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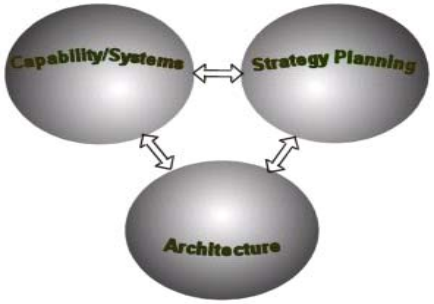
CCRTS 2004

Title: Systems and Capability Relation Management in Defence SoS Context



Authors: Pin Chen and Ronnie Gori
Integrated Capabilities Branch
DSAD, DSTO.

Outline

- Introduction
- Classification of Relations
- Rationales of Relation Management
- DAIM-Based Approach to Relation Management
- Benefits and Applications
- Conclusions

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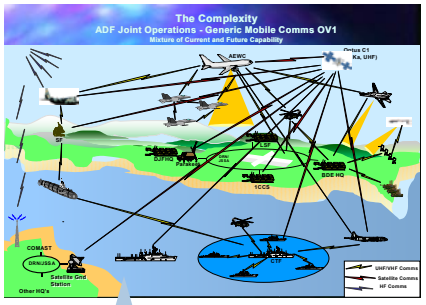
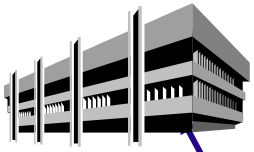
Relation Complexity from Scenario, Capability to Systems

Operation Scenario



Military Operation Centre



Partner-with

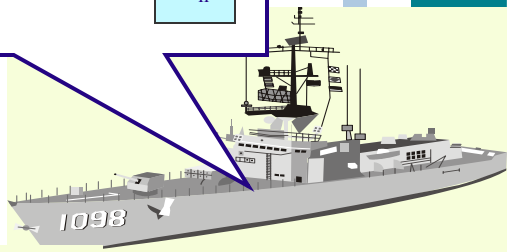
Part-of

A C4ISR Federation

S_1 S_2 S_n

Interact-with

Integrated Air Picture



Warships

Capability Planning

CURRENT FORCE

Preparedness Plan

- CDF Preparedness Directive (CPD)
- COMAST Operational Preparedness Directive (OPD)
- CN/CA/CAF Preparedness Directives (CNPD, CAPD, CAFPD) & DLOC Contracts

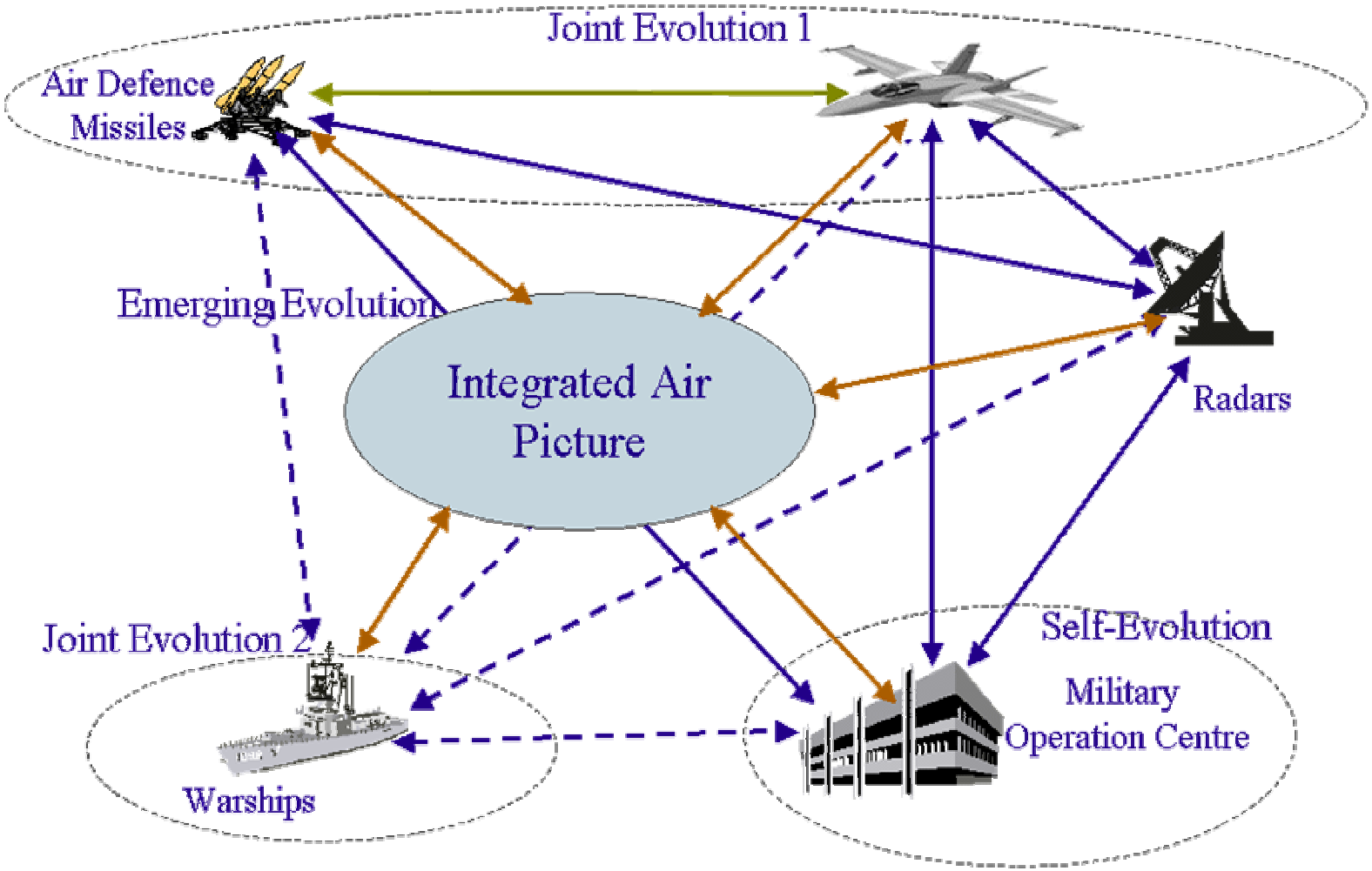
Approved Operations and Tasks

PLANNED FORCE

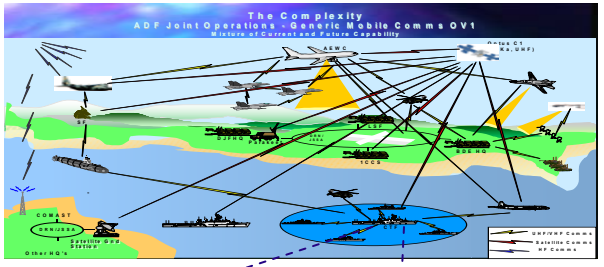
Capability Management Plan

- Defence Capability Plan (DCP)
- Capability Definition Mandates (CDMs)
- Operational Concept Documents (OCDs)
- Capability Acquisition Mandates (CAMs)

Capability and System Relations in Evolution

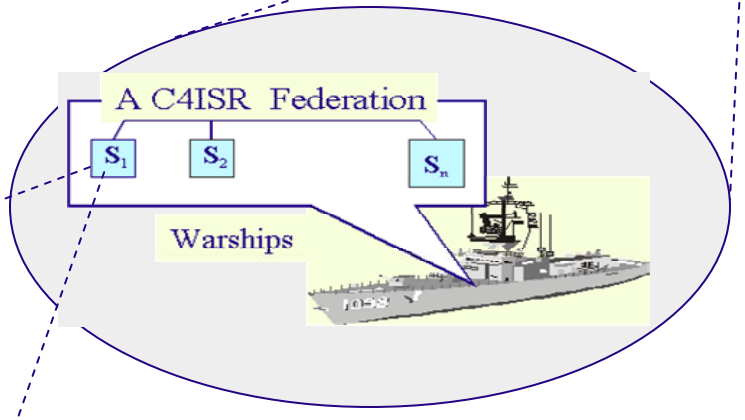


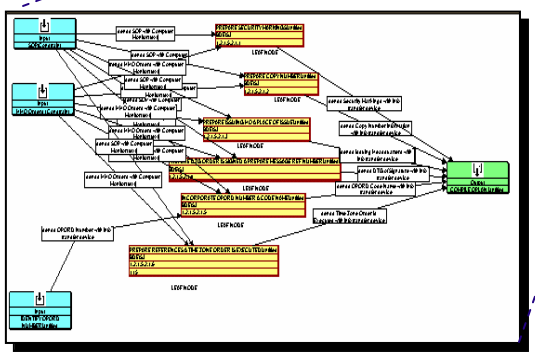
Relation Complexity Explored through Architecture



Operation Scenario (capability) Level:
- "N" nodes involved with different features;
- Shared by all nodes involved;
- Relations between scenarios.

Node (platform) Level:
- Each node contains one or more systems.
- Each system may have sub-systems.
- Interfaces:
  - Between nodes;
  - Between systems;
  - Between subsystems;
  - Between components.





System Level:
- Internal system /subsystems views.
- Relations to other systems (7 possible types)

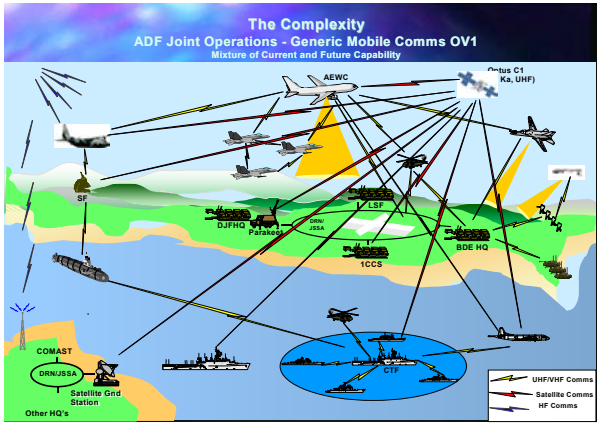
Classification of Capability and System Relations

- ***Structure-related*: *System A* and *System B* are structure-related if *System A* has one of the following relationships to *System B*:**
  - *System A* is a component of *System B*; or
  - *System A* is a basis of *System B*.
- ***Function-related*: *System A* and *System B* are function-related if to perform its own functions, *System A* requires certain functions or services delivered by *System B*.**
- ***Information-related*: *System A* and *System B* are information-related if there are requirements for information flows or information exchanges between two systems (e.g. connectivity and information reach-ability).**
- ***Operation-related*: *System A* and *System B* are operation-related if they are both used in an operation scenario to jointly fulfil a mission.**
- ***Generation-related*: *System A* and *System B* are generation-related if one will be a replacement of another.**

When and How is a Relation Defined?

- Implicitly or explicitly defined in ad hoc manners when:
  - A capability concept is studied or created;
  - An operational scenario is created;
  - An operational view of architecture is created
  - A system is planned or designed; or
  - A system view of architecture is created.

- What does such a defined relation mean to the involved systems?
  - A requirement specification,
  - A concept of design or operations,
  - An artefact of architecture,
  - An agreement between involved systems.



- How should a relation be managed?

- How should a relation be used? ------ SoS Planning and Analysis

Issues in Systems and Capability Relation Management

Issues:

- Managing system and capability relations is an issue concerning the whole life cycle of SoS, including planning, development, management and operation, from individual systems and capabilities to various contexts of SoS;
- The relations can be either conceptualised and represented explicitly or implicitly understood;
- The relations can be either static/fixed or dynamic;
- The relations vary with different degrees of looseness or tightness;
- Each relation has its associated rules;
- Architecturally speaking, the relations are determined by the interfaces between systems or manners in which they are integrated or operated.

Questions:

- Who should be responsible for definitions and management of the relations; and
- Where and how the relations should be defined and managed.

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Architecture Fusion in Defence SoS Context

Architecture Fusion Requirements:

- Systematic management of all architectures of individual systems;
- Systematic integration of all architectures into SoS context;
- Filling architecture gaps;
- Relating systems and their various contexts of SoS;
- Provision of linkage and traceability of architecture;
- Throughout the life cycle of SoS;
- Dynamic and multiple views of Defence SoS context; and
- Becoming a capability in the architecture practice;

Three key concepts

- Architecture fusion framework
- Architecture fusion facility
- Architecture fusion process

Rationales of Relation Management

Main objectives:

- Concept management through defining classes;
- Conceptual relation management through defining relations of classes;
- Systems relation management (relations of objects);
- Interface relation management;
- Provision of linkage and traceability of system (and capability) knowledge;
- Throughout the life cycle of SoS;
- Support architecture fusion in Defence SoS context; and
- Being part of the architecture practice;

Three perspectives at the enterprise level

- Architecture relation (interfaces, integration and information exchange)
- Acquisition relation
- Operation relation

Concept and Conceptual Relation Management

- Why?
  - Concepts, such as scenario, capability, system and architecture, mean different things to different people or in different contexts.

- Need a combined modelling power of three elements.
  - Taxonomy (for managing concepts and their classes);
  - Ontology (for defining relations between concepts and classes) ;
  - Meta data (for specifying attributes).

- An integration of the three elements through an Object-Oriented Model.

- The purpose is to achieve the context management of concepts and objects.

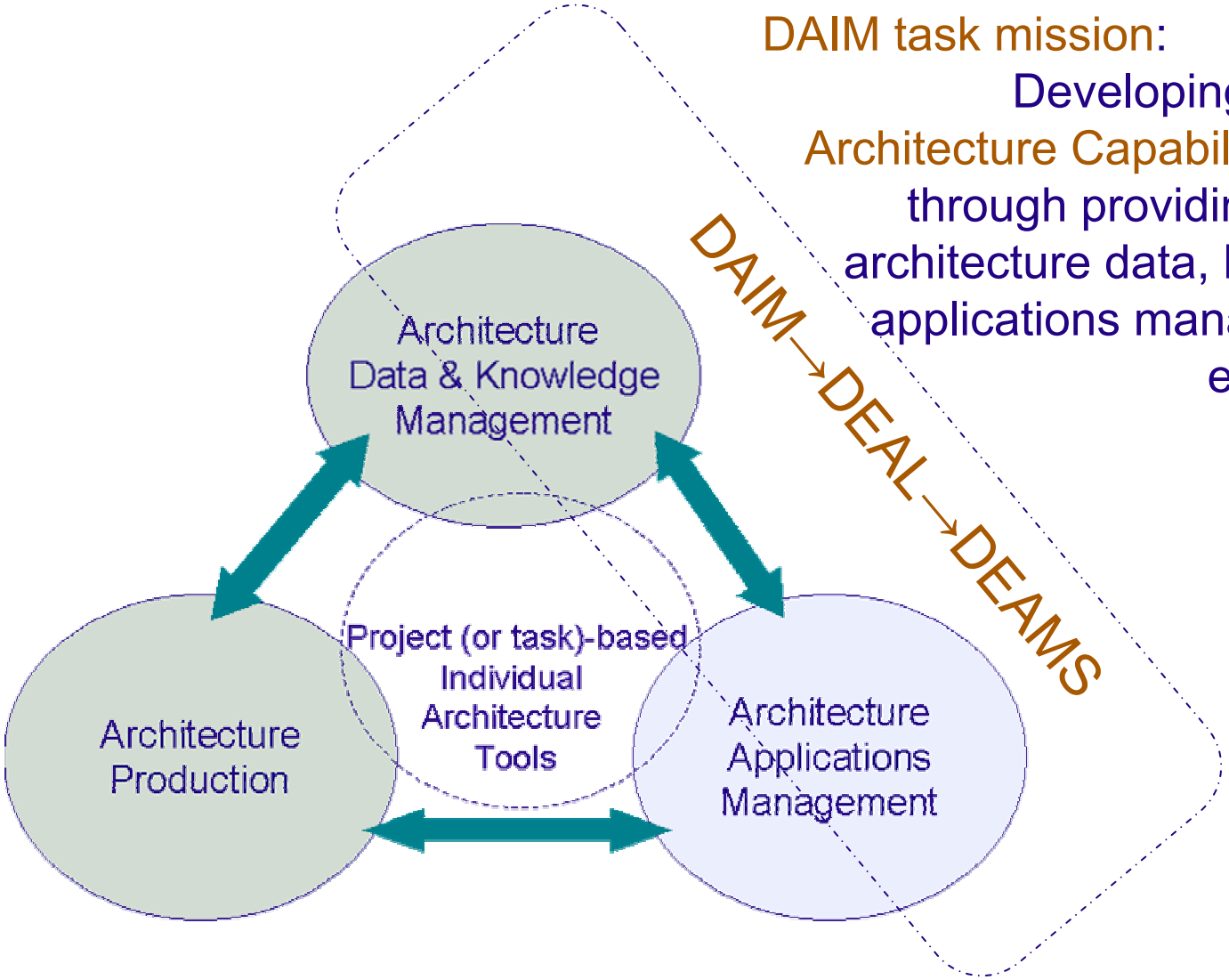
Context Management

- Concept/Class context
  - Definitions of all relations for a given class and their associated concepts or classes;
  - Defining a schema for managing object context.

- Object context
  - An object is an instance of a class.
  - An object context is determined by:
    - ✓ All specified relations to other objects;
    - ✓ All specified attribute values.

- An object store for implementing the object context management

Defence Architecture Information Model (DAIM)



DAIM task mission:

Developing an Integrated Architecture Capability for the ADO through providing solutions for architecture data, knowledge and applications management at the enterprise level.

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Defence Architecture Data Management

Key concepts for Defence Architecture Data Management:

- Defence Architecture Framework (DAF)
- Defence Architecture Information Model (DAIM);
- Defence Enterprise Architecture Library (DEAL);

  DEAL is a DAIM-based repository environment;
- Defence Enterprise Architecture Management System (DEAMS).

  DEAMS = DEAL + processes + applications

A development path: DAIM ==> DEAL ==> DEAMS

What is DAIM?

• A holistic information model represents the whole capability, system and organisation architecture space;

• A knowledge schema for construction of the body of knowledge for Defence capability, systems and enterprise, which include:

- ➢ Taxonomical structures for definitions of concepts and classes (around 100 classes) grouped into six concept packages:
  - ✓ Scenario Package
  - ✓ System Package
  - ✓ Architecture Package
  - ✓ Enterprise Package
  - ✓ Document Package
  - ✓ Project Package;
- ➢ Ontological linkages defining relations among concepts and classes, and across the packages for relation management of concepts and objects; and
- ➢ A basis for object context management.

➢ A conceptual model for generating a data schema for the development of an enterprise architecture library or repository.

System Classification

- System
  - Business system
  - Military operation system
  - Platform system
  - Information-based system
    - Business support system
    - C2 support system
    - Intelligence support system
    - Reconnaissance system
    - Surveillance system
    - Infrastructure system
    - Federation system
- SoS context
  - Capability information environment
  - Business information environment
  - Force operation environment

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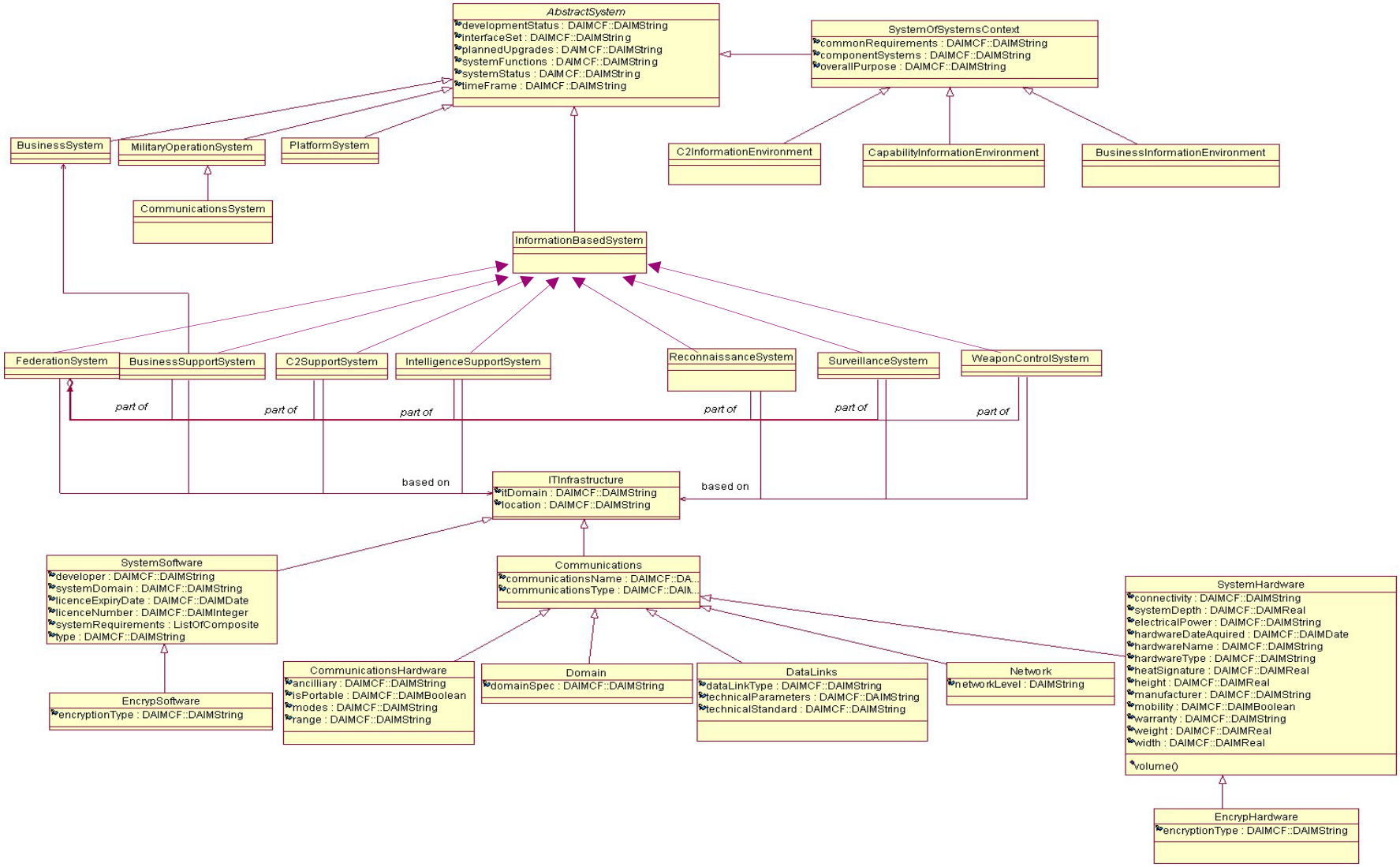
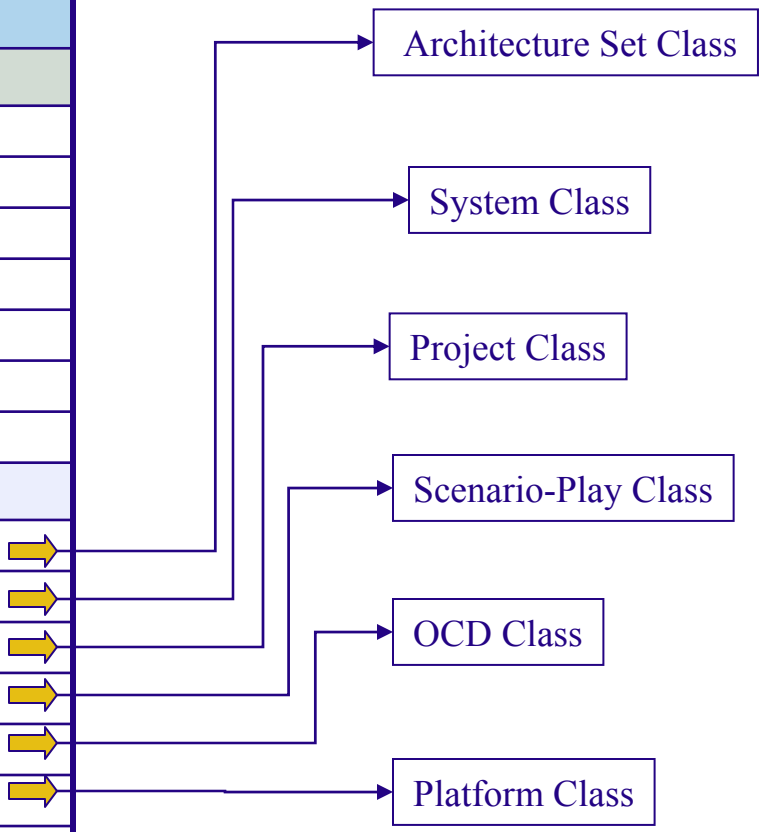
System Package in DAIM



Class Example ----- Systems

Class Name: System	Class id: xxxxx
Attributes	
Abbreviation	
Description	
Status in Lifecycle	
Owned-by	
Security -level	
Project manager	
.....	
Relations	
Architecture set	Link to
Systems	Links to
Project	Link to
Scenario-Play set	Links to
OCD document	Link to
Platforms	Links to
.....	
Methods/Rules	
Method 1	Function 1
Rule 1	Process 1
.....	



What do DAIM and DEAL provide?

They can support capability and systems relation management in System of System (SoS) Context, in particular

- traceability
- visualisation
- dependency analysis
- interoperability analysis
- simulation and experimentation of systems and capabilities.
- a means to store architecture data in context
- a facility for enabling relation management processes and architecture fusion

DAIM and DEAL can provide an environment to deal with "big pictures" of defence capability and the Defence Information Environment (DIE).

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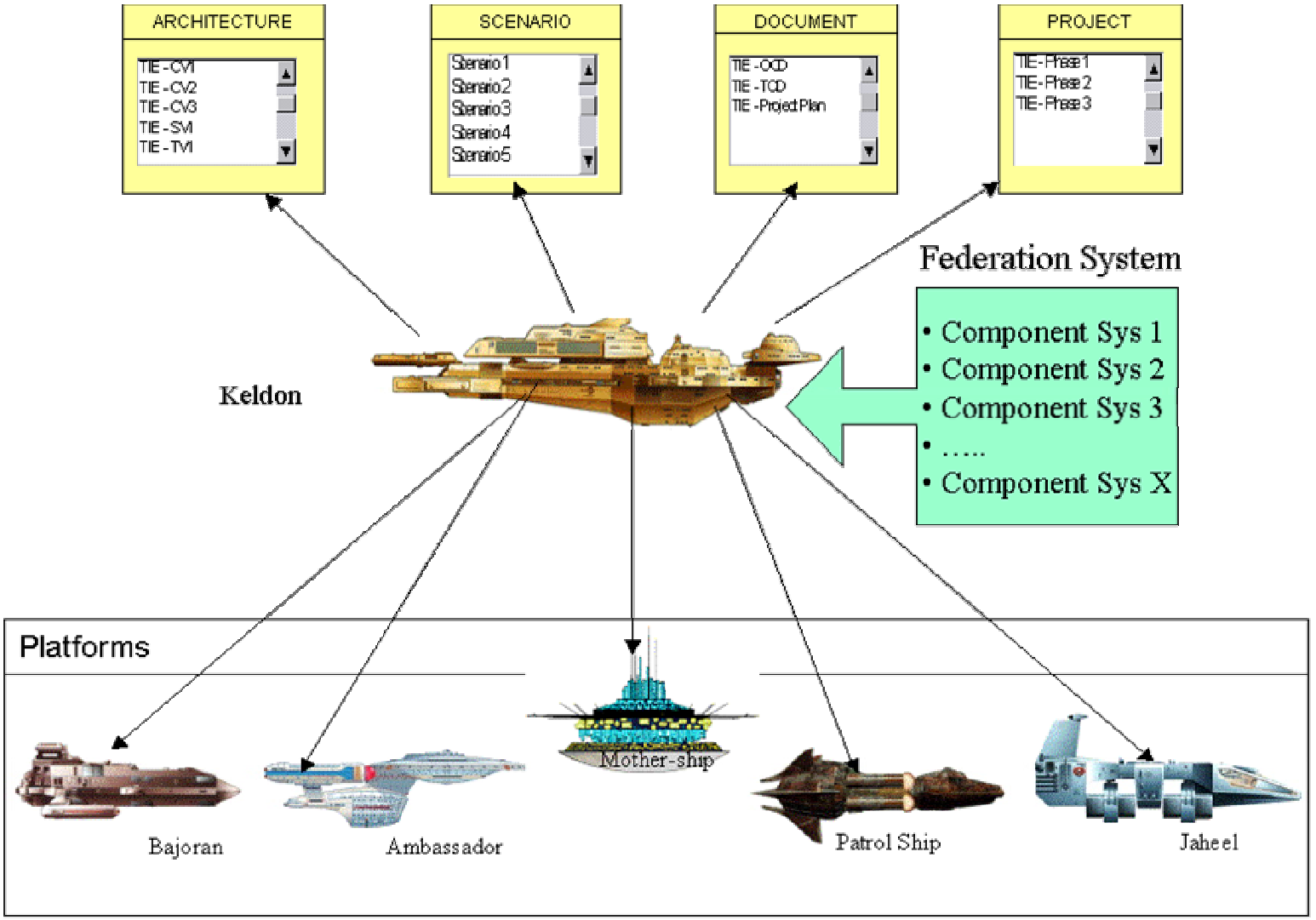
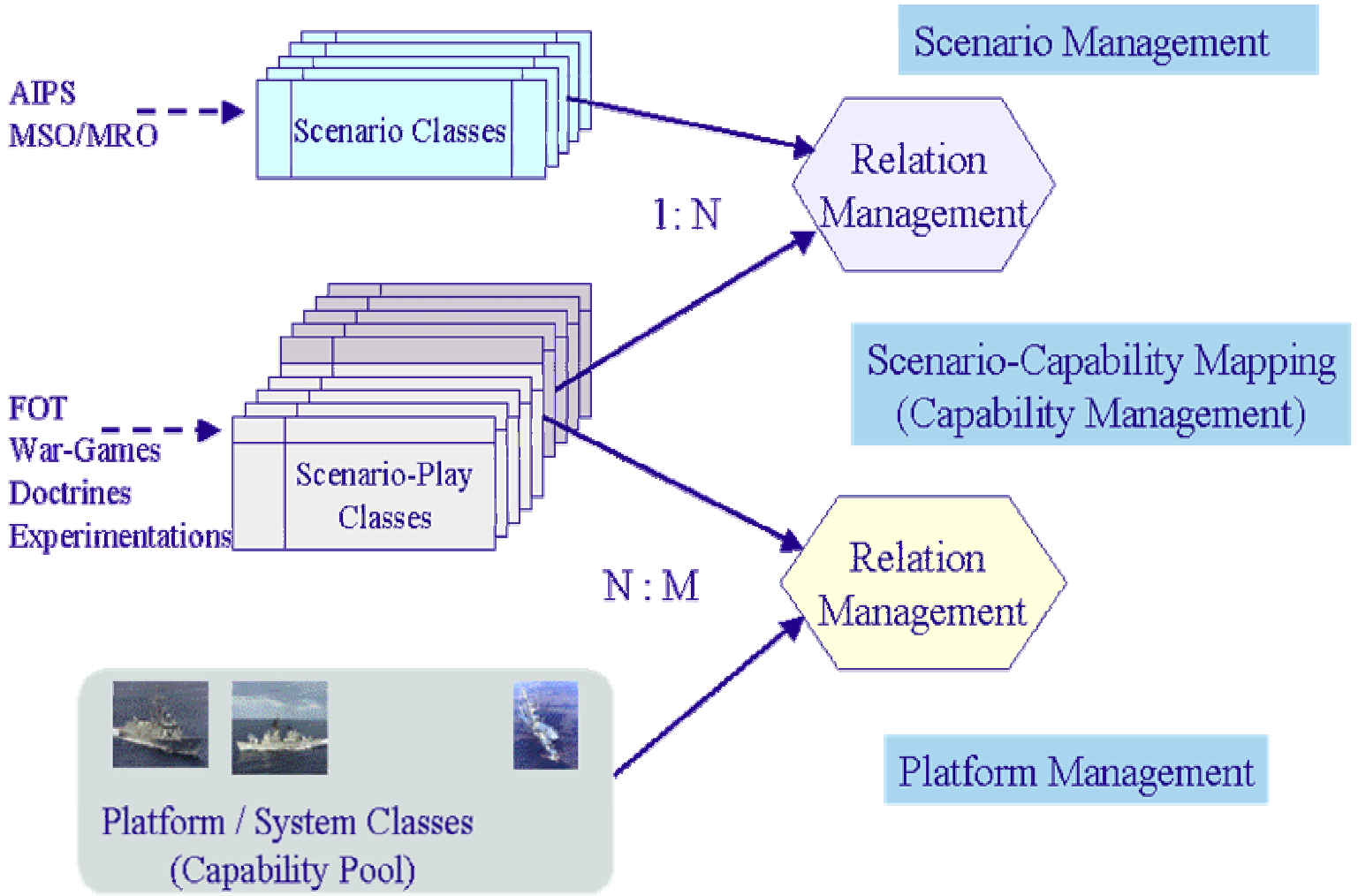
Object Context Management and Visualisation



Relation Management across concepts



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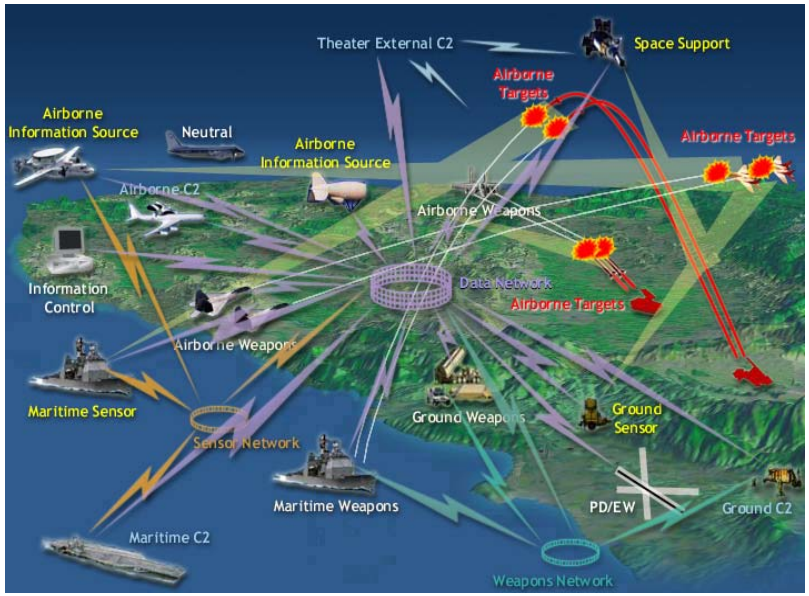
Systems Architecture Analysis Functions



: LISI Level 4
: LISI Level 3
: LISI Level 2
: LISI Level 1
: LISI Level 0

Links to associated architecture descriptions

Functions for generating a Systems Interoperability Profile Matrix

	Sys 1	Sys 2	Sys 3	Sys 4	Sys 5		Sys N
Sys 1							
Sys 2							
Sys 3							
Sys N							

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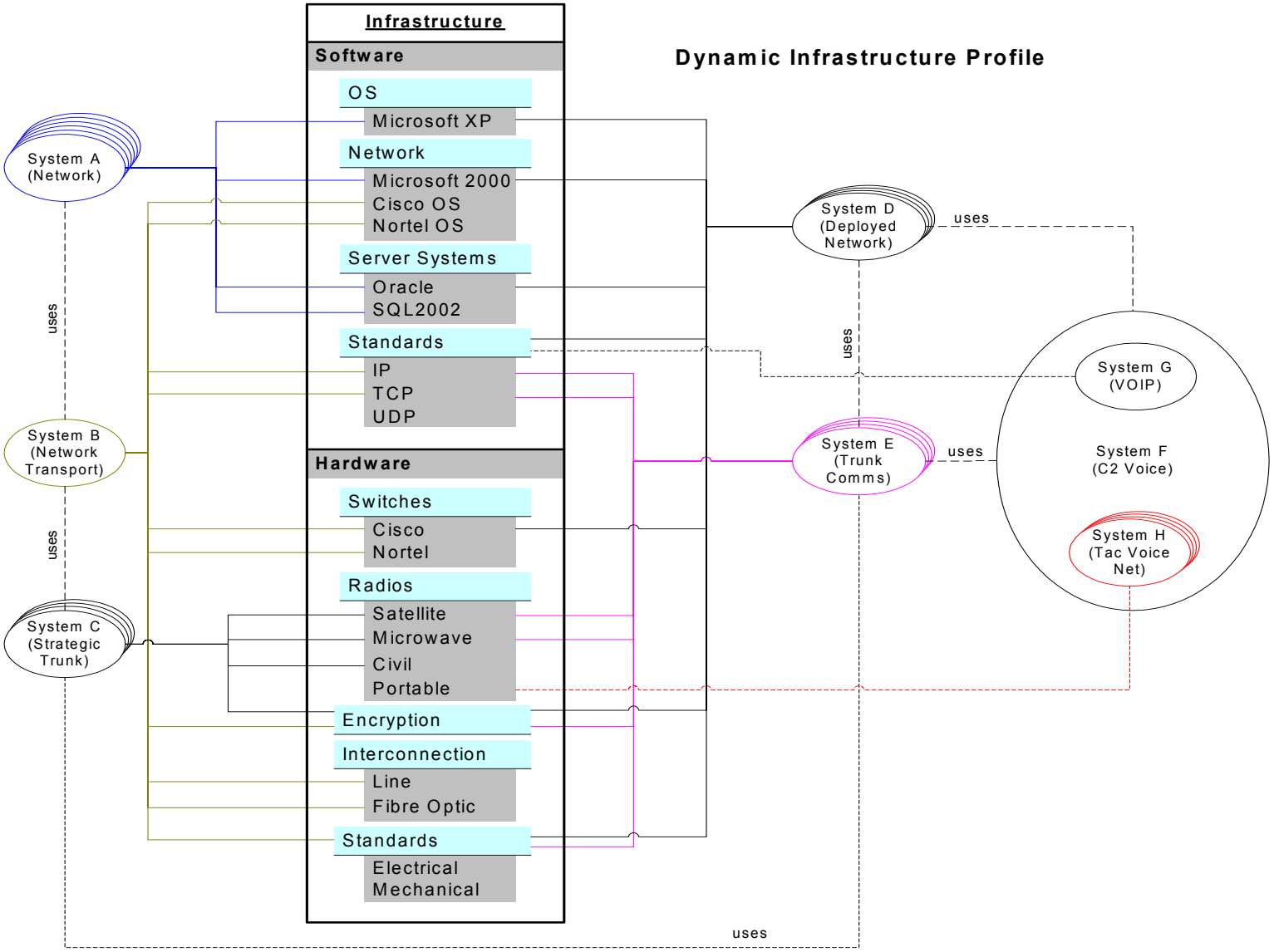
Use Case examples: Visualisation of Infrastructure Profiles



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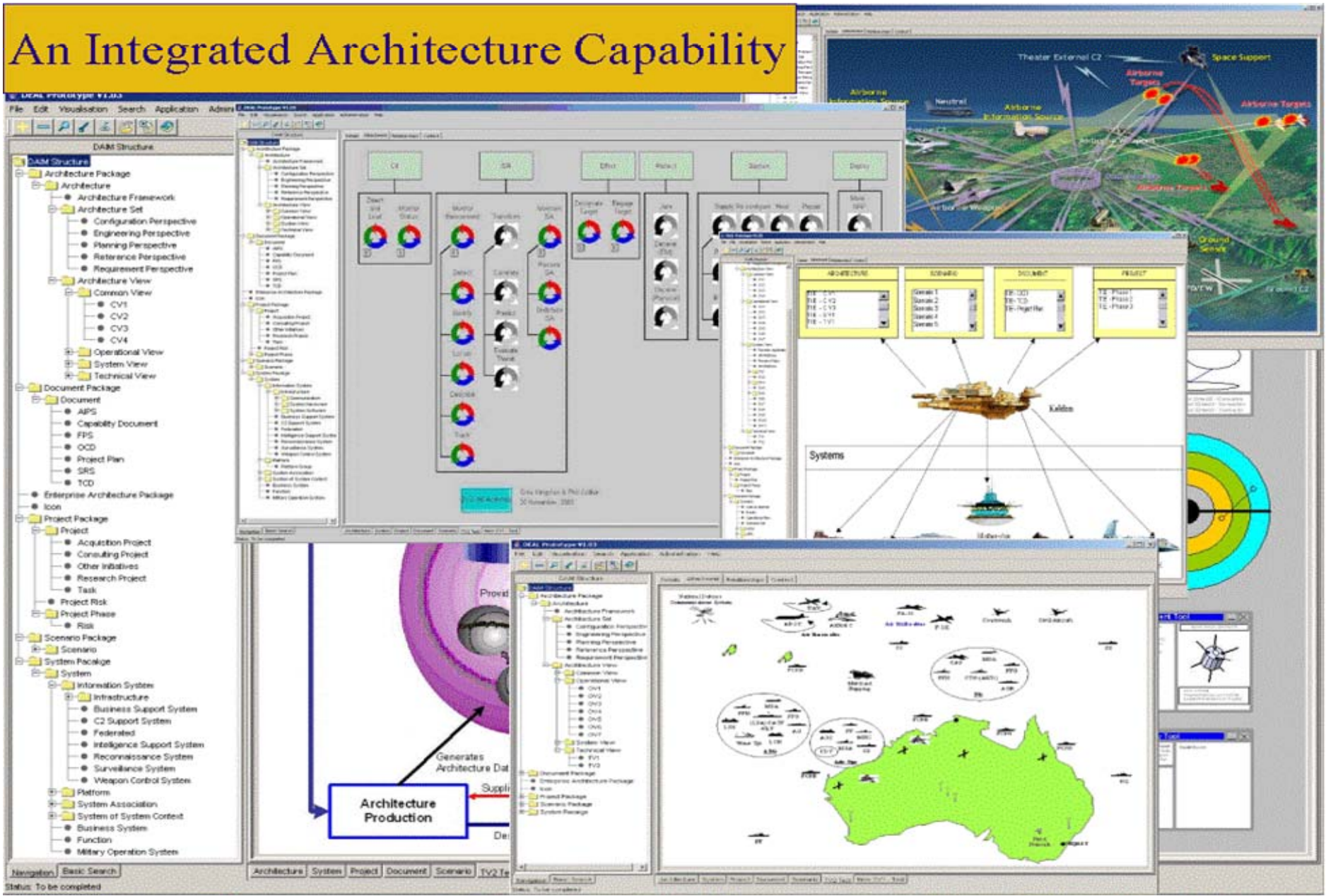
An Integrated Architecture Capability



Architecture-Based Capability Analysis

- Scenario-based Capability analysis
  - Scenario classification analysis
  - Scenario dependency analysis
  - Capability gap analysis
  - Scenario conflict analysis
  - Scenario-based interoperability analysis
- Platform-based Capability Analysis
  - Platform operation analysis
  - Platform dependency analysis
  - Platform-based interoperability analysis

Relation Management

- System-based Capability Analysis
  - System relation/dependency analysis
  - System interoperability analysis
  - System interface analysis
  - Complexity analysis of SoS
- Project-based Capability Analysis
  - Project dependency/relation analysis
  - Project schedule analysis
- Impact Analysis
  - From Scenario to: platforms, systems, and projects
  - From Platform to: scenarios, systems, and projects
  - From System to: scenarios, platforms, projects
  - From project to: scenarios, platforms and systems

Conclusions

- Systems and capability relation management is a missing component in the architecture of Defence SoS.

- Existing disciplines and methods, such as Systems Engineering and architecture approaches/frameworks, cannot address it in SoS evolution context.

- The DAIM-based approach demonstrates not only concepts, solutions but also an architecture capability for Defence to manage systems and capability relations.

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Questions?