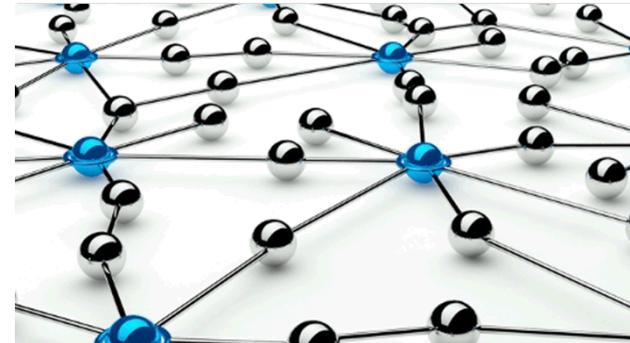


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Exploring Human-Technology Interaction in Layered Security Military Applications

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System of Systems Background

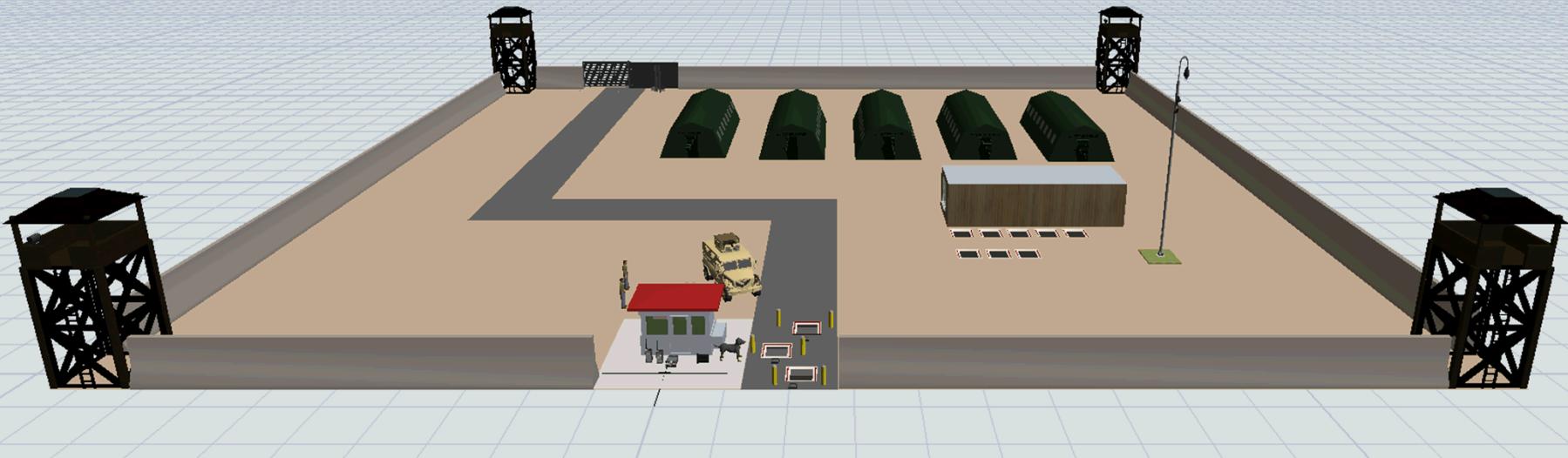
- A System of Systems (SoS) is a collection of systems that can function independently but which provide additional functionality of interest when viewed as a network
- Want to know how changes propagate through the entire SoS
 - What are the SoS mission impacts from changes to individual system's performance?
 - How do changes to the logistics support system impact the SoS mission performance?
- A great example of an SoS are military base camps
 - Have multiple types of systems such as vehicles, kitchens, operations centers, showers, etc.
 - Systems share limited resources such as electricity and water that must be replenished
- Traditional SoS modeling has used discrete-event, stochastic modeling to capture systems, resources, and missions



Background and Purpose

- Many (if not all) Systems of Systems (SoS) are human-centric, but SoS models do not factor in human/HSI effects
 - Humans introduce greatest amount of uncertainty and potential for error (e.g., Y12, Three Mile Island)
 - Human-related uncertainty can lead to higher cost, greater logistics tail, increased vulnerability
- Potential exists for significant gained efficiencies and risk mitigation if human & human-system effects are understood and accounted for in the SoS engineering process
 - E.g., lower troop-to-task ratio, lower error rates, fewer cascading failures
- Research purpose: Develop an SoS modeling framework that includes human behavioral models with enough fidelity to understand interactions with technology, and resulting impacts on organizational performance
 - Enable more realistic assessment of SoS performance and efficiency under different circumstances
 - Understand impact of changes such as augmentation/automation, organizational/doctrinal revisions, improved technologies and interfaces, etc.

Use Case Model: Layered Security at Forward Operating Base (FOB)



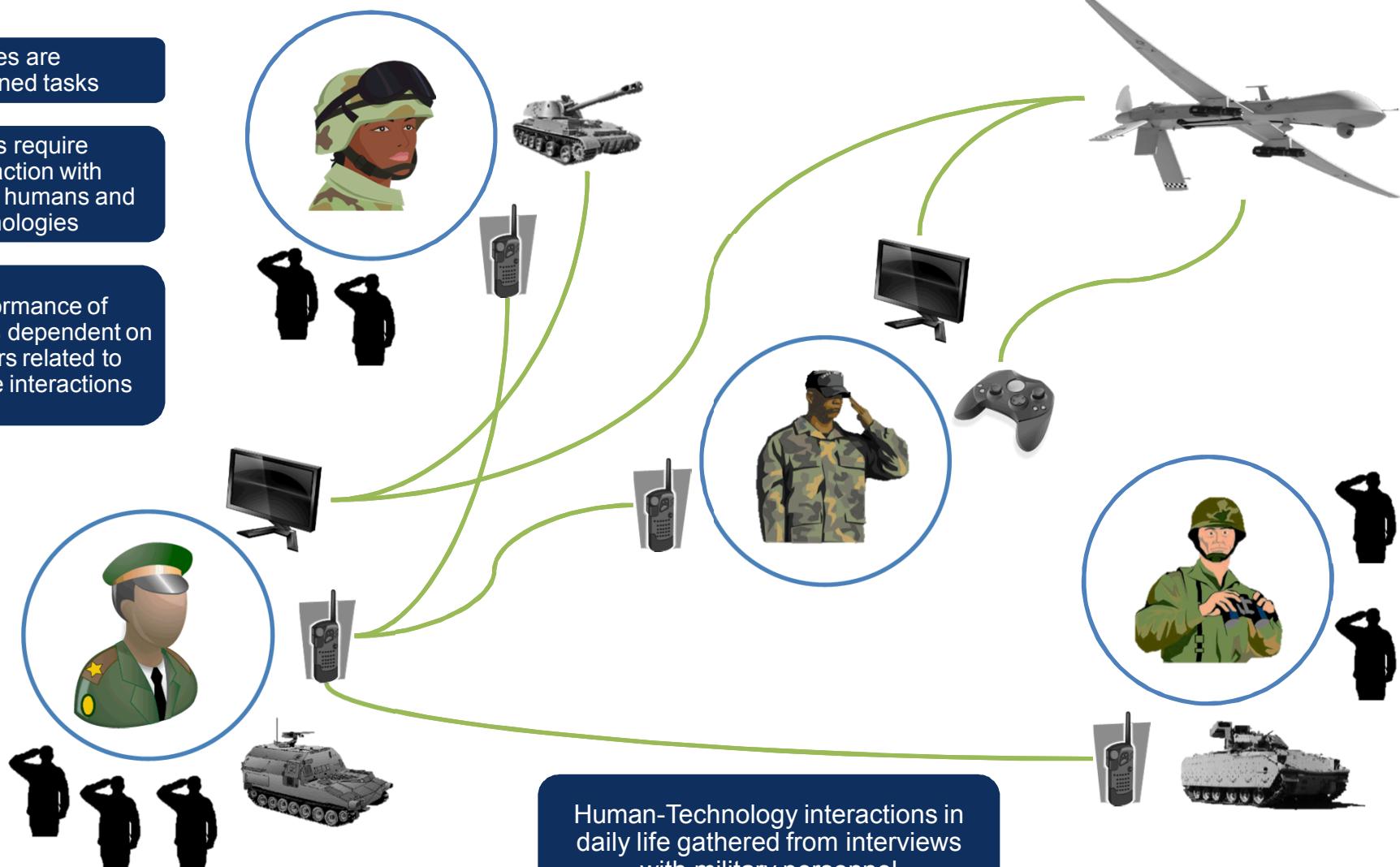
- Implemented in FlexSim, a general process modeling environment
- Baseline model effort looks at FOB and how human-technology interaction affects ability to complete tasks
 - Explicitly models interdependence between humans, technology, tasks, and communication/response modes
- Starting with VBIED scenario, expanding to complex attack

Mental Model

Entities are assigned tasks

Tasks require interaction with other humans and technologies

Performance of tasks dependent on factors related to these interactions



VBIED Scenario Example

- Model randomly assigns IED to some vehicles
- Tasks specified based on location (holding area, entry gate, TOC, etc.)
- Multiple technologies needed for tasks
 - Examples: radios, biometric scanners, security cameras, etc.
 - Failure modes with time to repair specified for each technology
- Probabilities defined for each threat type
 - Logic includes false positives and false negatives
 - Detailed communication modes determine how successfully threat is communicated and whether response is appropriate to threat type
- Ability to complete task based on interactions with required technology and affected by performance-modifying conditions such as weather and fatigue
- Jobs, tasks, and technologies obtained through SME input



Types of Factors and Impact

Sample Impacts to Human-Technology Interaction

Human Factors

- Fatigue
- Learning Curve

Technology Factors

- Complicated Interface
- Weight

External Factors

- Sand Storm
- Extreme Cold/Heat

$$AHP = BHP * HPM_1 * HPM_2 * \dots * HPM_n$$

Adjusted
Human
Performance

Baseline
Human
Performance

Human
Performance
Modifiers

Model Fidelity Obstacle: Current research does not always support generation of baseline performance and performance modifiers. More research/SME input is needed in military domain.

Path Forward

