NorduGrid Tutorial

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Tutorial Contents

- Part 1: Introduction to Grids and NorduGrid
  - Moving towards Grid: what changes?
  - NorduGrid collaboration and middleware
  - Authentication and authorization in Grids
  - Grid environment compared to local computational resources
  - Submitting jobs in NorduGrid, writing job description files, demo

- Part 2: Hands-on Exercises
  - Installing NorduGrid client software
  - Submitting jobs
  - Monitoring jobs using the Grid Monitor graphical interface
What is Grid?

- Hot term: many users, many definitions
- Uniform and secure access to geographically distributed heterogeneous systems
- Both the set of users and connected resources vary dynamically
- Grids go across **multiple administrative domains**!
- Collaboration and social networking, not only technology
Moving Towards Grid — What Changes?

- Importance of physical location of computers and data diminishes
- User accounts are replaced by certificates, number of passwords reduces
- Uniform interfaces to heterogeneous platforms, but library dependencies and other OS related problems remain
  - Virtual machines may bring improvements in the future
  - Error reporting and debugging currently rudimentary, will get better as middleware packages mature
- Users can still specify a target system if they need, but apps which work flexibly in different environments have an edge
Common misconceptions

• Grid multiplies available resources
  - Common comparison with the World Wide Web doesn't work:
    • One web server serves 1000 users => price 0.001 x
    • One grid user wants to use 1000 servers => price 1000 x
  - Load balancing can bring some savings, but new services and easy access much more important

• Grid is a black box: everything inside happens automatically
  - Vision: computing power as electricity from the plug
    Reality: still quite far from it
  - Possibility to monitor job execution is important — trying to make a black box results easily in a black hole
Does one need to change existing applications?

● Three different approaches:

1) Using the application as is: grid middleware will move it and data to target system
   • Linking statically helps in library dependency hell...

2) Installing the application on the target system and using it via the Grid interface
   • Batch processing type applications normally work without changes, interactive apps and graphical interfaces more difficult

3) Modifying the application to fully exploit a distributed environment
   • Distributing over a large geographical area is not practical unless the application can split a computation to independent subtasks
Role of Middleware

Application

Grid Middleware

System 1
- Batch jobs
- User administration
- Operating system
- Hardware

System 2

System 3

Storage 1
NorduGrid collaboration

- Started in 2001, originally for connecting resources in Scandinavia and Finland
- Has been later joined by groups in Estonia, Germany, Slovakia, Slovenia, Germany and Australia
  - Currently about 5000 CPUs total (mostly Linux clusters)
- NorduGrid ARC middleware
- Open for anyone to participate
Facts on NorduGrid

- Academic Grid, serves researchers and consists of academic resources
  - Largest user group is high energy physicists, but other applications are also constantly being run on the Grid
- Built from “bottom to top”, connecting already existing resources to the Grid
  - Resources NOT dedicated to the Grid
- Production Grid available 24/7 since July 2002
  - Real users and applications, also a good platform for Grid research
- Dynamic: resources come and go
NorduGrid Middleware

- Called Advanced Resource Connector (ARC)
- Built upon Globus Toolkit 2 libraries, currently being ported to GT version 3.2.1
  - In particular, the security infrastructure comes from Globus
- However, many important differences to core Globus:
  - GRAM (Globus gatekeeper and job manager) replaced by NorduGrid ARC Grid Manager
  - Own gridftpd server
  - Own user interface and broker
  - Extended job description language and information model
- GPL license
What does it look like?

<table>
<thead>
<tr>
<th>Country</th>
<th>Site</th>
<th>CPUs</th>
<th>Load (processes: Grid+local)</th>
<th>Queueing</th>
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</table>

- Grid Monitor shows currently connected resources
  - Take a look yourself at [http://www.nordugrid.org](http://www.nordugrid.org)
Grid Security

• "It's like when the PC came..." (Urpo Kaila, manager, information security, CSC)
  - Grid account is a pass to computers beyond organizational domains!
  - New risks, IT staff often afraid
  - Great power => great damage

• On the other hand: development started when viruses and worms were already around — security aspects have been considered
  - Strong authentication and encryption: no plain-text passwords
  - Identity tied to a certificate: revocation blocks access in the whole Grid
Certificates

- User authentication is based on X.509 certificates in almost all Grid middleware, including NorduGrid
- Certificate represents user's identity in the Grid
  - Each user has his/her own personal certificate
  - Based on public key encryption, tried and tested technology
  - Does not automatically give access to resources
- Trusted third party called Certificate Authority (CA)
  - Gives his guarantee of the identity of the user by signing the certificate
  - Maintains a list of revoked certificates
Certificate Trust Chain

1. Hi, I'm the CA for Estonian users!
   - Public key, ID
   - Public key
   - ADMIN
   - CLUSTER
   - CA

2. Hi, I'm Ville Vilkas from Tallinn University.
   - Request, ID
   - Signed certificate
   - USER
   - CA

3. Can I get access?
   - Identity string
   - Certificate signed by CA
   - ADMIN
   - CLUSTER
   - USER

4. Happy user
   - Grid job
   - Job results
   - USER
   - CLUSTER
Virtual Organizations (VO)

• Lists of user identities in the Grid
  – Allow to manage users as groups

• Typically, access to a resource is granted to a virtual organization, meaning that all members of that VO can use the resource
  – Similar to a group visa in physical world
  – Implies trust towards the organization managing the VO

• Implemented as simple text files, LDAP servers or databases specially designed for VO management
Questions?

• Next:
  – Grid environment compared to local computational resources (Juha Lento)
  – Submitting jobs in NorduGrid, writing job description files (Arto Teräs)
  – Demo (Juha Lento)