Service Provisioning for HLA-based Distributed Simulation on the Grid

Yong Xie
SMA Programme, Singapore

Yong-Meng Teo
NUS, Singapore

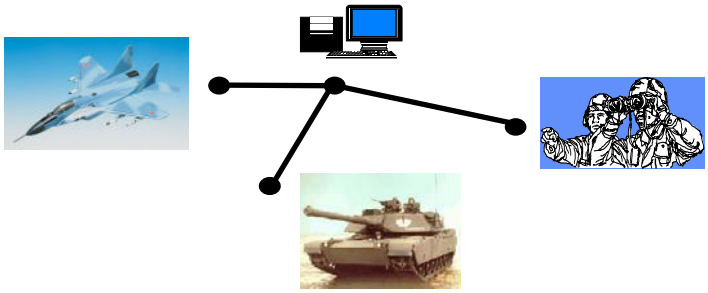
Wentong Cai & S. J. Turner
NTU, Singapore

Outline

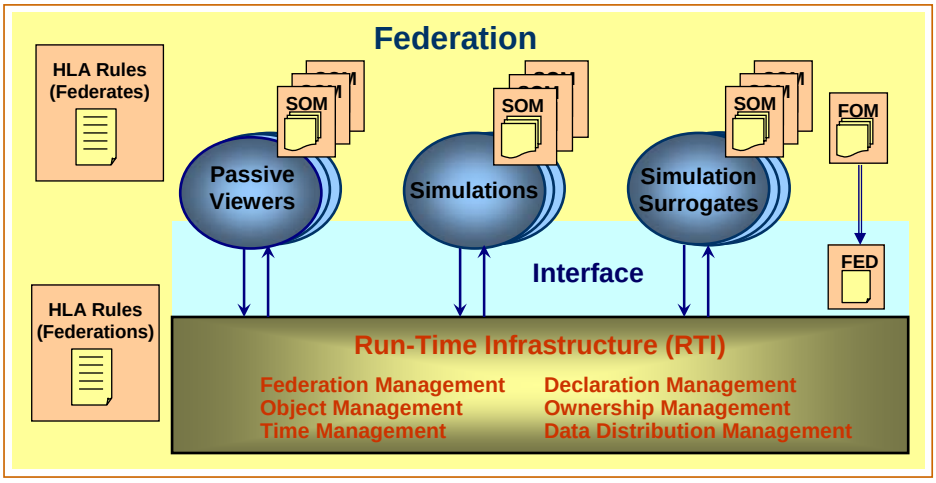
- Background & motivation
- Objective
- Design
- Implementation
- Experiments
- Discussion
- Conclusion & future work

Distributed Simulation

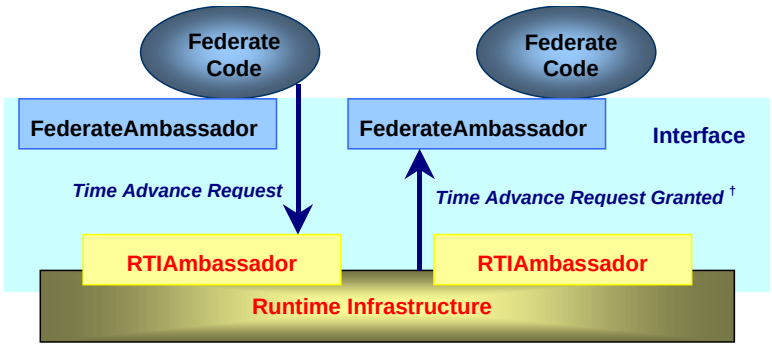
- Provides a way of linking simulation components (federates) of various types at possibly different locations to create a common virtual environment (federation).



High Level Architecture



HLA/RTI: Communications



Motivation: Provision of Services

- Distributed Simulation over the Wide-Area-Network using IEEE HLA/RTI requires:
  - Hardware and software
  - Arrangements beforehand
- Increase in scale and complexity of simulation -> large amounts of resources, provision of services are more difficult
- Resources: RTI execution services, simulation model, underlying DS infrastructure

The Grid

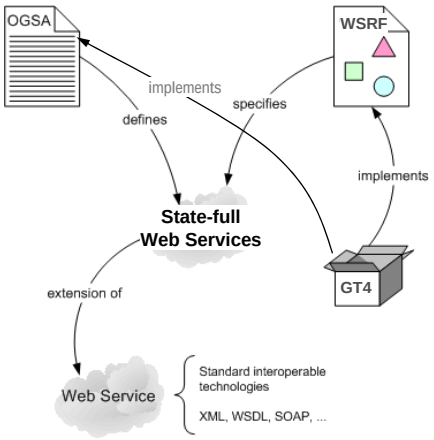
OGSA

OGSI / WSRF

Grid Service

Web Service

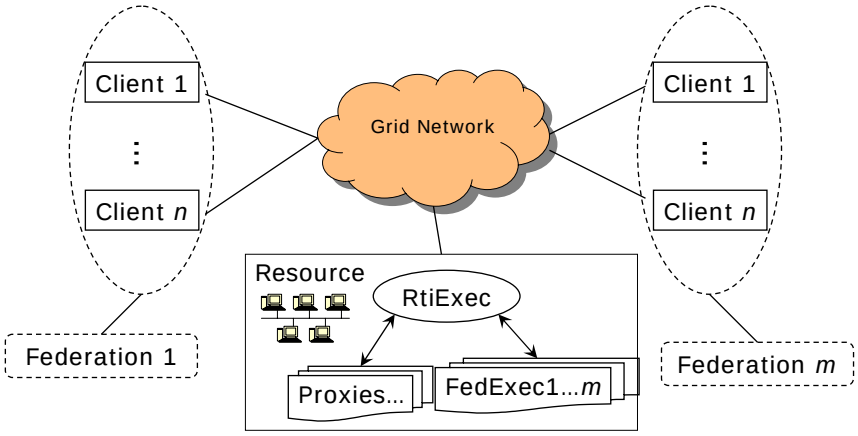
Globus Toolkit



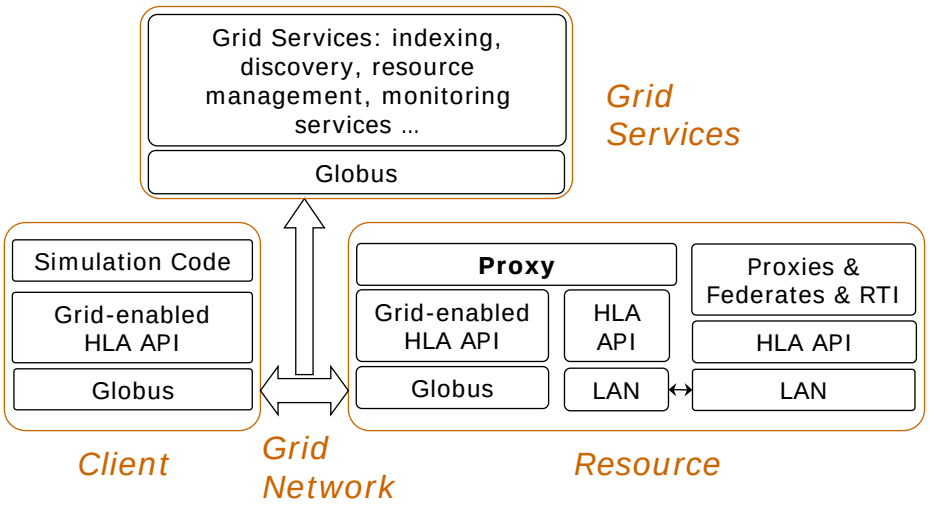
Objective

- To support RTI service to be used on demand
- To support dynamic discovery of federations
- To provide a standard HLA API: for interoperability and reusability
- To overcome the limitation of firewalls in traditional HLA/RTI implementation (e.g. DMSO HLA/RTI)
- To support hierarchical federation

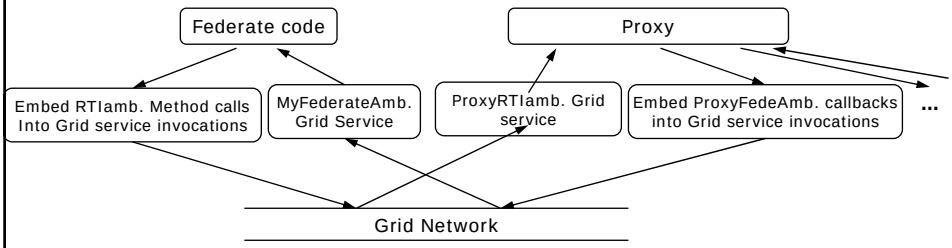
Design



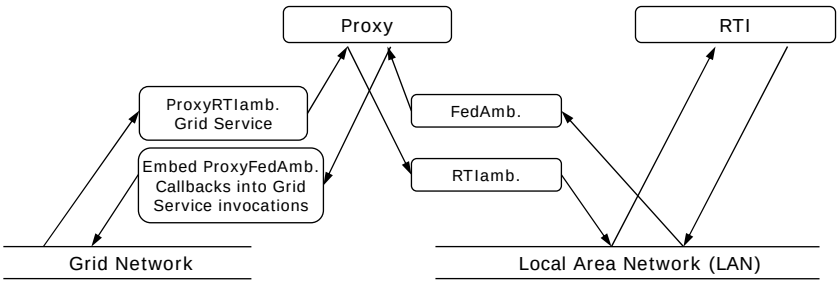
Design (Client-Proxy-RTI)



Design: Client-Proxy



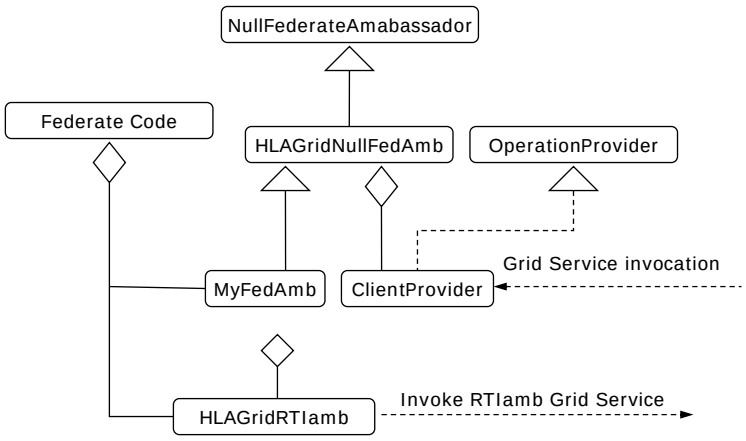
Design: Proxy-RTI



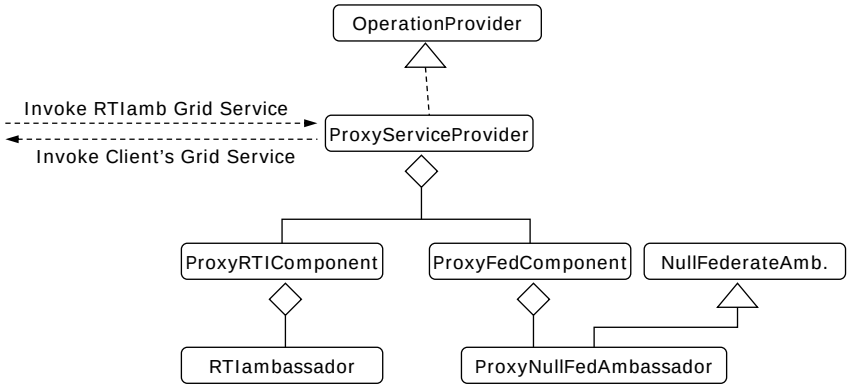
Implementation

- Prototype of proposed framework is implemented in Java using DMSO RTI 1.3NG v6
- Grid system runs the Globus Toolkit v.3
- Implmented the RTIambassador services' API for Federation Management, Time Management, Object Management, Declaration Management, and Ownership Management
- Data Distribution Management (DDM) implemenation in process

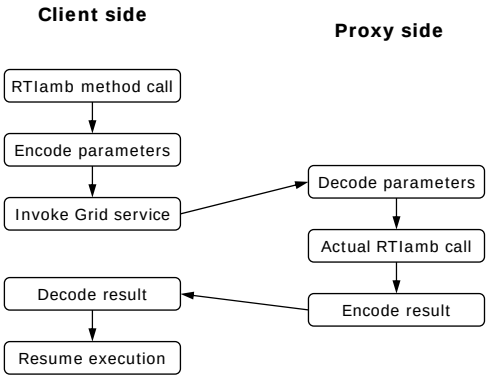
Implementation: Client Side



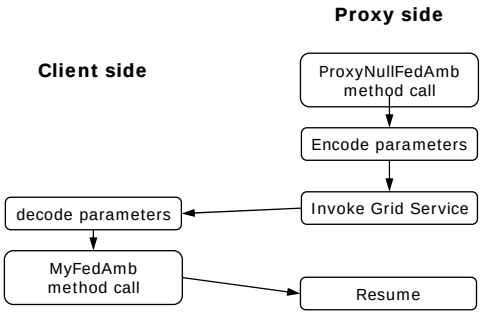
Implementation: Proxy Side



Implementation: Client→Proxy



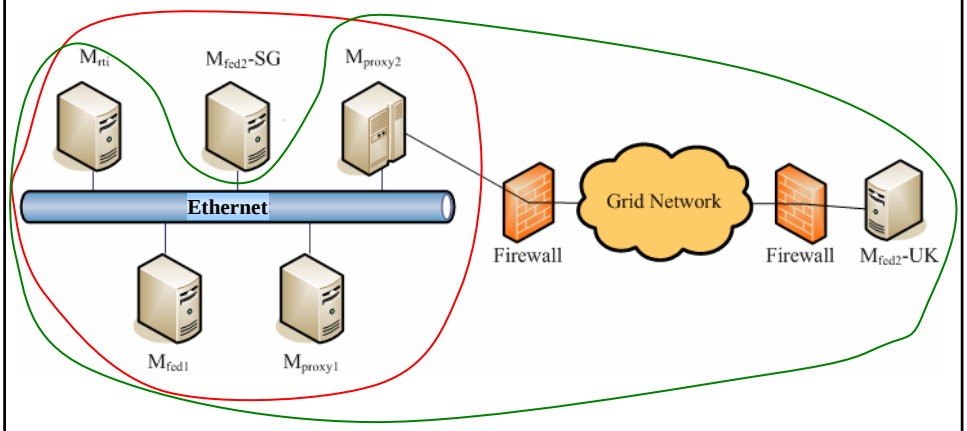
Implementation: Proxy→Client



Experiments

- Investigate the overhead incurred in the proposed framework
- Converted the benchmark programs from DMSO's HLA/RTI package into Java, and tested under different network configurations
- Two main benchmarks: Latency and Time Advancement
- Testing environments:
  - Linux cluster in Parallel and Distributed Computing Center at Nanyang Technological University
  - Linux workstations in School of Computer Science at Birmingham University

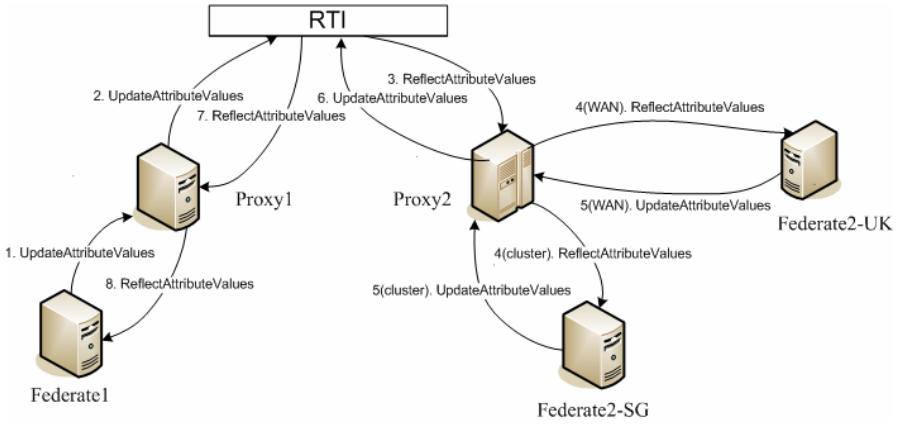
Experiments Environment



Experiments (Hardware)

	M_{proxy2}	M_{rti}, M_{fed1}, M_{fed2}-SG	M_{proxy1}	M_{fed2}-UK
CPU	4xPentiumIII 500MHz	PentiumIII 733MHz	2xPentiumIII 733MHz	AMD Athlon 1.5GHz
Memory	1 Gbyte	1 Gbyte	1 Gbyte	2 Gbyte
OS	Redhat Linux 7.0	Redhat Linux 7.0	Redhat Linux 7.0	Redhat Linux 7.3
gcc	3.0.2	3.0.2	3.0.2	3.0.2
HLA	DMSO NG 1.3 V6	DMSO NG 1.3 V6	DMSO NG 1.3 V6	DMSO NG 1.3 V6

Experiments (Benchmarks)



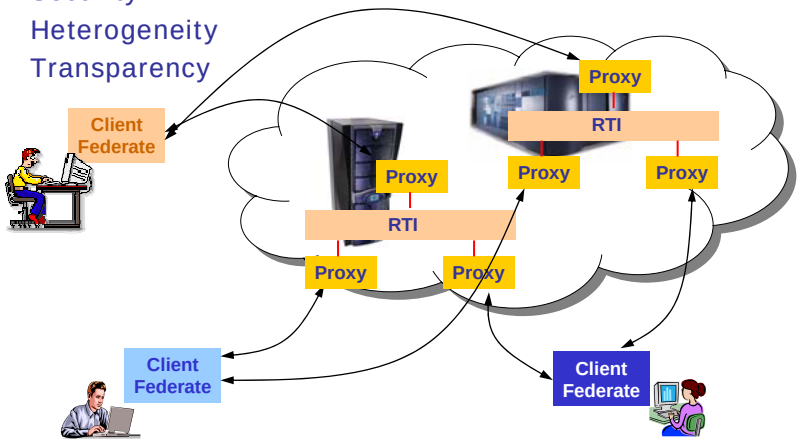
Experiments (Results)

		HLA	HLAGrid
Latency	Cluster	10 millisecond	50 millisecond
	WAN	305 millisecond	1200 millisecond
Time Advancement	Cluster	680 grants/second	150 grants/second
	WAN	2 grants/second	0.41 grants/second

- Overhead in cluster: latency = 40 millisecond
  - Use of GT3, encoding/decoding of parameters/results, and the communication costs
- Overhead in WAN: latency = 895 millisecond
  - Mainly caused by the increase in communication using SOAP messages over long distances -> increase number of packets

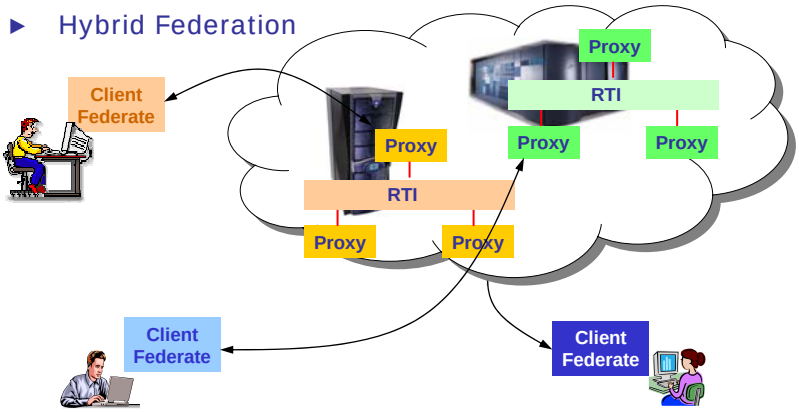
Benefits of the Architecture

- Decoupling
  - Security
  - Heterogeneity
  - Transparency



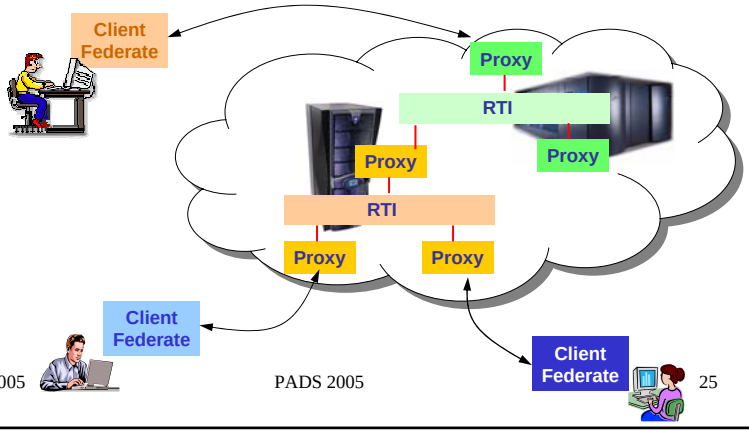
Benefits of the Architecture

- Flexibility
  - Multi-federation
  - Hierarchical Federation
  - Hybrid Federation



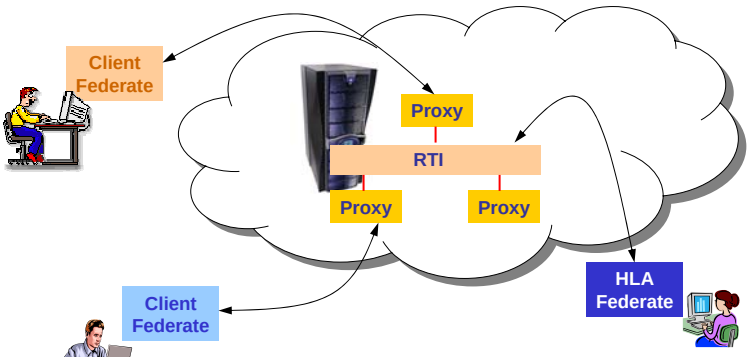
Benefits of the Architecture

- Flexibility
  - Multi-federation
  - Hierarchical Federation
  - Hybrid Federation



Benefits of the Architecture

- Flexibility
  - Multi-federation
  - Hierarchical Federation
  - Hybrid Federation



Conclusion & Future Work

- Design and implement a framework to extend HLA to support Grid-wide distributed simulation using Federate-Proxy-RTI architecture
- Provision of services through Grid Service invocations
- Prototype using Glogus Toolkit v3 and DMSO RTI 1.3NG v6
- Overhead incurred in the prototype suggests coarse-grained application
- Future work: federate migration, fault tolerance, integration with security

Questions?