



# Concepts and Architecture of the Grid

Summary of Grid 2, Chapter 4



# Concepts of Grid

- Mantra: “Coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations”
  - Allows for resources to be shared by mistrustful participants with varying degrees of prior relationship
  - Virtual Organization (VO): formed by a set individuals/institutions defined by the sharing rules.



# The Sharing Relationship

- **Policy: Who can access what when? Resource owner makes available subject to various constraints:**
  - Security concerns
  - Qualification of requestor/resource owner (has enough budget, etc.)
- **Server-Client and Peer-to-Peer**
  - coordinated resource sharing
  - dynamic relationship
- **Resource use may vary in different contexts**
- **Achieving various qualities of service**
  - response time, throughput, etc.



# Evolution of Grid Technologies

- Custom solutions (early 90s):
  - Grid exploration work.
  - Applications built directly on Internet protocols
    - Limited functionality in terms of security, scalability, robustness
- Globus Toolkit version 2 (GT2) (1997):
  - Open Source
  - Quickly became the standard for Grid Computing
  - Defined and implemented standard protocols, API's, and services.
- Open Grid Services Architecture (OGSA) (2002)
  - Community standard with multiple implementations
    - OGSA-based GT 3.0, released in 2003
  - Built on GT2 concepts and technologies.
  - Service-oriented architecture and based on Web services.
- Managed, Shared Virtual Systems (???)

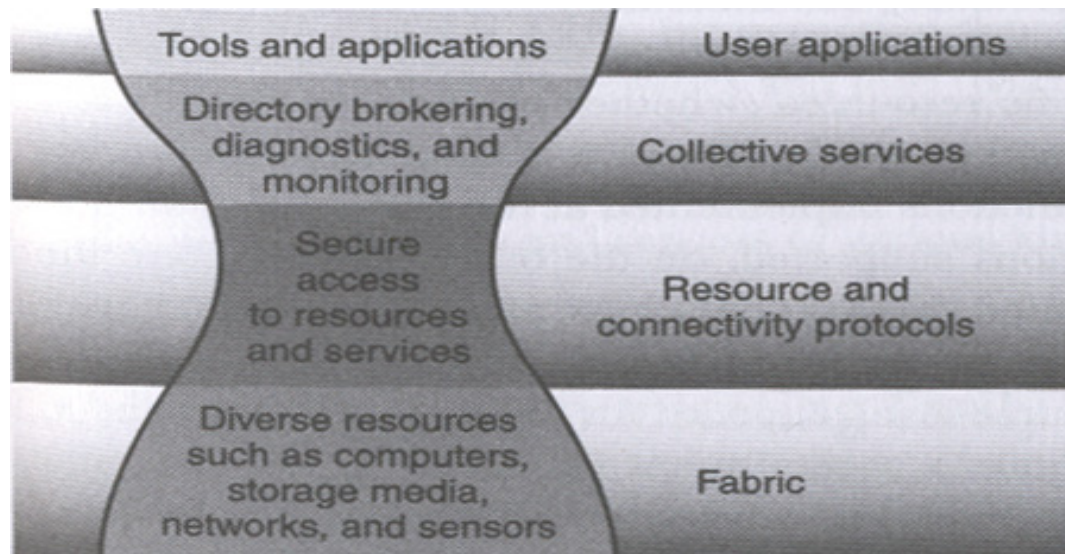


# The Grid Vision

- Grid: “A system that coordinates distributed resources using standard, open, general-purpose protocols and interfaces to deliver nontrivial qualities of service.”
  - Coordinates distributed Resources
    - Resources and users under different domains
      - Desktop vs central computing
      - Different administrative units of the same company
  - Standard, Open, General Purpose Protocols and Interfaces
    - Issues like authentication, authorization, ...
    - Important they are standard and open
  - Deliver nontrivial qualities of service
    - Response time, throughput, availability, security

# Grid Model

- Grid based on the “hour-glass” model
  - Thin center - few standards
  - Wide top - many high-level behaviors can be mapped.
  - Wide bottom - many underlying technologies





# Grid Architecture

- Requirements for general component classes
  - User applications
  - Collective services:
    - Coordinated use of multiple resources
  - Resource/connectivity protocols:
    - secure access to resources/services
  - Fabric:
    - individual physical/logical resource available in a grid
      - PC
      - Storage
      - Sensors
      - Networks



# The Fabric Layer

- Implements local, resource-specific operations
  - e.g. NFS storage access protocol.
- Introspection mechanisms and management mechanisms for
  - Computational resources
  - Storage resources
  - Network resources



# Connectivity Layer

- Tasks include transport/routing/naming.
- Some security requirements:
  - Single sign-on: one sign-on for all resources
  - Delegation: user delegates privilege to processes; processes delegates to other processes.
  - Integration with local security solutions: allow interoperability between 'global' and 'local' security policies.
  - User-based trust relationship: trust based on user, not the resource providers.



# Resource Layer

- Builds on connectivity layer communication and authentication protocols.
- 2 major classes of resource protocols
  - Information protocols: obtaining information about a certain resource (e.g. load, usage policy, configuration)
  - Management protocols: negotiating access to a shared resource (presenting requirements and operations to be performed, etc.)



# Collective Layer

- Provides means to coordinate the sharing behaviors:
  - Directory services
  - Coallocation, scheduling, brokering services
  - Monitoring and diagnostics services
  - Data replication services
- Tools define/invoke collective layer functions:
  - Grid-enabled programming services
  - Workflow Systems
  - Software discovery services
  - Collaboratory services:
- Addresses security, policy, and accounting issues:
  - Community authorization servers: enforces community policies.
  - Community accounting and payment services



# Applications

- Constructed in terms of services defined at any layer.
- May call on sophisticated libraries and frameworks, which may themselves define protocols, services, and APIs.



# Grid Implementation (GT 2)

- Address issues of security, information discovery, resource management, data management, communication, fault detection and portability.
- Fabric Layer
  - Leaves most local operations to each local resource.
  - However, does include components interfacing to resource-level protocols. Including advanced reservation capabilities (GARA, PBS, Condor, etc.)
- Connectivity Layer
  - based on Grid Security Infrastructure (GSI) which is based on PKI
  - Single Sign-on: uses *Proxy Credential*, digitally signed certificate. This certificate allows the holder to perform operations on behalf of the signer.
  - Delegation: remote services use the proxy credential to act on behalf of the user.



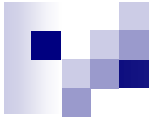
# Grid Implementation (GT 2)

## ■ Resource Layer

- Uses Grid Resource Allocation and Management (GRAM) protocol
- Uses Monitoring and Discovery Services (MDS-2)
  - Discovering/accessing configuration and status info.
- Uses GridFTP: extended FTP.
  - Allows partial file access, management of parallelism for high-speed transfers.

## ■ Collective and Tools

- Limited number of collective layer capabilities from GT2
- Many are developed by others



## OGSA (Open Grid Services Architecture)

- Significant redesign of GT2
  - Factoring component behaviors of GT2.
  - Enabling uniform treatment of all network entities for service orientation.
  - Aligning with Web services, usage of Web Service Description Language (WSDL)
- Sees Grid service as a Web service
- Builds on OGSI's defined interfaces and behaviors.



# The Grid Community

## ■ Global Grid Forum (GGF)

- Coordinates grass-roots and government-sponsored efforts in many countries
- Draws 1/3 of its participants from the industry
- Participation increased ten folds since 1998.



# Future Directions

- Need to refine OGSA model and develop additional building block services
- Need for program development and execution tools (compilers, debuggers, etc.)
- Scaling (more entities, smaller devices)