Analysis of Modeling and Simulation to Support Test and Evaluation of Chemical and Biological Defense Systems

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Purpose

• Provide an overview of AMSAA study results of modeling and simulation (M&S) to support test and evaluation (T&E) chemical biological defense (CBD) systems

• Present top-level results, conclusions, and recommendations
Objective

- Determine M&S needs to support T&E of Chemical and Biological Defense (CBD) systems in an operational context; identify M&S capability gaps
- Develop strategic recommendations
- Examine feasibility of an integrated CBD M&S capability for T&E
- Scope
  - CBD commodity areas considered:
  - M&S areas considered
    - System performance
    - Operational effectiveness
    - System of Systems
    - Ancillary/supporting models and databases

Study sponsored by Defense Threat Reduction Agency (DTRA)/Joint Science and Technology Office (JSTO)
Problem

- General community consensus for the need to develop/mature CBD Modeling and Simulation capability to support T&E
- Technical and programmatic approach not well defined; basis for future POM effort needed

“What are the community needs in terms of M&S support to T&E models to support evaluation in an operational context”
Why is M&S Needed?

- Can’t use “live” agents in operational tests
- Need to bridge gap from component testing to system-level performance
- Difficult to translate system performance to “operational effectiveness”
- Whole system testing currently impractical
- CB testing is expensive
- Range of CB agent physical properties extensive
- Need to consider TICs, TIMs, NTAs
- Limited “library” of actual “effects”
**Approach**

**Input**
- Identify users and stakeholders
- Visit and interview potential user and stakeholder organizations

**Process**
- Define user and stakeholder needs, existing capabilities, and gaps
- Refine requirements
- Translate to high level technical requirements

**Output**
- T&E M&S needs
- Feasibility of current T&E M&S approaches
- T&E M&S gaps
- T&E M&S requirements
- Strategic recommendations; Path forward

**Stakeholder organization interviews:**
- DTRA/JSTO, TEMA, DOT&E
- JPEO-CBD, JPMs (BD, NBC-CA, CP, Decon, IP, IS, Guardian), PD-TESS
- ATEC, DTC, AEC, MCOTEA, AFOTEC, OPTEVFOR, ECBC, WDTC

**T&E IPT participation:**
- TECMIPT, OSD CB M&S IPT, T&D IPT AUSCANUKUS, JECP Test WIPT, JPM-IS Working Group, RDECOM M&S IPT
- Use IPTs to facilitate community review
General User/Stakeholder Requested Information

• What are your CB T&E M&S needs?
• What CB T&E M&S system(s) are you currently using to meet your needs?
• What are the capabilities of the CB T&E M&S system(s) you are using?
• What are the limitations of the systems that you are using relative to your CB T&E M&S needs?
• What CB T&E M&S system capabilities/resources do you require that are not available or that are inadequate?
• Are you developing any CB T&E M&S systems or are there systems that you recommend be developed?
• Who provides the data/information for use in the T&S M&S models that you use?
• Who uses the products of your CB T&E M&S efforts?
• What organizations should participate in a CB T&E M&S review group?
• How much do you know about CBD T&E models under development?

Questions presented during CBD T&E community interviews to generate discussion
General CBD T&E M&S Needs

- Prediction of system-level performance:
  - From component test data (e.g., swatch, coupon)
  - Under conditions that cannot be currently tested
    - Greater range of conditions (weather, terrain, background, interferences)
    - Open-air live agents (agent-to-simulant correlation/improved simulants)
    - Use of NTAs, TICs/TIMs (agent-to-simulant correlation)
- Translate systems performance into quantitative measures of operational effectiveness – Impact of system(s) on force
- Prediction of operational effective of CBD system of systems (i.e., commodity area systems working together)
- Test planning tools (test design, post-test support, scope development)
- Incremental capability improvement – interim solutions
- Common CB threat scenarios
- Reference data, standards for data, model architectures
- High fidelity Transport and Dispersion models
Current CBD T&E M&S Capabilities and Gaps

• System performance
  – Limited capability to predict system performance
    • Current Contamination Avoidance models are first-order, physics-based models and have limited T&E application
    • Other model efforts (Decon, ColPro, IP) are in early stages and face significant technical challenges and data gaps
  – Methods to translate component data to system effects are first-order estimates

• Operational effectiveness
  – Limited CB effects in Army force-on-force combat simulations
  – Limited capability to support T&E; limited to qualitative assessments
    • Recent CB effects modifications to IWARS demonstrated potential to quantify operational effects; Used by AEC for JCAD system evaluation
  – No capability to assess the operational effectiveness of CBD system of systems

• Ancillary models/databases
  – Weather, terrain models mature
  – Existing supporting models/databases with varying degree of robustness
  – Toxicological exposure and effects models exist but lack community consensus
  – Threat scenarios used are program specific – not common between programs
  – T&D models lack fidelity to support T&E
CBD Integrated Simulation Framework (CBD-ISF) Concept

- **Concept:** An overarching model comprised of underlying physics-based and/or empirical, commodity area T&E models, ancillary models (Weather, Transport and Diffusion, Terrain, combat simulations, others), and databases (toxicology, background, interferences, others) intended to provide materiel item operational performance assessment.

- **Users:** T&E community (developmental and operational), combat developers, materiel developers, and warfighters.

- **Technical Challenges:**
  - Requires commodity area system performance models.
  - Current commodity area approaches at varying levels of maturity.
  - Underlying system models require sufficient V&V; current system DT efforts may not provide enough underlying data for adequate V&V.
  - Current model architectures not designed for future integration across all commodity areas.
  - Integration of CBD effect modeling capability with current combat simulations in early stages.
  - Integration of system performance models and operational effectiveness models.

*ISF concept could potentially address many T&E M&S needs.*
CBD-ISF Concept

- **Agent behavior**
  - Hazard/Environment
  - Agent characteristics
  - Weather/Terrain
  - Interferents
  - Background
  - Transport & Dispersion
  - Threat

- **System-Agent Interaction**
  - System Performance
    - CA
    - Decon
    - CP
    - IS
    - IP
    - BD

- **Human/System/Agent Interaction**
  - Human Interface
    - Toxicology
    - Human factors
  - Operational Scenario

- **Human/System/Agent/Force Interaction**
  - Operational Effect
  - Effect on Force
  - Combat Simulations

**Ancillary/supporting models/databases**

**Prediction of System Performance in the synthetic environment**

**Ability to assess effect of human interaction with system and agent**

**Assess effect of the CBD system, or system of systems, on an operational force conducting its mission under a specified scenario of interest (environment, threat, etc.)**

**Human-Agent-System-Force interaction = Operational Effectiveness**

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Questions?

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<tr>
<td>POM</td>
<td>Program Objective Memorandum</td>
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<tr>
<td>TIC</td>
<td>Toxic Industrial Chemical</td>
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<td>TIM</td>
<td>Toxic Industrial Material</td>
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