REST-ful GIS services for simplified interoperability in blended LVC and model-based situational awareness

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Abstract — Modeling and simulation (M&S) tools are essential to a variety of mission goals; supporting readiness, training, and on-going operations. As development of advanced capabilities and models continues, differences in assumptions and engines make interoperability increasingly complex thus lowering general utility. Many frameworks exist but can be difficult to incorporate; many require modifying the underlying simulation or are not readily available across platforms (e.g. mobile). In this work, we propose using a transactional web service, called GeoDispatch, as an alternative. While not a simulation system or run-time infrastructure (RTI), GeoDispatch provides a simple interface using widely-supported protocols and data types (e.g. ArcGIS geometry) to simplify the exchange of simulation events and information. Integration does not require changes to the individual simulations. We highlight GeoDispatch's effectiveness by demonstrating bi-directional interactions between live assets and the Umbra simulation framework where live clients receive situational awareness information while interacting with virtual sensors and entities.

1 Introduction

Interoperability remains a large challenge across Live, Virtual, and Constructive (LVC) systems and simulations and has received significant attention from the research community. The evolving multitude of models operating under different scales, assumptions, methodologies, and platforms only adds to the interoperational complexity. However, their continued and increasing importance across numerous mission domains makes this a necessity. Many distributed simulation solutions exist; most are managed by a centralized service. The High-Level Architecture [1] (HLA) and the Distributed Interactive Simulation [2] (DIS) standards are among the most popular, though can be challenging to integrate since they frequently require 3rd party software libraries, do not have a standardized protocol, and may require changing assumptions of the simulation to implement.

In contrast, we propose interoperability based on "REpresentational State Transfer" (REST) services [3] popularized by world wide web principles. Modern REST-ful services already provide many of the capabilities we need; standardized protocols, predefined schemas and formats for data and event exchange, and supporting libraries are readily available across many platforms and programming languages. While other approaches (e.g. RISE[4] and Taverna[5]) have explored RESTful services for interoperability, our approach, called GeoDispatch, focuses on live simulation support and a simple but general API as a lightweight middleware to synchronize simulation resources and provide analytical results.

In comparison to prior approaches, GeoDispatch is not a workflow, a simulation system, nor does it contain any run-time infrastructure (RTI). Instead, it aids in interoperability by running a continuous service that (1) provides a set of interfaces that simulations can access during run-time, (2) standardizes data type and interchange via widely-supported formats and data types (e.g. ESRI ArcGIS geometry via JSON), and (3) maintains the state of the set of entities and metadata. By providing the basis for asset and graphical data exchange, GeoDispatch allows simulations the flexibility to retrieve, consume, and publish data as they see fit.

2 Key Elements

At its core, GeoDispatch serves as a platform for the exchange of real and virtual locations of entities as well as geospatial graphics. It is defined by a simple API that is accessible via "universal resource identifiers" (URIs) or endpoints. Each endpoint handles GET, POST, and DELETE HTTP requests, allowing client applications to retrieve, update, or remove information, respectively. Data is both sent and received in JSON format to make it simple yet expressive.

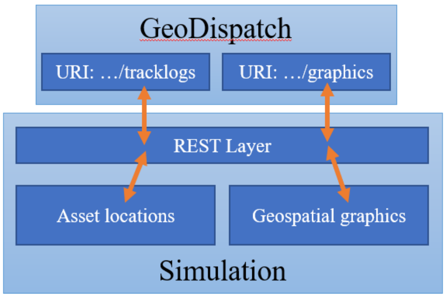

Fig. 1. Service architecture and simulation integration

The service architecture includes two primary endpoints (see Figure 1). The *tracklogs* endpoint allows it to receive and provide real-time multiple concurrent entity locations (e.g. actual smartphone locations or virtually generated locations) while the *graphics* endpoint handles arbitrary real-time geospatial graphics data representing real or virtual points, lines, or areas.

GeoDispatch can share real-time locations of entities (virtual or otherwise) by name and can dispatch geospatial graphics notifications/information (virtual or otherwise) to client applications; e.g. individuals, groups or M&S processes. Simulations are free to retrieve or publish the associated information, allowing GeoDispatch to integrate real and virtual situational awareness communications between any types of clients.

3 Results

To explore the effectiveness of the framework we developed multiple two simulation clients, one web browser-based solution and one that interacted with

Umbra, a simulation and analytics framework developed by Sandia National Laboratories (see Figure 2).

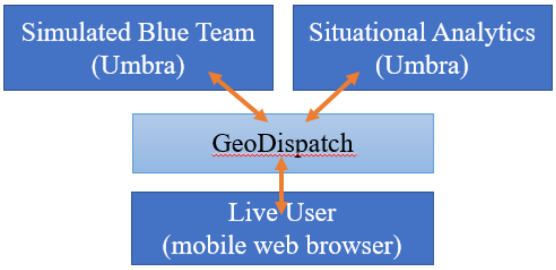

Fig 2. Components in notional LVC exercise

From these clients, we modeled an exercise that incorporated both live and virtual assets with computed situation awareness information (see Figure 3). A live mobile/web client (orange dot) publishes its location while receiving information from GeoDispatch. Umbra had different uses over multiple instances. One instance modeled a blue-team at a facility with virtual sensors, entities, and a command-and-control station while another provided situational awareness for the live clients. As the live clients moved through the real facility, it would trigger virtual sensors and the subsequent blue response. The live user would be able to see the virtual response (blue dots in Figure 3) while also receiving (likely) sensing viewsheds (pink region) and tactically advantageous routes (green dotted lines) for itself and its team based on its known information and the terrain.

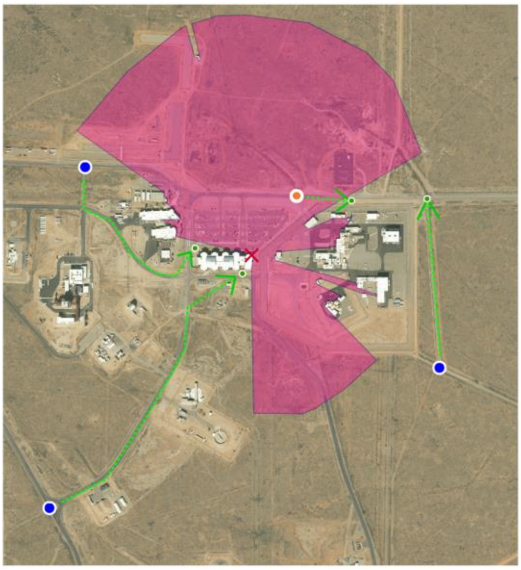

Fig 3. A mobile user's browser-based client tactical view.

By relying on common data specifications and libraries, client implementations only needed to implement GeoDispatch's REST interface to ingest and use information from other clients. Thus, client applications did not depend on the underlying models, algorithms or assumptions of the other simulations. Given its flexibility, we expect that this framework can easily bridge multiple types of models and analyses across a variety of current and future platforms and technologies.

4 Conclusion

In this work, we describe a framework using REST-ful services as a synchronization tool to support interoperability between M&S tools. This approach is advantageous in that it uses standardized protocols and data schemas with a popular and ubiquitous service model that is suitable for live applications. This allows for ease of integration across a variety of methodologies and platforms without requiring in-depth knowledge of how the other tools operate. Finally, we show a potential application and the effectiveness of the approach by integrating live assets into a virtual "blue-team" scenario while simultaneously providing it with live situational analytics.

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Russell Gayle is a Principal Member of the Technical Staff at Sandia National Laboratories. He has a PhD in Computer Science and his research interests include simulation, robotics, and autonomy. Since joining Sandia, he has lead several programs and worked on expanding and investigating novel applications for the Umbra framework.

Fred Oppel is a Distinguished Member of the Technical Staff at Sandia National Laboratories in the Interactive Systems, Simulations, and Analysis Group. He has experience in the areas of operational 3-D simulations and analysis, autonomous command and control, and author of the Umbra simulation framework at to support this activity.

Leo Bynum has prior incarnations at NASA's Jet Propulsion Lab, ESRI professional services, Autodesk, NearSpace, and as a Senior Engineering Architect with bd Systems developing the Bay Area Transit web site www.511.org. He joined Sandia National Labs in 2005 where he supports dynamic geospatial and visualization web applications.