UK PBL/PFI Examples & Supportability Audit

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Logistics Seminar - IPS in UK & PLCS Standards
Grand Hill - Ichigaya
21st November 2019

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Our Purpose

To optimise the cost and availability
of supporting complex equipment systems or fleets
that require maintenance

Quantified modelling and analysis will support logistic decision making to increase performance and reduce cost
while mitigating commercial and operational risk

Do More, with Less through ***Smarter Ownership***

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Scope

- Budgetary issues and contracting methods – PBL & PFI
- Total System view
- Through-Life Support and Continuous Improvement
- Support Modelling & Analysis - Techniques & Tools
  - Data Availability, Data Quality
  - LCC Techniques
  - Spares Optimisation and budget setting
  - Life Cycle Costing & multi-resource optimisation
  - Supportability Audit
  - Through-Life Supportability Modelling Capability
- Case Studies
- UK Design for Supportability Centre of Excellence

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For the want of a nail, the shoe was lost

For the want of a shoe, the horse was lost

For the want of a horse, the rider was lost

For the want of a rider, the battle was lost

For the want of a battle, the kingdom was lost

And all for the want of a horseshoe-nail

Benjamin Franklin

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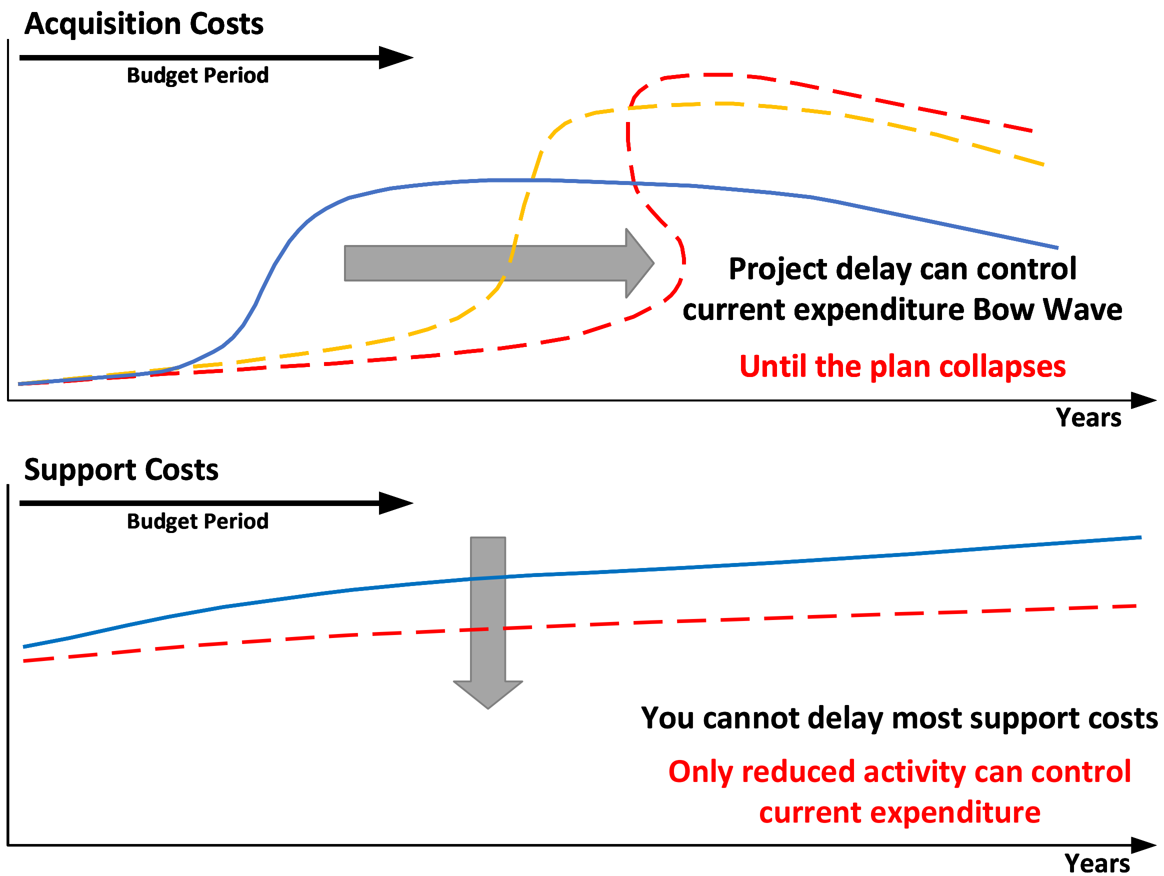
Acquisition & Support Cost Budgets



More than half UK's equipment budget (£23Bn) is spent on support (£12.8Bn)
Must ***Do More with Less***
Modernising Defence target to save £10Bn over 10 years (8%)

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Contracting Mechanisms

The Contracting for Availability Staircase

UK

Traditional
Time & Materials
Business As Usual

Spares Inclusive
Repair & Overhaul
Assured Lead Time

Contracting for Availability
Guaranteed System
Availability

Contracting for Capability
Full Service
Responsibility

Business As Usual
Time &
Materials

PBL 1
Lead Time Assurance
Assured Lead Time
Production & R&O

PBL 2
Fill Rate Assurance
Guaranteed
Spares Fill Rates

PBL 3
Equipment Availability
Guaranteed
System Availability

PBL 4
Capability Assurance
Guaranteed
Systems

US PBL

TFD dV
System Data

MAAP

EDCAS | **EDCAS**

VMetric | **VMetric/Tempo**

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PBL Contracting
Key Questions

How can Governments and Industry work together through PBL contracts to deliver effective support, affordably while making a profit?

- What must be considered in constructing fair and reasonable deals?
- What should the requirements be?
- How do you identify, size and manage risk?
- How do you establish a fair but profitable price?
- How can Industry manage its risk after contract award?

How can modelling help to inform the commercial issues?

- What are the steps to create a successful PBL contract?
- What are the methods to manage a successful PBL contract?

A contract mechanism to pay for an agreed service level (availability or use)

The objective is reduced cost, better service level, or both

Do More with Less

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What is PBL?
Outputs not Inputs

Traditional support contracts are for the provision of spare parts, repairs, labour and other enablers for system sustainment. These can be specified and measured as individual ***Inputs*** for system sustainment.

- Customers must specify and contract for each individual element, and manage the service integration risk.
- For example, if spares and repairs are contracted item-by-item and priced per item, suppliers are rewarded for poor reliability.
- The supplier is incentivised to increase the quantity and price of inputs.

PBL contracts require delivery of system sustainment over specified periods as ***Outputs*** where the service is measured by performance at the system level.

- The customer defines the output performance and the supplier must manage the integration risk.
- If items have worse than predicted reliability, the supplier bears the additional cost but makes additional profit if reliability is improved.
- The supplier is financially incentivised to improve output performance

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What is PBL?
Outputs not Inputs

PBL Buyers must:

- Understand their requirements in output terms.
- Avoid excessive metrication just for comfort.
- Attack Suppliers' costs – not their profit (its more effective)
- Specify Key Performance Indicators that incentivise the Supplier to meet their needs.
- Be assured that the Supplier can and will deliver the service.

PBL suppliers must:

- Design and cost a complete, coherent support system capable of delivering system performance.
- Negotiate an agreed price for delivery of that service, at a profit, taking account of variability, uncertainty and risk within measurement periods.
- Deliver the service by integrated management of all elements
- Seek continuous improvement to improve service delivery, enhance margins and improve future competitiveness.

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Why PBL?

Faced with increasing pressure on military resources to ***Do more for less***, customers want to contract industry using Performance Based Logistics (PBL)

Support plans are often sub-optimal in practice because in reality:

- equipment characteristics such as Reliability and Maintainability are different and change over time
- support performance (TRT, price etc) doesn't turn out as planned over time

leading to the risk of:

- poor availability
- increased system cost
- inadequate military capability

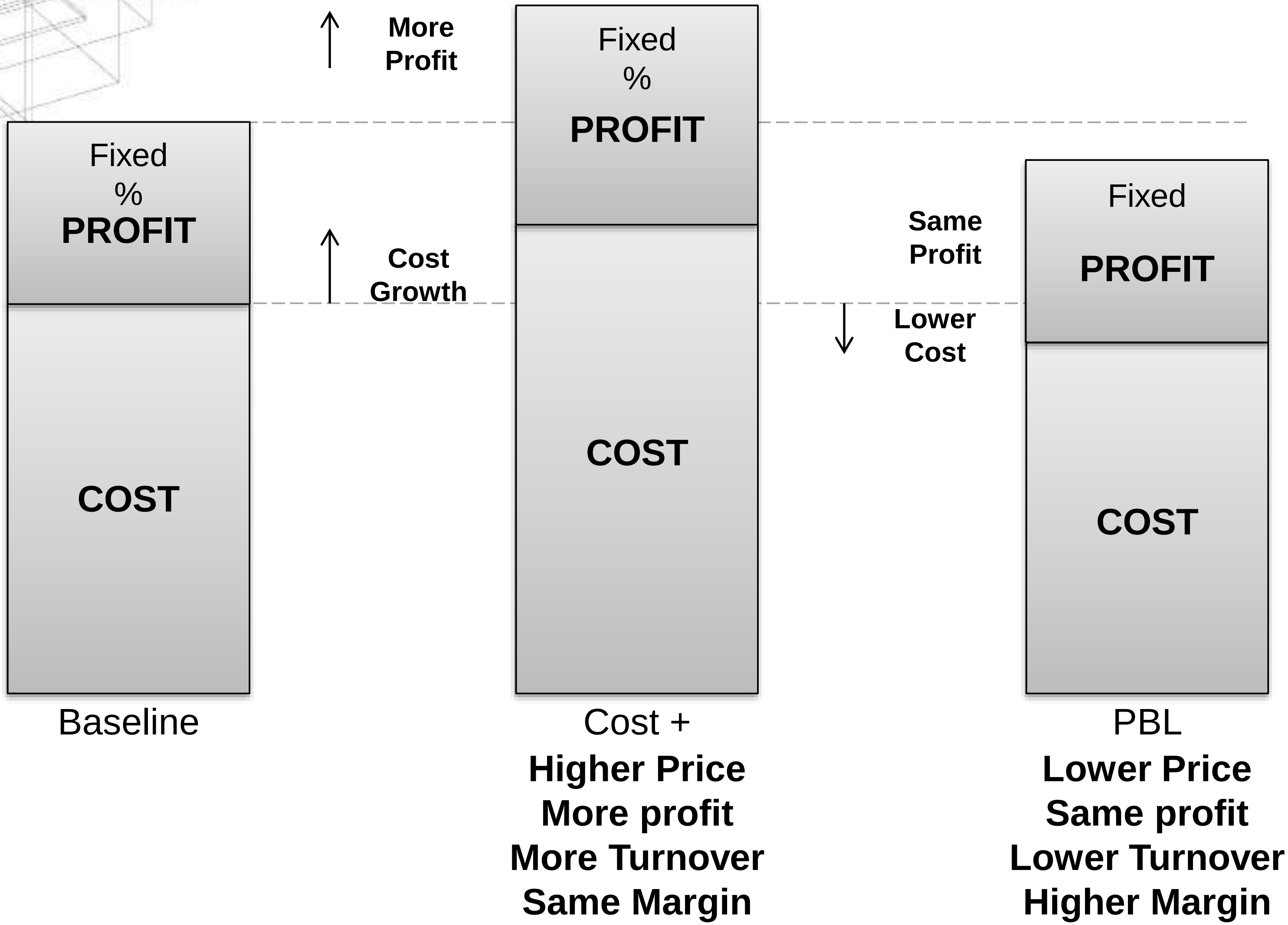
The Support Manager's Mission is to:

Plan, implement and improve through-life the effective support of a system to meet the required tasks, while seeking efficiencies to use fewer systems and balance more output with lower cost.

PBL is a potential contracting option to transfer risk to industry and incentivise better support performance

Do More for Less

PBL
Mutual Incentive Theory



PBL should incentive industry to take more responsibility and risk to gain a higher margin
So that the customer pays a lower overall price

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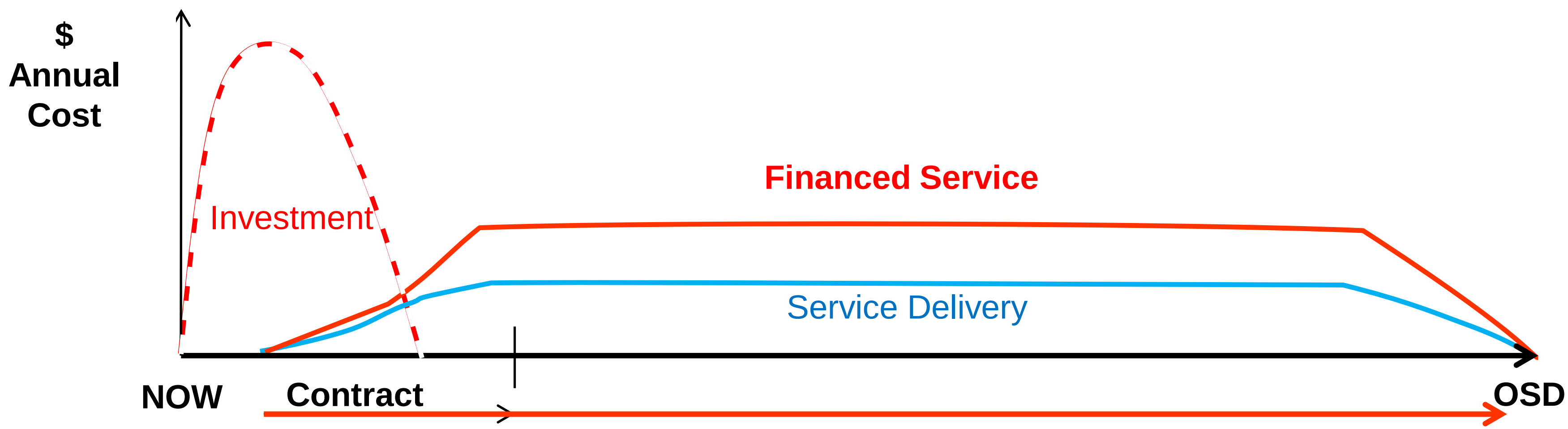
Private Finance Initiative - PFI
The Extreme Case

Governments can always borrow at the cheapest rates – but at a cost to national debt.

Where budgets do not allow up-front investment, PFI is a mechanism for industry to borrow on markets and recover the investment in a long-term financed service.

The debt remains on the Government balance sheet **unless industry takes the risk.**

But lenders don't like taking risk and impose very robust due diligence. Robust due diligence improves deliverability of the deal and assures the service.



RISK – Pass It On, Pass It Back, or Price It

But if you Price it, KNOW how to turn Risk into Profit

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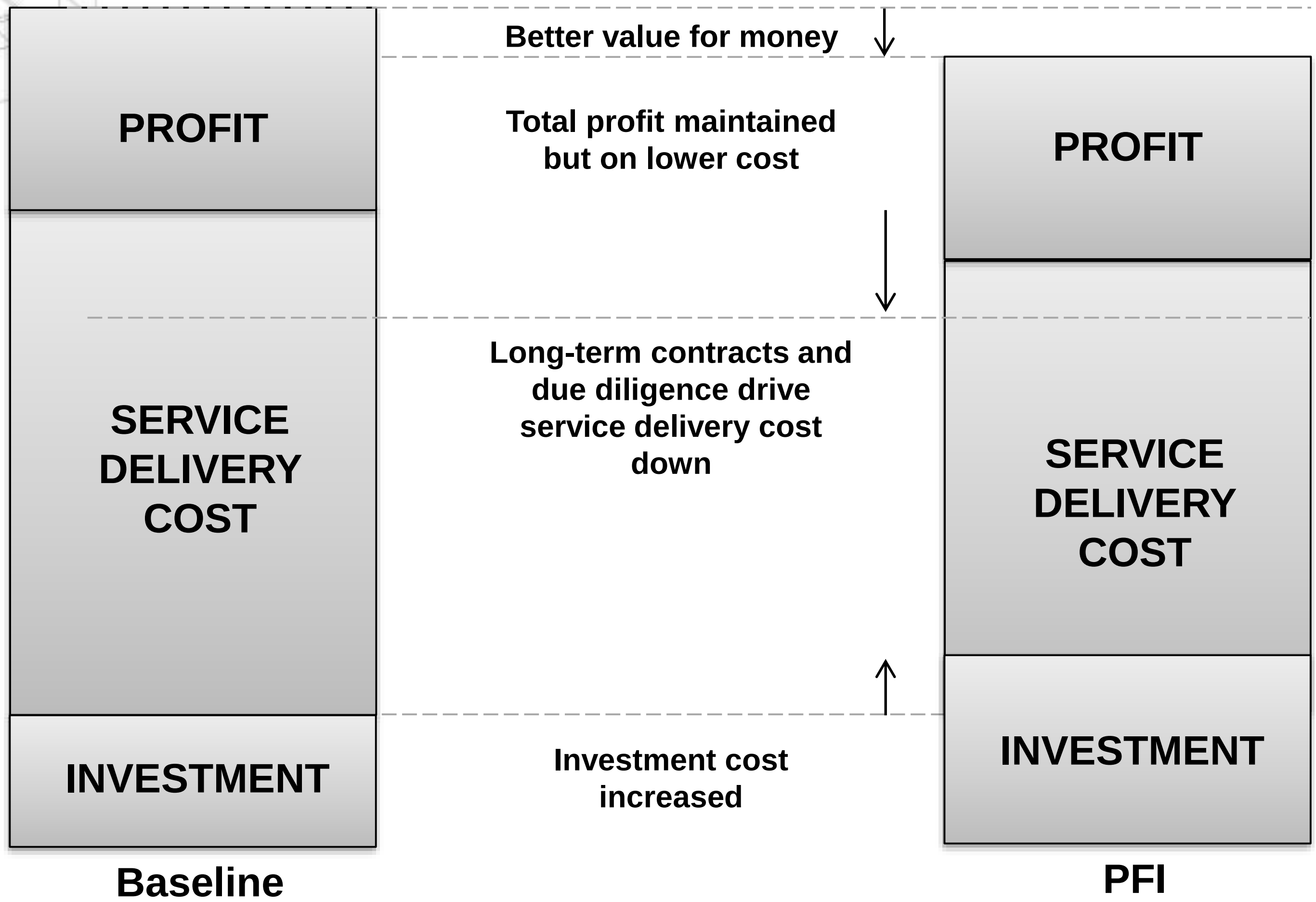
Private Finance Initiative
The Extreme Case



PFI can be VFM offering a lower price for government
with same profit for industry on a lower delivery cost for higher margin.
Win-Win?

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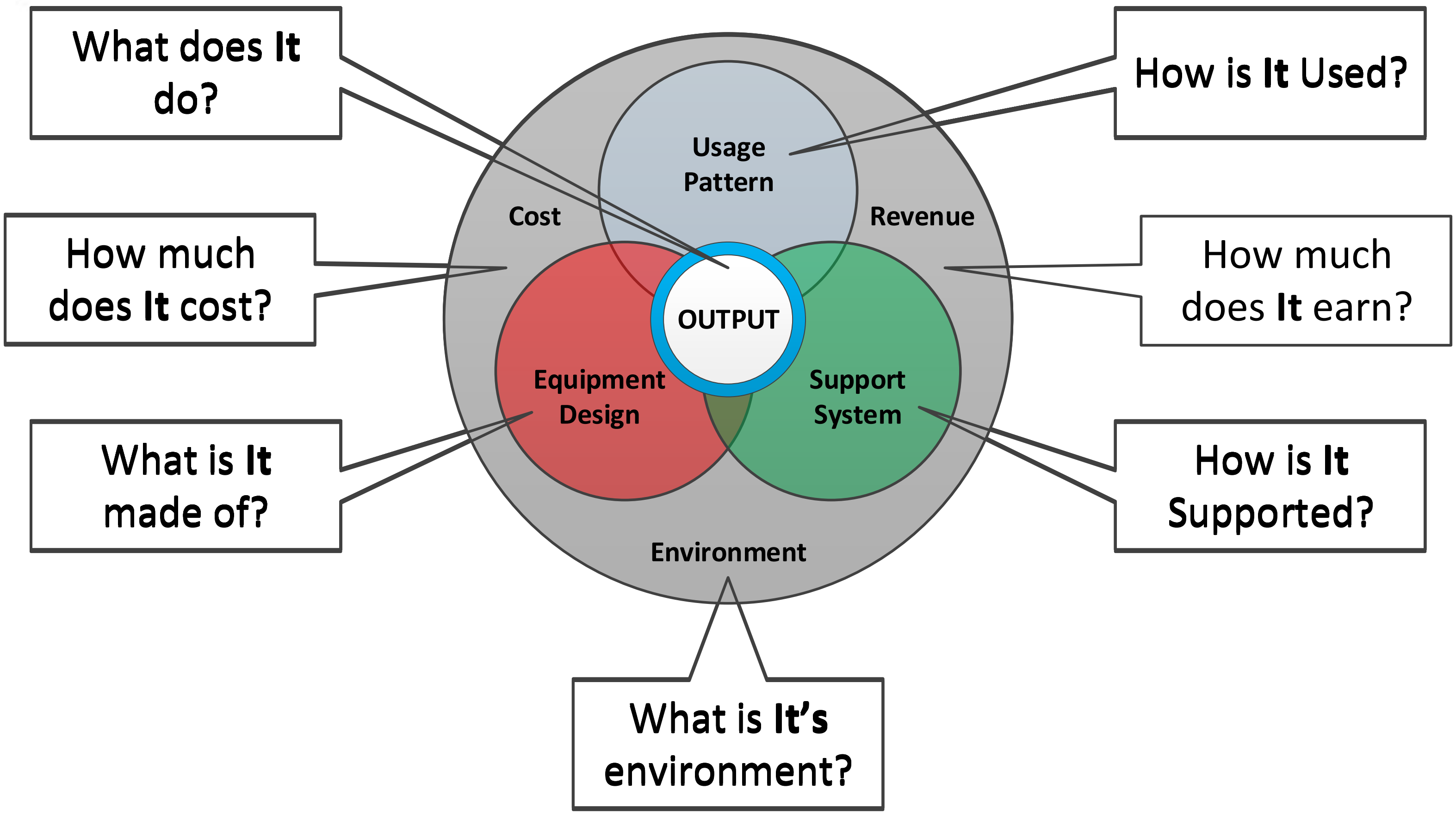
The Total System



How does **It** all work as a Total System?

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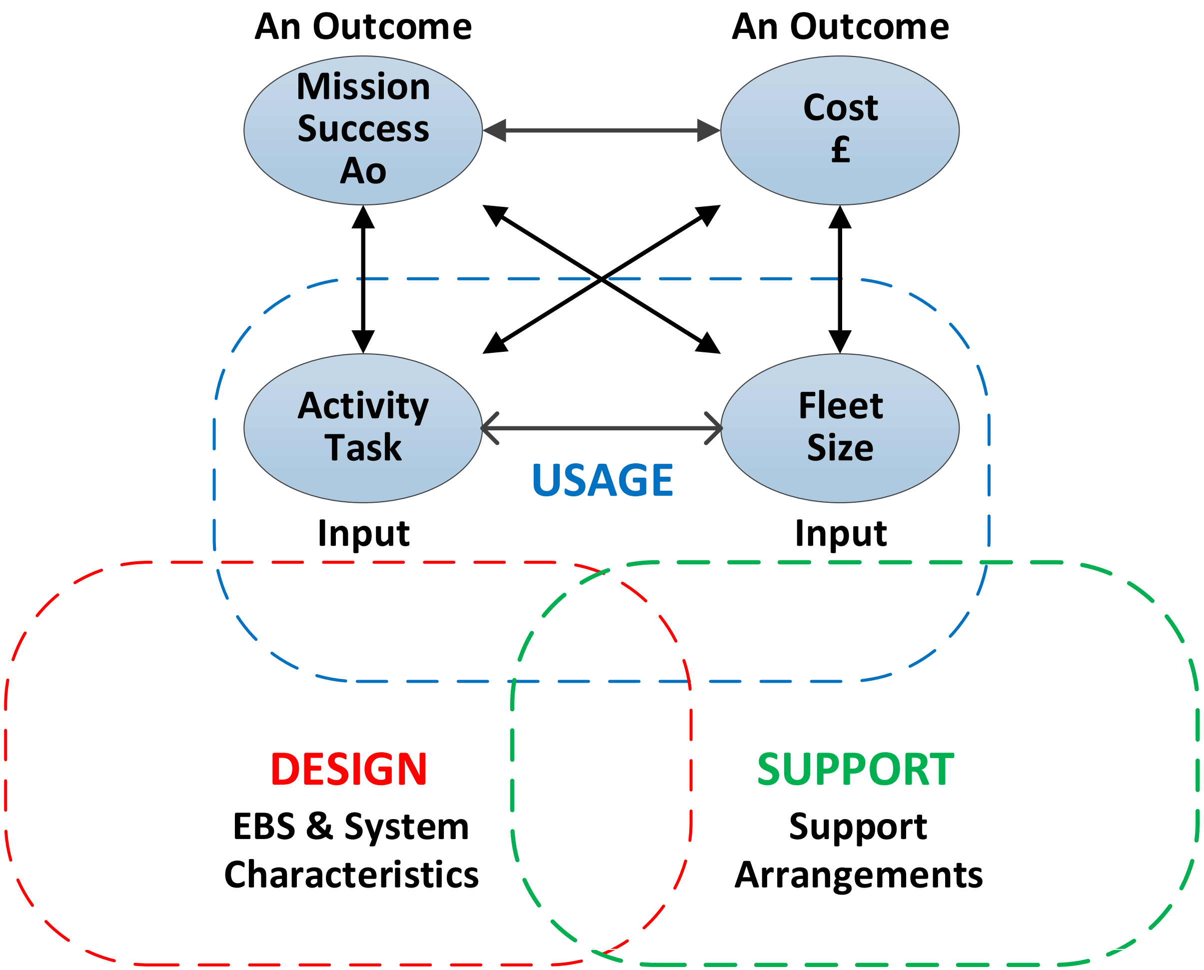

System Availability and Cost are driven by the interaction of Usage, Design and Support

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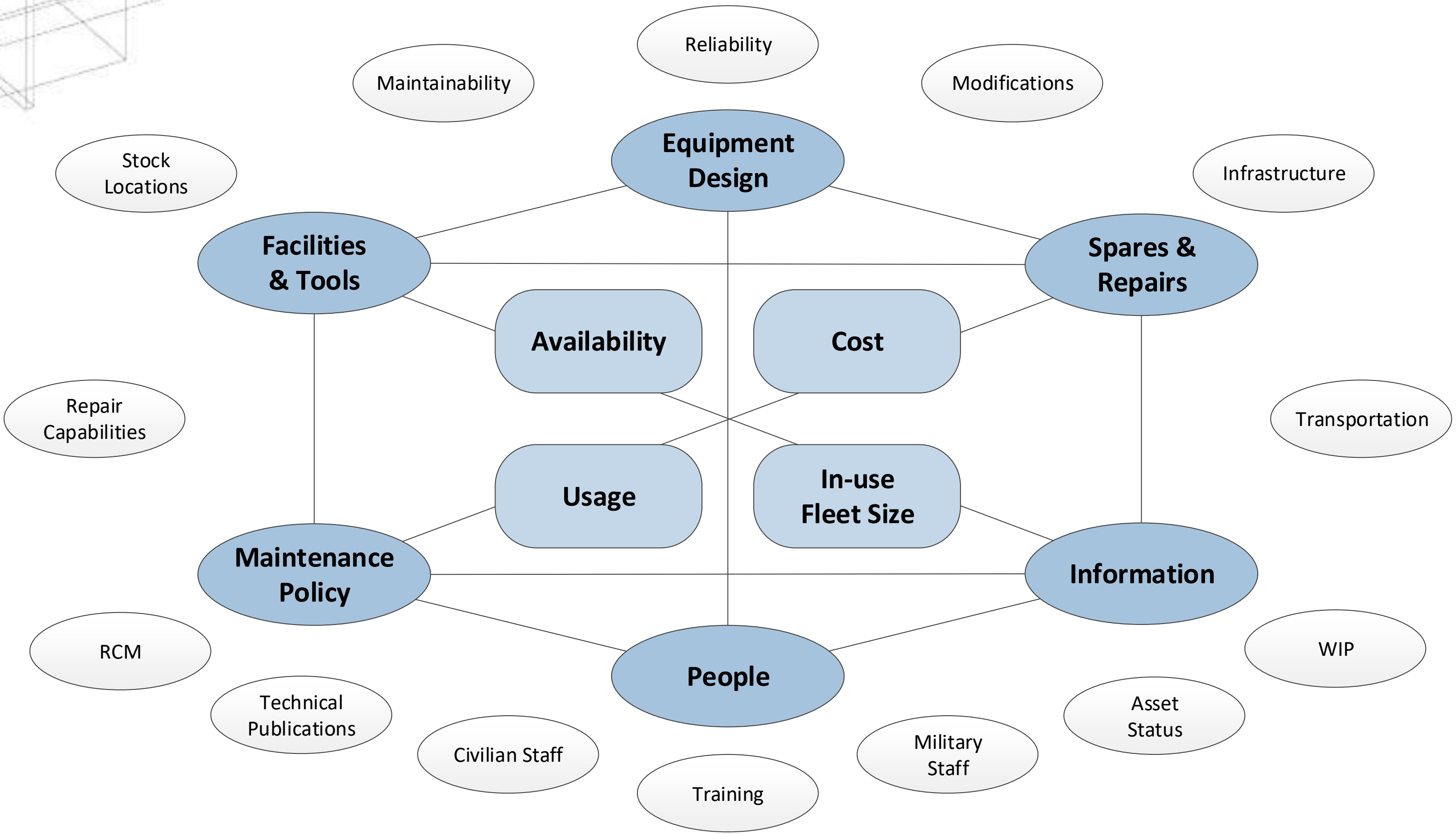
Interactions of Support Disciplines



Support activities are complex, interconnected and must be tuned to avoid unintended outcomes

It is critical to handle the complex interaction of all these activities

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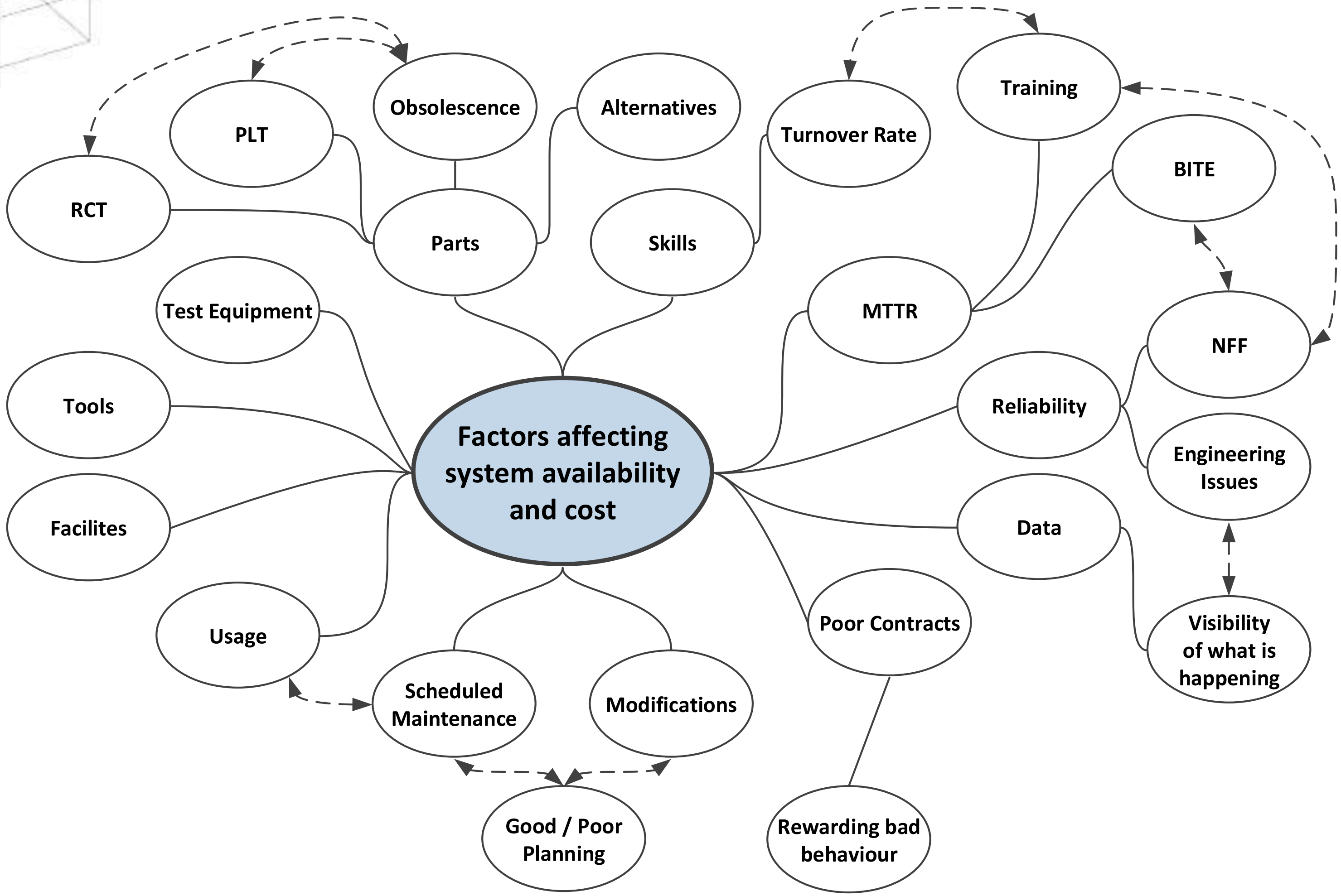
Interactions of Support Disciplines



Support interactions are complex and hard to quantify independently

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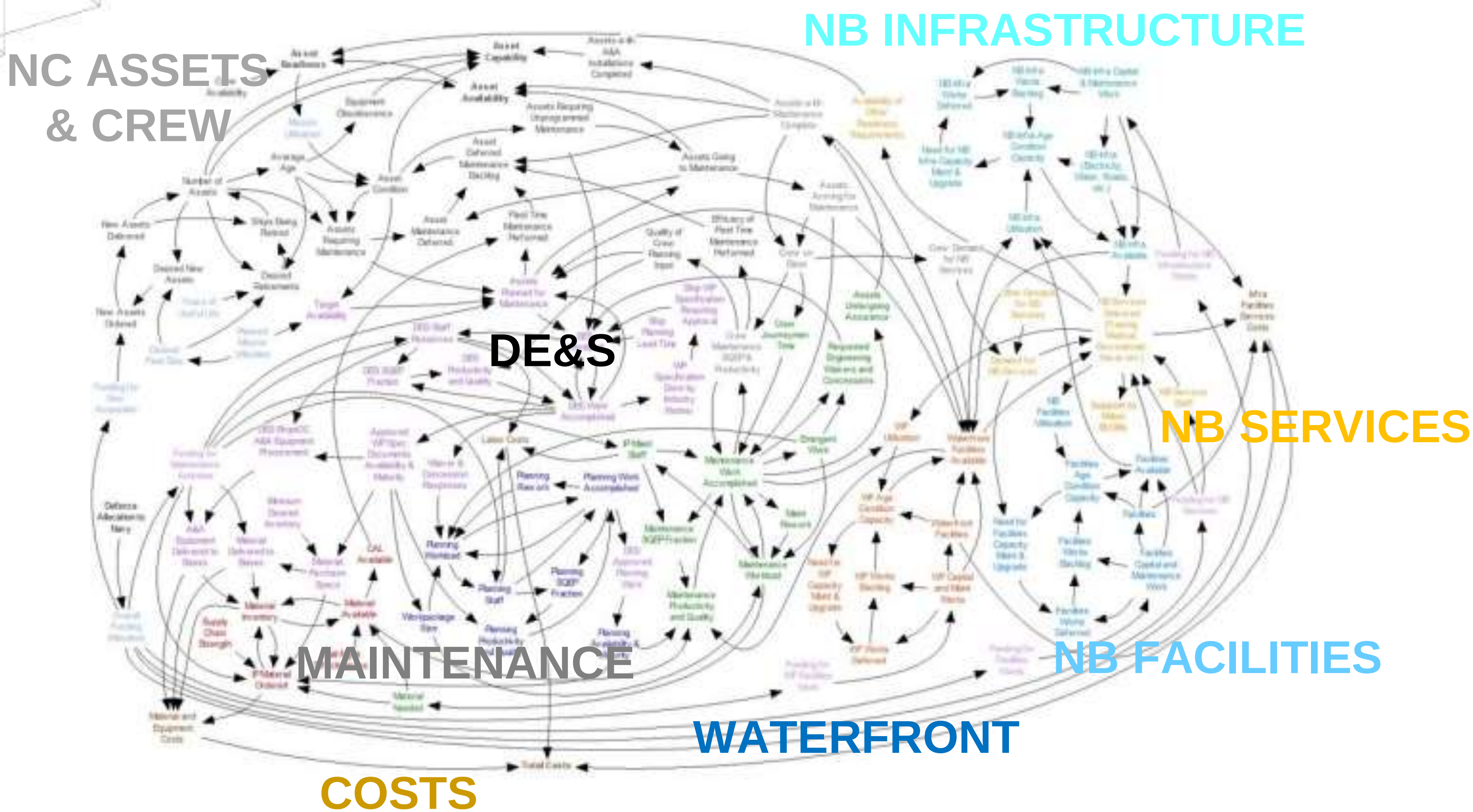
Interactions of Support Disciplines

Future Maritime Support Causal Model – Level 1



Support interactions are complex and hard to quantify independently
Their relationships are critical and the system must be optimally tuned
A ***Wicked Problem*** that cannot be solved top-down

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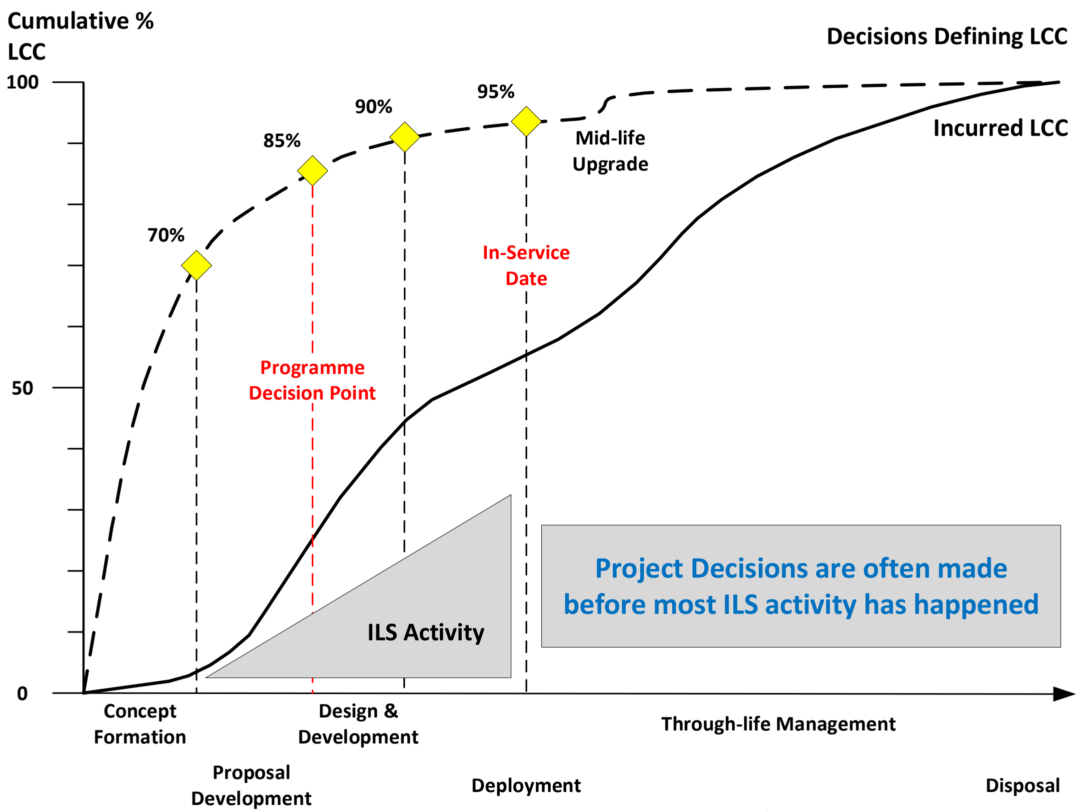
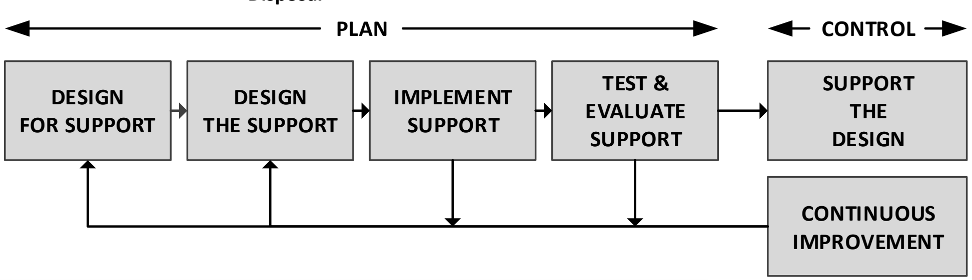
Timing of Support Planning





Support must be addressed from the start of the Life Cycle

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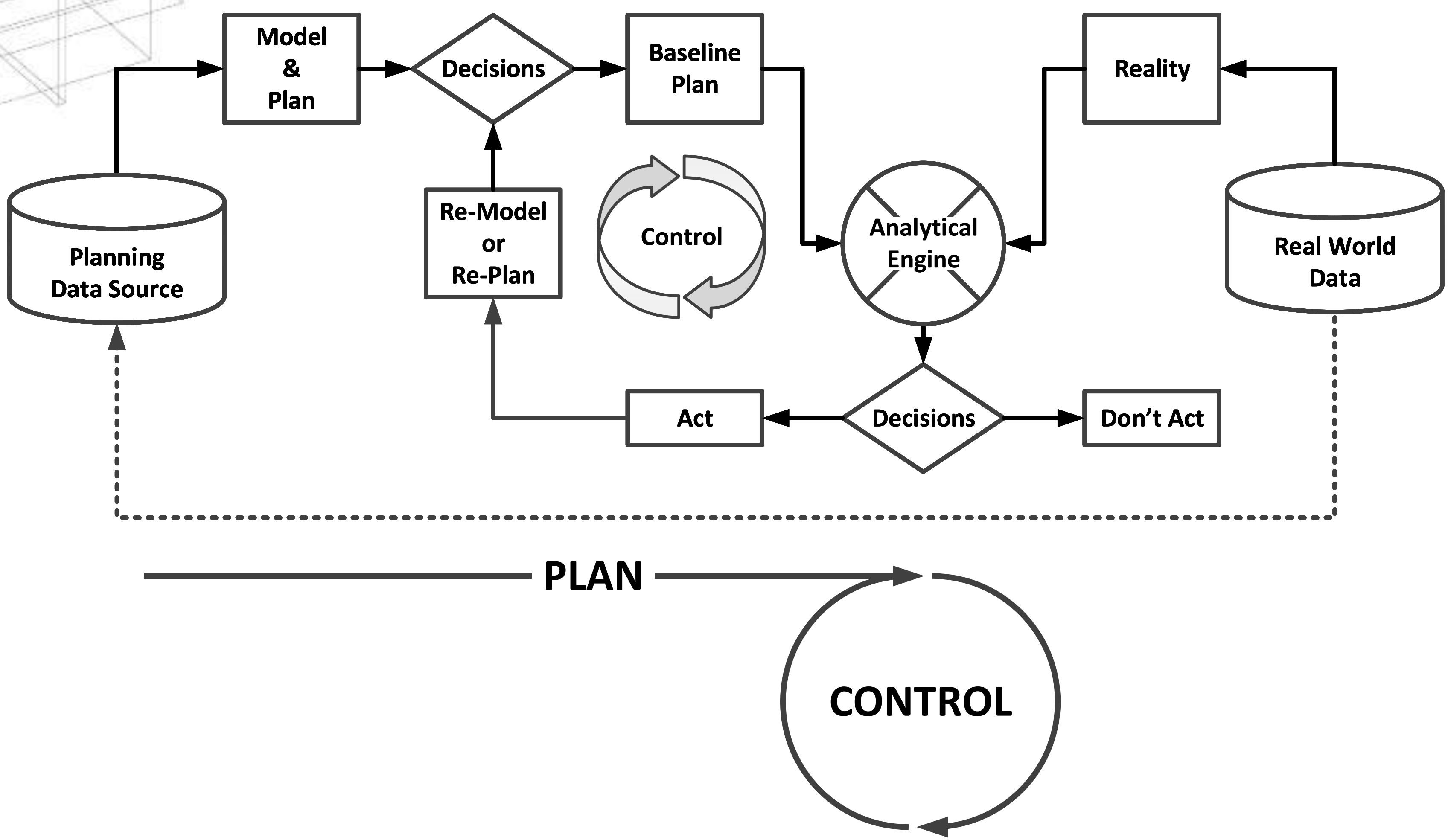
Continuous Improvement



Achieving **AFFORDABLE AVAILABILITY** requires both **PLANNING** and **CONTROL**
CONTROL requires **FEEDBACK** which requires **VISIBILITY**

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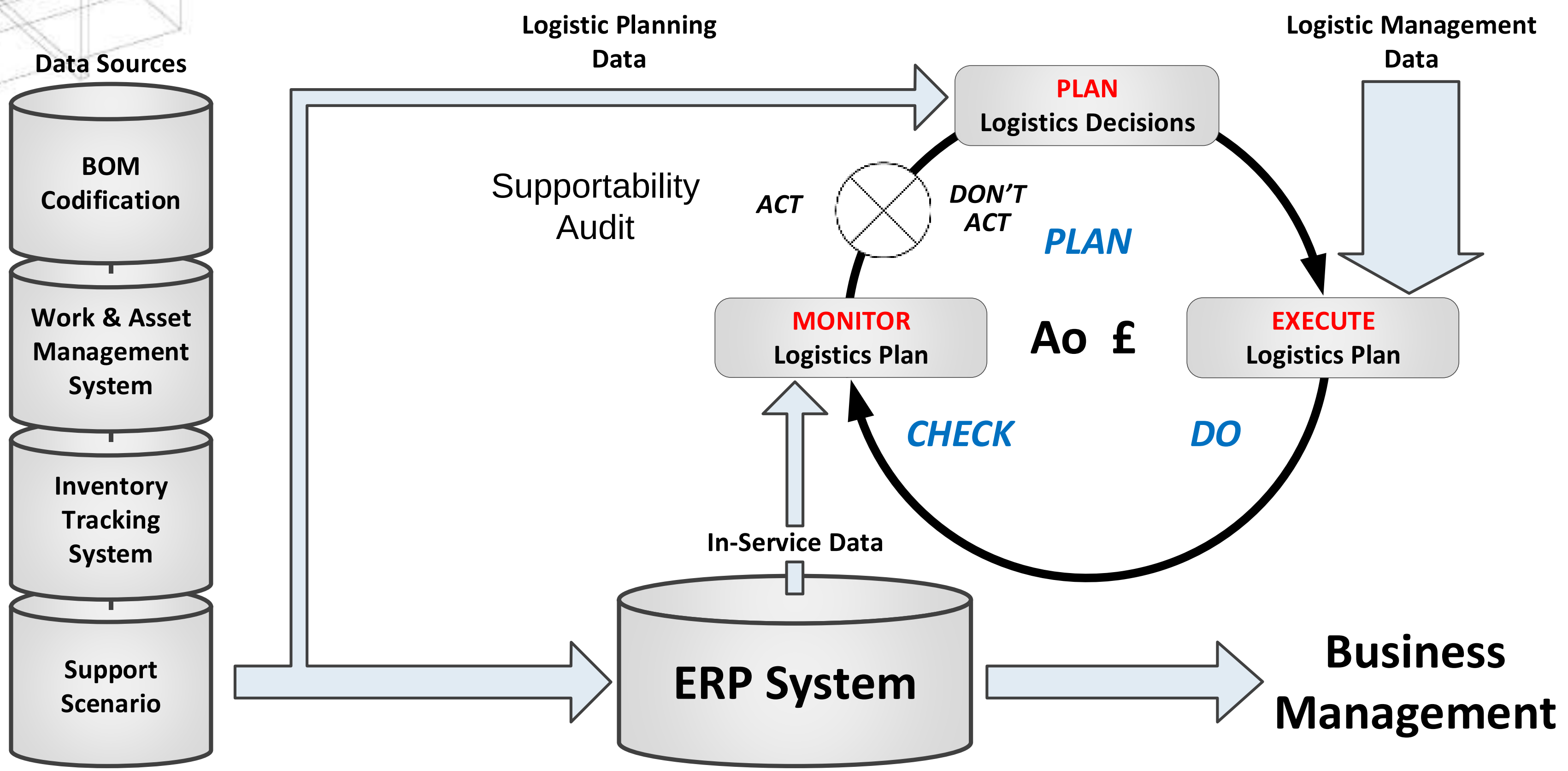
Continuous Improvement



Build a ***Digital Twin*** of Support
Use it continuously to improve **Availability** and **Cost**
To Do More, For Less through **Smarter Ownership**

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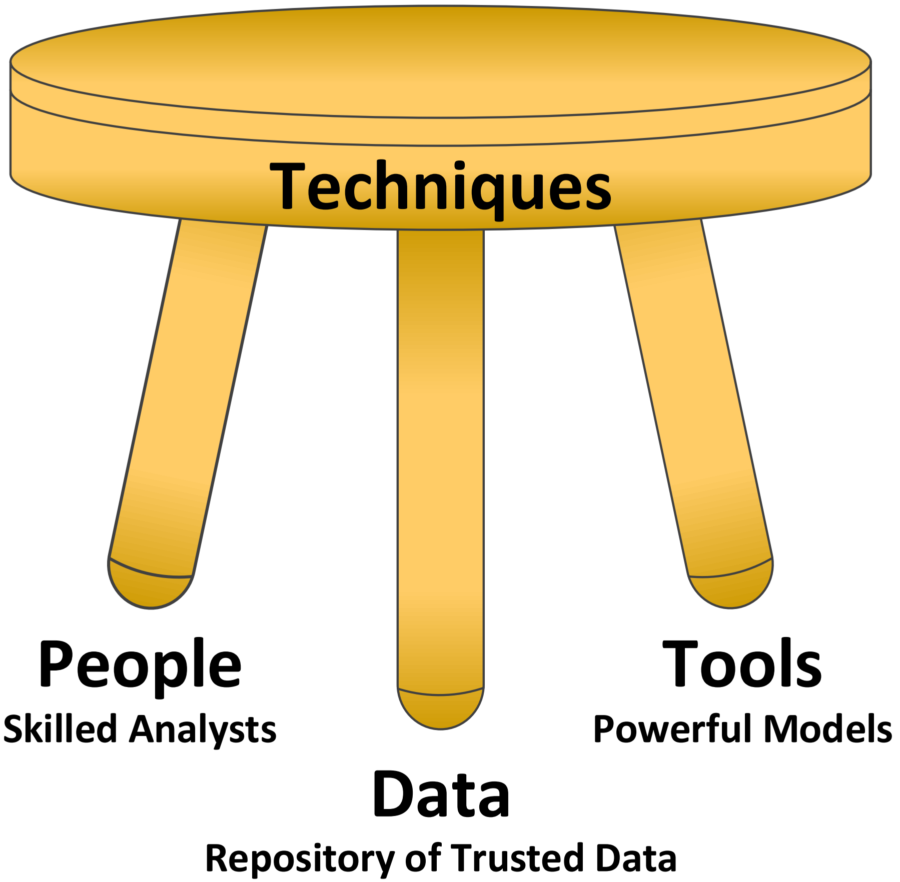
Support Modelling & Analysis

Building & Using the Digital Twin for Support



Without good techniques, modelling is ineffective

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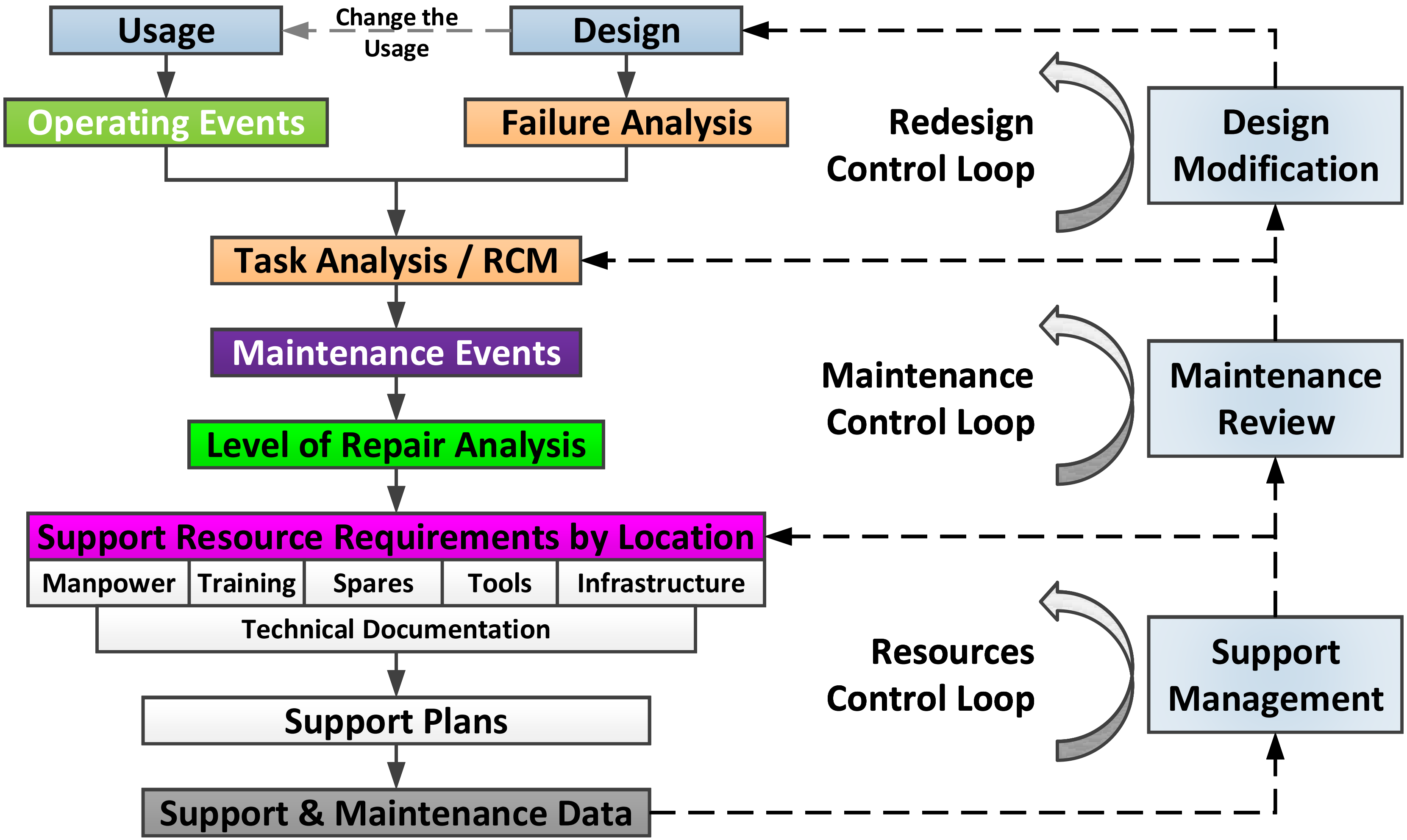
Integrated Support Planning & Control



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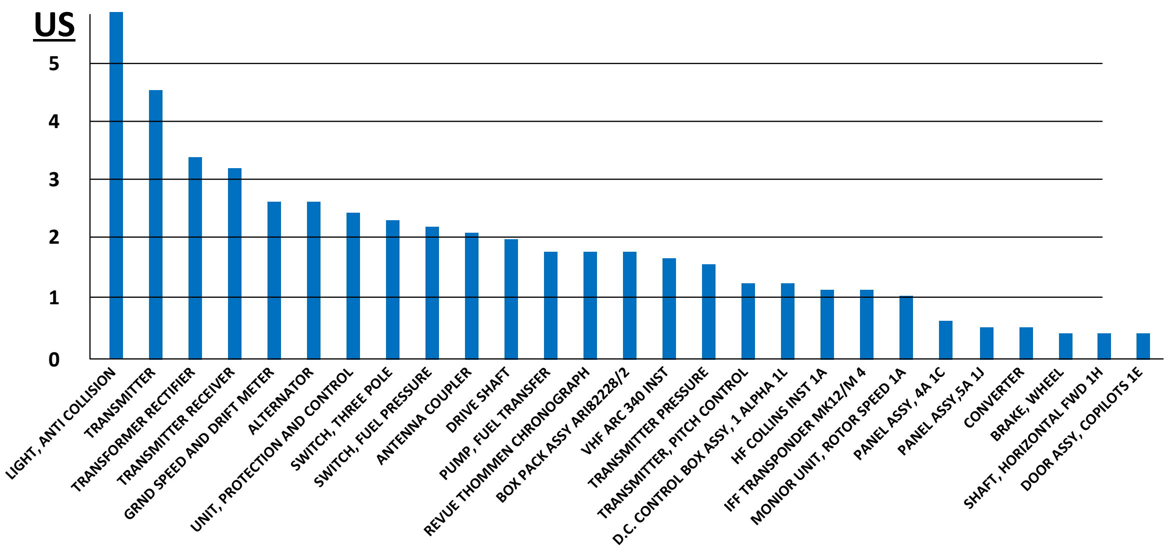
Supportability is the responsiveness to unreliability that prevents a system's utility

When there's a problem on a system, how quickly can its utility be restored?

***UnSupportability* (<u>US</u>)** *is a metric* to describe downtime

$$\underline{\mathrm{US}} = \sum(\boldsymbol{TTR} + \boldsymbol{PM\ Time} + \boldsymbol{CBM\ Time} + \boldsymbol{ALDT})$$



Each component has a specific ***<u>US</u>*** metric

The ***System <u>US</u>*** metric is a single number for the total area under the curve

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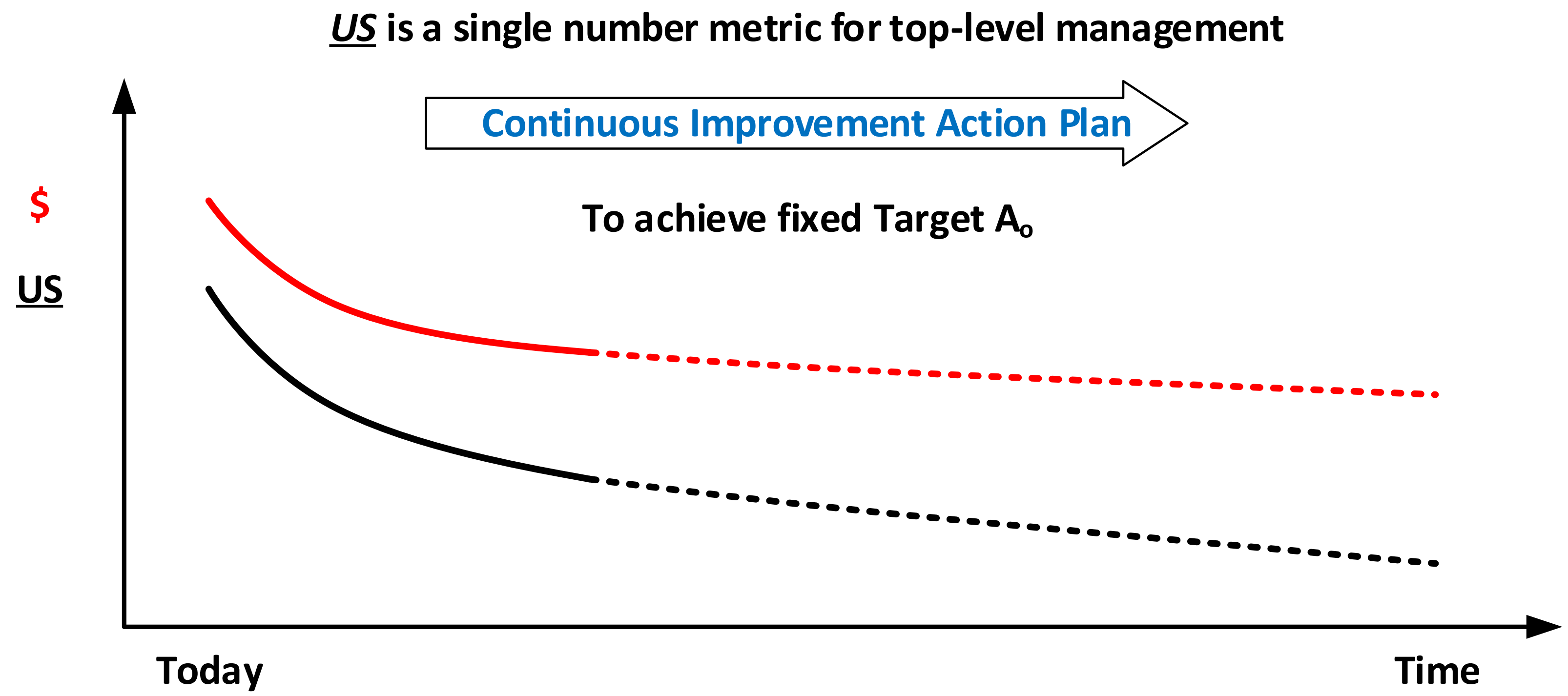

Kaizen to progressively reduce both the cost of support and improve availability

Bend the Cost Curve to ***Do More with Less*** through ***Smarter Ownership***

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I want modelling to be simple (cheap), quick and accurate

Tough – you can only have 2 out of 3!

Typical Responses to Requests for Data for Modelling

- We haven't got it, or not all of it
  - ***Yes you do***
  - ***It already exists in current maintenance plans***
- The data we have isn't good enough
  - ***We know, nobody's is***
  - Make assumptions
  - Test sensitivity
  - Evaluate uncertainty
  - Establish the confidence level
- It needs too much data and takes too much time to assemble
  - ***A lot less than you imagine***

Modelling with limited data is better than not modelling at all – that's just guessing

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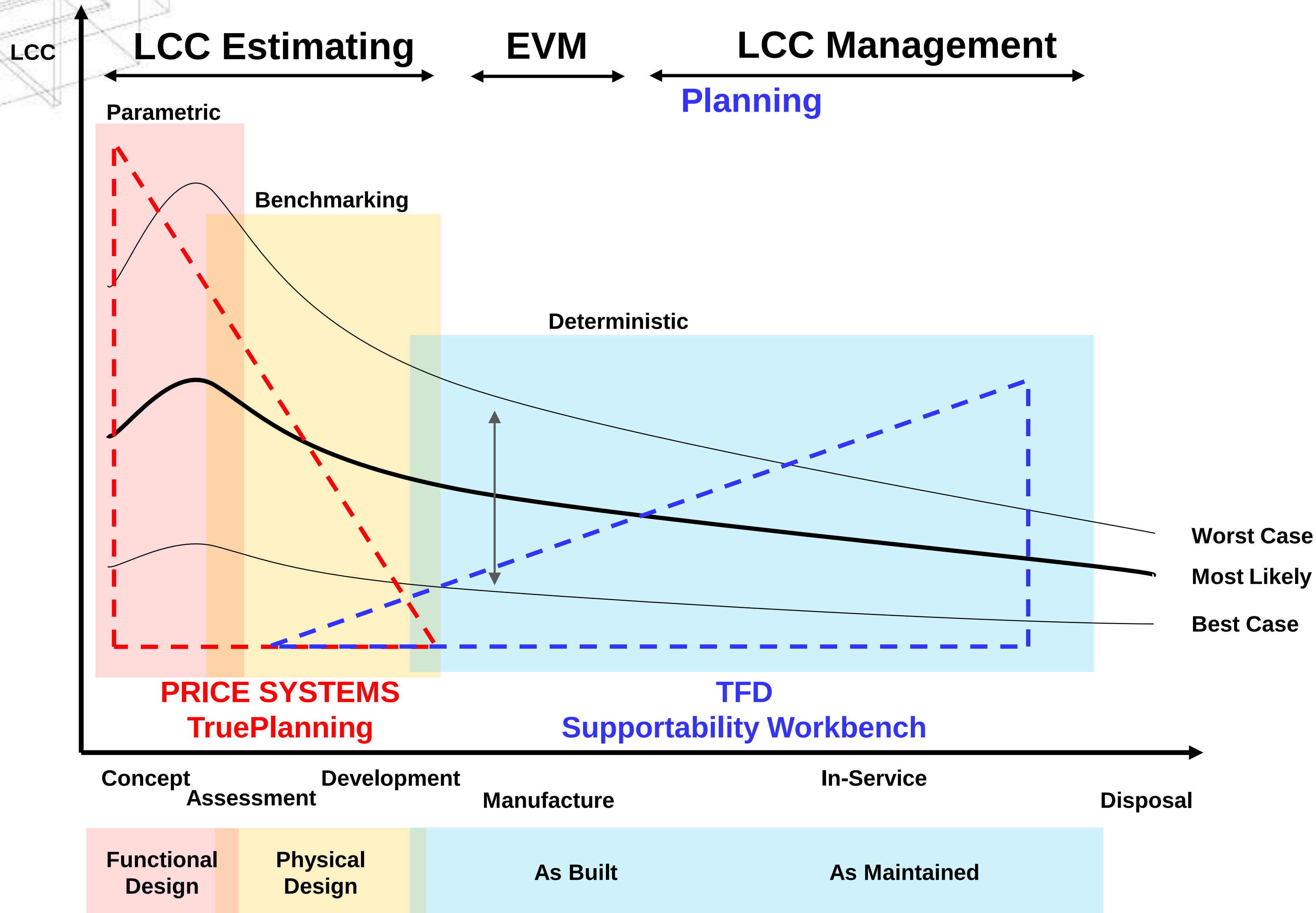
LCC Techniques



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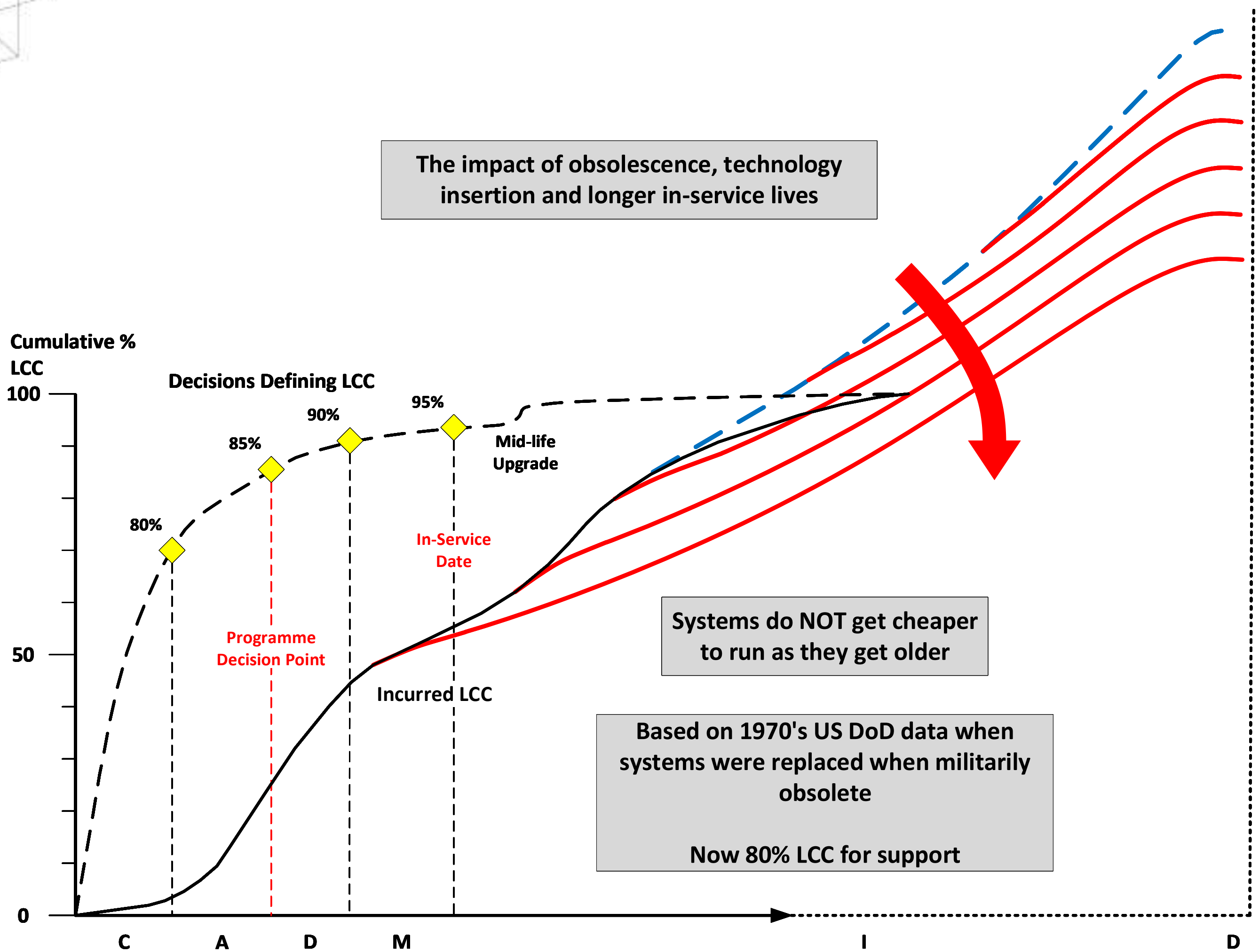
Supportability Audit
‘Bending the Cost Curve’



‘Bend the Cost Curve’ using ***Supportability Audit***

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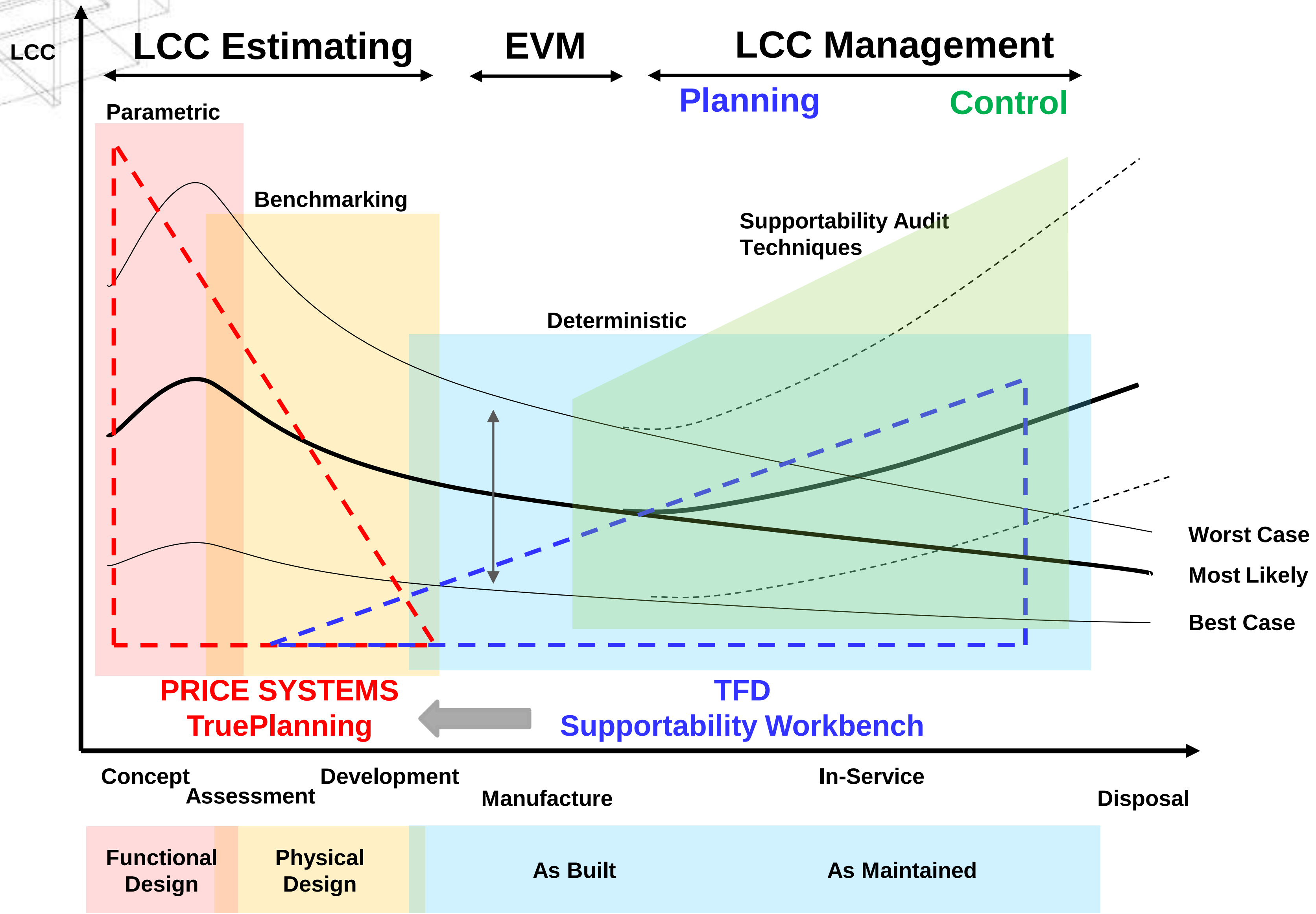
LCC Techniques



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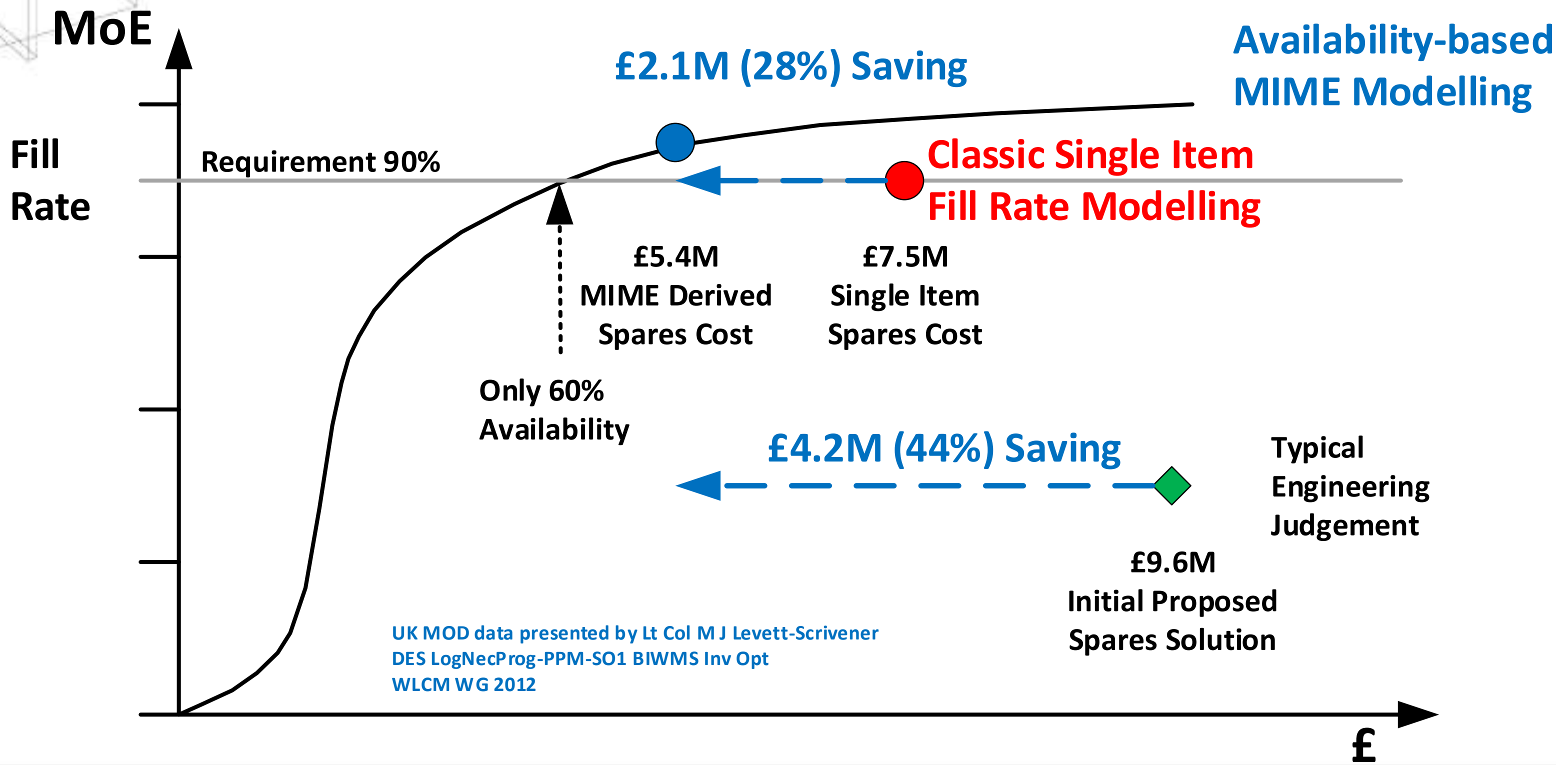
Spares Optimisation

Happy Shelves or Happy Systems?



For Single Item Fill Rate modelling, the price of each spare is irrelevant

Each and every item is provisioned to exceed its requirement

For System availability modelling, items are traded-off based on price

The Fill Rate is achieved at the system level

System breakdown structure is essential for System Availability modelling

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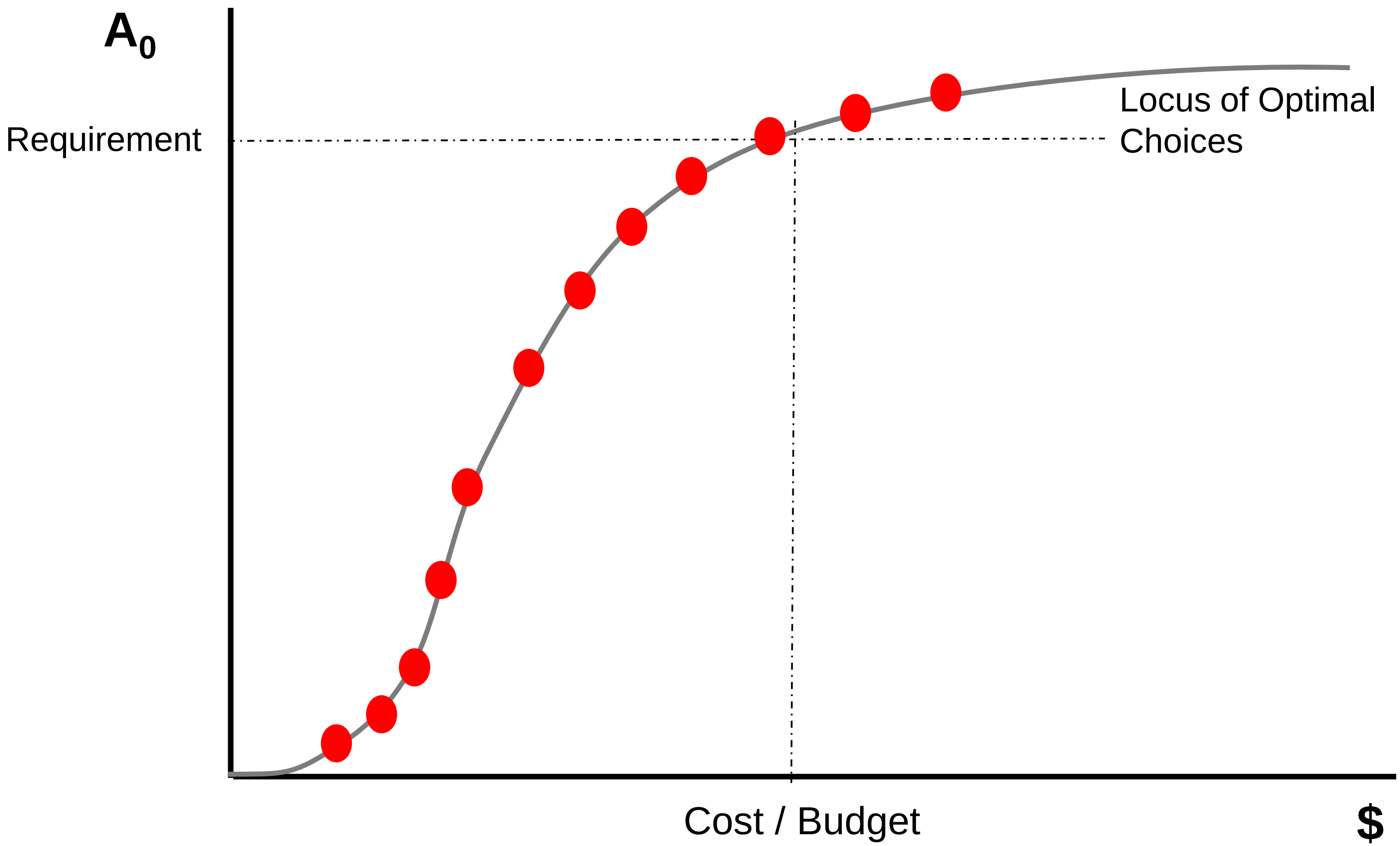
Spares Optimisation
Marginal Analysis



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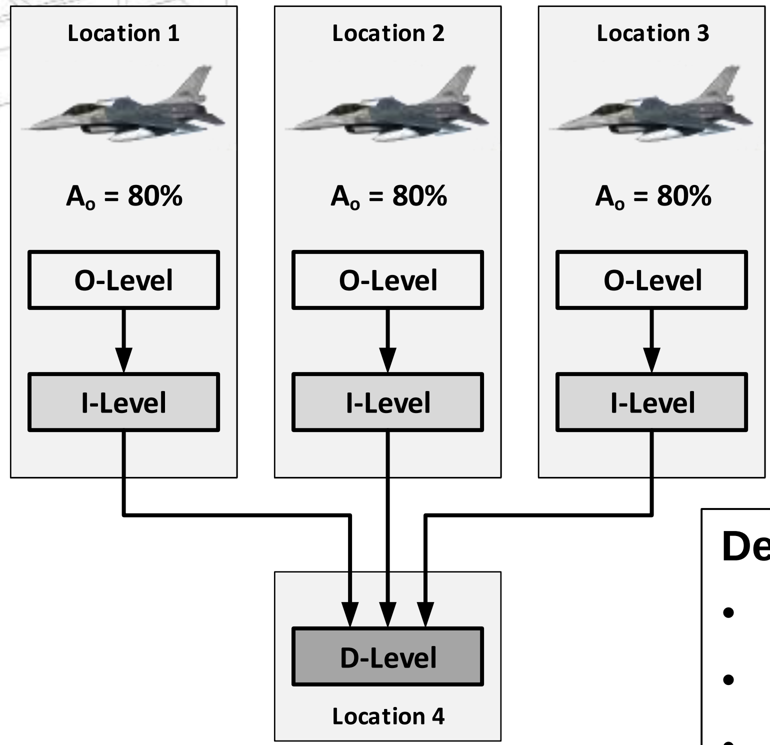
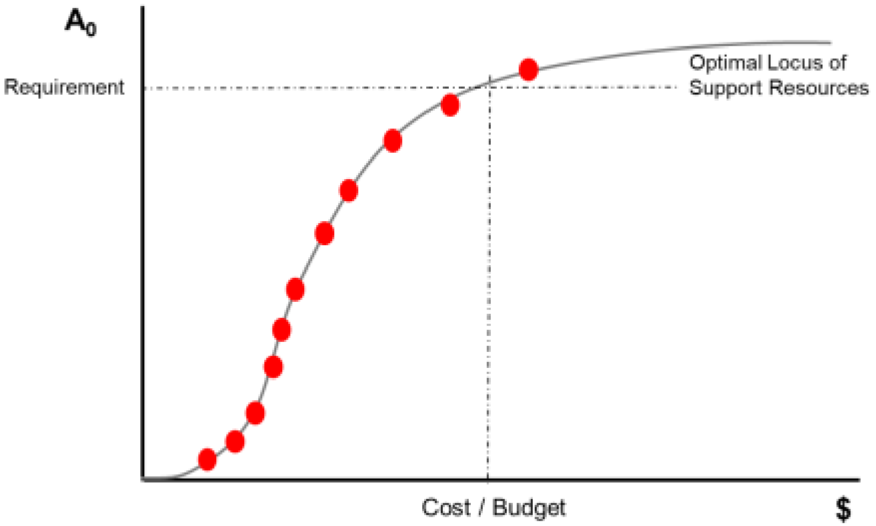
How to Set Optimal Spares Budgets
Single System, Multiple Locations





Defines the optimal spares list and cost

- To deliver the required A_o
- At each level of maintenance
- At each location

Tempo handles changing scenarios over multiple years

- Automated multiple runs to reflect changes over time
- Using a single model

Tempo identifies the optimal fleet spares & repairs budget allocation **for each year**

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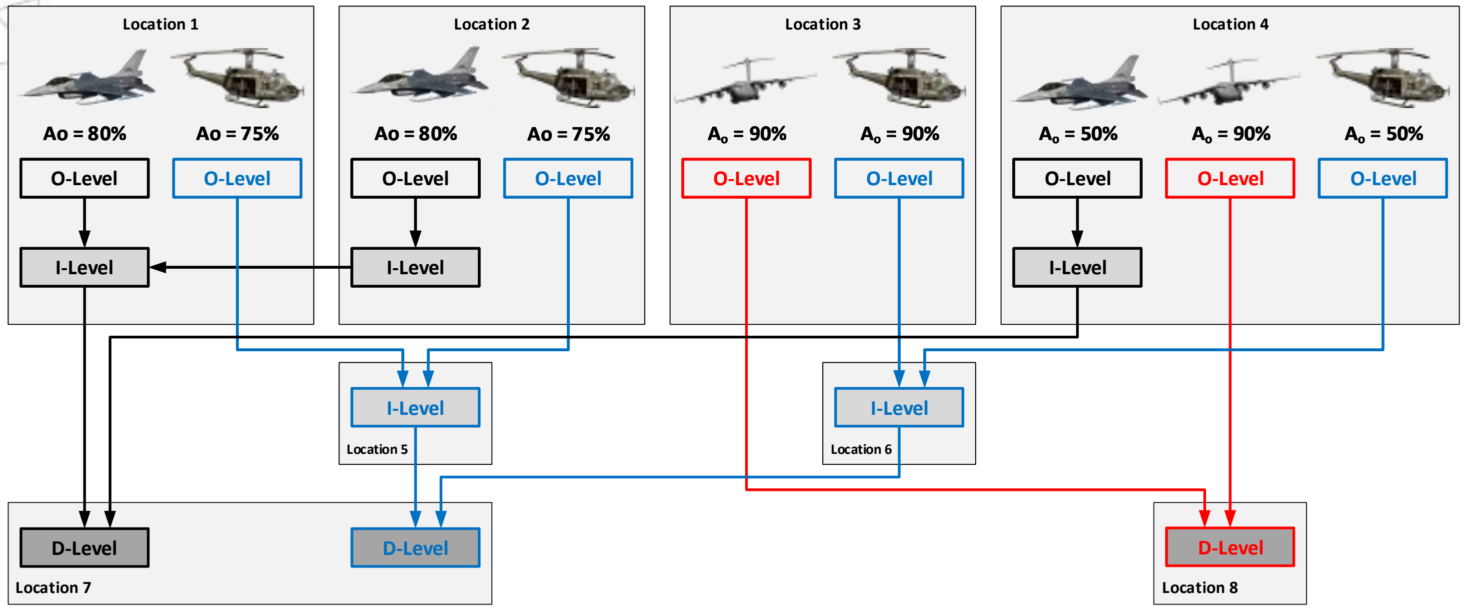
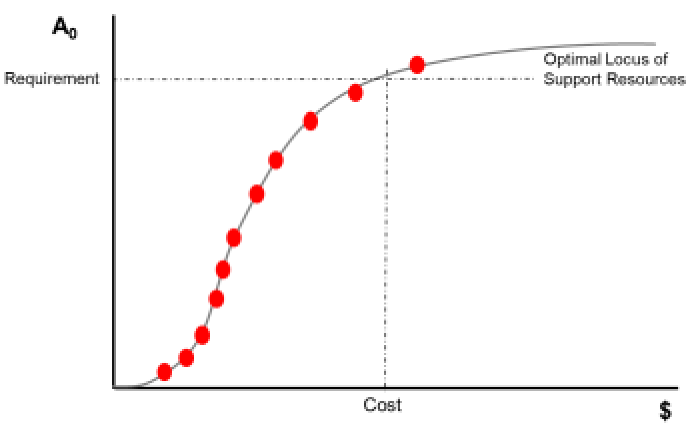
How to Set Optimal Spares Budgets

Multiple Systems, Multiple Locations, Multi-year





Defines budgets for each fleet's optimal spares

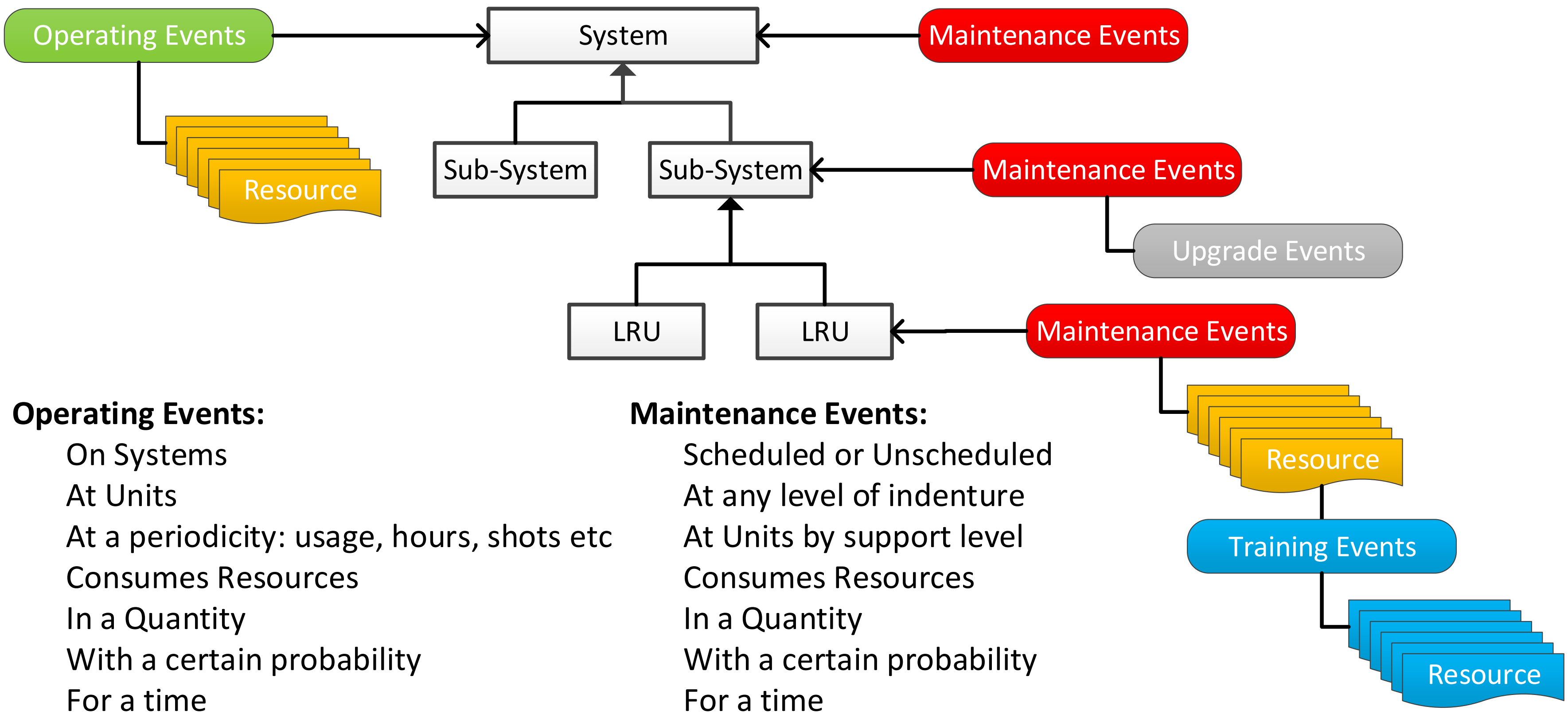
- To deliver the required A_o
- For each system
- At each maintenance level
- At each location

Tempo handles changing scenarios over multiple years

- Automated multiple runs to reflect changes over time
- Using a single model

Tempo identifies the optimal spares & repairs budget allocations **for each year across multiple fleets**

Life Cycle Costing & Multiple Resources
MAAP Operating & Maintenance Events



Operating Events:
- On Systems
- At Units
- At a periodicity: usage, hours, shots etc
- Consumes Resources
- In a Quantity
- With a certain probability
- For a time
- At a cost defined by the resource

Maintenance Events:
- Scheduled or Unscheduled
- At any level of indenture
- At Units by support level
- Consumes Resources
- In a Quantity
- With a certain probability
- For a time
- At a cost defined by the resource

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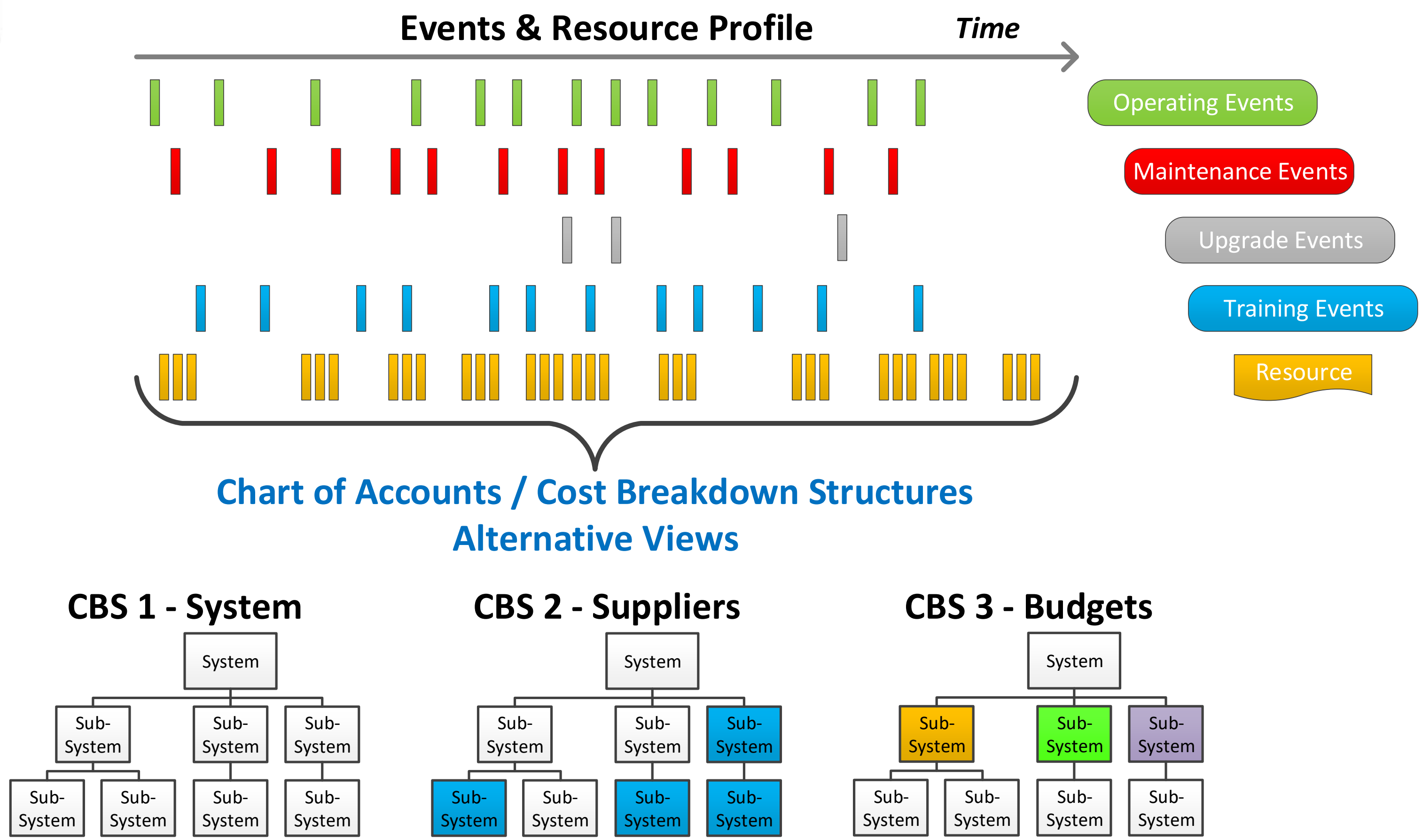
Life Cycle Costing & Multiple Resources
MAAP



An event-driven, activity-based 'adding engine' of 'cost atoms' to derive LCC
It handles automatically all the complex interactions of support

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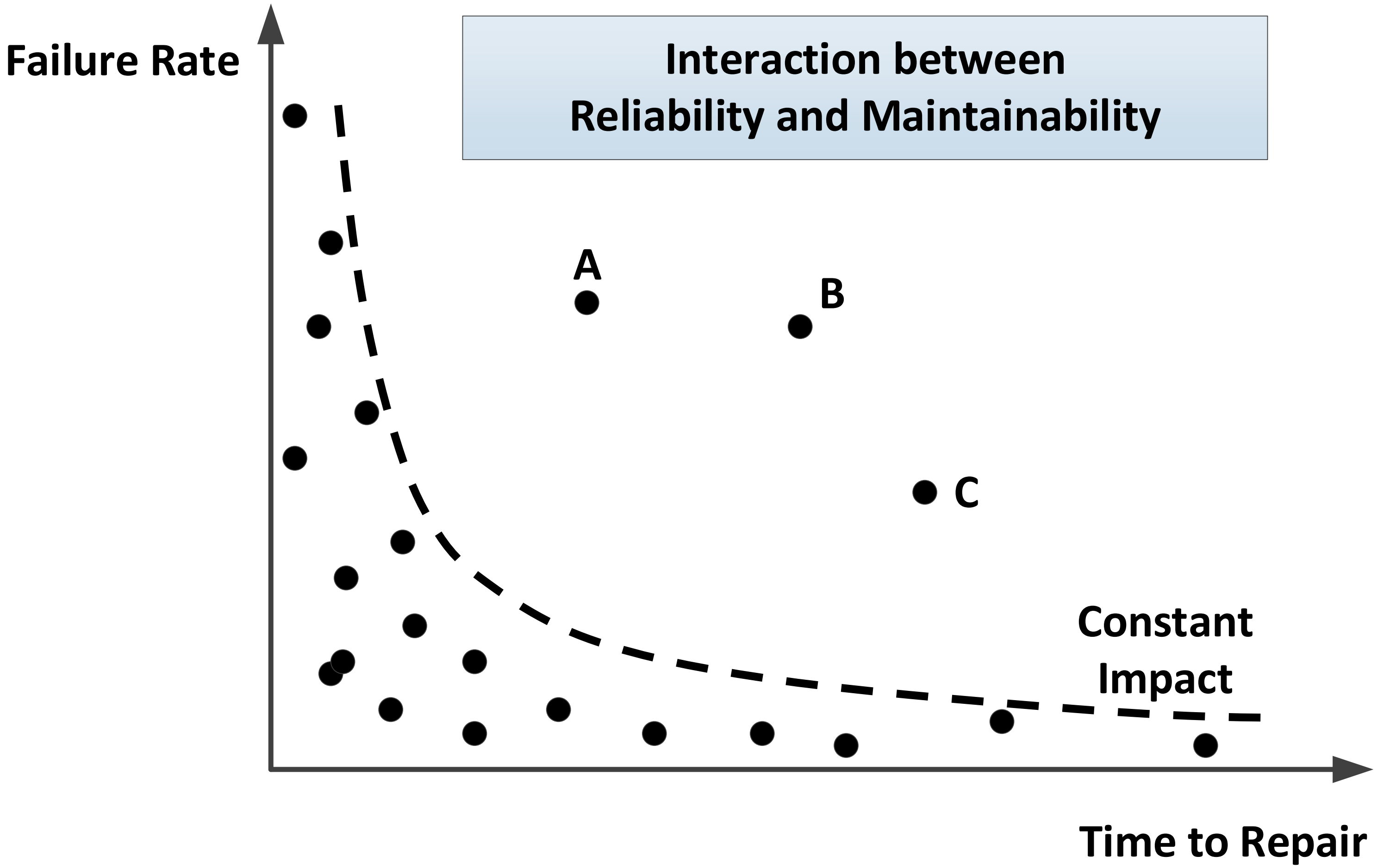

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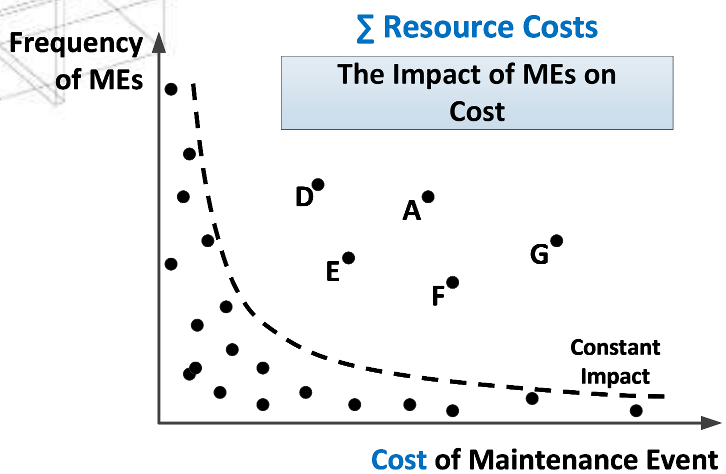
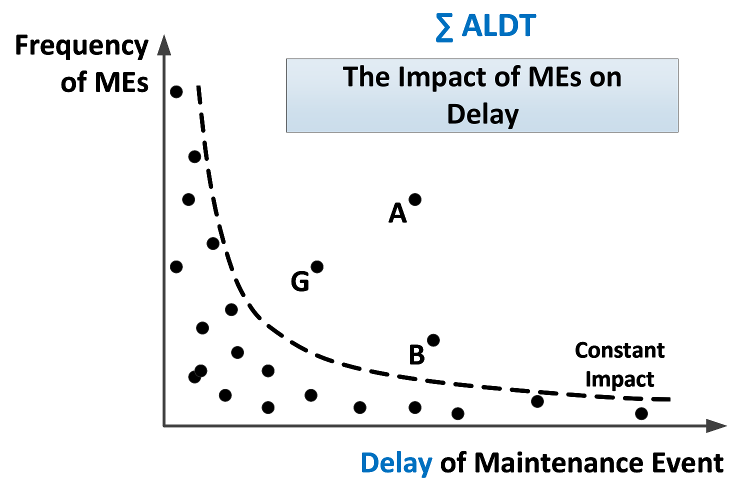
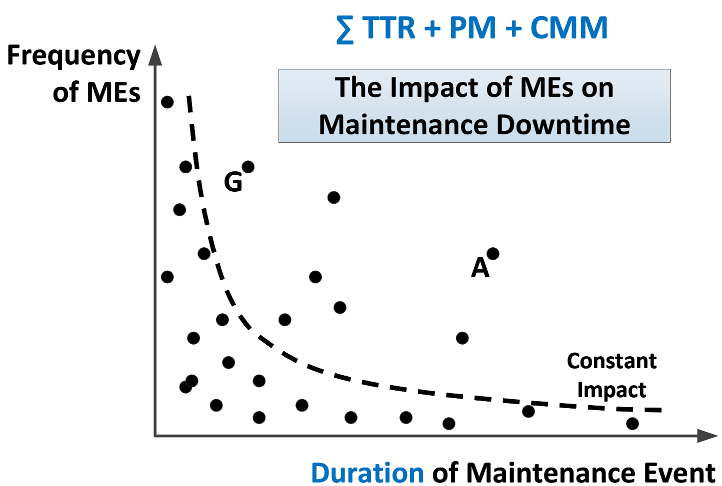
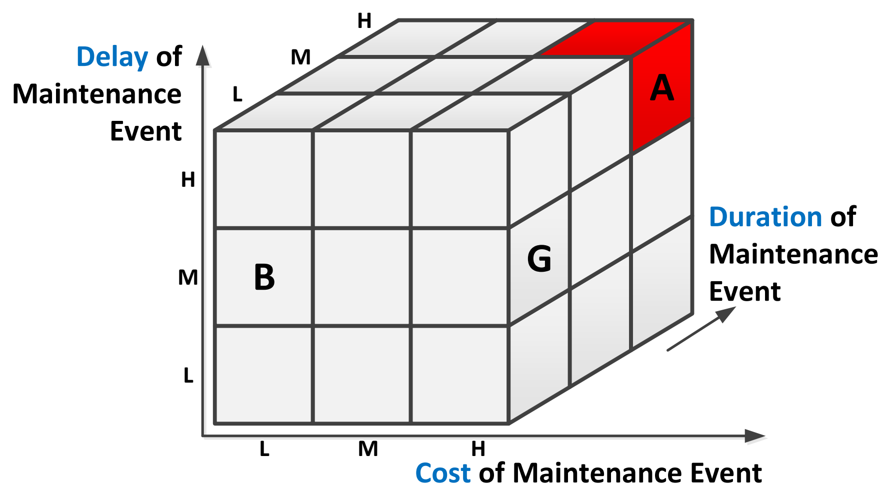
Supportability Audit
Identifying the Problems









$$A_0 = \frac{Uptime}{Uptime+Downtime} = \frac{MTBA}{MTBA + MTTR + PM\ Time + ALDT}$$

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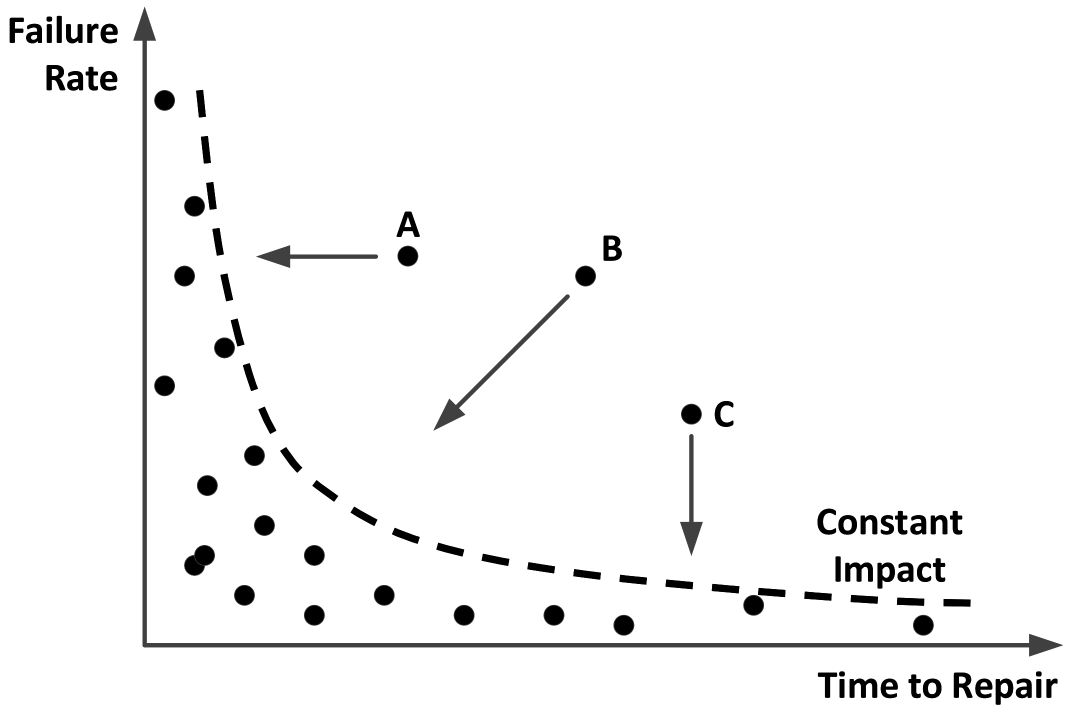
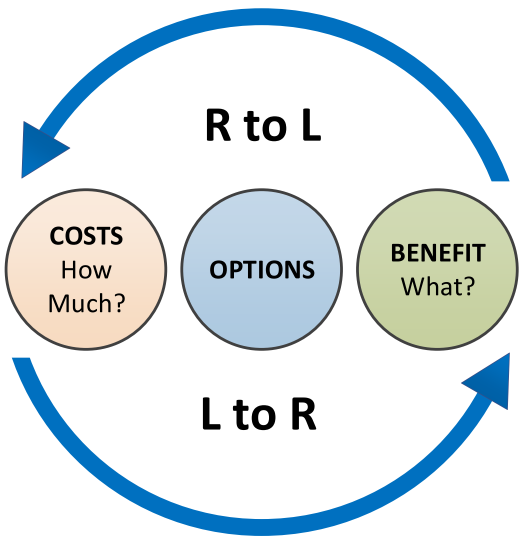
What is the impact on
cost, frequency, resources, duration and delays?





Compare previous System LCC with assumed future System LCC, and previous System Availability with Future System Availability, to derive potential cost and availability benefits

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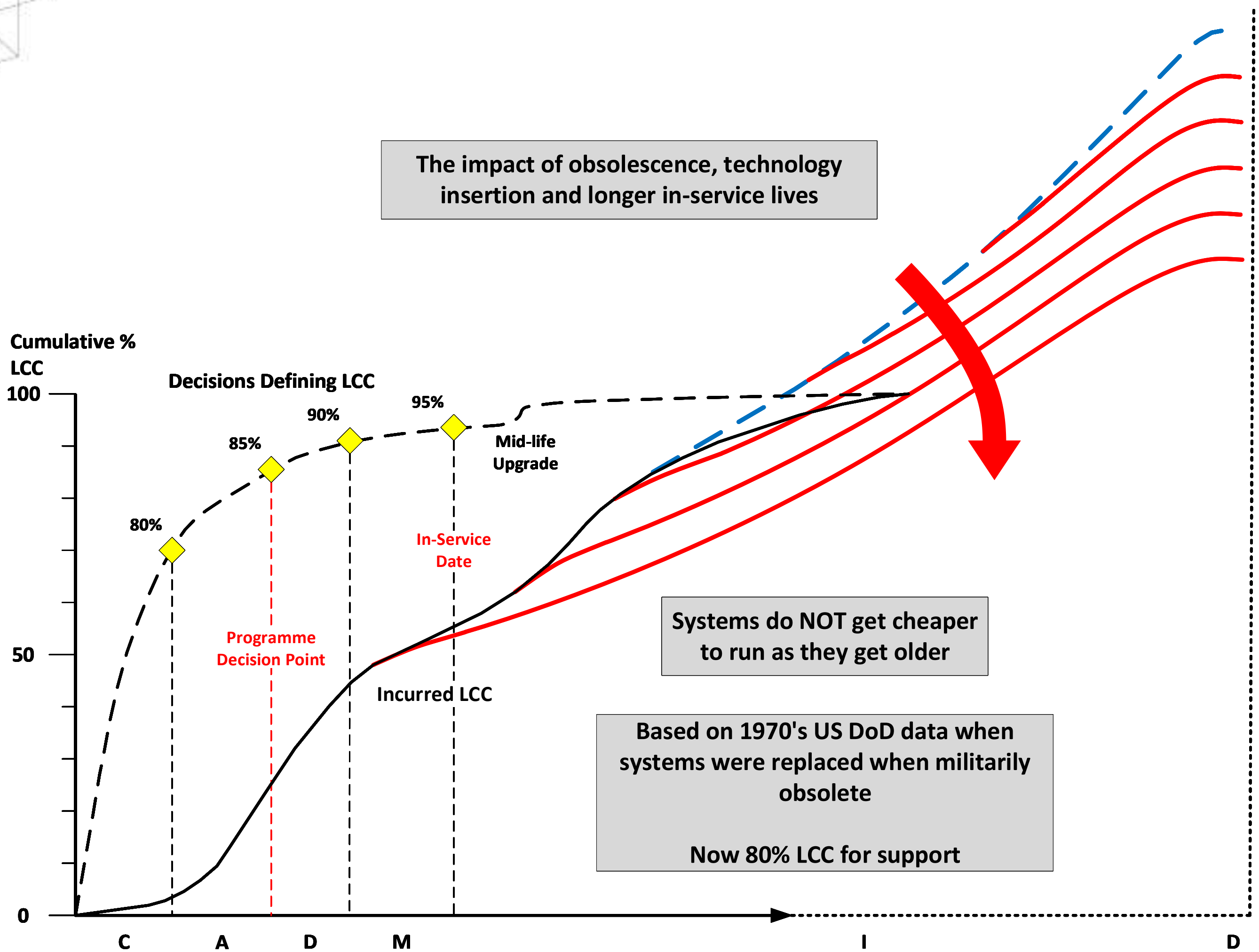
Supportability Audit
‘Bending the Cost Curve’



‘Bend the Cost Curve’ using ***Supportability Audit***

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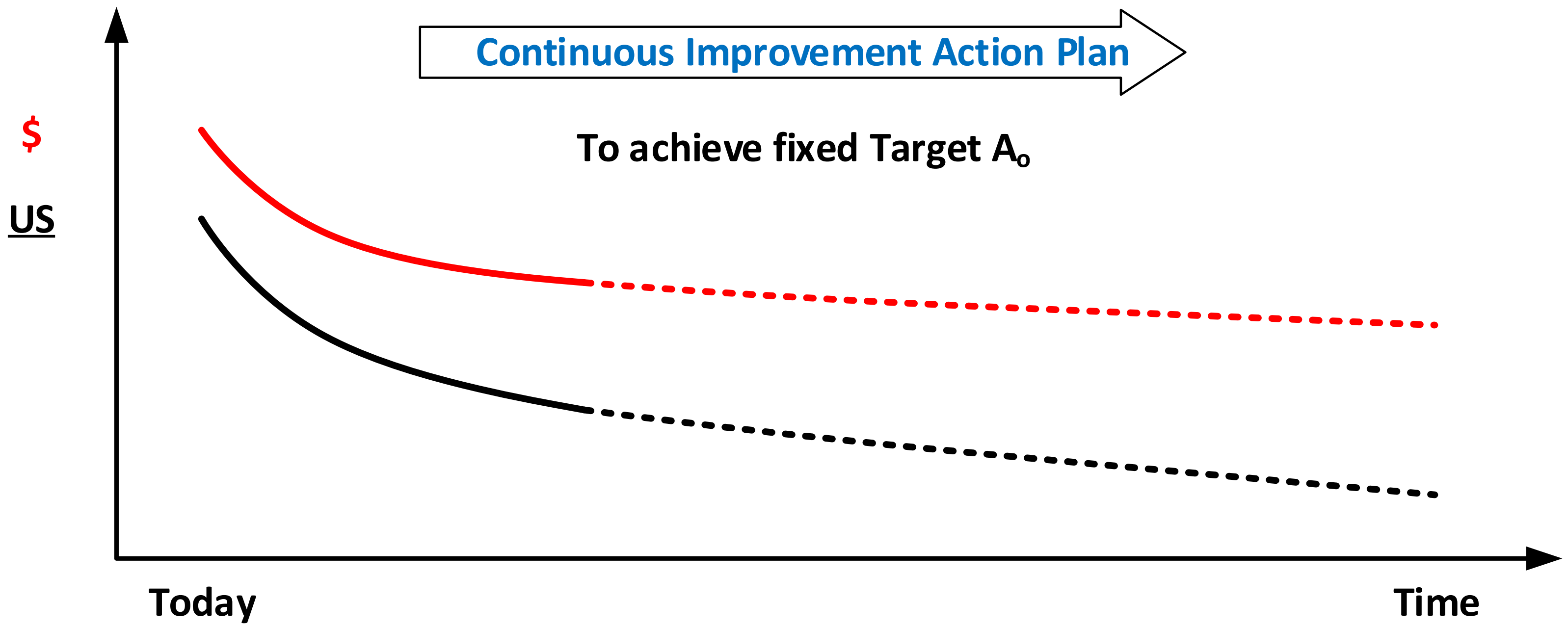
US is a single number metric for top-level management



Kaizen to progressively reduce both the cost of support and improve availability

Bend the Cost Curve to **Do More with Less** through **Smarter Ownership**

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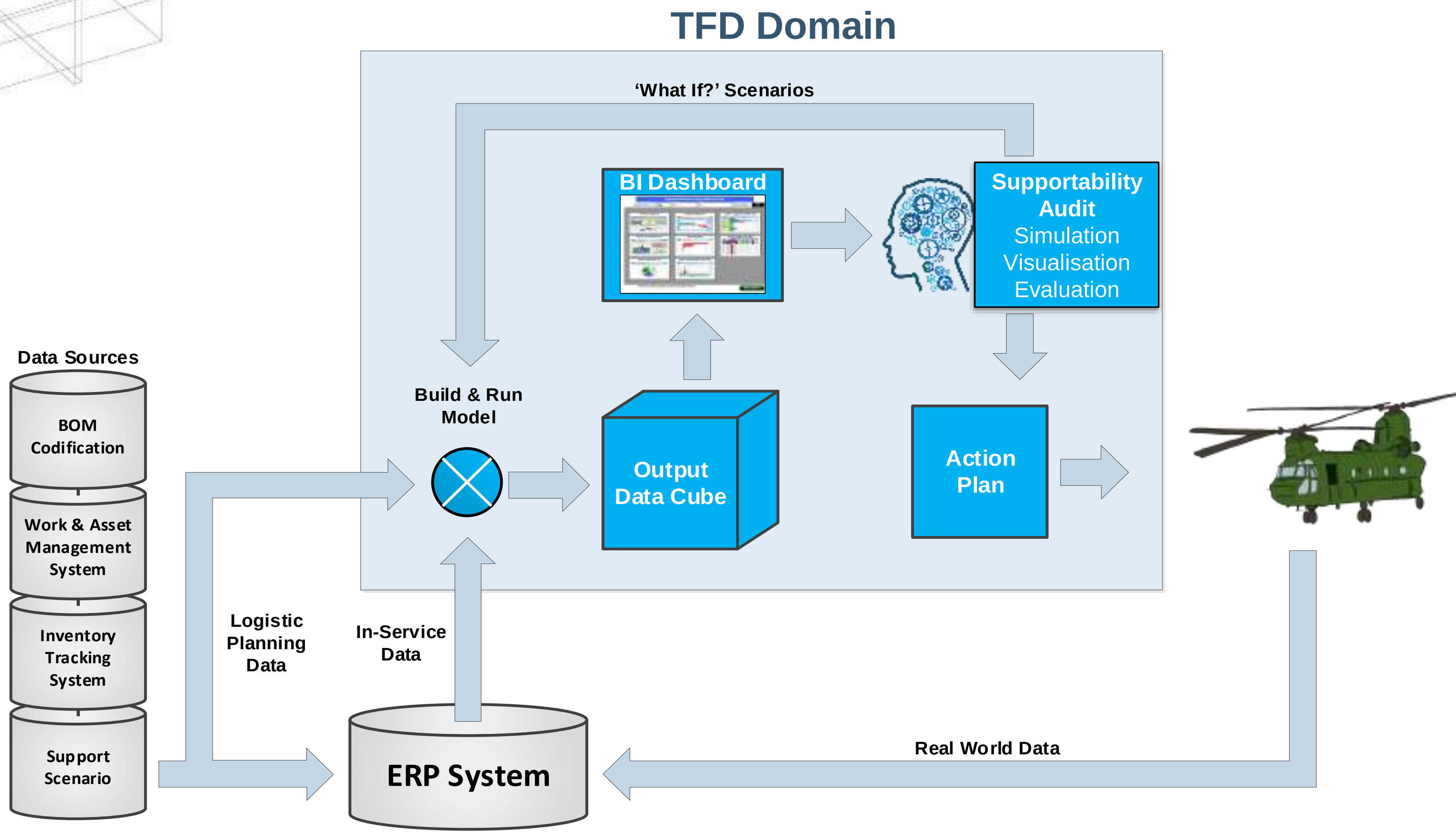
Through-life Modelling
Planning & Control



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Through-life Engineering Services (TES)

PAS280:2018

PAS 280:2018

Through-life engineering services – Adding business value through a common framework – Guide

Innovate UK

bsi.

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SA is a powerful analytical technique to find, assess and quantify the business case for significant support cost savings.

SA can be applied cost effectively to most, if not all, systems covering a wide range of environment, technology and maturity.

Extrapolating the benefits from these examples across Defence could make significant inroads into the cost of support.

SA requires a small investment to build the models.

A programme of SA projects will be better than self-funding.

Supportability Audit - Interrogate the Digital Twin

Do More, with Less through ***Smarter Ownership***

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UK
RAF Chinook CH47 Case Study

During Afghanistan & Iraq conflicts, severe pressure for greater output from RAF Chinook fleet for more flying hours (FH) on operations and for training.

RAF achieving 65 FH per aircraft per month on operations but only 40 FH in training compared with about 200 FH for civilian operators. Even setting aside obvious differences in the environment, considerable room for improvement.

Question - How to increase fleet flying from 12,500 FH to 16,500 FH, 18,500 FH and, eventually, to 21,000 FH?

Method

- Structured diagnostic interviews
- Data capture and analysis
- Build a model to test hypotheses
- Construct a coherent action plan

Potential for 39% more FHs

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UK
RAF Merlin Mk3/3A (EH101) Case Study

RAF Merlin Force only achieving 60% of flying task, without any complication of operations in Afghanistan.
62% fleet unserviceability with 38% awaiting resources.

- Manpower 17.9%
- Spares 12.8%
- Info 4.4%
- Crew 2.0%
- Weather 0.5%
- Tools & Test 0.4%

Shortage of resources impeding management efficiency

Question - How to increase fleet achievement to achieve annual task?

Method

- Structured diagnostic interviews
- Data capture and analysis
- Build a model to test hypotheses
- Construct a coherent action plan

Potential for 32% more FHs and 13% more Serviceable aircraft

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UK
British Army and Royal Navy Lynx Case Study

British Army and Royal Navy operated a fleet of 160 ageing Lynx helicopters in 4 variants in the battlefield utility, anti-armour, search and rescue and anti-submarine warfare roles.

Rapidly increasing support costs.

Transition to the successor was unaffordable.

MOD Proof of Concept contract to demonstrate that support modelling & analysis could deliver a minimum Return on Investment of 10:1

- What costs could be reduced with minimum impact on availability?
- Identify potential problems in transition from the old to the new aircraft

Two sets of models - ***spares optimisation*** & ***through-life support costs*** – showed that:

- Spares holdings had been over-provisioned by £70M
- Reducing current inventory value by £70M would reduce A_o by only 0.4%
- Current stock of Main Rotor Gearbox was 66 whereas optimal stock was only 27
- Immediate savings of £1M made by halting purchase of 2 MRGBs each costing £500K

Study demonstrated savings greatly exceeding 10:1 Return on Investment

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RAF Sentinel - Airborne Stand-Off Radar Surveillance

Raytheon proposed a top-up spares buy of £88M to supplement existing stock of £33M

Shadow spares modelling reduced estimate to £3.5M

Army Apache – Attack Helicopter

Westland Helicopters estimated life cycle cost for 25 year contract at £450M

Shadow modelling reduced estimate by £110M - 25%

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US Air Force
B-2 Spirit

Despite supplier achieving the logistic KPIs in a PBL contract, B-2 Spirit weapons system A_o was unsatisfactory.

Only 28% A_o achieved against 85% required

Question – How to improve A_o whilst keeping the supplier incentivised under PBL?

Poor performance was partly attributed to conflict and interaction between KPIs which drove wrong behaviours.

To inform re-negotiations, TFD evaluated KPI regime at the higher contract level to identify commercial ‘sweet spots’ for customer and contractor, and identify risk margins.

Using simulation based on MAAP data models, TFDE derived new contract KPI framework for an acceptable balance between A_o requirements and supplier incentivisation

‘Happy System’ not **‘Happy Shelves’**

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RAF Puma Mk1 – Support Helicopter

Supportability Audit to identify potential support shortfalls and opportunities for improvement

- Number of aircraft on both 230 Sqn & 33 Sqn reduced by 3 aircraft but the total flying task was maintained at each unit; each aircraft flew more sorties
- Fleet operational availability (A_o) target increased from 75% to 80%
- Maintenance staff to receive either additional training, or maintenance procedures improved, to reduce maintenance task durations by 15%
- Suppliers to improve production lead times (PLTs) on first time demands by 15%
- Suppliers to deliver a price challenge of 15% challenge on purchase and repair prices
- RCM-based review of maintenance policy to reduce frequency of all unplanned corrective maintenance by 15%

Potential cost savings of £5.6M or 23% of annual costs
AND 5% increase in availability delivering same task with 6 fewer aircraft

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Tgb 14/15 – Utility Support Vehicle

Supportability Audit to identify potential support shortfalls and opportunities for improvement.

Tgb 14/15 is a fleet of 347 vehicles used only in training and fully supported by Mercedes. The basic Geländewagen is a very mature vehicle that has been in production for 36 years. More than 200,000 have been built.

- Vehicle utilisation was low and up to 70 vehicles could have been placed in storage reducing maintenance costs by 11% while meeting availability levels and driving an additional 2,750Km.
- Despite the maturity, issues were identified with:
    - Air filter – this was traced to incorrect item identification data which was driving excessive and wasteful procurement
    - Central locking system which was an acknowledged intermittent system fault. The Audit quantified the cost enabling FMV to press Mercedes for a solution.

Potential savings of £250K over 10 years - 2.7% of annual costs, 11% less maintenance meeting availability targets using 70 fewer vehicles

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Sweden Tgb 360
Supportability Audit

Tgb 360 – Armoured Terrain Vehicle

Tgb 360 is a new fleet of 113 Armoured Fighting Vehicles of 4 variants built by Patria, supported by FMV and operating from 2 bases in Sweden.
As a new vehicle with little in-service data available, this SA set a modelling baseline while identifying current weaknesses and potential areas for improvement.

Issues identified included:

- Maintenance policy review by location and interval identified potential to reduce resources by 8% with a PM cost reduction of 2%.
- Data quality review revealed errors and omissions in the contractor's maintenance data that identified the risk of system under-performance and erroneous procurement.
- Major materiel cost drivers review identified the need and benefit of modifying 2 additional items.

Confirmed majority of key support metrics but identified annual cost savings of >2% on SEK 29M. Protected A_o by identifying key data errors

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PBL BCA

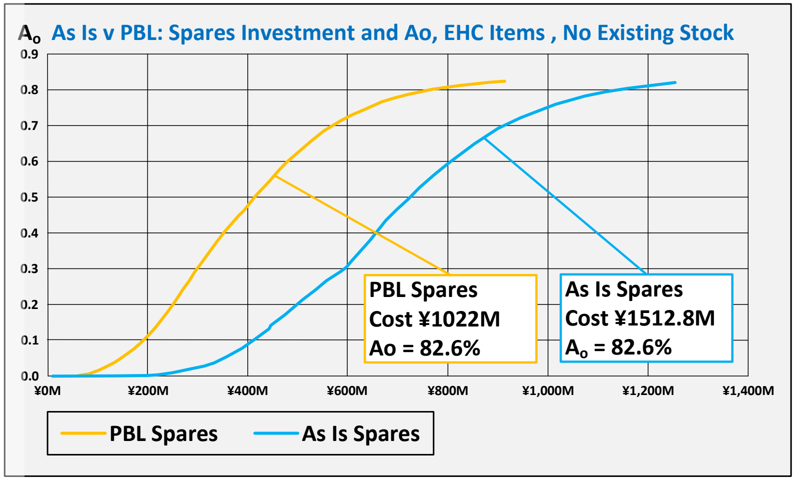
TH-480B – Basic Training Helicopter

TH-480B is the JGSDF's basic training helicopter. Japan wish to adopt PBL to increase A_o at reduced cost.

JGSDF GSO tasked TFD with an independent Business Case Analysis of a bidder's proposal.

TFD used VMetric and EDCAS models to quantify the spares investment and annual costs for repairs and consumption

- PBL could save approx ¥329.3M (20%)
- Cost within budget providing both VFM and Affordability but analysis showed that:
  - Spares scale proposed by bidder would be inadequate
  - Savings could be achieved with a different optimal spares scale
  - Potential for further 5% saving by performing a review of the repair policy for Discard items



Subject to changes identified through TFD's analysis, PBL could yield savings of approximately ¥411.6M representing 25% of current spares and MRO budgets

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FMV Sweden
MAAP Models

Tgb 14 – Utility Support Vehicle

Mercedes Geländewagen

Tgb 15 – Utility Support Vehicle

Mercedes Geländewagen

Tgb 16 – Utility Support Vehicle

BAE Systems

Tgb 360 – Armoured Modular Vehicle

Patria

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FMV Sweden
MAAP Models

CV 90 – Armoured Modular Vehicle

Hägglunds and Bofors

Strv 122 – Leopard Main Battle Tank

Krauss-Maffei

Hkp 10 - Puma EC 225 Helicopter

Eurocopter

Hkp 14 – NH90 Helicopter

Eurocopter

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FMV Sweden
MAAP Models

CB 90 – Fast Patrol Boat

Dockstavarvet

BV 410 – Amphibious Vehicle

BAE Systems Hägglunds

Tp 84 – C130 E/H Transport Aircraft

Lockheed

C130J – Transport Aircraft

Lockheed Martin

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Design for Supportability Centre of Excellence

D4S COE

Design for Supportability Centre
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Exploitation of Asset Data

Including implementation MBSE, digital twin, data science, predictive & condition-based monitoring

Augmenting the Hu

Including robotics, co-botics, AR simulation

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TFD GROUP

TOOLS FOR DECISION

QUESTIONS ?

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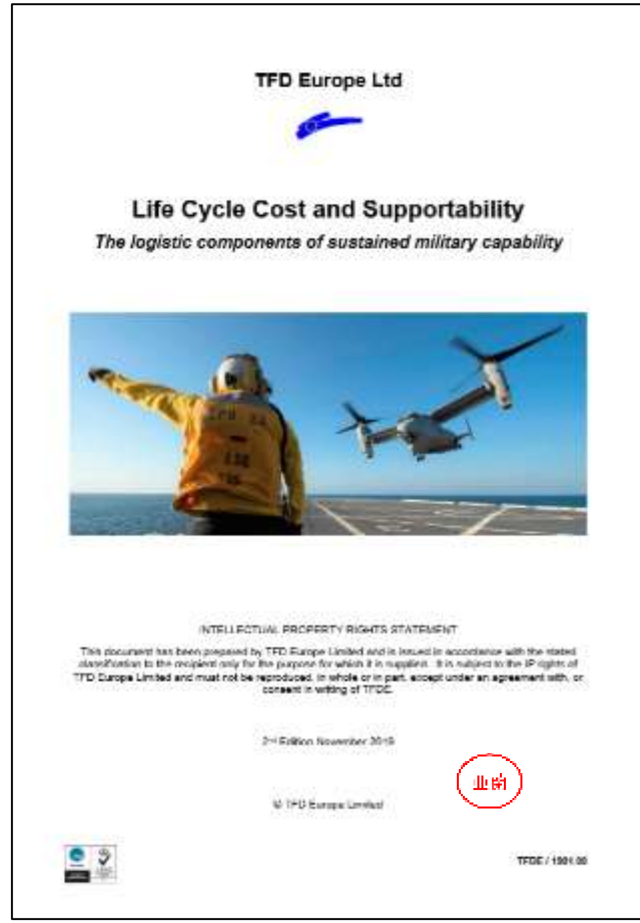
TFD Europe Ltd

Life Cycle Cost and Supportability

The logistic components of sustained military capability

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