Business Models of Platform as a Service (PaaS) Providers: Current State and Future Directions

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Abstract:

Cloud computing, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) are terms that denote new developments in the software industry that are completely changing the way software is produced, consumed, and distributed. In particular new PaaS business models have a disruptive effect on existing business models and require thorough business model innovation in the software industry. Despite their impact, PaaS business models have not been considered in a sufficient manner in literature yet. The paper at hand contributes to this gap by providing an overview of typical characteristics of PaaS based on a systematic literature review, a classification model of existing PaaS business models based on case studies, and an overview of the current state and future development directions of PaaS.

Keywords: Platform as a service, business models, cloud computing

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INTRODUCTION

Cloud computing and its components, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS), are terms that denote new developments in the software industry that are completely changing the way software is produced, consumed, and distributed. Infrastructure such as computing resources and storage are bundled, shared, and provided as a service. Previously highly protected software platforms were opened and are further developed in emerging ecosystems of independent, third-party developers and platform owners. Functionality of software is consumed over the browser. Consumers do not buy licenses of software products anymore, but pay for its usage on a pay-per-use basis. Due to all these changes, information technology is transforming into a general-purpose technology that can provide a fundamental contribution that promotes growth and competition and is opening new opportunities for users as well as producers of computing technology and software (Etro 2009). These developments have a disruptive influence on business models of existing players in the software and hardware industry.

The changing way of producing, consuming, and distributing software requires innovative, effective business models from new players and thorough business model innovation of existing players in the software industry (Chesbrough 2007; Johnson et al. 2008). Major changes to business models in the software industry are imposed, in particular, through the trend toward software platforms. In general, platforms can be defined as "a set of subsystems and interfaces that form a common structure from which a stream of related products can be developed and produced efficiently" (Halman et al. 2003). Business models based on the platform paradigm are at least two-sided or even multi-sided business models and require a flourishing ecosystem or community of external contributors. PaaS business models are just emerging in the software industry. At present, there is a lack of detailed knowledge about their specific characteristics. This paper contributes to fill this gap by considering the following research questions:

- What types of business models are emerging in the PaaS market and how can they be classified?

- What are the major future opportunities for PaaS providers to position in potential future markets of PaaS?

To answer the research questions, three research methods were applied: first, a systematic qualitative literature analysis to define and extract main characteristics of PaaS; second, explorative case studies in order to investigate the current state of today's PaaS providers; and third, a classification scheme is developed in order to provide an overview of the current state before future directions of PaaS providers are deduced.

The remainder of the paper is structured as follows. The next section defines the research approach, before the conceptual background is described. Next, previous findings regarding market size, structure, and players of the PaaS market are synthesized, and the need for evolution of PaaS business models is motivated. The following section presents the main characteristics of PaaS, identified based on a literature analyses, and presents three selected case studies in detail. Subsequently, a classification model for PaaS providers' business models is introduced and used to classify the twenty-five investigated PaaS providers. The pre-final section summarizes the

CONTRIBUTION

This paper provides important contributions especially to information systems research related to Platform as a Service (PaaS) business models:

1) It defines and characterizes PaaS as part of cloud computing and identifies the main features of PaaS platforms.

2) Based on twenty-five case studies of PaaS providers, it proposes a classification schema for PaaS business models and illustrates it in a morphological box.

3) It identifies three distinct types of PaaS business models: development focused platforms, application-based platforms, and distribution-channel-focused platforms and illustrates each type with a detailed case description.

4) It also identifies two future development trends of PaaS: in the short term development toward platform-based two-sided business models and in the midterm toward platform wars.

The theoretical and practical contributions are of particular interest for researchers who are interested in research related to business models in general and to PaaS in particular. The contributions may also serve decision makers as a starting point and guideline for their business model innovation plans and for potential investors interested in the growing PaaS market.

insight on future directions of PaaS providers. The paper concludes with a discussion of theoretical and practical contributions, as well as a summary of findings.

METHODOLOGY

In order to answer the research questions raised in the introductory section, a research approach based on the following three methods of primary and secondary research was chosen: systematic qualitative literature research, explorative case studies, and classification.

Systematic Qualitative Literature Research

From a qualitative literature analysis, in line with Levy and Ellis (2006), vom Brocke et al. (2009), and Webster and Watson (2002), two main research findings have been deduced: first, a basic definition for platforms in general and software platforms in particular were derived, and second, the major characteristics of PaaS offerings were identified.

Pursuant to vom Brocke et al. (2009), the first step of the performed literature analysis comprised the definition of the review scope. We defined the focus on research outcomes in order to summarize scholarly literature as well as to integrate our findings. It is hoped that the expected results are of some value for researchers interested in the economics of information systems, as well as practitioners. Once the scope of the analysis was defined, working definitions of the key terms were provided and are introduced in the background section. Step three of the five proposed steps by vom Brocke et al. (2009) involves the actual literature search that begins with identification of relevant journals and databases. Consentient with Levy and Ellis (2006), we identified *Business & Information Systems Engineering, Communications of the ACM, International Journal of Business Information Systems, IEEE Transactions and Computer,* and the *Journal of the Association for Information Systems* as relevant. In addition, five prominent databases, ACM Digital Library, IEEE Xplore, AIS Electronic Library (AISeL), Springerlink, and ScienceDirect, were targeted. These five databases cover almost all the identified relevant journals and most of the top-ten IS conferences, according to Levy and Ellis (2006) and WKWI (2008). Thus, these databases were considered comprehensive enough to gain a set of literature that represents the current status of IS research literature. The resulting working definition of PaaS and their main characteristics are introduced in the following section.

Explorative Case Studies

The main research effort was dedicated to explorative case studies, which investigate the business models of existing PaaS providers. An explorative case study approach was chosen because of its ability to investigate problems that need to be examined in their real-world context, due to their complexity and interdependencies (Cavaye 1996; Eisenhardt 1989; Yin 1981, 2003). With the use of case study research, the goal to describe and to structure the complex business models of today's PaaS providers was pursued.

Yin distinguishes four basic types of case studies based on the number of cases (single-case vs. multi-case) and the number of investigated units of analysis within a case (a unitary unit vs. multiple units of analysis) (2003). In the context of the research presented in this paper, multiple case studies were used, as they allow the replication of results, the analysis of patterns between the cases, and a better generalization. A selection of suitable PaaS providers was conducted based on the characteristics of PaaS offerings derived as a result of the preceding qualitative literature analysis. The entire list of the investigated providers is shown in Table 7.

Each case study of a multiple-case design can either focus on the same unit of investigation or multiple logically delimitable units (Yin 2003). Since the aim of our research is the investigation of business models of PaaS providers, we focused on multiple units, which together define the business models of PaaS providers. For each case, the approach suggested by Osterwalder and Pigneur (2010) was adopted as a common research framework. The analysis framework and structure applied is described in detail in the subsequent section, Business Model Analysis.

Classification Scheme

In order to provide an overview of the current state, a classification scheme for PaaS providers business models was developed, based on the classification methodology introduced by Fettke and Loos (2003). According to Fettke and Loos (2003), a classification scheme is "a set of characteristics, which are suitable to classify objects of a specific application domain." The five phases of the proposed classification methodology were applied as follows: (1) Inception: The aim is the development of a classification scheme for business models of PaaS providers. The resulting classification scheme should provide a comprehensive, but abstract survey. (2) Elaborate categories: The

concept of analyzing within-case data as well as searching for cross-case patterns were applied to elaborate categories based on the data collected (Eisenhardt 1989; Smith 1990; Yin 1981, 2003). "This process allows the unique patterns of each case to emerge before investigators push to generalize patterns across cases" (Eisenhardt 1989). In the course of the cross-case pattern search, two tactics were applied: First, the business model building blocks introduced by Osterwalder and Pigneur (2010) were used as categories in order to look for within-group similarities and intergroup differences. Second, pairs of cases were selected and similarities and differences between cases were listed in order to identify new categories. (3) Specify classification scheme: The identified categories of PaaS providers business models were structured by using a morphological matrix according to Zwicky (1969); see Figure 2. (4) Test: The developed classification scheme was iteratively tested and improved by classing a total sample of twenty-five PaaS providers; classing means providers were assigned to classes that have been previously defined (Bailey 1994; Marradi 1990). (5) Use and maintenance: The resulting characteristic-based classification schema was used to analyze the twenty-five investigated PaaS providers and to shape hypotheses regarding future directions for PaaS providers.

BACKGROUND

Platforms as a Service

Cloud computing and especially PaaS are terms that denote a new computing paradigm in the IT industry and that are completely changing the way software is produced, consumed, and distributed. In order to build the research on a rigorous foundation, the terms *cloud computing* and *PaaS* are subsequently introduced and recent developments are illustrated.

A considerable amount of literature has been published on cloud computing. However, up to this point there is no clear or even standardized and, therefore, generally accepted definition of cloud computing. As a result, in the following, two common definitions are presented. One of the most cited and well-established, but quite general, definitions is the one provided by the National Institute of Standards and Technology (NIST): "Cloud computing is 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" (Mell and Grance 2011).

The definition of Vaquero et al. (2009) is taking into account the most elementary aspects of the concept and will serve as a basis for the paper at hand: "Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms, and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the infrastructure provider by means of customized SLAs" (Vaquero et al. 2009).
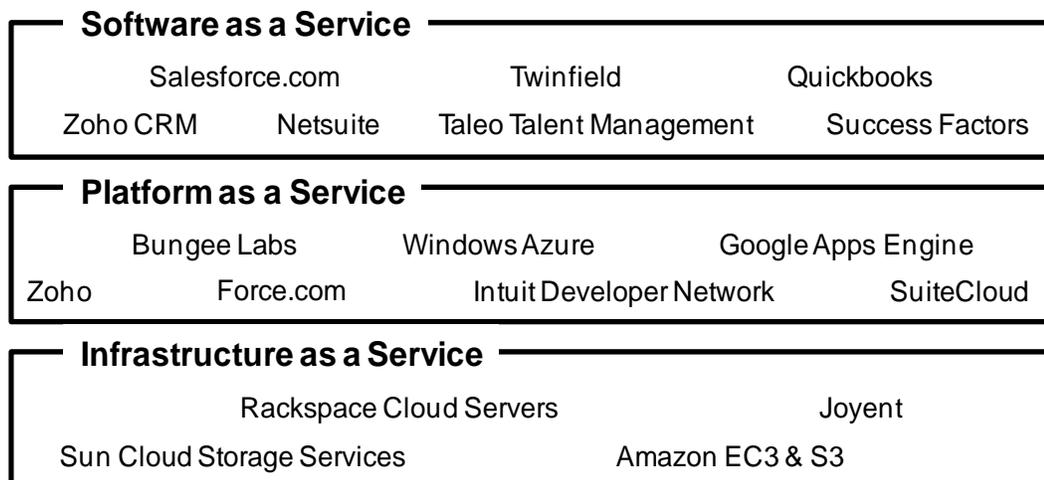

Figure 1: The three layers of cloud computing: SaaS, PaaS, and IaaS.

According to the most cited architectural concepts for clouds and cloud computing, PaaS are an important part of cloud computing architecture; see Figure 1. PaaS are the middle layer connecting the IaaS and the SaaS layer of clouds (see Höfer and Karagiannis 2011; Marston et al. 2011; Mell and Grance 2011; Stanoevska-Slabeva and Wozniak 2009; Subashini and Kavitha 2011; Vaquero et al. 2009; Viega 2009; Zhang et al. 2010). The IaaS layer

offers computing resources such as processing, storage, networks, and other fundamental computing resources that can be obtained as a service (Mell and Grance 2011; Stanoevska-Slabeva and Wozniak 2009). The SaaS layer is the most visible service of cloud computing, due to the fact that the software applications are accessed directly by the end-users (Stanoevska-Slabeva and Wozniak 2009). These applications are deployed and executed in cloud systems and can be accessed from various client devices through a thin client interface such as a Web browser (Mell and Grance 2011). The PaaS layer, connecting the IaaS and the SaaS layer, will be discussed in detail in the following.

Platforms in general can be defined as "a set of subsystems and interfaces that form a common structure from which a stream of related products can be developed and produced efficiently" (Halman et al. 2003). In analogy to this general definition, platforms in the software industry are referred to as "... a hardware configuration, an operating system, a software framework or any other common entity on which a number of associated components or services run" (Poel et al. 2007). While the general definition provides a broad selection of what a platform in the software industry might be, the exact definition of PaaS is still open to debate. An overview of descriptions for PaaS in literature is provided in Table 1.

Table 1: Descriptions for Platform as a Service	
Reference	**Definition**
Lawton 2008	PaaS systems are generally hosted, Web-based application-development platforms, providing end-to-end or, in some cases, partial environments for developing full programs online.
Vaquero et al. 2009	… instead of supplying a virtualized infrastructure, they can provide the software platform where systems run. The sizing of the hardware resources demanded by the execution of the services is made in a transparent manner.
Rodero-Merino et al. 2011	PaaS clouds offer an execution environment based on some software platform. … A PaaS cloud provides a container platform where users deploy and run their components.
Mell and Grance 2011	The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.
Khalidi 2011	PaaS solutions provide a complete application development and hosting site delivered as a cloud service. In addition to managing the underlying infrastructure and offering a metered-by-use cost model, PaaS also facilitates application development, testing, deployment, and ongoing maintenance, liberating the customer to focus on managing the application instead of the underlying infrastructure.
Zhang et al. 2010	Built on top of the infrastructure layer, the platform layer consists of operating systems and application frameworks. The purpose of the platform layer is to minimize the burden of deploying applications directly into VM containers.
Rimal et al. 2010	The idea behind PaaS is to provide developers with a platform including all the systems and environments comprising the end-to-end lifecycle of developing, testing, deploying and hosting of sophisticated Web applications as a service delivered by a cloud-based platform.
Marston et al. 2011	A Platform as a Service, or PaaS, facilitates the development and deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers.
Subashini and Kavitha 2011	PaaS is one layer above IaaS on the stack and abstracts away everything up to OS, middleware, etc. This offers an integrated set of developer environment that a developer can tap to build applications without having any clue about what is going on underneath the service. It offers developers a service that provides a complete software development lifecycle management, from planning to design to building applications to deployment to testing to maintenance.

While the definitions are quite heterogeneous, several common features can be identified: PaaS is a Web-based development platform which is opened toward external developers and can be used by them to develop components that can run on it.

Business Model Analysis

According to Johnson et al. (2008), "One secret to maintaining a thriving business is recognizing when it needs a fundamental change." Further prior studies that have noted the importance of analyzing business models are Chesbrough (2007), Drucker (1994), Morris (2009), and Osterwalder et al. (2005).

Based on an analysis of definitions for business models in literature, the definition of Osterwalder et al. (2005) was taken as a basis for the research presented in this paper. According to them, "A business model is a conceptual tool containing a set of objects, concepts, and their relationships with the objective to express the business logic of a specific firm. Therefore, we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and what are their according financial consequences." The same authors propose a so-called business model canvas for analyzing business models. The canvas is comprised of a predefined structure along with business model components. According to Osterwalder et al. (2005) and Osterwalder and Pigneur (2010), a business model consists of the following nine building blocks: Value Proposition, Customer Segment, Customer Relationship, Distribution Channel, Revenue Stream, Key Resources, Key Partners, Key Activities, and Cost Structure. While the first five components describe how the business model appears on the market and is experienced by customers, the remaining four components represent rather the internal view of the business model, i.e., how it is implemented by a specific company. Given the fact that the focus of the analysis presented in this paper is on the customer and market perspective of the business model and not on how it is implemented in the specific company, the analysis focused on the market-view components proposed by Osterwalder et al. (2005) and Osterwalder and Pigneur (2010). This also allowed for concentrating the analysis of the existing PaaS providers' business models on secondary data, i.e., data that is available online or through other available documentation and provides detailed information for the market view of the business models. Information about the internal view of the business model (i.e., key resources, partners, and activities, as well as cost structure, which in most of the cases is kept confidential) is difficult to obtain. Thus, the analysis was based on a subset of business model components presenting the market view of it. An overview of the considered components is given in Table 2.

Table 2: Business Model Building Blocks based on Osterwalder et al (2005)	
Business Model Building Block	**Description**
Value Proposition	Gives an overall view of a company's bundle of products and services
Customer Segment	Describes the segments of customers a company wants to offer value to
Customer Relationship	Explains the kind of links a company establishes between itself and its different customer segments
Channel	Describes the various means of the company to get in touch with its customers
Revenue Stream	Describes the way a company makes money through a variety of revenue flows

RELATED WORK

Market research companies are regularly publishing market analysis regarding cloud technologies. However, studies from an academic point of view are still missing. Thus, the related work presented below focuses on market research studies and gives an overview on the size, structure, and players on the market for PaaS.

Size of the PaaSMarket

In 2010 and 2011 IDC published multiple market and competitive analyses for Application Development and Deployment cloud services, for short, ADDaaS (IDC 2010a, 2010b, 2011a, 2011b). Within these reports the ADDaaS market is divided into three submarkets, whereby PaaS is one of these submarkets and according to the studies also the fastest growing segment of ADDaaS. In 2009, the PaaS market had revenue of €186.7 million, which represents a growth of 147.6 percent referred to 2008. The largest share of PaaS revenue was accounted in America with €137.7 million and thus 73.8 percent. Europe, the Middle East, and Africa (EMEA) recorded revenue of €36.8 million (19.7 percent) and Asia/Pacific (APA) trailed with a revenue share of 6.5 percent (€12.2 million). From 2005 to 2009, more than 65 percent of the total PaaS market revenue had been made by Salesforce.com with 27.7 percent, Amazon.com with 26.4 percent and IBM with 12 percent, while all other vendors had a share in the region of 1 percent or less. However, even though provider shares vary widely, the growth rates of PaaS providers also

vary greatly (IDC 2010a). In other words, it is expect that the distribution of market shares will change dramatically in the next few years.

While the worldwide ADDaaS market had revenue of €1,115.7 million in 2009, IDC forecasts that in 2014 it will be €6,466.4 million. The market revenue in 2014 will be distributed among America, EMEA, and APA by 62.1 percent, 27.4 percent, and 10.6 percent (IDC 2010b). IDC believes that the market for PaaS is a growth market due to a low penetration of the total addressable market. They state that this is due to the maturity that the industry has achieved in virtualization and the ability to leverage platform technologies on top of virtualized infrastructure (IDC 2011a). They also predict an increased interest and adoption of PaaS by small and medium-sized enterprises, especially in configurable PaaS offerings for application development and customizing. In addition to this, IDC expects an increased adoption of PaaS in developing countries because of its ease of access (IDC 2010b).

Structure of the PaaSMarket

In Gartner's Hype Cycle 2010 some cloud technologies are approaching the Peak of Inflated Expectations (Gartner 2010a). However, Gartner is seeing an "increased interest in Platform as a Service (PaaS) due to the need for enterprises to re-architect their software and empower their users to create cloud-optimized applications and process services" (Gartner 2010b). While SaaS solutions continue to gain acceptance, the PaaS wars are heating up (Gartner 2010b). In its reports (Gartner 2011a, 2011b), the market research company concludes that the PaaS market is under construction and calls the respective market an emerging contingent.

Gartner states that the current PaaS market is largely experimental and fragmented and names thirteen categories of specialized cloud-based platforms. Gartner believes that in 2013 these thirteen categories will be consolidated to five so-called use-pattern-targeted PaaS Suites, which are designed to meet requirements of the prevailing PaaS use patterns: (1) aPaaS—application platforms for hosting and managing individual application services and data, (2) iPaaS—integration platforms for integration and intermediation of applications services, (3) kPaaS—knowledge platform for access and analysis of broad data resources in context, (4) uxPaaS—user experience platforms for multichannel, multi-device userfacing applications; and (5) dPaaS—data platforms for hosting and serving data.

Gartner forecasts also that by 2015 there will be only a few large PaaS providers left, offering a comprehensive PaaS suite that meets the requirements of most projects by offering an integrated and optimized PaaS (Gartner 2011a).

Players in the PaaSMarket

In May 2011, Forrester Research published their 149-criteria evaluation of ten PaaS vendors in which they have identified salesforce.com and Microsoft as the leaders in the PaaS market (see Forrester 2011a, 2011b). In line with IDS and Gartner, Forrester states that "the PaaS market is a sprawling, fast-changing, and immature market," while "most PaaS vendors are small, and even big vendors like Google and Microsoft have incomplete, new products" (Forrester 2011a).

The evaluation of PaaS vendors was done separately for each of the three customer segments Forrester is distinguishing: (1) "coders"—meaning traditional application development and delivery professionals, (2) business experts, and (3) independent software vendors (ISV). Salesforce.com, a PaaS addressing the "Coders" market, "has built a powerful product, market position, and strategy in which Microsoft has also quickly built a leading position" (Forrester 2011a). Cordy and LongJump are also named as leading strong performers. The second segment is business experts resp. developers, which prefer to work with tools for creating applications or extensions. Forrester concludes that salesforce.com is the only leader in this segment, whereby Caspio and WorkXpress provide strong alternatives (Forrester 2011a). (3) The third customer segment is independent software vendors (ISVs) who want to bring their SaaS applications to the market. Again, Forrester names salesforce.com as the top choice for ISVs, followed by Crodys, LongJump, Microsoft, and WordXpress (Forrester 2011b).

In summary, it can be stated that the PaaS market is a fast-growing market with a potential market volume of more than €6 billion in 2014. The current PaaS market is largely fragmented. However, it is expected that in the future there will be a market consolidation toward only a few large PaaS providers that are offering a comprehensive PaaS suite. Although the market is currently dominated by Microsoft, salesforce.com, and Crodys, the distribution of market shares may change dramatically in the coming years, depending on the strategies of current PaaS providers. In order to sustain their place in the market, PaaS providers have to adapt their product and especially their business model in order to address future requirements and opportunities of different customer segments in this fast growing market.

BUSINESS MODELS OF PAAS PROVIDERS

Characteristics of Platform as a Service

In the background section, PaaS were described as important in the architectural concept of cloud computing and PaaS represents the middle layer connecting the IaaS and the SaaS layer. As a consequence, the ten features of cloud computing, which have been identified by Vaquero et al. (2009), are also applicable for PaaS. The ten general cloud characteristics are User Friendliness, Virtualization, Internet Centric, Variety of Resources, Automatic Adaptation, Scalability, Resource Optimization, Pay per Use, Service SLAs, and Infrastructure SLAs (Vaquero et al. 2009). However, PaaS, defined as an execution environment where external developers deploy and run their components, have further distinguishing characteristics in addition to the essential characteristics of cloud computing. Within the scope of the systematic, qualitative literature analysis, described in the methodology section, seven characteristics of PaaS have been identified and are presented together with the references, where they are mentioned in Table 3.

Table 2: Characteristics of Platform as a Service	
Characteristic	**Reference**
Essential Characteristics	
Opened Toward External Developers	Lawton 2008; Vaquero et al. 2009; Weinhardt et al. 2009; Rodero-Merino et al. 2011; Mell and Grance 2011; Khalidi 2011; Banerjee et al. 2011; Viega 2009; Zhang et al. 2010; Höfer and Karagiannis 2011; Rimal et al. 2010; Marston et al. 2011; Subashini and Kavitha 2011; Foster et al. 2008; Gartner 2011a
Deployment and Execution	Dikaiakos et al. 2009; Weinhardt et al. 2009; Vaquero et al. 2009; Stanoevska-Slabeva and Wozniak 2009; Lawton 2008; Foster et al. 2008; Gartner 2011b; Forrester 2011a; Narasimhan and Nichols 2011; Ojala and Tyrväinen 2011; Rimal et al. 2010; Marston et al. 2011
Automated Resource Management	Mell and Grance 2011; Vaquero et al. 2009; Buyya et al. 2008; Dikaiakos et al. 2009; Stanoevska-Slabeva and Wozniak 2009; Erdogmus 2009; Narasimhan and Nichols 2011; Höfer and Karagiannis 2011; Khalidi 2011; Marston et al. 2011
Significant Characteristics	
Development Environment	Narasimhan and Nichols 2011; Leavitt 2009; Lawton 2008; Weinhardt et al. 2009; Stanoevska-Slabeva and Wozniak 2009; Foster et al. 2008; Gartner 2011a; Forrester 2011a; Ojala and Tyrväinen 2011; Höfer and Karagiannis 2011; Rimal et al. 2010; Marston et al. 2011; Subashini and Kavitha 2011
Test and Simulation Facilities	Lawton 2008; Foster et al. 2008; Narasimhan and Nichols 2011; Höfer and Karagiannis 2011; Rimal et al. 2010; Subashini and Kavitha 2011
Administration and Management	Weinhardt et al. 2009; Buyya et al. 2008; Lawton 2008; Lindner et al. 2010; Forrester 2011a; Narasimhan and Nichols 2011; Höfer and Karagiannis 2011; Rimal et al. 2010; Subashini and Kavitha 2011
Knowledge Management	Leavitt 2009; Lawton 2008; Gartner 2011a

Even though the definitions are quite heterogeneous, several common essential characteristics can be identified: PaaS is a software platform, which is opened toward external developers, in order to develop, deploy, and run their components. A PaaS platform abstracts from the hardware resources demanded for the execution of the components. Developers no longer have to manage or control the underlying infrastructure, including network, servers, operating systems, or storage; these resources are managed automatically by the platform. While the openness toward external developers, deployment, execution, and automated resource management are essential characteristics, PaaS also has specific identified characteristics that seem to be significant. These are Development Environment, Test and Simulation Facilities, Administration and Management, and Knowledge Management.

In order to enable external developers to use a PaaS platform, they are usually provided with a development environment. Development environments can be provided in three different ways: first, by providing a software development kit (SDK) that allows developers to continue working in their favorite development environment and deploy directly on the platform; second, by providing a browser-based development environment; and third, by providing customers with powerful software modeling tools that allow creating applications on the platform without writing source code. A prominent example for the latter are mashup tools. As a consequence, test and simulation facilities that allow debugging, testing, and simulation of the developed software components should be part of PaaS offerings.

PaaS platforms facilitate developers to administrate their applications themselves by providing management tools to start, stop, configure, and/or backup their applications and data. In addition to this, PaaS platforms usually encourage interactive exchange of knowledge between developers by providing knowledge management facilities. Knowledge management in this context comprises several practices used to identify, create, distribute, and share insights and experiences concerning development in general and the platform in particular.

Based on the conducted literature review and the identified characteristics, the following working definition guides the paper at hand: PaaS refer to an execution environment in which external developers deploy and run their components. PaaS facilitate the development, testing, deployment, execution, and management of software components, as well as the exchange of knowledge between developers.

Case Studies

To assess the current state of PaaS providers' business models and to see how providers align themselves, the business models of twenty-five PaaS providers were analyzed. These providers were selected because each corresponded to the PaaS working definition proposed in this paper, fulfilled the seven characteristics of PaaS, and had a platform available to customers as of February 2011, when this research began. The final list of PaaS providers we have evaluated is shown in Table 7. Due to space limitations, only three case studies are presented in detail in the following subsections. The reason for choosing exactly these case studies is that they match different patterns identified within our research and serve as a foundation for the classification model introduced subsequently in this paper.

Windows Azure

The Windows Azure platform is a set of Cloud Computing services provided by Microsoft that can be used together or independently to build solutions that run in the cloud. The Windows Azure platform comprises the following developer services (Microsoft 2011): (1) Windows Azure: a cloud services operating system that serves as the development, service hosting, and service management environment for the Windows Azure platform; (2) SQL Azure: provides data services in the cloud, based on SQL Server capabilities; and (3) AppFabric: a set of .NET services that provide key building blocks required by many cloud-based and cloud-aware applications.

The Windows Azure SDK provides several APIs for programming in the Windows Azure environment, among others a storage services API and a service management API is included. The platform supports several programming languages like .Net, C#, Java, Python, Ruby, PHP, C++, Visual Basic, REST, SOAP, XML, as well as easy integration with other Microsoft services (Nelson 2010). However, there is a high grade of dependency on Microsoft technologies. The Windows Azure platform of Microsoft mainly addresses developers, meaning independent software vendors and small and medium-sized enterprises, who would like to develop and provide software solutions to private and business end-consumers or for own use (Berg 2010; Chappell 2009).

Microsoft Windows Azure leaves it up to the service providers to choose one of the following revenue streams: (a) subscription offers, subdivided into three packages: Windows Azure Core for $59.95/base unit/month, Windows Azure and SQL Azure extended for $109.95/base unit/month, or SQL Azure Core for $74.95/base unit/month; (b) transaction-based resp. pay-per-use models based on computing (extra small instance for $0.05 per hour, up to extra-large instance for $0.96 per hour), virtual network usage, storage usage or use of the content delivery network; and (c) Microsoft offers MSDN and Partner Packages. Service consumers are addressed by the Windows Azure marketplace called Microsoft Pinpoint, which is currently in beta version and does not yet handle payment services for consumers. Table 4 summarizes the business model of Windows Azure.

SAP Business ByDesign

SAP Business ByDesign (ByD) is a fully integrated on-demand business management software designed for midsize companies or small businesses (SAP 2011). It enables preconfigured process best practices for managing financials, customer relationships, human resources, projects, procurement, and the supply chain. SAP Business ByDesign is the name of both an on-demand Enterprise Resource Planning (ERP) system and SAPs PaaS solution. SAP takes care of installation and maintenance. The solution can be run on a PC with an Internet connection and a Web browser, while the software and data are stored on the host servers.

Table 3: Case Study — Windows Azure

Business Model Building Block	Description
Value Proposition	- Main developer services: - Windows Azure: a cloud services operating system - SQL Azure: provides data services - AppFabric: a set of .NET services - High integration with other Microsoft services and products - Hosting of the developed applications - Software developer kit (SDK)
Customer Segment	- Small and medium-sized enterprises - Independent Software Vendor ISV - Private and business end-consumers
Customer Relationship	- Microsoft Developer Network (MSDN) - Forums, FAQs, and Events - Online Knowledge transfer via MSDN Community Centre
Channel	On Demand
Revenue Stream	- Subscription, subdivided into three packages with a monthly base fee. - Transaction-based, models based on computing, virtual network usage, storage usage, or use of the content delivery network - MSDN and Partner Package

Within feature pack (FP) 2.6, SAP provides a SDK, which enables SAPs ByDesign partner network to develop extensions for SAP Business ByDesign solutions. The SDK, which is based on Microsoft's Visual Studio, is named "SAP Business ByDesign Studio" and was formerly known as "Copernicus" (Wolf and Zinow 2010). SAP Business ByDesign add-ons can be written in two scripting languages: Business Object Description Language (BODL) and Advanced Business Script. In addition, SAP offers two different APIs, one internal (called A2A) and one external (A2X), allowing other platforms to interact with ByDesign apps (Koch 2010). SAP has introduced their marketplace for the ByD add-ons in spring of this year. However, before being accepted by SAP, all ByDesign partner solutions must pass a quality review. Regarding the revenue streams, SAP gets a revenue share of partners. SAP's ByDesign solution is sold to consumers for a monthly subscription fee: from $149 for basic users to $54.00 for efficiency users.

Table 4: Case Study—SAP Business ByDesign

Business Model Building Block	Description
Value Proposition	- Application-based platform - Applications can be integrated into SAP's business management software solution - Best-Practice Solution Content - SDK "ByDesign Studio" resp. "Copernicus" - Interaction with other cloud-based applications via API
Customer Segment	- Small Medium Enterprises (SME) - Companies with 100–500 Employees - Large Enterprise Subsidiaries - Software Vendor with SAP's Ecosystem
Customer Relationship	- SAP Community Network - SAP Developer Network - ByDesin Partner network - SAP Support
Channel	On demand
Revenue Stream	- User-based monthly subscription fee - Revenue share of ByDesign partner solutions - Additional services

Facebook Developers

The Facebook Developer platform offers development tools and an execution environment for the social network Facebook (Facebook 2011). It enables enterprises and individual developers to integrate its applications and services with the Facebook website, gaining access to millions of potential users. When this research was conducted, there were more than 550,000 active applications on the Facebook platform, and people on Facebook install 20 million applications every day. Facebook is not only a PaaS, it is also a distribution channel where developers can find their potential users. However, Facebook does not offer application hosting and, hence, does not also support automated resource management.

Developers can work in three directions: integration of Facebook in websites, integration of Facebook in mobile applications, or integration of applications into Facebook (Facebook 2011). The main components of the Facebook Developers platform offer are: (1) The Graph API, a RESTful API that allows developers to read and write data to Facebook and manage the Facebook Social Graph, its objects (e.g., people, photos, pages, etc.), and connections between them. (2) The Social plugins that allow the easy integration of Facebook features into any Web page. In addition to this, Facebook provides SDKs for several programming languages like JavaScript, PHP, Python, iOS for iPhone and iPad and Android.

The revenue of Facebook is mostly based on advertisement and revenue sharing with Facebook developers. Facebook introduced a virtual currency within their platform and offers an API for service providers, which enables developers to use so-called credits as a method for purchasing digital and virtual goods within their application (transaction-based or based on upgrades within the applications). Service providers can redeem credits received at a rate of $0.10 per credit, minus a service fee of $0.03 per credit redeemed.

Table 5: Case Study—Facebook Developers	
Business Model Building Block	**Description**
Value Proposition	▪ Access to world's largest social network Facebook ▪ Development tools and execution environment for Facebook apps. 　▪ Read and write data to Facebook 　▪ The Social plugins for easy integration of Facebook features 　▪ Advanced APIs: Graph Realtime API, Facebook Query Language (FQL), Facebook Markup Language (FBML) ▪ High reach of Facebook application marketplace ▪ Broad linking possibilities
Customer Segment	▪ Facebook social network users ▪ Software vendors ▪ Individual developers
Customer Relationship	▪ Facebook developer Web page ▪ Online documentation ▪ Forum, blogs, and showcases
Channel	▪ On demand
Revenue Stream	▪ Advertisement ▪ Revenue sharing—usually Facebook takes ca. 30% revenue share of applications.

CURRENT STATE OF PLATFORM-BASED BUSINESS MODELS

Classification Model

Based on the data collected, a classification model of PaaS providers' business models was deduced according to Fettke and Loos (2003) and visualized by using a morphological box; see Figure 2 (Zwicky 1969). By applying a cross-case pattern search, the first three categories have been derived from the business model framework by Osterwalder et al. (2005) and Osterwalder and Pigneur (2010): (1) customer segments, (2) core value proposition, and (3) revenue stream. While the fourth category, (4) technical value proposition, has been deduced by a pairwise comparison of the cases.

Customer Segments	Independent Software Vendor	Small and medium enterprises	Business end-consumer	Private end-consumer
Core Value Proposition	Distribution Channel	Application-based Integration		Development
Technical Value Proposition	Strong Constrains	Some Constrains		No Constrains
Revenue Streams	Sub-scription	Trans-action-based	Revenue Sharing	Adver-tisement	Additional Services

Figure 2: Classification model for PaaS providers business models.

Customer Segments

The category *customer segment* defines "the different groups of people or organizations an enterprise aims to reach and serve" (Osterwalder and Pigneur 2010). Based on the investigated platforms, four customer segments for PaaS providers have been identified: (1) Independent software vendor, (2) small and medium-sized enterprises, (3) business end-consumers, and (4) private end-consumer. Almost all platforms address the customer segment of independent software vendors who develop and sell SaaS solutions (Forrester 2011a; IDC 2010a), as well as small and medium-sized enterprises that develop applications for internal use. On the other hand, some platforms do not address consumers at all. End-consumers can be divided into business and private end-consumers (Koehler et al. 2010). Prominent representatives of PaaS, which address business end-consumers, are SAP Business ByDesign, Force.com, and SuiteCloud. Platforms such as Facebook Developers and Andorid, however, address mainly end-consumers from the private sector.

Core Value Proposition

The category *core value proposition* lists the main services a PaaS provider offers to its customer segments. Based on the case studies, three groups, describing the most important value propositions, were derived: First, the main value proposition of a PaaS can be to facilitate the development of applications (Development focused platforms). Examples of this are Microsoft Azure, Google App Engine, and Bungee Connect. Second, the main value proposition of PaaS can be the integration of the developed applications into an existing SaaS solution (Application-based Integration). For instance, SAP Business ByDesign, Force.com, and SuiteCloud allow the development of applications which can be integrated into their existing SaaS solutions (ByDesign, salesforce.com, and Netsuite). The third group of PaaSproviders offers a distribution channel as its most important service to both of its customers—software developers and private end consumers. Facebook Developers, Apples iOS, and Zoho Creators provide distribution channels where app developers can find their potential users. Figure 3 summarizes the possible main value propositions of cloud-based platforms.

Technical Value Proposition

The last category has been deduced by a pairwise comparison of the cases. It is remarkable that the technological capabilities of individual PaaS offerings vary greatly. For that reason *technical value proposition* was added as a fourth category to our classification model. The category *technical value proposition* describes restrictions regarding programming languages, application programming interfaces (APIs), inter-component communication protocols, and database services. Technical value proposition was partitioned into only no, some, and strong engineering constrains, since the main focus of the underlying case studies was to analyze the business models of PaaS providers and, therefore, less on the analysis of technical features. Platforms like Apples iOS, Xing, and Facebook Developers have strong engineering constrains, while Zoho Creators, Force.com, and Android have only some constrains. Platforms like Microsoft Azure, Google App Engine, and Bungee Connect offer the greatest degree of freedom and have almost no restrictions.
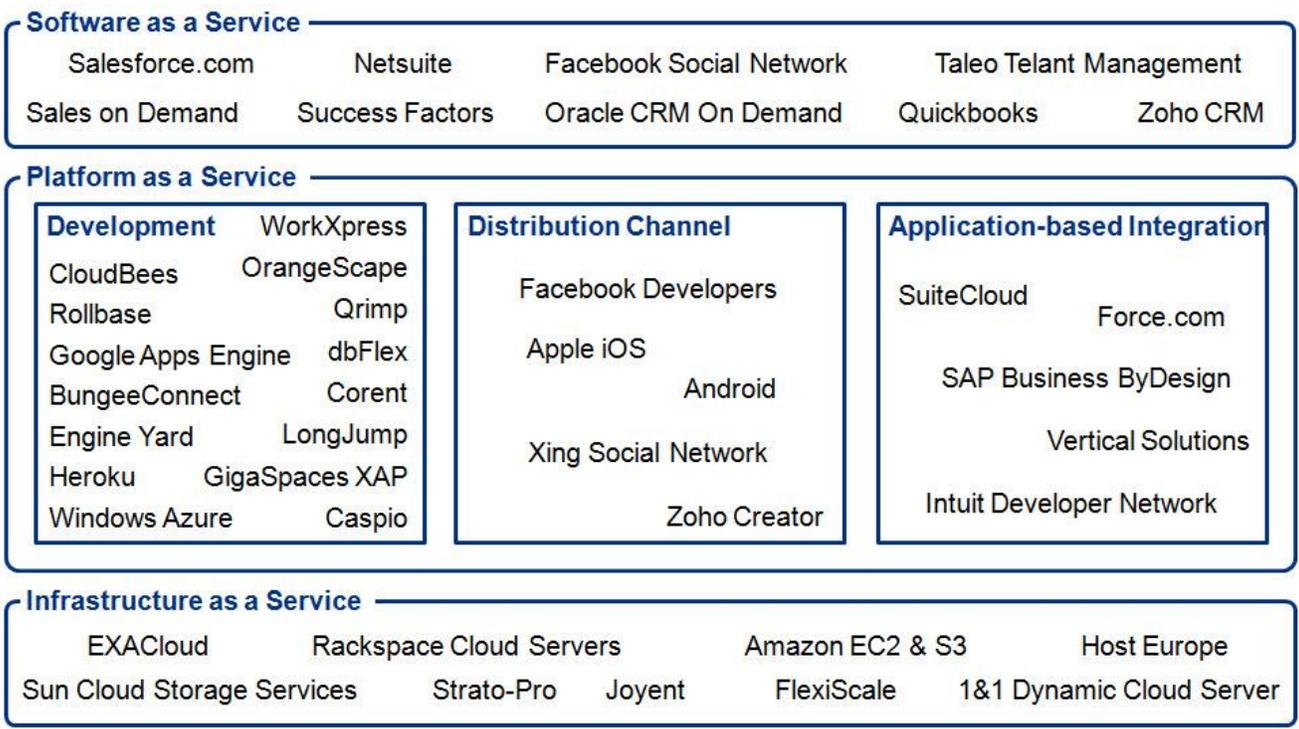
Figure 3: The three main sub-classes of value proposition.

Revenue Streams

Revenue streams "describes the way a company makes money through a variety of revenue flows" or, in other words, "represent the cash a company generates from each customer segment" (Osterwalder et al. 2005; Osterwalder and Pigneur 2010). Based on the investigated case studies, five kinds of revenue streams could be identified: (1) Subscription, (2) Transaction-based, (3) Advertisement, (4) Revenue Sharing, and (5) Additional Services. Most PaaS providers focus on direct revenue streams, which typically are based on subscription fees. Development-focused platforms rely on transaction-based revenue streams in addition and charge a static rate per utilized unit, for example, per hour or per GB CPU. Most revenue comes from the ISVs and SMEs, which is quite unsurprising as these customer segments are addressed by almost all platforms. Application-based integration platforms feature more differentiated revenue streams and focus on the consumer side as well. The major income stems from subscriptions at the consumer side, see SAP ByDesign and Force.com. Distribution-channel-focused platforms are the platforms that tend also to make use of advertisements, which can be explained by the large consumer base of these platforms. Revenue sharing is a concept that is rather prevalent in this type of PaaS. However, the major revenue stream for this type of platform as well is the subscription stream. Application-based integration and distribution-channel-focused platform providers also make some profit with additional services such as training or certification. A detailed analysis and discussion of revenue streams of PaaS providers can be found in Eurich et al. (2011).

Current State: Evaluation of PaaS Providers Business Models

The previously introduced classification model was used in order to evaluate the business models of the investigated twenty-five PaaS providers. Table 7 illustrates which platform provider currently offers which core value proposition, addresses which customer segments, relies on which revenue streams, and provides which level of engineering constrains.

The conducted investigation shows, that the majority of PaaS providers focus on providing development platforms for independent developers. Hence, they mainly address independent software vendors and predominantly have only a few technical restrictions. This type of service provider typically charges its customers with a monthly fee (subscription) or transaction-based fees. Application-based platform providers address both developers and consumers, whereby business end-consumers are addressed more often than private end-consumers. Due to the integration opportunity into an existing SaaS solution, these kinds of platforms often have technical limitations, for instance, the choice of programming language. Furthermore, certain application-based platforms and distribution-channel-focused platforms ask for additional admission fees as well as certification from the developers. Platforms, whose core value proposition consists of access to a distribution channel, usually address all four customer

segments, meaning both business and private end-consumers as well. However, these platforms also have the strongest engineering constrains and often use a revenue-sharing model.

Classification Model / PaaS Providers	Core Value Proposition			Customer Segments				Techn. Value Proposition			Revenue Stream				
	Distribution Channel	Application-based Integration	Development	Independent Software Vendors	Small and Medium-sized Enterprises	Business End-Consumer	Private End-Consumer	Strong Constraints	Some Constraints	No Constraints	Subscription	Transaction	Revenue Sharing	Advertisement	Additional Services
Development-focused Platforms															
Bungee Connect			X	X	X					X	X				
Caspio			X	X	X	X				X	X	X			
CloudBees			X	X	X	X				X		X			
Corent			X	X	X	X				X	X		X		
dbFlex			X	X	X	X			X		X				
Engineyard			X	X	X	X				X		X		X	X
GigaSpaces XAP			X	X						X	X	X			
Google App Engine			X	X	X	X				X		X			
Heroku			X	X	X	X				X		X			X
LongJump			X	X	X	X			X		X				X
Microsoft Azure			X	X	X	X	X			X	X	X			X
OrangeScape			X	X	X	X	X			X	X	X			
Qrimp			X	X	X	X				X	X				
Rollbase			X	X	X	X				X	X		X		X
WorkXpress			X	X	X					X	X				
Application-based Integration															
Force.com		X		X	X	X			X		X				X
Intuit		X		X	X	X	X		X		X		X		X
SAP Business ByDesign		X		X	X	X			X			X	X		X
SuiteCloud		X		X	X	X			X		X				
Vertical Solutions		X		X	X	X				X					
Distribution Channel															
Android	X			X	X	X	X		X		X	X	X	X	
Apples iOS	X			X	X	X	X	X			X	X	X	X	
Facebook Developers	X			X			X	X				X	X		X
Xing	X			X		X	X	X				X	X	X	
Zoho Creator	X			X	X	X			X		X			X	X
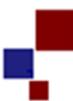
The classification of the twenty-five PaaS providers business model shows a clustering based on the criterion core value Proposition (see Table 7). The values of the remaining classification criteria seem to be highly dependent on a PaaS providers core value proposition. Therefore, three main types of prevailing business models of PaaS providers were identified: (1) Development focused Platforms—illustrated by the case Windows Azure, (2) Application-based Integration Platforms—illustrated by the case SAP Business ByDesign, and (3) Distribution Channel Platforms—illustrated by the case Facebook developers. In the following, potential future directions for these three types of platforms will be derived based on the results of the evaluation of existing PaaS providers' business models.

FUTURE DIRECTIONS: PATTERNS IN PAAS PROVIDERS BUSINESS MODELS

Toward Platform-based Two-sided Business Models

The tendency to stick to an established business model is well-known in the history of technological innovations. Companies seem reluctant to change a traditional business model or simply lack the knowledge and experience to do so (Chesbrough 2010). However, this is not an option for current PaaS providers, since they operate in a strongly growing market with low penetration (Forrester 2011a; Gartner 2011a; IDC 2011b). All this new demand for PaaS provides new opportunities, but also new challenges. In the last phase of the investigation presented in this paper, hypotheses regarding future directions and expected evolutions for PaaS providers have been shaped by leveraging the finding of the case study analysis. Figure 4 illustrates our hypotheses graphically.

SaaS Provider Develop Toward Application-based Platforms

Successful SaaS solution providers tend to open up their systems for the integration of third-party applications that are typically enhancements or add-ons to the core SaaS application. By doing so, existing SaaS solution providers evolve into application-based platforms with a two-sided business model. Lawton (2008) describes this as follows: "Several vendors have taken the SaaS concept a big step further and now offer Platform as a Service systems." Prominent examples of this trend are the transition from the CRM solution salesforce.com toward the force.com platform, as well as the evolution from the business software Netsuite toward the SuiteCloud platform. The extension of an existing SaaS solution toward an application-based PaaS solution promises two major advantages for the provider: First, by leveraging the specific customer knowledge, contributions, and investment of independent developers, the existing SaaS solution is extended with additional functionality provided by partners. In this way, the original SaaS solution can be enhanced with additional features faster, and, at the same time, it can be better adjusted to specific customer needs. The cooperation with developers usually results in access to new customer segments that might not have been addressed by the SaaS provider before. Second, application-based platform providers can charge a revenue share of up to 30 percent from third-party application developers. Consequently, the business model transformation from SaaS solution provider toward an application-based platform provider opens a new customer segment (Software developers), increases the number of end consumers, and opens up a new revenue stream. Thus, positive network externalities on one of the customer sides is expected to initiate positive network externalities on the other customer side.

Application-based Platforms as well as Development-focused Platforms Evolve Toward Distribution Channels

The success of application-based and development-focused platforms depends on the success of all of their customers. This is especially true for the customer segment of ISV that makes its revenue by selling SaaS or add-In solutions. In order to help ISV customers find and serve their end customers, PaaS providers expand their platforms with a distribution channel. The distribution channel can have different forms. It can be provided in form of application directories or markets for services, where the PaaS provider opens its customer base to the independent software vendors. End-consumers can find and test the developed third-party applications. Thus, application-based and development-focused platforms incrementally transform their business model in order to provide more comprehensive and attractive conditions for ISVs. The provided additional added value by platform providers enables them to tap into the revenue stream of ISVs. For instance, PaaS providers take a share of the sales of their developing customers. This implies a further diversification and extension of their revenue streams toward revenue sharing or even indirect revenue streams such as advertisement. Prominent examples for first attempts to diversify the payment streams are SAP with its SAP Store,[1] WorkXpress Store, LongJump Solution, and SuiteApp.

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[1] http://store.sap.com
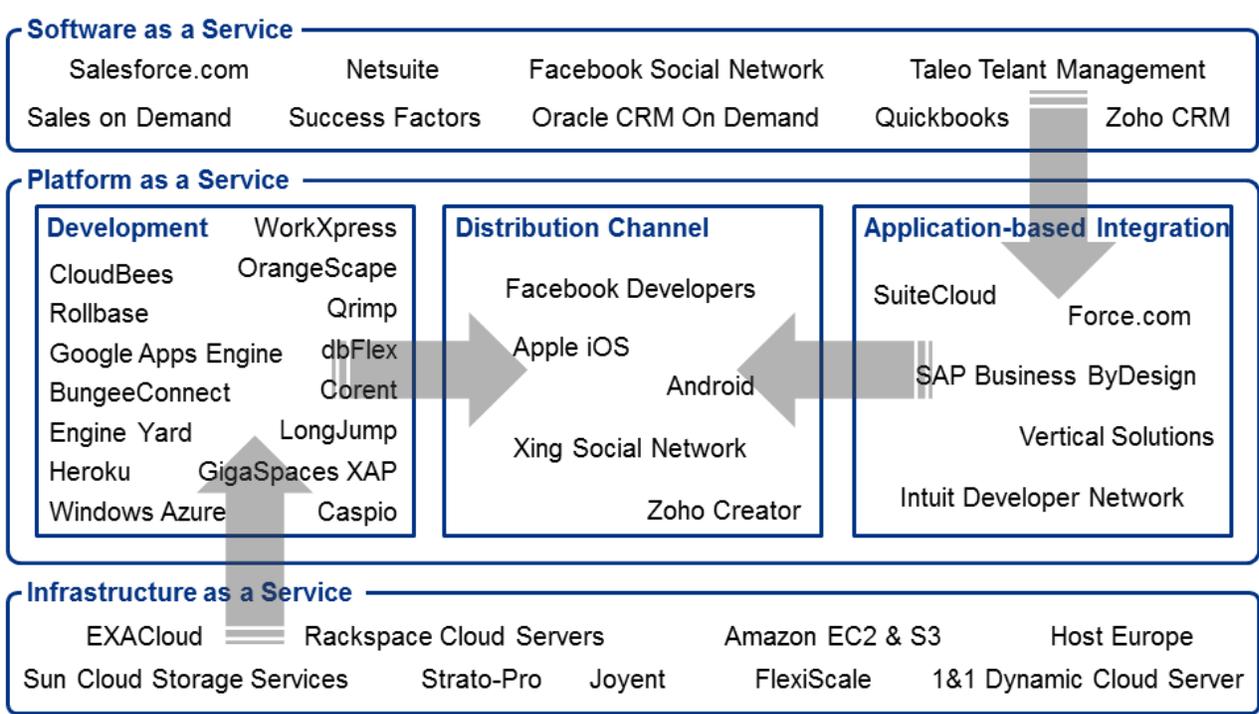
Figure 4: Future directions of PaaS providers.

PaaS Providers Started to Complement Their Platforms by Adding Marketplace Functionalities

Only a few PaaS providers have already discovered that in addition to the development of applications, trading of resulting third-party applications and enhancements could be supported by integrating a respective marketplace in the cloud. Providers such as Facebook[2] and Apple[3] have already started to introduce marketplaces that allow developers to directly offer their applications to the large number of end consumers. Providers of application-based platforms face the requirement to extend their platforms with at least minimal marketplace functionalities in order to be attractive for developers of add-ons and extensions for their original SaaS solution. Examples of this are the appexchange[4] marketplace of salesforce.com, as well as the Intuit Marketplace.[5] Even development focused PaaS providers have started to integrate marketplace functionalities into their platforms, for instance, Windows Azure Marketplace[6] or Google App Marketplace.[7] However, this trend is just emerging, and none of the investigated platforms offers an open electronic marketplace (Bakos 1991; Malone et al. 1987; Schmid et al. 2002), where demand and supply for cloud-based services meet, beyond the applications and services developed within their platform.

In summary, the analysis shows that existing PaaS have different origins and are currently developing toward a platform-based two-sided business model. The two-sided business model addresses two customer segments: developers or ISV on the one side and end consumers on the other side. Thereby, end consumers are divided in business customers, or private end customers. Depending on the origin of the PaaS, this transformation process requires different approaches. Original SaaS providers are transforming their application into a platform and are opening their platform for external developers. They need to develop competences for both provisioning a development environment to external developers and for smooth inclusion of external components into their application and distribution channel. Development platforms are extending into distribution channels in order to provide a sales channel for their developers. Finally, online services like Facebook also transform into platforms in order to make the huge amount of end-customers accessible to developers of applications that run on the platform. The final goal of all these PaaS providers independent of their origin is to create a strong ecosystem of developers and end consumers around their own platform, which is capable of creating strong positive network (Katz and

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[2] http://apps.facebook.com/marketplace/
[3] http://www.apple.com/iphone/apps-for-iphone/
[4] http://appexchange.salesforce.com/home
[5] http://marketplace.intuit.com/
[6] http://www.microsoft.com/windowsazure/marketplace/
[7] http://www.google.com/enterprise/marketplace

Shapiro 1985; Katz and Shapiro 1994; Shapiro and Varian 1999), as well as lock-in effects and fast growth. In the transformation phase toward platform-based two-sided business models, a high number of offered applications and services increases the attractiveness for further developers to join a specific PaaS, which in turn increases the attractiveness to end-consumers.

Toward Platform Wars

With the transformation toward platform-based n-sided business models, the process of future development is not finished and goes into a next phase. Platform-based n-sided business models are not a new phenomenon in the offline and online business. This phenomenon has been broadly analyzed in management- and strategy-focused literature. Prominent authors and publications in this context are Halman et al. (2003), Gawer and Cusumano (2002), Eisenmann et al. (2006), and others. Typical platform markets as, for example, the game-console market, are subject to platform wars and result, according to Cusumano (2010a), in either "winner take all" or "winner take most" markets. In analogy with the findings of the market research companies summarized in the section on "Related Research" in this paper and the scientific literature related to platform-based n-sided business models, it can be expected that in the midterm emerging PaaS will enter platform wars. This is, in particular, a very probable scenario for PaaS providers that offer a similar customer value and address the same segments on both customer sides. An example of such potentially competing PaaS providers are those providers offering such enterprise software as, for example, SAP Business ByDesign and SalesForce.

Cusumano (2010a) considers the cloud markets to be still open whether they are a "winner take all"-market like Microsoft in desktop operating systems, or the VHS format in home VCS, or "winner take most" market such as Google in Internet search. Thereby, according to Eisenmann et al. (2006), a "winner take all"-market emerges if the following three conditions apply: (1) Multi-homing costs, that is the consumption of offerings from similar, competing platforms at the same time are high for at least one customer side, (2) Network effects are high—at least for the customer side with high multi-homing costs, and (3) Neither customer side has strong preferences for special features. Any strong preference for special features creates high demand for niche products and services and creates a market opportunity for competitors. If one or more of these conditions are not met, than the market is rather a "winner take all" market on which strong providers with sufficient differentiation among their offerings can sustain in parallel on the market. As long as the platform providers maintain some differentiation among the platform offerings, direct network effects are not too powerful and switching is not too expensive for application developers or users, then there are favorable conditions for several PaaS to coexist (Cusumano 2010a).

Who wins and who loses the competition on a platform market at the end "is not simply a matter of who has best technology or the best product. It is often who has the best platforms strategy and the best ecosystem to back it up" (Cusumano 2010b). Thus, critical success for platform providers for diversification and competitiveness purposes are a creating network, strong direct and indirect network effects, strong lock-in effects for customers so that multi-homing is prevented and customers cannot easily leave to go to competitors, and comprehensive solutions that minimize opportunities for competitors (Cusumano 2011; Eisenmann et al. 2006).

Summary and Recommendations

In summary, it can be concluded that PaaS providers are currently in the middle of the process of transformation and building up their platform-based, at least two-sided business models. However, they have to consider that probably most of them are active in markets that are subject or will be subject to platform wars. PaaS providers should consider this fact and each PaaS provider needs to carefully analyze his position on the market and develop a strategy for how to position and survive either in a "winner take all" market or in a "winner take most" market. One major key success factor, beside the specific concept for the core value proposition and business mode, is the introduction of diversification aspects in the PaaS business model during the transformation toward platform-based n-sided business models. Based on the results of the case study analysis, several opportunities were identified that offer diversification potential:

The majority of the current PaaS providers are development-focused platforms that mainly address ISVs and SMEs. Most of these providers specialize in a specific service platform. However, customers usually attempt to minimize the number of providers. Hence, providers of development-focused platforms should expand their platforms in order to provide an integrated, optimized, and comprehensive PaaS suite that meets the requirements of most development projects (Gartner 2011a). Continuing in this way, they could also profit from Lock-in Effects (Shapiro and Varian 1999).

In order to protect and increase their market share, these platforms should also consider adjusting their revenue model to their strategic goals. Currently, these platforms rely mainly on subscription and transaction-based revenue models. However, there are a lot more suitable revenue streams for PaaS, such as revenue sharing, advertisement,

admission fees, downloads/upgrades, affiliate services, and additional platform services like training material, courses, or certifications (Eurich et al. 2011). For example, by integrating an affiliate marketing provider, PaaS providers can help their customers make money through advertising and claim a revenue share. Eisenmann et al. (2006), Parker and Van Alstyne (2005), and Varian et al. (2004) describe further strategies for platform pricing.

As already described in the previous section, PaaS providers started to complement their platforms by adding marketplace functionalities. However, in the long-term only a few marketplaces for cloud-based services will be sustainable. Especially for development-focused platforms, it might be interesting, instead of introducing their own marketplace, to integrate with an existing one. By doing so, they are able to reach a higher number of end-consumers, which might result in a higher number of developers (Katz and Shapiro 1985).

Application-based platforms arose mainly from SaaS solutions. These providers have opened their solutions for third-party applications in order to leverage network effects. However, in order to protect and increase their market share, these platforms rely on a strong ecosystem. Partners, developers, and consultants within the ecosystem are of great value as they extend and support application-based platforms. Application-based platform providers could even go one step further and open their systems for additional services. For instance, they could integrate with business process outsourcing providers and provide internal business functions like human resources or finance and accounting as a service via their platform.

In the context of distribution-channel-focused platforms, the evolution was vice versa compared to application-based platforms. The actual platform was there before; however, only platform operators were able to make use of it. For example, initially only Apple developed apps like calendar or a calculator for the Apple iOS. After these platform providers recognized the high potential of their platform as well as the high demand of apps, they opened their platforms for third party-applications. Consequently, distribution-channel-focused platforms already have a large user base, and a lot of developers are already motivated to leverage these platforms. However, the weak points of these platforms usually are development environments, test and simulation facilities, automated resource management and application hosting, if they provide hosting at all. In order to protect and increase their market share, distribution-channel-focused platforms might assess integration opportunities with development-focused platforms, in order to facilitate the development (Erdogmus 2009). In this manner, existing PaaS providers could even complement each other (Katz and Shapiro 1994).

Finally, at present providers of PaaS have the same goal in common, namely, to grow. This can be achieved especially if cloud platforms benefitted from network effects (Katz and Shapiro 1985). In order to profit from direct network effects, PaaS providers will try to create a lock-in effect that makes it difficult for users to switch platforms (Cusumano 2010a). PaaS providers could also benefit from indirect network effects by leveraging the popularity of a platform. That is, the attractiveness of a platform should be further enhanced by adjusting the business model (Cusumano 2010b). As more applications and services appear on a PaaS, more developers are attracted by the platform. This creates a positive loop that contributes to the growth of the platform very well.

DISCUSSION

Evolution of Platform as a Service

The main goal of the research presented in this paper was to investigate the current state and future directions of PaaS providers business model in order to illustrate the evolution of this new way of developing and selling software. Based on a systematic qualitative literature review, first the main characteristics constituting a PaaS were identified. These characteristics are (1) Openness toward external developers, (2) a programming environment, (3) test and simulation facilities, (4) automated resource management, (5) application hosting, (6) administration and management tools, and (7) knowledge management support. Furthermore, explorative case studies were performed, which investigated the business models of existing PaaS providers by using the business model canvas proposed by Osterwalder et al. (2005) and Osterwalder and Pigneur (2010). Based on the data collected, a classification schema for PaaS provider models was developed. Hence, one of the main research outcomes of this paper is a classification schema for business models of PaaS providers, which is illustrated by using a morphological box. The classification model distinguishes four categories: (1) Customer segments, (2) Core value proposition, (3) Revenue streams, and (4) Technical value proposition. Another main result is the identification of three core types of current PaaS providers based on their value proposition: (1) development focused platforms, (2) application-based platforms, and (3) distribution-channel-focused platforms. Depending on their type, platforms undergo a different evolution and future development path. Finally, the findings of the various analysis performed, were used as a basis for the assessment of potential future developments of PaaS. Two phases of future developments have been identified: (1) short-term development toward platform-based two-sided business models, and (2) midterm development toward platform wars.

The above results provide significant practical and scientific contributions. The identification of the main characteristics of PaaS solutions, as well as the embedding in the overall cloud computing concept, contribute scientifically to the understanding of the PaaS phenomena and its importance as a core component of cloud solutions in the future. Even more, taking into consideration that the three types of PaaS cover a substantial number of currently available cloud solutions prevailing on the market, it can be concluded that transformation of such single cloud offerings as SaaS or IaaS or online services toward platforms and inclusion of PaaS is becoming a dominant design in the cloud area. From the practical point of view, the list of features defines must-have features of current and future PaaS and cloud platforms, which are necessary to assure the competitiveness of PaaS providers.

The results of the case studies, the classification schema, and the typology of business models also contribute to the understanding of the PaaS business model phenomena from the scientific and practical point of view. While there are many attempts in literature to classify business models in general and in particular, there are seldom classification schemas and typologies that are grounded in a systematic classification approach. This paper contributes to theory, on the one hand, by demonstrating how classification methodology can be applied to classify PaaS business models and, on the other hand, with the specific PaaS classification result. The easy-to-understand-and-use classification schema can be applied by practitioners to visualize their business models and compare them with the features of their competitors. With this approach, similarities and differences among business models can be detected and visualized. The identification of the three types of PaaS business models also can help practitioners identify their type of business models and use the knowledge provided to optimize their current market position and develop future development strategies.

The future development directions were identified based on the case studies and by relating the discovered business models to the rich management and strategy literature dedicated to platform-based n-sided business model. This allows, on the one side, to tap into existing knowledge related to possible strategies and outcomes of platform-based n-sided business models. On the other side, clouds and PaaS are new cases where theory and research findings about platform-based n-sided business models can be applied and verified. The identification of the future directions and characterization of the market into "winner take all" and "winner takes most" market is helpful for PaaS providers and investors in this area. PaaS providers can identify the market they are active in and develop well-informed strategies based on scientific findings. Finally, by using the well-established canvas of Osterwalder to analyze the business models, this paper contributes to the verification of the canvass model and provides suggestions for the improvement of the canvass methodology for analysis of n-sided business models.

Analyzing Multi-sided Business Models

The results of our investigations show clearly that PaaS providers pursue platform-based multi-sided business models. "Multi-sided business models bring together two or more distinct but interdependent groups of customers" (Osterwalder and Pigneur 2010). Multi-sided business models of the analyzed PaaS providers in this study, differ fundamentally from traditional cloud computing offerings like IaaS or SaaS. In business models of SaaS and IaaS providers, "value moves from left to right: To the left of the company is cost; to the right is revenue. In multi-sided business models, cost and revenue are both to the left and the right, because the platform has a distinct group of users on each side" (Eisenmann et al. 2006).

The business model canvas proposed by Osterwalder et al. (2005) and Osterwalder and Pigneur (2010) is of limited use for the analysis of multi-sided business models. One reason for this is that it is not possible to assign a specific value proposition to a specific customer segment. As presented in the case study section, PaaS providers usually offer different, often disjoint value propositions per customer segment. The same is true for revenue streams. The information, which value proposition, and which revenue stream is assigned to which customer segment is not considered in the business model canvas by Osterwalder et al. (2005) and Osterwalder and Pigneur (2010). However, this information is essential when describing and analyzing multi-sided business models, since the design of multi-sided business models is significantly dependent on the customer segment.

The challenges to describe and analyze multi-sided business models in a clear and structured way has already been addressed in literature, see Ballon (2007); Evans (2003); Faber et al. (2003) as well as Pateli and Giaglis (2004). However, none of the introduced frameworks can be considered as established. The identified weaknesses of business model frameworks might serve as a basis for future research.

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

The main goal of the research presented in this paper was to investigate the current state and future directions of PaaS providers' business model. Based on a comprehensive methodology-mix, this paper provides results with significant scientific and practical contribution. The theoretical and practical contributions may serve as a starting point for decision makers' business model innovation plans.

Major practical and scientific results are the list of PaaS features, the classification schema for PaaS business models, the typology of PaaS platforms, and the identified future development trends. From a business model and technical prospective, these results can be a starting point for a design theory for PaaS. The development of a design theory for platforms and business models of PaaS and cloud offerings might be one future research question. Furthermore, given the fact that PaaS are just entering the platform war stage, longitude analysis of the transformation processes in terms of features of the technical platforms and business models can provide input to the design theory but also to the knowledge related to platform-based n-sided business models in general. Thus, a longitude analysis of selected key PaaS players representing different markets segments can be another future research direction.

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