

The background of the slide is the official seal of the United States Department of Defense. It features a central bald eagle with wings spread, holding an olive branch and arrows. The eagle's chest is covered by a shield with vertical stripes and a blue top section. Above the eagle are thirteen stars. The entire seal is encircled by a blue ring with the text "DEPARTMENT OF DEFENSE" at the top and "UNITED STATES OF AMERICA" at the bottom.

Software-Intensive Systems Producibility Research

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Presentation Overview

- Agenda
 - DoD's needs for producing Software-Intensive Systems
 - F-22, SBIRS High
 - Future Developments
 - Current efforts to address Software-Intensive Systems (SIS) Producibility
 - Envisioned program



DoD's SIS Challenge

“DoD estimates that it spends about 40% of its RDT&E budget on software - \$21B for FY2003” – GAO



F-22



SBIRS-High

“[Software] continues to grow in importance in our weapons systems - and remains a significant contributor to program cost, schedule and performance shortfalls.” -- Pete Aldridge

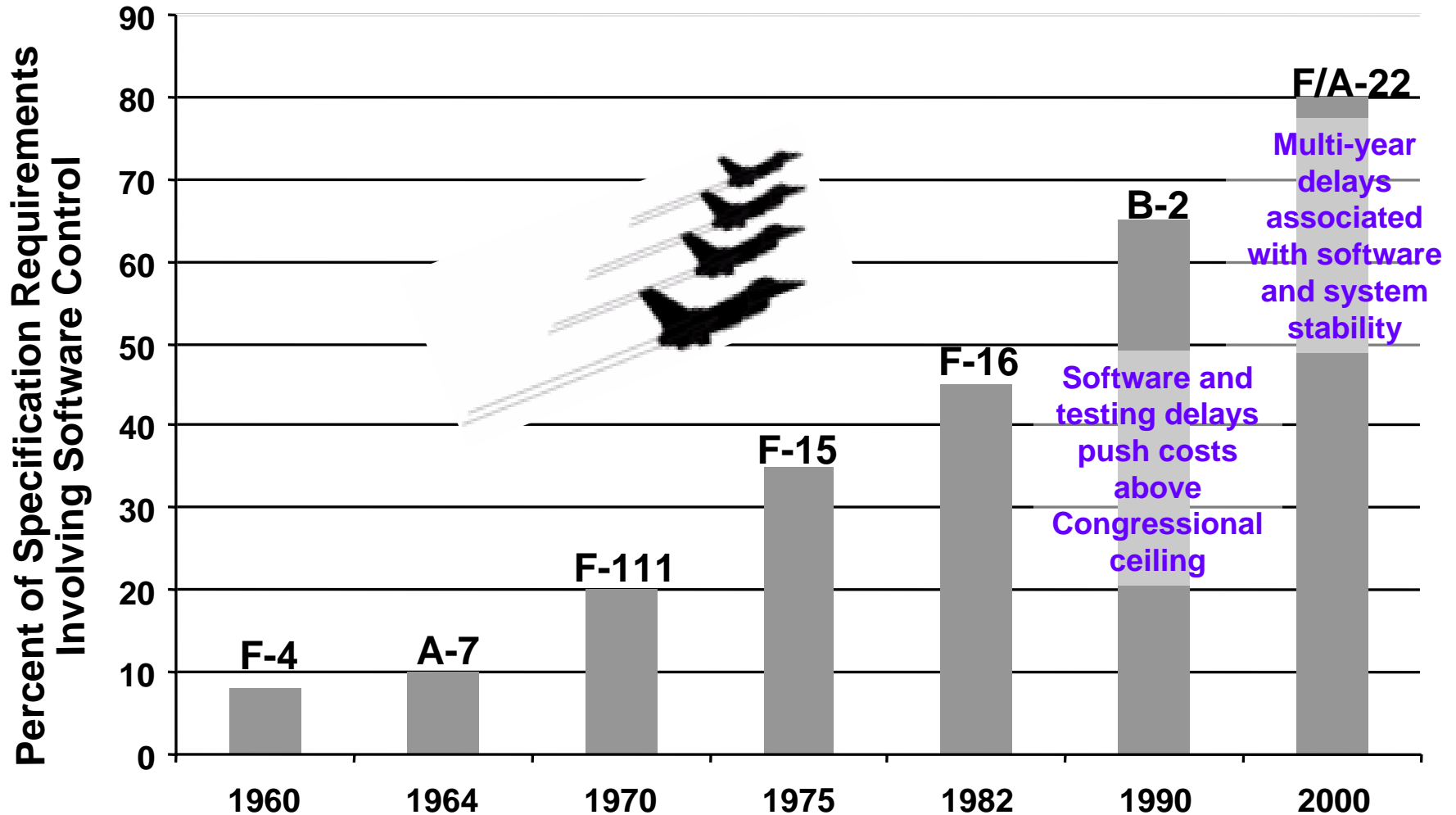


Opportunities for Improvement

- Development tools do not adequately provide system-level awareness
 - Start-up, shut-down, reconfiguration
 - Establish, track, assess system-level properties
 - Reliability, Resource utilization, Deadlines etc.
 - Enforcement of design principles during development
- Development details still dominated by expert involvement and peer reviews



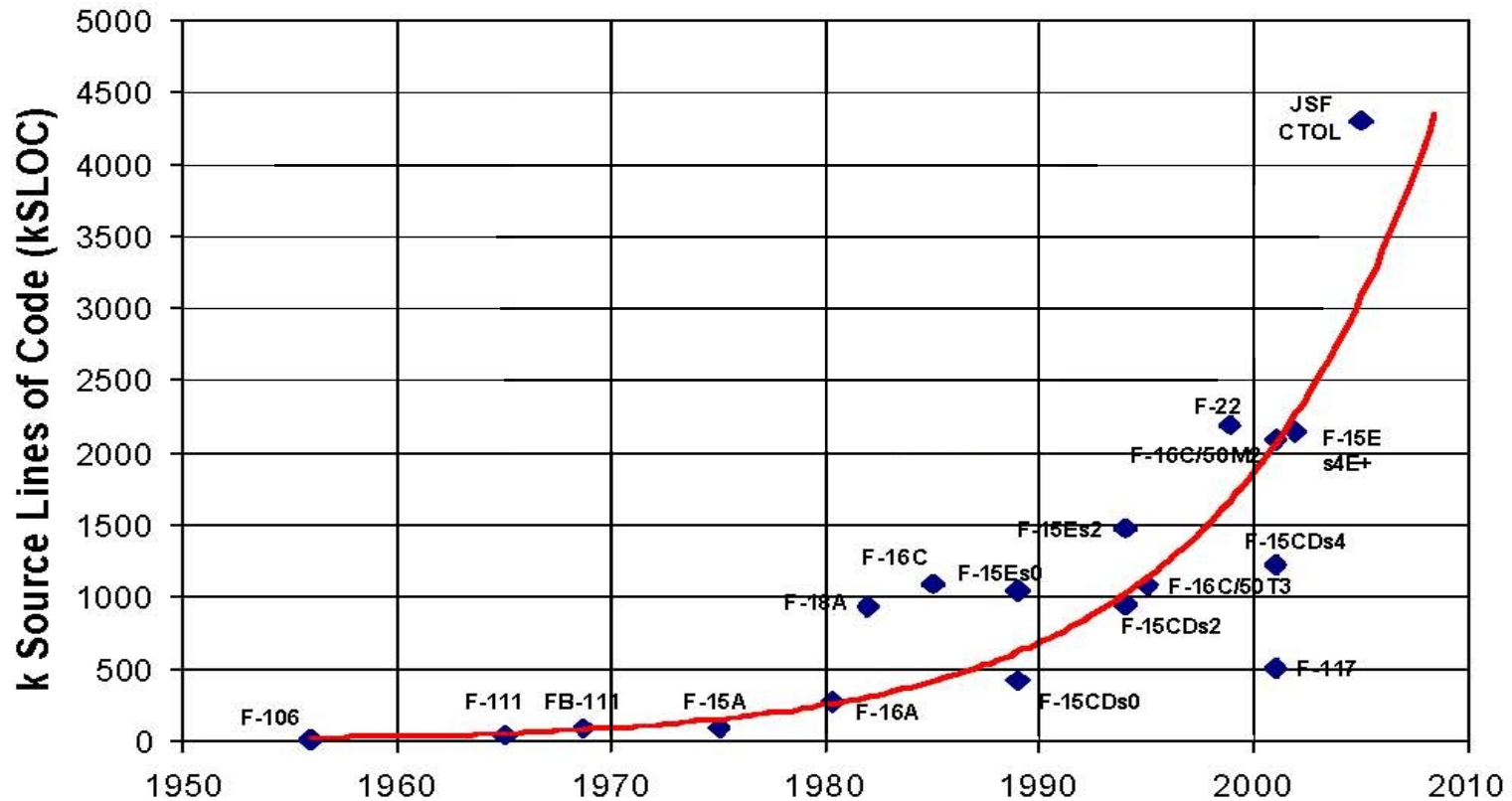
Capability Provided by Software in DoD Systems is Increasing but so are the Challenges...





DoD Software is Growing in Size and Complexity

Total Onboard Computer Capacity (OFP)





Opportunities for Improvement

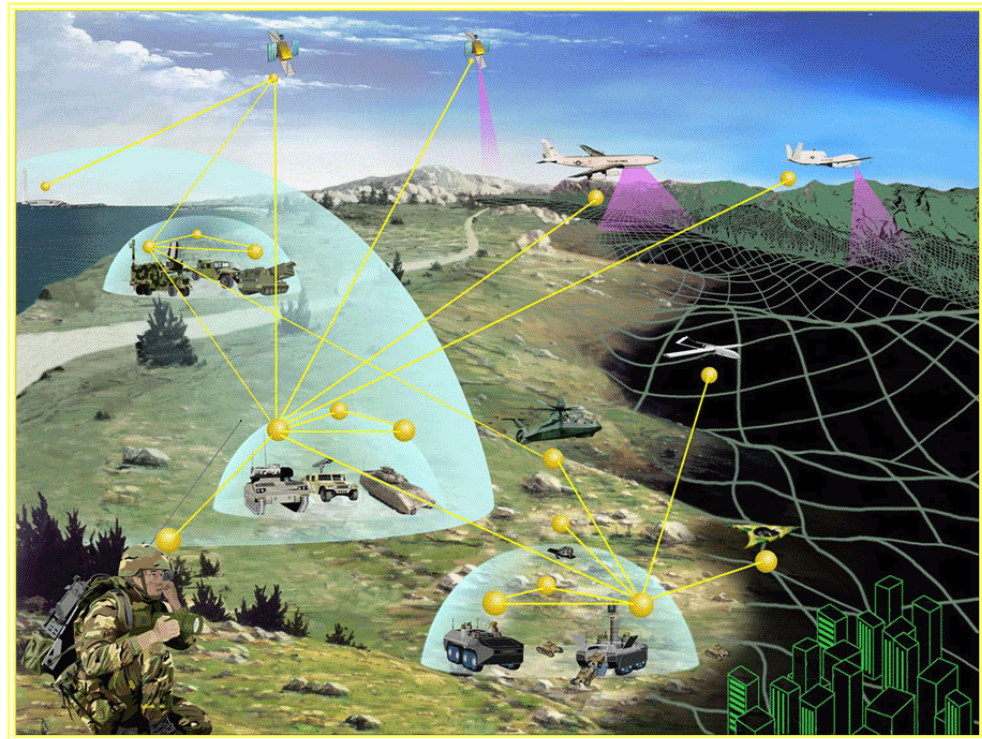
- Software and System development tool suites must:
 - Automate tasks not done consistently well by humans
 - Code generation
 - Enforcement of architectural policies
 - Provide consolidated system-awareness
 - Service, resource and application prioritization
 - Design trade-offs
 - Simplify testing and verification



Army Future Combat System Challenges

“The software task alone is five times larger than that required for Joint Strike Fighter and ten times larger than the F-22, which after two decades is finally meeting its software requirements.”

- **Congressman Curt Weldon, House Armed Services Committee tactical air and land forces subcommittee hearing April 1, 2004 as quoted in Defense News April 12, 2004**



- Emphasis on network dependence
- V&V will be difficult



Opportunities for Improvement

- Development environments for net-reliant embedded systems must:
 - Readily embrace emerging data and knowledge management strategies
 - Automatically facilitate and assess interoperability protocol implementation compatibility
 - Address system-of-systems design
 - Properties-in-the-large, composeability, security
 - Accommodate data and functional uncertainties associated with ad-hoc networks and transient application relationships
- System-of-Systems Verification

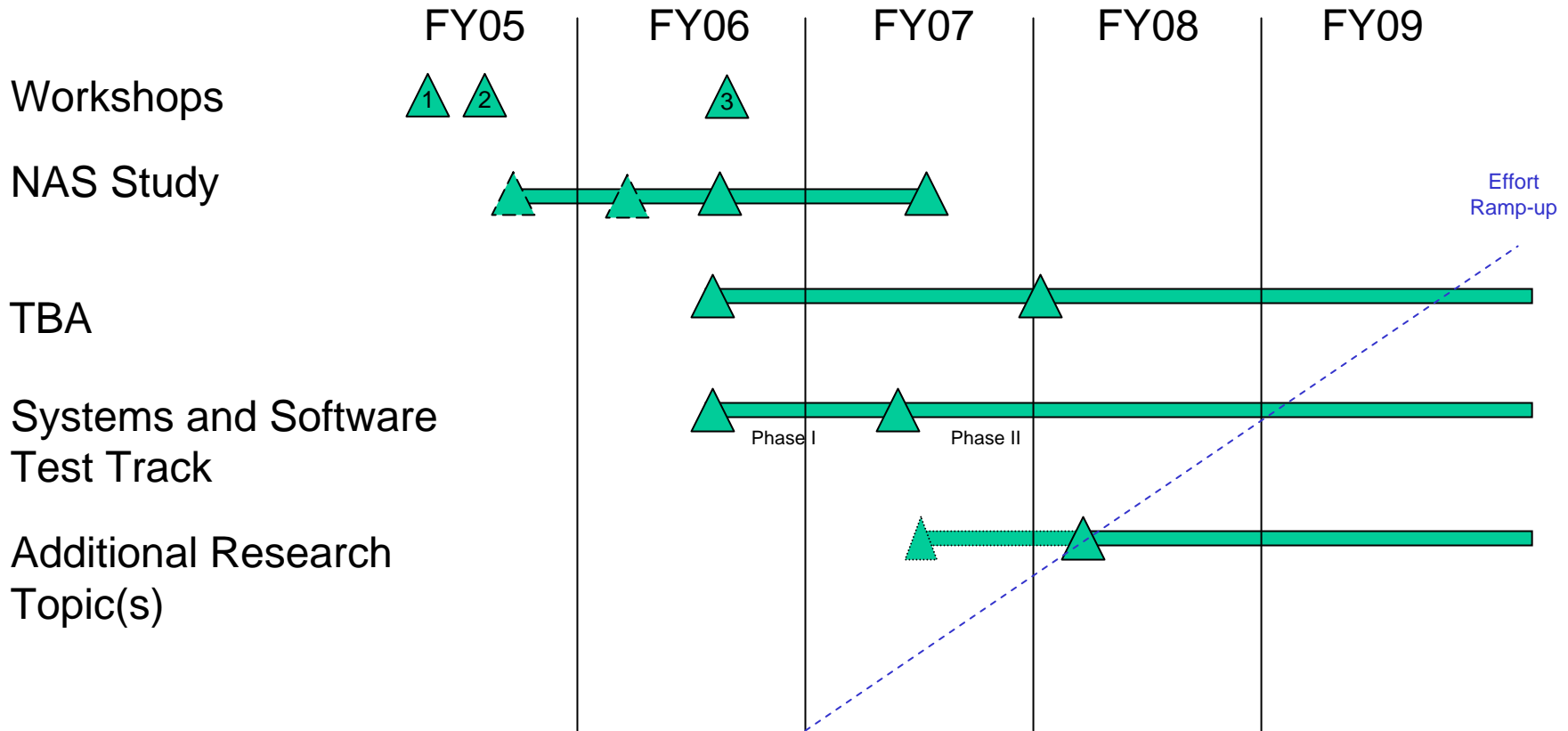


Emerging Interests

- Software Assurance
 - Ensuring applications and infrastructure are free from vulnerabilities and malware
- Open Technology Development
 - Open Source
 - Open Standards



Overview – Existing Program





Workshops

- #1 Establish Overall Research Agenda
 - Held May 17/18 2005 - ZAI, Rosslyn VA
- #2 Establish Research Goals, Infrastructure Requirements
 - Held July 2005 – UC Berkeley
- #3 Industry – Transition & Motivation
 - Scheduled for May 17-19 2006
 - ZAI Rosslyn VA
 - Include Gov/Industry Exec Session May 19





National Academies Study

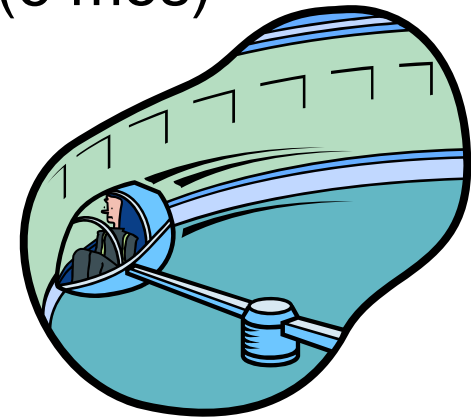
- FY05-07 (2 year effort),
 - Independent expert committee (15), Workshops, Interim & Final reports
- Assess
 - Progress in tech base
 - R&D organization
 - Tech transition
 - Long-term SIS maintenance and evolution
- Recommend National-scale SIS S&T investments
 - Collaborate with other Federal investments





Systems and Software Test Track

- Purpose
 - Bring researchers together with developers and development artifacts to ‘test drive’ emerging technologies and techniques
- Activities
 - FY06 – Phase 1 Planning and Definition (6 mos)
 - Scope, funding estimate, programmatic
 - FY07 – Implementation
 - Establish facility
 - Begin populating with developer products,
 - FY08 –
 - Full operations
 - Allow researchers to apply innovative tools, technologies and techniques





Other On-going Activities

- STTR topics
 - Error Handling paths and policies analysis
 - Security Escorts for Not-Yet-Trusted software
 - Software System Reliability Analysis
 - Assessing Interoperability Through Cross-Domain Protocol Compatibility Analysis
- HPEC-SI
 - Signal processing library
- SBIR Topics
 - Design Visualization
 - Malicious Code Diffuser
 - Robust Complex Systems
 - Software Test Engineering: Analysis of Trace Semantics
 - A Software Hub for High Assurance Model-Driven Development and Analysis
 - Software Verification
- Open Technology Development
 - Blend of open source and open systems approaches



What We Need . . .

- A 7 year, \$20-32M per year investment in software-intensive systems development technologies
 - Research
 - Testing
 - Transition



Return on Investment (ROI)

Combined Improvement ROI

	10% Improvement in Productivity	20% Improvement in Productivity	50% Improvement in Productivity
10% Reduction in Rework	7:1	11:1	21:1
20% Reduction in Rework	9:1	14:1	24:1
50% Reduction in Rework	16:1	20:1	30:1

- Assumptions
 - New effort, 7 year investment
 - Calculated for 10 future acquisition programs
 - Based on estimated industry productivity¹ and rework for DoD systems²

1 – DACS Software Tech News Volume 7, Number 2 Article “Industry Software Cost, Quality and Productivity Benchmarks” by Donald Reifer, June 2004

2 – GAO report 04393, title “Stronger Management Practices Are Needed to Improve DOD’s Software-Intensive Weapon Acquisitions”, dated March 2004



DoD Software S&T

- Current State of Play:
 - Research investments tailing off
 - Government expertise-base has atrophied
 - Software tools and techniques sometimes developed by acquisition programs themselves
 - CMU Software Engineering Institute focused on SWE process and transition, not advancing technology base
- Missed Opportunities: No DoD-wide approach to
 - Working with acquisition programs to address common SW technology issues
 - Developing standards (e.g., CORBA, UML)
 - Engaging 3rd-party software vendors (e.g., Rational (IBM), Mathworks, Green Hills Software)



What about Industry?

- Industry investments are usually inappropriate for DoD problems
 - Research is targeted for specific products, not general long-term improvements
 - Focused on selling software products – quality and reliability are lower priorities
 - Global resourcing for research and development limits applicability to DoD
- For Defense contractors -
 - Software may not be a direct profit driver
 - Software technologies difficult to retain as company IP



Envisioned Program Overview

- **Description:**
 - Reinvigorate SIS development research and provide dedicated efforts to demonstrate and transition improvements to acquisition programs
 - Enable DoD engineers and industry partners to develop and acquire SIS with reasonable and repeatable cost, schedule and performance
- **Benefit:** What is the benefit to the Department?
 - Increase efficiency, reduce cost and schedule overruns, and reduce critical failures associated with software for warfighting and management
 - Successful development of software that meets our growing expectations in software program size and complexity
- **Major Elements:**
 - Research - Technologies, Tools and Techniques
 - Systems and Software Test Track
 - Transition



Previous DoD S&T Investments Have Had a Major Impact

Examples:

- Real-Time Computing: an Efficient Principled Approach to Process Task Coordination and Schedulability
- MoBIES: Model-Based Integration of Embedded Software for Design and Testing
- Quorum: Quality-of-Service Middleware for Robust, Portable Mission-Critical Applications capable of Adapting to the Dynamic, Uncertain Conditions of Network-Centric Warfare



Call for Action

- DoD needs to reinvigorate its investments in software and systems development technologies
 - Increased dependence on software
 - Common problem for acquisition programs
- This Cross-Component issue necessitates a jointly coordinated effort
 - We welcome cooperation with Industry, Academia and other Federal agencies