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The Journey to Better ERP Estimation

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- Introduction to Defense Business Systems and Enterprise Resource Planning (ERP) Systems
- ERP Cost Estimating Challenges
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Objective

Objective

- Utilize Department of Defense data from Enterprise Resource Planning (ERP) programs to develop an estimating methodology and calibrated model to support future DoD ERP cost estimates

- Initial Effort: Develop calibration factors from data
  - 4 Programs
  - Total of 20 Releases

Introduction to Defense Business Systems and Enterprise Resource Planning Systems

Defense Business Systems and Enterprise Resource Planning Systems

Business Systems

Business systems are information systems that are operated by, for, or on behalf of the Department of Defense, including: financial systems, financial data feeder systems, contracting systems, logistics systems, planning and budgeting systems, installations management systems, human resources management systems, and training and readiness systems. A business system does not include a national security system or an information system used exclusively by and within the defense commissary system or the exchange system or other instrumentality of the DoD conducted for the morale, welfare, and recreation of members of the armed forces using non-appropriated funds.

DOD Instruction 5000.75 Business Systems Requirement and Acquisition

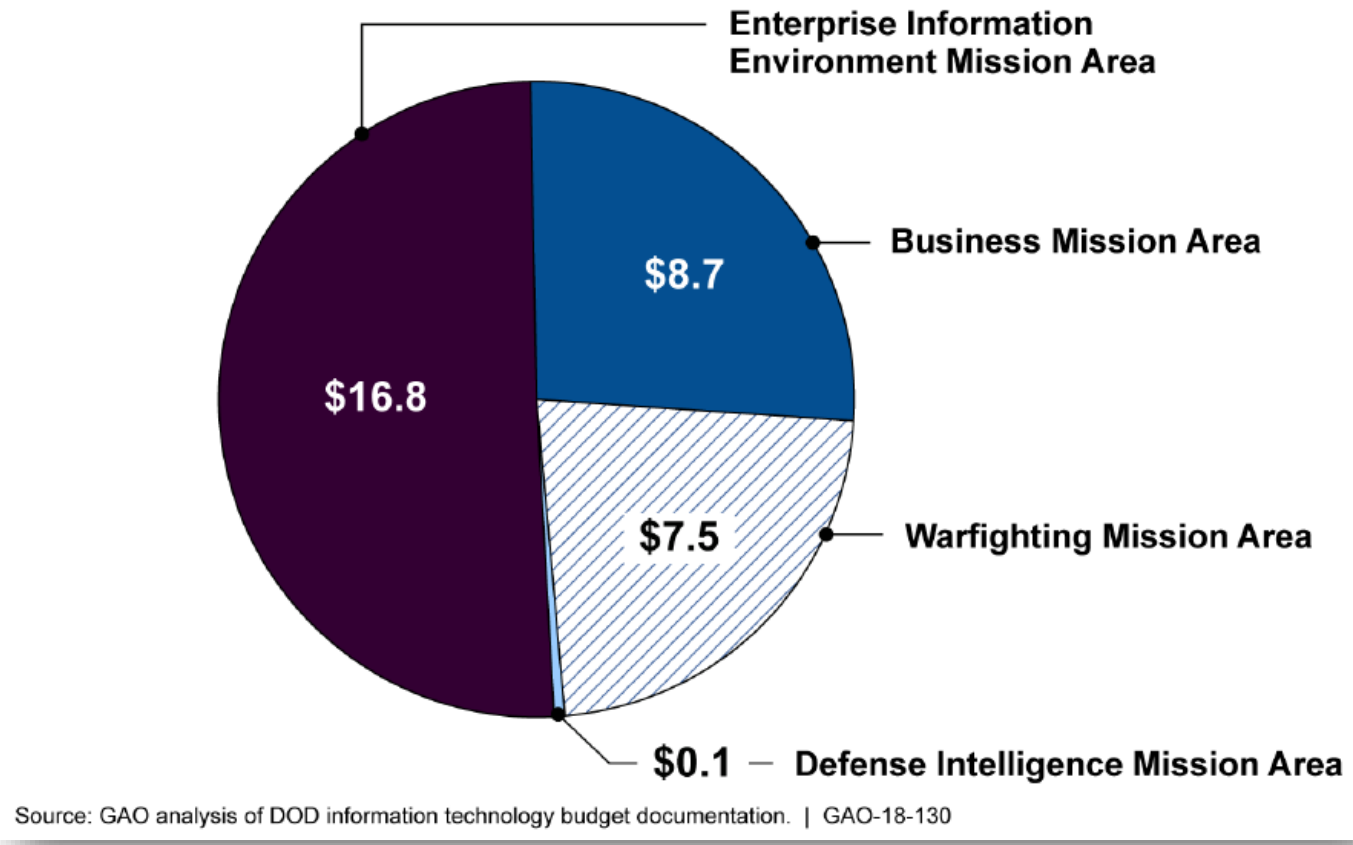
Enterprise Resource Planning System

Enterprise resource planning (ERP) is defined as the ability to deliver an integrated suite of business applications. ERP tools share a common process and data model, covering broad and deep operational end-to-end processes, such as those found in finance, HR, distribution, manufacturing, service and the supply chain.

Gartner: https://www.gartner.com/it-glossary/enterprise-resource-planning-erp/

*The DoD has more than **2,000** business system investments.*

Figure 1: Department of Defense (DOD) Fiscal Year 2018 Information Technology Budget by Mission Area (projected)



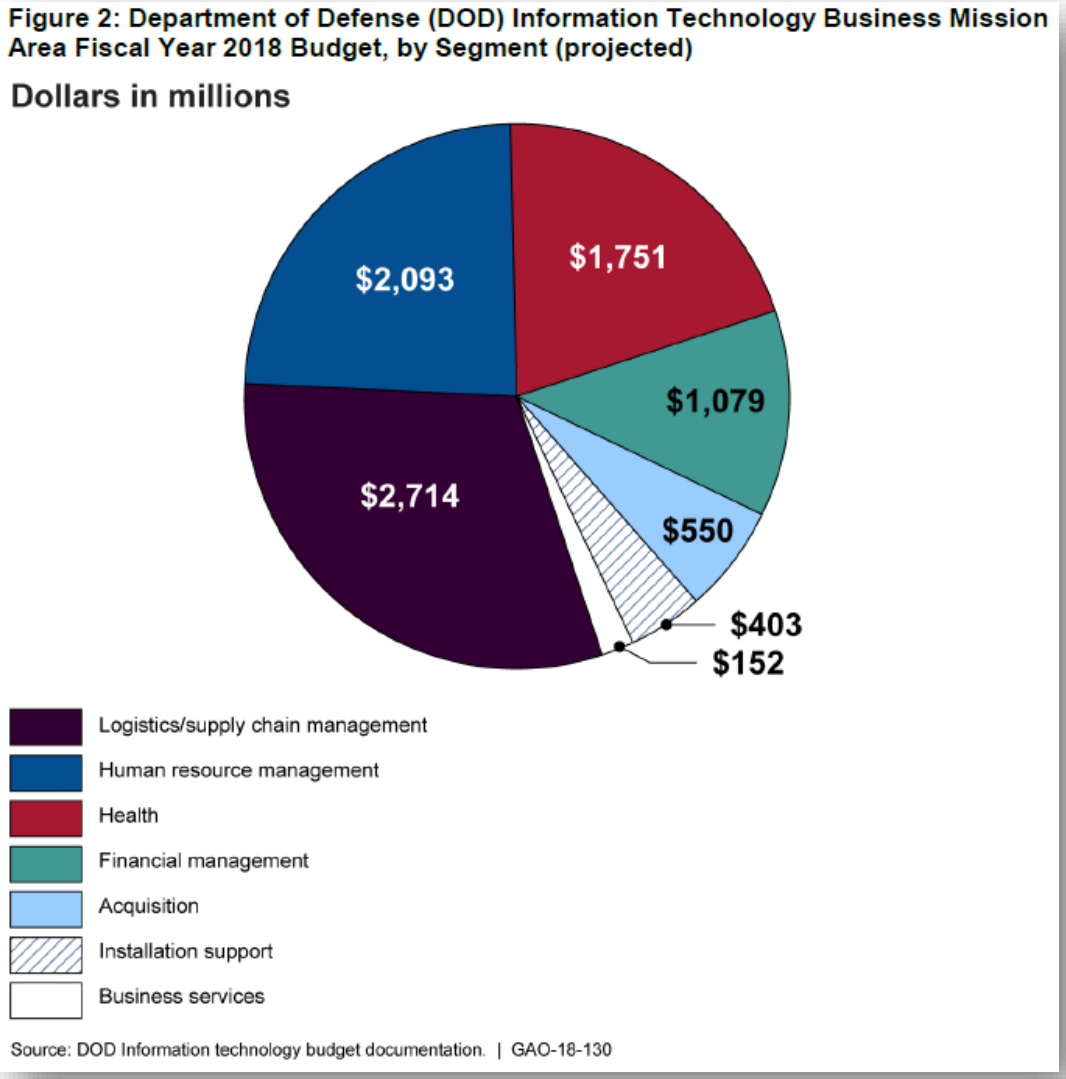
Source: GAO analysis of DOD information technology budget documentation. | GAO-18-130

GAO: Defense Business Systems, DOD Needs to Continue Improving Guidance and Plans for Effectively Managing Investments, April 2018

DoD business systems investment focused on mission areas that are increasingly addressable by ERP solutions:

- Logistics/supply chain
- Financial management and accounting
- Human resources

Figure 2: Department of Defense (DOD) Information Technology Business Mission Area Fiscal Year 2018 Budget, by Segment (projected)



GAO: Defense Business Systems, DOD Needs to Continue Improving Guidance and Plans for Effectively Managing Investments, April 2018

What are the primary functions of ERP Systems?

https://commons.wikimedia.org/wiki/File:ERP_Modules.png
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Partial List of DoD ERP Systems

Army

- Army Enterprise Systems Integration Program (AESIP)
- Global Combat Support System – Army (GCSS-A)
- Logistics Modernization Program (LMP)
- General Fund Enterprise Business System (GFEBS)
- Army Training Information System (ATIS)
- Army Contract Writing System (ACWS)
- Integrated Personnel and Pay System – Army (IPPS-A)

Navy

- Navy Enterprise Resource Planning (Navy ERP)
- Global Combat Support System-Marine Corps (GCSS-MC)

Air Force

- Defense Enterprise Accounting Management System (DEAMS)
- Expeditionary Combat Support System (ECSS)

DLA

- Enterprise Business System (EBS)

Other DoD

- Defense Agency Initiative (DAI)

Appears that all DoD ERPs to date are based on SAP or Oracle platforms

ERP Cost Estimating Challenges

ERP Estimating Challenges

- ERPs in the DoD are relatively new and few in number so there is not a lot of historical data
- Defense Business Systems do not have the same EVM and reporting requirements (CSDR/SRDR) as warfighter systems
  - DOD Instruction 5000.75 Business Systems Requirement and Acquisition
- Large, complex COTS-based solutions with built-in configuration and tailoring tools
- Different software sizing measures commonly used that cost estimators are less familiar with
- Different organization of and language for SDLC activities (e.g., Blue Printing)

Sizing (Customization)

- ERPs generally not sized with familiar measures such as SLOC, Function Points, Story Points, etc.

RICEFW	Definition
Reports (R)	An executable program that reads data from the database and generates output based on the filter criteria selected by the end user
Interfaces (I)	Send and receive of data for processes and functions executed or maintained in external systems
Conversions (C)	Data that is converted from one format to another format and from one system to another
Enhancements (E)	Add / modify existing functionality to ERP platform's standard business applications
Forms (F)	Printouts produced by the ERP system. Can be a standard form with pre configured layout and design or custom developed
Workflows (W)	A sequence of connected activities resulting in exchange of information

Paraphrased from https://blogs.sap.com/2014/05/20/ricefws-in-sap-projects-and-role-of-functional-consultant/

- Complexity typically simply defined (e.g. Low, Medium, High) and not always consistent
- There are a plethora of other object types associated with Business Intelligence and other aspects of ERPs

Sizing (COTS Configuration & Tailoring)

- Measuring and estimating size is less well understood
- Critical to accurately estimating ERP effort and schedule

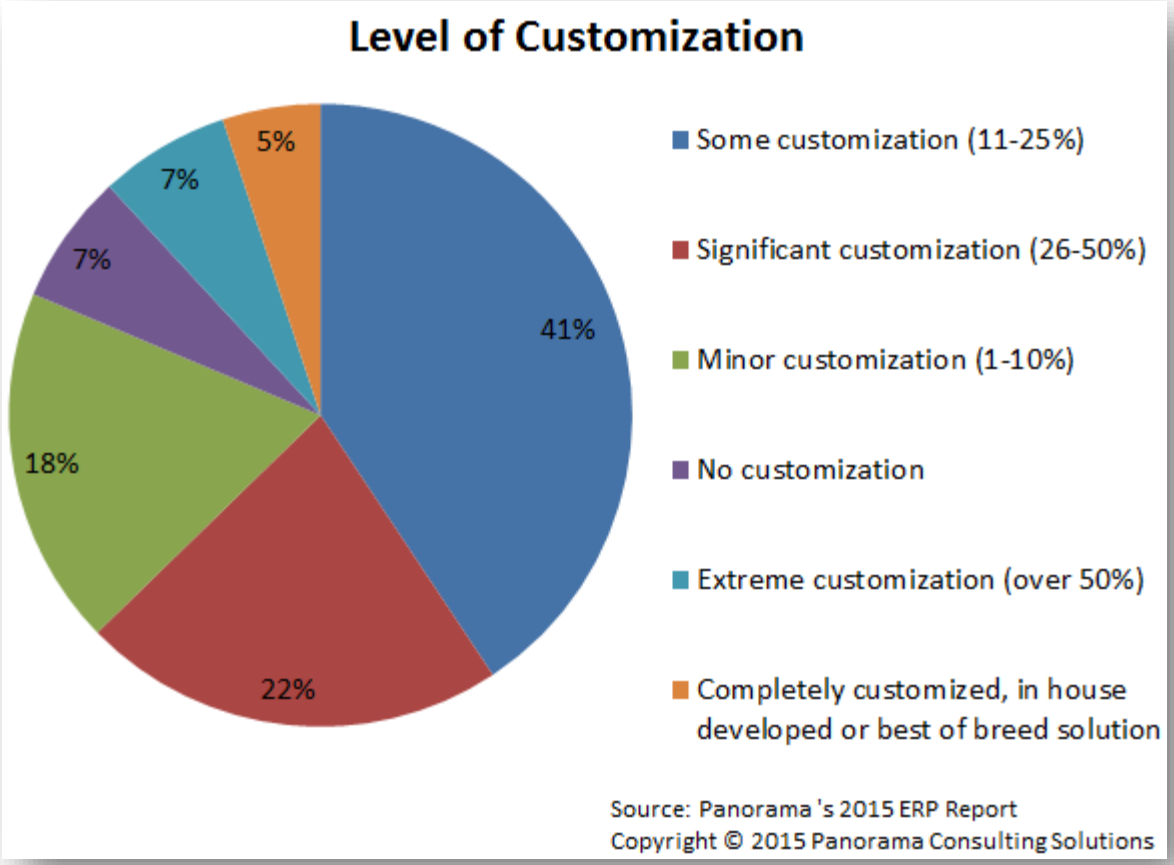
- Potential size measures for COTS effort:
  - *Function Points*
  - *Other Functional Size Measures*
  - *Number of Configurations*
  - *Number of Tailoring Requirements*
  - *Number of Roles*
  - *Number of Requirements*
  - *Number of Business Processes*
  - *Number of Business Subprocesses*
  - *Number of Legacy Interfaces*

- Other cost factors
  - *Glue code requirements*
  - *Vendor maturity, documentation, training, cooperation*

ERPs a Mix of COTS, Configuration and Customization

Based on completed surveys of 562 industry respondents:

- 63-percent of organizations had some customization or significant customization
- Significant capability being delivered by COTS solution



http://panorama-consulting.com/resource-center/2015-erp-report/

Data Analysis

Data Analysis Overview

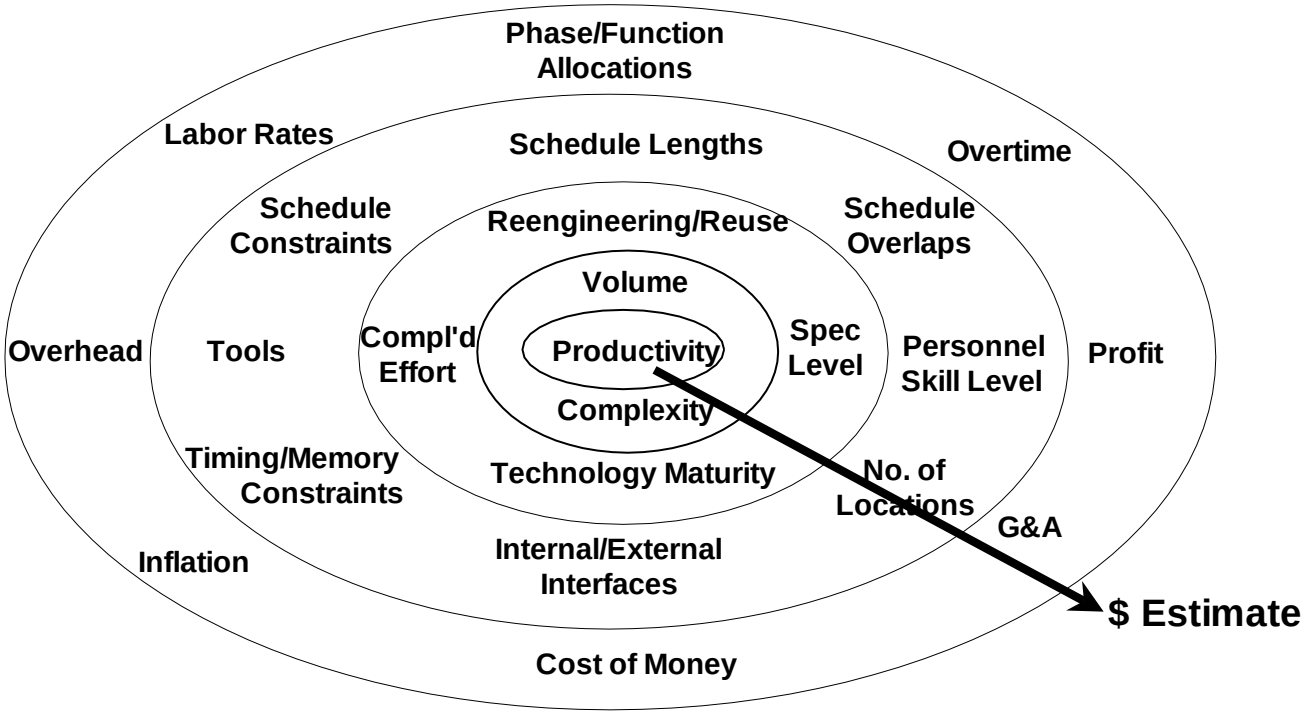
Objective: Develop an estimating methodology and calibrated model to support future DoD cost estimates

Data: 4 programs, 20 total releases

Solution: Calibrated Organizational Productivity

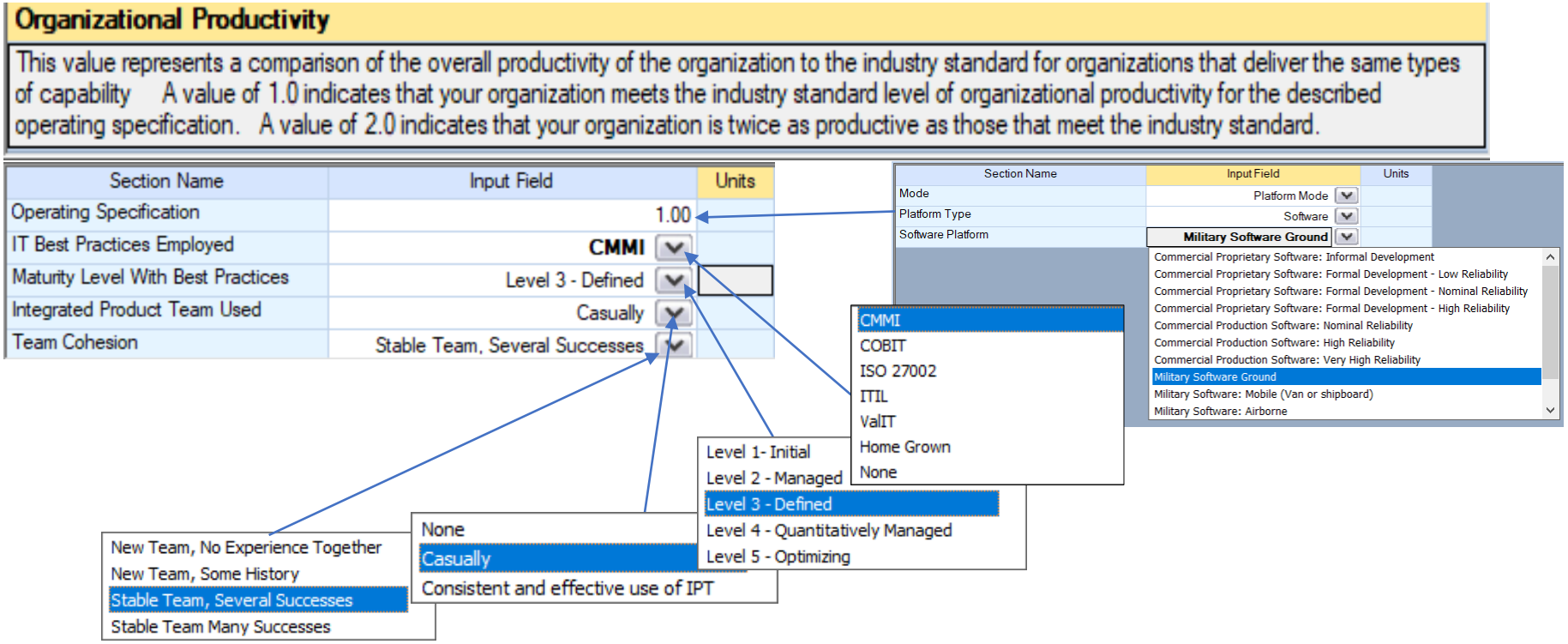
Primary drivers:

- Size and Complexity
- Operating Specification (Environment)
- Functional Complexity
- Development Team



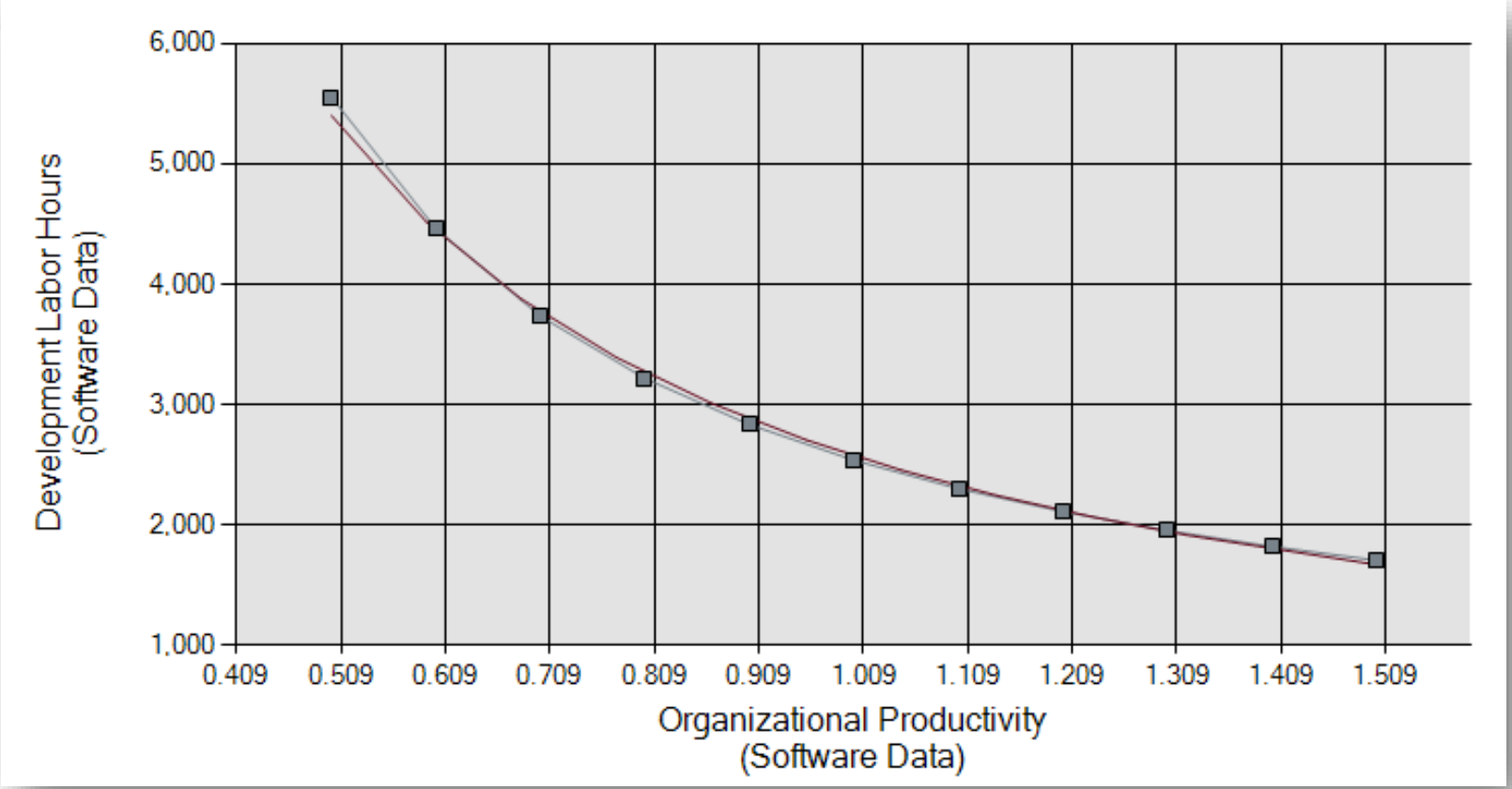
Organizational Productivity

- Industry Standard Productivity
- Reduces development effort as a function of Organizational efficiencies
- Determined by user (Input Calculator):



Organizational Productivity

- Sensitivity with respect to Effort (Development Labor Hours)



Initial Data

- Four Programs representing unique ERP systems
  - 2 Financial, 2 Logistics
  - 20 Releases Total

Data Collected	Data Utilized
Start and End Dates	✓
RICEFW Size Measures:	N/A
Reports	✓
Interfaces	✓
Conversions	✓
Extensions	✓
Functions	✓
Workflows	✓
New versus Modification	✓
Complexity	✓
Effort Hours	✓
Business Processes	✓
Business Subprocesses	✓
Requirements	-
ERP Modules	-
Legacy Interfaces	✓
CMMI Level	✓
Configuration Designs	-
Development Process	✓

Product Breakdown Structure (PBS)

- Typical Product Breakdown Structure for a single release

Summary	Cost Object	Description
SE, PM, Doc for Release	Contractor Management Release n	SE, PM and Documentation for Release
Build, assemble, and I&T in a dev environment	Development at Supplier's	Assembly-level I&T in Dev environment
	RICEFW Dev	Writing code to create new functionality
	RICEFW Dev (Modifications)	Modifying code from prior developments
	Legacy I/F Dev	Writing code to interact with legacy systems
	COTS ERP	Configuring the COTS package
Make changes, assemble, and I&T in a test environment	Acceptance/Val	Assembly-level I&T in Test environment
	RICEFW & Legacy I/F	Testing the newly developed functionality
	COTS ERP	Testing the COTS configuration
	RICEFW from Previous Releases	Testing code from previous Releases
	COTS ERP from Previous Releases	Testing COTS configuration from previous releases

Product Breakdown Structure (PBS)

- Mapping of Key Data Collected to PBS elements

Summary	Cost Object	Key Historical Data Utilized
SE, PM, Doc for Release	Contractor Management Release n	
Build, assemble, and I&T in a dev environment	Development at Supplier's	Business Processes, Interfaces
	RICEFW Dev	New RICEFW, Complexity
	RICEFW Dev (Modifications)	Modified RICEFW, Complexity
	Legacy I/F Dev	Legacy Interfaces
	COTS ERP	Business Subprocesses
Make changes, assemble, and I&T in a test environment	Acceptance/Val	
	RICEFW & Legacy I/F	All RICEFW, Complexity, Interfaces
	COTS ERP	Business Subprocesses
	RICEFW from Previous Releases	RICEFW, Complexity from prior releases
	COTS ERP from Previous Releases	Business Subprocesses from prior releases

Conversion to Function Points

RICEFW Inputs

Section Name	Input Field	Units
Reports		
Reports - Low Complexity	3	
Reports - Average Complexity	2	
Reports - High Complexity	2	
Interfaces		
Interfaces - Low Complexity	6	
Interfaces - Average Complexity	4	
Interfaces - High Complexity	5	
Conversions		
Conversions - Low Complexity	2	
Conversions - Average Complexity	1	
Conversions - High Complexity	1	
Enhancements		
Enhancements - Low Complexity	4	
Enhancements - Average Complexity	9	
Enhancements - High Complexity	0	
Forms		
Forms - Low Complexity	2	
Forms - Average Complexity	0	
Forms - High Complexity	0	
Workflow		
Workflow - Low Complexity	0	
Workflow - Average Complexity	3	
Workflow - High Complexity	1	

Conversion from RICEFW to Function Points Table

Object	Low Complexity	Average Complexity	High Complexity
Reports	5	8	12
Interfaces	8	18	35
Conversions	19	23	28
Enhancements	8	14	23
Forms	5	8	12
Workflows	8	14	23

Calculation of Total Function Points

11	**Software Size**	
12	Size Units	**IFPUG Function Points**
13	New Size	**672**

Organizational Productivity Calibration

- Calibrated Organizational Productivity to be within 5% of actuals at the total Release Level
- Notional Example – Program 1 Release X:

Cost Object Name	Cost Object Type	Org Prod	Estimated Hours	Actual Hours
Contractor Management Release X	System		424,658.3	441,644.6
Development at Supplier's	Assembly			Δ4%
RICEFW Dev	Software Component	0.847		
RICEFW Dev (Modifications)	Software Component	0.847		
Legacy I/F Dev	Software Component	0.847		
COTS ERP	Software COTS	0.847		
Acceptance/Val	Assembly			
RICEFW & Legacy I/F	Software Component	0.847		
COTS ERP	Software COTS	0.847		
RICEFW from Previous Releases	Software Component	0.847		
COTS ERP from Previous Releases	Software COTS	0.847		

- Calibrated Organizational Productivity = 0.847

Some Challenges during Analysis

- Limited data set
- Some reported data was incomplete and not all data gaps could be filled/extrapolated
- Potentially erroneous data (e.g. not intuitive, potentially duplicative)
- Interpolation of some data based on small dataset
- Consistency of definitions for key drivers such as RICEFW
- Clearly identifying scope of effort captured during data collection
- Know issues that were hard to compensate for (e.g., data migration)

Scope of Calibrated Data

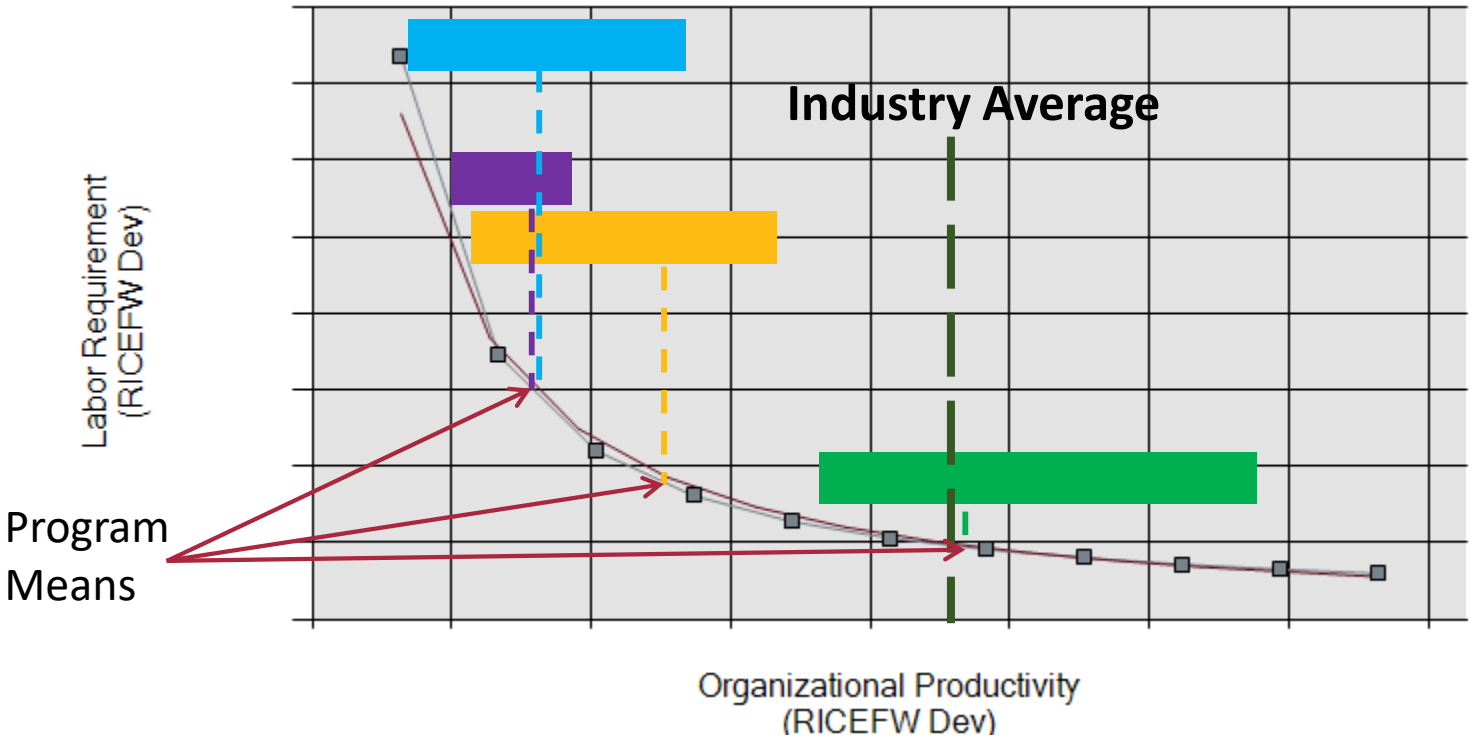
	Activities	In Scope?
System (PM, SE)	Project Initiation and Planning for Dev	-
	Project Management and Control for Dev	-
	Quality Assurance Management for Dev	-
	Configuration Management for Dev	-
	Vendor Management for Dev	-
	Documentation for Dev	✓
Assembly (I&T)	Requirements Definition and Analysis	✓
	System Design	✓
	Development Engineering	-
	Development Manufacturing	-
	Development Tooling and Test	-
	Production Engineering	-
	Production Manufacturing	-
	Production Tooling and Test	-
	Software Integration and Test	✓
	Hardware Software Integration and Test	-
	Operational Test and Evaluation	✓
	Assembly Operation and Support	-

	Activities	In Scope?
Developed Software	Software Requirements Analysis	✓
	Evaluation and Selection	-
	Configuration and Tailoring	-
	Software Design	✓
	Code and Unit Test	✓
	Software Integration and Test	✓
	Software Qualification Test	✓
	Software Deployment	-
	Software Maintenance	-
	Software Adaptation	-
COTS Software	Software Requirements Analysis	✓
	Evaluation and Selection	-
	Configuration and Tailoring	✓
	Software Design	-
	Code and Unit Test	-
	Software Integration and Test	-
	Software Qualification Test	-
	Software Deployment	-
	Software Maintenance	-
	Software Adaptation	-

Initial Results

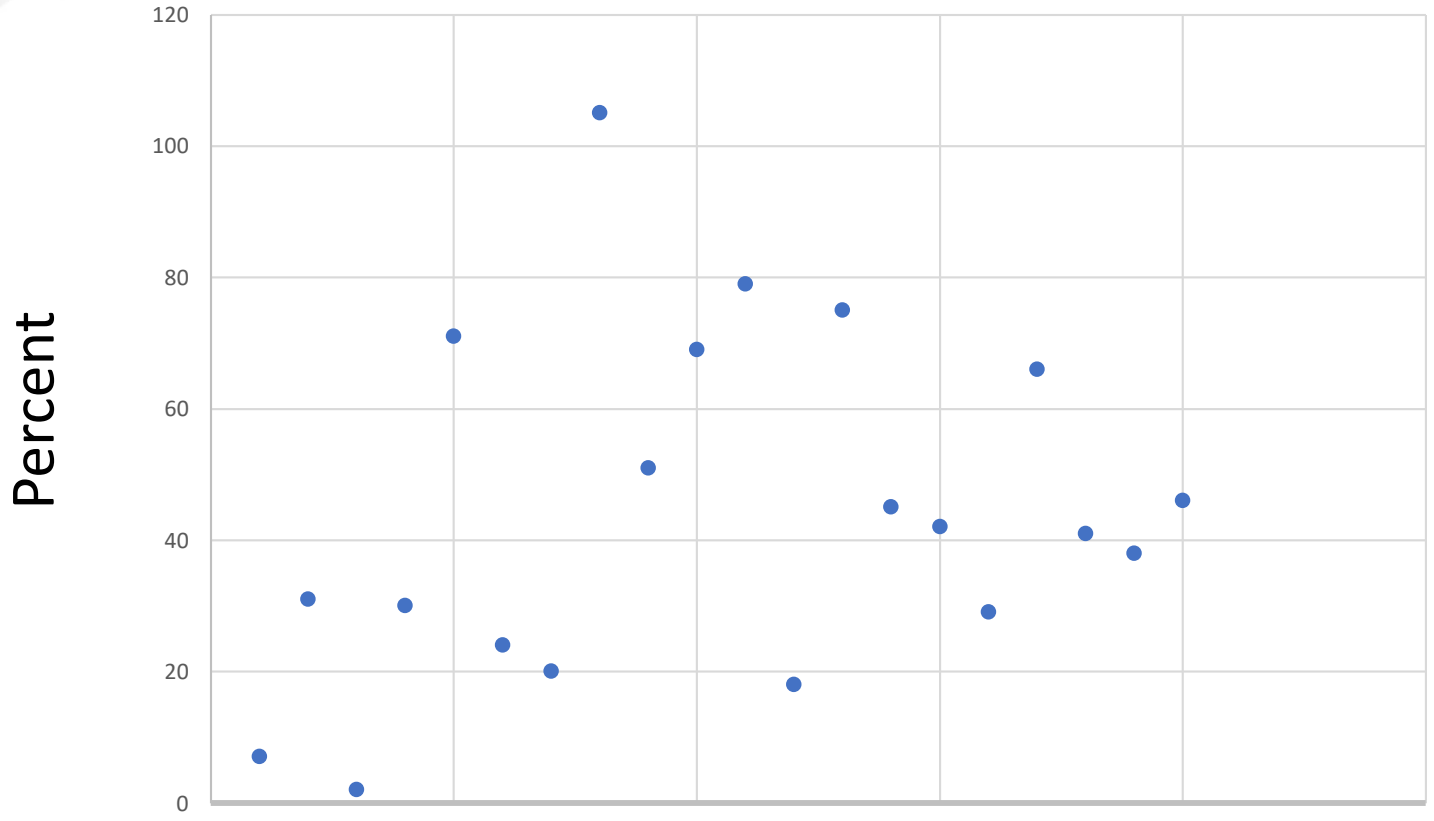
Variation of Data

- The boxes represent the range of the Organizational Productivities observed for the Releases from each of the 4 Programs



Absolute Percent Error by Release

- Utilizing a single, calibrated Organizational Productivity value across all 20 releases



Future Research

Recommendations for follow on efforts

- Continue to gather historical ERP data to improve models and calibration
  - Expand study to include the other DoD ERP Programs
- Research additional ERP cost drivers in addition to RICEFW
  - Business Processes, Subprocesses, Configurations, Roles, other object types
- Interview ERP development and implementation SMEs to obtain greater insights into the drivers of effort for ERP programs