WHY YOU SHOULD READ THIS DOCUMENT
This white paper is about platform as a service (PaaS), a group of cloud-based services that provide developer teams with the ability to provision, develop, build, test, and stage cloud applications. It describes how PaaS:

• Creates demand for and broadens adoption of cloud services across your organization by making it easier for developers to make applications available for the cloud

• Unleashes developer creativity so that the focus is on creating innovative value-added services rather than the complexity of design and deployment

• Facilitates the use of cloud-aware design principles in applications that make it simpler to move to a hybrid cloud model

• Provides an ideal platform for developing mobile applications for multiple platforms and devices

• Offers a strategic option for your organization by following six steps for planning
Contents

3  Unleashing Developer Creativity Drives Demand for Cloud Services
5  PaaS: A Cloud Layer for Application Design
8  Developing for the Cloud
11 Planning for PaaS in Your Organization
Unleashing Developer Creativity Drives Demand for Cloud Services

As cloud technology continues to mature, more and more businesses are offering cloud services to a broad constituency across the organization. Typically, the service offered is infrastructure as a service (IaaS), one of three potential layers of service in the cloud. Offering IaaS is an excellent first step in the delivery of cloud services. It’s a great way to introduce cloud computing as a model for making IT operations more scalable and efficient, and it helps position IT as the broker of cloud services in the organization. However, private cloud service delivery is in no way limited to IaaS.

Offering higher-level platform as a service (PaaS) is another significant opportunity for deriving maximum value from your private cloud by making it easier to build cloud-aware applications quickly and consistently. Especially for development and test offerings, building a PaaS layer with open APIs gives developers the ability to rapidly consume IaaS built on a PaaS framework. By working in an elastic web-scale development environment, developers can take advantage of rich services that are secure and flex up to public cloud services on demand in a hybrid model.

Cloud Service Layers

IaaS is the lowest service layer in a basic cloud delivery model. IaaS provides access to infrastructure in an easy-to-consume way so that businesses can use on-demand virtual machines (VMs), storage, databases, and other services. The top service layer is software as a service (SaaS), which offers a cloud-based version of an application. PaaS provides an application development platform for building and hosting customized applications that are tuned specifically for an organization’s needs.

PaaS addresses problems of development speed and productivity. Slow traditional development cycles can’t keep up with the demands of today’s agile world. PaaS makes it possible to rapidly develop, test, and deploy consistent cloud-aware applications. With just IaaS, IT can easily deploy VM-centric workloads, but PaaS can simplify and accelerate test and development through standardized access to APIs and common programming languages to bring new services to market.

This paper focuses on how private cloud, as the foundation for the delivery of new services, can use PaaS to enable IT systems operations staff and developers to work more efficiently in a DevOps model. It describes how PaaS can unleash fresh creativity in your developer community to produce new innovative and differentiating business services that help derive greater value from your cloud. Much of the best practices in this paper were established based on Intel IT’s own experience with PaaS. Check out the additional references cited throughout this paper for more detail.
Growing Interest in PaaS

Today, the PaaS market is in the early stages of growth. However, as the technology matures, enterprises are turning to PaaS as a way to broaden general cloud adoption across the organization and to streamline the development process. Gartner forecasts that the global market for PaaS will grow from $3.8 billion in 2012 to more than $14 billion in 2017.² While those revenue numbers represent about 6 percent of the $235 billion projected for enterprise spending on the cloud for 2017,³ vendors continue to offer a range of services, from tools and application platforms for developers to services that can be used by business analysts.

PaaS provides IT organizations with significant benefits.

- **Improved time to market of new services.** Developers can significantly accelerate production of new cloud applications over the traditional development cycle through access to a broad set of automated tools and technologies that enable them to design and deploy cloud-aware applications more quickly and at minimal capital costs. Reduced development cycle time enables more new products to reach the market faster. With the time it takes to start, test, and deploy software projects dramatically reduced, IT also can support limited-duration projects such as marketing campaigns.

- **Access to services that are available only in the cloud.** Developers can customize, extend, and integrate SaaS offerings from public cloud providers by selecting specific functionality to be delivered as a service through the PaaS platform. The solution is tailored to user needs so that line-of-business (LOB) managers are less likely to pursue shadow IT initiatives.

- **Ability to rehost or re-architect legacy applications to run in the cloud,** often with minimal changes. Porting existing applications can cut IT operational costs, increase agility, broaden reach, and enable developers to focus on core competencies rather than the complexities of legacy infrastructure.

- **Address application integration issues by building cloud-aware applications specifically for dynamic environments.** Designing applications that move across environments easily can increase adoption of private cloud technology internally. It also paves the way to a hybrid cloud that effectively integrates both internal and public-hosted resources.

---

About DevOps

DevOps is an emerging IT discipline that accelerates cloud-aware development and deployment.

In a DevOps model, development and operations are no longer siloed. Application development, testing, deployment, scaling, and monitoring are automated and provisioned through platform as a service (PaaS). Developers can streamline the building of custom applications and deploy them into infrastructure themselves.
PaaS: A Cloud Layer for Application Design

PaaS is a group of services that abstracts application infrastructure, operating system, middleware, and configuration details, and provides developer teams with the ability to provision, develop, build, test, and stage applications without IT assistance. PaaS facilitates application deployment through self-service, on-demand tools, resources, automation, and a hosted platform runtime container. This eliminates the need for an installation kit, and developers no longer have to configure and wait for physical servers or VMs or to copy files from one environment to another as they move through the application life cycle.

PaaS streamlines and standardizes life-cycle management, from building the application to removing it at end of life, automating the many steps and functionality associated with each milestone. PaaS can also simplify version updates, patching, and other maintenance activities.

How Does PaaS Work?

PaaS pushes an application to the cloud from a command-line interface or directly from an interactive development environment (IDE) using a plug-in. After analyzing the application, PaaS hosts it in the runtime container that matches its resource requirements.

In addition to scaling capabilities, PaaS also provides high availability, automatic configuration, load balancing, and management tools.

PaaS can instantiate multiple copies in the same or multiple clouds for environments that might need to be isolated from others in the business. This is important for applications that must take into consideration compliance issues or internal-facing versus external-facing sets of applications. In each of these usages, the developer can still use common tools and best practices, but has a separate, secure environment. With PaaS, companies can also combine local resources and data for personalized mashups for a variety of web services.
PaaS and IaaS

PaaS is most efficient when it is built on top of IaaS. Developers building in a cloud environment typically prefer the deep platform access to application servers, web servers, and databases.

In an IaaS environment, PaaS can easily scale capacity, not just for the application, but for the PaaS capability as well. You can also host a mix of custom and commercial applications together in the same IaaS environment. Find out more about offering IaaS in Planning Guide: Private Cloud Infrastructure as a Service.

Building platform as a service (PaaS) on top of infrastructure as a service (IaaS) can help improve developer productivity. As PaaS adoption grows, IT investment and the total cost of ownership should lower.


Intel IT’s PaaS Initiative

Intel IT got great results automating server provisioning via infrastructure as a service (IaaS): Time to provision resources dropped from months to less than an hour. The next logical step was to accelerate customer application development and facilitate cloud-aware design principles via platform as a service (PaaS). Previously, custom applications took an average of 70 days and required developers to be familiar with underlying infrastructure, virtual machine (VM) provisioning, configuration, operating systems, middleware, and storage. Intel’s goal was to reduce that process to a day. Intel IT targeted three types of applications with its platform service: mobile applications, hybrid applications (those hosted on multiple clouds), and service-oriented applications.

During a three-month proof of concept, Intel IT standardized on open-source programming languages and deployed PaaS in Intel’s private cloud IaaS. The resulting solution provides a flexible self-service environment, on-demand tools, resources, automation, and a hosted platform that supports the programming languages and frameworks in use at Intel.

Intel IT continues on a roadmap for enriching services and capabilities, including automating the path to production, hosting, provisioning, and patching, as well as integrating the service more closely with web services. Other short-term goals are to provide design patterns for mobile and hybrid applications and experiment with partial and full migration of applications in a hybrid cloud.

Source: Extending Intel’s Enterprise Private Cloud with Platform as a Service, Intel IT (June 2012).
The PaaS Vendor Landscape

The PaaS vendor landscape is expanding rapidly, and PaaS can be offered as part of private cloud services or through a public cloud provider. Offerings can include support for multiple languages, application services, and data technologies, as well as integration and business process management services.

Many public PaaS providers, such as Amazon Web Services, Facebook, and Google, offer services targeted to business users. IT can get ahead of LOB users who want to use these services independently by offering PaaS as part of enterprise IT services.

Enterprise-level solutions target different design needs and are offered by established players as well as a number of newcomers. For example, Red Hat OpenShift offers a hosted and private data center version of PaaS. The Cloud Foundry platform is an open-source PaaS first released in 2011 and developed by VMware, released under the Apache License 2.0. It’s also part of the product offerings from Pivotal, a start-up that released Pivotal One in late 2013, a special-purpose PaaS for big data analytics. The Jelastic cloud hosting platform is designed to build Java and PHP applications with minimal coding and has international hosting partners and data centers.

Enterprise-Level PaaS Offerings

Examples of established platform-as-a-service (PaaS) players:
- Amazon Elastic Beanstalk
- Salesforce1 platform
- Google App Engine
- IBM Bluemix
- Oracle cloud platform
- Red Hat OpenShift
- Windows Azure web sites

Examples of start-ups:
- AppFog
- Apprenda
- AppScale
- Caspio
- Cloud Foundry (open source)
- CloudBees
- cloudControl
- dotCloud (now Docker)
- Engine Yard
- Heroku
- Iron Foundry (open source)
- Jelastic
- Nodejitsu
- Pivotal CF
- Ubuntu for cloud
- WaveMaker (formerly ActiveGrid)

Developing for the Cloud

Thoughtful cloud-aware application development can take full advantage of underlying infrastructure for improved scalability, performance, and resiliency. Applications can be enhanced with integration capabilities right from the start, enabling a hybrid cloud deployment with workloads that can burst to a public cloud or repatriate to private cloud as needed. Plus, applications for dynamic environments support business continuity goals since applications can be hosted in redundant data centers (or with multiple cloud providers) to avoid losing data and services in a disaster zone.

From the developer perspective, however, PaaS provides a platform for innovation and creativity—an opportunity to design applications for the cloud using cutting-edge tools and technology.

Cloud Development Challenges

Developers face a number of challenges to building and deploying custom applications for the cloud.

- **Complexity and time** – Development is a lengthy process, with manual steps and dedicated environments for each phase. A review of the development process at Intel described 16 major steps and 75 substeps, with 43 manual activities. Only 16 activities were fully automated.\(^5\)

- **Inefficient resource utilization** – Developers must provision capacity for their application development, but have little understanding of what they really need. As a result, they generally overestimate, leading to poor resource utilization and higher costs.

- **Standards and extensibility** – Developers generally treat each application stack individually—as a one-off—without standards for configuration, operating system, and middleware. In addition to being inefficient, this can have a negative effect on patching and updating later. Lack of standards also makes it very difficult to migrate an application from one environment to another.

- **Cloud application design principles** – Developers are often unaware of the cloud-aware design principles they can use to create applications that run as simplified, fault-tolerant, and modular services in a virtualized, elastic, multitenant environment.

Promoting Cloud Development Principles: Code-a-Thons at Intel

Intel is training developers to design for the cloud by using hands-on training events called Cloud-Aware Code-a-Thons. Developers compete with each other to win prizes, such as a new Ultrabook™ device, for creating the best applications. Participants use PaaS to deploy their applications into Intel’s enterprise private cloud environment. As part of the experience, they learn about cloud-aware design principles, do hands-on coding, and practice landing their applications. Judging is based on how effectively the application used cloud-aware principles, such as security in every layer and consumption of web services, as well as overall usefulness.

The results have been interesting, and new applications include Expert Finder (links employees to Intel experts); cafeteria applications (provide up-to-date availability of certain items); a parking application (locates open parking spots at Intel campuses); and a sabbatical countdown calendar (counts down to sabbatical eligibility).

Developer Gains from Using PaaS

PaaS provides developers with a new approach for addressing design challenges and enables them to do what they do best—create applications. Together with an agile development methodology (such as Scrum, Crystal, Dynamic Systems Development Method [DSDM], and Feature-Driven Development), PaaS increases developer productivity by reducing complexity, increasing automation, and enabling component reuse. PaaS also fits a DevOps model by streamlining the design and deployment processes and providing developers with the control of the combined process. Applications can be programmed and deployed more easily without developers having to worry about the supporting systems—only the application design.

In addition to streamlining development and deployment, PaaS also provides developers with these benefits:

• **Reduced product cycle time** – Developers can create more services and get them to market faster.

• **Greater standardization and extensibility** – This enables portability across platforms and devices.

• **Improved resource utilization** – Automated infrastructure provisioning provides the capacity developers need without overestimating requirements.

• **More efficient security and business continuity** – Applications can be written with defined security standards and for high availability; tools to check common coding errors support increased application reliability.

• **Greater control** – PaaS gives developers control and visibility into their applications, from development to deployment—which reduces time and facilitates cloud-aware development.

• **Increased independence** – Developers generally value the ability to self-provision resources, which provides them with the ability to work independently.

Cloud-Aware Application Design Principles

Developing for the cloud is different from building an on-premises application. Understanding these cloud concepts can help developers move more easily to PaaS:

• **Virtualization and elasticity** – Enabling applications to autoscale, take advantage of dynamic IP addresses, and compartmentalize components so they can run across multiple virtual machines (VMs)

• **Standard, consumable web services** – Enabling the application to work in mashups by using a secure web API such as representational state transfer (REST)

• **Fault tolerance and high availability** – Using load balancing with VMs in multiple availability zones, process threads that resume on reboot, state resynchronization by reloading messages from queues, and avoidance of application states maintenance in memory by writing to a shared database so user context persists across multiple hosts

• **Multitenancy** – Using scripts and configuration for on-demand new-tenant provisioning and selecting the multitenancy model by using a security rating

• **Platform-agnostic applications** – Avoiding lock-in by assuming applications will run on multiple clouds and including progressive features, such as detecting which platform is being used

• **Performance** – Improving availability and performance by distributing applications across multiple geographies and using application performance management tools to monitor the code base

*Source: Extending Intel’s Enterprise Private Cloud with Platform as a Service: Intel IT (June 2012).*
PaaS as a Facilitator for Hybrid Clouds

PaaS can make it easier for enterprises to seamlessly consume resources across private and hybrid cloud environments. If your existing private cloud applications have been built using cloud-aware design, you have the investment protection and flexibility to dynamically run applications in a hybrid model as the need arises for additional capacity. Other applications will need to be rebuilt to maximize cloud advantages and integrate with hybrid technology. You can do this by creating a PaaS environment in a public cloud IaaS hosting service or by using a public cloud PaaS provider with the same underlying PaaS stack used in your private cloud. For applications you don’t want to re-architect, you can containerize the application in a raw VM on IaaS.

Whatever you decide for existing applications, many cloud management platforms—open-source and commercial offerings—offer DevOps tools to streamline the application development process and make it easier to move applications between private and public cloud environments. Some also offer more sophisticated capabilities to modify or remove applications as part of the life cycle.

PaaS for Mobile Applications

PaaS is ideal for building cloud-aware applications for a mobile platform, providing a cost-effective way to support the growing trend for the consumerization of IT and Bring Your Own Device (BYOD) programs. Not only is development and deployment fast (necessary for software that generally has a short life), but mobile cloud applications offer users some advantages, such as the ability to run the same application across multiple devices.

Most mobile cloud applications run outside the mobile device. Users access data storage and computing via the cloud platform rather than on the device itself. This changes the basic architecture from client-server to cloud-client.

Cloud-client architecture requires better design skills for front-end input, and developers need to make trade-offs between the use of native mobile-device operating systems and cross-platform standards such as HTML5 or mobile enterprise application platforms (MEAPs). Mobile cloud applications are generally developed independently of operating systems, so they can offer more capabilities across devices.

Security and other management are also centralized on the mobile platform. Security threat detection, authentication, and real-time, automated audit reports on any attempted access violations can be run and logged in the cloud.
Offering PaaS as part of your cloud services delivery provides multiple benefits to the enterprise and your developer teams and creates new demand for your cloud offerings. PaaS enhances the value you are already achieving with IaaS services, delivering even greater agility and cost savings to free up resources for innovation on new business models or services.

In addition to increasing the speed of building and deploying applications, PaaS promotes cloud-aware design principles. By gaining skills in cloud application development, your software engineers have the opportunity to work with robust, cutting-edge tools and technology. While your developers can be more productive for the organization, they can also tap into greater creativity to design innovative and differentiating business services—great for professional satisfaction and the organization.

Finally, PaaS allows you to provide greater ease of use for your internal customers, who may currently be setting up raw, hard-to-migrate VMs in an external cloud provider because of perceived benefits around speed and ease of development. Deploying PaaS offers your internal customers the flexibility and speed they want in a managed and secure environment that maintains governance and risk-management policies.

### Planning for PaaS in Your Organization

If you are considering PaaS for your organization, take these six steps:

1. Learn more about PaaS.
2. Consult with your developer organization to determine interest and readiness.
3. Learn about vendor offerings. In addition to abstracting application runtime, middleware, and data services from the underlying infrastructure, make sure your solution supports multiple languages, application services, and data technologies and avoids vendor lock-in with deployment options.
4. Define what type of applications you want to target:
   - Mobile applications
   - Hybrid applications
   - Service-oriented applications
5. Decide if you want to port existing applications—and which ones.
6. Conduct a proof of concept.

Intel can help simplify your delivery of cloud services with guidance and resources for building and buying services for private and hybrid cloud environments, including PaaS. Learn more by visiting intel.com/cloud.
Endnotes


More from the Intel® IT Center

What Is PaaS? Is brought to you by the Intel® IT Center, Intel's program for IT professionals. The Intel IT Center is designed to provide straightforward, fluff-free information to help IT pros implement strategic projects on their agenda, including virtualization, data center design, cloud, and client and infrastructure security. Visit the Intel IT Center for:

- Planning guides, peer research, and solution spotlights to help you implement key projects
- Real-world case studies that show how your peers have tackled the same challenges you face
- Information on how Intel's own IT organization is implementing cloud, virtualization, security, and other strategic initiatives
- Information on events where you can hear from Intel product experts as well as from Intel's own IT professionals

Learn more at intel.com/ITCenter.

Share with Colleagues

This paper is for informational purposes only. THIS DOCUMENT IS PROVIDED "AS IS" WITH NO WARRANTIES WHATSOEVER, INCLUDING ANY WARRANTY OF MERCHANTABILITY, NONINFRINGEMENT, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION, OR SAMPLE. Intel disclaims all liability, including liability for infringement of any property rights, relating to use of this information. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted herein.

Copyright ©2014 Intel Corporation. All rights reserved. Intel, the Intel logo, Intel Core, Intel vPro, the Look Inside, logo, and Ultrabook are trademarks of Intel Corporation in the U.S. and/or other countries.

*Other names and brands may be claimed as the property of others.