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IT@INTEL

Utilizing PaaS for Business Agility and IT Efficiency

Our new private PaaS has reduced application development time to production from weeks to a day.

Executive Overview

As part of our effort to strategically transform data centers and accelerate application delivery, Intel IT used design best practices to create a cloud application platform. This platform—more specifically, platform as a service (PaaS)—makes it easy to create, deploy, and manage web and mobile applications. The platform provides a highly available and secure environment, eliminates the need for time-consuming server management tasks, and frees Intel developers to focus on application development. The PaaS capability has enabled Intel to move quickly and reduce costs with 800+ applications in varying stages of the development process now deployed to the PaaS environment.

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Contents

Acronyms

DBaaS	database as a service
DevOps	development and operations
IaaS	infrastructure as a service
PaaS	platform as a service
SaaS	software as a service
VM	virtual machine

Business Challenge

The ongoing evolution of technology continues to change the business world. Changes such as the free movement of diverse information, custom mobile applications and services, and the variety and growth in devices are having a significant impact on Intel IT. Data must be available everywhere and securely accessible from any device. Users need the right information at the right time—tailored to their usage model. Other factors of change include the introduction of new devices as part of Intel's Bring Your Own Device program, the increased frequency in OS and browser updates, and the pace at which new capabilities are released to support the business. All these factors made us realize we needed to change our method of developing and delivering applications.

Traditional approaches to application development and testing are expensive for both commercial off-the-shelf and internally developed software. Business software is now indispensable for growth and competitive differentiation. Software that quickly integrates existing capabilities and supports new deployments is needed. We needed to standardize development environments around a common toolset and platform to meet agile business needs.

As part of Intel's cloud strategy we are deploying public software-as-a-service (SaaS) solutions and a private platform-as-a-service (PaaS) cloud. Many of our applications are central to Intel's business, which make them less viable candidates for public clouds, including public PaaS. For some applications, the business acceptance criteria for performance requires solutions closer to the user's internal systems. In many cases integrating existing solutions with an external environment can significantly extend the application development and delivery by several weeks or months.

These security, business, and environmental factors led us to the development of our own private PaaS solution hosted within our private cloud infrastructure.

Business Drivers for PaaS

Building applications for the cloud enables business agility. The word "private" in private PaaS means that IT manages the PaaS solution, but it can be installed on both publicly managed infrastructure and internally managed infrastructure, implemented as infrastructure as a service (IaaS). The primary business benefits of private PaaS include the following:

- Significantly decreases delivery time for custom applications through shared services and performance features
- Increases the pace of development through a reduced administrative burden on developers
- Improves integration with legacy solutions
- Lowers infrastructure costs through location independence and shared services
- Improves security compliance through platform-enabled efficiencies

Our goal is to get 20 percent of Intel internally developed applications onto our private PaaS by the end of 2016.

Reduction in Time to Market for Custom Applications

With private PaaS, an application and associated database can be created and configured in less than a day instead of weeks (see Figure 1). Developers can innovate quickly, providing business solutions on demand. Leveraging private PaaS simplifies application deployment and management and increases developer productivity through shared services.

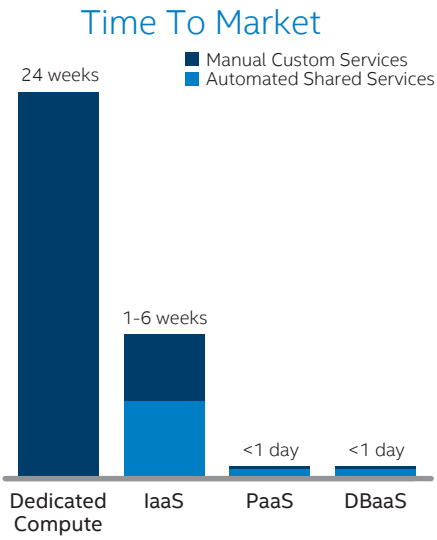


Figure 1. Platform as a service (PaaS) can reduce application development time from weeks to less than a day.

Increased Pace of Development

PaaS allows developers to frequently change or upgrade application features by automating routine tasks. Because solutions can be readily deployed to a common environment, development teams can more easily collaborate on projects, such as testing new feature sets and integrating services. Further, with PaaS developers no longer have the administrative burden of software patching and updates and can instead focus on development tasks. This benefit is particularly important with today's increased frequency of security updates.

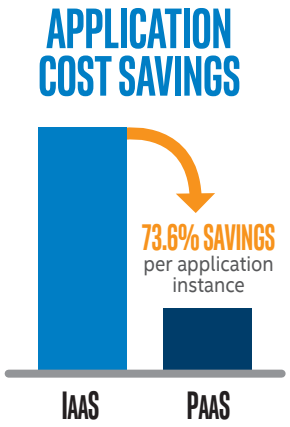
Improved Integration with Legacy Solutions

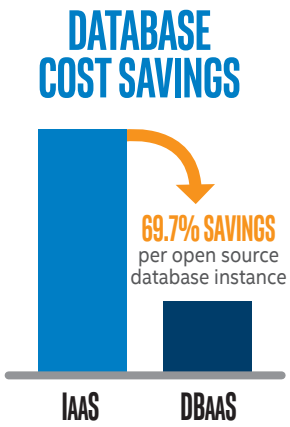
Businesses have justifiable reasons for leaving legacy systems in place once deployed; often a key reason at Intel is the ability to access historical data and reports, system integration, and services. A major advantage of private PaaS is the ease of integration with existing solutions. When landing solutions externally, development teams spend a significant amount of time rewriting portions of the application to enable external connectivity. Even with experienced application teams who have experience with external integration, the nature of the development integration can be costly for a time and development effort. Now with the internal PaaS environment, the development teams can focus on the key application areas that need to be enhanced.

Lowered Infrastructure Costs

The cost advantages of cloud platforms make these platforms popular with IT decision makers. Because they are location-independent and resistant to failure and latency, cloud platforms enable IT to locate computing hubs worldwide, further improving the computing cost profile.

To remain cost competitive in today's business climate, many businesses must now depend upon cloud application platforms to better control costs for business application development, infrastructure, and security. Private PaaS simplifies an application's back-and-forth migration between public clouds and internal IT by abstracting the application away from infrastructure and enforcing a common inheritable architecture in the different environments. For example, architecture patterns common to most applications and clouds are built into PaaS middleware to reduce coding time. A PaaS self-service console allows developers to upload code and publish it to infrastructure dictated by policy automation.





PaaS increases the efficiency of resources for IT departments. Compute density can be increased by switching from single-tenant to multitenant hosting. This efficiency leads to lower support costs. IT takes ownership of the OS and database patching and compliance. Fewer personnel are required for supporting the application and database infrastructure.

Private PaaS can greatly reduce costs by improving infrastructure utilization, automating many manual configuration tasks, and employing self-service interfaces. We have achieved a 73.6 percent savings on the costs of application instances after moving the application from IaaS to PaaS. In addition, we achieved a 69.7 percent savings on the cost per open source database instance after switching from IaaS to PaaS.[1]

When assessing cost benefits it is also important to consider both internal and external cloud offerings. Intel IT performed a cost comparison between the deployment of cloud solutions hosted within our own infrastructure (internal IaaS) and those hosted with a public service provider (public cloud). The financial assessments (see Figure 2)[2] indicated that it was twice as expensive to use an external cloud environment, making our internal PaaS savings even more compelling. The percentages were calculated as a year-over-year savings from a baseline study we conducted starting in 2010. In addition, we found that the time to market can be delayed by as much as six weeks for external solutions as the project schedule is adjusted for the refactoring of application code to integrate data and services, governance, and security reviews.

[1] Cost savings are based on Intel IT's internal infrastructure costs.

[2] External cloud pricing is based on volume discounted price. Full technical feasibility to use cloud was not done. Minimum required internal IT heads to support external cloud is included.

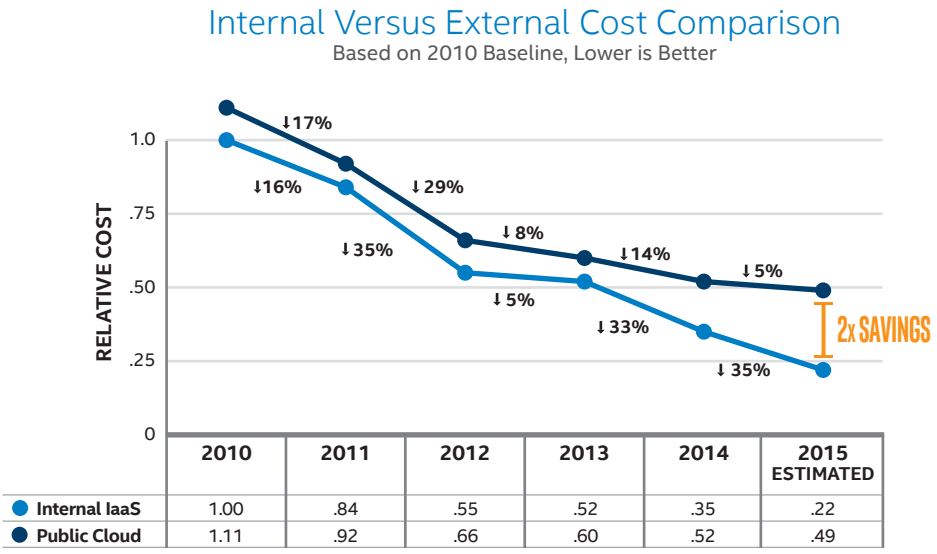


Figure 2. We achieved a savings of more than 50 percent, compared with the cost of external solutions. Source: Intel internal measurements, 2015.

Improved Security Compliance

Security is an often overlooked, but significant benefit of private PaaS (see Figure 3). Governance control is simplified, because applications and data are centralized and do not span thousands of virtual machines. The platform used by Intel developers is pre-approved by our security governance teams and streamlines the process for landing solutions and enabling network access through the appropriate firewalls. The infrastructure experts, not the application developers, secure and manage the platform infrastructure.

Private PaaS enables an organization to manage all its applications from a central location, lessening concerns about being outside the bounds of IT governance. A cloud application development platform can provide central control over development and hosting operations, including recommendations and best-known methods to help ensure compliance and security.

Within an IaaS environment the application has a unique OS and software configuration that must be patched and maintained. Within a PaaS environment the standardization of the application OS and software drives a loose coupling with the OS and software and reduces the time for patching and configuration, thereby reducing costs to the business. Perhaps more important, it also leads to the ability to address vulnerabilities more quickly.

Finally, by using a private PaaS, developers can easily migrate away from applications that may have code vulnerabilities because they are based on older, non-patched libraries or frameworks.

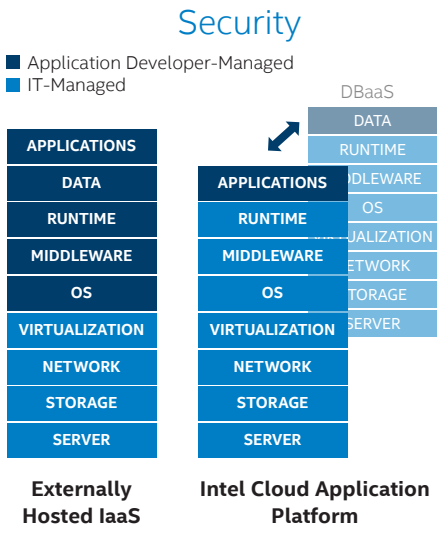


Figure 3. We have found that PaaS provides better security than IaaS.

Intel Cloud Application Platform Solution

To address the business challenges discussed above, we built a private PaaS that we call the Intel Cloud Application Platform.

The Intel Cloud Application Platform is a cloud service based on open source PaaS software that makes it easy to deploy and manage web and mobile applications. The platform service supports a variety of application stacks, including open source software. It provides a highly available and secure environment, eliminates the need for time-consuming server management tasks, and frees developers to focus on application development.

The following sections discuss the benefits we have gained from the Intel Cloud Application Platform, our application developers' response to the platform, and the platform's effect on development and operations (DevOps).

Benefits

We have found that the Intel Cloud Application Platform provides several benefits to IT and application developers.

Quick Development of Cloud-Ready Applications

The Intel Cloud Application Platform provides an automated development environment for end-to-end solutions with a streamlined process. The platform can host almost any web-based application if it is designed as a cloud-aware application. Those applications can deliver content to mobile devices or any other device that can consume data over http and https protocols. The developer uses the Intel Cloud Application Platform interface to push an application into the cloud. The platform includes web services registry access (publish and consume). With a single "push" deployment, the application landing process steps are automated.

The Intel Cloud Application Platform is a complete platform for deployment and hosting. This platform provides administration utilities such as provisioning, patching, and upgrading. Developers can choose to take advantage of abstracted middleware included in the platform to reduce setup and configuration. Also included are a runtime container, an OS, and middleware. Supported developer utilities and tools include a command-line interface, APIs, and a web portal. We provide a self-service path to hosting capabilities, production automation, and integration with solutions. The developer can quickly move an application through development, test, and production with fewer steps and less complexity than traditional hosting and IaaS. The Intel Cloud Application Platform also provides a community developer space that we call the Intel IT Developer Zone, where developers can share recommendations and tips for quickly deploying cloud applications.

Efficient Resource Utilization and Component Reuse

The Intel Cloud Application Platform leverages application deployment policies to enable fine-grained mapping of applications and application components to the infrastructure. This mapping to the infrastructure supports both internally and externally facing applications.

The front-end supports multiple platforms, enabling Intel developers to be productive on any client platform (see Figure 4). These platforms include a variety of devices and inputs, and multiple operating systems and browsers.

The Intel Cloud Application Platform incorporates IaaS. We used Intel's IaaS for enterprise private cloud and moved the back-end (the server runtime environment) to the cloud.

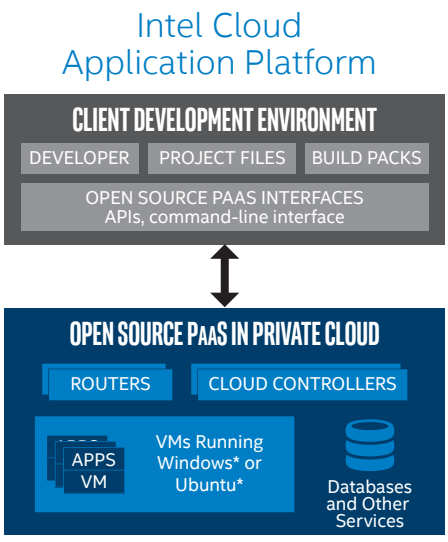


Figure 4. The design of the Intel Cloud Application Platform supports multiple platforms, enabling application developers to be productive on any client platform.

Security and Governance Built-In by Design

In the past, Intel had multiple application silos with different security rules and configurations based on each business unit's needs. The Intel Cloud Application Platform enables developers to consolidate applications on a shared infrastructure, while using sophisticated deployment policies to comply with specific business, security, or legal requirements. Security governance with separate approval processes is used for production enclave applications and exclave applications.

Previously, some developers were not sure how to properly secure the OS and software configuration for cloud hosting. We found that developers from different teams integrated security in different ways or, in some cases, misconfigured the environment. PaaS prevents these errors by automatically applying a secure configuration. Not only does this reduce costs because fewer people are required to monitor the environment and correct any problems, but it also equates to a faster time to address vulnerabilities once applications are deployed.

Built-In Elasticity with High Availability

Scaling is achieved by using redundant multiple platform instances. The Intel Cloud Application Platform provides application hosting from source code and is built to scale quickly for bursting workloads. We monitor capacity and add virtual machines as needed for scaling. In the future, we plan to develop capacity models and triggers to automate elastic scale-out and scale-back.

With the abstracted middleware, the Intel Cloud Application Platform can run in multiple clouds. This makes it easy to extend the platform to span data centers. Developers can quickly deploy applications to different zones for scaling workloads or redundancy.

High availability is achieved by hosting applications on lightweight containers that are abstracted from the infrastructure and are able to rehydrate on other servers if the hardware fails. Load balancing across multiple platform instances ensures that the application experience is never diminished. To prevent service degradation, the Intel Cloud Application Platform uses highly sensitive telemetry monitoring, which assures that users get the performance they require.

Scalable Databases

Databases are external to the native Intel Cloud Application Platform. We use our own database as a service (DBaaS) for secure, persistent data. By using our own DBaaS we can right-size the environment dynamically using a scale-out model.

Where the databases are hosted is not important to developers. They simply use a portal to request a new database instance and a connection string is returned. Every database provisioned can have three logins: schema owner (manage the database structure), application owner (read/write data), and read-only.

Multiple applications on the Intel Cloud Application Platform can share the same database if they have the same application owner. Developers can create and populate tables within a database three ways:

- Build the application so it can detect whether there are tables and, if not, create them as needed.
- Build a small additional application that performs all initialization and population of any tables.
- Use a native database client to create tables and upload data.

Users manage their own tables and data; however, we provide standard backups and patching, indexing, and disaster recovery backups.

Linkage to Application Performance Monitoring Tools

Developers can monitor and manage their applications using built-in tools (see Figure 5). Developers are able to self-manage their applications from launch to end of life. Management goes beyond performance monitoring to create, destroy, and scale application instances. Additionally, developers can view platform utilization and error logs.

With Intel Cloud Application Platform capabilities, a developer needs to manage only the application. IT manages the underlying platform and infrastructure.

The Application Developers' Perspective

To engage Intel's developers with the Intel Cloud Application Platform, we launched a site known as the Intel IT Developer Zone. We introduced the zone to developers as the 5 Star Applications Initiative. This tool highlights to developers the benefits to using the Intel Cloud Application Platform (see Table 1).

The Intel IT Developer Zone connects teams with experts and tools. The site consists of code development guidance, code assets, application generator, best practices, tools, service depot, training, and code samples. User interface assets consist of guidance, code, and samples. Code security and audits are integrated into the Intel Cloud Application Platform. Developers can trust that within their applications, the data and identity are protected.

Developers are enthusiastic about the Intel IT Developer Zone and Intel Cloud Application Platform. Within 60 days, we logged 1,400 unique users. The most frequent types of applications being developed were screencasts and assets, services, and metrics instrumentation.

Table 1. Features and Benefits of the 5 Star Applications Initiative.

Criteria	Developer Benefit
Security and Audit	My data and identity are protected.
User Experience	My application is intuitive and easy to use.
Platform	My application is accessible and works on my choice of platform.
Device Capability	My application takes advantage of my device and its features.
Interact and Evolve	My application supports emerging devices and interactions (for example, touch, voice, and gesture).

Intel Cloud Application (ICApp) Platform Components

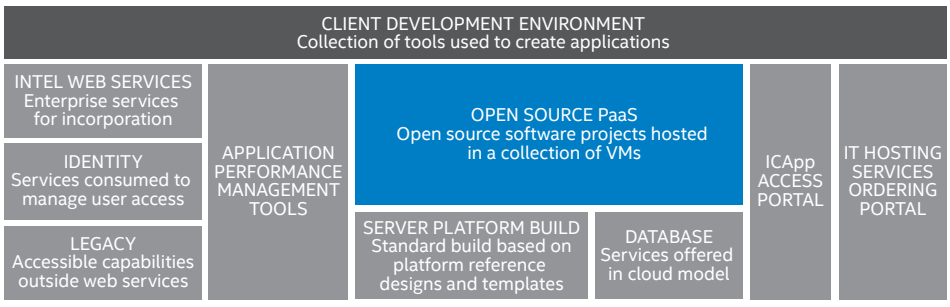


Figure 5. The Intel Cloud Application Platform consists of components that enable application developers to focus on managing their applications, while Intel IT manages the underlying platform and infrastructure.

As shown in Figure 6, application development starts by logging into the Intel Cloud Application Platform client development environment. Using a browser interface, developers get access to open source PaaS tools, a hosting service catalog, the Intel Cloud Application Platform portal, and the application performance monitoring dashboard. Command-line interface utilities and integrated development environment plug-ins are also available so developers can choose their favorite tools.

Developers do not have to provision servers to start or test their applications. Applications developed on the Intel Cloud Application Platform are not locked in to any specific infrastructure. Applications are load balanced and can be deployed to multiple locations for rapid scaling. The Intel Cloud Application Platform provides access to our cloud database (DBaaS) or developers can use one of their own. Finally, developers can use single sign-on for viewing their application logs and application life cycle management.

The Intel Cloud Application Platform provides developers application frameworks such as .NET Core*, Java*, Python*, HTML, Node.js*, Ruby*, and PHP*. The Intel Cloud Application Platform application stack uses containers to prevent noisy neighbors. In development, applications are deployed to a node that has the right resource stack, sharing with other applications that have similar resource needs.

Developers have the flexibility to configure the path to production that makes sense for their project. For example, applications are created in spaces within organizations to separate the path to production phases in one or more instances of the Intel Cloud Application Platform.

When the application is pushed to production, developers manage the application life cycle using the application performance monitoring dashboard.

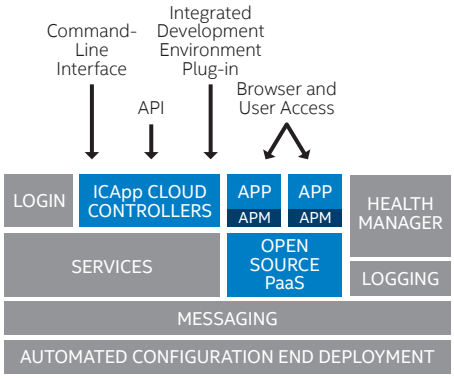


Figure 6. The Intel Cloud Application Platform uses open source PaaS.

The DevOps Perspective

The Intel Cloud Application Platform significantly improves DevOps. Intel's DevOps teams align communication, collaboration, and integration between software developers and IT operations.

Traditional software development processes involve multiple transfers between teams—from business analysts to architects to coders, then to quality assurance and finally to operations. Project transfers can create a number of misunderstandings and miscommunications, which lead to issues with quality and deployment speed.

We have embraced Agile software development. Agile methodologies create more frequent releases of incremental functionality, continuous integration, and continuous delivery. Agile development eliminates many of the bottlenecks and transfers between the business and the development teams. Despite the move to Agile development, DevOps was still left with a growing number of issues.

The Intel Cloud Application Platform eliminates the problems with transfers and Agile development. With developers standardizing their code on a common platform and tools, code integration, testing, and releases now run smoothly. DevOps tasks used to be done manually and only once in a cycle. As shown in Figure 7, now with the Intel Cloud Application Platform, we do the same tasks continuously with automation. These tasks include the following:

- **Release planning.** The Intel Cloud Application Platform allows business developers to define much smaller, more frequent releases. Small frequent releases improve quality because they are much easier to test and have less impact on the production environment. This practice can also improve the final product because end users can try out smaller portions of the system and provide feedback for future releases.
- **Continuous integration.** Continuous integration is a practice that requires developers to integrate (check-in) code into a shared repository several times each day. With the Intel Cloud Application Platform, check-in kicks off an automated build; with the integrated code management tools, teams can detect problems early, making errors much easier to fix.
- **Continuous delivery.** Continuous delivery builds on continuous integration by extending the automated build process to all of the final stages required for production deployment. This means software is always production-ready throughout its entire life cycle. Developers using the Intel Cloud Application Platform can now release any build in minutes.
- **Continuous testing.** Adoption of continuous integration means that working increments of the product are available continuously for testing. The Intel Cloud Application Platform enables developers to continuously test their code across the development life cycle. This shortens testing cycles and provides continuous feedback on quality.
- **Continuous monitoring and feedback.** Continuous monitoring helps keep applications performing at optimum levels. With the built-in system monitoring tools in the Intel Cloud Application Platform, developers can build self-monitoring and analytics-gathering capabilities right into the applications.

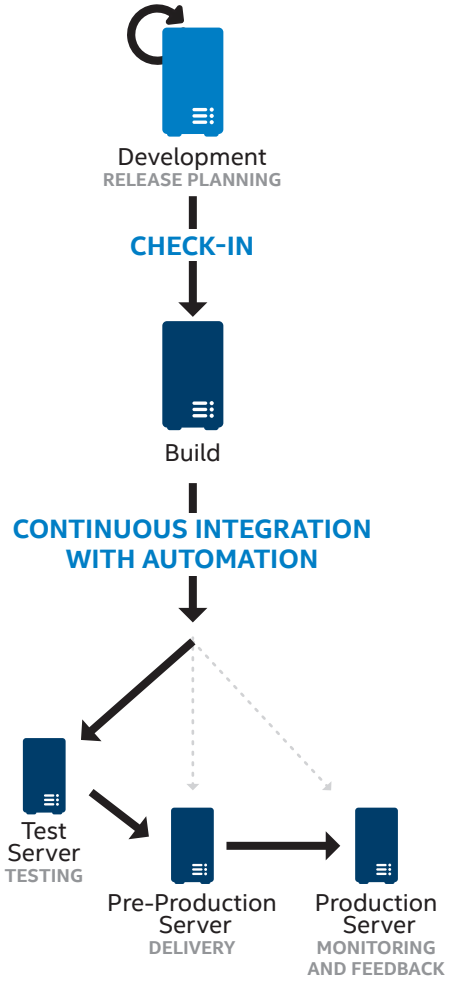


Figure 7. The Intel Cloud Application Platform supports DevOps best practices.

Results

We are well on our way of achieving our goal of getting 20 percent of Intel-developed applications onto the Intel Cloud Application Platform by the end of 2016. The platform took three calendar quarters to develop and put into production. Within these three quarters, we launched the platform in two data centers. Currently, we have over 350 unique users who have developed more than 800 unique applications. The top three most deployed languages are Node.js, Python and .NET Core. This year, we are receiving 500,000 requests per day for applications hosted on the Intel Cloud Application Platform.

Next Steps

With the success of our initial Intel Cloud Application Platform deployments, we plan to implement additional security controls to support a wider range of applications and users. The platform will integrate network segmentation, either through virtual LANs or physical segmentation. This capability will support applications that have higher information classifications and criticality. Processes will use a library of reusable vetted code, such as code for authentication and authorizations. Multitenant security will be improved by integrating vulnerability scanning and adding a static code analysis tool. Finally, security logging will be added to allow for easier integration with enterprise capabilities. To implement these features, we may consider SaaS solutions.

Conclusion

We needed a more flexible approach to application development that supports business solutions across a range of devices. We needed to achieve the following:

- Enable the business units in new models of computing while reducing costs
- Make data securely available anywhere and on any device
- Improve developer efficiency by creating new tools and actively sharing best-known methods

The Intel Cloud Application Platform is a way to rapidly build and host applications in the cloud; it enables developers to go from innovative idea to production service in less than a day. The platform is preprovisioned with abstracted middleware and infrastructure. The platform provides runtime containers, elastic scaling, and high availability. Resource sharing is maximized through the use of multitenancy and reusable web services. Developers code their applications and deploy into production without IT assistance.

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