

# **Navigating Beyond the SLOC: Exploring Improvements in Software Cost Estimating**

**Naval Postgraduate School  
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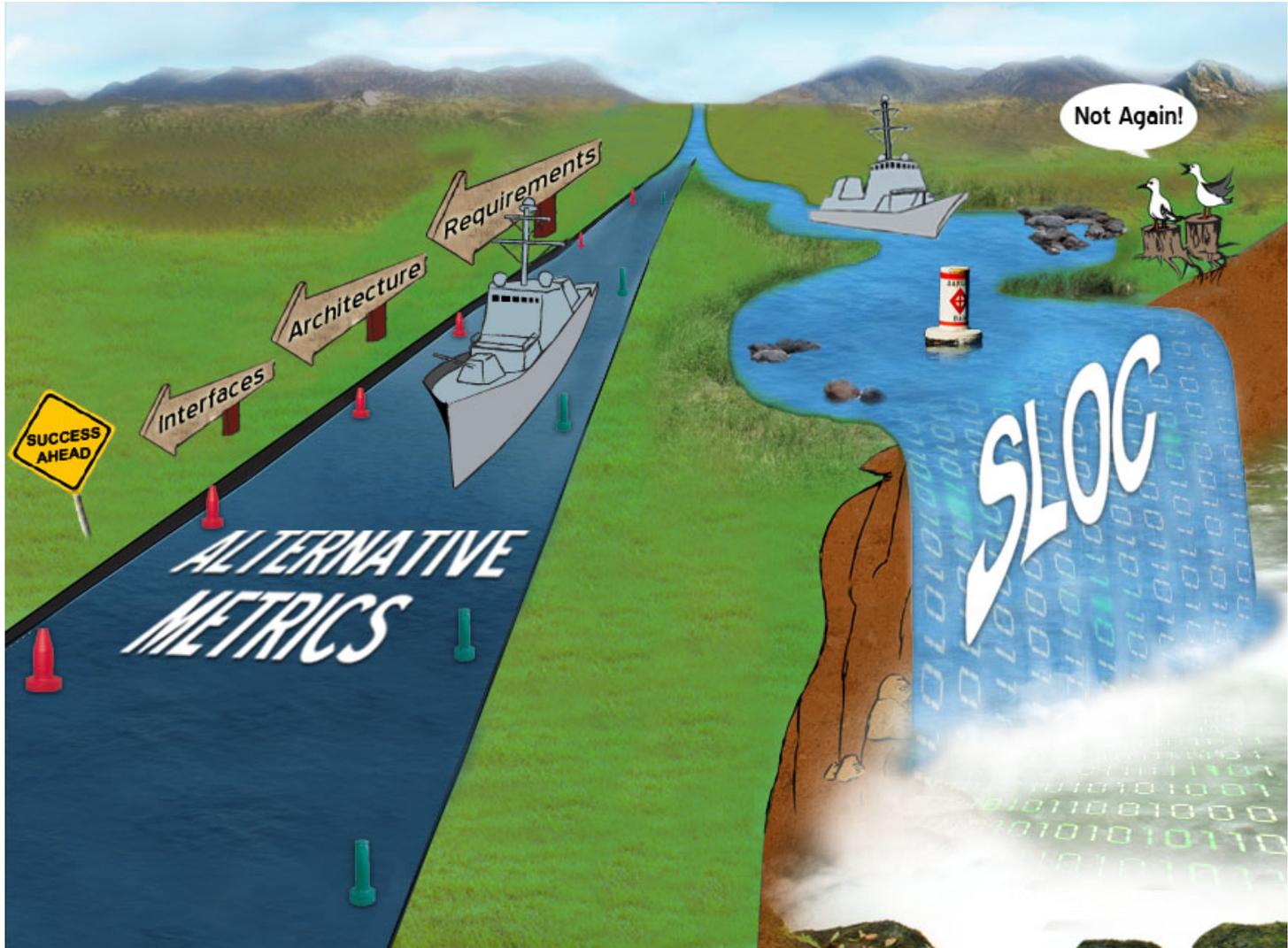
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# Navigating Beyond the SLOC: Exploring Improvements in Software Cost Estimating



# Overview

- **Department of Defense (DoD) Software (SW) cost estimating**
  - Estimates that fully encompass development scope are key
- **Source Lines of Code (SLOC)-based methods don't make sense**
  - Analogous to estimating the complexity of a house painting job based on gallons of paint
- **Other methods & metrics**
  - What is used?
  - What is useful?
  - What is mandated?

## Overview (Cont'd)

- **Divergence in policy versus practice**
  - Are current policies misguided?
- **Are non-SLOC-based alternatives feasible?**
- **Documents, specifications, and management reviews**
  - How do we quantify non-Design Code Test (DCT) effort?
- **Findings and recommendations from two recent Naval Surface Warfare Center, Dahlgren Division (NSWCDD), studies**
  - Software Estimating and Modeling (SEAM)
  - Software Estimating Enhancement Task (SWEET)

# SWEET Fiscal Year 2011 Study Approach

## Researched SW Policy



- DoD 5000 series
- DCARC/SRDR
- ASN(RDA) Guidebook

## Reviewed SW Guidance



- NAVSEA05C
- NAVAIR 4.2
- NCCA
- Air Force STSC
- GAO
- NASA

## Collected Data

(via Data Calls, Interviews, Questionnaire, Site Visits)

- NSWCCD SW Programs (40+ efforts)
  - SLBM, TTWCS, Mk 160, NFCS
  - LCS, AEGIS, SSDS
  - SPS, SGS/AC, Next-Gen Simulation
- External Organizations
  - China Lake, SPAWAR, NAVAIR

## Identified Best Practices

- Estimate SW Effort with appropriate metric
- Align methodology with program maturity
- Institute EVM and Metrics tracking
- Validate estimating tools and estimates

## GAP Analysis

Example:  
EVM not uniformly instituted

## Recommended Process Improvements

- Interface with the SW Community of Practice
- More rigorous EVM

## Assessed Current Practices

- Variations in:
  - SW development process and maturity
  - Metrics collection and tracking
  - EVM implementation and utilization
  - SW estimating methods (LOE, SLOC, etc.)

*Future Implementation*

# SLOC-Centric Policy and Guidance

- **Policy does not always make sense**
  - What works on paper does not always translate to practical, real-life scenarios
- **For Acquisition Categories (ACATs) I and/or IA programs, the DoD 5000 series mandates contractor delivery of Software Resources Data Reports (SRDRs) through the Defense Cost and Research Center (DCARC)**
- **Cost and Software Data Reporting (CSDR) plan required for ACAT I/IA programs**
- **Non-ACAT programs, e.g., AEGIS, are not required to submit SRDRs**

## SLOC-Centric Policy and Guidance (Cont'd)

- Assistant Secretary of the Navy (Research, Development, and Acquisition) [ASN(RDA)] *Guidebook for Acquisition of Naval Software Intensive Systems* – limited application by program offices (function of awareness)
- Naval Sea Systems Command (NAVSEA) Program Executive Office Integrated Warfare Systems guidance
  - Detailed data requested (other than SRDR) from additional programs, e.g., ACAT II, III, but
    - There is still no mechanism for enforcement
    - There is no Data Item Description (DID) to give contractors specific guidance and definitions

No single policy or mechanism exists to collect “good” data from both large and small programs.

## NSWCDD

- **Most projects use engineering build-up and Level of Effort (LOE)-based approaches**
- **Few projects currently use SLOC-based methods or models, e.g., COCOMO II, SLIM**
- **Some projects use code-counting tools, e.g., USC Universal CodeCount\* (UCC)**
- **There is no common tool, standards, or approach across all NSWCDD projects**

## External Entities

- **AIR 4.1, Process Improvement Group-affiliated projects use detailed engineering build-up**
- **AIR 4.2, Space and Naval Warfare Systems Command (SPAWAR) 1.6, NAVSEA 05C, and the Naval Center for Cost Analysis use SLOC-based methods or models**
- **Handbooks are descriptive, not prescriptive, so variations exist**

\* Developed by University of Southern California Center for Systems and Software Engineering

## NSWCDD

- Several projects collect historical cost data
- Few projects utilize this data to improve cost estimates
- No projects leverage cost performance metrics from other programs, i.e., there is limited collaboration
- No projects employ a focused approach to data analysis
  - No cost estimating relationships ascertained
  - No “bidding database”

## External Entities

- Data availability issues pose problems across the board
  - Processes are not in place for the cost estimating community to efficiently capture execution data from program offices
  - Program offices are unwilling to share data outside their program
  - Lack of consistency in interpretation
  - CSDR/SRDR: Reliability can be suspect
- Progress is being made but is hindered by lack of funding for working-capital organizations, and lack of resources for mission-funded organizations

## NSWCDD

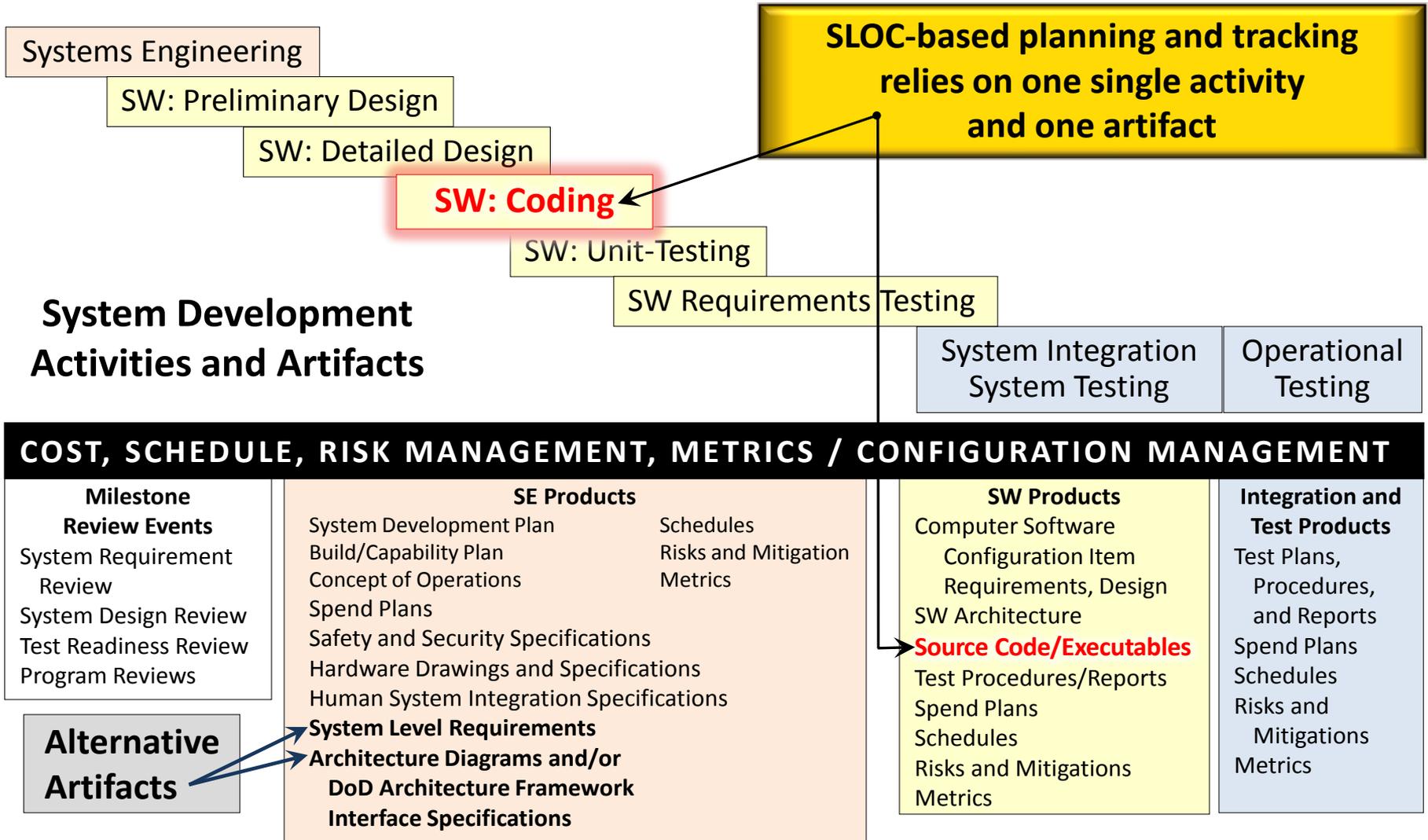
- Few projects adhere to reporting requirements imposed on the industry, e.g., rigorous Earned Value Management (EVM) System and proposal bases of estimate
- Most projects use a work breakdown structure to estimate, track, and report execution data
- Most projects use Microsoft Project or Excel-based in-house tools
- Tomahawk, Submarine Launch Ballistic Missile (SLBM), and Littoral Combat Ship (LCS) Surface Warfare (SUW) have the most mature processes
  - Tomahawk uses a progress tracking tool, but its emphasis is tracking not estimating, and reports SLOC using SLIM to compare estimates to actuals, i.e., validation
  - SLBM uses a technical effort tracking tool for both tracking and estimating

## External Entities

- A variety of tools are used, but relatively few achieve the “ideal state”
  - The ideal state being the capability of comparing estimates to actuals while capturing incremental changes throughout the SW acquisition life cycle

In the areas of cost estimation, historical data, and tracking and reporting, NSWCDD has challenges similar to those of other organizations.

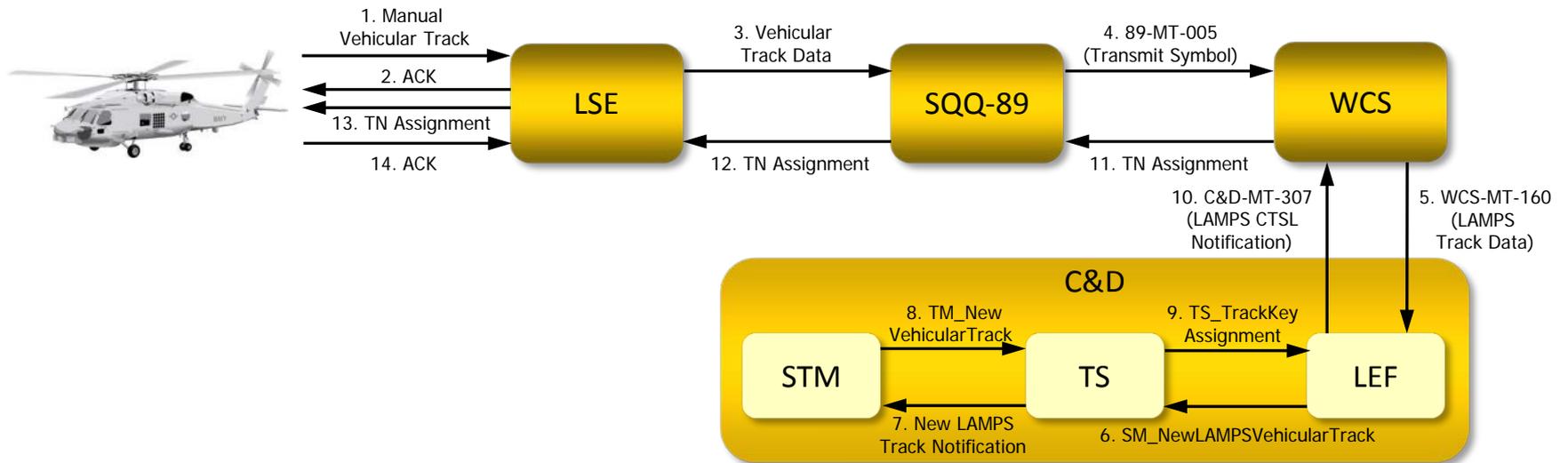
# SLOC is Only One Artifact



## Literature Search: Alternatives to SLOC

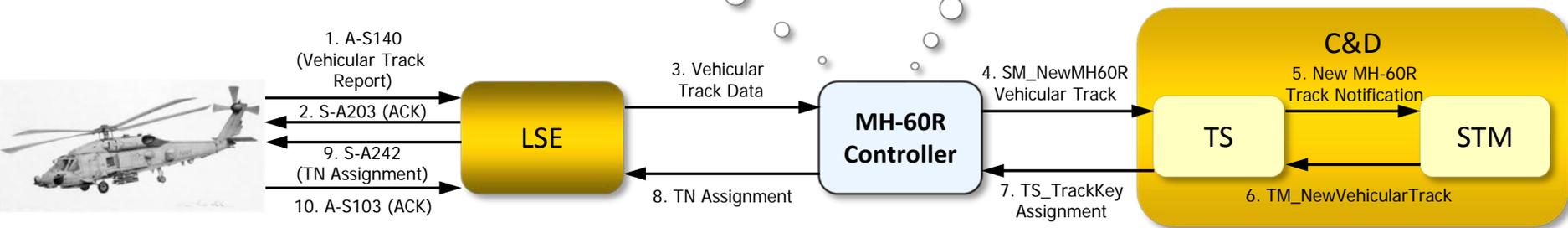
- **Identified 33 methods for defining SW scope, categorized**
  - by SW development phase
  - by manual or auto counting
- **Other than function point analysis, no method using early artifacts is uniformly adopted across the SW community**
- **No “one best way” endorsed by the SW community**
- **SLOC and function points are still the prevailing metrics**
- **Additional research is needed to fully assess applicability**
  - It is premature to recommend an alternative approach or tool for SW estimating

# An Example of SW Interfaces – MH-60R Integration: Vehicular Track Report



## SH-60B Integration

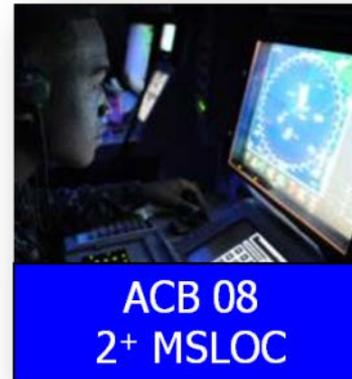
## MH-60R Integration



# Source Code Analysis – Logical Lines of Code (Cont'd)

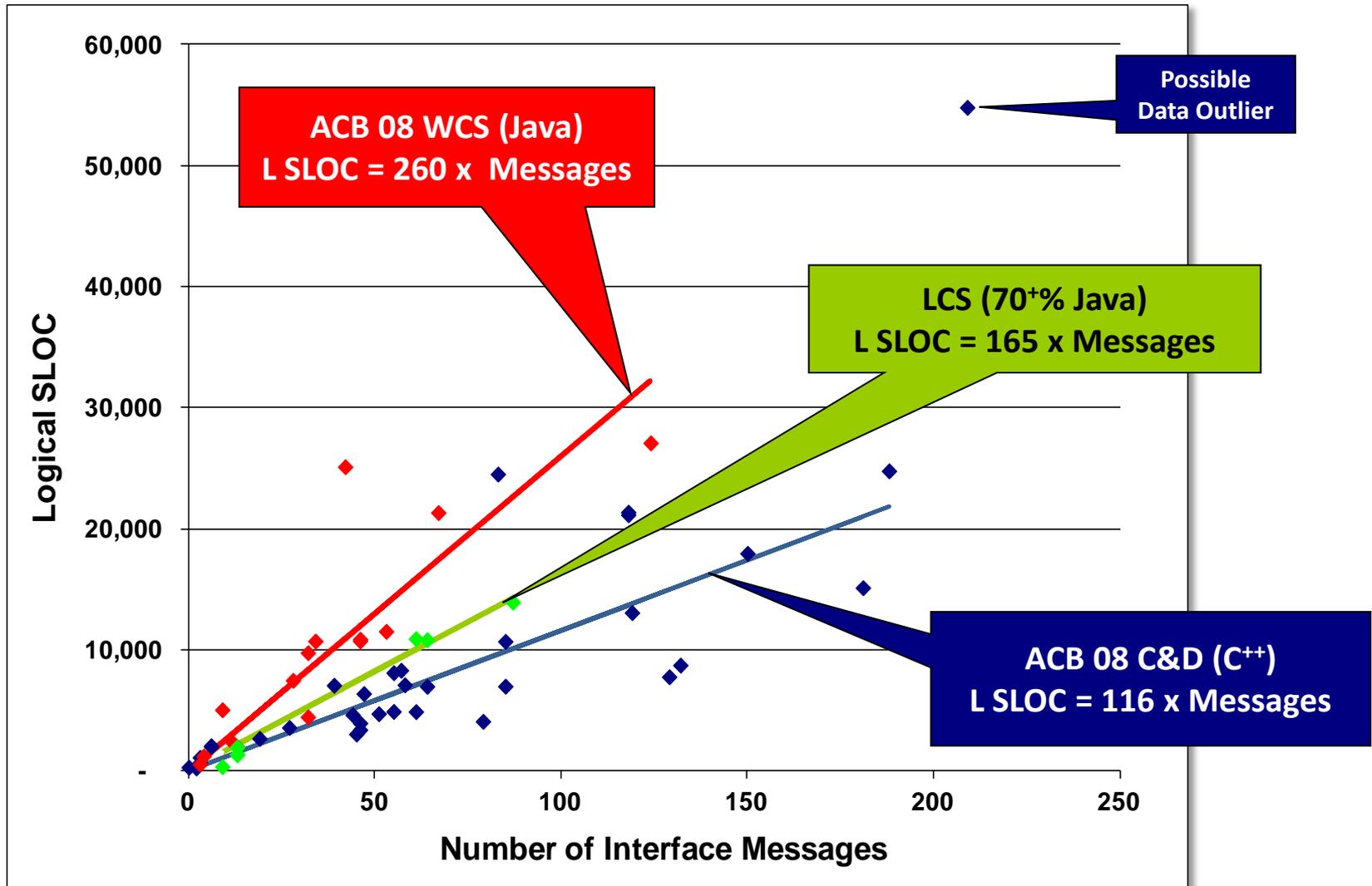
Interface Messages → Logical SLOC → \$\$

- **Selected tactical programs that represent a range of complexity and coding languages**
  - **AEGIS Advance Capability Build (ACB) 08**  
Complex, Multimission Combat Management System (Java, C++)
  - **TTWCS**  
Tomahawk Missile Weapon Control System (C/C++, User Interface Language, Ada)
  - **LCS SUW Mission Package**  
Integrated Warfare Mission Module (Java)



U.S. Navy-Released Photos

# SW Estimating Relationships (Preliminary)



# Navigational Path Forward

- **Develop draft Contract Data Requirements List/DID to implement guidance**
- **Adopt the code counting standards used by the UCC tool or adopt the actual tool**
- **Implement changes to code counting practices in future DoD contracts**
- **Increase government access to development artifacts, e.g., code and associated LOE expenditures**
- **Investigate relationships for estimating non-DCT efforts**
- **Develop methods for collecting and using actual costs and other metrics, e.g., EVM, Dashboard, as part of optimal project management**

# Questions?

