Architecting Microsoft Azure Solutions [1]

Infrastructure as a Service (IaaS)c

Virtual Machines

Availability Set
- 2 fault domains for classic
- 3 fault domains for Resource Manager deployments
- 5 update domains

Scale Set
- Max 100 VMs
- Max 1000 VMs with placement groups (auto scale)
- Managed disks needed for large scale sets

VM Series
- A0-7, Av2, B — General purpose
- F — Compute optimised
- D,E,G — Memory optimised
- L — Storage optimised
- N — Graphic GPU optimised
- H — High performance computing

Join VMs to domain
- Enable Azure AD Domain Services

High Performance Compute

HPC Workload Series
- A8-11 — General purpose
- N — Graphic GPU optimised
- H — High performance computing

HPC Pack
- Windows Server 2012, 2016, and Linux
- Create HPC clusters on-prem

Azure Batch
- Most cost-effective option for scientific calculations

Cloud-native HPC solution
- HPC head node and compute nodes
- Virtual Machine Scale Sets (VMSS)
- VMs using RDMA are placed in same VMSS
- Virtual Network
- Azure Blob Storage for node disks

Hybrid HPC solution
+ ExpressRoute to connect cloud with on-prem
+ VPN Gateway endpoint between cloud and on-prem

Hybrid Applications

Relay Service

Hybrid Connections
- Establish a rendezvous point in the cloud
- On-prem app connects using HTTP/ Sockets to cloud

WCF Relays (Service Bus Relays)
- On-prem app uses WCG bindings to connect to Srv Bus

Data Management Gateway

Data-integration service
- Create workflows to automate data move + transform
- Connect to ML, HDInsight, Data Lake Analytics
- Data sent over HTTP using certificates
- No firewall ports need to be opened

App Service Hybrid Connections

Connects Azure and on-prem applications using TCP
- Uses Azure Relay Service
- Part of App Service and is a separate Azure feature

App Service VNet Integration

Enables access from app to other services
- Deploy app inside a VNet
- Access services within same VNet (VMs, DBs, ...)
- TCP or UDP

AD Application Proxy

Access on-prem web apps from the cloud
- Provides single sign on (SSO) + secure remote access
- Connector – lightweight agent on on-prem server
- External endpoint – direct URL or access via MyApps

On-Premise Data Gateway

Bridge between on-prem data sources and Azure
- Uses Service Bus
- Azure -> Analytics, Logic Apps, Flow, Power Apps, ...
- On-Prem -> SQL Server, SQL Analytics, SharePoint, ...

Web Apps

App Service Plans

Free and Shared
Basic
- Up to 3 instances (manual)

Standard
- Up to 10 instances (auto scale)
- 5 Slots
- Daily backups
- Azure Traffic Manager

Premium
- Up to 20 instances (auto scale)
- 20 Slots
- Daily backups
- Azure Traffic Manager

Isolated
- App Service Environment (ASE) – scalable, secure
- Up to 100 instances/plan or 100 plans with one instance

Redis Cache

Basic
- Ideal for development, testing, and non-critical work
- No SLA

Standard
- Ideal for production and cost effective
- Data replication between two nodes
- High availability SLA

Premium
- Redis persistence
- Create workloads > 53GB
- Ability to isolate

Scalability

Up
- Select different (better) Service Plan

Out
- Scale out Web App manually or automatically

Traffic Manager

Routing methods
- Performance, Weighted, Priority, Geographic

Handle load & locate closest geo region at DNS level

Content Delivery Network (CDN)

Cache static content to multiple regions

Web APIs

Multiple programming languages
- ASP.NET, Core, Angular, React.js, Java, Python

Securing Web API
- Azure AD
- Azure AD B2C – with Facebook and Google providers
- Active Directory Federated Services (ADFS)
- API Management – policies, API keys, throttling, ...

Serverless and Microservices

Functions

Serverless compute service
Event-driven actions and triggers
- HTTP-based API endpoints (HTTP triggers)
- Timer triggers

Programming Languages
- C#, F#, Node.js, Java, PHP, PowerShell, Batch, JavaScript, Python, Typescript

Plans
- Consumption App Service Plan (cost effective)
- Other App Service Plans

Containers

Azure Container Instances (ACI)
- One ACI = one Docker container
- Role Based Access Control (RBAC)
- Short-running workloads

Azure Container Services (AKS)
- Load balancing
- Orchestration
- Long running workloads

API Management

Service that exposes different apps as APIs
API Gateway
- Bridge between app and outside world
- Enhanced security, policies, authentication
- Caching, throttling

API Management Portal
- Define custom APIs
- Package APIs into open or protected products

Developer Portal
- Developers can access APIs and documentation

Deployments vs Migrations

Cloud Infrastructure Ready
- Host on VMs as-is

Cloud DevOps Ready
- Use containers to develop and deploy
- Decouple application from infrastructure

Cloud Optimised
- Modernise mission critical application

Logic Apps

Workflow Driven
Integration with cloud and on-prem services
- BizTalk, ...

Service Fabric

Orchestration Platform
- Cloud and on-prem
- Container orchestration

Lifecycle Management
- Service developer (creates microservices)
- Application developer (creates applications)
- Application administrator (creates config & packages)
- Operator (deploys, monitors, maintains)

IoT Hub vs Event Hub

IoT Hub – Two-way communication Azure ←→ Devices
Cost effective data ingest, on-way communication from Devices → Azure - **Service Bus**

Scalable Data Implementations

Data Catalog

Provides central repository
- One catalog per tenant
- Sources – Blob Storage, Data Lake, QL Server, Oracle, ...

Data Factory

Cloud Service for big data processing and analytics
- Data pipelines, activities, datasets, linked services, triggers, pipeline ru, parameters, control flow
- Available in - East US, East US2, West Europe

Data Lake

Big data storage and analytics service
- Based on Hadoop Yes Another Resource Negotiator (YARN)
- Solutions - Store, Analytics, and HDInsights

Data Lake Store
- Storage repository for big data workloads
- Unlimited structured, semi-, and unstructured data

Data Lake Analytics
- Uses serverless approach
- Pas-as-you-go, monthly commitment
- Uses U-SQL to analyse the data

HDInsights
- Deploys Hadoop components in form of clusters in cloud
- Opensource service for analysing and processing data
- Apache Hadoop, Spark, HBase, Storm, Kafka, Interactive Q
- Microsoft R Server

SQL Data Warehouse

Massive Parallel Processing (MPP)
- Uses Hadoop/Spark and Machine Learning for insights
- Uses Data Movement Service (DMS) between nodes

Analysis Services

Same architecture as SQL Server Analysis
- Enterprise grade data modelling in the cloud

MySQL

Open source relational database
- Used by PHP developers, CMS WordPress
- ACID, replication, Performance, security, extensibility, concurrency, JSON support
- Pricing
  - Basic – 1TB, 4 CPUs, locally redundancy
  - General Purpose – 1TB, 4 CPUs, local+geo redundancy
  - Memory Optimised – 1TB, 5 CPUs, local+geo red.

SQL Database

Relational database
- Elastic Database Pools (eDTUs)
- Individual databases (DTUs)
- High availability, geo-replication, failover groups
- Backup and Recovery
  - Basic – 7 days retention
  - Standard and Premium – 35 days
  - Restore - Point-in-time, deleted DB, Geo, and Az Recovery Vault

SQL Server Stretch Database
- Move or archive cold data from on-premises SQL Server to Azure SQL

PostgresSQL

Open source relational database
- Open Source, ACID, Replication, Performance, Security, Concurrency, JSON, JSON Indexing, Extensibility

Storage Solutions

Storage and Replication

General-purpose v1
- Classic, does not support latest features.

General-purpose v2
- Newest, that combines v1 and blob storage
- Latest features at a reduction in costs

Blob storage
- Same features as storage v2 acc, but only block blobs.

Replication (X redundant storage)
- Locally – 3 copies within data center
- Zone – US East 2 and US Central, 3 datacenter copies
- Geo – three regional copies

Blob Storage

Unstructured data – VHDs, images, audio, etc.
- Max 1TB page blob, 200GB block blob

Access tiers
- Hot – optimised for frequently accessed data
- Cool – Suitable for backups and not often viewed data
- Archive – set at blob level, cannot be read or modified

File Storage

Create file shares in the cloud
- Access with Server Massage Block (SMB) protocol
- Cached fast access on Win Server using Azure File Sync

Table Storage

Semi-structured, non-relational data
- Suitable for datasets without complex joins
- Access via OData and LINA queries
- Max 500TB data

StorSimple

Integrated storage spanning on-rem an cloud
- iSCSI and SMB support

StorSimple Virtual Array
- Hyper-V 2000 R2 and VMWare 5.5
- iSCSI server (AN) or File Server (NAS).

StorSimple 8000 Series
- Leased physical device
- Virtual Appliance Manager replicates data to cloud

Queue Storage

Asynchronous processing of messages
- REST.API supports GET, PUT, and PEEK
- Messages max 64KB and max 7days lifetime

Disk Storage

Used for VMs stored in Az Blob storage as page blobs.
- Standard – unmanaged HDD disk drives. LRS and GRS redundancy only.
- Premium – SDD, high-performance disk support

Cosmos DB Storage

Premium Azure Table Storage
- Multi-model and globally distributed database
- Low latency, high availability, high performance

APIs
- SQL, MongoDB, Gremlin (Graph), Table, Cassandra

Search

Rich search experience over Azure storage
- SQL Database, CosmosDB, Blob Storage
- Text search, analysis, and linguistic analysis

Tiers
- Free, Basic
- Standard $S1^{25GB,50\ indexes}$, $S2^{100,200}$/$S3^{200GB}$/$HD^{1000\ indexes}$

Networking

Virtual Network

VNets
- Max 50 VNets per subscription

Subnets
- Max 1000 subnets per VNet
- Max 10 VNet connections (peering) per subscription

Pubic Address
- Max 60 public dynamic addresses per subscription
- Max 20 public static addresses per subscription

Private Address
- Max 4096 private addresses per VNet

DNS
- DNS for multiple VNets requires own DNS server

Load Balancer

Load Balancing
- Transport Layer 4
- Any protocol
- Azure VMs and Cloud service endpoints
- VNet: Internet and internal facing
- Endpoint monitoring: Supported via probes

Types
- Basic
- Standard ... up to 1000 VMs, HA ports, and NSG.

Traffic Manager

Traffic management
- DNS level
- Any protocol
- VMs, Cloud Service, Web Apps, and external endpoints
- VNet: Internet facing
- Endpoint monitoring: HTTP/HTTPS GET

Load balancing
- Use with load balancer for high-avail and high-per

Application Gateway

Gateway
- DNS level
- Application level 7
- HTTP and HTTPS
- VNet: Any public or internal IP address
- Endpoint monitoring: Supported via probes

SSL
- SSL off loading to avoid costly decryption

Firewall
- Web Application Firewall (WAF)

Network Security

DMZ
- Network Security Groups (NSG)
- User Defined Routes (UDR)
- Firewalls

Network Security Groups
- Inbound and outbound rules
- Checked between VMs, VNets, and other services
- Applied to one or more subnets or network interfaces
- Low order numbers are higher priority

User Defined Rules
- Create UDRs & IP forwarding by creating a routing table

Virtual Network Service Tunneling
- Force external traffic through a site-to-site VPN tunnel

Web Application Firewall
- Part of Application Gateway and based on OWASP 3.0
- Can protect max 20 applications behind an App G/W
- Examples: SQL Injection, Cross-Site Scripting, Bots, ...

External Connectivity

Azure VPN
- Basic – max 10 site-site, 128 point-site, avg 100Mbps
- VpnGw1 – max 30 site-site, 128 point-site, avg 650Mbps
- VpnGw2 – max 30 site-site, 128 point-site, avg 1Gbps
- VpnGw3 – max 30 site-site, 128 point-site, avg 1.25Gbps

Site-to-site
- Requires Routing and Remote Access Service (RRAS)
- Internet Protocol Security (IPSec) connection
- Internet Key Exchange (IKE) management protocol

Point-to-site
- Connect IKE2 or Secure Socket Tunneling Protocol (SSTP)
- No RRAS device required

VNet-to-Vnet
- Max 10 VNet connections (peering) per subscription

ExpressRoute
- Any-to-Ant (IPVPN) – provider sets up secure connection
- Point-to-Point Ethernet –two provider connections
- Co-Located at Cloud Exchange – two cross connections
- Maximum 10GB

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Architecting Microsoft Azure Solutions [2]

Securing Resources

Active Directory

Directory and identity management
- Plans – Free (no SLA, 500k objects), Basic, Premium P1/P2
- Protocols – OAuth 2.0, OpenID Connect
- Endpoint V1
  - Work and school accounts
  - Azure Active Directory Library (ADAL)
- Endpoint V2
  - Work, school, and personal accounts
  - Microsoft Authentication Library (MSAL)

Microsoft Graph
- Connects multi services and provides single endpoint
- AAD is integrated in Microsoft Graph

AD Federation Services

Authentication provider for external users to on-prem
- WEB SSO for federated users accessing on-prem apps, using Azure AD Connect
- Web Services (WS) – WS-Federation compatible
- No external user account management – own credentials using Security Assertion Markup Language (SAML)
- Install on-prem of Azure VM and use MS Graph.

Multi-Factor Authentication

Two step verification (MFA)
- Know – password
- Have – phone, verification app, 3rd party OAuth tokens
- Are - biometrics

AD Connect

Synchronise on-prem AD identities with Azure
- AAD password hash synchronisation
  - User passwords hashes synched between AD and AAD
  - Hash synched with any change
  - Provides single sign-on (SSO)
- AAD pass-through authentication
  - Passwords are not synchronised, but validated on-prem
  - Provides single sign-on (SSO)

AD Business to Consumer B2C

Cloud identity management for mobile and web apps
- Leveraged using MSAL
- Social Accounts – Facebook, Google, LinkedInn
- Enterprise Accounts – OpenID Connect, SAM
- Local accounts – email/user and password
- App must be registered inside Azure B2C tenant

AD Business to Business B2B

Enables organizations to work safely with others
- Enabled by default for all AAD tenants
- Integrated with Office 365
- AD Premium Features requires license ration of 5:1
  Every AS Premium licence = five external users
- Set conditions for users, for example, enforce MFA
- Use policies to delegate permissions

Securing Data

Key Vault

Store cryptographic keys and secrets
- Service Tiers: Standard and Premium
- Hardware Security Modules (HSM) with Premium

Disk Encryption

Encrypt Windows and Linux VMs
- Windows – Bitlocker
- Linux – dm-crypt

AD Managed Service Identity

Managed identity for resources in Azure
- Service Principal only known within bounds of Az resources
- Assign appropriate Role-based Access Control (RBAC)

SQL Database Security

Security for data in transit, rest, and in use
- HTTPS – security in transit
- Transparent Data Encryption – security at rest
- Always Encrypted – data in use, AlwaysEncrypted columns

Storage Encryption

Encryption for data at rest
- Storage Service Encryption (SSE)
- Written to storage account using 256-bit AES encryption
- Set with Portal, PowerShell. CLI, and REST API

Governance and Policies

Role-Based Access Control

Implement the principle of least permissions
- Roles in Azure can be added to a scope
- Scope cam be subscription, Resource Group, or Web App
- Set 2000 role assignments from Portal, PS, CLI, Rest API
- Built-in Roles: Owner, Reader, Contributor

AD Privileged Identity Mngt.

Manage and control access inside an Az AD tenant
- Az AD Prem P2 or Enterprise Mobility + Security E5 feature
- Grant permanent or temporary role access
- Flow: User request, review, approval, notification, action, monitor

Operations Management Suite

Hybrid cloud and data management tool
- Manage on-prem and Az infrastructure
- Azure, AWS, Win Server, Linux, VMWare and OpenStack
- Services:
  - Security and Compliance Solution
  - Security and Audit
    - Security Domains
    - Notable Issues
    - Detection
    - Thread Intelligence

Resource Policies

Define and enforce rules and actions for resources
- NOT about users, groups, or application access
- Apply governance strategy
- Example: All VMs use managed disks

AD Identity Protection

Premium protection for Az identities
- Detect identity based issues
- Detect compromised identities
- Policies: MFA registration, user risk, sign-in risk

Security Center

Advanced Thread Protection and Security Mngt.
- Features:
  - Centralised policy management
  - Continuous security assessment
  - Actionable recommendations
  - Advanced Cloud protection
  - Prioritised alerts and incidents
  - Integrated security solutions
- Tiers: Free and Standard (hybrid environments)
- Advanced Threat Detection
  - Activity group, campaign, and threat summary report
- Az Endpoint Protection
  - Anti malware protection for Az and on-prem VMw

Operations Automation Strategies

Operation Automation

Automation ensures consistency and saves time
- Development, testing, acceptance, and production
- PowerShell – create resources and configure
- Desired State Configuration (DSC) – enforce config
  - Features: Configurations, Resources, Local Config Mgr.
- Azure Automation
  - Process Automation – automate management
  - Configuration Management – DSC, PowerShell
  - Update Management – Cloud + on-prem environments
  - Shared capabilities
- 3rd Party
  - Chef – virtual and physical config management, Windows + Linux + Mac
  - Puppet
- Azure Event Grid – supports automation tasks
- Azure Logic Apps – supports call to automation runbooks
- Azure DevOps – CI/CD

Autoscaling Strategy

Meet performance and SLA requirements
- Vertical scaling – change VM sizes
- Horizontal Scaling – add / resource resources
- Strategies
  - Monitoring and alerting
  - Decision Making Logic – automation runbooks
  - Az Monitoring Scale – integrated in Az Monitor
  - App Architectures – Service Fabric scales horizontally

Messaging Services

Storage Queue

Asynchronous processing of messages
- Messages up to 64KB in size
- 7 days retention maximum
- Messages become visible after 30sec if not deleted
- Multiple receivers

Service Bus

Reliable, brokered messaging system
- Ideal for Integration and IoT scenarios
- Messages up to 256KB (basic) and 1MB (premium)
- Queues – first in first out (FIFO), one consumer
- Sessions – grouping of messages by session ID
- Topics – Publish/subscribe by multiple consumers
- Subscriptions – Apps connect to sub to get to topics
- WCF Relays – gateway for on-prem WCF services to Azure
- Tiers – Basic, Standard (topics, tx, sessions), Premium

Queue or Bus?

Queues - Standard queuing with messages up to 64KB
Brokering at enterprise scale with messages up to 1MB, transactions, and sessions - **Service Bus**

Event Grid

Event management across Azure resources
- Apps are notified when an event happens
- Throughput of millions of events and 24h retry
- Publishers – Az subscriptions, Event Hubs, Topics, IoT Hub, Resource Groups, Blob storage, Service Bus, V2 storage, ...

Notification Hubs

Push notifications from backends to mobile
- Scenarios – Send codes, notifications, news
- Tiers
  - Free – 1 million messages / month
  - Basic – 10 million messages / month
  - Standards – 10 million messages / month

Monitoring and Logging

Log Analytics

Collects and analyzes log files from resources
- Azure and on-prem resources
- Analysis tools – OMS, Security Center, AI, PowerBI

Advisor

Helps you follow best practices for Az deployments
- High Availability
- Security
- Performance
- Costs

Network Watcher

Az resource network monitoring for network comms
- Capabilities
  - Topology
  - IP flow velocity
  - Next Hop
  - Security Group View
  - VPN diagnostics
  - Packet Capture
  - Connection Troubleshooting

Monitor

Monitoring solution in Az Portal
- Infrastructure metrics and logs for Az services
- Capabilities:
  - Activity Log – info on all types of events
  - Diagnostics Settings – info on events within specific srv
  - Metrics – time-based metric points for resources
  - Alerts – View and manage Az alerts

Service Health

Az Portal Dashboard showing resource issues
- Views
  - Service issues
  - Planned Maintenance
  - Resource Health
  - Health Alerts

Application Insights

Monitoring solution for cross-platform apps
- Az and on-prem apps
- Events
  - Rate data
  - Exceptions
  - Page views and performance
  - Diagnostic logs
  - Custom Events
  - Integration

AI, IoT, and Media Services

Cognitive Services

Create modern, intelligent applications, with AI/ML
- Artificial Intelligence (AI) & Machine Learning (ML)
- Services: Vision, Speech, Language, Knowledge, Search
- Vision – Categorise, moderate, classify, index, ... images
- Speech – Speech enabled, recognition, translate
- Language – LUIS, spelling, linguistic, text analysis, web, ...
- KB – Personal experience, train AI to converse naturally
- Search – Bing, autosuggest, entity and custom search

Machine Learning

Algorithms to apply complex math calc to big data
- Tools
  - Machine Learning Studio – drag/drop predictive models
  - Leaning Workbench – end-end science solution
  - AI Gallery – community-driven solutions
  - ML Modules – out-box models for analyzing data
  - Data Science VMs – preconfigured workloads

Stream Analytics

Pipeline for event processing and real-time analysis
- Sources – Apps, sensors, IoT Hub, Event Hub, Blog storage
- Targets – Data Lake, PowerBI, SQL data Warehouse

Media Services

Secure and high-quality streaming and storage
- Flow – Upload → Encode → Secure → Analyse
- Cognitive Azure Media Analytics
  - Indexer, Hyper lapse, Motion detect, summarize, character recognition, face recognition, and moderation

Bot Service

Environment to build and deploy bots
- Freeform communication
- Tiers
  - Free – up to 10,000 messages
  - Standard S1 – pay for 1,000 messages at a time, SLA

IoT Hub, Event Hubs, IoT Edge

Internet of Things (IoT) Hub
- Send massive amounts of data to Az for processing
- Bi-directional, secure and routable communication
- Scale up to millions of connected devices
- Integrated with Azure Monitor
- Tiers: Basic (8k msg/day), S1 (400k), S2 (6M), S3 (300M)

Event Hub
- Ingress of device data streams
- One-way communication
- Aggregated metrics monitoring
- Tiers: Basic (100 connect), Standard (1K), Dedicated (25K)

IoT Edge
- Installed at the edge of on-prem network, DMZ
- Collect device data and send to IoT Hub

Time Series Insights

Provide valuable insights into IoT data
- DB storage for massive amounts of data
- Sources – IoT Hub, Event Hub
- Join data – metadata, telemetry, and visualise
- Features – Integration, storage, visualization, query

IoT Hub vs Event Hub

IoT Hub – Two-way communication
One-way communication for cost effective data ingest – **Event Hub**

Architecting Microsoft Azure Solutions 3

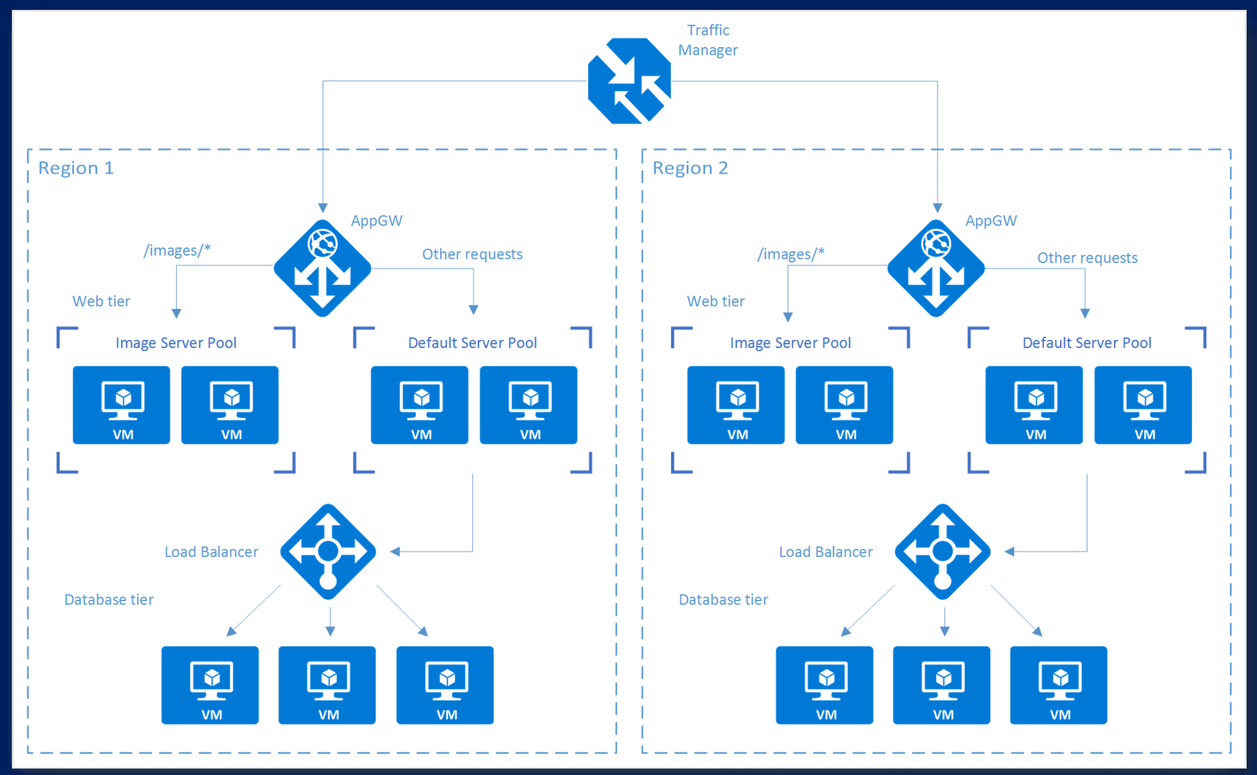
	SQL Databases	MySQL	PostgreSQL	Cosmos DB	Blob	Table	Queue	File	Disk	Data Lake Store	SQL Data Warehouse
Relational data	X	X									
Object-relational data			X								
Unstructured data				X	X						
Semi-structured data						X					
Queue messages							X				
Files on disk								X			
High-performance files on disk									X		
Store large data					X			X	X	X	X
Store small data	X	X	X	X		X	X	X	X		
Geographic data replication	X			X							

Azure Service Bus Queues	Azure Storage Queues
Message lifetime >7 days	Message lifetime <7days
Guaranteed (first in–first out) ordered	Queue size >80 GB
Duplicate detection	Transaction logs
Message size ≤1 MB	Message size ≤64 KB

Service for Msg/Events	Event Grid	Event Hubs	IoT Hub	Service Bus Topics	Service Bus Queues	Storage Queues
Event ingestion	X	X	X			
Device management			X			
Messaging	X	X	X	X	X	X
Multiple consumers	X	X	X	X		
Multiple senders	X	X	X	X	X	X
Use for decoupling		X	X	X	X	X
Use for publish/subscribe	X					
Max message size	64 KB	256 KB	256 KB	1 MB	1 MB	64 KB

	Azure Container Services	Azure Container Instances	Azure Service Fabric
For production deployments of complex systems (with a container orchestrator)	X		
For running simple configurations (possibly without orchestrator)		X	
For long-running workloads on containers	X		
For short-running workloads on containers		X	
For orchestrating a system based on containers	X		X
Orchestrating with open-source orchestrators (DC/OS, Docker Swarm, Kubernetes)	X		
Orchestrating with built-in orchestrator			X

Service	Azure Load Balancer	Application Gateway	Traffic Manager
Technology	Transport level (Layer 4)	Application level (Layer 7)	DNS level
Application protocols supported	Any	HTTP and HTTPS	Any (An HTTP endpoint is required for endpoint monitoring)
Endpoints	Azure VMs and Cloud Services role instances	Any Azure Internal IP address or public internet IP address	Azure VMs, Cloud Services, Azure Web Apps, and external endpoints
Vnet support	Can be used for both Internet facing and internal (Vnet) applications	Can be used for both Internet facing and internal (Vnet) applications	Only supports Internet-facing applications
Endpoint Monitoring	Supported via probes	Supported via probes	Supported via HTTP/HTTPS GET



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