# Providers Comparison

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| Virtual Instances | | | | |
|---|---|---|---|---|
| | Amazon Web Services<br>AWS | Google Cloud Platform<br>GCP | Microsoft Azure | IBM Cloud |
| 1. Architecture | Amazon Elastic Compute Cloud (Amazon EC2) is built on a infrastructure that uses Nitro hypervisor. | Google Compute Engine utilizes the open-source KVM hypervisor. | Azure Virtual Machines (VMs) are built on top of the Microsoft Hyper-V hypervisor, which provides hardware virtualization. | IBM Cloud gives user the choice to select hypervisor providers from the following - XenServer (Citrix), VMware, and Hyper-V |
| 2. Networking | Amazon VPC enables you to launch AWS resources, EC2 instances, into a virtual network dedicated to your AWS account, known as a virtual private cloud (VPC) | Google Cloud also uses Virtual Private Cloud (VPC) networks to provide connectivity for your VM instances. | Azure uses Virtual Networks (VNets) that allows instances and other resources to securely communicate with each other. | IBM Cloud uses Virtual Private Cloud (VPC) that gives instances - cloud security, with the ability to scale dynamically. |
| 3. Instance Types | EC2 provides a broad range of instance types, including T3, M5, M7, C7, C6, C5 R5, and P3 instances. These instances vary in terms of CPU, memory, storage, and networking capabilities. | GCP offers mainly 5 Machine Families (or instance types) - E, N, C, M, GPU. These machine families are curated with a set of processor and hardware configurations optimized for specific workloads. | Azure VMs offer a variety of sizes and series, such as B-series, D-series, F-series, and N-series. Each series is designed for specific workload requirements, offering different combinations of CPU, memory, and storage capacities. | IBM Cloud users can select from seven families of profiles: Balanced, Compute, Memory, Ultra High Memory, Very High Memory, Storage Optimized, and GPU.<br>A profile is a combination of instance attributes, such as the number of vCPUs, amount of RAM, network bandwidth, etc. |
| 4. OS and Images | AWS EC2 supports a wide range of operating systems, including various Linux distros, Windows versions, and other specialized OS options. Users can choose from pre-configured Amazon Machine Images (AMIs) provided by AWS or create custom AMIs as per their specific requirements. | GCP also support variety of OS, including different versions of Windows, Linux, and specialized OS images. Uses can choose from one of the following OS image types:<br>Public OS images or Custom OS images. | Azure VMs also support large number of operating systems, including different versions of Windows Server, Linux distributions, and specialized OS images. Users can select from a marketplace catalog of VM images or create custom images using Azure VM image builder | Similarly IBM cloud instances number of operating systems, including different versions of Windows Server, Linux distributions. Users can select from the supported virtual server operating system stock images, the virtual server operating system bundle stock image, or a custom image that you import from IBM Cloud Object Storage |
| 5. Scalability and Auto Scaling | AWS uses AWS Auto Scaling that monitors applications and automatically adjusts capacity to maintain steady performance at lowest possible cost. AWS Auto Scaling can setup scaling for multiple resources and provides simple user interface. | GCP uses Managed Instance Groups (MIGs) that offer autoscaling capabilities and let user automatically add or delete virtual machine (VM) instances based on load. Autoscaling helps your apps gracefully handle increases in traffic and reduce costs when the need for resources is lower. | Similar to others Azure uses Azure Virtual Machine Scale Set that can increase or decrease the number of VM instances to reduces the management overhead to monitor and optimize the performance of your application. | IBM also offers rich Autoscaling panel that allows users to auto scale, based on usage over time. Autoscaling is designed to respond to the short-to-medium term trends in resource usage |
| 6. Pricing | AWS has a complex pricing structure. It also has a free usage tier across various services, available for the first year after sign-up. | GCP offers competitive discounts, free tier and a $300 credit. Another key differentiator is that Google charges per second of resource usage, compared to the per minute charging model of AWS and Azure. | As with AWS, Azure pricing can get quite complex. Like AWS, Azure has a free usage tier, and also offers a $200 credit for new sign ups. | IBM offers a free products and a $200 credit. |


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| Managed SQL Database | | | | |
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| | Amazon Web Services AWS | Google Cloud Platform GCP | Microsoft Azure | IBM Cloud |
| 1. Cost | Pay based on hardware resources (CPU, RAM, storage, network), with additional costs for backups and data transfer. This applies to both Amazon RDS and Amazon Aurora. | Pay-as-you-go model based on resource usage (vCPUs, memory, storage, network egress), offering flexibility and scalability. | Costs based on database size, service tier, concurrent connections, and throughput levels, with options for different purchasing models. | Upfront licensing costs and maintenance fees, less flexible with significant initial and ongoing expenses, but cloud-based options offer more flexibility. |
| 2. Use case | Amazon RDS supports both OLTP and OLAP workloads, with the ability to integrate Oracle OLAP for complex queries. Amazon Aurora, compatible with MySQL and PostgreSQL, efficiently handles both OLTP and OLAP tasks. | Offers a range of database services for both OLTP and OLAP, with BigQuery specifically designed for analytical workloads. | Supports both OLTP and OLAP but may not be as optimized for complex analytics as dedicated data warehousing solutions. | Versatile database management system supporting a wide range of workloads, including OLTP and OLAP, with dedicated analytics platforms available for more intensive processing. |
| 3. Data Transformation | Requires integration with other AWS services like AWS Glue and Amazon EMR for data transformation. | Offers a comprehensive set of tools and services for data transformation and integration, facilitating ETL operations, real-time data processing, and advanced analytics. | Supports data transformation through SQL Server Integration Services (SSIS), Azure Data Factory, and Azure Databricks. | Provides robust data transformation capabilities through a suite of integrated tools and services, including InfoSphere DataStage, SQL PL, Data Replication, Cloud Pak for Data, and Data Virtualization. |
| 4. Query Language | Support standard SQL and are compatible with MySQL and PostgreSQL. | Offers robust support for standard SQL across its relational database services, with additional features for distributed databases (Cloud Spanner) and specialized query languages for other services (Firestore and Bigtable). | Supports T-SQL, Microsoft's proprietary SQL language optimized for SQL Server and Azure SQL Database. | Supports the SQL standard with its own extensions and enhancements, providing advanced features for data management and analytics. |
| 5. Disaster Recovery | Both Amazon Aurora and Amazon RDS achieves disaster recovery using cross-region read replicas and cross-region automated backups. | Leverages read replicas for disaster recovery, with options for regional or multi-regional replicas, acknowledging potential data loss due to asynchronous replication. | Offers deployment options for achieving high availability and disaster recovery, including deployment across multiple regions. | While reliable, may require additional configuration for implementing high availability and disaster recovery solutions. |
| 6. Machine Learning Support | Integrates with AWS SageMaker for machine learning capabilities. | Offers various services like BigQuery ML, Vertex AI, and AutoML for building machine learning models directly on data stored in Google Cloud databases. | Integrates with Azure Machine Learning and supports in-database machine learning with Microsoft R and Python. | Integrates with Watson Studio, Watson Machine Learning, SPSS Modeler, and Cloud Pak for Data, providing comprehensive support for building and deploying machine learning models directly on data stored in Db2. |


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| Emerging Technologies - Machine Learning | | |
|---|---|---|
| | Amazon Web Services<br>AWS | Google Cloud Platform<br>GCP |
| 1. Products | AWS offers three powerful tools: Amazon SageMaker for comprehensive machine learning on EC2 instances, Amazon Lex for integrating chatbots with natural language processing and speech recognition, and Amazon Rekognition for advanced computer vision tasks like face and object recognition. | Google provides several powerful machine learning tools: Google Machine Learning Engine for complex tasks using GPUs and TPUs with automated resource management, Google Cloud AutoML for beginner-friendly model training and testing, TensorFlow for deep learning and numerical computation, and Vertex AI for MLOps with pre-trained APIs for NLP and computer vision. |
| 2. Data Services | AWS provides services such as Amazon Redshift for data storage and Amazon DynamoDB for NoSQL databases, which can be used in conjunction with AI applications. | GCP offers BigQuery for data analytics and Bigtable for NoSQL database needs, which can be integrated with AI workloads. |

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| Emerging Technologies - Internet of Things | | |
|---|---|---|
| | Amazon Web Services<br>AWS | Microsoft Azure |
| 1. Architecture | AWS IoT provides a scalable and secure cloud-based platform for building and deploying IoT solutions, with a focus on serverless architecture and powerful local computing via AWS IoT Greengrass. | Azure IoT also offers a scalable and secure cloud-based platform for IoT solutions, emphasizing modularity and providing a ready-to-use IoT application through Azure IoT Central. |
| 2. Integration | AWS IoT provides a range of SDKs, APIs, and tools for building IoT solutions and integrating them with other cloud services. It offers secure and scalable connectivity options for connecting devices to the cloud and edge computing capabilities for processing and analyzing data at the edge. A key feature is AWS IoT Greengrass, which provides local computing and messaging capabilities at the edge. | Azure IoT also offers a range of SDKs, APIs, and tools for building IoT solutions and integrating them with other cloud services. It provides secure and scalable connectivity options for connecting devices to the cloud and edge computing capabilities. A notable feature is Azure Functions, a serverless computing service for real-time data processing. |

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