



# *Joint Unmanned Combat Air Systems*

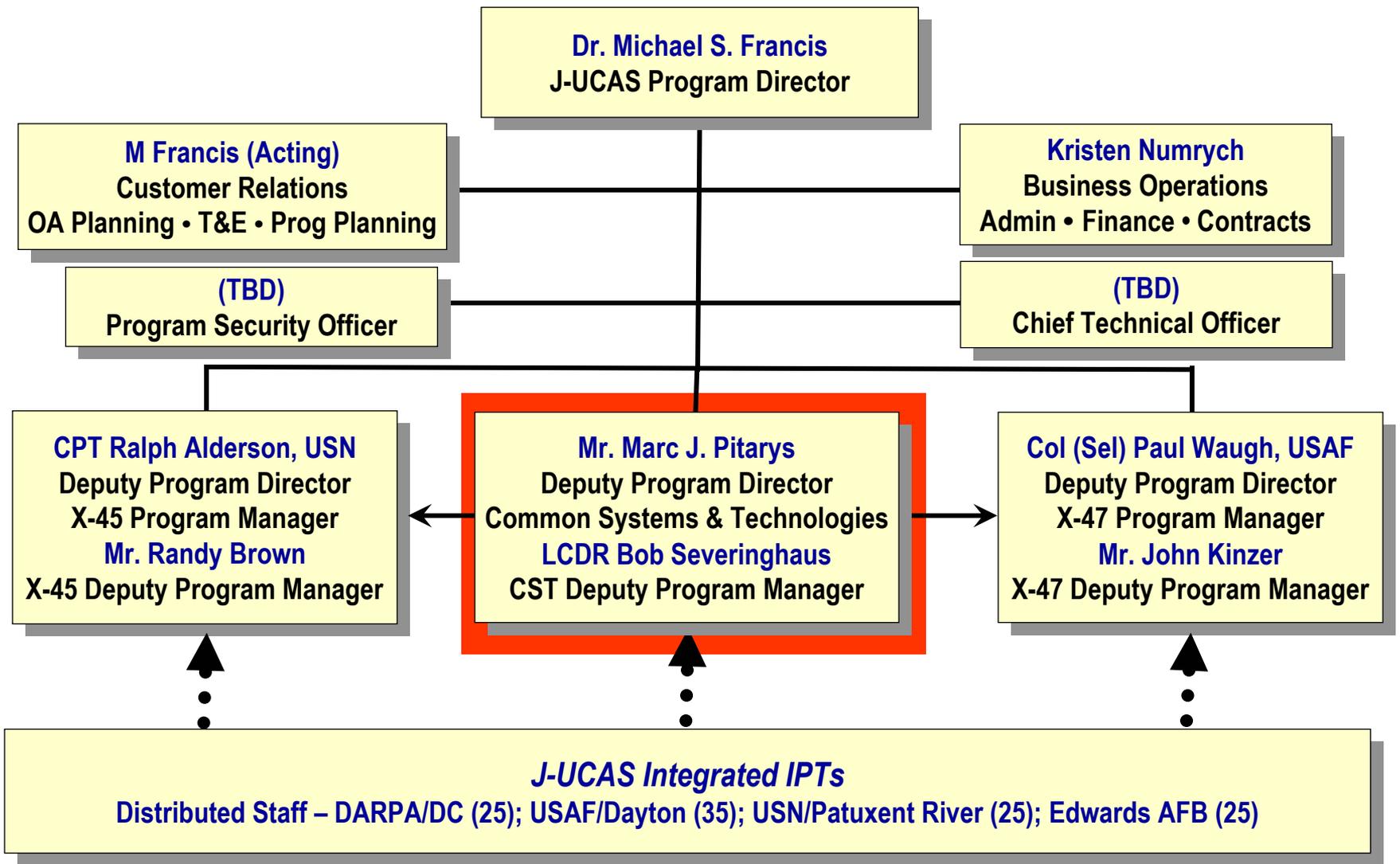
A 3D digital illustration of a desert landscape with mountains in the background. A satellite in orbit is connected by green lines to several unmanned combat air vehicles (UCAVs) flying in the sky. The UCAVs are projecting green beams of light onto the ground, illuminating various targets. In the foreground, there are several small, dark, cylindrical objects on the ground, some of which are being illuminated by the UCAVs. The overall scene depicts a coordinated unmanned combat mission.

## ***Common Systems and Technologies Organization & Common Operating System Overview***

**Marc J. Pitarys**  
**Deputy Director, Common Systems and Technology**  
**20 APR 2004**



# J-UCAS Office Structure



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# Common Systems and Technologies (CST) Mission Statement & Focus



## MISSION

- To develop a common operating system to facilitate the integration of systems (e.g., sensors, weapons, and communications) while minimizing the impact of platform constraints
- To develop a common system architecture to ensure intra and inter-operability of J-UCAS system elements
- To develop common hardware and software application components
- To develop common sensors

## Focus

- Reduce redundancies to minimize cost and resource expenditures
- Remove barriers of entry with regard to adopting new technology for J-UCAS
- Accelerate the introduction of a network centric war fighting capability

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# Common Systems & Technologies Responsibilities



- **Common Operating System**
- **System Architecture**
- **Interoperability**
- **Sensor, weapon and communication capabilities.**
- **Mission Ops/Control, Planning, & Intel**
- **Distributed Modeling and Simulation Capability**
- **Command and Control Definition**
- **Information Assurance**

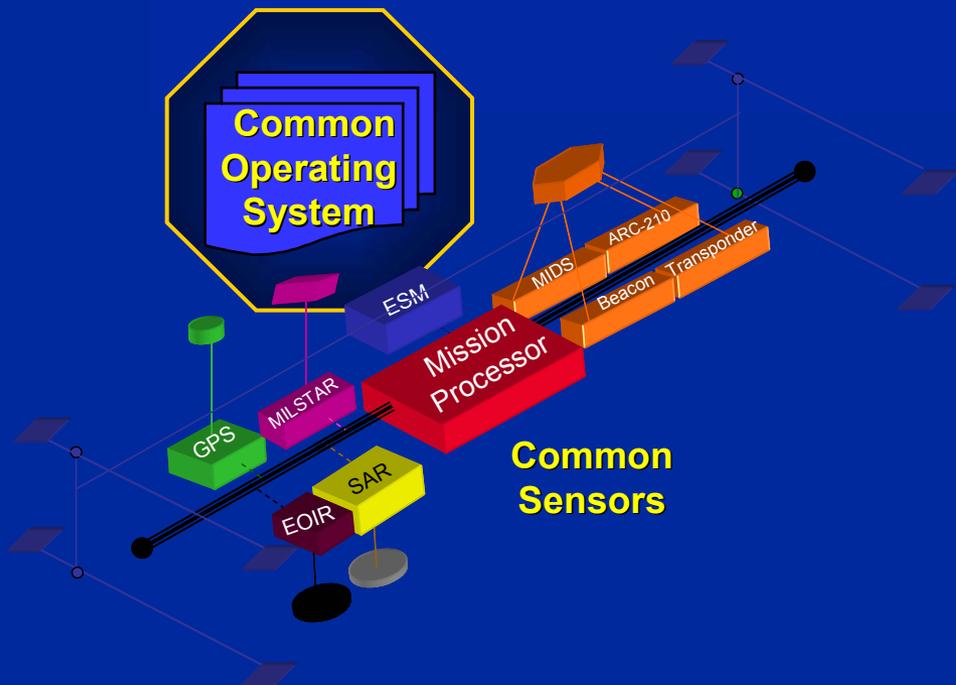
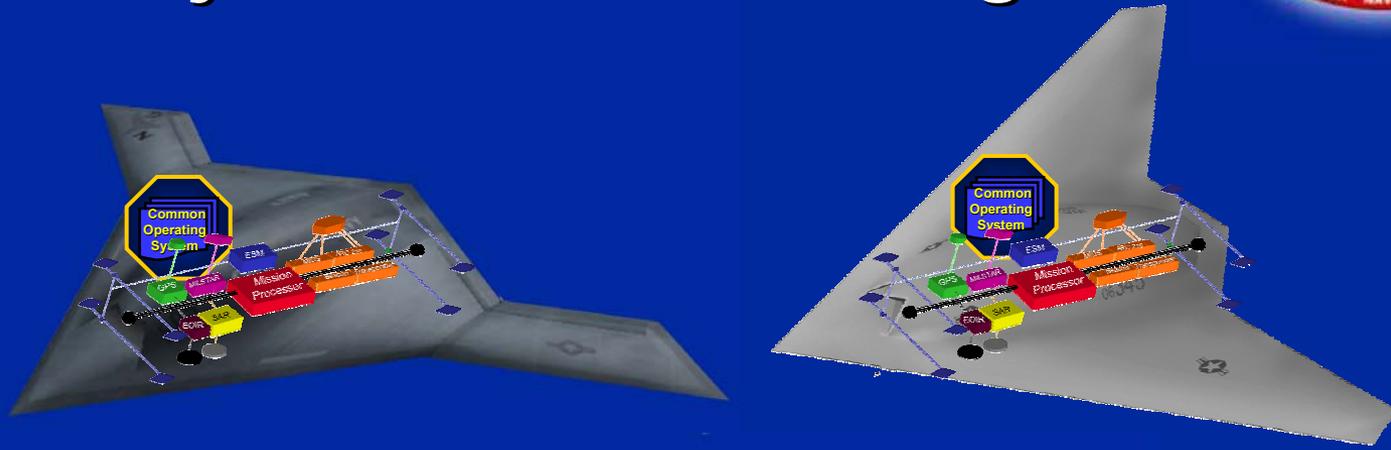
**Common Systems and Technologies  
have an effect across multiple levels of the program**

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# Common Systems & Technologies



- Common Operating System
- Communications capability
- Sensors
- Weapons
- Avionics hardware (e.g. processors)

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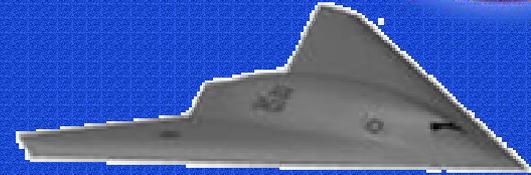
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# J-UCAS System Elements



## Operational Infrastructure

- Communications Relay
- Navigation
- Sustainment
- Transport



## Platform/Vehicle(s)

- Mission-Tailored Design
- Vehicle Management
- Vehicle Autonomous Functions

## Communications

- Secure Links/Network
- LOS or BLOS Ops



## Operating System

- System C2 & Interfaces
- Comms Management
- Mission Planning
- Autonomous Functions
- Health/Status
- Logical HSI ...

## Control Station(s)

- Physical HSI (Displays, I/O, ...)
- Launch/Recovery Control
- Vehicle-Payload Operations
- Human Crew



## Payload Systems

- Sensor(s)
- On-Board Processing
- Data Relay
- Weapons



## Direct Support

- Maintenance
- Logistics
- Launch/Recovery Infrastructure



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# Common Operating System



## Rationale

- Ensures Common Architecture, Protocols, and Interfaces
- Decreases Complexity Of System-of-Systems Integration
- Assures Intra- and Inter-operability of J-UCAS Elements
- Enables Autonomous Collaborative Operations
- Decouples Air Vehicle & Other Hardware From System's Information Technology Component

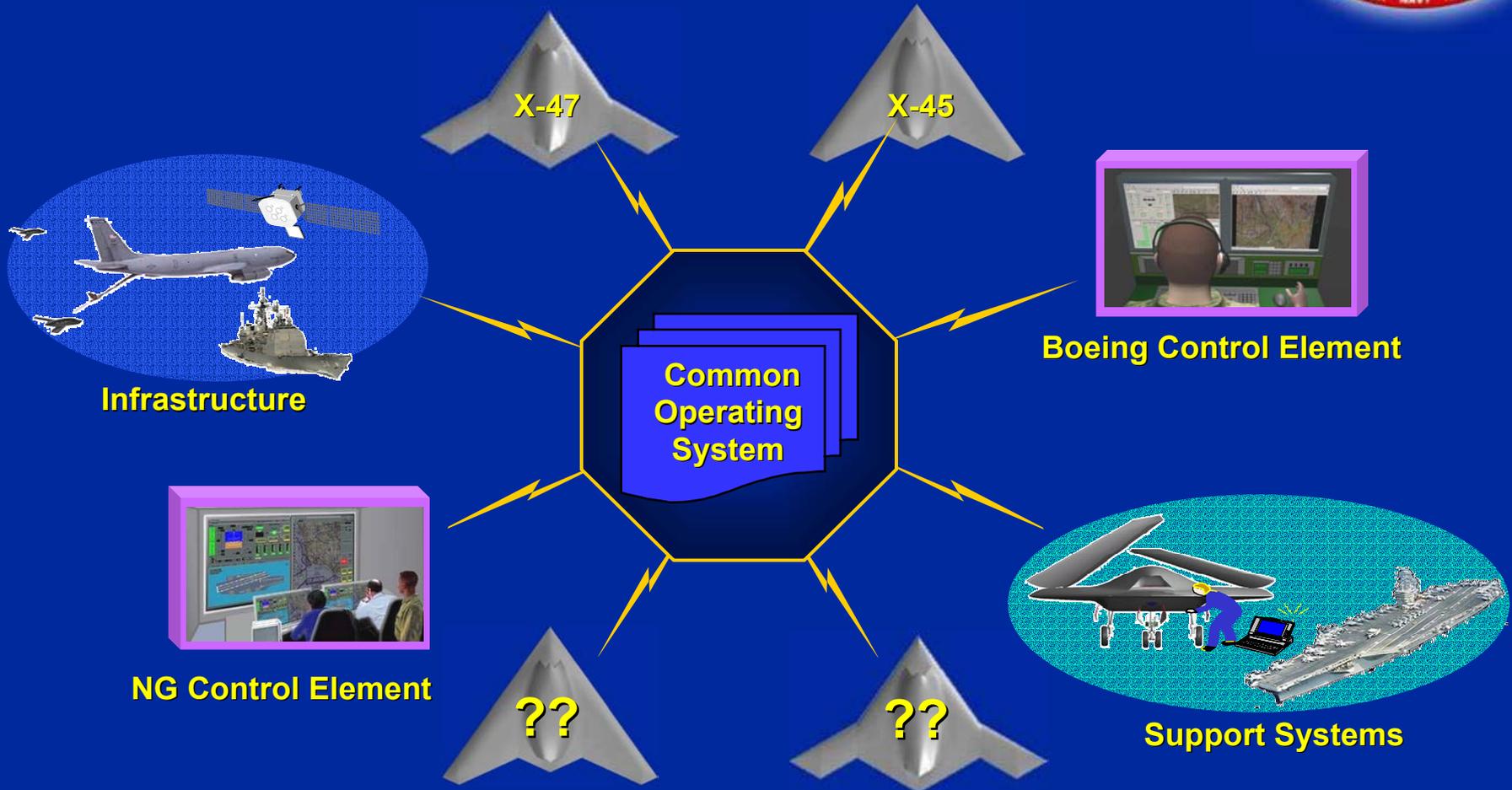
## Impact

- Not dependent on single contractor
- Reduces cost of entry for new technologies
- More rapid fielding of capabilities
- Improves ability to upgrade/modify
- Enables inter-vehicle collaboration
- Enables information exchange with external entities (e.g. platforms, C2)
- Increases op tempo & network centric warfare capabilities
- Improves battle-space awareness
- Minimizes impact of platform changes on system development
- Provides mechanism for evolutionary system improvements

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# The Integrated System



- *Intra- and inter-operable elements ... GIG-compliant network*
- *Flexible autonomy and H-I-L operations ... Dictated by mission*
- *Range-payload performance dictated by platform selection*

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# Common Operating System



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# Common Operating System Functionality



## Information Management

- Publish/Subscribe
- Fusion

## Battle Management

- Common Relevant Operational Picture
- Integrated Fire Control

## Critical GIG Interfaces

- MILSTAR
- Link 16
- SIPRNET
- TCDL
- JWICS

## Human System Integration

- Display Management
- Decision Aids
- Situation Awareness

## Resource Management

- Sensors
- Payloads
- Attack
- Power

## Contingency Management

- System
- Mission

## Network Management

- Quality of Service
- Bandwidth Allocation
- Link Control

## Planning

- Mission Planning
- Collection Planning
- Dynamic Re-planning

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# *Common Operating System Vignettes*

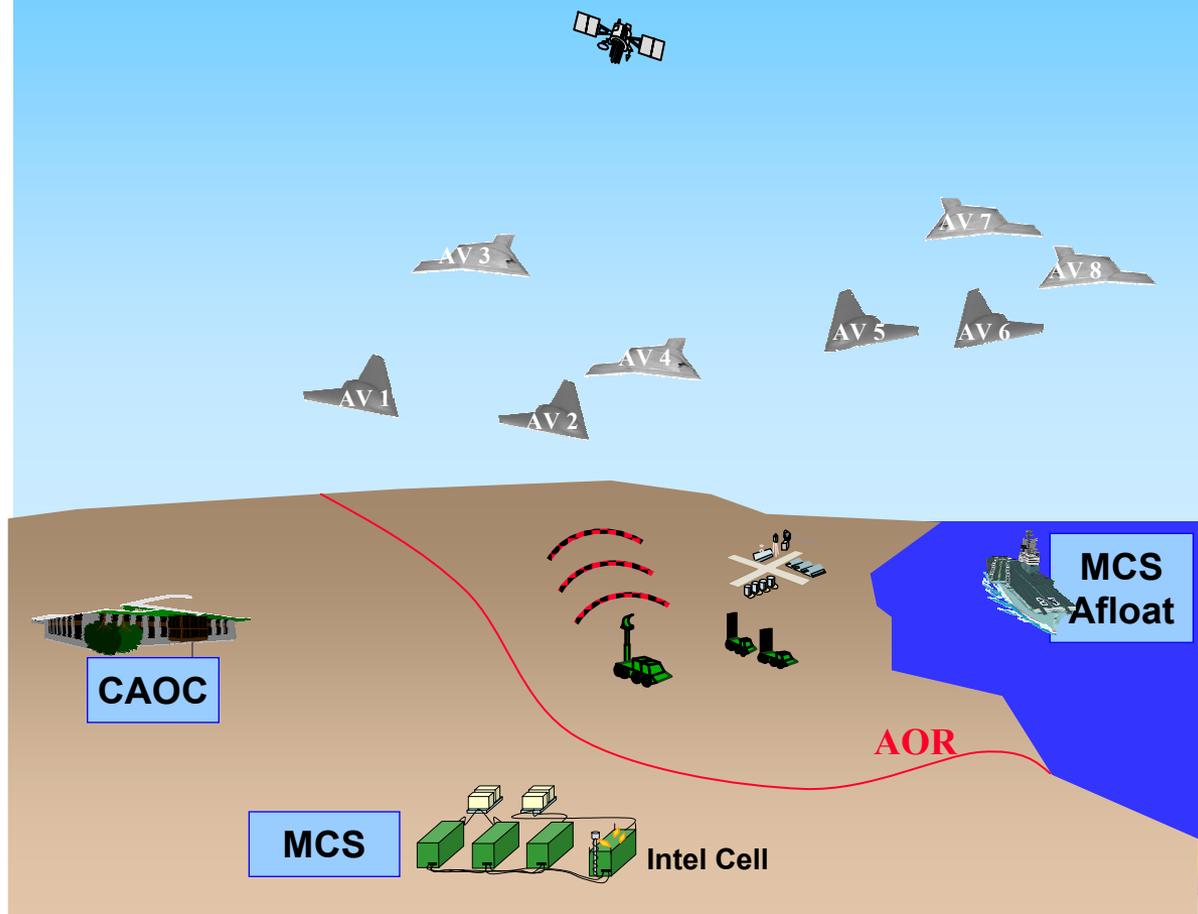
**SEAD Mission  
Contingency Management**



# SEAD Mission with COS



## 1. Threat begins emitting radar signal



**Common Operating System**

**Sensors**

- ESM
- SAR
- EO/IR

**Comm**

- Intra Vehicle Data Link
- SAT COM
- LAN

**Weapons**

- J-DAM 2k
- J-DAM 1k
- J-DAM 500
- Small Diameter Bomb

**Intel**

**Emission Detected**

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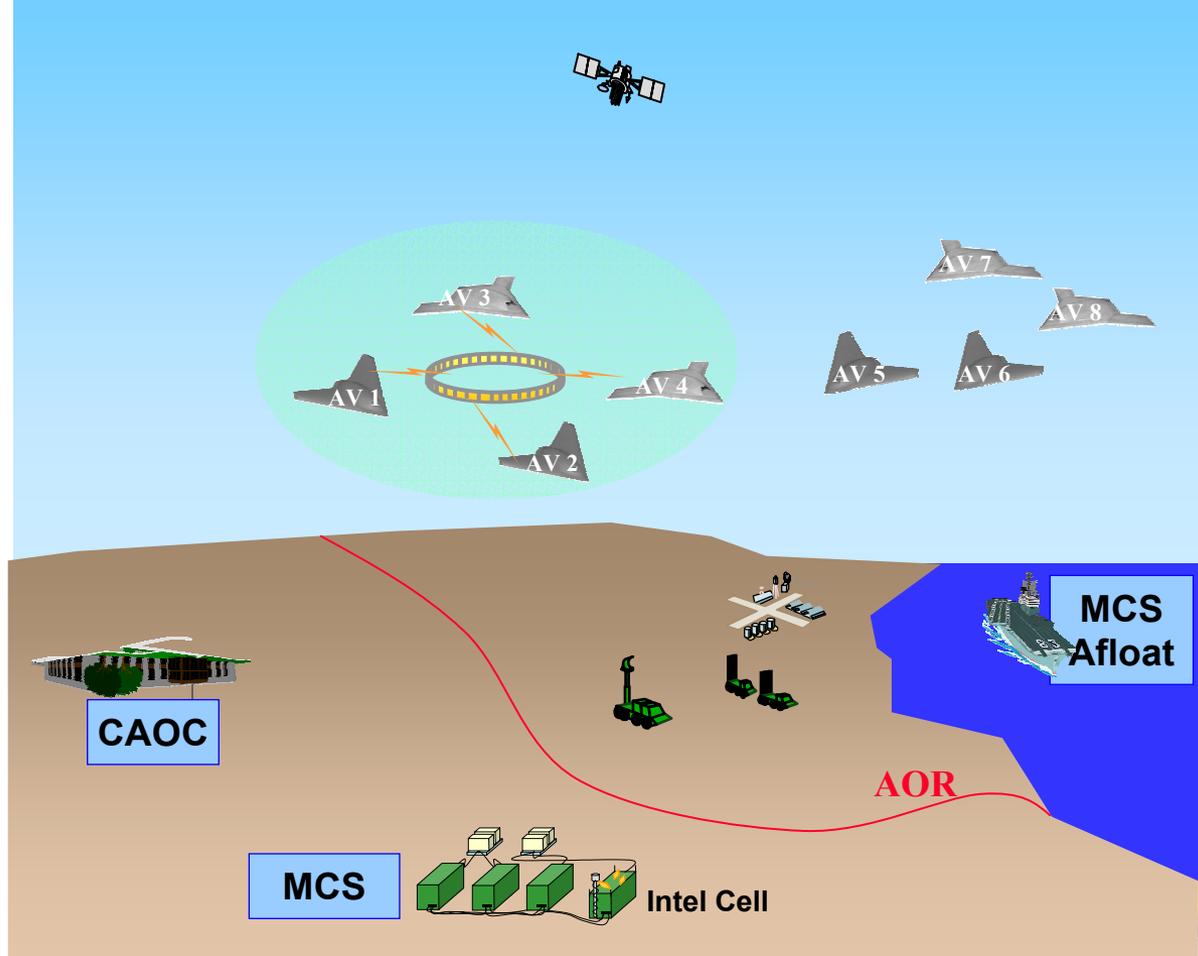
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# SEAD Mission with COS



## 2. ESM locates and IDs the threat

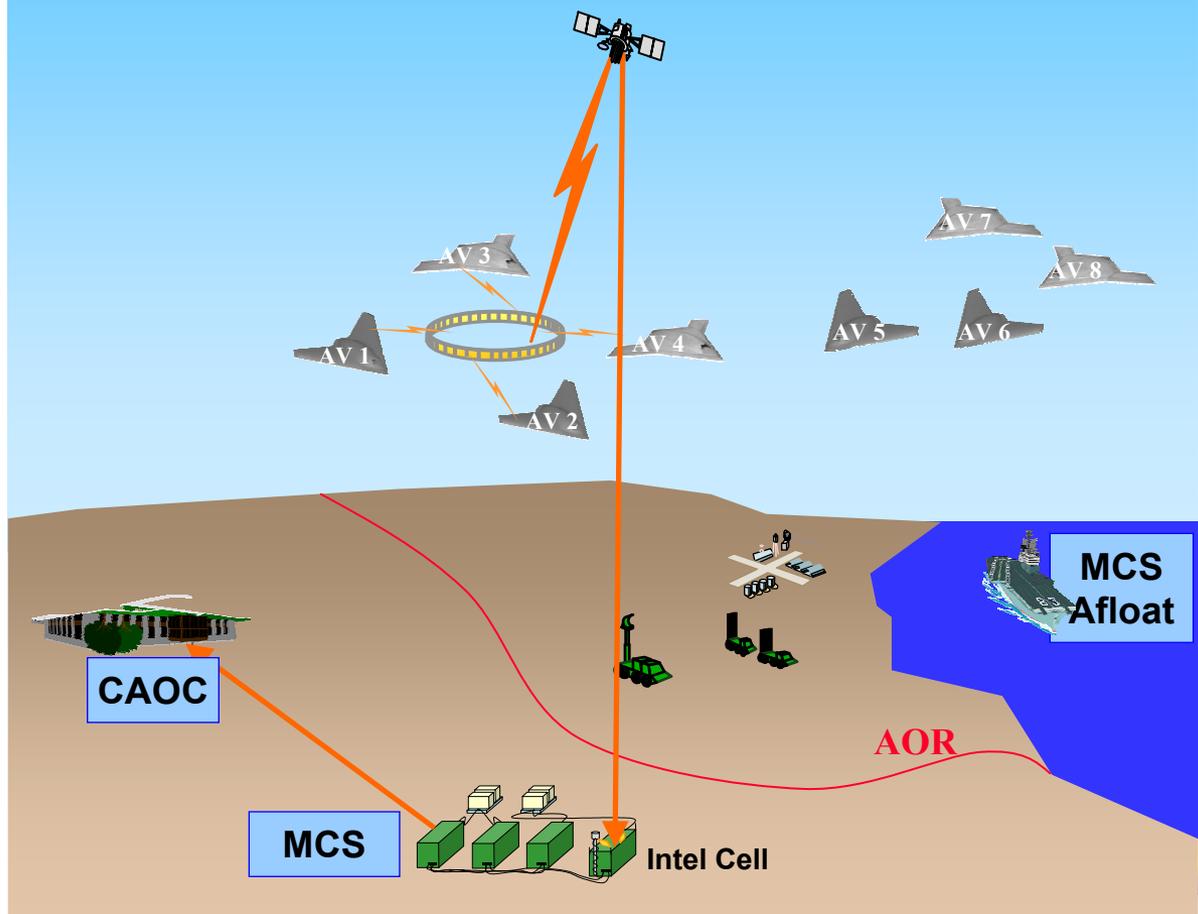


<b>Common Operating System</b>			
<b>Sensors</b>			
<b>ESM</b> AV1 AV2 AV3 AV4	<b>SAR</b>	<b>EO/IR</b>	
<b>Comm</b>			
<b>Intra Vehicle Data Link</b> AV1 AV2 AV3 AV4	<b>SAT COM</b>	<b>LAN</b>	
<b>Weapons</b>			
<b>J-DAM 2k</b>	<b>J-DAM 1k</b>	<b>J-DAM 500</b>	<b>Small Diameter Bomb</b>
<b>Intel</b>			
<b>Perform ESM script selected</b>			

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## 3. Threat data pushed to MCS & Intel Units



**Common Operating System**

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**Sensors**

ESM

SAR

EO/IR

---

**Comm**

Intra Vehicle Data Link  
AV1 AV2  
AV3 AV4

SAT COM

LAN

---

**Weapons**

J-DAM 2k

J-DAM 1k

J-DAM 500

Small Diameter Bomb

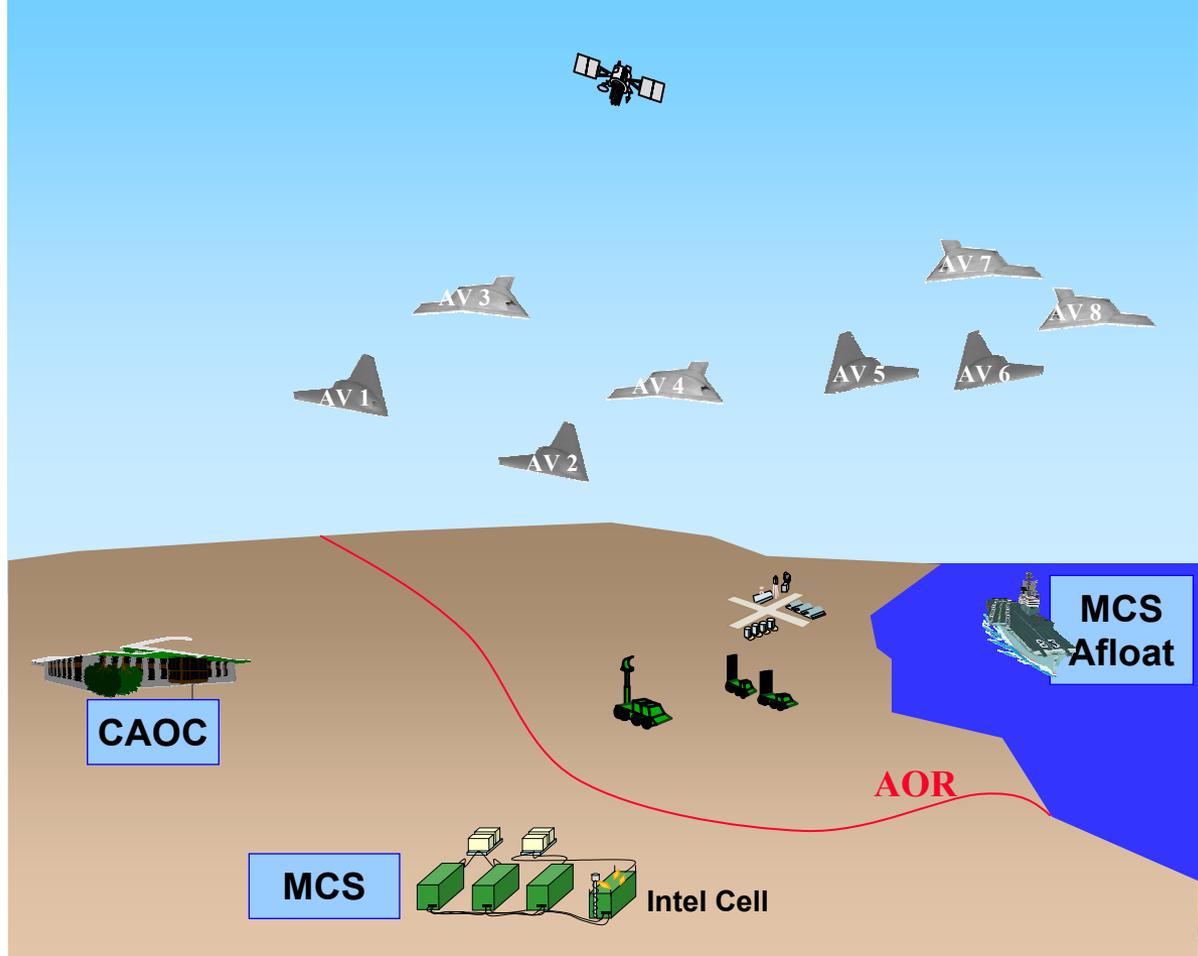
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**Intel**

Link 16 track detection received

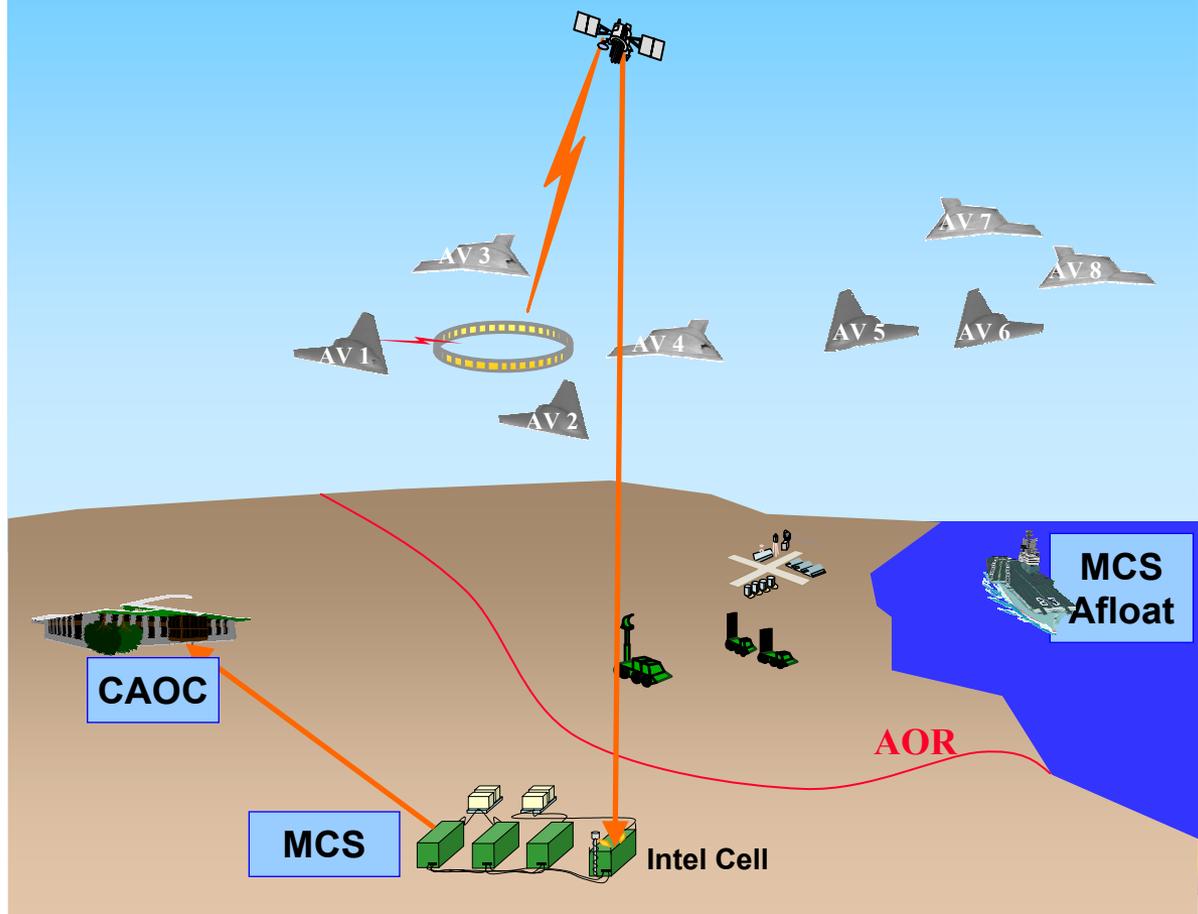


## 4. Air vehicle performs SAR maneuver



<b>Common Operating System</b>			
<b>Sensors</b>			
ESM	<b>SAR</b>	EO/IR	
AV1			
<b>Comm</b>			
Intra Vehicle Data Link	SAT COM	LAN	
<b>Weapons</b>			
J-DAM 2k	J-DAM 1k	J-DAM 500	Small Diameter Bomb
<b>Intel</b>			
<b>Capture SAR script selected</b>			

## 5. SAR image pushed to MCS & Intel Units



**Common Operating System**

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**Sensors**

ESM	SAR	EO/IR
AV1		

---

**Comm**

Intra Vehicle Data Link	SAT COM	LAN
AV1		

---

**Weapons**

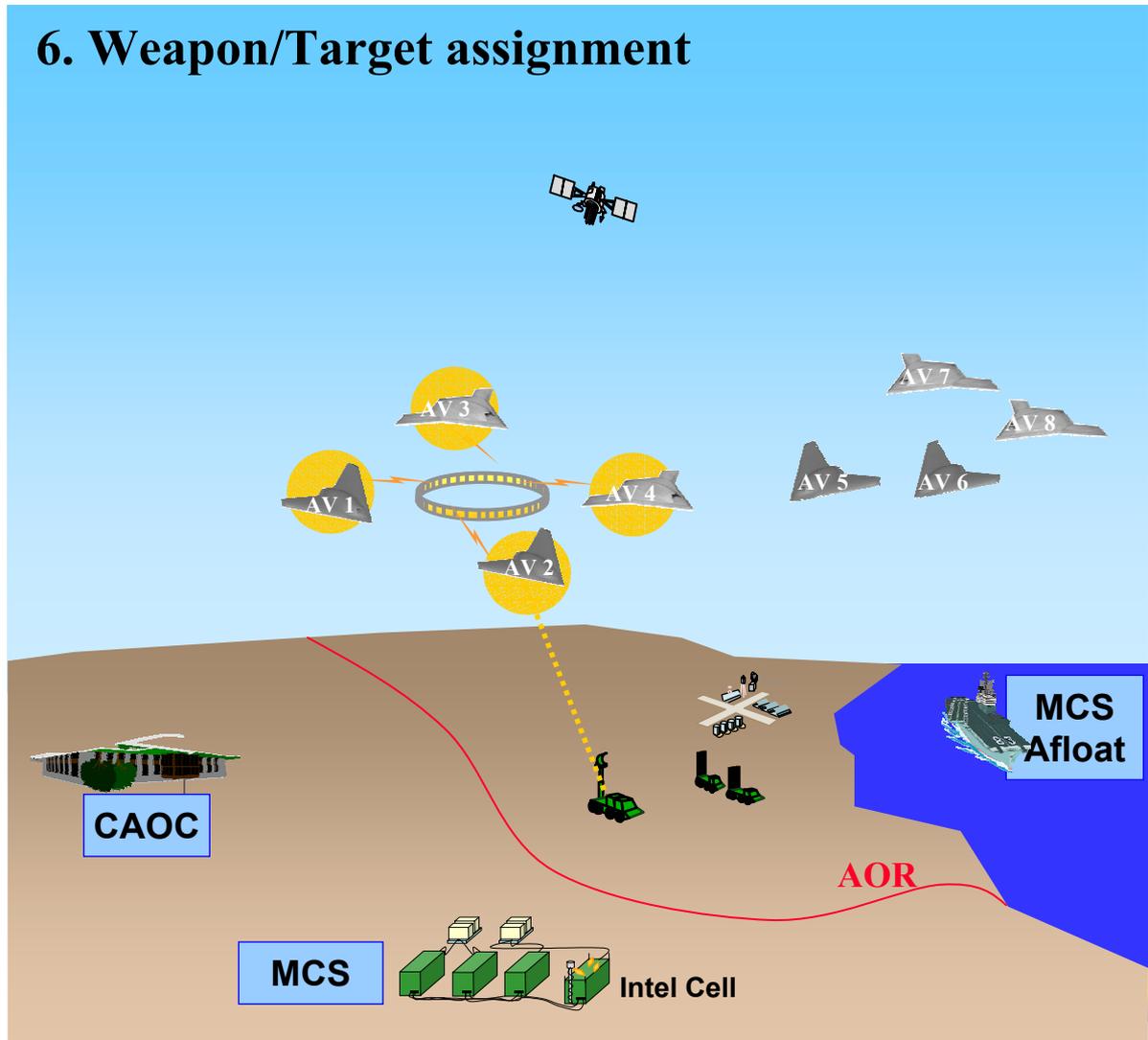
J-DAM 2k	J-DAM 1k	J-DAM 500	Small Diameter Bomb
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**Intel**

**SAR image sent to MCS and copied to CAOC server**

## 6. Weapon/Target assignment



**Common Operating System**

**Sensors**

ESM	SAR	EO/IR
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**Comm**

Intra Vehicle Data Link AV1 AV2 AV3 AV4	SAT COM	LAN
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**Weapons**

J-DAM 2k	J-DAM 1k	J-DAM 500	Small Diameter Bomb
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**Intel**

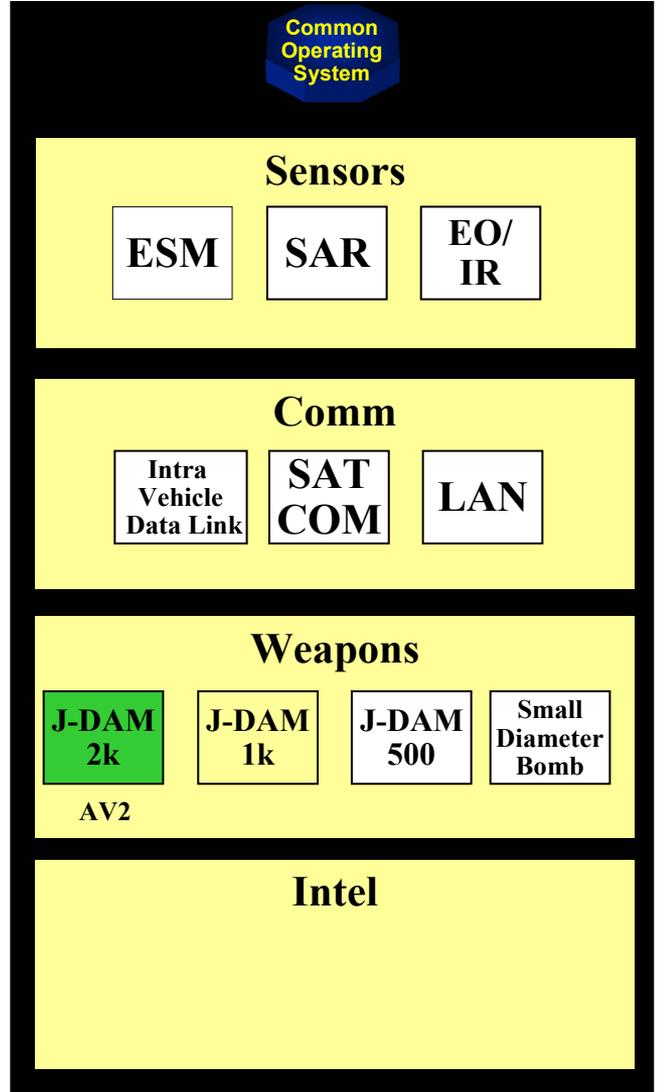
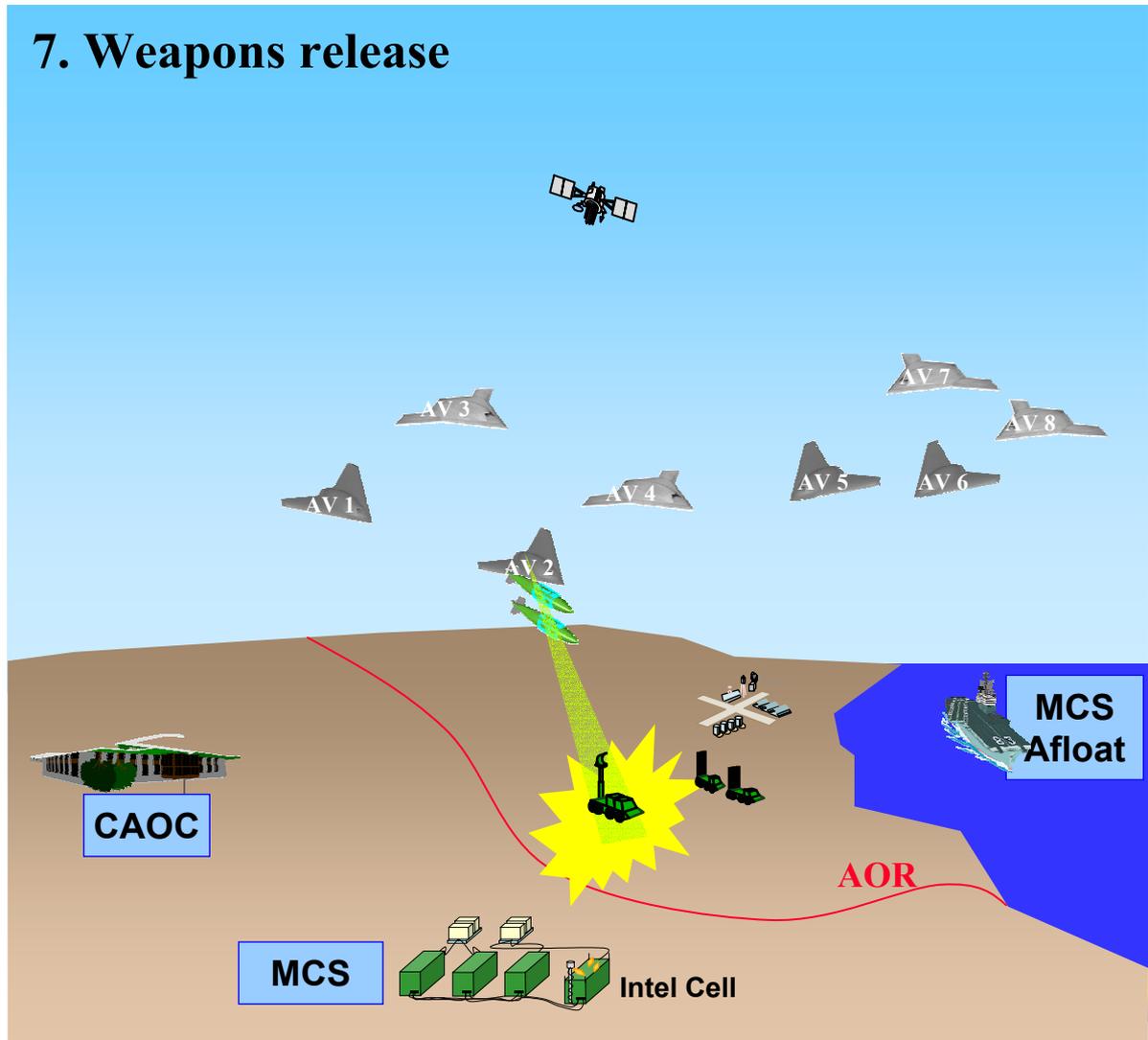
Threat	Weapon	Vehicle
SA-10	2K J-DAM	AV2



# SEAD Mission with COS



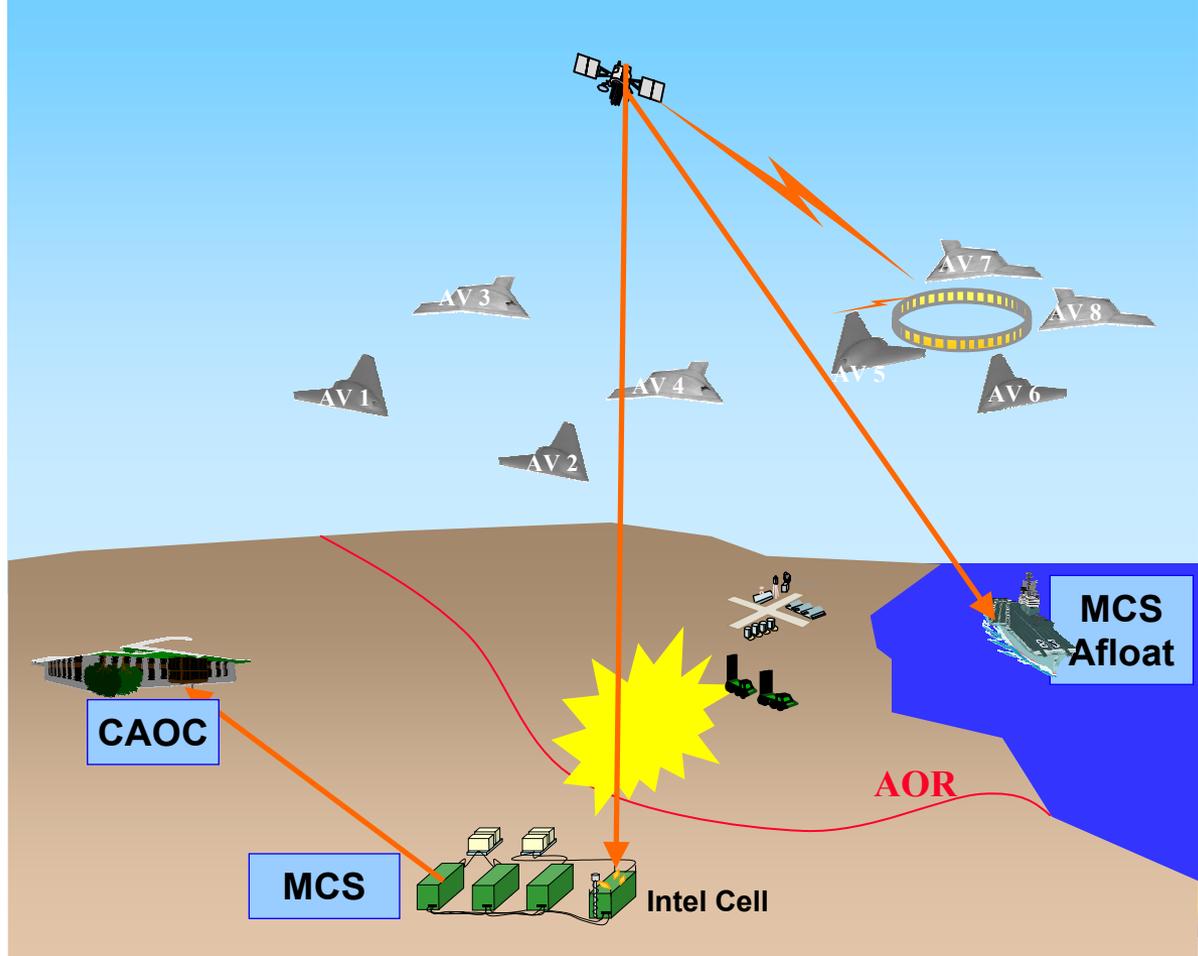
## 7. Weapons release



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## 8. Battle Damage Assessment



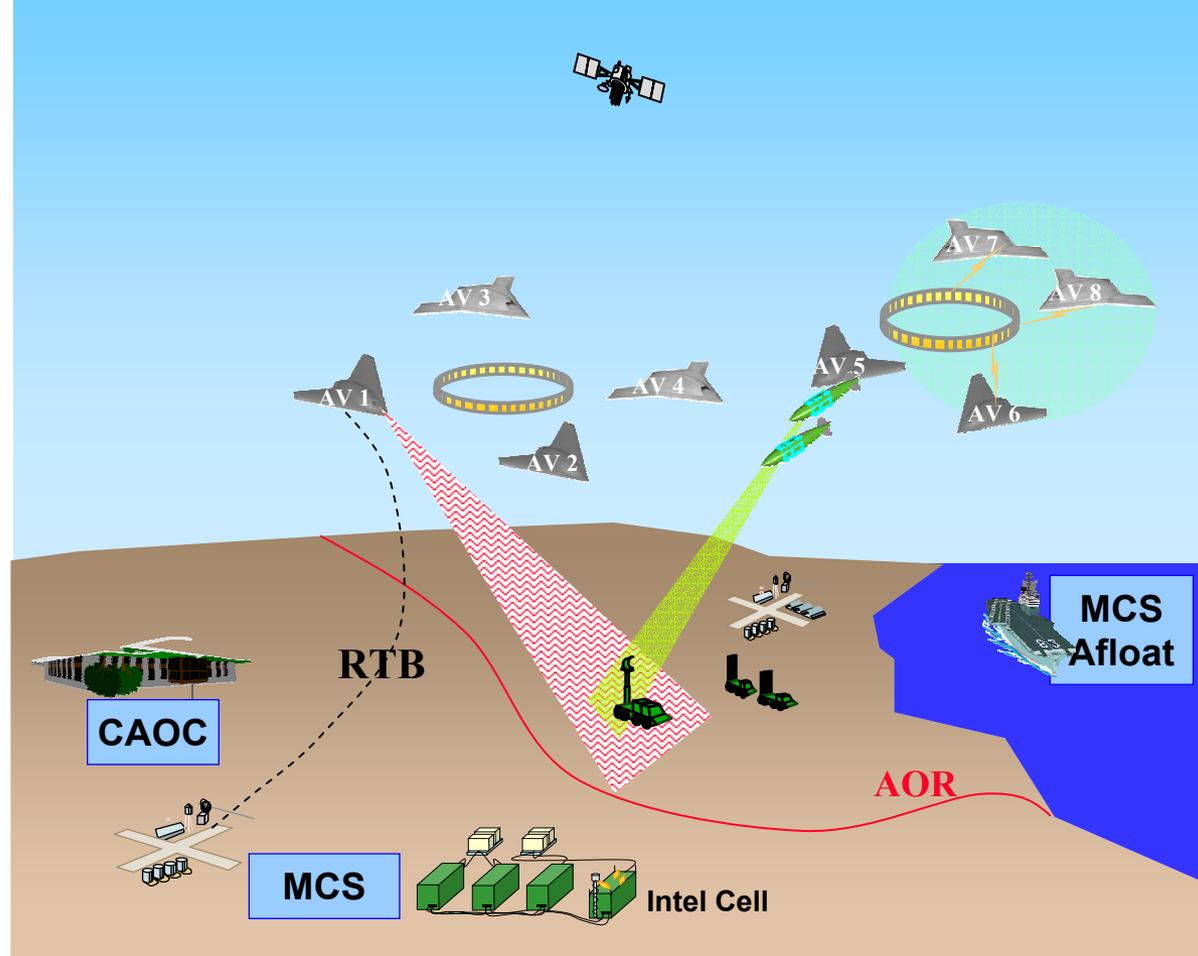
<b>Common Operating System</b>			
<b>Sensors</b>			
ESM	SAR	EO/IR AV5	
<b>Comm</b>			
Intra Vehicle Data Link	SAT COM AV5	LAN	
<b>Weapons</b>			
J-DAM 2k	J-DAM 1k	J-DAM 500	Small Diameter Bomb
<b>Intel</b>			
<b>AV5 completed EO/IR maneuver for battle damage assessment (BDA)</b>			



# Contingency Management with Common Operating System



## Contingency Management Scenarios



<b>Sensors</b>			
ESM	SAR	EO/IR	
AV6, AV7, AV8	AV2		
<b>Comm</b>			
Intra Vehicle Data Link	SAT COM	LAN	
AV6, AV7, AV8			
<b>Weapons</b>			
J-DAM 2k	J-DAM 1k	J-DAM 500	Small Diameter Bomb
AV5			
VMS	<b>Vehicle Contingency</b>		
AV 1 Low on Fuel: Return to Base Unable to complete SAR			
Common Operating System	<b>System Contingency</b>		
Reconfigure remaining sensors Commence SAR imagery from AV2			
AV5 ESM Failure: Unable to detect threats Locate threats with AV6, AV7, AV8 Attack with AV5			

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# Operational Assessment Source of Requirements

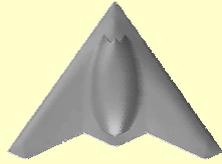


## Common Operating System

- Attack Management
- Sensor Management
- Weapon Management
- System and Mission Contingency Management
- Fusion
- Interfaces to the Global Information Grid
- Inter/Intra-operability
- Situation Awareness
- Networking
- Route Planning
- Battle Damage Assessment
- Battle Management Decision Aids



**X-47**

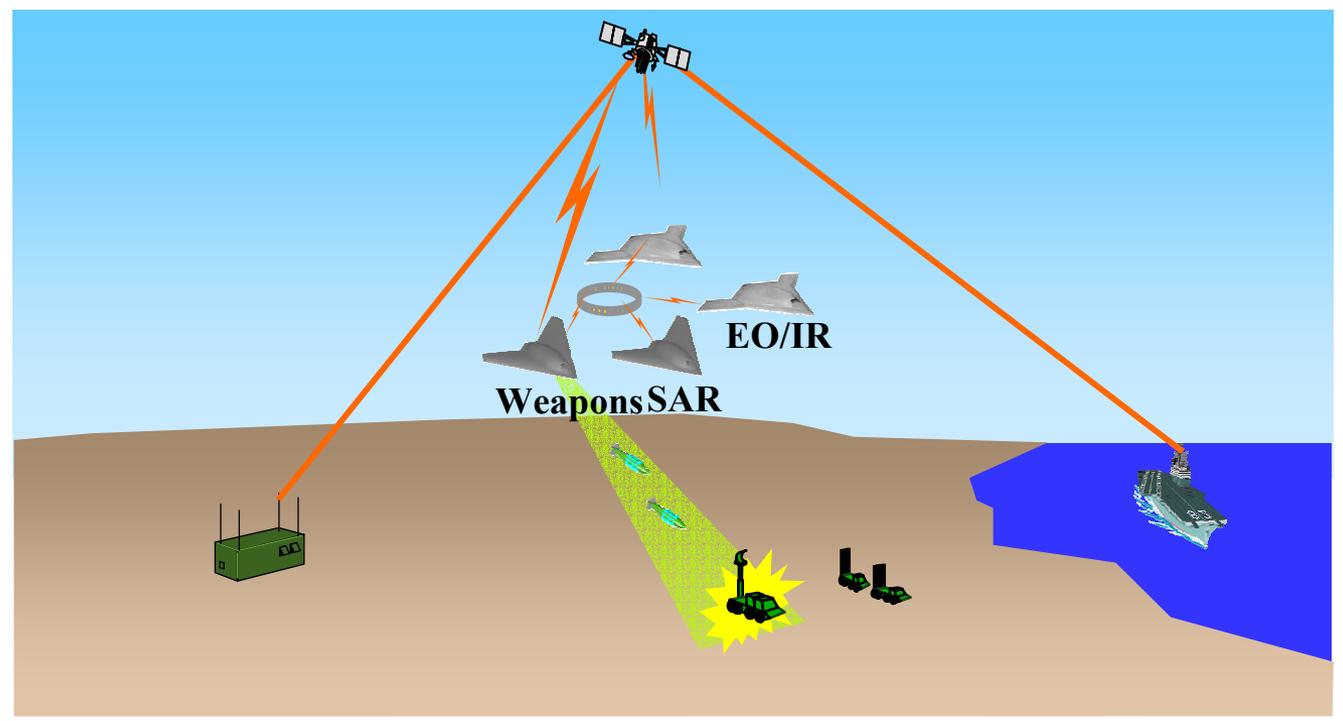


**X-45**



## Mission Control

- Operator Displays
- Communications
- Processing



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# System Architecture

- Common Operating System
- System Architecture
- Interoperability
- Sensor, weapon and communication capabilities.
- Mission Ops/Control, Planning, Intel
- Distributed Modeling and Simulation Capability
- Command and Control Definition
- Information Assurance

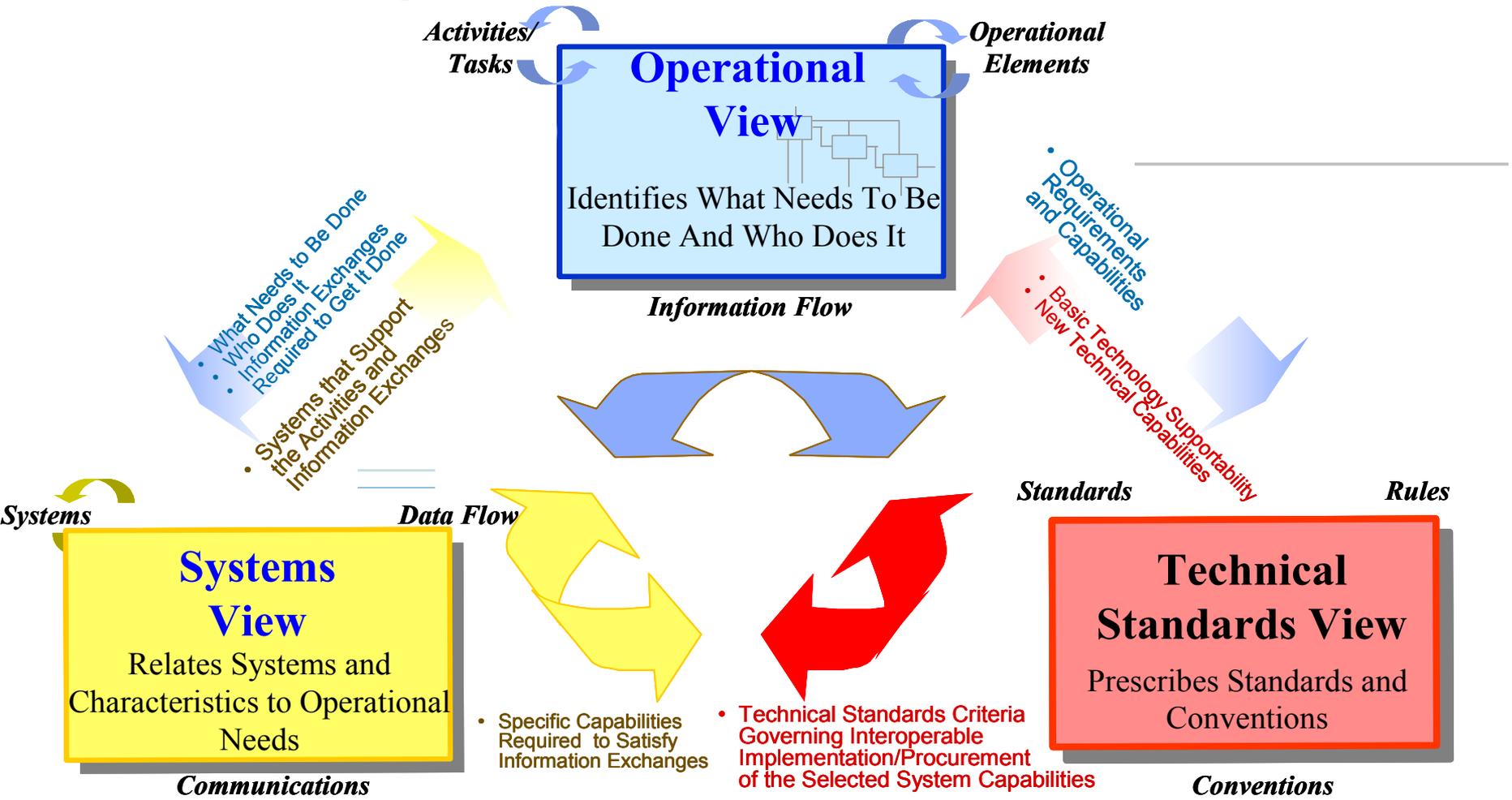
## *Architecture Defines the Fundamental Structure and Relationships of the J-UCAS:*

- How J-UCAS Is Partitioned and Where the Interfaces Occur
- How The J-UCAS Components Interact with Each Other and the Outside World
- What Universal Rules the J-UCAS and Its Parts Must Comply With (Priorities, Operating Modes, Standards, Safety, etc.)

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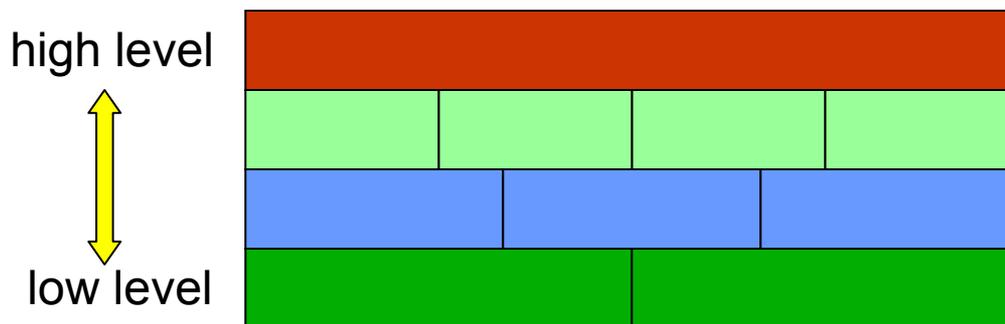
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## An Integrated Architecture with Three Views



# Service Based Architecture

- Architecture composed of software layers
- Software layers composed of software services
- Software services provide open, loosely coupled service interface



Service interfaces encapsulate the service isolating users & other services from the detailed operations inside.



# Intra- and Inter-operability (I2-Operability)

- Common Operating System
- System Architecture
- **Interoperability**
- Sensor, weapon and communication capabilities.
- Mission Ops/Control, Planning, Intel
- Distributed Modeling and Simulation Capability
- Command and Control Definition
- Information Assurance



## Joint Interoperability Directives & Instructions



**DoDD 4630.5**  
IT and NSS interoperability and supportability is essential.

**DoDD 5105.19**  
DISA shall ensure end-to-end interoperability.

**CJCSI 6212.01B**  
All NSS and IT, regardless of ACAT, must be tested and ... certified by JITC.

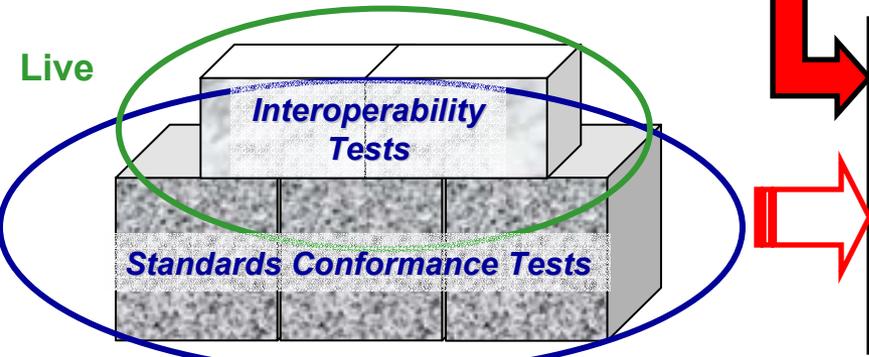
**DoD 4630/5000**  
Interoperability is the ability to provide and accept data, information, materiel, and services ... and ... includes both the technical exchange of information and the end-to-end operational effectiveness of that exchange, as required for mission accomplishment.

**DoDI 4630.8**  
All systems must be tested for interoperability before fielding ... and certified by JITC ... throughout a systems life.

**CJCSI 3170.01C**  
Mandates interoperability KPP for CDD, CPD and CRD.

**DoD 5000 series**  
For IT systems, including NSS, ... JITC shall provide system interoperability test certification memoranda ... throughout the system life-cycle and regardless of ACAT.

### J-UCAS Interoperability Certification



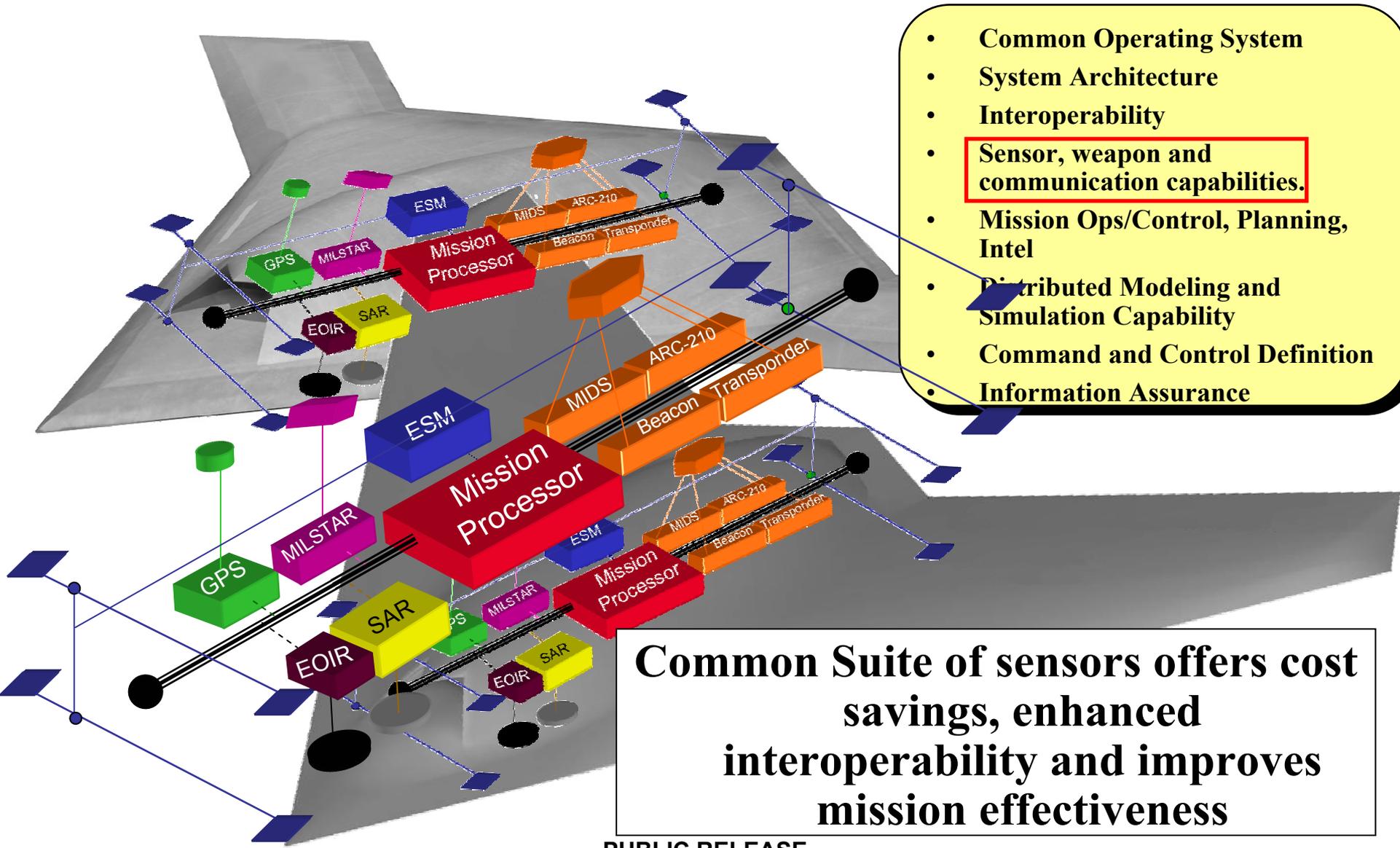
**•Standards Conformance**  
Standards conformance is the ability to adhere to rules contained in the applicable standards.  
  
Note: Standards provide a necessary building block for ensuring interoperability, but are not sufficient to ensure that systems are interoperable in a joint environment.

**•Joint Interoperability**  
Ensures that system effectively exchanges information with joint participants in both environments.

Building Block Approach Laboratory

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# Common Sensors and Communications



- Common Operating System
- System Architecture
- Interoperability
- **Sensor, weapon and communication capabilities.**
- Mission Ops/Control, Planning, Intel
- Distributed Modeling and Simulation Capability
- Command and Control Definition
- Information Assurance

**Common Suite of sensors offers cost savings, enhanced interoperability and improves mission effectiveness**

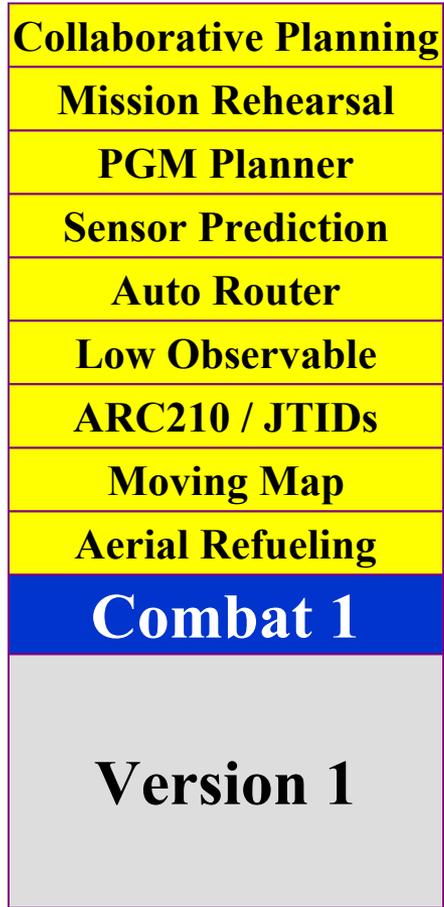
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# Mission Planning and Intel Support

## Joint Mission Planning System (JMPS) Current Plans

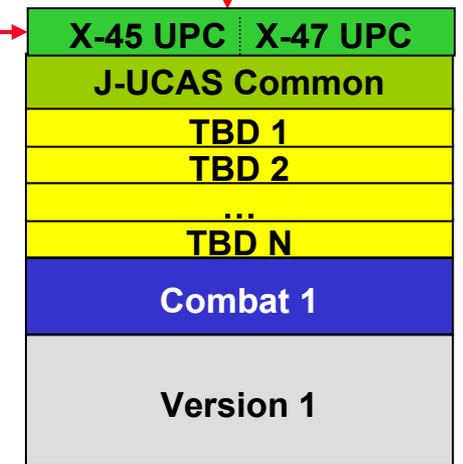
- Common Operating System
- System Architecture
- Interoperability
- Sensor, weapon and communication capabilities.
- **Mission Ops/Control, Planning, Intel**
- Distributed Modeling and Simulation Capability
- Command and Control Definition
- Information Assurance



32 Common Capabilities



Develop components common to the J-UCAS domain

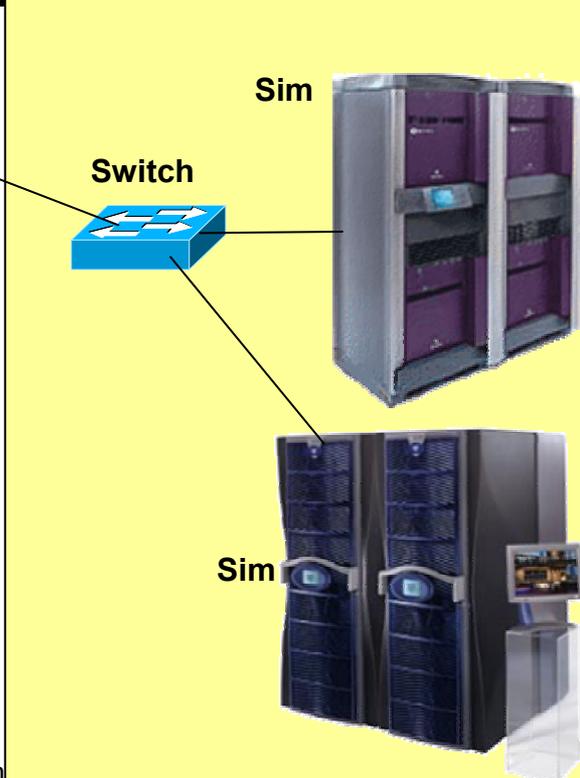
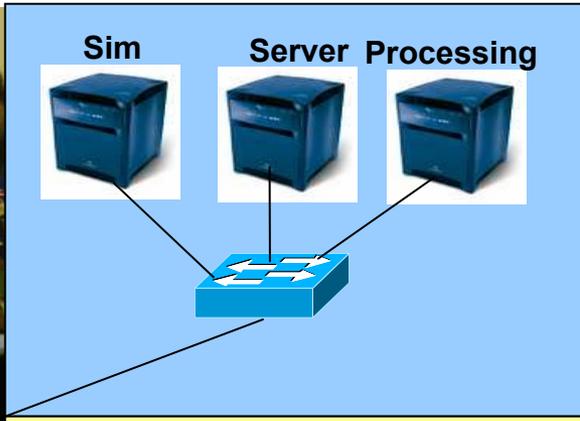
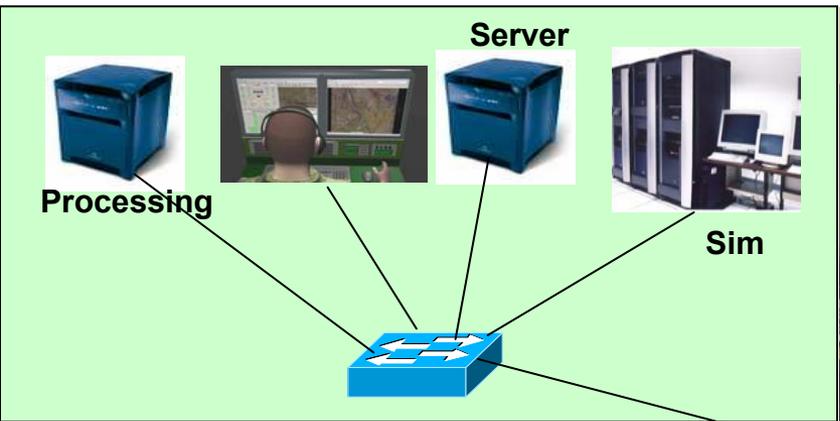


UPC: Unique Planning Component

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# Distributed Modeling and Simulation



- Common Operating System
- System Architecture
- Interoperability
- Sensor, weapon and communication capabilities.
- Mission Ops/Control, Planning, Intel
- **Distributed Modeling and Simulation Capability**
- Command and Control Definition
- Information Assurance

**Distributed Modeling & Simulation Capability with multiple levels of fidelity**

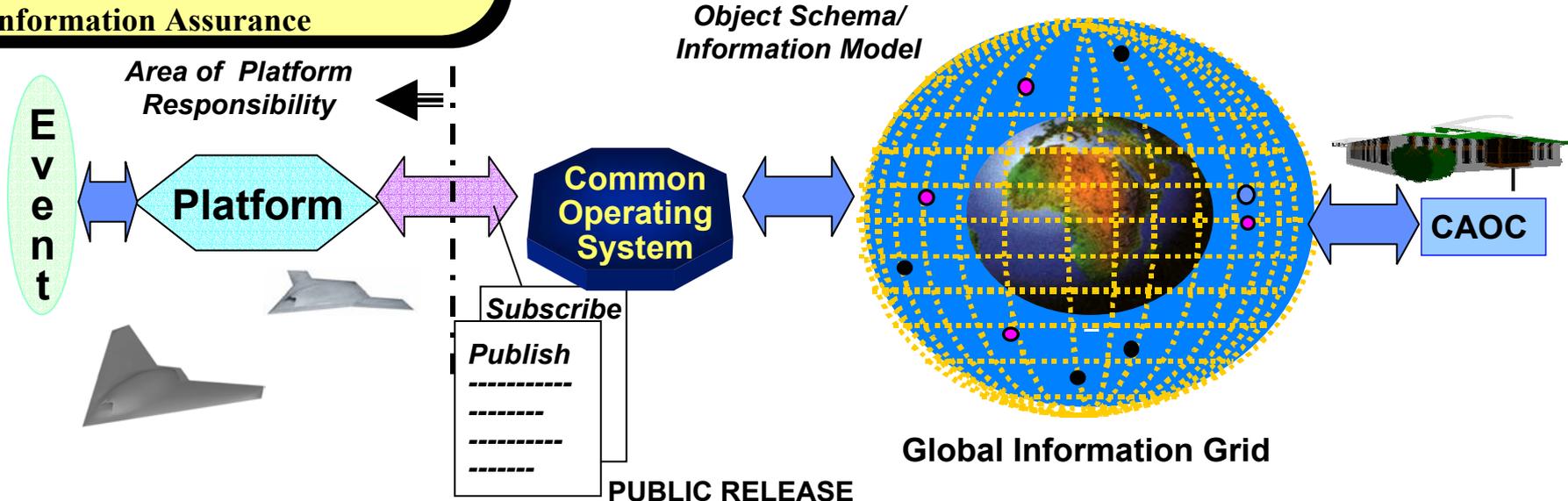
- Support integration of common system components,
- Demonstrate interoperability,
- Conduct joint exercises

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# Command and Control

- Common Operating System
- System Architecture
- Interoperability
- Sensor, weapon and communication capabilities.
- Mission Ops/Control, Planning, Intel
- Distributed Modeling and Simulation Capability
- **Command and Control Definition**
- Information Assurance

- ### J-UCAS Command and Control (C2)
- Information Exchange through “Publish and Subscribe”
  - Transforms Data into Information, then Knowledge
  - Distributed Collaboration Operations



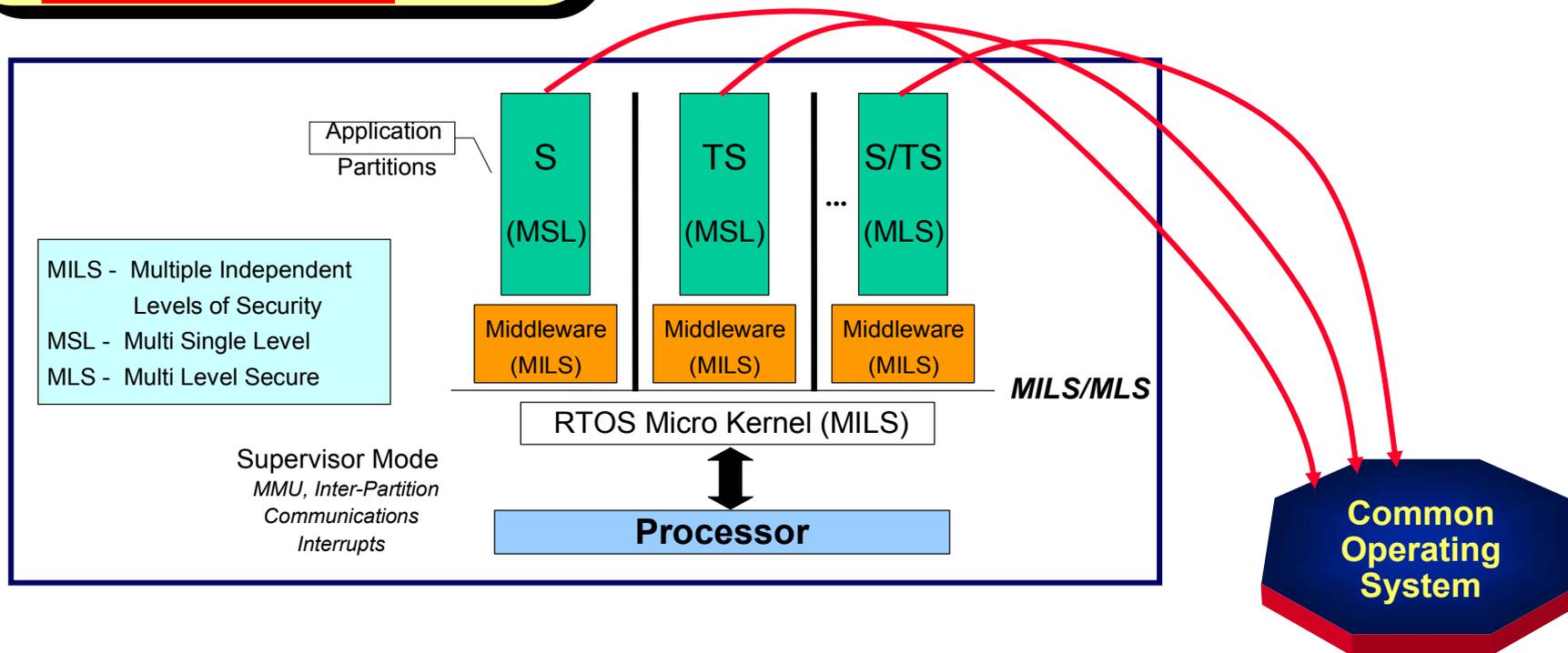


# Information Assurance

- Common Operating System
- System Architecture
- Interoperability
- Sensor, weapon and communication capabilities.
- Mission Ops/Control, Planning, Intel
- Distributed Modeling and Simulation Capability
- Command and Control Definition
- **Information Assurance**

## Approach

- J-UCAS to work with commercial Real Time Operating System (RTOS) vendors, consortium, and NSA in providing one or more certified RTOS MILS Micro Kernels to support X-45 and X-47
- Work with commercial vendors, consortium, & NSA in providing a high assurance certified MILS middleware layer



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