Cost of Software Obsolescence Resolution of Real-Time Software

09/10/2019

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The QinetiQ Team

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Estimating Manager- Cyber, Information and Training

- ICEAA Certified Cost Estimator / Analyst with the Parametric Specialism (ISPA)
- Chairman and member of the board of the Society for Cost Analysis and Forecasting (SCAF)
- Fellow of Defence Equipment and Support, MoD, UK
- Recipient of the ICEAA Technical Achievement of the year 2017 award
- Member of EPSRC Centre of Innovative Manufacturing (Through Life Engineering Services, Cranfield University)

Publications:

- More than 30 publications in National, International, Scientific Journal papers
- Supported in the development of modules for ICEAA Software CEBoK
- Contributor to a study undertaken by Institute for Defence Analysis (US DoD) sponsored by Defence Logistics Agency (DLA, DoD) on Obsolescence titled " A Research and Development Investment Portfolio for Diminishing Manufacture Sources and Material shortages"

5

5 fundamental mobile phone technologies including Touch Screen and Liquid Crystal Displays (LCD) developed by QinetiQ experts

12

12 Empire Test Pilot School students have become astronauts including Major Tim Peake

3 secs

Every 3 seconds a Boeing aircraft takes off or lands that has been tested in QinetiQ's low speed Wind Tunnel

40

40 organisations, including the Royal Navy involved in 6 weeks of operations during the Unmanned Warrior Exercise

50+

including 50+ unmanned vehicles operating in the air, land and sea

We are QinetiQ

85+
locations woldwide

1,300+
patents (including 300+ pending)

£833m
FY2018 revenue

6,000+
people with unique science and engineering expertise

1,850km

1,850km of the TANAP pipeline will be protected by OptaSense®

16

Our Ocean Basin in Gosport, UK contains enough water to fill 16 Olympic swimming pools

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Agenda

1	Research Aim
2	Definitions
3	Introductions
4	Software Obsolescence Cost Analysis Framework
5	Software Obsolescence Resolution Cost Optimization Model
6	Summary
7	Conclusion

Software Obsolescence

Research Aim

Research Aim

"To develop a cost analysis framework to estimate the cost of Software Obsolescence Resolution of a bespoke real-time software in defence and aerospace"

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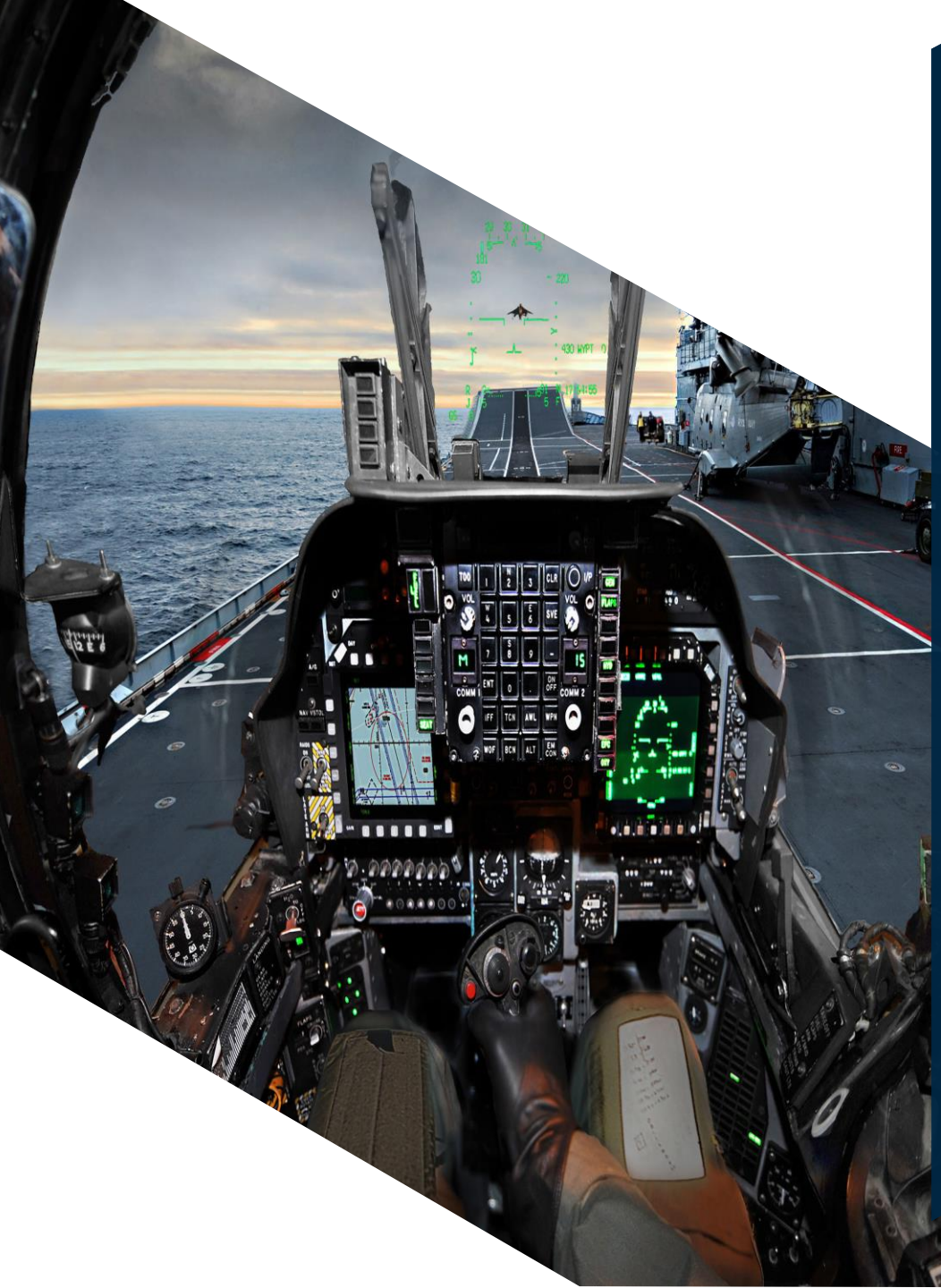

Software Obsolescence

Definitions

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Software Obsolescence Definitions

Software Obsolescence is defined as “ what happens when the original and authorised third party ceases to provide support with regular update, upgrade, fixes or due to the changes in target or operating environment, systems or hardware which makes the software unusable”

-S Rajagopal et al; (2014)

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Software Obsolescence vs Software Maintenance

Software Maintenance	Software Obsolescence
Bug fixes	Replacement of entire application if need be to a new one
To address fault/Failures, security patches etc.	To address the issues with the application in totality
Maintenance is the review of the stored files to ensure they are still useable	Solves unavailability of fixes, licenses, permission and upgrades
Software maintenance takes care of the current versions to ensure that its up and running and meeting the requirements	Software Obsolescence management looks forward the industry standards and other software to continue supportability of the software
Maintenance deals with the upgrading the software to enhance capability	Obsolescence management deals with enforced changes in the environment

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Software Obsolescence

Introduction

- Text

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Introduction

The need for a Software Obsolescence Cost Analysis Framework

Software Obsolescence Cost Analysis Framework

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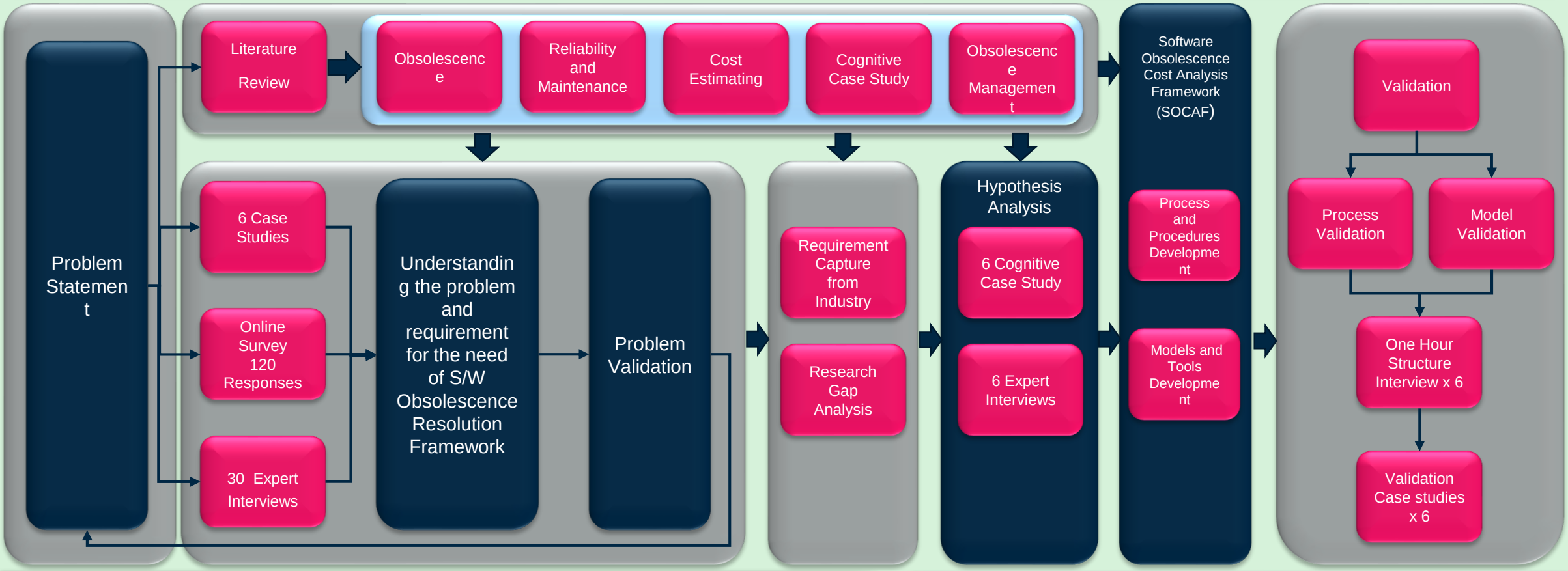
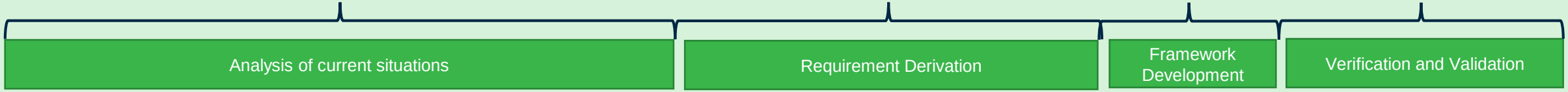
Software Obsolescence Cost Analysis Framework

Following process was undertaken to develop the Framework

Research Methodolgy





Software Obsolescence Cost Analysis Framework

The framework has the following attributes

- This framework is in its final iterations.
- This framework's foundation is based on the Literature Searches, Case Studies, Online Survey results, SME Interviews and Cognitive Case Studies.
- This framework has several attributes that can be mapped across from and to, to the software estimating principals.
- This framework looks at the Cost Risk and Uncertainty.

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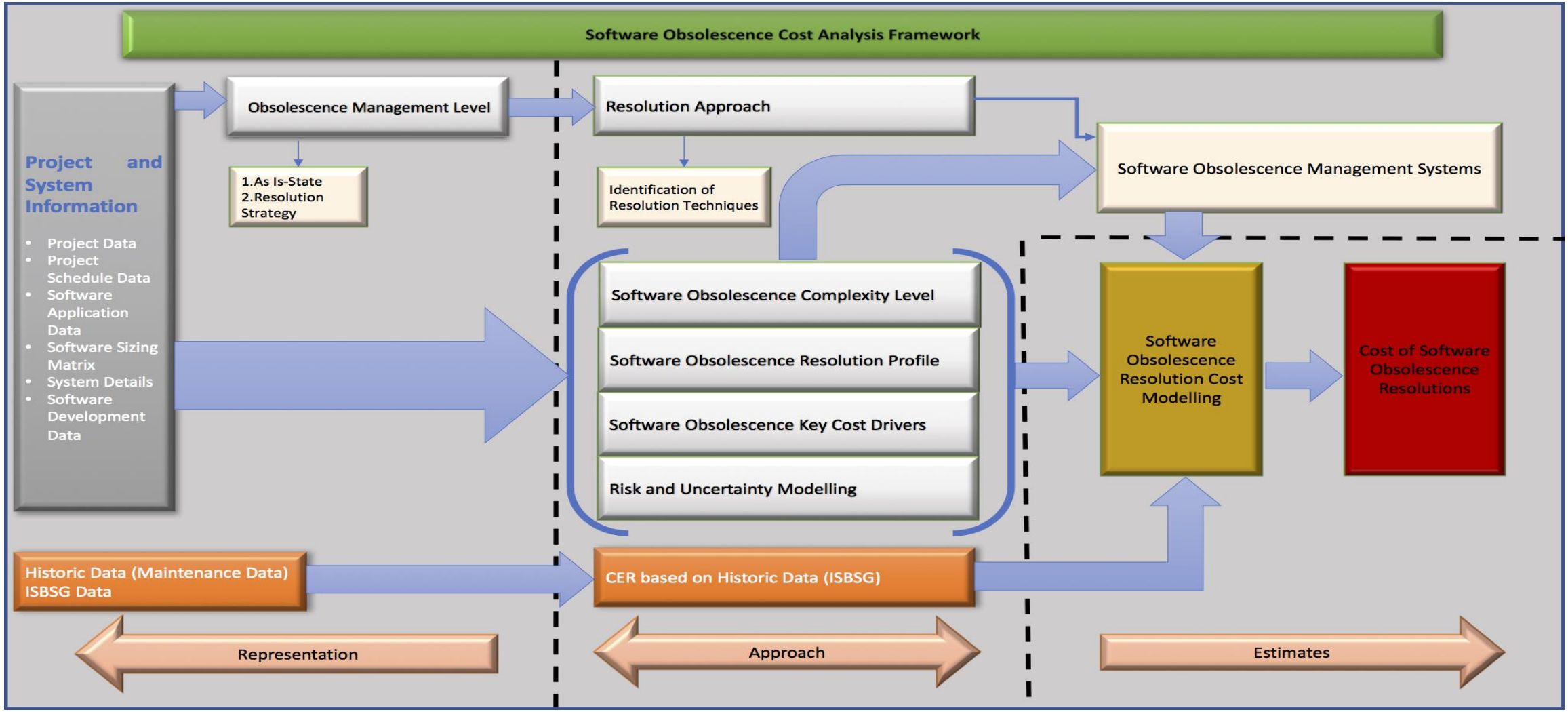
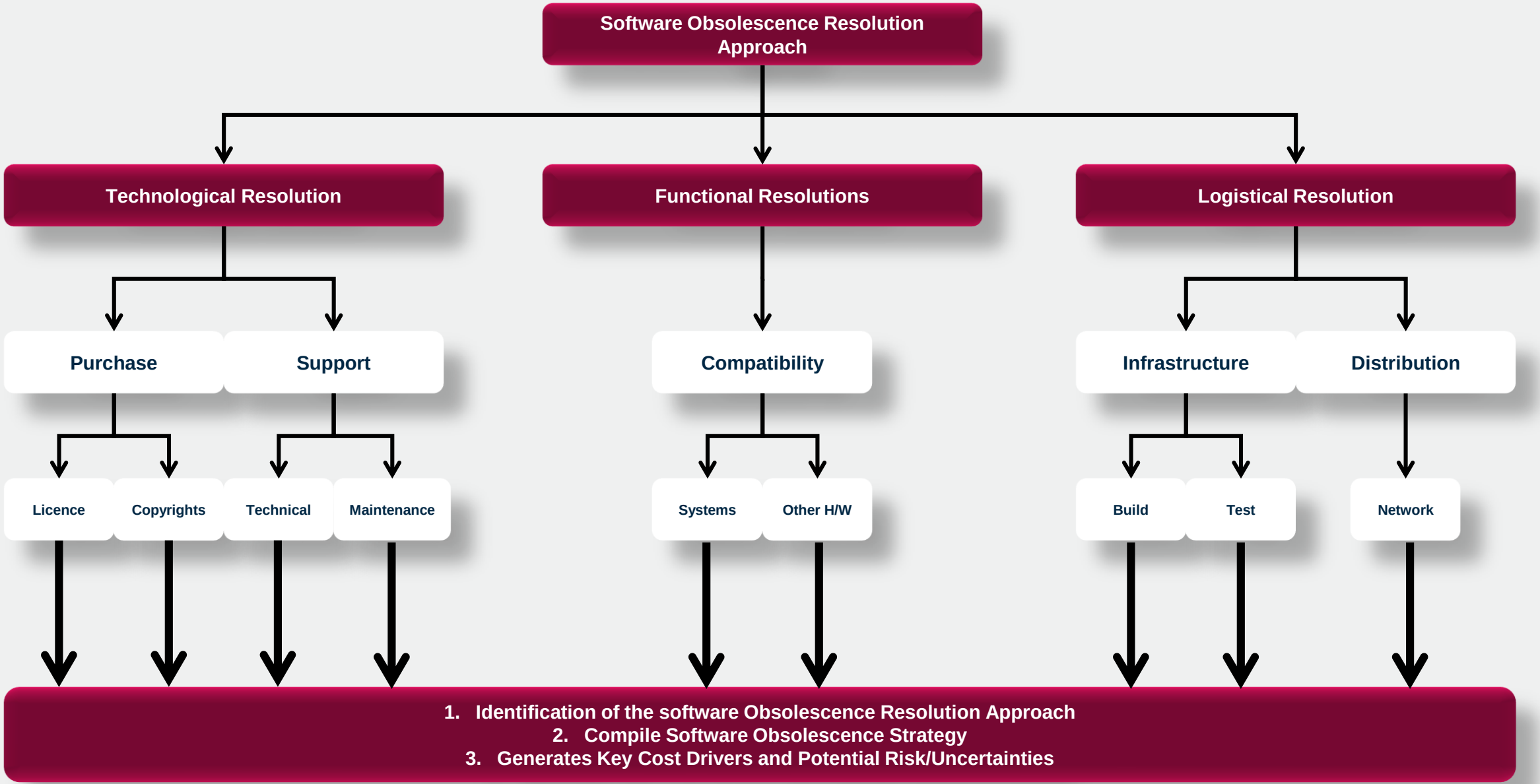
Software Obsolescence Cost Analysis Framework





Software Obsolescence Management Level

Reactive----------Transitions----------Proactive

S/W Obs Mgt Level 1	S/W Obs Mgt Level 2	S/W Obs Mgt Level 3	S/W Obs Mgt Level 4	S/W Obs Mgt Level 5
• Deal with Software Obsolescence Reactively • No Obsolescence Management Strategy • Freeze and do nothing • CMMI Level 1 • Low TOMCAT Score	• No Software Obsolescence Management Strategy • Reactive but dealing with Software Obsolescence by reverse engineering and code conversion • CMMI Level 2 • Low TOMCAT Score	• Deploy software Obsolescence Monitoring process or tool if available • Monitoring software Supply Chain • Monitoring skills and technological insertions • Deploy software Obsolescence professional • Monitoring software Obsolescence Proactively • CMMI Level 3 • Medium TOMCAT Score	• Deploy S/W Obs Mgt Strategy • Proactive Mgt of update, upgrade and migration • Employ and deploy appropriate skills in-house • Mgt of Software Supply Chain and monitoring any technology insertions • Escrow agreement in place or third party partnership in place • CMMI Level 4 • Medium TOMCAT Score	• Proactive Mgt of S/W Obs • Deploy effective Mgt of S/W Obs Mgt Strategy • Continuous Monitoring of S/W Obs • Management of S/W obsolescence as BAU • Considering software Obsolescence at the design and development stages • CMMI Level 5 • High TOMCAT Score

Software Obsolescence Complexity Level

Proactive ---------- Reactive

High Complexity

- Custom Software
- Real Time Software
- Custom Middleware
- Custom Glue Code
- Safety Critical Software
- High Requalification and testing requirement
- Require high end hardware
- Single Source
- Low Reliable suppliers
- Machine Code, 1st and 5th generation language
- No backward or forward compatibility
- Not easy to emulate

Medium Complexity

- Medium level of requalification and testing
- Non Safety Critical Software
- 2nd and 3rd generation language
- Readily available but requires minor re-design
- Easy to adapt
- Easy to emulate

Low Complexity

- Standard software
- Standard middleware
- Low requalification and testing requirement
- 4th generation language
- Readily available
- Backward and Forward compatible

High Risk Software ---------- Low Risk Software

Software Obsolescence Key Cost Drivers

Key drivers are determined by the following

- The resolution approach
- The level of integration (these are both software to software and software to hardware integration)
- Software/System multipliers
- Type of platforms
- Testing and requalification
- Level of modification required

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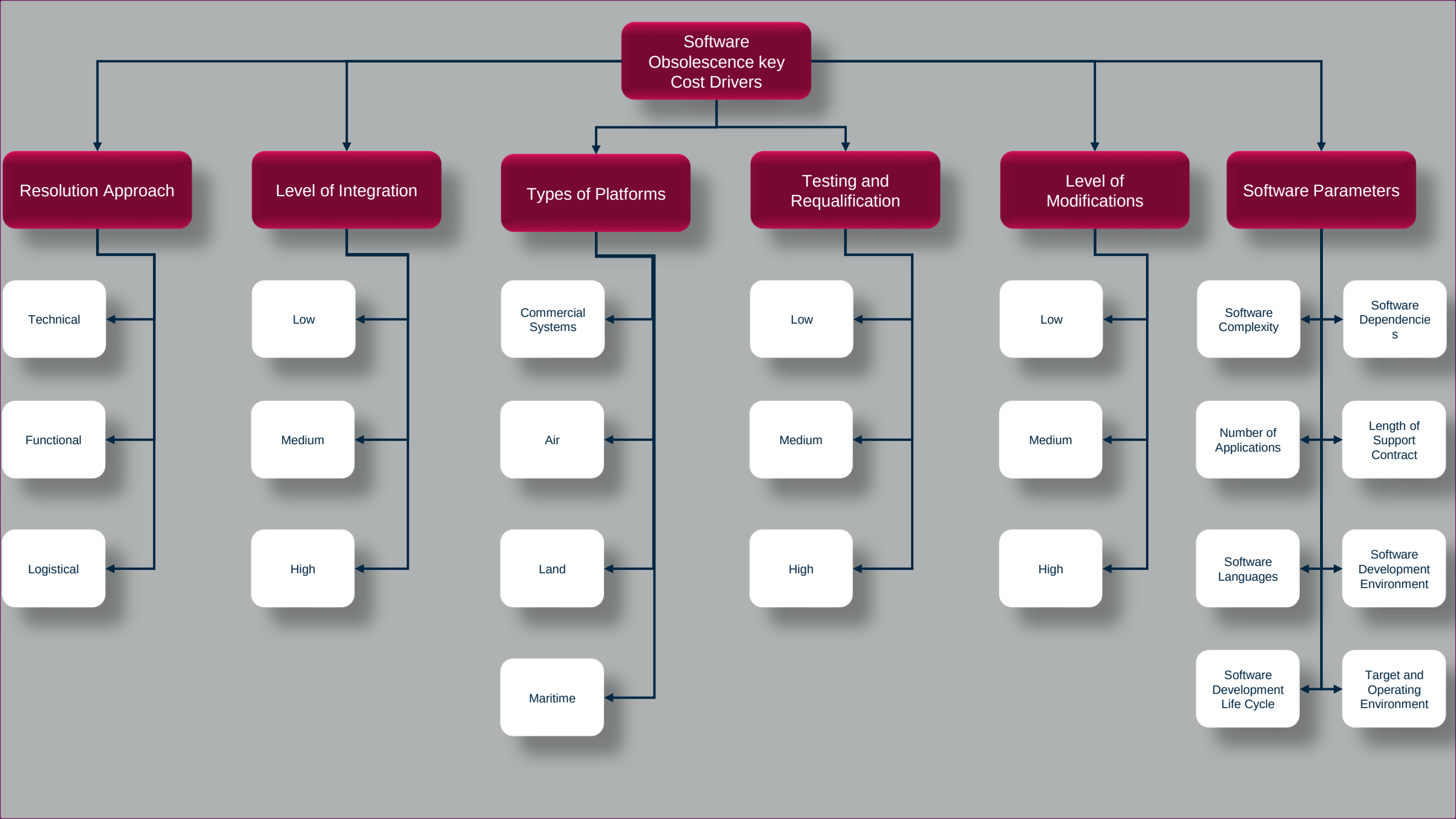
Software Obsolescence key Cost Drivers
Resolution Approach
Technical
Functional
Logistical
Level of Integration
Low
Medium
High
Types of Platforms
Commercial Systems
Air
Land
Maritime
Testing and Requalification
Low
Medium
High
Level of Modifications
Low
Medium
High
Software Parameters
Software Complexity
Software Dependencies
Number of Applications
Length of Support Contract
Software Languages
Software Development Environment
Software Development Life Cycle
Target and Operating Environment

Software Obsolescence and Maintenance

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Types of Software Maintenance

There are four different types of Software Maintenance. (from ISBSG)

- Perfective Maintenance: - Perfective maintenance is the modification of a software application, after delivery, to improve performance or maintainability
- Preventative Maintenance: - The modification of a software application after delivery to detect and correct latent faults in the software product before they become effective faults
- Corrective Maintenance: - The reactive modification of a software product performed after delivery to correct discovered problems.
- Adaptive Maintenance: - Enhancements necessary to accommodate changes in the environment in which a software product must operate

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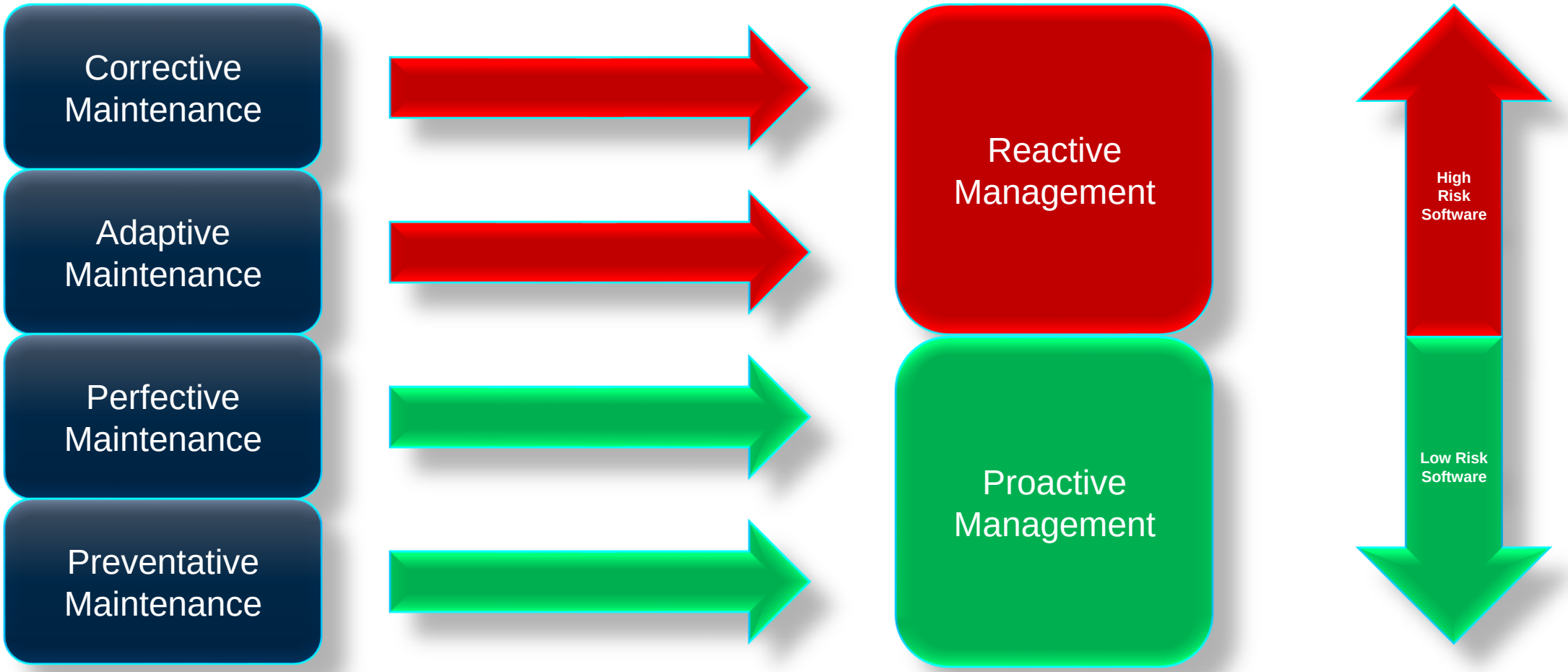
Maintenance Vs Obsolescence



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Case Study – Software Maintenance Vs Software Obsolescence

- On Software with larger applications, about 95% of the time is spent on corrective maintenance.
- This indicates that more time is spent on reactive management of the software.
- In order to reduce software obsolescence, more time should be spent on preventive and perfective maintenance.

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Software Obsolescence Resolution Cost Optimisation Model (SRCOM)

- Text

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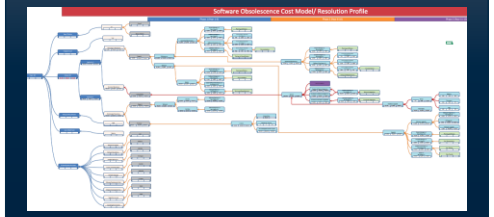
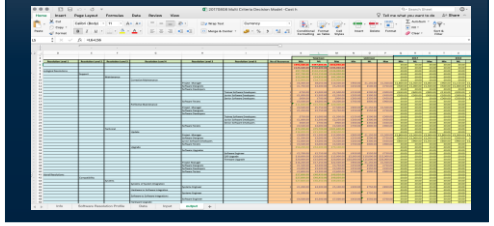
Integration of all the Models

Software Obsolescence Data Collection Form

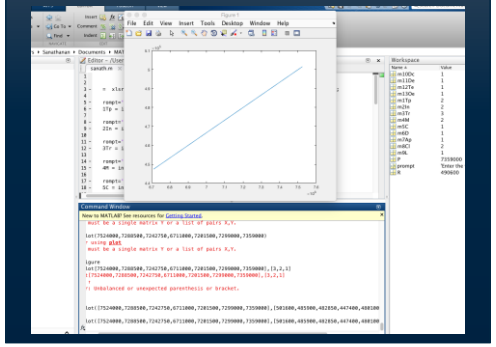
Software Obsolescence Resolution Model



Software Obsolescence Resolution Cost Model



Software Obsolescence Optimization Model



Optimized Through Life Resolution Profile with Cost

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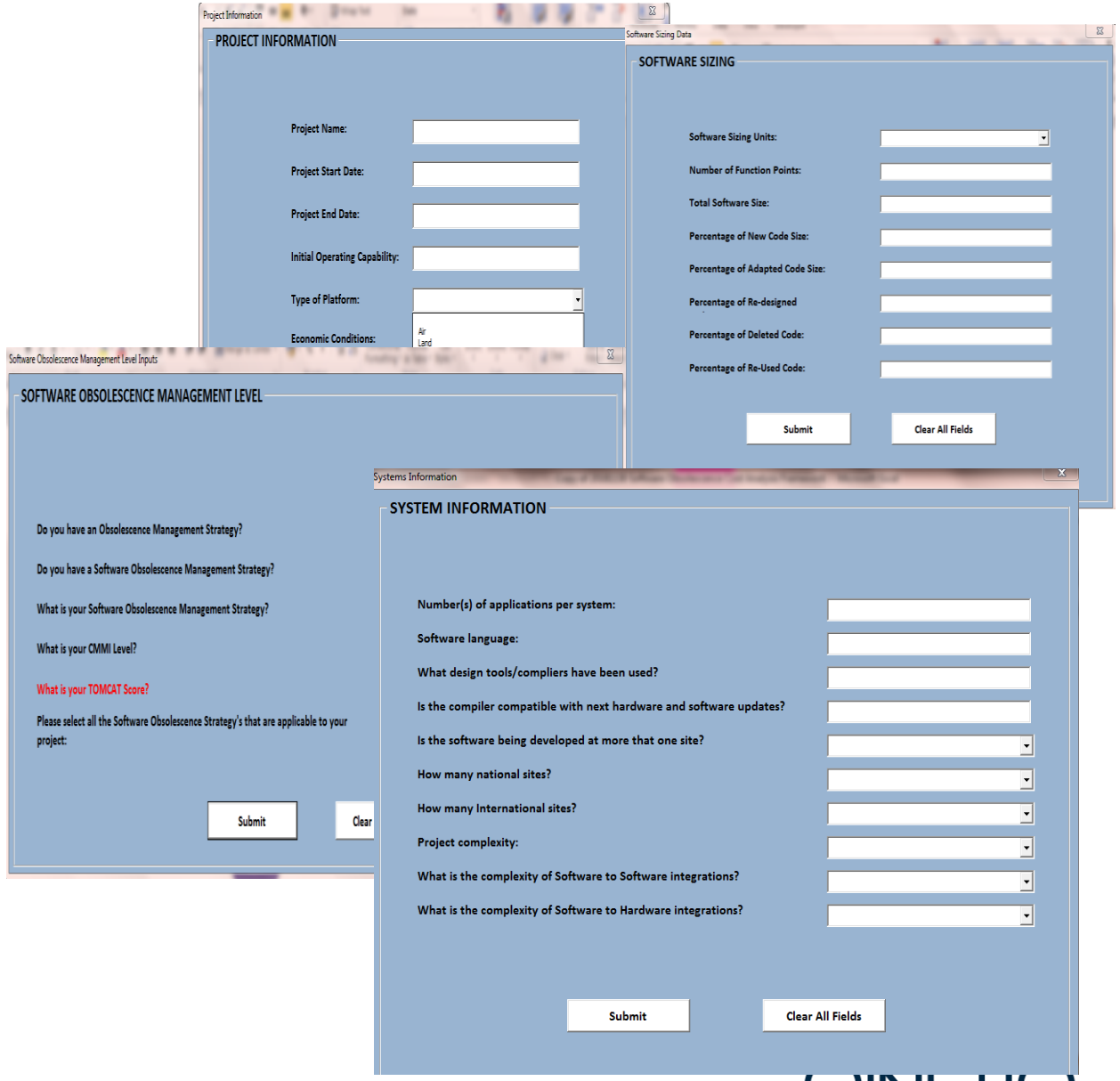
Model build ups

- The model is in three parts
  - Data Collections
  - Resolution model
  - Cost model /Optimisation Model

- The data collection form is based on the back of the literature review, case studies, expert interviews and cognitive case studies.
- There is about 150 questions been asked on these forms.
- High level validation on these questions have been undertaken by,
  - Cross checking these with the outputs from Case studies and online surveys
  - Questions were send out to the Software Project managers in QinetiQ



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Software Obsolescence Resolution Cost Optimisation Model (SRCOM)

- This model will recommend the best resolution approach based on the cost
- Optimisation is undertaken using MatLab Optimisation toolbox
- This model is at a very early stages of its development and
- This methodology involve diagrammatical representation of the cost
- Diagram represents decompositions of cost from output node through successive levels to individual inputs nodes
- This decomposition is the focus of the diagram and technique
- The diagram will be converted into a set of inputs and calculations
- Each nodes have inputs (Min, ML and Max)

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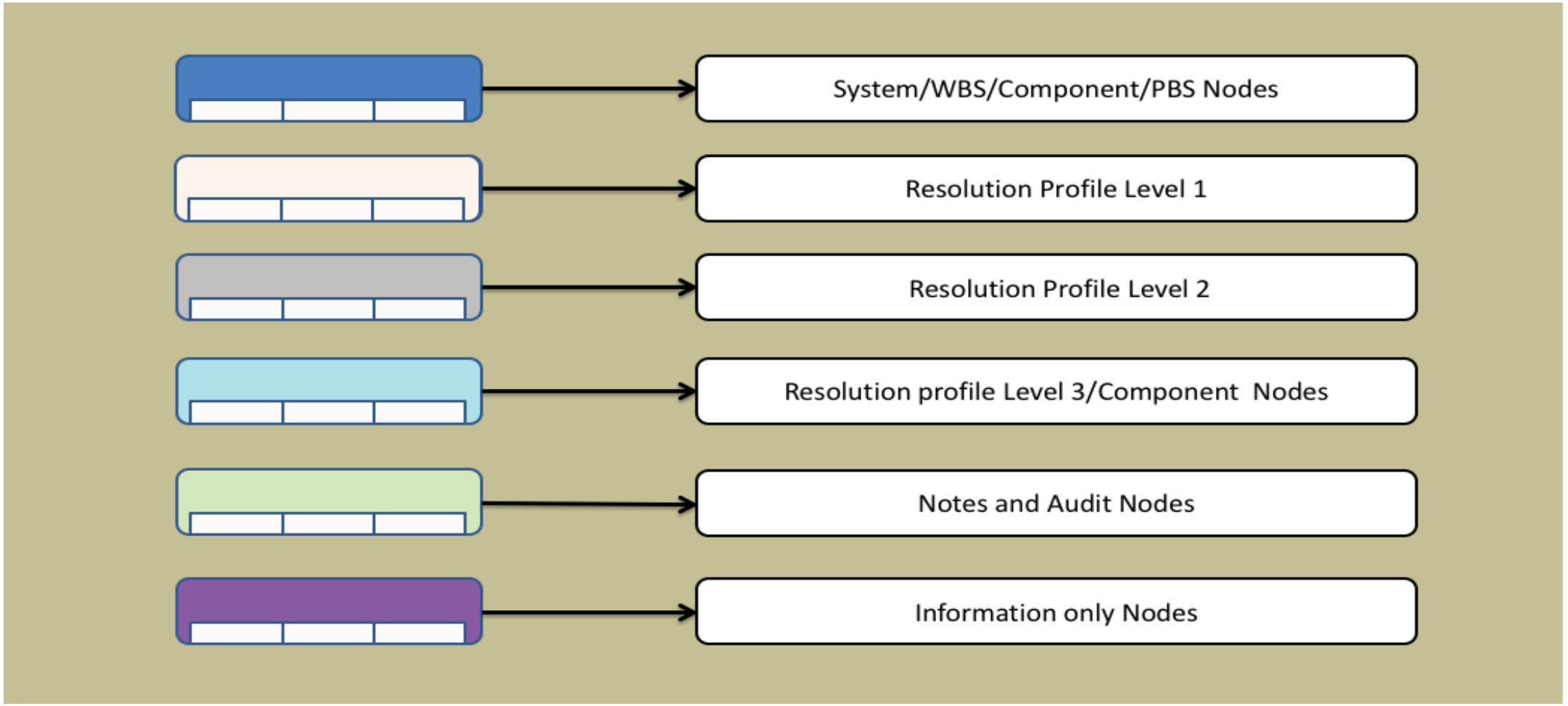
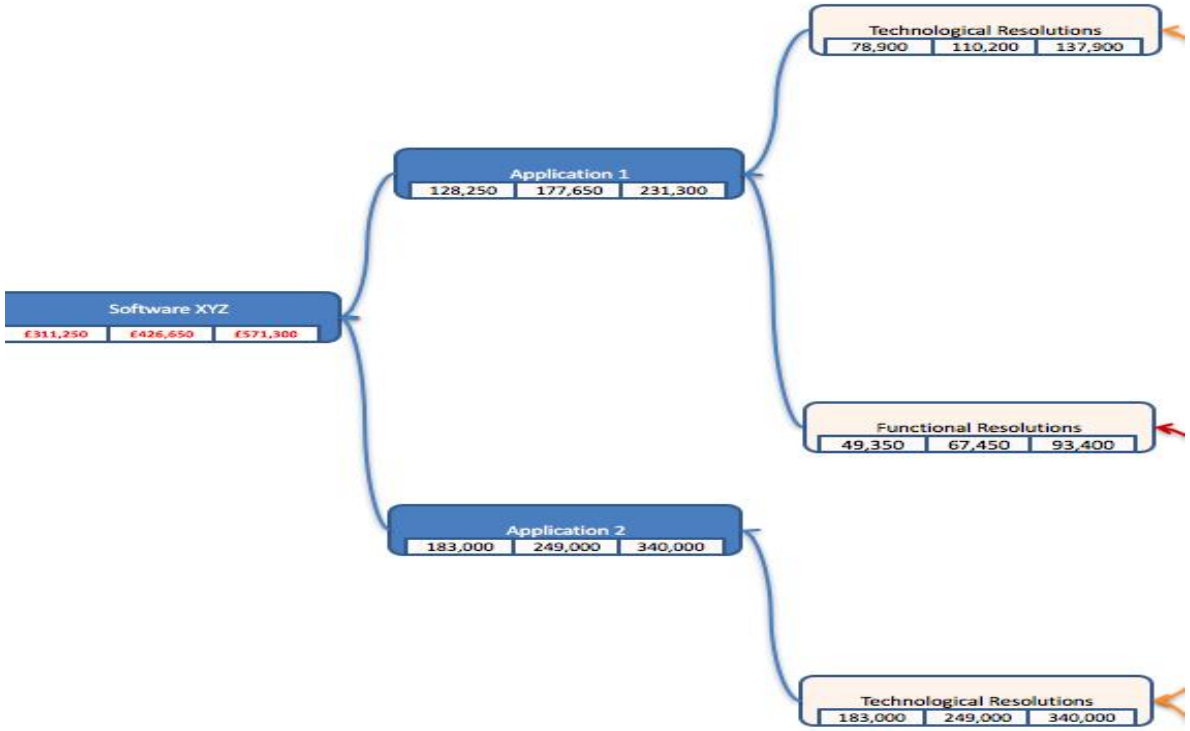
Software Obsolescence Resolution Cost Optimisation Model - Nodes



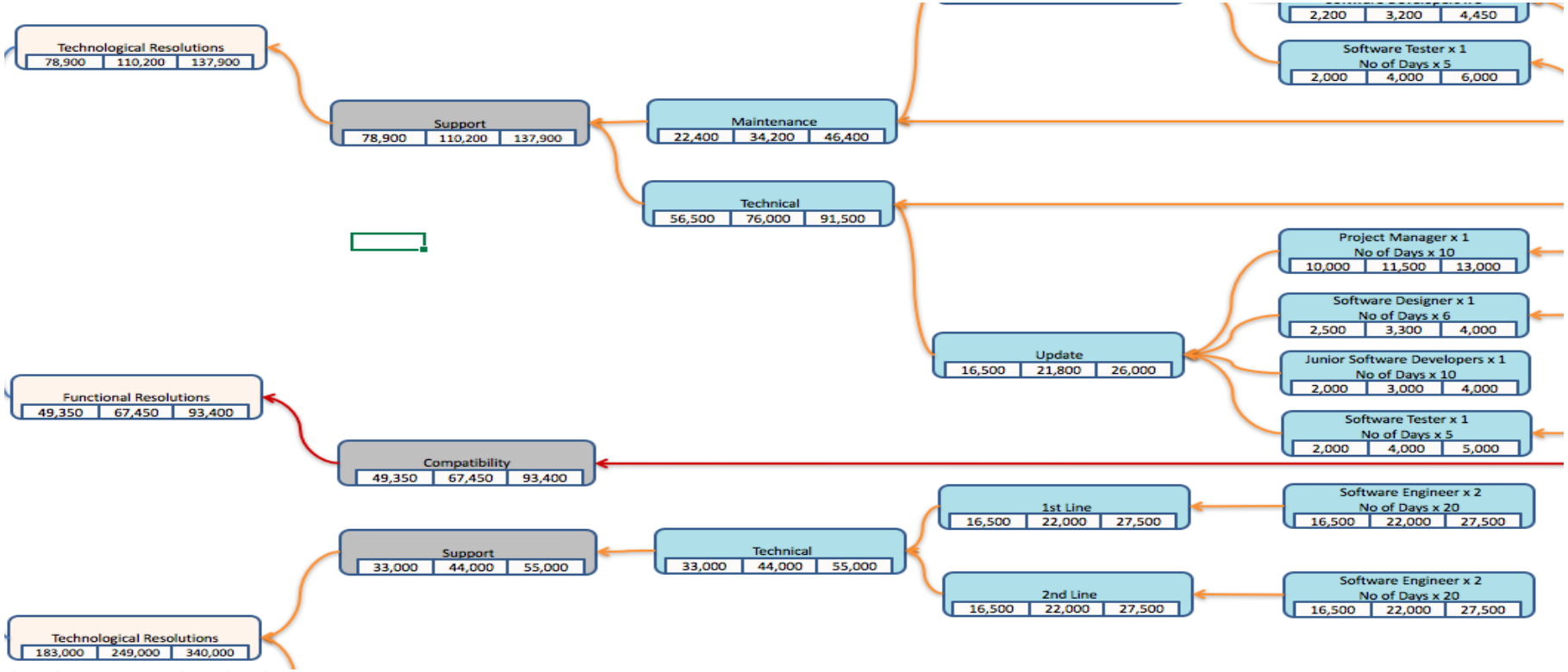
Software Obsolescence Resolution Cost Optimisation Model - Nodes

- Software has several components and each component undergoes different obsolescence resolution profiles which can be diagrammatically represented using above methodology.
- Diagram represents decomposition of cost from output node (on the left) through successive levels to individual input nodes (on the right);
- This decomposition is the focus of the diagram and technique.

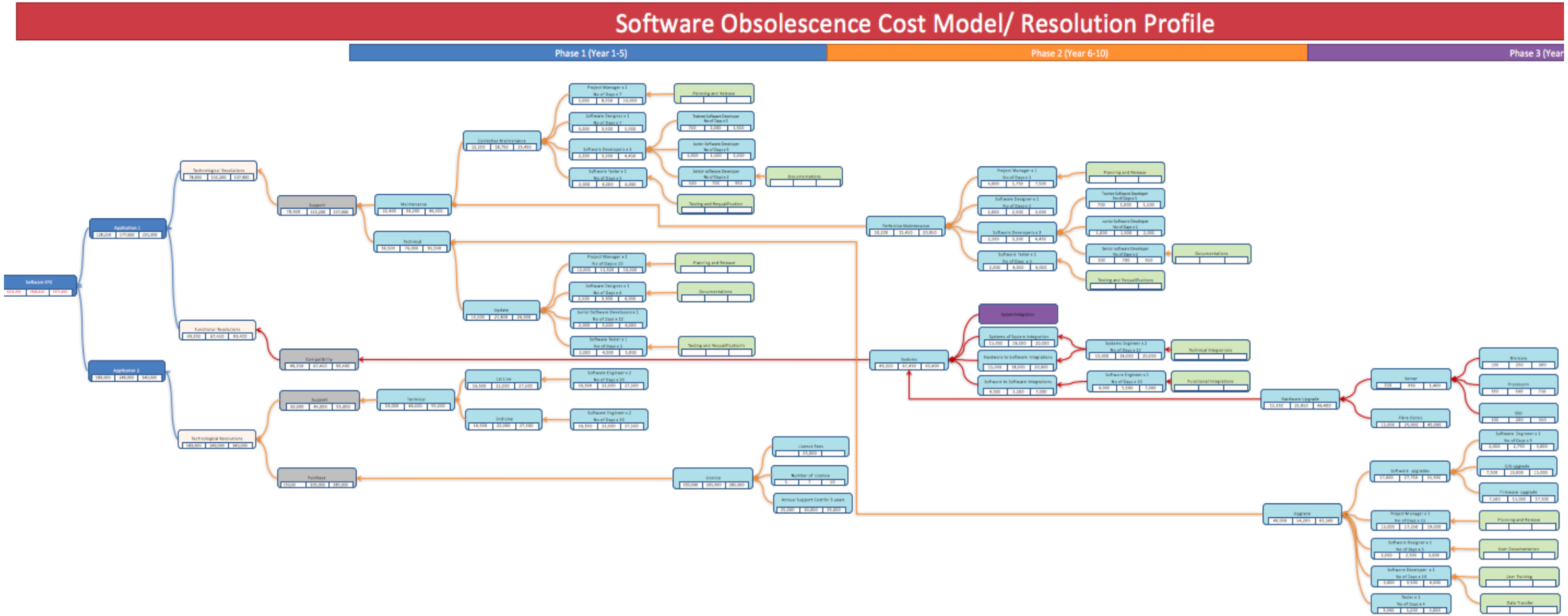


Software Obsolescence Resolution Cost Optimisation Model - Nodes

- Input values are entered on the right of the diagram and aggregate through the model to give the vignette cost.
- Each node has a specific formula for combining inputs, which are defined in the diagram.
- Module nodes allow repeated use of common elements, such as Software Engineers rates.



Software Obsolescence Resolution Cost Optimisation Model – Example



Optimisation Options

- In order to undertake Optimisation, it is necessary to identify the following
  - External Variables
  - Objective Functions
  - Constraints
- It is also necessary to develop a formula that uses the above variables, constraints and Objective functions in order to generate optimisation of
  - Cost
  - Resolution Strategy

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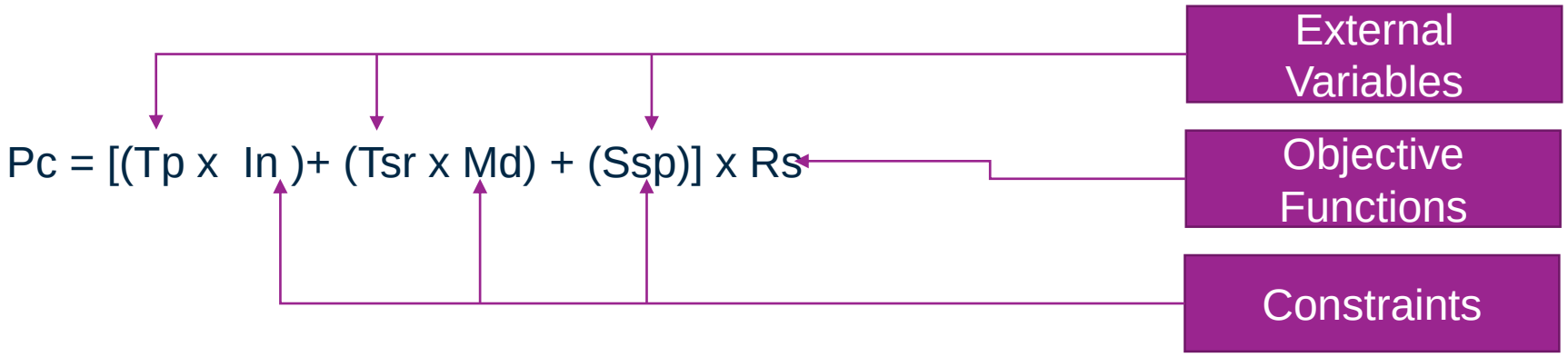
Optimisation Formula



Tp = Type of Platform
In = Level of Integration
Tsr = Testing and Requalification
Md = Level of Modification
Ssp = Software System Parameter
Rs = Resolution Strategy Cost

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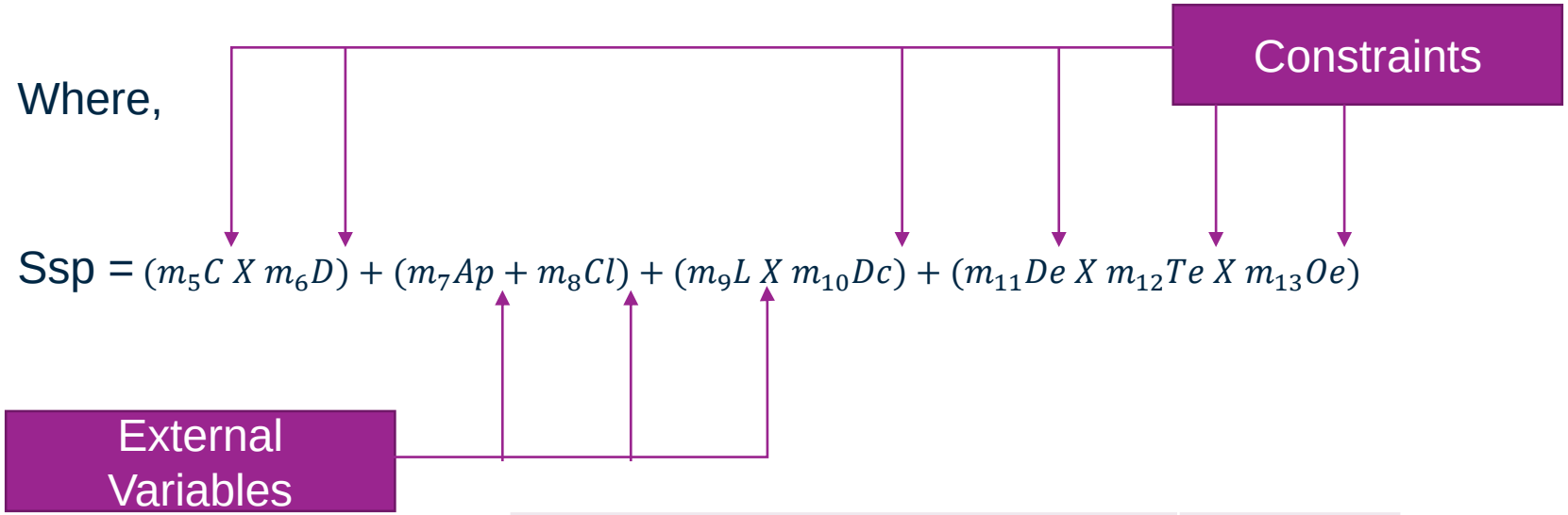
Optimisation Formula

Where,



C = Software Complexity	
D = Software Dependency	
Ap = Number of Applications	
Cl = Software Contract Length	
L = Software Language	
Dc = Software Development Cycle	
De =Software Development environment	
Te = Target Environment	
Oe = Operating environment	

Optimisation Formula

$$P = [(m_1 Tp\ X\ m_2 In) + (m_3 Tr\ X\ m_4 M) + \{(m_5 C\ X\ m_6 D) + (m_7 Ap + m_8 Cl) + (m_9 L\ X\ m_{10} Dc) + (m_{11} De\ X\ m_{12} Te\ X\ m_{13} Oe)\}]\ X\ R$$

Multiplier Identification number	Descriptions	Values
1	Communication and System	2
	Air	2
	Land	1
	Maritime	1
	Commercial System	1
2,3,4,5,6	High	3
	Medium	2
	Low	1
7	10-50 Apps	1
	51-100 Apps	2
	101-500	3
	501 or More	4
8	1-5 years	1
	6-10 years	2
	11 years or more	3
9	1st Gen/Machine Code	3
	2nd and 3rd Gen	1
	4th Gen	2
	5th Gen	3
10	Waterfall	3
	Spiral/Iterative	2
	Incremental	1
	Agile	3
11,12,13	Stable	1
	Unstable	2

Optimisation –Test Case

Discription		Values
Type of Platform	Air	2
Level of Integration	Medium	2
Testing and Requalification	High	3
Level of Modification	Medium	2
Software Complexity	Low	1
Software Dependency	Low	1
Number of Applications	2	1
Software Contract Length	6-10 years	2
Software Language	2nd Generation	1
Software Development Cycle	Stable	1
Software Development environment	Stable	1
Target Environment	Stable	1
Operating environment	stable	1

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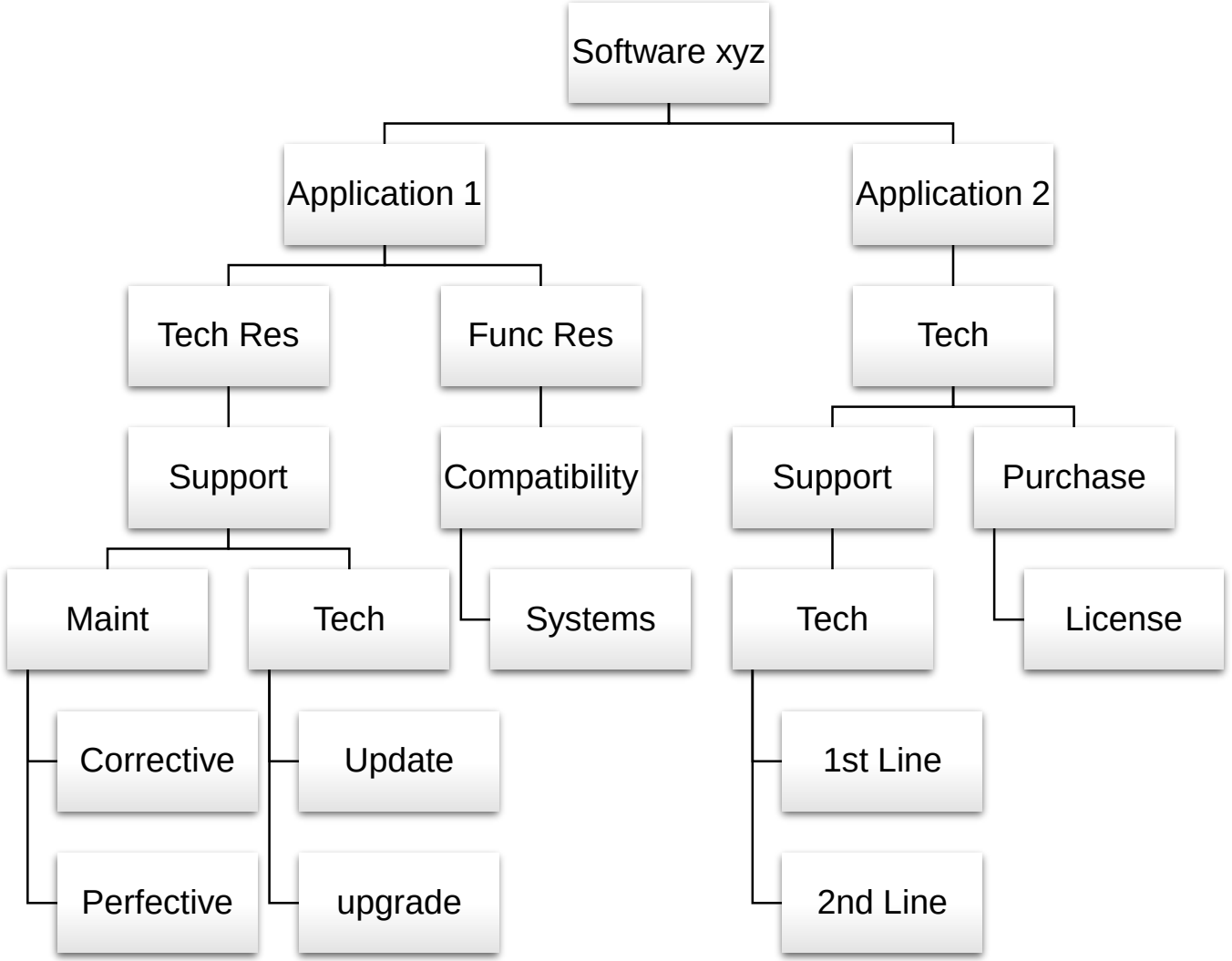
Optimisation –Test Case (Resolution Strategies)



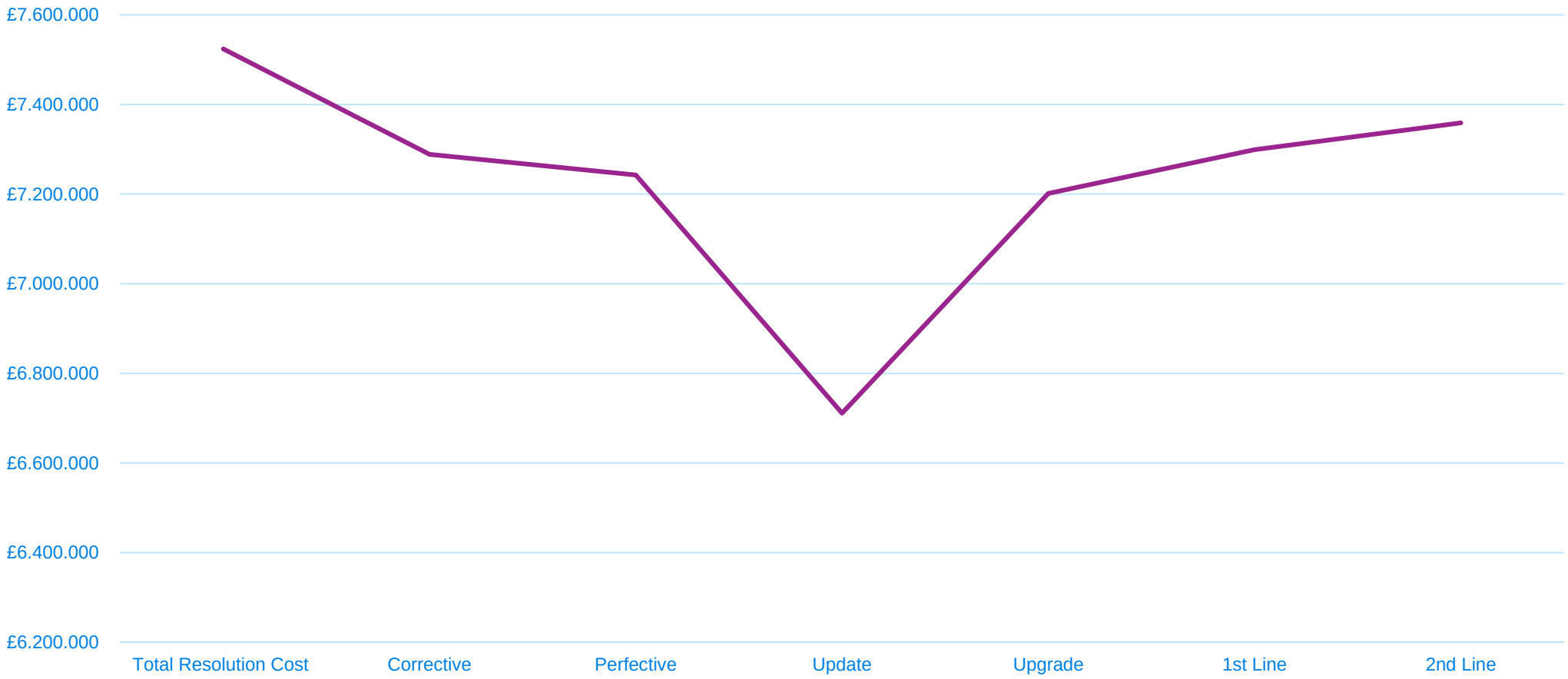
Optimisation Level 1

Optimisation Level 2

Optimisation Level 3

Optimisation Level 4

Optimisation –Results



Summary

Software Obsolescence is a an emerging issues and it is important to understand how much Software Obsolescence is going to cost at a very early stages of development life cycle. In order to do so we need to

- Define what Software obsolescence is
- Understand the difference between Software Maintenance and Obsolescence
- Identify how Software Obsolescence is triggered
- Have a framework to manage software obsolescence proactively
- Identify the key Software Obsolescence Resolution approaches

Conclusions

- Software plays an important role in defence. Almost every project in defence has software elements with various degrees of complexity and dependencies.
- In order to understand and see the bigger picture and challenges; software developers and the customers need to foresee the following issues that drive the whole life cost and should be in a position to develop innovative means to mitigate these issues by:

  - Anticipation of the Software Obsolescence at a very early stage of projects.
  - Understanding the technology insertion, technology update requirement.
  - Understanding the relationship between Software Maintenance and Software Obsolescence.
  - Anticipation of future capability integration to the existing platforms taking into account systems of systems, software to software and software to hardware integrations.
  - Formulation and evaluation of alternative architectural framework to inform the software designers that recognises the key market and cost drivers.

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Thank you –Any Questions ?