Cloud Computing, IaaS and PaaS

Cloud Computing Defined

"There's no such thing as cloud computing, it's just somebody else's computer."

-Anonymous

While a bit trite, this statement is, technically, accurate. Cloud computing has become a pervasive technological evolution for building at-scale, distributed applications. Gone are the days when your only option for development and deployment involved significant effort to design, implement, and deploy distributed applications. Oftentimes, the physical realization of an n-tier system mirrored its logical tiers; a machine dedicated to the database, another for the application service logic, and a third tier consisting of the client computers used for rendering the presentation services. Deploying, managing, and scaling this type of architecture proved unmanageable for many and, as a result, other models of distributed computing were sought. The period from 2006 to the present saw unprecedented innovation in the development of services that helped alleviate the problems inherent in traditional system deployments. In 2006, Amazon began to offer server-based hosting for large-scale distributed systems. Microsoft soon followed suit and what we ubiquitously refer to as the "cloud" was born and still thrives.

If you're reading this, I'm assuming that you have some questions about what it all means and would like a simple explanation of what the "cloud" really is. As mentioned earlier, the cloud is really just someone else's computer. That definition serves as useful only at the highest levels of abstraction. We need a better way to conceptualize something as ephemeral as a cloud and that is the precise goal of this document.

When viewed at a logical level, distributed application architectures are built from a variety of services offered by cloud providers such as Amazon, Microsoft, and Google. Fundamentally, a cloud application is simply middleware hosted on computers located within the provider's datacenters accessible through the Internet. Each cloud provider offers a broad range of platform and infrastructure services to satisfy each solution's unique requirements; it's the composition of these services that define a cloud architecture.

Generally speaking, there are 2 models of cloud computing most closely associated with the development of a distributed system:

- **IaaS** - Infrastructure as a Service
- **PaaS** - Platform as a Service

Each model prescribes a clear separation of concerns with respect to the responsibilities for application and infrastructure deployment and maintenance.

The distinction between the models is, largely, characterized by the degree to which a cloud-hosted service is managed by the cloud provider. All cloud architectures are different and usually require the consumption of both IaaS and PaaS services. Hybrid applications are also possible whereby an organization can host its own services as well as include a cloud provider's IaaS and PaaS services.

IaaS Model

IaaS is a managed compute service that offers an organization complete control of the operating system (OS) and the platform stack upon which applications are built and deployed. The unit of deployment in IaaS is a virtual machine (VM). A synchronized DevOps process deploys a package of virtual machines, applications, and data to the IaaS compute infrastructure. Even though developers have complete control of the software stack at the design time, the influence of IaaS-provided storage, virtual networking, and managed services are still an important consideration. Even though IaaS gives developers design time portability, how the application takes advantage of provider-managed services has an impact on the solution's overall portability to other cloud service providers.

In IaaS, the cloud computing provider assumes responsibilities for deployment and management of the following list of infrastructure concerns.

- Virtualization (Hypervisors)
- Servers
- Storage
- Networking

The following figure illustrates the management boundary between the organization and the cloud provider.

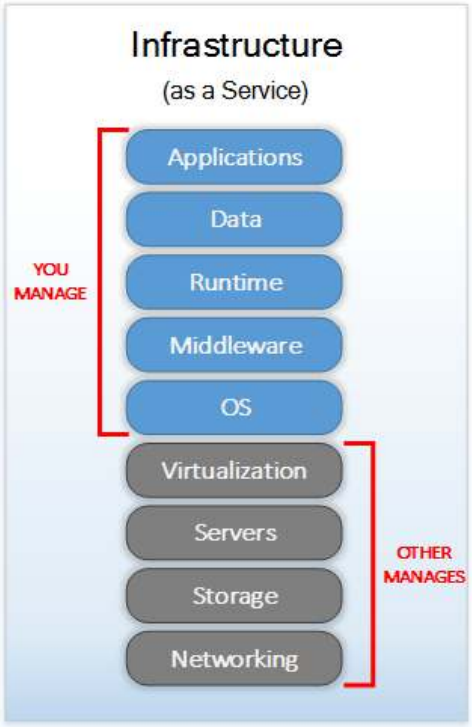

Figure 1 - IaaS Responsibilities

IaaS Benefits

Accelerated Cloud Transition

Due to the productivity enabled by IaaS, startups and growth-stage companies can now easily start offering cloud hosted services to their customers with minimal effort. A low total cost of ownership is achieved by delegating hardware and operating system updates of the virtual machines to the IaaS provider. As a result, new sources of revenue can be realized by offering managed services made available with SaaS hosted with IaaS. The quick time-to-market aspects of IaaS coupled with readily available IaaS expertise of Independent Software Vendors (ISV) allows companies to leapfrog competitors in their respective domains through the rapid adoption of disruptive Internet technologies.

Mature ISV Ecosystem

Mature ISV ecosystems currently offer a variety of solution-based and operational components that are popular in on premise (i.e. customer-hosted) web applications. As a general rule, all application features and components of an on premise web application are compatible for running on IaaS. From the operations perspective, leveraging 3rd-party components for integrating with the enterprise helpdesk, trouble ticket systems and management and monitoring infrastructure is trivial relative to PaaS.

High Degree of Control

Applications that require complete control (e.g. Disaster Recovery services that need to clone the drive by capturing disk I/O at the driver level, software licensing service based on the virtual network address) can be built on IaaS. The developers and IT professionals have access to the complete application platform stack, user mode subsystems, and OS kernel so that the VM can be customized to the needs of the business domains they serve. Some business domains, like telecom and financial services, require security hardened OS distributions that can only be satisfied by IaaS.

Solution Portability

IaaS allows excellent design-time portability of the application assets as the granularity of the deployment is a virtual hard disk (VHD) containing both OS and the deployed application. Application owners can easily migrate their Windows as well as Linux application and system code to a cloud provider with minimal effort. This assumes that all the system dependencies including database servers and other 3rd-party dependencies are also portable along with the application. ISVs strive to maximize the value of their investment by reusing the existing software assets in the cloud, and IaaS is a perfect vehicle for accomplishing that.

PaaS Model

PaaS is a "self-service" compute service that is concerned with provisioning computing resources in terms of processor, memory, and volatile disk storage through resource descriptors provided at deployment time. The unit of deployment in PaaS is an application manifest and its associated data. PaaS is characterized by stateful or stateless compute nodes that consume a set of managed application services to accelerate delivery to the organization's consumer audience.

Automated server maintenance and auto-scaling of compute resources to meet variable resource demands are two significant features offered by PaaS and can lower the operating cost of operations with PaaS, as compared to IaaS. Commodity services (like content management, collaboration, storage and other horizontal services) tend to have a lot of competition both from open source as well as the proprietary providers; the resulting price competition of these commoditized services and their inclusion in PaaS also makes PaaS a suitable and cost-effective hosting platform.

In PaaS, the organization assumes responsibilities for deployment and management of the following list of platform services.

- Application Code
- Application Data

The following figure illustrates the management boundary between the organization and the cloud provider.

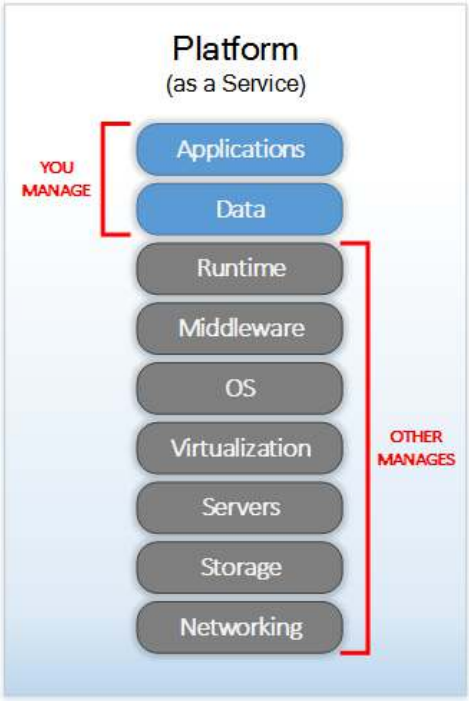

Figure 2 - PaaS Responsibilities

PaaS Benefits

Accelerated Innovation

Cloud providers test the latest OS and application platforms and make them available for developers to use in their applications. Developers will be able to move to new releases easily and build innovative solutions to meet the market demands. With IaaS, applications tend to possess an affinity to the underlying platform due to the tight coupling resulting from the complete control developers have on the OS and application platform stack. Migrating to newer versions of the infrastructure is much harder in IaaS and results in applications becoming inextricably bound to legacy platforms. This lack of agility stifles innovation.

Improved Development Operations

PaaS is characterized by the application's use of software service interfaces accessible through a variety of standard protocols and fine-grained interaction with application-specific deployment artifacts. These service interfaces are developer-friendly for simplified application deployment. Developers are no longer needed to work at technical levels requiring deep understanding of the OS and the networking infrastructure. OS patch management and upgrades are no longer needed when operating PaaS hosted applications.

Adding a new network interface, public or private, is merely an administrative task; application developers no longer need to be aware of the VM's network adapters, IP address bindings, and port number exceptions in the server firewall or to set up routing tables. PaaS makes all of this trivial by allowing a developer to add network endpoints with public and private port mapping through intuitive commands or UI. Developers can also specify system diagnostics like performance monitor counters and application specific events from within the deployment descriptor without ever knowing the arcane configuration aspects of the operating system. Essentially, developers work with the applications and data with which they are familiar.

Risk Mitigation

Maintaining physical or virtual servers in IaaS hosted applications is laborious as it involves downloading OS patches, testing them on a representative sample of servers, verifying application compatibility, distribution of patches, and performing rolling upgrades so as to not to impact the availability of mission critical applications that have the potential to impact customer access and loss of revenue. In spite of the advances in automation, IaaS still requires significant effort on the part of an organization's DevOps team to keep the infrastructure healthy. In PaaS, cloud providers assume responsibility for the infrastructure health by keeping the infrastructure updated against all the known vulnerabilities for which fixes have been distributed. Since this process is automated and opaque to developers, the risk of information breach resulting from the known vulnerabilities is significantly reduced.

Examples of Traditional PaaS Services

- Container and Process Orchestration
- Event Streaming
- Analytics & Machine Learning
- Database
- Hadoop
- Web Application Hosting
- Message Queueing
- Distributed Storage Technologies

Summary

PaaS and IaaS are part of a larger cloud ecosystem where managed services add significant value to the deployment in terms of the accelerated solution development. While these two cloud models have their respective benefits as outlined in this document, PaaS and IaaS are just a part of the overall application run time compute environment. PaaS has an economic advantage over IaaS for applications where the operational cost of maintaining commodity application services is high. On the other hand, IaaS offers complete control of the OS and application platform stack which is a requirement for certain classes of applications.

In essence, risk management, agility, cost, and the composition of the application are the key drivers to consider before investing in either architectural model. Only after performing an analysis of the application's requirements should a decision to invest in IaaS and PaaS be made. Typically, both IaaS and PaaS services are used in combination and the business and technology justification emerges organically. In most cases, the organization and deployment model is a reflection of an application's business requirements and is not prescriptive based on the technical differences between PaaS and IaaS.

If you have questions about the cloud and how your next application could benefit, please reach out to The RND Group. Our cloud computing team has a reputation for providing right-sized solutions to the most complex challenges with which your business is faced.

Sources:

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