A Case Study for Future Munition: An Analysis of Alternatives

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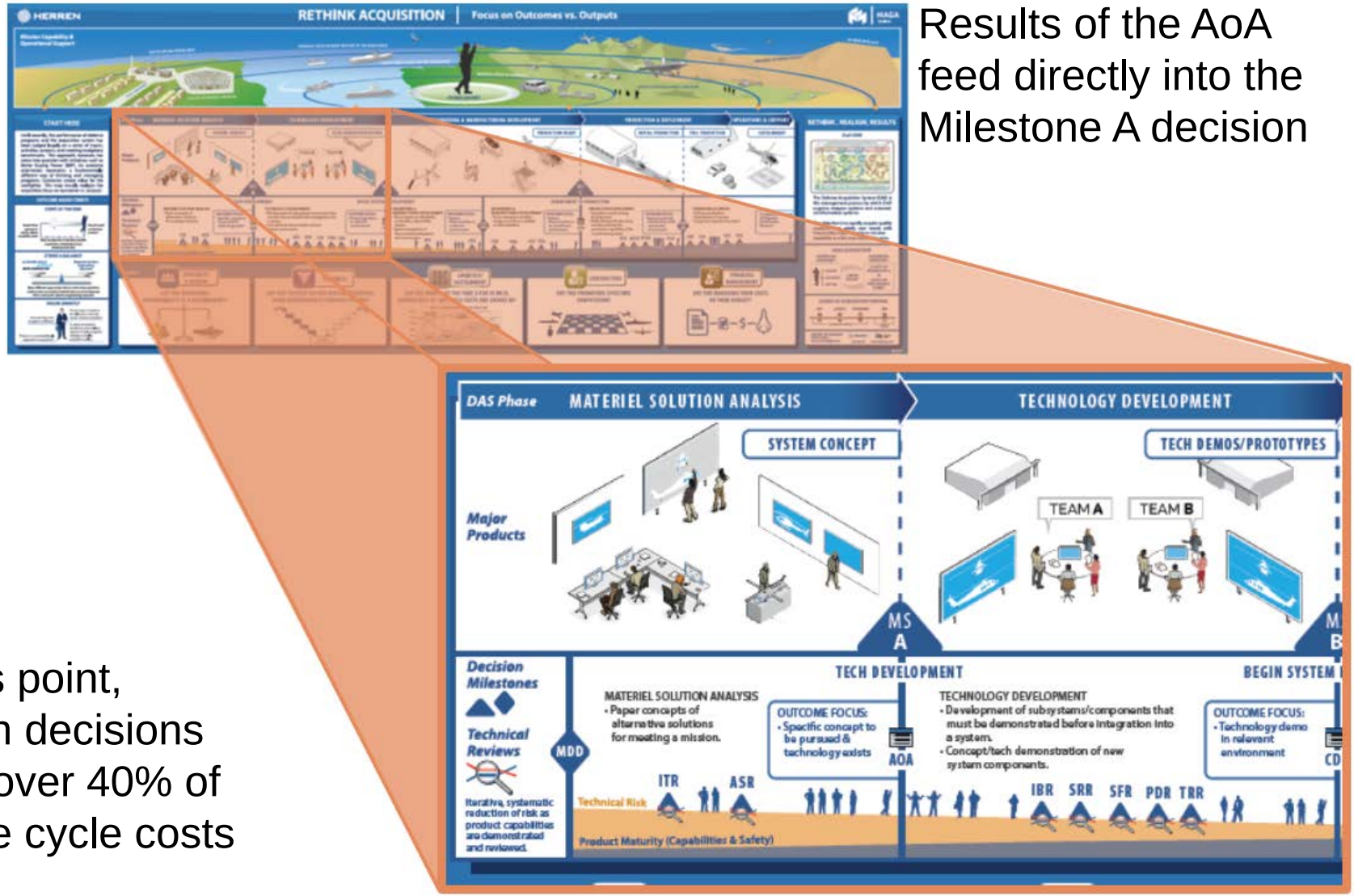
Presented at the 2018 ICEAA Professional Development & Training Workshop - www.iceaaonline.com

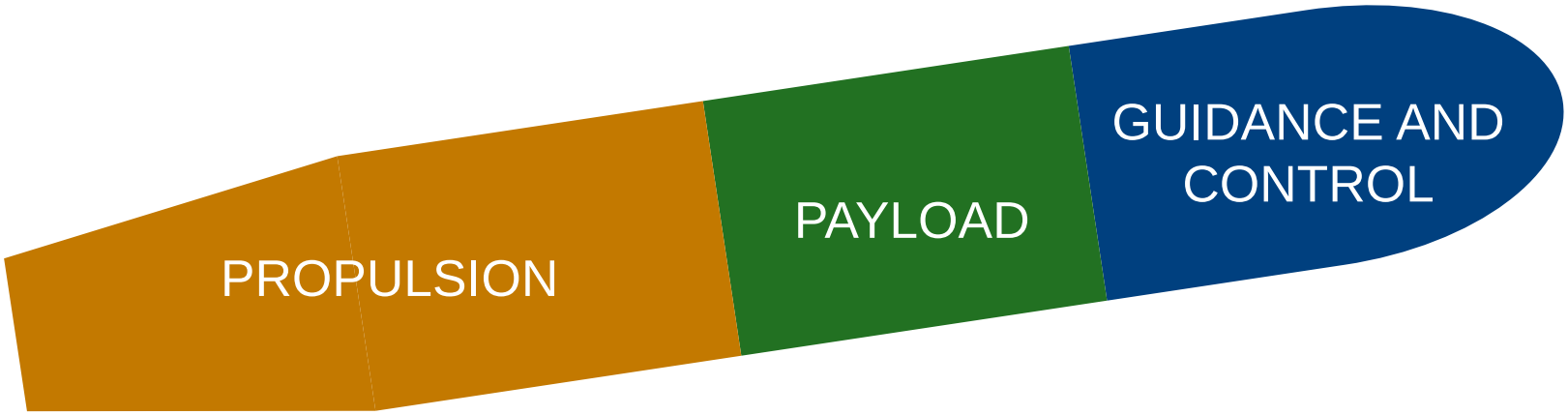
Tasked to assist with the cost portion of an Analysis of Alternatives (AoA) for a future munition.



Results of the AoA feed directly into the Milestone A decision

At this point, design decisions drive over 40% of the life cycle costs

The hardware (broken down into three main sections) contained different options for each section.



Option 1
Option 2
Option 3
Option 4
Option 5

Option 1
Option 2

Option 1
Option 2

Courses of Actions (COAs) for this AoA were created by pulling the different options together for the complete munition.

Creating the Total Ownership Costs (TOC) for each COA was challenging.

Stop Gap Solution

- Additional solution added to leverage older, fully functioning portions of munition
- Stop gap solution option to deliver capabilities sooner
- Base procurement quantity of 500 units
- 130 GFE can be leveraged to provide quicker capabilities to the fleet

Creating the Total Ownership Costs (TOC) for each COA was challenging.

Phased software development

- Some simpler development with more critical capabilities that were needed for munition sooner
- Mainly used for stop gap solution options to upgrade the GFE

Different service lives

- Stop gap solution where GFE was used had a 10 year service life
- Two other solutions had different service lives

Creating the Total Ownership Costs (TOC) for each COA was challenging.

Different maintenance turns

- Stop gap solution where GFE was used was not maintained after it reached the end of its service life
- Two other solutions had different maintenance turns

Different procurement schedules

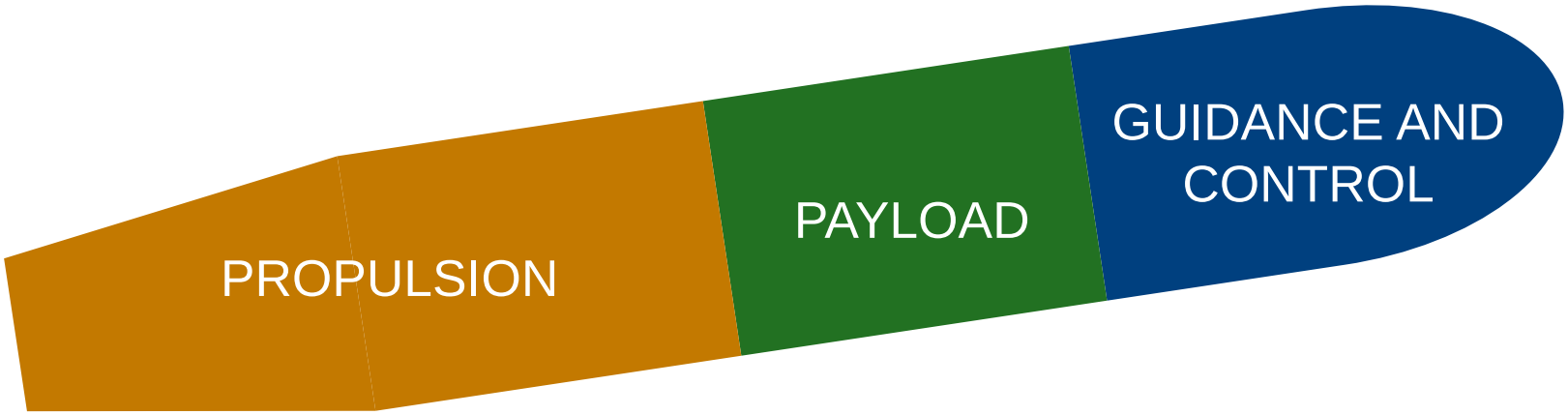
- Stop Gap only solution with 130 total procurements
- New procurements (normal) solution with 500 total procurements
- Solutions that combine stop gap solution and normal solution

Creating the Total Ownership Costs (TOC) for each COA was challenging.

Unknown and changing requirements

- As this was pre-MS A, the stakeholders did not completely have all of the information
- Would receive information in small pieces with a lot of caveats to begin building the estimate
- New information we would receive would sometimes make previous work useless

The hardware (broken down into three main sections) contained different options for each section.

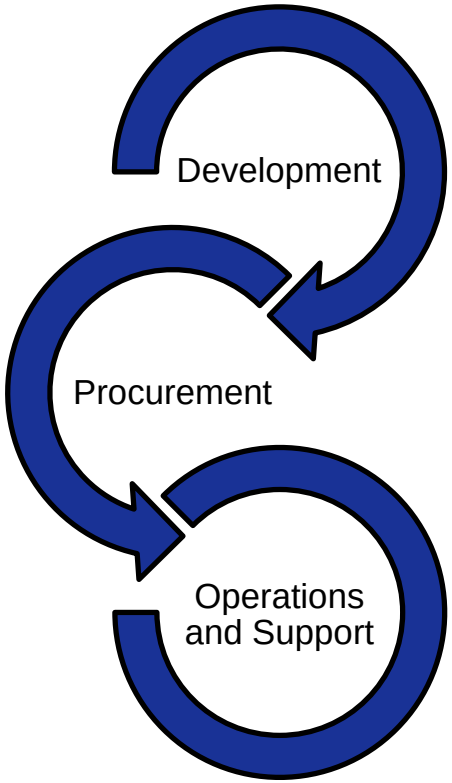


PROPULSION	PAYLOAD	GUIDANCE AND CONTROL
Option 1	Option 1	Option 1
Option 2	Option 2	Option 2
Option 3		
Option 4	Stop Gap Option	Phased Software Development
Option 5		

After all the options were flushed out, essentially would have been 21 different PLCCEs with constant changing requirements

Hardware and software of the ordnance is the key differentiator, but most alternatives are the same across other life cycle elements

MIL STD 881C and the O&S Guide was used to develop an all encompassing work breakdown structure (WBS):

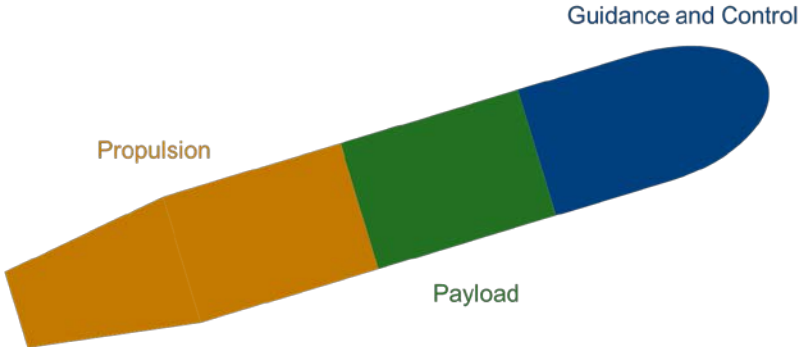


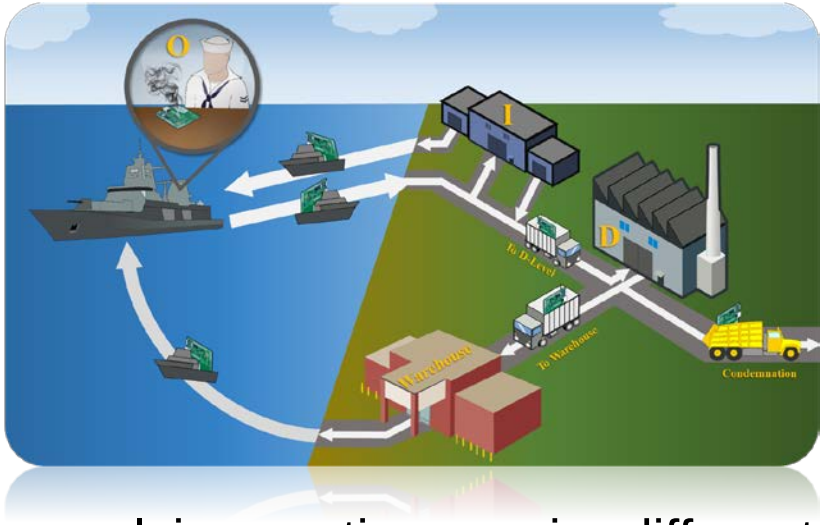
Development and Procurement
Ordnance System
- Munition
  - Guidance and Control
  - Payload
  - Propulsion
  - Software
- Ordnance System Integration
- Systems Engineering & Program Management
- Test and Evaluation
- Training
- Data
- Support Equipment
- Initial Spares

Operations and Support
- Maintenance
- In-Service Support

Integration of the new munition into the different platforms and maintenance of the munition can be significantly impacted depending on alternative

Each platform has its own hardware and software integration requirements





Differences in things such as fuel for the propulsion section require different maintenance efforts as well as infrastructure to carry out the maintenance

For similar studies, we use a data collection process that uses a matrix approach across the alternatives and work breakdown structure

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  - Payload 2
  - Payload 3
  - Propulsion 1
  - Propulsion 2
  - Propulsion 3
  - Propulsion 4
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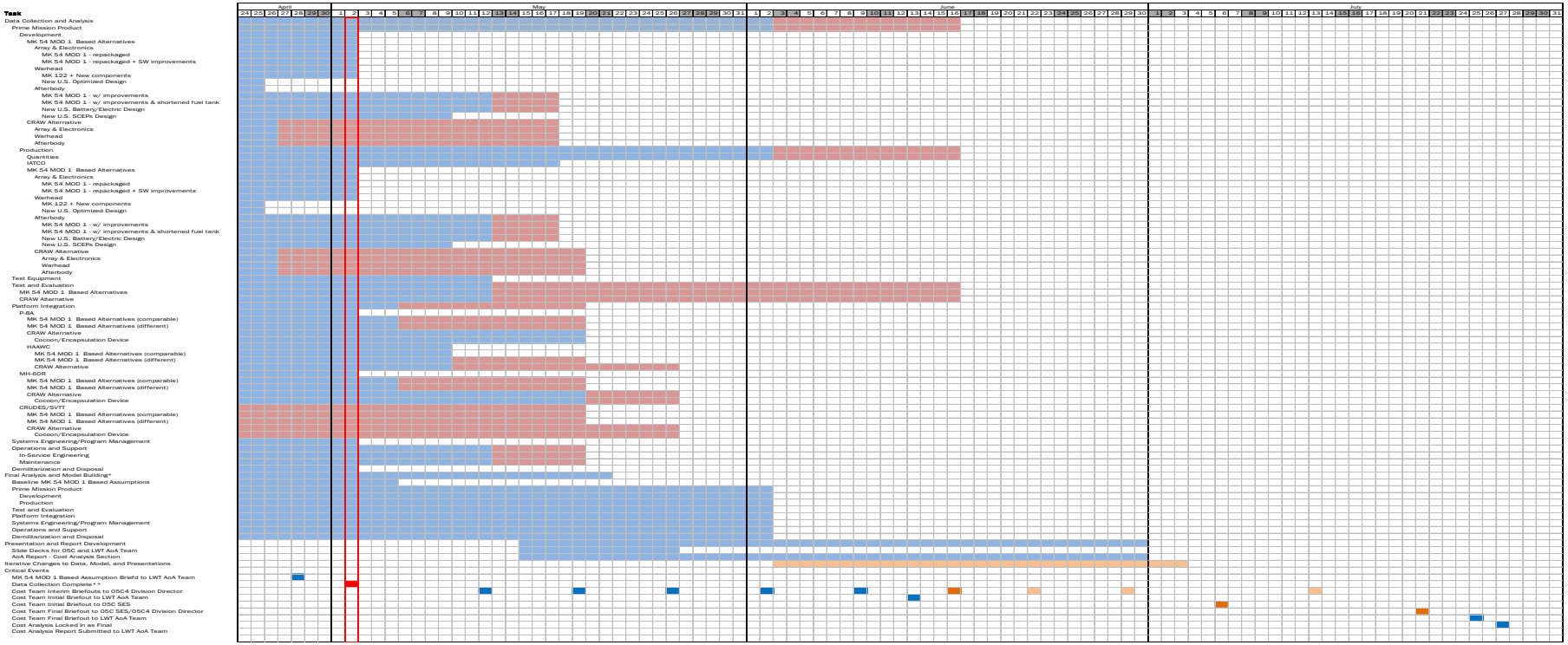
For the munition hardware, since multiple alternatives used some of the same sections, data and inputs only needed to be gathered once

Across the remainder of areas:
- Some elements are assumed to be the same no matter the alternative, with either a set cost and a factor applied to hardware and software
- Other elements were specific to the alternative, driven by the sections included
- The remainder used groupings of the alternatives based on the development required

The matrix approach also allowed us to identify the key organizations, points of contact, and subject matter experts for each element



- Tracking data requests is very important when working across an AoA involving many organizations and individuals
- In some cases, an AoA can be equivalent to working multiple program life cycle cost estimates concurrently – so processes around data collection help ensure successful execution and highlight issues

Our approach to analyzing and modeling the cost estimate for each alternative mirrors our data collection approach

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Operations and Support
- Maintenance
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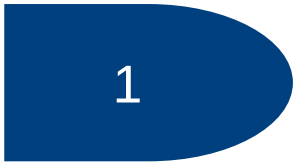
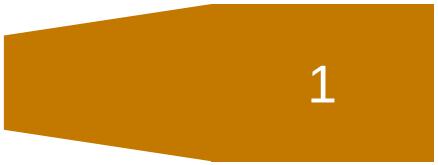
- For the munition hardware and software, we analyze each of the individual sections independently and then roll these up into the overall munition – considering uncertainty around both cost and schedule
- For all other areas, we analyzed the alternative composed of the specific sections
- The options selected for each alternative combination drive the cost in other elements, such as the ordnance system integration and maintenance

We use Microsoft Excel to develop our AoA cost models, consolidating all alternatives into one work book and using Crystal Ball.

		Development	Procurement	O & S
Guidance and Control		**G&C 1 Dev. $ + Payload 1 Dev. $ + Propulsion 1 Dev. $ = Alternative 1 Munition Dev. $**	**{G&C 1 Unit $ + Payload 1 Unit $ + Propulsion 1 Unit $} X # of Units = Alternative 1 Munition Proc. $**	
Payload				
Propulsion				
Integration		**Alternative 1 Integration Dev. $**		
Maintenance		**Alternative 1 Test Equipment & Infrastructure Dev. $**		**Maint. $ per Unit X # Units per Year**

The dynamic model was created to accommodate the changing and unknown requirements from the clients.

1 Placeholders were created to easily account for changing requirements.

Quantities		FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	F
Quantity Schedule 1		0	0	5	20	100	0	0	0	0	0	
Quantity Schedule 2		0	0	0	0	5	40	70	200	200	200	
Quantity Schedule 3		0	0	0	0	4	30	53	150	150	150	
Quantity Schedule 4		0	0	0	3	23	40	113	113	113	0	
Quantity Schedule 5		0	0	4	15	75	0	0	0	0	0	
Quantity Schedule 6		0	0	0	0	6	50	88	250	250	250	

T1Calculations	Total	CIC	PRE	FY19	FY20	FY21	FY22
Option 1	$680	94%	94%	$0	$0	$0	$0
Option 2	$680	100%	100%	$0	$0	$0	$0
Option 3	$680	97%	95%	$0	$0	$0	$0
Option 4	$350	94%	94%	$0	$0	$0	$0
Option 5	$350	100%	100%	$0	$0	$0	$0
Option 6	$350	94%	94%	$0	$0	$0	$0
Option 7	$200	100%	100%	$0	$0	$0	$0
Option 8	$320	94%	94%	$0	$0	$0	$0
Option 9	$320	94%	97%	$0	$0	$0	$0
Option 10	$280	100%	100%	$0	$0	$0	$0
Option 11	$280	94%	94%	$0	$0	$0	$0
Option 12	$280	94%	94%	$0	$0	$0	$0
Option 13	$250	100%	100%	$0	$0	$0	$0
Option 14	$250	97%	94%	$0	$0	$0	$0
Option 15	$250	97%	94%	$0	$0	$0	$0
Option 16	$480	97%	94%	$0	$0	$0	$0
Option 17	$480	97%	94%	$0	$0	$0	$0
Option 18	$710	94%	94%	$0	$0	$0	$0
Option 19	$470	94%	94%	$0	$0	$0	$0
Option 20	$470	100%	100%	$0	$0	$0	$0
Option 21	$470	94%	94%	$0	$0	$0	$0
Option 22	$210	96%	94%	$0	$0	$0	$0
Option 23	$310	96%	96%	$0	$0	$0	$0
Option 24	$210	94%	94%	$0	$0	$0	$0
Option 25	$310	94%	94%	$0	$0	$0	$0

The dynamic model was created to accommodate the changing and unknown requirements from the clients.

2

A unique identifying number that serves as a “tag” is assigned to each option that is rolled through the rest of the model.

		FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27
17.91647	Option 1	$ 6,300	$ 6,300	$ 5,600	$ -	$ -	$ -	$ -	$ -	$ -
17.9722	Option 2	$ 6,300	$ 6,300	$ 5,600	$ -	$ -	$ -	$ -	$ -	$ -
18.02776	Option 3	$ 6,900	$ 7,400	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18.08314	Option 4	$ 6,900	$ 7,400	$ 9,400	$ 10,600	$ -	$ -	$ -	$ -	$ -
18.13836	Option 5	$ 8,300	$ 9,200	$ 8,700	$ 8,200	$ -	$ -	$ -	$ -	$ -
18.19341	Option 6	$ 5,700	$ 6,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18.24829	Option 7	$ 12,900	$ 100	$ 14,000	$ 12,600	$ -	$ -	$ -	$ -	$ -
18.30301	Option 8	$ 12,900	$ 100	$ 14,000	$ 12,600	$ -	$ -	$ -	$ -	$ -
18.35756	Option 9	$ 5,700	$ 6,000	$ 6,000	$ 6,100	$ 6,000	$ 5,900	$ 5,900	$ 5,700	$ -
18.41195	Option 10	$ 90	$ 90	$ 8,000	$ 8,000	$ -	$ -	$ -	$ -	$ -
18.46619	Option 11	$ 10,800	$ 10,800	$ 8,800	$ 8,800	$ -	$ -	$ -	$ -	$ -
18.52026	Option 12	$ 21,400	$ 63,700	$ 58,600	$ 22,100	$ 5,700	$ -	$ -	$ -	$ -
18.57418	Option 13	$ 46,700	$ 65,600	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18.62794	Option 14	$ 63,100	$ 124,300	$ 58,600	$ 22,100	$ 5,700	$ -	$ -	$ -	$ -
18.68154	Option 15	$ 46,700	$ 65,600	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18.73499	Option 16	$ 37,100	$ 119,900	$ 109,900	$ 380	$ 6,400	$ -	$ -	$ -	$ -
18.78829	Option 17	$ 46,700	$ 136,200	$ 130,000	$ 53,900	$ 25,100	$ 19,900	$ 19,400	$ 5,600	$ -
18.84144	Option 18	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18.89444	Option 19	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18.9473	Option 20	$ 18,700	$ 53,900	$ 49,700	$ 19,300	$ 5,600	$ -	$ -	$ -	$ -
19	Option 21	$ 50	$ 6,800	$ 6,600	$ 50	$ -	$ -	$ -	$ -	$ -
19.05256	Option 22	$ 50	$ 6,800	$ 6,600	$ 50	$ -	$ -	$ -	$ -	$ -
19.10497	Option 23	$ 7,600	$ 7,600	$ 6,900	$ -	$ -	$ -	$ -	$ -	$ -
19.15724	Option 24	$ 7,600	$ 7,600	$ 7,600	$ 7,600	$ 6,900	$ 6,900	$ -	$ -	$ -
19.20937	Option 25	$ 7,600	$ 7,600	$ 7,600	$ 7,600	$ 6,900	$ 6,900	$ -	$ -	$ -

Unique identifying number associated with phased costs

The different elements with their “tag” can be chosen by a COA.

The dynamic model was created to accommodate the changing and unknown requirements from the clients.

3

A single set of calculations are then performed, using Crystal Ball's Decision Analysis and Excel's "IF" formulas to pull in the Assumptions

Alternative	1
Procurement Quantity	400
Maintenance Quantity	800
In Service Support Years	20

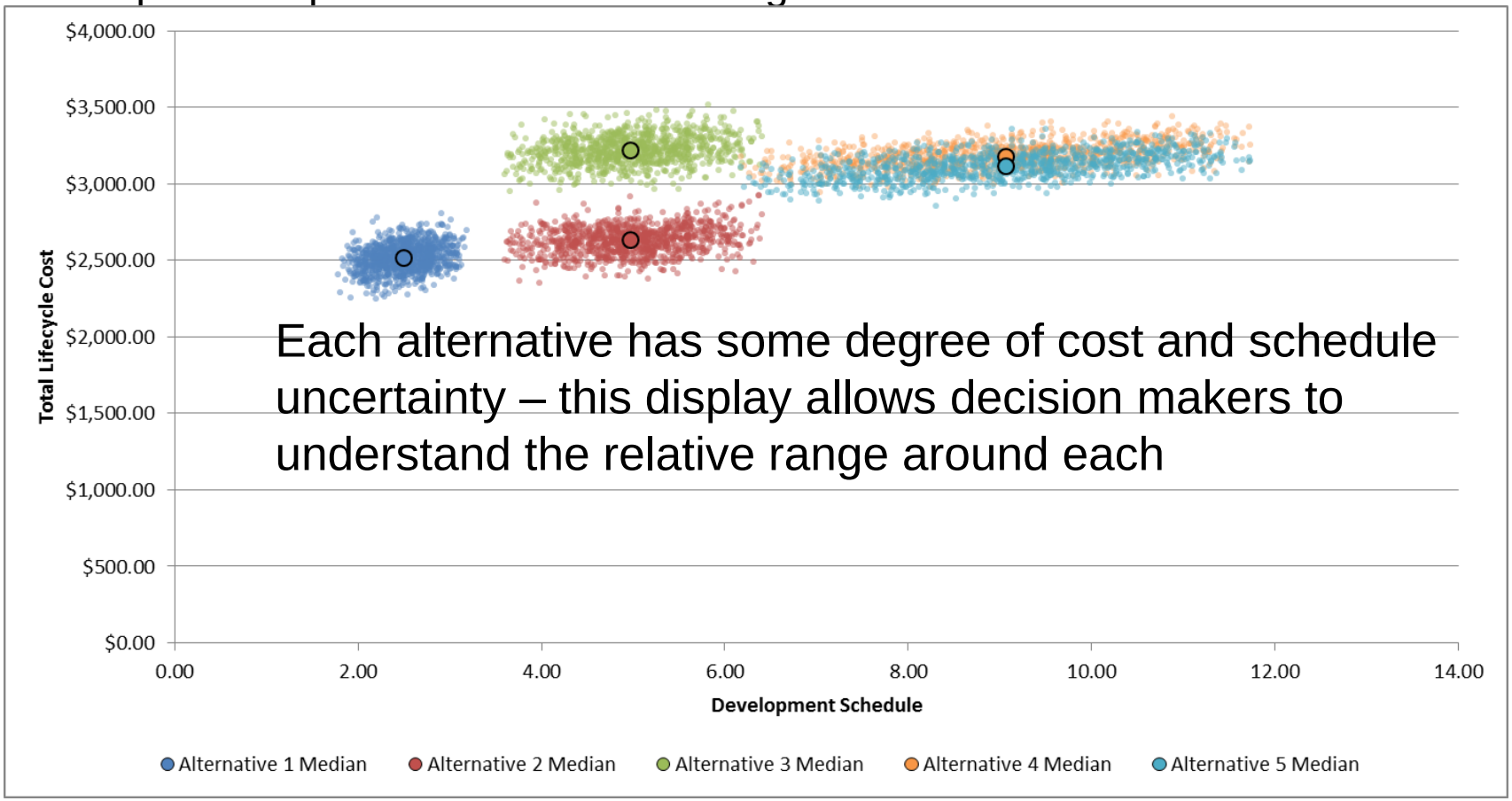
Name	Section	Calculation
Guidance and Control PMP	Development	$ 20.00
Payload PMP	Development	$ 75.00
Propulsion PMP	Development	$ 10.00
Software PMP	Development	$ 7.00
Integration	Development	$ 68.75
SEPM	Development	$ 35.00
T&E	Development	$ 106.25
Data	Development	$ 4.20
Support Equipment	Development	$ 20.00
Guidance and Control PMP	Procurement	$ 320.00
Payload PMP	Procurement	$ 150.00
Propulsion PMP	Procurement	$ 266.67
SEPM	Procurement	$ 184.17
Data	Procurement	$ 22.10
Support Equipment	Procurement	$ 30.00
Initial Spares	Procurement	$ 22.10
Maintenance	Operations and Support	$ 560.00
In-Service Support	Operations and Support	$ 140.00
Training	Operations and Support	$ 90.00
	TOTAL	$ 2,131.23

- This example is simplified for our presentation – typically calculations would span across several spreadsheets and include phasing by year
- We select the alternative, and based on the "tag", different inputs are pulled in
- We've also included schedule uncertainty that drives cost on the Integration, SEPM, T&E, and Data elements

The dynamic model was created to accommodate the changing and unknown requirements from the clients.

4

The stakeholders that requested the AoA study had a desire to see the costs rolled up at multiple levels – the first being a total level

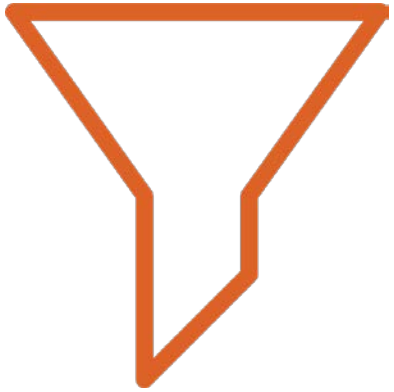


A key piece to consider here is the measures of effectiveness – a decision maker may will to pay more to get a certain capability sooner

This solution increased the dynamic capability of a cost model.

Reduced duplicative work

Incorporated robustness and ease of use of a dashboard



Streamlined Crystal Ball simulations and results generation

This AoA required us to use a build up approach as munition alternatives were composed of a combination of section options rather than end items.

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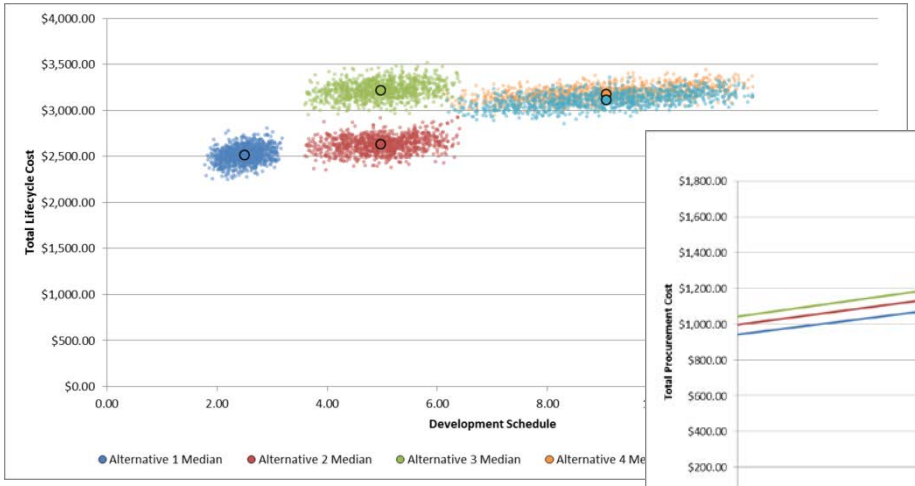

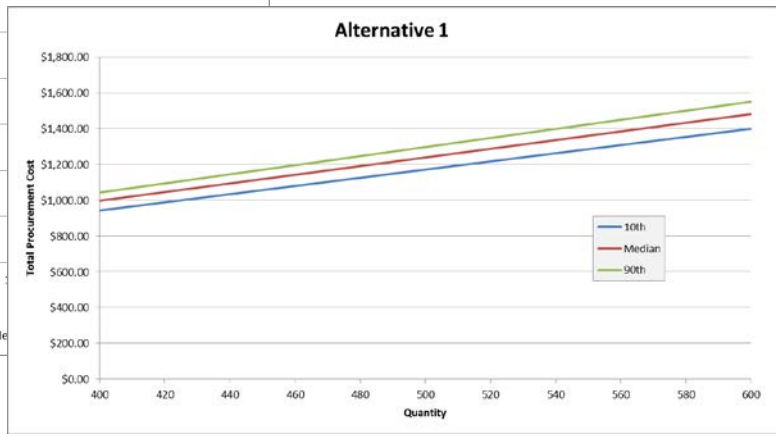

- Using a matrix approach across our data collection, analysis, and modeling allowed us to use Crystal Ball's Decision Analysis tool to automate and streamline simulation and result generation
- This also allowed us to include all life cycle cost estimates within one Excel file, reducing duplicative work in updating multiple files or sheets due to a change in inputs – updating it once rolls changes throughout all alternatives

Questions?