
IET SUSSEX CENTRE
HAWTH THEATRE CRAWLEY
7th.FEBRUARY 2007

**IDENTIFICATION
- FRIEND OR FOE**

RICHARD M.TRIM OBE CEng FIET

IDENTIFICATION FRIEND OR FOE – A DEFINITION

- **IN PRINCIPLE, THE TERM “IFF” COULD REFER TO ANY SYSTEM WHICH SEEKS TO DISTINGUISH FRIENDS FROM FOES – INCLUDING THE NUMBER ONE EYEBALL!**
- **IN PRACTICE – AND SINCE ITS INCEPTION IN 1935 – IT REFERS TO A RADIO BASED, ELECTRONIC TECHNIQUE IN WHICH TARGETS, WHOSE PRESENCE AND POSITION HAS BEEN DETERMINED BY AN ASSOCIATED PRIMARY SENSOR – USUALLY A PRIMARY RADAR - ARE INTERROGATED BY MEANS OF A CODED RADIO SIGNAL TO WHICH FRIENDLY PLATFORMS MAKE A CODED IDENTIFYING RADIO REPLY.**
- **SINCE THE COLLAPSE OF THE WARSAW PACT, THE MOST COMMON FORM OF IFF IS THAT USED BY NATO NATIONS WITH NON-NATO NATIONS USING A “LOOK ALIKE”, THE FREQUENCIES OF OPERATION BEING STANDARDISED ON 1030MHz FOR INTERROGATION AND 1090MHz. FOR REPLY.**



SEVENTY YEARS AFTER ITS INVENTION IFF REMAINS RELEVANT AND VITAL

PRELUDE

- **Invention of IFF by Robert Watson-Watt in 1935**
- **Independent Development by USN and in Germany in 1936-37**
- **Passive IFF – UK Watson-Watt 1935 patent**
 - **Trials with Anson, Harrow and Scapa Flying Boat**
- **USN Trials with vertically polarised dipoles**
- **Active IFF – Watson Watt patent of 1936**
- **USN trials with XAF shipboard radar 1938**
- **1937 Air Defence Exercises – Pip Squeak.**
- **1939 – Position at outbreak of WWII**

The Inventor of IFF and of Secondary Radar

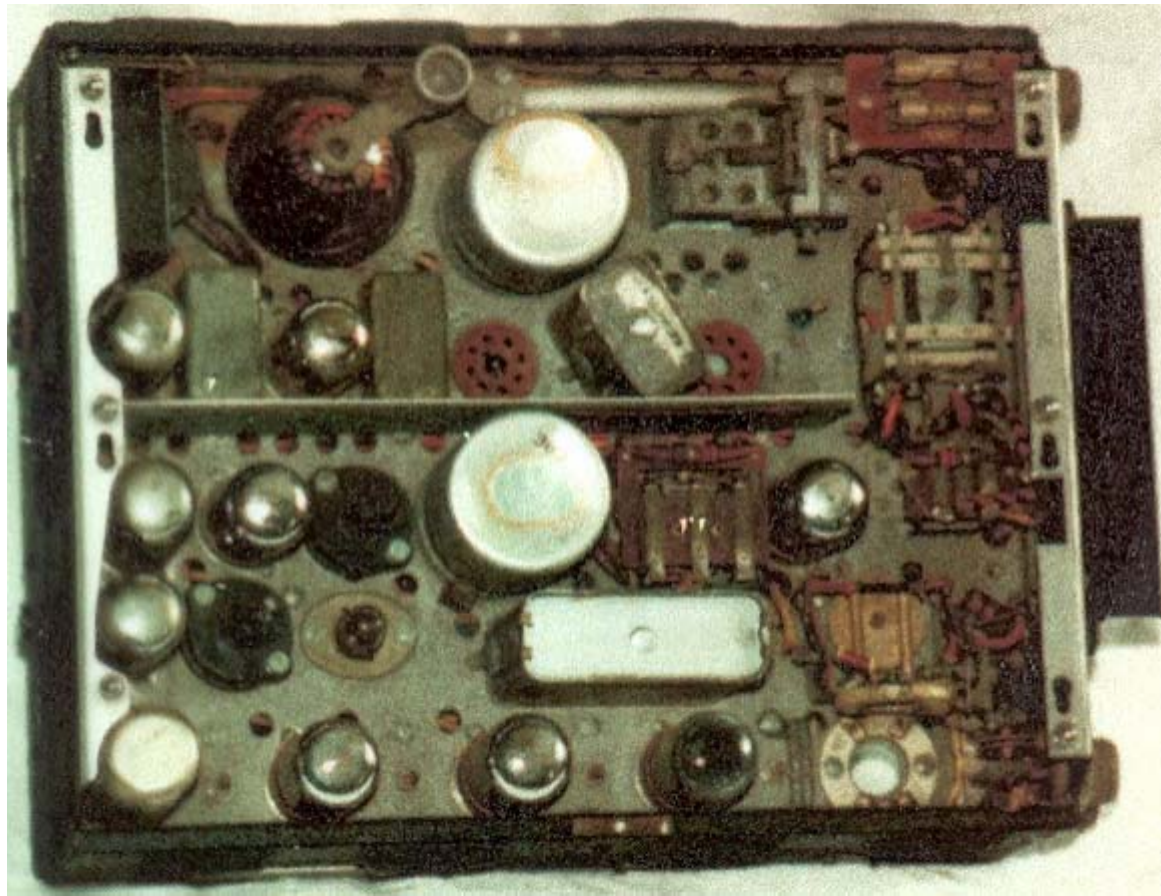


Sir Robert Watson-Watt

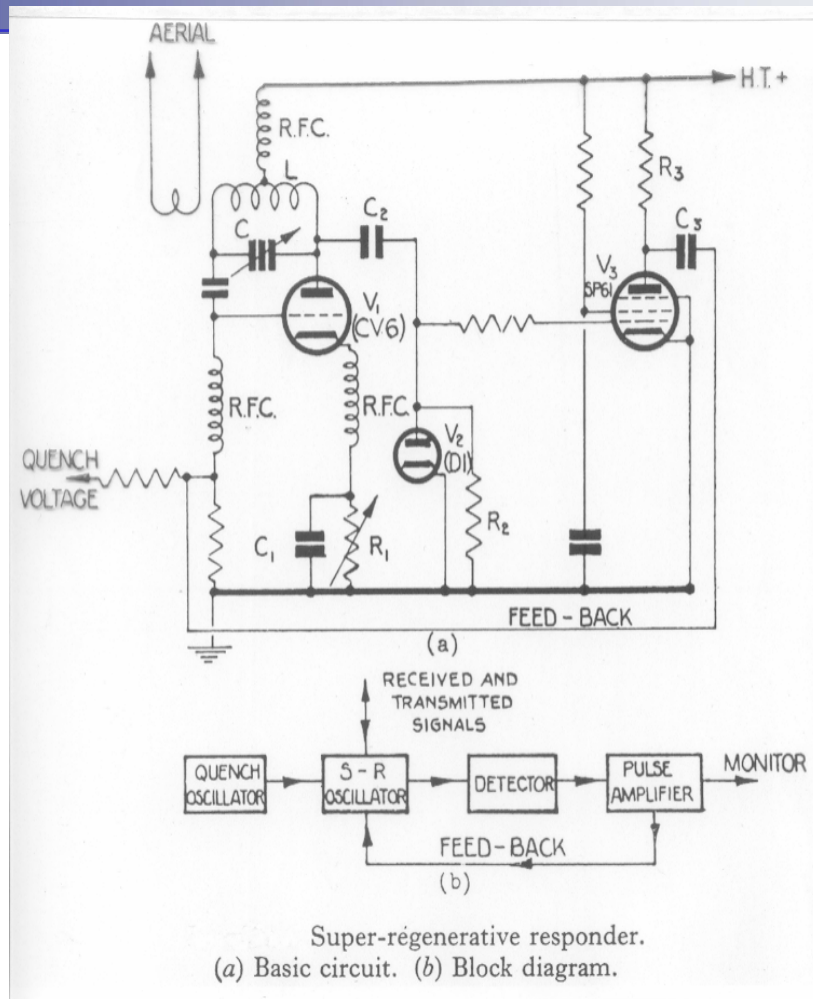
SIR ROBERT WATSON WATT – INVENTOR OF IFF AND SECONDARY RADAR

WWII Developments – 1940-45

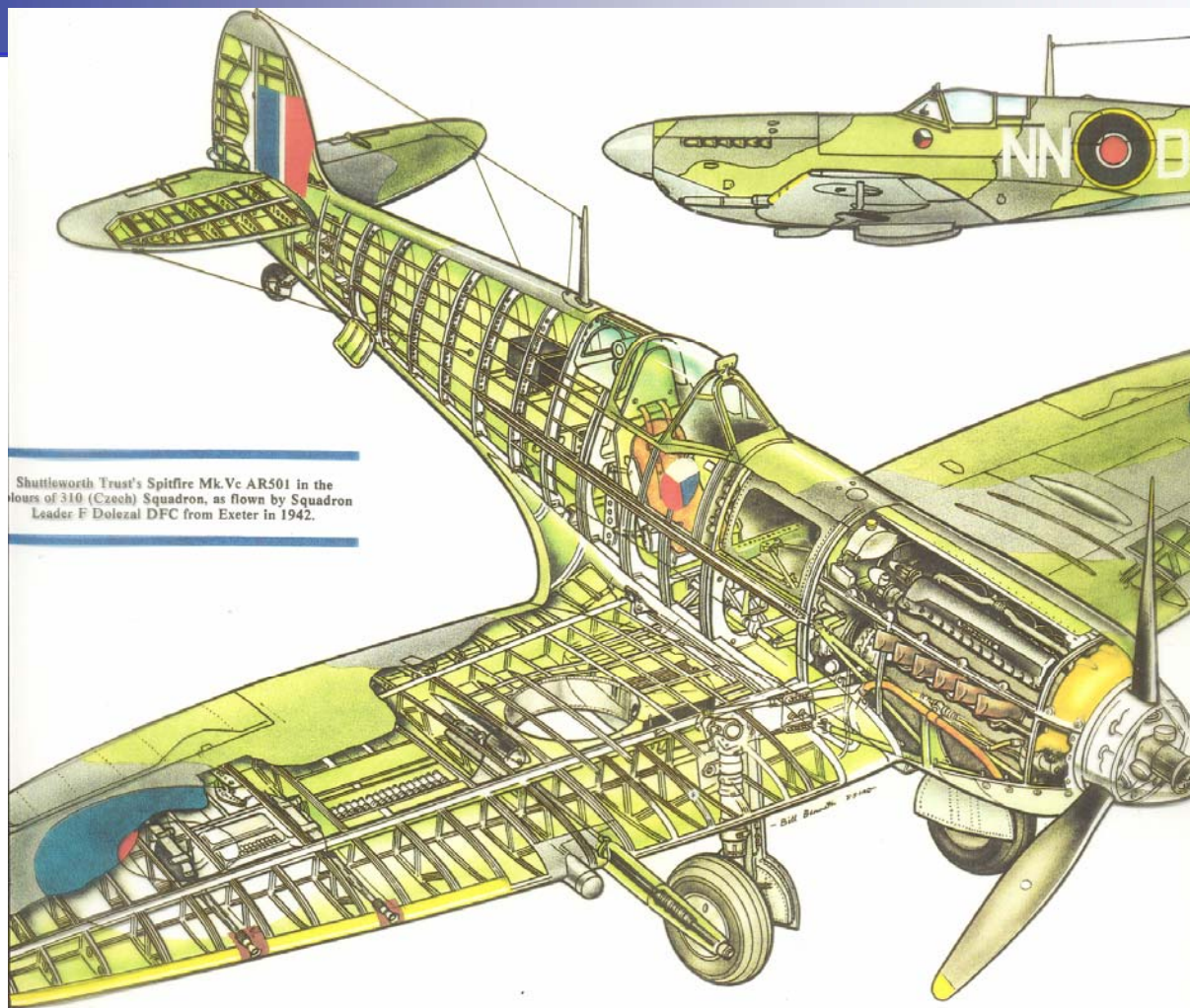
- **1939 – UK IFF Mk.I – CH Band (20-30MHz.)**
- **1940 – UK IFF Mk.II – CH and CHL (200MHz.) Bands**
Naval N1 (195-227MHz.) and N2(38-52MHz.)
- **1941 – UK IFF Mk.III – Separate Band IFF (F.C.Williams).**
- **1941 – Allied Adoption of IFF Mk.III – Over 200,000 built.**
- **USN IFF Mk.IV – 470MHz. BL and ABA**
- **Luftwaffe FuG 25a.**
- **Japanese IFF – Separate Navy and Army Systems – incompatible**
- **United Nations Beaconry – Central Research Group – IFF Mk.V**



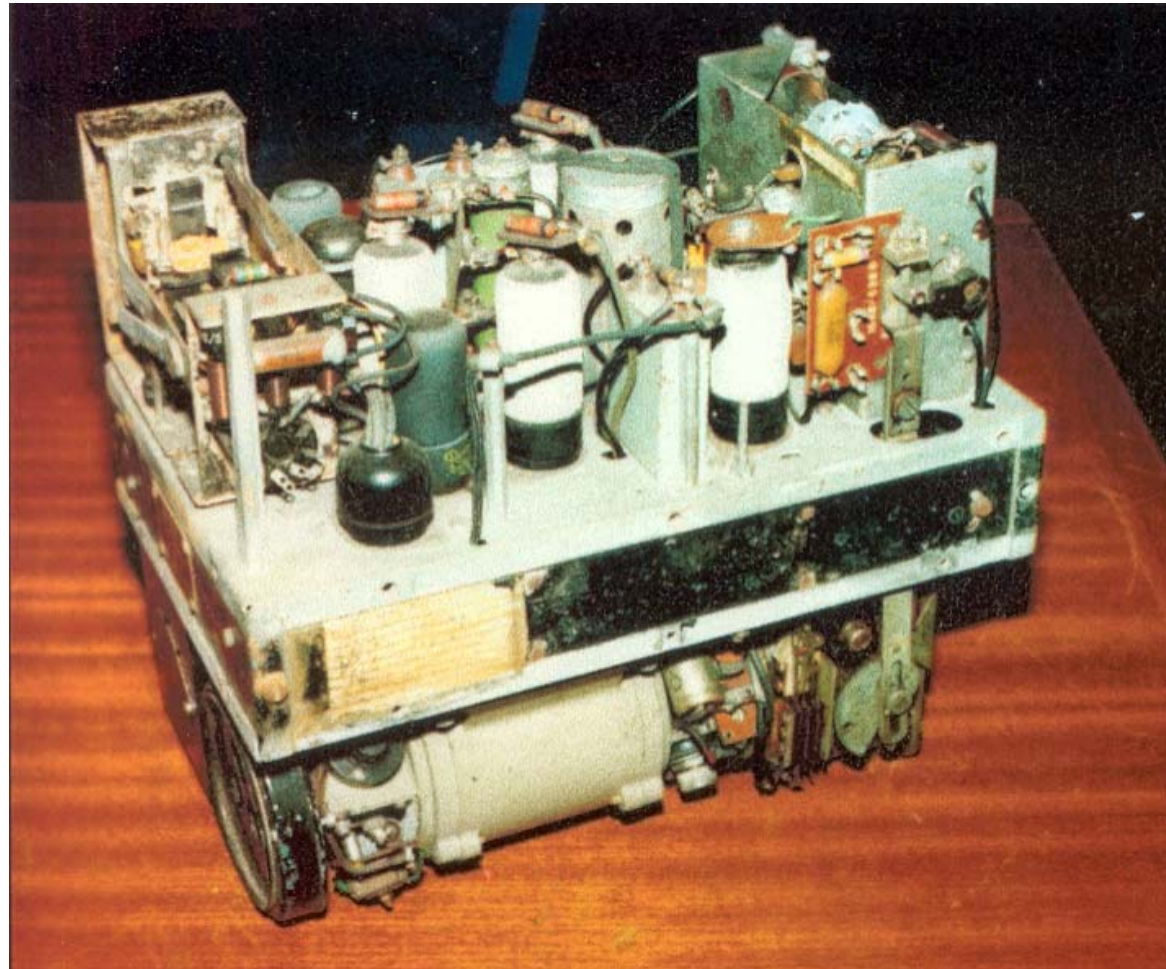
1940 – US NAVY ABA IFF TRANSPONDER – 470MHz.



1939 - BASIC CIRCUIT OF BRITISH IFF Mk. I TRANSPONDER



1941 - RAF SPITFIRE Mk.VC FITTED WITH IFF Mk.II TRANSPONDER



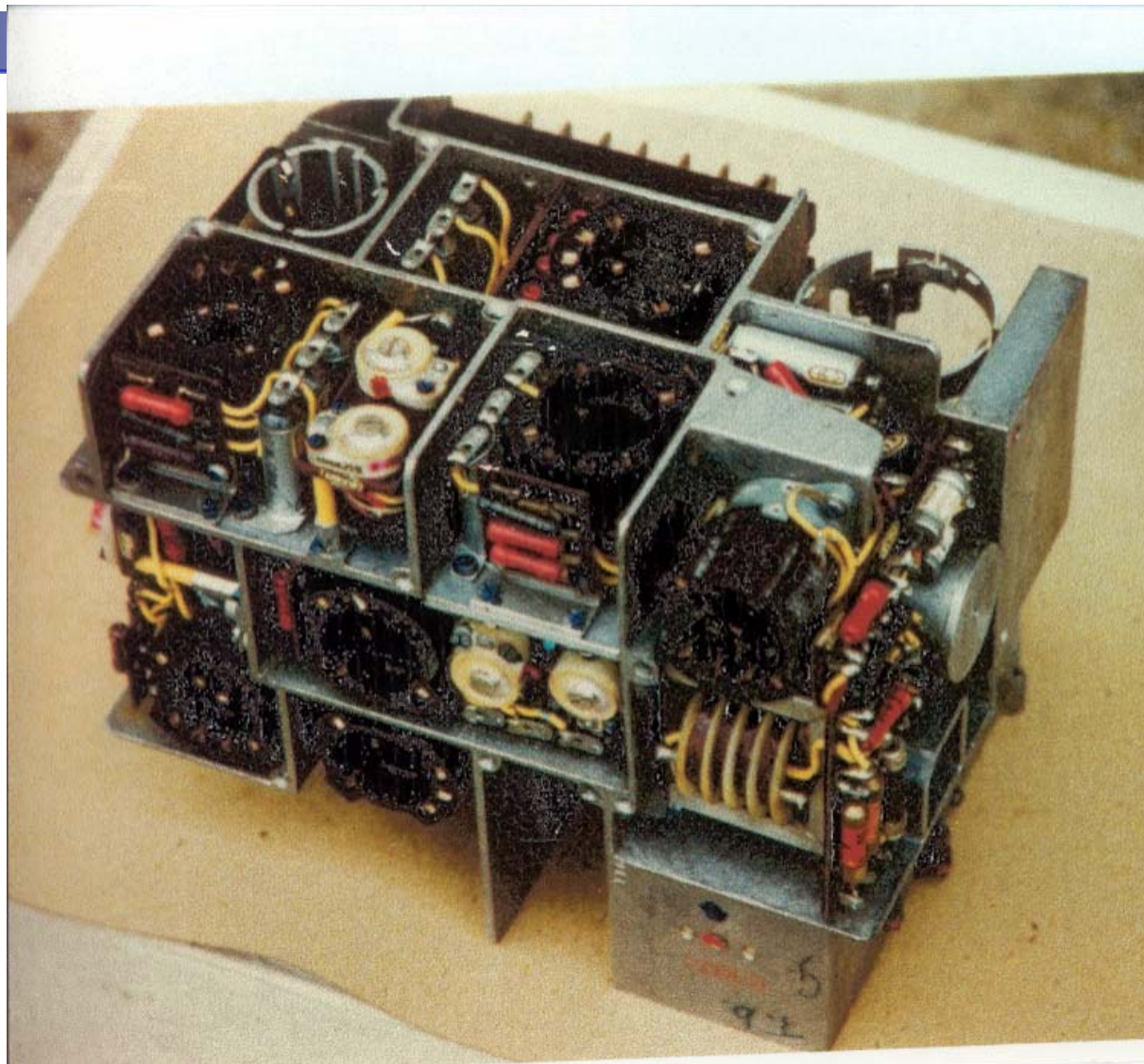
1943

BRITISH IFF Mk.III TRANSPONDER WITH ROOSTER BEACON CHANNEL

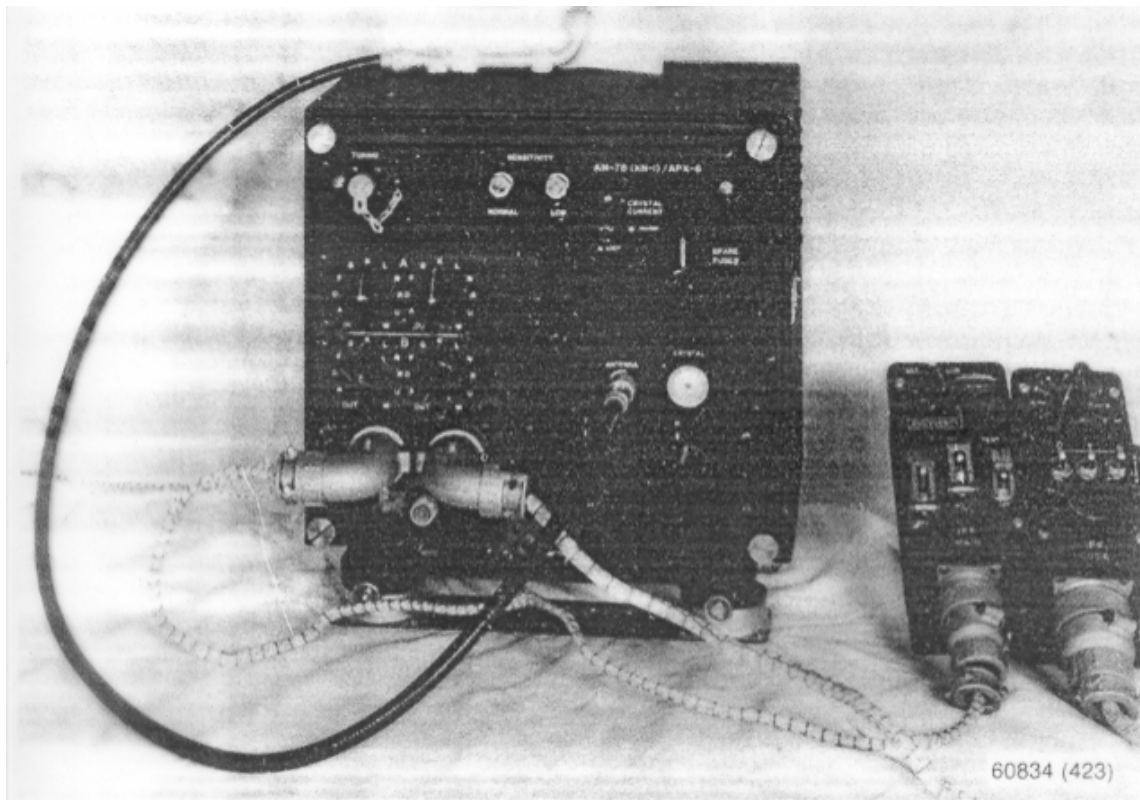


USN ABK IFF Mk.III TRANSPONDER – 1944

OVER 200,000 UNITS BUILT – MAINLY BY HAZELTINE



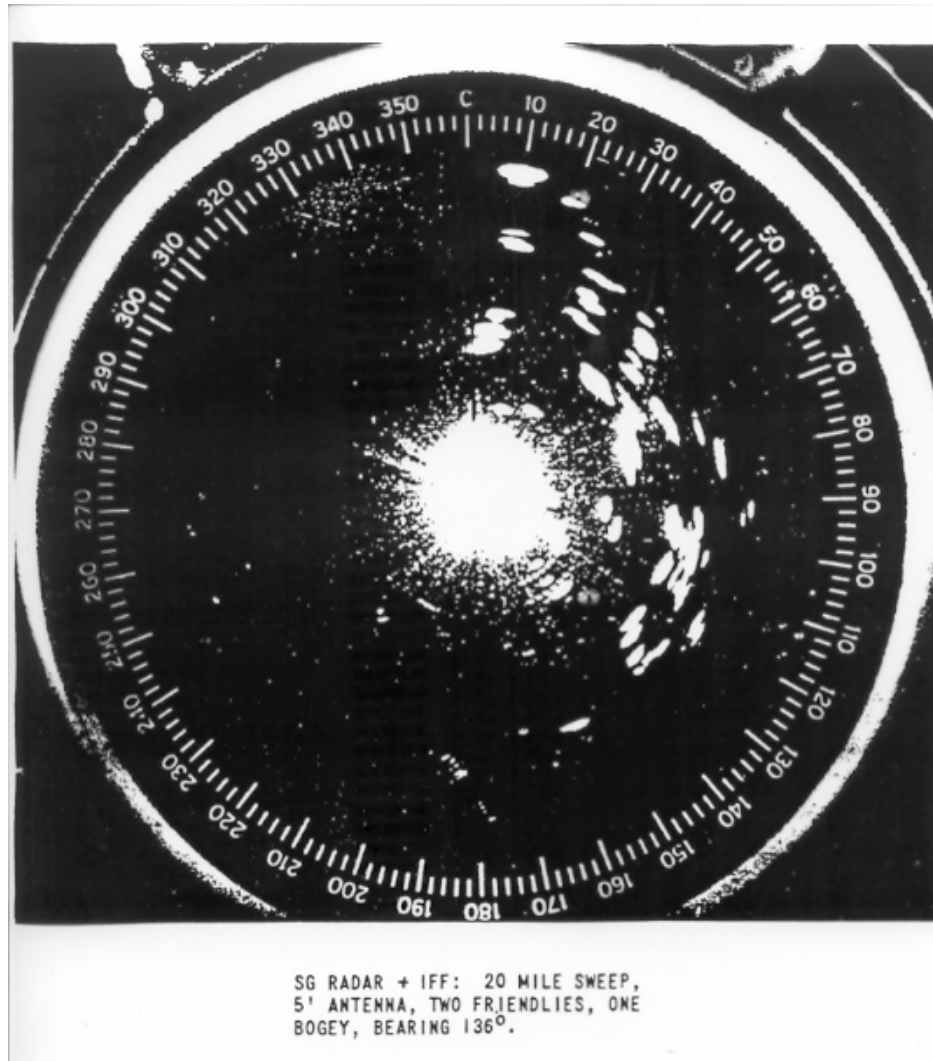
1944 – LUFTWAFFE FuG 25a IFF TRANSPONDER



MARK V IFF SYSTEM TRANSPONDER - THE AN/APX-6

This IFF system, developed by the Combined Research Group at NRL during World War II under NRL technical leadership, incorporated the NRL-originated features of separate frequencies or challenge and reply, independent of radar frequencies, and IFF responses associated with radar echoes in PPI presentations.

1945 – AN/APX-6 IFF Mk.V TRANSPONDER



IFF Mk.V TRIALS WITH USN SG RADAR - 1945

1945 – 1950

- **United Nations Beaconry IFF Mk.V Project Terminated**
 - **IFF Mk.V Project Continued by USN as Classified Project**
 - **RAF and USAF continue to use IFF Mk.III**
 - **Berlin Airlift (1949) leads to setting up of NATO**
 - **Korean War (1951) – Need for improved IFF system for NATO**
 - **By 1950 USN had developed IFF Mk.V into IFF Mk.x**
 - **IFF Mk.x adopted by NATO.**
 - **IFF Mk.x becomes IFF Mk.X**
 - **Limitations of IFF Mk.X (Basic) reply coding leads to development of Selective Identification Feature (SIF).**
-

1950 – 1960

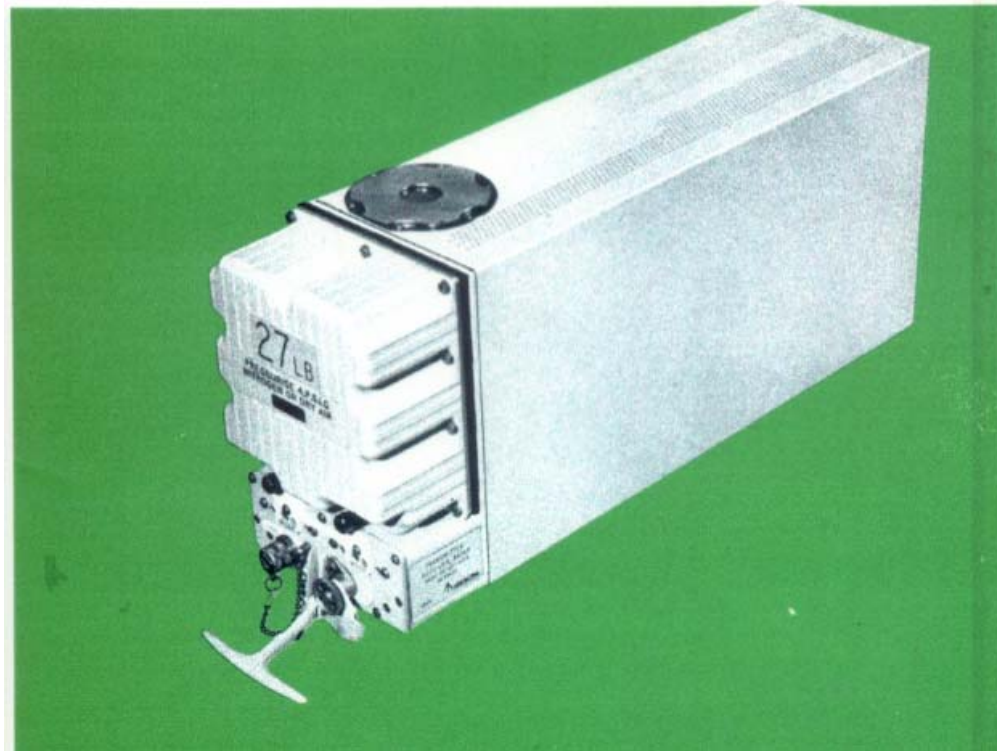
- **1953 – US North American Air Defence (NORAD) Policy Requires all aircraft entering US airspace to be positively identified by means of IFF MK.X(SIF) compatible SSR.**
- **Technical characteristics – but not operational uses - of IFF Mk.X(SIF) declassified**
- **Successful Cossor demonstration of ISLS at USN ATC Patuxent River in 1957 – “Setrin Fix” for 17,000 AN/APX-6 IFF Transponders**
- **Civil SSR compatible with IFF Mk.X(SIF) adopted by ICAO in December 1957**
- **Need for classified mode of IFF leads to US development of cryptographic mode of IFF – High Security IFF (HSI) – evolved into Mode 4 of IFF Mk.XII.**

1960 - 1970

- **Adoption of Interrogation Path Side Lobe Suppression (ISLS) makes IFF and SSR practicable.**
 - **Warsaw Pact adopts Soviet KREMI 2 IFF system.**
 - **US and UK cooperation results in IFF Mk.XII Mode 4 Technical Improvement Program (TIP-A and TIP-B)**
 - **Widespread international adoption of civil SSR for ATC.**
-

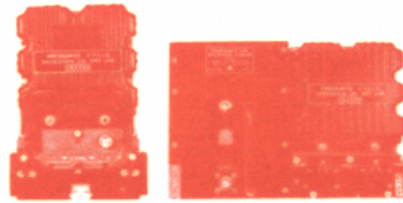
COSSOR

**SSR 1500 AIRBORNE IFF 10
TRANSPONDER**



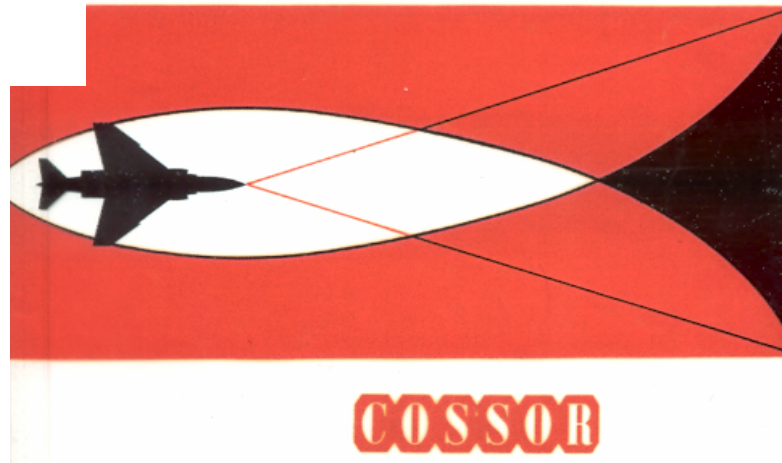
SSR 1500 IFF TRANSPONDER AS DEVELOPED FOR TSR-2 - 1961

SSR 1500 SSR 1520



FOR IDENTIFICATION

TRANSISTORISED IFF TRANSPONDERS



1965

**SSR 1500 IFF TRANSPONDER FITTED TO ALL UK F4 PHANTOM AIRCRAFT
SSR 1520 IFF TRANSPONDER STANDARD FIT IN MOST RAF AND RN AIRCRAFT
OVER 2000 BUILT**

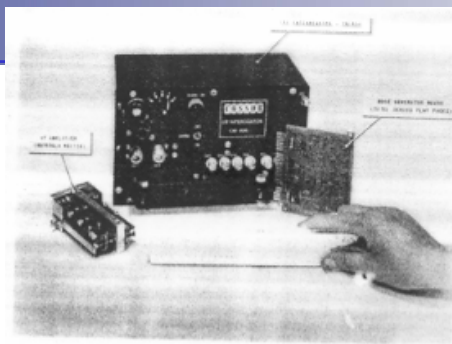


Figure 1. Microminiature IFF Interrogator CR 1600

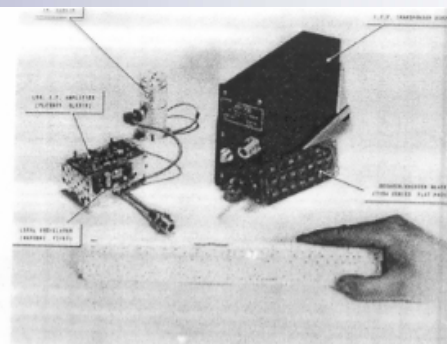


Figure 3. IFF Transponder-SSR 2800

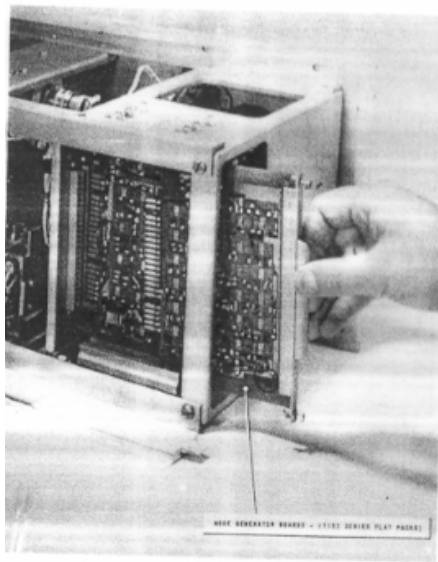


Figure 2. IFF Interrogator Test Set SSR 2800

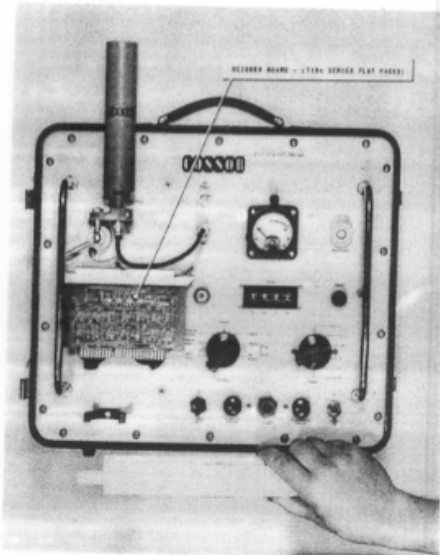
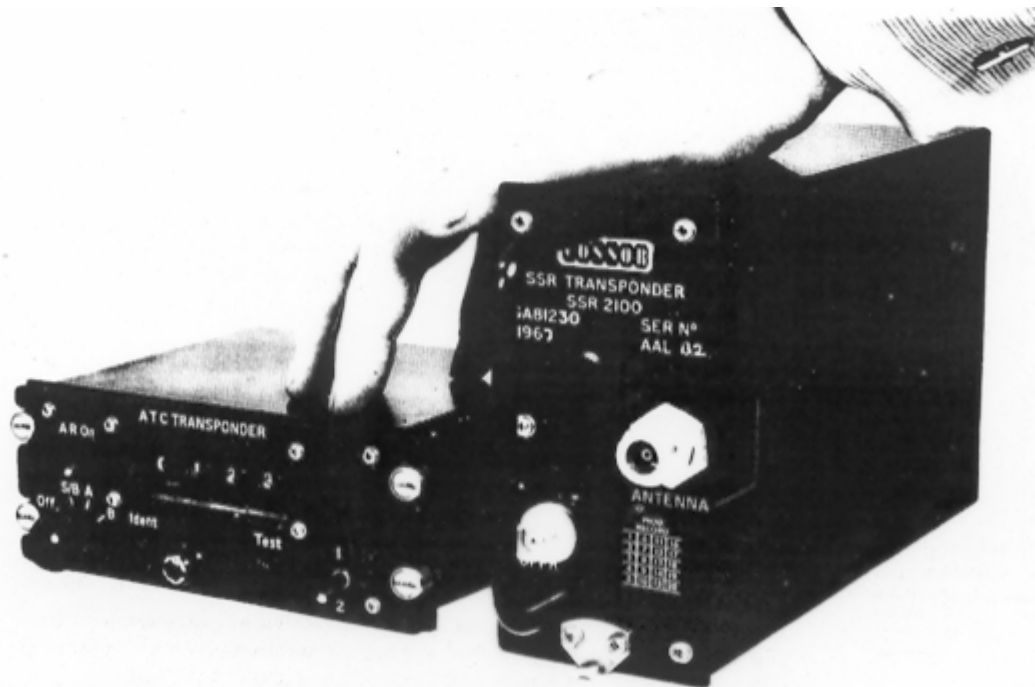


Figure 4. IFF Transponder Test Set CRM 544

**1967 IEEE SEMINAR ON THE APPLICATIONS OF MICROELECTRONICS
PROTOTYPES OF CRI-600 RAPIER INTERROGATOR, IFF2800 TRANSPONDER
AND CRM544 IFF FLIGHT LINE TEST SET (COSSOR)**



COSSOR

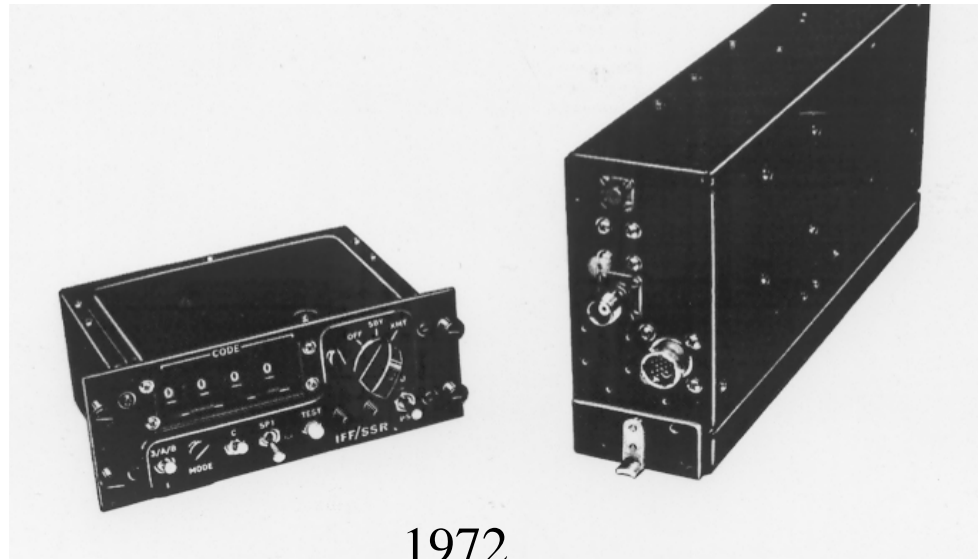
COSSOR ELECTRONICS LTD.
The Pinnacles, Elizabeth Way, Harlow, Essex, England
Telephone: Harlow 26862. Cables: Cossor Harlow. Telex: 81228
A subsidiary of A.C. Cossor Limited and of Raytheon Company, U.S.A.

1970

SSR2100 – WORLDS FIRST MICROMINIATURE SSR TRANSPONDER

IFF2800 – IFF TRANSPONDER VARIANT FITTED TO RAF HELICOPTERS

LIGHTWEIGHT IFF/SSR TRANSPONDER PTR446A



PLESSEY PTR-446 LIGHTWEIGHT IFF TRANSPONDER FITTED TO HAWK
AND TO SOME RAF HELICOPTERS



*KREMI 2 "EASTERN" IFF
ODD RODS TRANSPONDER ANTENNA*

1970 - 1989

- **Early 1970's – East-West Relations Worsening**
- **West Germany (FRG) in Firing Line**
- **Urgently needs improved IFF system**
- **FRG Develops CAPRIS IFF System (IR Laser BIFF, Air Defence E/F-Band & I-Band, Improved Crypto)**
- **CAPRIS forms basis for NATO New IFF System (NIS)**
- **US Version known as IFF Mk.XV**



MK-XV Combat Identification System

We are developing the MK-XV Combat Identification System for the U.S. Air Force. Mark XV is a replacement of the existing Mark XII Identification Friend or Foe (IFF) system with full ATC capability including the Mode-S. It utilizes spread spectrum techniques to overcome jamming and improve systems performance. The Mark XV system is slated for use through the end of the century and into the 2000's

IFF MK.XV EQUIPMENT BEING DEVELOPED BY ALLIED SIGNAL IN 1985 BEFORE THE PROJECT WAS CANCELLED

Warsaw Pact Collapses in 1989

- **US Cancels IFF Mk,XV Program**
 - **European NIS Project goes on hold**
 - **Gulf War emphasises need for interoperability within Alliance to avoid Fratricide**
 - **Mode 4 Capability fitted to UK aircraft operating in Gulf**
-

*AN/TPX-56
IFF Interrogator
The World's Most
Compact Identification
Friend or Foe
Interrogator for
Air Defence*



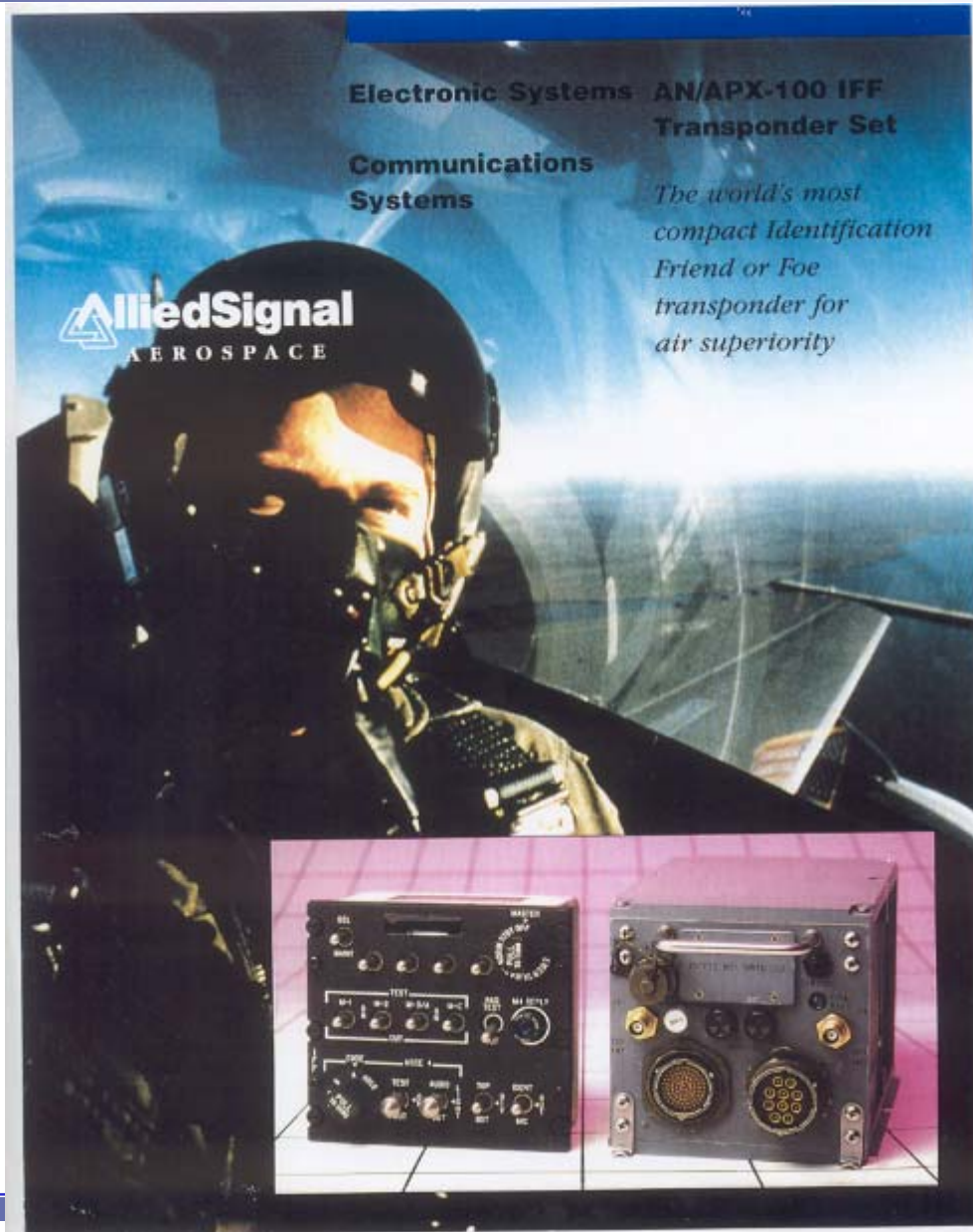
**RAYTHEON AN/TPX-56 SHORAD INTERROGATOR
NOW BEING SUPERCEDED BY AN/TPX-57 MODE 5
COMPATIBLE SHORAD INTERROGATOR**

Electronic Systems **AN/APX-100 IFF
Transponder Set**

**Communications
Systems**

*The world's most
compact Identification
Friend or Foe
transponder for
air superiority*

AlliedSignal
AEROSPACE



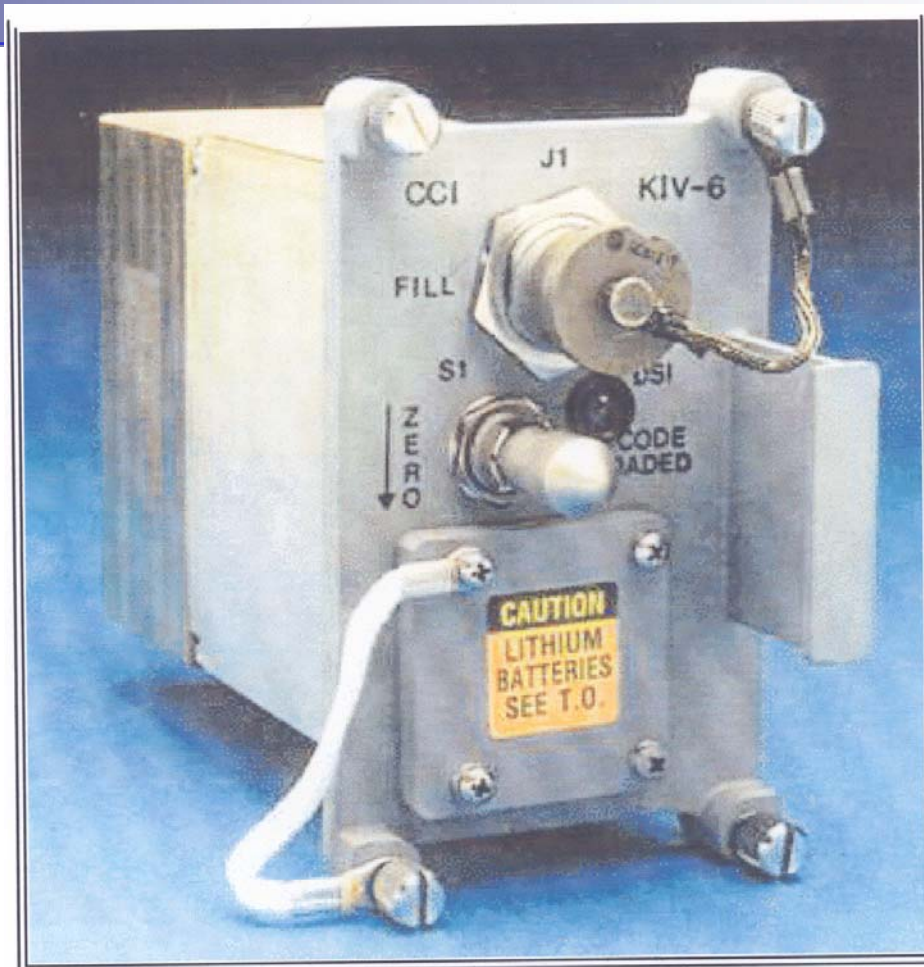
RAYTHEON AN/APX-100 AIRBORNE IFF TRANSPONDER

BAE SYSTEMS

**AN/APX-113(V)
COMBINED INTERROGATOR/TRANSPONDER
F-16 CONFIGURATION**



**BAE SYSTEMS AN/APX-113(V) COMBINED INTERROGATOR /TRANSPONDER
CIT**



KIV-6 photo courtesy of U.S.N.

**KIV-6 IFF MODE 4 CRYPTOGRAPHIC UNIT FOR
CIT AN/APX-111 (F-18) and AN/113 (F-16 and Helicopters).**

Raytheon

Raytheon Systems Limited

the **condor** range

Monopulse Secondary Surveillance Systems with Mode S and Military Mode 4

With over 200 Condor Systems commissioned worldwide, Raytheon has been selected to supply:

- 213 Condor 2 MSSR systems for the DoD/FAADAS programme.
- 127 Condor 2 Mode S Level 2 systems for the FAA'S ATCBI-6 programme.
- Eurocontrol POEMS Mode S Level 5 systems to UK NATS and German DFS
The company has also been selected by Germany (DFS) Switzerland (skyguide) and Netherlands (LVNL) under the Common Mode S (Comos) programme for Mode S level 5 systems.
- Condor 2 MSSR systems with Mode 4 cryptographic capability to the Royal Australian air force and various European air forces.
- Stand alone or PSR co-mounted (including Integral Plot Combiner).

Condor offers superior performance and lowest cost of ownership through continuous product evolution.

Evolved from the original Cossor Condor MSSR, which was the world's first operational MSSR in 1982, today's Raytheon Condor 2 is the most advanced technology secondary radar in operational service.

- Condor 2
Condor 2 is the best performing and top selling MSSR. It is operationally proven and available off the shelf.
- Condor 2 Model S Level 2
The in-service Condor 2 Model S Level 2 variant provides enhanced surveillance to ICAO level 2 together with a comprehensive ATN capability. This system is available with Mode S incorporated into the MSSR at the time of delivery or as a field upgrade. It is designed for Mode S multi-site identity operation.
- Condor 2 Mode S Level 5
The Mode S Level 5 ground networked system is a full Mode S performance Condor 2 variant, developed within the Pre-Operational European Mode S (POEMS) programme.

All Condor 2 variants can include Mode 4 cryptographic military IFF capability. This product can also be supplied with interlaced, or sectorial, Mode S and Mode 4.

Low Life Cycle Costs

•

Proven Product

•

Turnkey Capability
Including:

•

Programme Management

•

Risk Management

•

Safety Assurance

•

Integrated Logistics Support

•

Civil Engineering

•

Financing



**RAYTHEON SYSTEMS CONDOR CIVIL SSR MODE S / MILITARY MODE 4
LONG RANGE INTERROGATOR (LORAD)**

Identification

The Identification Friend or Foe (IFF) function is critical to air force operations. Thales Communications is the only supplier in the world to offer a complete range of equipment for all types of platforms and weapon systems. Tailored to each different type of mission — friendly fire prevention, surveillance and control, and collision avoidance – this equipment incorporates Mode S compatibility and is fully compliant with the NG IFF new-generation military identification standard, which will be applicable in the near future.

► IFF product range in particular : TSA 1400



Among the latest IFF products developed by THALES Communications, the **TSA 1400 IFF Interrogator has become the new standard for Vshorads**. The TSA 1400 is a miniaturized Digital IFF interrogator suitable for all man portable and vehicular VShorads / Shorads applications having a range from 250m up to 100 Km (upon antenna). TSA 1400's main potential applications are Starstreak, Mistral, ASRAD, Iгла, Stinger, Crotale, Pantzir.

► Did you know ?

- THALES Communications has delivered more than 15,000 IFF products worldwide for combat aircraft (Mirage 2000, Rafale, Jaguar, Tornado, MIG, etc.), surveillance aircraft (ATL2, Nimrod, Erieye), transport planes and helicopters (Puma, Cougar, NH-90, Tiger, etc.), Air Defence Radars, Air Defence Weapon systems (Mistral, Stinger, Crotale NG, etc.), and ships.
- The company was also **selected recently by Greece to equip IFF systems** of Erieye, Mirage 2000 and Crotale NG, and its millimeter wave technology has been recommended to NATO for battlefield IFF applications and a Full Scale Development and Production contract has been signed by the French MoD.

THALES VSHORAD INTERROGATOR TSA 1400

Current Position

- **Need to ensure interoperability throughout NATO leads to current NGIFF Program (UK SIFF Project)**
- **NGIFF includes compatibility with civil ATC SSR Mode S Level 2, with TCAS-II and with growth capability to Mode 5 .**

*The IFF 4800 series of
Transponder designed to
meet the requirements of
Airborne and Shipboard
applications*



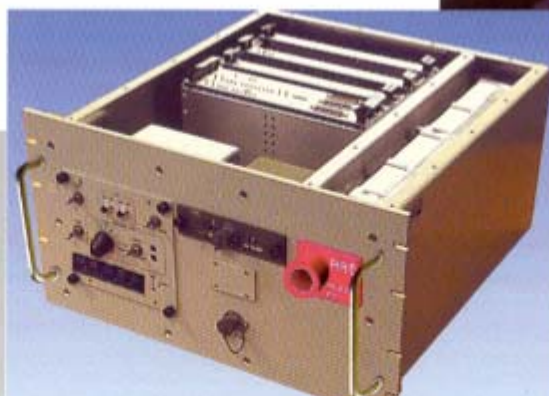
**RAYTHEON IFF 4800 SHIPBOARD AND AIRBORNE IFF Mk.XII
TRANSPONDER- IFF 4810 VERSION FOR UK SIFF PROGRAMME
MODE S AND ACAS INTERFACES – MODE 5 GROWTH PROVISIONS
OVER 1000 FITTED TO 40 PLATFORMS IN UK SIFF PROJECT**

*AN/APX-114
Airborne Interrogator
The World's Most
Advanced Long-Range
Identification
Friend or Foe
Interrogator for
Airborne Superiority*



**RAYTHEON AN/APX-114 AIRBORNE INTERROGATOR
IFF Mk.XII/MODE S LEVEL 2/MODE 5 – RAF TORNADO F-3
USAF VARIANT NOW UPGRADED TO MODE 5
IFF 4500 FOR UK SIFF PROJECT**

provide the utmost in flexibility. Utilising an industry standard 19" rack packaging configuration this system provides full Mk XII, Mode S, Mode 5 compatibility for surface combatants. Support for all standard serial computer interfaces permit local and remote control of the interrogator. Additional 6U VME slots in the chassis permit unparalleled growth capability.



*IFF 5000
Long-Range Shipborne
and Air Defence
IFF Interrogator System*

RAYTHEON IFF 5000 SHIPBORNE AND AIR DEFENCE LORAD INTERROGATOR Mk.XII / MODE S / MODE 5 - UK SIFF PROJECT

NORTHROP GRUMMAN
Electronic Systems

AN/APX-108 Mode S Mark XII IFF Transponder

Design features of the APX-108 include true open systems architecture, commercial off-the-shelf (COTS) modules, advanced microwave packaging, and removable Mode 4 INFOSEC module with Mode 5 growth.



NORTHROP GRUMMAN
Electronic Systems

The AN/UPX-39(V)1 communicates with the transponders on aircraft to provide detailed information on the plane

AN/UPX-39(V)1 MSSR Interrogator



The AN/UPX-39(V)1 Monopulse Secondary Surveillance Radar (MSSR) is a completely new Interrogator designed for the most demanding Air Traffic Control System requirements and to replace aging IFF Interrogators that can no longer be maintained.

The AN/UPX-39(V)1 replaces thirty-year-old analog equipment with modern, digital COTS equipment. The AN/UPX-39(V)1 meets current military, FAA and international standards for Identification and Air Traffic Control system requirements as well as adding Remote Control, Monitor and Fault Isolation capability. The Reliability, Maintainability and Supportability of the AN/UPX-39(V)1 significantly lowers maintenance costs.

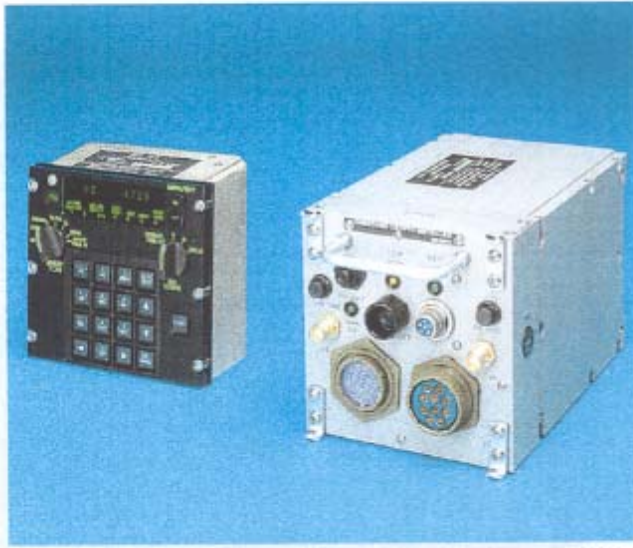
The AN/UPX-39(V)1, also known as the beacon subsystem, is a long-range Interrogator with 2,000 watts of output power, ISLS operation, three receiver channels, RSLs, GTC/STC, Target Extractor, and Target Tracker.

The AN/UPX-39 outputs Digital Target Reports in ASTRIX, CD2 or a host of other common formats over ETHERNET, RS-232 or other standard bus to the Primary Radar or Air Traffic Control Station. The AN/UPX-39(V)1 communicates with the transponders on aircraft to provide detailed information on the plane, which is used for air traffic control and military reporting.

Long-Range System Performance

- Standard military/civil operating modes (1, 2, 3/A, C, 4)
- Mode S Level 2 Option (internal)
- High target resolution (amplitude monopulse)
- Extensive use of COTS hardware
- Growth to additional operating modes (S Level 4, ADS-B, 5)
- Software Programmable COTS Architecture

NEXT-GENERATION COMMON IFF TRANSPONDER



000015

FIG. 7

- **Key features**

- Flexible interface designed to accommodate retrofit and new installations
- Supports Modes 1, 2, 3/A, C, 4 and Mode 5 growth
- Supports Mode S Level 3 and interface to TCAS II system
- Dual crypto interface; supports external or embedded crypto
- Direct replacement for APX-64, APX-72, APX-100, and APX-101
- Form, fit, functional replacement for APX-100
- DoD AIMS 97-1000 compliant
- MIDS/JTIDS compatible
- Airborne bay mounted, airborne remote control unit, and shipboard versions
- MCAS growth

- **Program status**

- Currently in development at BAE SYSTEMS Greenlawn, NY
- Selected by Boeing for F/A-18 retrofit
- Selected by U.S. Navy/Army for next-generation Common Digital Transponder (CXP)

**BAE SYSTEMS NEXT GENERATION COMMON IFF TRANSPONDER IFF
Mk.XII / MODE S LEVEL 3 / MODE 5**

THROP GRUMMAN
Electronic Systems

GOODRICH

AN/APM-424(V)3 Interrogator/Transponder Test Set

AN/APM-424(V)3 accommodates a variety of aircraft, ship platform test Transponder interrogator functions



CIVIL/MILITARY AIR TRAFFIC CONTROL MODE S COMPATIBILITY

- **ALL AIRCRAFT FLYING IN CONTROLLED AIRSPACE ARE REQUIRED TO BE FITTED WITH A MODE S LEVEL 2 COMPATIBLE TRANSPONDER**

CIVIL/MILITARY AIR TRAFFIC CONTROL AIRBORNE COLLISION AVOIDANCE (ACAS II)

- **ALL MILITARY TRANSPORT AIRCRAFT ARE REQUIRED TO BE FITTED WITH ACAS II COMPATIBLE AIRBORNE COLLISION AVOIDANCE EQUIPMENT**

 - **MILITARY FAST JETS ARE EXEMPTED**
-

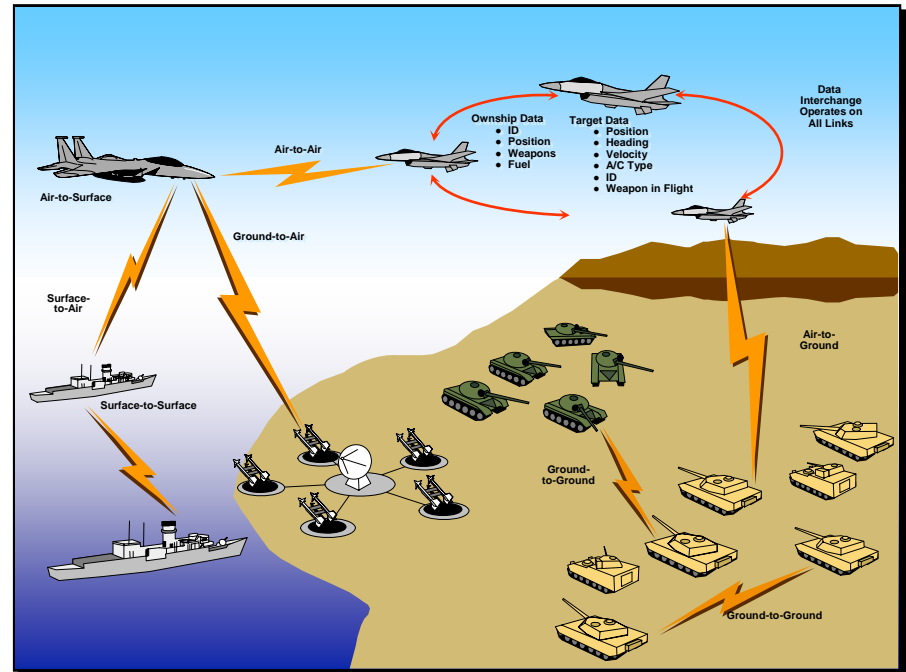
Operational experience has shown that TCAS II - the only commercially available equipment meeting the ACAS II specification performs effectively, but is currently not compatible with military fast jets.

-The growing number of privately-owned, ex-military jets has prompted the CAA and its European partners to explore the feasibility of exempting these 'warbirds' from the new requirements.

**CURRENT EUROPEAN CIVIL AVIATION CONFERENCE (ECAC)
INFORMATION ON THE CARRIAGE OF ACAS II**

Mark XIIA Mode 5

Improved IFF
with Secure,
Interoperable,
Real-Time Situation
Awareness
and
Data Transfer



Helping To Integrate the Battlespace

IFF MODE 5 BEGINNINGS

MARK XV

- **USAF PROGRAMME STARTED IN LATE 70's WITH NATO INVOLVEMENT**
- **PROCEEDED TO SYSTEM DESIGN AND DEVELOPMENT WITH TRI SERVICE DEMO**
- **RAN INTO TECHNICAL PROBLEMS; LONG WAVEFORM REDUCED SYSTEM CAPACITY**
- **INTERIM ACTIVITY – 1991-1997**
- **RAYTHEON/BAE DERIVED “MODE 7” FROM MK.XV**
 - **SHORT 1µS. MSK PULSES REPLACED LONG Mk.XV SYMBOLS; Q&A ONLY**
- **UK DERIVED “MODE 8”**
 - **MARK XV WAVEFORM REDUCED BY $\frac{3}{4}$; Q&A ONLY**
- **LITTON/NSDD DESIGNED “MODE 9”**
 - **ASYNCHRONOUS POSITION AND ID REPORTING**
 - **TRIGGERED BY AN INTERROGATION AND RANDOMLY SQUITTERED**
 - **INCREASED SYSTEM CAPACITY & ELIMINATED GARBLE**
 - **ADDED SYSTEM FUNCTIONALITY INCLUDING:**
 - **AIR-TO-GROUND ID, DATA LINK, ACMI, LANDING SYSTEM**
 - **PASSIVE SITUATION AWARENESS, STATION KEEPING**

MODE 5 DEVELOPMENT

NRL CONTRACT

- **NRL ISSUE RFP TO SOLICIT NON-PROPRIETRY IFF CONCEPTS**
- **LITTON, BAE AND RAYTHEON RESPONDED**
- **CONTRACTS LET TO ALL THREE**

SYSTEM DEVELOPMENT

- **NRL LEAD US-ONLY MODE 5 WORKING GROUP**
 - **LITTON, BAE, RAYTHEON, JSC**
 - **TRI-SERVICE PARTICIPATION, AIMSPO, NSA. DOD**
 - **NATO PARTICIPATION BEGAN – 1998**
 - **US LEAD NATO WORKING GROUP MEETINGS**
 - **EVENTUALLY HANDED OVER TO UK**
 - **DEVELOPED STANAG 4193 PARTS V AND VI**
-

Mark XIIA Mode 5

- NATO Sponsored Development -

■ **Mark XIIA IFF is**

- **Mark XII + Mode 5**

■ **Mode 5 Developed by NATO TWG**

- **US, UK, France, Germany, Italy participation**
- **NSA and NATO COMSEC agencies**

■ **Mode 5 Specifications**

- **STANAG 4193 Parts V and VI specify interoperability requirements**
- **Crypto Interoperability Requirements Specification**

Mark XIIA Mode 5

- Adds Important Functionality to IFF -

■ Serves All Mission Areas

- Air-to-Air
- Ground-to-Air
- Air-to-Surface
- Ground-to-Ground
- Ship-to-Air
- Special Ops

■ Four Levels of Secure Operation

- Level 1: Improved Q&A Identification
- Level 2: Situation Awareness with GPS Position Reporting
- Level 3: Selective Addressing of Friends
- Level 4: Data Transfer

Mark XIIA Mode 5

- Designed for Easy Integration -

- **Operates with existing antennas**
 - **Directional or OMNI**
- **Provides new crypto computer**
 - **Mode 5 and Mode 4 capable**
 - **Red and Black key loading**
 - **Automatic code change at UTC midnight**
 - **Over-the-air COMSEC re-key capability**
- **Utilizes two waveform types**
 - **Processing gain and high data rate**

Mode 5 Level 1

Improved Q&A Identification

■ Secure Friend-from-Friend ID

- PIN Codes plus Country Codes plus Mission Codes
- Mode 1, 2, 3/A, C, I/P, X and Emergency data
- Lethal interrogation message included to indicate engagement intent

■ High confidence ID in any Scenario

- Provides higher PID and increased system capacity
- Provides longer ID Range with modest processing gain
- Eliminates most shortcomings of Mark XII including mutual interference, garbling, exploitation and spoofing

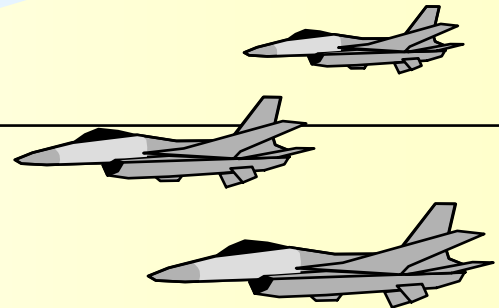
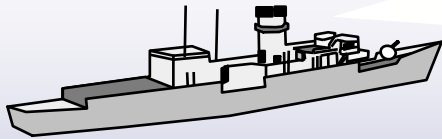
■ Reduces Interference to Civil ATC

- Message structure specifically designed to reduce interference
- Interrogation rates reduced to less than half of Mark XII

Mode 5 Level 1 Operation

Mode 5 replies have different delays to reduce garble and mutual interference

Mark XII replies all have same delay and signal structure

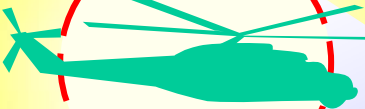
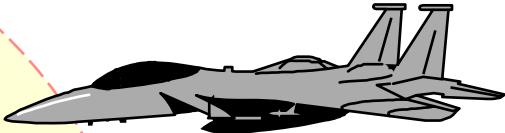


Mode 5 replies have more security bits to reduce exploitation and spoofing

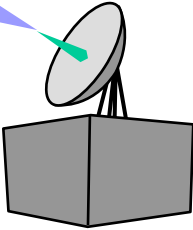
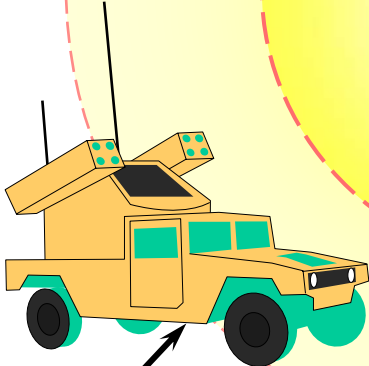
Mode 5 reply spreading codes provide automatic defruiting and improved performance in fading

Mode 5 Level 2 Operation

Position Report "squittered" at low rate for 360° situation awareness

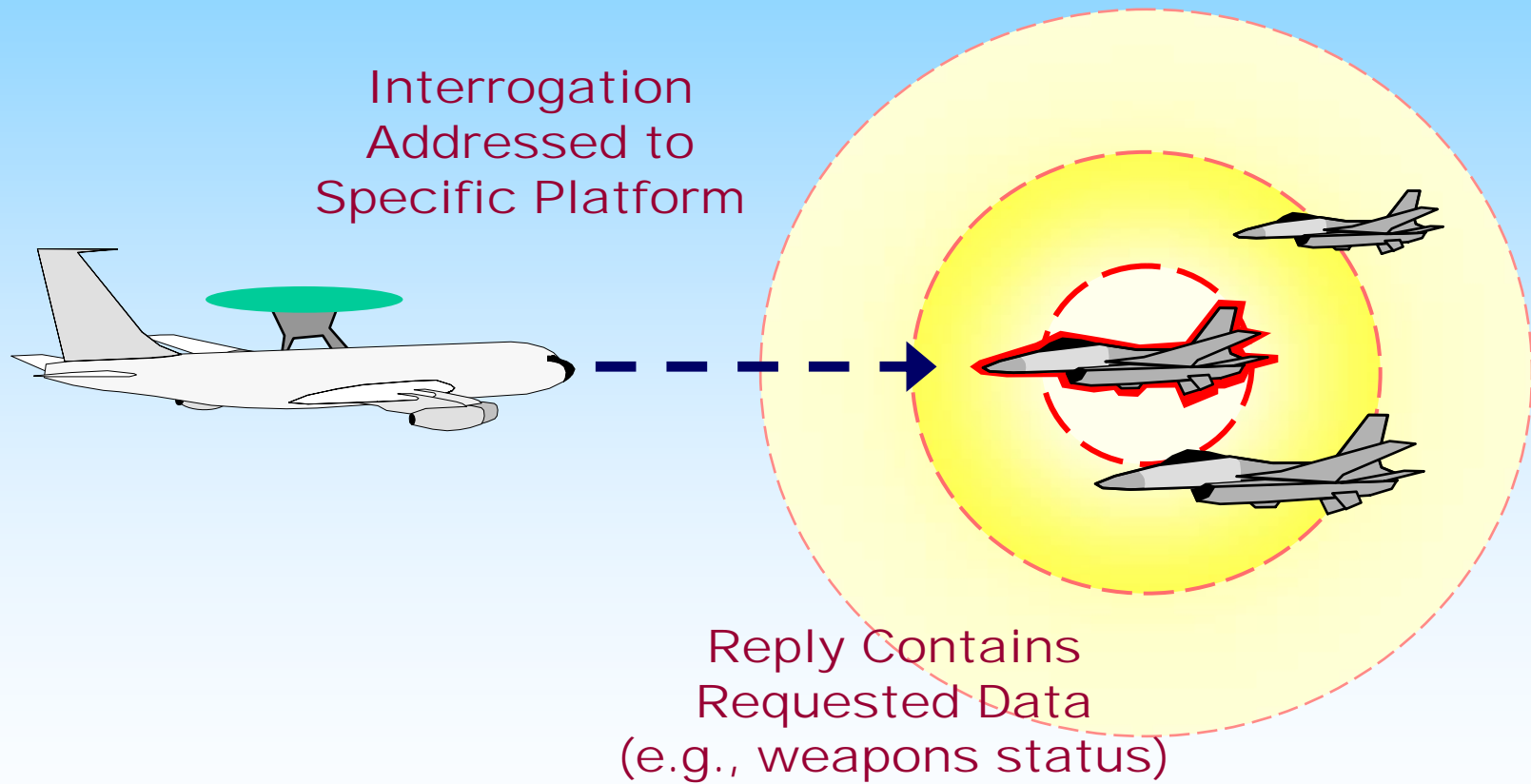


Position Report "triggered" at higher rate for long-range ident

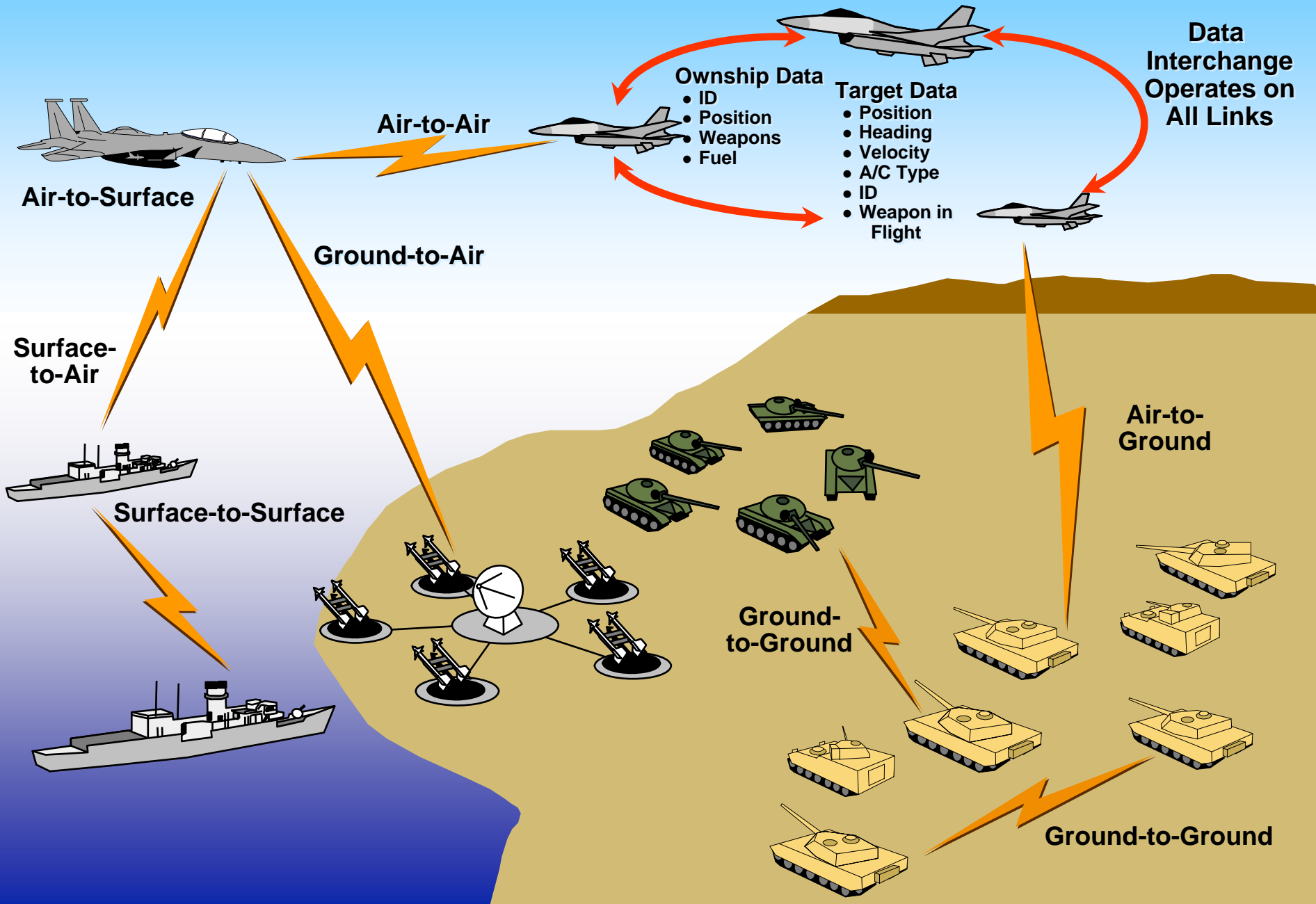


Passive Reception of Situation Awareness data by air and ground users

Mode 5 Level 3 Operation



Mode 5 Level 4 Operation



FUTURE ISSUES

- **IFF MODE 5 – IMPLEMENTATION**
 - **T-CAS FOR MILITARY FAST JETS**
 - **PRIMARY RADAR ANTENNA - IFF ANTENNA PATTERN
CORELLATION**
 - **COMBAT (BATTLEFIELD) ID**
-

END OF THIS PRESENTATION

BUT NOT THE END OF THE DEVELOPMENT OF IFF AND SSR

QUESTIONS AND DISCUSSION

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