Costing a Ballistic Schedule

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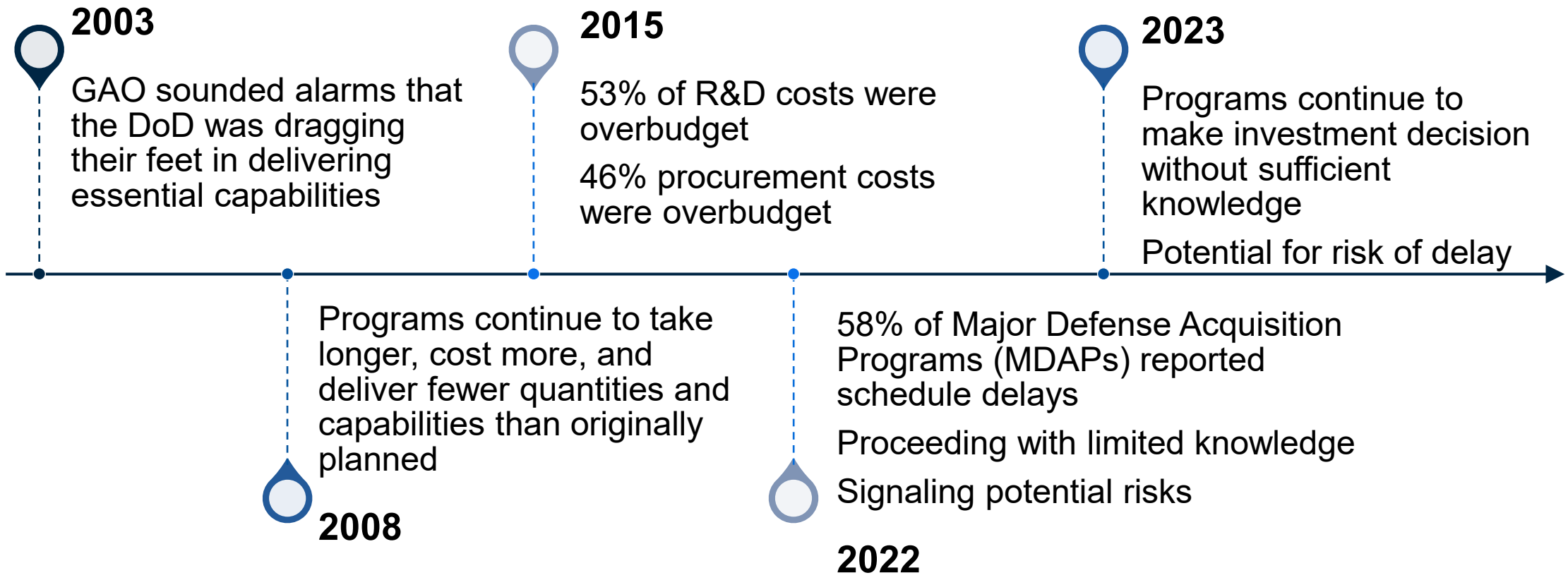
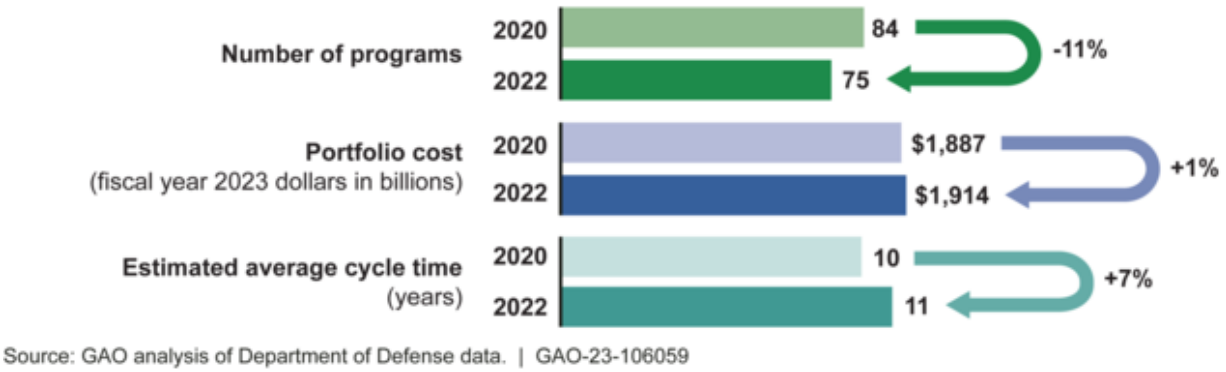
Objectives

- Enhance the value of Integrated Cost & Schedule Risk Analysis (ICSRA)
- Promote interest in producing Joint Confidence Level (JCL) estimates for DoD level programs
  - Providing joint likelihood of meeting cost & schedule
- Case study example utilizing ICSRA and producing a JCL for a critical milestone decision

All the data in this case study has been sanitized and modified for proprietary purposes

Government Accountability Office (GAO) Weapon Systems Annual Assessment





Source: GAO analysis of Department of Defense data. | GAO-23-106059

MDAPs are taking longer, costing more, and **delivering less capabilities**

Program Name	Months Delayed	Years Delayed
DDG 1000 Zumwalt Class	176	14.67
MQ-4C Triton	92	7.67
Next Generation Operational Control System	83	6.92
Integrated Air and Missile Defense	80	6.67
CH-53K King Stallion -1	79	6.58
KC-46A Tanker Modernization	76	6.33
CVN 78 Gerald R. Ford Class	75	6.25
Small Diameter Bomb Increment II	74	6.17
F-35 Lightning II	62	5.17
VC-25B Presidential Aircraft	37	3.08
F-15 Eagle Passive Active Warning Survivability System	37	3.08
Infrared Search and Track	35	2.92
Ship to Shore Connector	34	2.83
T-AO 205 John Lewis Class	31	2.58
Next Generation Jammer Mid-Band	24	2.00
MQ-25 Stingray	23	1.92
HH-60W Jolly Green II	18	1.50
MH-139A Grey Wolf	17	1.42
T-7A Red Hawk	12	1.00
FFG 62 Constellation Class	12	1.00
LGM-35 Sentinel	12	1.00

Source: GAO analysis of Department of Defense Data - GAO-23-106059 Pages 46-47

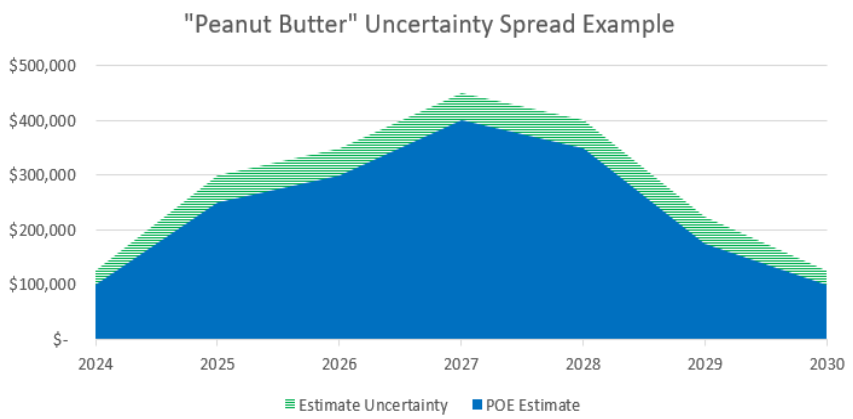
Defense Acquisition Challenges

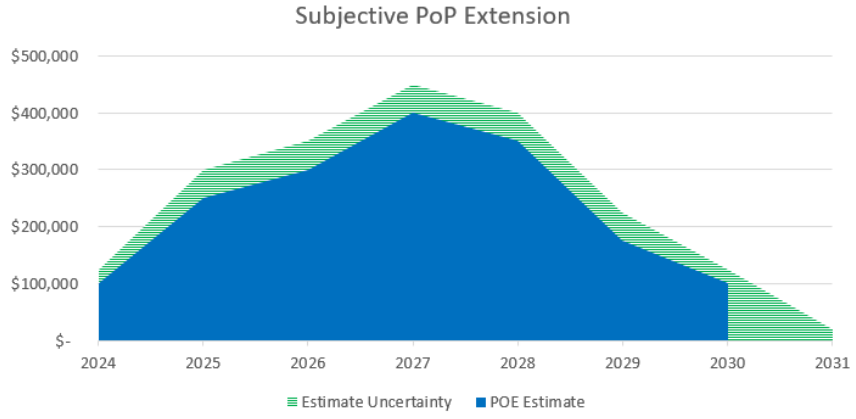
Perspective

- **In general, integrated cost-and-schedule estimates are not performed within the DoD**
  - Impact: Estimates don't account for cost growth and consequences when schedules **DO SLIP**
- **Why do most programs not perform an ICSRA estimate?**
  - Incomplete Integrated Master Schedule (IMS)
    - Would not pass a Defense Contract Management Agency (DCMA) 14-point assessment
    - Missing logic, has hard constraints, etc
  - Time consuming
- **The capability exists to assess the joint cost-and-schedule confidence levels and model uncertainty**

Schedule Uncertainty Modeling Challenges

- **Current schedule influences cost estimate**
  - Models typically “peanut butter spread” uncertainty dollars over the original period of performance
  - Not truly reflective of future work performance
- **Subjective extended period of performance**
  - Added time and phased over the PoP





Schedule uncertainty $$ are not properly phased when required

ICSRA Capabilities

- **Quantitative product that shows realistic mean schedule end date vs using Subject-Matter Expert (SME's) best judgement**
- **Quantitatively visualize schedule growths impact on cost**
- **Produce higher quality estimates**
  - Estimates are far more reasonable, realistic, and complete
  - Funding is more accurately phased into the year of requirement

	Pros	Cons
ICSRA	Quantitative Results More Realistic	Agile to update Time Consuming
Traditional	Easy to model	Inaccurate phasing
Subjective Approach	Quick Results SME input	SME bias Inaccurate phasing

Advantages

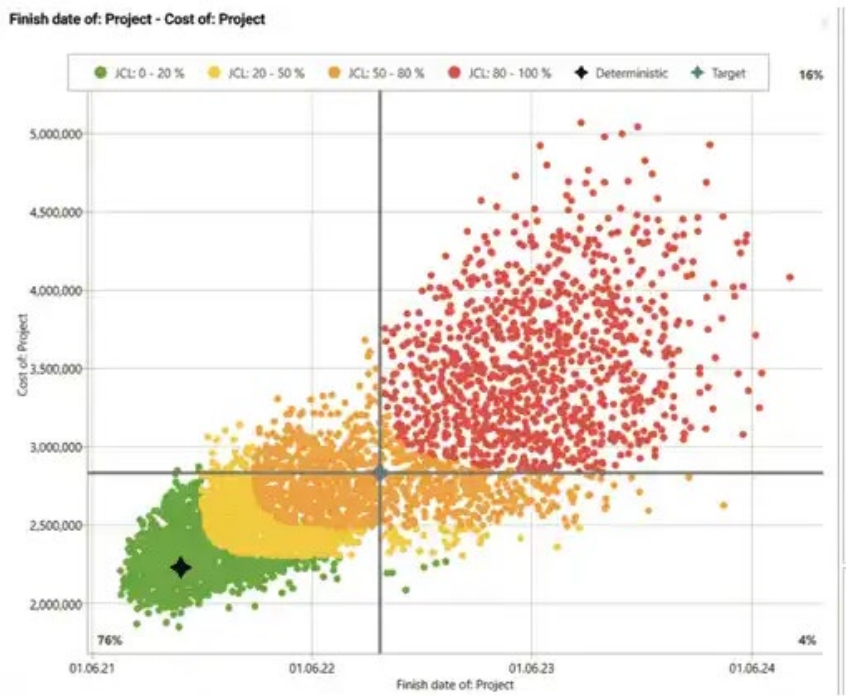
- **Accurate Program Planning**
  - Comprehensive view of cost & schedule risks and uncertainty
- **Inform Decision Making**
  - Optimization of resource allocation & program outcomes
- **Improve Communication**
  - Facilities communication among stakeholders'
- **Enhance Program Success Rate**
  - Quantitatively derived timeframe

Top Level Challenges Faced

- **Planning Schedule**
  - Schedule was workable logic wise, but had quite a bit of float
  - Had to identify critical path of IMS tasks to affect schedule when tying discrete program risks
- **IMS schedule included only CTR scope and tasks**
- **JCL tool currently isn't the most agile with updates**
  - Anytime the POE was updated, the JCL uncertainty parameters needed to be updated
  - Very time consuming

The JCL Process

JCL Process



- Step 1: Produce a cost estimate (POE)
- Step 2: Conduct a schedule risk analysis (SRA)
- Step 3: Map POE WBS elements to SRA schedule
- Step 4: Define TI vs TD relationship
- Step 5: Phased mapped elements
- Step 6: Calculate & analyze results

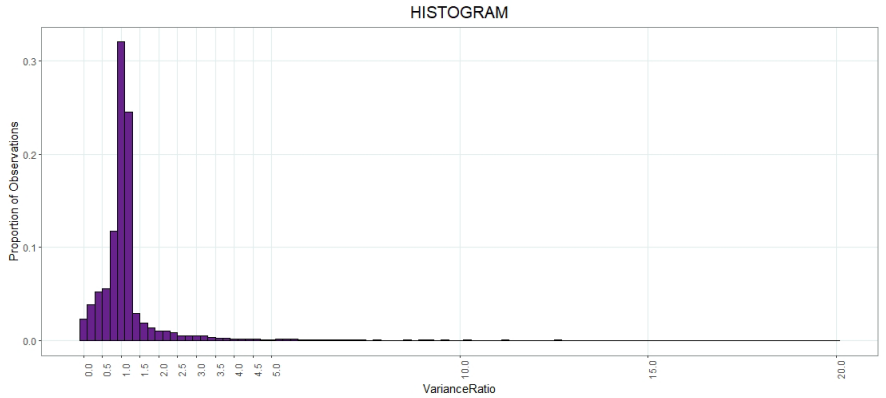
Step 1: Produce Cost Estimate

- **After months working with PMs, ENGs, and other stakeholders, the program's POE estimate was:**
  - ~ $800.0 at Point Estimate (PE)
  - ~ $900.0 at PE w/risk & uncertainty

Estimate DID NOT account for schedule growth or schedule uncertainty/risk

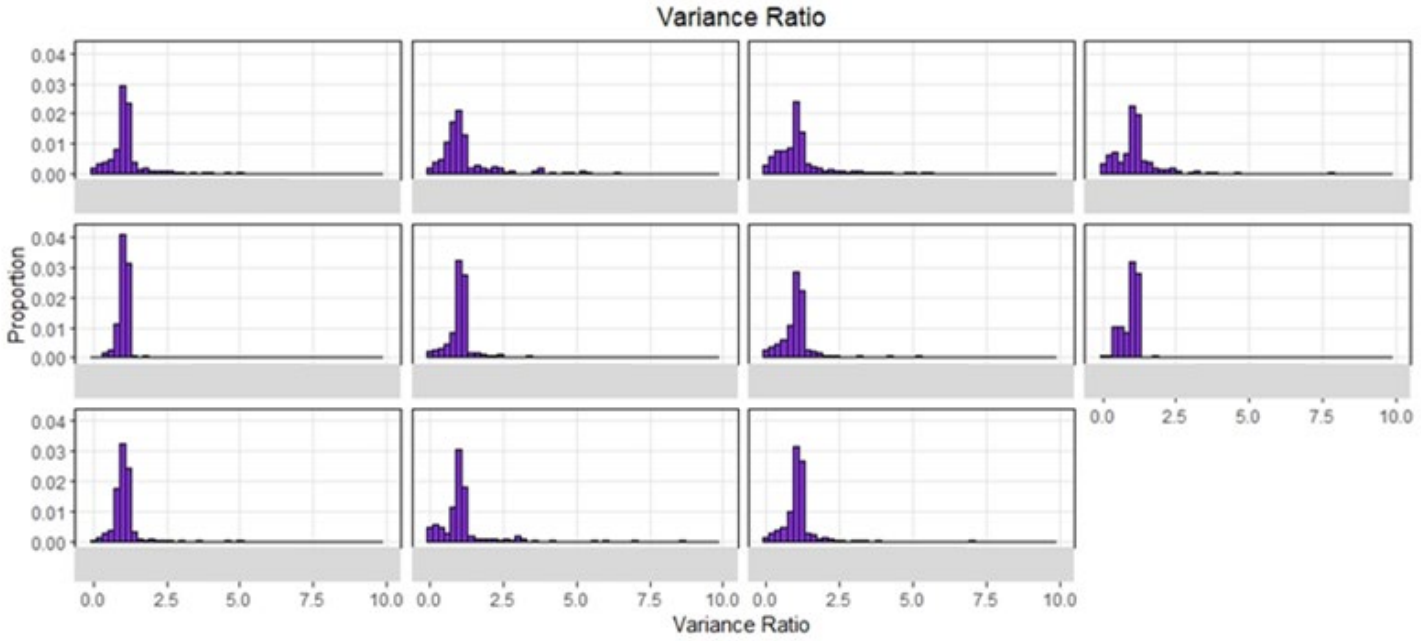
Step 2: Conduct an SRA

- To build SRA… the program used an analogy to an existing similar program
  - Analogous program had completed over 15,000 tasks
  - Variance Ratio = Actual Duration / Baseline Duration
    - (e.g., Variance Ratio = 1.5 for a task that took 50% longer to complete than the baselined duration)
  - Overall Analogy performance
    - LogNormal Distribution. Peak ~ 1.0 (e.g., actual duration = baseline duration)
    - A very small percentage of tasks have a Variance Ratio > 5 (some as large as 20)



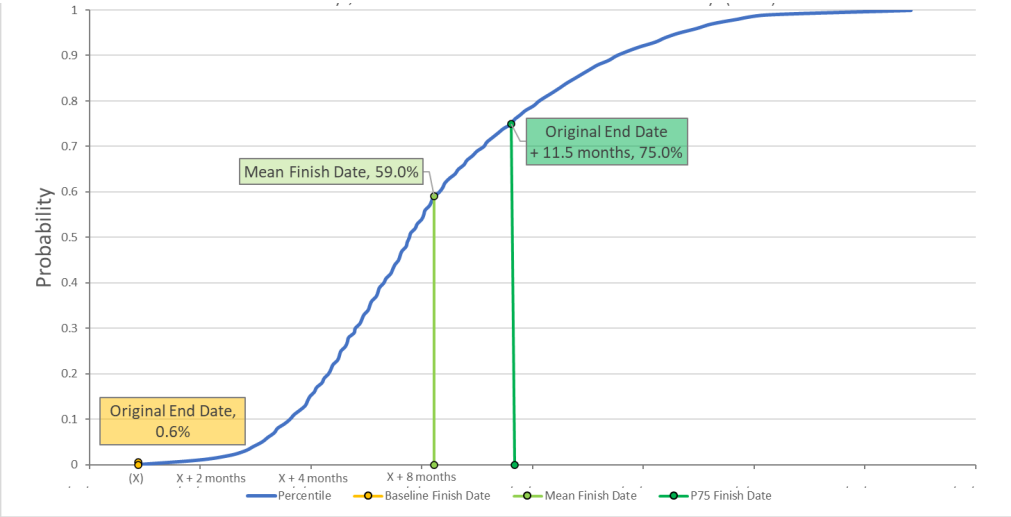
Program Analogy – OBS Mapping

- Applied uncertainty to SRA schedule tasks through analogy to analogous program's applicable OBS structure
- Data was stratified by OBS
  - Differences in most distributions are statistically significant



Step 2: Conduct an SRA (cont)

- Probability of Successfully completing milestone phase by proposed end date was very low (~0.6%)
- SRA Results
  - 0.6% Confidence Level: Original schedule end date
  - 59% Confidence Level: Original schedule end date + 9 months -- Mean finish date
  - 75% Confidence Level: Original schedule end date + 11.5 months



Step 3: Map WBS Elements

- Map cost WBS elements to Project schedule

Milestones	1676 d	2	Mon 9/17/29	Fri 5/23/36
EMD Program Milestones	805 d	3	Mon 9/17/29	Wed 12/8/32
!SM! EMD ATP	0 d	4	Mon 9/17/29	Mon 9/17/29
!FM! IBR	0 d	5	Mon 3/11/30	Mon 3/11/30
!FM! dPDR	0 d	6	Mon 10/7/30	Mon 10/7/30
!FM! System CDR	0 d	7	Wed 7/23/31	Wed 7/23/31
!FM! Milestone C Approval (Govt Reference)	0 d	8	Thu 2/14/30	Thu 2/14/30
!FM! FFT	0 d	9	Fri 12/12/31	Fri 12/12/31
!FM! SQVR	0 d	10	Thu 6/10/32	Thu 6/10/32
!FM! SQVR Closure	0 d	11	Fri 10/8/32	Fri 10/8/32
!FM! PRR	0 d	12	Mon 10/18/32	Mon 10/18/32
!FM! OTRR (Prior to JST87NE_FTU10)	0 d	13	Wed 5/12/32	Wed 5/12/32
!FM! EMD PoP Completion	0 d	14	Wed 12/8/32	Wed 12/8/32

Project Schedule

JACS Build-up

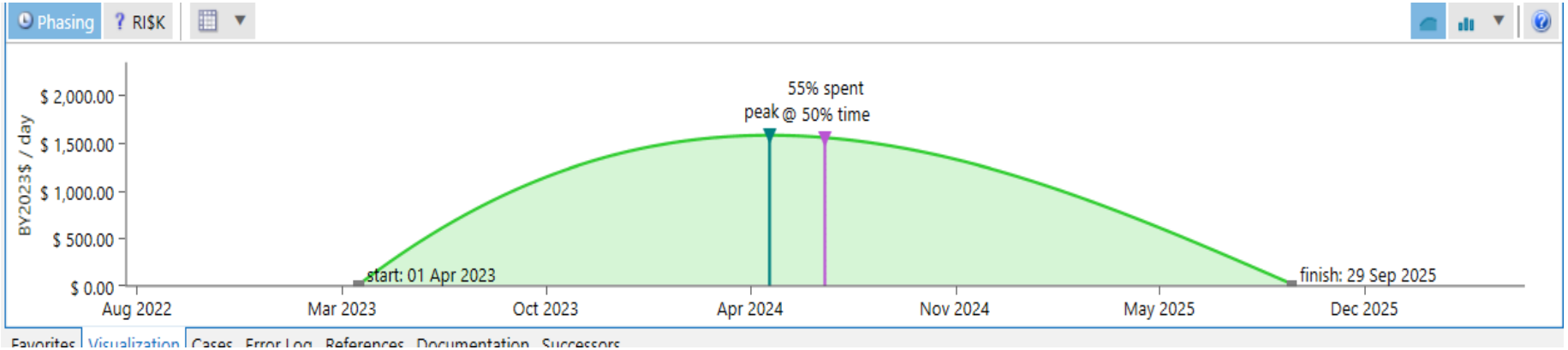
Contractor Costs	3907 d	11606	Mon 9/17/29	Mon 12/12/44	
EMD Costs	3907 d	11607	Mon 9/17/29	Mon 12/12/44	
EMD Non-Recurring Engineering	2392 d	11608	Mon 9/17/29	Mon 2/21/39	
EMD Component #1	2320 d	11609	Mon 9/17/29	Thu 11/11/38	
WBS Element - 1.1	805 d	11610	Mon 9/17/29	Wed 12/8/32	
WBS Element - 1.1	0 d	11611	Mon 9/17/29	Mon 9/17/29	4SS
WBS Element - 1.1	0 d	11612	Wed 12/8/32	Wed 12/8/32	14FF
WBS Element - 1.2	805 d	11613	Mon 9/17/29	Wed 12/8/32	
WBS Element - 1.2	0 d	11614	Mon 9/17/29	Mon 9/17/29	4SS
WBS Element - 1.2	0 d	11615	Wed 12/8/32	Wed 12/8/32	14FF
WBS Element - 1.3	805 d	11616	Mon 9/17/29	Wed 12/8/32	
WBS Element - 1.3	0 d	11617	Mon 9/17/29	Mon 9/17/29	4SS
WBS Element - 1.3	0 d	11618	Wed 12/8/32	Wed 12/8/32	14FF

Step 4: Define TI vs TD Relationship

- Each WBS element has a portion of its cost that is time independent (TI) and time dependent (TD):
  - Tasks such as LOE efforts tend to be highly time dependent
  - Tasks such as the purchase of materials tend to be more time independent
- Worked with program cost SMEs and personnel to identify what portion of each element's total cost was time independent vs dependent
  - Time Dependent Tasks: 80/20; 70/30 split
  - Time Independent Tasks: 70/30; 60/40 splits

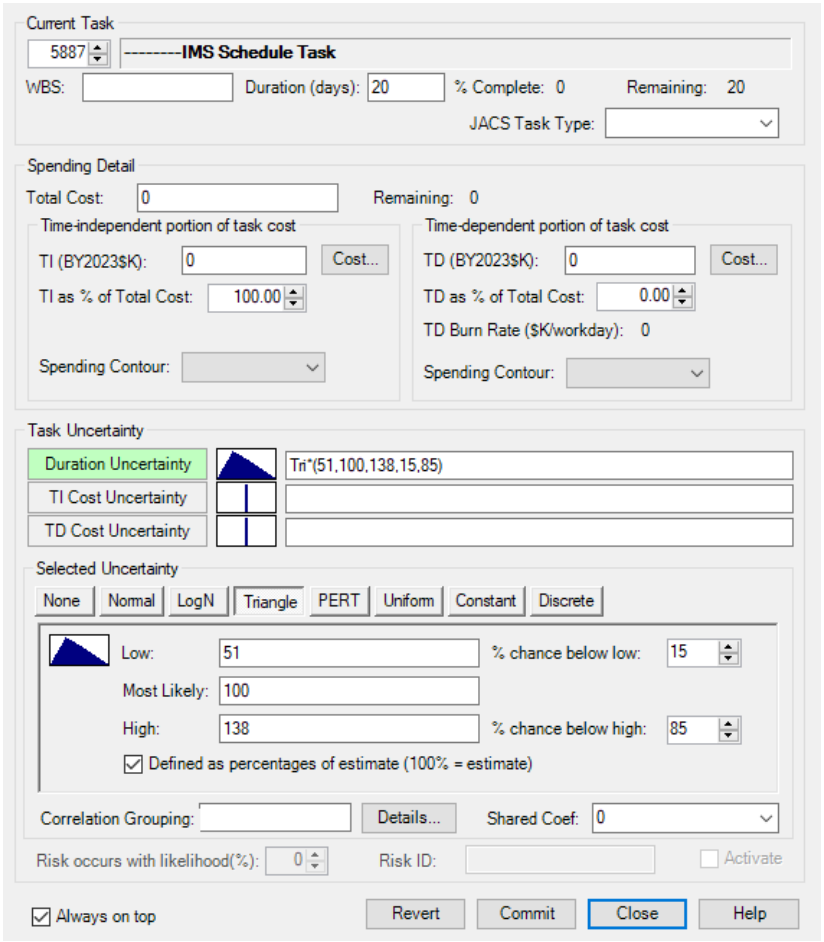
Step 5: Phasing of JACS Model

- **Phased JCL according to outlay used in cost estimate**
- **Can phase via the following spending contours:**
  - **Bell curve**
  - **Flat**
  - **Ramp up/Steady State/Ramp Down**
  - **Front/Back Loaded**

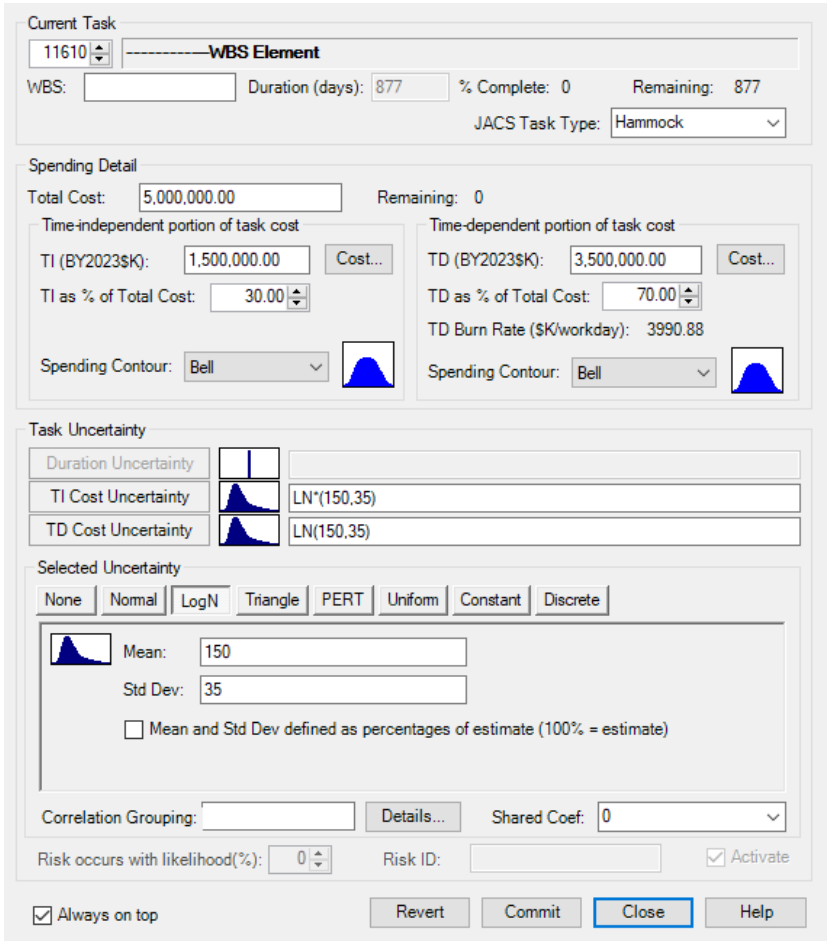


How it looks in JACS

Schedule Uncertainty for SRA



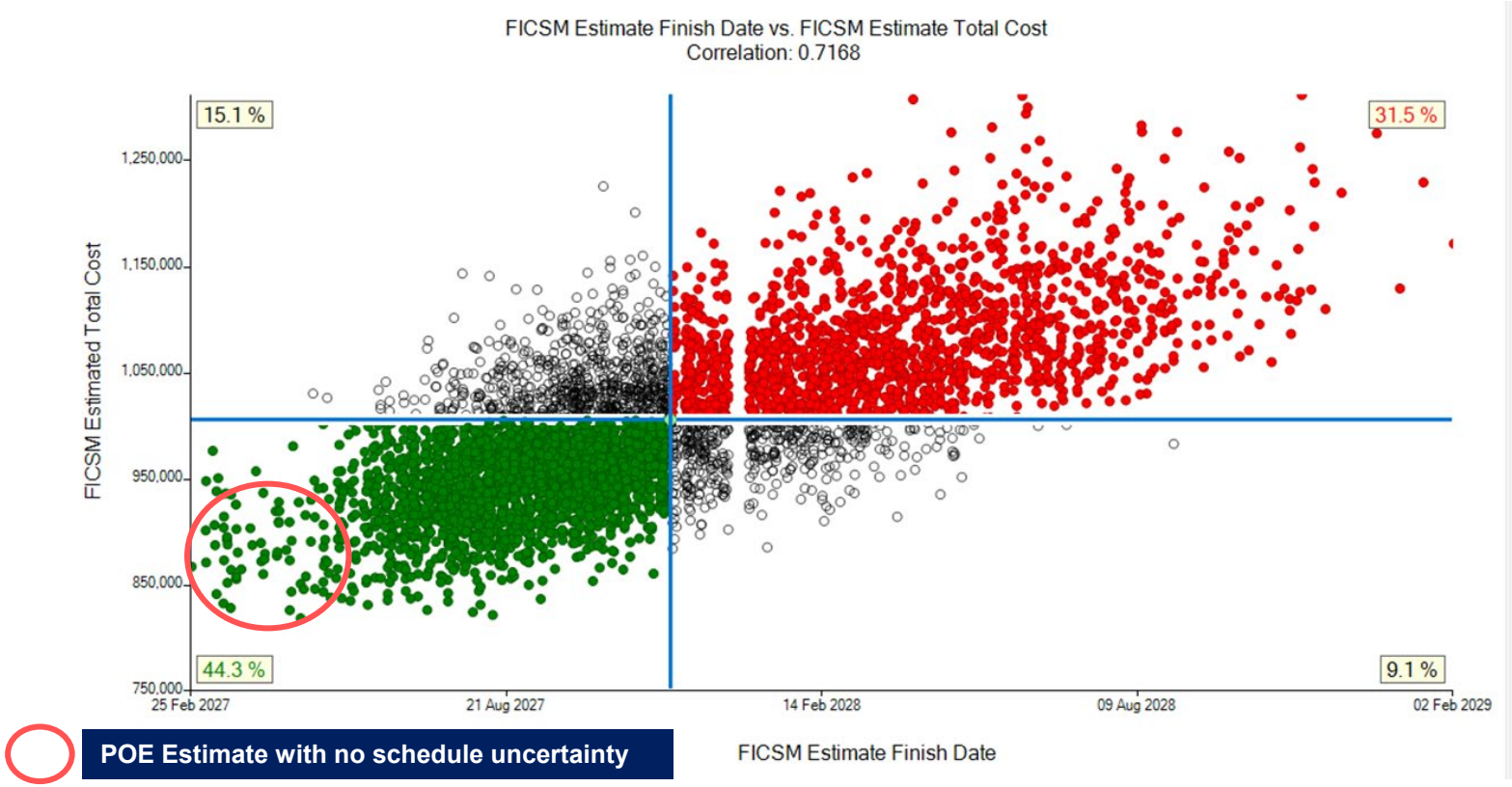
Cost Uncertainty from POE



Results…

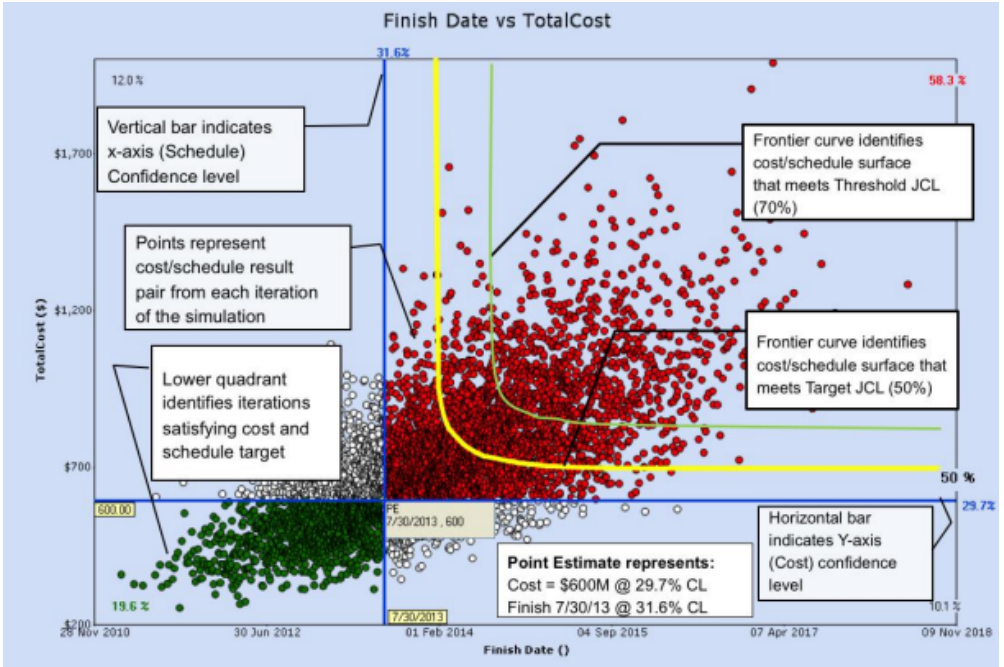
Step 6: JCL Results

- **Probability of completing EMD by the SRA's mean finish date, and mean JCL cost = *44.3% confidence level***



Step 6: JCL Results (cont)

- Trade space discussion
  - With a JCL analysis, though, trade space can be analyzed:
    - ICBMs: Typically, in our experience, programs are baselined and funded to the *mean finish date* and *mean cost* (50-55% typically)
    - NASA: Though baselines and funds to the 70% confidence level
  - Program Office's can evaluate trade space based on:
    - Risk tolerance / Inherent uncertainty
    - Maturity / Current program phase
    - Overall portfolio management



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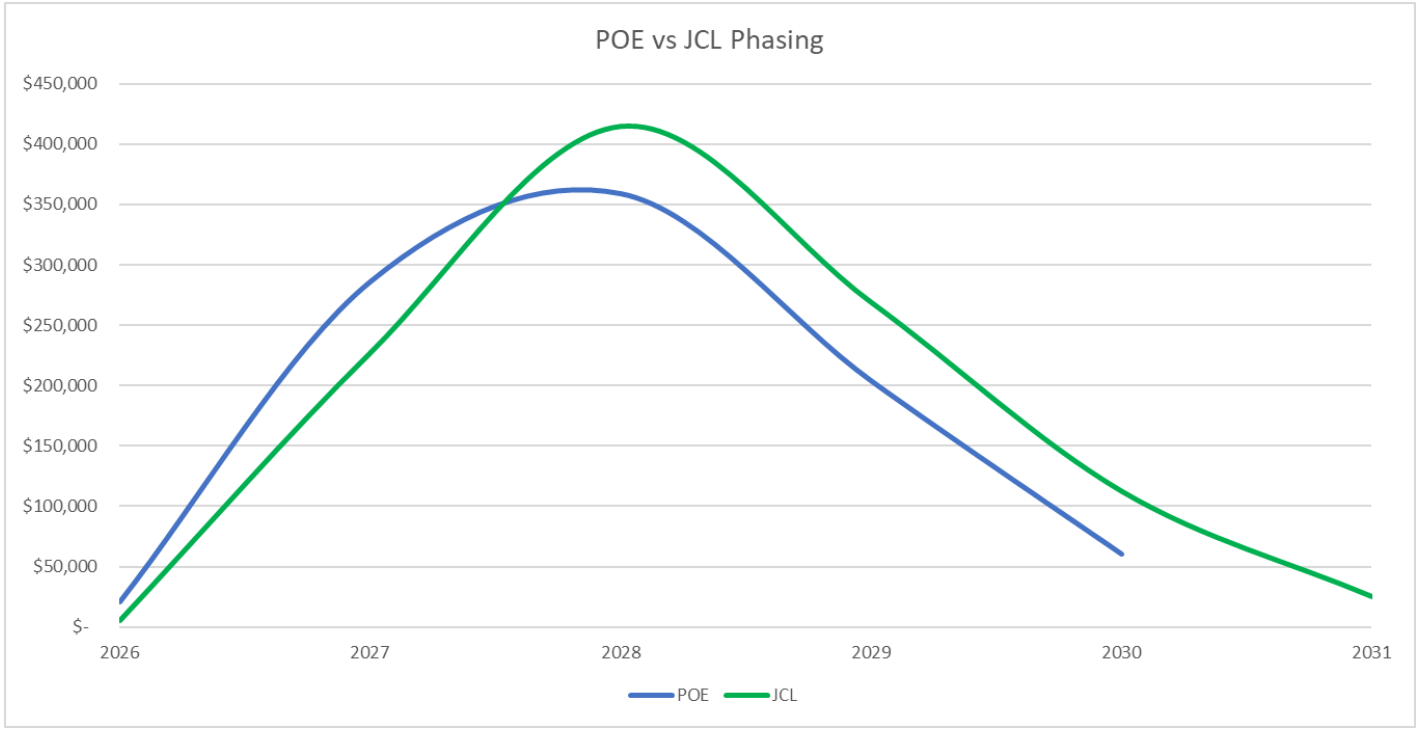
POE vs JCL Phasing



JCL enables phasing of POE based on expected time of requirement

Final Takeaways

JCL Contributions

- **Baselined to Realistic Schedule**
  - Probability of completing contract by the POE's finish date, and mean POE cost, ~$900.0, <0.6% confidence
  - Probability of completing contract by the SRA's mean finish date, original end date + ~9 months, and mean JCL cost = 44.3% confidence
- **Program Impact**
  - Two-thirds of the way through the proposal process
  - The program stopped and instructed the contractor to rebid to the new schedule
- **Result**
  - Prime contractor re-proposal came in within the JCL estimate

Takeaways

- ***Improved Forecasting:*** Enhances the ability to estimate cost and schedules accurately
- ***Comprehensive Insights:*** Provides a holistic view of the program's timeline and budget requirements
- ***Early Risk Identification:*** Helps identify potential risks and issues at an early stage
- ***Trade Space Analysis:*** Facilitates analysis of alternatives and what if drills
- ***Informed Decision-Making:*** Enables informed decisions to keep the program on track and avoid schedule or cost breaches

Questions