

## **Notes – Multi-Grid Interoperation Planning Meeting**

17-November 2005  
Seattle, Washington, US

Moderators:

Charlie Catlett  
University of Chicago and Argonne National Laboratory (TeraGrid Project)

Satoshi Matsuoka  
Tokyo Institute of Technology (NAREGI Project)

### Abstract

Many production grid projects have begun to offer services to end-users during the past several years, with an increasing number of application projects that require access to resources in multiple grid systems. Most of the production grid projects regularly interact with other grid projects in pair wise fashion, discussing opportunities to collaborate and to work toward interoperation. These bilateral discussions have identified a number of opportunities where, with minor modification, specific services offered by multiple grid systems could interoperate.

*Directors and Technical leaders from nine major production grid projects in Europe, North America, and Asia-Pacific met together on 17-November-2005 to discuss these opportunities and to plan for production interoperation in three to six specific services within the next year.*

This report documents that discussion, including four areas of production interoperation to be pursued by the group over the next year. As a next step, the group will develop application-driven plans for interoperation in these areas by the end of January 2006, followed by an open workshop at GGF-16 in February 2006 to invite other grid projects to join in these efforts to establish specific services with production interoperation.

### Status of this Memo

This memo is a draft set of notes and action items from a meeting of leaders from multiple production grid projects. It does not describe standards, but rather provides a current set of plans to achieve production interoperation with a small set of services. These services are selected opportunistically based on current state of technology and standards. When final plans are prepared (January/February 2005) the intent is to integrate them with this report and submit as a GGF Informational document.

### Participants

<u>Name</u>	<u>Grid / Institution</u>	<u>Name</u>	<u>Grid / Institution</u>
Alessandrini, Victor	DEISA/IDRIS	Lee, Jongsuk Ruth	K*Grid/KISTI
Andrews, Phil	TeraGrid/SDSC	Liming, Lee*	TeraGrid/UC-ANL
Arzberger, Phil	Pragma/UCSD	Lin, Fang-Pang	Pragma/NCHC
Bair, Ray	TeraGrid/UC-ANL	Linesch, Mark	GGF/HP
Catlett, Charlie	TeraGrid/UC-ANL	Livny, Miron*	OSG/UW
Fogel, Robert	GGF/Intel	Matsuoka, Satoshi	NAREGI/TIT
Foster, Ian*	TeraGrid/UC-ANL	Newhouse, Steve	UK NGS/OMII
Francis, Rhys	APAC/CSIRO	O'Callaghan, John	APAC
Geddes, Neil	UK NGS/CCLRC	Papadopoulos, Philip	Pragma/SDSC
Green, Mark	OSG/CCR	Pordes, Ruth	OSG/FermiLab
Heinzel, Stefan	DEISA/MPG	Saga, Kazushige	NAREGI/NII
Karayannis, Fotis	EGEE/GRnet	Sekiguchi, Satoshi	BusinessGrid/AIST
Katz, Mason	Pragma/SDSC	Showerman, Mike	TeraGrid/NCSA
Kranzlmueeller, Dieter	EGEE/CERN	Skow, Dane	TeraGrid/UC-ANL
Laure, Erwin	EGEE/CERN		

\*by telephone



*Front (left to right):* Mike Showerman (TeraGrid), Ray Bair (TeraGrid), Charlie Catlett (TeraGrid), Satoshi Matsuoka (NAREGI), Satoshi Sekiguchi (BusinessGrid), Robert Fogel (GGF), Mark Linesch (GGF), Jongsuk Ruth Lee (K\*Grid), Dane Skow (TeraGrid), Kazushige Saga (NAREGI), Peter Arzberger (Pragma)  
*Back (left to right):* Ruth Pordes (OSG), Neil Geddes (UK NGS), Erwin Laure (EGEE), Steven Newhouse (UK NGS), John O'Callaghan (APAC), Rhys Francis (APAC), Mark Green (OSG), Stefan Heinzel (DEISA), Victor Alessandrini (DEISA), Fang-Pang Lin (Pragma), Mason Katz (Pragma), Phil Papadopolous (Pragma)  
*Not pictured:* Phil Andrews (TeraGrid), Dieter Kranzlmueeller (EGEE), Ian Foster (TeraGrid), Lee Liming (TeraGrid), Miron Livny (OSG), Fotis Karayannis (EGEE)

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## 1 Introduction

Charlie Catlett provided background on the purpose of the meeting and a potential medium to long-term approach to deciding on interoperation focus areas and moving toward production interoperation in those areas. (see Appendix: Introductory Slides) It was stressed that production interoperation in the near-term, *motivated by specific applications and use cases*, is the objective. Long term “interoperability” as a goal should be kept in mind and, where possible, captured and integrated into standardization efforts. “Near-term” was defined as “within one year,” i.e. a near term solution is one that can be put into production within one year.

The objective to this meeting was as follows:

- a. Agree to work together to define specific opportunities for production interoperation, driven by real, specific applications.
- b. Identify several areas of “low hanging fruit”
- c. Volunteer effort to develop 1-2 page outline of problem space, solution space, and recommended approach to interoperation in each area.
- d. Volunteer effort to refine outlines into specific plans, with milestones, to reach interoperation over the course of 6-9 months.

Each participant introduced himself/herself along with institution and brief thoughts on interoperation needs and opportunities.

## 2 Exploring Areas for Production Interoperation in 2006

Satoshi Matsuoka provided an overview of areas that many bilateral grid project discussions have identified as potential opportunities for interoperation (see Appendix: Introductory Slides).

*Table 1: Areas for Possible Interoperation*

General Area	Score
Authorization & Identity Management	20
Resource and Information Schema and Services	10
Job Submission, Audit, Tracking	13
Data Movement & Management	13
Workflow	4
Co-Scheduling	3
Accounting and Allocations	1

Table 1 shows the general areas discussed. The table also shows results of a rough poll taken by show of hands where each of the participants was asked to indicate his or her selection of the three areas where interoperation would be highest priority for his or her user community, and was potentially achievable within one year at least at a basic level.

Within the top four general areas we discussed specific interoperation components, refining the general area into specific capabilities within that area. The results of these discussions are indicated in Table 2 along with an identified organizer for each.

*Table 2: Specific Topic Areas and Volunteer Organizers*

General Area	Specific Topic	Leader
Motivating Applications and Use Cases	A set of applications that require one or more of the four areas of interoperation, covering all four.	Ray Bair (TeraGrid)
Authorization & Identity Management	Authentication, Authorization, and Delegation	Dane Skow (TeraGrid)
Resource and Information Schema and Services	Mapping between predominant schemas (CIM, Glue)	Satoshi Matsuoka (NAREGI/TIT)
Job Submission, Audit, Tracking	job description language	Steven Newhouse (UK_NGS/OMII)
Data Movement & Management	Data location description and movement	Ruth Pordes (OSG/FNAL)

Additional individuals were suggested for each of these topics, along with general approaches for each area as outlined below. *NOTE: Apologies to individuals whose names appear below but who have not yet been asked to participate!*

## **2.1 Motivating Applications and Use Cases**

The selection of interoperation areas and their prioritization must begin with user need and requirements. Many application projects have been initiated between two or more Grid projects and it is important to use these types of projects to drive interoperation. A set of application and use case scenarios that motivate the need for interoperation must be documented. Many of these were seen during the SC05 conference, where a large number of application projects showed use of multiple grids.

To provide a context to frame the four selected interoperation efforts there will be a team focusing on bringing together a set of representative application use cases. Ray Bair (TeraGrid) will lead this group, working with Victor Alessandrini (DEISA) and John O'Callaghan (APAC)

who agreed to participate. In addition, the following individuals were suggested to join and will be invited to do so: Yoshiyuki Watase (NAREGI), and Vincent Breton (EGEE).

## **2.2 Authorization and Identity Management**

The subject of nearly unanimous interest was in managing identity and supporting secure authorization for users attempting to access resources in multiple autonomous Grid infrastructures. EGEE and OSG have extensive experience in the area of cross-grid authorization and identity management. Dane Skow presented an outline of the EGEE/OSG approach done with Ake Edlund in September 2005 (see Appendix: Introductory Slides).

Dane Skow will work with a team to take interoperation plans developed by EGEE and OSG and use these as a base for general application among multiple grid projects. Individuals suggested to join this team were: Stephen Pickles (UK NGS), Shinichi Mineo (NAREGI) and Von Welch (TeraGrid).

## **2.3 Resource Information Schema and Services**

In order for users to identify appropriate resources within a Grid infrastructure there must be some form of resource information, provided through standard schema and with standard query mechanisms. Most of the represented production grid projects today use some form of the GLUE schema for historical reasons, however CIM is widely adopted within industry as a standard system resource schema, and the organization developing CIM (DMTF) is starting to work closely with the Grid community through its alliance with GGF. NAREGI has experience extending the CIM schema to be applicable to Grids, as well as building an actual distributed information system for grids that can collect information from the information providers, perform translation and store the information into the CIM database, and allow the clients to query the info using the extended CIM schema and the OGSA-DAI service API. A separate activity, primarily in the UK with the UniGridS project, has been looking at the commonalities as well as the differences between Glue and CIM, including possible mappings between them.

Satoshi Matsuoka will work with a team to pursue a Glue/CIM mapping approach. Suggested individuals to be invited to participate in this team included: Jennifer Schopf (TeraGrid), Yuji Saeki (NAREGI), Dave Snelling (UniGridS), Hiro Kishimoto (BusinessGrid), and Sergio Andreozzi (EGEE).

## **2.4 Job Submission, Audit, Tracking**

To submit a task or set of tasks for execution on a resource or set of resources it is essential that there exist some basic common description format. The alternative requires users to learn and track how to describe jobs to execute on the many resources in various Grid infrastructures that

they may need to access. In this area there is substantial adoption, or plan for adoption, of the recently published GGF JSDL specification. Many mappings (such as to Globus or Condor) and extensions have been developed for JSDL already.

Steven Newhouse will work with a team to identify a specific set of JSDL functions necessary for interoperation, and will coordinate with the GGF JSDL working group to ensure support from the standards activity. Suggested individuals to be invited to participate in this team included: Paolo Malfetti (DEISA), Kazu Saga (NAREGI), Mark Green (OSG), Massimo Sgaravatto (EGEE) and Stuart Martin (TeraGrid).

## 2.5 Data Movement and Management

Participants generally found that multi-grid applications require some common method for specifying and moving data. Many possibilities could be pursued in this area, ranging from grid filesystems to high-performance transport, replication, or catalog approaches. The group felt that the key interoperation area would be to support data specification (i.e. location of data) and movement. Most grid efforts plan to support the SRM standard, which is transport-independent however most SRM use is expected to be in conjunction with GridFTP.

Ruth Pordes will lead a team to develop plans for interoperation based on SRM/GridFTP. Suggested individuals to be invited to participate in this team included: Erwin Laure (EGEE), Rhys Francis (APAC), Ari Shoshone (OSG), and Andreas Schott (DEISA).

## 3 Next Steps

Each group organizer agreed to contact team members to verify their willingness to help with the following schedule of action items:

- 1) Develop a 1-2 page draft plan that outlines the problem area, including the user/application capabilities that drive interoperation needs. The plan should also summarize the solution space and recommended interoperation plans for both near term (2006) and long-term (2007 or later, if known) production implementation. These plans may need to specify a timeline for evaluating options and making decisions during early 2006.  
**Deadline: 13-January-2006.**
- 2) Refine this plan based on feedback from the planning group (those who participated in this meeting), resulting in a final draft plan. The final draft should include specific applications that will be enabled along with metrics for determining success.  
**Deadline: 3-February-2006.**



- 3) Present plans for discussion at an open workshop at GGF-16 in Athens, Greece (likely to be held early in the week, e.g. 13-February), refining as necessary based on workshop discussions and interactions with relevant GGF working groups at GGF-16.
- 4) Lead the execution of the plan for interoperation during 2006. We expect that these teams will meet periodically (e.g. at GGF meetings or various grid project meetings) and communicate regularly (via mailing lists and teleconference calls). *The plans developed in the first three steps should outline specific milestones that can be tracked, including metrics for evaluating success. Plans should also include, where applicable, interactions with appropriate standards activities.*

## 4 Glossary and References: For More Information

<b><u>Grid/Organization</u></b>	<b><u>Website</u></b>
APAC	<a href="http://www.apac.edu.au/programs/GRID/">www.apac.edu.au/programs/GRID/</a>
BusinessGrid	<a href="http://www.jpgrid.org/english/">www.jpgrid.org/english/</a>
DEISA	<a href="http://www.deisa.org/">www.deisa.org/</a>
EGEE	<a href="http://public.eu-egee.org/">public.eu-egee.org/</a>
GGF	<a href="http://www.ggf.org">www.ggf.org</a>
GRnet	<a href="http://www.grnet.gr/index.php?language=en">www.grnet.gr/index.php?language=en</a>
K*Grid	<a href="http://www.ksc.re.kr/eng/project/project3.htm">www.ksc.re.kr/eng/project/project3.htm</a>
NAREGI	<a href="http://www.naregi.org/index_e.html">www.naregi.org/index_e.html</a>
US NMI	<a href="http://www.nsf-middleware.org">www.nsf-middleware.org</a>
OMII	<a href="http://www.omii.ac.uk/">www.omii.ac.uk/</a>
OSG	<a href="http://www.opensciencegrid.org">www.opensciencegrid.org</a>
Pragma	<a href="http://www.pragma-grid.net/">www.pragma-grid.net/</a>
TeraGrid	<a href="http://www.teragrid.org">www.teragrid.org</a>
UK NGS	<a href="http://www.ngs.ac.uk/">www.ngs.ac.uk/</a>
UniGridS	<a href="http://www.unigrids.org">www.unigrids.org</a>
<b><u>Technology</u></b>	<b><u>Website</u></b>
CIM	<a href="http://www.dmtf.org/standards/cim/">www.dmtf.org/standards/cim/</a>
Condor	<a href="http://www.cs.wisc.edu/condor/">www.cs.wisc.edu/condor/</a>
Globus	<a href="http://www.globus.org">www.globus.org</a>
GLUE	<a href="http://www.cnaf.infn.it/~andreozi/datatag/glue/">www.cnaf.infn.it/~andreozi/datatag/glue/</a>
GridFTP	<a href="http://www.ggf.org/documents/GFD.47.pdf">www.ggf.org/documents/GFD.47.pdf</a>
JSDL	<a href="http://www.ggf.org/documents/GFD.56.pdf">www.ggf.org/documents/GFD.56.pdf</a>
OGSA	<a href="http://www.ggf.org/documents/GFD.53.pdf">www.ggf.org/documents/GFD.53.pdf</a>
OGSA-DAI	<a href="http://www.ogsadai.org.uk/">www.ogsadai.org.uk/</a>
SRM	<a href="http://forge.gridforum.org/projects/gsm-wg/">forge.gridforum.org/projects/gsm-wg/</a>



## **5 Appendix: Introductory Slides**

Appended are introductory slides used by Charlie Catlett and Satoshi Matsuoka at the start of this meeting as well as slides shown by Dane Skow providing an overview of authentication and identity management approaches.

# Multi-Grid Interoperation

Planning and Exploration of  
Production Interoperation Opportunities

Seattle, Washington, US  
17 November 2005

## Participating Projects

APAC, DEISA, EGEE, K\*Grid, NAREGI, OSG,  
Pragma, TeraGrid, UK NGS

Charlie Catlett  
Director, TeraGrid

17-Nov-2005

Multigrid Interoperation Planning  
Charlie Catlett



# Multi-Grid Interoperation

- In the past 2 years many grid projects - and grid applications relying on those projects - have moved from prototype to “production”
- Increasingly, users want resources from multiple grids and grid projects are having bilateral discussions about support for those capabilities
- Each of our production grid projects is at a different point of evolution due to differing requirements and boundary conditions (funding, local expertise, software selection, etc.)
  - Building out new capabilities in Grid X is easier if adopting a solution proven in Grid Y - and results in greater possibility for interoperation as well.

17-Nov-2005

Multigrid Interoperation Planning  
Charlie Catlett



# Interop{eration, erability}

- “Perfect Interoperability is the enemy of interoperation” (C. Catlett)
  - (adapted from Italian proverb: “Il meglio e nemico del bel bene” - The perfect is the enemy of the good)
  - Order of preference for solutions\*:
    - Very Good
    - Good
    - Best
    - Not Good
    - Horrible

\*from “Selling the Invisible,” Harry Beckwith
- Interoperation is a long term goal
  - It involves very difficult issues
  - It involves many components, each of which need to be interoperable
- Interoperation is a near term goal
  - It involves compromise and cooperation with specific goals - to make something work today
  - Done properly, it should inform us as to how to achieve interoperability in specific areas over the long term, and should not prevent us from adopting interoperable solutions when they become available

17-Nov-2005

Multigrid Interoperation Planning

Charlie Catlett



## Your Turn

- Name, Institution
- Role in your Grid Project
- Thoughts on Interoperation
- Particular area of interest- where do you think we can make the best and most progress now?
- (you can reserve the right to completely change your mind after today's discussions!)

17-Nov-2005

Multigrid Interoperation Planning

Charlie Catlett



# Interoperation Today

- **General Application Types include...**
  - Portal projects allowing users to launch jobs
  - Workflow applications using multiple resources in concert
  - Distributed applications using multiple resources tightly coupled
- **Component Capabilities include...**
  - Authorization, identity management
    - Individuals, communities (VO's)
  - Job submission, audit/tracking
    - Job description language, etc.
  - Coordinated scheduling
  - Accounting, allocations
  - Data movement and remote access
  - Resource discovery
    - Resource description schema, information services
  - Workflow
    - Description, tracking...

17-Nov-2005

Multigrid Interoperation Planning

Charlie Catlett



# Tentative Schedule

- **Today - common vision, volunteering to go further**
  - Decide on 4-6 application-driven interoperation components worth investigating
  - Pairs of volunteers taking each of multiple topic areas and fleshing out the problem space and solution space
- **January 15, 2005 - Draft Plans**
  - Review recommendations, discuss implications, evaluate reality, develop milestones
- **February 13 - open workshop (at GGF-16)**
  - Present plans, get feedback, tune plans, add volunteer *workers*
  - Provide input into relevant GGF working groups
- **March - September 2006**
  - Limited interoperation tests at various venues such as all-hands meetings, GGF meetings, aimed at providing "forcing functions" to help with deadlines
  - Periodic management check to see how things are progressing
- **SC06**
  - A Multi-Grid Interoperation Challenge? Should demonstrate *production capabilities*, not just demos.
  - Reconvene to evaluate progress and determine if this process is useful.

17-Nov-2005

Multigrid Interoperation Planning

Charlie Catlett





# To be or not to be (interoperable)

---The Low and High Hanging Fruits---

Satoshi Matsuoka

Professor, Global Scientific Information and  
Computing Center,

Deputy Director, NAREGI Project

Tokyo Institute of Technology / NII



GLOBAL SCIENTIFIC INFORMATION AND  
COMPUTING CENTER

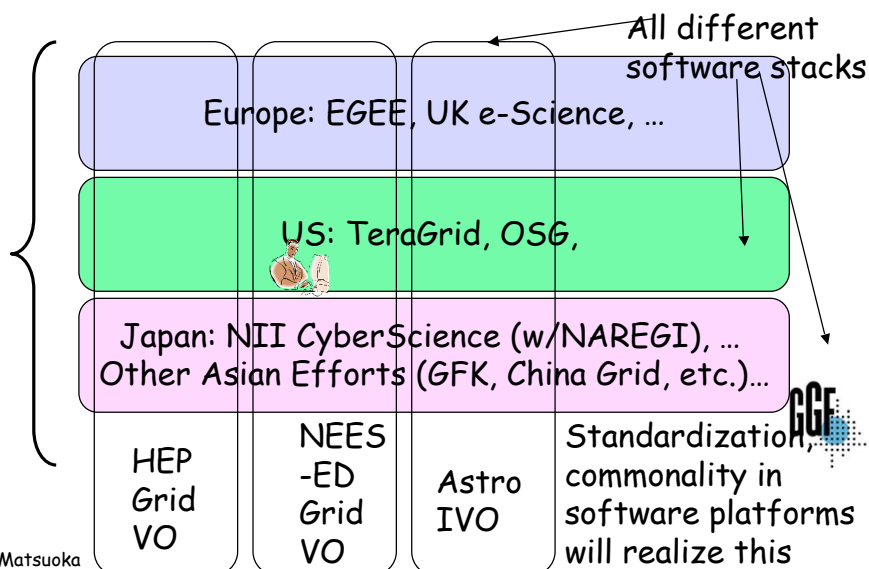
**GSIC**

Satoshi Matsuoka



## The Ideal World: Ubiquitous VO & user management for international e-Science

Grid Regional Infrastructural Efforts  
Collaborative talks on PMA, etc.

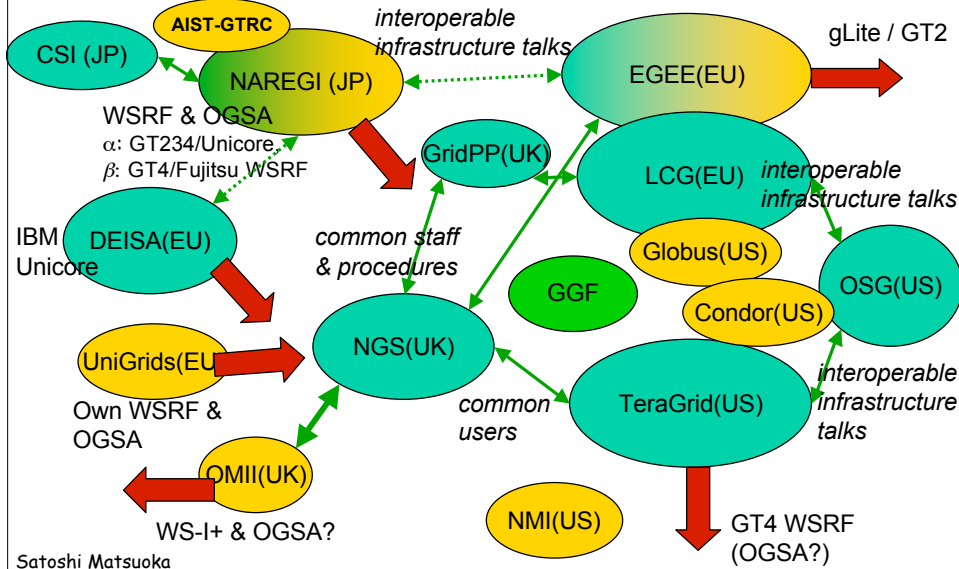


Satoshi Matsuoka



## The Reality: Convergence/Divergence of Project Forces

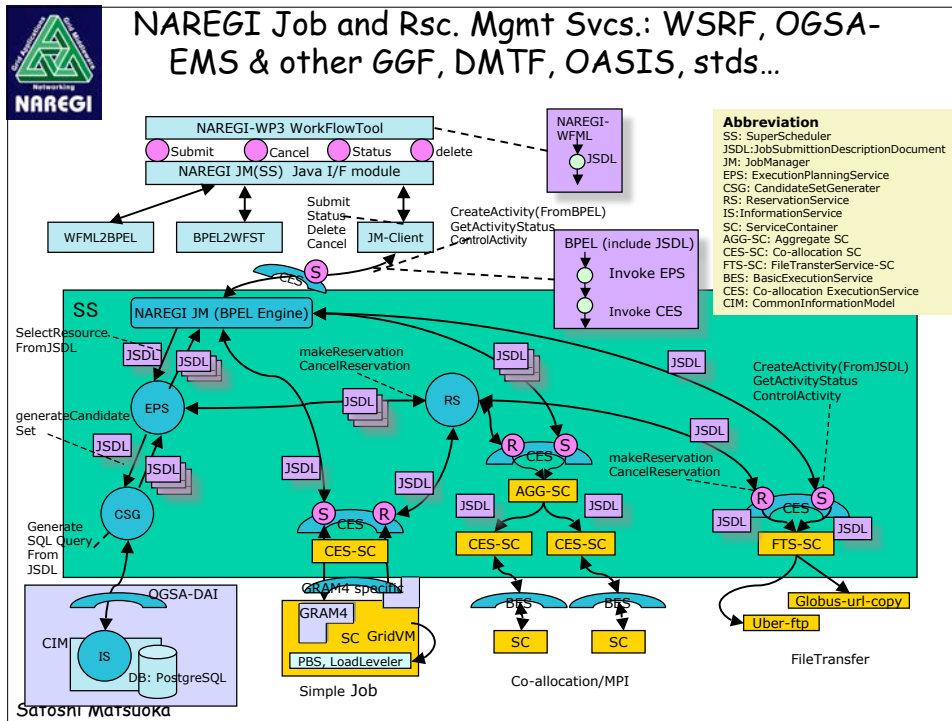
(original slide by Stephen Pickles, edited by Satoshi Matsuoka)



## Challenge: Identifying the Key Grid Technology Areas

- "Agreeing to Agree on what needs to be Agreed first"
  - Essential for interoperability, difficult to change later on
- Key Common Services are (not excluding others)
  - Authorization, identity management
    - Individuals, communities (VO's)
  - Job submission, audit/tracking
    - Job description language, etc.
  - Coordinated scheduling
  - Accounting, allocations
  - Data movement and remote access
  - Resource discovery
    - Resource description schema, information services
  - Workflow
    - Description, tracking...
- Also Identify "Unique Services" pertinent to a particular project and agree to use them if they seem really useful for everyone (but not covered here).

Satoshi Matsuoka



**Authorization, identity management, VOs**

- Short-term:
  - Many seem to be converging to GSI + VOMS + MyProxy (incl. NAREGI beta)
  - Bilateral trusts -> IGTF established to agree on lightweight CA interoperability policies
- Mid-Term:
  - Authorization - XACML?
    - NAREGI uses "lightweight" XACML
  - Identity Mgmt - GridShib?
- Longer-term
  - Web Services Security compatibility
    - SAML 2.0, XAKML, etc.
    - Ubiquitous trust anchors with national-level PKIs (e.g., Japanese UPKI effort - 3 million researchers, students)

Satoshi Matsuoka





## Job submission, audit/tracking Job description language.

- Job Submission
  - OGSA-BES
    - BES almost standard, ref. impl. in UK
    - NAREGI is "almost compliant", currently WS-GRAM + extensions as OGSA-EMS service container
    - Need more service container types (NAREGI has 4)
- Job Description
  - JSDL
    - NAREGI extends JSDL 1.0 with co-scheduling compound document structure, but is upper compat.
    - JSDL used throughout as description document throughout job submission
  - gLite: JDL => JSDL planned?
- Audit Tracking
  - ??? (need resource and workflow agreement)

Satoshi Matsuoka



## Co-Allocation

- Seems to be on everyone's hotlist
- Need either reservation or preemption w/job submission
  - NAREGI currently employs reservation, but is extremely sophisticated
  - Much harder than people think to get it right.
- Intricate interactions with other resource management

Satoshi Matsuoka



## Accounting, allocations

- OGSA-RUS
  - NAREGI employs RUS schema, but stores them as CIM DB in a common Information Service
  - Extended CIM to accommodate Grid accounting

Satoshi Matsuoka



## Data movement, Management

- Some convergence?
  - GGF - Grid FileSystem (GFS), SRM, ...
  - What are really being used?
    - VDT/SRM in EGEE, OSG, ...
    - NAREGI employs GGF-GFS + Data Transfer Service Container as OGSA-EMS service, OGSA-DAI for queries everywhere...
- Need to figure out

Satoshi Matsuoka



## Resource discovery Resource description schema, information services

- GLUE (homebrew) vs. CIM (industry standards)
  - NAREGI implements CIM as core DB with Grid schema extensions, with OGSA-DAI and RUS query interfaces
  - Many projects employ GLUE
    - A few studies to see how GLUE could be embedded into CIM
- What is the best convergence?
  - Query both? Converge to CIM but have GLUE features?

Satoshi Matsuoka



## Workflow Description, tracking...

- Low level agreement on BPEL?
  - But too low level?
  - Lots of dialects
  - NAREGI translates from high-level NAREGI WFML to BPEL with JSDL embeddings
  - Also need to track workflow exec.
  - How do we converge here?

Satoshi Matsuoka



## How do we agree? (technology level)

- Low hanging fruit: Just agree on interfaces, build translators, etc.
  - Lower level substrates different
    - NAREGI employs Globus 4.0 and other svcs.
    - gLite employs Condor, Globus 2 svcs. VDT, etc.
    - Etc...
- Are there lower-level "atomic services"
  - UniGrids identified 5 atomic services
  - Subject to standardization?

Satoshi Matsuoka



## Management and Activities

- Stakeholder Commitments required
  - Both project/institutional and people
  - Persistent/production quality commitment a **MUST**
    - This is not academic research
    - No students---need professionals
    - Corporate buy-ins and involvement
- Various activities and deliverables
  - Meetings
  - Documents
  - Testbeds and Plugfests (e.g. NMI)
  - Policy agreements (a.k.a. IGTF)
  - Identifying Applications (HEP, Astronomy, ES, ...)
- Exploit Opportunities
  - GGF, SC --- others?

Satoshi Matsuoka



But of course I could change  
my mind...

Satoshi Matsuoka

# A Proposal on Interworking

Ake Edlund and Dane Skow

EGEE Meeting  
15 September, 2005

Ake Edlund; Dane Skow

## Service Specifications

- All service interface specifications have written specifications
  - Pointer to authoritative document with product
- Those internal to service documented with service
- Those internal to project documented with project
- Those exposed for grid interop documented in GGF

Ake Edlund; Dane Skow

## Interop agreements list

- GSI/SSL Authentication
  - User identification and authentication
- Authorization Attributes (VOMS)
  - VOMS proxy format and symantics
  - Vincenzo will update documentation
- Delegation
  - Olle will work on restarting team
- SUExec callouts
  - Required for late binding
  - Dane and Gerben will follow up

Ake Edlund; Dane Skow

## Interop Agreements

- Proxy Redlegation (not required)
  - Redlegation is the responsibility of the WMS
- Authorization Policy Statements
  - Optimization, not requirement
- What needed for auditing/accounting ?
  - Agreement on account records (Matt Thorpe)
  - Request identifiers ?

Ake Edlund; Dane Skow



## Make these lists public

- We use GGF as intergrid info exchange
- We work partnerships in pairwise meetings like MWSG

Ake Edlund; Dane Skow