

CLOUD COMPUTING: PLATFORM AS A SERVICE

Aaron Gomes
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EXECUTIVE SUMMARY

This report provides a definition of Platform as a Service (PaaS), the business value of PaaS, key PaaS providers and their offerings, and the control implications of using PaaS, including risks, ways to mitigate these risks, and control frameworks that may be adopted by PaaS users. This report also briefly describes some trends in the PaaS industry that could affect the future of IT and technology.

Research was done using various sources, such as cloud vendor websites, articles from some of the leading publications in business and technology, among other sources. Through this research it was found that PaaS is a service that allows developers to create applications on outsourced infrastructure owned by cloud vendors, using development tools, such as programming languages and API's provided or approved by cloud vendors. It was also found that utilizing PaaS could result in significant cost savings, and speed up the development and deployment of applications. There were key PaaS risks that were found, such as risks over security, connectivity and business continuity. Control frameworks such as the Software Development Lifecycle, Trust Services Framework and the Twelve-Factor Methodology were recommended as frameworks to control risks of using PaaS. Finally PaaS' implications on IT departments, computing power-independent software, and mobile app growth were analyzed.

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CLOUD COMPUTING: PLATFORM AS A SERVICE

INTRODUCTION

Platform as a Service (PaaS) is a rapidly growing and increasingly critical component to the cloud-computing ecosystem. More developers are taking advantage of the offerings of PaaS vendors than ever before, and it is becoming a critical investment for software developers in order to stay competitive¹. The following paper contains an analysis of PaaS, the business benefits of PaaS, an analysis of the various PaaS vendors and their offerings, and the control implications of PaaS, as well as future trends in PaaS.

WHAT IS PLATFORM AS A SERVICE?

Platform as a Service is a cloud-computing platform that is utilized by software developers. It is generally considered the middle layer of the cloud computing “stack”, sitting in between the Infrastructure as a Service and Software as a Service². PaaS allows software developers to develop their own applications using the tools, libraries, operating system and infrastructure of the cloud vendor³. These applications are hosted on the vendor’s servers, and sold to end-users as a SaaS⁴.

There is often some confusion about what PaaS is, and it is generally confused with the two larger cloud services, IaaS and SaaS. However there are key differences between the three services. The diagram in Exhibit I illustrates what is managed by the cloud vendor for a PaaS, compared to what is offered for an IaaS and SaaS. As shown in the diagram, vendors of a PaaS manage both the hardware infrastructure, such as servers and storage, as well as the development environment, with tools such as the OS, middleware, and several API’s. Developers only need to be concerned with the applications they are developing, and neither the infrastructure supporting it or the distribution to end-users. In comparison, an IaaS vendor only provides the infrastructure of an IT system; the customer must manage everything else. This means that the customer must supply the operating system, and any applications that they may need to run. SaaS vendors

¹ <http://www.forbes.com/sites/anthonykosner/2012/06/08/developers-in-demand-platform-as-a-service-is-key-to-growth-of-mobile-cloud-computing/>

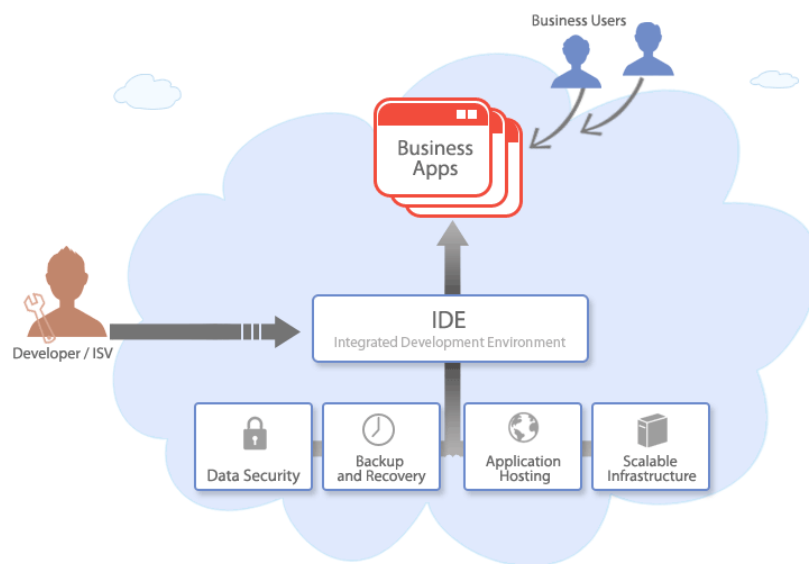
² <http://www.cloudcomputingadmin.com/articles-tutorials/paas/platform-service-paas-2014.html>

³ <http://thoughtsoncloud.com/2014/02/what-is-platform-as-a-service-paas/>

⁴ Ibid

manage all parts of the IT system, and customers only need to concern themselves with using the applications that are being hosted by the cloud vendor.

PaaS vendors generally provide a subscription fee to customers in order to use their infrastructure and development tools⁵. The vendor must also specify to the developer the approved programming languages and API's that are compatible with the vendor's infrastructure.⁶ PaaS vendors are also responsible for the security of the data, backup and recovery of the data, application hosting, and scaling the infrastructure for the end user's needs⁷.



<http://www.zoho.com/creator/paas.html>

WHAT IS THE BUSINESS VALUE OF PaaS?

There are several ways that utilizing PaaS creates value for a business that develops software. The main advantage that utilizing PaaS provides is that these businesses do not need to invest in infrastructure required to build software⁸. Instead of having to build a data centre, failover controls, manage the centre, and pay for utilities related to keeping the hardware running, the businesses that utilize PaaS only need to worry about the costs of developing applications⁹. All of the servers, operating systems, and networking solutions are managed by the cloud vendor,

⁵ <http://www.tomsitpro.com/articles/paas-platform-as-a-service-comparison-review,2-615-2.html>

⁶ <http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>

⁷ <http://www.zoho.com/creator/paas.html>

⁸ <http://www.salesforce.com/paas/overview/>

⁹ Ibid

which removes significant costs from developing software. In addition, because users of PaaS do not need to own and set up the infrastructure, fewer employees are needed to maintain and update the infrastructure, reducing costs further¹⁰. The only costs that businesses need to incur are the subscription fees for the cloud service, which are often times “on demand” fees whose magnitude is based on the resources required¹¹. As a result of these reduced costs, the ROI of companies that have switched to PaaS from traditional software development have increased significantly. Market research firm IDC has calculated that customers of Salesforce.com’s PaaS have increased ROI by 721% three years after moving from a traditional approach to a PaaS approach.¹²

Another benefit that PaaS brings to a business is that it speeds up the process of developing applications. The time needed to build, test and maintain infrastructure can be avoided, and may be dedicated towards developing the applications. This increases overall productivity, as programmers can perform the function that they excel in, which is developing applications.¹³ As a result of this, PaaS helps developers focus on building innovative, ground-breaking applications¹⁴.

Additionally, PaaS vendors provide services that can assist in adding extra functions to applications, which can be helpful for developers¹⁵. For example, App.net, a cloud vendor that provides both PaaS services and a social networking platform, allows developers to use a social networking module in their apps, which automatically tracks the number of users using the apps, the number of users using similar apps, and provides the ability for users to follow and recommend apps, so that developers do not fall into the “Blank App” problem, where the app is built and is functional, yet there are no users.¹⁶ The developers do not need to build in these functions into their apps, but rather use the API’s that are provided by the vendor when making

¹⁰ <http://www.infoworld.com/d/cloud-computing/paas-market-reach-14-billion-2017-idc-says-230440>

¹¹ <http://www.cloudcomputingadmin.com/articles-tutorials/paas/platform-service-paas-2014.html>

¹² <http://www.salesforce.com/fr/assets/pdf/whitepapers/whitepaper-idc-force-roi-study.pdf>

¹³ Ibid Footnote 10

¹⁴ <http://www.salesforce.com/paas/overview/>

¹⁵ <https://www.youtube.com/watch?v=rQp-Zpgp9X4>

¹⁶ <https://app.net/about/>

their application. This also helps save significant amounts of time when building applications. Below are some of the additional services and modules Salesforce.com offers on their PaaS:



<http://www.salesforce.com/paas/overview/>

Utilizing PaaS also assists with the deployment of software¹⁷. Generally, most software is either put onto physical media, such as CD's or compact flash cards, and distributed and sold through brick and mortar stores or online, are distributed digitally via online platforms such as Google's Play Store, or are self distributed through the company's own website. These methods of distribution often require finding a publisher and foregoing part of the profits from the sale of the software to a distributor, and deployment can often take large amounts of time. By using PaaS, since the software is already being developed on the cloud vendor's servers, the vendors are able to distribute the software as a SaaS to the end users. Developers do not need to spend time deciding on how they are going to deploy their software, and it allows them to move on to new projects more quickly. In a research study conducted by Apprenda, a provider of PaaS technologies, JP Morgan Chase was able to improve its time to market of its applications by 50 days.¹⁸ This proves that utilizing the cloud to develop software helps save time developing and distributing software.

Another advantage that PaaS provides to businesses is that the cloud infrastructure and development software are always up to date¹⁹. Developers do not need to upgrade their IT system as the cloud vendor invests in all upgrades to the system. Due to this, the developer can always develop for the latest in technology. Also, using cloud computing provides a completely scalable environment for developers to use. This prevents the problem where developers create an

¹⁷ <http://www.cloudcomputingadmin.com/articles-tutorials/paas/platform-service-paas-2014.html>

¹⁸ <http://robustcloud.com/reflections-on-the-future-of-paas/>

¹⁹ <http://www.cloudcomputingadmin.com/articles-tutorials/paas/platform-service-paas-2014.html>

application that is adopted so rapidly, that the developer's servers cannot handle the demand²⁰. This can cause down time for applications, and require the developer to invest more money by purchasing additional servers. By developing applications on the cloud, the developers can request that their vendor add additional servers when there is a large demand for their applications, and then reduce the number of servers when the demand is low. This flexibility is only available when utilizing cloud technology.

Overall, the savings obtained by subscribing to PaaS for software development are enormous. Based on research done by Zoho Creator, a vendor of cloud services, to develop an application that would take 80 man hours to complete from initial requirements gathering to deployment, using a traditional development process, it would take only 25 hours to complete using PaaS, a 69% saving. Additionally, infrastructure and software that would cost \$3,375 to implement on a developer's premises could be replaced by a \$270 subscription to their PaaS platform, a 92% saving²¹.

KEY OFFERINGS IN THE PaaS MARKET

The cloud computing industry is highly saturated with several cloud vendors selling their services to businesses. Three of the larger PaaS providers and their offerings are described below.

Microsoft Azure

Microsoft's PaaS solution utilizes the Windows operating system, and is an IaaS and PaaS in one. It supports programming languages such as .NET, Node.js, PHP, Python, Java and Ruby, and allows developers to use Microsoft's proprietary Visual Studio to create and deploy applications. It allows users to store data using an SQL Database, Tables and Blobs. The main competitive advantage for Microsoft's platform is that it is both an IaaS and PaaS, so users can mix and match IaaS components with the PaaS offerings, giving the customer more control over the system. Pricing of Microsoft Azure is based on the size of the instances running the customer's applications. A small instance with 768MB of RAM would cost \$0.03/hour, a

²⁰ <http://www.oracle.com/technetwork/topics/cloud/platform-as-a-service-faq-v4-444924.pdf>

²¹ <http://www.zoho.com/creator/database-software-vs-traditional.html>

medium instance with 3.5MB of RAM would cost \$0.17/hour, and an extra large instance with 14GB of RAM would cost \$0.68/hour^{22 23}.

Google App Engine

Google's App Engine is designed for the distribution of web applications, and is aimed at developers that use Java, Python, PHP, and Go. Data is stored using Datastore, and the system automatically handles scalability, without the need for the developer to request for more servers. A competitive advantage of App Engine is that it uses a sandbox model that isolates processes, which reduces the risk that a failed process on a server will disrupt the operations of other processes on the same server. Pricing of App Engine is based on usage, as Google offers 28 hours of free service along with 1GB of storage, and users are charged \$0.05/hour for any usage exceeding the free service quota. Google also charges for other services such as additional API's, and additional storage^{24 25}.

SalesForce.com Heroku

Heroku was one of the earliest PaaS providers, and is known for its ability to facilitate quick deployments and fit a wide range of applications and programming languages such as Python, Ruby, Java, Scala, Cloture and Node.js. It also works best for applications using the Twelve-Factor App methodology, which will be explained later in this paper. Heroku was acquired by SalesForce.com in 2010, and is their primary PaaS platform. Heroku has a tiered pricing model, with a 512MB RAM instance costing \$0.05/hour, and a 1GB instance costing \$0.10/hour. Heroku also charges for additional services such as additional storage^{26 27}.

CONTROL IMPLICATIONS OF PaaS

The use of a PaaS service brings along with it various risks for developers. In order to mitigate these risks, multiple control frameworks that developers may adopt have been recommended.

²² <http://www.tomsitpro.com/articles/microsoft-azure-paas-cloud-computing-sql-server,2-605.html>

²³ <http://azure.microsoft.com/en-us/pricing/details/cloud-services/>

²⁴ <http://www.tomsitpro.com/articles/google-app-engine-paas-cloud-computing-web-application,2-598.html>

²⁵ <https://developers.google.com/appengine/pricing>

²⁶ <http://www.tomsitpro.com/articles/paas-heroku-dynos-cloud-computing-web-application,2-601.html>

²⁷ <https://www.heroku.com/pricing>

Risks of PaaS

When developers are deciding whether switching from a traditional software development model to a PaaS model, there are several risks that they must consider. The following are some of the risks these businesses should be aware of.

Vendor lock-in

Often times when a business decides to use a PaaS service to build their software, they may run into the problem of vendor lock-in. Vendor lock-in occurs when cloud vendors make it difficult for developers to switch between PaaS providers, through the use of proprietary protocols, standards and tools²⁸. This can hinder the flexibility and portability of software development, and it is a problem that typically grows as the developer puts more data onto the cloud²⁹. For example, if a developer would like to switch to a less expensive alternative to the PaaS vendor they currently use, the costs of removing and reconfiguring the data may outweigh the savings from switching to the new vendor, preventing the move³⁰. The cause of this problem is due to the lack of standardization within the industry, as most cloud vendors have their own specifications and requirements for any applications hosted on their servers³¹. To mitigate this risk, it is recommended that developers create an exit strategy, and build these exit costs into their initial cost analysis when first deciding on a cloud vendor, and lobby for standardization within the cloud computing industry³².

Technical Immaturity

Since PaaS, and cloud computing in general, are relatively new concepts in IT, the industry is still fairly immature. Because of this, there is a lack of standards, as previously mentioned. This could result in several issues, such as the costs of the PaaS service changing overnight, changes in quality of the service, changes in tools and protocols, all with very little notice to the customer. To mitigate this risk, customers should build into their SLA between the vendor and

²⁸ <http://gigaom.com/2012/06/21/vendor-lock-in-and-the-challenge-to-platform-as-a-service/>

²⁹ Ibid

³⁰ Ibid

³¹ <http://www.forbes.com/sites/joemckendrick/2011/11/20/cloud-computings-vendor-lock-in-problem-why-the-industry-is-taking-a-step-backwards/>

³² Ibid

the customer, contingencies for outages, quality changes and tool changes, as well as a fixed price or a clause regarding changes in price.³³

Privacy and Security

Privacy and security is huge concern not only for companies using utilizing PaaS, but for any company using cloud computing. Security concerns stem from the fact that when using cloud computing, the customer is no longer handling their own data, and must entrust the cloud vendor with the security over their data. However, the customer, not the vendor still owns the risk of stolen data.³⁴ There are several reasons why PaaS in particular has security concerns:

- **Data Location:** A developer's application data is often duplicated throughout the vendor's servers in order for it to be easily accessed by the developer. By creating multiple copies of the data, there is a greater chance that the data may be stolen, and when a customer decides to leave the vendor, some of the duplicated application data may be unknowingly left on the servers, susceptible to theft.³⁵
- **Access Controls:** Most companies have implemented role based access controls in their information system, ensuring that only authorized individuals have access to certain information. However, by using PaaS, the handling of this control is given to the vendor, who may not have strong procedures over giving access to the appropriate individuals, which may lead to application data (depending on the app this could include: user credit card info, phone numbers, SINS, etc.) being stolen by unauthorized individuals³⁶.

These security concerns may be mitigated by obtaining SOC 2 reports over security and privacy, or SOC 3 reports from the vendor, and by including into the SLA the risks and responsibilities of each party regarding the security of the application data³⁷.

Connectivity

Constant connectivity is critical when utilizing cloud technology, as any amount of downtime can lead to significant cost overruns for developers. In order to mitigate the risk of a connection

³³ <http://www.informationweek.com/cloud/software-as-a-service/the-risks-and-benefits-of-platform-as-a-service/d/d-id/1083609?>

³⁴ Ibid

³⁵ <http://searchcloudsecurity.techtarget.com/tip/An-examination-of-PaaS-security-challenges>

³⁶ <http://searchcloudsecurity.techtarget.com/tip/An-examination-of-PaaS-security-challenges>

³⁷ <http://www.cloudcomputingadmin.com/articles-tutorials/paas/platform-service-paas-2014.html>

failure, customers should assess the networking capabilities of the cloud vendor to determine that the connectivity will meet peak demand, and negotiate a downtime guarantee, as well as ensuring that the customer's own ISP can handle the bandwidth requirements of the PaaS³⁸.

Business Continuity and Disaster Recovery

Since all application data is being hosted on the PaaS vendor's servers, there is the risk that a catastrophic event may occur that could destroy all the data on the vendor's servers.³⁹ To mitigate this risk, businesses should discuss with possible PaaS vendors the procedures put into place in case of a disaster, learn about business continuity insurance, and have a contingency plan in place in case the vendor is unable to continue the service due to a disaster.

Control Frameworks

There are several control frameworks that companies can implement and follow to address any risks that may be created by using PaaS. The following control frameworks will be discussed: the Software Development Lifecycle, the Trust Services Framework, and the Twelve-Factor App framework.

Software Development Lifecycle

The Software Development Lifecycle (SDLC) is a framework that defines the tasks performed in each stage of software development. It is used by many software developers, as it helps developers create high quality products effectively and cost-efficiently⁴⁰. However, the SDLC framework must be slightly altered when applying it to a PaaS method of developing software, as many of the stages of the cycle are abbreviated due to the speed and ease that PaaS brings to development. The following are the stages of the SDLC and how they must be adjusted for when using PaaS⁴¹:

- Planning: proper planning must always be done, regardless of whether the developer is using PaaS or a traditional method of development. The application idea must be well

³⁸ <http://www.cloudcomputingadmin.com/articles-tutorials/paas/platform-service-paas-2014.html>

³⁹ <http://www.cliftonlarsonallen.com/Risk-Management/The-Benefits-and-Risks-of-Cloud-Computing.aspx>

⁴⁰ <http://www.veracode.com/security/software-development-lifecycle>

⁴¹ <http://americas.nttdata.com/Blogs/Cloud/2014/April/SDLC-Still-Critical-under-PaaS.aspx>

defined, along with the user requirements and specifications. The utilization of the PaaS solution must also be planned effectively.

- Development: the development stage does not change at all when moving to a PaaS solution. A development timeline still must be created, and the application still has to be coded inline with the specifications.
- Testing: the testing of code should always be done. PaaS technology may make it easier to do so, with various tools that can debug code, but testing is still necessary.
- Deployment: using a PaaS solution may make this phase shorter, or eliminate it entirely from the developer's point of view, but it must still be governed. Any changes to code must be deployed to an offline test environment and be tested before being uploaded to the PaaS servers for deployment.
- Maintenance: all PaaS created application must undergo periodic maintenance, similar to traditionally developed applications.

Additionally, similar to traditional development, when using a PaaS solution, the SDLC must be reviewed and revised yearly in order to improve its effectiveness.

Trust Services Framework

The Trust Services framework is a control framework that assesses information systems using five different criteria: security, availability, processing integrity, confidentiality, and privacy.⁴² Businesses that utilize PaaS solutions should require that the cloud vendor that they are subscribing to is able to meet the requirements of each of these criteria. A method of doing this is to require a SOC report from vendors before signing up for their services that assures the developer that the cloud vendor meets whichever criteria would be most critical. A SOC 2 type 2 (which covers a period of time) report for each of the Trust Services criteria, or a SOC 3 type 2 report over all criteria should be requested from the vendor before signing on to their PaaS service. If the vendor does not provide the SOC reports, the developer may hire external auditors to conduct an audit of controls over the trust services criteria, or visit and inspect the vendor's premises on their own. See Exhibit II for EY's opinion on the controls of Salesforce.com, which is an example of an external auditor's assessment of a cloud vendor's controls, using the Trust Services framework.

⁴² <http://www.webtrust.org/overview-of-trust-services/item64420.aspx>

Twelve-Factor App Framework

The Twelve-Factor App framework is a methodology to building applications that will eventually be used as SaaS applications, which includes most PaaS developed apps. The framework was developed by several individuals who have vast experience in the development and deployment of hundreds of cloud-apps, and is a collection of ideal practices for developing SaaS applications⁴³. As described on the website for Twelve-Factor App, the framework is used to develop apps that:

“Use **declarative** formats for setup automation, to minimize time and cost for new developers joining the project; have a **clean contract** with the underlying operating system, offering **maximum portability** between execution environments; are suitable for **deployment** on modern **cloud platforms**, obviating the need for servers and systems administration; **minimize divergence** between development and production, enabling **continuous deployment** for maximum agility; and can **scale up** without significant changes to tooling, architecture, or development practices.”⁴⁴

The framework consists of twelve factors that developers should follow in order to make quality SaaS applications. These factors are listed in Exhibit III.

THE FUTURE OF PaaS

Over the next several years, the market for PaaS services looks to grow substantially. IDC expects the global market for PaaS to grow from \$3.8 billion in 2012 to \$14 billion in 2017. IDC has also expects the annual growth rate for PaaS from 2012-2017 will be 30%, compared to the 4% growth rate in overall IT spending in 2013⁴⁵. PaaS is becoming an integral part of the software development industry, and may eventually become the standard method of development for most applications.

With the rapid growth in PaaS usage, some of the implications that it will have on the future of IT, and technology in general, include:

- The future of IT departments within companies. With the relative ease the PaaS allows companies to make software, the productivity of developers increases substantially. With

⁴³ <http://12factor.net/>

⁴⁴ Ibid

⁴⁵ <http://www.infoworld.com/d/cloud-computing/paas-market-reach-14-billion-2017-idc-says-230440>

that comes a lesser need to keep many programmers on staff, fewer IT maintenance staff, and fewer staff are needed to build servers and data centres⁴⁶. This could potentially have an effect on the job market for IT workers, and organizations will have to decide whether to cut their IT staff, or reinvest the saving from using a PaaS into their IT department to develop more innovative solutions that could help cut more costs down the road.⁴⁷

- The widespread growth in mobile app and web apps. According to EngineYard, a PaaS provider, by 2015 mobile applications will out-number native PC applications 4 to 1.⁴⁸ Also, between 2009 and 2014, the market for cloud-based mobile apps is projected to increase 90%⁴⁹. Developers believe that ability to scale applications and the time savings from using PaaS are the main drivers for this growth, and that these factors will allow for greater innovation in applications. For example, in 2012 Netflix, the incredibly popular movie-streaming web and mobile app, moved from developing only on its own servers, to creating a PaaS on top of Amazon Web Services, which they can now develop on, in order to obtain the scalability to handle the often-spiky demand of customers⁵⁰. As the demand for these types cloud-based applications continues, so will the need for PaaS development.
- A shrinking need for computing power for end users. With cloud computing and PaaS, developers can create powerful applications which any computer user can run, regardless of computing power, due to the scalable nature of cloud computing. An example of a scalable platform which developers are creating content for is Microsoft's Xbox One video game console. Typically, video game consoles have a finite life, and as computer graphic rendering technology advances, the console begins to become out-dated. As a result, as technology improves, it will be difficult for developers to create modern games that can run on the aging hardware. To solve this problem, Microsoft has leveraged their Azure platform and their Xbox Live service to connect all Xbox Ones to their cloud infrastructure, and created a service called Xbox Live Compute. This service takes the computationally intensive tasks of a game, such as artificial intelligence and physics, and

⁴⁶ <http://www.infoworld.com/d/cloud-computing/paas-market-reach-14-billion-2017-idc-says-230440>

⁴⁷ <http://thoughtsoncloud.com/2013/09/how-will-platform-as-a-service-paas-affect-the-it-staff/>

⁴⁸ <https://blog.engineyard.com/2012/platform-as-a-service/>

⁴⁹ Ibid

⁵⁰ <http://gigaom.com/2012/03/28/netflix-we-dont-need-no-stinkin-data-centers/>

offloads it to the “cloud”.⁵¹ This improves the performance of the applications running on hardware, and essentially makes the computing power of the console irrelevant. As a result, developers develop for the “cloud”, rather than the Xboxs in the homes of users, allowing them to focus more on the experience and fun of their games, rather than worry about optimizing the application for a specific piece of hardware. This could result in faster development time, lower development costs, and more innovative applications. An example of this is the Xbox One game “Titanfall”, which uses Azure to handle the game’s artificial intelligence and the game’s overall networking, reducing lag and improving the game’s performance, and was critical to delivering the experience the developers wanted to create⁵². This is only the beginning for these kinds computing power-independent applications. Without hardware being the bottleneck for software development, developers can create applications that are truly innovative and boundary pushing.

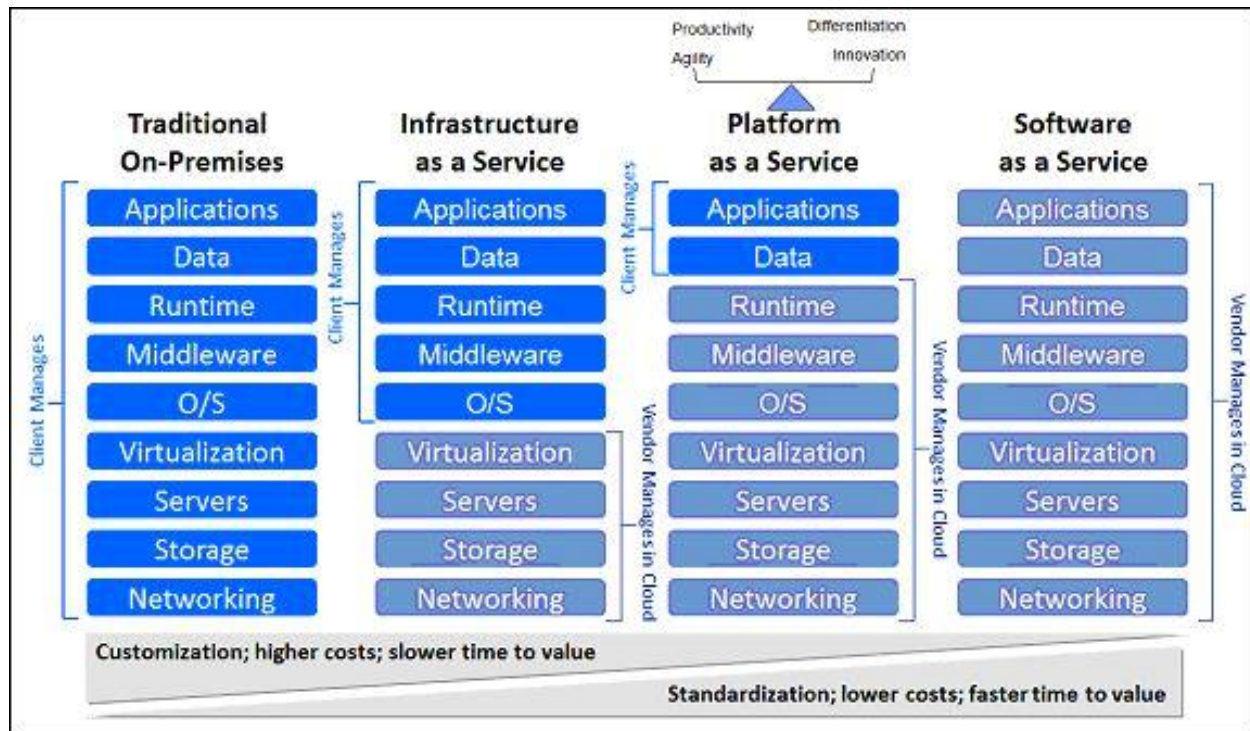
CONCLUSION

Based on the analysis done on Platform as a Service, there is significant business value in investing in these services. Through cutting IT costs, speeding up the development and deployment of software, and promoting innovations in application development, PaaS truly provides value to organizations. There are risks that must be considered before investing in a PaaS solution, however, such as vendor lock-in, business continuity risks, connectivity and downtime risks, and security risks. However, there are control frameworks that can be used in order to mitigate these risks, such as the SDLC, the Trust Services Framework, and the Twelve-Factor App Methodology. Finally by investing in PaaS, organizations may also be exposed to trends such as the reduction in IT staff, computing power-independent software, and the growing market for mobile and web apps.

⁵¹ <http://news.xbox.com/2013/10/xbox-one-cloud>

⁵² <http://www.engadget.com/2014/03/10/titanfall-cloud-explained/>

Exhibit I: Comparison of Cloud Services



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⁵³ <http://thoughtsoncloud.com/2011/10/paas-comes-of-age-why-platform-as-a-service-needs-to-be-part-of-your-cloud-strategy/>

Exhibit II: EY Opinion on the Controls of Salesforce.com



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⁵⁴ <https://cert.webtrust.org/pdfs/salesforce.pdf>

Exhibit III: The 12 Factors of the Twelve-Factor App Methodology



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⁵⁵ <http://12factor.net/>

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