Force Mix Modelling to Assess Value for Money Early in the Project Lifecycle

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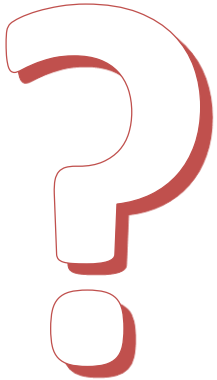
Overview

- MBDA **design and produce missiles and missile systems** to meet current and future needs of the armed forces
- Role of OA team is to **evaluate the military effectiveness** of current and future products and to **understand the future battlespace** and its requirements

- **The question:** What is the desired mix of weapon types to meet the requirements in the context of a future UK Surface attack/ Land attack Force Mix ?

- **Further questions:**
  - How can weapon system concepts make a cost-effective contribution to the future force mix ?
  - What is the role of utility and specialist weapons?
  - How do weapon system concept options compare to the competitors?

- **Model design driver:** Simplicity



Potential Applications of the Model

- Identify **% use of systems**– which is the most **popular solution**
- Understand **relative cost requirements** to improve %use
- Understand **weapon – platform preferences** and **Internal or External carriage**?
- Investigate **relative costs vs scenario completion** for different Force Mix options
- Identify **specialist weapons** capability and use
- Identify concept **design drivers** through sensitivity analysis

Model Design

VIGNETTE

- A single target type
- Vignette parameters:
  - Range
  - Timeliness
  - Collateral Risk
  - Is the target moving?
  - Threat Densities
- Vignette Frequency

SCENARIO

System Definition: Platform + Weapon Type

System
Platform and weapon combination

Platform Configuration
- Internal or External Carriage
- Survivability

Platform
- Performance parameters
- Cost

Weapon
- Quantity
- Performance parameters
- Survivability
- Cost per launch platform

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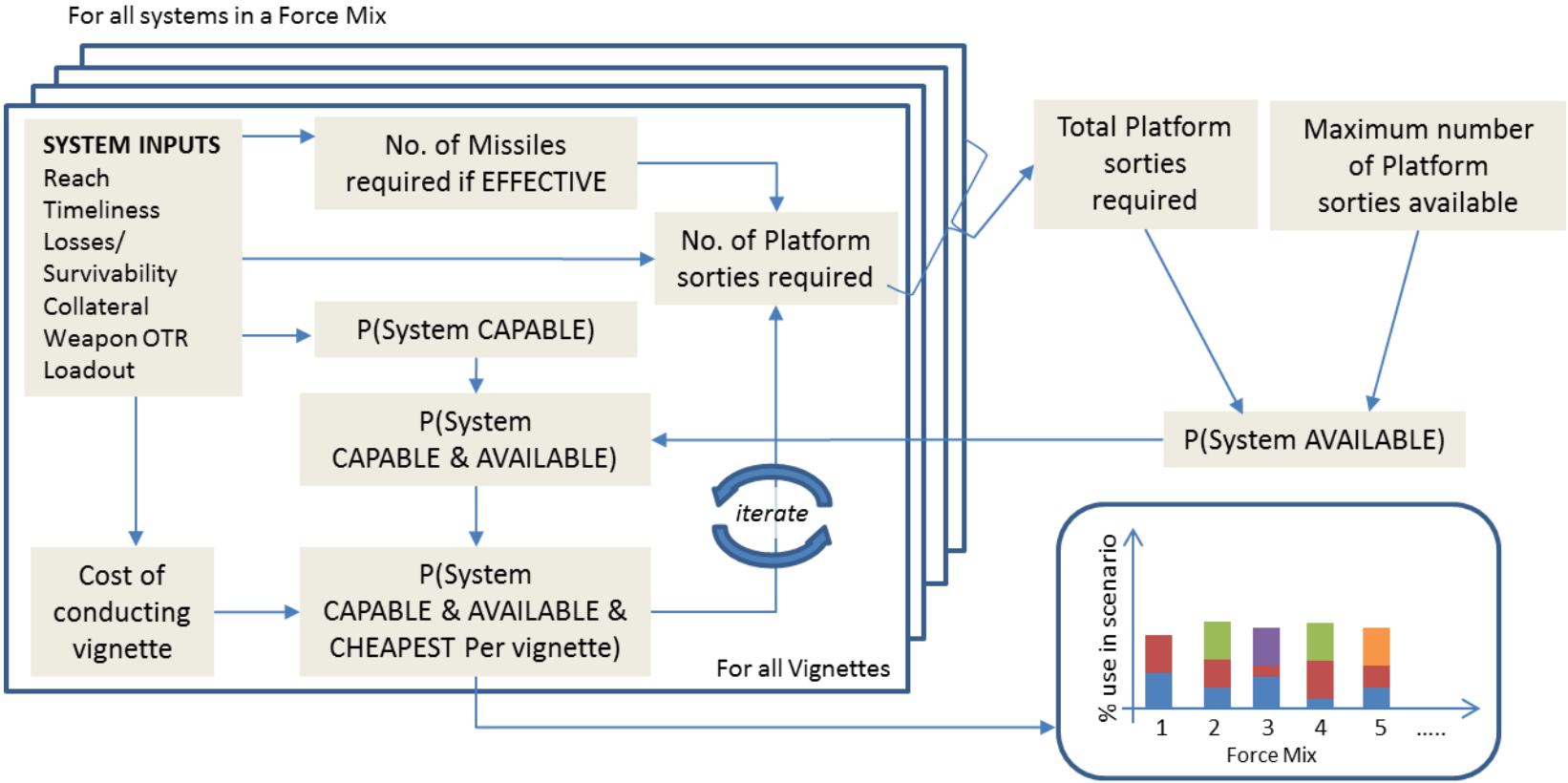
Overall Model Process



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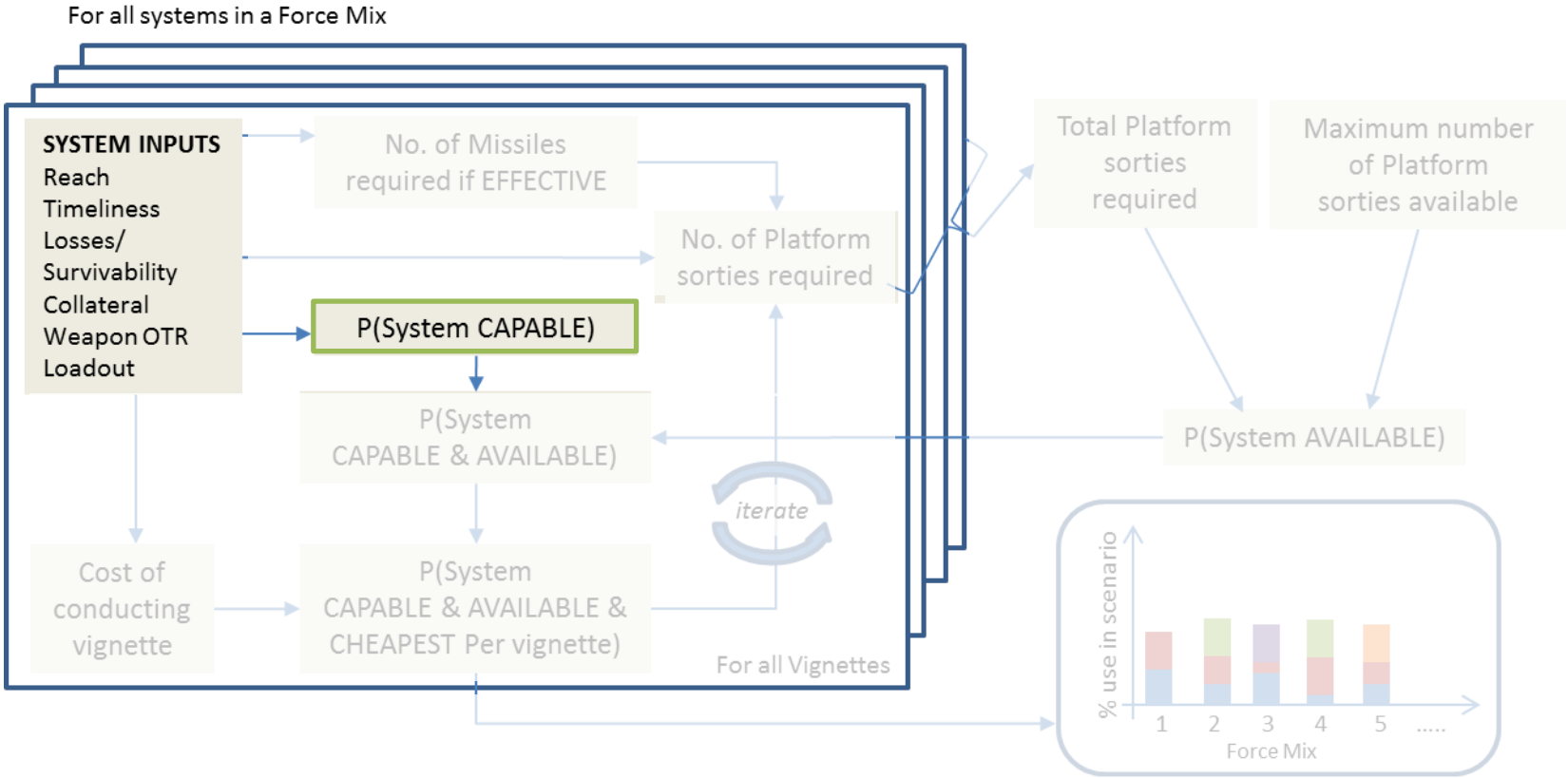
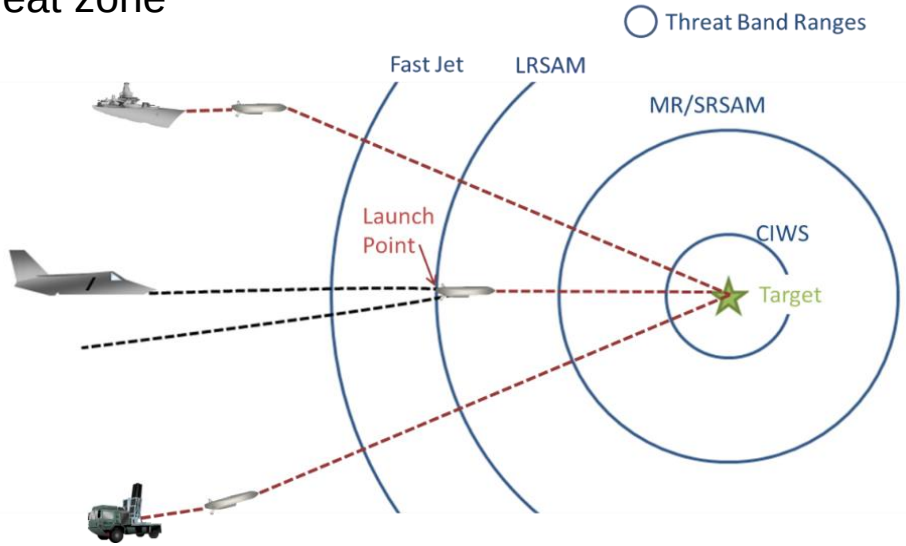


Probability System Capable against Vignette

P(System Capable) = P(Time Feasible) x P(Range Feasible) x P(Collateral Risk Feasible) x P(Weapon Survivable) x P(Platform Survivable)

- **P(System capable) is a multiple of all the feasibility probabilities** (collateral risk, range and time) **and the probability weapon reaches the target** (weapon and platform survivabilities)
- **Calculated for each system against each vignette**

- 4 types of **threat zones** radially out from target, each with a defined range within the scenario
- Weapon and platform are assigned a loss rate per km value for each threat type and the **P(weapon or platform survivable)** is determined by the distance travelled through each threat zone



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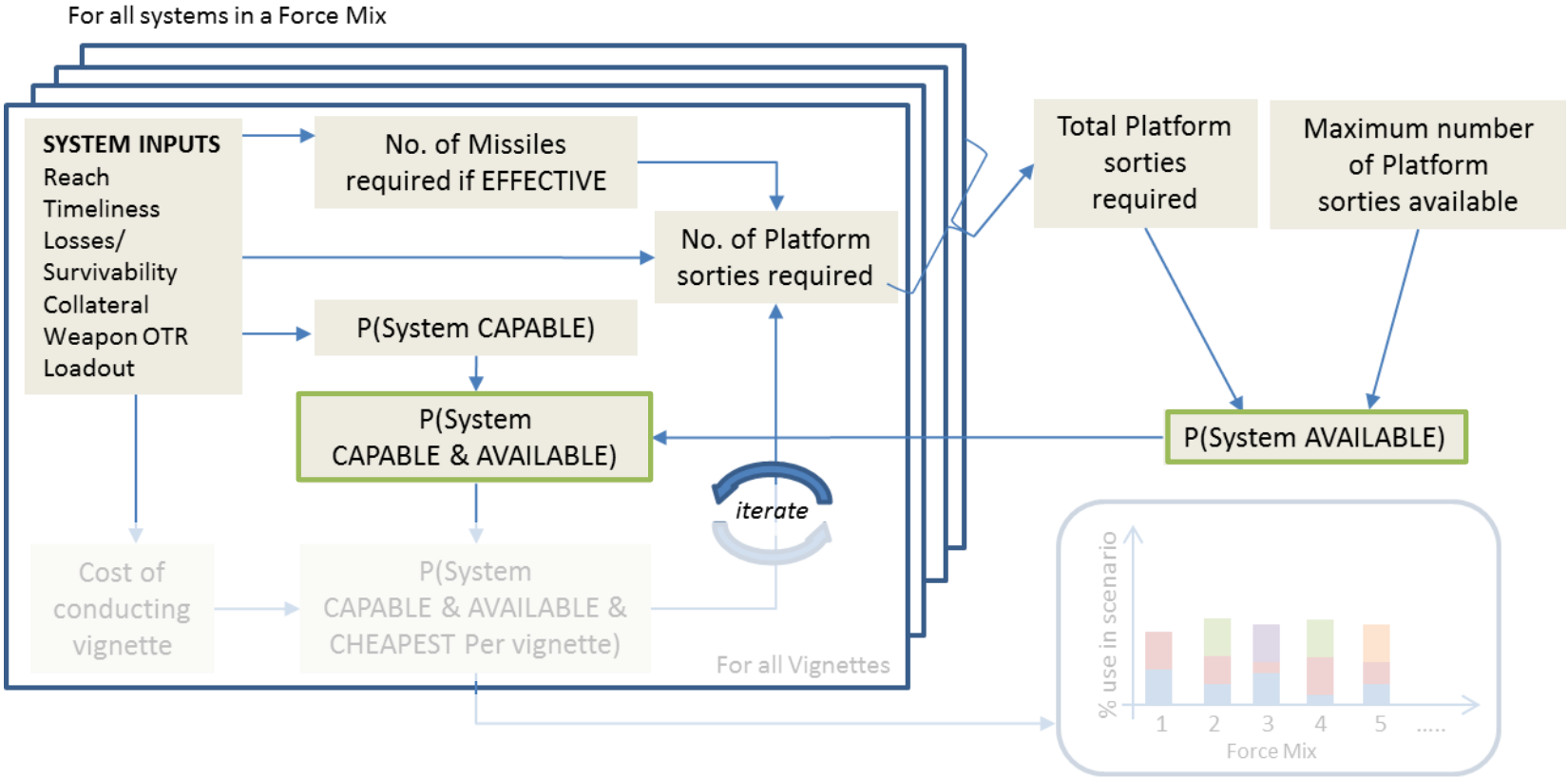
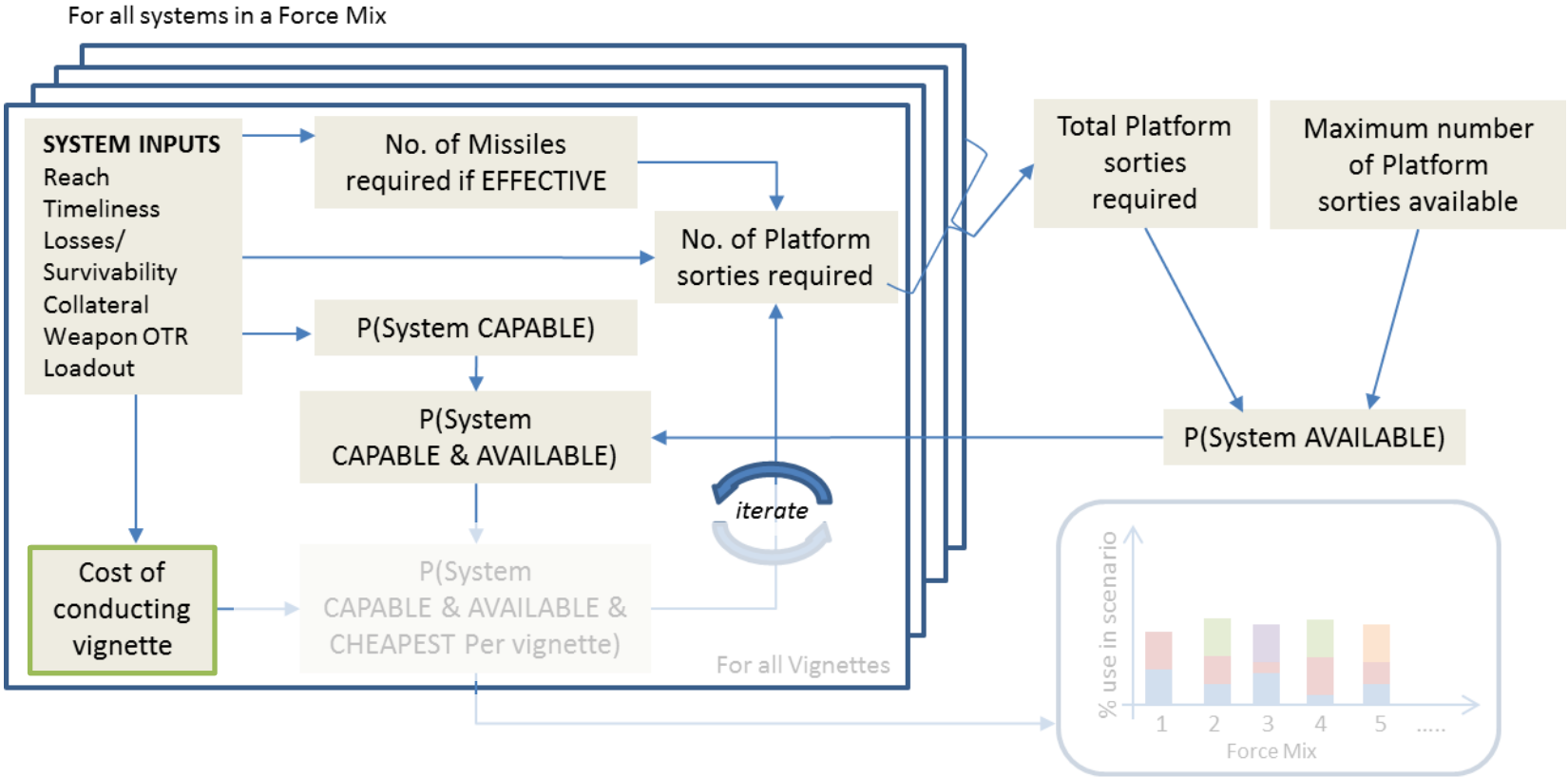


- **P(Available)**
  - 1 for the first run of the model
  - Recalculated after each iteration based on:
    - Systems use in previous runs → weapons used
    - Platform – Weapon loadout → number of sorties
    - Number of sorties available - defined in inputs
  - Iterate until convergence within a tolerance

- **System P(Capable and Available)**

$$P(\text{C\&A}) = P(System\ Capable) * P(System\ Available)$$

Overall Model Process



Cost per vignette

Weapon Cost = **Weapon UPP** x **Weapons Required**

Weapons Required = **Weapon OTR** x **Vignette No. of Targets** x **Vignette No. of Aim points per target**

Platform Cost = **Platform UPP** x **Probability Platform Loss** x **Sorties Required**

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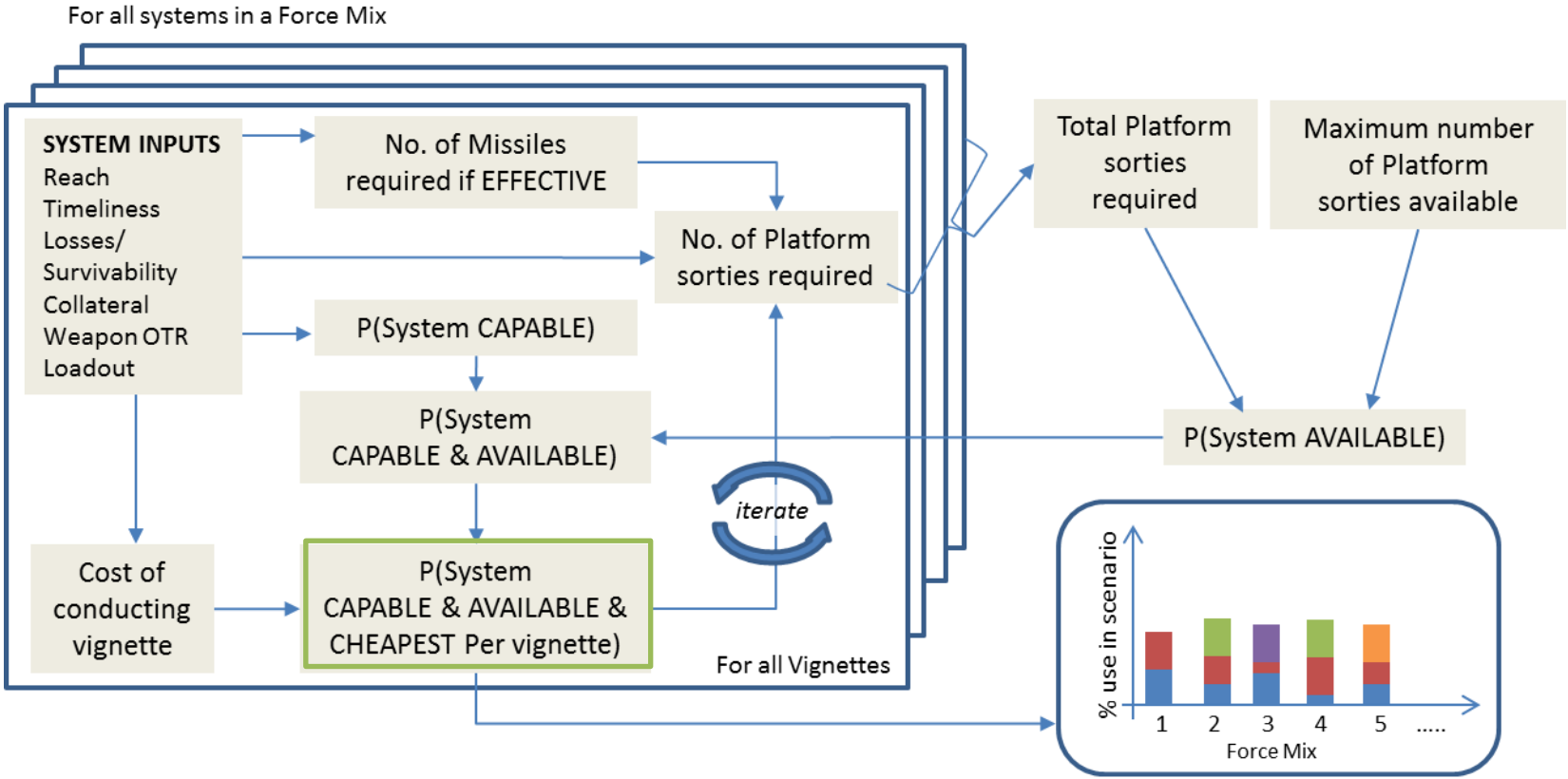
Overall Model Process



P(Capable, Available and Cheapest) for each vignette

- **Example:**

System	P(C+A)	System Cost
W	0.8	2
X	0.6	1.75
Y	0.4	1.5
Z	0.3	1

Compare X and W cost: X is cheaper

- $\mathrm{P}\,(X\ Ca \cap Av \cap Ch) = \mathrm{P}(\,X\ Ca \cap Av)$
- $\mathrm{P}(W\ Ca \cap Av \cap Ch) = \mathrm{P}(W\ Ca \cap Av) * (1 - \mathrm{P}(X\ Ca \cap Av))$

	W	W+X	W+X+Y	W+X+Y+Z
W	0.8	0.32	0.192	0.058
X	-	0.6	0.36	0.348
Y	-	-	0.4	0.28
Z	-	-	-	0.3

% Split of each system use for a vignette

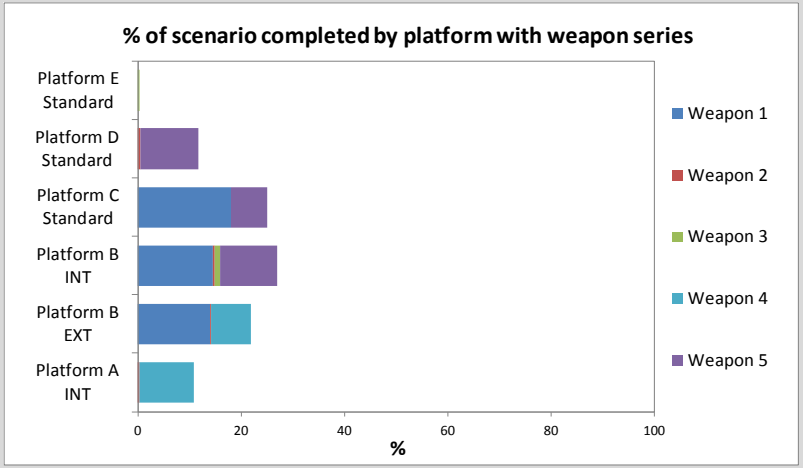
Total = 0.98

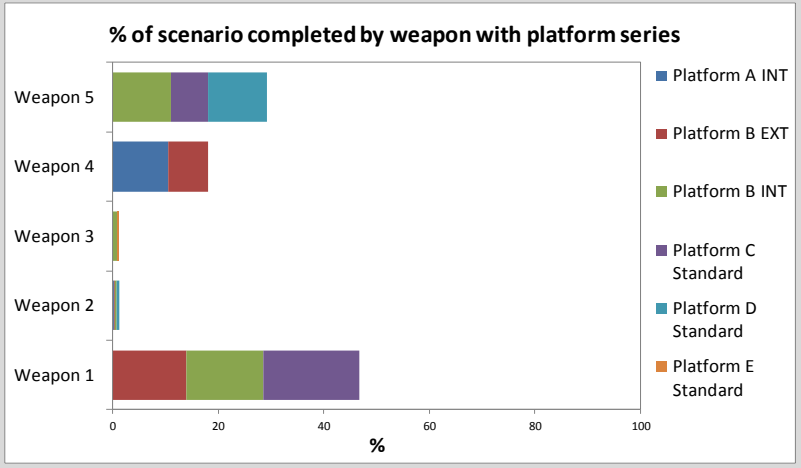
Results

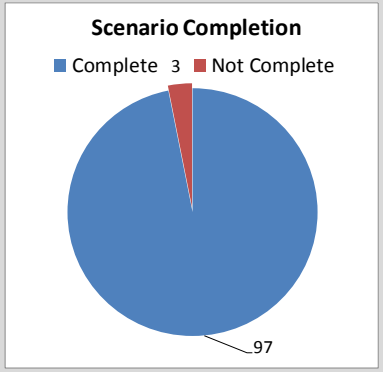
- **Platforms**
  - 5 – Named platform A to E
  - A and B are air platforms
  - A has two configurations – internal and external carriage
- **Weapons**
  - 5 – Named weapon 1 to 5
- **Scenario**
  - 20 vignettes
  - Varying target types and domains

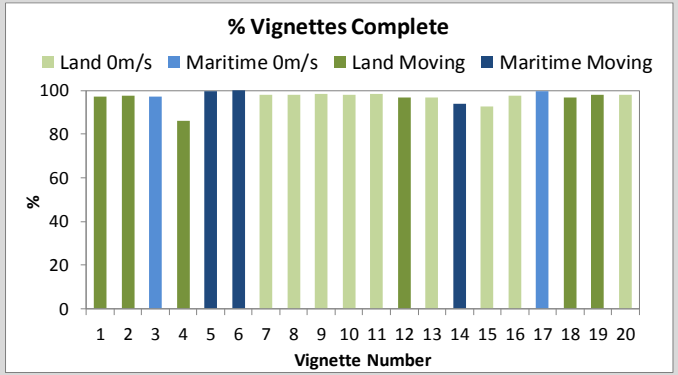
Example Data

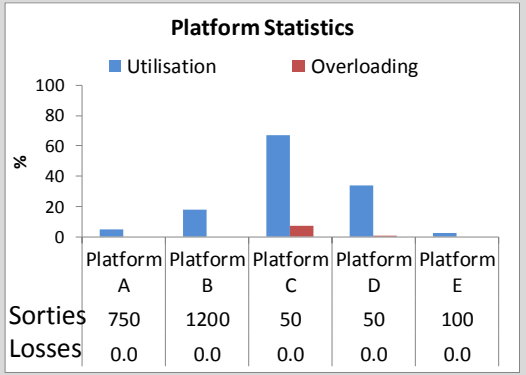
Outputs dashboard











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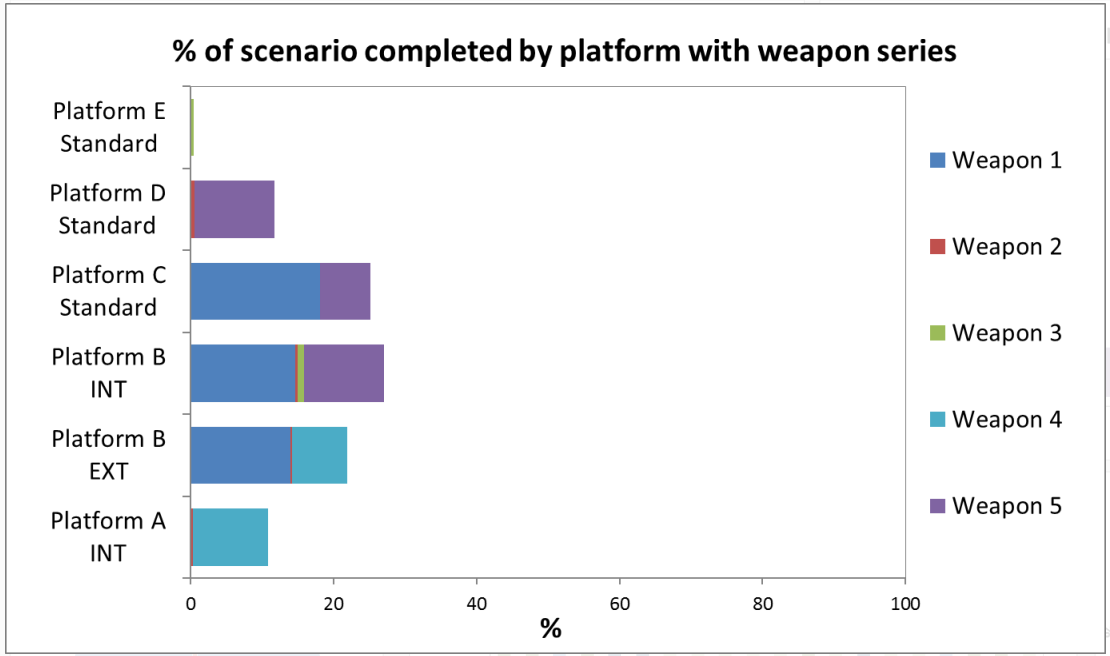

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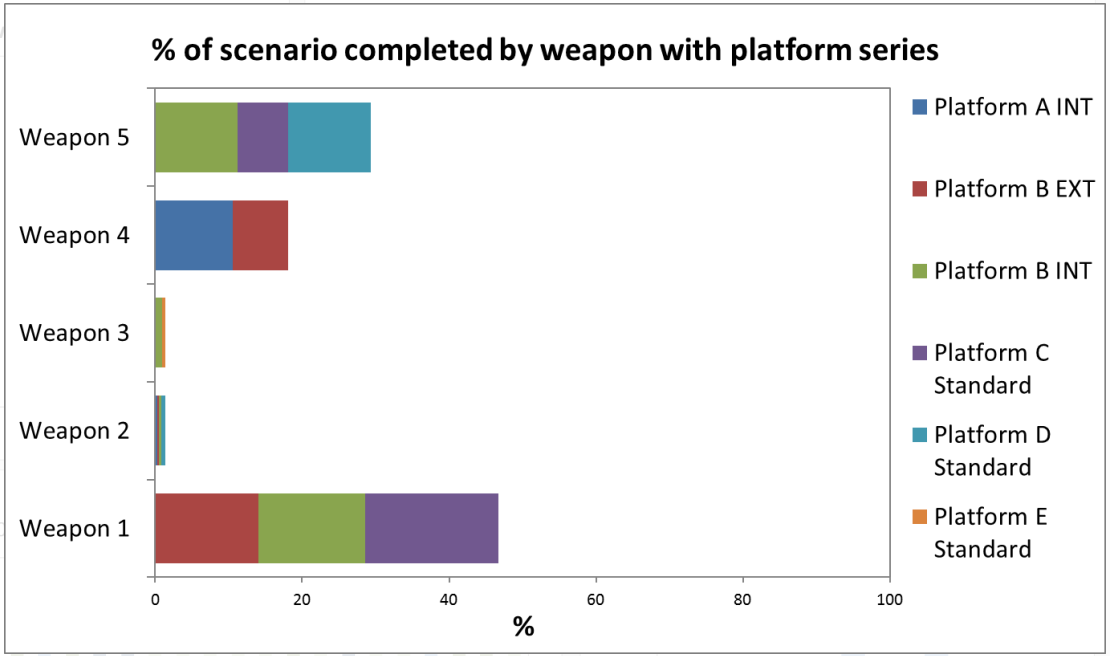

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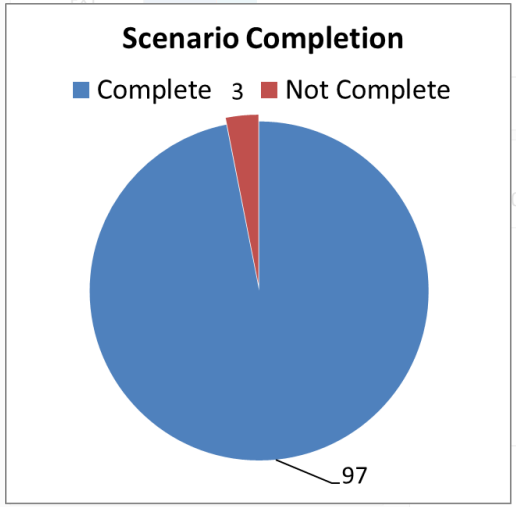

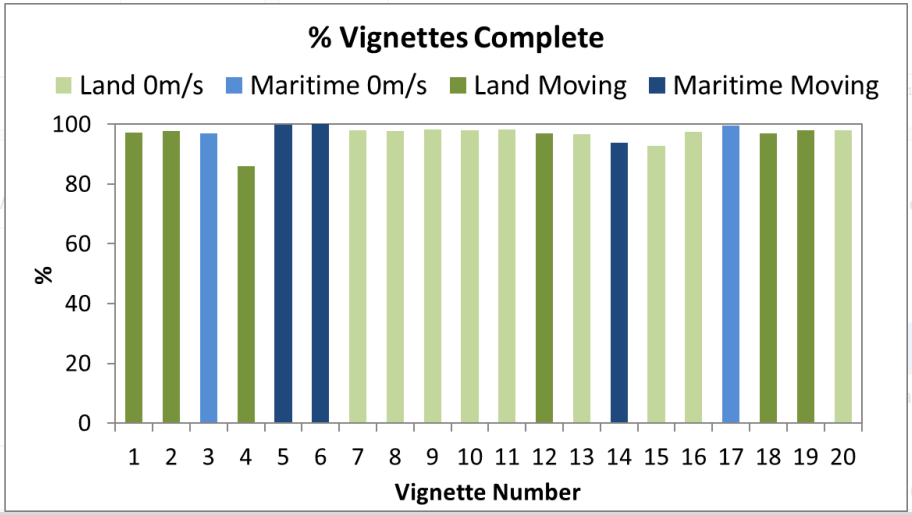

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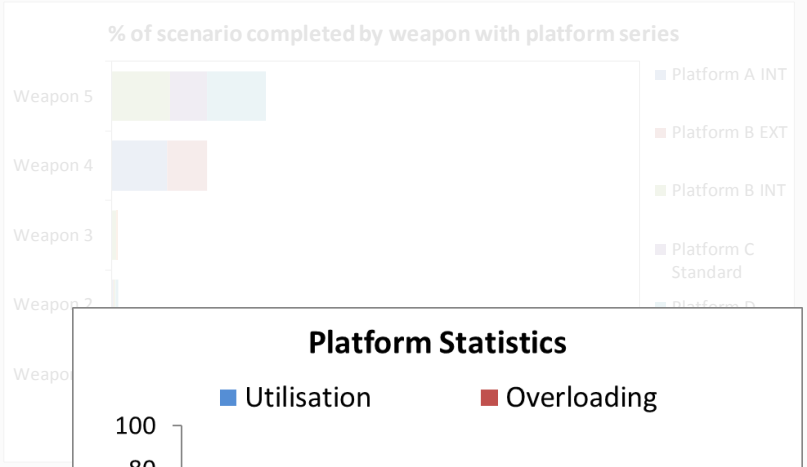

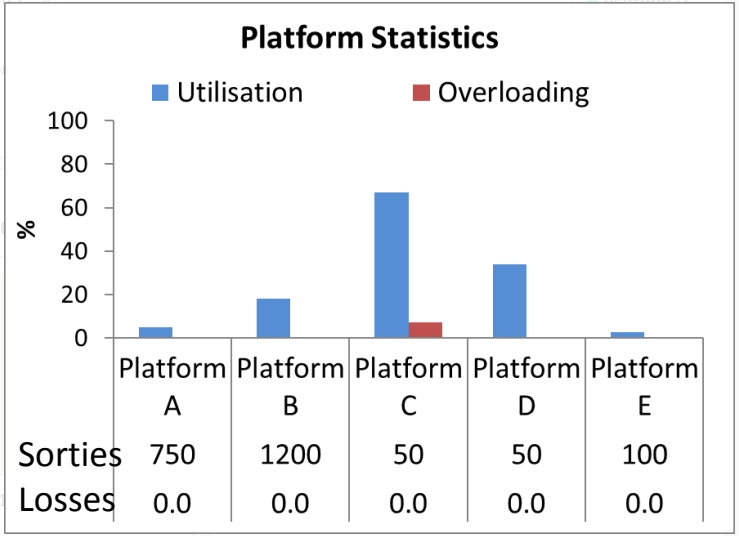

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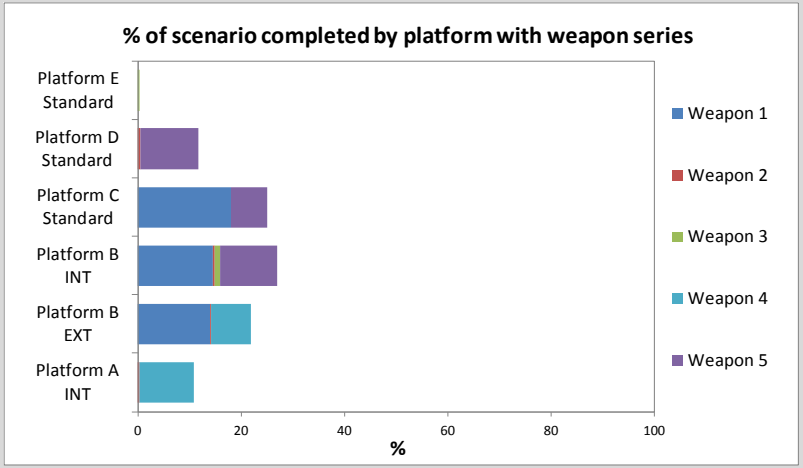

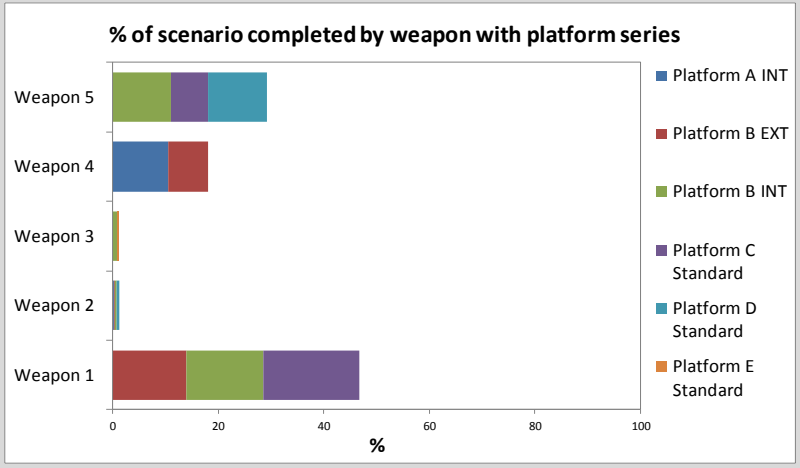

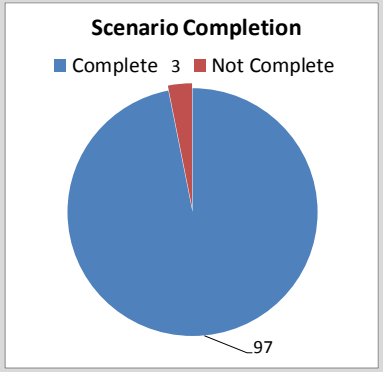

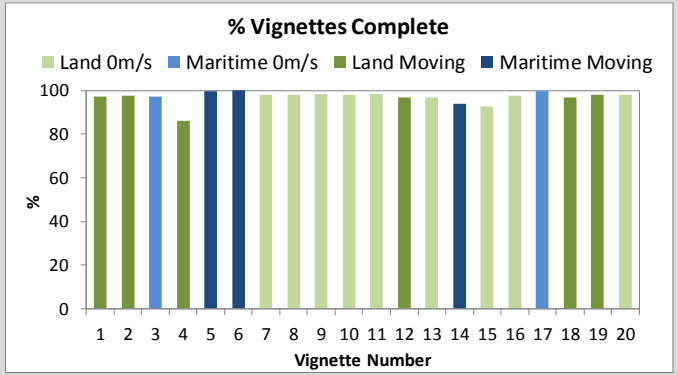

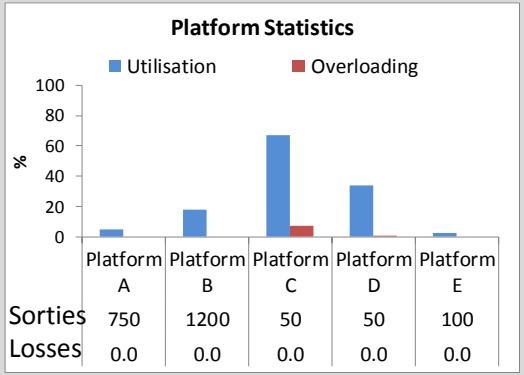

Summary

- **Built a simple force mix model to assist with a weapon system concept study**
- **Investigated percentage use of different weapon and platforms against future surface attack scenarios**
- **Most interested in impact of data changes and relative performance of force mixes**
- **Further applications in assisting with concept studies**

Questions?

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