



Singapore Institute
of Manufacturing
Technology

Grid Computing Platform for Supply Chain Decision Support System

Grid Computing Application Sub-theme Presentation

Areas addressed:

1. Distributed Supply Chain Design, Integration & Optimization

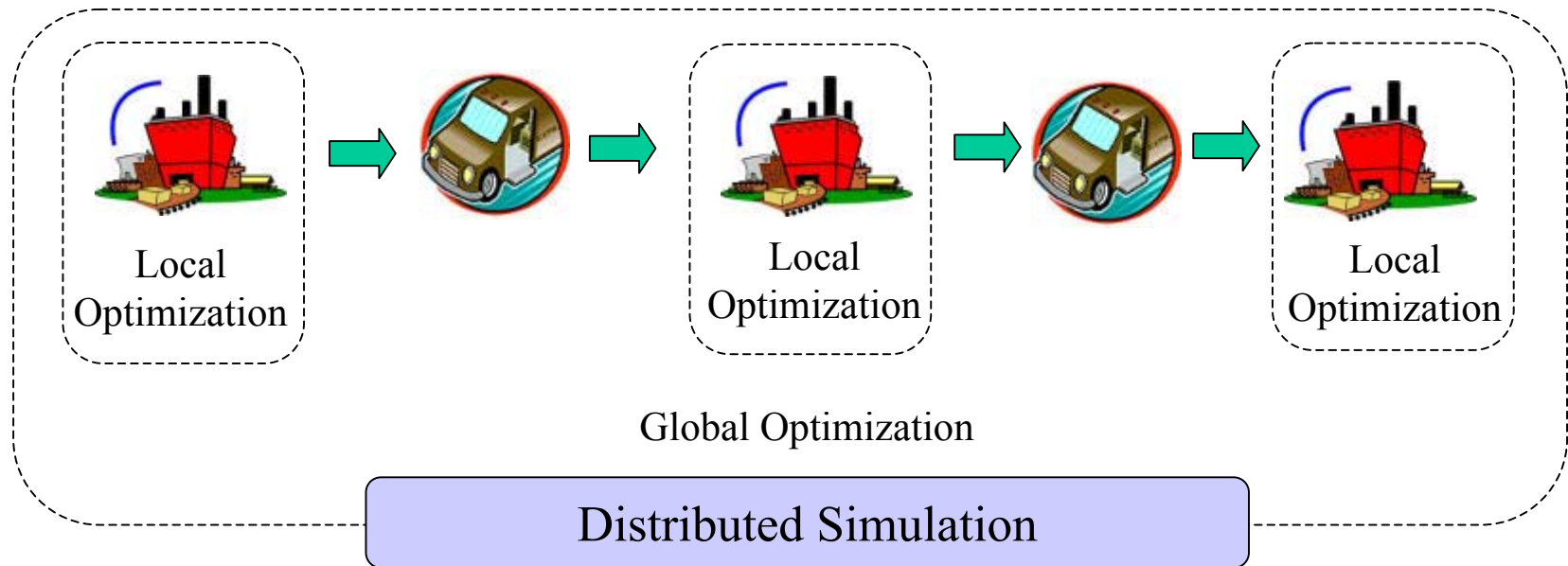
2. Distributed Decision Support System

- **Singapore Institute of Manufacturing Technology (SIMTech)**, Production and Logistics Planning Group: Dr Malcolm Low Yoke Hean, Dr. Peter Lendermann, Mr. Gan Boon Ping and Mr. Nirupam Julka
- **School of Computer Engineering, NTU**, Parallel and Distributed Computing Centre: Associate Professor Stephen Turner and Associate Professor Cai Wentong
- **Brunel University, UK**, Centre for Applied Simulation Modelling: Dr Simon Taylor

Motivation and Relevance to Singapore

- An increasingly collaborative world in which countries rarely make entire products from start to finish
 - Design, production, distribution and servicing are split into segments and spread all over the world
 - Singapore has to carve a niche for itself by excelling in some areas, while linking up with other countries in the supply chain
 - Economic Review Committee Report 2003
- Enterprises today need to establish dynamic and adaptive supply chains with different business partners to tackle uncertainties and exceptions
 - Simulation is an effective tool for strategic, tactical and operational decision making in the manufacturing industry
 - Existing studies focus on monolithic intra-enterprise simulation models
 - Inter-enterprise dependencies are not considered in existing decision making processes
- New operational challenges for managing complex inter- and intra-enterprise processes
 - Typical of high-tech industries such as semiconductor manufacturing.
 - global sales in semiconductor industry to reach US\$173 billion in 2003 - Gartner report
 - Simulation is needed to explore and realize the impact of local decisions to global operations

Motivation and Relevance to Singapore



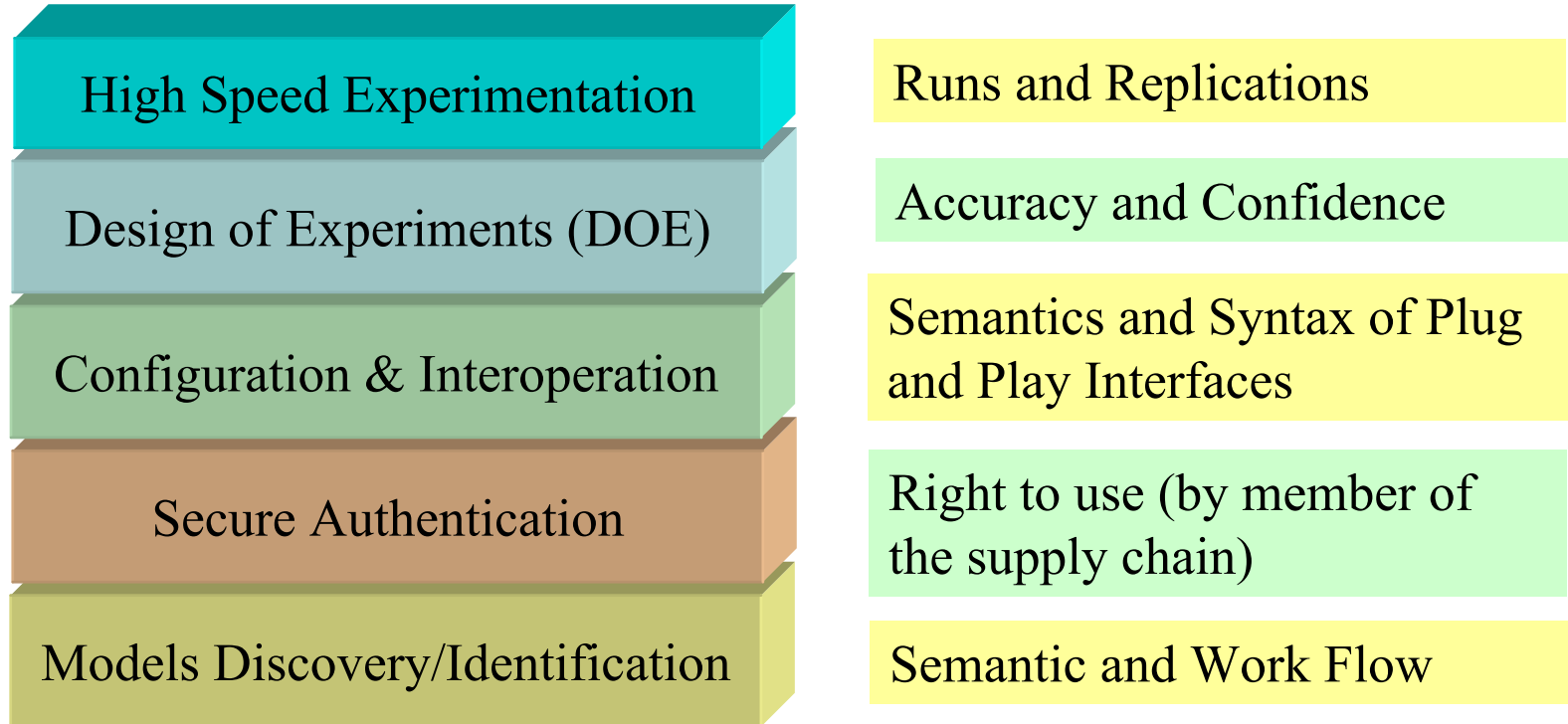
- Distributed Simulation enables the development of complex simulation applications
 - Allows collaborations between researchers
 - with different domain knowledge and expertise
 - possibly at different geographically dispersed locations
 - **High Level Architecture (HLA)** is the de facto standard for interoperability between simulation models
 - Collaboration and the use of distributed computing resources are enabled by **Grid Technologies**

Current Status/Activities

- SIMTech and NTU PDCC have been working extensively on middleware for HLA
 - Hierarchical HLA
 - Shared-state Synchronization
 - Simulation Cloning
- Brunel, NTU PDCC Lab and SIMTech are members of an international forum, HLA Commercial Off-the-shelf Package Integration Forum (HLA-CSPIF) (www.cspif.com)
 - Approved by Simulation Interoperability Standards Organization (SISO)
 - Develop standardized approaches to support the interoperation of discrete event models created in commercial-off-the-shelf simulation packages using HLA.
- SIMTech is also involved in collaborative research projects with local/overseas semiconductor companies and research institutions in the areas of
 - Enhancing operational performance on an aggregate level through enabling material-in-progress in-between similar production facilities of an extended enterprise
 - Coordinating complex interdependencies between two successive critical manufacturing nodes of an extended enterprise
 - Managing complex logistical flows in emerging manufacturing networks with high degree of outsourcing

Research Challenges

- Tools, techniques and methodologies for enabling "**plug and play**" simulation of intra/inter enterprise models on Grid Computing platform



Research Challenges

Models Discovery/Identification

- Based on the business requirement, “suitable” simulation models are selected to form a supply chain
 - Leverage on Web Services for interfacing with HLA simulation models
 - Models may be pre-selected from a list of existing supply chain partners, or dynamically discovered as required
 - What kind of simulation models are required by the case study?
 - Where are the simulation models located?
 - What are the configurable parameters of the simulation models?
 - Does the simulation model satisfy the business requirements?
 - If the required simulation model is not available, can it be replaced by another simulation model, or a chain of a few other simulation models?
 - How reliable are the simulation models?
 - Is this simulation model HLA compliance? Does it conform to any standard reference models (e.g. HLA-CSPIF, SISO)?

Research Challenges



Secure Authentication

- Supply chain partners should be allowed to specify partial or complete restriction in access to their simulation models
 - Does a supply chain have access to a particular simulation model?
 - What kind of enterprise data in the simulation model is exposed to other supply chain partners?
 - Can a user selectively share sensitive data with different supply chain partners?
 - Does the simulation model originate from a trusted supply chain partner?
 - What are the set of configuration parameters of the simulation model that are available to the user?

Research Challenges

Configuration & Interoperation

- Configuration of a supply chain involves checking interoperability between individual simulation model from different sources
 - description of supply chain configuration using workflow
 - verifications of simulation models interoperability using semantics
 - Can the output of a simulation model feed into the input of another?
 - How to describe the work flow of the configuration process ?
 - What are the mechanisms for verifying the correctness of the supply chain configuration?

Research Challenges

Design of Experiments (DOE)

- Design of Experiments (DOE) is a tool to derive the number and nature of simulation runs based on the required confidence level
 - limited by the computing resources available in the enterprise
 - effectiveness of the decision is based on the speed at which it is made
 - tradeoff between accuracy, speed and cost often means semi-optimal results are accepted due to resource constraints
 - How many different scenarios should be explored?
 - How many repetitions should each scenario be run?
 - What are the computing resources needed for these runs?
 - How long will the entire set of experiments be completed?
 - How accurate are the data from these simulation runs?
 - How should the DOE process take into consideration the availability of resources on the Grid computing platform?
 - What is the cost of executing the experiments on the Grid?

Research Challenges

High Speed Experimentation

- The Grid computing platform provides enterprises access to high-end computational capabilities required for such supply chain decision support system.
 - Future enterprise may purchase computing services (cycles) from Grid vendors to supplement their needs for high speed decision making
 - Scheduling, load management and fault tolerance of HLA simulations on Grid
 - How much computing resources should be purchased to execute the experiment?
 - How can the different simulation runs be partitioned onto the available computing resources?
 - What kind of fault tolerance mechanisms does the underlying grid platform support?
 - How to improve performance when real-time systems are incorporated into a simulation?
 - How do techniques such as “*simulation cloning*” reduce the execution time of a set of experiments?

What we would like to do...

