Modeling & Simulation

Chemical, Energy and Environmental Technologies
Health and Life Sciences
Advanced Systems Technologies

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Topics

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- Portal GUI
- Flex API Utilization
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- Benchmarking
MATRIC is an independent, nonprofit, 501(c)(3) research corporation headquartered in WV.

Specializing in Advanced Systems Technologies, Chemical and Environmental Technologies, and Health and Life Sciences research.
Developed for the WV Dept. of Military Affairs and Public Safety (WVDMAPS) Regional Catastrophic Preparedness Grant Program (RCPGP) as a consequence management prototype system.

- Assist with all phases of disaster management

Prototype includes evacuation from national capital into four WV counties.

- Allows for design and trial of dynamic “What-if?” simulations

Uses combination of ArcGIS Server geoprocessing and ArcGIS API for Adobe Flex

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M&S Team

- **Azimuth, Inc.**
  - Responsible for:
    - Data gap analysis and data collection.

- **MATRIC**
  - Responsible for:
    - Design and implementation of simulation logic and portal.

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M&S Project Milestones

- Project Kickoff: 06-22-10
- Stakeholder meeting: 08-19-10
- Preliminary Design Review: 09-8-10
- Critical Design Review: 10-14-10
- Demonstration: WVDMAPS Showcase: 04-13-11
- Demonstration: FEMA Showcase (Available on YouTube): 05-26-11
- Deployment to WV GIS Technical Center: 06-15-11
- Project close: 06-22-11
M&S System: Architecture

Data
- Shelter
- First Aid
- Fuel
- Water
- ArcGIS Desktop GeoProcessing

GeoProcessing Services
- Develop simulation models using ESRI ArcObjects, Python, and C# capabilities.
- Publish simulation models
- GeoProcessing Models
- ArcGIS Server Tier
- SQL Server Tier
- Authentication Server

Presentation
- M&S CM Client Application
- WWW
- Client Devices
- Base Maps, Streaming Data Providers, etc.

Client Devices
- Laptop
- PC

WWW
- ESRI
- WV DOT
- Shelter
- Fuel
- Water
- First Aid
- Fuel
- Water
M&S System: Intercommunication

- The user interface is a web based Portal with an embedded Adobe Flex component used to interact with the GIS information.
- Tight integration between simulation logic geoprocessing services (ArcGIS Server) and Portal UI (ArcGIS API for Adobe Flex)
The portal is capable of a range of functions including:

- User Management
- Simulation Management
  - Creation, Modification, and Deletion of Simulations
- Comparative Simulation Analytics
  - Comparison of two or more simulations using a range of criteria represented in bar or pie graph format.
- Simulation Report Generation (*.PDF, *.XLS, *.CSV)
The ArcGIS Adobe Flex API is capable of a wide range of functions including:

- **Fully “Time-Aware” Layers**
  - Ability to “Pause”, “Play”, “Rewind”, and “Skip To” dates and times within a simulation.
  - Temporally active symbology capable of dynamic changes over time.
- **Rich Simulation Interaction**
  - Ability to dynamically place road barriers and activate/deactivate facilities (i.e. shelters)
  - Ability to select a wide range of base maps and “live layers” for an enriched simulation immersion.
The entire M&S System is highly extensible and scalable given the unique needs of a region and/or event. This capability was tested and proven using a 9-County area surrounding the state capital of Charleston, West Virginia.

- The new extent encompasses a much larger area in both a physical geographic region and infrastructure.
- Testing illustrates that the extended area integrates into the simulation logic and portal with ease and allows for an entirely new simulation.
MATRIC conducted extensive benchmarking and performance analysis to determine the ideal conditions (both hardware and software) for the simulation environment.

Through testing, the MATRIC team was able to isolate and accurately manipulate variables in both hardware and software and become experts in the field of large-scale GIS performance tuning.
Development Environment: VMware Virtualization

Virtual Server #1 – ArcGIS Server
- Operating System - Microsoft Windows Server 2008 R2 (64-bit)
- Random Access Memory (RAM) – 16 Gigabytes
- Processor – 4 Cores ~ 2.67 Gigahertz
- Software – ArcGIS 10 Service Pack 1

Virtual Server #2 - SQL Database Server
- Operating System - Microsoft Windows Server 2008 R2 (64-bit)
- Random Access Memory (RAM) – 16 Gigabytes
- Processor – 2 Cores ~ 2.67 Gigahertz
- Software – Microsoft SQL Server 2008

Virtual Server #3 – Portal Host Server
- Operating System – Ubuntu 11.04
- Random Access Memory (RAM) – 2 Gigabytes
- Processor – 4 Cores ~ 2.67 Gigahertz
- Software – Apache 2.2.17
Performance Benchmarking

- Benchmark performance of asynchronous geoprocessing services vs # SOC processes on a VMware based Arc10 server
- Benchmarked service is a custom rerouting tool (C# spawning Python) that spawns varying # of concurrent threads

![Asynchronous Geoprocessing Benchmarks (Virtualized)](chart.png)
Performance Benchmarking (cont.)

Asynchronous Geoprocessing Benchmarks (Non-Virtualized)

Max Concurrent Rerouting Threads:
- 1
- 3
- 6
- Infinite

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<th>6 SOC Processes</th>
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Performance Benchmarking (cont.)

Virtualized vs. Non-virtualized CPU Performance

![Graph showing CPU performance comparison between virtualized and non-virtualized configurations.](image)

- MATRIC Non-virtualized - Intel Xeon E5640 @ 2.67 Ghz
- MATRIC Virtualized - 32% estimated performance decrease
- WVGISTC Non-virtualized - Intel Xeon E5540 @ 2.53

*CPU benchmark scores from: cpubenchmark.net
Performance Benchmarking (cont.)

M&S Benchmarks (Deployed vs. Local)

- Mean: MATRIC Dev (No Congestion)
- Mean: WVGISTC (No Congestion)
- Mean: MATRIC Dev (Congestion)
- Mean: WVGISTC (Congestion)

- Data Loading
- Computing
- Publishing
- Totals

Seconds
M&S System: Wrap-Up

The Modeling & Simulation prototype system is a scalable performance-tuned consequence management system for “what if” planning of real-world disaster scenarios that allows for a great range of extensibility and customization to suit the needs and conditions of a given disaster scenario or region.