

Performance evaluation of the use of IaaS, SaaS, and PaaS providers in different applications

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Contents

1	Abstract	1
2	Overview	1
2.1	Experiment Outline	1
2.2	Proposed Analysis	2
3	Project Analysis	2
3.1	Cloud Services Description	2
3.1.1	SaaS	3
3.1.2	PaaS	4
3.1.3	IaaS	6
3.2	What parameters are we going to consider	7
3.3	Services Performance Analysis	8
3.3.1	Office suite – SaaS	8
3.3.2	Customer Relationship Management - SaaS	9
3.3.3	Cloud file hosting – IaaS	10
3.3.4	Big Data Analysis – IaaS	12
3.3.5	Web applications – PaaS	13
3.3.6	IoT– PaaS	15
4	Created Benchmarking	17
5	Conclusions	18
6	References	19

List of Figures

1	Schema of the implementation.	3
2	Differences between services.	7
3	AWS Prices.	11
4	Azure Prices.	12
5	Deployment workflow.	14
6	index.html	17
7	Results html	18

1 Abstract

The traditional model is the idea of using physical data centers for storing digital assets and running complete networking systems for daily operations. In this model the user only has available data that is stored in the system.

As volumes of data and the need for computing capabilities increase very rapidly, this model seems like a very costly idea and in certain applications, not a very practical one as volumes of data and needs for processing can vary a lot in certain fields.

Alternatively, we have the cloud computing model, where a collective combination of configurable system resources and advanced services can be delivered quickly through the internet. Cloud computing can be divided into three different services, each one of them offering different aspects that need to be carefully considered before jumping into one of them without knowing how they work, what they offer, and what they are made for.

Nowadays, cloud computing is a hot topic for companies of every size, whether the company wants to start a business in the cloud or if a company wants to migrate its business to the cloud.

The questions that this paper will try to solve are in what applications can cloud computing outperform the traditional model, and what type of cloud computing service would fit the best this given applications.

2 Overview

2.1 Experiment Outline

The project will start by evaluating and comparing the performance between different IaaS, SaaS, and PaaS solutions in different types of applications. The evaluation will include information about which one of the services fits the best in each application, considering different inputs such as cost of deployment, time to develop, and best-considered provider for said application.

Considering the service that fits the best, it will also be evaluated which one of the most common service providers would fit the given company as well as different parameters when it comes to launching conditions.

To analyze which one of the services fits the best a given application we need to understand what they are and what they provide.

- **Software as a Service (SaaS):** SaaS applications run directly through your web browser, which means they do not require any downloads or installations on the client side.

- **Platform as a Service (PaaS):** PaaS delivers a framework for developers that they can build upon and use to create customized applications
- **Infrastructure as a Service (IaaS):** IaaS is fully self-service for accessing and monitoring computers, networking, storage, and other services.

All these services have advantages, disadvantages, and limitations, that's why this is a very important decision for a company, as changing between services can be a hard task [1].

2.2 Proposed Analysis

For the analysis we will start by defining what the main advantages and disadvantages are for each of the services, this will help us understand what the ideal company and applications would be for each of the services.

Considering this, we need to define what parameters are those that could be the most relevant for an application and provide them as input to the benchmarking that will be designed in the following sections.

Lastly, we need to consider what service providers we have available, and which one would have the best conditions when it comes to the launch of the application.

Therefore, the program will output a benchmark giving us the information about which of the models fits best a given application by percentages and for the one with the highest percentage, which service provider would be the best for our company.

3 Project Analysis

This section will analyze the types of services, service providers for an application, and which are the parameters that are the most relevant for this project. The section will start by analyzing the cloud services and then focus more on the providers of each service.

3.1 Could Services Description

To properly analyze cloud services, let's have a look at the definition of the service, and both its advantages and disadvantages.

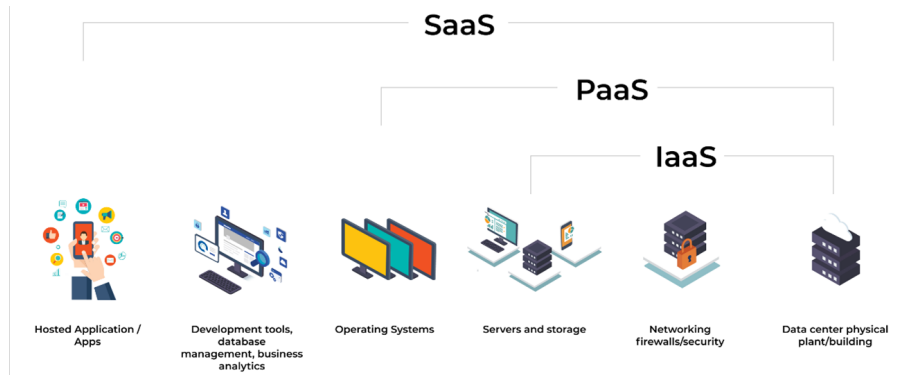


Figure 1: Schema of the implementation.

3.1.1 SaaS

Software as a service (SaaS) is a cloud computing service that offers its users access to a vendor's cloud-based software, this provides an alternative to the standard software installation model (traditional model). The applications in SaaS reside on a remote cloud network that can be accessed through an API or from the web. You just pay for the period you are using the service. The top five advantages of using SaaS are the following [2]:

- **Reduced time to benefit:** The fact that you can just provide an instance in the cloud and that you will have the application ready to use in just a couple of hours significantly reduces the amount of time spent on configurations and installation as well as reducing the issues that can appear when doing the software development.
- **Lower costs:** Being a multi-tenant environment where the hardware and software costs are low compared, SaaS usually provides some cost-saving benefits.

Also, scaling is a very important consideration when it comes to small and medium businesses as SaaS allows these customers to use software that otherwise they would not be able to afford due to the high cost of licensing.

Maintenance is also a relevant factor, since the user does not own the environment, the provider is the one that will carry the maintenance of the environment.

- **Scalability and integration:** Another important consideration is that with SaaS we can scale and integrate different SaaS offerings. This scaling and integration can be used up and down based on the needs of the customer.
- **New releases (upgrades):** Whenever the provider upgrades its solution, it becomes available to all its customers. This means that you don't need to spend time upgrading your solution as the provider will do it for you.

- **Easy to use and perform proof-of-concepts:** As SaaS comes with the considerations of best practices and some samples in them, they are considered to be easy to use. Users can do some testing and perform proofs-of-concept for a new software functionality or release feature, this is included even in large environments.

Now that we know what the advantages of this kind of service are, let's look at some of the disadvantages [3]:

- **Loss of control:** As organizations rely on third-party vendors to deliver their services, these services are not completely in the end user's control. In some extreme cases, the cloud service provider can just go out of business without a previous warning. Another important consideration is the vendor lock-in, this is basically that a vendor can manipulate a system to make it difficult or expensive to migrate to another solution.
- **Software integration problems:** The integration problems can range from network latency to architectural problems. Trying to keep a balance between on-premises software and SaaS can be difficult to organize, and sometimes almost impossible to migrate all their software.
- **Security:** This is one of the main concerns when it comes to using SaaS. Using SaaS involves storing the data offsite in the service provider who oversees the security and backup of the data.

According to an Archive360 and Pulse survey, 58% of the world's technology leaders say many SaaS vendors do not meet all their security requirements

- **Wasted Spending:** SaaS has the potential to run rampant unless closely monitored, for example, if a staff member takes long breaks from using the service or gets easily distracted. Also because of overlapping functions, a business can end up paying for features that they are not using and therefore, wasting money.
- **SLA:** The service-level agreement needs to be viewed as a potential trap for unsuspecting victims. These documents are designed to be long and tedious to read so people don't finish reading the document, this can lead to confusion, unmet expectations, and paying for services that are never used.

3.1.2 PaaS

Platform as a service consists of a complete development and deployment environment in the cloud, depending on what your goal is you can deliver from a simple cloud-based app to sophisticated could-enterprise solutions.

PaaS includes not only infrastructure but also middleware, development tools, business intelligence services, and more. PaaS can support the complete application lifecycle. [4]

As we did before, let's have a look at some of the advantages of using PaaS [5]:

- **Reduction in operating cost:** Using PaaS eliminates the need for expensive hardware and development tools, this means that a developer doesn't need to worry about the procurement of servers, development tools, etc.
- **Effective scalability:** This is one of the main benefits when it comes to cloud computing. For a business it's very important to keep up with the demand of the customers, however, this means that the company will need to increase the computing resources.

Cloud Computing as in SaaS allows businesses to scale up or down whenever there is a peak in demand or a drop in use.

- **Platform Maintenance:** In traditional deployments there needs to be a team of specialists to maintain the platform, this can make the process of upgrading a technology a very challenging process. PaaS enables automatic security patches and updates.

PaaS eliminates the need to maintain a specialist team regularly, therefore, saving a tremendous cost.

- **Flexibility:** This kind of service is one of the most sought-after cloud computing services for a very wide range of customers. It offers many readily available tools and helps developers conceptualize, design, and develop their solutions without dependencies.
- **Ready for the future:** PaaS helps companies to be ready for the future as the provider is constantly adding features, capabilities, and bug fixes. This means that the focus will be on the important aspects of the business rather than on IT work.

Now let's look at the disadvantages of using this kind of service [6]:

- **Security:** As happened with SaaS, security in PaaS can be a very important issue as private and sensitive information can be viewed by the provider. This is why it is the responsibility of the business to select a trustworthy provider, so information is not at risk.
- **Control** When a business uses PaaS sometimes there can be some problems of lack of control. For example, if the provider increases the price scheme the price for the app related to the platform is very likely to go up.
- **Reliability:** When using PaaS, businesses must be ready to face downtimes as there can be some power outages, natural disasters, or other troubles that cannot be predicted.

As a result, there can be devastating consequences, that's why businesses need to own data backups to avoid data loss.

- **Compatibility:** Compatibility issues can be important as some infrastructures are not designed to include certain features or characteristics, so businesses need to be aware that some features will be very hard to include.

Similarly occurs with integration as two PaaS solutions cannot be integrated, as some contradictions will be seen. Furthermore, changing from one PaaS provider to another can be a hard task

3.1.3 IaaS

Infrastructure as a service is the last type of cloud computing service that we will be analyzing in this paper, it focuses on offering essential computing, storage, and networking resources on demand.

By migrating an organization's infrastructure to an IaaS solution, you can get maintenance reduction, reduce hardware costs, and gain business insights. Let's dive deeper into this kind of service. [7]

Following the previous schema, we will start analyzing the advantages of using this service [8]:

- **Cost savings:** Again, being cost saving one of the main benefits of cloud computing, IaaS is no different. The reason in this case is the low infrastructure costs, companies don't have to spend money to make sure that the hardware and the equipment are in great condition.
- **Support for DR, BC, and High Availability:** Another common benefit among cloud services is that companies can scale up or down the system depending on requirements. This scalability allows companies to market themselves faster to any potential customers.
- **Focus on business growth:** IaaS allows businesses to spend more time growing the business rather than making smaller technology decisions.
- **On-demand access :** Being IaaS an on-demand system, the cost is lowered considerably as companies only must pay for the resources they are using.

To end this section, we will talk about the disadvantages of using this service [8]:

- **Security:** As mentioned before for all the cloud services, security in these cases is a very relevant issue and the service level agreement should always be carefully read.
- **Lack of flexibility:** Some providers won't upgrade the software for some businesses even though they provide maintenance for said service.

- **Over dependency:** When a company uses IaaS becomes almost fully dependent on that provider which can be a problem to consider in certain cases.
- **Upgrade and maintenance:** After getting an IaaS service, the company is the one responsible for any upgrades that the company might need.
- **Virtualization services and User-Privacy:** IaaS is dependent on virtualization services; this involves a limit in user-privacy.

All the characteristics, features, and characteristics of the previously said services can be summarized in the following figure.

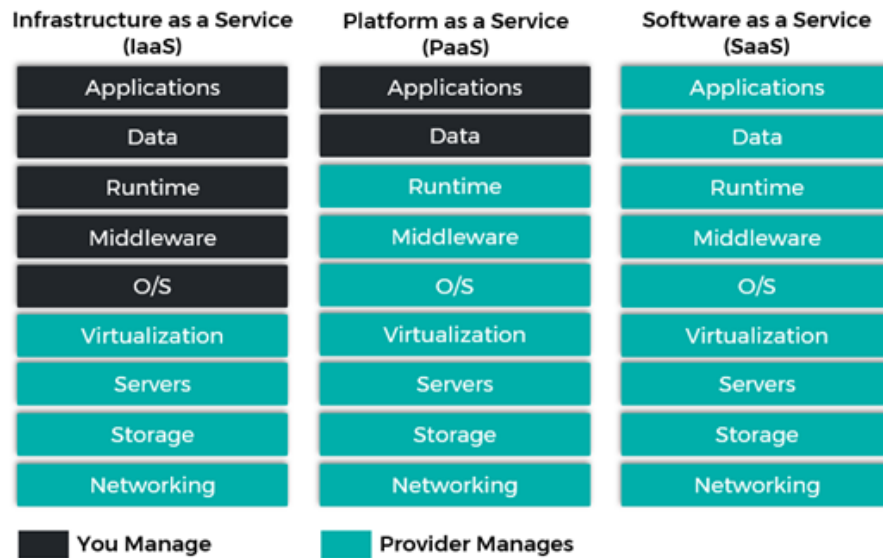


Figure 2: Differences between services.

3.2 What parameters are we going to consider

Now that we know what each service proposes, we can draw some conclusions about what parameters will be the ones that define what kind of service will be the best for a given application. [9]

For SaaS, the situations where we believe can outstand the most are:

- **Size of company:** small companies that need to quickly launch an application and don't have time to develop the software and fix issues.
- **Time of the project:** short-term projects that require affordable collaboration.

- **Type of access:** good when the application needs access through the web and mobile
- **Need of the app:** SaaS is better when apps are not needed too often.

For the case of PaaS, we have the following:

- **Customization:** one of the main benefits of PaaS is if you need to customize your application.
- **Streamline workflow:** PaaS can streamline workflows when multiple developers are on the same project.
- **Other vendors:** if other vendors need to be included, PaaS can be a very practical choice.
- **Resources:** if the company has a good team of developers and can quickly deploy the app PaaS can significantly reduce costs.

Finally, we have IaaS, where we found the following situations:

- **Deployment cost:** small companies may prefer to avoid spending time and money on purchasing and creating hardware and software.
- **Retain control:** large companies, may prefer to retain control over their infrastructure and applications, but they just want to purchase what they consume.
- **Rapid growth:** if a company needs to have good scalability, IaaS will allow them to change hardware and software as their needs evolve.

3.3 Services Performance Analysis

In this section, we are going to analyze the performance of the different services based on the previously said parameters for different applications. [10]

3.3.1 Office suite – SaaS

This application is the one where SaaS will outstand the most, as we know there are companies that have their own private messaging, virtual meeting platforms, email communications, and so on. Companies like Google Workspace and Microsoft 365 are the biggest providers that deliver this type of software, they have very optimized platforms and in general, a company will use them for their employees to communicate rather than to create an application that does this. Therefore, when it comes to communications SaaS is the clear winner. [11]

Let's have a look at what these two providers offer and how they differentiate from each other on the technical aspects, we will focus on the performance of the services and price.

Starting with price, with Google Workspace we have four plans that will allow the business to pay for different features, ranging from 6\$/user/month for the basic plan to a non-specified price enterprise plan. When it comes to Microsoft they are not as straightforward as Google is with their prices, as they have a lot of plans so this won't be helpful when deciding which one to choose.

Talking about performance, file storage in Google Workspace has a better proposal as their plans offer more file storage and also more email storage when compared to the ones from Microsoft.

If you are concerned with cloud storage or email storage Google Workspace might be the best solution, apart from this it depends on what the company is used to working with and what platform you like more.

3.3.2 Customer Relationship Management - SaaS

Every CRM is unique, so just because one platform has a higher score doesn't mean it's inherently superior or will serve your needs better. This section merely compares the features of the CRM of Salesforce and SAP. To keep the analysis short, we will be focusing on the features that we consider are more relevant.[12]

Business Intelligence

With its ease of use and little to no dependency on IT, Salesforce's paid add-on QlikView offers business intelligence benefits with close to real-time analytics. Salesforce.com users may measure pipeline trends throughout the sales cycle with QlikView to increase sales efficiency and effectiveness. Users may design and track marketing efforts to find ways to improve by evaluating customer and lead data.

SAP is not a pure CRM specialist like Salesforce. It combines features like KPI reporting from SAP's BusinessObjects BI solution. Without the need for a separate BI system, it may be used directly in SAP CRM, but this might often limit how comprehensive it is.

Salesforce provides users with an all-around more powerful BI module because it makes use of a distinct, strong BI platform that interacts effortlessly.

Online case Management

Users can see and update service cases using Salesforce case management from any location. This technology enables sales representatives to quickly escalate situations to subject matter experts, who may then quickly and accurately respond to the consumer. Ticket options can be tailored to your business, increasing the likelihood that customer service agents will resolve issues promptly and effectively.

SAP Case Management gathers data from numerous sources and saves it in a searchable database that is simple to use. SAP CRM case management handles a variety of internal HR and financial issues, including illness benefits, dispute management, tax audits, and collection management, in addition to processing customer support tickets. To make sure that nothing is overlooked when describing a problem, SAP's incident tracking system provides configurable fields and thorough data storage. To remotely monitor closures, admins can create unique parameters for closing cases and reps can categorize cases according to predefined priority hierarchies.

SAP offers more robust functionality and diversity in its case management feature.

Industry Business Process Support

Salesforce essentially authored the CRM book. Their CRM software optimizes the corporate operations involved in sales, customer service, and marketing. Additionally, it offers in-depth analysis of crucial client and sales data, resulting in higher client satisfaction.

The SAP Business All-in-One solutions cover essential business processes across a number of industries and are based on the SAP ERP application. These procedures involve accounting, managing logistics and purchasing, creating new products, and managing human resources.

SAP's diversity may make it appealing to a wider range of industries, but Salesforce wins for CRM-specific business process support.

Conclusions

Although it's a close race between SAP CRM and Salesforce, we believe that Salesforce outperforms SAP CRM for more specific features. Having said that, Salesforce might not be the best CRM for every business, therefore it's crucial to consider your needs while comparing CRMs.

3.3.3 Cloud file hosting – IaaS

We ultimately decided to go with Microsoft Azure for cloud file hosting over Amazon S3 because it is more affordable and has a larger network. The service offers a great user experience overall and integrates well with both Storage Made Easy and CloudBerry Backup.[13][14]

Let us get more into detail and see how different the costs and server network are between platforms.

Amazon S3 & Amazon Glacier

Amazon has a vast network of data centers, improving your ability to upload and download files quickly. Although Amazon S3 storage isn't cheap, prices have dropped significantly in recent years. Amazon Glacier is another archival IaaS solution that you can choose from if you only need to back up your files and don't need regular access to them. It offers considerably lower storage fees but operates more slowly.

Storage costs with Amazon S3 are tiered. Additionally, there are three different types of storage: standard, standard-infrequent, and Amazon Glacier.

Standard storage is hot storage (it's storage that needs to be accessed frequently). While storage costs are high, data upload and download speeds are faster and usage rates are lower.

It's important to note that uploading data is free with S3 Standard, however, data retrieval is not, the costs for Amazon S3 Standard are detailed in the next table.

First 1GB per month:	Free
Up to 10TB per month:	\$0.090 per GB
Next 40 TB per month:	\$0.085 per GB
Next 100 TB per month:	\$0.070 per GB
Next 350 TB per month:	\$0.050 per GB

Figure 3: AWS Prices.

In a word, Amazon IaaS storage fees are not only expensive but also unclear. If a lot of data is stored and downloaded regularly, it's important that the user understands how everything functions. Make sure, in particular, if you plan to use Amazon S3 for developing apps.

For some, the confusing pricing structure will be worth it because of the quick data uploads and downloads, which are especially beneficial for large backup processes. As previously established, those speeds are made possible by Amazon's extensive global network of cloud servers.

Azure

Depending on the storage type utilized, such as Azure Files, Azure Disks, or Azure Blobs, there are various Azure charges. For example, Blobs should be used for cloud storage and backup since it allows unstructured data.

With Microsoft Azure, blob storage is tiered and charged per gigabyte per month. Depending on how frequently you plan to access your data, you can choose between hot and cold storage. The following image depicts the prices for the different plans:

	Premium	Hot	Cool	Archive
First 50 terabyte (TB) / month	\$0.15 per GB	\$0.018 per GB	\$0.01 per GB	\$0.00099 per GB
Next 450 TB / month	\$0.15 per GB	\$0.0173 per GB	\$0.01 per GB	\$0.00099 per GB
Over 500 TB / month	\$0.15 per GB	\$0.0166 per GB	\$0.01 per GB	\$0.00099 per GB

Figure 4: Azure Prices.

When it comes to server-network size, Microsoft Azure wins the prize: there are data-center networks available in more than 50 different regions across the world. The United States, Canada, Brazil, France, Germany, the United Kingdom, Australia, India, Japan, Korea, and China are among the nations possessing server facilities. Soon, servers will arrive in South Africa.

Considering this, Microsoft Azure should have higher speeds for file hosting than Amazon has, and you are able to store data almost wherever you want to in the world.

3.3.4 Big Data Analysis – IaaS

In this field the providers that outstand over the others are Amazon Elastic Compute Cloud and Google Compute Engine, now we will analyze the proposal of these two providers.

Similar building elements like Data Processing, Data Orchestration, Data Analytics, Machine Learning, Visualizations, and Streaming Analytics are available from both companies. The fact that Google will offer more services than AWS does, gives Google the advantage in the Big Data case, however, in this section we will be focusing on data warehouse specifically RedShift vs BigQuery.[15]

If your company uses Amazon Simple Storage, RedShift Spectrum enables you to run RedShift queries directly against Amazon S3 storage, which is excellent for accessing your data lakes. If so, RedShift Spectrum is almost certainly a superior choice for your company.

You have the option of using RedShift’s huge Dense Storage or its dense compute. You can spin up a 160GB dc2.large node for \$0.25 per hour, which is the least expensive node you can buy. Dense Storage costs \$4.25 per TB per

hour to operate. This price includes both processing and storage. The least expensive rate on RedShift is therefore \$306 per TB per month. Additionally, you might get huge discounts by paying in advance.

This makes using RedShift interesting. You can significantly reduce costs if you can predict your run-times and how frequently you'll need to spin up each node, especially if you pay in advance. Since the majority of organizations won't be running their RedShift nodes all the time, going granular is typically in your best interest.

BigQuery is suitable for heavy queries, those that operate using a big set of data. The bigger the dataset, the more it is likely to gain in performance. This is when compared to the traditional relational databases BigQuery implements different parallel schemas to speed up the execution time. So, considering the pricing for the service if you run rapid queries a few times a day, you do data mining operations or you are a data scientist running ML BigQuery would be a far better option.[16]

There isn't a winner here. RedShift is more economical for everyday data warehouse operations for most businesses. But, BigQuery is better for businesses looking to do data mining or those who deal with extremely variant workloads.

3.3.5 Web applications – PaaS

The cloud platforms that offer PaaS are in great demand because they offer the entire package - APIs, abstractions, and tools for developers so they can just focus on building and deploying amazing applications. This allows developers to concentrate solely on creating and deploying outstanding apps. Azure App Service and AWS Elastic Beanstalk are the two most popular systems for hosting applications and offering PaaS. [17][18][19]

To facilitate quick application deployment, Azure Web Service incorporates a number of services, including Microsoft Azure Sites, Mobile Services, and BizTalk Services. It has additional functions that make it possible to integrate cloud and on-premises solutions.

AWS Elastic Beanstalk, on the other hand, is quick to deploy and administer and has no trouble with tasks like capacity provisioning, load balancing, automatic scaling, and application performance monitoring.

Let's see how these two big platforms come to a like with each other.

AWS Elastic Beanstalk

Simple upload: Amazon PaaS service, aids in the deployment of applications to the AWS cloud. Elastic Beanstalk manages capacity provisioning, load

balancing, scaling, and application health monitoring automatically as part of cloud uploading.

Complete control of features: While it manages the application, you can also maintain full control over the AWS resource feed. However, you only need to pay for the resources that you use to store and run the applications.

Deployment workflow: An illustration of the deployment workflow is given below:

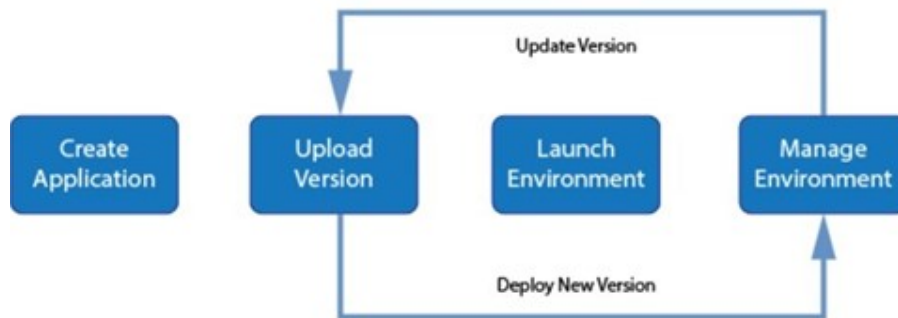


Figure 5: Deployment workflow.

The AWS required resources are created and configured automatically by Elastic Beanstalk. You can manage your environment and roll out new application versions once your environment has launched.

Azure App Service

High productivity development: Developers can focus on the core aspects of their development process and build scalable and powerful Web, mobile, and API applications using java, Ruby, .NET Core, PHP, Python, Node.js and Docker.

Load balancing: App Service helps you save infrastructure costs through your built-in load balancers. This helps to share the workload because there will be a group of machines, not just a single server to handle requests. This makes it economical for small medium-sized businesses.

Available for Linux and Windows: Both Linux and Windows are supported by Azure Web App, allowing developers and users to choose the platform and operating system that best suits them. Additionally, there are numerous programming languages available to developers.

Sizing as per demand: Scalability can be done on demand, with Azure functions, a less event-oriented experience. There are nano-services that give

the developer the freedom to scale on demand and pay only for the resources that are used.

Support for multiple languages: You can build, host, and use APIs written in multiple languages through Azure API applications. Other features such as turnkey API security, on-premises resource connectivity, and definition support do Swagger are added advantages.

Conclusion

To conclude this analysis, the user must take the project's needs, the developers' degrees of experience, and other factors into consideration before choosing between Azure App Service and AWS Elastic Beanstalk.

AWS is an established cloud platform with a wide range of features. Offerings of numerous layers are what contributes to its popularity. And the fact that it consistently reduces prices is sufficient evidence for them to comprehend what the client wants.

For those that utilize Windows Server, SQL Server, Exchange, and other Microsoft technologies for cloud transition, Microsoft is always used with major commercial customers. It is easy and seamless to publish applications to Azure if you are a .NET developer. The hassle of managing servers and deploying applications is not required. Azure is therefore a perfect choice for requirements like with applications receiving high traffic or Microsoft stores, especially since it has great SDK for .NET.

3.3.6 IoT– PaaS

Amazon AWS IoT and Microsoft Azure IoT are the two most trustworthy IoT service providers out of the many ones that are now accessible. Both provide top-notch services to aid businesses in accomplishing their objectives. There are different arguments in favor of both Azure IoT and Amazon IoT.[20][21]

Azure

The IoT Hub: The IoT Hub is one of the most powerful weapons in the Azure IoT toolbox. Simple, secure, and bidirectional communication is established between IoT assets and the cloud by Azure IoT Hub. Why is the Microsoft IoT Hub more dependable than the Amazon IoT Hub? The system's extensive built-in capability for interacting with other programs is mostly to blame. Simply said, this considerably reduces the amount of unique programming required, resulting in faster and more cost-effective development.

SDK and Language Support: In comparison to Amazon's solution, Azure IoT has better support for SDKs and languages. While C and NodeJS are

supported by AWS IoT, .Net, UWP (Universal Windows Platform), and Java are also supported by Azure IoT. This indicates that the likelihood that the current coders will be prepared to write new programs for the IoT project is higher.

AMQP Support - Device interactions: The final and open replacement for proprietary messaging middleware is the Advanced Messaging Queuing Protocol. When it comes to messaging protocols, a crucial component in the construction of any IoT system, it is one of the most dependable and interoperable options available. As the AWS offering only supports HTTP and MQTT, both of which are a part of Azure, Azure IoT is the better option if we need to use AMQP.

Service Fabric for Low Latency: An innovative method for developing micro service-based applications is Azure Service Fabric. In other words, these are precisely the applications that lend themselves to Internet of Things solutions. It also provides the lowest latency performance because it reduces a significant amount of coding overhead and streamlines the development process.

Amazon Web Service

Device management: AWS has the features you require, regardless of whether your devices are simple and numerous or complicated and few. Beginning with device state shadows in AWS IoT Core, they progress to include remote monitoring and security in Device Management and Device Defender. Together, they give you access to more options and a larger scale of device management than Azure's Hub service does.

Edge capabilities: As they come with a variety of purpose-built libraries to enable you tap into the edge, FreeRTOS and Greengrass set AWS apart from Azure in the battle of the clouds between the two. With Azure IoT Edge, which is restricted to Microsoft-specific containers, you don't have that flexibility. AWS offers a larger infrastructure to expand its edge computing capabilities across use cases, saving you money on unneeded cloud modifications and data storage.

Scalability: Compared to Azure, AWS offers more IoT options and makes it simpler to set up your project for autonomous scalability. When you utilize the integrated Rules Engine to request more resources for your new devices, integrations with Lambda and other services are also important. The amount of data that may be sent is unrestricted, and the pricing becomes more adjustable as you proceed.

Conclusion

In conclusion, AWS will typically be more likely to draw more clients, but there may be certain unique situations where some quick development is required, the customer may need to utilize a language that is only available in Azure, or they may need to use AMQP.

4 Created Benchmarking

Along with this document on the delivery can be found a set of folders containing .html documents and images, these files correspond to the created benchmarking. This section will explain how to run this web page to get the results.

The screenshot shows a web application titled "CSP 554 - Project Benchmark". Below the title is a subtitle: "Performance evaluation of the use of IaaS, SaaS, and PaaS providers in different applications". The interface contains two dropdown menus. The first dropdown is labeled "Select the Cloud Service you want to analyze" and has a placeholder "Select Cloud Service". The second dropdown is labeled "Select one of the proposed service applications below" and has a placeholder "Select Application". To the right of these dropdowns is a dark green button labeled "Submit values". Below the dropdowns are three diagrams illustrating cloud service models: SaaS (Software as a Service), PaaS (Platform as a Service), and IaaS (Infrastructure as a Service). Each diagram shows a central cloud icon with various application icons (laptop, smartphone, mail, document, etc.) connected to it.

Figure 6: index.html

The image above depicts the initial layout of the application, to get to this point we need to open the file "index.html", located on the uploaded folder on the "Benchmark" folder. Also, the code can be accessed via Github, the url for the repository can be found on the references section of the paper.

Once we are on the web page, we can find two boxes to select the values we want to analyze, the first one is designed to select the type of service, the second box will display the chosen applications for the previously selected service based on the value of the first box.

After selecting the values for both boxes, to see the desired analysis, we need to press the button on the right of the screen and this will redirect us to the results of the analysis. Once we are on the results page we will be provided with some relevant considerations about each service and some conclusions, if we want to

go back we will need to press the button located on the top right of the screen. An example of this can be seen on the image below.

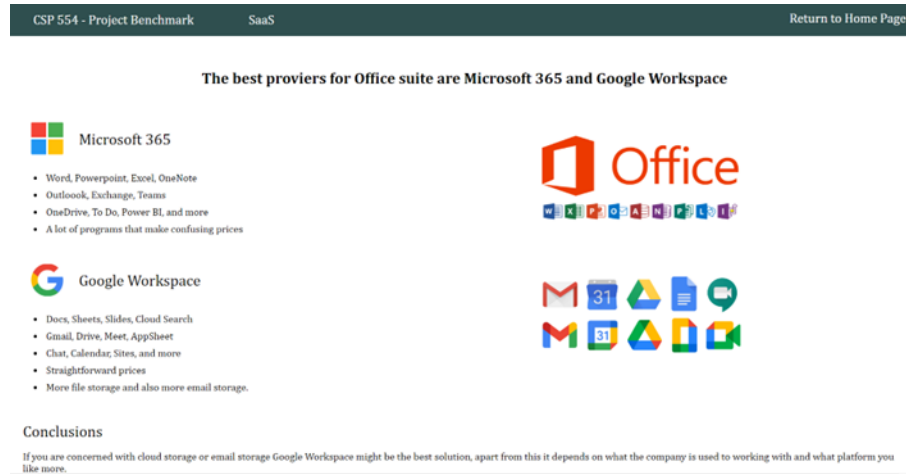


Figure 7: Results html

It is important to note that due to time limitations the web page won't fit perfectly in any device, the user may need to make the screen of the laptop smaller to see the results properly.

5 Conclusions

This project has evaluated the different types of cloud services, we started by providing a general comparison of the many services offered, along with an analysis of each service's benefits and drawbacks. We next began to study individual use cases for each service when this analysis was finished.

For the proposed services we analyzed what we believed were the two most common use cases, and for each one of them we compared the proposal of the main service providers to see which one had the best offer.

The conclusion we reached almost always is that the greatest firms offer extremely competitive goods with impressive performance, and it comes down to minor details or specific needs of a company to choose the best service provider.

6 References

Link to the Github Repository: <https://github.com/adliIT/BIgDataProject>

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