CROWN project: a Service-oriented Grid middleware and its challenges

Prof. Jinpeng Huai
Beihang University
crown@act.buaa.edu.cn
http://www.crown.org.cn
Grid/P2P computing is much considered as the next wave of distributed computing, which promise to enable the federation of heterogeneous and geographically dispersed computing resources to provide more powerful, reliable and uniform services. Strive to integrate various resources, including computational power, data storage, communications, software and even human experts.
Content

- Overview about CROWN
- Next for Distributed Computing?
Our Mission

- **Huge Demand for network/Distributed Computing In China**
  - Computing Capacity: First 50 Computers in Top100: 30TFlops, More R&D Instruments
  - Hundreds of National Key Labs …

- **Huge Demand from IT applications, e-Gov, e-Com, e-Oly Game**…

- But, China invests a lot on new resources, At the same time a lot are seating idly, so we have to utilize idle or underused computing power and resources
Our Mission

- **Needs for greater computing capability**
  - Science & Engineering computation
  - High performance Information services
  - Social and economical problems to solve

- **Needs for cooperative works**
  - Concurrent engineering and Distributed computing

- **Needs for resource sharing capability**
  - Computing power, Expensive instruments and services
Grid and Advanced Computing Activities in China

**Ministry of Science and Technology**

- The biggest R&D program, National Hi-tech Program (863) started by Mr. Deng Xiaoping and supported by the Ministry of Sci. and Tech (MOST)

**ChinaGrid**, by Ministry of Education

**NSFGrid**, an e-Science Key Project

- Network-based Scientific Research Environment
Overview

CROWN denotes:

- China Research and Development Environment Over Wide-area Network
- 2004 – 2007, NSF of China + 863 MOST

Goal: Providing Grid-enabled research environment for scientists

- Resource Sharing
- Collaborating
- Trustworthy Distributed Computing
- Grid Infrastructure Research & Construction
CROWN

- Top five universities and research institutes, in China, with other pilot applications providers
- Many valuable research resources
Resource Organization & Management
CROWN Partners
Overview of CROWN

cooperation
manageability
trustworthy

open, dynamic
autonomic
heterogeneous

CROWN
A highly dynamic grid testbed

- 2-Tier Resource Organization
  - Backbone (Stable Resources)
  - Active Nodes (Volunteer Resources)

- Connecting to Other Grid Testbeds
CROWN Node Server

- Node Server: A GT 4.0.0-core Extension as Service Container
  - GAR: a File format for portable service
  - Hot/Remote Deploy with Security Consideration
  - Resource Dynamic Information Collecting & Reporting
  - Web Management UI
CROWN RLDS

**RLDS: Resource Locating & Description Service**
- A distributed Grid Information Service Architecture
- Soft-state, topology management of RLDS
- Collecting of Information of Resources (Hosts) & Web Service / Grid Services
- Advanced GIQL Query to find available services
- Unified Grid meta info management (GIMS)
- **S-Club: Overlay based high efficient Grid information organization and query**
CROWN Designer

- an Eclipse Plug-in for Grid Service Development
  - Support the WSRF/WS-I Service Development and Deployment
  - Auto Generation of Code Skeleton for Java Web/Grid Services
**CROWN Scheduler**

- Scheduler: A Hierarchical Job Submission and Execution Service
  - Job Submission: JSDL
  - Job Persistency: Hibernate
  - Hierarchical Job Scheduling
  - Job Execution: POSIX / Web Service / PBS Job supported
  - Interoperability with other Job Execution Service

![Diagram of CROWN Scheduler]

GS = Global Scheduler
LS = Local Scheduler
CROWN Monitor

Monitor: *An event based grid monitoring system*

- PUSH / PULL information collecting
- Event Collectors / Consumers
- Eclipse RCP based UI
- Quasi real-time monitoring
Security Architecture in CROWN

Region 1
- Region CA
- Domain CA
  - Domain Authentication Service
  - Domain Authorization Service
- Node 1
  - Node 2
  - Node n

Region 2
- Region KDC
- Domain KDC
  - Domain Authentication Service
  - Domain Authorization Service
- Node 1
  - Node 2
  - Node n

Identify Mapping & Credential Converting Service
CROWN Security

Node Security Chain

Authorization Handler
Authentication Handler
SecConv & ATN Handler
Security Chain Framework

Security Services
Authz Service
Identity Mapping
Auth Service
ATN
SecConv
WS-SecConv
WS-Policy
WS-Trust
WS-Security

XACML
SAML
Release History

First Preview version v0.92

May 18, 2005 CROWN v1.0
May 23, 2005 **CROWN v1.0** English Version

v1.0RC1 v1.0RC2

Dec 23, 2005 CROWN v2.0 Release

Internal update v1.5 v2.0RC1 v2.0RC2

Internal update v2.5

v2.5.1
Performance evaluation CROWN Node Server

- **Metrics**
  - Throughput
  - Average response time
  - Success rate

- **Benchmark service**
  - echoString: stateless service
  - counter: stateful service

- **Performance Comparison with GT4.0**
Figure 6. Throughput vs. Num of concurrent requests (echoString)

Figure 7. Average response time vs. Num of concurrent requests (echoString)

Figure 8. Comparison of doPost function processing time (echoString)

Figure 9. Success rate vs. Num. concurrent requests (echoString)
Figure 10. Throughput vs. Num of concurrent requests (counter)

Figure 11. Average response time vs. Num of concurrent requests (counter)

Figure 12. Comparison of doPost function processing time (counter)
Performance evaluation Security

Identity mapping

Trust negotiation
International Testing

- UK e-Science Engineering Task Force (ETF)
  - CROWN System Evaluation, May 2005
    - First China Grid Middleware Evaluated
    - GT4 evaluated by ETF in June 2005
  - 4 aspects evaluated
    - General
    - System Management
    - User Experience
    - Developer Experience
  - 3 UK Universities participated
    - University of Southampton (SeSC)
    - Imperial College (LeSC)
    - University of Newcastle (NEReSC)
Applications - gViz
Running on UK White Rose Grid + CROWN Grid (demo at AHM’05)
UK OMII

- Interoperability between CROWN and OMII
- OMII-China project
  - Beihang: coordinator of OMII-China

- OMII-Europe project
  - EU FP6 project
  - Beihang: one of the five Chinese partners
Globus Alliance

- Globus / ANL
  - Prof. Ian Foster
  - Exchange ideas with CROWN team
  - MOU: grid middleware and trusted computing

- INRIA
  - Web Service/ECHOGRID project
Applications

- **AREM**: Advanced Regional Eta-coordinate Numerical Prediction Model. (This is a Numeric Simulation of Weather Forecasting for a certain region)
- **MDP**: Massive Multimedia Data Processing Platform
- **Blast**: A well-known Gene Sequence Comparison Program

- **DSSR**: Digital Sky Survey Retrieval, an of Virtual Observatory
- **UDMGrid**: University Digital Museum Powered by CROWN, a application of OGSA-DAI. Heterogamous Databases Integration

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CROWN Testbed (2006)
Interoperability among Grids

Don’t interrupt deployed applications, Make least or no modification to grid middleware
  Make full use of extension points of grid middleware

Approaches
  ◆ Gateway
    Bridge different grid middleware together
    Make it easy for management, monitor and control
  ◆ Workflow Enactor
    Assemble distributed services into one
    Work in client side manner
    Extensible or easily develop
  ◆ Adaptor
    Different adaptor for different underlying middleware
    Service invocation
    Soap message translation and so on
**Interoperation Demo, UK e-Science AHM 06**

*Cross Grid Scheduling Job Submission Interoperation Between OMII- GridSAM / CROWN Scheduler*

News Press: [http://www.omii.ac.uk/projects/SS-CROWNGrid.jsp](http://www.omii.ac.uk/projects/SS-CROWNGrid.jsp)
Interoperation Demo, SuperComputing06

SC 2006: Multi-Grids Interoperation Demo
Open Grid Forum HPC Profile Workgroup
CROWN has interopereated with Globus, OMII, UNICORE, etc

Interoperation Demo, SuperComputing06

- Globus
- GridSAM
- CROWN
- EGEE
  - gLite + CREAM
- Microsoft
- Platform
- U. of Virginia
  - .Net + Genesis II
- Fujitsu - Unicore
Content

- Overview about CROWN
- Next for Distributed Computing?
**Vision**

Client/ Virtual Network or Environment?

- Internet Application
- Network Application
- Word Processing
- Mathematic Computing

Scope

Host, PC, Intranet, Internet
The trend of Grid Computing

- **Functionality & Standardization**
  - Web services
  - Open Grid Services Arch
  - Globus Toolkits
  - Conventional Distributed Computing

- **Historical Milestones**
  - 1990: Conventional Distributed Computing
  - 1995: Internet Standards
  - 2000: Globus Toolkits
  - 2005: Managed Shared Virtual Systems
  - 2010: Increasing degrees of virtualization, richer forms of sharing, increased qualities of service, variety of forms of active management

- **Key Features**
  - De facto standard
  - Multiple implementations

- **Service Evolution**
  - 1990: Conventional
  - 2000: Managed Shared Virtual Systems
  - 2010: Increasing degrees of virtualization, richer forms of sharing, increased qualities of service, variety of forms of active management
New Challenges for distributed computing?

**What are big challenges for future Distributed Computing?**
- Service is the atomic unit
- Open vs controlled environment

**What is Distributed Computing if Service-oriented Computing?**
- Our next “Internet”
- How to design dis. soft?
- Service-oriented Software
- Security and trust
- Evaluation
What challenges?

■ “Soft” issues is not soft, compared to hard issues/functional requirement in Internet!

- Open Internet/wireless/mobile Net, dynamically changing computing on its evolution
  - Internet: Nodes – routers   Links – optical fibers
  - WWW:   Nodes – document files   Links – hyperlinks
  - Social Networks: Nodes – individuals   Links – relations

- Soft/nonfunctional requirement become a new kernel, such as on intra-/inter-/extra-virtual organizations, dependability, trusting, availability…

- what is Internet programming model? or new internet model-virtual computing environment for the “Soft”
What challenges?

What is our opportunities?

- Virtual Service Overlay
- Synthetical is good, such as service composition with dependability + trusty + tolerance
- Practical app or real runtime monitor, and interoperations among VOs

The solution of every problem creates a new big problem/Challenges!
A new network: virtual Service Network

Nodes:
- Services
  - information transaction stream
- Users
- Virtualized Devices
  - Actuator, sensor

Links:
- Hyperlinks
- Relationships
- Physical link
- Virtual (VPN)
- Channel (PVC...)

Data:
- Commands
- Notifications
- Typed information
- Bits
- Packets

Managed by:
- Information Technology
- Service Technology

Managed by a new group: Service Technology

Large-Scale
Dynamic + Distributed
Autonomous + Uncontrollable
Heterogeneous + Cross-domain
Needs: dependable, secure, Available...
Where shall we go: dependable Service-oriented Computing?

1) is possible for Overlay-based “Virtual Service Network” with Dependability
   - application-level distributed Service-oriented system
   - Provide a overlay to build the disordered internet into being Managed, dependable and Adaptive
   - Security, Privacy and information Integrity/Assurance
   - Provide a quantitative and provable approach for evaluating the Dependability, Availability and Reliability of the system
What is the link?

**Attributes**
- Availability
- Reliability
- Safety
- Integrity
- Maintainability

**Means**
- Faults
- Failures
- Errors
- Fault Prevention
- Fault Tolerance
- Fault Remove
- Fault Forecasting

**Threats**

**Dependability and Security**
What is the link?

- Availability
- Reliability
- Safety
- Confidentiality
- Integrity
- Maintainability

Dependability → Security
Where shall we go: dependable Service-oriented Computing?

- 2) High Dependable Soft and Systems
  - How to combine the dependability into Service-Composition for Service on Demand, Protocol computing
  - High Dependable Service-oriented Computing toolkits/testing-bed on both of WR and CROWN?
  - High Configurable security services with dependability and online evolution
Service-based dependable software design & Production

Past

Fixed goal + control

decompose

New

Service-based paradigm

Multi-compose

service

compose

entity

S

S

S
Service-based dependable software
Design & Production

- Protocol-based computing for cross-organizational SDP sys

Domain A

protocols

s1

Domain B

s2

protocols

protocols

Domain C

s3
Where shall we go:
dependable Service-oriented Computing?

3) Testing, **Maintainability** and Evaluation?
   - Maybe we should have some practical experiments/applications for evaluating our system, especially for dependability, availability, Security (privacy, integrity), and their Combination to the Service-Overlay, software

How to combine DBMS into Service-oriented Computing?

4) Testing and Evaluation for distributed Software and Security is more complex
CROWN3.0 Virtual Computing Environment

- 5-Tier Architecture
  - Service Coordination Layer
  - Service Management Layer
  - Open Service Layer*
  - Virtual Resource Layer*
  - Physical Resource Layer
ACT focus on “Future”

- **Basic platform**
  - Operating system
  - DB
  - Basic service

- **Middleware supporting platform**
  - Web service
  - CORBA
  - EJB
  - Other components

- **Software production platform**
  - Service & management
  - Toolkits for registry and deploy

- **Component resource**

- **Quality and Security Management**
  - Require. Specification
  - toolkits for Software Developing

**Toolkits for registry and deploy**

**Service schedule**

**Service & management**
Thank You!

Q&A

More:
crown@act.buaa.edu.cn