National Infrastructure Simulation & Analysis Center

MIT Center for Grid Computing

Investigation of Agent-Based Simulation Architectures for Simulating US Critical Infrastructures
A Distributed Hardware and Software Test-bed for Agent Based Simulation

Agent-Based Simulation

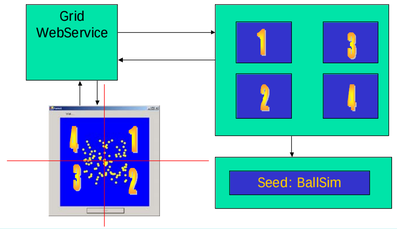
The Problem:
Simulation of large critical-infrastructure systems involves both a predictive capability and real-time data-driven detection capability. The detection of attacks requires an assessment of infrastructure state from real-time data gathered from multiple organizations and facilities running different operating systems and server software. To allow this kind of simulation this project investigates cross-platform integration and the development of a Windows .NET compatible version of the Globus Open Grid Services Architecture.

This project develops a Web Services architecture to support agent based simulation of the US Critical Infrastructure across multiple platforms. The MIT Grid Computing Center, in collaboration with NISAC, has set up a distributed hardware and software test bed for agent-based web services simulation. The initial nodes are in NISAC and in MIT. The center is investigating the following issues:

Communication Capability Tests between NISAC and MIT
The MIT Grid Garden .NET Agent model and OGSA GT3 (J2EE version) have been deployed and are being investigated to determine interoperability and protocol issues. Distributed simulations have been tested running across the Internet with NISAC accessing Web Services at MIT across the Internet.

GRID Garden.NET – A Prototype .NET Implementation of OGSA GT3
A prototype .NET version of Globus OGSA GT3 has been developed and is being tested.

SOAP Interoperability and Practical Limits to Message Size
This investigation is documenting compatibility issues between .NET and Apache Tomcat based SOAP messaging. The feasibility of using web services to provide an interface to very large datasets, such as GIS, for geo-spatial data analysis and presentation.



Grid Garden.NET can transfer state-bearing simulation objects to other Grid Workstations (locally or remotely) and these objects can be processed using different "seeds" or code-library files at each station.

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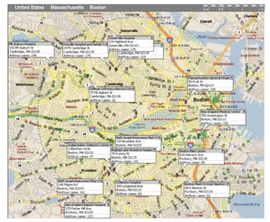
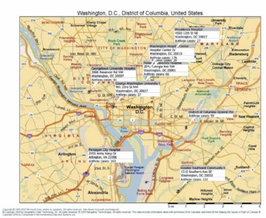
GIS Mapping Services

The Problem:
Decision makers need real time geo-spatial data from multiple sources that can be interpreted quickly. The Live Simulation Mapping Agent (LSMA) acts as a geo-spatial computation agent. It provides useful mapping visualizations and interacts with other agents. It can provide important routing and live-update demographic and infrastructure data.

• LSMA is an "add-on" program that allows users to do special feature-searches and lookups in MapPoint 2002.

• It provides programmatic interface exposure that can be harnessed over the Internet to coordinate with other distributed agent services.





Functionality:
• The Live Simulation Mapping Agent (LSMA) version 1.0 includes a system that can find locations by plain-text lookup or by longitude and latitude coordinates.

• The plain-text lookup finds a number of string matches and selects what is considered the most-likely location using a heuristic evaluation system.

• Locations can be programmatically entered and the software connects to remote sources of spatial data using Web Services.

• LSMA can find specific types of spatial data (such as hospitals or airports.) These Points of Interest (POIs) are available using the MapPoint 2002 engine from meta-data that is internal to the application. The meta-data for each location includes data such as what type of facility and the relative size of the facility that is being operated.

• Additional data can be displayed using hospital and airport intelligent agents that search for and connect to web services providing live data. The data can be leveraged in calculations, visualizations and mapping information, such as Repast.

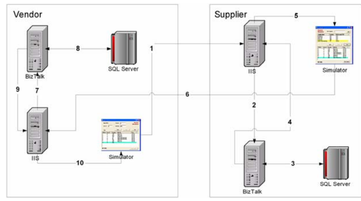
• Using LSMA 1.0, it is be possible to find all hospitals or airports in a specific radius and to view a specific value that the system can provide. These values include the number of cases of a certain disease at each hospital or the number of passengers delayed at each airport within the entered radius.

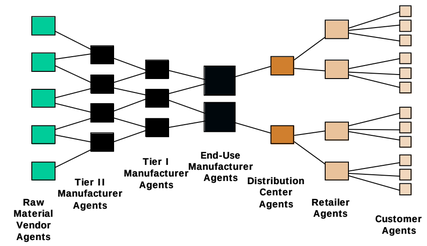
• Potential uses of LSMA include coupling to smart algorithms that calculate ambulance routing, triage management and patient routing, infrastructure management (including plotting who may need scarce resources and how the resources can be most effectively and quickly allocated.)

Supply Chain Simulation

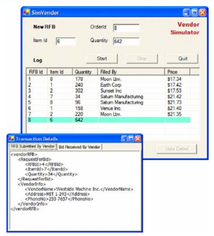
The Problem:
Different organizations use different XML representations for the same information. If we are to detect anomalies in infrastructure operation we must be able to interpret from one XML schema to another. This simulation software demonstrates the capability of messaging handling involving different XML Schema. It highlights XML transformation on purchase orders, message queues and activating server processes from Web Services calls.

Example: Two groups of businesses involved in a supply chain use different XML Schema to bid on order fulfillment. The vendor requests bids for goods from wholesale suppliers. The suppliers bid depending on complex model and the lowest bidder wins the bid. The winner supplier then fills the order, and sends an invoice to the vendor.

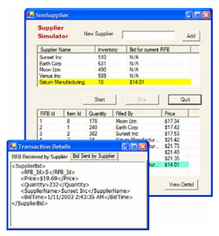




XML Supply Chain Networks often involve a large number of independently administered naming schema and systems that could benefit from quick and automated agreement and nomenclature mappings.



Vendor

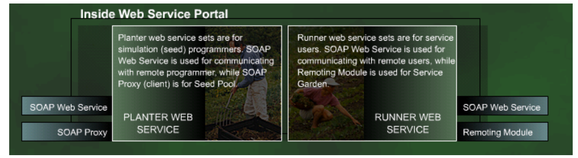


Supplier

Grid Garden.NET

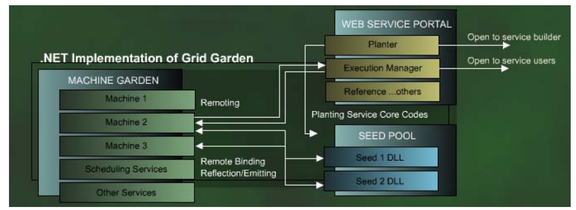
The Problem:
Large scale simulation requires a Grid computing framework, such as that proposed by the Globus Open Grid Services Architecture OGSA GT3. However, GT3 has no implementation for the .NET Architecture. Real-time diagnostics of critical infrastructure will require grid computing that spans Linux, Windows and other operating systems.

Grid Garden.NET
Grid Garden.NET is a prototype that implements similar functionality to that provided by OGSA GT3-J2EE, but specifically targets large-scale simulation. Grid Garden.NET focuses on providing distributed agent computation within a VPN environment. The "Grid Garden" consists of a loosely coupled network of computers that run a lightweight harness called a Plant Box. A Plant Box can contain many Plant Pots and a different executable can be remotely loaded into each Pot from a central Web Services Manager. The Manager provides the user proxies for each of the Plant Pots, so that computations may be started, paused or killed (as specified in the GT3 architecture). The Grid Garden provides stateless, semi-stateful and stateful services.



Grid Garden.NET Particle & Encryption Examples:
The sample computations include molecular dynamics and an MD5 encryption cracker. These samples have been implemented with seeds on both Windows and Unix platforms. The components of the Grid Garden.NET services are as follows:

• Web Services Portal - web services that can be accessed to configure/run a specific service. The Portal contains two sets of Web Services. One is for Service Builders and the other one is for Service Users.
• Seed Pool - code collection that is uploaded by the programmer. "Seeds" are core of the computational services that the Web Services Manager controls. All the seeds have common interface that allows the harness to control them.
• Grid Garden - a domain inside a LAN that provides machine connectivity. It has worker nodes (Plant Pot) as well as a Manager. "Plant Pot" is a container that loads Seed and provides services. Different Plant Pots may run on a same worker computer or different worker computers.



NISAC's core partners are Sandia National Laboratories and Los Alamos National Laboratory.
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Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405 ENG-36.