

Operational Capabilities of The Eurofighter Typhoon



Presented by Chris Worning
Test Pilot, EADS



Presentation Format



- **Situational Awareness**
- **Low Workload**
- **Flexibility and Fire Power**
- **Performance**
- **Reliability**



The Presenter:

- *15 years in the RDAF (F-100 and*
- *15 years with EADS*
- *Current on 4 types (3 fighters)*
- *10 years, ca. 500 hours Eurofighter*
- *5000+ total flying hours*



Situational Awareness



Eurofighter – RADAR

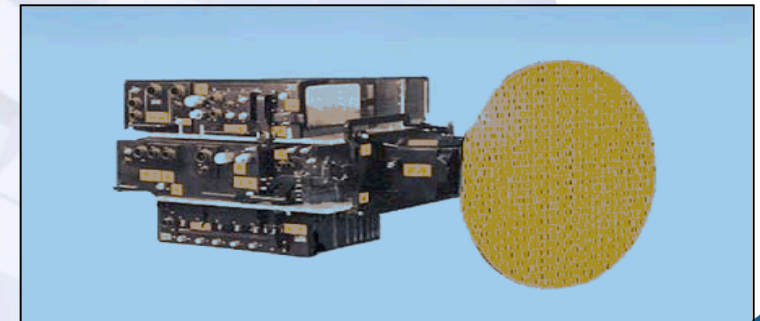
□ ECR-90 Captor Monopulse Doppler RADAR

➤ A-to-A modes

- Search modes (VS, RWS, TWS, PS, PT)
- Lock follow modes (STT, Visident, DGS)
- Acquisition modes (HUDACQ, SACQ, VACQ, External, Sector)

➤ A-to-G modes

- Real beam and high resolution mapping
- Track modes
- Air to surface ranging
- SAR implementation capability



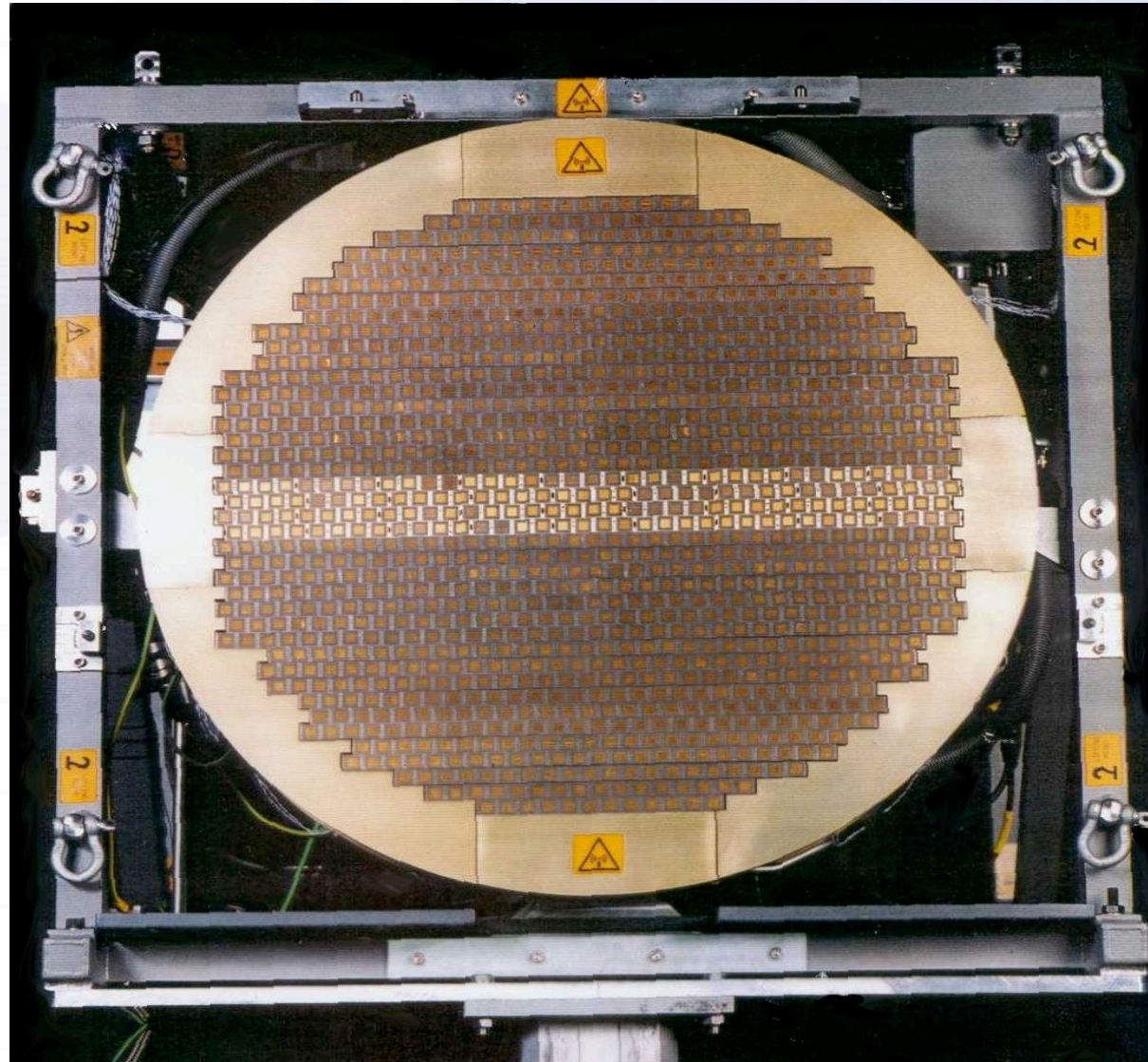
E-Scan Prototype Environmental Tests



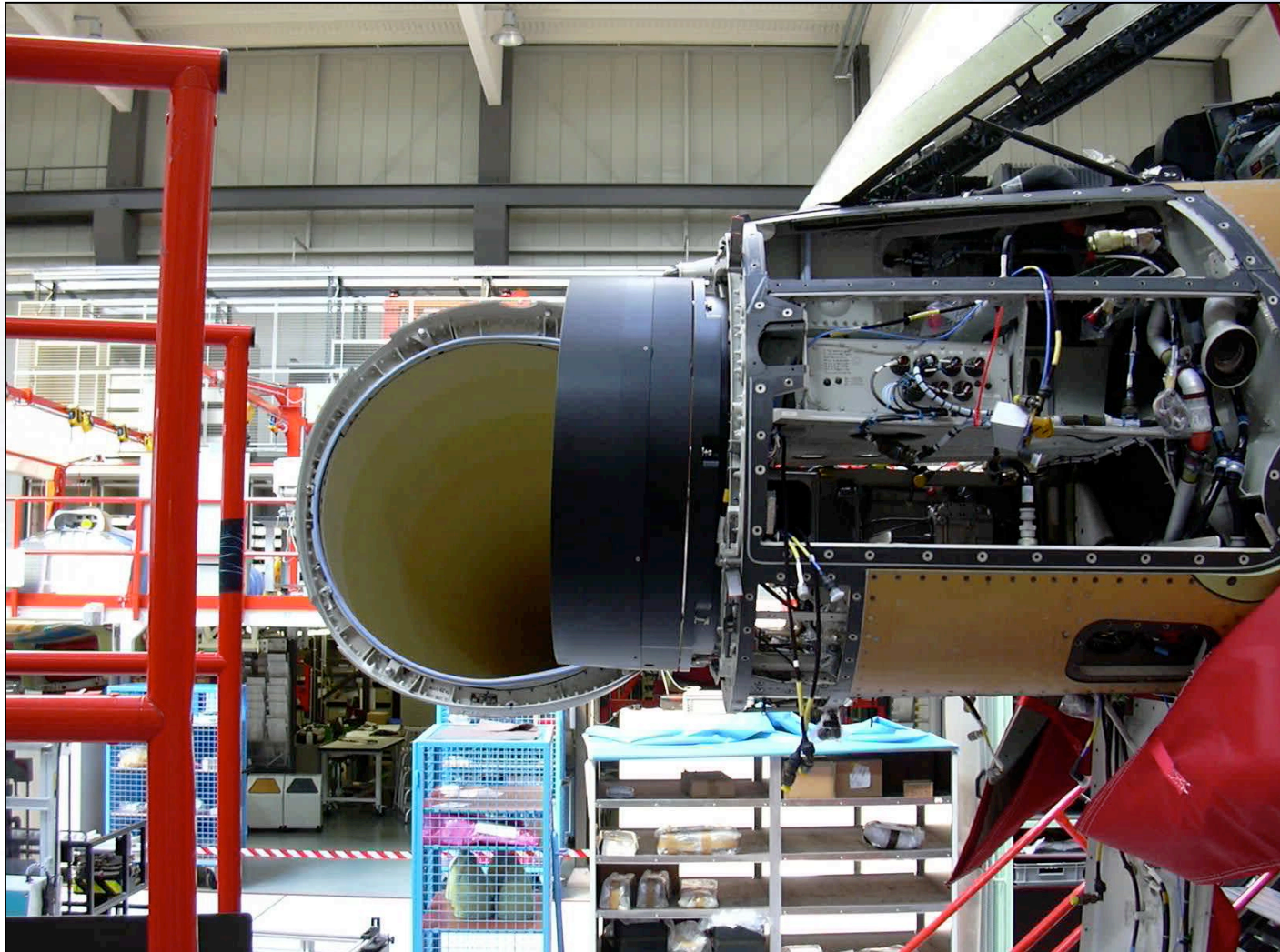
E-Scan Prototype installed in Hack Aircraft



E-Scan Prototype on Test



E - Scan Installation Tests in Eurofighter

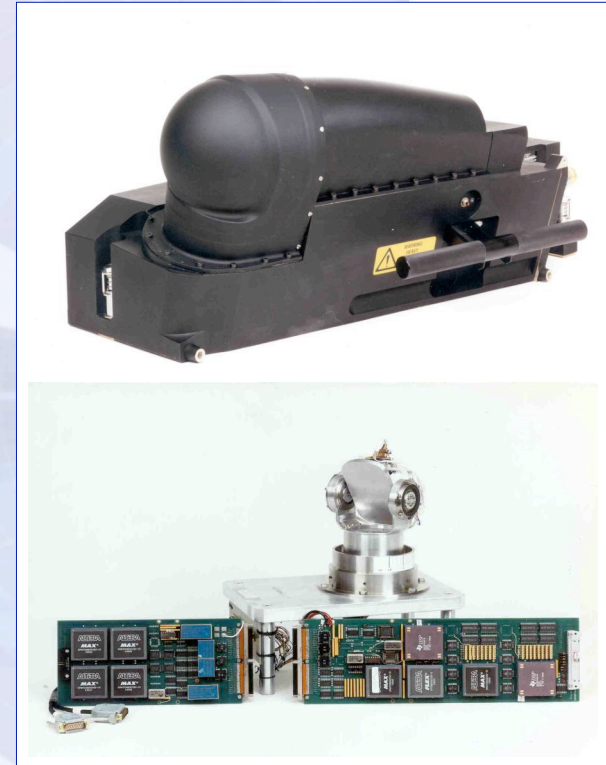


Eurofighter –IRST / FLIR Key Features

- Infrared Search and Track:
 - Tracking of airborne targets
- Forward Looking Infrared (FLIR):
 - Thermal image (virtual pictures)
 - Navigation and Landing Aid
- Thermal Cueing:
 - Determine the position of hot objects



IRST / FLIR turret



- Works day and night
- Passive (Stealth)
- VERY difficult to disturb
- No counter stealth measures



IRST-Attack Format

B-Scope

PPI

Semi-Scan Width



Performance Indicator

Elevation Side Scale

Bars

Elevation coverage

Scan Azimuth Centre

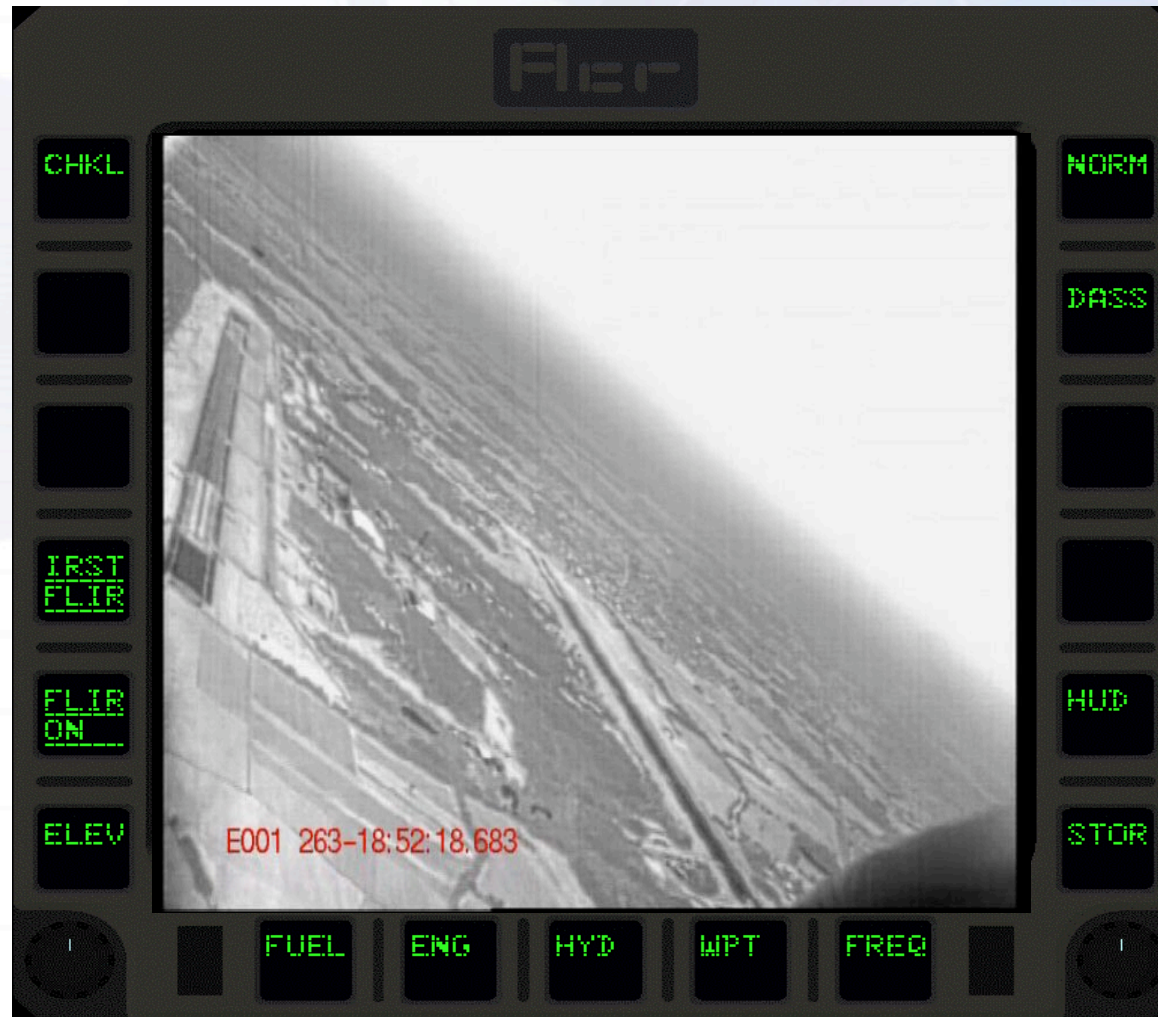


Semi-Scan Width



FLIR Picture Manching

20.9.06, 2052L



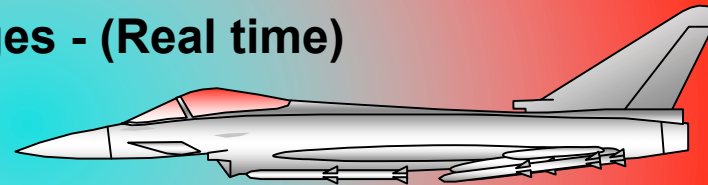
FLIR Picture Manching

20.9.06, 2100L

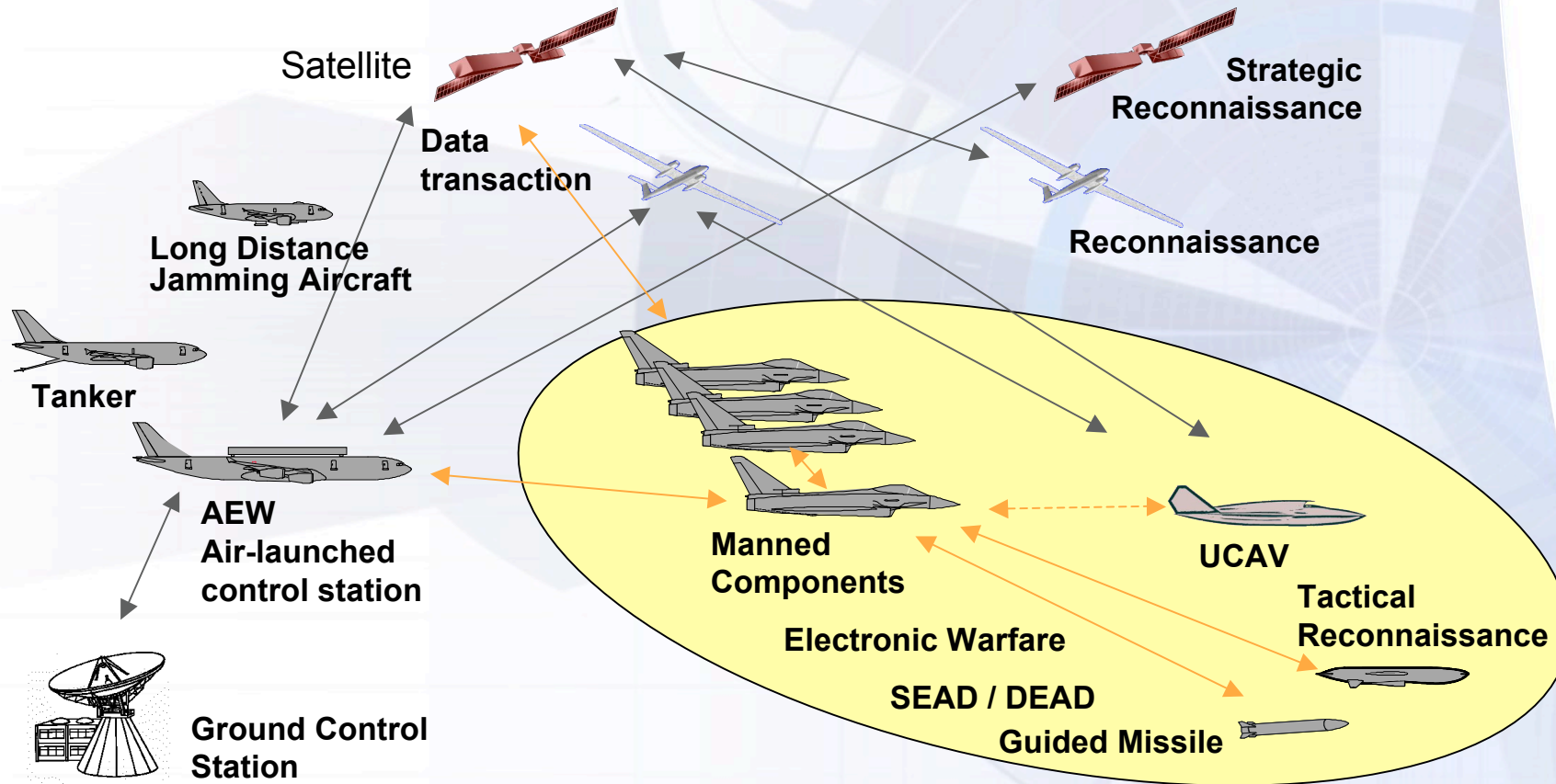


Data-Link (MIDS)

- **Multiple targets from other players**
- **Discrete voice and automatic messages**
 - Engagement Commands
 - Re-tasking
 - Weather/NBC status
 - Threat changes - (Real time)
- **Situational Awareness**
 - Wingman position
 - Escort positions
 - Threat development
- **Stealth firing capability**
- **Target identification**



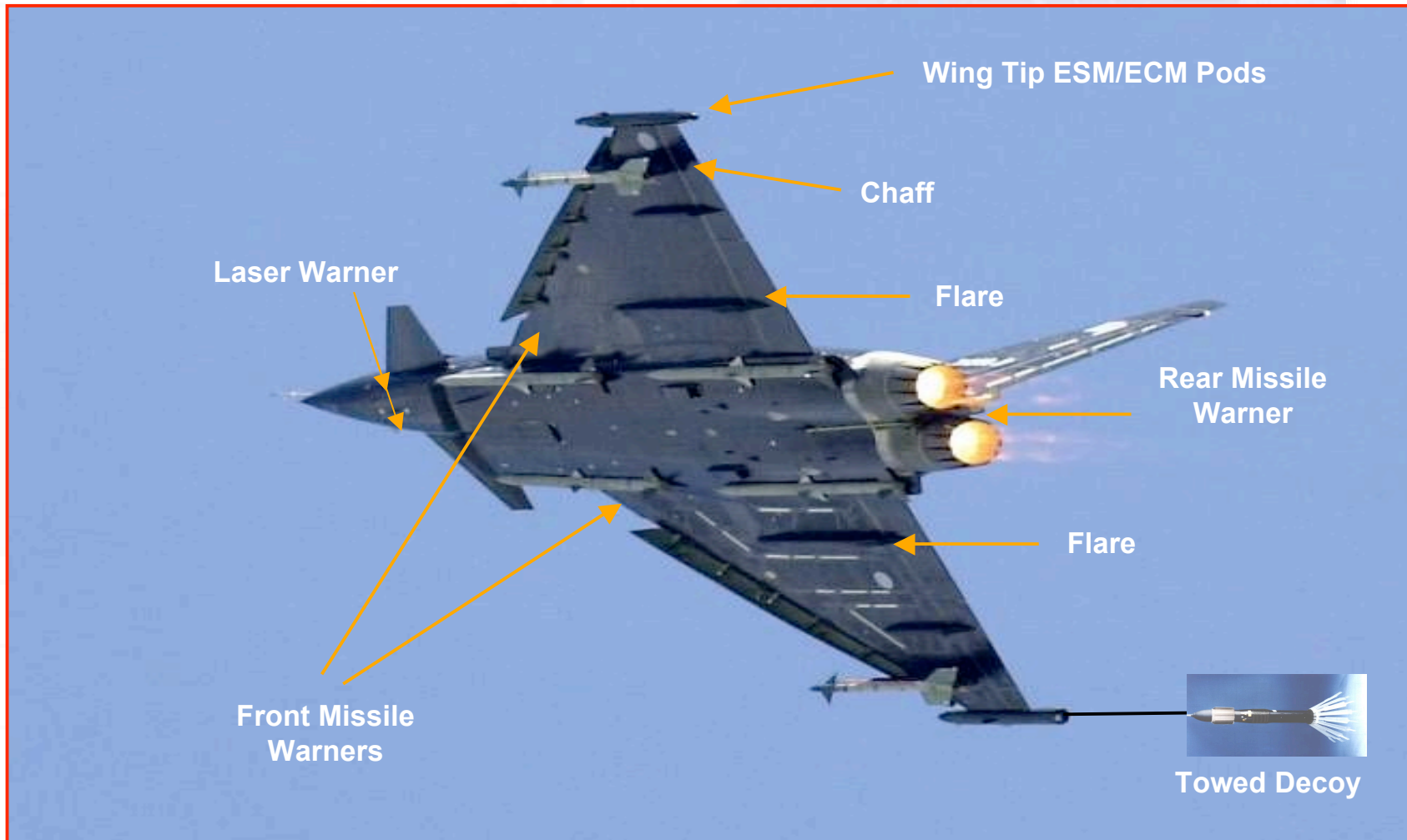
Eurofighter A Key System in the Network Centric Warfare



- Eurofighter will be the „backbone“ of Future European Combat Air Systems
- Multi-Role Capability is essential
- Operation with UAVs is likely to emerge in 2012+ timescales

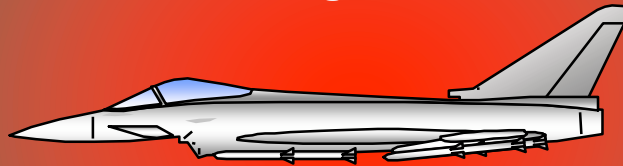


Military Air Systems **Defensive Aids Sub-System (DASS)**



Defensive Aids Sub System

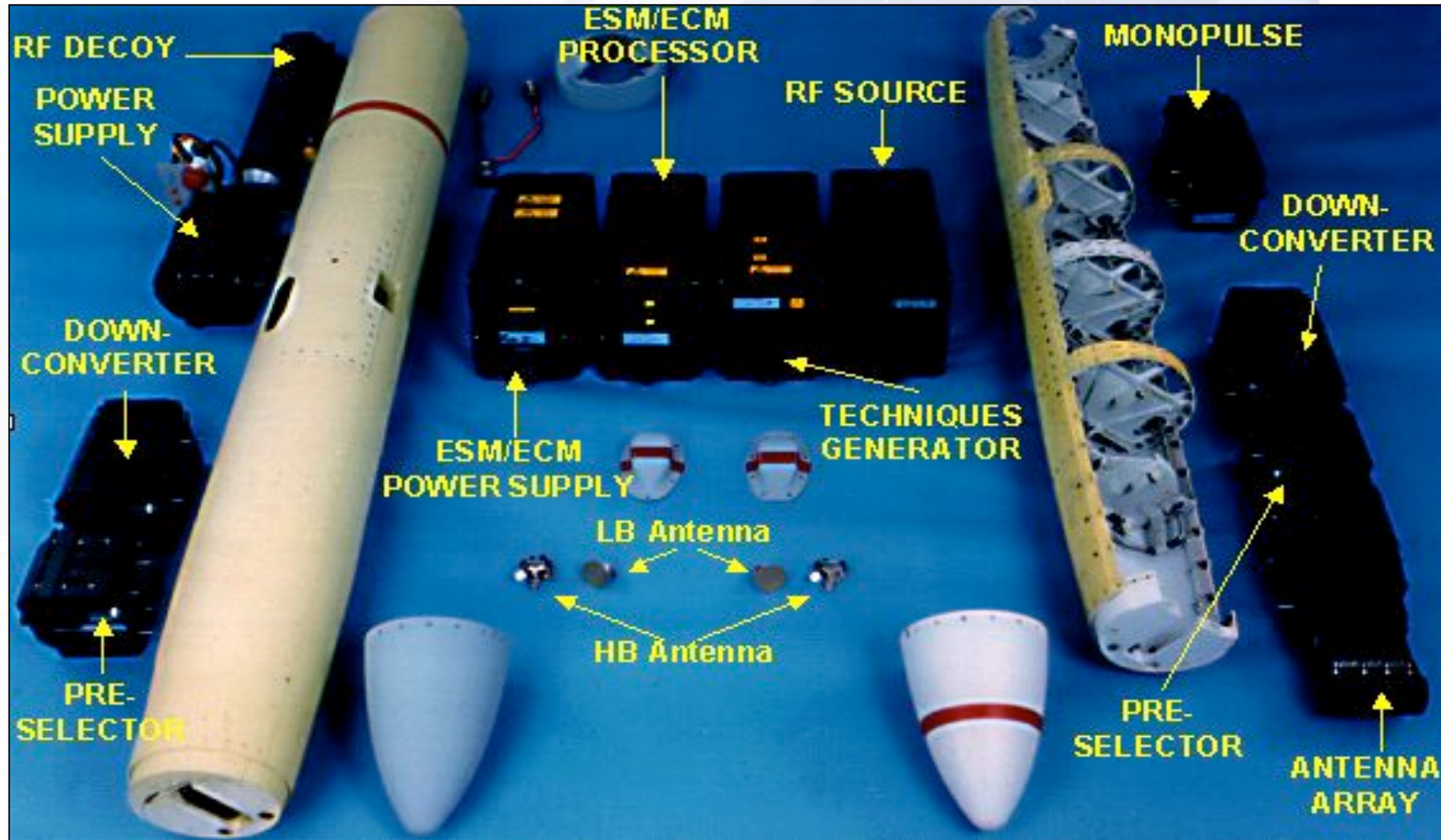
- Integrated within basic design
- Individually mounted, utilising wing tip pods for good all-round aspect and performance
- Provision for future growth and developments



- Interception, analysis, identification and prioritisation of transmissions and threats
- Range of countermeasures, automatically and manually deployed



Eurofighter – ESM-ECM Equipment



Eurofighter – DASS Format



Airspeed Aircraft Heading Altitude

Radar Range/Azimuth Coverage

Range Circles 0, 20, 40 NM

Chaff/Flare Load

Elevation bar $\pm 60^\circ$

Elevation bar $\pm 5^\circ$

Towed Decoy Status

PA Format



Eurofighter Coordinated Countermeasures



- Manoeuvres
 - Last ditch Manoeuvre
 - Escape Manoeuvre
 - Support Manoeuvre
 - Required Flight Condition
- Expendables
- ECM (Jamming)

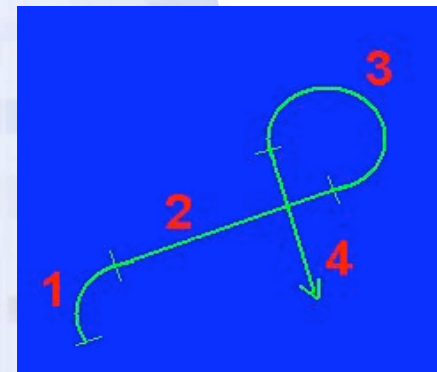
- ECM + Expendables
- ECM + Manoeuvre
- Expendables + Manoeuvre
- ECM + Expendables + Manoeuvre

HUD indication

For Extensions: Direction Limit Box

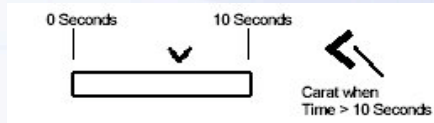
For Turns: Direction Arrow

Commanded Gs (pull)



Maneuver Name (BOOGIEY-I) & Total maneuver time (13)

Time to initiate next maneuver (v)



Eurofighter – Anti-jamming protection

- Safe radio communications (HAVEQUICK, SATURN)
- RADAR ECR-90 (ECM resistant)
- IRST/FLIR (not jamable)
- MIDS Link 16 LVT featuring:
 - Secure transmission (always encrypted)
 - ECCM (very fast frequency hopping)
 - Low probability of interception (spread spectrum)



Low workload



The cockpit problem



Threats:
Bullets
Missiles
Germs
Radiation

Radio & Warnings & Data Link Audio

**Radar Track
IRST Track
MIDS Track
DASS Track
Lookout**



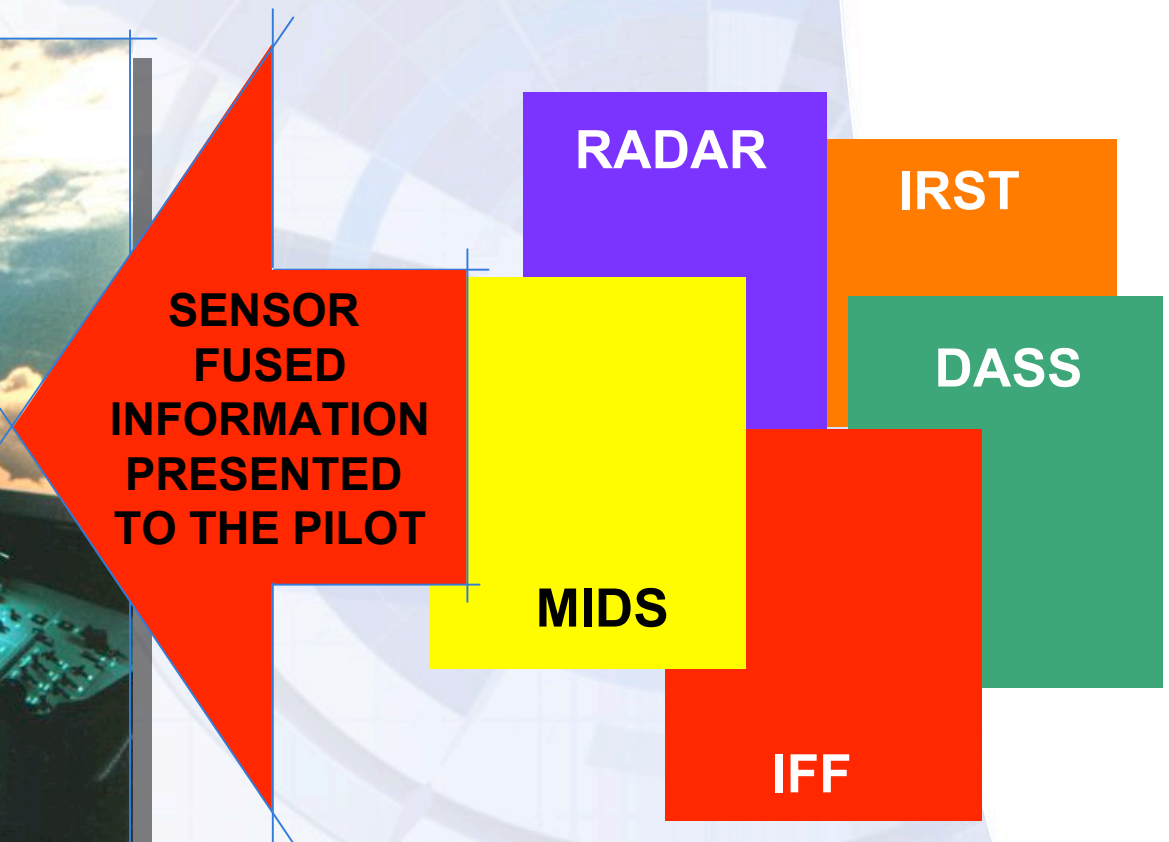
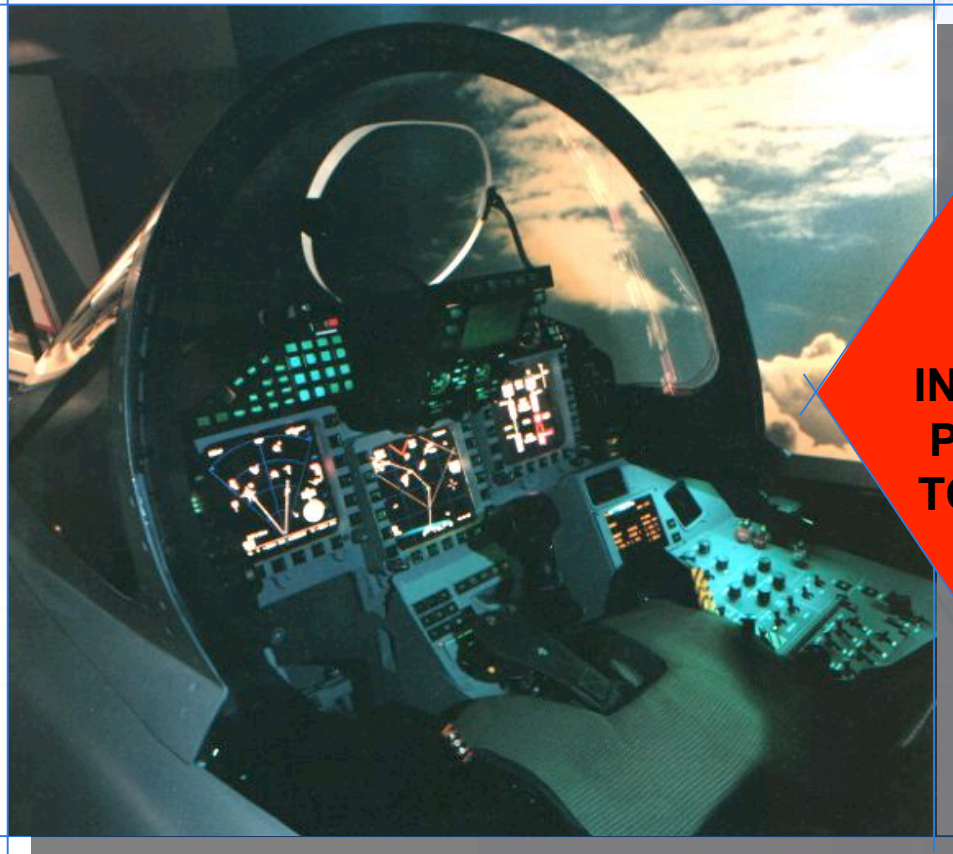
Rules of Engagement (Politicians) Blue on Blue?

Has the wife /partner taken the Credit Card shopping?

**Managing the:
Wingman
Tactics
Aircraft
Weather**



Sensor Fusion



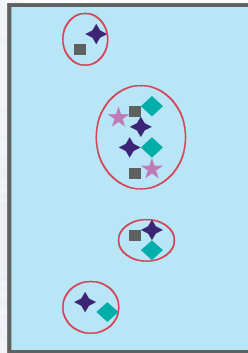
Eurofighter – Sensor Fusion

Scenario



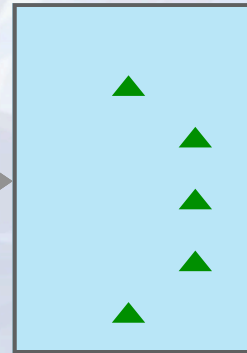
Sensor Data

(■ : Radar, ◆ : MIDS
★ : FLIR, ◆ : ESM)

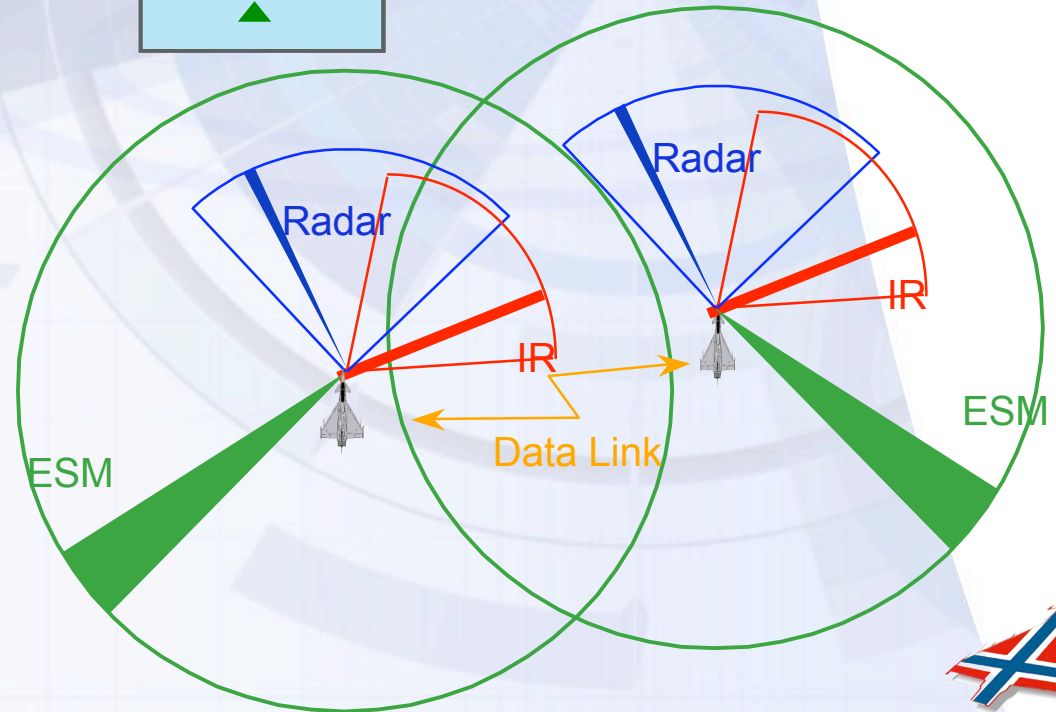
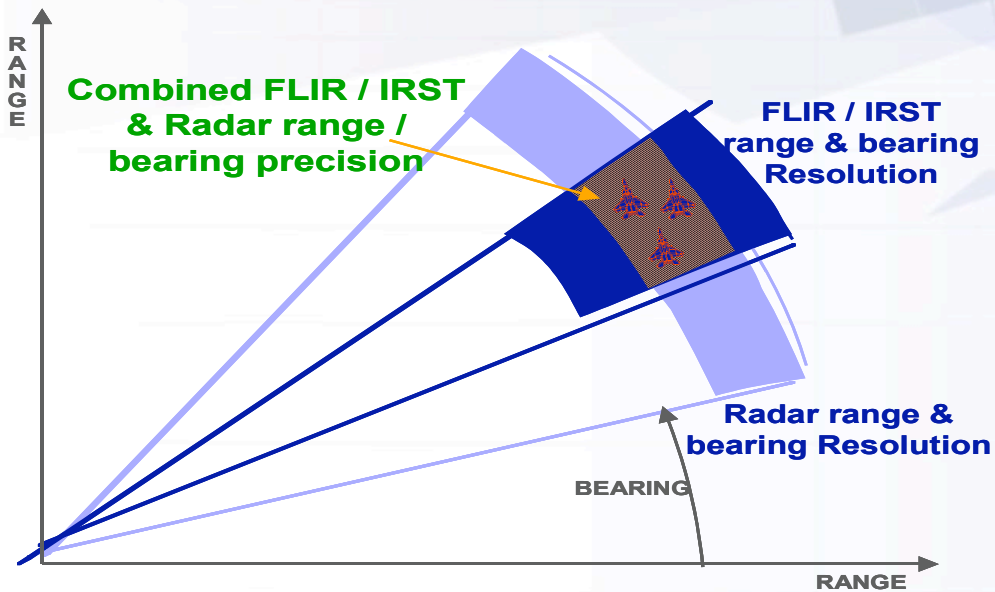


Sensor Fusion

Central Tracks



Extended Spatial Coverage



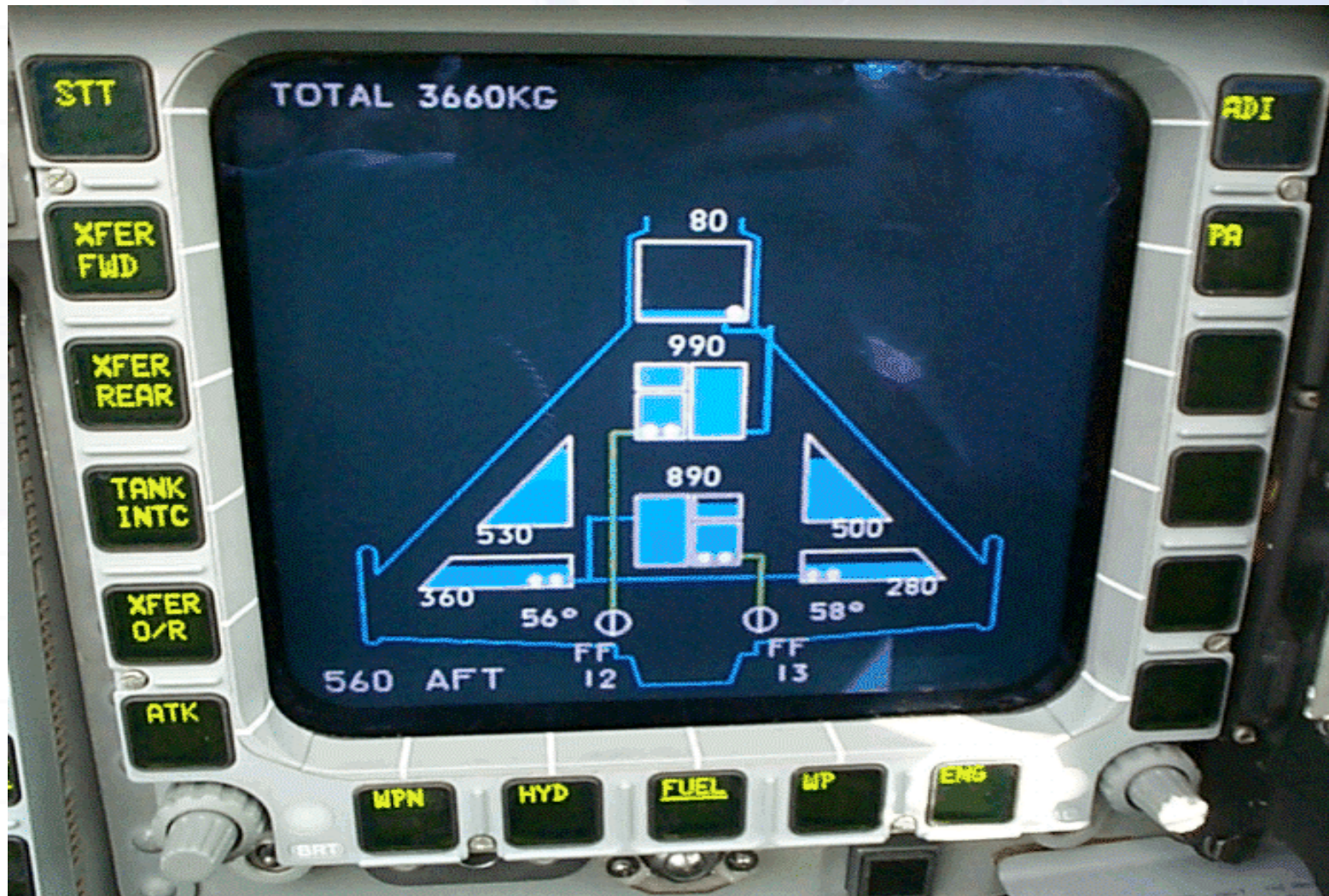
Cockpit - Main Features



- **Helmet Mounted Display**
 - **Wide FOV HUD (Primary Flight Instrument)**
 - **Multi-function colour Head-Down Displays**
 - **HOTAS controls**
 - **Direct Voice Input**
 - **Multifunction Data Entry**
 - **Reversionary Flight Instruments**
 - **Integrated voice warnings and status system**
- } **V-TAS**



Cockpit Displays



Power UP



ECS
RIGHT BOOST PUMP
MASS

FCS NOT READY **PWR UP** **FCS/MIDS**
ALIGN 3.6NM/H
READY IN 9 S
GPS FOM9

XPDR - HI POWER
INT - HI POWER
IFF MODE 3A CODES
1031 - 18:00 HOURS
1224 - 18:30 HOURS
PP - N53:00.00

ATCK PWR UP

MAG TRUE
TRK NTH
COMP
MAP TAC
AIR OFF

317kt
434kt
094/
3:39

RNG 10.5 BRC 344 21,920 FT

727cs
L 1:33
U 14:02:43

DFLT
CHRT OFF
ARCS OFF
A/C GND
C/D BALL

MAP CRSE TACT MIN HSI

LINTK 3° - ENG- RINTK -7°

AJ 34 82.0 NH
AJ 42 75.0 NH

TBT 695 TBT 840

50 FWD

WPN HYD FUEL WP ENG



MASS stby



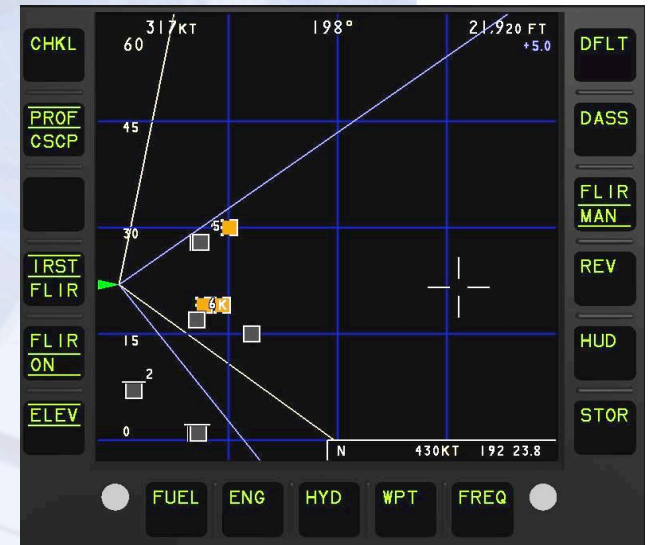
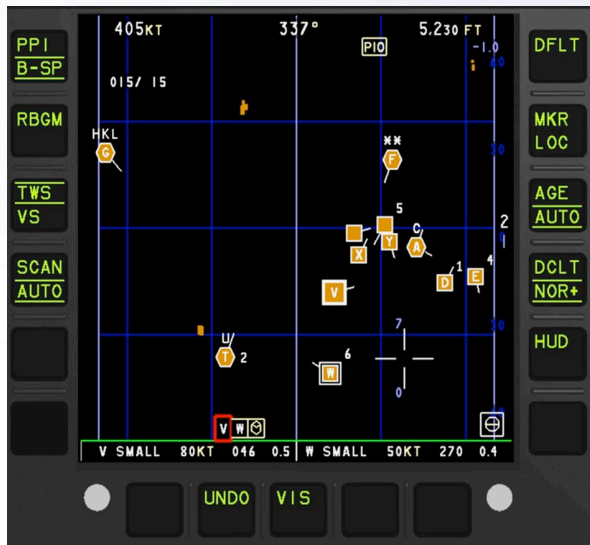
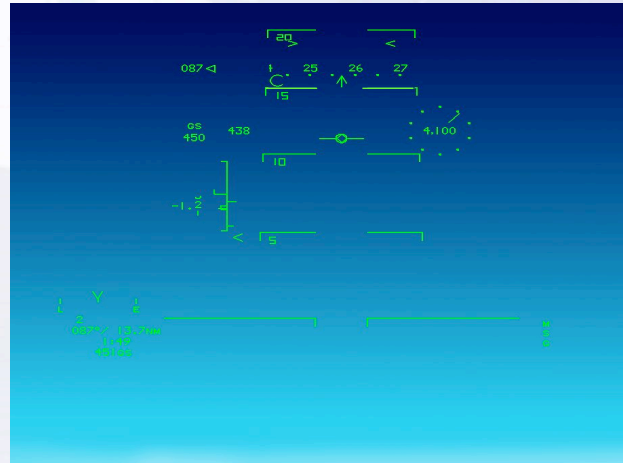
MASS status panel showing various system indicators and controls. The panel includes a 'RIGHT BOOST PUMP' indicator, 'MASS' status, and a 'PWR UP' warning. It also displays 'FCS NOT READY' and 'GPS FOM?' status. The bottom section shows 'XPDR - HI POWER' and 'INT - HI POWER' warnings, along with 'IFF MODE 3A CODES' and 'PP - N53:00.00'. A 'NAV MODE' section on the right includes 'ALGN NORM', 'ALGN MEMO', and 'ALGN HUD' options. A 'MAP' icon is visible at the top right.

MASS tactical display showing a map with various data points and controls. The map displays a target area with a heading of 198° and a range of 10.5. A bearing of 344 and a distance of 21.920 FT are also shown. The display includes a 'MAG TRUE' indicator, 'TRK NTH', 'COMP', 'MAP TAC', and 'AIR OFF' options. A '727cs' speed indicator and 'L 1:33' time are visible. The bottom of the display features 'MAP CRSE', 'TACT MIN', and 'HSI' buttons.

MASS weapon status panel showing a diagram of a missile with various components and status indicators. The diagram includes a 'STORE' label, 'MRAAM' and 'SRAAM' labels, and a '1000L' label. The panel also displays 'CHKL', 'CHAFF FLARE DECOY', 'MASS LIVE', and 'NORM' indicators. A 'DASS' indicator is visible on the right. The bottom of the panel features 'FUEL', 'ENG', 'HYD', 'WPT', and 'FREQ' buttons.



After Take Off



Eurofighter Helmet



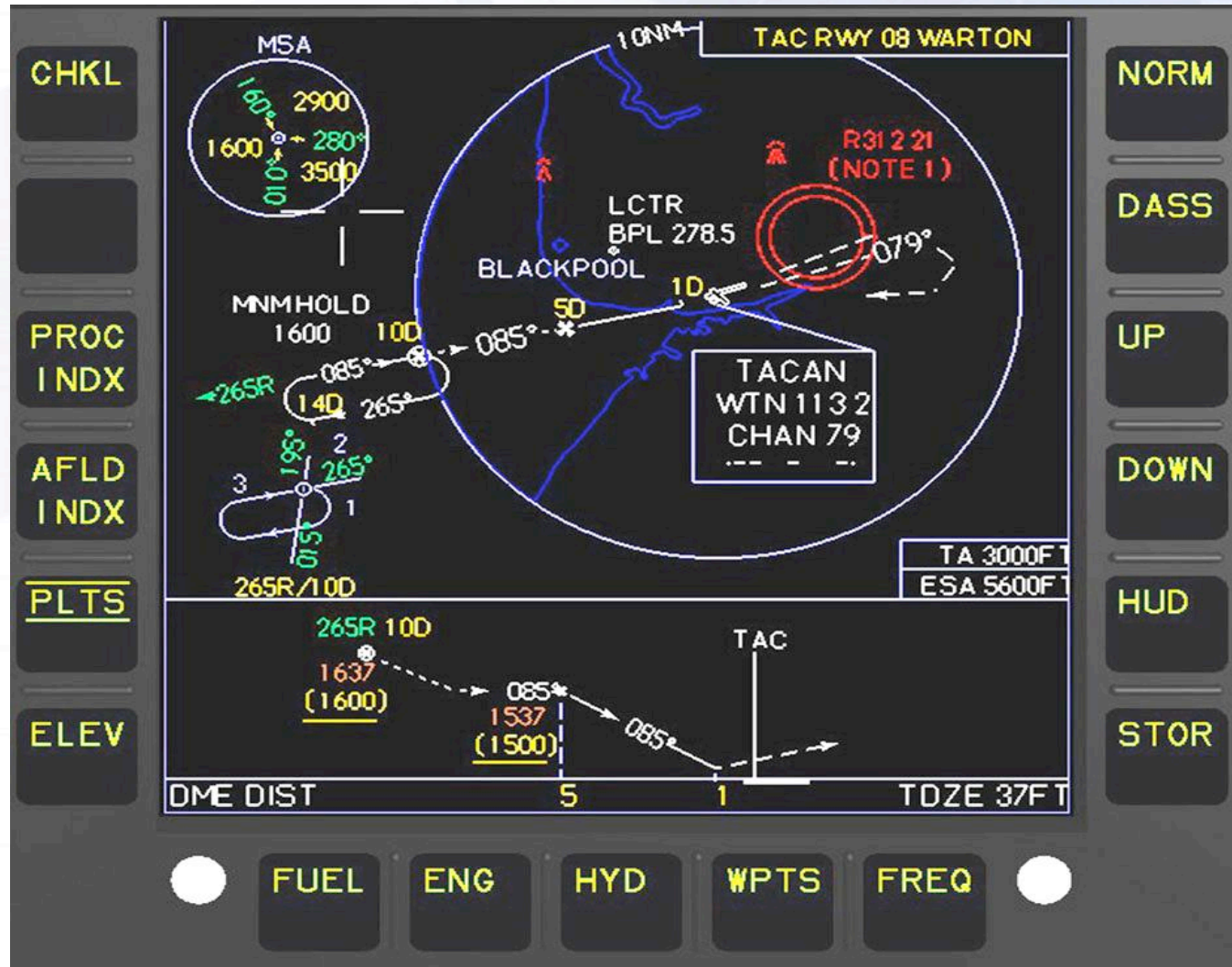
Cockpit Displays - Procedures



The image shows a cockpit display titled "PROCEDURES". The display is framed by a dark grey border with several control buttons. On the left side, from top to bottom, are buttons labeled "W", "PROC CONS", "NEXT", "PLUS CHKL", and "ELEV". On the right side, from top to bottom, are buttons labeled "NORM", "PAGE DOWN", "HUD", and "PLUS STOR". At the bottom of the display are five buttons: "PLUS FUEL", "PLUS ENG", "PLUS HYD", "WPT", and "FREQ". The main display area has a black background with white and yellow text. At the top center, the word "PROCEDURES" is written in white. Below it, there are two columns of yellow buttons: "L GBOX", "L UTIL P", "L CONT P", "L GEN", "L COWL" in the left column; and "FCS I", "NWS", "ELEC I", "A BRAKE" in the right column. The "L GBOX" and "L CONT P" buttons are highlighted in red. In the center of the display is a white crosshair. Below the crosshair, the text "THROTTLE. . . . IDLE OR SHUT DOWN" is displayed, with "IDLE OR SHUT DOWN" in a grey box. Below that, "(IF POSSIBLE)" is displayed. Further down, "LAND. ASAP" is displayed, with "ASAP" in a grey box. At the bottom center, the word "CONTINUE" is displayed. Below "CONTINUE", "PAGE 1 OF 2" is displayed. At the bottom left of the display area, the word "CONSEQ" is displayed in a white box.

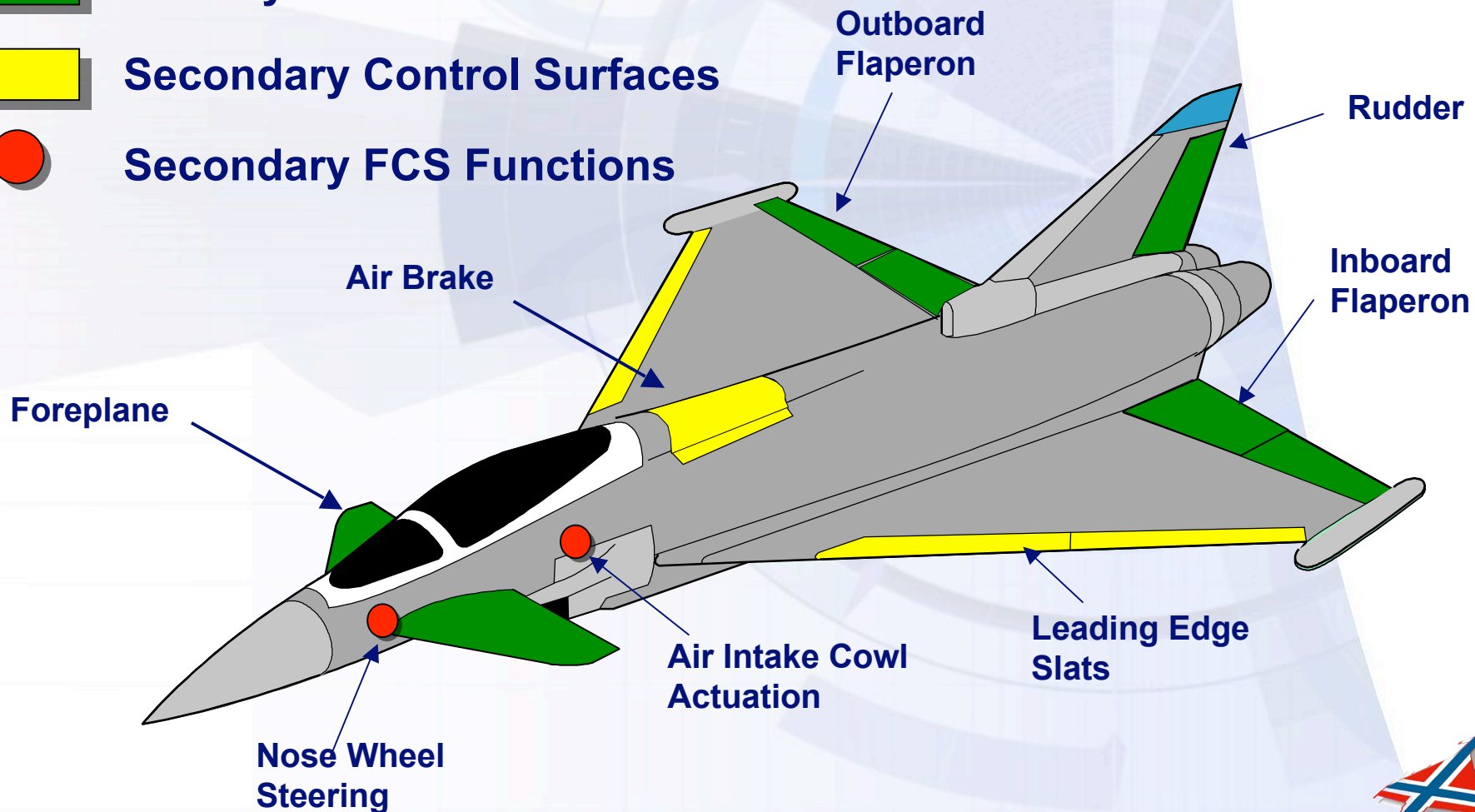


Cockpit Displays - Plates

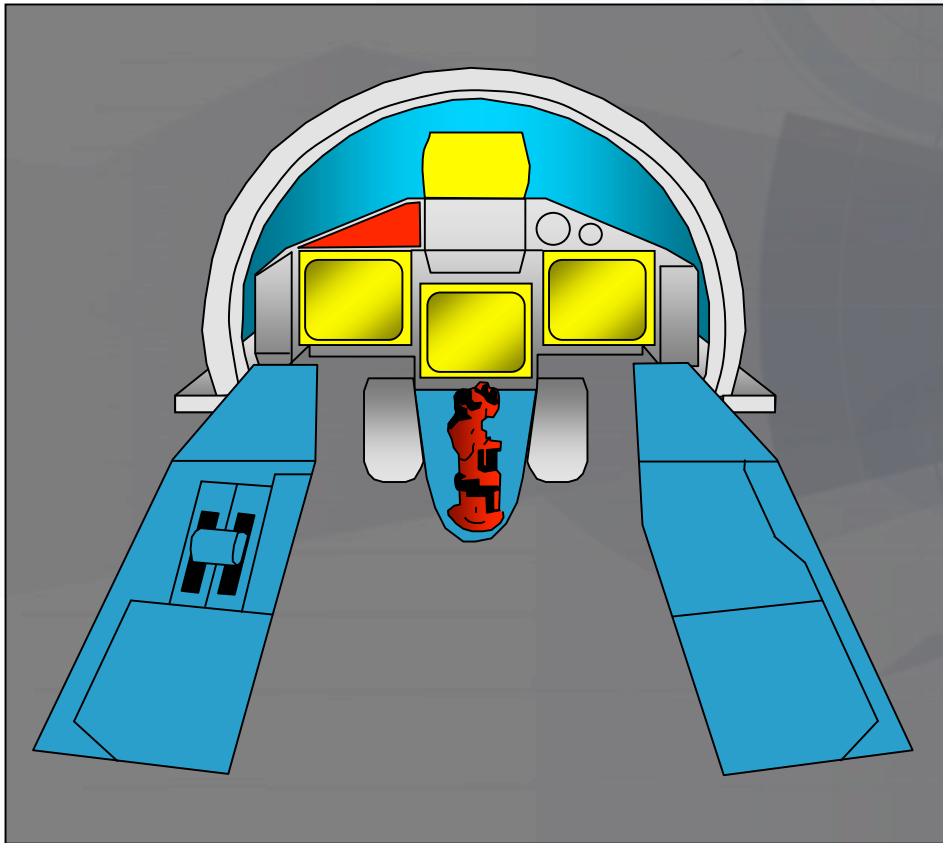


Flight Control System

-  **Primary Control Surfaces**
-  **Secondary Control Surfaces**
-  **Secondary FCS Functions**



Autopilot & Autothrottle



Autopilot modes

- Attitude Hold
- Altitude Acquire and Hold
- Heading Acquire and Hold
- Track Acquire and Hold

- Auto Attack
- Auto Cap
- Auto Approach

- Disorientation recovery

Autothrottle

- IAS/MACH Acquire and Hold



“If it’s broke she’ll tell you”

***“Nagging
Nora”***



Voice Control



“Fuel state”

“Say “please”

“Fuel state”

“Don’t use that tone with me!”

“FUEL STATE !!”

“Typical - want, want, want,
and no manners”

“Alright - fuel state please”

“No, its too late now,
you don’t really mean it”



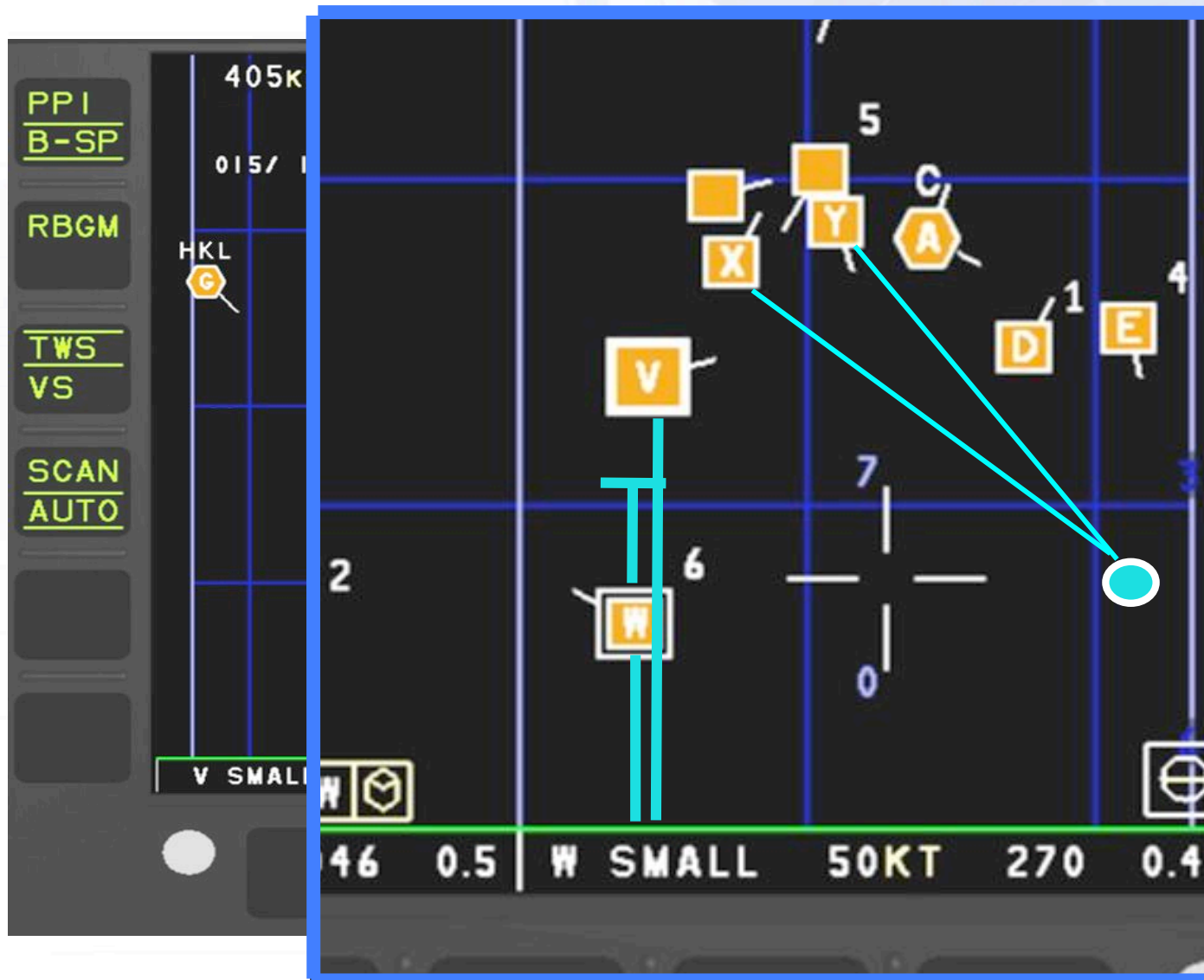
DVI - Decide and Do (1)



**“Target
Wiskey, Victor,
Assign Two,
Xray, Yankee,
Engage, GO”**



DVI - Decide and Do (2)



„Sort 2“



Flexibility and Fire Power



Air to Air

- 27 mm Gun
- SRAAM
 - AIM-9L
 - IRIS-T
 - ASRAAM
- MRAAM
 - AMRAAM A/B/C-5/7
- Advanced MRAAM
 - Meteor
- Training ACMI pod

Air to Ground

- GBU 10/16/24
- GBU 32 (JDAM)
- PAVEWAY II/III/IV
- Litening III LDP
- ALCM
 - Taurus
 - Storm Shadow
- Brimstone

13 Hard points (8 wing/ 5 fuselage)

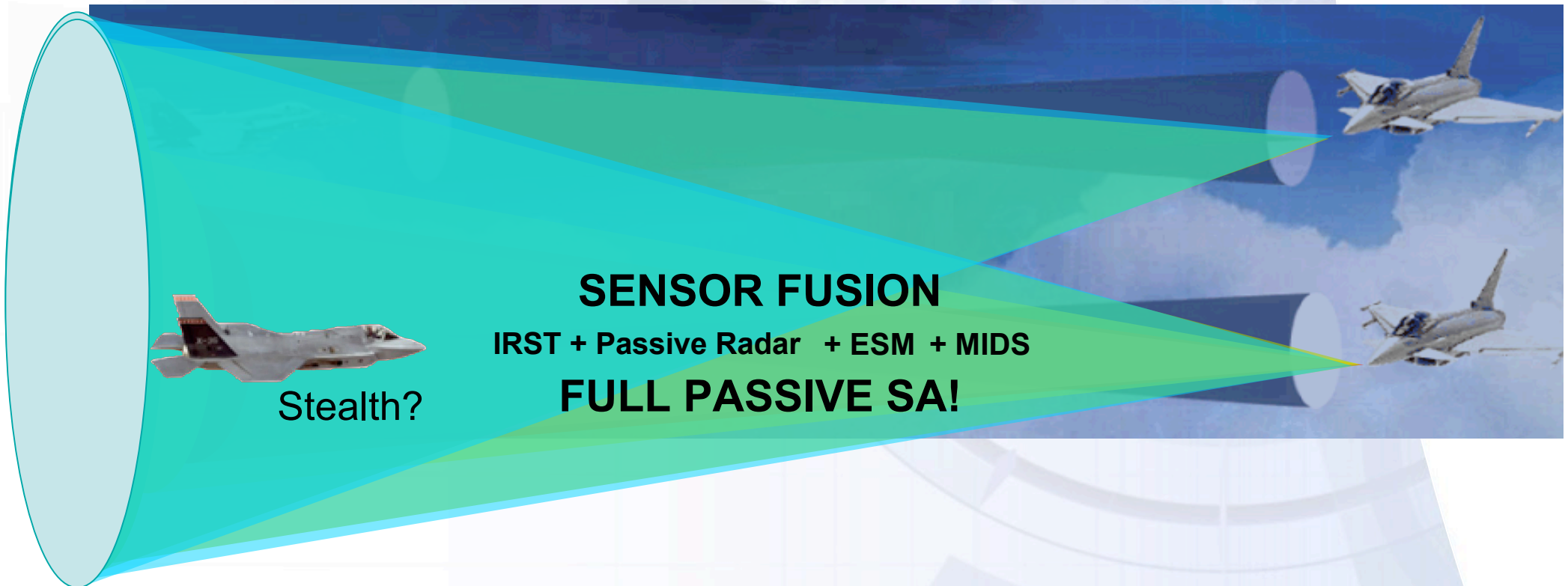


- ✓ Massive firepower
- ✓ Swing / Multi-role capability
- ✓ A-A active missiles & A-G high accuracy weapons



Stealth / Counter Stealth

A Broader Perspective



Low Observability (LO) Operational Impact

The dilemma:

- Invisible but blind

Mitigation:

- External information
- Passive sensors



“Conventional“ design Operational Impact

The dilemma:

- Visible

Mitigation:

- Highest possible situational awareness
- Maximum performance
- Defensive aids

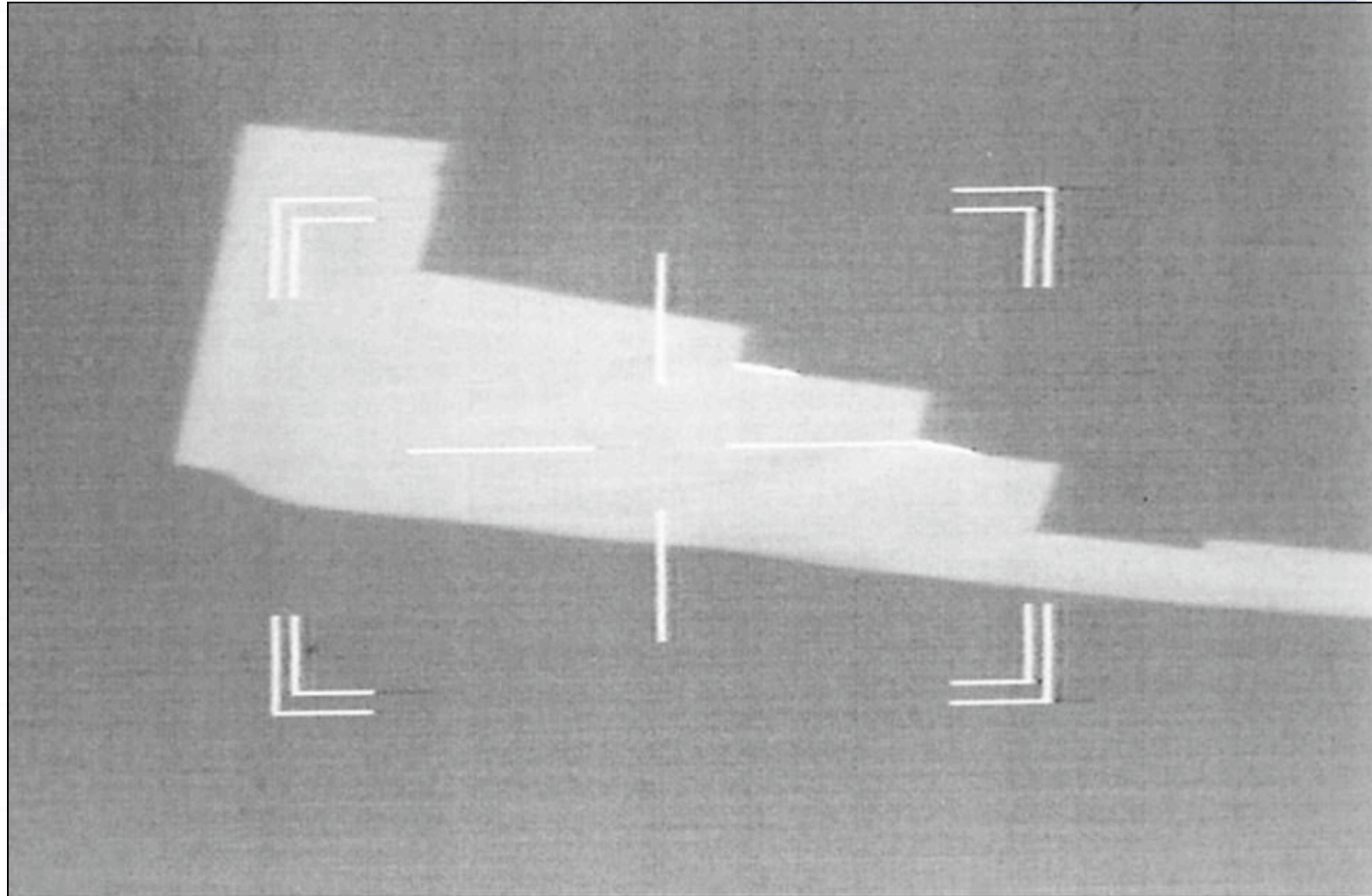


Against LO/VLO threat (very unlikely):

- Stay passive
- IRST becomes primary internal sensor



IR Picture of VLO Bomber

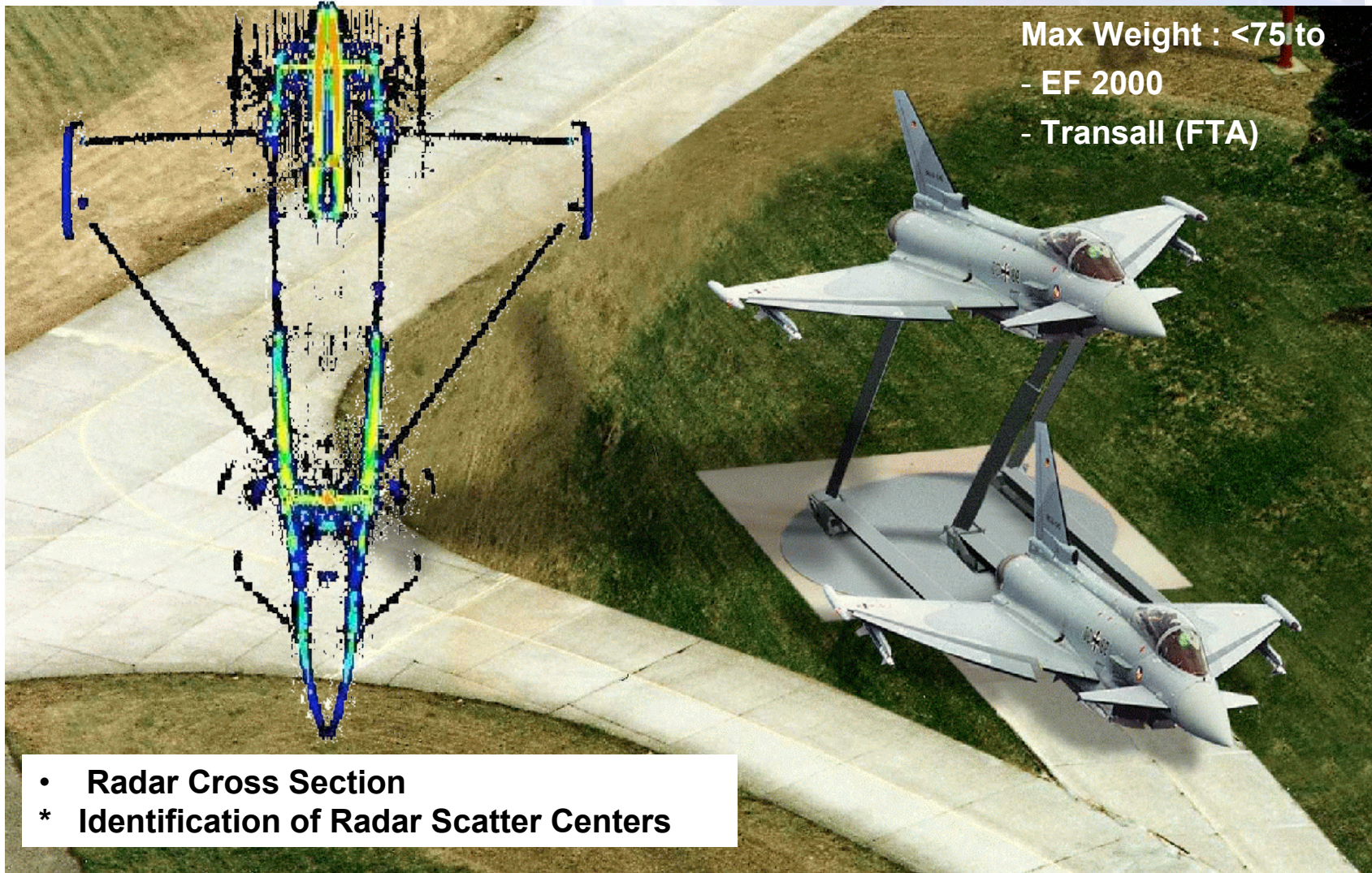


Stealth

- Visual
 - Small airframe
 - Low engine emissions
- Radar
 - Airframe shaping
 - Very Low frontal RCS signature
 - Hidden engine compressor faces
 - Absorbent materials and coatings
- Electro-optic
 - Passive detection -IRST
 - Passive Night Vision - FLIR/NVE
 - Helmet-Aiming
- Defensive aids
 - Passive elements
- Communications
 - Secure radio transmissions
 - Datalink (MIDS)

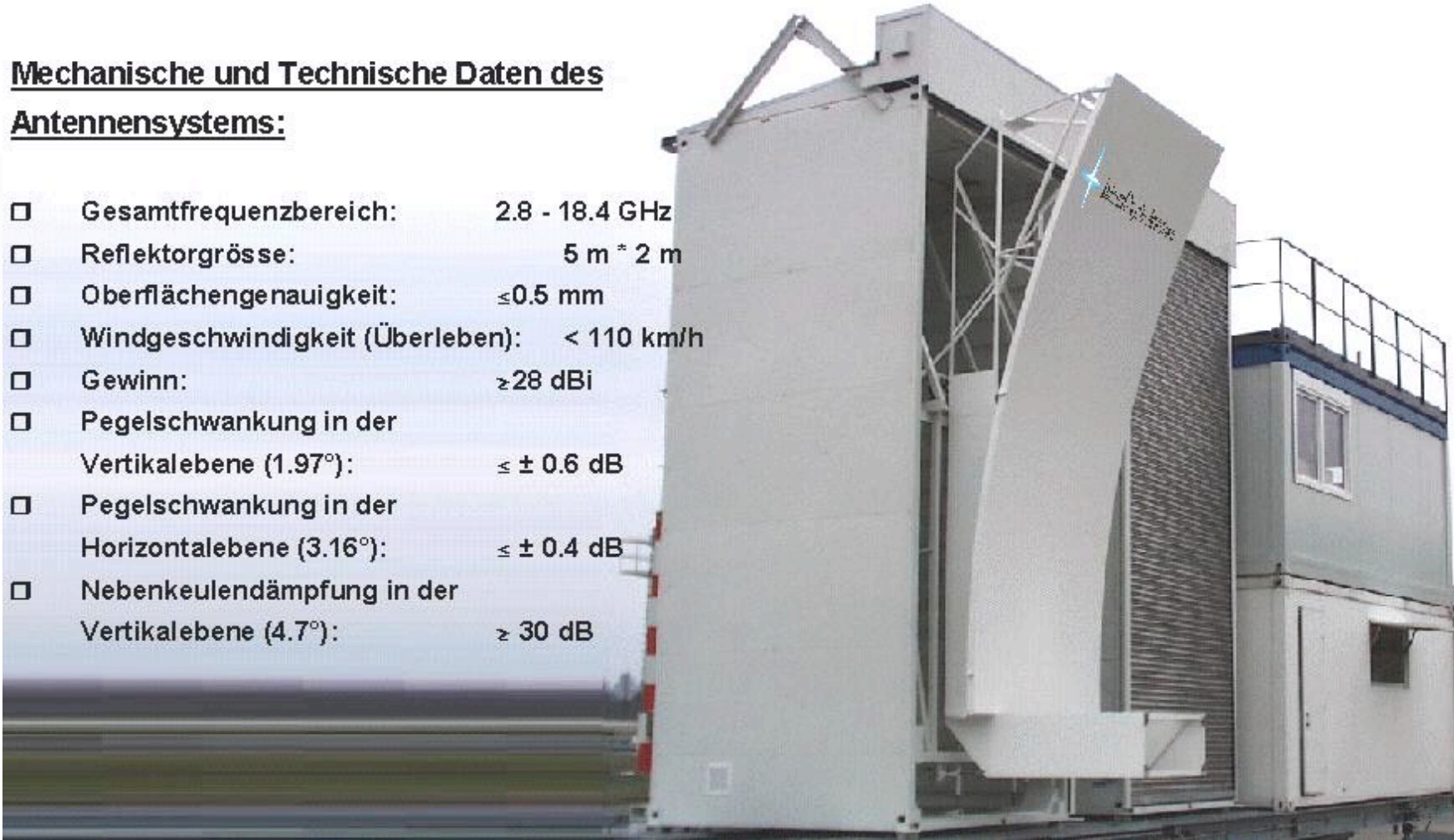


RCS Test Facility Manching



Mechanische und Technische Daten des Antennensystems:

- Gesamtfrequenzbereich: 2.8 - 18.4 GHz
- Reflektorgrösse: 5 m * 2 m
- Oberflächengenauigkeit: ≤ 0.5 mm
- Windgeschwindigkeit (Überleben): < 110 km/h
- Gewinn: ≥ 28 dBi
- Pegelschwankung in der Vertikalebene (1.97°): $\leq \pm 0.6$ dB
- Pegelschwankung in der Horizontalebene (3.16°): $\leq \pm 0.4$ dB
- Nebenkeulendämpfung in der Vertikalebene (4.7°): ≥ 30 dB



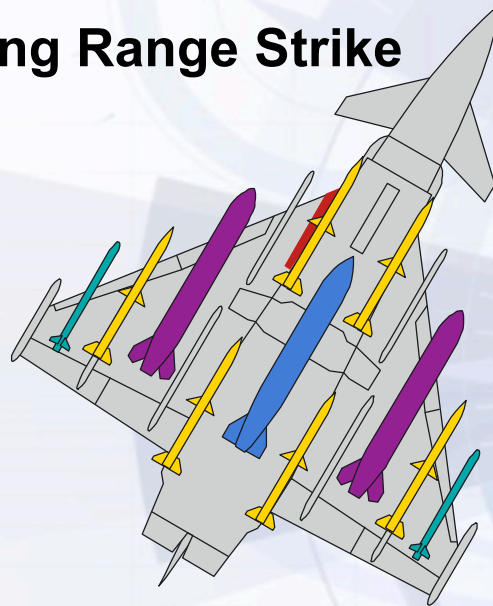
Typical weapons configurations

Air-to-Air



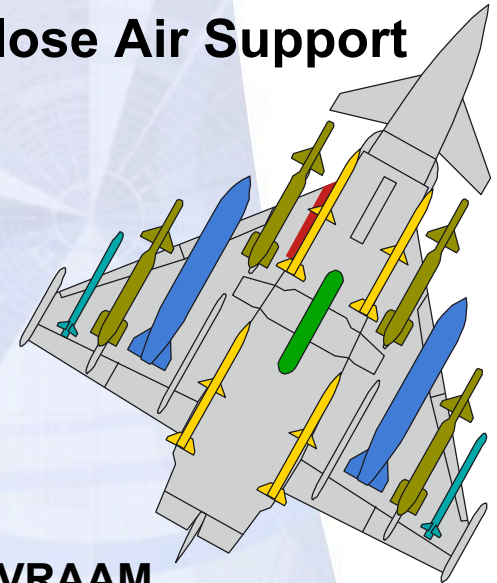
- ◆ 6 BVRAAM
- ◆ 2 SRAAM
- ◆ 27 mm Gun
- ◆ 3 Tanks

Long Range Strike



- ◆ 2 Cruise Missiles
- ◆ 6 BVRAAM
- ◆ 2 SRAAM
- ◆ 27 mm Gun
- ◆ 1 Tank

Interdiction Close Air Support



- ◆ 4 BVRAAM
- ◆ 2 SRAAM
- ◆ 27mm Gun
- ◆ 1 LDP
- ◆ 4 GBU 16 or PW II or IV
- ◆ 2 Tanks



- **Home Defence**
 - **Airspace policing and defence**
 - **Information gathering (monitoring/identifying intruders)**
 - **Surface Attack (land and sea)**
- **Coalition Operations (Expeditionary Air)**
 - **Peace Keeping to all out conflict**
 - **Protection of own forces**
 - **Precision attack (land & sea targets)**
 - **Close Air Support**

Fulfilling these roles needs ability to provide

proportional response

and credibility (political & operational)



Interoperability Multi / Swing – Role

- Key capability which provides commanders (and politicians) with the required flexibility to meet/adapt to current and future operational requirements
- Vital capability for single type Air Forces

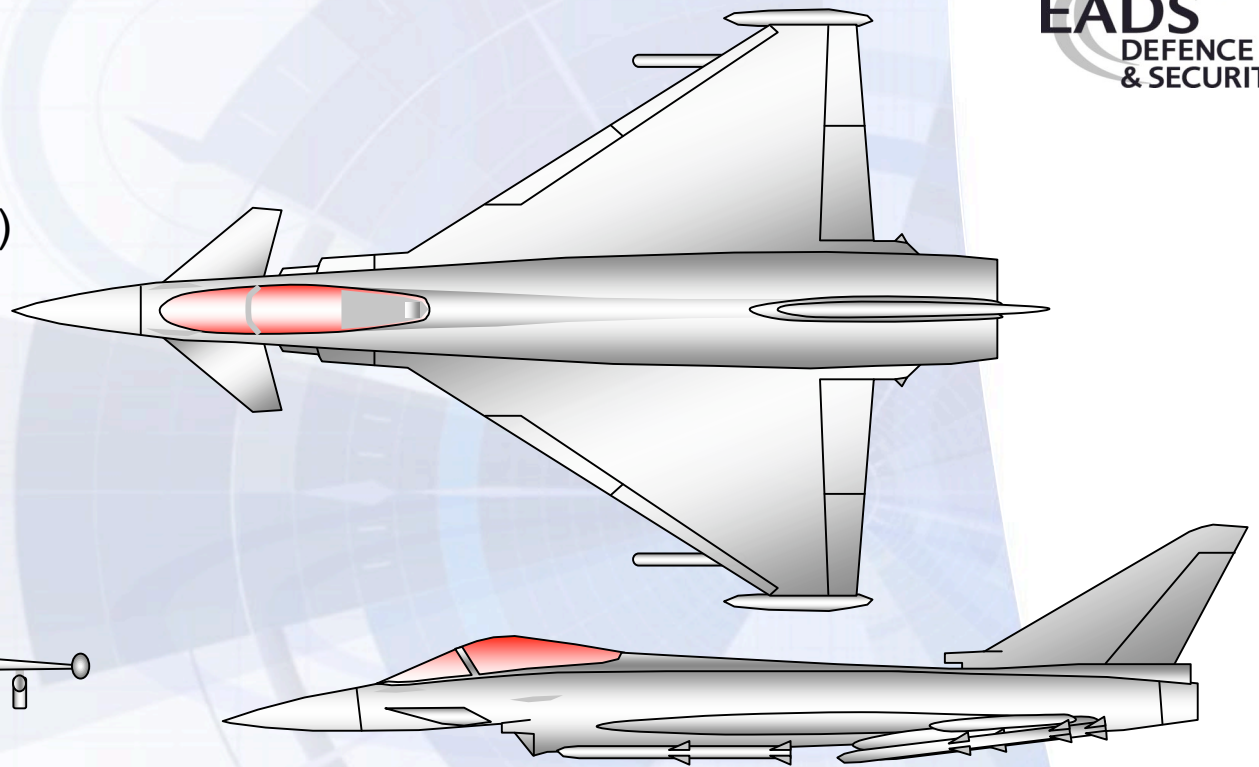


Performance



General Arrangement

Wing span - 10.95m (35 ft 11ins)
 Length - 15.96m (52 ft 4 ins)
 Height - 5.28m (17 ft 4 ins)



Air – to – Air

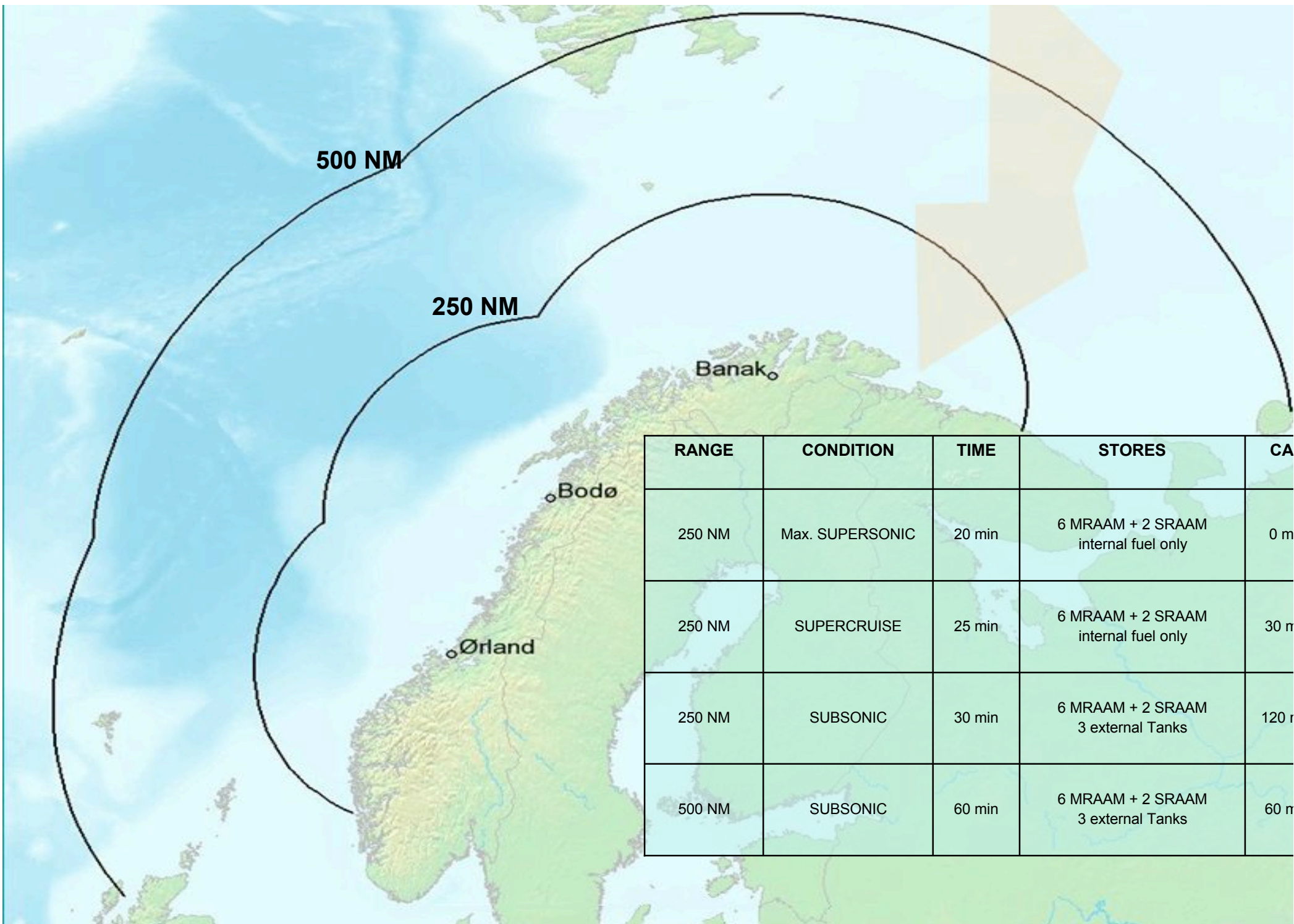
	EF	F-22
T/W Ratio	1,13	1,16
Wing Loadin	320	350
Fuel Fractio	0,31	0,30



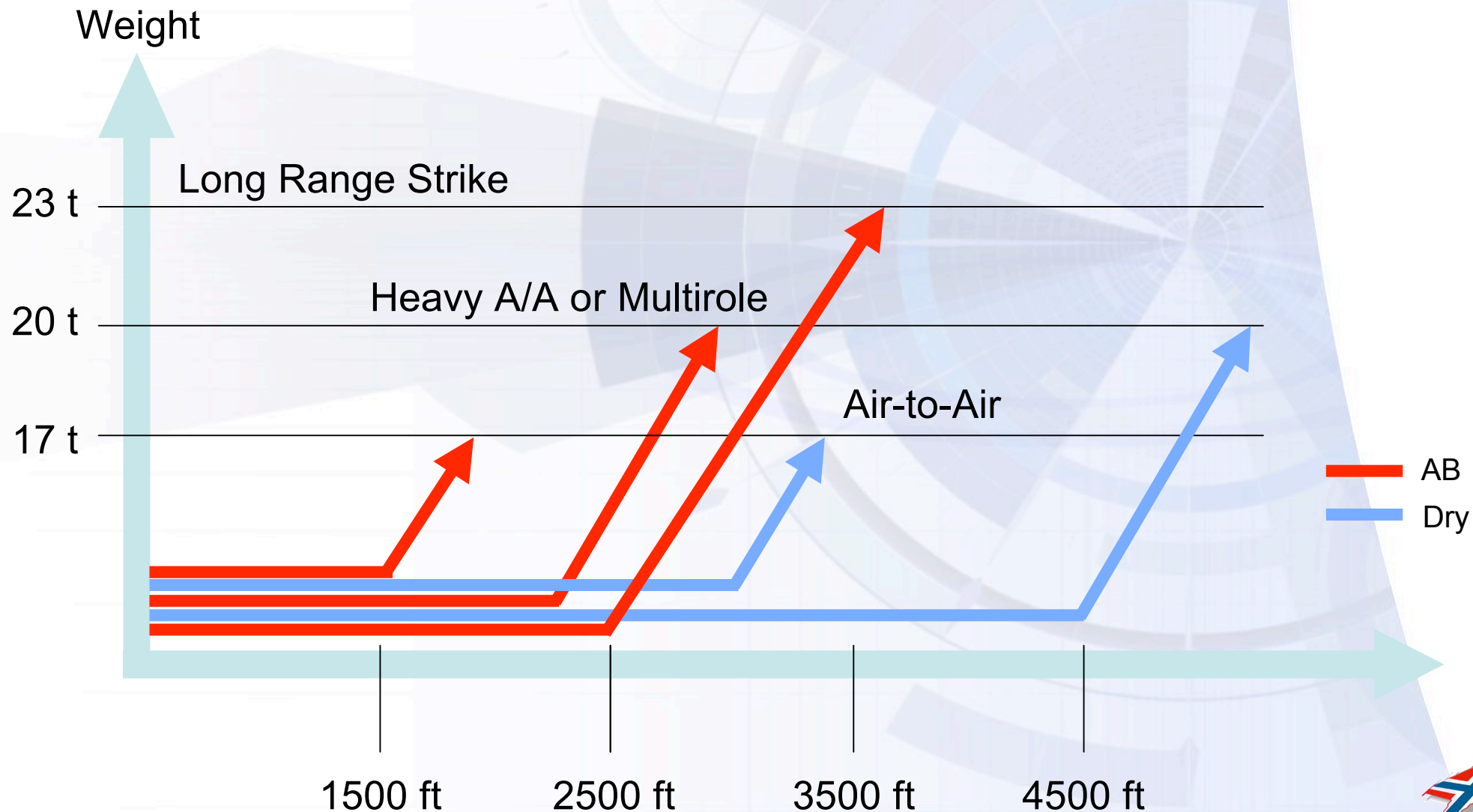
Air – to – Surface

	EF	JSF
T/W Ratio	0,94	0,83
Wing Loadin	382	500
Fuel Fractio	0,40	0,39





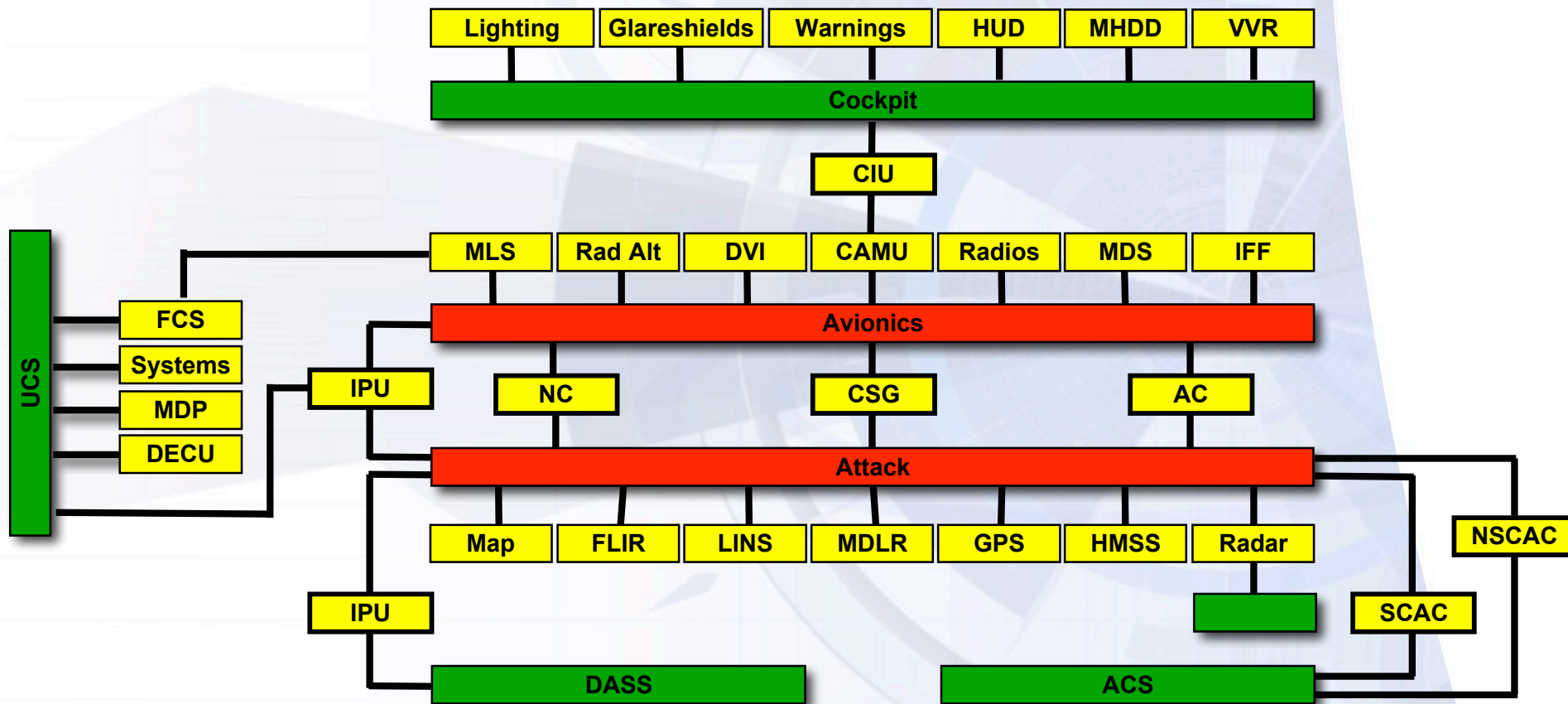
Take-Off Distances



Reliability



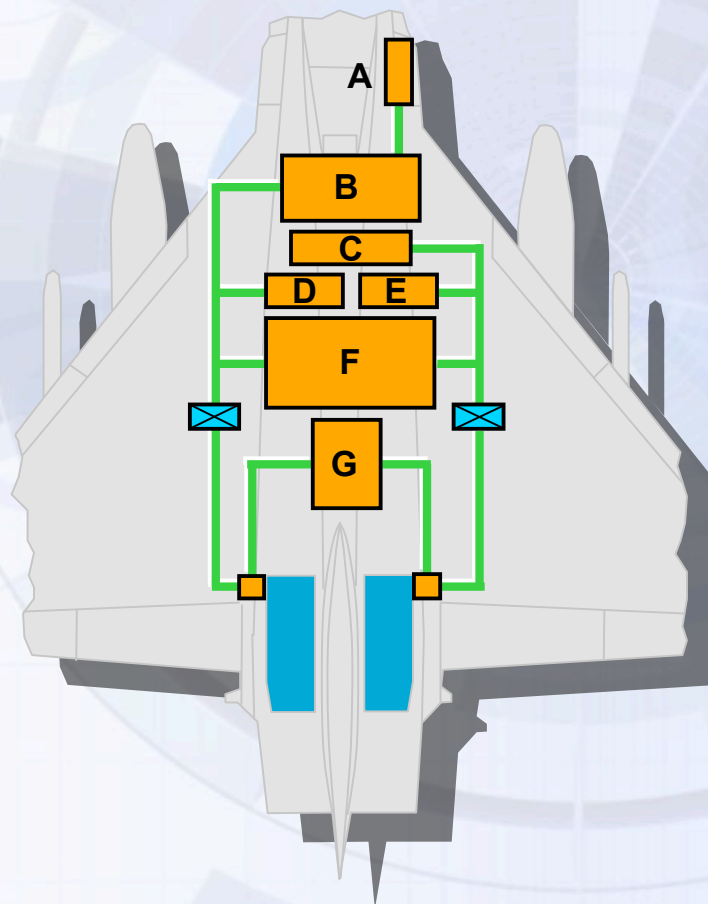
Avionics Architecture



Hydraulic System

- Two Independent Systems
- Flight control Protection

- A** - Gun
- B** - Nose Steering
- Canopy
- C** - Park Brake
- D** - Airbrake
- E** - L. Utilities
- F** - R. Utilities
- Landing Gear
- FR Probe
- Brakes
- G** - Slats
- FCS



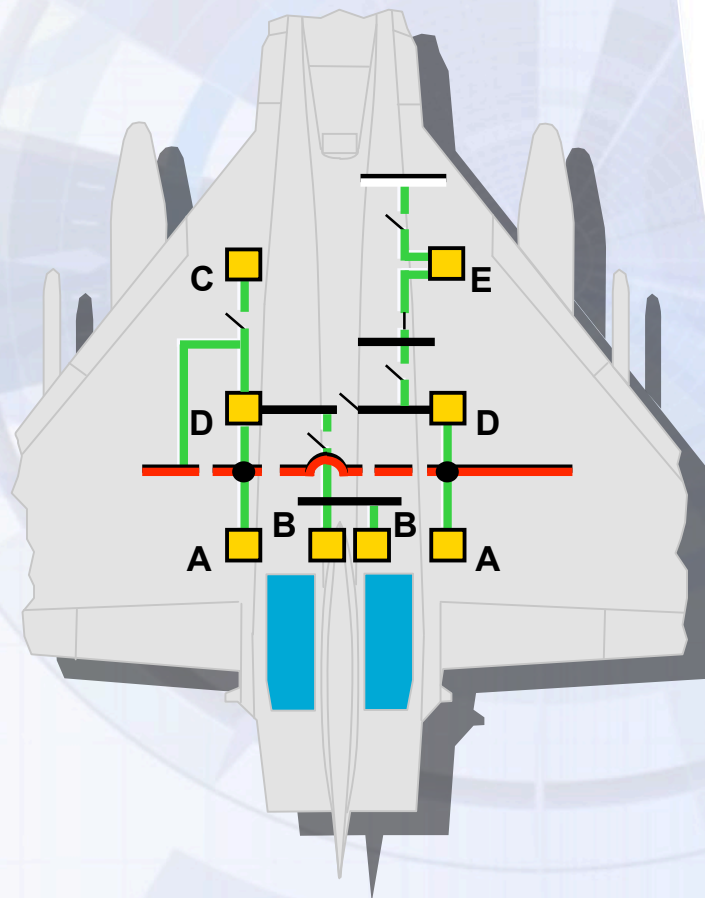
Electrical System

- A - AC Generators**
- B - DC Generators**
- C - APU Generator**
- D - TRUs**
- E - Battery**

 **DC Busbars**

 **AC Busbars**

 **Maintenance Busbars**



USAF flight safety statistics



Fiscal Year	F-16 Class A Mishaps	F-16 Engine-Related Class A Mishaps	F-16 Engine-Related Destroyed Aircraft
FY99	18	9 (50%)	9 (100%)
FY00	9	3 (33%)	3 (100%)
FY01	13	7 (54%)	7 (100%)
FY02	7	2 (29%)	2 (100%)
FY03	11	2 (18%)	2 (100%)
FY04	2	0 (0%)	0 (0%)
FY05	5	2 (40%)	2 (100%)
Total	65	25 (38%)	25 (100%)

Based on 48 aircraft over 35 years:

6 aircraft lost

Fiscal Year	F-15 Class A Mishaps	F-15 Engine-Related Class A Mishaps	F-15 Engine-Related Destroyed Aircraft
FY99	7	3 (43%)	1 (33%)
FY00	5	1 (20%)	0 (0%)
FY01	2	0 (0%)	0 (0%)
FY02	7	4 (57%)	0 (0%)
FY03	4	3 (75%)	0 (0%)
FY04	3	0 (0%)	0 (0%)
FY05	3	1 (33%)	0 (0%)
Total	31	12 (39%)	1 (8%)

1/2 aircraft lost

Source: U.S. Air Force Safety Agency (via Flying Safety; 1/1/2006; Wolff, Bob)



Questions ?

