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Cloud giants: AWS, Azure and GCP

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Abstract — This work studies cloud giants such as Amazon Web Services, Azure and Google Cloud Platform and then compares them in detail. The work identifies 20 characteristics of their performance. Providers are evaluated for competitiveness, which includes analysis of various aspects and characteristics that are important for organizations and customers using cloud services. A comparative table and diagram based on which, taking into account such key features as security, impact of providers on business processes and IT infrastructure of company showed that each of them has its own features and limitations, which must be known for optimal choice of cloud provider.

Keywords— *Platform, Information Systems, Cloud Technologies, Cloud Providers, Comparison.*

I. INTRODUCTION

Cloud Technology (CT) is nowadays important part of information systems (IS) and technology as it provides infrastructure for data storage and processing [1, 2].

CTs have been widely implemented due to ability to store, process and provide access to data and software solutions via Internet, which is convenient and has become particularly relevant in last three years, which are characterized by fact that most people work remotely. CTs enable both private enterprises and organizations:

- increase scale of their information systems;
- reduce hardware and support costs;
- increase availability of data and services to users.

Modern organizations use cloud platforms to develop and implement their information systems, as well as to provide access to data and applications from any location and device, so topic of paper is and will be relevant.

Informatization is key factor in today's world to improve efficiency and competitiveness of organizations, with IS and cloud technologies interacting and importantly, complementing each other [3, 4].

The topic of this work is cloud giants: Amazon Web Services (AWS), Azure and Google Cloud Platform (GCP), as result of research conducted it is planned to highlight features of their functioning; find out how they compete and what they offer to users; focus of paper will be on security issues and impact of advanced cloud providers on business processes and information technology infrastructure (IT infrastructure).

This topic aroused our interest, because in remote working environment, ability to respond quickly to changes in business environment allows you to manage resources more efficiently and reduce costs. And, as result, it will help you make decision on choosing cloud provider for your business or project.

Therefore, we plan to: review the features of AWS, Azure and GCP; compare them.

II. RELATED WORK

A number of papers have been devoted to study of cloud technologies and providers, where authors reveal importance of choosing right cloud provider and emphasize that AWS, Azure, GCP have their unique features and capabilities that can meet different user needs [5-9].

A review paper on cloud service providers-AWS, Azure, GCP [5]. The authors briefly described: cloud architecture; cloud deployment models; cloud service models and compared AWS, 2023 2nd International Conference on Innovative Solutions in Software Engineering Ivano-Frankivsk, Ukraine, November 29-30, 2023

Azure and GCP on 16 features, as result, they concluded that AWS has higher performance than Azure and Google Cloud, however, security issues are not considered.

The study of cloud data analytics solution is investigated by [6] in which authors selected 20 features to compare Amazon Web Services, Google Cloud Platform, Microsoft Azure, authors, make subjective conclusion that only reason why customers should choose GCP cloud provider is because it has best pricing structure for services.

Another new study [7] focusing on performance evaluation when deploying dockerized web application on AWS, GCP and Azure. The authors in this study tested JMeter, SysBench and Apache Benchmark in Docker Container environment deployed on AWS, GCP and Azure, however, nothing is said about limitations for testing.

In [8], performance of existing MQTT brokers operating in AWS, Microsoft Azure and Google Cloud Platform cloud services is analyzed. The authors emphasize on IoT implementation which requires MQTT protocol with high communication performance, fast response and small size.

Security issues and problems in cloud computing are analyzed in [9]. The authors reviewed existing types of services.

III. METHODOLOGY

This research will conduct a comparative study of AWS, Microsoft Azure, and Google Cloud Platform cloud providers to evaluate their features, capabilities, and performance. This type of research will help users and organizations make more informed decisions about choosing cloud provider based on their specific needs and requirements.

This study will address impact of advanced cloud providers on business processes and IT infrastructure and as result, determine what are differences and similarities between AWS, Microsoft Azure and GCP cloud providers in context of their performance, functionality and their security.

First, quick word about AWS. AWS offers more than 200 services including computing, storage, databases, analytics, artificial intelligence, Internet of Things (IoT), and more. AWS has data centers in different parts of world [10, 11].

Users can increase or decrease capacity in real time, allowing for efficient resource utilization and cost reduction. AWS provides wide range of tools and services to ensure data security and privacy. They comply with standards and regulatory requirements, making them suitable for large number of industries.

Azure and GCP also offer more than 200 services and services, just like AWS. Azure is integrated with wide range of Microsoft products and services, including Windows Server, Active Directory, SQL Server and many others, and this makes it easy to migrate existing applications and infrastructure to cloud.

Azure supports hybrid cloud model, allowing organizations to combine cloud resources with on-premises infrastructure. Microsoft is actively investing in Azure security, providing tools and certifications to protect customer data and applications [13, 14].

Rounding out Google Cloud Platform. GCP has powerful resources and services that enable development and deployment of machine learning applications and models, including tools like TensorFlow, AI Platform and BigQuery ML.

GCP offers BigQuery, high-performance and scalable real-time data analytics system that enables analysis and visualization of data large volumes. GCP also, like first two providers, provides high level of security for its customers [14, 15].




Let's highlight characteristics by which comparison will be made (Table 1).

The main criterion is security of these providers and we will emphasize assessment of each provider impact on business processes and IT infrastructure.

In Table 1: 1* Containerization is virtualization method that allows you to package and run applications and their dependencies in isolated containers [16]; 2* Server less solutions is architectural approach to developing and deploying applications where developers do not have to

worry about managing infrastructure, including virtual servers (VMs) or containers. Instead, developers focus on writing application code and its business logic, and cloud provider automatically manages infrastructure, scaling, and execution of code [17, 18].

Table 1 – Comparison of cloud providers features

No	Features	AWS 	Azure 	GCP 
1	Market leadership	Largest provider, market leader	The second largest provider in market	The third largest provider in market
2	Scalability	26 regions, 81 available zones	60 regions, 140 available zones	24 regions, 76 available zones
3	Service Level Agreement (SLA)	Subject to change depending on services		
4	Integration with other services	Wide range of integrations and services	Deep integration with Microsoft	Many integrations and services
5	Virtual machines	EC2	Virtual Machines	Compute Engine
6	Network services	VPC, Direct Connect	Virtual Network, ExpressRoute	VPC, Interconnect
7	Databases	RDS, DynamoDB	Azure SQL Database, Cosmos DB	Cloud SQL, Firestore
8	Analytics and machine learning	Amazon EMR, SageMaker	Azure Machine Learning	AI Platform, BigQuery
9	Data storage	S3, EBS, Glacier	Azure Blob Storage, Azure Disk	Cloud Storage, Persistent Disk
10	Identification and access control	IAM, Cognito	Azure Active Directory	Identity and Access Management
11	Containerization (1*)	Amazon ECS, EKS	Azure Kubernetes Service (AKS)	Google Kubernetes Engine (GKE)
12	Serverless solutions (2*)	AWS Lambda	Azure Functions	Cloud Functions
13	Security Management Center	AWS Identity and Access Management (IAM) provides flexible access control.	Azure Active Directory (Azure AD) for access control and authorization. Provides flexible access control.	Google Cloud Identity and Access Management (IAM) provides flexible access control.
14	Data access	AWS Identity and Access Management (IAM) allows you to customize access policies.	Azure Active Directory (Azure AD) and Azure RBAC for access control.	GCP Cloud Identity & Access Management provides granular access control.
15	Physical security	Ensures physical security of its data centers and networks.		
16	Data protection	AWS also provides means to encrypt	Azure provides data encryption	Google Cloud offers wide range of tools

		data in different layers.	and key management tools.	for encrypting data at rest and in motion.
17	Monitoring and threat detection	AWS offers Amazon GuardDuty for threat detection and security monitoring.	Azure Security Center for threat monitoring and detection.	Google Cloud offers Chronicle for threat detection and analysis.
18	Flexibility	Highly flexible to respond quickly to changing business needs.	Mid-level flexibility, more integrated with Microsoft solutions.	Good flexibility, especially when combined with Kubernetes and other tools.
19	Deployment speed	Rapid deployment of resources and services, enabling faster launch of new products and projects.	Deployment may take longer, but is integrated with other Microsoft products.	Relatively fast deployment, especially using templates and automation.
20	Cost and economic efficiency	AWS provides wide range of pricing models and payment options that can help optimize costs.	Azure also offers flexible pricing options, but is integrated with other Microsoft solutions.	GCP offers similar pricing options, with emphasis on simplicity and transparency in pricing.

The choice of cloud provider depends on project developers specific requirements, budget and preferences.

The selected characteristics will help determine which cloud provider best meets the needs of particular type of business and IT infrastructure. It is also important to consider specifics of organization, project timelines and budget constraints.

IV. RESULTS

The results of research conducted will help determine characteristics of each these giants, and hallmark of this study is to determine impact of these cloud providers on business processes and IT infrastructure while taking into account security issues addressed. As result, choosing best partner for cloud services.

So, having analyzed cloud providers according to selected criteria (Figure 1).

Figure 1 proposes diagram in which providers have been evaluated for competitiveness, which includes analyzing various aspects and characteristics. The cloud providers (AWS, Azure and GCP) are compared on a scale: 1 – best option, 2 – average option and 3 – worst option with emphasis on security of these providers and evaluating impact each of them on business processes and IT infrastructure.

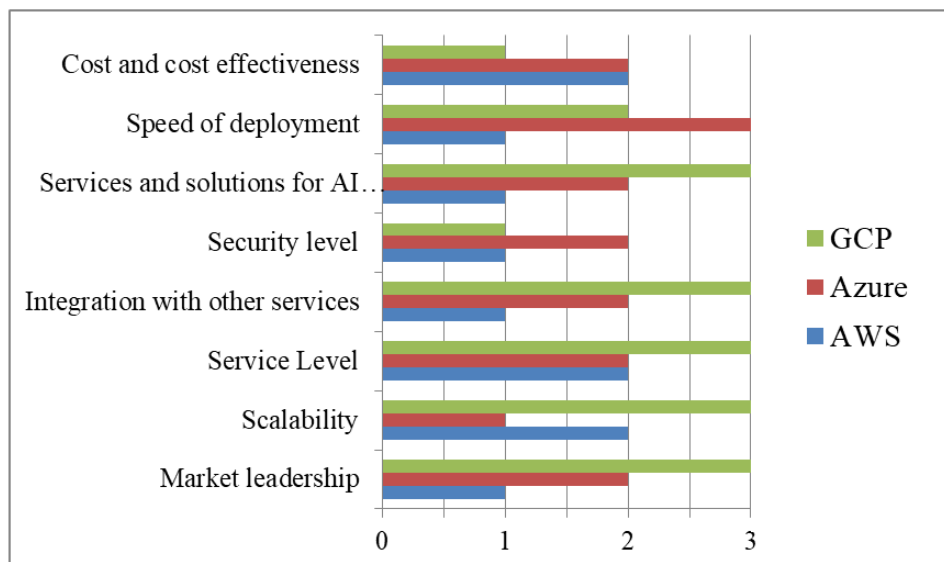


Figure 1 – Diagram comparing AWS, Azure, and GCP

Based on research conducted, following conclusions can be drawn:

- AWS is leader with high security, scalability, and wide range of integrated services. AWS is rated by us as best option;
- Azure provides medium level of services and security, with deep integration into Microsoft ecosystem – this is middle option;
- GCP provides good level of security and fast deployment, but is rated as worst option due to lower scalability and service levels.

V. DISCUSSION

Taking into account results of research conducted to determine impact of advanced cloud providers such as AWS, Azure, GCP on business processes, information technology infrastructure and based on analysis conducted taking into account performance, functionality and security of these providers, several key conclusions can be drawn:

- AWS is leading the way, as this result is evidenced by its high level of security, flexibility and extensive set of integrated services. AWS gives companies ability to build and grow complex information infrastructures with high degree of reliability and security. Companies that are scalability-oriented and ready to invest in cloud solutions can find optimal partner in AWS;
- mid-tier – Azure, as Microsoft Azure provides mid-tier level of services and security. It stands out for its deep integration into Microsoft ecosystem, making it attractive choice for companies that already use Microsoft products or wish to integrate them into cloud environment. However, Azure can be less flexible than AWS, which can require additional effort in planning and resource management;
- relatively "low tier" – GCP, although this provider provides good level of security and fast application deployment. However, GCP's ranking as worst option is due to its more limited scalability and service levels. This provider may be attractive to innovation-oriented companies willing to utilize Google's advanced technologies, but it may require additional effort to ensure scalability as business grows.

In any case, it is important to consider specifics of each particular organization, project timelines and budget constraints.

VI. FUTURE RESEARCH

Future research can investigate timing of real-world projects and service level definitions.

VII. CONCLUSION

As result of research conducted on cloud giants such as Amazon Web Services, Azure and Google Cloud Platform and then comparing them in detail, 20 characteristics of their performance are highlighted. A competitive evaluation of providers has been done, which includes analysis of various aspects and characteristics that are important to organizations and customers using cloud services. A comparative table and diagram based on which, taking into account such key features as security, impact of providers on business processes and IT infrastructure of company showed that each of them has its own features and limitations, is given.

VIII. DISCLOSURES

We declare that there are no conflicts of interest associated with this work.

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