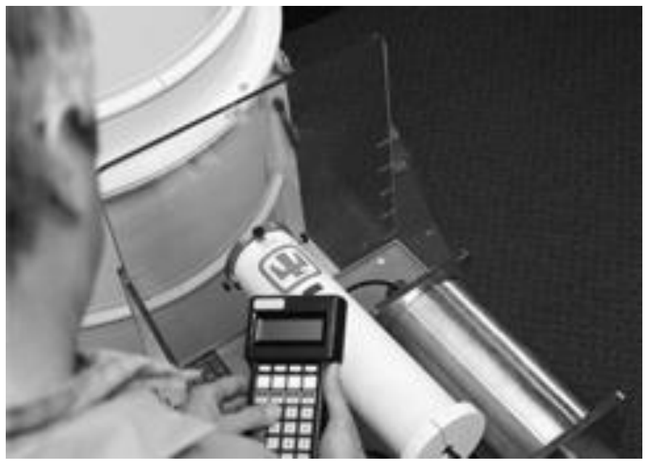
SAND 2014-3718P

Exceptional service in the national interest

Sandia National Laboratories



Physical Security Simulation and Analysis Tools

A presentation for the Canada & United States Security Simulation Technologies Group

Unclassified Unlimited Information
For Public Dissemination

Review Official Name/Org: Ken Summers, 6134
Date: 5/2/2012
Guidance () _____N/A_____

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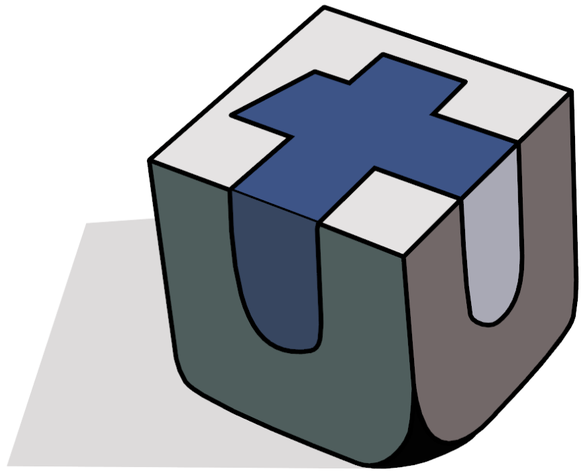
U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Outline

- Overview of Sandia National Laboratories
- Physical Security Simulation Activities at Sandia
- The Umbra Framework
- Operational Viewshed (OpShed)
- Dante Force-on-Force Modeling



Sandia's History

Sandia National Laboratories

THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

I am writing a similar note direct to Dr. O. E. Buckley.

Very sincerely yours,

Harry Truman

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.

U.S. ATOMIC ENERGY COMM. SANDIA LABORATORY ALBUQUERQUE NEW MEXICO

AMERICAN TELEPHONE & TELEGRAPH CO. BELL SYSTEM AND ASSOCIATED COMPANIES

Sandia National Laboratories

Interactive Systems Simulation & Analysis Department

Sandia National Laboratories

What

- Systems analysis and software engineering
- Simulation & Gaming Terrain Team
- Embodied Agents (Physics, Behaviors, 3D environ.)
- Live Virtual Constructive Simulations

Impact

- DOE Physical Security – Safety of NW Complex
- DOE Facility Design - Sensor layouts
- DoD Warfighter Missions – Operational Information
  - Reduce Mission Risk to Save lives

Unique

Multi-disciplinary Staff - Domain Experts

Systems Engineers, Systems Analysts,
Modelers, Software Developers

Software Tools

Modular Software Framework

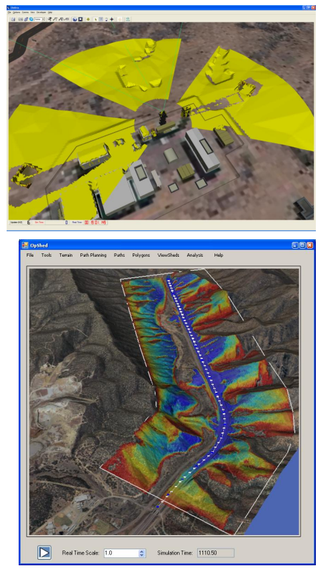
Terrain Generation & Gaming

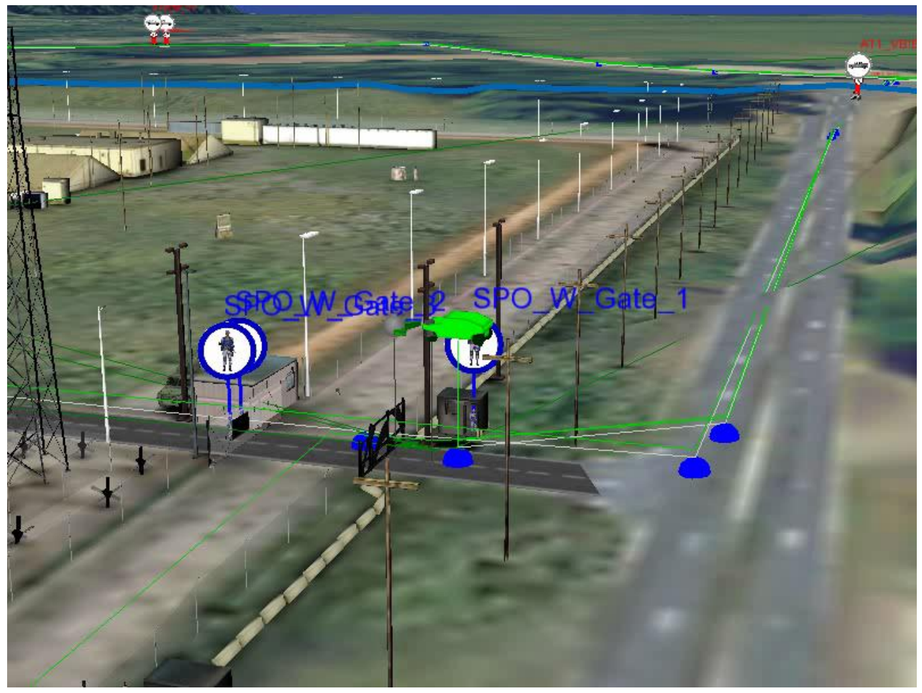
Force-on-Force Constructive and Tabletop

Sensor Operations & Path Planning

Examples

OpShed Sensor Analysis





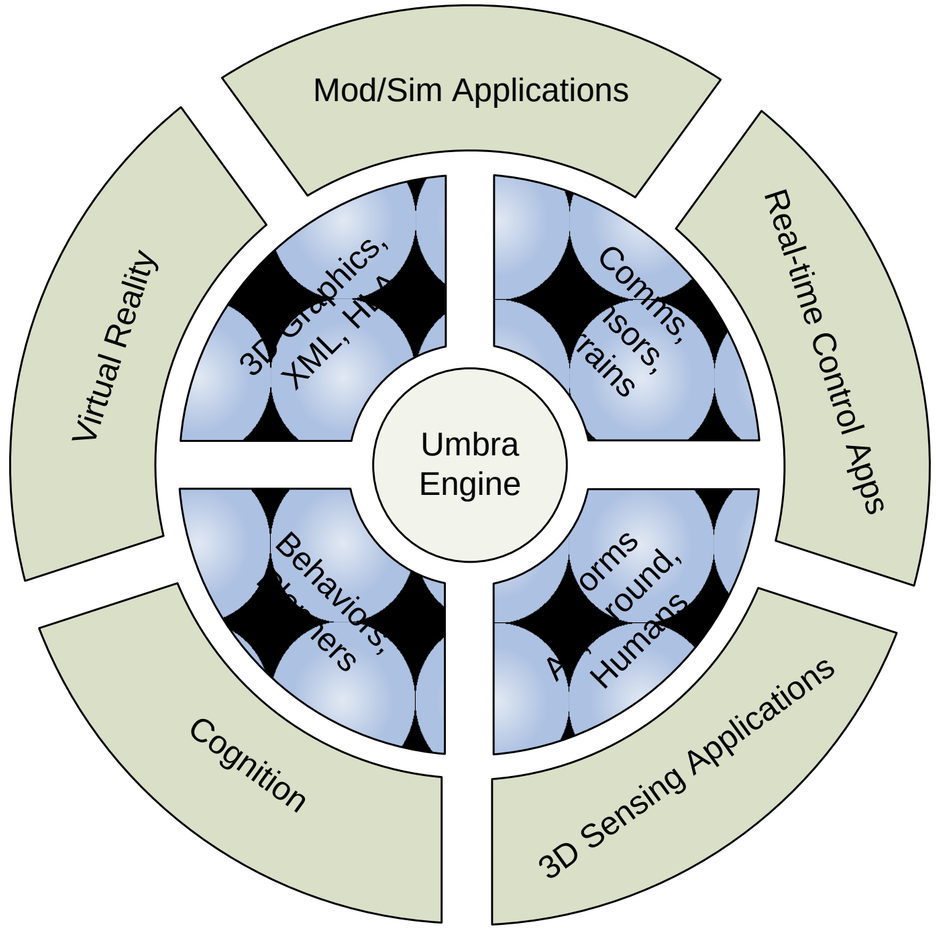
Dante Constructive Simulation
Small Arms Engagement

Dante Tabletop

Umbra Models
Multi Fidelity Physics and Environments

Umbra Simulation Framework

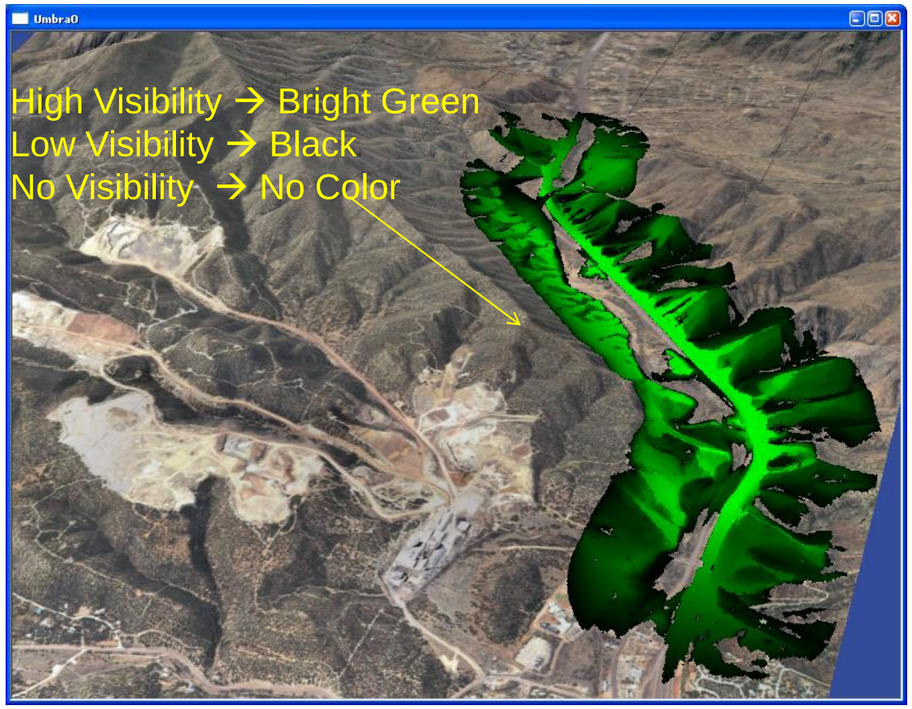
- Umbra engine version 4.8.5
  - Modular c++ core based on object oriented design
  - Flexible scripting for module construction
  - Enables both physics-based (time-step) & event-based models to co-exist
  - Supports batch and 3D interactive modes
  - Uses Open Scene Graph engine
  - Optimized computational geometry package
  - Umbra Worlds support non-linear interactions
- Umbra packages (existing libraries)
  - Platforms (air, ground, humans)
  - Communications, sensors, terrains
  - Behaviors, planners
  - 3D graphics, GUI
  - XML scenario description
  - HLA distributive computing

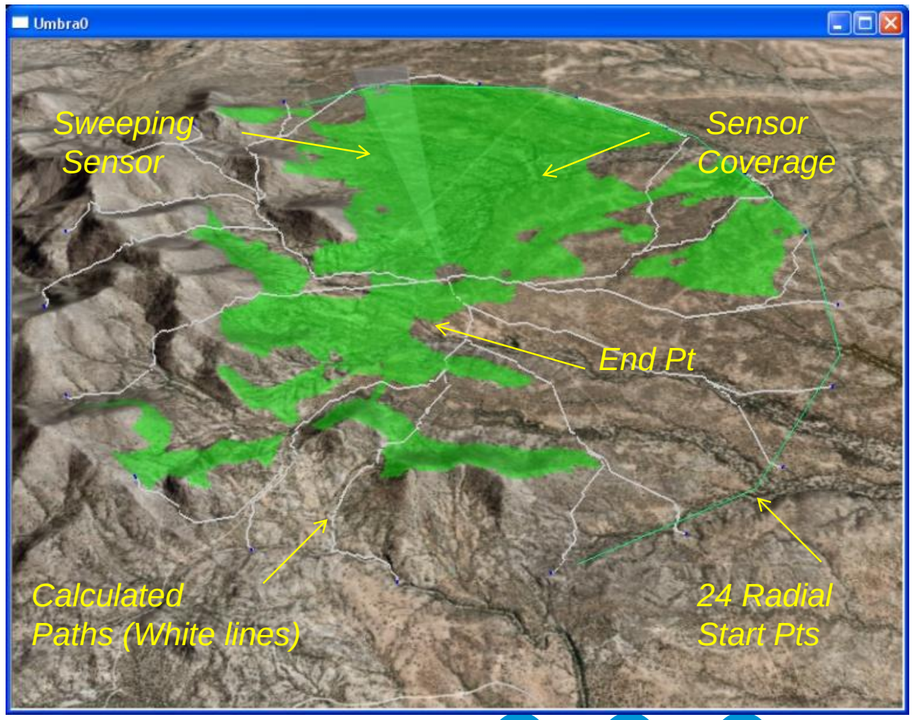


OpShed – Operations Viewshed

- Purpose
  - Combine sensor layout and analysis with operations to investigate capabilities and/or vulnerabilities
- Viewsheds / Sensors
  - Cameras, radars, imagers, seismic, magnetic, radios, jammers, etc
- Operations
  - Includes sophisticated planners over diverse terrain environments
  - Based on variations of stealth, shortest distance, sensor avoidance, terrain features, and other inputs
  - Targets can contain heterogeneous sensing properties

Sensor and Path Planning



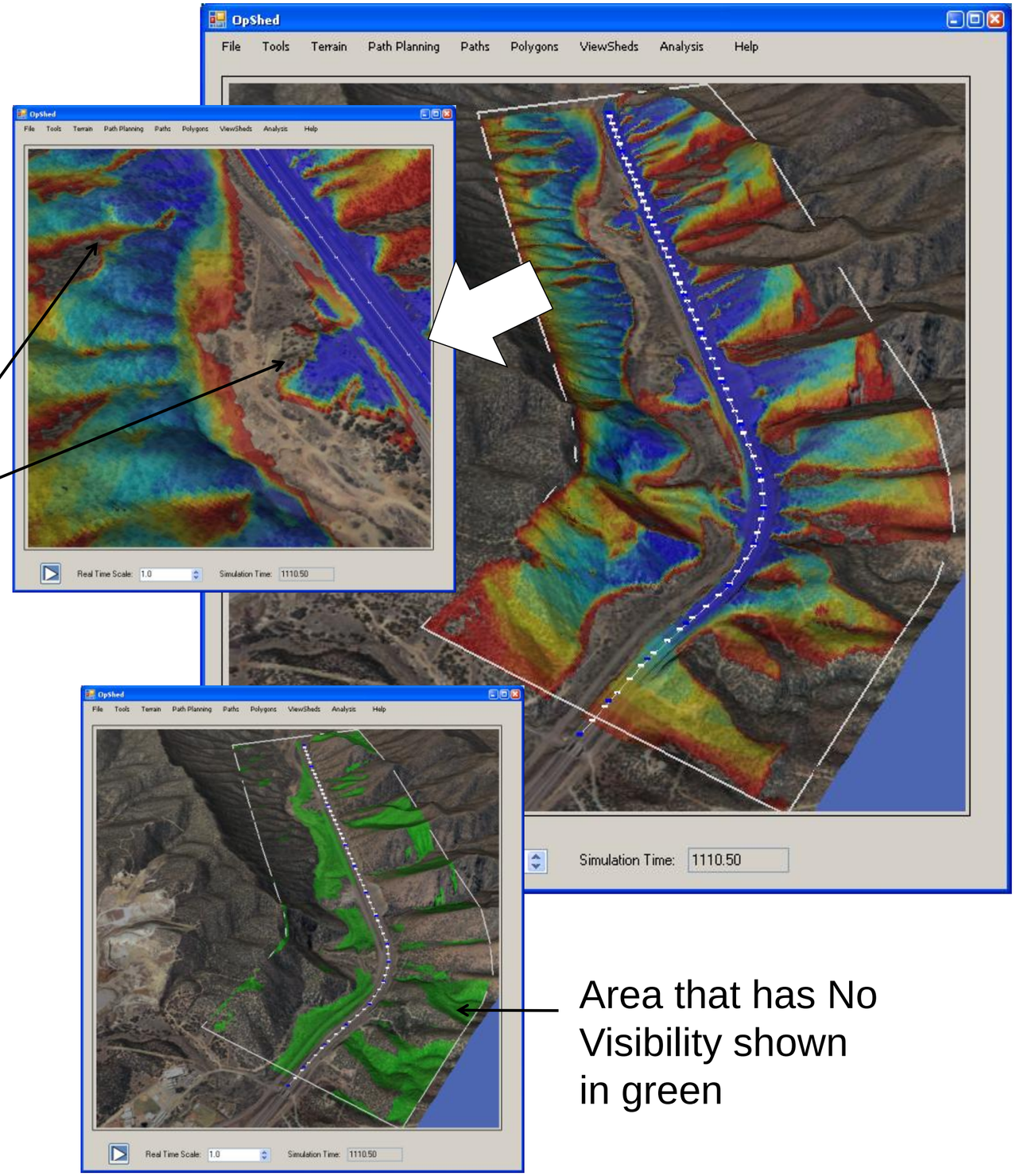


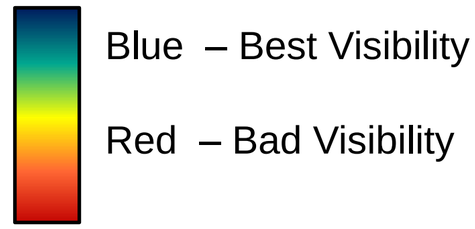
OpShed – Input and Setup

- Inputs
  - Terrain environment
    - Surface – Openflight, GeoTiff, ive, 3ds, etc
    - Buildings, fences, barriers
    - Roads, water
  - Sensor performance data
- Setup
  - Sensor creation
    - Interactively place in 3D terrain
  - Target creation
    - People, vehicles
  - Tactical actions
    - Terrain awareness paths
    - Sensor avoidance paths

Path Visibility

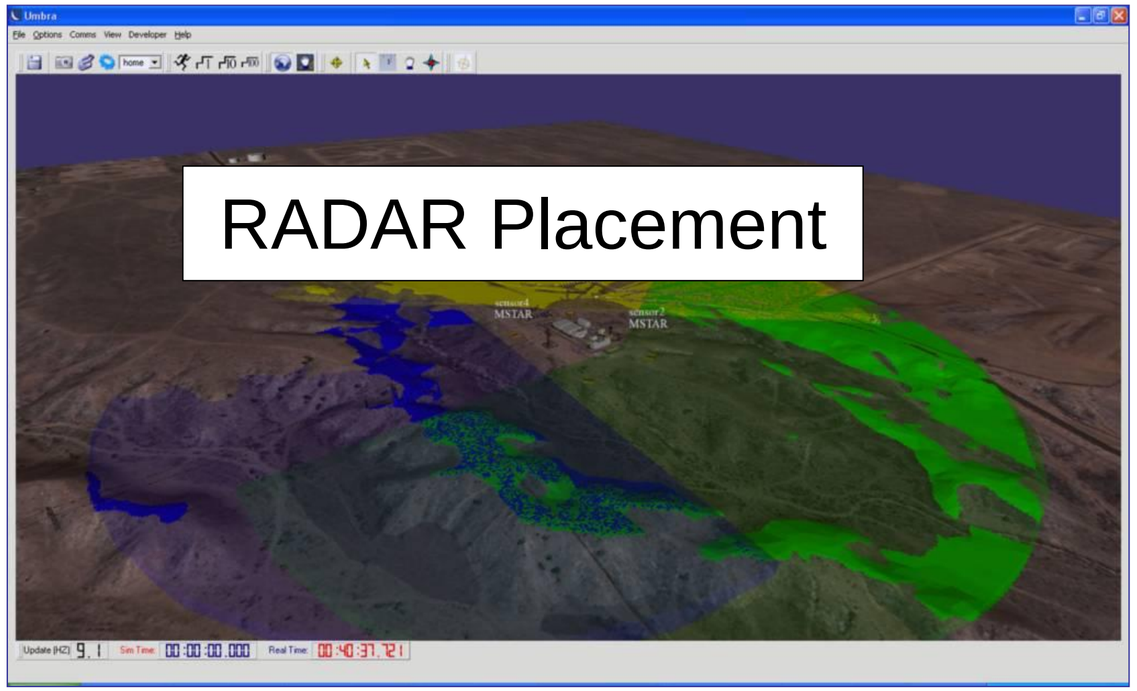
- **Description**
  - **Evaluate the viewable area over entire path**
- **Features**
  - **Identify Hidden Locations**
  - **Identify Overwatch Locations**
  - **Discover Points of Interest**
    - **Sharp Transitions from visible to non-visible**
- **Example**
  - **Patrol Paths**
  - **Convoys**





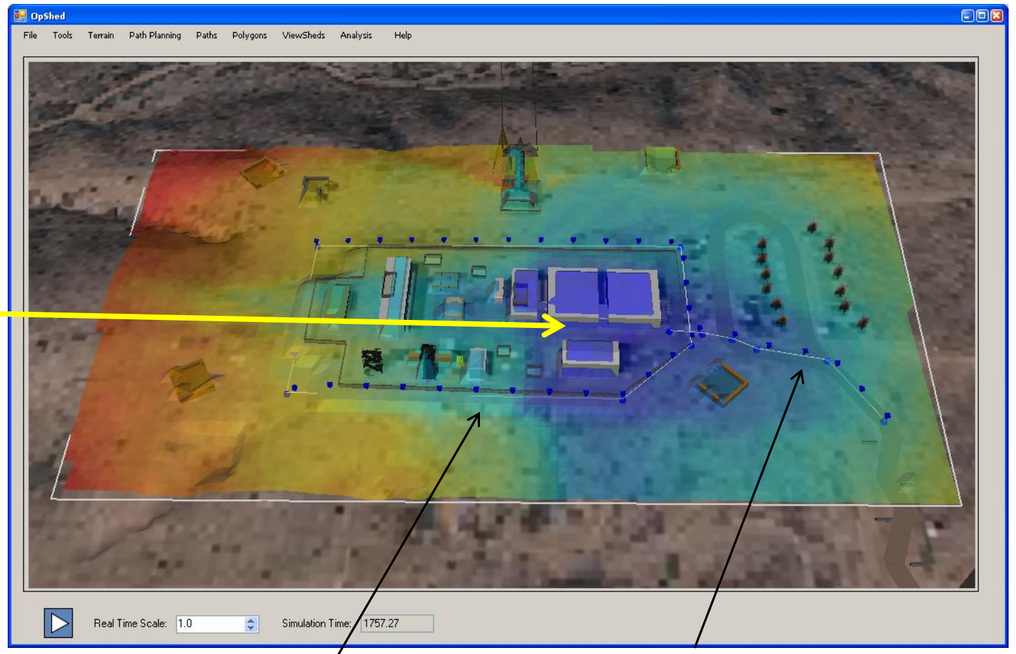
Facility Sensor Installation

- Sensor layout and analysis
  - Evaluate sensor coverage
    - Over 3D terrain and buildings
  - Line-of-sight analysis
    - Imagers, radars
  - Energy propagation over terrain
    - Radios, seismic, magnetic, jammers
- Variety of target properties
- Multiple sensor analysis
  - Single coverage
  - Multi coverage
  - No coverage



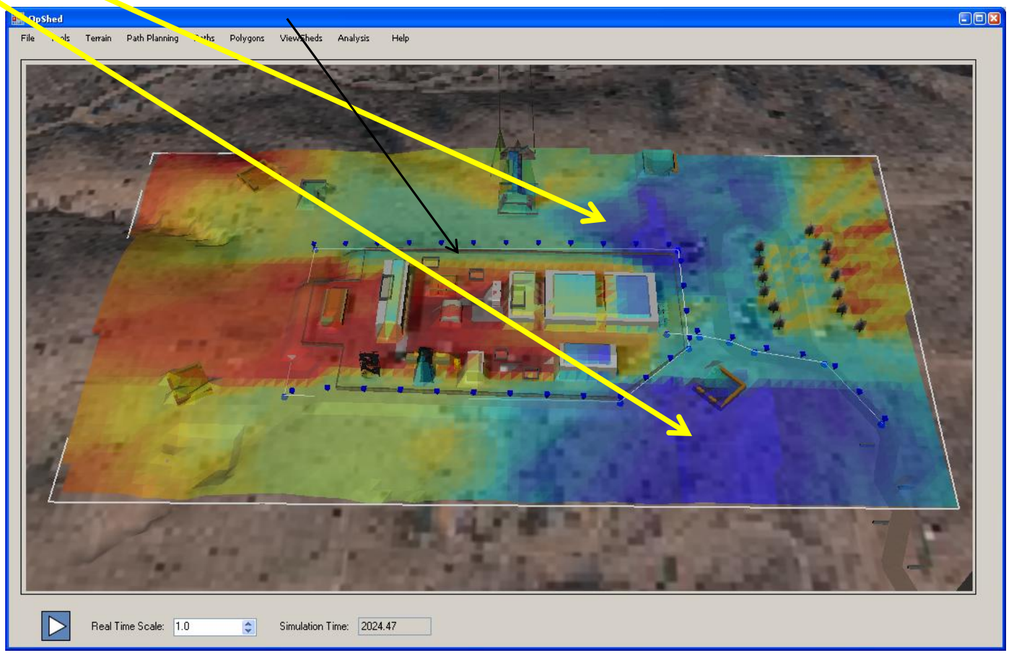
Optimizing Tower Locations

- Determine best locations of a camera tower to observe people along fence and on road entrance
- 20m tower optimal locations
  - Single camera tower may be capable inside fence
- 5m tower optimal locations
  - Require 2 camera towers outside fence



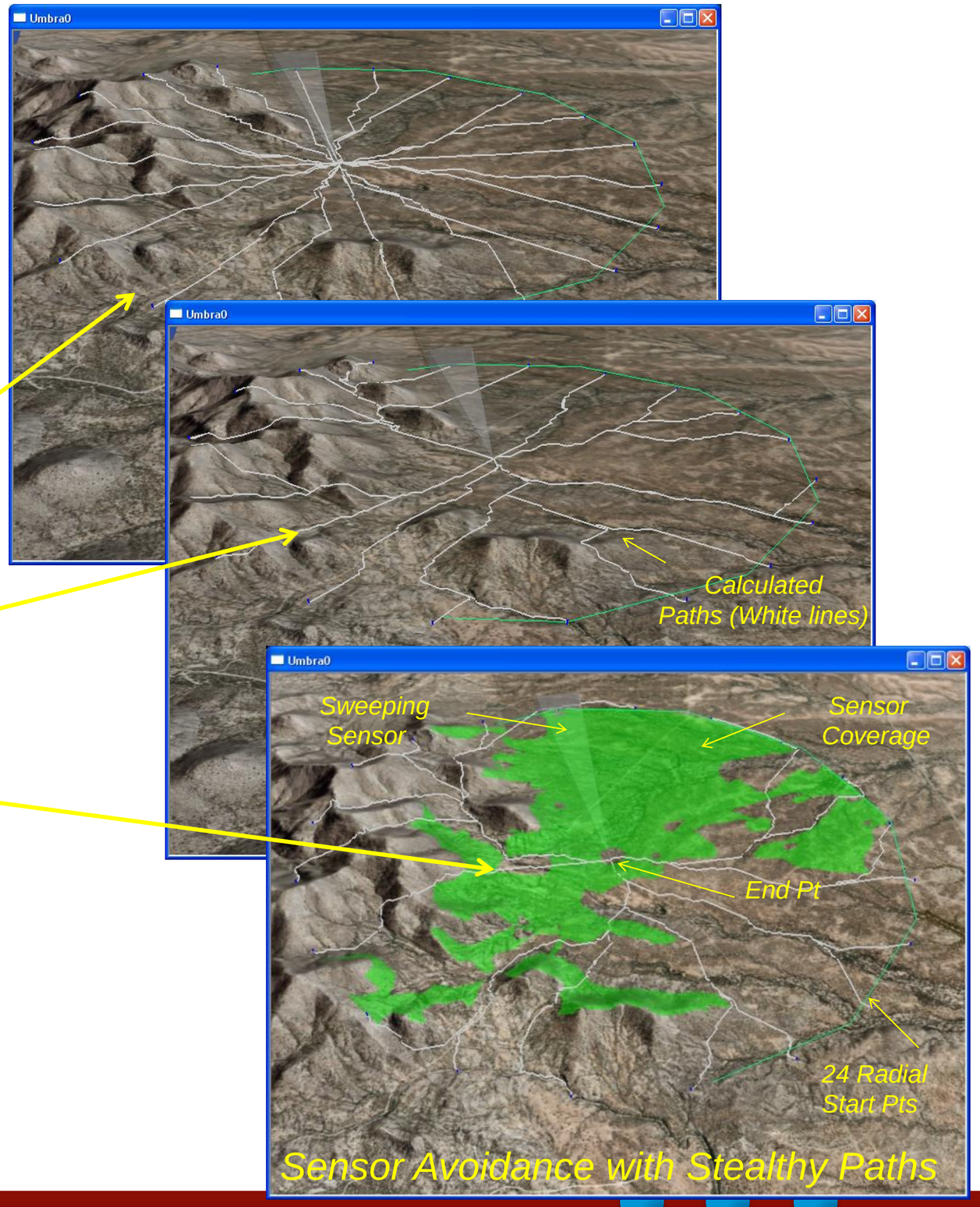
Fence

Road Entrance



Tactical Operations & Sensor Models

- Sensor Performance
  - More than line-of-sight
  - Include sensor scanning, detection performance
  - Vary target types
  - Include target operations
  - Analyze paths
- Adjustable path planner
  - Shortest distance
  - Stealthy or visibility
  - Sensor viewshed
  - Terrain features



LVC Tracker

High-accuracy tracking system linking live elements to virtual scenarios

- **Features**
  - **Support rapid sensor testing and evaluation**
  - **Link live tracks and radars to simulations**
    - **Radars, UAVs, UGVs, and personnel**
  - **Provide post-processing recordings for quick display of analysis data**
  - **Enables validating simulation models**
- **Technology**
  - **1 meter accuracy for precision sensor testing, improvable with differential GPS**
  - **Configurable setup via repeaters, mobile units, and packs**
    - **NovAtel GPS and FreeWave radio**
  - **Adjustable tracking rates up to 20 Hz**
- **Results**
  - **Records and displays real-time tracks up to 15 objects**
  - **Allows data re-loading for later review and replay**

Example display of 7 tracked units

DANTE™

Built upon

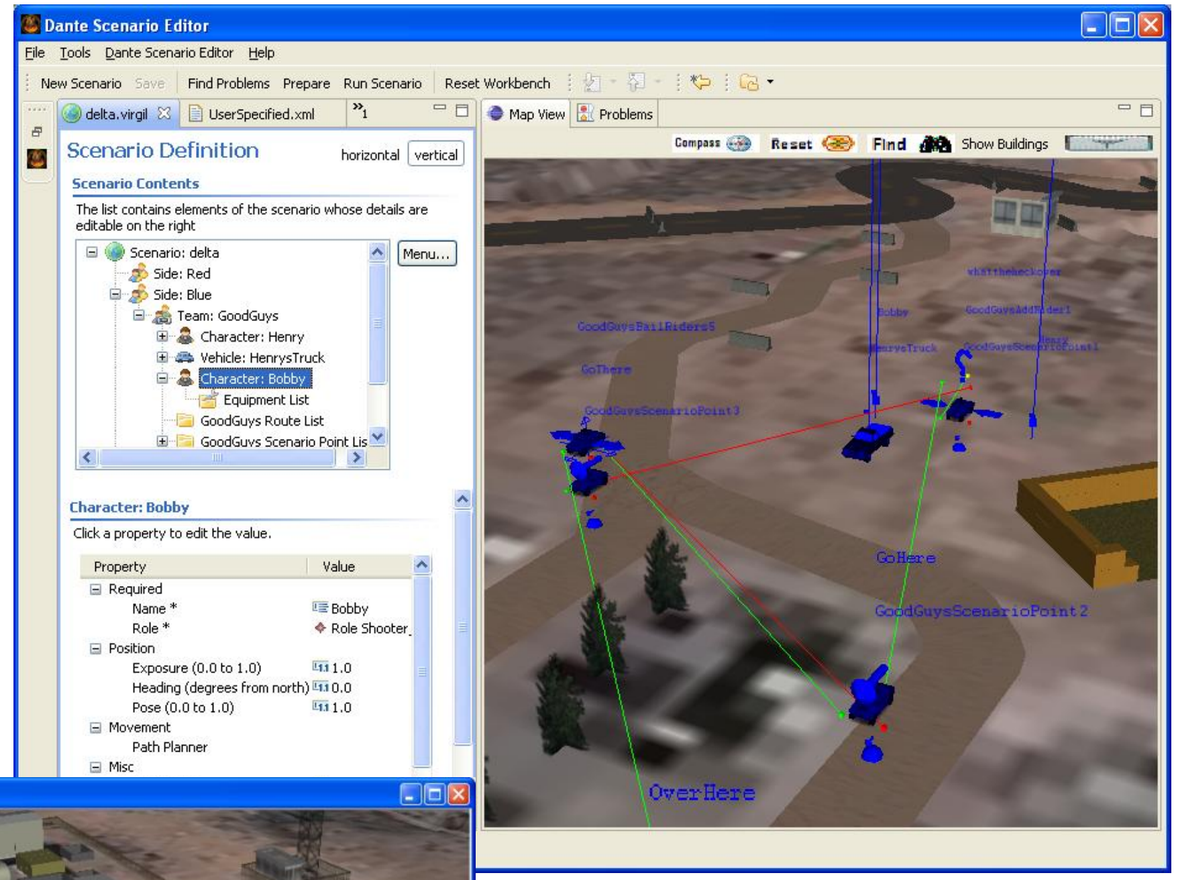
UMBRA™

LVC Tracker

Sandia National Laboratories

Dante Overview

- 3D Force-on-Force Combat Simulator
  - High level of physics fidelity
  - Squad/Platoon Level
- Analyze the mission impact of
  - Insertion of technologies
  - Changes to TTPs & CONOPS
- Batch mode processing
  - Generates statistical data
  - Explore possible outcomes
  - 1000's of runs overnight on a laptop



Dante Tool Suite

- Scenario Editor
  - Development for Analysts
  - Interactive 3D environment
  - Mouse-based operation
- Run-time execution and visualization
  - Physics calculations
  - Enhanced Ph/Pk
  - Real Time Lethality Model
    - Select Target Location from table
    - Includes ballistic flight
    - Terrain / objects can intercept weapon flight
    - Can include body zones
- Batch run management
  - GUI-based
  - Multi-core design
- Data analysis and visualization
  - Statistical analysis
  - Graphical analysis
  - Map-based event display
  - Database-enabled

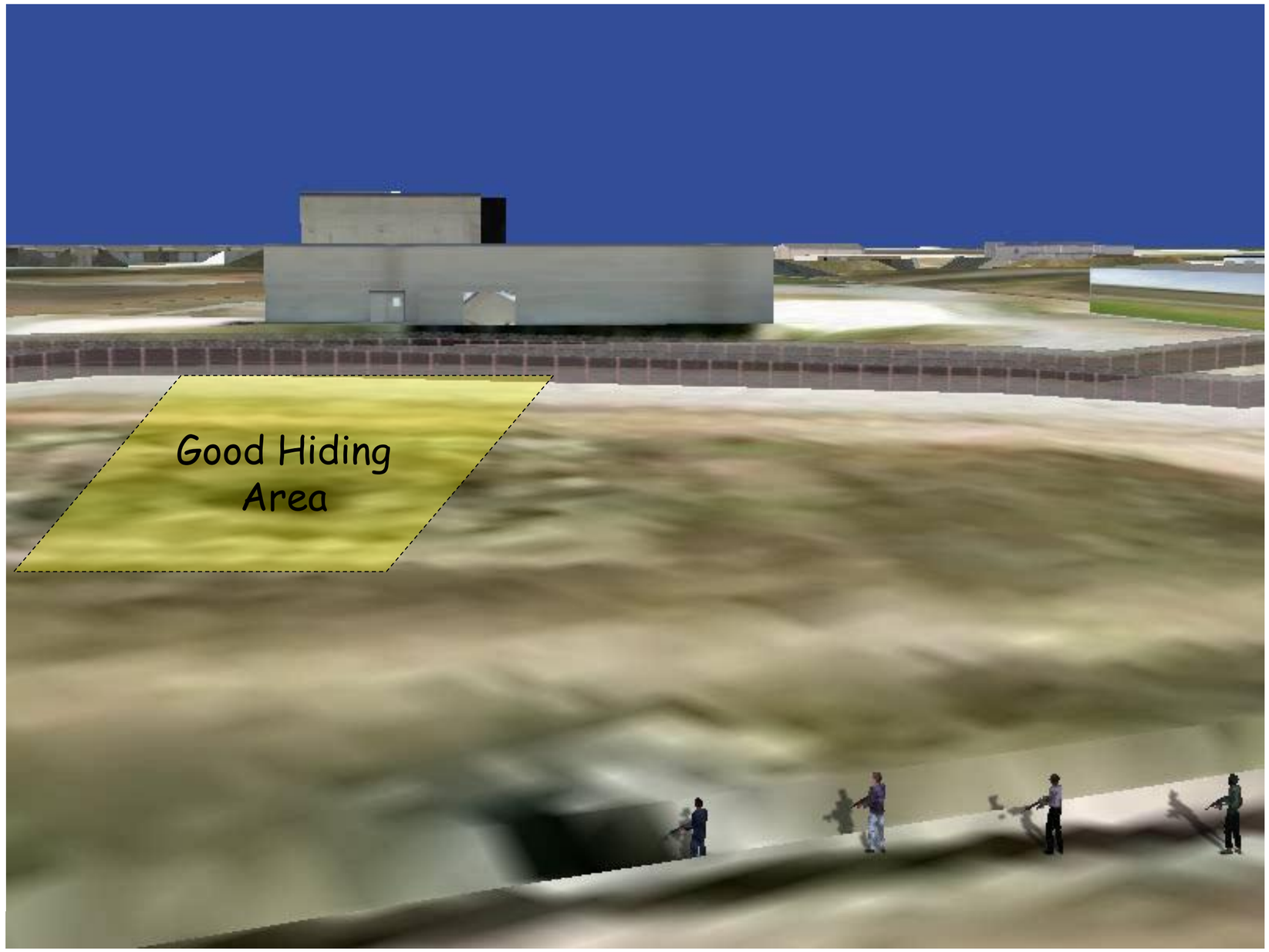
Dante – Input and Setup

- Inputs
  - -3D Terrain Environment
    - Terrain Surface
      - Openflight Terrain format
      - GeoTiff image
    - Buildings, Fences, Barriers
      - Support various formats
    - Roads, Water, etc…
- Setup using Dante Scenario Editor
  - –Define up to 3 different sides
  - –Create assets for each side
    - people, weapons, platforms, sensors
  - –Create actions for each side (TTPs)
    - Breach, Patrol, Move, Drive, Fly, Mount, …
    - Connected to make a plan (fail and success)
  - –Assign actions to a team or individual
  - –Preview actions to confirm intended execution

Dante Scenario Editor

Team Behavior: Breaching Example

- Team Based Behavior
  - Breaching Example
- The **only** commands given:
  - Fence Breach Point
  - Building Breach Point
- Team autonomously:
  - Finds hiding area
  - Finds stealthy Paths
  - Sets up perimeter protection
  - Provides cover
- Next man “steps up” if needed
  - E.g. if breacher is killed
  - Team based goals



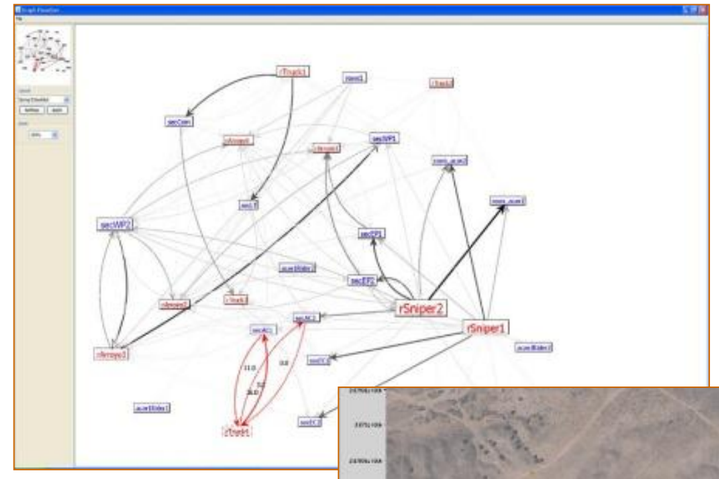
Dante Example:
Red on Blue with Non-Combatants

- Red is intermixed with civilians and moving to do a breach.
- Blue has surrounded the area, but will not shoot with friendlies (Green) in the way.
- Red starts their breach and decides to engage blue.
- Green scatters when they hear shots fired.
- Once green has scattered out enough, blue can finally start engaging without worrying about hitting green.

Scenario Data Analysis

- Data capture tools
  - XML (player events)
  - SQL server express
- Post-processing tools
  - Dante built-in interaction analysis
  - Tableau data mining
- Typical analysis
  - Shot/kill affinity (A)
  - Geo-physical plots (B)
  - Temporal distribution of kills (C)
  - Kills under specific termination conditions (D)

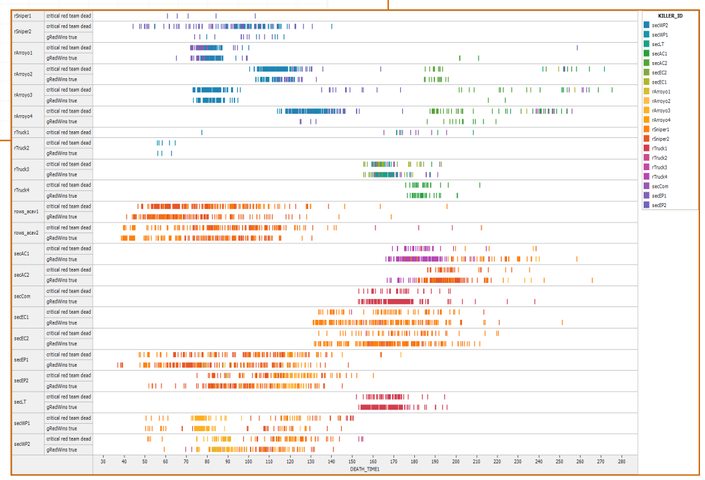
A.



B.

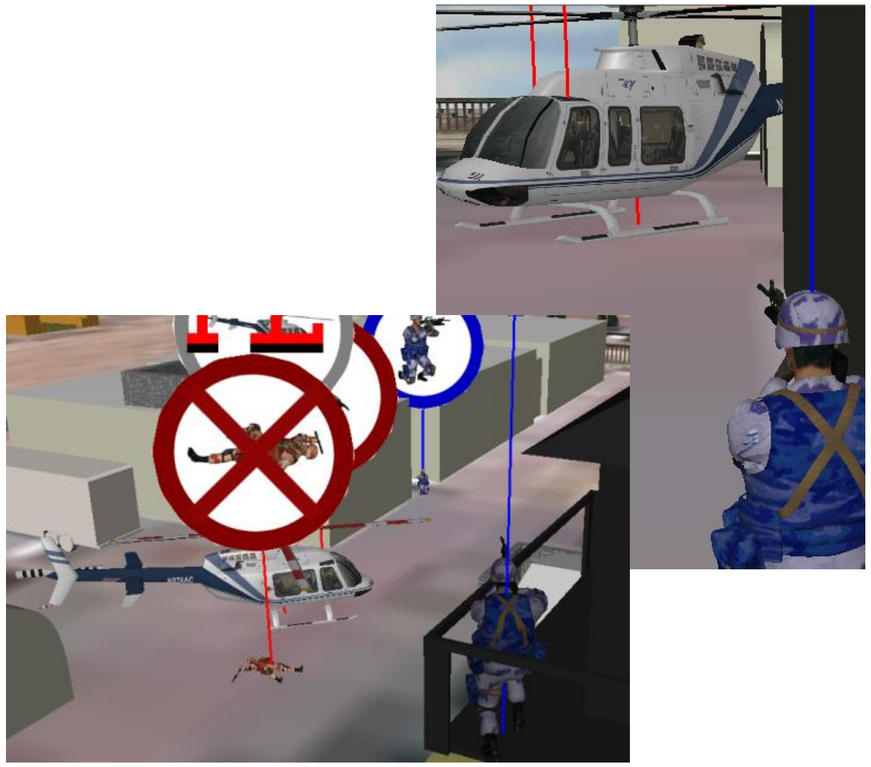
C.

D.



Dante Tabletop

- Distributed operation
  - Coordinated simulations for Red & Blue
  - “Fog of War” concealing hidden actions
  - Referee/Spectator view
- Trainer mode
  - Red side automated
- Multi-player mode
  - Participants control single character or groups
  - Integrated communication
  - Widely distributed (LAN or WAN)



Thank You -Questions?