This is the first in a series of whitepapers on platforms and cloud computing. The series has been created by the Cloud Foundry Foundation community, and is intended to provide clarity on the current market, trends, and the role that platforms play in cloud computing.

This first installment seeks to provide a lay of the land for readers interested in the usage and benefits of a platform, as well as what solutions are available today. In the second paper, we will dive deeper into specific use cases for each available platform and provide a series of questions for potential users looking to decide among the products available. Finally, in the last segment, we will provide a detailed overview of how to get started with Cloud Foundry for those who have chosen to employ it as their platform.

1 A Note on Platforms: For the purposes of this white paper series, the definition of a “platform” refers to both structured (PaaS) and unstructured (CaaS) platforms. The word “platform” is not meant to be used interchangeably with the term “PaaS” but instead refers to a deployment tool that developers or application owners can use to deploy and manage software. When referring specifically to a Platform-as-a-Service, we will use the abbreviation “PaaS” - in all other instances, “platform” will comprise a broad definition.
Not too long ago, a company was merely the products it sold. Today, every major enterprise is a software company. Digital transformation is precipitating revolutionary growth within the enterprise to meet customer demand for fast, seamless UI. As companies hustle to meet customer expectations, their engineering teams are under a new kind of pressure that requires agility, flexibility and velocity. Developers hold the power to effect change within their organization, but they need the right tools to achieve true transformation through cloud-native architecture.

Cloud computing has emerged from three service perspectives – software, platform, and infrastructure – over the past few years:

**Software-as-a-Service (SaaS)** delivers entire functioning applications through the Internet. Salesforce is an example of a SaaS provider.

**Infrastructure-as-a-Service (IaaS)** is at the other end of the spectrum, providing the underlying resources – compute, storage and networking – to individuals and organizations who purchase service “instances” of varying sizes. Amazon Web Services, Microsoft Azure and Google Compute Platform are all examples of IaaS providers.

**Platform-as-a-Service (PaaS)** lies in the middle of SaaS and IaaS, and is the subject of this whitepaper series. The complexity of managing enterprise infrastructure requires middleware to provide many of the services necessary to deploy and manage applications within the infrastructure stack. Automated provisioning is steadily increasing in importance in the world of PaaS, and has led to the vital incorporation of Continuous Integration and Continuous Delivery (CI/CD).
The reality is there are more components to the cloud computing stack. There are myriad services that fit into this grey area, including many analyst-defined terms that end in “as-a-Service.” There has been a particular rise in interest most recently around an additional service:

**Containers-as-a-Service (CaaS)** is a service offering that focuses on managing container-based workloads. A CaaS offers a framework for deploying and managing application and container clusters by delivering container engines, orchestration, and the underlying resources to users.

Virtually every Global 2000 enterprise is now migrating some services to the cloud. A key question becomes how much of their core operations will be migrated, and when.

Companies may choose to stage their email on Google mail, for example, and consider that part of a migration to the cloud. Companies using Salesforce and/or collaborative applications such as Slack, WhatsApp, or Telegram may also tout their commitment to the cloud and tell the story of their “digital transformation journey.”

Many large enterprises also have their development teams firing up third-party cloud instances, creating Proofs of Concept (PoCs) and Minimum Viable Products (MVPs) on laptops.

But how many enterprises are deploying their core applications and services in the cloud? Research by a leading industry event, Cloud Expo, indicates that 10 to 15 percent of core enterprise workloads in North America are now deployed by a PaaS onto cloud-computing infrastructure.² What advantages can platforms offer to convince enterprise IT decision makers to move ever-increasing amounts of that workload to the cloud?

Confusion may be an impediment to cloud and platform adoption for many enterprise IT decision makers. There are many platform offerings on the market with unique histories, approaches, and capabilities. Certain platforms may also complement one another in various ways, complicating the picture as potential users search for that perfect fit.

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² This is proprietary research shared with the conference chair of the event, who is a member of the Cloud Foundry community, and which has not been made public.
PaaS and Virtualization

A key to the emergence of cloud computing, and the platforms that deploy it, is the concept of virtualization, in which discrete computing resources are separated (or “abstracted”) from their original hardware and pooled into a “virtual” pool of resources. This makes it much easier for cloud providers to use software to automate the provisioning and configuration of systems, which traditionally required hardware level configuration.

The original idea of virtualizing an enterprise’s IT resources or buying those resources from a public cloud provider continues to evolve, as concepts such as containers, microservices, serverless, and several types of resource management software begin to paint a more complex and nuanced canvas.

Enterprises also struggle with the short-term dilemma of innovating on the latest cloud technology while remaining dependent on legacy technology for the bulk of their operations—all while trying to take a long-term view of a complete migration to the cloud.
The Open Source Question

One significant question about any platform is whether it is available as an open source version. Open source proponents believe this approach is the only way to go, as it allows enterprises to customize the software and avoid vendor lock-in.

One example of an open source project is the Cloud Foundry Application Runtime, which can be used to deliver a PaaS experience by cloud providers and internal enterprise teams. Cloud Foundry Application Runtime is available for end users directly as open source software, or via several commercial distributions, including Certified Platforms Atos Cloud Foundry, Fujitsu K5, Huawei FusionStage, IBM BlueMix Cloud Foundry, Pivotal Cloud Foundry, SAP Cloud Platform and Swisscom Application Cloud. All certified offerings use the same core Cloud Foundry Application Runtime software, and ensure application and skill portability across providers. End users have different reasons for choosing one of these proprietary versions of Cloud Foundry Application Runtime over another, instead of the open source version, as each Certified Platform offers a slightly varied package of benefits.

Like all open source projects, the open source nature of Cloud Foundry means if you see an issue, you can contribute to the fix. Industry’s best minds collaborate to guarantee that end users can continue to do what they do best: write code and ship apps. This is the primary benefit of choosing an open source platform, whether structured or unstructured.
Platforms - be they PaaS or CaaS - are delivered with varying degrees of included features and structure. Based on the applications, environment, and the preferred level of operational abstraction, enterprises can consider a combination of structured and unstructured platforms to deploy applications. These platforms are on a spectrum of composability and structure, varying from more structured to unstructured capabilities.

Structured platforms (e.g., Platform-as-a-Service offerings) offer a greater level of automation by abstracting operational processes away from application developers. As we move towards the unstructured end of this spectrum, there are offerings that address a specific function, rather than a broad set of features that the more structured platforms address. Unstructured platforms (for e.g., Containers-as-a-Service offerings) allow developer and app teams to own the app delivery workflow with in-house development or leveraging third party APIs for those capabilities. The choice of where to develop along this continuum of structure is often driven by the difficulty of migrating (or on-boarding) existing applications to a new platform, while maintaining a consistent experience for developers across all applications.

**STRUCTURED PLATFORMS**

- Abstract the operational processes of application deployment away from developers and app teams.
- Can be deployed across private and public clouds.
- Capabilities like service brokers, monitoring, scaling, etc. are integrated natively.

**Examples:**
Cloud Foundry Application Runtime, Red Hat OpenShift, Apprenda, etc.

**UNSTRUCTURED PLATFORMS**

- Provide control and autonomy for app teams and developers over app deployment workflow.
- Can be deployed across private and public clouds.
- Capabilities like service brokers, monitoring, scaling, etc. must be developed or delivered by additional services.

**Examples:**
Cloud Foundry Container Runtime, Kubernetes, Mesosphere, Docker, Tectonic, etc.
Apprenda focuses on developers at financial services companies and healthcare providers, which tend to prefer private over public cloud. Launched in 2007 with a focus on the Microsoft .NET framework, the platform now provides services to enable enterprises to deploy on private, public or hybrid clouds.

Cloud Foundry Application Runtime is an application-centric platform that focuses on simplifying the entire development lifecycle. The container module (Diego) and BOSH simplify large, distributed application deployments to private, public, and hybrid clouds. Commercial offerings include Atos Cloud Foundry, Fujitsu Cloud Service K5, Huawei FusionStage, IBM Cloud Platform, Pivotal Cloud Foundry, SAP Cloud Platform, and Swisscom Application Cloud.

Cloud Foundry Container Runtime offers a uniform way to instantiate, deploy, and manage highly available Kubernetes clusters on a cloud platform using BOSH. Commercial offerings include Pivotal Container Service (PKS).

Docker is a container platform that provides an abstraction and automation layer of OS-virtualization on Windows and Linux. Docker containers are used by the Red Hat OpenShift platform and can be integrated into the platform tools offered by Amazon, Google, and Microsoft.

Kubernetes is a containerized application management tool that was developed by Google and is now open source. While it can serve as a platform, it is also foundational to (in the case of OpenShift) or integrated with (in the case of Cloud Foundry) other platforms.

Mesosphere is the commercial distribution of Apache Mesos’ cluster management system and simplifies executing and managing applications in a datacenter. Datacenter operators and companies who need to host significant operations on private clouds are its prime customers.

Red Hat OpenShift is based on Docker container packaging and Kubernetes cluster management. Red Hat OpenShift is an open source container platform to manage large container clusters. Organizations can deploy and manage OpenShift on private, public or on-prem cloud environments.

Tectonic from CoreOS is a commercial distribution of Kubernetes packaged with the CoreOS Linux distribution. It is designed to run containers at scale in distributed environments, including public, private and hybrid.
In many cases, enterprises will find there is a use case for both structured and unstructured platforms in their development environment. Incorporating both PaaS (structured) and CaaS (unstructured) solutions into a deployment solution is the newest approach in a rapidly evolving landscape, and played a significant role in the recent announcement by Cloud Foundry Foundation to offer both options in the form of Cloud Foundry Application Runtime (PaaS) and Cloud Foundry Container Runtime (CaaS).

For a developer who needs to get from code to production as quickly as possible, you will benefit enormously using a PaaS. A structured PaaS facilitates more consistency in how you design, deploy and maintain applications and services, and enables operations teams to help manage resiliency and the scale of applications as development teams grow. It is a platform that can take care of containers for a developer.

Increasingly, when enterprises need more flexibility and developer-built containers for applications, or are using pre-packaged applications delivered in a container, they are choosing an unstructured CaaS. And of course, there are use cases where enterprises benefit from both - e.g., app teams that use a database built to run on Kubernetes used by custom applications deployed to Cloud Foundry Application Runtime (CFAR) can deploy apps quickly with both CFAR and Cloud Foundry Container Runtime.
The cloud space is increasingly complicated, with evolving needs driving more and more innovation. As developers run across new circumstances in their work, they create new solutions to streamline their processes. Platforms by definition continue to proliferate and take new shapes, whether structured or unstructured. Of course this means that choosing a platform is not a simple task. As more organizations offer both structured and unstructured solutions, especially in conjunction with one another, it is becoming ever easier for enterprises to choose the right tool for the right job.

RECOMMENDED READING
Be sure to read the other two white papers in this series:
• “Right Tool, Right Job,” which discusses which platforms are best suited to specific use cases
• “Move Fast and Make Things,” which concentrates on the unique benefits of Cloud Foundry