CASE STUDY

CLOUD COMPUTING

COCSC15

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Google Cloud Platform

INTRODUCTION

Google Cloud Platform (GCP), offered by Google, is a suite of cloud computing services that runs on the same infrastructure that Google uses internally for its end-user products.

Google Cloud consists of a set of physical assets, such as computers and hard disk drives, and virtual resources, such as virtual machines (VMs), that are contained in Google's data centers around the globe. Alongside a set of management tools, it provides a series of modular cloud services including computing, data storage, data analytics and machine learning.

TYPE OF CLOUD

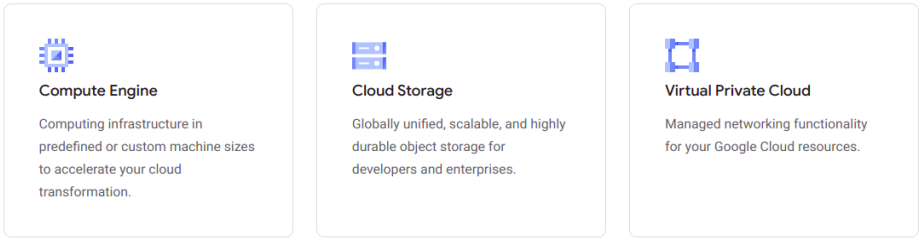
Google cloud offers a *public cloud deployment* model where other organizations and users outside Google can use and employ services as and when they are required.

TYPES OF SERVICES

Google Cloud Platform provides infrastructure as a service, platform as a service, and server less computing environments.

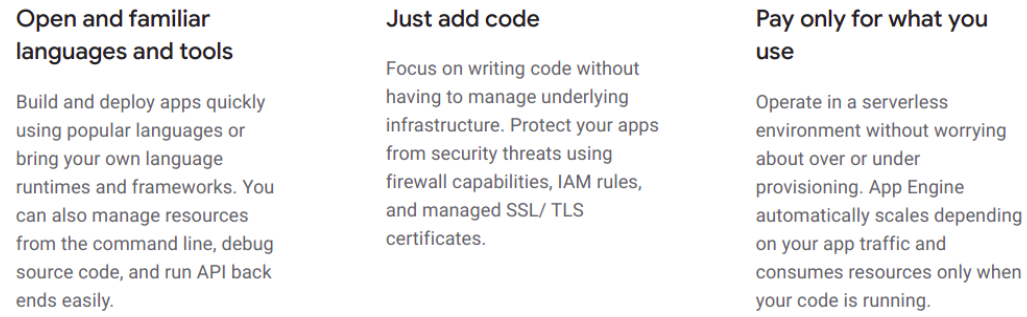
- **Infrastructure as a Service**

Google Cloud's IaaS products allow enterprises to mix and match services into combinations that provide the precise environment they need. IaaS services at google cloud allow users to run testing and deployment cycles, improve disaster recovery, perform big data analytics, and handle scaling and provisioning required resources quickly. Some products offered in the IaaS domain are:

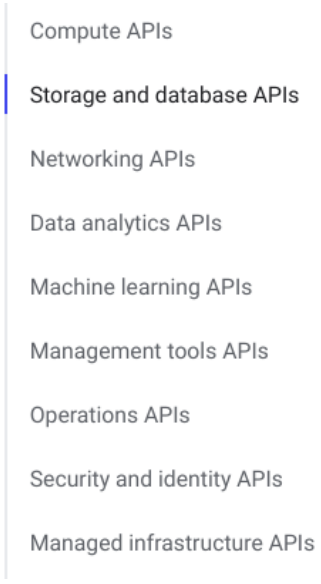


- **Platform as a Service**

Google cloud's app engine is the best example of providing a platform as a service. It is used for building web applications and mobile backend using container instances preconfigured with one of several available runtimes, each of which include a set of standard App Engine libraries. Some key benefits include:



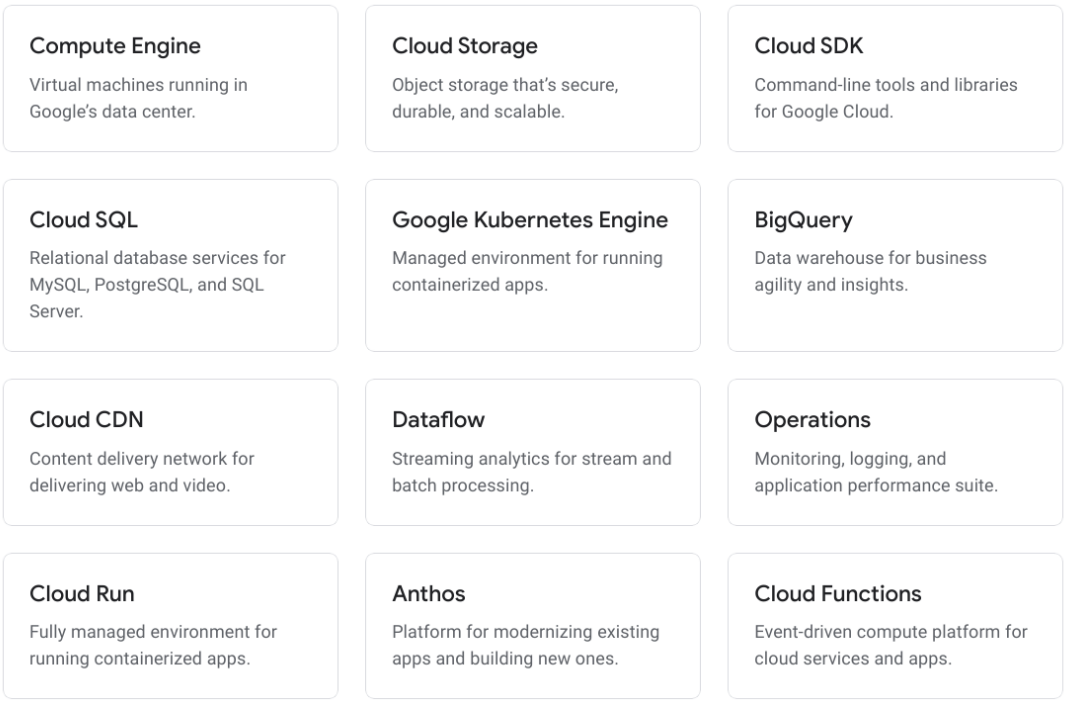
- **Software as a Service**



Google cloud provides multiple services such as Anthos, Kubernetes Engine and a large number of APIs as SaaS offerings. These services not only are SaaS but also help other users to build efficient and scalable SaaS products. They open users to cutting-edge data analytics, and machine learning capabilities along with efficient management of users and deployment.

PRODUCTS

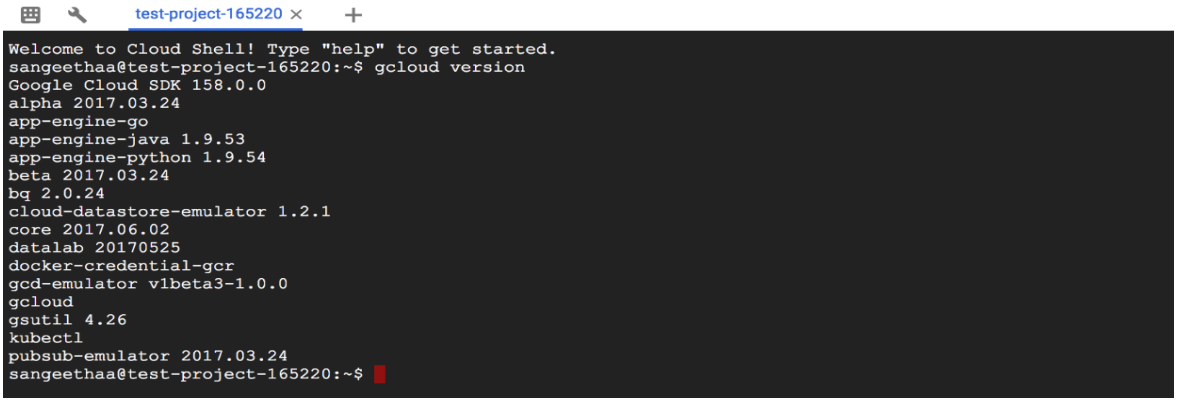
Google cloud features over 100 products through its services. Customers interacting with the products interact in a pay-as-you-use type architecture.
Some of the featured products that the platform offers are:



INTERACTION MEDIUMS

Google Cloud provides three basic ways to interact with the services and resources.

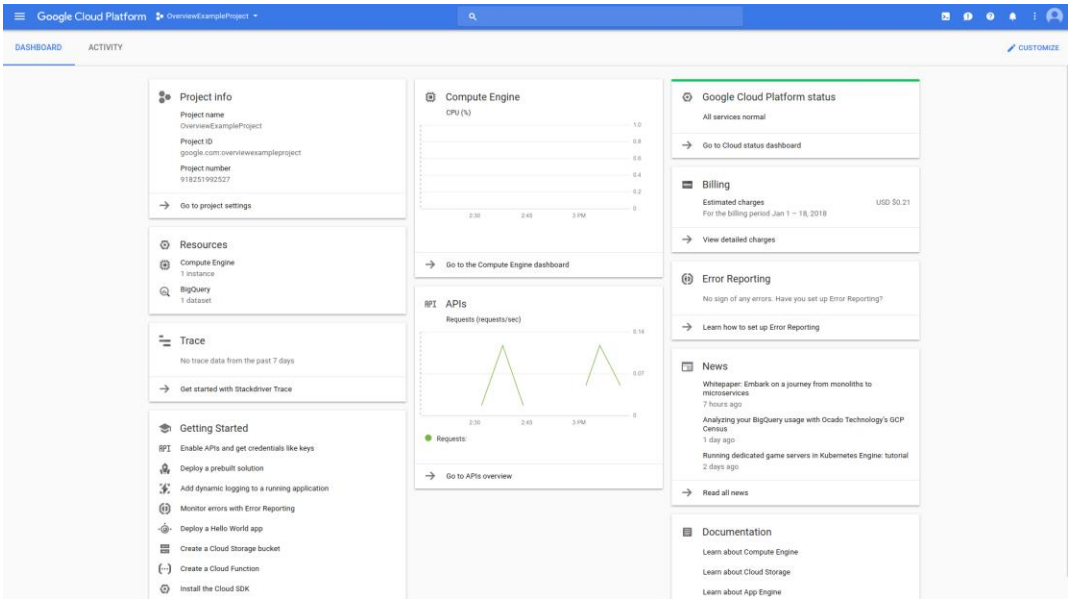
- **COMMAND-LINE INTERFACE**



Most Google Cloud tasks can be performed by using the gcloud command-line tool. The gcloud tool lets you manage development workflow and Google Cloud resources in a terminal window. **gcloud** commands can be run by using the google Cloud SDK or the Cloud Shell interfaces.

- **GOOGLE CLOUD CONSOLE**

The Google Cloud Console provides a web-based, graphical user interface that can be used to manage Google Cloud projects and resources. When you use the Cloud Console, you either create a new project or choose an existing project, and then use the resources that you create in the context of that project.



- **CLIENT LIBRARIES**

Google Cloud provides client libraries that enable easy creation and management of resources. Google Cloud client libraries expose APIs for two main purposes:

- *App APIs* provide access to services. The libraries are designed around service metaphors, so you can work with the services more naturally. The libraries also provide helpers for authentication and authorization.
- *Admin APIs* offer functionality for resource management for facilitation in building automated tools.

Amazon Web Services (AWS)

INTRODUCTION

Amazon Web Services (AWS) is the world's most comprehensive and broadly adopted cloud platform, offering over 200 fully featured services from data centers globally. Millions of customers—including the fastest-growing start-ups, largest enterprises, and leading government agencies—are using AWS to lower costs, become more agile, and innovate faster.

AWS has significantly more services, and more features within those services, than any other cloud provider–from infrastructure technologies like compute, storage, and databases–to emerging technologies, such as machine learning and artificial intelligence, data lakes and analytics, and Internet of Things. This makes it faster, easier, and more cost effective to move existing applications to the cloud and build nearly anything you can imagine.

TYPE OF CLOUD

Amazon web services is a public cloud, that is, it is available to everyone over the internet and is owned and managed by amazon.com Inc.

TYPE OF SERVICES

AWS provides all Infrastructure as a service, platform as a service as well as software as a service. AWS is PaaS or IaaS or SaaS. Each service of Amazon has its own merits and flaws and is suitable for the specific needs of a company.

- ## Infrastructure as a service

What is AWS IaaS? IaaS or Infrastructure as a service is one of Amazon Web Services that focuses on providing infrastructure services based on cloud computing technology. It has clients in 190 countries and 66 available Zones within 21 geographic regions. IaaS Amazon Service is used to replace physical resources, such as servers, with virtual resources hosted and managed by Amazon. System users can run any operating system or application on these leased servers, without incurring any extra fees for maintenance and operation.

All these features make AWS IaaS a widely-used platform by companies nowadays. **Magento** can be considered a typical example of IaaS in AWS.

AWS IaaS Benefits

- Availability of separate development environment
- Hardware and operating system specifications for the service can be selected and used directly from the network
- Allow expanding the resources of the server in terms of quantity and functionality
- No errors or extra costs arise while upgrading the system

- ## Platform as a service

Among 3 Amazon service solutions that apply cloud computing technology namely Iaas Paas Saas AWS, PaaS plays an important role in simplifying the application development process on the web. With cloud technology, developers can access the platform data from anywhere. This can facilitate project development on a global scale. However, it also means that the developers will have less control over the application design environment.

AWS SaaS benefits

- ➔ Able to use directly over the network without having to install any software.
- ➔ All data can be stored on the Internet.
- ➔ Data can be accessed via any device, as long as an Internet connection is available.
- ➔ Multiple users can access the same data warehouse.
- ➔ Quick setup and operation of advanced applications.

- **Software as a service**

Apart from AWS IaaS Paas, Amazon also includes SaaS in its services. This Software as a service (also called Web-based software, on-demand software, or hosted software) is a software distribution model whose applications are hosted and made discoverable to the customers over the Internet. When embracing this solution, you will have access to the application, along with its security, availability, and performance managed by the provider. SaaS is also one of Amazon's web services favored by a large number of users worldwide.

AWS SaaS benefits

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PRODUCTS

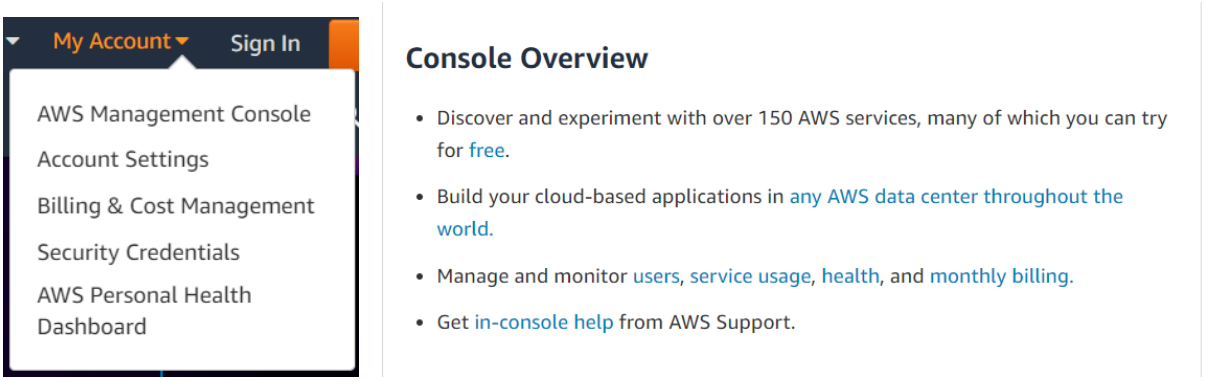
Amazon Web Services offers a broad set of global cloud-based products including compute, storage, databases, analytics, networking, mobile, developer tools, management tools, IOT, security and enterprise applications. These services help organizations move faster, lower IT costs, and scale.

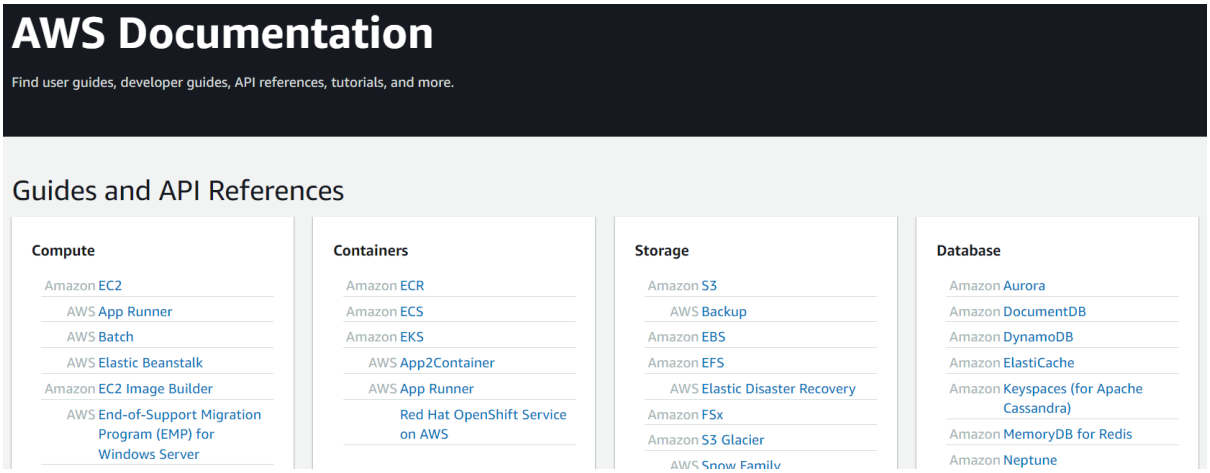
It offers more than 200 products including machine learning, amazon augmented artificial intelligence, database, business analytics, compute engine for raw computing power and many more.

INTERACTION MEDIUMS

AWS offers extensive documentation to use its services and products as well as AWS management console using which users can easily manage their existing resources, issue more cloud resources and get their billing summary.

It also helps corporations to manage the admins in their cloud project and change security credentials and settings, and manage permissions.





SECURITY

AWS is architected to be the most flexible and secure cloud computing environment available today. Our core infrastructure is built to satisfy the security requirements for the military, global banks, and other high-sensitivity organizations. This is backed by a deep set of cloud security tools, with 230 security, compliance, and governance services and features. AWS supports 90 security standards and compliance certifications, and all 117 AWS services that store customer data offer the ability to encrypt that data.

Identity & access management

Securely manage access to services and resources	Identity & Access Management (IAM)
Cloud single-sign-on (SSO) service	AWS Single Sign-On
Identity management for your apps	Amazon Cognito
Managed Microsoft Active Directory	AWS Directory Service

Infrastructure protection

Network security	AWS Network Firewall
DDoS protection	AWS Shield
Filter malicious web traffic	AWS Web Application Firewall (WAF)
Central management of firewall rules	AWS Firewall Manager

Data protection

Discover and protect your sensitive data at scale	Amazon Macie
Key storage and management	AWS Key Management Service (KMS)
Hardware based key storage for regulatory compliance	AWS CloudHSM
Provision, manage, and deploy public and private SSL/TLS certificates	AWS Certificate Manager

Microsoft Azure

INTRODUCTION

Microsoft Azure, often referred to as Azure is a cloud computing service operated by Microsoft for application management via Microsoft-managed data centers. Azure is a complete cloud platform that can host your existing applications and streamline new application development. Azure can even enhance on-premises applications. Azure integrates the cloud services that you need to develop, test, deploy, and manage your applications, all while taking advantage of the efficiencies of cloud computing.

At its core, Azure is a public cloud computing platform—with solutions including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) that can be used for services such as analytics, virtual computing, storage, networking, and much more. It can be used to replace or supplement your on premise servers and supports many different programming languages, tools, and frameworks, including both Microsoft-specific and third-party software and systems.

TYPE OF CLOUD

Microsoft Azure is an example of a public cloud. With a public cloud, all hardware, software and other supporting infrastructure is owned and managed by the cloud provider. You access these services and manage your account using a web browser.

TYPES OF SERVICES

Azure offers all three of the core service models and depending on which of Azure's many services you opt for, you can take advantage of IaaS, PaaS, and SaaS on Microsoft's cloud platform.

- **IaaS ON AZURE**

Azure's IaaS offering lets customer's outsource all their network and computing needs to Microsoft, removing all infrastructure from the customer's own servers and basing it all at Microsoft's end. All infrastructure is managed on the customer's behalf, leaving you to purchase, install, configure, and operate the software that runs on it, such as operating systems, apps, and middleware.

Azure can provide a virtual data center, complete with security features, through which businesses can host websites, store and backup data, develop and test environments, build web apps, and run high-performance computing.

Azure offers a massive range of IaaS facilities depending on the needs of your business, from compute and networking to security and storage, including Container Service and Virtual Machines. Find out more about individual services here.

- **PaaS ON AZURE**

If you prefer to go down the PaaS route on Azure, there's no shortage of services to help you implement a cloud-powered development platform. Through PaaS services like App Services, Azure Search, and Azure CDN, Azure offers everything companies need to deliver cloud applications on a pay-as-you-go basis, from the smallest web apps to enterprise-level software.

Azure's PaaS offerings give developers total control over their application, allowing them the freedom to work on building, safe in the knowledge that things like OS patches or load balancing will just work. With services like Azure Functions, businesses can take advantage of PaaS power without having to worry about server configuration or scaling, which is automatic.

- **SaaS ON AZURE**

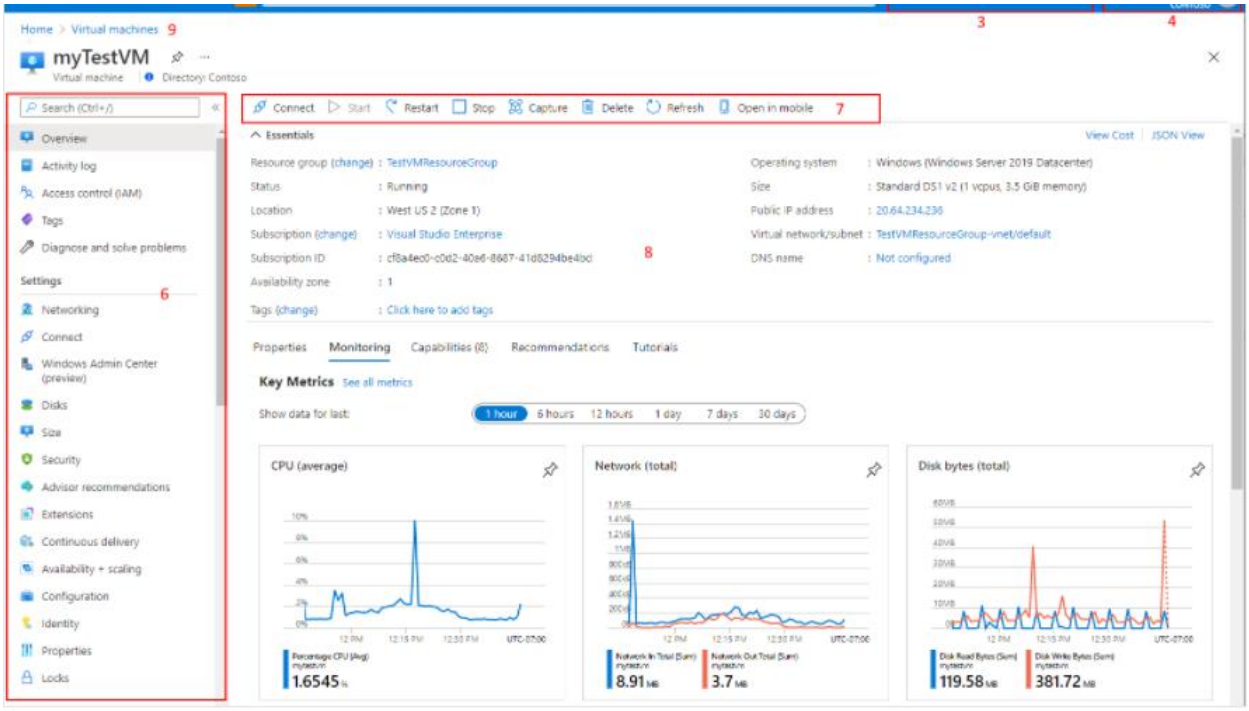
Azure can be used both to host apps you've created yourself, and to access other Microsoft SaaS services. Cloud-based Microsoft products like Dynamics 365, Outlook, and Office 365 are all built and hosted on Azure.

Using Azure as a foundation for your SaaS apps lets you take advantage of powerful technology and intelligent tools like analytics and machine learning.

HOW TO USE AZURE?

The Azure portal is a web-based, unified console that provides an alternative to command-line tools. With the Azure portal, you can manage your Azure subscription using a graphical user interface. You can build, manage, and monitor everything from simple web apps to complex cloud deployments. Create custom dashboards for an organized view of resources. Configure accessibility options for an optimal experience.

The figure below labels the basic elements of the Azure portal, each of which are described in the following table. In this example, the current focus is a virtual machine, but the same elements apply no matter what type of resource or service you're working with.



HOW SECURE IS AZURE?

Here are a few of the security precautions Microsoft takes to protect Azure customers:

- Automatic encryption. Everything sent within the Azure environment is automatically encrypted. The Azure network has automatic detection to prevent distributed denial-of-service (DDoS) attacks, similar to some of the largest services on the Internet, such as Xbox and Microsoft's Office 365.
- Other safeguards include automated smart traffic monitoring and profiling. It is easier to detect and deflect threats when systems know when something looks out of the ordinary, reducing the risk any threats pose that may have breached external security systems.
- Smart access control. Management (admin) accounts are run over separate networks than most team members. Managers can also control and restrict access to a limited time period, device, or even a specific document.
- Microsoft goes to great lengths to protect hardware and firmware, constantly reviewing and revising code, even creating hardware that can automatically detect threats before software is loaded and active. If anything malicious is detected, it can pause software activity until the threat is removed.
- Azure is the first cloud platform to support both software and hardware-based Trusted Execution Environments (TEEs). TEEs ensure that encrypted data – whether it is stored, in transit or inactive is – safe from unauthorized access and tampering.

- Operational security is serious business. Microsoft employs 3,500 cybersecurity experts, including 200 who continually look for weaknesses. Any that are found are input into the operational security procedures Azure uses to improve against potential external threats.
- You don’t even need to worry if you are working off-site and need secure access. With ExpressRoute, you can access Azure through an encrypted Virtual Private Network (VPN), wherever you are in the world.

Meghraj Cloud Initiative

INTRODUCTION

In order to utilize and harness the benefits of Cloud Computing, Government of India has embarked upon an ambitious initiative - "GI Cloud" which has been named as "MeghRaj". The focus of this initiative is to accelerate delivery of e-services in the country while optimizing ICT spending of the Government.

MeghRaj will ensure optimum utilization of the infrastructure and speed up the development and deployment of eGov applications. The architectural vision of GI Cloud encompasses a set of discrete cloud computing environments spread across multiple locations, built on existing or new (augmented) infrastructure, following a set of common protocols, guidelines and standards issued by the Government of India.

TYPE OF CLOUD

Meghraj GI is a Hybrid Cloud. Hybrid cloud deployments allow for the Government Department to benefit from features of Cloud as well as on-premise deployments.
Listed below are the features that would make hybrid cloud attractive for Government Departments:

1. Hybrid Integration Styles: Combining app integration, API integration and data integration.
2. Hybrid Connectivity: Reach across secure connections to get access to data residing on premise from Cloud.
3. Hybrid deployment: Application and virtual machines can be flexibly migrated or deployed on cloud and on-premises to optimize solution architecture.

TYPE OF SERVICES

The National Informatics Centre (NIC) is providing National Cloud services under the initiative MeghRaj. The services offered are as follows.

- **Infrastructure as a Service (IaaS)**

IaaS provides you with basic virtual compute infrastructure resources like CPU, Memory, Disk Storage attached to blank VMs allowing you to install OS, using ISOs, from scratch and customization. However you have to use your own licenses for OS and Application software (if any).

- **Platform as a Services (PaaS)**

PaaS provides pre-installed web and database servers so that you can publish and run web applications without worrying about server setup. The servers are pre configured ready with basic security hardening. Use PaaS service to quickly deploy servers and publish your web applications. The OS & Application Software licenses are provided by us as part of offering.

- **Software as a Services (SaaS)**

This provides on demand software service. SaaS is a software delivery model where users are not responsible for supporting the application or any of the components. The server infrastructure, OS and software is being managed by cloud services. If you are having a web application and want to distribute it to users, use our Cloud Service to deliver through Software as a Service.

- **Storage as a Service (STaaS)**

SaaS provides a need based storage solution. It provides an excellent alternative to the traditional on-site and dedicated storage systems and reduces the complexities of deploying and managing multiple storage tiers. You can use it to mitigate risks in disaster recovery, provide long-term retention for records and enhance both continuity and availability.

Hosting Environments

NIC Cloud Services provides 3 different types of environment for creating virtual machines i.e. Production, Staging and Development so that you keep your VM segregated and manage them properly based on the business need for both PaaS as well as IaaS service model.
Following are the Services support provided to your application as part of the cloud hosting:

1. Server Vulnerability Assessment
2. Server Antivirus
3. Server Backup
4. Network/Application Firewall

ADVANTAGES OF GI CLOUD

- ➔ Optimum utilization of existing infrastructure
- ➔ Rapid deployment and reusability: Any software made available by any government of department in India can be made available to other departments as well without additional costs.
- ➔ Manageability and maintainability: It provides a single point for maintaining Information & Communication Technology (ICT) infrastructure in India.
- ➔ Scalability: According to the demands from the citizens of India, infrastructure of the government can be increased accordingly.
- ➔ Efficient service delivery
- ➔ Security: A security framework for the entire GI Cloud will lead to less environmental complexity and less potential vulnerability.
- ➔ Increased user mobility
- ➔ Reduced effort in managing technology
- ➔ Ease of first time IT solution deployment
- ➔ Cost reduction

- ➔ Standardization: GI Cloud shall prescribe the standards around interoperability, integration, security, data security and portability etc.

USE CASES

Some of the Recently Hosted e-Gov Applications on NIC Cloud are:

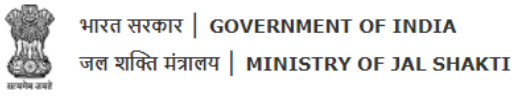
Sakhi Dashboard - Ministry of Women and Child Development

An online platform for the functionaries of One Stop Centers (OSCs) and Women Help Lines (WHLs), Mahila Police Volunteers (MPVs) to populate and view various important information about the cases of violence affected women coming to them, as well as about their establishments.

DST Dashboard - Ministry of Science and Technology

The Department of Science & Technology (DST) was established in May 1971, with the objective of promoting new areas of Science & Technology and to play the role of a nodal department for organizing, coordinating and promoting S&T activities in the country. The Department has major responsibilities for specific projects and programmer

Ministry Of Jal Shakti



The Government of India has created the Ministry of Jal Shakti by integrating the Department of Drinking Water and Sanitation and the Department of Water Resources River Development and Ganga Rejuvenation, with a goal of integrated water resources management under one umbrella, so that all the issues relating to water are dealt with in a holistic manner. This Ministry will also look after rural sanitation and take forward the Swachh Bharat Mission, ensuring that the achievements made under the Mission are sustained and in furtherance, arrangements be made for safe disposal of solid and liquid waste in rural areas.

MSME Dashboard - Ministry Of Micro, Small & Medium Enterprises

MSME DASHBOARD
सूक्ष्म, लघु और मध्यम उद्यम मंत्रालय
Ministry Of Micro, Small & Medium Enterprises

Micro, Small and Medium Enterprises (MSME) sector has emerged as a highly vibrant and dynamic sector of the Indian economy over the last five decades. MSMEs not only play crucial role in providing large employment opportunities at comparatively lower capital cost than large industries but also help in industrialization of rural & backward areas, thereby, reducing regional imbalances, assuring more equitable distribution of national income and wealth. MSMEs are complementary to large industries as ancillary units and this sector contributes enormously to the socio-economic development of the country.

VMWARE

INTRODUCTION

VMware, Inc. is an American cloud computing and virtualization technology company headquartered in California. VMware was the first commercially successful company to virtualize the x86 architecture·

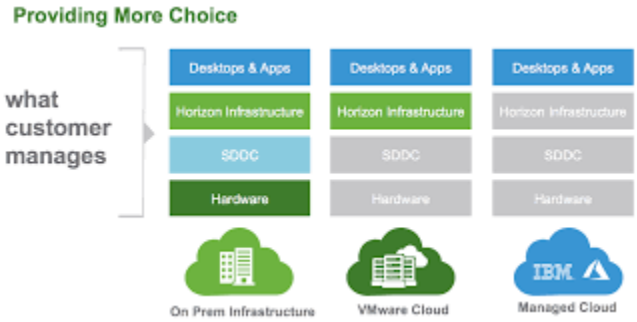
VMware's desktop software runs on Microsoft Windows, Linux, and macOS, while its enterprise software hypervisor for servers, VMware ESXi, is a bare-metal hypervisor that runs directly on server hardware without requiring an additional underlying operating system·

VMware's most notable products are its hypervisors. VMware became well known for its first type 2 hypervisor known as GSX. This product has since evolved into two hypervisor product lines: VMware's type 1 hypervisors running directly on hardware and their hosted type 2 hypervisors.

DEPLOYMENT MODELS

Two main types of deployment models are available for deploying VMware Identity Manager in the DMZ, one that integrates with a Workspace ONE UEM deployment, and one that does not require Workspace ONE UEM and uses the VMware Identity Manager connector.

- Deployment Model using AirWatch Cloud Connector
  If you have an existing Workspace ONE UEM deployment, you can integrate VMware Identity Manager with it quickly. In this model, user and group sync from your enterprise directory and user authentication are handled by Workspace ONE UEM. You deploy VMware Identity Manager in the DMZ.
  Note that integrating VMware Identity Manager with resources such as Horizon 7 and Citrix-published resources is not supported in this model. Only integration with Web applications and native mobile applications is supported.
  See On Premises Deployment Model Using AirWatch Cloud Connector.



- Deployment Model using VMware Identity Manager Connector in outbound-only connection mode
  In scenarios that do not require a Workspace ONE UEM deployment, you can install the VMware Identity Manager server virtual appliance in the DMZ and a VMware Identity Manager connector virtual appliance in the enterprise network. The connector connects the server with on-premises services such as Active Directory. The connector is installed in outbound-only connection mode and does not require inbound firewall port 443 to be opened. In this model, user and group sync from your enterprise directory and user authentication are handled by the VMware Identity Manager connector.
  See On Premises Deployment Model Using VMware Identity Manager Connector in Outbound-Only Connection Mode.
  - Adding Kerberos authentication support to your VMware Identity Manager Connector deployment
    you can add Kerberos authentication for internal users (which requires inbound connection mode) to your deployment based on outbound-only connection mode connectors.

TYPES OF SERVICES

VMware Cloud services are services that enable you to integrate, manage, and secure applications on cloud resources. These services work for any cloud service using VMware and can help you centralize the management and maintenance of hybrid or multi-cloud environments.

VMware Cloud services enable you to determine how resources are used and where workloads are deployed while applying a single operational model. This enables you to standardize security, reduce management complexity, and improve your ROI.

You can use VMware Cloud services with either public or private clouds. When integrating these services you do not need to re-architecture applications or convert data. This can help you simplify app modernization and ensure high performance.

VMware Cloud services are available in a variety of technologies provided as part of a VMware Cloud subscription. This subscription offers a wide range of services. The following services are particularly helpful for monitoring and managing your cloud environments:

- VMware Cloud on AWS
- Cloud Provider Metering
- vRealize Network Insight Cloud
- vRealize Log Insight
- vRealize Automation

- **Infrastructure as a Service(IaaS)**

VMware Cloud is available as a standalone service. It is also available as an integration with Amazon Web Services (AWS). This integration was developed jointly by AWS and VMware and applies VMware services to AWS infrastructure. You can use this integration to extend on-premises or other cloud services to AWS.

When you integrate VMware Cloud with AWS you gain access to a single-tenant infrastructure built on Elastic Compute Cloud (Amazon EC2) instances. EC2 instances are optimized for high volume input/output operations and storage with low-latency solid-state drives (SSDs) based on Non-Volatile Memory Express (NVMe).

This infrastructure supports up to 16 vSphere host clusters on bare metal infrastructure. In your deployment you can control scaling with options for between three to sixteen hosts on each cluster you operate.

Additionally, VMware Cloud on AWS enables you to run the VMware Software-Defined Data Center (SDDC) stack directly on your hosts. It does not require nested virtualization, making configuration and management simpler.

When migrating workloads you have access to cold (manual), VM template, and vMotion (live) options.

- **Cloud Provider Metering**

Cloud Provider Metering is a service you can use to centralize and automate reporting on resource use. It is made up of two components—VMware vCloud Usage Meter agents and VMware vCloud Usage Insight. Cloud Provider Monitoring enables you to collect data from on-premise instances via the agent and analyze that data with Usage Insight.

Once reports are created, you can view, manipulate, or export data from the VMware Cloud Provider Commerce Portal. Additionally, reports are retained by Usage Insight for up to three years, eliminating the need to store data separately.

- **Platform as a Service (PaaS) on VMware**

VMware vRealize Network Insights is a service you can use to deploy secure, highly-available hybrid and multi-cloud infrastructures. It enables you to leverage network visibility and analytics to optimize micro-segmentation of your components and services, and minimize risk during migration. This service also supports both VMware NSX deployments and Kubernetes deployments.

vRealize Network Insight Cloud includes features that enable you to discover services in your environment and map dependencies. It can also provide you with recommendations for troubleshooting issues and optimizing performance.

- **Software as a Service (SaaS) on VMware**

1. VRealize Log Insight

VRealize Log Insight is a virtual appliance you can use to aggregate, analyze, and manage system log data. You can use it to monitor application logs, messages, configuration files,

network traces, and performance data in real-time. It enables you to more easily manage and troubleshoot your environments and includes features for security and compliance auditing.

VRealize Log Insight works via an agent on each device you wish to monitor. This agent collects performance, state, and log data and sends it to a centralized server where it is aggregated and analyzed. You can access this data via the customizable dashboard. Customization options include visualizations, alerts, reporting, saved queries, and a search feature.

2. VMware vRealize Automation

VMware vRealize Automation is a platform that you can use to automate infrastructure management tasks. It includes features for self-service provisioning, role-based governance, and resource lifecycle management. The vRealize Automation is also extensible through integrations with existing VMware and third-party tools.

The vRealize Automation platform includes a service broker that enables you to aggregate content from across your cloud resources and manage content with role-based policies. This includes content from Cloud Assembly which you can use to manage your cloud with DevOps.

You can define vRealize automation via a drag and drop interface or as code with Code Stream. Code Stream enables you to create a pipeline in which policies are defined as YAML and can be managed through Git integration and APIs.

ADVANTAGES OF VMWARE

Some advantages VMware has over other services in the industry are:

- Elimination of many routine administrative tasks for the in-house IT staff
  More time for in-house staff to research and implement technology in innovative ways to address pressing business needs
- More robust backup and data protection options, reducing the risk of data loss
- Increased application availability, reducing system downtime
- Improved business continuity with shortened data recovery times
- Increased profitability as a result of decreased capital and operational expenses

According to Gartner's Magic Quadrant ranking, VMware is the leader in this market both in market share and in innovation. In Gartner's overview, they note the following four strengths of VMware:

1. Virtualization strategy and road map that lead to private and hybrid cloud computing
2. Technology leadership and innovation

3. High customer satisfaction
4. Large installed base