Capability Engineering – An Analysis of Perspectives

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INCOSE UK Capability Working Group

Introduction

- What is Capability Engineering?
  - Capability is a polyseme: *a word with multiple distinct, but related, meanings*
- Capability and Capability Engineering: terms widely used across many industrial sectors
    - Capability-based acquisition, capability engineering and management, Through Life Capability Management, capability sponsor, etc.
- INCOSE UK:
  - *What needs to be done to improve our understanding and approach to capability, and how can systems engineering help? (Lister, 2009)*

Where are we heading?

- Capability is the ability to do something; it is not a synonym for a system function or system purpose.
- Capability engineering is significantly different from product systems engineering and broader than the process perspective of systems engineering
- Capability engineering is the overarching approach that links value, purpose, and solution of a systems problem.
- Capability engineering comprises mindset (holistic thinking, assumptions), trade-offs, design, processes, values and policy, and outcomes.

Agenda

- Defining Capability and Capability Engineering
  - Data collection: capture the weltanschauungen of capability engineering
  - Analysis: Mapping the weltanschauungen and creation of an Entity Relationship Diagram for capability
  - Conclusions: Position statements about capability engineering and recommendations for CWG

WORLDVIEWS

The Weltanschauungen of Capability and Capability Engineering

Which is your view?

What do you see?

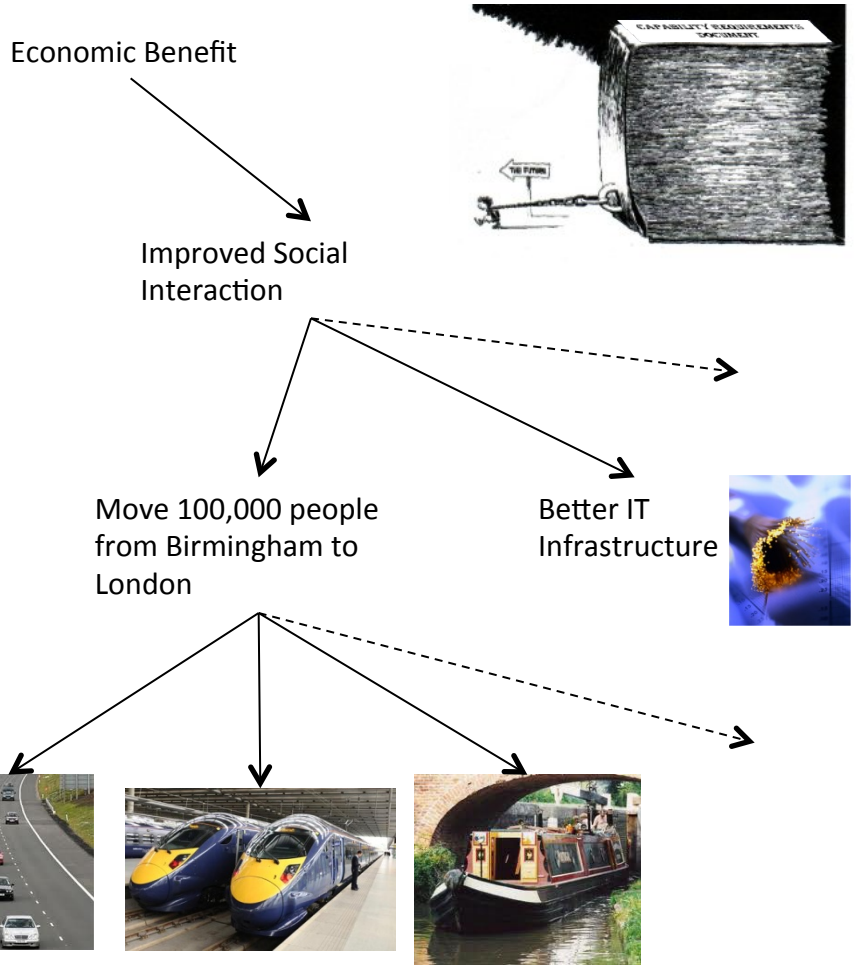
Young children see
Dolphins

W1: Equipment Capability

- Weltanschauung: **Equipment has capability**
- *Described by a system in which:*
- *A buyer defines the needs of users against which suppliers design and develop equipment that has capability, which assumes the user's skill, the effectiveness of the supply chain and the equipment's maintained state at the time at which the capability is realised.*

W2: Capability Planning

- Weltanschauung: **"Capability" describe solution independent requirements**
- Described by a system in which:
- *A buyer attempts to translate a set of explicit user wants into a written set of solution independent requirements within the constraints of procurement policy, against which a supplier may generate system design options to satisfy the capability need, that is defined and constrained by the context in which the equipment is used, the user's skill, the effectiveness of the supply chain and the equipment's maintained state at the time at which the capability is realised.*

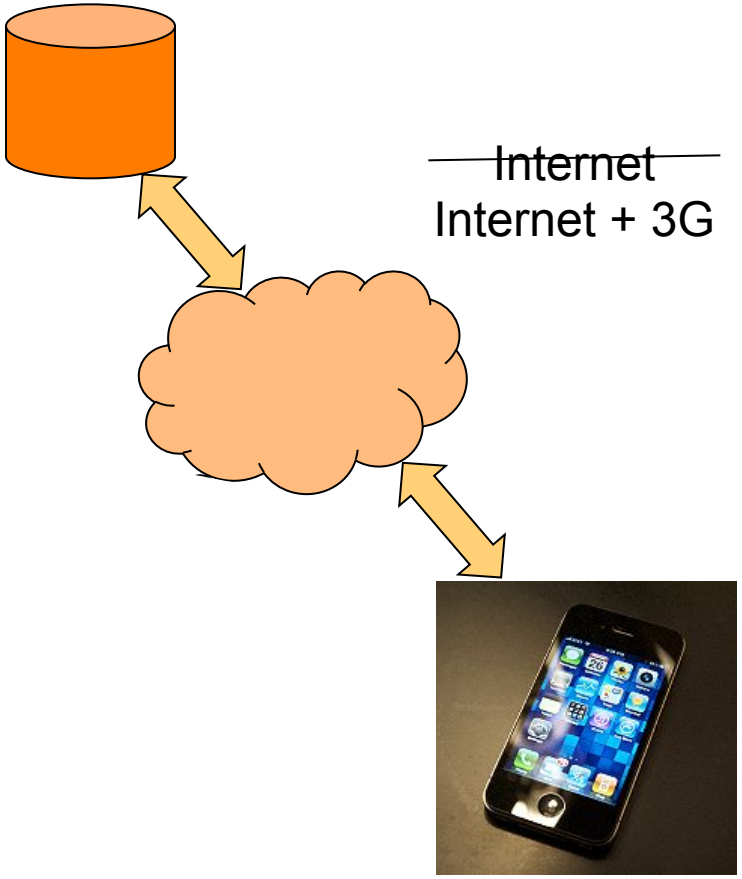


W3: Capability Trade-off

- Weltanschauung: **Deciding / balancing in which capability to invest**
- Described by a system in which:
- *A planner or strategist continually and continuously determines capability needs and the funds available, and an architect designs a programme to deliver systems to meet the capability needs, in order to decide in which capabilities fund holders should invest to achieve an overall capability balanced across users' needs, within the constraints of the pertaining political environment, commercial structures (supply chain) and taking account of existing systems.*

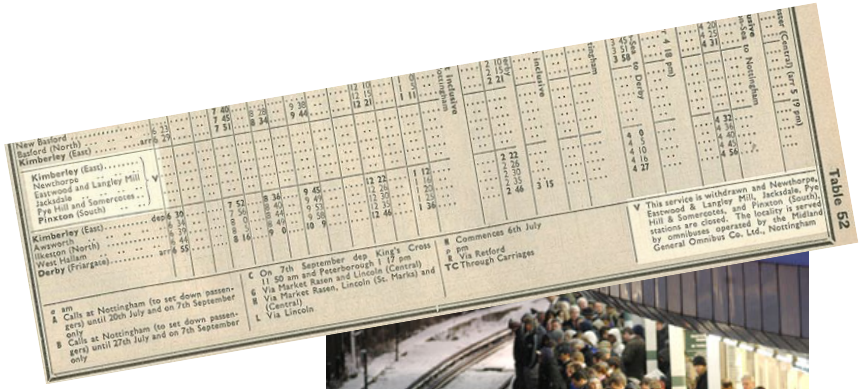
W4A: Service Capability

- Weltanschauung: **Delivering specific business services**
- Described by a system in which:
- *A service Provider delivers specific business services to a Service Recipient (e.g. a passenger); achieved by the provider, users, and functional responsible person defining the quality of service required, designing the service, transitioning capability components into service, operating the service, and continuously improving the service, in line with the provider's strategic plans and the extant operating conditions.*



W4b: Contingent Service Capability

- Weltanschauung: **Developing fallback services to be used at a future date**
- Described by a system in which:
- *A service Provider designs and develops specific fallback services for a Service Recipient (e.g. a passenger); achieved by the provider, users, and functional responsible person defining the quality of service required, designing the fallback service, and storing for transition of capability components into service, operating the service in line with the provider's strategic plans and the extant operating conditions.*



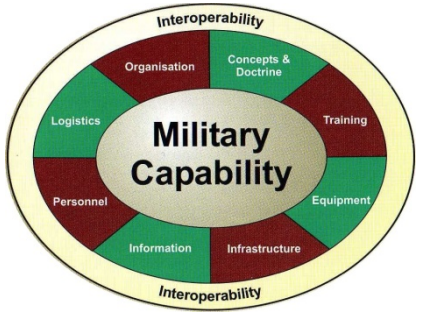
In England, winter is an unplanned emergency that occurs every year

W5: Dynamic Capability Reconfiguration

- Weltanschauung: **Reconfiguring available assets, people and processes quickly to meet current circumstances**
- Described by a system in which:
- *A user understands that circumstances have changed and picks, modifies and implements the most appropriate plan to meet the specific circumstances by reconfiguring the available assets, people and processes within an appropriate timeframe to meet the current circumstances.*

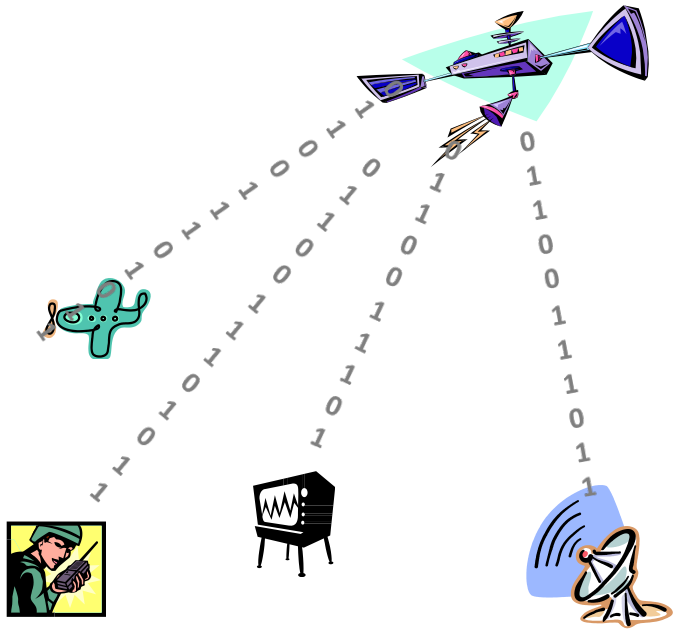
W6: Capability Systems Engineering

- Weltanschauung: **Developing a capability (all Components of Capability) solution**
- Described by a system in which:
- *An enterprise of users, suppliers, and buyers develop and operate a capability solution across (and incorporating) all contributing components, by deploying all appropriate systems engineering approaches/techniques to understand the problem, investigate options, develop, integrate, transition to service, operate, maintain, renew, upgrade and dispose of the components that together meet the need.*



W7: Enterprise Planning

- Weltanschauung: **Managing the interdependencies between capabilities**
- Described by a system in which:
- *Strategists (supported by all CoC Owners) develop, maintain and ensure implementation of an integrated plan in order to manage the interdependencies between all CoC changes, across all capabilities, and all business service delivery in order to support strategy, finance, and CoC owners.*



W8a: Organisational Capability

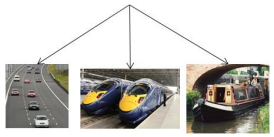
- Weltanschauung:
  Organisations have capability
- *Described by a system in which:*
- *an organisation controls resources that it can configure to maximise its performance in the creation, by its employees, of products and/or services that are desired by consumers/ users, in order to maximise the return on investment of its shareholders (stakeholders).*

W8b: Relational Capability

- Weltanschauung**: Capabilities emerge through processes of interaction between individuals, groups and organizations**
- Described by a system in which:
- *consumers of products and services benefit from improved commercial offerings of companies whose operational capabilities are enhanced through the relationships with their supply chains; the overall capability of the supply chain being revealed through the interactions between the organisations within the supply chain that represents an extended knowledge enterprise.*

Which W best describes the view from your day job?

W1: Equipment Capability 10%



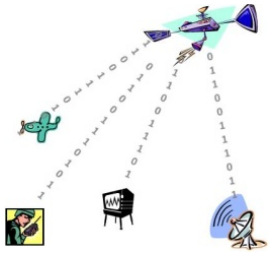
W2: Capability Planning

W3: Capability Trade-off 35%

W4: Service Capability 15%

W5: Dynamic Capability Reconfiguration 15%

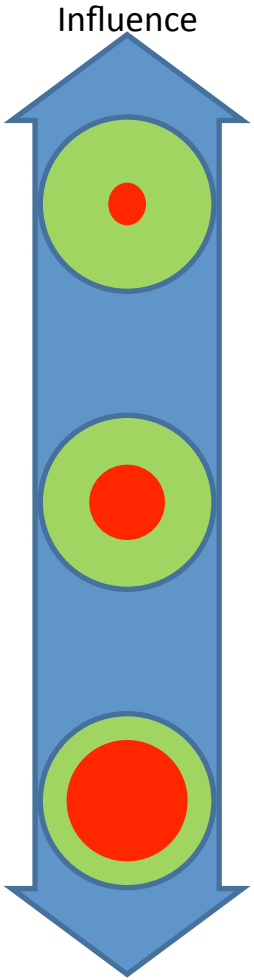
W6: Capability Systems Engineering 45%



W7: Enterprise Planning 35%

W8: Organisational Capability 45%

A moment of insight



Client side SE

Supplier side SE (the V model)

Capability value chain trade-off

Capability integration / service development

Ring, J. (2002). Toward an ontology of systems engineering. INSIGHT , 5 (1), 19-22

Mapping the Weltanschauungen

W1: Equipment Capability

W2: Capability Planning

W3: Capability Trade-off

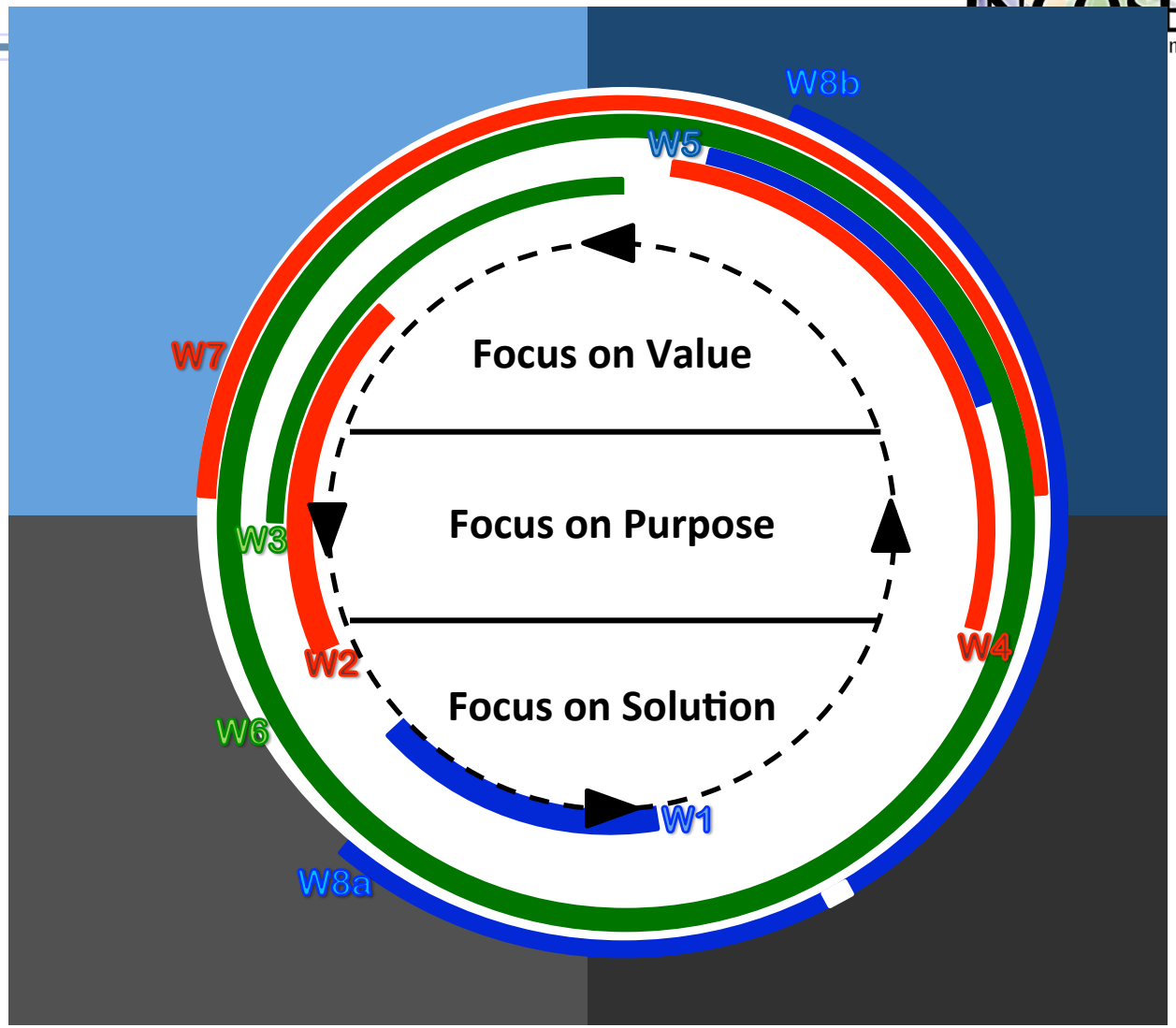
W4: Service Capability

W5: Dynamic Capability Reconfig.

W6: Capability Systems Eng.

W7: Enterprise Planning

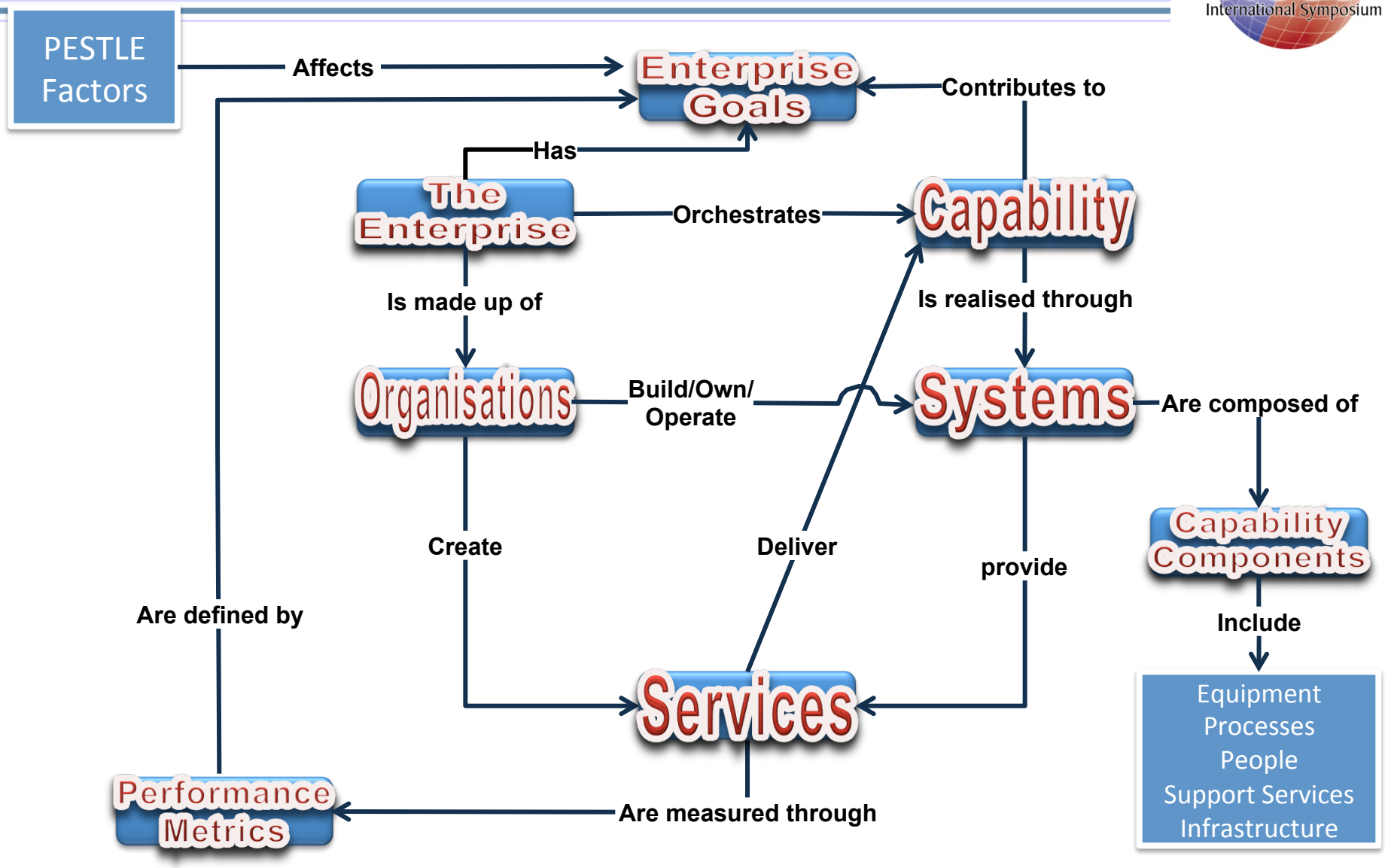
W8: Organisational / Relational Capability



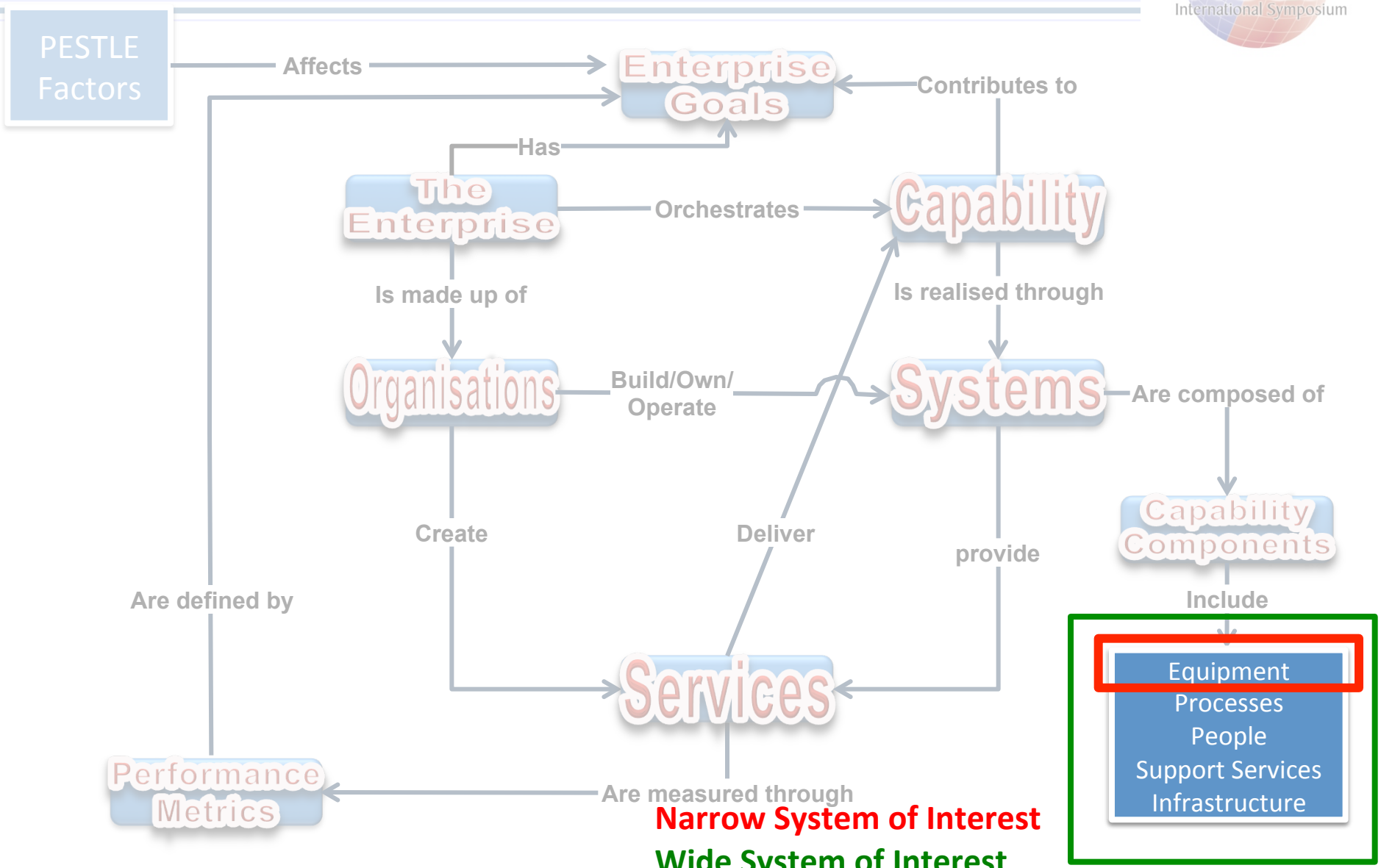
Capability value chain trade-off

Capability integration / service development

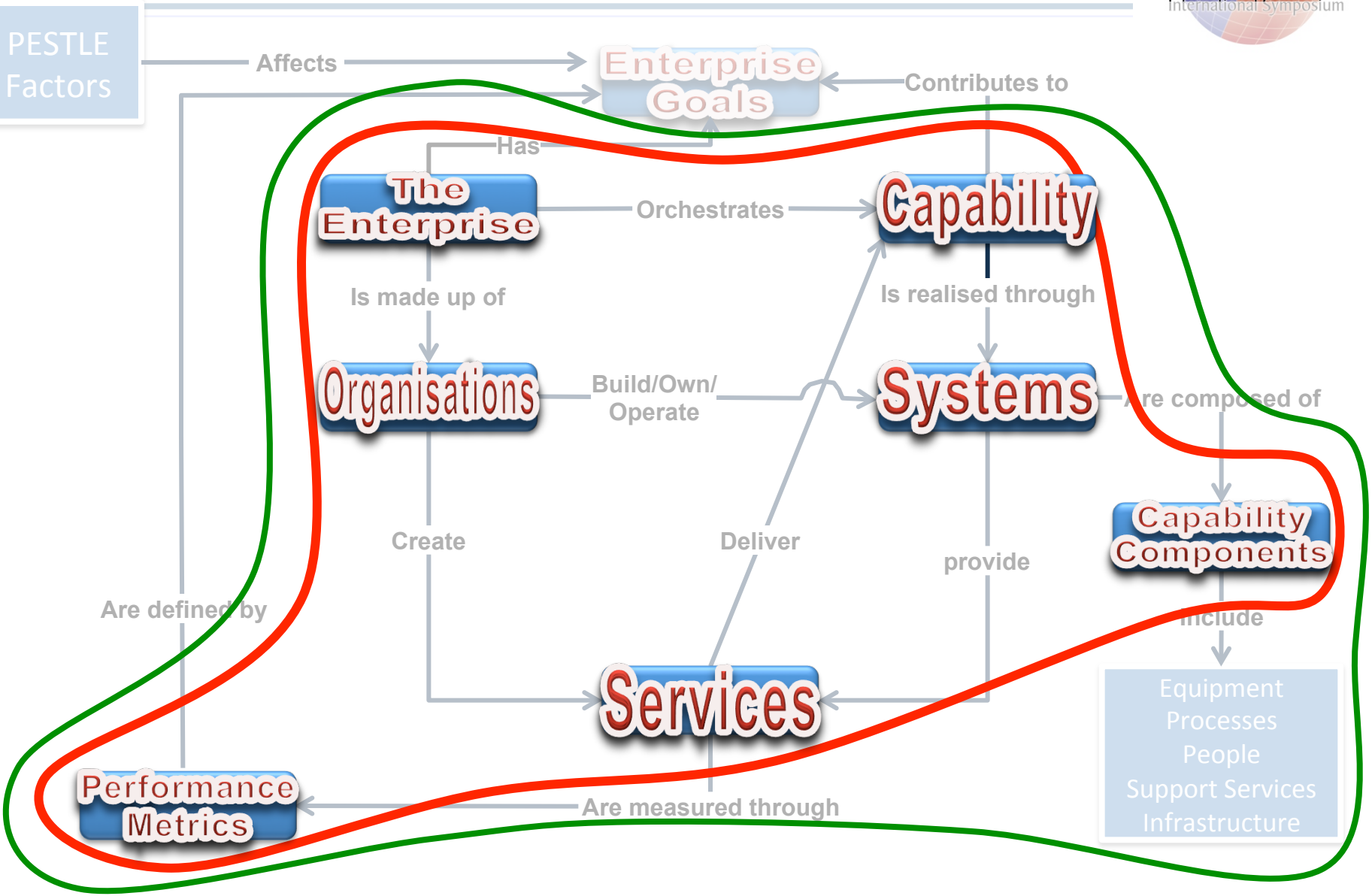
The Concepts of Capability Engineering



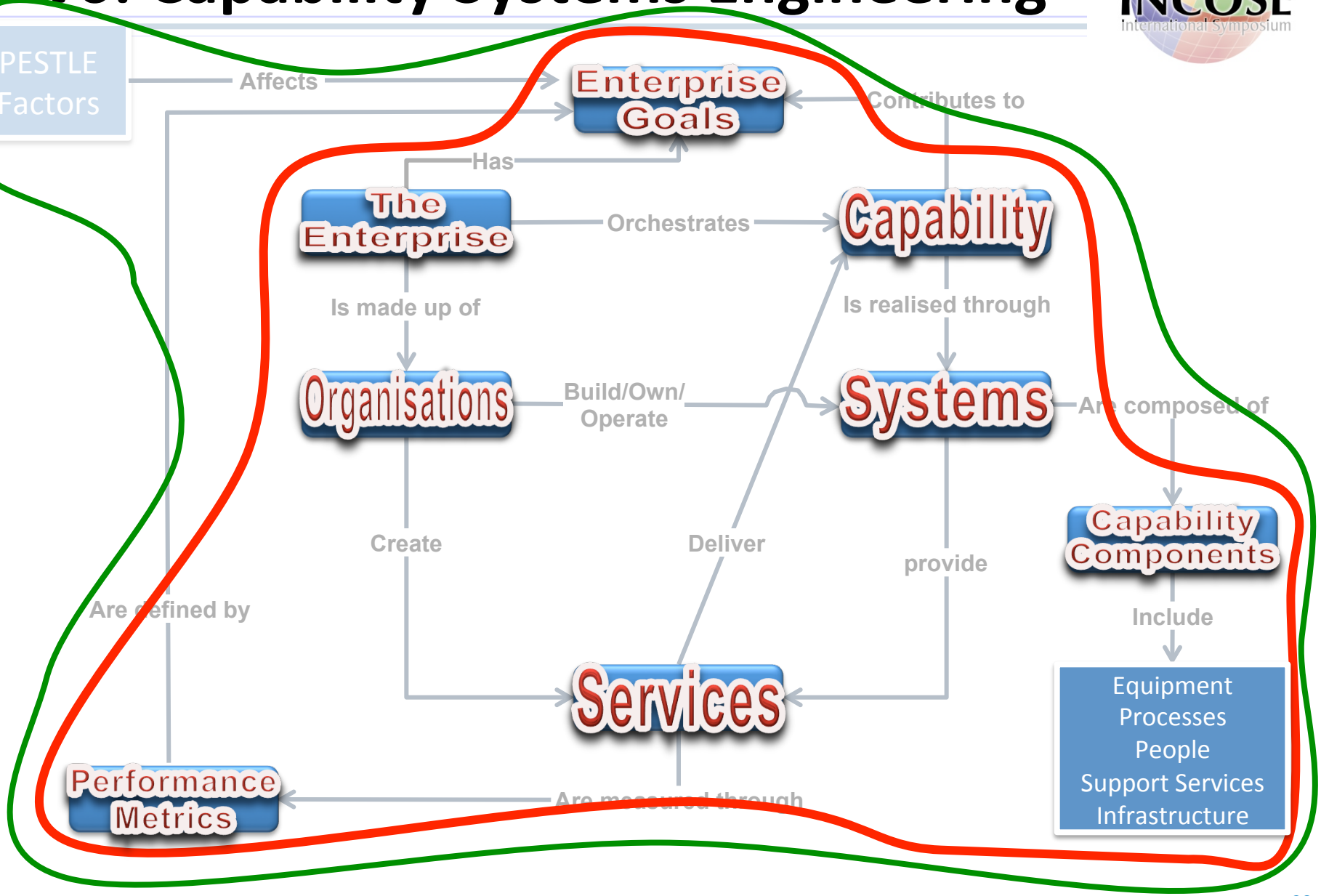
W1: Equipment Capability



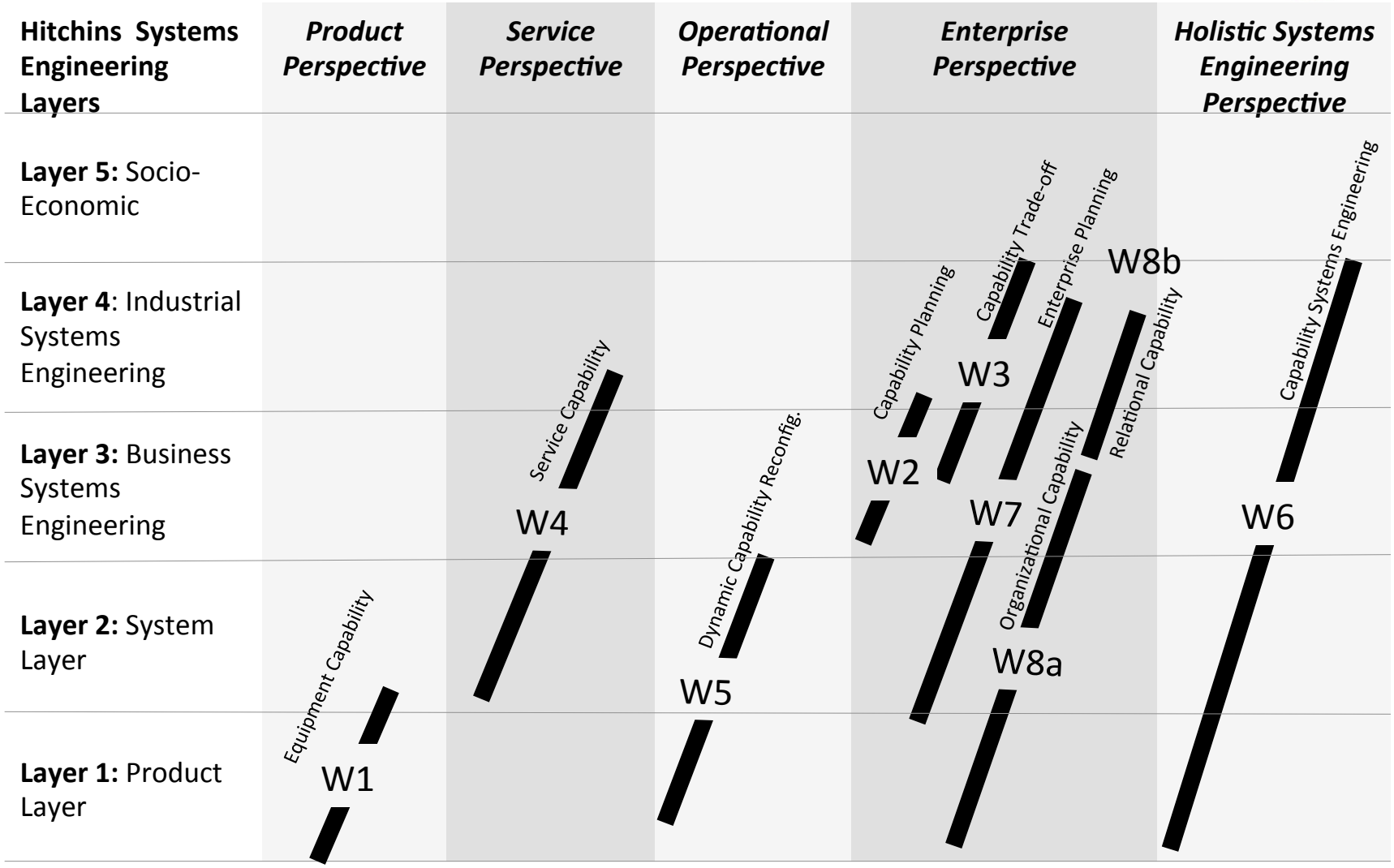
W4: (Contingent) Service Capability



W6: Capability Systems Engineering



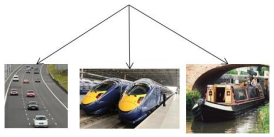
Mapping Ws to Hitchins' Five Layers

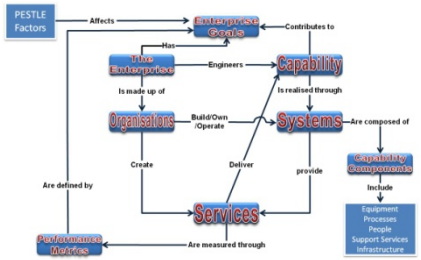


SO WHAT?

The foregoing has led the CWG to the following ten position statements

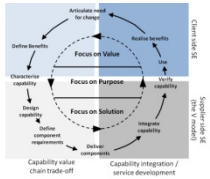
Position Statements (1 & 2)

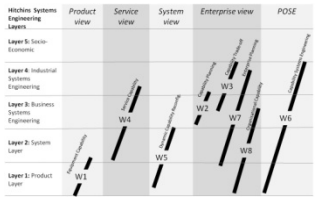


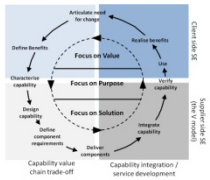


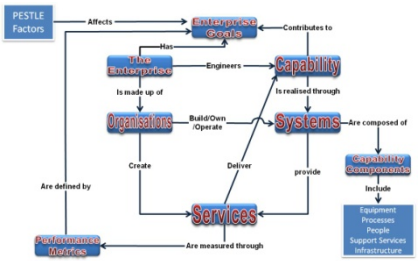
- It is the group's view that **capability is the ability to do something**; it is not a synonym for a system function or system purpose. Clearly there are some perspectives of capability that contradict this (W1).
- A corollary of the statement above is that **capability engineering is** significantly **different** from product systems engineering and broader than (though it incorporates) the process perspective of systems engineering.

Position Statements (3, 4, & 5)



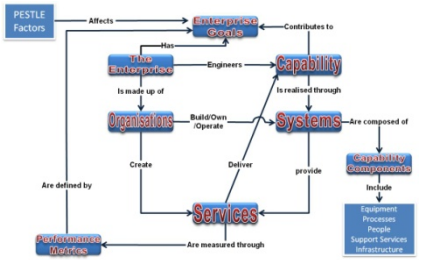


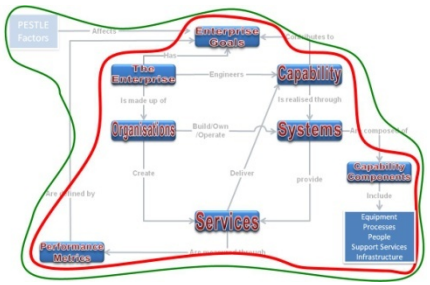




- **Capability engineering is** very **similar** in scope to views of systems engineering such as **Ring's Value Cycle** (Ring, 2002) and layers 1-4 of **Hitchins' Five Layer Model** (Hitchins, 1994).
- **Capability engineering** is the overarching approach that **links value, purpose, and solution of a systems problem**.
- As such, **capability engineering comprises mindset** (holistic thinking, assumptions), **trade-offs, design, processes, values and policy, and outcomes**.

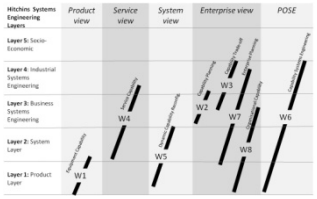
Positions Statements (6 & 7)

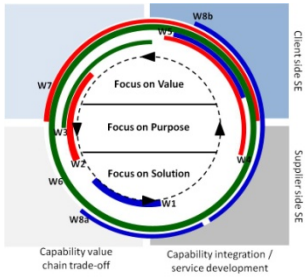




- **Capability** is realised through a combination of components that **include hard** (equipment) **and soft** (people and processes) **systems** together with **supporting services and infrastructure**.
- The **processes for capability engineering** are largely the **same as traditional systems engineering**, but the mindset and system boundary are different.

Positions Statements (8, 9, & 10)





- There are significant practice and **examples** of capability engineering from (at least) the UK **rail provision, defence, and Information Services**.
- One's Weltanschauung of capability engineering is clearly dependent on where one draws the systems boundary. It is the view of the Perspectives Analysis sub-group that the most appropriate place to draw the **systems boundary for capability engineering is to enclose layers 1-4 of the Hitchins' Five Layer Model of systems engineering**.
- **Capability and capability engineering** are important concepts that **reaffirm the holistic view of systems engineering**; this may imply the need for further INCOSE guidance at the higher Hitchins' layers (3 and 4).

What next?

- Ontology development
  - To test SOI for Ws and underpin definitions
  - To translate Capability language between sectors / domains
- Why do Capability Systems Engineering? And what does good CSE look like?
- Literature review
- Worked examples of good CSE
- Communication and education

Capability's Engineering