



Modeling and Simulation of a System of Systems: Incorporating Electromagnetic and Radiation Effects into the Army's Future Combat Systems

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Background

- Army's Future Combat Systems (FCS)
 - FCS operates as a system-of-systems
 - Whole greater than sum of parts
- Net-centric
 - Enables soldiers to perceive, comprehend, shape, and dominate the future battlefield
 - Network provides the synergistic glue for FCS
 - Performance not dependent on single element, but on success of the system-of-systems (SoS)



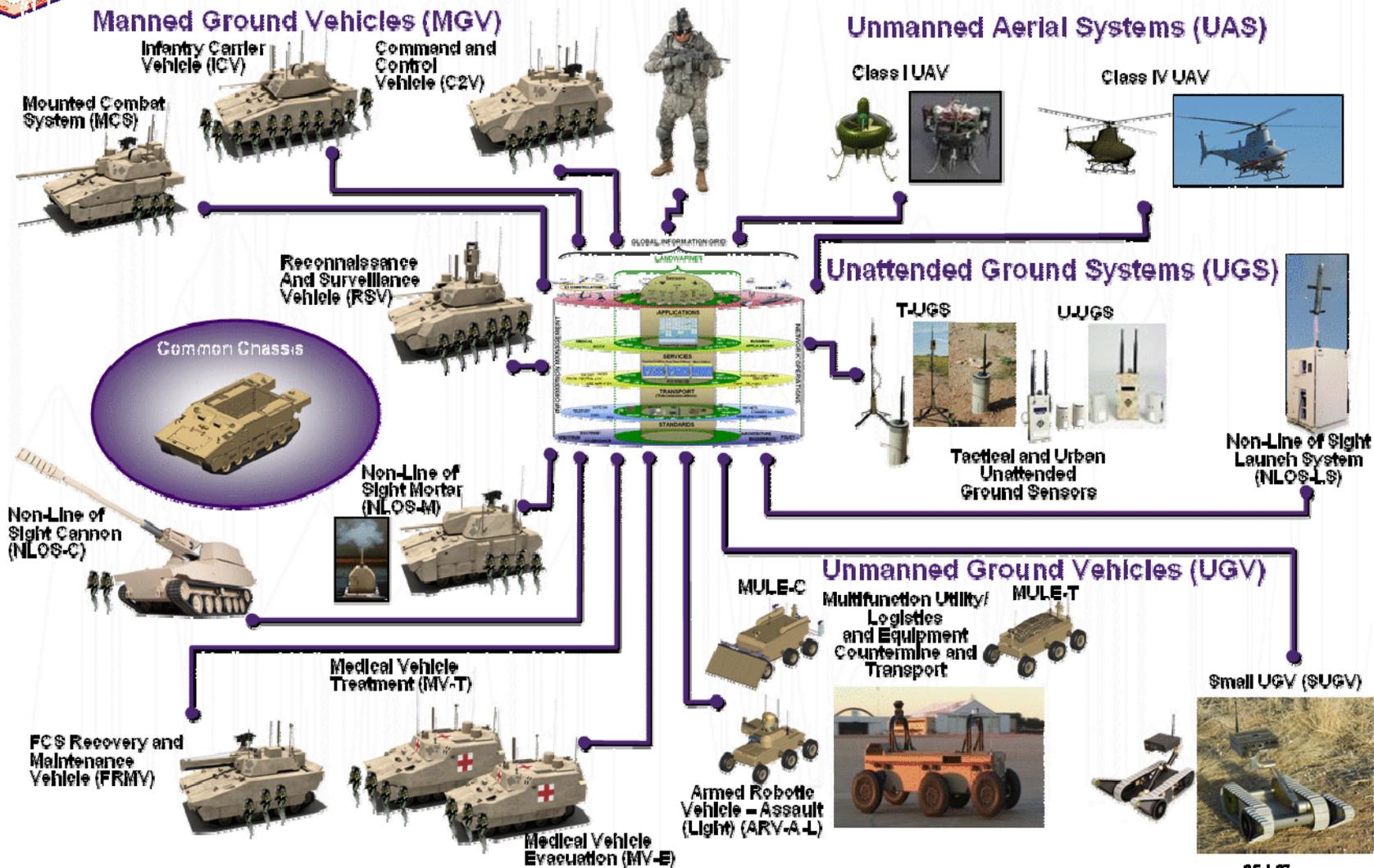
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FCS Brigade Combat Team...



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System-of-Systems Qualification

- Challenge
 - Performance measured at SoS level
 - Can SoS complete mission?
 - Many new platforms
 - Platforms developed in parallel
 - Platforms must work together
- Solution
 - Rely on wargaming
 - Mix live elements with simulated battlefield and weapon effects
 - Modeling and simulation V&V'd
 - Models tethered to data



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NETS and DETES

- Nuclear Effects Threat Simulator (NETS)
 - Models effects from ground and near ground bursts
 - Gammas, neutrons, overpressure,...
 - Two main components
 - Platform model: *Testable Hardware Toolkit (THTk)*
 - Real-time wargame simulation: *SurVNETS*
- Directed Energy Threat Environment Simulator (DETES)
 - Models EM environment effects
 - HEMP, HPM, lightning,...
 - Two components
 - Platform model: *Unified Electromagnetic Design (UEM)*
 - Real-time wargame simulation: *DETES*



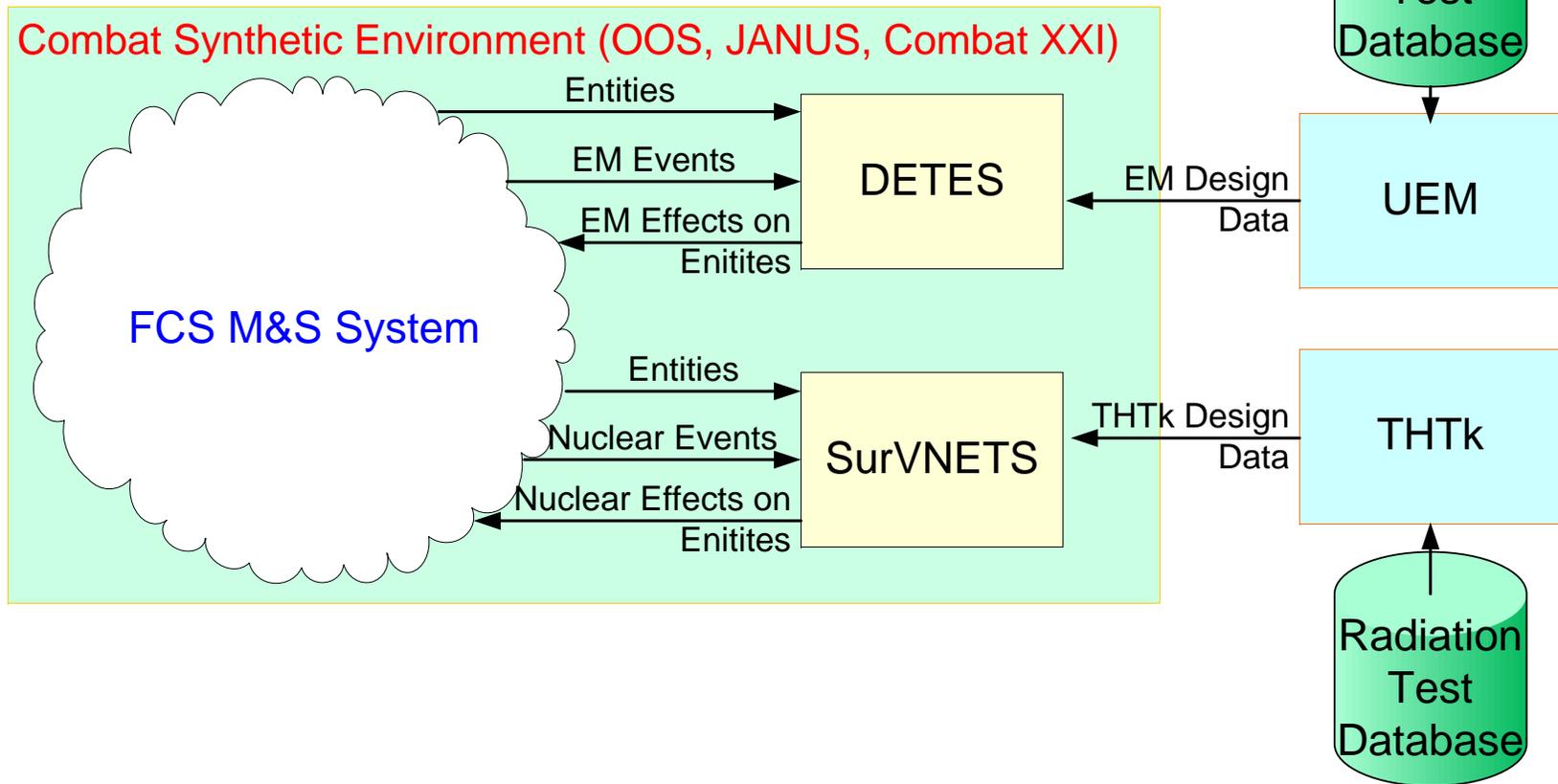
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NETS / DETES Operational Diagram



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NETS

- NETS Tools
 - Build platform models with *THTk Workbook*
 - *SurVNETS* operates in near real-time Combat Synthetic Environment
- SurVNETS
 - Effects threshold data
 - High-speed nuclear environments
 - Conveys functional impact on all battlefield entities to combat synthetic environment



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NETS: Effects Thresholds

SurVNETS Properties Editor

File Edit Help

All Categories

- Other
- Platform
 - Other
 - Land
 - Air
 - Other
 - Fighter/Air Defense
 - Attack/Strike
 - Bomber
 - Cargo/Tanker
 - ASW/Patrol/Observation
 - Electronic Warfare (EW)
 - Reconnaissance
 - Surveillance/C2 (Airborne Early Warning)
 - Attack Helicopter
 - Utility Helicopter
 - Antisubmarine Warfare/Patrol Helicopter
 - Cargo Helicopter
 - Observation Helicopter
 - Special Operations Helicopter
 - Trainer
 - Unmanned
 - Non-Combatant Commercial Aircraft
 - Surface
 - Subsurface
 - Space
 - Other
 - Manned
 - Unmanned
 - Booster
 - Munition
 - Life form
 - Environmental
 - Cultural feature
 - Supply

Air

Inherit from parent

Susceptibility Properties

Overpressure:

Mobility Threshold: 1.5

Firepower Threshold: 1.5

Destroyed Threshold: 3

Reference: JMJ estimates

Gamma Dose Rate:

Mobility Threshold: 1000000000

Firepower Threshold: 100000000

Destroyed Threshold: 10000000000

Reference: JMJ estimates

Gamma Dose:

Mobility Threshold: 10000

Firepower Threshold: 10000

Destroyed Threshold: 100000

Reference: JMJ estimates

Display Properties

Image File: GenericAirPlatform.png



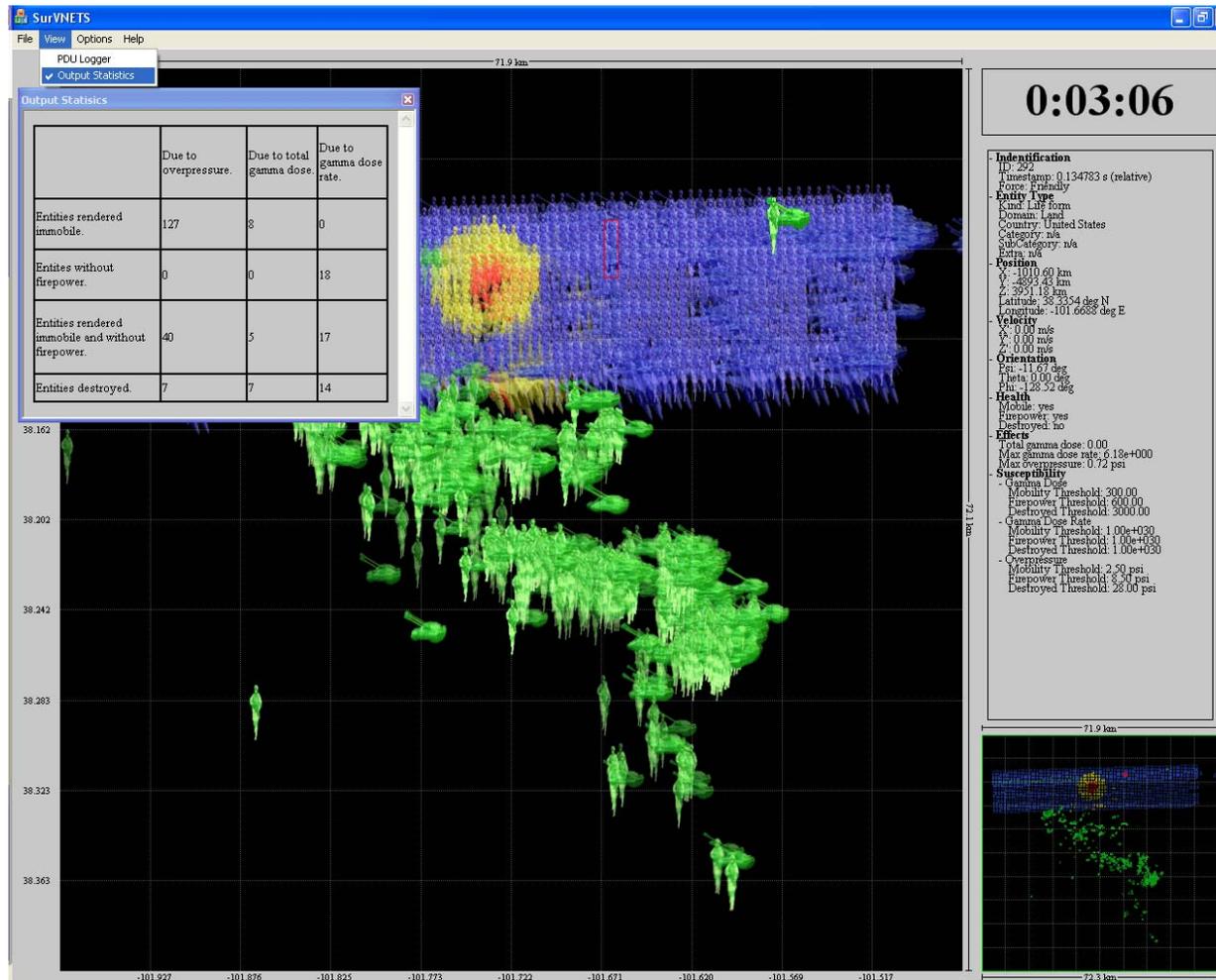
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NETS Tools: SurVNETS Interface



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DETES

- DETES Tools
 - Build platform models with *UEM Design*
 - *DETES* operates in near real-time Combat Synthetic Environment
- *DETES*
 - Probability of effect models
 - High-speed EM environments
 - Conveys functional impact on all battlefield entities to combat synthetic environment



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DETES User Interface Exercise Runtime Mode

DETES Version 1.0 Main Control Form

Setup UDP
 Byte Swap Received Data Byte Swap Send Data

Remote Host: 255.255.255.255 Receive Port: 3000 Send Port: 3000

Data Base
Path and Name: C:\Documents and Settings\All Users\Documents\DETES Phase 2\Version 1.0\Version 1 w new db\Test Data Bases\DETES Da

DETES Processing

Entity State
Janus Site: 1
Janus Host or Application: 1

Global Entity State
 Static Learn

Fire
 Log Fire PDUs

Nuclear Effects
 Do Statistical Upset/Damage
 Log Nuclear Effects PDUs
 Send Nuclear Effects PDUs

PDU Rate: [Slider]

Detonation
 Log DETES Detonation PDUs
 Log all Detonation PDUs

HEMP HOB
 Detonation PDU HEMP Form

Global Detonation
 Static Learn

Environment Parameters
 Static (Forms) Dynamic (PDU/Data Base)

PDU Status

Number of PDUs: [Slider]

PDUs Received: 1
PDUs Not Processed: 0

 Display Next PDU

Protocol Version 5
Exercise Identifier 1
PDU Type 1
Protocol Family 1
Time Stamp 0
PDU Length 104
Site 1
Host 1
Entity 1
Force ID 225

Self Test

Entity State
 Single PDU PDU Rate: [Slider]
 Multiple PDUs

Repeat #: [Slider]

Detonation - Extra (Byte80)
 HEMP HPM Static

Nuclear Effects

HPM Environment

Source

Power (MW): 10.0 Frequency (GHz): 5.0

Antenna Aperture (m²): 10.0

Environment

Peak Field @ 1 m (V/m): 4576510.07258 Maximum Range (m): 4576.51007

Upset Threshold (V/m): 1000

HEMP Environment

Weapon Information

Height of Burst (50 to 400 km): 50
Gamma Ray Yield (0.001 to 10.0 KT): 10.0

Earth

Radius (km): 6370.062326
Tangent (km): 6419.8676208878

HEMP Environment Levels

Maximum Field (kV/m): 28.951739335457 Tangent Field (kV/m): 13.386248510651

Scaling

Scaling Exponent: 0.15888397834 Range (km): 50 Environment (kV/m): 28.9517393354579



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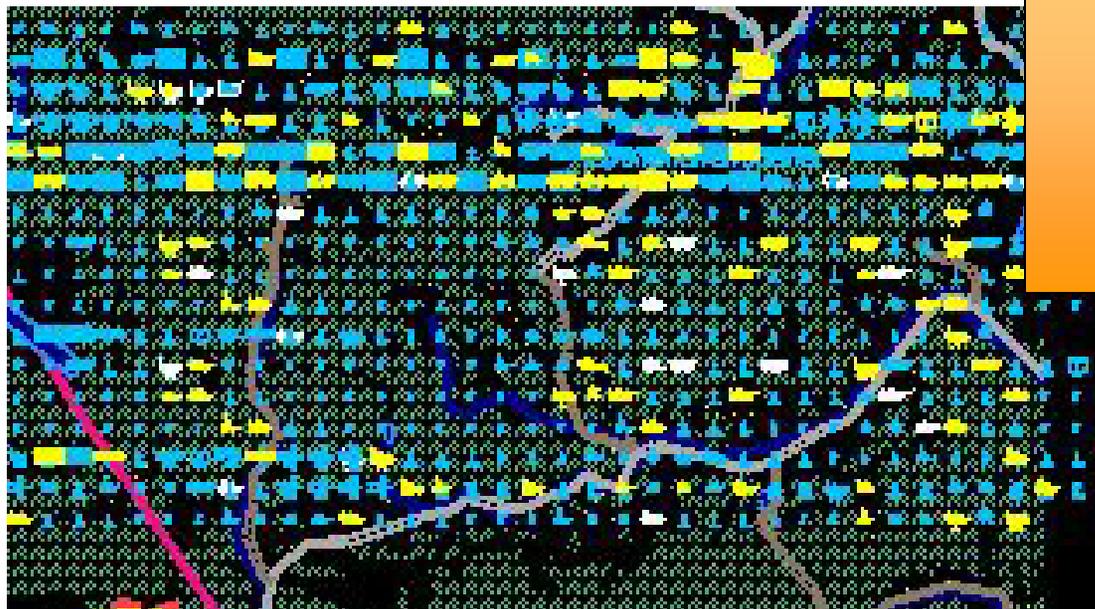


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EM Effects Results for a Hypothetical HEMP Event

- Hardness levels arbitrarily set by type of equipment
- 5,624 entities processed for upset and damage effects
- Percentages consistent with P_e for each class



Color Code:
No Effect
Upset
Damaged



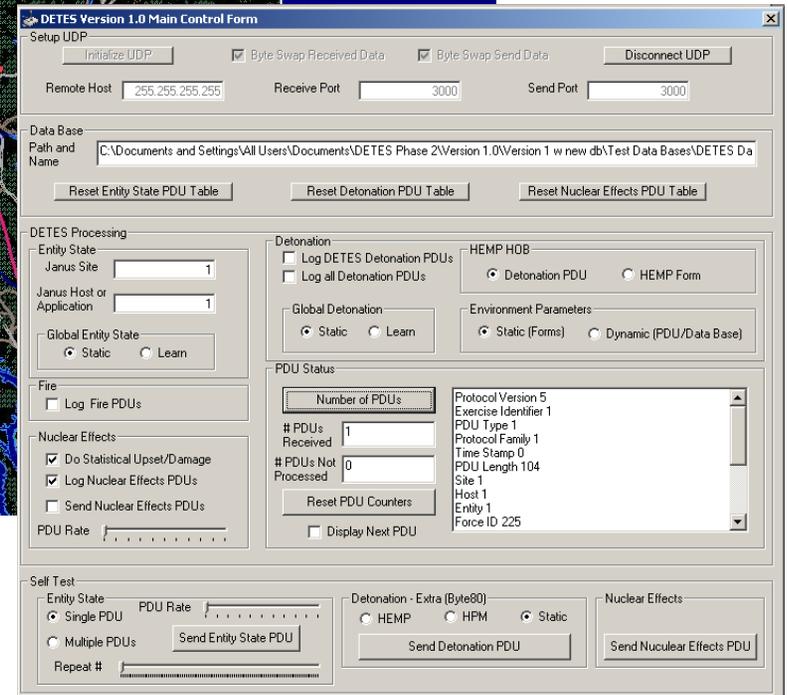
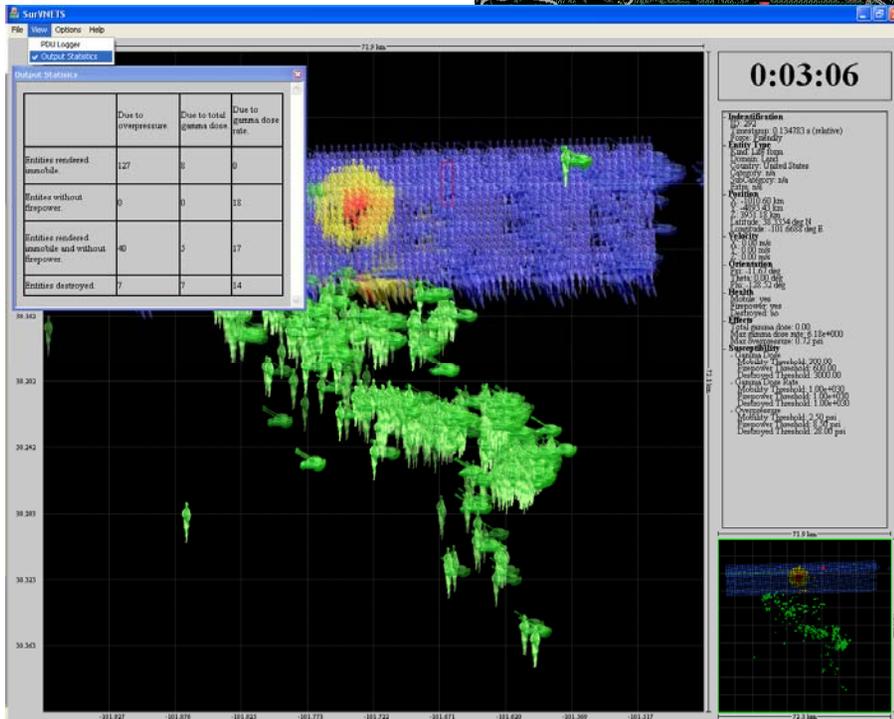
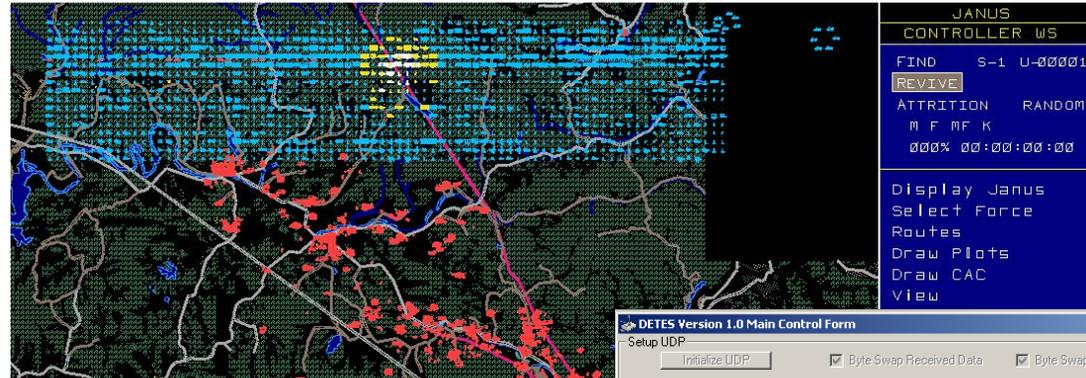
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JANUS Battlefield Simulation



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Conclusion

- NETS and DETES Version 1.0 development complete
- Software development included Verification and Validation
- Capability demonstration with *JANUS*
- Future development will include interface with other M&S applications



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