CHALLENGERS

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The standards roadmap to international grid interoperability by 2020

Conclusions of the fifth consultation workshop
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Information Society Technologies

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When researchers require access to resources that they cannot provide themselves they must outsource the provision – access to extra computational or data storage resources, access to specific data sets, or access to experimental facilities. In business, a manufacturer will outsource the supply of components to other businesses which will in turn outsource the supply of smaller parts – thereby complex supply chains are created. This outsourcing can take place between enterprises, or across large enterprises. Whenever provision is outsourced, there is a reduction in the immediate control of the ultimate manager, and therefore an increase in the risks of the activity failing. Grid technologies are intended both to provide a computational means to reduce these risks, and to increase the efficiency of the management of resources which are operated locally.

Grid technologies build upon service oriented architectures (SOA) of individual services that can be composed into large parallel computations, sequential workflows of Web Services, or a combination of the two. SOA provide clearly defined services operating under the hardware and software environment of the provider, where the quality of the service provided can be clearly assured to users. Grids add a layer of middleware upon the Web Services which manages the interaction of the composed services, monitoring service delivery and quality to the contractually agreed assurances. The assurances act as trust substitutes for users who do not have established relationships with the service providers, to reduce the risks in outsourcing services. SOA and grid technologies should therefore foster the academic and business collaborations required to create the critical mass, and complex supply chains needed to compete in our global marketplace.

The business relationships established may be long term design and manufacture, or short term information aggregation; the topology of the relationships may be those of supply chains, hub and spoke etc..; the legal form of the relationship may be supplier contracts, partnerships, or shared risk virtual organizations. The technology to support this vision of a global automated business environment will need to be sufficiently flexible to support all these alternative business relationships; it will need to be consistent with the various international legal environments; it will need to be secure enough to be trusted by businesses and not breach individual privacy; and most of all it will have to provide the correct balance of automated and human roles with interfaces that are usable for each person involved to undertake their role. Grid technologies are today used by the academic community to share resources in national and international e-infrastructures supporting collaborative scientific research projects. Grid technologies are also used to support enterprise wide interoperation in businesses where services are provided by widely distributed parts of an enterprise between which there may be no established collaborative experience or trust. Technologists expect Grid technologies to be more widely adopted for inter-enterprise interoperability, initially in market sectors with supply chains and collaborations which are intensively information based, such as finance, engineering design and pharmaceutical development.

To move from academic, and intra-enterprise grids to interoperable inter-enterprise business grids requires the technologies to become standardised and competitively available from competing suppliers – businesses do not wish to reduce the risks of collaborating, only to increase the risks and cost of being tied to a single ICT supplier.

This report describes a roadmap for the standards required for grid technologies to move from the current position to achieve interoperable inter-enterprise grids. The report summarises the conclusions of the fifth consultation workshop organised by the EU funded Challengers project in order to provide guidance to the EU and the ICT research community in planning future work programmes, and future research proposals.

Several roadmaps have recently been produced planning the future of grid technologies which were used as input to the workshop reporting here. These included those from the e-IRG, CoreGrid, NESSI, the ECHOgrid and the Challengers project.

The current position: 2007

Considerable progress has been made in the development and use of SOA and Web Service technologies in the 10 years to 2007. Global companies such as Amazon and eBay take a large proportion of their revenue from buyers accessing third party suppliers from their portals through web service interfaces. Software vendors such as SAP and Oracle are decomposing their complex monolithic Enterprise Resource Planning (ERP) Systems into components which can be distributed within enterprises and allow them to view into those of other companies to increase the transparency of supply chain management. ICT providers such as Sun, HP and IBM provide data centres accessible through Grid technologies

for peak demand applications such as the rendering of animated films. Providers such as Amazon, Oracle and Google provide “cloud” computing resources to accommodate peak computing demands from enterprises accessible through Web Services. Academic researchers across the world share computing resources through Grids such as EGEE in Europe, CNGrid and ChinaGrid in Chain, Naregi in Japan, Teragrid and Open Science Grid in the USA. These successes of Grid computing, SOA and web services have reduced computing costs, increased the utilisation of computing centres, and increased collaboration, resulting in new science and successful business.
Despite these advances in both the academic and commercial world there are serious problems with grid computing today:

Too many incompatible Grid middleware solutions

Each of the main commercial grid solutions and those from different countries’ academic communities (e.g. Scandanavia – ARC; USA – Globus; Japan – Naregi; China – Crown; Germany – UNICORE; Europe - gLite)uses its own middleware, which are incompatible in many ways. Although there are commonly accepted Web Services standards from W3C which defined the SOAP exchange format and WSDL format for describing Web Services, standards from OASIS which define the security of Web Services (WS-Security, XACML, SAML) , as well as those from the OGF which define the agreements between services that constitute the core assurances of the Grid (WS-Agreement) with the architecture (OGSA) and information model for monitoring and accounting (GLUE), these are not always adopted by each middleware solution, and those solutions have become incompatible with each other. This issue is being addressed by the OGF-GIN activity between the main academic grids, but there is still considerable division at the higher layers of the stack in the commercial solutions.

Too many bodies appearing to standardise Grid technologies

Among the bodies which are developing standards related to grids are: IETF, W3C, OASIS, ETSI and the Open Grid Forum (OGF). Between them these appear to be producing too many, duplicated, overlapping, and contradictory standards. OGF is emerging as a modelling and framework establishment organisation rather than one which provides detailed standards, while OASIS is emerging as one which defines early versions of standards or peripheral standards which do not require the heavyweight standards process of IETF or W3C. The role of ETSI is still not clear, although as Grid provision becomes a significant business for telecom companies their experience in this domain may well be significant in mediating between these IT standards and telecoms standards from the ITU.

Uncertain business model

The outsourcing of computing effort and storage has been addressed by several technologies and business models in the last few years: Application Service Provision (ASP), cloud computing, services on demand etc… Following the introduction of Amazon and Google into this marketplace, there do appear to be emerging standard units of charging in the form of CPU hours per year, and terabytes of data storage per month. However, the charging unit for database storage and access, and application use are still unclear. The cost of security & quality monitoring, billing and accounting is becoming an increasing proportion of the costs of Grid computing above the web services that provide simple computing resources.

The Grid brand.

As a result of the competing, incompatible Grid solutions, and the proliferation of standards, and the competing business models, over the last 10 years the Grid brand has become confused and tainted. By 2007, most companies are moving away from it, and branding products and services as virtualisation, cloud computing etc…

Uncertain application licensing conditions

The benefit of the SOA model beneath grid technologies is that assurances can be made by the service provider about the performance of the service offered. If this service is a simple computing service, then these assurances refer to the availability and performance on the computing resource. If the service is an application then these assurances refer to the performance of the application. If the service is an application, then it should be suitably licensed by the service provider. However, when users run their own applications on simple computing services, they are responsible for licensing the application. In both cases there is considerable variation in the licensing conditions for different applications to be run on the licensee’s computers, or used by the licensee or to be used by others elsewhere. This license variation needs to be addressed, and licence details available to users as part of the service assurances.

Energy costs and environmental impact

Computing costs over the years have been dominated by the costs of hardware, staff, or software. Currently, hardware costs are still falling, staff costs are controlled, and software costs are fairly stable. The dominant rising costs are those of energy in operating and cooling computer centres, and in the environmental impact of those data centres. This shift in the cost base of computing will have an impact on the centralisation and location of future computing centres, and therefore act as a driver towards large data centres where energy costs can be minimised with Grid solutions for access, and away from increasing the computing power of thousands of desktop machines in an enterprise. This centralisation is intended to increase utilisation rates from the current 50% up to above 90% by 2020, thereby reducing energy costs and CO_2 emissions.

Service description, discovery, composition, and end to end assurances

Each service in an SOA needs to be described in a directory so that users can find it. The description needs to cover what is does, when it will deliver, its cost, its quality and its security measures. There are many academic solutions to this description and directory problem which allow services to be described, discovered in directories, composed together into workflows, and even sometimes have the assurances on each service composed into assurances of the end to end workflow. However, many grid systems do not address anything beyond the simplest descriptions, and very few provide directories which support assured composition. This problem is generally referred to as one of *semantics* which is prone to grand academic solutions which do not address the evolution of business solutions. Many advanced technologies using agents and brokers have been demonstrated operating over services described in directories, but until common descriptions are adopted in open directories there is no environment for these technologies to operate in. To enable inter-enterprise Grids, the business evolution of a solution to this problem must be addressed, and must be standardised to avoid the fragmentation of solutions.

The vision: Global Grid for business by 2020

New network and service infrastructures will emerge replacing the current Internet and Web. This "*Future Internet*" will feature almost unlimited bandwidth capacity, magnitudes of higher computing performance, wireless access anywhere, trillions of devices interconnected, integrated security and trust for all parties, and adaptive and personalised services and tools such as 3D semantic-based browsing systems.

These developments are driven by wider and different forms of use of Internet and Web technologies some of which we see already emerging with e.g. Web 2.0 applications, the "*Internet of Services*" and "*Internet of Things*". Grid technologies provide the management mechanism for the "*Internet of Services*" enabling them to be advertised, aggregated into workflows, operated under established security and quality of service agreements, and financially accounted for.

The Grid for business would enable businesses to make joint use of resources and services in order to exploit new business opportunities quickly, and flexibly. The Grid would be a significant tool where the business opportunity required the sharing of resources for evidence based decision making in the public sector, or the creation of content in sectors such as finance, energy, pharmaceuticals, and engineering design.

The future networked services will be established around the aggregation of multiple building blocks available from multiple sources and vendors. Clear emphasis must therefore be placed on ensuring interoperability through agreed interfaces through industry standards. Technical interoperability must be complemented by semantic interoperability, enabling the integration of business or social processes stemming from heterogeneous environments at the enterprise or consumer level.

The Grid Standardisation Roadmap

The purpose of this roadmap is to link decisions about research funding, to common standardised solutions, so that European business collaborations can be more profitable with less risk, and thereby make the European knowledge economy competitive in the global marketplace.

Standards take about 3 years to pass through standards bodies. It usually takes about a year to get the standards body to agree that a piece of work is mature enough, sufficiently important, and has enough interest from actors to establish a group to draft a standard. A research project will take 3 years to undertake, following a one year period of a call for proposals, proposal writing, submission and evaluation. Therefore from the publication of a call for research proposals to an agreed standard will take 8 years, with the transition from research to standardisation at about 4 years. Exceptional research projects have developed technologies to start standardisation in the second year of the project, reducing the total cycle time to 6 years.

Therefore anything becoming a standard by 2012 must already be on the standards agenda now, while those standards to be published in 2016 will be as a result of calls in 2008, and finally standards published in 2020 will arise from calls for research proposals before 1015 at the latest, more likely in the first call of the 8th Framework Programme. The roadmap is divided into these three stages to plan the route to the vision for 2020.

Grid Standardisation Roadmap 2007–2012

Several core Web Service and Grid technologies that are currently undergoing standardisation are expected to complete the process in this time frame: The OGF WS-Agreement for service metrics, service level agreements and contracts; the OGF Basic Execution Model; the OGF GLUE information model; the OGF OGSA JSDL job description language for submitting jobs across multiple simple compute services; and W3C SKOS as a simple knowledge representation language for thesauri and vocabularies where the full complexity of an ontology language is not required.

Semantically rich descriptions of services for discovery, composition and end to end assurance are well addressed in the current FP7 projects: SENSEI, MOMENT, SOA4All, SERVFACE, SHAPE based on the OMG UML Profile and Metamodel for Semantically-enabled Heterogeneous service Architectures, SERVICE Web 3.0, VICTORY, COIN, and iSURF based on the UN/CEFACT Core Component Technical Specification. Although SHAPE is implementing the OMG UPMSHA submission, and iSURF is based on the existing UN/CEFACT vocabulary, both of which are building on standards, the other projects do not aim to have a significant impact on standards. The OMG UPMSHA builds on both the OMG UML PMS standard and the IBM and University of Georgia 2005 submission to W3C of WSDL-S which enables semantic annotations to WSDL service descriptions using concepts defined in the 2004 W3C member submission OWL-S for an ontology for service properties. However, none of these submissions were actually judged mature enough to develop into standards, because the business community could not see an evolutionary path to them from where they are now. Although the need for these semantic web and semantic grid technologies is recognised as necessary in order to achieve the vision, it is also required that they can be presented to the business community as mature enough to standardise, which so far they have not.

Current grid technologies re-use services to compose workflows, and there is a growing need in this timescale to address libraries of workflows which can themselves be re-used.

It is expected that new industries will evolve from Web 2.0 technologies and social networking sites which move towards the storage of rich life records for people. These will add pressure for the standardisation of representations of life records, probably using RDF based technologies such as FOAF, so that customers can port their records from one networking site to another. Such developments will also drive the development of standards for privacy information, again based on semantically rich, machine understandable descriptions.

The biggest driver for standards in this period will be usability of the Grid. This is a rich area going beyond end user interfaces to include accounting information, and the usability of the semantically rich descriptions. It is hoped that if the information can be made more accessible and usable by human users, then its value can be more easily justified to the business community, leading to its standardisation.

Grid Standardisation Roadmap 2013-2016

It is acknowledged that the currently used UDDI registries standardised by OASIS in 2003 are not fit for their current purpose. There is a need to standardise registries for semantically rich service descriptions, and it is expected in this period, but the main constraints are on the standardisation of the semantically rich service descriptions themselves in the previous period, and in clarifying more exactly the role of registries for intra- and inter-enterprise grids.

End to end security and quality of service are recognised as technologies which are expected to achieve standardisation in this time frame, but without the previous standardisation of the semantically rich descriptions of services, their quality and security properties, there is no basis on which to standardise it. However, there are clearly many technical issues and issues of risk management associated with end to end quality of service and security which need to be addressed in this time scale.

Other issues which are expected to achieve standardisation in this period include:

- Policy languages & ontologies for controlled vocabularies
- Linking policies & workflows
- Semantics are required for increased expressiveness
- Better self-description of services / resources
- Auditing, pricing models, utility billing etc.
- Regulation of reputation/service registries like credit rating agencies
- SLA & contracts addressing variations in legal jurisdictions

Grid Standardisation Roadmap 2017-2020

Issues which are expected to achieve standardisation in this period include:

- Business rules (respecting / addressing legislation & regulation)
- Enhanced service descriptions
- Accounting to control usage optimisation, reduction of power consumption etc
- Privacy and confidentiality
- Usage of highly aggregated & composed services
- Trust of composed services & workflows
- Accountability of composed services
- Legal framework and legislation for service guarantees & regulation
- Sensor input to services – Internet of things

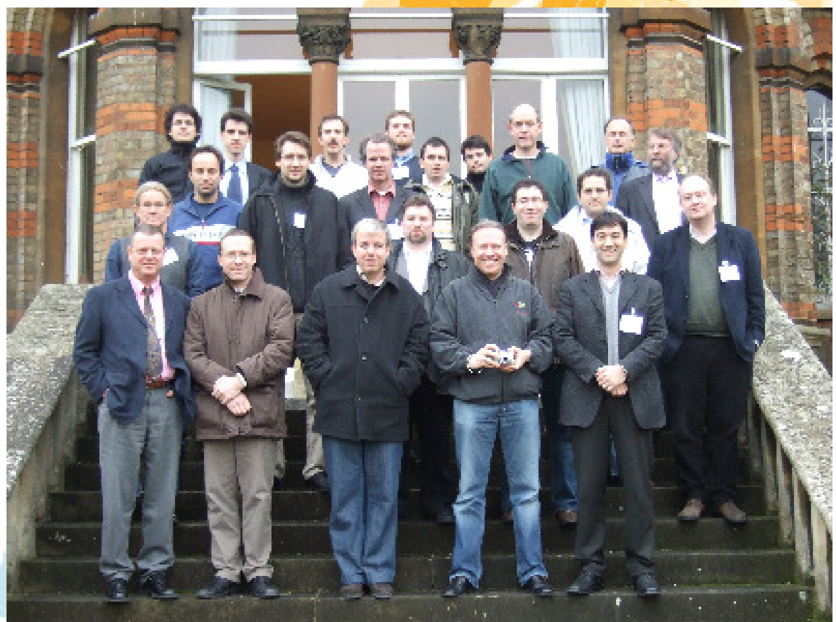
Further Workshop Information

The full workshop programme, presentations and position papers submitted by participants are available at:

http://www.w3c.rl.ac.uk/pastevents/ChallengersWorkshop/

The fifth Challengers consultation workshop

The fifth Challengers workshop was organised by the Science and Technology Facilities Council at St Hilda's College, Oxford, UK. The following invited experts attended the workshop and contributed to the conclusions reported here:



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