



MORS Cover Slide



MOOTW FAST Toolbox: A Loosely Coupled System



73rd MORSS CD Cover Page

712CD

UNCLASSIFIED DISCLOSURE FORM CD Presentation

For office use only 41205

21-23 June 2005, at US Military Academy, West Point, NY

Please complete this form 712CD as your cover page to your electronic briefing submission to the MORSS CD. Do not fax to the MORS office.

Author Request (To be completed by applicant) - The following author(s) request authority to disclose the following presentation in the MORSS Final Report, for inclusion on the MORSS CD and/or posting on the MORS web site.

Name of Principal Author and all other author(s):

Mr. John S. Cipparone
Mr. Curtis Blais
Dr. Dean S. Hartley III
Mr. Wayne Randolph

Phone: 571-226-8765
Fax: 571-226-8640
Email: jcipparone@drc.com

Original title on 712 A/B: Integrated Analysis Tools for Military Operations Other Than War

Presented: WG 16, 22, 29, 31

This presentation is believed to be:
UNCLASSIFIED AND APPROVED FOR PUBLIC RELEASE

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 23 JUN 2005		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Integrated Analysis Tools Military Operations Other Than War				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) DSMO				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES See also ADM201946, Military Operations Research Society Symposium (73rd) Held in West Point, NY on 21-23 June 2005 . , The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 36	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Integrated Analysis Tools



U.K. MoD



CDN-DND



DoD M&S Vision

1. In 1991, the Deputy Secretary of Defense assigned over responsibility of all DoD M&S to the USD(A), now the USD and Technology. To assist the USD(A) in managing DoD M&S, the USD(A) established the DoD EXCIMS and granted it oversight and management authority. The USD(A) tasked the EXCIMS to develop a vision for DoD M&S to help focus the DoD's M&S community on core functions and on applying M&S in ways that would enhance overall DoD effectiveness.

2. These ideas were incorporated by the EXCIMS into the DoD M&S vision:

- a. Defense modeling and simulation will provide readily available, operationally valid environments for use by the DoD community:
 - (1) To train jointly, develop doctrine, operational plans, and assess war
 - (2) To support technology assessment, prototype and full-scale development structuring.

Furthermore, common use of these environments will promote a closer interaction between the operations and acquisition communities in carrying out their respective responsibilities. To allow for common and flexibility, these modeling and simulation environments will be constructed from affordable, reusable components interoperating through and open systems architecture.



U.S. DoD

Military Operations Other Than War



HARTLEY
CONSULTING





Presentation Interests



MOOTW FAST Toolbox: A Loosely Coupled System

☐ **Toolbox Synopsis**

- Needs
- Objectives
- Tools

☐ **User Interface**

☐ **Toolbox Support to JCS J-8**

- Toolbox Application
- Methodology
- S&T Initiative

☐ **Toolbox Usage at NPS**

- Research using FAST
- Curriculum Support



Defining MOOTW M&S Needs



MOOTW FAST Toolbox: A Loosely Coupled System

❑ M&S deficiencies in OOTW

- WARSIM & JWARS ORD
- PACOM's MOOTW Requirements Analysis

❑ Comments identified in WARMOND

- M&S analytic tools to support JTF for OOTW. Current models do not provide the capability ... particularly non-force-on-force, peacekeeping OOTW. (EUCOM)
- CINC battle staffs currently lack a federated simulation that provides the detailed resolution needed in today's asymmetrical warfare environment. (JFCOM)
- A standardized, collaborative and distributed crisis action planning tool for analyzing COA, especially in areas of OOTW and SASO. (PACOM,TRAC)
- A model that can be used for missions disaster relief, refugee, peacekeeping, counter-drug and stability operations. (SOUTHCOM)
- OOTW Simulation for SOF missions. (SOCOM)

❑ Outreach generated listing of desired "FAST Features"

❑ SPG 06-11 identified Stability Operations as a major M&S shortfall

OOTW: A Top Warfighter M&S Need



Toolbox Objectives



MOOTW FAST Toolbox: A Loosely Coupled System

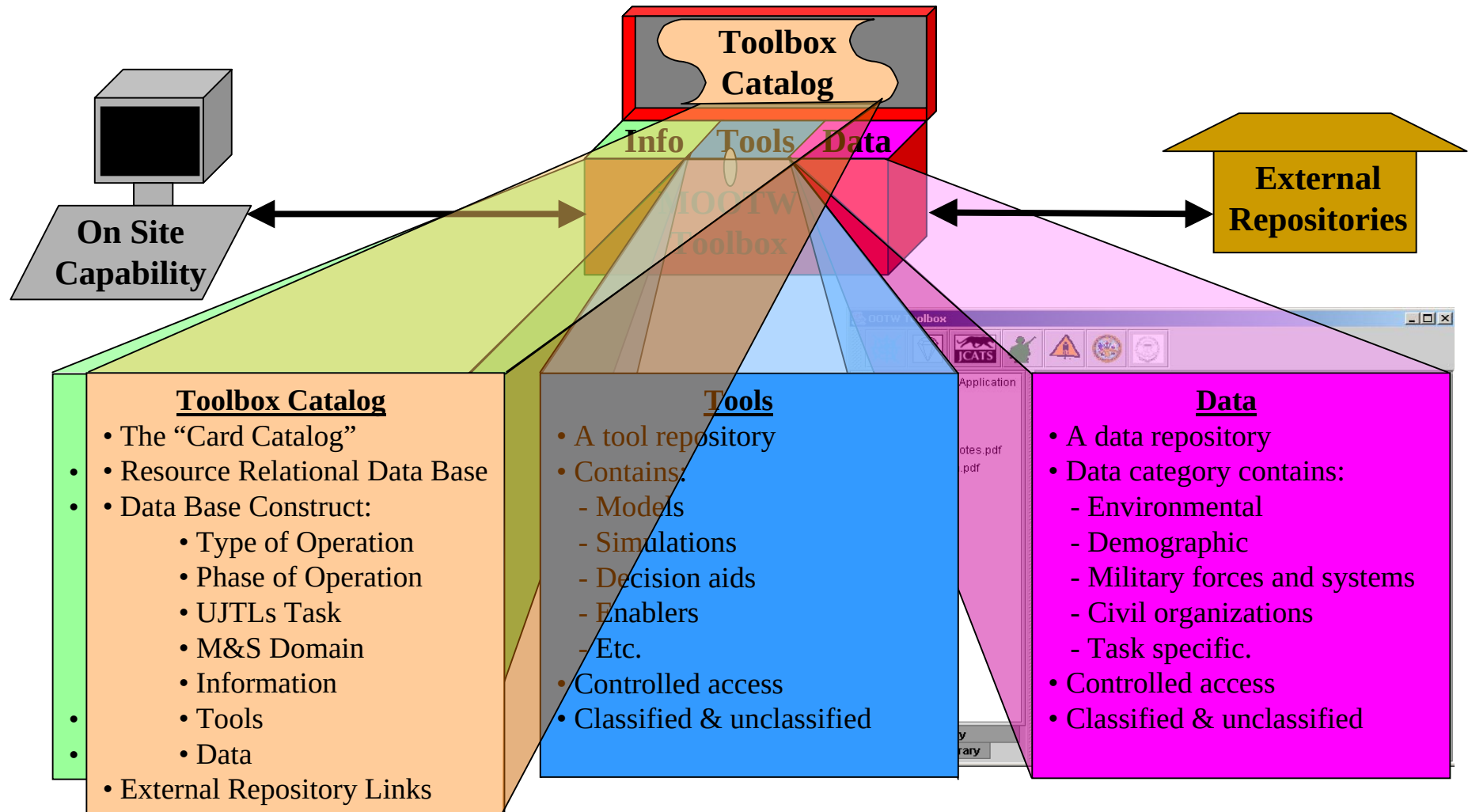
- ☐ **Build a prototype toolbox in a laptop for disparate M&S tools to operate in a complementary manner**
- ☐ **Selectively implement automated methodologies for tools to share data in support of operational planning & analysis**
- ☐ **Provide access to authoritative force & C⁴I data**
- ☐ **Advance rapid update of scenario files**
- ☐ **Employ the toolbox in an MOOTW setting**



Toolbox Controller



MOOTW FAST Toolbox: A Loosely Coupled System



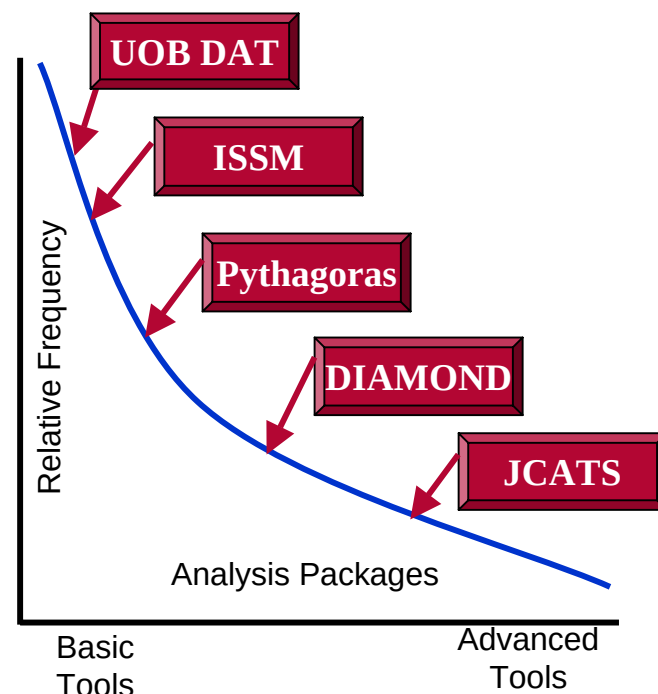


Tool Overview



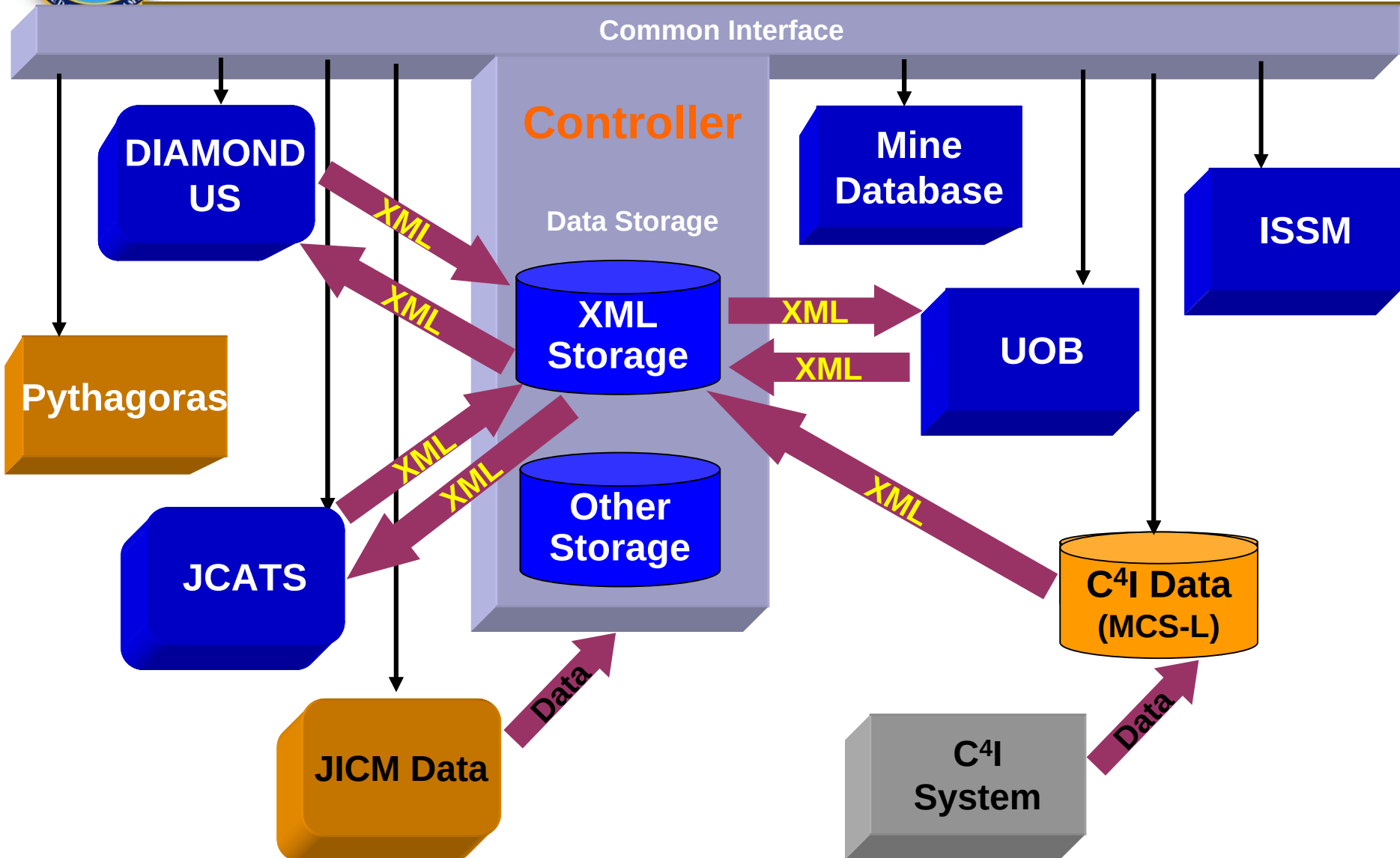
MOOTW FAST Toolbox: A Loosely Coupled System

- ❑ **Canadian Forces Landmine Database**
 - Pictorial representation of over 350 mines cross referenced for tactical employment
- ❑ **Unit Order of Battle Data Access Tool**
 - Tailors forces & equipment to specific missions across the levels of war
- ❑ **Interim Semi-static Stability Model**
 - Civil stability & durable peace model applicable at the strategic & operational levels of war
- ❑ **Pythagoras**
 - Agent based distillation that can be applied across the levels of war
- ❑ **DIAMOND**
 - High-level simulation that advances planning/analysis at the operational & tactical levels
- ❑ **Joint Conflict and Tactical Simulation**
 - Interactive simulation for conducting training & mission rehearsal at the tactical level





Architecture Roadmap





Interface with Users



MOOTW FAST Toolbox: A Loosely Coupled System

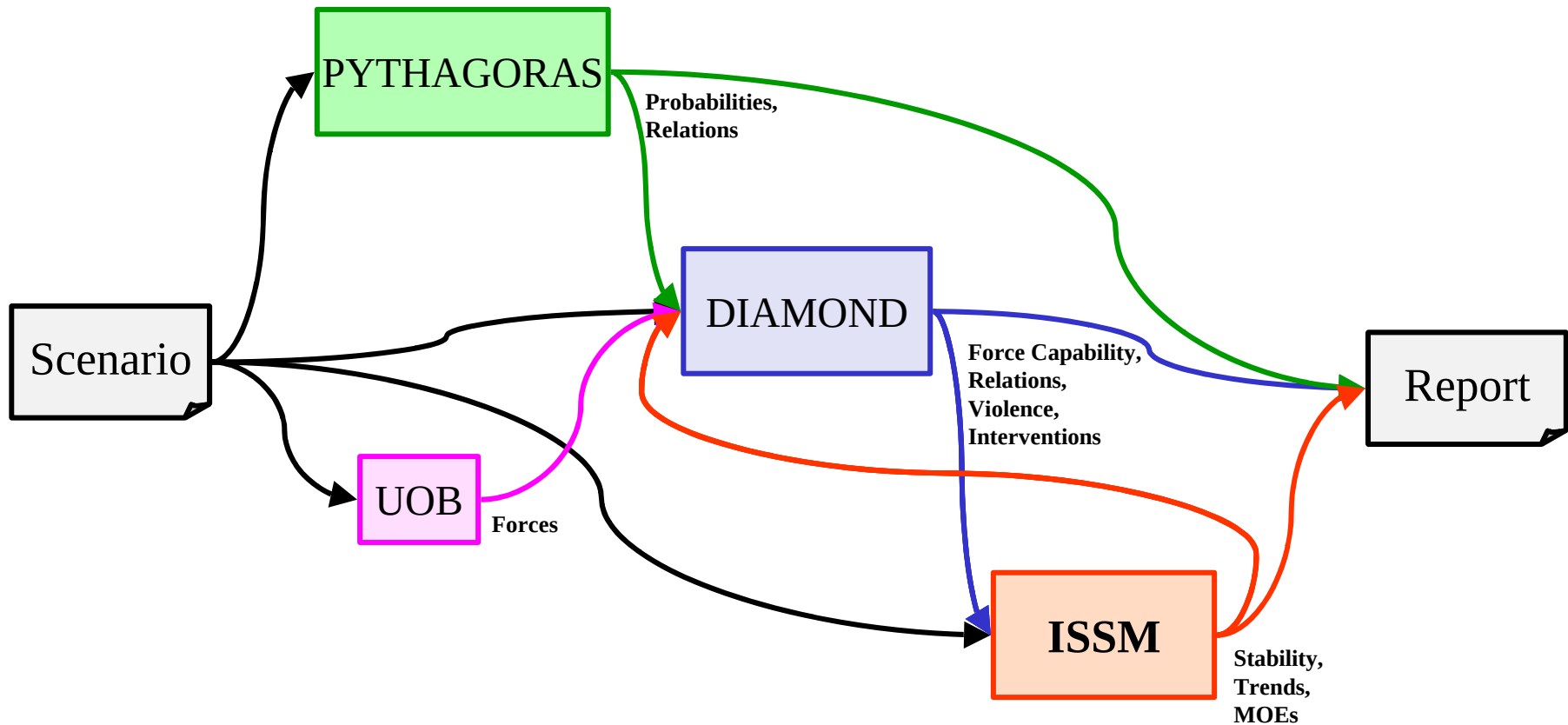
- ☐ **Prototype Toolbox selectively used by CAA analyst in post-war Baghdad**
 - Evaluated UOB and ISSM concepts
- ☐ **Recommendations by CAA turned into 04 tasks**
 - UOB & ISSM
 - UOB enhancement used by DIAMOND-US
- ☐ **Who's using toolbox/tools**
 - JCS J-8: Funded 05 support of ESS Study
 - ✓ Pythagoras, ISSM, UOB DAT, & DIAMOND-US
 - ✓ Toolbox transition planned for during 06
 - USA G-2: DIAMOND-US & ISSM in support of study
 - ✓ Toolbox requested in conjunction with study
 - CAA: DIAMOND-US in support of study
 - NPS: Toolbox being used in curriculum & ESS Study



Integrating Tools



MOOTW FAST Toolbox: A Loosely Coupled System





ESS Study MOE



MOOTW FAST Toolbox: A Loosely Coupled System

☐ **Percent of Situational Understanding**

- Percent of Expectations Met: Campaign Authority

☐ **Time Required to Achieve Security**

- Local
 - ✓ Forces Used
 - ✓ Percent of Force Elements Employed
 - ✓ Capabilities Used

☐ **Country Stability Indicators**

- Time Required to Provide Basic Needs: Food, Shelter, Water, etc.
 - ✓ Percentage of Supplies Delivered

☐ **Percent of Supporting Factions**

- Time Required to Affect Faction Allegiance

☐ **Integration & Efficiency of NGOs**



Methodology

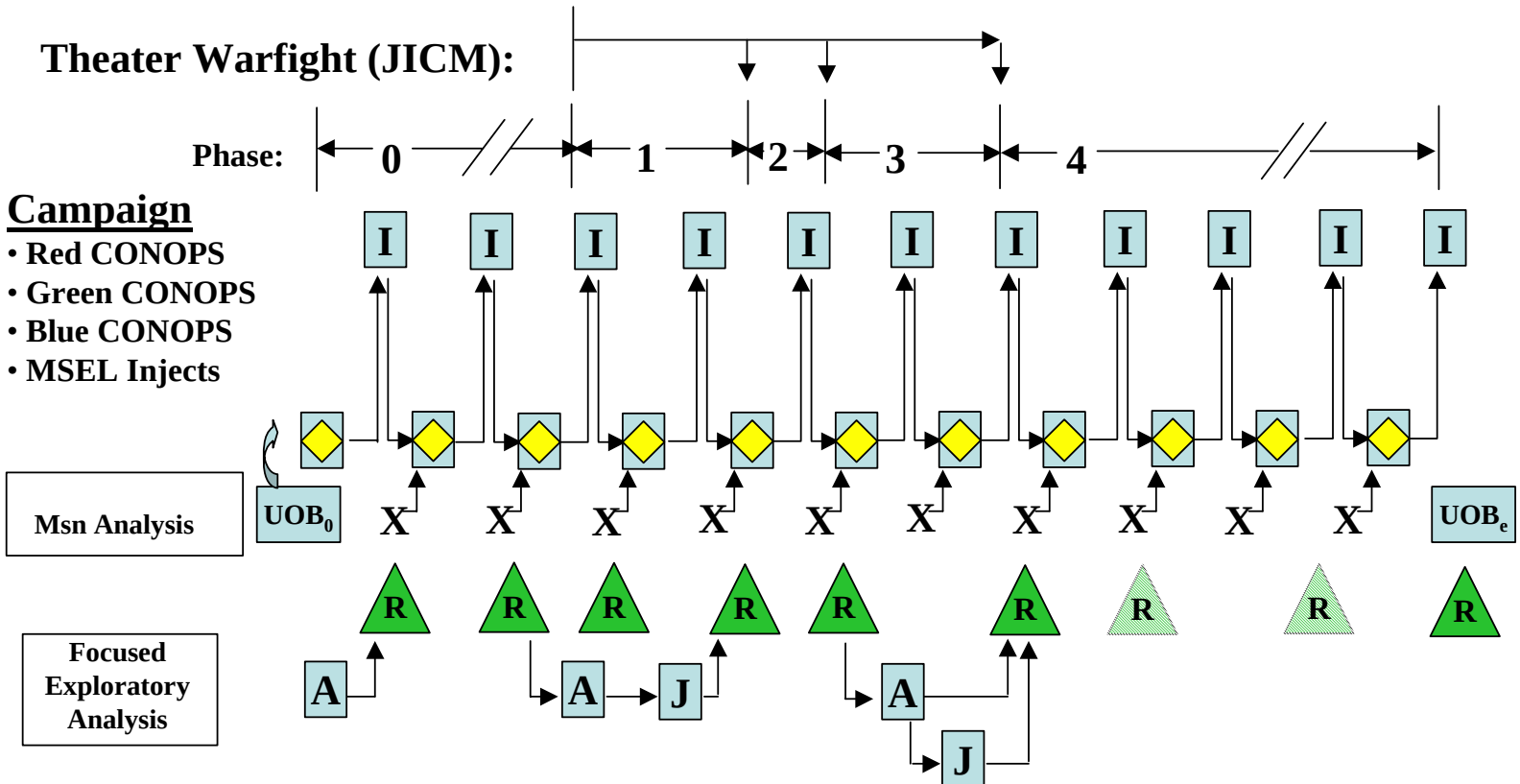


MOOTW FAST Toolbox: A Loosely Coupled System

Theater Warfight (JICM):

Campaign

- Red CONOPS
- Green CONOPS
- Blue CONOPS
- MSEL Injects



Legend

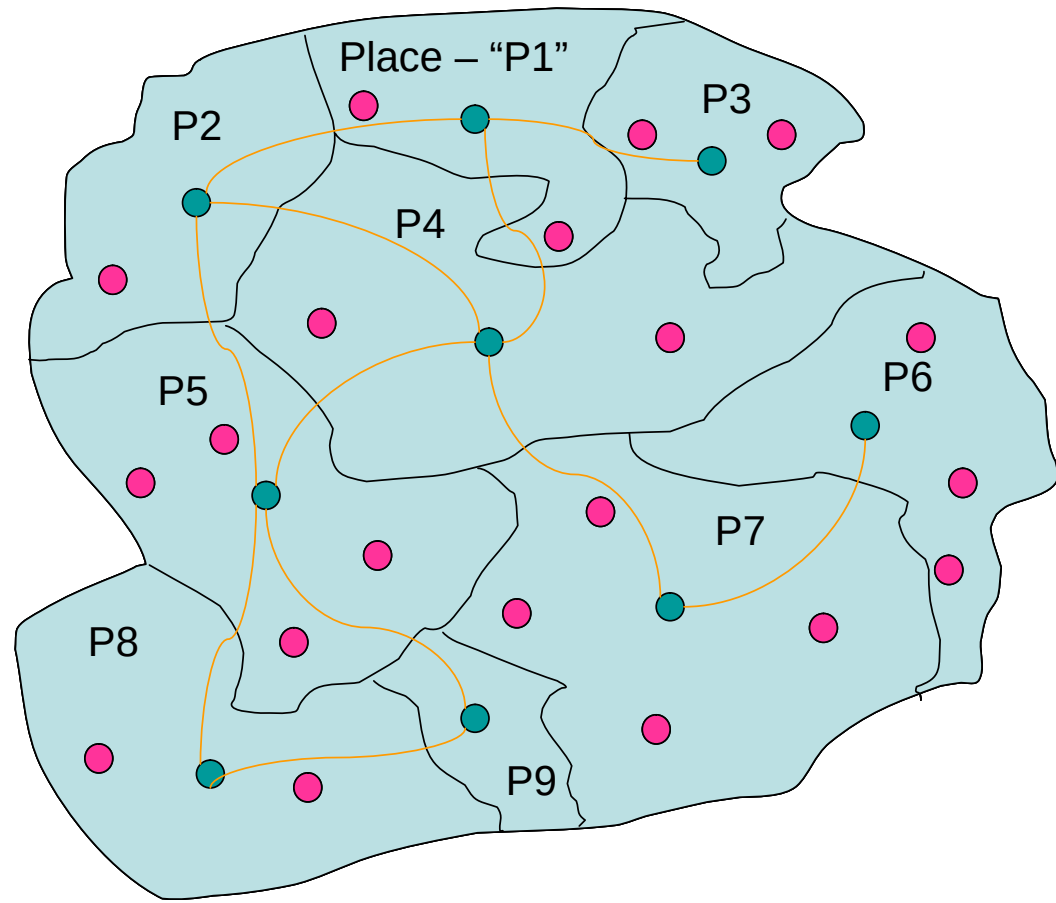
I	ISSM	J	JCATS	R	WG Review
◇	DIAMOND	A	ABM (Pythagoras, MANA, PAX...)		
X	Change Task Organization, Missions, Mission Areas; Update UOB & COP Version of DIAMOND.				



JICM



MOOTW FAST Toolbox: A Loosely Coupled System



- - JICM Place Centroid
- - DIAMOND Node

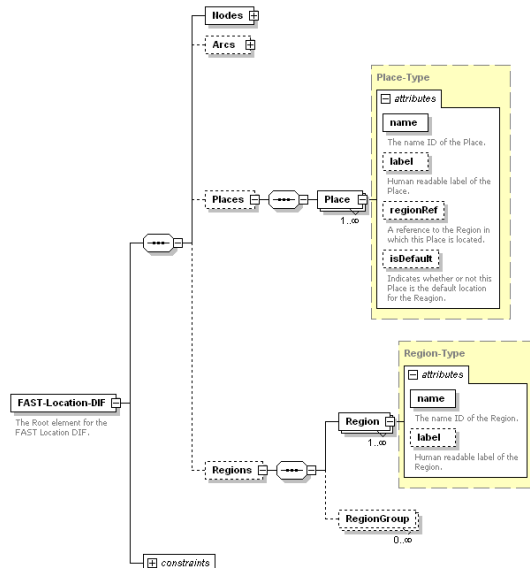
— - JICM Link



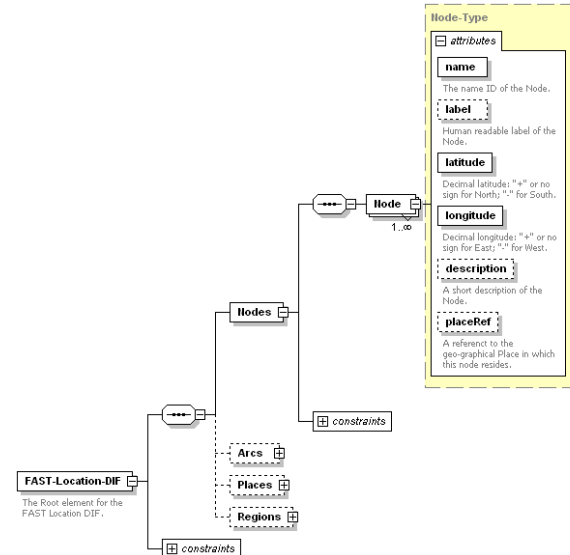
Data Interchange Format



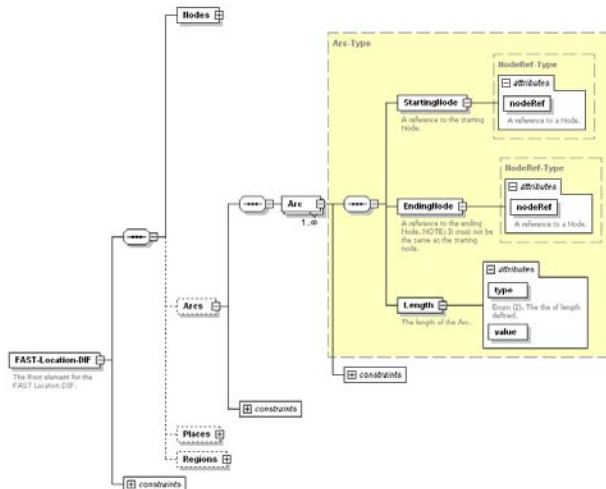
MOOTW FAST Toolbox: A Loosely Coupled System



Generated with XMLSpy Schema Editor www.altova.com



Generated with XMLSpy Schema Editor www.altova.com



Generated with XMLSpy Schema Editor www.altova.com

Using JICM data in the Toolbox

□ Prototype DIF has been developed for XMT to import JICM places & links as Arcs & Nodes as initialization data for DIAMOND



Toolbox Use at NPS



MOOTW FAST Toolbox: A Loosely Coupled System

☐ Research

- **Data Interchange**
- **Agent-based Simulation**
- **Candidate Tools**

☐ Education

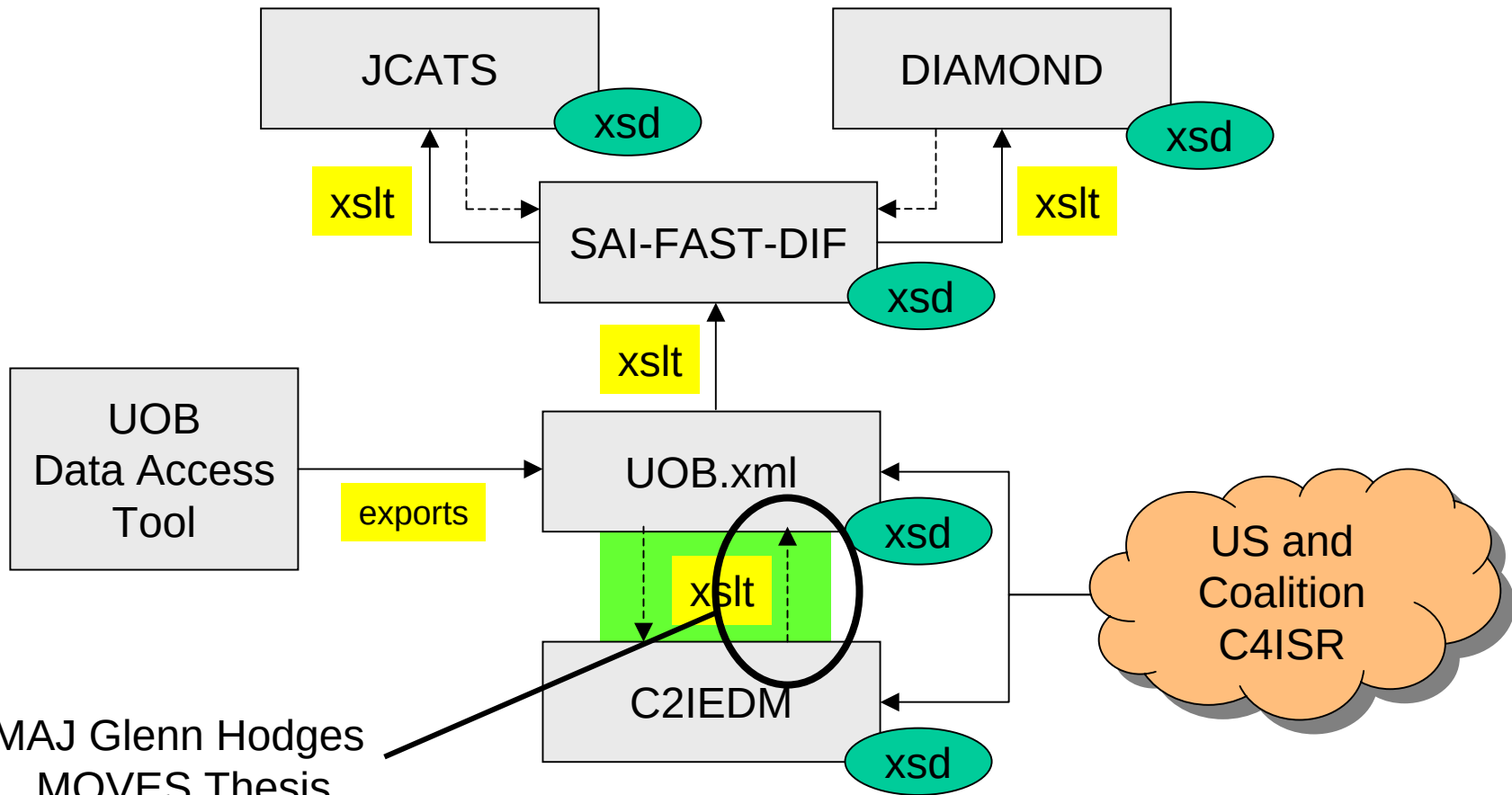
- **Curriculum Development**
- **Student Thesis Research**



Extending Unit Data Interchange



MOOTW FAST Toolbox: A Loosely Coupled System



MAJ Glenn Hodges
MOVES Thesis
September 2004

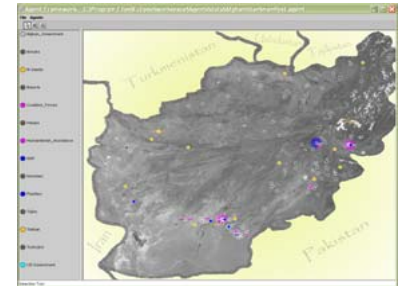


Agent-Based Simulations



MOOTW FAST Toolbox: A Loosely Coupled System

- ☐ Agent model built using NPS multi-agent simulation framework and initialized from DIAMOND Afghanistan scenario
 - Units/Factions
 - Nodes/Arcs
- ☐ Demonstrated that the use of open standards and exposed data structures enables arbitrary simulation models to readily read and operate on FAST data
- ☐ Conduct of studies using Pythagoras, PAX, Mana (refer to Profs Lucas and Sanchez)





Design of Experiments



MOOTW FAST Toolbox: A Loosely Coupled System

- ❑ Analysts often use large high-dimensional simulation models to provide insights to warfighters/decision-makers
- ❑ A design is a plan that specifies the input combinations of the variables

- ❑ Sample design:

	Factor 1	Factor 2	Factor 3
Run 1	High	Off	Yes
Run 2	High	On	No
Run 3	Low	On	Yes
Run 4	Low	Off	No
Run 5	Low	Off	Yes
Run 6	High	On	No

- ❑ Typically only a few variables are varied at two or three levels for a limited number of pre-determined alternatives instead of employing good experimental design techniques



Design of Experiments



MOOTW FAST Toolbox: A Loosely Coupled System

❑ LTC Tom Cioppa dissertation: “*Efficient nearly orthogonal and space-filling experimental designs for high-dimensional complex models,*” NPS, 2002

- Orthogonality exists when each column of the design matrix has zero correlation with each of the other columns in the design matrix
 - ✓ Cause-and-effect relationships and quantitative assessment of critical interactions can be made
- Space-filling means the design points are scattered throughout the multi-dimensional outcome space
 - ✓ Allows the design points to be spaced throughout the region
 - ✓ Opens up the ability to have multiple levels per factor, increasing the capability to explore a broader range of possibilities



Candidate Tools



MOOTW FAST Toolbox: A Loosely Coupled System

□ Simkit/Viskit

- Discrete Event Simulation (DES) application program interface (API) in Java
- Graphical User Interface for design and development of discrete event simulations (DES) using event graph notation and the Simkit DES application program interface
- Repository of components and previously developed models

□ Incident Reporting System

- Network and Graph Markup Language (NaGML)
- Visualization and analysis of incident data streams



Education: FAST in the Curriculum



MOOTW FAST Toolbox: A Loosely Coupled System

- ☐ New course conducted Spring (April-June) 2005:
*“Modeling and Simulation (M&S) for Military Operations Other Than War (MOOTW)”***
 - Multi-disciplinary (OA, MOVES, CS, IS)
 - Seminar format
 - Review MOOTW missions
 - Examine M&S requirements to support MOOTW
 - Explore existing applications in FAST (primarily DIAMOND and ISSM) and other existing/emerging simulations (e.g., agent-based models)



M&S for MOOTW: Course Description



MOOTW FAST Toolbox: A Loosely Coupled System

- ☐ **Course presented and discovered issues, challenges, and opportunities for application of M&S to MOOTW**
- ☐ **Considered application of M&S for MOOTW from the perspectives of analysis, training, acquisition, and mission planning/rehearsal**
- ☐ **Students had hands-on experience with current and emerging MOOTW M&S simulations and computational tools**
 - **ISSM, DIAMOND from the FAST Toolbox**
 - **MANA, Pythagoras from Project Albert**



Student Project Outline



MOOTW FAST Toolbox: A Loosely Coupled System

- ☐ **Select problem area of interest**
- ☐ **Describe scenario**
- ☐ **Define MOEs/MOPs**
- ☐ **Design experiment**
- ☐ **Select model to support analysis**
- ☐ **Represent scenario in model**
- ☐ **Obtain data (provisional)**
- ☐ **Analyze and report results**
- ☐ **Report lessons learned and future directions**



Student Project Topics



MOOTW FAST Toolbox: A Loosely Coupled System

- ☐ **Patrolling national waters**
- ☐ **Unmanned Aerial Vehicle (UAV) swarming**
- ☐ **Aggressiveness and population control**
- ☐ **Pier-side Force Protection**
- ☐ **Force allocation in protection of relief operations**
- ☐ **Protection of polling places in elections**
- ☐ **Protection of shipping**
- ☐ **Embassy reinforcement**
- ☐ **Oil infrastructure protection**
- ☐ **Border patrol**
- ☐ **Non-lethal weapons and crowd control**



FAST: Student Thesis Research



MOOTW FAST Toolbox: A Loosely Coupled System

- ❑ MAJ Glenn Hodges, USA: “*Designing a Common Interchange Format for Unit Data Using the Command and Control Information Exchange Data Model (C2IEDM) and XSLT*”, September 2004**

<http://www.movesinstitute.org/Theses/HodgesThesis.pdf>

- ❑ LCDR Shane Brown, USN: “*Analyses of Infrastructure Protection Using Network Optimization and Simulation Tools*”, September 2005**



Toolbox End State



MOOTW FAST Toolbox: A Loosely Coupled System

- ☐ **Addresses warfighter needs supporting MOOTW**
- ☐ **Enables one-stop shopping through an information-centric architecture**
- ☐ **Allows disparate applications to run on same laptop**
- ☐ **Provides access to authoritative force data via UOB DAT**
- ☐ **Advances complementary use of tools across levels of war to promote planning, analysis, and training supporting stability type missions within MOOTW**
- ☐ **Uses XML via automated processes to share data in a standardized environment that creates time savings**
- ☐ **Ingests C⁴I data into the toolbox for simulation initialization/ update through XMT**
- ☐ **Reuses scenario data through XMT**



QUESTIONS



MOOTW FAST Toolbox: A Loosely Coupled System

□ John Cipparone

- DRC
- 571-226-8765
- jcipparone@drc.com

□ Curtis Blais

- NPS MOVES Institute
- 831-656-3215
- clblais@nps.edu



MOOTW FAST Toolbox: A Loosely Coupled System

Back-ups



C2IEDM



MOOTW FAST Toolbox: A Loosely Coupled System

- ❑ **Command and Control Information Exchange Data Model: Multilateral Interoperability Programme**
<http://www.mip-site.org>
- ❑ **October 2004: XML tagset corresponding to the logical schema passed validation in the DoD Metadata Registry; posted in the COAL (Coalition) namespace**
 - All XML resources for both the physical and the logical representations are now available for review and download at the Registry Website:
<http://diides.ncr.disa.mil/xmlreg/user/index.cfm>
 - Status of these tags is currently “Developmental”; status expected to change to “Operational” soon
- ❑ **November 2004: US Army drafting policy statements to require use of C2IEDM in the C4I and simulation domains**



Example 6-factor design (OLH)



MOOTW FAST Toolbox: A Loosely Coupled System

Low level	5	10	5	5	-50	-50
High level	25	50	25	50	50	50
Factor name	Vehicle speed	Sensor range	Weapon range	Comms range	Toward live enemies	Toward live friends
	11	50	21	22	-25	44
	6	20	23	30	-50	-19
	8	28	6	16	13	31
	9	35	11	50	6	-38
	20	48	14	11	-19	-50
	25	23	13	42	-44	25
	18	18	25	19	38	-6
	16	45	20	47	31	13
	15	30	15	28	0	0
	19	10	9	33	25	-44
	24	40	8	25	50	19
	23	33	24	39	-13	-31
	21	25	19	5	-6	38
	10	13	16	44	19	50
	5	38	18	13	44	-25
	13	43	5	36	-38	6
	14	15	10	8	-31	-13



M&S for MOOTW: Primary Texts



MOOTW FAST Toolbox: A Loosely Coupled System

- Bradd C. Hayes and Jeffrey I. Sands, Doing Windows: Non-Traditional Military Responses to Complex Emergencies, CCRP, 1998 (<http://www.dodccrp.org>)
- D. S. Hartley III, "Operations Other Than War: Requirements for Analysis Tools Research Report," Center for Modeling, Simulation, and Gaming, K/DSRD-2098, December 1996
- Joint Publication 3-07, Joint Doctrine for Military Operations Other Than War, 16 June 1995
- Stability Operations Joint Operating Concept, US Joint Forces Command, September 2005



Simkit



MOOTW FAST Toolbox: A Loosely Coupled System

- Application Program Interface (API) for building Discrete Event Simulation (DES) models
- Event list simulation engine
- Flexibility for random variate generation
- Simulation components based on Event Graphs
- Loose coupling of simulation components
- Extensive use of listener pattern for model building and data collection
- Platform-independent (Java)

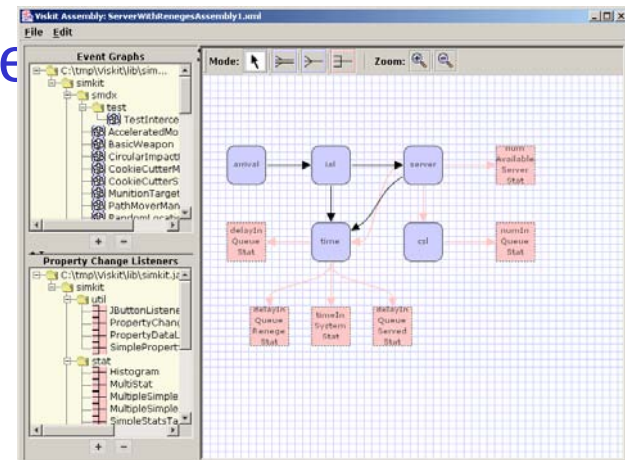
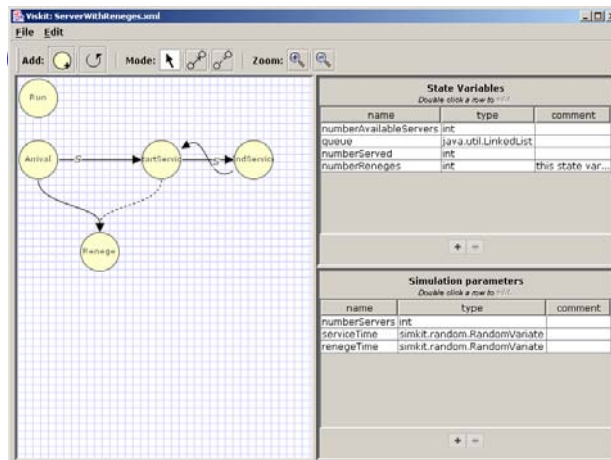


Viskit



MOOTW FAST Toolbox: A Loosely Coupled System

- Create and edit Simkit components visually
- Reduces need for programming expertise
- Eliminates many common errors
- Graphical assembly of components
- Saves components and assemblies in XML





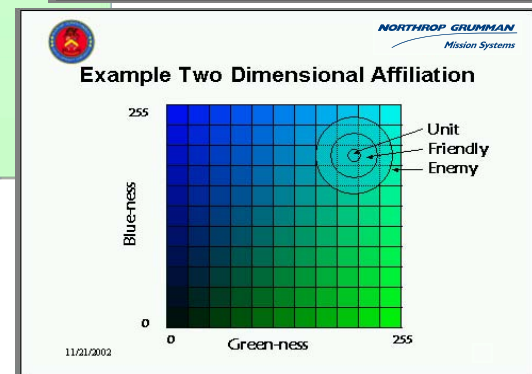
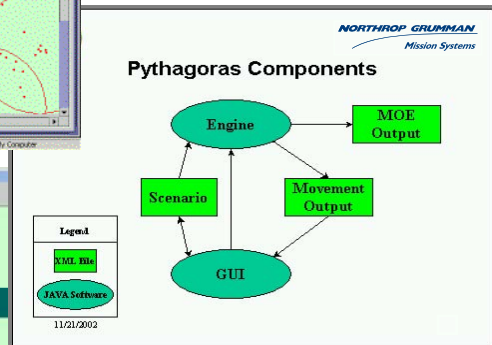
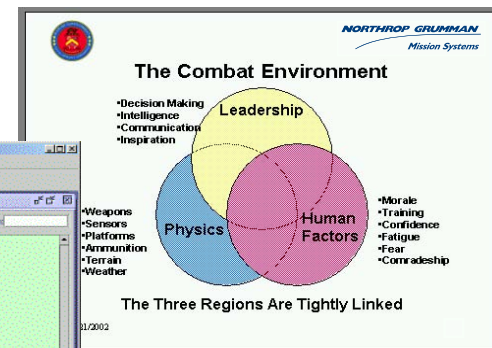
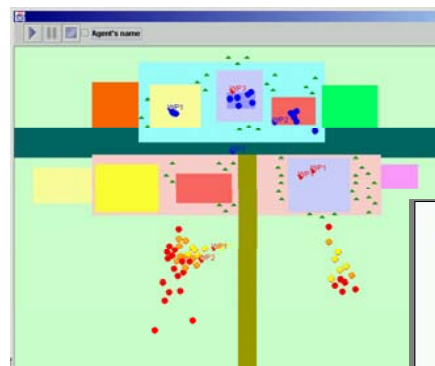
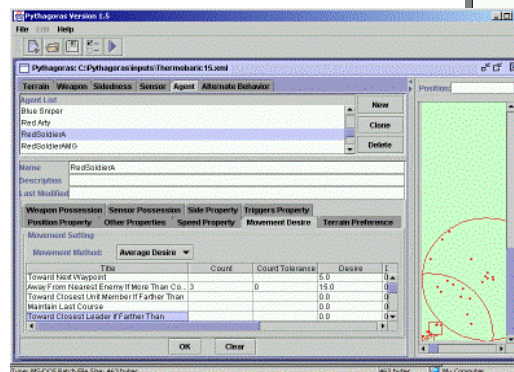
Pythagoras



MOOTW FAST Toolbox: A Loosely Coupled System

Agent-Based Technology

- Behaviors Rather Than Scripts
- Multiple Affiliations/Sides
- Traditional Capabilities
 - ✓ Weapons (Including Non-Lethal)
 - ✓ Sensors
- Peacetime Operations and War Time Engagements & Missions
- Computer Literacy Not Required
- Widely Applicable for Analysis
 - ✓ MOUT
 - ✓ Humanitarian Relief
 - ✓ ASW
 - ✓ Air Operations
 - ✓ Mine Clearing
 - ✓ Many Others





DIAMOND

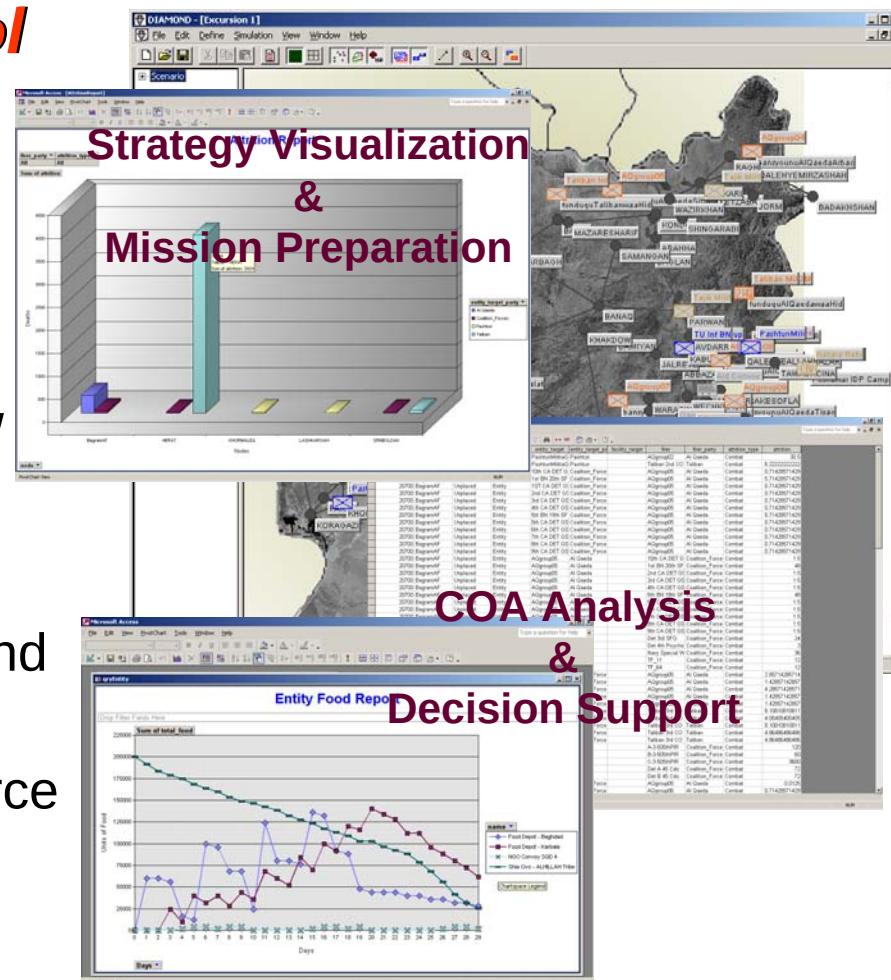


MOOTW FAST Toolbox: A Loosely Coupled System



“Best Breed” OOTW Tool

- ❑ Low resolution campaign model
- ❑ Stochastic simulation
- ❑ Interactive and multi-sided/ROE
- ❑ C2 Mission-based Architecture
- ❑ Improves understanding of MOOTW
 - Represents stability functions
- ❑ Aims to:
 - Assess utility of military elements and equipment
 - Assess effectiveness of different force structures
 - Assess possible outcomes of operational strategies





ISSM



MOOTW FAST Toolbox: A Loosely Coupled System

Time Chart: Internal Inputs

Iraq, Scenario A: Core Values

