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A comparison of AWS services with traditional solutions

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Abstract: AWS offers a wide range of services and resources that enable organizations to scale their applications, store data, and manage cloud infrastructure. This paper presents key AWS services, analyzes their architecture, and explores their applications in various industry sectors. Different service categories will be presented, including cloud computing (EC2), data storage (S3, EBS), databases (RDS, DynamoDB), networking and content delivery (VPC, CloudFront), analytics and machine learning (Athena, SageMaker), and many others. Special attention will be given to the characteristics, functionalities, and advantages of each service, with an emphasis on scalability, security, reliability, and flexibility provided by AWS.

Keywords: Amazon Web Services, AWS, cloud computing, services, architecture, scalability, security, on-prem, traditional approach

1. Introduction

The term Cloud Computing refers to computer resources made available to users from remote locations, typically via the Internet, as well as the delivery of various applications from these resources. Essentially, cloud computing is virtual networking, where one program simulates the operation of one or more server computers [1].

The advantages of AWS over traditional approaches are enormous. Data protection, regulatory compliance, quantity, flexibility, cost-effectiveness, redundant storage, automatic scaling, on-demand data access, data-centric encryption, and high-performance processing are the benefits of AWS cloud. In the AWS concept, there are six main advantages of cloud computing⁷:

- GO GLOBAL IN MINUTES – Programming global applications with just a few clicks, spanning multiple continents with minimal data latency.
- STOP SPENDING MONEY ON DATA CENTERS – Focus on application development, not hardware, and invest in application development.
- BENEFITS FROM MASSIVE ECONOMIES OF SCALE – Discounts on data quantities used by large companies due to the "pay as you go" or "pay as you use" payment model, impossible to match the server capacity that Amazon possesses.
- INCREASE SPEED AND AGILITY – Improved services for fast applications and data throughput offered by Amazon.
- GUESSING CAPACITY – Eliminate worries about space; AWS allows matching space precisely to our needs.
- TRADE CAPITAL EXPENSE FOR VARIABLE EXPENSE – Pay for what is consumed, without excessive upfront investments.

2. Cloud Computing

Cloud computing represents a revolutionary concept that has changed the way organizations access and manage IT resources [5]. Instead of the traditional approach with local hardware and infrastructure, cloud computing allows access to resources via the Internet, providing flexibility, scalability, and cost-effectiveness. One of the key cloud service providers is Amazon Web Services (AWS), which has become an industry leader⁸, offering a wide range of services and resources for various organizational needs [1].

Amazon Elastic Compute Cloud (EC2) is one of the most important services provided by AWS in its cloud computing portfolio. EC2 allows users to virtually lease computing resources, such as virtual machines (instances), in a scalable and secure environment. Users can customize their instances according to their needs for processing power, memory, storage, and network capacity. EC2 offers numerous advantages that are crucial for organizations. Firstly, it enables users to quickly access and launch new instances, eliminating the need for physical procurement and hardware configuration. Additionally, EC2 provides

⁷ According to the official AWS Cloud Practitioner course

⁸ According to research at the end of 2022, it has been confirmed that AWS has the highest profit in the cloud market.

scalability, allowing users to increase or decrease resource capacities in response to changing application requirements. This flexibility enables efficient resource usage and cost optimization. The use of the EC2 service can be observed in web application hosting, as well as in running business applications and software development and testing.

Another important characteristic of EC2 is the ability to choose from various instance types that differ in performance, pricing, and specific functionalities. This way, users can tailor their instances to the specific requirements of their applications. Moreover, EC2 offers advanced capabilities concerning resource security and management. Users have control over network configuration, access, and the security of their instances. Additionally, AWS provides automatic infrastructure management services, ensuring high availability and reliability.

In traditional services, there is a risk of hardware failures, natural disasters, or power outages, which can impact their availability and reliability. Furthermore, they require the ownership of physical infrastructure on the company's premises, as well as significant investments for procurement and maintenance. The scalability of traditional services can be limited by resources that are pre-purchased and installed. Moreover, they are less flexible and require more time and resources for configuration and capacity changes [2].

3. Data Storage

Data storage is a key component of modern business operations. Amazon Web Services (AWS) provides several powerful cloud data storage services. Among the most popular and frequently used data storage services on the AWS platform are Amazon Simple Storage Service (S3) and Amazon Elastic Block Store (EBS).

Amazon Simple Storage Service (S3) is a cloud data storage and management service provided by Amazon Web Services (AWS). S3 is easy to use, reliable, and scalable, allowing users to store and retrieve any amount of data from anywhere via the internet.

Some of the advantages and features of the S3 service include:

- Object storage: S3 uses the concept of object storage, where data is stored as objects. Objects can be images, videos, documents, or any other digital data.
- Buckets: S3 organizes data into so-called buckets. A bucket is the basic storage unit in the S3 service and represents a logical container where objects are stored.
- Regions: S3 is available in various AWS regions worldwide. Users can choose the region in which they will create their buckets and store data.
- Security: S3 provides advanced security features to protect data. Users can configure access controls, and data encryption in transit and at rest, and implement other security mechanisms.
- Scalability: S3 is a highly scalable service that can adapt to users' changing needs. It can scale to support the storage and retrieval of large amounts of data.
- HTTP Interface: S3 provides an HTTP interface, enabling easy data management via APIs. Users can use the S3 API to add, retrieve, and delete objects, as well as configure access permissions.
- Pricing: S3 has a flexible pricing policy based on the amount of data users store and the amount of data transferred.

On the other hand, Amazon EBS is a block storage service that provides permanent, low-latency, and resilient storage for EC2 instances. EBS allows users to attach block devices (volumes) to their cloud-based virtual machines, providing data persistence. Users can dynamically manage their block devices, increasing their size, taking snapshots, or migrating them between instances. EBS data is fault-tolerant and ensures high availability. The combination of Amazon S3 and Amazon EBS services offers organizations flexibility and security when storing their data in the cloud. S3 is ideal for storing large amounts of data frequently used for analytics, backup, or archiving and managing them. On the other hand, EBS provides high-quality and fast storage for cloud-based virtual machines, allowing users to retain their data even during instance changes. The use of S3 and EBS services is evident in secure file storage and sharing, data backup, and hosting static web pages.

In the traditional approach to data storage, physical data storage on local servers and devices within the organization or company is prominent. This requires the procurement, maintenance, and management of proprietary data storage infrastructure. Capacity is limited by physical resources and the infrastructure owned by the organization. Increasing capacity would entail additional investments and costs. Data availability can be restricted by local factors such as power outages, hardware failures, and natural disasters. Data loss is the most significant risk since data is not stored in remote locations, and often there is no backup. Data security in the traditional approach depends on the security mechanisms that the organization possesses and applies, including physical room security and access control.

4. Content Delivery

Network and content delivery are key aspects of cloud infrastructure, and Amazon Web Services (AWS) provides powerful services for network management and efficient content delivery. Two key services for these purposes are Amazon Virtual Private Cloud (VPC) and Amazon CloudFront.

CloudFront is a content delivery service within the Amazon Web Services (AWS) platform. It allows users to quickly and efficiently deliver their web applications, and static and dynamic content to users worldwide. CloudFront uses a network of global servers deployed at various locations known as Edge locations. When a user accesses a website or application hosted on CloudFront, the content is delivered from the nearest Edge location. This enables faster content delivery to users and reduces latency. CloudFront is a powerful and scalable service that enables users to quickly deliver their content to users worldwide. With a global network of Edge locations and numerous advanced features, CloudFront is a popular choice for accelerating the delivery of web pages and applications.

Amazon VPC is a service that allows users to build isolated and private virtual networks in the AWS cloud. VPC enables users to define their virtual network infrastructure, including IP addresses, subnets, routers, and access control. This service enables organizations to create secure environments for their cloud resources, isolated from other users and the public internet. VPC also provides the ability to establish secure VPN connections between user's local networks and VPC, allowing users to extend their existing network infrastructure to the cloud. The combination of Amazon VPC and Amazon CloudFront provides users with the ability to create a secure and scalable network infrastructure and efficiently deliver content to users worldwide. VPC enables organizations to build private networks and achieve a high level of security and control over their cloud resources. On the other hand, CloudFront provides fast and reliable content delivery, improves user experience, and optimizes application performance. The use of the CloudFront service can be observed in accelerating the delivery of web applications and content via a Content Delivery Network (CDN), resulting in faster page loading and a better user experience.

The traditional approach involves local content delivery through the organization's own network and infrastructure, including web servers and network equipment. Content is hosted and delivered directly from the organization. The content delivery capacity is limited by hardware resources. Increasing capacity may require additional equipment and infrastructure upgrades. Availability may be limited to the geographic region where the infrastructure is located. Content delivery over long distances may be slower and more susceptible to significant delays. Security depends on the organization's security mechanisms, including network protection, authentication, and authorization of access.

5. Databases

Databases on the Amazon Web Services (AWS) platform provide a flexible, scalable, and secure environment for storing and managing data. AWS offers various database services that cater to different user needs and requirements.

There are several database services, and some of them include [3, 6]:

- Amazon RDS (Relational Database Service): Amazon RDS is a service for managing relational databases. It supports popular databases such as MySQL, PostgreSQL, Oracle, SQL Server, and others. RDS provides automatic hardware management, upgrades, and security backups, making database administration easier.
- Amazon DynamoDB: DynamoDB is a fully managed service for fast and flexible NoSQL databases. It offers scalability without maintenance, high availability, and data replication capabilities worldwide. DynamoDB is an ideal choice for applications that require low latency and great flexibility in data handling.
- Amazon Aurora: Amazon Aurora is a highly available and scalable relational database compatible with MySQL and PostgreSQL. Aurora combines the performance of traditional relational databases with the flexibility and scalability of the cloud. It provides automatic data replication and quick recovery after a failure.
- Amazon Redshift: Redshift is a data warehousing and analytics service in a columnar format. It is specifically designed for fast queries and analytical workloads. Redshift enables efficient processing of large volumes of data and supports integration with various business intelligence tools.
- Amazon Neptune: Neptune is a cloud-based graph database service. This service allows the storage, management, and querying of graph data. Neptune is suitable for applications that require modeling relationships between data, such as social networks, search, recommendations, and similarity analysis.

The traditional approach involves installing databases and managing them on local servers and computers within the company. The capacity of local databases is limited by hardware resources and the company's infrastructure. The company is responsible for database management, maintenance, and database backups. This aspect, in addition to the costs of resources and infrastructure, also requires additional personnel. Unlike cloud services, where payment is based on usage, in the traditional approach, costs are much higher because funds are invested in licenses, space, and hardware.

6. Analytics and Machine Learning

Analytics and Machine Learning are key components in the AWS (Amazon Web Services) ecosystem that enable organizations to derive valuable insights from their data and develop intelligent applications. The combination of analytics and machine learning on AWS allows organizations to optimize their business processes, discover hidden patterns in data, predict future trends, personalize the user experience, and make informed decisions. AWS provides a wide range of tools, services, and resources to support these areas, making it easier for organizations to harness the power of analytics and machine learning in the cloud. AWS offers various data analytics services, including [3, 6, 7]:

- Amazon Redshift: This is a scalable and fast data warehousing service that enables organizations to analyze large volumes of data in real-time.
- Amazon Athena: This service allows for interactive SQL queries on data stored in Amazon S3 (Simple Storage Service) without the need to manage infrastructure.
- Amazon QuickSight: This is a business analytics service that enables the creation of interactive visualizations and reports from various data sources.

Machine Learning is also a significant field within AWS, and SageMaker is the primary machine learning service that provides a comprehensive environment for developing, training, and implementing machine learning models. SageMaker allows organizations to use various algorithms and frameworks for model development and training, such as TensorFlow, PyTorch, MXNet⁹, and others [8]. Additionally, AWS offers services for image recognition (e.g., Amazon Rekognition), natural

⁹ Libraries for developing and training machine learning models in the Python programming language.

language processing (Amazon Comprehend), and time series forecasting (Amazon Forecast). The combination of analytics and machine learning on AWS enables organizations to optimize their business processes, discover hidden patterns in data, predict future trends, personalize the user experience, and make informed decisions. AWS provides a wide range of tools, services, and resources to support these areas, making it easier for organizations to harness the power of analytics and machine learning in the cloud.¹⁰

Traditional data analytics, as well as the development of machine learning models, require the use of various tools and software that need to be configured and maintained separately. Additionally, infrastructure for analytics and machine learning must be provided, which may involve the purchase of additional hardware, server setup, network and software configuration. The level of security in this approach is lower than in a cloud environment.

7. Monitoring and Error Identification

Monitoring on AWS enables organizations to track, and analyze the performance of their cloud resources and applications, and manage them [6, 7].

- Amazon CloudWatch: CloudWatch is the central monitoring and management service on AWS. It provides detailed metrics, logs, and alarms for various AWS services such as EC2 instances, S3 storage, RDS databases, and many others. You can monitor resource performance, receive threshold alerts, generate reports, and analyze logs.
- Metrics and alarms: CloudWatch allows you to collect metrics on resources and applications, such as CPU load, network traffic, request counts, and more. You can set up alarms to notify you when a metric breaches a defined threshold, enabling you to respond to issues in real-time.
- Auto scaling: AWS enables automatic resource scaling based on performance metrics. For example, you can set up scaling policies that automatically increase the number of EC2 instances as load increases and decrease them as load decreases, ensuring optimal resource usage.
- Error tracking: CloudWatch Logs provide the option for collecting, monitoring, and analyzing logs from various sources, including applications, operating systems, and services. You can track errors, analyze the root causes of issues, and optimize application performance.

Monitoring on AWS allows organizations to maintain a high level of availability, efficiency, and security for their applications and resources. It provides insights into system performance, identifies issues, and enables timely responses to improve service quality.

In the traditional approach, error identification often occurs manually or through network and server monitoring tools. This may involve log tracking, reviewing system alerts, or manually monitoring system performance. Tools like SNMP¹¹ or performance monitoring tools are used. These tools provide information about the status of the network, servers, and applications but often require specific configurations and maintenance. The main difference between on-premises systems and AWS is that AWS offers integrated services that simplify error identification and system monitoring.

8. Security

Security is a crucial component of the AWS (Amazon Web Services) infrastructure. AWS provides various services and tools for protecting data and resources, as well as managing identities and access [6, 7].

- Identity and access: AWS Identity and Access Management (IAM) enables organizations to define users, groups, and roles, control resource access, and manage privileges. You can establish rules and policies that define who has access to specific resources and implement two-factor authentication for an additional layer of security.
- Data protection: AWS offers various mechanisms for data protection. S3 (Simple Storage Service) enables data encryption at rest and during transit. Amazon Key Management Service (KMS) provides key management for data encryption. You can use AWS CloudHSM for key management in a fully controlled environment.
- Network security: AWS Virtual Private Cloud (VPC) allows network traffic isolation and control. You can use network Access Control Lists (ACLs) and security groups to define access rules for resources. AWS Web Application Firewall (WAF) provides protection against web application attacks.
- Detection and prevention of fraud: AWS offers fraud detection and prevention services, such as Amazon GuardDuty, which analyzes network traffic and identifies unusual activities and potential threats. Additionally, you can use AWS Config to monitor configuration changes and detect irregularities.
- Compliance and certifications: AWS complies with various security standards and regulations, including ISO 27001, SOC 1 and SOC 2, HIPAA, GDPR¹², and others. AWS provides detailed security information and offers certificates to confirm compliance with relevant standards.

Security on AWS is continuously updated and advanced, providing organizations with a secure environment for data storage and processing. AWS continually works on enhancing security features and providing tools and resources to assist users in implementing best security practices.

In traditional systems, organizations are responsible for all aspects of security, including network protection, server security, data protection, and applications. This requires the implementation and maintenance of security measures such as

¹⁰ "Amazon Web Services in Action" – Andreas Wittig, Michael Wittig, Manning Publications, 2015.

¹¹ Simple Network Monitoring Tools

¹² Privacy rules and laws.

firewalls, antivirus programs, encryption, and more. Organizations are also responsible for physical security, including server access control, protection against theft or hardware damage, and other security measures. Organizations must monitor and analyze security events and incidents using network and log monitoring tools to identify potential threats and respond to them.

Both environments, in terms of security, require careful planning, configuration, and monitoring. AWS provides many security services and tools that can be useful in protecting infrastructure and data, but it still requires active user involvement in configuring and implementing the right security measures.

9. Payment Methods

On the Amazon Web Services (AWS) platform, there are different payment methods for using the services.

- Pay-as-you-go model: AWS uses a pay-as-you-go model, which means you only pay for the resources you actually use. There is no minimum usage or contractual commitment. Costs are calculated based on the usage of resources such as virtual machines, data storage, network traffic, and more.
- Amazon Simple Monthly Calculator: AWS provides a calculation tool that allows you to estimate the monthly costs of using AWS services. You can enter information about the type and quantity of resources you plan to use, and the calculator will show you estimated monthly costs.
- AWS Billing and Cost Management: AWS provides tools for tracking and managing the costs of using services. You can monitor consumption, set budget alerts, and adjust settings to optimize costs. Additionally, you can generate cost reports and access detailed information about all billing items.
- Amazon Elastic Compute Cloud (Amazon EC2) Reserved Instances: AWS allows you to reserve virtual machines for longer periods (one year or three years) at significantly lower prices compared to the pay-as-you-go model. This option is suitable for long-term projects or applications with stable or predictable resource needs.
- Cost management: AWS provides tools and resources for cost management, such as AWS Budgets, Cost Explorer, and AWS Cost Optimization. These tools help you track and optimize resource consumption, identify potential savings, and make budget-related decisions.

In a traditional on-premise system, organizations typically make a capital investment when it comes to acquiring hardware, software, and infrastructure. This involves allocating a significant upfront sum of money for purchasing and setting up the system. Additionally, there are ongoing costs for purchasing licenses, support, updates, and maintaining the system in a functional state over time. The system lacks the ability to scale on-demand, and additional investment is required to purchase or replace hardware and infrastructure to accommodate the organization's growing needs.

The key advantage of AWS is the flexibility in resource payment and scaling according to the organization's needs. It allows organizations to adjust their costs and take advantage of the pay-as-you-go payment model.

10. Customer Support

AWS offers various levels of support known as Support Plans [4].

- Free Tier Support: All AWS users are entitled to free support, which includes access to AWS documentation, user forums, and self-help resources. This support is available 24/7 and provides basic information and guidance on using AWS.
- AWS Support Basic: AWS Support Basic is a paid support plan that provides users with additional benefits, such as direct communication with the AWS support team via email, access to a customer forum with responses within 24 hours, and support for third-party operating systems and applications.
- AWS Support Developer: The AWS Support Developer plan offers more advanced features, including access to AWS technical staff via email, chat, or phone. This support plan also includes additional tools for monitoring and analyzing system performance.
- AWS Support Business: Business Support is a higher-level support plan that provides priority support, additional cost management tools, and access to AWS Trusted Advisor for optimizing architecture and resources. This support plan also includes direct contact with AWS technical staff via phone 24/7.
- AWS Support Enterprise: Enterprise Support is the highest level of support plan, offering the highest level of support and benefits. This support plan includes a rapid response to critical issues, customized training, architectural advisory support, and direct access to technical staff via phone, email, or chat.

Unlike AWS solutions, in traditional systems, customer support is typically provided by the IT team or help desk team, responsible for resolving issues and providing support to users. Internal support in such a system often has limited resources, both in terms of the number of support experts and availability. This can lead to longer response and problem-resolution times.

The key advantage of AWS in terms of customer support is the availability of a large number of expert support teams, a wide range of contact channels, and 24/7 support availability. Additionally, support is provided for different levels of users, from beginners to advanced users and environments. This also includes a wide range of different issues they may encounter, practically meaning that there is no problem they cannot resolve.

11. Network Services

AWS provides various network services that allow users to build and manage their cloud-based network infrastructure [6, 7].

- Amazon Direct Connect: Amazon Direct Connect enables users to establish a private connection between their on-premises infrastructure and AWS. This connection provides high capacity, and low latency, and enhances the security of communication between the on-premises environment and AWS.
- Elastic Load Balancer: Elastic Load Balancer (ELB) is a load balancing service that distributes incoming network traffic across multiple instances or services to achieve high availability and scalability. ELB automates the load-balancing process, allowing efficient traffic management and preventing the overloading of individual resources.
- Amazon Route 53: Amazon Route 53 is a DNS management service that allows users to register domains, manage DNS records, and route traffic to the appropriate resources. Route 53 provides high availability, reliability, and scalability for managing DNS infrastructure.
- AWS PrivateLink: AWS PrivateLink allows users to privately connect their VPCs to supported AWS services and third-party services over a private network. This service eliminates the need for public IP addresses and encrypts traffic, ensuring secure and private communication.

These network services provide flexibility, scalability, and security for building and managing cloud-based network infrastructure. Users can configure network resources according to their needs and optimize the performance and security of their applications and services on AWS.

AWS has a global presence and utilizes highly available network services. They have fault-tolerant architectures such as Availability Zones (AZs) and Regions, ensuring high availability and reliability of network services. In an on-premises system, organizations must provide redundancy and backup systems themselves to achieve high availability.

Additional information or data may be provided in an appendix, such as explanations of experiment details that could disrupt the flow of the main text but are essential for understanding and replicating the research presented in the main text, that is, figures or replicas related to experiments for which representative data is mentioned in the main text. The appendix can also be used for conducting mathematical proofs of results that are not of fundamental significance to the work.

12. Conclusion

AWS offers a wide range of services that enable organizations to harness the benefits of the cloud and develop scalable, secure, and highly available applications. AWS provides infrastructure services such as Amazon EC2 for virtual machines and Amazon S3 for data storage, as well as services for data analytics, machine learning, network security, automation, and many others. The application of AWS services is diverse and includes various industries and verticals. Organizations can use AWS services to build and manage web applications, store and analyze data, develop and deploy machine learning models, perform complex analytics, support Internet of Things (IoT) solutions, and more. AWS provides a high level of security with tools and data protection mechanisms, identity and access management, as well as resource monitoring and management.

It has become evident that AWS services have become an indispensable part of the infrastructure and technological strategy for many organizations worldwide. The flexibility, scalability, security, and wide range of services make AWS a leader in the field of cloud computing.

AWS services empower organizations to innovate rapidly, efficiently use resources, and gain competitive advantages.

The choice between AWS services and on-premises systems depends on various factors such as business requirements, budget, security needs, and the IT resources of the organization. Many organizations opt for a hybrid approach, combining the benefits of AWS with on-premises systems to leverage the scalability and flexibility of the cloud while retaining control over certain parts of the infrastructure on-premises.

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