



## ***F-35 Program & VMF Overview***

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## *Agenda*

- **F-35 Overview/History**
- **Why VMF?**
  - *Operational Utilization*
  - *Network Players*
  - *Message Menu*
  - *Implementation*
- **Provide an Overview of JSF Verification**
- **Show the JSF approach to VMF verification**



## ***JSF Program Focus***

### Affordability

**Low Flyaway Cost  
Significantly Reduced Life Cycle Costs**

### Lethality

**Adverse Weather Accurate Weapons Delivery  
Weapons Flexibility**

### Survivability

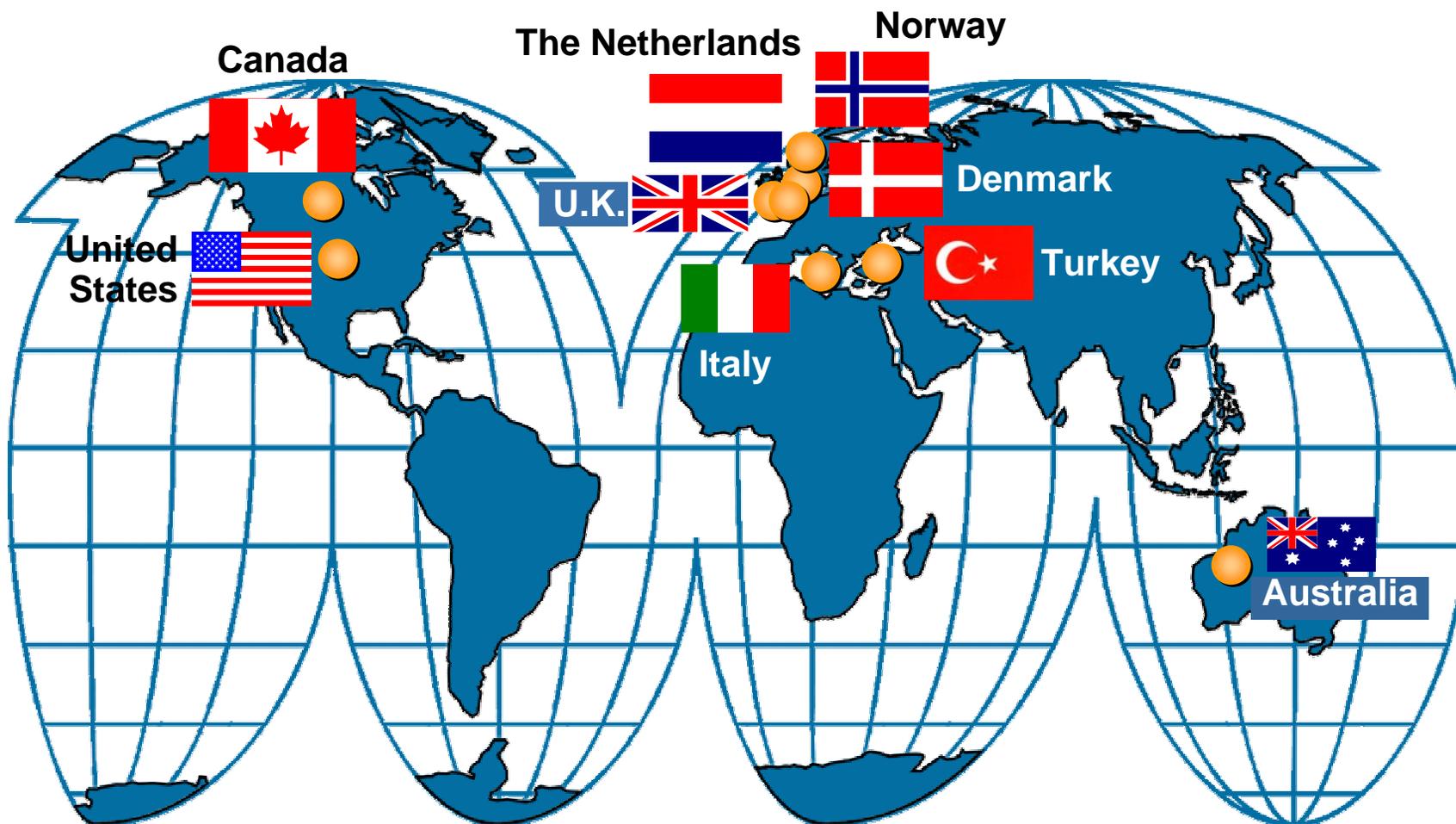
**Signature  
Performance, SA, Countermeasures**

### Supportability

**Service Basing Requirements  
LO Maintainability**



# JSF International Participation



**Lockheed Martin currently contracted to meet US and UK requirements and understand other partner country requirements**

Approved for Release to UK, DK, IT, NL and NO MOD, TU MND, CA DND and AS DOD



## Aircraft Configurations

**F-35A**



**CTOL**  
**(USAF)**

**F-35B**



**STOVL**  
**(USMC and UK)**

**F-35C**



**CV**  
**(USN)**

- **Highly Common Airframe/Propulsion Configurations**
- **Common Mission Systems**
  - *Within limits of National Disclosure Policy*



# JSF Autonomic Logistics System



## INTEGRATED SUPPORT

- Design Data → Direct to → Support Information
- Failure Prediction → Remove Unit Before Failure



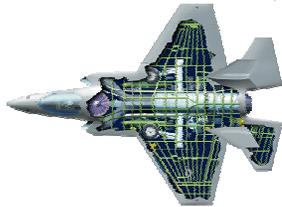
## TECHNOLOGICALLY-ENABLED MAINTAINER



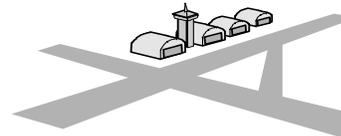
## FLIGHT OPERATIONS

- Integration for Optimal Mission Performance
- High Sortie Generation Rate
- Low Logistics Footprint

## AUTONOMIC LOGISTICS INFORMATION SYSTEM



## Joint Aircrew & Maintainer Training



## INTELLIGENT AIR VEHICLE

- Prognostics & Health Management
- Design for Supportability
- High Reliability & Maintainability

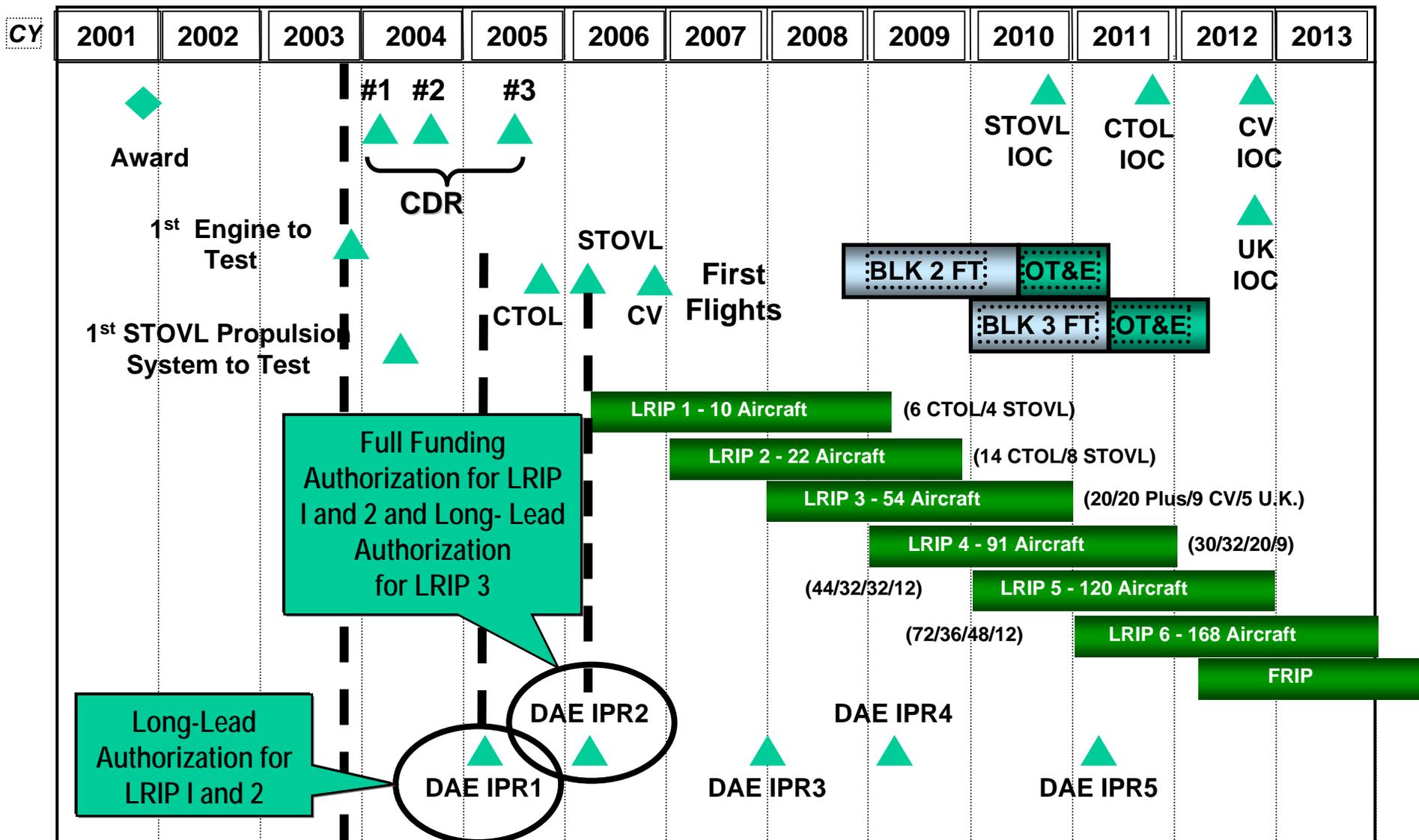
## INTEGRATED TRAINING

- Common, Joint Pilot/Maintainer Training
- Modular, Flexible Training
- Embedded Training

**Integrated JSF Autonomic Logistics System  
Supports High Tempo Combat Operations**



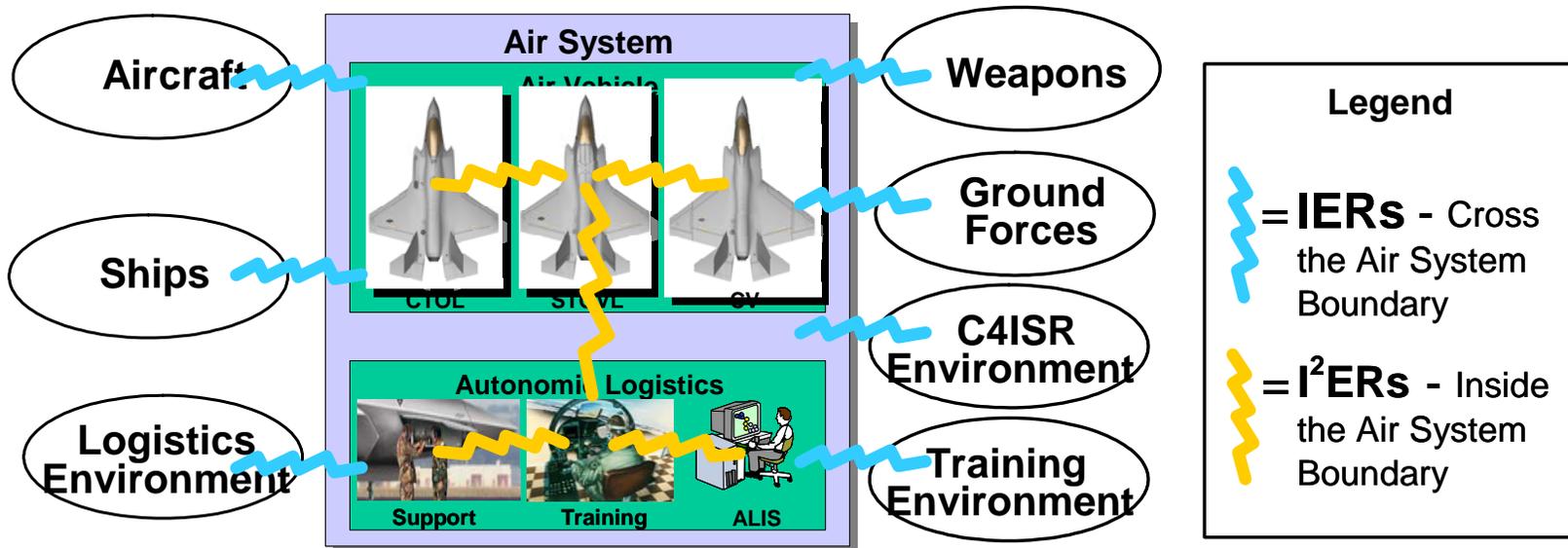
# USG Program Plan





# JSF Interoperability Requirements

- Be Compatible With the 2010 C4I Architecture
- Communicate With Others To Support JSF Missions
  - JCS and Appendix B, F and G-3
    - 17 Mission Types
    - 94 Information Exchange Requirements to External Systems
    - 50 Information Exchange Requirements Internal to Air System





# JSF JCS Appendix F Information Exchange Requirements



IER #	EVENT	INFORMATION CHARACTERIZATION	SENDING NODE	RECEIVING NODE	CRITICAL	FORMAT	TIMELINESS	CLASS
44	<b>Receive info that impacts mission</b> <ul style="list-style-type: none"> <li>• Replan mission, as required</li> <li>• Obtain 9-line info from FAC, FAC(A), or controlling agency, if needed</li> </ul>	Changes to 9-line briefing information	ASOC, TACP, UK TACP, TACC, TAOC, DASC, FAC, FAC(A), FACP, TAC(A), ABCCC, SOLE/ SOTAC/ SOCCE	JSF air vehicle	Yes	Data	12 sec	S, FR
45		Changes to 9-line briefing information	JSF air vehicle	ASOC, TACP, UK TACP, TACC, TAOC, DASC, FAC, FAC(A), FACP, TAC(A), ABCCC, SOLE/ SOTAC/ SOCCE, AH-64, AH-66, AH-1, UK WAH-64, OA-10, F-22, F-15E, F-15C, AV-8, F-18, F-16, F-14D, B-2, B-52, Tornado GR4	No	Data, Audio	12 sec	S, FR



# IER 45 – Changes to 9-Line Briefing Information Acknowledgement/Updates

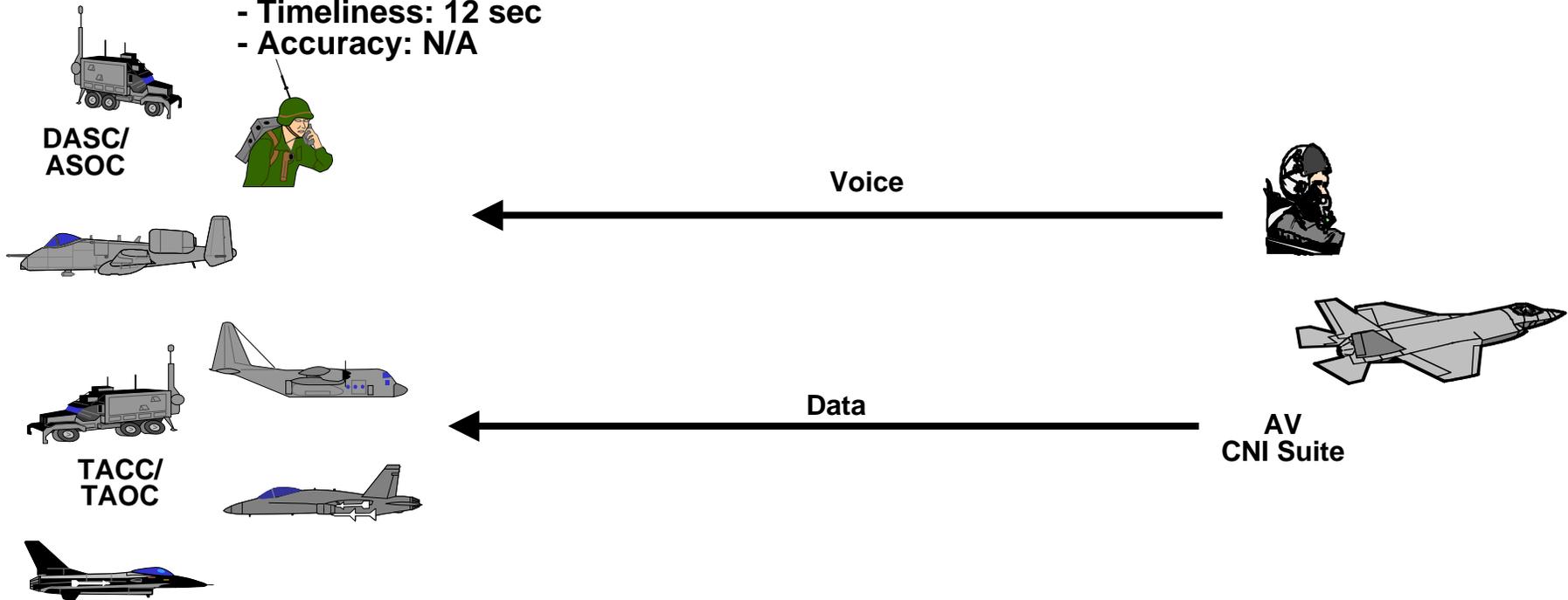


## Mission Segment: Ingress

**Driving Event:** Receive *info that impacts mission* – Replan mission, as required; obtain 9-line info from FAC, FAC(A), or controlling agency, if needed

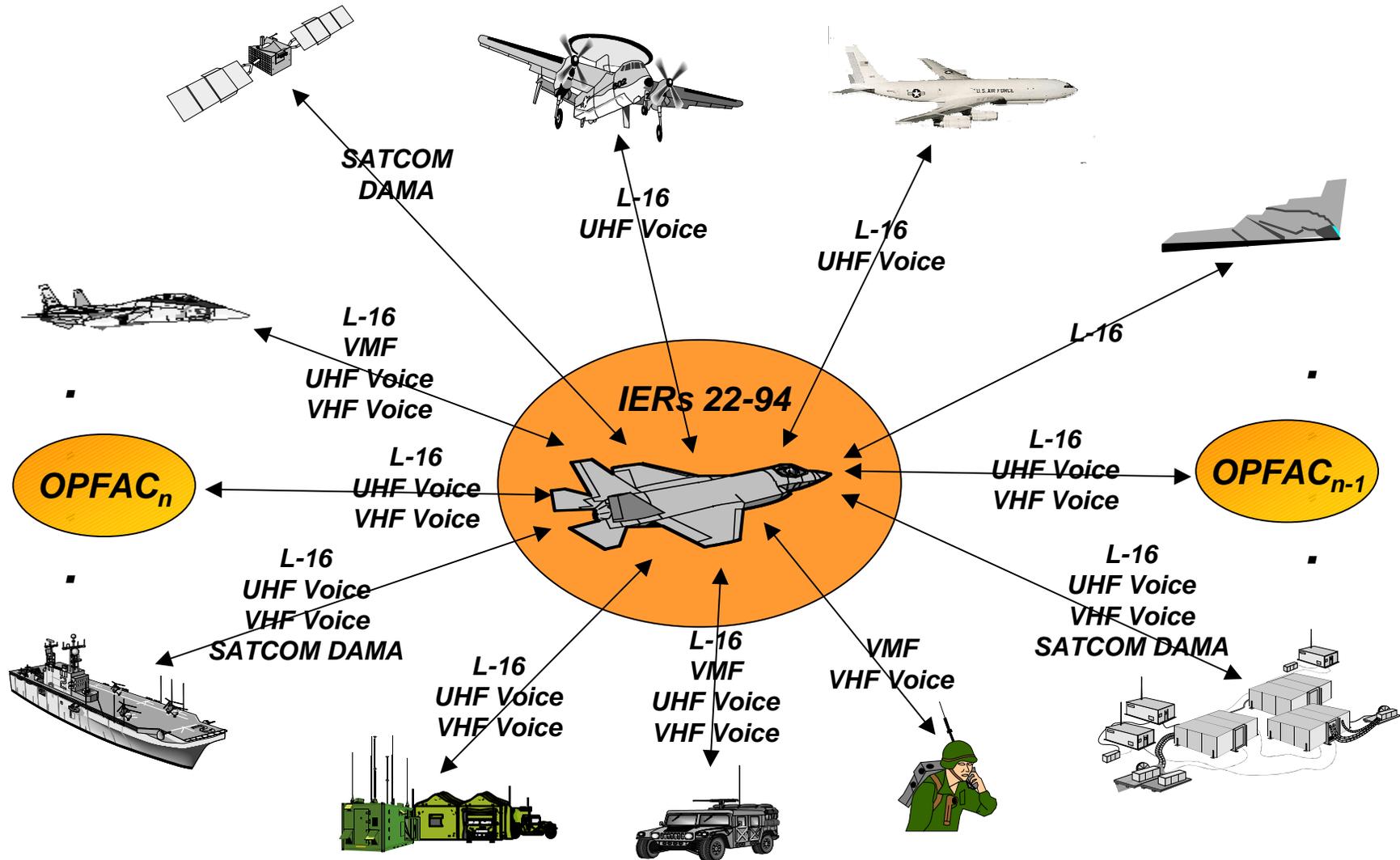
## Information Characterization:

- JSF acknowledgement and feedback of provided changes for confirmation as well as identification of any updates/modifications based on observations, etc. (Tgts of Opportunity sited, etc.)
- Classification: Secret/Foreign Releasable
- Info size: Kbits
- Info format: Data, Audio
- Transmission frequency: As Required
- CRITICAL: No
- Timeliness: 12 sec
- Accuracy: N/A





# Simplified View of Appendix F Requirements





## Capabilities Validation

- **Performed extensive analysis to define robust functionality within the JSF Air System to support interoperable communications**
  - *Surveyed App F OPFAC list for compatible comm needs*
- **Validated that these capabilities supported the current requirements**
  - *Missions*
  - *CONOPs*
  - *IERs*
  - *OPFACs*
- **Responded to other requirements to assure easy modification to adjust to expected unknowns**
  - *“Open/scalable architecture”, “easy insertion of new H/W & S/W”, etc.*
- **Developed key design elements to address broad spectra of intersections**
  - *S/W programmable radio suite, multi-function apertures, etc.*



# Robust Communications Capability (U)



## Voice Communications

- ✧ UHF/VHF Clear/Secure
- ✧ VHF AM (108-156 MHz)
- ✧ VHF Lo-FM (30-88 MHz)
- ✧ VHF Hi-FM (136-174 MHz)
- ✧ UHF AM/FM (225-400 MHz)
- ✧ HAVEQUICK
- ✧ SATURN
- ✧ SINGGARS
- ✧ GUARD Monitor (243/121.5)
- ✧ SATCOM Secure Voice
- ✧ Survival Radio Comm
- ✧ Link 16

## Data Message Formats

- ✧ Link 16 (J-Series)
- ✧ VMF (K-Series)
- ✧ IBS (CMF-B)
- ✧ JRE (J-Series SATCOM)

## Audio Functions

- ✧ Air Refuel Intercom (CTOL)



## Navigation/Landing Aids

- ✧ INS
- ✧ GPS
- ✧ ILS Marker Beacon
- ✧ ILS Glideslope
- ✧ ILS Localizer
- ✧ TACAN
- ✧ Carrier ILS
- ✧ MLS (w/DME-P)
- ✧ JPALS

## Identification/Surveillance

- ✧ Mark XII Transponder
  - Modes 1, 2, 3/A, C, 4, 5
- ✧ Mark XII Interrogator
  - Modes 1, 2, 3/A, C, 4, 5, S
- ✧ ADS-B

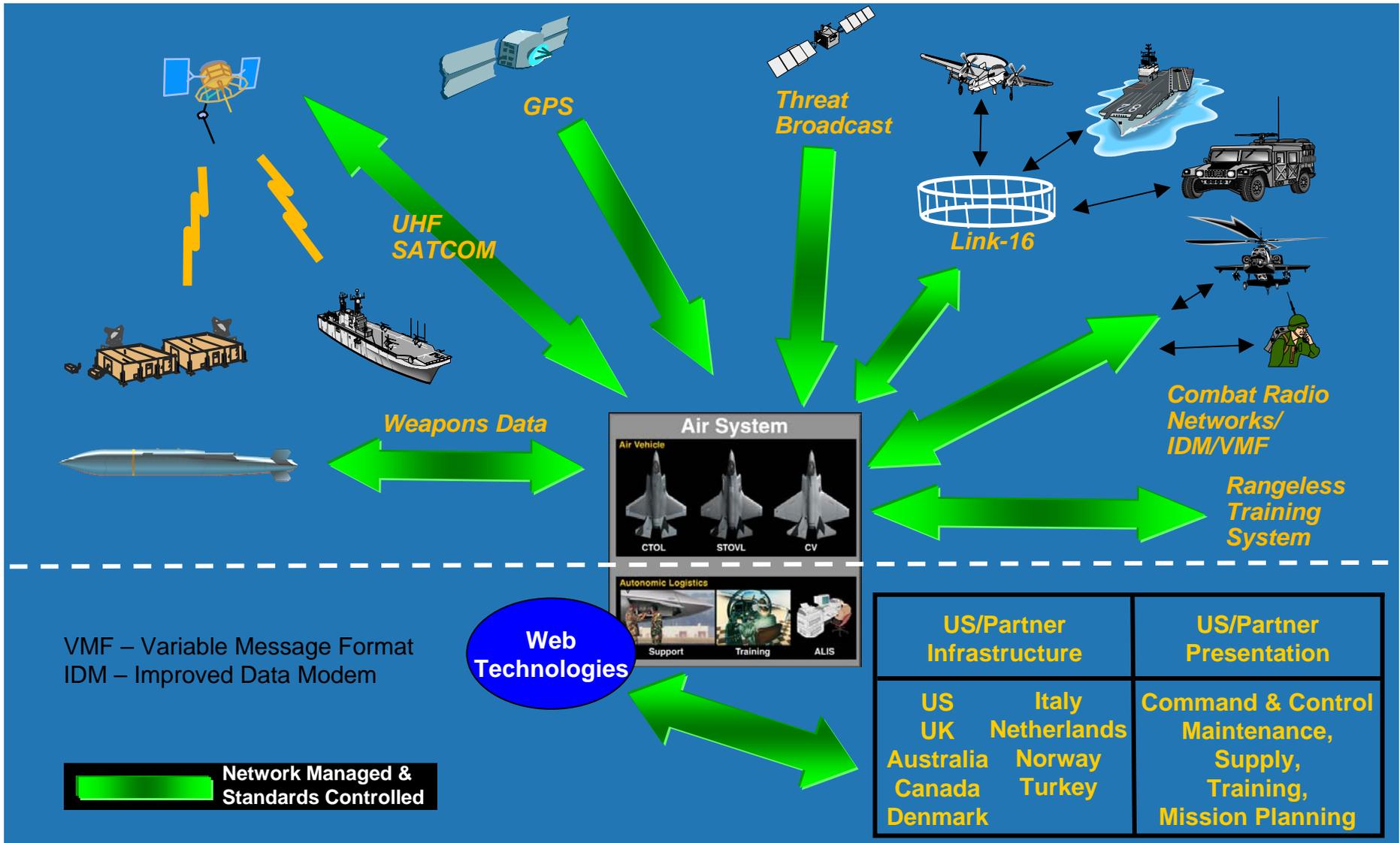
## Data Communications

- ✧ Link 16
- ✧ MADL (intra-flight)
- ✧ IBS (receive only)
- ✧ UHF SATCOM DAMA (tx/rcv)
- ✧ Digital Battlefield (SINGGARS/IDM, SATURN)
- ✧ P5 CTS / RAIDS
- ✧ Skynet 5
- ✧ SR(LA)4000

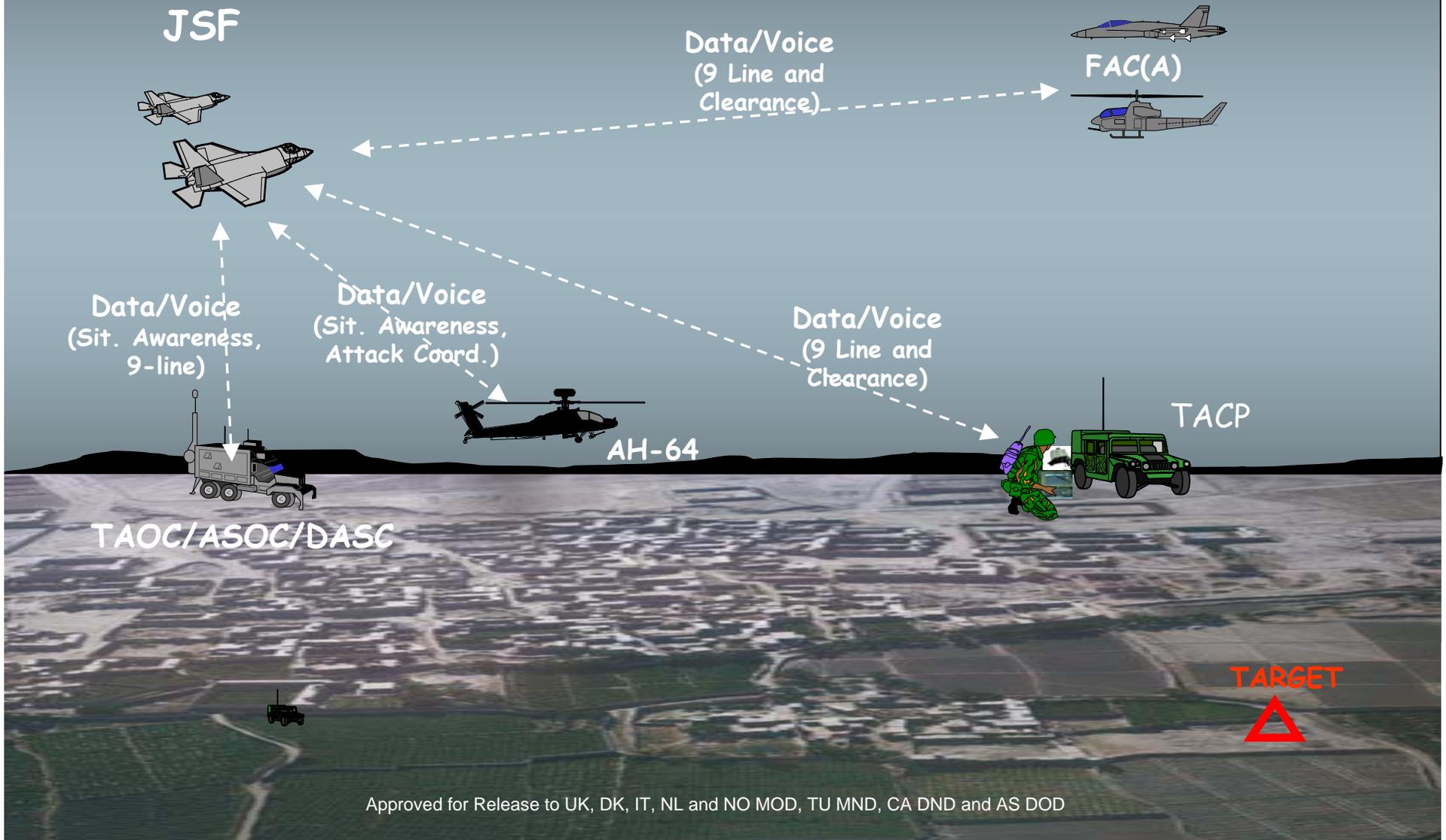




# External Interfaces Design Approach



# Key Battlefield Communications Operational Picture





## **JSF VMF Message Set - DRAFT**

- **K01.1 – Free Text**
- **K01.2 – Unit Reference Query/Response**
- **K02.15 – Fire Spt. Coord. Measures**
- **K02.16 – End of Mission & Surveill.**
- **K02.24 – In-Progress Mission Not.**
- **K02.25 – End of Mission Notification**
- **K02.27 – CAS Request**
- **K02.28 – CAS Mission BDA Report**
- **K02.31 – Mission Request Rejection**
- **K02.32 – CAS Request Acceptance**
- **K02.33 – CAS Aircrew Briefing**
- **K02.34 – Aircraft on-Station**
- **K02.35 – A/C Depart Initial Point**
- **K02.36 – A/C Mission Update**
- **K02.38 – Target handover**
- **K03.2 – Engagement Rpt/BDA**
- **K03.6 – MAYDAY Message**
- **K04.1 – Observation Report**
- **K04.8 - Entity Emission Warning Message**
- **K05.1 – Position Report**
- **K02.57 – Aircraft Attack & Tgt Designation**
- **K02.58 – CAS Aircraft Final Attack Control**
- **K02.59 – Request for Aircraft Attack Position & Tgt Designation (ICPs in-work; F-35 intends to implement)**
- **K03.N1 – K03.N7 – Air Refuel Msgs (ICPs under development – being considered by F-35)**



## ***Expected VMF Network Players***



- ***USMC FAC***
  - VMF
- ***USN/USMC F-18***
  - TAC(A), FAC(A)
  - Link 16 and/or VMF
- ***USAF/SOF TACP***
  - Link 16 and/or VMF
- ***USA AH-64***
  - VMF
- ***UK WAH-64***
  - Assumes migration to VMF
- ***UK TACP***
  - VMF

**Mission Type, Joint Service/Coalition Requirements, Mission Planning will determine exact makeup of communications path used operationally**



## ***F-35 Interoperability Verification Approach***

- It would be cost prohibitive to verify all requirements and certify all capabilities against the entire set of IER/IIERs with all OPFACs/Systems
- Minimize/eliminate concern relative to what specific type of platform is on the other side of our interface from a requirements, design, verification perspective
  - *“If we build to a recognized, consistent, unambiguous standard – then F-35 will meet its interoperability requirements regardless of the capabilities of the platform on the other end”*
  - *Consistent with Net-Centric concept*
- Recognize that we WILL HAVE TO verify and certify with real systems to some extent – judiciously selected a set of key OPFACs/Systems that serve to represent the total
  - *Airborne C2 = AWACS & E-2C*
  - *Maritime C2 = CVN, UK CVF, DDG, UK Type 45 Destroyer, LHD*
  - *Airborne ISR = JSTARS, RJ, IBS, UK ASTOR, UK NIMROD-R, EA-6B*
  - *Ground C2 = TACP, AOC*
  - *Fighter = F/A-18, F-16, F/A-22, Eurofighter, F-15E*
  - *Battlefield Support = AH-64, AH-1Z*
  - *Bombers = B-2*
  - *Transport/Cargo = V-22*



## General Verification Approach for VMF on JSF



- **Vendor-level Analysis & Test**
  - *Verify the ability of CNI to support exchange of VMF messages over MIL-STD-188-220 and MIL-STD-2045-47001.*
  - *Software programmable radio functionality*
- **Stand-Alone and Integrated Lab Test, M & S, Analysis**
  - *Verify ability to exchange K-Series messages in accordance with MIL-STD-6017 through use of Mission System Integration Lab (MSIL) and Air System Integration Facility (ASIF)*
    - **Integration with JSF Interoperability Lab (JIL)**
      - *Hi-fi OPFAC models (e.g., VSTARS)*
      - *OPFAC “emulators” (e.g., ASCOT, ASSET)*
      - *Data link test tools (e.g., VTT, TIGER)*
  - *“Radio” integrated with message handling software, processing software and PVI*
- **Flying Testbed, Demonstrations, HITL/MITL M & S, Ground and Flight Test,**
  - *Verify the Air System’s ability to exchange information to satisfy operational needs.*
    - Testbed supports early integration in dynamic environment
    - Demos, MITL M&S, HITL provide operator interaction and support model validation
      - *Use Cases and scenarios provide the context for verifying Information Exchange Requirements (IERs)*
    - F-35 Ground and Flight Test supply final verification check and model validation



# Interoperability Verification is a "Build-Up"



Tier 1

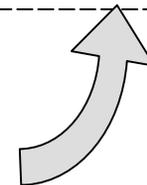
- MITL Sim (FPTs, ISPs), MITL Demos (JEFX) – (A1, D2)
- Pilot/Operator Surveys/Questionnaires – (A1)

-Mission	
	-Exchanges Clear
	-Actions Understood
✓	-Symbology Correct
	-Registration Correct
✓	-Correlation Correct

Tier 1+

Operational  
Reqmts Spec (ORS)  
Level

	Title	Tran r Recv	Voice	JTIDS/ L 16	IDM (VMF/ TAC	SATCOM/ JREAP
				(JSLIRS Annex/J- Msg)	FIRE/ AFAPD)	(J-Msg over UHF
IER#						
25	Aircraft/Pl atform Relative/A ctual Position	R	Voice	C,P/ 2.0, 1 2.3, 2.5, 2.6	5.1 AFAPD(TBD)	2.0, 2.2, 2.3, 2.5, 2.6
26	Aircraft & Systems Status	T	Voice	C,P/ 13.2	AFAPD(TBD)	13.2



- IERs Over Defined Links Met (A1, A2, A3)
- JCS Reqmts Met (A1, A2, D2)

Tier 3-

Tier 3 &  
below

Platform Reqmts Spec Level	Mission Systems		
	L16	VMF	SATCOM
J2.2	T3/T5/T6		T3/T5/T6
	A1/A2/A3		A1/A2/A3

H/W Specs S/W Specs	CNI	XCOM	PVI
	T1/T2		T2
A1/A2/A3	A1/A2 S1 T2	A2 T2	

MSIL  
CATB  
FT

- Messages over Defined Links Met
- Transactions Met
- Simultaneity Requirements Met
- Range/FOV Performance Met

Vendor  
Labs

- R/F-Terminal Performance Met
- Message Structure Met

S/W  
Labs

- Transaction Met



# Verification Activities & Interop Evals/Assessments Support Each Other



**Tier 1**

- MITL Sim (FPTs, ISPs), MITL Demos (JEFX) – (A1, D2)
- Pilot/Operator Surveys/Questionnaires – (A1)

-Mission	
-Exchanges Clear	
-Actions Understood	
-Symbolism Correct	✓
-Registration Correct	
-Correlation Correct	✓

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**Tier 1+ Operational Reqmts Spec (ORS) Level**

IER#	Title	Trans Recv	Voice	JTIDS/ L 16	IDM (VMF/ TAC JREAP)	SATCOM (J-Msg over UHF)
25	Aircraft/Platform Relative/Actual Position	R	Voice	C,P/ 2, 2.3, 2.5, 2.6	5.1 AFAPD(TBD)	2.0, 2.2, 2.3, 2.5, 2.6
26	Aircraft & Systems Status	T	Voice	C,P/ 13.2	AFAPD(TBD)	13.2

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**Tier 3- Platform Reqmts Spec Level**

Mission Systems			
	L16	VMF	SATCOM
J22	T3/T5/T6		T3/T5/T6
A1/A2/A3			A1/A2/A3

MSIL CATB FT

- Messages over Defined Links Met
- Transactions Met
- Simultaneity Requirements Met
- Range/FOV Performance Met

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**HW Specs S/W Specs**

CNI	XCOM	FVI	Vendor Labs
T1/T2	A1/A2 S1 T2	T2	A2 T2
A1/A2/A3			

RF-Terminal Performance Met  
Message Structure Met  
Transaction Met

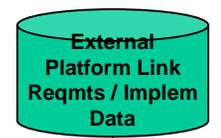
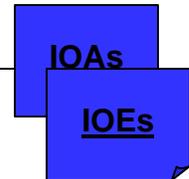
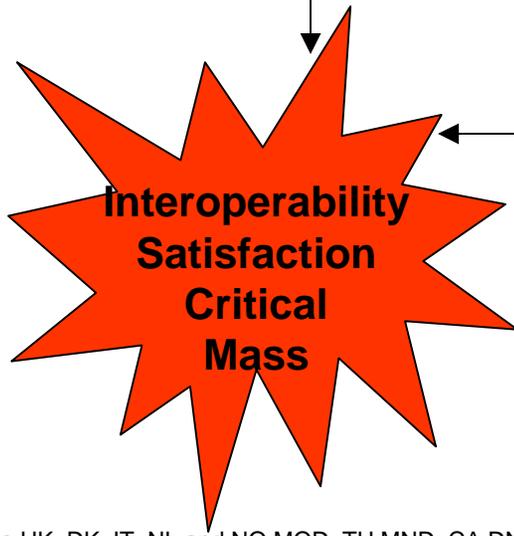
## Verification Activities

**Primarily focused on:**  
“Have I met my Reqmts?”  
(supports answering the **HOW INTEROPERABLE** question)

Analysis, M&S, Test Rig, MSIL, ALISIL, CATB, etc  
Verif Evidence

**Primarily focused on:**  
“How interoperable are we relative to external environment?”  
(supports answering the **REQMTS SATISFACTION** question)

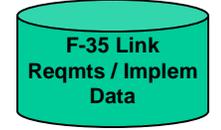
## iSMART Activities



F-35 vs OPFAC

“Paper” Analyses

F-35 vs Our Reqmts





# Lab Facilities

