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

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Abstract— The Integrated Modeling, Mapping, and Simulation (IMMS) program is partnering with the Federal Emergency Management Agency (FEMA) to bring modeling and simulation (M&S) to bear on national exercises and incident response management. IMMS, funded by the Department of Homeland Security Science and Technology Directorate (DHS S&T), is creating an integrating framework that brings together diverse models for use by the emergency response community. SUMMIT (Standard Unified Modeling and Mapping Integration Toolkit) is the initial software framework that connects users such as exercise planners with modeling resources, bridging the gap in expertise and technical skills between these two disciplines. IMMS has conducted a pilot program with FEMA to deploy SUMMIT at the National Exercise Simulation Center (NESC) in order to gather lessons learned to improve SUMMIT while it is under development, and to allow FEMA to introduce the use of integrated M&S in their exercise programs.

Keywords-SUMMIT, NESC, modeling and simulation.

I. INTRODUCTION

The Integrated Modeling, Mapping, and Simulation (IMMS) program is partnering with the Federal Emergency Management Agency (FEMA) to bring modeling and simulation (M&S) to bear on national exercises and incident response management. IMMS, funded by the Department of Homeland Security Science and Technology Directorate (DHS S&T), is creating an integrating framework that brings together diverse models for use by the emergency response community. SUMMIT (Standard Unified Modeling and Mapping Integration Toolkit) is the initial software framework that connects users such as exercise planners with modeling resources, bridging the gap in expertise and technical skills between these two disciplines. IMMS has conducted a pilot program with FEMA to deploy SUMMIT at the National Exercise Simulation Center (NESC) in order to gather lessons learned to improve SUMMIT while it is under development, and to allow FEMA to introduce the use of integrated M&S in their exercise programs.

The NESC provides support for national-level, federal, state and local exercises. Additionally, the NESC serves as "future planning" support for FEMA's Disaster Operations Directorate and other FEMA and DHS directorates by providing technical M&S tools that enable the emergency preparedness community to better visualize potential disaster scenarios. In order to fulfill its commitment as a national resource for M&S to the emergency preparedness community, the NESC maintains a heavy focus in M&S technologies.

SUMMIT provides the NESC with a scientific-based set of models from which interagency planners across the nation can create ground truth data for exercises and test their emergency response plans against plausible scenarios. SUMMIT provides a foundation for FEMA to introduce M&S to National Level Exercises, tabletop exercises, and National Simulation Cell functions. In addition, FEMA can outreach to local and state emergency planners to introduce M&S to FEMA's broader emergency preparedness community.

II. SUMMIT ARCHITECTURE

A. System Components

The SUMMIT architecture has three main components: distributed clients, core SUMMIT architecture, and data and models. The "data" and "model" icons (Figure 1) are components owned by model contributors; these components typically run on hosts that are remote to the SUMMIT server. The SUMMIT client and user interface allows users to log in and interact with SUMMIT from a remote

machine. Clients include a native rich client platform, a browser-based client, and interfaces to advanced visualization. The controller/session manager manages the distribution operation of SUMMIT, including access control. The discovery engine interacts with users to find appropriate resources, and configures simulation templates with specific inputs and SUMMIT-compliant models. The federation runtime builder takes a configured simulation template and constructs an executable runtime. The queue manager manages the execution of runtimes. Lastly, the results management engine stores and obtains the results.
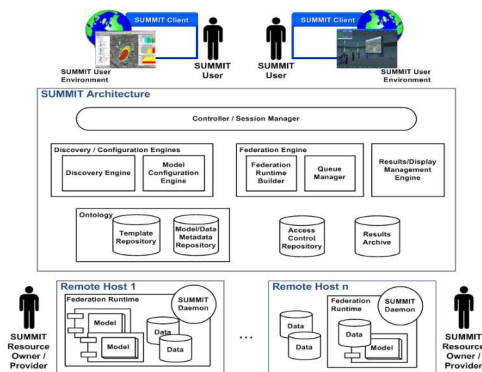

Figure 1. Architecture Overview

B. Modeler Support Components

In addition to the architecture components, SUMMIT provides a Software Development Kit (SDK), which is a collection of tools that allow content to be added to a SUMMIT system. The SUMMIT SDK assists scenario designers in the creation of new simulation templates. A new simulation template will address a particular emergency or threat scenario by defining modeling tools and how they link in an abstract manner.

The SUMMIT SDK also assists model owners in the wrapping and integration of new SUMMIT-compliant models to a SUMMIT system. Model owners are responsible for contributing and maintaining modeling and simulation tools that can be used in a simulation template. The SDK allows modelers to define or reuse an abstract slot that can be connected with other slots in a template. The slot conveys model functionality in an intuitive way, and defines a software interface so SUMMIT can broker execution with minimal user involvement. The SUMMIT SDK helps model owners define an interface, and provides a test bed to prove that a wrapped model is SUMMIT-compliant.

C. Mission Support Description

Mission Support includes adding new templates and models to the system. First, scenario designers create templates. A template moderator receives each new template and reviews it prior to adding it to a system deployment. This template moderator can identify gaps in the template, for example, where new models are needed so that the template can be configured and executed.

If a gap is identified by FEMA or another agency, DHS S&T can locate a model or contract software developers to create a new model that can be used in the system. This new model will be wrapped using a system model wrapper. Once a model is wrapped, that model is received by a model moderator. The model moderator reviews the model for system compliance before it is made available through the system. A permissions coordinator negotiates MOUs and determines what users can access the new models.

A final moderator is a data type expert. The data type expert reviews templates and model slots for consistent data types of inputs and outputs. Further, the data expert may determine if data translators are necessary to enable interoperability between models.

III. PILOT PHASES

The NESC pilot is being delivered in three phases in relation to the following objectives: Installation, testing, and training of SUMMIT; Alignment with the NESC business processes, and; application of SUMMIT to exercises supported by FEMA.

A. Installation, Testing, and Training

Installation of SUMMIT was conducted at the NESC and included the delivery of instructions for users to verify the basic operational capability of the SUMMIT client using an externally facing SUMMIT server hosted at Sandia National Laboratories. Training was delivered to representatives of FEMA's National Exercise Division (NED) and was intended to introduce users to a singular system capable of running cascading effects of multiple models. This capability differed

from the previous use of M&S for exercise support primarily because it allowed users to access multiple models on a singular platform. Training allowed users to configure templates (See Figure 2) based on DHS National Planning Scenarios to include the use of an improvised nuclear device or a chemical attack. Users would specify inputs and view results to determine their utility in a disaster exercise.

Figure 2. System Operational Process Workflow

Training recipients were particularly interested in the use of the SUMMIT results archive feature. Once a template is executed, a user can archive the results. Users were also able to easily access and rerun templates, as well as search and find results in the archive.

B. Alignment with NESC Business Process

The NESC is a Congressionally-mandated state-of-the art training and exercise facility within FEMA headquarters. The NESC is designed to be a scalable, flexible simulation center to accommodate a wide range of services, including, but not limited to, executive briefings, unique training events, tabletop exercises, and exercise Master Control Cell and National Simulation Cell functions. The NESC supports the all-hazards preparedness and response mission through: employing a mix of live, virtual and constructive simulations; providing standardized and sustained exercise and training support and; pooling resources to maximize efficiency. As such, it is envisioned that the NESC will serve as the distribution hub for users of SUMMIT for local, state, and federal exercises.

A reach-back capability (possibly through a specified NESC staff position(s)) will be needed for some of the more complicated models that require guidance on assumptions and limitations. This support is critical at the regional level, where M&S experts are not available, and may include information tabs in SUMMIT with phone numbers and email addresses of points of contacts at universities and national laboratories.

The NESC will have additional staffing requirements outside of the end users (exercise planners and participants) to operate SUMMIT, assist and train the end user to utilize SUMMIT, update software changes, monitor the system, and conduct minor troubleshooting if required.

C. Support of Exercises

The final phase of the pilot is to ensure that NESC/NED staff is prepared to utilize SUMMIT to support an exercise and to therefore begin the transition of the use of M&S to the larger exercise community that includes local and state exercise planners. This will be accomplished by leveraging existing exercise programs in FEMA regions. One such program is the FEMA Regional Exercise Support Program (RESP). The purpose of the RESP is to provide support to regionally coordinated exercise initiatives. The RESP supports exercises dealing with the full range of hazardous scenarios and incidents (e.g. natural disasters, terrorism, technological disasters). SUMMIT is well suited to support RESP initiatives through the use of template configuration as it relates to the National Planning Scenarios. An objective of the pilot is to assist local and state exercise planners in the use of SUMMIT to develop scenarios, ground truth data, and considerations for response to a cascade of modeling outputs.

The use of SUMMIT to support exercises will focus on two main elements as it pertains to the pilot – design and conduct.

Exercise planners can utilize SUMMIT during the design phase by selecting models that are aligned with the objectives associated with the hazard or scenario. SUMMIT makes it easy to populate templates with models and configure run templates, and therefore, an exercise planning modeler may populate the same template with different models or rerun the same template with varied inputs in order to develop a detailed scenario, ground truth data, or exercise inject. A planning modeler can create a number of "what if" scenarios by applying science-based analysis. The planning modeler can create qualitative injects, based on science-based models. Furthermore, exercise planners can use the system to

display capabilities (data visualization, graphical and tabular displays) to refine scenario and ground truth data with other exercise stakeholders.

During the conduct phase, the system can be used in several ways. It can be used to update exercise inject information and events to influence exercise player actions. SUMMIT models can provide on-demand injects and alter ground truth during an exercise, as needed. System-provided data visualization, in some cases – 3D, can be provided to the exercise controllers and evaluators to give a common operating picture of the exercise scenario and events.

IV. CONCLUSIONS

M&S through SUMMIT is one viable technology solution to address deficiencies in the ability to make exercises more realistic and science-based. Through the pilot at the NESC, SUMMIT can be advanced to provide scientific reality in a cost-effective manner by allowing exercise planner to use scientifically-grounded information and produce "what-if" analysis without stressing resources. SUMMIT provides the NESC with the capability to train in a cost and time-effective environment, plan and support exercises with science-based analysis, and improved overall preparedness to a variety of hazards. The breadth and depth of valid models integrated together provide a rich set of information to exercise planning and operational response.

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