The ARC Middleware – An International Grid Initiative

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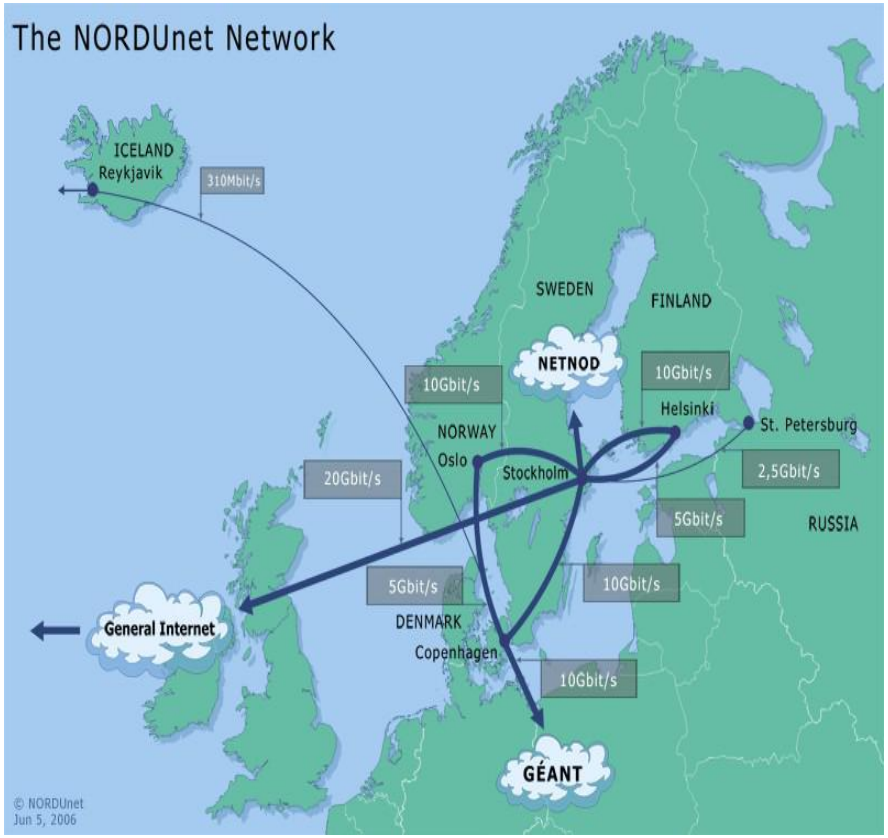
Outline

- NORDUnet
- NorduGrid collaboration and ARC middleware
- ARC-related projects
  - NDGF
  - NGIn
  - KnowARC
- Use of ARC in the ATLAS experiment

NORDUnet

Nordic Infrastructure for Research & Education

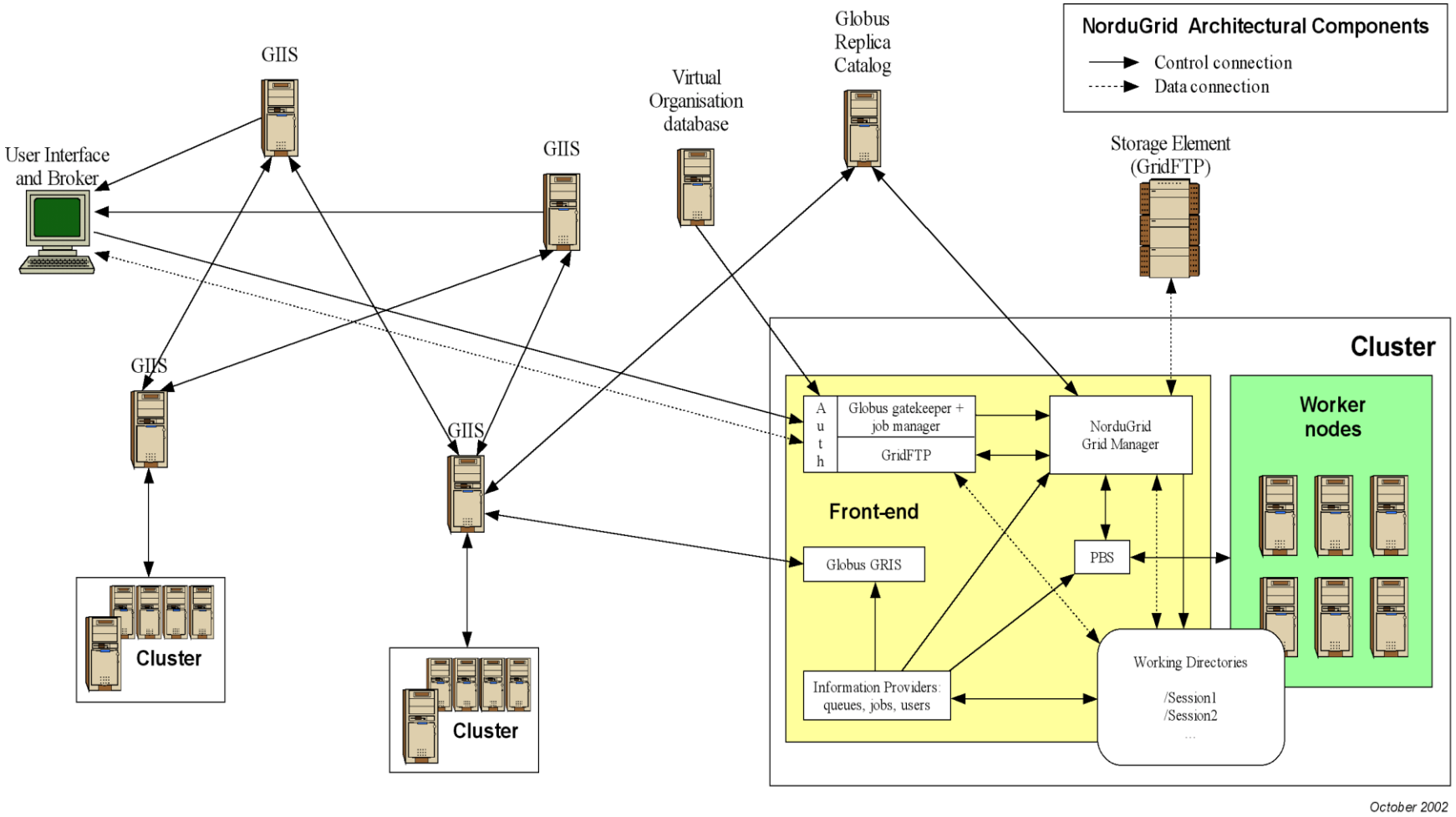
- Collaboration between the Nordic national networks for research and education.
- NORDUnet interconnects these networks and connects them to the worldwide network for research and education and to the general purpose Internet.



ARC Middleware

- ”Advanced Resource Connector”
  - Connect existing computing and storage resources
- First generation ARC was product of NorduGrid collaboration – www.nordugrid.org
  - Motivated by need for grid infrastructure for Nordic participation in the LHC experiments at CERN (HEP)
  - Funded by NORDUnet
- Wide user base today (e.g. ~1/3 of Swegrid users are HEP)

ARC Architecture

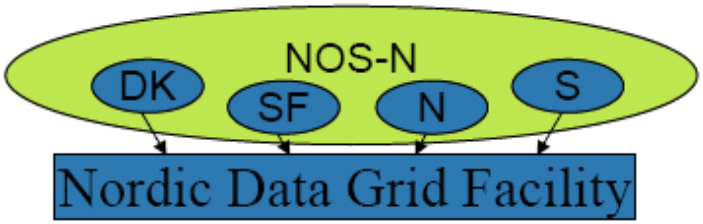


What is the NDGF?

NDGF
Nordic DataGrid Facility

- A Co-operative Nordic Data and Computing Grid facility
  - Nordic production grid, leveraging national grid resources
  - Common policy framework for Nordic production grid
  - Joint Nordic planning and coordination
  - Operate Nordic storage facility for major projects
  - Co-ordinate & host major e-Science projects (i.e., Nordic WLCG Tier-1)
  - Develop grid middleware and services
- NDGF 2006-2010
  - Funded (2 M.EUR/year) by National Research Councils of the Nordic countries
  - Builds on a history of Nordic grid collaboration

•Support and develop ARC
•Support for gLite and ARC+gLite sites



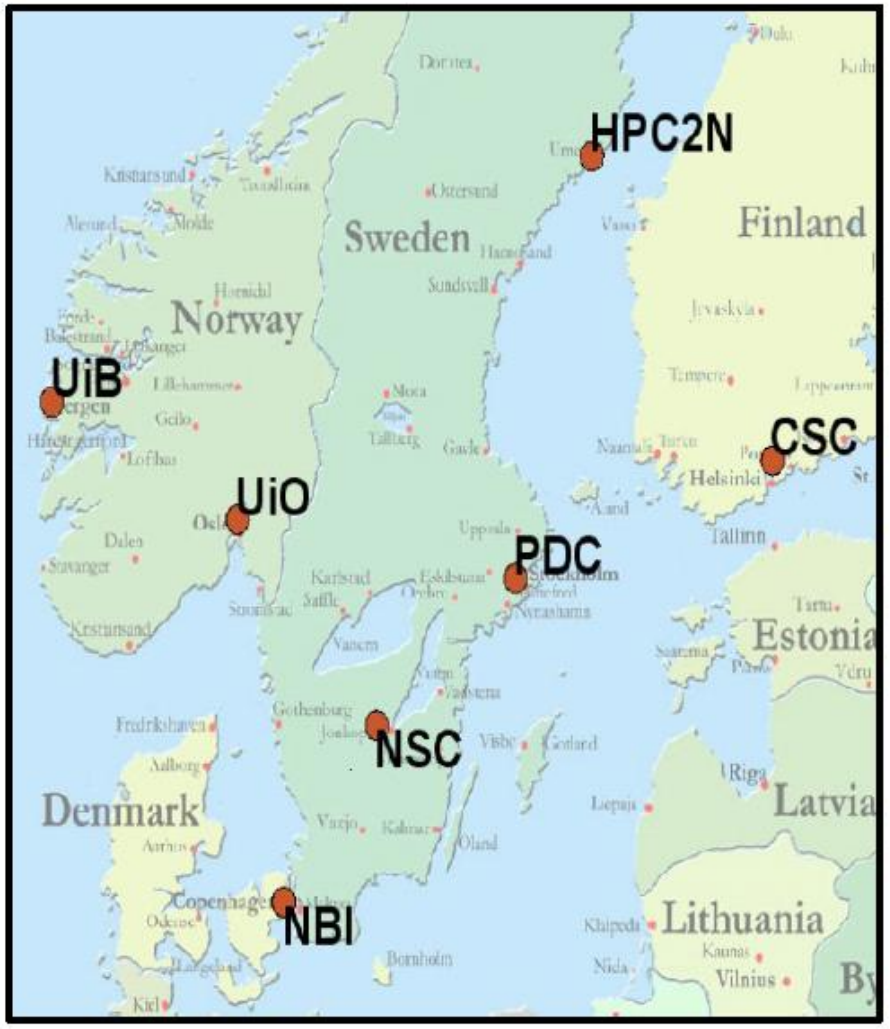
Michael Grønager, CHEP'07

NDGF Tier-1 Resource Centers

NDGF
Nordic DataGrid Facility

- The 7 biggest Nordic compute centers, dTier-1s, form the NDGF Tier-1
- Resources (Storage and Computing) are scattered
- Services can be centralized
- Advantages in redundancy
- Especially for 24x7 data taking

New in 2008: Associated site IJS in Slovenia



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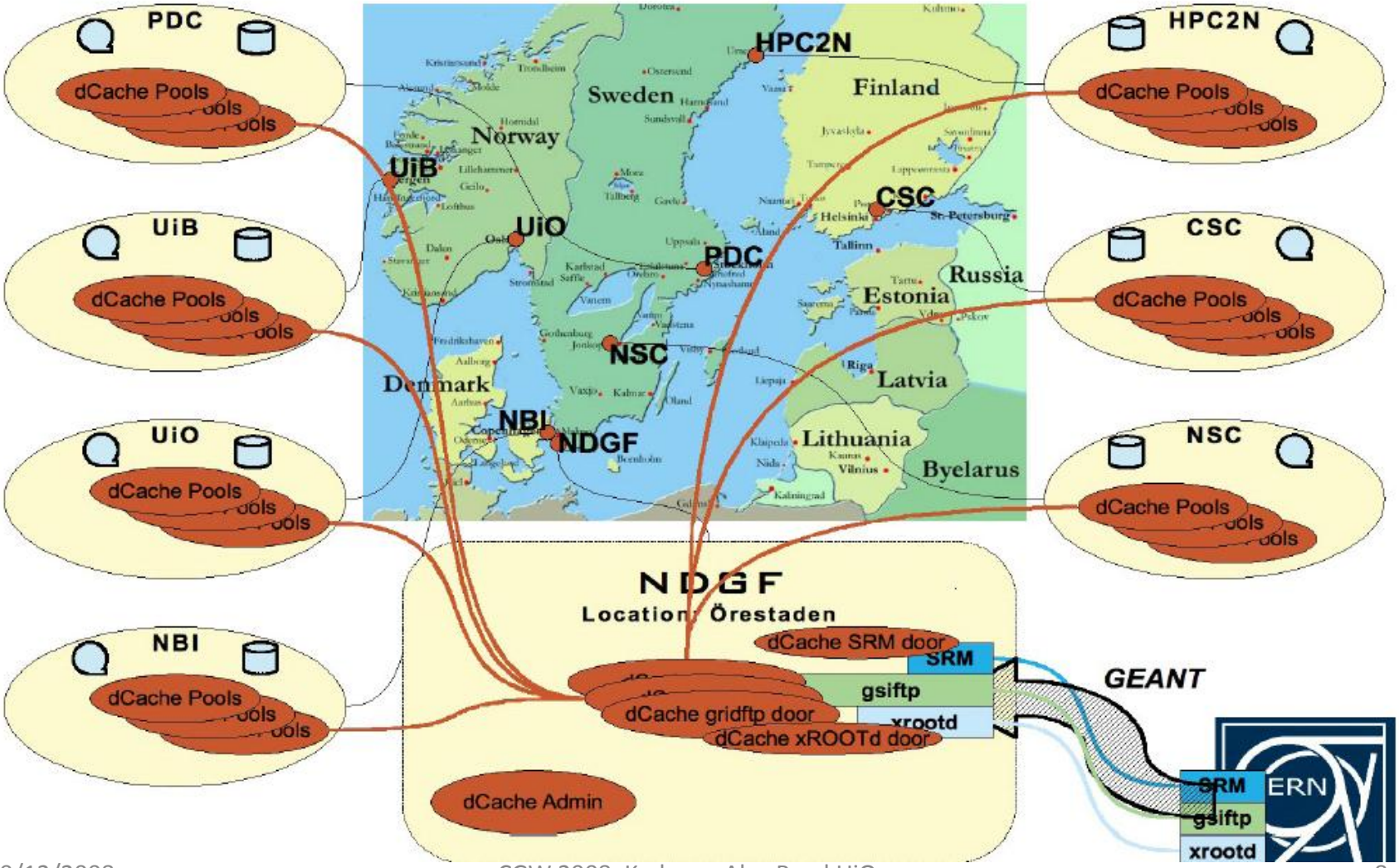
NDGF
Nordic DataGrid Facility

NDGF Storage
(~1.1 PB 10.08)



NGIn

- ”Innovative Tools and Services for NorduGrid” - www.nordugrid.org/ngin/
- Funded by Nordic Nordunet3 programme
  - Internet research program of the Joint Committee of the Nordic Natural Science Research Councils (NOS-N), NordForsk, the Nordic Council of Ministers, and NORDUnet A/S
- 2006-2010
- 5 PhD positions (1 unfilled)
  - Data management (x2)
  - Distributed data analysis
  - Fine-grained delegation of rights
- Grid schools (at annual NorduGrid Conferences)

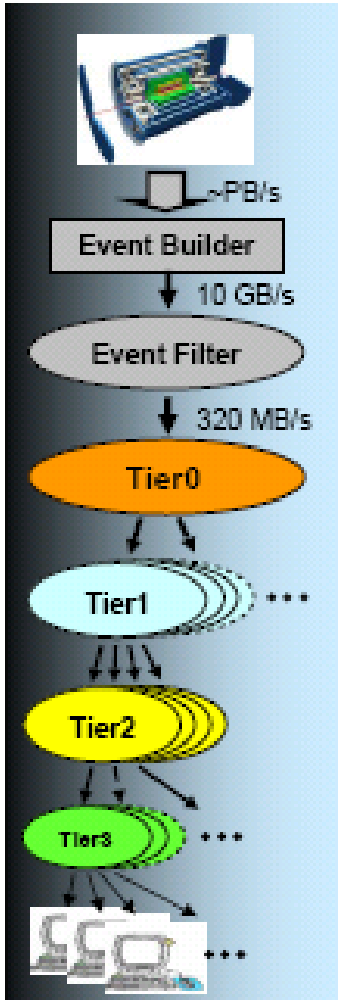
KnowARC

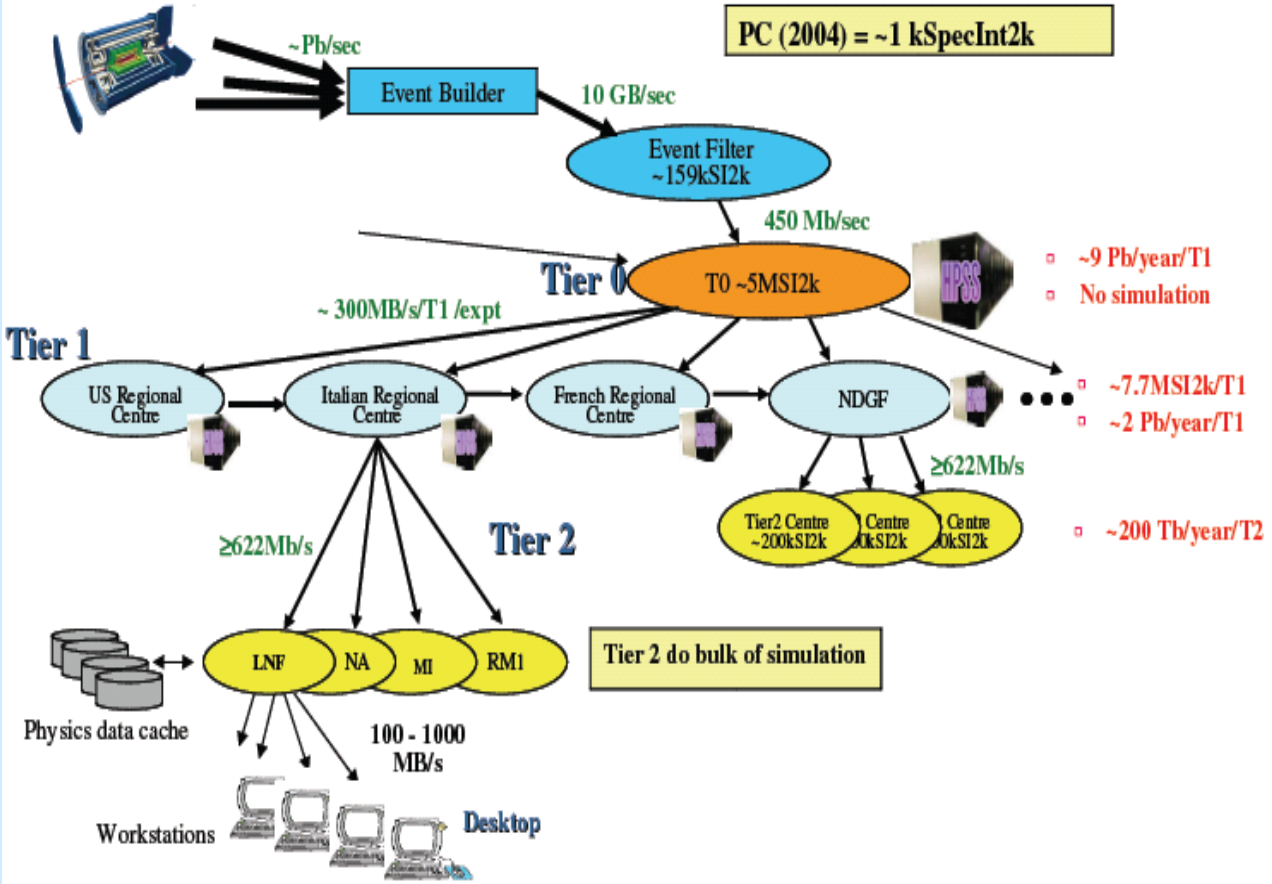
- EU FP6 project – www.knowarc.eu
- 2006-2009
- Partners from NorduGrid collaboration and beyond
  - Medicine, bioinformatics, industry
  - Germany, Hungary, Switzerland
- Improve and extend ARC middleware
  - Open standards
  - WS interfaces to services
  - New services (workflows, application repositories,..)
  - New platforms (Mac OS X, Solaris, Windows)

Summary of projects

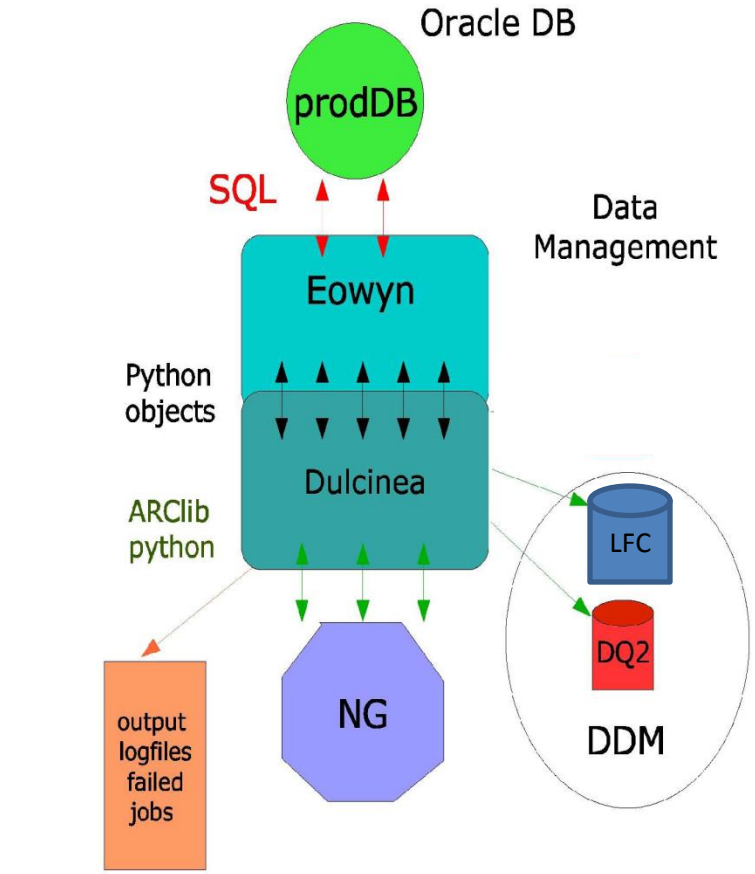
- ARC is the the middleware product
- NGIn, NDGF, KnowARC all contribute to further development of ARC
- NorduGrid is a MoU-based collaboration
  - Umbrella organization for the projects
  - Will insure long-term home-base and support for ARC

ATLAS Distributed Computing
The Tiers of ATLAS





The NDGF Cloud



http://grid.uio.no/atlas/jobinfo

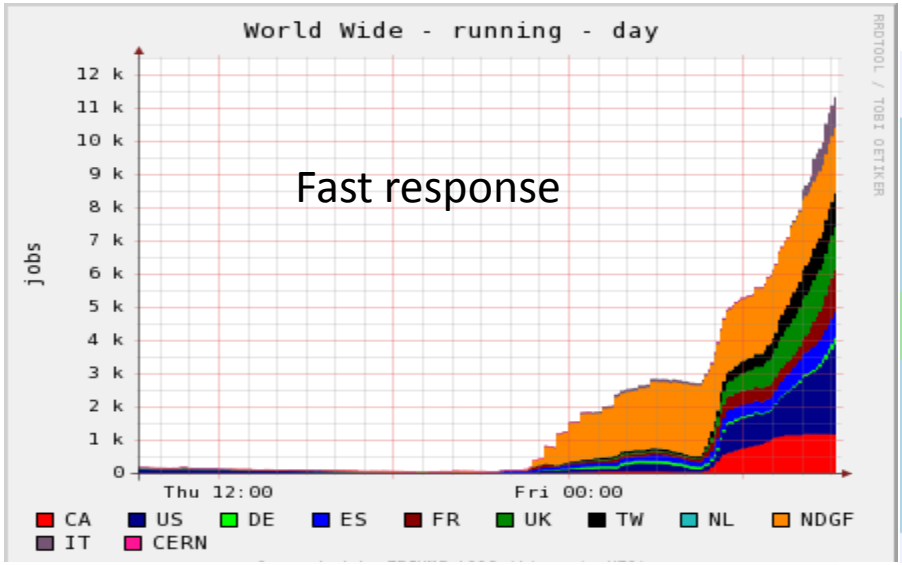
ATLAS Grid Monitor

2008-10-12 CEST 01:01:14

Processes: Grid Local

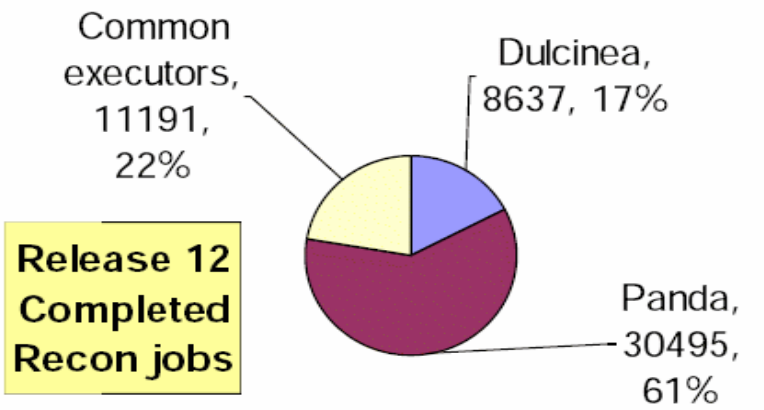
Country	Site	CPUs	Load (processes: Grid+local)	Queueing
Denmark	Steno (DCSC/KU)	2100	0+462 (queue inactive)	0+0
Norway	EPF (UiO/FI)	18	0+4	0+175
	Hyperion (UiO/USIT)	199	0+185	22+10
	Titan A (UiO/USIT)	3870	40+3058	573+0
Slovenia	SiGNET	492	490+1	255+0
Sweden	Grad (SweGrid, Uppmax)	512	173+0	0+2
	Ritsem (SweGrid, HPC2>	424	337+0	0+0
	Siri (SweGrid, Lunarc)	504	0+240 (queue inactive)	0+19
	Smokerings (NSC)	528	60+48	273+0
Switzerland	Bern ATLAS T3 Cluster	26	11+0	0+0
	Bern UBELIX T3 Cluster	512	0+315	0+591
	Geneva ATLAS T3	152	100+0	30+0
	Manno PHOENIX T2	405	0+360	0+43
TOTAL	*13 sites*	*9742*	*1211 + 4673*	*1153 + 840*

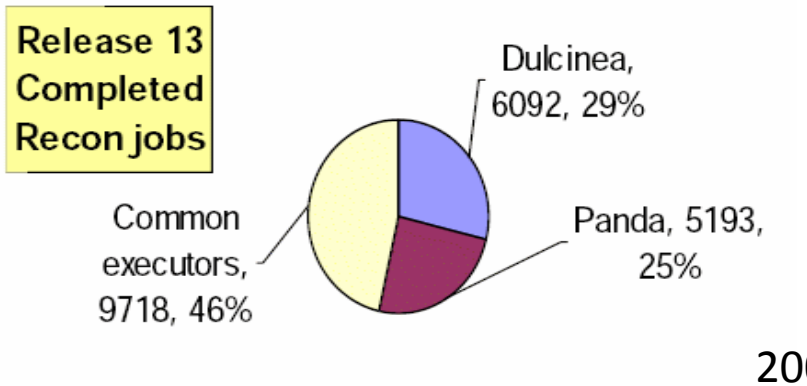
Performance



Jan-Sep 2008 High eff.

cloud	success	failure	success (walltime)	failure (walltime)	efficiency	efficiency (walltime)
BNL	1858544	475548	38945904273	9567257611	79.6%	80.3%
LYON	1212010	526114	21969799355	8522418201	69.7%	72.1%
None	921758	442265	17587093843	2636305596	67.6%	87%
RAL	902004	322264	21345637478	8428690553	73.7%	71.7%
FZK	698721	224721	12141329759	1916123651	75.7%	86.4%
TRIUMF	799243	94005	14197704678	1836233372	89.5%	88.5%
NDGF	793309	69568	13499699400	429178080	91.9%	96.9%
ASGC	488458	174965	8862776147	1231201001	73.6%	87.8%
PIC	306409	145230	5566037902	1390178354	67.8%	80%
CNAF	281535	141351	6138543368	1183067723	66.6%	83.8%
SARA	249277	145929	4533276867	1318246017	63.1%	77.5%
CERN	11746	10756	46961324	34237529	52.2%	57.8%
total	*8523014*	*2772716*	*1.64834764394e+11*	*3.8493137688e+10*	*75.5%*	*81.1%*





2007

Effective use of (less than 10%) computing resources

Under the hood

- ”Single” SRM-dCache site in the cloud
  - Easier to maintain (don’t need SE for every CE)
  - Smaller (but focussed) operations team
- No middleware on the worker nodes
  - ARC Grid-manager handles data-transfer and controls number of transfers per site
  - File registration done in the job-manager (Dulcinea) limits load on file catalog service (e.g. LFC)
- Input/Output of jobs straight from/to primary storage independent of Tier-1/2/3 status of CE

Conclusion

- First-generation ARC middleware with Nordic, high-energy physics origins in production since years
- NDGF project with deployment, operational, middleware development activities appears to be working well
- Second-generation ARC with partners across Europe reaching out to other fields than academic physical science
  - In recent breakthrough ARC included in list of 3 major European middlewares considered as a basis for the future FP7 European Grid Initiative (EGI).