Geospatial Data Use in Modeling and Simulation

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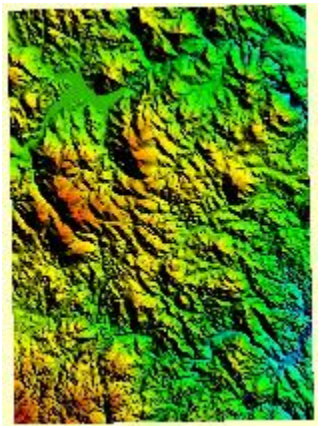
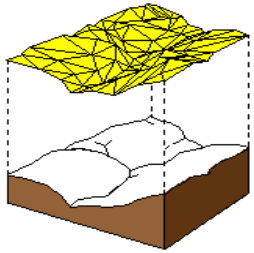
Overview

- Traditional Terrain Database Generation Process for M&S
- GIS-Enabled Modeling and Simulation (GEMS)
- Terrain Server Approach

M&S Terrain Database Generation Process

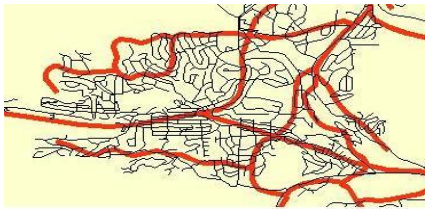


Digital Elevation Model (DEM)

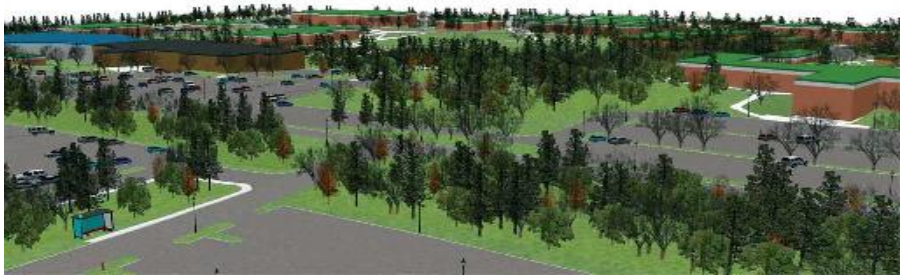


Creation of a Triangulated Irregular Network (TIN) from the elevation data.

Application of Imagery onto the surface of the TIN

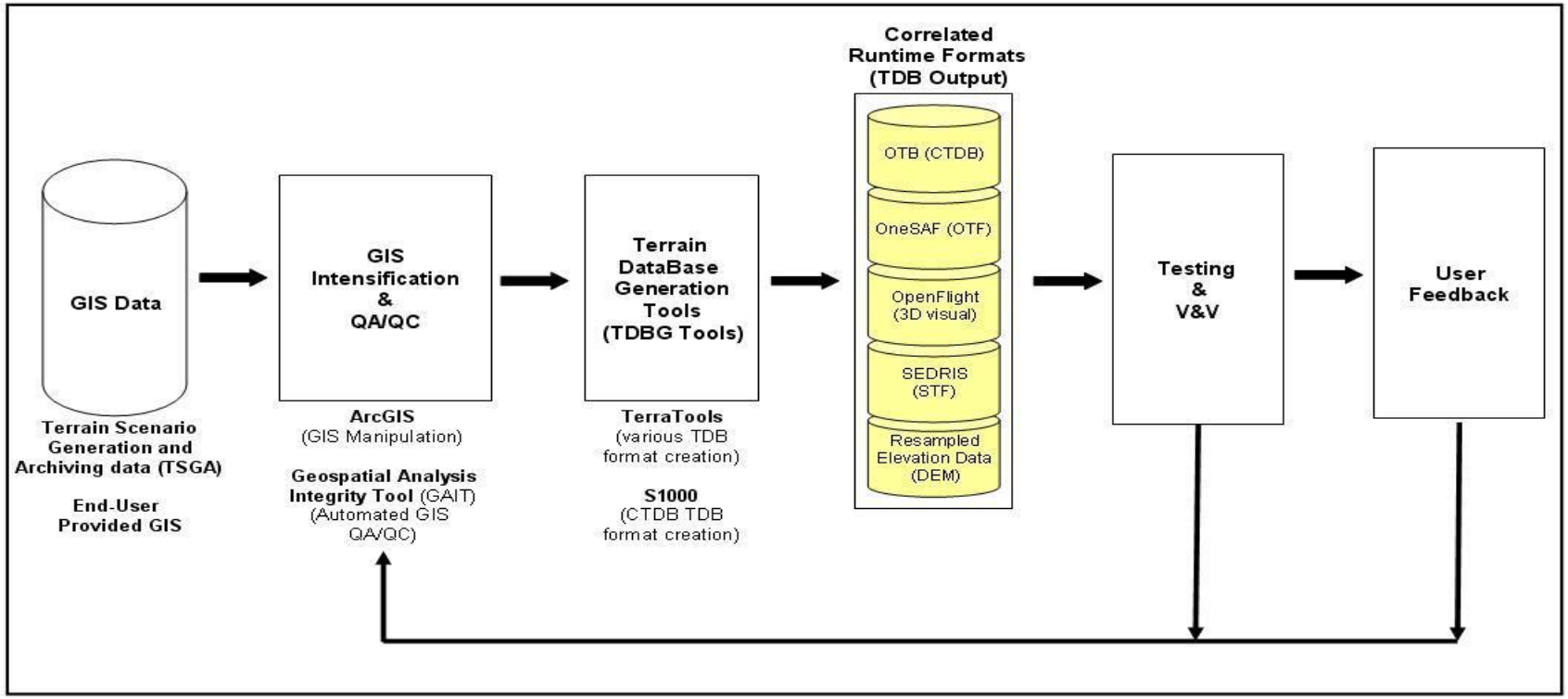


Collection and creation of Geospatial features (i.e. roads and buildings)



Completed database featuring elevation data, with overlaid imagery, and integrated GIS features compiled together into a synthetic environment.

Terrain Generation for M&S
Current Practice



Takes Time – Costs Money

Continuum of Terrain Database Approaches

Each Approach Has Merits

Geospatial Interoperability between M&S and Battle Command

Geospatial representations are quite different

- BC uses GIS-based geospatial data and mapping components
  - Raster elevation, imagery, vector features
- M&S uses proprietary, highly optimized run time terrain database formats
  - Specialized for each application

The GEMS project was started to address BC and M&S interoperability

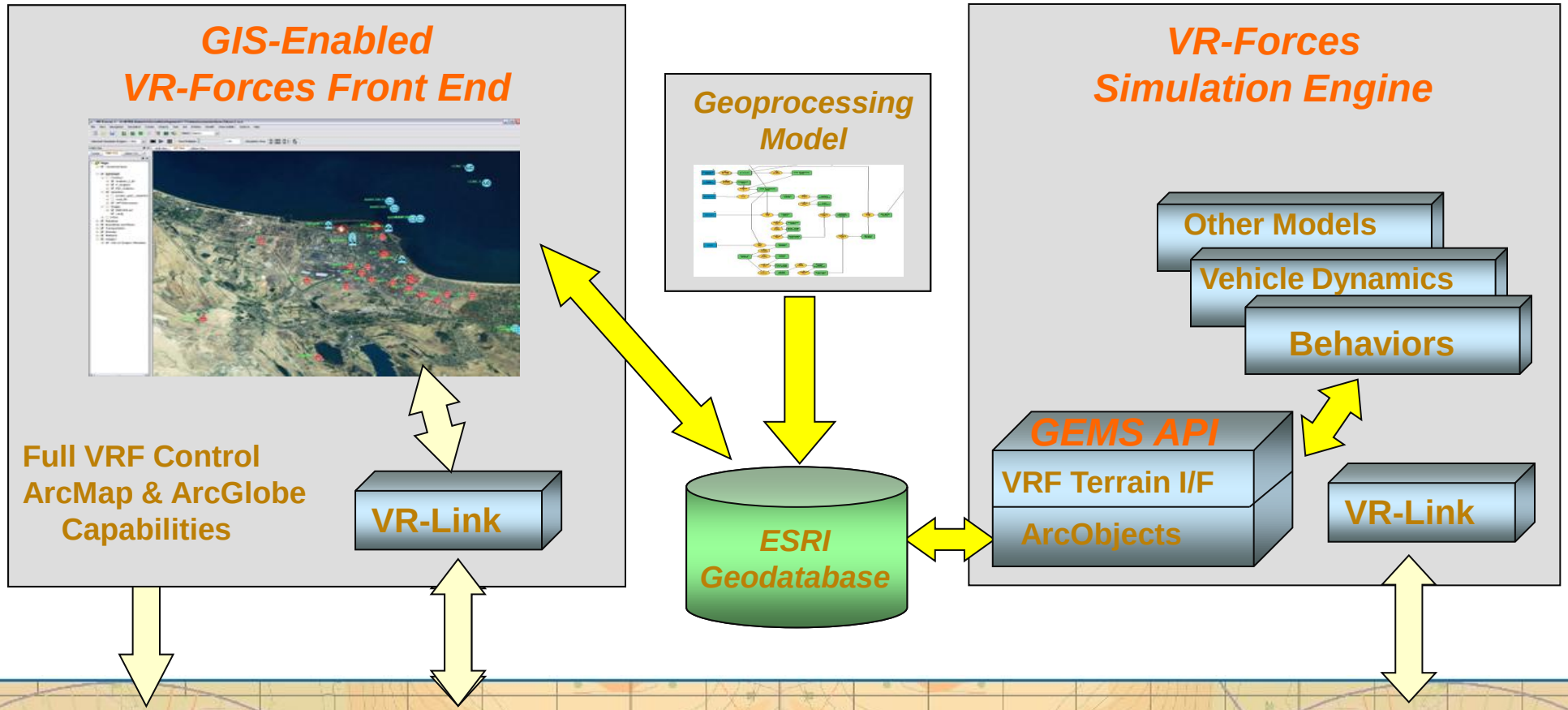
Army Geospatial Center bringing these domains closer together through use of common geospatial data, geospatial enterprise, and terrain analysis capabilities

- Leveraging GIS capabilities in Commercial Joint Mapping Toolkit (CJMTK)

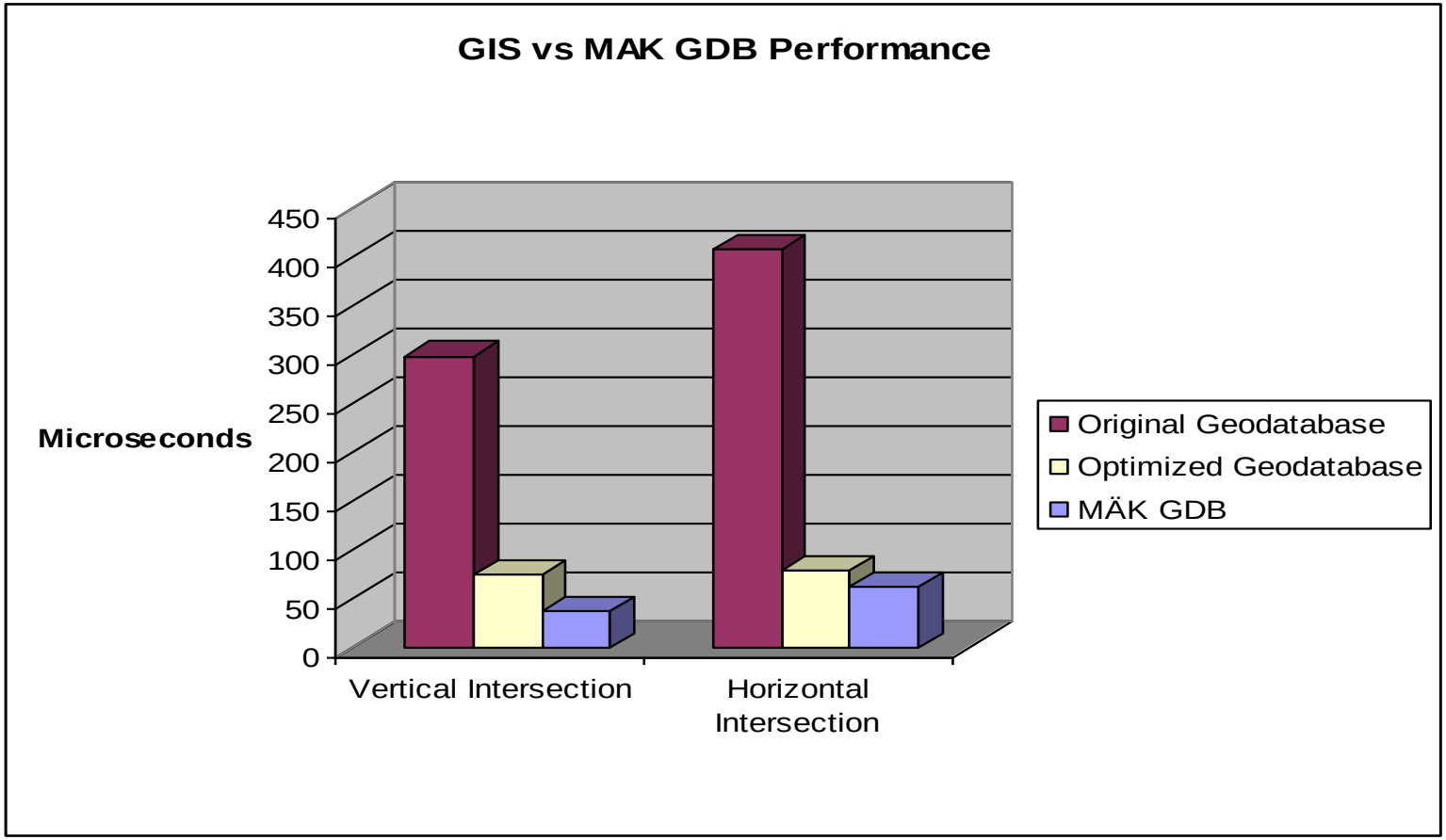
GEMS - GIS Enabled M&S

- GEMS is a technical architecture and set of functional components that allow M&S systems to run directly on operational geospatial data
- Started by TEC (now AGC) in 2006
  - Developed initial prototype using MÄK VR-Forces as simulation
- Continued with funding from US Army Simulation to C4I Interoperability (SIMCI) program in 2008
  - Added GIS enterprise capabilities
- Continued with funded by SIMCI and Army Modeling and Simulation Office (AMSO) in 2009 and 2010
  - Integrating GEMS capabilities into OneSAF
- Current SIMCI project to perform formal testing of OneSAF GEMS

GEMS Architecture



GEMS Performance



GEMS API

Designed with integration into more than just VR-Forces in mind

Two layers

- ESRI (ArcObjects) specific layer for access to geodatabase
- Simulation application specific layer
  - Backward compatible to existing terrain APIs
  - Packages up result of queries for applications

GEMS Enterprise Capabilities

Used ArcServer to move from static, file geodatabase to distributed geodatabase

- Dynamic geodatabase
  - Changes to layers used by GEMS API as simulation is running
  - Content and extents
- Shared geodatabase between different simulation applications
  - Still using only VR-Forces back ends and front ends for prototype

Remote geoprocessing capabilities

- Terrain analysis queries that can be run on GIS server
- Demonstrated use of Web services in enterprise GIS environment

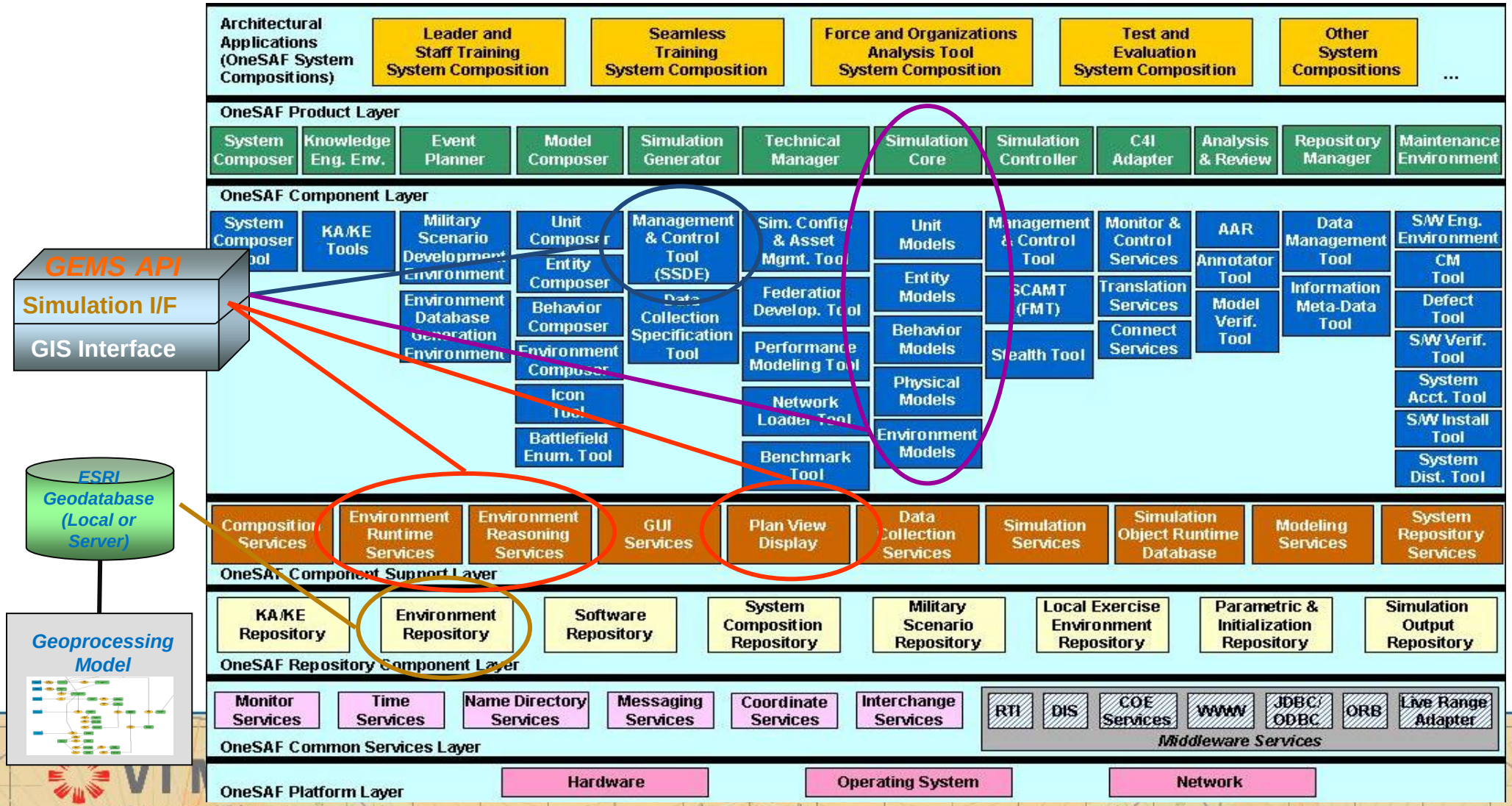
Enhanced the GEMS API to work in distributed environment

- Remote geoprocessing infrastructure
  - Asynchronous queries and results
- Modified VR-Forces models to demonstrate enterprise capabilities

GEMS in OneSAF

- Examined OneSAF terrain API and determined design for GEMS API and geodatabase changes to support OneSAF
- Integrated GEMS API into OneSAF
  - Developed a OneSAF specific layer (plus)
- Modified the OneSAF MCT (GUI) and behaviors to use GIS environment

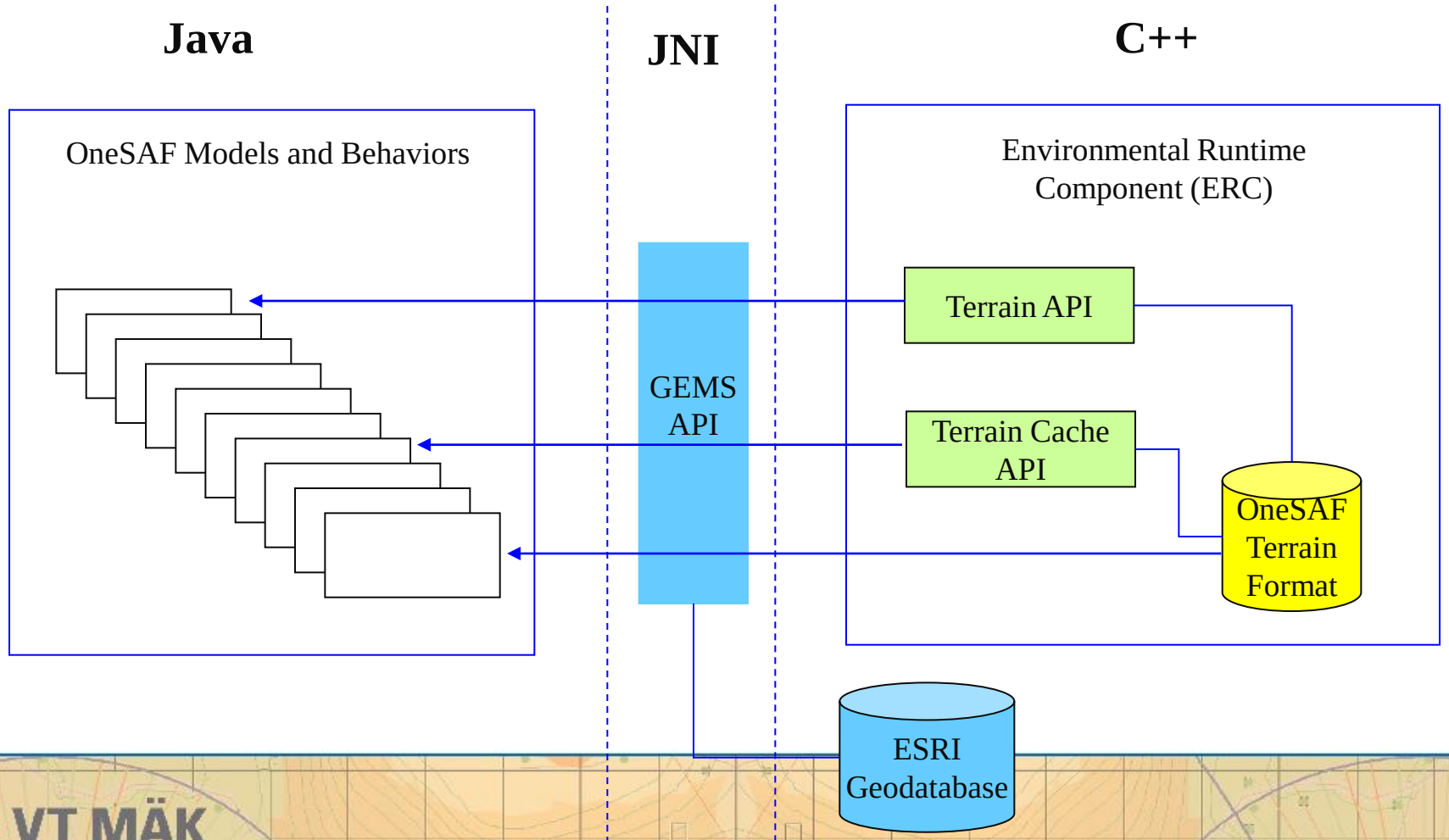
GEMS in OneSAF PLAF



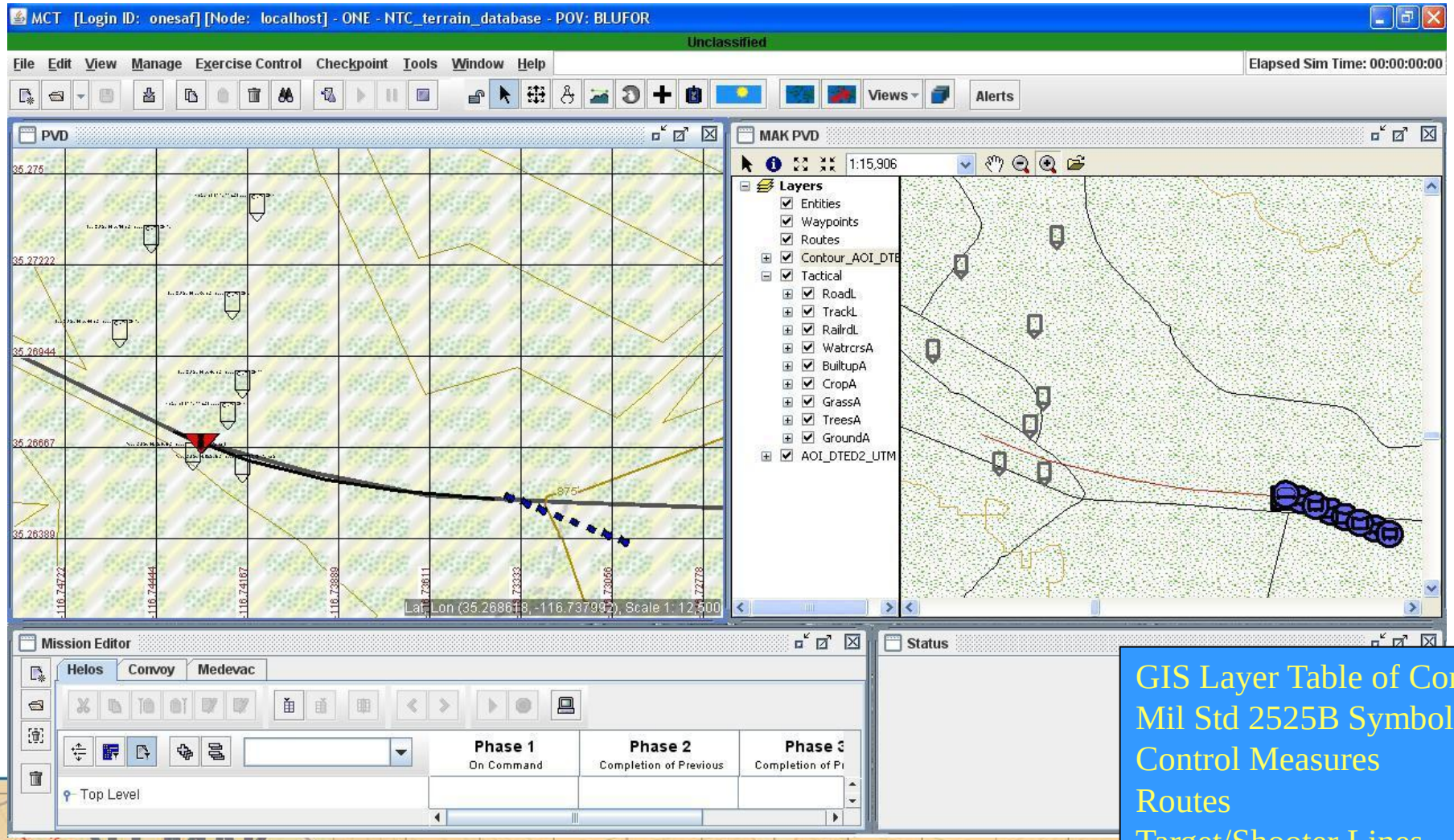
GEMS in OneSAF

- Running OneSAF models and behaviors on GIS data either locally or from server
  - Incremental loading of geospatial data into simulation
  - Caching and background loading of data
- Same operational data as used in C4I systems
  - Augmented with high resolution for simulation-specific purposes
- Can change geospatial data while simulation is running
- Can use GIS for remote terrain reasoning using operational algorithms
- Use GIS functions for geospatial data management and control in user interface

Design and Implementation Approach

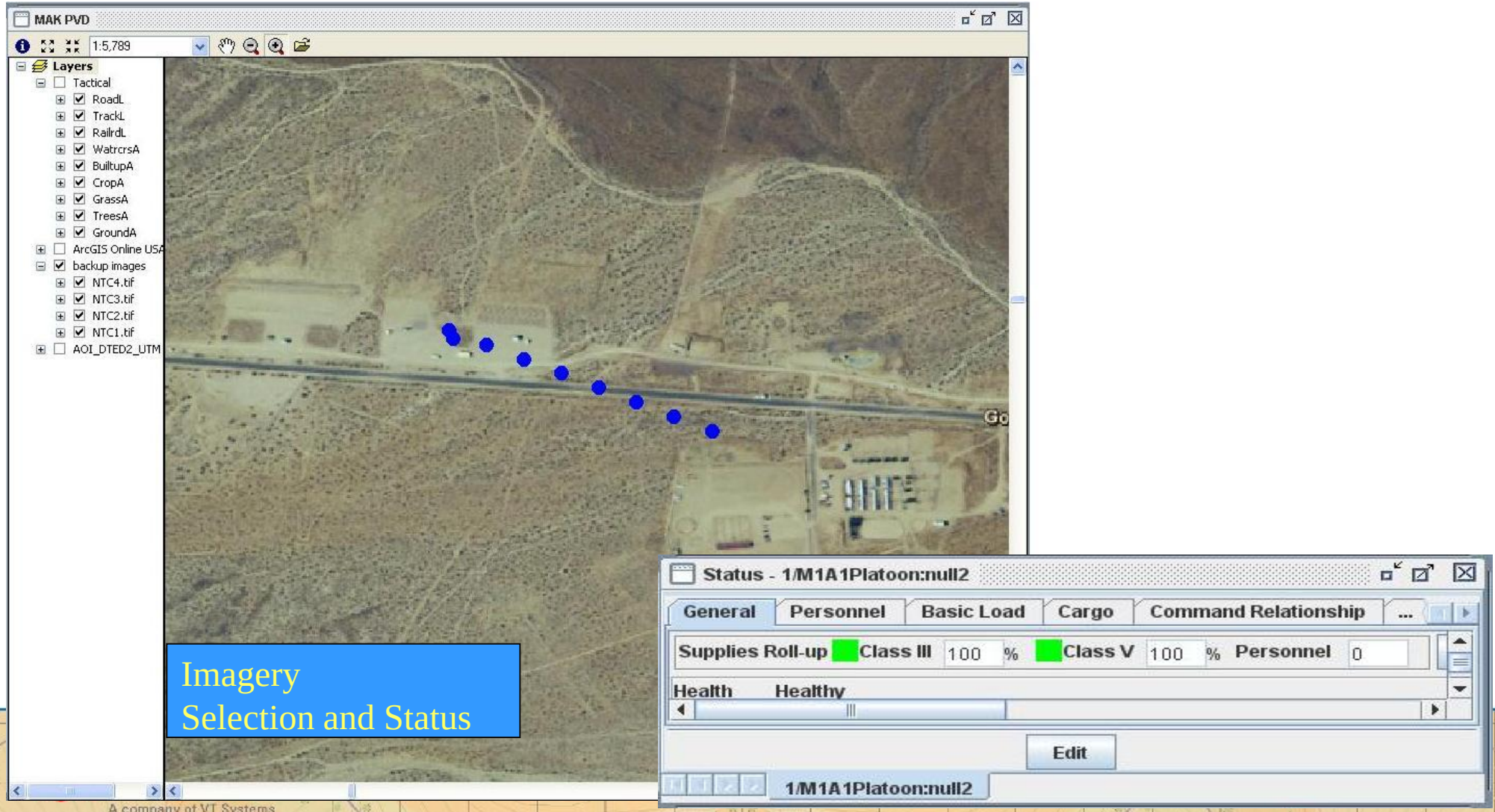


GIS Pane in MCT



GIS Layer Table of Contents
Mil Std 2525B Symbology
Control Measures
Routes
Target/Shooter Lines
Detonations

GIS Pane in MCT



OneSAF Behaviors using GIS

Route Generation in GIS
Movement and LOS using GIS terrain
Covered and concealed locations in movement behaviors

SIMCI FY 10 Project
Formal Testing of GEMS in OneSAF

More formal testing of GEMS OneSAF

- In cooperation with PM OneSAF
- Three test cycles
  - Increase complexity of scenarios and terrain

Updated GEMS API to work with OneSAF 4.0

- Came out in Spring 2010

Using standard ERC test routines for first test phase

  - Instrumented to collect performance metrics

Benefits of GEMS Approach

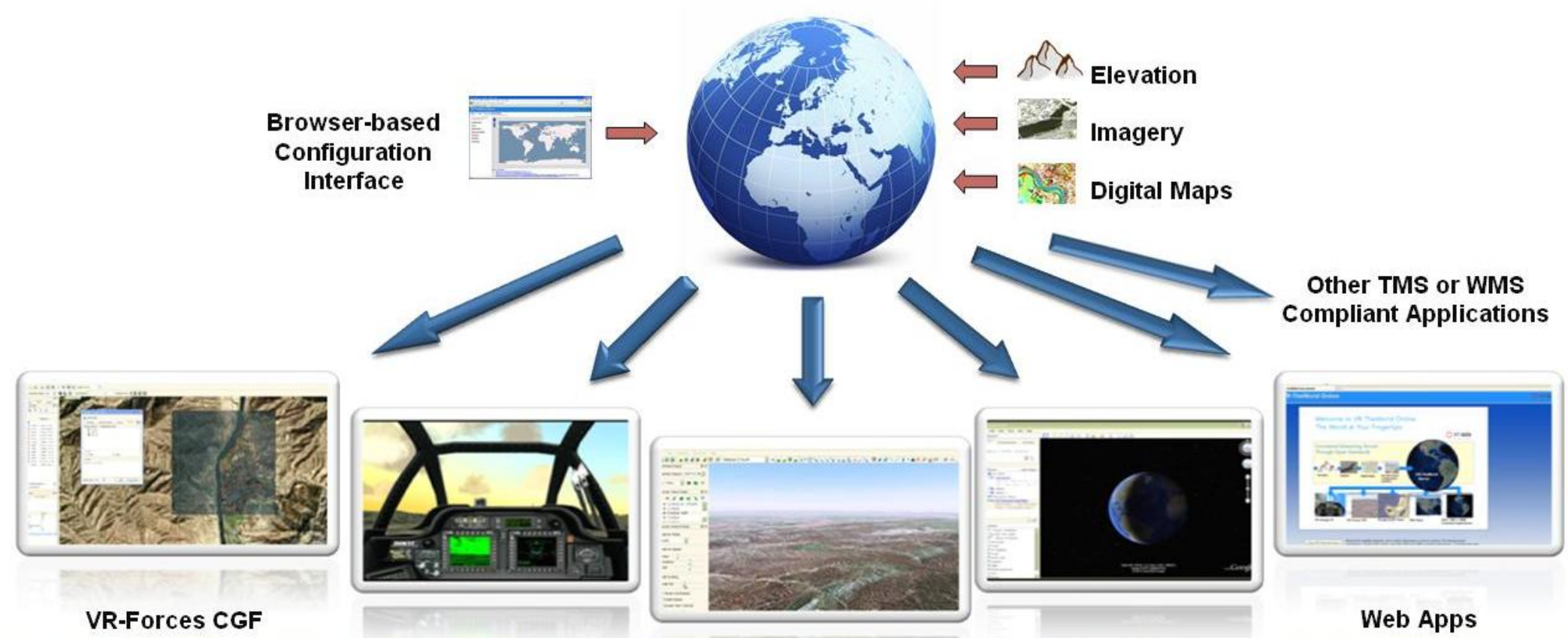
- Use operational geospatial data and terrain reasoning algorithms
- Reduce need for compiled run time simulation formats
- Dynamic geospatial data supported by server technology
- Enterprise GIS allows large area coverages of variable spatial resolution

Limitations of GEMS Approach

- Run time performance close to optimized terrain databases but not exceeded
  - Supports medium size scenarios, 80% of entities per simulation engine vs optimized TDB
- Some initial geoprocessing currently needed to obtain meet performance requirements
  - Working to move these to run time function as part of terrain paging
  - Convert elevation grids to TINs
    - This step no longer necessary – can generate terrain surface on the fly as portions are brought into the simulation
  - Expansion of linear and point features to areas

Terrain Server Approach (VR-TheWorld)

Correlated Streaming Terrain Through Open Standards



VR-TheWorld

Open-standards-based streaming terrain server

- WMS (OGC's Web Mapping Service)
- TMS (OSGeo's Tile Map Service)

VR-TheWorld Server

- Host terrain locally

VR-TheWorld Online

http://www.vr-theworld.com/

- 4TB of elevation and imagery

Summary

- More options now for geospatial data in M&S
- GIS tools in CJMTK and geospatial products from the AGC provide a powerful capability for improving M&S and BC interoperability
  - Reduction in time and cost for geospatial data
  - Increased currency and data correlation
  - Facilitating embedded training in BC systems
- Simulations decisions now based on same geospatial data and information as human decision makers

Questions?