Exceptional service in the national interest

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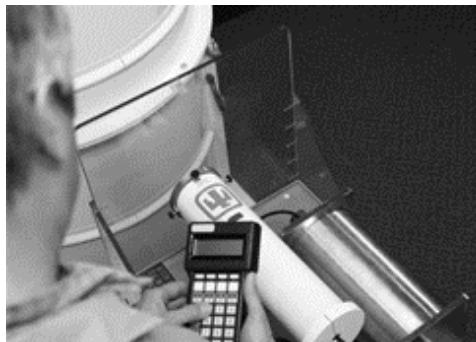
Sensor Coverage Modeling

Using Operations Viewshed (OpShed) for Physical Security Design and Analysis

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U.S. DEPARTMENT OF ENERGY

NNSA
National Nuclear Security Administration

# OpShed is built with the Umbra Simulation Framework

Umbra Features

- **General Purpose Modular Composition**
  - **Hybrid Time-Step and Event Driven**
- **3D Models and Visualization**
- **Patented "World" simulation**
  - **Environments and Physics**
- **Patented "LVC" interface**
  - **Real and Virtual Entities co-exist**
  - **Trainers with Real Hardware present**
- **Composable Entities**
  - **Variable Fidelity Physics and Behaviors**
- **Federate (HLA) co-simulate**
- **Broad spectrum of applications**
  - **Quickly Adaptable**
- **Laptop-Desktop-Cluster**
  - **Windows, Mac, Linux**
- **Government owned**
  - **17 years library development**
- **Used to create Dante, OpShed and other applications**
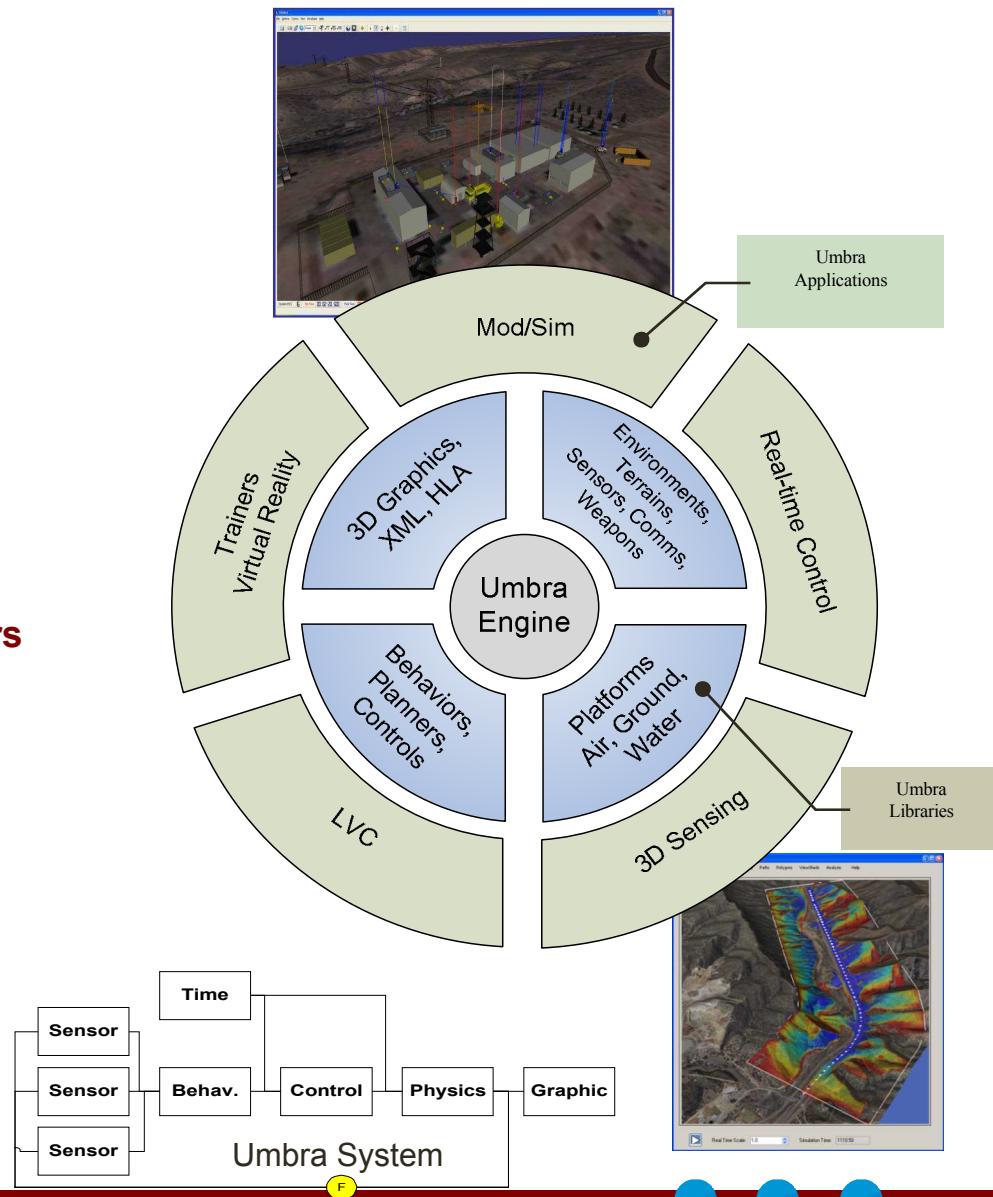
OpShed- Sensor Analysis and Operations for Physical Security Analysis

- **Evaluate 3D Sensor layout & performance aspects**
  - **Determine sensor coverage**
  - **Multi-heterogeneous sensor systems**
    - **Radars, Imagers, Seismic, Magnetic, Radios, Jammers, Radiation**
  - **Variety of target properties**

- **Using Tactical Operation Simulation**
  - **Tactical Operations**
    - **High Fidelity planners over diverse terrains**
    - **Stealth, shortest distance, sensor avoidance …**

- **Impact**
  - **Investigate sensor effectiveness against tactical operations to determine capabilities and vulnerabilities**
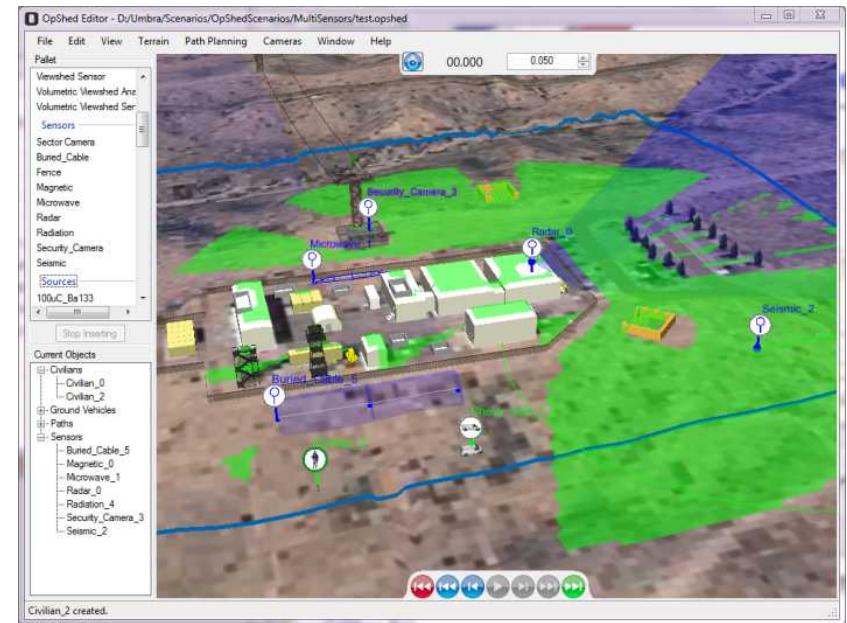
OpShed– Input and Setup

OpShed Scenario Editor

- **Inputs**
  - **Terrain Environment**
    - **Terrain Surface**
      - **Openflight Terrain format**
      - **GeoTiff image**
    - **Building, Fences, Barriers**
      - **Support various formats**
    - **Roads, Water, etc…**
  - **Sensor Performance Data**
    - **Detection data wrst to target types**
- **Setup using OpShed Editor**
  - **Create Sensors**
    - **Interactively place in 3D terrain**
  - **Create Targets**
    - **People**
    - **Vehicles**
 - **Define Tactical Movement for Targets**
    - **Terrain Awareness Paths**
    - **Sensor Avoidance Paths**
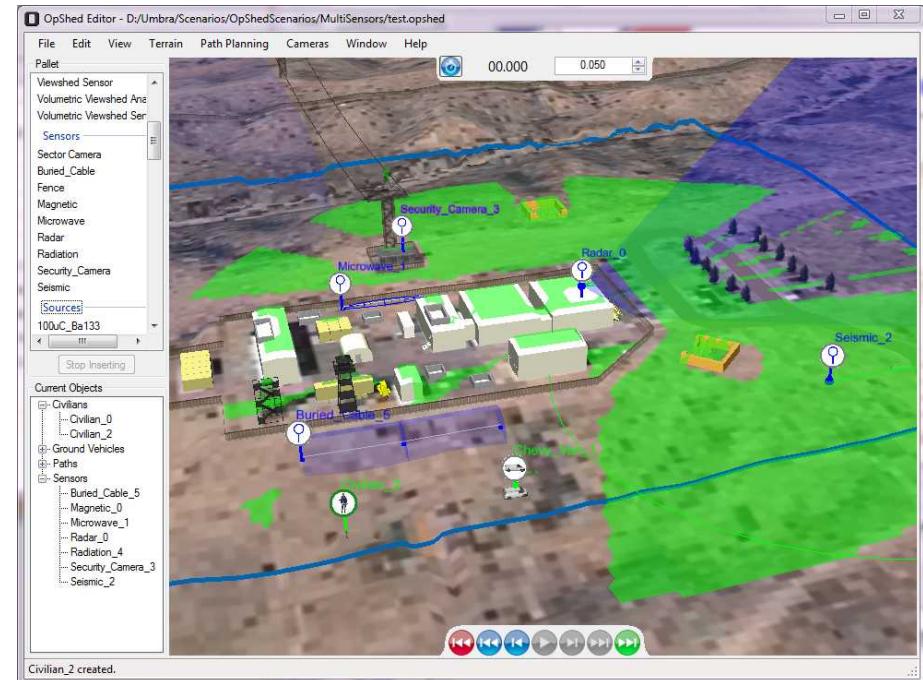
Sensor Marker

Action Symbols

Person Marker

Vehicle Marker

OpShed– Execution and Output

- **Execution Mode**
  - **Interactive**
  - **Batch**

- **Analysis**
  - **Sensor Coverage**
  - **Sensor Performance**
  - **Sensitivity Studies**

- **Post Processing Output**
  - **Data capture over time**
    - **Sensing events**
    - **Target positions**
  - **3D Scenario Replayer**
    - **Interactively navigate and query**
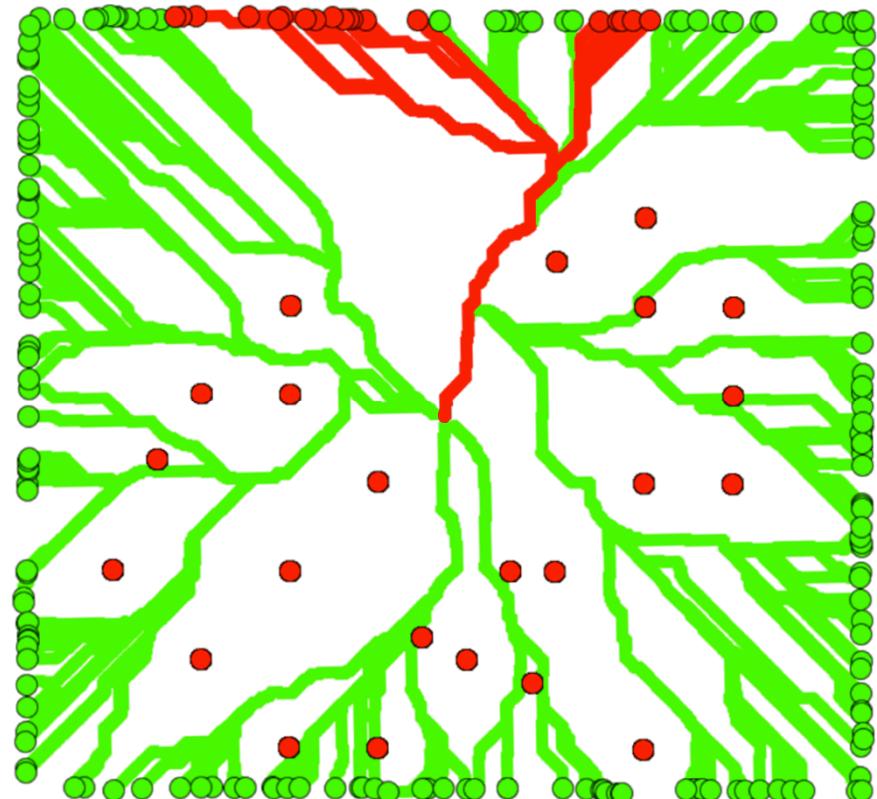
**Post processing: Sensor laydown and path evaluation**

Facility Sensor Installation

- **Sensor Layout**
  - **Rapidly place sensors within 3D terrain environment**
    - **Imagers, Radars**
    - **Radios, Seismic, Magnetic, Radiation**
    - **Jammers**
  - **Assign Target properties**
    - **Multiple properties on a target**
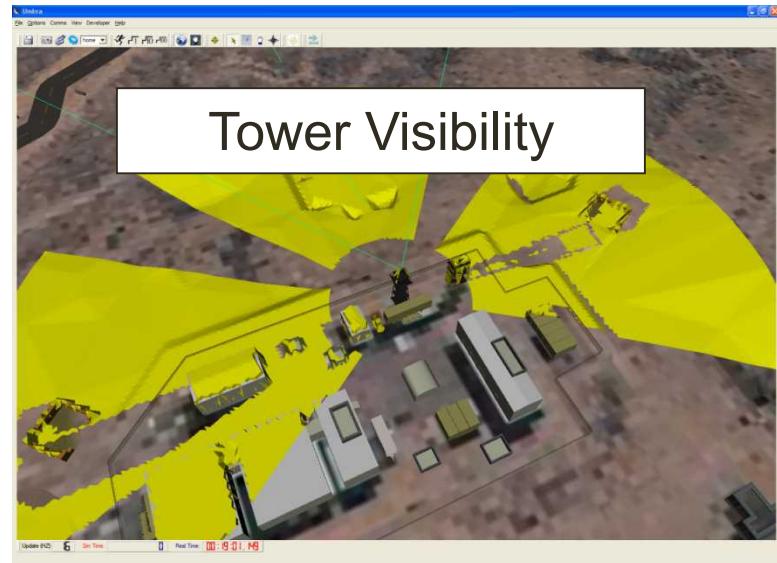
- **Sensor Analysis**
  - **Evaluate sensor coverage**
    - **Over 3D terrain and buildings**
  - **Line-of-sight analysis**
    - **Imagers and Radars**
  - **Multiple Sensors**
   - **Single Coverage**
    - **Mutiple Coverage**
    - **No Coverage**

Tower Visibility

RADAR Placement
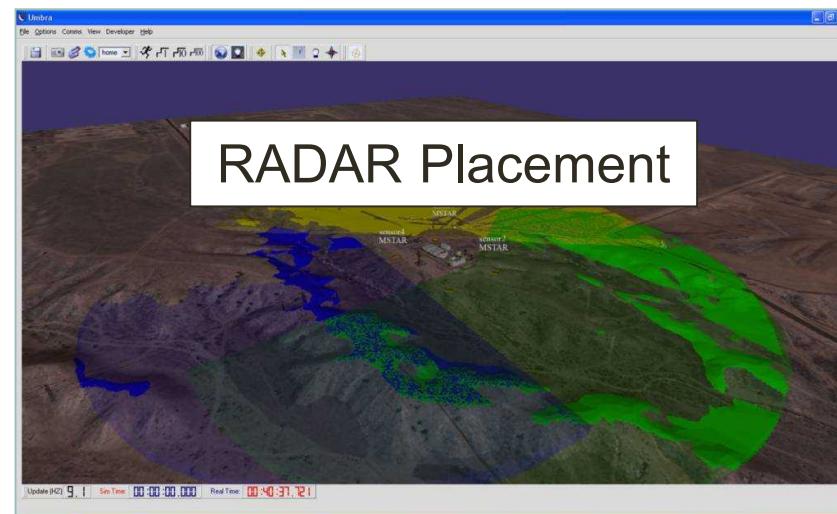
Sensor and Camera layout for Security Fences

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- **Define Sector Volume to be viewable for each camera over entire Security Fence**

- **User Selects the Camera Placement within 3D environment**

- **Perform Calculations**

  - **Determine best Camera Lens from a database for maximum resolution**

  - **Determine camera viewing axis or 3D location to align camera**
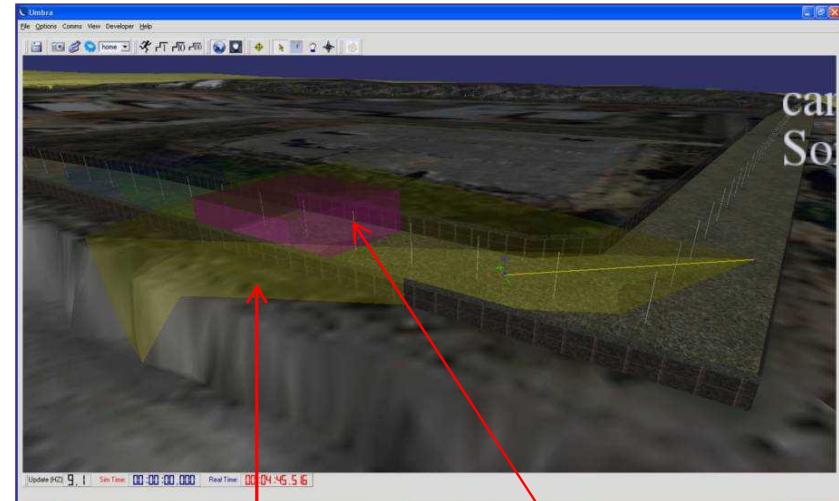
Camera Frustum containing Sector Volume
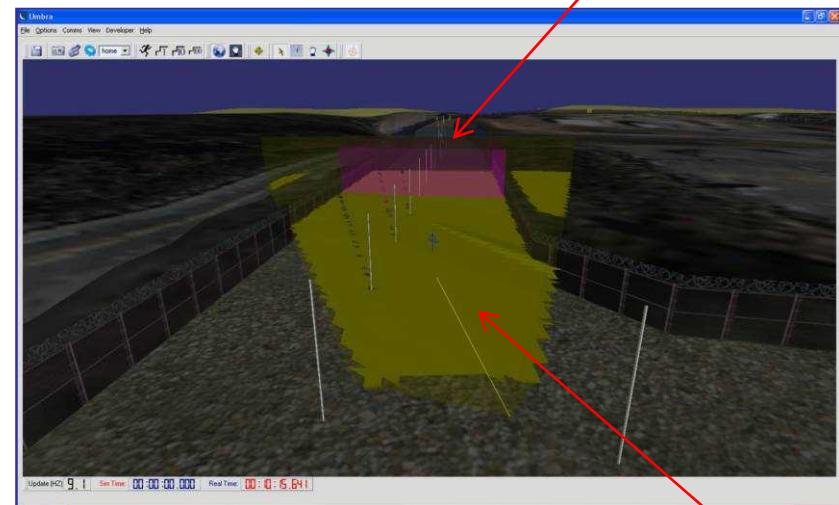
Camera View of Sector Volume with ViewShed

Optimize Tower Locations

- **Determine best locations of a camera tower to observe people along fence and on road entrance**

- **20m Height Tower Optimal Locations**
  - **Single camera tower may be capable inside fence**

- **5m Height Tower Optimal Locations**
  - **Require 2 camera towers outside fence**

Blue – Best Location

Red – Bad Location

Fence

Road Entrance
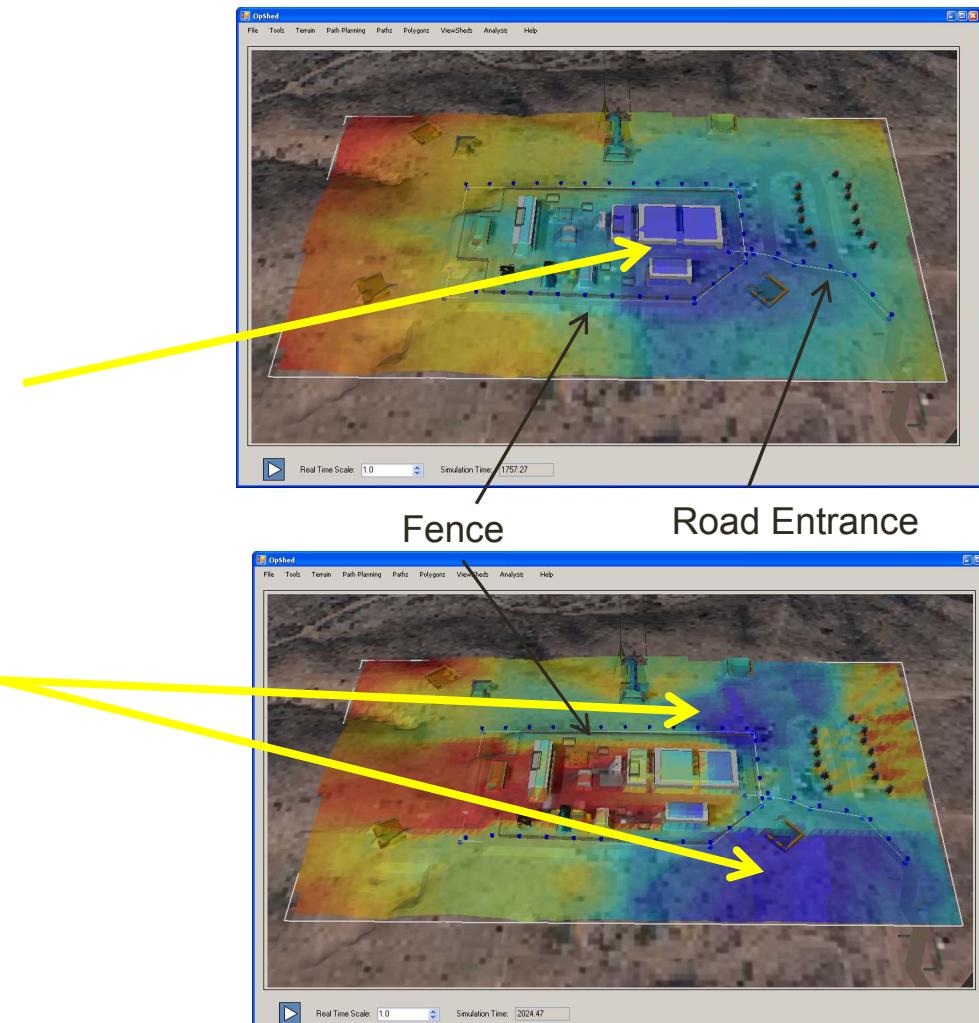
Path Visibility

- **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**

Blue – Best Visibility

Red – Bad Visibility

Area that has No Visibility shown in green
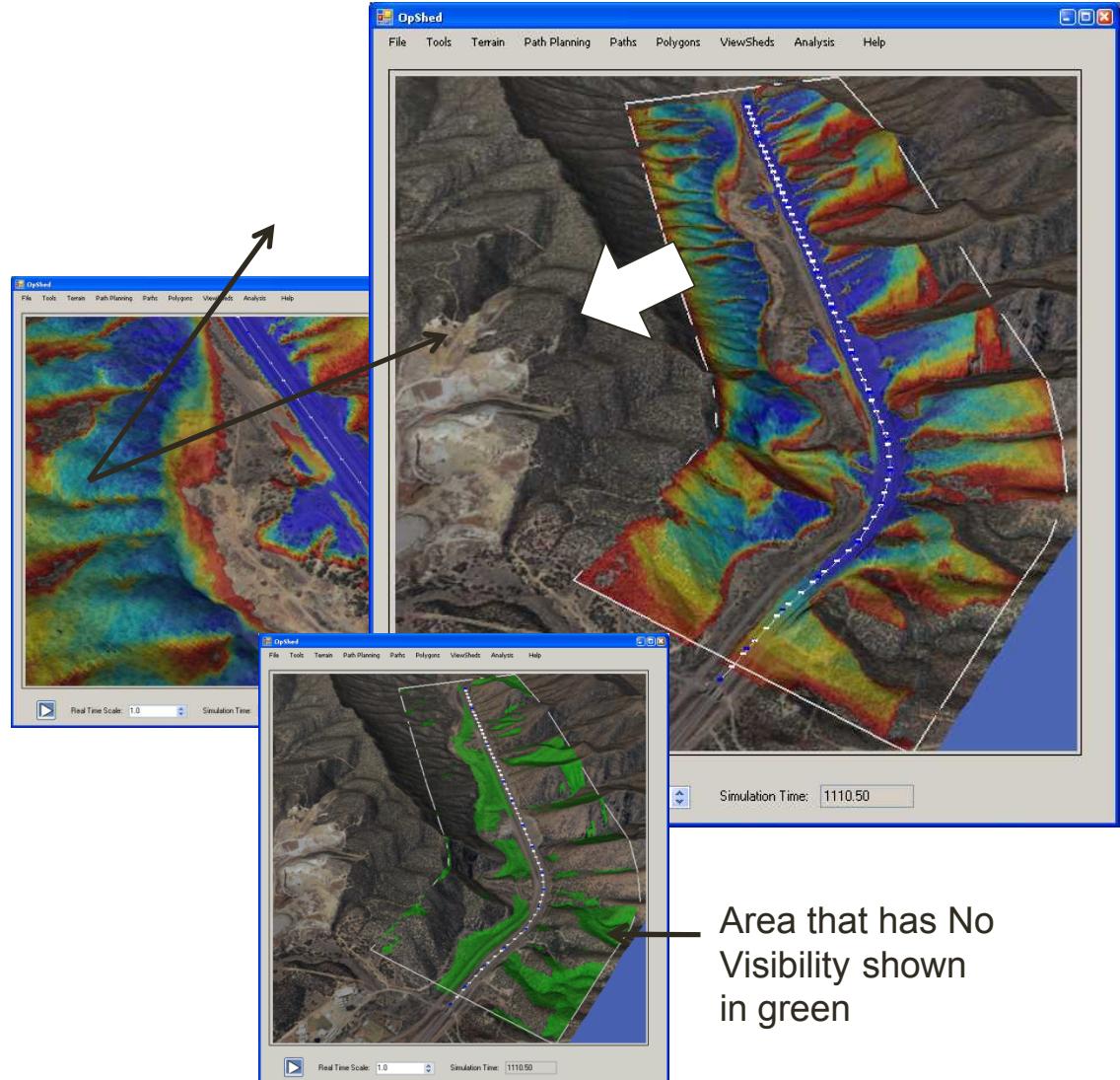
Tactical Operations & Sensor Models

- **Sensor Performance**
  - More than line-of-sight
  - Include sensor scanning, detection performance
  - Vary Target types
  - Include target operations
  - Analyze Paths

- **Path Planner**
  - Adjust planner features
    - Shortest Distance
    - Stealthy or Visibility
    - Sensor Viewshed
    - Terrain Features

Calculated Paths (White lines)

Sweeping Sensor

Sensor Coverage

End Pt

24 Radial Start Pts

Sensor Avoidance with Stealthy Paths