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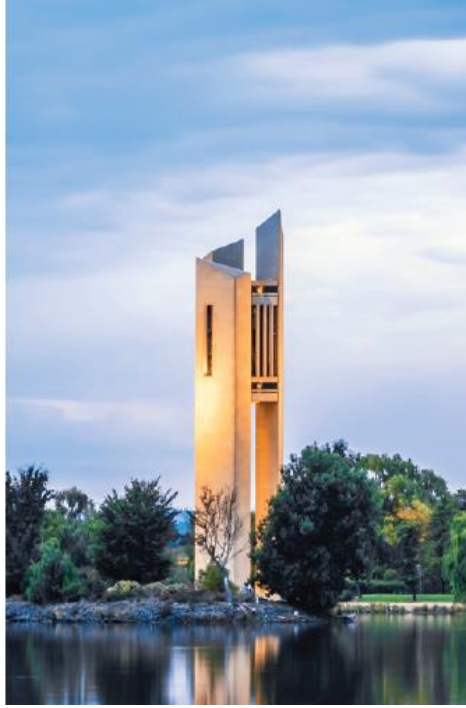
29 April – 1 May 2019



SYSTEMS SCIENCE & ENGINEERING FOR A BETTER AUSTRALIA SETE2019.COM.AU

ESTABLISHING A COMBAT SYSTEM REFERENCE ARCHITECTURE TO SUPPORT CONTINUOUS NAVAL SHIPBUILDING

David Culpin CPENG

Background & Motivation

- Australian Government has released a Naval Shipbuilding Plan, which outlines the strategy to build a sustainable and continuous naval shipbuilding capability in Australia:
  - Over $89 billion in new naval major surface combatants, OPV's and submarines;
  - Desire to move away from acquisition of independent platforms; and
  - Mandated product-line elements (AEGIS, CEA Radar, SAAB interface).

- Systems (combat and platform) have traditionally been designed, developed, integrated, tested and sustained specific to individual platforms – in isolation to other projects.

- Naval Shipbuilding Plan represents an opportunity to evolve.

Can the development of a Combat System Reference Architecture (CSRA) be the key enabler to support the Naval Shipbuilding Plan?

Purpose & Objectives

- Outline the benefits of a CSRA to support current and future state requirements for all classes of Major Surface Combatant; identifying opportunities to optimise warfighting capability, improve interoperability and realise efficiencies associated with potential combat system commonality.

- Identify an MBSE-based approach by which common functional, logical and physical elements of a combat system capability can be shared between ship classes; including inter- and intra-relationships with other entities; and

- Develop a proposed CSRA to demonstrate the utility of this approach as a tool for the Naval Shipbuilding Enterprise.

Why MBSE?

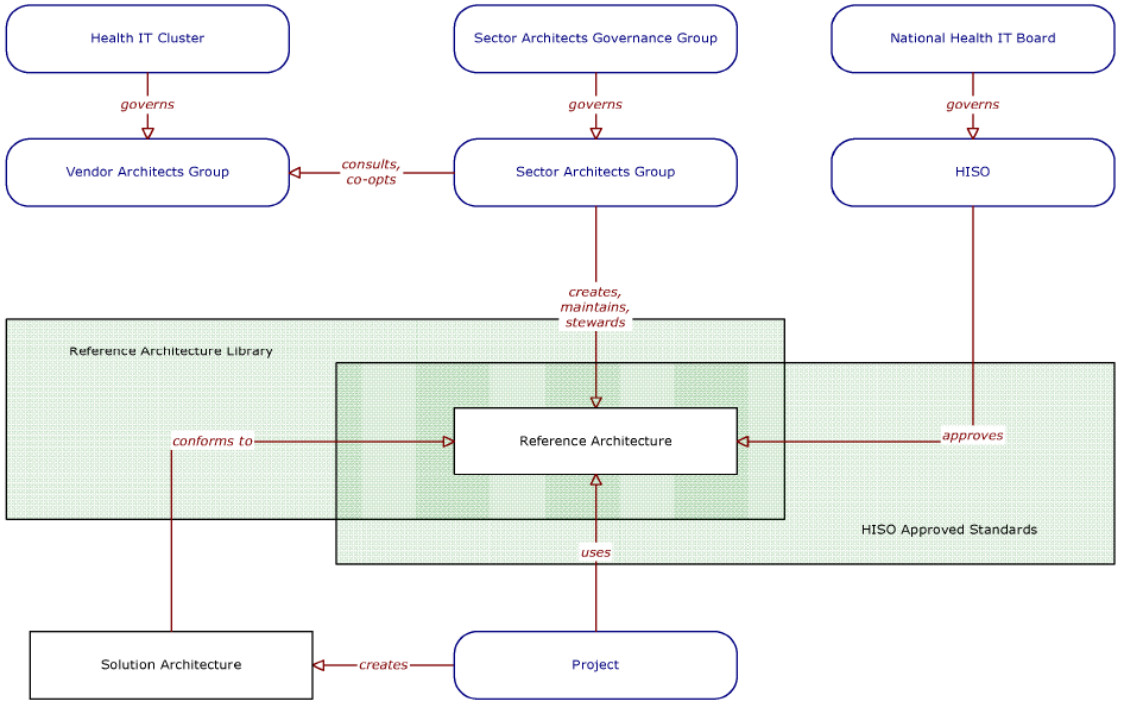
- Capability documentation (including requirements) are often text based - limited insight into the behaviour/end user needs desired by the customer;
- Traceability/rationale for a particular decomposition of the system solution usually not documented well (if at all) – time between events compounds the problem;
- Logical modelling of the system is often missed – project teams focus on the physical architecture;
- Efficient communication of requirements and constraints is a challenge – difficult to achieve consensus;
- Often difficult to assess capability gap between desired capability (user needs) and final solution once fielded – this includes consideration for major block upgrades; and
- No single source of truth.

MBSE approach aims to mitigate these notorious shortcomings

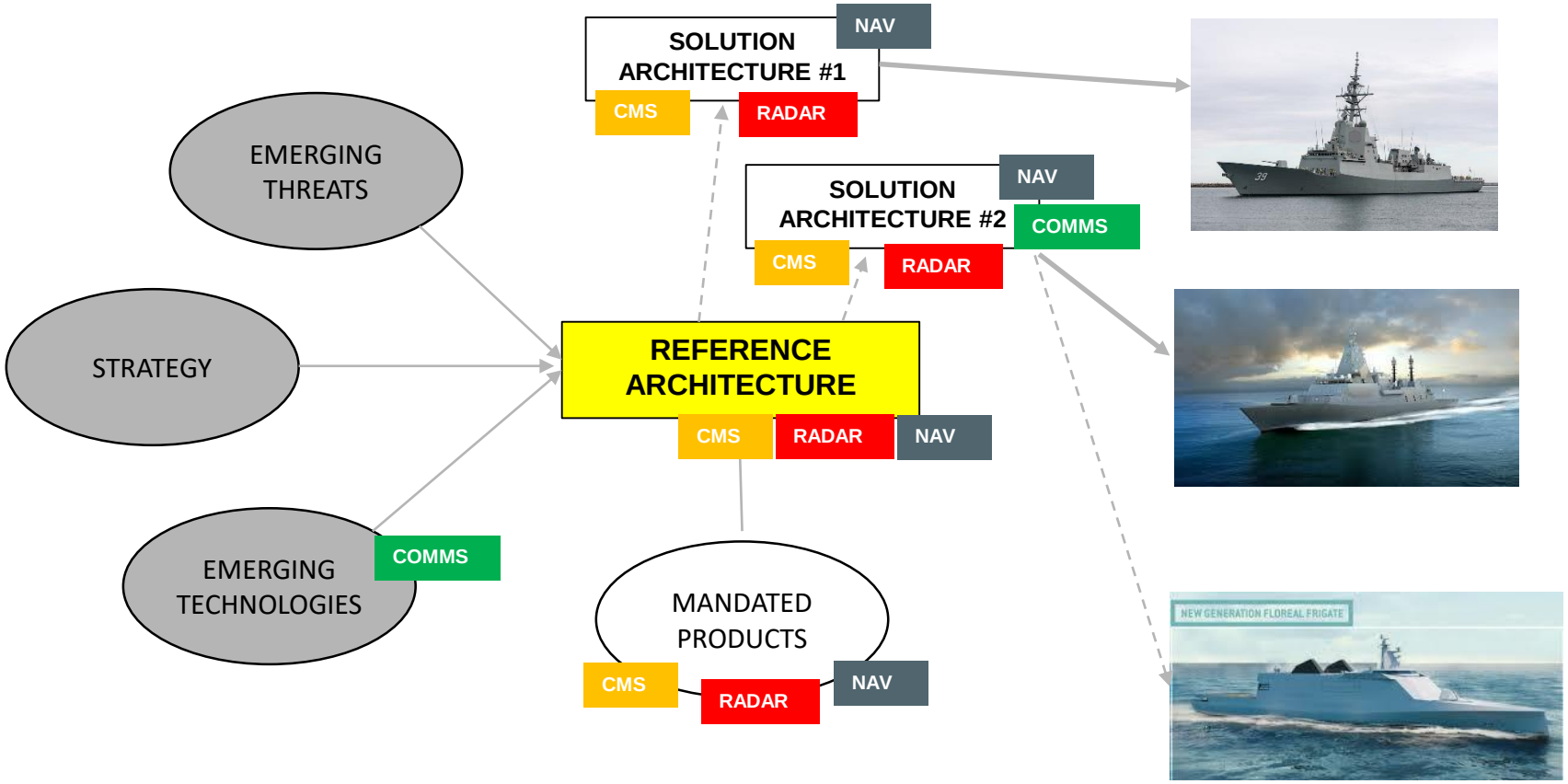
Reference Architecture

- *"Reference Architecture serves as a tool for providing common information, guidance, and direction to guide and constrain architecture and solutions"* (US DoD, 2010)
- *"It is a template solution and provides a common vocabulary with which to discuss implementations, often with the aim to stress commonality"* (NZ Health, 2011)

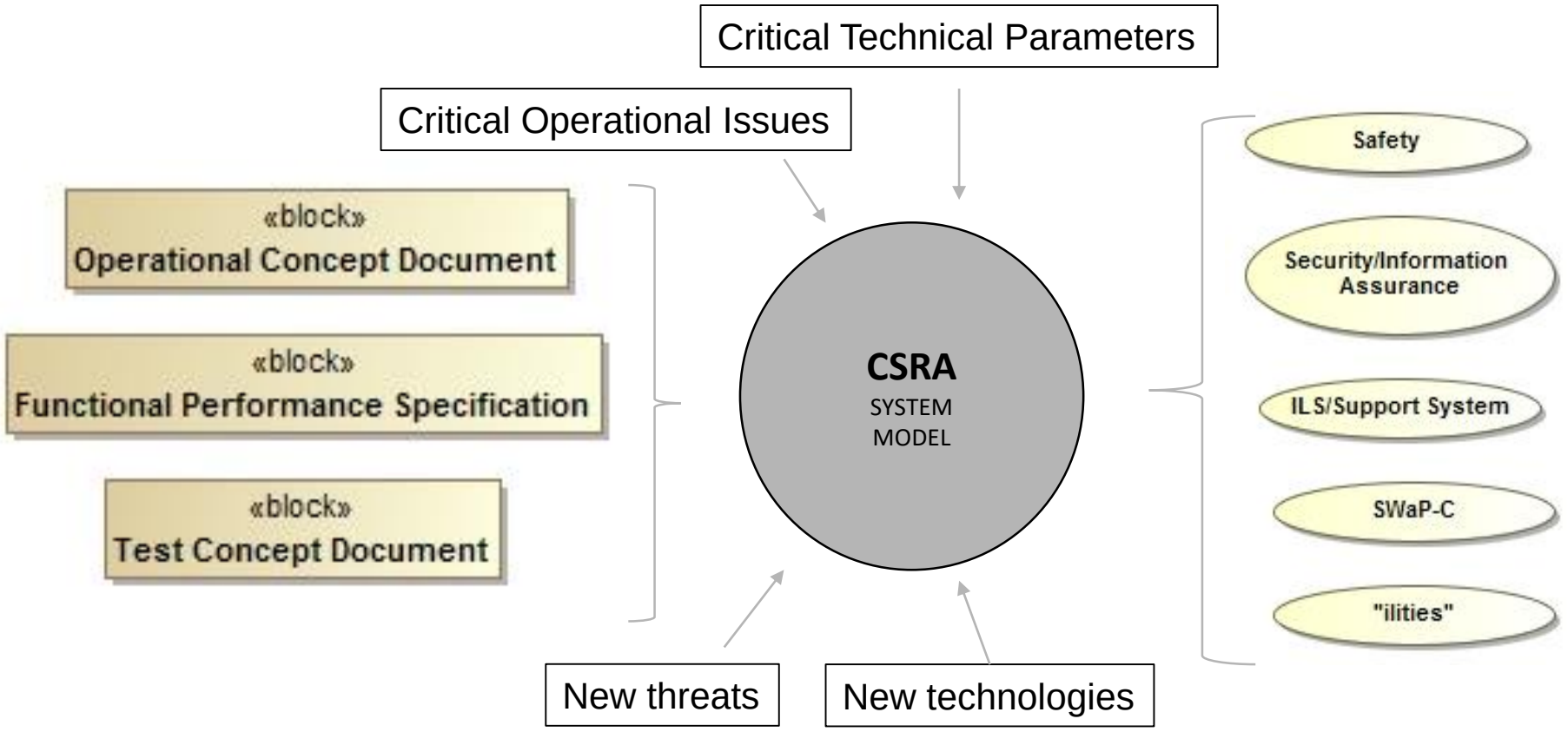
A repository of common combat system architecture principles, standards and views (functional and logical) to support combat system evolution for Major Surface Combatants – all within a system model



Reference Architecture Concept

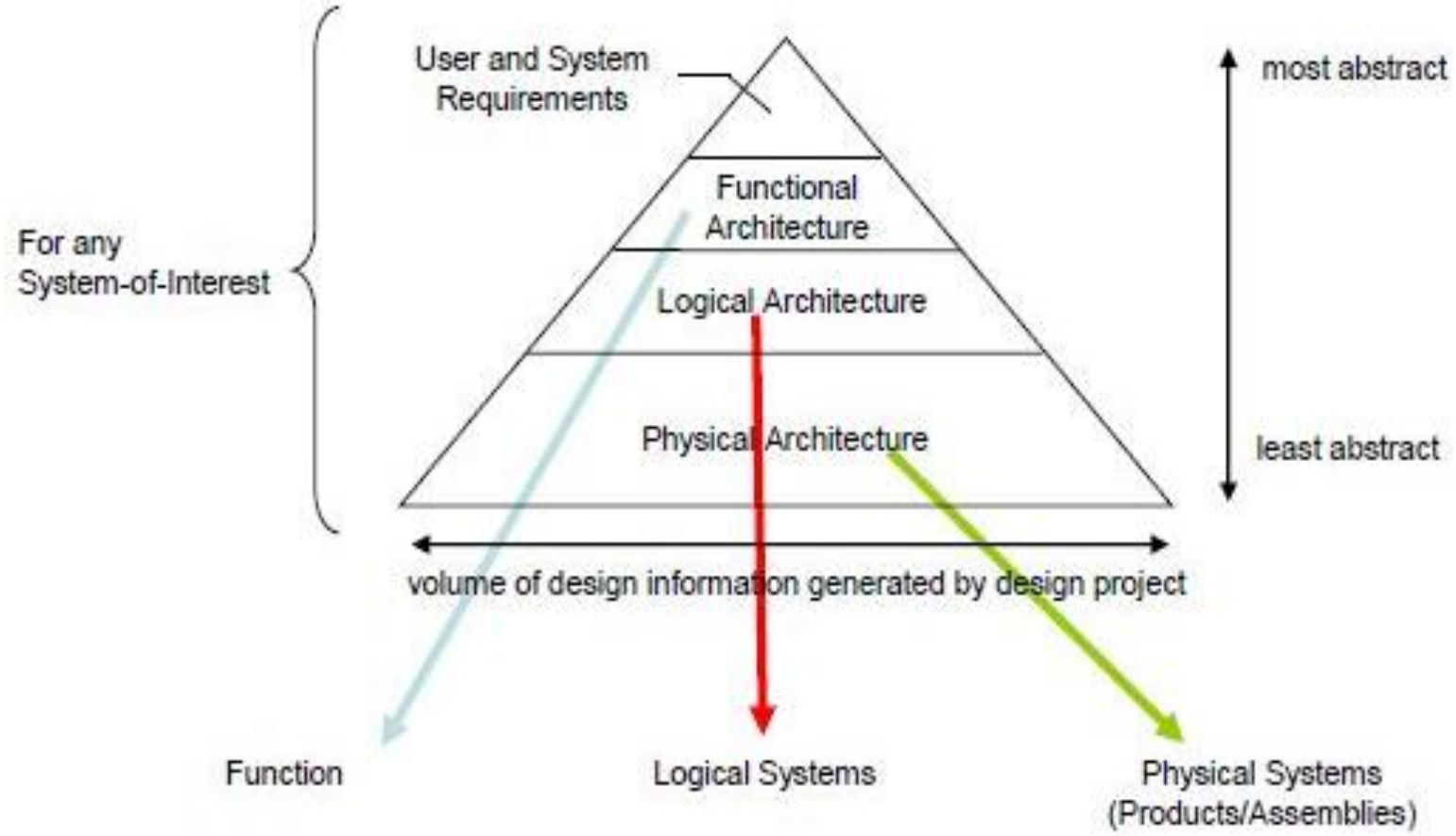


CSRA System Model



Focus on elements common to all Major Surface Combatants

Levels of Abstraction



Pearce, P. Friedenthal, S. 2013, *"A Practical Approach For Modelling Submarine Subsystem Architecture In SysML"*, Submarine Institute of Australia Science, Technology & Engineering Conference

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Functional Architecture

- Understand user needs
- Develop Use Cases, Scenario's/Vignettes
- Develop CSRA requirements set

CONTEXT DIAGRAMS

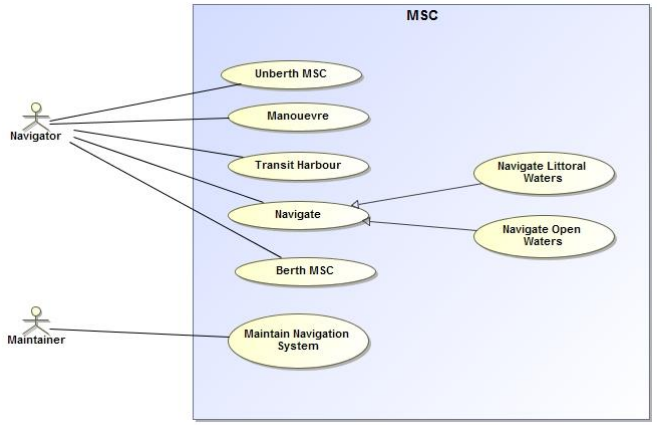
USE CASE DIAGRAMS

DATA FLOW DIAGRAMS (FFBD)

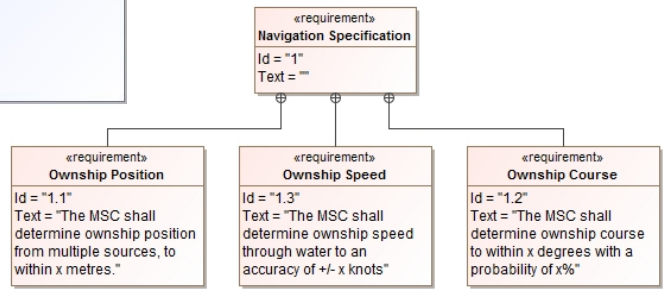
FUNCTIONAL DECOMPOSITION DIAGRAMS

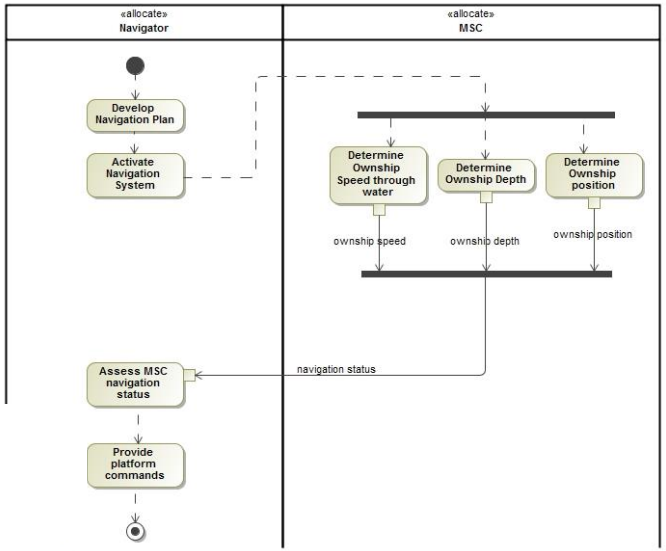
SCENARIO/NARRATIVE DIAGRAMS

FUNCTIONAL INTERFACE DIAGRAMS



CSRA
SYSTEM MODEL

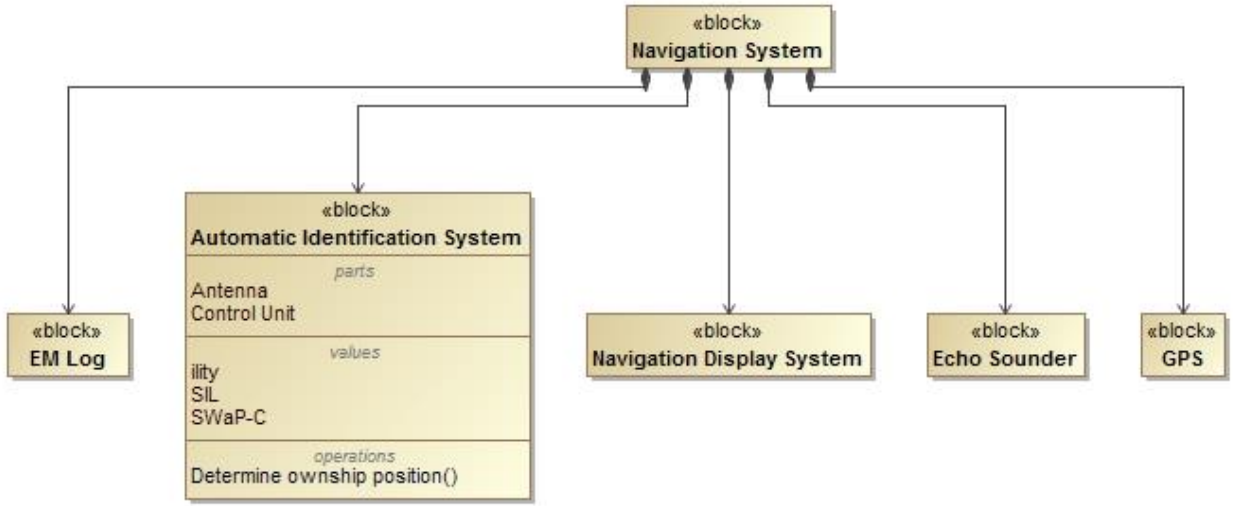




Logical Architecture

- Allocate activities/functions to logical elements
- Develop BDD/IBD's to level of detail to suit all Major Surface Combatants

CSRA
SYSTEM MODEL



LOGICAL DECOMPOSITION DIAGRAMS

LOGICAL INTERFACE DIAGRAMS

SYSTEM BREAKDOWN STRUCTURE (SBS)

DATA FLOW DIAGRAMS (FFBD)

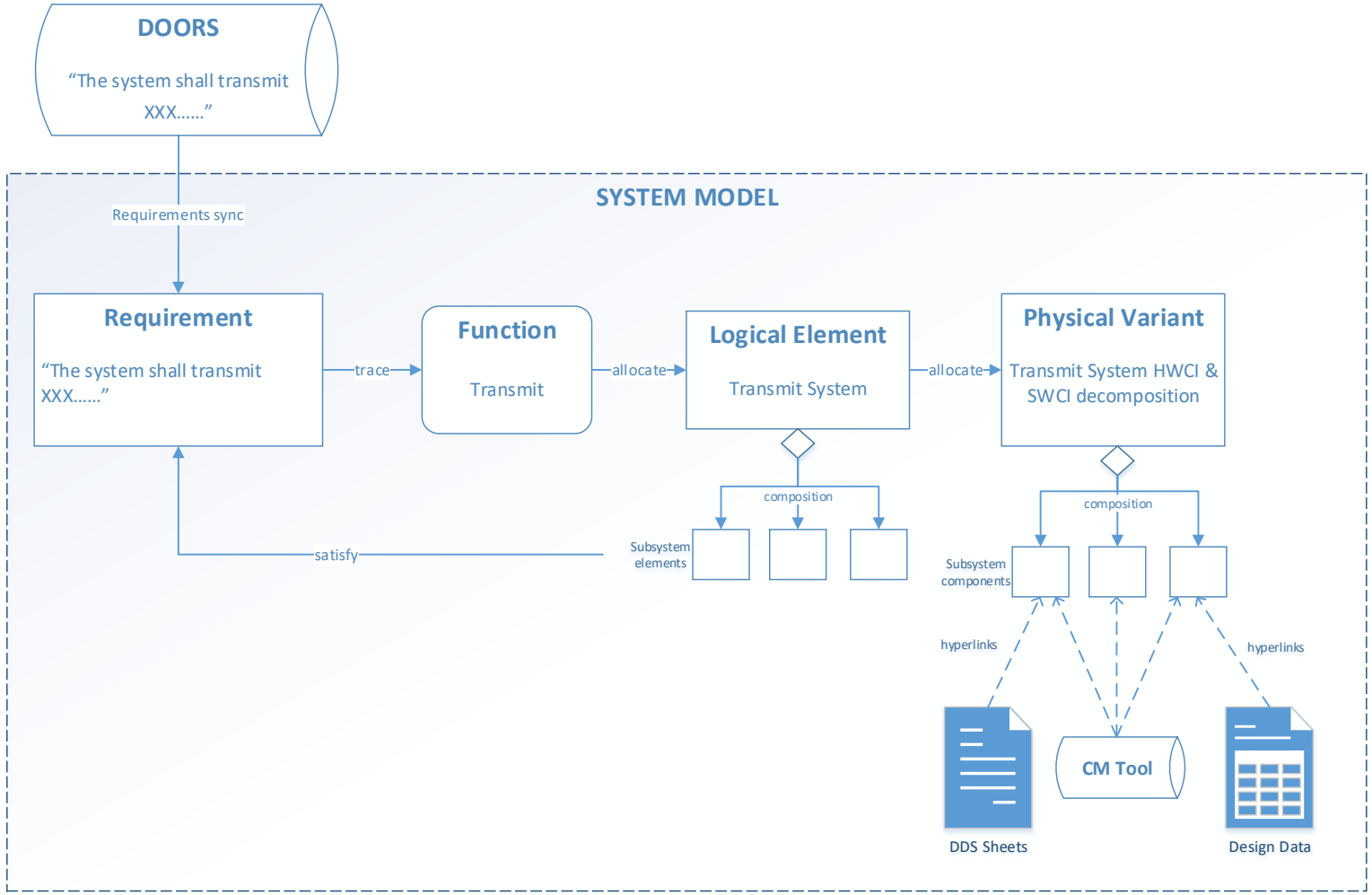
SCENARIO/NARRATIVE DIAGRAMS

Where now?

- The resultant system model now defines the functional and logical architecture for the CSRA; encompassing common stakeholder needs, system requirements and logical system elements. The system model can be used as an effective tool to assess requirements traceability (identifying orphan requirements and redundant logical elements), technical feasibility of the logical architecture (interfaces and compliance to budgets and margins) and levels of commonality for all classes of MSC.

- *Time to synthesise candidate physical architectures* - instantiations or physical solutions, comprised of physical components. These components are configurable items, which are defined by a unique part number (for hardware) and version number (for software).

Design Traceability



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Potential Benefits for Naval Shipbuilding

- Optimise - leverage common combat system solutions to reduce procurement and operational lifecycle costs;
- Define future state - facilitate planned evolution (technology roadmaps);
- Technical Integrity - encourage a robust selection and integrated change management process for physical solutions and encourage adherence to common standards and specifications;
- Provide a common and consistent language;
- Promote centralised oversight and governance; and
- Encourage greater interoperability (functional and semantic) within an extremely complex, distributed and dynamic environment.

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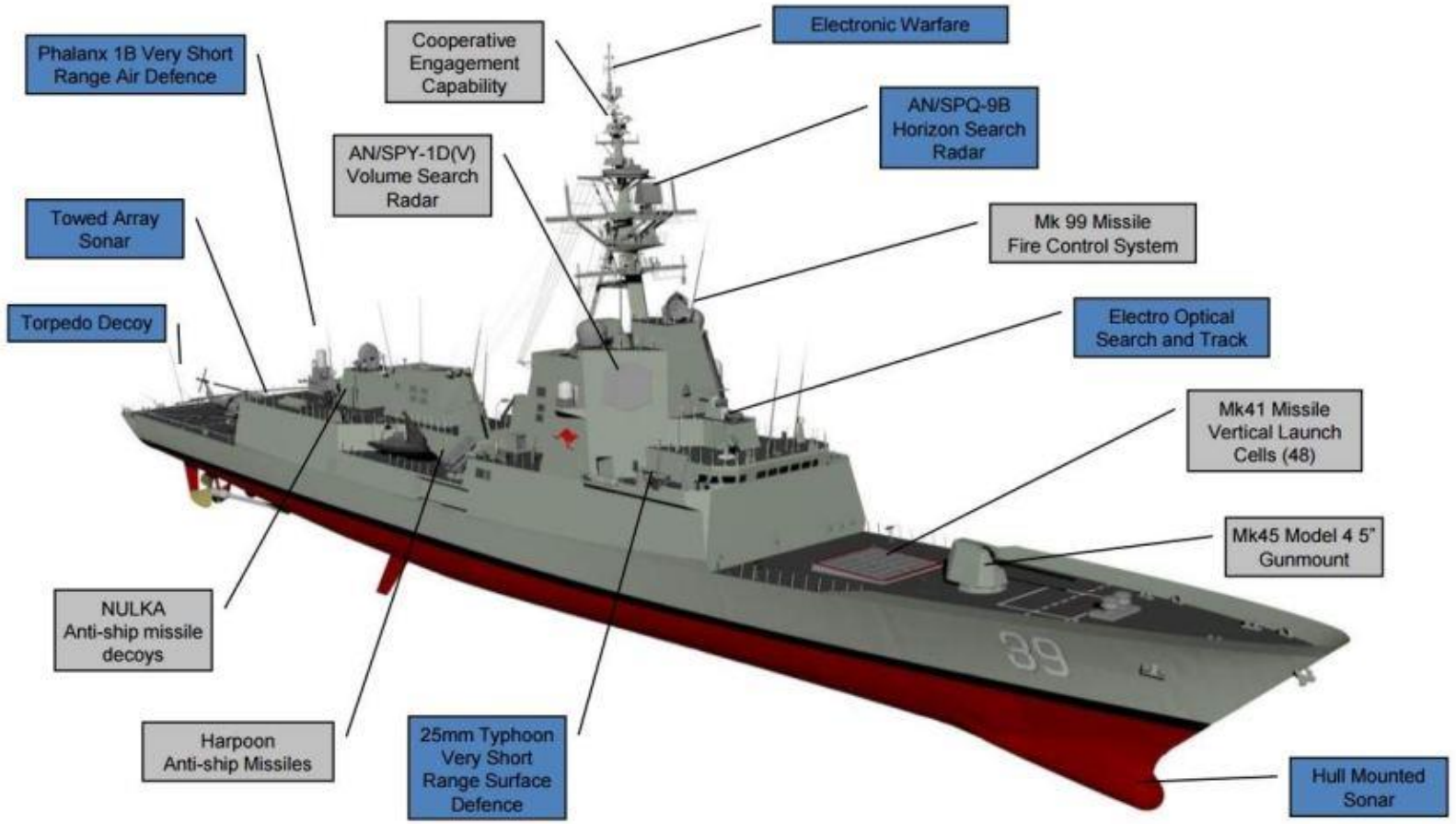
QUESTIONS?



https://www.abc.net.au/news/2017-01-30/some-of-the-features-of-the-air-warfare-destroyer-hobart-suppli/8223192