

The following presentation was given at:

The SCAF 2015 Cost Estimating Challenge

*Tuesday 14th April 2015
BAWA Centre, Bristol*

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Free Freedomia!

Bristol | April 2014



Introductions

Del Roberts

- Certified Cost Estimator/Analyst (ICEAA)
- Registered Cost Engineer (ACostE)
- 5 years experience with MOD CAAS and Employee at BMT Reliability Consultants Ltd for 5 months

Hazel Atkins

- First Class Hons degree in Mathematics
- Employee at BMT Reliability Consultants Ltd for 2 months

James Ibbitson

- Masters Degree in Mechanical Engineering
- Professional Cost Estimator/Analyst (ICEAA)
- 2 years experience in Manufacturing Operations at AgustaWestland Ltd and employee at BMT Reliability Consultants Ltd for 20 months

RCL provides **decision support solutions** to our clients across the world in the areas of **asset acquisition and through life operation**.

We deliver value by **enabling improved performance and cost efficiencies**.

We differentiate ourselves through a holistic approach and bringing the relevant breadth and depth of **domain knowledge**, skills and experience from across the BMT group, keen to **enhance our clients' reputation** as their independent, engineering partner.



Agenda

1. Objective
2. The Approach
3. The Offensive
4. Sustaining
5. Summary



Objective

1

Task

Aim

To plan and cost a contingency repatriation mission for Freedonia; conducting a **Balance of Investments (BOI)** analysis and estimate the **Whole Life Cost (WLC)**.



Initial Assumptions

Seizing Freedonia

- The opposition's offensive force does not lose capability while capturing Freedonia
- The invading country are of a defeatable military power
- The opposition does not reinforce the island

Cost assumptions

- 2014/2015 inflation: 2.5%
- 0.68 USD to the pound
- Costs do not vary through the year.
- **No budget restraints**

The **A**ttacking SCAFlan**d** force

- Access to similar assets to the UK in 2015
- No assistance
- Access to a Reaction Force
- Reservists are not required
- **No constraints on asset availability**

Failure is not an option!

- **SCAFlan**d** will win**
- Time, cost and assets being the variable factors

Eliminated Options

We have discounted:

Doing nothing



Rationale:

We have considered a “minimum option” as per JSP 507

Using all of SCAFLand’s assets



Leaves SCAFLand vulnerable

Acquire additional assets/support from other countries for the attack



Costly, unpredictable and unnecessary due to the size of the invading force

Fixed wing aircraft



Fleet size and logistic constraints

Attrition

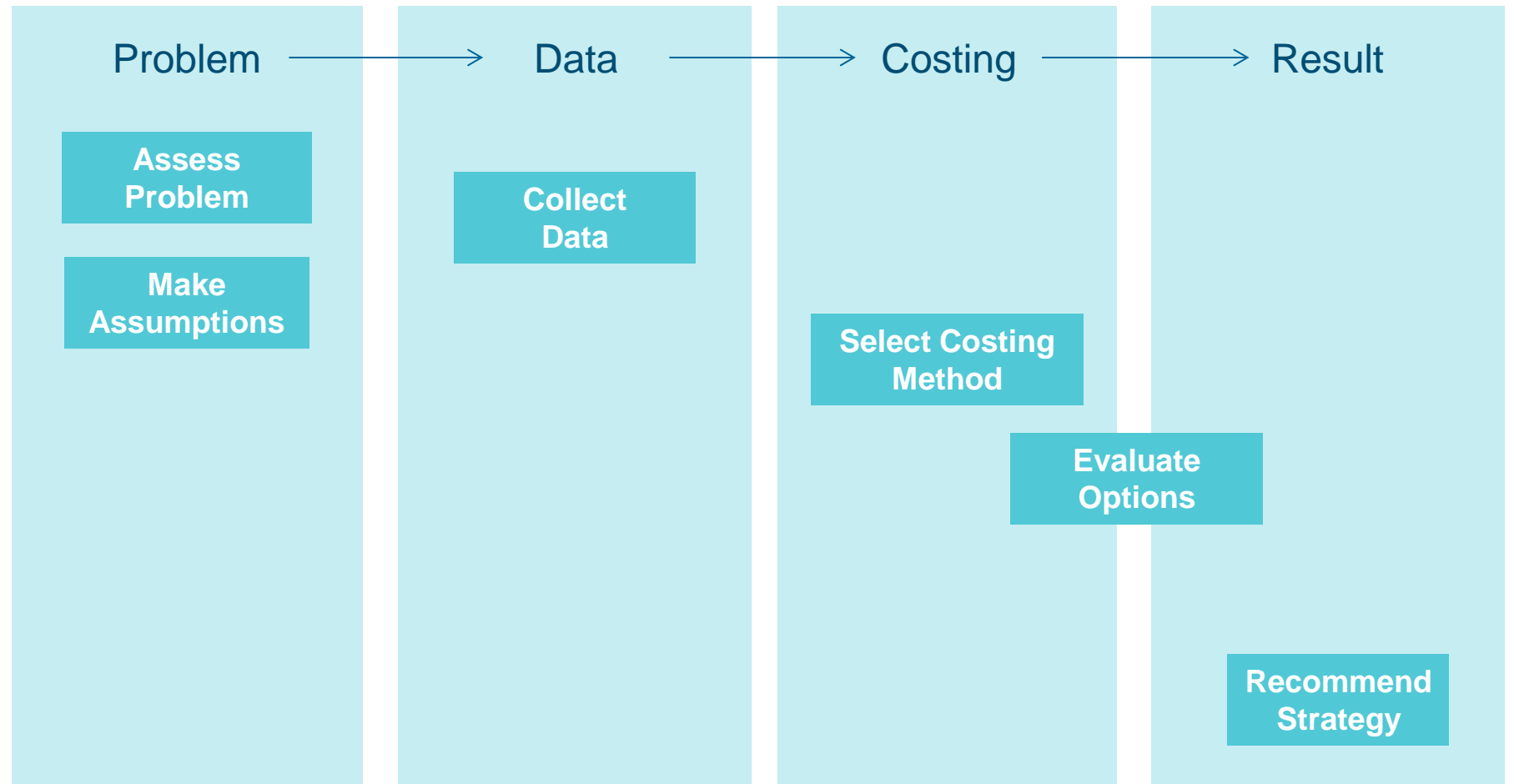


Time constraints

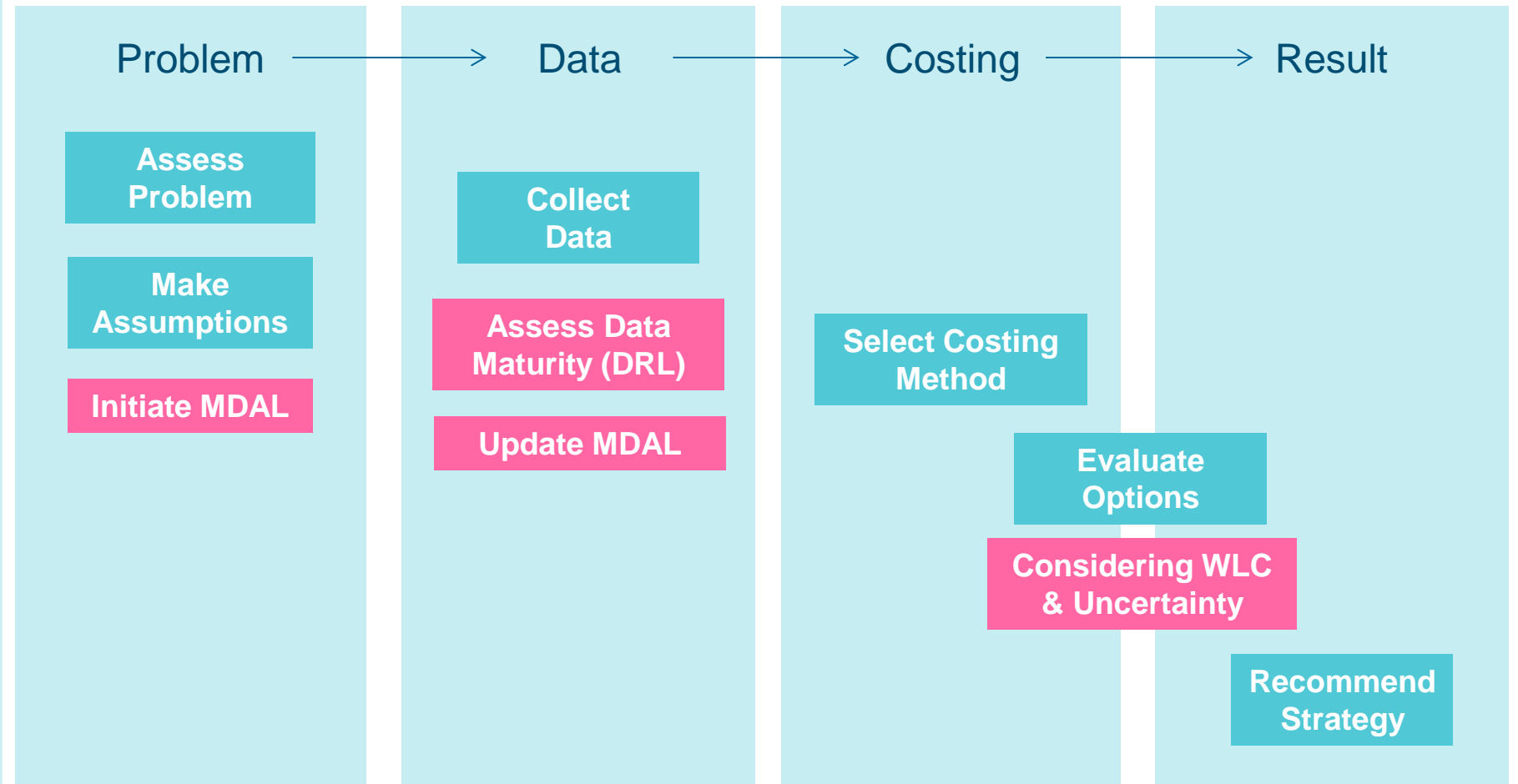
The Approach

2

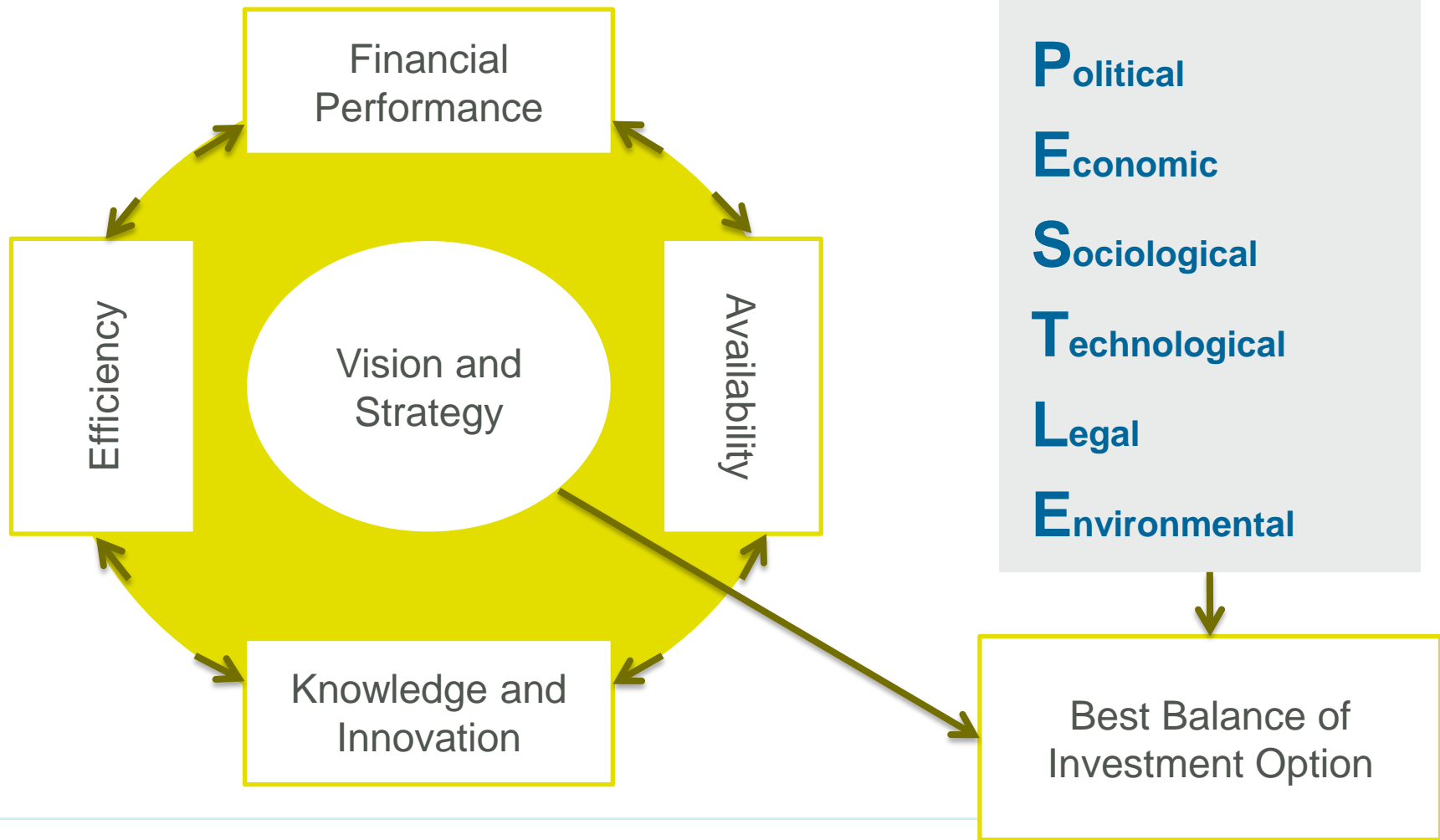
Costing Approach for this exercise



Costing Approach for this exercise



BOI Factors to Consider



Data Collection & Estimating Techniques

Asset	Non Recurring Development Cost	Recurring Production Cost	Annual Operating and Support Cost	Source	Quantity Available
Utility Vehicle					
Self Propelled Gun					
Multiple Rocket Launch System (MRLS)					
Armoured Fighting Vehicles					
Destroyer & Crew					
Attack Submarine					
Support Ship					
Frigate					
Helicopter					
Attack Helicopter					
Troop					
1 x Troop Rotation					

Data Collection & Estimating Techniques

1. Collect data and scale to 2015

Asset	Non Recurring Development Cost	Recurring Production Cost	Annual Operating and Support Cost	Source	Quantity Available
Utility Vehicle	£143,500,000	£92,250	£46,125	SCAF 2014	152
Self Propelled Gun	£3,070,000			Wiki USD undated	89
Multiple Rocket Launch System (MRLS)		£2,021,638		Armedforces.co.uk 2012	42
Armoured Fighting Vehicles	£512,500,000	£7,175,000		thinkdefence.co.uk 2014	5,948
Destroyer & Crew	£461,250,000	£666,250,000	£71,750,000	SCAF 2014	6
Attack Submarine	£1,232,050,000	£1,428,238,844	£81,454,495	NAO 2011	3
Support Ship	£852,975,000		£20,876,928	Parliamentary Answers 2010	3
Frigate		£307,500,000	£51,250,000	warshipsifr.com 2012	14
Helicopter	£194,750,000	£5,125,000	£768,750	SCAF 2014	402
Attack Helicopter	£1,484,029,425	£39,053,406	£6,377,012	Telegraph	65
Troop	N/A	£34,850	£256,250	MOD 2015	146,980
1 x Troop Rotation	n/a	n/a	£9,244	armytimes.com 2015	n/a

Data Collection & Estimating Techniques

2. Data Split Assumption

Asset	Non Recurring Development Cost	Recurring Production Cost	Annual Operating and Support Cost	Source	Quantity Available
Utility Vehicle	£143,500,000	£92,250	£46,125	SCAF 2014	152
Self Propelled Gun	£1,888,050	£1,258,700		Wiki USD undated	89
Multiple Rocket Launch System (MRLS)		£2,021,638		Armedforces.co.uk 2012	42
Armoured Fighting Vehicles	£512,500,000	£7,175,000		thinkdefence.co.uk 2014	5,948
Destroyer & Crew	£461,250,000	£666,250,000	£71,750,000	SCAF 2014	6
Attack Submarine	£1,232,050,000	£1,428,238,844	£81,454,495	NAO 2011	3
Support Ship	£524,579,655	£349,719,770	£20,876,928	Parliamentary Answers 2010	3
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Data Collection & Estimating Techniques

3. Analogy

Asset	Non Recurring Development Cost	Recurring Production Cost	Annual Operating and Support Cost	Source	Quantity Available
Utility Vehicle	£143,500,000	£92,250	£46,125	SCAF 2014	152
Self Propelled Gun	£1,888,050	£1,258,700	£41,922	Wiki USD undated	89
Multiple Rocket Launch System (MRLS)	£200,142,186	£2,021,638	£80,865	Armedforces.co.uk 2012	42
Armoured Fighting Vehicles	£512,500,000	£7,175,000		thinkdefence.co.uk 2014	5,948
Destroyer & Crew	£461,250,000	£666,250,000	£71,750,000	SCAF 2014	6
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Helicopter	£194,750,000	£5,125,000	£768,750	SCAF 2014	402
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Data Collection & Estimating Techniques

4. SME Estimation

Asset	Non Recurring Development Cost	Recurring Production Cost	Annual Operating and Support Cost	Source	Quantity Available
Utility Vehicle	£143,500,000	£92,250	£46,125	SCAF 2014	152
Self Propelled Gun	£1,888,050	£1,258,700	£41,922	Wiki USD undated	89
Multiple Rocket Launch System (MRLS)	£200,142,186	£2,021,638	£80,865	Armedforces.co.uk 2012	42
Armoured Fighting Vehicles	£512,500,000	£7,175,000	£735,437	thinkdefence.co.uk 2014	5,948
Destroyer & Crew	£461,250,000	£666,250,000	£71,750,000	SCAF 2014	6
Attack Submarine	£1,232,050,000	£1,428,238,844	£81,454,495	NAO 2011	3
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Data Readiness Level (DRL)

Ratings:

1. SME / No evident Data Source
2. Unclear / Unreliable Data Source
3. Base on limited Data
4. Sourced but no base of estimate
5. Strong methodology based on limited Data
6. Good data but not been reviewed within 3 years
7. Actual data reviewed less than 3 years ago
8. Currently maintained
9. Valid Project actual cost

SCAFland Defence Organisation's suggested DRLs:

The table is tilted and contains a legend on the left side with color-coded boxes. The legend categories are: Red (1-2), Orange (3-4), Yellow (5-6), Light Blue (7-8), and Green (9). The table columns include 'Category', 'DRL', 'Description', 'Suggested DRL', and 'Suggested DRL'. The table is rotated approximately 45 degrees clockwise.

Data Collection & Estimating Techniques

5. DRLs

Asset	Non Recurring Development Cost	Recurring Production Cost	Annual Operating and Support Cost	DRL	Quantity Available
Utility Vehicle	£143,500,000	£92,250	£46,125	7	152
Self Propelled Gun	£1,888,050	£1,258,700	£41,922	2	89
Multiple Rocket Launch System (MRLS)	£200,142,186	£2,021,638	£80,865	4	42
Armoured Fighting Vehicles	£512,500,000	£7,175,000	£735,437	4	5,948
Destroyer & Crew	£461,250,000	£666,250,000	£71,750,000	7	6
Attack Submarine	£1,232,050,000	£1,428,238,844	£81,454,495	6	3
Support Ship	£524,579,655	£349,719,770	£20,876,928	5	3
Frigate	£218,206,731	£307,500,000	£51,250,000	4	14
Helicopter	£194,750,000	£5,125,000	£768,750	7	402
Attack Helicopter	£1,484,029,425	£39,053,406	£6,377,012	4	65
Troop	N/A	£34,850	£256,250	6	146,980
1 x Troop Rotation	n/a	n/a	£9,244	3	n/a

The Offensive

3

Options to Win back Freedonia

The mission is initiated by sending in a Reaction Force for 6 months.

Three subsequent repatriation scenarios considered to commence upon withdrawal of the Reaction Force:

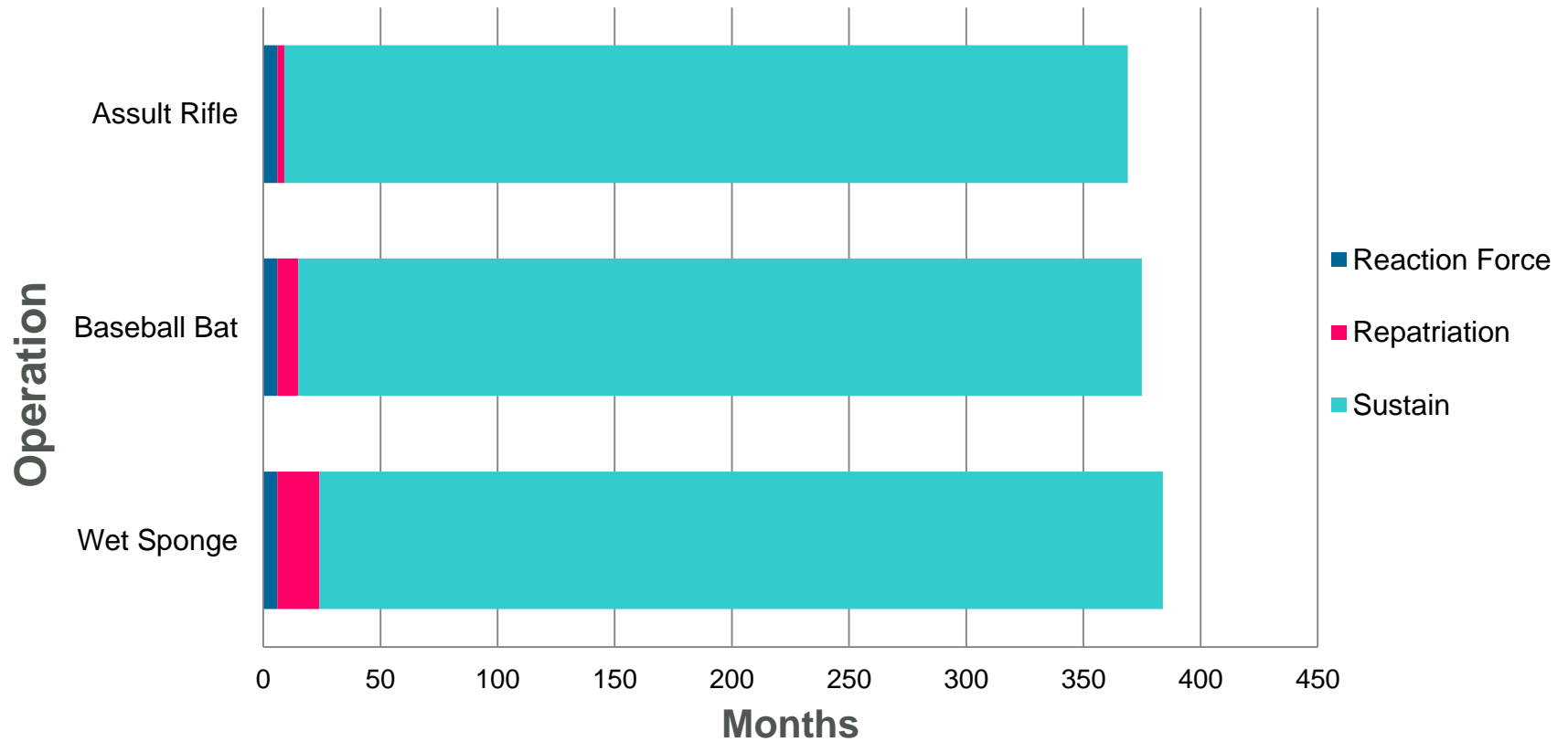
- Operation 1: Wet Sponge (18 months)
- Operation 2: Baseball Bat (9 months)
- Operation 3: Assault Rifle (3 months)

The repatriation is to be followed by a 30 year sustainment period.

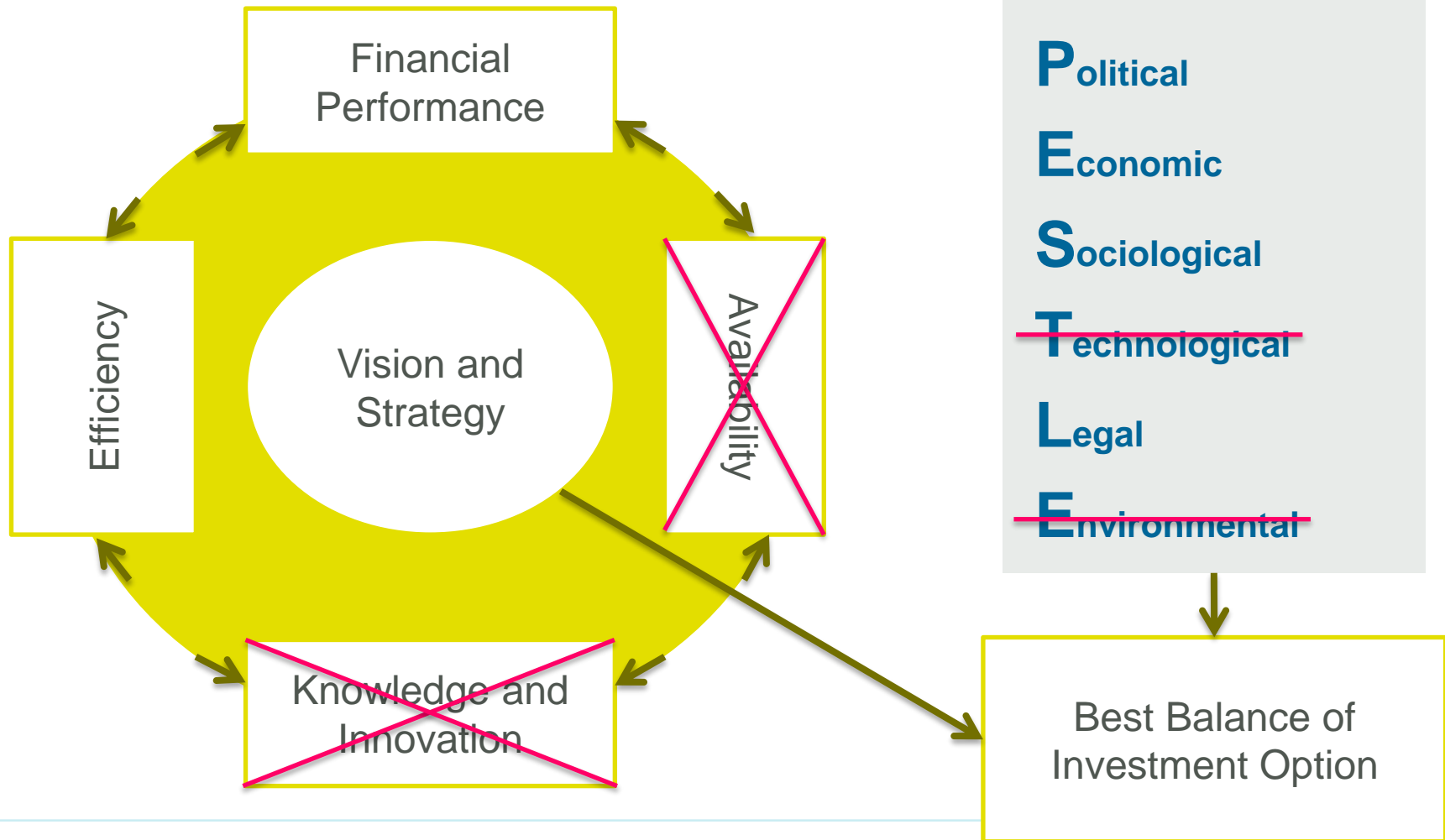


Image: http://legionpost553.com/yahoo_site_admin/assets/images/0511-1105-0516-3629_Cartoon_Military_General_with_Lots_of_Medals_clipart_image.263133136_std.jpg

Scenario Options and Timescale



BOI Factors to Consider



Cost Calculation

Cost =

$$\Sigma \left(\frac{\text{Asset Annual Operating \& Support Costs}}{12} \times \text{Deployment Duration} \right)$$

Reaction Force Cost

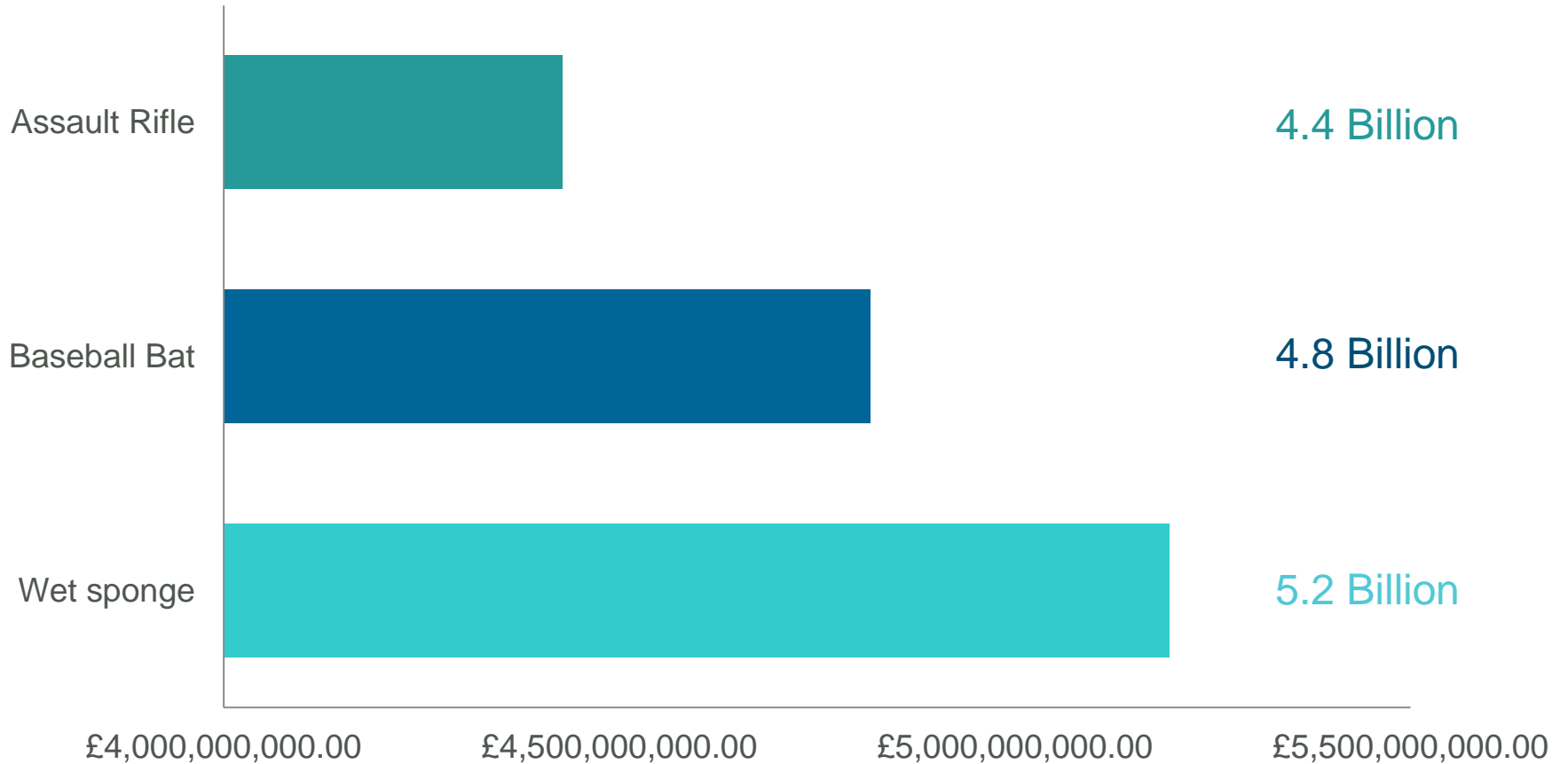
Asset	Quantity
Utility Vehicle	143
Self Propelled Gun	5
Armoured Fighting Vehicles	42
Fully equipped Destroyer & Crew	2
Fully equipped Attack Submarine	1
Fully equipped Support Ship	1
Troops	500

**Total Cost
(6 months)
£360m**

Repatriation Scenarios

	Wet Sponge	Baseball Bat	Assault Rife
Asset	18 months	9 months	3 months
Utility Vehicle	25	30	100
Self Propelled Gun	12	20	80
Multiple Rocket Launch System	9	18	40
Armoured Fighting Vehicles	325	400	4,000
Destroyer	1	2	5
Attack Submarine	0	1	2
Support Ship	1	1	2
Frigate	1	5	10
Helicopter	20	100	350
Attack Helicopter	5	25	50
Troops	10,000	18,000	50,000
Rotation costs	3	1	0

Scenario Repatriation Costs



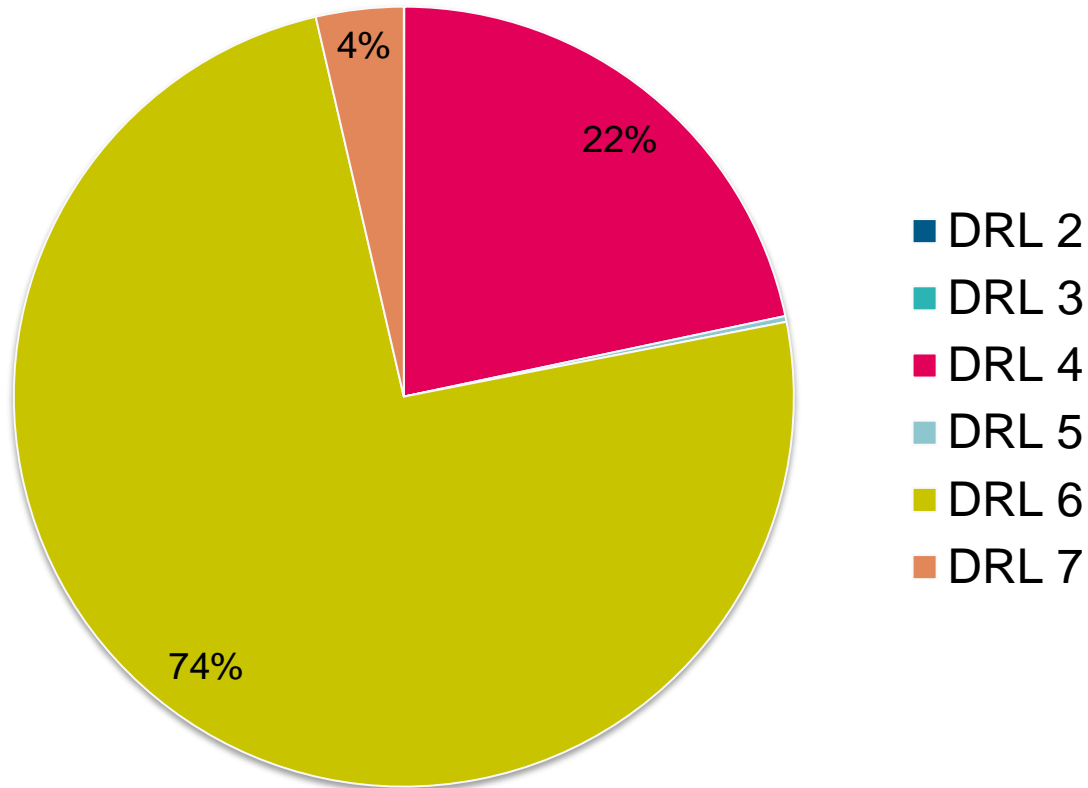
Effective Annual Cost of each Operation combined with Reaction Force

Assault Rifle:
£6.3 Billion

Baseball Bat:
£4.1 Billion

Wet Sponge:
£2.8 Billion

Scenario 'Assault Rifle' DRL Breakdown



Repatriation Mission Summary:

Stage 1: Reaction Force £360m

- Fixed for all scenarios
- Sensible offensive strategy

Stage 2: Assault Rifle £4.4 billion

- Chosen for its low cost and efficiency
- Political advantages
- Economic advantages
- Sociological advantages
- Legal advantages
- Potential schedule risk

Total so far: **£4.8 billion**

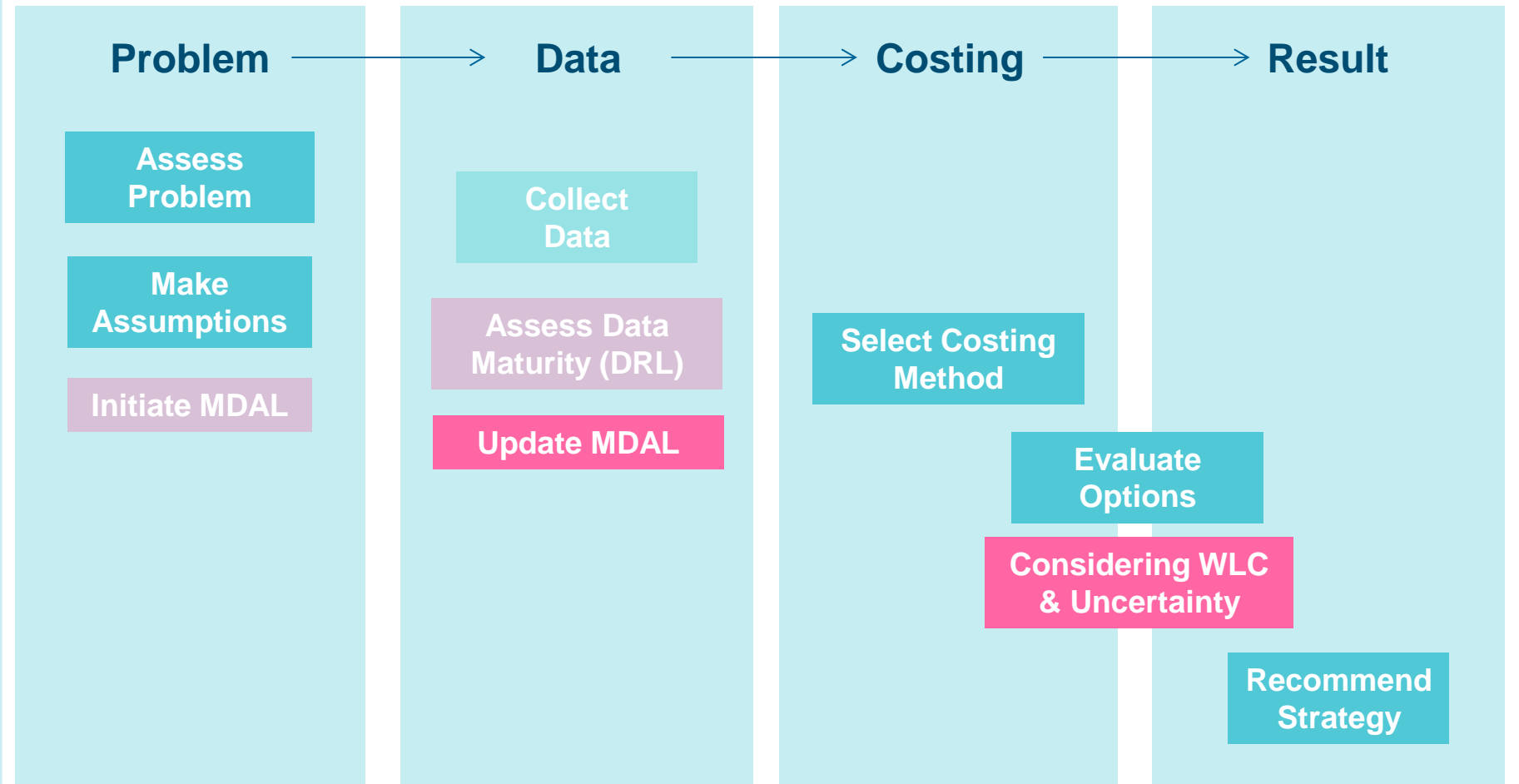


Image: <https://thekitchenandthecave.files.wordpress.com/2013/10/20131018-143649.jpg?w=529>

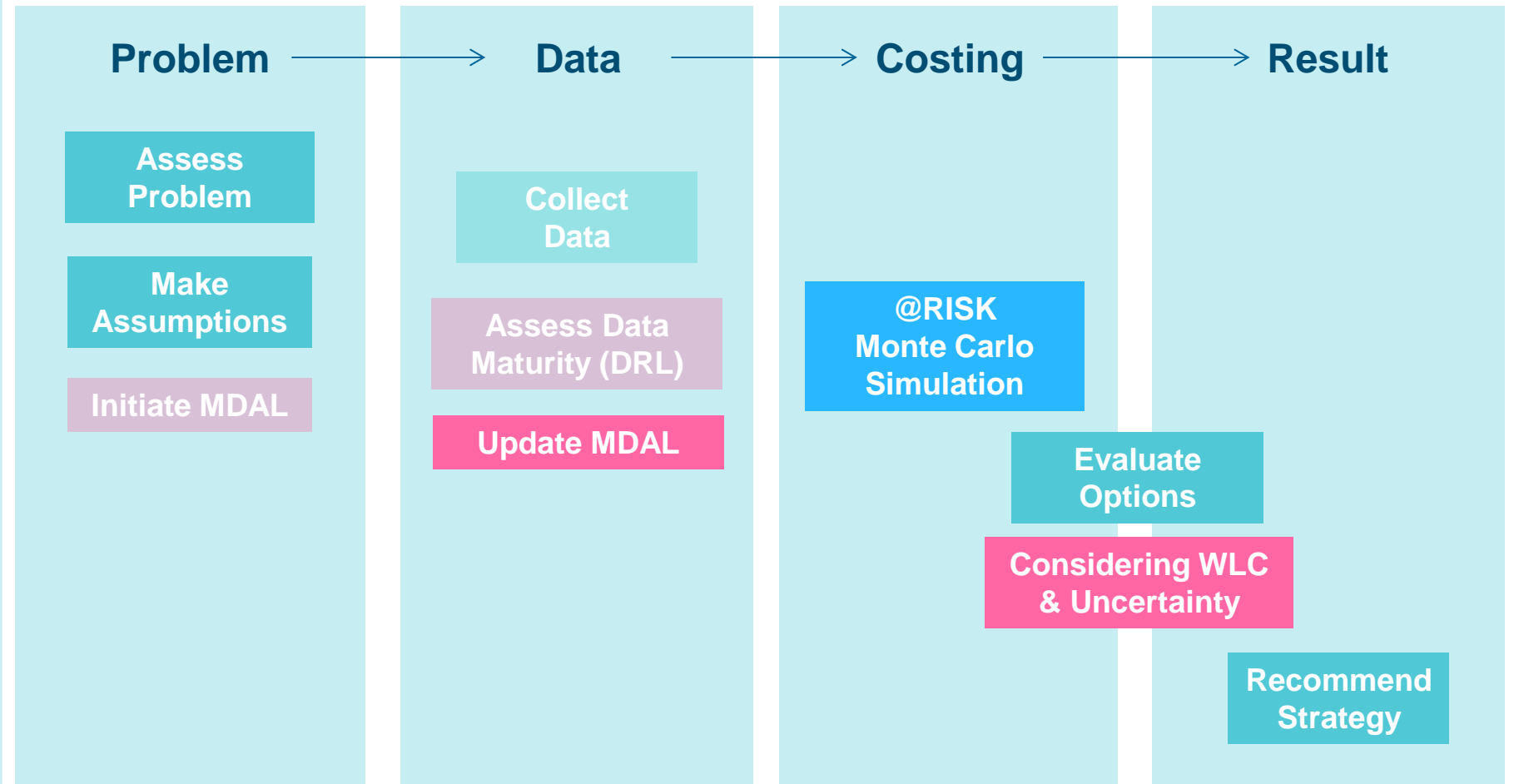
Sustaining

4

Costing Approach



Costing Approach



Assets and Options



3 Options to consider, each using the same assets with a different investment policy:

Fixed assets to be used over 30 years:

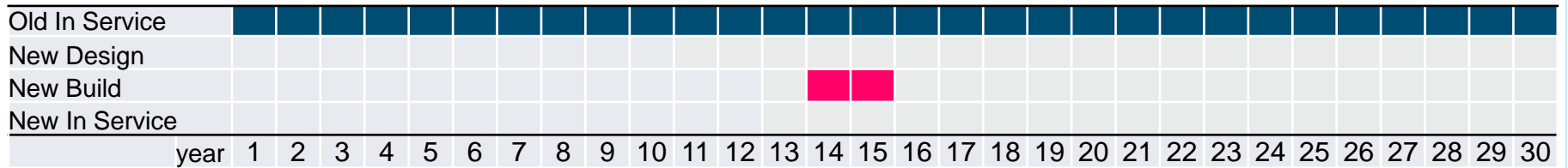
- 1500 Troops
- 1 Destroyer (30 year life)
- 10 Helicopters (30 year life)
- 200 Utility Vehicles (30 year life)
- 15 MRLS (15 year life)

Investment Policies:

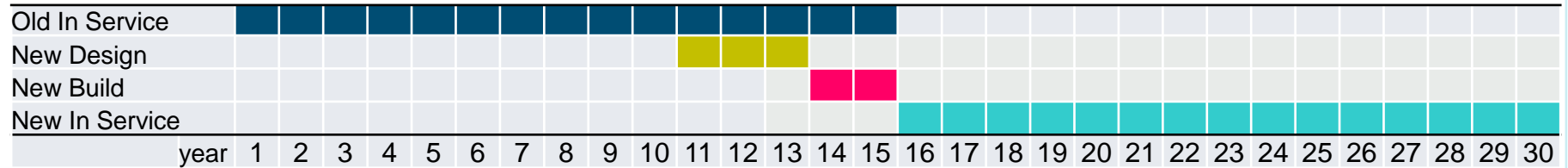
1. Build new when required from **existing** design
2. Build new when required from **new** design
3. Build new **immediately** from new design

Destroyer Schedule

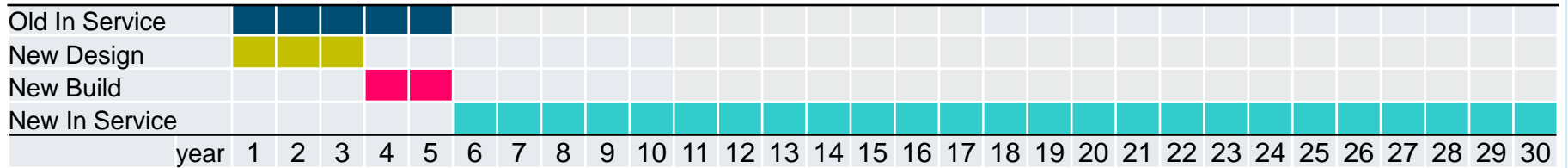
Option 1:



Option 2:



Option 3:



Additional Assumptions for Assets and Options

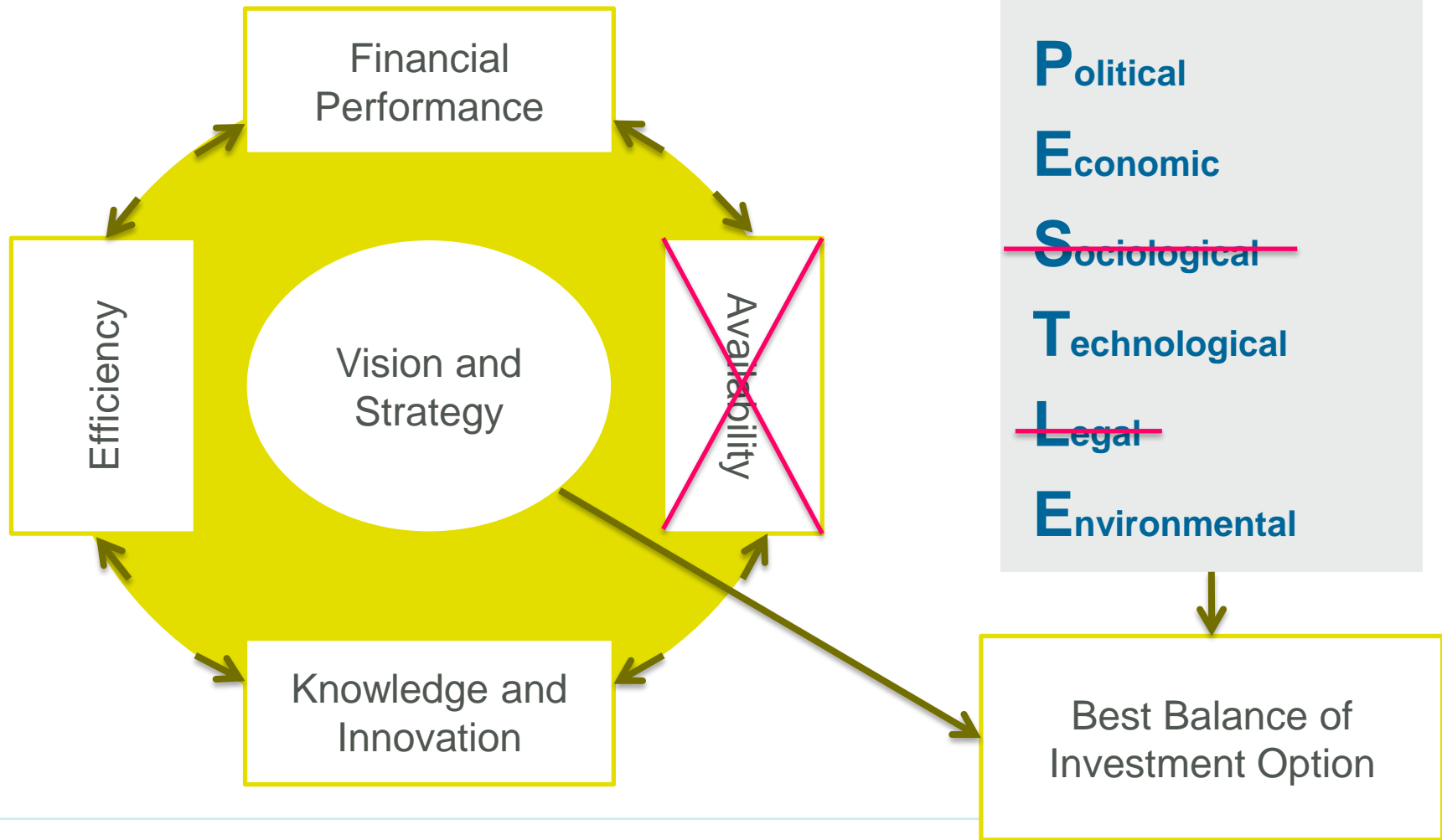
Technology Forecasting:

- New Design Cost Factor: 1.2
- New Build Cost Factor: 1.1
- New Build Annual Operation & Support Cost Factor: 0.85

Consideration Given To:

- Design/Build Period & Production Capacity
- Current Fleet Age
- Troop Rotation Costs

BOI Factors to Consider



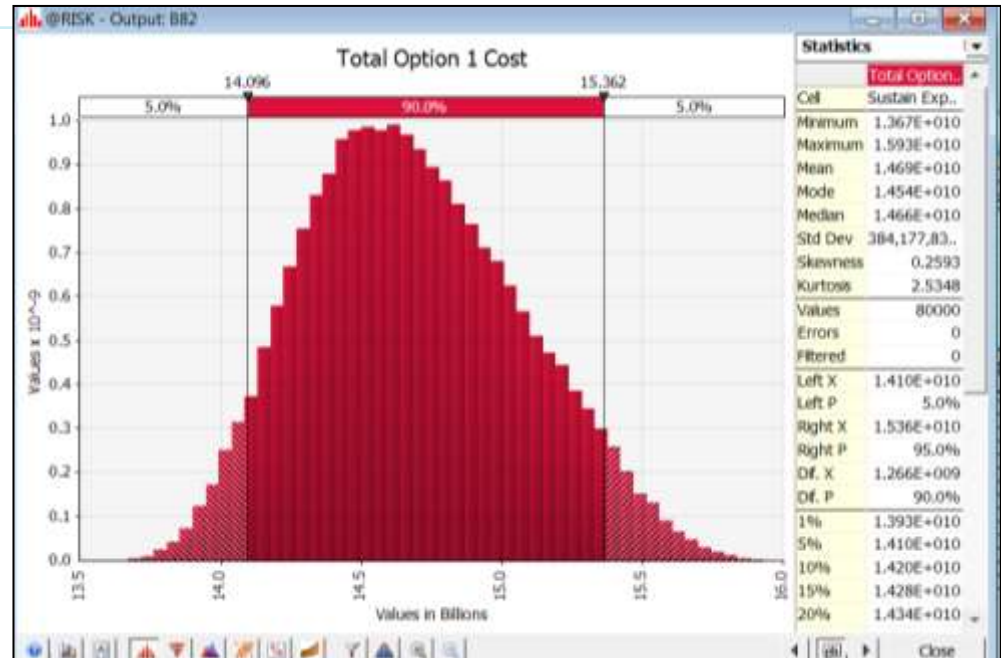
@RISK 3 Point Estimate

Monte Carlo:

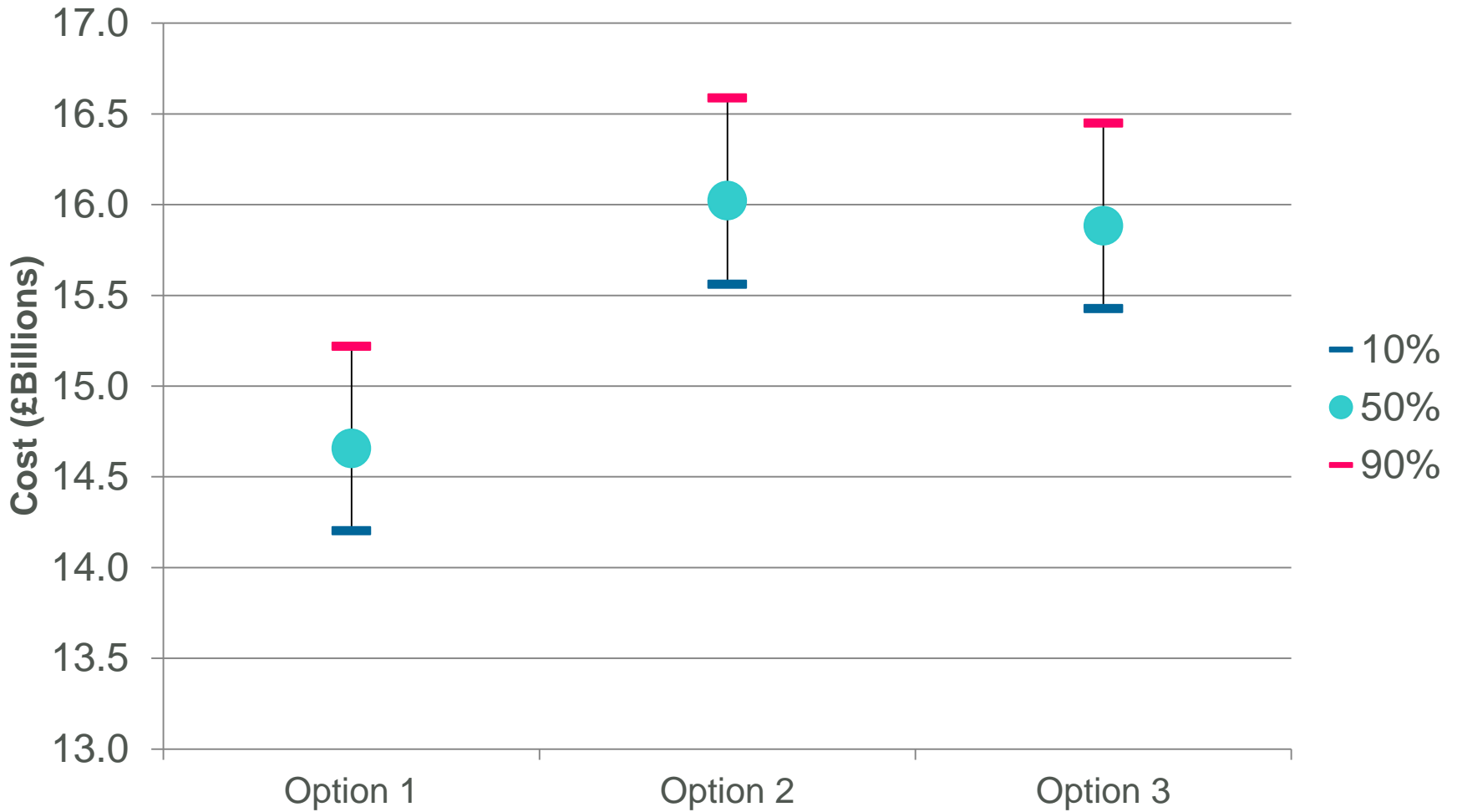
- 3 point estimate limits based on DRL scores
- Sensitivity on cost

Modelling Exclusions:

- Cost of SCAFland assets **not deployed** for the Sustainment of Freedonia are not included
- **Decommissioning** costs have been excluded
- Learner



@RISK 3 Point Estimate



Balance of Investment

Option 1 (build from old design):

- **Pro** – Cheapest Option, PESTLE
- **Con** – Out of date equipment / Obsolescence

Option 2 (build from new design):

- **Pro** – Improved Capability, PESTLE
- **Con** – Most expensive Option

Option 3 (build ASAP from new design):

- **Pro** – Improved Capability, PESTLE
- **Con** – Expensive and additional costs to maintain non-deployed assets

Sustainment Summary

Recommendation:

- Option 2 - New assets when required from new design

Cost of Sustainment (30 years):

- £16 billion (50%ile)

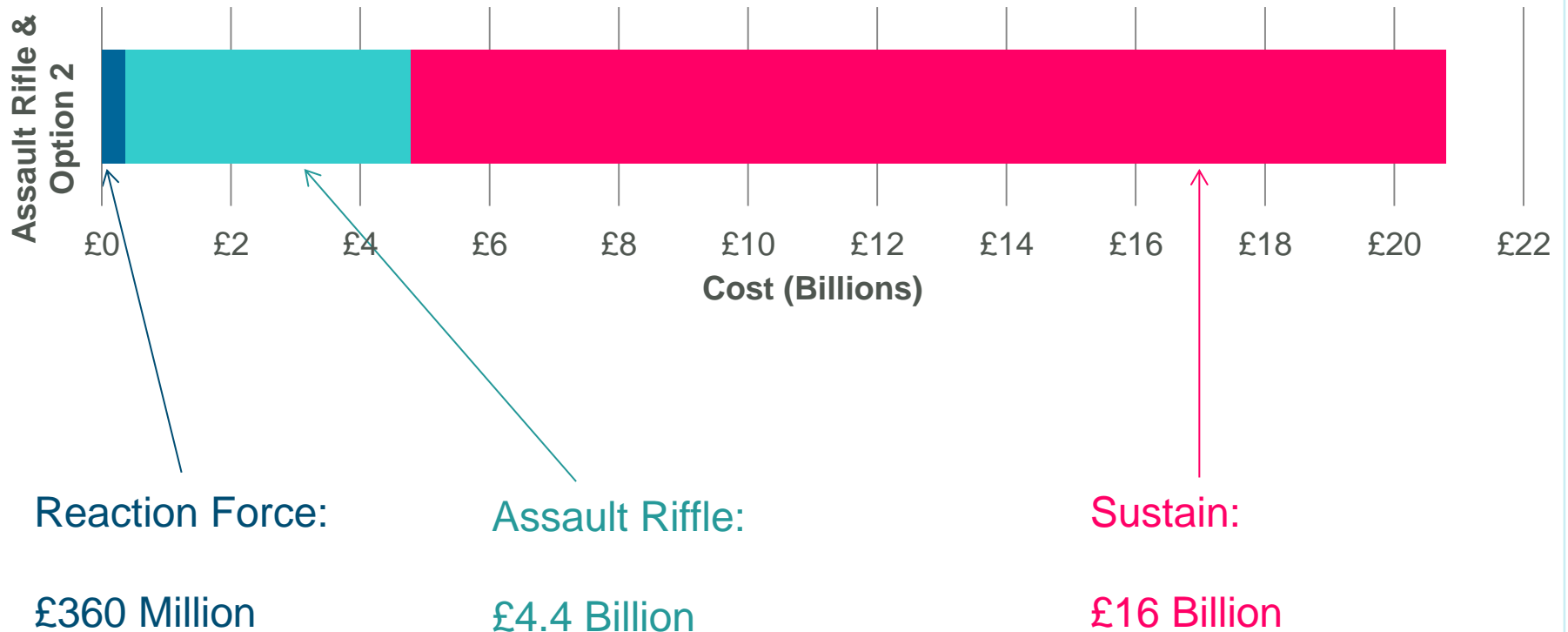
Rationale:

- Political advantage in terms of perceived military presence
- Economical advantage through new design and build work
- Increased capability in terms of technology advancements
- Future conformity for environmental/operating requirements
- Reduced risk of non-utilised assets

Summary

5

Whole Life Cost : £20.8 Billion



Risks/Uncertainties

- Future manufacturing capability
- Schedule delays
- Technology forecasts
- Modifications / additional supplies not considered (e.g. ammunition)
- Obsolescence



feridundemir.org

Improvements

- **Separate analysis** of optimum action for each asset
- Better **data** of existing costs (focus on **significant** cost drivers with **low** DRLs)
- **Compare** with another method (e.g. Independent Cost Estimate)
- Apply **DRLs** to each data element, not each data line
- Consider annual **budget** / equivalent annual costs
- **Quantify** the non monetary benefits (PESTLE)
- Quantify the required **capability / effectiveness** & optimise by cost

Lessons Learnt

- DRLs and associated confidence limits
- @RISK Monte-Carlo
- JSP 507 Investment Appraisal & Evaluation familiarity
- Future lessons, to be discovered...

Thank You