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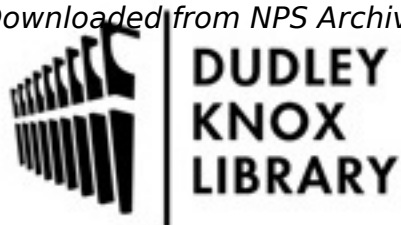
**The Mobility Common Operational Picture
Data Model: A Foundation for Conceptual
Interoperability in the Domain of Ground
Vehicle Mobility and Maneuver**

**Nagle, Joyce A.; Burk, Robin K.; Gates, Burhman Q.;
Goerger, Niki C.; Richmond, Paul W.; Blais, Curtis**

Paper 06F-SIW-005, Fall Simulation Interoperability Workshop, Simulation
Interoperability Standards Organization, Orlando FL
<http://hdl.handle.net/10945/31185>

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2006 Fall SIW
10th Anniversary

Paper 06F-SIW-005

**The Mobility Common Operational Picture Data Model:
A Foundation for Conceptual Interoperability
in the Domain of Ground Vehicle
Mobility and Maneuver**

Joyce A. Nagle, Curtis L. Blais*, Robin K. Burk,
Burhman Q. Gates, Niki C. Goerger,
and Paul W. Richmond*

Fall SIW 2006
10-15 September 2006

*presenters



Outline

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- Project Team
- Objectives
- Approach
- M-COP Definition
- Data Modeling
- M-COP Data Categories
- M-COP Semantic Modeling
- JC3IEDM Comparison
- Recommendations
- Summary



M-COP Team

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US Army Engineer Research and Development Center

- Paul Richmond, Project Director
- Burhman Gates
- Niki Goerger (United States Military Academy)
- Joyce A. Nagle



US Army TRADOC Analysis Center

- LTC John Willis
- Mr. Harold Yamauchi (Rolands & Associates)



NPS MOVES Institute

- Curtis Blais



United States Military Academy

- MAJ Robb Keeter
- Robin Burk



Objectives

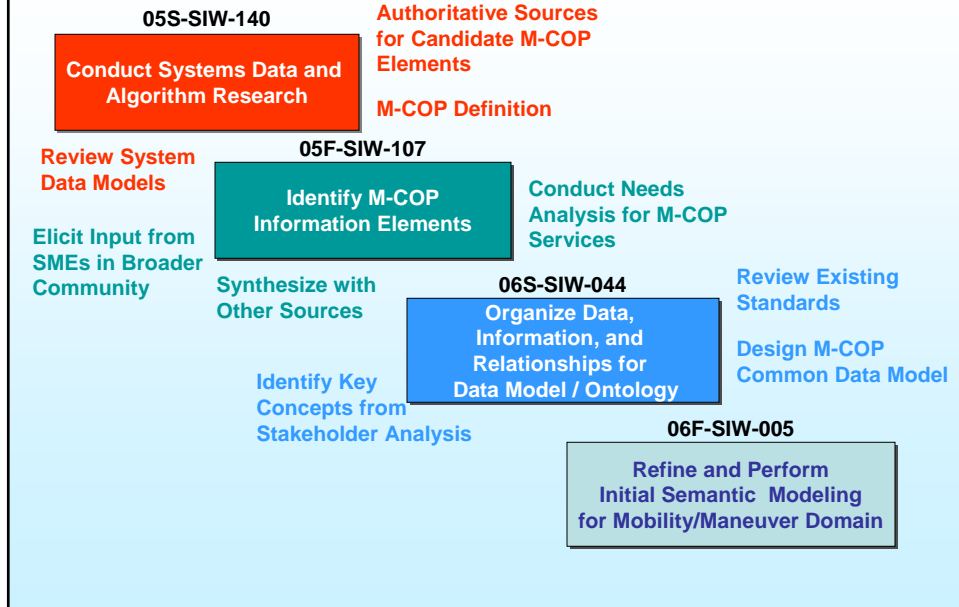
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- **Develop standards describing ground vehicle mobility input to COP (data, terminology, concepts, and information formats / conventions)**
- **Support interoperability across Battle Command (BC) and Modeling and Simulation (M&S) systems enabling Future Force assured mobility**
- **Limited to ground vehicles conducting tactical, and to some extent, operational maneuver**



Approach

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Approach

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- Apply systems engineering principles to develop a *standardized vocabulary and relationships* for transfer of ground vehicle maneuver data (planned routes, trafficability assessments) and other parameters
- Develop a *description of the Mobility COP* from/for BC and M&S for relevant parameters and products that show linkages between existing systems and data models (EDMs, BML, JC3IEDM) to enable Future Force Assured Mobility.

EDM = Environmental Data Model
 BML = Battle Management Language
 JC3IEDM = Joint Consultation, Command and Control Information Exchange Data Model



Definition

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Mobility Common Operational Picture (M-COP)

The M-COP is a subset of the COP consisting of relevant tactical movement and maneuver data and information shared by more than one command. The M-COP can be tailored for various users and will include data and information for mobility of individual combatants, ground vehicles, and autonomous / robotic vehicles.



Authoritative Sources for Candidate M-COP Elements

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- **Joint and Army Doctrine**
- **Data Structures and Specifications**
- **Existing Systems**
- **Global Information Grid (GIG)**



GIG Services & Generation of M-COP

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Identify M-COP Information Elements

- Conduct Needs Analysis for M-COP Services
- Synthesize with Other Sources
- Elicit Input from SMEs in Broader Community



M-COP Potential Services

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Route planning: Best route based on user provided constraints (a'la www map directions) – output as graphic or text based turn by turn direction.

Obstacle locations & status: A reflection of standard military engineer obstacle analysis.

Bridge location and status: Data relating to military load class, traffic conditions, security, SISO.

Key terrain: A reflection of terrain analysis and commander's intent, or rules of engagement.

MSDL products: Specific products for M&S scenario input.

Maneuver network product: While a geospatial tool, C/JMTK for example along with human in the loop analysis will be required to develop a maneuver network, once produced, it should be available outside of the producing tool and available in standard format.



Data Modeling

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Organize Data, Information, and Relationships for Data Model / Ontology

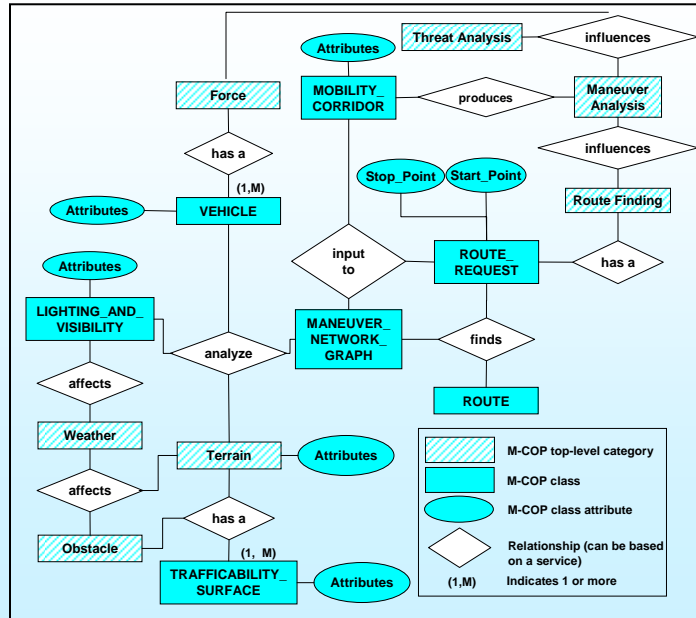
- Identify Key Concepts from Stakeholder Analysis
- Review Existing Standards
- Design M-COP Common Data Model



M-COP Data Categories

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Categories	Descriptions
Terrain	Natural and manmade features and attributes that influence mobility or maneuver of ground vehicles.
Obstacles	Terrain features or other objects or conditions that disrupt or impede movement of ground vehicles.
Weather	Observed and forecasted weather conditions that affect mobility and maneuver.
Maneuver Analysis	Results of analysis of ground vehicle movement relative to mission, C2, local culture, and other considerations.
Route Finding	Results and related information of finding a minimum-cost route in a maneuver search space.
Threat Analysis	Locations, capabilities, potential actions and other information relating to threat maneuver that can include, in addition to enemy forces, local population, and cultural effects.
Forces	Information relating to maneuver and transportation units, individual platform locations, and capabilities as related to mobility and maneuver.
Utilities	Metadata applicable to all or multiple elements of the M-COP.



Refine and Perform Initial Semantic Modeling for Mobility/Maneuver Domain

- Semantic metadata provides a much richer capture of the meaning and implications of data.
 - Useful for intelligent software to reason against
 - Useful to ensure that groups of people mean the same thing by terms
- Encoded using the Web Ontology Language (OWL)
- **KEY RESULT: Important relationships in mobility and maneuver information can be expressed using description logic**
 - cf. 'Trafficability' is a relationship between a terrain, equipment and weather conditions



Classification Scheme

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mcop:Terrain (instance of owl:Class)

CLASS EDITOR

For Class: (instance of owl:Class) Inferred View

Property	Value	Lang
<input checked="" type="checkbox"/> rdfs:comment	Natural and man-made features and thier atributes which may influence mobility or maneuver of ground vehicles.	

Annotations

Properties and Restrictions

- hasTrafficability (single TrafficabilitySurface) (someValuesFrom TrafficabilitySurface)
- hasGeometry (multiple Geometry) (someValuesFrom Geometry)

Superclasses

- owl:Thing

Disjoints

Logic View Properties View



Description Logic

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mcop:Terrain (instance of owl:Class)

CLASS EDITOR

For Class: (instance of owl:Class) Inferred View

Property	Value	Lang
<input checked="" type="checkbox"/> rdfs:comment	Natural and man-made features and thier atributes which may influence mobility or maneuver of ground vehicles.	

Annotations

Asserted Conditions

NECESSARY & SUFFICIENT

NECESSARY

- owl:Thing
- hasGeometry **some** Geometry
- hasTrafficability **some** TrafficabilitySurface

Disjoints

Logic View Properties View



Constraints/Conditions

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The screenshot displays the Protégé 3.2 beta interface. The main window is titled 'MCCOP_v03 Protégé 3.2 beta'. The left pane, 'CLASS EXPLORER', shows a tree view of classes under the project 'MCCOP_v03'. The right pane, 'CLASS EDITOR', shows the details for the class 'mccop:ManeuverAnalysis'. The class has a comment: 'The results of an analysis related to ground vehicle movement relative to mission, command and control, local culture and other considerations. Also includes some information classes required for the analysis.' Below the comment, there are associated conditions: 'owl:Thing', 'assignCost min 1', 'considerManeuverFactors min 1', and 'produceCostManeuverNetwork min 1'. The bottom right corner of the window shows 'Logic View' and 'Properties View' options.



JC3IEDM Comparison

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Terrain and Obstacles: Significant lack of detail in the attributes associated with JC3IEDM FEATURE and FACILITY OBJECT-ITEMs

Weather Category: Good alignment in general; JC3IEDM is missing a few attributes

Forces Category: Most information required is found; more complete technical data for vehicles needs to be added



JC3IEDM Comparison (Continued)

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Utilities Category: JC3IEDM does not contain adequate information for metadata (i.e., DDMS)

Maneuver Analysis: Many attributes represented but significant gaps exist

Route Finding: Several attributes missing

Threat Analysis: Most attributes represented and others can be used to create the remaining components



Recommendations

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- Establish a working group to fully specify the M-COP information model in context of the JC3IEDM.
- Conduct a Formal Concepts Analysis (FCA) of the M-COP data model.
- Further develop an M-COP ontology and submit it to the DOD Metadata Registry and Clearinghouse.
- Assign the NRMM and Standard Mobility API XML Schemas to an appropriate XML Namespace and submit them to the DOD Metadata Registry.



Recommendations (Continued)

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- Configure STNDMob API to operate as a Web service and offer the service for use in the Defense Information Systems Agency (DISA) GIG prototyping efforts.
- Develop a demonstration which uses M-COP services and its emerging ontology, with OOS as a route planning client and BTRA maneuver network products as a basis for routing calculations, possibly to complement emerging geoBML efforts.



Summary

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- **High fidelity ground vehicle mobility and maneuver data is voluminous, particularly in area of terrain attribution.**
- **Linkages and analysis required between terrain information and maneuver performance can be complex, first steps to achieve an M-COP from and between BC and M&S perspectives accomplished.**
- **The M-COP project is one of several recent initiatives in the DOD striving to introduce stronger semantics into data representations to improve interoperability across M&S and BC systems.**
- **The M-COP data model as presented here is example of an “80% solution” that is so important to today’s advances in military information technology.**



Questions?

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