Strategies, technologies and providers:

A compendium for IT decision-makers

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crisp RESEARCH

On behalf of:

PIRONET NDH

Ein CANCOM Unternehmen.

Contents

Foreword

“Software is eating the world” – With this sentence in an article for the Wall Street Journal in 2011, the inventor of Netscape and famous venture capitalist Marc Andreesen described a trend which is today more than apparent: software will provide the foundation for transforming virtually all industries, business models and customer relationships. Software is more than just a component for controlling hardware: it has become an integral part of the value added in a large number of services and products. From the smartphone app to the car computer. From music streaming to intelligent building control. From tracking individual training data to automatic monitoring of power grids.

60 years after the start of the computer revolution, 40 years after the invention of the microprocessor and 20 years after the launch of the modern internet, the requirements for developing, operating and above all distributing software have changed fundamentally.

But not just the visionaries from Silicon Valley have recognised this structural change. European industrial concerns such as Bosch are in the meantime also investing a large percentage of their research and development budgets in a new generation of software. So we find Bosch CEO Volkmar Denner announcing that by 2020 all equipment supplied by Bosch will be internet-enabled. Because in the Internet of Things, the benefit of products is only partially determined by their design and hardware specification. The networked services provide much of the benefit – or value added – of the product. And these services are software-based.

The implications of this structural shift have been clearly apparent in the IT industry for a few years now. Large IT concerns such as IBM and HP are trying to reduce their dependency on their hardware business and are investing heavily in the software sector.

In the meantime, the cloud pioneer Salesforce, with sales of four billion USD, has developed into one of the heavyweights in the software business. Start-ups like WhatsApp offer a simple but extremely user-friendly mobile app which have gained hundreds of millions of users worldwide within a few years.

State-of-the-art software can cause so-called disruptive changes nowadays. In companies and markets. In politics and society. In culture and in private life. But how are all the new applications created? Who writes all the millions of lines of

code?[1]. Which are the new platforms upon which the thousands upon thousands of applications are developed and operated?

This compendium examines these questions. It focuses particularly on the role that "Platform as a Service" offerings play for developers and companies today. Because although after almost a decade of cloud computing the terms IaaS and SaaS are widely known and many companies use these cloud services, only a few companies have so far gathered experience with "Platform as a Service".

The aim is to provide IT decision-makers and developers with an overview of the various types and potential applications of Platform as a Service. Because there is a wide range of these, extending from designing business processes (aPaaS) right through to the complex integration of different cloud services (iPaaS). To this end, market trends and the emergence of the first PaaS platforms are initially described (Chapter 1) and a definitional basis for the further discussion is provided (Chapter 2). Then follows a description of the various operating models in which PaaS is now available (Chapter 3). Relevant application scenarios and use cases are contained in Chapter 4.

Preceding a detailed profile of the various platforms, providers and technologies in Chapter 7, an analysis of the requirements for Platform as a Service offerings is first provided in Chapter 5, whilst relevant criteria for selecting a provider according to user groups are presented in Chapter 6. Because the requirements of start-ups, established software houses and large companies differ considerably.

Chapter 8 presents the current usage level and planning status of PaaS in corporate practice, based on the results of an initial empirical study which was conducted together with PIRONET NDH. This appraisal is followed in Chapter 9 by a description of the strategies for successful use of Platform as a Service in which the changes with respect to strategy, culture, organisation and processes are examined.

The compendium closes with an assessment of the outlook (Chapter 10) from the analyst's viewpoint and covers both the strategic development of selected platforms and technologies and how CIOs and developers deal with the topic.

With this compendium, the authors and the initiator, PIRONET NDH, wish to make a small contribution to the better understanding of state-of-the-art cloud-based software development

1 http://www.informationisbeautiful.net/visualizations/million-lines-of-code/

processes and platforms. This compendium is designed to support all entrepreneurs, managers and IT experts who will have to decide on the development and use of new applications and software-based business processes in the coming years. The authors see Platform as a Service becoming one of the cornerstones for implementing the digital transformation in companies, because the majority of the new digital applications will be developed and operated on PaaS platforms.

We hope you enjoy reading this compendium.
Dr. Carlo Velten and Rene Buest

Acknowledgment

Various factors led to the decision to write this compendium. Over recent years, the authors have themselves gained experience in numerous software development projects with the new technologies, frameworks and PaaS platforms. In addition, there has been a surge in the number of enquiries from interested user companies and software houses.

On top of this comes the range of PaaS technology stacks which have recently become available, with these enabling totally new operating and hosting strategies for PaaS. This gave rise to the cooperation with PIRONET NDH, one of the pioneers operating enterprise PaaS platforms for corporate customers in German data centres. PIRONET NDH is consequently one of the first Managed Service Providers in Germany to have implemented the PaaS technology stacks from Microsoft (Azure Pack) and Red Hat (OpenShift) in its cloud infrastructure. Given the great technical complexity and early development phase of these terminology stacks, this is a genuine innovative achievement!

Arising from intensive expert discussions with software vendors - in particular with the Federal Association of Small and Medium-Sized IT Enterprises (BITMi), the largest lobbyist for small and medium-sized IT enterprises in Germany - the compendium also examines the questions and requirements of the Independent Software Vendors. The guideline focuses particularly on the perspective of small and medium-sized ISVs.

From the joint discussions came the idea of creating an overview of the different varieties, application scenarios and platforms, with a view to making it easier for developers and IT decision-makers to plan and select suitable PaaS platforms.

This led to the creation of the first German compendium on the topic of Platform as a Service. We would like to take this opportunity to sincerely thank PIRONET NDH for the support provided in implementing the project.

1. Software development in the cloud era

The times when software was programmed on local machines and operated in isolation on corporate networks are long gone. In the cloud era, the value of a software service increases with its connectivity and level of distribution. This has fundamental implications for how applications are developed, tested and operated today. This chapter is intended to provide an introduction to main influences and technology trends which will shape software development in the coming years.

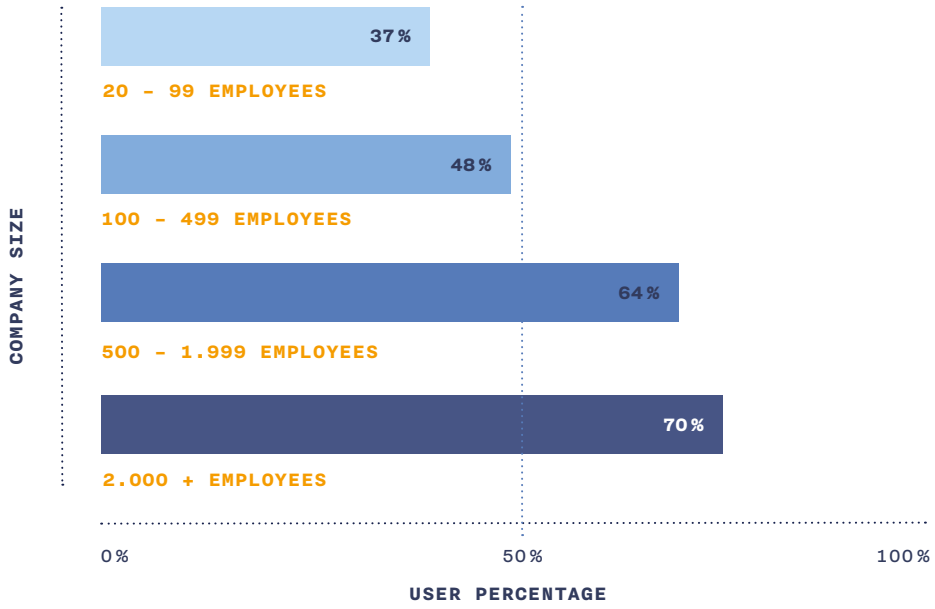
1.1. Cloud computing and Software as a Service

What started some ten years ago as a hip technology trend has long become an everyday feature in companies. Companies no longer operate a large number of their applications in their own data centres or on their own IT infrastructures ("on-premise"), but use instead cloud infrastructures from external service providers ("IaaS"). Alternatively, companies establish their own "private clouds" to operate their applications using a flexible, virtualised and standardised infrastructure. However, in order to make full use of IaaS's potential, the applications must have been developed in modern programming languages and have multi-client capability. Legacy applications make little sense for cloud operations.

An increasing number of companies are also utilising standardised applications in the "Software as a Service" model. As studies and forecasts confirm, the demand for SaaS across all company boundaries continues to grow. As one of the pioneers, Saleforce is now one of the ten largest software houses, posting sales of around four billion USD. In the meantime, more and more start-ups and ISVs (Independent Software Vendors) are developing and marketing the new generation of their software solutions as "Software as a Service", using a monthly leasing model. According to estimates of Crisp Research, over 600 professional ISVs in Germany alone are developing new SaaS solutions.

But large user companies are also switching to Software as a Service and are setting up in-house app stores and marketplaces to provide software and cloud services in accordance with the new paradigm. This not only has advantages for the end users who can enjoy quick provision (self-service) and state-of-the-art

Use of cloud computing in companies is increasing
Cloud computing users according to company size



SOURCE: BITKOM - KPMG, 2014

solutions with good usability; it also means that the in-house IT organization no longer needs to support local installations, that releases can run automatically in the background and that user behaviour can be better understood by means of analytics. These are all reasons for expanding Software as a Service.

1.2. Mobile applications

Mobility first! That is now the mantra of many software companies. Regardless of how big (Microsoft, SAP, etc.) or small, the adaptation of in-house software solutions for use on mobile devices is considered to be imperative – above all on the new generation of tablets and smartphones.

In order to achieve this, however, the design and development must undergo a complete rethink, the reason being that the user experience on mobile terminals is influenced by many factors which only play a minor role on the desktop in the local corporate network – such as user-friendliness, the bandwidth available and security in public radio networks. In order to really satisfy mobile users, the mobile applications must adapt to the user's situation (context) and the device concerned. Alongside basic considerations concerning the "Responsive Web Design", development frameworks - such as jQuery Mobile and PaaS platforms - play a major role for developers, in that they significantly simplify the development, testing and distribution processes over multiple OS and device platforms. The combination of the development framework and the PaaS platform enables the developers to focus totally on the application, while the IT infrastructure required to manage the user and application data is provided automatically. That this combination is a successful model is proven by the high proportion of developers of mobile applications already using Platform as a Service today. According to a recent survey by Crisp Research, the figure already stands at over 45 per cent.[2]

But for some years now, mobile provision of applications has begun to play an increasingly important role in large companies. Under the banner of "Enterprise Mobility", companies have started to gradually equip their operators with tablets and smartphones for a mobile working style. Now the relevant business applications will be adapted for mobile use.

Current empirical studies show that more than half of employees are already working on a mobile basis.[3]

2 http://www.business-cloud.de/paas-trendstudie-cloud-verursacht-erdbeben-im-softwaremarkt/

3 http://idc.de/de/ueber-idc/press-center/56517-idc-studie-deutsche-unternehmen-setzen-auf-mobile-apps-zur-verbesserung-ihrer-geschaftsprozesse

For this reason, more and more medium-sized and large companies are checking to see which PaaS platforms and mobile development frameworks are best suited to their needs. Because the number of mobile apps provided in German companies is scheduled to almost double from 10 to 17 in the next twelve months.

1.3. API Economy

Software development in the cloud era also means that applications must not only be error-free in functional terms, but must also ensure good usability (see section 3.6). In fact, state-of-the-art applications today generally employ a large number of data sources which are addressed via so-called APIs (Application Programming Interfaces). When it comes to the number and variety of APIs, the growth over recent years has been explosive. For example, the approximate number of 2,000 APIs in 2010 has increased to approximately 11,500 in 2014[4] and is likely to continue growing over the coming years.

Open, well-documented interfaces are able to create an ecosystem which not only strengthens the innovative power of an in-house technology platform by new applications using in-house data and functions. APIs can also contribute substantially to the expansion of a service and thus open up new sources of revenue. Consequently, almost all successful cloud companies employ an open API strategy to bind external developers to them as partners. Above all Amazon, Google, Facebook, Twitter and Salesforce. The example of Salesforce demonstrates that such a strategy can be successful, not only in the consumer IT environment, but also in the enterprise IT environment. For instance, so far some 800,000 developers have written over 2.5 million applications based on the Force.com API.

The result of this is that currently over 60% of the traffic on the Salesforce platform and the majority of sales are generated via the API.

For companies and software developers, a familiarity with the large cloud providers' APIs is therefore crucial, in order to be able to tap into or integrate themselves into this demand. Doing this in practice requires both the necessary know-how as well as suitable API developer and management tools, such as Runscope[5] or APIScience[6]. In addition, companies and developers should define their own API strategy, describing in detail how

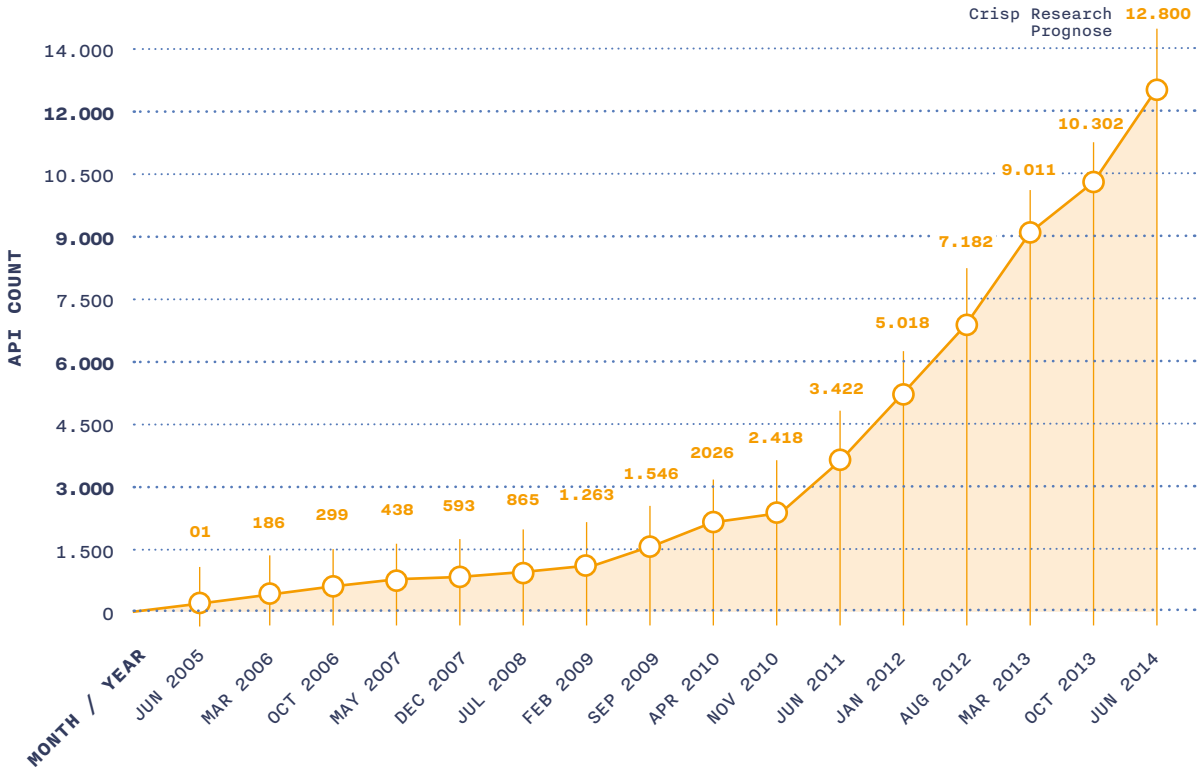
4 http://www.programmableweb.com/api-research

5 https://www.runscope.com/

6 https://www.apiscience.com/

they handle their own and third-party data. While a company's own data can be commercialised (geographical data, user data, movement data, machine data, etc.) and third-party data simply used, a legally sound definition should provide the foundation here.

Growth in Web APIs from 2005 to 2014



SOURCE: programmableweb, Crisp Research AG, 2014

1.4. The Internet of Things

The slowly emerging "Internet of Things" and the "Industrial Internet" will also have a marked influence on software development. In the coming years an enormous demand will thus evolve for additional developer resources to develop and implement the application and integration logic for the large number of new devices. There will also be a large demand for the development of control, monitoring and security functions for the intelligent devices and sensors. According to forecasts from various analysts and consulting firms, there will be between 25 and 50 billion networked devices by 20207 – including cars and telephones. Crisp Research estimates that the global market potential for the new services in the "Internet of Things" and the "Industrial Internet" will amount to around 160 billion euros by the end of 2016.

The world of data
Datability market volume worldwide (in million EUR)

	2011	2012	2013	2014	2015	2016	CAGR
Sensors & Networking (Internet of Things)	990	1.330	1.830	2.560	3.635	5.020	38,4%
IT-infrastructure, Software & Services (Big Data)	3.158	4.055	5.462	7.554	10.205	13.542	33,8%
Analytic Services & Data Products (Data Economy)	19.538	27.742	40.924	63.378	95.349	142.046	48,7%
Total volume (Datability)	**23.686**	**33.127**	**48.216**	**73.492**	**110.190**	**160.609**	**46,6%**

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

Currently, what are primarily missing are generally recognised standards and platforms to enable the various device types, sensors and their backend systems to be interconnected and controlled. However, these will be developed systematically in the coming years. Initial steps in this direction have been taken by the Industrial Internet Consortium (ICC)[8], which was founded by industrial and IT companies such as AT&T, Cisco, General Electric, IBM and Intel.

In addition, various IT companies such as Salesforce (Salesforce1) and Blackberry (Project Ion[9]) are setting up their own platforms to manage networked terminals and sensors. New alliances are also being established, for example between IBM and Bosch and between T-Systems and Siemens. But it is not

7 Gartner 2013 http://www.gartner.com/newsroom/id/2636073

8 http://www.iiconsortium.org/

9 http://el.blackberry.com/projection

merely the number of new devices and sensors which is critical from the development perspective. Complexity management, the maintenance of industrial software solutions and integrating the systems with each other will present central challenges. The software systems integrated into top-of-the-range cars today have a code basis of up to 100 million lines of code10. In a world in which the car is constantly interacting with its external world (traffic lights, road sensors, objects in the environment, other cars) and its occupants, this code basis and interfaces required will continue to increase.

The Internet of Things and the Industrial Internet will therefore also accelerate the use of Platform as a Service because companies and developers will be forced in this context to work on an extremely standardised and automated basis.

1.5. Global scalability

Another major driver for Platform as a Service is the demand for global scaling capability for new applications. Irrespective of whether a start-up, an export-oriented medium-sized company or a corporate group is involved: the question of whether there is an option of a global roll-out is generally asked at the outset, with a view to redeeming the investments in a new application. This applies equally for the launch of a new online game as for the provision of a company-wide SaaS application for marketing. Companies want to be able to roll out successful applications and processes as quickly as possible, either to conquer markets quickly or to utilise internal synergies. And in this context, the PaaS platforms of the large cloud providers offer the necessary global infrastructure.

If applications are developed from the outset with multi-client capability and on the basis of modern programming languages, normally nothing stands in the way of automated and worldwide scaling via PaaS platforms.

10 http://www.informationisbeautiful.net/visualizations/million-lines-of-code/

1.6. User experience and design thinking

Aside from the more technological trends (APIs, scalability, Internet of Things), the users with their own expectations also play a very central role in new applications. As the alternative app or application is generally only a click away in the cloud era, the user experience becomes a success factor in many application categories.

The themes of "design thinking" and "User Experience Management" now play a role not only in designing applications for private users: they have also gained a permanent place in enterprise software product development. Here, too, it is the case that corporate users only accept new solutions and use them effectively when their design, functionality and performance meet their expectations.

While a race for functions and features prevailed up to the turn of the millennium, at present the successful software developers and software companies are those that are able to conceal the complexity of their solutions behind user interfaces and menus which are as simple and intuitive as possible. Simplicity in user guidance is coupled with highly complex backend processes and the fine-tuning of the middleware and IT infrastructure. The objective here is to achieve as high a performance as possible for the cloud services and apps on the user side (browser, mobile app). Because even slight delays in displaying web pages or low latencies in transferring video or online games can lead to significant dropout rates, lower sales and decreased user satisfaction.

Various requirements must be satisfied to implement a process of continuous enhancement of the user experience. PaaS platforms facilitate the testing and release management of new functions and designs for developers without any great manual effort. The preconfigured plug-ins and templates on PaaS platforms enable new functions to be implemented quickly, for instance Site Analytics for Wordpress.

A/B tests can also be conducted without major effort by cloning instances of a solution and making these clones available to a test group with a modified feature set or design.

1.7. Flexible software development

The use of PaaS platforms is also influenced by new trends in software development methods. Due to the increasing complexity and technological variety on the one hand and ever shorter innovation and release cycles on the other, traditional "waterfall methods" can only be used to a limited extent. Flexible development methods such as SCRUM, by contrast, are becoming increasingly important. An iterative approach with frequent feedback processes enables new requirements to be integrated dynamically during the development process and errors to be corrected at an early juncture. Particularly when it comes to developing web applications which work with APIs from other platforms, it is necessary to programme in a very flexible manner.

1.8. Digital transformation

"Digital transformation" – For companies this term means that almost every industry is currently undergoing a change in their business processes and business models and is moving towards a networked organisation which maps their value creation processes and customer relationships on an entirely digital basis.

Not only sound industry and process know-how is required in order to translate the vision of the digital factory or a good "digital customer experience" into reality, but above all great expertise in developing state-of-the-art software architectures and designing user-friendly applications and cloud services.

1.9. DevOps

The topic of DevOps is currently one of the most important IT trend topics. The term is derived from the prefix "Dev" from software developer and the suffix "Ops" from IT operations. The compound term DevOps is emblematic of the close cooperation of the two corporate areas software development and IT operations. Like cloud computing, DevOps has developed over the course of time and is an organisational and process model which helps companies expedite and optimise software and product development. It enables the error rate in software development to be significantly reduced and the frequency of innovations and new releases to be considerably escalated by means of DevOps approaches. Since a quicker time to market is a decisive success factor in the digital world, DevOps is currently being adopted in ever more companies.

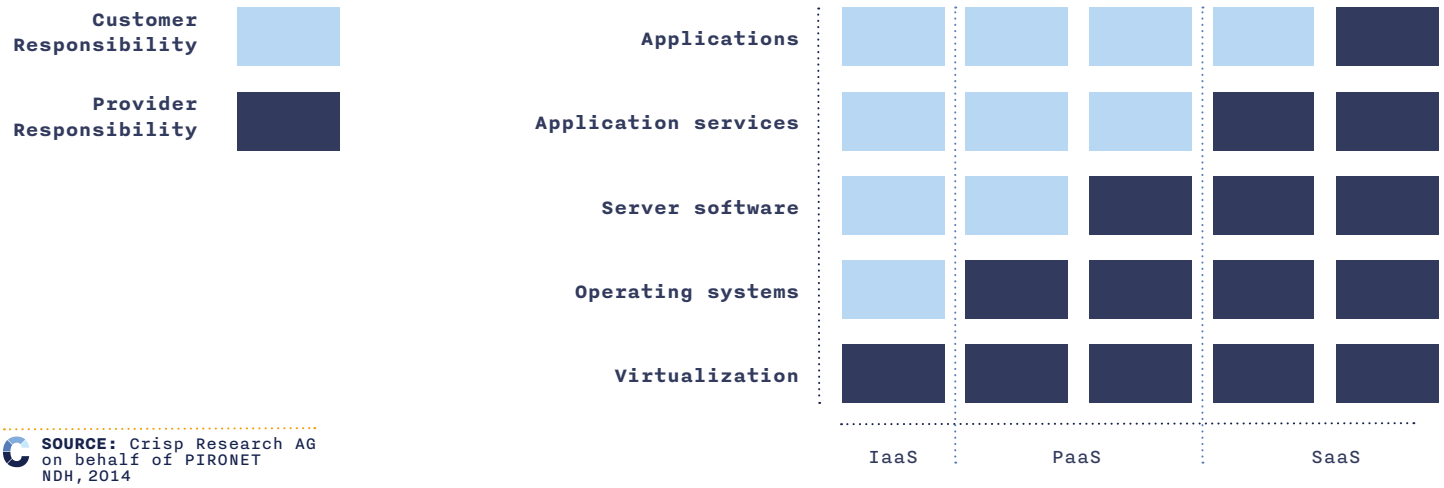
2. Fundamentals and history

2.1. IaaS, PaaS and SaaS –The cloud service types

Cloud computing has developed over the past eight years from being the subject of hype to becoming a genuine alternative for the flexible procurement of IT resources which are deployed from the data centres of the cloud providers centrally and distributed worldwide. In total, companies in Germany will spend around seven billion euros for cloud services and technologies and integration processes in 2014.

Cloud services can be classified in the categories IaaS, PaaS and SaaS. They can be differentiated on the basis of the distribution of the tasks between users and provider. Whereas with Infrastructure as a Service, the provider offers only the computing power and storage space, in the PaaS model they also take on responsibility for the operating system, runtime environment, middleware and security. In both cases, the user or developer can still intervene, configure, and manage parts of the cloud stack according to their requirements. This is not possible with Software as a Service. Here the complete application is provided as a ready-made cloud service and operated and controlled in its entirety by the provider.

CLOUD-STACK METHODOLOGY



SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS) provides computing power, storage space and other services which can be used to set up a separate virtual data centre. The provider is only responsible for providing and maintaining the hardware and ensures that a virtual infrastructure can be developed. The customer is responsible for all other required resources, such as the operating system or applications, although these can also be made available by the provider.

Software as a Service (SaaS)

Software as a Service (SaaS) enables platform-independent access to applications via a standard web browser. The possible SaaS applications are Office and Collaboration Suites, Customer Relationship Management Systems (CRMs) and other types of business applications. The provider must ensure that the software is constantly kept up-to-date. The provider must furthermore make the infrastructure for hosting the software available or, in turn, must use an IaaS or PaaS provider.

Cloud service types

Type	Description	Use
SaaS	· Multi-client-capable applications · Operating-system- and browser-independent use · Rapid provisioning · No up-front investments (CAPEX)	→ Operated as an alternative to on-premise or hosted solutions.
PaaS	· Development and runtime environments · Application development · Management of the application lifecycle · No up-front investments (CAPEX)	→ Platforms for developing new, web-based and scalable applications.
IaaS	· Virtual infrastructures · Server, storage space, network · Infrastructure services · No up-front investments (CAPEX)	→ For operating existing standard applications and virtualised server environments.

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

While the focus in recent years was on IaaS platforms and these attracted most of the attention from CIOs and the press, Platform as a Service (PaaS) is now becoming increasingly important.

Because quick and flexible development of new applications is currently becoming the benchmark for many IT managers. In the context of large-scale digital transformation projects and the long-term implementation of enterprise mobility strategies, a growing number of applications will have to be available on a mobile basis. The frequency with which the new functions are developed, tested and rolled-out is increasing, as a result of which PaaS platforms are becoming the platforms of choice for software houses and also IT organisations.

2.2. Platform as a Service – A definition

With Platform as a Service (PaaS), cloud services and cloud platforms are offered which make complete development and operating environments available to the users. These are generally provided in the form of a fully managed runtime and development environment. In contrast to IaaS, the complete lifecycle of an application can be mapped and managed in its entirety on PaaS platforms. The platform of the provider concerned is addressed using APIs. Only a local desktop, a web browser, possibly a local development environment and an internet connection are required to use it. The remaining elements of the development infrastructure - such as web servers, operating systems, runtime environments, frameworks, middleware and operation of the underlying infrastructure - are the responsibility of the provider, who both provides and manages them.

As a result, users can concentrate on actually developing applications and no longer need to concern themselves with operating, scaling and maintaining the infrastructure and middleware.

PaaS thus permits companies and software developers to focus on their core competences and to outsource and automate IT operating tasks. In comparison to conventional on-premise development infrastructures, the PaaS environments stand out in particular because of the options of distributed development of source code, including versioning provided for this purpose, and source code development directly in the PaaS environment. Many PaaS platforms also offer integrated functions for monitoring and analysing the application and its current status.

Application Lifecycle

Build	Deploy	Run	Management
· Development	· Configuration	· Scaling	· Issue Tracking
· Integration	· Management	· Monitoring & Reporting	· Source Code Control
· Management	· Provisioning & Orchestration	· Optimization	· Test Automation
· Test Management	· Release Management		· Project & Team Management
			· Governm. & Compliance
			· Security Management

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

A PaaS environment typically uses a scalable infrastructure (e.g. Infrastructure as a Service, IaaS) and is therefore able to scale the computing performance and storage space according to requirements and utilisation (autoscaling). Using PaaS, multi-client-capable Software as a Service (SaaS) applications can be developed and provided on a scalable basis.

The strategic goals which users and developers associate with the use of PaaS can be summarised as follows:

- Time-to-Market - expediting the development process
- Integration of development and operations (DevOps)
- More innovations (increased frequency of releases)
- Standardisation of the development and operating processes (fewer errors, simplification)
- Use of state-of-the-art tools, development frameworks and APIs
- Better checking and greater transparency in the development and operation process

PLATFORM AS A SERVICE APPLICATION LIFECYCLE

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

2.3. The emergence of Platform as a Service:

PaaS services were first offered by the start-ups EngineYard (2006) and Heroku (2007) – more or less at the same time as the Amazon Web Services were released. The primary aim of the founders of EngineYard and Heroku was to facilitate the development and operation of RubyOnRails applications.[11] Their PaaS services were principally intended for developer friends who focused on developing web and mobile applications. They wanted them to be able to concentrate on developing their applications without having to concern themselves with setting up and administering the infrastructures required for this purpose. Initially no other programming languages were supported apart from RubyonRails, but this situation has considerably improved over the course of time. When the Google App Engine (2008) appeared, Python and Java were incorporated as languages into the PaaS world. The SaaS CRM provider Salesforce uses the proprietary language APEX for its platform Force.com (2008). With Windows Azure (2010), Microsoft introduced its well-known programming language ASP.NET into the PaaS world.

PaaS providers

Provider	Year released
EngineYard	2006
Heroku (today part of Salesforce.com)	2007
Force.com (today Salesforce1)	2008
Google App Engine	2008
cloudControl	2009
Appeleon	2009
Microsoft Azure	2010
Jelastic	2010
CloudBees	2010
Red Hat Openshift	2011
Cloud Foundry	2011
Amazon Elastic Beanstalk	2011
GBS AG	2011

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

11 https://blog.heroku.com/archives/2007/10/30/the_big_kickoff

With the launch of a large number of other PaaS platforms and the integration of programming languages which are relevant for enterprise IT, the PaaS model has become established over the years and now offers nearly all user groups interesting options for developing and operating state-of-the-art applications – from freelance developers to ISVs and right through to enterprise IT departments. The evolution of the PaaS platforms in recent years can be classified using the aforementioned categories and generations.

Autoscaling, on the other hand, was immediately widespread, because it typically stands for cloud computing. Autoscaling ensures that the number of servers beneath a PaaS platform is automatically scaled.

When server utilisation increases, the work is handled by a larger number of servers. When the server utilisation decreases, the servers no longer required are automatically shut down.

2.4. First generation Platform as a Service

"Application Platforms as a Service" (aPaaS, see Chapter 3.1) were the platforms of the first generation (2006-2010). These were aimed primarily at developers of mobile and web applications. However, because of their level of maturity, they were initially not very robust and were not supported by SLAs (Service Level Agreements) which were suitable for corporate use. In the early years, the fact that only a few programming languages were supported was also problematical. This situation has in the meantime improved radically. On the one hand, numerous programming languages can be used on the various platforms, and on the other, the maturity level of the platforms has developed to the degree that they can be used for company-specific projects.

The first generation PaaS platforms were also characterised by restrictions and a low degree of standardisation. Some providers used proprietary programming languages which they were more familiar with or developed their own programming languages and models. One example is Salesforce's APEX programming language. Using a Java-like syntax, developers can write commands in the form of database stored procedures in order to control processes and transactions on the Salesforce platform.

This situation considerably restricted the development and control options for the users. Because "programming takes place against the platform's APIs", the developers had no opportunity to create granular configurations on the underlying infrastructure and middleware. Cloud ecosystems in which partners' services and technologies can be conveniently integrated and mutually supported did not yet exist in this first market phase.

2.5. Second generation Platform as a Service

First generation PaaS solutions were provided via a public cloud, but the second generation (2010-2015) also offers operating concepts from a hosted and managed cloud (see Chapter 5), via which familiar PaaS stacks such as OpenShift and Microsoft Azure Pack are made available. In other words, the PaaS services can also be obtained from local data centres.

In addition to aPaaS, new varieties of PaaS have also become established. One new product category is "Integration Platform as a Service" (iPaaS, see Chapter 5). This functions as middleware or an integration layer in order to interconnect various cloud services and platforms. Mulesoft, Informatica and Skyyva are examples of this category.

The second generation PaaS platforms also stand out on account of new functions, methods and technologies:

Cloud-based IDE
In this instance, development environments are provided directly on the PaaS platform - in other words, in the browser.

Application containers
The application container technology - for example, that offered by Docker - enables complete applications to be provided in a virtual container. This is made possible by bundling the application and all its dependencies, which allows it to be moved to and operated as required on any Linux server. This not only facilitates the processes of deployment and testing - it also reduces the risk for developers and users of a vendor look-in.

Ecosystems
PaaS platform providers use add-ons to provide an ecosystem/marketplace for extending PaaS applications. Examples of the solutions within such ecosystems include Load Testing as a Service, Database as a Service, Application Performance Monitoring, Analytics and Email as a Service.

The control level of the PaaS solutions remains low. However, because of new IaaS+ approaches (see Chapter 5) such as Amazon Elastic Beanstalk, the IaaS solutions are growing closer to PaaS platforms because the user is automatically provided with the necessary infrastructure and can then implement configurations on the servers and in the software.

Many PaaS providers have also set up an ecosystem of partners on the basis of marketplaces. The marketplaces incorporate external cloud services and data sets which can be integrated into the user's own applications as subcomponents or a data

stream by means of an API. These include, for example, services for email or sending text messages or for monitoring and database services.

2.6. Third generation Platform as a Service

The PaaS platforms of the third generation (starting in 2015) will be characterised in particular by their greater level of corporate customer-orientation, in that the offerings are moving away from a pure focus on platforms for developers towards application platforms for companies and ISVs. This is evidenced particularly in the fact that attention is shifting further to technologies such as Docker, which will lead to applications becoming more portable and consequently enable genuine hybrid and multi-PaaS strategies to be implemented.

Since established companies do not start application development on greenfield sites, existing applications and services will constantly have to be integrated with each other. iPaaS functionalities and services can provide essential support here and handle or automate certain integration tasks.

DEVELOPMENT OF PLATFORM AS A SERVICE

2006 - 2010	2010 - 2015	2015 +
Platform-as-a-Service 1.0	**Platform-as-a-Service 2.0**	**Platform-as-a-Service 3.0**
Application Platform-as-a-Service	Integration Platform-as-a-Service	Multi-PaaS
No enterprise SLA	Hosted Private PaaS	Hybrid PaaS
Not very robust	Managed Private PaaS	High demand for integration
No ecosystems	Cloud IDE	IaaS and PaaS merge
Few programming languages	Container (Docker)	Control level will be increased
Restrictions for APIs	Ecosystems enterprise-ready	
Little standardisation	IaaS+	
Low control level	Continous Integration	
	Control level still low	

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

IaaS and PaaS will merge still further, as the evolution of Microsoft Azure and the Google App Engine has already shown. According to assessments of Crisp Research, the platforms will in future become more granular at the control level. Users who wish to have a greater individual influence on the underlying infrastructure will thus have the opportunity to do so.

The PaaS platforms of the third generation will be distinguished by the following characteristics:

- Support of hybrid operating concepts and architectures
- Implementation of complex governance and role-based security
- PaaS platforms will be intermeshed with enterprise app stores and form a new service delivery model in large organisations
- Support of technologies and workflows for implementing DevOps concepts

3. Development variants and models

It is not only in the cloud service category "Infrastructure as a Service" that a large number of different variants and operating models can be found. In the PaaS sector, too, numerous variants have developed over recent years in order to employ development platforms more quickly and more flexibly.

PaaS platforms have already existed for some time (Heroku 2007, Google AppEngine 2008, Microsoft Azure 2010), but theses have largely only been made available as pure "public cloud services" from US data centres. The substantial increase in maturity over the last 24 months and the option of also using PaaS technologies (e.g. Openshift, Azure, CloudFoundry) in flexible, local operating concepts (e.g. hosting in the case of a local provider or on-premise in the in-house data centre) mean that these will also become increasingly interesting for German companies.

3.1. Variants of Platform as a Service

Application Platform-as-a-Service (aPaaS)
An Application Platform as a Service (aPaaS) provides a cloud environment in which corporate applications can be developed and operated. It has a graphical web interface and various interfaces for programming (APIs). Progress Software with Rollbase and Heroku, Cloud Foundry and OpenShift are examples of aPaaS.

Integration Platform-as-a-Service (iPaaS)
An Integration Platform as a Service (iPaaS) provides an environment for integrating various services which can be used to connect multiple cloud services as well as on-premise applications. An iPaaS replaces middleware solutions which would otherwise be used for this purpose. Poviders such as MuleSoft, Dell Boomi and Microsoft Azure BizTalk are examples of an iPaaS.

Infrastructure-as-a-Service Plus (IaaS+)
Compared to an aPaaS, an Infrastructure as a Service Plus (IaaS+) offers a significantly larger control level. Applications are provided automatically on an IaaS+. In the background, the service sets up the required infrastructure in accordance with the performance required. The user retrospectively obtains granular access to this infrastructure and can configure the relevant servers and software according to its own needs. Amazon Elastic Beanstalk is an example of an IaaS+.

Portable vs. vertically integrated PaaS

From the technical/organisational viewpoint, two types of PaaS can be distinguished:

Portable and vertically integrated. The portable platforms include all those which are based on open standards and which, together with the applications developed on them, can be shifted between public and private clouds.

Vertically integrated PaaSs are combined seamlessly with the underlying IaaS and are consequently not portable.

3.2. Operating concepts for Platform as a Service

Various operating concepts for Platform as a Service have been developed in recent years. These are defined largely by the type of provision model and the intensity of the consultancy services that they offer.

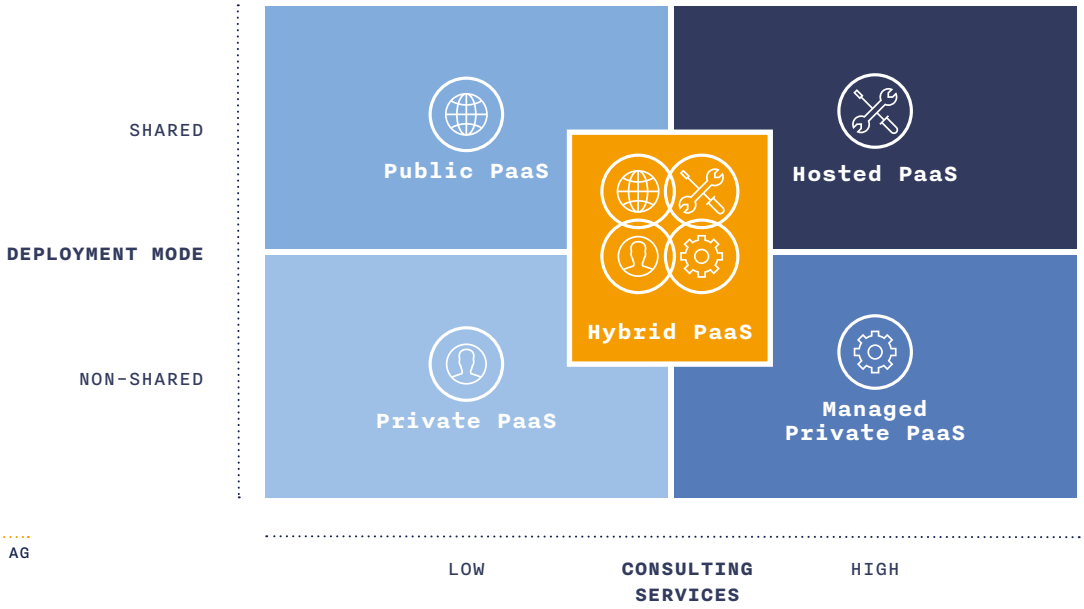
For a period of around five years, the first public PaaS solutions predominated. In this model, all customers share the same physical infrastructure and are separated from each other on a virtualised basis. At the same time, the focus is on self-service. This means that no further consultancy services can be obtained from the provider side.

Private PaaS solutions encapsulate all the technical functions of a public PaaS into a software, which can then be used for in-house operations. As the software is primarily designed for use in companies, the PaaS is located in a non-shared environment in a self-managed infrastructure. In this case, the user is self-sufficient, meaning that no consultancy services are available.

These private PaaS solutions are now increasingly being used by the hosting sector in order to offer their own PaaS solutions in a hosted PaaS or managed private PaaS model. In both cases, the consultancy service is very important in order to provide support for the customer when performing the transition and in developing their applications. Self-service as in the public PaaS does not exist. A hosted PaaS differs from a managed private PaaS in its provision model. Whereby the hosted version employs a physical infrastructure in which the customers are separated from each other on a virtualised basis, a managed PaaS provides an exclusive physical infrastructure which is managed by the provider.

The hybrid PaaS model enables the various PaaS platforms to be interconnected and integrated. Depending on the scenario, this permits the different models to be combined with each other.

METHODOLOGY OF PLATFORM AS A SERVICE



SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

Public PaaS

A public PaaS environment consists of a shared infrastructure. Here all the customers share the same physical infrastructure. The PaaS platform is logically separated for each customer on the basis of a virtualised security infrastructure. The platform is accessed over the public internet. Some providers now have a so-called Direct Connect or VPN connections which enable the infrastructure to be accessed directly and exclusively.

Private PaaS

On a private PaaS platform, the customer operates its own PaaS platform and is responsible for its set-up and maintenance.
A private PaaS platform is built according to the design concepts of a public PaaS platform with respect to scalability and flexibility. However, because of the absence of economies of scale, the scalability of a public PaaS platform is virtually unachievable.

Hybrid PaaS environments

A hybrid PaaS platform connects a private PaaS platform to the resources of a public PaaS platform. In this case, a company operates its own PaaS platform and, either as required or on an ongoing basis, utilises the scalability and economies of scale of a public PaaS provider to avail of further resources in the form of computing power or other services.

Hosted PaaS

The hosted PaaS model transfers the idea of the public PaaD to a hosted variant managed by a local provider. Here all the customers are integrated on the same physical infrastructure and are securely separated from each other on a virtual basis. In this case, the PaaS provider has a local data centre, for example in Germany. The PaaS platforms here are based on various technology stacks from public PaaS providers, for example Microsoft Azure Pack, Red Hat OpenShift or Cloud Foundry.

Managed Private PaaS

A managed private PaaS is an enhanced variant of the hosted PaaS. It is particularly attractive for companies who wish to avoid the public PaaS model (shared infrastructure, multi-tenancy) but who do not possess the financial resources and knowledge to provide a PaaS platform in their own IT infrastructure. In this case, the provider offers a customer an exclusive and reserved physical area on its provider infrastructure. The customer can use the managed private PaaS exactly like a public PaaS, but on an infrastructure which is not shared and is located in the provider's data centre. Furthermore, the provider assists with consultancy services which help the customer either to transfer their applications to the platform or to develop new ones there.

3.3. Development environment (IDE) - local or from the cloud

Typically, a local (integrated) development environment (IDE) is used to develop applications for a PaaS. The source code is written on the developer's computer and then copied to the PaaS platform, where it is rolled out and operated. When changes are made, these are also initially made locally and then transferred to the PaaS platform.

New PaaS variants go one step further and have the IDE integrated - in other words, the IDE is presented in the browser. This enables the source code to be written, modified and rolled out directly on the PaaS itself. This also improves cooperation, as a number of developers can work in parallel on the same source code.

4. Applications areas

Companies and developers can use PaaS platforms in various scenarios and use cases. Users should define their requirements up front and consider whether the following requirements (see section 6.1) are satisfied in their particular project. The most relevant use cases for using PaaS are outlined in section 6.2, and the option of application integration using PaaS (section 6.3) is then described.

4.1. Requirements for using Platform as a Service

Even if PaaS is currently being treated like one of the hot trends in cloud computing and the platforms have matured significantly in recent years, companies and developers must nevertheless critically question as to whether PaaS makes sense for their particular project. When the following requirements exist for a planned software development project, significant benefits can be achieved using PaaS:

- Several releases are planned per year to extend the application's functionality (yes/no?)
- Application development is to take place using a flexible software development method (yes/no?)
- Integration of multiple APIs is planned (yes/no?)
- Development requires the use of state-of-the-art web frameworks and development tools (yes/no?)
- The IT infrastructure requirements (server performance, storage capacity) are difficult to assess at the start of the project (yes/no?)
- The first release is to take place in less than six months (yes/no?)
- No full-time administrator is provided for IT operation of the application (yes/no?)

However, the question of whether or not to use PaaS can also be one of strategic importance for medium-sized and large companies who develop their own applications. If, for instance, a company is planning to develop new applications (possibly also with external partners) as part of larger-scale enterprise mobility or digital transformation programmes, PaaS platforms provide a helpful tool to coordinate application development across company boundaries and also to define and monitor quality and control standards for external partners.

4.2. Use cases for the application of Platform as a Service

The range of possible use cases for the application of PaaS is very broad. In practical application, the following use cases have proved to be particularly relevant in recent years. Most of the requirements described in section 6.1 also apply for these.

- Web applications
- eCommerce
- Media Streaming
- Social Web/Social Collaboration
- Mobile applications/Apps
- Analytics/Reporting
- Transactional applications

Since the development of enterprise applications still only takes place in a very small number of companies and is essentially restricted to the integration and customising of standard software, PaaS platforms have so far played a minor role in this context. This picture will gradually change with the availability of the first enterprise PaaS solutions - in other words, with hosted PaaS environments which include the necessary compliance and government functions. When it comes to linking classic enterprise and SAP applications with state-of-the-art web applications and mobile frontends, PaaS platforms will also become relevant for the enterprise IT.

4.3. Application integration via Platform as a Service

Aside from the development and operation of new applications, PaaS platforms (specifically iPaaS) can play an important role in merging various SaaS applications and in implementing hybrid cloud environments. Wherever SaaS applications (e.g. Salesforce CRM or social collaboration services such as Microsoft Sharepoint Online) access internal data sets or user profiles (LDAP/ Active Directory), an intelligent integration layer must be implemented. This can generally be realised considerably more easily and more flexibly by using iPaaS platforms than by using traditional middleware stacks. These also offer the option of largely standardising service integration and of creating an integration architecture which will facilitate the connection of new cloud services and APIs in the future.

5. Requirements

5.1. Availability

On the technical side, the PaaS platform must ensure that the applications operated on it, as well as the backend infrastructure, can be accessed at all times. The provider is responsible for guaranteeing this. Depending on the provider's platform, the customer must take this into account when programming its applications.

5.2. Scalability

Flexible adaptability of the basic infrastructure is an important feature of a PaaS platform. The provider must ensure that the platform offers options for automated scalability for the applications when this is required. Depending on the provider's platform, the customer must consider this when programming its applications.

5.3. Multiple access options

The platform must offer the customer various options for interacting with the platform. This includes access to APIs via a command line and the web browser.

5.4. Ecosystem and partners

An extensive and constantly growing ecosystem of partners attests to a certain attractiveness of the provider and enables the customer to access further external resources to enhance its applications more simply with value added services.

5.5. Multiple development frameworks and languages

A large selection of different frameworks and extensive support of programming languages helps potential customers in deciding on a platform to which they can migrate their existing applications or on which they can develop new ones.

5.6. Multiple operating concepts

Depending on the application scenario, it must be possible to implement different operating concepts to satisfy individual requirements. State-of-the-art PaaS platforms should be able to permit public, private, hybrid, managed or hosted concepts.

5.7. Professional support and Service Level Agreements

For companies in particular, professional support is of critical importance in the decision to either to migrate their existing applications to the PaaS platform or to develop new ones on it. In this context, special mention should be made of Service Level Agreements, on the basis of which availability on a contractual and organisational basis can be regulated. This enables a provider to draw attention to their quality in terms of the reliability of their service. The customer thus has a contractual document to which they can refer.

5.8. Security

The provider must take care of the entire security of the platform. This includes all measures relating to the Authentication, Access Control and Authorization (AAA). Furthermore some options must be available to the customers at application level so that they can protect their applications. In this context it is also necessary to clarify whether the different customer applications influence each other in any way.

6. Criteria for selecting a provider

As seen above, different requirements play a role when selecting a PaaS platform or a PaaS provider. A distinction must be made here between the further factors listed below:

- User type (start-up, ISV, corporate IT or digital agency)
- Development/Test organisational and process model
- Category/Characteristics of the application to be developed

The principal characteristics and requirements are shown and explained below, in accordance with PaaS user types.

6.1. Start-ups/Freelance developers

In the first phases of a project, start-ups and developers lack one thing above all: capital. Investments in professional infrastructure resources for developing and testing an application are extremely cost-intensive. In most cases, it is also not at all clear in advance as to whether these up-front investments will generate a profitable turnover in the long term. The demand-oriented billing model provided on a PaaS platform is therefore extremely suitable for young companies who want to develop a first prototype and present it to the public. If the necessary success fails to materialise, the resources used on the platform can be disabled and cause no further costs.

Assuming a positive case, many young companies forget the great complexity that arises from inevitable growth. Sudden fame “over night” has taken more than one start-up unawares. If start-ups and developers are not able to expand and scale their infrastructure appropriately in the face of rising access rates and user numbers, serious consequences may ensue: unsatisfied customers, lower sales and a bad image.

The central requirements start-ups and freelance developers have of suitable PaaS platforms are shown in the table below:

Requirements of PaaS - Start-ups

Type	· Freelance developers · Distributed developer teams · Small ISVs, software start-ups
Features	· Mostly no IT/data centre infrastructure of their own · Quick development cycles as success factor · Focus on new programming languages and tools · Limited/No budget for local development/test infrastructures
Core requirements	· Range of resources/images · Support of multiple developer tools · Pay-per-use price model / Go-to-Market Support · High degree of self-service/goods APIs · Outstanding usability
Typical applications	· Websites · eCommerce/eShops · Media apps · Web applications · Content Management Systems · Mobile apps

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

6.2. Independent Software Vendors (ISVs)

Independent Software Vendors (ISVs) can look back on a long and successful history. However, the majority of them are increasingly getting into difficulties because of the growing use of SaaS applications and cloud services. The reasons are clear. The customer groups are gradually switching from using on-premise software to cloud-based applications. This saves on investments in unused licences and also reduces costs for maintaining the software. At the same time, SaaS and cloud-based applications offer staff simple access, irrespective of location and the device used.

But the ISVs themselves can also profit from the switch to a PaaS-based development and operating model. If the new product generation is developed and provided on the basis of a multi-tenancy architecture, the development effort and maintenance costs can be substantially reduced – while at the same time increasing the frequency of innovations and releases. However, to profit from these advantages, ISVs must do more than just reorganise their development and IT operating processes and move towards “continuous releases” or “continuous delivery.

Consequently, completely new challenges also emerge for the ISVs, for instance regarding the description and contractual documentation for their future performance guarantees and cloud offerings (e.g. comprehensive, legally sound Service Level Agreements which are also marketable) for their end customers. Furthermore, addressing additional (online) target groups means that supplementary, primarily web-based sales and marketing strategies must be developed to enable the new cloud offerings to really be successfully introduced into and positioned on the market. PaaS providers who can support and assist them effectively during this transformation process are consequently interesting for ISVs.

ISVs consequently also have special requirements with respect to the selection of PaaS platforms to be used for productive operation: (See next page)

Requirements of PaaS - ISVs

Type	· Professional software companies · Professional service companies with their own software development
Features	· Distributed developer teams (mixture of on-shore/off-shore) · Re-use of components, test environments and processes very important · Intensive use of generally in-house development and test environments · Long-term transformation towards SaaS/cloud business models
Core requirements	· Effective administration and security functions · Support of multiple developer tools · High scalability to satisfy enterprise IT requirements · Hybrid and private operation for PaaS environment - preferably with local data centre location · Go-to-Market Support
Typical applications	· Development of standardised software packages · Migration of existing software packages to a SaaS model · Development of customised software · SAP implementation and customised corporate software

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

6.3. Corporate IT

IT departments should strive to deliver the best service they can for their internal customers and to support the customers in enhancing the flexibility and process speed.

This includes rapid and uncomplicated access to IT resources by the specialist and development departments. Because constant tests and the development of prototypes are essential to enhance competitiveness. This can be decisively supported by the provision of PaaS environments.

The requirements from the company viewpoint consist of those of the specialist departments (rapid prototyping and testing, state-of-the-art development tools, flexible use and billing of the PaaS resources) and those of the IT department (security level, governance and rights management, integration with existing cloud environments). If the PaaS platform is to be used to not only develop and test applications, but also to operate them productively, the availability, SLAs and the data centre location play important roles.

Private PaaS environments are particularly interesting for large companies, in that they can retain and control the responsibility for, and supervision of, data and development processes. If more resources are required later, the applications can be swapped out to a hybrid system or transferred in their entirety to a public/ hosted PaaS.

Requirements of PaaS - Corporate IT

Type	· Developer teams in company · Internal IT department · Innovation teams
Features	· Mixed and distributed developer teams (on-shore, off-shore, service providers) · Development projects involving major integration effort · Re-use of components, test environments and processes very important · Mostly own IT/data centre infrastructure available for operating development/test environments
Core requirements	· Highly-secure platform which satisfies internal standards · Support of complex development and test processes and distributed teams · Clearly defined SLAs which correspond to the internal processes · PaaS platforms with a large number of interfaces and integration options · Hybrid operating concepts interesting for PaaS
Typical applications	· Digitisation of existing and new business processes · Migration/Porting of existing solutions to cloud platforms · Analytics applications · SAP enhancements and add-ons · Portals and eCommerce solutions · Mobile solutions

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

7. Technology and providers

The technological maturity, range of products and functions, scalability and infrastructure, development history and SLAs and IT operating concepts all have a decisive influence when selecting a PaaS platform provider. On the basis of a large number of consultancy and research projects, the most relevant providers for the German-speaking market are portrayed briefly below.

The tables below provide an overview of the features and the technical options (deployment variants, programming languages supported) offered by these providers.

Provider	cloudControl	Google App Engine	Heroku
Year released	2009	2008	2007
Website	http://cloudcontrol.com	https://appengine.google.com	http://heroku.com
Target group	Developers, digital agencies	Freelance software developers, start-ups	Freelance software developers, digital agencies
Development model	Public PaaS, private PaaS	Public PaaS	Public PaaS
Programming languages	PHP, Java, Python, Ruby, Node.js	Python, Java, Go, PHP	Java, Node.js, Scala, Clojure, PHP, Perl
Special features	cloudControl does not have its own infrastructure and uses the public IaaS of Amazon Web Services for this purpose. The "Application Lifecycle Engine" enables the cloudControl technology also to be operated as a private PaaS.	Part of the Google cloud platform and consequently on an infrastructure offering extremely high scalability. Access to other Google web and cloud services via API.	One of the most experienced PaaS providers with a broad user/customer base. Acquired by Salesforce in 2010. Infrastructure nonetheless operated on Amazon AWS.

Provider	HP Helion Public Cloud aPaaS	IBM Bluemix	Microsoft Azure
Year released	2014	2014	2010
Website	http://www.hpcloud.com/products-services/application-paas	http://bluemix.net	http://azure.microsoft.com
Target group	Companies, developers	Companies, software developers	Companies, software developers, ISVs
Development model	Public PaaS, private PaaS	Public PaaS	Public PaaS, private PaaS (Azure Pack)
Programming languages	Clojure, Go, Java, Node. js, Perl, PHP, Python, Ruby	Java, Node.js, Ruby	PHP, .NET, Node.js, Python
Special features	The HP Helion Cloud aPaaS is based on the open source PaaS Cloud Foundry. Cloud Foundry is also part of the HP Helion OpenStack Distribution, which enables a private PaaS to be implemented.	The open source PaaS solution Cloud Foundry is the basis for IBM Blue-Mix.	The Microsoft Azure Pack enables private PaaS environments to be set up and used on the basis of an in-house IT infra-structure or in hosted operation.

Provider	Pironet NDH Enterprise PaaS	Pivotal Web Services	Progress Software - Rollbase
Year released	2013	2013	2013
Website	http://www.pironet-ndh.com/Enterprise+PaaS	https://run.pivotal.io	http://www.progress.com/products/rollbase
Target group	Companies, ISVs, digital agencies	Companies, developers	Companies, (Citizen) developers, ISVs,
Development model	Hosted PaaS, managed private PaaS	Public PaaS, private PaaS	Hosted PaaS, Private PaaS
Programming languages	PHP, .NET, Node.js, Python, JavaScript, Ruby, Perl, Haskell	Java, Node.js, Ruby	Java, C, JavaScript, OpenEdge ABL
Special features	PIRONET NDH is the first managed service provider in Germany to offer a hosted variant of Microsoft Azure (Azure Pack) and Red Hat OpenShift from a German data centre.	Pivotal is a spin-off of VMware and EMC and develops the open source PaaS solution Cloud Foundry. Cloud Foundry consequently also provides the basis for the pivotal public and private PaaS.	Rollbase is part of the Progress Pacific Platform and provides the basis for Rapid Application Development (RAD) of SaaS applications and their deployment. The solution can be used either as a private PaaS or in a hosted model.

Provider	Red Hat OpenShift	SalesForce1	T-Systems Cloud Integration Center
Year released	2011	2008 (ehemals Force.com)	2014
Website	https://openshift.com	http://www.salesforce.com/de/platform/overview/	http://testen-und-bestellen.t-systems.de/ecp-de/testen-bestellen/cloud-integration-center-applikationen/6290
Target group	Companies, software developers	Salesforce developers/ Salesforce users	Companies
Development model	Public PaaS, private PaaS	Public PaaS	Managed private PaaS
Programming languages	JavaScript, Ruby, Python, PHP, Perl, Java, Haskell, .NET	Apex	JavaScript, Ruby, Python, PHP, Perl, Java, Haskell, .NET
Special features	OpenShift can be used as a public service. OpenShift Enterprise is the variant for the private cloud.	Serves as platform for developing applications and services for Salesforce.	The platform is based on Red Hat OpenShift and has as its basis the global VMware vCloud infrastructure of T-Systems.

Provider	Website
Amazon Elastic Beanstalk	http://aws.amazon.com/de/elasticbeanstalk/
Appeleon	https://www.appeleon.com
Apprenda	http://apprenda.com
AppScale	http://www.appscale.com
CenturyLink	http://www.centurylink.com
CloudBees	http://cloudbees.com
Dell Boomi	http://www.boomi.com
Docker	https://www.docker.com
EngineYard	https://www.engineyard.com
GBS AG	http://www.gbs.com/de
IBM	http://www-03.ibm.com/software/products/de/cast-iron-live
Informatica	http://www.informatica.com
Jelastic	http://jelastic.com
Jitterbit	http://www.jitterbit.com
Mulesoft	http://www.mulesoft.com
Nodejitsu	https://www.nodejitsu.com
Oracle	https://www.oracle.com/cloud/paas.html
SAP	http://www.sap.com/pc/tech/cloud/software/hana-cloud-integration/index.html
Skyvva	http://skyvva.com
SnapLogic	http://www.snaplogic.com
Software AG	http://www.softwareag.com/de/products/softwareag_live/integration_live/default.asp
TerraSky	http://www.terrasky.com/skyondemand/
Tibco	https://cloudbus.tibco.com
WSO2	http://www.wso2.com

8. Platform as a Service in practical application

The appeal of PaaS environments is growing hand in hand with the worldwide increase in digitalisation. For the German market, Crisp Research surveyed 83 German software houses on behalf of PIRONET NDH. The focus of the study was an empirical examination of the cloud transformation at German ISVs and the use of PaaS platforms.

German software houses have very specific requirements when it comes to the use of PaaS in the context of their development, testing and operating processes. The conditions for operation and the operating concept - in other words, whether the PaaS services are operated according to the public or private model or as part of a hosting model - are particularly relevant. And a lot has changed here in the last 12 months.

For example, up to mid-2013, none of the leading PaaS platforms was available as a technology stack for in-house or hosting operation. Until then, the public cloud was the only operating model available. VMware (today at Pivotal) took the first step with the release of the Cloud Foundry technology under an open-source licence. PaaS technologies can now also be obtained as a software package from Microsoft (Microsoft Azure Pack), Red Hat (OpenShift) and VMware (vFabric), and can thereafter be operated individually. This offers companies, software developers and hosting partners completely new opportunities to offer PaaS services on a customised basis and to optimise them with respect to specific application scenarios.

Which of the technologies will establish themselves in the medium and long term is currently difficult to predict, as most ISVs, hosting providers and corporate users have not made a final commitment to any particular one. While IBM and HP have selected Cloud Foundry, a number of hosting providers offer their customers a choice of multiple platforms.

However, at present only a handful of hosting providers who offer PaaS in a hosting model exist on the German-speaking market. There are various reasons for this.

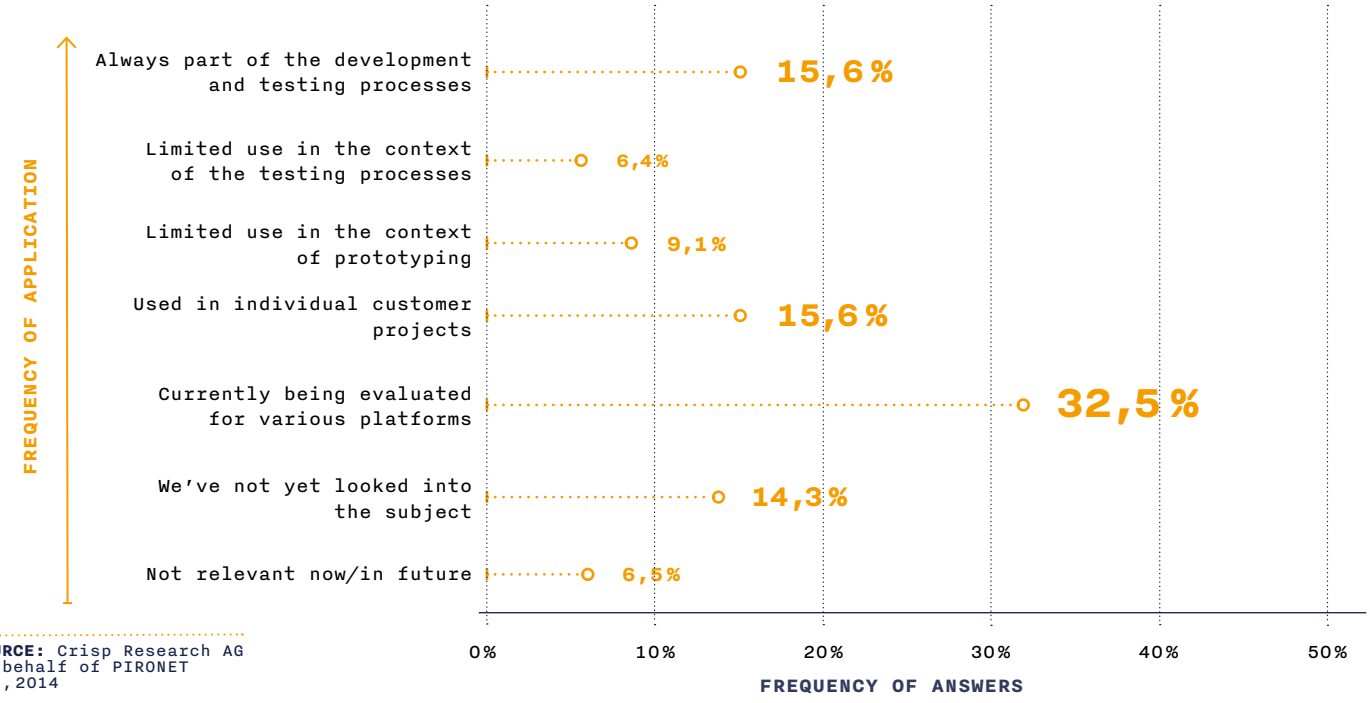
Some providers, for instance, probably do not view the market opportunities as promising. Others simply lack the resources and skills to establish and operate the technically demanding and complex platforms. Hosting providers must also build up a greater understanding and more know-how with respect to the processes and special requirements of the ISVs, start-ups, and

freelance and corporate developers, because their needs differ significantly from the requirements for classical hosting or infrastructure outsourcing. The number of experienced architects, developers and project managers in the PaaS sector in Germany is still extremely modest.

8.1. Usage level and planning

PaaS offerings are today frequently a permanent feature in state-of-the-art software development, testing and operating procedures. However, in the Anglo-American world, these offerings are primarily used by developers who are not (or only rarely) active in the corporate environment. This is attributable to – until recently – the limited availability of alternatives to the large public cloud offerings.

What role do PaaS and cloud platforms play in your development process?



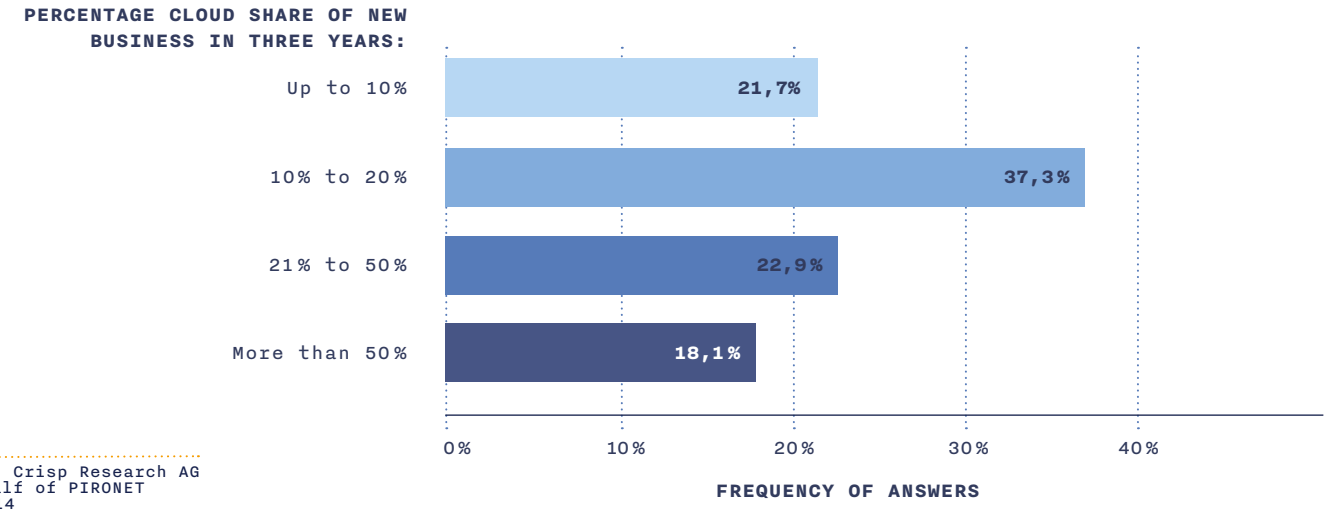
SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

However, almost a third of all those surveyed (33 per cent) are currently evaluating PaaS platforms. A further 32 per cent use such offerings only occasionally and to a limited extent. Above all, this means one thing: the market is still very much in a state of flux, given that around two thirds of the ISVs have not yet made a final decision on this topic. The struggle for this important target group has consequently just begun, and it is still unclear who will emerge as the winner. However, this study provides clear indications of where this journey could lead, as most software providers have clear ideas about deployment variants and other requirements.

Just how important a successful cloud transformation actually is for the German software houses can be seen from the planned new business in this sector.

Almost every fifth company (18 per cent) is planning to post over 50 per cent of its sales in new business using cloud-based models in the next three years. 23 per cent of companies are planning to achieve from 21 to 50 per cent of their new business by means of cloud computing. This once again illustrates the potential growth opportunities resulting from this model, but also evidences the extremely high pressure to succeed which the

How high is the planned cloud share in your new business in three years?



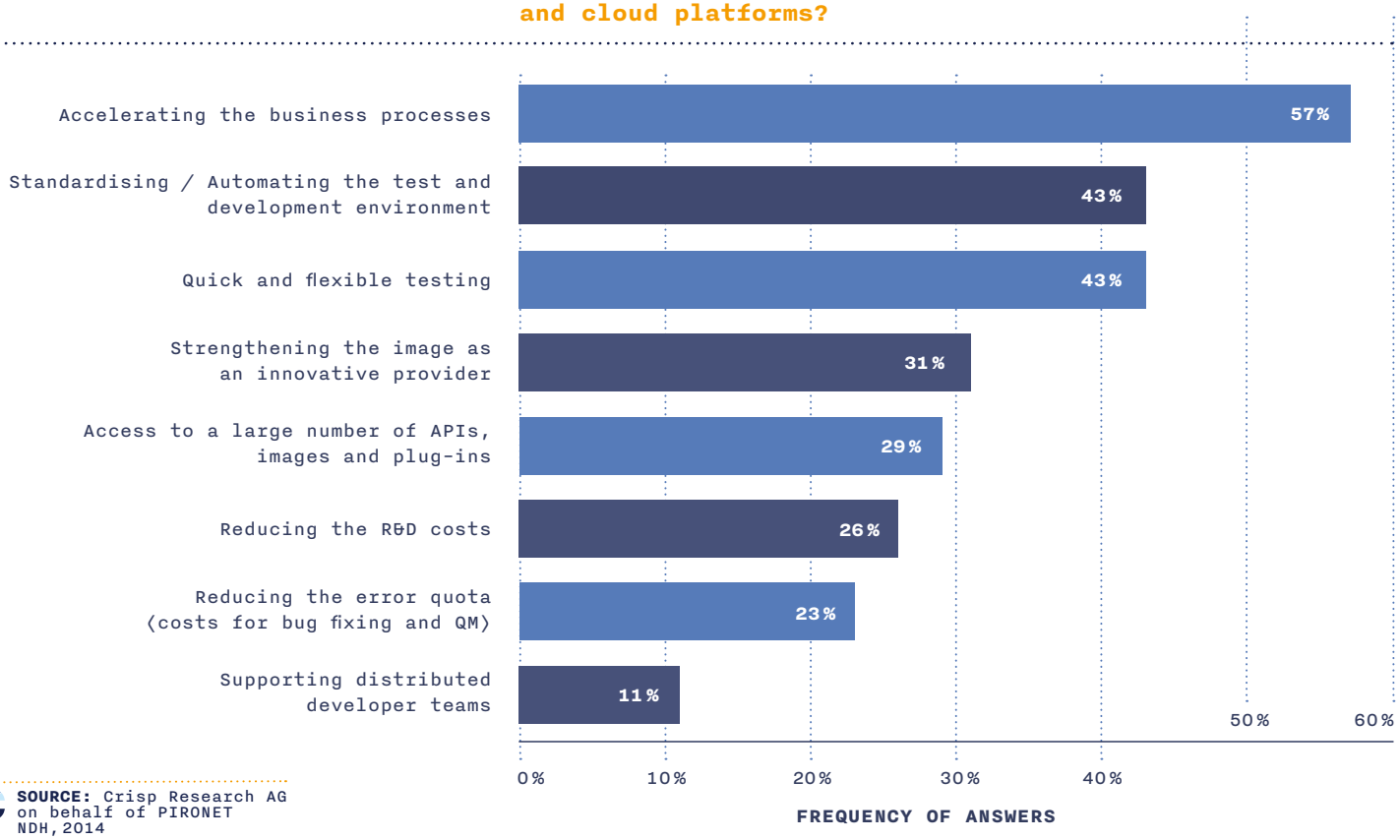
SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

software houses face. 37 per cent of the software houses surveyed see the chance of achieving a small part of their turnover (10 to 20 per cent) by means of SaaS-based offerings.

8.2. Reasons for and against using Platform as a Service

Those software houses and ISVs who are already using PaaS regard the acceleration of their business processes (57 per cent) as their most important motivation. The demands to go live quickly, for shorter innovation cycles and for flexible development methods - such as Scrum - continuously increases the pressure on the software industry to expedite its processes. The use of PaaS appears to provide an effective solution here.

What are the decisive reasons for using PaaS and cloud platforms?



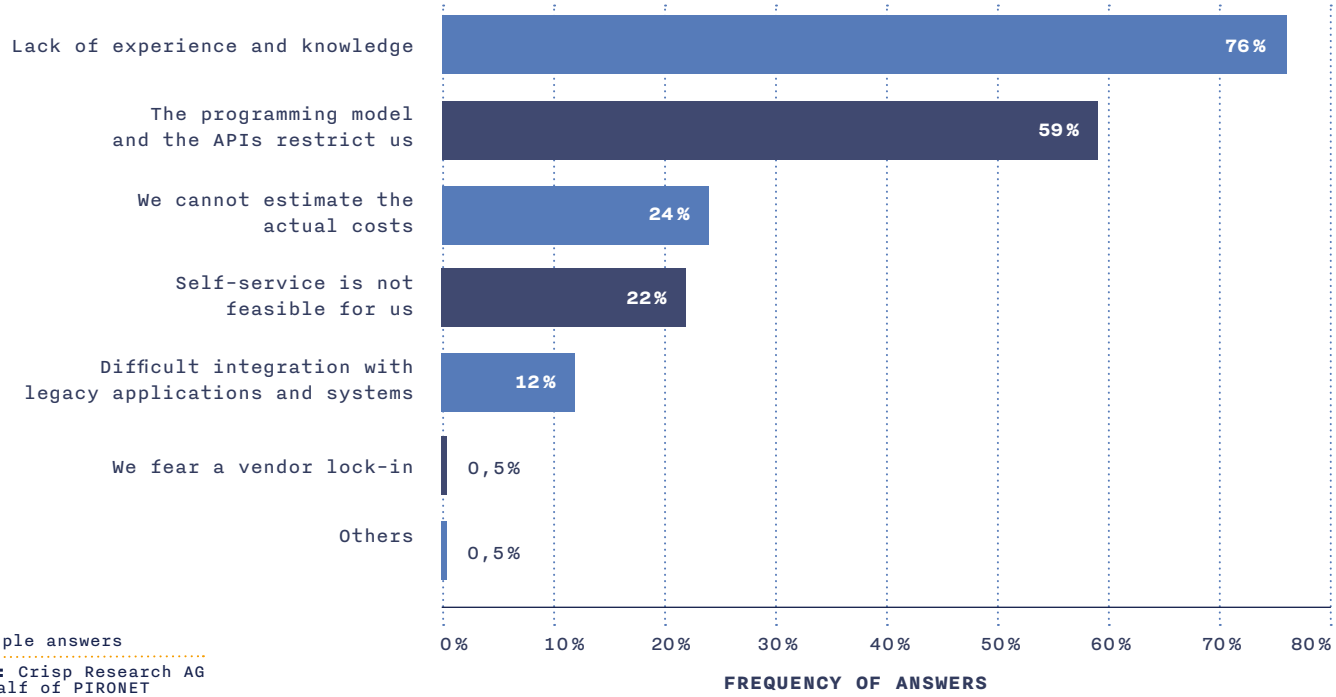
SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

A similar motivation is evident in the statement of 43 per cent of those surveyed, who hoped for improved standardisation and automation of their testing and development processes. This is one of the central prerequisites for expediting processes.

Expectations are also high with respect to testing. 43 per cent of the ISVs anticipate greater speed and flexibility. One third of those surveyed also anticipate that their image as an "innovative provider" will be enhanced by using PaaS.

Every fourth company surveyed (26 per cent) hopes that Platform as a Service will reduce their R&D budget. That 23 per cent of those surveyed expect to reduce the error quotas fits well into the overall picture emerging, because this would result in a reduction of costs.

For what reasons would you not use Platform-as-a-Service?



n41, Multiple answers

SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

For the overwhelming majority of the ISVs questioned (76 per cent), their not using PaaS is solely due to lack of experience and not having the available know-how. The services offered are extremely complex and varied, and not all software vendors have enough talented people who can deal with such platforms intuitively.
58 per cent regard the restrictions caused by the programming model and APIs as another important reason militating against the use of standardized PaaS platforms. Because of the relative newness of the topic, the software vendors are evidently afraid that they could make mistakes and be at a disadvantage, not just when it comes to timing, but also in questions of quality. Very few are afraid of the risks involved in a possible vendor lock-in. For around a fifth (24 per cent), the inability to calculate costs is a reason for not using PaaS offerings.

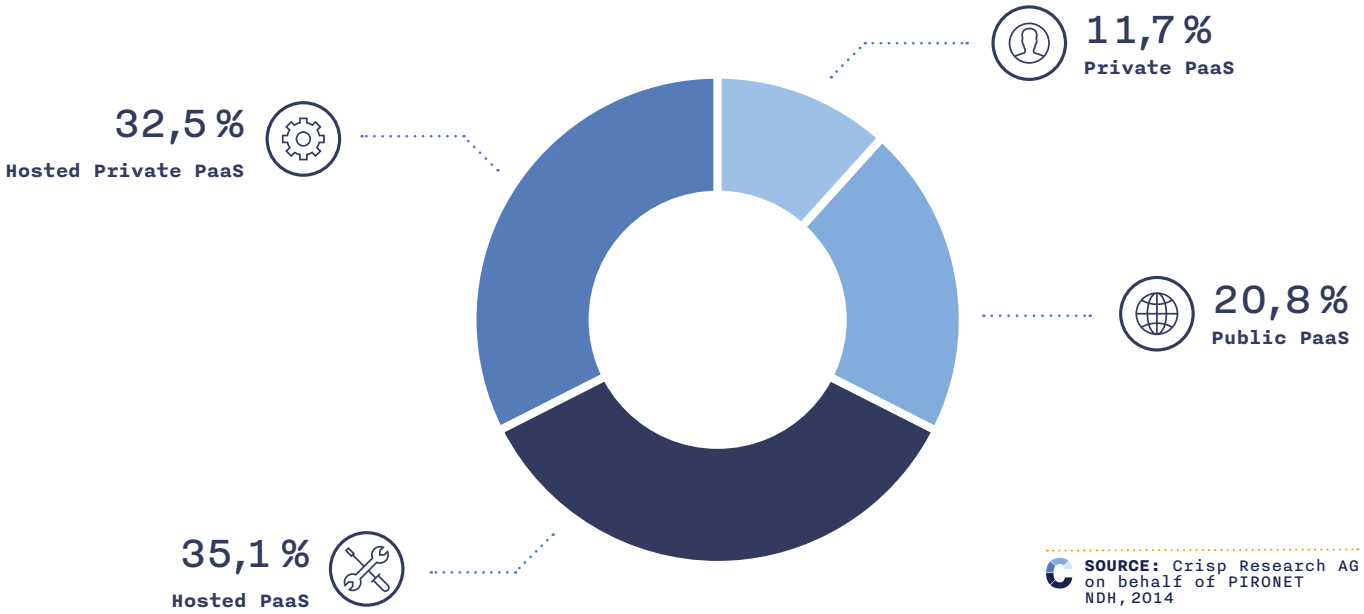
The study also showed that, in future, a market for “managed PaaS” will emerge, but 22 per cent of ISVs assume that their use in the context of a self-service model is not practicable.

In conclusion, it can be observed that many of the negative reasons can be overcome, particularly the reason pertaining to experience and know-how, but also that concerning the ability to forecast costs.

8.3. Favoured operating concepts for Platform as a Service

The statements of the software houses questioned in the course of this study paint a very clear picture. Asked about their favoured operating concept for using PaaS services in development processes, “just” 21 per cent declared they preferred the existing public cloud model, while 12 per cent would choose internal operation on a “private PaaS platform”. The majority of well over 60 per cent would prefer to obtain PaaS services for development and testing in the context of a hosting model.

Which operating concept would you most likely employ to use PaaS services for development?



SOURCE: Crisp Research AG on behalf of PIRONET NDH, 2014

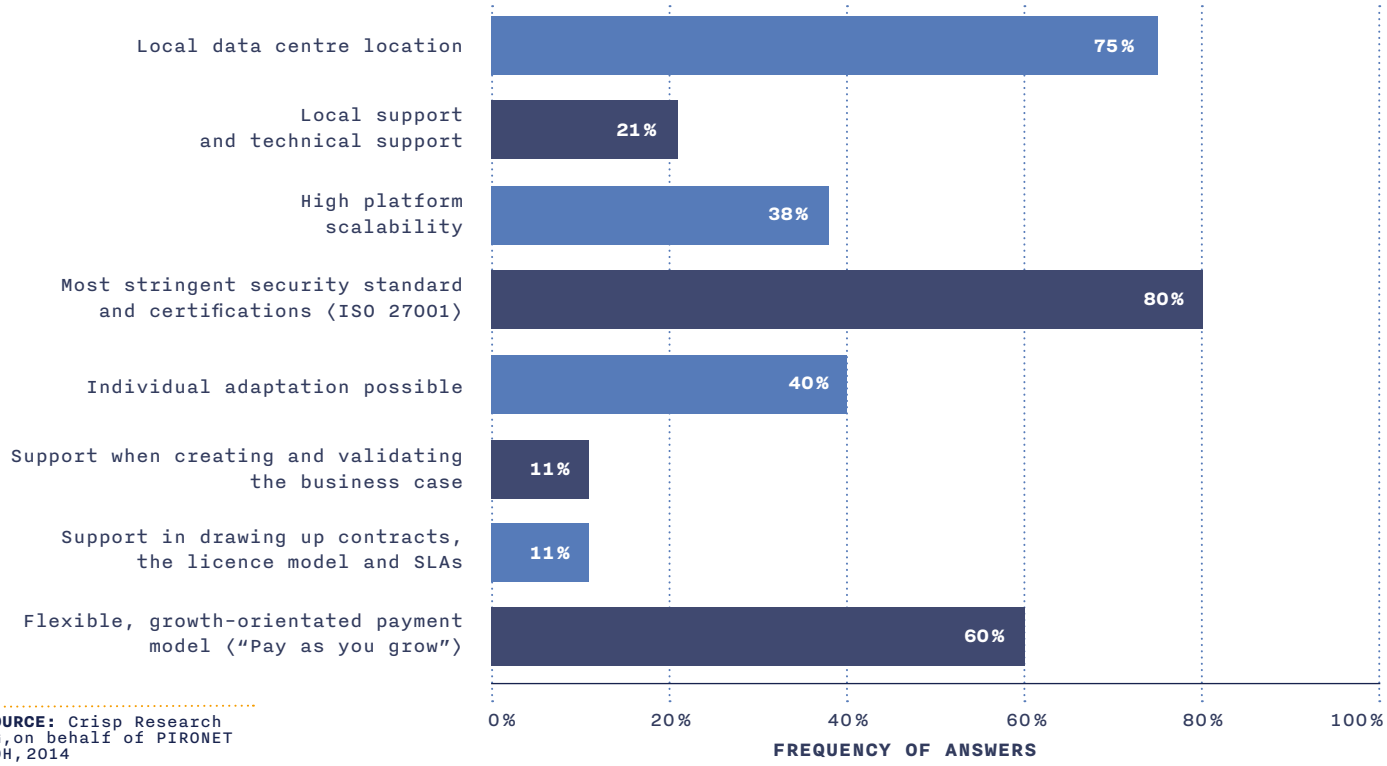
The software houses surveyed are even somewhat more demanding when it comes to application operation. Here, a mere 11 per cent of the companies asked would support operating in a public cloud environment. The majority (38 per cent) regard hosted PaaS as their preferred operating model for operating applications in the cloud. A further 30 percent state that the dedicated variant (“hosted private PaaS”) is their favoured model. Over 1/5 of the software companies surveyed would only operate their applications in a private PaaS environment.

8.4. Requirements of the Platform as Service providers

On examining the statements regarding the central requirements of providers of PaaS services, the reasons why the previous public cloud models were not considered by many professional software developers become quickly evident. For around 80 per cent of the German software houses surveyed, the topics of high security standards, ISO certification and a German data centre location were right at the top of their agenda.

A flexible payment model is also relevant (60 per cent). Interestingly, the individual adaptation of the PaaS platform is just as important for German ISVs as the scalability of the platform – an argument which has commanded prime position in many debates in recent years. Here it has apparently been recognised that the scaling capacity of the technology platform only need match the growth on the customer or user side.

What criteria must a potential cloud platform provider fulfil and which relevant services must be made available?



SOURCE: Crisp Research AG, on behalf of PIRONET NDH, 2014

It seems surprising that “only” 20 per cent of the ISVs wish for local and technical support “on site”. Only every tenth ISV stated in the survey that they require support in drawing up the licence models and SLAs. This is perhaps also due to the fact that, so far, only a few ISVs have gained in-depth experience with the topic – and consequently view the future a little too optimistically.

9. Strategies for successful use

The introduction of PaaS platforms into existing development and IT operating processes is a complex challenge. Because the successful use of PaaS not only entails the use of new tools: the existing processes and IT organisation models also change. A brief outline of the tasks that are required to establish PaaS in a company's own IT organisation is provided below. These are considered under the headings of strategy, culture, organisation and processes

9.1. Strategy

First of all, a company should establish clarity concerning whether or not it needs to use such new platforms and the associated cloud development and operating models. Companies whose focus is only on implementing standard software and who have little requirement for development and integration may possibly be able to do without PaaS. Any company whose customers and partners are integrated into new digitised processes and are connected to the company by means of state-of-the-art web applications will hardly be able to avoid upgrading its application development and IT operating processes.

In the evaluation and planning phases, appropriate assessments can assist in determining the need for transformation and the requirements for the PaaS platforms in the company on the basis of the status quo.

Since the PaaS platforms currently still differ greatly in terms of functionality, SLAs and range of uses, a foresighted and detailed evaluation of the platform certainly makes sense for large companies.

As a parallel process, Crisp Research recommends that the developers and people responsible for IT should be involved as early as possible in the evaluation and planning processes and, as appropriate, should be actively engaged throughout the test and prototyping phases. Trying things out and refining various aspects does cost time, but it guards against platforms being chosen which are unsuitable for the company. An exclusively top-down planning approach is not advisable for PaaS projects.

Aside from the business case analysis, the evaluation of the providers and project planning, the operating concept (private, public, hosted, etc.) and integration questions also play a decisive role.

Furthermore, it may already be necessary at this stage to press ahead with necessary strategic considerations connected with the later provision and marketing of the future cloud solutions. A go-to-market strategy which is geared to the new requirements and target groups and which is consistently implemented is frequently the decisive factor in the commercial success of smaller start-ups or of ISVs who have little experience in marketing cloud-based software solutions and a marketing approach which has thus far tended to be traditional. Cloud-based provision models also generally require considerable changes in the price strategy. For start-ups and ISVs, the predominant billing model in the cloud - namely billing costs on a usage basis and each month - also means that investments, step-fixed costs and running costs can be profitably brought in line with revenues, which typically are initially low because they are generated on a monthly basis.

The strategic tasks can be summarised as follows:

- Analysis of use case/business case
- Evaluation of platforms/providers
- Proof of concept/testing
- Planning the PaaS architecture and operating concept/SLAs
- Roadmap for implementation/project management
- Planning integration requirements
- Anchoring PaaS in IT strategy
- SaaS Go-to-Market support

9.2. Culture

The cultural aspect is extremely decisive for the successful use of PaaS in a company. Only if companies value the work of software developers and establish a “developer culture” or innovation culture, can the concepts associated with PaaS - such as DevOps, flexible programming and flexible project management - be implemented. The trend towards outsourcing internal application development entirely to IT service providers and concentrating primarily on the use of standard software has resulted in the skills required for in-house development being lost.

Crisp Research is of the opinion that there is an urgent need to rethink matters here if companies seriously want to master the challenges of the digital transformation. At a minimum, it should be ensured that sufficient developer talent is available throughout the company to devise and design the new digital applications and to plan their integration into the corporate IT at the architecture level. Naturally, external resources can also be involved in the final development. Ideation, prototyping, concept and architecture should, however, be handled by the company itself.

Various initiatives are required to establish and maintain this "developer culture" in the company. Developer labs can offer (free) space for testing, prototyping and PoCs. In addition, more attention should be paid to the topics of user experience and design thinking.

The success of the new generation of applications and solutions– regardless of whether digital marketing, mobile apps or the Internet of Things is concerned – depends fundamentally on their benefits and user-friendliness. Ticking boxes in feature lists as long as your arm can and should no longer be at the forefront of application development. To sum up:

- Developer culture and building up in-house developer capacities
- Active IT innovation management
- Creating labs and free space for prototyping/testing
- Embedding user experience/design thinking in the IT environment

9.3. Organisation

Changes will also be required in IT organisation if PaaS is to be embedded in the company. The partially inflexible organisational structures in infrastructure operation - whereby structures are still frequently arranged according to server, storage and network – either will be broken down through the provision of IaaS and PaaS via cloud platforms or must be more fully integrated.

The keyword trend "DevOps" anticipates the greater intermeshing of application development, testing and IT operations. In a cloud-based world, new features are constantly being worked on and the performance of applications must constantly be enhanced and adapted to new requirements (terminals, bandwidths, security standards, etc.). Annual releases with fixed dates are a thing of the past. In the era of "continuous releases", development, testing, staging and release management are performed continuously and, so to speak, in productive operation.

Here it is necessary to create the corresponding organisational models and team structures. Developers must also be made aware of the implications of their decisions with respect to the infrastructure. In other words: how can applications be programmed to ensure they are operated as efficiently as possible ("Lean Software Development – LSD"). Conversely, the IT infrastructure teams must concentrate more on the developers' requirements and know precisely which tools, frameworks and APIs are currently needed.

Above all, new and joint KPIs are needed in this context. While developers and IT operations are incentivised using different KPIs, the DevOps model cannot be successful. KPIs such as adoption rate, user assessments and application performance can serve as initial steps towards DevOps. The following aspects are therefore important:

- Creating DevOps team structures
- Use of flexible development methods
- Joint KPIs for development and IT operations
- Inclusion of all necessary stakeholders

9.4. Process

After the ground has been properly prepared in terms of strategy and organisation and the first steps have been taken to change the mindset in favour of "developer culture" and IT innovation management, there still remain a few tricky tasks that need to be dealt with. These concern the influence of PaaS on internal processes.

Adaptations are required, for instance, in the field of requirements- and demand-management. When flexible development methods and the use of PaaS are planned, it is important to develop these processes more towards "user-centric design". The design and assessment of features and requirements must concentrate more on the viewpoint of the end users and bear in mind their specific application scenarios.

Various changes are also involved in the developers' onboarding and the development processes. For example, new tools and APIs are provided via the PaaS platform and no longer from a separate service catalogue or portal. Developers must familiarise themselves with the new environment and adapt their development processes to the PaaS logic. The onboarding process also changes when new developers are added to the project team (roles, authorisations, tools, etc.).

Initial sizing of the infrastructure required for testing - and later of the productive systems - is as a rule performed by the developers in the PaaS model. During ongoing operation, availability and capacities are then managed via IT operations. To ensure a smooth transition and optimisation of performance, usability and costs during ongoing operations, corresponding monitoring, incident management and reporting processes must be implemented which are available both to the IT infrastructure teams and the developers. This is essential for the successful realisation of integrated Application Performance Management.

PaaS also has repercussions for the Policy and Security Management processes. On the one hand, the question is raised as to whether the PaaS platform concerned can implement, in functional terms, the governance policy required by the company. On the other hand, many responsibilities are transferred to the developers because of the self-service approach. Some Deployment and Release Management tasks that were formerly performed manually will also be automated on the platforms. It is therefore important to recognise the new responsibilities and define rules - for example, to specify the upper limits for the provision of infrastructure (no more than 200 compute units per developer).

The following selected processes are influenced by the use of PaaS:

- Requirements Engineering & Demand Management
- Development & Developer Tooling
- Testing & Test Automation
- Deployment & Release Management
- Availability & Capacity Management/IT-Operations (SLAs)
- Reporting, Metering & Chargeback
- Application Lifecycle Management
- Application Support
- Policy Management
- IT Security Management

10. Outlook

For the coming 2-3 years, Crisp Research sees the following trends in the development of PaaS platforms and their use by European companies and ISVs:

Hybrid and private PaaS will become established side by side with the public platforms

Public PaaS platforms, such as Salesforce1, Heroku and Microsoft Azure Websites, have established themselves on the market in recent years and offer developers scalable and robust alternatives to developing their web applications or as backends for mobile applications. However, corporate users generally have their own individual requirements with respect to scalability, SLAs and data centre location. This is also the case when choosing a PaaS provider. Furthermore, the large and medium-sized companies prefer to implement hybrid or multi-cloud models in order to realise various application scenarios and to distribute the risk.

Cloud Foundry and Microsoft Azure as the key technologies. OpenShift as an alternative.

Three leading technologies have now emerged from the various PaaS stacks. These are Cloud Foundry, which was developed by VMware/Pivotal and published under open source, OpenShift from Red Hat, and Microsoft Azure Pack, which can be used both for enterprise private PaaS and also on PaaS platforms for web hosters and managed service providers.

Local IT service providers are establishing their own PaaS offerings

In line with the trend towards local data storage and customer proximity, an increasing number of IT service providers are now offering PaaS services on the basis of technology stacks (Cloud Foundry, OpenShift, Microsoft Azure Pack) from their own local data centre locations.

Users can thus profit from the benefits of a PaaS platform and at the same time satisfy their requirements with respect to data protection, security and individually defined performance.

Developers as a new core target group

It is not only the quote from Marc Andreesen that "Software is eating the world" that indicates that developers will play a major part in determining the future of the IT industry and will exert a great influence in shaping the digital economy in general. The large IT firms have also recognised this. In recent years, their traditional partners (integrators, system houses, ISVs) have not managed to develop enough innovative and novel applications and solutions based on the new cloud platforms. Now start-ups are aiming to fill this gap and are emerging as a core target group for Microsoft, HP, Cisco and SAP. Added to their corporate structure and culture of innovation and growth, their knowledge of the new programming languages and tools means they are also predestined to be a user group.[12]

Mobile workloads and Internet of Things as major drivers

What was regarded as a phenomenon for a few selected users two years ago is today standard – mobile use of corporate applications on tablets and smartphones and other mobile devices. As of late, software houses have had to be able to develop their solutions and services so that they can run without error on a large number of terminals, browsers and operating systems. This presents genuine challenges for the providers, not only with respect to development and testing, but also to operating the applications.

The same applies for the new trend towards the "Internet of Things" (IoT). The development of sensor networks is constantly advancing in order to network household items, cars, industrial plants, wearables, etc. Arising from this, the need for further resources for developers will increase in the coming years in order to develop applications for a large number of new devices and to integrate these with each other. Figures from Evans Data Corporation[13] show that 17 per cent of developers are already actively working on IoT applications. 23 percent expect project orders in this area.

Container technology as the basis for portable applications

Providing applications flexibly across several different cloud environments causes less concern with respect to long-term use of the cloud. Docker, which has been available since 2013, is a technology/service which permits these types of deployment

12 http://www.crisp-research.com/deutschland-2014-startup-katastrophe-oder-neue-it-grunderzeit-teil-1/

13 http://www.zdnet.com/thing-1-thing-2-internet-of-things-starts-to-gain-a-developer-following-7000032011/

mechanisms. Docker has taken the idea of container transport and transferred it to software development and has implemented a platform for providing distributed applications. For this purpose, Docker offers a standardised abstraction layer which is used to package applications and their dependencies in a virtual container that can then be executed on any Linux server. Developers can consequently port their applications flexibly between different environments.[14]

Collaborative development by spreading browser-based IDEs

The aim of development has always been to enhance the quality of software. The well-known flexible software development method "pair programming" is a concept which enables the error rate to be reduced by up to 15 per cent. In this case, two programmers work in parallel on one computer.

While one of them writes the source code, the other is responsible for solving problems and checks the programme code.

As cloud IDEs spread – that is, browser-based development environments - this development method will become easier to implement technically. Irrespective of the location, a number of developers can work in parallel on the same source code and at the same time check each other's work. This leads to genuine "collaborative development" and improves productivity, quality as well as the time to market for the software.

Managed services and professional support as a success factor in the PaaS transformation

The PaaS transformation entails various challenges for both enterprise IT and for ISVs. A PaaS platform must always be understood to be a technical basis on which companies and providers from the software industry can implement their digital transformation. On the road to this metamorphosis, professional support from a managed PaaS provider can prove helpful during the go-to-market phase and thus reduce the time to market.

14 http://www.crisp-research.com/docker-container-die-zukunft-moderner-applikationen-und-multi-cloud-deployments/

Emergence of national and international marketplaces for PaaS products

As with the development of Software as a Service marketplaces, these marketplaces will also gain in importance for PaaS products in the short and medium term. A role model here is the “PaaS-port” initiative. This EU project is being promoted by the BITMi, the project coordinator. A project consortium combines expertise and resources from IT associations, research partners and small and medium-sized IT enterprises from around Europe. The aim is to create a marketplace which enables developers and providers of Software as a Service solutions to compare PaaS offerings. Particular value is placed here on the interoperability of the PaaS solutions. PaaSport will be based on the cloud standard CAMP.

Further information on the BITMi and the PaaSport project is provided in the appendix.

About PIRONET NDH

Pironet NDH is one of the leading German providers of cloud computing. The company, which is listed on the stock exchange, has its headquarters in Cologne and was founded in 1995. As of 2014 Pironet NDH is part of the affiliated group CANCOM SE in Munich. Its focus ranges from providing corporate software over the internet right through to complete desktop solutions and business-critical applications from SAP and Microsoft.

With its Hosted Business Cloud®, Pironet NDH provides virtual IT resources and standard business applications as turn-key cloud services with flexible costs (Software as a Service) from its highly secure German data centres. The Business Cloud® is based on the AHP Private Cloud Platform developed and tested by CANCOM, as well as service components and network and infrastructure services.

The service offering, the IT infrastructure and also the internal organisation are all certified according to strict, internationally recognised guidelines, including, among others, DIN ISO/IEC 27001. For customers this certification ensures the operative excellence of Pironet NDH in all processes, as well as compliance with stringent standards with respect to both technical and security aspects.

Customers include numerous medium-sized companies as well as international corporations. More information is available at: http://www.pironet-ndh.com

PIRONET NDH

Ein CANCOM Unternehmen.

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About BITMi e.V.

The Bundesverband IT-Mittelstand e.V. (Federal Association of Small and Medium-Sized IT Enterprises - BITMi) is the only specialist IT association which exclusively and distinctively represents the interests of small and medium-sized IT companies. The membership consists of mostly owner-managed small and medium-sized IT enterprises from all areas of the IT sector. The association brings together both established IT companies and start-ups so that they can define their interests together. In addition to the direct members of BITMi, associated organisations have also joined together with us. The association thus represents more than 1,000 small and medium-sized IT enterprises in Germany with a sales volume of several billion euros.

The aim of the BITMi is to expedite company growth, to increase the productivity of the IT SMEs and to promote market development through intensive networking. In pursuing this aim, the association considers it particularly important that Germany as a location be strengthened. To this end, the BITMi cooperates with the Federal Ministry for Economic Affairs and Energy and ensures that small and medium-sized IT enterprises have a voice with the Ministry. The BITMi's membership of the PIN-SME - the only European association which exclusively represents IT SMEs - ensures that its opinion is also heard at European level. Prospects, strengths, importance, opportunities and challenges of small and medium-sized IT enterprises are communicated in the political and public domains.

On behalf of its members, the BITMi is the point of contact for end customers who wish to get up to speed with the latest state-of-the-art in information technology or who are looking for solutions to their problems. The association organises events, maintains an extensive network of partners, runs successful public relations campaigns and enables knowledge transfer with universities and research institutes.

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Overview Projekt PaaSport

Introduction and Motivation

According to market researchers the PaaS market is predicted to reach $20.1 billion in 2014, more or less tripling its size not only in terms of revenues but also in terms vendors active in the sector. Although giant vendors occupy this emerging space, including Microsoft, Amazon, Google, and Salesforce.com, many startups try to enter the market.

But the prospects for new startups and SMEs entering the PaaS market are not that positive and the barriers can often be humongous. Giant vendors, such as Amazon and Google, have actually gained the lion´s share of the market and have evolved into de-facto standards. Interestingly the vast majority of the Cloud providers are of non-EU origin (most of them are US-based). The battle for dominance between the big vendors on who will take the lead in the market makes them reluctant to agree on widely accepted standards promoting their own, mutually incompatible Cloud standards and formats (Gagliardi and Muscella, 2010). This dominance increases the lock-in of customers in a single Cloud platform, preventing the portability of data or software created by them. But even if in theory application and/or data portability is supported, the high complexity and in most cases the additional switching costs discourage users from doing so (McKendrick, 2010). The high effort required for exporting ones application and data from a Cloud platform also discourages start-ups and SMEs from entering and bestirring in the flourishing Cloud market.

Our discussion so far proves that Cloud computing solutions have not been built with interoperability in mind leading to a closed and hard-to-enter Cloud market (Rimal et al., 2011). Interoperability remains one of the greatest challenges that the longed-term adoption of Cloud computing is facing. During the next five years the leading enterprise software vendors as well as the large Cloud specialists will introduce new PaaS offerings while both large and small Cloud PaaS providers will grow through partnerships (Gartner, 2010). The formation of partnerships and federations between heterogeneous Cloud PaaS Providers involves interoperability.

The Cloud community and the EC have realized the significance of interoperability and has initiated several approaches to tackle this challenging issue. The first efforts to explore interoperability in PaaS are also well on track, e.g. CAMP and Cloud4SOA. A recent study conducted on behalf of the EC recommends that:

→ The EC should promote common standards and interoperability of public cloud systems, to maximize economies of scale across the EU and create the preconditions for portability between cloud vendors.

→ The EC should create the pre-conditions so that the principle of data access and portability between cloud vendors is widely accepted and the risk of lock-in of users in proprietary systems is prevented.

We believe that building upon and further extending such initiatives can provide us the means for delivering value to European Cloud PaaS vendors (existing and potential ones) and software SMEs and raise the barriers that prevent them from entering the dynamic and evolving but yet monopolized PaaS market.

Companies developing applications should be able to choose between different Cloud PaaS offerings, e.g. selecting the most reliable, the most well-reputed, the most cost-efficient or simply the one that meets their technical requirements, and should also be able to switch easily and transparently between Cloud providers whenever needed, e.g. when an SLA is breached or when the cost is too high, without setting data and applications at risk, e.g. loss of data or inability to run the application on a different platform. Moreover, they should be able to compare Cloud offerings with different characteristics, such as resource, pricing or Quality of Service (QoS) model, and to choose the one that best matches their computing needs of their services and applications (Borenstein and Blake, 2011).

An open market of interoperable Cloud platforms will enable the IT industry to small-medium European Cloud providers and strengthen their market position (Foster et al., 2008). They will then interoperate and cooperate creating new business models according to demand without conflicts due to interoperability problems. For example, an unexpected increase in processing power capacity could force Cloud providers to cooperate in order to overcome the problem of limited resources. Otherwise, SMEs would seem unreliable to provide the negotiated QoS, leading consumers to rely on big players for hosting their services and data (Gartner, 2010). Therefore, initiatives are needed to ensure that the IT industry does not remain dominated by monopolies of giant multinationals and to support competition in the Cloud market.

PaaSport Vision and Key Technological Concepts

With this problem formulation, the ultimate goal for the PaaSport project is to resolve the application and data portability issues that exist in the Cloud PaaS market through a flexible and efficient deployment and migration approach. These include, but are not

limited to: image conversion to be suitable for target hypervisor, compression to aid, speed of transfer, image encryption, secure protocols, QoS gaurantees, trust issues and cost sharing models.

To this end, PaaSport will combine Cloud PaaS technologies with lightweight semantics in order to specify and deliver a thin, non-intrusive Cloud-broker (in the form of a Cloud PaaS Marketplace), to implement the enabling tools and technologies, and to deploy fully operational prototypes and large-scale demonstrators.

Hence, PaaSport will enable European Cloud vendors (in particular SMEs) to roll out semantically interoperable PaaS offerings leveraging their competitive advantage, the quality of service and value delivered to their customers, and improving their outreach to potential customers, particularly the pan-European software industry. PaaSport will also enable European Software SMEs to deploy business applications on the best-matching Cloud PaaS and to seamlessly migrate these applications on demand. PaaSport contributes to aligning and interconnecting heterogeneous PaaS offerings, overcoming the vendor lock-in problem and lowering switching costs.

In particular, the PaaSport Marketplace will enable European Software SMEs, such as the members of the Software SME Associations participating in the consortium, to seamlessly deploy and migrate their applications to the best-matching Cloud PaaS offering. From a business perspective, PaaSport aims at lifting the barriers that impede exporting ones applications and data from a Cloud platform, thus empowering Cloud customers and Cloud application developers (in particular, European SME Software vendors) and allowing them to choose freely the Cloud PaaS offering that best fits their needs. PaaSport is also expected to empower the position and encourage the entrance of European SME Cloud vendors, such as Flexiant, in an emerging market which is currently dominated by American colossi, such as Google and Amazon.

From a scientific and technical perspective, relevant issues and discussions in regards to Cloud PaaS interoperability are becoming lively, leaving room for the PaaSport consortium to work towards the specification and implementation of a semantically-enhanced Cloud-broker architecture and marketplace. In order to maximize the communities awareness and adoption of the PaaSport results, the PaaSport partners (mainly the participating Software SME Associations) intend to design and implement a focused set of European-wide dissemination activities.

For further information on BITMi´s Projekt PaaSport visit
http://paasport-project.eu

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Rene Buest is the author of numerous specialist articles on cloud computing and technology. He is also a speaker and participant in expert panels. At CloudUser.de he writes about cloud computing, IT infrastructures, technologies, management and strategies and is registered on Twitter as @ReneBuest. He is a trained IT specialist on system integration with a degree in Computer Engineering from the University of Applied Sciences Bremen and an MSc in IT Management and Information Systems from the University of Applied Sciences Paderborn.

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About Crisp Research AG

Crisp Research is a European IT research and consulting firm. With its team of experienced analysts, consultants and software developers, Crisp Research assesses current and upcoming technologies and market trends. Crisp Research supports companies in implementing the digital transformation of their IT and business processes. Cloud computing and Digital Business Transformation are the focal themes of Crisp Research.

In our Crisp Labs, we have an innovative team of software developers and architects who evaluate new cloud services and technologies under live conditions.

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