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

Ian Griffiths, Andrew Solman, Neil Dyer – Dstl

Doug Brain – RiskAware

Mark Biwer – Northrop Grumman

Lt Col Mike Wall – DTRA

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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

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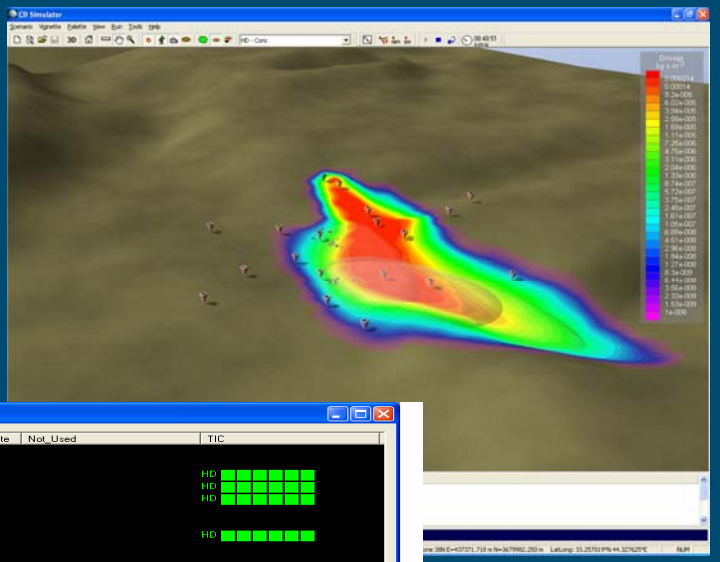
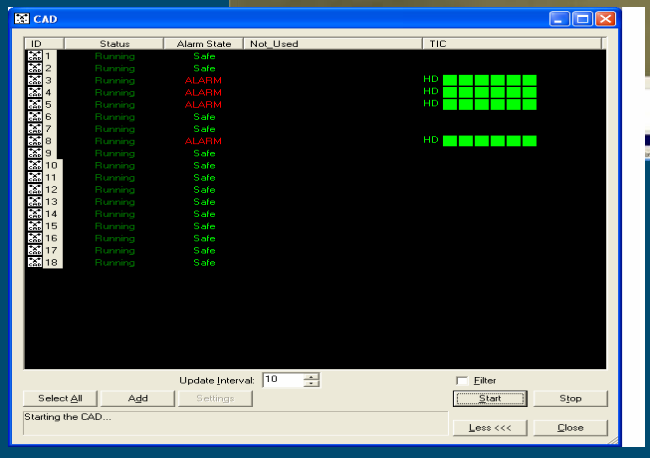
Real-World Representation

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





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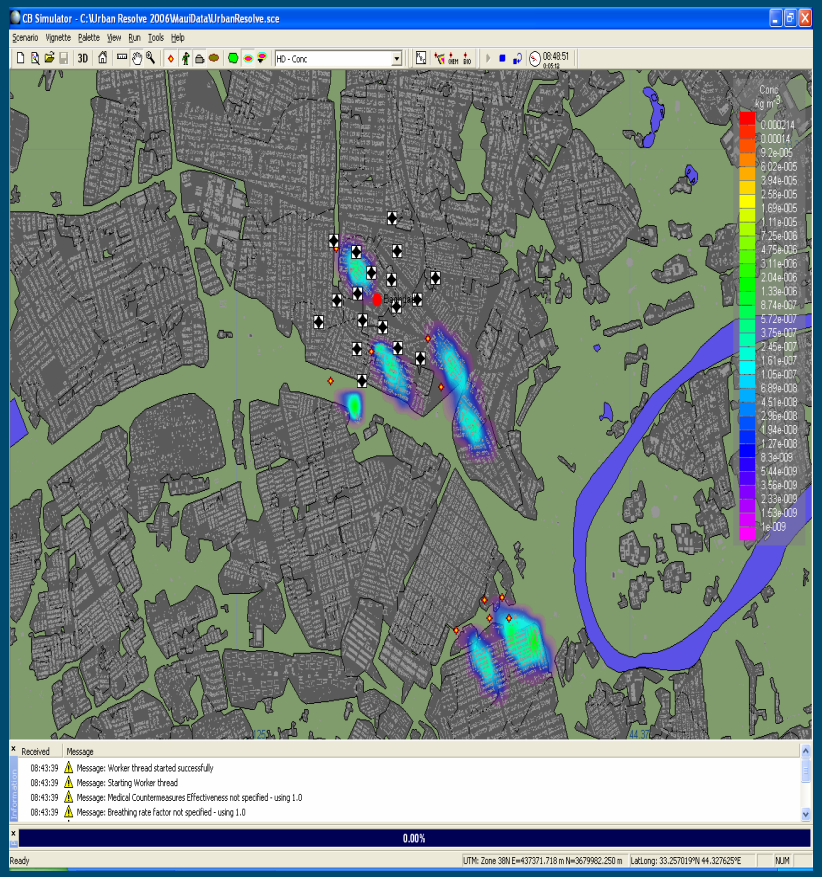
CBSim

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



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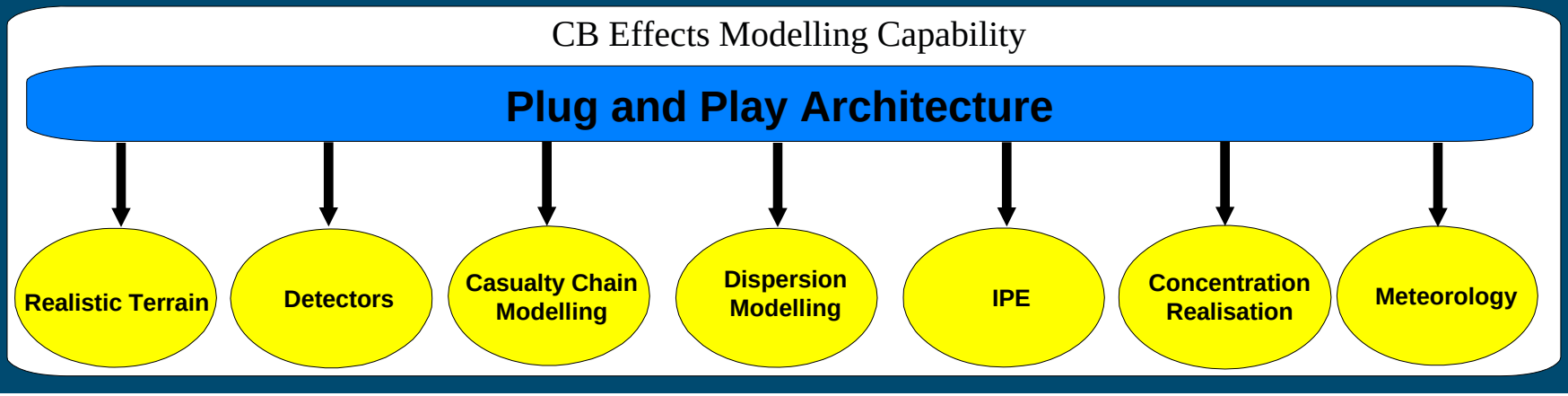
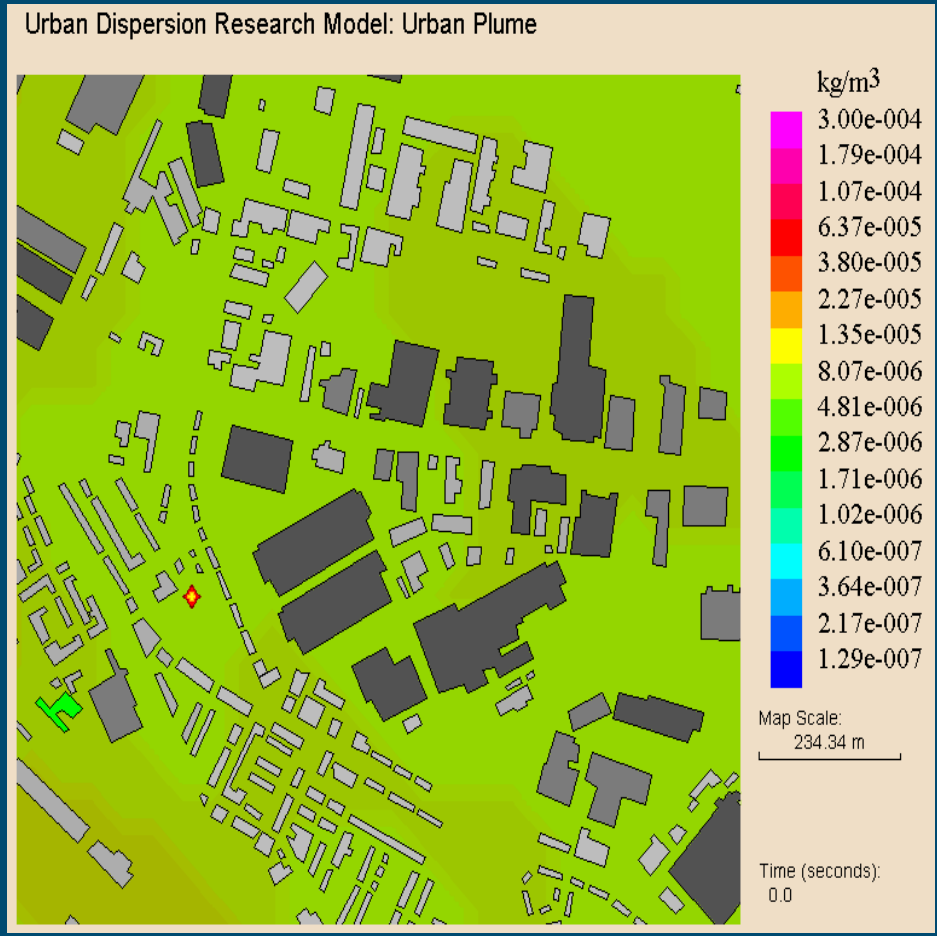
CB Effects Modelling Capability

- 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



Dispersion Modelling - The UDM

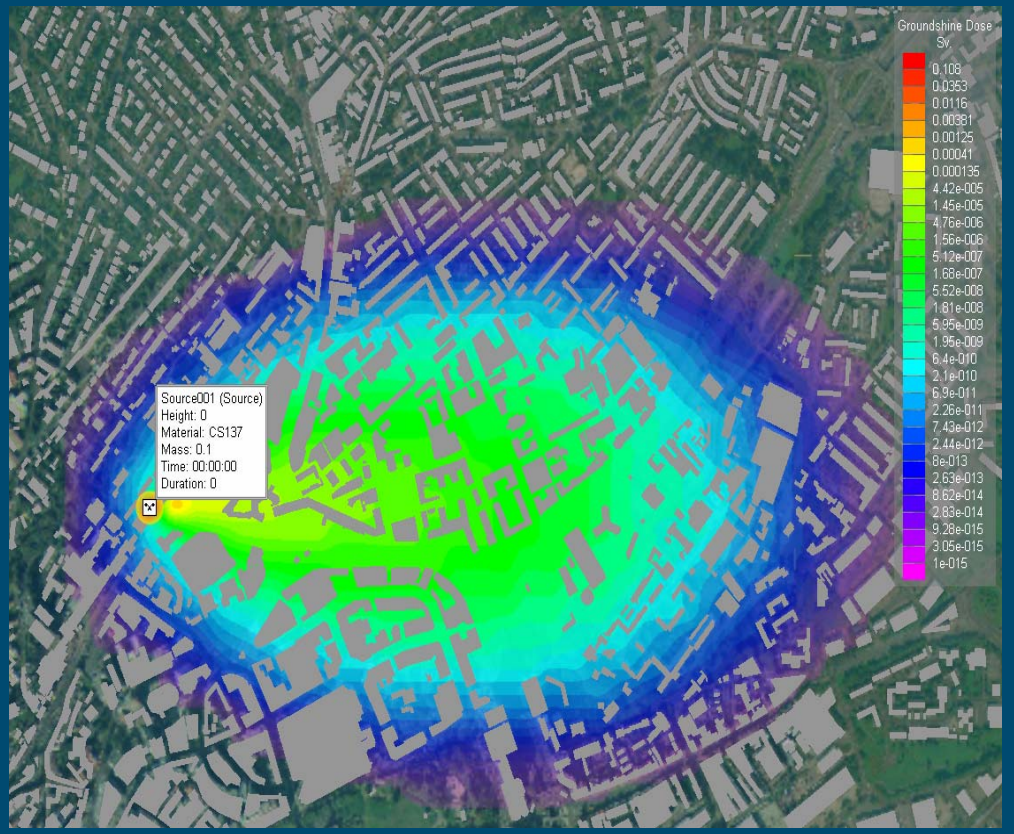
- Runs in
  - Real-time
  - Instantaneous mode
    - Different to ensemble hazard, e.g. HPAC, JEM
    - Gives a single realisation
- Uses updating wind input



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



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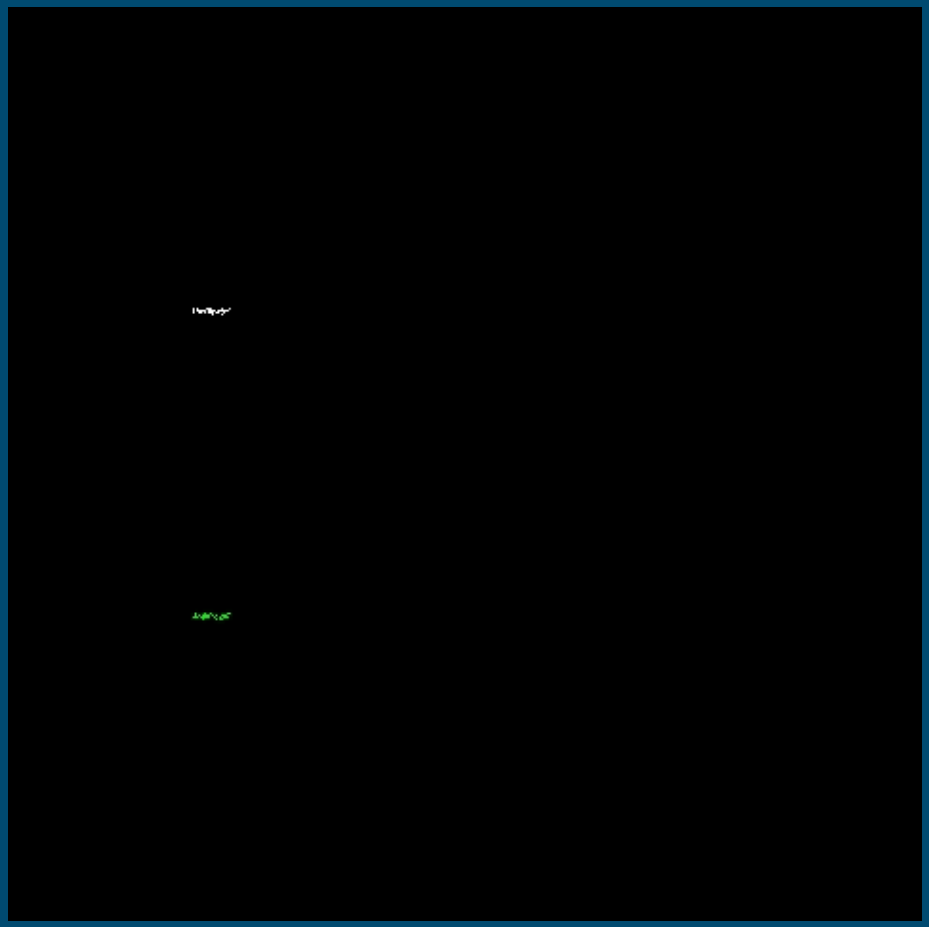
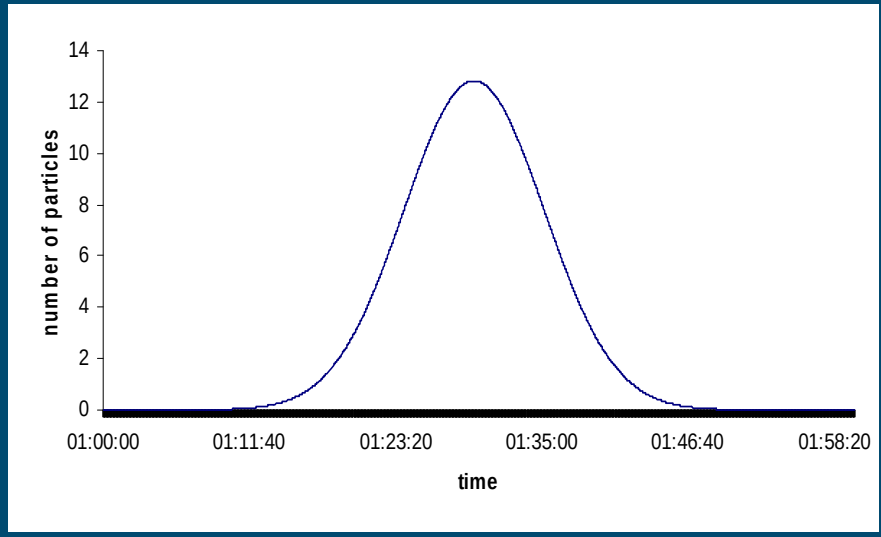
Realistic Meteorology modelling

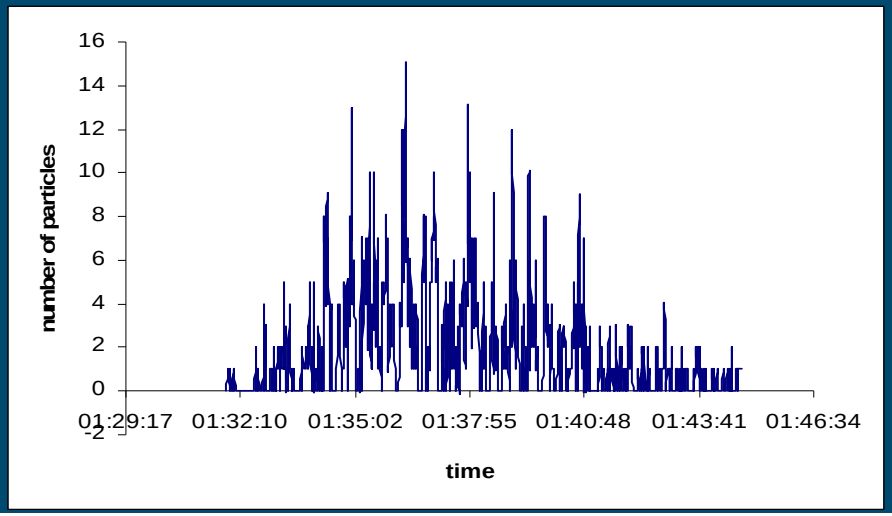
- Meander Model
- AERMET boundary layer model
- Empirical sea breeze model
- Linear model of flow over hills
- Slope flow model



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





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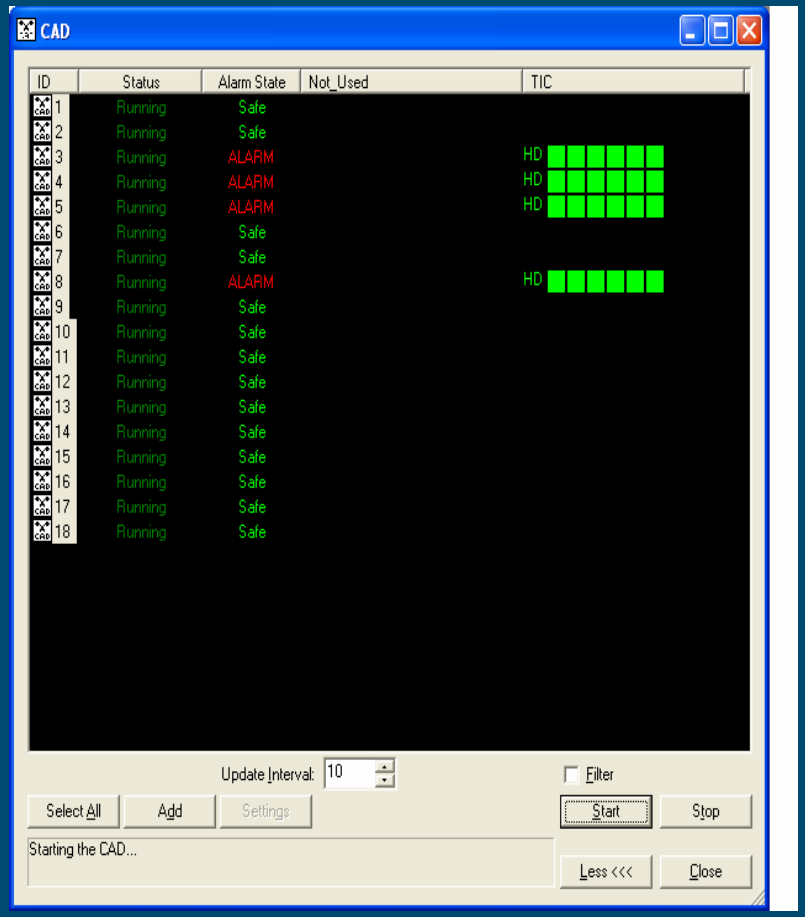
Detector models

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



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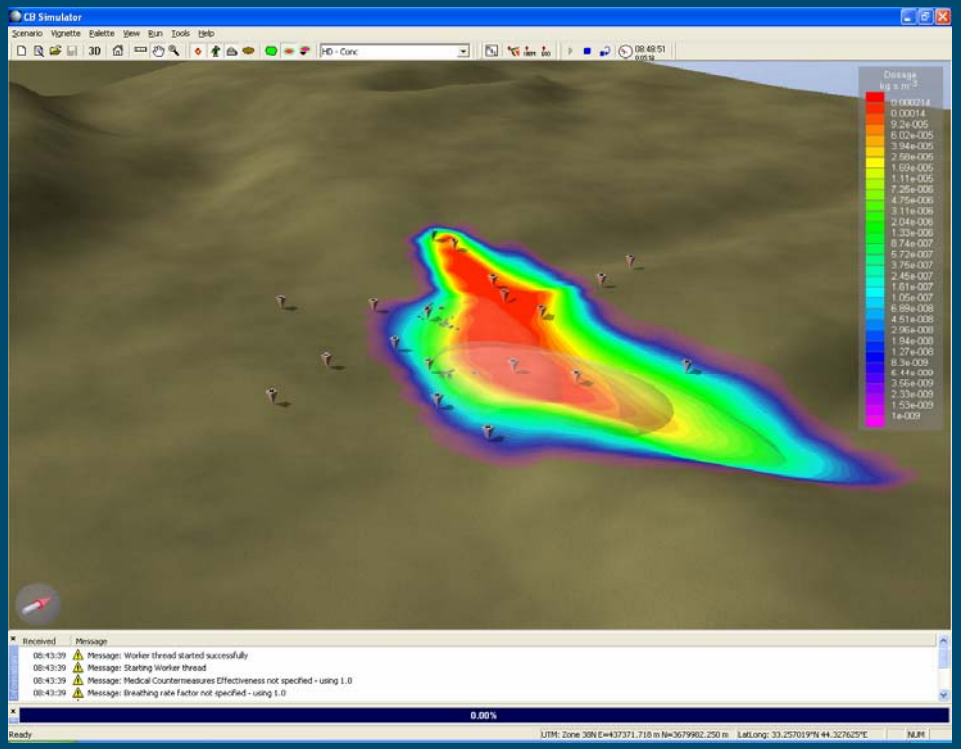
Ground Truth Visualization

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



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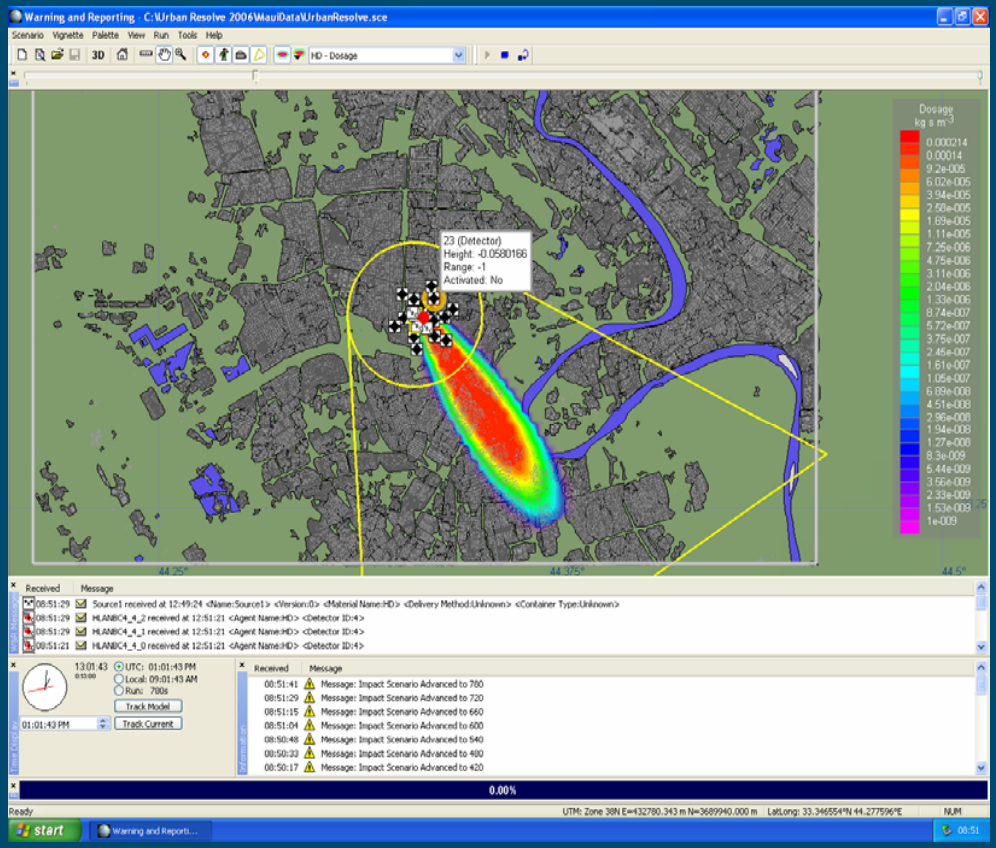
Hazard Prediction Concept Demonstrator

- 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



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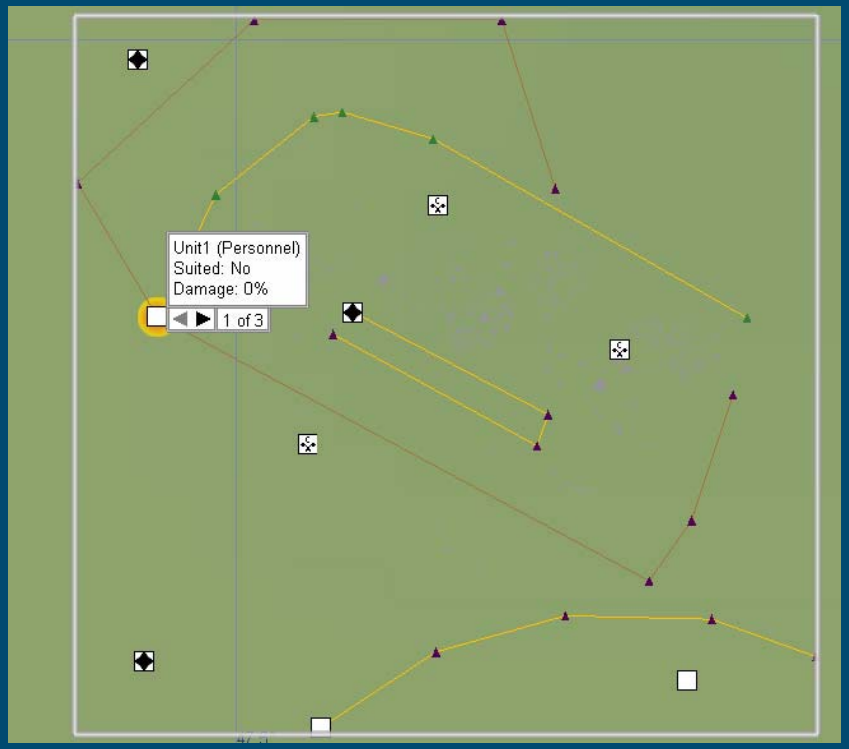
Alternative Courses of Action Capability

- ACAT tool allows alternative routes around plume to be evaluated.
- Hazard provided by the W&R Concept Demonstrator



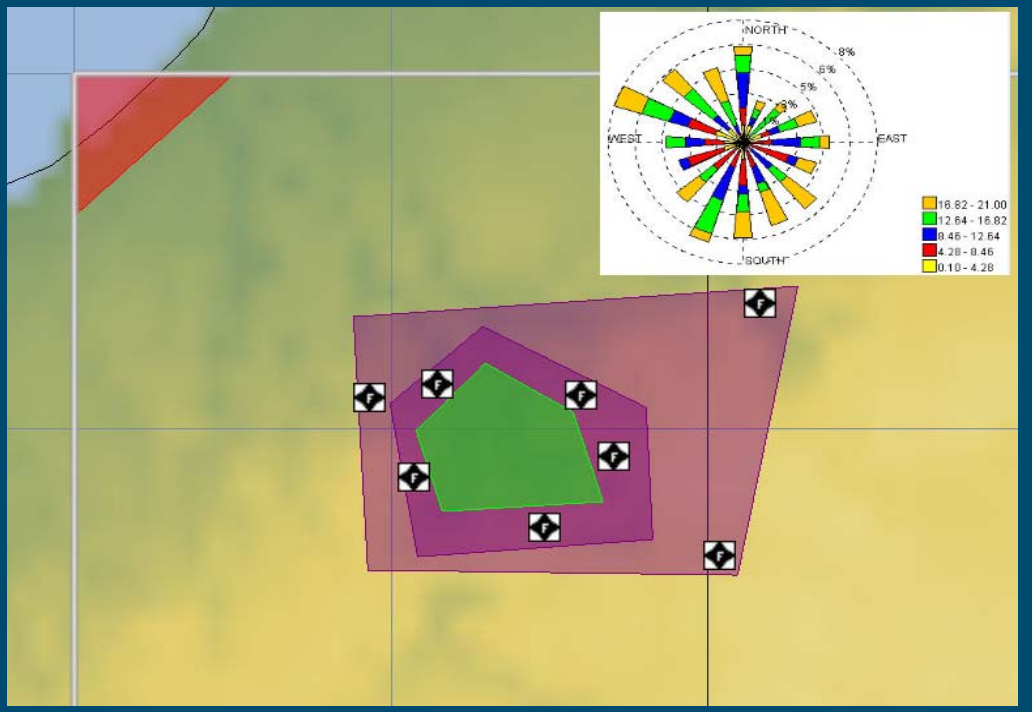
REACT hand-held commander's tool

- 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

Wind rose



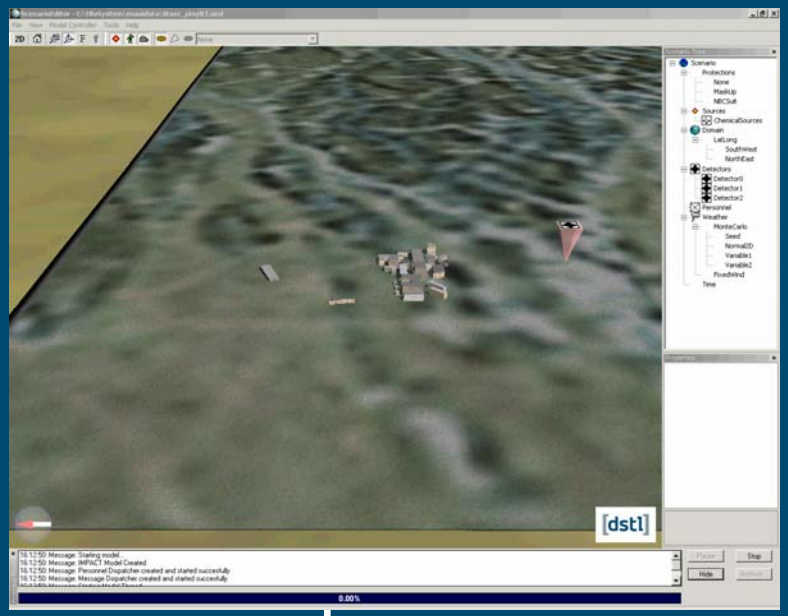
Optimal sensor placement to protect green area, including desirable (purple) and exclusion (red) areas

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

CBSim



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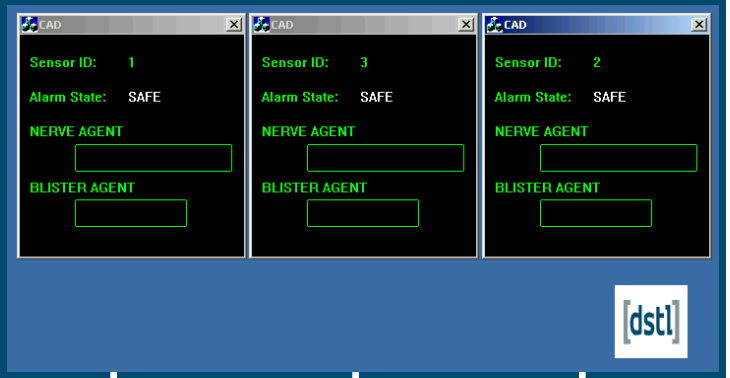
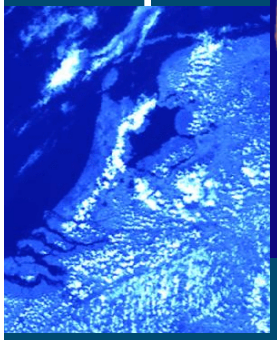
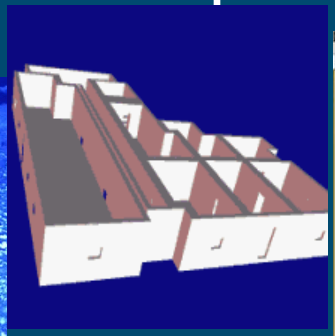
Detectors



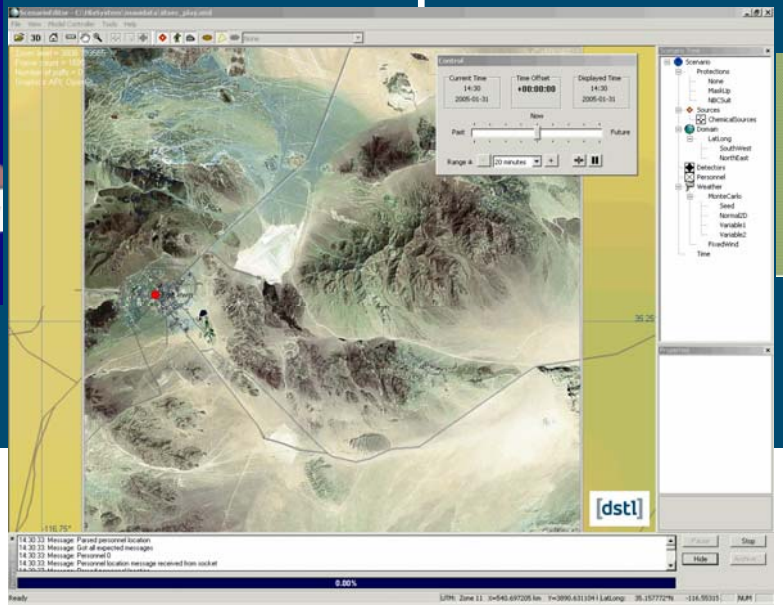
Network



Met



Damage



ACAT

Hand-helds

W&R

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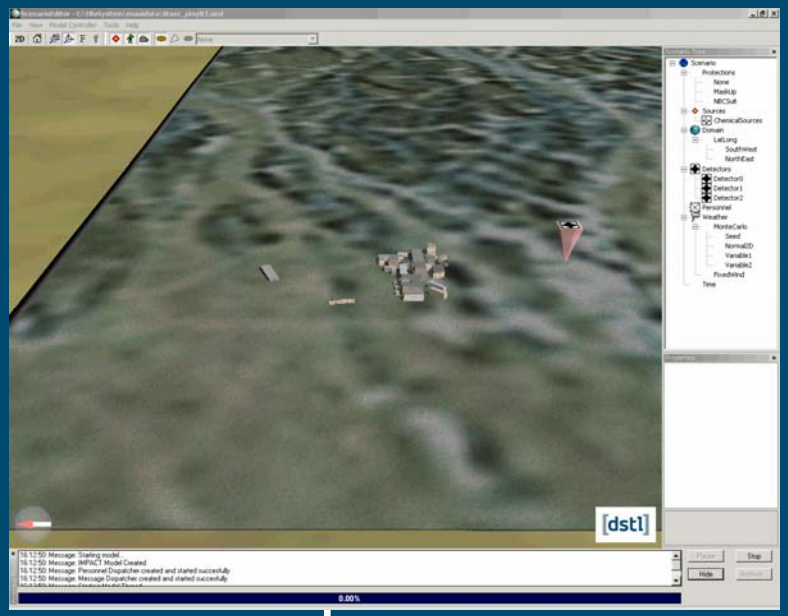
CBSim



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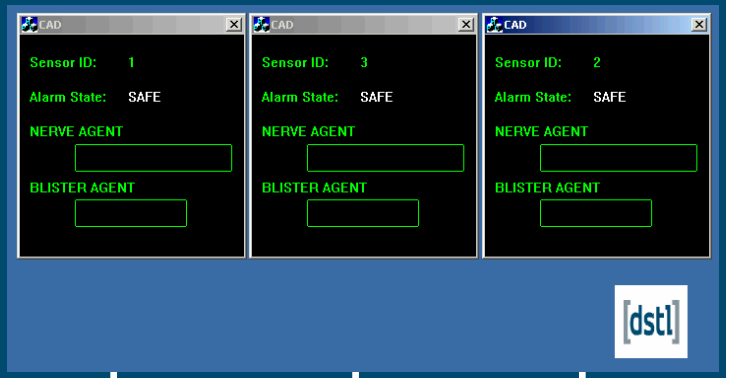
Detectors



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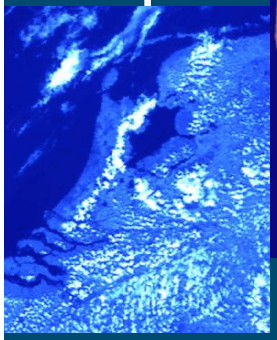

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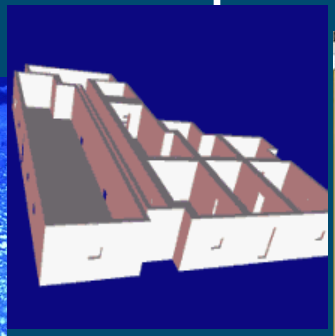

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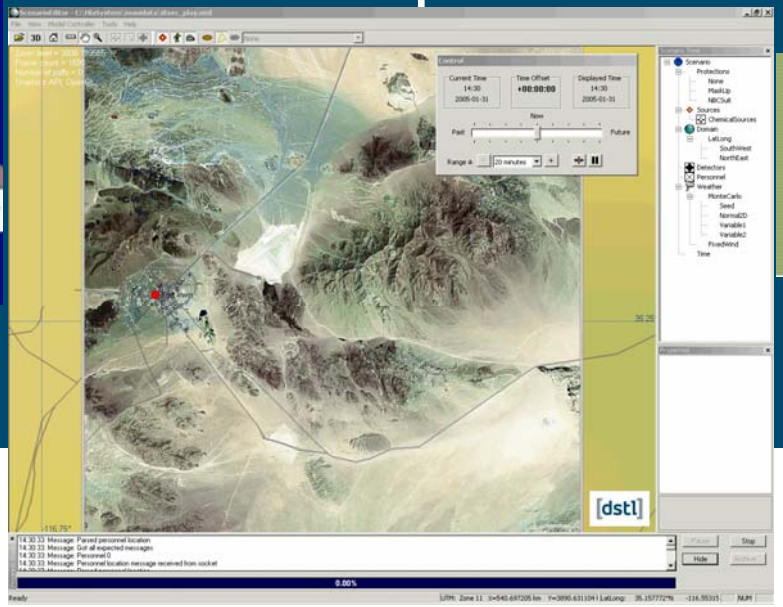

ACAT

Hand-helds

W&R

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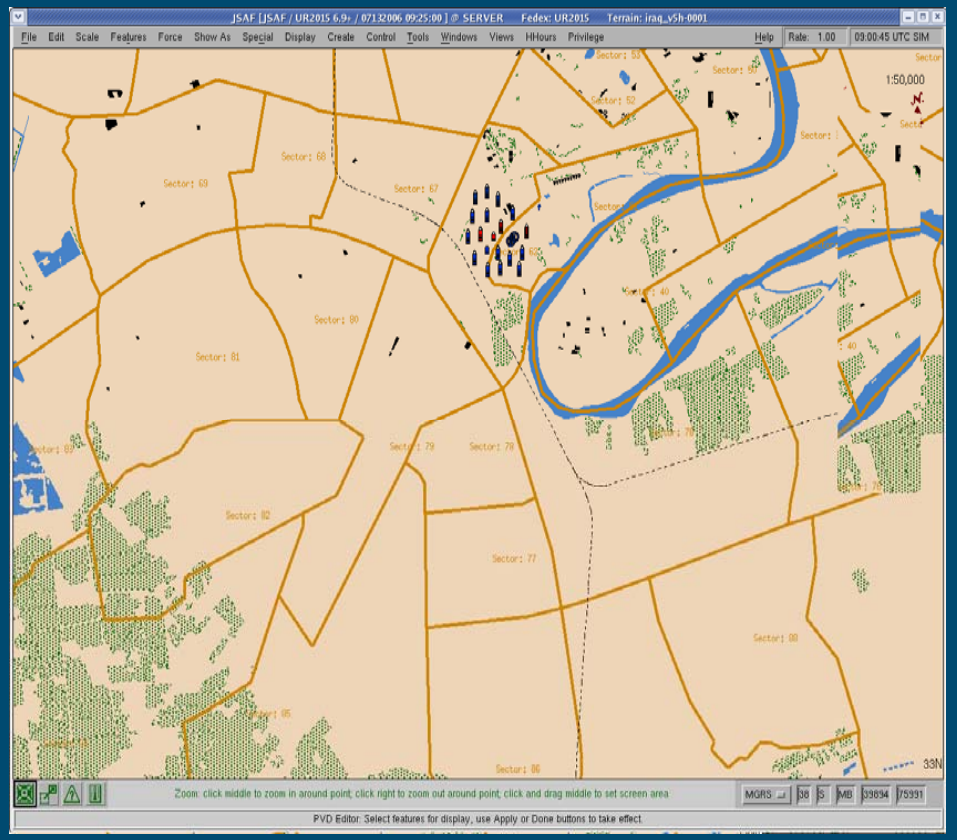
Application 2: Experimentation

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



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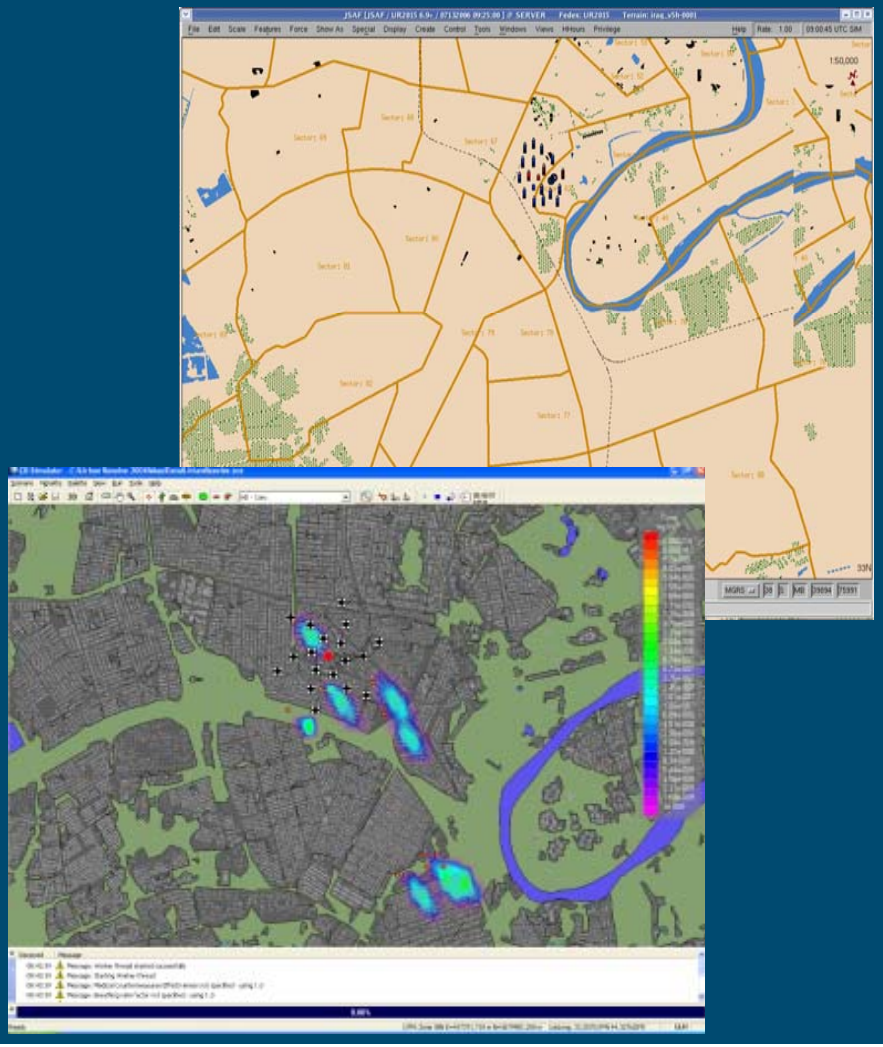
JFCOM J9 Urban Resolve 2015 Experiment

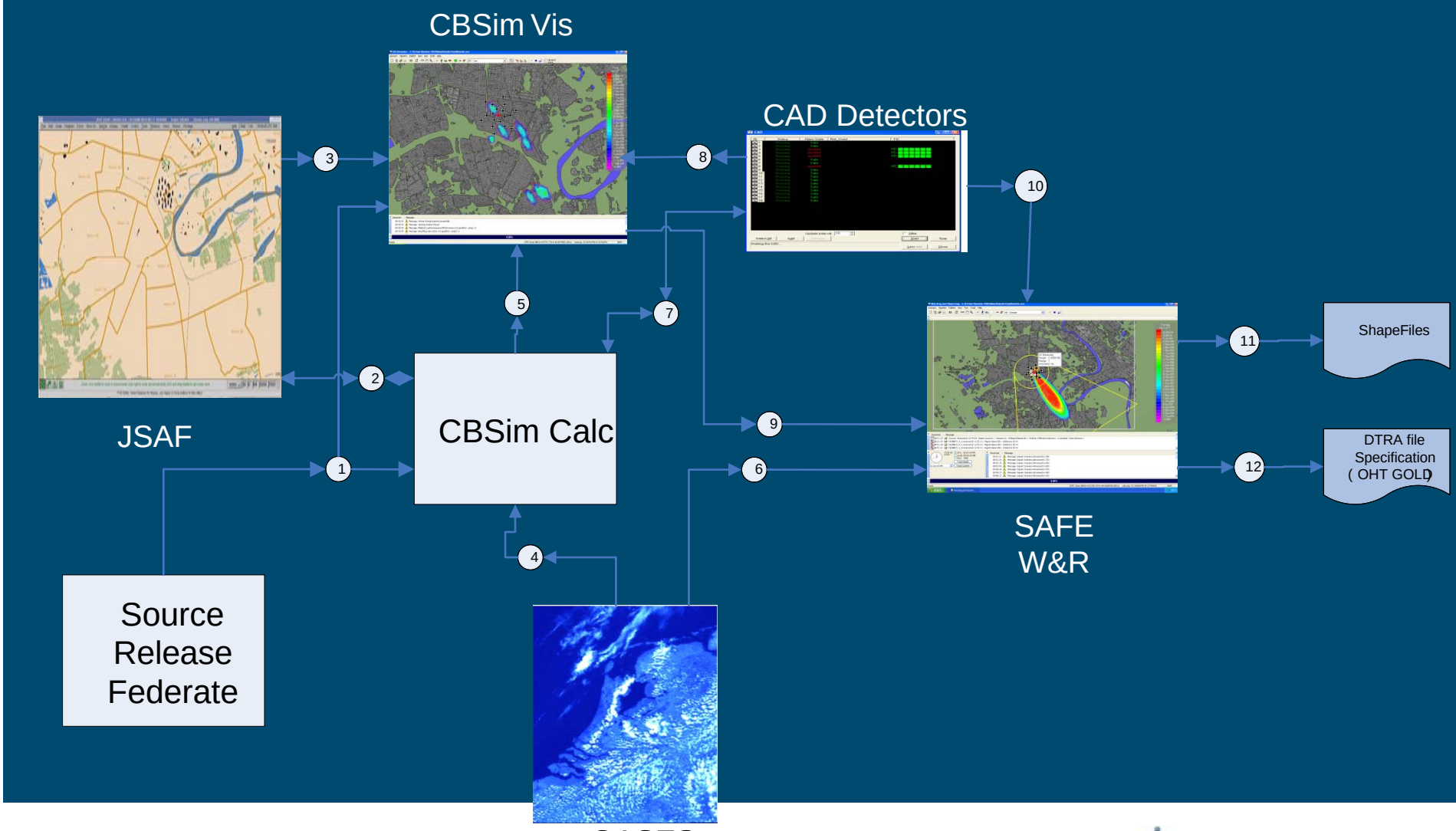
- CBRN component
  - Assess effect of potential integrated CBRN defence solutions
  - Effort led by DTRA & J8 JRO CBRND
  - Ground truth provided by CBSim
  - 2005 capability represented by HPAC
  - 2015 capability of JWARN/JEM/JOEF
    - Emulated by SAFE W&R and associated tools



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

JFCOM J9 Urban Resolve 2015 Experiment



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