

Geospatial Data Use in Modeling and Simulation

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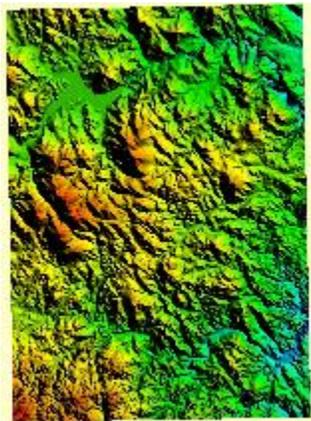
Overview

Traditional Terrain Database Generation Process for
M&S

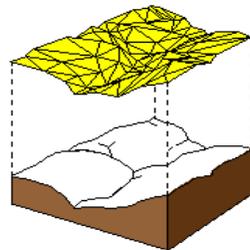
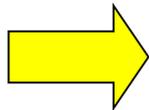
GIS-Enabled Modeling and Simulation (GEMS)

Terrain Server Approach

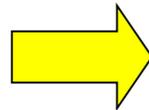
M&S Terrain Database Generation Process



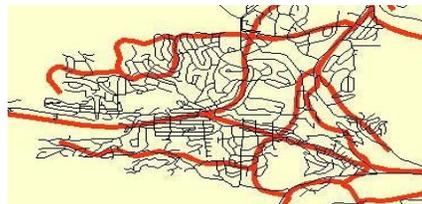
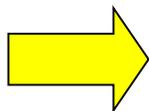
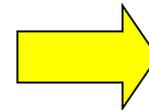
Digital Elevation Model (DEM)



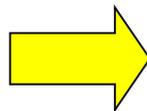
Creation of a Triangulated Irregular Network (TIN) from the elevation data.



Application of Imagery onto the surface of the TIN



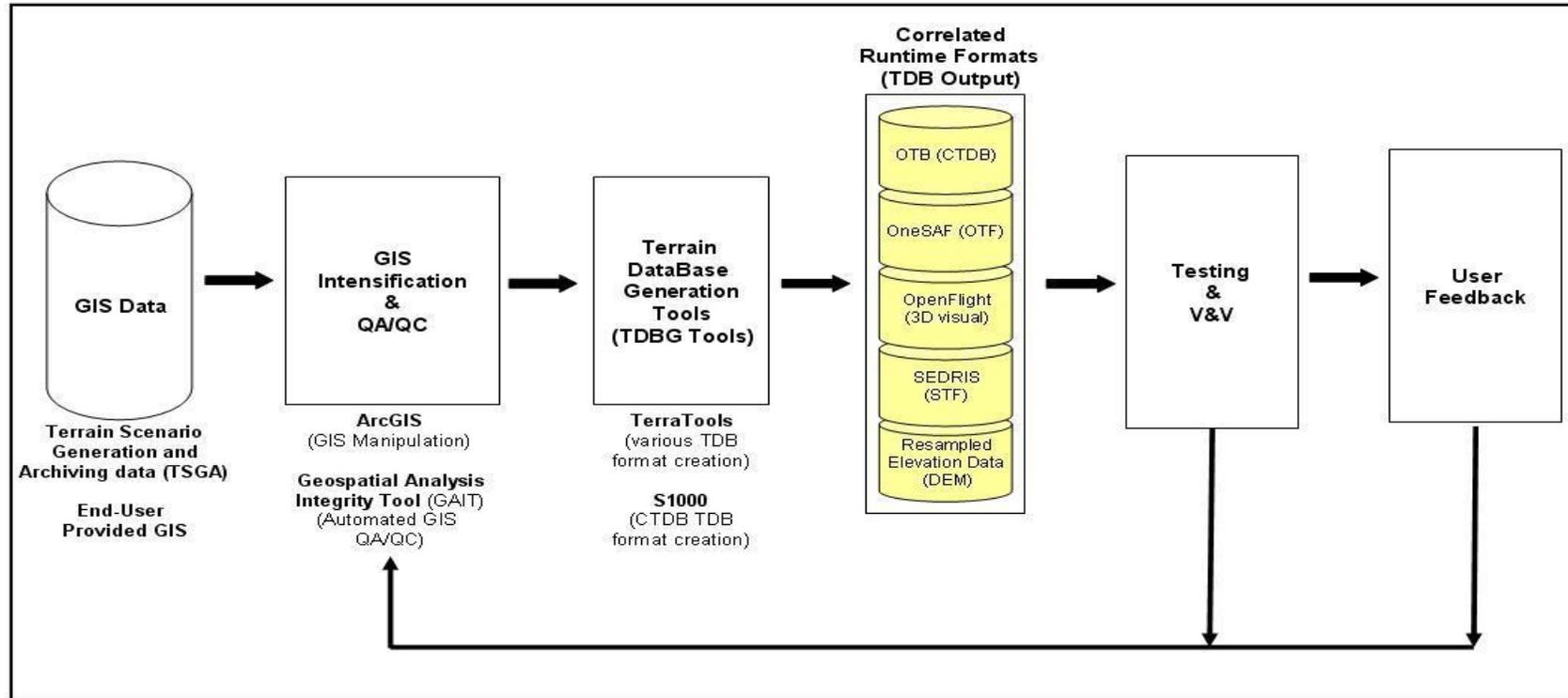
Collection and creation of Geospatial features (i.e. roads and buildings)



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

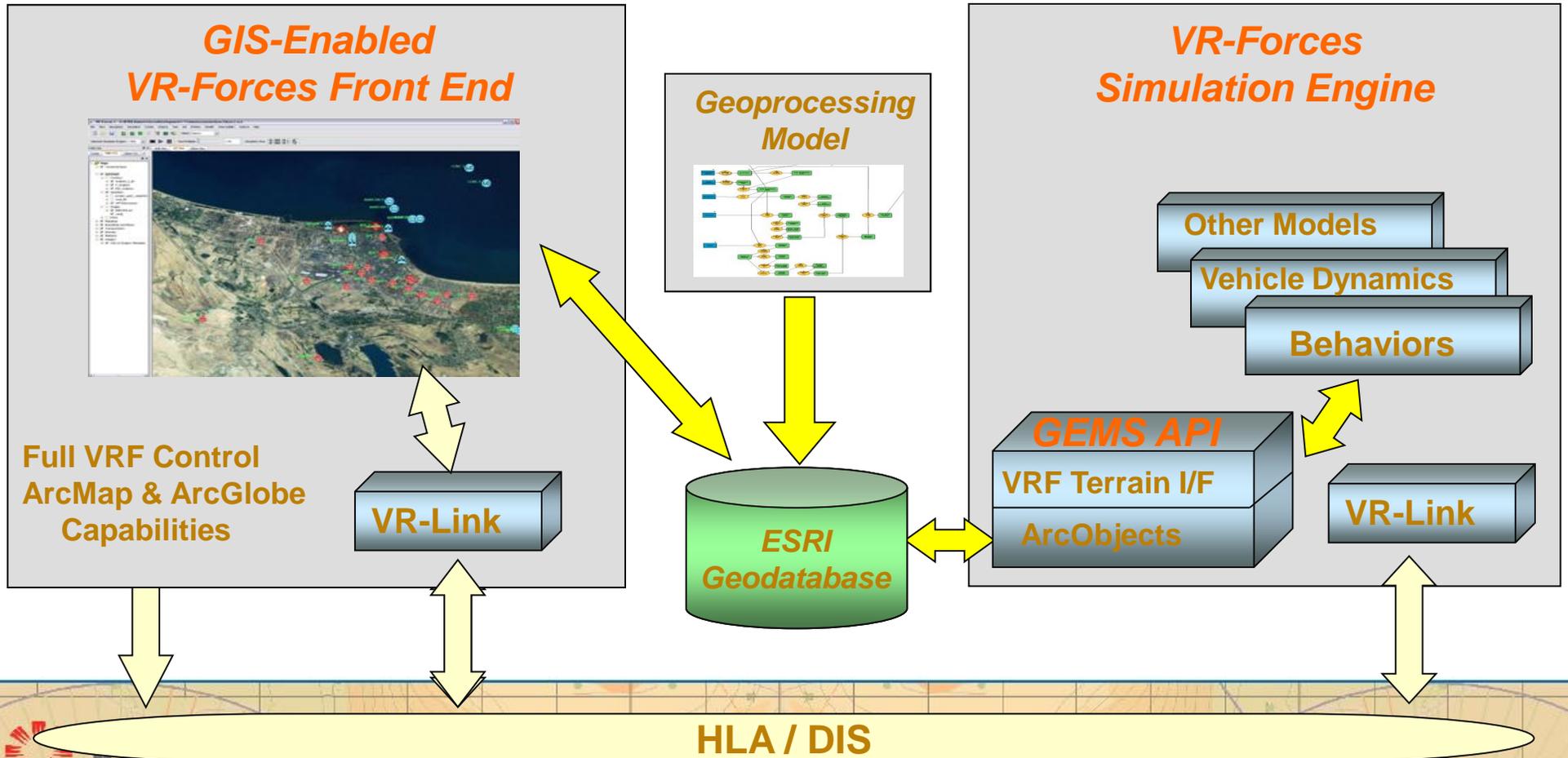
- ▶ Added GIS enterprise capabilities

Continued with funded by SIMCI and Army Modeling and Simulation Office (AMSO) in 2009 and 2010

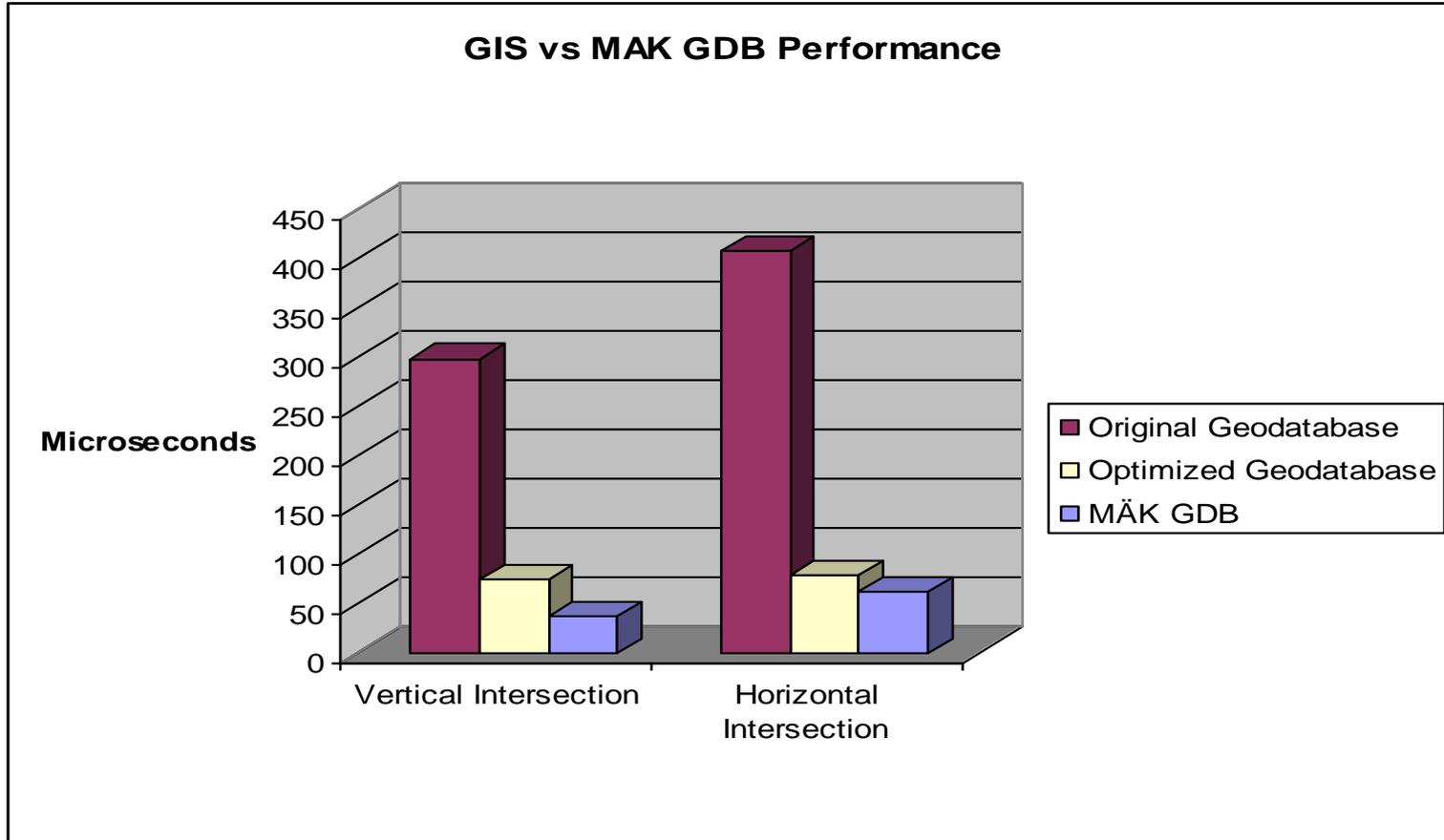
- ▶ Integrating GEMS capabilities into OneSAF

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

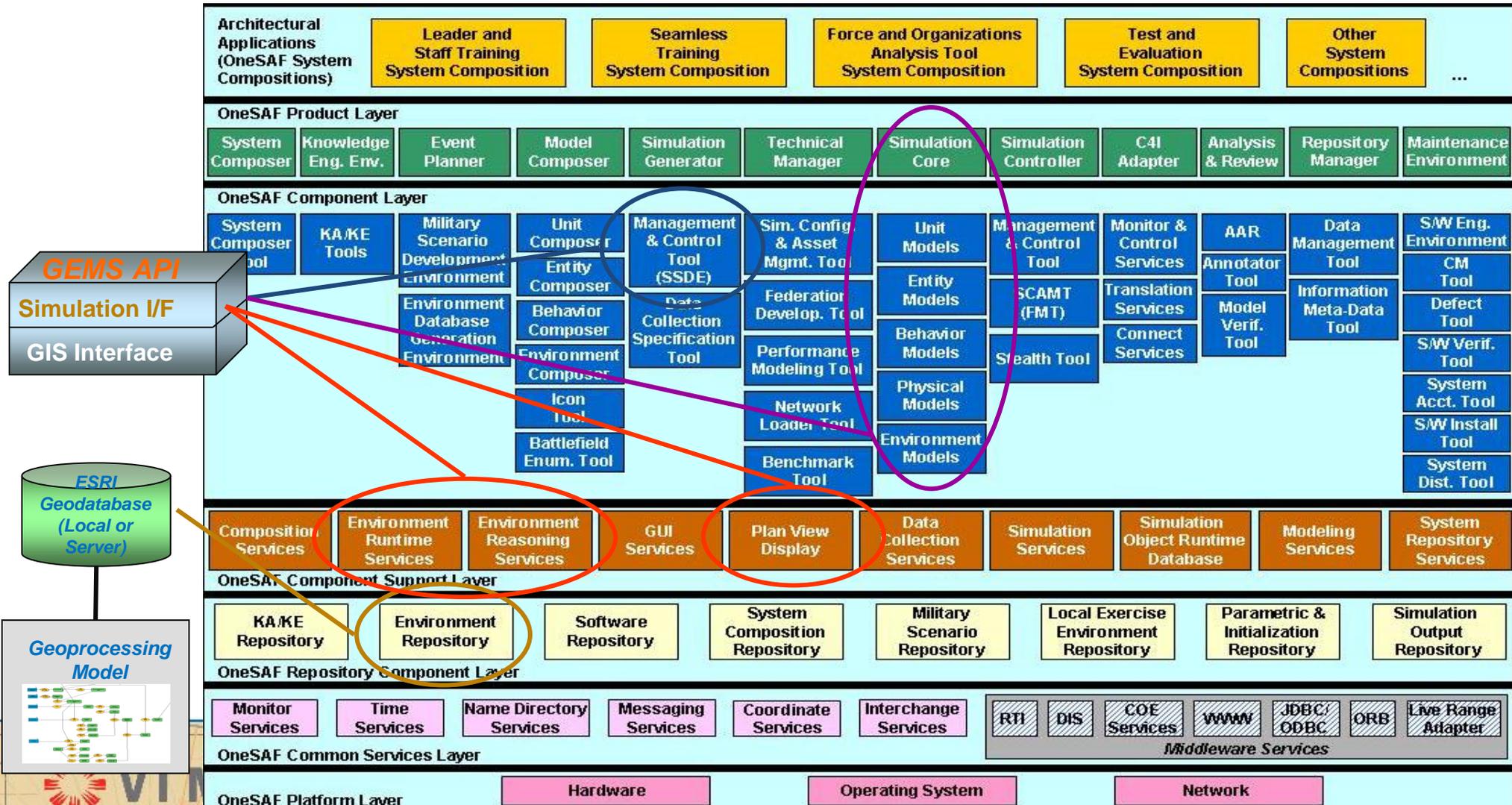
Examined OneSAF terrain API and determined design for GEMS API and geodatabase changes to support OneSAF

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

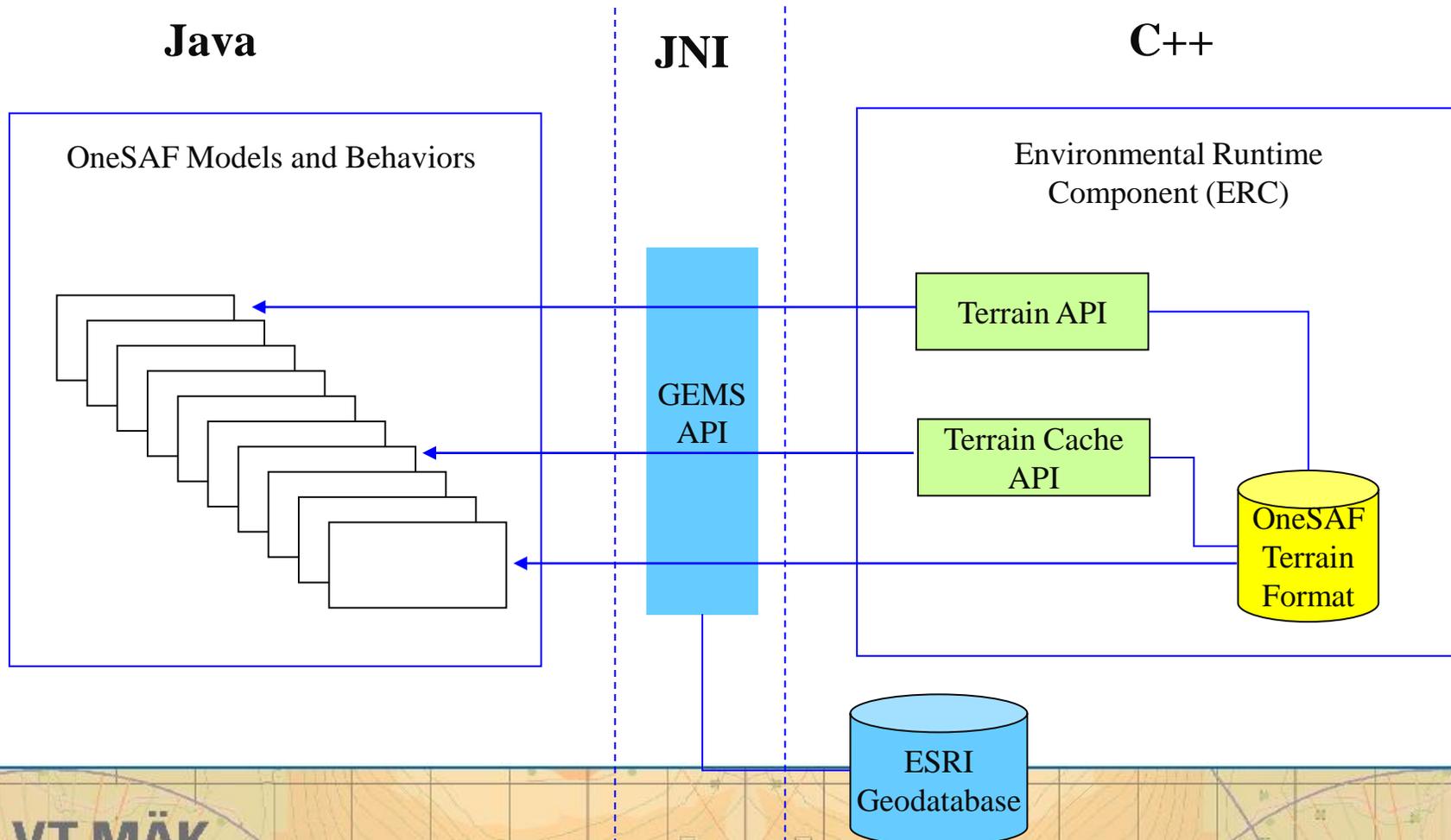
- ▶ Augmented with high resolution for simulation-specific purposes

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

The screenshot displays the MCT software interface. At the top, the title bar reads "MCT [Login ID: onesaf] [Node: localhost] - ONE - NTC_terrain_database - POV: BLUFOR". Below this is a menu bar with "File", "Edit", "View", "Manage", "Exercise Control", "Checkpoint", "Tools", "Window", and "Help". A toolbar contains various icons for navigation and editing. The main workspace is divided into several panes:

- PVD (Positioning View Display):** Shows a grid with elevation contours and a route. A red triangle marker is visible on the route.
- MAK PVD (Mission Area Key Positioning View Display):** Shows a detailed map view of the terrain with various features and a route. A scale of 1:15,906 is indicated.
- Layers:** A table of contents for the GIS data, listing various layers and their visibility status.
- Mission Editor:** A panel for managing mission phases and tasks.
- Status:** A panel for monitoring mission progress.

The "Layers" pane contains the following items:

Layer Name	Visibility
Entities	Checked
Waypoints	Checked
Routes	Checked
Contour_AOI_DTE	Checked
Tactical	Checked
RoadL	Checked
TrackL	Checked
RailrdL	Checked
WatcrsA	Checked
BuiltupA	Checked
CropA	Checked
GrassA	Checked
TreesA	Checked
GroundA	Checked
AOI_DTED2_UTM	Checked

The Mission Editor pane shows a table with columns for "Phase 1", "Phase 2", and "Phase 3".

	Phase 1	Phase 2	Phase 3
	On Command	Completion of Previous	Completion of Pi

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

GIS Pane in MCT

The screenshot shows the MAK PVD interface. On the left is a 'Layers' panel with a tree view containing the following items:

- Tactical
 - RoadL
 - TrackL
 - RailrdL
 - WatrcrsA
 - BuiltupA
 - CropA
 - GrassA
 - TreesA
 - GroundA
- ArcGIS Online USA
- backup images
 - NTC4.tif
 - NTC3.tif
 - NTC2.tif
 - NTC1.tif
- AOI_DTED2_UTM

The main map area displays an aerial view of a terrain with a road and several blue circular markers. A status window is overlaid on the bottom right, titled 'Status - 1/M1A1Platoon:null2'. It has tabs for 'General', 'Personnel', 'Basic Load', 'Cargo', and 'Command Relationship'. The 'General' tab is active, showing the following data:

Supplies Roll-up	Class III	100 %	Class V	100 %	Personnel	0
Health	Healthy					

An 'Edit' button is located below the status window. At the bottom of the status window, the text '1/M1A1Platoon:null2' is displayed.

Imagery
Selection and Status

OneSAF Behaviors using GIS



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

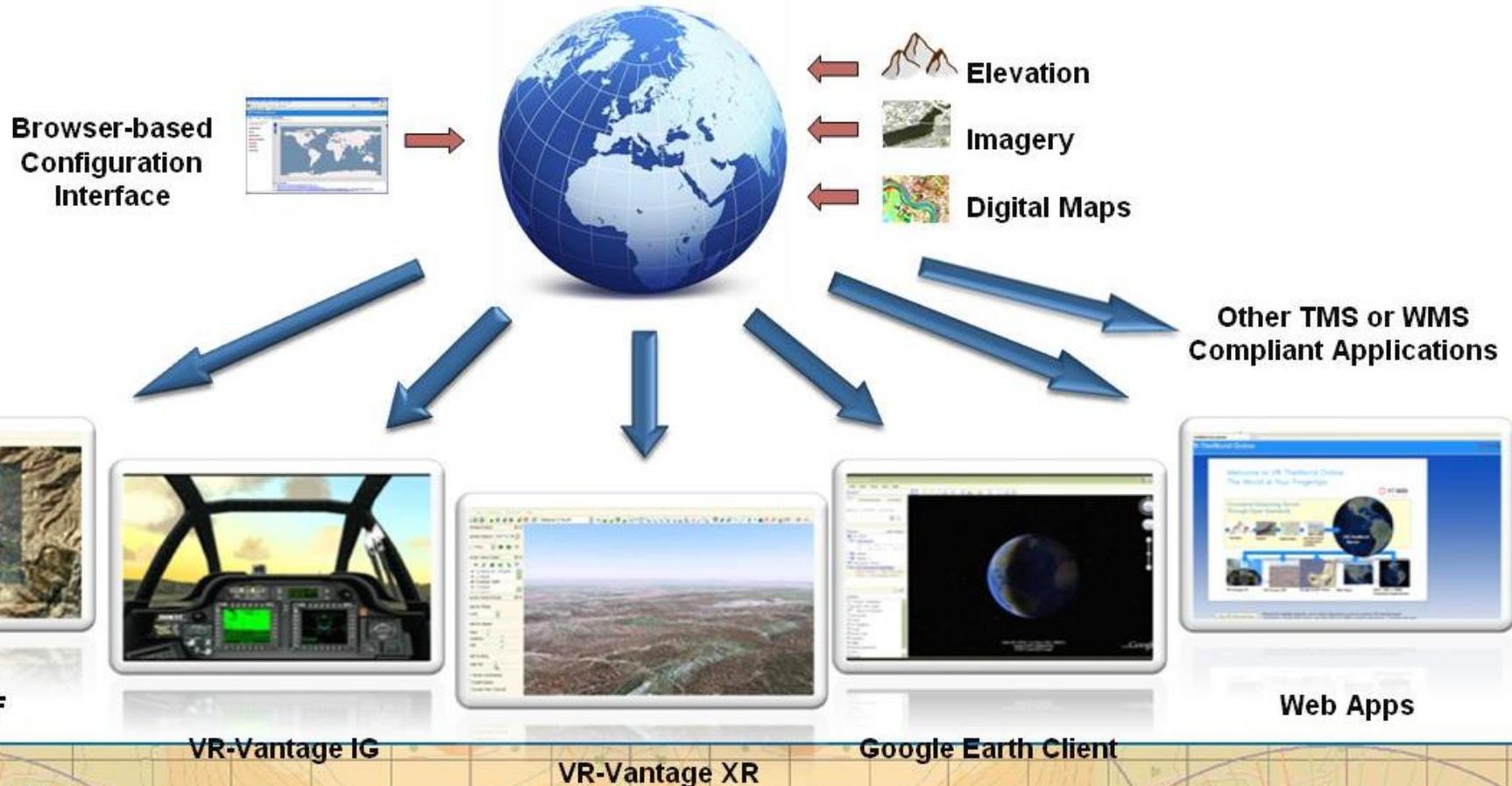
- ▶ Supports medium size scenarios, 80% of entities per simulation engine vs optimized TDB

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?