Using Experimentation to Support Future Capability Needs: CB Effects in the JFCOM Urban Resolve Experiment

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Overview

• Aim of M&S
• Capability
  – Real World Representation
  – Hazard Prediction Concept Demonstrator
• Applications
  – Training – JVTSE
  – Experimentation – Urban Resolve
• Summary and future plans
Aims of M&S

- Concept demonstration
- Training
- Experimentation
  - Evaluating effect on campaigns
  - Requirements definition
  - Balance of investment
- Raising technology readiness
Dstl’s CBR M&S Capability

• The capability splits into two areas
  – Real-World Representation
    • Exists to stimulate Hazard Prediction Concept demonstrator and other systems
  – Hazard Prediction Concept Demonstrator
    • Allows demonstration and evaluation of emerging technologies
    • Exploration and clarification of requirements for future hazard prediction systems
Real-World Representation

- Sophisticated CBR modelling used to
  - Simulate realistic ground truth
  - Stimulate other systems
Real-World Representation

- The “Ground Truth” representation consists of the following elements
  - Chemical and Biological Simulator (CBSim)
  - Detector models
  - Ground-truth visualisation
CBSim

- CBSim provides real-time modelling capability
  - Urban dispersion
  - Instantaneous dispersion realisation
    - Terrain effects
    - Meander effects
    - Concentration realisation
  - Stimulation of detectors
  - Casualty calculations
CB Effects Modelling Capability

- Dispersion Modelling
  - 2D and 3D CBRN sources and hazard plumes
- Terrain
  - FACTS, Meander, Buildings
- Meteorology
- Value of Information

- Detectors
  - Chemical, Biological, Bio Background
- Casualty Chain Modelling
- Effects of Hazards
  - IPE
- Concentration Realisation
- Aggregated Entities

CB Effects Modelling Capability

Plug and Play Architecture

Realistic Terrain  Detectors  Casualty Chain Modelling  Dispersion Modelling  IPE  Concentration Realisation  Meteorology
Dispersion Modelling - The UDM

- Runs in
  - Real-time
  - Instantaneous mode
    - Different to ensemble hazard, e.g. HPAC, JEM
    - Gives a single realisation
- Uses updating wind input
CBR Plume Output

- Output of CB material plumes
  - Dosage
  - Deposition
  - Concentration
- Radiological material plumes
  - Cloud and ground shine
  - Energy deposited in tissues
  - Also inhaled dose

Ground shine 1 minute after a 190kg release of Cesium 137
Realistic Meteorology modelling

- Meander Model
- AERMET boundary layer model
- Empirical sea breeze model
- Linear model of flow over hills
- Slope flow model
Generating realistic time series

- Concentration of challenge at detector calculated by UDM driven by large scale meandering winds
- Concentration realisation agent used to generate realistic time series
  - Simulates turbulent variations in concentration within puff
- Particles then sampled from this time series with noise
Detector models

- Configurable chemical detector models
- Bar based detector
- Alarms at a threshold
- Challenged by realisation of concentration
Ground Truth Visualization

- 2D/3D representation
  - Buildings
  - Terrain
  - Dosage, concentration, effects contours
  - Puffs
  - Detectors/entities
- Visualiser can be distributed from CBSim calculation core
Hazard Prediction Concept Demonstrator

- The Concept Demonstrator consists of
  - SAFE Warning & Reporting, including STEM
  - Alternative Courses of Action Capability
  - REACT hand-held commander’s tool
  - Sensor Placement Operational Tool (SPOT)
SAFE Warning & Reporting

- Warning and Reporting system includes
  - Source Term Estimation
  - ATP-45 style templates
  - Ensemble Average Hazard prediction
Alternative Courses of Action Capability

- ACAT tool allows alternative routes around plume to be evaluated.
- Hazard provided by the W&R Concept Demonstrator
REACT hand-held commander’s tool

- Rapid Evaluation and Awareness Command Tool (REACT)
- Displays CBRN situational picture from W&R Concept Demonstrator on a PDA
- Allows observer messages to be send into W&R Concept Demonstrator
- Allows investigation into and evaluation of hand-held PDA devices for operational hazard prediction systems
Sensor Placement Operational Tool (SPOT)

- Monte Carlo parameters
  - Wind speed / direction
  - Release type
  - Agent type
  - Time of release
  - Mass
- Use optimization techniques to place sensors
  - Genetic Algorithm
  - Simulated Annealing
  - Greedy Algorithm

Optimal sensor placement to protect green area, including desirable (purple) and exclusion (red) areas
Application 1: Input into Collective Training
JFCOM J7 Joint Virtual Training Special Event 2005

• DTRA provided CBRN input into Collective training systems

• Systems involved
  – SPOT
  – CBSim
  – Detectors
  – Warning and Reporting Concept Demonstrator
  – ACAT tool
  – REACT PDA
  – External systems
    • OASES and WALTS
Application 2: Experimentation
JFCOM J9 Urban Resolve 2015 Experiment

- Assess effect of technologies which will be available in 2015 against a 2005 baseline
  - Overall scenario is peace enforcement in Baghdad
JFCOM J9 Urban Resolve 2015 Experiment

- CBRN component
  - Assess effect of potential integrated CBRN defence solutions
  - Effort led by DTRA & J8 JRO CBRND
  - Ground truth provided by CBSim
  - 2005 capability represented by HPAC
  - 2015 capability of JWARN/JEM/JOEF
    - Emulated by SAFE W&R and associated tools
CBRN and Supporting Components

• Source release federate – modelled sources
• OASES – provided weather to federates
• CBSim – provided ground truth and CB effects on JSAF entities
• CAD Detectors
• JSAF – modelled Iraqi military, some US military, and non-military entities (Iraqi police, insurgents, NGO, civilians, others)
• SAFE warning & reporting concept demonstrator
  – Includes source term estimation, ATP-45 & plume prediction
  – Emulated key required capabilities for JWARN/JEM
Details

- **Releases**
  - Munition detonation (120mm motar attack) mustard
  - 11,500 gallon chlorine tanker truck
    - Several levels of damage modelled dependent on attack

- **JSAF** modelled ~230,000 entities in Baghdad

- **CBSim**
  - Modelled dispersion for multiple sources
  - Provided updates of CB casualty states due to contamination to ~10,000 (peak 30,000) entities every 5-20 seconds

- **SAFE W&R concept demonstrator**
  - Fused detector readings to estimate source term
  - Modelled ensemble plume hazard
  - Exported hazard contours compatible for display on COP
Urban Resolve 2015 Results

- CBRN systems must be integrated with the entire battlespace awareness and command and control suite of the Joint Task Force
- CBRN events unfold over a significant amount of time – speedy response based on solid data and good analysis saves lives
- Future CBRN systems and processes require non-military functionality (e.g. political, economic and social)
Summary

• Presented DTRA led applications of CB simulation capability in
  – Training (JFCOM J7 JVTSE)
  – Experimentation (JFCOM J9 Urban Resolve)
• M&S capability demonstrably able to meet requirements
  – Significant enhancements made
• Experimentation results of benefit to decision makers, guiding future programmes
Future Plans

• Enhancements to CBSim
  – Performance improvements
  – Potential to increase functionality, e.g.
    • Improved meteorological modelling
    • Biological background
    • Advanced CB protection models
    • Improved human effects modelling
    • Physiological burden

• Exploring possibility of linking/integrating capabilities with IWMDT/IWMDTSim