[dstl] The Science Inside

Application of a Novel Technique to Help Determine Mission Success in Computational Multi-Mission Modelling

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Joint Analysis and Decision Support Group

40 ISMOR, July 2023

Ministry of Defence

Agenda

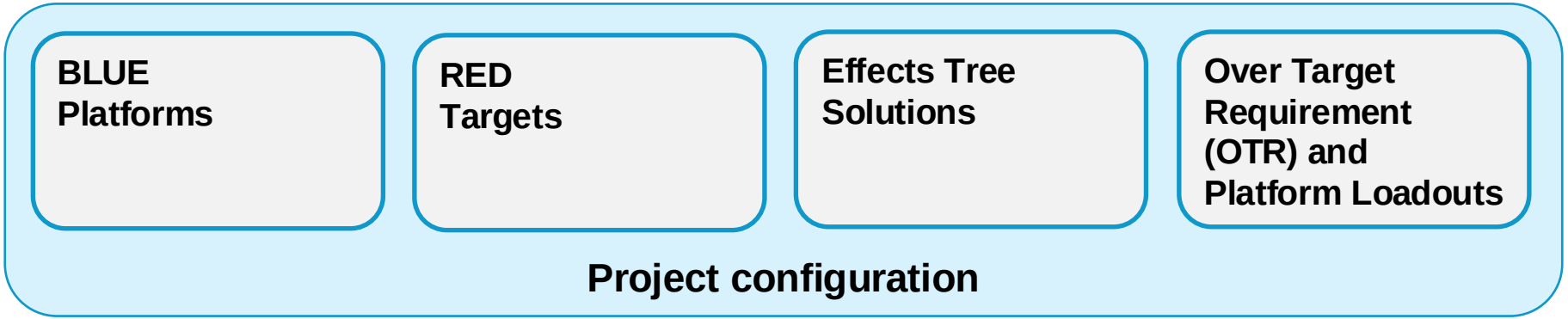
- Introduction
- Decision Maker
- Effects Trees
- Force Mix Score
- Applications of Force Mix Score
- Wrapping Up

Introduction

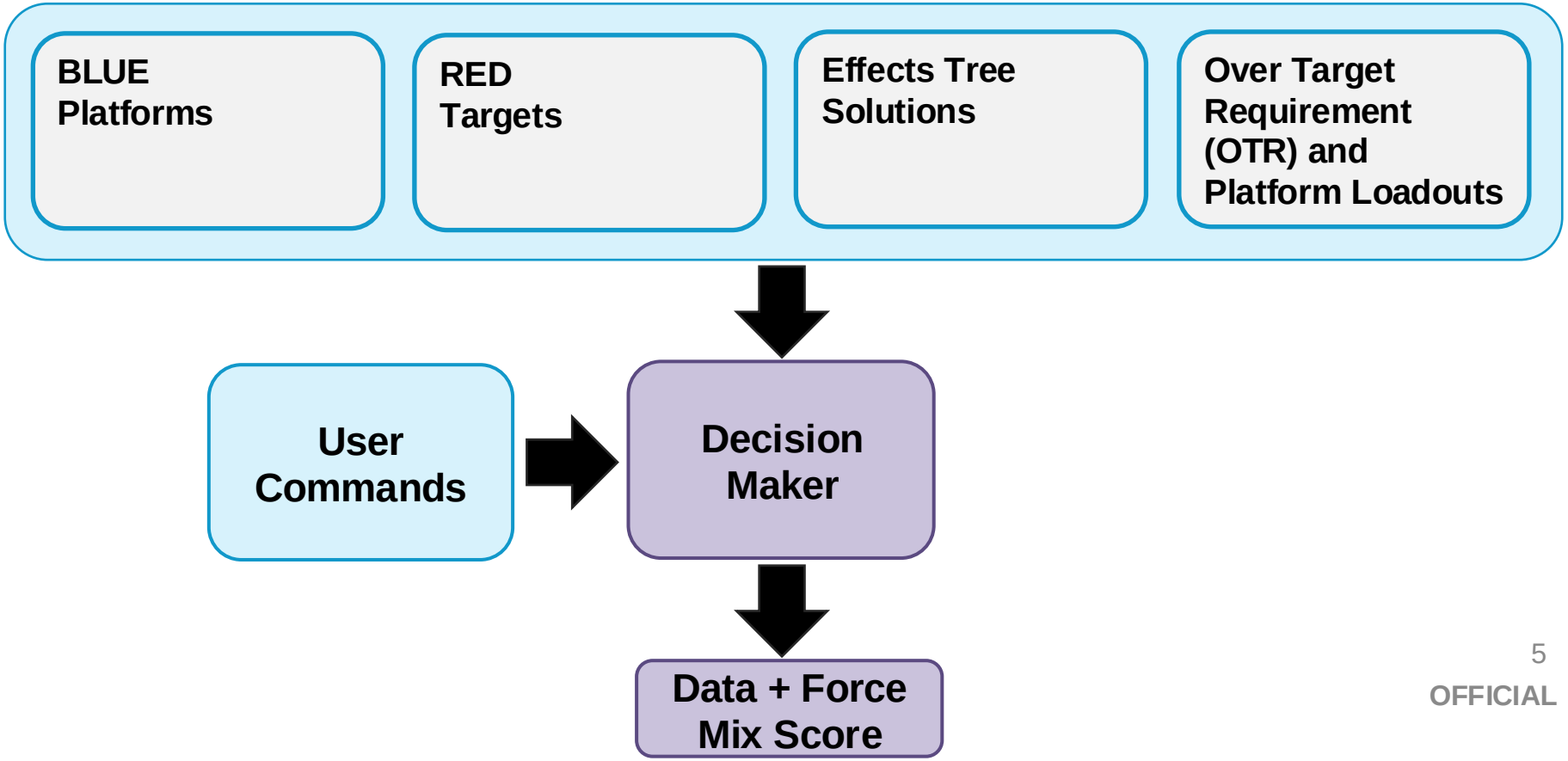
- Dstl performs analysis to inform MOD decision makers.
- One of the analysis tools is Force Mix Score.
- It was initially designed for campaign level analysis.
- Evolved to be used in single and multi-mission models.
- Decision Maker is the software that runs the simulations and generates a Force Mix Score.

Decision Maker

- ‘Decision Maker’ (DM); is a Python toolset for a complex physics-based simulation software, used to plan and run multi-mission models.
- It takes in a variety of data through spreadsheets and prompts through a command line interface.

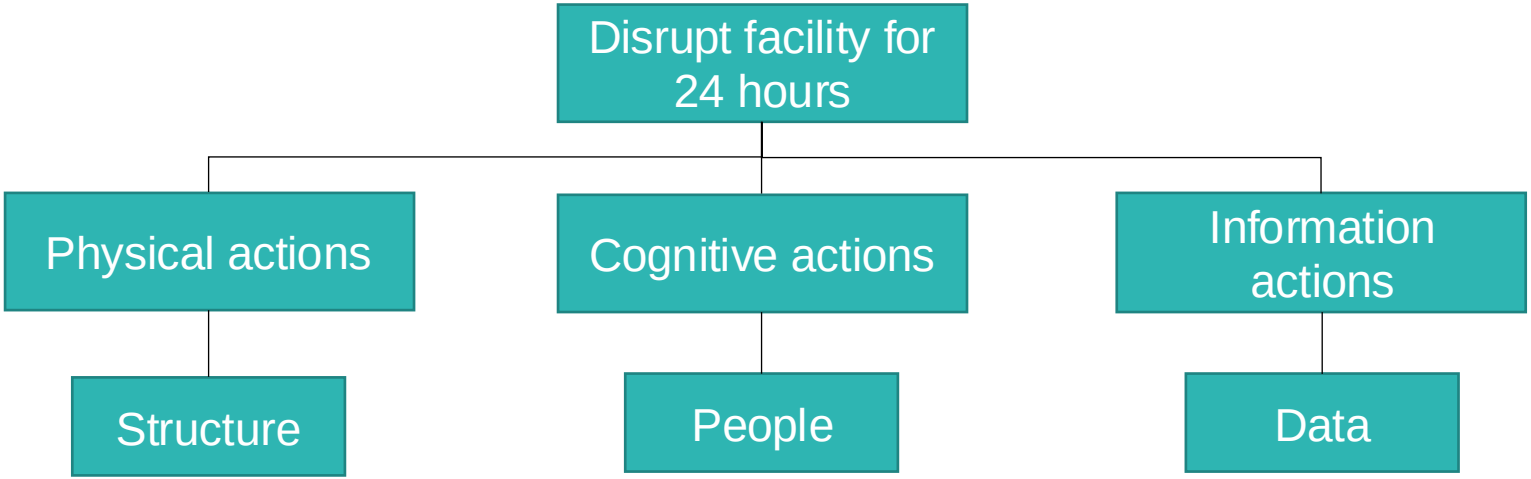


Decision Maker



Effects Trees

- Effects Trees are a way of exploring **full spectrum targeting** options
- They allow for multiple options of enabling the same military effect to occur



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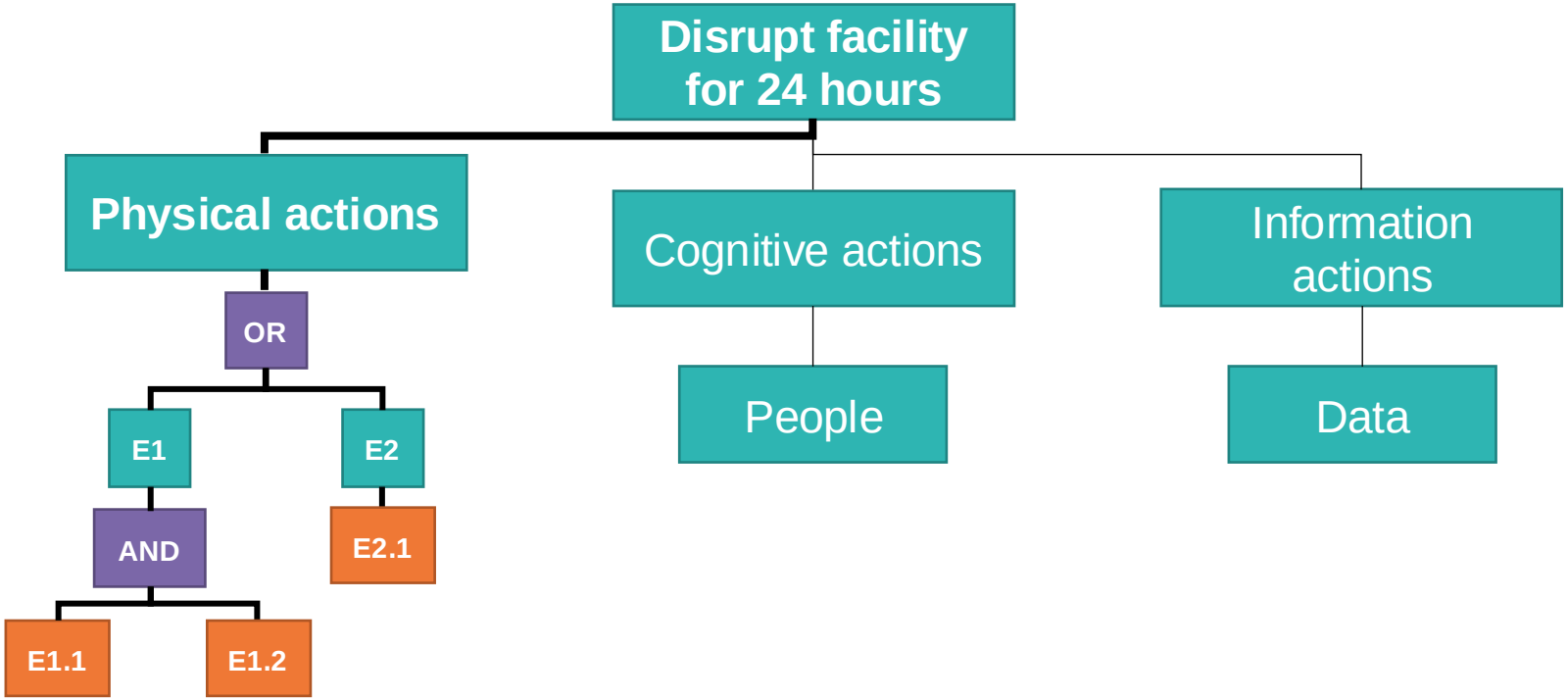

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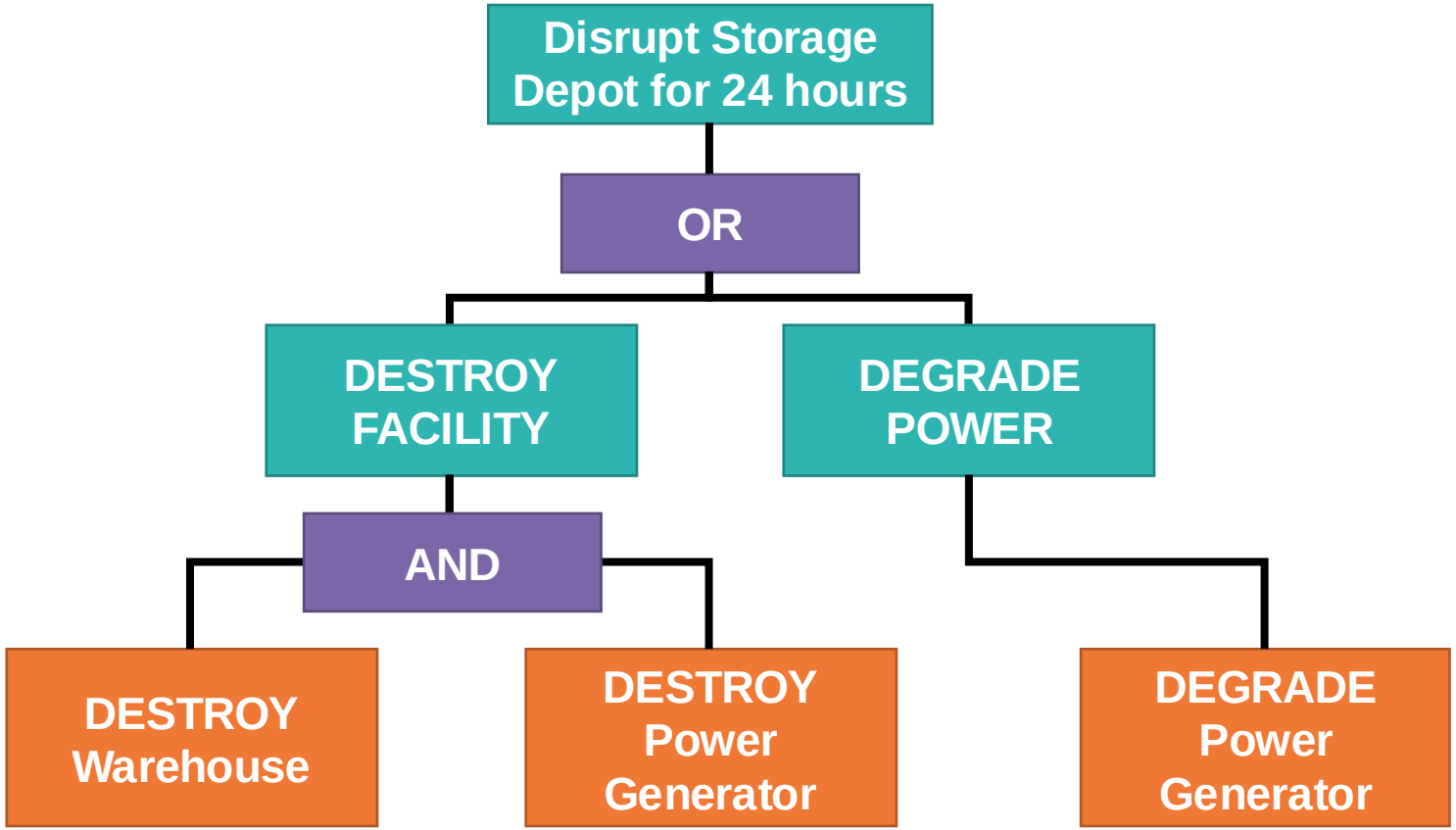
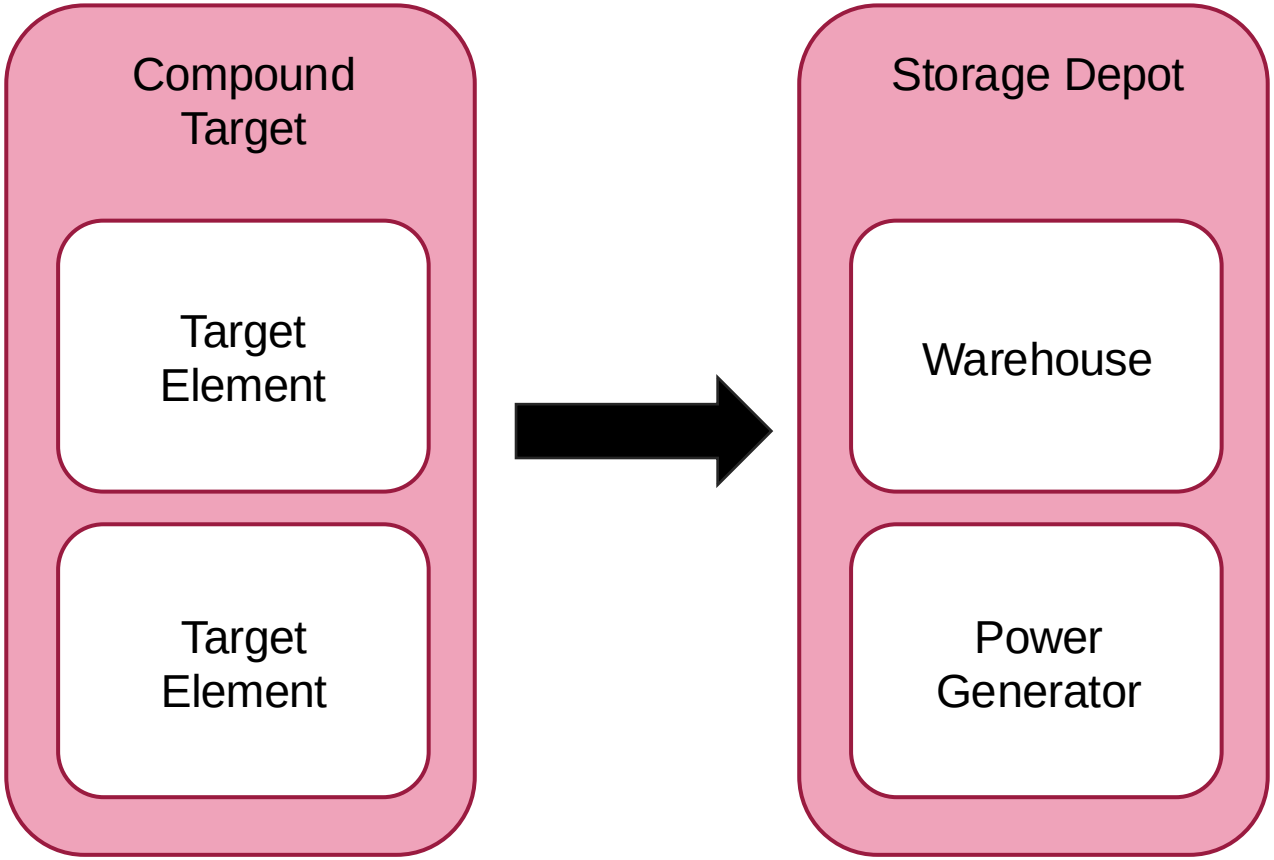
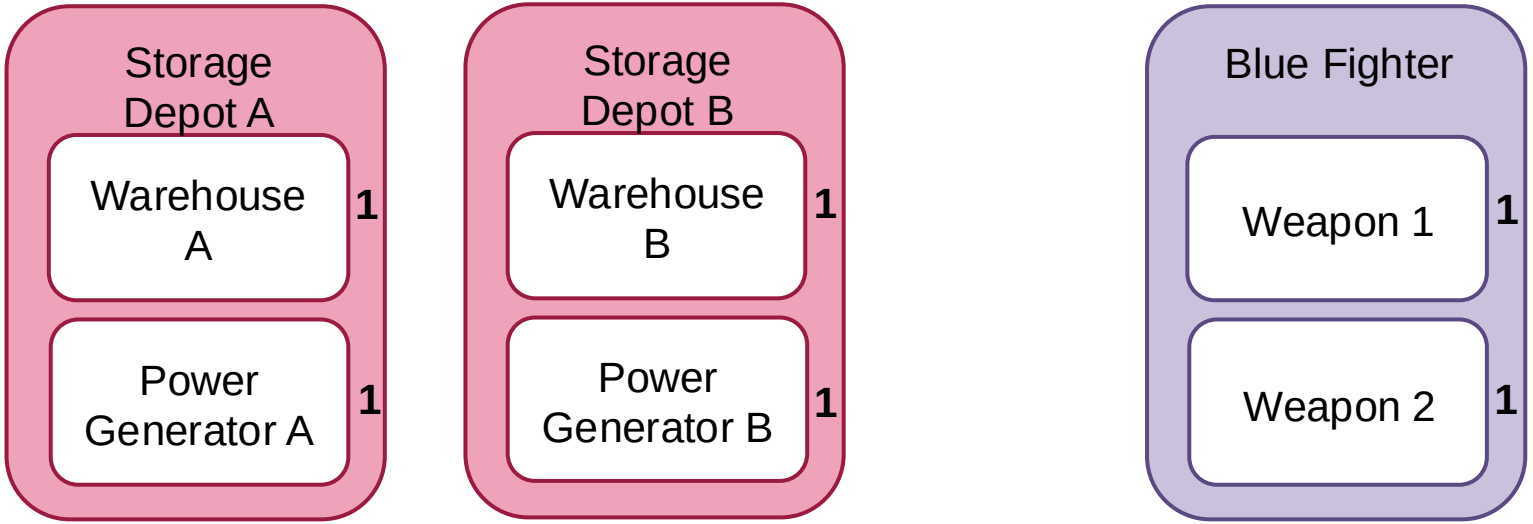


Targets



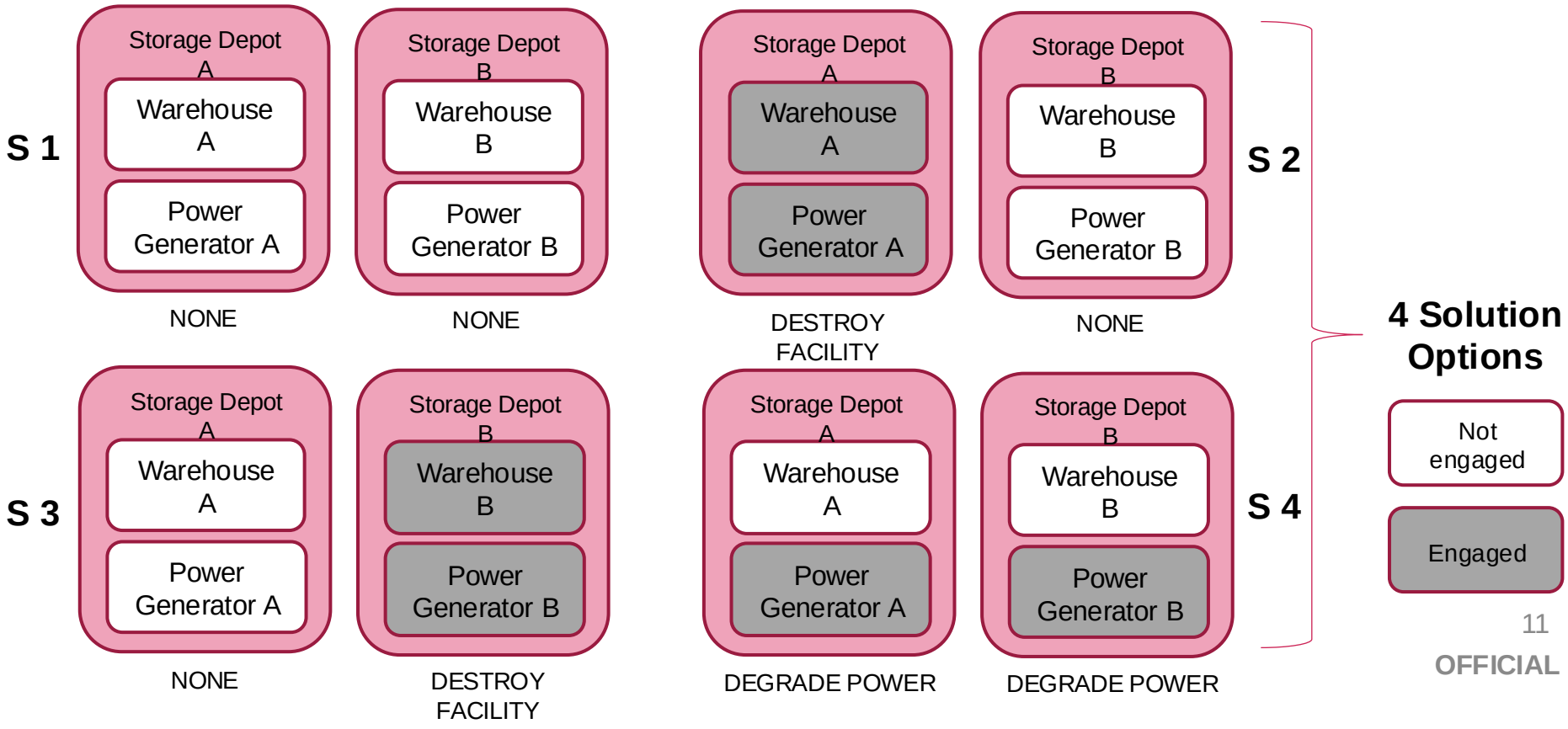
Simple Scenario



4 weapons required in total to engage both targets fully

Only 2 weapons available

Decision Maker & Effects Trees



Force Mix Score

- Force Mix Score is a way of summarizing how effective a mission has been at engaging compound targets, compared to the total number of compound targets in the mission.

$$FMS = \sum_{i=1}^{T} s_i p_i \Big/ \sum_{i=1}^{T} p_i$$

T = number of compound targets in the mission
s_i = service value [0, 1/5, 1]
p_i = target priority value [1, 2, 3, 4]
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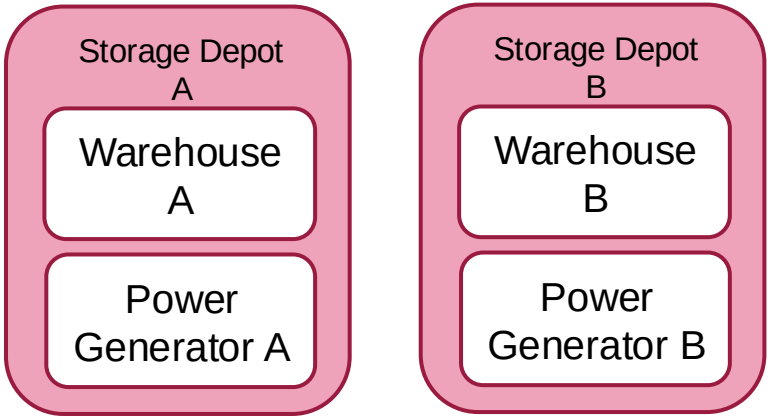
Our scenario has 2 compound targets



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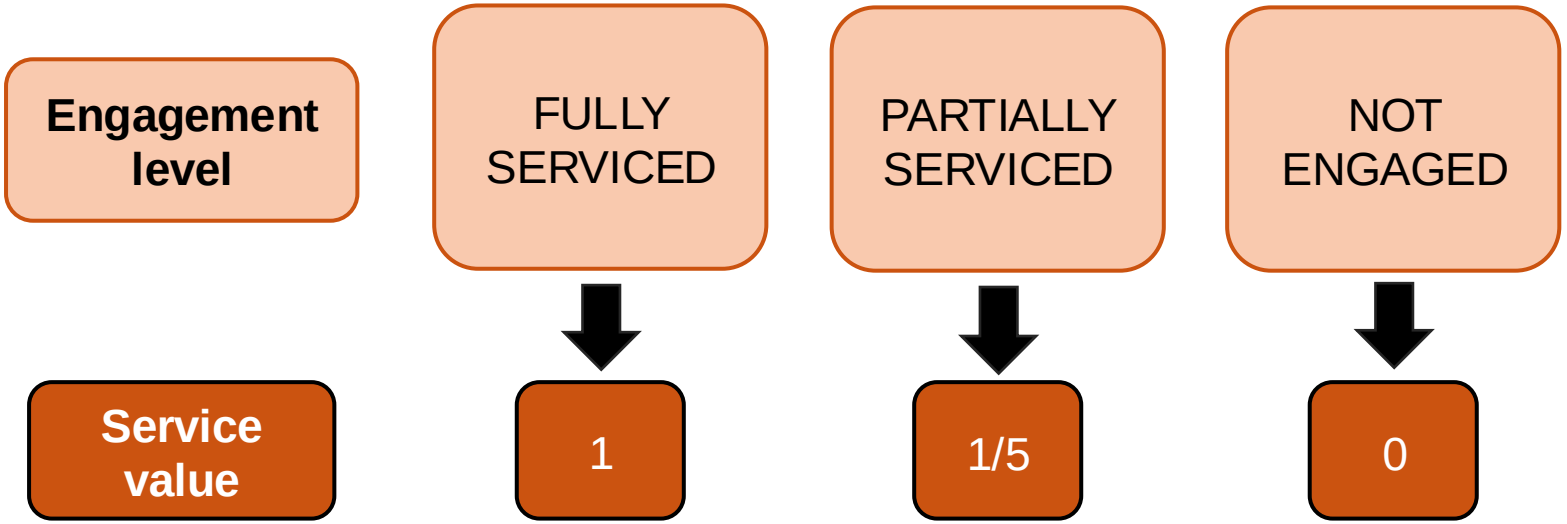

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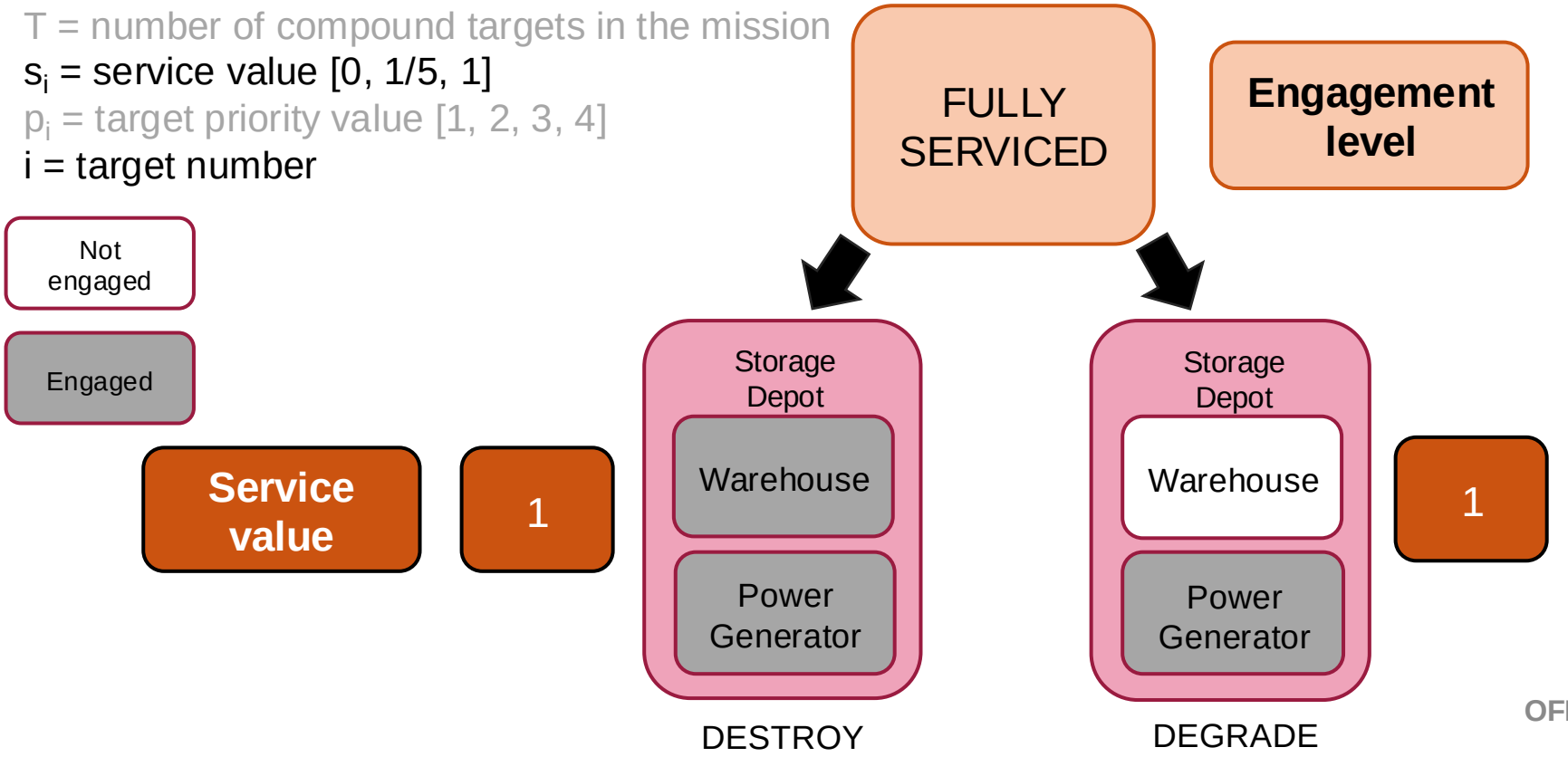

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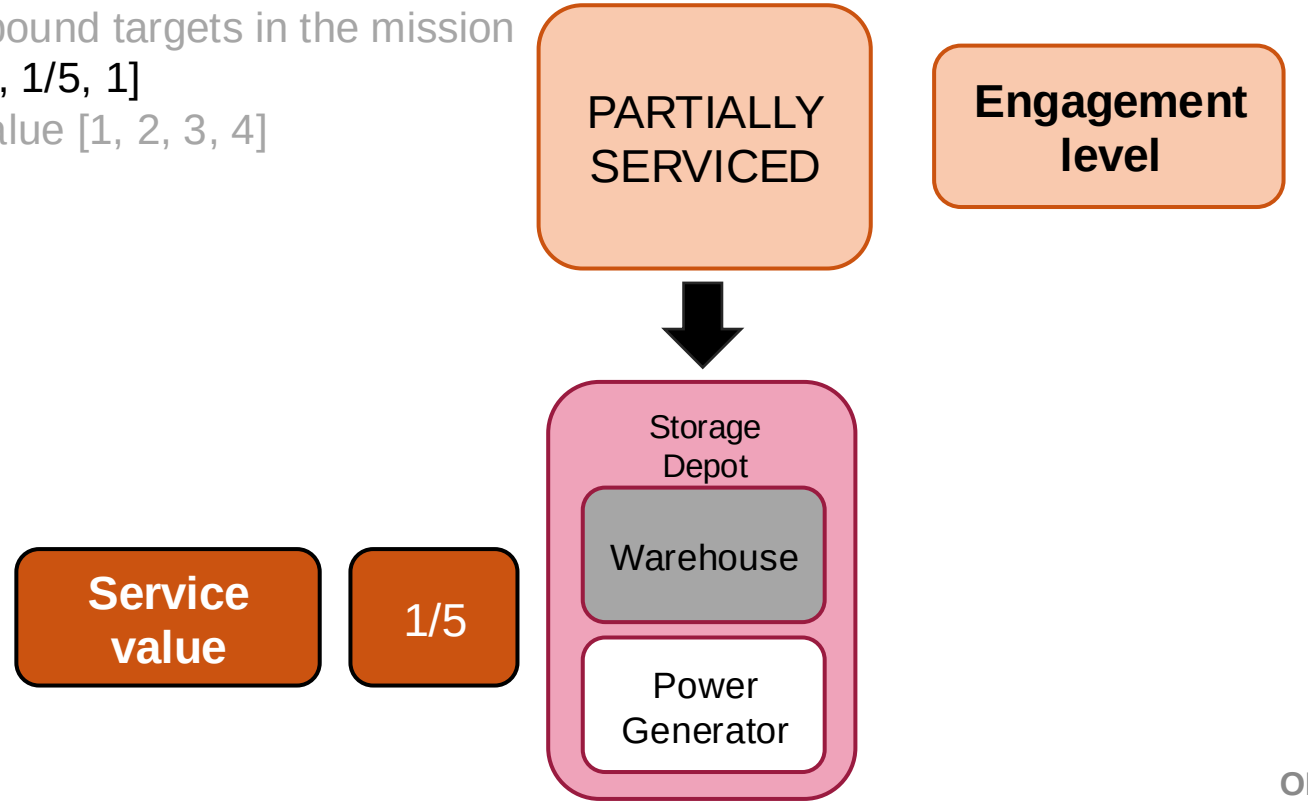
Not engaged

Engaged



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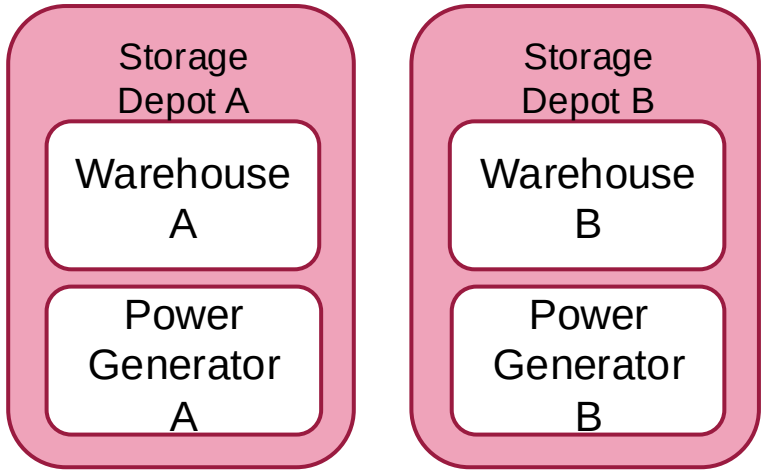

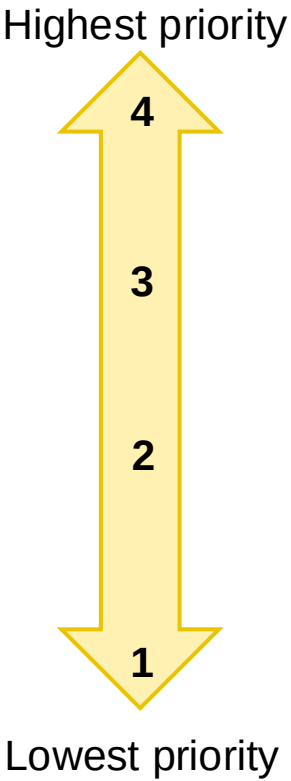

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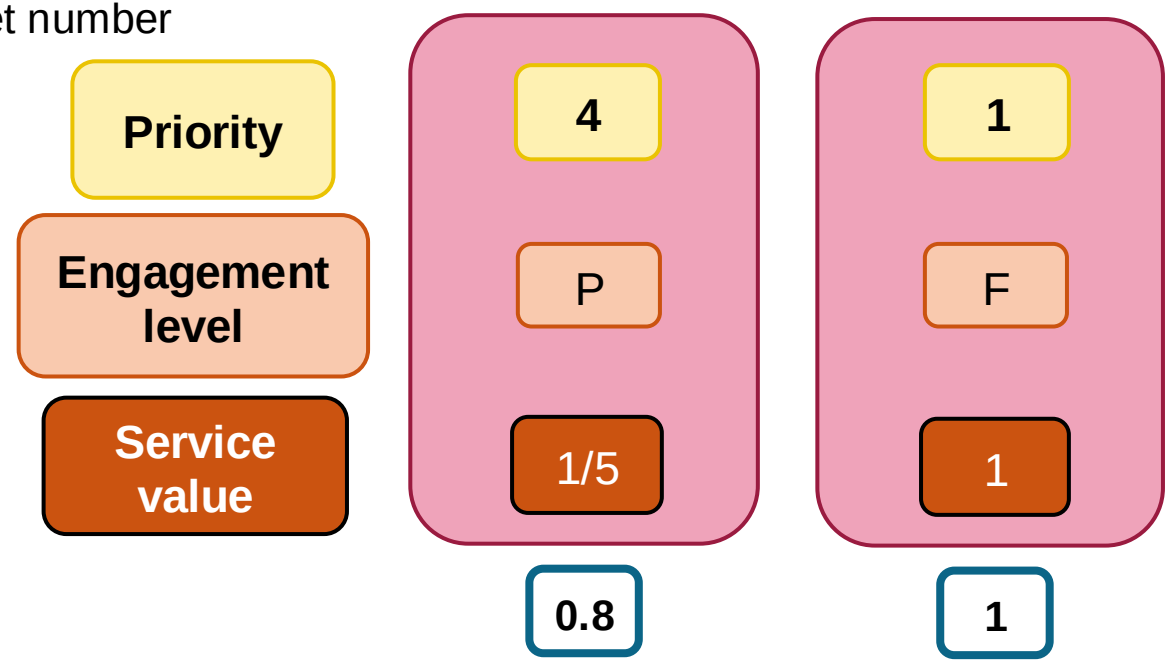

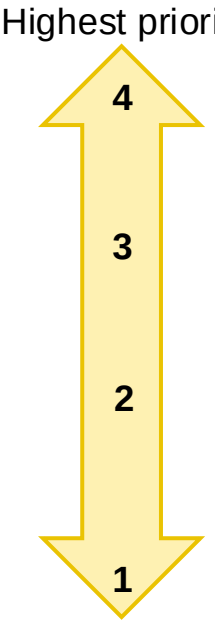

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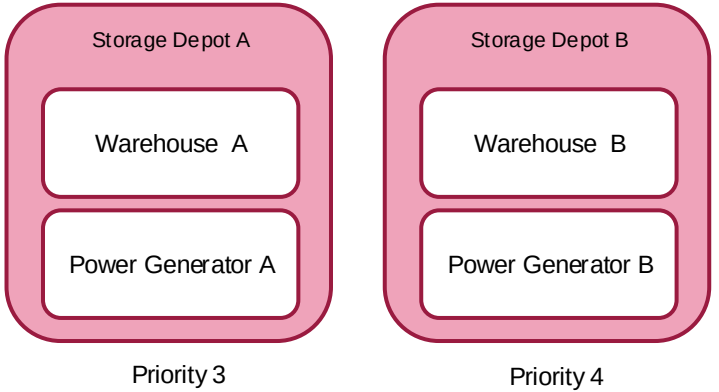
Force Mix Score = Mission **Calculated** Target Engagement Score / Mission **Maximum** Target Engagement Score

Force Mix Score

Mission **Maximum** Target Engagement Score



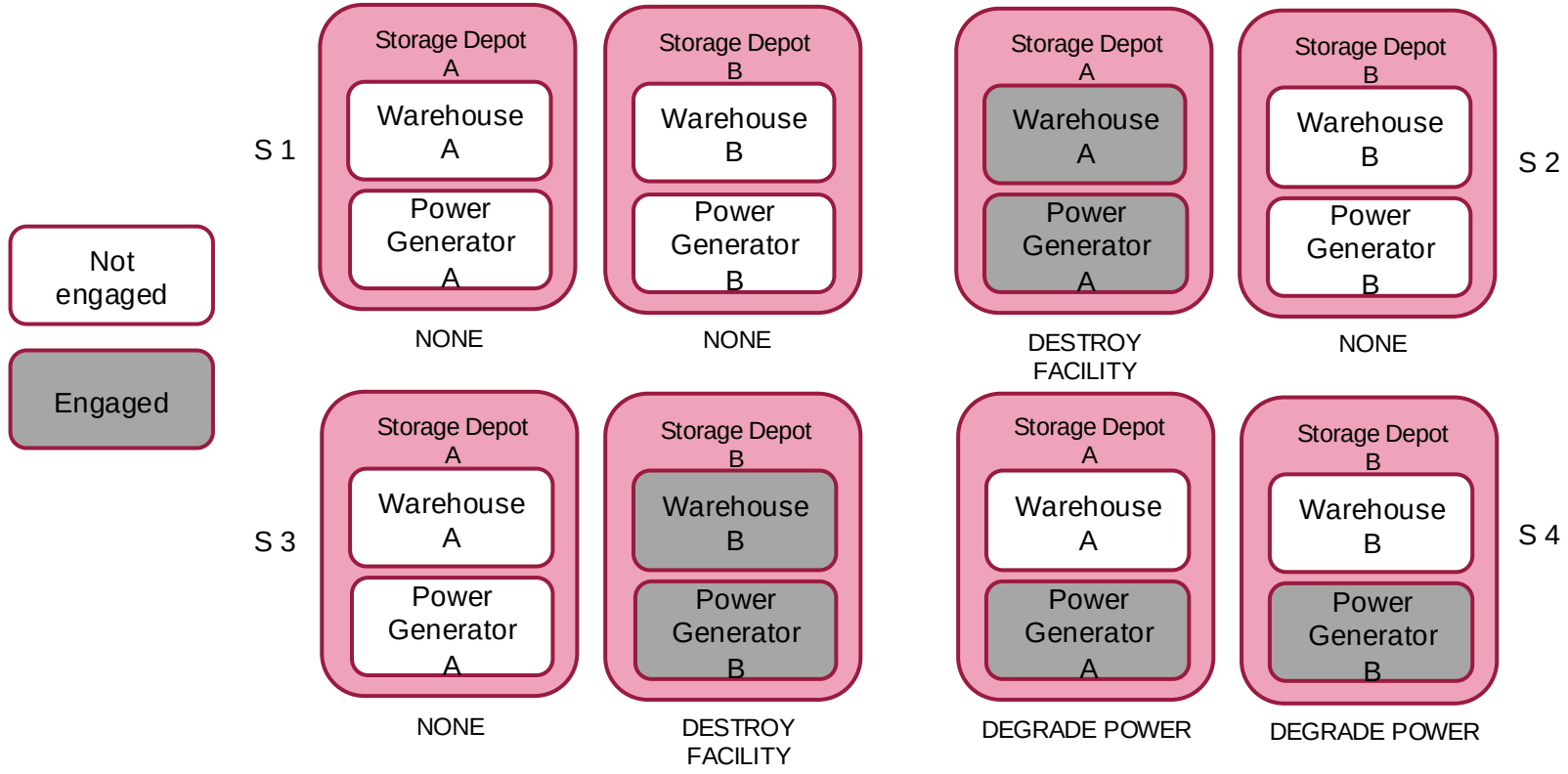
FULLY SERVICED

Service value

Priority

3 * 1 + **4** * 1 = **7**

Force Mix Score



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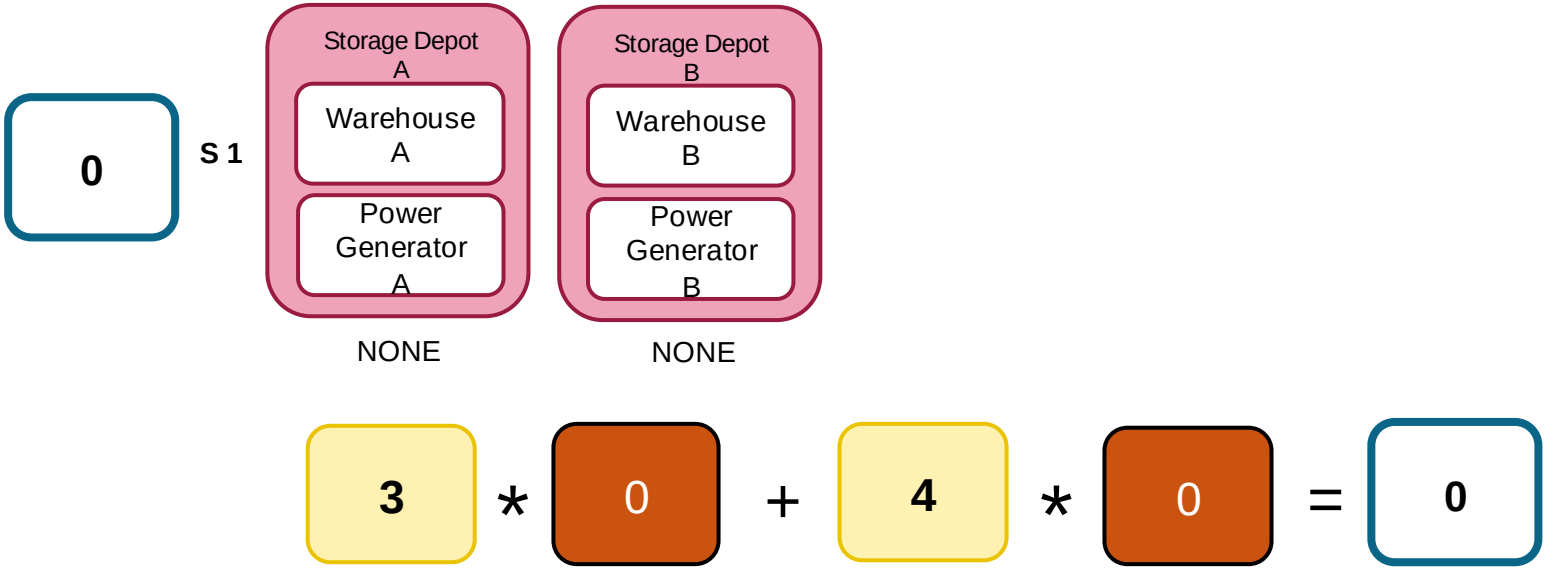

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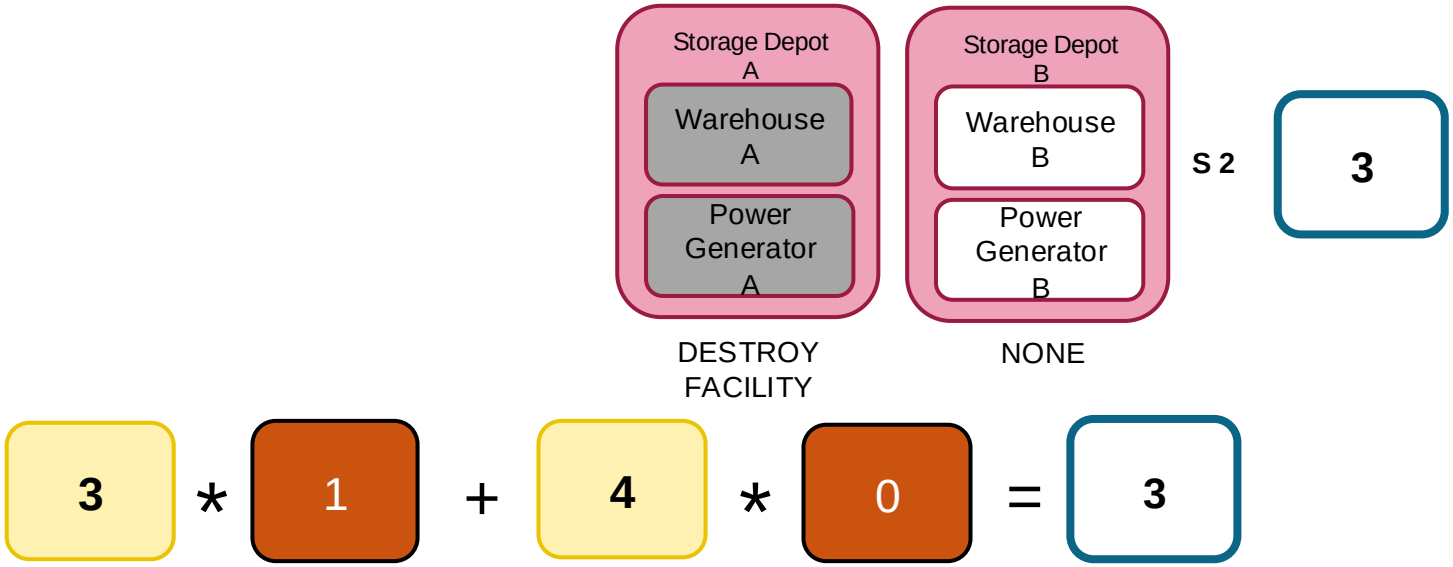

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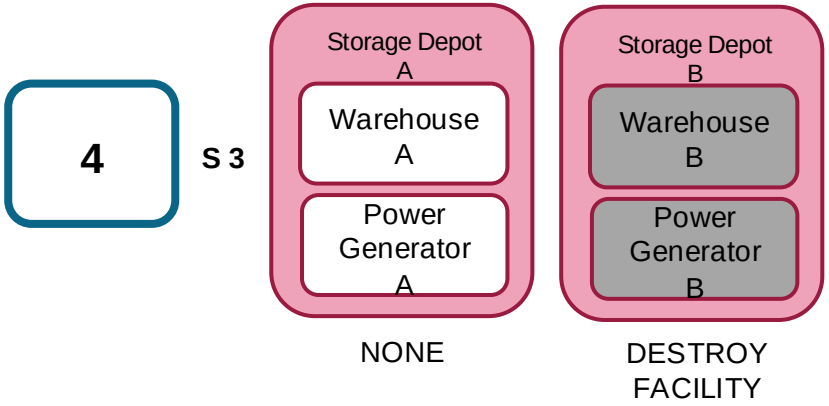

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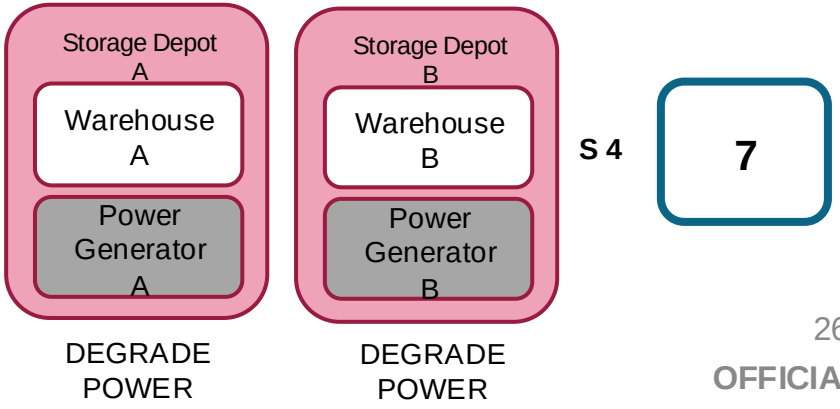

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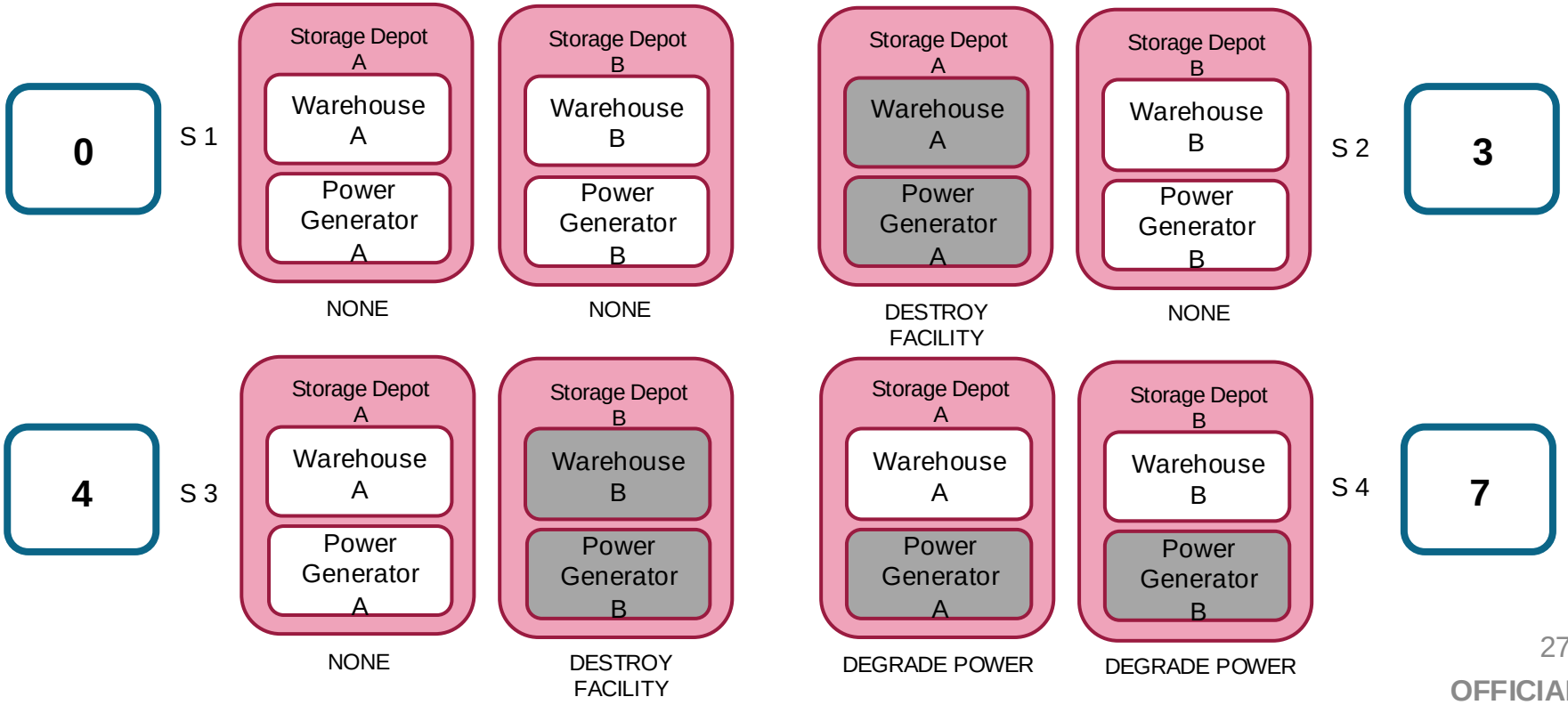
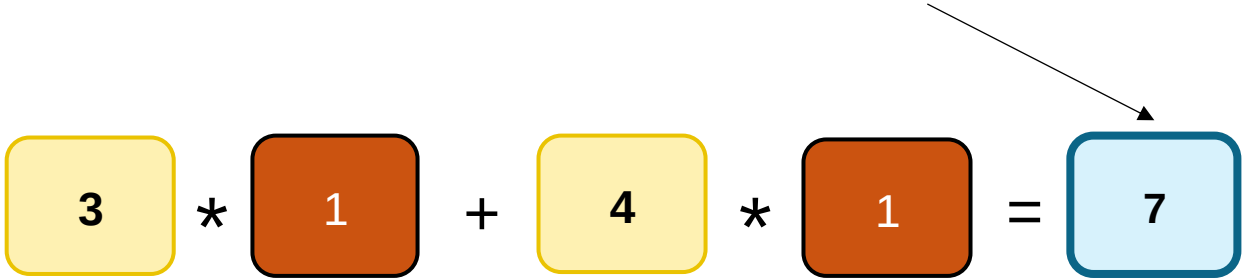


Force Mix Score

Force Mix Score = $\dfrac{\text{Mission } \textbf{Calculated} \text{ Target Engagement Score}}{\text{Mission } \textbf{Maximum} \text{ Target Engagement Score}}$



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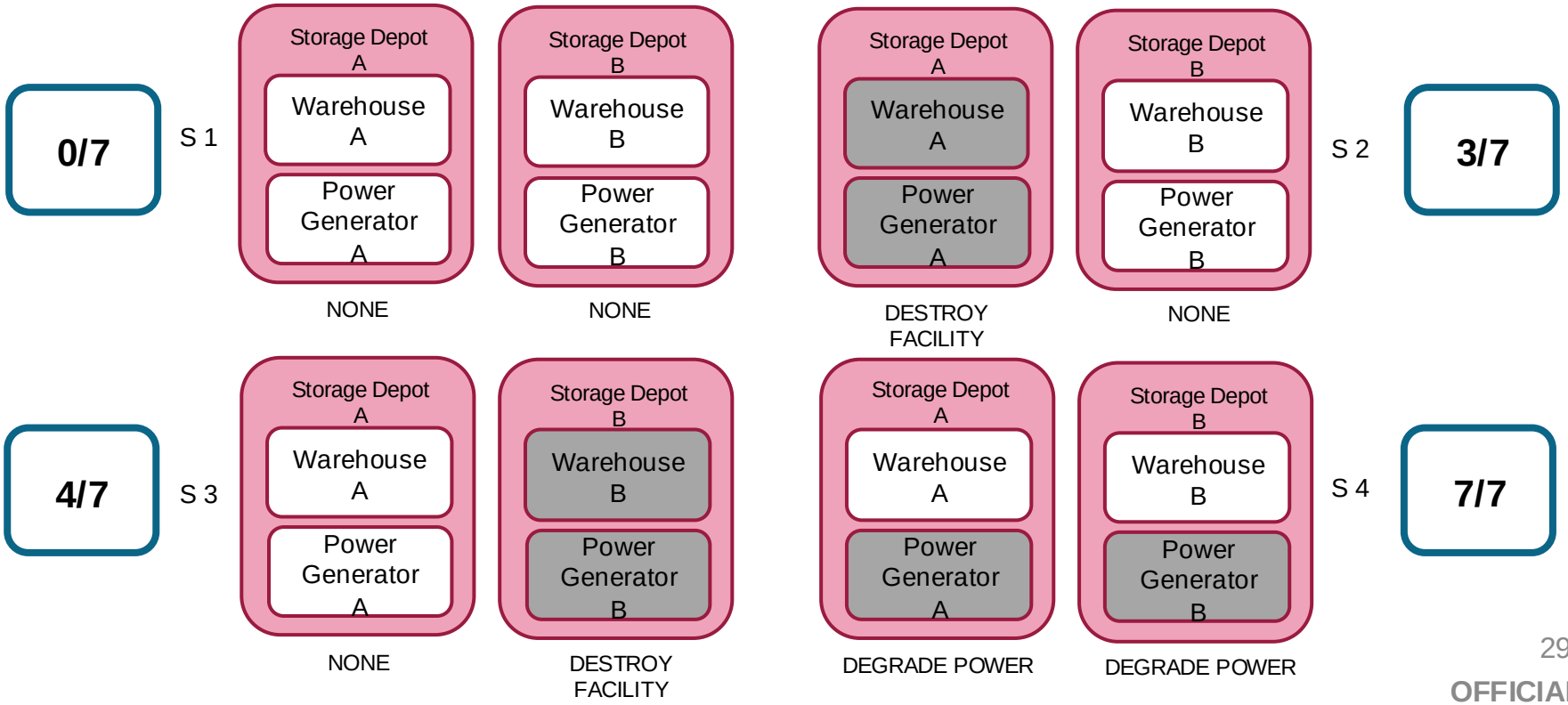

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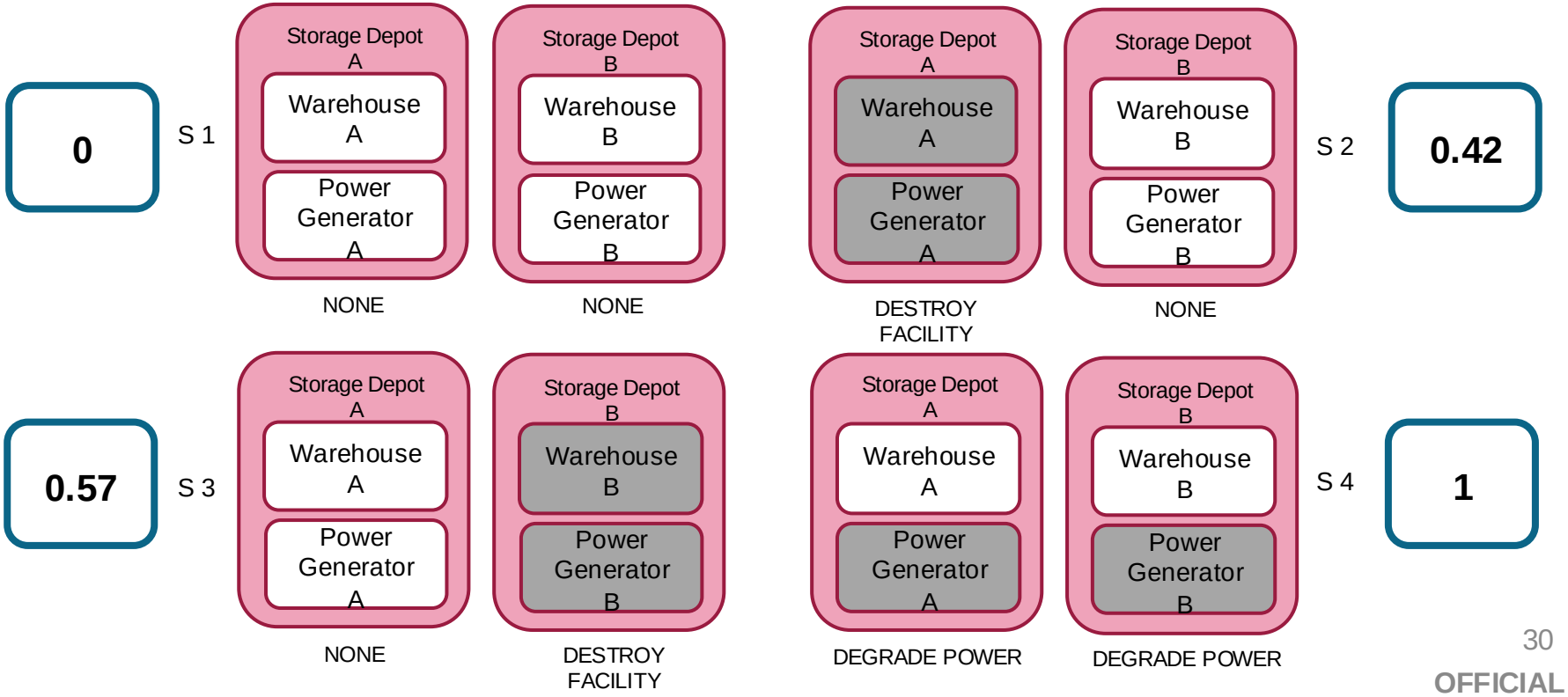

Applications of Force Mix Score

- We can use it to assess mission clustering configurations

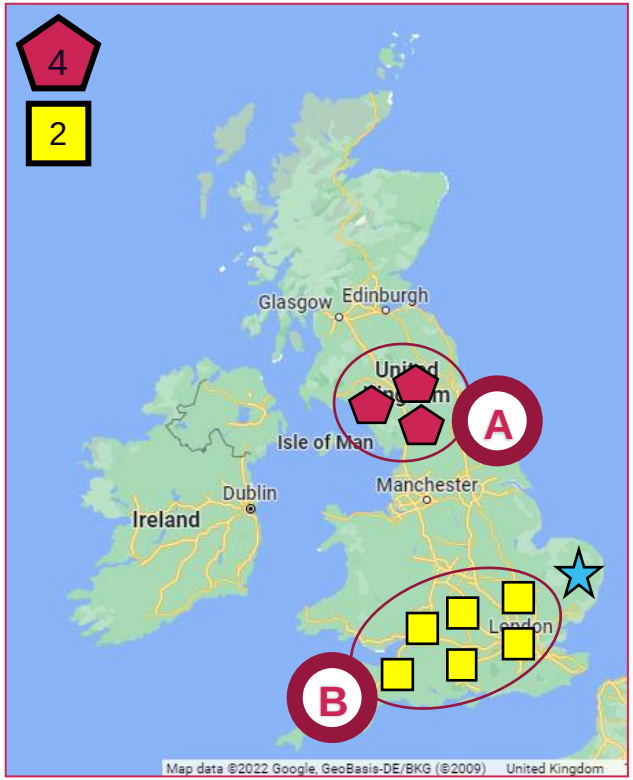

Image source: maps.google.com

Applications of Force Mix Score

- Comparing situations where multiple platforms are available

Image source: maps.google.com

- Platform A
- FMS: 0.7

- Platform A & B
- FMS: 0.8

Applications of Force Mix Score

- We can also apply Force Mix Score to the outcome of simulation engagements.

Image source: maps.google.com

Scenario	FMS	Weapons launched	Platforms lost
A	0.8	20	3
B	0.76	25	1
C	0	0	10
D	0.24	4	0

Applications of Force Mix Score

- Now imagine we need to assess a scenario like this:

- Consider…
  - The number of clusters
  - Platforms available
  - Priority of targets
  - Weapons required
  - Cost
  - Risk to blue
  - Collateral considerations

Image source: maps.google.com

Wrapping up

- Force Mix Score is a useful tool that can be used for mission planning and analysis of simulation results.
- It relies on Effects Trees and breakdown of compound targets into their key target elements.
- It helps planners utilise resources in order to achieve high levels of mission effectiveness.
- It is used to support MOD decision makers quickly make sense of complex military scenarios.

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Discover more