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STUDY OF EFFICIENCY OF USING IT-INFRASTRUCTURE-AS-A-SERVICE FOR CLOUD COMPUTING

Abstract. With the growth of the information technology market and the constant increase in demand, companies began to carry an unprecedented burden on their own infrastructure, trying to meet t customers' growing expectations. Safe, reliable, and fast services are a top priority for companies that are largely trying to meet the expectations of their customers and adjust to the constant changes in the service market. With constant efforts to increase their own computing power, infrastructure and storage space, companies are increasingly finding that the cost of developing and maintaining a reliable, secure, and at the same time scalable infrastructure is prohibitive.

To cope with the challenges of acquiring and maintaining their own infrastructure solutions, companies can take advantage of off-the-shelf solutions such as cloud computing. Cloud computing is a fast-growing industry that allows companies not to focus on expanding their own local infrastructure and, instead, move to the use of ready-made Internet services. Cloud service providers provide access to storage and processing, as well as software at affordable and dynamic prices, which allows companies to save money by adopting cloud solutions. Cloud services provide a variety of service models, each capable of meeting a specific set of business requirements and needs. The main service models include Infrastructure as a Service (IaaS), Software as a Service (SaaS) and Platform as a Service (PaaS), the features and disadvantages of which vary and are interchangeable, allowing you to choose a more suitable model.

This article explores existing solutions and services and provides the advantages and disadvantages of using one or another solution for various needs and highlighted the most universal solution suitable for most requests. In the study, the most popular solutions related to cloud computing present and analyze their key features. The most powerful and attractive service for processing a large amount of input data, including space images, is IaaS. When used, it provides high speed and availability of resources, adaptation to the task, data security due to distributed storage and processing, which allows increasing performance and minimizing latency for the end user.

Keywords: cloud computing, data processing, saving data, infrastructure as a service, platform as a service, software as a service.

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1. Problem statement

Using and maintaining infrastructure is a very costly practice, as the companies have to constantly hire qualified personnel and upgrade the current infrastructure. Among other things, the company needs to constantly worry about security, as vulnerabilities can be found in the software used, potentially leading to security problems. An equally important problem with the support of its infrastructure is adaptability to growing and seasonal demand, since with an increase in the number of customers, the load increases, which leads to the mandatory expansion of the infrastructure. The variability of demand leads to the fact that most of the time, the equipment is idle since it must be ready for peak and seasonal loads, which leads to unnecessary costs for its support. The use of cloud computing helps avoid most of the problems, but the company needs to choose its needs.

This paper proposes the features of the leading cloud computing models and comparisons with the most versatile of them. The research results use to select a more suitable solution and use it based on the need for specific needs.

2. Analysis of recent reports and publications

The field of cloud computing is the most growing niche in the IT industry today. Many tech giants have changed their priority for several years to provide access to their resources and increasingly integrate with IoT and cloud computing. Some of the most prominent players in this market that provide their services are such companies as Google, Oracle, Amazon, Microsoft, IBM [1-5], each of which, in turn, provides the maximum coverage of all possible areas related to storage data, cloud computing, artificial intelligence, analytics, and many other services.

One of the problems in communicating information about services is focusing on their advantages and solutions, compared to competitors, which is a regular business practice, but creates difficulties for companies and customers when selecting and searching for information on the technology itself, and not on a specific service provider. Implementation of cloud solutions allows companies to save up to 30% [6]. Also, selecting a suitable technology and migration from an existing service is quite common, which creates additional difficulties during migration associated with a partial or complete incompatibility between various service providers, which mainly make customers more attached to their ecosystem.

Concerning IaaS, this service is provided by all major service providers since this is one of the most popular services among the services provided. However, the approach may differ from provider to provider, which can present some difficulties,

in the event of which, IaaS will be the universal service in this regard since it allows us to change the supplier at a lower cost.

3. Purpose of the Study

The study's primary purpose is to analyze and evaluate existing service solutions for use in cloud computing, data storage, and data analysis in the information space. A comparison of the most popular cloud computing solutions, namely, these include their features, advantages, and disadvantages, compared to IaaS.

4. Description of Main Material of Research

Cloud computing is needed for its application, regardless of the type of task and industry. The main advantages of cloud computing are the following:

- Flexibility: the use of cloud computing allows us to get access to the most advanced technological solutions since all the care of updating the infrastructure and using the latest solutions falls on the cloud service providers.
- Cost minimization: by the cloud, we can pay only for the resources used, which avoids the downtime of already paid equipment.
- Elasticity: cloud computing allows us to gradually scale the required number of resources according to needs and respond to surges in activity or unforeseen situations more quickly.

As well as advantages, cloud calculating also has disadvantages that must be considered when using the cloud services, like the following:

- Constant connection to the network: to gain access to the services provided by the clouds, we need a constant connection to the Internet.
- Closed source: most cloud providers systems are closed and do not provide at all or with some restrictions the ability to customize the service for our purposes.
- Confidentiality: for all the reliability of storing data in public clouds, it is still not recommended to use them to store valuable documents or essential information. Today it is impossible to guarantee complete confidentiality and data protection.

There are three main groups of cloud computing: Infrastructure-as-a-Service ("IaaS"), Software-as-a-Service ("SaaS"), and Platform-as-a-Service ("PaaS"). These services are also called cloud computing stacks, as they stack on top of one another. Each of them should be used depending on the needs since there is no universal approach. The business needs to choose the appropriate one depending on the task at hand.

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- IaaS: one of the main groups of cloud computing. The use of the IaaS scheme provides IT infrastructure on demand (virtual machines, storage, servers, and others.), which gives maximum flexibility and scalability, as well as a pay-as-you-go system.

- PaaS: refers to services that provide access to development tools, which require deploying a system for managing web or mobile applications and eliminates the need to deal with the underlying infrastructure of servers, storage, and databases required for the development.

- SaaS: a model in which the customer's software deploys at a cloud solution provider’s infrastructure. It uses in cases where instead of spending money on maintaining our infrastructure, the subscription model is the best solution.

The best way to understand the main difference between the models is to compare their management approaches responsible for and available to the end-user. Unlike traditional IT and its approach, IaaS, PaaS, and SaaS provide a more progressive level of abstraction. IaaS abstracts aspects such as data storage, networking, physical computing, and the technology required to virtualize these resources. The PaaS model, in turn, abstracts the runtime, software, and operating system. SaaS provides the end-user with all applications as a service, entirely abstracting everything else.

Figure 1 - Management approaches of different models

Cloud technologies with different forms of ownership divided into different types, the choice or application of any of them are suitable for different cases and depend on the purpose of the main types of clouds. The following three can be distinguished:

- Private: A controlled and secure IT infrastructure that is deployed and operated for a single organization. The third party or contractor is fully responsible for the deployment and management of the infrastructure.
- Public: it is used simultaneously by many companies and services that do not have access to this cloud's management and maintenance, but the resource owner does the maintenance, allowing anyone to buy resources for their own needs, regardless of whether it is a company or an individual.
- Hybrid: Includes the best solutions and qualities of private and public clouds to solve a glorified task. It mainly uses seasonally when the internal IT infrastructure does not cope with the tasks set, the public cloud's capacity is rented and used, and when necessary, to provide access to the company's resources to a third party from the outside.
- Multi-block environment: The main difference from the hybrid approach is the use of many cloud computing resources and power in a single, cohesive architecture.

The development of cloud computing is proceeding at an incredible pace; in 2020, 48% of IT infrastructure spending directed to the cloud, which is approximately $57.8 billion [7].

The essential benefit of IaaS is its flexibility and scalability in use. Using this approach, the business or the end-user can control when it is necessary to increase or decrease the infrastructure's capacity, which will allow it to adapt to seasonal or temporary needs and save on this in the long term. Flexibility in configuration will allow us to automatically adjust the distribution and use of resources according to the need, which will avoid problems with a sharp increase in traffic. Doing international business allows us to leverage on-premises or nearby cloud computing resources, increasing the system's speed and responsiveness since clouds are in many locations worldwide. Using off-the-shelf cloud solutions will allow us to focus on expanding our business without investing in additional infrastructure.

Security should always be a priority in any aspect of the IT infrastructure, as it poses a threat to the entire infrastructure, business, and privacy. Most IaaS services make considerable investments in their security system, as they are responsible for the safety and security of the data they store. The primary means of protection are:

- strict binding to the service's physical location,
- compliance with local laws on the storage of information, and
- the use of reliable authentication systems in the service.

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One of the critical security enhancements provided by IaaS is data encryption, such as end-to-end encryption when transmitting and storing sensitive data, which in most cases provides a greater level of protection than using own infrastructure for hosting, responsibility for the safety of which lies entirely with us.

The improved performance is one of the well-known benefits of IaaS, as it is fully scalable, and many cloud services support full control over it. The cloud architecture provided for use by the provider is, in most cases, much more redundant and reliable than its solutions. It is a paramount quality at the initial stages of building a business, as it allows us to save on building our own IT infrastructure and its maintenance while reducing total capital costs (CapEx) and allows us to get a more productive system at the start. The Service Level Agreement (SLA) provided by the IaaS service providers ensures that the level of performance will be maximum on the cloud infrastructure used.

The guarantee of business continuity, the safety of backups, and a disaster recovery system are the most significant advantages of IaaS cloud computing, which allows us to protect ourselves from unforeseen situations. Most IaaS service providers place their equipment in locations with maximum security, availability, redundant power, and constant network access. Using our infrastructure, any of the listed problems can ultimately limit the work, in contrast to using the cloud. Also, for early resumption in case of an unforeseen situation, backup cloud resources can be used, which is another advantage of clouds, which will maximize uptime.

Summing up the most significant advantages that can serve to use IaaS, the following list can be distinguished:

- Speed of work: using the IaaS model, we can allocate more of the required resources in a shorter time, or vice versa, reduce the number of resources used, which allows us to adapt to the desired task quickly;

- Multi-zone regions: allows us to significantly increase the availability of resources and fault tolerance of systems since the entire infrastructure is not assigned to a specific region, which makes storing data and their copies more secure;

- Response and performance: a more comprehensive geographic coverage allows us to minimize latency to the end-user since the service that is closest to the end-user is selected, increasing productivity;

- Pay-as-you-go: the model allows us to get rid of the traditional prepayment for using the service since the cost depends on the number of resources used.

A less popular non-mainstream alternative to IaaS is Bare-metal-as-a-Service ("BMaaS"), currently being marketed by companies such as Intel and IBM. This

service provides lower-level management than traditional IaaS. In BMaaS, resources are also provided upon request and bills on a pay-as-you-go basis, just like IaaS. The main difference from IaaS is that this model does not provide the end-user with access to cloud computing and storage but provides direct access to the underlying equipment. This approach provides almost complete control over the used hardware, which can be helpful in some tasks. The big plus of this model is that it provides access to hardware, and not virtual space, as in the case of other approaches, which provides the most significant potential performance, which is extremely important for computing cases like HPC and GPU computing, analytics, high-load database and more.

When comparing similar IaaS and BMaaS models compared to the rest, they are not competing, and each of them is suitable for a specific task and a specific use case, and we cannot say which one is better or worse.

5. Conclusion

This paper discusses the current models for distributing services such as IaaS, SaaS, and PaaS, also less popular and similar to the IaaS model - BMaaS. A detailed analysis of the above services allows us to come to the following conclusion about the advantages and disadvantages of each of them:

- IaaS: is one of the most scalable services, allows you to select and deploy the infrastructure for the required task, as it provides a lower-level management. Of the disadvantages, it is worth emphasizing that a higher level of entry and suitable skills are required to work with the service;

- PaaS: provides the best solution for a specific task, such as data storage and management, also allows us to increase the necessary capacity at any time, which is useful for fast-growing projects. Of the shortcomings, it is worth noting that in most cases there are difficulties when migrating from one provider to another, with data transfer;

- SaaS: has a high number of abstraction levels, which will allow us to quickly deploy infrastructure for simple and trivial tasks. The disadvantages include the fact that when expanding the service on this infrastructure, problems begin to arise with scalability and the transition to another, lower-level service.

After weighing all the advantages and disadvantages, we came to the conclusion that the most attractive service for processing large amounts of data, namely aerospace images, is IaaS. This service allows us to use the necessary infrastructure as needed, and scalability allows us to select a configuration depending on the task.

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Further exploration could be to deepen the use of the different models and decompose their features in more detail, to represent areas of use more directly and in more detail, and to create new sub-models that could cover different needs in more detail.

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Дослідження ефективності використання IT-інфраструктури як сервісу для хмарних обчислень

З ростом ринку інформаційних технологій і постійним збільшенням попиту, компанії почали нести безпрецедентне навантаження на власну інфраструктуру, намагаючись виправдати зростаючі очікування клієнтів. Безпечні, надійні і швидкі послуги - є основним пріоритетом для компаній, які в значній мірі намагаються виправдати очікування своїх клієнтів і підлаштовуються під постійні зміни на ринку послуг. З постійними спробами збільшення власних обчислювальних потужностей, розширенням інфраструктури і простору для зберігання даних, компанії все частіше виявляють, що витрати на розробку і обслуговування надійної, безпечної і в той же час масштабованої інфраструктури є непомірно великими.

Для того щоб впоратися з проблемами придбання і підтримки власних інфраструктурних рішень, компанії можуть скористатися готовими рішеннями, такими як хмарні обчислення. Хмарні обчислення - є швидкозростаючою галуззю, яка дозволяє компаніям не загострювати увагу на розширенні власної локальної інфраструктури і, замість цього, перейти на використання готових інтернет-сервісів. Постачальники, які займаються

хмарними послугами, надають доступ до зберігання та обробки даних, а також програмного забезпечення за доступними і динамічним цінами, що дозволяє компаніям заощадити за рахунок впровадження хмарних рішень. Хмарні сервіси надають різні моделі обслуговування, кожна з яких здатна задовольнити певний набір вимог і потреб бізнесу. До основних моделей послуг належать такі як «Інфраструктура як сервіс» (IaaS), «Програмне забезпечення як сервіс» (SaaS) і «Платформа як сервіс» (PaaS) особливості і недоліки яких варіюються і взаємозамінні, що дозволяє підібрати більш відповідну модель.

У роботі проведено дослідження існуючих рішень і засобів, а також надані переваги і недоліки використання того чи іншого рішення для різних потреб і виділено саме універсальне рішення, що підходить під більшість запитів. В ході дослідження наведені найпопулярніші на даний момент рішення, пов'язані з хмарними обчисленнями і виконаний аналіз їх ключових особливостей. Найбільш потужним та привабливим сервісом для обробки великого обсягу вхідних даних, зокрема космічних знімків, є IaaS. При його використанні забезпечується висока швидкість роботи та доступність ресурсів, адаптація до поставленої задачі, безпечність даних за рахунок розподіленого зберігання та обробки, що дозволяє збільшити продуктивність та мінімізувати затримку для кінцевого користувача.

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