



Applying Systems Engineering Techniques
to the
Budgeting Decision
for
Complex Systems
with
Monsarrat®

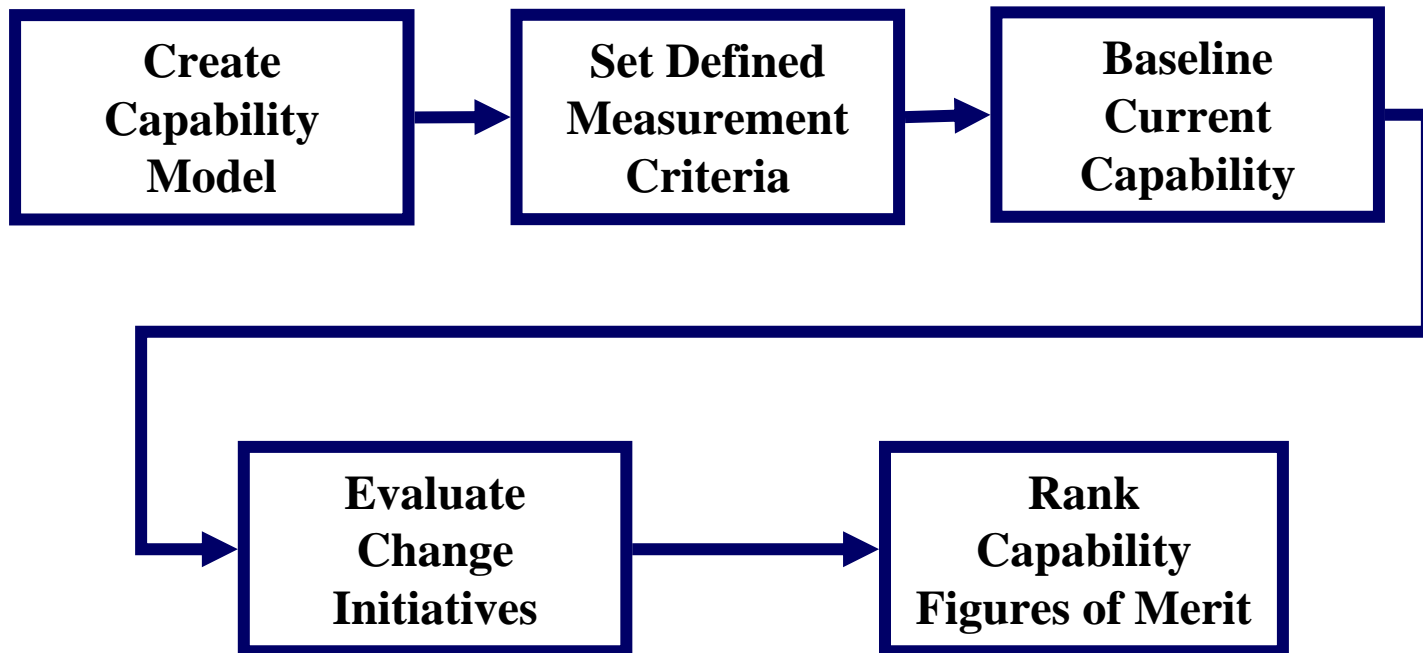
Introduction

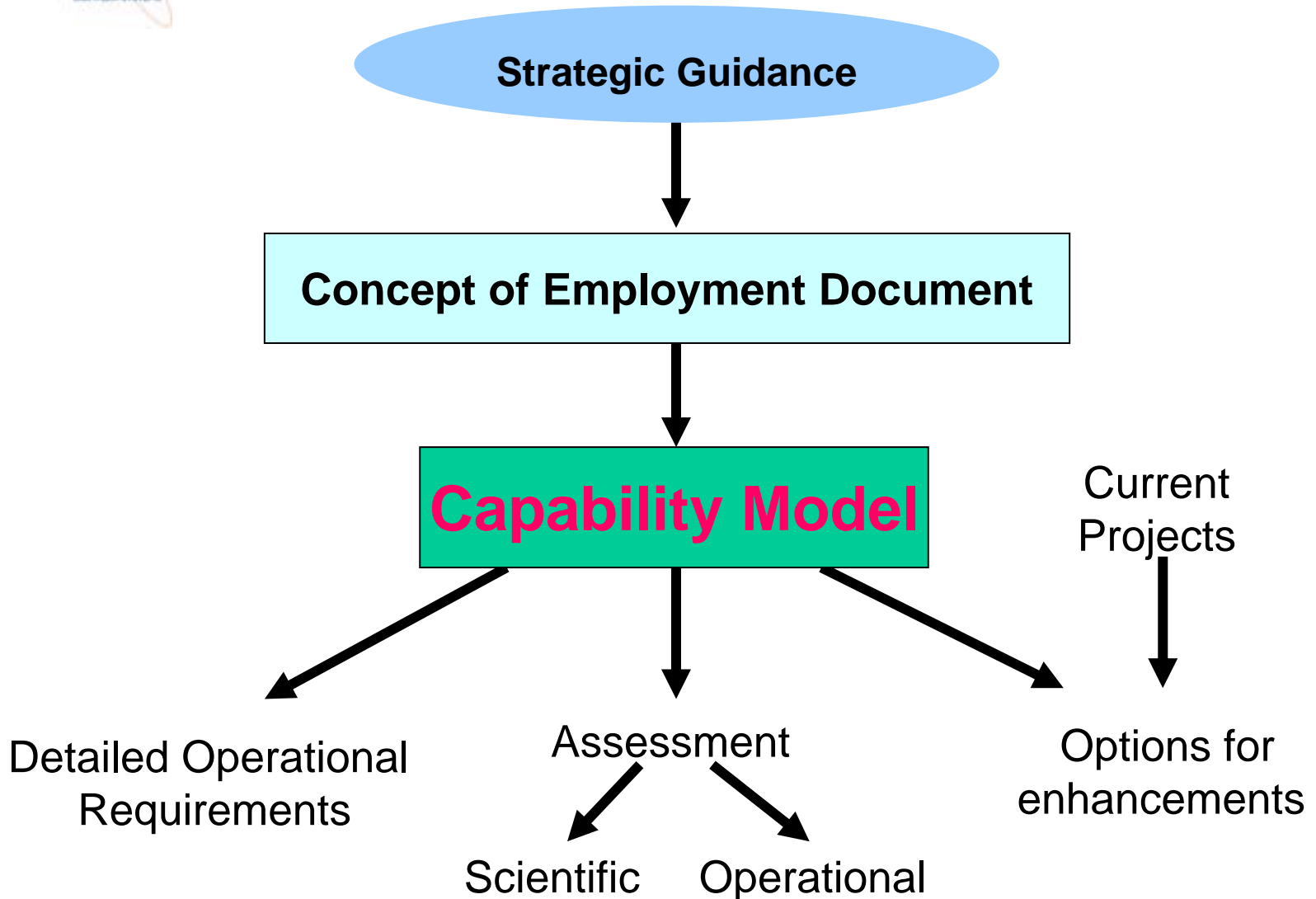
- In 2001, after rectification of the Prescott Enquiry deficiencies, the Collins Submarine Project and FEG was faced with some 270 disparate initiatives to enhance the submarine force's capability.
- Various stakeholders were pushing their own initiatives.
- 'Apples' v 'Oranges' decisions.
- The challenge was to decide which to progress, within budget constraints.



- To address the problem, a decision process and tool, Monsarrat[®], was developed.
- Monsarrat has now been deployed with the Amphibious & Afloat Support FEG for the LPA and Oiler capabilities and ACT Justice & Community Safety Department.

BASIC MONSARRAT PROCESS





Capability Model

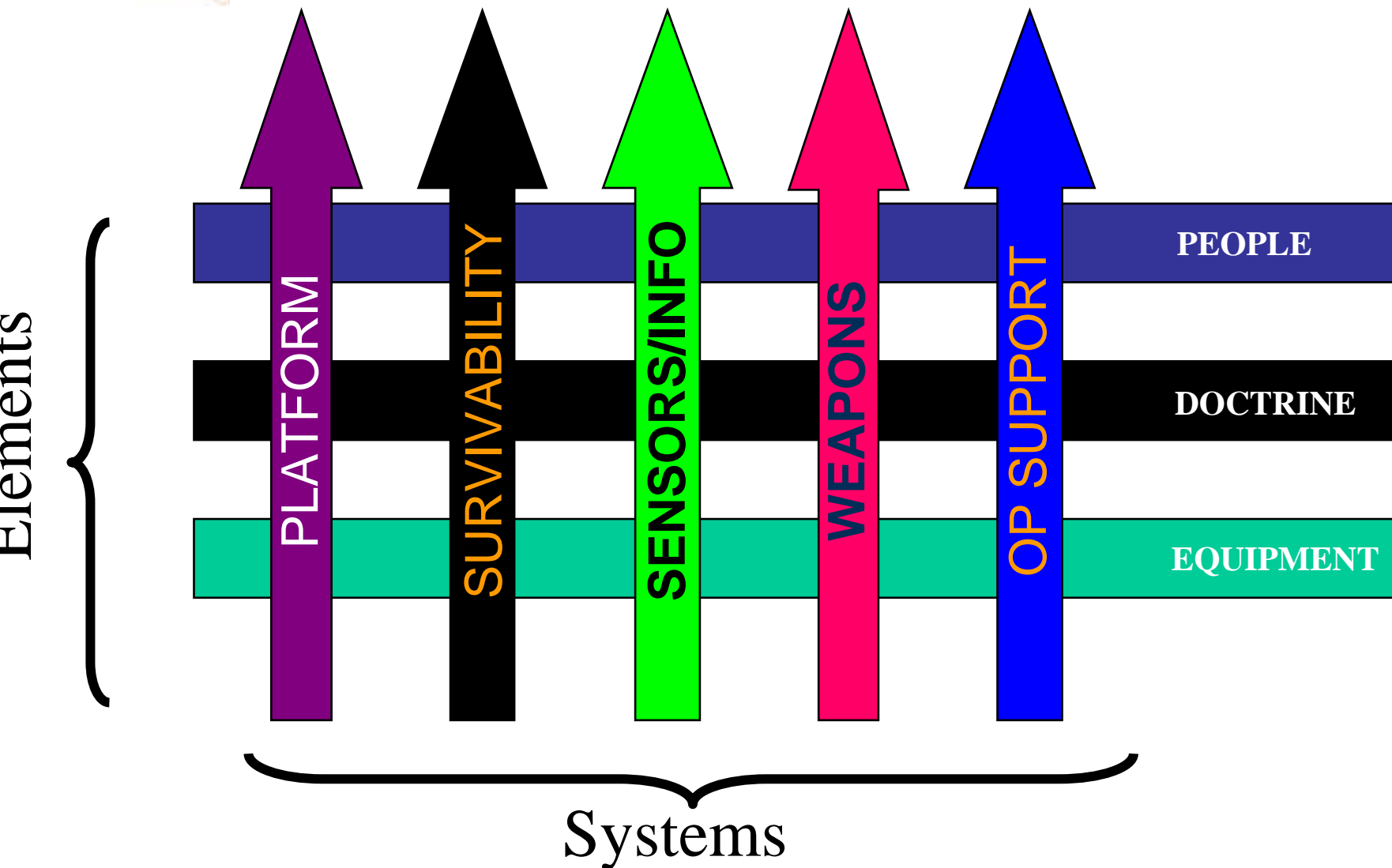
- A “future proof” set of concise statements summarising all the functional factors that contribute to the outputs of an organisation.
- A grouping of these statements according to:
 - **Systems,**
 - **Elements, and**
 - **Operating Environments.**

Capability Systems

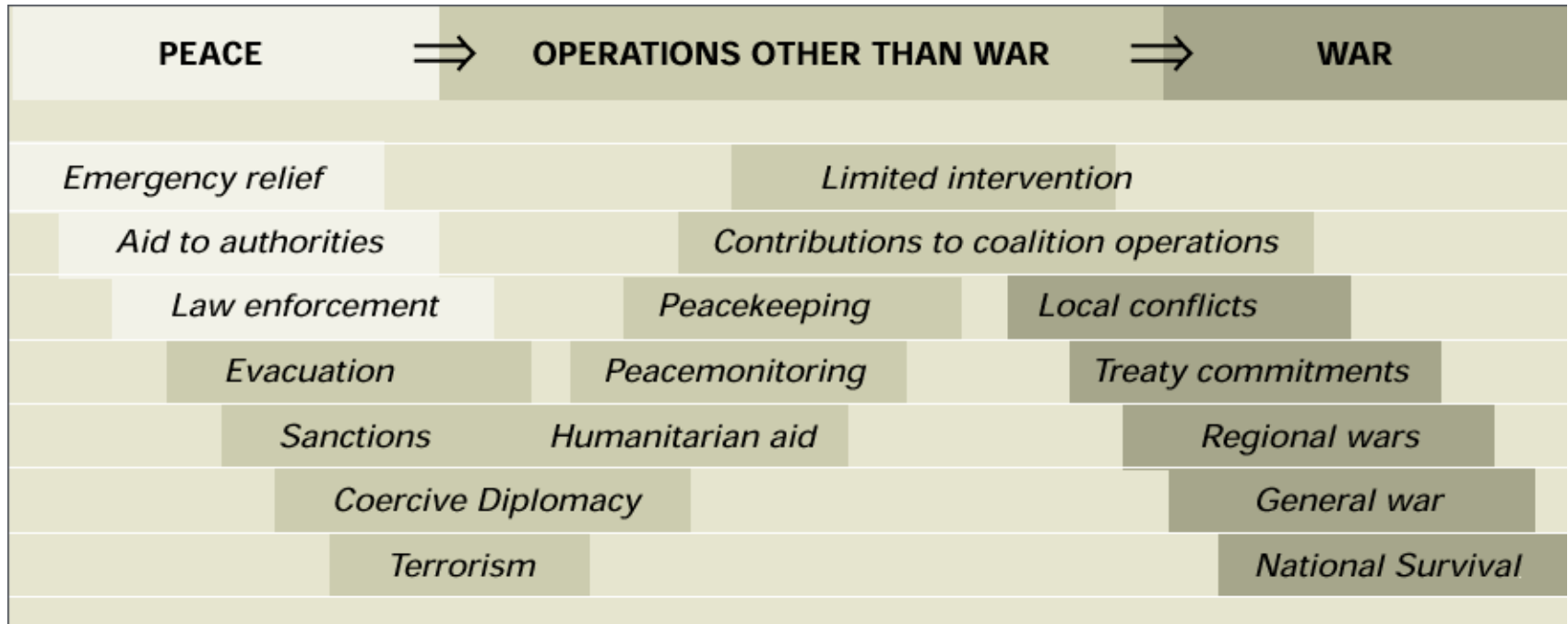
'Capability Contributors' may be allocated to systems or sub-systems; for example:

- **Platform**
- **Survivability**
- **Sensors and Information**
- **Weapons**
- **Operational Support**
 - ***Each System comprises many contributing sub-systems...***

Example Model: A Submarine Force



A 3rd Dimension... 'Tempo'



From "Force 2020" Page 9

Tempo's for a submarine force

Tempo 1

Trials and Training

Short duration, no threat, emphasis on platform

Tempo 2

Peacetime Surveillance Patrol

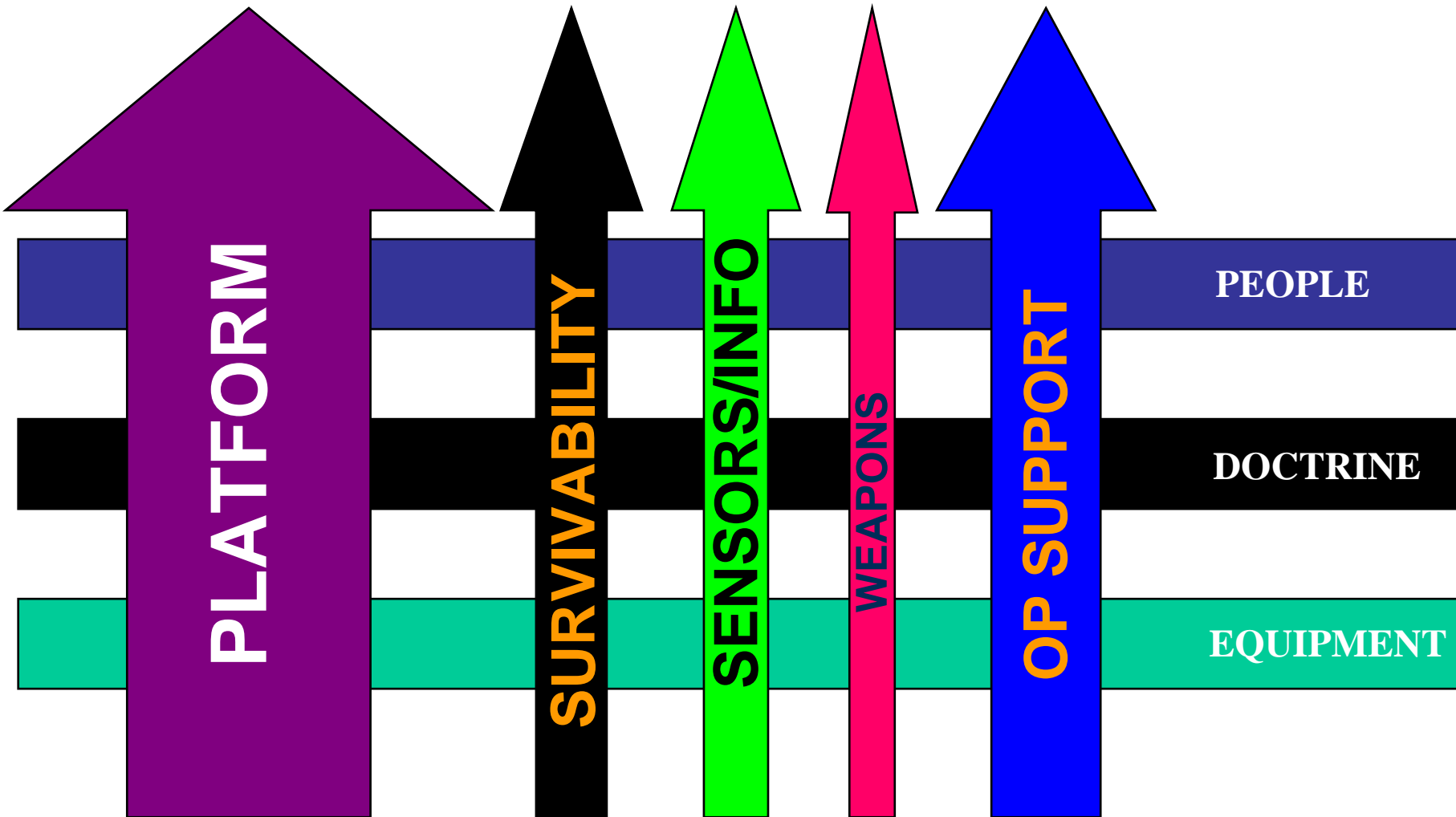
Medium duration/range, self-defence, emphasis on sensors

Tempo 3

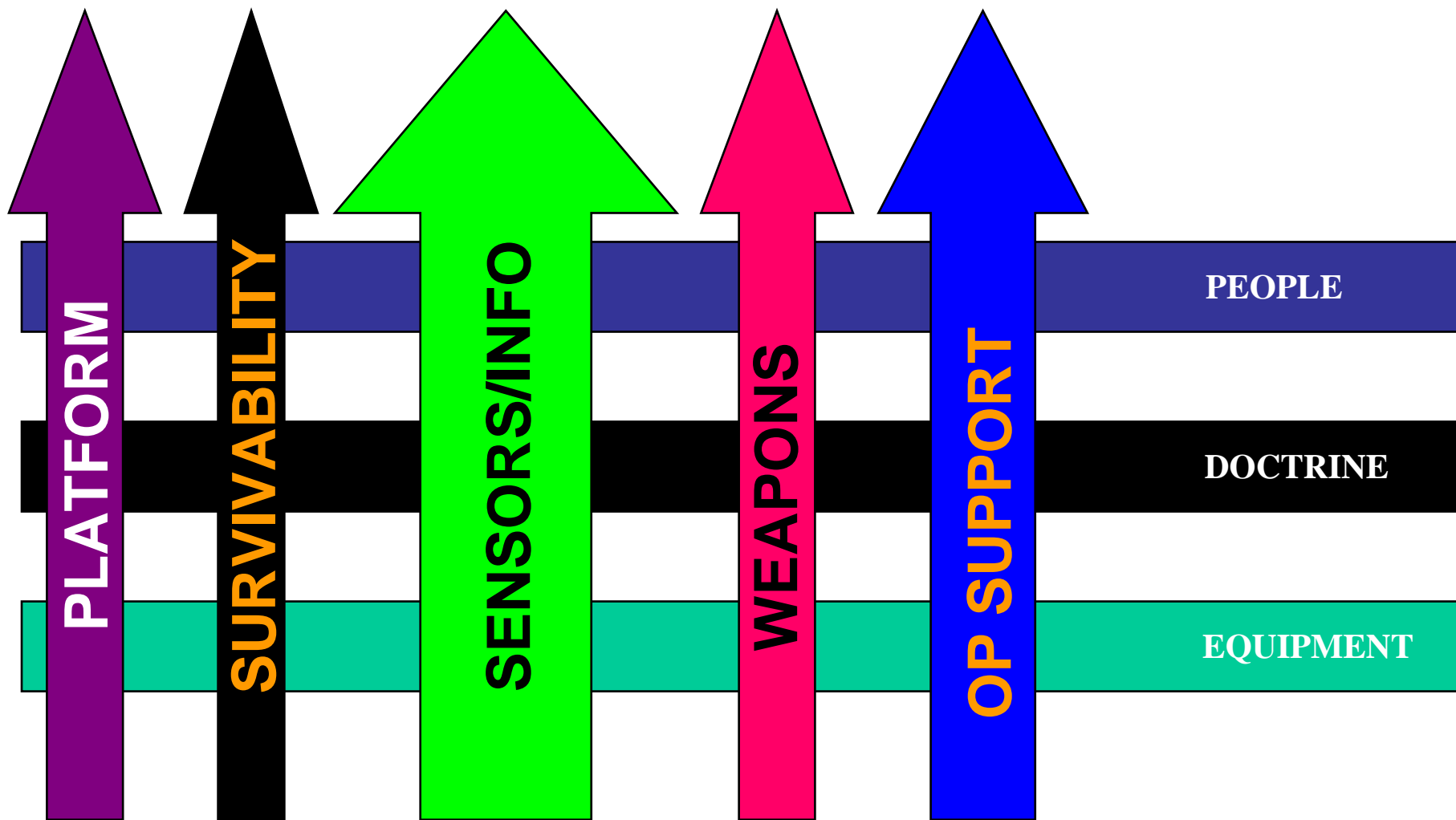
Wartime Operations

Long duration/range, emphasis on weapons & complex warfare

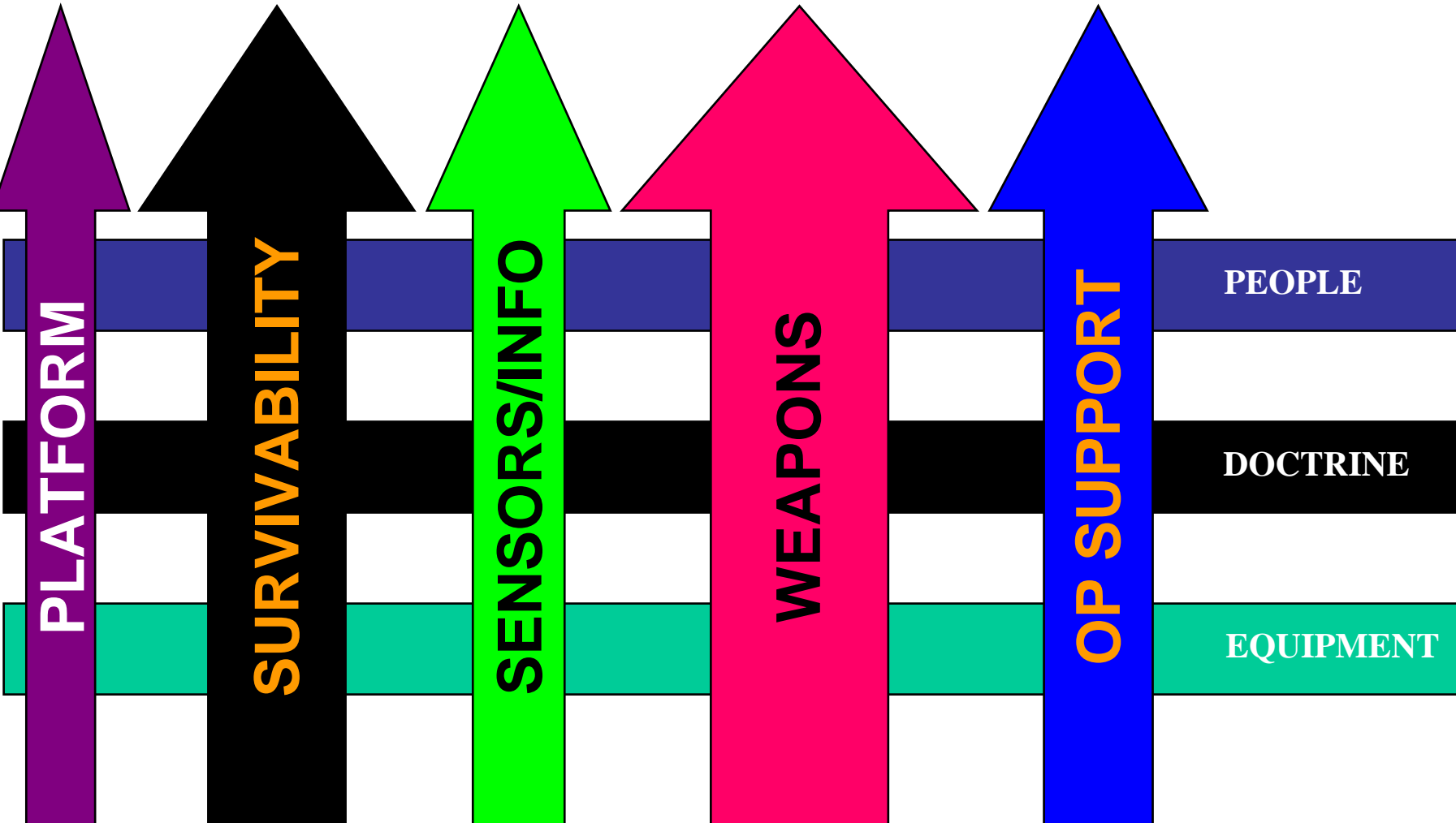
Submarine Capability - Tempo 1

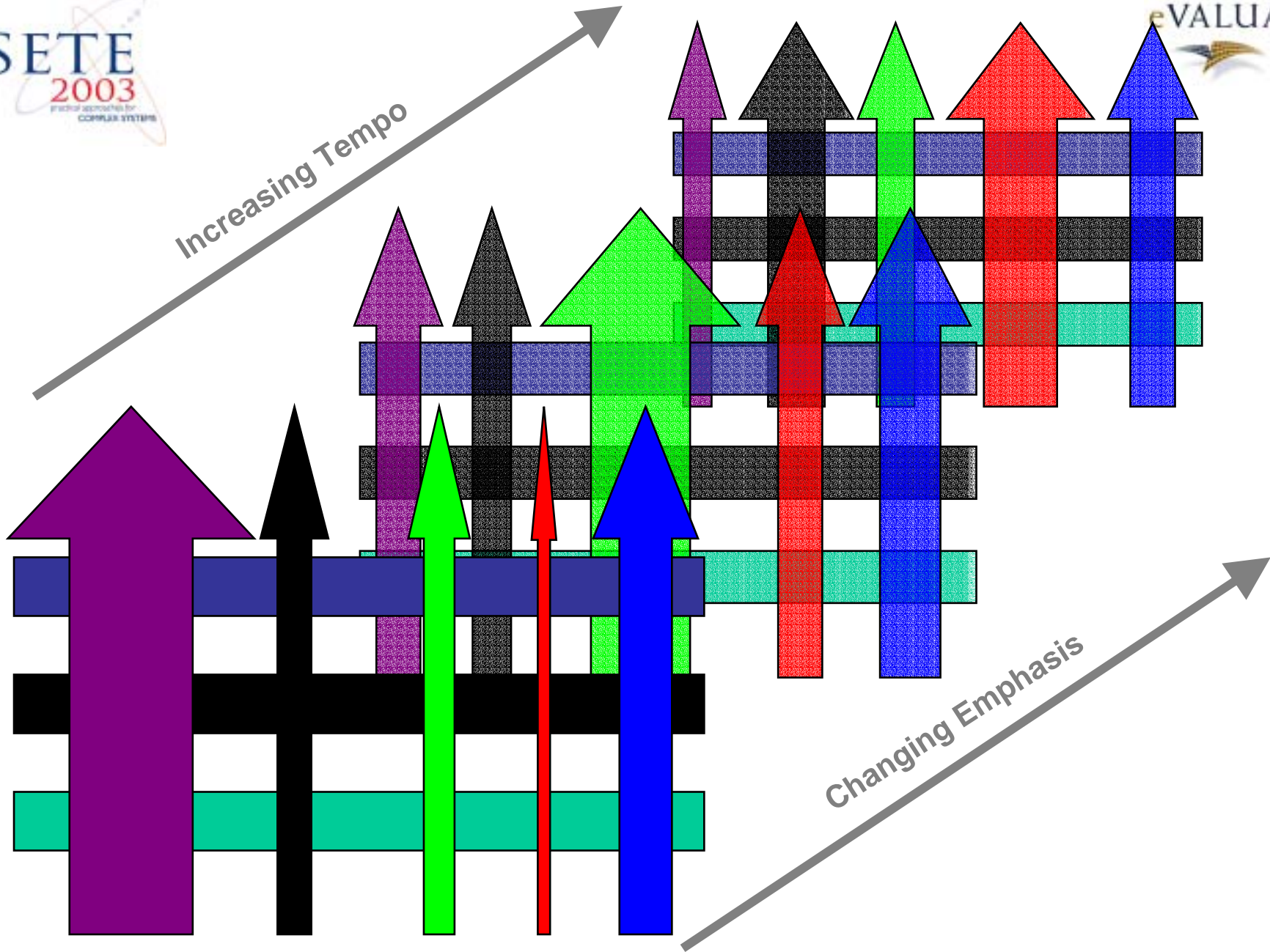


Submarine Capability - Tempo 2

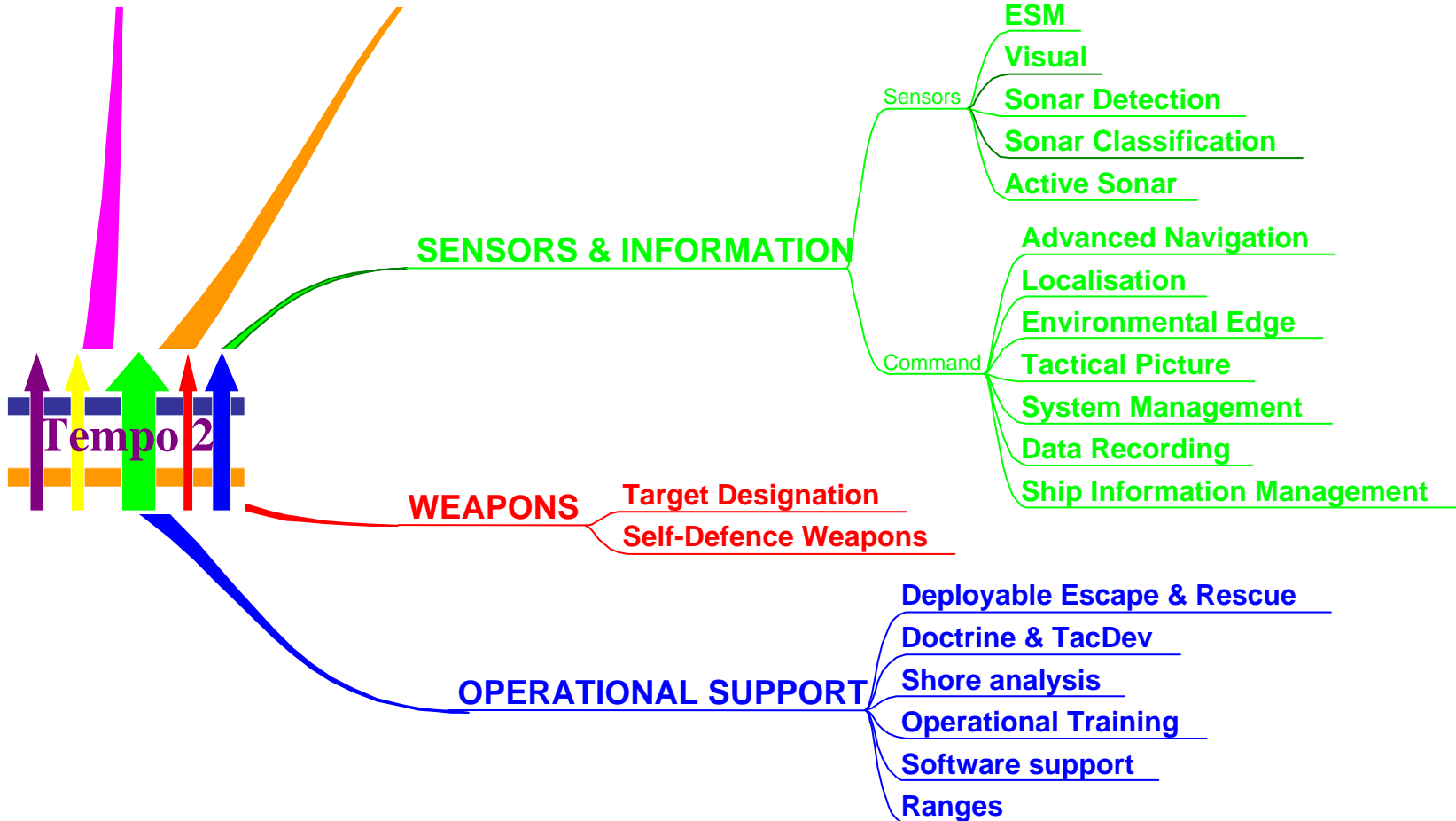


Submarine Capability - Tempo 3





Tempo 2 Capability Contributors

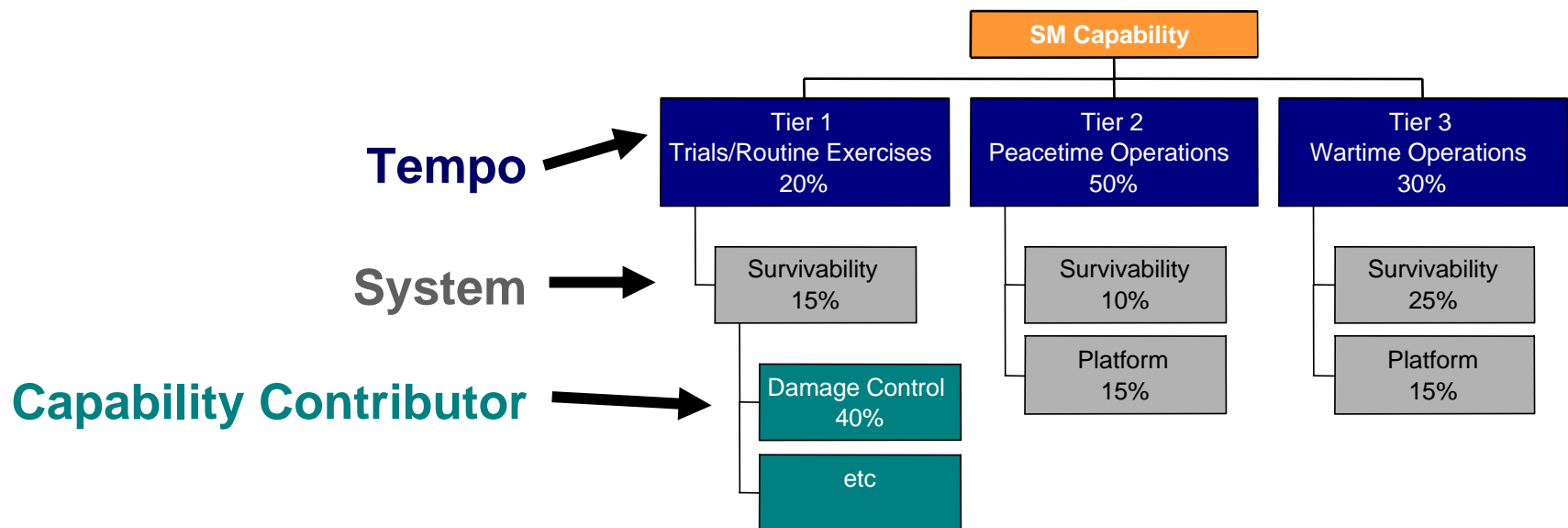


Example “future proof” description

Stability, Buoyancy & Depth Keeping:

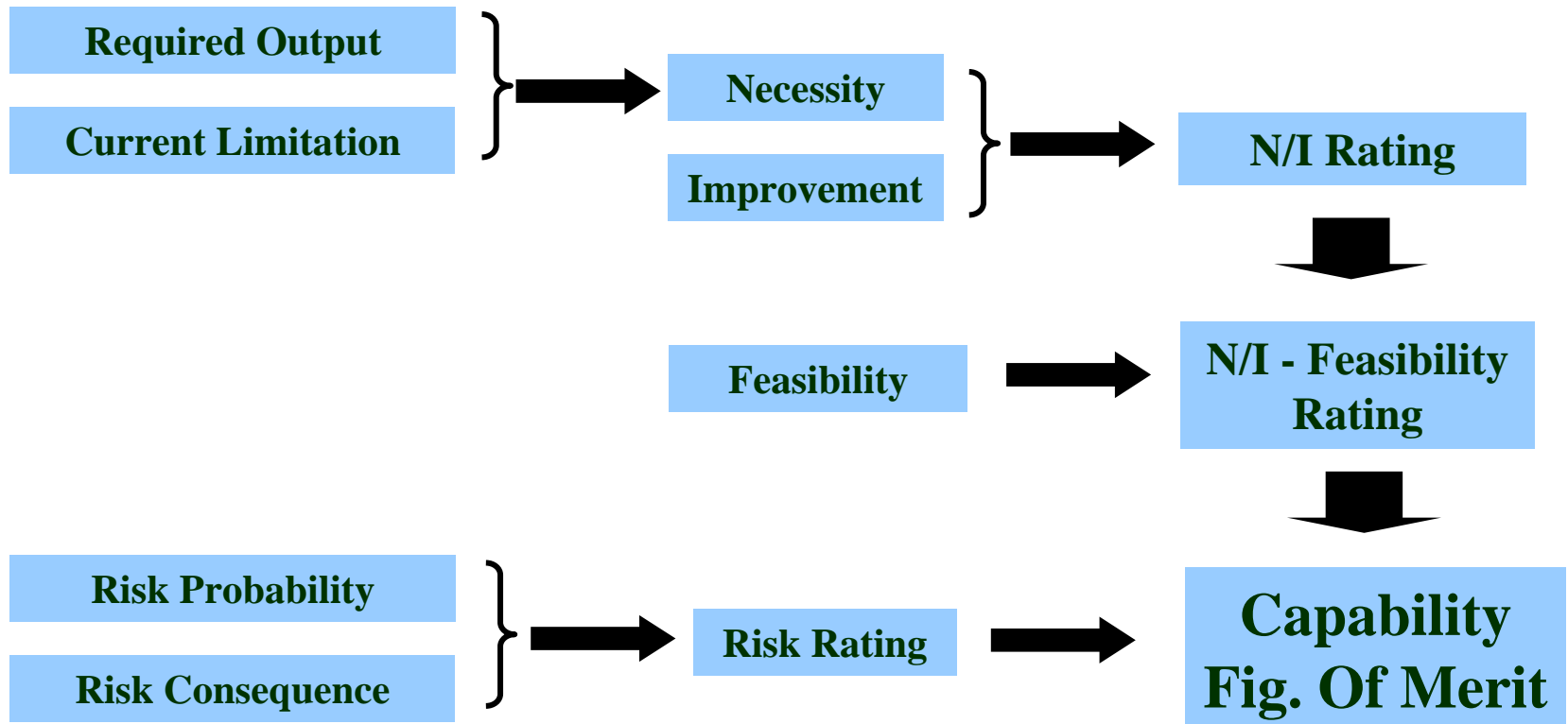
“The ability to dive and to surface, to control the depth and bodily weight, and to compensate for embarked stores in all water conditions found within the submarine area of operations, while maintaining adequate margins of stability.”

Evaluation Architecture



Capability Evaluation Criteria

Capability Evaluation Criteria are contained in Tables and matrices to enable the evaluator to make consistent judgments by combining differing decision points in a logical sequence to develop a Figure of Merit



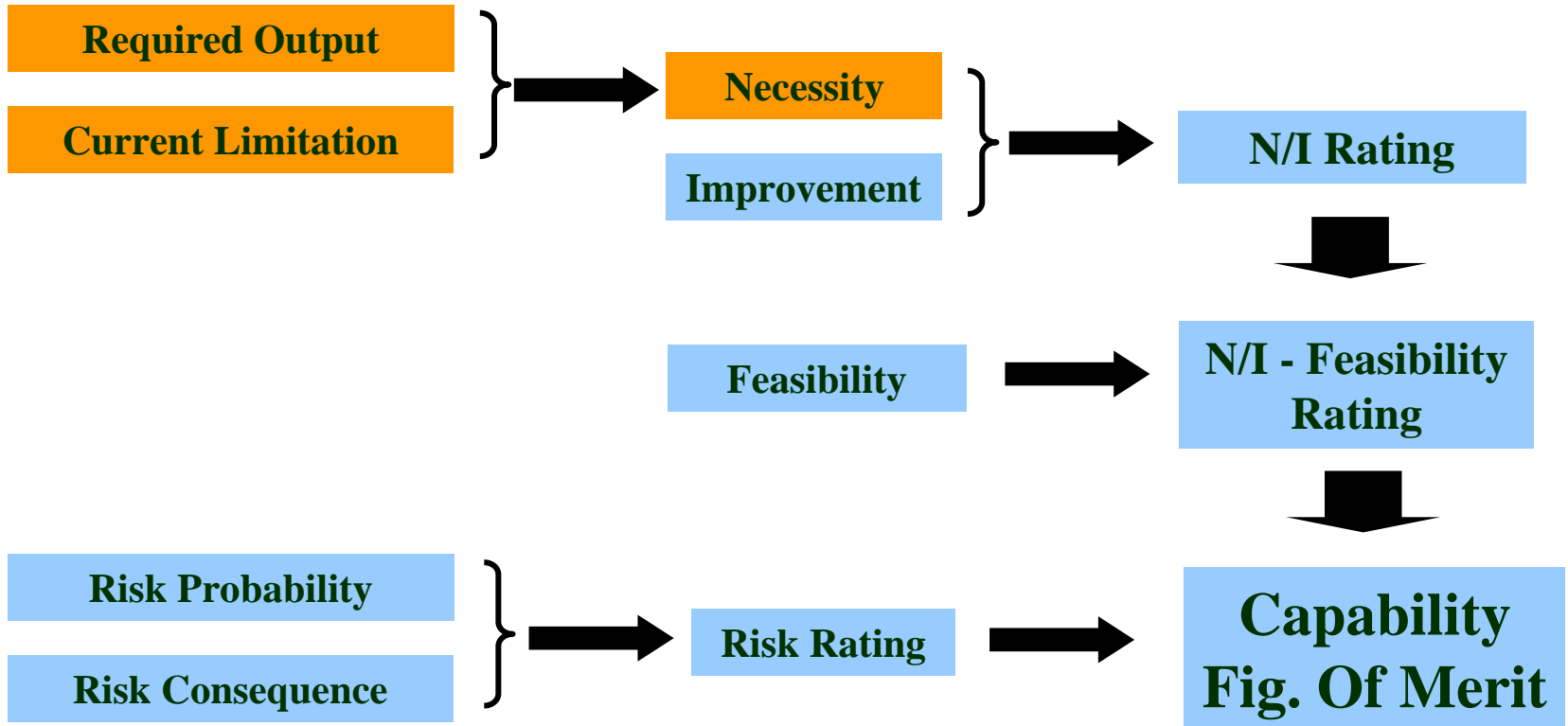
Required Output

| | |
|-------------|--|
| Essential | <ul style="list-style-type: none"> * Capability is required to accomplish mission. * Without capability mission must be aborted or not assigned. |
| Important | <ul style="list-style-type: none"> * Capability is a significant factor in ability to accomplish mission. * Lack of capability significantly increases the probability of not being able to accomplish mission. |
| Substantial | <ul style="list-style-type: none"> * Capability contributes to mission efficiency and effectiveness. * Without the capability the mission can be accomplished but with some degradation in the planned outcomes. |
| Desirable | <ul style="list-style-type: none"> * Capability is not mandatory for mission outcomes. * Capability may be desirable for other reasons. |
| | |

Current Limitation

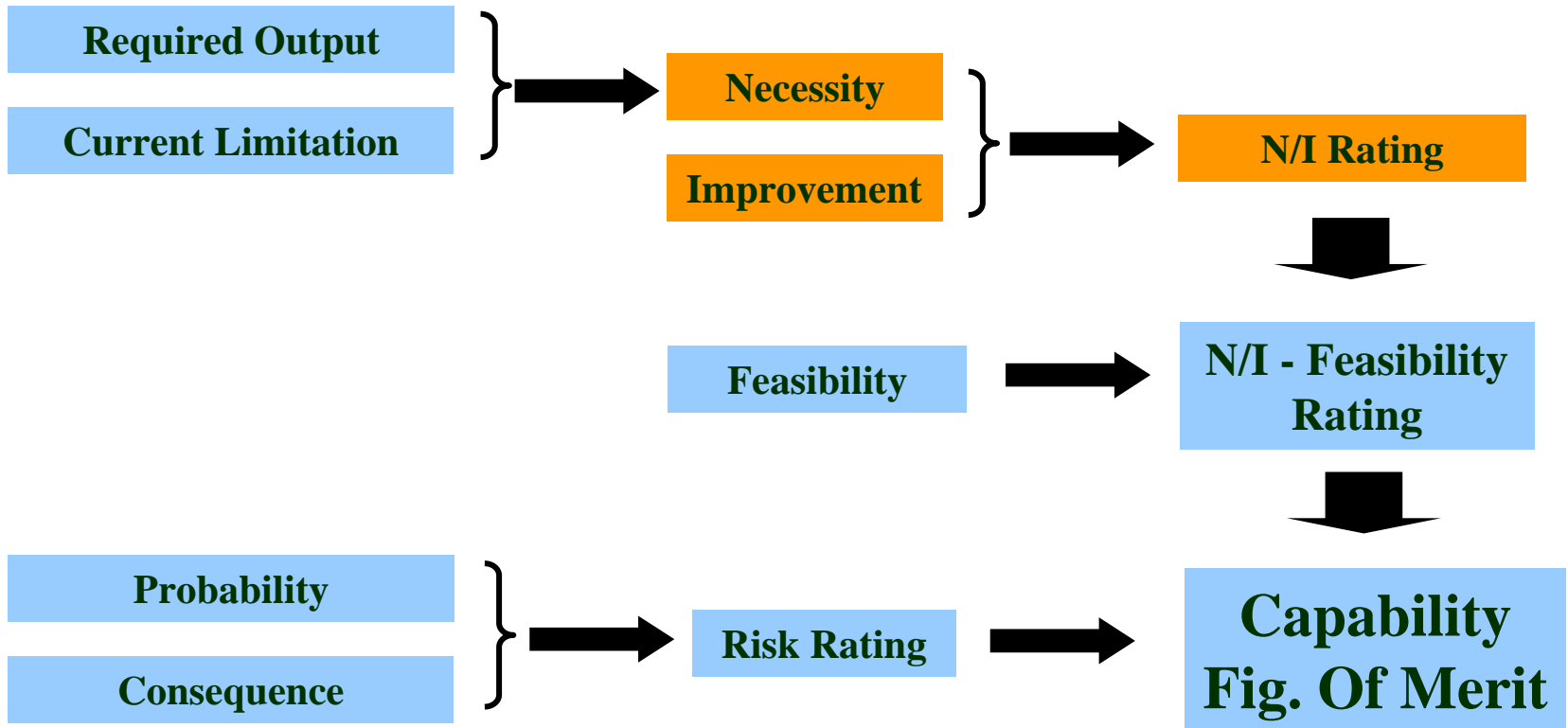
| Description | Definition |
|---------------|---|
| No Capability | <ul style="list-style-type: none"> * No capability exists in this area. * Capability is unable to meet requirements at any level. * Prevents assignment of mission items requiring capability. |
| Critical | <ul style="list-style-type: none"> * Limitation is such that capability is inadequate to achieve its purpose due to degradation, reliability or underdevelopment. * Prevents achievement of mission items requiring the capability that are consistent with current preparedness directives. |
| Major | <ul style="list-style-type: none"> * Limitation significantly reduces capability, but does not preclude scheduled operational activities. * Significantly increases the probability of not being able to complete potential operational tasking with current preparedness directives and the capability of the submarine. |
| Minor | <ul style="list-style-type: none"> * Limitation reduces operational effectiveness, however the mission can be accomplished with an approved workaround or ad hoc arrangement. * Able to complete operational tasking with current preparedness directives. |

TABLE RELATIONSHIPS



Necessity Index

| | | | | | |
|---------------------------|----------------------|------------------|------------------|--------------------|------------------|
| Current Limitation | No Capability | 1 | 3 | 6 | 10 |
| | Critical | 2 | 5 | 9 | 14 |
| | Major | 4 | 8 | 12 | 15 |
| | Minor | 7 | 11 | 13 | 16 |
| | | Essential | Important | Substantial | Desirable |
| Required Output | | | | | |

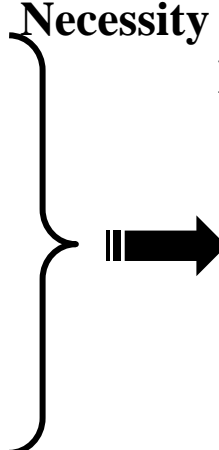


Improvement Table

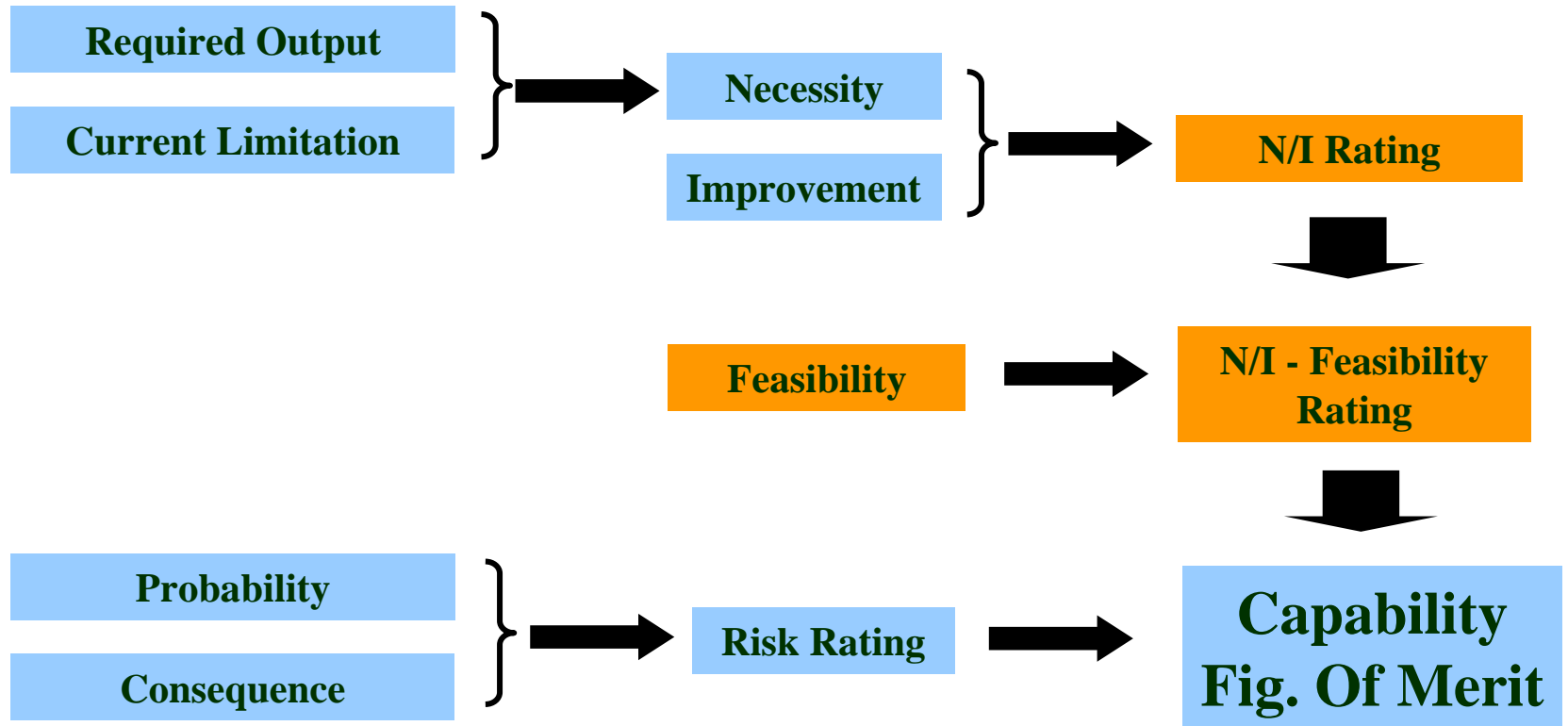
| Improvement Rating | Definition | Guiding Score |
|-------------------------|--|---------------|
| Significant Improvement | Provides the maximum possible enhancement to current capability | 9 - 10 |
| Major Improvement | Enhances current capability with few exceptions which are of no consequence | 6 - 9 |
| Minor Improvement | Enhances current capability with some exceptions | 3 - 6 |
| Negligible Improvement | Has a small positive impact on current capability | 0 - 3 |
| Negligible Degradation | Has a small negative impact on current capability | 0 to -3 |
| Minor Degradation | Reduces current capability in some areas | -3 to -6 |
| Major Degradation | Reduces current capability to the extent that other operations may not be possible | -6 to -9 |
| Significant Degradation | Effectively removes capability in this area | -9 to -10 |

Necessity - Improvement

Necessity

| | | | | | | | | | |
|--------------|-----------|-----------|-----------|-----------|-----------|------------|------------|-----------|--|
| 1-5 | Neg | Neg | Neg | Neg | M | H | VH | VH | Necessity - Improvement Rating  |
| 6-9 | Neg | Neg | Neg | Neg | L | M | H | H | |
| 10-13 | Neg | Neg | Neg | Neg | L | L | M | H | |
| 14-16 | Neg | Neg | Neg | Neg | Neg | L | M | M | |
| | Sig. Deg. | Maj. Deg. | Min. Deg. | Neg. Deg. | Neg. Imp. | Minor Imp. | Major Imp. | Sig. Imp. | VH |
| | | | | | | | | | H |
| | | | | | | | | | M |
| | | | | | | | | | L |
| | | | | | | | | | Neg |

Improvement



Feasibility

| Description | Definition |
|---------------------|--|
| Simple | Off the shelf / no integration or IP issues / No R&D |
| Moderate | Technically feasible subsystem modifications / minor IP issues / minor R&D |
| Difficult | Submarine system level modifications required / Major IP issues / Major R&D |
| Extremely Difficult | Requires significant change to submarine Design / Significant and extended R&D |

Necessity / Improvement - Feasibility

Necessity - Improvement Rating

| | | | | | | | | |
|------------|--------------|-----------|-----------|-----------|-----------|---|---|---------------------------------|
| | | | | | | | | N/I - Feasibility Rating |
| VH | M | H | H | VH | VH | } | → | VH |
| H | L | M | H | H | H | | | H |
| M | VL | L | M | M | M | | | M |
| L | No Go | VL | VL | L | L | | | L |
| Neg | No Go | VL | VL | VL | VL | | | VL |

Extremely Difficult Moderate Simple Trivial
Difficult

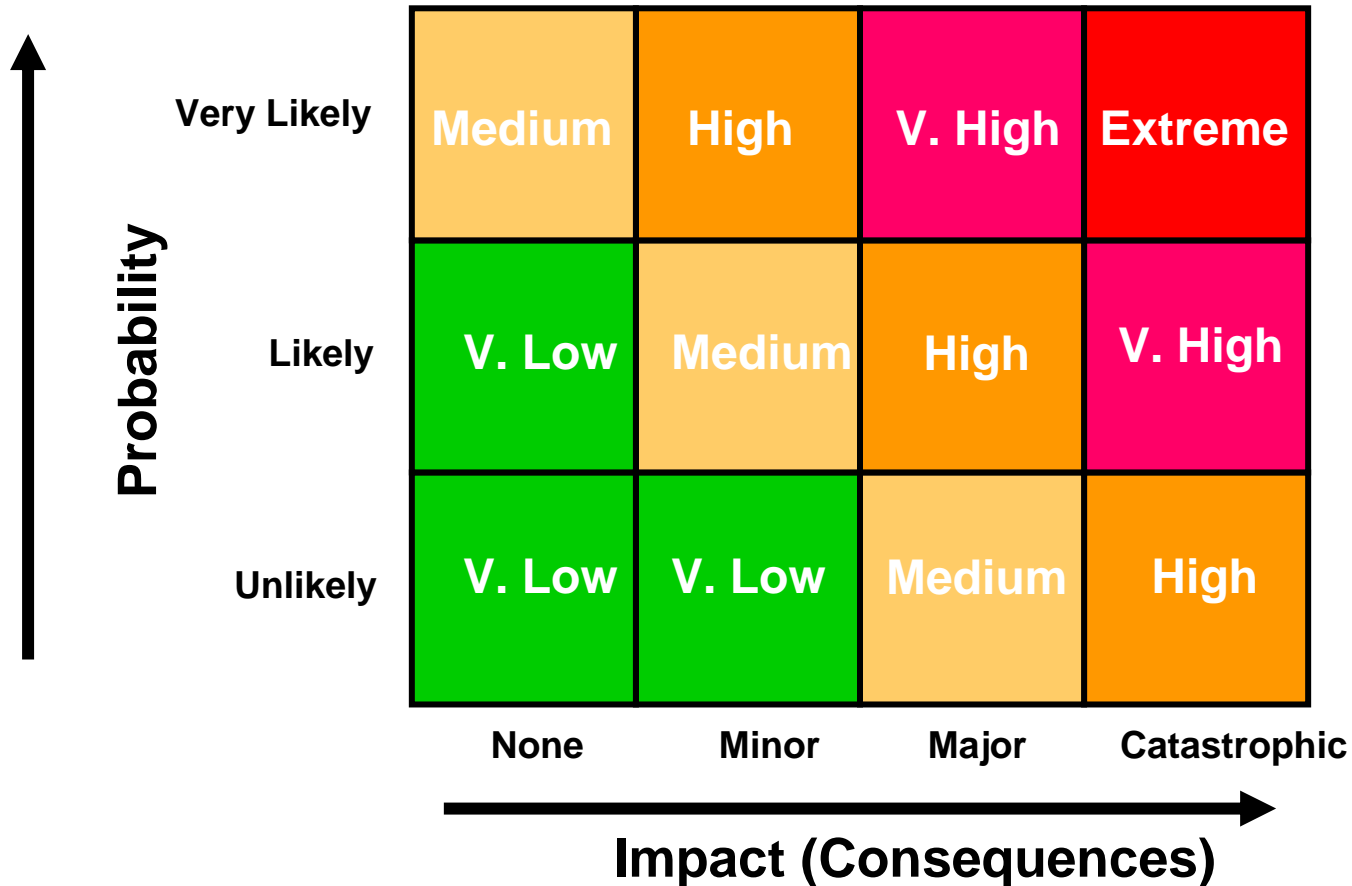
Feasibility Rating

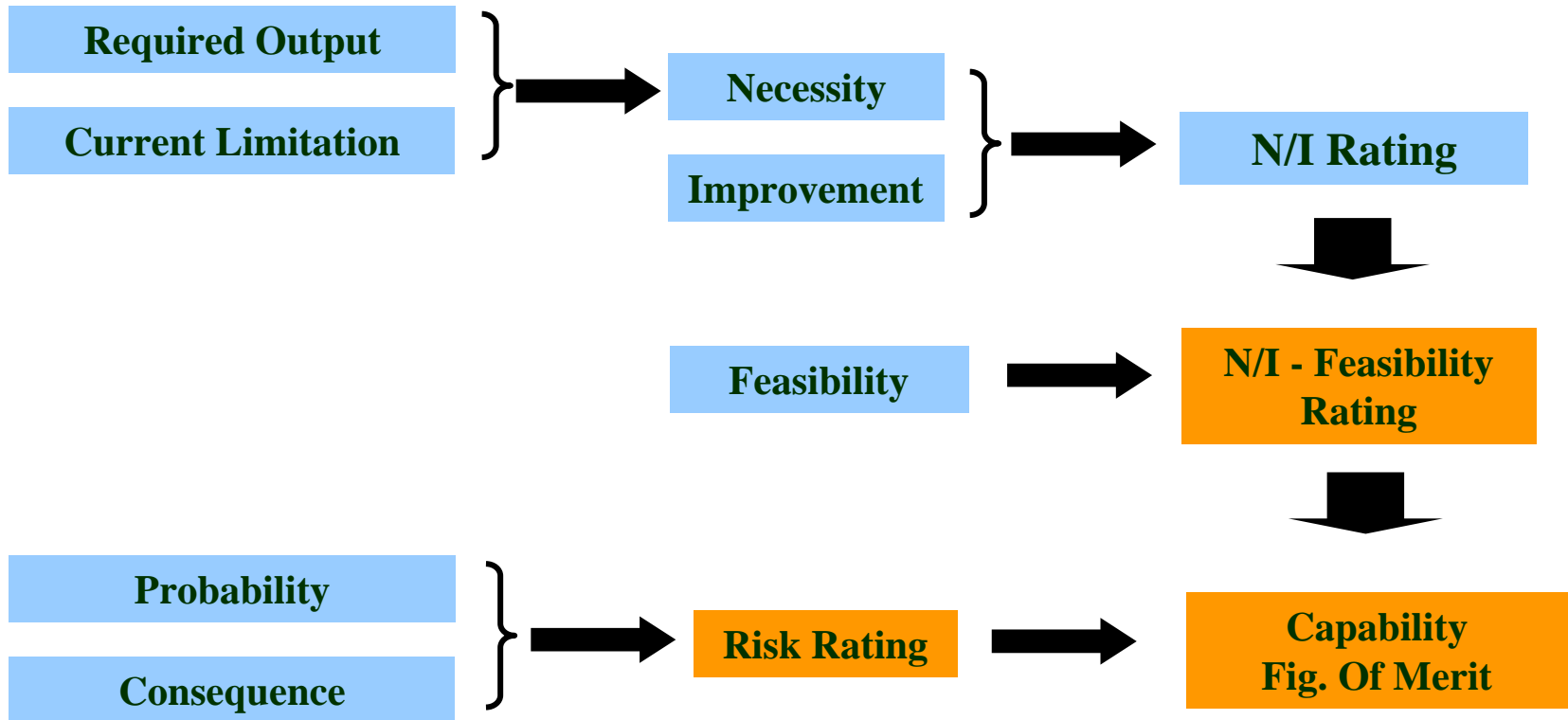
TABLE RELATIONSHIPS



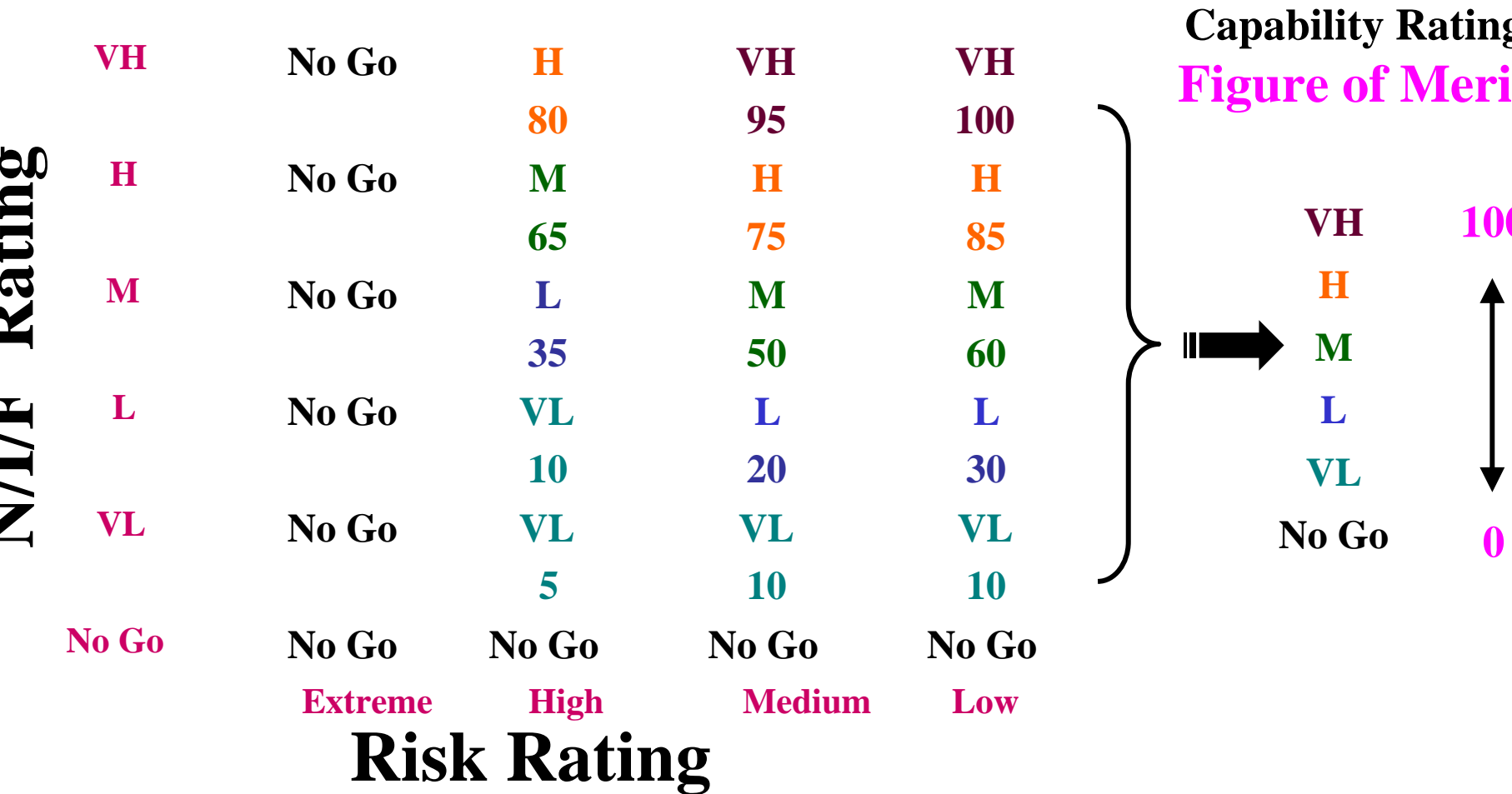
Risk Matrix

Risk Rating



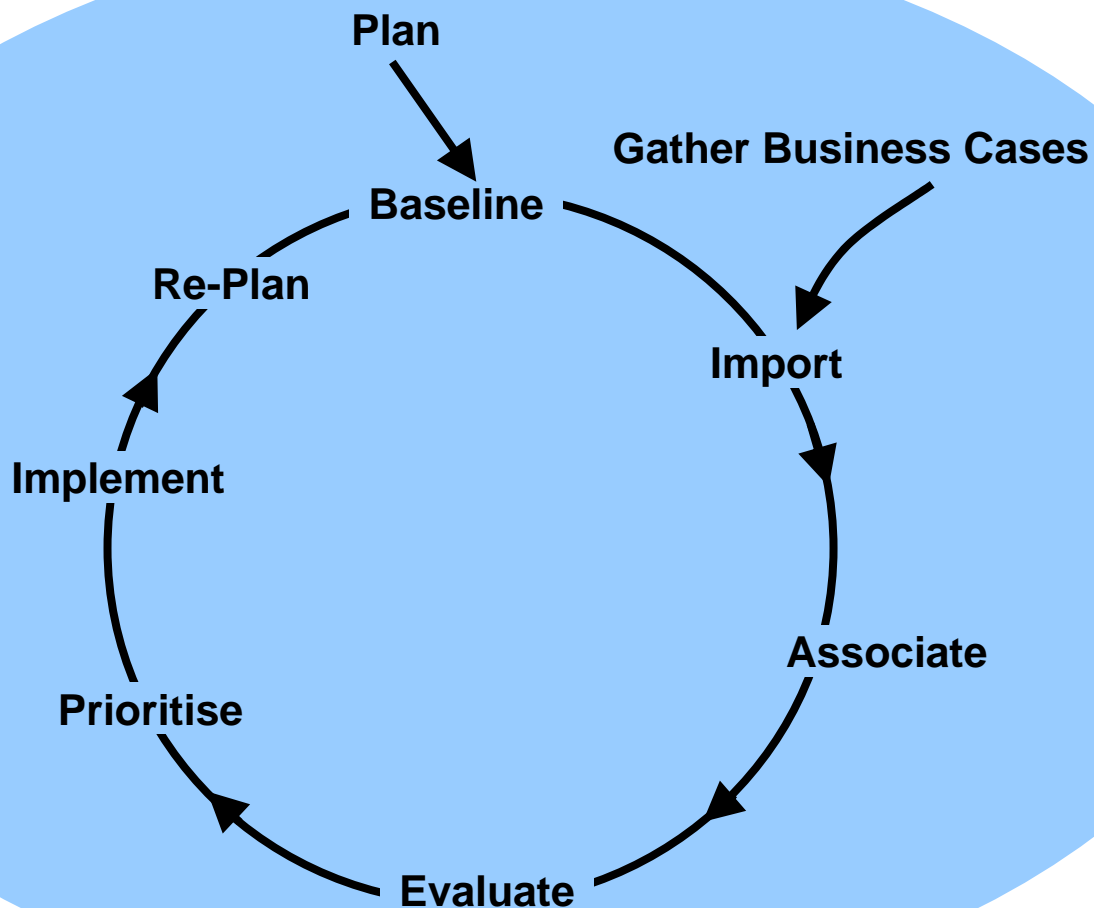


Necessity / Improvement / Feasibility – Risk > Figure of Merit



USING THE MONSARRAT PROCESS

Monsarrat Cycle



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Baselining

- Each Capability Contributor is rated to establish a Baseline of the current output capability.
- This is workshopped by a team of domain experts, using the predefined adjectives
- Baselining provides insights into
 - The veracity of the Capability Architecture
 - The current capability status
 - Understanding of current structure/practice

Tier 1
Trials/Routine Exercises
20%

Tier 2
Peacetime Operations
50%

Tier 3
Wartime Operations
30%

Survivability
15%

Survivability
10%

Survivability
25%

Damage Control
40%

Operational Damage Control
30%

Countermeasures
35%

Escape & Rescue

Signature

Shock

**Overall Impact
+ 3.99% (Negligible)**

**Example Business Case:
New Ice Cream Machine**

Improve habitability

Improve (Significant) 31.63%

Use more power

Degradation 27.64% (Significant)

Increase signature

Friendly Identification
20%

Technical Skills
20%

Platform
15%

Platform
15%

Manoeuvrability
15%

Habitability
5%
7
9

Endurance
80%

Energy
15%
7
6.5

Manoeuvrability
10%

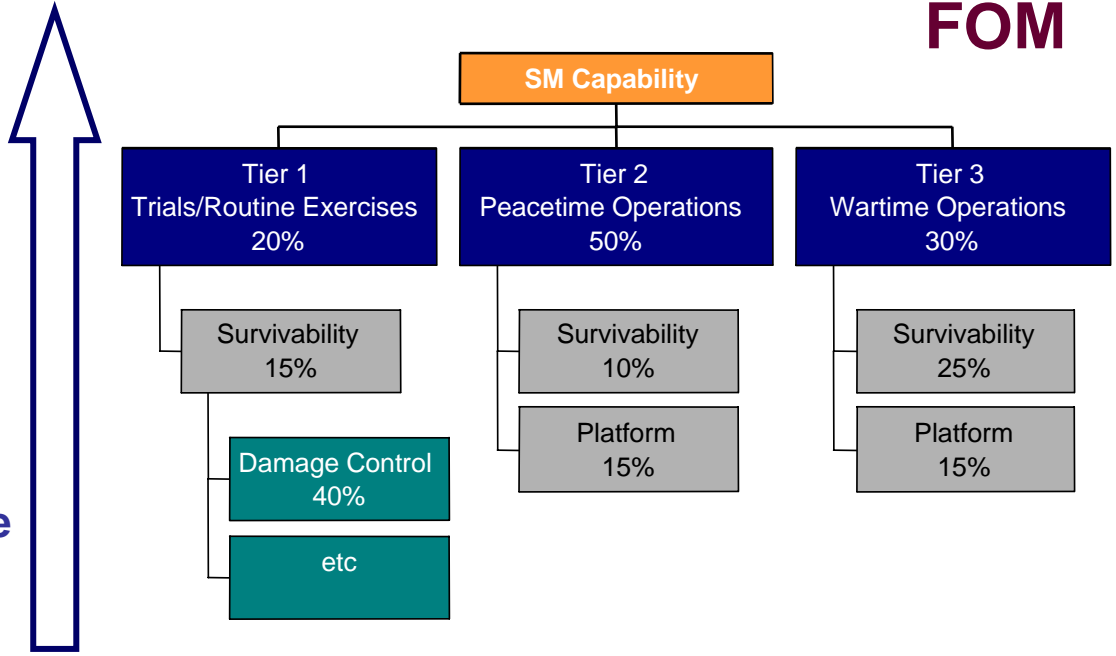
Operating Envelope
20%

Energy
5%
7
5

Note: No association with other Capability contributors

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Necessity | Improvement | Feasibility | Risk > Capability FOM



**Assess Capability
Contribution of New Initiative**
Baseline Current Capability

Evaluation

- Qualitative ratings, using the defined adjectives are assigned, along with written justifications.
- After qualitatively evaluating the Business Cases and Figure of Merit is assigned
- The cost and spend timelines are then considered
- The team uses their judgement – this a human driven process, not a computerized “black box” output

Prioritise

At the end of the Decision Phase the users generate three lists:-

- those business cases that have been accepted,
- those that have been rejected and
- those that are to remain for consideration with the next cycle.

Implementation

- Monsarrat is a cyclical process – 2nd cycle in progress
- Maybe tied to a budget cycle
- Loaded on RESTRICTED and SECRET Defence WANs

Thank You

Question Time