

MultiSimulation Interface (MSI) for Complex Simulation

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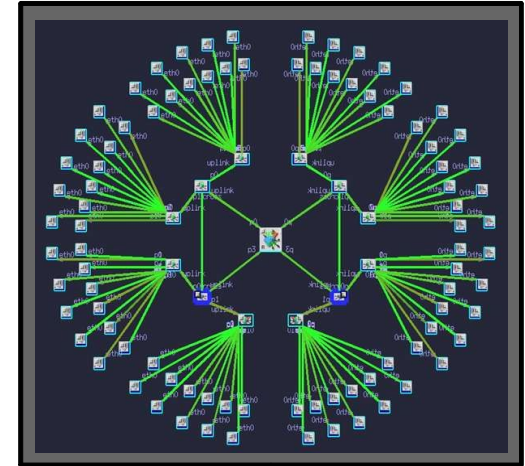


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Overview

Distributed Simulations

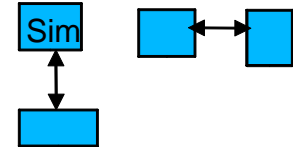
- **Complex simulations are often realized by interconnecting multiple distinct simulators.**
- **Distributed interactive simulation has long history of methods.**
- **In 2001 Advanced Technology Laboratories used DMSO HLA for distributed fasterthanrealtime (FTRT) simulation of 50,000node communication network.**
 - **HLA traffic saturated LAN, preventing performance objective.**
 - **Lightweight alternative, MSI, developed to meet requirements.**



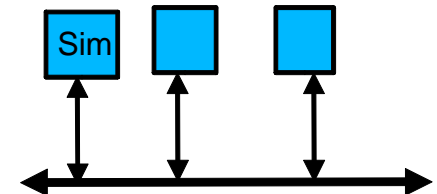
Background

Simulation Interconnection Frameworks

- **Adhoc/pointtopoint: From before 1980's through current day.**
 - Custom interfaces for each pair of simulators.
 - Not easily maintained, nor scalable.



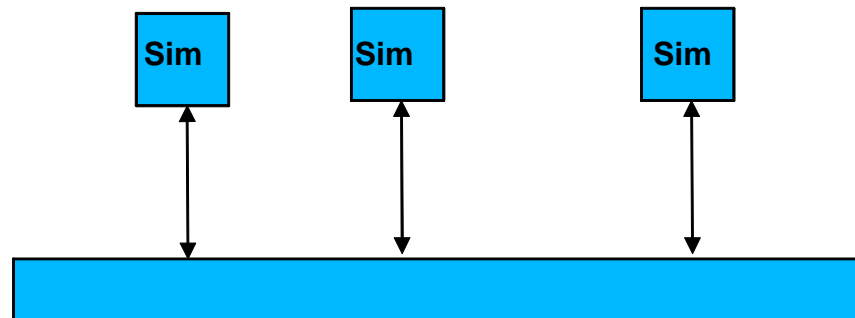
- **SIMNET and DIS (Distributed Interactive Simulation): 1980s**
 - Standard message formats broadcast to disseminate state/event information.
 - Aimed at loosely synchronized training simulations.
 - Realtime only.
 - Each simulator processes every message.
 - Not efficiently scalable to large federations.



Background (cont.)

Simulation Interconnection Frameworks

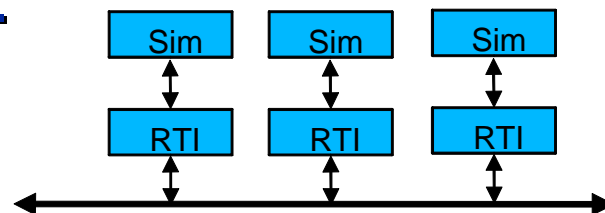
- **ADS and ALSP: Early 1990s**
 - **Advanced Distributed Simulation project led to Aggregate Level Simulation Protocol.**
 - **Three advantages over DIS:**
 - **Centralized clock management.**
 - **Common data representation system.**
 - **Architecture independence.**



Background (cont.)

Simulation Interconnection Frameworks (cont.)

- **HLA (HighLevel Architecture): Circa 1996**
 - **Developed by Defense Modeling Simulation Office (DMSO).**
 - **Sophisticated reusable technologies encapsulated in Run-TimeInterface (RTI).**
 - **Includes time and data management.**
 - **Publish/Subscribe method distributes event data only where needed; ==> more scalable.**
 - **Initial DMSOfunded reference release was binaryonly, quickly obsolete.**
 - **OMG and IEEE adopted; IEEE Std. 1516.**
 - **Several commercial vendors now support licensed versions, but cost can be prohibitive.**



Background (cont.)

Simulation Interconnection Frameworks (cont.)

- **MSI (MultiSimulation Interface): 2001**

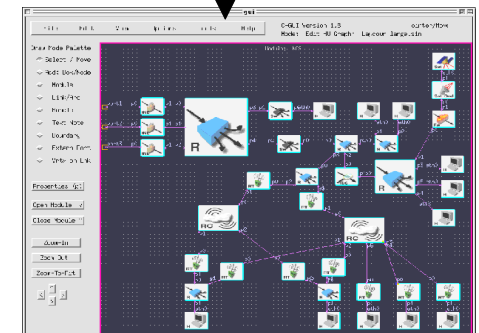
- Although HLA was well designed, some usability, performance, and availability issues.
- MSI addresses some of the issues.
- Lightweight HLAlike simulation-interconnect engine.
- Free OpenSource, Unencumbered Lessor-GPL (LGPL); hosted on SourceForge.
- XML based.
- <http://msi.sourceforge.net/>



Overview (continued)

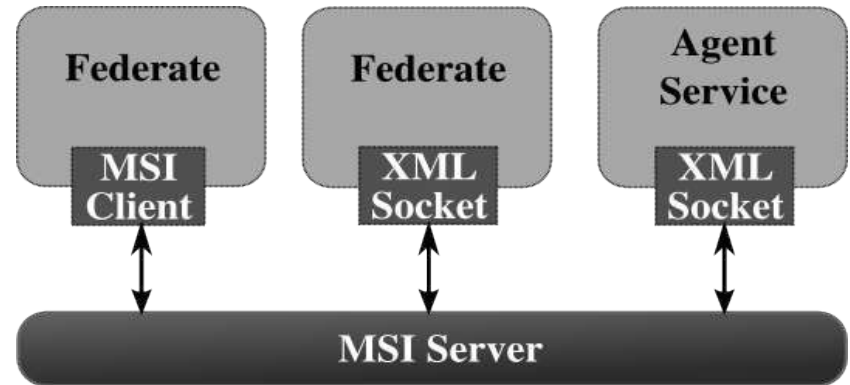
MSI (MultiSimulator Interface)

- **MSI (MultiSimulator Interface)**
 - Three order of magnitude reduction in code size/complexity.
 - Exhibited order of magnitude reduction in LAN traffic.
 - Supports new and diverse simulation types, such as: agentbased, social/economic modeling, and system of system simulations.
- Continued MSI developments provide an alternative addressing: complexity, availability, scalability, support, standardization, and most importantly— cost of building complex multidomain systems.
- Presentation reviews distribution technologies, MSI features.



MSI Features

- **Based on XML socket stream.**
- **Usable from any programming language – C, C++, Java, Ada, Perl, etc.**
- **No library dependencies.**
- **Crossplatform code, portable to all major OS platforms (Linux, Solaris, Irix, HPUX, Mac OS X, Microsoft Windows, FreeBSD, etc.).**
- **Provides managed federation startup (join) control.**
- **MSI is a single executable file.**
- **Distributed with example code for simulator (federate) side interface.**



MSI Description

Concepts

- **Data exchange formats**

- Many prior frameworks force clients to convert all shared data to neutral formats.
- Metadata is added to each exchange, enabling envelope parsing; ==> Verbose.
- High processing and bandwidth costs to transform and pack all data.



Direct face-to-face mappings

- **MSI Rosetta Stone approach**

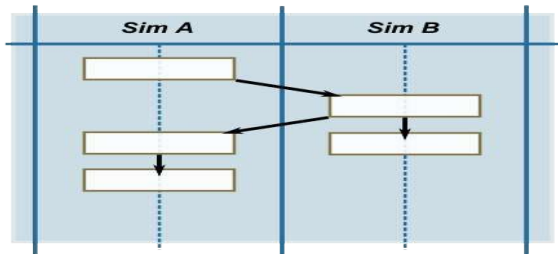
- Instead of transforming data on input, MSI leaves data in original form for efficient transfer.
- MSI clientside library transforms data to best local form.
- If receiving simulation can parse incoming data, then no translation overhead incurred.
- XML enables context insensitive parsers and transformability.
- XSLT can specify arbitrary transforms; ==> Supports direct inter-ontology mappings .



Lean Time & Data Management

- **Maintaining Causality**

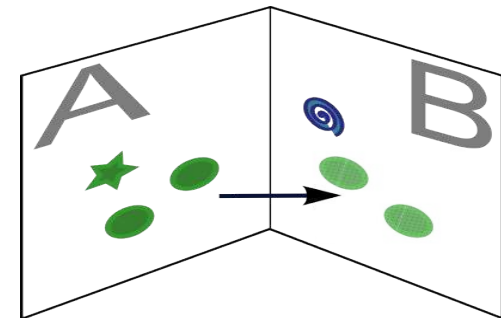
- Temporal ordering of events must be managed among distributed federation.
- Data and events may be cached to simplify federation startup; asynchronous joining.
- MSI supports conservative and loose time management.
- Each federate reports time of next event (TONE).
- Global Virtual Time (GVT) enables advancement as it is safe to do so.



Temporal Causality

- **State Data Management: Reduces Network Bandwidth**

- MSI enables subscription to object states by subfields and/or instances, not just types.
- Data caching of existing states also minimizes network traffic, as well as federate accesses.
- Dynamic data culling by clients; filtering changes with time and conditions.

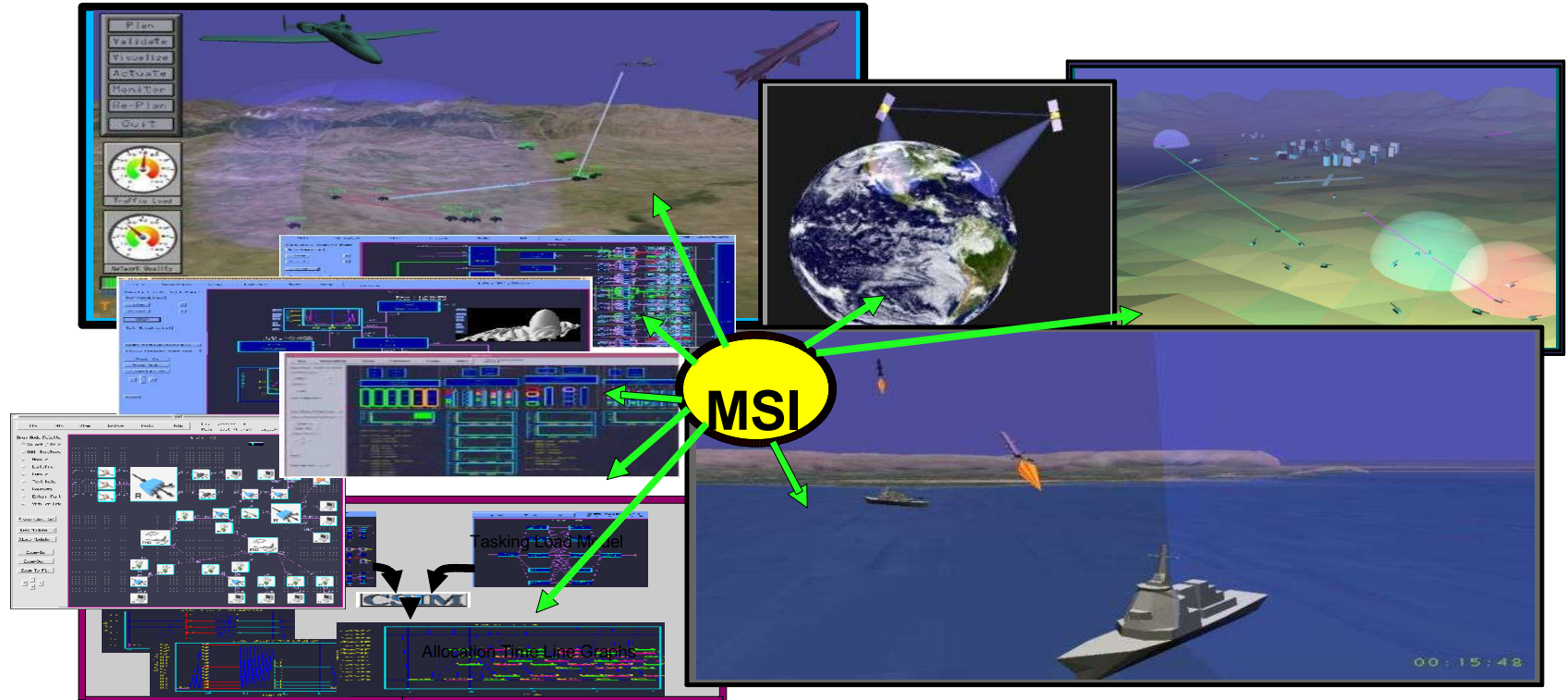


Data Coherency



MSI Conclusions

- Simple powerful tool for connecting simulations; small number of simple interfaces.
- Advances and updates prior efforts.
- Balances learning curve, complexity, and efficiency.
- Enables new kinds of distributed systems, mixed abstraction levels, systems of systems simulation.
- Data transformation approach facilitates agent based, service oriented systems, etc..



<http://msi.sourceforge.net/>