Model-Based Military Scenario Management for Defence Capability Analysis

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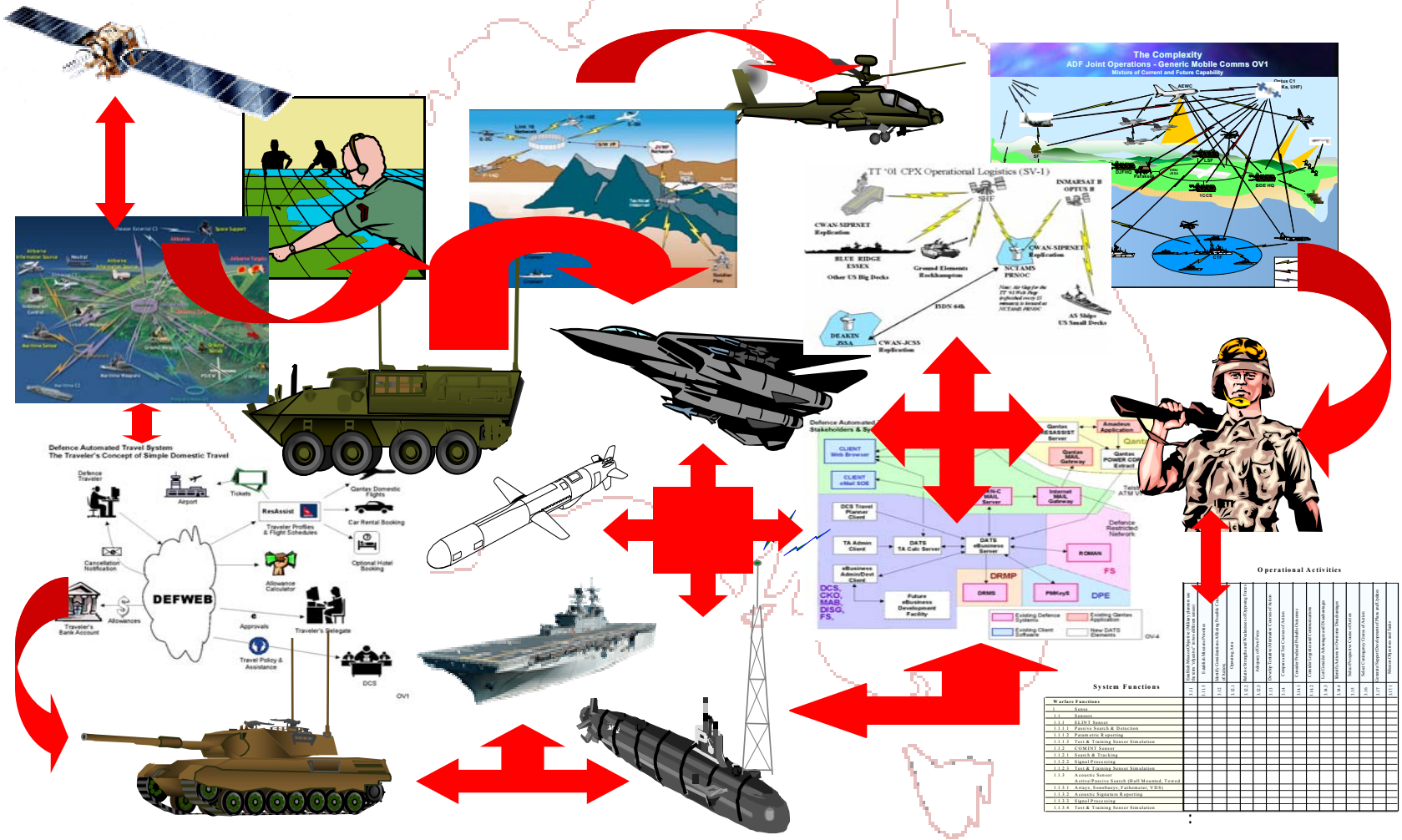
Presented by Thea Clark

Outline

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

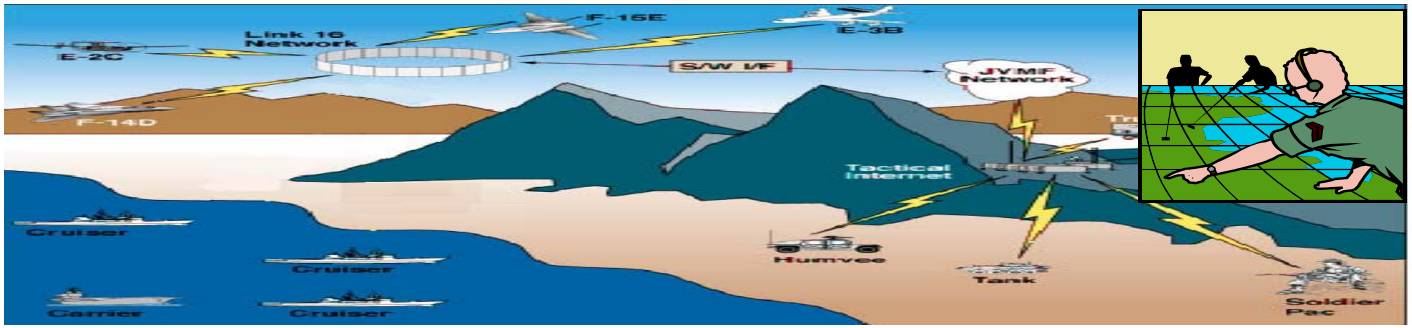
Scenario and Architecture Related Activities



Why Scenarios?

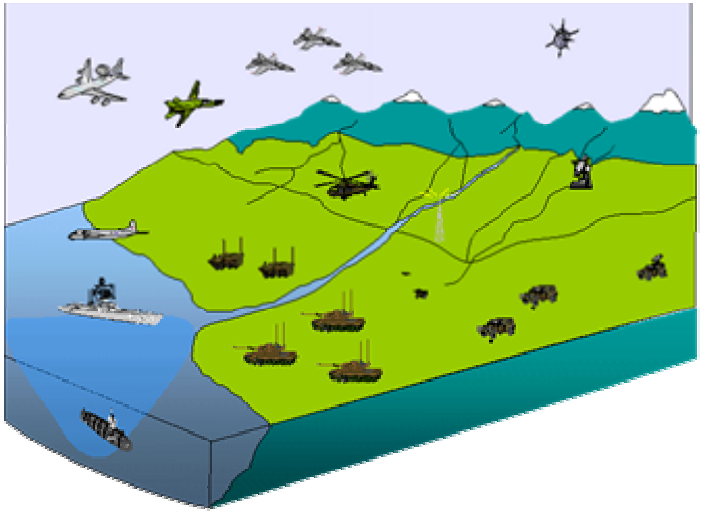
Scenarios are inputs or outputs of the following defence activities:

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

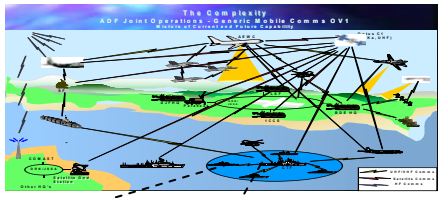


What is a scenario?

- A description of:
  - an event
  - an military operation
  - a military response
  - deployment of force
  - deployment of capability
  - 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
  - a view of architecture (OVs)

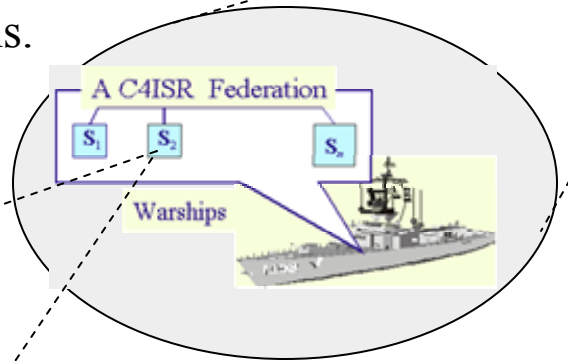


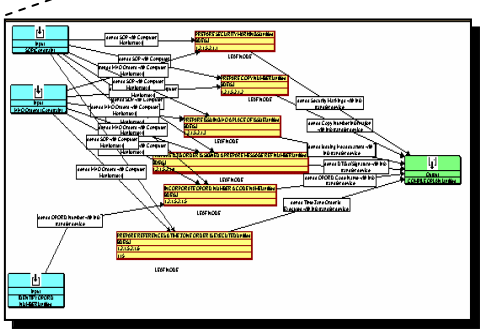
Architecture Complexity Embedded in a Scenario



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

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 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**

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
    - ✓ Format 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 meta data definitions.
- A conceptual model for generating a data schema for the development of an enterprise architecture library or repository.

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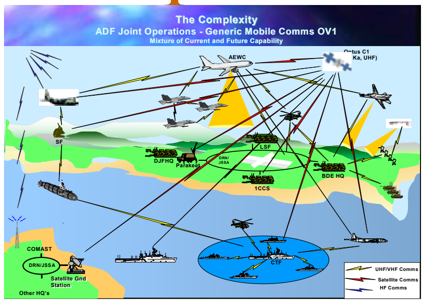
Scenario Class Definition Example



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

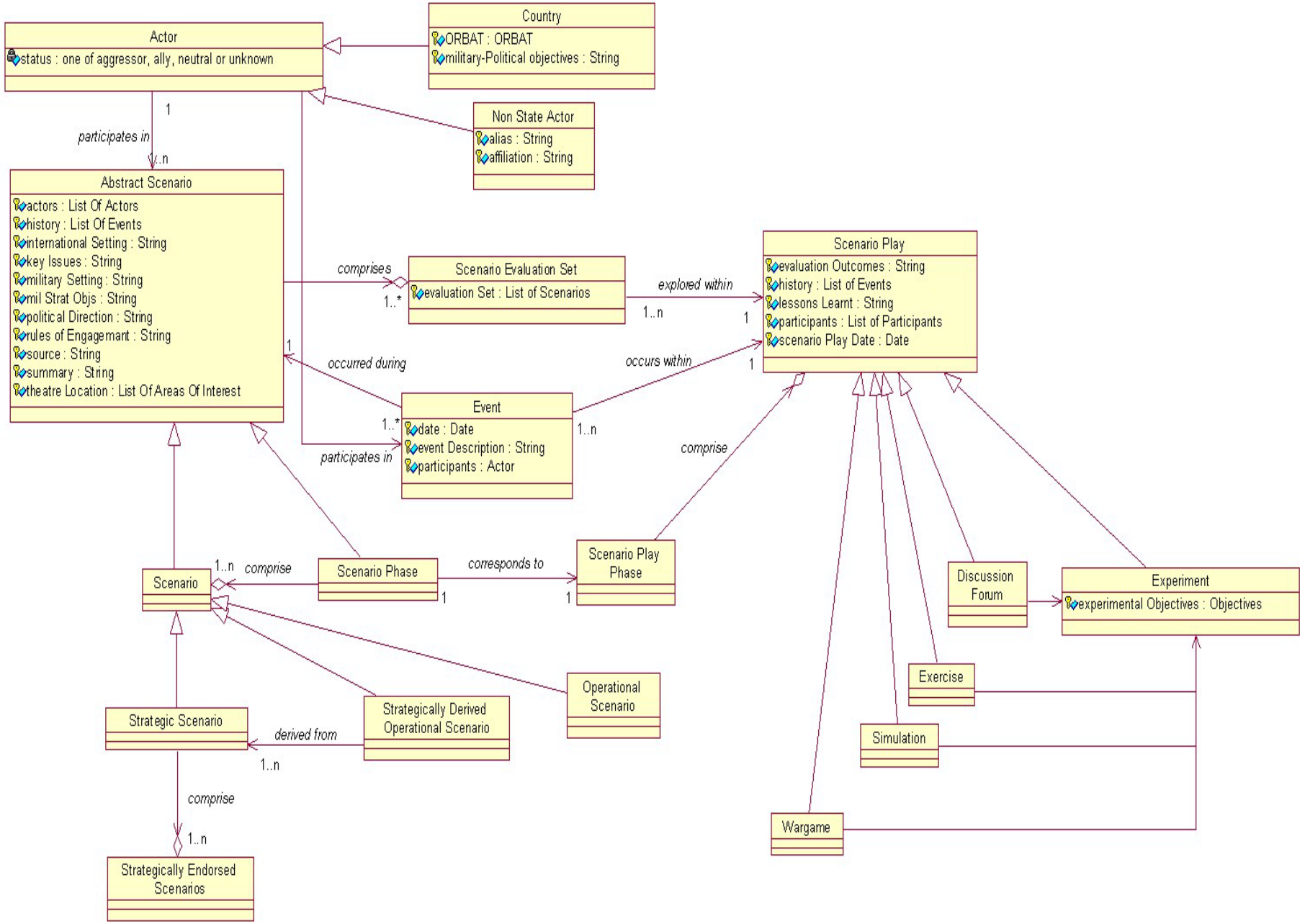
Other scenario classes

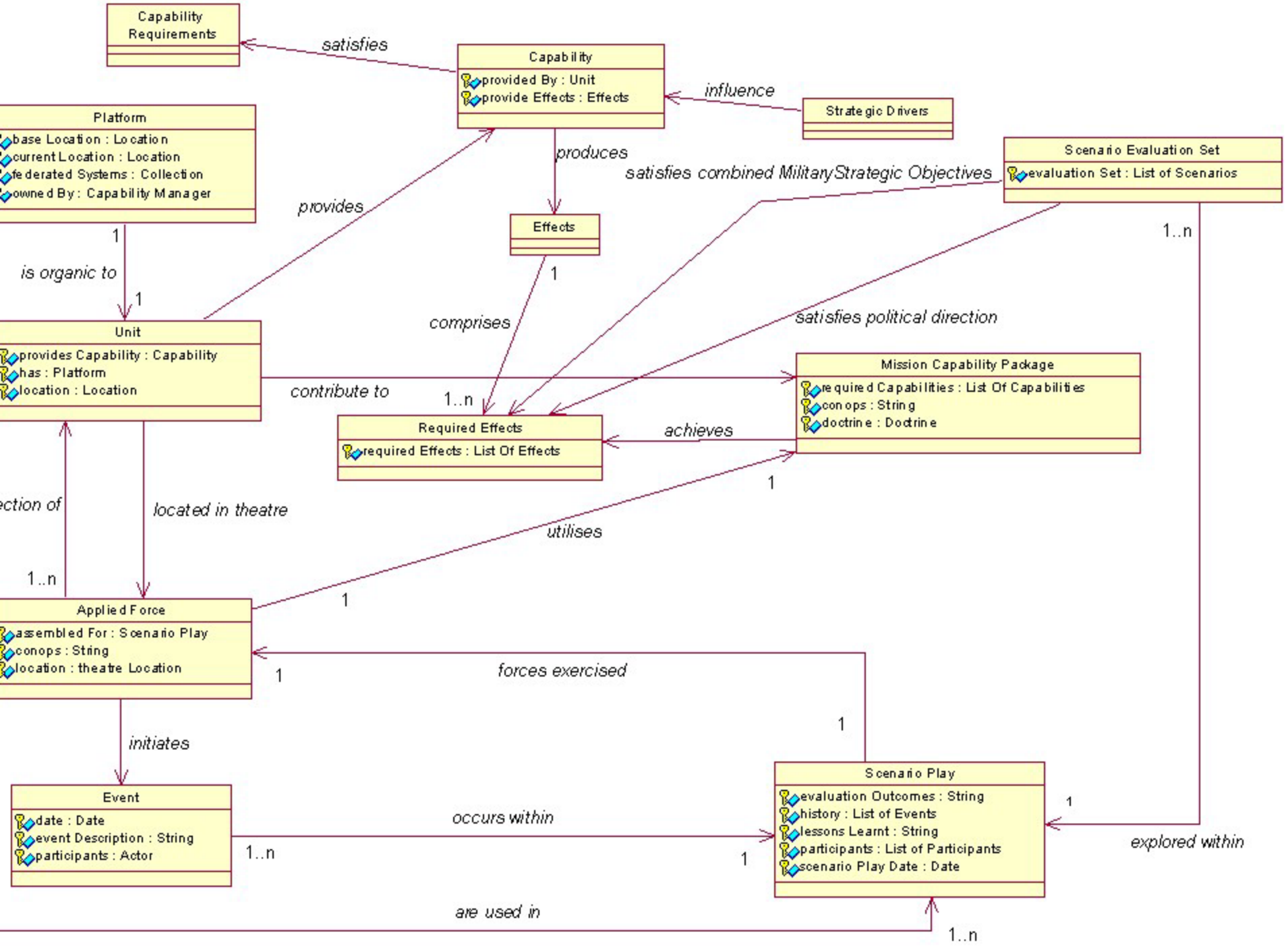
Platform class

Requirements for Scenario Based Knowledge Management

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?


Actor
status : one of aggressor, ally, neutral or unknown
Country
ORBAT : ORBAT
military-Political objectives : String
Non State Actor
alias : String
affiliation : String
participates in
1
1..n
Abstract Scenario
actors : List Of Actors
history : List Of Events
international Setting : String
key Issues : String
military Setting : String
mil Strat Objs : String
political Direction : String
rules of Engagemant : String
source : String
summary : String
theatre Location : List Of Areas Of Interest
comprises
1..*
Scenario Evaluation Set
evaluation Set : List of Scenarios
explored within
1..n
1
Scenario Play
evaluation Outcomes : String
history : List of Events
lessons Learnt : String
participants : List of Participants
scenario Play Date : Date
occurred during
occurs within
1
1..*
1..n
Event
date : Date
event Description : String
participants : Actor
participates in
comprise
1..n
comprise
Scenario
Scenario Phase
corresponds to
1
1
Scenario Play Phase
Discussion Forum
Experiment
experimental Objectives : Objectives
Exercise
Operational Scenario
Strategic Scenario
derived from
Strategically Derived Operational Scenario
1..n
Simulation
comprise
1..n
Strategically Endorsed Scenarios
Wargame


Capability Requirements
satisfies
Capability
provided By : Unit
provide Effects : Effects
influence
Strategic Drivers
Platform
base Location : Location
current Location : Location
federated Systems : Collection
owned By : Capability Manager
produces
Scenario Evaluation Set
evaluation Set : List of Scenarios
satisfies combined MilitaryStrategic Objectives
provides
Effects
1
is organic to
1
1..n
Unit
provides Capability : Capability
has : Platform
location : Location
comprises
1
satisfies political direction
contribute to
1..n
Mission Capability Package
required Capabilities : List Of Capabilities
conops : String
doctrine : Doctrine
Required Effects
required Effects : List Of Effects
achieves
1
ection of
located in theatre
utilises
1..n
1
Applied Force
assembled For : Scenario Play
conops : String
location : theatre Location
1
forces exercised
1
initiates
Event
date : Date
event Description : String
participants : Actor
occurs within
1..n
1
Scenario Play
evaluation Outcomes : String
history : List of Events
lessons Learnt : String
participants : List of Participants
scenario Play Date : Date
1
explored within
are used in
1..n

A view of a Platform-based Scenario Space

National Strategic Scenarios

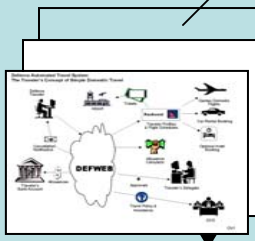
Capability Development Scenarios

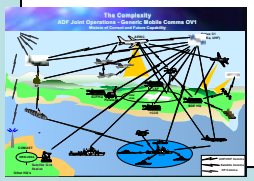
Force Planning Scenarios

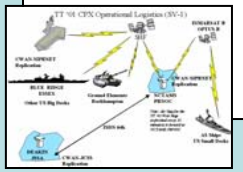
C2 Operation Scenarios

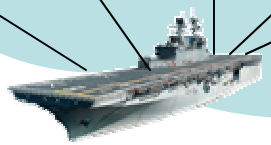
Coalition Scenarios

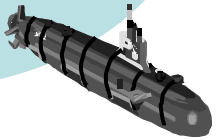
R & D Scenarios

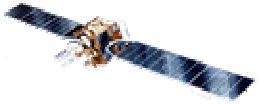




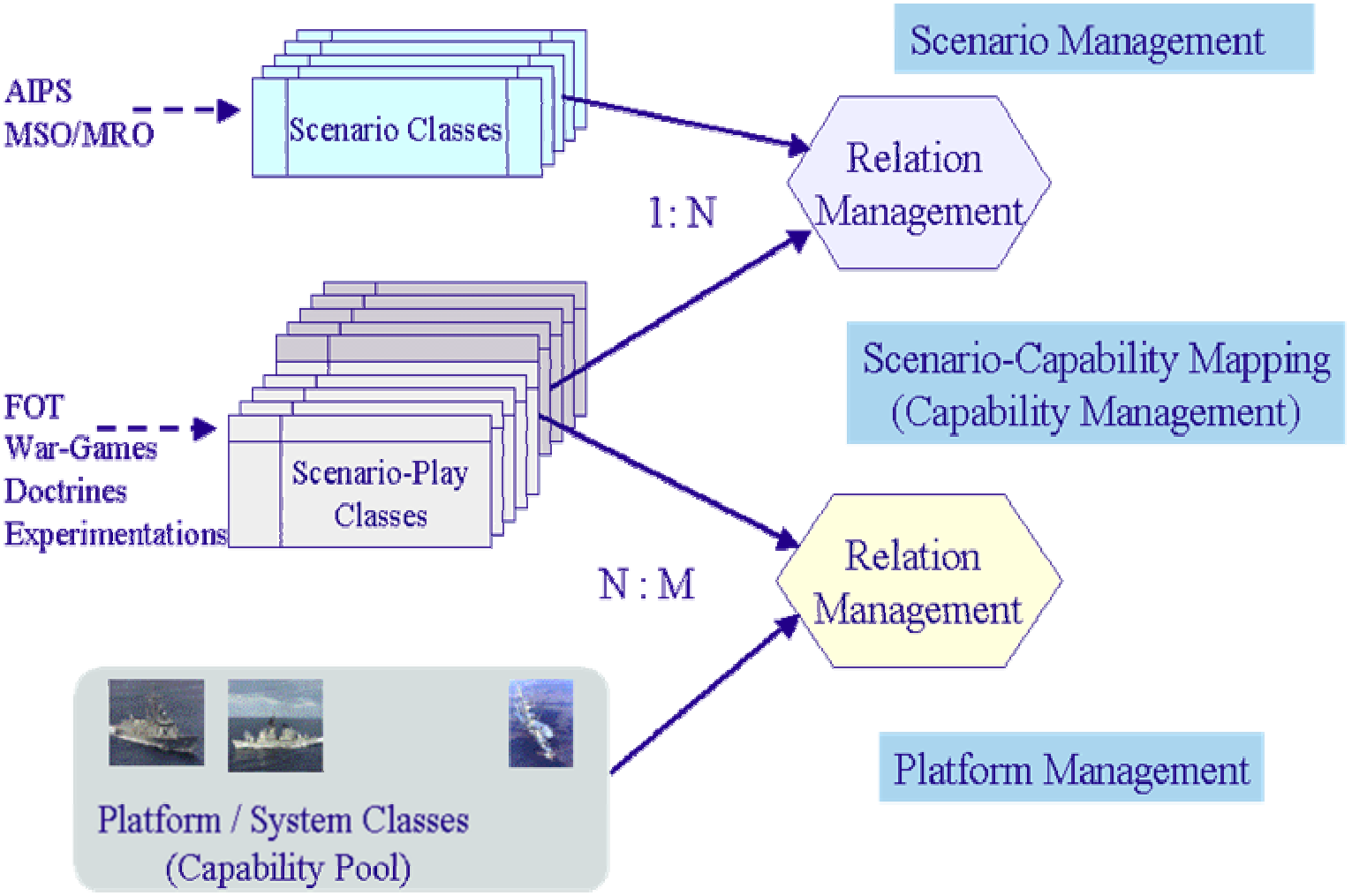








Cross Concept Relation Management



Future Work

Need to:

- Start to engage with stakeholders
- Develop use cases with potential users
- Refine and improve the information models
- Further develop the DEAL concept demonstrator

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

Architecture-Based Capability Analysis

- 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

- Government has clearly articulated its requirements for rigorous advice regarding capability options
- Complexities of concept development and experimentation, capability analysis, prioritisation and development require significantly enhanced computer based analytical support
- Have developed an information model (taxonomy, ontology and meta-data) that relates scenarios, the results of scenario "executions" with forces, platforms and capabilities
  - Should be extensible to capture experimental results and analytical outcomes.
  - Will allow users to analyse and compare scenarios and their experimental outcomes together with their relationships to forces, platforms and capabilities.
  - Part of a larger information model, with links to projects, systems and architectures.

Questions

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