

b. 4 parity bits

c. 1 spare bit.

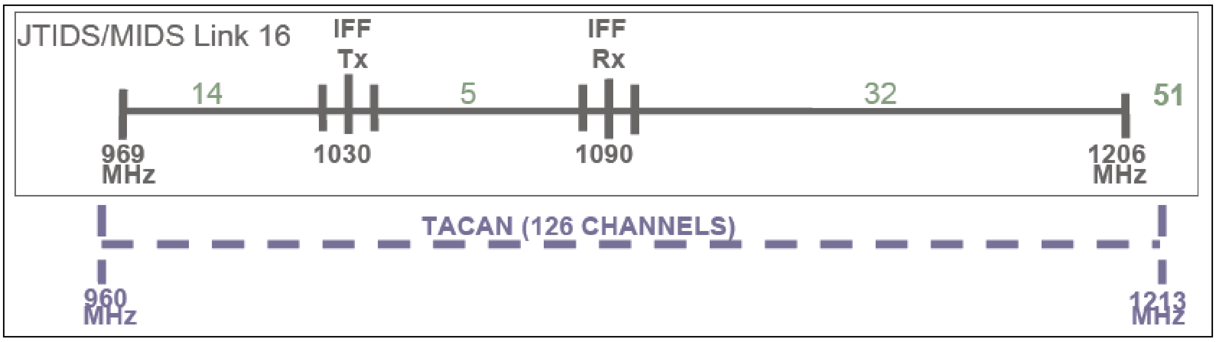

Figure 4-5: Link 16 Operating Frequency Spectrum

37. As depicted above, Link 16 operates in the 969 MHZ- 1206 MHz UHF Band on 51 fixed frequencies. These Link 16 frequencies operate in the same band as air navigation aids such as TACAN, ILS (Instrument Landing System) and IFF. Link 16 operates in the aeronautical UHF Band (Lx Band) and hence shares the frequency band with other aeronautical equipment, such as IFF/SIF, TACAN and ATC Beacons/Transponders.

38. Link 16 provides a uniform pulse frequency hopping over 51 carrier frequencies, which consist of 14 Low Frequencies, 5 Centre Frequencies and 32 High Frequencies. The waveform is designed for compatibility with DME/TACAN and ATCRBS/Mode S/IFF. There is no carrier centre frequency allowed closer than 22 MHz from IFF (1030/1090 MHz) bands.

Network Design

39. Link 16 Uses J-Series Messages, which supports 32 Labels or Categories of messages (0 – 31) and 8 Sub Labels (0 – 7) J0.0 to J31.7, which provides 256 different message combinations.

40. Each transmission consists of a stream of pulses spaced 13 microseconds apart. Every pulse is assigned its centre frequency pseudo-randomly, which gives its frequency hopping pattern. Each pulse contains 5 Bits of data. Each time slot can have 258 or 444 pulses, depending on packing structure selected by the Network Designer. The pseudo-random selection sequence is called a Hopping Pattern. In Link 16 a hopping pattern is called a “NET”; each NET is unique to a Transmission and is not related to each other. Each NET use the same frequencies but in a different order.

41. Network Participation Groups (NPG) are the building block of the Link 16 Network Design. They support a specific function for a platform to achieve. NPG’s are virtual circuits that support the exchange of J series messages. An NPG is created by a combination of messages with in a time slot. In essence an NPG is a predetermined template of messages for a specific function.

42. NPGs are divided into two functional categories:

a. Network maintenance including net entry, round trip timings, net management & PPLIs.

b. Data and voice NPGs.

43. Depending upon the requirements for a given network, different NPGs will have allocated timeslots from which JU’s can then transmit or receive in formation. The NPGs to be used in a network are selected to ensure that they are able to complete the operational task at hand and manage the running of the network. Obviously at some stage you will run out of timeslots on one hopping pattern so to increase the amount of data on a Link 16 Network, multiple hopping patterns are used.

44. Link 16 uses a Precise Position Location and Identification (PPLI), which is a message sent to all Link 16 Units identifying themselves and their location. The system employs relative navigation techniques to constantly fix each unit's position. These techniques include messages such as Round Trip Timing and PPLI. PPLI is transmitted every 12 seconds for C2 Units and at a faster rate for fast moving aircraft such as fighters.

45. A PPLI message (J2.x) is used to:

a. link JUs,

b. assist with Data Forwarding,

c. initiate Air Control,

d. enable passive Synchronization, and

e. Provide positive Id, Status Information (Air Control & Voice Net Numbers, Time & Position Qualities).

46. PPLI messages contain the following information:

a. Position and Qualities (0-15);

b. Course, Speed, Height/Depth;

c. Time Quality (0-15);

d. Platform Type (e.g. BOMBER);

e. Platform Activity (e.g. REFUELLING);

f. IFF Codes (MODES I, II AND III);

g. Strength;

h. Command And Control Indicator, Flight Leader Indicator;

i. Emergency Indicator, Bailout Indicator;

j. Mission Correlator(s);

k. Voice Call sign, Channel;

l. Exercise Indicator; and

m. Silence Indicator.

47. Link 16 provides an increased level of information exchange over Link 11, these areas include:

a. Network Management and Track Management

b. Precise Participant Location & Identification (PPLI)

c. Platform, System and Airfield Status on Link participants

d. Track Reporting in all environments (Space, Air, Surface and Land)

e. Reference Points and Areas

f. Mission Management

g. Weapon Coordination

h. Digital Air Control

i. Electronic Warfare (Parametric Information and Coordination)

j. Threat Warning

k. Free Text and Imagery, and Digital Voice.

Maximising network capability – Variable Packing Structures

48. Time slots can have different packing structures to increase capacity. Time slots can be packed with additional data or the information can be sent twice. The 4 packing structures are:

a. Standard Double Pulse (STDSP),

b. Pack 2 Single Pulse (P2SP),

c. Pack 2 Double Pulse (P2DP), and

d. Pack 4 Single Pulse (P4SP).

49. With the Lower packing structures, that have jitter available to them and can be propagated further. With an increase in packing, there is a decrease in the range it can be propagated and also a reduction in the amount of electronic protection available. The packing structures used are determined by the Network Designer and are not usually available for change by Operators.

50. Links 16 Terminals are capable of producing multiple hopping patterns. This allows network communications to be 'Stacked' Networks or 'Multi' Networks depending upon their function.

51. A link 16 Multi Net provides the first means to extend the capacity of a Link 16 Network. This allows for different NPG's to complete different tasks on the same timeslot but utilising a different hopping pattern (net number)

52. As an example below, most participants on a Link 16 Network want to know about the HUR PPLI information produced by the Fighters (in pink and on the main net). A picket platform may not need to know about HUR PPLI information sent by the fighters. Instead of just "listening in", they make practical Operational use of the network and utilise a different hopping pattern for those timeslots to do Electronic Warfare on Net Number 1. . This allows for greater use of Time Slots As Multi-nets operate simultaneously but are pre-determined during the network design phase.

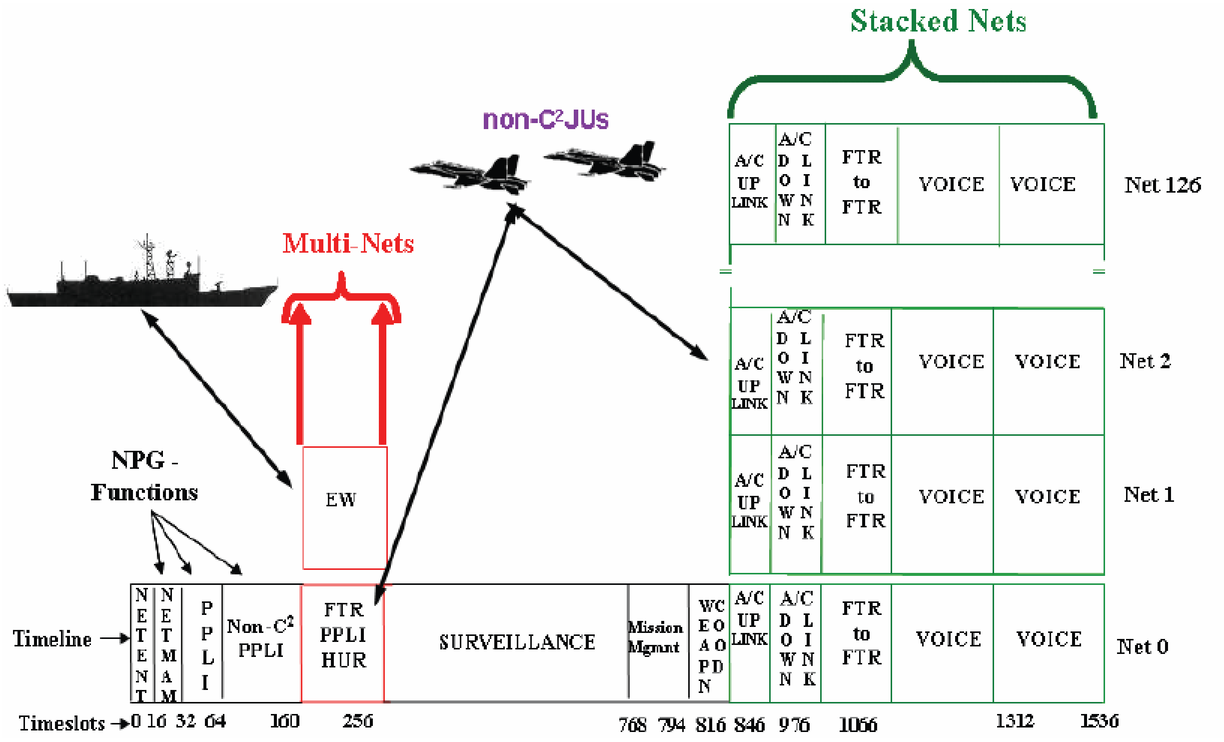

Figure 4-6: Link 16 Stacked and Multi-Nets

53. A stacked Net is similar to a Multi Net but utilises the same NPG to provide multiple Nets (hopping patterns) for the same function within Link 16. Link 16 can have up to 127 different dial able nets. For an Operator, Net selection will be similar to selecting specific frequencies on any other Radio. The Net Number for a given task and will be promulgated within the OPTASK Link

COMMON DATA LINK MANAGEMENT SYSTEM (CDLMS)

References: TECHNICAL MANUAL OPERATIONS AND MAINTENANCE INSTRUCTIONS ORGANIZATIONAL LEVEL – AN/UYQ-86(V) Common Data Link Management System (CDLMS)

Overview

54. The AN/UYQ-86(V)2 Common Data Link Management System (CDLMS) is a tactical data link message distribution system that provides real-time control and management of TDL (Link 11 and 16) in support of all major surface ship Command, Control, and Communications (C3) systems.

55. The AN/UYQ-86 has six hardware variants (V)1 through (V)6 depending on the Combat Direction System (CDS) Block and Baseline configurations. The RAN FFG configuration is (V)2.

56. The CDLMS consists of three major functions as depicted below in the CDLMS Basic Block Diagram.

a. Command and Control Processor (C2P). The Navy's existing C2P System software that has been rehosted from a AN/UYK-43 computer onto a commercial Single Board Computer (SBC) resident in a VME chassis.

b. CDLMS Human Machine Interface (HMI). A single shipboard operator position for Link operations and a position for CDLMS maintenance.

c. Common Shipboard Data Terminal Set (CSDTS). A common shipboard Link-11 Data Terminal Set [except variant AN/UYQ-86(V)1]. The CDLMS Model 5 provides the ship with full Link-16, Link-11, and Link-4A control and monitoring capabilities. CDLMS Model 4 does not include full Link-11 control and monitoring.

57. The AN/UYQ-86 consists of up to three separate hardware units interfaced together and three Computer Software Configuration Items (CSCI). The hardware units are:

a. The OJ-741/2/3/4/5(P)/UYQ Embedded System Processor Group (ESPG).

b. The OJ-746(V)/UYQ Operator Human Machine Interface (HMI).

c. The OL-649(V)/UYQ or OL-649(V)2/UYQ Maintenance Display Unit (MDU).

58. The ESPG is one of the AN/UYQ-70 family of equipment, specifically the air-cooled OA-9481/UYQ-70(V) or OA-9482(V)5/UYQ-70(V)2. It has been modified from the OA- 9481/9482 configuration to convert it into the OJ-741/2/3/4/5 as required. The MDU is the CDLMS maintenance workstation. The ESPG and MDU are situated adjacent to each other in one of the ship's electronic equipment rooms

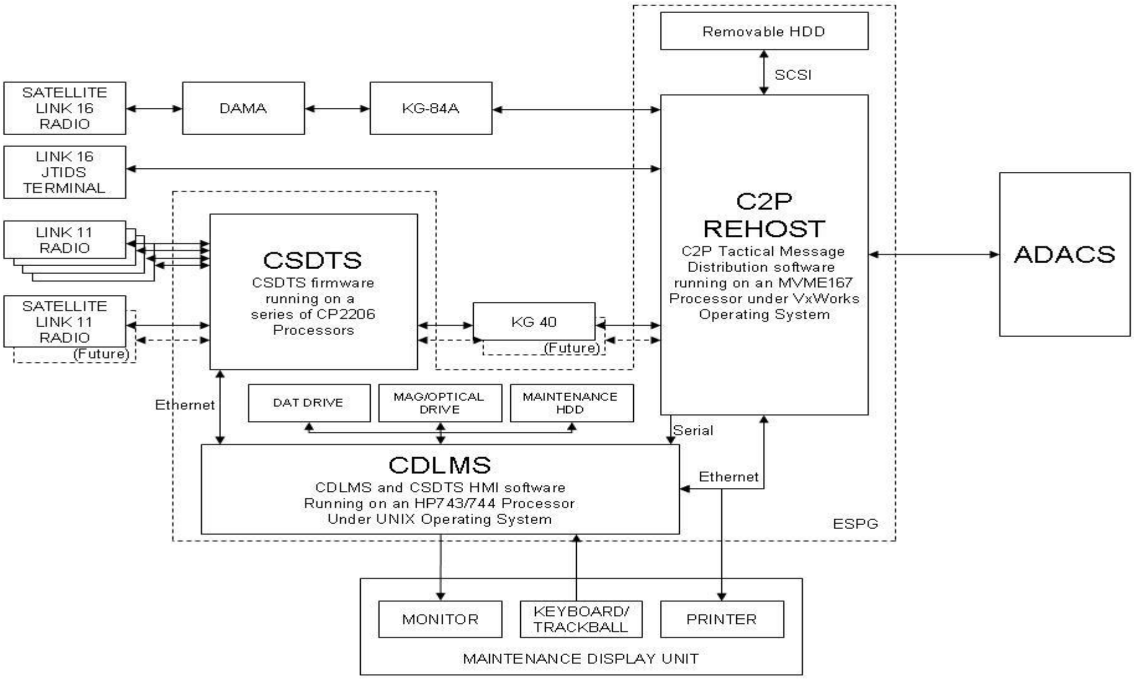

Figure 4-7: CDLMS Basic Block Diagram

59. The Operator HMI is an X-terminal session on ADACS and is accessible via the TRKSUP role at a C&Di console.

60. The CDLMS CSCIs are:

a. The C2P Rehost CSCI running in the ESPG.

b. The CDLMS HMI CSCI running in the ESPG and the Operator HMI (if equipped).

c. The CSDTS CSCI running in the ESPG.

61. CDLMS Mission. In a joint battle space environment surface units, submarines, aircraft and land units, require tactical information to be continuously passed between the individual combatants by means of a series of tactical data links including Link-11 and Link-16. Onboard the FFG the CDLMS is the interface between ADACS and these TDLs.

62. The CDLMS automatically normalises incoming and outgoing Link messages and distributes them to their correct destinations. The CDLMS relieves the ship's CDS computer from the processing and memory burdens imposed by data link message protocol processing.

63. The CDLMS interfaces with ADACS, Link-11 and Link-16 as shown above. The CDLMS communicates with the following:

a. The CDS using a MIL-STD-1397 Type E serial input/output interface, except AN/UYQ-86(V)1 as noted below.

b. Up to four HF or UHF radio sets patched to CDLMS for Link-11 using an audio input/output interface conforming to MIL-STD-188-203-1A via a KG-40 using a MILSTD-1397 Type A parallel input/output interface.

c. A UHF radio set patched to CDLMS for Satellite Link-11 using an RS-232 input/output interface.

d. The Link-16 Terminal using a MIL-STD-1553 (MIL-STD-1397F) input/output interface. Data Link couplers are included at each end of the MIL-STD-1553 bus for impedance matching.

System Description

64. AN/UYQ-86(V)2 consists of three units: the ESPG, the Operator HMI (C&Di Console), and the MDU. The ESPG and MDU are situated adjacent to each other in RICER.

65. The CDLMS Functional Block Diagram below provides a basic overview of the interfaces between the subsystems. The primary function of the CDLMS is to automatically manage the transfer of data link information between the CDS and the Data Link equipment under the overall control of the CIC TIC/TRKSUP. The Data Link equipment consists of:

a. Multi-Frequency Link-11 (MFL) using up to four separate and independent Link-11 radios (except the AN/UYQ-86(V)1 variant, one only).

b. Satellite Link-11.

c. Link-16.

d. Satellite Link-16 (S TADIL-J).

e. Link-4A.

66. Link-11 audio is received from up to four independent Link-11 UHF/HF radios and/or the Satellite Link-11 radio and converted into Link-11 messages by the CSDTS hardware and software. The highest quality UHF/HF Link radio signal is selected by CSDTS. Messages from the selected UHF/HF Link radio and/or messages from the Satellite Link-11 radio are routed to a KG-40 where they are decrypted and then routed to the C2P Rehost function where they are sorted, filtered, and the message format normalised (not normalised in Model 4), then disseminated to the CDS. In the AN/UYQ-86(V)1 variant, Link-11 receive audio is routed to the Link-11 Data Terminal Set where it is digitized prior to routing to the KG-40.

67. Link-16 messages, received from the AN/URC-107(V) Link-16 Terminal, are similarly sorted, filtered, and normalised (not normalised in Model 4). The AN/URC-107 contains an integral crypto device. These messages are then disseminated by the C2P Rehost function to the CDS and/or forwarded to other ships via data link radios.

68. Link-16 messages, received from the S TADIL-J radio via Demand Assigned Multiple Access (DAMA) equipment are decrypted by a KG-84A and are similarly sorted, filtered and normalised (not normalised in Model 4). These messages are then disseminated by the C2P Rehost function to the CDS and/or forwarded to other ships via data link radios.

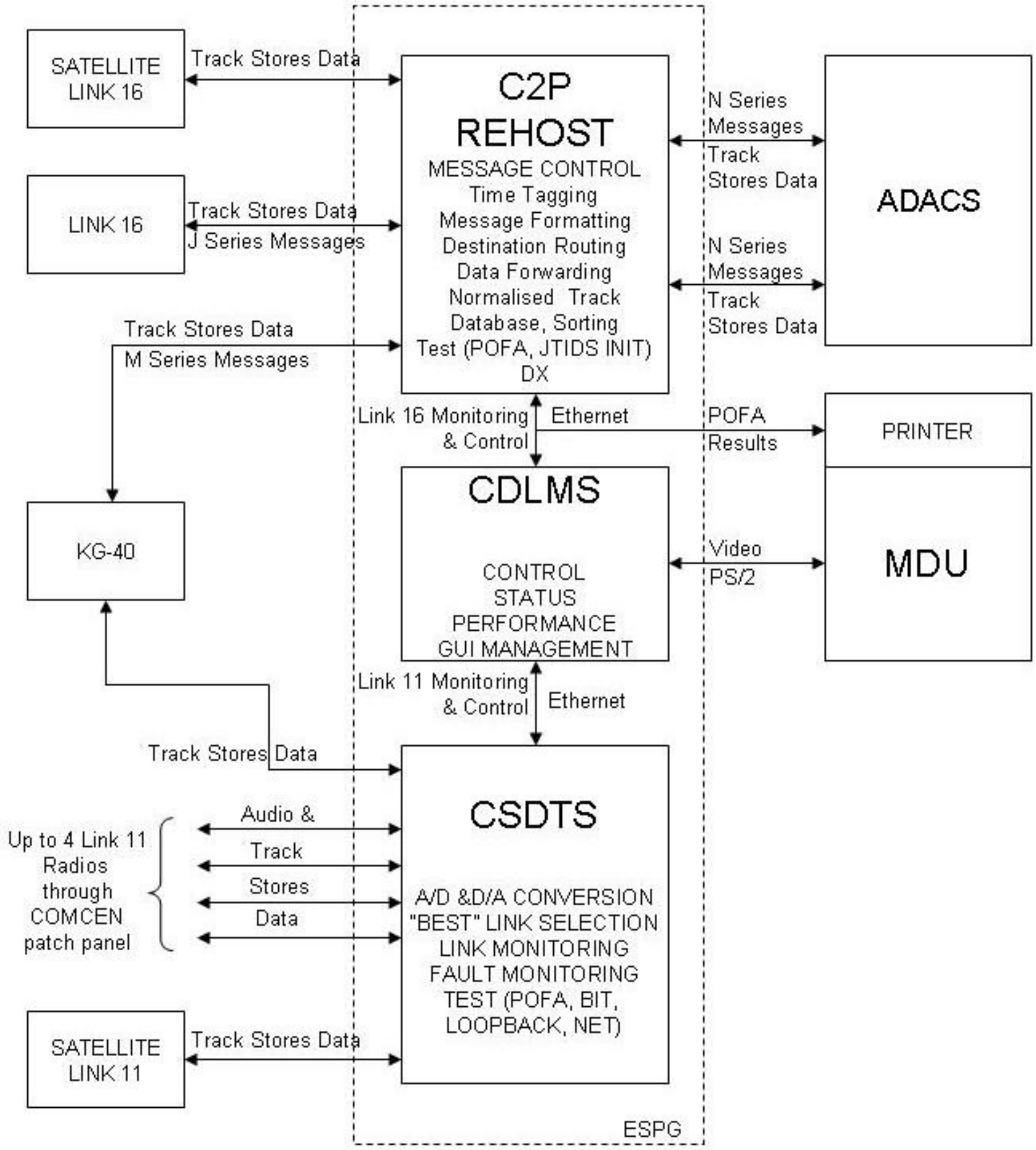

Figure 4-8: AN/UYQ-86(V)2 CDLMS Functional Block Diagram

69. Link messages generated by own-ship are likewise received by the C2P Rehost function from the CDS, sorted, filtered, and formatted for dissemination on Link-11 and/or Link-16 radios via the encryption devices. The precise routing of link messages is determined by the Link mode.

70. In addition to this primary function, the CDLMS performs control and monitoring functions for Link-11, Link-16, and Link-4A. CDLMS also incorporates a data extraction function. There are two forms of data extraction. One is used as an In Service Engineering Agent (ISEA) debug tool for performance monitoring, testing, training and mission analysis. The second is installed only in AEGIS versions and is termed War Diary (not yet implemented).

71. The AN/UYQ-86(V)2, (V)3, (V)4, (V)5, and (V)6 variants, which have CSDTS, provide all Link-11 performance monitoring functions previously embodied in the Link-11 Monitoring System (LMS-11).

72. To achieve these functions, the CDLMS employs up to nine separate but inter-connected processors, up to seven input/output circuit card assemblies, and two workstations. The processors are connected by four different types of interface depending on interface requirements. These are: Ethernet, fibre optic, VME backplane, and low level serial interfaces.

73. The tactical functions are performed by the C2P Rehost Tactical Application Element running on a MVME167 Single Board Computer (SBC) with an MC68040 processor using VxWorks, a real-time DOS-based Operating System (OS). This SBC resides in a VME chassis in the ESPG and communicates, via a VME backplane, with the CDS, Link-16, Link-4A, and CSDTS (the Link-11 Data Terminal Set (DTS) in the AN/UYQ-86(V)1 variant) using MIL-STD-1397 Input/Output Cards. It also communicates with the S TADIL-J equipment using an RS-422 interface. The MVME167 operator interface uses the ESPG Electroluminescent (EL) Panel.

74. The Link-11 functions are performed by the CSDTS Application Element running on up to five CP2206 processors interfaced together via a VME backplane. The Netmaster processor communicates with the C2P Rehost function using a MIL-STD-1397 Input/Output Card and the Satellite Link-11 radio via the VME backplane. The remaining four MFL processors communicate with their respective Link-11 radios directly. In the AN/UYQ-86(V)1 variant, Link-11 functions are performed by the Link-11 DTS.

75. The operator interface control and monitoring functions are performed by three software elements running together. These elements are: the C2P Rehost HMI Element, the CDLMS HMI Element and the CSDTS HMI Element. These run together on the ESPG HP743/744 SBC (hereafter referred to as the HP SBC) using a Hewlett Packard-UNIX (HP-UX) operating system that implements X-Windows and Motif Graphical User Interface (GUI).

76. In AN/UYQ-86(V)1 through (V)4 variants, the Operator HMI acts as the tactical operator console using a second HP SBC running some CDLMS HMI files and using the display and keyboard/trackball in the unit. It is operated by the TIC/TRKSUP and provides the capability to control the C2P Rehost Tactical Application Element and CSDTS Application Element dependent upon the tactical environment. In AN/UYQ-86(V)5 and (V)6 variants, this function is performed at the TIC Console.

77. The HP SBC in the ESPG also acts as the Maintenance and System Administration interface using the display and keyboard/trackball provided in the MDU (NAVMACS Workstation in the AN/UYQ-86(V)5 variant). Under casualty conditions (i.e., Operator HMI inoperative), the ESPG HP SBC can assume Operator HMI functions. Tactical operations and maintenance functions cannot be used simultaneously.

78. C2P Rehost, CDLMS HMI, CSDTS HMI, JTIDS Network Library (JNL), UNIX and Maintenance Test Interface (MTI) software is delivered on up to six separate Digital Audio Tapes (DAT). The software is copied from the DAT to hard drives attached directly to each processor by Small Computer System Interfaces (SCSI). The software is executed by the processors accessing their respective hard drives. Ship’s force has the capability of loading upgraded software.

79. The CSDTS Application software is loaded from a laptop computer at installation onto the CSDTS processors, where it resides as firmware. CSDTS Application firmware upgrade will only be carried out by intermediate or depot level personnel.

80. A printer is provided to print the results of Programmed Operational Functional Appraisal (POFA) tests.

81. OJ-742(P)/UYQ Embedded System Processor Group. The ESPG is a modified OA-9481/UYQ-70(V) or OA-9482(V)5//UYQ-70(V)2 which is an off-the-shelf, US Navy-supported variant of the AN/UYQ-70 family of equipment with a pre-existing maintenance policy and support concept. It is a six-foot enclosure containing two totally independent hardware systems: System A and System B. System A houses the C2P Rehost function and the CDLMS HMI function in two independent 20-slot VME chassis supported by an Uninterruptible Power Supply (UPS) and an Electroluminescent (EL) Panel. System B houses CSDTS in a 14- slot VME chassis supported by a second UPS (the AN/UYQ-86(V)1 variant does not have CSDTS). Three half-height mass storage devices and three or four (depending on variant) Ethernet transceivers for the implementation of Local Area Networks (LAN) are shared by the processors. The UPSs allow graceful shutdown of the processors in the event of the loss of main power. The cabinet rear panel provides input and output cable connections for all interfaces, while the front panel contains the EL Panel and power control panel. Exhaust fans at the rear provide cabinet air cooling.

82. ESPG System A. The upper of the two 20-slot VME chassis in System A contains the MVME167 Processor running the C2P Rehost Tactical Application Element, six or seven (depending on variant) MIL-STD-1397 cards for interfacing with the CDS and Links, and an S TADIL-J Converter Card for interfacing with the Satellite Link-16 radio. The MVME167 Processor is connected to a fixed hard drive via a SCSI bus for execution of the C2P Rehost Tactical Application Element (removable hard drive for systems with Ballistic Missile Defense [BMD]).

83. The lower of the two 20-slot VME chassis in System A contains the HP SBC Processor running the C2P Rehost HMI Element, CDLMS HMI Element, and CSDTS HMI Element. The Fiber Data Distributed Interface (FDDI) Card is used to interface with the Operator HMI or AEGIS LAN Interface System (ALIS) in the AN/UYQ-86(V)5 and (V)6 variants. If FC2 is installed the ALIS interface is Fast Ethernet instead of FDDI. The VLAN Card is used to interface with CSDTS by Ethernet. The MIL-STD-1397 Type E Card is used for the low level serial interface with the C2P Rehost function. This HP SBC is connected via a SCSI bus to two mass memory devices: a removable hard drive and a DAT drive. The software is executed from the removable hard drive. In AEGIS variants, a second HP SBC may be installed in a separate and independent portion of the VME backplane. When FC1 is implemented, this will provide War Diary functions.

84. All the System A processors are connected internally to a common Ethernet for operator control and monitoring purposes. The MVME167 and HP SBC processors are also connected together using a low level serial interface for passing CDS Track Stores messages from the C2P Rehost function to the CDLMS HMI function. This interface is termed the Tactical Message Interface (TMI).

85. ESPG System B. The upper 14-slot VME chassis in System B contains up to five CP2206 Processors, each running the CSDTS Application Element. Of the five processors, one is the Netmaster Processor, which, together with its associated CV-4252 NTDS Interface Card, interfaces with the C2P Rehost function via a KG-40 to pass Link-11 messages. Each of the remaining four CP2206 MFL Processors interfaces with a separate Link-11 radio, via an audio switchboard, to receive and transmit Link-11 audio. An Ethernet Card provides the interface with the HP SBC, via the VLAN Card, in System A. A Maintenance Panel provides the capability to load firmware onto the processors. The AN/UYQ-86(V)1 variant does not utilize System B.

86. The lower 18-slot VME chassis in System B is currently empty and will be used in the future to provide the Joint Range Extension (JRE)/Link-22 function.

87. OL-649(V)/UYQ/OL-649(V)2/UYQ Maintenance Display Unit. The MDU consists of a monitor or flat panel display, keyboard/trackball, and printer. The display and keyboard/trackball are interfaced with the HP SBC processor installed in the ESPG System A. The printer is driven from the C2P Rehost/CDLMS Ethernet. The MDU is functionally replaced by the NAVMACS Console in the AN/UYQ-86(V)5 variant.

JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS)

References: EE187-CD-OMP-010/URC-107(V)7 Equipment Manual for Shipboard Operation and Maintenance

Overview

88. A shipboard Link 11 system includes a KG40A for encryption, a Link 11 DTS for analogue-to-digital conversions and a radio for transmission and reception. The shipboard AN/URC-107(V) Joint Tactical Data Distribution System (JTIDS) terminal incorporates the functions of all three of these components (the KG, DTS, and radio) into one cabinet that provides many other capabilities in addition to exchanging tactical information

89. The JTIDS terminal provides jam-resistant, digital communications of data and voice for command and control, navigation, relative positioning and identification. JTIDS is a Time Division Multiple Access (TDMA) communication system operating in the 960-1215 MHz frequency band. The primary function of JTIDS terminal is to distribute tactical information in digital form. Spread spectrum and frequency hopping techniques make JTIDS resistant to jamming and data encryption makes it secure.

90. The primary function of JTIDS is to distribute tactical information in secure digital form. JTIDS technology also locates and identifies subscribers with respect to other users. Secondary functions include:

a. Precise Participant Location and Identification - Each PPLI message contains an abundance of information about a unit, including its detailed position and identification information its time quality its IFF codes and more.

b. Relative Navigation - Relative Navigation (RELNAV) is also an automatic function of the JTIDS terminal. It uses both position estimates received from other units (PPLI messages) as well as its own unit navigational inputs to calculate own unit's position. RELNAV is based on the ability to accurately determine inter-platform ranges using RF pulses. The mutual exchange of PPLI messages allows the positional accuracy of all platforms to approach that of the best unit in the network. Position is reported in both geodetic and relative grid coordinate systems.

c. Synchronisation - Synchronisation is another automatic function of the JTIDS terminal, and it is required for network entry and participation. A new unit awaiting entry to the network "listens" for an Initial Entry (IE) Message transmitted by the Network Time Reference (NTR). Once the IE is successfully received the new unit is said to be in coarse synchronisation with the network. It can then transmit a Round Trip Timing (RTT) message to, which the NTR replies. This exchange of RTT messages allows the new JTIDS terminal to adjust its clock to match, with in nanoseconds, that of the NTR in a process called fine synchronisation JTIDS must maintain fine synchronisation to communicate with other units in the network.

d. Secure Voice – The JTIDS terminal supports two simultaneous secure voice channels, referred to as J1 and J2. Each terminal contains two 16 kb/s voice digitisers that convert voice into a bit stream in its appropriate time slot. Multiple Link 16 voice channels can be operated simultaneously as each channel can operate over any one of a possible 127 Nets ie. user A and user B can utilise J1 simultaneously through different nets.

e. Relay – the JTIDS terminal employs relay techniques to extend communications beyond LOS. This is achieved through retransmission of messages received during one time slot in another designated time slot at a later time. The delay between the original transmission and the relay transmission varies between 6 and 31 time slots. Any Link 16 terminal can function as a relay, but relays must be designed into a Link 16 network in advance because Link 16 terminal must be assigned pairs of time slots in its initialisation load. After a terminal has been initialised as a relay it will automatically perform the function unless directed otherwise Note that the use of relays doubles the number of time slots required to exchange data

f. Built in Test - The Built-in Test (BIT) function of the JTIDS terminal performs both on-line performance monitoring and manually initiated monitoring for fault isolation. While the terminal is operating in the Link 16 network the on-line performance monitoring function runs automatically and continuously in the background. If a fault is detected a light will be illuminated on the status panel. The manually initiated BIT is more thorough than on-line monitoring but it can be run only when the terminal is not in the Link. Manual BIT will isolate problems down to the Shop-Replaced Assembly (SRA) level- for example to a faulty card. BIT is intended to eliminate the need for support equipment to isolate a JTIDS terminal fault.

Figure 4-9: AN/URC-107(V)11(C) - JTIDS

91. The JTIDS terminal is air cooled and requires 115VAC 3φ 60 Hz.

92. Its spread-spectrum and frequency hopping techniques make JTIDS resistant to jamming and data encryption makes it secure. As a digital system for both data and voice, JTIDS can handle very large amounts of data.

93. A JTIDS terminal automatically broadcasts outgoing messages at pre-designated, and repeated, intervals. When a terminal is not transmitting, it receives messages sent by other terminals that transmit, in turn, in a prearranged order.

94. The main features of JTIDS include:

a. Time Division Multiple Access (TDMA) Network

i. 128 Nets Maximum

ii. 128 Slots/Sec/Net

b. Message Catalog

i. J Series (TADIL J)

ii. Interim JTIDS Message Standard (IJMS), available with F15, AIA, E3, and MCE Terminal Configurations

c. Frequency Operation

i. JTIDS 969 to 1206 MHz @ 3MHz Channel spacing

ii. TACAN 962 to 1213 MHz @ 1MHz Channel Spacing

d. Information Data Rate

  i. 28.8 to 238 kb/s; Selectable Message Format

e. Cryptographic Secure Communications

  i. Two Channels of Digital Voice @2.4 and 16 kb/s

f. Anti-jam Features

  i. Fast Frequency Hopping

  ii. Direct Sequence Spreading

  iii. Error Detection and Correction

g. Communications Security (COMSEC)

  i. External Encryption Device, KGV-8A/B/C

  ii. Embedded Encryption Device, DS-101/-102

h. Transmit Power

  i. 200 W TDMA (1000 W with High-Power Amplifier)

  ii. 500 W TACAN

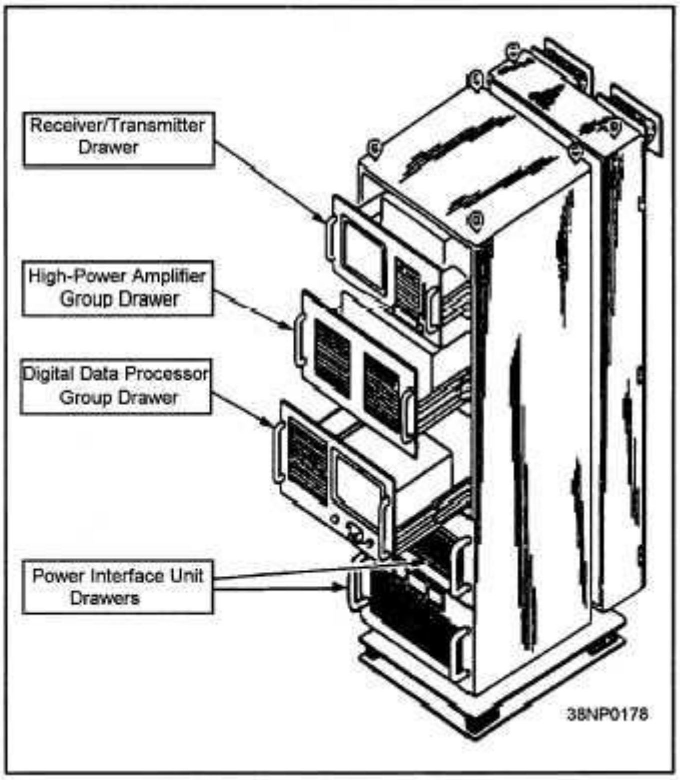

Figure 4-10: AN/URC-107(V)11(C) – JTIDS subcomponents

95. AN/URC-107(V)11 is comprised of the subcomponents:

a. Receiver-Transmitter (RT) drawer – the major components of Receiver-Transmitter Drawer 1A1 are Radio Receiver-Transmitter RT- 1784/URC- 107(V)11(C) 1A1A1 (Receiver- Transmitter), Indicator Control C-12069/URC- 107(V)7 1A1A2 (Indicator Control), and Status Panel Assembly 1A1A3 (WRA Fail Status Panel).

b. High Power Amplifier Group (HPAG) drawer – contains the high power amplifier and antenna interface unit. There are no external controls or indicators. The major components of the High Power Amplifier Group Drawer 1A2 (HPAG) is High Power Amplifier Group OG-189/URC. 107(V) (High Power Amplifier Group) which provides the high power TDMA output. HPAG 1A2 digitally interfaces with Digital Data Group Processor, OL.636/URC-107(V) 11(C) (Digital Data Group Processor) and Receiver-Transmitter 1A1A1. It also interfaces with the Receiver-Transmitter in an analogue RF manner.

c. Digital Processor Group (DPG) drawer – contains the interface unit, the digital data processor, On/Off/Standby switch assembly, Keymat control panel. The major component of Digital Processor Group (DPG) Drawer 1A3 is Digital Data Group Processor (DDGP). The DDGP consists of two major subcomponents: Interface Unit (IU) 1A3A1 and Digital Data Processor (DDP) 1A3A2.

d. Safe To Transmit (STT) drawer (not depicted above) – Safe To Transmit drawer 1A4 provides a maintenance safety key (RADHAZ key) that allows the repair technician to disable the transmit function of the AN/URC-107(V)11(C).

e. Power Interface Unit (PIU) drawer

96. Battery backup - Rechargeable battery 1A3BT1 contains three batteries: one nickel cadmium (NiCad) and two lithium sulphur dioxide cells. The NiCad battery is rechargeable and will maintain synchronisation and initialisation data in global memory in the event of a brief primary power interruption. In the event of NiCad battery failure, the entire rechargeable battery must be replaced. The two lithium sulphur dioxide cells ale replaceable and are used to maintain power to the chronometer. An internal heater and thermostat maintain an acceptable operating temperature during low temperature operation.

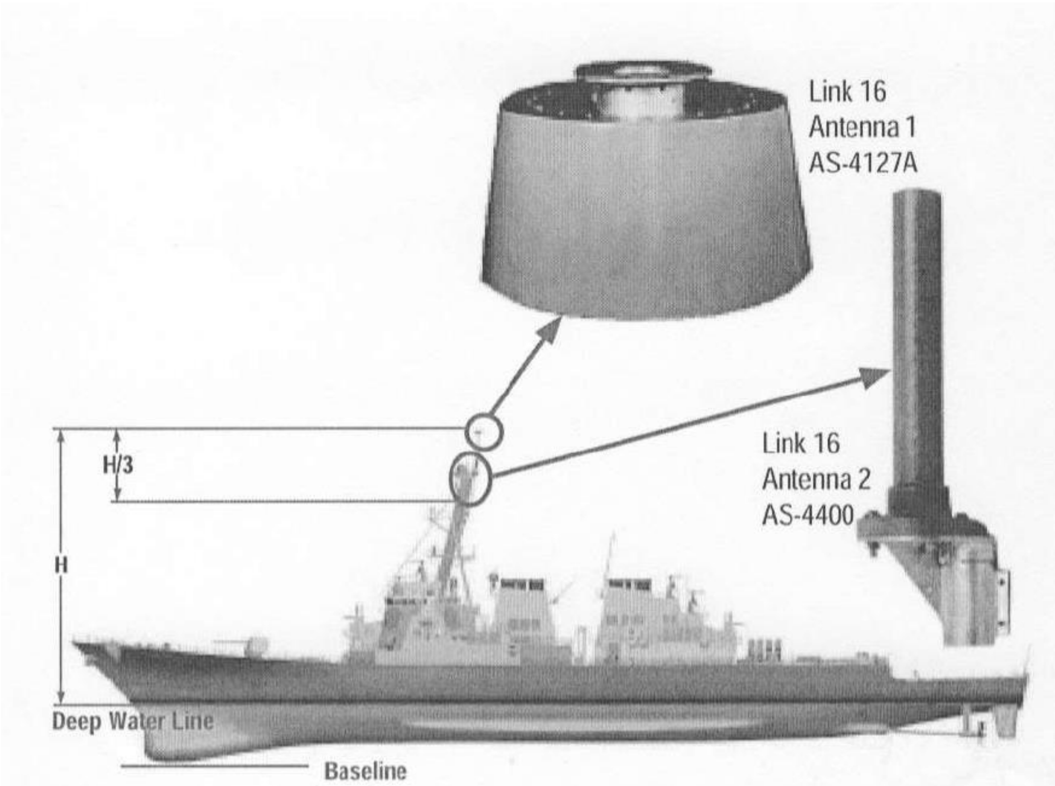

Figure 4-11: JTIDS System antennas

97. The Link 16 antenna system consists of the AS-4127A Transmit/Receive (TR) antenna and the AS-4400 receive only (RO) antenna. These units are issued as a set for shipboard installation and AEGIS ships were the first to receive them. The AS-4127A is a two-half wrap-around antenna that is 19.5inches high, 43 inches in diameter and weighs 50 kg. It is mounted on the upper main mast and includes support for the TACAN antenna. This configuration also provides the best LOS communication. The AS-4400/URC antenna is a two-element collinear array, is 17.7 inches high, 6 inches wide at the base, and weighs 2.5 kg. It has a high gain and an excellent voltage standing wave ratio(VSWR) throughout the JTIDS band.

98. The AS-4400 can be used as a transmit antenna if a failure occurs in the main 4127A antenna however there will be some degradation in the beam pattern coverage due to structural interference. It can also be used as a transmit/receive antenna for the UPX-28 IFF transponder unit or a shipboard JTIDS TR antenna when JTIDS requirements must be met without supporting the Tactical Air Navigation (TACAN) antenna.

99. Both antennas are broad band vertically polarised UHF antennas that provide omnidirectional coverage of the 9 60 to 1215-MHz JTIDS frequency band. Both have a "peak-of-beam" at the horizon which maximises LOS, both can operate at 1.2k W peak power and 140W average power. They are typically mounted so that the antenna elevations have a 1:3 ratio. This height diversity is to resolve multipath problem.

HELICOPTER DATA LINK

100. The HDL is a data link established between the shipboard command and decision system and the helicopter tactical system for the exchange of surveillance data, status data, and orders. The HDL Data Link Modem interfaces to the external communications system from which it receives and transmits audio level signals. It conducts digital to audio, and audio to digital conversions, as well as being the controlling data terminal set for the HDL.

101. The Helo Data Link (HDL) is operated from within the ADS (i.e. at a C&Di console) via the ASAC's HDL array. Only one operator can access this array at any given time; the array must be released to make it available to another ASAC operator.

102. Prior to enabling the HDL interface, ownship's STN must be set and DLRP entered. These are required for Link-11 operations, therefore the existing settings are normally used for HDL.

Data Messages

103. Several different types of data message are transmitted over the HDL, including:

a. tracks (initiations, and updates);

b. sonobuoys;

c. weapons;

d. special points (initiations and updates);

e. status;

f. arrative (barracuda codes or 32 characters free text);

g. drop track (cease reporting); and

h. environmental data (from helo only).

104. PU status and environmental reports can be viewed via the HDL PU status tab window in ADS. As well as endurance data (fuel/time remaining), the helo reports wind and water speed and direction, air temperature, weapons remaining, and sonobuoys remaining by type.

Modes of Operation

105. In comparison to Link-11 or Link-16, the Helo Data Link (HDL) is relatively simple in its operating modes and states, as follows:

a. network state – defines the architecture of the transmission authorities. Options are Controlled or Autonomous:

   i. Controlled State - a net control station polls the participating units (PUs) in sequence;

   ii. Autonomous State - transmissions are broadcast at the operator's discretion (i.e. manually selected);

b. transmission mode – whether or not transmissions are authorised. Options are Covert and Overt:

   i. Covert – transmissions are inhibited, and

   ii. Overt - transmissions are authorised;

c. crypto mode – defines whether data transmissions are to be encoded. Options are Plain and Cipher:

   i. Plain – data transmissions are not encrypted; and

   ii. Cipher - transmissions are encrypted; and

d. baud rate – sets the baud rate for data transmissions. Options are 75, 150, 300, 600, and 1200.

Network State

106. Refer to ABR 6511 Section 1, Chapter 3, Pg 32, para 3-163.

Transmission Mode

107. Ownship transmission mode - overt/covert. In overt mode, a PU will respond to an interrogation and will transmit an acknowledgement of received data. In covert mode, a unit will not transmit in response to an interrogation, and will not send any acknowledgement, but may send a message initiated by that unit's HDL operator. When the net is in the autonomous state, both the helo and the FFG may operate in either overt or covert mode. In the controlled state, all units must operate in overt mode.

108. When in controlled/overt, the helo responds to each NCS data transmission with an acknowledge message, and to each poll with the requested data. If no data is available a no data message is sent (the NCS will continue to poll until an answer is received from the helo). When data is transmitted, the receiving unit will generate an acknowledge message. If the acknowledge is not received, the sending unit retransmits once. In the autonomous state, data is transmitted from a unit at the discretion of the HDL operator. An overt receiving unit generates an acknowledge. A covert receiving unit will not respond, resulting in one retransmit of the same message.

Cryptographic State

109. Refer to ABR 6511 Section 1, Chapter 3, Pg 32, para 3-166.

Baud Rate

110. In the plain cryptographic state, all baud rates are available, ie: 75, 150, 300, 600 or 1200 baud. In cipher, due to KY-58 limitations, the baud rate may only be set to 75, 150 or 300 baud. If Cipher is selected, and a previous baud rate was greater than 300 (i.e. 600 or 1200), then a baud rate of 300 will be automatically selected.

Defaults

111. The default states and modes of the HDL are:

a. network state – autonomous;

b. transmission mode – covert;

c. crypto – plain; and

d. baud rate – 75.

System Monitoring & Testing

112. HDL system status is reported to ADS for display by VAB or SDA pushbutton. A data link modem self test can be initiated by the operator to run an internal BIT by selecting the ‘DLM self test’ VAB in the Common Equipment array. During the test, normal processing is suspended, thus HDL is unavailable for between 35 seconds and two minutes. To run the test, HDL must be in an overt transmission mode. An indication of whether the test is running or not, and the result of a test, is provided in the HDL status tab window.

Chapter 5. Beacon Video Processor

Reference: ABR 6511 Section 1, Chapter 3, Pg 33

Overview

1. There are two Beacon Video Processors (BVP’s) that initiate interrogations, and detect and process responses from the AIMS Mk XII IFF system into contact reports that are sent to the Command and Decision system to augment the air and surface surveillance pictures. The reports, containing decoded IFF information are associated with system tracks or used to initiate new system tracks as part of the dissimilar sensor fusion function. The unit provides a high probability of detection and monitors its own performance by detecting failures and reporting faults down to the circuit card level.

2. Each BVP comprises a beacon target extractor (BTE), type BTE-2000. One BTE processes SPS- 49 IFF, the second processes the Mk 92 CAS Search IFF. The BVP provides the operator with the functionality to conduct IFF interrogations against individual tracks or within adjustable zones, using all IFF modes. The zones set for the BVP’s are independant of each other, ie: adjusting the SPS-49 zone does not affect the Mk 92 CAS Search interrogation zone. Interrogations will automatically be triggered when a track is detected within the specified zones, or when a track is ordered for engagement. Automatic interrogation of tracks can be turned on and off at will. Additionally, operators can select a specific track for interrogation at any time.

3. Both BVP’s are operationally controlled at a C&Di console via the BVP array, a tactical array only available to Track Supervisor or ADT roles. A maintenance computer can be connected directly to the BTE’s for accessing parameters, adjusting default settings, and running diagnostics.

4. Interfaces between ADS and BVP are not dual redundant like most others in the combat system. Each BTE interfaces directly with a single server:

   a. The BVP associated with SPS-49 IFF is connected to ADS server 2.

   b. The BVP associated with Mk 92 IFF is connected to ADS server 1.

MODES OF OPERATION

5. Each Beacon Video Processor has 3 modes of operation, selected by a toggle switch at the BTE front panel:

   a. Normal,

   b. Maintenance 1, and

   c. Maintenance 2.

Normal Mode

6. Normal mode is used under normal operating conditions. The reply detection units (RDUs) process live IFF replies and non-interfering maximum range internally generated self-test replies. This is the only mode that interrogates and decodes real IFF targets.

Maintenance Modes

7. Maintenance 1 mode processes self-generated replies only. A single ring of 32 equally spaced sectors with test targets at maximum range is produced. The BTE internally generates all input stimulus ACP, ARP, mode identification triggers, and test video.

8. Maintenance 2 mode provides a more extensive test capability by producing multiple rings of test targets throughout the entire range coverage. Input stimulus is generated in the same manner as for maintenance 1 mode.

9. In the maintenance modes, the test target generator produces targets in the 32 independent azimuth sectors. Each sector generates a unique test scenario, verifying performance of a different aspect of the reply/ target detection process. These aspects include: bracket detection, code detection, code validation, range and azimuth determination, SPI/Ident and military emergency detection, code extraction, multi-path elimination, and garble detection/phantom elimination. In addition, the test target generator is capable of repeating the same user defined test scenario in all 32 sectors to enhance fault isolation capability.

BVP OPERATION

BVP Interrogation Zones

10. The BVP operators (Trk Sup or ADT) must ensure that interrogation zones reflect the current operating environment. Individual interrogation zones are set for both BVPs; these define the 360 degree area around ownship in which the BVPs will process data for display. Responses are analysed by BVP and assigned to corresponding tracks as part of the dissimilar sensor data fusion process.

11. BVP range settings are nominally done in accordance with ABR 6511 Section 7, Chapter 2, Pg 34, Para 2-197.

Auto Interrogation Zone

12. Once the BVP interrogation zones are set, the operators define the auto interrogation zone. Like the other zones, it is a 360 degree area around ownship with editable inner and outer ranges. The auto interrogation zone should cover the full area of the two BVP interrogation zones. Any track which has not previously been interrogated that falls within this zone will be set for automatic interrogation. The BVP used depends on the track's position in relation to the BVP interrogation zones; if it falls within both zones, then both BVPs will interrogate it.

13. Two VABs provide the operator with the ability to turn auto interrogations on and off; one for IFF modes 1, 2, 3A, and C, the other for mode 4. PWO/AWO permission is normally required prior to setting the mode 4 auto interrogations to on.

Specific Track Interrogations

14. All ADS operators have the ability to interrogate any tracks, regardless of their location. With a track hooked, whenever 'Int 1/2/3A/C' or 'Int 2/4' VABs are depressed, a temporary search sector is assigned to the hooked track. The Mk 92 sector is 10.6 degrees in azimuth, and the SPS-49 sector is 17 degrees; both sectors are centred on the hooked track. Once a reply from either Mk 92 BVP or SPS-49 BVP has been decoded and appended to the track, the sector is deleted in readiness for its next requirement. If no response is received in two scans of the parent radar (SPS-49) or five scans (Mk 92), the interrogation sector is removed.

15. BVP can have an effect on engagements as described in ABR 6511 Section 7, Chapter 2, Pg 34, Para 2-201.

16. The AWO can turn the automatic identity function off, however ADS will raise an alert when a valid mode 4 is received. Acknowledgement of the alert hooks the track and displays the track ID tab window, with the identity field of 'friend' highlighted. Selection of 'OK' would then change the ID to friend and cancel the engagement: selection of 'cancel' would close the ID tab window and leave the ID of the track unchanged and allow the engagement to continue.