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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

- 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

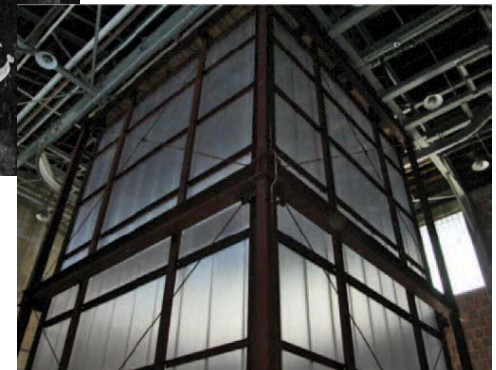


- General community consensus for the need to develop/mature CBD Modeling and Simulation capability to support T&E
- Technical and programmatic approach not well defined; basis for future POM effort needed

“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"



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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, JECF 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

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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

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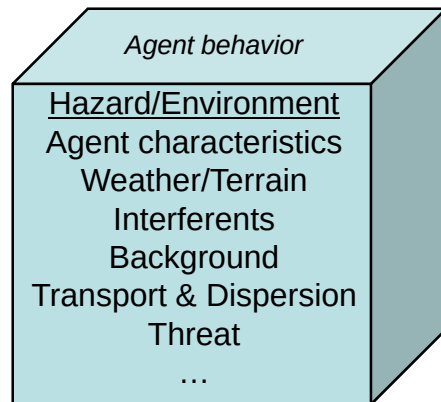


CBD Integrated Simulation Framework (CBD-ISF) Concept

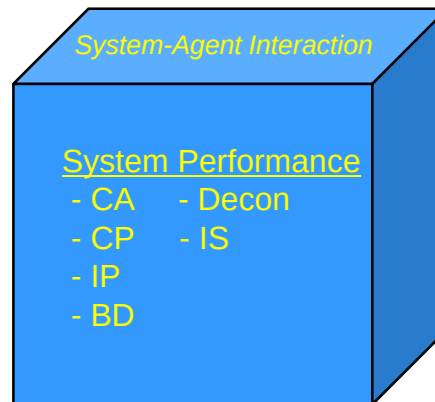


- **Concept:** An overarching model comprised of underlying physics-based and/or empirical, commodity area T&E models, ancillary models (Weather, Transport and Diffusion, Terrain, combat simulations, others), and databases (toxicology, background, interferences, others) intended to provide materiel item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

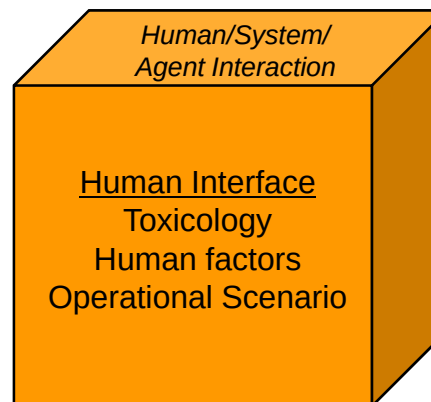
ISF concept could potentially address many T&E M&S needs



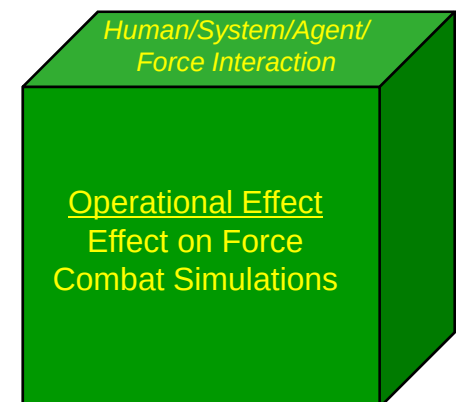
Ancillary/supporting
models/databases



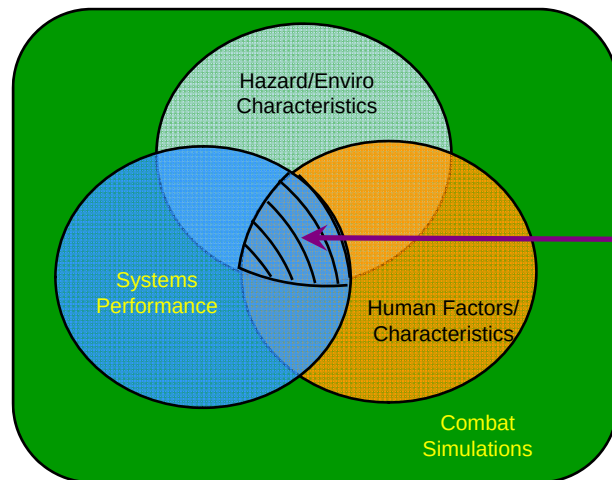
Prediction of System
Performance in the
synthetic environment



Ability to assess effect
of human interaction
with system and agent

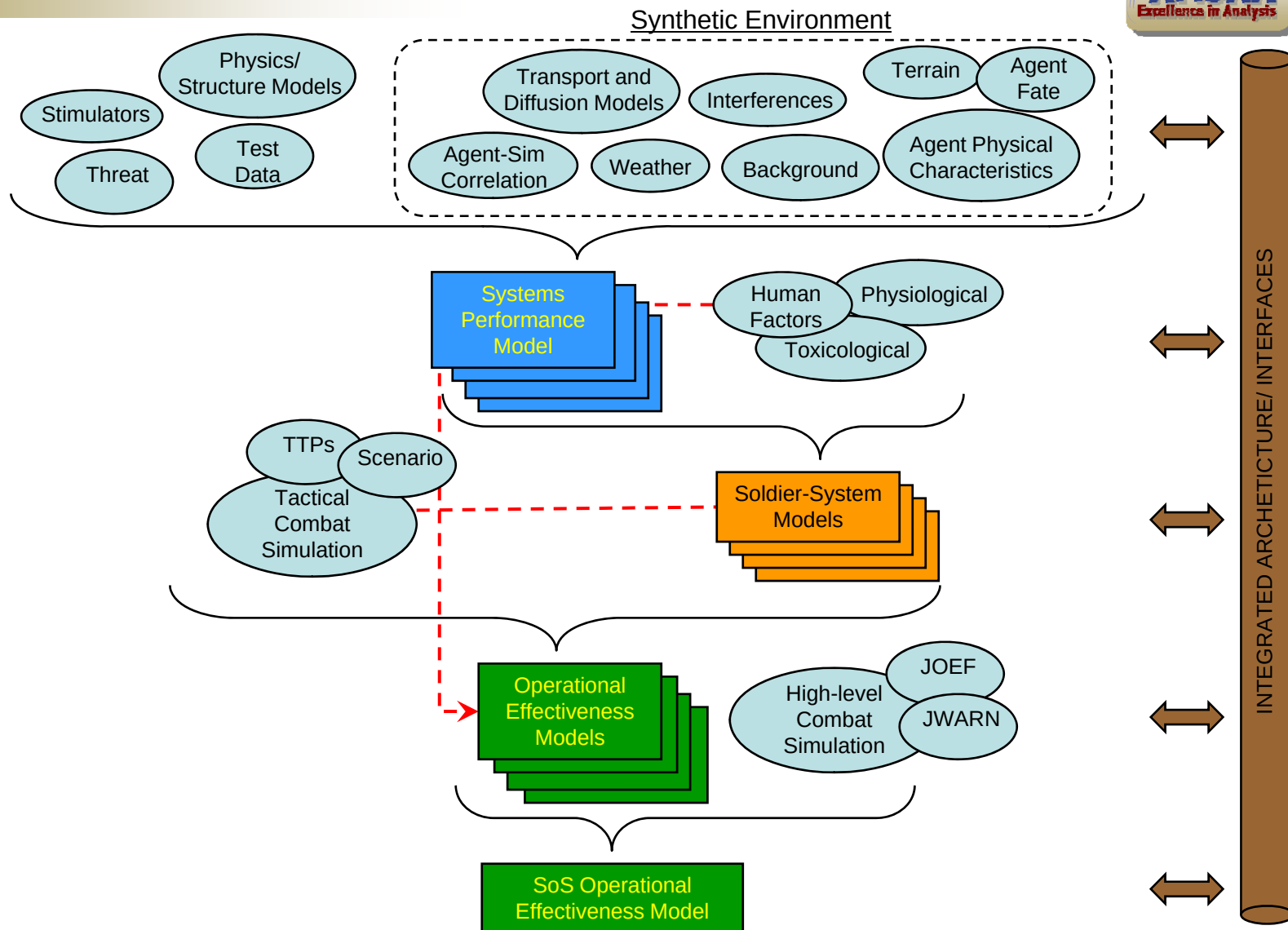


Assess effect of the
CBD system, or system
of systems, on an
operational force
conducting its mission
under a specified
scenario of interest
(environment, threat,
etc.)



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

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Questions?

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Acronym List



POM	Program Objective Memorandum
TIC	Toxic Industrial Chemical
TIM	Toxic Industrial Material
NTA	non-traditional agent
IPT	Integrated Product Team
V&V	Verification and Validation
DT	Developmental Testing
ISF	Integrated Simulation Framework