



# Using Army Software Sustainment Cost Estimating Results DASA-CE

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Presented to  
ICEAA  
June 2018

# SWM Initiative Objective and Strategy

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Accurately estimate Army system software sustainment costs to:

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

Collect and evaluate SWS cost and technical data for all Army operational systems (Phase I and Phase II data call)

Generate and validate cost estimating relationships from Phase I and Phase II data collection

Implement systemic Army SWS data collection via the SRDR-M. Populate cost and technical data repository

Improve Army SWS policy, business, and technical requirements

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



# Purpose

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Purpose: Share Software Sustainment cost estimation initiative approach and results to facilitate data driven portfolio analysis including:

- Data collection approach
- Lessons learned about data collection, evaluation, and normalization
- Initial analysis results including data categorization, distributions, and benchmarks
- Influencing factors and design decisions that drive the cost of sustainment

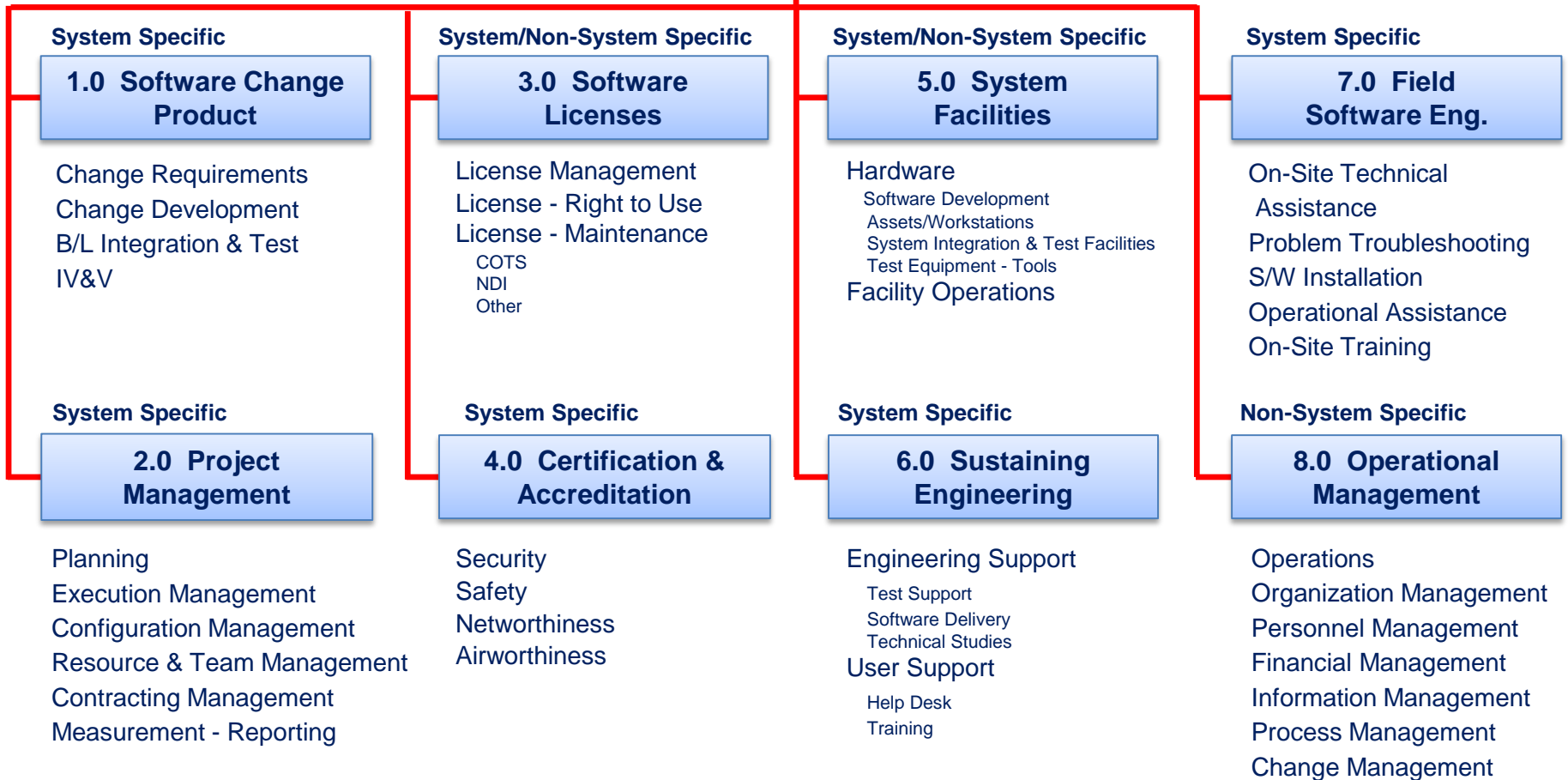
Implementation: DASA-CE implemented a data-call across the Army (PEOs and LCMCs) broken into two phases

- Phase I (56 programs)
- Phase II (~150 programs)



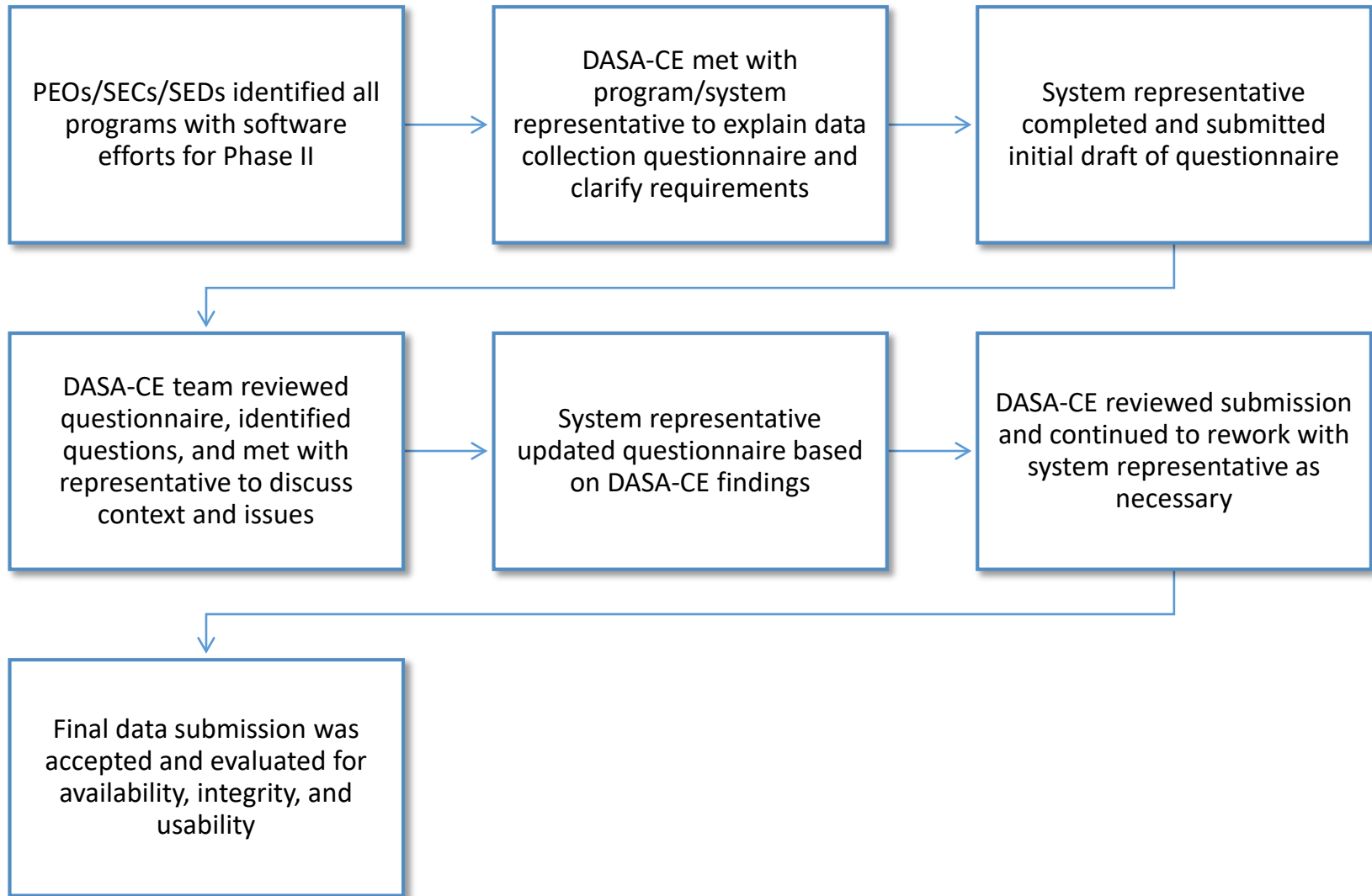
# DASA-CE SWS WBS

## Software Sustainment



Version 4.4d

# Data Collection Process



# Data Fields in Questionnaire

## System Level Context (1 of 3)

System Description	System Name
	System Description
	Services (Army, Navy, AF, etc)
	ACAT Level
Phase / Milestone	Current Phase
	Start Date of Phase
Context Information	# of Baselines
	# of Systems Fielded
	# of Variants
	# of Users
	Maintenance Activities Performed
	Maintenance Process
	Operational Tempo
Data Rights	Software Process Maturity
	Data Rights Type
	Data Rights Cost
Organization Information	Data Rights Ownership
	Analogous Systems
	Funding Appropriations Used
	Collection Date
	POC Information
	PEO & SEC
Transition to SEC Date	
	Developers & Current Maintainers



# Data Fields in Questionnaire

## System Level Annual (2 of 3)

WBS Element - Cost and Effort
System Total
Software Change Product (SW Releases)
Project Management
Software Licenses
Certification and Accreditation
System Facilities
Sustaining Engineering
Field SW Engineers
Operational Management
Labor Hours per Year & Labor Rate

License Questions
License Name
Company name
Quantity
Entitlement
Total Cost
Type
Duration
Award Date

- Programs were requested to report 3 years of cost and effort data broken out by the WBS as well as license information, certification frequency, and certification type (DIACAP, RMF, NSA, etc.)
- Data from government and contractor activities



# Data Fields in Questionnaire


## Software Release Level (3 of 3)

Report Context	Release Name	SLOC	Software Language
	Release Description		Baseline Code Count
Release Characterization	% Enhancements		New Code Count
	% Maintenance		Modified Code Count
	% Cybersecurity		Reuse Code Count
	% Other		Auto-Generated Code Count
	Release Status		Comments Count
Product and Maint. Description	SW Release Anomalies		Deleted Code Count
	Operating Environment		Delivered Code Count
	Manned vs Unmanned	Non-SLOC Sizing	Sizing Method
	Application Domain / Super Domain		Total Size
Release Schedule	Start Date		Count of Size Type
	End Date		Number Implemented
Release Effort & Cost	Government Cost & Hours	Software Changes	Total Number of Changes
	Contractor Cost & Hours		Priority 1
Requirements / Interface Size	Requirements /Interfaces Description		Priority 2
	Requirements at Release Start		Priority 3
	Requirements Affect in Release		Priority 4
	Total System Interfaces		Priority 5
	Interfaces Affected in Release	IAVAs	Number of Changes in Backlog
			Number of IAVAs Addressed






# Data Demographics

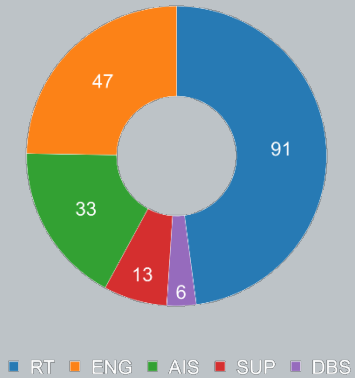
 193 Programs

 1,036 Total Releases

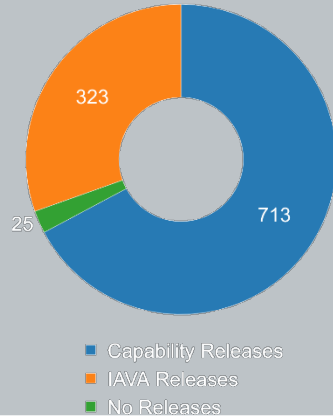
 3,434 Licenses

 411K Data Fields

Programs by Super Domain



Release Types

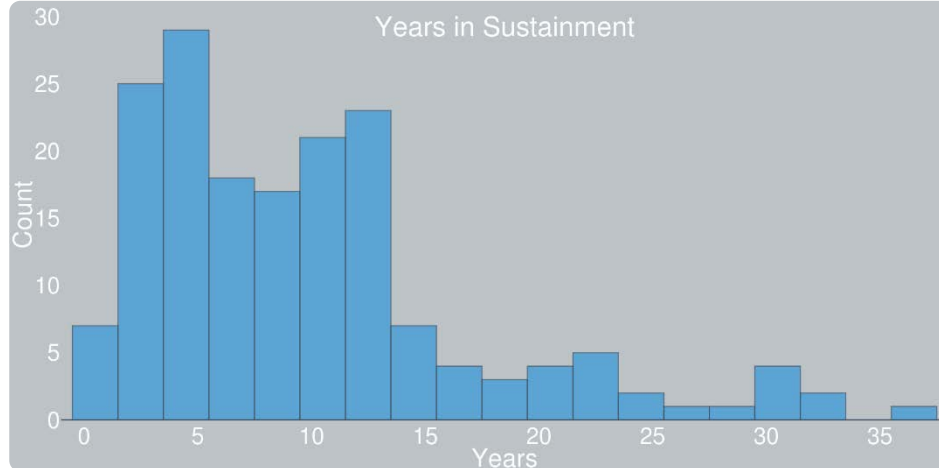


Size Reported by Release



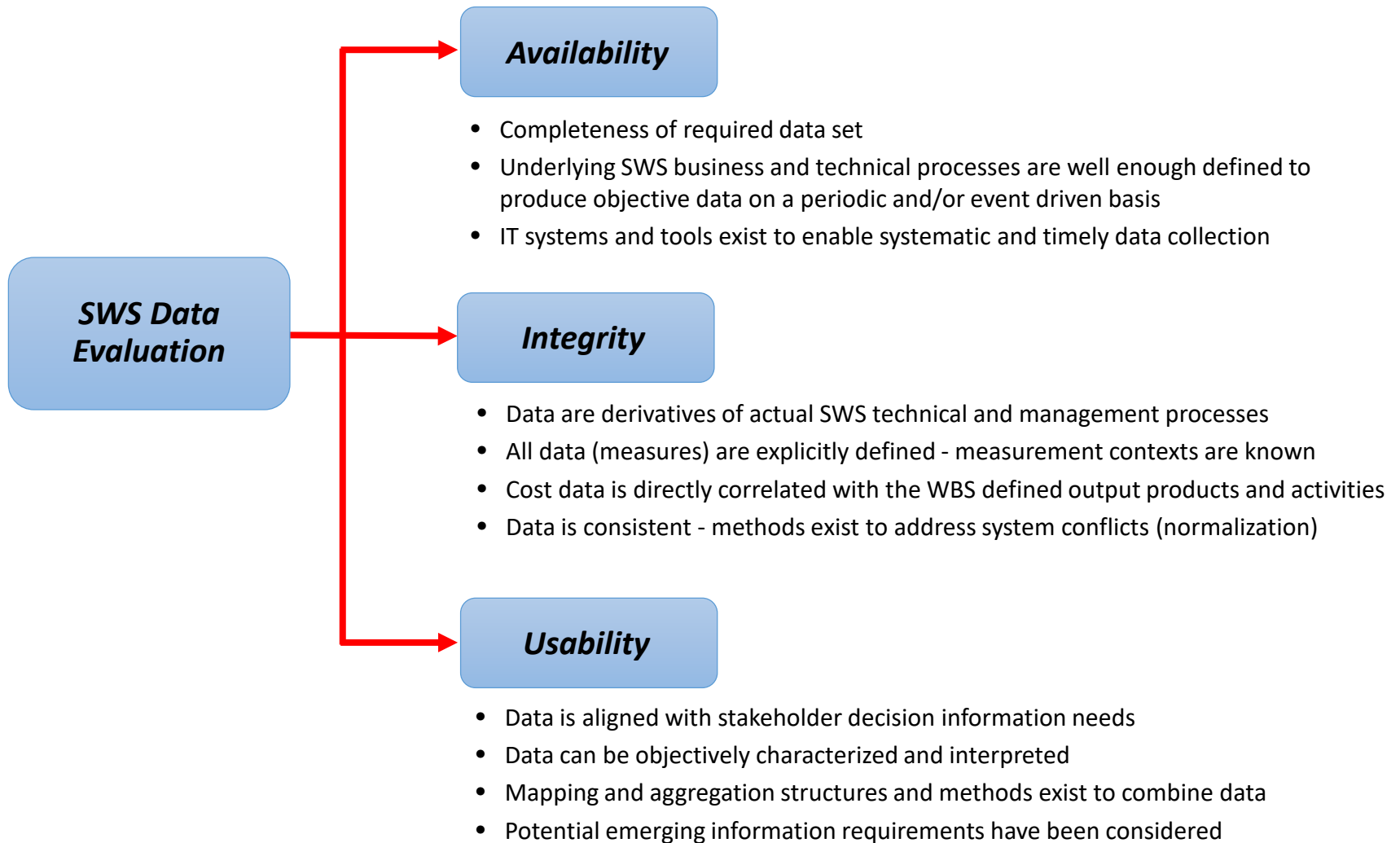
- Largest DoD Software Sustainment database
- Total Dollar Value Captured: \$3.1B
- Programs collected ranged from ACAT I to Non-Program of Records

Years in Sustainment



# Software Sustainment Data Evaluation

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# Data Quality Evaluation

## Annual Cost Level

Color	Definition	Value
<b>R</b>	Red indicates there is no planning or actual data reported	0
<b>Y</b>	Yellow indicates FTE or partial, actual data was reported	1
<b>G</b>	Green indicates that actual data was reported	2

System Level Annual											
Initial System Overall				Detailed System Assessment							
Rating	Definable Maint. Process	Total Program Effort/Cost	WBS 2-8	Change Product (WBS-1)	Project Mgmt (WBS-2)	License Mgmt (WBS-3)	C&A (WBS-4)	Facilities (WBS-5)	Sustaining Engineering (WBS-6)	Field S/W Engineering (WBS-7)	Operational Mgmt (WBS-8)
<b>R</b>	25	16	60	67	74	112	60	105	95	44	137
<b>Y</b>	79	36	93	36	61	8	36	19	13	11	26
<b>G</b>	76	138	37	87	55	51	72	45	78	47	27
<b>N/A</b>	10	0	0	0	0	19	22	21	4	88	0
<b>Total</b>	<b>190</b>	<b>190</b>	<b>190</b>	<b>190</b>	<b>190</b>	<b>190</b>	<b>190</b>	<b>190</b>	<b>190</b>	<b>190</b>	<b>190</b>

- Data was collected from 190 programs
  - 174 programs provided total system SWM costs (G, Y)
  - 16 programs could not provide even planned total cost
- A lot of programs could not articulate how much was spent for licenses or facilities, often because these are paid for by enterprise or overhead funds



# Data Quality Evaluation

## Capability Releases

Release Level (Capability Releases Only)										
Initial Release Overall			Detailed Release Assessment							
Rating	CER Usability	SER Usability	Schedule (WBS-1)	Effort (WBS-1)	Size: Requirements	Size: External Interfaces	Size: SLOC	Size: Non-SLOC	Size: SW Changes	IAVAs
<b>R</b>	270	220	71	196	372	425	296	0	175	451
<b>Y</b>	89	133	0	144	0	0	0	0	0	0
<b>G</b>	348	354	636	367	200	134	145	37	532	164
<b>N/A</b>	6	6	6	6	141	154	272	676	6	98
<b>Total</b>	<b>713</b>	<b>713</b>	<b>713</b>	<b>713</b>	<b>713</b>	<b>713</b>	<b>713</b>	<b>713</b>	<b>713</b>	<b>713</b>

- Data was collected from 713 capability releases
  - 437 releases had sufficient data to use in CER cost calculations (G, Y)
  - Size data was not always consistently tracked and generally was not mapped to resource (effort/cost) information
    - 532 releases tracked some sort of software change counts (defects, PTRs)
    - Many of the capability releases did not track the number of IAVAs addressed
    - Effort was often not tracked at the release level
    - Systems in different super-domains used different size measures
      - Software changes was the most commonly used size measure



# Data Quality Evaluation

## IAVA Only Releases

Release Level (IAVA Releases Only)										
Initial Release Overall			Detailed Release Assessment							
Rating	CER Usability	SER Usability	Schedule (WBS-1)	Effort (WBS-1)	Size: Req'ts	Size: External Interfaces	Size: SLOC	Size: Non-SLOC	Size: SW Changes	IAVAs
<b>R</b>	87	30	11	27	68	116	99	0	103	70
<b>Y</b>	147	169	0	170	0	0	0	0	0	0
<b>G</b>	89	124	312	126	59	10	8	2	31	253
<b>N/A</b>	0	0	0	0	196	197	216	321	189	0
<b>Total</b>	<b>323</b>	<b>323</b>	<b>323</b>	<b>323</b>	<b>323</b>	<b>323</b>	<b>323</b>	<b>323</b>	<b>323</b>	<b>323</b>

- Many programs reported IAVA only releases which are releases that address known cybersecurity vulnerabilities
- Data was collected from 323 IAVA only releases
  - 236 releases have sufficient data to use in CER cost calculations (G, Y)
  - Programs sized IAVA releases by the count of IAVAs information assurance vulnerability alerts

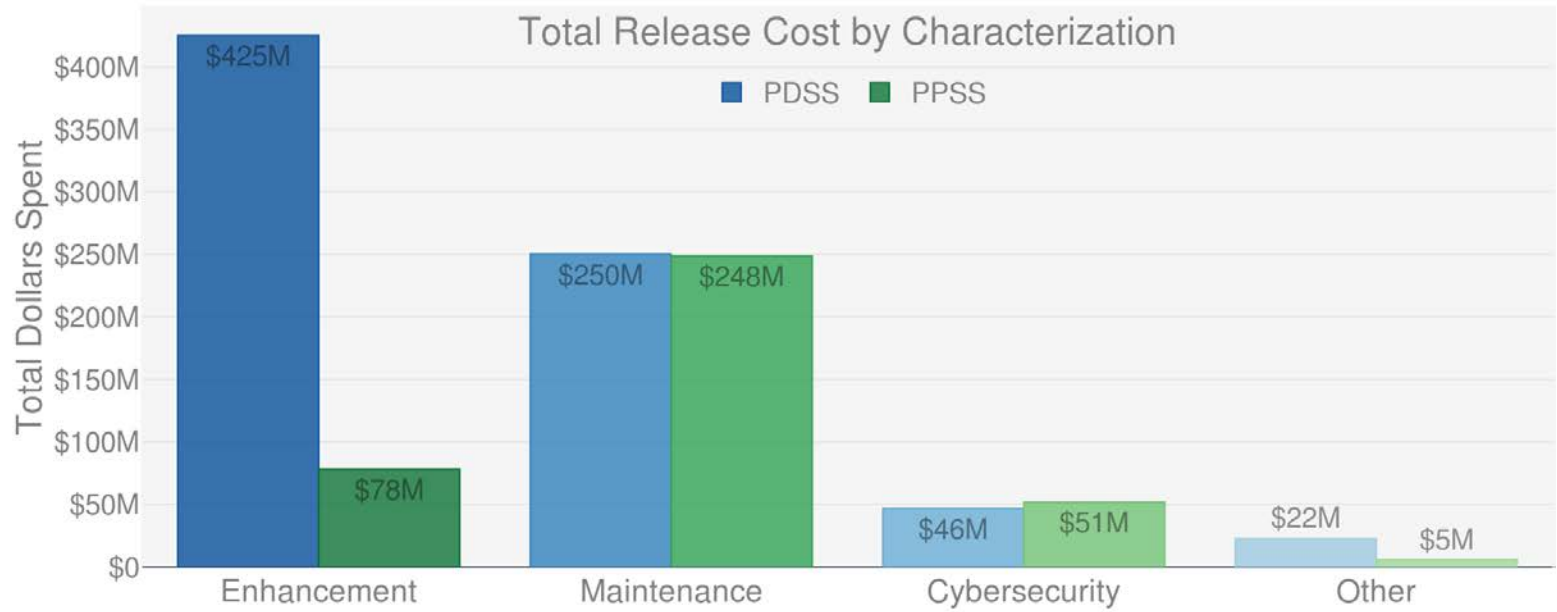
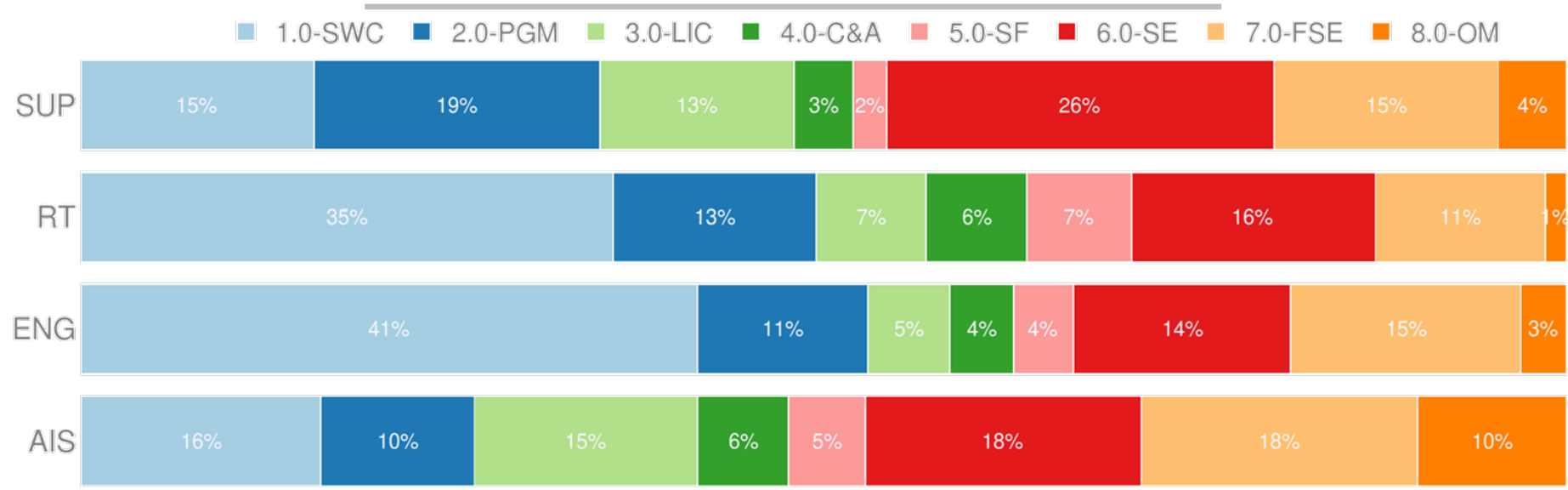


# Super Domain Definitions

Real-Time	Engineering	Support	AIS
<p>Real-Time is the most constrained type of software. These are specific solutions limited by system characteristics such as memory size, performance, or battery life. These projects take the most time and effort due to constraints.</p>	<p>Engineering software operates under less severe constraints than real-time software. This software may take real-time software outputs and further process them to provide human consumable information or automated control of devices. Or the software may perform transformation and aggregation / distribution of data.</p>	<p>Support software assists with operator training and software testing. This software has few constraints.</p>	<p>Automated information system software provides information processing services to humans or software applications. These applications allow the designated authority to exercise control and have access to typical business / intelligence processes and other types of information access. These systems also includes software that facilitates the interface and control among multiple COTS / GOTS software applications.</p>
Application Domains	Application Domains	Application Domains	Application Domains
<p>Microcode &amp; Firmware Signal Processing Vehicle Control/Vehicle Payload Other Real-Time Embedded Command &amp; Control Communications</p>	<p>System Process Control Scientific and Simulation Test, Measurement, Diagnostic and Evaluation</p>	<p>Training Software Tools</p>	<p>Mission Planning Custom AIS Software Enterprise Service Systems Enterprise Information Systems</p>
Examples	Examples	Examples	Examples
<p>Field Programmable Gate Arrays, Flight Control, Missile Control, Radar Altimeter, Network Operations, Signal Electronics, Tracking Sensors, Encryption, Radio Networks, Propulsion</p>	<p>Operating Systems, Image processing, Simulation &amp; Modeling, Test Equipment, File Management, Artificial Intelligence, Manufacturing Process Control</p>	<p>Computer Based Training, Compilers, Programming Aids, Code Generators, Assemblers, Courseware, Test case generation, Linker/loaders, Code Auditors</p>	<p>Scenario Generators, Target Planning, Enterprise Service Management, Enterprise Resource Planning, Transaction Processing, Data Warehousing, Financial Transactions</p>



# SWS Cost Allocation by WBS



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# Distributions and Benchmarks

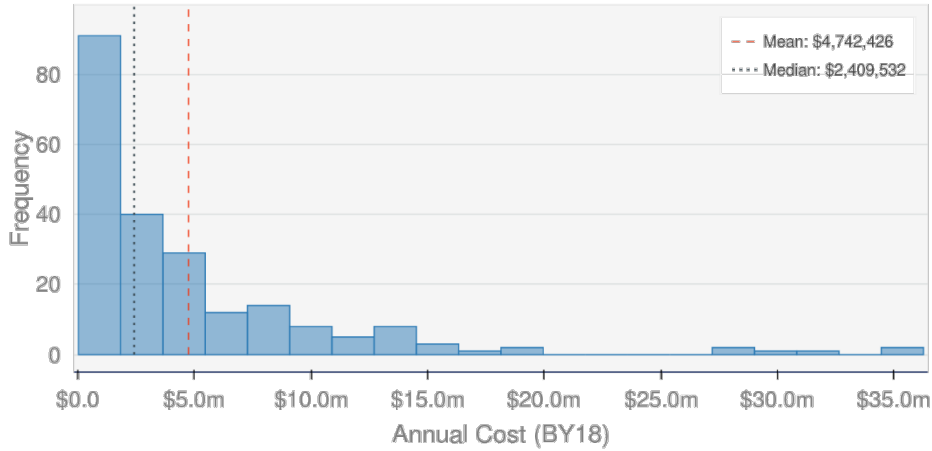




# SWS Total Annual Cost Distributions

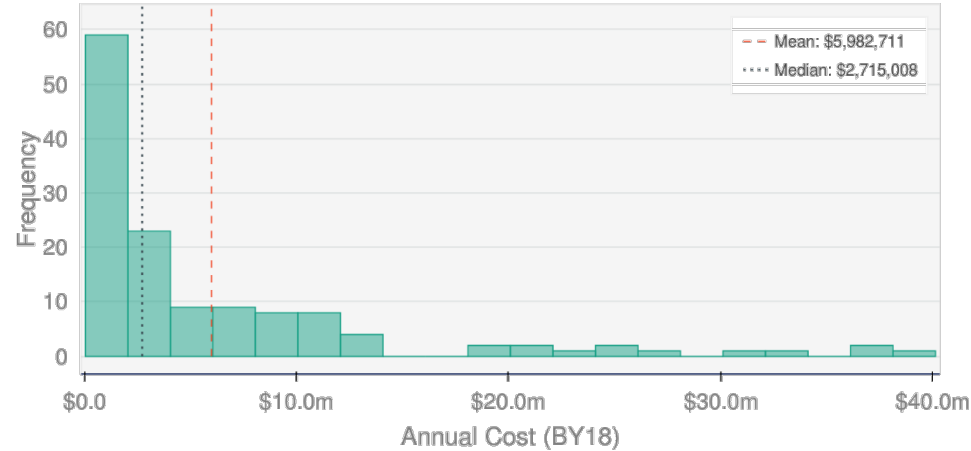
## Annual Cost by Super Domain

RT - Annual Total



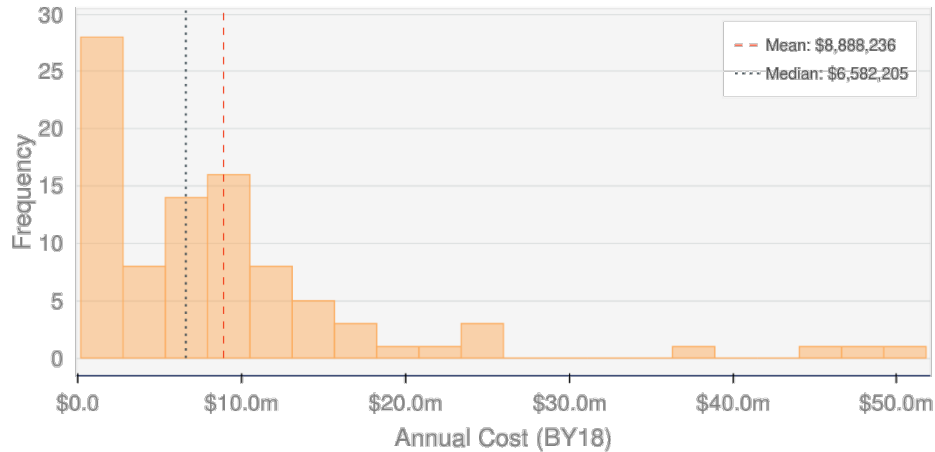
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
219	\$16,047	\$992,952	\$2,409,532	\$5,780,354	\$36,278,114	\$4,742,426

ENG - Annual Total



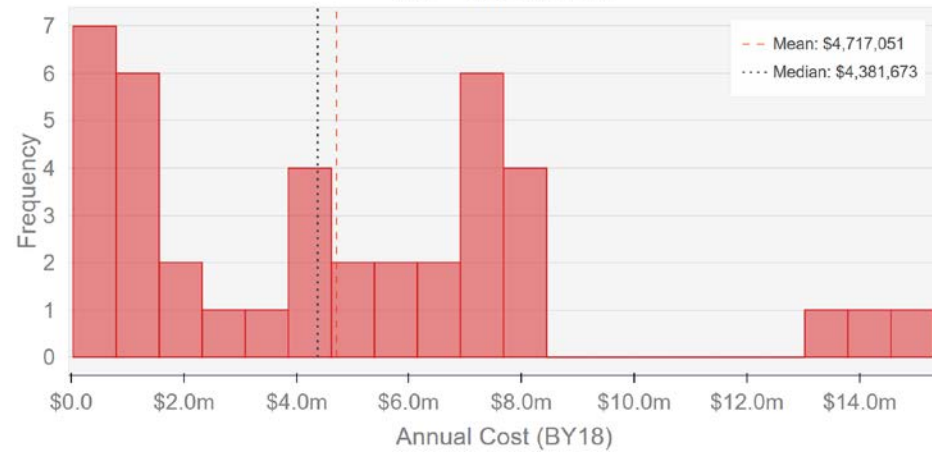
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
133	\$35,841	\$1,005,502	\$2,715,008	\$7,579,732	\$40,141,088	\$5,982,711

AIS - Annual Total



Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
91	\$168,409	\$1,899,573	\$6,582,205	\$10,648,955	\$51,797,592	\$8,888,236

SUP - Annual Total



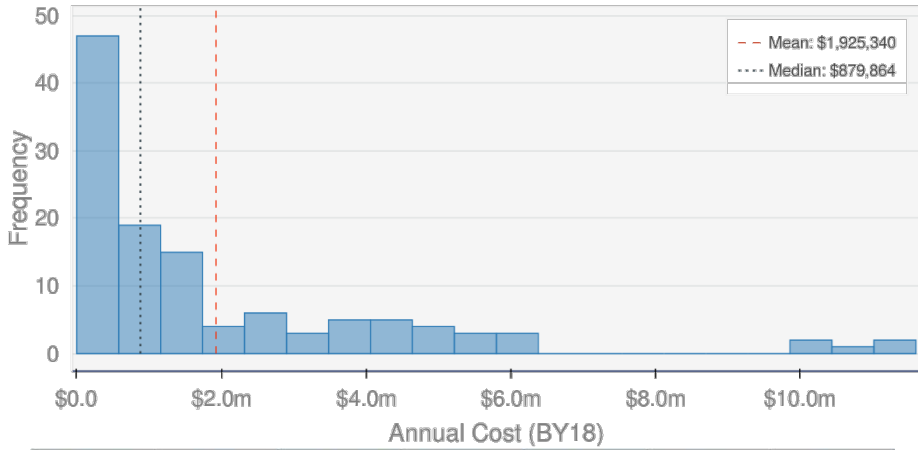
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
40	\$38,203	\$891,637	\$4,381,673	\$7,073,955	\$15,319,248	\$4,717,051



# WBS 1.0 – Software Change Product

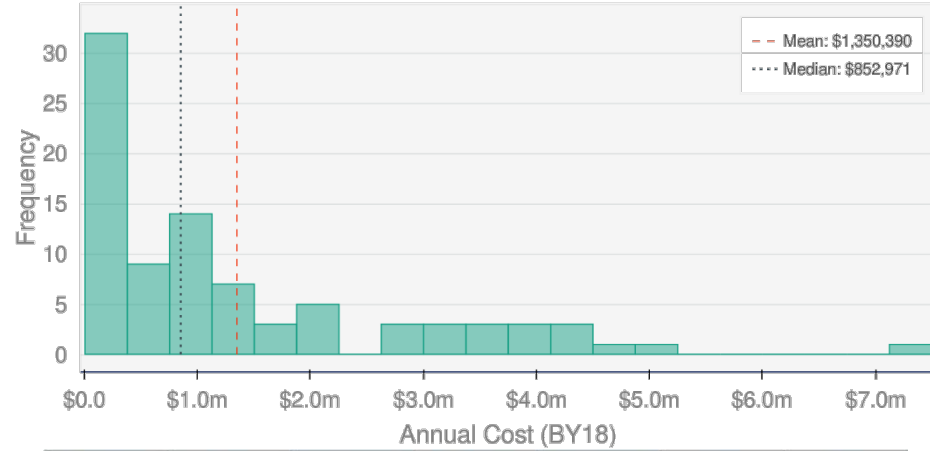
## Annual Cost by Super Domain

RT - Software Change Product



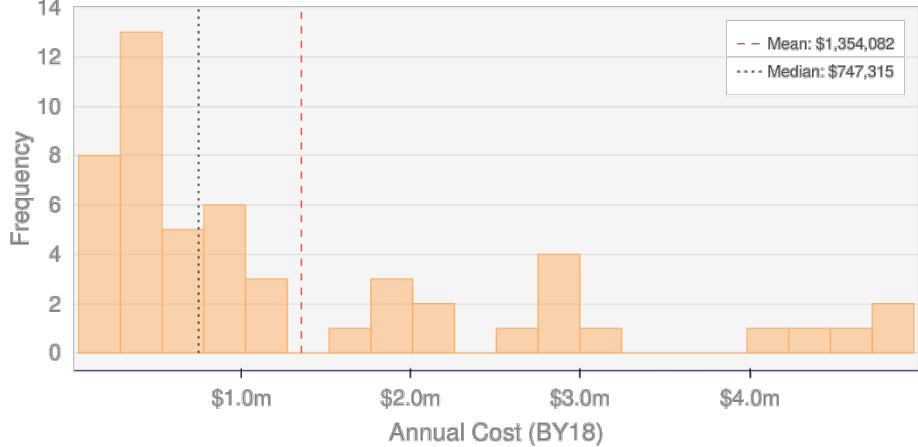
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
119	\$235	\$258,447	\$879,864	\$2,760,751	\$11,597,624	\$1,925,340

ENG - Software Change Product



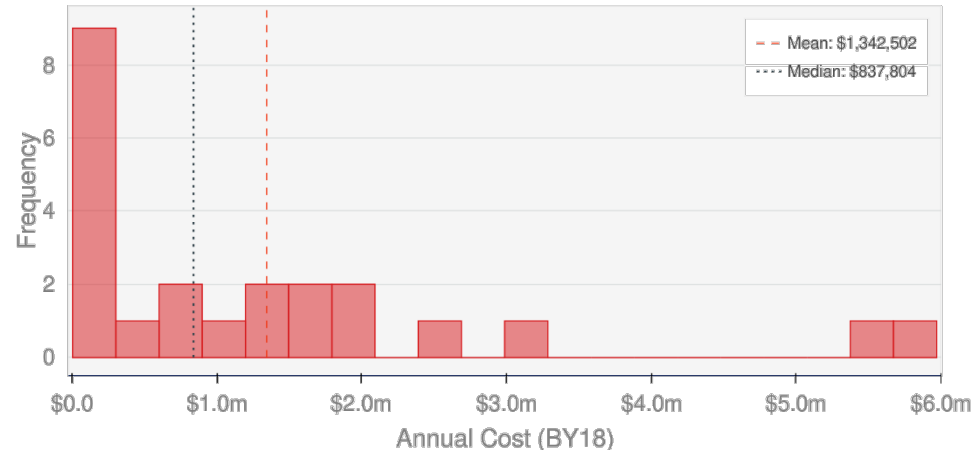
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
88	\$5,704	\$169,199	\$852,971	\$2,092,788	\$7,496,722	\$1,350,390

AIS - Software Change Product



Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
52	\$39,115	\$394,703	\$747,315	\$1,951,402	\$4,969,549	\$1,354,082

SUP - Software Change Product



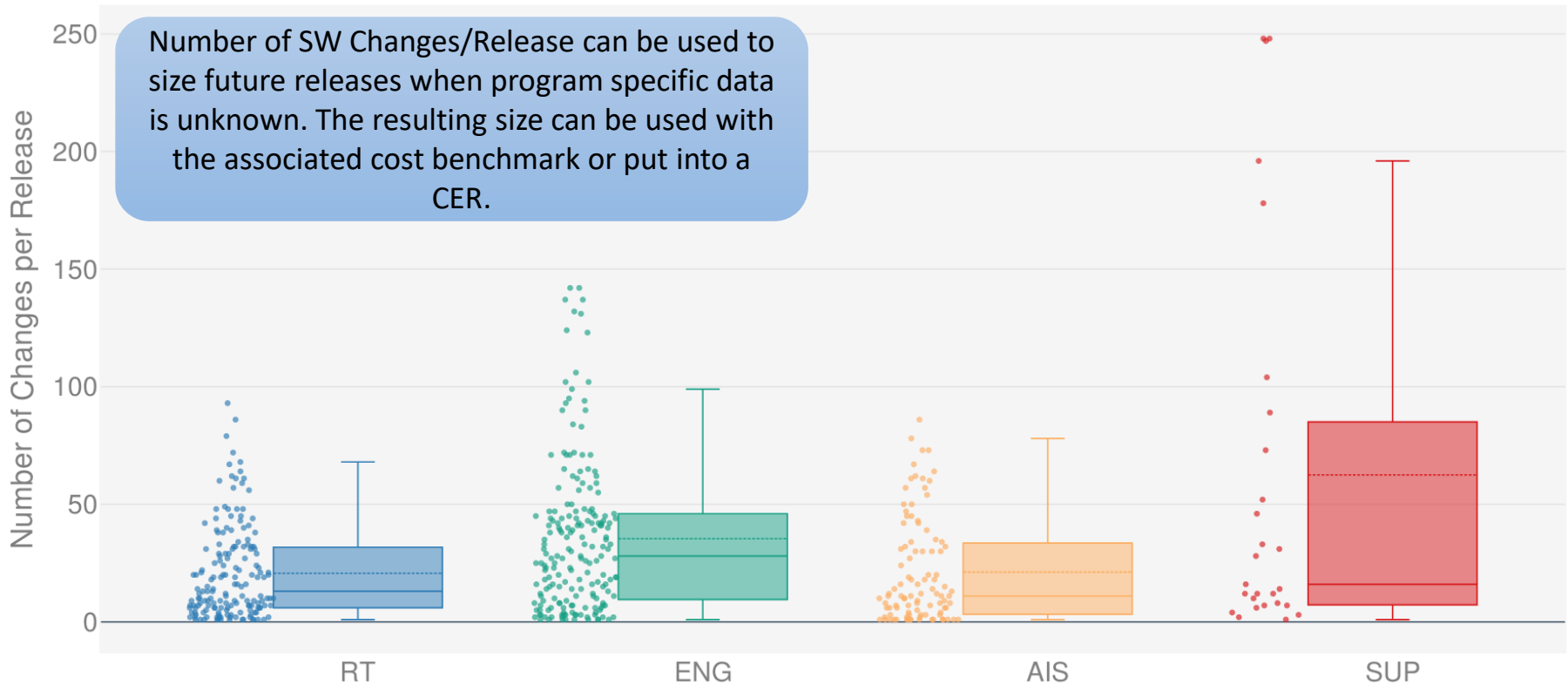
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
23	\$2,089	\$221,520	\$837,804	\$1,782,828	\$5,972,031	\$1,342,502



# Distribution of Software Changes

## Capability Releases

### Software Changes per Release

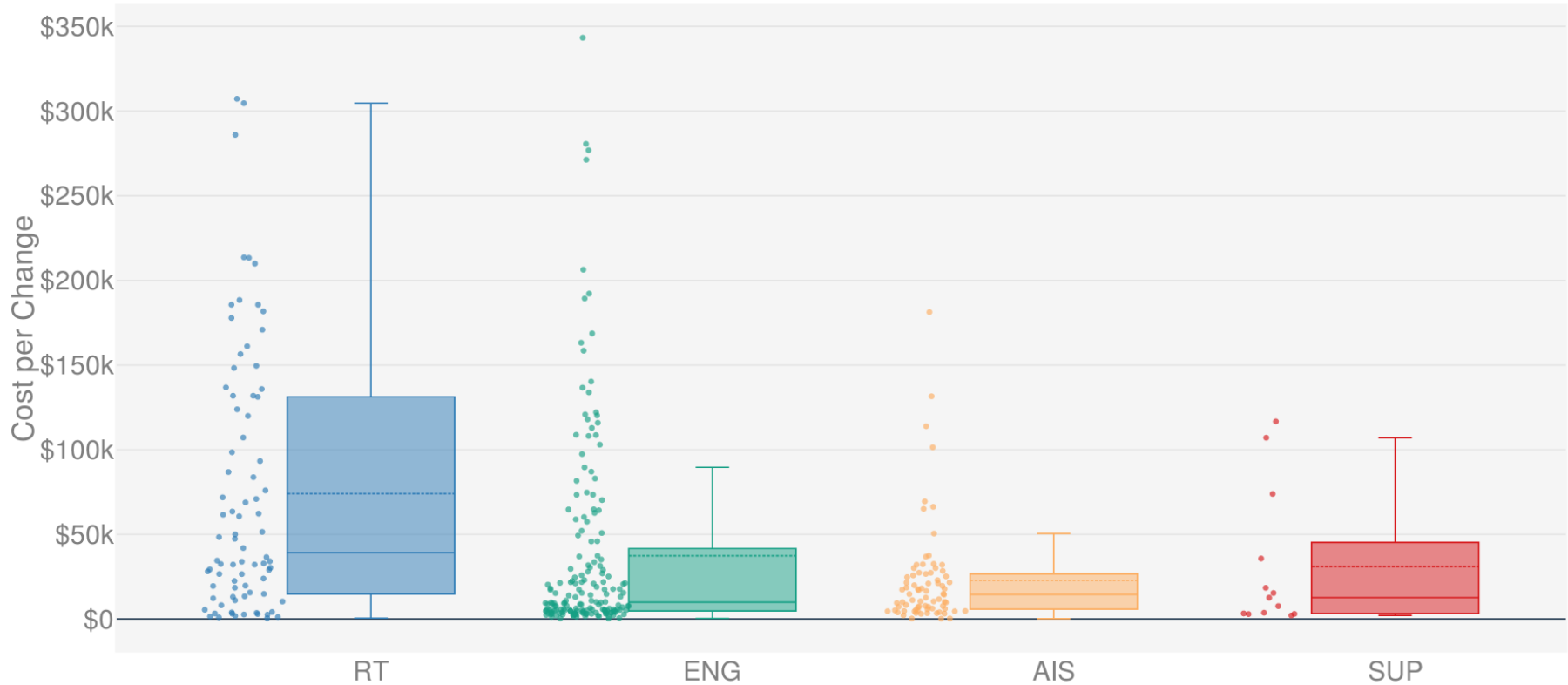


Super Domain	Count	Min	25%	50%	75%	Max	Mean	Std
RT	167	1	6	13	31	93	20	19
ENG	192	1	9	28	46	142	35	32
AIS	99	1	3	11	33	86	21	22
SUP	27	1	7	16	81	248	62	83



# Cost per SW Change Capability Releases

## Cost per Software Change



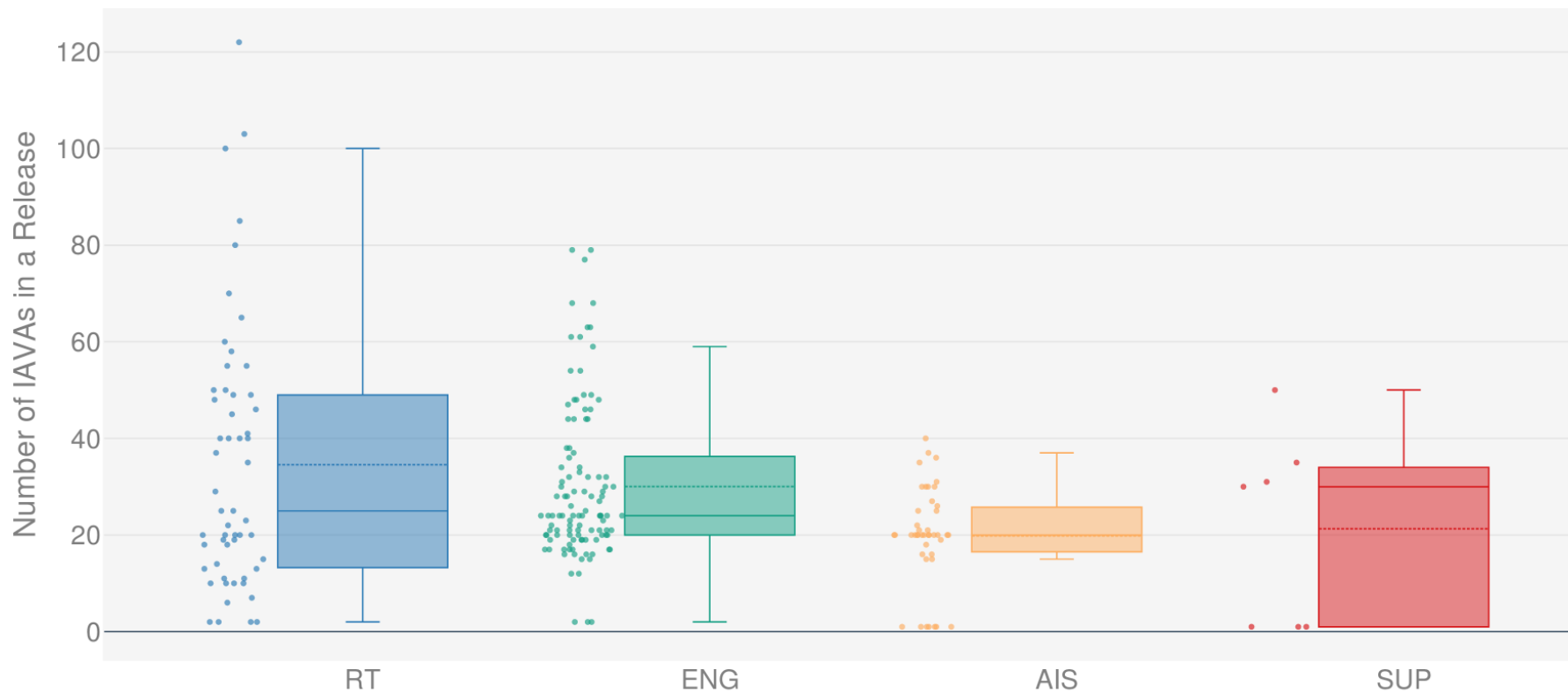
Super Domain	Count	Min	25%	50%	75%	Max	Mean	Std
RT	82	\$488	\$15,019	\$39,219	\$129,365	\$307,244	\$74,082	\$76,622
ENG	176	\$354	\$4,774	\$9,885	\$39,472	\$343,344	\$37,350	\$58,891
AIS	78	\$187	\$5,871	\$14,547	\$26,412	\$181,292	\$22,763	\$30,236
SUP	13	\$2,106	\$3,290	\$12,603	\$35,735	\$116,673	\$30,954	\$41,022



# Distribution of IAVAs

## IAVA Releases

### IAVAs per Release



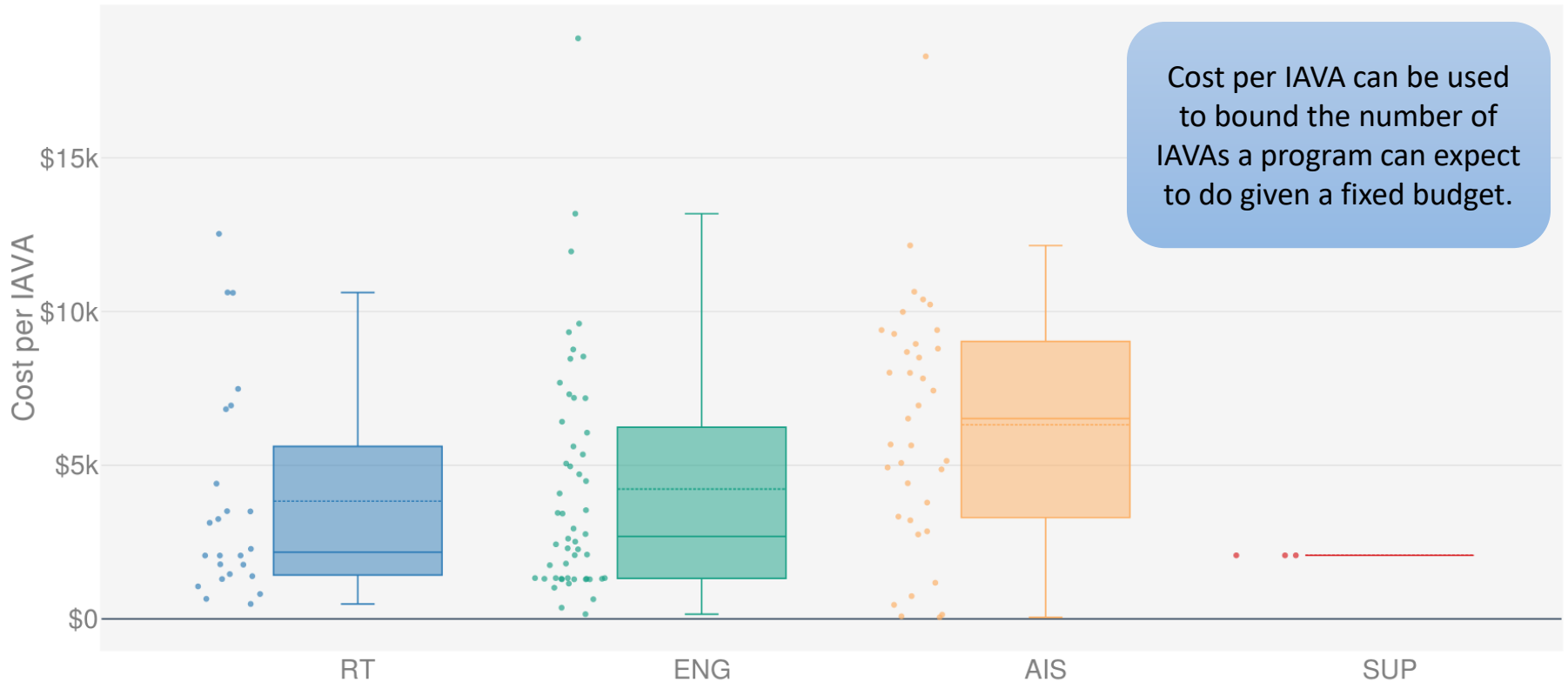
Super Domain	Count	Min	25%	50%	75%	Max	Mean	Std
RT	55	2	13	25	49	122	34	27
ENG	109	2	20	24	36	79	30	16
AIS	43	1	17	20	25	40	19	10
SUP	7	1	1	30	33	50	21	20



# IAVA Cost Benchmark

## IAVA Releases

### Cost per IAVA



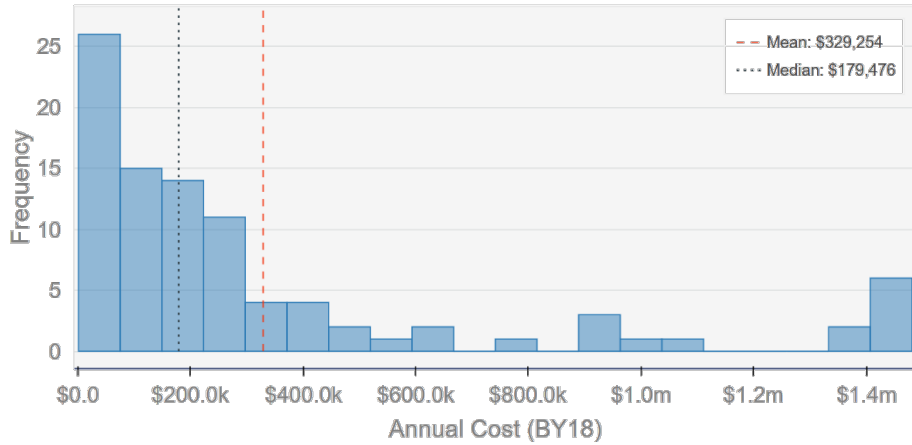
Super Domain	Count	Min	25%	50%	75%	Max	Mean	Std
RT	24	\$484	\$1,439	\$2,167	\$5,005	\$12,528	\$3,829	\$3,474
ENG	52	\$152	\$1,320	\$2,684	\$6,146	\$18,889	\$4,224	\$3,779
AIS	37	\$50	\$3,325	\$6,516	\$8,945	\$18,303	\$6,315	\$3,986
SUP	3	\$2,065	\$2,065	\$2,065	\$2,065	\$2,065	\$2,065	\$0



# WBS 4.0 – Certification & Accreditation

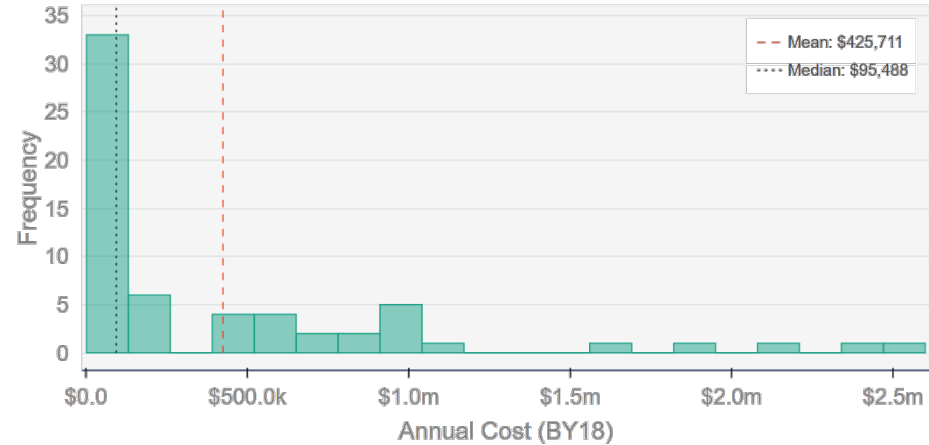
## Annual Cost by Super Domain: All Years (FY13-FY17)

RT - C&A Total



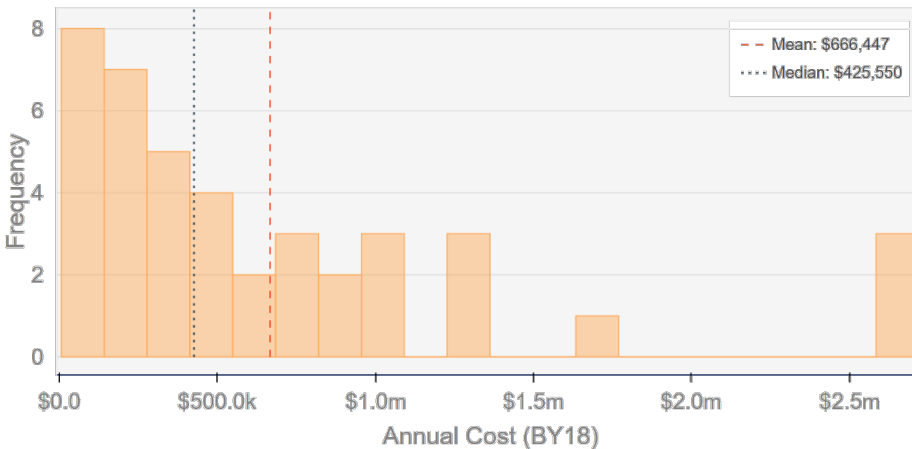
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
93	\$1,589	\$74,148	\$179,476	\$368,363	\$1,481,020	\$329,254

ENG - C&A Total



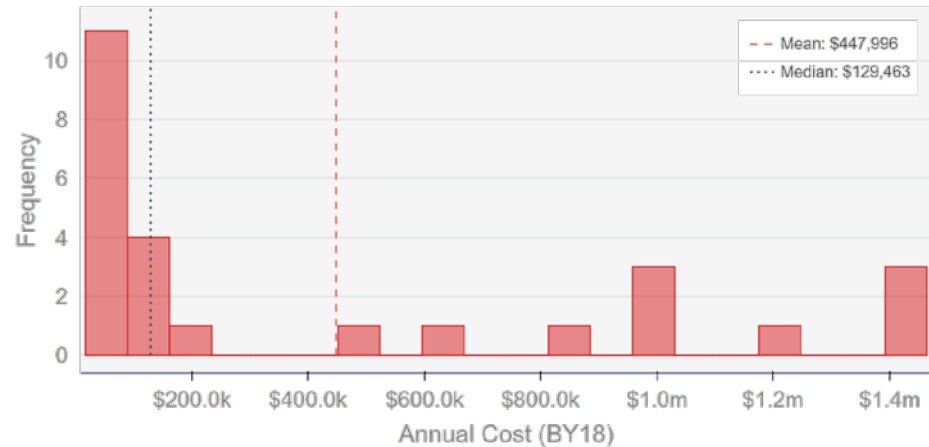
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
62	\$3,070	\$36,196	\$95,488	\$569,705	\$2,600,117	\$425,711

AIS - C&A Total



Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
41	\$5,149	\$178,445	\$425,550	\$878,470	\$2,719,843	\$666,447

SUP - C&A Total



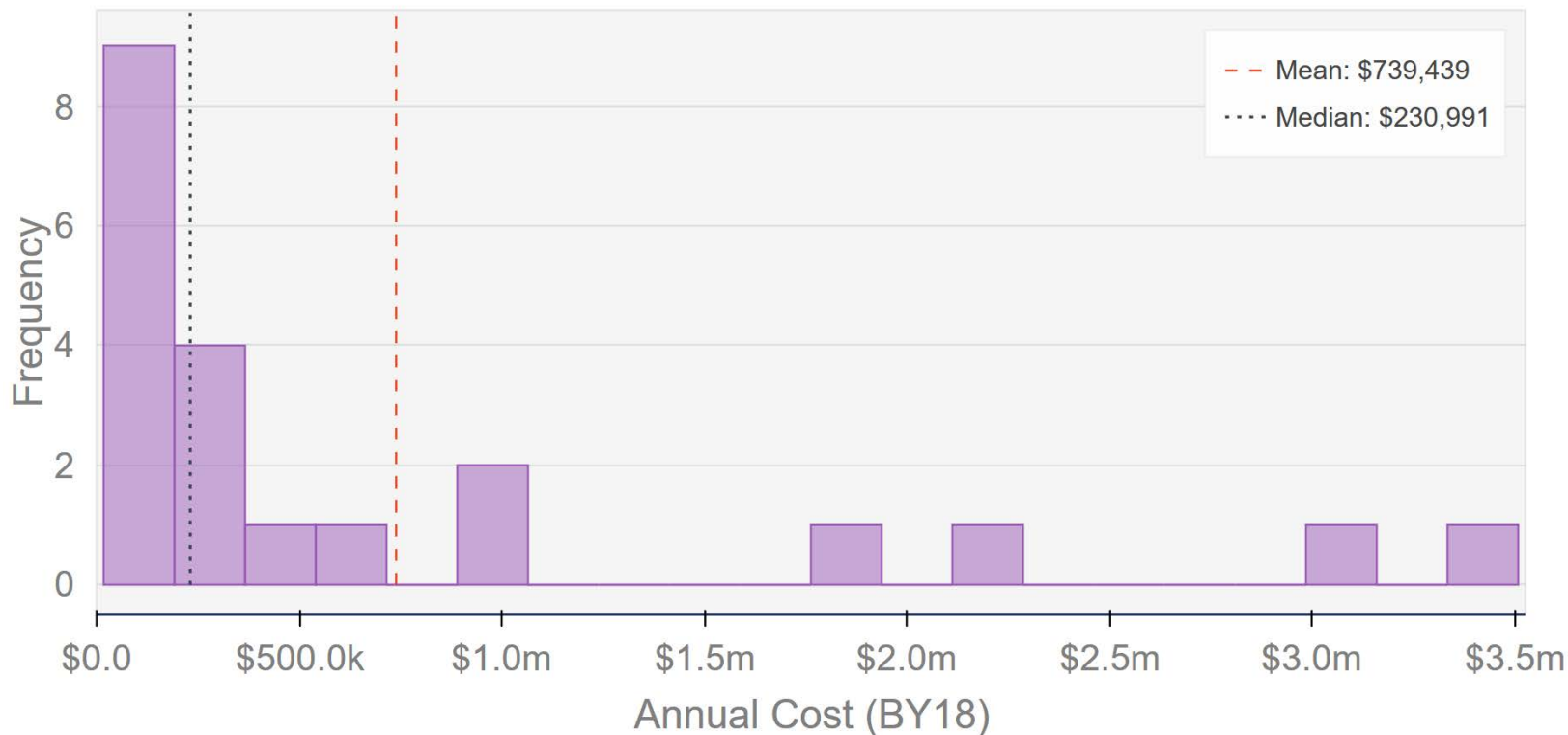
Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
26	\$17,262	\$42,449	\$129,463	\$940,186	\$1,463,958	\$447,996



# WBS 4.0 – Certification & Accreditation

All Super Domains: FY16-FY17

## Certification and Accreditation



Count	Min	1st Quartile	Median	3rd Quartile	Max	Mean
21	\$17,262	\$126,804	\$230,991	\$928,354	\$3,509,878	\$739,439

- Higher cost of C&A's in more recent years reflects the transition period of moving from DIACAP certification to Risk Management Framework (RMF) certification which generally requires more effort





# Software Change Definition Variability

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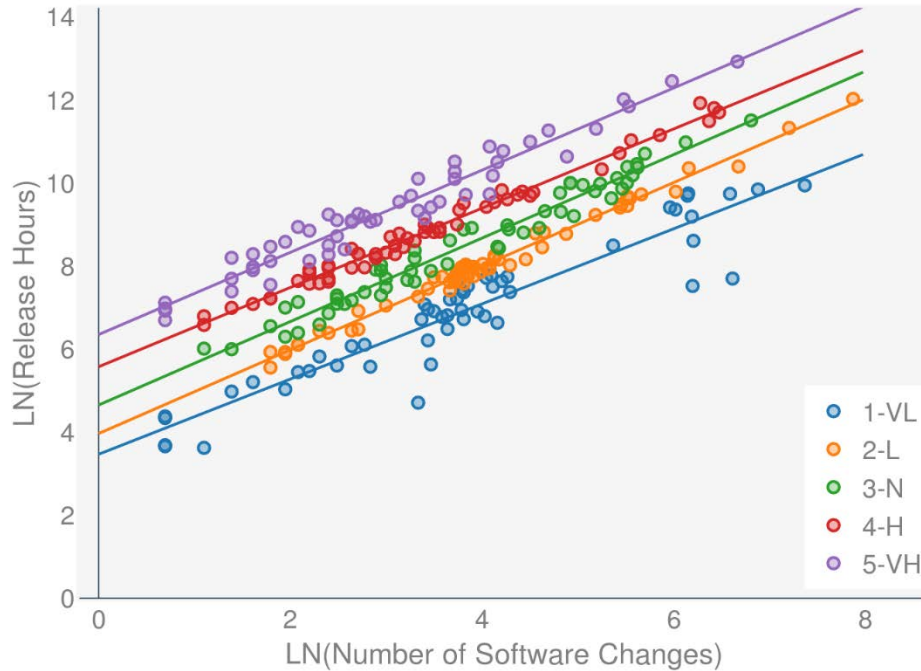
- Within WBS 1.0, the effort associated with software releases is captured. A software release can be sized using the count of the number of software changes.
- A software change describes a change where source code/script is altered whether it be added, deleted or modified. Respondents defined a software change as:
  - Enhancement
  - New Requirements – Change or clarification of a requirement that results in a source code modification
  - New Capability: Addition of a new capability
  - Improvement: Enhancement to an existing capability
  - Issues
  - “Bug” fix: defect
  - Change or clarification of a design that results in a source code modification
  - Change request: changes to the requirements and the corresponding implementation.
  - Defect report: Defects are changes to the software to make them meet the requirements.
  - Problem Change Reports
  - Modification requests

Since there was significant variability across the programs in the definition of a software change, a more in-depth analysis was conducted to understand the costs of different types of software changes

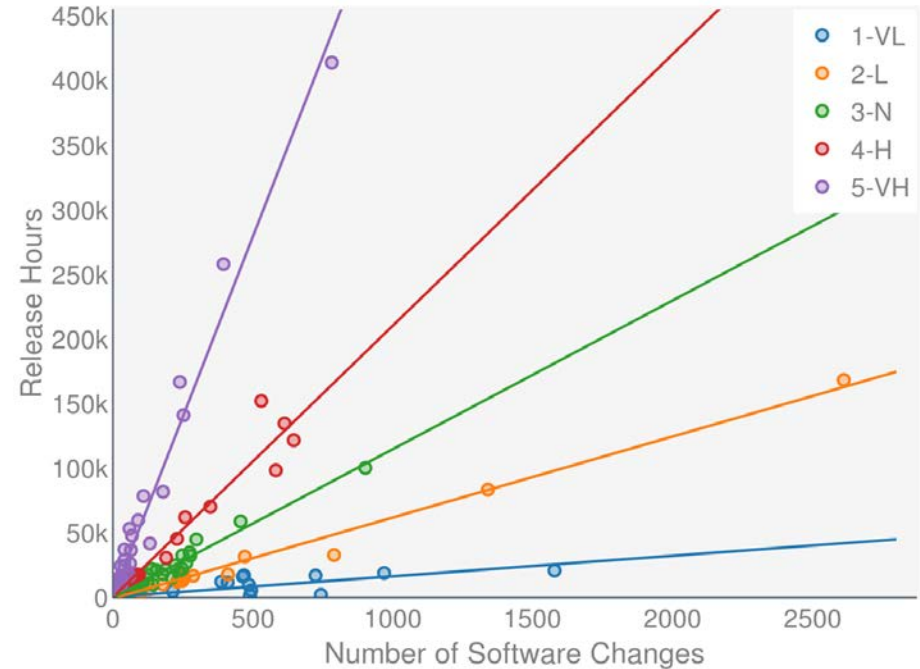


# Unit Cost Grouping Levels: Hrs/SC

Release Hours vs Software Changes (Transformed-Space)



Release Hours vs Software Changes (Fit-Space)



Release Hrs per Software Change	1-VL (Count: 49)	2-L (Count: 46)	3-N (Count: 41)	4-H (Count: 48)	5-VH (Count: 39)
Mean	26.8	60.8	138.3	413.4	2,725.2
Median	28.6	60.8	129.5	403.3	1,437.9
Min Value	2.0	46.9	78.2	212.1	718.0
Max Value	46.2	78.0	211.3	699.9	11,136.0



# Category Analysis Exploration

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- ✓ Maintenance Organization (17)
  - Location of Maintenance Organization (11)
  - Commodities (10)
  - Super Domains (RT, ENG, SUP, AIS)
- ✓ Change types (Enhanced, Maintenance, Cybersecurity)
- ✓ Business models (Government, Contractor, Integrated)
- Maintenance Phase (MS-C LRP, MS-C FRP, O&S)/Time in Phase
- ✓ ACAT Level
  - Number of Software variants
  - Number of Platform variants
  - Number of Users
  - Number of Licenses
- ✓ Number of Inter-Services Partners
- Release/Total Cost

In order to determine into which cost grouping (1-VL through 5-VH) a program will fall, a number of characteristics were examined for significance



# Unit Cost Level One-Category Criteria

- Each slide presents Unit Cost levels by a category criteria
- There are two tables:
  - Top table are the counts of each Release’s Unit Cost at a level
  - Bottom table are the percentages of the counts
- The bottom table is examined for a “percentage” or “adjacent sum of percentages” greater than or equal to 50% (green highlight)
- For example, **Business Model**:

Release Unit Cost Level count by **Business Model**

Business Model	Count	1-VL	2-L	3-N	4-H	5-VH
Government	1	1				
Integrated	77	19	26	12	9	11
Contractor	142	25	18	31	35	33

Release Unit Cost Level count % by **Business Model**

Business Model	Count	1-VL	2-L	3-N	4-H	5-VH
Government	1	100.0%				
Integrated	77	24.7%	33.8%	15.6%	11.7%	14.3%
Contractor	142	17.6%	12.7%	21.8%	24.6%	23.2%



# ACAT & Inter-Services

## Release Unit Cost Level Count % by ACAT

ACAT	Count	1-VL	2-L	3-N	4-H	5-VH
ACAT I	38	5.3%	15.8%	26.3%	18.4%	34.2%
ACAT II	41	31.7%	4.9%	9.8%	24.4%	29.3%
ACAT III	101	24.8%	31.7%	16.8%	13.9%	12.9%
Non PoR	2			100.0%		

## Release Unit Cost Level Count % by Inter-Service

Inter-Service	Count	1-VL	2-L	3-N	4-H	5-VH
Army Only	165	24.8%	23.0%	19.4%	18.2%	14.5%
2	11	9.1%	36.4%	9.1%	27.3%	18.2%
3	7			42.9%	14.3%	42.9%
4	7	14.3%		14.3%	28.6%	42.9%
5	33	6.1%	6.1%	24.2%	27.3%	36.4%



# Super Domain

Release Unit Cost Level Count % by Super Domain

Super Domain	Count	1-VL	2-L	3-N	4-H	5-VH
Real Time	115	27.0%	28.7%	10.4%	18.3%	15.7%
Engineering	54	3.7%	13.0%	29.6%	27.8%	25.9%
AIS	49	18.4%	10.2%	34.7%	16.3%	20.4%
Support	6	50.0%			16.7%	33.3%

- Since the previous results were inconclusive, a more detailed analysis was conducted
  - Software changes were characterized based on contextual comments in the questionnaire and by Super Domain



# Software Change Types

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- Enhancements
  - New capability: ECPs, new requirements
  - Redesign / rewrite: 100% new code, new architecture
- Maintenance
  - Defect repair: bug fixes, PTR fixes
  - Reconfiguration: threat loads, EW parameters
  - Rehost: migration from Windows to Linux
  - Testing: interoperability testing
  - Update: weapon tables, switch configurations, Operating System
  - Update, Defect repair (see above)
  - Upgrade: upgrade the v “n” to v “n+1”, upgrading applications
- Cyber
  - Vulnerabilities: enhance security posture not resolved through IAVA process



# Engineering

Change Type	1-VL	2-L	3-N	4-H	5-VH
<b>Enhancement SC</b>					
Rewrite: Testing	X				
Rewrite: 4 services		X			
New Cap: Handheld device		X	X		
New Cap: Heavy COTS		X	X	X	
Rewrite: Handheld device			X		
New Cap: 5 services			X		
New Cap: 4 services					X
<b>Maintenance SC</b>					
Reconfiguration: Parm load; Heavy COTS	X				
Testing	X				
Defect repair: Heavy COTS		X			
Rehost: Port		X			
Update, defect repair: Patch rel	X		X		
Reconfiguration: Heavy COTS			X		
Defect repair: Handheld device				X	
Testing: Handheld device		X		X	X
Update: Handheld device		X		X	X
Update: Heavy COTS				X	X
<b>Cyber SC</b>					
General			X	X	
Cyber: Vulnerabilities				X	





# Automated Information Systems

Change Type	1-VL	2-L	3-N	4-H	5-VH
<b>Enhancement SCs</b>					
New Cap: Web platform; Heavy COTS (>=75)	X				
New Cap: Web platform		X	X		
New Cap: Web platform; 5 services			X	X	X
New Cap: Web platform, Emergency rel					X
Rewrite: Web platform; 5 services					X
<b>Maintenance SCs</b>					
Defect repair: Web platform	X				
Update, defect repair: Web platform	X				
Upgrade: Web platform; COTS upgrade	X	X			
Reconfiguration: Limited rel; 4 Services		X			
Update: Handheld device		X			
Defect repair: Web platform; 5 services	X		X		
Update: Web platform	X		X		
Update: 4 services			X		
Upgrade: Web platform			X		
Upgrade, rehost: Web platform; 5 services			X		
Update: Web platform; 5 services			X	X	
Rehost: Handheld device				X	
Rehost: Web platform; 5 services				X	
Upgrade: Web platform; 5 services				X	X
<b>Cybersecurity SCs</b>					
General		X			
Vulnerabilities: Web platform; 5 services		X			



# Real-Time

Change Type	1-VL	2-L	3-N	4-H	5-VH
<b>Enhancement SC</b>					
New Cap: Heavy COTS				X	
New Cap: Redesign				X	
<b>Maintenance SC</b>					
Reconfiguration: Parm load	X				
Update: Patch rel	X				
Update, defect repair: Minor rel	X				
Defect repair: Handheld device				X	
Testing					X
Upgrade					X

Initial analysis can be used to identify analogous release data points. Additional detailed analysis will be completed to further define characteristics that affect software change productivity



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## Lessons Learned/Next Steps



# Software Sustainment Estimating Framework

## 1.0 Software Change Product

<b>Activities</b>	IAVAs, SW Changes (defects/enhancements)
<b>Performing Org.</b>	Contractor
<b>Challenges</b>	Use of inconsistent size measures; effort not generally tracked by release

## 2.0 Project Management

<b>Activities</b>	CM, Execution, Project/Engineering Leads
<b>Performing Org.</b>	Government/Contractor
<b>Challenges</b>	Roles/Responsibilities spread throughout WBS; contractor generally paid by overhead

## 3.0 Software Licenses

<b>Activities</b>	License Cost
<b>Performing Org.</b>	Government/Contractor/Outside Organization (enterprise licenses)
<b>Challenges</b>	Payed for by multiple sources; licenses generally underreported; not always tracked

## 4.0 Certification and Accreditation

<b>Activities</b>	DIACAP/RMF, STIGs
<b>Performing Org.</b>	Government/Outside Organization
<b>Challenges</b>	Differs between types of C&A's, Difficult to track prep vs certification vs fixes post certification

## 5.0 System Facilities

<b>Activities</b>	Lab infrastructure, Mgmt
<b>Performing Org.</b>	Government/Contractor/Outside Organization
<b>Challenges</b>	Facilities paid by various sources; inheriting hardware from other sources

## 6.0 Sustaining Engineering

<b>Activities</b>	Help Desk, Delivery/Installation, Test Support
<b>Performing Org.</b>	Government/Contractor/Outside Organization
<b>Challenges</b>	Inconsistent/varying activities reported; category generally misunderstood

## 7.0 Field Software Engineers

<b>Activities</b>	Field Maintenance, Installation, Troubleshooting
<b>Performing Org.</b>	Government/Contractor/Outside Organization
<b>Challenges</b>	Difficult to estimate required support; shared between multiple programs

## 8.0 Operational Management

<b>Activities</b>	Enterprise Management, Business Management
<b>Performing Org.</b>	Government/PEO/Contractor
<b>Challenges</b>	Generally treated as overhead, spread across programs



# Lessons Learned

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## Data Collection and Normalization:

- Numerous iterations were required for every data submission (average 4 submissions/program) to ensure data was accurate
- Data cleansing and normalization consumed significantly more time than expected
- Automation/use of macros streamlined data quality checks and consolidation
- Lack of standardized naming conventions extended data merging effort

## Data Analysis Findings:

- Need better measures of size (output) for software sustainment
- Cybersecurity releases for many Army programs are done very frequently (monthly/weekly)
- Release descriptions indicate that COTS changes and interfaces are a prominent cause of software changes
- “Percent Enhancement” of maintenance releases is a good predictor of Software Change Product

## Observations Informed by Interviews:

- Many programs did not track actual costs in detail
- There is a lack of standardized processes across the SECs/PEOs
- Delayed retirement of legacy systems generates resource/overhead burden
- Multiple funding streams limit total system cost traceability



# Core Truths of Cost Estimation

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- No cost estimation decision is better than the data that supports it
- If you don't collect execution data, your cost estimate will be unreliable
- If you don't own the data, your cost estimate will likely be untrustworthy
- If your data is not related to actual performance, your cost data will be incomplete
- If you don't have a good software sustainment process, your cost data will be inconsistent
- If you don't compare planned to actual performance, you can't improve your cost estimates
- If no one asks for or uses the data, it will not exist
- If the quality of software sustainment data doesn't match that of acquisition development data, it will never be used by senior decision makers

Software is not static: it has to be continually monitored and updated to address cybersecurity issues, COTS changes, new/revised interfaces, changing platforms, platform capability shortfalls, new parameters, emerging threats, etc.



# Conclusion & Next Steps

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## Importance of Data Collection

- Consistent and accurate technical/cost data allows for more meaningful CERs that are relevant to the changing environment of software sustainment
- Software sustainment data can be used to better inform design decisions and cost analysis
  - DASA-CE and the Army cost community are now able to develop cost products that use analogous program data and technical output to estimate software maintenance. This facilitates major milestone estimates, O&S cost targets, Operation Sustainment Reviews, and yearly POM reviews
  - Phase I dataset is hosted on CADE under “Library”. Phase II dataset will be posted onto CADE upon completion of Analysis (est. July 2018)

## Next Steps

- Additional analysis of data, including:
  - Refined CERs/SERs by appropriate categories (application domain, organization, operating environment, etc.)
  - Cost of impacts of DIACAP vs RMF
  - Cost of Cybersecurity
  - Release rhythm analysis
- Systemic data collection
  - The Software Resources Data Reporting for Maintenance (SRDR-M\*) closely aligns to the DASA-CE SWM WBS and data requirements
  - Moving forward, the SRDR-M will be utilized to collect SWM data from a large number of programs across the Army
  - Ongoing analysis will be performed as data is made available through the SRDR-M

\*See <http://cade.osd.mil/policy/dids> for more information



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# Backup

# Army Software Maintenance Definition

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For this effort, 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

