The Policies and Economics of Software Sustainment: DoD's Software Sustainment Ecosystem

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Outline:

- Motivation
- Study overview and observations
- Key take-aways

Software Is a Foundational Technology… It Is Everywhere

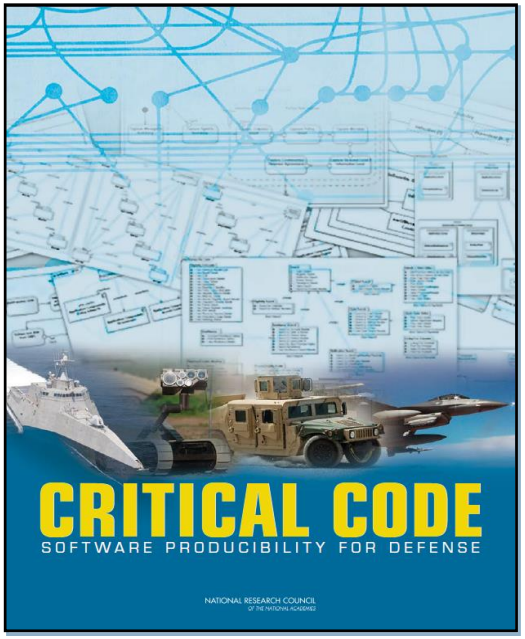
The foundational construction material for the engineering of systems

- We depend on software for nearly aspect of our lives
- Low production cost
- Can be distributed worldwide in seconds
- Does not wear out…not about the physics of failure
- **It is not about mx, it is about continuous engineering of the SW product baseline to deliver > performance and function**

It is the most economical way to implement almost any complex function or control.

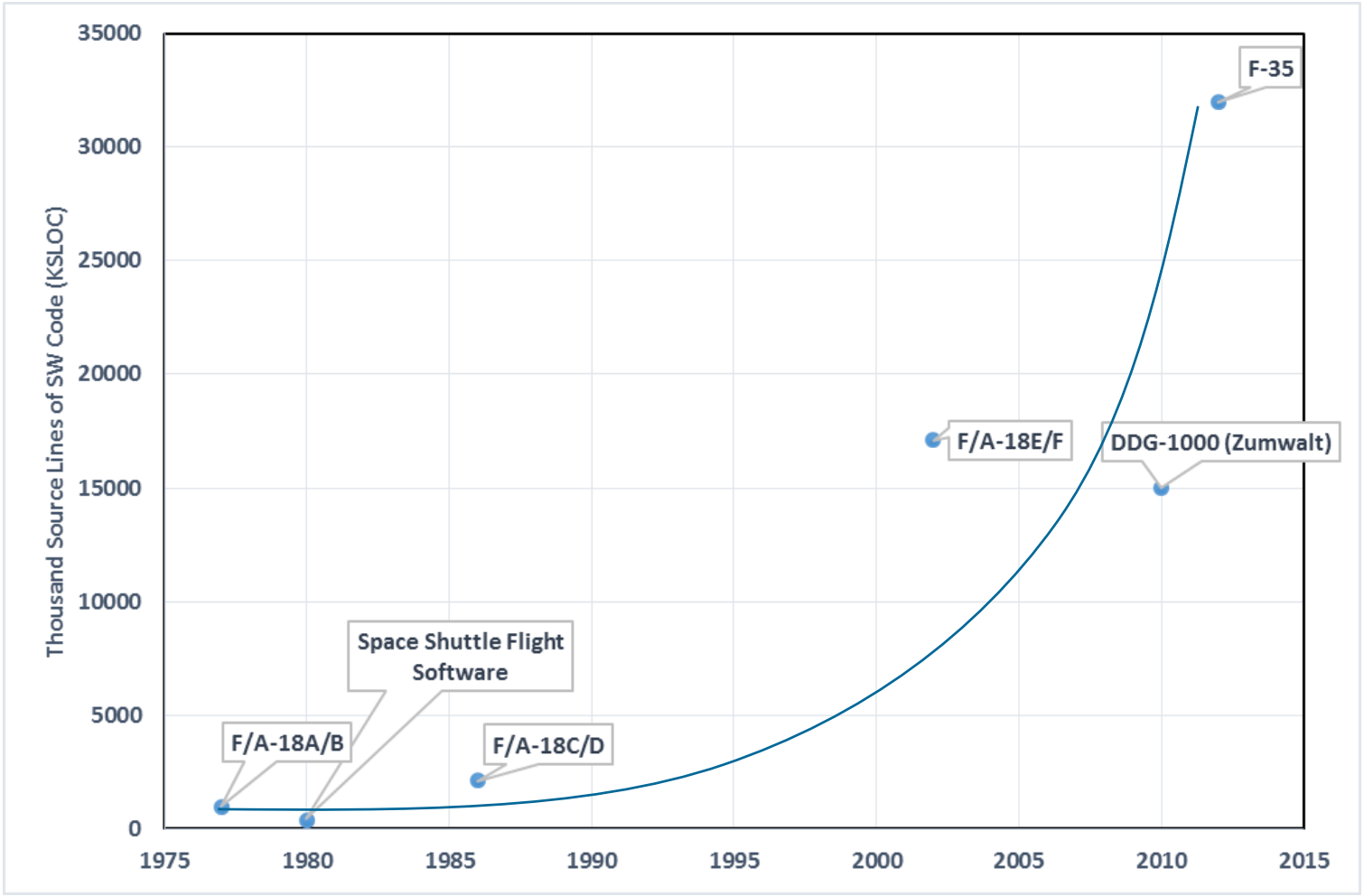
Software and DoD

- Warfighter capability embodied in **software…**a unique source of strategic, military advantage
- DoD's ability to *produce and evolve* **software a**t core of achieving and sustaining mission superiority, agility, more timely and better decisions
- **Software…**essential to vast range of military system capabilities, operations…deepening and broadening role [NRC Critical Code, 2010]
- Many aspects of **cyber security (defensive and offensive)** closely linked with software capability
- Creates imperatives for leading and managing software-intensive systems



DoD's Reliance on Software: No Plateau in Sight

The software in DoD's systems continues to grow in size and complexity – Enabling almost 100% of capability and increasing cost



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Study Background

Research goal: *Characterize* the factors that affect the effectiveness and cost of **software sustainment** in the DoD.

- Identify and describe the major factors that DoD organizations must manage, in order to impact software sustainment performance.

Multiple streams of data and experience

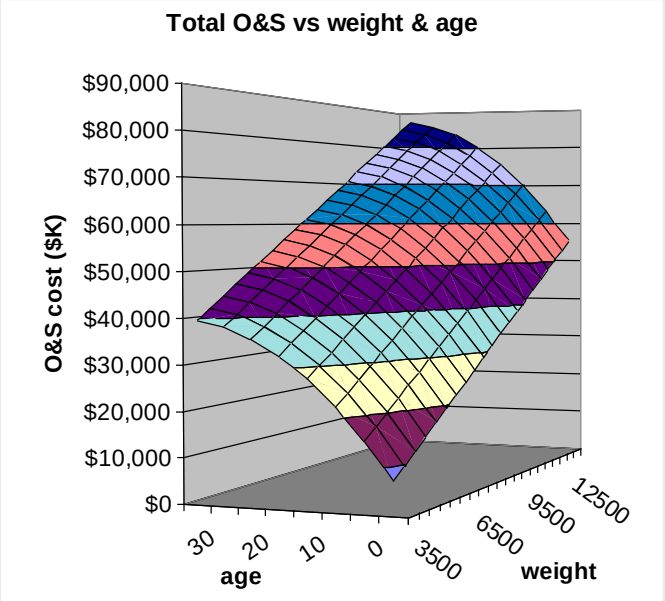
- Interviews across OSD and the Services
- Literature search; prior studies by Defense Science Board, National Academy of Sciences
- Prior experience supporting DoD sustainment programs

Sustainment – An Evolving Perspective

- Typically, defined as O&M, modernization (upgrades) of capability…
- Ensure safety, availability, and effectiveness of aging aircraft/systems
- Identify technology needs and approaches
  - Extend service life; ease mx burden
  - Facilitate future adaptations and performance enhancements
- Shift to SW digital systems functionality was “game changer”
  - Large increase in SW size/complexity
  - Software-enabled capabilities replacing HW
  - Software use/complexity, rapid technology refresh growing faster than DoD’s ability to address it across the lifecycle

Software Sustainment Cost Drivers Not Like HW

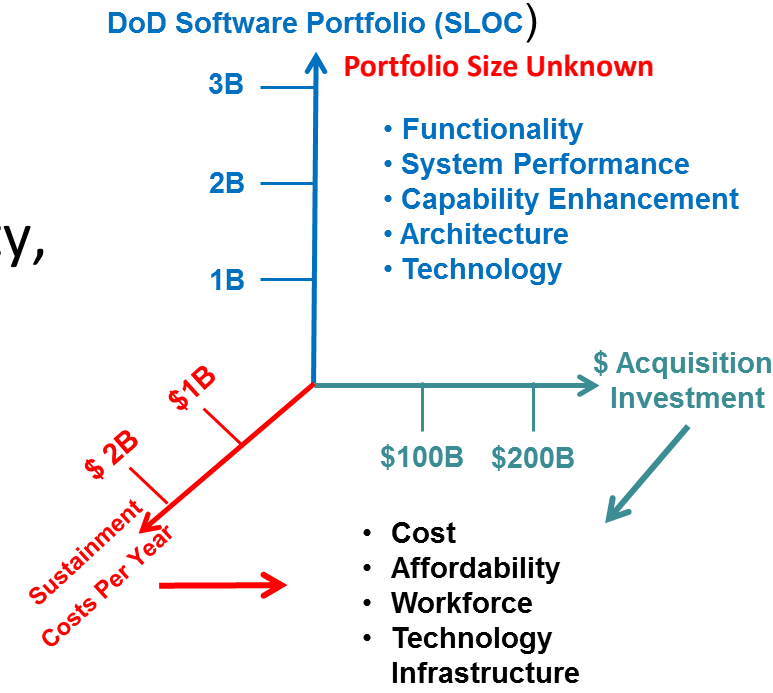
- Hardware cost: Driven by physical factors (aging, weight, operating hours/cycles, etc) creating failure…
- Software sustainment does not scale, driven by
  - Increasing functionality to meet new war warfighter performance needs
  - Fact-of-life changes to remain operational in the changing "netted" space
  - Technical demands of being in "all about data & information environment"
  - Resolving "technical debt" carryover from acquisition
  - Multiple configurations
  - New systems; future configurations
  - Fixed-cost SW engineering & technology-based SIL infrastructure



Most critically: The way that software is utilized in DoD systems means that **Software is never "done":** *Continuous engineering* not maintenance

Software Sustainment – Key Challenges

- *Our paradigms about sustainment formed from decades of HW experience that do not translate to SW*
- Results:
  - Increasing, unrecognized bow wave of demands (composition, complexity, characteristics,* tech debt**
  - Complex technical infrastructure*** needing constant refresh , $; opportunities to achieve > value
  - Unaffordable O&S trends
- **Enterprise challenge requires an enterprise strategy**



* Software demographics (size, language, architecture, etc.
** Technical debt - a metaphor referring to the eventual consequences of inadequate architecture and software development
*** Workforce, knowledge, practice, tools, systems integration lab/test environment

DoD's SW* to Sustain is Large… But There is Limited Enterprise Visibility of the Inventory**

*Includes COTS, GOTS, and Custom Code

* *This is a notional topology; there is no DoD inventory of SW and on-going analysis of its demographics to inform decisions

Strategic Trends Impacting SW Sustainment

- The future is software-centric
- Advanced DoD capabilities manifested in algorithms/software
  - Autonomy, machine learning, collaborative systems, competitive networking, system resiliency, IoT, hybrid cloud computing, human computer interaction, digital security, analytics for decision making…
  - Anticipating/adapting to new dynamic threats & rqmts
- Warfighter needs coupled with technology innovation dynamics drives need for strategic enterprise focus on evolving a DoD enterprise SW strategy to be aligned with this changing environment
  - Policies
  - Current and future infrastructure capabilities
  - Investment strategies

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Software Sustainment - Definition

Software sustainment:

Orchestrating the processes, practices, technical resources, information, and workforce competencies for systems and software engineering…

….to enable systems to continue mission operations and also to be enhanced to meet evolving threat and capability needs.

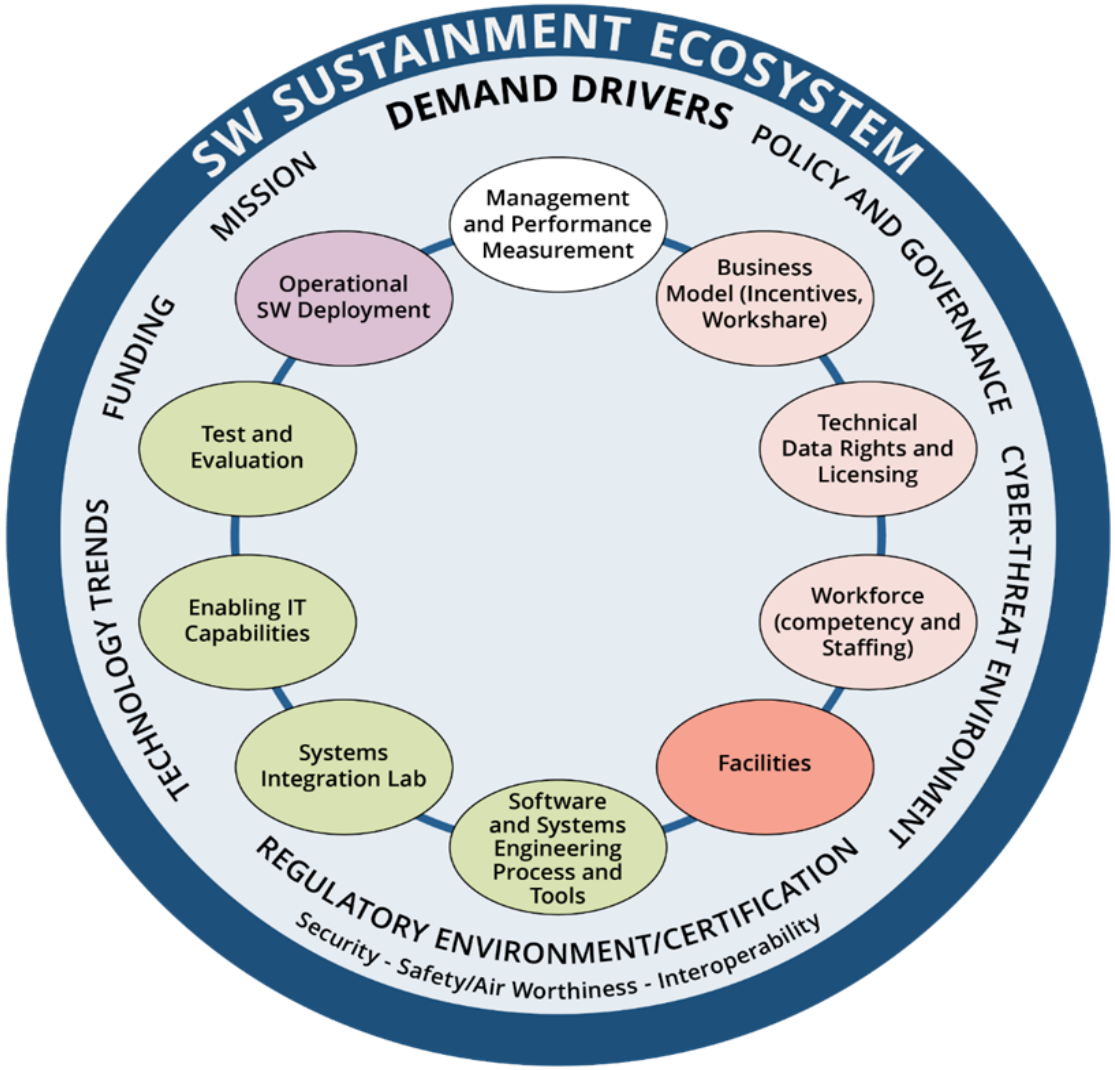
Enterprise Challenges

DoD SW sustainment centers create significant value…challenges relate to achieving > productivity and capability across DoD to address affordability, bow wave of demands, and infrastructure modernization in a dynamic technology environment.

- DoD continues to focus on HW aging and depot infrastructure for better alignment to achieve > productivity, but for SW…..
  - Large SW engineering and technology infrastructure not well understood
  - Need for consistent approach to measure enterprise performance
  - Continued investment to keep pace with technology
- ***Limited information to enable DoD visibility/management of SW as an enterprise asset to inform corporate decisions***
  - ***PEO/PM centric model inhibits corporate enterprise perspective***
  - ***SW inventory/demographics and on-going analysis not evident***
  - ***Need to link SW sustainment cost/$ to delivered capability***

Ecosystem Overview

- Four **infrastructure** elements: Basic, fundamental resources necessary for the sustainment activities
- Three **knowledge and expertise** elements: Skill sets, the government organic workforce, access to necessary technical information needed to deliver and deploy the capabilities for the warfighter
- Three ungrouped elements:
  - Facilities
  - Operational SW Deployment
  - Mgmt / Performance Measurement



Take Aways

- Continual transformation due to the pace of technology innovations *enabled by software…* continually enhance warfighter capability for new/legacy systems
- For DoD, no steady state…no service life… ***software is never done.***
- Critical to focus on HW to assure safety, availability, effectiveness of systems for warfighter, but also software
- Need to develop enterprise visibility, leadership, management of software across the life cycle

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Backups

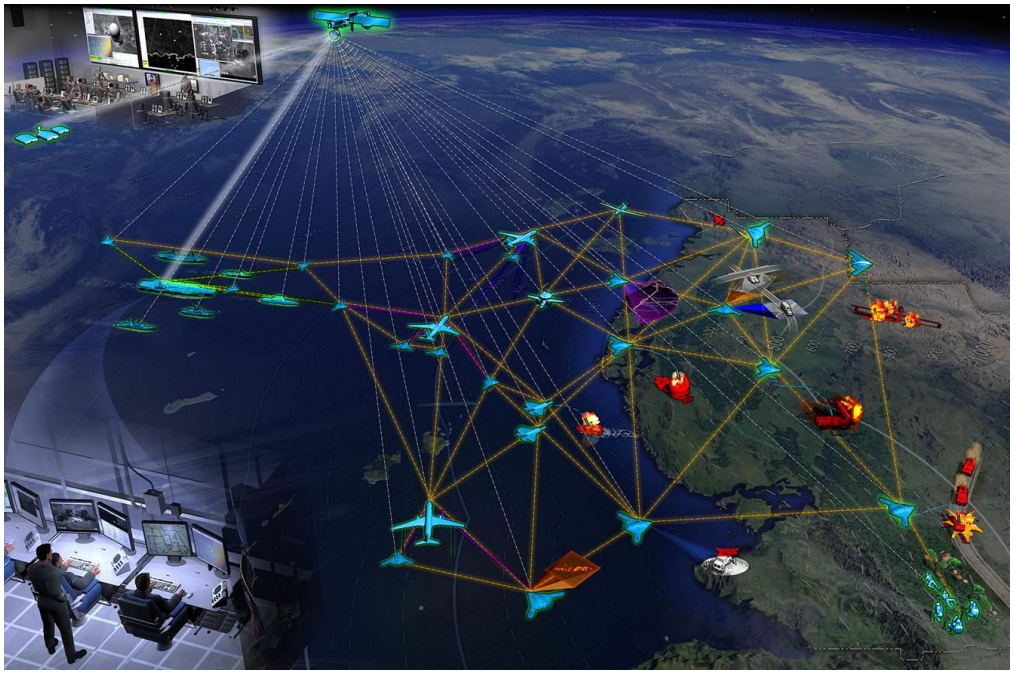
Software Sustainment Headlines

SW Sustainment as "Continuous Engineering," Different from HW Sustainment

Nature of SW Continuous Engineering	Nature of HW Mx - Repair
• Unbounded by laws of physics; no plateau	• Design conforms to laws of physics; limits
• Material of 1's and O's	• Metals, composites, etc.
• Conformity to exacting specs	• Specified tolerances for manufacture/repair
• More complex for size; large # unique interacting parts; encapsulates functions	• Piece parts manufactured and assembled to specifications and tolerances
• Failures difficult to predict/mostly eliminated in dev/test	• Life limited/wear/tear/known/predicted patterns of failure
• Demand/$ insensitive to OPTEMPO/force structure/inventory/mostly enhancements	• Demand/$ driven by OPTEMPO/force structure/inventory/repair of failures
• Any "fixes/enhancements" can create more bugs/new configuration	• Repair fixes root cause/does not change configuration/serviceable unit goes on "shelf"
• Unique application of software engineering	• Repeatable repair processes
• SW change/improvement applies to entire force structure inventory/no supply system inventory	• HW mx about restoring use of individual inventory items returned to supply system
• Engineering based workforce	• Non-engineering based workforce

Software Challenges for Leadership

- Acquire & **sustain** software-driven systems operating interdependently with high assurance in a complex net-centric, cyber environment to continuously achieve mission success over the life cycle
  - Affordably with velocity
  - Spectrum of systems (Bus IT… C4ISR…Platforms…nodes in a larger scale SoS ecosystem
  - All systems are SW or controlled by SW



- Create technical & program mgmt *infrastructure capabilities* to acquire and continually engineer systems for warfighter competitiveness
- Plan & execute in a dynamic *policy*, governance, advancing technology, & $$$ constrained environment for life cycle program success