Service Collaboration Environment

Martin Henkel[1], Jelena Zdravkovic [1,2], Erik Perjons[1]

[1] Royal Institute of Technology and Stockholm University
Forum 100, 164 40 Kista
Sweden
martinh, perjons@dsv.su.se

[2] Department of Computer Science,
University of Gävle
Kungsbäcksvägen 47, 80 277 Gävle
Sweden
jzc@dsv.su.se

Abstract

The extended use of services for cross enterprise collaboration rely on that the use and provisioning of services are simple, and yet that the provided services follows a coherent set of rules for their behaviour and interaction. This balance between simplicity and regulation is crucial for the stepwise evolution of both business and software services. In this paper we present the concept of a service collaboration environment to denote a domain of services working under a limited set of regulations. We use the theory of competitive market forces to define a set of guidelines that aims to enable service growth by stimulating new service consumers and providers to enter the environment. Furthermore, the guidelines, being both technical and business oriented, can be applied to balance the competitive forces from service consumers and providers.

Key words: software service, integration, service market

1 Introduction

The use of software services have started to evolve from point-wise use within single organizations towards large-scale use across enterprise boundaries. From a technology point of view standardised technologies such as SOAP and WSDL pave the way for simpler and thus cheaper integration of systems. Trends such as outsourcing and process based business engineering promote the use of services from the business perspective.

Increasing the extent of service use and the number of actors involved put emphasis on finding a sustainable model for how services should be managed and regulated both on a business and on a technical level. In a controlled environment, such as an organizations intranet, strict rules might be applied for the interaction and design of services. However putting up such restrictions for collaboration with external organizations might hinder new innovative actors from providing services. On the other hand, having no rules or regulations on the services an organization uses might result in the use of a number of incompatible services with varying quality. The innovative use of services relies on enough flexibility to allow new actors and at the same time enough regulations and infrastructure to uphold a required level of quality.

The balance between flexibility and regulation is especially required for domains where the overall quality and sustainability cannot be left to ad-hoc evolution. Examples of such domains are the health care sector and other areas regulated by the Government. Software services provisioned in these domains need to work under at least some form of supervision.

An example of a services working in an environment where the balance of regulation and simplicity is health care e-services supporting operations, health examinations etc. In the case of Swedish health services these are regulated on the national and county levels. For example, on the technical level the interconnection of software services in the County of Stockholm are currently undergoing regulation by a new service environment named Shared Health Care Data (“Gemensam Vård Dokumentation”, GVD). GVD defines standard interfaces for the exchange of patient information, as well as an infrastructure for exchanging messages among the “GVD compatible” systems. Incorporating new services into the GVD environment requires that they adhere to both the business and technical rules defined by the County council of Stockholm.

In this paper we suggest a high-level model of how to handle domains where extensive uses of multi-vendor software services are anticipated and desired. We use a notion of *Collaboration environment* to denote a network of interconnected services that work and evolve under a set of guidelines such that the environment gets “balanced”. By “balanced” we mean that the environment should stimulate both consumers and providers of services to use respectively supply new services. Thus neither the consumer side nor the provider side should

dictate the overall evolution of the environment. The guidelines are based on the now classical framework for assessing competitive forces and entry barriers by Michael Porter (Porter 1979). The guidelines are aimed at being applied by the party regulating the environment. In the case of the health care in Stockholm the guidelines would thus be implemented and enforced by the County council.

Our approach targets the high-level design of an environment of services and its evolution, rather than the ground-up design and development of single services. The research on design of services commonly focus on model-based requirement analysis (Ambler 2002, Ruiz 2005, Quartel 2004, Martin 2003) and thus forms a ground for the design of individual services in a well known environment. Even thought some research target the design of services that forms processes across business boundaries (Piccinelli 2002, Fremantle 2002, Papazoglou 2003, Hull 2003) there is a lack of analysis of what makes these processes and services work and evolve over time. Our contribution is to point out design guidelines that can control the long-run competitive forces exerted between consumers and providers. This work thus complements prior research on service design by pinpointing the design guidelines that affect the long-run sustainability of service collaborations.

The approach of using economic forces to analyze e-service environments are following recent years focus on modeling economic (i.e. value) based business constellations. For example Osterwalder and Pigneur (Osterwalder 2002), describes the logic of a "business system", interrelating product innovation, infrastructure management, customer relationship and financials. Also related to the work presented is this paper is Gordijn et al. (Gordijn 2003, Pascal 2004) who define "value web" as a concept for modeling creation, distribution, and consumption of economic values in a network of multiple enterprises and end-consumers. Further efforts to formalizing aspects of e-services using the theories of business service management and marketing are present in the OBELIX project (Akkerman 2004). In the project study, the authors emphasize the need for an interdisciplinary approach to services that relies not only on computer science but also on economics, systems theory, and business practice. The mentioned works addresses the important problem of modeling business values in a specific domain, while we in this paper focus on a domain-independent analysis of economic forces. A possible future work would be to combine modeling of a domain with the force analysis we perform in this paper.

We begin this paper with a short case description based on the health care project REMS (Section 2). We use this case throughout the paper to exemplify the guidelines. Section 3 introduces the notion of a "collaboration environment". In Section 3 we describe guidelines on how to balance the "market forces" that work within an environment. Section 4 concludes the paper by a discussion on the future extension of the guidelines.

2 The REMS Case Study

In order to illustrate the guidelines presented in this paper, we report on the work being conducted as part of the REMS project (REMS). The projects main aim is to develop a set of e-services that can be used to create, manage and transfer health care referrals between S:t Erik's eye hospital, primary care units and private eye specialists in Stockholm. The project also examines new methods that can be used when analysing and designing e-services in the healthcare region of Stockholm. As referrals are used as a mean to route a patient from a local physician to the correct level of specialist care, the problem domain is a complex mixture of actors, patient information and health care routines.

Figure 1 shows the main flow of the referrals today in the county of Stockholm: Having a problem with the eye(s), the patient first contacts the local primary care unit, in order to get investigated. If the primary care physician cannot help the patient, the physician may refer the patient to an eye specialist clinic for further investigation or treatments. A referral (a paper form) is sent to the clinic with information about the patient, including a first diagnosis or description of the symptoms. The clinic will review the referral and prioritize between all received referrals from primary care units around the county. The patient will then be booked on a certain day according to the prioritization. If there is a lack of physicians related to the number of referrals received, the clinic may pass the referral to a private eye specialist, which will carry out the investigation or treatments. When the patient is investigated or/and treated, a referral answer (a paper form) is sent to the primary health care, informing the primary care physician about the results from investigations and/or treatments. The set of e-services developed in the REMS project aims to solve problems like: the flow of referrals is not efficient because of manual routines, too many referrals has a low quality (i.e., missing information) which make it hard

for the clinic to carry out a appropriate prioritization, referrals may be lost because of manual routines and use paper forms.

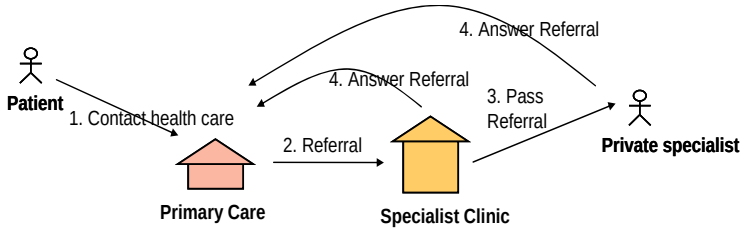

Figure 1, The flow of referrals between primary care units, the specialist clinic and private specialists.

Further, the developed e-services in the REMS project will be part of a future collaboration environment, consisting of a large set of coherent e-services supporting all health care units in the county of Stockholm. The idea is that the set of e-services in the collaboration environment should be used by different healthcare applications, which may combine different e-services from the collaboration environment. The collaboration environment, which is a e-services layer, will also be based on a common database, GVD , which is described in the Introduction. The County council of Stockholm has decided the business and technical rules for incorporating e-services into GVD. However, there is a lack of rules regarding the planned collaboration environment for e-services.

3 Collaboration Environment – Key Concepts

Clusters of services that serve a specific domain will evolve naturally. As stated in the introduction there exists domains where it is important to have at least partial control over the services. For this purpose we define a *collaboration environment* as *a set of interconnected and partially regulated software services that serve actors in a domain*. Companies that are in the forefront of service development (such as Sandvik (Henkel 2004)) have already developed a coherent set of services together with their sub-suppliers. Taken together these services form a market of services that can be interconnected. The drivers of increased business flexibility and lower cost will drive further evolution of services in these markets.

While services in an uncontrolled market can evolve freely and ad-hoc it is important for services in a collaboration environment to follow the regulations as specified in the environment. Our aim is not to invent new technologies that support such an environment but rather discuss the forces that influence how the environment of services evolves.

For clarity we first discuss the concept of *service* and then classify a set of *roles* involved in the environment. In Section 4 we will then use these concepts to discuss the forces of environment evolution.

A *service* can be defined as a well defined piece of work that can be offered by a provider to a consumer. A service can be carried out manually or automatically. The latter is called an e-service, and is the focus of this paper. E-services provided in a collaboration environment are used through service interfaces. A service interface can either be constructed for direct use by a person or by a system. For example, a service aimed at direct use by a (human) user may be constructed as graphical web interface, while an interface for system to system communication might be constructed following the Web service standards WSDL and SOAP (Gudgin03). Central to the concept of service is that it is provided by an actor, commonly an economically independent unit. Examples of actors in the health care sector are hospitals and private specialists.

Related to the concept of e-services is the concept of service-oriented architecture (SOA) (WSA 2004). Commonly a service-oriented architecture involves the roles of service provider and service consumer. In a collaboration environment we add the role of *environment supervisor* to represent the authority setting the rules for the environment. The roles have the following responsibilities:

The *service provider* is responsible for the run-time availability of the provided service, as well as the responsibility for actually performing of the service upon request. The provider is an actor working in the domain of the service environment. This means that while IT specialists might construct the actual software source code for the service it is the business related actor that is responsible for the service in run-time. Likewise,

the provider is still responsible for the service if the technical provisioning of the service outsourced to a third party, for example a web-hotel in the case of a web application. A driving force behind suppliers of services is that consumer usage of the service renders profitable work, or that service usage reduces cost or increases quality compared to other manual alternatives.

The *environment supervisor* is the initiator of the environment and governs the rules that the services must follow. For example, the supervisor might define minimum requirements for security, or define the communication standards that must be used within the environment. The requirements can be represented as for example a business rules, a concrete standard or as an infrastructure service. For example in the case of GVD the County council has defined a set of services that must be used in order to authenticate a user. Such infrastructure services are a way for the supervisor to exert control over the services in the environment. Another example is the use of standardized information structures such as HL7 (HL7 2003) for the health care domain.

The *consumer* of the services uses the services. For example a hospital might use the services of private specialist in order to short patient queues. In the case of a system-to-system service the consumer must have its own system to take advantage of the provided service.

The growth of a service collaboration environment can be measured not only in the amount of services, but also in the number of consumers and providers. A useful service might attract new consumers into the environment, while providers might enter the environment to attract new consumers or lower its costs. However, as will be described in the next section, there might also be hinders in the environments that repels possible new providers and consumers, thereby stalling the evolution of the service environment.

4 Forces in the Evolution of a Collaboration Environment

Every collaboration among actors in a business environment are driven by, and affected by, a set of forces exerted by the collaborating parties. For example, a new service provider that enters a service environment might compete with existing providers, thereby giving consumers an increased ability to select provider. In this case the force of *consumer bargaining power* increases. The environment supervisor can also exert the environment for forces, by setting rules. On an high level the collaborating parties in a service environment are affected by the rules similar to that on an economic market. We therefore employ Michael E. Porters theory (Porter 1979) on competitive markets to analyze these forces. Four main forces are defined in Porters framework; Bargaining power of suppliers, bargaining power of consumers, threat of substitutes and the threat of new entrants (Figure 2).

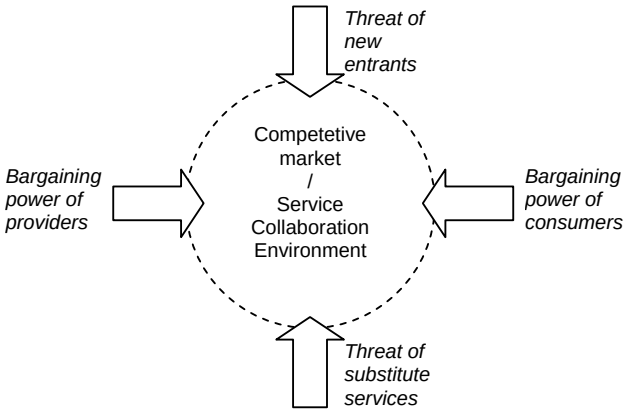

Figure 2, Forces affecting service collaboration (adjusted from Porter, 1979)

These four forces influence a market of products, or services, as in the case of a collaboration environment. Actors active in the environment will take strategic decisions based on the strength of the forces, and change the use or provisioning of services accordingly. These strategic movements in the market are in (Porter 1979) referred to as the fifth force. A balance of the forces results in what economists call a "perfect market", where there is healthy competition that drives the evolution of the market. However, unbalanced forces might result in monopoly situations, as in the case if powers of suppliers are not matched by either consumer power or threats of new entrants, or both.

An environment supervisor, for example the County council of Stockholm, can balance the forces by setting management and architectural rules. We consider rules set in business terms as being "business" rules, while rules set on the software architecture are considered to be "technical" rules. For example, setting rules on specific contracts that must be used within the environment are a business rule, while specifying that all service must use the SOAP protocol (Gudgin 2003) is a technical rule. By setting rules the environment supervisor pushes the environment in certain directions with the aim to support new innovative services and actors. Taking the environment supervisor regulating powers into consideration is in line with extensions to Porters initial work, (Carr 2005) defines a sixth force as being exerted by the government.

In the following, we will use the five forces to identify technical and business guidelines that aid an environment supervisor to steer a collaboration environment. The guidelines are meant as being a basis for formulating rules.

4.1 Bargaining Powers of Providers

The bargaining power of providers represents the control the provider has over the consumers in the environment. A powerful provider might dictate both the business and technical rules for the use of its services. By analysing the features/problems of an environment that got powerful providers we can identify guidelines that work to balance these powers. The following features (extracted from (Porter 1979)) and corresponding guidelines can be defined for an environment with powerful providers:

- Provider power in form of *unique or highly specialised service interfaces.* Having unique service interfaces means that the consumer are tightly coupled with the provider – it is simply difficult for the consumer to change provider since its means the consumers need to make extensive changes to its systems. To counter this situations the environment provider should *provide a clear development path for service interfaces* – from point-to-point interfaces towards highly specified interfaces that can be implemented by several providers. In the REMS case this guideline would mean that a standardised interface for sending referrals would be beneficial since it would enable service consumers to easily communicate with multiple providers (e.g., if a specialist physician at the clinic need to pass a referral to a private specialist, the physician at the clinic will be able to choose among several private specialist physicians).
- Provider power due to *forward integration*. Forward integration is when a service provider incorporates a part of the consumers business, and thus provides "larger" services. In the REMS case an example of forward integration would be if clinics would provide the same services as offered by the primary health care. This could result in that a single provider that would be strong in that it encloses a large chain of services – from basic health examinations to specialist eye-surgery. To balance this situation the environment supervisor could *pose requirements for modularized services*, thereby allowing consumers to combine services from different providers.
- Provider power due to that the customers using the service environment are *not vital for the provider*. A reason for this could be that the bulk of the providers business are derived from other sources. In order to carry out its business the provider is thus not dependent on the existence of the service collaboration environment. For example, if the private specialists already have enough patients, the private specialist may not opt to connect to the environment for receiving referrals from clinics. An action that could balance this power is for the environment supervisor to *make a clear statement that future business will be done using software services* in the collaboration environment. In the REMS case an example of such statements would be if the County council announced that all future referrals to private specialist would go through the collaboration environment, this would force providers to start interact with the services in the environment.
- Provider power due to the *domination of a few providers*. If there is only a few set of providers in the environment the drawback could be that these providers may stall innovation. The few providers may also pose a limiting factor if the need for services increases. In the case of the REMS case it would be a problem if only one clinic provided booking of eye examinations through services in the environment, while the private specialists do not provide such e-services. However, in this case eye-examinations can be carried out at, and booked at, private eye-specialist as well. To counter the possible problem of having few providers the environment supervisor can make it easy to enter the market for (new) providers, by making the specification for e-services easy to understand and use. This will facilitate for (new) providers to develop e-services, increasing the threat of new entrants (for guidelines, se further description of the threat of entrants force).

4.2 Bargaining Powers of Consumers

The force of bargaining powers of consumers represent the consumers powers to select services, and to govern the overall evolution of services by having a strong influence on the terms of service use. To some extent these forces are balanced by the bargaining powers of providers. Based on (Porter 1979) we distinguish three features of this force, and set guidelines that balance these:

- Consumer power due to that *purchasing of services are done in large volumes*. Purchasing (the execution of) services in large quantities can be done by for example having long contractual times – for example a year. Further, bulk byes means that smaller providers can not participate – they simply cannot provide the amount of services. An REMS example of long contract times that might increase the power of consumers, would be that the County council of Stockholm set yearly limits on the amount of referrals that the specialists can receive. To counteract this, the supervisor can make it possible (and preferable) to *make contracts on service use on shorter time intervals*. The extreme would be the possibility to change provider for each service use (this is referred to as just-in-time binding, (Andrade 2001)), rather than having a yearly contracts negotiated.
- Consumer power due to that the used services are *non-unique services*, there simply is no difference between provided services, the consumer can therefore switch provider very easily. If services follow exactly the same specification, there is no possibility for providers to excel and provide a better service. For example, if the quality of services is not considered when the clinic chooses e-services among the private eye-specialist, all services are considered to be equally good. To counter this it is desirable to make it possible for a provider to differentiate their services, but still follow the overall service specifications. An overall goal for the environment supervisor is to *enforce the use of quality criteria's when specifying and selecting services*, thereby letting providers differentiate their services in quality terms.
- Consumer power by *backward integration*. This means that consumers by themselves provide the same services as their (potential) providers and are thus not inclined to use the services in the collaboration environment. Note that this situation is the opposite of a provider power, namely forward integration. In the REMS case an example of backward integration would be if the primary health care, or opticians, would start to perform advanced treatment offered by the eye specialists. For a potential consumer (patients in this case) it would in this case not be possible to combine services from different providers. The environment supervisor can counteract this situation by following the same guidelines as for forward integration, by *enforce modularised services*.

4.3 Threat of new Entrants

The force of threat of new entrants constitutes the potential of new providers that enters the collaboration environment and thereby pose the threat of changing the balance – to the consumer advantage. Seen from a positive side new entrants can provide new innovative services. Hinders for new providers are entry barriers. We identify two entry barriers, and corresponding guidelines that can lower them in a collaboration environment:

- Entry barriers due to *advantage of scale* for existing providers. An example of scale advantage is large providers, such as clinics, that due to their size can have its own IT staff. These providers have no problem cooping with advanced technology. For smaller (presumptive) providers, like private eye-specialists, the cost associated with the (technology) required to enter the collaboration environment is an entry barrier. This entry barrier can be amended by making it easier for a provider to enter the environment in a small scale by *setting low initial requirements on required technologies and their complexity*.
- Entry barriers due to missing (or costly) *access to distribution channels.* In the case of software services the distribution channel is the technologies that transfers messages to the receiving services, for example message middleware servers. A step that can be taken to limit this barrier is to *make the distribution channel available for all providers*, following available protocols. If necessary, the environment supervisor can host necessary middleware servers for message routing and translation, thereby avoiding provider control off the communication means.

4.4 Threat of Substitute Services

If it is possible to substitute a service for another without affecting the consumer, new service implementations (both technical and business) can be introduced. We define a single feature for the threat of substitute services:

- A service might easily be *substituted* for another service if it is fulfilling the same consumer need. A substitute service is a service that has the ability to replace an existing service, using the same interface, but with a different "content". Porter (Porter 1979) takes the example of cheap corn syrup replacing traditional sugar in the food industry. In the context of the REMS case, it could be the case that new ways of doing eye examinations replaces older methods. From the overall development of the environment this is positive – it can lead to higher quality or decreased costs. A guideline for the design of services interfaces is that they should, as far as possible, *be independent on how the service is performed*. Service interfaces should focus on the required input and on the result. An example in the REMS case would be to avoid parameters coupled to a special way of doing eye-examinations.

The guidelines presented above can be categorized as working on two different levels, technical and business levels. We consider guidelines set in business terms as being "business" guidelines, while rules set on the software architecture are considered to be "technical" guidelines. For example, a guideline proposing rules on the contracts that must be used within the environment are a business guideline. Specifying that all service must use the SOAP protocol is a technical guideline. The application of the guidelines will be manifested as either a constraint in the technical requirements or a business constraints exerted by the environment supervisor. In the following table we classify and summarize the described guidelines:

Table 1, Summary of the presented guidelines

Category	***Affects/controls force***	***Guideline***
Technical	Provider power	*Provide a clear development path for service interfaces, from point-to-point to standardized interfaces*
	Provider power	*Pose requirements for modularized services*
	Consumer power	*Pose requirements for modularized services*
	New entrants	*Set low initial requirement on required technologies and their complexity.*
	New entrants	*Make the distribution channel available for all providers*
	Substitutes	*Service interfaces should be independent on how the service is performed*
Business	Provider Power	*Make clear statement that future business will be done using software services*
	Consumer power	*Make contracts on service use on shorter time intervals.*
	Consumer power	*Enforce the use of quality criteria's when selecting services*

The success of applying these guideless lies both in the ability for the supervisor to detect unbalanced forces and to implement the guidelines in both the architecture and business requirements.

5 Conclusion

In this paper we have identified a set of business and technical service design guidelines that influences competitive forces among actors using software services. Some of the identified guidelines are well known in service oriented design, such as the use of standardised interfaces. The novelty of the approach is rather the combination of guidelines and the identified relation to competitive forces.

The main use of the guidelines is as a control mechanism for controlling a domain of interrelated services. Controlling such an environment is a delicate matter, over regulation will stall the development of new services, while less regulation might hamper the overall quality of the services. By using the guidelines it is possible to

issue rules to specifically counteract a single force (for example overly powerful suppliers), thereby avoiding over-regulation.

This work can be extended in several ways. First of all the relationship between business and technical guidelines could be clarified. For example, posing requirement on modularised e-services on a technical level might also pose corresponding requirement for a modularized business. Another area of extension would be to provide means to analyse a specific domain, such as health care, and provide tailored design guidelines. A promising way of performing such an analysis is the use of value models (Wieringa 2005).

Acknowledgements

The REMS project is funded by the Swedish agency for innovation systems (VINNOVA), the Stockholm county council and S:t Eriks eye hospital.

References

AKKERMAN H., BAIDA Z., GORDIJN J., PENA N., ALTUNA A., LARESGOITI I., (2004) “Value Webs Using Ontologies to Bundle Real-World Services” IEEE Journal of Intelligent Systems Vol 19, Iss 4, pp. 57-66.

AMBLER S.W., (2002) “Deriving Web services from UML models”, http://www-106.ibm.com/developerworks/webservices/library/ws-uml1/, March.

ANDRADE L., FIADEIRO J., (2001) ”Coordination Technologies for Web-Services”, OOPSLA Workshop on Object-Oriented Web Services, 2001.

CARR,N., (2005) “The Public wants your Profit”, Forrester Magazine, Issue 3.

FREMANTLE P., WEERAWARANA S., KHALAF R., (2002) “Enterprise Services,” Communications of the ACM, Vol. 45, No 10, October 2002.

GORDIJN J., YAO-HUA T. (2003) “A Design Methodology for Trust and Value Exchanges in Business Models”, On-line proceedings of the 16th Bled eCommerce Conference. http://ecom.fov.uni-mb.si/Bled2003 , accessed 21-08-2006.

GUDGIN M., ET. AL., (2003) “SOAP Version 1.2”, W3C Recommendation,June, http://www.w3.org/TR/soap12-part1, June 2003.

HENKEL M. (2004) "Architectural Case: Sandvik", Technical report, The Serviam project, Document No Serviam-ARC-05, available at www.serviam.se, May.

HL7, Health Level 7 (2003), V2.5, ANSI standard, http://www.hl7.org, June.

HULL R., BENEDIKT M., CHRISTOPHIDES V., J. SU. (2003) “Eservices: A look behind the curtain”, In Proceedings of the International Symposium on Principles of Database Systems (PODS), ACM Press, San Diego CA, USA, June 2003.

MARTIN J., ARSANJANI A. ,TARR P., HAILPERN, B. (2003) "Web Services: Promises and Compromises," Queue vol. 1, pp. 48-58.

OSTERWALDER A., PIGNEUR Y. (2002) “An e-Business Model Ontology (eBMO) for Modeling e-Business”, In: the Bled EC Conference of the 15th Bled eCommerce Conference. http://ecom.fov.uni-mb.si/Bled2002 , accessed 21-08-2006.

PAPAZOGLOU M. P., YANG J. (2003) “Design Methodology for Web Services and Business Processes” In: Proceedings of the Third International Workshop on Technologies for E-Services, LNCS, Vol. 2444, Springer Verlag pp. 54–64.

PASCAL E., GORDIJN J., WIERINGA R. (2004) “Based Design of Collaboration Processes for e-Commerce” In: Proceedings of the IEEE International Conference on e-Technology, e-Commerce, and e-Services (EEE 04), IEEE Computer Society, pp. 349-358.

PICCINELLI G., EMMERICH W., ZIRPINS C., SCHÜTT K., (2002) “Web Service Interfaces for Inter-organisational Business Processes”, Proceedings of the 6th International Enterprise Distributed Object Computing Conference (EDOC’02). IEEE Computer Society, pp. 285-292.

PORTER M. (1979) "How competitive forces shape strategy", Harvard Business Review, March/April.

QUARTEL D. A. C., DIJKMAN R. M., VAN SINDEREN M. J. (2004) "Methodological Support for Serviceoriented Design with ISDL," in proceedings 2nd ACM International Conference on Service Oriented Computing (ICSOC), New York City, USA.

REMS (REferral Management and Support) Project, http://www.rems.se, last accessed 2006-06-29.

RUIZ M., VALDERAS P., PELECHANO V. (2005) “Applying a Web Engineering Method to Design Web Services”, 6th International Conference on Service Oriented Computing (ICSOC). Lecture Notes in Computer Science Vol. 3826.

WIERINGA R.J., J. GORDIJN, (2005) “Value-Oriented Design of Service Coordination Processes: Correctness and Trust”. 20th ACM Symposium on Applied Computing. ACM Press.

WSA, (2004) “Web Services Architecture”,W3C Working Group Note, February.