Model-Based Military Scenario Management for Defence Capability Analysis

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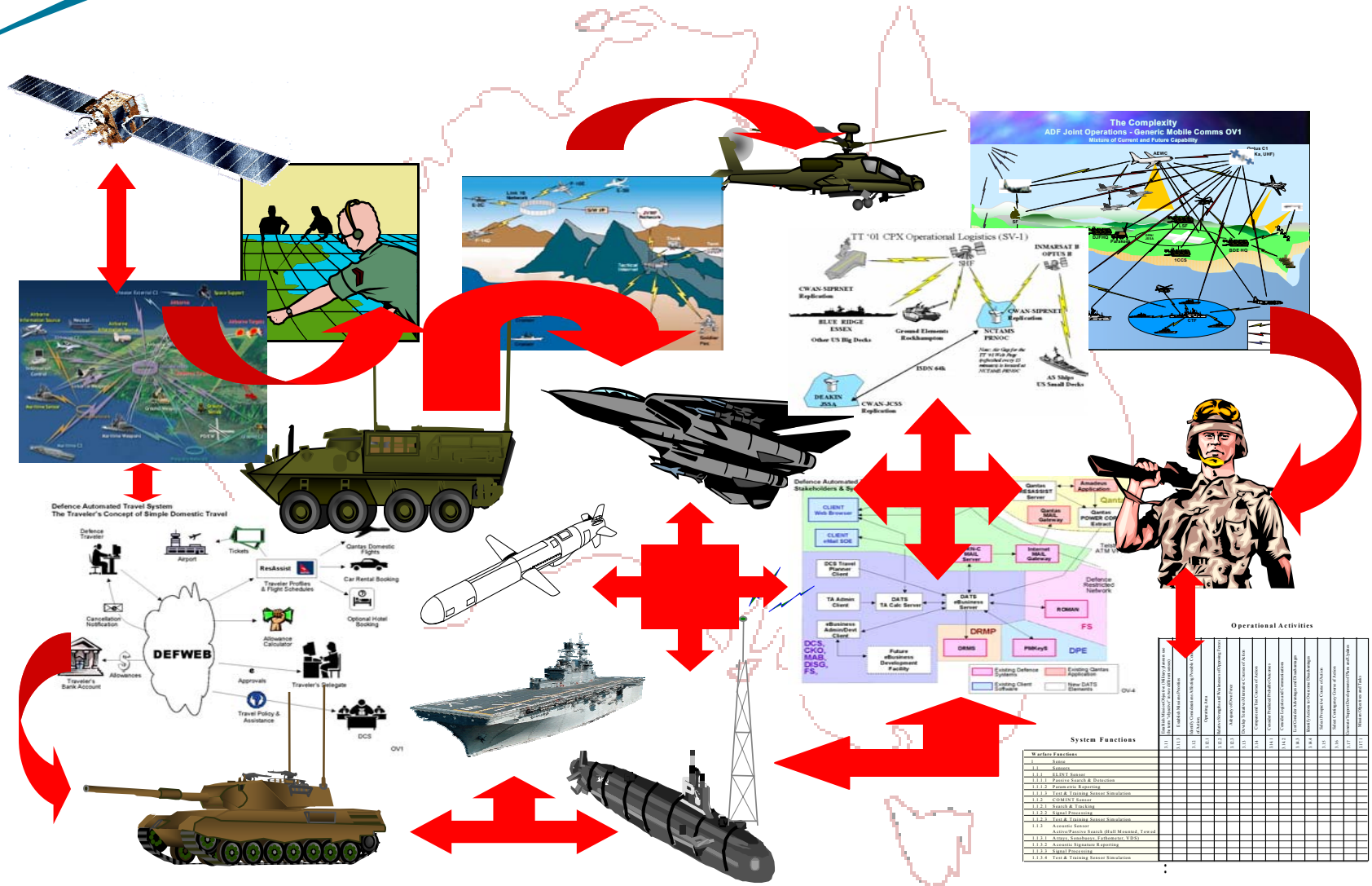
Outline

- Introduction
- Scenario management requirements
- Rationales for scenario management
- Scenario Classification
- DAIM-based approach
- Benefits and applications
- Conclusions

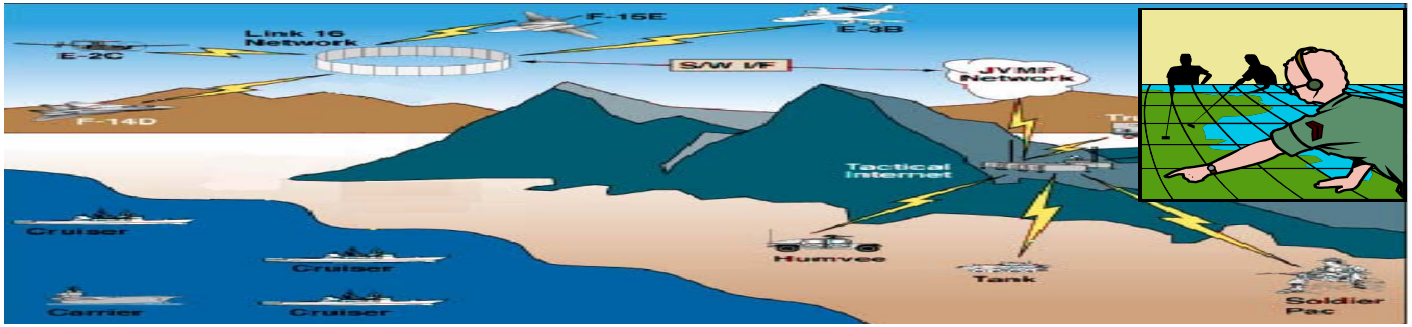
Scenario and Architecture Related Activities



Why Scenarios?

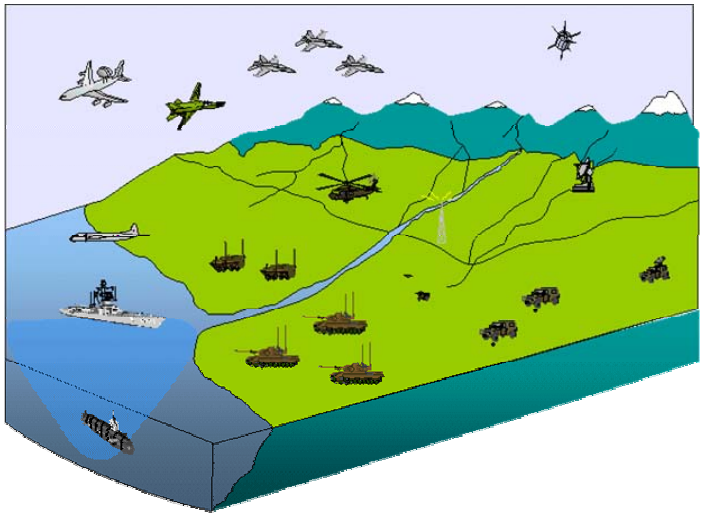
Scenarios are inputs or outputs of the following defence activities:

- Identification of defence strategic requirements
- Identification of capability gaps
- Prioritisation of capability development
- Study of future force and capability
- Force projection and transformation
- Development of a business case for capability acquisition
- Defining a context for simulations, experiments and wargames
- Determining preparedness
- Planning for campaign, operations and exercises



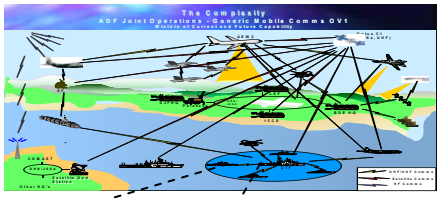
What is a scenario?

- A description of:
  - an event,
  - an military operation,
  - a military response,
  - deployment of force,
  - deployment of capability, or
  - configuration of systems.



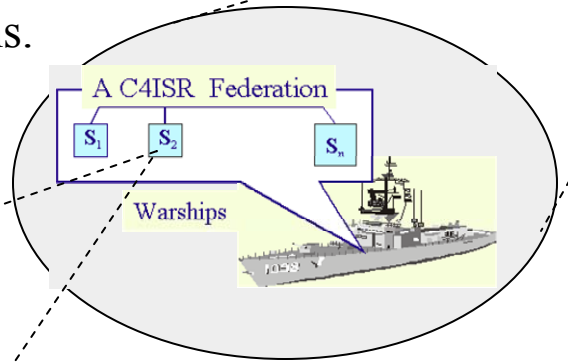
- A scenario can be seen as:
  - a context of a military response,
  - a reference model used in planning,
  - a case study of experiments, simulations or wargames,
  - a requirement specification of capability/systems, or
  - a view of architecture (OVs)

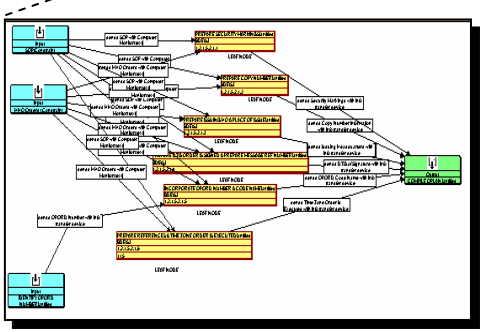
Architecture Complexity Embedded in a Scenario



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)

Capability-Based Planning

- Work by Paul Davis of RAND

  Proposes an analytical framework with three components:
  - a thorough understanding of capability requirements
  - an assessment of capability options at the level of mission or operation
  - an ability to choose between capability levels and amongst capability options in an integrative portfolio framework that considers other factors (eg, force management), different types of risk and economic limitations.

- Need to explore a scenario space, a design space and a requirements space in a context of architecture

- Need to explore these spaces iteratively and recursively

What Scenario Management Helps

Should allow a user to pose, and then answer, the following questions:

- How can Defence plan and evaluate their capabilities in multiple operational scenarios?
- How many scenarios can Defence cope with, in parallel, at a given level of capability?
- How can Defence analyse conflicts, shortage or gaps of capabilities in coping with multiple scenarios?
- How can Defence analyse impact and consequence of the change to an instantiated operational scenarios to other scenarios due to the constraints of capability requirements shared among those scenarios?
- How can Defence Information Environment information flows be examined in different warfighting contexts?

Scenario Management Requirements

- Why is the scenario management required?
  - ➢ Core knowledge on force operations and capability deployment and development
  - ➢ Direct impact on decision making and operation
  - ➢ Rich in background and context information and knowledge
  - ➢ Related to each other with high complexity
  - ➢ Involving multiple stakeholders
  - ➢ Losing of knowledge due to frequent change or turnover of staff
  - ➢ Problems and difficulties in the current practice:
    - ▪ No commonly agreed definitions of scenario concepts and relations;
    - ▪ Creating, defining and managing scenarios in ad hoc manners;
    - ▪ No mechanism supporting scenario analysis, evaluation and validation;
    - ▪ Based on assumptions or hypothesis;
    - ▪ No linkage and traceability of information and knowledge to capability and systems.

Scenario Management Rationales

- Military operation knowledge management
  - Scenario concepts management
  - Scenario relation management
  - Scenario context management
  - Scenario management process

- Innovations
  - Model-based
  - Scenario repository
  - Rule-based scenario analysis
  - Being part of Defence architecture management

Types and Areas of Scenarios and Relevant Concepts

Strategic Level	**Strategic Scenarios**	**Military Response Options** **Strategic Drivers** **Joint Operation Concepts** **Contingency Planning**
Operation Areas and Levels • **Joint** • **Air** • **Army** • **Navy** • **Coalition**	**Planning Scenarios** **Operation Scenarios** **Deployment Scenarios** **Preparedness Scenarios** **Reference Scenarios** • **OR study scenarios (Sim/Exp/Wargame)** • **Testing scenarios**	**Operation Plans** **CON-plans** **Campaign Plans** **Effect Assessment** **Mission Capability** **Force Projection** **Force Transformation**
Capability • **Study** • **Acquisition**	**Capability Operation Scenarios** **Configuration Scenarios**	**FPS** **CONOPs** **Capability Plans** **OVs**

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

Scenario Attributes, Formats and Context

- Different scenarios have:
  - ➢ different attributes,
  - ➢ different formats,
  - ➢ different contexts (relations to other scenarios or other concepts).

- Scenario definition — the first step towards Scenario Management
  - ➢ Class definition, including:
    - ✓ Attribute definitions
    - ✓ Context definition
    - ✓ Formate definition

    Also possibly,
    - ✓ Rules
    - ✓ Processes

What is DAIM?

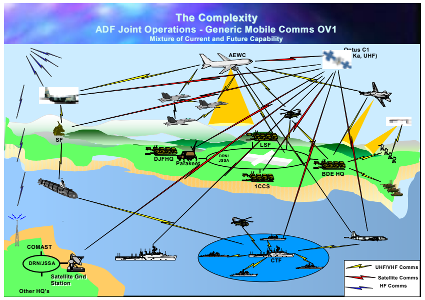
• A holistic information model represents the whole capability, system and organisation architecture space;

• 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 through mate data definitions.**

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

Scenario Class Definition Example



Class Name: Scenario	Class id: xxxxx
Attributes	
Owned-by	
Description	
Created-by	
Reviewed-by	
Security -level	
Use status	
…….	
Relations	
Architecture descriptions	Link to
Systems required	Links to
Project related	Link to
Scenario-Play set	Links to
Reference Scenarios	Link to
Platforms required	Links to
……	
Methods/Rules	
Method 1	Function 1
Rule 1	Process 1
………	

Architecture class

Project class

System class

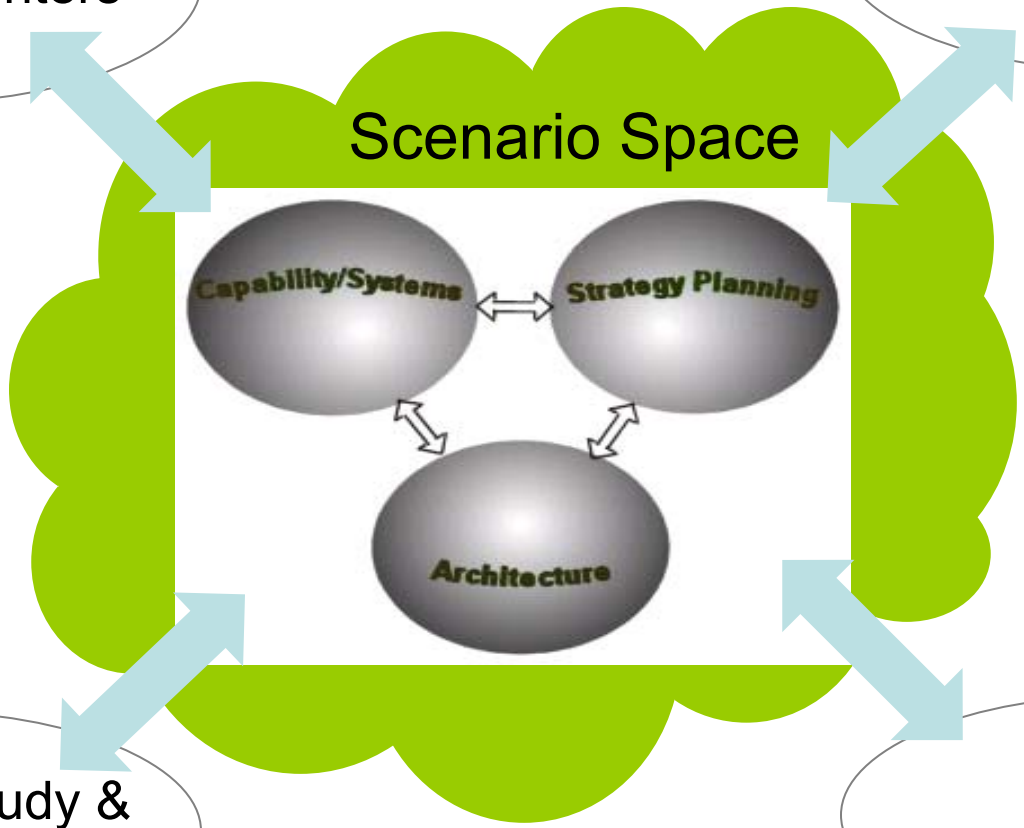
Other scenario classes

Platform class

Scenario-Based Communications

C2 or Warfighters

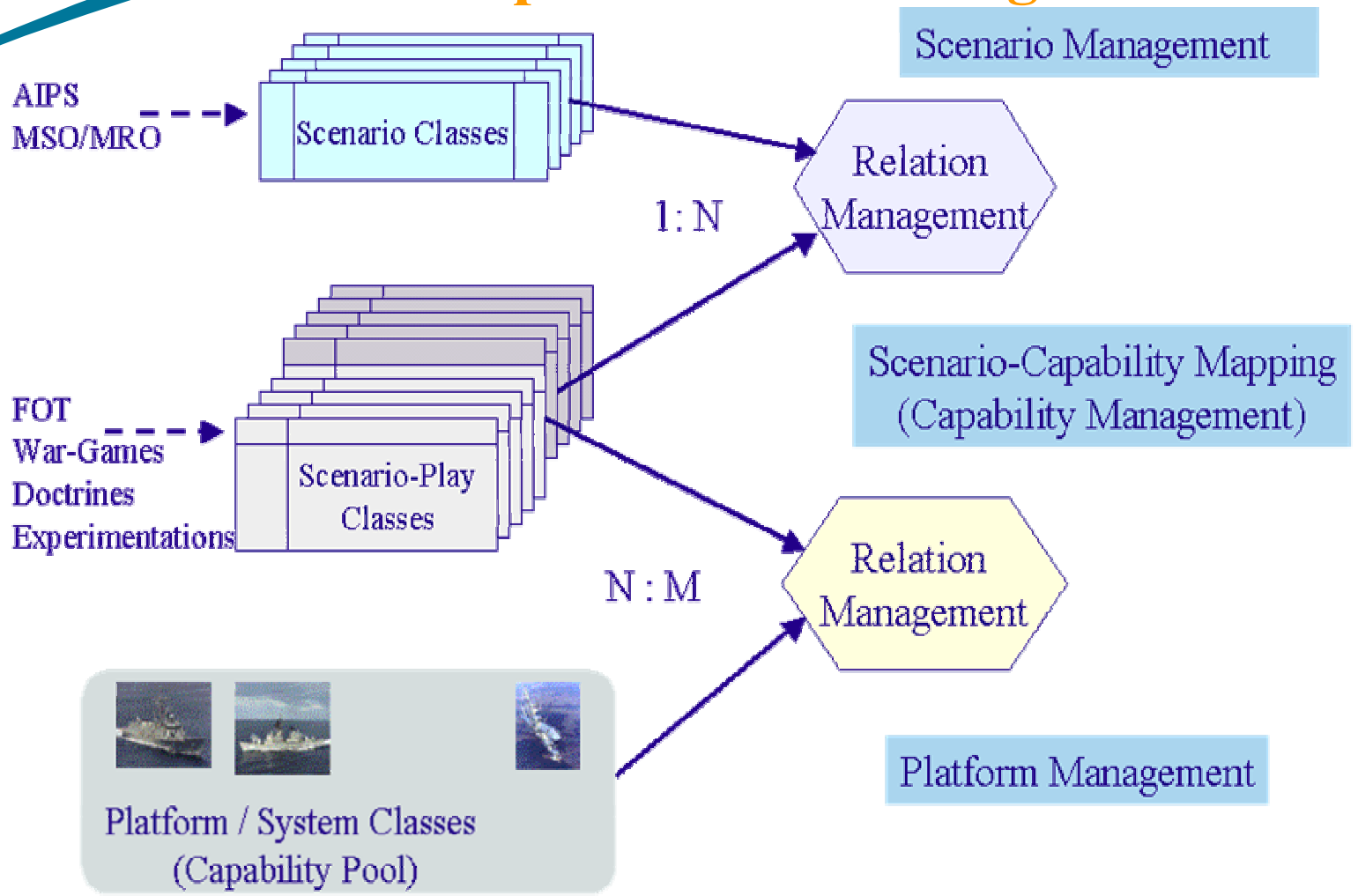
Strategic Planning



Capability Study & Development

R&D and Operation Research

Cross Concept Relation Management



A view of a Platform-based Scenario Space

Architecture-Based Capability Analysis

Activities to be supported by DAIM and DEAL:

- 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

Architecture-Based Capability Analysis

Activities to be supported by DAIM and DEAL:

- 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

Conclusion

- The scenario is an important concept for Defence;
- It means different things in various areas or contexts;
- Scenarios are often related;
- Relations between scenarios are complicated and important;
- The scenario management is an initiative across all relevant areas of Defence;
- The scenario management is a kind of knowledge/information management and requires a well-defined model; and
- The scenario management should be part of Defence architecture management.

Questions

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