UNIVERSITÄT KOBLENZ · LANDAU

Institut für Wirtschafts- und Verwaltungsinformatik

FB 4 Informatik

Cloud Computing for Standard ERP Systems: Reference Framework and Research Agenda

Petra Schubert
Femi Adisa

Nr. 16/2011

Arbeitsberichte aus dem Fachbereich Informatik

Universität Koblenz-Landau • Campus Koblenz • Universitätsstraße 1 • 56070 Koblenz
Telefon +49 261 287-0 • http://www.uni-koblenz.de

Arbeitsberichte des Fachbereichs Informatik

ISSN (Print): 1864-0346
ISSN (Online): 1864-0850

Kontaktdaten der Verfasser

Petra Schubert, Femi Adisa
Institut für Wirtschafts- und Verwaltungsinformatik
Fachbereich Informatik
Universität Koblenz-Landau
Universitätsstraße 1
D-56070 Koblenz
Email : schubert@uni-koblenz.de, fa.caict@cbs.dk

Cloud Computing for Standard ERP Systems: Reference Framework and Research Agenda

Petra Schubert
University of Koblenz-Landau
Department of Computer Science
Institute for IS Research
Koblenz, Germany
petra.schubert@uni-koblenz.de

Femi Adisa
Copenhagen Business School
Centre for Applied Information and Communication Technologies – CAICT
Copenhagen, Denmark
ph.caict@cbs.dk

ABSTRACT

Cloud Computing is a topic that has gained momentum in the last years. Current studies show that an increasing number of companies is evaluating the promised advantages and considering making use of cloud services. In this paper we investigate the phenomenon of cloud computing and its importance for the operation of ERP systems. We argue that the phenomenon of cloud computing could lead to a decisive change in the way business software is deployed in companies. Our reference framework contains three levels (IaaS, PaaS, SaaS) and clarifies the meaning of public, private and hybrid clouds. The three levels of cloud computing and their impact on ERP systems operation are discussed. From the literature we identify areas for future research and propose a research agenda.

Keywords: Cloud Computing, Enterprise Systems, IT Outsourcing, IT Services

Table of Contents

1 Background and Research Question

"In the wake of the 2008-09 financial and economic crises, firms have looked for ways to consolidate their ICT infrastructures and services and increase returns on their investments. Cloud computing appears an attractive option." (OECD 2010, p. 148)

Cloud computing is a concept that has gained increasing attention over the last years (OECD Report, p. 27). In many ways it is not a completely new phenomenon as it incorporates elements of IT outsourcing which has been available for more than 10 years (e.g. the provision of software over the Internet or the housing of IT infrastructure for client companies). There are clear signs that companies' interest in cloud computing services is rising: "Demand for cloud computing services is expected to continue to increase; according to IDC, the market for cloud computing services will grow by around 40% in 2010" (OECD 2010, p. 148). Some authors argue that cloud computing represents the future way of using information technology in businesses (Barnatt 2010; Velte et al. 2010). They point out that obtaining computer power over the Internet could have a profound impact on the whole computer industry and rid companies from having to install software on their own internally operated systems. As a consequence, they will not need to purchase or maintain hardware and software that can simply be rented online.

1.1 Emergence of Cloud Computing

The development of services for cloud computing (as a particular form of IT outsourcing) has been stimulated by three complementary and very influential technological achievements:

1. *AJAX technology*
   which enables a client to communicate with the server in the background and to dynamically change Web pages without reloading them. AJAX technology helps create a "rich client", a so called RIA, and has boosted the use of thin clients and mobile devices. (Linthicum 2009, p. 190)

2. The concept of *multitenancy*
   which describes the shared use of an installation of a single software program by multiple client companies using their own, private, individual data spaces. (Velte et al. 2010)

3. Last and most importantly *virtualization*
   which enables the sharing of physical computer resources. (Babcock 2010, p. 51ff.)

AJAX makes rich clients possible and thus improves the capability of running an externally hosted application locally, *Multitenancy* is the prerequisite to the shared use of software, and *virtualization* allows for dividing of physical resources – all three together drive the cloud computing market.

Cloud computing, like similar forms of IT outsourcing, is heralding certain promises to user companies (also see Loh and Venkatraman 1995; Clarke 2010):

- The decrease of *capital cost* because the customer does not acquire hardware or licenses up front any more (OECD 2010, p. 147)
- *Cost* transparency e.g. through pay-per-use or subscription models (Ovum 2010, p. 10)
- The decrease of *operational costs* (Velte et al. 2010, p. 3; OECD 2010, p. 147)
- Increased *flexibility* for business processes due to lower switching cost (Iyer and Henderson 2010)
- Guaranteed *service level* (Mell and Grance 2009)
- *Simplicity* through commodity services (Ovum 2010, p. 10)

These advantages of cloud computing are backed by the latest Ovum report (2010) and the OECD 2010 report on information technology: "Cloud computing is one of the most discussed and publicized technologies of recent years. Interest in cloud computing is mainly motivated by its potential to reduce capital expenditures and to deliver scalable IT services at lower variable costs." (OECD 2010, p. 147)

On the other hand, the literature discusses some open problems (Clarke 2010; Linthicum 2010):

- Permanent access (if Internet connection is down the service is down) (Velte et al. 2010, p. 5).
- Service provided can be down (Velte et al. 2010, p. 6)
- Sensitive or proprietary information which cannot be stored outside the company does not allow for cloud computing in certain application areas

- Integration of applications run by different providers (Iyer and Henderson 2010)
- Lock-in with vendors (getting your data "out" when you want to move is connected to hefty moving fees) (Velte et al. 2010)
- Some vendors are not established players and might not be able to sustain their operations for long (Iyer and Henderson 2010)

1.2 Cloud Computing and ERP

This paper investigates the impact that cloud computing might have on the way standard ERP systems are operated (their "operations model"). ERP systems are integrated software packages with a common database that support business processes in companies (Staehr 2010). They comprise different functional modules that reflect the departmental structure of a company (accounting, procurement, sales, production, warehousing, etc.). They are developed and offered by ERP vendors and sold as "standard software" that fits the needs of many companies, often optimized for certain industries (industry or vertical solutions). Since ERP systems support the core processes and have to reflect the organizational structure of a company they come in many different sizes and specializations. Most importantly, they usually go through a substantial customization process to make them fit to the needs of a particular company; and they often need to be electronically linked with other software systems (e.g. legacy systems or partner systems). The feasibility of such adaptations need to be addressed before the decision for cloud computing is taken. Whilst there is little doubt that cloud computing can be beneficial in the areas of office computing and work group collaboration (Barnatt 2010), it is interesting to examine different forms of operating a complex business software system (such as an ERP system) in a cloud environment.

The parties that need to be discussed when looking at cloud computing as an operations model for ERP systems are the following:

1. User company (the company that uses the ERP system for their daily business processes)
2. ERP vendor (the company developing and selling licenses for the software)
3. ERP implementation partner (the company that supports the user company with the implementation), and the
4. Cloud service provider (the company running the cloud environment).

1.3 Definitions and Research Questions

There is no common definition of the term cloud computing in the literature yet (Velte et al. 2010. p. xiv). This paper synthesizes definitions and perceptions from a broad range of literature (academic and industry) and provides a framework of reference for IS research. We base our terms and definitions on the understanding reflected in the majority of literature sources and apply it to the area of ERP systems. At the basis, we are using the NIST 2009 definition of cloud computing which seems to have gained common acceptance in the literature (Mell and Grance 2009; Iyer and Henderson 2010; Babcock 2010; Vaquero et al. 2009; Buyya et al. 2009). The NIST definition describes different types of services in a layer model (infrastructure, platform, software) and distinguishes private, public, community and hybrid clouds depending on the exclusiveness of the service model. Table 2 contains terms and definitions and the following section explains these concepts in more detail.

The underlying research questions of this paper are the following:

What impact is cloud computing going to have on the operations model of ERP systems?

What are the future opportunities and challenges of cloud computing for ERP systems?

In order to discuss these questions, we first need to define and understand what exactly cloud computing is. For this we developed a reference framework of underlying terms and concepts. With the help of this framework we discuss cloud aspects which could be influential for ERP systems. Based on the literature and our own observations we then propose a research agenda for "cloud computing and ERP systems".

The remainder of the paper is structured as follows: First we present our literature analysis and the resulting reference framework for cloud computing. We then discuss the relevance of cloud computing for ERP systems. Next we propose and discuss an IS research agenda for cloud computing. The concluding section contains a reflection on our research findings and casts a look on future research.

2 Reference Framework for Cloud Computing

This section explains the research steps and introduces the reference framework for cloud computing.

2.1 Research Steps

We performed a review of the academic literature in order to identify the use (definitions) of terms and to analyze current topics and issues for cloud computing. Following Torrasco's guidelines for literature reviews we are providing an integrative literature review which is suited for topics that address new or emerging topics "that would benefit from a holistic conceptualization and synthesis of the literature to date." (Torrasco 2005, p. 357) Torrasco suggests that the outcome of such a work is normally a model or framework, the latter being ideally suited for our purpose. In essence, the literature review helped us (1) to define and clarify the problem, (2) to summarize previous investigations in order to inform the reader of the state of current research, (3) to identify relations, contradictions, gaps, and inconsistencies in the relevant literature and (4) to suggest the next step or steps in solving the problem.

Step 1 "*Source selection*": We began our search in the IS basket of eight top journals as according to Webster and Watson (p. xvi), major contributions in a field are likely to be in leading journals. Since cloud computing is a fairly new topic, our search yielded very few articles of relevance. We further extended the journal list to include 22 journals based on the Rainer and Miller (2005) MIS journal rankings.

This was supplemented by proceedings from eight IS conferences, including four that were considered major international conferences important for the IS field (Caya and Pinsonneault 2004, p. 2; Gonzalez et al. 2006, p. 822). Table 1 shows the number of papers that were found in the respective outlets.

Step 2 "*Time frame selection*": Although the term cloud computing was stated to have first been used in 2006 by Google's CEO, with the first Google Scholar article appearing in 2008 (Clarke 2010), we chose a time period of 2000 to 2010 to capture the development of the concept of cloud computing rather than picking up from when the term cloud computing started to gain prominence.

Step 3 "Paper selection": We started with the keywords" cloud computing", "software as a service" and "SaaS" and performed a snowball approach adding upcoming new keywords. A majority of the papers were discarded for irrelevance after reading them.

No. of papers	Outlet
0	MISQ, ISR, IJEC, I&M, ISJ, JACM, JCIS, IT&M, AJIS, JASIS, IJTM, SJIS, ECIS, CONF-IRM, MCIS, UKAIS
1	EJIS, JAIS, IS, AMCIS, MISQ exec, BLED, PACIS
2	JSIS, IJIM, ISM
3	JIT, ISF
4	CACM
5	JMIS
6	ICIS

Table 1. Number of papers found in the listed journals and conference proceedings

We used the literature review to (1) develop our definitions and the reference framework and (2) to identify themes for a research agenda. In the following section we introduce our reference framework for cloud computing. The research agenda will be introduced and discussed in the last section.

2.2 Definitions

Before engaging in the analysis of research issues in the literature, we needed to understand the phenomenon of cloud computing in detail. Table 2 contains the definitions which are pivotal to our discussion. In the first step we collected all available definitions (academic and industry) in a table. In the second step we identified the common concepts and distilled them into a single, coherent definition suitable for the area of ERP systems.

We then supplemented it with a graphical representation of the framework (cf. Figure 1). The suggested definitions reflect our common understanding and perceptions and are an important part of our research findings.

The definitions are grouped in three main areas:

1 = general terms and infrastructure
2 = service type (service model)
3 =cloud type (service boundaries)

#	Term	Definition	Source
1	Cloud computing	The operation of infrastructure, platforms and software in a virtualized environment whose components can be accessed and used over the Internet. The word “cloud” signals that services are offered without the need of explicit knowledge about where these services are physically located.	NIST 2009; Smith 2010; Johnston Turner and Gens 2009, p. 3; Clarke 2010, p. 573
1	Cloud service	Any provision of access to computing devices or human resources including hardware, software, networks or staff which are based on a cloud computing delivery model.	Smith 2010
1	Virtualization	The configuration of a physical server that allows installing multiple instances of virtual servers on a single machine.	Velte 2010, p. 317
2	Software as a Service (SaaS)	The provision of an application which is hosted (off premise) by a provider as a service to customers who access it via the Internet. In contrast to application service providing (ASP), SaaS is based on a multi tenant model where many customers are using the same program code but have their own private data spaces. SaaS is only suited for software “out of the box” that does not require much customization or integration with other applications.	Iyer and Henderson 2010; Velte 2010, p. 11
2	Platform as a Service (PaaS)	The provision of resources required to build applications and services (software development environment) to a customer by an outsourcing provider. Typical use scenarios are application design, development, testing and deployment.	Velte 2010, p. 13
2	Infrastructure as a Service (also called hardware as a service) (IaaS)	The provision of computing resources (CPU cycles, memory, storage, network equipment) to a customer by an outsourcing provider. In this service model it is possible to share a server among multi tenants. The service is typically billed on a utility computing basis (resource consumption).	Velte et al. p. 15
3	Private cloud	The provision of a cloud computing environment that is based on a collection of physical servers that are exclusively run for one customer. When referred to in an outsourcing scenario, the customer rents physical servers as a dedicated resource.	Iyer and Henderson 2010, p. 119; Velte 2010, p. 317; Iyer and Henderson 2010, p. 119; Mell and Grance 2009, p. 2
3	Public cloud	The provision of a cloud computing environment that is based on a collection of virtual servers where multiple customers share a physical hardware. In this outsourcing model the customer rents virtual servers on demand.	Iyer and Henderson 2010, p. 118; Velte 2010, p. 318; Iyer and Henderson 2010, p. 119, Mell and Grance 2009, p. 2
3	Hybrid cloud	The provision of a cloud computing environment that comprises two or more clouds (public and/or private). In this outsourcing model the customer operates (on premise) or rents (off premise) a base set of physical servers and adds virtual servers on demand.	Iyer and Henderson 2010, p. 120; Smith 2010, p. 25; Iyer and Henderson 2010, p. 120, Mell and Grance 2009, p. 2
3	Community cloud	The provision of a cloud computing environment that is shared by several organizations and which is managed by either a participating organization or a third party.	Iyer and Henderson 2010, p. 119; Smith 2010, p. 18; Iyer and Henderson 2010, p. 119; Mell and Grance 2009, p. 2
3	Internal cloud	Cloud network that exists entirely within a company’s own IT infrastructure (on premise)	Barnatt 2010, p. 95
3	External cloud	Cloud network that is provided to a customer by a cloud service provider on the provider’s IT infrastructure (off premise)	Barnatt 2010, p. 95

Table 2. Definitions of terms

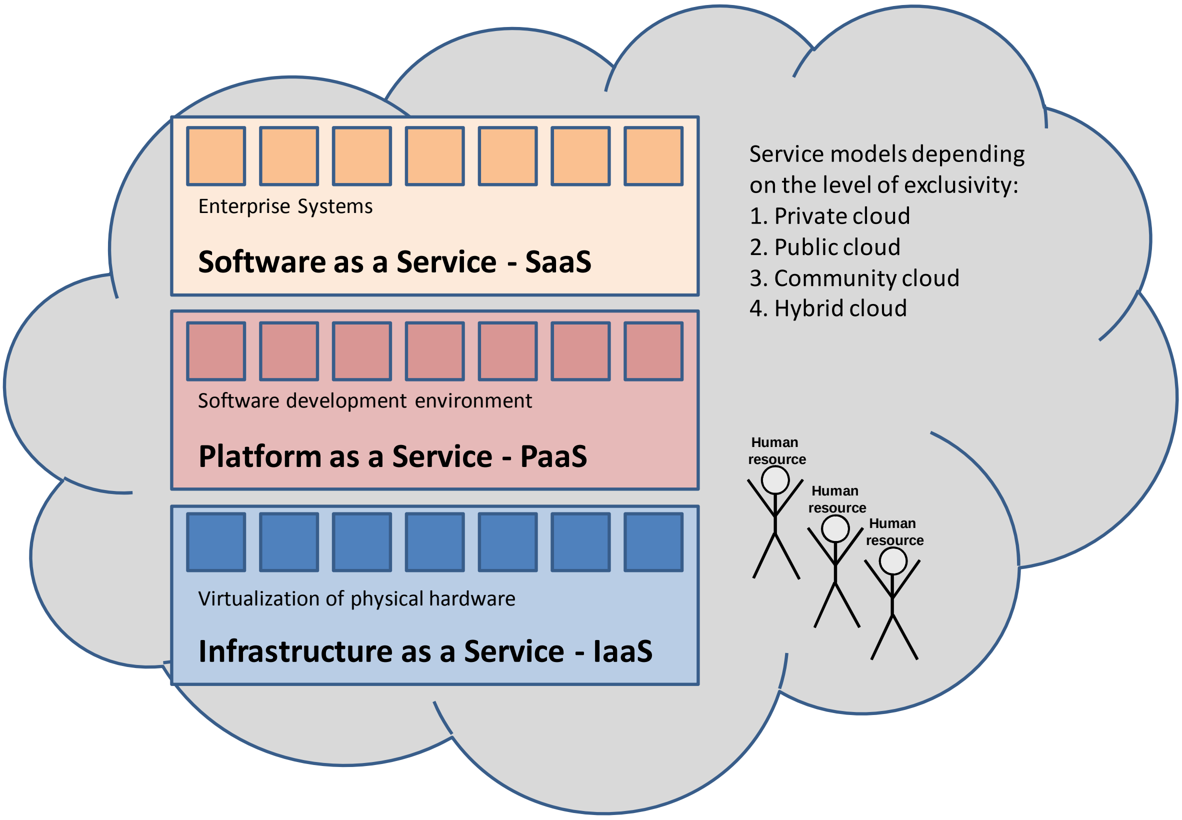

Figure 1. Level model for cloud computing

A key concept for cloud computing is server virtualization. Figure 2 shows a physical server which has been subdivided into three separate virtual servers. The virtualization software (e.g. VMWare) provides the necessary resources to the virtual servers. Each virtualized server perceives the system resources (such as CPU, memory, NIC, and disk) as unique to them (Velte 2010, p. 265). This topology helps switching virtual machine disks from one data storage system to another with no downtime and dynamically balancing the storage workload and addressing performance bottlenecks.

The "*public* cloud" is often just described as "available to everyone" and run by a third party (cf. Iyer and Henderson 2010, p. 118 or Velte et al. 2010, p. 318). While this describes the word "public" it does not really give an explanation on how this "public access" is technically realized. One option is the use of virtualization technology (cf. Figure 3) to share servers among many users.

As a logical consequence the user of a "private cloud" would then have the physical server at their exclusive use (as suggested by Barnatt 2010, p. 95). Even a private cloud could then, of course, still make use of server virtualization (but exclusively for this company). Such a virtualized environment could be called *private* cloud and be operated by a third party (*external* cloud) or the user company itself (*internal* cloud).

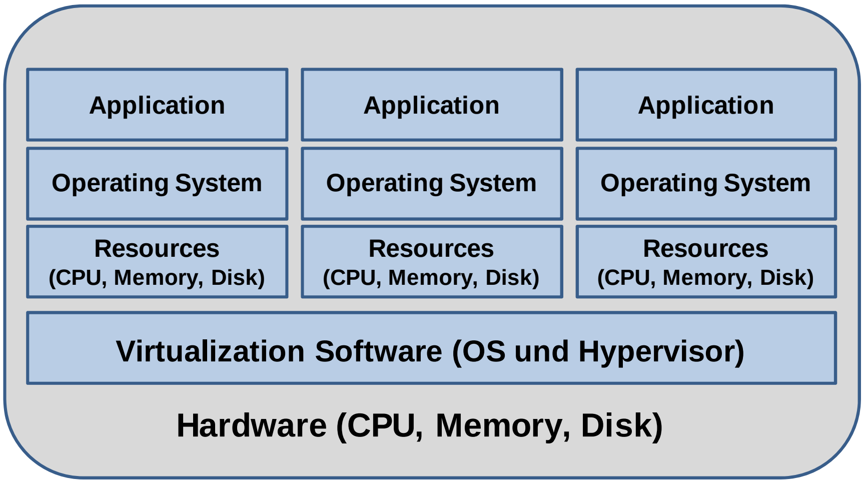

Figure 2. Server virtualization

We find the most controversial explanations for the term "hybrid cloud". Some see it as the combination of physical (private) servers as a permanent resource plus the on demand adding of virtual (public) servers (Barnatt 2010, p. 95). Others claim that hybrids combine two clouds that remain unique entities but that are bound together for enabling data and application integration (Mell and Grance 2009; Iyers and Henderson 2010, p. 120). We follow the first definition because it is the most useful concept from an IT management perspective due to its aspects of scalability and clear cost structure.

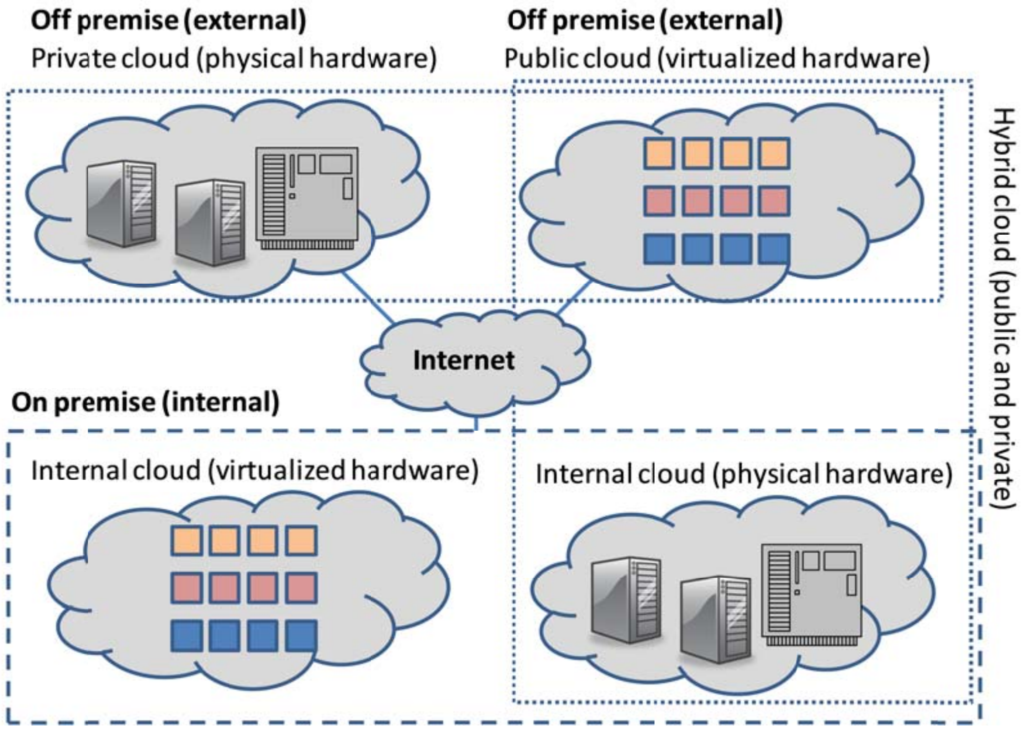

Figure 3. Cloud types

3 ERP Systems in the Cloud

ERP systems are the hardware and software systems that support business processes and are thus, by definition, complex systems that span different parts of the enterprise and often even beyond company borders.

A large part of the current discussion on cloud computing runs in parallel with advances in social software services (Facebook and Google). Many cloud offerings are suited for *private use* and use in small companies. The cloud service market boasts manifold examples for office computing.

The current literature is generally vendor-driven meaning that it discusses the possibilities of cloud computing by looking at current offers and not at the requirements of user companies (e.g. Barnatt 2010; Linthicum 2010; Ovum 2010; Iyer and Henderson). Most books on cloud computing show an overview of current offerings and classify them into the three different levels of IaaS, PaaS, and SaaS. Typical providers to name a few are: Google with Google Apps (SaaS), EMC Corporation (driving the virtualization market with their product VMware), Microsoft with Azure Services Platform (PaaS) and Windows Live (SaaS), IBM with Cloud technology consulting services and LotusLive (SaaS), Amazon with Amazon SimpleDB (PaaS) and Amazon EC2 (IaaS), Salesforce.com with The Sales Cloud (SaaS) and Force.com (PaaS). A list of cloud vendors can be found in Velte et al. (2010, pp. 319-326). Additionally, there are many SaaS providers that target private consumers and small businesses with office and collaboration software such as Zoho (databases), Salesforce (CRM), Employease (HR), Clarizen (project management), Netsuite (business apps), WebEx WebOffice (collaboration tools) (Barnatt 2010). These systems span the whole company, contain sensitive company-critical data and their data needs to be integrated to support seamless business processes.

3.1 IaaS for ERP systems

When using IaaS for the operation of an ERP system the user company "rents" the computing resources from a cloud service provider. In this setting the user company can still freely choose the ERP vendor of the ERP system and buy the licenses for the software. The market already indicates that this will be a viable operations model and ERP vendors (or implementation partners) and cloud service providers are likely to form alliances offering the user company a combined service. Vertical integration happens when the ERP vendor offers IaaS themselves and become a cloud service provider.

3.2 PaaS for ERP systems

We argue that the second level of the cloud model is not really suited for the provision of an ERP system. Platform services provide resources in a pre-defined software environment that are attractive for software development, testing, or the distribution of software but not for the actual operation of an ERP system.

3.3 SaaS for ERP systems

In the Software-as-a-Service model the ERP system is provided by the cloud service provider. The roles of cloud service provider and ERP vendor are merged in this setting (vertical integration). There are a number of new players coming up with offerings in the last years (in Europe e.g. e-conomic and Scopevisio). Some "traditional" ERP vendors have developed new versions that can be deployed in the cloud (e.g. SAP Business ByDesign, Abacus vi). This allows user companies to choose their preferred operations model (e.g. running the ERP software in their own *internal* cloud or in an *external private* cloud).

Given its natural suitability for private consumers and *small* companies, it is surprising that many publications on cloud computing focus on the potential of big companies and do not discuss small and medium-sized companies (SMEs) (e.g. Linthicum 2009; Iyer and Henderson 2010; Babcock 2010; Velte and Velte2010). It is easy to see that the provision of Web 2.0 functionality gains increasing attention in cloud computing. Web 2.0 features are usually geared at communication and sharing. The data stored in or with such services is usually not confidential or sensitive to attack.

ERP systems, on the other hand, need customization which may eventually always require a private cloud (or an ASP-like approach) where one instance of the program is individualized for a specific company. Multitenancy is difficult if the adaptations are too extensive. This is easier in the area of CRM and explains the big success of Salesforce.com with its CRM solution.

ERP systems are different from CRM systems in that they support *all core business processes* of a company – not just one area. Their databases store the necessary master data about customers and products as well as the transactional data about the daily activities. This means that most of the data represents company assets and is thus critical to company operation and success. Managers are not likely to move this data and the processing power into the cloud when it is not guaranteed that confidentiality of the data is assured and that the system performs at least at the same level as a comparable on-premise solution.

There are the following big players in the ERP systems market (with approximate market shares): SAP (30%), Oracle Applications (21%), The Sage Group (18%), Microsoft Dynamics (14%), SSA Global Technologies (7%) (Pang 2008). In addition, there are hundreds of smaller ERP system vendors targeting mostly the small and midsize market. The big players have different sales models and channels. Microsoft, for example, uses an indirect sales channel and has built up an ecosystem of implementation partners for their Dynamics Suite (Antero and Holst Riis 2012).

The indirect sales channel limits the possibilities for cloud services for ERP system vendors. They would cannibalize their own distribution partners if they offered cloud services directly to customers. Their role is limited to making sure that the ERP system meets the technical requirements for virtualization and multitenancy. It would be the natural role of the implementation partners (ISVs and VARs) to offer the actual cloud service to the customer.

However, it is important to note, that there are a number of start-up companies (such as e-conomic or Scopevisio) who have entered the ERP market with innovative SaaS offerings. These companies still have to prove the viability of their business model over the next year. Due to their small service fees, they require a large amount of customers to be able to offer SaaS in a sustainable operational and financial model. Looking at the market development, the leading ERP vendors would be well advised to focus their efforts on two things:

1. Making their product *technologically ready* for the cloud (virtualization, multitenancy)

2. Develop business models for ERP service delivery in the cloud

An important issue that user companies are well aware of is that ERP systems are the core business applications of the company and need to be integrated with circumjacent systems. When ERP software is obtained from the cloud the service provider has to make sure that integration can be achieved through well documented and open interfaces (e.g. Web services). Iyer and Henderson 2010 (p. 125) point out that this is a current trend in social software where we find a number of open API specifications (e.g. OpenSocial API published by Google). In the area of ERP systems, however, it seems unlikely that ERP vendors will open their systems fully without keeping a firm grip on their interfaces.

Newcomers such as e-conomic, however, understand the new rules and follow the approach of social software. This SaaS ERP system provider has published API specifications on their Website. It remains to be seen if the leading ERP system developers will change their policy in the area of interfaces thus adapting to current trends from the social software movement.

The cloud could, however, even bring advantages to ERP user companies when it comes to data exchange across company borders (interorganisational systems, B2B integration). Iyer and Henderson (2010, p. 128) mention the facilitation of the "the extended enterprise". So far, integration requires ERP users to rely on the services of a third party that manages contracts, infrastructure and exchange formats between business partners (EDI gateways, B2B integration providers). Now, these functions could be provided directly in the form of cloud services. AbaNet is a good example for an ERP integration service that has already been providing B2B integration for more than a decade for users of the standard ERP system ABACUS.

4 Proposed Research Agenda

From the 17 relevant publications we identified five research propositions. These propositions are discussed below.

4.1 Factors which drive the adoption of ERP systems in the cloud

There are certain factors which drive the adoption of cloud computing services, among which are *cost*, *flexibility* and *scalability* (OECD 2010). Koehler et al. (2010a) emphasize the importance of identifying consumer preferences for cloud services attributes and also revealing the relative importance of different attributes of cloud services. Other authors discuss the benefits and risks from the user perspective (Clarke 2010; Koehler et al. 2010b). Benlian et al. (2009) posited that the adoption of SaaS could be looked at from three theoretical perspectives: transaction cost theory, resource-based view, and theory of planned behaviour, all which have been previously applied to study IT outsourcing decisions and adoption behaviour of firms, with a view to identifying factors which influence adoption. It seems that there is still a paucity of research into aspects motivating or inhibiting SaaS adoption and that this calls for a solid research model on the drivers of SaaS adoption, informed by multiple theoretical lenses and assessed based on scientific rigor and a broad dataset instead of a few isolated cases (Benlian et al. 2009).

4.2 Physical location of ERP system data

While the physical location of the hardware that enables cloud computing is meant to be transparent to the user, and a user has no technical need to be aware which server running on which host is delivering the service, nor where the hosting device is located (Clarke 2010), the physical location of the hardware is currently a *decisive factor* for the decision to use cloud computing for enterprise systems. Companies prefer service providers within their own country (i.e. within the same legislative system) (McCabe 2009, p. 2). The ERP SaaS provider Scopevisio is e.g. putting a lot of effort in building "trustworthy" environments which are physically placed in the Frankfurt banking cluster (www.scopevisio.de). Amongst the various concerns expressed by potential adopters and watchers of cloud computing security, concerns about privacy and data protection are prominent. Furthermore, organizations can be further restrained by local laws in countries where they operate which prevent certain kinds of information to be kept off-shore (as in the US Patriot Act and EU Data Protection Directive, Ovum 2010, p. 65). Problems of jurisdiction might arise where the cloud crosses jurisdictional boundaries; even where a user somehow gathers sufficient information about a privacy breach, they are likely to face difficulties initiating and pursuing actions in the jurisdictional location(s) in which the breach has occurred (Clarke 2010). Other risks that are attributed to physical location include how organizations can make sure quality of service is really achieved when outsourcing IT services to a third party.

4.3 Business model for ERP delivery through the cloud

Every revolutionary paradigm shift brings along new opportunities for doing business and cloud computing is not an exception. Incumbents, as well as new providers of IT services are positioning themselves horizontally and/or vertically along the cloud computing layers. However one of the biggest questions being asked is how to effectively price IT services. Different pricing models have been studied (Hedwig et al. 2010) among them e.g. fixed/variable (Koehlar et al. 2010b; Wu and Banker 2010), negotiating (Choudhary 2007; Ahmed and Paul 2004), SLA-related ones (Buyya et al. 2009) or Pay-as-you-go (Armbrust et al. 2010). Developing nations are also seeing the opportunity of providing cheaper hosting services (Kshetri 2010); Iceland's bid to attract huge data centre operators to setup centres there, purporting to offer cheap, zero-emissions energy sources is attracting huge interest, with Opera (developer of web browser software) already moving its data centre there (The Datacenter 2010). Cloud computing predecessors (IT outsourcing and ASP) have been studied using several theoretical perspectives borrowed from the field of economics in describing and explaining the outcomes and to provide guidelines for practice (Beath 1987; Klepper 1993; Lacity and Hirschheim 1993; Bensaou 1993). We believe there is a need to look at cloud computing from such inter-disciplinary perspectives as well in order to establish the viability of this model and provide guidance for practice. Anandasivam and Weinhardt's (2010) study looked at the problems faced by cloud services providers of how providers can price infrastructure in such a way that it may impact resource utilization. Huang and Wang (2009) investigated the relationship between the SaaS software delivery model and the productivity of software vendors, comparing scale economies of pure SaaS firms versus non SaaS and mixed SaaS firms.

4.4 ERP as SaaS will especially benefit small and medium-sized companies

SaaS is promoted by IT providers to be mainly relevant for SMEs that lack necessary IT capabilities and resources. Sultan (2010b) argues that cloud computing is likely to prove commercially viable for many small and medium enterprises (SMEs) due to its flexibility and pay-as-you-go cost structure, particularly in the current climate of economic difficulties.

However, first empirical studies have found that large enterprises also see considerable opportunities applying SaaS in different areas (Benlian et al. 2009). The software level of cloud computing will benefit small companies because it can lower the barriers to the use of ERP systems in general. SMEs can have access to full-fledged ERP systems without the need of running their own IT department or to hire an expensive IT consultant. Analyses have been undertaken from the perspective of service providers (Armbrust et al. 2010). The need exists for analyses from the viewpoints of prospective organizational users and individual users (Clarke 2010).

4.5 Open Challenges for ERP delivery through the cloud

There are certain challenges which still need to be addressed before cloud computing will become the leading paradigm of IT consumption. IDC names security, performance, availability, integration with in-house IT and the difficulty of customization as some examples (IDC 2010).

Another great obstacle to the widespread adoption of cloud computing and SaaS is interoperability amongst the different cloud providers and lack of an industry platform. In theory, one way cloud computing is said to differ from traditional IT services delivery is the absence of long-term commitments on the consumer side, enabling them to switch between providers at will and at little or no cost. In practice however, users might find themselves reluctantly tied-in and exposed to high switching costs by a provider who uses a proprietary format to store their data. For cloud computing to rise to the level of an industry platform, firms will have to open their technology to other industry players, including complementors and potential competitors, rather than simply using the Web as an alternative delivery and pricing mechanism for what used to be packages software products (Cusumano 2010).

5 Conclusions and Outlook

In our paper we developed a reference framework for cloud computing providing terms and definitions for IS research. We discussed the importance of the phenomenon for ERP systems and suggested research imperatives for future research. A limitation of the paper is that it could only build on the scarce body of academic literature that has been forming since the emergence of the term in 2006 (Clarke 2010). In order to address this limitation and to base our study on a broader basis, we included books and industry studies in our analysis. It will be interesting to see if cloud computing will really lead to the adoption of a zero IT strategy in companies and what the influencing factors will be. However, while the market for cloud computing is further evolving, firms are well-advised to start thinking about formulating their cloud-based strategy for unique competitive benefits and researchers are encouraged to assist in the identification of the necessary capabilities. Iyer and Henderson (2010) outlined seven capabilities of cloud computing firms can use to develop their cloud strategies based on their study of the cloud industry ecosystem. What may be even more interesting is the customer view on capabilities or factors that influence their possibility to use a cloud service offering.

6 References

Ahmed, E. and Paul, L. (2004): Negotiation in Service-oriented environments. Communications of the ACM, 47 (8), 103-108.

Anandasivam, A. and Weinhardt, C. (2010): Towards an Efficient Decision Policy for Cloud Service Providers, ICIS 2010 Proceedings.

Antero, Michelle; Holst Riis, Philip (2011): Strategic Management of Network Resources: A Case Study of an ERP Ecosystem, International Journal of Enterprise Information Systems (IJEIS), 7 (2), 18-33.

Armbrust, M.; Fox, A.; Griffith, R.; Joseph, A. D.; Katz, R.; Konwinski, A.; Lee, G.; Patterson, D.; Rabkin, A.; Stoica, I. and Zaharia, M. (2010): A view of cloud computing, Communications of the ACM, 53 (4), 50-58.

Babcock, C. (2010): Management Strategies for the Cloud Revolution: How Cloud Computing Is Transforming Business and Why You Can't Afford to Be Left Behind, New York et al.: McGraw-Hill, 2010.

Barnatt, C. (2010): A Brief Guide to Cloud Computing: An Essential Introduction to the Next Revolution in Computing, London: Robinson, 2010.

Beath, C. (1983): Strategies for managing MIS projects: a transaction cost approach. Proceedings of the Fourth International Conference on Information Systems, pp. 133-147.

Benlian, A.; Hess, T. and Buxmann, P. (2009): Drivers of SaaS-Adoption – An Empirical Study of Different Application Types, Business & Information Systems Engineering, 5, 357-369.

Bensaou, M. (1993): Interorganizational cooperation: the role of information technology – an empirical comparison of US and Japanese supplier relations, ICIS 1993 proceedings, 117-127.

Buyya, R.; Yeo, C.S.; Venugopal, S.; Broberg, J.; and Brandic, I. (2009): Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility, Future Generation Computer Systems, 25, January 2009, 599-616, available at http://www.buyya.com/gridbus/papers/Cloud-FGCS2009.pdf.

Caya, O. and Pinsonneault, A. (2004): Are we in crisis? An assessment of thirty years of introspection in IS, Proceedings of the 32nd annual conference of the Administrative Sciences Association of Canada (ASAC 2004). Quebec, 2004.

Choudhary, V. (2007): Comparison of Software Quality Under Perpetual Licensing and Software as a Service, Journal of Management Information Systems, 24 (2), 141-165.

Clarke, R. (2010): Computing Clouds on the Horizon? Benefits and Risks from the User's Perspective, Bled eConference, 2010, 569-590.

Cusumano, M. (2010): Technology Strategy and Management: Cloud Computing and SaaS as New Computing Platforms, Communications of the ACM, 53 (4), 27-29.

Gonzalez, R.; Gasco, J. and Llopis, J. (2006): Information systems outsourcing: A literature analysis, Information & Management, 43 (7), 821-834.

Greengard, S. (2010): Cloud Computing and Developing Nations, Communications of the ACM, 53 (5), 18-20.

Hedwig, M.; Malkowski, S.; and Neumann, D. (2010): Toward Autonomic Cost-aware Allocation of Cloud Resources, ICIS 2010 Proceedings, 1-10.

Huang, K. and Wang, M. (2009): Firm-Level Productivity Analysis for Software as a Service Companies. ICIS 2009 Proceedings, 1-17.

Iyer, B. and Henderson, J.C. (2010). Preparing for the Future: Understanding the Seven Capabilities of Cloud Computing, MIS Quarterly Executive, 9 (2), 117-131.

Johnston Turner, M. and Gens, F. (2009): White Paper: Cloud Computing Drives Breakthrough Improvements in IT Service Delivery, Speed, and Costs, April 2009: IDC Research, 2009.

Klepper, R. (1993): Efficient outsourcing relationships. Proceedings of the Outsourcing of Information Systems Services Conference, University of Twente, the Netherlands, 20-22 May, 1994.

Koehler, P.; Anandasivam, A.; and Dan, M.A. (2010a): Cloud Services from a Consumer Perspective, AMCIS 2010 Proceedings.

Koehler, P.; Anandasivam, A.; Dan, M. A.; and Weinhardt, C. (2010b): Customer Heterogeneity and Tariff Biases in Cloud Computing, ICIS 2010 Proceedings.

Kshetri, N. (2010): Cloud Computing in Developing Economies, IEEE Computer Society, 0018-9162/10.

Lacity, M. and Hirschheim, R. (1993): Information Systems Outsourcing: Myths, Metaphors, and Realities, Wiley, Chichester, 1993.

Linthicum, D.S. (2009): Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide, Boston: Pearson Education, 2009.

Loh, L. and Venkatraman, N. (1995): An Empirical Study of Information Technology Outsourcing: Benefits, Risks, and Performance Implications, International Conference on Information Systems (ICIS), 1995, 277-288.

McCabe, Bruce (2009): Cloud computing: Australian lessons and experiences, in: KPMG IT Advisory, [http://www.kpmg.com/AU/en/IssuesAndInsights/ArticlesPublications/Documents/Cloud-computing-Australian-lessons-and-experiences.pdf], 2009. [Accessed: 07/12/2010].

Mell, P. and Grance, T. (2009): The NIST Definition of Cloud Computing, in: NIST Website (National Institute of Standards and Technology), [http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc], 10/07/2009. [Accessed: 05/12/2010].

OECD (2010): OECD Information Technology Outlook 2010, in: OECD Publishing, [http://dx.doi.org/10.1787/it_outlook-2010-en], 2010. [Accessed: 29/11/2010].

Ovum (2010): Planning for Cloud Computing: Understanding the organizational, governance, and cost implications, in: Ovum IT Management and Strategy Report, November 2010.

Pang, C. (2008): Dataquest Insight: ERP Software Market Share Analysis, Worldwide, in: Gartner Research, 2007, 1 August 2008, [http://www.gartner.com/DisplayDocument?id=735723]. [accessed: 30/11/2010].

Smith, D.M. (2010): Hype Cycle for Cloud Computing, 2010, Stamford: Gartner Research, July 27, 2010.

Staehr, L. (2010): Understanding the role of managerial agency in achieving business benefits from ERP systems, Information Systems Journal, 20 (3), 213-238.

Sultan, N. (2010a): Cloud computing for education: A new dawn?, International Journal of Information Management, 30 (2), 109-116.

Sultan, N.A. (2010b): Reaching for the “Cloud": How SMEs can manage, International Journal of Information Management, In Press, Accessed Corrected Proof.

The DATACENTER Journal (2010): Iceland as a Prime Data Center Location. http://datacenterjournal.com/index.php?option=com_content&view=article&id=3648:iceland-as-a-prime-data-center-location&catid=25&Itemid=100126. [Accessed: 2/12/2010].

Torraco, R.J. (2005). Writing integrative literature reviews: Guidelines and examples, Human Resource Development Review, 4 (3), 356-367.

Vaquero, L.M.; Rodero-Merino, L.; Caceres, J.; and Lindner M. (2009): A Break in the Clouds: Towards a Cloud Definition, ACM SIGCOMM Computer Communication Review, 39 (1), 50-55, available at http://ccr.sigcomm.org/online/files/p50-v39n1l-vaqueroA.pdf

Velte, A.T.; Velte, T.J. and Elsenpeter, R. (2010): Cloud Computing: A Practical Approach, New York et al.: McGraw-Hill, 2010.

Webster, J. and Watson, R.T. (2002): Analyzing the Past to Prepare for the Future: Writing a Literature Review, MIS Quarterly, 26 (2), pp. xiii-xxiii.

Wu, S. and Banker, R. (2010): Best Pricing Strategy for Information Services, Journal of the Association for Information Systems, 11 (6).

Bisher erschienen

Arbeitsberichte aus dem Fachbereich Informatik
(http://www.uni-koblenz-landau.de/koblenz/fb4/publications/Reports/arbeitsberichte)

Petra Schubert, Femi Adisa, Cloud Computing for Standard ERP Systems: Reference Framework and Research Agenda, Arbeitsberichte aus dem Fachbereich Informatik 16/2011

Oleg V. Kryuchin, Alexander A. Arzamastsev, Klaus G. Troitzsch, Natalia A. Zenkova, Simulating social objects with an artificial network using a computer cluster, Arbeitsberichte aus dem Fachbereich Informatik 15/2011

Oleg V. Kryuchin, Alexander A. Arzamastsev, Klaus G. Troitzsch, Simulating medical objects using an artificial network whose structure is based on adaptive resonance theory, Arbeitsberichte aus dem Fachbereich Informatik 14/2011

Oleg V. Kryuchin, Alexander A. Arzamastsev, Klaus G. Troitzsch, Comparing the efficiency of serial and parallel algorithms for training artificial neural networks using computer clusters, Arbeitsberichte aus dem Fachbereich Informatik, 13/2011

Oleg V. Kryuchin, Alexander A. Arzamastsev, Klaus G. Troitzsch, A parallel algorithm for selecting activation functions of an artificial network, Arbeitsberichte aus dem Fachbereich Informatik 12/2011

Katharina Bräunlich, Rüdiger Grimm, Andreas Kasten, Sven Vowé, Nico Jahn, Der neue Personalausweis zur Authentifizierung von Wählern bei Onlinewahlen, Arbeitsberichte aus dem Fachbereich Informatik 11/2011

Daniel Eißing, Ansgar Scherp, Steffen Staab, Formal Integration of Individual Knowledge Work and Organizational Knowledge Work with the Core Ontology *strukt*, Arbeitsberichte aus dem Fachbereich Informatik 10/2011

Bernhard Reinert, Martin Schumann, Stefan Müller, Combined Non-Linear Pose Estimation from Points and Lines, Arbeitsberichte aus dem Fachbereich Informatik 9/2011

Tina Walber, Ansgar Scherp, Steffen Staab, Towards the Understanding of Image Semantics by Gaze-based Tag-to-Region Assignments, Arbeitsberichte aus dem Fachbereich Informatik 8/2011

Alexander Kleinen, Ansgar Scherp, Steffen Staab, Mobile Facets – Faceted Search and Exploration of Open Social Media Data on a Touchscreen Mobile Phone, Arbeitsberichte aus dem Fachbereich Informatik 7/2011

Anna Lantsberg, Klaus G. Troitzsch, Towards A Methodology of Developing Models of E-Service Quality Assessment in Healthcare, Arbeitsberichte aus dem Fachbereich Informatik 6/2011

Ansgar Scherp, Carsten Saathoff, Thomas Franz, Steffen Staab, Designing Core Ontologies, Arbeitsberichte aus dem Fachbereich Informatik 5/2011

Oleg V. Kryuchin, Alexander A. Arzamastsev, Klaus G. Troitzsch, The prediction of currency exchange rates using artificial neural networks, Arbeitsberichte aus dem Fachbereich Informatik 4/2011

Klaus G. Troitzsch, Anna Lantsberg, Requirements for Health Care Related Websites in Russia: Results from an Analysis of American, British and German Examples, Arbeitsberichte aus dem Fachbereich Informatik 3/2011

Klaus G. Troitzsch, Oleg Kryuchin, Alexander Arzamastsev, A universal simulator based on artificial neural networks for computer clusters, Arbeitsberichte aus dem Fachbereich Informatik 2/2011

Klaus G. Troitzsch, Natalia Zenkova, Alexander Arzamastsev, Development of a technology of designing intelligent information systems for the estimation of social objects, Arbeitsberichte aus dem Fachbereich Informatik 1/2011

Kurt Lautenbach, A Petri Net Approach for Propagating Probabilities and Mass Functions, Arbeitsberichte aus dem Fachbereich Informatik 13/2010

Claudia Schon, Linkless Normal Form for ALC Concepts, Arbeitsberichte aus dem Fachbereich Informatik 12/2010

Alexander Hug, Informatik hautnah erleben, Arbeitsberichte aus dem Fachbereich Informatik 11/2010

Marc Santos, Harald F.O. von Kortzfleisch, Shared Annotation Model – Ein Datenmodell für kollaborative Annotationen, Arbeitsberichte aus dem Fachbereich Informatik 10/2010

Gerd Gröner, Steffen Staab, Categorization and Recognition of Ontology Refactoring Pattern, Arbeitsberichte aus dem Fachbereich Informatik 9/2010

Daniel Eißing, Ansgar Scherp, Carsten Saathoff, Integration of Existing Multimedia Metadata Formats and Metadata Standards in the M3O, Arbeitsberichte aus dem Fachbereich Informatik 8/2010

Stefan Scheglmann, Ansgar Scherp, Steffen Staab, Model-driven Generation of APIs for OWL-based Ontologies, Arbeitsberichte aus dem Fachbereich Informatik 7/2010

Daniel Schmeiß, Ansgar Scherp, Steffen Staab, Integrated Mobile Visualization and Interaction of Events and POIs, Arbeitsberichte aus dem Fachbereich Informatik 6/2010

Rüdiger Grimm, Daniel Pähler, E-Mail-Forensik – IP-Adressen und ihre Zuordnung zu Internet-Teilnehmern und ihren Standorten, Arbeitsberichte aus dem Fachbereich Informatik 5/2010

Christoph Ringelstein, Steffen Staab, PAPEL: Syntax and Semantics for Provenance-Aware Policy Definition, Arbeitsberichte aus dem Fachbereich Informatik 4/2010

Nadine Lindermann, Sylvia Valcárcel, Harald F.O. von Kortzfleisch, Ein Stufenmodell für kollaborative offene Innovationsprozesse in Netzwerken kleiner und mittlerer Unternehmen mit Web 2.0, Arbeitsberichte aus dem Fachbereich Informatik 3/2010

Maria Wimmer, Dagmar Lück-Schneider, Uwe Brinkhoff, Erich Schweighofer, Siegfried Kaiser, Andreas Wieber, Fachtagung Verwaltungsinformatik FTVI Fachtagung Rechtsinformatik FTRI 2010, Arbeitsberichte aus dem Fachbereich Informatik 2/2010

Max Braun, Ansgar Scherp, Steffen Staab, Collaborative Creation of Semantic Points of Interest as Linked Data on the Mobile Phone, Arbeitsberichte aus dem Fachbereich Informatik 1/2010

Marc Santos, Einsatz von „Shared In-situ Problem Solving“ Annotationen in kollaborativen Lern- und Arbeitsszenarien, Arbeitsberichte aus dem Fachbereich Informatik 20/2009

Carsten Saathoff, Ansgar Scherp, Unlocking the Semantics of Multimedia Presentations in the Web with the Multimedia Metadata Ontology, Arbeitsberichte aus dem Fachbereich Informatik 19/2009

Christoph Kahle, Mario Schaarschmidt, Harald F.O. von Kortzfleisch, Open Innovation: Kundenintegration am Beispiel von IPTV, Arbeitsberichte aus dem Fachbereich Informatik 18/2009

Dietrich Paulus, Lutz Priese, Peter Decker, Frank Schmitt, Pose-Tracking Forschungsbericht, Arbeitsberichte aus dem Fachbereich Informatik 17/2009

Andreas Fuhr, Tassilo Horn, Andreas Winter, Model-Driven Software Migration Extending SOMA, Arbeitsberichte aus dem Fachbereich Informatik 16/2009

Eckhard Großmann, Sascha Strauß, Tassilo Horn, Volker Riediger, Abbildung von grUML nach XSD soamig, Arbeitsberichte aus dem Fachbereich Informatik 15/2009

Kerstin Falkowski, Jürgen Ebert, The STOR Component System Interim Report, Arbeitsberichte aus dem Fachbereicht Informatik 14/2009

Sebastian Magnus, Markus Maron, An Empirical Study to Evaluate the Location of Advertisement Panels by Using a Mobile Marketing Tool, Arbeitsberichte aus dem Fachbereich Informatik 13/2009

Sebastian Magnus, Markus Maron, Konzept einer Public Key Infrastruktur in iCity, Arbeitsberichte aus dem Fachbereich Informatik 12/2009

Sebastian Magnus, Markus Maron, A Public Key Infrastructure in Ambient Information and Transaction Systems, Arbeitsberichte aus dem Fachbereich Informatik 11/2009

Ammar Mohammed, Ulrich Furbach, Multi-agent systems: Modeling and Virification using Hybrid Automata, Arbeitsberichte aus dem Fachbereich Informatik 10/2009

Andreas Sprotte, Performance Measurement auf der Basis von Kennzahlen aus betrieblichen Anwendungssystemen: Entwurf eines kennzahlengestützten Informationssystems für einen Logistikdienstleister, Arbeitsberichte aus dem Fachbereich Informatik 9/2009

Gwendolin Garbe, Tobias Hausen, Process Commodities: Entwicklung eines Reifegradmodells als Basis für Outsourcingentscheidungen, Arbeitsberichte aus dem Fachbereich Informatik 8/2009

Petra Schubert et. al., Open-Source-Software für das Enterprise Resource Planning, Arbeitsberichte aus dem Fachbereich Informatik 7/2009

Ammar Mohammed, Frieder Stolzenburg, Using Constraint Logic Programming for Modeling and Verifying Hierarchical Hybrid Automata, Arbeitsberichte aus dem Fachbereich Informatik 6/2009

Tobias Kippert, Anastasia Meletiadou, Rüdiger Grimm, Entwurf eines Common Criteria-Schutzprofils für Router zur Abwehr von Online-Überwachung, Arbeitsberichte aus dem Fachbereich Informatik 5/2009

Hannes Schwarz, Jürgen Ebert, Andreas Winter, Graph-based Traceability – A Comprehensive Approach. Arbeitsberichte aus dem Fachbereich Informatik 4/2009

Anastasia Meletiadou, Simone Müller, Rüdiger Grimm, Anforderungsanalyse für Risk-Management-Informationssysteme (RMIS), Arbeitsberichte aus dem Fachbereich Informatik 3/2009

Ansgar Scherp, Thomas Franz, Carsten Saathoff, Steffen Staab, A Model of Events based on a Foundational Ontology, Arbeitsberichte aus dem Fachbereich Informatik 2/2009

Frank Bohdanovicz, Harald Dickel, Christoph Steigner, Avoidance of Routing Loops, Arbeitsberichte aus dem Fachbereich Informatik 1/2009

Stefan Ameling, Stephan Wirth, Dietrich Paulus, Methods for Polyp Detection in Colonoscopy Videos: A Review, Arbeitsberichte aus dem Fachbereich Informatik 14/2008

Tassilo Horn, Jürgen Ebert, Ein Referenzschema für die Sprachen der IEC 61131-3, Arbeitsberichte aus dem Fachbereich Informatik 13/2008

Thomas Franz, Ansgar Scherp, Steffen Staab, Does a Semantic Web Facilitate Your Daily Tasks?, Arbeitsberichte aus dem Fachbereich Informatik 12/2008

Norbert Frick, Künftige Anfordeungen an ERP-Systeme: Deutsche Anbieter im Fokus, Arbeitsberichte aus dem Fachbereicht Informatik 11/2008

Jürgen Ebert, Rüdiger Grimm, Alexander Hug, Lehramtsbezogene Bachelor- und Masterstudiengänge im Fach Informatik an der Universität Koblenz-Landau, Campus Koblenz, Arbeitsberichte aus dem Fachbereich Informatik 10/2008

Mario Schaarschmidt, Harald von Kortzfleisch, Social Networking Platforms as Creativity Fostering Systems: Research Model and Exploratory Study, Arbeitsberichte aus dem Fachbereich Informatik 9/2008

Bernhard Schueler, Sergej Sizov, Steffen Staab, Querying for Meta Knowledge, Arbeitsberichte aus dem Fachbereich Informatik 8/2008

Stefan Stein, Entwicklung einer Architektur für komplexe kontextbezogene Dienste im mobilen Umfeld, Arbeitsberichte aus dem Fachbereich Informatik 7/2008

Matthias Bohnen, Lina Brühl, Sebastian Bzdak, RoboCup 2008 Mixed Reality League Team Description, Arbeitsberichte aus dem Fachbereich Informatik 6/2008

Bernhard Beckert, Reiner Hähnle, Tests and Proofs: Papers Presented at the Second International Conference, TAP 2008, Prato, Italy, April 2008, Arbeitsberichte aus dem Fachbereich Informatik 5/2008

Klaas Dellschaft, Steffen Staab, Unterstützung und Dokumentation kollaborativer Entwurfs- und Entscheidungsprozesse, Arbeitsberichte aus dem Fachbereich Informatik 4/2008

Rüdiger Grimm: IT-Sicherheitsmodelle, Arbeitsberichte aus dem Fachbereich Informatik 3/2008

Rüdiger Grimm, Helge Hundacker, Anastasia Meletiadou: Anwendungsbeispiele für Kryptographie, Arbeitsberichte aus dem Fachbereich Informatik 2/2008

Markus Maron, Kevin Read, Michael Schulze: CAMPUS NEWS – Artificial Intelligence Methods Combined for an Intelligent Information Network, Arbeitsberichte aus dem Fachbereich Informatik 1/2008

Lutz Priese,Frank Schmitt, Patrick Sturm, Haojun Wang: BMBF-Verbundprojekt 3D-RETISEG Abschlussbericht des Labors Bilderkennen der Universität Koblenz-Landau, Arbeitsberichte aus dem Fachbereich Informatik 26/2007

Stephan Philippi, Alexander Pinl: Proceedings 14. Workshop 20.-21. September 2007 Algorithmen und Werkzeuge für Petrinetze, Arbeitsberichte aus dem Fachbereich Informatik 25/2007

Ulrich Furbach, Markus Maron, Kevin Read: CAMPUS NEWS – an Intelligent Bluetooth-based Mobile Information Network, Arbeitsberichte aus dem Fachbereich Informatik 24/2007

Ulrich Furbach, Markus Maron, Kevin Read: CAMPUS NEWS - an Information Network for Pervasive Universities, Arbeitsberichte aus dem Fachbereich Informatik 23/2007

Lutz Priese: Finite Automata on Unranked and Unordered DAGs Extented Version, Arbeitsberichte aus dem Fachbereich Informatik 22/2007

Mario Schaarschmidt, Harald F.O. von Kortzfleisch: Modularität als alternative Technologie- und Innovationsstrategie, Arbeitsberichte aus dem Fachbereich Informatik 21/2007

Kurt Lautenbach, Alexander Pinl: Probability Propagation Nets, Arbeitsberichte aus dem Fachbereich Informatik 20/2007

Rüdiger Grimm, Farid Mehr, Anastasia Meletiadou, Daniel Pähler, Ilka Uerz: SOA-Security, Arbeitsberichte aus dem Fachbereich Informatik 19/2007

Christoph Wernhard: Tableaux Between Proving, Projection and Compilation, Arbeitsberichte aus dem Fachbereich Informatik 18/2007

Ulrich Furbach, Claudia Obermaier: Knowledge Compilation for Description Logics, Arbeitsberichte aus dem Fachbereich Informatik 17/2007

Fernando Silva Parreiras, Steffen Staab, Andreas Winter: TwoUse: Integrating UML Models and OWL Ontologies, Arbeitsberichte aus dem Fachbereich Informatik 16/2007

Rüdiger Grimm, Anastasia Meletiadou: Rollenbasierte Zugriffskontrolle (RBAC) im Gesundheitswesen, Arbeitsberichte aud dem Fachbereich Informatik 15/2007

Ulrich Furbach, Jan Murray, Falk Schmidsberger, Frieder Stolzenburg: Hybrid Multiagent Systems with Timed Synchronization-Specification and Model Checking, Arbeitsberichte aus dem Fachbereich Informatik 14/2007

Björn Pelzer, Christoph Wernhard: System Description:“E-KRHyper“, Arbeitsberichte aus dem Fachbereich Informatik, 13/2007

Ulrich Furbach, Peter Baumgartner, Björn Pelzer: Hyper Tableaux with Equality, Arbeitsberichte aus dem Fachbereich Informatik, 12/2007

Ulrich Furbach, Markus Maron, Kevin Read: Location based Informationsystems, Arbeitsberichte aus dem Fachbereich Informatik, 11/2007

Philipp Schaer, Marco Thum: State-of-the-Art: Interaktion in erweiterten Realitäten, Arbeitsberichte aus dem Fachbereich Informatik, 10/2007

Ulrich Furbach, Claudia Obermaier: Applications of Automated Reasoning, Arbeitsberichte aus dem Fachbereich Informatik, 9/2007

Jürgen Ebert, Kerstin Falkowski: A First Proposal for an Overall Structure of an Enhanced Reality Framework, Arbeitsberichte aus dem Fachbereich Informatik, 8/2007

Lutz Priese, Frank Schmitt, Paul Lemke: Automatische See-Through Kalibrierung, Arbeitsberichte aus dem Fachbereich Informatik, 7/2007

Rüdiger Grimm, Robert Krimmer, Nils Meißner, Kai Reinhard, Melanie Volkamer, Marcel Weinand, Jörg Helbach: Security Requirements for Non-political Internet Voting, Arbeitsberichte aus dem Fachbereich Informatik, 6/2007

Daniel Bildhauer, Volker Riediger, Hannes Schwarz, Sascha Strauß, „grUML – Eine UML-basierte Modellierungssprache für T-Graphen“, Arbeitsberichte aus dem Fachbereich Informatik, 5/2007

Richard Arndt, Steffen Staab, Raphaël Troncy, Lynda Hardman: Adding Formal Semantics to MPEG-7: Designing a Well Founded Multimedia Ontology for the Web, Arbeitsberichte aus dem Fachbereich Informatik, 4/2007

Simon Schenk, Steffen Staab: Networked RDF Graphs, Arbeitsberichte aus dem Fachbereich Informatik, 3/2007

Rüdiger Grimm, Helge Hundacker, Anastasia Meletiadou: Anwendungsbeispiele für Kryptographie, Arbeitsberichte aus dem Fachbereich Informatik, 2/2007

Anastasia Meletiadou, J. Felix Hampe: Begriffsbestimmung und erwartete Trends im IT-Risk-Management, Arbeitsberichte aus dem Fachbereich Informatik, 1/2007

„Gelbe Reihe“
(http://www.uni-koblenz.de/fb4/publikationen/gelbereihe)

Lutz Priese: Some Examples of Semi-rational and Non-semi-rational DAG Languages. Extended Version, Fachberichte Informatik 3-2006

Kurt Lautenbach, Stephan Philippi, and Alexander Pinl: Bayesian Networks and Petri Nets, Fachberichte Informatik 2-2006

Rainer Gimnich and Andreas Winter: Workshop Software-Reengineering und Services, Fachberichte Informatik 1-2006

Kurt Lautenbach and Alexander Pinl: Probability Propagation in Petri Nets, Fachberichte Informatik 16-2005

Rainer Gimnich, Uwe Kaiser, and Andreas Winter: 2. Workshop "Reengineering Prozesse" – Software Migration, Fachberichte Informatik 15-2005

Jan Murray, Frieder Stolzenburg, and Toshiaki Arai: Hybrid State Machines with Timed Synchronization for Multi-Robot System Specification, Fachberichte Informatik 14-2005

Reinhold Letz: FTP 2005 – Fifth International Workshop on First-Order Theorem Proving, Fachberichte Informatik 13-2005

Bernhard Beckert: TABLEAUX 2005 – Position Papers and Tutorial Descriptions, Fachberichte Informatik 12-2005

Dietrich Paulus and Detlev Droege: Mixed-reality as a challenge to image understanding and artificial intelligence, Fachberichte Informatik 11-2005

Jürgen Sauer: 19. Workshop Planen, Scheduling und Konfigurieren / Entwerfen, Fachberichte Informatik 10-2005

Pascal Hitzler, Carsten Lutz, and Gerd Stumme: Foundational Aspects of Ontologies, Fachberichte Informatik 9-2005

Joachim Baumeister and Dietmar Seipel: Knowledge Engineering and Software Engineering, Fachberichte Informatik 8-2005

Benno Stein and Sven Meier zu Eißen: Proceedings of the Second International Workshop on Text-Based Information Retrieval, Fachberichte Informatik 7-2005

Andreas Winter and Jürgen Ebert: Metamodel-driven Service Interoperability, Fachberichte Informatik 6-2005

Joschka Boedecker, Norbert Michael Mayer, Masaki Ogino, Rodrigo da Silva Guerra, Masaaki Kikuchi, and Minoru Asada: Getting closer: How Simulation and Humanoid League can benefit from each other, Fachberichte Informatik 5-2005

Torsten Gipp and Jürgen Ebert: Web Engineering does profit from a Functional Approach, Fachberichte Informatik 4-2005

Oliver Obst, Anita Maas, and Joschka Boedecker: HTN Planning for Flexible Coordination Of Multiagent Team Behavior, Fachberichte Informatik 3-2005

Andreas von Hessling, Thomas Kleemann, and Alex Sinner: Semantic User Profiles and their Applications in a Mobile Environment, Fachberichte Informatik 2-2005

Heni Ben Amor and Achim Rettinger: Intelligent Exploration for Genetic Algorithms – Using Self-Organizing Maps in Evolutionary Computation, Fachberichte Informatik 1-2005