GEMS

Technology Enabling Command & Control Interoperability with Modeling & Simulation

Why is SIM-C4I interoperability important?

As command and control systems move into the 21st century, they are increasing looking to embed simulation capability for training, course of action analysis, mission planning, and other "what if" scenarios. In order to interoperate modeling and simulation assets with operational command and control systems, a number of technical challenges must be addressed. This paper describes those challenges and how VT MÄK can help solve them.

What is GEMS?

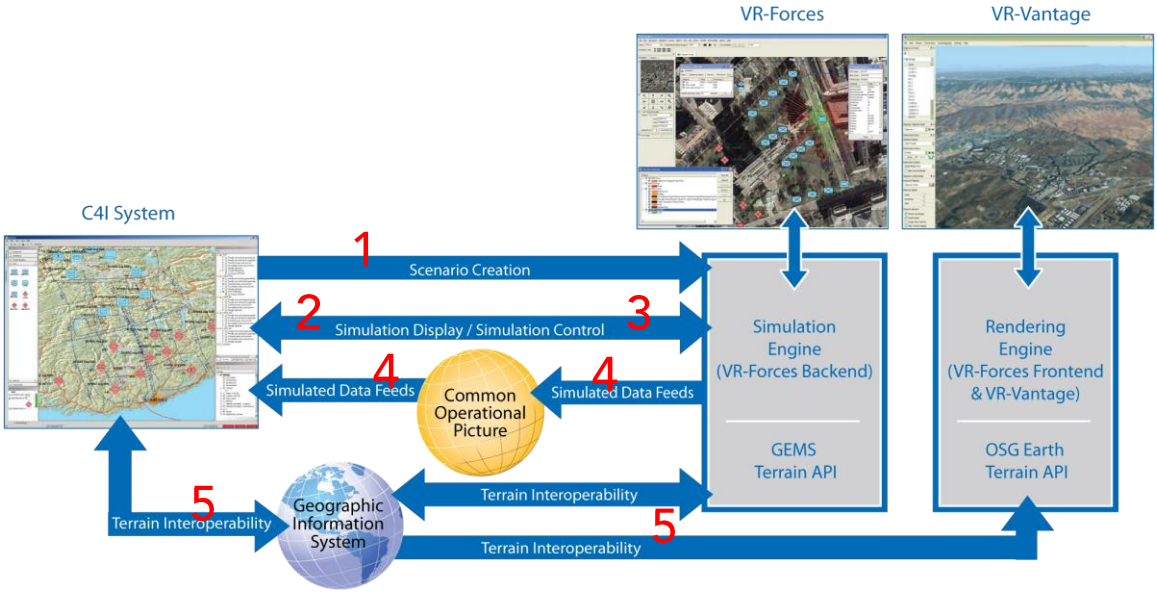
GEMS is a technical architecture and set of functional components that enable Modeling & Simulation (M&S) systems to interoperate with Geographic Information Systems (GIS) systems.

How does GEMS facilitate Interoperability?

C2 and C4I systems are increasingly using the Commercial Joint Mapping Tool Kit (CJMTK) as the infrastructure for managing geo-spatial data. CJMTK includes the ESRI's ArcGIS geographic information system.
So what GEMS does, is allows your M&S systems to directly access the geospatial data and geoprocessing power of the same GIS system that your C2 and C4I systems are using.

What would an interoperable system architecture look like?

Let's have a look at the five points of inter-connection between C4I and M&S systems.



1. Scenario Creation

Use live intelligence from the C4I system to create simulation scenarios.

In order to make a simulation, you must extract the units (aka entities), their organizational structure (aka order of battle) and their tasking (aka plans) from the C4I system and bring them into your simulation engine. Collectively this is known as a simulation scenario.

Ideally, the simulation scenario would be exchanged automatically between the C4I system and the simulation systems, such as VR-Forces. SISO is working towards this goal by defining a scenario definition standard called Mission Scenario Definition Language (MSDL) and a Coalition Battle Management Language (CBML). After these standards are defined MÄK can implement them in VR-Forces so that a scenario developed in a C4I system (or other M&S system) can be loaded and executed. Until then, MÄK can develop custom exchanges or you can use the VR-Forces GUI to interactively create scenarios that match your operational conditions.

2. Simulation Display

Display the real-time simulated entities and interactions within the C4I system GUI.

In the Simulation Display component of the architecture, the native map display of the C4I system is extended to display updating information from the simulation. This allows you to monitor the real-time activity in the simulation including entity positions, status, and interactions.

For C4I systems using CJMTK, MÄK has developed a toolkit that extends the map display to dynamically visualize simulation network data. The toolkit uses MÄK's VR-Link technology to link to GIS software with standard simulation protocols, including Distributed Interactive Simulation (DIS) and High Level Architecture (HLA).

3. Simulation Control

Start, stop, and interactively control the simulation activity from the C4I system.

This component of the architecture enables the operator of the C4I system to interactively control the execution of the simulation scenario.

Two levels of integration have been developed. The first is the VR-Forces Toolbar, which extends the C4I GUI to start and stop the simulation and to control simulation time. The second uses the VR-Forces toolkit API to embed the complete VR-Forces menu system into the C4I application. This gives the C4I GUI complete control to setup up scenarios, define unit tasking, and interactively alter the simulation while it runs.

4. Simulated Data Feeds

Simulate a Common Operating Picture (COP) by generating intelligence reports derived from simulated missions.

As a simulation is running in VR-Forces, the sensor models on the simulated vehicles determine the probability of detection, classification, and identification of other entities in the simulation. The simulation can be tasked to issue reports that convey this detection and other situational awareness information.

The Simulated Data Feeds component of the architecture relies on brokers to be written for VR-Exchange that post spot reports to the COP database.

5. Terrain Interoperability

Simulate directly on the operational geospatial data without developing a separate M&S terrain database.

Traditional M&S systems require a specialized terrain database. C4I systems operate directly on the geospatial data within the GIS. Terrain Interoperability allows you to simulate directly on the C4I system's geospatial data without developing a separate database.

MÄK's GEMS Terrain API enables M&S simulation applications to access the same geospatial data, used by C4I systems, for 3D unit location, terrain reasoning and vehicle dynamics.

The GEMS Terrain API consists of a GIS specific layer for accessing the terrain data, and a simulation specific layer for providing the data to the simulation models. The API has been developed for MÄK's VR-Forces simulation system and for the Army's OneSAF system. Other simulation specific layers can be developed as needed (for other CGF systems).

MÄK's VR-Forces and VR-Vantage tools leverage the OSG Earth terrain API to stream elevation and imagery, from the GIS, directly into M&S visualization applications.

What are some of the use cases that benefit from C4I interoperability with M&S?

Correlate M&S systems with Operational Terrain Data —
You can use geographic information system (GIS) data and geoprocessing models to interoperate in the same terrain environment. And use intelligence in the Common Operational Picture (COP) to create relevant simulation scenarios.

- Battlefield Awareness – simulation behaviors will more closely match the decisions made by C4I human operators.
- Concept Evaluation – enables systems integrators to prototype a platform, weapon system or sensor.

Stimulate C4I Systems with M&S Systems —
To allow C4I operators to sustain their training on Tactics, Techniques, and Procedures (TTP), M&S can be used to stimulate the C4I system with events from a variety of preplanned and interactive scenarios.

- Sustainment Training – C4I operators can keep sharp on Tactics, Techniques, and Procedures (TTP) by being exposed to a variety of scenarios.

Embed M&S Capabilities into C4I Systems —
Rehearse timing of operations and evaluate mission plans, using M&S to play out scenarios defined in the COP. Provide decision support by modeling scenarios and performing course of action analysis (COA).

- Mission Planning and Rehearsal – where simulation is used to play out the plan for the day, thus giving the operator a sense of the timing of operations and synchronization points in the mission.
- Course of Action Analysis (COA) – where the simulation is used to model multiple scenarios based on the mission plan, thus providing opportunities to analyze unit mobility, sensor utilization, and communication network effectiveness.

Implement C4I Systems using M&S Technology —
Implement C4I systems, battle management systems, and situational awareness systems with distributed simulation protocols, tactical map displays, and 3D visualization developed for M&S.

- Situational Awareness Systems – Use the same geoprocessing algorithms used in operational terrain analysis, to, for example, develop navigation paths that avoid threats. By off-loading geospatial reasoning functions, simulations can use their processing cycles for higher level models and behaviors.
- Simulated Battle Management Systems – where M&S technologies are used to develop BMS systems concepts.

This matrix illustrates the points of inter-connection between C4I and M&S systems that must be addressed to satisfy each use case.

	Points of inter-connection between C4I and M&S				
GEMS Use Cases	**Scenario Creation** Create simulation scenarios from Live Intel	**Simulated Data Feeds** Simulate missions and generate intelligence reports	**Simulation Display** Display real-time simulation in C4I system	**Simulation Control** Control simulation from C4I system	**Terrain Interoperability** Interoperate with geospatial terrain data
Correlate M&S systems with Operational Terrain Data	✓				✓
Stimulate C4I systems with Modeling & Simulation	✓	✓			✓
Embed M&S Capabilities into C4I Systems	✓	✓	✓	✓	✓
Implement C4I Systems using M&S Technologies	✓				✓

What Are the Benefits of M&S Systems Using GIS?

By leveraging a GIS, VR-Forces can benefit from enhanced functionality to manage, access, and visualize terrain data. The benefits include the ability to:

- Manage data seamlessly for anywhere, at any scale, from a number of distributed geo-databases.
- Load a wide variety of terrain data types and formats.
- Support hundreds of coordinate systems, datums, and projections.
- React to changes in the geospatial data enabling dynamic terrain functionality.
- Access operational data directly, reducing the need for specialized runtime terrain databases that are time consuming to produce and costly to maintain.

What is operational terrain data?

Operational terrain data is the map data used in real world command and control systems. In the US, this data is generated by organizations such as the US Army Geospatial Center (AGC) for use in the field. The Theater Geospatial Database (TGD) is an example of a US operational terrain data set.

What is a geoprocessing model?

A geoprocessing model is an algorithm for manipulating geospatial data.
These models can be used for route planning, mobility analysis, cover and concealment analyses, line of sight analyses, and the locating military significant terrain features, like battle positions and choke points.
They can be composed using built-in GIS functions or they can be defined as scripts using languages such as Python or Visual Basic. These models can be executed locally or run remotely on a GIS server.
With GEMS, the results of these models are available for use within the simulation.