Using Web Services to Integrate Heterogeneous Simulations in a Grid Environment

J. Mark Pullen, C3I Center, George Mason University

Don Brutzman, MOVES Institute, Naval Postgraduate School

Michael Hieb, Alion Science & Technology

Katherine L. Morse, Ryan Brunton, and David Drake, SAIC

Andreas Tolk, Virginia Modeling, Analysis & Simulation Center, Old Dominion University

Presentation Overview

- What and why is XMSF?
- Web services and interoperability
- Composing simulations using MDA
- Implementing distributed simulation with Web services
- Web services and the Grid
- Summary

Motivation

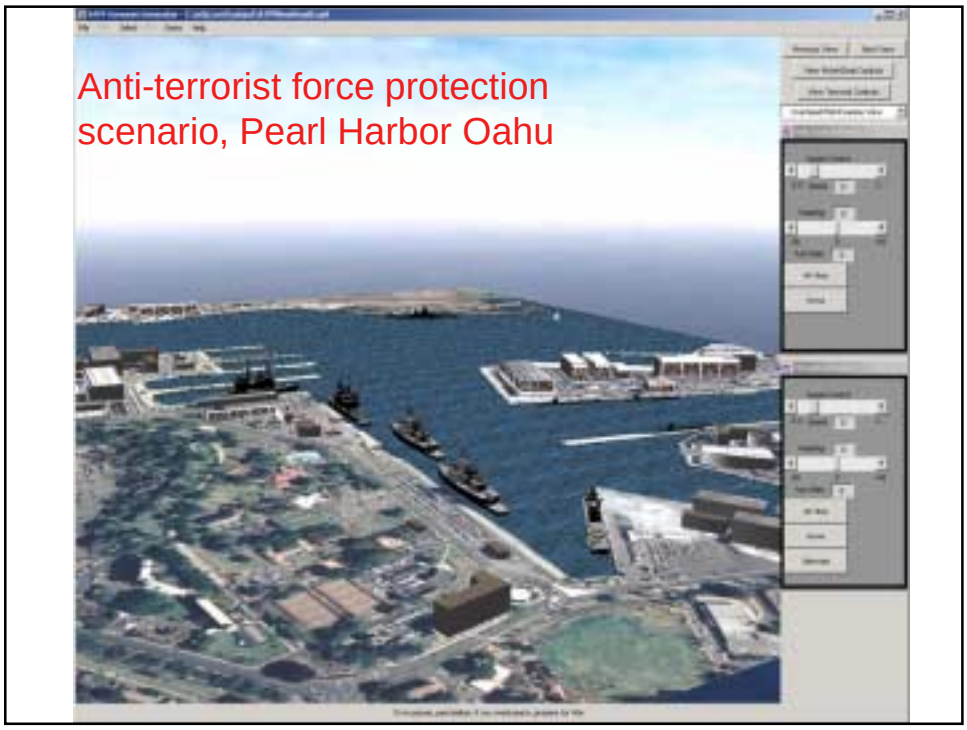
Transformational technologies are needed to scale up defense modeling/simulation to meet real-world needs

Web technologies provide a common framework:

- Dynamic capabilities, open standards, Web business model provide lift to support government and commercial success
- Easy use and open extensibility for developers and users, fueling rapid growth of interoperable simulations
- Bring defense modeling/simulation/tactical support into mainstream of enterprise-wide best-business practices

Visualizing Al Queda USS Cole attack

agent-based simulation of terrorists and friendlies



XMSF precepts

Web-based technologies can provide an extensible modeling and simulation architecture, to support a new generation of interoperable applications

Simulation support is needed for operational warfighting capabilities

XML-based architecture can provide a bridge between emerging rehearsal/reality/replay requirements and open/commercial Web standards

Particularly promising for C4I-Simulation interoperation

Web = best tech strategy + best business case

XMSF Definition

The Extensible Modeling and Simulation Framework (XMSF) is defined as a set of Web-based technologies and services, applied within an extensible framework, that enables a new generation of modeling & simulation (M&S) applications to emerge, develop and interoperate.

Current work in Web Services appears to be an appropriate basis for organizing and composing the many necessary capabilities of Web/XML and Internet/networking needed for M&S applications.

What Does XMSF "Look Like?"

A set of profiles rather than a single architecture

- Formal technical specifications for interoperability of Web based technologies in support of modeling and simulation
- A profile may define a new capability or define interoperability between two or more existing capabilities

XMSF profiles will include

- Applicable Web technologies, protocol standards, data and metadata standards
- A tailoring of the set of selected standards
- Recommendations and guidelines for implementation

XMSF Leadership Challenge

Develop a coordinated DoD approach to applying commercial Web standards for interoperable M&S

- Supported by commercial investment wherever possible

Recognize and take advantage of legacy technology

- But recognize it is a sunk cost
- To be exploited, not honored just because it exists

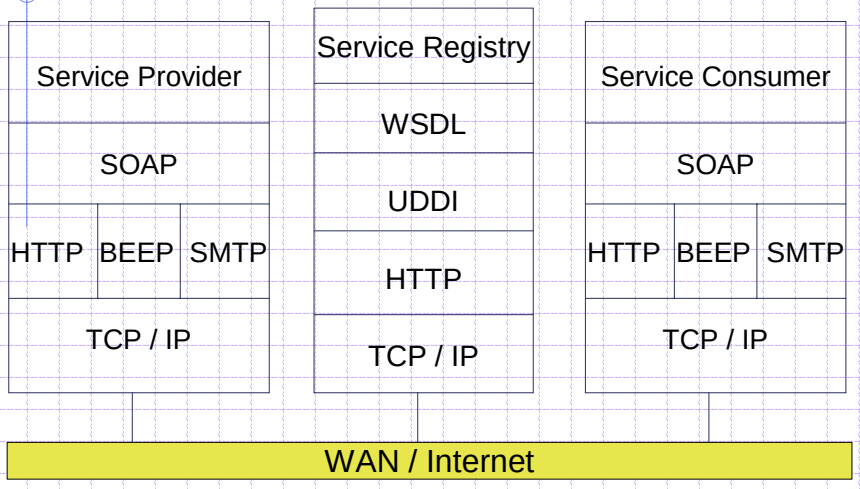
Maintain involvement in key commercial standards so DoD gets needed capabilities

- Pay for what is needed while leveraging OPM
  - Other people's money!

Web Services

Repositories Where approved services reside	**Administrative** Exemplar: DoD XML Registry
Services Discovery Publish, search capabilities	**UDDI, LDAP** Universal Description, Discovery Integration Lightweight Directory Access Protocol
Services Description Detailed methods, parameters	**WSDL, BPEL4WS** Web Services Description Language Business Process Execution Language for Web Services
XML Messaging Simple XML encoding/decoding	**XML-RPC, SOAP, XMLP** Remote Procedure Calls, XML Protocol
Service Transport Move messages between apps	**HTTP, SMTP, FTP, BEEP** Transfer is independent of messages

Web services protocol stacks



Composing simulations using MDA

XMSF seeks to bridge gaps:

- HLA Federations with other software
- Message-driven software on heterogeneous platforms

This requires work in both technology and architectures

- Web service standards for self-description, publication, location, communication, invocation, and data exchange
- Model-driven architecture for semantic interoperability

OMG standards for Platform Independent Model (PIM)

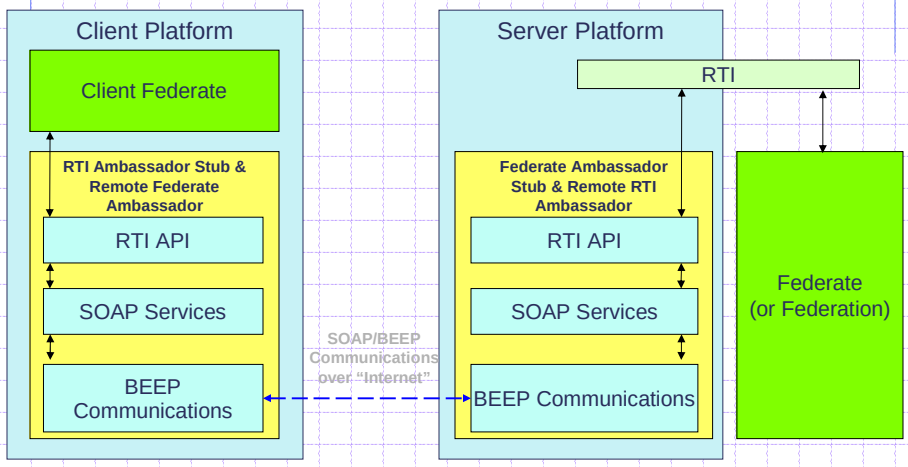
- Unified Modeling Language (UML)
- Meta-Object Facility (MOF)
- Common Warehouse Metamodel (CWM)

Implementing Distributed Simulation With Web Services

Web Enabled RTI as a Web Service

- HLA federations using XMSF compliant web Services for communication between federates
- Federates callable as web services
  - SOAP formatted RTI calls using BEEP communications
  - HLA specification compliant (DMSO RTI)
  - Bi-directional calls allow call backs to remote federates
- Demonstrated in three federations
  - HPAC and ITEM in DTRA's WMDOA federation
  - Circuit building exercise in HLA-ADL integrated instruction
  - XMSF DCEE Viewer (XDV)

Web Enabled RTI Communication Architecture



XMSF DCEE Viewer (XDV)

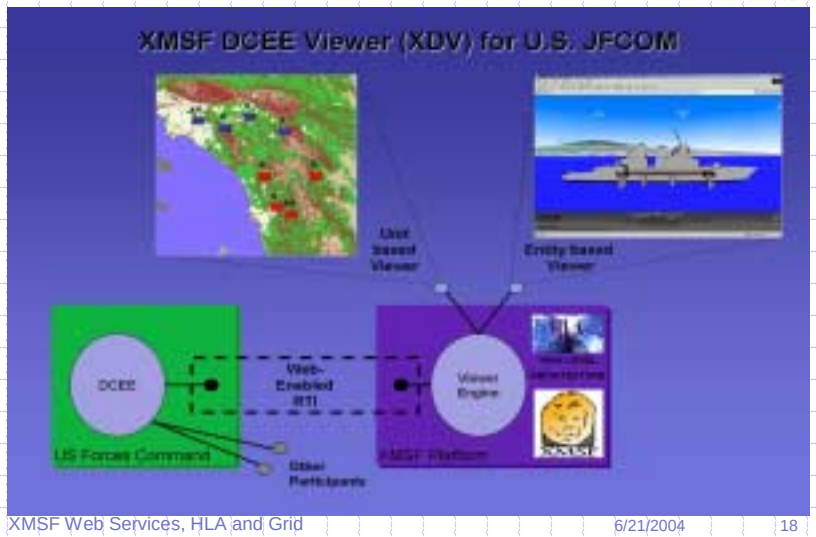
Open standards-based Viewer for the Distributed Continuous Experimentation Environment (DCEE)

Sponsor: U.S. Joint Forces Command Experimentation Directorate (JFCOM/J9)

Six-week project completed Summer 2003

- Proof-of-principle prototype runs on Commercial-off-the-Shelf PCs
- Uses web-based protocols to display the actual situation within the DCEE federation
- Can be used by eligible DCEE users wherever Internet is available
- Comprised of Web-Enabled RTI with an Entity Based Viewer and a Unit Based Viewer

XDV Architecture



Experimentation C2 Interface (XC2I)

- Concept derived from XDV proof of principle
  - ODU, SAIC, GMU working with GD to implement
- Internet-deployable viewer-controller for experiments and exercises
  - Supports participation remote from simulation
- Web services provide network linkage
  - Aggregation Interest Management
  - Area of Interest Management
  - Role-based access control
- Overlay multicast option for network efficiency

Extensible Battle Management Language

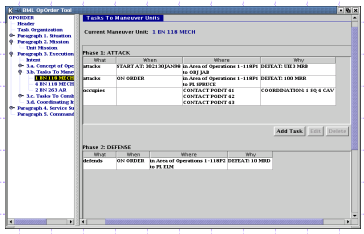
Focus: C4I-Simulation Interoperability

DMSO-funded project to transfer very promising Army Battle Management Language (BML) to open Web standards
- Spearhead: Dr. Mike Hieb of Alion

Expanding to Joint/Combined arena with C2IEDM
- Moving force: Dr. Andreas Tolk of ODU

ACS converted Army BML to XBML Web services in three months
- Demonstrated at I/ITSEC'03

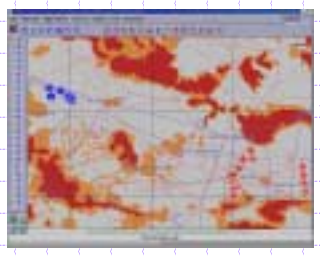
XBML



BML GUI commander's orders

XML/ SOAP

OTB simulation



XML/ SOAP

Multi Source Database

XML/ SOAP

CAPES Army C4I

XBML Phase II

- Deploying a usable XBML based on the NATO Command and Control Information Exchange Data Model (C2IEDM)
- Coordinated effort
  - DMSO funded GMU-ODU-ACS-Alion project
  - Army BML deployment using XMSF approach
  - JFCOM funding Air Battle Order ODU-Gestalt
  - Allies interested in participation: UK, France, Australia
- Goal in sight: unambiguous language enables C4I-Simulation interoperation

Sonar Visualization

Merges technologies to provide the military with relevant real-time sonar analysis :

- physics-based sonar-modeling algorithms
- 3D graphics visualization tools
- Web-based technologies

Tactical decision aids use

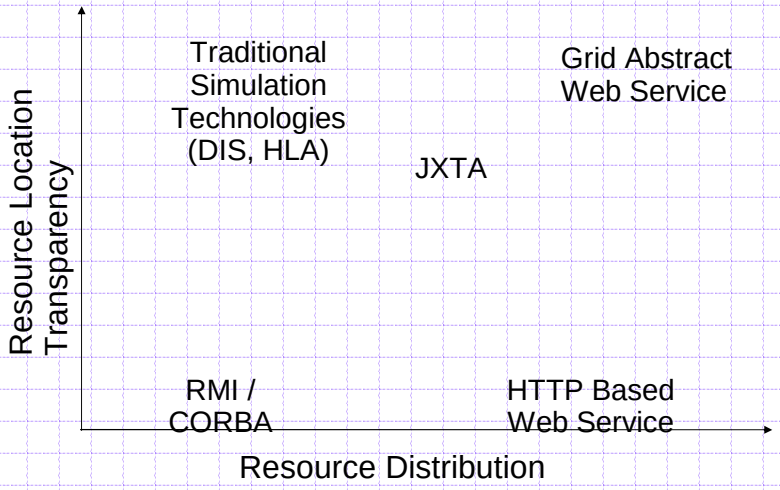
- Web-based Extensible 3D (X3D) models for composable rendering
- Web Services messaging
- XML Schema-Based Compression (XSBC) for reliable transmission

Animations of multipath sonar propagation

XMSF and the Grid

- Grid computing is a natural evolution of distributed computing technologies such as RMI and CORBA
- Robust and transparent architecture
  - allows resources to discover each other over WANs
  - lesson learned from the mistakes of proprietary technologies and Web services
  - using open standards and protocols, Grid computing solutions gain ubiquity of peer resources

Distributed computing paradigms



Combining Grid and Web Services

Describe distributed computing technologies in orthogonal ways:

- Web services definition focuses on the use of XML to describe both service interfaces and the communication messaging format.
- Grid computing focuses on the system architecture, leaving the particulars of protocols and message formats unspecified.

With complimentary goals and orthogonal requirements have been merged into coherent distributed systems known as Grid services that use

- XML to describe their interfaces and encode messages
- open internet protocols for communication

Examples:

- Open Grid Service Architecture (OGSA)
- Sun's JXTA

Simulation, C4I, and the GIG

DISA, the leading C4I element of DoD, has undertaken a major new initiative called the Global Information Grid (GIG)

- High-capacity network access worldwide
- Network-Centric Enterprise Services: software that is broadly available in the GIG
- Community of Interest (COI) as an organizing principle
  - Each COI has an associated NameSpace that defines a basis for information exchange
- Web services provide application-level information exchange

Summary

Web-based technologies and techniques can provide an extensible modeling and simulation framework

- Support a new generation of interoperable applications
- Integrate/reuse existing M&S technologies
- Clear path to integration with Grid computing

Open standards preserve stakeholders' past investment and protect against the future risk of proprietary technologies

XMSF is a community initiative

- Exemplars prove feasibility
- Profiles capture interoperability enablers
- Working for broader involvement

Contacts

http://www.MovesInstitute.org/xmsf

Don Brutzman	brutzman@nps.navy.mil	831.656.2149
Curt Blais	clblais@nps.navy.mil	831.656.3215
Mark Pullen	mpullen@gmu.edu	703.993.1538
Michael Hieb	mhieb@msiac.dmso.mil	703 933-3376
Katherine L. Morse	morsek@saic.com	858.826.6728
David Drake	david.l.drake-2@saic.com	858.826.2278
Andreas Tolk	atolk@odu.edu	757.686.6203

This work was supported in part by the US Defense Modeling & Simulation Office (DMSO) and JFCOM