75th MORSS 712CD Cover Page

12-14 June 2007, at US Naval Academy, Annapolis, MD

If you would like your presentation included in the 75th MORSS Final Report CD it must:

1. Be unclassified, approved for public release, distribution unlimited, and is exempt from US export licensing and other export approvals including the International Traffic in Arms Regulations (22CFR120 et.seq.),
2. include MORS Form 712CD as the first page of the presentation and
3. a MORS form 712 A or B must be in the MORS Office no later than **14 June 2007**.

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): Timothy K. Perkins, Thomas A. Bozada

Principal Author's Organization and address: U.S. Army Corps of Engineers – ERDC-CERL, P.O. Box 9005, Champaign, IL 61826-9005
Phone: 217-373-4574 Email: timothy.k.perkins@us.army.mil

Original title on 712 A/B*:* Technical Approach of the End to End Deployment Simulation (E2EDS)

Presented in: WG(s) # 31 Backup _____,

Demonstration, _____, Tutorial, _____ or Focus Session # _____

The following presentation is believed to be: unclassified, approved for public release, distribution unlimited, and is exempt from US export licensing and other export approvals including the International Traffic in Arms Regulations (22CFR120 et.seq.)

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	2. REPORT TYPE	3. DATES COVERED
01 JUN 2007	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Technical Approach of the End to End Deployment Simulation (E2EDS)	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) **U.S. Army Corps of Engineers ERDC-CERL, P.O. Box 9005, Champaign, IL 61826-9005**	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 ADM202526. Military Operations Research Society Symposium (75th) Held in Annapolis, Maryland on June 12-14, 2007, The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**25**	

Technical Approach of the End to End Deployment Simulation (E2EDS)

Timothy K. Perkins

Thomas A. Bozada

U.S. Army Engineer Research & Development Center

Outline

- Capability Required
- Capabilities Developed
  - E2EDS
  - Installations
  - Agents
- Advantages, Challenges
- Lessons Learned, Next Steps
- Key Points

Capability Required

- Ability to assess impacts on deployment (and other installation processes) due to changes of:
  - Infrastructure
  - Unit selection (personnel/equipment)
  - Resources
  - Policies/procedures
- Extended to End-to-End Deployment Simulation
  - Include installation capability, plus assessing impacts at forward locations

Questions

- *How does unit readiness affect the time and resources required to deploy?*
- *How does resource allocation impact the time it takes units to deploy?*
  - *Where are chokepoints?*
  - *Where is excess capacity?*
- *How does the physical location of deployment facilities in relation to others impact the time required to deploy?*
- *How do proposed process changes impact the time and resources required to deploy?*

- *What is the resource contention between multiple units deploying at the same time?*
- *How does force mix (warfighting versus support units) impact throughput in the deployment pipeline?*

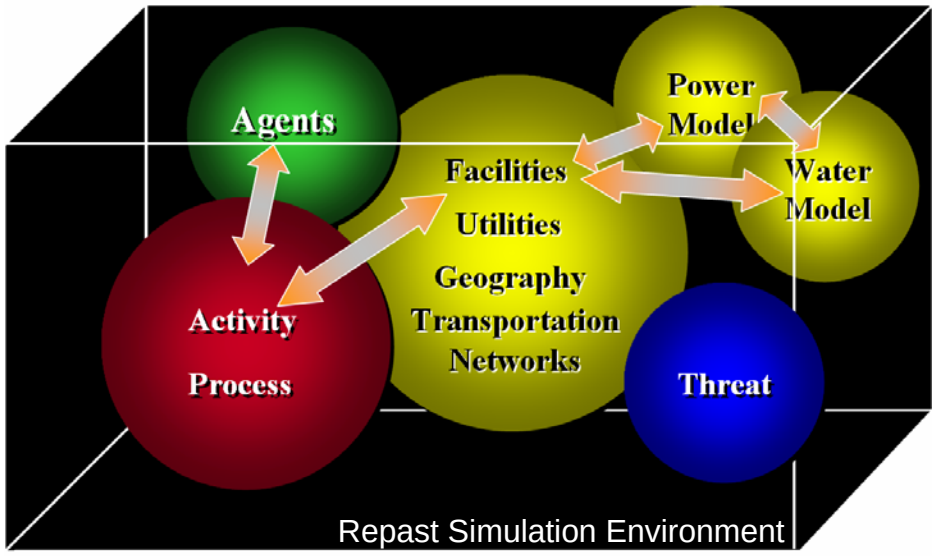
Challenges of Modeling Deployments

- Non-standard execution
- Installations are unique
  - Different requirements
  - Status/readiness of Units (personnel, equipment, and vehicles)
  - Training requirements
  - Transportation assets
  - Facilities
- Capability shift (installation ➔ E2E)

Capability Developed

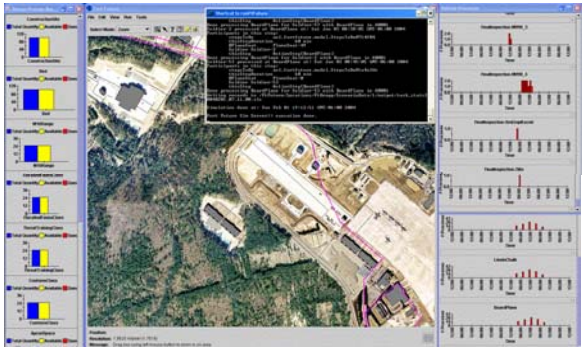
Developed the Virtual Installation

- Each node as a discrete-event simulation integrating:
  - GIS (infrastructure)
  - Physics-based utility models (power, water)
  - Agent-based modeling (personnel, equipment, resources)
  - Behavior-oriented design (processes)

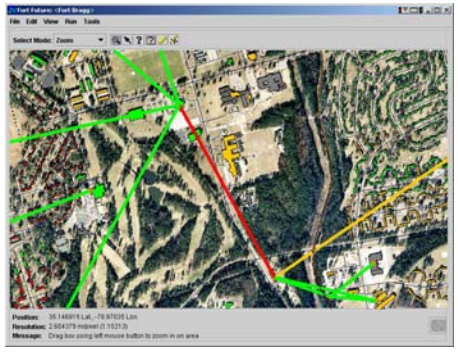


Collaboration with Argonne National Laboratory

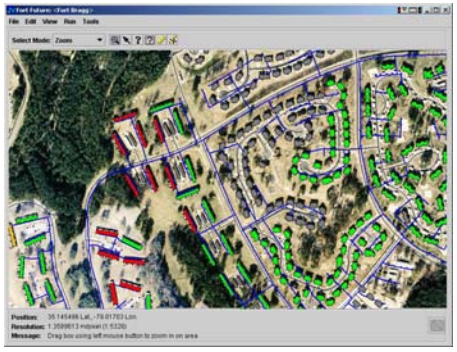
Virtual Installation



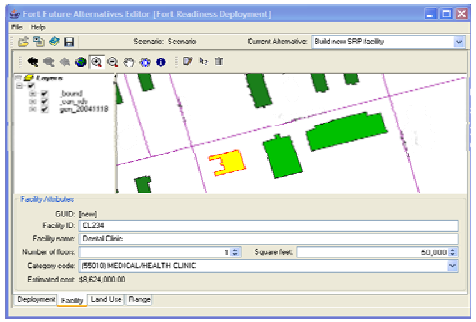
Deployment
(personnel, equipment, processes)



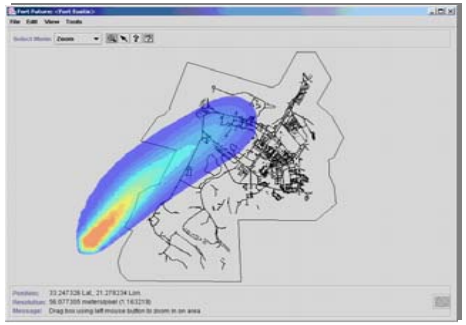
Electrical Infrastructure
(capacity, interruption)



Water Infrastructure
(flow, CBR)

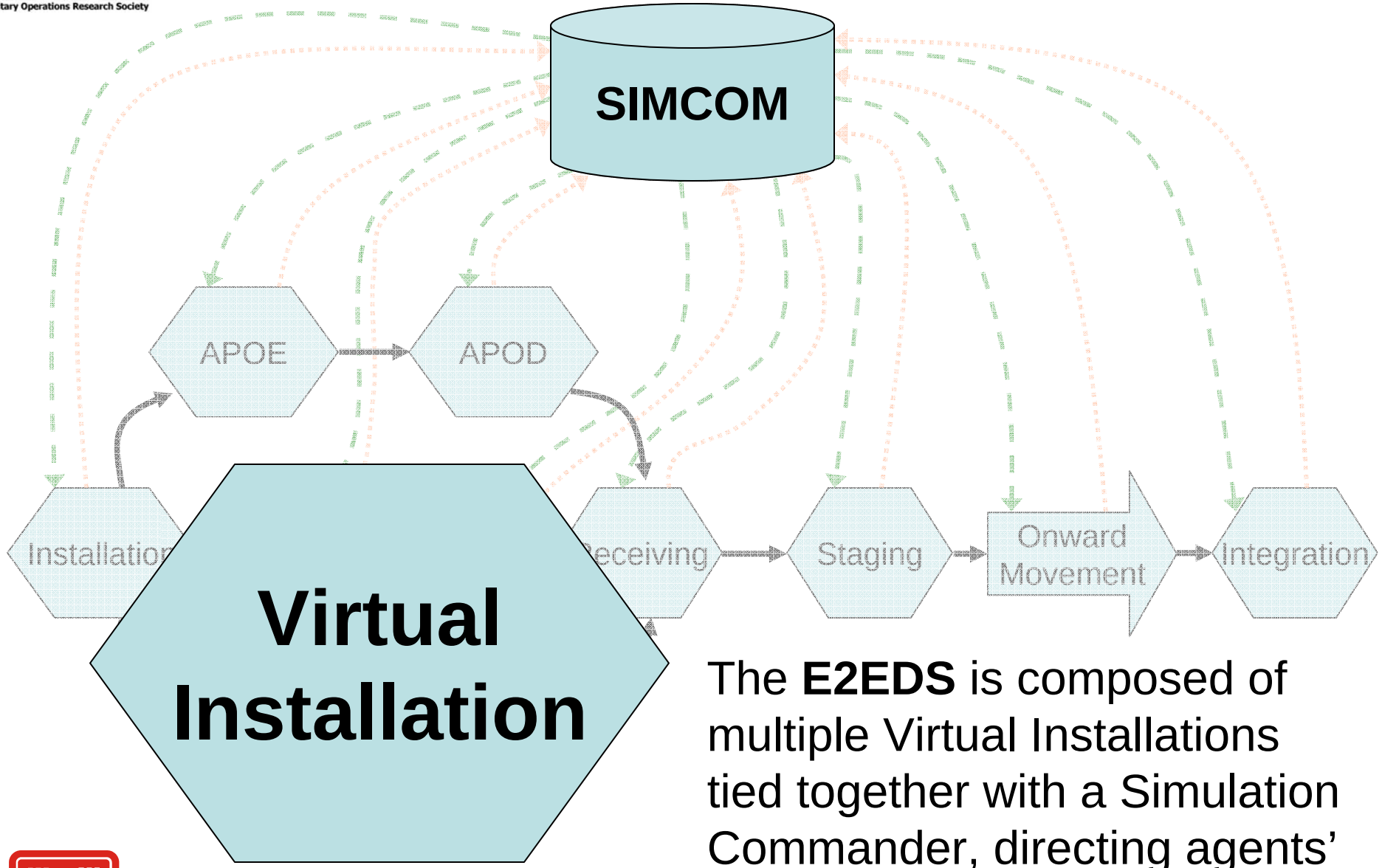


Facility Siting

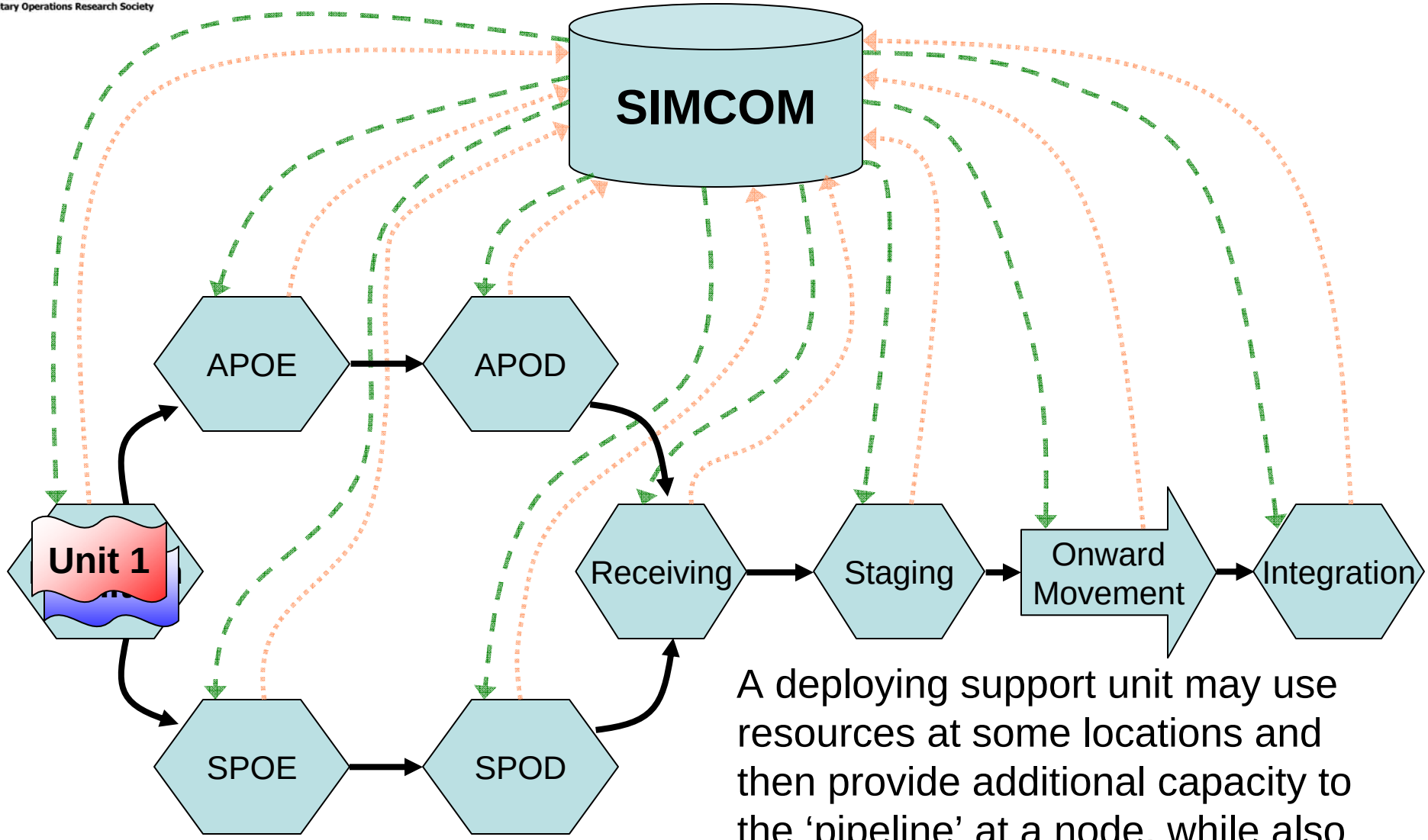


CBR Plume Modeling

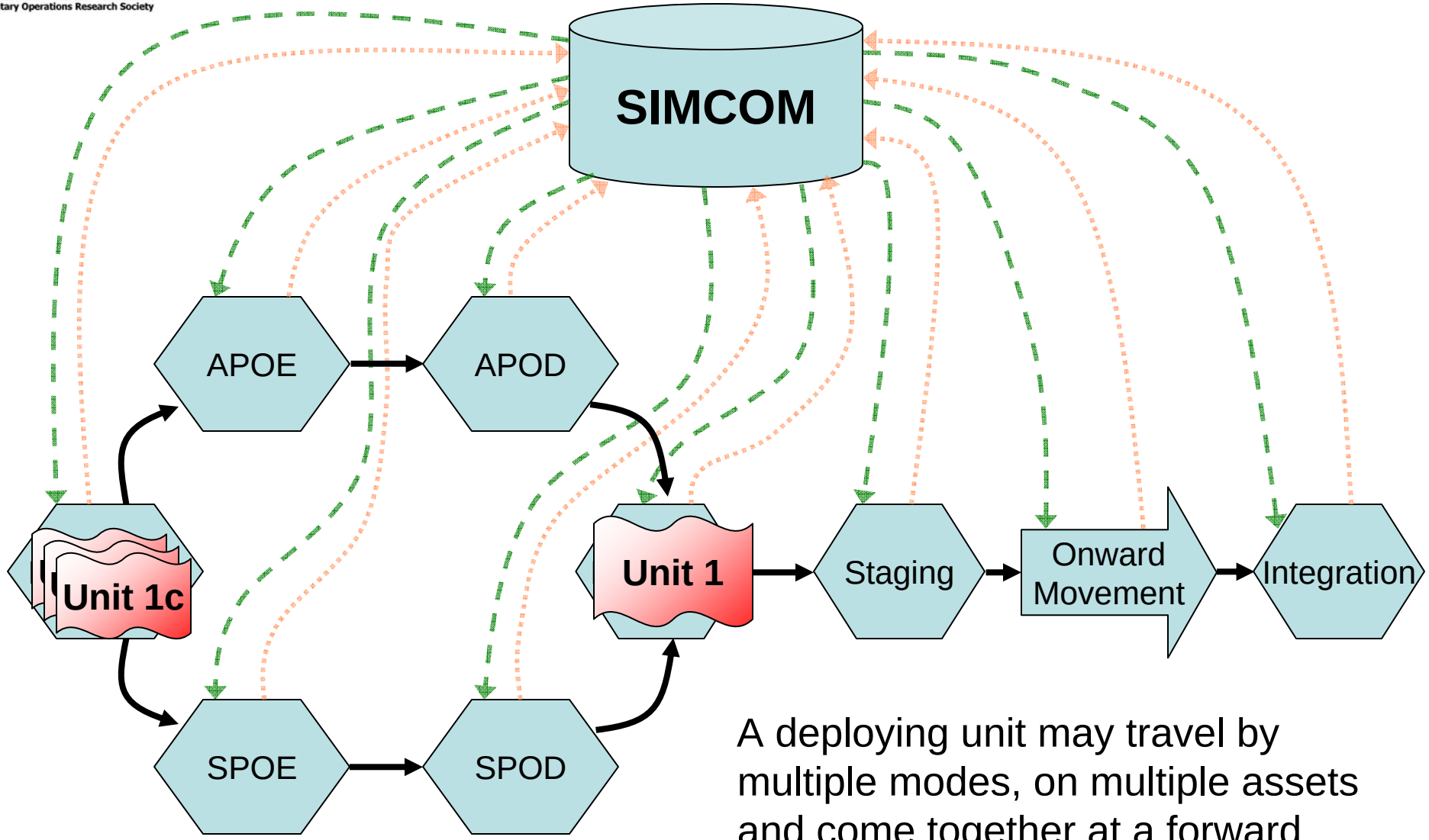
Collaborative Web-based Decision Support



The **E2EDS** is composed of multiple Virtual Installations tied together with a Simulation Commander, directing agents' movements between locations.



A deploying support unit may use resources at some locations and then provide additional capacity to the 'pipeline' at a node, while also consuming certain resources at the node.



A deploying unit may travel by multiple modes, on multiple assets and come together at a forward location and then move as a single unit.

Macro Simulation Parameters

- Establish the nodes (e.g., Installations)
  - GIS, XML Specifications
- Unit METL -> Unit Goals -> Unit Plan
  - (define movement schedule, goals)
- Load / Create the unit actions that satisfy the requirements of the goal
- Load / Select / Create units
  - Contain attributed soldiers, vehicles, and equipment
  - Unit attribution is based on real unit characteristics
    - E.g., level of readiness, capabilities, specialties, etc.
    - Or generic units…

Micro Simulation Parameters

Within Virtual Installation

- Specific locations (e.g., Motorpool) in each macro node (e.g., Home Installation), including reactive plans for agents at the locations
- Select / Create potential events within nodes
  - Nested reactive plans, influencing agent behavior if the event takes place

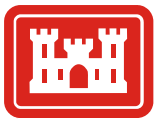
Behavior-Oriented Design Approach

- BOD is based on agents that have multiple, sometimes conflicting goals, and a decision-making process to arbitrate which behavior to act upon based on:
  - Goals and state of self
  - State of the environment
- Implemented with variant of Parallel-rooted, Ordered Slip-stack Hierarchical Reactive Plan (POSH)
  - Dr. Joanna Bryson, University of Bath, United Kingdom
- Modified to Enhanced Shared Reactive Plans (ESReP)

Role of the Individuals

Variability in human behavior impacts deployments

- Actions of a single soldier can be critical
- Knowledge, training and skill of the individual soldier
- Multiple roles of individual soldiers
- Interactions with the environment
- Reactions to events contrary to the plan



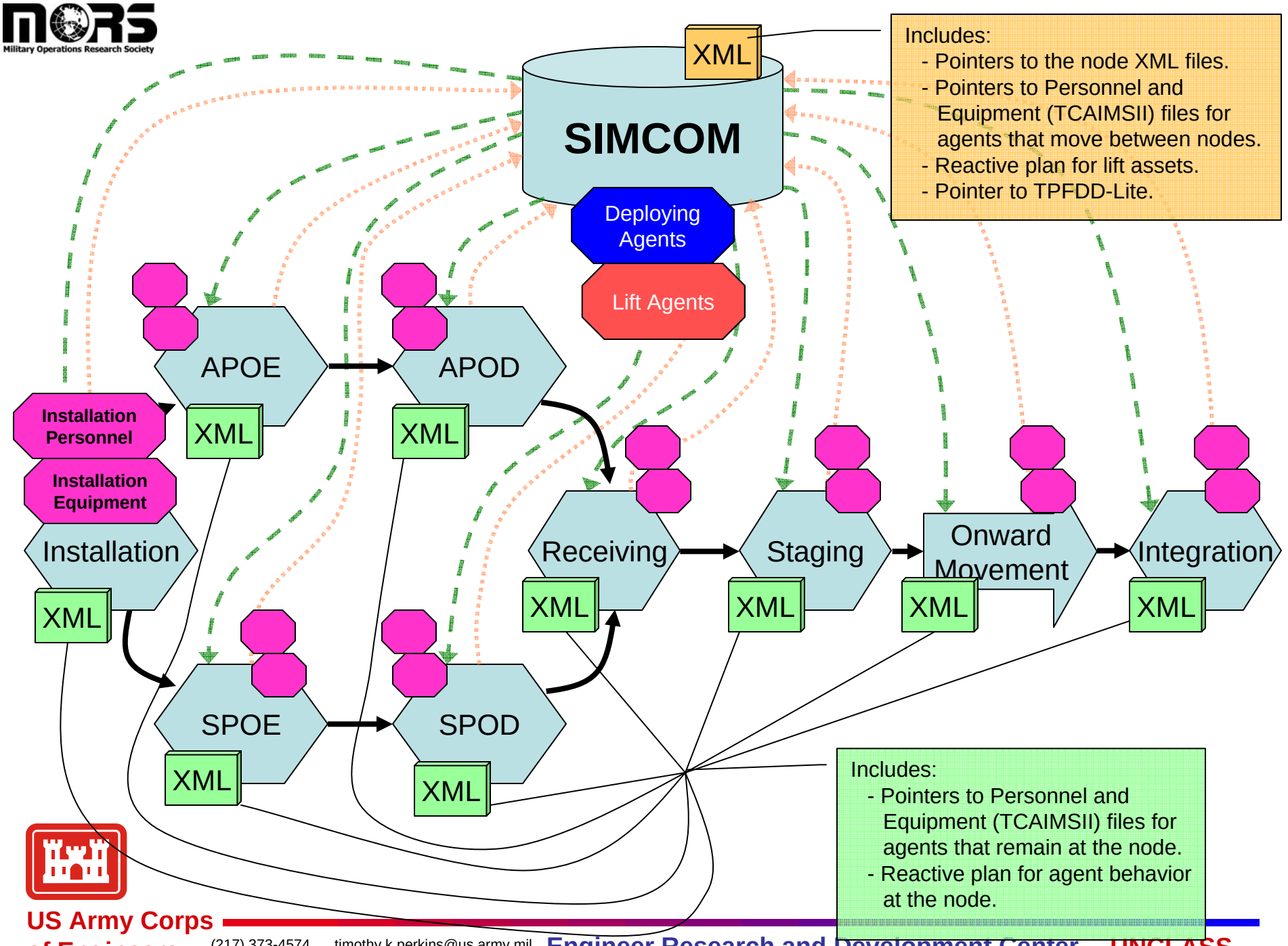
Enhanced Shared Reactive Plans (ESReP)

ESReP is a good way to model deployments

- Implicit in a Reactive Plan is a priority ordering to the sequences of tasks and the preconditions (or triggers) that activate them.
- Military deployments involve complex sets of concurrent and sequential tasks.
- Agent behaviors in deployment modeling are well-addressed with reactive plans because deployments are planned, structured, and *similar* from one deployment to another.
  - Typically, variants are units, locations, sometimes processes
- Drives multiple agents without redundant plan creation

Enhanced Shared Reactive Plans (ESReP)

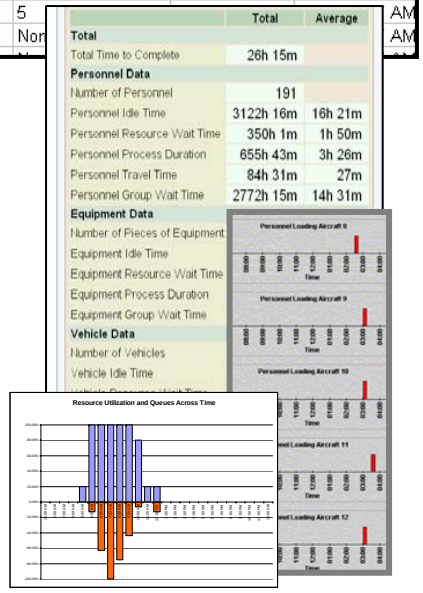
- Implemented using XML
- Discrete-event
- Stochastic
  - Participation
  - Durations
  - Activity/Task/Event Results
- Sensing
  - Other agents
  - Environmental
- Actions based on attributes


XML
SIMCOM
Includes:
- Pointers to the node XML files.
- Pointers to Personnel and Equipment (TCAIMSII) files for agents that move between nodes.
- Reactive plan for lift assets.
- Pointer to TPFDD-Lite.
Deploying Agents
Lift Agents
APOE
APOD
Installation Personnel
Installation Equipment
Installation
Receiving
Staging
Onward Movement
Integration
SPOE
SPOD
XML
Includes:
- Pointers to Personnel and Equipment (TCAIMSII) files for agents that remain at the node.
- Reactive plan for agent behavior at the node.

Evaluation

- Courses of action
- End-to-end force flow (teeth v. tail) – resource sufficiency?
- Time utilization of units overall, individuals
  - Officers have time for planning?
- Process efficiencies
  - Individuals causing delays?
  - Officers go first through lines?
  - Too much positive control (direct order v. discretion)?
- Resource efficiency (Underused or overworked resources?)
- Vulnerability
- Examine individual agents / types of agents
- Facility selection

Installation	Agent ID	Agent Type	Field Name	From	To	Date	Time
Fort Readiness	PIDB1B009	Person	resourceType	none	driver_tc	1/1/2010	5:29:34 AM
Fort Readiness	PIDB1B010	Person	Recall_status	1	2	1/1/2010	1:54:14 AM
Fort Readiness	PIDB1B010	Person	Recall_status	2	3	1/1/2010	2:24:14 AM
Fort Readiness	PIDB1B010	Person	Movement_status	none	Need_bus_to_SRP	1/1/2010	5:12:16 AM
Fort Readiness	PIDB1B010	Person	Recall_status	3	4	1/1/2010	5:12:16 AM
Fort Readiness	PIDB1B010	Person	End_loc	none	4101	1/1/2010	5:12:16 AM
Fort Readiness	PIDB1B010	Person	Start_loc	2102	2102	1/1/2010	5:12:16 AM
Fort Readiness	PIDB1B010	Person	Recall_status	4	5		AM
Fort Readiness	PIDB1B010	Person	End_loc	4101	Nor		AM



Advantages/Challenges

Advantages of E2EDS

- Integrated
  - GIS, infrastructure models, process models
- Agent-based capabilities
  - interacting agents, sensing changes
- Transparent
  - record of agent actions, decision criteria
- Output
  - database, logs
- Standard inputs
  - geospatial, soldier records, etc.
- Reusable components
  - GIS and unit data swap-out, processes

Advantages/Challenges

Challenges of E2EDS

- Still a 6.2 project
- Changes to certain details may mean customization effort
- Needs additional development
  - Data acquisition
  - Processes / decision-making
  - Time and readiness distributions

Next Steps

- Collaboration for interim staging base
- Document template processes available in the E2EDS
- Partnering
  - Reactive plan development
  - Expand modeled activities (processes, senses)
  - Infrastructure models

Deployment Modeling Lessons Learned

- Need more than a typical discrete-event simulation package
  - Deployment modeling should go beyond standard DES (single tasks or short-tons) – need behaviors, interactions
  - No link to utility, plume models, or accept GIS input
- Need agent-based simulation (Distributed Information Architecture System (DIAS))
  - Reactive behavior enhances capabilities, enhancing decision-making
  - Allowed wrapping of other models (utilities and plume)
  - Agents need to be more aware of and interact with other agents, as well as be aware of when their role should change
- Need to be aware of other agents/environment, better interaction (Repast-Simphony)
  - Used to create an Agent-based Discrete Event Simulation
  - Preserves wrapping of external models and ESReP
  - Allows for sensing the environment

Technical Key Points

The E2EDS – multiple Virtual Installations

- Discrete-event simulation integrating:
  - GIS (infrastructure)
  - Physics-based utility models (power, water)
  - Agent-based modeling (personnel, equipment, resources)
  - Behavior-oriented design (processes)
- Atypical Developments
  - Able to represent entities as resources, vice-versa
  - Integrated physics-based models of infrastructure, with agent-based models of personnel, equipment
  - Scenario rapidly adaptable (units, facilities, details)

Questions?