Research & Development on Azure Global Infrastructure

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1.Introduction

What is Azure ?

The launch of Microsoft Azure in 2010 was a turning point for the transition from on-premises datacenters to cloud computing. Azure reduced the time and capital for maintaining on-premises infrastructure by providing businesses with a global network of datacenters that Microsoft maintains and manages.

Since its inception, Azure has expanded its capabilities beyond primarily simplifying infrastructure administration. Azure provides a unique approach to cloud computing by integrating complete AI, data, and application capabilities. Its open and adaptable cloud platform is intended to assist any company's business strategy and stage of AI transformation.

Key takeaways

- Azure, Microsoft's cloud computing platform, provides over 200 products and services across a global network of datacenters.
- With over 400 highly secure datacenters in over 70 areas, Azure has the most comprehensive cloud footprint, giving businesses more options than any other cloud provider.
  95% of Fortune 500 firms rely on Azure to help them manage their businesses and fulfill enterprise-scale demands.
- Businesses of all sizes rely on Azure to help them realize their visions, seamlessly integrate their technologies, and innovate on trust.
  Azure includes built-in security solutions to protect companies' workloads from code to cloud.
- Azure AI Foundry offers an end-to-end AI platform that includes models, tools, safety measures, and monitoring capabilities to assist enterprises in designing and scaling AI applications in an efficient and cost effective manner.
- There are over 11,000 Azure AI Foundry models available, providing enterprises with unmatched freedom in selecting and building AI solutions tailored to their specific needs.
- Looking ahead, Azure will continue to drive innovation in cloud infrastructure and AI-powered services, giving businesses the choice and flexibility they require to meet changing needs.

2.Benefits : Why do organizations choose Azure?

As a leading cloud platform, Azure empowers developers and organizations of all sizes to drive business growth through accelerated and sustained innovation.

- **Cloud platform—wherever you are**
  Azure possesses the industry's most extensive cloud footprint, connected by one of the world's largest networks. Azure offers more regions than any other cloud service provider, with over 300 highly secure datacenters in more than 60 countries across the world.

  The Azure global network enables organizations to deploy apps closer to their consumers and staff, resulting in faster and more responsive experiences. Azure delivers material swiftly and reliably to its intended destination thanks to low latency, smart networking, and optimal routing.

- **Enterprise expertise**
  Azure is designed to accommodate enterprise-scale demands while providing the high availability and dependability required for mission-critical workloads. considering its emphasis on enterprise readiness, Azure has become the preferred platform for 95% of Fortune 500 firms, supporting critical applications including as SAP, Databricks, VMware, SAP, and high-performance computing.

- **Extensive partner network**
  Microsoft provides an extensive network of Azure partners to support customers at every level of their cloud adoption journey. Customers can choose from a variety of partners who possess the skills, services, and industry understanding required to discover and deploy the best Azure solutions for their specific needs.

- **Industry-leading AI developer services**
  Azure encourages open-source innovation by allowing enterprises to select the tools and solutions that best suit their needs:
  More than 60% of Azure client cores run on Linux, and customers can choose any distribution.
  Azure also supports a wide variety of prominent technologies, such as Kubernetes, PostgreSQL, MySQL, Redis, Apache, Cassandra, and MongoDB. The list is continually growing.
  Some of the most popular AI developer tools, frameworks, and experiences in the world are based on open communities. Here are some notable Azure open-source collaborations. Azure OpenAI, GitHub, Canonical, Red Hat, Databricks, Hashicorp, Redis, and SUSE, among others, have made contributions to Python, Node.js, the Linux kernel, and Kubernetes. Find out more about open source on Azure.
  The Azure AI Foundry Model includes over 11,000 models to facilitate AI-powered

creativity. These include open and frontier models, the most recent OpenAI releases, large language models, and the Microsoft Phi family of small language models.

- **Built-in security**
  Azure clients can rest assured that their workloads are safeguarded by built-in security solutions that safeguard their data from code to cloud. A specialized staff of over 10,000 security specialists regularly analyzes systems, discovers vulnerabilities, and keeps track of breach patterns and criminal actors. To analyze and guard against cyberthreats, the team synthesizes 78 trillion security signals per day using AI and advanced analytics. Microsoft reaffirms this commitment with a $20 billion security investment over the next five years.

3.Solutions : What does Azure do?

- **Taking businesses to the next level**
  The Azure cloud platform is designed to help organizations bring novel solutions to life by providing industry-leading AI and cloud services. Developers use their preferred tools and frameworks to design, execute, and manage applications in cloud, hybrid, and edge environments.

- **Optimizing operations**
  Azure offers over 200 cloud-based products and services, enabling organizations to optimize their operations in data storage, networking, virtual computing, databases, analytics, and AI. Azure enables businesses to put their ideas into action by minimizing costs, automating procedures, and boosting decision-making.

- **Managing distributed environments**
  Azure hybrid solutions let businesses effortlessly extend Azure services to on-premises, multicloud, and edge environments. A unified platform enables organizations to efficiently manage, control, and secure their servers, Kubernetes clusters, and apps. Hybrid solutions are suitable for updating outdated systems, enhancing disaster recovery, and enabling remote or hybrid work patterns.

- **Providing cost-effective scalability**
  Azure is highly adaptive and scalable, allowing organizations to dynamically adjust their cloud resources based on demand while paying only for what they use. Whether responding to seasonal increases in consumer engagement or scaling operations for expansion, Azure provides a cost-effective foundation for rapid and efficient adaptation.

- **Improving decision-making**
  Azure combines diverse data, regardless of where it is stored. This enables businesses to generate actionable insights, improve apps using AI, and make intelligent choices faster. Organizations can stay flexible while preserving their data with solutions for managing analytics, machine learning, and databases that include built-in governance.

- **Accelerating developer productivity**
  Azure accelerates app development using tools such as GitHub, Visual Studio, and Azure DevOps, providing a highly secure environment for rapid code development, collaboration, and deployment. Built-in provisioning, automated security patching, and continuous integration help developers build next-generation applications efficiently.

- **Supporting AI-powered innovation**
  Microsoft is a recognized pioneer in enterprise-ready AI services, providing solutions that are highly secure, flexible, and proven. Azure AI provides a comprehensive set of cloud-based AI services and tools, allowing developers to create AI apps without needing direct

AI or data science expertise. Whether developers utilize prebuilt models or build, train, and maintain custom models with their own data, Azure delivers the tools and flexibility needed to move AI initiatives from concept to code to production.

- **Supercomputing power for AI**
  Azure is built to handle the most sophisticated AI workloads, including hosting the world's most advanced supercomputer and serving as OpenAI's sole cloud provider. The Azure AI infrastructure provides the most comprehensive compute platform for AI applications, featuring a diversity of silicon from AMD, NVIDIA, and Microsoft Maia AI accelerators.

- **End-to-end AI platform**
  Azure AI Foundry offers an end-to-end AI platform that includes models, tools, safety measures, and monitoring capabilities to assist enterprises in designing and scaling AI applications in an efficient and economical way. Azure AI Foundry integrates with popular developer tools such as GitHub, Visual Studio, and Microsoft Copilot Studio to provide developers with seamless access to its comprehensive portfolio of services. This comprises cutting-edge AI models, Azure-based agent development tools, and a unified toolchain for accessing AI services via one interface.

- **Empowering responsible AI**
  Azure includes built-in tools and technologies to help you build ethical and efficient AI programs, from development to deployment, while keeping your content safe. Azure is committed to advancing AI based on ethical principles that prioritize people, as guided by the Microsoft Responsible AI Standard.

- **Providing cloud service models**
  Cloud service models describe how cloud services are supplied and used. Azure cloud service models help enterprises at any level of digital transformation.

  Infrastructure as a service (IaaS) provides critical IT infrastructure for organizations to easily generate and manage resources.

  Platform as a service (PaaS) provides a cloud platform for developing, running, and managing applications, eliminating the need to maintain underlying infrastructure.

  Software as a service (SaaS) enables easy access to software applications via the internet, removing the need for local installation.

  Artificial intelligence as a service (AIaaS) uses the cloud to deliver AI tools and services, accelerating innovation.

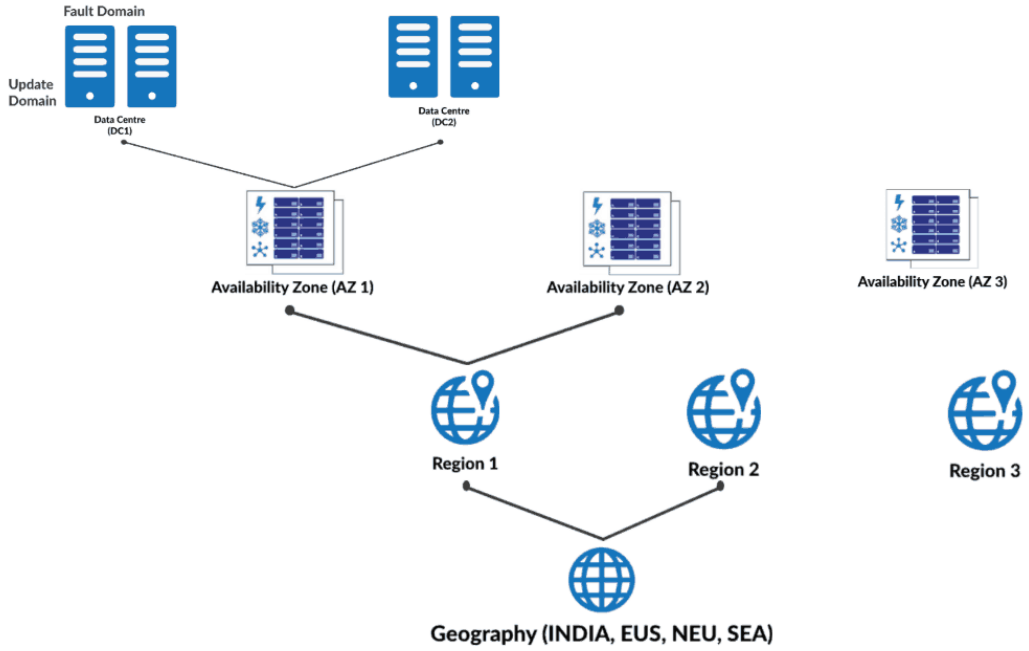
  Model as a service (MaaS) provides serverless APIs for machine learning models, simplifying app deployment.

4.Azure Global Infrastructure

https://datacenters.microsoft.com/globe/explore/

What Is A Region?

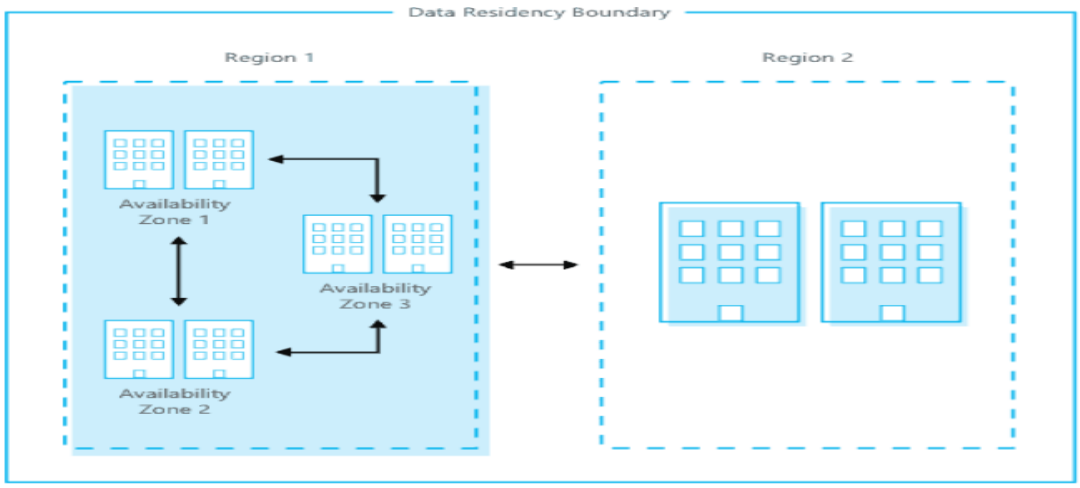
- A region is a geographical area containing at least one, but potentially multiple datacenters that are nearby and networked together with a low-latency network.
- When one deploys a resource in Azure, one needs to choose the region where you want your resources deployed.
- Examples of regions are West US, Canada Central, West Europe, Australia East, and Japan West.



What Is Availability Zone?

- Availability Zones are physically separate datacenters within an Azure region.
- Each Availability Zone is made up of one or more data centers equipped with independent power, cooling, and networking. It is set up to be an *isolation boundary*.
- Azure creates a duplicate of your data and resources so that the information is safe, in case of failure. If one zone goes down, the other continues working.
- Resources are highly available through Availability Zones.

- **Not every region has support for Availability Zones.** The **examples of Availability Zones** are Central US**,** East US 2, West US 2, West Europe, France Central, North Europe & Southeast Asia



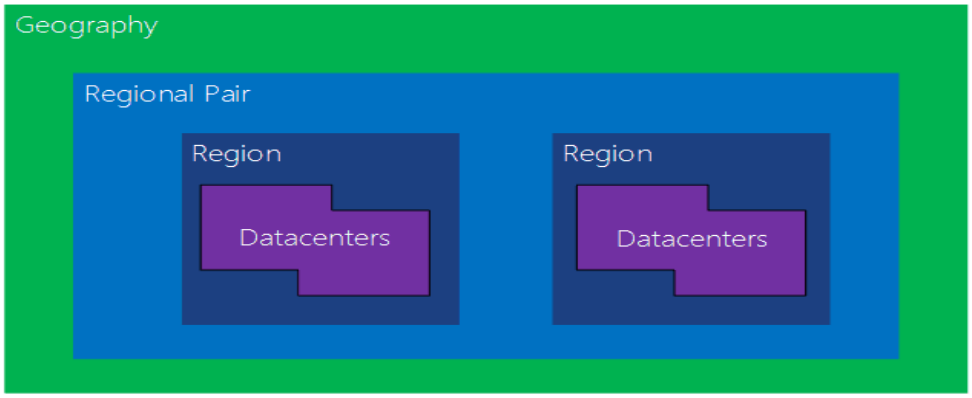
What Is A Regional Pair?

- Each Azure region is paired with another region within the same geographical area, which is at least 300 miles away.
- It allows replication of resources (such as VMs) which helps in reducing the interruptions due to natural disasters, civil unrest, power outages, or physical network outages.
- Azure updates are rolled out to paired regions one region at a time to minimize downtime and risk of application outages.
- **Examples of region pairs** are West US paired with East US, South-East Asia paired with East Asia.

Geography	Regional Pair A	Regional Pair B
Canada	Canada Central	Canada East
China	China North	China East
India	Central India	South India
Japan	Japan East	Japan West
North America	East US	West US

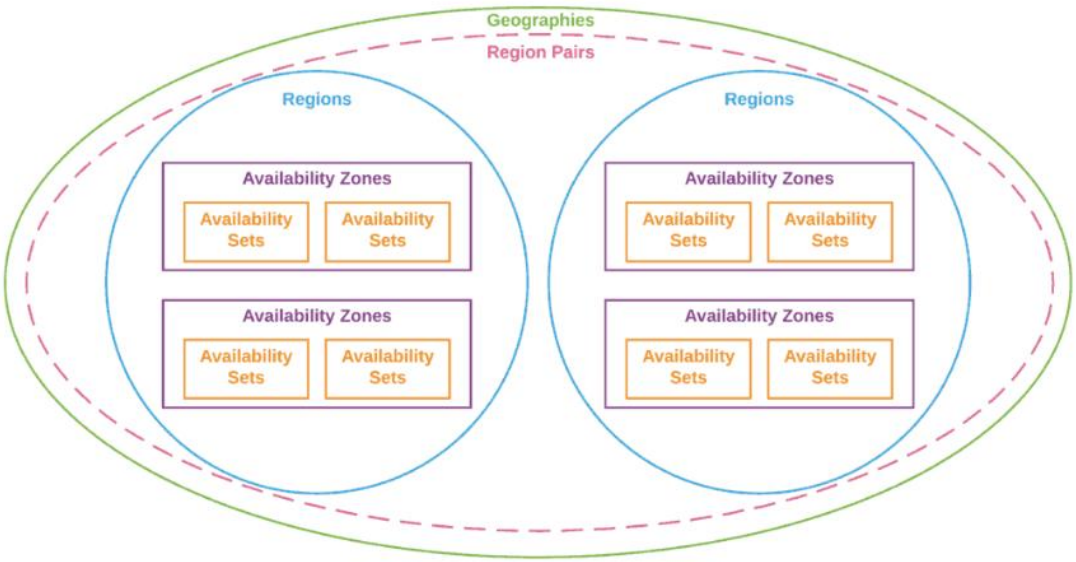
What Is Geography?

- Azure divides the world into geographies that are defined by geopolitical/country boundaries typically containing two or more regions that preserve data residency and compliance boundaries.
- Geographies allow customers with specific data residency and compliance needs to keep their data and applications close or within geographical boundaries.
- Geographies are fault-tolerant to withstand complete region failure through their connection to dedicated high-capacity networking infrastructure**.**



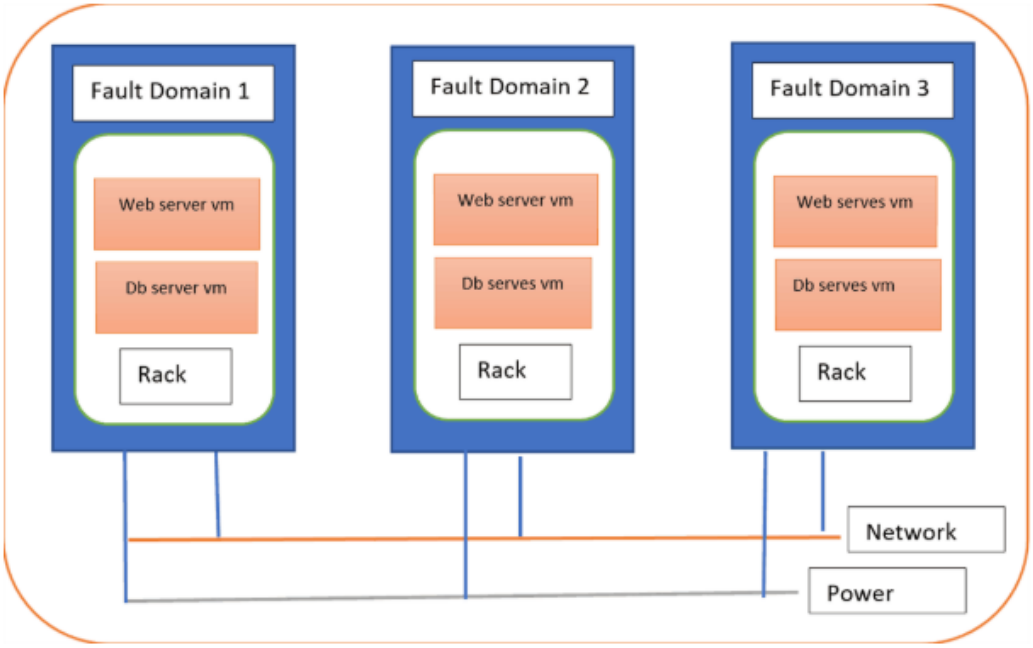
What Is Availability Set?

- An Availability Set is a logical grouping capability for isolating VM resources from each other when they're deployed.
- By deploying your VMs across multiple hardware nodes Azure ensures that if hardware or software failure happens within Azure, only a sub-set of your virtual machines is impacted and your overall solution is safe and in working condition.
- It provides redundancy for your virtual machines.
- The availability set spreads your virtual machines across multiple fault domains and update domains.



What Is the Fault Domain?

- Fault domains are the group of virtual machines that share a common power source and network switch.
- Each and every fault domain contains some racks and each rack contains a virtual machine.
- Each of these Fault domain shares a power supply and a network switch.
- All the resources in the fault domain become unavailable when there is a failure in the fault domain.
- You should place your VMs in such a way that each fault domain gets one web server, one database server, and like that.



What is an Azure Datacenter?

A distinct physical structure called an Azure data center houses hundreds of real servers and has its own power, cooling, and networking systems. These data centers are dispersed throughout the world. There are more than 160 Azure datacenters as of the time of this course recording.

China East, China East 2, China East 3, East Asia, Central India, South India, West India, Japan East, Japan West, Australia Central, Australia Central 2, Australia East, Australia Southeast, China North, China North 2, China North 3, East Asia, Japan East, Japan West,…

5.Why are azure geographies important ?

Each Azure geography has one or more regions and complies with regulations around data residency and compliance. This enables you to maintain close proximity of your business-critical data and applications on high-capacity, fault-tolerant networking infrastructure.

Azure regions are meant to provide both protection against regional or big geography disasters with disaster recovery and protection from localised disasters with availability zones.

Well, it's possible that regulated data, such as financial, health care, or credit data, cannot leave the country. According to the law, your business must keep such data in the nation where the operations are being conducted. So, if you choose a location, like India, for instance, Azure makes sure your data is not stored elsewhere. The data remains inside the states if you choose the United States. You have full control over the geographic areas where your data and applications will be used. You may rest certain that Microsoft won't keep client information outside the region you designate, with the exception of some non-regional services.

We advise using the available multiple enabled regions for apps that support multiple active areas. This procedure guarantees maximum application availability and cuts down on recovery time in the event of an event that reduces availability. Design your application to be as resilient and disaster-recovery-friendly as practicable whenever possible

6.What is cross-region resiliency?

Numerous enterprises demand both the high availability offered by availability zones as well as protection from local and global disasters. Azure regions are built to provide protection against local disasters via availability zones, as was covered in the resiliency overview for regions and availability zones. However, they can also offer protection from local or widespread calamities through disaster recovery by utilizing a different region that makes advantage of cross-region replication.

One of several crucial foundations in the Azure business continuity and disaster recovery plan is cross-region replication. By employing availability zones within your primary Azure region for high availability, synchronous replication of your apps and data already takes place. Cross-region replication improves on this. For disaster recovery protection, cross-region replication asynchronously duplicates the same applications and data across different Azure regions.

7.Azure Zonal services and Zone-redundant services

Zonal, zone-redundant, and always-available services are three different categories of Azure services that enable availability zones. When developing your resilience strategy, you can incorporate all three of these architectural strategies.

- **Zonal services**: To meet more rigorous latency or performance criteria, a resource might be deployed to a particular, self-selected availability zone. By replicating applications and data to one or more zones within the area, resilience is self-architected. A zone can have resources pinned to it.
- **Zone-redundant services**: Resources are automatically replicated or dispersed across zones. Zone-redundant services, for instance, duplicate the data over three zones such that a failure in one zone doesn't impair the data's high availability. Zonal, zone-redundant, and always-available services are three different categories of Azure services that enable availability zones. When developing your resilience strategy, you can incorporate all three of these architectural strategies.
- **Services that are always accessible**: Always accessible throughout the whole Azure geography and resilient to both zone- and region-wide failures. See Products available by region for a comprehensive list of Azure's non-regional services, also known as always-available services.

8.Benefits of paired regions

- **Physical separation between datacenter :**

  Microsoft rigorously limits physical access to the places where your data is held when designing, constructing, and running datacenters. Microsoft is committed to assisting in the security of the datacenters that house your data because it recognizes the value of keeping your data secure. At Microsoft, we have a whole division devoted to planning, constructing, and managing the physical infrastructure that supports Azure. This group is committed to upholding cutting-edge physical security.

- **Region recovery in the event of an outage :**

  Regions are the conceptual and physical divisions of Azure. A region is made up of several closely spaced data centers. Availability zones, which can be utilized to increase resilience against outages in a single data center, are supported by many areas and services. To increase the availability of your solution, think about employing regions with availability zones. In exceptional cases, it is possible for all of the facilities within a

region or availability zone to become unreachable, for example because of network outages. Or, a natural calamity, for instance, could result in the complete loss of facilities. Applications that are deployed across zones and regions can be created using Azure. This dispersal lessens the likelihood that a failure in one zone or region could have an impact on other zones or regions.

- **Automatic Platform-provided replication**:

  Replication that is automatically provided by the platform: Services like Geo-Redundant Storage automatically replicate data to the paired area. This has many advantages. You still have access to the data from the other region in the region pair in the event that one of the regions goes down.

- **Data residency, compliance and legal requirements azure**:

  Data residency is a compliance requirement that places emphasis on a company's data being stored in a certain geo-location. This obligation may exist for a variety of reasons, but it is typically controlled by government compliance, such as the GDPR in Europe.

- **Sequential system updates:**

  Azure releases platform updates on a regular basis to enhance the host infrastructure for virtual machines' dependability, performance, and security. These updates serve a variety of purposes, including as upgrading networking hardware, decommissioning hardware, or patching software components in the hosting environment.

  The hosted VMs seldom ever experience updates. Azure selects the least disruptive technique for updates when they do have an effect: If the update doesn't call for a reboot, the VM is either halted while the host is updated or it is live-migrated to a host that has previously undergone the update.
  You are informed of the scheduled maintenance if it necessitates a reboot. Azure additionally gives you a window of time within which you can initiate the maintenance on your own, whenever it is most convenient for you. For Host machines, the self-maintenance window is normally 35 days unless the work is essential. Azure is investing in technology to lessen the frequency of planned platform maintenance situations where the VMs need to be rebooted. Handling planned maintenance provides guidelines for handling planned maintenance notifications using the Azure CLI, PowerShell or portal..

8.Conclusion

The global infrastructure of Microsoft Azure is a foundational pillar in enabling secure, scalable, and resilient cloud services for organizations across the world. As businesses increasingly demand low-latency access, strict data compliance, high availability, and global reach, Azure's architecture—comprising over 60+ regions, 160+ datacenters, paired regions, and availability zones—sets a benchmark in the cloud computing ecosystem.

Azure's intelligent design not only ensures geographical and operational redundancy but also empowers organizations to innovate with confidence. Features such as cross-region replication, zone-redundant services, and a robust paired-region model guarantee business continuity, even during large-scale failures or regional disasters. Microsoft's continuous investments in cutting-edge infrastructure, sustainability, and security—backed by a $20 billion commitment to cybersecurity—reflect its long-term vision to be the cloud of choice for critical and compliant workloads.

From a security standpoint, Azure's global infrastructure is engineered to meet the needs of highly regulated industries, enabling full control over data residency, sovereignty, and compliance. This is particularly relevant in an era where organizations must strike the balance between performance, privacy, and protection.

In conclusion, Azure's global infrastructure exemplifies a future-ready, security-first approach to cloud computing. As businesses transform digitally and embrace AI-powered innovation, Azure provides the geographic flexibility, operational resilience, and enterprise-grade security needed to thrive in a cloud-first world.