A R&D report
on

Azure Global Infrastructure

Submitted to **Celebal Technologies** in partial fulfillment of the internship task

Week 3

in

Cloud Infra and Security

By

Mr. Ganesh Ghadge

StudentId: CT_CSI_CI_6124

Objective

This document aims to comprehensively understand **Microsoft Azure's Global Infrastructure**, focusing on its core components: **Geographies**, **Regions**, **Availability Zones**, and **Data centers**. These elements form the backbone of Azure's ability to deliver scalable, secure, and resilient cloud services globally. By explaining the hierarchical structure and operational roles of each component, this document will help individuals gain a foundational knowledge of how Azure ensures service continuity, data residency, and regional compliance.

The document's objectives are as follows:

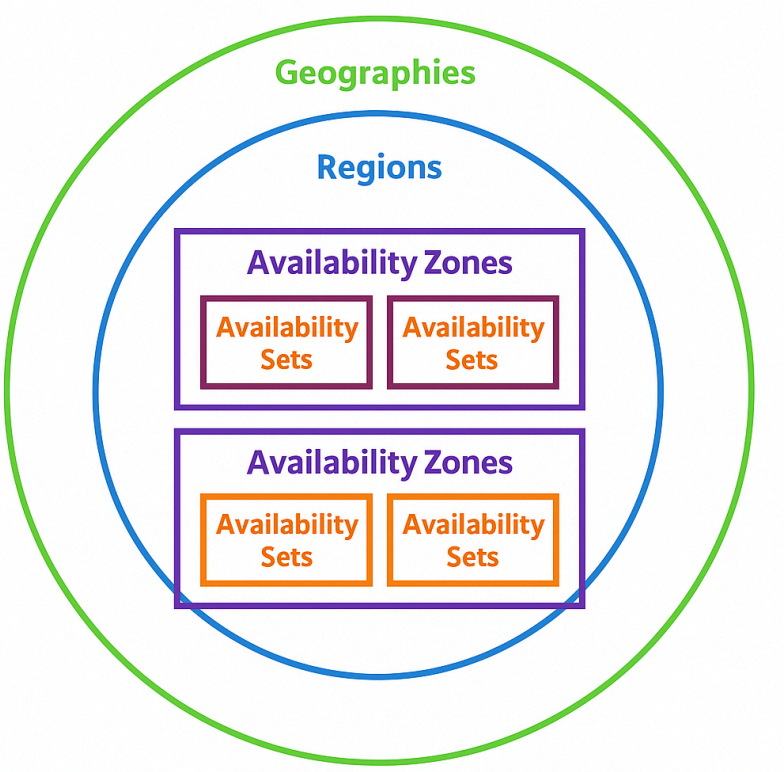
- Describe the concept of **Azure Geographies** and their role in ensuring compliance, data sovereignty, and regional isolation.
- Explain **Azure Regions** as operational units for deploying cloud resources, including the idea of paired regions and latency optimisation.
- Understand **Availability Zones**, their structure within regions, and how they provide fault isolation and high availability.
- Introduce the concept of **Azure Data centers**, focusing on their physical infrastructure, global distribution, and sustainability efforts.
- Illustrate how these components work together to support enterprise-grade applications and maintain disaster recovery capabilities.
- Provide real-world usage scenarios to demonstrate how organisations leverage Azure's infrastructure to meet performance, availability, and compliance requirements.

Introduction

As cloud computing continues to transform the way businesses operate, the underlying infrastructure that powers these cloud services becomes critically important. Microsoft Azure, one of the leading cloud platforms, delivers its services through a globally distributed infrastructure designed for reliability, security, scalability, and compliance.

Azure's global infrastructure is composed of several interconnected layers:

- **Geographies**, which represent defined areas for data residency and compliance;
- **Regions**, which are collections of data centers in a specific geographic area;
- **Availability Zones**, which are isolated locations within a region to ensure fault tolerance.
- **Physical Data centers**, which house the computing, storage, and networking hardware.



Each of these layers plays a vital role in enabling Azure to provide high availability, disaster recovery, and global reach while respecting legal and regulatory requirements. Understanding the structure and purpose of Azure's infrastructure is essential for architects, developers, and IT professionals planning to build and scale cloud-based solutions.

This document will explore these foundational elements in detail, offering clarity on how Microsoft organises and operates its cloud infrastructure to serve customers across the globe.

Azure Geographies

The **Azure Geographies** are defined areas of the world that contain one or more Azure Regions. Each geography is designed to meet specific data residency, compliance, and sovereignty requirements. These geographies align closely with national boundaries or regional market requirements to ensure that customers can keep their data within their desired jurisdiction.
Geographies are especially important for industries and governments that have strict legal or regulatory requirements for data storage and processing, such as healthcare, finance, and public sector organisations.

Key Features

- Data Residency: Ensures that customer data stays within the defined geography.
- Compliance Support: Helps organisations meet local regulatory and legal requirements.
- Isolation for Disaster Recovery: Provides clear boundaries for designing region-paired disaster recovery and business continuity strategies.

Examples of Azure Geographies

- United States
- Europe
- Asia Pacific
- India
- Middle East & Africa
- China (operated independently by 21Vianet)
- Germany (dedicated geography for compliance with German data protection regulations)

Each geography contains one or more Azure Regions, and Microsoft does not replicate customer data outside a geography unless explicitly configured by the customer.

Use Case Example

A financial institution in Germany may choose to deploy resources within the German geography to ensure that all customer data remains within German legal jurisdiction, aligning with strict data protection laws such as GDPR and local financial regulations.

Azure Region

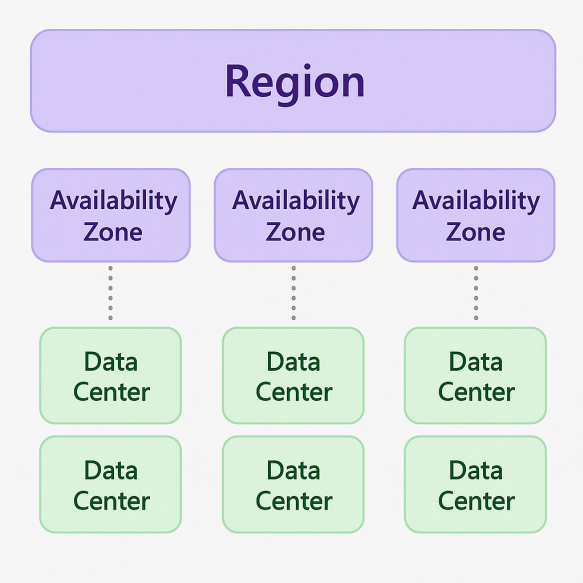
An **Azure Region** is a set of data centers deployed within a specific geographic area, connected through a low-latency network. Each region is designed to provide high availability, fault tolerance, and regional redundancy for running applications and storing data.
Microsoft Azure has more global regions than any other cloud provider, which enables customers to deploy resources closer to users for better performance, compliance, and geographic redundancy.

Structure of a Region

Each Azure region typically includes multiple data centers and offers a full range of Azure services. Some regions also include Availability Zones for higher resiliency.

A standard region structure includes:

- Multiple physical facilities (data centers)
- High-speed interconnects for low-latency performance
- Shared access to global services (e.g., Azure Active Directory, DNS)



Examples of Azure Regions

- East US
- West Europe
- Southeast Asia
- UK South
- Australia East
- South Central US

Each region is named based on its relative location, not the exact city where it resides.

Region Pairs

Azure organises most regions into region pairs, which are two regions within the same geography that are directly connected and synchronised. This pairing is critical for:

- Disaster recovery
- Data replication
- Sequential updates (only one region in a pair is updated at a time)

Example: East US is paired with West US, allowing services to fail over between regions if necessary.

Benefits of Using Azure Regions

- Proximity to Users: Reduced latency and faster access to services.
- Compliance: Helps meet regulatory requirements based on data location.
- Availability: Supports high availability through regional replication and failover.
- Service Scope: Some Azure services are only available in specific regions.

Use Case Example

An e-commerce company operating globally may choose to deploy applications in East US, West Europe, and Southeast Asia to serve users in those markets with low-latency access and localised data compliance.

Availability Zones

Availability Zones (AZs) are physically separate locations within an Azure Region, designed to ensure high availability and fault isolation. Each zone is made up of one or more independent data centers with distinct power, cooling, and networking to minimize the risk of a single point of failure.
Azure's Availability Zones help organizations build resilient applications and services by providing infrastructure that can withstand localized failures, such as hardware faults, power outages, or network disruptions.

Structure of an Availability Zone

Each Azure Region that supports Availability Zones has at least three zones, and each zone is:

- Physically separated from the others
- Connected via high-speed, low-latency links
- Designed for independent operation

Key Characteristics

- Fault Isolation: A failure in one zone does not affect others.
- High Availability SLAs: Microsoft offers a 99.99% uptime SLA when services are deployed across multiple zones.
- Zonal Services: Some Azure services (like Virtual Machines, Managed Disks, and Load Balancers) can be deployed in specific zones or across multiple zones for redundancy.

Examples of Regions with AZ Support

- East US 2
- West Europe
- Japan East
- Southeast Asia
- Australia East

Not all regions support Availability Zones. Microsoft is continuously expanding AZ support to more regions globally.

Use Case Example

A healthcare application that requires high reliability and availability can deploy its compute resources across three Availability Zones in East US 2, ensuring that even if one zone experiences an outage, the service remains operational.

Azure Data Centers

An **Azure Data center** is a physical facility that houses the computing, storage, and networking hardware that powers Azure's cloud services. These data centers are the core building blocks of Azure Regions and Availability Zones, enabling Microsoft to deliver services at massive scale, with global reach and enterprise-grade reliability.

Azure data centers are located strategically around the world to provide:

- Low-latency access
- Redundant connectivity
- Regulatory compliance
- Environmental sustainability

Design and Architecture

Each data center is designed with:

- Redundant Power Supply: Multiple power sources, UPS systems, and backup generators.
- Environmental Controls: Precision cooling and fire suppression systems.
- Security: Multi-layered security including biometric access, perimeter fencing, 24/7 surveillance, and security personnel.
- Networking Infrastructure: High-speed fibre links and redundant internet connectivity.
- Sustainability Goals: Microsoft is committed to running 100% of its data centers on renewable energy by 2025 and achieving zero-waste operations by 2030.

Data Center Roles in Azure Infrastructure

- Foundation for Regions & Zones: Multiple data centers make up a region; in AZ-enabled regions, they're distributed across zones.
- Service Hosting: Data centers host VMs, databases, containers, AI models, and storage services.
- Backup and Redundancy: Critical for disaster recovery and business continuity planning.

Use Case Example

An enterprise might choose to deploy critical financial workloads in regions with geo-redundant data centers, such as East US and West US, to ensure resilient service delivery and data protection in the event of a local outage or natural disaster.

References

1. Global Infrastructure | Microsoft Azure
   https://azure.microsoft.com/en-us/explore/global-infrastructure
2. Azure Regions Documentation
   https://azure.microsoft.com/en-us/explore/global-infrastructure/geographies
3. Availability Zones Overview
   https://learn.microsoft.com/en-us/azure/availability-zones/az-overview
4. Microsoft Data Centers' Sustainability Efforts
   https://www.microsoft.com/en-us/sustainability/emissions-impact-dashboard
5. Azure Paired Regions
   https://learn.microsoft.com/en-us/azure/best-practices-availability-paired-regions
6. Azure Compliance Offerings
   https://learn.microsoft.com/en-us/compliance/regulatory/offering-home