



CLOUD COMPUTING : RETHINKING THE PLATFORM AS A SERVICE IN CURRENT ERA

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Abstract

Cloud computing and its different models like IaaS (Infrastructure as a Service), SaaS (Software as a service), and PaaS (Platform as a service) are well established new generation technologies. Many small businesses as well as individuals are using these cloud models to solve their problems. PaaS is especially popular among Cloud Service Providers as well as cloud-users due to its various aspects. This paper explains PaaS in the current era of AI & Automation. The paper discusses PaaS in the current era of AI & Automation. AI & Automation created two versions of PaaS: MLOPs, & DevOps. This Paper looks briefly into these two extensions of PaaS.

The paper presents the explanation about: What we mean by platform? How platform can be offered as a service? What are the requirements and issues of PaaS? What is architectural difference between PaaS and other cloud computing models? What are the implementation challenges for PaaS? And, finally how PaaS is more sensible in the current era of AI & Automation as MLOPs and DevOps. These questions need to be answered for better understanding of PaaS. In this paper we tried our best to answer these and related questions about PaaS by carrying a comprehensive research of PaaS.

Keywords: Cloud Computing, PaaS, IaaS, SaaS, automation, AiaaS, AI, DevOps

I. Introduction

Cloud computing is now established technology and needs to be analyzed to get modified with current era. The re- searchers should go beyond the NIST definition of Cloud Computing by studying its past, present, and future [1] and should introduce AI and automation component to PaaS [2]. NIST [3] defined cloud computing as "A Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and customers and can be ubiquitously accessed from any connected devices over the internet." Technically the term cloud computing is misleading and meaningless [4]. Scientists used to show Internet or very large network using symbol of cloud, and so computing heavily involving Internet or very large network is called as cloud computing.

There are three basic models of cloud computing IaaS (Infrastructure as a Service), SaaS (Software as a service), and PaaS. The layer stack for these can be shown as in figure 1 depicting similarities and differences in these basic cloud computing models [4], [5], [6], [7], [8]. The reason for PaaS becoming so popular was the various business models offered by it [9]. PaaS is used for producing, consuming, and distributing software in an innovative, effective way through collaboration and parallel development, DevOps is the example of advanced PaaS [10]. The recent development in PaaS is offering AI enabled PaaS often called as AIaaS (AI as a Service); it offers AI enabled development

platforms as a service to end user.[2].

PaaS liberates user from unnecessary buying and maintenance of costly Infrastructure as well as Platforms(Refer figure1). User only needs to concentrate on data and application(s)required to process user-data. This liberation from capital investment and technical complexity helps automatically in development of more innovative use of system by user. Cloud simply transfers the complexity from user to cloud provider, where dedicated technical experts handle everything for the user(s)[11]. Advanced version of PaaS like DevOps, AIaaS, are adding an extra edge in software/applications development[2].

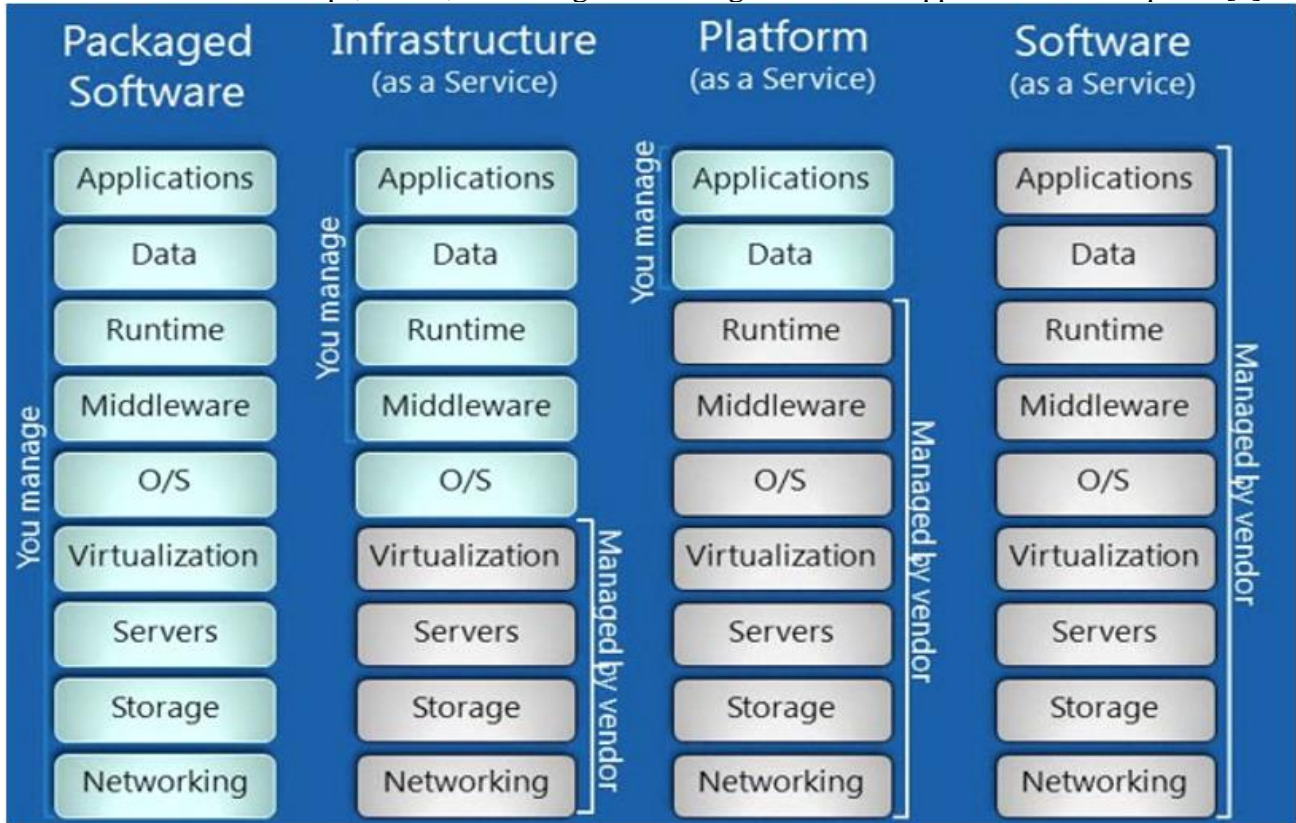


Figure 1: Layered Stack of Cloud computing Models

II. Platform as a Service

There is no clear definition available for platform from software industry. Platform can be seen as any operating system or middleware or Integrated Development Environment(IDE) using which or on which a developer can develops and deploy an application(s). In simple term anything which is reprogrammable, customizable by an outside entity, say programmer or developer, and/or act as intermediary tool(s) as well as resource(s) can be seen as platform.[12] On the other hand applications are not customizable or reprogrammable by any outside entity. Applications can only be used in a sense its originator intended; only for a particular task in a particular way.[13], [14]

When such platform(s) is(are) provided as ‘on demand service’ we can say it as PaaS. So, instead of buying the full fledged platform and then maintaining it for life time for developing one or more application(s); many companies(users) simply uses PaaS. Here, all desired Platform(s) are maintained by a third party, PaaS-Provider(PSP), who simply charges per usage of it to users. Type of application that can be developed using PaaS depends upon the Infrastructure’s capability on which PaaS is running.

PaaS frees users from unnecessary investment of capital in buying bulky platform(s) and maintaining it. Due to affordability of the PaaS, many small time users (Users who requires platform for hardly one or two application development and won’t have enough capital to buy and maintain it.)usually chooses PaaS instead of piracy. Thus indirectly PaaS minimizes piracy of software[15]. An abstract working

model of PaaS is as shown in figure2.

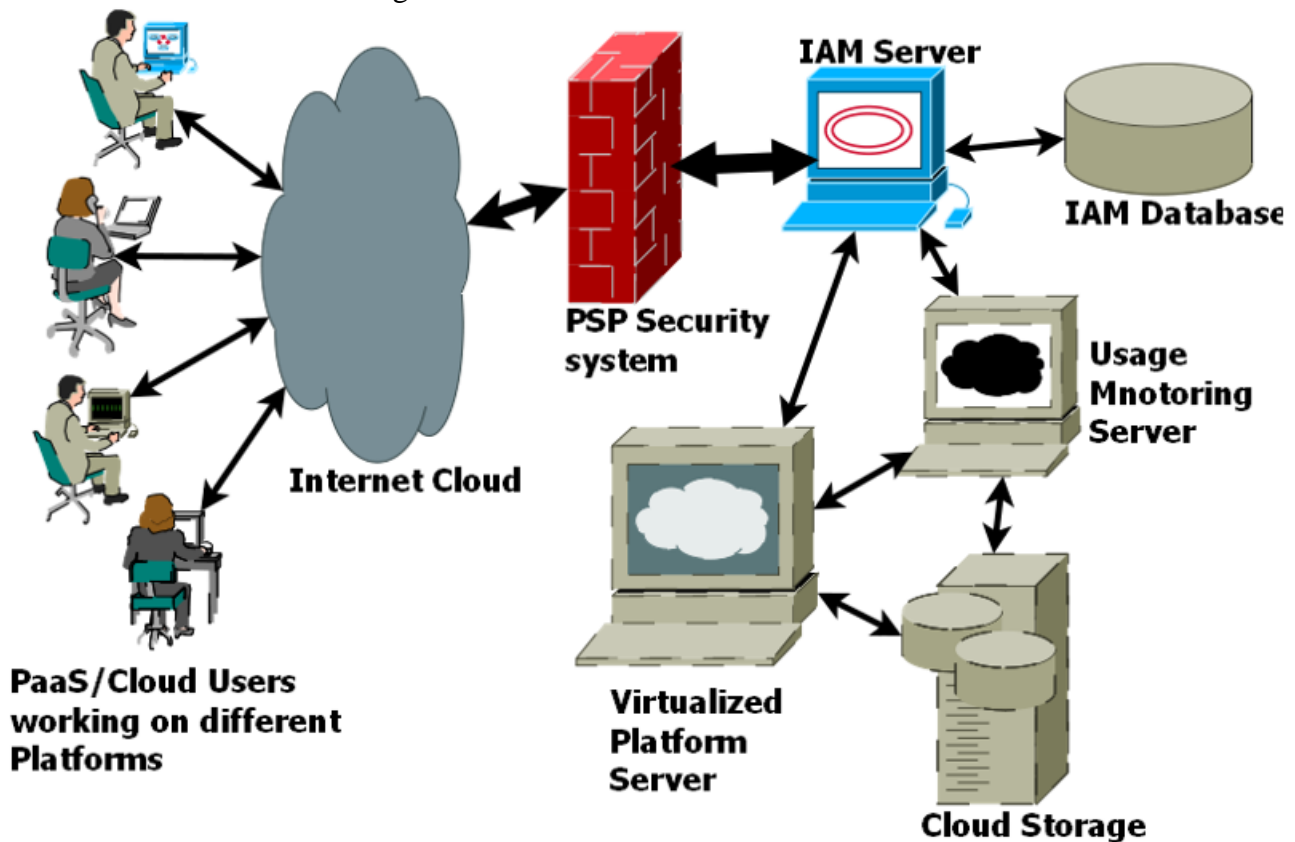


Figure 2: An abstract working model of PaaS

The model resembles client- server system. Difference lies in execution, instead of some predesigned service(s), an entire platform(s) is(are) offered as service(s) by PSP to the user. An usage monitoring system keeps track of the usage for billing. The storage security system keeps track of data-storage rules and security of data if user intend to save the data in cloud(PaaS) storage. IAM server governs Identification and Authentication management of the PaaS users.

Service Level agreements(SLA)[16], [17] in PaaS require to concentrate on availability, capacity, performance, band- widths, and data transfer thresholds. A good SLA promises QoS(Quality of Service) in PaaS and trust of user on PSP[18].

III. Requirements and Issues of PaaS

If Internet connectivity is available 24×7, then converting any existing machine in to CSP requires following. As PSP is nothing but the specific type of CSP; same requirements are applicable to it.

1. **Uninterrupted Power Supply** Regular UPS is very necessary to keep machine(s) continuously running as PSP.
2. **Alternate machine** An alternate machine with same configuration as backup is useful when original machine may fail. This assure QoS in PaaS.
3. **Air Cooling System** An air cooling system helps in tem- perature maintenance thereby saving PaaS-machineries from possible hazards that might happen due to heat generation because of continuous running of PaaS- machineries.
4. **Security system** Physical security of machinery from dust, fire, etc is essential. This can be achieved by introducing a good holding chamber with sufficient venti- lation, air cooling, fire & electricity resistant architectures and so on.

In similar way, logical security of digital informa- tion on machineries is also important. This can be achieved by deploying proper firewalls, Intrusion detec- tion systems(IDS), Anti-viruses and anti- malware appli- cations,apart from a good IAM. Data redundancy princi- ples required to be used



while storing data. And, a good data encryption system is necessary to make data virtually unreadable to anyone without encryption key.

5. **IAM** Identity and access management plays very important role in all network based computing. PSP needs to create an IAM which can guarantee no inadvertent access to its services. IAM also provides initial and finish points for billing to usage monitoring. It also opens up the desired platform to the user based upon his credentials.

IV. PaaS Architecture

PSP architecture or PaaS architecture in its simple form can be as given in Figure 3. It shows an abstract view of physical and logical requirements of PSP/PaaS. At physical level PSP needs an interconnected high capacity storage with a cluster of hardware. This is loaded with a microkernel system over which a logical databases and operating systems and servers are loaded. These operating systems, servers, and platforms can be accessed via virtualized system of Middlewares and Runtimes. Access to these is given through some secure channel to ensure trust among PaaS users. Apart from the computing hardware and storage; PSP needs a proper air cooling and UPS. Replication of hardware and systems loaded on hardware acts as emergency rescue to any failure in working system and this require continuous update of mirrored system. PaaS user is strictly kept unaware of internal working of PSP. PaaS user simply need to take care of its local applications and data. PaaS user can save the processed data either on local machine or on cloud-storage provided by PSP. Generally the local applications of PaaS user includes a minimal operating system with application to access Platforms and services offered by PSP.

V. Implementation Challenges for PaaS

From the points discussed in section III and IV, we can say that following are the some of the many challenges for Implementation of PaaS.

Cost Cost, or initial and running capital is the first issue with implementation of PaaS.

Security As system of PSP is exposed to open and untrusted Internet, implementing a security system to win users trust in PaaS is a challenge.

Compartmentalization Every users requirements are different, and so the PaaS accessing channel must behave according to each users requirement. Implementing proper rules for such access and accordingly allocating memory to each user and isolating each users information from others is a big challenge. Proper compartmentalization ensure that no user can access others users data if not explicitly stated by the user.

Mirroring Hardware as well as software, all need to be mirrored to provide 24×7 performance to end user. This increases cost of implementation as stated earlier. It also increase complexity of the system. Improper mirroring may leads to complete failure[12].

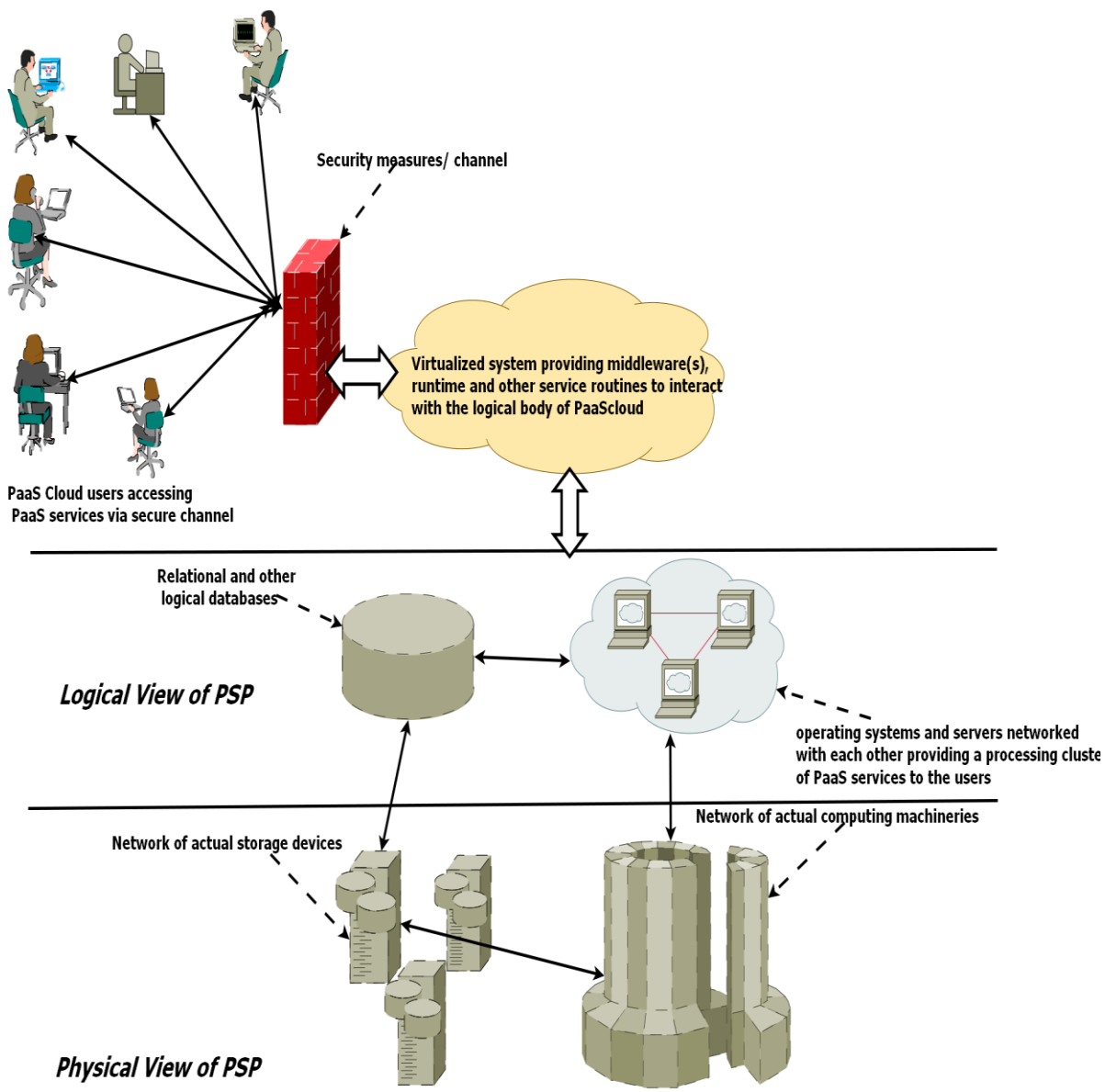


Figure 1: Abstract view of PaaS Architecture

Coping with Legal matters Users of PSP are generally from the different part of the world and can cause many legal problems to PSP. If Legal system of any country is not allowing operations of PSP in its province, then operations becomes criminal offence and PSP may face trouble. Handling this is the great challenge in acting as PSP.

Expertise Though Cloud computing frees users from all unnecessary headache of maintenance of hardware and software systems; it loads the Cloud provider with same. Getting expert human as well as system(non human) aid to handle these complexities at Cloud provider is a tedious job due to scarcity in resources available. Good technical experts are like diamonds; and Diamonds are costly business.

VI. Why it is popular

One reason of popularity of cloud computing and its three variants is the reduction of capital cost with reduction of unnecessary maintenance trace on the user of the system. Few reasons particularly applicable to PaaS popularity among its users are :

- No need to invest in buying costly platforms for development of some small time projects.



- Pay per use model.
- PaaS allows user to concentrate on real development and frees the user(s) from any supplementary work of system maintenance.
- Allows users to use costly platforms almost for no-cost. The charges for usage are negligible compare to cost involved in buying and maintaining those many platforms and hardware required for their running.

Few reasons particularly applicable to PaaS popularity among PSP are :

- Better utilization of the investment done in hardware and software in spare time(When these are not in use within organization).
- Rental income adds to extra financial stability.
- Reduces software/platform piracy to a great extent. Many Platform manufacturers are now a days started acting as PSP due to this reason.
- Increases overall profit margins of the organization acting as PSP.

VII. Existing PSP

Apart from industry majors like Microsoft, Amazon Web Services, Google, IBM, Oracle, etc. . . , there are many PSPs. Follows the list of some existing PSP gathered from google search. The given list in table I is neither comprehensive nor final.

Table 1: Some Existing PSP (PaaS Service Providers)

URL of PSP (PaaS Service Provider)	What is Provided by the PSP
http://www.cloudbees.com/	CloudBees makes life easier for application developers by providing an easy platform for developing applications - in the programming language you want to use (Scala, Play2, Java, Python, Javascript, Maven and more).
http://www.orangescape.com/	Want fast and easy app development? Look to OrangeScape. Its PaaS play enables developers to build out solutions quickly and easily using a model-driven visual development environment for business applications that can be deployed as SaaS or on-premise.
www.Openstack.org	OpenStack, an open-source cloud platform launched by Rackspace and NASA, has revolutionized the cloud computing game. Users and providers can leverage the platform to launch their own cloud services using code culled from a community of contributors
www.thinkgrid.com	ThinkGrid tackles pretty much every facet of the cloud, but it's its service oriented cloud platform that takes the cake. The platform gives partners and customers the keys to design, build and launch business services that solve specific problems while executing tasks like billing and managing in the same interface.
www.gridgain.com	GridGain's open-source cloud application platform helps developers build scalable applications that can work natively on managed infrastructure, from a Google Android device to large grids and clouds. The software supports major OSes and provides native support for Java and Scala.
salesforce.com	Force.com, Salesforce.com's Platform-as-a-Service arm, has set the standard for developing multitenant cloud applications. Through



URL of PSP (PaaS Service Provider)	What is Provided by the PSP
	Force.com, Salesforce opened up its in- frastructure so everyone can use it for custom app de- velopment and build business apps that run on Salesforce’s servers.

VIII. DevOps and AiaaS, the future of PaaS

Technology trend is shifting towards Artificial Intelligence and Automation. AutoML, MLOPs are already the integral part of SaaS. In the era of AI and Automation, PaaS got the new faces, DevOps or Development and Operations[10] and AIaaS[2]. DevOps is a collaboration between development and information technology operations to make software pro- duction and Deployment in an automated & repeatable way. PaaS is exactly the same, offering platforms for development of information technology operations, but with less or no automation. Rise of AutoML and AI enabled PaaS with automation and its become DevOps[10]

With the increase of number of users and advent in different technologies it is difficult to have everything on one machine. Collaboration, networking, and automation through PaaS is the only solution to carry out the developments and operations. The freelance developers with less capital but great skills will obviously thinking in terms of PaaS. PaaS is offering multi-sided business models equally to the individuals and industries[9].

Even companies like Microsoft, Amazon, Oracle, IBM, and other will obviously go for renting their technologies to minimize piracy. In fact cloud providers such as Amazon, Google, IBM, Microsoft, Salesforce, or SAP have started to offer machine learning, deep learning analytics through their PaaS, calling it as AI as a Service[2].similar to PaaS, AIaaS as cloud-based systems providing ‘on demand services’ to organizations and individuals to deploy, develop, train, and manage AI models or AI applications. Right now Azure ML Studio offers a suite of pre-built examples and startup codes for rapid AI application development through its PaaS or DevOps or AIaaS model. Most of the new AI enabled PaaS models are integrated with AI Suite comprising standard AI algorithms and models and provides tools that allow data scientists, data analysts, and AI developers to work together for development of applications[2].

So may be in near future all computing devices will come with preloaded minimal configuration as per the users require- ment and rest will be provided via cloud by using anyone of the three cloud architectural models, refer sectionI. And, PaaS, as many of us require many platforms once or a while is going to be dominant cloud computing model among many cloud users[1].

IX. Summary

In section I, Introduction, we tried to clarify the term cloud computing using NISTs definition of cloud computing. Figure 1 and explanation following it discussed the architectural differences among three cloud computing models and explained PaaS in brief.In section II,Platform as a Service, and in subsequent sections paper discussed the PaaS with its abstract working model and tried to answer the questions like: What we mean by platform? How platform can be offered as a service? What are the requirements and issues of PaaS? What is architectural difference between PaaS and other cloud computing models? What are the implementation challenges for PaaS? From the study of PaaS features and its advantages; we can say that PaaS has better future prospects. PaaS may become a dominant cloud computing model among users and vendors due to its very win-win type architecture. PaaS is going to dominate the application development through its DevOps and AIaaS variation.

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