First year Evaluation and Assessment Report (D12)

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1 Introduction

This report attempts to evaluate the progress of the TAPAS project during the period April 2002 to March 2003. Clearly, this requires an evaluation of technical progress, but dissemination activities are also relevant.

Section 2 outlines the technical progress that has been made during this period, and evaluates it with respect to the technical objectives. We describe the deliverables that were due during this reporting period and evaluate the contribution they have made. Additionally, we describe and evaluate other work, carried out within the various work packages, that is not represented by those deliverables.

The TAPAS project and its results have to be presented not only to the scientific community but also to the community of potential end users of its technology. Catching the interest and getting feedback from both communities is of equal importance in order to disseminate our results.

In the rest of this evaluation report, we first assess the technical outcomes for the first year of the project against the goals we set ourselves in the description of work, and then present the results of our dissemination activities, in order to demonstrate the progress we are making towards our objectives.

Section 3 summarises remarks made by Industrial Advisory Board (IAB) members with regard to the importance of the TAPAS project. Finally, Sections 4 and 5 describe the TAPAS related publications and other dissemination activities during this reporting period.

2 Progress with respect to the description of work

2.1 Overview

The goals of the first year of the project were to produce the technical deliverables D1 “Application Hosting and Network Requirements”, D2 “Specification Language for SLAs”, D5 “Architectural Design Document” and D7 “QoS Container Interface Specification”. These deliverables are outputs of the workpackages WP1, WP2 and WP3. D1 has already been completed on schedule. The other deliverables are currently under construction and will be finished at the end of the first TAPAS year.

In addition to producing these specific deliverables, work has continued within the various technical topics of each work package as appropriate. In particular, a major activity during this period has been the development of the notations for expressing SLAs to enable specification of QoS as well as trust relationships. This activity was performed as part of workpackage WP1, and is also evaluated in this section. The section ends with an evaluation of a wide range of activities that have been performed within workpackages WP2 and WP3 during this period.

The upcoming workpackages in the TAPAS project plan are WP 4, WP 5, WP 6. The evaluation of research results has already started, the report at hand is the first deliverable of WP 4.

Workpackages WP 5, dissemination, and WP 6, project management, have also been started, but are not highlighted here in detail. Section 5 refers to dissemination activities.

2.2 Workpackage WP1

One of the goals of workpackage WP1 was to develop notations for expressing SLAs (Service Level Agreements) to enable specification of QoS as well as trust relationships. Deliverables D1 and D2 are to be completed within workpackage WP1 at the end of the first year: D1 has already been published, while D2 is in preparation.

Deliverable D1 contains two major parts.

The first part identifies application hosting requirements, which are relevant for the TAPAS project from an industrial viewpoint. This part of deliverable D1 considers an ASP scenario with help of the auction scenario and defines SLAs resulting from the industrial experience. It represents the basis for SLA specification in deliverable D2 and TAPAS architecture in deliverable D5. Moreover we discuss the technology standards relevant for TAPAS and outline the technical and commercial criteria to be used in the assessment of the project’s success. Below we will evaluate the progress of workpackages with reference to the requirements mentioned in sections “Technical Criteria” and „Standards“ of deliverable D1. The commercial criteria can be evaluated as recently as at the end of the project.

The second part identifies QoS networking requirements, which are relevant for the TAPAS project from the viewpoint of an ISP. Due to the fact that the performance of the network largely determines the quality of application provisioning, we discuss the ASP and the network SLAs separately in deliverable D1.

Regarding the future development of networks as identified in D1, important progress has been achieved. Statistical models for end-to-end performance, formulas for

throughput and expected time could be identified, which in turn support the measurement of SLAs and thereby the monitoring.

Peering and multihoming raises some interesting questions regarding network SLAs between different ISPs, e.g. how to propagate QoS settings between different peers. The transport level SLAs are discussed, which seem to offer more appropriate QoS facilities than the traditional ISP SLAs, i.e. the SLAs between different ISPs. These are truly horizontal SLAs. The timescale for execution of transport level SLAs turns out to be much shorter and therefore beneficial.

Deliverable D2 aims at the specification of SLAs. QoS provisioning has multiple facets and requires complex agreements between network services, storage services and middleware services. D2 introduces SLAng, a language for defining service level agreements that accommodates these needs.

Deliverable D2 contains three main contributions:

1. The service provision reference model with a definition of vertical and horizontal SLAs according to the requirement R2.7.
2. SLA definition language (SLAng) designed according to the requirement R2.2, including contractual statements, end-point description and service level specifications. SLAng syntax is defined using XML standards satisfying requirements R2.10 and R1.2. The semantic of SLAng allows expressing the most important topics of SLAs and therefore fulfils the requirements R2.1 and R2.10. It takes into consideration correlations between different stakeholders according to the requirement R2.9.
3. A case study that uses a web services specification to support the processing of images across multiple domains in a quality of service aware manner. SLAng is evaluated based on the experience gained from this case study. SLAng adds non-functional aspects (QoS) to the Web Services technologies (R1.5) that makes it universal for the different kinds of services offered by ASPs.

Among the list of all application hosting requirements SLAng modelling language satisfies the following important requirements:

- it is expressive enough to reason about all aspects of SLAs according to the requirement R2.6 and it can be used during the negotiation phase as a part of electronic contract
- XML files, containing negotiated SLAs, serve as input for configuration and deployment of QoS containers. This allows the government of component execution in order to satisfy the requirement R2.11:

The visual editor for the specification of SLAs will be designed as well (s. R2.5).

Continued activities in workpackage WP1 have contributed issues on Model Driven Performance Analysis (MDPA). The project aims to adopt UML as the language for the description, modelling and analysis and extend it with formally defined stereotypes and properties. The MDPA research activities have already led to publications. The participation in the standardization committees of the OMG is planned.

2.3 Workpackage WP 2

Workpackage WP2 develops support architectures that provide QoS negotiation, establishment and adaptation facilities to enable component containers to become QoS enabled. SLA trust specifications will be used for deriving service invocation

primitives enriched with authentication, non-repudiation mechanisms, with or without the involvement of trusted third parties.

At the end of the first year deliverable D5 is to be completed within workpackage WP2.

Deliverable D5 “TAPAS architecture: concepts and protocols” contains four main contributions:

1. A virtual enterprise (VE) model as a distributed ASP scenario
2. An executable contract (x-contract) definition, monitoring and enforcement of x-contracts using its abstraction by FSM (Finite State Machine)
3. Trust and trust-related models
4. A trust enforcement consisting of two parts:
    - Open Role Based Access Control (RBAC) Model defining tasks of x-contracts, containing role management, rights and obligations of the role players, authentication and authorisation by role players. RBAC uses PKCs (Public Key Certificates) and also takes care of relay attacks and confidentiality.
    - monitoring and enforcement of x-contracts using middleware for non-repudiable information sharing

The issues mentioned above represent a consistent concept of x-contract, its content, form and responsibilities regarding physical enterprise. While virtual enterprises refer to actual objects in the physical enterprise, x-contracts provide policies for accessing actual objects using RBAC and B2B middleware service collecting non-repudiable digital evidence. Thereby the contract enforcer guarantees that the rights and obligations stipulated in the contract are monitored and enforced.

The B2B middleware ensures that all operations performed by stakeholders are recorded and are non-repudiable. One of the major advantages of B2B middleware is that it ensures this without the need of involving centralised trusted third parties (TTPs). This approach takes into consideration concerns on the role of TTPs mentioned in section 2.5.

2.4 Workpackage WP 3

WP3 implements a collection of QoS enabled services as required by the architecture designed in WP2. The overall implementation framework will be defined by the first task (QoS-aware containers) that will run concurrently with workpackage WP2.

In the end of the first year deliverable D7 is to be completed.

Deliverable D7 “TAPAS architecture: QoS enabled application servers” principally deals with the architecture of the application server, and contains an extensive state of the art assessment of end-to-end QoS architectures. It consists of three main parts.

The first part addresses issues on end-to-end QoS architectures with relevant examples of these architectures. A QoS Policy Architecture serves as a model for the architecture of the TAPAS platform. The QoS architecture uses a control loop with an interpreter, controller and configuration unit in order to enforce SLAs performance. We find this well-known technical approach quite useful for QoS supervision. It seems to be a wise decision to apply control theory to the field of QoS middleware.

The second part contains the use cases picturing application hosting and auction hosting, the requirements analysis and the mapping of requirements to services. The use cases describing an auction scenario cover quantitative aspects of SLAs and seamless configuration of the electronic contract into the TAPAS container. They could be extended by qualitative requirements in order to cover a cheating scenario as discussed during the TAPAS workshop in February in Dortmund.

The third part addresses implementation issues and more detailed concepts that define the middleware services. The middleware services need to be considered from an interface or API point of view in order to specify the functionality implemented by the service. QoS aware application server architecture containing Controller Service, Configuration Service, Event Notification System enables automated configuration and deployment of the TAPAS container reporting SLAs fulfilment to the stakeholders.

Regarding the contents of deliverables mentioned above we assess that all wide spread standards defined as requirements in deliverable D1 (s. R1.1) like J2EE, JDBC, JMS can be found again in the TAPAS architecture. During the workshop meeting in Dortmund the project team decided to use the well-known open source application server JBoss for the implementation.

2.5 Monitoring

During the design of TAPAS middleware components in WP2 the issue of trust management turned out to have some impact on the architecture. In an ASP scenario an ASP will run an application on TAPAS middleware like an application server, meanwhile the ASP client will use the application from the Internet. In the TAPAS scenario the application execution will be governed by SLAs that have been negotiated between client and ASP. SLAs are only useful if their compliance is enforced and monitored. To achieve this aim TAPAS uses SLAs not only as an inter-organisational contractual feature but also to govern component execution. A client will then have to supervise the SLA fulfillment in order to compute e.g. monetary penalties for violations.

However, in today's ASP business an ASP himself is responsible for compiling statistics, which of course causes a trust problem. On the other hand clients may fake statistics themselves, though the ASP has fulfilled the SLA. Hence a trusted third party (TTP) could be beneficial to supervise the ASP and to prohibit falsifications.

The project team encountered the TTP issue when designing QoS-aware middleware. Discussions before and during the workshop meeting in February led to the problem that the introduction of TTPs will increase the overall ASP costs, which in turn have to be paid by the clients. In fruitful discussions the TAPAS project team elaborated the idea of minimizing the duties of an ASP and thereby minimizing the costs. An appropriate level of security could be reached by utilizing encryption techniques in a way that TAPAS components generate digitally signed reports. A TTP could then check if an ASP has deployed the correct components. This discussion had some impact on the work on middleware architecture in deliverable D5.

Regarding monitoring topics the project team began a lively discussion during the workshop meeting in Dortmund. The following questions are still open:

- What kind of SLAs should be monitored for reporting to the customer?
- Where should SLAs be monitored?

- The ways of the monitoring on the network level

They have to be answered by the next deliverables, before QoS monitoring services have been designed.

3 Feedback from industrial advisory board

The members of the IAB were invited to meet with the TAPAS Executive Board at the TAPAS EB/IAB Meeting, held in Cambridge on 8th July 2002. Five members of the IAB attended: Dr. Tobias C. Kiefer (Commerz NetBusiness AG), Andrew Watson (Technical Director of the OMG), Prof. Dr. Rudolf K. Keller (Zühlke Engeneering), Dr. Stuart Wheater (HP Arjuna Labs), Paul McKee (BT exact Technologies), Dr. Stuart Wheater (HP Arjuna Lab).

This section summarises the remarks made by these IAB members with regard to the progress of TAPAS by July 2002, as evidenced by the presentations.

During the meeting the IAB members were interested to learn more about the project's aims and it's context regarding different participants and their main tasks.

The project partners presented their approaches to the different TAPAS issues, like the ASP requirements, the SLA modeling language, TAPAS middleware architecture and multicast protocols. At the time of the meeting the application hosting and network requirements had roughly been identified and classified in a draft version of deliverable D1.

The IAB members expressed the general impression from the presentations that all research activities are heading in the same direction. In turn the feedback of the project team was that all project partners profited from the comments of IAB, which expressed real-life concerns on TAPAS topics.

Stuart Wheater asked whether the TAPAS project intended to formalise SLAs. In fact, the activities for definition of SLAng include the formalization.

Rudolf K. Keller was interested in the different levels of SLAs, namely application, system and network levels and how it will be differentiated in the modelling language. He also asked about the project research management and how all work packages fit together. He remained positive about the progress of the project.

Paul McKee initiated a lively discussion about the business requirements at the application level.

There was an interesting exchange of views about authentication mechanisms in different EU countries, especially about digital signatures. Tobias C. Kiefer expressed serious concerns regarding PKI models. Regarding his banking background PKI is hardly used in the practice, because there are no economical models at the technical level, e.g. there are still different standards in different countries.

The other comments of the IAB members regarding their perception of the progress of TAPAS all referred to the security and trust issues. On the one hand it is necessary to deal with certificates to standardise work across international systems. On the other hand Paul McKee commented that companies probably would not want to pay the overhead for just one transaction.

Summarised by Jon Crowcroft saying that the economic approach as Tobias C. Kiefer mentioned is a very viable one to investigate.

4 Publications

The principal way of evaluating research is to look at the quality of the corresponding publications. The following TAPAS or TAPAS related publications have appeared during the reported period:

G. Morgan, A. I. Kistijantoro, S. K. Shrivastava and M. C. Little, “Component Replication in Distributed Systems: a Case study using Enterprise Java Beans”

J. Skene and W. Emmerich. Model Driven Performance Analysis of Enterprise Information Systems. In Proc. of International Workshop on Test and Analysis of Component Based Systems, Warsaw, April 13th, 2003 in conjunction with European Joint Conferences on Theory and Practice of Software (ETAPS) 2003, Electronic Notes in Theoretical Computer Science, Elsevier Science B. V. To appear.

D. Lamanna, J. Skene and W. Emmerich. SLAng: A Language for Defining Service Level Agreements. Accepted for Poster presentation, Middleware 2003, Rio de Janeiro, Brazil

D. Lamanna, J. Skene and W. Emmerich. SLAng: A Language for Defining Service Level Agreements. In Proc. of The International Workshop on Future Trends of Distributed Computing Systems (FTDCS'2003), San Juan, Puerto Rico. IEEE Computer Society Press. To appear.

W. Emmerich. Distributed Component Technologies and their Software Engineering Implications. Proc. of the 24th Int. Conference on Software Engineering, Orlando, Florida. pp. 537-546. ACM Press. 2002.

G. Piccinilli, W. Emmerich and C. Zirpins and Kevin Schuett. Web Services Interfaces for Inter-organizational Business Processes: An Infrastructure for Automated Reconciliation. In Proc. of the 6th IEEE Int. Conference on Enterprise Distributed Object Computing, Lausanne, IEEE Computer Society Press. pp. 285-292. 2002.

W. Emmerich and N. Kaveh. Component Technologies: Java Beans, COM, CORBA, RMI, EJB and the CORBA Component Model. Proc. of the 24th Int. Conference on Software Engineering, Orlando, Florida. pp. 691-692. ACM Press. 2002.

A. Aldini, M. Bernardo, R. Gorrieri & M. Roccetti, “QoS Evaluation of IP Telephony Services: A Specification Language Based Simulation Software Tool", Systems Analysis Modelling Simulation, Taylor and Francis Group Pub., accepted for publication, December 2002.

N. Mezzetti, F. Panzieri, "The Data Grid: Security and Privacy Issues", Proc. 4th European Dependable Computing Conference, Toulouse (F), 22-25 Oct. 2002.

G. Lodi, " End-to-end QoS-aware Middleware Services", 7th Cabernet Radical Workshop, Bertinoro (FC), Italy, 13-16 Oct. 2002.

E. Turrini, "A Platform for Request Routing in Content Distribution Inter-networks", 7th Cabernet Radical Workshop, Bertinoro (FC), Italy, 13-16 Oct. 2002.

E. Turrini, F. Panzieri, "Using P2P Techniques for Content Distribution Internetworking: A Research Proposal", in proceedings of the 2nd IEEE International Conference on Peer-to-Peer Computing, Linköping, Sweden, 5-7 Sept. 2002.

N. Cook, S.K. Shrivastava and S.M. Wheater, “Distributed Object Middleware to Support Dependable Information Sharing between Organisations”, IEEE/IFIP International Conference on Dependable Systems and Networks (DSN-2002), June 2002, Washington DC.

S.K. Shrivastava: Middleware for supporting inter-organisational interactions, Proceedings of Workshop on Future Directions in Distributed Computing (FuDiCo), Bertinoro, Italy, June 02.

5 Other dissemination activities

In addition to the publications listed in section 4 some specific dissemination activities are listed below.

5.1 Conferences

TAPAS project members attended the following conferences during the first six months of the project: Jon Crowcroft attends the Global Grid Forum meeting, where he co-chairs the working group on High Performance Network requirements.

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3rd, International Workshop on Software Engineering and Middleware, Orlando, Florida attended by W. Emmerich

23rd International Conference on Software Engineering, Orlando, Florida, May 2002 attended by W. Emmerich

3rd. International Workshop on Software Performance (WOSP), Rome, July, 2002 attended by D. Lamanna and J. Skene

ACM SIGCOMM 2002, Pittsburgh, USA, 23-25 August, attended by Jon Crowcroft

W. Emmerich: 17th IEEE Int. Conference on Automated Software Engineering, Edinburgh, Sept 2002.

2nd IEEE International Conference on Peer-to-Peer Computing, Linköping, Sweden, 5-7 Sept. 2002, attended by E Turrini.

Santosh Shrivastava and Paul Ezhilchelvan: IEEE/IFIP International Conference on Dependable Systems and Networks (DSN-2002), June 2002, Washington DC

Santosh Shrivastava: Workshop on Future Directions in Distributed Computing (FuDiCo), Bertinoro, Italy, June 02.

Santosh Shrivastava, Fabio Panzieri, Jon Crowcroft: IST Broadband Networking Conference, Bucharest, October 02.

Giovanna Ferrari attended 7th Cabernet Radical Workshop, Bertinoro (FC), Italy, 13-16 Oct. 2002.

5.2 Cooperation with other IST projects

Santosh Shrivastava, Fabio Panzieri, Jon Crowcroft: participated in a Cluster meeting on engineering of service functionality that was held during the IST Broadband Networking Conference, Bucharest, October 02.

Wolfgang Emmerich is involved in SEGRAVIS (Syntactic and Semantic Integration of Visual Modelling Techniques) project

Santosh Shrivastava, Graham Morgan attended the ADAPT project (IST-2001-37126)

Kickoff meeting in Madrid, Sept 02; TAPAS and ADAPT have specific collaboration on trust management.

5.3 German press review

One of the TAPAS goals is to cause a growth of the ASP market by not only developing new methods and technologies but as well by influencing research and business activities. This is intended to cause a general interest and shall also lead to a growth in the number of ASP projects. Besides the overall increase in the ASP sector of the market adesso as the industrial partner is of course interested in increasing the number of adesso's ASP projects and customers.

Hence we started public relations activities to make the TAPAS project known in the industry. This is achieved by placing articles in German business magazines.

Up to now the TAPAS project has been mentioned in the following articles:

- Article „Marktbelebung durch mehr Sicherheit und Qualität" („Market upturn by more security and quality") in „Versicherungswirtschaft" („Insurance economy") pp 67, Verlag Versicherungswirtschaft GmbH, 1/2003, Karlsruhe, Germany
- Article „EU-Forschungsprojekt fördert ASP-Markt" (EU research project encourages ASP market) in „Industriemanagement" („Industrial management"), pp 77, GITO mbH Verlag,1/2003, Berlin, Germany

Currently we plan to expand the public relations activities by placing articles in further magazines like "Computerwoche" ("Computer week").