TripCom

Triple Space Communication

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Deliverable

D9.4

Analysis of Mutual Influence of Grid and Triple Space Technologies

Hans Moritsch
Daniel Martin

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Executive Summary

The aim of this deliverable is to investigate the mutual influence of Grid and Triple Space Technologies. For this purpose, it orientates itself by the structure of functions and areas of the Open Grid Forum (OGF), which represent relevant aspects of Grid Computing.

After giving an overview of Grid Computing, overlappings and interferences of Grid and Triple Space Technologies with respect to these areas are examined. Whereas potentially technologies of the one group could serve in the realization of the other, documentation of current mutual influence is hardly to identify.

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Authors (Partner)	Hans Moritsch (TUW) Daniel Martin (USTUTT)			
Resp. Author	Hans Moritsch		**E-mail**	hans@complang.tuwien.ac.at
	Partner	TUW (Vienna University of Technology)	**Phone**	+44 (1) 58801-18517

Abstract (for dissemination)	This deliverable investigates the mutual influence of Grid and Triple Space Technologies with respect to the various aspects of Grid Computing which are subject to the Open Grid Forum working groups.
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Project Consortium Information

Acronym	Partner	Contact
Semantic Technology Institute Innsbruck http://www.sti-innsbruck.at	STI	Prof. Dr. Dieter Fensel Semantic Technology Institute (STI) Innsbruck, Austria E-mail: dieter.fensel@sti-innsbruck.at
National University of Ireland, Galway http://www.deri.ie	NUIG	Dr. Laurentiu Vasiliu Digital Enterprise Research Institute (DERI) Galway, Ireland Email: laurentiu.vasiliu@deri.org
University of Stuttgart http://www.iaas.uni-stuttgart.de/	USTUTT	Prof.Dr. Frank Leymann Inst. für Architektur von Anwendungssystemen (IAAS) Stuttgart, Germany E-mail: frank.leymann@informatik.uni-stuttgart.de
Vienna university of Technology http://www.complang.tuwien.ac.at/	TUW	Prof.Dr. eva Kühn Institut für Computersprachen Vienna, Austria E-mail: eva@complang.tuwien.ac.at
Free University Berlin http://www.ag-nbi.de/	FUB	Prof. Dr.-Ing. Robert Tolksdorf AG Netzbasierte Informationssysteme Berlin, Germany E-mail : tolk@inf.fu-berlin.de
Ontotext Lab, Sirma Group Corp. http://www.ontotext.com/	ONTO	Atanas Kiryakov, Vassil Momtchev, Ontotext Lab, Sirma Group Corp. Sofia, Bulgaria E-mail: vassil.momtchev@ontotext.com
Profium OY http://www.profium.com/	Profium	Dr. Janne Saarela Profium OY Espoo, Finland E-mail: janne.saarela@profium.com
CEFRIEL SCRL. http://www.cefriel.it/	CEFRIEL	Davide Cerri CEFRIEL SCRL. Milano, Italy E-mail: cerri@cefriel.it
Telefonica I+D http://www.tid.es/	TID	Noelia Pérez Crespo Telefonica I+D Madrid, España E-mail: npc@tid.es

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List of Abbreviations

API	Application Programming Interface
DCM	Digital Contents Management
DAM	Digital Asset Management
DoW	Description of Work, TripCom Annex I.
GGF	Global Grid Forum
OGF	Open Grid Forum
OGSA	Open Grid Services Architecture
OGSA-DAI	OGSA Data Access and Integration
OGSA-DQP	OGSA Distributed Query Processing
OGSI	Open Grid Services Infrastructure
OWL	Web Ontology Language
OWL-S	Semantic Markup for Web Services
RDF	Resource Description Framework
RDFS	RDF Schema
TripCom	Triple Space Communication
TSC	Triple Space Computing
TS API	Triple Space API
UC	Use Case
UML	Unified Modelling Language
W3C	World Wide Web Consortium
WP	Work Package
WS	Web Service
WSDL	Web Service Description Language
WSML	Web Service Modelling Language
WSMT	Web Service Modelling Toolkit
WSMX	Web Service Execution Environment
WSRF	OASIS Web Services Resource Framework
WSDM	OASIS Web Services Distributed Management
XML	Extensible Mark-up Language

1 Introduction

Since the mid nineties, when first large-scale applications we would nowadays call Grids were developed, the Grid has gained growing attention. Communities were founded, standards were developed and more importantly, emerging technologies were adopted so that Grid technology can be integrated into existing environments. Here, the most significant trend has been the transition towards a service oriented model and its convergence with Web services. The Grid itself covers a broad area of technology and standards, best described by Ian Foster and Carl Kesselman in [6]

> "Grid technologies provide mechanisms for sharing and coordinating the use of diverse resources and thus enable the creation, from geographically and organizationally distributed components, of virtual computing systems that are sufficiently integrated to deliver desired quality of service."

The primary objective of Triple Space Communication as formulated by the TripCom project itself is [9]

> "the development of a highly scalable, semantically enhanced communication infrastructure which is the result of the integration of Tuple Space, Semantic Web (triple), and Web service technologies".

By comparing the goals of TripCom (for details on the model behind, the interested reader is referred to [16]) to what the Grid provides, it is clear that these technologies share similarities in both the functionality provided and in particular in some fundamental technologies such as Web services The aim of this deliverable is to identify and analyze similarities of the technologies, based on the structure of the workgroups of the Open Grid Forum (OGF). The Grid is a manifold subject, the OGF as the community behind captures its aspects and divides them into meaningful pieces in the form of workgroups. We reuse this structure for our analysis of the topic by using the results of each of the workgroups and analyze similarities and mutual influences with what we provide in TripCom.

The deliverable is structured as follows: in Chapter 2.1, we give an overview of the Grid, technologies involved and explain our approach for identification of interelationships with TripCom. Chapter 3 goes through the structure of the OGF workgroups, discusses mutual influences following the approach as described in Chapter 2.1. Chapter 4 concludes our findings.

2 Grid Computing

2.1 Overview

The term *Grid* was coined in the mid nineties to denote a distributed computing infrastructure for science and engineering in order to provide concepts and technologies enabling resource sharing within scientific collaborations. This initiative was born from the increasing need for large scale collaborations, i.e. no single research institution is able to provide the amount of required storage or computing power for large bioinformatics or high energy physics experiments. The idea was to collaborate on a global level, sharing resources needed to carry out computationally- or data intensive research using a network of interconnected sites that is comparable to the electrical power grid. According to [6], large-scale scientific experiments require "coordinated resource sharing and problem solving in dynamic, multi-institutional virtual environments", and a system termed as a Grid has to fulfil the following three criteria:

Coordination of distributed resources A Grid integrates and coordinates resources that live within different control domains – for example, the user's desktop versus central computing, different administrative units of the same company, and/or different companies – and addresses the issues of security, policy, payment, membership, and so forth that arise in these settings.

Use of standard, open and general purpose protocols and interfaces A Grid is built from multipurpose protocols and interfaces that address such fundamental issues as authentication, authorization, resource discovery, and resource access. It is important that these protocols are standard and open.

Deliver "non-trivial" quality of service A Grid allows its constituent resources to be used in a coordinated fashion to deliver various qualities of service—relating, for example, to response time, throughput, availability, and security—and/or coallocation of multiple resource type to meet complex user demands, so that the utility of the combined sytem is significantly greater than that of the sum of its parts.

The evolution of Grid technology in the past can be divided into three distinct phases (see Figure 2.1). Originally, there were custom solutions built by individual research institutions to solve high performance computing problems in a distributed manner. In order to collaborate with other research institutions, applications were built on top of custom protocols leveraging internet technologies, with limited functionality in the area of security, scalability and robustness. Interoperability of similar systems was not given, since they all were custom solutions.

Phase two was started by the development of the Globus Toolkit [5] as a *de facto* standard for Grid computing. It achieved wide acceptance, although its protocols were still proprietary, yet partially built upon standard internet formats. The Globus Toolkit provides solutions to common problems like authentication, resource discovery and resource access, it was never subject to standardisation and approved by a formal standardisation organisation.

Interoperability was the main reason to drive the development of the Open Grid Services Architecture [7] (OGSA), and the establishment of a community, the Open

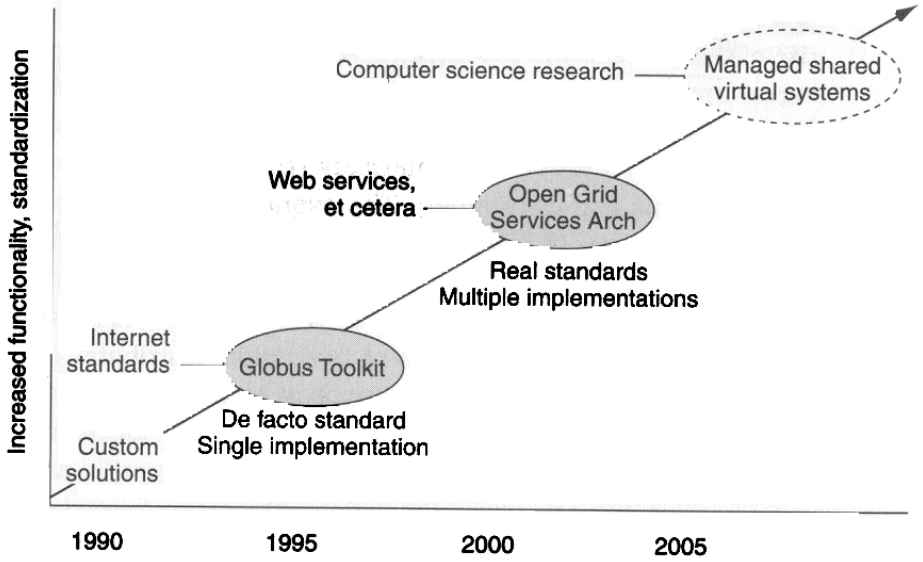

Figure 2.1: The evolution of the Grid [6]

Grid Forum[1] (OGF), to maintain and foster Grid technologies and their acceptance. The OGSA provides standardized interfaces and services to address many technical challenges of the Grid, such as resource discovery and allocation. Through the use of Web services, Grid technology technology is aligned with leading industry initiatives and integrates well into a Service Oriented Architecture (SOA). Web service technology is not only utilized, but also forms the foundation for OGSA Grid Services and their protocols, e.g., the Web Services Resource Framework[2] (WSRF), a set of Web service specifications which describe and manage the lifecycle of resources in the Grid.

2.2 Analysis Approach

So far, we briefly introduced Grid technology and outlined its foundations from a very high-level point of view. Similarities to TripCom may already be visible, e.g. both technologies are aiming at large-scale deployments, while still providing non-trivial Quality of Service (QoS) and are tightly integrated into the Web service standards stack. In order to provide a structured approach for our analysis we orientate ourselves by the structure of the OGF groups to cover all aspects of the Grid. go from there and discover similarities, differences and mutual influences in form of related projects, technologies, ideas and use cases. Each of the OGF groups is analyzed using the following structure.

Related Work in Grid Technology This section gives an overview over related work in Grid technology in the analyzed field specified by the respective OGF work group. Major work and their key contributions are summarized in order to allow for precise assessment.

Related Work in Triple Space Technology In this section, related work and findings in TripCom – if applicable – are presented.

[1] `www.gridforum.org`, `www.ogf.org`
[2] `www.globus.org/wsrf`

Assessment In this section, we assess the work presented before, try to identify possible interrelationships and conclude with a final judgement. Interrelationships can be e.g. the recommendation of reuse of technology/knowledge of the Grid in TripCom or the other way around. The final judgement gives a recommendation how to deal with the findings, e.g. monitor the respective group of researchers, propose to contact persons from that area, propose to disseminate new findings in the respective area or simply declare the identified areas as irrelevant for each group.

3 Open Grid Forum Working Groups

Our systematic investigation of potential mutual influence of Triple Space and Grid technologies is based on a classification of aspects of Grid computing as expressed by the structure of OGF's working groups. The OGF is a forum of users, developers, and vendors for the development of open standards and the promotion of best practices for Grid computing. The OGF is divided into a number of working groups organized in three major *functions* (each of which consists of different *areas*):

- the **E-Science** function for working with scientific, engineering and education communities,
- the **Enterprise** function for working with business, IT and vendor communities,
- the **Standards** function for developing architectures and specifications supporting the interoperability of Grid software.

In the following, the groups are presented as described in the OGF's list of functions, areas and groups [13].

3.1 E-science Function

The following groups perceive the various requirements of E-science.

3.1.1 Community Affairs Area

3.1.1.1 Build, Test and Certification of Grid Software

This group considers best practices of building, testing and the certification of Grid software, including middleware and applications deployed on the Grid, and adresses also tools and techniques currently used for this purpose. In particular, it aims at

- identifying the challenges in building and testing complex Grid software,
- investigating current release procedures and
- the role automation plays in current build and test procedures

Related Work in Grid Technology

- The ETICS[1] project ("eInfrastructure for Testing, Integration and Configuration of Software") aims at helping software developers, managers and users to better manage complexity and improve the quality of their software. It allows for fully automating software builds and tests and provides software professionals with an out-of-the-box build and test system, powered with a build and test product repository. For each build and test the following metrics are automatically calculated: lines of code, code coverage, complexity, coding convention.

[1] eu-etics.org/

- Metronome/NMI[2] is an execution engine internally used by ETICS to manage remote build and test jobs on different platforms. It is a distributed, multi-platform framework designed to provide automated software building and testing capabilities to a variety of Grid computing projects.
- OMII-Europe[3] is a project which has been established to identify key software components that can interoperate across several heterogeneous Grid middleware platforms. It affirms open standards and open source and has chosen particular open standards for the Grid that are assumed essential for achieving interoperability across global resources. It focuses on re-engineering of software components rather than on the development of new software.

Related Work in Triple Space Technology Currently, no comparable attempts can be identified.

Triple Space - Grid Possible interrelationships include the use of Triple Space in the implementation of the methodologies and tools described as well as in the coordination of large scale testing activities.

Grid - Triple Space The approaches described can possibly applied to Triple Space software in a similar way as to Grid software.

Final judgement Monitor

3.1.1.2 Education and Training

The purpose of this group is to bring together practitioners in grid-related education and training to share and develop best practice, to stimulate greater investment in Grid-related education and training and above all to build a mutually supportive community of Grid trainers and educators.

We do not view education and training in Grid computing as part of Grid technologies as such. Hence, besides suggesting a general potential of Triple Space for education and training purposes, we do not further investigate this interrelationship.

3.1.1.3 Grid Reliability and Robustness

This research group is addressing reliability and robustness issues in industrial and scientific Grid systems developed on the basis of Web Services and Grid specifications.

The scale of Grid computing systems is expected to grow dramatically as Grid technology spreads to industrial use. Operational Grid systems are likely to be subjected to volatile and uncertain conditions that potentially endanger or severely degrade their effectiveness.

Mechanisms for improving reliability and robustness in Grid computing systems include Grid FTP, Grid monitoring services, Grid replication services, checkpointing and recovery services, autonomic computing services as well as mechanisms for maintaining consistent system and component states though time.

[2] nmi.cs.wisc.edu/
[3] omii-europe.org/OMII-Europe/

Related Work in Grid Technology Research in this group[4] focuses on

- developing test methods and metrics to evaluate Grid systems reliability and robustness, including the ability of Grid systems to detect, and respond to various kinds of failures, such as failures of individual components, links, as well as entire subnetworks;
- defining benchmarks, minimum performance levels and thresholds for Grid system reliability and robustness (e.g., it will be important to understand if an increase in the size of Grid system, both in terms of numbers of nodes and workload, leads to unexpected behaviour that impair reliability);
- specific issues such as evaluation of the stability of service interface versions (for Grid and Web service) that may differ across a network, whose interactions may result in unpredicted instability.

A survey of the state of current work in Grid system reliability is given in a draft [4].

Related Work in Triple Space Technology Currently, no comparable attempts can be identified.

Triple Space - Grid Triple Space can be used in the implementation of the described approaches of evaluating and improving reliability, e.g., for maintaining knowledge about the system.

Grid - Triple Space The same reliability problems which arise in Grid computing, apply in principle to Triple Space, and hence the approaches to solving them.

Final judgement Monitor

3.1.2 Grid Operations Area

3.1.2.1 Certificate Authority Operations

The purpose of this group is to develop operational procedures and guidelines that facilitate the use of X.509 and other technologies for cross Grid authentication. It is concerned with the organization of operational aspects of cross Grid authentication. Documents currently under the publication process

Related Work in Grid Technology

- The Grid Certificate Profile[5] provides a guidance and rationale for naming and extensions in X.509 certificates, for CAs and end-entities.
- The Audit Guidelines[6] provide guidelines for auditing CAs and includes an auditing check list.
- The Authentication Service Profile[7] states the definition of an authentication profile, and requirements for writing authentication profiles.

[4] gridreliability.nist.gov
[5] https://forge.gridforum.org/sf/go/doc13741
[6] https://forge.gridforum.org/sf/go/doc4858
[7] https://forge.gridforum.org/sf/go/doc4856

- The Relying Party Defined Namespace Policies[8] identifies the requirements on the expression of the namespace constraints policy and on the processing and interpretation semantics of the policy by the relying parties.

Related Work in Triple Space Technology X.509 certificates and certificate authorities are central in TripCom WP5 "Security and Trust".

Triple Space - Grid The security approach of Triple Space as developed in TripCom [8] can be examined with regard to its applicability to Grid computing.

Grid - Triple Space See above, vice versa.

Final judgement Monitor

3.1.2.2 Grid Interoperation Now Community

The purpose of this group is to coordinate a set of interoperation efforts among production Grids interested in interoperating in support of applications that require resources in multiple Grids. The results of the work is expected to lead to a more seamless usage of different Grid infrastructures by applications.

Currently there is no direct indication of a mutual influence of these techniques and Triple Space, therefore no further analysis has been undertaken.

3.1.2.3 Production Grid Services

The purpose of this group is to develop guides to organizations moving a Grid to the persistent level. It explores new paradigms in supporting Grids that aspire to become large scale Grids with a large user- and application base, in particular when moving Grid testbeds to production environments.

Also with this group there is currently no indication of a mutual influence of its topics and Triple Space, therefore no further analysis has been undertaken.

3.1.2.4 Remote Instrumentation Services in Grid Environment

This group explores issues related to the exploitation of Grid technologies for conducting and monitoring measurement tasks and experiments on complex remote scientific equipment. It aims at bringing together various existing approaches in defining remote access interfaces to sophisticated laboratory equipment and integrating scientific instruments with the Grid. This includes the systematic identification of instruments and corresponding user communities, the definition of their requirements as well as careful analysis of the remote instrumentation synergy with next-generation high-speed communications networks and Grid infrastructures.

No evidence has been found for a mutual influence of this group's requirements and Triple Space.

[8] `https://forge.gridforum.org/sf/go/doc4857`

3.1.3 Research Applications Area

3.1.3.1 Applications Developers and Users

The objective of this group is to facilitate the exploitation of Grid technologies by application developers and users. The intent is to inform application developers and users about what is possible through the use of Grid technology and to inform the developers of Grid technology about what improvements are needed in Grid technology, best practices and standards.

3.1.3.2 Astronomy Applications

This group explores issues related to the use of Grid technology in support of astronomical data collections and data analysis pipelines.

3.1.3.3 Humanities, Arts, and Social Sciences

This group will identify and develop capability for the Humanities, Arts and Social Science with Information Technology on a Grid infrastructure. It will bring together members of the humanities, arts, social science, computer science, engineering and IT communities into a common Grid computing dialogue.

3.1.3.4 Life Sciences Grid

This group explores issues related to the integration of Information Technology with the Life Sciences on a Grid infrastructure. The interface between the life sciences and information technology is a rapidly developing branch of biology and is highly interdisciplinary, using techniques and concepts from informatics, statistics, mathematics, chemistry, biochemistry, physics, and linguistics. This interface derives knowledge from computer analysis of information stored in the biological processes, experimental results from various sources, patient statistics, public and private databases, and scientific literature.

Triple Space could be an alternative implementation for knowledge sharing applications related to life sciences.

3.1.3.5 Particle and Nuclear Physics Applications

This group discusses issues related to particle and nuclear physics applications and production Grids.

3.1.3.6 Preservation Environments

This group will (1) describe to the preservation community best practices for implementing distributed preservation systems, and (2) identify for the Grid community the consistency constraints that are required between Grid services for a viable preservation system.

3.1.4 Technology Innovators Area

3.1.4.1 Grid Computing Environments

This group aims at contributing to the coherence and interoperability of frameworks, portals, problem solving environments (PSEs), and other Grid-based computing environments by establishing standards that are required to integrate technology implementations and solutions.

3.1.4.2 Semantic Grid

This group aims at bringing forward the added value of emerging Web technologies and approaches, in particular Semantic Web and Web 2.0, for Grid users and developers, i.e., the application of these technologies and approaches in Grid applications and infrastructure, the identification of case studies and good practice.

Triple Space deals with distributed knowledge as well.

3.1.4.3 Workflow Management

The purpose of this group is to explore, evaluate and propose workflow representation and mapping techniques that enable the high-level description of application workflows and their execution in the Grid environment.

3.2 Enterprise Function

3.2.1 Industry Applications Area

3.2.1.1 Enterprise Grids Requirements

The purpose of this group is to identify key technical requirements and common approaches to enterprise Grid computing.

3.2.1.2 Storage Networking Community

This group is for vendors and users who are interested in and/or are already involved in providing or leveraging data storage resources in/for Grid systems.

3.2.1.3 Telecomm Community

This group focuses on how network providers and the Grid community can seek to create common approaches in dealing with significant changes in the offering of services and applications, as well as using infrastructure that will support Grids and their evolution.

3.3 Standards Function

3.3.1 Applications Area

The only group within the OGF application area related to TripCom activities is the Grid-RPC group, developing a Grid enabled remote procedure call mechanism.

3.3.1.1 Grid Remote Procedure Call

The GridRPC Working Group is responsible to produce a OGF recommendation for a Grid-enabled, remote procedure call (RPC) mechanism. In the course of this work, two distinct documents are produced: the first document entitled "A GridRPC Model and API for End-User Applications" is targeted to end-users to enable a wide range of end-user applications to be integrated with Grid applications. The second document entitled "A GridRPC Model and API for Middleware Developers" extends the first document and describes the middleware API and the associated programming model for GridRPC middleware tool developers. The goals of the GridRPC work group can be summarized as follows:

- Definition of a specific data structure to be used for GridRPC arguments in middleware
- Definition of a "grpc_arg" data type, if necessary, to be used in conjunction with the argument data structure.
- Definition of the argument data structure creation, destruction, lifetime and copy semantics.
- Definition of possible introspection capabilities for call arguments and attributes.
- Definition of mechanisms for handling persistent data
- Definition of API mechanisms to enable workflow management.
- Evaluate the compatibility and interoperability with other systems

Related Work in Grid Technology In his work, Lee [15] describes the need for a standardized RPC mechanism in Grid environments as a high-level programming abstraction to invoke remote program logic. A Grid specific requirement is the need to be inherently fault tolerant and to be able to recover gracefully in case of failures. The OmniRPC [15] project is a Grid RPC system specifically designed to support master-worker type Grid applications, based on the beforementioned proposal for Grid RPC of the OGF. Other similar systems are Netsolve [2] and Ninf-G [17].

With the development of GTK4 and the wide adoption of Web service standards to be used within Grid systems, Web services [1] are another way for invocation of remote functionality in the Grid.

Related Work in Triple Space Technology TripCom itself is a generic large-scale communication middleware platform, it does not provide RPC mechanisms as its core functionality. RPC is a much higher abstraction than simple message passing, i.e. the semantics of a local method call has to be emulated. Therefore, TripCom does not provide any equivalents to Grid RPC as described above.

Part of the TripCom Web services integration work however is a Web service binding that allows to use TripCom as a transport mechanism to invoke Web services [14]. Using this path, remote functionality can be invoked using TripCom.

Triple Space - Grid There is one commonality of TripCom and the Grid: both use Web service technology to enable remote invocation. The only difference is the use of different transport protocols underneath. Since Web services are a transport independend technology however, both TripCom and Grid are effectively already use the same technological basis.

Grid - Triple Space See before

Final Judgement As both areas use the same technologies already, no action is required.

3.3.2 Architecture Area

3.3.2.1 OGSA Naming

The objective of this work group is to produce two OGF specifications, namely the "Resource Namespace Service" (RNS) and the "Web-Service Name Resolution" (WSNR) specification to realize a three level name space for the OGSA. Three-layers of names are envisioned: human names are mapped to abstract names, which are then mapped to a concrete address in the form of an EPR for instance. The ultimate goal of this work group is to produce a specification called WS-Naming, which itself is based on WS-Addressing [3] in order to integrate Grid naming services with existing Web service technology. TripCom is – in the same spirit as the Grid – a Web service centric technology. However, TripCom does not have the notion of a "resource" in the same sense as used in the Grid. More specifically, an equivalent to Grid resources and thus the reason for introducing the concept of three-level naming is not applicable to TripCom. In different context however, naming plays an important role in TripCom: TripCom kernels are identified by DNS names, effectively reusing the naming system of the internet [11].

3.3.2.2 Open Grid Services Architecture

The Open Grid Services Architecture is envisioned to be the blueprint for standards-based Grid computing. According to the workgroup charter[9] , 'Open' refers to the process used to develop standards that achieve interoperability. 'Grid' is concerned with the integration, virtualization, and management of services and resources in a distributed, heterogeneous environment. It is 'service-oriented' because it delivers functionality as loosely coupled, interacting services aligned with industry-accepted Web service standards. 'Architecture' defines the components, their organizations and interactions, and the design philosophy used.

The purpose of the OGSA work group is to manage an architectural process of OGSA standards by working to collect requirements, evaluate the maturity of specifications, and produce periodic updates to OGSA informational documents and OGSA recommendation profiles. The scope of the working group is to produce the following documents:

Architecture document The Architecture document identifies the framework, taxonomy, and functionality that should be provided to address use case requirements.

[9] `www.ogf.org/gf/group_info/charter.php?review&group=ogsa-wg`

Glossary The glossary provides an unambiguous definition of terms used in the Architecture document.

Service Description and Scenario documents Service Description documents describe each OGSA service in natural language, listing the interfaces and operations defined by each service. Scenario documents demonstrate how these services can implement the use cases, using a combination of natural language and UML.

OGSA Roadmap document The Roadmap document expresses OGSA-WG views on the likely future evolution of OGSA to address unmet requirements and/or respond to technology evolution.

Guideline documents Guideline documents outline how to write specific OGSA normative documents. Examples of guideline documents include the OGSA Profile Definition document and the Grid Information/Data Model Guidelines document.

OGSA Profiles An OGSA Profile specifies requirements on referenced specifications and other profiles to improve interoperability. A Profile has 'conformance statements' and 'extension points' as specified in the OGSA Profile Definition document.

Related Work in Grid Technology In [6], the OGSA is described in detail, together with description of academic and industrial use-cases, tools and required infrastructure. There are numerous other works about the subject matter, as we investigate the core architecture of Grid applications however, this book is the reference we align our work with.

Related Work in Triple Space Technology In TripCom, we follow a very similar approach that is surprisingly well aligned with the goals of the OGSA work group: similarly TripCom also defines a reference architecture document [11] that describes core components, integration technology to wire these together, possible client applications and the development methodology we use. The architecture comprises views on

- Use cases
- Data
- Logical groups of functionality (components)
- Processes
- Deployment

and thus is roughly equivalent to the various documents provided by the OGSA work group.

Triple Space - Grid As TripCom uses roughly the same methodology as the OGF to describe the architecture, no mutual influence can be detected for this part.

Grid - Triple Space See before.

Final Judgement No action required

3.3.2.3 Reference Model Working Group

The goal of the OGF reference model working group is to create an agreed upon glossary and a set of terms in order to share a common language when describing Grids, Grid technology and related standards. According to the group description, the purpose of the glossary is not to replicate work of individual standards documents, but to develop a broader model that brings together, references and extends existing work where appropriate.

Related Work in Grid Technology As of today, there is only a draft document of the "OGF Reference Model" available in the OGF GridForge system.

Related Work in Triple Space Technology In TripCom, we follow the good practice of documenting our shared terminology in the form of a glossary, which is part of TripCom Deliverable D6.2 [11] and was updated in D6.3 [12].Part of the TripCom reference architecture [11] is also a graphical meta model to describe relationships between the main entities. Recognizing the need for unambigious definition of terms, TripCom additionally provides a formal description of the meta-model in form of an ontology[10] (in RDF, OWL and WSML form).

Triple Space - Grid As the OGF is also planning on formalizing their glossary terms and relations between them in a future version, no action is required.

Final Judgement No action required

3.3.3 Compute Area

The Compute Area is focused on the description and execution of computational tasks, and the scheduling and negotiation of Grid resources. Consequently, the following problems are addressed by this OGF area:

- Resourcrce allocation
- Grid scheduling
- Grid profile for High Performance Computing (HPC)
- Job submission and description language
- Basic execution services
- Resourcrce selection services

As allocation, scheduling and management of computing resources is not the focus of TripCom, this OGF area is ignored for this report.

[10] `TripCom.org/ontologies/`

3.3.4 Data Area

3.3.4.1 Data Format Description Language

The goal of the DFDL work group is to define an XML-based language – the Data Format Description Language (DFDL) – for describing the structure of binary and character encoded files and data streams so that their format, structure, and metadata can be exposed.

Related Work in Grid Technology There are various data description languages proposed to be used in the Grid. Amongst others, there is the "Binary Format Description" (BFD) from SAM[11] and the "Earth Sciences Markup Language" (ESML)[12]. BinX [18], the "Binary XML Description Language" being the most similar to the DFDL proposal from the OGF and will very likely serve as a reference implementation. In [19], the authors even motivate an extension of BinX to use Ontologies to describe types and simple structures.

Related Work in Triple Space Technology The basic data format of TripCom is RDF [10], thus TripCom already uses what the OGF is envisioning as a model for future extensions of their data description language.

Triple Space - Grid Can learn how to efficiently manage massive amounts of data

Grid - Triple Space Encourage the use of semantics

3.3.4.2 Database Access and Integration Services

Provide TripCom access components to enable TripCom access for the Grid

3.3.4.3 Grid File System

GFS implementation based on TripCom

3.3.4.4 Grid Storage Management

Looks like a short term solution instead of the GFS; use this as a start for Grid TripCom access

3.3.4.5 OGSA Byte IO

Provide a WS Layer for File-System based access to TripCom

3.3.5 Infrastructure Area

3.3.5.1 Network Markup Language (NML)

Use TripCom to store ontology and network instance data (utilisation of network, ...)

[11] collaboratory.emsl.pnl.gov/docs/collab/sam/
[12] esml.itsc.uah.edu/index.jsp

3.3.5.2 Network Measurements

Store sensor data about network info in TripCom. TS is a web scale data store for sensor data. Like a big, federated Database about network info for a world wide Grid.

4 Conclusion

Mutual influences of Grid and Triple Space Technologies have been systematically analyzed, based on the Open Grid Forum's Areas and Groups. Commonalities have been found, but also potential has been discovered, where the two technologies could learn and benefit from each other. In a next step, these approaches would have to be written out in full and reported for the first time.

References

[1] G. Alonso. *Web Services: Concepts, Architectures and Applications*. Springer, 2004.

[2] DC Arnold and J. Dongarra. The NetSolve environment: progressing towards the seamless grid. *Parallel Processing, 2000. Proceedings. 2000 International Workshops on*, pages 199–206, 2000.

[3] D. Box, F. Curbera, et al. Web Services Addressing (WS-Addressing), 2004.

[4] C. Dabrowski. Reliability in Grid Computing Systems, 2007. `gridreliability.nist.gov/ReliabilityIDdraft1b.pdf`.

[5] I. Foster and C. Kesselman. Globus: a Metacomputing Infrastructure Toolkit. *International Journal of High Performance Computing Applications*, 11(2):115, 1997.

[6] I. Foster and C. Kesselman. *The Grid 2: Blueprint for a New Computing Infrastructure*. San Francisco, CA, USA: Morgan Kaufmann Publishers Inc, 2003.

[7] I. Foster, C. Kesselman, J. Nick, and S. Tuecke. The Physiology of the Grid: An Open Grid Services Architecture for Distributed Systems Integration, 2002. `www.globus.org/research/papers/ogsa.pdf`.

[8] Alessandro Ghioni, Davide Cerri, Francesco Corcoglioniti, Jacek Kopecký, Gerson Joskowicz, Lyndon Nixon, Dario Cerizza, and Noelia Pérez Crespo. Definition of security and trust support model for the reference architecture. TripCom Deliverable D5.2, September 2007.

[9] ISTweb. *TripCom - Triple Space Communication*, March 2005. `cordis.europa.eu/ist/kct/tripcom_synopsis.htm`.

[10] O. Lassila, R.R. Swick, et al. Resource Description Framework (RDF) Model and Syntax Specification. 1999.

[11] Martin Murth, Gerson Joskowicz, eva Kuhn, Dario Cerizza, Davide Cerri, David de Francisco, Alessandro Ghioni, Reto Krummenacher, Daniel Martin, Lyndon Nixon, Nuria Sanchez, Brahmananda Sapkota, Omair Shafiq, and Daniel Wutke. Triple Space Reference Architecture. TripCom Deliverable D6.2, March 2007.

[12] Lyndon JB Nixon, Daniel Martin, Daniel Wutke, Martin Murth, Elena Simperl, Reto Krummenacher, Brahmananda Sapkota, Zhangbing Zhou, Hans Moritsch, Omair Shafiq, German Toro del Valle, Davide Cerri, and Vassil Momtchev. Platform API Specification for Interaction Between All Components. TripCom Deliverable D6.3, March 2008.

[13] Open Grid Forum. *OGF Areas and Groups*, March 2008. `www.ogf.org/gf/group_info/areasgroups.php`.

[14] Brahmananda Sapkota, Dario Cerizza, Emanuele Della Valle, Daniel Martin, Martin Murth, Omair Shafiq, Henar Munoz, and Andrea Turati. Architectural integration of triple spaces with web service infrastructures. TripCom Deliverable D4.1, 2007.

[15] M. Sato, T. Boku, and D. Takahashi. OmniRPC: a grid RPC system for parallel programming in cluster and grid environment. *Cluster Computing and the Grid, 2003. Proceedings. CCGrid 2003. 3rd IEEE/ACM International Symposium on*, pages 206–213, 2003.

[16] E. Simperl, R. Krummenacher, and L. Nixon. A Coordination Model for Triplespace Computing. In *9th Int'l Conference on Coordination Models and Languages*, 2007.

[17] Y. Tanaka, H. Nakada, S. Sekiguchi, T. Suzumura, and S. Matsuoka. Ninf-G: A Reference Implementation of RPC-based Programming Middleware for Grid Computing. *Journal of Grid Computing*, 1(1):41–51, 2003.

[18] M. Westhead and M. Bull. Representing Scientific Data on the Grid with BinX–Binary XML Description Language. *EPCC, University of Edinburgh*, 2003.

[19] M. Westhead, T. Wen, and R. Carroll. Describing data on the grid. *Grid Computing, 2003. Proceedings. Fourth International Workshop on*, pages 134–140, 2003.