Dynamic Grid Computing

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Overview

- Introduction to Grid Computing
  - Attributes of grid computing
- Types of grid
- Architecture of the Grid Computing
  - Service orientation
- Grid resource management
- Grids Vs Supercomputer
Overview

- Design computation
- Working
- Advantages & Disadvantage
- Applications
- Conclusion
Grid Computing: Introduction

- The Grid Computing is about resource sharing and coordinated problem solving in dynamic, multi-institutional virtual organizations.

- The hype: Computing within organizations make very inefficient use of resources.
  - Advanced Systems are slow to change and expensive to maintain.
  - Grid computing addresses this problem by providing an adaptive software infrastructure

- The essence of Grid Computing is federation, processing acceleration and virtualization of computing resources.
Grid computing: Introduction (2)

- **Vision**: The central idea is that **computing should be as reliable and transparent as a utility**
  - Information or computation power should be **delivered on demand**. (Apart from type and location)

- **Origin**: Conceived by academic and research communities.
  - GC originated from the needs of the scientific community.
  - **Create** a dynamic computing environment for sharing resources and results
  - **Scale** to accommodate petabytes of data, and teraflops of computing power, and keep costs down
**Dynamic Grid Computing: Introduction**

- **What’s New:** It removes fixed connections among components, and treats them as virtualized services.
  - Resource utilization and responsiveness is optimized. Resource availability, scalability, performance and low-cost is achieved.
  - Capacity can be added/removed at any time

- **New trends in Hardware and software**
  - Processors, blade servers, networked storage and network interconnects provides enhanced capabilities
  - The power of Dynamic grid computing comes from the software
Grid Computing: Attributes

- **Virtualization:** Abstracting grid entity into service
  - It enables grid components to integrate tightly without creating rigidity and brittleness in the system.
  - Components quickly react to change, and adapt failures without compromising performance and reliability.

- **Dynamic Provisioning:**
  - It simply means distributing supplies where they are needed. Supplies mean request, data, computation.
  - A grid service broker links grid elements together automatically and dynamically, based on the knowledge about their requirements and attributes. and adjust the association according to the change and failures.
Grid computing: Attributes (2)

- **Resource Pooling:** contributes to lower cost
  - Consolidation and pooling is used for better utilization.
  - Provide flexibility to optimize the association

- **Self-Adaptive Software:**
  - Everyday task of administrator are automated and simplified. The bulk of maintenance and tuning is automated to reduce IT staff cost.

- **Unified Management:**
  - Self-adaptive software does not eliminate human interaction. Unified management is provided to simplify the management process.
  - Single tool can be used to provision, monitor, administer
Grid computing: Components

- **Computation:**
  - Computing cycles provided by processors of grid machines. Simple, parallel, iterative uses of computing elements

- **Networked Storage:**
  - Integrated view of data storage (Datagrid). Local disk, secondary storage, mountable, Unified name space

- **Network interconnects:**
  - Fast interconnection technologies. Redundant and external Internet connections makes parallel processing faster, and management better.

- **Software and licenses**
  - Expensive software, Sharing Expensive licenses, Limited use of multiple installation
Types of grid:

- Computational grid
- Scavenging grid
- Data grid
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Grid Architecture

- Identifies system components, specifies purpose and function, indicates interaction
- Interoperability is the core issue
- Grid Arch is a protocol Architecture
  - Negotiation, establish, manage sharing relationship
- Standard protocol ~ Standard services
  - Service defined by protocol it speak and behaviour it implements.
Grid Architecture (Layered)
Grid Architecture (Service-oriented)
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Resource Management

- What needs to be managed: **Resources**
  - **Physical resources** (computer, disks, databases, networks, scientific instruments).
  - **Logical resources** (jobs, executing applications, complex workflows etc.).

- What is the Goal
  - **Resources must be available and meet performance criteria.**

- What is Management:
  - The process of locating various types of capability, arranging for their use, utilizing them and monitoring their state.
    - Manatenance of resources and environment
    - Monitoring their state and performance
    - Reacting to internal and external changes in resource or its env
    - Initiating routine operations: initialization, start/stop and tuning
Manageability

- The ability of a resource to be managed

- Manageability interfaces support common operations (control and monitor)

- Manageability standards specify standard interfaces

**Problem:**
- Existing interfaces are generally resource-specific
- Almost impossible to add standard interfaces to legacy resources
- New standards may require additional interfaces

**Solution:**
- Common standards
- Based on Service orientation, integration and virtualization.
**Service orientation**

- **Software services**
  - A service provides some capability to its clients through message exchanges
  - represent the physical manageable entities
  - understand the unique interfaces for the entities they represent
  - implement applicable standard interfaces

- **Integration**
  - Encapsulated application in services become Integratable building blocks

- **The management process**
  - Manager invokes the operation (service’s standard interface)
  - Service performs operation on managed entity (resource’s unique interface)
  - Service returns result to manager (through the standard interface)

- **Problem**
  - Need a common way to implement service

- **Solution**: Web Services
Virtualization
Traditional Resource Management

- Batch schedulers, workflow engines, operating systems
- Designed and operated under the assumption that:
  - They have complete control over a resource
  - They can implement the mechanisms and policies needed for effective use of that resource in isolation
- This is not the case for Grid Resource management
  - Separate administrative domains
  - Resource Hetrogeneity
  - Lack of control and difference policies
Grid Resource Management

- **What is Grid Resource Management?**
  - **Identifying** application requirements, resource specification
  - **Matching** resources to applications
  - **Allocating/scheduling and monitoring** those resources and applications over time in order to run as effectively as possible.

- **Challenges in Grid Resource Management**
  - Resources are heterogeneous in nature
    - Processors, disks, data, networks, other services.
  - Application has to compete for resources
  - **Lack of available data** about current systems, needs of users, resource owners and administrators
Grid RM Mechanisms

- **Resource Information Dissemination**
  - Published by the Resource (push) or gathered by GIS (pull)
  - On-demand dissemination (by agents)
- **Resource Discovery**
  - Centralized or distributed queries, agents, distributed queries + agents
  - Resources are described in schema/language or objects
- **Resource Scheduling/Job execution**
  - Assigning resources, centralized, hierarchical, distributed
- **Resource Monitoring and Re-Scheduling**
  - Monitoring can be done by application (polling) or by resource (notification to the app or periodic status updates).
Grid Resource Brokerage

- Discovering suitable resources for user's job
- Currently scenario: Manual or semi-manual
  - users manually target their work at the machine that is already known to them.
- For larger grids, manual solution is not feasible
- Solution is Grid Resource Broker:
  - The user describes their needs to a third party (software)
  - which searches for suitable resources, and passes the result(s) back to the user.
Grid Resource Brokerage

- Role of the Broker in a Management System
  - Resource discovery
    - Authorization filtering, Application definition, Minimum Requirement filtering
  - System Selection
    - Dynamic information gathering, system selection
  - Allocation and Advance reservation
- Grid Information System
  - Organize a set of sensors on resources so that client or broker can have easy access to data (static or dynamic)
Matchmaking

- Process of selecting resources based on application requirements
- Symmetric matchmaking
  - Attribute-based matching
    - Resource provider and resource user have to agree on a schema, attribute names and value ranges
    - Syntax based like ClassAds
- Asymmetric matchmaking
  - Ontology based matching
    - Ontologies, domain background knowledge, matchmaking rules
Open issues

- Multiple layers of schedulers
  - The higher level scheduler has less information about the remote resources, local resource managers actually control the resources

- Lack of control over resources
  - Grid scheduler does not have ownership or control over the resources

- Shared resources and variance
  - No dedicated access to the resources (resources are shared)
  - This results in a high degree of variance and unpredictability

- Conflicting performance goals
  - Many participants have different/conflicting preferences
  - Many different local policies, cost models, security
**Grid vs Supercomputer**

- Grid computing is a special type of parallel computing which relies on complete computers connected to a network by a conventional network interface, such as Ethernet.
- Supercomputer has many processors connected by a local high-speed computer bus.

- **Advantages:** cost, independent units, dispersed/distributed, electricity, cooling capability.
- **Disadvantage:** performance lack due to low network speed.
Working

- Resources
  - Workstations, Servers, Software Storage
  - Resources and rules are published beforehand
- Resource broker
  - Suppliers and wits for reply
- Scheduler
  - Distributes resources
- Grid security infrastructure – security access
  - Confidentiality and Authorization
Advantages

- Can solve larger, more complex problems in a shorter time

- Easier to collaborate with other organizations

- Make better use of existing hardware
Disadvantages

- Grid software and standards are still evolving
- Non-interactive job submission
Applications

- Virtual Organization
- Scientific researches
- Automobile and aeronautical business
- Crash simulations
- Computer - aided design
- In a particular industry for better management resources, administrative tasks & maintenance.
Conclusion

Just as the internet provided an means for explosive growth in information sharing, Dynamic grid computing provides an infrastructure leading to explosive growth in the sharing of computational resources. This is making possible functionality that was previously unimaginable.
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Thank you