

***Grid Computing
Middleware and Management Sub-Theme***

Resource and Service Management

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Fundamental to the success of Grid is the ability to discover, allocate, negotiate, monitor, and manage the use of network-accessible capabilities in order to achieve various end-to-end or global qualities of service

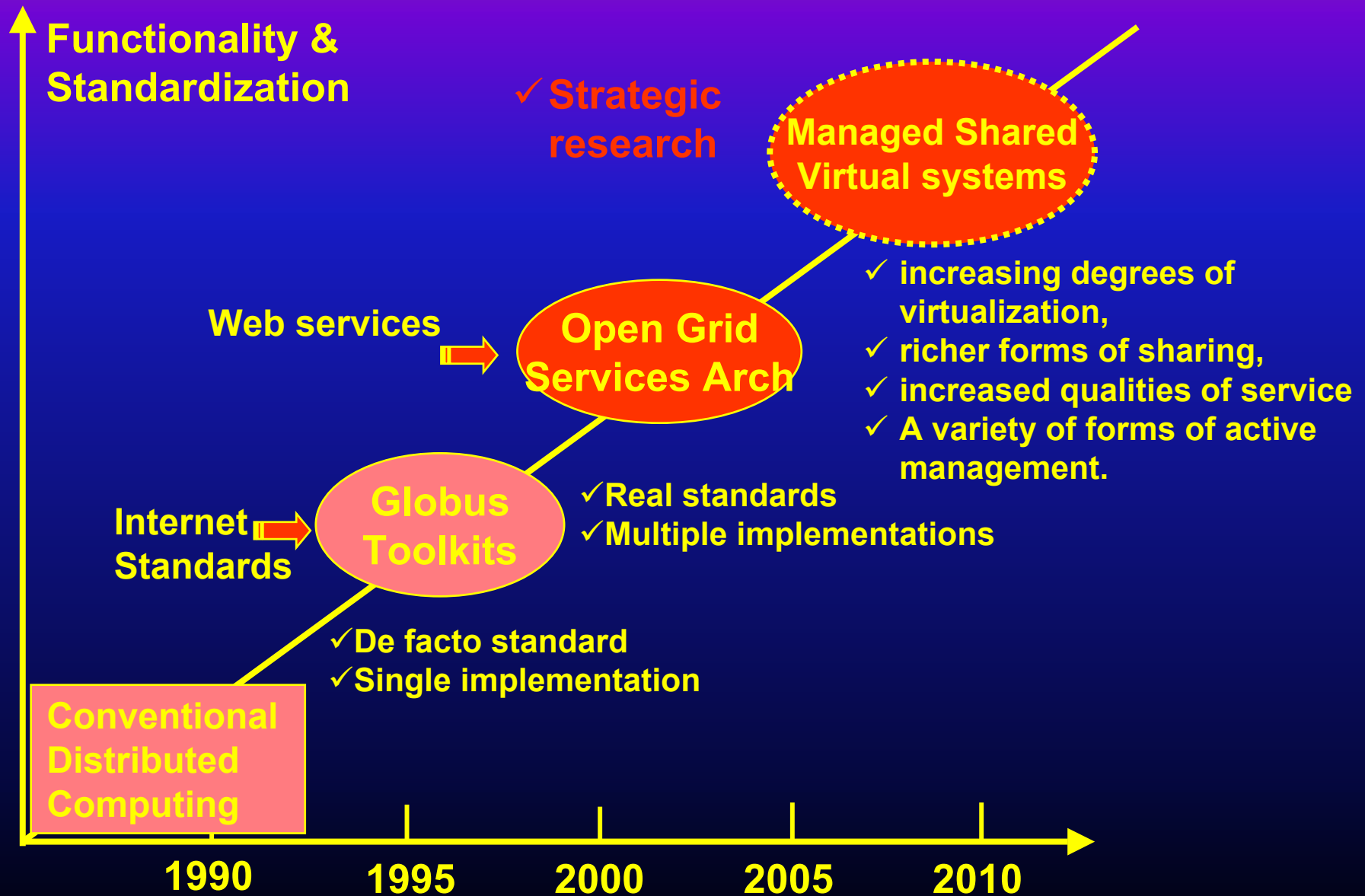


Agenda

- ❑ **Challenges and State of the Art of Grid resource and service management**
- ❑ **A research framework of Grid resource and service management**
- ❑ **Research focus areas**

Challenges and State of the Art: Resource and Services Management

State of the Art



Challenges in Resource Management

- ❑ In traditional computing systems, resource management is a well-studied problem.**
 - ☞ Resource managers exist for many computing environments.**
 - ☞ These resource management systems are designed and operate under the assumption that they have complete control of a resource and thus can implement the mechanisms and policies needed for effective use of that resource in isolation.**
- ❑ Unfortunately, this assumption does not apply to the Grid.**
 - ☞ We must develop methods for managing Grid resources / services across separately administered domains, with the resource heterogeneity, loss of absolute control, and inevitable differences in policy that result.**

Open Issues in Resource Management

❑ Service virtualization

- ☞ disseminate work across service instances, with the number of instances of different services deployed varying according to demand**
- ☞ As a building block for assembling application**

❑ Multiple layers of schedulers

- ☞ Resource refers to anything that can be scheduled: a machine, disk space, a QoS network, and so forth**
- ☞ It involves many different layers of schedulers.**

❑ Lack of control over shared resources and variance resources

- ☞ may not (usually does not) have ownership or control over the resources**
- ☞ Such sharing results in a high degree of variance and unpredictability**

Open Issues in Resource Management

□ End-to-end resource provisioning

☞ Today's Grid environment is primarily oriented toward best-effort service which is substantially different in the next several years, with end-to-end resource provisioning and virtualized service behavior.

□ Adaptive Brokering

☞ The complexities in brokering resources: impossible to reliably predict the future performance

☞ Flexible delegation to intermediate brokers

□ Service management

☞ Metering, accounting, billing

A Research Framework of Resource and Service Management

Research Focus Areas in RM and SM

Appl. Prov.
Framework

Policy-based
E2E QoS

Service
composition
Framework

OGSA-based
platform

QoS-by-Contract
RM&SM

Adaptive
Service Mgmt

Data Mining &
Info service

Agents for Grid

M
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Policy-based, QoS Contract (Agreement-based)

Sharing &
Access

Security

Optimization

Provisioning

Virtualization Engine

Computing

Storage

Networking

Applications

Research Focus Areas in Resource & Service Management

Research Focus Areas

- 1. Application Provisioning Framework**
- 2. QoS-by-Contract Resource management and Super-scheduling**
- 3. Policy-based End-to-End QoS**
- 4. Adaptive Service management**
- 5. OGSA-based Grid Platform**
- 6. Service Composition Framework**
- 7. Agents for resource management**
- 8. Grid Data Mining and information service**
- 9. International Grid Testbed**

Application Provisioning Framework

□ Provision & Replicate on Demand

- ☞ New, including environment & compiler related**

□ Packaging an Application

- ☞ Public or restricted; 'black-widow' (high security)**
- ☞ Consolidation of Libraries, makefiles, environment variable; Filters for automatic data conversion**
- ☞ Post-mortem of application performance**

□ Grid workflows with legacy components

- ☞ Workflows abound in biomedical applications**
- ☞ An expressive workflow description language and tools**

□ Principal researchers: IHPC, BII

- ☞ In collaboration with U. Konkuk (Korea), KISTI (Korea), IBM, Rolls Royce, BAe Systems, Cardiff University, Swansea University, Hewlett Packard**

QoS-by-Contract Resource Management

- Ability to create services of RM and adjust their behavior (and policies) based on organizational goals and application requirements**
- Understanding how various mechanisms can be effectively combined to create seamless virtualized views of underlying resources and services --- service contracts**
- The research is concerned with the notion QoS-by-Contract (SLA): including issues of**
 - representation of contracts to represent potential complex ongoing relationship,**
 - negotiation protocols to reach an agreement (negotiability)**
 - constrain satisfaction models and contract fulfillment.**

QoS-by-Contract Resource Management

□ A super-scheduling framework:

☞ In general, the super-scheduling problem has been defined as assigning Grid resources to tasks across multiple administrative domains.

☞ The framework allows different scheduling strategies to be composed and configured: QoS-enhanced schedulers (e.g., statistically guaranteed allocations); best-effort schedulers

☞ Protocols and algorithms being devised

□ Principal researchers: NTU, SUN (APSTC), BII (GridX), and NUS(ECE)

☞ Collaborating with AIST (Japan)

Policy-based End-to-End QoS

- ❑ Focused on understanding and managing diverse policies from the perspective of RM & SM**
 - ☞ Synthesizing end-to-end resource management in spite of diversity**
- ❑ Two and three-tier Policy Framework**
 - ☞ Outsourcing model and provisioning model**
- ❑ Specification and expression of resource policy for purposes of discovery, access, sharing, and enhanced security models**
 - ☞ protocols between policy enforcement, policy decision and policy repository**
 - ☞ End-to-End provision of policy information on the grid**
- ❑ Support flexible delegation of resource**
- ❑ Principal researchers: NTU, ASP**

Adaptive Service Management

- ❑ **Grid is a service marketplace**
 - ☞ **Support of different economic models and service trading**
 - ☞ **New approaches to allow resources to be measured and priced in response to supply & demand pressures**
 - ☞ **support *utility* computing: Metering, accounting, and billing**
- ❑ **Effective management for adaptive service provisioning**
- ❑ **End-to-end management and high availability service architecture**
- ❑ **Management API, management service and toolkit**
- ❑ **Principal Researchers: NTU, ASP**

OGSA Based Grid Computing Platform

- ❑ To develop an OGSA based Grid Computing platform with a pool of Grid services for**
 - ☞ Efficient management of and easy & secured access to HPC resources; and**
 - ☞ Efficient support of science & engineering applications in a Grid environment**
- ❑ Service Pools**
 - ☞ Fundamental component of the Grid Platform, e.g., Information Service, Execution Management Service, Scheduling service**
 - ☞ Higher level services for Globus Toolkit 3.0**
 - ☞ OGSI-compliant**
- ❑ Principal researchers: IHPC, NUS**

Agents for RM and SM

- ❑ Multi-agent system (MAS) for grid**
 - ☞ RM and SM seen as an act of agent Interactions in the Grid**
- ❑ Agents act on behalf of service owner**
 - ☞ Managing access to services**
 - ☞ Ensuring agreed contracts are fulfilled**
 - ☞ Scheduling local activities according to available resources**
 - ☞ Ensuring results are delivered**
- ❑ Agents act on behalf of service consumer**
 - ☞ Locating appropriate services**
 - ☞ Receiving and presenting results**

Agents for RM and SM

- ❑ Making service level agreements**
 - ☞ Typically achieved through some form of negotiation (since agents are autonomous)**
- ❑ Number of service providers cooperating to deliver new services**
 - ☞ Each delivers a portion of the overall picture**
 - ☞ Need to be combined in context sensitive way**
- ❑ Protocols for agent interactions, negotiations, goal-fulfilments**
- ❑ “Semantically-aware” discovery service**
- ❑ Principal researchers: NTU, ASP, IHPC**

Data Mining on the Grid

- ❑ Finding unknown data patterns in Grid**
- ❑ Specialized Mining Tools needed to tackle Challenges**
 - ☞ Data is geographically distributed, may not be possible to replicate to a centre location for mining operation**
 - ☞ Protocols for coordinating data mining processes**
 - ☞ Need to handle heterogeneous data with a high update frequency**
- ❑ Efficient data mining algorithms**
 - ☞ Adapting SVM subset algorithm jointly developed by IHPC & NUS as a specialised DMG algorithm**
 - ☞ Based on Support Vector Machine -- promising learning algorithm for classification / regression, even clustering**
- ❑ Principal researchers: IHPC, NTU, NUS**

Service Composition Framework

- ❑ **Service virtualization introduces the challenge, and opportunity, of service integration.**
 - ☞ **Once applications are encapsulated as services, application developers can treat different services as building blocks that can be assembled and reassembled to adapt to changing business needs.**
 - ☞ **Different services can have different performance characteristics; and, in a virtualized environment, even different instances of the same service can have different characteristics.**
- ❑ **Thus new distributed system integration techniques are needed to achieve end-to-end guarantees for various qualities of service**
- ❑ **Principal Researchers: NTU, ASP**

International Grid Testbed

□ Initial efforts for ApGrid: Asia Pacific Grid Testbed

 Japan, Korea, Australia, China,...

□ Fund support from A*Star is required to make the ApGrid testbed operational, and widely accessible by the Grid research community, Singapore.

Thanks, and
We are looking forward to

