



Diploma Thesis for Fabian Gubler

Task Description:	Martin Waldburger, Prof. Dr. Burkhard Stiller
Topic:	Accountable Units for Grid Services in Mobile Dynamic Virtual Organizations
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Location:	Institut für Informatik, 27-H-12
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1. Introduction and Motivation

Grid systems have evolved over time from traditional grid computing to service grids. Grid computing focuses on high performance computing, based on the concepts of cluster-building and resource sharing, by which grid systems are able to solve data- and computationally intensive tasks. Service grids include additionally virtualized, application field-specific services, providing for geographically and organizationally distributed service provisioning in a virtual organization (VO). Evolution of grid systems has not stopped at that stage, but leads currently toward knowledge grids [1]. In knowledge grids, adaptive workflows are of major interest [2]. A complete view on the current status of a virtual organization with respect to executed processes and services is gained by a service aggregator.

This type of grid systems is characterized by its focus on knowledge-intensive tasks which are modeled by business processes. Accordingly, high performance computing services may still be available and helpful, but they are not regarded anymore as a central concern. However, knowledge grids require functional extensions in other areas, specifically in commercialization and mobility support. A platform as the one to be developed within the project Akogrimo [3] will support pervasive access to knowledge by means of offering mobile grid services, that help its possibly dynamically changing organizational members to fulfill complex problems in specific application domains with a clear economic orientation such as e-health.

The first requirement of commercialization is caused by grid computing's traditional orientation toward research projects. While large companies like IBM [4] were actively involved in grid-related standardization bodies [5] [6] [7] from the beginning, commercial grid exploitation activities have only started recently. The second requirement, namely support of mobile grid services, is constituted by people's ever-growing mobility. In mobile grids - knowledge grids that explic-

itly provide mobile access - it should not matter where or by use of which (fixed or mobile) device a knowledge-intensive task is started, executed, and solved. It is wishful that services and sessions can be transferred to other devices, and that relevant changes during service execution, such as a temporary loss of a bearer signal, are detected and the respective measures can be taken. These technical details however have to happen transparently for a mobile grid user. From an organizational viewpoint, mobile grids are represented by mobile dynamic virtual organizations (MDVOs), which are seen as extended virtual organizations [1].

Regardless of fixed or mobile grid service provisioning, offering commercially exploitable services requires that users are correctly authenticated and that they dispose of sufficient authorization privileges to access a service. Once that access is granted, resource usage has to be accounted reliably, whereupon accounting data becomes retrievable for auditing purposes or it is finally transferred into charging records which in turn will be equipped by monetary values so that a bill to the service consumer can be issued. These steps are reflected by AAA (Authentication, Authorization, Accounting) [8] [9] and its extended view, A4C (AAA plus Auditing and Charging) [10] [11].

Assuming that authentication as well as authorization has been successfully performed, the question arises what kind of data is needed to be accounted. The processes of metering [12] [13] [14] and accounting [15] [16] both are costly, in so far as they have to be designed in a way that provides for scalability at all times. Accounted data has to be meaningful in the sense that available information is useful for internal analysis and optimization as well as for following steps such as charging and billing.

2. Description of Work

When considering a mobile grid supply chain, 2 structural parts are identified within the mobile dynamic virtual organization: A business-to-business (B2B) and a business-to-consumer (B2C) part. The first consists of VO members that do not maintain contractual relations with end-customers, while the second part embraces members with direct end-customer contact.

Accounted data potentially contains valuable information for a grid service provider about current and past service as well as resource usage, what can be used for instance for internal optimization processes. This however requires accountable units that equip a service provider with significant information that correlate with chosen optimization criteria. Focusing on cost drivers is the optimization strategy that shall be followed during this diploma thesis.

Grid computing and virtual organizations economically are based on the idea that services that are not assessed as core competences for a specific VO member are outsourced to and thus provided by a dedicated grid service provider. Concentrating on core competencies is practical in economic terms, it however can cause also problems such as loosing direct customer access and thus loosing knowledge about what is demanded on the end market. Furthermore, in a highly competitive environment, not even specialization might protect a grid service provider from its competitors, since being only one grid service providers among many others, can expose service providers to hold-up effects.

This thesis' main interest however is not found in directly retrieving a solution for the above mentioned issues. But this work is concerned with developing an accounting model that determines meaningful accountable units. If these accountable units can be identified it is assumed that accounting data can be used to provide services even better than competitors, so that in the end potential negative effects of providing services as a highly specialized service provider, but without a complete understanding of the overall business logic, are at least lowered.

3. Thesis Goals

- The main target consists of determining an accounting model for grid services that are offered in a mobile dynamic virtual organization. This model has to satisfy the following requirements:
 - It is based on an embracing research on related work, namely mobile grid computing and AAA in general, and economic theories of costs as well as grid accounting in particular.
 - It determines accountable units for a to-be-defined range of accountable metrics. It however also allows for extending those metrics by self-defined types.
 - It is compliant with Global Grid Forum's (GGF) open grid services architecture (OGSA) [17] and with Diameter [18].
 - It is targeted at business-to-business relations within core components of an MDVO, i.e. it is concerned with accounting (in a broader sense) for grid service providers, but the model does not cover business-to-consumer-related issues, such as formation of end customer prices.
- By means of an application of this accounting model to the chosen mobile grid scenario the model's practical usability shall be demonstrated and assessed.

4. Activities

Based on the description of work the following activities - some in parallel - are recommended:

- Introduction to fields of interest and provide a motivation for your work. Focus is to be set on mobile grids in a commercial environment. This includes also an outline of used concepts and terms.
- Give an overview of state-of-the-art with respect to related work in the areas of:
 - Mobile grids and mobile dynamic virtual organizations. Sharpen your view on cooperation and role models that offer a conceptual tool to reflect financial flows in inter-domain service provisioning. For this work, only grid services are assessed to be relevant - network services are offered transparently to the grid layer and thus being assumed to be present and accessible.
 - AAA and its extended view A4C: Concentrate on accounting in a broader sense, meaning that accounting itself shall be in center-view, but following and preceding steps have to be considered as well. AAA-protocols (Radius [19], Tacacs [20], and Diameter) have to be presented and compared with regard to accounting-related functionality. Again, accounting has to focus on grid accounting, i.e. resource usage is not to be accounted for pure network usage. Present the current status and ongoing work in grid accounting. Concentrate on OGSA/OGSI/Globus Toolkit influenced by GGF and OASIS and its respective working groups, but present also other approaches.
 - Economic theories of costs. Show how different types of cost elements reflect usage of production factors and which rules apply to reach optimal cost allocation. Cost theory forms one of the center-piles for this thesis which requires it to be done thoroughly and in detail. It includes a view towards the process of formation of prices, whereas price-building in business-to-business is to be focused.
- Out of the motivation and the analysis of related work, derive requirements on resource usage records and on accountable units for mobile grid services. Note, that although business-to-consumer-related formation of prices is not covered directly, it shall not be neglected when thinking of accountable units, since these have to be meaningful in the end also for end-user prices.

- Propose an accounting model, based on, but not limited by a selected range of resource usage types. The central unit within such an accounting model is formed by accountable units, which have to reflect cost drivers.
- Apply this model to a mobile grid scenario which can be either developed from scratch or taken from the existing scenario in e-health and tourism [1]. Determine for selected VO members how accounting for provided grid services is achieved by adopting the proposed grid accounting model. Focus on accountable units and depict usage records and accounting records as well as sample charging records.

5. General Notes

- Provide a proposed schedule for your steps within the first two weeks of your work. Clarify details with your supervisor and finalize the schedule of tasks, basically in a bi-weekly fashion. Prepare an intermediate report and a short internal presentation after half time (date to be set) and discuss this with your supervisor. At the thesis' end a final public presentation has to be given.
- The final written report will document all work undertaken and remember that this report must be self-contained. Major technical basics are to be included and detailed knowledge obtained during the work must be documented. Assumptions, design decisions, configuration choices, and results are part of the report as well as implementation details and usage information. Correct bibliographic references and a list of papers, recommendations, and descriptions used must be added, including those ones given below.
- Establish weekly meetings with the supervisor to report on progress and problems.
- Students involved are required to read and answer e-mails related to this project at least twice a week.
- The sheet on hints for diploma/semester thesis work is required to be known.

6. Formal Results

Besides an oral presentation of your work in exactly 20 min plus 10 min for questions and answers during the public presentation, the following written documents are part of your work and need to be handed in to the supervisor in time:

- A report in a soft cover binding, printed double-sided, and in 3 copies (in English, preferred): It covers the problem to be solved, the discussion of the design choices, a set of arguments on the final design choice, a list of solved and open issues, a table of content and figures (including tables), a valid list of bibliographic references, and optional appendices as required. A critical consideration of the task, the work, and the result will conclude the report. The official acknowledgement section is mandatory, a personal one optional, however recommended, as usually a number of people took part in the process of finalizing the thesis. The text processing shall be done in FrameMaker (preferred).
- A documentation of the implemented/configured system, covering the systems view point, an implementation description, a use and installation manual, a documentation of all program and data structures developed or utilized. All of this may be part of the report below, however, in case it will not be included, it must exist in a separate document.
- A dedicated CD has to be produced: (1) a collection of all program sources, software components, protocol implementations utilized, hardware/product documentation in PDF, related work papers in PDF or full HTML pages, and a directory description; (2) the written thesis (report) in source files, figures in source file and gif or eps, and a full printable PS as well as PDF file, the set of slides for the final presentation in PowerPoint, and all further material used, if available in electronic form, such as all existing and documented test scenarios, testing plans, and test results.

- A German (or English, in case of a German report) summary of maximum 2 pages, which will enable a quick and clear survey of this work's tasks and results. This summary will be part of the bound report, and is included after the front page and before any other text will follow. It includes four short sections on: 1. Introduction, 2. Aims and Goals, 3. Results, and 4. Further Work.
- The complete set of copies of the report, the CD, and the talk must be completed and handed in to the supervisor in time before the diploma thesis will change into "submitted" status.

7. References

The following list of references addresses key points. Further paper, scenario, and document research is a must:

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- [7] The Globus Alliance: *The Globus Alliance*; <http://www.globus.org>, September 2005
- [8] S. Mullen, M. Crawford, M. Lorch, D. Skow: *Site Requirements for Grid Authentication, Authorization and Accounting*; Global Grid Forum GFD-I.032 <http://www.ggf.org/documents/GFD.32.txt>, October 2004.
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- [13] Global Grid Forum (GGF): *Usage Record Working Group (UR-WG)*; <https://forge.gridforum.org/projects/ur-wg#gotoDocuments>, 2003.
- [14] Global Grid Forum (GGF): *Resource Usage Service (RUS)*; <https://forge.gridforum.org/projects/rus-wg/document/draft-ggf-rus-service-4-public/en/1>, February 2004.
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- [16] T. Sandholm: *SweGrid Accounting System*; 6th NorduGrid Workshop, Lund, <http://www.pdc.kth.se/grid/sgas/docs/presentations/NorduGridSGAS.pdf>, November 2003.

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- [18] P. Calhoun, J. Loughney, E. Guttman, G. Zorn, J. Arkko: *Diameter Base Protocol*; Network Working Group RFC 3588, <http://www.ietf.org/rfc/rfc3588.txt>, 2003.
- [19] C. Rigney, S. Willens, A. Rubens, W. Simpson: *Remote Authentication Dial In User Service (RADIUS)*; Network Working Group RFC 2865, <http://www.faqs.org/rfcs/rfc2865.html>, June 2000.
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