ARC, the Grid middleware of the NorduGrid

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Quick introduction

- NorduGrid is a collaboration by universities in Denmark, Estonia, Finland, Norway and Sweden (so far)
- NorduGrid developed and implemented a real Grid system based on the ARC middleware, working non-stop since May 2002
- To the date, this Grid spreads from Norway to Australia to Canada to Japan
- This Grid is used for real problem solution (physics, meteorology, genomics, chemistry etc): not a test project, but a true system
A realistic picture of a real Grid

“a true system serving users since May 2002”
outline

- Motivation, philosophy, design
- The middleware: components, functionality, implementation, TODO list
- The Grid running on the ARC middleware
- Applications
Some Background
The driving force behind

Initial Motivation:
- High Energy Physics Institutes from Scandinavia wanted to share their computing resources and jointly contribute to CERN/LHC computing
  - Clusters, Storages, CPU allocations on existing HPC centers

They needed a Grid!
- HEP institutes together with NorduNet launched the "Nordic Testbed for Wide Area Computing and Data Handling" (May 2001- May 2003)
Back in 2001 ...(history)

- The Grid hype just begun
- First Grid projects just started up
  - EDG, UK projects, US projects, NorduGrid
- Globus emerged as the 'de facto' standard Grid middleware (pushing behind Unicore, Legion)
- NO production ready middleware was available or seen on the horizon as of November 2001:
  - Very alpha Globus GT-2.0 (GRAM-1.5, MDS-2.0)
  - Globus & IBM already started to work on OGSA/I, i.e. GT v.3 (which was announced in February, 2002)
  - EDG was in an extremely embryotic phase
Scandinavia needed a functional grid:

- NorduGrid Project decided to develop a production ready Grid middleware by making use of Globus GT2 libraries
  - Design, development started in February 2002
  - first release was deployed in May, 2002
  - A production grid was built by July, 2002
    - HPC centers deployed the software on non-dedicated resources!
    - The first Grid ever to contribute to an ongoing HEP Data Challenge (not EDG, not US) and it remained the only Grid running massive production in 2002-2003

- The initial goal was achieved: HEP institutes created a production Grid based on the alternative Nordic middleware
A short Grid history

The beginnings: “Grid Book”, Globus jumps into the middle of interests
2000 September: GT-1.1.4 released
2001 January: EDG started up
2001 November: GT-2.0 was announced (very much alpha-quality software)
2002 February: OGSA Initiative
2002 April: long-awaited GT-2.0 was delivered with GRAM-1.5, MDS-2.0 (missing critical functionality, stability problems)
2001 June: First meeting of the NorduGrid developers
2001 September: Grid Testbed with GT-1.1.4, switching to GT-2.0 pre-alpha, evaluating EDG
2002 February: decision to develop an alternative middleware by making use of Globus libraries. NorduGrid design, architecture, philosophy
2002 May: 3rd NorduGrid Workshop, Helsinki demonstration of the first release of the middleware on the Testbed
2000 2001 2002 2003 2004
GT-1.1.4 GT-2.0 alpha OGSA GT-2.0 GGF5,OGSA GT-2.2 GT-3.0 alpha GT-3.0
A short history, cont.

2001

2002

2003

2004

GT-1.1.4

GT-2.0 alpha

OGSA

GT-2.0

GGF5, OGSA

GT-2.2

GT-3.0 alpha

GT-3.0

GT-3.2 beta

2002 July: GGF5, Edinburgh, OGSA partnership, GT-3 plans

2002 August: Globus-NorduGrid meeting in Copenhagen

2002 October: GT-2.2 released with GRAM-1.6, MDS-2.2 (the first usable GT software)

2003 January: GT-3 alpha released

2003 June: GT-3.0 is out (serious performance problems)

2004 January: WS-RF, GT4 by 3rd quarter

2004 March: GT 3.2 beta, GT 2.4

2002 May: First Atlas validation job completed

2002 July: The testbed transforms into a production Grid, the middleware is deployed throughout Scandinavian centers, the HEP group starts running their Atlas data challenge on the Grid

2002 July: NorduGrid is presented in one of the GGF sessions, application-driven development continues

2003 July: HEP group completes the 3rd phase of their data challenge

2004 April: 0.4 release of ARC middleware

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Today ...

- Every civilized country runs (a) Grid project(s) or participates in international Grid(s)
  - Some grid projects operate a facility
    - very few of those Grid facilities are being used by 'ordinary' users
  - NorduGrid is one of those Grids: serving everyday users since May, 2002

- Grid is largely degraded as a marketing term due to the IT industry

  New standards together with new 'Standard bodies', though no production ready implementations of standards yet
Quick middleware snapshot

- **Globus Toolkit**
  - GT2, or pre-WS product line
  - GT3, OGSA/OGSI, was a dead end
  - GT4, GGF WS-RF-compliant, pre-alpha as of August, stable for February, 2005

- **LCG middleware**
  - Successor of the EDG middleware ('GT2-based')
  - Mass deployment due to LCG/EGEE project

- **Unicore, Legion**
  - Large scale deployment (?)

- **EGEE Glite (Arda, Alien)**
  - Prototype design exists, first release for March 2005

- **ARC from NorduGrid Collaboration**

- Many more ...

*general comment: middleware deployment decisions are extremely sensitive political issues*
Grid: our definition

For us the Grid means

- Resource sharing infrastructure
- General purpose computing infrastructure, solution
- Infrastructure providing uniform access to dynamic, heterogeneous systems
- Decentralized system spanning multiple administrative domains, where both the set of users and resources vary dynamically

Therefore we don't think that every distributed computing solution is a Grid, e.g. these are not Grids:

- Standalone application specific web/grid services
- Computing clusters, cluster management tools
- Database replication/mirroring tools
NorduGrid philosophy

- Create a *functional and usable system* within finite amount of time
  - Use available solutions if available
  - Create own solution if cost of waiting overweights cost of development
  - Reliability, performance, stability
- Follow standards, try to reuse available “de facto standard” implementations
- Don't be afraid to implement your own solution in case of no standards and if the “de facto standard” software lacks crucial functionalities.
- Start with something simple that *works for users* and add functionality gradually
  - Try to be user friendly: application driven development (e.g. GRAM 1.5 and Globus MDS schema was replaced within ARC)
- Try to be sysadmin friendly:
  - Don't require full reconfiguration
  - Create light-weight, portable and non-invasive software
  - Support those systems which are needed
Design principles and decisions

- Decentralized architecture, try to avoid central services
- Light-weight grid layer, keep simple things simple
- Non-intrusive software, grid should only be a layer on top of local setup, respect the local computing unit
- Support reasonably heterogeneous systems
The middleware
ARC: general overview

- Provides reliable implementation of fundamental Grid services:
  - Job submission (direct or via brokering), job management and monitoring
  - Information services: resource aggregation, representation, discovery and monitoring
  - Logging service
  - Data management functionality
  - Integrates computing and storage resources via a secure common Grid layer

- Built upon standard open source solutions, makes use of standard protocols
  - Relies on Globus Toolkit® 2 API and libraries, makes minimal use of GT2 provided services and utilities
  - OpenLDAP, OpenSSL, SASL, SOAP, GridFTP, GSI
ARC: it is not Globus

ARC is built upon the GT2 (pre-WS) libraries and partially makes use of the GT2 framework, BUT

- ARC implements its own set of core Grid services, original GT2 solutions are replaced!
  - No GRAM!, no Globus-Gatekeeper, no Globus-jobmanager, no GT2 information model (MDS schema), no Globus Gridftp-server, no GT2 user tools

- Innovative ARC solutions:
  - Grid-manager, ARC Gridftp, SSE, Userinterface & Broker, Information model and providers, Monitoring, Logging, XRSL

- ARC is a Globus library-based middleware therefore it heavily depends on GT2 as an external software
  - Actually, this limits our portability
  - Nordugrid contributed lots of fixes to pre-WS GT
Architecture: ARC functional components

Goal: no single point of failure
Architecture explained

- Dynamical, heterogeneous set of resources
  - **Computing**: Linux clusters (pools) or workstations, SMPs
    - Oriented towards batch jobs
    - a gateway solution permits the addition of exotic resources too
  - **Storage**: disk storage (no tape storages offered so far)

- Each resource is connected to the Grid via services running on the front-end (preserved local autonomy behind the frontend)
  - Custom **GridFTP server** for all the communications (including job submission!)
  - **Grid-Manager**, an interface to the local system
  - Local **information service**: a special LDAP Database (so-called GRiS)

- Resources are dynamically linked together via Indexing Services
  - Hierarchical multi-rooted customized tree topology implemented via LDAP registrations and a stripped-down special LDAP-backend (so-called GIISes)
  - Data indexing services (Metadata or Replica catalogs)

- Lightweight brokering clients perform resource discovery, matchmaking and job submission independently

- Auxiliary management services: User, Usage or resource Allocation
ARC components: Grid layer on a computing resource

- Computing resource is usually a cluster of PCs managed by a batch system (PBS, SGE, Condor, Fork...)
- Grid jobs are submitted through a custom gridftpd plugin
- Runs a service (grid daemon) called grid manager responsible for local job management (e.g. Job submission to local batch system). It is capable to manage pre- and post-staging of Grid data, optionally using Metadata Catalogs.
- Provides a scratch disc space “session directory” and “cache” for grid job's data
- Grid jobs are isolated in their “session directory”, this directory is available through gridftpd!
- Runtime environment support
- Runs a local information service (LDAP) which registers to some Resource Index Service(s).
- Grid services are only installed on the frontend!
ARC components: Grid layer on storages

- "Classical" Storage Element
  - Usually GridFTP server.
  - Any other protocol supported by available tools can be used.
  - It's just a shelf where users put their files.
  - Several authorization solutions: unix file permission based, Grid Access Control List (GACL) based

- "Smart" Storage Element (SSE)
  - Currently being developed
  - More standard protocols: HTTPS/G, SOAP
  - Flexible access control
  - Data integrity between resources
  - Support for data replication
  - Storages can be registered to Information or Metadata Indices
ARC components: Information System

- Built upon Openldap and Globus' GIIS/GRIS backends
  - Planning to use native Openldap
- **Information indices** form a redundant hierarchical topology
  - Store the contact URLs of local information services (only the URL!)
- **Local information service**
  - Information model (schema) represents
    - Clusters, Grid jobs, Grid users
  - Efficient **information collectors** fill the information model with data
  - Runs on every resource (cluster and SE):
    - pull model with caching
ARC Components: support for metadata catalogs

- Metadata Catalogues or Data Indexing services are Databases to store information about distributed data instances
- Currently ARC supports the following two Globus products:
  - **Replica Catalog**: scalability and stability problems, but fairly reliable (LDAP DB)
  - **Replica Location Service**: was very unstable and unreliable (fixed by NorduGrid) but fashionable, requested by users (MySQL DB)
ARC components: User Interface & Broker

Provides a set of utilities to be invoked from the **command line**:

- `ngsub` to submit a task
- `ngstat` to obtain the status of jobs and clusters
- `ngcat` to display the stdout or stderr of a running job
- `ngget` to retrieve the result from a finished job
- `ngkill` to cancel a job request
- `ngclean` to delete a job from a remote cluster
- `ngrenew` to renew user's proxy
- `ngsync` to synchronize the local job info with the MDS
- `ngcopy` to transfer files to, from and between clusters
- `ngremove` to remove files

- **ngsub** contains a **personal broker** that polls Infosys and decides to which queue at which cluster a job should be submitted
- Fully **decentralized model**, no central broker, no central UI
- Light-weight set of commands, collection of tools to control job's execution from submission to retrieval of results
- Additional tools to handle data files at Storage Elements and MetaStorage, plus a complete test suite (**ngtest**)
- Every user can run his own UI(s), or **switch between Uls**, job information is kept in the Grid and not on the UI
- Communicates via **XRSL**

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ARC components: next generation UIs

- General purpose UI library is under design (ARC CLIENT GRID API)
  - Will implement and extend the functionality of the current command line UI
  - C/C++, Python bindings
  - Will be used by GUIs, application portals
  - Will hide the complexity of the infrastructure
    - submit_job(xrsl_file, jobid)
    - find_resources(user_id, xrsl_file, target_list)

- GUI prototypes being developed
  - Java-based
  - QT-based
ARC components:

Grid monitor

The Monitor is available at www.nordugrid.org/monitor

- PHP4 client, visualization tool for the distributed Information System
- No caching, real time LDAP queries (try to run it in debug mode)
- Provides information on grid jobs, status of resources (clusters, storages) and active users.
- Localized so far in 3 languages including Russian
ARC components: User management, logging

- User Management:
  - User lists are periodically pulled by the resources in order to generate local synchronized grid-mapfiles
  - The lists can be fetched from anything ranging from an HTTPS-served text file to an LDAP database, to VOMS
  - Currently we have ca. 20 user lists in total (over 800 potential users)

- Logging service:
  - job provenance database,
  - Reliably filled by Grid Manager with the job usage record
  - Both the user and the resource owner can specify a logger database
ARC components: XRSL Job Description Language

(&{executable="recon.gen.v5.NG")
(arguments="dc1.002000.lumi02.01101.hlt.pythia_jet_17.zebra" "dc1.002000.lumi02.recon.007.01101.hlt.pythia_jet_17 eg7.602.ntuple"
"eg7.602.job" "999")
(stdout="dc1.002000.lumi02.recon.007.01101.hlt.pythia_jet_17 eg7.602.log")
(stdlog="gridlog.txt") (join="yes")

(|(&(cluster="farm.hep.lu.se") (cluster="lscf.nbi.dk") (*cluster="seth.hpc2n.umu.se") (cluster="login-3.monolith.nsc.liu.se"))
(inputfiles= "dc1.002000.lumi02.01101.hlt.pythia_jet_17.zebra"
"rc://grid.uio.no/lc=dc1.lumi02.002000,rc=NorduGrid,dc=nordugrid,dc=org/zebra/dc1.002000.lumi02.01101.hlt.pythia_jet_17.zebra")
("recon.gen.v5.NG" "http://www.nordugrid.org/applications/dc1/recon/recon.gen.v5.NG.db")
("eg7.602.job" "http://www.nordugrid.org/applications/dc1/recon/eg7.602.job.db")
("noisedb.tgz" "http://www.nordugrid.org/applications/dc1/recon/noisedb.tgz")
)

(inputfiles= "dc1.002000.lumi02.01101.hlt.pythia_jet_17.zebra"
"rc://grid.uio.no/lc=dc1.lumi02.002000,rc=NorduGrid,dc=nordugrid,dc=org/zebra/dc1.002000.lumi02.01101.hlt.pythia_jet_17.zebra")
("recon.gen.v5.NG" "http://www.nordugrid.org/applications/dc1/recon/recon.gen.v5.NG")
("eg7.602.job" "http://www.nordugrid.org/applications/dc1/recon/eg7.602.job")

)

(outputFiles= "dc1.002000.lumi02.recon.007.01101.hlt.pythia_jet_17 eg7.602.log"
"rc://grid.uio.no/lc=dc1.lumi02.recon.002000,rc=NorduGrid,dc=nordugrid,dc=org/log/dc1.002000.lumi02.recon.007.01101.hlt.pythia_jet_17.
eg7.602.log")
("histo.hbook"
"rc://grid.uio.no/lc=dc1.lumi02.recon.002000,rc=NorduGrid,dc=nordugrid,dc=org/histo/dc1.002000.lumi02.recon.007.01101.hlt.pythia_jet_17.
eg7.602.histo")
("dc1.002000.lumi02.recon.007.01101.hlt.pythia_jet_17 eg7.602.ntuple"
"rc://grid.uio.no/lc=dc1.lumi02.recon.002000,rc=NorduGrid,dc=nordugrid,dc=org/ntuple/dc1.002000.lumi02.recon.007.01101.hlt.pythia_jet_17.
eg7.602.ntuple")
)

(jobname="dc1.002000.lumi02.recon.007.01101.hlt.pythia_jet_17 eg7.602")
(runTimeEnvironment="ATLAS-6.0.2")
(CpuTime=1440)(Disk=3000)(ftpThreads=10))
ARC: User Work flow

• The User:
  – prepares her job-description in the xRSL job-description language.
  – submits the xRSL to the NorduGrid resources using the user-interface
  – While the job is running, she can query the status of her jobs.
  – When the jobs have finished, she can download the output of jobs -- or the output can be placed on permanent storage directly.

• Meanwhile the components of the Grid do their job:
  – The brain of the Grid, the client “UserInterface” does resource discovery, brokering, Grid job submission and monitoring
  – The Information system, the nervous system of the Grid answers the queries of the UI and the monitoring tools
  – The “heart”(s) of the Grid, the Grid Manager(s) perform data movement, keeps track of job status, manages and controls session directories, prepares preinstalled software, accepts job submissions from the clients
One more glimpse on ARC

User Interface & Broker

Information Service

Computing resource

GSI everywhere

User Interface & Broker

GSI everywhere

User Interface & Broker

MetaStorage

Storage Element

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ARC software status

- Current stable release: 0.4.3,
  - latest development tag: 0.5.12 ("Smart" Storage Element, enhanced logger, etc)
- The GPL-licensed code is written in
  - C/C++, php, perl, bash scripts
  - Some new development in python & Java (GUIs)
- External dependency (everything is available from the download area)
  - Globus (2.x, 3.2.1): Globus RLS, Globus RC, OpenSSL, OpenLDAP, SASL (best option is to download a globus-ng package)
  - gSOAP, GACL, libxml2, Mysql clientlibs, VOMS (above 0.5.x optional)
- Download, Installation:
  - Sources, binaries, external softwares from the download area
    http://ftp.nordugrid.org
  - Client and server Install instructions (~4 MB standalone binary client package, 5 minutes install)
ARC software status cont.

- **Supported platforms**
  - Binary build (daily build snapshots) for every major Linux distros: Mandrake, Debian, Fedora, Suse, Redhat
  - 64 bit systems: alpha, AMD x64, AIX
  - Ongoing work (client): Windows, MAC OS-X
    - Globus libs are the show stoppers

- **Middleware Support: best-effort support is offered**
  - nordugrid-support@nordugrid.org
    - Both software and deployment support
  - Bug reports: http://bugzilla.nordugrid.org

- **Documentation:**
  - Manuals, scientific papers, tutorials, man pages
  - www.nordugrid.org -> Documentation

- **Open Development: Everybody is welcomed to contribute**
  - Join nordugrid-discuss@nordugrid.org (very busy list!)
  - Come to a nordugrid technical meeting (it is free)
Ongoing work, TODO list

- **User interface**
  - General purpose UI library for GUIs, application portals
  - GridSSH, interactive login
  - Job baby sitter, job manager

- **Build, Packaging**
  - CVS reorganization (e.g. to support make client)
  - Configuration cleanup
  - New platforms, stripped-down Globus

- **Data management**
  - Smart Storage Element
  - Data Indexing Service,
  - Flexible, robust, reliable automatic replication

- **Information System**
  - Native LDAP implementation
  - Alternative resource topologies, more flexible network building
  - Authorization to sensitive information
TODO list cont.

- Resource management
  - Quotas, limits, reservations, sand boxing
  - Flexible access control for resources. From clients to servers and administration.

- Application support (Runtime Environments)
  - Parallel jobs
  - RE registry

- The infrastructure of a non-free (commercial) Grid
  - Policies, Logging, Accounting, Grid Market, Grid Bank

- Upcoming standards to be evaluated and adopted
  - Small BUT critical things: logging UR, Info schema, grid job representation
  - And the big stuff: (currently) WS-RF
The Grid and its users
ARC Grid

- Sites connected by the ARC middleware
- No 'political' commitments
- Three steps to join the OPEN Grid:
  - Download the GPL middleware
  - Carefully configure (open up) your local resource
  - Register to one of the Indexing Services

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ARC Grid in terms of numbers

- 40 clusters, ~4000 CPUS from 10 Countries (why don't you check it out on the Monitor?)
- 42TB total, 28TB free storage
  - Note: here may be some double counting
- Over 1000 potential users registered in one of the authorized user groups
  - Plus the locally mapped Grid users
- 17 Sept, 10:30 snapshot:
  - 59 active users (users with grid job in the system)
  - 621 running Grid job, 2399 running locally submitted jobs
  - 1870 queuing Grid job, 1631 queuing local job
Some facts

- A large international Grid facility which originates from North Europe (originally it was called NorduGrid) but OPEN to the WORLD
- It is an evolving Infrastructure with increasing number of resources and participating countries
- It is a Grid which links national Grids (SweGrid, DCGC, ...)
  - Resource Allocation is made on a National level
- It is a Production Grid not a TestBed, nor a DEMO Grid, available 24/7 since July 2002 to a growing set of users.
- An “academic” Grid, serves researchers and consists of academic resources
- A general purpose Grid, it is not a High Energy Physics Grid although at the moment they are the main customers
- A Grid built from “bottom to top”, originally connecting already existing resources belonging to different administrative domains
  - Resources are NOT owned by the Grid
- A unique Grid research facility:
  - A challenging platform for development
  - A test platform for fundamental Grid research
Some facts, cont.

- A dynamic Grid, resources come and go
- Mostly a cluster Grid but there'll be some SMPs as well
  - Non-dedicated clusters
  - Homogeneity is preferred within a (sub)cluster
  - Many flavors of Linuxes + some UNIXes
- Grid connected resources cover almost everything the academics can provide from small to large
  - Small dedicated test clusters (1-4 CPUs)
  - Large dedicated Grid clusters (SweGrid)
  - Some junkyard-class second-hand clusters (4 to 80 CPUs)
  - Non-dedicated university production-class facilities (20 to 60 CPUs)
  - non-dedicated world-class TOP500 clusters
    - NSC: Monolith 398 CPUs, 103rd position on November/2003 TOP500 list
    - Umeå: Seth 238 CPUs, 357th position on November/2003 TOP500 list
  - Academic Network (up North it is the excellent NorduNet)
Usage statistics from the logger service

- www.nordugrid.org -> NGLogger
- Logger service is under development
- Central logger works on a voluntary basis
- Sub-Grids can run their own logger services

The logger (and not the Grid:) went down
People behind the statistical numbers

- “We are also grateful to the NorduGrid project, for inviting us test their facilities. Many of our results were obtained with grid computing” T.Sjöstrand and P.Z.Skands, Baryon Number Violation and String Topologies, *Nuclear Physics B* vol. 659, no. 1-2, (2003) pp.243-298


Parallel jobs on the grid

- Portability of MPI binaries in a heterogeneous Grid
  - Compile on site A, ship the binary to site B
  - Compatible MPI environments, every HPC Center has its own locally tuned MPI
  - It is not the Hardware!

- Coallocation (cross cluster parallelism) in a production environment
  - Technically possible (MAUI's advanced reservation)
  - Do we really need it?
Users & Applications

- Main users:
  - High Energy Physics, ATLAS simulations (CERN)
  - Quantum Monte Carlo simulations of spin systems
  - Quantum Chemistry
  - Protein folding
  - Planet formation
  - Climate simulations

- 2003: Sweden starts allocating CPU slots on SweGrid running ARC, some of the projects which got CPU time on SweGrid:
  - “A Novel computational approach to fold recognition”
  - “Numerical simulation of three-dimensional plasma dynamics..”
  - “Modeling the climate of the Baltic Sea”
  - “Quantum Monte Carlo simulations of spin systems”

Please note, that the we did not have “dissemination and marketing” team, no manpower to recruit, support, introduce potential new users.
Users: HEP Atlas group

- The Scandinavian High Energy Physics Atlas Group has been one of the main driving force behind the NorduGrid development
- **Atlas Detector**: 40x20x20 m, 8000 tons, 10 PB of data per year to process, purpose is to find the elusive Higgs particle or Supersymmetric particles
- **Atlas DATA Challenges**
  - A series of computing challenges of the Atlas collaboration with increasing size and complexity
  - Preparation for the 2007 start of the Large Hadron Collider
  - With introduction and use of Grid middleware as fast and as much as possible
NorduGrid in the Atlas DC1

- Took place in the second half of 2002 and first half of 2003
- Around 50 institutes from all around the world participated
- Scandinavia participated via the NorduGrid
- It was the Only Grid platform which was capable joining the production runs, no EDG, no LCG, no USGrid(s)
- The NorduGrid contribution ramped up from 2% to 15% within a year due to expansion (ca. 4TB of data, more than 4750 single jobs, a typical job was 2 to 30 hours long)

NorduGrid in the DC2

- Atlas DC2 is an ongoing live production at the moment with several phases.
- **Three Grid platforms**, LCG/EGEE (EU), Grid3 (USA), NorduGrid (ARC-connected sites world-wide) are participating on an “equal footing” through the Atlas Production System.
- Scale: 100,000+ CPU-days of simulations (1 CPU day ~2.4 Ghz machine).
- The complete task (100%) was divided among the 3 grid-flavors depending on the resources they could initially offer for the DC2:
  - LCG (60%) 3000-4000 CPU's
  - NorduGrid (20%) 800 CPU's
  - Grid3 (20%) 800 CPU's
DC2 production system with the three grids

Don Quijote
DMS

Windmill Supervisor

Dulcinea executor
NorduGrid resources

Lexor executor
LCG resources

Capone executor
Grid 3 resources

Production Database
ATLAS DC2 Production Status

Overview of Grids

as of 2004-09-17 13:49:58

<table>
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<th>Grid</th>
<th>submitted</th>
<th>pending</th>
<th>running</th>
<th>finished</th>
<th>failed</th>
<th>efficiency</th>
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<td>27</td>
<td>4</td>
<td>1624</td>
<td>35637</td>
<td>18438</td>
<td>66%</td>
</tr>
<tr>
<td>NorduGrid</td>
<td>154</td>
<td>1223</td>
<td>36494</td>
<td>20487</td>
<td>65%</td>
<td></td>
</tr>
<tr>
<td>LCG</td>
<td>1</td>
<td>584</td>
<td>829</td>
<td>53096</td>
<td>46%</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>182</td>
<td>588</td>
<td>3676</td>
<td>120082</td>
<td>92021</td>
<td>57%</td>
</tr>
</tbody>
</table>

Correction: 4700 jobs (corresponding to the corrupted B4 dataset) running on NorduGrid were canceled

The Production is running close to its end ~ 97%, successful jobs delivered by the three Grids:

LCG: 39% (60% allocated originally)
NG: 32% (20% allocated originally)
Grid3: 29% (20% allocated originally)
Summary

- NorduGrid’s ARC is a reliable and robust Grid middleware, supporting distributed production facilities already for 2 years
  - Still a lot needs to be done, especially in the data management and Authorization area
- The development of the middleware follows an open source track, everybody is welcomed to use and contribute
- There is growing, large Production Grid originating from North Europe since summer 2002, this Grid is open:
  - To the (potential) Users:
    - Installing the ARC client does not give you an automatic access to any resource: please negotiate with the resource owners (create Virtual Organizations)
  - To the resource providers:
    - Deploying ARC does not open doors to all the users: resource owners decide whom to authorize
- A general purpose Grid that works – and is being used!
acknowledgments

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- Some of our users: Alex Read, P. Z. Skands, Nils Gollub, O. F. Syljuasen
- Management, Steering Committee: P. Eerola, T. Ekelöf, J. R. Hansen, F. Ould-Saada
Useful information

- Downloads: http://ftp.nordugrid.org
  - Serves all the required external software (e.g. Globus) too
  - RPMs and tarballs, sources and binaries
- Documentation, papers, Tutorials:
  - www.nordugrid.org/papers.html
- Reporting bugs: http://grid.uio.no/bugz
  - Anybody can report a bug or request a feature
- CVS at http://grid.uio.no/cvs/cvsweb.cgi
  - Read access to everybody
- User and new site support:
  - nordugrid-support@nordugrid.org