

**ATAL BIHARI VAJPAYEE INDIAN INSTITUTE OF INFORMATION
TECHNOLOGY AND MANAGEMENT GWALIOR - 474015**



Cloud Computing

Case Study : Microsoft Azure

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Q.1. What is Microsoft Azure? Explain its Services? Prepare a configuration wise pricing list of computing resources.

Microsoft Azure is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through Microsoft-managed data centers. It provides software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS) and supports many different programming languages, tools, and frameworks, including both Microsoft-specific and third-party software and systems.

Services :

Microsoft lists over 600 Azure services, of which some are covered below :

☐ **Computer services :**

- ❖ Virtual machines, infrastructure as a service (IaaS) allowing users to launch general-purpose Microsoft Windows and Linux virtual machines, as well as preconfigured machine images for popular software packages.
- ❖ Most users run Linux on Azure, some of the many Linux distributions offered, including Microsoft's own Linux-based Azure Sphere.
- ❖ App services, platform as a service (PaaS) environment letting developers easily publish and manage websites.

☐ **Mobile services :**

- ❖ Mobile Engagement collects real-time analytics that highlight users' behavior. It also provides push notifications to mobile devices.
- ❖ HockeyApp can be used to develop, distribute, and beta-test mobile apps.

☐ **Storage services :**

- ❖ Storage Services provides REST and SDK APIs for storing and accessing data on the cloud.
- ❖ Table Service lets programs store structured text in partitioned collections of entities that are accessed by partition key and primary key. It's a NoSQL non-relational database.

☐ **Data management :**

- ❖ Azure Data Explorer provides big data analytics and data-exploration capabilities
- ❖ Azure Search provides text search and a subset of OData's structured filters using REST or SDK APIs.
- ❖ Cosmos DB is a NoSQL database service that implements a subset of the SQL SELECT statement on JSON documents.

❑ Internet of Things (IoT) :

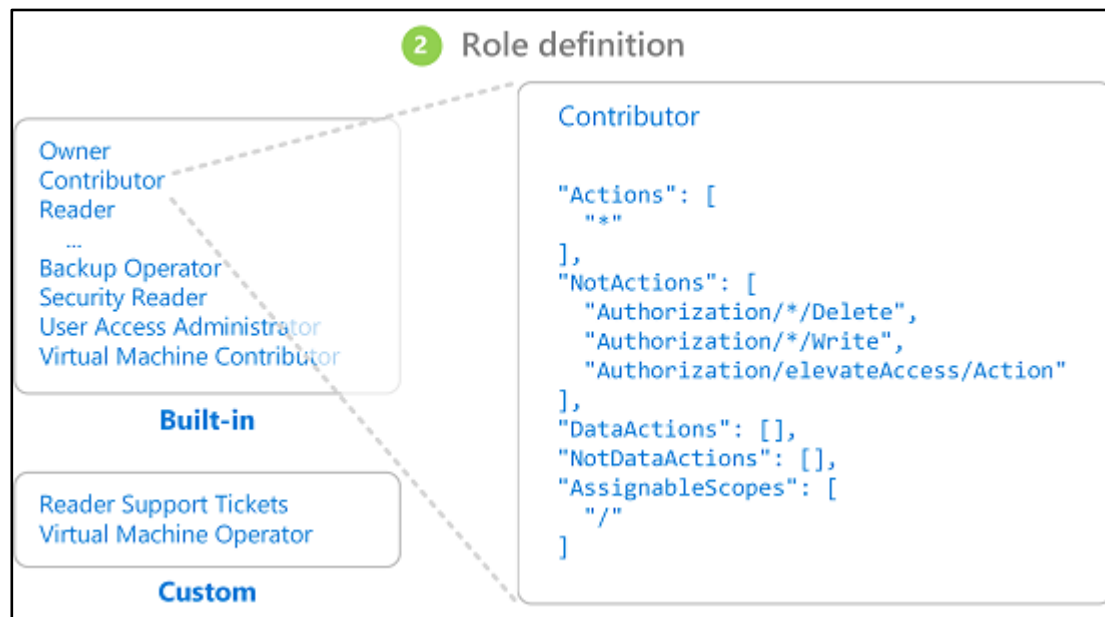
- ❖ **Azure IoT Hub** lets you connect, monitor, and manage billions of IoT assets. On February 4, 2016, Microsoft announced the General Availability of the Azure IoT Hub service.
- ❖ **Azure IoT Edge** is a fully managed service built on IoT Hub that allows for cloud intelligence deployed locally on IoT edge devices.
- ❖ **Azure IoT Central** is a fully managed SaaS app that makes it easy to connect, monitor, and manage IoT assets at scale. On December 5, 2017, Microsoft announced the Public Preview of Azure IoT Central; its Azure IoT SaaS service.

Pricing :

Resource Type	Azure Instance	Azure OD Hourly	Azure /GB RAM
Standard 2 vCPU w SSD	D2 v2	\$0.114	\$0.016
Highmem 2 vCPU w SSD	D11 v2	\$0.149	\$0.011
Highcpu 2 vCPU w SSD	F2	\$0.099	\$0.025
Standard 2 vCPU no SSD	D2 v2	\$0.114	\$0.016
Highmem 2 vCPU no SSD	D11 v2	\$0.149	\$0.011
Highcpu 2 vCPU no SSD	F2	\$0.099	\$0.025

Q.2. What is the role concept in Azure? What are the roles available in Windows Azure? Explain.

A *role definition* is a collection of permissions. It's typically just called a *role*. A role definition lists the operations that can be performed, such as read, write, and delete. Roles can be high-level, like owner, or specific, like virtual machine readers.



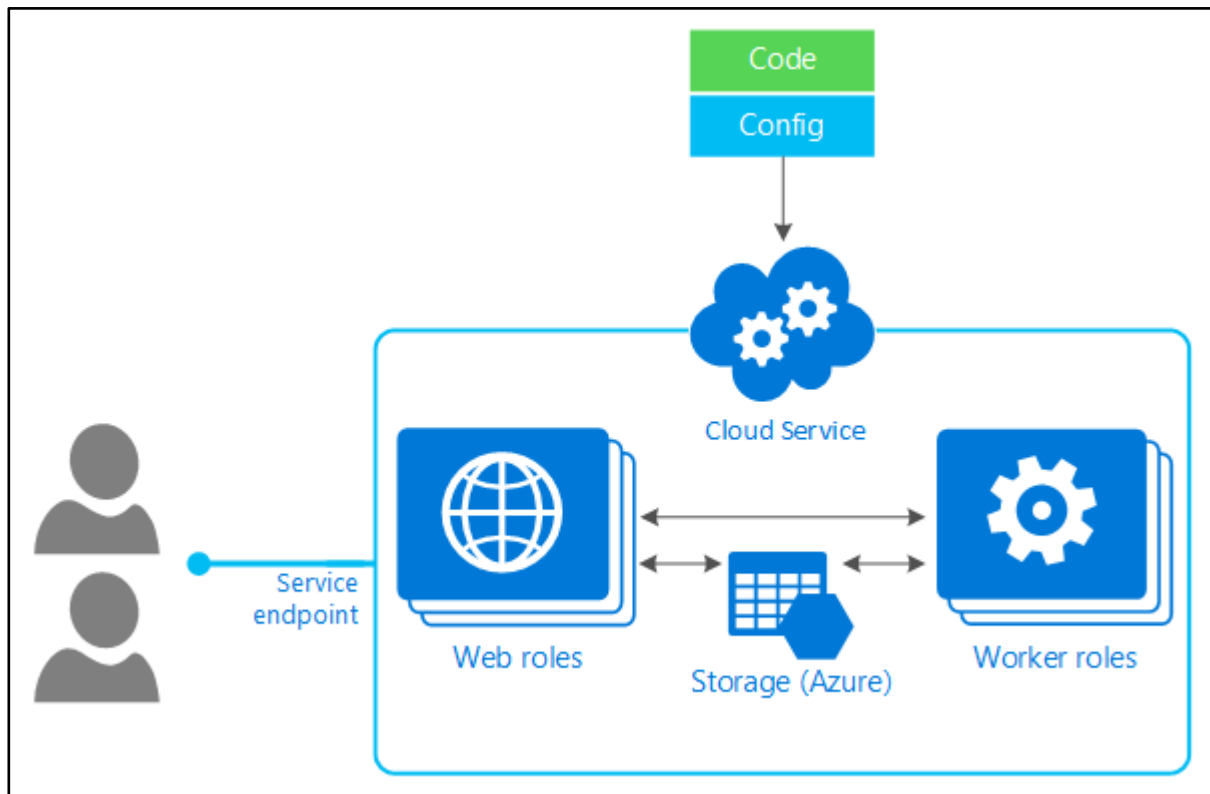
Azure includes several built-in roles that you can use. The following lists four fundamental built-in roles. The first three apply to all resource types.

- ☐ **Owner** : Has full access to all resources including the right to delegate access to others.
- ☐ **Contributor** : Can create and manage all types of Azure resources but can't grant access to others.
- ☐ **Reader** : Can view existing Azure resources.
- ☐ **User Access Administrator** : Lets you manage user access to Azure resources.

There are two types of Azure Cloud Services roles. The only difference between the two is how your role is hosted on the VMs:

- ☐ **Web role** : Automatically deploys and hosts your app through IIS.
- ☐ **Worker role** : Does not use IIS, and runs your app standalone.

For example, a simple application might use just a single web role, serving a website. A more complex application might use a web role to handle incoming requests from users, and then pass those requests on to a worker role for processing. (This communication might use Azure Service Bus or Azure Queue storage). The platform scales and deploys the VMs in an Azure Cloud Services application in a way that avoids a single point of hardware failure. Even though applications run in VMs, it's important to understand that Azure Cloud Services provides PaaS, not infrastructure as a service (IaaS).



Q.3. Explain about the architecture of Windows Azure? Explain the main components of Windows Azure?

Microsoft Azure is built on Microsoft's definition of commodity infrastructure. The most intriguing part of Azure is its cloud operating system that is at its heart. During the initial days of azure when it started it started using a fork of windows as its underlying platform Back then they named it as red dog operating system & red dog hypervisor. If you go into the history of Azure the project which became azure was originally named as project red dog. David Cutler was the brain behind designing and developing the various Red Dog core components and it was he who gave this name.in his own words-the premises of Red Dog (RD) is being able to share a single compute node across several properties. This enables better utilization of compute resources and the flexibility to move capacity as properties are added, deleted, and need more or less compute power. This in turn drives down capital and operational expenses.

It was actually a custom version of Windows and the driving reason for this customization was because hyper v during those didn't have the features which was needed for Azure (particularly support for booting from VHD). if you try to understand the main components of its architecture we can count four pillars-

- ☐ Fabric Controller
- ☐ Storage

- ❑ Integrated Development Tools and Emulated Execution Environment
- ❑ OS and Hypervisor

Azure Fabric Controller :

Among there one component which contributed immensely in its success is fabric controller. The fabric controller owns all the resources in the entire cloud and runs on a subset of nodes in a durable cluster. It manages the placement, provisioning, updating, patching, capacity, load balancing, and scale out of nodes in the cloud all without any operational intervention.

Fabric Controller which still is the backbone of azure compute is the kernel of the Microsoft Azure cloud operating system. Azure Fabric Controller regulates the creation, provisioning, de-provisioning and supervising of all the virtual machines and their back-end physical server. In other words It provisions, stores, delivers, monitors and commands the virtual machines (VMs) and physical servers that make up Azure. One added benefit is that It also detects and responds to both software and hardware failure automatically.

Patch Management :

When we try to understand the underlying mechanism/workflow which Microsoft follows for patch management the common misconception is that it keeps updating all the nodes just like we do in our environment. But things in the cloud are a little different, AS Azure hosts are image-based (hosts boot from VHD) and it follows the image based deployment. So instead of just having patches delivered, Azure rolls out a new VHD of the host operating system. Means they are not actually going and patching everyone but instead azure updates at one place and because it's orchestrated.

Partitioning :

Under Azure's Fabric Controller it has two types of partitions: Update Domains(UDs) and Fault Domains(FDs). These two are responsible for not only high availability and also for resiliency of infrastructure with this in place to empower Azure with the ability to recover from failures and continue to function. It's not about avoiding failures, but responding to failures in a way that avoids downtime or data loss.

Update Domain: An Update Domain is used to upgrade a service's role instances in groups. Azure deploys service instances into multiple update domains. For an in-place update, the FC brings down all the instances in one update domain, updates them, and then restarts them before moving to the next update domain. This approach prevents the entire service from being unavailable during the update process.

Fault Domain: Fault Domain defines potential points of hardware or network failure. For any role with more than one instance, the FC ensures that the instances are distributed across multiple fault domains, in order to prevent isolated hardware failures

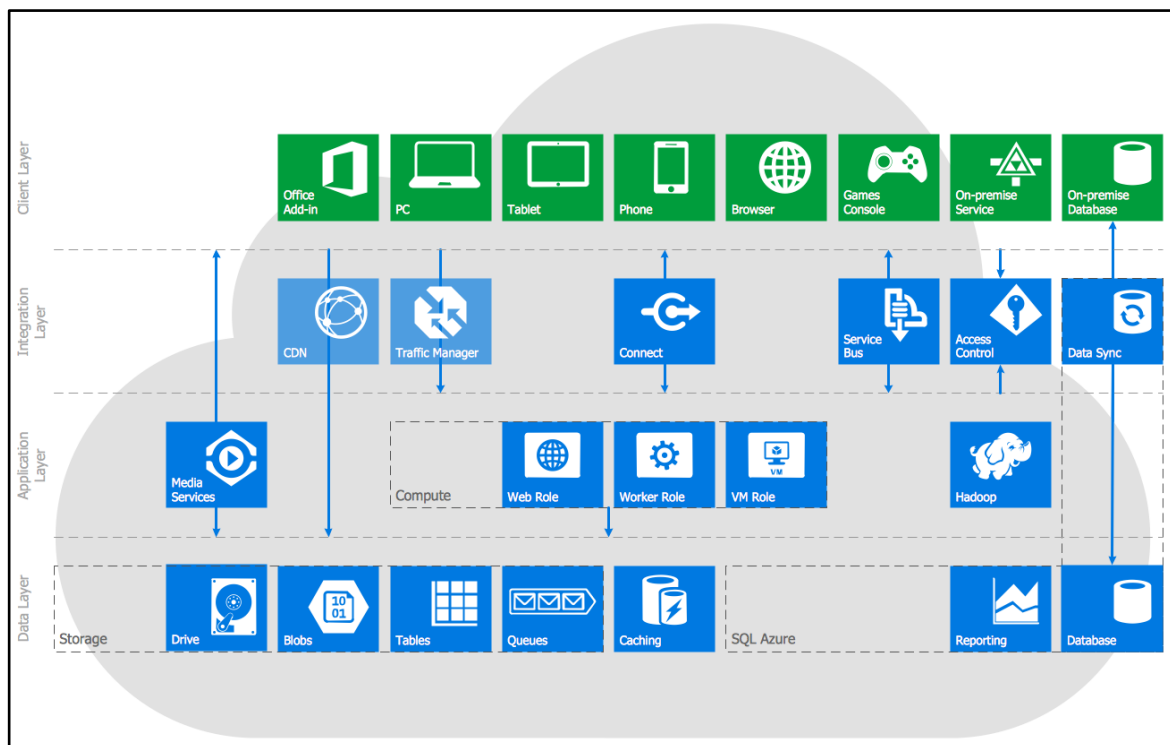
from disrupting service. All exposure to server and cluster failure in Azure is governed by fault domains.

Azure Compute Stamp:

As in Azure, things get divided into stamps where each stamp will have one fabric controller and this fabric controller is the one responsible for managing the VMs inside that stamp. In Azure, there are only two types of stamps, it could either be a compute stamp or storage stamp. This Fabric controller is also not single; it has its distributed branches.

VM Availability :

Talking about Azure Virtual Machines there are three major components (Compute, Storage, Networking) which constitute Azure VM. While discussing Azure Virtual Machine (VM) resiliency with customers, they typically assume it is comparable to their on-prem VM architecture and as such, features from on-prem is expected in Azure. Well it is not the case, thus I wanted to put this together to provide more clarity on the VM construct in Azure to better understand how VM availability in Azure is typically more resilient than most on-prem configuration.



Q.4. What is the Queue concept in Windows Azure? How many types of Queues are in Windows Azure? Discuss.

In the common language used by developers, a queue is a data structure used to store data which follows First in-First out rule. A data item can be inserted from the back of the queue while it is retrieved from front. Azure queues are a very similar concept that is used to store the messages in a queue. A sender sends the message and a client receives and processes them. A message has few attributes attached to it, for example expiry time.

A client usually processes and deletes the message. Windows Azure service lets the message to be stored for 7 days and later it gets deleted automatically, if it is not deleted by the client. There can be one sender and one client or one sender and many clients or many sender and many clients.

Azure supports two types of queue mechanisms : **Storage queues** and **Service Bus queues**.

Storage queues, which are part of the Azure storage infrastructure, feature a simple REST-based GET/PUT/PEEK interface, providing reliable, persistent messaging within and between services.

Service Bus queues are part of a broader Azure messaging infrastructure that supports queuing as well as publish/subscribe, and more advanced integration patterns.

While both queuing technologies exist concurrently, Storage queues were introduced first, as a dedicated queue storage mechanism built on top of Azure Storage services. Service Bus queues are built on top of the broader messaging infrastructure designed to integrate applications or application components that may span multiple communication protocols, data contracts, trust domains, and/or network environments.

Q.5. What is SQL Azure Database? What are the different types of databases in SQL Azure? Discuss.

Azure SQL Database is a fully managed Platform as a Service (PaaS) Database Engine that handles most of the database management functions such as upgrading, patching, backups, and monitoring without user involvement. Azure SQL Database is always running on the latest stable version of SQL Server Database Engine and patched OS with 99.99% availability. PaaS capabilities that are built into Azure SQL database enables you to focus on the domain-specific database administration and optimization activities that are critical for your business. With Azure SQL Database, you can create a highly available and high-performance data storage layer for the applications and solutions in Azure. SQL Database can be the right choice for a variety of modern cloud applications because it enables you to process both relational data and non-relational structures, such as graphs, JSON, spatial, and XML.

Types :

- ❑ **Azure SQL Database** : A choice between the DTU model (Basic, Standard and Premium) and vCore (General Purpose and Business Critical). Within this space there are two different architecture types used by Microsoft under the covers.

- ❑ **Azure SQL Database Serverless** : Automatically scales compute based on workload demand and bills for compute used per second. The serverless compute tier also automatically pauses databases during inactive periods when only storage is billed and automatically resumes databases when activity returns.
- ❑ **Azure SQL Database Hyperscale** : vCore variant allowing Support for up to 100 TB of database size.
- ❑ **Azure SQL Database Edge** : Running on ARM and Intel architecture, Azure SQL Database Edge – now in private preview – brings the most secure Microsoft SQL engine to the edge. This productivity tool for edge computing combines new capabilities such as data streaming and time series with in-database machine learning and graph features.

Q.6. What are the concepts of Azure Migrate and CoCo Framework for block chain networks? Explain.

Azure Migrate is a Microsoft service that helps an enterprise assess how its on-premises workloads will perform, and how much they will cost to host, in the Azure public cloud.

While Azure Migrate helps with planning a cloud migration, it does not actually transfer on-premises virtual machines (VMs) to the Azure cloud. For this, Microsoft suggests using either its Azure Site Recovery or Azure Database Migration service.

Azure Migrate provides the following features :

- ❑ **Unified migration platform** : A single portal to start, run, and track your migration to Azure.
- ❑ **Servers** : Assess on-premises servers and migrate them to Azure virtual machines.
- ❑ **Databases** : Assess on-premises databases and migrate them to Azure SQL Database or to an Azure SQL Database managed instance.
- ❑ **Web applications** : Assess on-premises web applications and migrate them to Azure App Service by using the Azure App Service Migration Assistant.
- ❑ **Virtual desktops** : Assess your on-premises virtual desktop infrastructure (VDI) and migrate it to Windows Virtual Desktop in Azure.
- ❑ **Data** : Migrate large amounts of data to Azure quickly and cost-effectively using Azure Data Box products.

Coco Framework is an open-source system that enables high-scale, confidential blockchain networks that meet all key enterprise requirements—providing a means to accelerate production enterprise adoption of blockchain technology.

Coco achieves this by designing specifically for confidential consortiums, where nodes and actors are explicitly declared and controlled. Based on these requirements, Coco presents an alternative approach to ledger construction, giving enterprises the scalability, distributed governance and

enhanced confidentiality they need without sacrificing the inherent security and immutability they expect.

Leveraging the power of existing blockchain protocols, trusted execution environments (TEEs) such as Intel SGX and Windows Virtual Secure Mode (VSM), distributed systems and cryptography, Coco enables enterprise-ready blockchain networks that deliver:

- ☐ Throughput and latency approaching database speeds.
- ☐ Richer, more flexible, business-specific confidentiality models.
- ☐ Network policy management through distributed governance.
- ☐ Support for non-deterministic transactions.

Q.7. Study the security policies used in Azure and prepare a list of various security policies at various levels.

A security policy defines the desired configuration of our workloads and helps ensure we're complying with the security requirements of your company or regulators. Azure Security Center makes its security recommendations based on your chosen policies. Security Center policies are based on policy initiatives created in Azure Policy. You can use Azure Policy to manage your policies and to set policies across Management groups and across multiple subscriptions. Security Center offers the following options for working with security policies: View and edit the built-in default policy - When you enable Security Center, a built-in initiative named 'ASC default' is automatically assigned to all Security Center registered subscriptions (Free or Standard tiers).

Some of the built-in policies are :

Name	Description	Effect(s)	Version
Vulnerability Assessment should be enabled on Virtual Machines	Monitors vulnerabilities detected by Azure Security Center Vulnerability Assessment on Virtual Machines	Audit Not Exists, Disabled	1.0.0-preview
IP Forwarding on your virtual machine should be disabled	Enabling IP forwarding on a virtual machine's NIC allows the machine to receive traffic addressed to other destinations, IP forwarding is required, and therefore, this should be reviewed by the network security team	Audit Not Exists, Disabled	1.0.0-preview

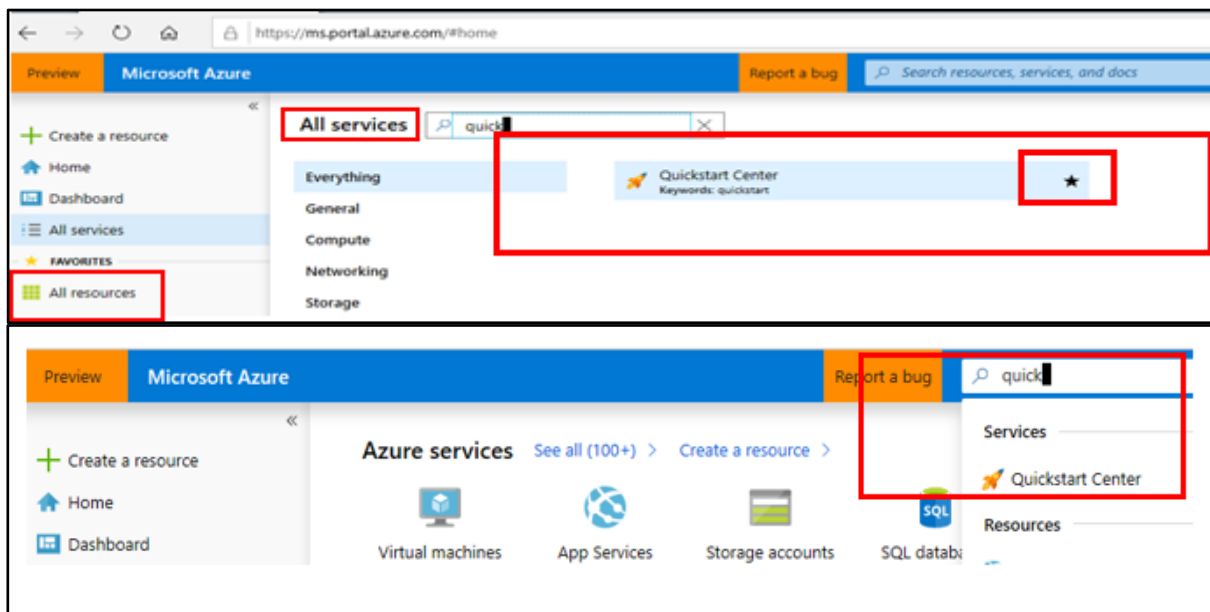
Pod Security Policies should be defined on Kubernetes Services	Define Pod Security Policies to reduce the attack vector by removing unnecessary application privileges. It is recommended to configure Pod Security Policies to only allow pods to access the resources which they have permissions to access	Audit, Disabled	1.0.0-preview
A maximum of 3 owners should be designated for your subscription	It is recommended to designate up to 3 subscription owners in order to reduce the potential for breach by a compromised owner	Audit Not Exists, Disabled	1.0.0
Access through Internet facing endpoint should be restricted	Azure Security center has identified some of your Network Security Groups' inbound rules to be too permissive. Inbound rules should not allow access from 'Any' or 'Internet' ranges. This can potentially enable attackers to easily target your resources	Audit Not Exists, Disabled	1.0.0
Adaptive Application Controls should be enabled on virtual machines	Possible Application Whitelist configuration will be monitored by Azure Security Center	Audit Not Exists, Disabled	1.0.0
Adaptive Network Hardening recommendations should be applied on internet facing virtual machines	Azure Security Center analyzes the traffic patterns of Internet facing virtual machines and provides Network Security Group rule recommendations that reduce the potential attack surface	Audit Not Exists, Disabled	1.0.0
Advanced data security settings for SQL managed instance should contain an email address to receive security alerts	Ensure that an email address is provided for the 'Send alerts to' field in the Advanced Data Security server settings. This email address receives alert notifications when anomalous activities are detected on SQL managed instances.	Audit Not Exists, Disabled	1.0.0

Q.8. Explain the stepwise procedure to work with Windows Azure.

Today, many organizations are leveraging digital transformation to deliver their applications and services in the cloud. At Microsoft Build 2019, we announced the general availability of Azure Quickstart Center and received positive feedback from customers. Azure Quickstart Center brings together the step-by-step guidance you need to easily create cloud workloads. The power to easily set up, configure, and manage cloud workloads while being guided by best practices is now built right into the Azure portal.

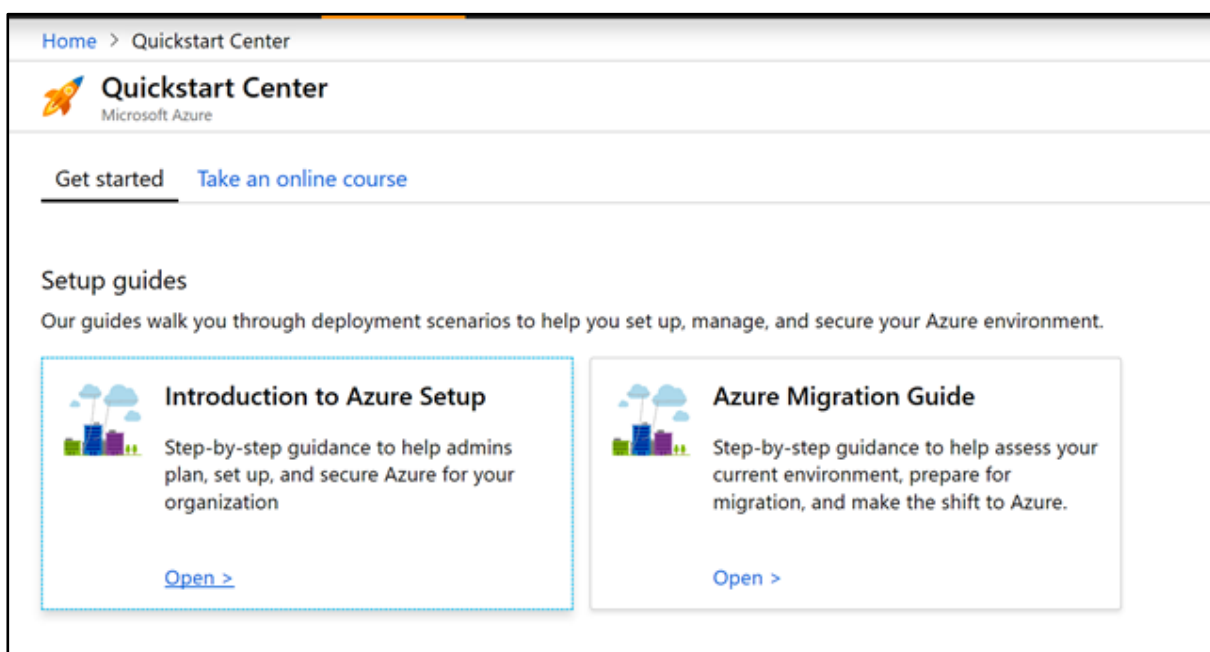
Access Azure Quickstart Center :

There are two ways to access Azure Quickstart Center in the Azure portal. Go to the global search and type in **Quickstart Center** or select **All services** on the left nav and type Quickstart Center. Select the star button to save it under your favorites.



Get started :

Azure Quickstart Center is designed with you in mind. We created setup guides, started a project, and curated online training for self-paced learning so that you can manage cloud deployment according to your business needs.



Setup guides :

To help you prepare your organization for moving to the cloud, our guides **Azure setup** and **Azure migration** in the Quickstart Center give you a comprehensive view of best practices for your cloud ecosystem. The setup guides are created by our FastTrack for Azure team who has supported customers in cloud deployment and turned these valuable insights to easy reference guides for you.

The **Azure setup guide** walks you through how to :

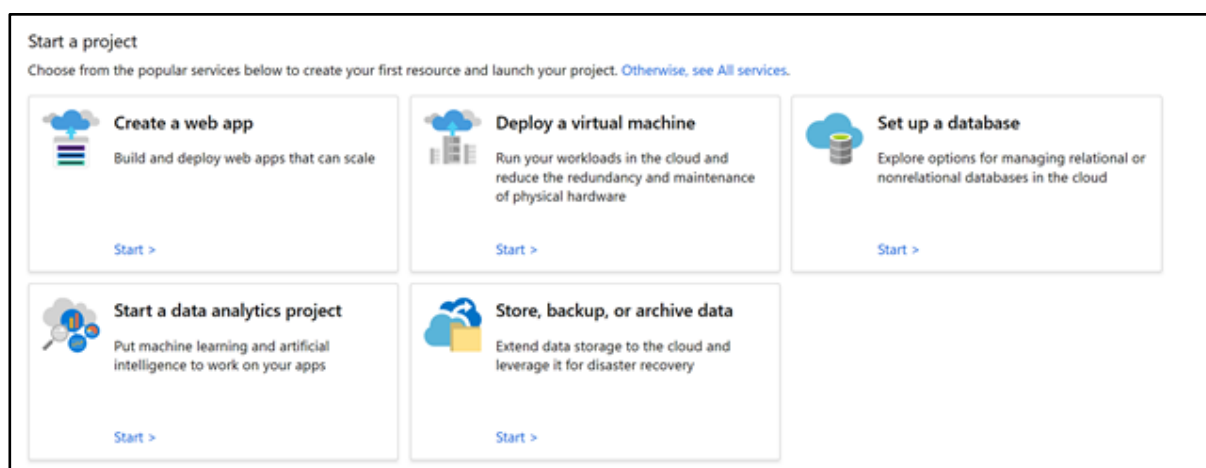
- ☐ **Organize resources:** Set up a management hierarchy to consistently apply access control, policy, and compliance to groups of resources and use tagging to track related resources.
- ☐ **Manage access:** Use role-based access control to make sure that users have only the permissions they really need.
- ☐ **Manage costs:** Identify your subscription type, understand how billing works, and how you can control costs.
- ☐ **Governance, security, and compliance:** Enforce and automate policies and security settings that help you follow applicable legal requirements.
- ☐ **Monitoring and reporting:** Get visibility across resources to help find and fix problems, optimize performance, or get insight to customer behavior.
- ☐ **Stay current with Azure:** Track product updates so you can take a proactive approach to change management.

The **Azure migration guide** is focused on re-host also known as lift and shift, and gives you a detailed view of how to migrate applications and resources from your on-premises environment to Azure. Our migration guide covers :

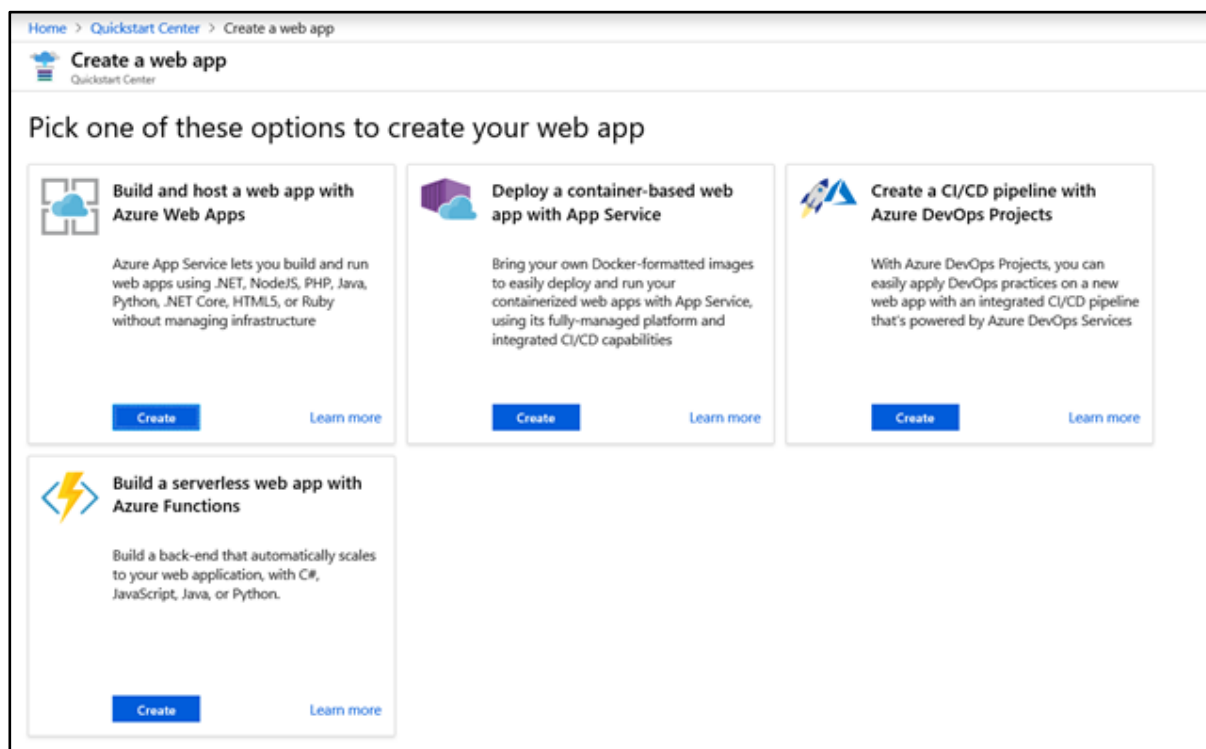
- ☐ **Prerequisites:** Work with your internal stakeholders to understand the business reasons for migration, determine which assets like infrastructure, apps, and data are being migrated and set the migration timeline.
- ☐ **Assess the digital estate:** Assess the workload and each related asset such as infrastructure, apps, and data to ensure the assets are compatible with cloud platforms.
- ☐ **Migrate assets:** Identify the appropriate tools to reach a "done state" including native tools, third-party tools, and project management tools.
- ☐ **Manage costs:** Cost discussion is a critical step in migration. Use the guidance in this step to drive the discussion.
- ☐ **Optimize and transform:** After migration, review the solution for possible areas of optimization. This could include reviewing the design of the solution, right-sizing the services, and analyzing costs.
- ☐ **Secure and manage:** Enforce and set up policies to manage the environment to ensure operations efficiency and legal compliance.
- ☐ **Assistance:** Learn how to get the right support at the right time to continue your cloud journey in Azure.

Start a project :

Compare frequently used Azure services available for different solution types, and discover the best fit for your cloud project. We'll help you quickly launch and create workloads in the cloud. Pick one of the five common scenarios shown below to compare the deployment options and evaluate high-level architecture overviews, prerequisites, and associated costs.



After you select a scenario, choose an option, and understand the requirements, select **Create**



You will go to the **create resource page** where you'll follow the steps to create a resource.

Home > Quickstart Center > Create a web app

Create a web app

Quickstart Center

Pick one of these options to create your web app

Build and host a web app with Azure Web Apps

Deploy a container-based web app with App Service

Create a CI/CD pipeline with Azure DevOps Projects

From a simple, static HTML5 website to a dynamic, large-scale web application, Azure App Service Web Apps brings together everything you need to quickly deploy and run web apps using the language of your choice. This platform-as-a-service (PaaS) offering lets you focus on your business logic while we take care of the infrastructure to run and scale your apps.

Why use Web Apps:

- Develop in your favorite language and run with ease on Windows or Linux.
- Deploy updates easily by using built-in CI/CD capabilities with GitHub, Azure DevOps Services, and more.
- Choose from an extensive list of application templates in the Azure Marketplace, such as WordPress, Joomla, and Drupal.
- Scale manually or automatically by applying pre-configured rules.
- Easily add a custom domain or SSL certificates.

Learn how to deploy your first application using App Service with our 5-minute Quickstarts

[Create](#) You can create 10 web apps at zero cost with your Azure free account. [See App Service pricing to learn more about costs.](#)

Reference architecture for a basic web app

Prerequisites:

- Code repository
- Text editor
- Language and framework-specific tooling

Build a serverless web app with Azure Functions

Q.9. Draw a comparative study of Microsoft Azure and Amazon EC2?

We will compare Microsoft Azure and Amazon EC2 with few parameters.

General Comparison of EC2 and Azure :

Feature	Amazon EC2	Microsoft Azure
Types of Cloud Computing Provided.	Amazon provides all three types of cloud computing ie SasS, PasS and IasS, but major players in IaaS.	Microsoft Azure provides all three types of cloud computing ie SasS, PasS and IasS, but is a major player in PaaS.
Relational Database Support	SQL, MySQL and Oracle	SQL Azure – Relational Database for Azure in SQL Server
Virtualization Technology	XEN Virtualization Technology	Hyper V – Hypervisor based virtualization Technology
IDE Support	SDK is available for Eclipse	SDK is available for Eclipse and visual studio.

Price comparison :

Feature	Amazon EC2	Microsoft Azure
Base Plan Price	\$0.11/hour	\$0.02 / hour
Virtual CPU Core	1 VCPU	-
RAM	3,840MB	768MB
Disk Space	4 GB	20 GB
Subscription Option	Hourly Rate Monthly Fixed Rate Reserved Instances Spot Instances	Hourly Rate

Specification :

Feature	Amazon EC2	Microsoft Azure
Server OS Types	Linux Windows	Linux Windows

Preconfigured Operating Systems	Amazon Linux Cent OS Debian Oracle Enterprise Linux Red Hat Enterprise Linux SUSE Enterprise Linux Ubuntu Windows Server	Cent OS FreeBSD openSUSE Linux Oracle Enterprise Linux SUSE Enterprise Linux Ubuntu Windows Server
Available Runtimes	.NET Java PHP Python Ruby	.NET Java Node PHP Python Ruby
Middleware	Tomcat	----
Frameworks	Django Drupal	Drupal Symfony

Conclusion :

Advantages of Amazon EC2 :

- ☐ EC2 is cheaper, at least to start. One can get an EC2 Windows 2008 R2 Server instance up and running for about \$40 per month.
- ☐ EC2 is familiar. The nice thing about EC2 is it's like having your own Windows Server without buying the hardware. I can do anything I want to it; I just have to remote desktop into it.
- ☐ EC2's biggest strength: it's conceptually simple. Anyone who's ever used any VMsoftware is going to be able to grasp what it does immediately. There's no learning curve, just instant gratification.

Advantages of Microsoft Azure :

- ❑ Azure may be cheaper than EC2 in the long run. Azure is a zero maintenance solution. You just deploy your application and Microsoft takes care of the software, patches and backups. There's a cost to maintenance which has to be taken into account when using EC2 compared to Azure. The problem is that cost is a bit hard to calculate.
- ❑ Scalability with Windows Azure is seamless. There's a good chance this application will grow to have many users and consume a massive amount of data. If it does, adding additional machines with Windows Azure is as simple as changing a value in the configuration file.