A Geospatial Battle Management Language (GeoBML) for Terrain Reasoning

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Michael Powers

Topographic Engineering Center

US Army Engineer Research and Development Center

Alexandria, Virginia

Michael.W.Powers@erdc.usace.army.mil

Dr. Michael Hieb
Dr. Mark Pullen
Martin Kleiner

Center for C4I

George Mason University

Fairfax, Virginia

mhieb@gmu.edu

Outline

- **Assumptions, Requirements and Challenges**
  - Geo-Centric
  - Force Centric
  - Net-Centric
- **Necessary Conditions for Success**
  - Architectural Framework
  - Representational Consistency – Battle Management Language
    - Computational
    - Semantic
- **Implementing Geospatial Information in a Net-Centric Enterprise**
  - Development of Net-Centric Geospatial Services
  - Focus on Shared Semantics
  - Experimentation with Geospatial Information in a Mission Context

geo-Centric View of Information

Beliefs and Assumptions

1. Possesses a ubiquitous quality across C2
   - Use is often very similar
   - Stable, sufficient representations is a goal

2. Deserves the same rigor of quality, consistency of representation applied to other battlefield information
   - Foundation for shared, common awareness

3a. Terrain and weather are fundamental enabler/constraint to
   - Combatant and non-combatant behavior
   - Force, system, sensor and soldier performance

3b. Military operations and behaviors are not random
   - Basis for relationships among battlespace entities and actors/actions
   - Organizing the Battlespace in space, time and tactical intent

4. Value F(x) of geo information: Knowledge > Information > Data
   - Hierarchy of Abstraction
   - Get out of the data ASAP……too many reasons to count

Enabling the Commander, Warrior and C² systems through embeddable geospatial information

Battle Command Centric

(Geospatial Information, Technology)

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WMI Services

Intelligent Services
- Role Manager
- Agent Authorizer
- Intelligent Operator Monitor

Presentation Services
- Presentation Tailor
- Presentation Builder
- Presentation Manager

- Collaborator
- Translation Interface Text-Voice, etc)
- Report Generator

I/O Services

- WMI Primitives
- Visualizer

WMI Element Services

- Task Integration Network Editor

Situation Understanding

- Battle State Assessor
- Readiness Monitor
- Weather Service

Assessor Services

- Object Refinement
- Fusion Process Refinement
- Situation Refinement
- Threat Refinement
- Battlespace Object Priority Manager

BSO Understanding Services

- SU Toolset
- SU Presentation

SU Tool Services

Planning & Preparation

- Airspace Planner
- COA Planner
- Plan Assessor
- Ground Space Planner
- Objective Planner
- Fires & Effects Planner

Tactical Planning

- Sensor Planner
- Comms Network Planner
- Maneuver Assessor
- Security Planner
- Survivability Planner
- Air Defense Planner

Resource Planning

- Terrain Analyzer
- AAR Services

Planning Analysis Services

- Rehearsal Services
- Simulation

PPS Support Services

Battle Command & Mission Execution

- Incoming Order Processor
- Action Requester
- Policy Editor
- Task Organization
- Order, Report & Authorizer
- Notification

Command Services

- Manned Ground Vehicle Remote Operation
- Unmanned Payloads Control
- Unattended Munitions Control
- UAV Control
- UGV Control
- UGS Control

Common Vehicle Control

- Airspace Control
- Ground Space Control
- Fires & Effects Control

Tactical Control

Embedded Sustainment

- Platform Soldier Mission Readiness System
- Administrative Services

Sustainment Info Services

- Maintenance Planner
- Supply & Distribution Planner
- Force Health Protection Planner
- Human Resource Services Planner
- Threat Monitor Service

Sustainment Planning Services

- Maintenance Manager
- Supply Manager
- Distribution Manager
- Force Health Protection Manager
- Human Resource Services Manager
- Rear Area Security Manager

Sustainment Control Services

SoS COE

- **Interactive / Computational Info Services**
- **Geo-based Decision Tools**
- **GeoBML and JC3IEDM**

Network Centric Challenges

- **Bandwidth**
  - **Design impact on actionable geospatial information products**
    - **Minimize the size of all information products**
    - **Achieve the best ratio of information value to bandwidth**
    - **Minimize the frequency of network transmissions**
      - Design a persistent quality into product….responsive to dynamic info
      - Design information products with the broadest application/recipient set
- **Computation and Storage**
  - **Design impacts**
    - **Computational abstraction.….develop base information products supporting a broad range of applications**
    - **Build information products with the broadest application / recipient set**

Network Centric Challenges

(Design Constraints)

Potential value of a Net-centric force is theoretically N^2

- **Metcalf's Law**

So the bigger the force the better my situational awareness …..right?

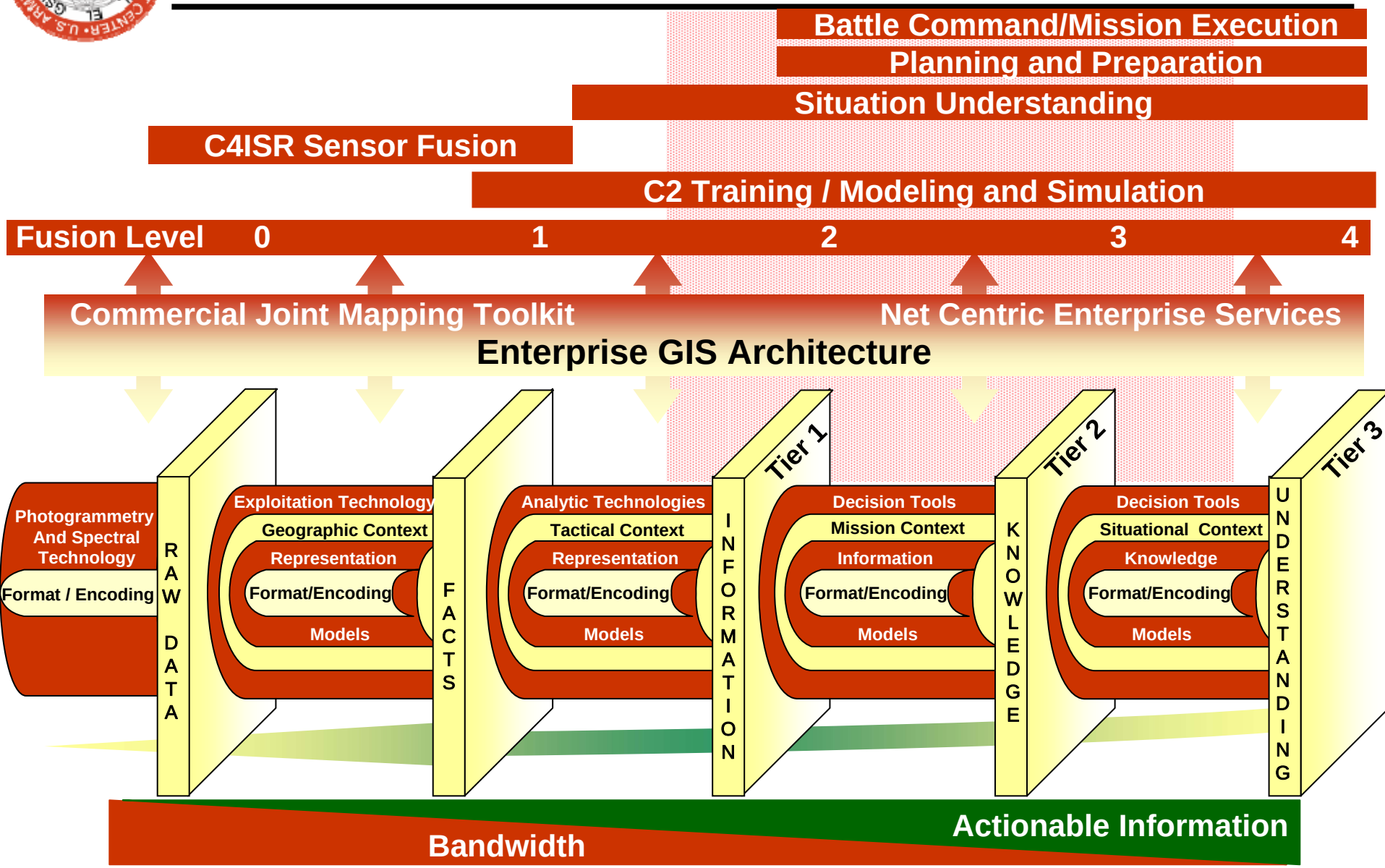
- **There are some assumptions that must be met**

1. **There is real potential in all transactions**
   - Geo-information product has utility to the functional C4ISR processes of the recipient ……. automated systems and soldiers
2. **All interactions have positive value**
   - As a function of value: Knowledge > Information > Data
   - Maximize OHIO / information should be "ready to use"
3. **N-way interactions create the most value**
   - Design geo-information product utility for the broadest set of Battlefield Functional Areas (BFAs), their systems and processes
4. **There will be both dense and sparse islands of interaction**
   - Design for varying organizational topologies

Derived from: "Network Centric Warfare, Developing and Leveraging Information Superiority" Alberts, Garstka and Stein, 1999

Architectural Framework

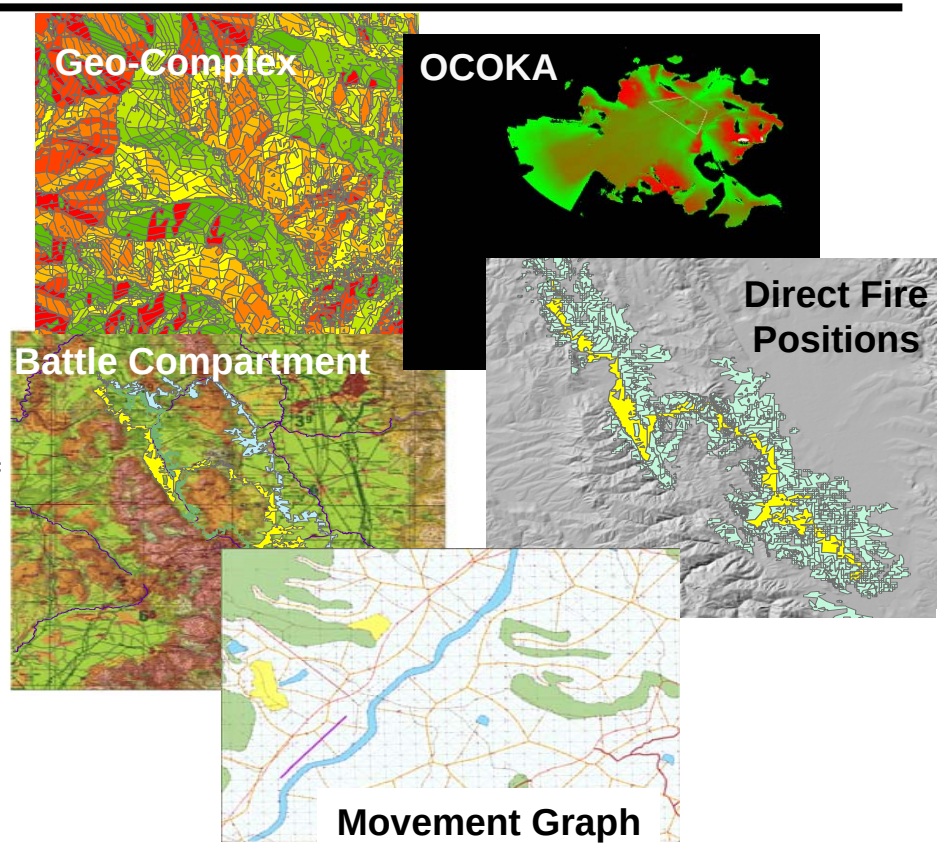
(Terrain and Weather)



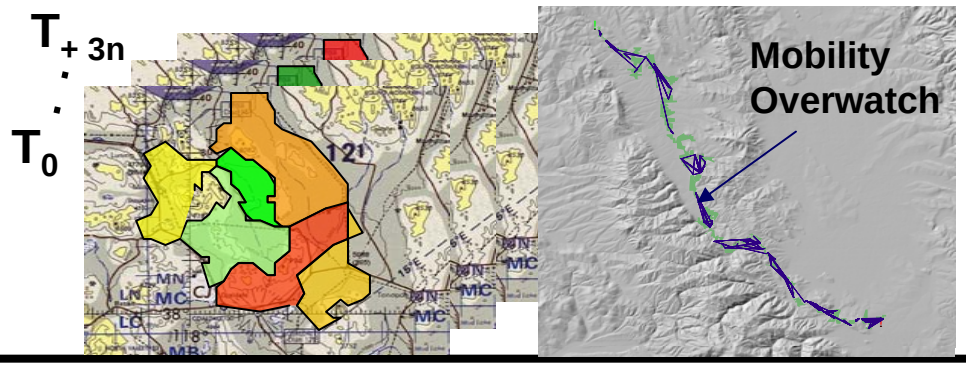
Spatial Objects and Representation

(Consistent Computational Representation)

- **Spatially Discrete Organization of the Battlespace**
  - Physical properties of terrain, organized to stable qualities as related to:
    - Spatial hierarchy of tactical employment within the battlescape
      - OCOKA, compartment or a position of advantage
      - Positions: Def / Attack , Blocking and Battle; Engagement areas, ambush
    - Task or Mission (C2IEDM)



- **Temporal / Relational Objects**
  - Movement graphs attributes
  - Task - to - mission relationships
  - Wx Effects-mobility & sensors
    - Every 3 Hrs out to 36 Hrs with 12 Hr updates (IMETS/BFM)



Current Spatial Objects for geoBML

Tier 1 Products (Terrain/Military Context)

- Natural Obstacles
- Concealment
- Fields of Fire
- Cross Country Movement
- Maneuver Network
- Mobility Corridors
- Chokepoints

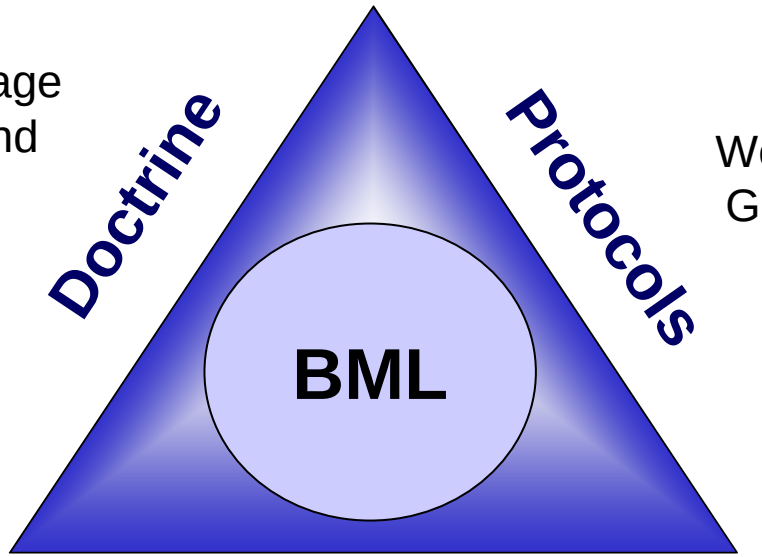
Tier 2 products (Mission Context) /Tier 3 products (Planned)

- Avenues of approach
- Assembly Areas
- Engagement Areas
- Tier 2 Routes
- Battle Positions
- Attack positions
- Axis of Advance
- Indirect Fire Firing Position
- Assault Positions
- Attack by Fire Positions
- Drop Zones
- Helicopter Landing Zones

Semantic Consistency

(Potential of a Battle Management Language)

Formal Language
with Syntax and
Semantics



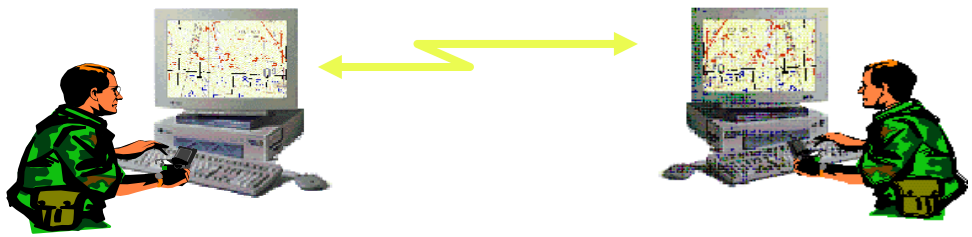
XML
Web Services/
Grid Services

Representation

Command & Control
Information Exchange
Data Model (C2IEDM)

Why a BML is needed

- Its vocabulary is found in FM 1-02, but it lacks clearly delineated rules governing its use (semantics and syntax).
- It is riddled with ambiguity and overlapping definitions.
- As such, it is incapable of transitioning to the full range of automation that the Army is implementing.
- It will not support the integration of advanced modeling and simulation with “digitized” command and control.



Semantic Consistency

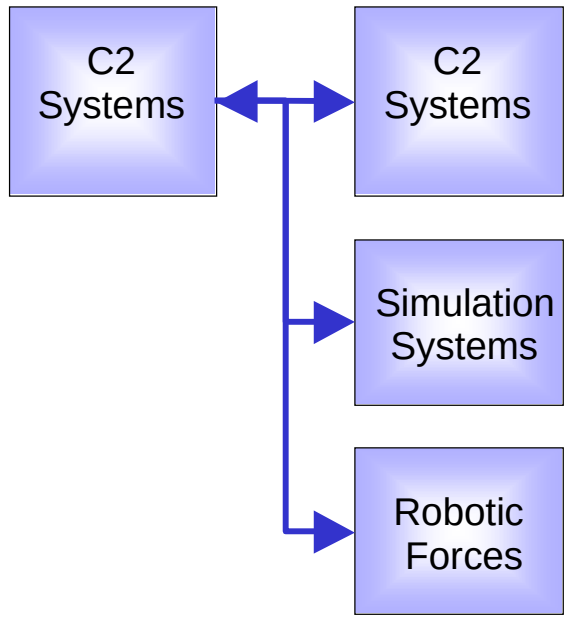
(Potential of a Battle Management Language)

Definition

BML is an unambiguous language used for the command and control of forces and equipment conducting military operations.

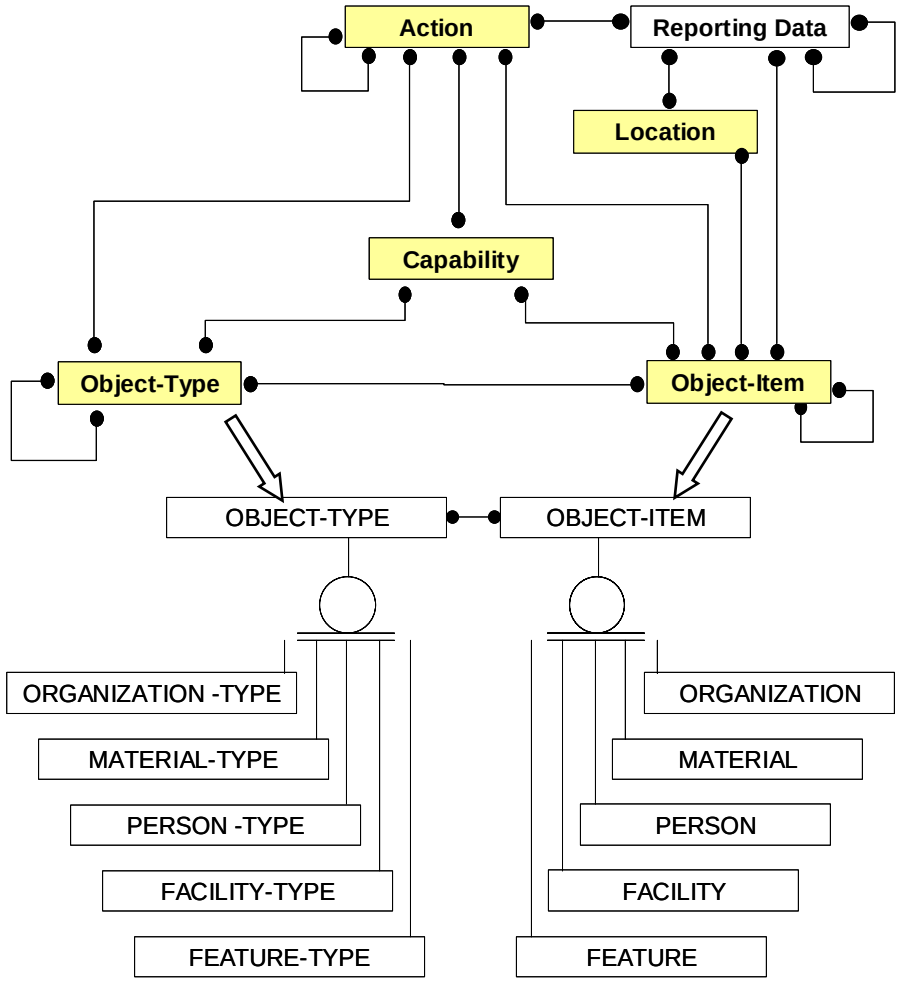
BML is being developed as a standard representation of digitized C2 information for executable plans, orders, Requests and reports

- for military units,
- for simulated forces, and
- for future robotic forces.



Command and Control Information Exchange Data Model (C2IEDM)

- Provides Core C2 Semantics
- Comprehensive
- Very well documented
  - Tables
  - Attributes
  - Relations
- Allows for Extension



Development of Formal Grammars to Support Coalition Command and Control:

A Battle Management Language for Orders, Requests and Reports

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Dr. Ulrich Schade

FGAN-FKIE

GERMANY

schade@fgan.de

Dr. Michael Hieb

George Mason University

US

mhieb@gmu.edu

Semantic Consistency

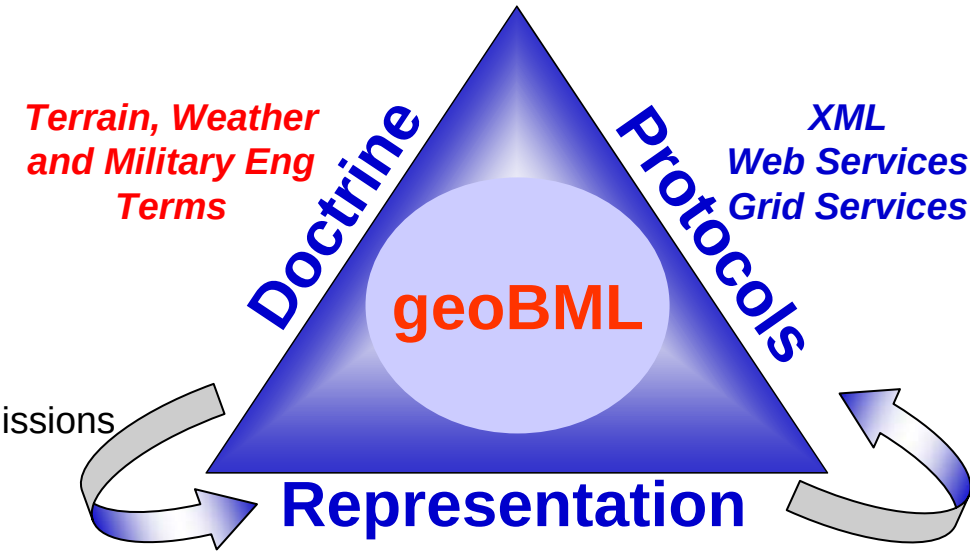
(geospatial Battle Management Language (geoBML))

geoBML is an Unambiguous Language

- Both domain specific and cross-cutting
- Defined by the role of actionable geo-information in the C2

Provides Unification…across

- Doctrine and terms
  - Explicit vocabulary and grammar
  - Specific context mapped to operations, missions and tasks
- Explicit Representation
  - Consistent extension to the C2IEDM
    - Standard framework and exchange model
  - Computational structure
  - Both necessary and sufficient for shared, common understanding
- Protocols
  - Explicit structure for transmission / sharing



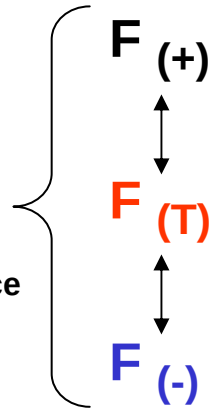
Geo-Environmental Extension to Command & Control Information Exchange Data Model (C2IEDM / JC3IEDM)

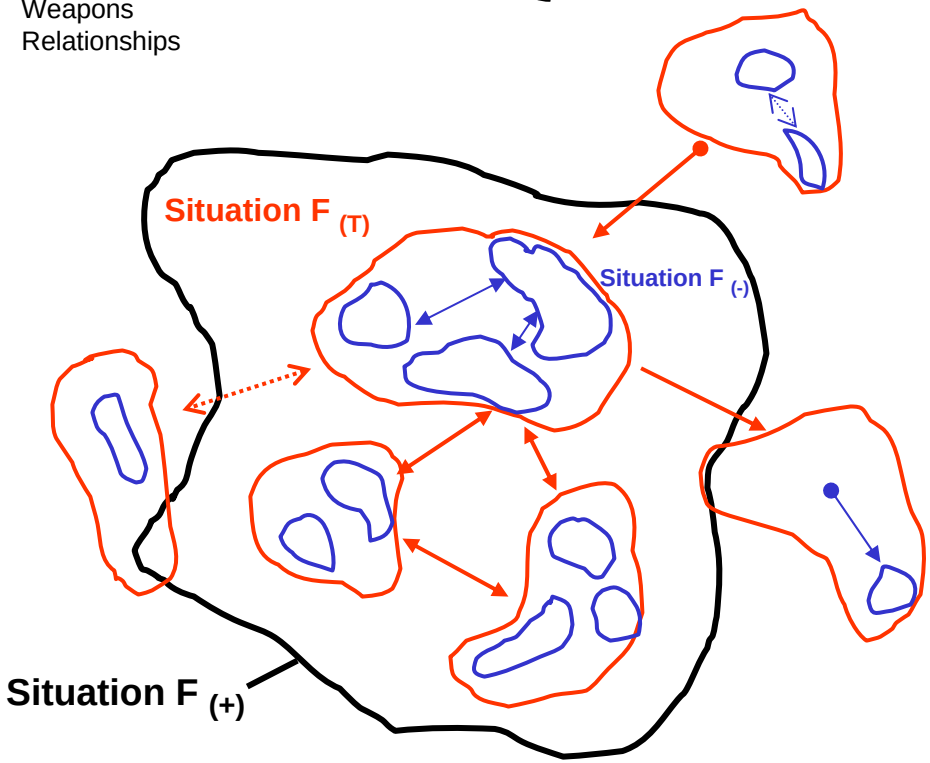
Explicit Computational Representation For Actionable Geospatial Information

Evolving a geoBML

Table of Organization and Equipment (TO&E)

Physical Account of the Force
Vehicle Type and Count
# of units
Spacing
Weapons
Relationships





Assumptions

1. Cohesive Formations occur to execute a tactical task or mission creating a situation
2. Grouping of objects…. So there are subordinate forces (children) forces comprising the Force (target)
3. Cohesive Formation and tasks argue that there are operational relationships required for the task (e.g. fire: complimenting angles and range fans)
4. Possible that there is parent to the target force ($F_{(+)}$)

Syntax and Semantics

1. Understand the elements and qualities of the force being evaluated
   - Possible Tasks, Activities and Missions
   - C2IEDM
2. Field Manuals –
   - TO&E, Physical Conditions and Behaviors
   - Universal Joint Task List (UJTL)
     - Language of Command
     - Battlefield Operating Systems (BOS)
     - Tactical Tasks and Missions

Evolving a geoBML

Table of Organization and Equipment (TO&E)

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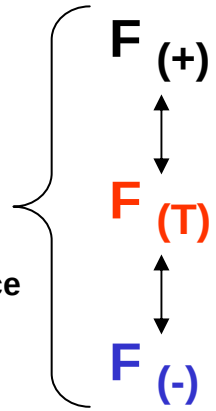
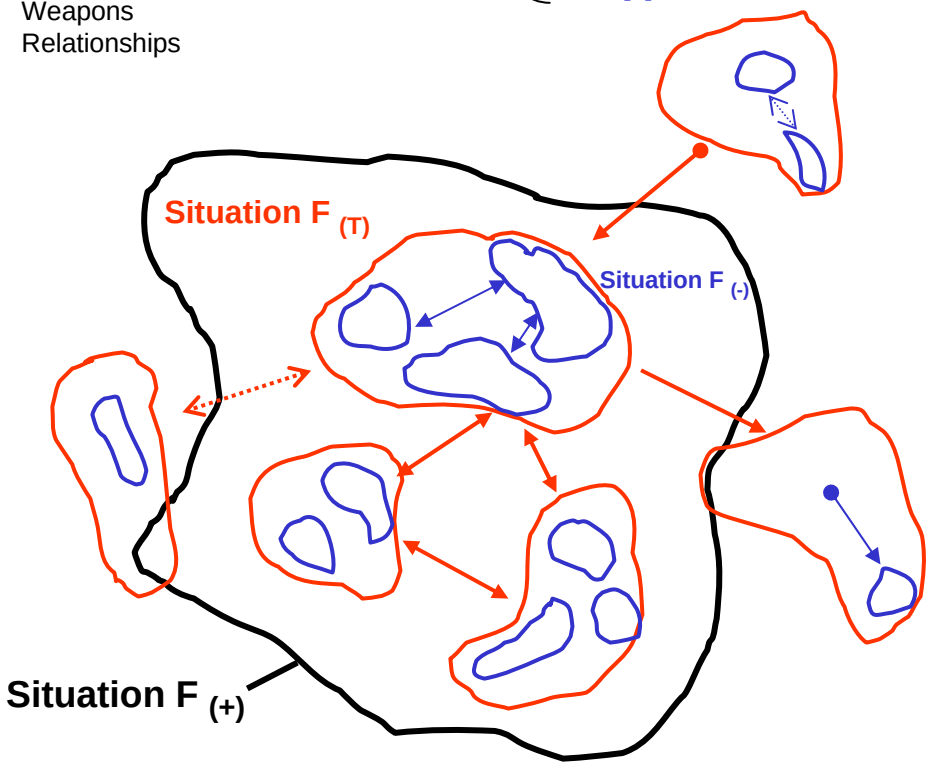




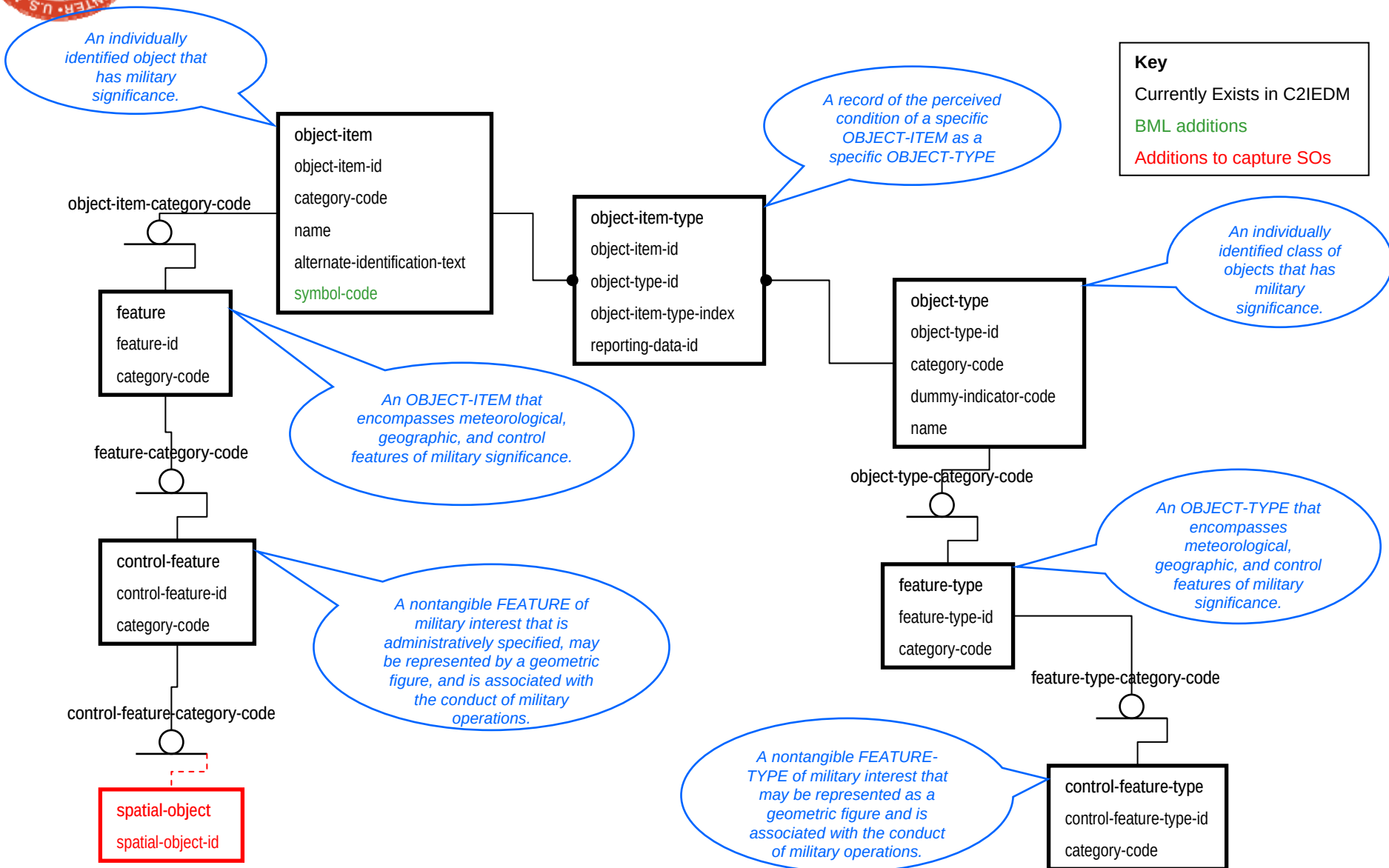
What Dynamics Impact the Representation

1. Weather
2. Other Battlefield information
3. Persistence of Operational Value

Computation Constraints

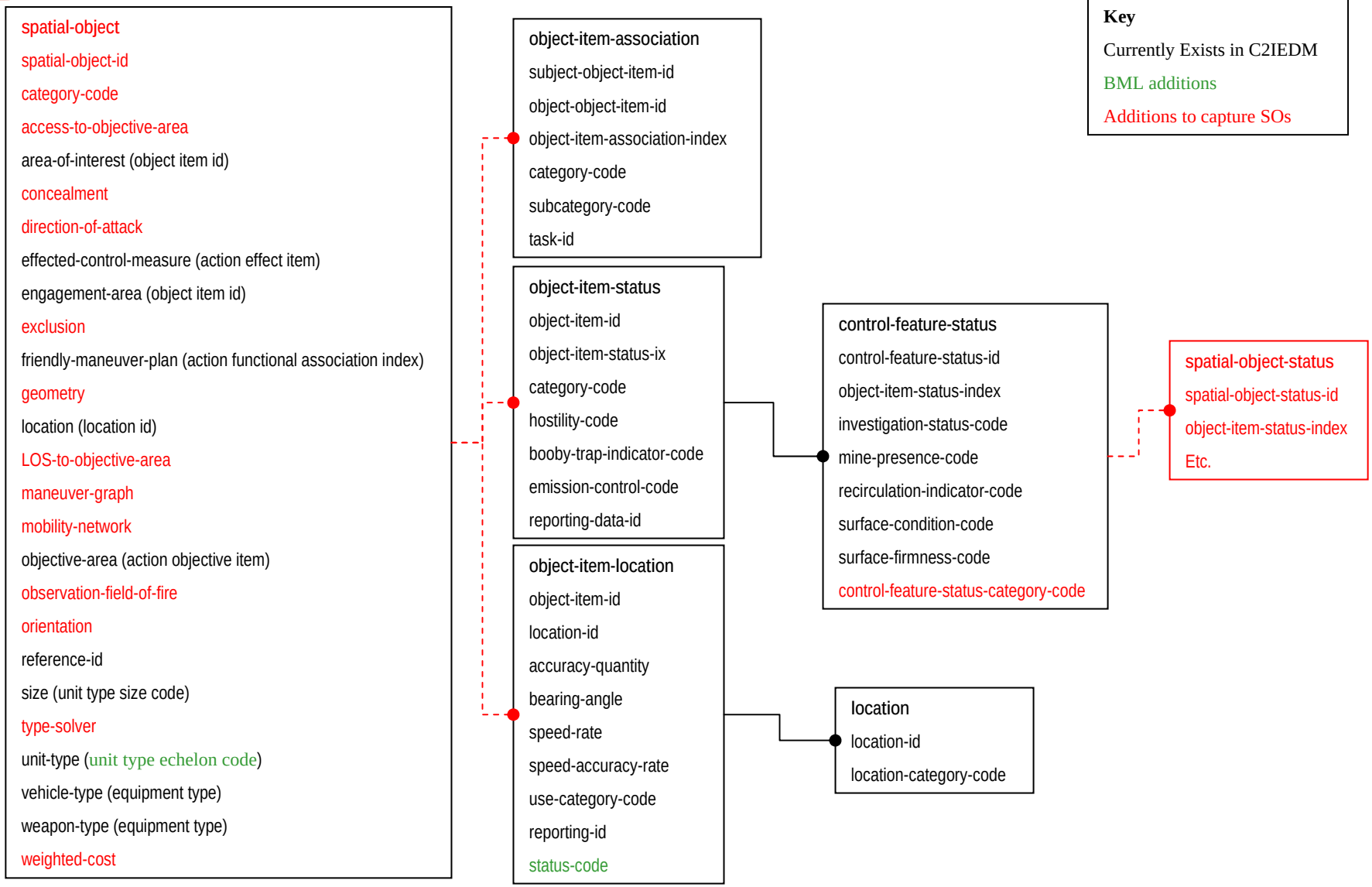
1. Data and Information Dependencies
   - Product Generation
   - Time Sensitivity
   - Computational Time Allowed
     - 1 Time, Intervals or at Run Time
   - Sensitivity to locally held data

C2IEDM Implementation of Spatial Objects

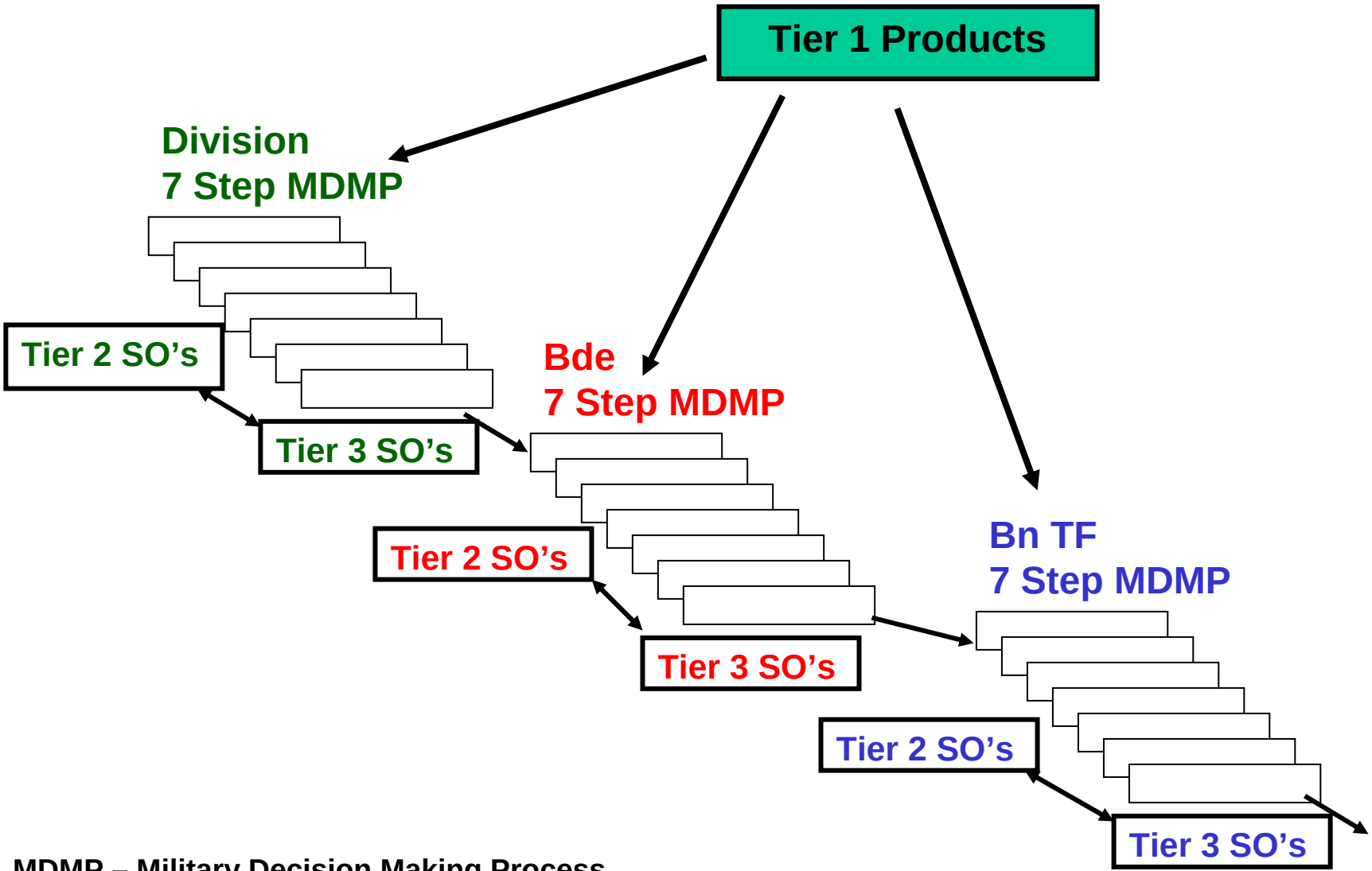


C2IEDM Implementation

(Spatial Objects defined)



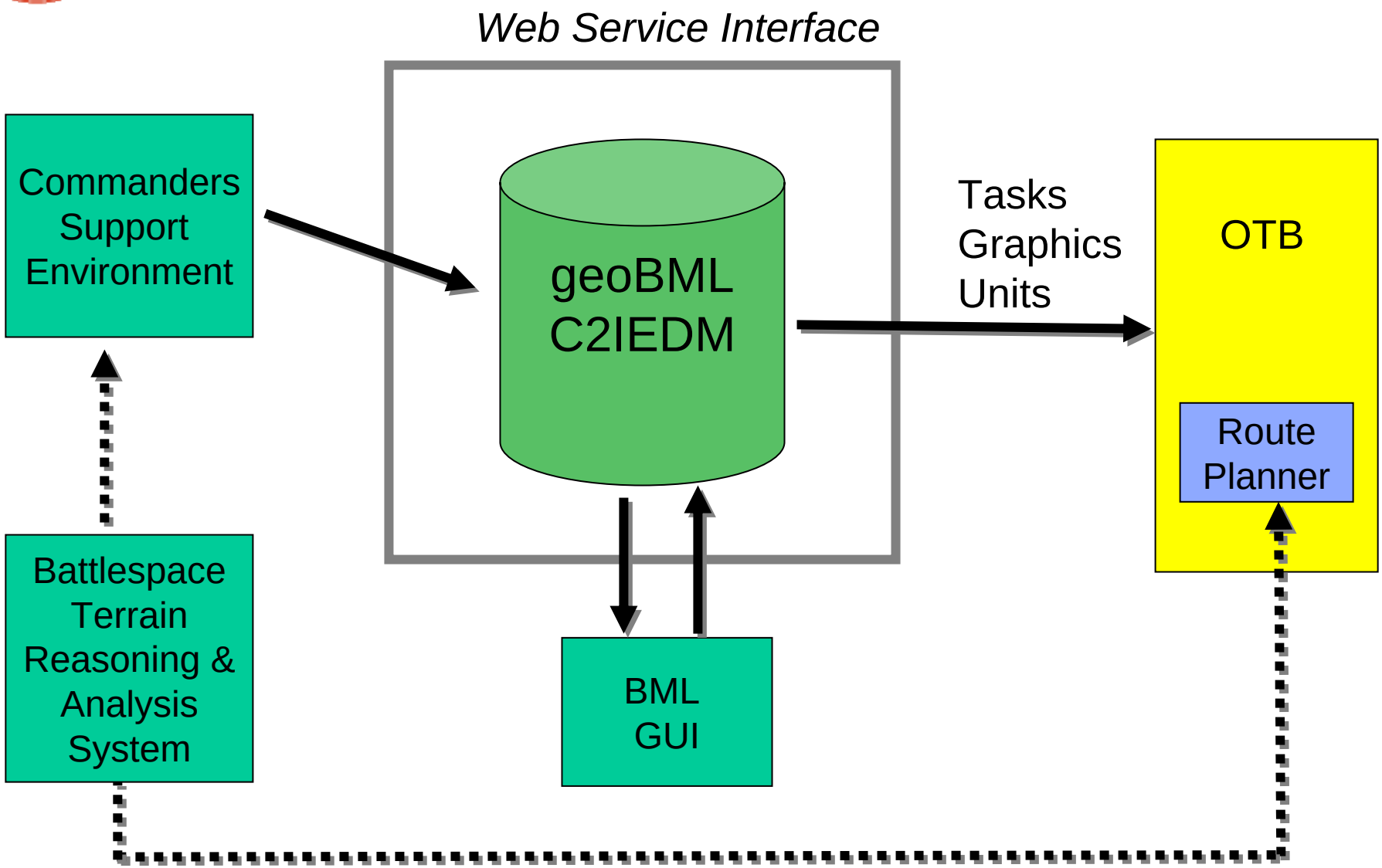
SO Product Usage



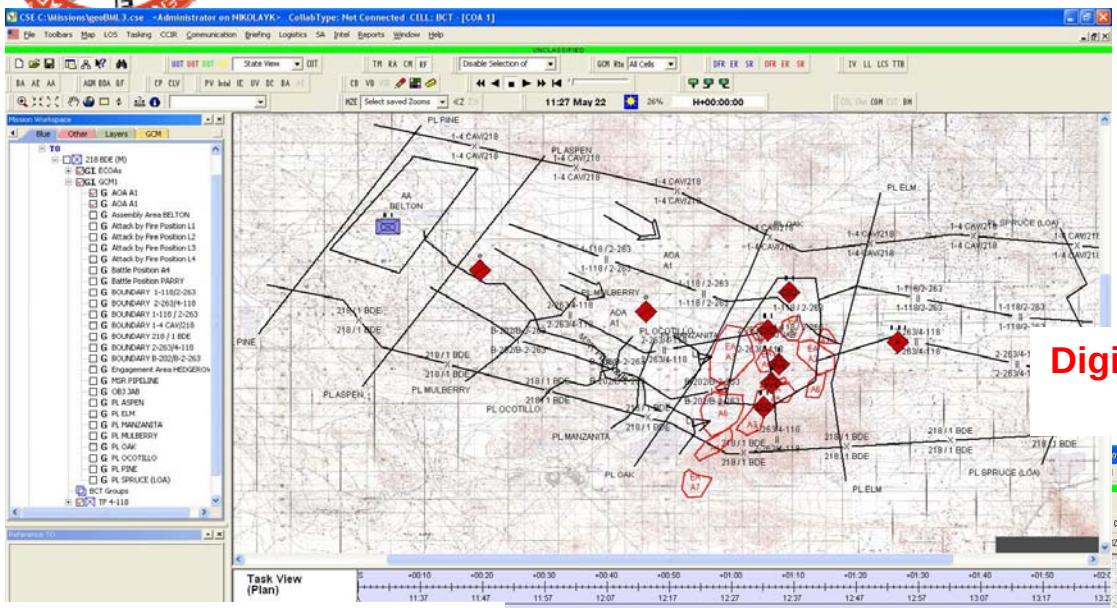
MDMP – Military Decision Making Process

Demonstration Architecture

(Proof of Concept)



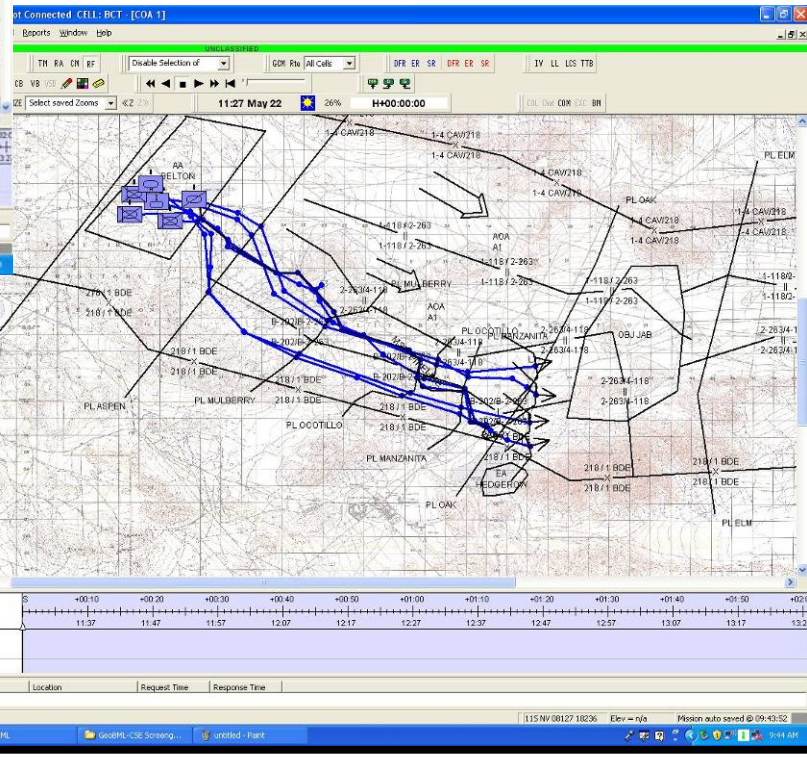
Example Spatial Objects



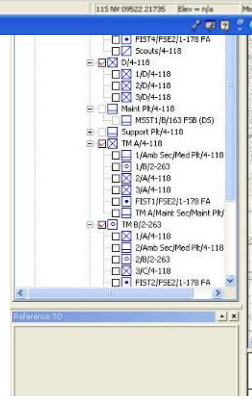
Simulation

Digital Plan / OPORDER
(geoBML)

Enemy Situation
(Tier 2 Engagement Areas)

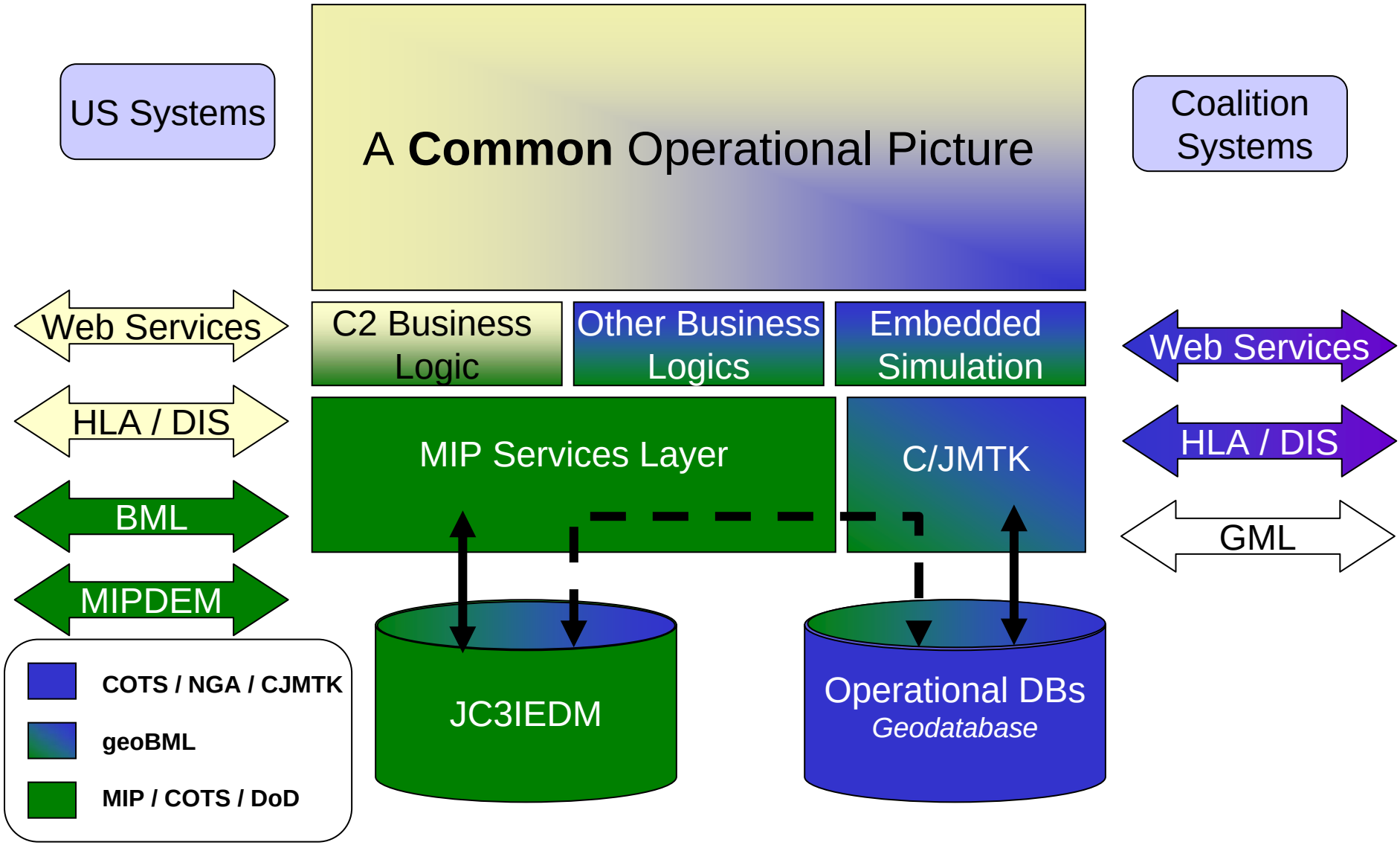


C2 System



Courses of Action
(Tier 2 Routes)

What this can mean for a Coalition



Partial BML Portfolio

- Growing community of investment
  - Shared belief that BML is a necessary component of Net-Centric Operations
- Challenges
  - Technological infrastructure enabling distributed, multi-national development and extension of BML
    - Operational Domains and specific requirements of National entities
  - Capability to maintain the integrity of the JC3IEDM

	Specification	Ground	Air	Naval	Implementation	Software Services	International
Coalition BML	X	X	X	X		X	X
NATO-WG		X			X		X
JBML	X	X	X	X	X	X	
geoBML	X	X			X		
XBML		X			X	X	X
Army BML		X			X		
AO BML			X		X		
MIP/JC3IEDM	X	X	X	X			X

Summary

- Network-Centric Operations require a change in paradigm for the employment of actionable geospatial information
- Digital Maps are not enough
  - Move beyond concepts of maps as the “wallpaper” of the COP
  - Actionable geo-information and decision tools need to empower C2 activities at the appropriate level of semantic and syntax representation
  - BML / geoBML is a formalization of C2 Information and representation
    - Allows Commanders to access the right environmental information to accomplish their intent
  - Spatial Objects forming geoBML will enable reasoning to adapt to both changed missions and a variety of terrain and environmental data
- Geospatial information and implementation concepts have achieved a state of maturity that merits inclusion in the Net-Centric Enterprise

Carry the right battlespace knowledge ……you carry the day