Logistics Mall—A Cloud Platform for Logistics

Damian Daniluk, Maren Wolf, Oliver Wolf and Michael ten Hompel

Abstract Increasingly, in logistics value chains a shift from core logistics tasks to higher-value logistics services can be observed. Competitive capability is characterized by a rapid design and implementation of these services. The technology of cloud computing enables the provisioning of various services over the internet. Particularly for logistics users a simple and rapid delivery of software components supporting the execution of individual business processes is of high interest. This allows the quick adaption of frequent business process changes along with an accounting on pay-per-use basis. After outlining the current situation of cloud computing in the field of logistics this paper presents the Logistics Mall, an approach for a domain specific cloud platform for the trading and usage of logistics IT services and logistics processes. Finally, results of a study about the acceptance of cloud computing solutions in the logistics domain like the Logistics Mall and an outlook are presented.

Keywords Logistics Mall · Cloud computing · Cloud platform · Business Process as a Service

1 Introduction

For a common understanding of the concept of cloud computing we adopt the working definition of NIST (Mell and Grace 2009) that defines it as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is

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composed of five essential characteristics, three service models, and four deployment models." The basic characteristics are on-demand self-service for consumers, broad network access, resource pooling to serve multiple consumers using a multi-tenant model, rapid elasticity of resources and metering capabilities for service provision. The identified service delivery models are software-as-a-service (SaaS) where consumers use a provider's application running on a cloud infrastructure, platform-as-a-service (PaaS) where a consumer can deploy an application on a cloud infrastructure using a provider's tools and platform, and infrastructure-as-a-service (IaaS) where a consumer can run arbitrary software on a provided cloud infrastructure.

Cloud computing is now a reality. After the initial furor and cautious hesitation, the technology was able to hold ground in the market and is now widely in use. Various sectors of the industry have recognized the advantage of distributed computing power and have put it to use in their respective areas of business. The numbers are clear: The rapidly increasing budgets of the past few years give us an indication of the size of the fundamental change in technology that it has brought—cloud computing has shaped and changed the IT market permanently in the same way that a disruptive innovation would. Extremely volatile business areas with strongly fluctuating requirements such as logistics benefit greatly from the flexible distribution of resources in the cloud.

1.1 The New Standard

In many places the use of cloud computing is now viewed as a matter of course and no further discussion is needed. For a few years this topic was still considered to be a future trend and although it caused heated discussions it was almost never viewed as relevant for the policy of a company. This has clearly changed: according to the Federal Association for Information Technology, Telecommunications, and New Media (BITKOM), cloud computing has been selected as the hot topic for the information and telecommunications industry in 2013 for the fourth time (KPMG AG and BITKOM 2013). The market research company Forrester Research predicted that for 2013 almost half of all North American and European companies will have a budget for investing in private clouds and many software development managers will plan to use cloud applications.

1.2 Making the Shift to Cloud Computing

The number of companies making the shift to cloud computing has changed greatly in the past few years: only 28 % of the companies surveyed in 2011 were open minded about cloud computing and interested in it. This number rose to 35 % in 2012. But, surprisingly, the number of sceptics also increased from 38 % (2011) to 44 % (2012).

The number of those who were undecided did go down, which indicates that companies improved their information policies and their uncertainty was dwindling. All discussions about the topic obviously helped decision-makers to make up their minds: the number of those who were undecided shrunk from 33 to 20 %.

The size of a company plays a role in how open they are to adapting the technology: fifty-five percent of companies with more than 2000 employees were open to it while smaller companies were clearly more reticent (KPMG AG and BITKOM 2013).

1.3 Cloud Computing in Action

According to the estimates of the Experton Group in 2013 German companies invest 5 % of their IT expenses in the cloud (Velten and Janata 2013). Compared to 2012 this is an increase of investments of about 52 %. The investments for cloud services, cloud integration and cloud consulting services and cloud technology in the business cloud (B2B) have a sum of 4.6 billion Euros in 2013. For 2014 a growth of 50 % is expected. The cloud investment volume would then be at about 6.9 billion Euros (Bayer 2013).

The strongest increase is expected for investments in cloud services (Mahmood and Hill 2011) like software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS). The segments cloud technology and integration as well as consulting will also grow at a constant rate, but they will evolve more restrained in comparison to the mentioned cloud services. Until 2017 investments on enterprise cloud services are expected to grow by an average of 50 % (Hackmann 2013).

Some of the reasons for the positive attitudes of many companies towards cloud computing are lower IT administration costs, shorter implementation times for new applications and solutions, rapid scalability of IT services, improved mobility and geographically distributed access to IT resources, lower IT costs, increased organizational flexibility, improved performance and availability, and a higher capacity for innovation. The opportunity to tap into new customer groups and save costs (hardware and personnel) also plays an important role. The main concerns are no longer with data protection but with the loss of data. Other risks that have been identified are a diminishing IT know-how and an unclear legal situation.

2 Logistics Mall

2.1 Vision

Common characteristics of all logistics business processes are individualisation and dynamically changing requirements of the customers' business. A process has to be

adapted to every new or changed requirement. Consequently, the underlying IT infrastructure is also subject to these frequently changing requirements.

Today a typical logistics process runs in a heterogeneous IT environment. Such systems are mostly standard software like SAP, Oracle, or more specialized logistics software systems like warehouse management systems (WMS) or production planning systems (PPS). All these systems do not entirely meet the requirements of logistics customers regarding short contract duration, pay-per-use accounting and the provisioning of individual IT services. The majority of the features of standard software is rarely used or not used at all, but has to be paid for, due to a monolithic architecture. Customizing software to adapt to new or changed requirements involves high efforts, costs and risks. Nevertheless the solution's flexibility for upcoming adaptations is not increased.

The introduction of cloud computing is a new opportunity to deliver different IT services over the internet. The idea of this IT paradigm is the abstraction of the underlying software and hardware. Based on this, users do not have to manage and administrate the physical hardware or software they are using. An additional advantage is that software can be acquired on-demand and paid per use (Schuldt et al. 2010).

The concept of providing services over a cloud encompasses three different stakeholders. Basically these are the operator of the cloud computing environment (CCE) being responsible for its administration, providers offering their applications or IT services and customers purchasing and using the services (Kaisler and Money 2011).

Regarding the dynamically changing requirements cloud computing provides the opportunity for a logistics customer to rent IT services only as long as they are needed. Furthermore, using a CCE to provide and use services enables customers and logistic service providers to focus on their key business by outsourcing the IT infrastructure to the cloud. Both customers and logistic service providers do not have to establish and administrate an internal IT infrastructure and only require a connection to the internet for interacting with the cloud. Additionally, pay-per-use accounting is another advantage for the customers. For providers cloud computing is a new opportunity to gain greater market relevance and design new offers by connecting their products with services provided by other independent providers (following the slogan "The whole thing is more than the sum of its components") (Goyal and Mikkilineni 2011; Scholz-Reiter et al. 2011).

2.2 Concept

The main idea of cloud computing—"Anything as a Service"—can be adapted to source complete logistics business processes, designed by connecting single IT services using an appropriate tool that is executed in the browser. Therefore, an adequate process modeling methodology is necessary to offer logistics customers an opportunity to model individual processes themselves. This service delivery model

is defined as Business Process as a Services (BPaaS). There are contributions that use BPaaS as abbreviation to indicate models that have the general idea of outsourcing of existing processes into the cloud (Bentounsi et al. 2012). Here, more specifically, the unique feature of this model is that both modeling and process execution are part of the cloud platform. This idea is the basis of the Logistics Mall, a development of the Fraunhofer Innovation Cluster "Cloud Computing for Logistics" (Fraunhofer Innovation Cluster 2013), that focusses on the modeling and execution of processes that are built from several IT services and that can be offered using a cloud platform. Most of the today available approaches are too complex to be used by logistics customers that have minor software engineering skills. On the one hand the vision of the Logistics Mall is to create a methodology that is capable to deliver business processes that can be deployed automatically for execution. On the other hand the logistician may not be overburdened by technical details.

The main idea of the Logistics Mall and the offering of BPaaS is visualized in Figs. 1 and 2. Today's monolithic software solutions are replaced by small, dedicated IT services of different service providers which can be combined to superior services that support the individual business processes of the logistician.

In addition to offering BPaaS solutions the Logistics Mall is also able to provide classic IT services corresponding to the Software as a Service (SaaS) cloud model. The main reason for this is to enable as many software providers as possible to offer IT systems that support a broad range of logistics processes. For an IT service that is offered in conjunction with BPaaS the technical requirements are much higher than for an IT service that is offered only as SaaS in the manner of ASP (application service providing). The reason for this is that BPaaS requires the IT service to use the same business object data model so that in the context of a modeled process IT services of different service providers have a common understanding of the data that is communicated between them. A detailed description of this data model and how it supports logistics business processes and reduces the business-IT gap is provided by Böhmer et al. (2015). Moreover the IT services in the context of BPaaS should

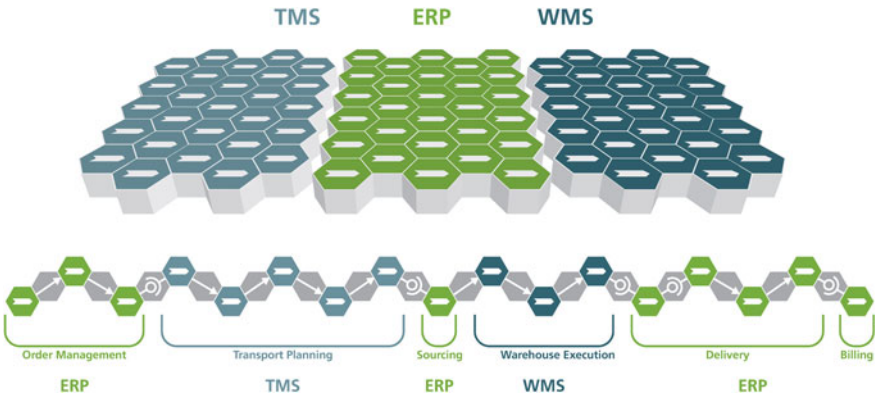

Fig. 1 Today's monolithic software solutions and their interaction within a business process

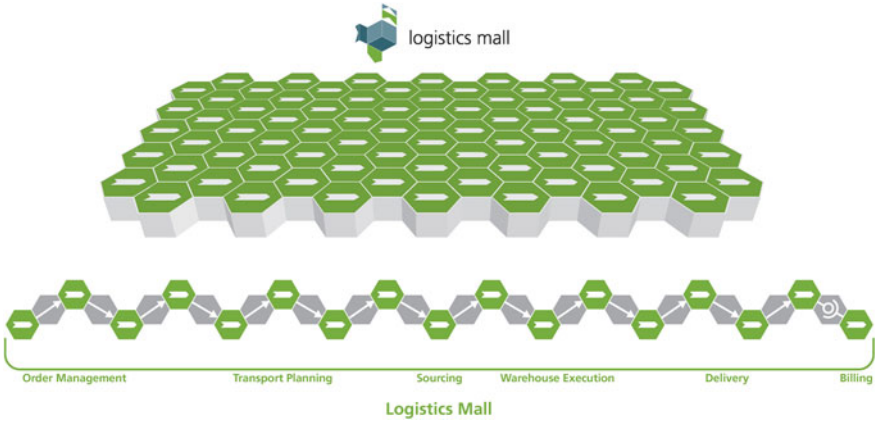

Fig. 2 The Logistics Mall as a cloud platform offers IT-services that can be combined to support individual logistics business processes

have a consistent look and feel of the GUI (Graphical User Interface) when they are used to support one business process. These requirements force service providers to undertake broad modifications on their existing IT services to be offered on the Logistics Mall. In contrast, providers have to only slightly modify their web-based IT services to offer them as SaaS products on the Logistics Mall platform.

Part of the concept of the Logistics Mall (Fig. 3) is that *IT developers* can offer and operate IT services in the cloud. Another target group is companies that have the function of integrators. As *logistics process designers* they combine IT services,

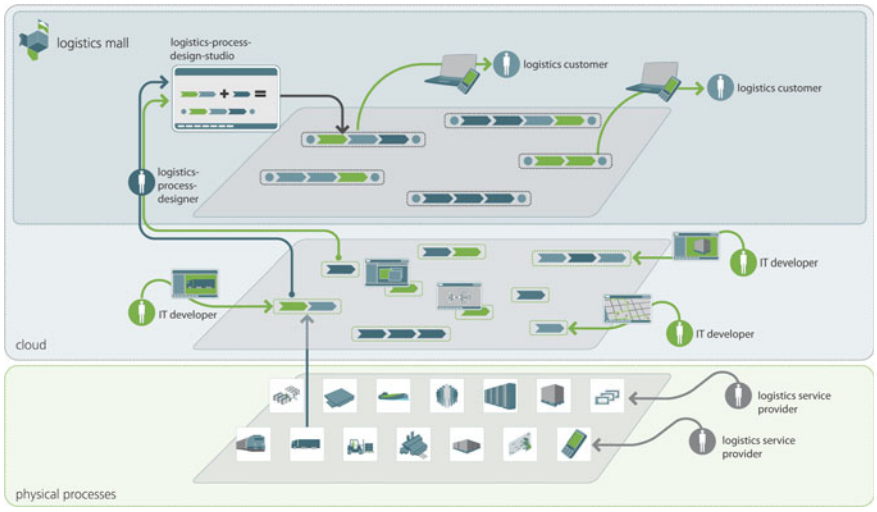

Fig. 3 Concept and stakeholders of the Logistics Mall

which are compatible to be used in the context of BPaaS, to more widespread IT solutions that support complete logistics business processes. The third group is the *logistics customers* that order and consume the IT solutions offered by the Logistics Mall.

Conceptually the Logistics Mall also supports the integration of physical services. Such serviced could be offered on the Logistics Mall platform by *logistics service providers*. An example is transport services, which encompass the transport of goods from a source to a destination.

Overall, the Logistics Mall is a comprehensive approach of an integrated platform that offers PaaS for IT developers and SaaS/BPaaS for logistics customers. The usage model behind the Logistics Mall for both groups is its operation as a public cloud or as a private cloud. Commercial operation of the Logistics Mall is available to the public at http://www.logistics-mall.com.

The design of the Logistics Mall is based on two pillars. The first pillar is the shopping frontend in the form of the mall marketplace (MMP). The MMP provides a publicly available online shop for the offered products. The second pillar of the Logistics Mall is a web portal that allows the operation and usage of the IT solutions rented on the MMP by the logistics customer. After ordering a product in the MMP it is provided on the so called Customized Access Framework (CAF). The CAF is an integrated environment that allows the user to switch between the GUIs of the rented applications and that offers a helpdesk and diverse administration functionality like user management and configuration of connections to external IT systems which are not executed on the Logistics Mall platform.

2.3 Experiences

The provision of BPaaS solutions using the Logistics Mall has been evaluated for the field of intralogistics. As a first step the so called *App Template* has been used. Basically the App Template is a Maven Archetype which is a Java based project templating toolkit for the build management tool Apache Maven. As part of the Logistics Mall the App Template is offered for software providers and enables them to develop IT services (Apps) that can be used in a tool that is called *Logistics Process Design Studio* (LPDS). This tool is also part of the Logistics Mall and allows to model the business process support that is needed by the logistics customer. The modeling is done by orchestration of Apps to build up a BPMN (Business Process Model Notation, a graphical representation maintained by the Object Management Group for specifying business processes) conform process model that supports the customers' individual business process. After the deployment of the process model the required IT support is provided in the CAF. In the CAF the user can access the user interface of Apps that are part of the process model and that need user interaction.

For evaluation of the Logistics Mall Apps were developed that support the intralogistics business process from incoming goods receipt to storage of these goods

in a warehouse. The test scenario showed the potential of the Logistics Mall solution as the process model successfully could be modified to support changed business process. The main advantage here is that process model modification can be performed in a very short time frame. The steps required for process model modification encompass the undeployment of the active process model, the modification of the process model within the LPDS followed by the deployment of the process model. Because the deployment and undeployment of a process model is fully automated process changes can be implemented very fast. In the test scenario for example the goods in process was extended with a goods testing procedure where in specific cases incoming goods have to be inspected by warehouse personnel.

3 Empirical Results

Fraunhofer IML conducted the market analysis "Cloud Computing for Logistics" in 2011 and 2013 to identify and analyse the opinions, needs, and requirements of the users and vendors in the logistics industry in terms of both cloud computing and the Logistics Mall model. The project team conducted qualitative interviews and used the results of those interviews as the basis for examining the potential as well as the barriers of this concept and for determining which requirements should be implemented in the Logistics Mall. By examining the acceptance and readiness of those surveyed, they could draw conclusions about the attitudes of the logistics experts in the industry. To perform the analysis, they compared reference values of 2011 with the new values of 2013.

The 70 study participants of the users group belonged to small and large companies from three branches of business: logistics service providers, industry, and wholesaler/retailer.

The 102 study participants of the vendors group came from small and large providers of logistics solutions.

The results showed that the spirit of innovation of the users group is split right down the middle, which validated the theoretical assumptions that were made before the project began: it is still too early for every second participant to use a technology like the Logistics Mall. When asked more concretely 56 % of the participants from the users group would be willing to use logistics software in the cloud—if the conditions were right in their own company. This value has actually decreased by 8 % compared to the study conducted in 2011.

The interviews with the study participants from the vendors group in 2013 revealed that the innovative spirit of the vendors group is slightly less than it was in 2011. Half of the participants (49 %) are willing to sell their products or services through an external online store, which is a decline of 9 % compared to 2011 (Fig. 4). A total of 67 % (70 % in 2011) would be willing to operate their applications in the cloud. In contrast to 2011, 10 % of the study participants in the vendors group are already in the concrete planning phase for using cloud architecture (Fig. 5).

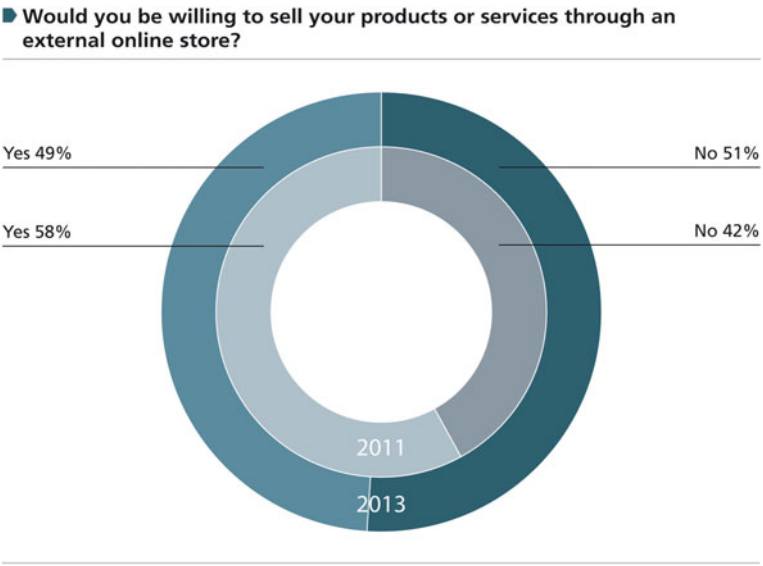

Fig. 4 The level of acceptance for selling products or services through an external online store (vendors)

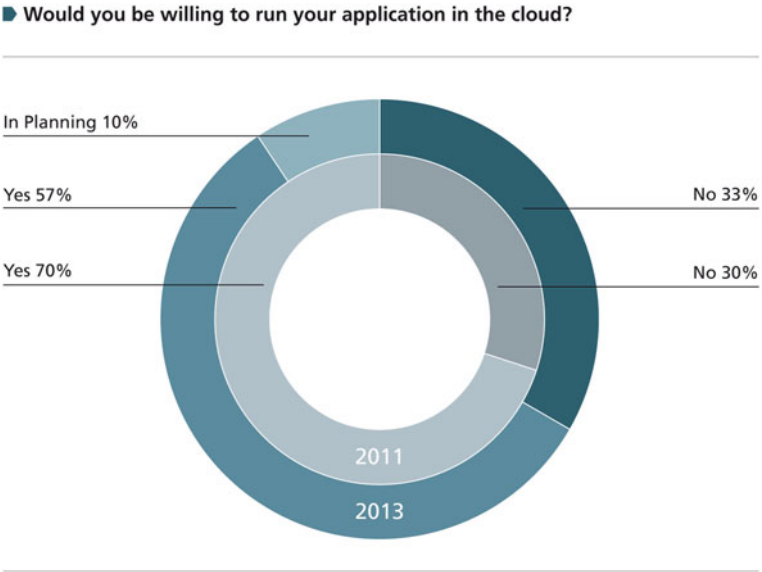

Fig. 5 The level of acceptance for operating applications in the cloud (vendors)

The agreement with these two fundamental Logistics Mall ideas diverges significantly with the size of the company. Small and medium-sized companies were more willing to change their views than larger companies. When the Logistics Mall was described in more detail, 58 % (75 % in 2011) of the vendors surveyed indicated that they would use it. In addition, 67 % (70 % in 2011) of the vendors said that they were sure that their customers would be willing to use cloud computing in logistics. A big shift in the answers to the question about the change in the relationship with the customer was observed when the 2013 data was compared to the 2011. About 56 % (39 % in 2011) accepted the fact that as a vendor they were no longer the main contact point for the user but that the operator of the Logistics Mall held that role instead.

4 Conclusions

The Logistics Mall platform aims at providing a market place for logistics services and business processes together with a cloud-based access and execution environment. It is foreseeable that the business culture will change over time. The focus will be on customized solutions. Monolithic software solutions as they are used in today's systems will be replaced by smaller dedicated subsystems that can be coupled and thereby can be assembled into higher-value services. The network concept that the Logistics Mall represents leaves a lot of creative leeway. Each company—no matter how big or small—has the chance to be a part of this development and help to shape it.

Cloud-based solutions such as the Logistics Mall presented in this paper are an important part of future scenarios like *Industry 4.0*. From the economic point of view this future scenario describes a new level of organization and control of the entire value chain through the life cycle of products. From the technological perspective there is required the availability of all relevant information in real time through integration of all entities involved in the value chain and on this basis the ability to derive the optimal value chain flow (Plattform "Industrie 4.0" 2014).

An important research field in the context of Industry 4.0 and cloud platforms is the involvement of physical processes on the shop floor level. Here, a main research question is how an interface between the applications running in the cloud and the machines on shop floor level consisting of different sensors and actors can look like. Given such an interface the applications in the cloud can provide shop floor monitoring and control functionality, which opens new possibilities in the design of business process supporting software.

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