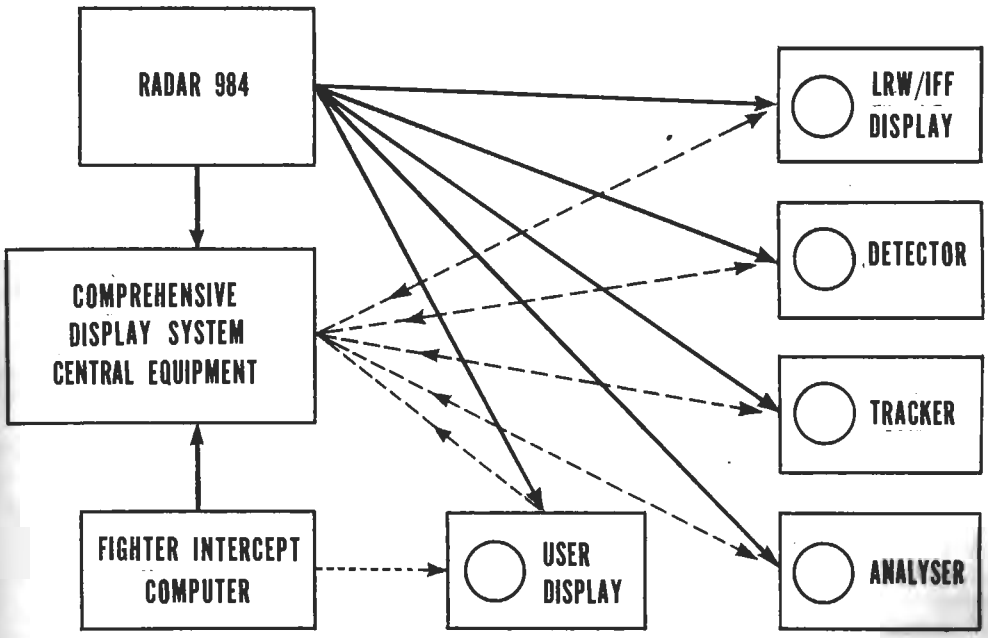
A HISTORY OF AUTOMATED AIO's

1.2 As early as 1944 the Royal Navy had recognised that a special organisation was required within a ship to handle action data and as a result, the Action Information Organisation (AIO) was brought into being. The tools of the art were largely human and electronic sensors, and manually controlled weapons. During the 1950s the development of the jet and rocket engines, together with increasingly sophisticated methods of weapon control such as homing devices, engendered a requirement to make a corresponding improvement to the methods of data handling in the AIO. The Royal Navy was convinced that rapid reaction was of paramount importance in the development of weapon systems.

COMPREHENSIVE DISPLAY SYSTEM (CDS)

1.3 In 1958 the RN commissioned the rebuilt carrier HMS VICTORIOUS with a radically new concept in the AIO the Comprehensive Display System (CDS). In this system, air track information obtained from a Type 984 long range warning radar is fed manually into electronic analogue data stores. The significant advance in data handling made by CDS is data access, since in this system, each operator can demand up-to-date information in the form in which he requires it rather than have to select information from a central common viewing unit. CDS is a successful system and, having seen service in the carriers HMS VICTORIOUS (now scrapped) and HMS HERMES, is currently in use in two class guided missile destroyers - HMS LONDON and HMS KENT.

OUTFIT	SHIPS
CDS/984	VICTORIOUS, HERMES and EAGLE
Modified CDS	ARK ROYAL



ACTION DATA AUTOMATION (ADA)

1.4 During the 1950s digital computer technology made great advances and the RN was quick to foresee their use in the AIO and to control weapons. CDS greatly improved data access time by storing data electronically, but the data was processed manually and, owing to the large quantity available, a large number of men were required to man the operations room. Manpower considerations have often made the Navy look for new ideas, as space is always at a premium in a ship and, in peacetime, the supply of men rarely meets the demand.

By the late 1950s, Ferranti were developing, in conjunction with the 'Admiralty Surface Weapons Establishment' (ASWE), the POSEIDON computer. This was, for its time, an extremely fast and powerful machine, and employed germanium transistor logic. Three were to be used in the Action Data Automation system in HMS EAGLE, which was being modernised to carry the latest aircraft, radar and other equipment. Another major development for this project was ADACD, a special-purpose equipment for automatic processing of radar data from HMS EAGLE's stacked-beam 3-D radar.

The ADA system was designed principally for the Action Information Organisation with particular emphasis on air-defence problems.

In ADA the power and storage capability of digital computers made considerable advances possible. Track and data capacity was greatly increased, and at the same time crew requirements were reduced by the use of automatic radar tracking. Data from all available sources is collected in the computers' stores, correlated, and made available for display at the operators' consoles in the form of labelled plan displays (LPDs) and 'totes'.

Some measure of weapon system control was attempted in ADA but proved unsuccessful due to insufficiently accurate data inputs to the computers from the sensors (Type 984 3D air surveillance radar, IFF, surface radar, radar data from other ships sent by digital link, own ship navigational information, and manual inputs). Some assistance in tactical decision-making by the Command is provided by ADA in the form of displays of lists of threatening targets and weapons available to take them. HMS EAGLE became operational in 1964 and ADA, in spite of some over-ambitious initial claims of its capability, fully justified the RN's investment in the development of digital computers for tactical data handling. Many lessons, not foreseeable in the laboratory or in committee, were learnt. In particular, many pointers for future development work on the man/machine interface were obtained. The still widely held belief that a computer is the answer to all data handling and weapon control problems was shown to be a myth and the popular cry of computer men, 'If you put garbage in, you will get garbage out', was shown to be perfectly true.

ACTION DATA AUTOMATION AND WEAPON SYSTEM (ADAWS)

1.5 The next logical development of ADA was to embrace the data handling requirements of all three environments (air, surface and sub-surface) into a computer-based system and, in addition, provide more weapon system control through the central processor.

A further series of ADA systems was ordered in 1961, for installation in the later ships of the RN's COUNTY class of guided-missile destroyers. These ships were the first to receive the Seaslug Mk 2 missile, giving improved performance compared with earlier types.

The system provides similar Action Information functions to that in HMS EAGLE, including facilities for automatic detection and tracking of surface and air targets. A new general-purpose auto-extraction equipment (SPADE) was developed for use with any typical 2-D (fan-beam) radar, and in these ships this equipment is fitted in conjunction both with long-range air-warning radar (P-band) and with S-band radars for target-designation and height-finding. The height-finding radar is in fact controlled by the computer system, obtaining height measurements automatically on targets selected either by operators or by computer program. This process both speeds up the rate of height-finding and also saves several operators.

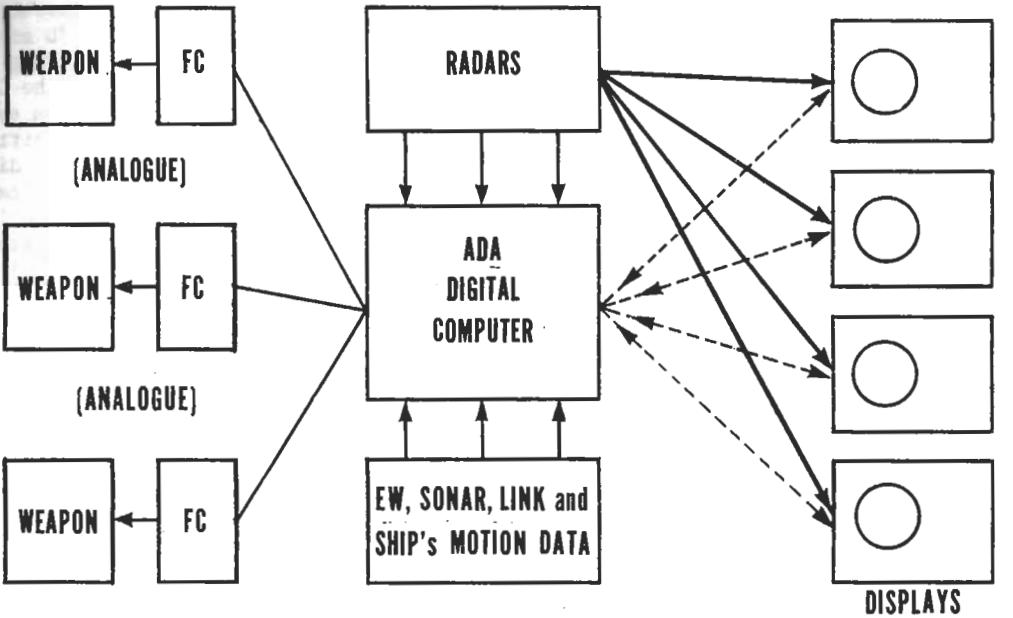
Other new functions were also included in these systems. Inputs of data from the ship's Electronic Warfare equipment are provided. Sonar data is input semi-automatically - that is, the sonar operator continues to detect and measure the positions of contacts, but his measurements are 'read' automatically by the computer. Aids to ASW operation include calculation of vector orders ('VECTACS') for an ASW helicopter using the MATCH ASW torpedo attack procedure.

In the air-defence field, instead of fighter allocation, control and recovery facilities, the COUNTY class system includes facilities to assist selection of targets for engagement by the ship's AA armament - SEASLUG, SEACAT, and 4.5 inch guns. For the guns and Seacat systems, outputs of target-indication range and bearing are provided, giving direct synchro control of their respective directors. For Seaslug, certain additional facilities are provided - in addition to target indication - to assist in control of engagements. Because of its greater involvement with weapon control, the COUNTY class system was given the title ADA Weapon System Mk 1 (ADAWS 1). It must be noted, however, that in these ships all the weapons retain their own separate analogue fire-control computers.

The ADAWS 1 system uses two Poseidon computers, and was first installed (in HMS FIFE) in 1965. The displays used in the Operations Rooms, like those in HMS EAGLE, were manufactured by Pye Ltd.

OUTFIT	SHIPS
DAA	EAGLE
DAB	FIFE, GLAMORGAN, ANTRIM and NORFOLK

ADAWS 1



Part 1 Fig 1

ADA WEAPON SYSTEM MK 2, 4 AND 5

1.6 By 1963, the Royal Navy was engaged in planning and development for the next 'generation' of ships, weapons and systems. These included the Type 82 class of guided-missile destroyers, and the projected new aircraft-carrier (CVA 01). For these ships a new anti-aircraft missile - SEADART - was being developed, and the destroyers were also to carry a British version of the Australian long-range ASW missile, IKARA. Both types of ship were also to be fitted with a new 3-D radar, being developed in Holland as a joint Anglo-Netherlands project.

A new ADA weapon system was to be developed, including a further broadening of the ADA functions.

These would now include an even closer involvement in the operation and processing of the 3D radar, and a general enlargement and improvement of AIO and display facilities. Most significantly of all, the system would incorporate all the fire-control functions, previously performed by separate computers, for SEADART, IKARA, and for 4-5 inch gun mountings. This called for a very considerable increase in system capacity, in terms of computing power, storage, and input/output capability. The new systems were, therefore, developed on the basis of a new type of computer (the 1600 series) and of a completely new range of modular units which could be used to form the 'building bricks' for a whole range of systems.

Subsequent changes in British Defence plans resulted in cancellation of the new aircraft-carrier development and reduction of the Type 82 class to a single ship - with a corresponding end to the need for the new 3-D radar. In their place, the RN planned to introduce a new class of smaller anti-aircraft destroyers armed with SEADART, and to deploy IKARA in a number of the existing LEANDER class frigates during their modernisation. Planning was also continued for a new class of large 'Command Cruisers', which would be equipped with a flight-deck for operation of helicopters and possibly V/STOL aircraft. Development of ADAWS 2 for HMS BRISTOL therefore continued, with the specific objective that sub-sets of both hardware and software modules from this ship should be applicable for ADAWS 4 (Type 42) and ADAWS 5 (LEANDERS), as well as providing the basis for a larger system for the new cruisers. ADAWS 2 equipment for HMS BRISTOL was installed in the spring of 1970, and delivery of ADAWS 4 and 5 commenced in 1971.

SMALLER AIO SYSTEMS

1.7 Systems of the same general type as ADA are now to be found in the major units of many of the world's leading navies. These systems, however, tend to be expensive. They are designed to cope with the most exacting situations - particularly in air defence; they employ the latest and most sophisticated types of display - often with digital time-base and deflection circuits; they operate in conjunction with very high capacity automatic data links,etc. These characteristics, while valuable in the right context, make the systems too expensive for general fitting in smaller ships.

Analysis of the operational needs of smaller ships such as ASW frigates showed, however, that these units would benefit greatly from the fitting of a digital AIO system, and of a medium-speed data link. The Royal Navy, therefore, set out to determine whether a practicable and useful system could be provided at a price low enough to allow widespread fitting. They also defined the characteristics of a simple medium-speed digital data link, for use both in the smaller systems and also in ADA-fitted ships.

The outcome of system investigations by the RN and a number of companies was the definition of CAAIS (Computer-Assisted Action Information System) - a system tailored to the needs of smaller units.

CAAIS and similar systems are based on the Ferranti FM 1600B computer - smaller than the FM 1600 used in ADAWS but fully compatible in program and engineering characteristics. These systems use the same type of technology and construction as ADAWS, and, indeed, incorporate many of the same digital equipment modules.

The main differences between ADAWS and the smaller AIO systems are thus as follows:-

a. Smaller capacity for storage and display of track data. Typically CAAIS systems provide for handling of up to 60 tracks - amply sufficient for small ship needs.

b. Simplification of some of the processing involved. In general, the CAAIS aim is to assist the operators to carry out their normal jobs more efficiently, rather than to replace them altogether by fully-automatic procedures.

c. Use of display consoles which, by accepting more modest standards for deflection and character-writing speeds, registration accuracy, etc, provide a remarkably economical solution.

The effect of a. and b. is to reduce the computer loading and storage requirements: together with the lower-cost display units, the whole system becomes more cost-effective.

The CAAIS concept has already shown a high degree of flexibility, providing modular systems to meet the requirements of frigates of various types and capable of extension to cover the needs of larger units. It is also planned to fit systems using this type of equipment in smaller craft.

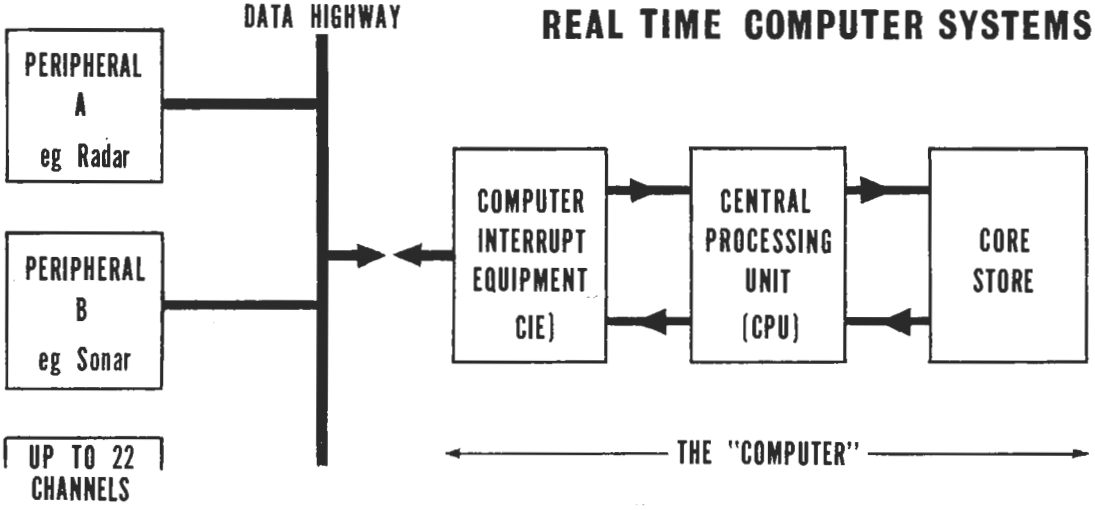
RN COMPUTER SYSTEMS

FM 1600B

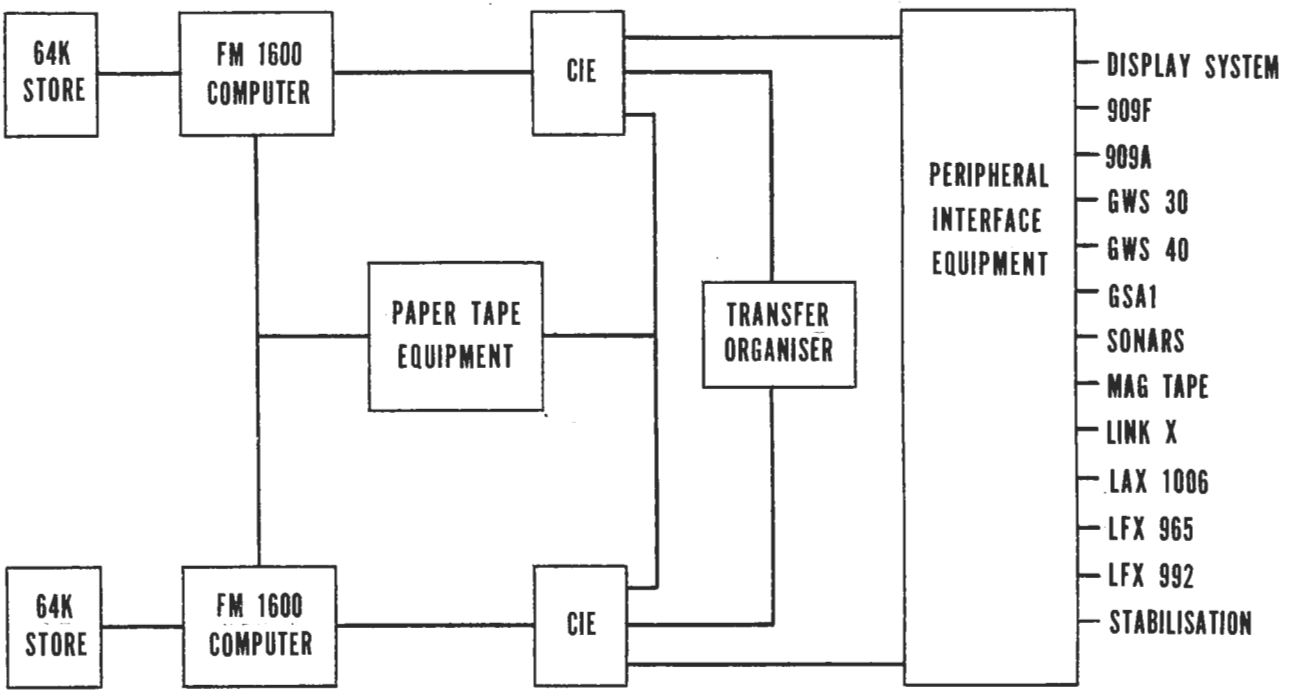
CAAIS	-	DBA1	-	Batch II Leanders	(8)
		DBA2	-	Type 21's	(8)
		DBA3	-	Hermes	(1)
		DBA4	-	MCMV	(12?)
		DBA5	-	Type 22's	(6?)
			-	Batch III Leanders	(10)
WSA4	-	DBD1	-	Type 21's	(8)
SONAR	-	2016	-	Type 22's	(56)
Submarine	-	DCA			≃ (20)
		DCB			
		DCD			
GWS25	-	DBB		Type 22's	(26)
		DBC			
		MAC		Batch III Leanders	

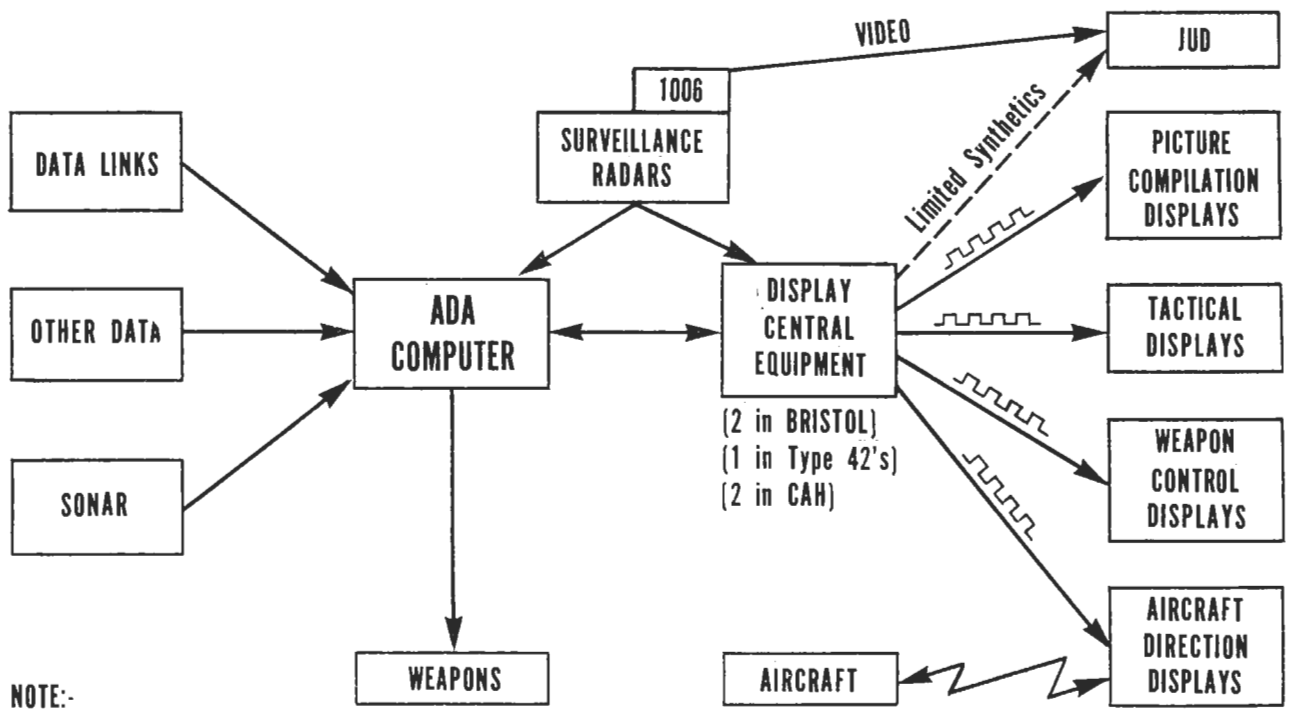
FM 1600

ADAWS	2	DAC	BRISTOL
	4	DAD	Type 42 - Batch 1
	5	DAE	IKARA Leanders
	6	DAF	INVINCIBLE
	7	DAG	Type 42 - Batch 2


REAL TIME COMPUTER SYSTEMS
DATA HIGHWAY
PERIPHERAL A eg Radar
PERIPHERAL B eg Sonar
UP TO 22 CHANNELS
COMPUTER INTERRUPT EQUIPMENT CIE)
CENTRAL PROCESSING UNIT (CPU)
CORE STORE
THE "COMPUTER"

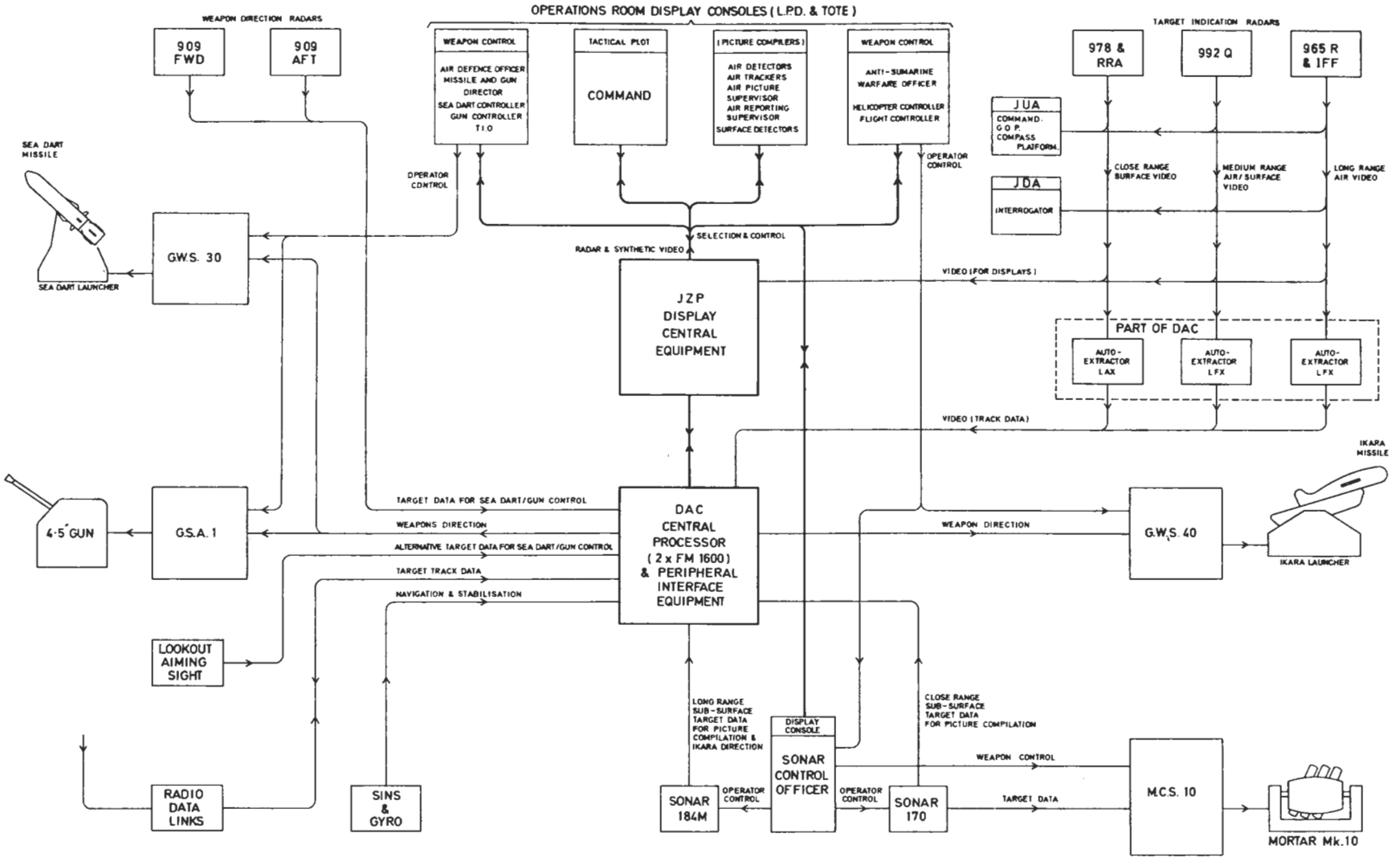
DAD/DAC DATA FLOW



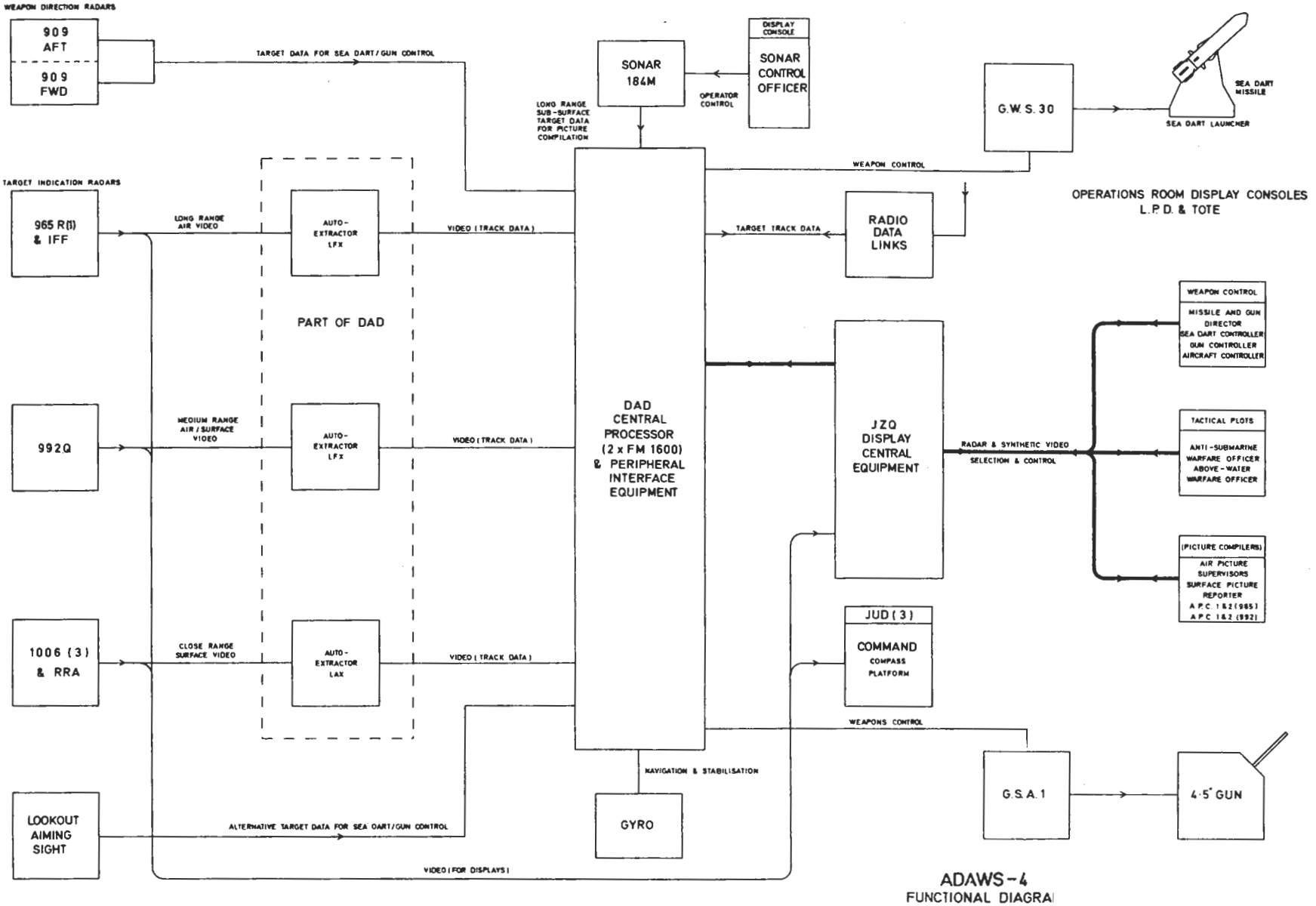


NOTE:-

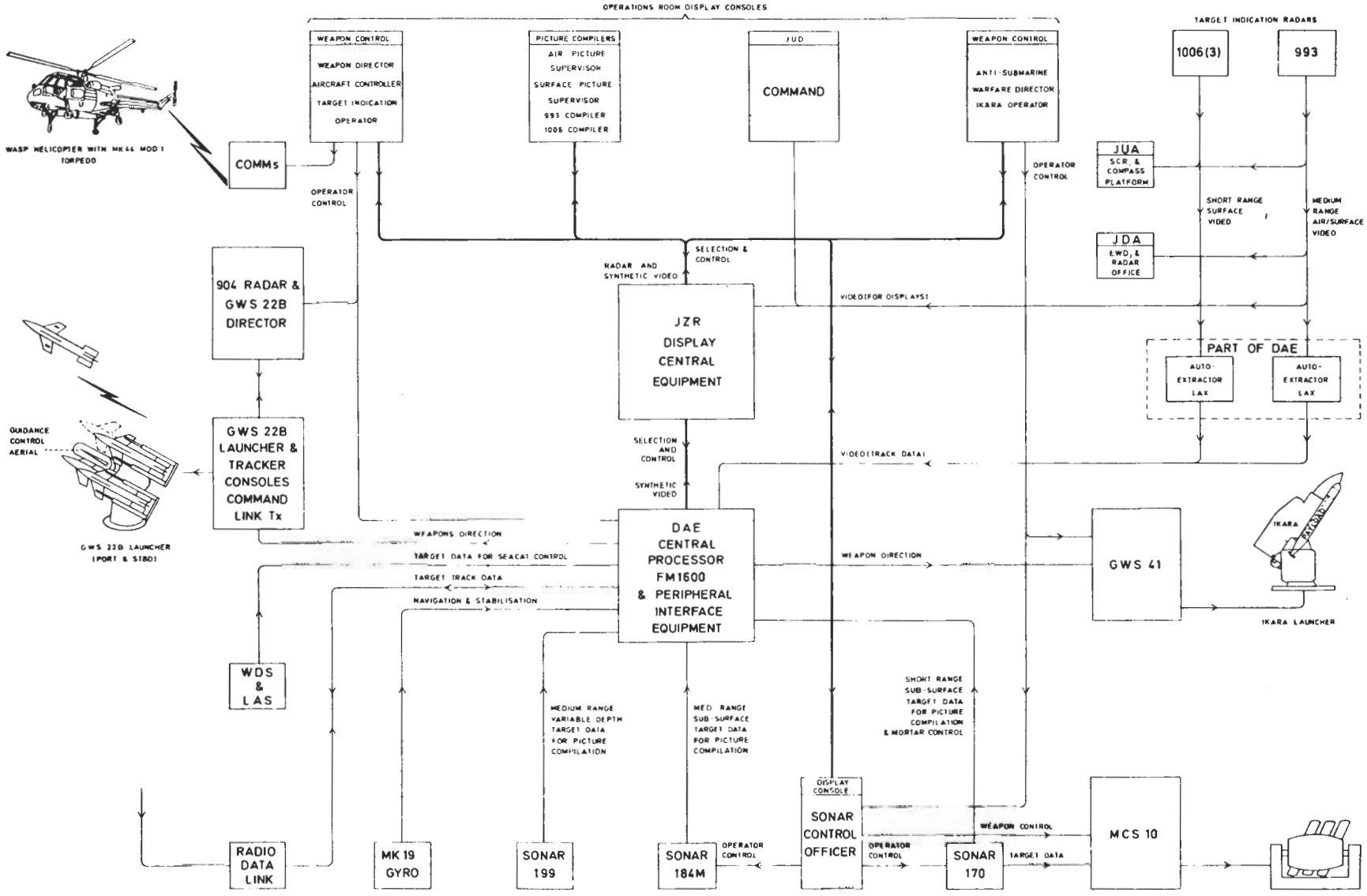
Type 42 has extra displays but these are slaved to main displays. This is an attempt to overcome the single DCE outfit



ADAWS 2
FUNCTIONAL DIAGRAM

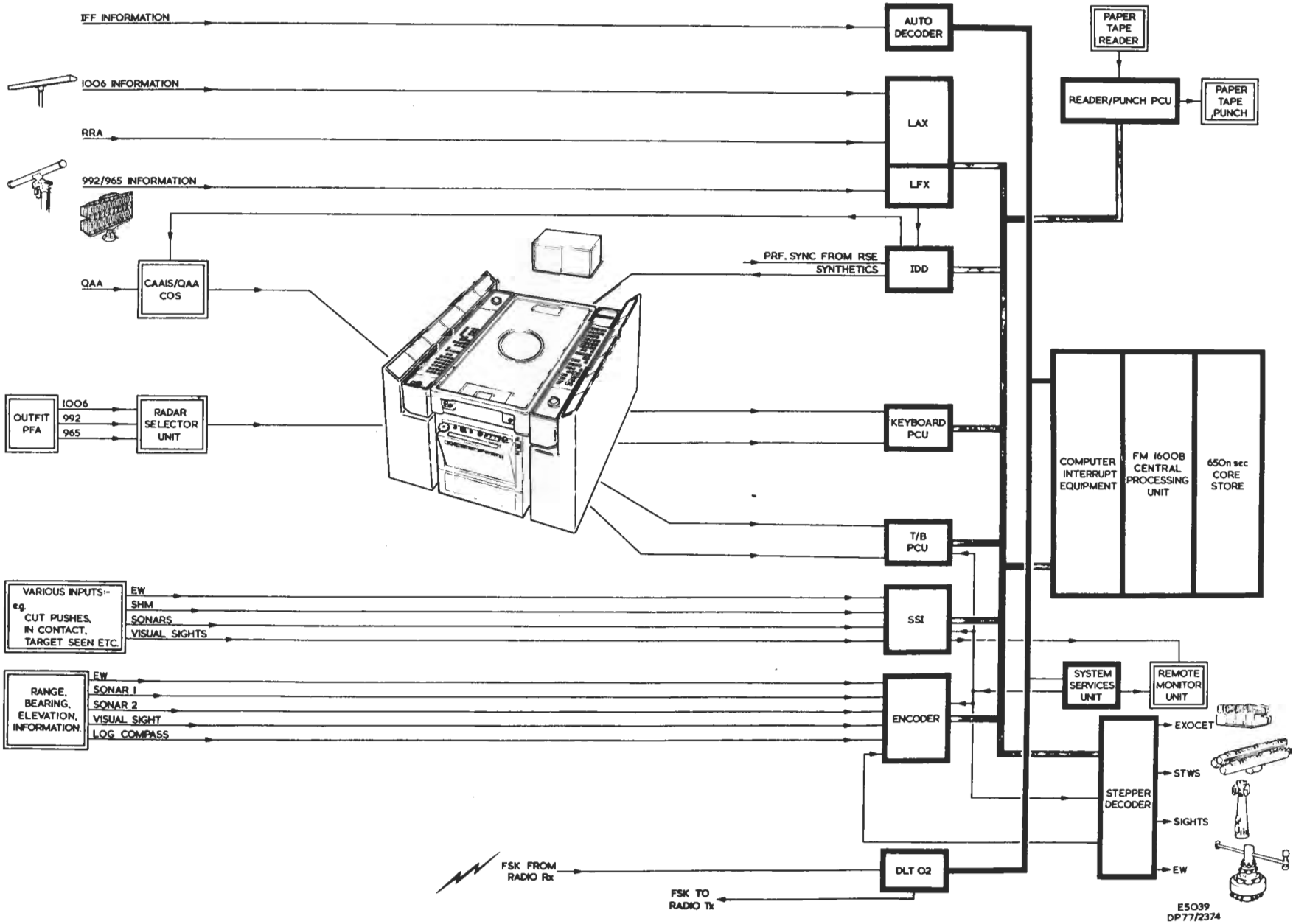


ADAWS-4
FUNCTIONAL DIAGRA

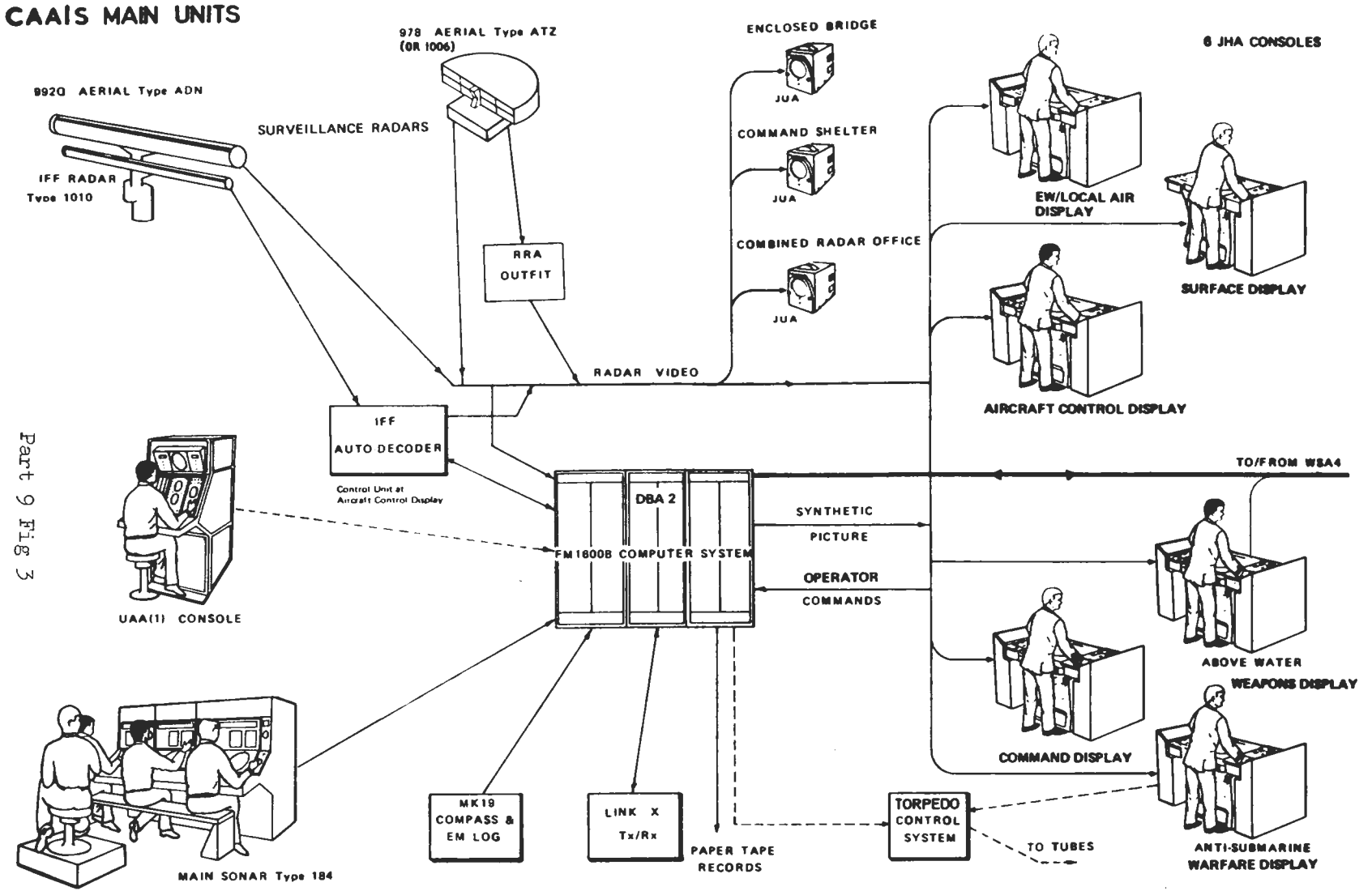


ADAWS-5
FUNCTIONAL DIAGRAM

BASIC CAAIS CONFIGURATION

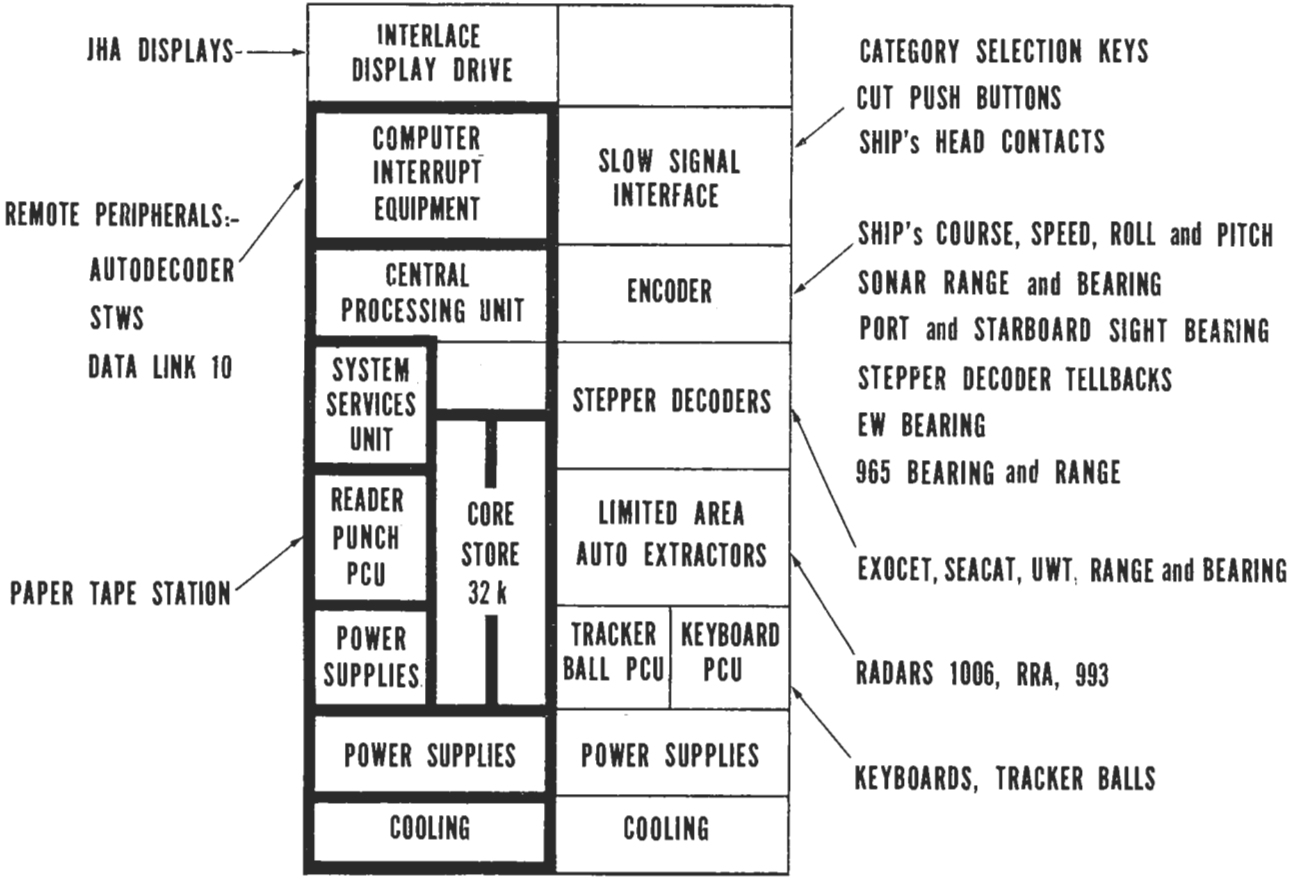


Part 9 Fig 2

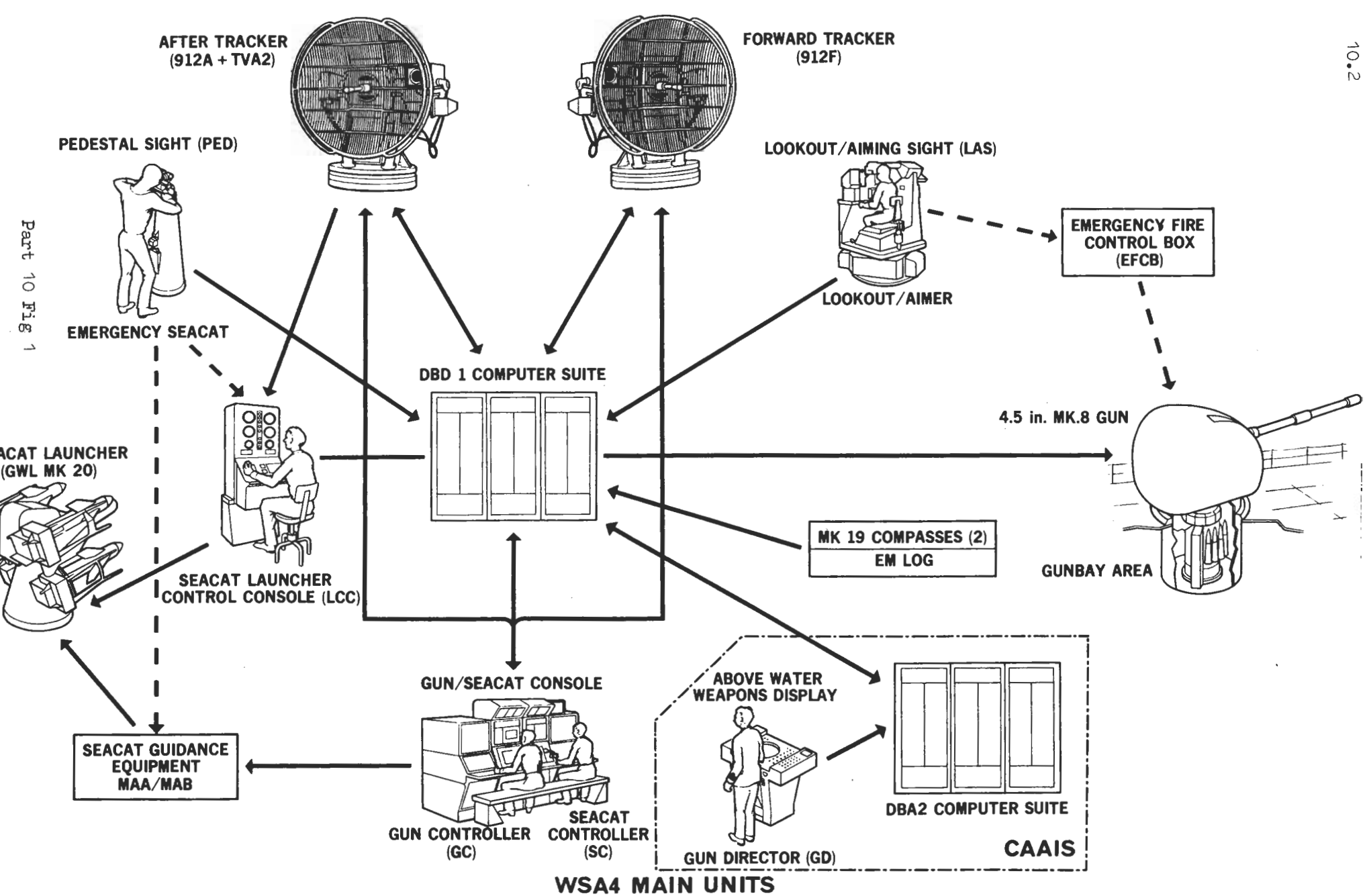

CAAIS MAIN UNITS
978 AERIAL Type ATZ
(OR 1006)
ENCLOSED BRIDGE
6 JHA CONSOLES
9920 AERIAL Type ADN
SURVEILLANCE RADARS
JUA
COMMAND SHELTER
JUA
IFF RADAR
Type 1010
RRA
OUTFIT
COMBINED RADAR OFFICE
JUA
EW/LOCAL AIR
DISPLAY
SURFACE DISPLAY
RADAR VIDEO
AIRCRAFT CONTROL DISPLAY
IFF
AUTO DECODER
Control Unit at
Aircraft Control Display
TO/FROM WSA4
DBA 2
FM1600B COMPUTER SYSTEM
SYNTHETIC
PICTURE
OPERATOR
COMMANDS
UAA(1) CONSOLE
ABOVE WATER
WEAPONS DISPLAY
COMMAND DISPLAY
MK19
COMPASS &
EM LOG
LINK X
Tx/Rx
PAPER TAPE
RECORDS
TORPEDO
CONTROL
SYSTEM
TO TUBES
ANTI-SUBMARINE
WARFARE DISPLAY
MAIN SONAR Type 184

Part 9 Fig 3

CAAIS SYSTEM DBA 1 – HMS CLEOPATRA

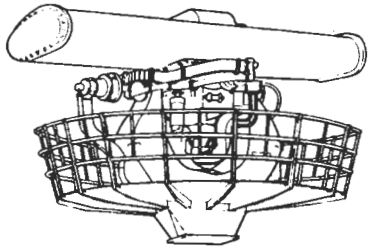


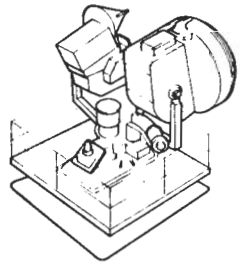
The area outlined is the basic "central processing' system" and is common to all computer suites

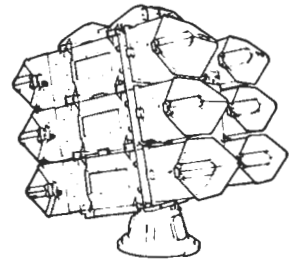


WSA4 MAIN UNITS

GWS 25 BLOCK DIAGRAM







AERIAL OUTFIT AZT

TRACKER

LAUNCHER

I.F.F. 1010/1011

RADAR 968

RADAR 967

I.F.F.

SECONDARY VIDEO

PRIMARY RADAR AUTOMATIC DETECTIONS

TARGET/ MISSILE ERRORS

GUIDANCE COMMANDS

FWD MISSILE GUIDANCE COMPUTER MAC

ELEVATION & TRAINING RATE DEMANDS

DATA LOGGING

TIMING AND CONTROL

LAUNCHING & FIRING CONTROL CABINETS

RADAR 1006

C.A.A.I.S. COMPUTER ASSISTED ACTION INFORMATION SYSTEM DBA

DIGITAL TARGET DATA FOR DISPLAY

SURVEILLANCE & TARGET INDICATION COMPUTER DBB

FWD TRACKING & LAUNCHING COMPUTER DBC

L.A.S.

MANUALLY SELECTED TARGETS

TRACKER ALARM RANGE RANGE RATE TRAINING TRAINING RATE SURFACE/AIR

MISSILE CONTROLLERS CONSOLE

AFTER SYSTEM