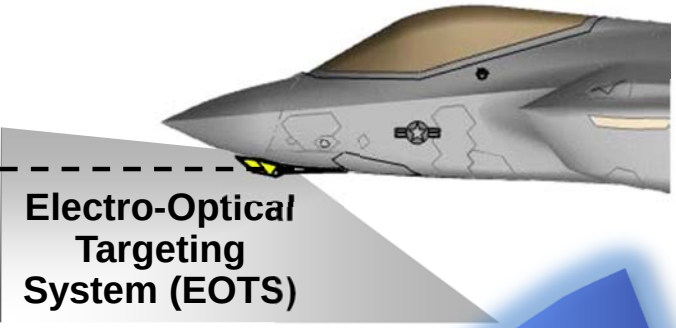
http://www.slideshare.net/SpazSinbad/savedfiles?s_title=combat-systems-fusion-engine-for-the-f35

Advanced Fusion Avionics Suite

http://www.f-16.net/f-16_forum_download-id-17620.html

Full Spherical Coverage by Distributed Aperture System (DAS)



Electro-Optical Targeting System (EOTS)

http://www.sldinfo.com/whitepapers/the-f-35-combat-systems-fusion-engine/

Radar Warning System 360° Coverage

Fwd Band 3 / 4

Band 3 / 4 Radar Warning

Fwd Band 2

DAS Apertures

Active Electronically Scanned Array (AESA)

RADAR

Aft Band 2

Electronic Support Measures

Fwd Band 2

Band 3 / 4 Radar Warning

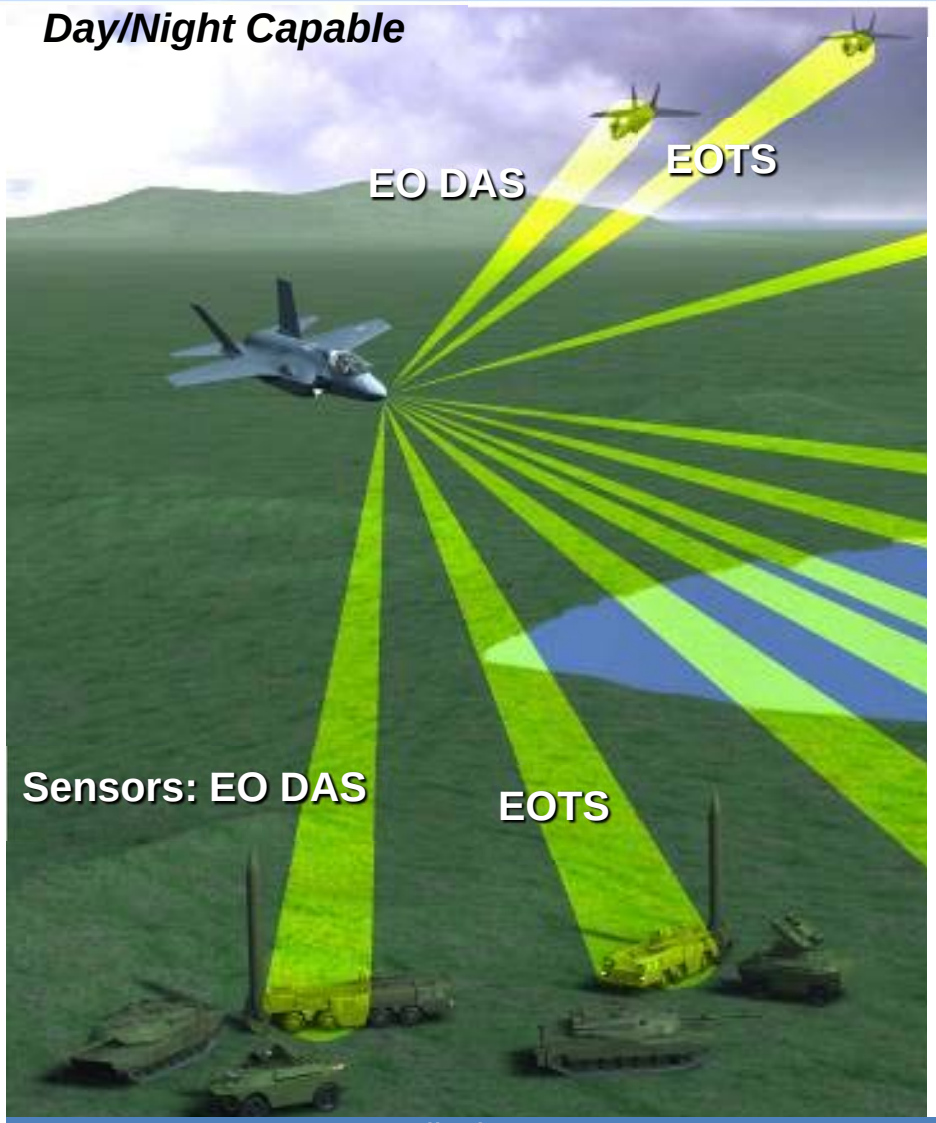
Fwd Band 3 / 4

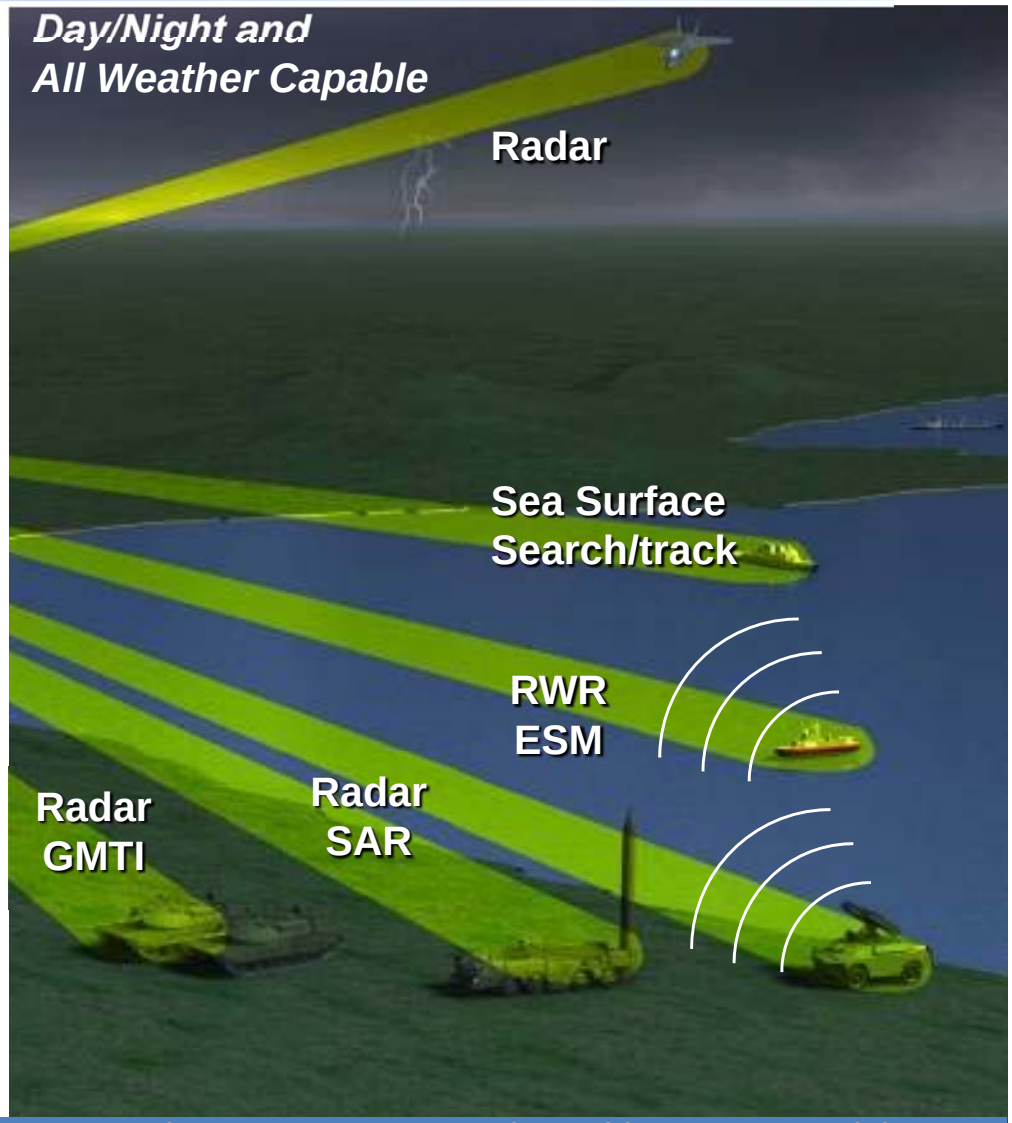
Emitter Locating

Data Links

All Aspect Stealth – Very Low Observable

Target Detection, Track, Classification and Identification



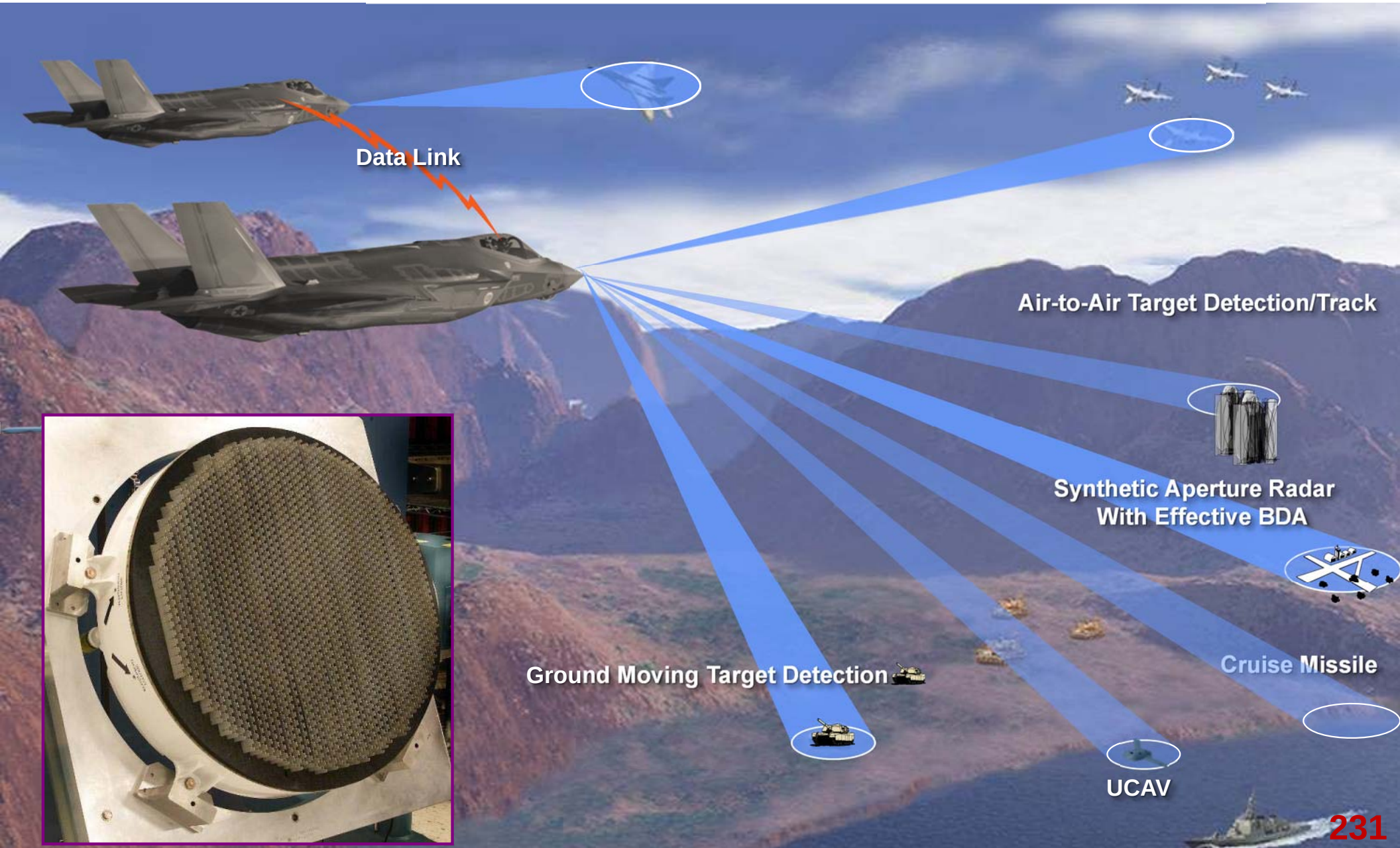


Target Class: All Classes | Moving | Relocatable | Emitting

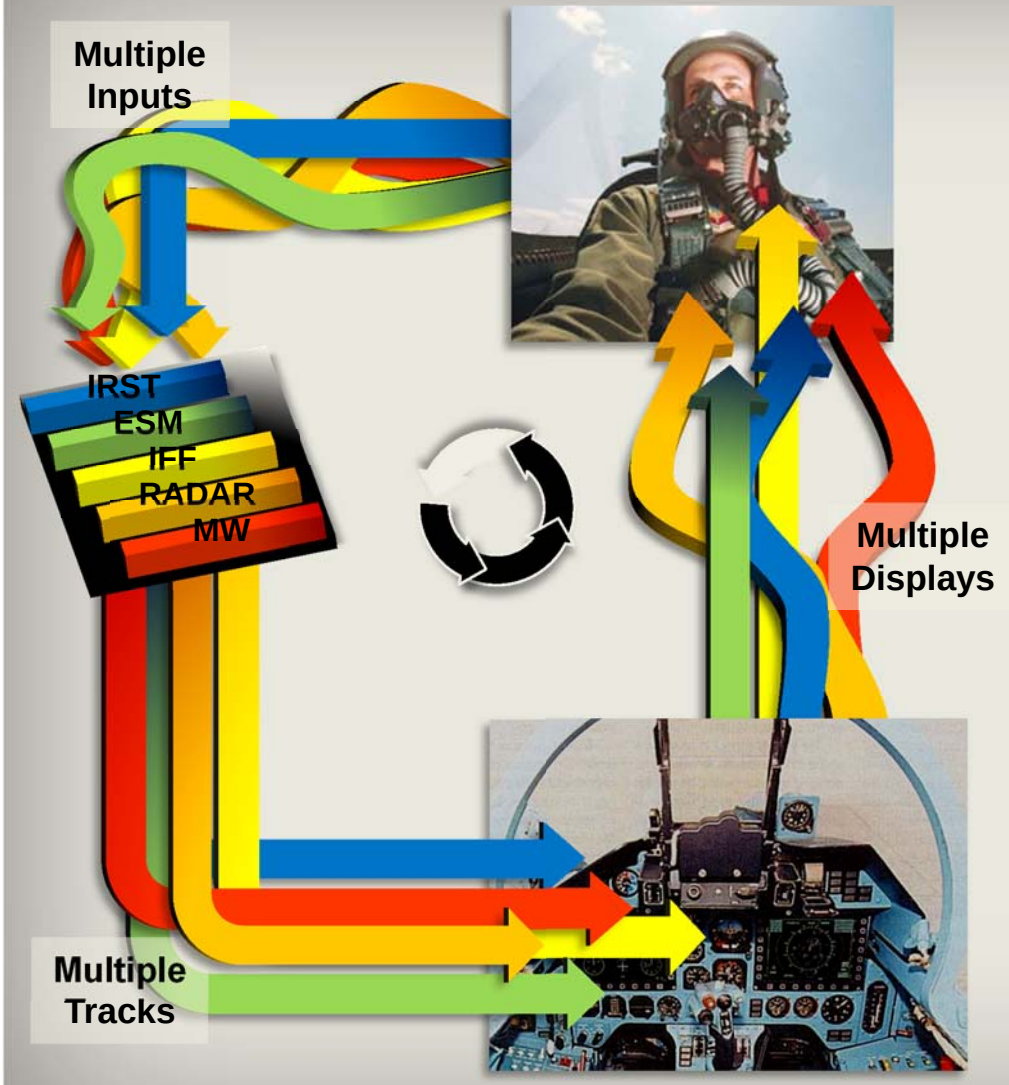
Increasing Range

F-35 Is Autonomous, Long Range and All Weather-Capable

APG-81 Radar Active Electronically Scanned Array Interleaved Search and Track



4th Generation
No Correlation



- Targeting Solution Is Radar Centric
- Assess & Engage Targets
- Pilot Left With Reduced Time to Act

- Limited ID of Targets
- Pilot Determines How to Task Active Sensors
- Task Saturation In Highly Dynamic Air Combat

ACT → OBSERVE → ORIENTATE

- Individual Sensors Accumulate Data
- Multiple Tracks Created

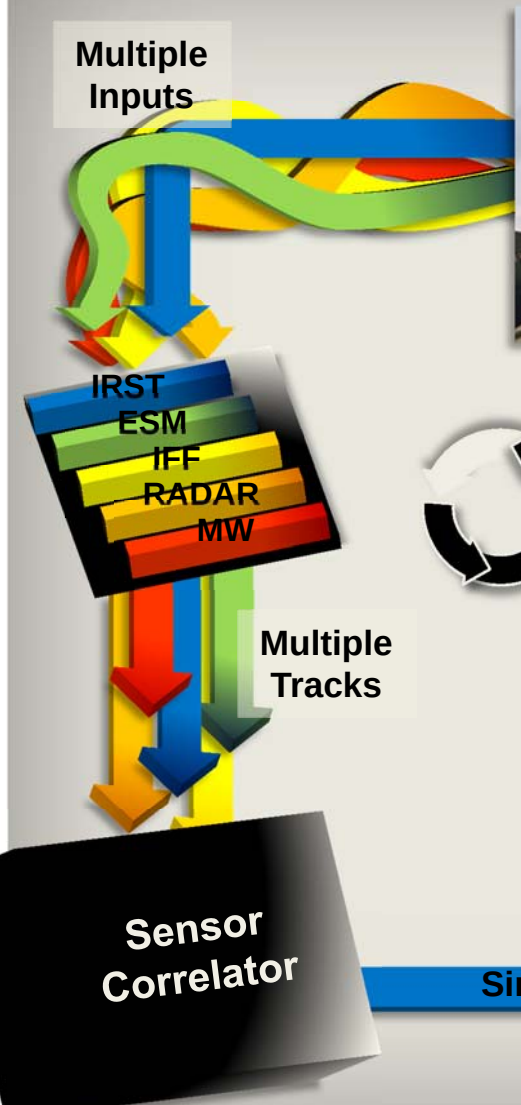
- One Sensor Per Display
- Pilot Must Interpret Individual Displays & "Correlate" Information In His Head

Pilot Must Manage Sensors and Sensor Workload

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

4th Generation – Correlation

"What the other guys call sensor fusion"



- SA Based on Partial Information
- Targeting Solution Relies on Primary Source
- Pilot Left With Reduced Time to Act

- Pilot Determines How to Task Active Sensors
- Task Saturation In Highly Dynamic Air Combat

ACT → OBSERVE → ORIENTATE

- Individual Sensors Accumulate Data
- Multiple Tracks Created

- "Display De-cluttering"
- Correlates Multiple Tracks to Single Best Source
- Extra Tracks Discarded

Pilot Manages Sensors and Acts on Correlated Display

F-35 Sensor Fusion

Off Board

MADL

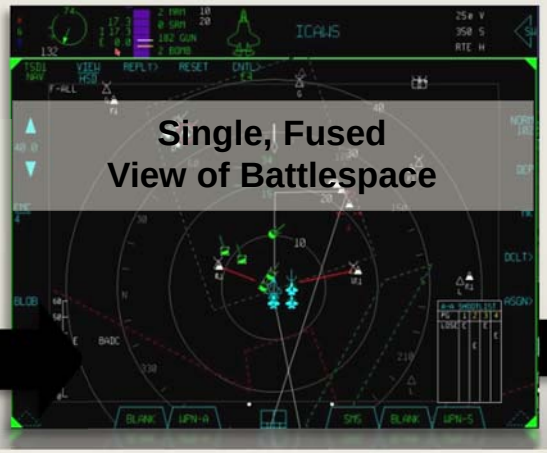
Sensor Tracks & Data

EOTS
ESM
IFF
RADAR
DAS

Fusion Server

- *Image Processing*
- *Sensor Management*
- *Tracker*

Fusion Manages & Tasks Sensors



- One Track, One ID
- On+Off Board Inputs
- Multi-Spectral Composite Situational Awareness
- Ownship, Wingmen, Network
- Automatic Sensor Tasking
- Automatic ID & ROE

ORIENTATE

OBSERVE

ACT

- OODA Loop is Accelerated
- All Information is Fused and Presented to Pilot
- Pilot Focuses On Acting out Tactics, Not Sensor Management

F-35 Pilot Expends Majority of Effort on Tactics

Slide 1 (A)

- **This graphic depicts the sensor, which are installed on every production F-35. This is an important point because legacy fighters, typically, only come with a radar. The client must purchase the other sensor and they are usually in the form of an external pod. External pods severely impact radar cross-section and aerodynamic performance.**
- **Radar - the radar is an Active Electronically Scanned Array (AESA). It is arguably the most advanced AESA in production today. The hallmark of an AESA is in its ability to steer beams through space in fractions of a second. From the pilot point of view it appears to be doing multiple functions at once. Some of these functions are air-to-air search and track, ground moving target indications, sea search, and synthetic aperture radar.**
- **EOTS - the Electro-optical Targeting System resides under the chin of the radome. The EOTS is a high magnification midwave infrared (IR) telescope, which can point along a line of sight and perform various targeting functions.**

Slide 1 (B)

- **Some of these functions are point track, area track, laser spot track, and IR search and track.**
- **EWS - an Electronic Warfare Suite is built into the aircraft. It performs a number of functions which on legacy fighters would have been federated. Among those functions are Radar Warning Receiver (RWR), emitter location, precise direction finding, and Electronic Counter Measures (ECM).**
- **DAS - the Distributed Aperture System is a unique sensor not found on legacy fighters. The DAS is comprised of 6 staring focal plane arrays, which gather midwave IR photons throughout the entire sphere surrounding the aircraft.**
- **The DAS performs these functions: short range IR search and track, missile launch detection, point of origin of missile launch, and navigation imaging. The pilot may use these cameras to "look through" aircraft structure. DAS imagery is displayed both head down on the PCD as well as head up on the HMD.**

Slide 1 (C)

- **CNI - the Communications Navigation and Identification suite is an advanced Software Defined Radio (SDR) within the aircraft.**
-
- **SDRs instantiate radio waveforms such as TACAN, ILS, voice channels, and datalinks. Because it is an SDR it is software upgradeable. This means as new radios and waveforms are needed/invented software rather than hardware will change.**

Slides 2-4

- **The fusion engine can automatically task individual sensors to search, detect, track, and identify things in battlespace. The pilot does not have to be involved in this because fusion understands the fields of regard and fields of view of each sensor and will task them accordingly. In addition, fusion may use multiple sensors on one track to get a better kinematic estimate of some particular piece of data.**
- **AESA provides near simultaneous air-to-air –air and air-to-ground radar coverage. Able to engage inbound enemy fighter, bomber and low flying helos and maintain air supremacy over the battle area while detecting, identify and targeting fixed and moving ground targets.**
- **The well known John Boyd OODA loop works well when trying to understand fusion or, in this case, lack of even correlation. This might represent an early 4th gen fighter. The pilot does the entire mental math to visualize battlespace.**

Slides 5 and 6

- **In the next graphic we see a modern 4.x gen fighter. These use correlation, which is a big step toward advanced sensor fusion. None the less, the pilot's workload and situation awareness are improved, but not like in a 5th gen fighter.**
- **5th gen advanced fusion has three key features: 1) a single integrated picture of battlespace, 2) automatic sensor tasking, and 3) connectivity in order to share the picture.**
- **These three key elements are the keys to providing extreme situational awareness (SA) while managing workload (WL). SA and WL contribute directly to increased lethality, greater survivability, and safety. Advanced sensor fusion is one of the hallmarks of the 5th generation**