RAISE: Reflective Middleware Architecture for Integrated Simulation Environments

Leila Jalali, Sharad Mehrotra, Nalini Venkatasubramanian

Department of Computer Science, University of California, Irvine

ljalali@ics.uci.edu, sharad@ics.uci.edu, nalini@ics.uci.edu

Abstract—RAISE is a research project aimed at building a framework and platform that supports the integration of multiple existing models, simulations, and data. The grand challenge is to facilitate the process of pulling the independently created models together. In our approach, RAISE, we explore a reflective middleware to address challenges of integrated simulation environments in which interoperability of different simulators can be ultimately achieved in a flexible and efficient manner. We evaluate our proposed techniques via a detailed case study from the emergency response domain by integrating four disparate simulators—a transportation simulator (VISUM), an evacuation simulator (Drillsim), a communication simulator (LTEsim), and a fire simulator (CFAST).

I. MOTIVATION

Modelling and simulation is an important methodology for addressing a variety of real-world problems; it offers numerous advantages instead of experimenting with the real system itself. One of the limitations of these simulators is that they are developed by domain experts who have an in-depth understanding of the phenomena being modelled and are typically designed to be executed and evaluated independently. The grand challenge is to facilitate the process of pulling all of these independently created models together.

Simulation integration has been studied in (a) military command-and-control and (b) games and virtual environments. Taking expert models of relevant aspects of each constituent real-world system, we aim to synthesize, engineer, and integrate those models, resulting in an interoperating complex model system in which policy-makers can try out alternatives in a low-cost, highly responsive way. In contrast to prior work on simulation integration, in RAISE, we do not need to integrate simulations tightly into a common framework, but we make it feasible to semi-automatically compose simulation models via a looser coupling approach that avoids the need to adhere to a rigid common interface, which can hinder leveraging prior work.

II. CONTRIBUTION

In RAISE, we explore a reflective middleware architecture (figure 1) to address challenges of integrated simulation environments in which interoperability of different simulators can be ultimately achieved in a flexible and efficient manner. The design aims to separate the base level aspects (of each simulator) from the meta-level observation and adaptation mechanisms. The base level encompasses aspects of the individual simulators. Reification of base level properties yield meta-level models, currently specified as UML diagrams. Base-meta interactions occur through simulator wrappers that handle the processing of external events in each simulator by forwarding requests to meta level. We have three key modules at meta level: (a) Synchronizer which uses the proposed approaches to monitor and control concurrent execution in the multisimulation environment; (b) Analyzer which analyzes the interactions between simulators and controls the consistency using the consistency controller; (c) Adapter which manages the data exchange and adapts information that is passed between simulators.

III. EXPECTED RESULTS

In this poster we will present a detailed case study for simulation integration in RAISE using four pre-existing real world simulators—our goal is to validate RAISE and understand issues in its realization. We focus primarily on integrating simulation and models aimed at informing emergency response policy decision making. The specific simulators in this case study are (1) CFAST, the Consolidated Model of Fire and Smoke Transport, is a fire simulator that simulates the effects of fire and smoke inside a building, (2) Drillsim, a multi agent evacuation simulator that models a response activity evacuation, (3) LTEsim, a communication simulator for the next generation wireless network infrastructure performs network level simulations of 3GPP Long Term Evolution, and (4) VISUM which is a multi-modal traffic flow simulation software. We show our proposed approach for the integration of independently created, deep domain models, is feasible, practical, flexible, cost-effective, attractive, and usable.

Fig. 3. RAISE Architecture for Simulation Integration

REFERENCES