Chapter 8

DYNAMIC MANAGEMENT OF BUSINESS SERVICE QUALITY IN COLLABORATIVE COMMERCE SYSTEMS

Bob Roberts, Adomas Svirskas

Abstract: The importance of e-business services quality continues to increase, as the use of e-commerce to support business activities becomes a routine practice for many enterprises. Companies need robust, predictable and efficient services that they can rely upon. This paper explores ways of how e-business quality can be established, monitored, reported and managed. A review of the literature considers the work recently undertaken in both business-level quality of service (QoS) and the QoS issues at the infrastructure level, as well as the relationship between these two areas. From a practical research perspective, the work within the framework of the EU-funded LAURA project is presented. The key goal of this project is to facilitate interregional zones of adaptive electronic commerce using the potential of the ebXML architecture. A Dynamic QoS Management framework is proposed to inform the implementation of QoS and SLA concepts within the LAURA project.

Key words: e-business, e-commerce, virtual organisation, service level agreement, SLA, quality of service, QoS, ebXML, Web Services

1. INTRODUCTION

The original motivation of the research discussed in this paper was to ensure an adequate level of business services quality in Request-based Virtual Organisations (RBVO). This task is very important for dynamic ad-hoc formations of enterprises, taking different roles in many different business processes at the same time. Quality of service (QoS) needs to be specified, agreed upon, measured and monitored. Parties should be compensated for deviations from a service level agreement (SLA). These

provisions promote trust between business parties and make e-business services predictable and manageable. The further organisation of this paper is as follows: Section 2 serves as a literature overview concerning Virtual Organisations, Quality of Service and Service Level agreements, Section 3 introduces the LAURA project, Section 4 explains QoS management within the chosen ebXML framework, raises some open points and discusses possible solutions, Section 5 summarises the overall effort and outlines future research.

2. REVIEW OF THE LITERATURE

2.1 Virtual Organisations and Enterprises

The concept of the virtual organisation (VO) is briefly discussed as our research on e-business is focused within this particular context. Tapscott (1996) discussed how companies are increasingly focusing on their core competencies and partnering with other organisations having complementary competencies. In mis scenario companies may enter into multiple and ever changing partnerships of collaboration to achieve competitive success. There are, however, various definitions of VO that reflect different perceptions of the concept. Some broad definitions of VOs are:

> *A VO or company is one whose members are geographically apart, usually working by computer e-mail and groupware while appearing to others to be a single, unified organisation with a real physical location (VO 2002)*
>
> *A temporary network of independent companies that come together quickly to exploit fast-changing opportunities (Byrne 1993)*
>
> *An opportunistic alliance of core competencies distributed among a number of distinct operating entities within a single large company or among a group of independent companies (Goldman et al 1995)*
>
> *Less a discrete enterprise and more an ever varying cluster of common activities in the midst of a vast fabric of relationships (Sieber et al 999)*

A VO is described in most cases as a network among organisations and/or individuals. Another opinion is that VO's should not be viewed solely as networks among organisations or individuals but as a radical approach to management, or a strategic approach that leads to dynamically re-configurable enterprises (Saabeel et al 2002). In such cases, the inherent limitations of being able to plan in an uncertain environment are taken into account by creating high structural flexibility (Davidow & Malone 1993).

2.2 Service Level Agreements

In its most basic form, an SLA is a contract or agreement that formalizes a business relationship, or part of the relationship, between two parties. Most often, it takes the form of a negotiated contract made between a service provider and a customer and defines a price paid in exchange for an entitlement to a product or service to be delivered under certain terms, conditions, and with certain financial guarantees.

In many e-commerce contracts, the service provider agrees to guarantee a certain level of QoS for each class of service, and in return, each business agrees to pay the service provider for satisfying the QoS guarantees in serving its set of customers. Those contracts are based on a Service Level Agreement (SLA) between each business and the service provider that defines the QoS guarantees for a class of service, the cost model under which these guarantees will be satisfied, and the anticipated level of per-class requests from the customers of the e-business.

Per-class SLAs usually have clauses where the service provider gains revenue for each request satisfying the per-class SLA, and incurs a penalty for each request failing to do so. Hence, in order to maximize profits, one needs to pay attention to resource management issues, so that customers can be served according to the restrictions defined in the SLAs.

The concept of SLA is revisited, from a more technical perspective, later in this paper (Section 4) where it is discussed in relation to an SLA specification language and the ebXML context.

2.3 Quality of Service in E-Business

Quality of Service can be viewed as a collective measure of the level of service a provider delivers to its customers or subscribers. In telecommunications, for example, QoS can be characterized by several basic performance criteria, including availability (low downtime), error performance, response time and throughput, lost calls or transmissions due to network congestion, connection set-up time, and speed of fault detection and correction. Service providers may guarantee subscribers a particular level of QoS as defined by a service agreement (IDC 2000, IBM2001, Schmidt 2000). The overall definition of the QoS of an e-business service can be determined by consolidating the compliance with the detailed SLA. To allow a machine to compare the SLAs with the real world behaviour the SLAs need to be mapped into measurements that can be taken from the running system (Sahai 2001).

The growing use of e-commerce is creating demand for SLAs with financial incentives in which service provider revenues are determined by

the number of completed transactions and where there are penalties for SLA violations such as exceeding response time guarantees. Diao et al (2002) introduce a simple profit model in which the service provider receives revenues for each completed transaction and where a cost is incurred if response times are excessive

Business-level QoS instrumentation often builds on top of the lower-layer QoS mechanisms. The closest layer in the e-business architecture stack is the application integration level, represented by Web Services, where QoS issues are quite intensively researched. For example, HP Laboratories have carried out various research projects on QoS and SLAs for Web Services. (Sahai 2001, Jin 2002, Pruyne 2000).

Sahai et al (2002) elaborate on SLA definition using XML schema-based model in an attempt to specify SLAs in precise and unambiguous manner as well as keep the specification flexible. Lammana et al (2002) propose the use of an SLA language (SLAng) to more thoroughly address the problem of SLA modelling and is further discussed below in section 4.2.

2.4 Relationship between QoS and Business Metrics

Wolter and van Moorsel (2001) discuss the effects of QoS degradations on the profitability of e-services. They characterise possible relationships between quality-of-service metrics (throughput, delay, availability) and business metrics (revenue, costs). This relationship is denoted as Q2B (quality of service to business). For IT and business managers there is a growing need to track the Q2B relationship at run-time in order to understand the consequences of QoS alterations on the bottom line. From a system management perspective, this implies monitoring both QoS and revenue or cost, as well as identifying the statistical correlation between the two. Based on such information, one may be able to tune a system or business process appropriately, thus bridging the gap between IT management and business management.

It is important to emphasize the conceptual similarity between the e-services and the RBVO underpinnings. This similarity is primarily defined by a possibility for the actors of both formations to issue requests for services upon dynamic discovery of these services. The actors can play roles of both service providers and consumers, thus enabling ad-hoc peer-to-peer value networks, depending on the circumstances. All interactions in RBVO are based on actors' requests; some of the requests might have associated monetary value, therefore the model proposed by Wolter and van Moorsel (2001) is relevant for QoS management in an RBVO environment.

Wolter and van Moorsel (2001) try to find answers to the following questions:

- Can a system of federated e-services (something conceptually similar to RBVOs) be instrumented, monitored and the Q2B relationship visualized?
- Can a business manager be notified if QoS starts influencing the bottom line?
- Can the business process be adapted to improve the overall gain in case of QoS changes?

To obtain the data necessary to correlate QoS with business metrics, e-services, which collect run-time data and visualise the above relationships are implemented using HP e-speak middleware, a proprietary service-oriented framework closely resembling Web Services architecture (HP 2001) and the HP ChaiServer framework for visualisation via Java applets (HP 1998). Visualisation of the business and QoS metrics allows a business manager to get the picture of the 'financial health' of the system and see if QoS influences this health parameter.

The conceptual and technological significance of their proposed approach has particular significance for the LAURA project discussed in section 3 because of the following attributes:

- The Service Oriented Architecture is used for the Q2B instrumentation framework. This fits with the concepts of Web Services and ebXML as HP 'e-speak' middleware is based on the same notions of unified description, registry-based publishing, dynamic discovery and on-demand invocation of services as Web Services and ebXML (HP 2001).
- It is based on a conceptual similarity to the RBVOs discussed in section 2.1 i.e. a dynamic network of business entities engaged in ad-hoc e-business activities with each other and the notion of federated e-services used to construct Q2B framework. RBVOs heavily depend on customer satisfaction and supplier flexibility, therefore dynamic monitoring, analysis of results and co-management of QoS and business processes is of great importance.
- It is a non-intrusive interceptor-based approach, orthogonal to the business e-services. This approach is used for monitoring, filtering, collecting and exchanging of QoS parameters. A chain of pluggable interceptors on either side of the service can be used to monitor different features of e-services. This technique is suitable for usage with many types of modern middleware tools. The interceptors can be implemented using different techniques (e.g. J2EE of .NET components, Web Services, etc.) for different nodes of heterogeneous network of e-services as long as they comply with the Q2B protocol
- The Q2B information exchange protocol is based on XML. This makes the information model of the Q2B framework as flexible as

XML and allows exploitation of many XML processing tools (transformation, data binding, messaging, etc.), which are available from commercial vendor and open source organisations.

Concepts from the Q2B framework are revisited in section 4 from the perspective of using the ebXML framework in the LAURA project context.

3. THE LAURA PROJECT

The authors of this paper are currently involved in an European Commission project sponsored by The Information Society Technologies (IST) Programme that is part of the Fifth Framework Programme for Research, Technological Development and Demonstration Activities. The project, called LAURA – 'Adaptive Zones for Interregional Electronic Commerce based on the concepts of Request-Based VO and sector-specific Service Level Agreements' (LAURA 2002, LAURA 2003) is directly related to the issues of e-business QoS.

LAURA is a project that innovates in terms of focusing on RBVOs, introduced in section 2.1, as a specific type of the VO taxonomy. RBVOs are clusters of partnering organizations that have replaced their vertical integration into a virtual one through collaborative networks between discrete business partners. Only some of the operations are within a particular organization - operations are now spread between separate organizations, which are linked to the original organization, to produce a new VO.

Managing and improving the service quality in both intra and inter-enterprise operations among collaborative network of enterprises, is virtually impossible in a reactive environment of a RBVO that does not provide a method of monitoring performance and measuring against SLAs. A VO has several individual enterprises-suppliers communicating with one another, fulfilling customer requests and/or triggering e-services that carry out their parts of some complex workflow of transactions. Without the right tools a VO has no way of knowing if it meets its commitments to the customer/user and supplier/user community.

Currently the described service is being implemented by the LAURA project team using an Open Source e-commerce framework called Open For Business (OFBiz). OFBiz is an e-business applications suite built on a common architecture using common data, logic and process components. This is an Open Source project with a rapidly growing user base characterized by cooperation between its creators, contributors and users. It is licensed under the MIT Open Source License (MIT 2003), which defines the rights users are granted to customize, extend, modify, repackage, resell,

and use it (OFBiz 2003). The open nature of the OFBiz framework will allow required enhancements in order to accommodate both ebXML interoperability options and QoS management extensions.

4. PRACTICAL ASPECTS OF QOS AND SLA IN EBXML ENVIRONMENT

4.1 The ebXML Framework and QoS

The ebXML framework, among other things, includes declarative, executable languages to express e-business collaboration protocol profiles and agreements (CPP/CPA) in a non-proprietary, XML-based format. These specifications can be shared and ported between compliant implementations. The ebXML messaging services complements these by offering a very capable standards-based e-business messaging system (ebXML & OASIS 2000, ebXML(b) 2003). These features fit the LAURA project business requirements very well, so ebXML has been chosen as a key component for implementation of the LAURA project.

Collaboration protocol profile (CPP) describes the company capabilities, such as the supported business processes, transport, security and messaging protocols. The profile defines the functional and technical support for business processes and roles for the trading partner. A trading partner, therefore, can publish information about their supported business processes and specific technical details about their data interchange capabilities (Chiu 2002).

To a certain extent QoS is supported in the ebXML framework through Collaboration Protocol Agreements, which are based on the Collaboration Protocol Profiles of the parties. A CPA defines the system-level agreement for data interchange between the trading partners and describes all the valid, visible, and hence enforceable, interactions between the parties and the way these interactions are carried out. It is independent of the internal processes executed at each Party. Each party executes its own internal processes and interfaces them with the business collaboration described by the CPA and Process Specification document. The CPA does not expose details of a party's internal processes to the other party. The intent of the CPA is to provide a high-level specification that can be easily comprehended by humans and yet is precise enough for enforcement by computers.

4.2 Specification of SLAs

Collaboration protocol agreements (CPA), explained in the previous section define mainly conversational and protocol aspects of the business interaction between the trading partners. A CPA does not specify business level agreements between the partners, therefore a CPA is not an SLA. An SLA is an agreement between a hosting service or similar service and the clients, which are hosted on or use that service. It includes the CPA functions related to communication between the hosting service and one of its clients but is primarily for expressing the measurable aspects of the services that the hosting service is providing to its hosted clients. The SLA might well be a separate agreement that can be referenced by the CPA with the hosting service. In this case, a non-trivial question of SLA specification arises, which we will discuss here, based on some related research.

Lamanna et al. (2002) also introduce a two-dimensional SLA taxonomy in their model. Horizontal SLAs are contracted between different parties providing the same kind of service while Vertical SLAs regulate the support parties get from their underlying infrastructure. For example, a container provider can define an agreement with an ISP for network services. Once again, the resulting types of SLA differ in terms of their expressiveness, and SLAng defines them separately. Therefore, an important goal of an SLA definition language is to provide the means to accurately express features of a service in both qualitative and quantitative terms. Lamanna et al. also claim that other relevant aspects are *"the possibility to easily make comparisons between offers, to advertise and retrieve information about them, to reason about service proposals, understanding what one can offer and expect to receive, and to easily monitor QoS guarantees, both for fulfilling and claiming them…… The main requirements for achieving these goals we had in mind while developing SLAng were parameterisation, compositionality, validation, monitoring and enforcement.*"

The resulting SLAng is an XML language for capturing Service Level Agreements while the legal issues are addressed by embedding the SLA in an SLA contract that is essentially a framework containing one or more SLAs as well as the names of the two juridical persons contracting the agreement, together with their digital signatures.

Lamanna et al claim that XML proves ideal for the parameterisation of service level specifications that is supported at different system tiers, including vertical and horizontal agreements as indicated below.

The vertical SLAs are:

- **Application:** between applications or web services and components
- **Hosting:** between container and component providers
- **Persistence:** between a container provider and an SSP

- **Communication:** between container and network service providers.

The Horizontal SLAs that parties enter into by composing vertical SLAs are:

- **Service:** between component and web service providers
- **Container:** between container providers
- **Networking:** between network providers

(adapt. from Martinka et al 1998, Pruyne2000, Woolter et al 2001, Lammana et al 2002,)

However, Lamanna et al (2002) concede that the efficacy of SLAng does need further validation through assessing the benefits of inserting SLAng instances into standard XML-based deployment descriptors and also in testing the effectiveness of SLAng for monitoring compliance to SLAs. However, SLAng does appear to provide a language to capture SLA related information and is compatible with the ebXML framework that will serve as the basis for the LAURA project implementation (see sections 3 and 4.1 above).

4.3 Dynamic QoS Management Framework

SLAng-based service agreements can constitute the data model for the QoS and Q2B based business quality enforcement discussed in sections 2.3 and 2.4 above. Taking an eclectic approach to draw on previous work in the areas of QoS and SLAs provides a valuable and useful basis for the development of an initial framework to guide the implementation of these aspects into the LAURA project. Figure 1 reflects the structure of the framework and possible flows of information between the components while business interactions between the parties are to be carried out using ebXML-based implementation.

This initial proposed framework is based on the following main ideas that are of direct relevance to the implementation of QoS and SLAs within the LAURA project:

- Specification of the SLAs using a flexible XML-based language
- Monitoring of business services performance at runtime using middleware-specific interceptors and XML-based data structures combining metrics of both performance and business features
- Comparison of actual performance metrics against the parameters specified in the SLAs
- Calculating statistical correlation between the infrastructure-level QoS and the overall business performance, e.g. profit, through usage of business metrics associated with e-transactions
- Notification of users and managers upon certain conditions when level of QoS threatens business-level performance of the services

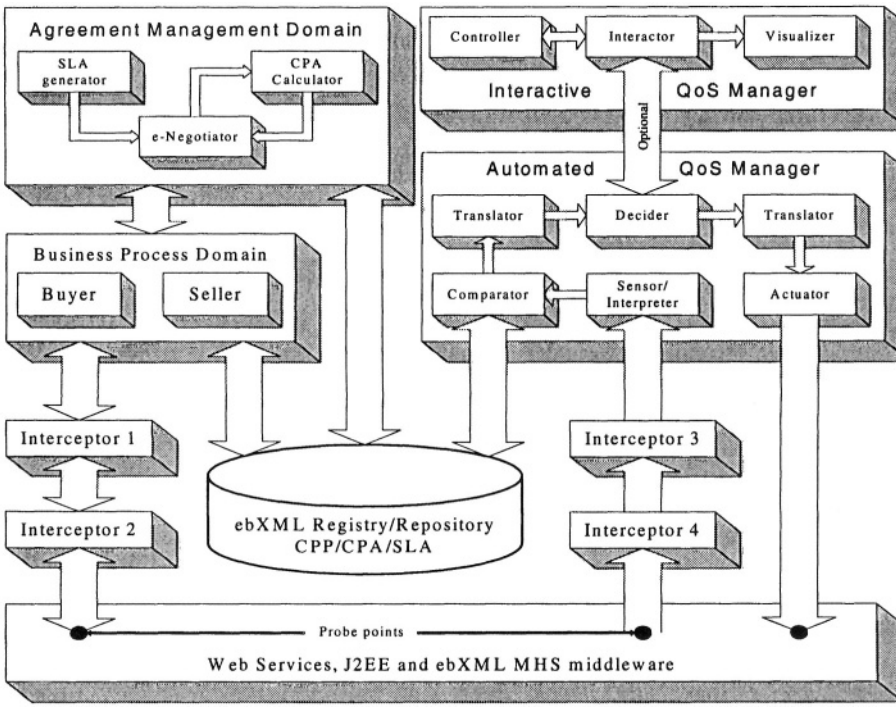

Figure 1 - Dynamic QoS Management Framework

- Dynamic adaptation and optimisation of business workflows according to the results of monitoring and comparison (with or without) human interaction
- Usage and enhancement of ebXML CPP/CPA mechanism to associate comprehensive SLAs to business collaboration
- Usage of ebXML registry to store the SLA data for run-time access

The LAURA project team currently is working on definition of flexible SLA templates adaptable to various industry sectors and geographical regions. The SLAs will provide the basis negotiate the terms of the business transactions and to measure business quality of service.

5. CONCLUSIONS

This paper discusses the need for QoS management in the context of RBVOs, the initial attempts to formalise business-level QoS and the early work of applying them in practice in the LAURA project. In general, there are ways to implement business level quality of service, however

instrumentation and models need further elaboration as more parameters will be needed to support a realistic e-business SLA.

The ebXML framework will play a key role in supporting QoS management through Collaboration Protocol Agreements. The LAURA project partners are already progressing towards a 'proof of concept' sector-specific SLA for monitoring business service compliance to the SLA and other related aspects of business level QoS. The concept of a RBVO implies close interdependence and SLAs will be a fundamental component in ensuring that contractual obligations are monitored and adhered to.

We have referenced two important concepts of business QoS management: the specification of SLAs in a technology-independent manner and a dynamic service monitoring and management framework based on the interrelation between QoS metrics and tangible business-level parameters. These two concepts combined provide a good basis for an ebXML-compliant business QoS management framework. Another area of research in the near future related to this framework is the provisioning of pluggable negotiation implementation components to calculate a CPA from a set of CPPs, as the ebXML specification leaves this to implementers.

The ideas and work related to QoS and SLAs discussed in this paper will inform continuing research to building and testing the validity of a technology framework for the LAURA project to support the concept of RBVO based adaptive e-commerce zones.

REFERENCES

Byrne, J. A., (1993), The Virtual Corporation, International Business Week, 8 February 1993, pp. 36-41

Chiu, E., ebXML Simplified: A Guide to the New Standard for Global E Commerce, John Wiley & Sons; 1st edition (June 15, 2002)

Diao, Y. et al., Hellerstein, J.L., Parekh, S. Using fuzzy control to maximize profits in service level management, IBM Systems Journal, Vol. 41. No 3, 2002, p.p. 403-420

Davidow., D. H., Malone, M. S., (1993), The Virtual Corporation: Structuring And Revitalising The Corporation For The 21st Century, New York, Harper-Collins

ebXML & OASIS (2000), "ebXML Business Process Methodology Guidelines", http://www.ebxml.org/project_teams/business_process/wip/ccbp-analysis/eMethodologyGuidelinesV0_3a.pdf, accessed March 2003

ebXML (a) Collaboration-Protocol Profile and Agreement Specification, http://www.ebxml.org/specs/ebCCP.pdf, accessed March 2003)

ebXML (b) Technical Architecture Specification, http://www.ebxml.org/specs/ebTA.pdf, accessed March 2003

Frolund, S., Koistinen J. QML: A Language for Quality of Service Specification. Software Technology Laboratory, HP Laboratories, HPL-98-10, February, 1998

Foster, I., Kesselman, C. and Tuecke, S. The Anatomy of the Grid: Enabling Scalable Virtual Organizations. International Journal of High Performance Computing Applications, 15 (3). 200-222. 2001. www.globus.org/research/papers/anatomy.pdf

Goldman, S. L., Nagel, R. N., Preiss, K., (1995), Agile Competitors And Virtual Organizations: Strategies For Enriching The Customer, New York: Van Nostrand Reinhold, International Thomson Publishing

HP ChaiServer Framework http://www.hp.com/emso/products/chaisvr/index.html, 1998

HP Web Services Platform: a Comparison with HP e-speak, 2001, http://www.hpmiddleware.com/downloads/pdf/espeak_webservices.pdf

IBM, Quality of service: Evolving to the next generation, October 2001, http://www-1.ibm.com/partnerworld/pwhome.nsf/vAssetsLookup/QOS.pdf/$File/ QOS.pdf

IDC, Quality of Service for eBusiness: - The Impact of Infrastructure, An IDC Brief, December 2000, http://www-1.ibm.com/partnerworld/pwhome.nsf/vAssetsLookup/IDC_QOS.pdf/$File/IDC_QOS.pdf

Jin, L., Machiraju, V., Akhil Sahai, A, Analysis on Service Level Agreement of Web Services, Software Technology Laboratory, HP Laboratories, Palo Alto, HPL-2002-180, June 21st, 2002

LAURA project on the IST Web site http://www.cordis.lu/ist/projects/projects.htm, accessed September 2002

LAURA The LAURA project official Web site. http://www.lauraproject.org , accessed March 2003

Lamanna, D., Skene, J., Emmerich, W. SLAng: A Language for Defining Service Level Agreements. 2002, http://www.cs.ucl.ac.uk/staff/d.lamanna/tapas/SLAng.pdf

Manthou, V., Vlachopoulou, M., Folinas, D., The Supply Chain Perspective Of E-Business Evolution, (2002), in Towards the Knowledge Society: eCommerce, eBusiness, and eGovernment, pp229-242, Monteiro, J., Swatman, P. M. C., L. Valadares Tavares (eds.), The Second IFIP Conference on E-Commerce, E-Business, E-Government (I3E 2002), October 7-9, 2002, Lisbon, Portugal. IFIP Conference Proceedings 233 Kluwer 2002, 766pp, ISBN 1-4020-7239-2

Martinka, J., Pruyne, J., Jain, M. Quality-of-Service Measurements with Model-Based Management for Networked Applications, Software Technology Laboratory HPL-97-167 (R.1) September, 1998

Meade, L. M., Rogers. K. J., A Method for Analyzing Agility Alternatives for Business Processes, Proceedings of the Sixth Industrial Engineering Research Conference. Miami Beach, FL. 1997. pp. 960-965.

(MIT 2003) The MIT License, http://opensource.org/licenses/mit-license (accessed May 2003)

Muller Nathan J. (1999), "Managing service Level Agreements", International Journal of Network Management, 9

Pruyne, J., Enabling QoS via Interception in Middleware, Software Technology Laboratory HP Laboratories Palo Alto HPL-2000-29 February, 2000

Preiss, K., 1995. Models of the Agile Competitive Environment. Bethlehem, PA: Agility Forum.

(OFBiz 2003), The Open For Business Project, http://www.ofbiz.org (accessed May 2003)

Saabeel, W., Verduijn, T. M., Hagdorn, L., Kumar, K., (2002), A Model Of Virtual Orgasnization: A Structure And Process Perspective, Electronic Journal Of Organizational Virtualness, Vol. 4, No. 1

Sahai, A., Ouyang, J., Machiraju, V., Wurster, K. Specifying and Guaranteeing Quality of Service for Web Services through Real Time Measurement and Adaptive Control, E-Services Software Research Department, HP Laboratories, HLP-2001-134,

Sahai, A., Durante, A., Machiraju, V. Towards Automated SLA Management for Web Services, Software Technology Laboratory HP Laboratories, Palo Alto, HPL-2001-310 (R.1), 11 July 2002

Schmidt, H., Service Level Agreements based on Business Process Modelling, http://www.darmstadt.gmd.de/%7Ewombach/sem_proc_02/schmidt00service.pdf

Sieber, P., Griese, J., (1999), Virtual Organizations As Power Asymmetrical Networks, Organizational Virtualness And E-Commerce, 2nd International VoNet Workshop, Zurich

Tapscott, D., 1996. The Digital Economy: The promise and peril in the age of networked intelligence. McGraw-Hill. 342 pp. ISBN 0-07-063341-8.

http://www.opengroup.org/public/member/q202/documentation/forums/qos/tunney.pdf

(VO 2002) Virtual Organization – A whatis Definition http://whatis.techtarget.com/definition/0,,sid9_gci213301,00.html (4th Nov 2002)

Wolter, K., van Moorsel, A. The Relationship between Quality of Service and Business Metrics: Monitoring, Notification and Optimization