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SYSTEMS ON BOARD THE NATO E-3A PLATFORM

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ABSTRACT

The article highlights the importance of the systems on board the NATO E-3A platform and how they influence the mission and work of the aircrew. The E-3A is an Airborne Early Warning & Control (AEW&C) system designed to provide early warning information to battle managers through surveillance of airborne and maritime objects, and to provide aircraft control capabilities. Even though the system is integrated on the old airframe of Boeing 707, in the past 35 years there have been numerous upgrades. The biggest upgrade of them all is the conversion of the entire fleet of aircraft to the NATO Mid-Term (NMT) configuration and then to "glass cockpit". Now, the fleet is embarking upon a final modernization effort to extend its service life to 2035.

KEYWORDS:

E-3A platform, E-3A system, surveillance radar, communications system

1. Introduction

In almost any kind of military operation today, armed forces depend, to greater or lesser degree, on electronics. The ability to detect and analyze emissions from these electronic systems is now widely recognized by all militaries as extremely important for three reasons:

- to interfere with and degrade enemy electronic systems;
- to protect own systems from enemy interference;
- to provide battle commanders and aircrews with real time electronic information.

In the E-3A, each set of related components is called a "system". There are 7 basic systems on the E-3A:

- Air Vehicle;
- Navigation Systems;
- Surveillance Radar System (SRS) – Active Sensor System;
- Identification System – Active Sensor System;
- Electronic Support Measures System (ESMS) – Passive Sensor System;
- Communications System;
- Mission Computing System (MCS).

2. Active and passive sensor systems

Surveillance Radar System (SRS) is the primary active sensor and is composed of four main parts:

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- Radar Control and Maintenance Panel;
- SRS computer;
- Transmitters;
- Antenna pedestal equipment.

These components work together to provide information on range, bearing, altitude, and velocity of surface and airborne tracks.

The E-3A's surveillance radar, or AN/APY-2 radar set, is the primary mission sensor for the platform, providing three-dimensional air space coverage. The radar system is quite versatile in the types of targets it can detect. The Surveillance Controller is responsible for adjusting the operational parameters of the radar in order to get the best detection and tracking of targets in areas of interest, based on several factors: mission tasking, terrain, search area, type of tracks, and so forth. One of the most critical decisions to make is which radar mode or modes to select for the surveillance tasking.

The AN/APY-2 system consists of two radars: pulse and PD (Northrop Grumman Corporation Airborne Surveillance Systems, 2009). Each radar has 3 possible configurations: active, passive, or off:

ACTIVE – In active configuration the radar transmits and receives radio frequency (RF) energy.

PASSIVE – In passive configuration no RF energy is transmitted but the radar receiver is turned on to process received signals. Signals received in passive configuration are processed to generate electronic protection measures (EPM) reports.

OFF – In the off configuration both the transmitter and receiver are completely switched off. RF energy is neither transmitted nor received.

A mode is a combination of pulse and pulse Doppler (PD) functions or operations. The pulse radar can be configured for three different functions (Northrop Grumman Corporation Airborne Surveillance Systems, 2009):

- Beyond the Horizon (BTH);
- Enhanced Beyond the Horizon (EBTH);
- Maritime Surveillance Capability (MSC).

The PD radar uses elevation scan or non-elevation scan operations. Since the pulse and PD radars operate at different frequencies, these radar operations can occur almost simultaneously. The radar modes can be combined and operated together to provide the crew the best support.

Proper radar mode selection depends on the type of mission flown and the situations that occur during that mission. Therefore, the crew must apply their knowledge and experience of the different radar modes to meet tasking requirements to provide the best possible radar picture to the crew.

Identification Friend or Foe (IFF) is the classic means for identifying aircraft. Developed for military aircraft in World War II, IFF is the design upon which the Air Traffic Control Beacon System (ATCBS) and the Selective Identification Feature (SIF) is patterned. Essentially a secondary radar, an airborne or ground based station's IFF/SIF system transmits interrogating pulses that friendly aircraft can respond to with coded replies (IFF Systems).

The E-3A IFF/SIF system consists of a transmitter and receiver called an interrogator set. The interrogator sends out a message consisting of 3 coded pulses: P1, P2 and P3. The time between P1 and P3 determines the requested mode. Friendly forces and civilian aircraft carry an IFF/SIF receiver and transmitter called a transponder. When the transponder receives the IFF/SIF coded pulse message, the transponder automatically sends a coded response message back to the interrogator. The interrogator receives and decodes the pulses, giving the bearing and range of the transponder with its SIF code. This all happens in thousandths of a second

permitting almost instantaneous identification of friendly aircraft.

ESM is the division of EW (electronic warfare) involving action taken to search for intercept, locate, record and analyze radiated electromagnetic energy for the purpose of exploiting them in support of military operations (United States Marine Corps, Joint Staff, 2020). Therefore, ESM provides a source of EW information required to conduct threat detection, warning, and avoidance.

ESM is not a stand-alone sensor. It is fully integrated into the system to provide amplifying information through data collection; the indications and warnings provided by the ESMS affect the entire crew. Thus, ESMS enhance the E-3A capabilities to detect, identify and locate air, surface and ground emitters. All crewmembers sitting at multi-purpose consoles are ESMS operators and the TD (Tactical Director) is responsible for ensuring that the crew uses ESM information effectively.

Since every crew position has different needs, the crew must share all information during mission planning and finally a successful mission under the statements made above.

The quality of the ESM database is of great importance to the efficiency of the ESMS. The ESMS uses a very large database of platforms, emitters and associated data. When an emitter is detected, the ESMS automatically sorts through all of this data in order to achieve an identification of the emitter and the platform. Once an emitter is identified, it must then be associated with a platform.

3. Communications system

The E-3A communications system includes radios for the mission crew and the flight crew. The flight crew has control of tuning its dedicated UHF and VHF radios.

With the Mid-Term modifications, one E-3A has 18 UHF radios available for use (not including the JTIDS transceiver). Although there are 18, six of the 18 are used in pairs with the receiver of one unit used in conjunction with the transmitter of another unit. This “duplexing” is necessary so the radios can be used for radio relay.

The UHF antennas are blade antennas with the receive antennas located toward the rear of the fuselage of the airplane and the transmit antennas located towards the front. This is to allow for simultaneous transmitter/receiver operations without interference

Over the last 35 years, the development of *Digital Data Links* (DDL) has concentrated on the exchange of tactical information between Command and Control (C2) elements. The complexity of the modern battlefield, combined with the requirement to transfer information in ‘real time’ and the growing electronic warfare capability of potentially hostile nations, has outstripped the capabilities of the majority of NATO’s current DDL systems. Therefore, there was a requirement for an Electronic Countermeasures (ECM) Resistant Communications System capable of providing secure communications between all elements involved in Anti Air Warfare/ Air Defense operations. In addition, NATO has a requirement for a Joint-Tactical Information Distribution System (JTIDS). JTIDS was developed for the US forces as a result of their experiences in trying to affect the command and control of joint and single service operations in the Vietnam War. It is designed to be a high capacity, secure, flexible, real time, ECM resistant and survivable integrated communication system.

IJMS was developed as an interim message format for JTIDS while Link-16 messages were being developed and fielded. The IJMS message catalogue is based closely on the M Series message catalogue associated with Link-11, but that is as far as the similarity goes; IJMS has greater capacity than Link-11 and is ECM resistant (Army Training and Doctrine Command Fortmonroe VA., 2000).

Link-16 does practically everything IJMS, Link-11, Link-4, and Link-14 can do, plus a lot more. NATO Link-16, also called TADIL-J, uses the J-series message sets to operate the JTIDS equipment.

Both Link-16 and IJMS are encrypted data links, which operate at very fast data exchange rates. Both offer flexible, jam resistant, real time data exchange between airborne, land-, and sea-based units. Each provides secure ECM Resistant Voice communication.

4. Conclusions

The E-3A is designed to provide early warning information to battle managers through surveillance of airborne and maritime objects, and to provide aircraft control capabilities.

The E-3A is equipped with long-range radar and passive sensors capable of detecting air and surface contacts over large distances. Due to a great integrated system, the platform is able to track and identify aircraft operating at low altitudes, at ranges exceeding 400 km, as well as to provide control to friendly aircraft. The ESMS is identified to be of a great importance because its ability to conduct data collection, threat detection, warning and avoidance.

After analyzing its systems, we recognized that the E-3A has many capabilities for surveillance and control, unmatched by previous systems. Still, the operators are the ones that are deciding the configuration and modes of the radar, as well as operating the ESM system. On top of that, without communications, the E-3A's capabilities are useless. In order to manage needs, because of limited number of radios, the crew has to be able to identify the capabilities and limitations of the E-3A communications equipment and to prioritize in order to accomplish the assigned missions.

Tactical data links identified on board facilitate and smoothen data transfer between the platform and other C2 centers or platforms in a safe and secure way.

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