Improving Software Maintenance & Sustainment Cost Estimation in Practice

Practical Software and Systems Measurement
User's Group Workshop
11 September 2018

Introduction

- **Facilitators**

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- **Participants**
- **Background - Perspectives**
- **Ground Rules**
- **Agenda**

Workshop Parameters

Premise

Better cost estimates will drive more efficient operational software resource allocations across the defined enterprise(s), eventually resulting in more effective mission performance

Objective

Brainstorming to identify practical approaches on how to make software sustainment and maintenance cost estimation as important as software acquisition cost estimation

Projected Outcome

Recommendations/idea for improving software sustainment and maintenance cost estimation policy and practice today and into the future

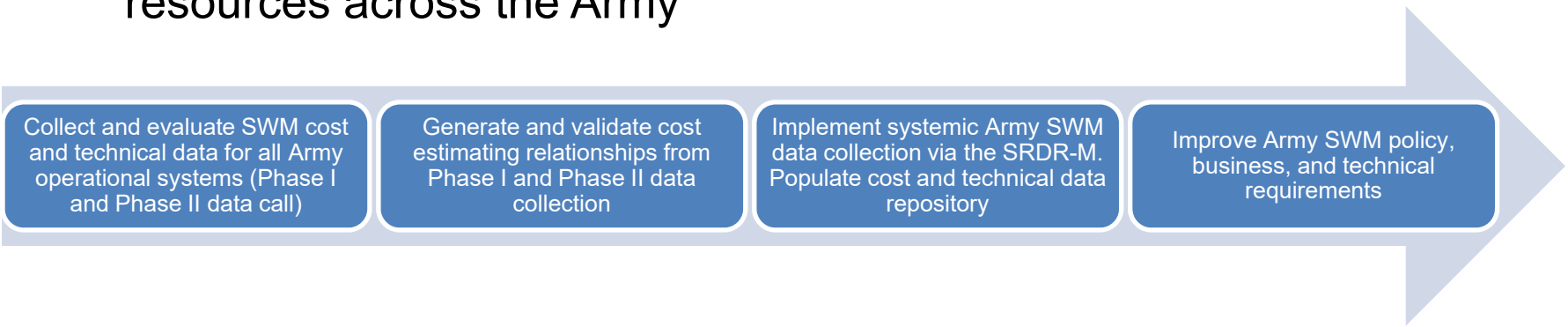
Agenda Topics

- SWS Cost Estimation Objectives
  - What Has Been Accomplished?
  - What is Coming?
- Why the Need for Cost Estimation Equality?
- What Needs to be Changed?
- Obstacles to Consider?
- Ideas on How to Gain Cost Estimation Equality?

SWS Objective and Strategy

Accurately estimate Army system software maintenance costs to:

- Effectively project and justify software and system life cycle costs
- Objectively evaluate Army system software maintenance execution costs
- Inform and optimize the allocation of available maintenance resources across the Army



Effective software maintenance cost estimation is the basis for Army system software life cycle cost management

Army Software Maintenance Definition

Software maintenance is defined as:

- Software maintenance includes all software change activities and products associated with modifying a software system after EMD has completed and a software release has been provided to an external party
- The release is the primary SWM change product - a composite of one or more changes - it can be either a formal release or an engineering release
- SWM includes software enhancements and software corrections/adaptations
- SWM includes activities and change products funded by multiple funding sources
- Fixed and Variable costs accrued at both the system and organizational levels by both organic and contractor resources
- Software maintenance and software sustainment are considered to be synonymous

Army Software Maintenance WBS

Software Maintenance

System Specific

1.0 Software Change Product

- Change Requirements
- Change Development
- B/L Integration & Test
- IV&V

System Specific

2.0 Project Management

- Planning
- Execution Management
- Configuration Management
- Resource & Team Management
- Contracting Management
- Measurement - Reporting

System/Non-System Specific

3.0 Software Licenses

- License Management
- License - Right to Use
- License - Maintenance
  - COTS
  - NDI
  - Other

System Specific

4.0 Certification & Accreditation

- Security
- Safety
- Networthiness
- Airworthiness

System/Non-System Specific

5.0 System Facilities

- Hardware
  - Software Development Assets/Workstations
  - System Integration & Test Facilities
  - Test Equipment - Tools
- Facility Operations

System Specific

6.0 Sustaining Engineering

- Engineering Support
  - Test Support
  - Software Delivery
  - Technical Studies
- User Support
  - Help Desk
  - Training

System Specific

7.0 Field Software Eng.

- On-Site Technical Assistance
- Problem Troubleshooting
- S/W Installation
- Operational Assistance
- On-Site Training

Non-System Specific

8.0 Operational Management

- Operations
- Organization Management
- Personnel Management
- Financial Management
- Information Management
- Process Management
- Change Management

Version 4.4d

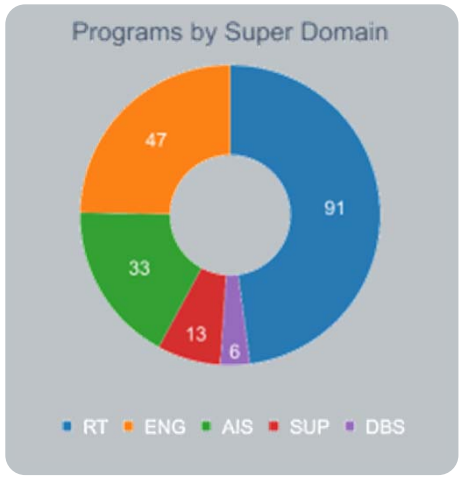
What Has Been Accomplished?

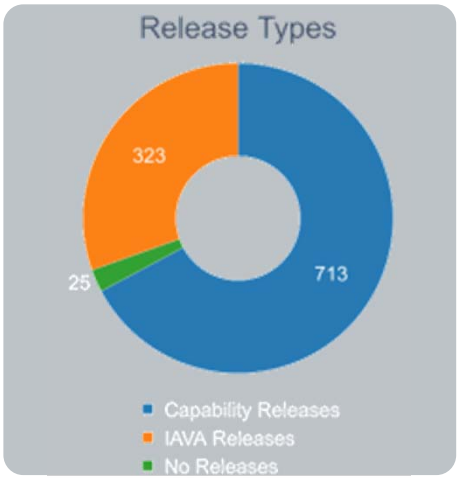
193 Programs of Record

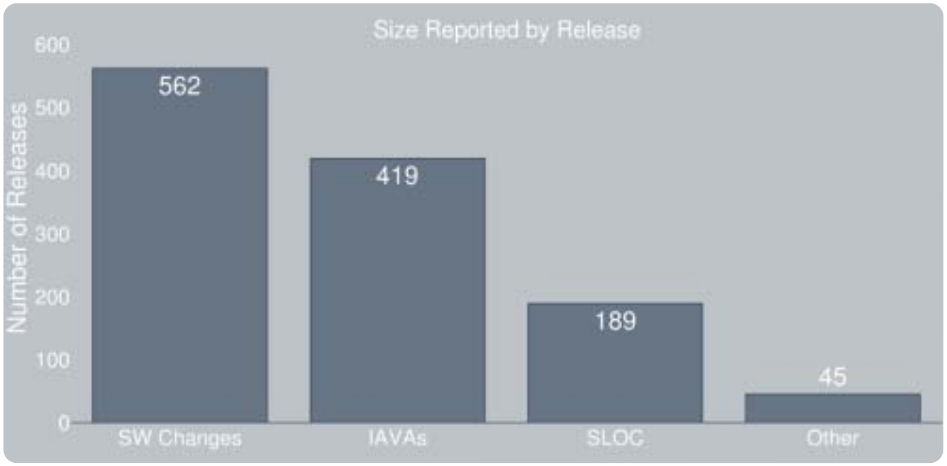
1,036 Total Releases

3,434 Licenses

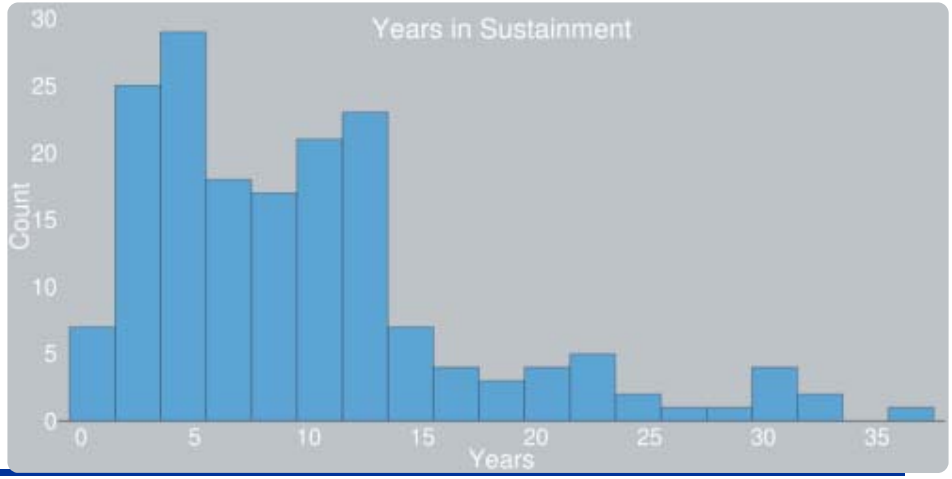
411K Data Fields



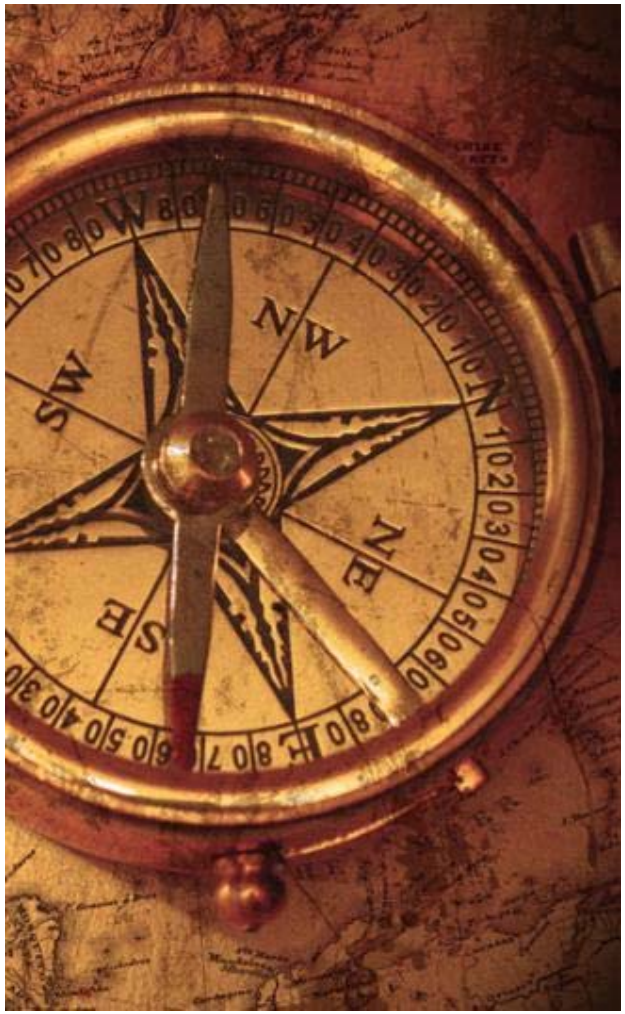




- Largest DoD Software Sustainment database
- Total Dollar Value Captured: $3.1B
- Programs collected ranged from ACAT I to Non-Program of Records



Near Term Improvements



- More programs to be analyzed
- More details on each program
- Enhanced analysis

What Needs to Be Done Next?

Software Sustainment Cost Estimation **needs to be seen by all DoD and support stakeholders as being as important – if not more than –** ***Software Development Cost Estimation***

Sustainment & Lethality

As of January 2018, the US Army Apache fleet has accumulated more than 4.3 million flight hours, including more than 1.2 million in combat.

"Right now, it's an incredibly capable aircraft that we know we are going to be flying well into the [20]40s."

Maj. Gen. William Gayler
Commanding General
USAACE and Fort Rucker
September 2018

Sustainment & Lethality

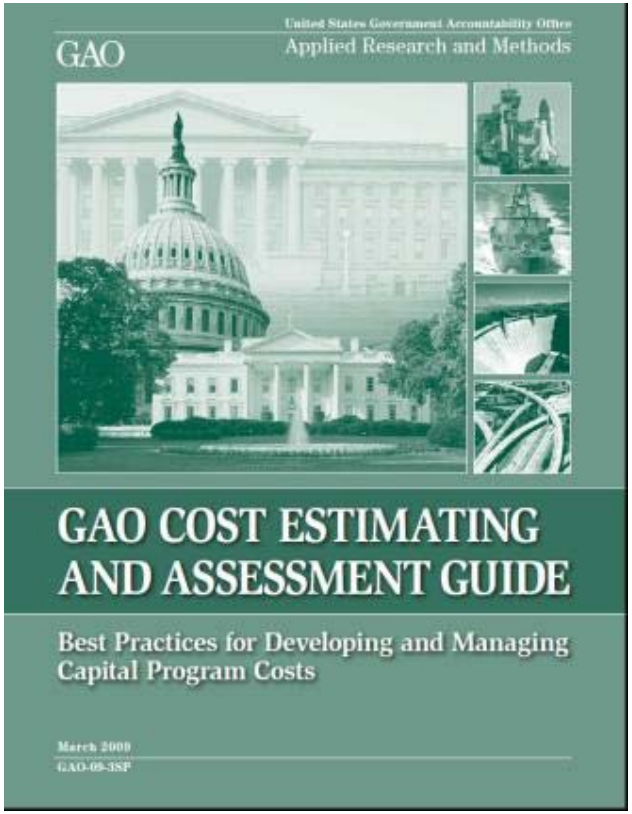
Software System Size Growth

107 - AH-64As

1620 - AH-64Ds

Apache Software Growth
300 KSLOC to Over 1.4 Million SLOC
Since 1984

Why Cost Estimation Focus?



"Our program assessments have too often revealed that not integrating cost estimation, system development oversight, and risk management—three key disciplines, interrelated and essential to effective acquisition management—has resulted in programs costing more than planned and delivering less than promised."

GAO Cost Estimating and Assessment Guide

Greatest Leverage–Highest Visibility–Affordability as Driver

Initial Ideas?

Discussion

Moving The Needle

High Cost of Weapons Threaten Security

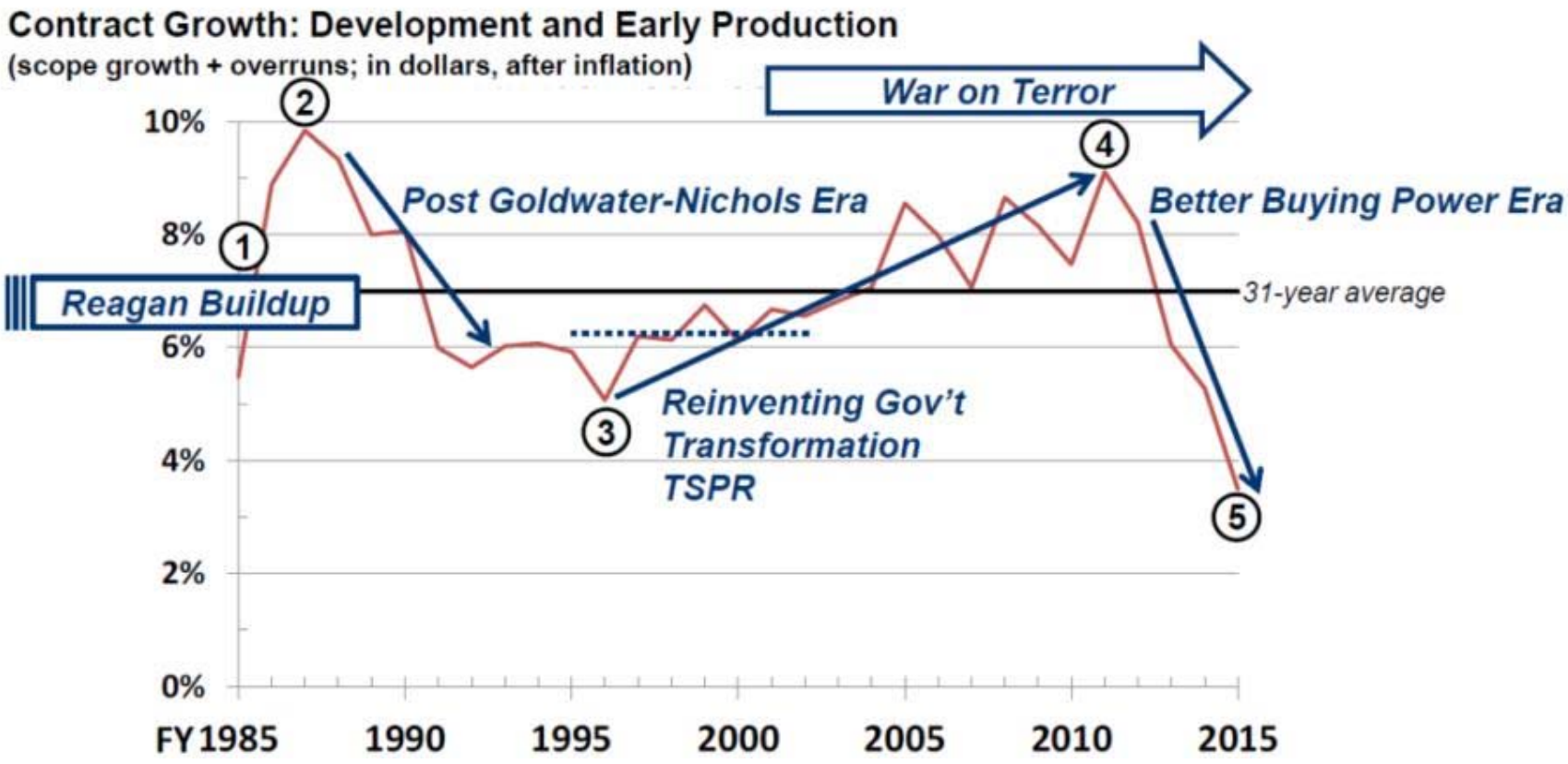
"I think we're seeing that direct link now between cost and our future capabilities. That's the problem that I think we have to deal with head on."

Arati Prabhakar
Ex-Director
DARPA

Moving The Needle Towards CE Equality

Best Buying Power Still Lives

Figure H-4. Actual Growth of Contract Costs (FY 1985–2015)



Source: Performance of the Defense Acquisition System, Department of Defense, 2016

Moving The Needle

CIO Thoughts on Army Software

"***Over the past 15 years, the exponential growth in the software environment—pace, size, complexity and costs—has the potential to negatively impact current and future Army warfighting functions —such as mission command, movement and maneuver, intelligence, fires, sustainment and protection —at every echelon in our formations*.**"

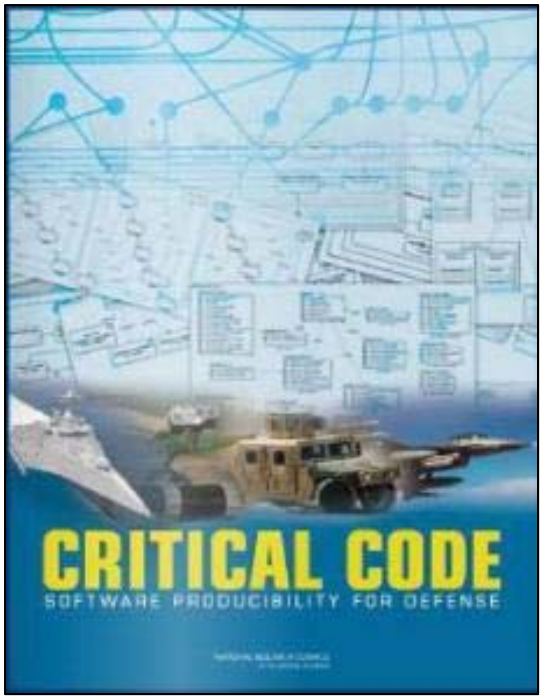
"Absent institutional change, current legacy software development and sustainment processes will continue to induce risks into the Army's ability to modernize, sustain and protect weapon systems and critical enterprise business applications. It is for these reasons that in the context of improving readiness of our formations and increasing the capacity of our weapon systems, I consider the software environment to be 'the next great frontier.' "

"How do we optimize enterprise Army software development and sustainment oversight and policy?"

Army CIO Maj. Gen. Bruce T. Crawford

Moving The Needle

Critical Code: Software Producibility for Defense (NAE 2012)



Recommendation 4-1: Effective incentives for preventive software assurance practices and production of evidence across the lifecycle should be instituted for prime contractors and throughout the supply chain.

Moving The Needle

Defense Science Board (DSB) Task Force on the Design and Acquisition of Software for Defense Systems (2018)

"Software is a crucial and growing part of weapons systems and the Department needs to be able to sustain immortal software indefinitely."

"The Milestone Decision Authority (MDA) with the Cost Assessment and Program Evaluation office (CAPE), the USD(R&E), the Service Cost Estimators, and others should modernize cost and schedule estimates and measurements. They should evolve from a pure SLOC approach to historical comparables as a measurement, and should adopt the National Reconnaissance Office (NRO) approach of contracting with the defense industrial base for work breakdown schedule data to include, among others, staff, cost, and productivity."

Moving The Needle

GAO's On-Going Study into DoD Software Sustainment

(1) To what extent does DOD have guidance, processes and organizations in place to manage the sustainment of operational system software on its major weapons systems?

(2) To what extent is DOD able to determine whether it has the expertise and necessary data rights to sustain and upgrade software on its major weapon systems?

(3) To what extent does DOD track, monitor, and assess key information on software sustainment, such as the type of code maintained, the number of different software versions maintained, the cost to maintain, and vulnerability to potential cyber threats?

Moving The Needle

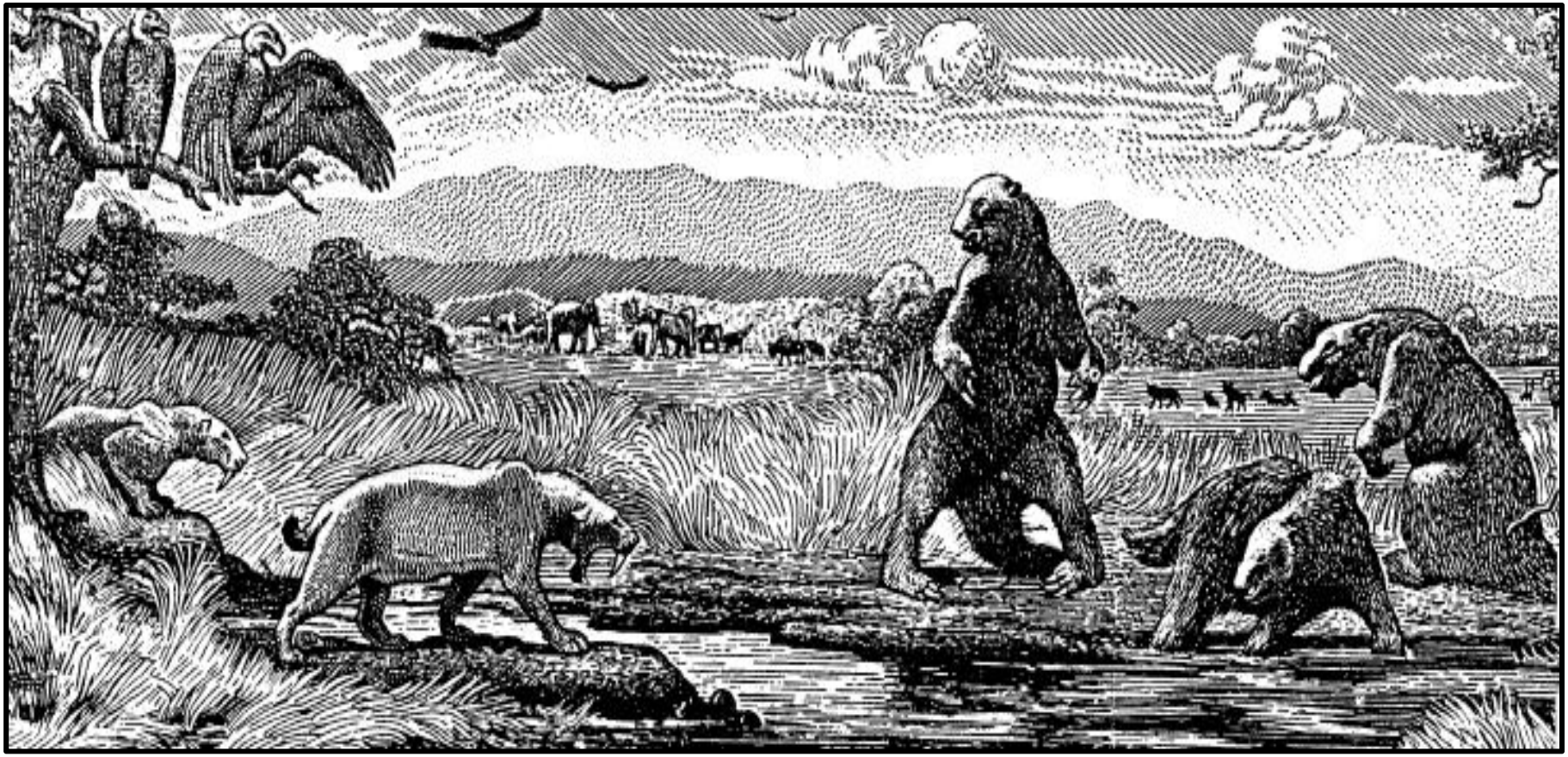
Secretary of Defense James Mattis plans to remove DoD's Chief Management Officer, DoD's third ranking official, for "lack of performance" for not finding ways to cut program costs and put the savings towards modernization.

News Reports
September 2018

Other Initiatives/Reports?

Discussion

Perceptions of Software Development



"No scene from prehistory is quite so vivid as that of the mortal struggles of great beasts in the tar pits. The fiercer the struggle, the more entangling the tar, and no beast is so strong or so skillful but that he ultimately sinks."

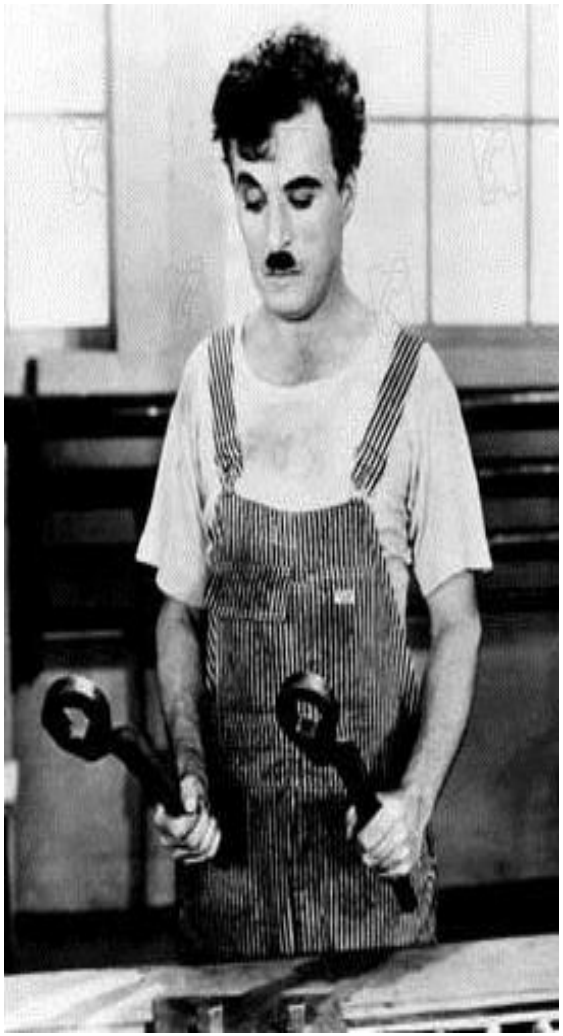
Perceptions of Software Maintenance

"Maintenance has lived in a twilight world, hardly visible in the formal accounts societies make of themselves."

David Edgerton

David Edgerton, *The Shock of the Old*, Profile Books, 2006

Perceptions of Software Maintenance



"Many people understand that as hardware gets older, it starts to deteriorate, is hard to change, requires preventive maintenance, and has high maintenance costs. It is now common knowledge among software professionals that software maintenance is important, difficult, and expensive. Unfortunately, all too many senior managers who control resources appear to have the erroneous perception that exactly the opposite is true for software. They believe it improves with age, is easy to change, does not require preventive maintenance, and is less expensive than the original cost."

Mark Jones
"The Effects of Budget Cuts on Army Materiel Command Post Deployment Software Support Facilities," (1994)

Perceptions of Software Maintenance

"Software not developed with maintenance in mind can end up so poorly designed and documented that total redevelopment is actually cheaper than maintaining the original code."

U.S. A.F Software Technology Support Center, "Guidelines for Successful Acquisition and Management of Software-Intensive Systems," (2000)

"There is no statistical difference in the total annual resources (adjusted for inflation) budgeted for software maintenance on ground combat vehicles. This means that there appears to be a set annual budget for each program."

Christopher Cannon
"Cost estimation of Post Production Software Support in Ground Combat Systems," (2007)

Additional Obstacles

"PSMs in six of our seven focus groups told us that their program management did not place a strong emphasis on the sustainment portion of a program's life cycle, because it was focusing on performance in the near term."

Weapon Systems Management, GAO 2017

"The procurement system does not encourage spending funds today to save money in the future."

William LaPlante Jr. (2013)

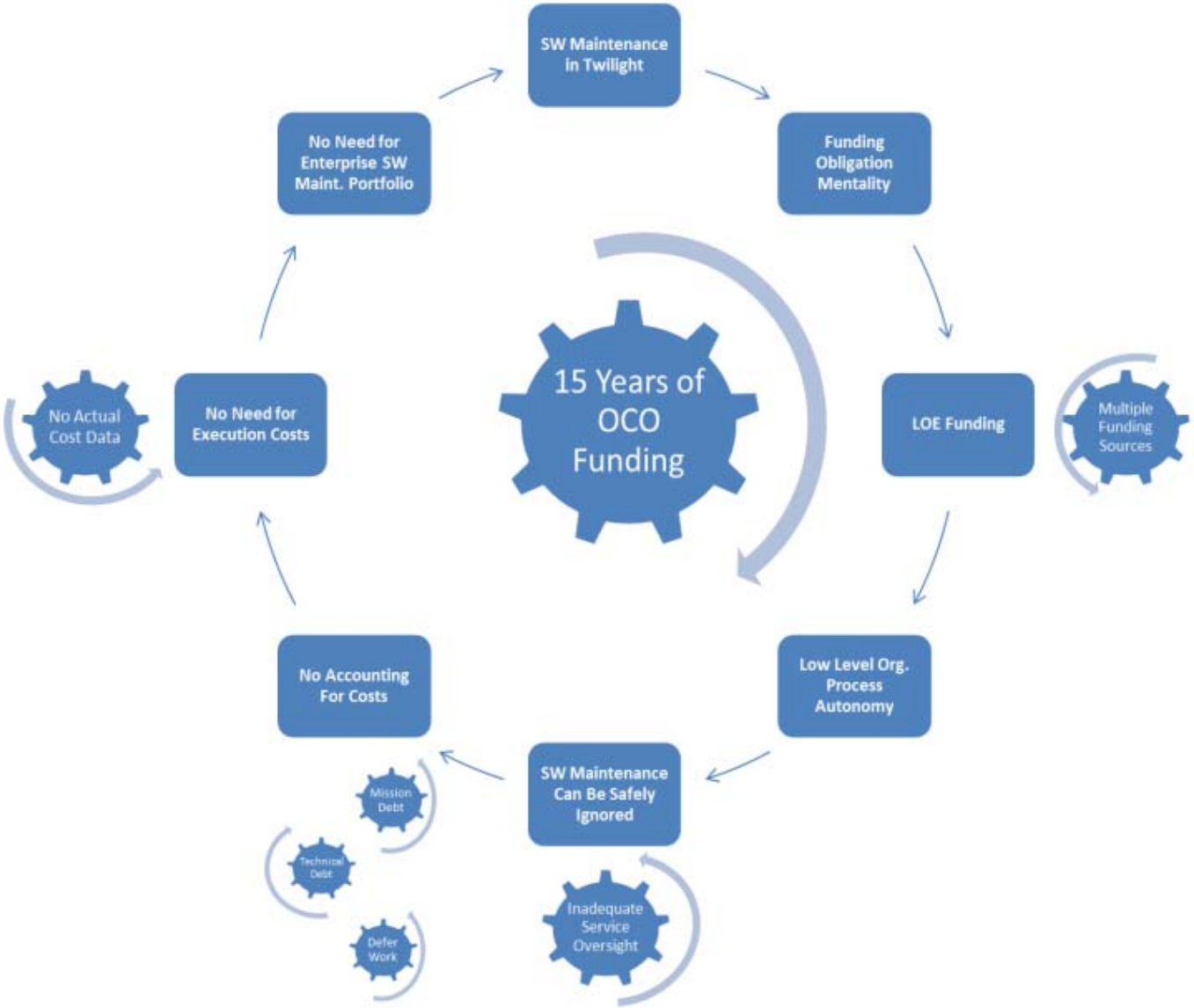
DoD budget has increased nearly 9% over the past two budget cycles.

Key Impediment Factors Aren't Independent

Typical Vicious Cycle Found in Failed Projects

- **Key Factors are both symptoms and causes**
- **They influence decision behaviors**
- **The behaviors can lead to sub-optimal performance**
- **When they negatively reinforce one or more other decision behaviors we can create a "Vicious Cycle"**
- **For example, poor project oversight can lead to missing project activities**

The Software Sustainment Vicious Cycle



Other Obstacles in the Way?

Discussion

Compelling Question

What are the primary technical and political requirements necessary to establish a viable enterprise software sustainment cost estimation and analysis capability across the Services?

How Do We Achieve CE Equality?

Hearts & Minds: Who Has To Be Convinced?

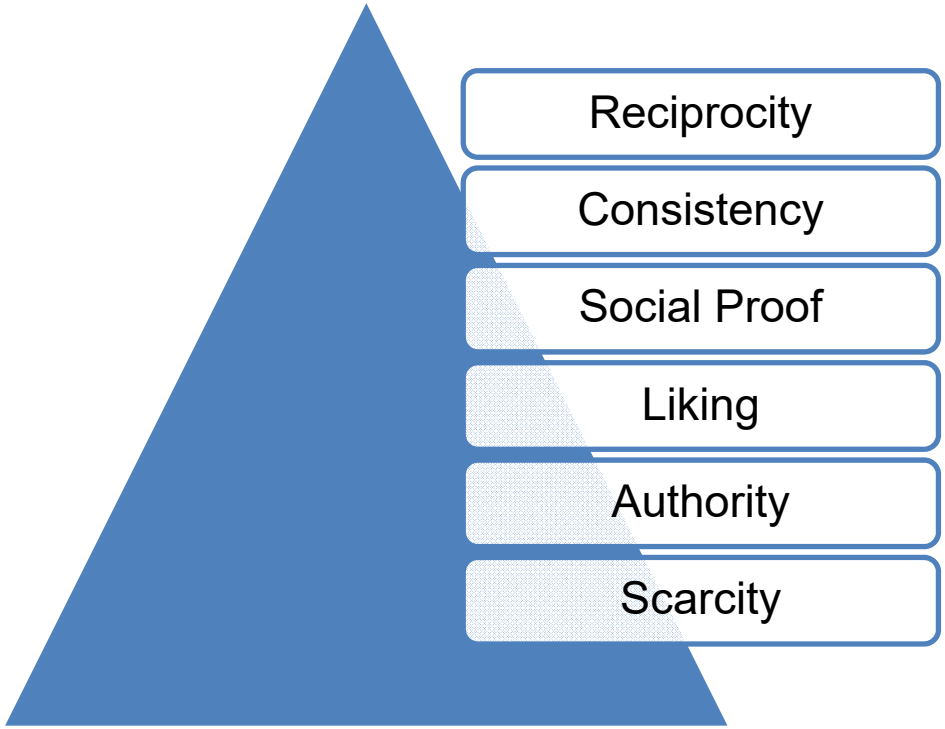
- Enterprise Resource/Technical Managers
- Multi-system Functional Managers (PEOs)
- Program - System Teams (PMs)
- Enterprise Managers & the SES
- Service Leaders
- OSD
- Congress

How Do We Achieve CE Equality?

What Do They Need To Be Convinced Of?

- "No cost estimation decision is better than the data that supports it."
- "If you don't collect the data, your cost estimate will be unreliable."
- "If one doesn't have a good software sustainment process, your cost data will be inconsistent."
- "If one doesn't own the data, the cost estimate will be untrustworthy."
- "If one's data is not related to actual performance, one's cost data will be incomplete."
- "If performance is not defined, one's cost data will be inconsistent."
- "If one doesn't compare planned to actual performance, one can't improve your cost estimates' reliability."
- "If no one asks for data, it will not be provided."
- "For software sustainment and acquisition cost estimation to be taken seriously, it needs to match the importance of cost estimation in acquisition."

How Do We Achieve CE Equality?



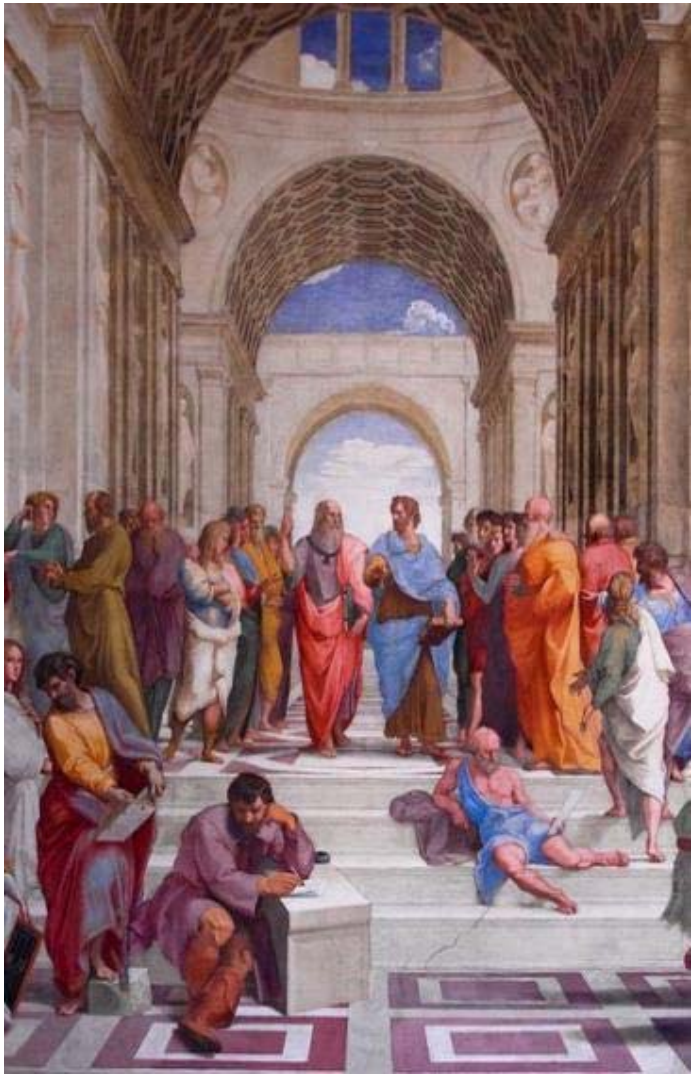
Cialdini ‘s Influencers

DSB & NAE Ideas

- **Software Factory**
- **NAO Contracting**
- **Emerging Dev./Sustmnt R&D**

What can be leveraged?
Create a Cost Estimate of Record?

How Do We Achieve CE Equality?

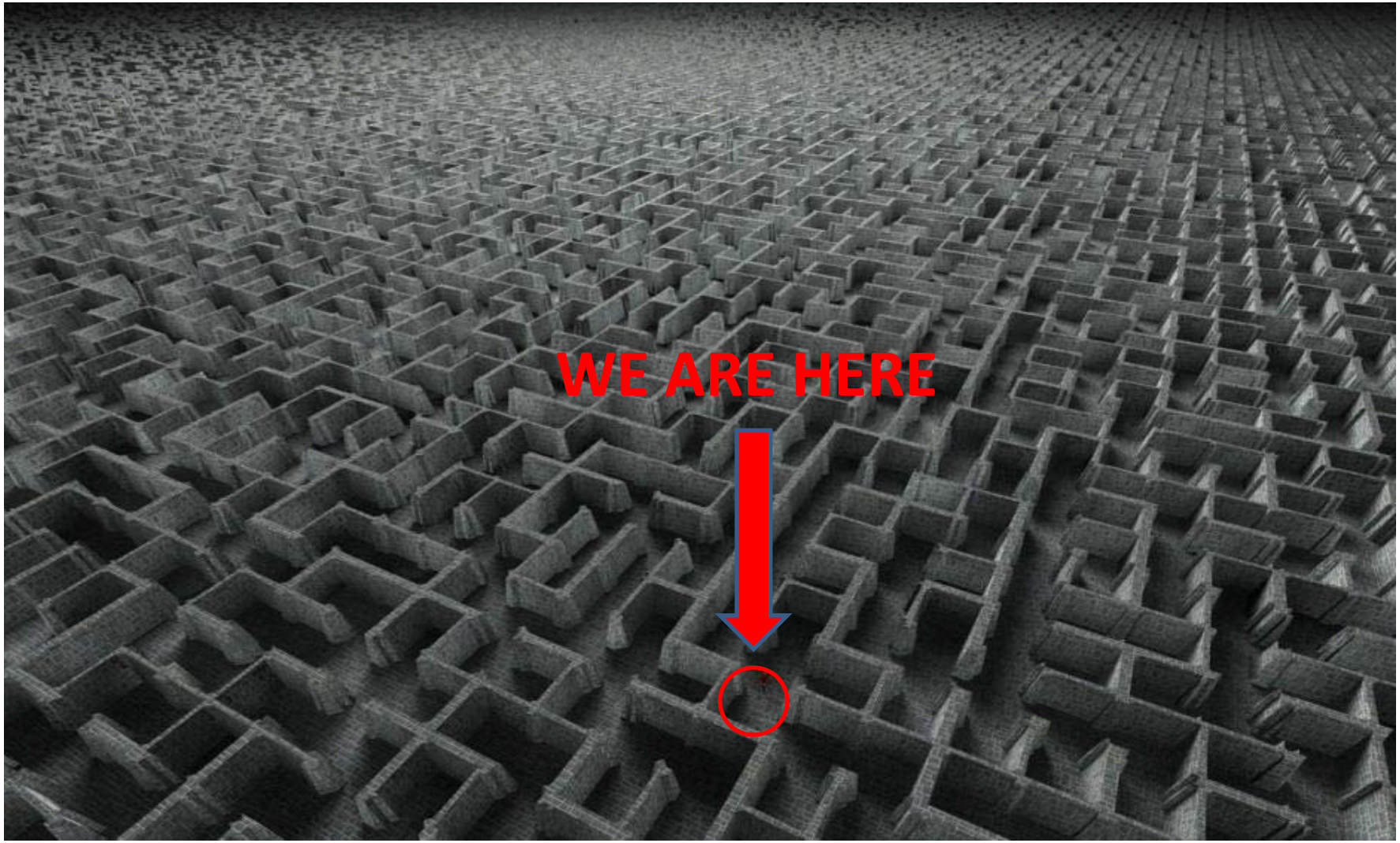


Tech Councils

- CIO Council
- ERM – CFO – PIC Councils
- National Science & Tech Committees
- Cost Estimation Council?

What can be leveraged?

What's The First Step?



Summary & Wrap Up

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Backup Slides

Observed Factors

General

SWS “In the Shadows” - focus in on development
Non-Alignment of Policy - Funding - Software Processes
Autonomous program/system authority
Focus on funds procurement - not funds execution
No SWS information communications infrastructure
Proliferation of systems to be sustained
Limited execution performance data
Lack of consolidated/aggregated portfolio data

Policy

Lack of SWS governance
Title 10 - Split responsibility/Software ownership
“Organic” capability mandates
“Separation” of funds management
Hard separations of acquisition and sustainment
Poor data rights policy/management

Observed Factors

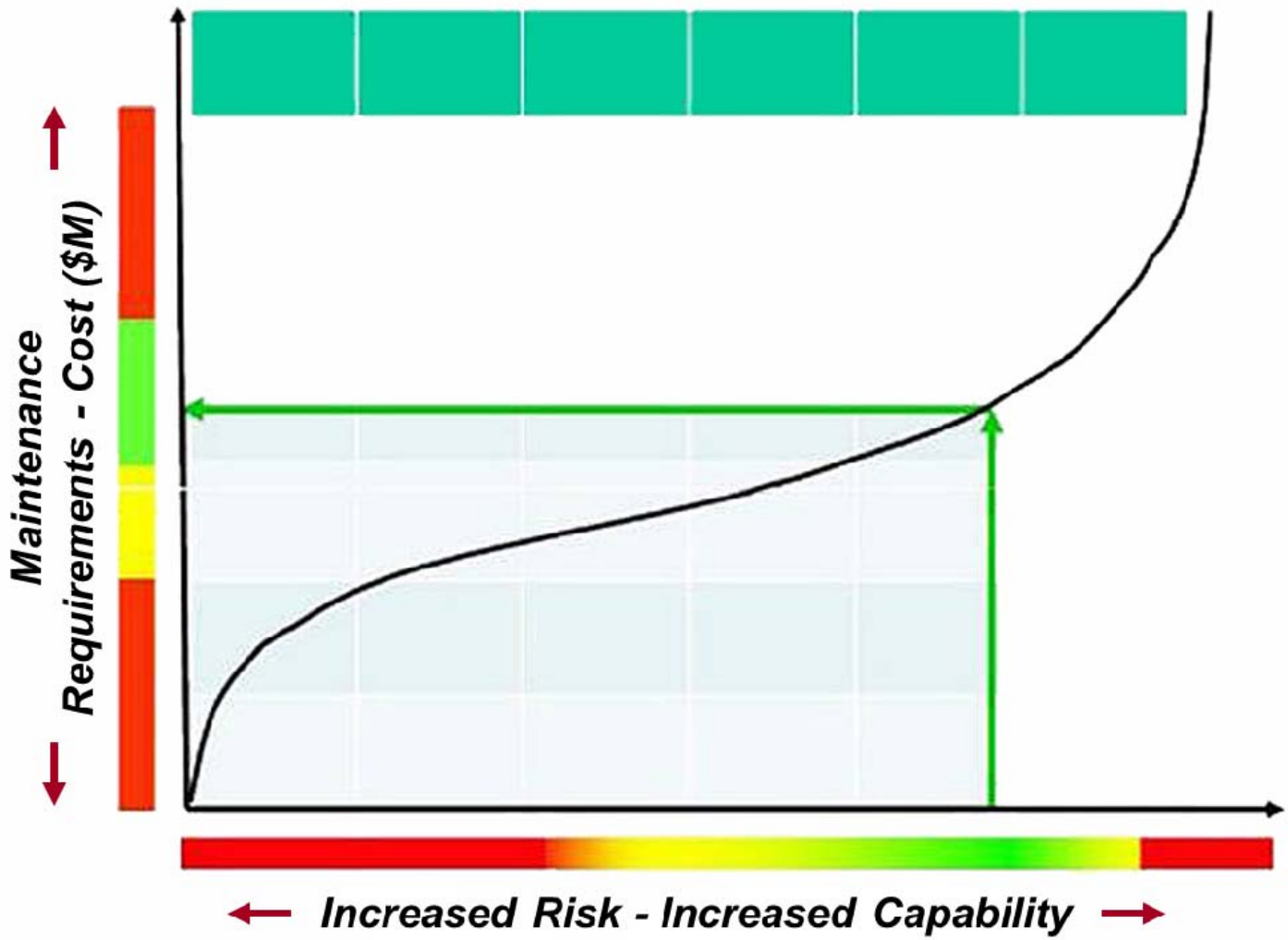
Funding - Cost Management

Inconsistent cost accounting accrual structures (system, functional, organizational, etc.)
Financial accounting - not cost accounting
LOE finding and management structures - fund people - not products
Executed resources ($) not tied to SWS output products
Multiple funding streams supporting outputs (effort)
Lack of contractor SWM performance data (cost/schedule/product output) (if they have it)
Limited accountability for organic government SWM labor expenditures
Accounting defined at a high level of aggregation
Stakeholders reluctant to share performance data (if they have it)
15 years of significant war-time funds availability - obligation emphasis

Software Technical - Life Cycle Processes

Continuous software development
System software process capability limitations
Disjointed requirements management
Software instantiated mission capability debt
Change requirements volatility

Ultimate Objective: Make Informed Cost-Capability Trades



It's All About the Money, Chein Hou, CAPE, November 2011