

The Use of Integrated Modeling and Simulation at FEMA for Emergency Preparedness Exercises

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**Homeland
Security**



Outline

- **IMMS Program**
- **FEMA NESC and SUMMIT**
- **SUMMIT Software Architecture**
- **Support of NESC Business Process**
- **NESC Pilot**
 - **Objectives**
 - **Training**
 - **Pilot Example**
- **Exercise Support Through the NESC**
- **Conclusion and Future Work**



IMMS Program

Vision: A capability for linking together “best-in-class” modeling and simulation tools to enable analysts, emergency planners, and incident managers more to effectively, economically, and rapidly prepare, analyze, train, and respond to real or potential incidents.

Central technological component of IMMS: the Standard Unified Modeling and Mapping Integration Toolkit (SUMMIT), which connects users such as emergency planners and exercise developers with modeling resources in an easy-to-use format.



SUMMIT

STANDARD UNIFIED MODELING, MAPPING, & INTEGRATION TOOLKIT

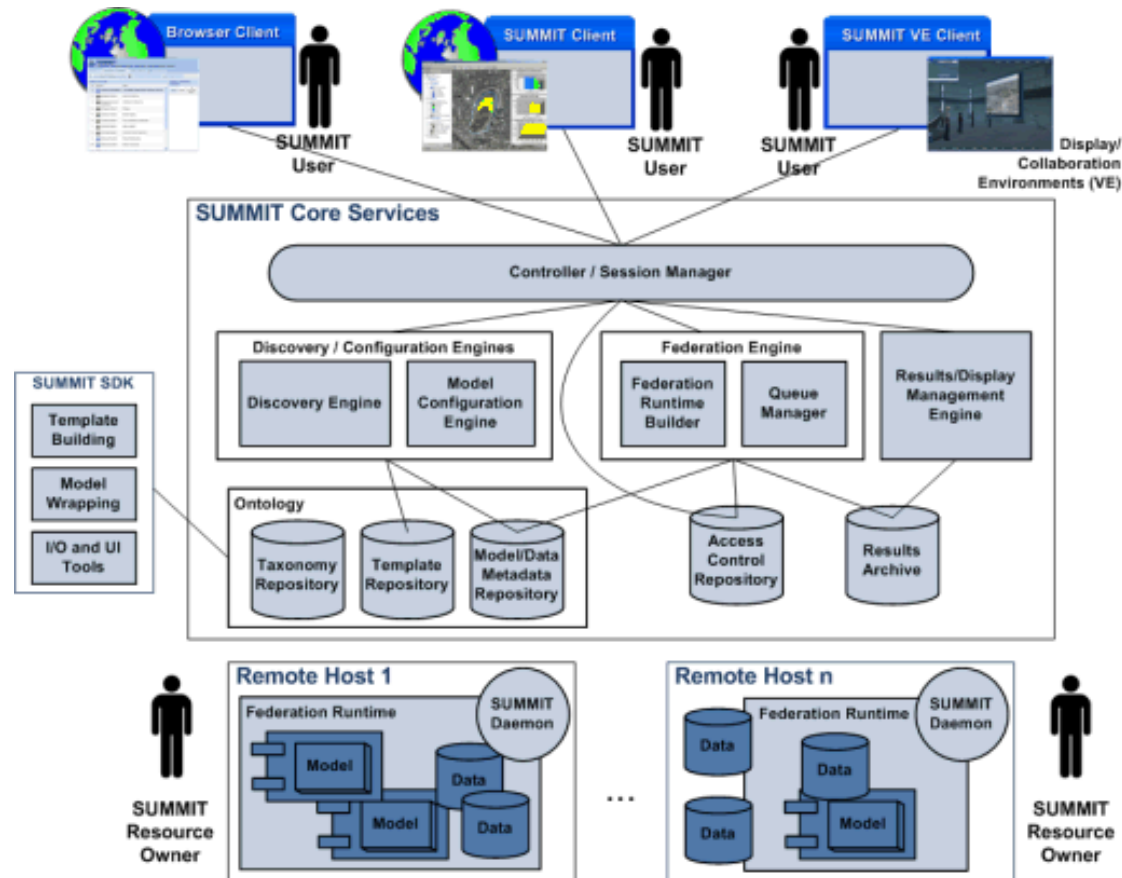


FEMA NESC and SUMMIT

- **Congressionally-mandated state-of-the art training and exercise facility within FEMA headquarters.**
- **Designed to be a scalable, flexible simulation center to accommodate a wide range of services.**
- **Supports the all-hazards preparedness and response mission.**
- **SUMMIT provides NESC with scientifically-based models for exercise planners to:**
 - **Create ground truth data**
 - **Develop exercise injects**
 - **Enhance scenario development**

SUMMIT Software Architecture

- Distributed system
- Multiple clients
- Remote hosting of SUMMIT-compliant models
- SDK tools
 - Template creation
 - Model wrapping





SUMMIT Software Architecture

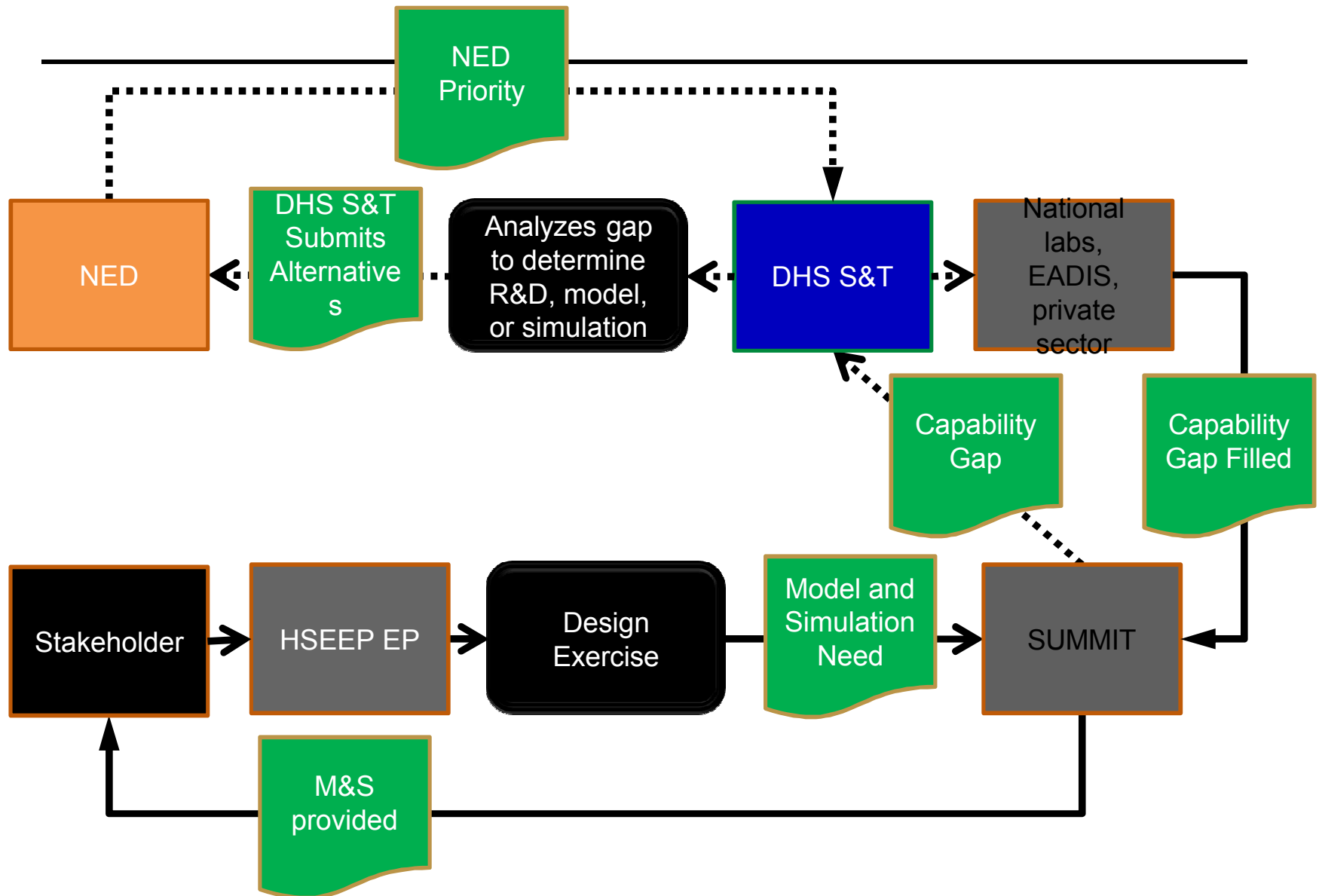
- **Modeler Support Components – SDK**
 - **Software Development Kit (SDK) is a collection of tools allowing content to be added to SUMMIT.**
 - **Assists scenario designers in the creation of new simulation templates.**
 - **Assists model owners in the wrapping and integration of new SUMMIT-compliant models to a SUMMIT system.**



SUMMIT Software Architecture

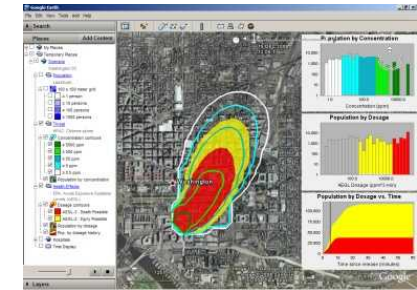
- **Mission Support Description**
 - **Includes adding new templates and models.**
 - **Scenario designers create new templates**
 - **Moderator can identify gaps prior to system addition**
 - **If a gap is identified, FEMA or DHS S&T can locate a model or contract software developers to create a new model that can be used in the system**
 - **New model will be wrapped and reviewed and included in SUMMIT**

NESC Business Process

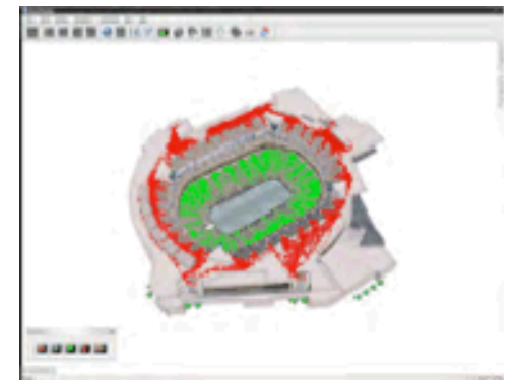


NESC Pilot: Objectives

- Objectives of the NESC Pilot:
 - Install, test, evaluate and refine SUMMIT capability in the NESC
 - Build understanding of how SUMMIT fits into NESC concept of operations
 - Increase the proficiency of NESC/NED users to apply SUMMIT capabilities in the exercise design process



HPAC visualized in Google Earth



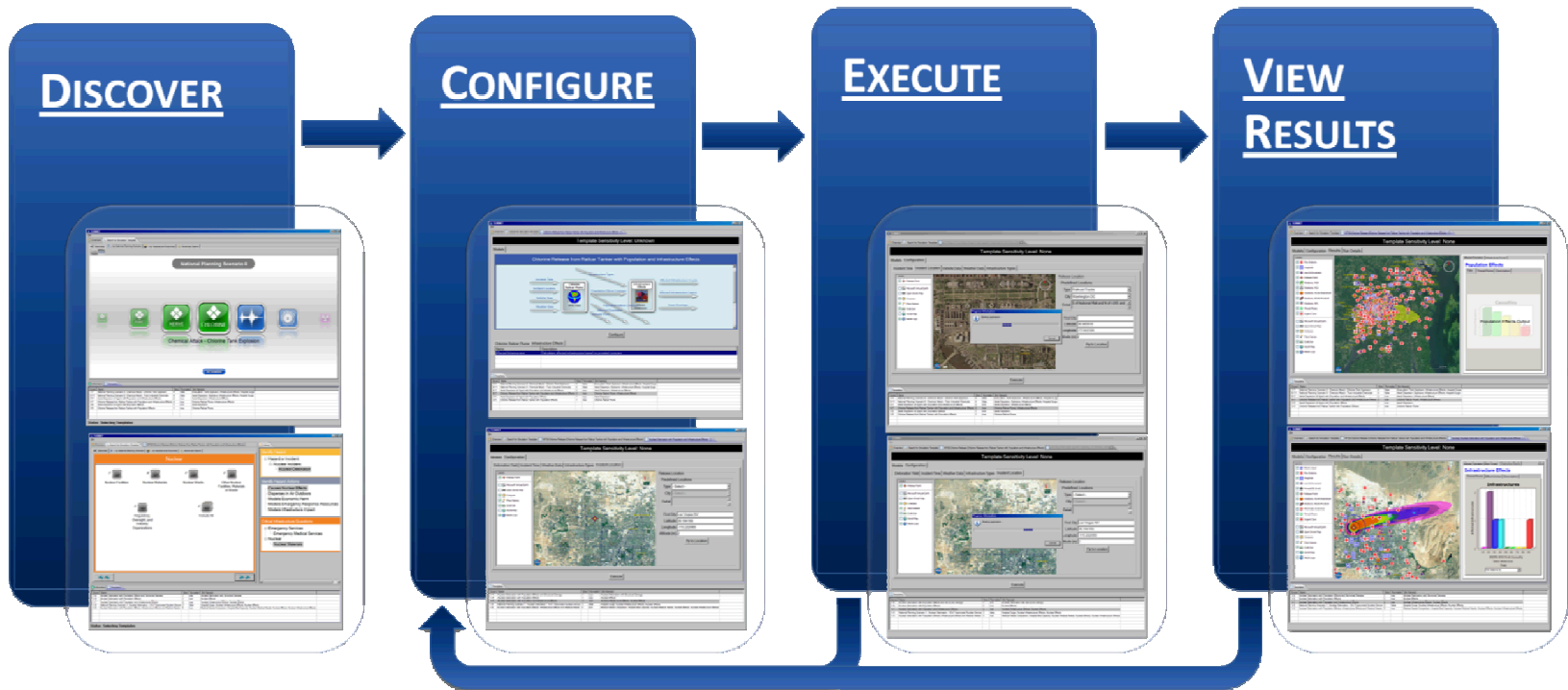
REGAL'S Evacuation Planning Tool



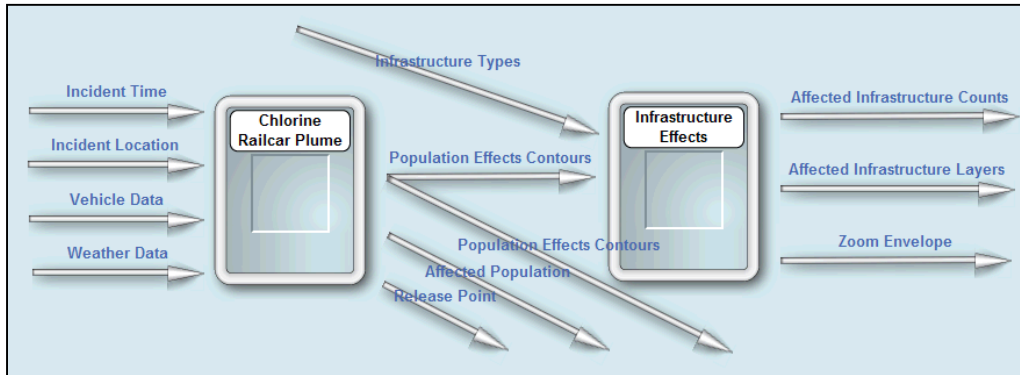
NESC Pilot: Training

- **Installation conducted at NESC – users verified basic operational capability of SUMMIT client.**
- **Training provided to FEMA NED.**
 - **Singular system capable of running cascading effects of multiple models**
 - **Allowed users to access multiple models on a singular platform**

NESC Pilot: System Operational Process



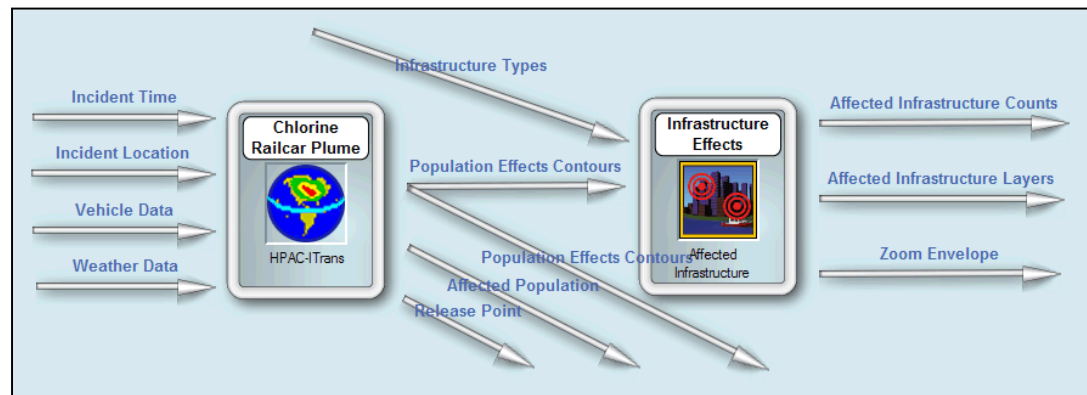
NESC Pilot: SUMMIT Template



Generic pattern for linking together models and data.

Each “slot” includes type and format of data inputs and outputs.

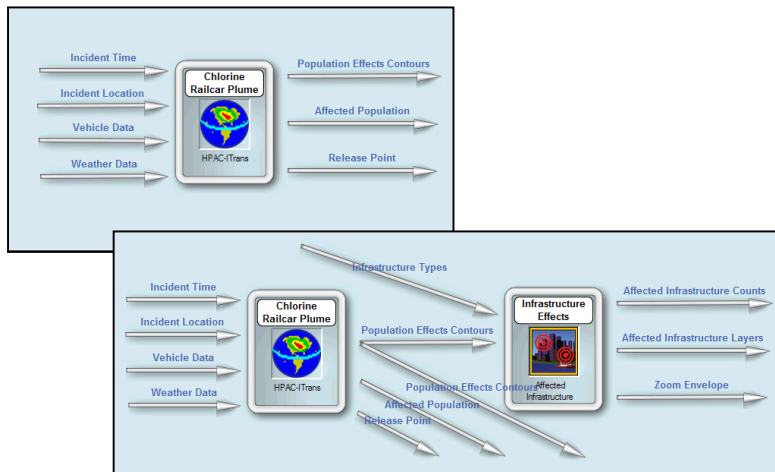
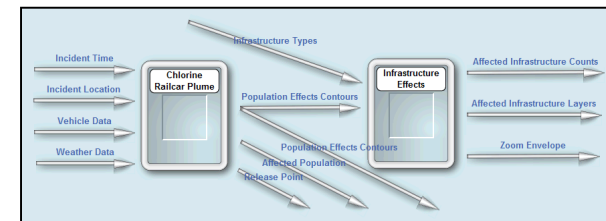
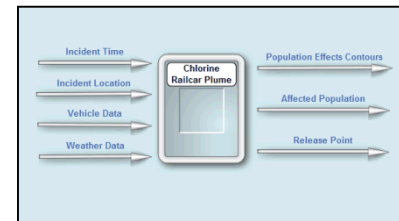
Model and data owners will use the SUMMIT Software Development Kit to wrap their tools so they fit within a “slot.” (a software engineering effort).



NESC Pilot: Discover

The SUMMIT Discovery engine walks users through a number of questions related to exercise or analysis objectives and scenario preferences, and uses those answers to discover relevant simulation templates.

Multiple templates may be relevant.

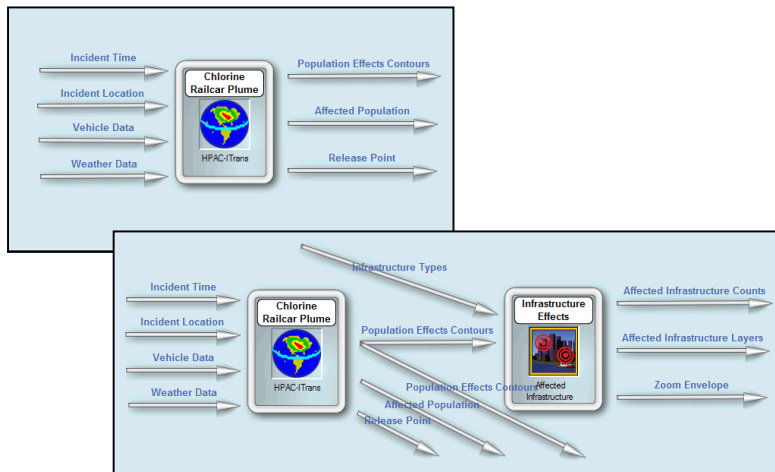
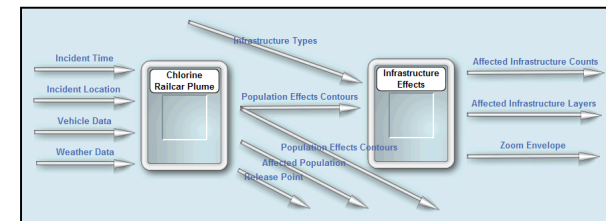
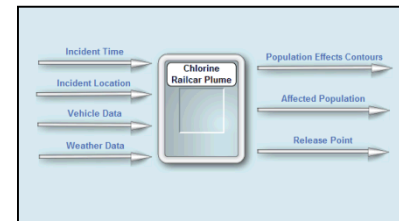


The Discovery engine also finds models and data that may fit into the template slots.

NESC Pilot: Discover

The SUMMIT Discovery engine allows the user to discover relevant simulation templates based on criteria such as National Planning Scenario, Target Capability, or Outcome.

Multiple templates may be relevant.



The Discovery engine also finds models and data that may fit into the template slots.

NESC Pilot: Discover Templates & Models

The first screenshot shows the 'Hazard or Incident' selection screen with icons for Chemical, Biological, Radiological, Nuclear, Explosives, Critical Infrastructure, Cyber Security, Ecosystem, Environmental, and Fire incidents. A blue arrow points from this screen to the second screenshot.

The second screenshot shows the 'Identify Hazard' screen with a tree view where 'Nuclear Incident' is selected, leading to 'Nuclear Detonation'. A blue arrow points from this screen to the third screenshot.

The third screenshot shows the 'Identify Hazard Actions' screen with a table of actions and their inclusion/exclusion status. A blue arrow points from this screen to the text on the right.

Identify Hazard Actions

Option	Include	Exclude	No preference
Causes Nuclear Effects	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Disperses in Air Outdoors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Models Economic Harm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Models Emergency Response Resources	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Models Infrastructure Impact	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Critical Infrastructure Questions

- Emergency Services
- Emergency Medical Services
- Nuclear
 - Nuclear Materials

and sets scenario scope (e.g., critical infrastructure, economic, population effects).

User chooses a hazard or exercise objective...

NESC Pilot: Discover Templates & Models

The SUMMIT application is a web-based tool for discovering simulation templates and models. It features a sidebar with navigation links: Overview, Find Archived Results, Create New Run, and Results Viewer. The main content area is divided into sections for selecting scenarios, hazards, capabilities, and outcomes, each with a corresponding table of results.

Top Left Screenshot: Select a Scenario

ID	Hazard	Title
1	Nuclear Detonation	Improvised Nuclear Device
2	Biological Attack	Aerosol Anthrax
3	Biological Disease Outbreak	Pandemic Influenza
4	Biological Attack	Plague
5	Chemical Attack	Blister Agent
6	Chemical Attack	Toxic Industrial Chemicals
7	Chemical Attack	Nerve Agent
8	Chemical Attack	Chlorine Tank Explosion
9	Natural Disaster	Major Earthquake
10	Natural Disaster	Major Hurricane
11	Radiological Attack	Radiological Dispersal Device
12	Explosives Attack	Bombing Using Improvised Explosive Device
13	Biological Attack	Food Contamination
14	Biological Attack	Foreign Animal Disease
15	Cyber Attack	

Top Right Screenshot: Matching Simulation Templates

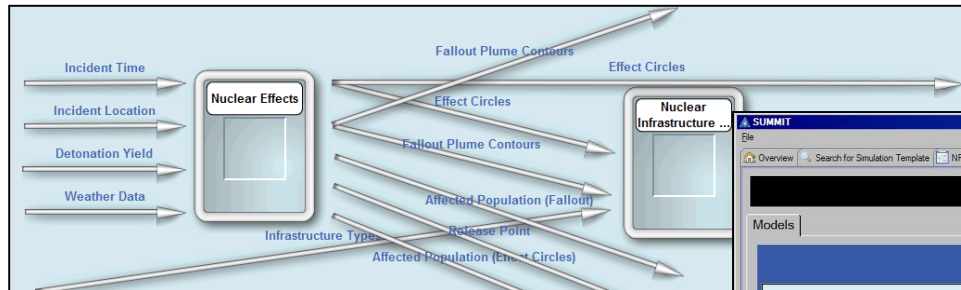
Score	Name	Runnable	# Archived Runs
1	Nuclear Detonation with Population and Infrastructure Effects	✓	1
1	Nuclear Detonation with Population Effects, Infrastructure Effects and Medical Needs	✓	1
1	Chlorine Release from Railcar Tanker with Population and Infrastructure Effects	✓	2
1	Chlorine Release from Railcar Tanker with Population and Infrastructure Effects, Infrastructure Effects and Medical Needs	✓	28
1	Aerial Dispersion of Agent with Population and Infrastructure Effects	✓	2
1	Earthquake Building Damage	✓	14
1	National Planning Scenario 9: Natural Disaster - Major Earthquake		0
1	National Planning Scenario 10: Natural Disaster - Major Hurricane		0
1	National Planning Scenario 11: Radiological Attack - Radiological Dispersal Device		0
1	National Planning Scenario 12: Explosives Attack - Bombing Using Improvised Explosive Devices		0
1	National Planning Scenario 13: Biological Attack - Food Contamination		0
1	National Planning Scenario 14: Biological Attack - Foreign Animal Disease (Foot and Mouth Disease)		0
1	National Planning Scenario 15: Cyber Attack		0
1	National Planning Scenario 2: Biological Attack - Aerosol Anthrax		0
1	National Planning Scenario 3: Biological Attack - Pandemic Influenza		0
1	National Planning Scenario 4: Biological Attack - Plague		0
1	National Planning Scenario 5: Chemical Attack - Blister Agent		0
1	National Planning Scenario 6: Chemical Attack - Toxic Industrial Chemicals		0
1	National Planning Scenario 7: Chemical Attack - Nerve Agent		0
1	National Planning Scenario 1: Nuclear Detonation - 10 KT Improvised Nuclear Device		0
1	National Planning Scenario 8: Chemical Attack - Chlorine Tank Explosion		0

Bottom Screenshot: Matching Simulation Templates

Score	Name	Runnable	# Archived Runs
1	Nuclear Detonation with Population Effects, Infrastructure Effects and Medical Needs	✓	1
1	Chlorine Release from Railcar Tanker with Population Effects, Infrastructure Effects and Medical Needs	✓	28
1	Earthquake Medical Supply Calculator	✓	14

User can choose a National Planning Scenario, a Hazard, a Target Capability, or an Outcome

NESC Pilot: Select Templates & Models



SUMMIT identifies and ranks relevant simulation templates based on the selected objectives, hazard and other scenario parameters.

Metadata is provided for models that are not SUMMIT-compliant.

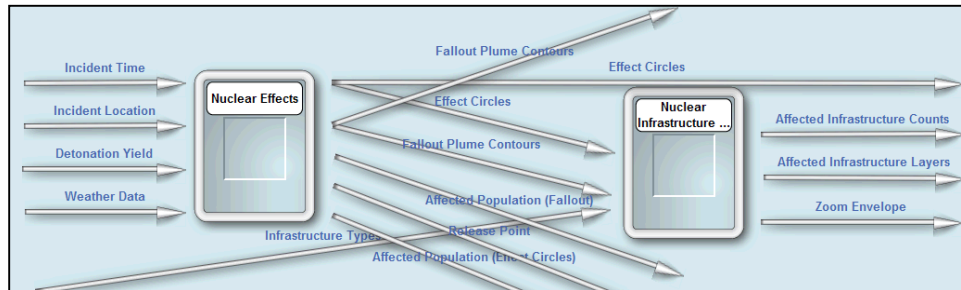
The screenshot shows the SUMMIT software interface. At the top, it displays 'Template Sensitivity Level: Unknown'. Below this, the 'Models' section shows a diagram of 'Nuclear Detonation with Population and Infrastructure Effects', which is a simplified version of the diagram on the left. The 'Configure' button is visible. Below the diagram, there are two tabs: 'Nuclear Infrastructure Effects' and 'Nuclear Effects'. The 'Nuclear Infrastructure Effects' tab is active, showing a table with the following data:

Name	Description
Nuclear Infrastructure Effects Mod	Calculates affected infrastructure based on provided contours and effect circles.

At the bottom, the 'Templates' section shows a table with the following data:

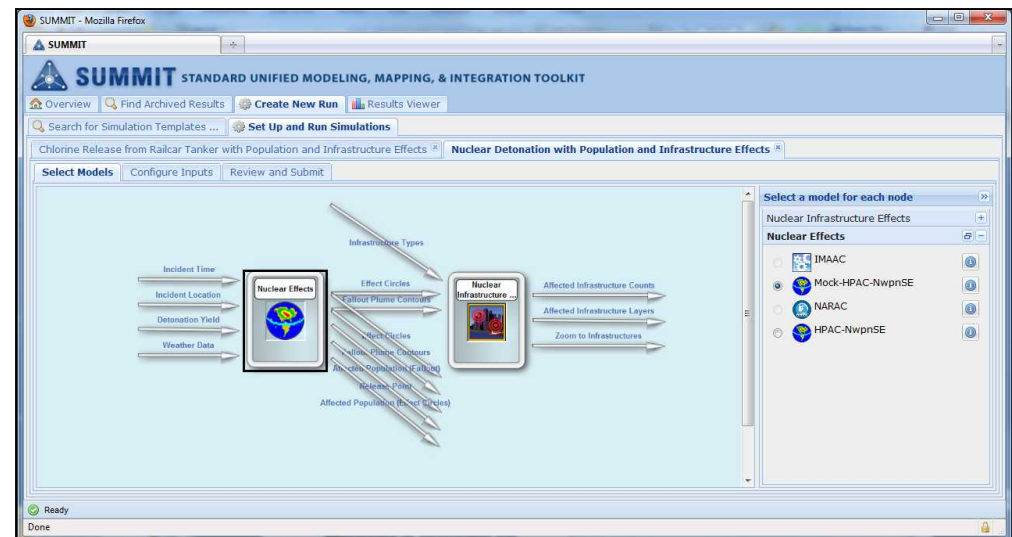
Score	Name	Sets	Runnable	Slot Name(s)
1/4	Nuclear Detonation with Population Effects and Structural Damage	1	true	Nuclear Detonation with Structural Damage
1/5	Nuclear Detonation with Population Effects	1	true	Nuclear Effects
1/7	Nuclear Detonation with Population and Infrastructure Effects	2	true	Nuclear Infrastructure Effects, Nuclear Effects
1/8	National Planning Scenario 1: Nuclear Detonation - 10 kT Improvised Nuclear Device	3	false	Hospital Surge, Nuclear Infrastructure Effects, Nuclear Effects
1/8	Nuclear Detonation with Population Effects, Infrastructure Effects and Medical Needs	5	true	Medical Needs Comparison, Hospital Bed Capacity, Nuclear Medical Needs, Nuclear Effects, Nuclear Infrastructure Effects

NESC Pilot: Select Templates & Models



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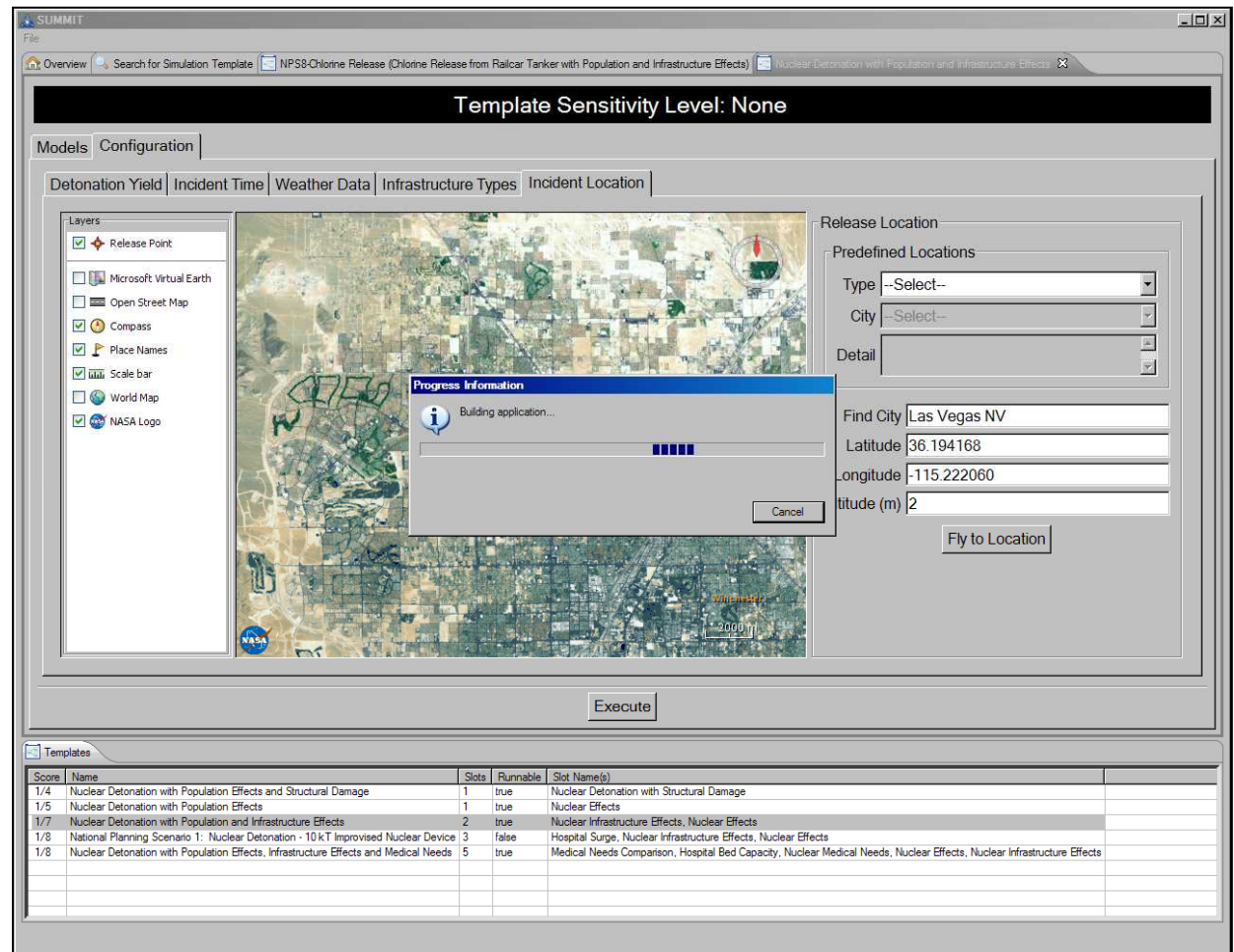
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NESC Pilot: Configure & Execute

If SUMMIT-compliant models are chosen, the user can configure the models (e.g., specify the scenario location, date/time, threat characteristics, etc.).

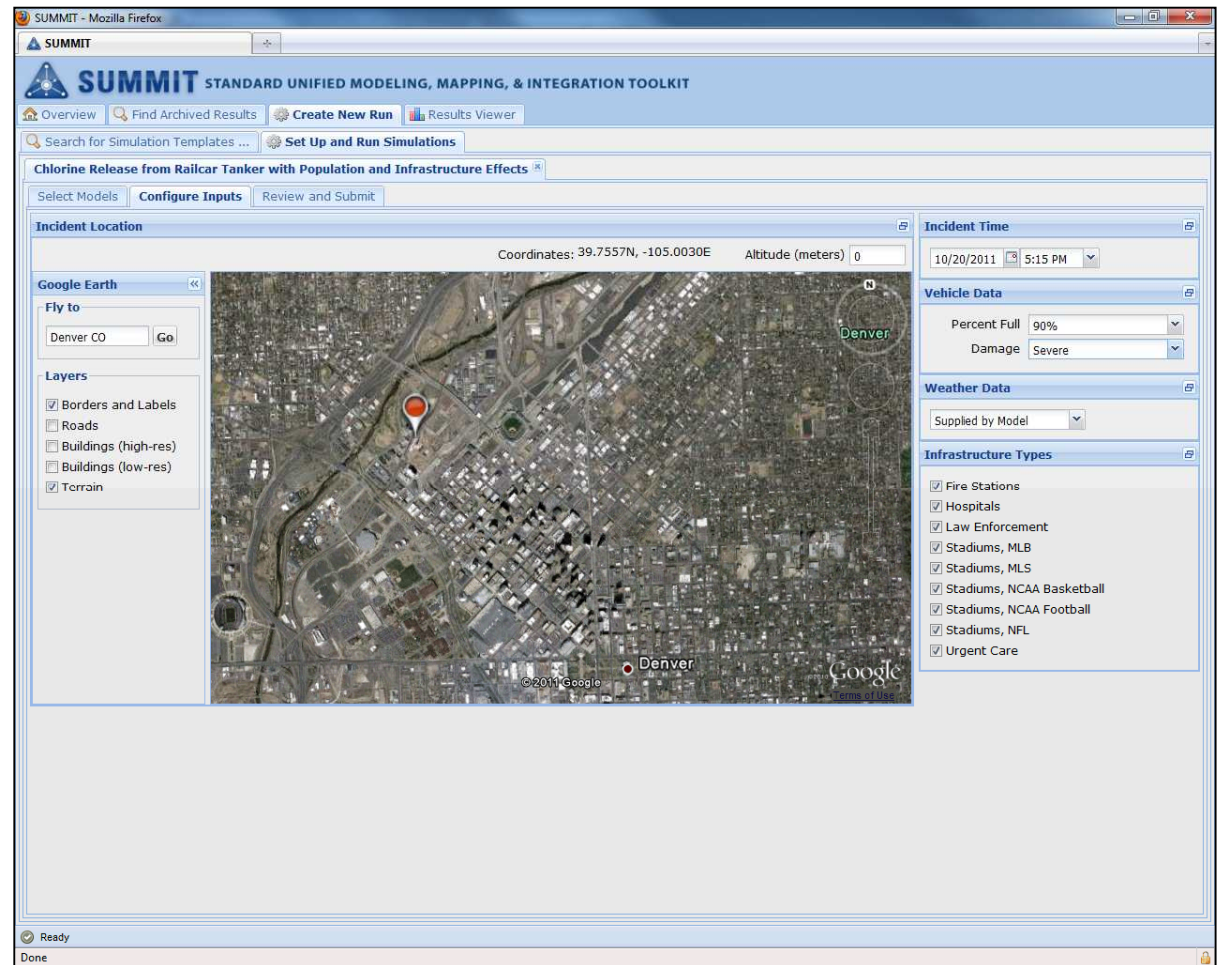
The system automatically links the models and seamlessly executes them.



NESC Pilot: Configure & Execute

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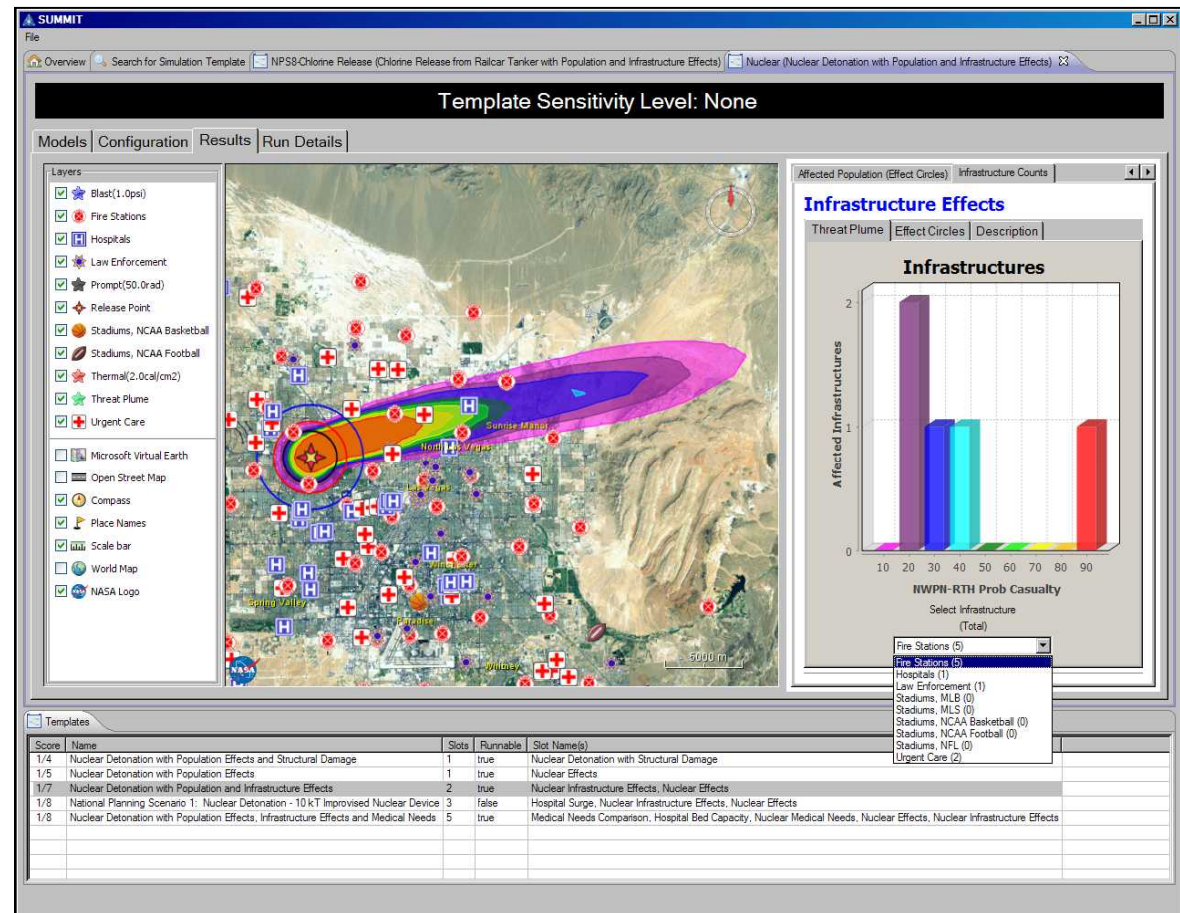


NESC Pilot: Results

SUMMIT Simulation Templates also support result integration.

Output from multiple models can be overlaid within GIS systems or displayed in other visualization tools.

Configuration parameters and results are archived and can be easily accessed and rerun.

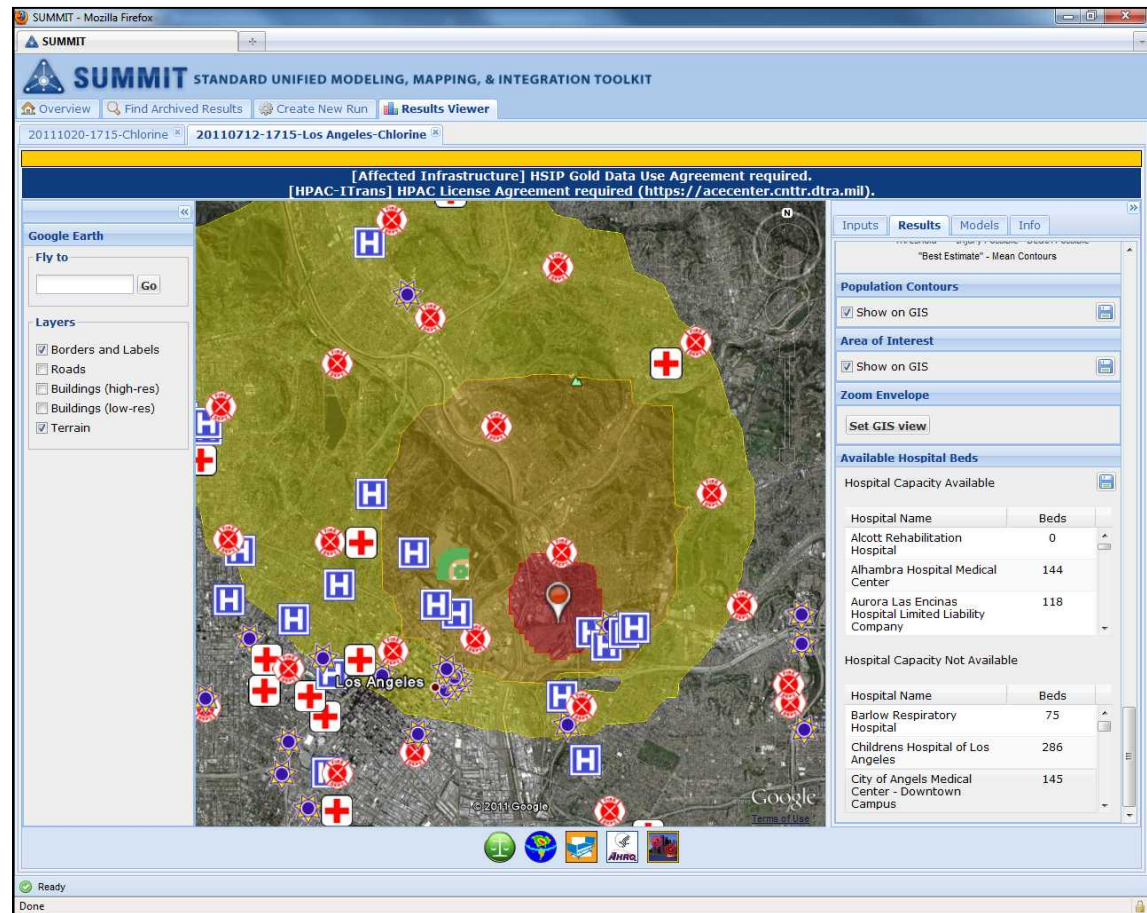


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Exercise Support Through the NESC

- **Transition the use of M&S to the larger exercise community**
- **FEMA Regional Exercise Support Program**
- **Types of Support**
 - **Development of scenarios**
 - **Ground truth data**
 - **Considerations for response to a cascade of modeling outputs**
- **Used in exercise design through template configuration**
- **Used in exercise conduct to support injects to prompt and challenge participant actions**



Conclusions and Future Work

- **Full SUMMIT transition underway**
- **Exercises support**
 - **NLE 2010, 2011, 2012**
 - **U.S./Sweden 2011**
 - **Utah Shakeout 2012**
 - **Evergreen 2010**
 - **WAARP**

To Learn More

- Visit dhs-summit.us
- “Integrated Modeling, Mapping, and Simulation (IMMS) Framework for Planning Exercises”, T. Plantenga, E. Friedman-Hill, (*IITSEC*), Nov 2010.
- “Simulation Templates in the SUMMIT System”, E. Friedman-Hill, T. Plantenga, and H. Ammerlahn, in *2010 SISO Spring Interoperability Workshop, Apr 2010*. To be reprinted in *M&S Journal* (www.dod-msiac.org).

Simulation Support for Emergency Preparedness & Response

SUMMIT is a software toolkit that enables analysts, emergency planners, responders, and decision makers to seamlessly access integrated suites of modeling tools & data sources for planning, exercises, or operational response.

The SUMMIT Early Adopter Program is currently underway.

