Platform as a Service (PaaS)
What Is It? Why Is It So Important?

An NJVC and Virtual Global Executive White Paper

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January 2012
I. Foreword

This paper attempts to answer two questions:

1. What is Platform as a Service?
2. Why is it so important?

The National Institute of Standards and Technology (NIST) describes three ways to deliver cloud computing capabilities: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). Of the three cloud service delivery models, PaaS usually generates the most confusion, though it potentially offers the greatest impact over any other aspect of cloud computing because it brings custom software development to the cloud.

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NIST describes PaaS as: “The capability provided to the consumer to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider.”

In simpler terms, PaaS provides developers (the consumer) with easier ways to create and deploy software on cloud infrastructure. Those “easier ways” may be graphical user interfaces (GUIs), sandboxes, programming languages, shared services, application programming interfaces (APIs) and other online tools for developers. PaaS implementations vary from vendor to vendor.

Keep in mind that the concept of development tools and platforms is not entirely new, although the underlying infrastructures have changed significantly. In the 1990s, desktop platforms (operating systems) and development tools catapulted the sale of PCs by empowering developers and making PCs easier to use. In the next 10 years, PaaS will drive demand for the cloud in similar ways.

So why is PaaS so important? Because it speeds development and saves a lot of money!

Using PaaS, it’s possible to save millions of dollars on a single, large-scale software development project. Developers can create and deploy software faster. Agencies can lower their risks, promote shared services and improve software security via a common security model. Data centers can leverage PaaS to make their infrastructure more valuable. PaaS can lower the skill requirements to engineer new systems and can lower risks by taking advantage of pretested technologies. It has been said that an order-of-magnitude in economics will change an industry. PaaS has been shown to provide enormous improvements in the economics of engineering and deploying custom software. An early 2009 IDC study demonstrated 720-percent return on investment for Force.com® stakeholders. Since that time, several new products have emerged. It is reasonable to expect the economics to improve as the market matures over time.

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1 The NIST Definition of Cloud Computing, Special Publication 800-145
2 Timothy Chou, PodTech transcript for “The End of Software”, Jan 22nd, 2007
Despite its many advantages, PaaS is not perfect. For example, many PaaS vendors require their customers to make long-term commitments to proprietary infrastructures. Some early adopters of PaaS have unknowingly made casual long-term commitments to infrastructure providers. It’s somewhat like buying gum at the counter, but needing to rent the store for 10 years. That’s why NIST is stressing the importance of openness and portability.

The NIST Cloud Computing Reference Architecture depicts PaaS as playing an integral role. In fact, platforms will play the same vital role in the cloud computing model as with prior computing models: namely desktops and mainframes. The value is simply too significant to ignore. A Gartner® report in 2011 predicted that PaaS would become mainstream, going so far as to say “the battle for leadership in PaaS and the key PaaS segments will engulf the software industry.” According to Fabrizio Biscotti, a Research Director at Gartner®, “PaaS is the least developed [of the service models], and it is where we believe the battle between vendors is set to intensify.” Mr. Biscotti goes on to say, “Clearly, from the attention given to this segment by the industry’s giants, it is likely that they are viewing PaaS as a strategic undertaking as much as an incremental market opportunity.”

The authors of this paper emphatically agree! For the IT industry, PaaS will drive sales of software, infrastructure and integration services. As we enter 2012, the interest in PaaS is reaching critical mass and the market is poised for hypergrowth. System integrators are leveraging PaaS to win more proposals and deliver faster. IaaS providers are leveraging PaaS to radically differentiate their offerings. IT buyers are looking toward PaaS to turn around troubled projects. Enterprise software companies are acquiring PaaS solutions to establish new identities. Understand it or not, PaaS is quickly becoming the new way to build and integrate software on the cloud.

In a few years, PaaS will likely be the norm rather than the exception. Soon, it will be unfathomable to build a software system without leveraging shared platform services.

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4 NIST Cloud Computing Reference Architecture, NIST SP 500-292
5 Gartner® Says 2011 Will Be the Year of Platform as a Service, March 14, 2011, Gartner Newsroom
6 Gartner® Says Worldwide Platform as a Service Revenue is on Pace to Reach $707.4 Million in 2011, Gartner Newsroom
II. What Is PaaS?

Let’s start again with the NIST full definition of PaaS: “The capability provided to the consumer to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider.” NIST goes on to say, “The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.”

Said another way, PaaS provides developers with easier ways to create and deploy software onto cloud infrastructure. Those “easier ways” typically exist as GUIs, sandboxes, programming languages, shared services, APIs and other online tools for software developers.

To better understand the basic concept of PaaS, imagine logging onto a website that lets you provision a “hello world” software application on top of cloud infrastructure. Now imagine using online tools and programming languages to build out your application for a more serious business need. Imagine adding forms, features and reports; integrating with legacy systems; and deploying your software on the cloud ... zero uploads, installations or system configurations to worry about. It’s all managed for you.

Whereas PaaS offerings may differ greatly from vendor to vendor, the purpose remains primarily for developers to create software on cloud infrastructure. According to NIST, “PaaS consumers employ the tools and execution resources provided by cloud providers to develop, test, deploy and manage the operation of PaaS applications hosted in a cloud environment. PaaS consumers can be application developers who design and implement application software; application testers who run and test applications in a cloud-based environment; application deployers who publish applications into the cloud; and application administrators who configure, monitor and manage applications deployed in a cloud. PaaS consumers can be billed according to the number of PaaS users; the processing, storage and network resources consumed by the PaaS application; and the duration of the platform usage.”

PaaS is not a single technology, but rather a collection of related services for creating and deploying software on the cloud. That collection of technologies is growing. Early PaaS offerings included limited feature sets, such as forms, databases and simple APIs. As the market matures, we are seeing PaaS offerings that manage user subscriptions, security, resource metering, workflow, commerce, role-based security, reporting and other shared services. These integrated PaaS offerings are evolving into operating systems for the cloud.

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Service Model Delivery

By definition, PaaS is provided as a service—you can use it over the internet with no need to ever install, upgrade or host. That means that PaaS is provided on demand in ways that support essential characteristics for cloud computing. It is elastic—it can be scaled up and down quickly based on needs. It also takes advantage of a shared pool of computing resources to handle surges. Developers can deploy their SaaS in a way that consumers only pay for what they use.

This has huge implications for software integrators! Until the emergence of PaaS, the term “cloud computing” was nearly synonymous with infrastructure services. The SaaS segment has been dominated by giants like Microsoft® and Google®. With PaaS, system integrators are empowered to enter the space with cloud-enabled mission solutions. In essence, PaaS is the enabling technology that finally brings custom software to the cloud.

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PaaS is readily distinguished from traditional web platforms, which require installations, uploads, downloads and managed hosting. “As a service” means that developers can provision and manage instances of the platform on demand—with no need to coordinate with their information technology (IT) departments or manage the underlying servers. More importantly, if you build cloud software on top of a PaaS, your solution is inherently “cloud ready,” taking advantage of underlying cloud infrastructure and as-a-service delivery models.

Along the same lines, PaaS is often confused with application frameworks, such as Ruby on Rails® or .Net. In short, there is little or no comparison. With PaaS, there is no need for uploading, configuring permissions and troubleshooting because it is delivered over the internet as a cloud service. Application frameworks and PaaS may coexist to support SaaS solutions, such as with the Heroku™ platform (owned by Salesforce.com®) and SaaS Maker™. Such platforms facilitate integration and deployment of applications that were written in a variety of programming languages.
III. Why Is PaaS So Important?

PaaS has been shown to speed development of complex software, while making it easier to deploy and manage applications on the cloud. It shields developers from the underlying complexities of installing and configuring applications on low-level operating systems. As a result, IT stakeholders benefit in several ways:

- **Lower costs:** PaaS has been shown to reduce costs by more than half, and in some cases improve return on investment (ROI) by more than 700 percent.\(^8\)
- **Faster time to market:** PaaS dramatically reduces time-to-market by serving as a launch pad for software applications and managing common functions.
- **Lower risks:** PaaS can reduce risks because common functions are already tested—sometimes over a period of years.
- **Rapid prototyping:** PaaS provides unique capabilities for developers to create and deploy concept applications on the cloud for their customers. It provides a way to demonstrate results faster to end users.
- **Higher security and interoperability:** The Federal Cloud Computing Strategy describes “potential platform strength” as “greater uniformity and homogeneity, and resulting in improved information assurance, security response, system management, reliability and maintainability.”\(^9\)

PaaS is a component of the NIST Reference Model for Cloud Computing. If you’re developing a custom software system **without** a PaaS, then you are likely building a stovepipe.

The NIST Cloud Computing Reference Architecture depicts PaaS as the middle layer in a three-layered architecture. The mysterious “inverted Ls” imply that SaaS may be created in either of two ways: as a layered architecture (on top of PaaS and IaaS) or as traditional ground-up stovepipes, avoiding PaaS altogether. Many of today’s established software vendors deliver SaaS without leveraging PaaS or IaaS technologies, often because PaaS was unavailable at development time.

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The authors of this paper believe that trends will rapidly move toward PaaS to knock down stovepipes and deliver shared services.

The stovepipe problem has existed for many years, with redundant approaches to managing security, workflow and multi-tenancy. PaaS consolidates common functions into shared services that are easy to consume. As a result, applications share common ways to do things and they achieve higher levels of integration and interoperability.

Although developers are the primary users of PaaS, all IT stakeholders will ultimately benefit from its advantages. IT buyers will benefit because they are the ones suffering from astronomical software engineering costs and delays. The end users will benefit from the lower usage fees and by gaining access to their applications sooner.

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How Big Is the Problem Being Solved?

PaaS solves the biggest problem with software development projects today: web-based software is extremely complicated, risky and expensive to engineer. These problems are largely related to stovepipe development projects.

The U.S. Chief Information Officer’s (CIO) 25 Point Implementation Plan to Reform Federal Information Technology Management sheds light on the problem this way: “Too often, agencies build large standalone systems from scratch, segregated from other systems. These systems often duplicate others already within the federal government, wasting taxpayer dollars.”

U.S. CIO Steven VanRoekel, recently prescribed a “shared-first” initiative aimed at solving the stovepipe problem. Among other advantages, platforms serve as a way to share services across an enterprise without reinventing the wheel.

The reason stovepipes are expensive is that they require labor intensive and error-prone engineering and integration. It’s like building a house from a pile of nails, lumber, pipes and wires ... often costing millions of dollars and taking years to construct. Instead imagine building a prefabricated house—you specify the color, size, type, carpet and more. The prefab house may be delivered in a fraction of the time, risk and cost.

10 U.S. CIO’s 25 Point Implementation Plan to Reform Information Technology Management
Believe it or not, enterprise software systems are similar. Using PaaS, it’s possible to order a prefabricated software architecture over the internet as a cloud service. Much of the integration is already done for you, saving months or years of engineering time. For example, the architecture may already support single user sign on, common search, records management, workflow, reporting and a multi-tenant architecture. If you’re asking the question, “What is a multi-tenant architecture?” … then exactly … that’s the point! Application multi-tenancy is highly complex when integrated with role-based security and reporting. You wouldn’t want to program it to every application. PaaS provides these features as shared services, so there’s no need to reinvent the wheel.
IV. Things to Consider

The term "platform" is plagued with market confusion and is often misused to refer to customizable software. Software that can be customized is simply that: customizable software. Some infrastructure vendors promote their products inaccurately as PaaS. Amidst the confusion are many "cloudwashed" Web 2.0 and middleware products that have been rebranded for the PaaS space. Traditional platform technologies have existed for years, and are long-associated with Web 2.0 projects.

PaaS comes in many shapes and sizes:

- **Google®** is currently dominating the consumer application platform with its Apps Engine.
- **Salesforce.com®** is emerging as a major player in the enterprise application platform space.
- **SaaS Maker™** provides integrated development tools, shared services and open interfaces.
- **Amazon's Elastic Beanstalk** provides sandbox capabilities on Amazon's infrastructure.
- **Heroku™** provides automated scaling and application management services.
- **Azure™** provides enterprise infrastructure and database services by way of APIs.

As cloud adoption increases, enterprise companies appear to be struggling for new identities. Oracle and other enterprise vendors appear to be rebranding traditional middleware offerings as PaaS. Similarly, many large system integration firms are still defending the old way of building software. History has demonstrated that companies must successfully transition to new platform models to survive. It's important to understand that cloud computing (including PaaS) is a highly disruptive technology—in the same way that cell phones disrupted the land line business or light bulbs disrupted gas lighting. It represents a true transformational shakeup of the IT industry, in which new leaders will emerge and former leaders will fall by the wayside. Remember DEC? Remember Wang?

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This is a time to value innovation.

Of the types of platforms that are offered as a service, enterprise business platforms may provide the greatest value to government, simply because enterprise business systems are extremely expensive—sometimes costing millions of dollars to engineer.

Here are a few questions to consider:

1. **Is it delivered as a cloud service?** By definition, PaaS delivers its platform as a cloud service and allows software to be published as a service. If it does not do both then it's not a true PaaS!
2. **Is it portable?** Can you run your applications on multiple cloud infrastructures?
3. **Does the PaaS do what you need it to do?** For example: does it support features for forms, reports and workflow? Does it support role-based access control? Does it allow apps to be published as a cloud service?
4. **Is it an open platform?** Are you overly reliant on a single software vendor, computer language, database or other technology for your PaaS-enabled applications?
Why Are Open Platforms So Important?

Open platforms allow multiple vendors to build on the platform using a variety of vendor-independent languages and technologies, and in doing so, open platforms lower the long-term costs of ownership, mitigate vendor lock in and increase solution choices.

IT buyers have an opportunity to learn from history. During the 1980s, the Department of Health and Human Services ran its personnel and payroll systems on Wang computers. If HHS needed computing services, the agency needed to buy it from Wang at whatever price—or else invest into migrating to more open Unix® platforms, which HHS eventually did over the course of a decade at great expense. We don’t want to repeat history as we move into the cloud. This is an ideal time to explore open platforms.

That’s why open platforms are important as the cloud unfolds. The term “open” has many meanings. The reality is that platforms usually have levels of openness—rather than an all-or-nothing openness. For example, Windows was much more open than Wang, because any vendor could develop on Windows. With Windows, we could buy software from thousands of vendors instead of being restricted to a single vendor. The Windows platform also supported multiple hardware (infrastructure) providers. A “more open” platform may actually make its APIs available as proposed standards so other platform vendors can adopt and implement them. In such cases, the software can run on any platform that supports the open standard interfaces. The authors of this paper anticipate that PaaS will similarly evolve with levels of openness. In some cases, PaaS may appear open, but will require a proprietary data center commitment. Developers should consider the possibility of porting their apps or data to a future platform, but not resort to ground-up stovepipes to do so. Instead it is important to consider levels of openness when choosing a platform.
V. PaaS as Operating Systems for Data Centers

Modern PaaS offerings are evolving into operating systems for cloud-enabled data centers. Similar to desktop operating systems, PaaS shields users from underlying complexities of the infrastructure, provides central administration and runs software applications. PaaS supports development tools and APIs for integrating on top of the platform.

It’s critical to understand that the cloud is a low-level computing platform that needs an operating system—just like its desktop predecessor. The need is growing as the cloud increases in its complexity with web services scattered across the Internet.

Dan Tapscott, author of *Wikinomics*, talks about the growing software complexity problem this way: “The Web look[s] increasingly like a traditional librarian’s nightmare—a noisy library full of chatty components that interact and communicate with one another.” Mr. Tapscott is referring to the cloud as a cluttered hodgepodge of web apps and services—each with their own logins, data sources and security/resource functions. In the absence of cloud platforms, we are recreating the wheel millions of times over. In a few years, the redundancies will drive up costs by billions within federal IT systems, health IT systems and other enterprise IT systems that rely on cloud services. All these IT systems will struggle with disparate security models and interoperability concerns.

As with desktop operating systems, PaaS provides a common user interface, common security model and core functionality (e.g., workflow, reporting), and manages resources, while shielding users from underlying complexities.
VI. Frequently Asked Questions

This section is dedicated to common questions about PaaS.

1. Should I build ground up to avoid a platform?

Absolutely not!

If there’s one thing that IT history has taught, it’s that ground-up stovepipes are the most costly forms of proprietary systems in existence. These “one offs” usually result in schedule and budget overruns and long-term dependencies on a single vendor. That is why stovepipes so often fail. These mega-million-dollar stovepipes continue to cost the federal government billions of dollars each year with their overreliance on a handful of large system integration firms.

On the other hand, developers can instantly leverage a PaaS to save years of development time and cost. In doing so, they are taking advantage of reusable technology and services that are shared between other organizations with similar challenges.

It is important however that IT buyers avoid platforms that implement proprietary programming languages or specific infrastructures to avoid long-term over-dependencies. We use the term “over-dependencies” to emphasize that dependencies are not necessarily bad; otherwise we would rarely leverage commercial software.

IT buyers can save years and millions on large-scale projects by leveraging platforms with open APIs and portability across data centers.

2. How is PaaS different from application frameworks?

Application frameworks (e.g., Ruby on Rails or .Net) are not inherently offered as a service. Some software companies are making frameworks available as part of bundled hosting plan. The approach more closely resembles glorified hosting because it falls short of supporting NIST's essential characteristics of cloud computing.

3. Is PaaS only relevant to new software projects?

No. You may be able to finish an underway project faster by switching to PaaS. The easiest way to start is to try a small prototype using a fraction of the larger budget. PaaS is an outstanding way to turn around failing software development projects.
VII. Trends

In a couple years, PaaS will become mainstream, just as platforms have played central roles in prior computing models. Forward-thinking CIOs are already looking toward platforms as a part of their migration strategies to do more with less as their budgets shrink. The U.S CIO’s 25 Point Implementation Plan to Reform Information Technology Management is a sign of growing trends toward platforms. The report describes “shared services” as a solution for the type of out-of-control IT project that is “outdated on the day it starts.” These same sentiments are reinforced by the U.S. CIO’s suggestion of a “shared-first” initiative and similar federal initiatives.

- **Open Platforms.** First, we will see trends toward open platforms. If we look back at the history of computing, we are reminded of the importance of openness versus the high cost of proprietary platforms. In a perfect world, we would see open standards established long before platforms are developed. However, such idealism is unrealistic in such a young market. The NIST Cloud Computing Reference Architecture was based on a guiding principle to “develop a solution that does not stifle innovation by defining a prescribed technical solution. This solution will create a level playing field for industry to discuss and compare their cloud offerings with the U.S. government.”

- **Software Shakeout.** We will see new software vendors emerge amidst innovation, while many large companies struggle for new identities. In the shakeout, there will be winners and losers. Some of today’s enterprise software leaders will remain sternly committed to the attractive revenue streams from their legacy technologies. Meanwhile, new leaders, such as Salesforce®, will emerge as major players in the enterprise platform market. The same will be true for large software integration firms that are major beneficiaries of stovepipe development and integration projects. Agile and lean “cloud development” companies will emerge and displace many of the federal projects that have so visibly failed in years past.

- **Changes in Project Awards.** We will see changes in the way projects are awarded. PaaS makes it uniquely possible for contracting officers to try a rapid prototype, rather than blindly vetting a technology for two years before making a long-term commitment. The shift toward cloud will be fully realized when contracting officers realize the opportunity to buy differently.

- **Special Purpose Platforms.** We will see several special purpose platforms, rather than the emergence of a single de facto platform as was the case with the Microsoft Windows® phenomenon. The reason for this is that the IT landscape is dramatically different than it was for desktop computing 30 years ago. An unprecedented number of software developers and applications for software exists across many industries. We will see special purpose PaaS offerings emerge for healthcare, manufacturing, financial management, federal systems and many other domains.

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11 U.S. CIO’s 25 Point Implementation Plan to Reform Federal Information Technology Management

12 NIST Cloud Computing Reference Architecture, NIST SP 500-292
The Next Big Trend in PaaS ... Portability

Many vendors are tightly coupling their PaaS offerings with their own infrastructures.

One of the most important trends in platforms is toward openness and portability. IT buyers should ensure that their PaaS solution is portable across data centers to avoid long-term lock in to a single infrastructure provider. In the absence of this understanding, some government agencies are making casual, long-term commitments to vendors that may span 20 years. The authors of this paper have compared it to buying a pack of gum with a requirement to rent the store.

Various interpretations of PaaS have led to a broad misconception that a cloud PaaS provider will also always provide the underlying IaaS resources. This misconception arises from the common commercial practice of bundling PaaS offerings with an underlying proprietary IaaS platform. Force.com®, Azure™ and AppEngine exemplify this practice.

The NIST U.S. Government Cloud Computing Technology Roadmap, Release 1.0 (Draft) includes the following language to further describe Platform as a Service:

“For PaaS, the cloud provider manages the computing infrastructure for the platform and runs the cloud software that provides the components of the platform, such as runtime software execution stack, databases, and other middleware components. The PaaS cloud provider typically also supports the development, deployment, and management process of the PaaS cloud consumer by providing tools such as integrated development environments (IDEs), development versions of cloud software, software development kits (SDKs), and deployment and management tools. The PaaS cloud consumer has control over the applications and possibly over some of the hosting environment settings, but has no or limited access to the infrastructure underlying the platform such as network, servers, operating systems (OSs) or storage.”

It is important to highlight that while the PaaS cloud provider “manages the computing infrastructure for the platform,” there is no requirement to actually provide the computing infrastructure. To emphasize this point, consider the separation of personal computer hardware vendors and operating system providers. PaaS will evolve in similar ways as former computing models, which have clearly proven the significance of portability.

These are not new concepts. Today’s Microsoft Windows® and Linux operating systems thankfully run on hardware from any number of vendors. This allows federal buyers to invest into large software systems that will run across hardware from a variety of vendors.

The same will (and must) be true of next generation platforms on the cloud.

13 NIST U.S. Government Cloud Computing Technology Roadmap, Release 1.0 (Draft)
About the Authors

Kevin Jackson is General Manager, Cloud Services, at NJVC®. Before joining the company, Mr. Jackson served in various senior management positions with Dataline, LLC; Cryptek™, Inc.; IBM®; and JPMorgan & Chase. Recently, he was named a “Cyber Security Visionary” by U.S. Black Engineer and Information Technology magazine. Mr. Jackson is the founder and author of “Cloud Musings” (http://kevinjackson.blogspot.com) and “Cloud Musings on Forbes” (http://blogs.forbes.com/kevinjackson), a Forbes magazine online blog dedicated to public sector cloud computing. He is also founder and editor of “Government Cloud Computing on Ulitzer” electronic magazine (http://govcloud.ulitzer.com). His first book, GovCloud: Cloud Computing for the Business of Government was released in spring 2011. Mr. Jackson has been deeply involved in the broad collaborative effort between industry and the U.S. National Institute of Standards and Technology on the federal government’s adoption of cloud computing technologies. He is the Network Centric Operations Industry Consortium’s Cloud Computing Working Group Chairman.

Cary Landis has more than 20 years experience building and deploying large-scale federal software systems. He currently owns and operates Virtual Global, Inc., where he serves as lead architect for the SaaS Maker™ enterprise cloud platform and TeamLeader™ SaaS for managing virtual teams. He served on the NIST working group to create its Reference Architecture for Cloud Computing, and led a NIST team to clarify the three service models (SaaS, PaaS and IaaS). Mr. Landis currently serves on the new Federal Enterprise Architecture Framework Working Group to create an Application Reference Model, and coauthored “Cloud Computing Made Easy” at cloudipedia.com. He also co-founded KeyLogic Systems. Mr. Landis is a member of the GovCloud™ team, and works closely with NJVC as a platform architect for GovPaaS™, a high-security PaaS for building and deploying federal information systems.

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