

# Designing a Risk-based Partner Selection Process for Collaborative Cloud Computing Environments

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**Abstract:** Cloud Computing represents a shift in technology and IT (information technology) service management and it opens up possibilities to build new organizational configurations. As in IT outsourcing, the selection of the right partner/vendor is of crucial importance. Thus, in this article we present a partner selection process for four Cloud Computing Environments: public cloud, community cloud, cloud chain and industrial cloud. We included data sensitivity and the risk attitude of the decision maker as major decision factors for partner selection. The constructed IT artifact (i.e. partner selection process) is evaluated by means of a conceptual evaluation (expert interviews) that demonstrates the applicability of the selection process.

## 1 Introduction

The advent of the internet, as well as advances in related concepts and technologies (as e.g. Cloud Computing) have led to an increase in research on Collaborative Networks and inter-organizational business practices [CA05]. In the course of that, researchers increasingly focused on the inter-organizational use of IT instead of taking a solely intra-organizational view (cf. [KD96]). Cloud Computing is a new paradigm for the delivery of scalable IT services via the internet on a pay-per-use basis [Ar10]. In this context, the term ‘cloud’ refers to data centers that offer virtualized computing resources and services. The combined investigation of Cloud Computing Services and Collaborative Networks results in new collaboration types with a focus on resource sharing. In this paper we posit that Cloud Computing works on the same basic principles as all Collaborative Networks: two or more businesses that are largely autonomous and geographically distributed collaborate with each other and are supported in this by IT networks [CA05, WRT09]. Thus, the sourcing of Cloud Computing services always implies some degree of dependency on external partners and a certain level of risk for each participating unit [KD96, Ar10]. One of the biggest challenges regarding the success of Collaborative Networks is the selection of partners in inter-organizational business settings [WCB91]. In view of all this we propose a partner selection method for conceivable Cloud Computing Environments with a focus on risk and security factors.

We aim at developing a new partner selection method for the field of Cloud Computing. The conceptual elaboration of the IT artifact is based on a systematic literature review focusing on terms from the field of Cloud Computing and provider/vendor selection that have been applied to publisher independent journal data bases [MT09]. Overall we identified a sample of 113 articles published in journals and conference proceedings. Finally we improved the artifact by means of three expert interviews. The interviewees were experienced practitioners and academics with 3 to 10 years of work experience in the field of Collaborative Networks, Partner Selection and IT outsourcing.

### 3 Reviewing Cloud Computing and Partnership Formation

Researchers have especially focused on gaining more insights into Cloud Computing and its multiple facets. For instance, Youseff et al. [YBS08] propose an ontology, which illustrates the relevant factors of Cloud Computing and their relationships. As yet, little research has been conducted on the success factors and the risks associated with Cloud Computing Services [MT09]. Koehler et al. [KAD10] found that the average reputation of the Cloud Computing Service provider and the use of standard data formats are more important than financial aspects such as cost reduction or pricing tariffs. Armbrust et al. [Ar10] present a list of ten obstacles for Cloud Computing, of which the following four are assumed to affect adoption: availability/business continuity, data lock-in, data confidentiality and auditability. We found that several authors point out the importance of risk and security methods for Cloud Computing Services [YBS08, MT09]. From a vendor perspective, there are some obstacles affecting the growth of Cloud Computing as well as policy and business issues, e. g. data transfer bottlenecks [Ar10]. Nevertheless, Cloud Computing facilitates the introduction of new products and services without large investments in IT infrastructure [Pu09]. Pricing strategies and revenue models are suggested for instance by Pueschel et al. [Pu09] in order to exploit the economic opportunities offered by this emerging paradigm. The literature review revealed that only little research has been conducted in the field of Collaborative Networks. The only article on this topic that we could identify is the one by Włodarczyk et al. [WRT09], who deal with the aggregation of several private Clouds to reduce security risks, which can also be regarded as a form of Collaborative Networks.

The duration of collaborations between different companies or organizations can be described by the so-called life cycle of enterprise networks [TJ01]. By and large, the enterprise network life cycle can be divided into four different phases: a *preparation phase* (preparing, first sourcing of partners etc.), a *formation/setting up phase* (final partner selection, legal issues, contracts etc.), an *operation phase* (daily management of the network) and a *dissolution phase* (decomposition of the network). Therefore, partnership formation happens both during the preparation phase and in the formation/setting up phase. *Partner identification* is concerned with the identification of possible business partners. For example, Large [La09] distinguishes – next to the different request types – also the *internet* as a source for identifying conceivable partners. Additionally he lists *classical sources* such as personal contacts, professional journals, annual reports, trading catalogues and alike. Apart from these two categories, it is also conceivable to identify possible partners indirectly, that is, via *intermediaries*.

What all these categories have in common is the fact that they are self-initiated approaches. *Partner selection*, as the second and final step in the process of partnership formation, can be performed by means of several methods and techniques. In the literature review by Weber et al. [WCB91] and Zhang et al. [Zh04] 123 articles have been reviewed paying special attention to the criteria and methods used in the partner selection process. As regards the methods applied, the following three categories were initially proposed by Weber et al. [WCB91]: *linear weighting approaches*, *mathematical programming techniques* and *statistical/probabilistic approaches*. We have added another category to this three-way categorization, which includes all *other approaches* found in the literature that did not fit any of these three categories – as, for instance, serious games and simulations [Ha08], agent-based approaches [Pe07] or activity-based costing [RK97]. However, the results of the literature review give the impression that the selection of partners in the context of Cloud Computing has not yet received sufficient attention from the research community. To the best of our knowledge, we are the first researchers to apply the concept of partner selection to the realm of Cloud Computing Environments with a specific focus on risk and security.

## 4 Collaboration Types in Cloud Computing Environments

A selecting process for Cloud Computing partners/vendors needs to consider the individual characteristics of each Cloud Computing Environment in order to be effective. The following typology was developed deductively on the basis of scientific literature and evaluated by means of expert interviews. In Thompson's [Th67] seminal work on organizational theory, he described *pooled*, *sequential* and *reciprocal* interdependencies for an intra-organizational perspective, which were later mapped to the inter-organizational context by Kumar & van Dissel [KD96]. In the field of Cloud Computing we have identified collaboration configurations that share the same structural properties as these inter-organizational system types. This analogy led to the definition of three distinct Cloud Computing types which are conceptually depicted in Figure 1. The following description points to security and risk-related aspects that are relevant for the development of a partner selection method. In *Pooled Cloud Computing* one business actor sources a service from the central point. This might be represented either by a (standard) public cloud environment or a community cloud environment [Ar10]. In contrast to public clouds, community clouds are only available for members of a specific community (i. e. shared needs of a business community), where interdependencies remain the same, which is the reason why both belong to the same collaboration type. Community clouds provide a slightly higher security level than public clouds [WRT09]. Public availability has an enormous impact on risk management, for it requires high risk management effort, whereas limited availability to specific communities reduces the effort. *Sequential Cloud Computing* includes public clouds and represents a chain of interdependencies by means of service flows (cloud chain). The access to this type of cloud is usually open, resulting in a low security level comparable to that of (standard) public clouds. Finally, in *Networked Cloud Computing* the output of each point can become input for the other points, as happens, for example, in so-called industrial clouds [WRT09]. However, the fact that they constitute a closed network of private clouds guarantees for a high level of security [WRT09].

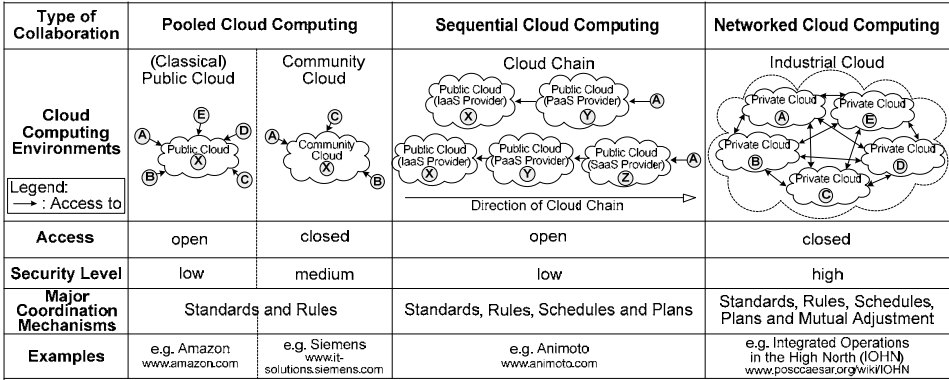


Figure 1. A comprehensive and risk-based overview of Cloud Computing Environments.

## 5 Development of a Partner Selection Process

The developed approach combines a standard partner selection process [CNR95, MF97] with a special focus on risk and security issues in Cloud Computing. The process is illustrated in Figure 2. The preparation phase starts with the prerequisites of a sourcing decision: the selection of a particular Cloud Computing Environment and the identification of potential partners. The formation phase comprises the actual partner selection and the initialization of the partnership. In addition to the actual process we added methods, theories and documents to individual process steps. Since we investigate the outsourcing of standardized Cloud Computing Services, we assume a newly arising requirement as the first process step (e. g. the demand for a new IT service triggered by a new business opportunity). This new requirement needs to be documented, analyzed and aligned to the business strategy and the IT strategy of the focal company [MF97]. This step is of particular importance for the follow-up activities because it accounts for security and risk requirements, too. The make or rent decision is made on the basis of the availability of internal resources and the ratio of production and sourcing costs. Next, the company needs to determine its requirements regarding the risk and security level of the IT service. During this step the risk attitude of the decision maker needs to be taken into account. If the company considers a relatively low security level sufficient and decides to enter an open access cloud it needs to distinguish between the Cloud Computing Environments “public cloud” (pooled Cloud Computing) and “cloud chain” (sequential Cloud Computing) (cf. Figure 1 and Figure 2). Within the former environment the focal company acts as an end user and within the latter environment as an intermediary. For the following steps of this track, we recommend applying the approaches discussed in Section 3. On the other hand, the process paths for closed access Cloud Computing types (community cloud and industrial cloud) with medium and high security levels can support companies in their search for existing community clouds or industrial clouds. Following the identification of suitable networks, the decision-making company retrieves more detailed information on these networks in order to review them and to set

up a ranking list. Finally, the company submits a request for membership to the best fitting network. If access to this network is denied, the next best one is applied for.

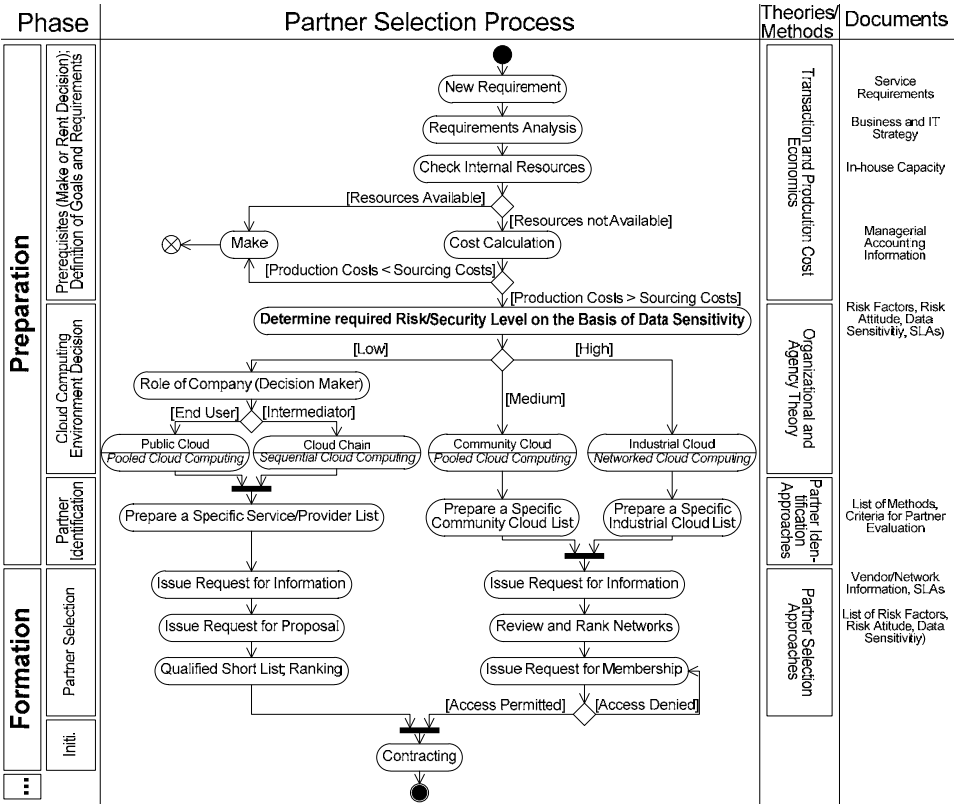


Figure 2. Partner selection process for specific Cloud Computing Environments.

## 6 Conclusions and Outlook

The presented methodic approach supports companies in selecting partners for collaborations in Cloud Computing environments and provides a strategic framework for such collaborations from a managerial, technological and organizational perspective. In this context, a strong focus was put on risk and security issues. In particular, the method serves to support companies with knowledge in the field of vendor management in Cloud Computing. We built the conceptual model (cf. Figure 2) on a deductive theoretical basis (theories and methods) and improved it iteratively by means of semi-structured expert interviews [Wal06]. Limitations of our approach lie in the limited number of decision factors we draw on (security and risk issues). Furthermore, we concentrated on the organizational forms Cloud Computing offers to companies. We are planning to adapt our method to the requirements of the different Cloud Computing Service types, which will mainly result in a modification of the first part of the process.

Furthermore, a closer look at interdependencies within clouds or between the participating collaboration partners could lead to important insights regarding the discussed Cloud Computing Environments. There are many interdependencies within industrial clouds. Partners in such a network are strongly dependent on each other, which offers new business opportunities, but also new risk factors.

## References

- [Ar10] Armbrust, M.; Fox, A.; Griffith, R.; Joseph, A.D.; Katz, R.H.; Konwinski, A.; Lee, G.; Patterson, D.A.; Rabkin, A.; Stoica, I.; Zaharia, M.: A View of Cloud Computing. In *Communications of the ACM*, Vol. 53, No. 4, 2010; pp. 50-58.
- [CA05] Camarinha-Matos, L.M.; Afsarmanesh, H.: Collaborative Networks: A New Scientific Discipline. In *Journal of Intelligent Manufacturing*, Vol. 16, No. 4-5, 2005; pp. 439-452.
- [CNR95] Chaudhury, A.; Nam, K.; Rao, H.R.: Management of Information Systems Outsourcing: A Bidding Perspective. In *Journal of MIS*, Vol. 12, No. 2, 1995; pp. 131-159.
- [Ha08] Hans, C.: Supporting partner identification for virtual organisations in manufacturing. In *Journal of Manufacturing Technology Management*, Vol. 19, No. 1, 2008; pp. 497-513.
- [KAD10] Koehler, P.; Anandasivam, A.; Dan, M.A.: Cloud Services from a Consumer Perspective Cloud Services from a Consumer Perspective. *AMCIS 2010*, Peru.
- [KD96] Kumar, K.; v. Dissel, H.: Sustainable Collaboration: Managing Conflict and Cooperation in Interorganizational Systems. In *MISQ*, Vol. 20; No. 3, 1996; pp. 279-300.
- [La09] Large, R.: *Strategisches Beschaffungsmanagement – Eine praxisorientierte Einführung*. Gabler, Wiesbaden, Germany, 2009.
- [MT09] Martens, B.; Teuteberg, F.: Why Risk Management Matters in IT Outsourcing - A Systematic Literature Review and Elements of a Research Agenda. *ECIS 2009*, Italy.
- [MF97] Michell, V.; Fitzgerald, G.: The IT outsourcing market-place: vendors and their selection. In *Journal of Information Technology*, Vol. 12, No. 3, 1997; pp. 223-237.
- [Pe07] Petersen, S.: Virtual enterprise formation and partner selection. In *International Journal of Networking and Virtual Organisations*, Vol. 4, No. 2, 2007; pp. 201-215.
- [Pu09] Poeschel, T.; Anandasivam, A.; Buschek, S.; Neumann, D.: Making Money with Clouds – Revenue Optimization Through Automated Policy Decisions. *ECIS 2009*, Italy.
- [RK97] Roodhooft, F.; Konings, J.: Vendor selection and evaluation an Activity Based Costing approach. *European Journal of Operational Research*, Vol. 96, No. 1, 1997; pp. 97-102.
- [TJ01] Thoben, K.-D.; Jagdev, H.: Typological issues in enterprise networks. In *Production Planning & Control*, Vol. 12, No. 5, 2001; pp. 421-436.
- [Th67] Thompson, J.D.: *Organizations in Action: Social Science Bases of Administrative Theory*. McGraw-Hill, New York, USA, 1967.
- [Wal06] Walsham, G.: Doing Interpretive Research. In *European Journal of Information Systems*, Vol. 15, No. 3, 2006; pp. 320-330.
- [WCB91] Weber, C.A.; Current, J.R.; Benton, W.C.: Vendor selection criteria and methods. In *European Journal of Operational Research*, Vol. 50, No. 1, 1991; pp. 2-18.
- [WRT09] Włodarczyk, T.W.; Rong, C.; Thorsen, K.A.H.: Industrial Cloud: Toward Inter-enterprise Integration. In *LNCS 5931*, Springer, Berlin, 2009; pp. 460-471.
- [YBS08] Youseff, L.; Butrico, M.; da Silva, D.: Toward a Unified Ontology of Cloud Computing. In *2008 Grid Computing Environments Workshop*, Austin, USA, 2008.
- [Zh04] Zhang, Z.; Lei, J.; Cao, N.; To, K.; Ng, K.: Evolution of supplier selection criteria and methods. In *Proceedings of the Second Globelics Conference Innovation Systems and Development, Emerging Opportunities and Challenges*, Beijing, China, 2004.