

Software Maintenance Data Collection and Estimating Challenges

SCEA 2012

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U.S. AIR FORCE

Abstract

Entering a period of fiscal austerity, it becomes more important than ever to estimate and consider operating and support (O&S) costs, which represent the lion's share of life cycle cost (LCC) for most platforms, during acquisition. Given the ubiquity of software in today's complex programs, a key component of O&S is software maintenance. This paper presents the results of a research study co-sponsored by the Air Force Cost Analysis Agency (AFCAA) and the Naval Center for Cost Analysis (NCCA) to collect software maintenance data from government support activities and development contractors to enable high-fidelity cost estimates for software maintenance.

Software maintenance cost estimates have often resorted to apocryphal rules of thumb or "black-box" off-the-shelf models. Rules of thumb might be in the form of "Annual software maintenance cost is such-and-such a percentage of software development cost" or "Each full-time staff person can maintain so many thousands of source lines of code (KSLOC)." Neither method is defensible if they are not readily traceable to the source data (if any) upon which they're based. It is this acute need for data that prompted the study team to undertake our effort. We collected data from multiple maintenance organizations, both government and contractor, across various platform types, yielding scores of data points, each constituting a maintenance release. We focused on the key parameters needed for estimating, primarily sizing, schedule, effort, and quality data. Where available, we also collected cost, capability, and complexity. We endeavored to follow best practices by: (a) developing a flexible Data Collection Form in Excel, which could be filled in from scratch or easily linked to an existing source; (b) working to understand each organization's process to provide context to the data; (c) visiting the organization when possible to speak directly with software managers, engineers, and estimators; and (d) documenting which activities were included in effort data.

The paper will present the summary metrics derived from the collected data and discusses important issues that arose, including (1) whether organizations focused on the base code being maintained or the code being changed with each release (more like a "mini-development"); (2) whether organizations focused on defects as a driver of maintenance effort or took a broader view of software trouble reports (STRs) as requested changes; and (3) how organizations accounted for infrastructure costs and sustaining engineering activities. It was evident that maintenance metrics were of increasing importance across all the organizations surveyed, and occasionally that meant that measurement systems themselves were in flux, often due to mergers or benchmarking against sister organizations. Finally, the paper will make recommendations as to the improvement of ongoing software maintenance data collection.

Outline

- Purpose of Presentation
- Background
- Identification of Data Sources
- Reasons for Participation
- Current SWMX Estimating Approach and Current Challenges
- Data Collection Study
 - Purpose
 - Joint Services Effort (MOA and ARDEC parallel study)
 - Study Objectives
 - Data Collection Approach
 - Data Protection
 - Desired Data
 - Data Collection Form
 - Data Assessment
- Study Challenges
- Results
- Road Ahead

Purpose of Presentation

- To present the current status of joint AFCAA/NCCA software maintenance data collection study
- To generate interest and solicit participation in the study
- To discuss challenges encountered and lessons learned on the study to date
 - To gather feedback from the community
- To present initial results from the study
 - Uncertain at “press time” how extensive these will be
- To complement the material being presented by Cheryl Jones (Army ARDEC)
 - The two study efforts are closely aligned, and some overlap is inevitable

“Software Maintenance, Sustaining Engineering, and Operational Support Cost Analysis Study,” Cheryl Jones, DoDCAS, 2012.

Background

- With the emerging fiscal constraint in the DoD budget, there is more focus on the operating and support (O&S) costs, which represent the lion's share of life cycle cost (LCC) for most platforms, during acquisition.
- One area of interest is the validity and defensibility of the estimates used to determine, allocate, and evaluate the value of software maintenance funds.
- Software maintenance cost estimates have often resorted to apocryphal rules of thumb or "black-box" off-the-shelf models. None of these methods are defensible if they are not readily traceable to the source data (if any) upon which they're based.
- A research study co-sponsored by the Air Force Cost Analysis Agency (AFCAA) and the Naval Center for Cost Analysis (NCCA), with joint participation from Office of the Deputy Assistant Secretary of the Army for Cost and Economics (ODASA-CE), Armament Research, Development and Engineering Center (ARDEC), and the Air Force's Electronic Systems Command (ESC), is collecting and analyzing software maintenance data from government support activities and development contractors to enable high-fidelity cost estimates for software maintenance.

ID of Data Sources – Government

- Data warehouses
 - Navy Visibility and Management of Operating and Support Costs (VAMOSOC), Army VAMOSOC Operating Support Management Information System (OSMIS), Air Force Total Ownership Cost (AFTOC)
- Data collectors
 - NAVAIR 4.1 Program Related Engineering (PRE)
- Cost estimators
 - NAVAIR 4.2, NAVSEA 05C, SPAWAR 1.6
- Maintainers
 - Air Logistics Centers (ALCs), Fleet Readiness Centers (FRCs)
- System Commands and Warfare Centers
 - MARCORSSYSCOM, NSWC Dahlgren
- Program Offices
 - ISPAN, JSF, DDG 1000

ID of Data Sources – Contractor

- Focus on Tier 1 defense contractors
 - Tend to have more and larger programs
- Grass roots aka “bottom-up”
 - Contacts from industry symposia, “kindred souls”
 - Heavily reliant on study sponsors
 - Self-motivated to participate, even if “guerilla” effort required
- “Top-down” via corporate leads
 - Overhead effort already committed, or at least authority to do so
- “Side-door” via established government-industry forum
 - Aviation Cost Integrated Product Team (CIPT), establishment of Software sub-group TBD
 - Process for information exchange already established

Reasons for Participation

- Improved Estimating
 - Participants will receive non-proprietary version of metrics
 - More defensible analysis for BOEs, insourcing studies, etc.
 - Data support better estimates, which in turn defend budgets and support better management
- Benchmarking
 - Learn where your organization's performance stands relative to industry averages
 - Insight into criteria for government evaluation of proposals
- Perception as Industry Leader
 - DoD-wide reputation as key contributor to elevation of the software cost estimating community
 - Access to the study group (Air Force, Army, Navy) as a Government Partner

All contribute to improved ability to manage and win business!

Current SWMX Estimating Approach and Challenges

- Level of Effort (LOE) or SLOC/FTE
 - Equivalent to analogy with SLOC scaling
 - Annual Change Traffic (ACT) effort
 - Cost Factor or % of Development
 - Defects and Productivity (hours/item, by severity)
 - Cost or Effort Estimating Relationships (CERs / EERs)
 - Time-Phasing
 - “Aging” of code (New to Modified to Carryover)
 - Ramp-down over time as you “work out the bugs”
 - Current estimates too often rely on apocryphal Rules of Thumb
-
- “30 KSLOC per maintainer”
- “Annual Maintenance is 20% of development”
- “40 hours for Code and Test for each SPR”

Need to improve methods drives the research study

Purpose of Study

- To collect actual data to improve software maintenance cost estimating
 - Sizing, schedule, effort, quality, etc.
- To develop appropriate cost estimating methodologies and cost estimating relationships (CERs) for use in future software maintenance cost estimating efforts
 - Plan to update maintenance chapter in AFCAA's Software Cost Estimation Metrics Manual
- Plan to share normalized data and insights with participants
 - Sanitized results will be segregated by commodity but with no identifying parameters
 - Mutual benefit to contractor and government organizations

Joint Services Effort

- This effort presents the results to date of a research study co-sponsored AFCAA and NCCA, with joint participation from the Army's ODASA-CE and the Air Force's ESC, to collect and analyze software maintenance data from government support activities and development contractors to enable high-fidelity cost estimates for software maintenance
- Another complementary effort is run by ODASA-CE and ARDEC that focuses more on developing improved software maintenance estimation processes, cost relationships, associated models, and establishing better policies
- The two efforts are collaborative; site visits and data collection trips are jointly supported
 - Recurring Software Maintenance Summit meetings between the three services, kicked off at DoDCAS 2012
- All three services signed a Memorandum of Agreement to share data and analyses

Joint Services MOA


Sponsor	MOA Signatory	Title	Study POC
Air Force Cost Analysis Agency (AFCAA)	John G. Georges	Division Director	Dr. Wilson Rosa
Naval Center for Cost Analysis (NCCA)	Justin E. Moul	Division Director	Dr. Corinne Wallshein
Office of the Deputy Assistant Secretary of the Army for Cost and Economics (ODASA-CE)	James Judy	Division Chief	Jeramia Poland
Air Force Materiel Command (AFMC) Electronic Systems Center (ESC), Hanscom AFB	David A. Morana	Chief, Cost Estimating Division	Brian Fersch

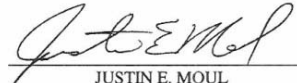
Joint Services Signed MOA

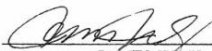
**MEMORANDUM OF AGREEMENT
BETWEEN THE AIR FORCE COST ANALYSIS AGENCY, THE NAVAL CENTER
FOR COST ANALYSIS, THE OFFICE OF THE DEPUTY ASSISTANT SECRETARY
OF THE ARMY FOR COST AND ECONOMICS, AND THE AIR FORCE MATERIEL
COMMAND ELECTRONIC SYSTEMS CENTER**


1. This Memorandum of Agreement (MOA) establishes roles, responsibilities, and deliverables amongst Air Force Cost Analysis Agency (AFCAA), the Naval Center for Cost Analysis (NCCA), the Office of the Deputy Assistant Secretary of the Army for Cost and Economics (ODASA-CE), and the Air Force Materiel Command (AFMC) Electronic Systems Center (ESC) in a joint study of Software Maintenance Data Collection of weapon system platform software.
2. AFCAA will be the lead service for the study with active participation and support from NCCA, ODASA-CE, and ESC.
3. AFCAA will develop final data collection sheets; provide documentation on participation, status, data, and data analysis; manage Non-Disclosure Agreement (NDA) or Proprietary Information Agreement (PIA) forms, as appropriate; provide resources; and share raw and normalized software maintenance data with NCCA, ODASA-CE, and ESC.
4. NCCA, ODASA-CE, and ESC will provide program participants' points of contact (POCs) to AFCAA; share in-house software maintenance data and corresponding documentation; provide resources; and review data collection sheets and documentation.
5. All organizations agree that it is essential to the success of this task that our efforts be open and transparent, and all data and information be shared to the maximum extent possible. In cases where it may not be possible to share data used in the study, each organization agrees to notify the others regarding data restrictions.
6. AFCAA will lead in sharing and presenting results of this study to organizations outside this MOA. All organizations will concur on release of this data to other government organizations not participating in this data collection study.
7. Deliverables include a final list of participants with their contact and organizational information; spreadsheets of raw and normalized data (per above); a description of normalization rules and procedures; collected source metadata; normalized source metadata; written descriptions of the overall scope, data analysis techniques used, and data analysis; a summary briefing and report; and a list of potential future software maintenance research where appropriate.
8. Participants providing software maintenance data will receive a normalized data set, a description of normalization rules and procedures, normalized source metadata, and a summary briefing and report.

9. Each organization is responsible for its respective contract management and overall data management.
10. This MOA will become effective upon signature of all parties. The MOA will remain effective after its effective date unless earlier revoked in writing by any party.


JOHN G. GEORGES
Division Director, Air Force Cost
Analysis Agency
1 MAR 20 11
(Date)

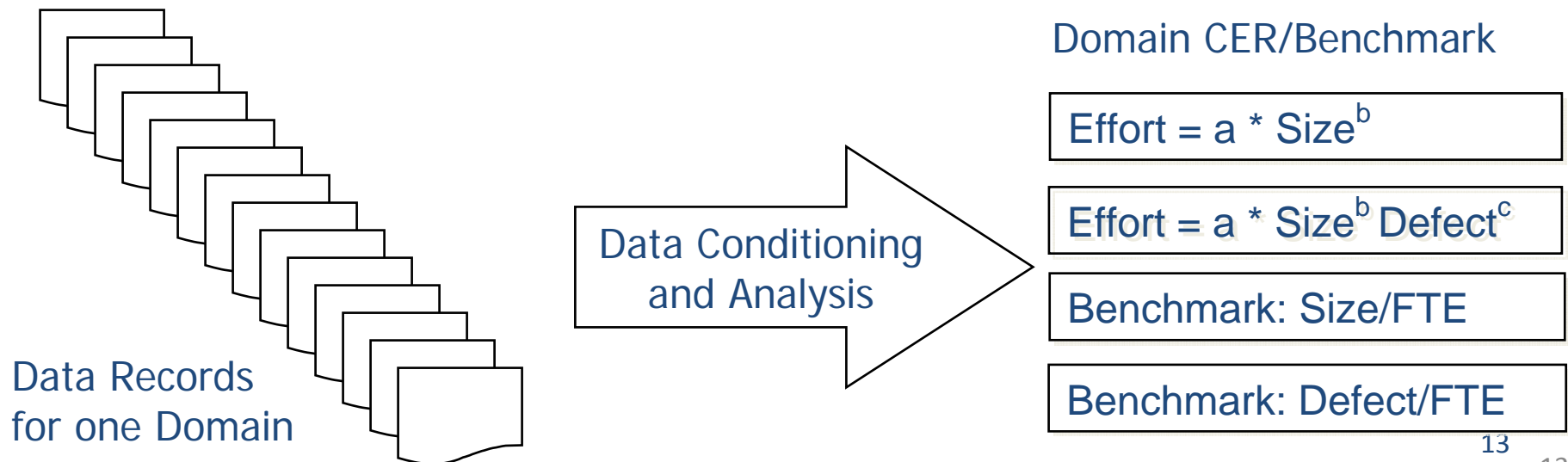

JUSTIN E. MOUL
Division Director, Naval Center for
Cost Analysis
2 MAR 20 11
(Date)


JAMES RODY
Division Chief, Office of the Deputy
Assistant Secretary of the Army for
Cost and Economics
2 MAR 11
(Date)


DAVID A. MORANA
Chief, Cost Estimating Division
Air Force Electronic Systems Center
17 MAR 20 11
(Date)

Study Objectives

- Provide summary metrics derived from collected data
 - Base code being maintained vs. the code being changed with each release
 - Defects as a driver of maintenance effort vs. software trouble reports
 - Infrastructure costs and sustaining engineering activities
- Make collected data useful to oversight and management entities
 - Provide guidance on how to condition data to address challenges
 - Segment data into different Application Domains and Operating Environments
 - Analyze data for simple Cost Estimating Relationships (CER) and Benchmarks within each domain
 - Develop rules of thumb for missing data



Data Collection Approach

- Collect data in as unobtrusive a manner as possible
 - Make use of the data collected in the course of business, in the form in which it is collected
 - Take advantage of data deliveries in support of milestone decisions (e.g., for follow-on programs) or other customer events
 - Remote collaboration where possible, site visit where appropriate
- Initial survey
 - Instrumentation in the form of Excel workbook with front-end form and back-end data table for AFCAA/NCCA
 - Enhancement of data collection form to accommodate data challenges and complement the Army's questionnaire
 - Ease of entry, ease of analysis
 - Link to existing data workbooks
- Follow-up interview for clarification and data validation

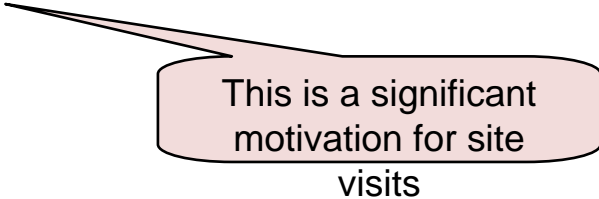
Data Protection

- Protection of the source data is of utmost concern to the study group
 - Our ability to estimate depends on data
 - Our ability to obtain data is only as good as our reputation for safeguarding it
- All data delivered directly to the government
- All personnel will sign Non-Disclosure Agreement (NDA) or Proprietary Information Agreement (PIA) as appropriate
- Sanitized results will be segregated by commodity but with no identifying parameters
 - Best practices from USC/CSE (COCOMO), ACE Libraries (ACDB)

We safeguard the data as if it were our own

Desired Data

- Focus on key parameters needed for estimating:
 - *Project Context and Maintenance Process*
 - Sizing Data
 - Code (Base, New, Adapted, Auto, etc.)
 - Change traffic
 - Schedule Data
 - Effort Data
 - Quality Data
 - Capability Data
 - Complexity Data
- Multiple projects, multiple releases (or annual snapshots)



This is a significant
motivation for site
visits

Make the most of the opportunity – collect only what's needed

Data Collection Form – General

- A modified version of an earlier questionnaire
- Data Priorities
 - High Priority fields show key parameters needed for estimating
 - Identifying Information
 - Sizing – Source Lines of Code
 - Schedule
 - Effort
 - Quality
 - Capability*
 - Lower Priority fields good to have for additional analysis and benchmarking
 - Cost
 - Requirements* * Later reprioritized based on study group discussions
 - Earned Value
 - Test Effort
 - Model Information (COCOMO)
- Features for ease of use and/or data integrity
 - MS Excel as data form
 - Drop-down menus
 - Hyperlinks to data dictionary (on ReadMe tab)

Data Collection Form – Project Identifying Info

SOFTWARE MAINTENANCE FORM 10-Apr-12

Form Instructions
 13 **Point of Contact Identifying Information (Mandatory)**
 20 **Project Identifying Information (Mandatory)**

21 Maintenance Organization Type
 22 Organization (In-House)
 23 Affiliated Service

27 Program Name
 28 Project Name
 29 Version/Release No & Name
 30
 31 System Name
 32 System Type
 33 Platform
 34 Application Domain

36 **Sizing (Mandatory)**
 37 Fill in number of logical SLOC by SI and sizing categories. If SLOC aren't available by SI, put total SLOC in SI #1 reuse Source in SI table

System, Program, Project, Version, Release, etc.

- Project Identification, which may have to be purposely obscured later anyway!
- Identification of multiple (preferably sequential) releases of the same software
 - Important for temporal analysis

System Type and Application Domain

- To date, we have *not* pursued AIS programs
- Application domain (software type), or even “super-domain”
 - Application domain can be collapsed into 3 “Super Domain” types depending on the number of data points based on Cheryl Jones DoDCAS brief

Platform

- Straightforward, but remains to be seen whether it drives differences in benchmarks (analogy vs. parametric thought process)
- In conjunction with Application Domain, or independently

23 Affiliated Service

27 Program Name
 28 Project Name
 29 Version/Release No & Name
 30
 31 System Name
 32 System Type
 33 Platform
 34 Application Domain

36 **Sizing (Mandatory)**
 37 Fill in number of logical SLOC by SI and sizing categories. If SLOC aren't available by SI, put total SLOC in SI #1 reuse Source in SI table

23 Affiliated Service

27 Program Name
 28 Project Name
 29 Version/Release No & Name
 30
 31 System Name
 32 System Type
 33 Platform
 34 Application Domain

36 **Sizing (Mandatory)**
 37 Fill in number of logical SLOC by SI and sizing categories. If SLOC aren't available by SI, put total SLOC in SI #1 reuse Source in SI table

23 Affiliated Service

27 Program Name
 28 Project Name
 29 Version/Release No & Name
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 31 System Name
 32 System Type
 33 Platform
 34 Application Domain

36 **Sizing (Mandatory)**
 37 Fill in number of logical SLOC by SI and sizing categories. If SLOC aren't available by SI, put total SLOC in SI #1 reuse Source in SI table

Data Collection Form – Sizing

13	Point of Contact Identifying Information (Mandatory)															
20	Project Identifying Information (Mandatory)															
36	Sizing (Mandatory)															
37	Fill in number of logical SLOC by SI and sizing categories. If SLOC aren't available by SI, put total SLOC in SI #1 row. List row, unadjusted SLOC only. List the Programming Language and other data by version/release.															
38	Fill in Reuse Source and Degree of Modification first in the second table prior to filling in Reuse Source in SI table. Insert Supporting File if needed at upper right.															
39	Sizing Categories (Number of Logical SLOC)												Insert Supporting File: <input type="text"/>			
40			New		Reused (no Modification)			Modified			Deleted					
41	Software Item (SI) Name	Programming Language	Coder Generated	Auto Generated	Carryover	Reused Internal	Reused External	Carryover (modified)	Modified Internal	Modified External	Deleted	Total Delivered	Reuse Source (Int)	Reuse Source (Ext)	SLOC Counter	
42	SI #1											-				
43	SI #2											-				
44	SI #3											-				
45	SI #4											-				
46	SI #5											-				
47	SI #6											-				
48	SI #7											-				
49	SI #8											-				
50	SI #9											-				
51	SI #10											-				
52	SI #11											-				
53	SI #12											-				
54												-				
55													Degree of Modification (Reuse-no modification)			
56			Degree of Modification (Reuse-no modification)				Degree of Modification (Reuse-with modification)				Number of Known Defects from Reuse Code					
57	Reuse Source	Programming Language	Raw Size (# of Logical SLOC)	% Design Mod.	% Code Mod.	% Integration Mod.	% Modified	% Design Mod.	% Code Mod.	% Integration Mod.	% Modified					
58	RS #0			0%	0%	100%	30%				-					
59	RS #1			0%	0%	100%	30%				-					
60	RS #2			0%	0%	100%	30%				-					
61	RS #3			0%	0%	100%	30%				-					
62	RS #4			0%	0%	100%	30%				-					
63	RS #5			0%	0%	100%	30%				-					
64	RS #6			0%	0%	100%	30%				-					
65	RS #7			0%	0%	100%	30%				-					
66	RS #8			0%	0%	100%	30%				-					
67	RS #9			0%	0%	100%	30%				-					
68	RS #10			0%	0%	100%	30%				-					
69	RS #11			0%	0%	100%	30%				-					
70	RS #12			0%	0%	100%	30%				-					
71			COCOMO SW Weights	40%	30%	30%					40%	30%	30%			
72																
73	Schedule (Mandatory)															
74	Fill in overall schedule dates below and fill in detailed schedule by SI and activities if available. Place schedule in first SI row if only total schedule by Software Maintenance Phases is available. Insert Supporting File if needed at upper right.															

Sizing

- Breakout of SLOC at these various levels is usually not provided
- Type of SLOC need to be specified with conversion factors assumption provided for normalization

Data Collection Form – Schedule

36 **Sizing (Mandatory)**

73 **Schedule (Mandatory)**

74 Fill in overall schedule dates below and fill in detailed schedule by SI and activities if available. Place schedule in first SI row if only total schedule by Software Maintenance Phases is available. Insert Supporting File if needed at upper right.

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76 Project Estimated Begin Date 1/0/00

77 Project Estimated End Date 1/0/00

78 Project Actual Begin Date 1/0/00

79 Project Actual End Date 1/0/00

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81 **Detailed Schedule:** Expand section for detailed schedule by SI and Software Maintenance phases. Option to overwrite duration if begin and end dates are not available.

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Software Item (SI) Name	Detailed Schedule	Software Maintenance Phases					Qualification Testing
		Software Requirements	Preliminary Design	Detailed Design	Code & Unit Test	Software I&T	
SI #1	Estimated Begin Date						
	Estimated End Date						
	Est Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
	Actual Begin Date						
	Actual End Date						
SI #2	Act Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
	Estimated Begin Date						
	Estimated End Date						
	Est Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
	Actual Begin Date						
SI #3	Actual End Date						
	Act Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
	Estimated Begin Date						
	Estimated End Date						
	Est Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
SI #4	Actual Begin Date						
	Actual End Date						
	Act Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
	Estimated Begin Date						
	Estimated End Date						
SI #5	Est Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
	Actual Begin Date						
	Actual End Date						
	Act Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
	Estimated Begin Date						
SI #6	Estimated End Date						
	Est Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	
	Actual Begin Date						
	Actual End Date						
	Act Duration (Calendar Mo	0.0	0.0	0.0	0.0	0.0	

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Schedule

- Breakout of schedule by CSCI and phases is usually not provided
- Top level schedule by each release is preferable to overall project schedule

Data Collection Form – Effort

157	Effort (Mandatory)												
158	Fill in overall effort in staff hours below, and fill in detailed effort by SI and/or activity if available. Detailed effort breakdown should match overall effort in staff-hours. Insert Supporting File if needed at upper right.												
159	Software Mtncce Effort		Sustaining Eng Effort			Total Effort		Insert Supporting File: <input type="text"/>					
160	Estimated Effort (staff-hours)					-		Insert>Object>From File					
161	Actual Effort (staff-hours)					-							
162	Standard Month (staff-hours)												
163													
164	Total Staffing Level (FTE Ave&Peak)		Average		Peak								
165	Labor Category		Junior		Mid-level		Senior		Management				
166	FTE Staff Breakout												
167	% Staff Breakout		0%		0%		0%		0%				
168	Labor Rates (\$/hr)												
169													
170	Detailed Software Maintenance Effort: Expand section for detailed effort. If effort can't be broken down by hrs per SI, check applicable activities or enter total hrs per activity. Option to overwrite % Activity Breakout and Total Effort are available.												
171	Check Acty If No Hrs Breakdown		Software Items (by staff-hours)										
172	Software Maintenance Activities		SI #1	SI #2					SI #11	SI #12	Total Effort (hrs)	% Activity Breakout	
173	Software Requirements										-	0%	
174	Preliminary Design										-	0%	
175	Detailed Design										-	0%	
176	Code & Unit Test										-	0%	
177	Software I&T										-	0%	
178	Qualification Testing										-	0%	
179	Program Management										-	0%	
180	Quality Assurance										-	0%	
181	Configuration Management										-	0%	
182	Information Assurance										-	0%	
183	IV&V										-	0%	
184	Other										-	0%	
185	Total Effort (hrs)		-	-							-		
186													
187	Detailed Sustaining Engineering Effort: Expand section for detailed effort. If effort can't be broken down by hrs per SI, check applicable activities or enter total hrs per activity. Option to overwrite % Activity Breakout and Total Effort are available.												
188	Sustaining Engineering Activities (As Applicable)		Same as Above	SI #1	SI #2					SI #11	SI #12	Total Effort (hrs)	% Activity Breakout
189	Contractor oversight		<input type="checkbox"/>									-	0%
190	Vendor coordination		<input type="checkbox"/>									-	0%
191	Distribution management		<input type="checkbox"/>									-	0%
192	Field service		<input type="checkbox"/>									-	0%
193	Hardware troubleshooting		<input type="checkbox"/>									-	0%
194	Independent V&V		<input type="checkbox"/>									-	0%
195	Problem analysis		<input type="checkbox"/>									-	0%
196	Problem investigation		<input type="checkbox"/>									-	0%
197	Quick service		<input type="checkbox"/>									-	0%
198	Security		<input type="checkbox"/>									-	0%
199	System administration		<input type="checkbox"/>									-	0%
200	Test facility maintenance		<input type="checkbox"/>									-	0%
201	Test facility support		<input type="checkbox"/>									-	0%
202	User support (help desk)		<input type="checkbox"/>									-	0%
203	User training		<input type="checkbox"/>									-	0%
204	User steering group		<input type="checkbox"/>									-	0%

Effort

- Estimated and actual staff hours by software maintenance and sustaining engineering activities at the total and/or CSCI level
 - Option for identifying activities or providing expert-based percentages if breakdown of hours is not available
 - Usually only available at total level
- Total staffing level by labor category
 - Remains to be seen whether it drives differences in benchmarks

Data Collection Form – Quality

SOFTWARE MAINTENANCE FORM							
							10-Apr-12
Form Instructions							
Point of Contact Identifying Information (Mandatory)							
Project Identifying Information (Mandatory)							
Sizing (Mandatory)							
Schedule (Mandatory)							
Effort (Mandatory)							
Quality (Mandatory) <input type="checkbox"/>							
Defect count dates are linked to overall schedule but can overwrite if needed. If tracking quality metrics other than the defects listed in table below, or if available per SI, please provide in a supporting file and insert at upper right.							
							Insert Supporting File: <input type="text"/>
							Insert>Object>From File
211	Prior Defect Count Date	<input type="text" value="0/0/00"/>					
212	Most Recent Defect Count Date	<input type="text" value="1/1/00"/>					
			Defect Category (Number of Defects)				Total # of Defects
Defect Information	Category 1 (Catastrophic)	Category 2 (Critical)	Category 3 (Serious)	Category 4 (Annovance)	Category 5 (Minimal)		
216 Known Defects (pre-existing prior to release)						-	
217 Known Defects planned to be fixed as part of this release						-	
218 Known Defects actually fixed as part of this release						-	
219 New Defects found during work on this release						-	
220 New Defects fixed as part of this release						-	
221 Total number of Known Defects fixed by Category	-	-	-	-	-	-	
222 Total number of Known Defects remaining by Catego	-	-	-	-	-	-	
Capability (Mandatory)							
Cost (Optional)							
Earned Value (Optional)							

Quality

- List of defect information by severity level but can possibly be reported via a different metric, e.g. STRs.
- Many organizations track defects within release throughout the process (peer reviews, etc.)

Data Collection Form – Capability

1	SOFTWARE MAINTENANCE FORM							
2								
3								10-Apr-12
4	Form Instructions							
13	Point of Contact Identifying Information (Mandatory)							
20	Project Identifying Information (Mandatory)							
36	Sizing (Mandatory)							
73	Schedule (Mandatory)							
157	Effort (Mandatory)							
208	Quality (Mandatory) <input type="checkbox"/>							
224	Capability (Mandatory)							
225	Fill in percentage of team experience from the range provided in the tables, or choose from the drop-down menu if only average experience information is available. Insert Supporting File if needed at upper right.							
226								
227	Process Maturity (CMM/CMMI Rating)	<input type="text"/>	Accreditation Method	<input type="text"/>				Insert Supporting File: <input type="text"/>
228								Insert>Object>From File
229	% Team Experience Breakout							
230	Experience Range	Only Average Available	≤ 2 Months	6 Months	1 Year	3 Years	6 Years	Check %
231	Application Experience							0%
232	Platform Experience							0%
233								
234	Language/Tool Experience							
235	Programming Language	Only Average Available	≤ 2 Months	6 Months	1 Year	3 Years	6 Years	Check %
236								0%
237								0%
238								0%
239								0%
240								0%
241								0%
242								0%
243								0%
244	If Other, List Below							
245								0%
246								0%
247								0%
248								
249	Cost (Optional)							
272	Earned Value (Optional)							

Capability

- Currently a mandatory field but can be optional
- List company maturity and accreditation rating
- Identifies experience levels and program languages used in the project
- This was often tracked at the organization level but not at the project level

Data Collection Form – Requirements

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P																
1	SOFTWARE MAINTENANCE FORM																															
2																																
3	10-Apr-12																															
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36	Sizing (Mandatory)																															
73	Schedule (Mandatory)																															
157	Effort (Mandatory)																															
208	Quality (Mandatory) <input type="checkbox"/>																															
224	Capability (Mandatory)																															
249	Cost (Optional)																															
272	Earned Value (Optional)																															
295	Requirements (Optional)																															
296	Provide the number of requirements for previous and current version/release as indicated below. Insert Supporting File if needed at upper right.																															
297																																
298	<table border="1" style="width: 100%;"> <tr> <td style="width: 15%;">Previous Release Requirements</td> <td colspan="5"></td> <td style="width: 15%; text-align: right;">Insert Supporting File:</td> <td style="width: 55%;"></td> </tr> <tr> <td>Total Number of Requirements (Cumulative)</td> <td colspan="5" style="text-align: center;">-</td> <td style="text-align: right;">Insert>Object>From File</td> <td></td> </tr> </table>																Previous Release Requirements						Insert Supporting File:		Total Number of Requirements (Cumulative)	-					Insert>Object>From File	
Previous Release Requirements						Insert Supporting File:																										
Total Number of Requirements (Cumulative)	-					Insert>Object>From File																										
299																																
300																																
301	<table border="1" style="width: 100%;"> <tr> <td style="width: 15%;">Requirement Type</td> <td style="width: 15%; text-align: center;">Added</td> <td style="width: 15%; text-align: center;">Deleted</td> <td style="width: 15%; text-align: center;">Changed</td> <td style="width: 15%; text-align: center;">Deferred</td> <td style="width: 15%; text-align: right;">Total Rqts (Traffic)</td> </tr> <tr> <td>Current Release</td> <td></td> <td></td> <td></td> <td></td> <td style="text-align: center;">-</td> </tr> </table>																Requirement Type	Added	Deleted	Changed	Deferred	Total Rqts (Traffic)	Current Release					-				
Requirement Type	Added	Deleted	Changed	Deferred	Total Rqts (Traffic)																											
Current Release					-																											
302																																
303																																
304	Test Effort Breakout (Optional)																															
316	Model Information (Optional)																															

Requirements

- Currently an optional field but should be mandatory especially if used as a sizing method
- Identifies the number of requirements by types
- May include non-defect STRs

SWMX Data Assessment





- During the SWMX Summit on 12 March, the group agreed on a process to identify the quality of data received from various sources
- Color-coding shows the usability of data for the SWMX study
 - Missing data*, unusable data
 - Incomplete data, can make assumptions to use data in analysis
 - Usable data for analysis, reliable values for key parameters
 - Eminently usable, more robust or more detailed data
- Data categories agreed upon at the summit are:
 - Identifying Information (**ID**): program name, organization, domain
 - Sizing (**SLOC**): base code *and* New/Modified/Reuse for release
 - Requirements/Functionality (**REQ**): number of items to be addressed
 - Schedule (**SKED**): total duration (preferably with begin and end dates)
 - Effort (**EFF**): labor hours or dollars or (preferably) both
 - Quality (**QUAL**): defect information
 - Backlog (**BACK**): requirements/defects remaining *after* release

LOE

rate

*Could also use gray for data that were not captured (by the source) and hence will *never* be available ●

Data Assessment Category Definitions

DATA CATEGORIES				
Identifying Information (ID)	No program information provided	Partial program information provided	Program information available in super-domain break-out from Cheryl Jones' brief	Detailed program information provided such as domain, platform, etc.
Sizing (SLOC)	No SLOC data	Partial SLOC data with no breakout	Total SLOC with break-out of Base, New, Re-use, Modify	SLOC with breakouts by CSCI
Requirements/ Functionality (REQ) can be enhancements but <i>not</i> defects	No requirements or functionality data provided	Partial requirements data provided	Identifies other counting points	Provides breakdown of data for other counting points
Schedule (SKED) ties to EFF	PoP not available (e.g., end date but no start date)	PoP is only available for top level program	PoP available for all releases	PoP available at CSCI level
Effort (EFF) ties to SKED	No indication of activities included	Includes core SWMX activities; dollars but no hours	Hours broken out across a wide range of activities	Includes all activities/phases of SWMX and hours for the program or release
Quality (QUAL)	No quality data provided	Quality metric is not defined but with priority level	Quality metric is defined with priority level	Quality metric is defined with priority level and identified for System Test and Operations phases
Backlog (BACK) could trace back to REQ and QUAL	No backlog information provided	Does not define Backlog but has tracking methods	Defines Backlog and tracking methods	Defines the Backlog definition and tracking methods with priority levels

Study Data Assessment

Source	Identifying Information (IDI)	Sizing (SIZ)	Requirements/ Functionality (R/F)	Schedule (SKD)	Effort (EFT)	Quality (QLY)	Backlog (BLG)
Source 1	Green	Yellow	Red	Red	Yellow	Green	Red
Source 2	Green	Yellow	Red	Red	Yellow	Green	Red
Source 3	Green	Yellow	Red	Red	Yellow	Green	Red
Source 4	Green	Yellow	Red	Red	Yellow	Green	Red
Source 5	Green	Red	Red	Red	Red	Green	Red
Source 6	Green	Yellow	Red	Red	Yellow	Green	Red
Source 7	Green	Yellow	Red	Red	Yellow	Green	Yellow
Source 8	Green	Yellow	Red	Red	Red	Green	Red
Source 9	Green	Yellow	Red	Red	Yellow	Green	Red
Source 10	Green	Yellow	Red	Red	Yellow	Green	Red
Source 11	Green	Yellow	Red	Red	Red	Green	Red
Source 12	Green	Yellow	Red	Red	Red	Green	Red
Source 13	Green	Yellow	Red	Red	Red	Green	Red
Source 14	Yellow	Red	Red	Red	Yellow	Green	Red
Source 15	Yellow	Red	Red	Red	Yellow	Green	Red
Source 16	Yellow	Red	Red	Red	Yellow	Green	Red
Source 17	Yellow	Red	Red	Red	Yellow	Green	Red
Source 18	Yellow	Red	Red	Red	Yellow	Green	Red
Source 19	Yellow	Red	Red	Red	Yellow	Green	Red
Source 20	Yellow	Red	Red	Red	Yellow	Green	Red
Source 21	Yellow	Red	Red	Red	Yellow	Green	Red
Source 22	Yellow	Red	Red	Red	Yellow	Green	Red
Source 23	Yellow	Red	Red	Red	Yellow	Green	Red
Source 24	Yellow	Red	Red	Red	Yellow	Green	Yellow
Source 25	Yellow	Red	Red	Red	Yellow	Green	Red
Source 26	Yellow	Red	Red	Red	Red	Green	Red
Source 27	Yellow	Red	Red	Red	Yellow	Green	Red
Source 28	Yellow	Red	Red	Red	Yellow	Green	Red
Source 29	Green	Yellow	Red	Red	Red	Green	Yellow
Source 30	Green	Yellow	Red	Red	Red	Green	Yellow
Source 31	Green	Yellow	Red	Red	Red	Green	Yellow
Source 32	Green	Yellow	Red	Red	Red	Green	Yellow
Source 33	Green	Yellow	Red	Red	Red	Green	Red
Source 34	Green	Yellow	Red	Red	Yellow	Green	Red
Source 35	Green	Yellow	Red	Red	Red	Green	Yellow
Source 36	Green	Yellow	Red	Red	Red	Green	Red
Source 37	Green	Yellow	Red	Red	Yellow	Green	Red
Source 38	Green	Yellow	Red	Red	Red	Green	Red
Source 39	Green	Yellow	Red	Red	Red	Green	Red
Source 40	Green	Yellow	Red	Yellow	Red	Red	Red
Source 41	Green	Red	Red	Yellow	Red	Red	Red
Source 42	Green	Yellow	Red	Yellow	Red	Red	Red
Source 43	Green	Yellow	Red	Yellow	Red	Red	Red
Source 44	Green	Yellow	Yellow	Yellow	Red	Red	Yellow
Source 45	Green	Yellow	Red	Yellow	Red	Red	Red
Source 46	Green	Yellow	Red	Yellow	Red	Red	Red
Source 47	Green	Yellow	Yellow	Yellow	Red	Red	Red
Source 48	Green	Yellow	Yellow	Yellow	Red	Red	Red
Source 49	Green	Yellow	Yellow	Yellow	Red	Red	Red
Source 50	Green	Yellow	Yellow	Yellow	Red	Green	Yellow

Currently over 200 data points in repository

General Study Challenges

- Data Scarcity
 - Desired data not commonly collected across organizations
- Data Consistency
 - Collection methods differ between organizations
 - Metrics measurement systems occasionally in flux, often due to mergers or benchmarking against sister organizations
- Study resistance
 - Lack of sufficient upper management support
 - Lack of resources
 - Data proprietary restrictions

Government Source Challenges

- Resources for study participation
 - Working Capital Fund (WCF) organizations need to maximize “direct-charge” work just like contractors!
- Granularity of data
 - Effort may not be tracked to individual maintenance release if there are multiple concurrent releases
 - Government timecard systems have the same implementation issues as those of contractor organizations
- Data Scarcity
 - Data collection driven by policy, often not in centralized database
- Data Consistency
 - Collection methods differ between organizations
 - Metrics measurement systems occasionally in flux, often due to benchmarking against sister organizations

Contractor Source Challenges

- Data access
 - Proprietary information agreements (PIAs)
- Resources for study participation
 - Limited ability to charge overhead, especially if not well-aligned with organizational objective
 - Drove study team to focus on “as-collected” data sources
- Data Scarcity
 - Data only collected if government deliverable or internal initiative
- Data Consistency
 - Collection methods differ between organizations
 - Metrics measurement systems occasionally in flux, often due to mergers

Results

- ~ 240 data points collected (at “press time”)
 - Comparable number of Government and Contractor data source
 - Former tend to have many more data points
- Initial Data Analysis
 - Computation of benchmarks (e.g., SLOC/FTE)
 - Exploration of cost drivers (e.g., scatterplot effort vs. STRs)
 - Testing for populations (e.g., Ground vs. Air)
 - Including reduced # of data points
- Initial Findings
 - TBD
- Data Repository Status
 - Air Force
 - Program, Organic and Contractor Software Support
 - Army
 - Organic and Contractor Software Support
 - Navy
 - Program, Data Warehouse, and Data Collectors
- Desired Metrics
 - TBD

**Preliminary Results to be updated
prior to June conference**

Road Ahead

- Focusing or “streamlining” data collection instrument
 - Content: Focus on key data elements
- Additional data collection
 - Previous and new sources
 - Are you interested?
- Database enhancement to include raw and normalize data collected
- Develop guidance and recommendations
 - Cost estimating methodologies and relationships
 - Update maintenance chapter in AFCAA’s Software Cost Estimation Metrics Manual
- Institutionalize data collection via policies/CDRLs
 - SRDR for Software Maintenance, DD Form 1921-4