



## **Advancing EVM with a Modernized Framework**

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## Contributors



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Senior Analyst

Aaron works as a Senior Analyst with experience providing EVM, Schedule Analysis, Life Cycle Estimating, and program management support on multiple programs. He has supported DoD and DHS clients. He has his B.S. in Industrial and Systems Engineering from Virginia Tech and a Masters Degree in Systems Engineering from Virginia Tech.



**Corey Maples**

Senior Analyst

Mr. Maples has experience providing independent cost estimates on military vehicles as well as a growing list of Canadian Proposal Evaluations. He currently supports multiple shipbuilding programs providing EVM analysis and support. He has his BS in Industrial and Systems Engineering from Virginia Tech and is a Certified Cost Estimator/Analyst through ICEAA.



**Scott Campbell**

Lead Analyst

Scott is a Lead Analyst that has supported several Navy programs over the last three years. He has experience providing life cycle cost estimating, proposal evaluations, EVM, and data tool development. He holds a B.S. in Integrated Mechanical Design Engineering with minors in Business and Engineering Management from the University of Colorado Boulder.

# Agenda

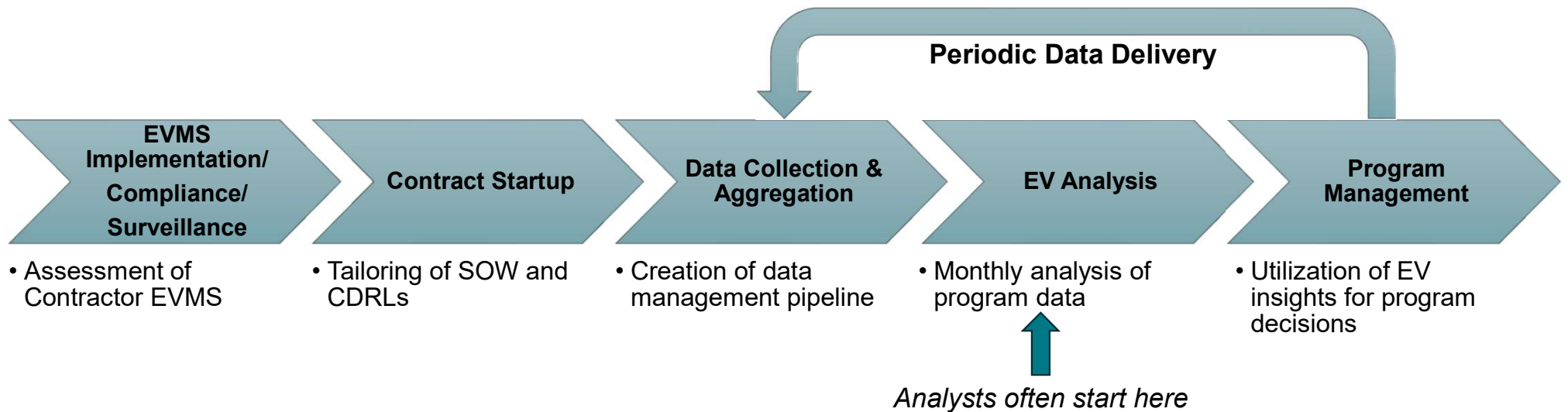
- EVM Framework Overview
- EVMS Implementation/Compliance
- Contract Startup
- Data Collection/Aggregation & Periodic Data Delivery
- EV Analysis
- Program Management

# Introduction

- Government acquisitions are growing in size and complexity to procure technologically advanced systems to stay ahead of adversaries around the world
- Effective program management is necessary to ensure efficient program cost, schedule, and technical success
- EVM is a proven method to support management of programs
  - Requires programs to think critically about their future cost, schedule, and risk through the IBR process
  - Provides the means to measure cost and schedule progress against a baseline or original plan
  - Allows for estimating cost at completion to support program budgeting
- EVM's effectiveness has been criticized throughout the years, often called costly and ineffective
  - Missteps in CDRL development negatively impacting data value
  - Inefficient data management and analysis processes
  - Lack of use of historical data to provide insights on current programs
- **EVM requires a holistic approach to view the entire lifecycle and practice effective and efficient program management**

# EVM Framework

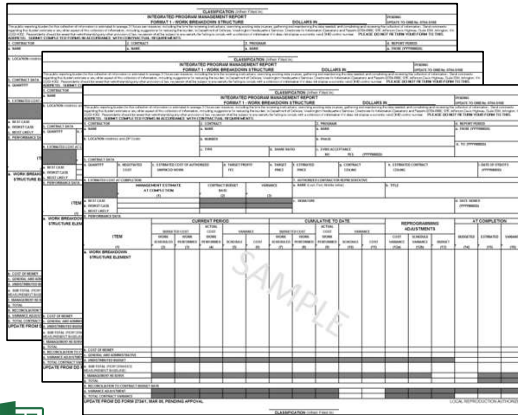
- The EVM Framework divides the process into key components to facilitate efficient and effective program management
  - Defines each component & importance
  - Identifies downstream impacts
  - Implements modern tools and processes to streamline
- Executing each step in the framework, understanding its importance, and driving efficiency creates a repeatable process that ensures analysis and program management is not hindered by early missteps.



# Transition to Modern Data Schemas

- Data deliverables are transitioning to more modern, data focused schemas
- IPMDARs represent this modernization through its relational schema and lack of human readable formats
  - Necessitates the use of modern tools to digest and extract performance data
  - Emphasizes the importance of early steps in the framework (i.e., Contract Startup)
- Deeper insights are possible, but gated behind additional ETL processes

## IPMR



Formats 1-4 and 7 (IPMR)



## IPMDAR

IPMDAR CPD Submission.zip  
506 KB

Name	Type
ACWP_ToDate	JSON File
BCWP_ToDate	JSON File
BCWS_ToComplete	JSON File
BCWS_ToDate	JSON File
ContractData	JSON File
ControlAccountCustomFieldDefinitions	JSON File
ControlAccountCustomFieldValues	JSON File
ControlAccounts	JSON File
CustomSummaryPerformance	JSON File
DatasetConfiguration	JSON File
DatasetMetadata	JSON File
EST_ToComplete	JSON File
EST_ToDate	JSON File
OBS	JSON File
ReportingCalendar	JSON File
ReprogrammingAdjustments	JSON File
SourceSoftwareMetadata	JSON File
Subcontractors	JSON File
SummaryIndirectPerformance_ToComplete	JSON File
SummaryIndirectPerformance_ToDate	JSON File
SummaryPerformance	JSON File
WBS	JSON File
WorkPackageCustomFieldDefinitions	JSON File
WorkPackageCustomFieldValues	JSON File
WorkPackages	JSON File
FileType	Text Document

IPMDAR SPD Submission.zip  
253 KB

Name	Type
CalendarExceptions	JSON File
Calendars	JSON File
CalendarWorkShifts	JSON File
DatasetMetadata	JSON File
ProjectCustomFieldDefinitions	JSON File
ProjectCustomFieldValues	JSON File
ProjectScheduleData	JSON File
ResourceAssignments	JSON File
ResourceCustomFieldValues	JSON File
Resources	JSON File
ResourcesCustomFieldDefinition	JSON File
SourceSoftwareMetadata	JSON File
TaskConstraints	JSON File
TaskCustomFieldDefinitions	JSON File
TaskCustomFieldValues	JSON File
TaskOutlineStructure	JSON File
TaskRelationships	JSON File
Tasks	JSON File
TaskScheduleData	JSON File
FileType	Text Document



Power BI



Power Query

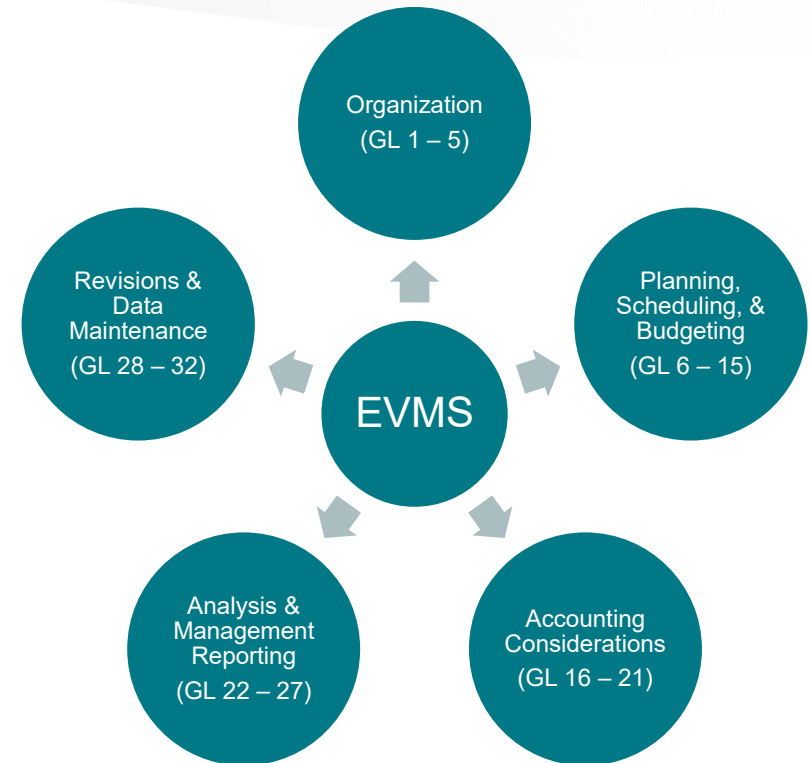


Microsoft Research

# EVMS Implementation



- Implementation of an EVMS that complies with the 32 guidelines
- Maintaining the system past initial implementation is critical
  - Regular review of system description
  - System updates to comply with changes to EVM DIDs
  - Implementation of modern tools within the system
- DECMs, logic checks, and regular tests are utilized to ensure compliance



# EVMS Surveillance/Compliance



- Reviewing contractor systems and data to determine if system complies with 32 guidelines
- Typically, the responsibility of oversight organizations (e.g., DCMA)
  - Performed on a periodic basis
  - Not guarantee data between surveillance reviews will be error free
- Compliance checks must be a regular part of monthly analysis
  - Ensure data quality
  - Highlight areas that could impact analysis
- Analysts should understand data format rules and schemas to strengthen approach to EVM process

Indicator	Definition
1	$BCWS_C > BAC$
2	$BCWP_C > BAC$
3	$ACWP_C > 0 \ \& \ BAC = 0$
4	$ACWP_P > 0 \ \& \ BAC = 0$
5	$BAC < 0$
6	$BAC = 0$
7	$LOE \ EVT \ w/ \ SV \ != \ 0$
8	$BCWP_C > 0 \ \& \ ACWP_C = 0$
9	Completed Work ( $BCWP_C = BAC$ ) w/ $ETC > 0$ ( $ACWP_C > EAC$ )
10	Incomplete Work ( $BCWP_C < BAC$ ) w/ $ETC = 0$ ( $ACWP_C = EAC$ )
11	Completed Work ( $BCWP_C = BAC$ ) w/ $ACWP_P > 0 \ \& \ BCWP_P = 0$
12	$CPI - TCPI > 0.1$ , implying overly pessimistic EAC
13	$CPI - TCPI < -0.1$ , implying overly optimistic EAC
14	$ACWP_C > EAC$
15	$BCWS_C < 0$ or $BCWS_P < 0$
16	$BCWP_C < 0$ or $BCWP_P < 0$
17	Reported $PC > 0$ w/ $BCWP_C = 0$ or $PC = 0$ w/ $BCWP_C > 0$



# Contract Start Up



- Step where the Government defines their EVM needs through the SOW and CDRL
- Opportunity for the Program Office to tailor EV deliverables to enhance analysis
  - EV data format such as IPMDAR
  - Granularity of data
  - Frequency of deliverables
  - End item reporting
- Neglecting this step can lead to:
  - Lack of insight into lower levels of data
  - Inability to track areas of interest
  - Inconsistent data formats

CONTRACT DATA REQUIREMENTS LIST										Form Approved OMB No. 0704-0102	
<p>NOTE: Reporting burden for the collection of information is estimated to average 100 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and reviewing the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing the burden, to: Department of Defense, Paperwork Reduction Project (0704-0102), Washington, DC 20303. Please DO NOT act on any of these instructions. Send one printed form to the Government issuing Contracting Officer for the Contract/PA No. listed in Block 4.</p>											
A. CONTRACT LINE ITEM No.		B. EXHIBIT		C. CALENDAR		D. SYSTEM/ITEM		E. CONTRACT/PA No.		F. CONTRACTOR	
[Insert Contract Line Item]		[Insert Exhibit]		[Insert Calendar]		[Insert System/Item]		[Insert Contract/PA No.]		[Insert Contractor Name]	
1. Contract No.		2. Title of Contract		3. Date		4. Agency Office		5. Reporting Office		6. Contract/PA No.	
AC97		Integrated Program Mgmt Data & Analysis Report (IPMDAR)		N/A		[Insert Program Office]		[Insert Program Office]		[Insert Contract/PA No.]	
7. DD Form		8. Use Statement		9. Frequency		10. Date of First Submission		11. Use of Data		12. Use of Subsequent Submissions	
N/A		Required		Monthly		See Block 16		See Block 16		See Block 16	
13. App Code		14. Address		15. Office		16. Distribution		17. Status		18. Remarks	
N/A		See Block 16		See Block 16		See Block 16		See Block 16		See Block 16	
<p>Block 4: Submission shall be in accordance with the NRO IPMDAR Data Item Description (Rev 0, 14 Aug 2020). See the Contractor Bidder's Library (CBL).</p> <p>The following tailoring and clarification apply to the DID:</p> <ul style="list-style-type: none"> <li>Per IPMDAR DID paragraph 1.4.1, the Direct Reporting Contractor is the prime contractor.</li> <li>Per IPMDAR DID paragraph 1.6, the CPD and SPD shall be delivered electronically in JSON format (or equivalent, e.g., EOJ) in accordance with the NRO-approved PFS and DEI. Contract and calendar names within the CPD and SPD files shall include the program name and remain consistent across submissions. The contractor shall coordinate the names and structure of any custom datafields with the government to maintain integrity of the government database. Custom datafields are defined as anything that does not follow the naming convention and relational structure defined in the PFS and DEI.</li> <li>Per IPMDAR DID paragraph 2.3.2.3, if contractor Elements of Cost are different than those listed in this paragraph, describe the EOCs used in the Performance Narrative Report.</li> <li>Per IPMDAR DID paragraph 2.4.2.8, provide the physical schedule percent complete values.</li> <li>Per IPMDAR DID paragraph 2.4.2.20, the Data Dictionary may be a stand-alone document or be included as a part of the Performance Narrative Report.</li> <li>Per IPMDAR DID paragraph 2.4.2.21, unless otherwise directed by the Government, the following shall apply to the Schedule Risk Assessment:                     <ul style="list-style-type: none"> <li>Provide individual three-point duration estimates for all tasks/activities on driving paths to contractual milestones/events and for all tasks/activities on the critical path to the end of the contract.</li> <li>Individual, rather than global, estimates and rationale shall be developed and applied to all tasks on the following paths:                             <ul style="list-style-type: none"> <li>Primary critical path to the final major program milestone</li> <li>Driving path and near driving path(s) with less than or equal to 10 days of float or as directed by Government.</li> <li>High-risk tasks/activities in the Contractor's risk management plan</li> </ul> </li> <li>'Remaining tasks' three-point estimates and rationale shall be individually or globally applied.</li> </ul> </li> <li>Per IPMDAR DID paragraph 2.5.3.4, the contractor shall report and address the 15 most significant program variances.</li> </ul> <p>Block 11: The following tailoring and clarification apply to the As of Date:</p> <ul style="list-style-type: none"> <li>Per IPMDAR DID paragraph 1.8.1, IPMDAR submissions shall be <b>uploaded</b> as of the contractor's accounting period cutoff date. Subcontractor and inter-divisional transfer data will be submitted for the same accounting period as that of the prime's, regardless of when the subcontractor's accounting period ends.</li> </ul>											
G. PREPARED BY				H. DATE		I. APPROVED BY				J. DATE	
COIR						Contracting Officer					

# Example: IPMDAR CDRL Tailoring

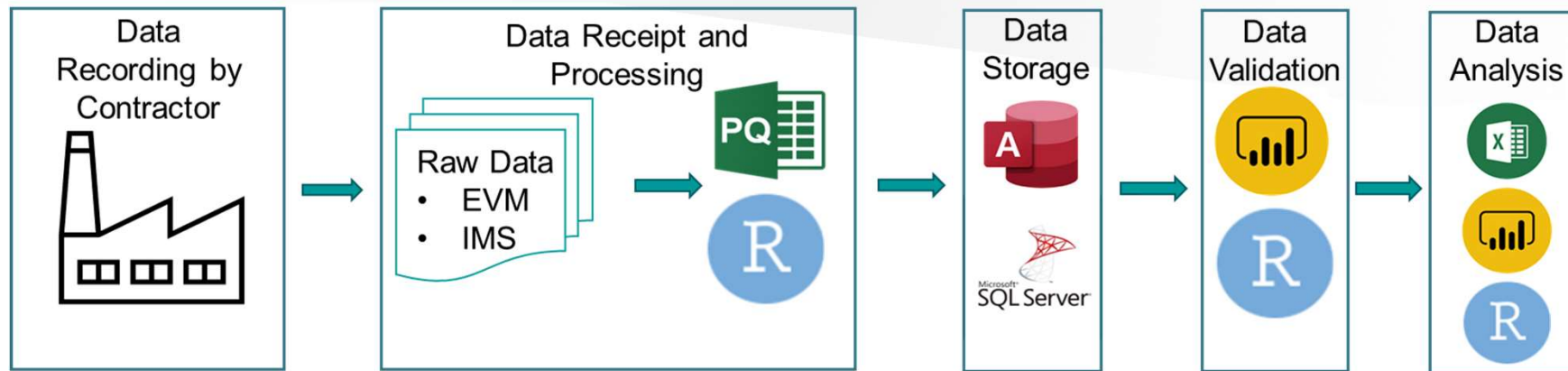
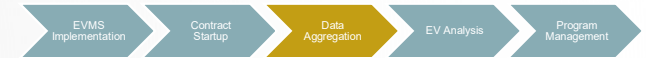


- The IPMDAR is the current DoD EV reporting format
- It contains a variety of dataset configurations that allow the Government to dictate the granularity of data
- Custom fields provide an option to map work packages, control accounts, or schedule activities to areas of interest
  - NRE/Recurring
  - Risk IDs
  - End items – ship set, variant, etc.
- Opportunity to translate program office needs to data deliverables, increasing value of later analysis

Configuration Option
Time Phased or Cumulative To Date
Direct Values in Detail Data
Indirect Values in Detail Data
Work Package or Control Account Reporting
Element of Cost Data
OH, COM, and G&A Burdening

Work Package	Custom Field 1
WP_1.1	Unit 1
WP_1.2	Unit 1
WP_1.3	Unit 2
WP_1.4	Unit 2

# Data Collection and Aggregation



- One of the most time intensive steps within the Framework
  - Collection and storage of data
  - Verification & Validation Efforts
  - Data integration
- Utilize modern tools R, Python, or Power Query to streamline process
- Consistent implementation allows data for completed programs to be used to inform future analysis/studies
- This step is repeated on a monthly as new data is delivered and must be designed with this in mind

# Government and Contractor Efforts



## ■ Government

- Validating and approving IPMDAR submissions from the contractor
- Enforcing DEI and FFS compliance across IPMDAR submissions
- Automating validation efforts and providing timely and actionable responses to contractors
- Managing submitters and reviewers assigned to efforts

## ■ Contractor (OEM)

- Implementing custom fields per contract requirements
- V&V of IPMDAR submissions against schema and DID to ensure compliance prior to delivery
- Responding to Government comments on IPMDAR submissions in timely manner
- Submission of validated IPMDARs to EVM-CR or another repository



OSD ADA IPM - EVM-CR Submitters Guide<sup>1</sup>

# Earned Value Analysis



- Delivers the necessary analysis that's made possible by the Data Collection and Aggregation step
- Includes typical cost and schedule performance metrics broken down by WBS level or further depending on the type of program (CPI, SPI, EAC, VAC, TCPI, etc.)

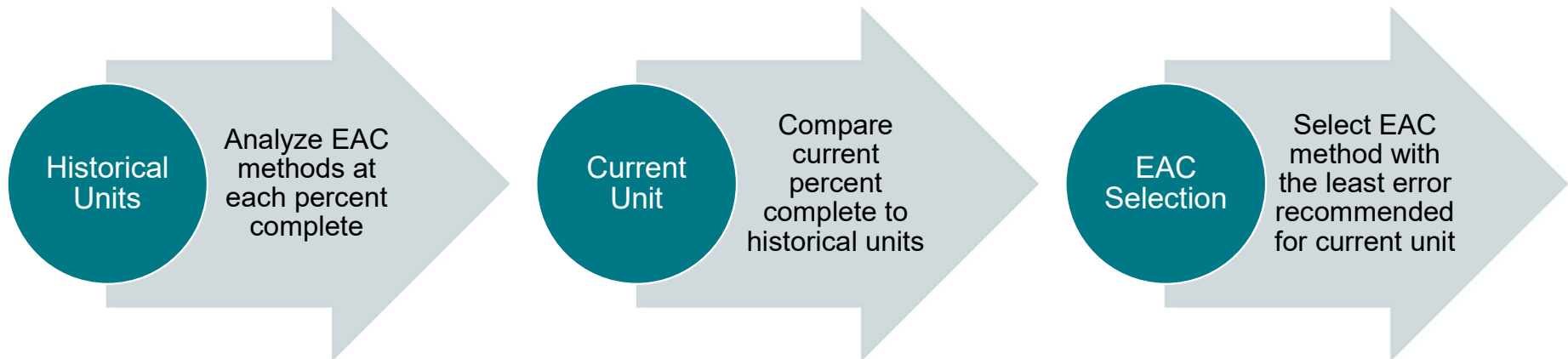
## Modernized Framework

- Choosing and integrating a platform within a modernized framework allows the analyst to take advantage of the entirety of the EVM dataset
- Utilizes scripts to retrieve periodic data from the database to perform analysis

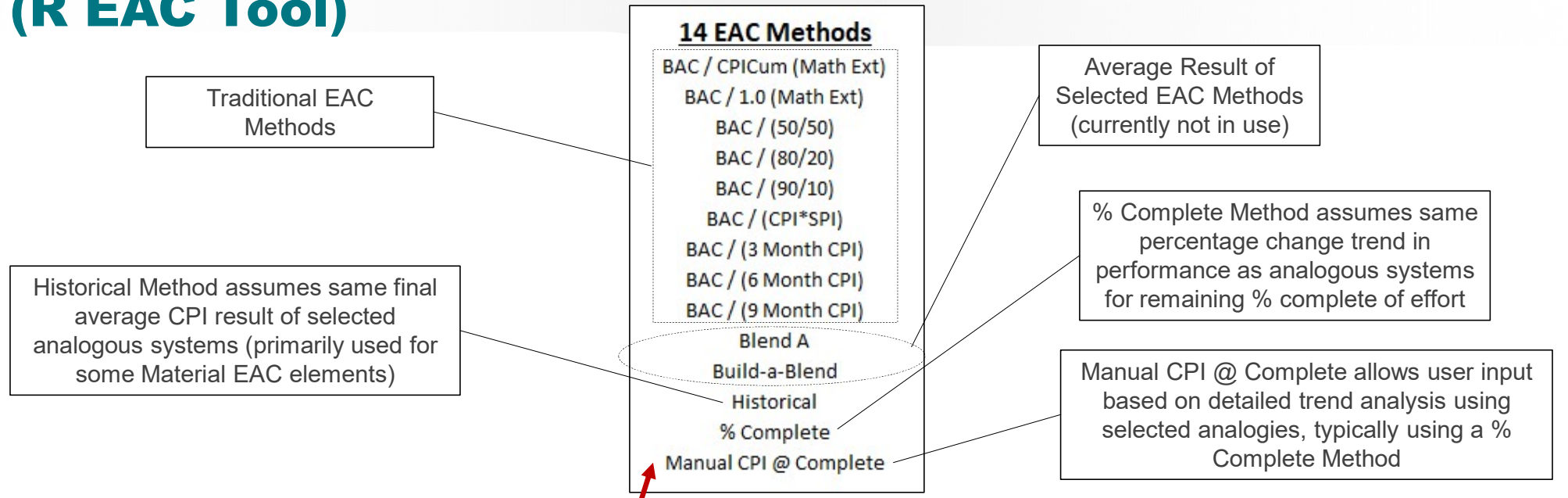
## Earned Value Analysis Example (R EAC Tool)



- Evolution from a previously utilized EVM tool created in Microsoft Excel, The Performance Metrics Model and Study (PMMS).
- Modernizes the PMMS to incorporate into the EVM Framework
  - Raw data stored in an MS Access
  - Statistical analysis performed in R
  - MS Excel tool created in R using all data and analysis



# Earned Value Analysis Example (R EAC Tool)



**Working Estimate View – EAC selection with the REACT recommended method**

Working Estimate								
WBS	Estimation Method	EAC	TCPI	VAC	CPI @ Complete	CPI @ Complete (Recommended)	Previous CPI @ Complete	Recommended Method
01.01.01	BAC / (6 Month CPI)	1,774.29	0.44	-655.16	0.63	0.64	0.71	% Complete
01.01.02	BAC / 1.0 (Math Ext)	0.38	0.95	-0.02	0.95		1.00	
01.01.03	% Complete	4,495.07	0.28	-1735.86	0.61	0.69	0.65	Historical
01.01.04	BAC / (3 Month CPI)	419.77	0.26	-114.45	0.73	0.73	0.75	BAC / (CPI*SPI)
01.01.05	BAC / (CPI*SPI)	790.55	0.03	-215.21	0.73	0.73	0.76	BAC / (CPI*SPI)

# Program Management



- Utilizes various pieces of program data to provide the program office with high level insight

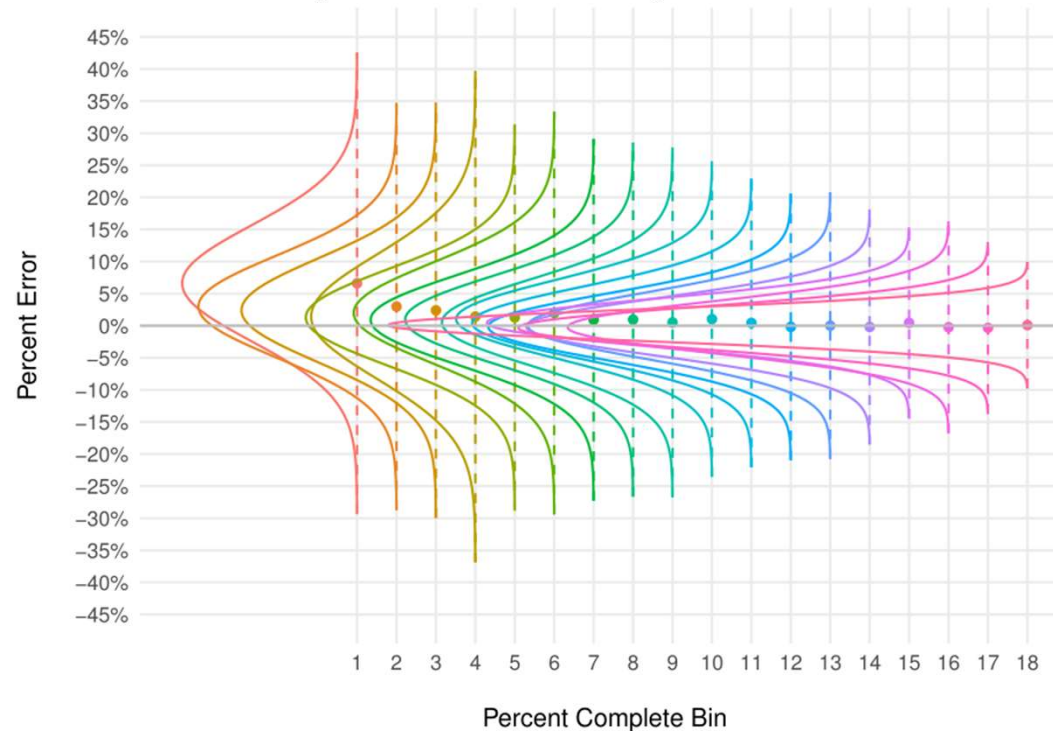
Budgeting and Financial Analysis	EACs and historical actuals
Contract Management	Analyzing past requirements and noting short falls
Risk Management	Past performance risk and issues
Systems Engineering	Using actuals to create Technical Performance Measures



# Program Management Example (Estimated Price at Complete)



Step 1: Determine the percent error of the delivered EACs based on the price at complete



## Program Management Example (Estimated Price at Complete)



Step 2: Determine and apply the percent error based on the percent complete bin and confidence bound

$$EAC_{EPAC} = \frac{EAC_{Base}}{1 + E_{0.75}}, \text{ where } E_{0.75} \text{ is the estimation error at the 75th percentile}$$

$$Factor_{EPAC} = \frac{EAC_{EPAC} - EAC_{Base}}{EAC_{Base}}$$

# Program Management Example (Estimated Price at Complete)



## Step 3: Compare Actual Error to the EPAC Adjusted Error

Unit	Effective EPAC Risk Adjustment Percentage					
	Legacy EPAC Model Error Percentile = 75%	EPAC Model Error Percentile = 50%	EPAC Model Error Percentile = 75%	EPAC Model Error Percentile = 80%	EPAC Model Error Percentile = 85%	EPAC Model Error Percentile = 90%
1	0.01%	0.00%	0.00%	0.08%	0.20%	0.35%
2	0.02%	0.00%	0.00%	0.08%	0.20%	0.35%
3	0.08%	0.00%	0.00%	0.08%	0.20%	0.35%
4	0.08%	0.00%	0.00%	0.08%	0.20%	0.35%
5	0.14%	0.00%	0.49%	0.76%	1.06%	1.44%
6	0.27%	0.00%	0.49%	0.76%	1.06%	1.44%
7	0.37%	0.33%	2.60%	3.18%	3.85%	4.68%
8	0.50%	0.24%	3.05%	3.76%	4.60%	5.65%
9	0.62%	0.19%	3.32%	4.11%	5.05%	6.22%
10	0.81%	0.00%	3.54%	4.44%	5.51%	6.86%

## Implementing the Framework

- Approach EVM for the program through the lens of the Framework
  - Understand what is needed from the data to effectively manage the program – involve analysts in CDRL development
  - Identify areas to automate and plan accordingly – utilize schema documents and sample data to design process early
  - Be mindful of client needs and address the type of analysis needed very early in the program
  - Develop methods and analyses that provide program offices with actionable insights



Incorporating EVM into an entire framework creates opportunities to enhance what is otherwise a mundane monthly deliverable



# Questions

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## Publicly Available Resources

- Resources from [www.acq.osd.mil](http://www.acq.osd.mil)
  - EVM-CR
  - Validation Utilities
  - Conversion Utilities
  - Sample Datasets
  - DEI and FFS standards
- Resources from <https://www.dcma.mil/HQ/EVMS/>
  - DECMs
  - EVMS Compliance Procedures
  - Organization and Contacts

## References

- 1. “Earned Value Management Central Repository (EVM-CR) User Guide: Submitter.” *EVM-CR Resources*, OSD ADA Integrated Program Management Division, 1 Feb. 2022, [www.acq.osd.mil/asda/ae/ada/ipm/docs/user-resources/EVM-CR%20Submitter%20Guide.pdf](http://www.acq.osd.mil/asda/ae/ada/ipm/docs/user-resources/EVM-CR%20Submitter%20Guide.pdf).