MINISTRY OF DEFENCE

International Technology Alliance
In Network & Information Sciences

Making Plans Alive

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Overview

- Context of Research
- Characteristics of Military Planning
- Proposed Framework
- Benefits
- Future Challenges

Context

- International Technology Alliance
  - Fundamental research in network and information sciences
  - UK MOD, US ARL, academia, industry collaboration
  - Technical Area 4: Distributed Coalition Planning and Decision Making

- Research Focus
  - Collaborative shared understanding and problem solving over a network
  - Military Planning is an example of a distributed collaborative problem solving process that is dependent on shared understanding.
    - How plan representations may be shared across tools and perspectives

Military Planning

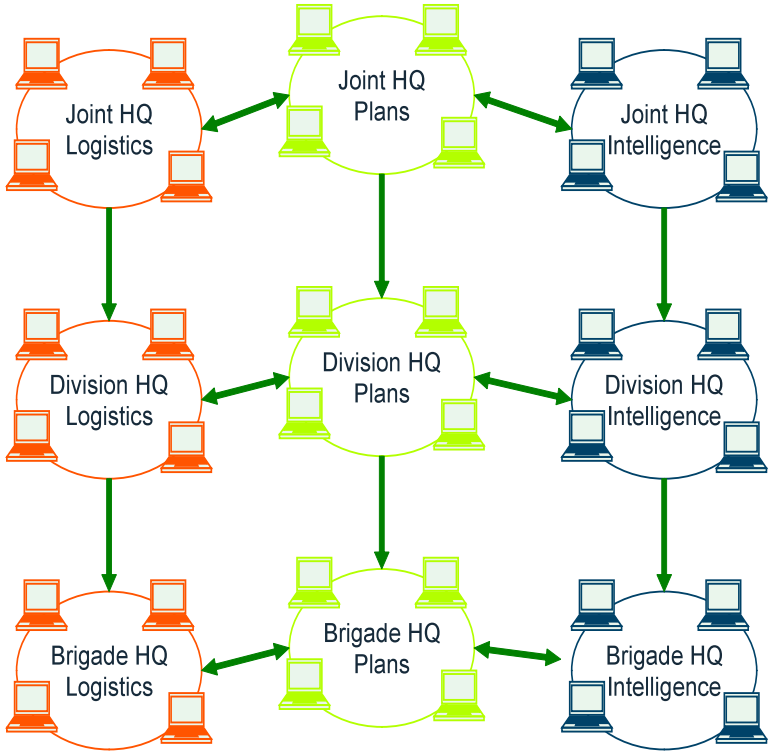
- Military operations involve
  - deploying, at short notice, to an unfamiliar theater and with uncertainty about many aspects of the operation.
  - two intertwined phases: planning and execution.
  - The need for a fast and robust planning process and the capability to change plans as information is updated or the requirements evolve.

- The present planning process is
  - largely manual and distributed across the deployed team.
  - Primarily a human activity where plans are generated and interpreted by humans.
  - represented in static format such as text, diagrams and spreadsheets which do not normally contain any of the reasoning, logic and interdependencies.

- As a result, the plans are not easy to update and tend to take a lot more time than is normally available.

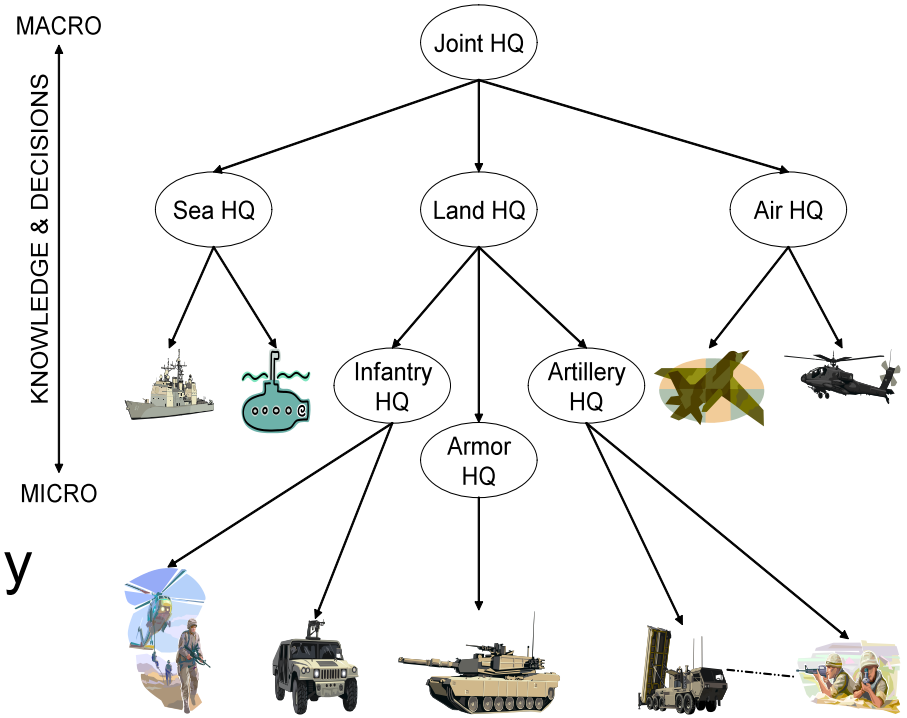
Collaboration Between Cells

- Cells working in **parallel**, at **different locations**, on **different aspects** of the plan
- Plans currently captured in a **static representations** such as text or diagram
- Cells **only share the outputs** of the planning activity
- Outputs do not typically contain any information about the **rationale, constraints or assumptions** for the decisions



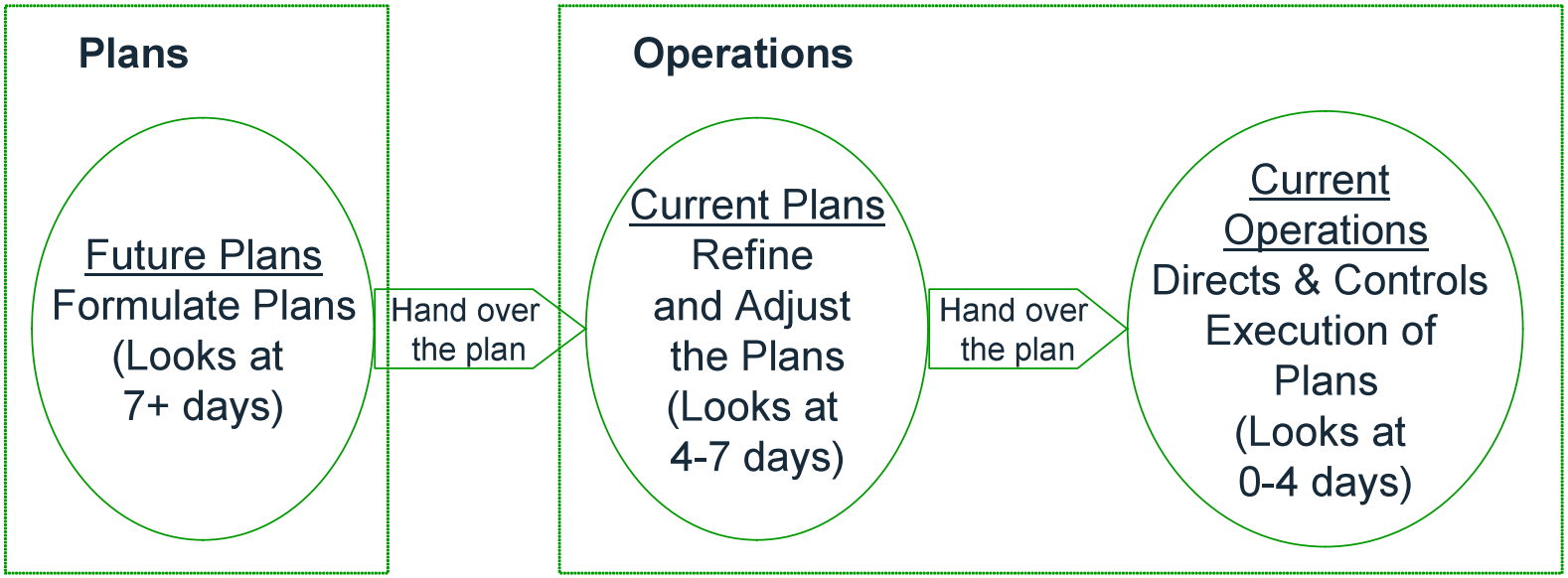
Specialization In Cells

- Significant differences in the **type of information** needed, **type of decisions** made, and **level of detail** processed
- Different phases **not discrete** and not conducted independently
- Cell's plans need to be **coherent and synchronized** with each other



Communication Between Cells

- Handover of plans often rushed due to **time pressures**
- Paper copies of the plans are handed over **without detailed background briefings** on issues, constraints, and assumptions considered during planning process



Changing Situation

- **Own and enemy actions** constantly change situation
- **Manual dynamic planning not practical** due to lack of time, dependencies, and knowledgeable resources
- No contingency plans for every situation, hence **improvisation is the norm**, which is very risky and could negatively impact operational effectiveness

Requirements For Planning Tools

- The planning state should be stored and communicated.
- A tool must support coordinated activities carried out by different teams, which may not be co-located (collaboration, specialization)
- A tool must support the diversity in information requirements and processing done in each of the teams (collaboration, specialization)

Requirements (2)

- A tool must support both planning and replanning which involve different types of information processing and is carried out by different staff, e.g., Planning or Operations (communication)

- A tool must support replanning during the execution phase to account for the dynamic nature of the battlespace.
  - Due to time constraints there is a need for automated support for replanning (changing situation)
  - Planning involves generation and selection of courses of action (COAs) whereas replanning will involves modification of the current COA.

Solution Options

- *Single Planning Tool*
  - The same tool is used by all planning teams
  - This is not a good option as it meets none of the requirements
- *Common Planning Tools*
  - Same tools superior and subordinate planning teams
    - will be strong tendency over plan by the superior cells
  - Different tools for different functional areas
  - Will not adequately support the diversity in info requirements/processing
- *Different Planning Tools*
  - Different planning teams use tailored tools to meet their needs
  - Partially satisfies requirements, assuming tools able to exchange data
  - Issues of shared understanding and coherence between plans
- *Different Planning Tools Linked with a Common Representation*
  - Share common representation of planning concepts
  - Different planning teams use tailored tools to meet their needs
  - This approach does satisfy the above requirements

Assumptions and Hypothesis

- Assumption: Everyone must use tools
  - Planning only happens as fast as slowest cell on planning cycle - if they use paper and pencil no gain on speed
- Assumption: the same tool is not going to work for everyone (different specializations)
- Challenge: if everyone using own tools, then how do they share?
- Hypothesis: shared understanding and collaboration facilitated by:
  - Communication of a **planning representation** facilitates a common understanding of commander's intent, objectives, resources, and constraints
  - **Decisions** made at any level of the planning can be better communicated if the justification for planning options chosen or alternatives rejected is communicated

Proposed Framework

- A **network of planning support tools** tailored to the needs of individual planning teams
- Diverse set of domain-specific tools communicate via **common representation** of planning concepts
  - Common representation could be the **basis** of a tool, or
  - **Interoperability** with tools could be achieved by creating an ontology mapping
  - What is shared between teams are **planning concepts**, not tools
- Examples of **planning concepts** include: Objectives, Tasks, Activities, Effects, Units, Agents
- Examples of **planning state concepts** include: Rationale, Assumptions and Constraints.
  - **Rationale** captures dependencies for replanning and reasoning for shared understanding

Collaborative Planning Model (CPM)

basic logic and rationale	Agent, Assumption, ConceptualSpace, Container, Entailment, Inconsistency, PossibleWorld, Proposition, PropositionIndex, Quantity, ReasoningStep, Set, Triple, VarBinding, WorldState
general	ConceptualThing, Constraint, Synchronisation, Context
temporal	Precede, TemporalConstraint, TemporalEntity, TimeInterval, TimeLine, TimePoint
space	Area, Elevation, Line, Point, SpatialConstraint, SpatialCoordinateSystem, SpatialEntity, SpatialIntersection, SpatialLocation, SpatialUnion
resources	Resource, ResourceAllocated, ResourceCapability, ResourceConstraint, ResourceQuantity, ResourceSet
actions	Activity, Effect, Precondition
collaborative problem solving	Choice Point, Collaboration, Commitment, Communication, ConstraintViolated, Decision, GoalSpecification, Influence, Issue, JointPersistentGoal, MutualGoal, Problem, Solution, Trust,
planning	Allocation, Evaluation, EvaluationCriterion, InitialState, Plan, PlanTask, PlanTaskDescription, PlanTaskTemplate, PlanningProblem, PlanningProblemContext, ResourceCommitment, ResourceReq, TaskCommitment
military planning	Terrain, Brigade, Division, Field Artillery, Rotary Wing, Mission, Intent, SEIZE, FIND, Intent Area, Decision Point, ResourcePool

CPM Addresses Challenges

- Representational Semantics
  - CPM seeks to define generic concepts, that are not necessarily one-to-one with military terminology (due to the confusions of the latter), but that have a logical meaning.
  - We then propose to map key military terminology onto the more generic CPM concepts, thus different cultures could share understanding of the same underlying concepts.
- Configuration Management
  - Planning constraints and version restrictions can be encoded in CPM/OWL that can facilitate the sharing of knowledge about configurations, across various systems.
  - Libraries of partial plans that could be used starting a new plan.

Context Aware Visualization

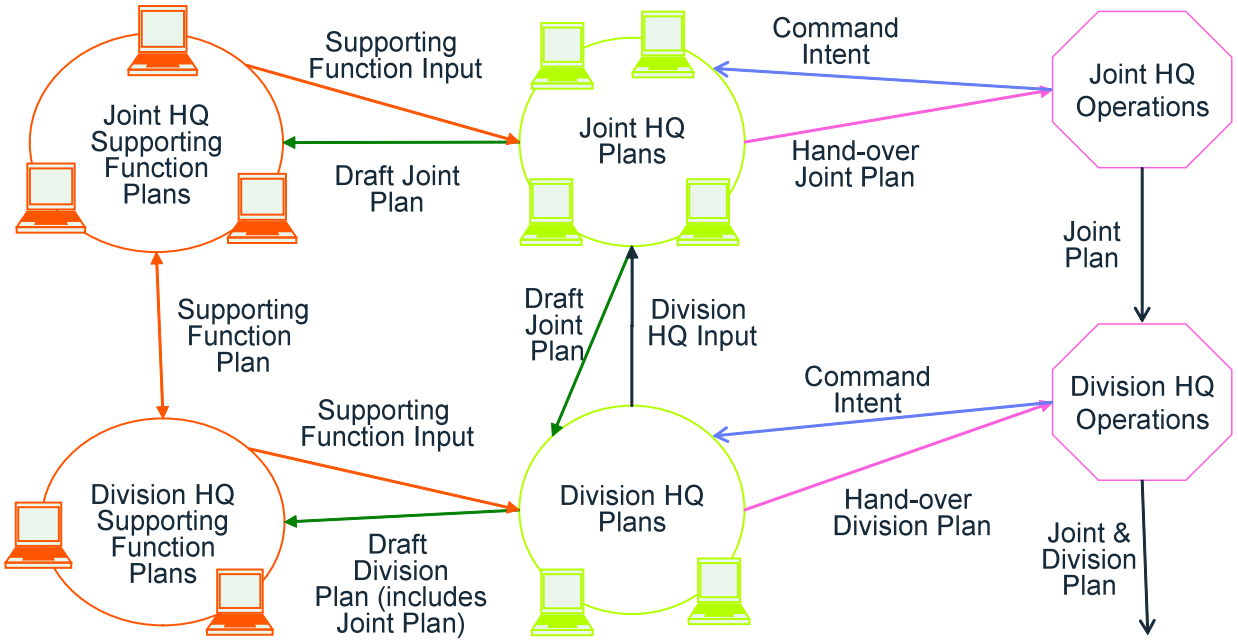
- What changes from context to context is not the representation of specific planning elements but what attributes, features, or relationships should be represented.

- Context aware representation speaks directly to the task-specific concerns and interests of specific group of users and, as such, it will selectively represent aspects of the plan and feature representations in which the user operates.

- Thus shared understanding may not require an understanding of the total plan, only those parts relevant to the planner's task in hand

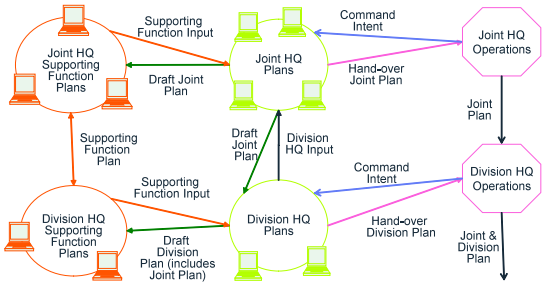
Information Flow Process

- "Joint Plan" includes all of the information that the Joint HQ Plans cell has generated during the planning process.
- Plan is held digitally so different planning teams are able to selectively visualize and amend the plan as necessary.



Information Flow Process

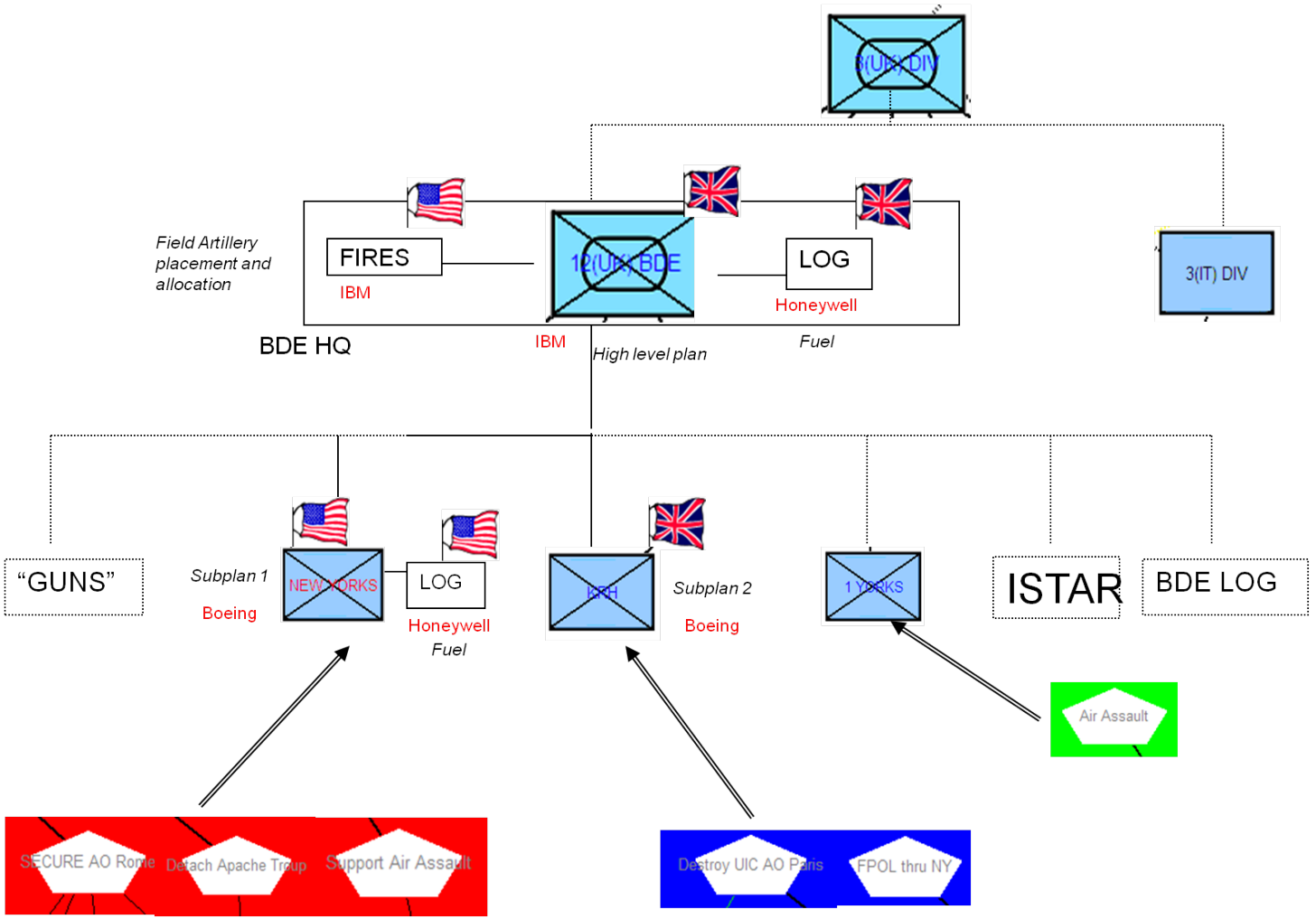
1. Once command intent received, Joint HQ Plans cell generates joint plan
2. Plan sent to Supporting Functions cell and Division HQ for their inputs
3. Once joint plan finalized, it is handed to Joint Operations cell for execution.
4. Plan flows down command hierarchy; at each level plan fleshed out with more details.
5. Process continues until execution.
6. Plans are continually modified during the execution cycle.



Benefits

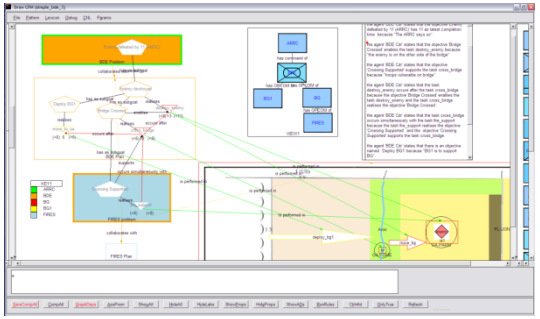
- **Improved timeliness** for generating plans
- Increased **shared understanding** between planning teams, able to see significantly more underpinning information (e.g., assumptions, constraints, rationale) in the plans.
- **Decreased information load** as synthetic agent technology used to quickly process information (e.g., route planning) leaving humans to focus on important tasks.
- **Improved plan quality** by making it easier to verify and validate plans using modeling and simulation tools.

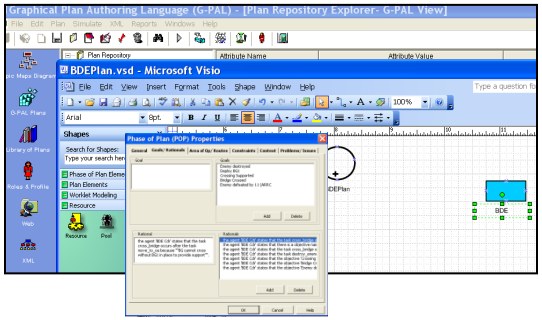
On-going Evaluations

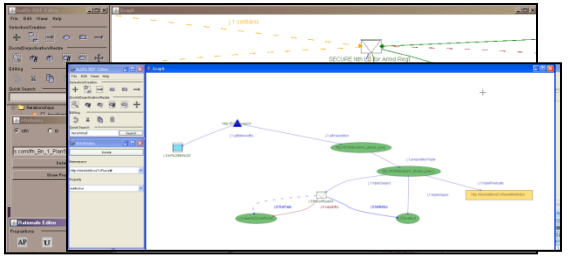


Supporting Multiple Tools

- Commonality between tools
  - Common representation
  - Shared planning concepts
  - Shared ability to import/export
- Difference between tools
  - Different specializations
  - Focus on different concerns
  - Different level of detail
- Common core that needs to be integrated







Future Challenges

- Representational semantics
  - contains all relevant constructs within planning process.
  - Must have both broad and deep semantics
  - Must support the range of planning from pre-deployment to dynamic ad-hoc re-planning during execution.
- Rationale
  - multiple sources of rationale information,
  - structured vs. unstructured rationale
  - capture of rationale in formalisms like Controlled English,
  - utility of context in creating and interpreting rationale.
- Plan interoperability
  - Must reconcile different military vocabularies.

Future Challenges

- Configuration management
  - identifying plan revisions at given points in time,
  - systematically controlling changes to the plan,
  - maintaining the integrity and traceability of plan throughout lifecycle
- Visualization utilizing context and filtering
  - how to share plans or portions of plans between functional teams and between levels,
  - how to visualize plans at different planning levels,
  - how to provide information during the planning process
- Interfaces
  - must support all phases of the military mission, from pre-deployment planning through execution to post operation activities.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