M-grid: Linux in the First Production Grid Environment in Finland

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(English version of the slides presented in Finnish)

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CSC — the Finnish IT center for science

- **Mission: National-level IT services for research and education, development and maintenance of the IT infrastructure**
- **Fields of service:**
  - Funet services
  - Computational services
  - Applications: software and databases
  - Information systems management
  - Expertise in scientific computing
- **Customers: Universities and poly-technics, research institutes and their staff who use information technology**
- **Owned by: Ministry of Education**

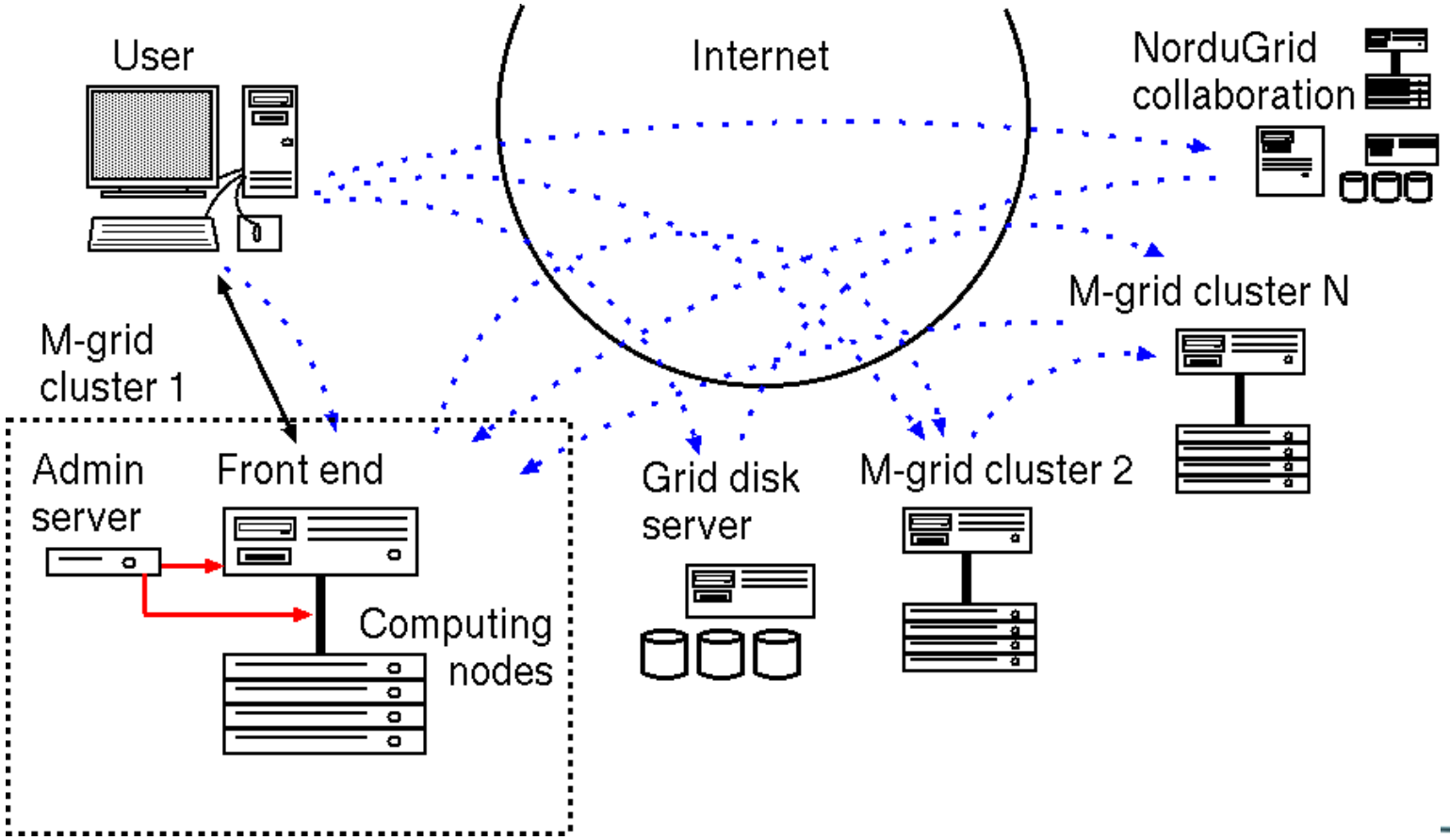
CSC

The Material Sciences Grid (M-grid)

- **Goal: Throughput computing capacity mainly for the needs of physics and chemistry researchers**
- **Joint project between seven Finnish universities, Helsinki Institute of Physics and CSC**
  - Partners mainly laboratories and departments, not university IT centers
- **Jointly funded by the Academy of Finland and the participating universities**
  - Funding application Nov 2003, deployment Oct 2004
- **First large initiative to put Grid middleware into production use in Finland**
- **Platform: Linux based PC clusters**

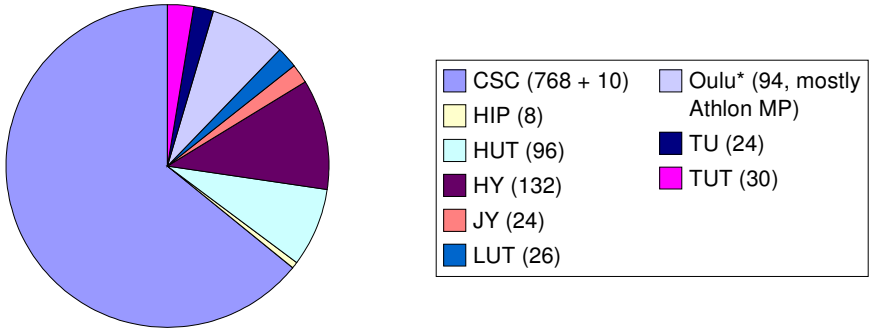
CSC

Grid environment



Hardware and CPU distribution

- **Ten clusters of varying size**
  - Dual AMD Opteron computing nodes (HP DL145): 1.8-2.2 GHz, 2-8 GB RAM, 80-320 GB local disk
  - Front end (HP DL585): 1-2 TB shared disk
  - Network 2 x Gbit Ethernet + remote administration network
- **Total 778 (CSC) + 434 (universities) CPUs in the computing nodes, theoretical total computing power 5 TFlop/s.**



Operating system and Grid middleware

- **NPACI Rocks Cluster Distribution**
  - Cluster oriented Linux distribution, main developer San Diego Supercomputing Center, U.S.A.
  - Based on Red Hat Enterprise Linux, but not a Red Hat product
  - http://www.rocksclusters.org

- **N1 Grid Engine batch queue system**
  - Local resource management in each cluster

- **NorduGrid ARC Grid middleware**
  - Enables shared use of the systems, the middleware selects a free resource automatically
  - http://www.nordugrid.org

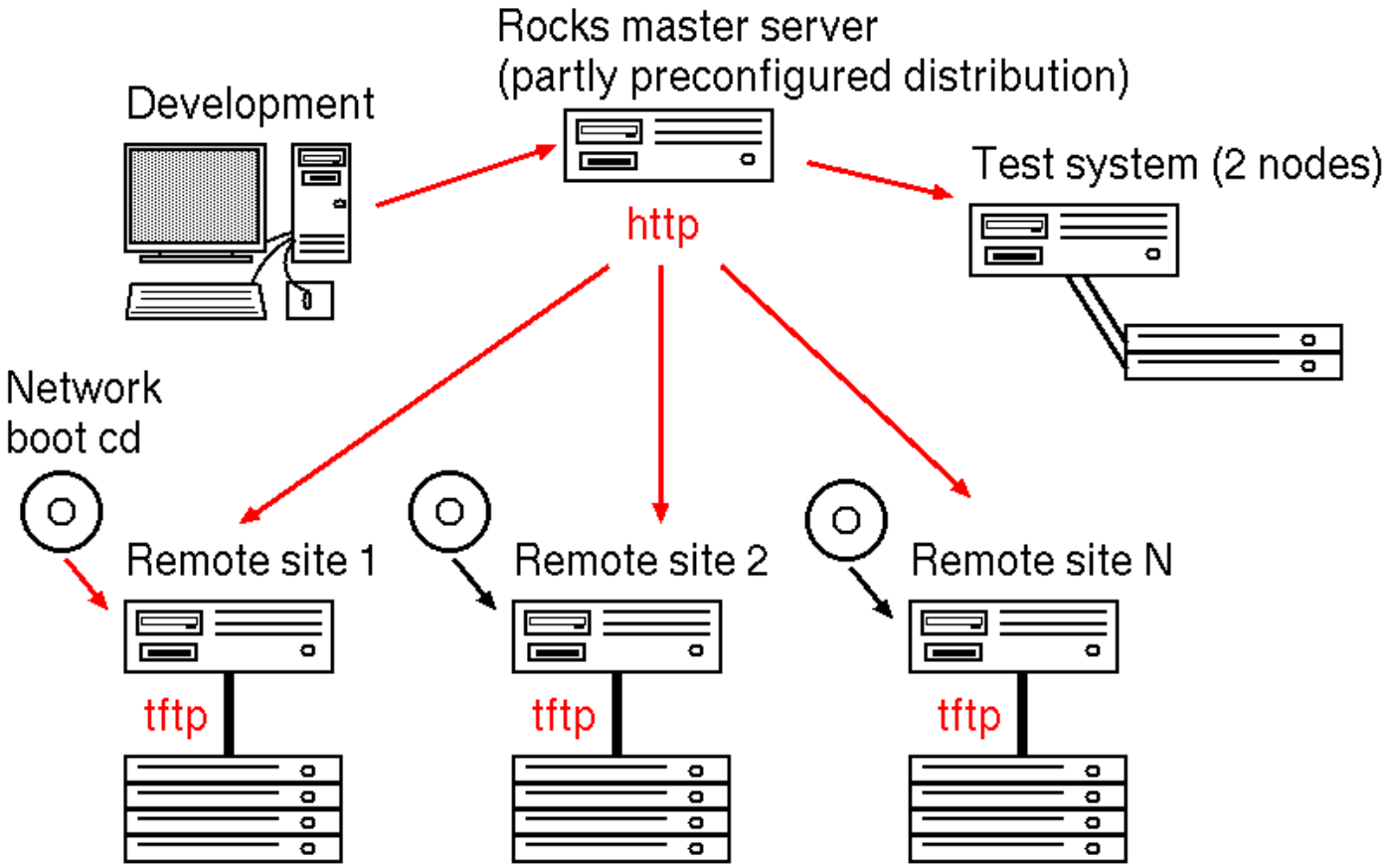
Standard package or a custom solution?

- **Linux was an easy choice — already the leading OS in computing clusters**
- **Both commercial and noncommercial options available for cluster management**
  - Our choice was Rocks: no commercial support but a relatively large user base and dedicated development team
  - Solutions offered by system vendors perhaps better integrated, but independence and ability to customize also important
- **A complete turn-key solution didn't exist**
  - Open source product gave the possibility to study and add own modifications in advance independently of the hw vendor choice
- **Reliability requirement: stable base environment and local use, more experimental grid environment**

System administration in M-grid

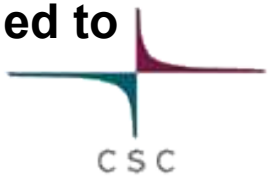
- **Tasks divided between CSC and site administrators**
- **CSC administrators:**
  - Maintain (remotely) the operating system, batch queue system, Grid middleware and certain libraries for all sites except Oulu
  - Separate small test cluster for testing new software releases
- **Site administrators**
  - Local applications and libraries, system monitoring, user support
- **Regular meetings of administrators every two months, common mailing list**

Installation

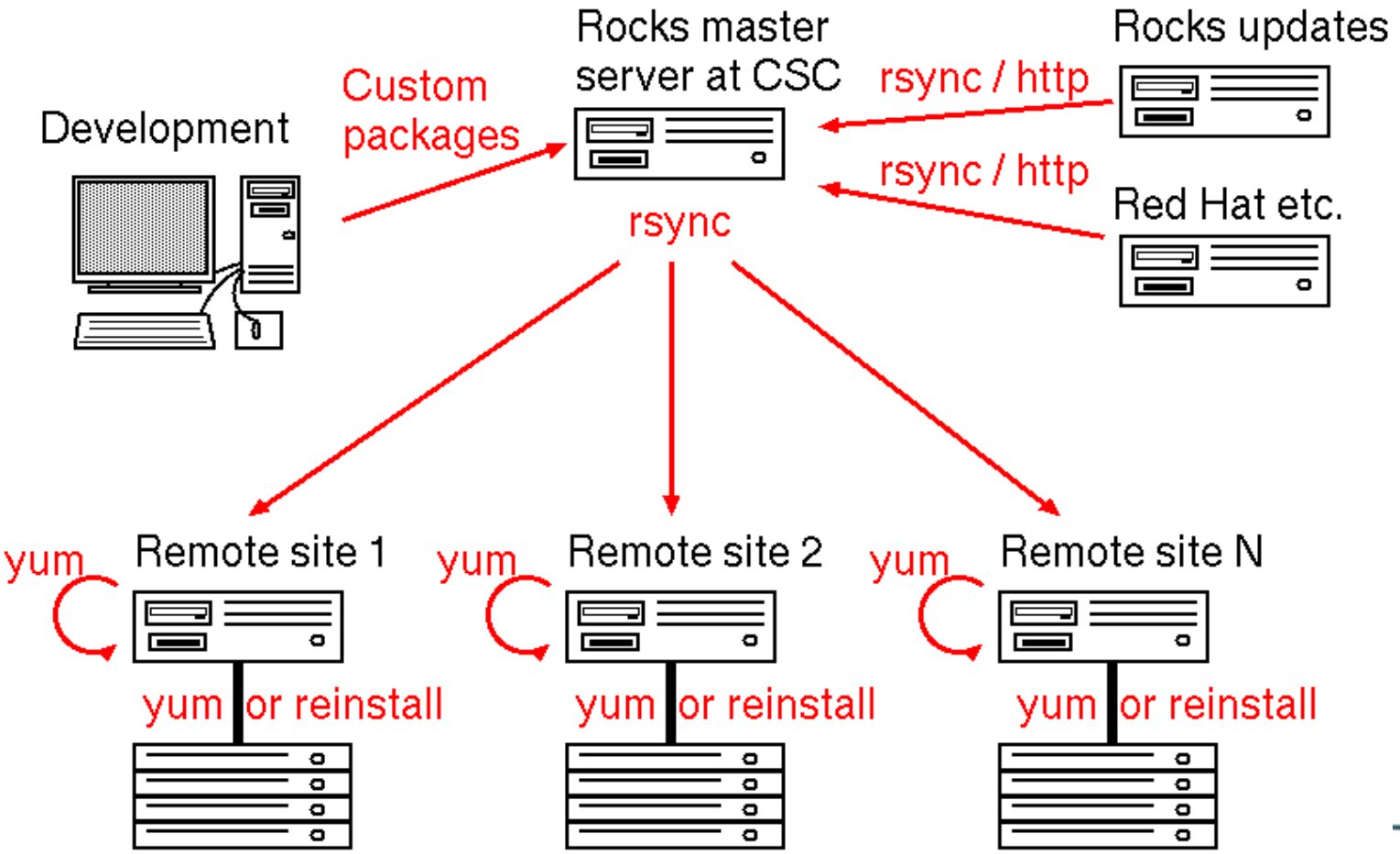


Deployment experiences

- **Hardware installation by the technicians of the vendor**
- **CSC prepared the distribution and a boot cd, local administrators responsible for installing their own cluster**
- **Preparing the distribution took more time than expected**
  - Hints for configuration and modifications from the Rocks mailing list as is common in the open source community
- **Actual deployment went rather smoothly**
  - Most sites spent less than a day installing the OS and nodes, larger sites took two days
  - One site had strange problems taking more time
- **A few settings especially concerning MPI parallel runs needed to be fixed manually afterwards**



Installing updates



Rocks pros and cons

Good:

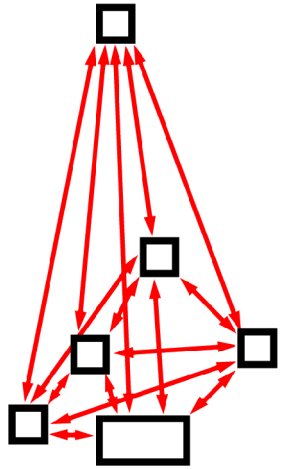
- **Easy to get started, designed for clusters**
- **Nice monitoring tools, many things work out of the box**
- **Most major vendors have their hardware certified for RHEL => Rocks usually works too**

Something to improve:

- **The Rocks team does not publish their own security hotfixes and commercial support is not available**
  - Red Hat source rpms or binaries from RHEL clones usually work
- **Diagnosis and debugging difficult when customizing the distribution**

Goals of Shared System Administration

- **Centrally administered foundation while maintaining local control**
  - A new paradigm -- traditionally in Finland academic HPC resources have been centralized at CSC
- **Easier for universities than setting up their own cluster from scratch**
  - However, needs a significant amount of work both from CSC and the local sysadmins
- **Take advantage of the local sysadmin expertise**
  - Site administrators know the software of their own group best => faster and better user support



36 pairs for collaboration!

Positive experiences

- **Site administrators have found CSC support valuable**
  - On the other hand local control (root access) enables quick fixes and is important psychologically
- **Site administrators have picked up tasks which benefit everyone — CSC has not done everything**
- **Collaboration has strengthened relationships between groups also in their research**
- **Systems are close to the user**
  - Easier to talk to the own group sysadmin, less support requests to CSC
- **Most site administrators are also users => direct usability feedback to CSC**

Negative experiences

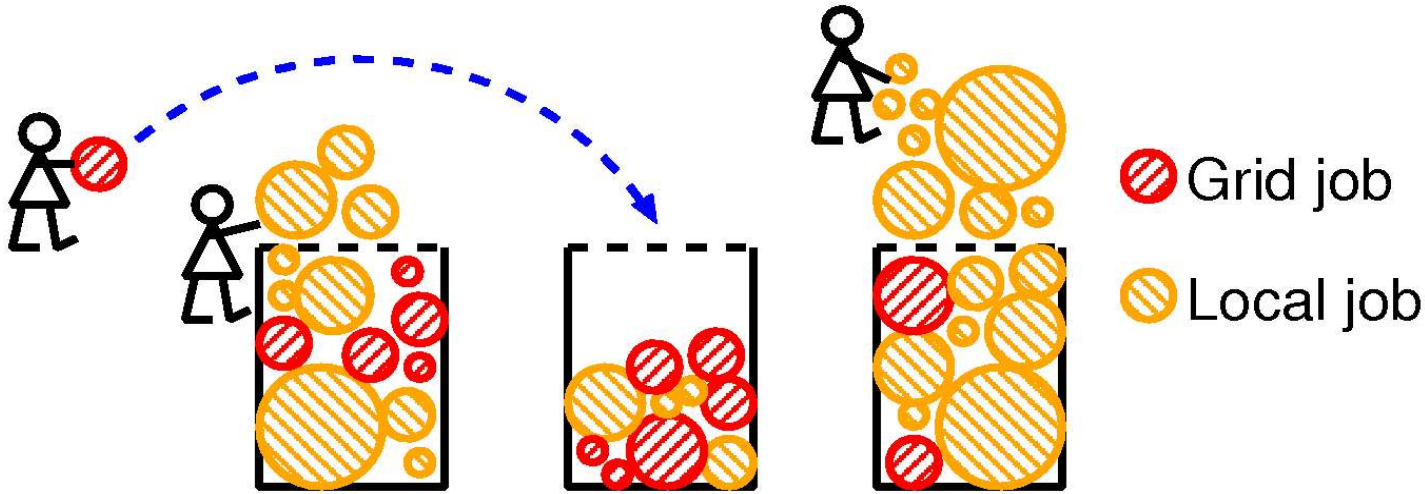
- **Configuring the Sun Grid Engine v. 5.3 batch queue system**
  - Current version 6.0 is more suitable for clusters
- **Wiki based FAQ hasn't become popular, questions and answers are buried on the mailing list**
  - The Wiki model can also be a success: e.g. Wikipedia
- **Gaps in the user documentation**
  - Mainly due to lack of human resources
  - Documentation can be written in a distributed group but compiling it needs central coordination
- **Some users found support poor**
  - Varying experiences: on some sites users are very happy

User experiences during the first year

- **Users got started relatively quickly: after a few months the average load was over 50%, currently close to 100%**
  - Linux was already a familiar enviroment for most users
- **Performance has been quite satisfactory**
- **Reliability has been mainly good**
  - Front ends had stability problems in the beginning, MPI runs are sensitive to changes in the environment
- **Choosing the Fortran compiler was difficult**
  - GNU Fortran compiler works but produces slow code: Pathscale now the recommended one
  - Some applications compatible only with some specific compiler

Grid use and resource sharing

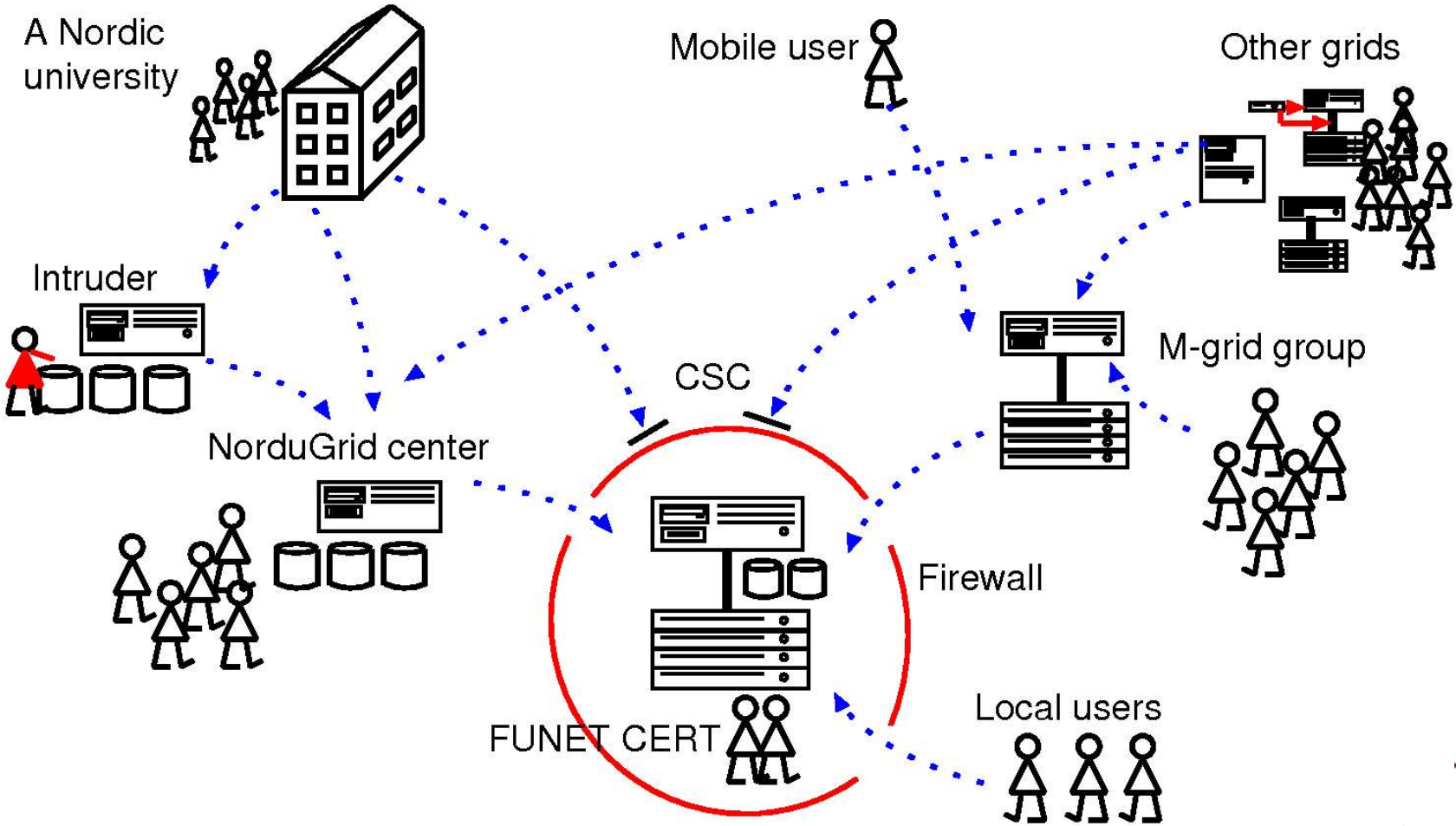
- **Policy: Jobs can be submitted both to the local queue and through the grid interface**
  - Queue priority: local jobs 80%, grid jobs 20%
- **Goal is to minimize waste of resources: empty nodes are always available for use (dynamical sharing)**



Grid experiences

- **Grid use started August 2005**
  - Installation was delayed due to other tasks and a few technical problems
  - Environment still in development
- **Grid environment must be better than the existing one, otherwise nobody will use it!**
  - Long queue in the local cluster and empty resources on the Grid may be a good enough incentive
- **Currently only a few Grid users, time will show how well the Grid environment will be adopted**
- **Collaboration model has been successful: Grid projects always have other aspects than just the technology**

Grid collaboration and security



Security challenges in the Grid

- **Grid goes beyond organizational borders**

  => Mutual trust is a key requirement!

- **A few new threats and all the old ones with an extended scope**
  - A single compromised user account still the easiest way to break into the system
  - An user account in grid is a pass to a large number of resources
- **Systems with hundreds of users are always a risk**
  - Compromises cannot be completely prevented in the long term: need to concentrate in detecting them quickly
  - Clear operating procedures for incident response necessary

Security challenges (continued)

- **Getting all the relevant parties involved**
  - Computing centers, university IT departments, local admins, CERTs and also users
  - International collaboration
- **Defining responsibilities important to establish trust**
  - Risk analysis
  - Acceptable use policy and user account administration
  - Incident response
  - Data protection and privacy

Conclusions

- **Sharing system administration tasks can work**
  - Personal contacts are important — face to face meetings are the best way to avoid flame wars
- **User support in a distributed system potentially very good but needs special attention**
- **A complete turn-key solution not available: chose a base which can be extended and built on**
- **Grid projects strenghten ties between groups also independently of the technology**
- **Grid goes beyond organizational borders: not possible without mutual trust**

More information

- **M-gridin homepage: http://www.csc.fi/proj/mgrid/**
- **Rocks homepage: http://www.rocksclusters.org**
- **NorduGrid homepage: http://www.nordugrid.org**
- **Contact people:**
  - Arto Teräs <arto.teras@csc.fi>
  - Kai Nordlund <kai.nordlund@helsinki.fi>
  - Olli-Pekka Lehto <oplehto@csc.fi> (Rocks)
  - Urpo Kaila <urpo.kaila@csc.fi> (security)
- **Thank you! Questions?**