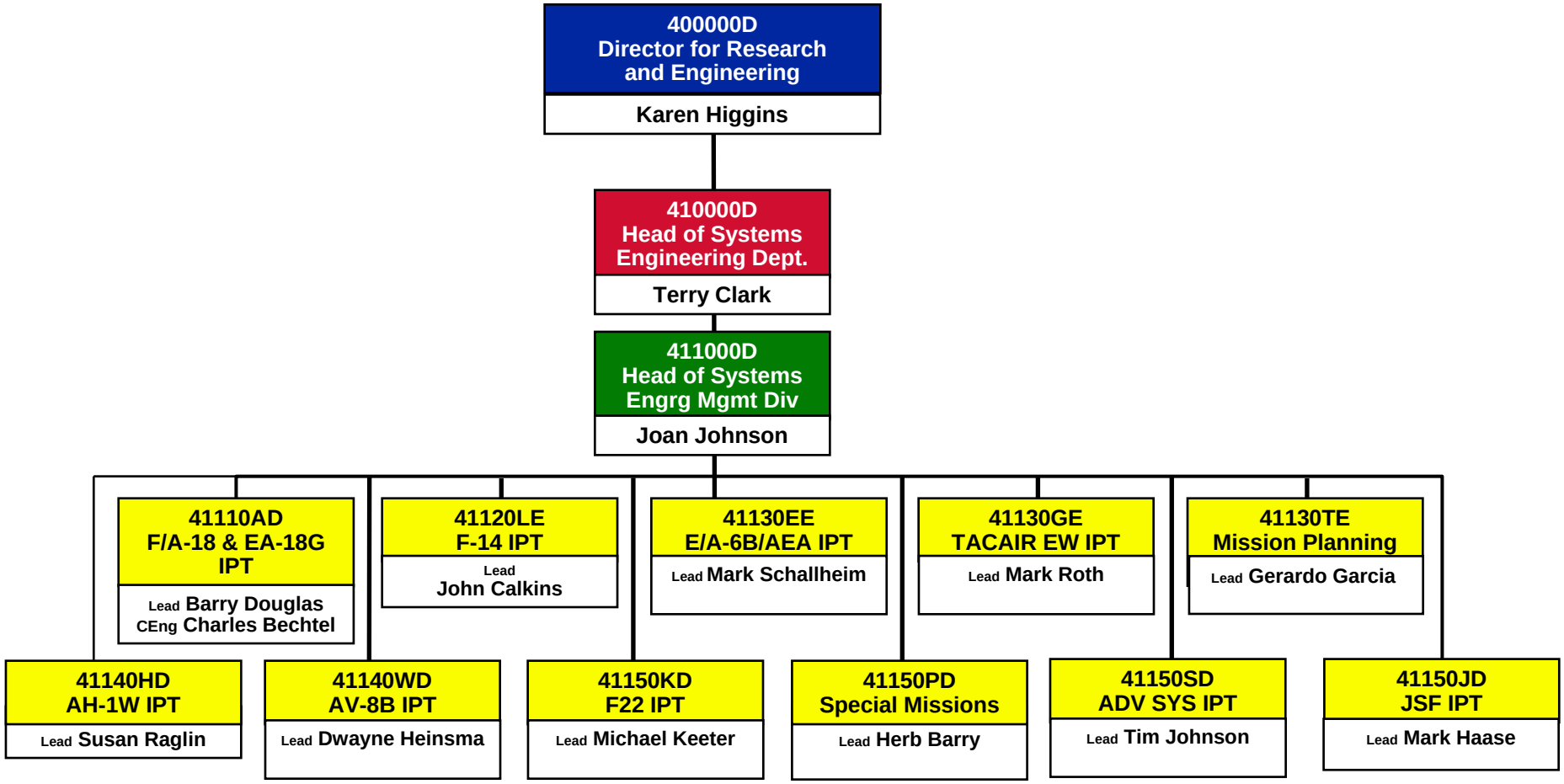
System Support Activities

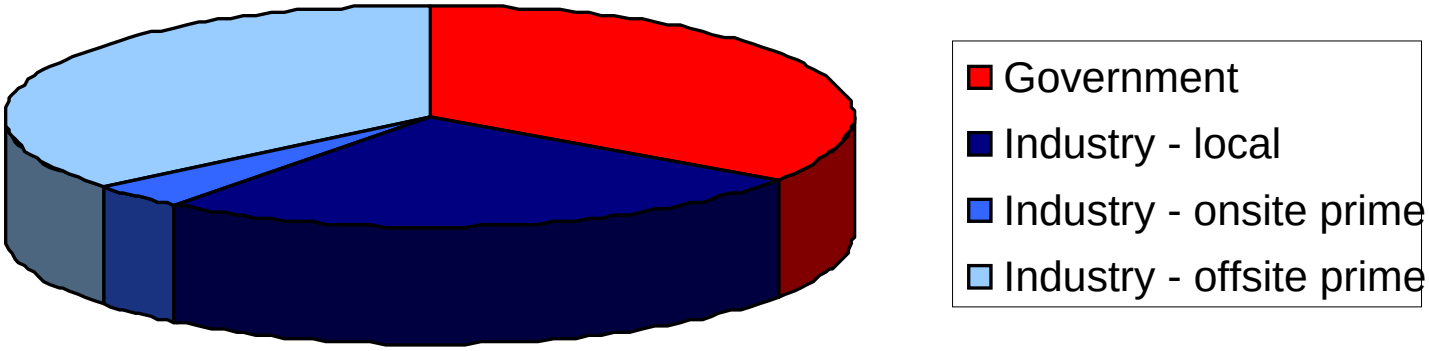
The F/A-18 & EA-18G Advanced Weapons Lab
China Lake

4.0 / 4.1 / 4.1.1 ORGANIZATION

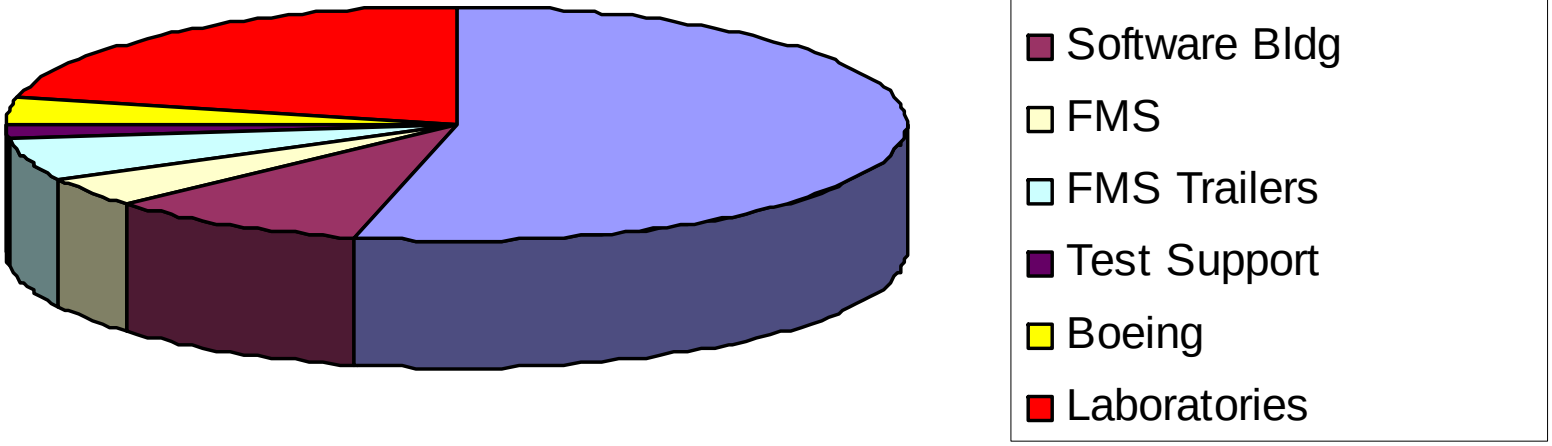


F/A-18 & EA-18G IPT MANPOWER & SPACE

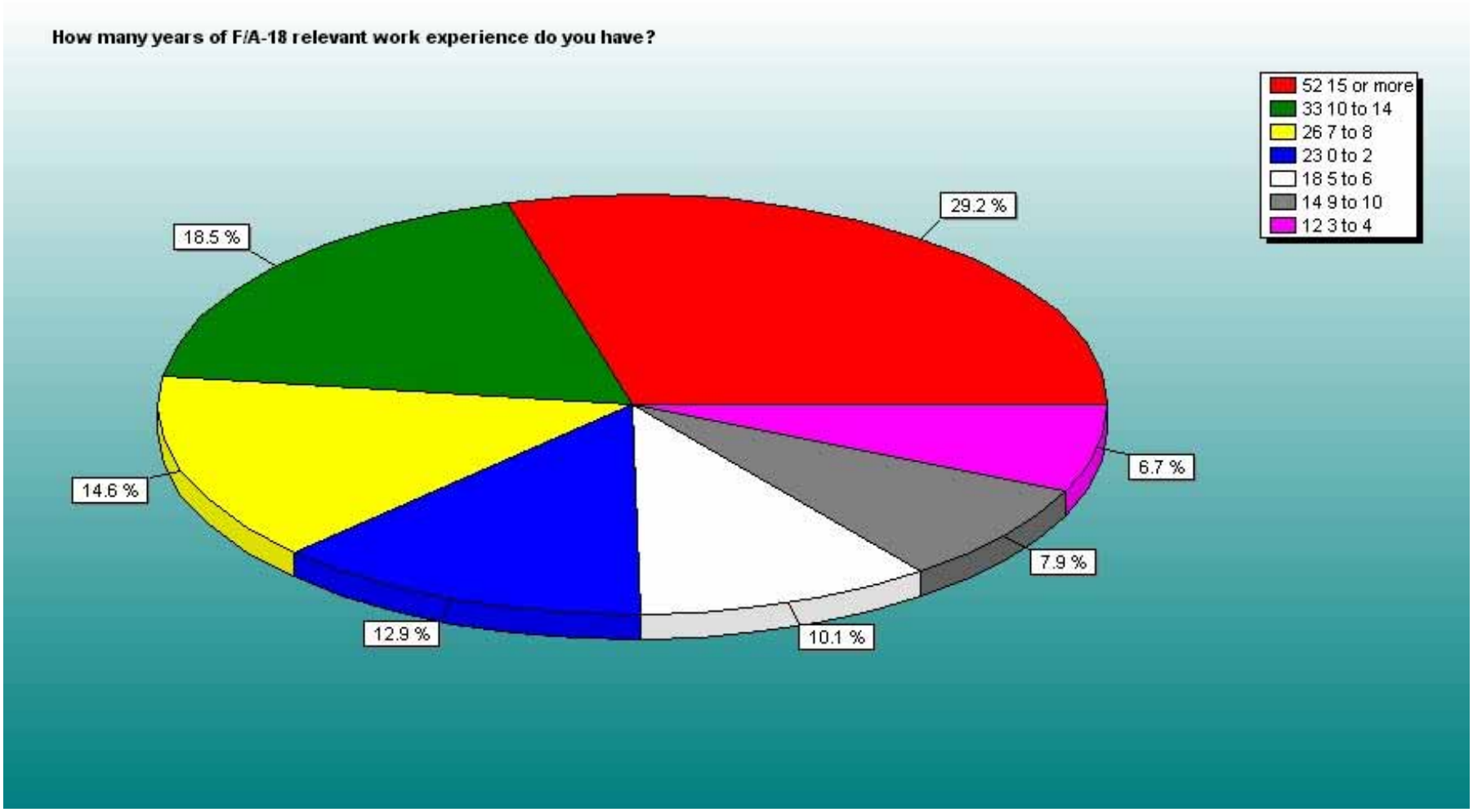
690 Work Years



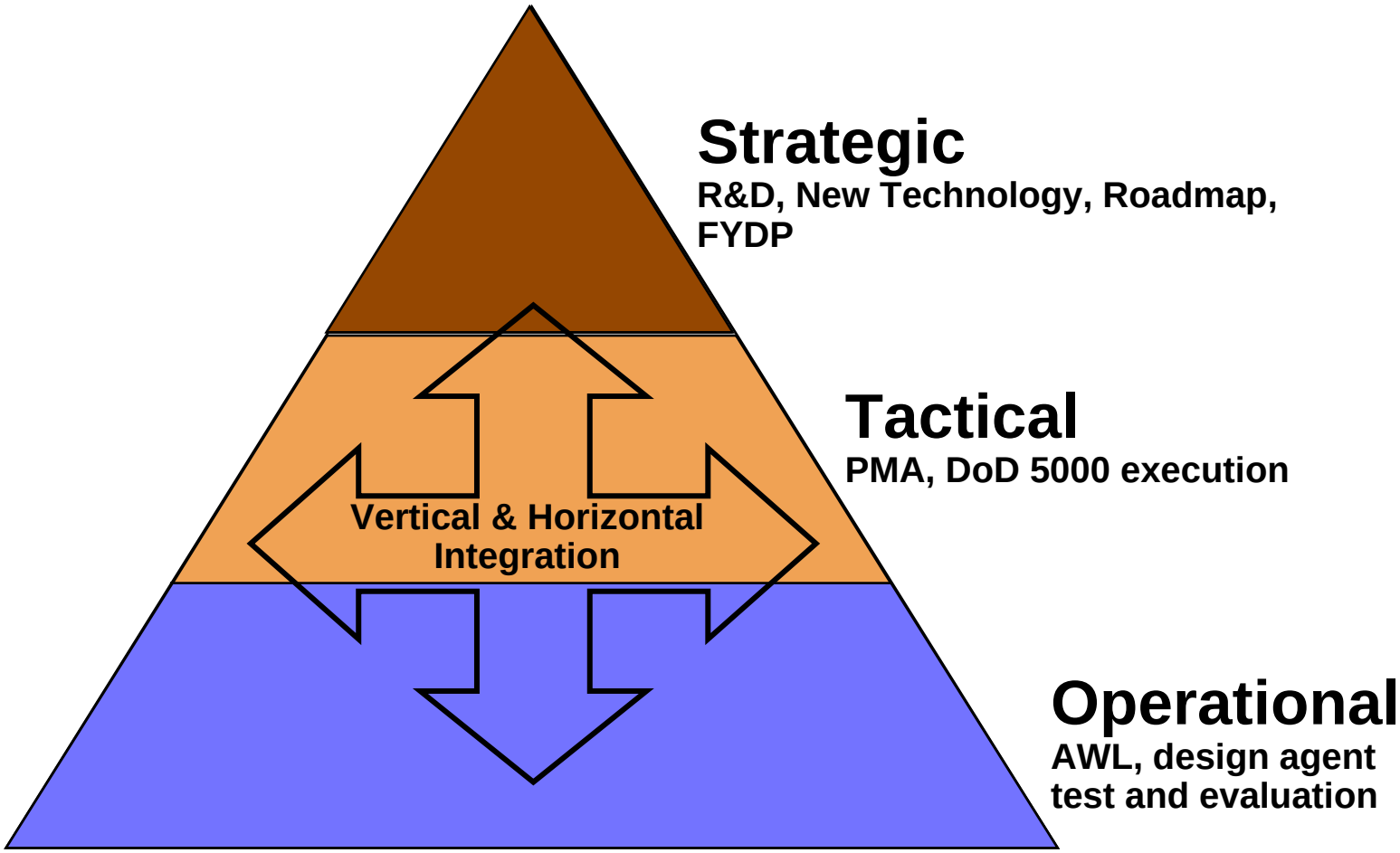
100,000 Sq Feet



F/A-18 & EA-18G AWL RELEVENT WORK EXPERIENCE



SYSTEM ENGINEERING FLOW DOWN



CVW TACTICAL AVIATION EVOLUTION

1985 | 1995 | 2005 | 2015 | 2020

Mission Centric Operations

F-14A

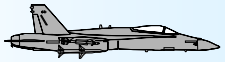
- Outer Air Battle
- Fighter Sweep

A-6 / KA-6

- Strike
- Tanking

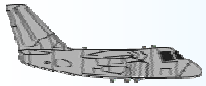
A-7

- Light Attack



F/A-18A

- Light Attack

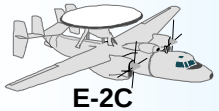


S-3B

- ASUW

EA-6B

- SEAD

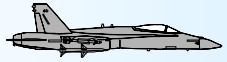


E-2C

- Blue Water AEW

Multi-Mission Operations

F-14D

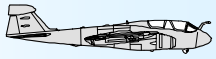


F/A-18A/C

- Precision Strike
- Air Superiority
- RECCE
- FAC(A)

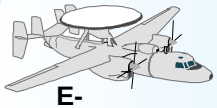
S-3B

- ASUW
- Tanking



EA-6B

- AEA/SEAD



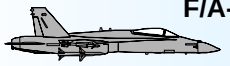
E-2C

- Littoral Ops (Limited)

Technologies :
Multi-role, GPS,
Night Attack……

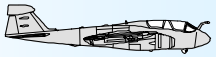
Network Centric Operations

F/A-18E/F



F/A-18C

- Time Critical Strike
- Precision Strike
  (Fixed and Moving)
- Air Superiority
- CSAR
- RECCE
- FAC(A)
- Battlefield Persistence
- Tanking



EA-6B

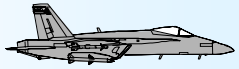
- AEA/SEAD

E-2C

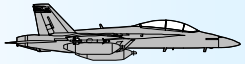
- Littoral Ops
- Digital Collaborative Targeting

Technologies :
AESA, Link-16, DCS,
Geo-Registration

Future Operations



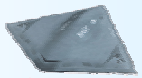
F/A-18E/F



EA-18G

F-35B/C

E-2C



- JUCAS

Technologies :
JAN-TE, JTRS, WPNS
DATA LINKS,
SATCOM, Blue Force
Tracker, Combat ID

F/A-18E/F STRATEGIC CAPABILITY ROADMAP
FY 2005-2012 Plan 05-1.2

Jan 2005

EA-18

Delivery Year	05 FY 05	06 FY 06	07 FY 07	08 FY 08	09 FY 09	10 FY 10	11 FY 11	12 FY 12
Incremental Upgrades to Basic Plan	Increment 1 • M2M Precision targeting • RTIC/RTOC Info & Imagery • Better Mission Assessment • Control of A/C via Digital CAS • Improved mission recording and debrief • Upgrade APG-73 A/A EP							
Proposed Technical Solutions			Increment 2 • M2M Precision Targeting • RTIC/RTOC Info & Imagery • Time Sensitive / Relocatable Target Attack • Enhanced A/G Target Acq and Cueing • Increased aimpoints on each pass • AESA improves A/A detection, MTT, ID, EP					
				Increment 3 • Real-time mission assessment ■ Control of A/C via Digital CAS ■ M2M Precision targeting • Increased aimpoints on each pass • Precision SOPD and DA Weapons ■ APG-73 High Res Maps (Exp 4/5) • All-weather, global ATC mobility • Improved A/A weapons • Integrated tactical picture for air targets (a limited L16 target ID taxonomy imp.)				
				Increment 4 ■ Time Critical Strike ■ Generation of precise target coordinates ■ Passive emitter targeting ■ Improved survivability vs RF threats • Precision SOPD and ~~DA~~ weapons • Increased comm range, reliability & QofS ■ Combat ID & Blue Force Tracking ■ Improved A/A PID ■ Improved A/A all aspect detection and tracking in clutter			
					Increment 5 ■ Precision moving target engagement ■ Combat ID & Blue Force Tracking ■ Improved survivability ■ Integrated tactical picture for ground and surface targets ■ Precision SOPD and DA Weapons			
						Increment 6 ■ Land target ATC and ATR ■ Moving target ID ■ RECCE improvements ■ Battlespace awareness ■ Prec. Engagement in a high work load env. ■ UAV connectivity ■ Increased comm range, reliability & QofS (wideband waveform, networked)		
							Increment 7 ■ Increased comm range, reliability & QofS (SATCOM) ■ Real time mission assessment	
System Design	Image Receive/Transmit Solid State Recorder ACAS 9-line via Link 16 Precision coord via L16 APG-73 EP		L16 / VMF HAE Tgt Ht Precision J12.6 (L16) Off Board Image Mensuration A/G Target Points L16 Multiple DMPI Tgting ATFLIR IR Marker	AMC T3 w/Dig Video DMD SIAP Blk 0 BHA Message CIT Mode S & ~~RNAV~~ Link 16 CAS TPDF via Link 16	Image Processor/MSU MIDS-JTRS Digital RWR and SEI Image Geo-registration Ground BFT via Link 16 Mode 5 Smart images	AESA GMTI/SAR ATFLIR MMTT A/G MSI TADIRCM SDB Increment 2 Laser JDAM Common Tactical Gnd & Surface Picture	MIDS-JTRS (WNW/TTNT like) AESA/SHARP RECCE AESA/ATFLIR ATC/ATR AESA GMT ID AESA Large Scale SAR UAV connectivity Real Time Msn Planning	SATCOM AESA SAR BHI
Basic Plan → Sea Power 21 Baseline	AESA Phase I Fibre Channel Net ACS AMC T2 ATFLIR LST J 82 on Parent Rack JSOW Unitary ATA AIM-120C7	IBKL-3 - ALQ-214 w/ ALE-55 (FOTD)	MIDS MAGR 2000	AESA Phase 1 (E's) JHMCS (aft)-ACS only ANAV - Full ANAV/AESA int. JASSM J 82/83 w/BRU-55/A J 83 Parent Rack AIM-120D	NAVWAR ~~JCM~~ AARGM			
	Funded		Future POM Issues					

■ Unfunded or technical issues

EA-18G Growler Schedule

ICAP III IOC

EA-18G IOC

FY	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
USN (CVW)	ICAP II									EA-18G				
			ICAP III											
USN (EXP)			ICAP II											
USMC	ICAP II								ICAP III			USMC Follow-on		
USAF											B-52 Plus Family of Systems			

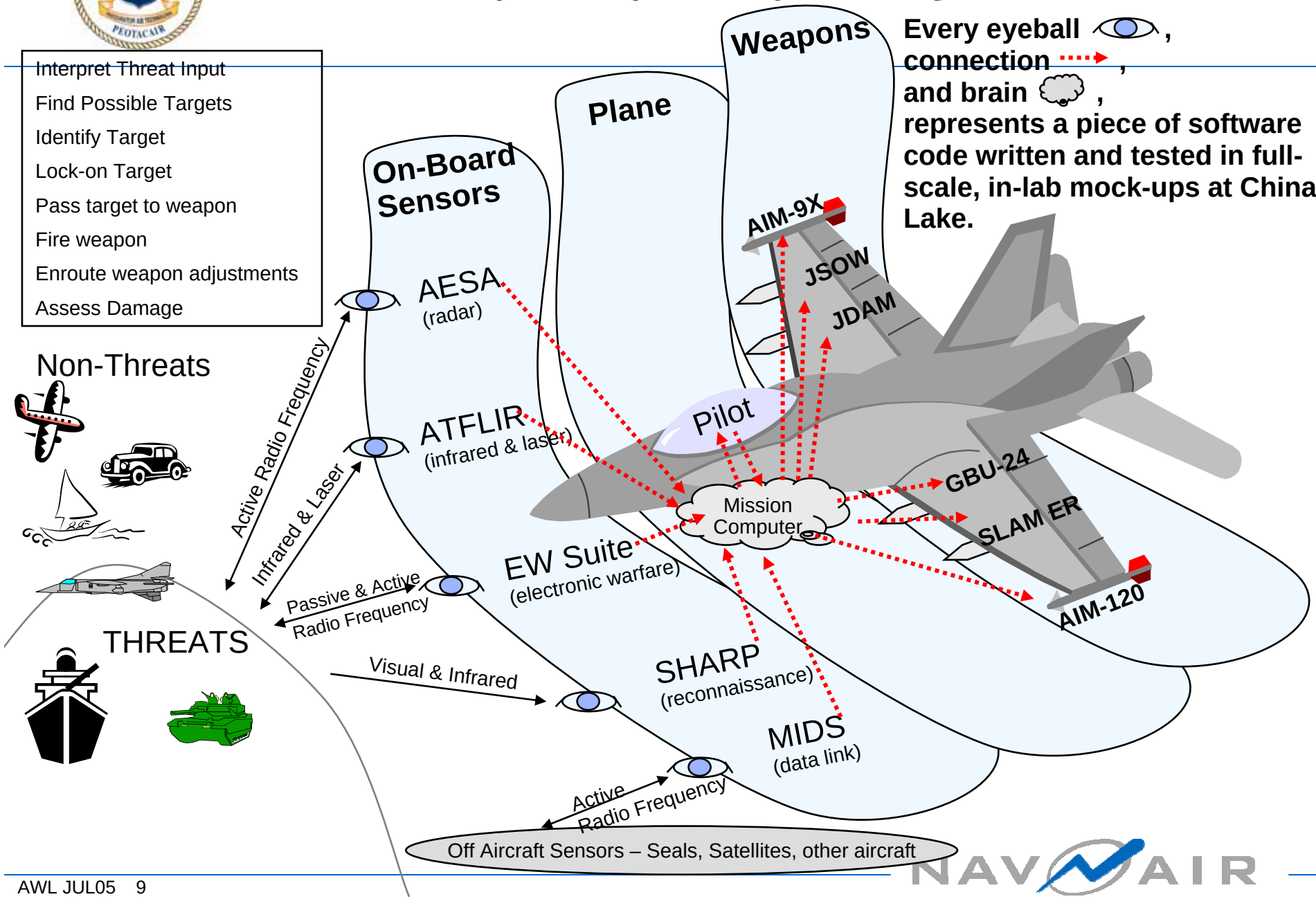
USAF Assumes Expeditionary Mission

UNCLASSIFIED

WIRED TOGETHER

i.e., an example of *Weapons and Systems Integration*

Every eyeball , connection , and brain , represents a piece of software code written and tested in full-scale, in-lab mock-ups at China Lake.



SENSORS IN THE ELECTROMAGNETIC SPECTRUM

Sensors = U.S.'s latest technological edge.

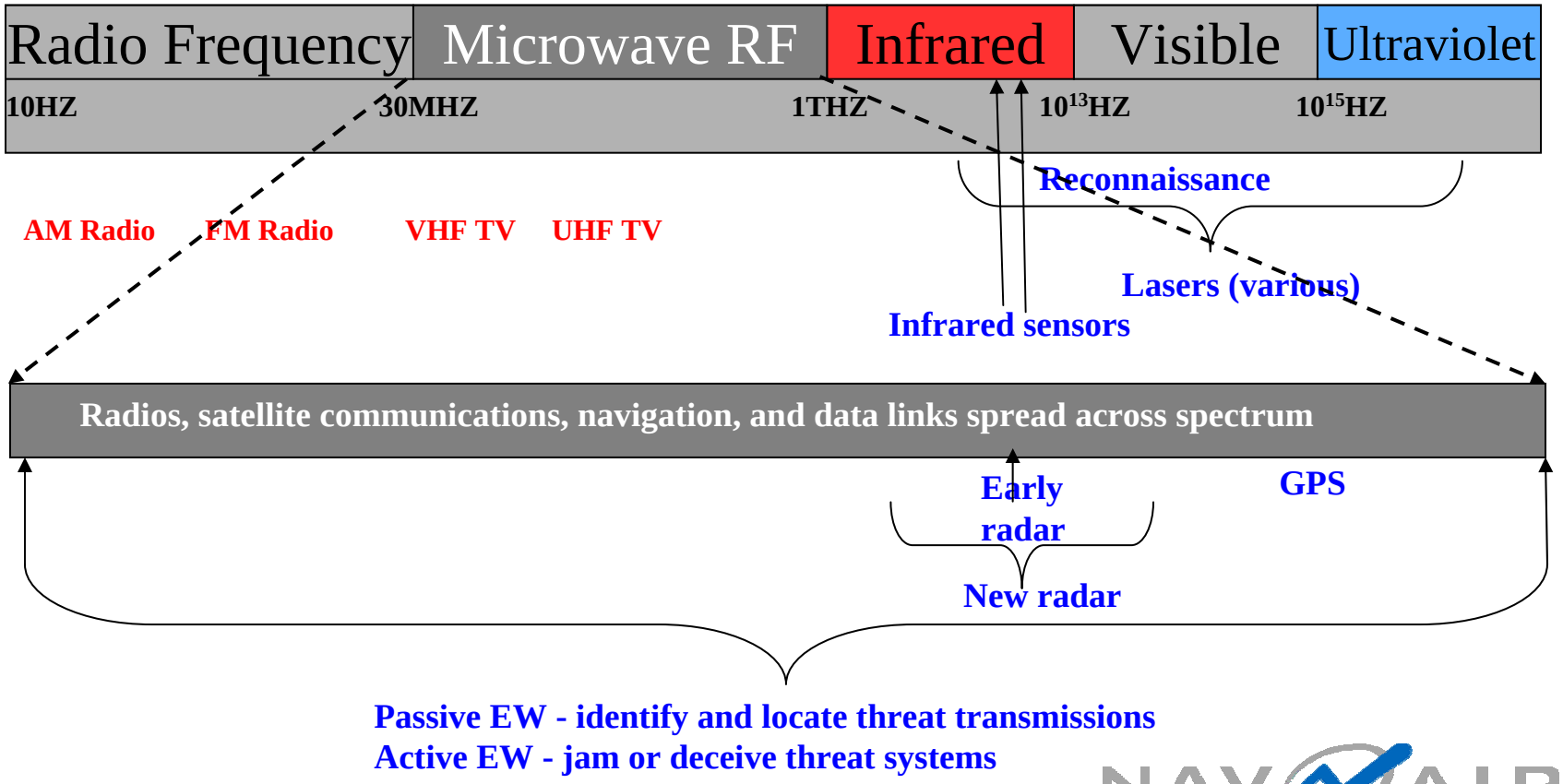
Air War = Public's preferred type of war.

Sensors on Aircraft = U.S.'s point of maximum opportunity.

The "eyes and ears" of a smart plane and a smart bomb.

Different kinds of Sensors for different areas of the Electromagnetic Spectrum.

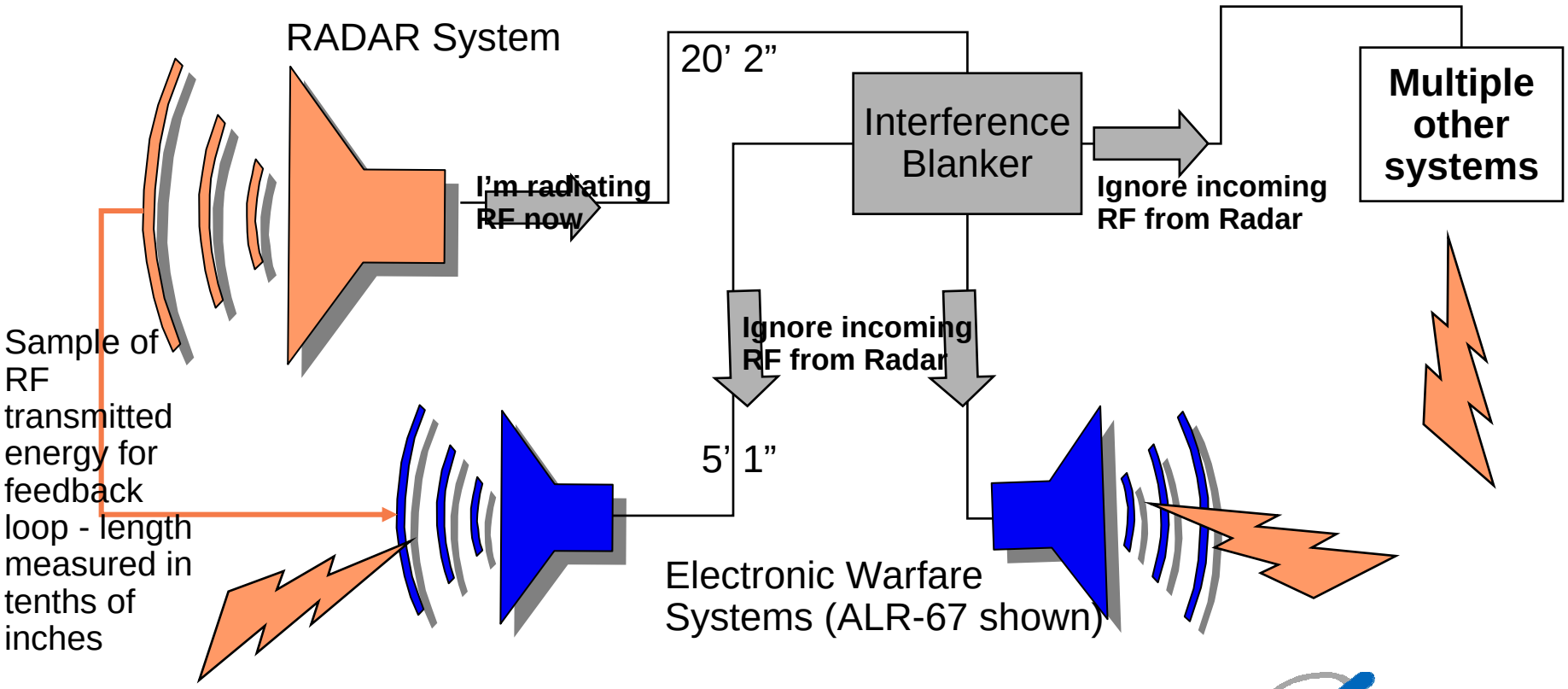
Note: not to scale



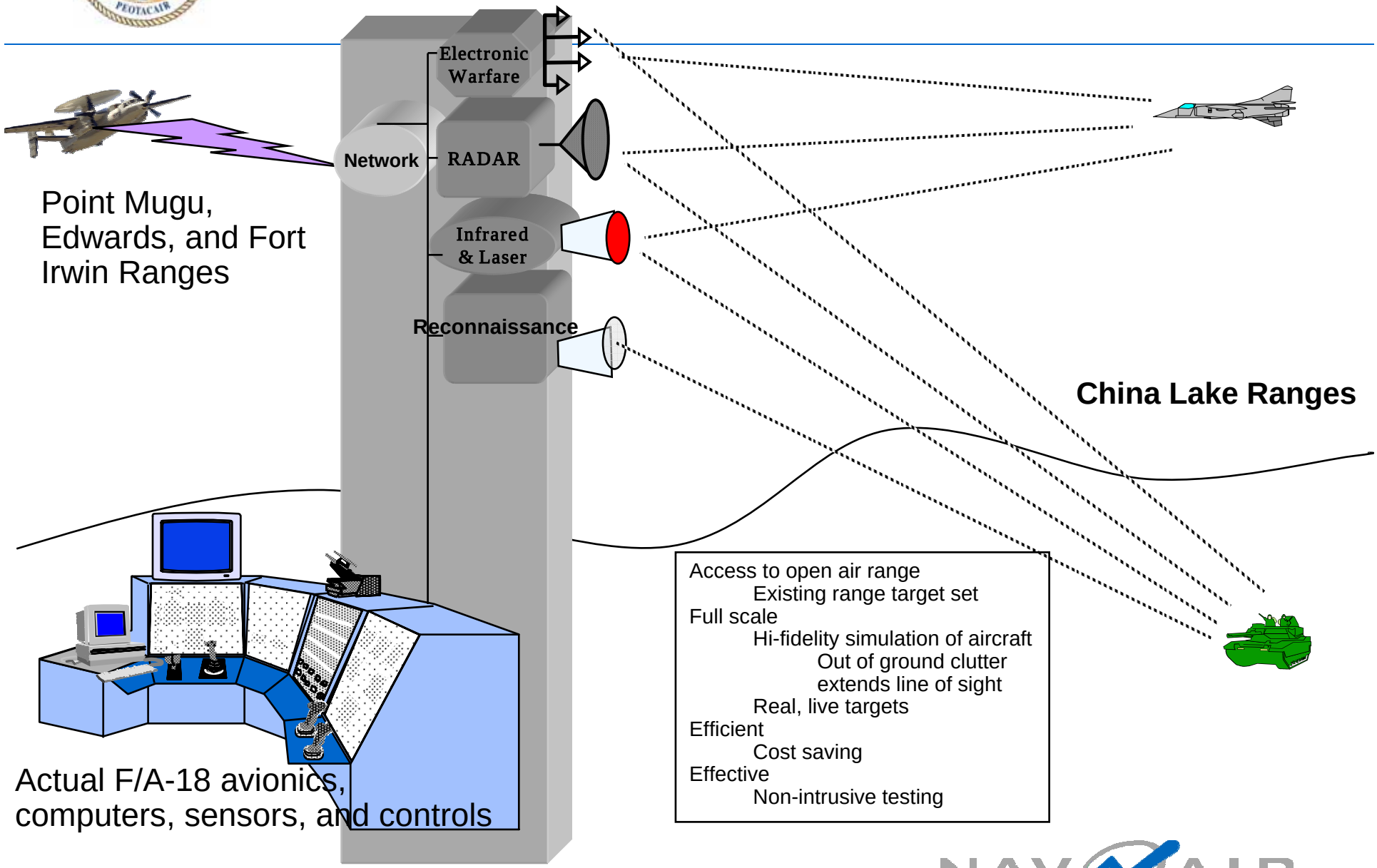
NANOSECOND PRECISION

Signals travel about I foot per nanosecond in wiring. Nanosecond accuracy is required. <u>Therefore length of wiring must accurately replicate aircraft wire lengths</u>, and all systems must be collocated.

Only Radar RF interference shown for simplicity



IN LAB MOCK-UPS



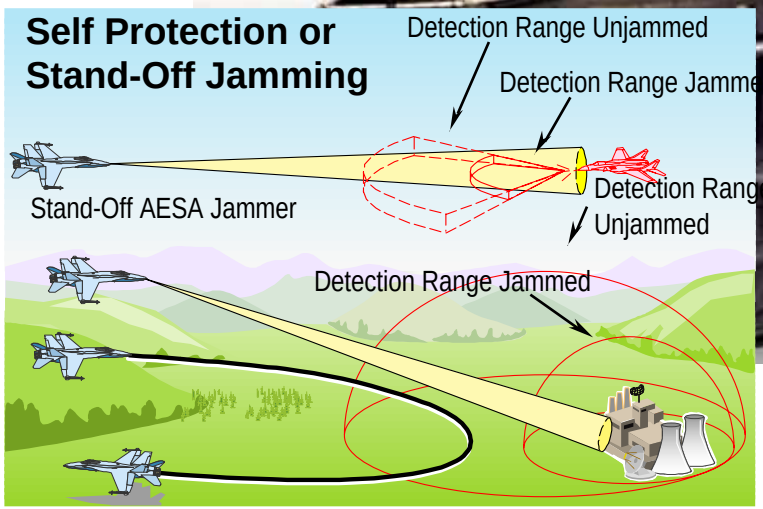
Access to open air range
- Existing range target set

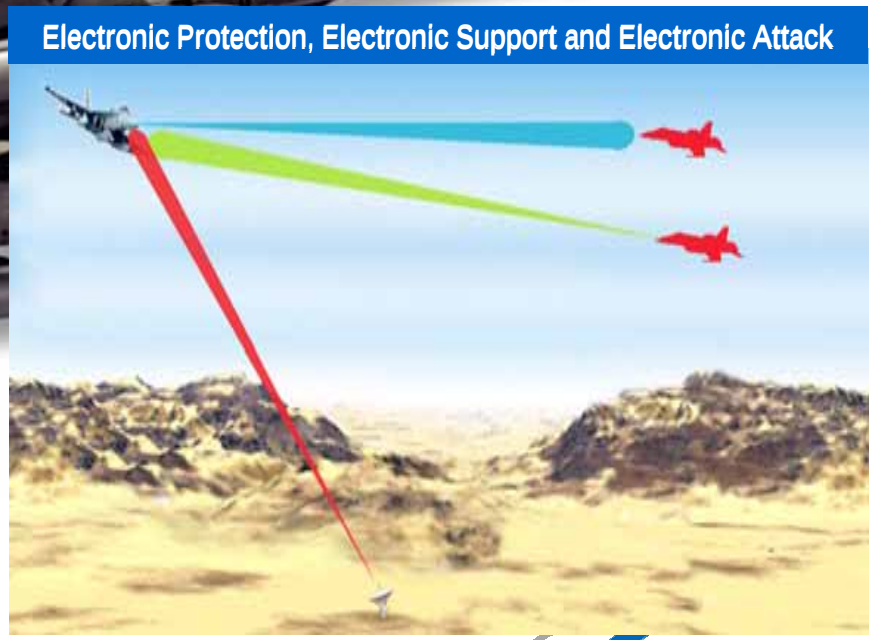
Full scale
- Hi-fidelity simulation of aircraft
  - Out of ground clutter extends line of sight
- Real, live targets

Efficient
- Cost saving

Effective
- Non-intrusive testing

AESA, THE GROWLER AND SPOT JAMMING





EARLY OPERATIONAL CAPABILITY IN OIF

- The following were pulled out of development before Operational Evaluation, or pulled out of Operational Evaluation, to provide an Early Operational Capability (EOC) for Operation Iraqi Freedom (OIF).
  - An advanced infrared system provided the Fleet with stand-off targeting and attack, and reconnaissance.
    - Delivered 3 refurbished Engineering Manufacturing Development (EMD) pods
    - Also used in Operational Enduring Freedom and Southern Watch
  - A new reconnaissance pod provided the Fleet reconnaissance capability.
    - Delivered 3 pods, one we delivered directly to ship pier-side in San Diego

EARLY OPERATIONAL CAPABILITY IN OIF, cont'd

- A new digital radio provided digital forward air control for close air support.
  - This was a software installation, hardware already extant
- A new data link system provided network centric warfare capabilities.
  - Low Rate Initial Production systems
  - Used for finding & designation targets, finding tankers, passing section/division data, and general situational awareness.

QUICK FLEET RESPONSE

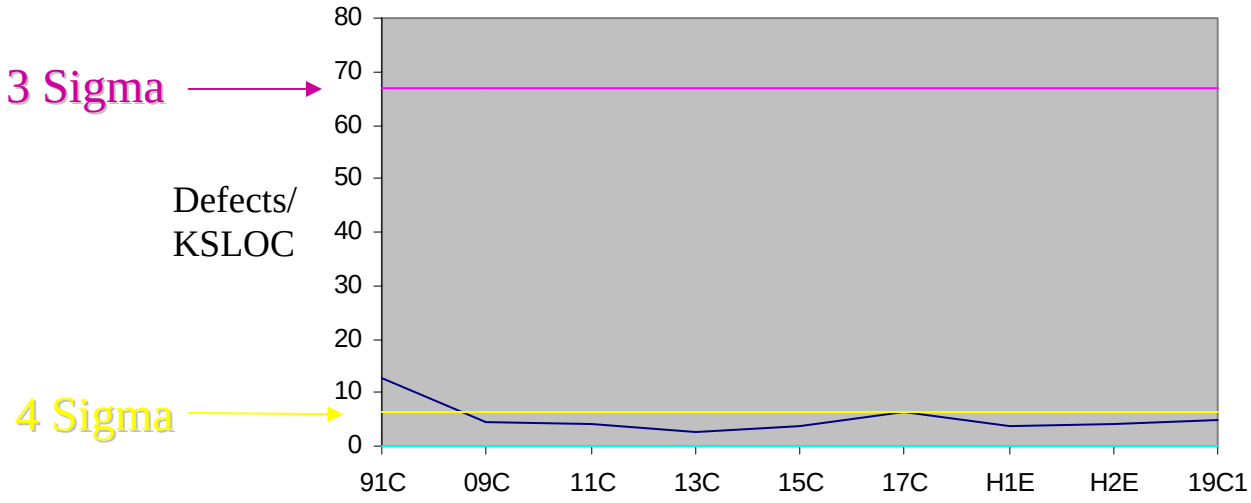
- In Afghanistan, the Fleet needed to simultaneously carry both a weapon to attack caves and a weapon to attack troops in the open
  - We provided a software solution in 20 days
- We supplied testing for the requested deployment of the Rapid Precision Targeting System (RPTS)
- In Kosovo they needed reconnaissance. We pulled a new development system forward and deployed it in less than 4 weeks

TYPICAL DATA PROVIDED AT THE "FLEET BRIEF" W/EACH NEW SCS

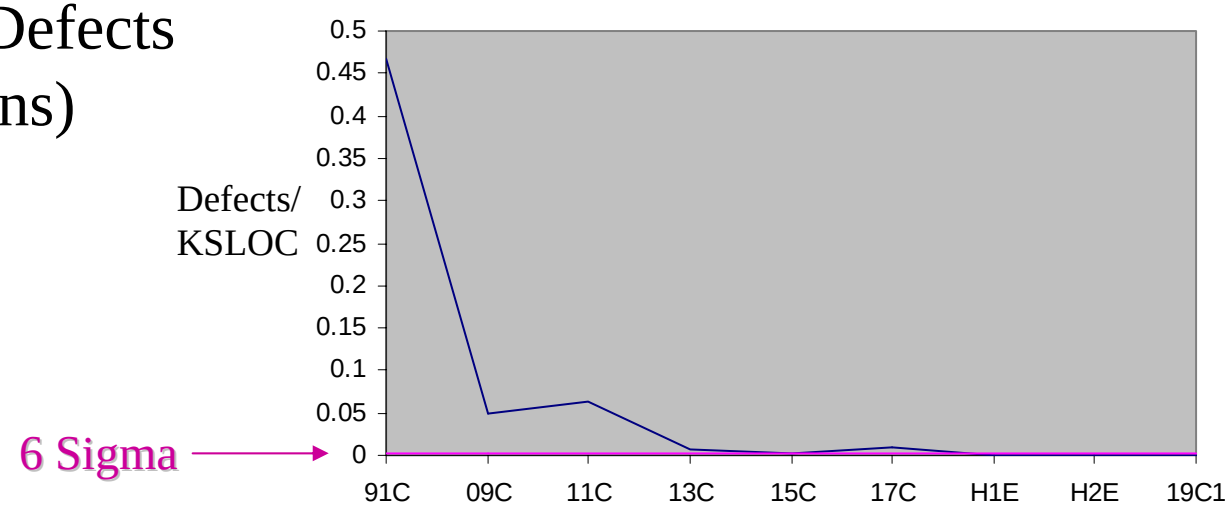
- Aircrew questions:
  - LCDR Allen "Caulk" Blocker
    - DSN 437-4987
    - allen.blocker@navy.mil
    - blockera@chinalake.navy.smil.mil (SIPRNET)
- Maintenance questions:
  - SSgt Kevin Schiermeyer
    - DSN 437-0118
    - kevin.schiermeyer@navy.mil
- Hornet Hotline
  - (760) 939-FA18 (3218)
  - DSN 437-FA18 (3218)
  - NWFA18AWL@NAVAIR.NAVY.MIL
  - Classified.Hornethelp@chinalake.navy.smil.mil (SIPRNET)

6 SIGMA QUALITY

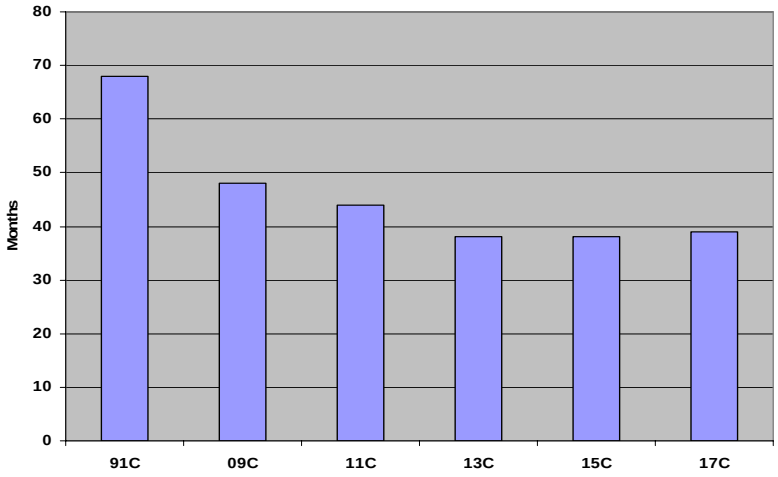
Life Cycle Defects
(all defects)

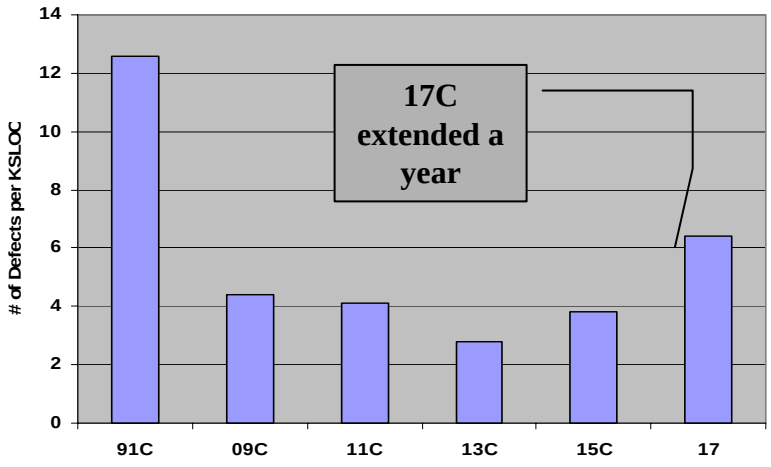


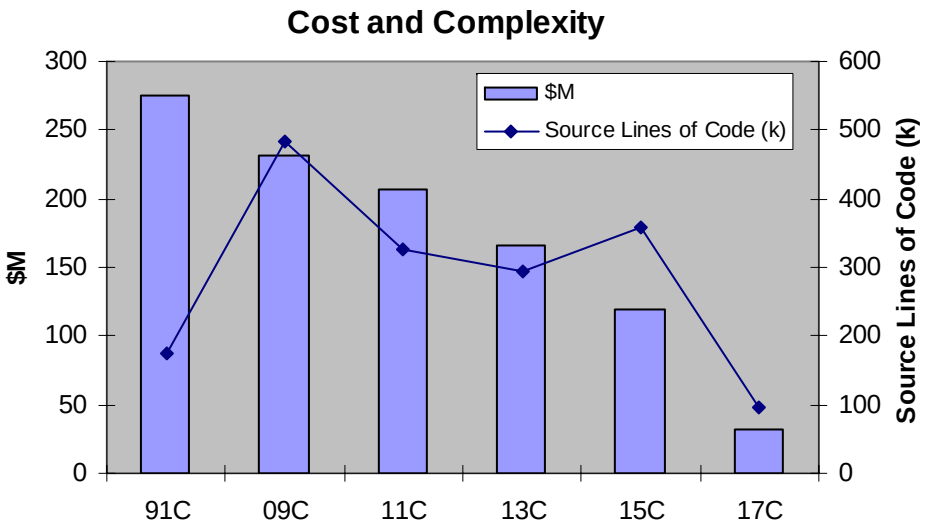
Customer Reported Defects
(that impact operations)

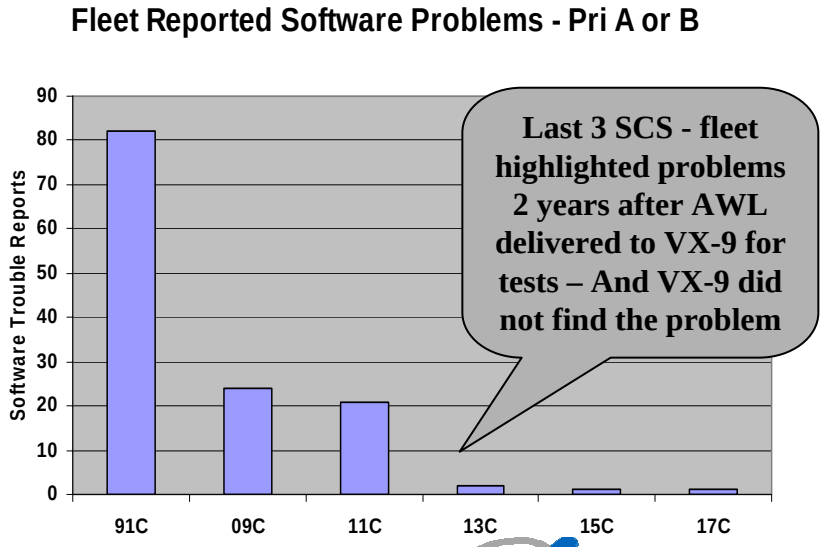


F/A-18C/D HISTORICAL DATA

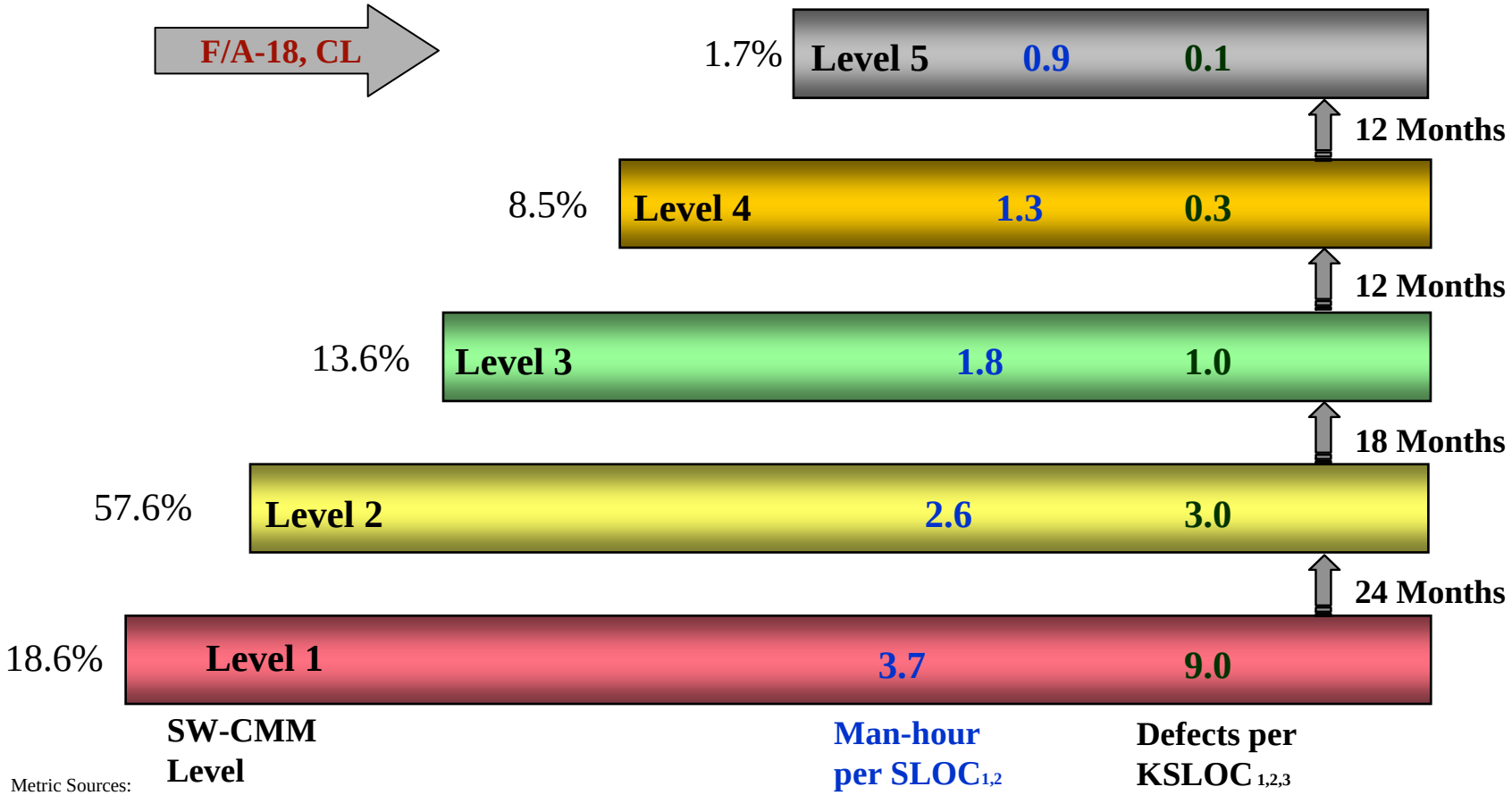








SW-CMM JOURNEY



Metric Sources:

1. 1994 Citibank Analysis
2. Applied Software Measurement, Capers Jones
3. Benchmarking F/A-18 Mission Computer Inspection 2000
4. March 2001 ISD, Inc and Carnegie Mellon University adapted

TWO TIME WINNERS OF *CrossTalk*

(Journal of Defense Software Engineering)

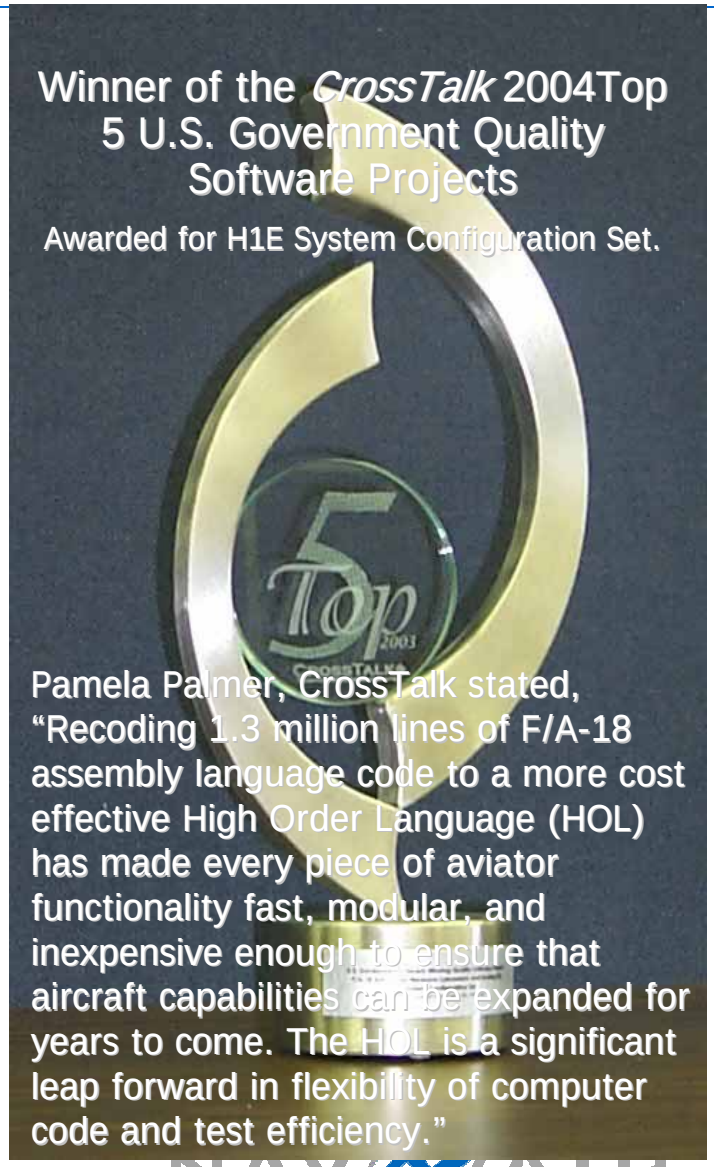
Winner of the *CrossTalk* 2001 Top 5 U.S. Government Quality Software Projects

Awarded for 15C System Configuration Set.

From *CrossTalk* January 2002 "These top five projects were selected from 87 nominations in this first event. They demonstrate how competent software project teams go about building successful products"

"This is a very large, real-time operational system that has made significant improvement in cost, schedule, and quality."

Dr. Jack Ferguson a Top 5 Judge



Winner of the *CrossTalk* 2004Top 5 U.S. Government Quality Software Projects

Awarded for H1E System Configuration Set.

Pamela Palmer, CrossTalk stated, "Recoding 1.3 million lines of F/A-18 assembly language code to a more cost effective High Order Language (HOL) has made every piece of aviator functionality fast, modular, and inexpensive enough to ensure that aircraft capabilities can be expanded for years to come. The HOL is a significant leap forward in flexibility of computer code and test efficiency."

GAO REPORT ON DOD SOFTWARE MANAGEMENT

Defense Acquisitions, March 2004, GAO-04-393:

"Stronger Management Practices Are Needed to Improve DOD's Software-Intensive Weapons Acquisitions".

A GAO study to:

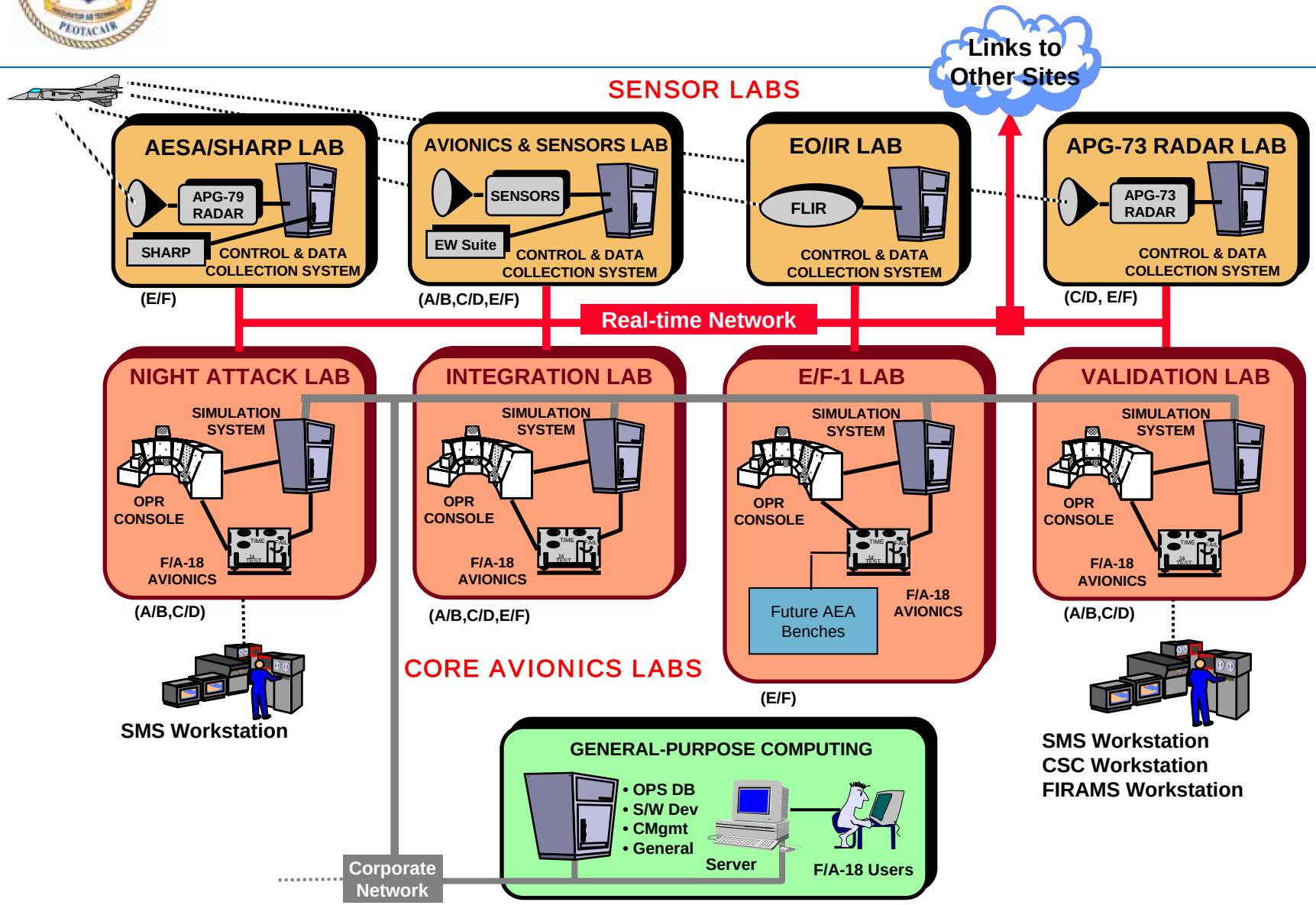
"...identify the practices used by leading companies...analyze the causes of poor outcomes of selected DOD programs...evaluate DOD's efforts to develop programs for improving software acquisition processes and to assess how these efforts compare with leading companies practices."

The study was very favorable to the F/A-18C/D in comparisons with 5 other DOD programs and 5 leading commercial companies:

"...and F/A-18C/D programs were developed in an evolutionary environment, engaged in extensive work on requirements, controlled requirements' changes, collected and used detailed metrics to track development progress...."

"...software for the F/A-18C/D...were very successful in meeting initial cost and schedule estimates. These programs emulated leading software development companies practices..."

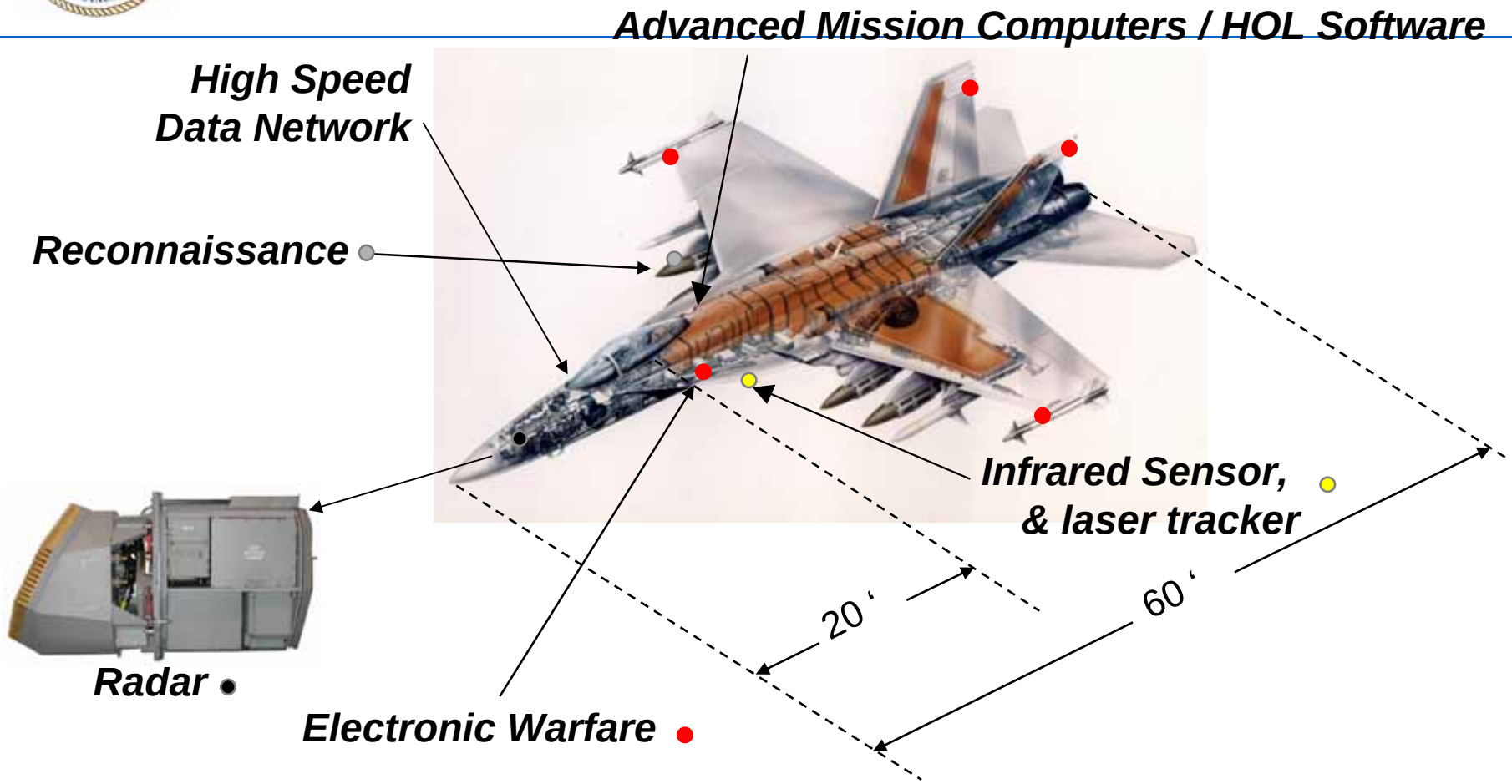
The F/A-18 AWL Labs



Questions?

Back-ups

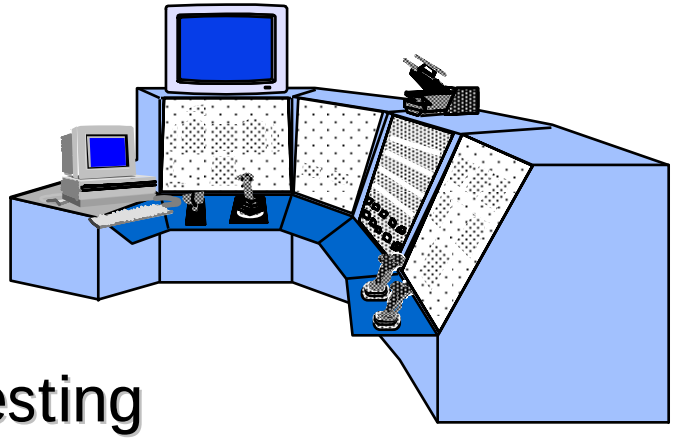
F/A-18 Weapon System Compatibility



Signals travel about 1 foot per nanosecond in wiring. Nanosecond accuracy is required. <u>Therefore length of wiring must accurately replicate aircraft wire lengths</u>, and all systems must be collocated.

F/A-18 AWL LAB FACILITY

Centralized Hardware-in-the-Loop Facility for Weapon System Integration and Test. . . .



- Development Testing
  - Software
  - System/Subsystem Integration
- Safety-of-Flight Testing
- Verification and Validation Testing
- Fleet Support
  - Quick-Response Investigations of Reported PROBLEMS
  - Flight Test AIRCREW Pre-flight Training
- Integration and Test of NEW Technology and Weapons

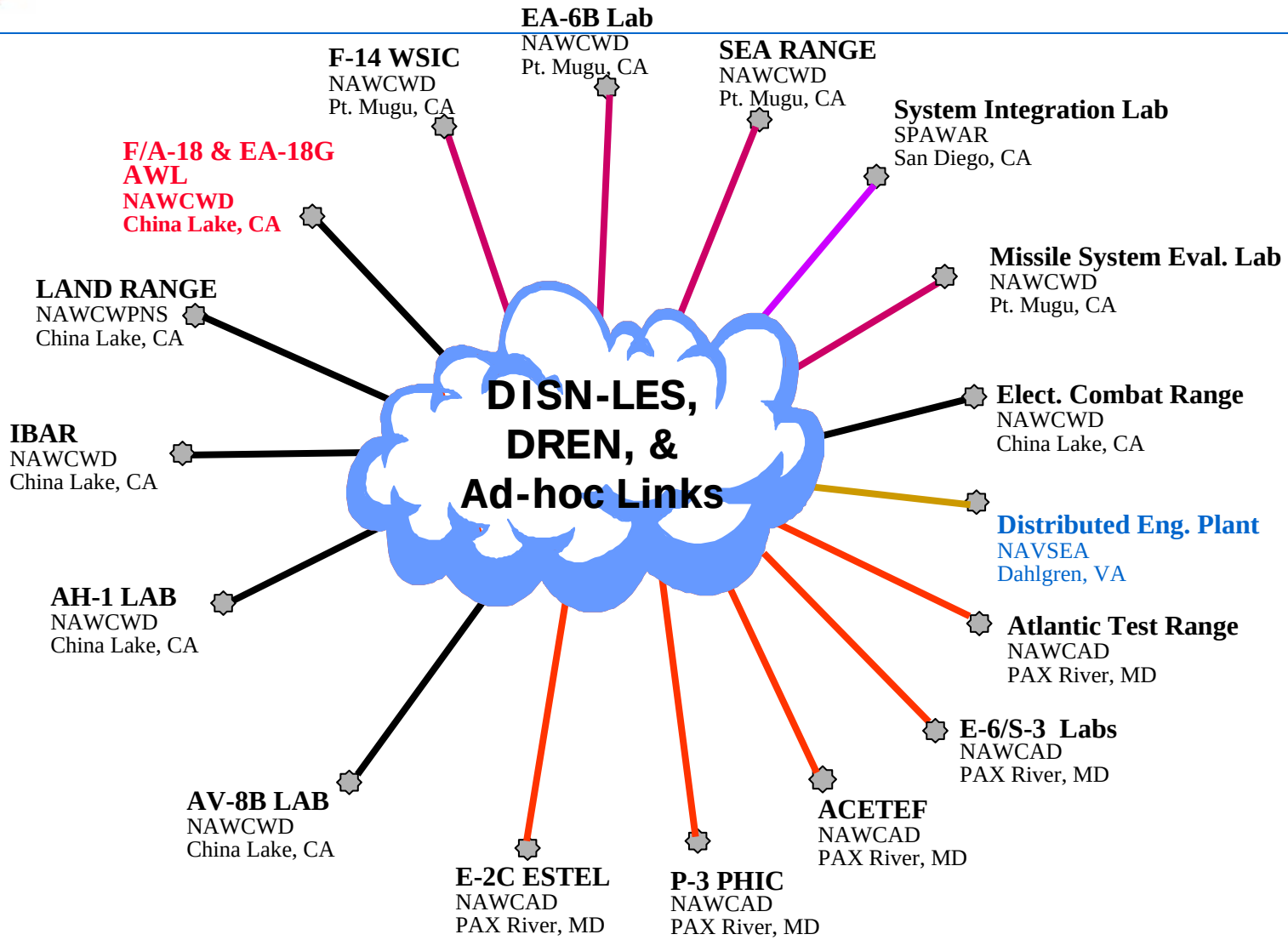
HOW DO WE IMPROVE?

AWL

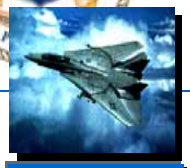
Level	Characteristics	Key Process Areas	Percentages
5 Optimizing	Continuous process capability improvement	Process change management Technology change management Defect prevention	*10.7/6.5/**1.7**
4 Managed	Quantitative measurement of process and qualitative management of product	Software quality management Quantitative process management	8.5/6.2/**8.5**
3 Defined	Software processes defined and institutionalized	Peer reviews Intergroup coordination Software product engineering Integrated software management Training program Organization process definition Organization process focus	27.5/44.0/**13.6**
2 Repeatable	Management controls in place; stable planning and product baselines; still dependent on individuals for new products	Software configuration management Software quality assurance Software subcontract management Software project tracking and oversight Software project planning Requirements management	43.5/36.1/**57.6**
1 Initial			9.7/7.2/**18.6**

•Based on 1543 organizations. * Presented in the following order Commercial/DoD-Federal Contractor/Military-Federal. August 2004 by Carnegie Mellon University adapted

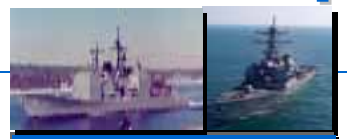
Missionized Test Via Existing Network Centric Dynamic Lab Links



Existing DEP Sites – Battle Force Interoperability Testing

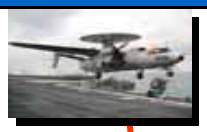


F-14D
NAWCWD
Pt. Mugu



1 CG / 1 DDG
ATRC – Dahlgren, VA

E-2C HE 2000
NAWCAD - PAX River, MD



SIMULATED PLATFORMS

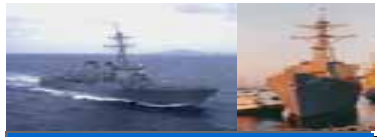
2 CVN	2 LHA
6 DDG	3 CG
3 DD	2 FFG
4 F18	

F14/F18 STRIKE PKG
V-24
SCSC – Wallops Island, VA

DEP OpCenter - DOC
NAVSEA – Dahlgren, VA

Battle Group LINK Monitor
NCTSI - San Diego

F/A-18
NAWCWD
China Lake

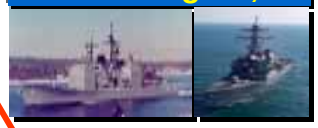


2 CGs
SCSC - Wallops Island

TOC & NOC
San Diego, CA

E-2C GII
SSC - San Diego SIF

1 CG / 1 DDG
ACC – Dahlgren, VA



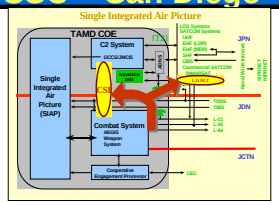
SIMULATED PLATFORMS

2 LHA	4 DDG
3 CG	8 FFG
1 DD	26 F18

10 F14
9 Coalition Forces
DOC
NAVSEA – Dahlgren,VA

3 CV/CVN CLASS
ICSTF - San Diego

GCCS-M / C4ISR
SSC – San Diego



1 LHA / 1 LHD / 1 DD
NAVSEA/ Dam Neck, VA

DEP Can Bridge-in JDEP Sites on Test-by-Test Basis