

QinetiQ Proprietary

## Team QinetiQ

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# Agenda

1. Defining the Challenge
2. Our Approach
3. Defining Performance
4. Calculating the Cost
5. Delivering Capability
6. Summary



## 1. Defining the Challenge

# Challenge

## Knowledge Based Estimating (KBE)

### Aim

Provide un-biased **quantitative** options analysis of Traditional and Spiral development programmes for a Unmanned Aerial Vehicle (UAV);

Data

Tools

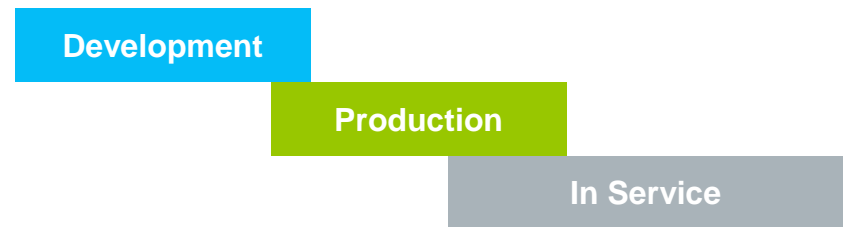
People

Processes

# Options Definition

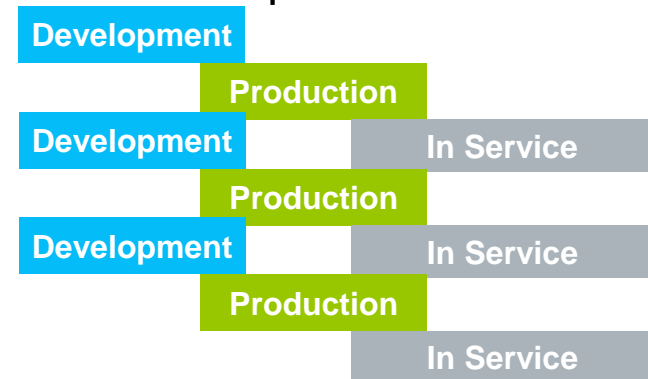
## Traditional Development

Acquiring a capability to meet a well defined set of requirements at the beginning and delivering to that set of requirements.



## Spiral Development

The capability is added / procured incrementally. Each increment delivers an ever increasing level of capability with a clear defined map of each increment and the end solution.



# Technology Solution

## Stealth Combatant Aircraft of the Future (SCAF) UAV Design Assumptions

- Propeller propulsion
- 17 hours endurance
- Reconnaissance Role
- Empty weight: 400kg

4 Sub-Systems assumed for the purposes of this analysis

- Airframe
- Propulsion
- Synthetic Aperture Radar (SAR)
- Infra Red Sensor (IR)



# Assumptions

Why a UAV??...

- **Hypothetical** exercise grounded in **realism** as much as possible;
- Utilised QinetiQ's **knowledge** and **experience** of UAV systems.

To ensure a fair comparison is made, the following assumptions are also made;

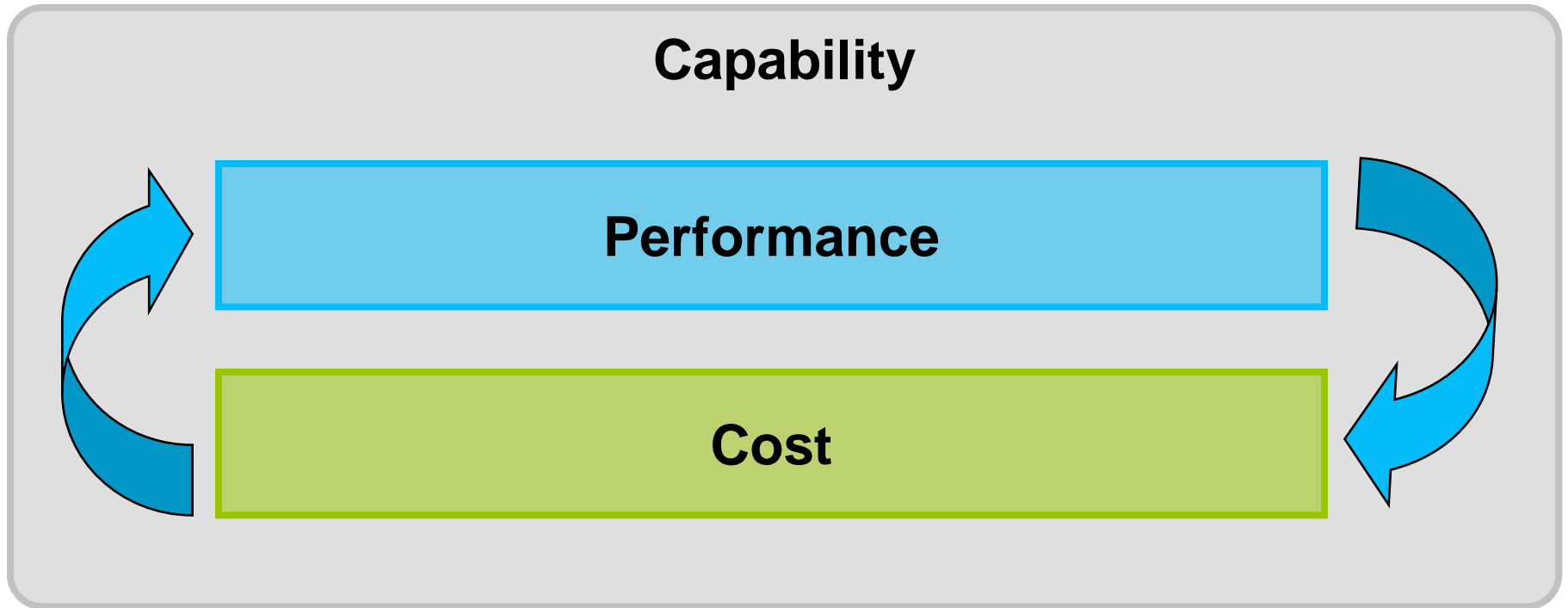
- Defining a set time period: 2010 to 2060
- Setting equal capability targets at points in time (2020 and 2040)
- Assumed a fixed requirement
- Maintaining the same overall number of aircraft (80)
- Simplified life cycle

## 2. Our Approach



# Approach

Integrating **Cost**, **Performance** and **Capability** process streams



# Approach

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In any trade off, one would look to complete the following at the minimum;

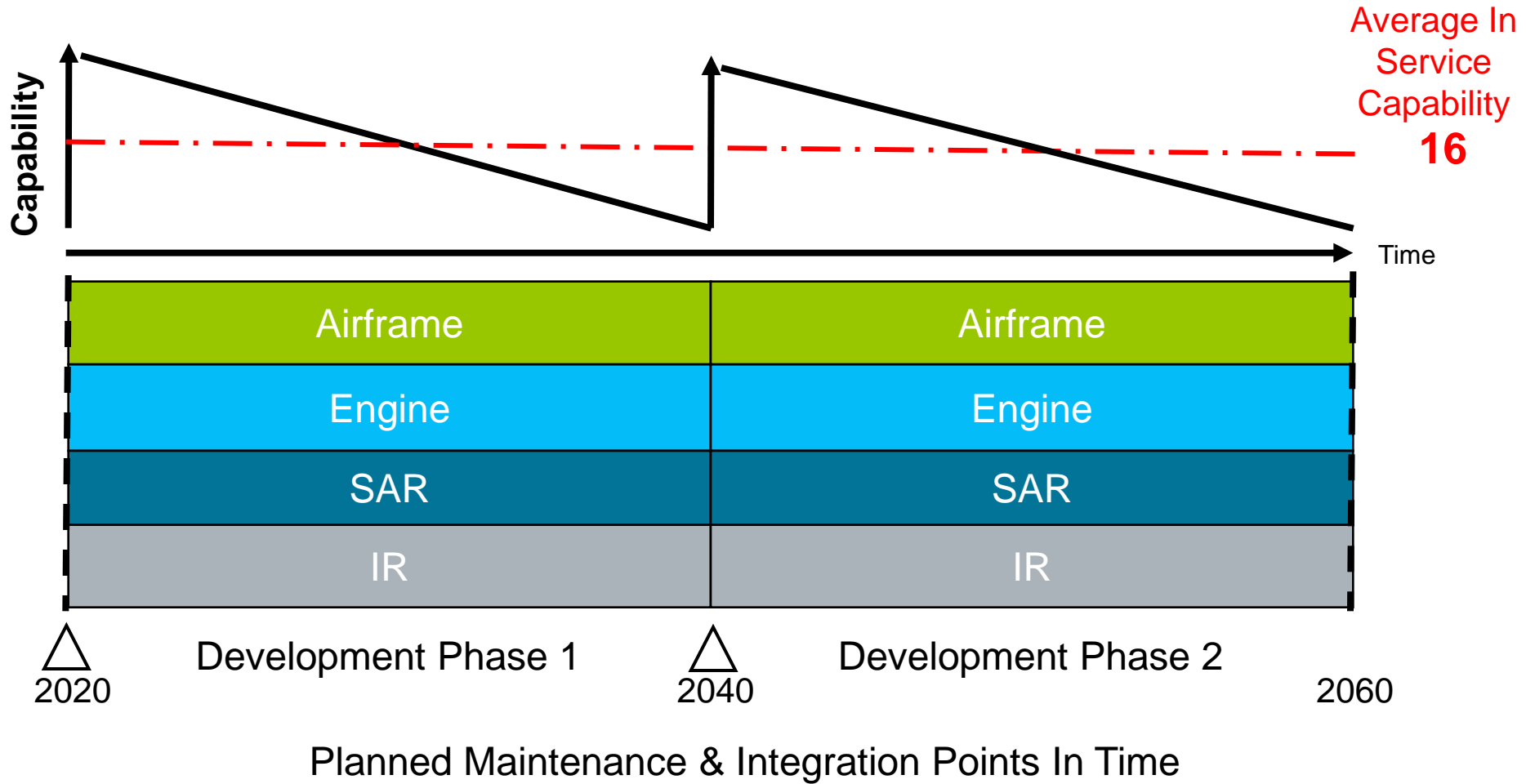
- Whole Life Cost (WLC)
  - Cost Data and Assumptions List (CDAL)
  - Cost and Schedule Uncertainty / Risk analysis
- Operational Analysis (OA)
- Defence Lines of Development (DLoDs) coherence

### 3. Defining Performance

# How is performance measured?

Sub System	Development Phase	Measure of Effectiveness				ISD
		Payload (Kg)	Power (BHP)	Detection Range	Identification Range	
Airframe	1	3				2020
	2	7				2040
Propulsion	1		3			2020
	2		7			2040
SAR	1			3		2020
	2			7		2040
IIR	1				3	2020
	2				7	2040

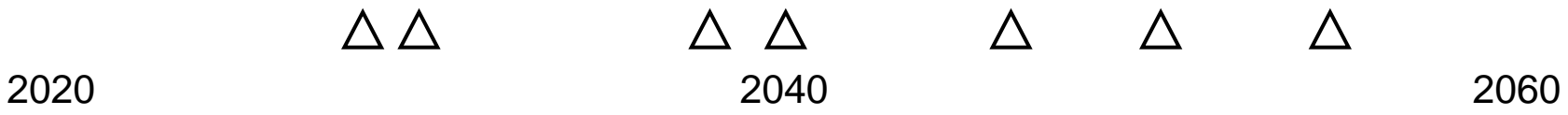
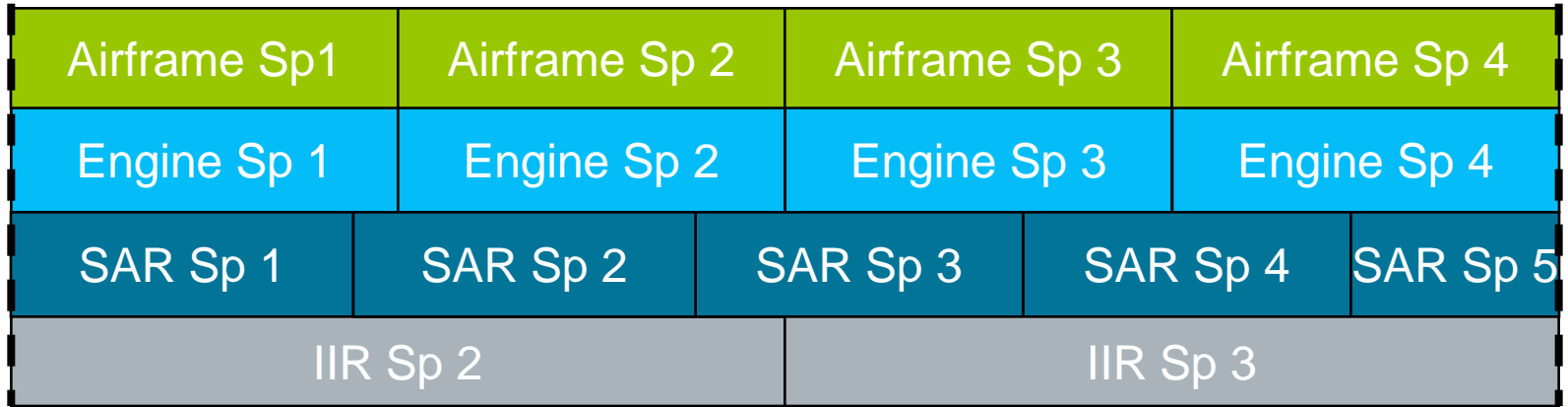
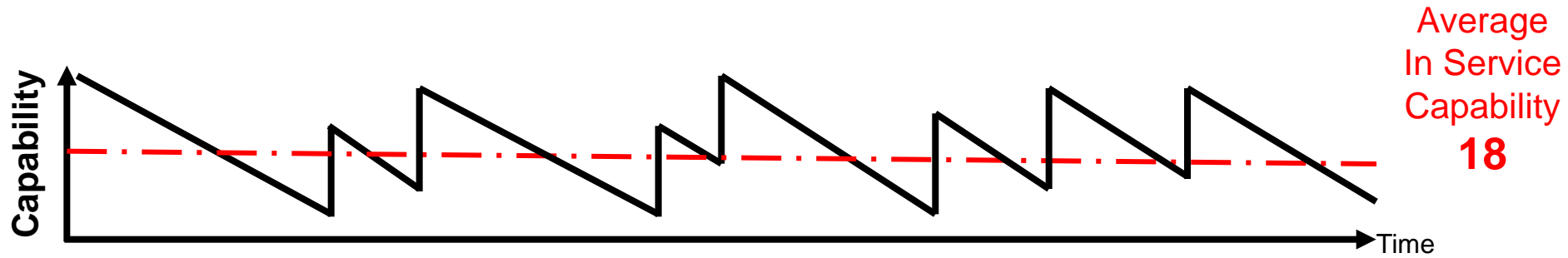
# Traditional Development Resultant Capability



# How is performance measured?

Sub System	Spiral	Payload (Kg)	Power (BHP)	Detection Range	Identification Range	Technology Insertion date
Airframe	1	2				2016
	2	3				2020
	3	6				2037
	4	8				2047
Propulsion	1		2			2016
	2		3			2019
	3		6			2036
	4		8			2056
SAR	1			2		2016
	2			3		2026
	3			6		2036
	4			8		2047
	5			10		2056
IIR	1				5	2028
	2				7	2036

# Spiral Development Resultant Capability

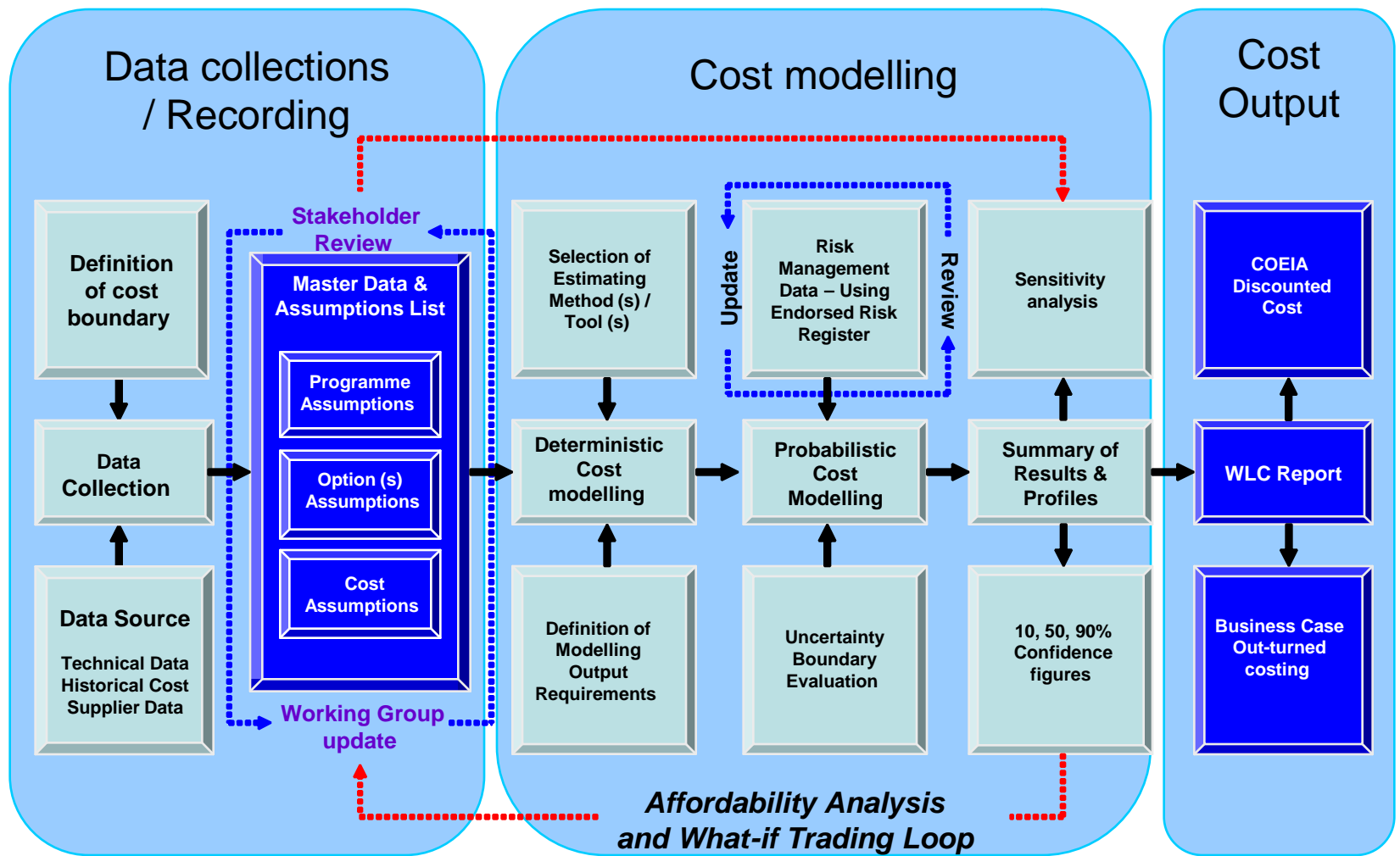


Planned Maintenance & Integration Points In Time

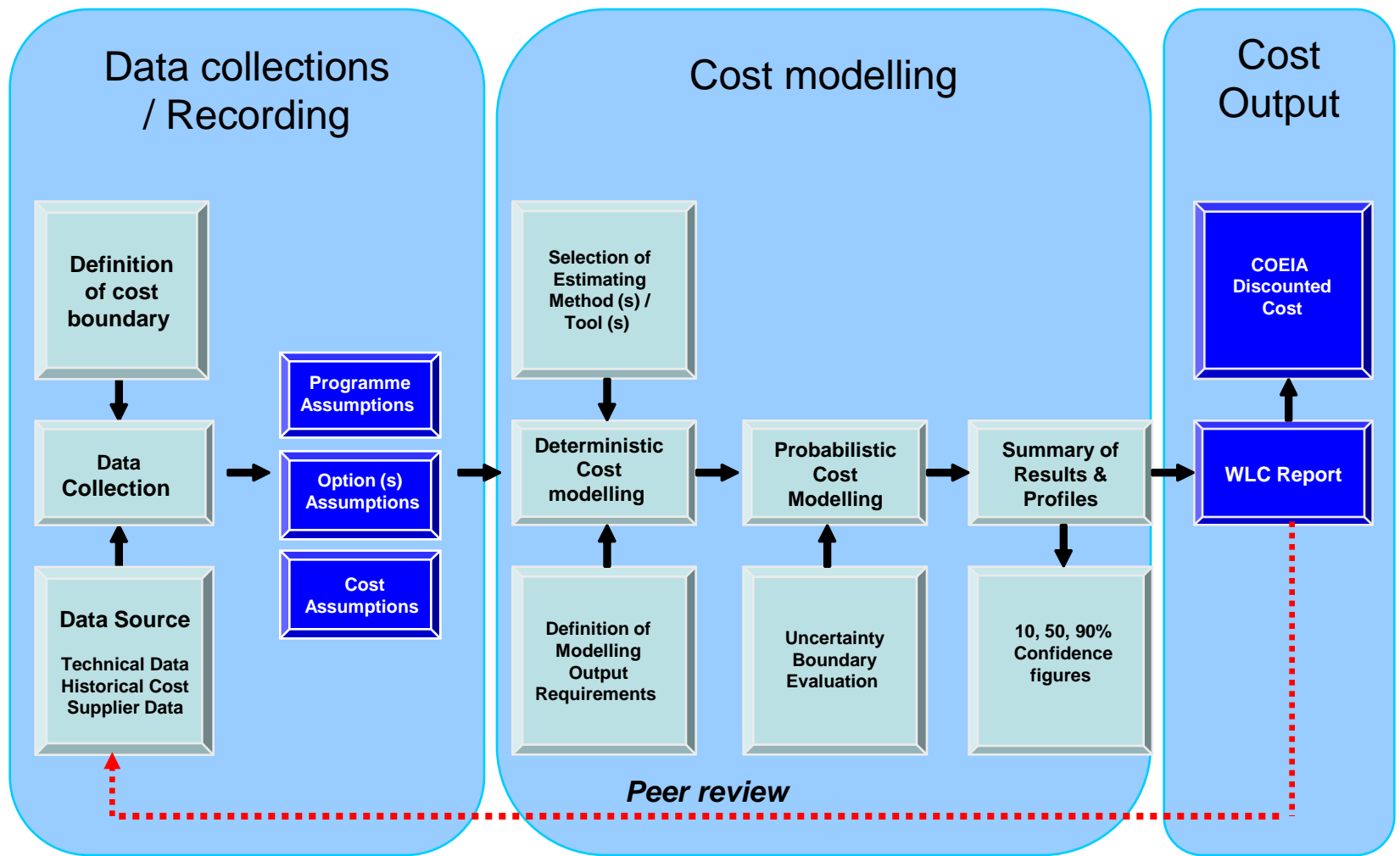
## 4. Calculating the Cost



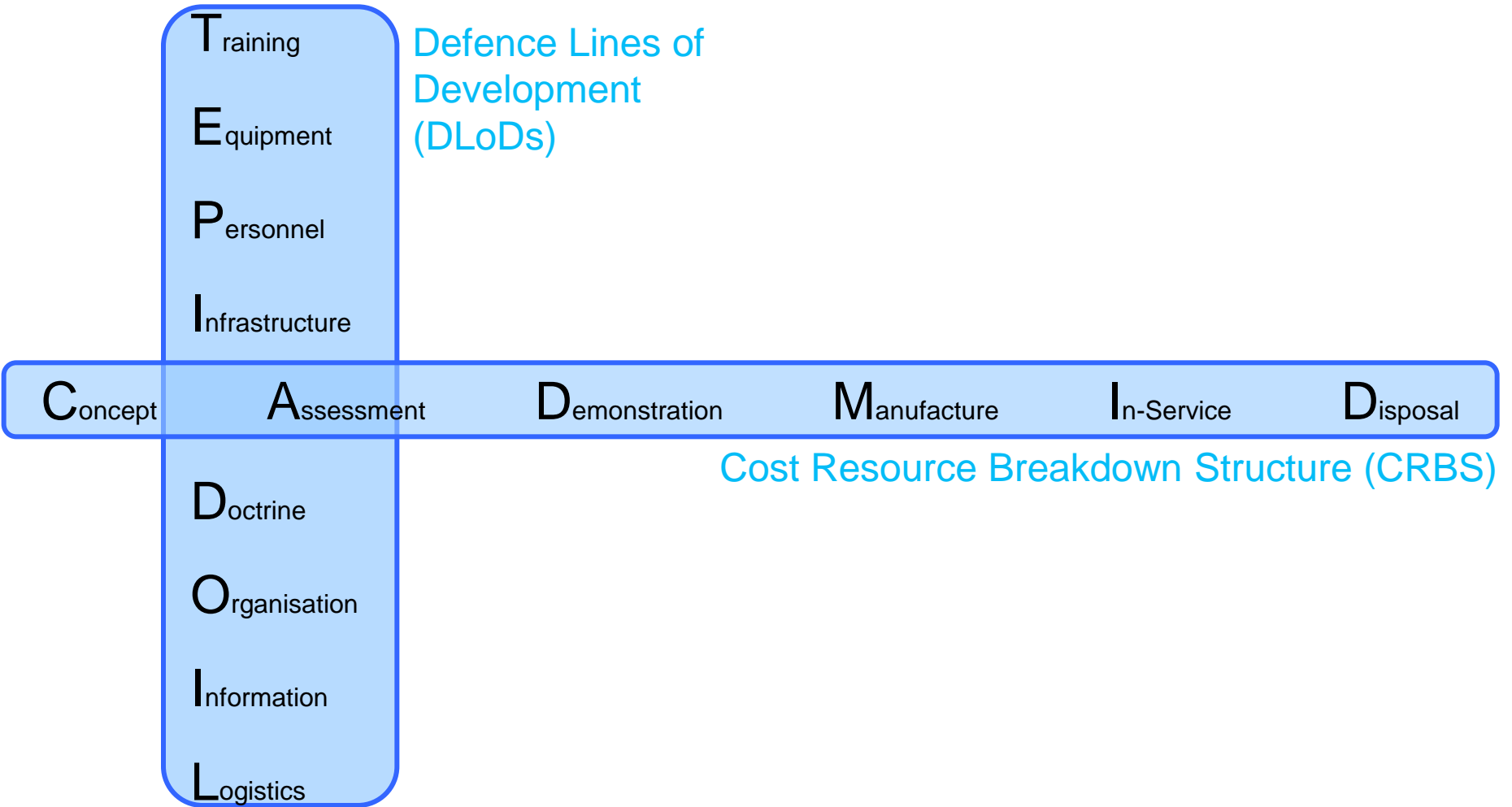
# Costing Approach



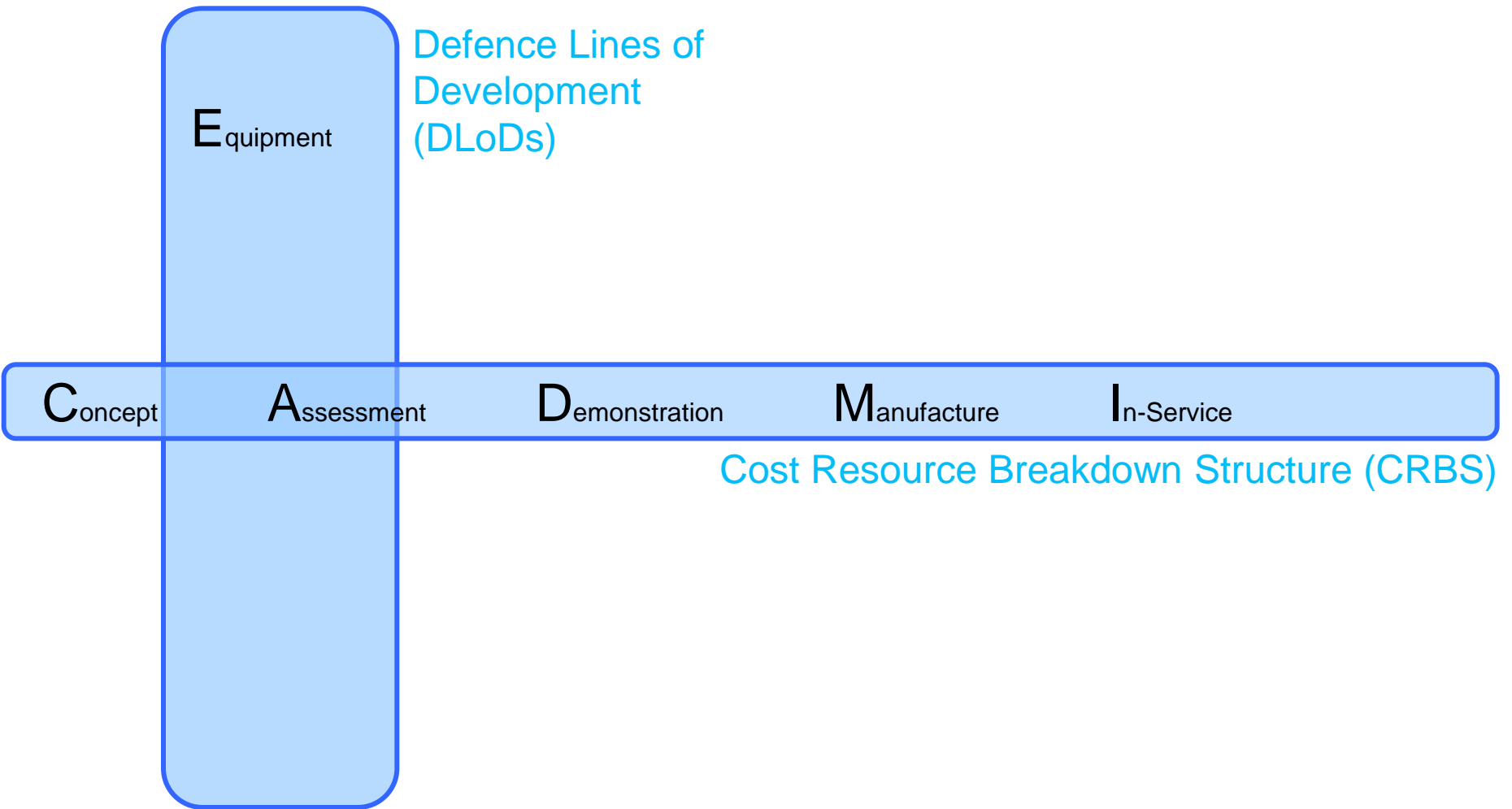
# Costing Approach – simplified for this exercise



# Whole Life Cost (WLC)



# Whole Life Cost (WLC) – Cost Boundary



# Cost Estimating

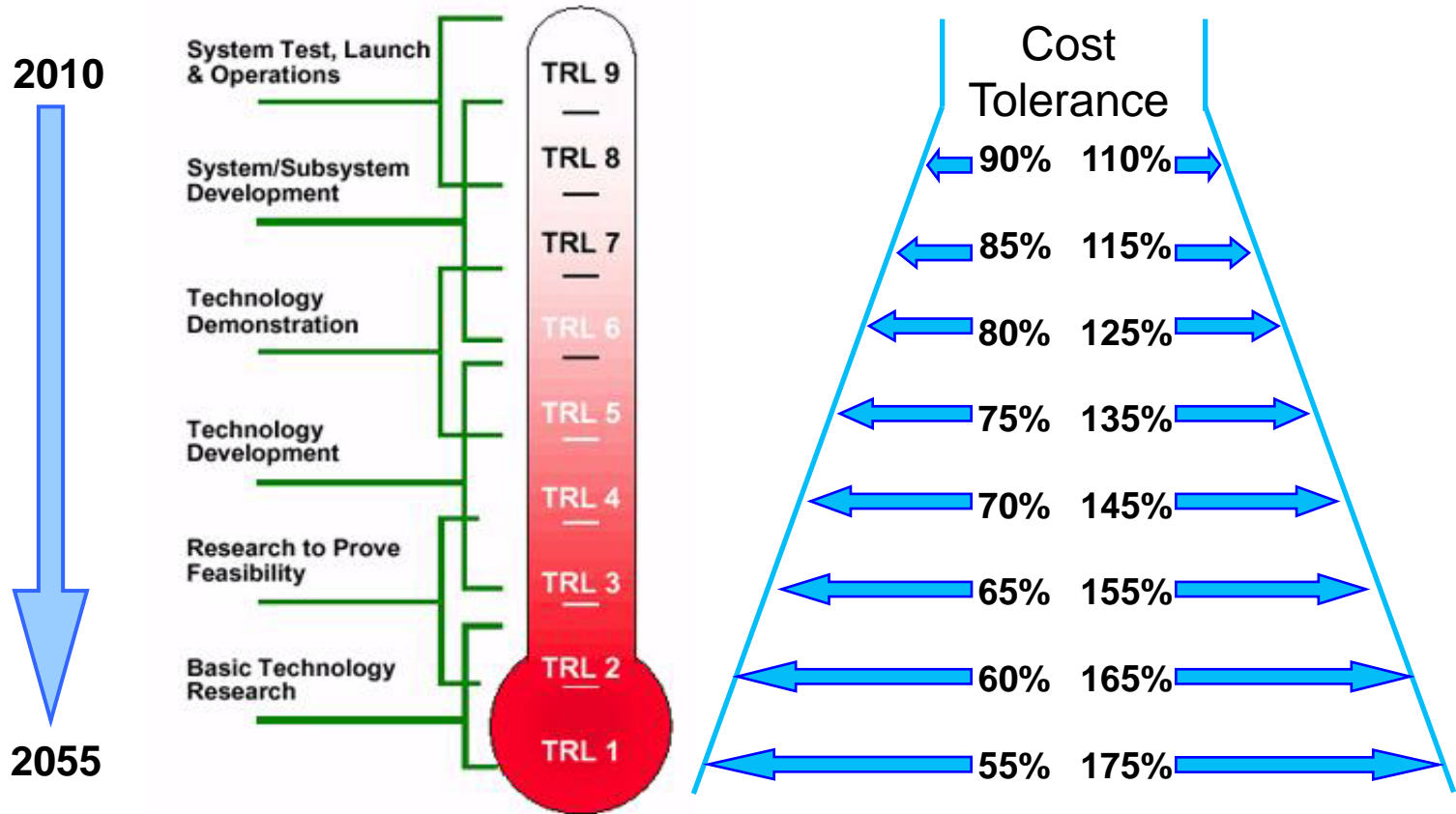
QinetiQ's Family of Advanced Cost Estimating Tool (FACET) was utilised to derive the three point cost estimates based on design parameter uncertainty.

Out of the 80+ modules within FACET, the following was used for this exercise;

The image displays three overlapping screenshots of the FACET software interface. The leftmost window shows the 'Family of Advanced Cost Estimating Tools Version 9.1' splash screen with the QinetiQ logo and a collage of images. The middle window shows a 'Cost Estimates' table for a 'UAV Fixed Wing Piston Engine - SCAF' under 'Economic Conditions € / 2010 / Million'. The rightmost window shows a 'Gantt Chart' for 'Programme overall and batch costs' from 2000 to 2024.

Category	Item	Value
Acquisition Costs	Development	783.35
	Production	547.38
	<b>Total Acquisition</b>	<b>1,330.73</b>
In-Service Costs	Non Crew	566.23
	<b>Total In-Service</b>	<b>566.23</b>
<b>Total LCC</b>		<b>1,896.96</b>
<b>Unit Production Cost (Units)</b>		<b>65,842,290</b>

- Multi Box model
- Air Module
- UAV Flight Vehicle



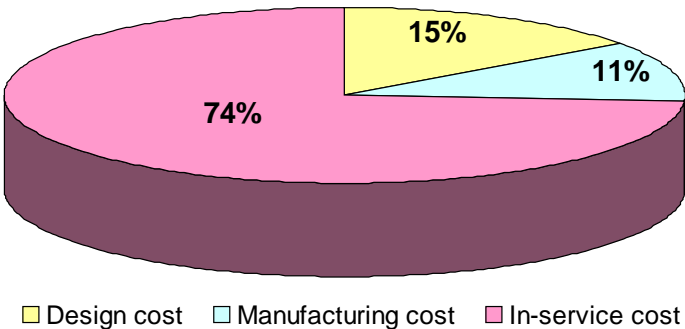
e.g. Spiral 5 SAR – Insertion Date 2056, Cost uncertainty -55% + 175%

# Whole Life Cost

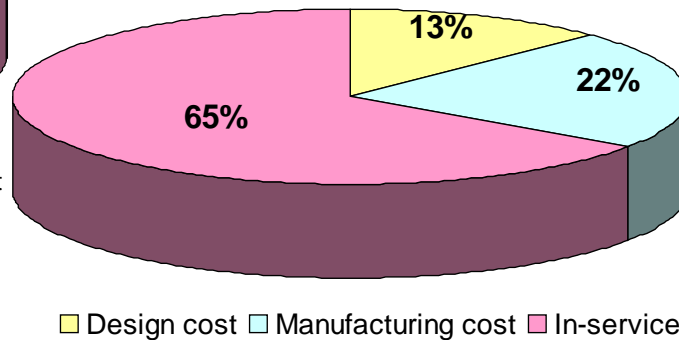
	2010 Constant Cost (£Bn)		
	10%	50%	90%
<b>Traditional Approach</b>	£10.1	<b>£11.8</b>	£12.9
<b>Spiral Development</b>	£11.1	<b>£13.2</b>	£15.8

Spiral Development **15%** higher cost

Traditional Approach Cost Apportionment



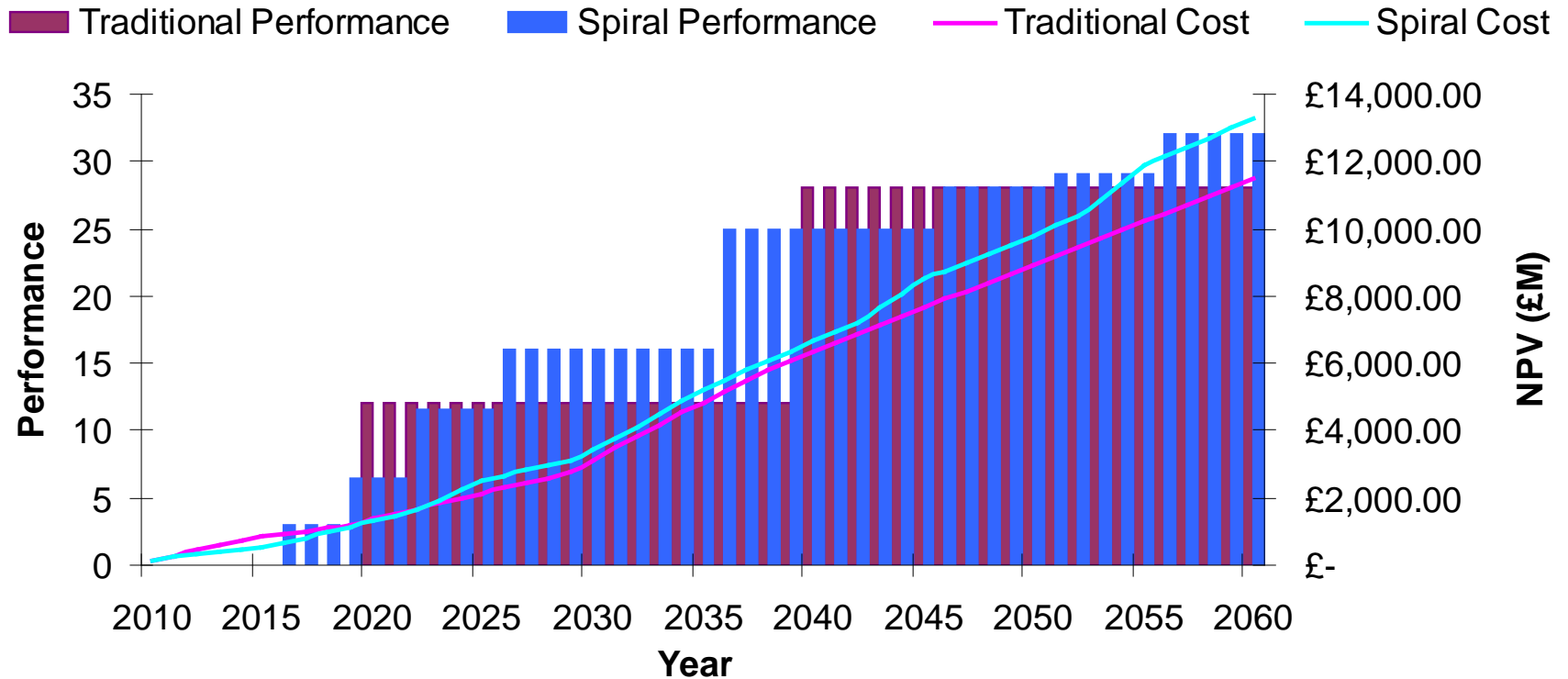
Spiral Development Cost Apportionment



**Manufacturing** Costs **Double** during Spiral Development

# Cost / Performance Results

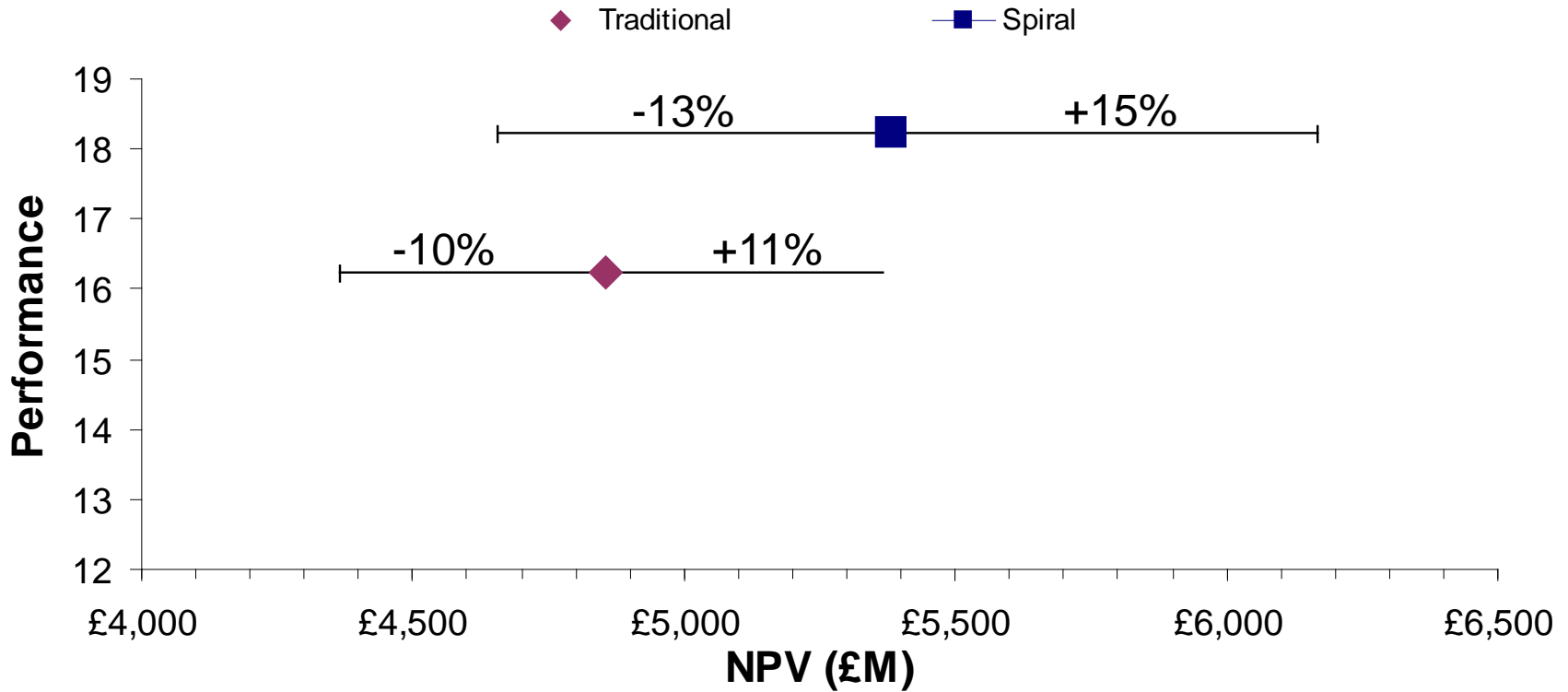
## Cost Performance





# Cost / Performance Results

## NPV Cost / Performance

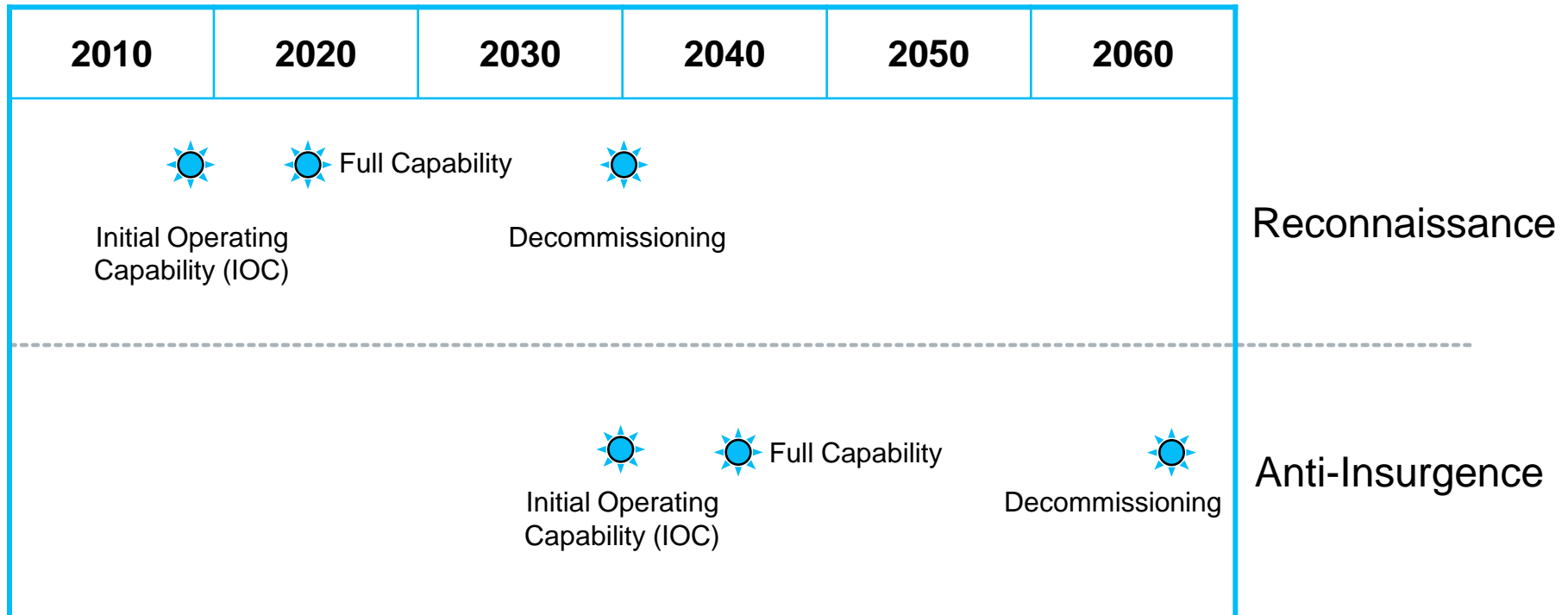


## 5. Delivering Capability

# Capability Planning

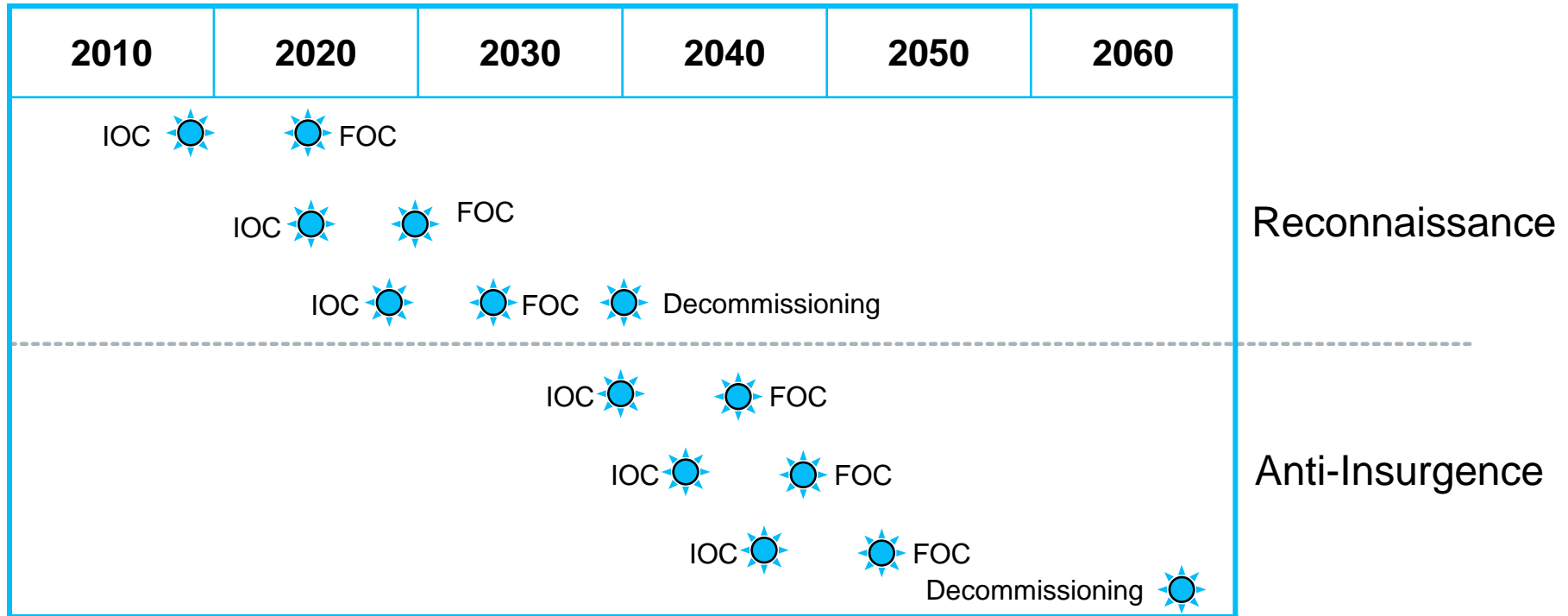
What are the actions required across the DLoDs to delivery Capability?

## Traditional Capability Plan



# Capability Planning

## Spiral Development Capability Plan



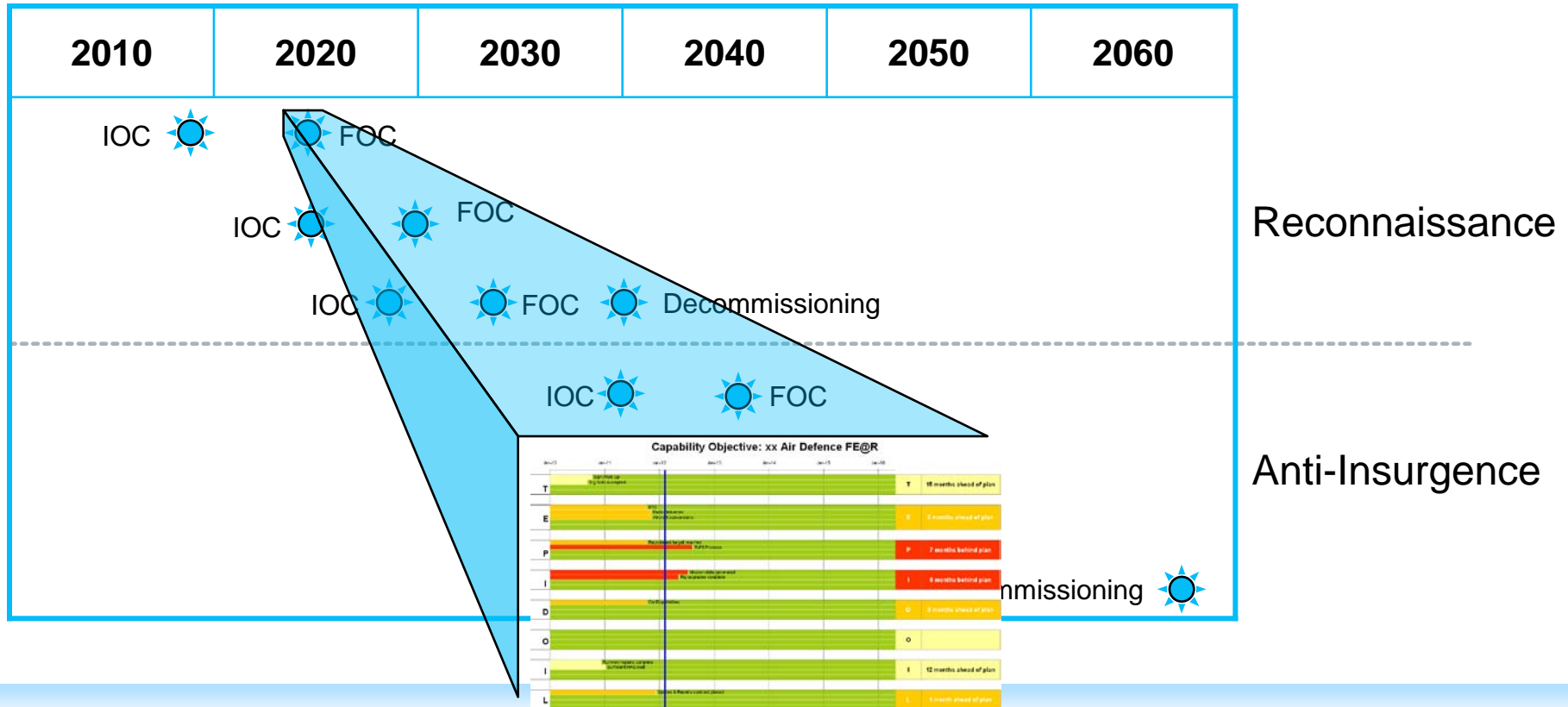
# Capability Road Map DLoDs Approach



# Capability Planning

What is the actions required across the DLoDs to delivery Capability?

## Spiral Development Capability Plan



## 6. Summary

## A touch of realism

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- Hypothetical Scenario – Assumed performance road maps
  - Analysis options limited to procurement approach rather than technology solutions
- DLoDs cost not currently taken into account
- Cost tolerance assumed to be correlated to TRL
- Risks not currently considered as they would be dependant upon the specific project circumstances



# Development Mode Merits

## Traditional Approach

- Cheaper overall
- Reduced number of configurations and equipments
- Reduced integration effort
- Reduced DLoDs impact
- Less uncertainty

## Spiral Development

- Greater flexibility to meet changing requirements
- Greater refresh of equipment throughout life cycle allowing
- Obsolescence is managed more effectively
- Development and design team continuity
- Provides greater focus on use of commercially available equipment
- Provides a more consistent and overall higher capability

Questions?

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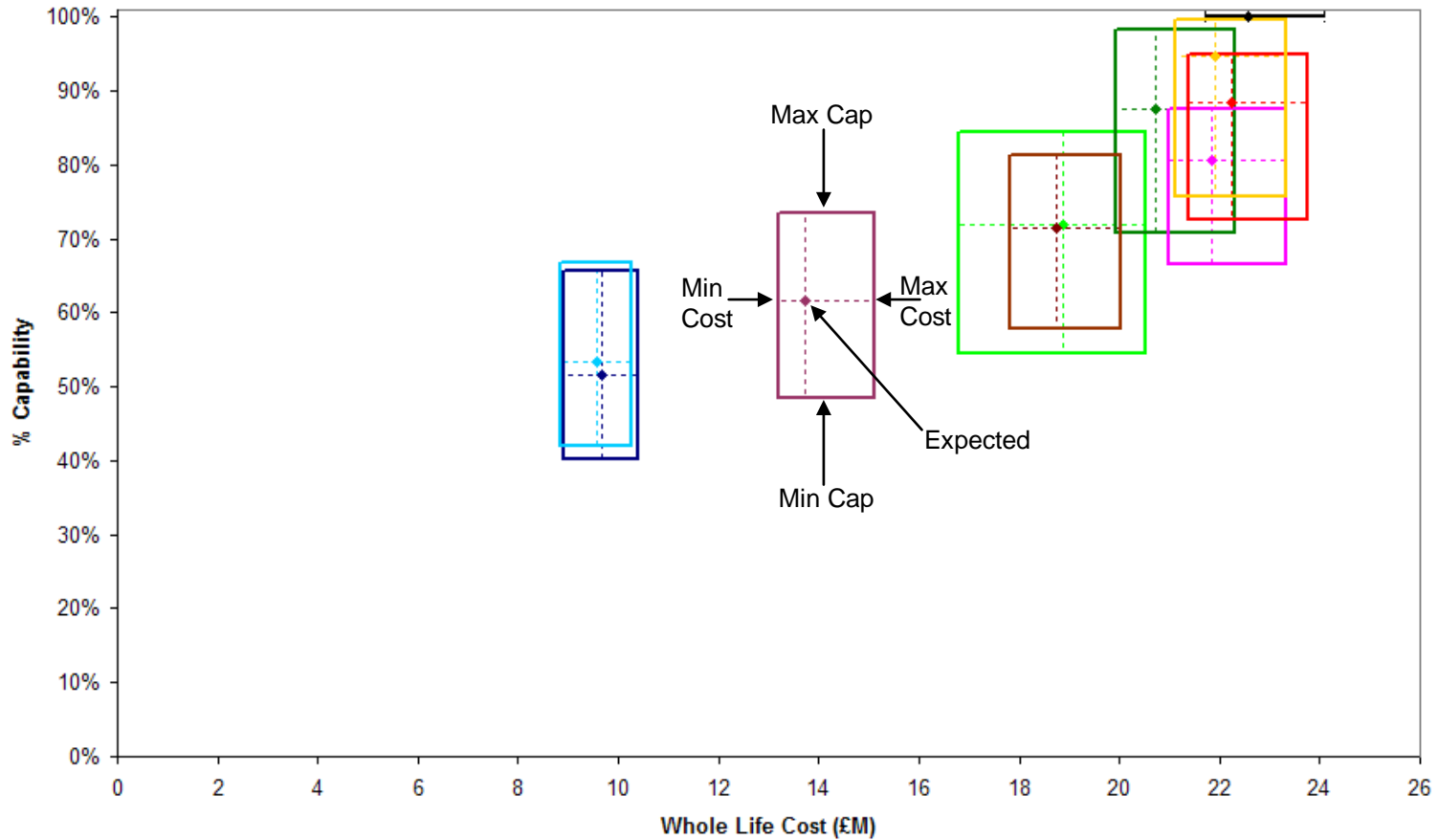
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# Cost / Performance Trade Off Space



Spiral development has a huge effect across the board. For the purposes of this task, a simplified view has been taken.

A spiral development would potentially mean a larger vehicle being designed from the beginning compared to a traditional development vehicle to ensure there is sufficient space to accommodate future technologies. This would mean a more expensive initial design.

A spiral development enables the capability to remain higher on average.

In service costs are potentially higher due to smaller scale purchase of spares and additional training that may be required on any new systems.

Spiral development may help where it is a new technology and limited budget. A technology demonstrator can be considered the first spiral.

Unless a clear development path is defined from the outset, there is potential for considerable risk and uncertainty.

Spiral capability is already being practised to some extent with Typhoon aircraft.

Spiral development can potentially be a method of maintaining sovereign skills albeit on a small scale over longer periods.

May help with affordability over the longer term.

Does not make sense to have too many spirals on high value items such as engines and airframe.

High degree of re-development can lead to program advancement regressing and potential project failure.

No analysis done but we suspect there is a relationship between TRL and capability.