Multi-Schema and Multi-Server Advances for C2-Simulation Interoperation in MSG-085

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Multi-Schema and Multi-Server

MSG-111 paper 4
Presentation Overview

• Introduction/overview
• NATO MSG and SISO
• Previous Server Systems and Clients
• Multi-Schema and Multi-Server Systems
• Conclusions
Generic BML Architecture

Command and Control Systems

BML Web Services

Simulation Systems

BML Messages (Orders, Reports, etc.)

Database(s)
Introduction/Overview

• Overall goal: interoperation of Command and Control (C2) systems with simulations
• Server supports Battle Management Language (BML)
  • Stores XML formatted documents
  • Publishes them to subscribed clients
• Major components:
  • Military Scenario Definition Language (MSDL)
    • Initialization of simulation and C2 systems
  • Coalition Battle Management Language (C-BML)
    • Orders, Requests, and Reports among C2 systems / simulations
  • Building block: Task (who/what/when/where/why) + its status
• Focus of upcoming NATO MSG-085 final demo
Advances Bring New Problems

• Schema Divergence
  • Each generation of prototyping creates new schema
  • Schemata are semantically equivalent (or nearly so)
  • Client proponents prefer to invest effort in new capabilities, not changing old ones
  • Solution: translating server

• Need for distributed servers
  • Efficient client distribution
  • Increased performance
  • Flexible architecture
NATO MSG and SISO
BML in NATO
Modeling and Simulation Group

- MSG has been nexus for BML cooperation
- MSG-048 Technical Activity started 2007
  - Stimulated by US-France project 2006
  - Demonstrations at I/ITSEC 2007 and 2008
  - One-week experimentation 2009 (9 nations)
- MSG-085 Technical Activity started 2010
  - Goal: operational use of MSDL/C-BML (12 nations)
  - Planning demonstration Dec 2013
- Supports trial use of new concepts before standardization
MSG-048 2009 Architecture

MNF C2IS
  - ABCS
  - BattleView
  - ICC
  - NORTaC
  - SICF

OPFOR C2IS
  - ISIS
  - C2LG

JC3IEDM

BML WEB SERVICES

DIS SIM EXERCISE
  - OneSAF
  - UAV-Sim
  - JSAF
  - SIMBAD
  - APLET

Pullen/MSG-091
MSG-085 General Architecture

Coalition Interoperation Services

- Mobile Client
- Overall C2
- National Ground C2
- Air C2
- Database
- Threat Simulation
- National Simulation
- Air Simulation

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MSDL Background

- Grew out of need in US Army OneSAF program
  - Reduce scenario development time
  - Re-use resulting scenarios
- XML-based military scenario format
  - Designed for use by current and evolving simulations
  - Prototyped within OneSAF 2001-2004
  - Spawned SISO Study Group
  - Product Development Group chartered 2006
  - SISO MSDL v1.0 standard approved 2008
MSDL Initialization Data Components

- Geographic Region of Interest
- Force/Sides
- Units
- Equipment
- Installations
- Overlays
- Graphics
- Military Operations Other Than War
C-BML Background

- **Purpose:** provide a common, agreed-to format for exchange of Orders/Requests/Reports between C2 and simulation systems
- Implemented using a repository where participating systems post and retrieve XML documents
  - Extended to publish/subscribe for efficiency
- **SISO study group** 2005
- **Product development group** chartered 2007
  - Phase 1 Standard package balloted 2012
  - “Full” schema includes “Light” subschema
- **Development informed by NATO Technical Activities MSG-048 and MSG-085**
C-BML XML Documents

- Orders: provide a collection of tasks in a common framework
  - Who/what/when/where/why in tasking grammar
  - Initial orders and later fragmentary orders (FRAGO)
  - Low data rate

- Reports: provide data for situational awareness
  - Much higher data rate
  - Typically units report about once per minute
MSG-085 Mission Statement

“Assess the **operational relevance** of *C-BML* while contributing to C2-Simulation standardization and assist in increasing the **Technical Readiness Level** of *C-BML* technology to a level consistent with **operational employment** by stakeholders.”

*Including the complementary use of MSDL for initialization*
Operational Thread and Capability Demonstrated

- Recce-focused integrated Air-Land vignette using BOGALAND Scenario
  - Ground force Recce cues UAV and fast jet CAS mission
  - Insertion of troops by helicopter
- Enables mission planning, C2 training, and mission rehearsal

Technical Capability

- MSDL/C-BML Infrastructure Information
- MSDL Toolset/Population Mechanism for Preparation and Initialization
- Aggregated MSDL initializes systems
- Scripted BML Server v2.5 bridges multiple schema versions
  - IBML(MSG-048) & SISO C-BML-Light
- Use of WISE Server (SAAB) linked through SBML server and populating 9Land BMS (Swedish C2 system)
- Use of ESRI Track server for Visualization
- Operational C2 systems; ICC and JADOCs integrated JSAF and OneSAF
- WAN-based system
MSG-085 JTF Mission Rehearsal

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Previous Server Systems and Clients
Scripted BML (SBML) Server

• Created during MSG-048 as open source solution to asynchronous exchange of BML documents (Orders and Reports)
  – Scripted approach allows rapid reconfiguration and reduces errors
• Matured to have a number of features
  – Most important is ability to translate among schemas with same semantic content
• GMU runs a server accessible via Internet
  – Under OpenVPN to avoid hacking
• Demonstrated supporting 10 documents per second
  – Performance reduced under translating feature
• Will remain available open source
SBML Architecture

Multi-Schema and Multi-Server
FKIE BML Server

• Developed as simpler alternative to SBML
  • Simple and fast
  • Retained capability to modify schema
• Input distributed over messaging service
  • Stored in file system for later requests
• XML is not changed or validated by server
  • Limited parsing to extract message type and ID
OneSAF Enhancements for MSDL/C-BML

- MSDL document validation
- Enhanced 2525B symbol code use
- Imports C-BML Full and Light Orders
- Exports C-BML Full and Light Orders from OneSAF Mission Editor
- Works with GMU Coalition Status Monitor
- Send and receive MSDL/C-BML from VMASC CBMS
- References C-BML documents within MSDL files
- Cross-references units and equipment tasking between MSDL and C-BML documents
MSDL Reference Design Pattern

Military Scenario Definition Language (MSDL) Instance Document

...<ScenarioID>
  ...
  <reference>
    <type>C-BML</type>
    <identification>C-BML.xml</identification>
  </reference>
  ...
  <reference>
    <type>BasicLoad</type>
    <identification>basicLoad.xml</identification>
  </reference>
...</ScenarioID>

...<Unit>
  ...
  <ObjectHandle>xxx</ObjectHandle>
</Unit>

...<Unit>
  ...
  <ObjectHandle>yyy</ObjectHandle>
</Unit>
...
Air Operation Systems

• Integrated and operated by QinetiQ/UK
• NATO Integrated Command and Control System (ICC)
  • Air component C2
• Joint Automated Deep Coordination System (JADOCS)
  • Joint battlespace C2 (linked to MSDL)
• JSAF entity level constructive simulation
  • Air simulation and perceived truth sensor
• Use IBML09 schema from MSG-048
Generic Architecture for Air Operations

C2/M&S System → System-specific i/f → Schema-specific parser → Middleware interface → C-BML Middleware
Evolving SBML to Commercial Infrastructure

- Scripting offers great flexibility
- Open source helps seed BML community growth
- But high-performance, industrially sustained infrastructure is needed for operational use of MSDL/C-BML
- GMU C4I Center and Saab are working together to achieve this
Saab WISE

- Widely Integrated Systems Environment is a Saab commercial product
  - Aimed at integrating information services (e.g. C2)
- Essentially a very high performance in-memory (non-persistent) database
  - Suitable for cloud environment
- Features a graphic scheme for programming information flows
  - Fills same role as scripting but easier/faster to use
- Saab has offered use of WISE to MSG-085 for use in experimentation
WISE
MSDL/C-BML SUPPORT

Order Data

Report Data

GMU STOMP output

STS SSL

GMU REST input

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Multi-Schema and Multi-Server Systems
WISE-SBML Architecture

- PSS: Publish/Subscriber Server Driver
- WSS: Web Services Server Driver
- JMS: Java Messaging Service
- STOMP: Simple Text Oriented Message Protocol
- REST: Representational State Transfer
- BMS: SAAB 9LandBMS Battle Management System
WISE-SBML

• Saab is supporting GMU fundamental research to show how to use WISE as BML server
  – Open publication and open source components to use with WISE
• GMU has completed prototype high-performance translating server
  – IBML/C-BML with MSDL, like previous SBML
  – MSG-085 CIG Land Ops
  – C-BML Light and compatible C-BML Full
  – Also unparsed/document mode
  – Logging/replay usable to provide persistence
    – (e.g. restart coalition from some point)
• Saab intends to productize this capability
  – Quality assurance and maintenance by Saab developers
  – Will make non-production WISE-SBML server available to developers on no-cost license
  – Also no-cost evaluation license for production
• GMU runs an instance on Internet over OpenVPN

Multi-Schema and Multi-Server
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WISE-SBML Processing Steps

- Steps in development:
  - Build input WISE Driver with parser per schema
    - Parses XML and stores elements in WISE database
  - Build output WISE Driver with XML generator per schema to publish
    - Also include support for directly interfaced systems
  - Build a WISE Driver for persistent recording
  - Edit the information flows using WISE editor

- Driver steps:
  - Input: parsing XML and loading database
  - Output: reading database, generating alternative schema XML, and publishing
WISE-SBML Processing

from network

Receive
REST
using
microHTTP

Interpret
Document
based on
schema

Generate
Document

Generate XML
per schema
(4 options +
MSDL & doc)

Publish XML
document
Using
STOMP
to network

Xerces

Parse XML
per schema
(4 options +
MSDL & doc)

WISE
In-memory
database

Multi-Schema and Multi-Server
WISE-SBML Architecture – Direct Connection

**Diagram Description:**
- **Replay Log** connected to **GMU.Replay**.
- **HornetQ** connected to **JMS** and **STOMP**.
- **GMU.PSS** connected to **PS Processing**.
- **GMU.WSS** connected to **WS Processing**.
- **WSS** connected to **BMS**.
- **BMS** connected to **STS.BMS**.
- **BMS** connected to **Client(SIM/CI)**.

**Key Components:**
- **GMU.PSS**
- **GMU.WSS**
- **Replay Log**
- **HornetQ**
- **JMS**
- **STOMP**
- **PS Processing**
- **WS Processing**
- **BMS**
- **STS.BMS**
- **Client(SIM/CI)**

**Technical Terms:**
- **PSS**: Publish/Subscriber Server Driver
- **WSS**: Web Services Server Driver
- **JMS**: Java Messaging Service
- **STOMP**: Simple Text Oriented Message Protocol
- **REST**: Representational State Transfer
- **BMS**: SAAB 9LandBMS Battle Management System

**Date:** 2/07/2013

**Image Source:**
- Diagram attributed to DBC.
Directly Interfaced C2 System: 9LandBMS

- Battalion/Brigade level operational/commercial C2 system
- Used by Swedish forces
- Runs on Windows platform
- Touch interface for field use (wearing gloves)
- Offered to MSG-085 for experimental use
- WISE interface available
  - Used to provide C-BML interface
9LAND BMS
WISE SUPPORTED MSDL/C-BML

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Adapting SBML to Support MSDL

• When multiple systems participate in a coalition their MSDL files must be merged
• Previously this has been done by hand
• GMU C4I team created a script to do it
  • Required one new script primitive
• Participating systems submit their MSDL prior to initialization
• Server merges it and publishes on command
MSDL Server Operation

Administrator — Initialize

Client — Add Units and Relations

Client — Add Units and Relations

Client — Add Equipment and Relations

Administrator — Publish

Publish

Master Controller

SBML Server

MSDL
Continued Progress In MSDL + C-BML

Common industry standard-based scenario data:

- Enables rapid development
  - Compliant import/export/merge tools
- Encourages ID and tracking of scenario development among slice providers
- Extends use of widely available spreadsheet and XML tools
- Supports data element extensions
- Key capability: cross-linked MSDL and C-BML
  - See 13S-SIW-039
WISE-SBML for MSG-085

- WISE-SBML will enable MSG-085 to interoperate all Common Interest Groups using data with shared semantics
  - Regardless of what schema they have implemented
  - Performance projected to be ~100 documents/second
- The hard part of development is done
  - Initial testing complete for three schema to be used
  - Completed work with Fraunhofer-FKIE to link servers
    - See 13F-SIW-024
- Saab also will make WISE-enabled 9LandBMS C2 system available for MSG-085 experimentation
Generic BML Architecture

Command and Control Systems

BML Web Services

Database(s)

Simulation Systems

BML Messages (Orders, Reports, etc.)
Distributed BML Servers

Command and Control Systems

Simulation Systems

BML Messages (Orders, Reports, etc.)

BML Web Services

Database(s)

Multi-Schema and Multi-Server

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MSG-085 Linked Server Architecture

- FKIE Schema clients
- CBML light schema clients
- CBML full schema clients
- IBML schema clients

- FKIE SERVER
- WISE-SBML SERVER
- FKIE Schema

Multi-Schema and Multi-Server
FKIE BML Server Options Supported

• Currently, supports:
  • IBML (MSG-048 schema)
  • SISO C-BML Phase 1
  • MSG-085 CIG Land Ops
  • MSDL for initialization
• No schema conversion in server
  • All clients must agree on one schema
• Supports same message exchange protocols as SBML
  • Input: SOAP and REST
  • Publication: JMS and STOMP
Linking WISE-SBML and FKIE Servers

- Basis for linking servers:
  - Each listens to the other’s STOMP publications
- Thus, server needs to implement client function
  - We did this in a separate Java client
  - Same client implements REST as input to own server
  - Filters based on first-forwarder IP address (parameter in REST header) so messages do not loop
    - Might also choose to filter out some schemata for efficiency
  - We call this a “back to back” (B2B) client
- B2B is started immediately after own server
  - Connects to the other server and starts forwarding
Server Linking Architecture

- **FKIE SERVER**
  - STOMP
  - REST

- **B2B CLIENT**
  - STOMP
  - REST

- **WISE-SBML SERVER**

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Limitation of Initial Linking Architecture

• Breaking loopback to first forwarder is essential
  • Without this, message would loop forever
• If more than two servers are linked, it becomes necessary to filter out any message that has already passed through this server
  • So the simple first forwarder test is insufficient
  • This would require including address of every forwarding server in the message header
  • Or configuring routing information in B2B
Conclusions

• MSG-085 continues to be a driving force for development of SISO standards
  • Final demonstration planned for 2013
  • Defined path to MSDL/C-BML convergence
• Development process has resulted in multiple, semantically-compatible schemata
  • Translating server using high-performance platform enables interoperation
• Also developed first example of linked heterogeneous servers
  • Improved efficiency/performance/flexibility
• Evolution of BML is likely to result in repeat of this pattern
QUESTIONS?