Microsoft

Microsoft Azure

Azure builds upon PostgreSQL

Security

Intelligent performance

AI

Global reach

Compliance

Ecosystem integration

Extensions

Rich indexing

JSONB

Full text search

Geospatial

Rich Data types

Constraints
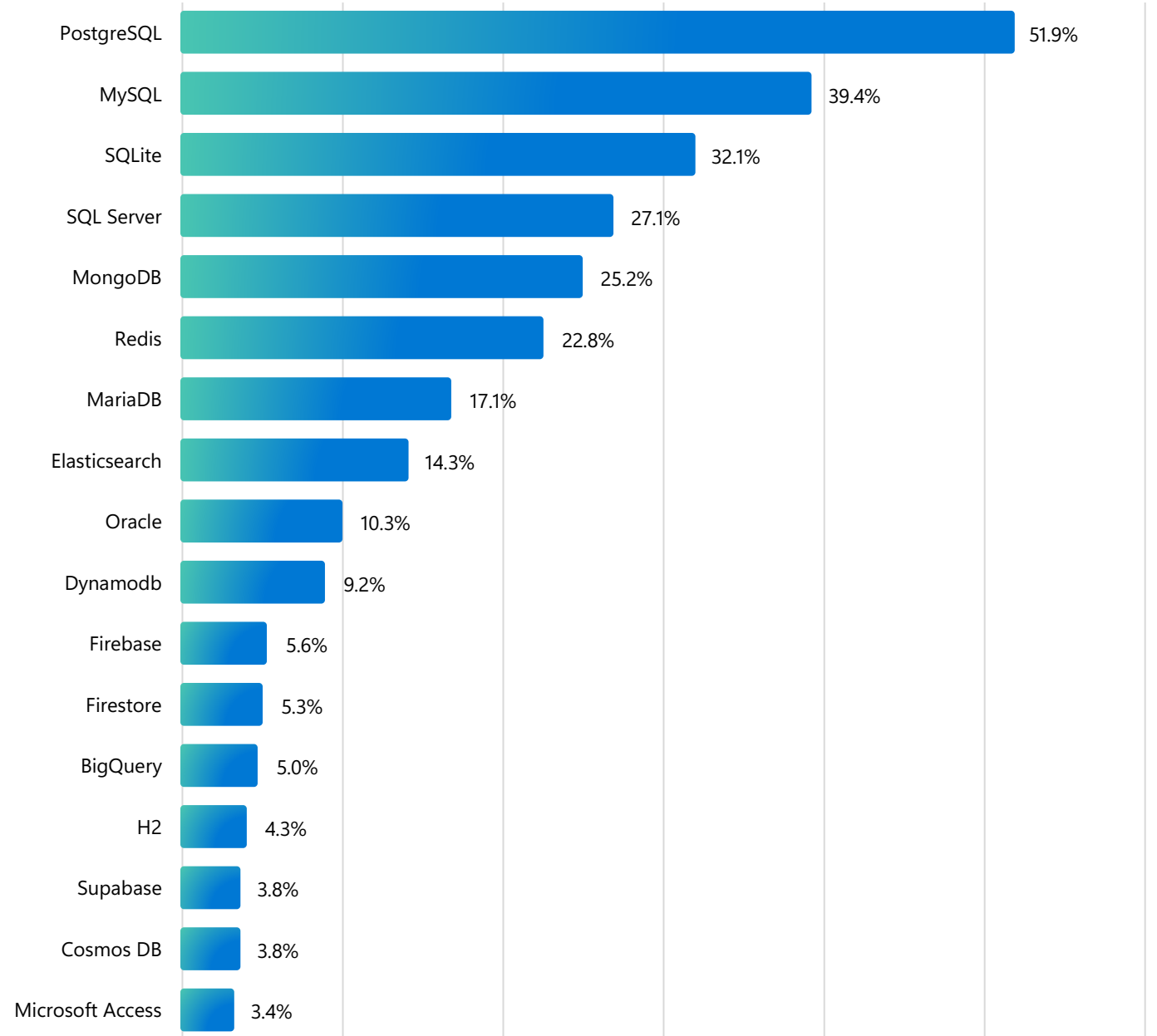
ACID

Scale up & out

Extension support

High Availability

Management Automation
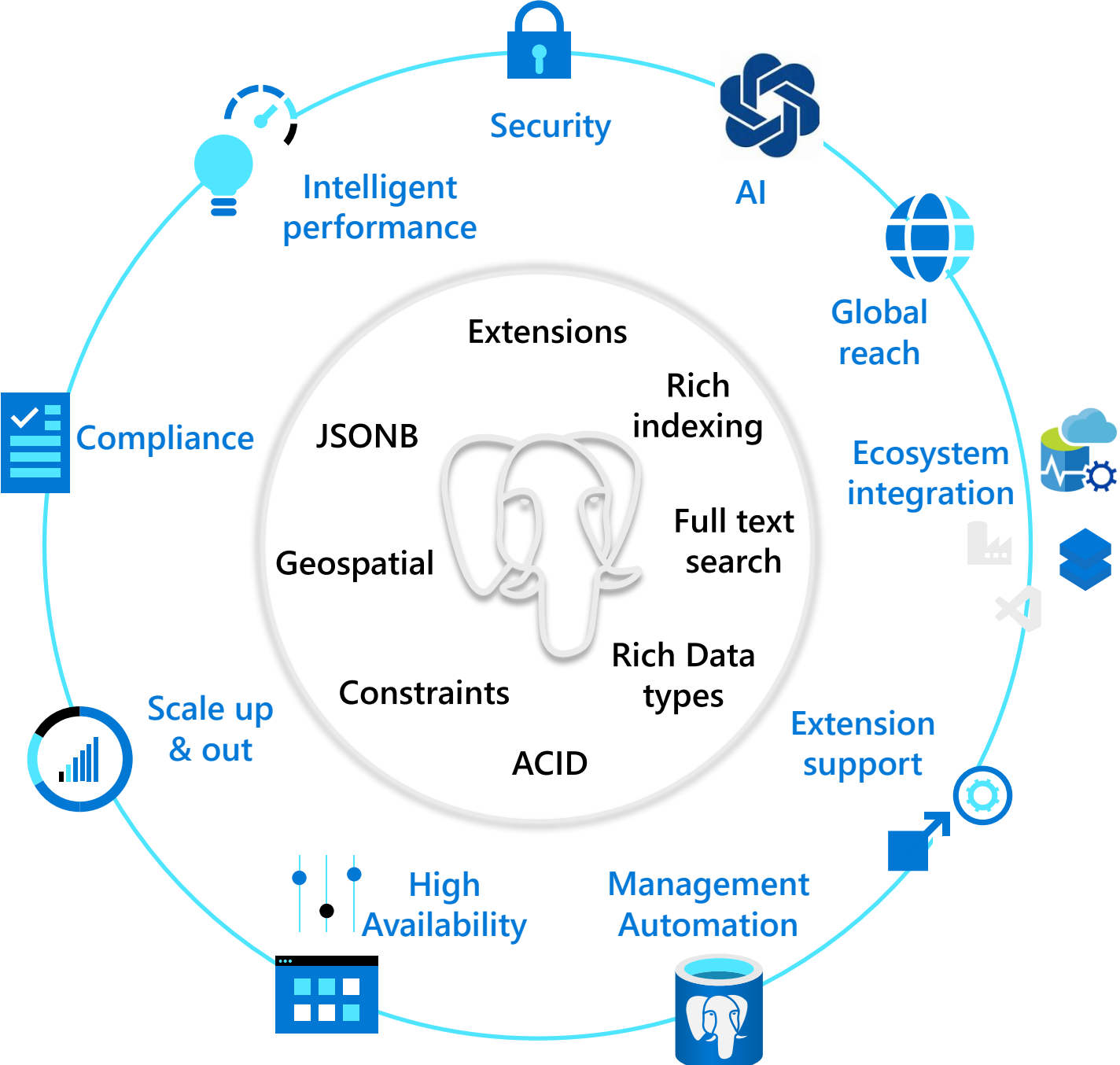
Postgres is the most popular database for professional developers

PostgreSQL extended lead 2024

*Which **database environments** have you done extensive development work in over the past year, and which do you want to work in over the next year? (If you both worked with the database and want to continue to do so, please check both boxes in that row.)*

**Source:
Stack Overflow Developer Survey 2024**

Database	Percentage
PostgreSQL	51.9%
MySQL	39.4%
SQLite	32.1%
SQL Server	27.1%
MongoDB	25.2%
Redis	22.8%
MariaDB	17.1%
Elasticsearch	14.3%
Oracle	10.3%
Dynamodb	9.2%
Firebase	5.6%
Firestore	5.3%
BigQuery	5.0%
H2	4.3%
Supabase	3.8%
Cosmos DB	3.8%
Microsoft Access	3.4%

Azure Database for PostgreSQL
Designed to meet both enterprise and developer needs

Enterprise

High Availability

Disaster Recovery

Scalability

Security

Developers

Ecosystem Integration

Idiomatic SDKs

Community led Open Source

Generative AI Apps

Azure Database for PostgreSQL is Enterprise Ready Today

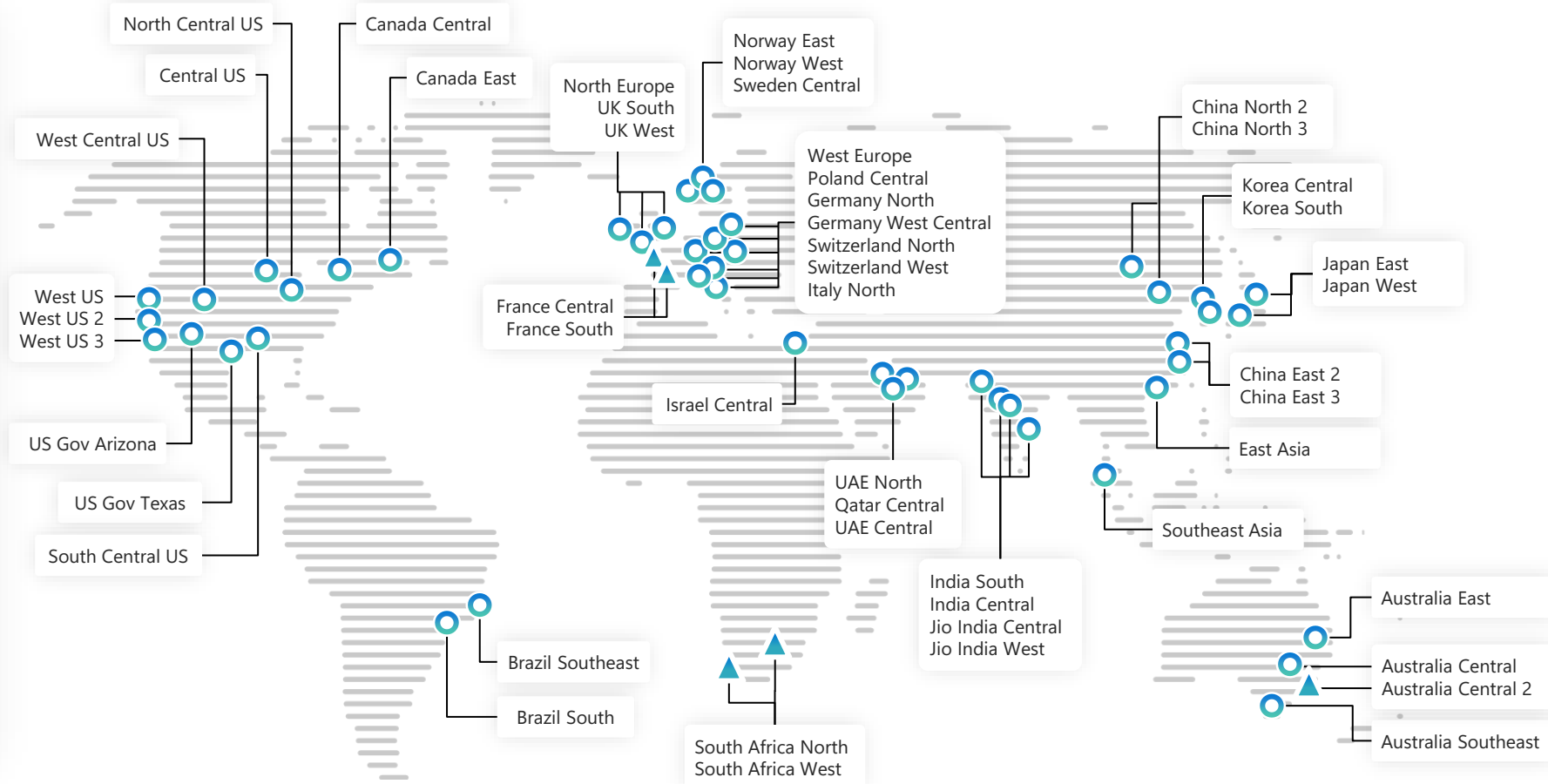| Entra ID	Private Endpoints	Virtual Networks	Data Encryption	Azure Defender	Availability Zones	Geo DR	Performance	Azure Policy	Azure Advisor

UBS accenture BOEING pwc American Airlines FedEx tomtom Swiss Re BMW

Industry Leading Global Reach

55+
Azure regions available

Available
Coming

North Central US

Central US

West Central US

Canada Central

Canada East

West US
West US 2
West US 3

US Gov Arizona

US Gov Texas

South Central US

Norway East
Norway West
Sweden Central

North Europe
UK South
UK West

West Europe
Poland Central
Germany North
Germany West Central
Switzerland North
Switzerland West
Italy North

France Central
France South

Israel Central

UAE North
Qatar Central
UAE Central

India South
India Central
Jio India Central
Jio India West

South Africa North
South Africa West

Brazil Southeast

Brazil South

China North 2
China North 3

Korea Central
Korea South

Japan East
Japan West

China East 2
China East 3

East Asia

Southeast Asia

Australia East

Australia Central
Australia Central 2

Australia Southeast

Postgres 17 Contributions

Top level metrics (as of April 2024)

353

Commits by Microsoft committers

27.2%

Microsoft commits done on behalf of other authors

331

Commits credited to Microsoft authors

Azure Database for PostgreSQL
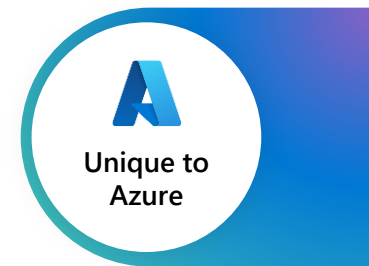
Industry leading AI
for building intelligent applications

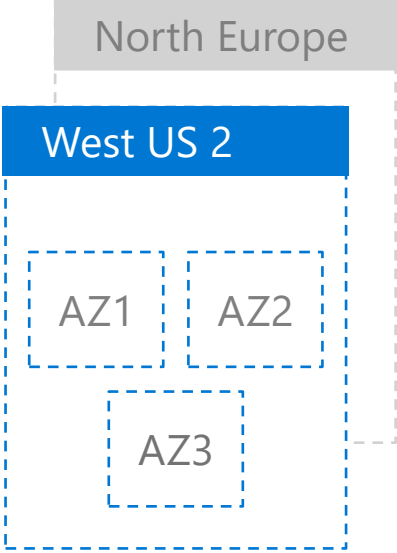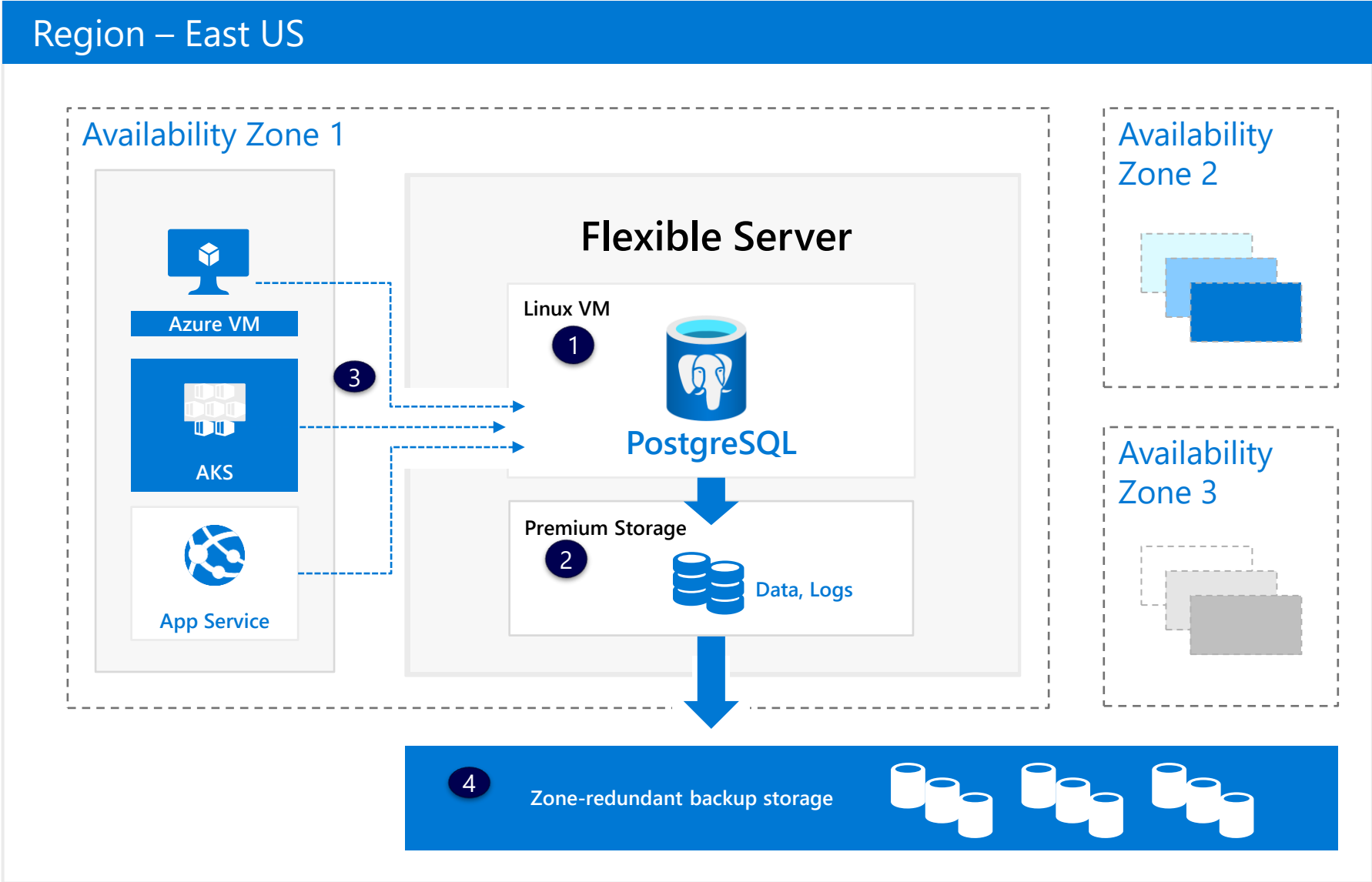Unique to Azure

[1.5, -0.4, ..., 20.2]

Native Vectors

Azure AI Integrated

Copilot Powered

Service Overview

Flexible Server Architecture

Workload Optimized Compute SKU's

Cost optimized for different workloads

Each switch between any SKU in minutes

Stop/Start during inactive periods

Reserved Capacity

Memory Optimized

Up to 96 vCores with 1:8 CPU to Memory ratio optimized for best performance of IO intensive workloads

General Purpose

Up to 96 vCores with 1:4 CPU to Memory ratio suitable for most database workloads

Burstable

Highly cost effective, ideal for Development and Testing

Elastic Compute and Storage

Scale compute in **under 20s**

Scale storage **online**

Scale **storage size and IOPS** separately

99.99% SLA with Availability Zones

Compute

vCore

96

Storage
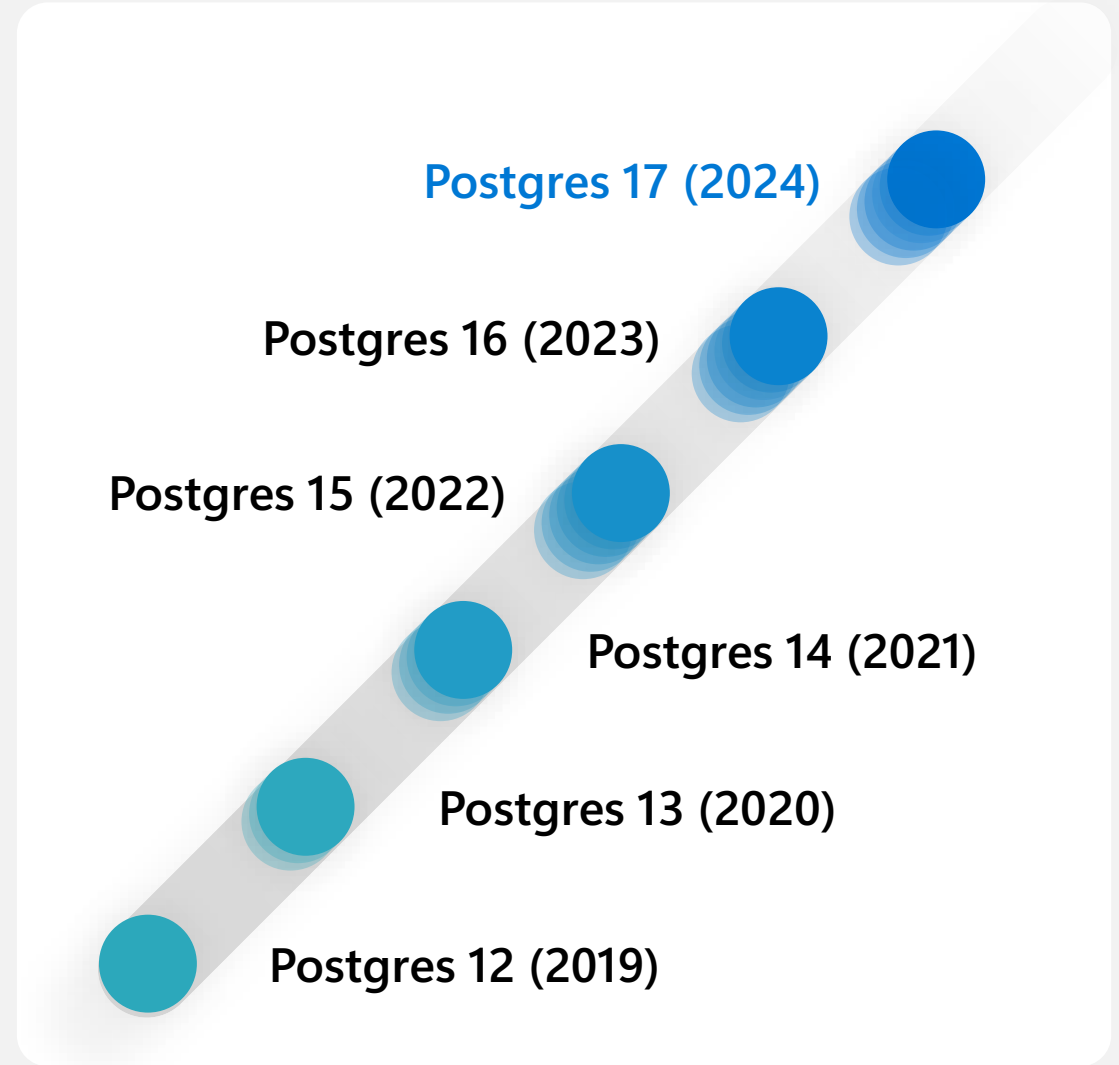
Size

64TB

IOPS

80K
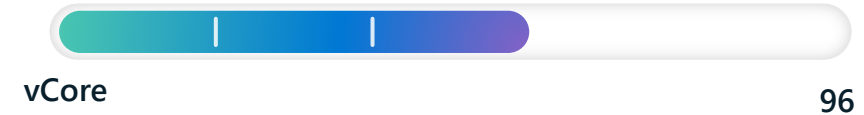
All Community Supported Postgres Versions

Major versions available **within weeks** of community GA

Minor versions **maintained automatically**

Upgrade in-place in minutes

Postgres 17 (2024)

Postgres 16 (2023)

Postgres 15 (2022)

Postgres 14 (2021)

Postgres 13 (2020)

Postgres 12 (2019)

Broad support for common Postgres extensions

60+ Postgres extensions supported

Enables developers to **extend the functionality of Postgres** beyond core capabilities

Microsoft **automatically maintains** extensions versions

address_standardizer	pg_freespacemap
address_standardizer_data_us	pg_hint_plan
amcheck	pglogical
azure_ai	**pg_partman**
azure_local_ai (Preview)	pg_prewarm
azure_storage	pg_repack
bloom	pgrouting
btree_gin	pgrowlocks
btree_gist	pg_squeeze
citext	pg_stat_statements
cube	pgstattuple
dblink	pg_trgm
dict_int	pg_visibility
dict_xsyn	plpgsql
earthdistance	plv8
fuzzystrmatch	**postgis**
hstore	postgis_raster
hypopg	postgis_sfcgal
intagg	postgis_tiger_geocoder
intarray	postgis_topology
isn	postgres_fdw
lo	semver
login_hook	session_variable
ltree	sslinfo
orafce	tablefunc
pageinspect	tds_fdw
pgaudit	timescaledb
pg_buffercache	tsm_system_rows
pg_cron	tsm_system_time
pgcrypto	unaccent
pg_failover_slots (Preview)	uuid-ossp
	vector

Extensive Monitoring

Rich metrics and logs provide observability into the entire database workload

Access to detailed metrics and logs

Quickly **diagnose performance** issues

Make informed scaling decisions

Set up alerts and auto-scaling for quick responses

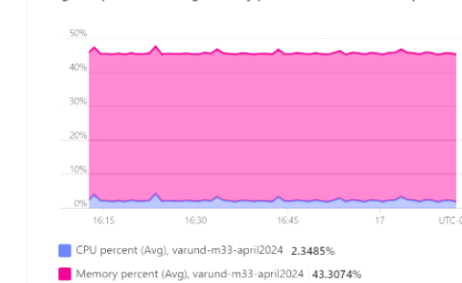**Visualize data** using the Portal, Power BI, Grafana, or Log Analytics
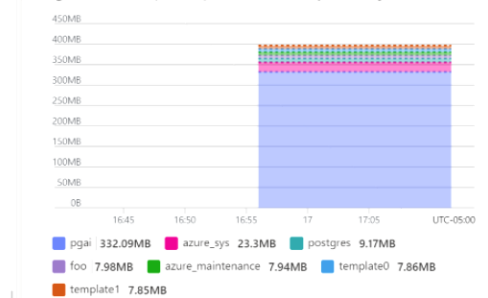
Integrated with Azure Advisor
Built-in recommendations for workload optimization

Unique to Azure

Azure Advisor supports over 16 recommendations for optimizing workloads on Azure Database for PostgreSQL

Performance optimizations are based on actual usage history to prioritize highest impact

Recommendations include optimizations for **logging**, **disk space**, and **memory usage** amongst others
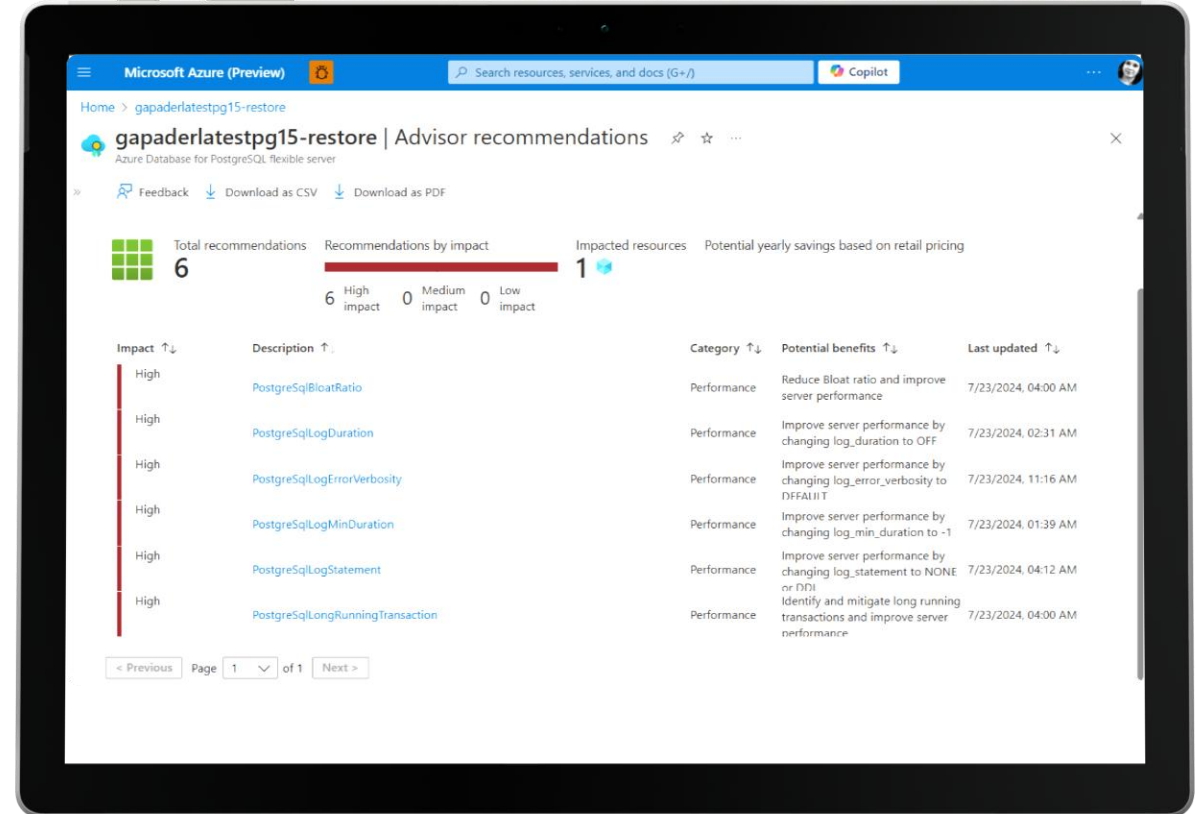
Enterprise-Ready

Enterprise Ready

Security

Identity

Encryption

Networking

High Availability

Availability Zones

RPO = 0

Automatic Failovers

Disaster Recovery

Backups

Geo-Redundancy

Long Term Retention

Enterprise Security

Azure Database for PostgreSQL is **the only Postgres offering** with support for Entra Id Authentication

Service or Customer Managed encryption keys to **protect data at rest**

Secure network connectivity via Private Endpoints

Entra Id
Enterprise Identity built into Postgres

Customer Managed Keys
Key Vault integration with optional HSM support

Private Endpoints
Network interface that uses a private IP address from your virtual network

Enterprise Security

Enterprise Identity

Azure Database for PostgreSQL is **the only Postgres offering** with support for **Entra Id** Authentication

No passwords stored in Postgres service

Users authenticate with their **Entra (formerly AAD) enterprise credentials**

Manage access within Entra to **grant/revoke permissions efficiently**

jsmith@contoso.com

Token Request

Token Response

Azure Database for PostgreSQL

Microsoft Entra
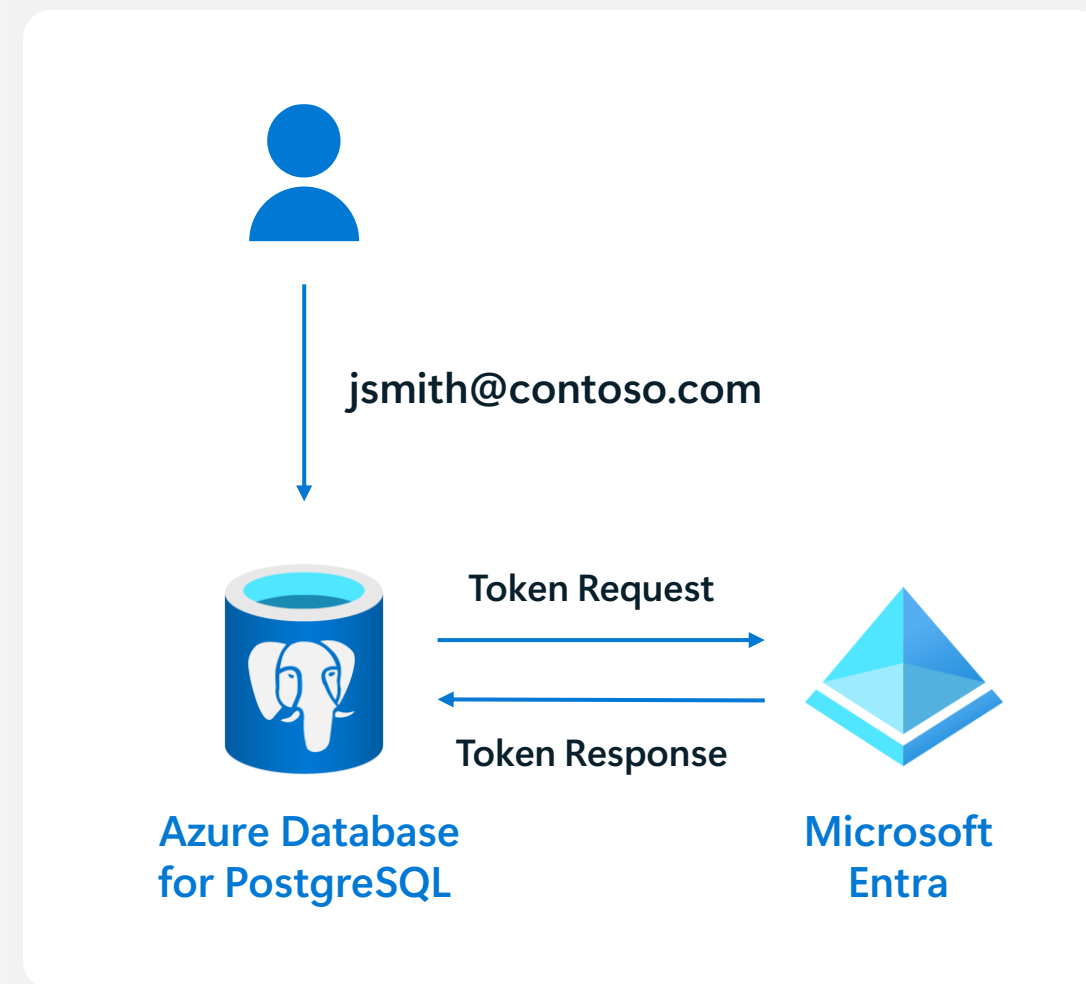
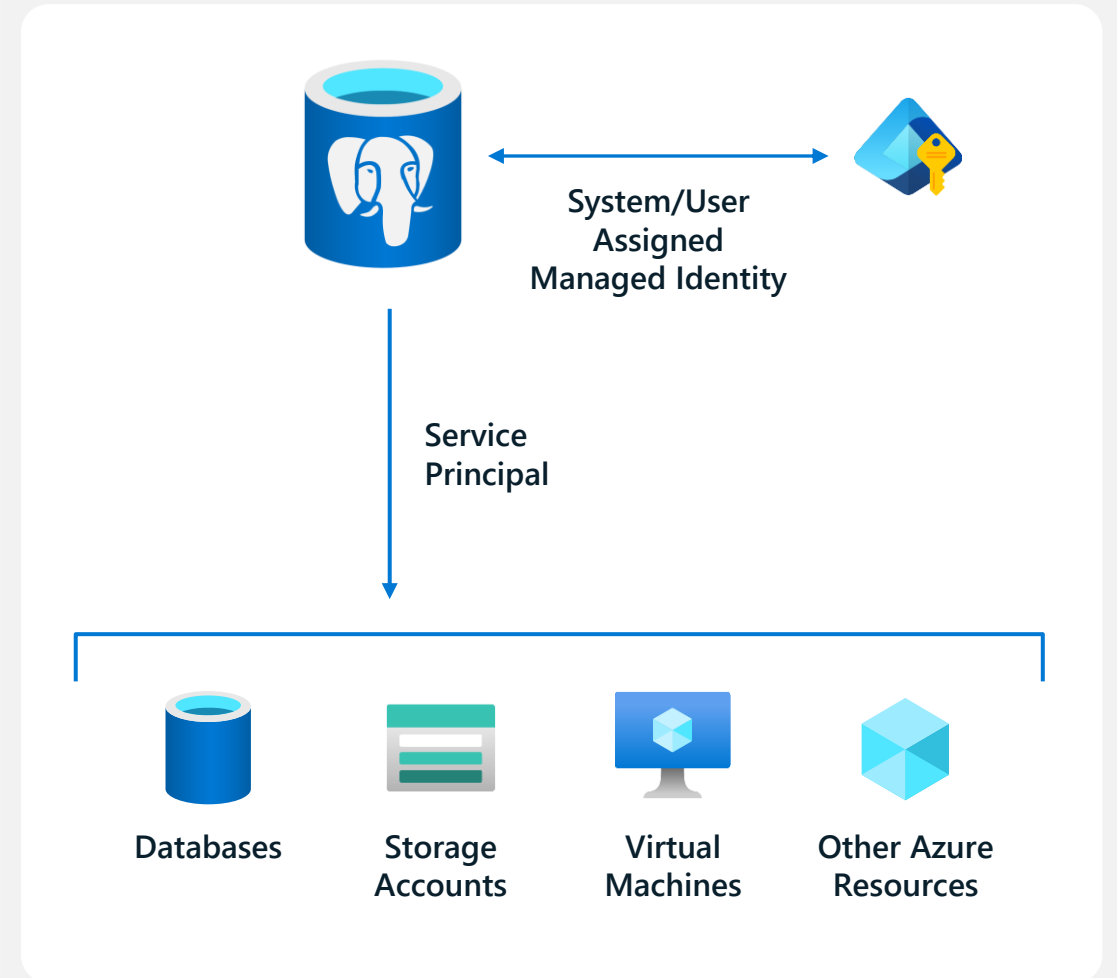# Enterprise Security

Enterprise Identity

Use Managed Identities to **connect to any Azure resource** that supports Entra ID

Eliminates the need to store and manage secrets within Postgres service

Support for both **User and System Assigned** Managed Identities

System/User Assigned Managed Identity

Service Principal

Databases

Storage Accounts

Virtual Machines

Other Azure Resources

Enterprise Security

Customer Managed Encryption Keys

Flexible Server supports **Customer Managed Encryption Keys** for securing data
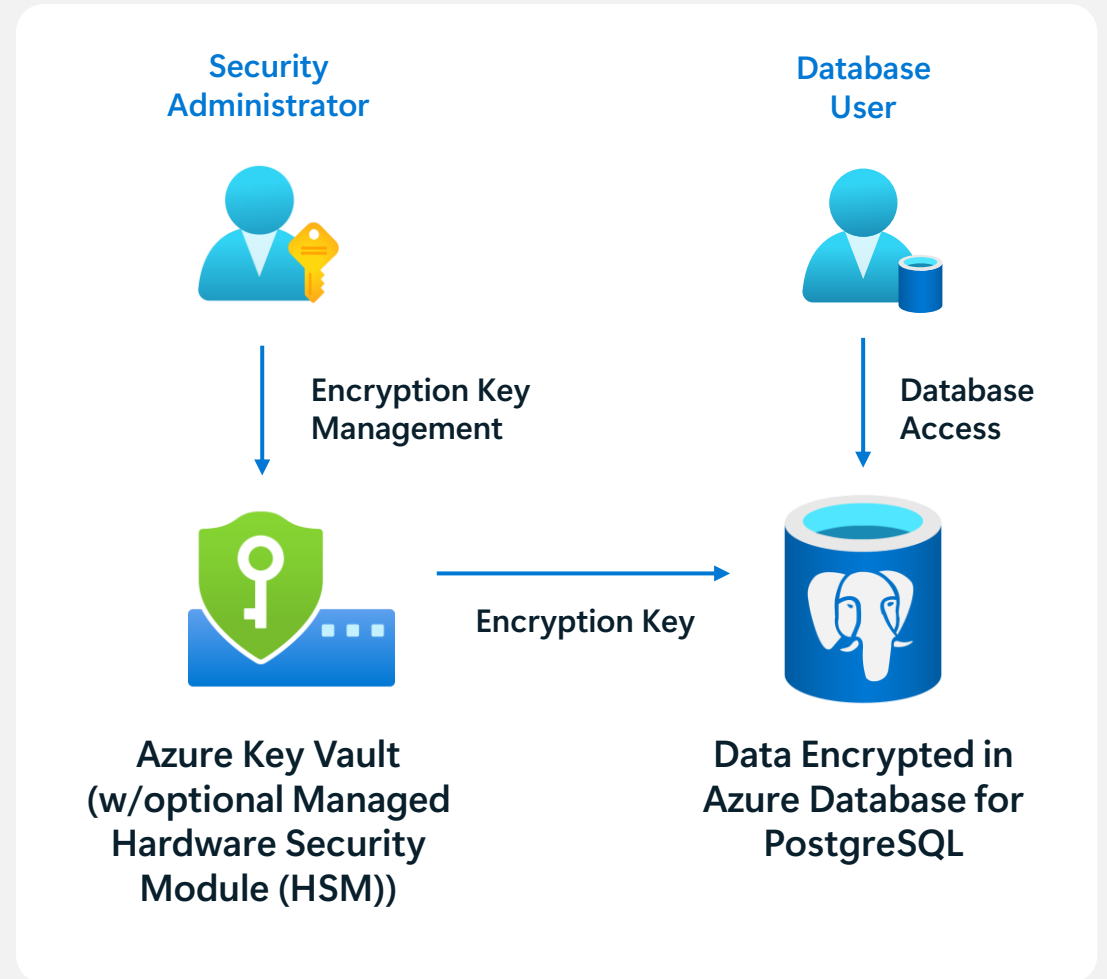
Rotate and revoke keys for Postgres as needed

Meet regulatory and compliance requirements by managing **key lifecycle and access** policies

Provides **separation of duties** to key management form data management

Centralized management of keys in Azure Key Vault or Managed HSM

Security Administrator

Database User

Encryption Key Management

Database Access

Encryption Key

Azure Key Vault (w/optional Managed Hardware Security Module (HSM))

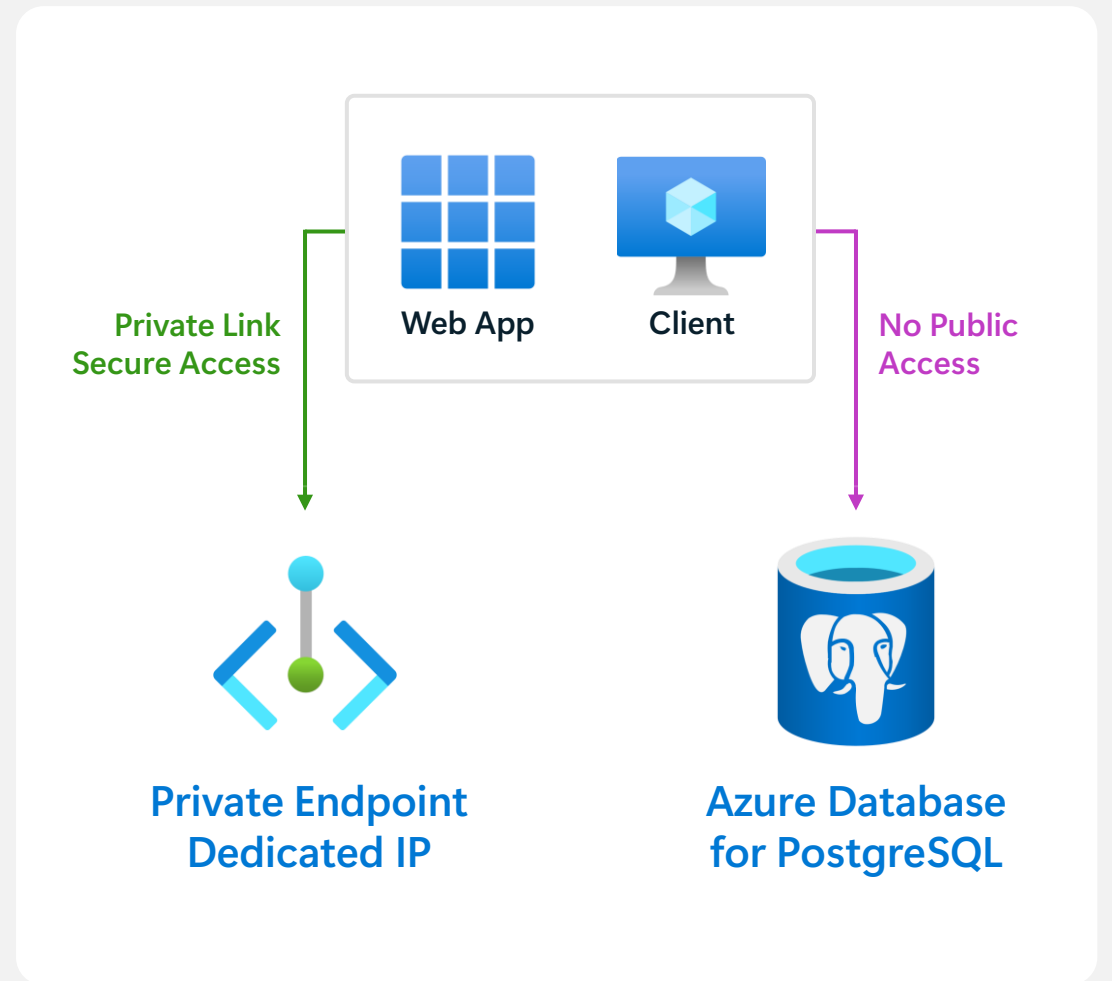Data Encrypted in Azure Database for PostgreSQL

Enterprise Security

Private Endpoints

Provides a **private IP address** from your virtual network for accessing Flexible Server.

Prevents data exfiltration from your virtual network

Improved performance using a direct route to Azure resources vs. connecting via Internet

Fine-grained access control using **network security groups (NSG's)** to restrict access to the private endpoint

Web App   Client

Private Link
Secure Access

No Public
Access

**Private Endpoint
Dedicated IP**

**Azure Database
for PostgreSQL**

High Availability

99.99% Uptime SLA

Provides a replica of the production database across Availability Zones with a (no data loss) **Recovery Point Objective = 0**

Automatic Failover in scenarios where servers or zones fail

Automatic rebuild of the Secondary HA instance after failover occurs

Database User

Virtual IP / DNS

Primary

Synchronous Replication

Secondary

Availability Zone 1

Availability Zone 2
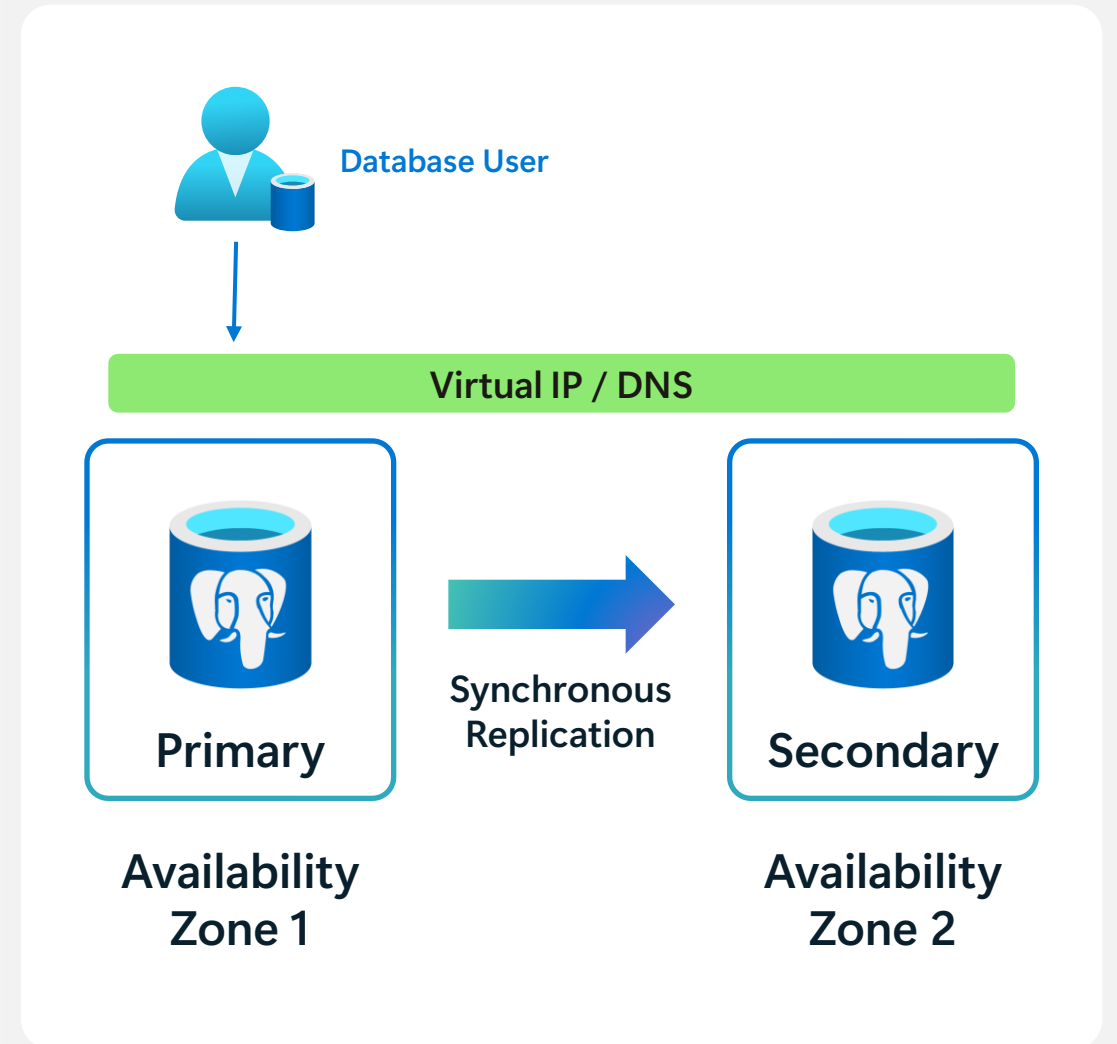
Disaster Recovery

Backup protection for major disruptions

**On-Demand** or **Automated** backups protect data from loss with 35 Day retention

Configure backups for **geo-redundant storage**, and restore to different regions in event of failure

Long-term backup retention for **up to 10 years** supports compliance requirements for data retention

RPO of 5 minutes

Production Database

On-Demand / Automated Backup

Local/Geo Redundant

Lond Term Backup Retention

Azure Backup
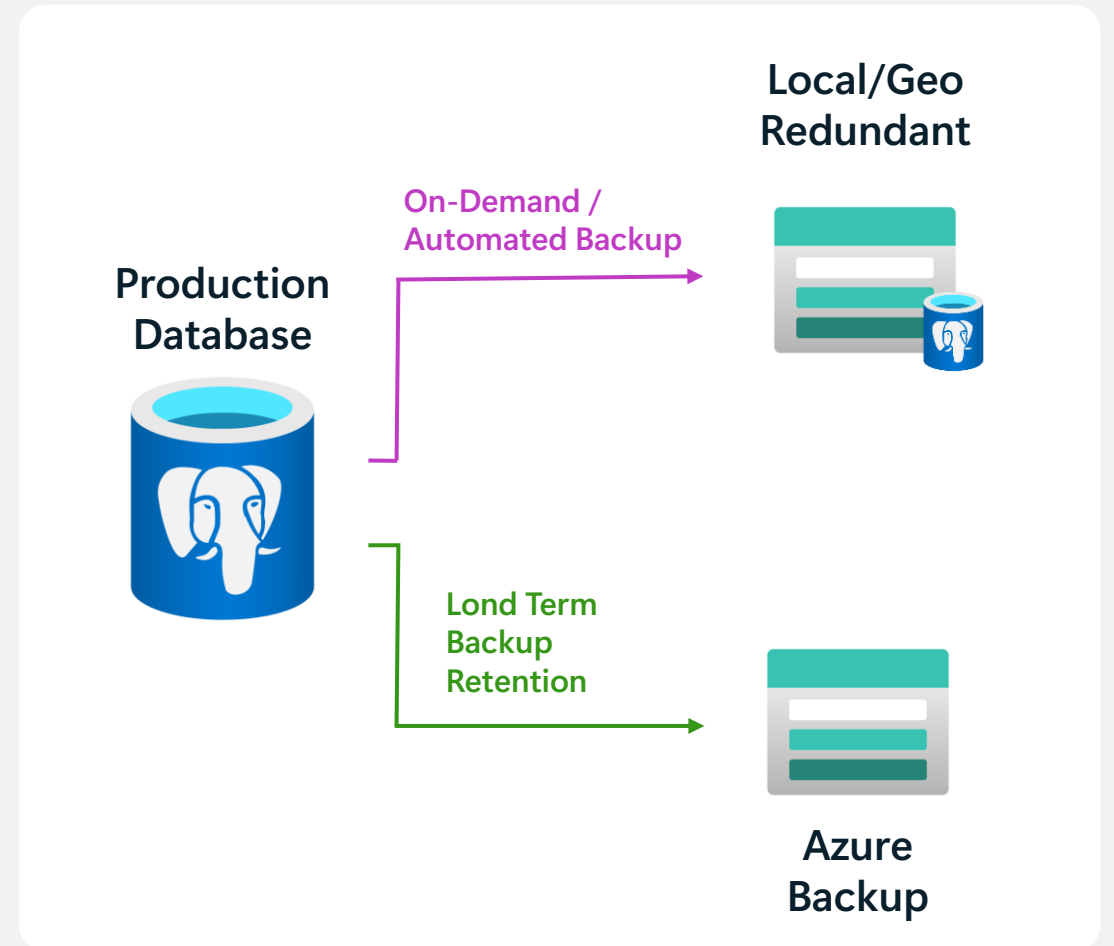
Disaster Recovery

Cross-region Failover

Planned or **Unplanned** failover to replicas running in any other Azure region

Execute a Planned Failover to **synchronize data between regions** prior to failover

Execute Unplanned Failover for **high impact emergency events** to move workload immediately without data synchronization

Both approached support Virtual IP with no application changes required

Disaster Recovery

Cross-region Failover – Portal Experience

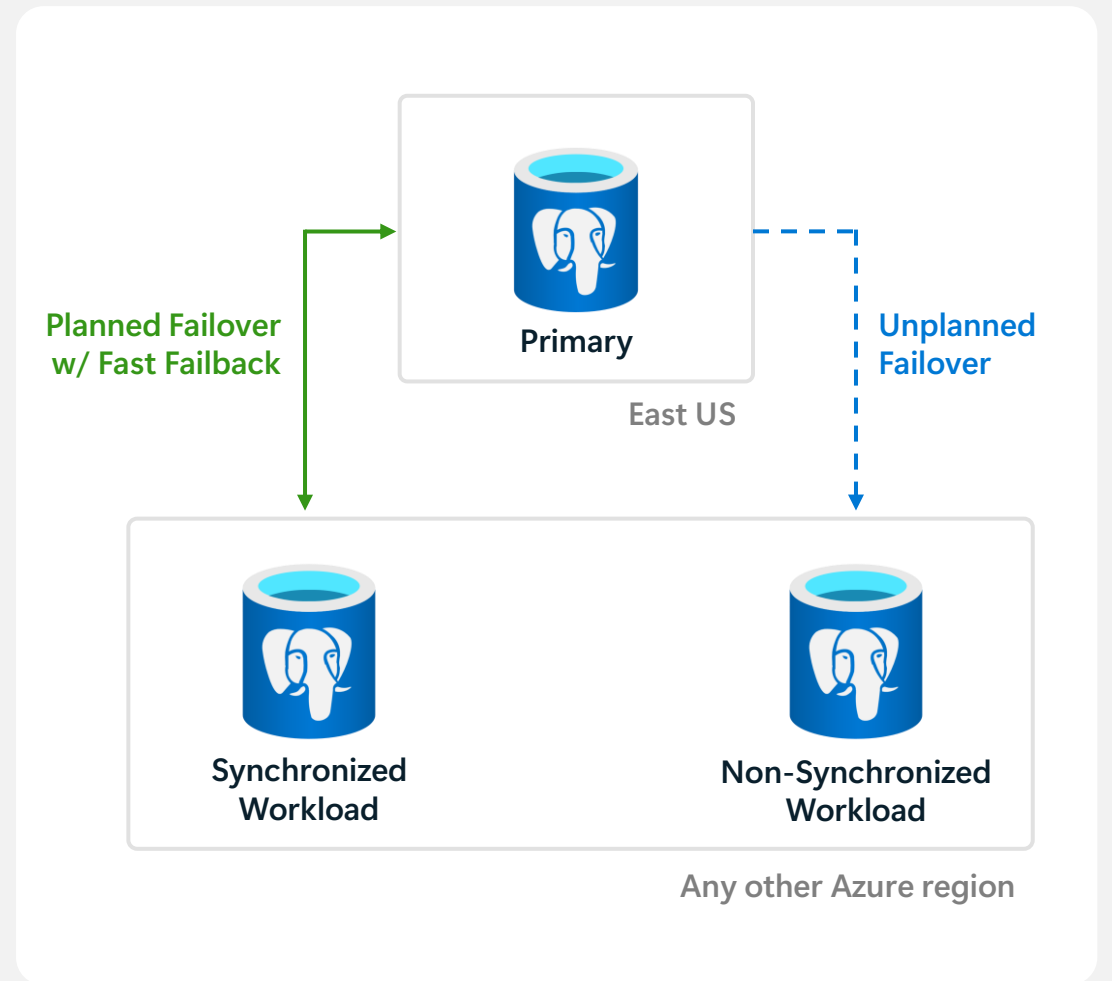**Planned** or **Unplanned** failover to replicas running in any other Azure region

Execute a Planned Failover to **synchronize data between regions** prior to failover

Execute Unplanned Failover for **high impact emergency events** to move workload immediately without data synchronization

Both approached support Virtual IP with no application changes required

---

Promote

Promote this read replica. Choose to make it the primary server or an independent server.
Learn more ⧉

Replica server to promote

Server
    rmendizabal-testreplica01.postgres.database.azure.com

Action
- ⚪ Promote to primary server.
- 🔵 Promote to independent server and remove from replication. This won't impact the primary server.

Data sync
- ⚪ Planned - sync data before promoting.
- 🔵 Forced - don't sync data, promote as soon as possible.

☑ I understand that this read replica will become an independent server and that its data won't be synced first. This action can't be undone.

[**Promote**] [Cancel]

Comprehensive IaC

Infrastructure-as-Code

Use your **preferred IaC provider** to programmatically deploy and manage Flexible Server resources

Integrate with existing **infrastructure workflows**

Version control IaC for robust resource change management

Terraform
Open-source IaC tool for configuring and deploying cloud infrastructure.

Bicep
A domain-specific language (DSL) that uses declarative syntax to deploy Azure resources

Ansible
Declaratively manage your Azure using a simple configuration language

ARM Templates
Declaratively manage your Azure using a simple configuration language

+ Rest API's, CLI, and PowerShell also
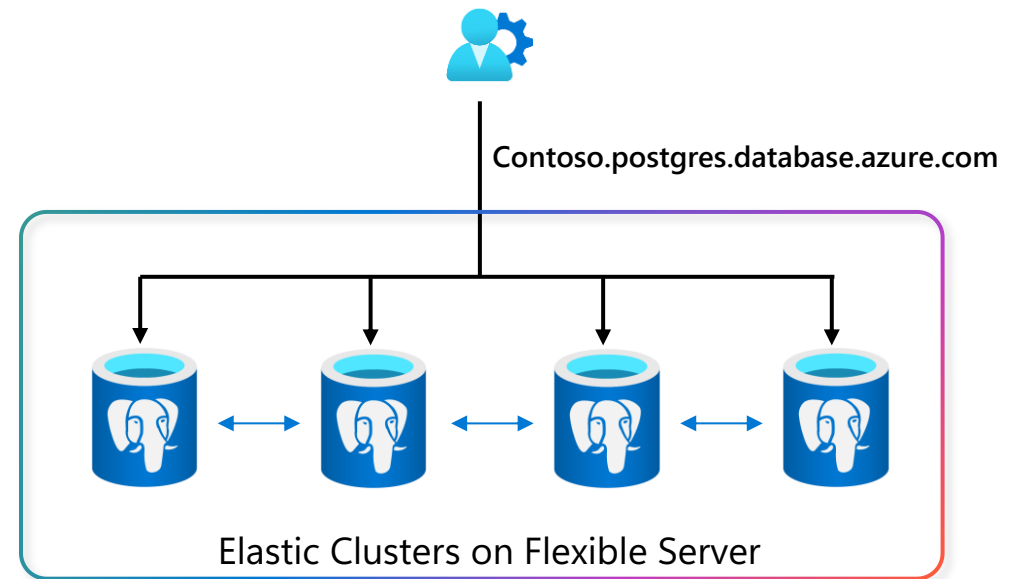
Elastic Clusters

Multi-node Cluster – sharded databased

Horizontal scaling: Now scale out to multiple nodes to power multi-tenant and AI applications

Simplicity: Offload sharding complexity to a managed service

Efficiency: Simplified management of server fleet at no additional cost

AI ready: Sharding models scale out vast amounts of vectorized data needed for modern AI applications

Contoso.postgres.database.azure.com

Elastic Clusters on Flexible Server

- Single cluster endpoint
- Scale a single database horizontally
- Shared nothing architecture
- Powered by Citus extension

Elastic Clusters – Row/Schema sharding

Row based sharding

Node A		Node B		

Accounts table (shard 1) — Node A

account_id	name	created_at
1	CNN	2016-07-12
5	Comcast	2016-07-19
...	...	...
1252	Walmart	2016-08-02

Accounts table (shard 2) — Node B

account_id	name	created_at
2	AT&T	2016-07-13
3	Exxon	2016-07-14
...	...	...
1253	UPS	2016-08-03

Campaigns table (shard 3) — Node A

campaign_id	name	account_id
1202	tv series	1
1204	superbowl	1
...	...	...
352042	chocolate	1252

Campaigns table (shard 4) — Node B

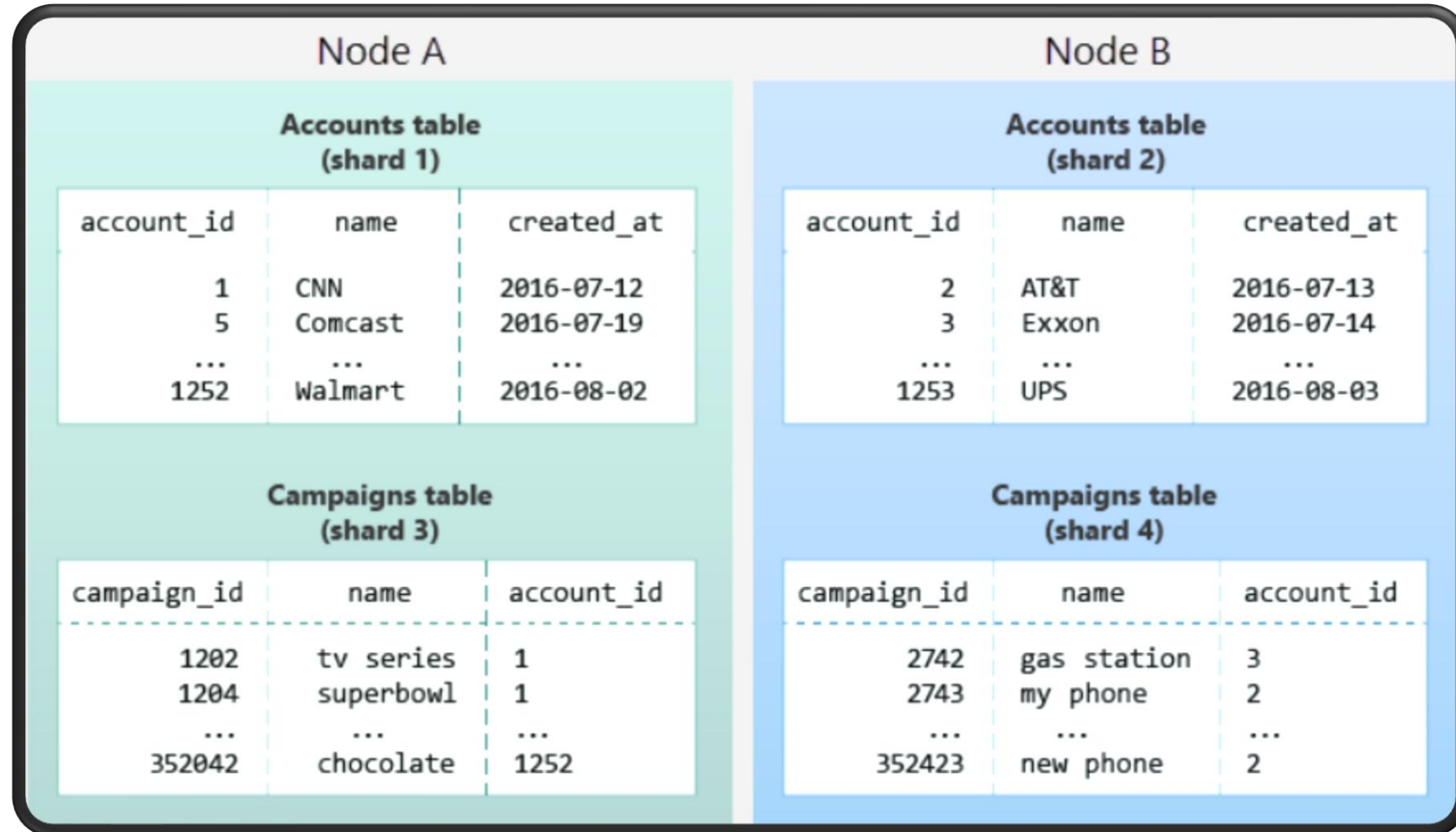| campaign_id	name	account_id
2742	gas station	3
2743	my phone	2
...	...	...
352423	new phone	2
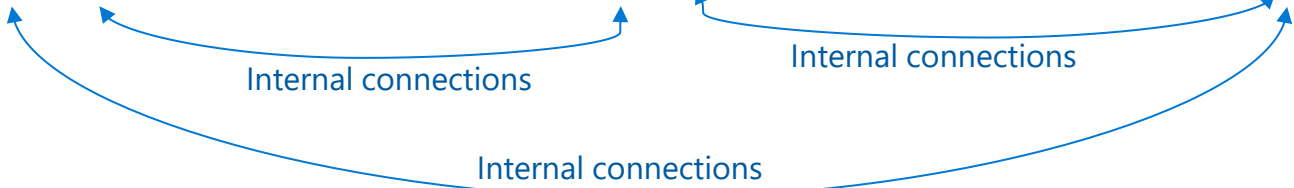
Built in Optimization - Automatic Tuning

Index Recommendations
Automatically determine optimal indexes based on user activity

Server Parameter Tuning
Refines server parameters to maximize workload performance

Minimize Server Resources

Maximize Workload Performance
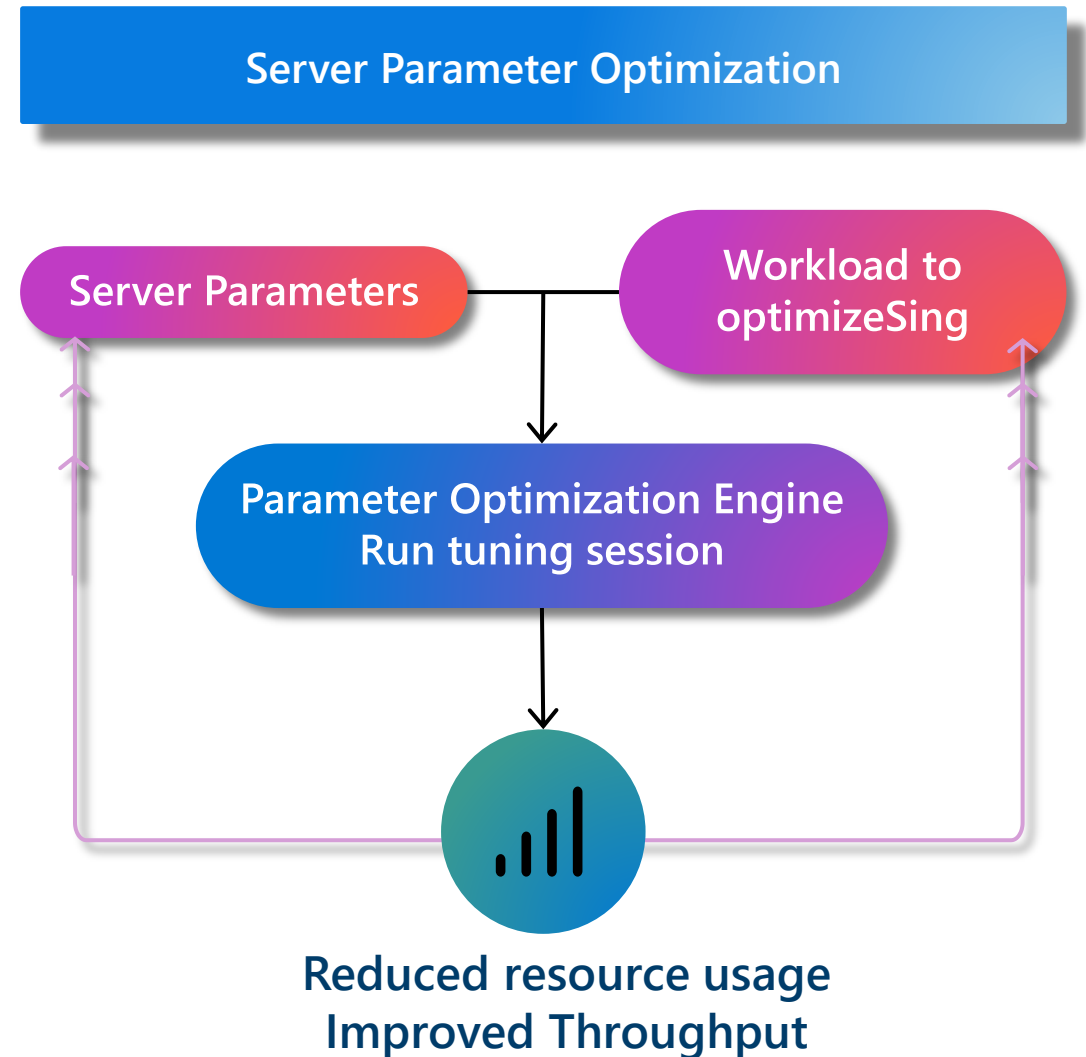
Autonomous Optimization

Index recommendations & server parameter tuning

Optimize index and server configuration with autonomous tuning

Improves workload performance by analyzing queries tracked by Query Store and providing index recommendations

Suggests indexes that could be added or removed during an index tuning session that can improve or reduce performance impact

Identifies indexes not used in a configurable period that could be removed to **reduce unnecessary consumption**

Server Parameter Optimization

Server Parameters

Workload to optimizeSing

Parameter Optimization Engine
Run tuning session

Reduced resource usage
Improved Throughput

AI-Ready

Generative AI uses-cases on Postgres

Chat history

Retrieval Augmented Generation (RAG)

Multi-tenant AI apps

Real-time Recommendations

Real-time Anomaly Detection

Multi-Agent AI

Built-in AI capabilities to empower your AI apps

Modern, AI apps on an integrated data platform

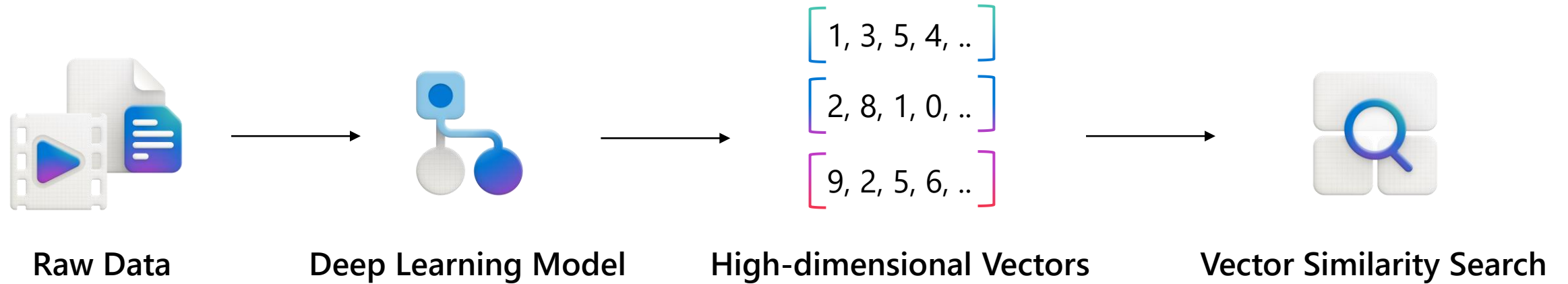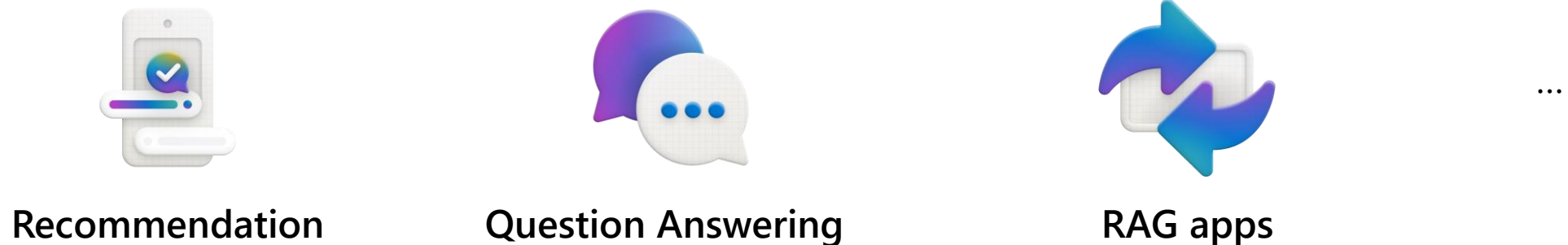| Vector Search	Azure AI extension	In-database embedding
Enable new AI-powered user experiences and chat with your data with pgvector extension and DiskANN for vector indexing and vector search	Build rich PostgreSQL generative AI applications with Azure AI extension integrated with Azure OpenAI, Azure ML, and other AI services.	Run faster AI apps by generating embeddings within the database for highly confidential or private workloads.

How Vectors Work: Important in the AI Era

Raw Data → Deep Learning Model → High-dimensional Vectors → Vector Similarity Search

$$\begin{bmatrix} 1, 3, 5, 4, .. \end{bmatrix}$$
$$\begin{bmatrix} 2, 8, 1, 0, .. \end{bmatrix}$$
$$\begin{bmatrix} 9, 2, 5, 6, .. \end{bmatrix}$$

Vector similarity search empowers Generative AI apps

Recommendation　　　　Question Answering　　　　RAG apps　　...

Azure Database for PostgreSQL: Native Vector Search

Open-source Pgvector extension provides support to store, index, and query vectors for similarity search scenarios

Supports multiple vector **distance functions**

Enables AI solutions to seamlessly integrate into **existing OLTP Postgres apps** without exporting data to specialize systems

Access control, encryption, high availability, disaster recovery all **"just work"**

Generative AI apps

RAG (Retrieval Augmented Generation) apps
Retrieve private data to ground LLM model responses

Recommendation/Semantic Search
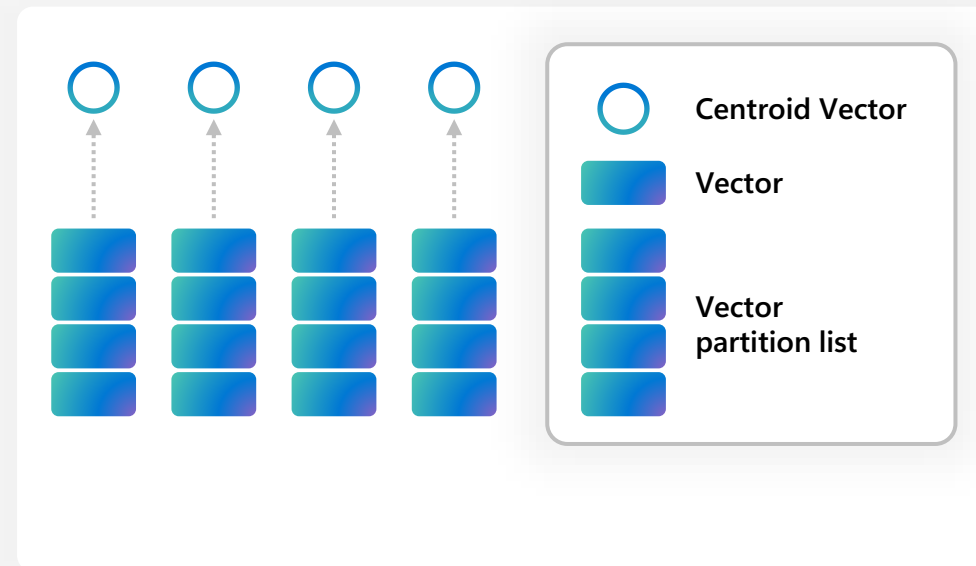Retrieve similar documents by distance between vectors

Hybrid Search
Combine vector search, row filtering, and full-text search
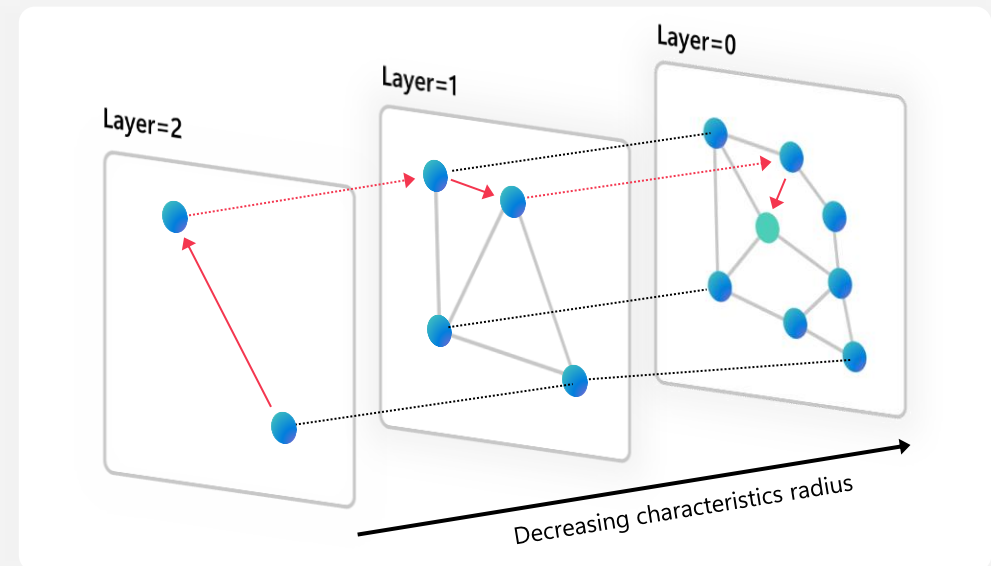
Vector indexes supported today

IVFFlat

- Clusters vectors by applying k-means clustering.
- Memory efficient but requires index rebuilds.

HNSW

- Builds a multi-layer graph with long and short connections between the vectors.
- The graph can be incrementally updated.

DiskANN Vector Index

Preview

Unique to Azure

Highly **performant, scalable, and accurate** index for vectors

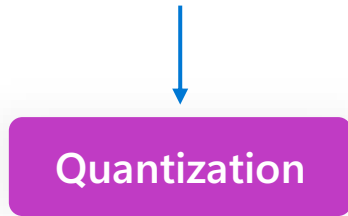Superior to native PGVector IVFLAT & HNSW index types

Reduced memory footprint by storing vectors on SSD

Compression and quantization **improve speed and accuracy** of vector search
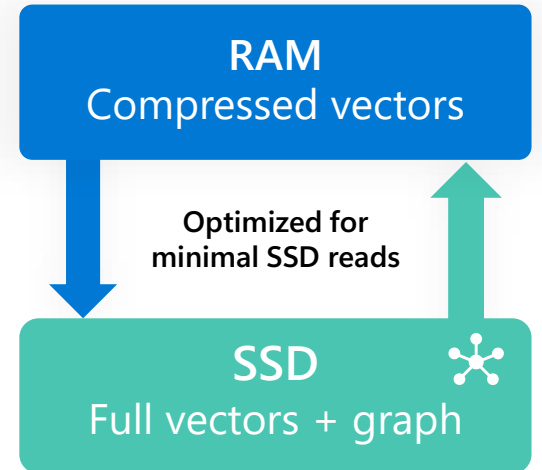
Accuracy retained as data changed

Vector compression

Large Vectors
{ D1, D2, D3, D4, D5, ..., D99, D100 }

↓

Quantization

↓

Compressed Vectors
{ D1, D2 .., D10 }

Optimized storage

RAM
Compressed vectors

Optimized for minimal SSD reads

SSD
Full vectors + graph

Semantic ranker improves recall accuracy

Azure Database for PostgreSQL **Semantic Ranker Solution Accelerator** is now available

Semantic ranker goes to the **text-level**, providing deep analysis of **semantic relevance** between two text strings

SQL Integration makes use of azure ai extension to make remote calls to the **Azure Machine Learning** model

Perform semantic ranking **directly in the SQL query language**

Semantic Ranker Solution Accelerator for PostgreSQL

PostgreSQL on Azure

rerank

Azure ML
Semantic Ranker Model

Customer subscription
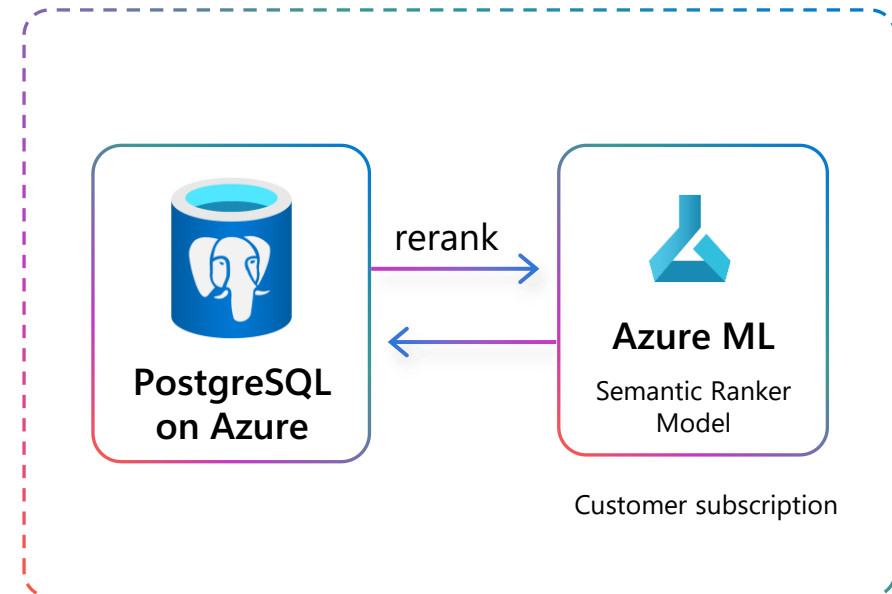
GraphRAG Solution Accelerator for Postgres

GraphRAG is an advanced RAG technique from Microsoft Research to **improve the quality of RAG system processes**

Stores graph natively in PostgreSQL using the **Apache AGE extension**

Consists of three basic steps:

1. Graph extraction
2. Entity summarization
3. Graph query generation at query time

The Solution Accelerator for GraphRAG is **now available**
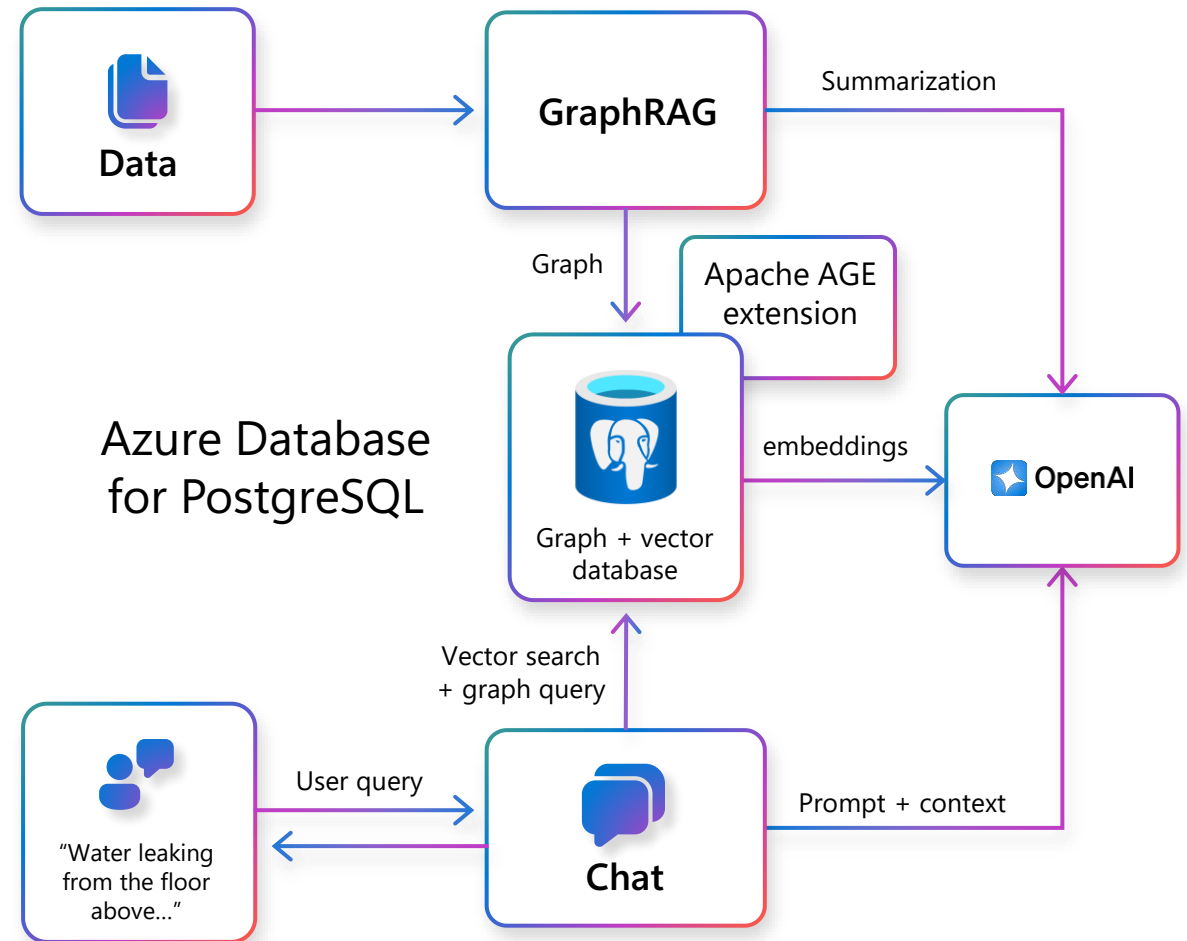
AI Services integrated with Azure Postgres

Make remote calls directly from PostgreSQL

The **azure_ai extension** provides a SQL-based interface to integrate with AI services

Supports:
- Azure OpenAI
- Azure AI Language Services
- Azure AI Translator
- Azure Machine Learning

Enables developers to **rapidly integrate AI capabilities** into their app without complex re-architecture or refactoring

Azure Database for PostgreSQL

Azure OpenAI

Azure AI Language Services

Azure AI Translator

Azure Machine Learning
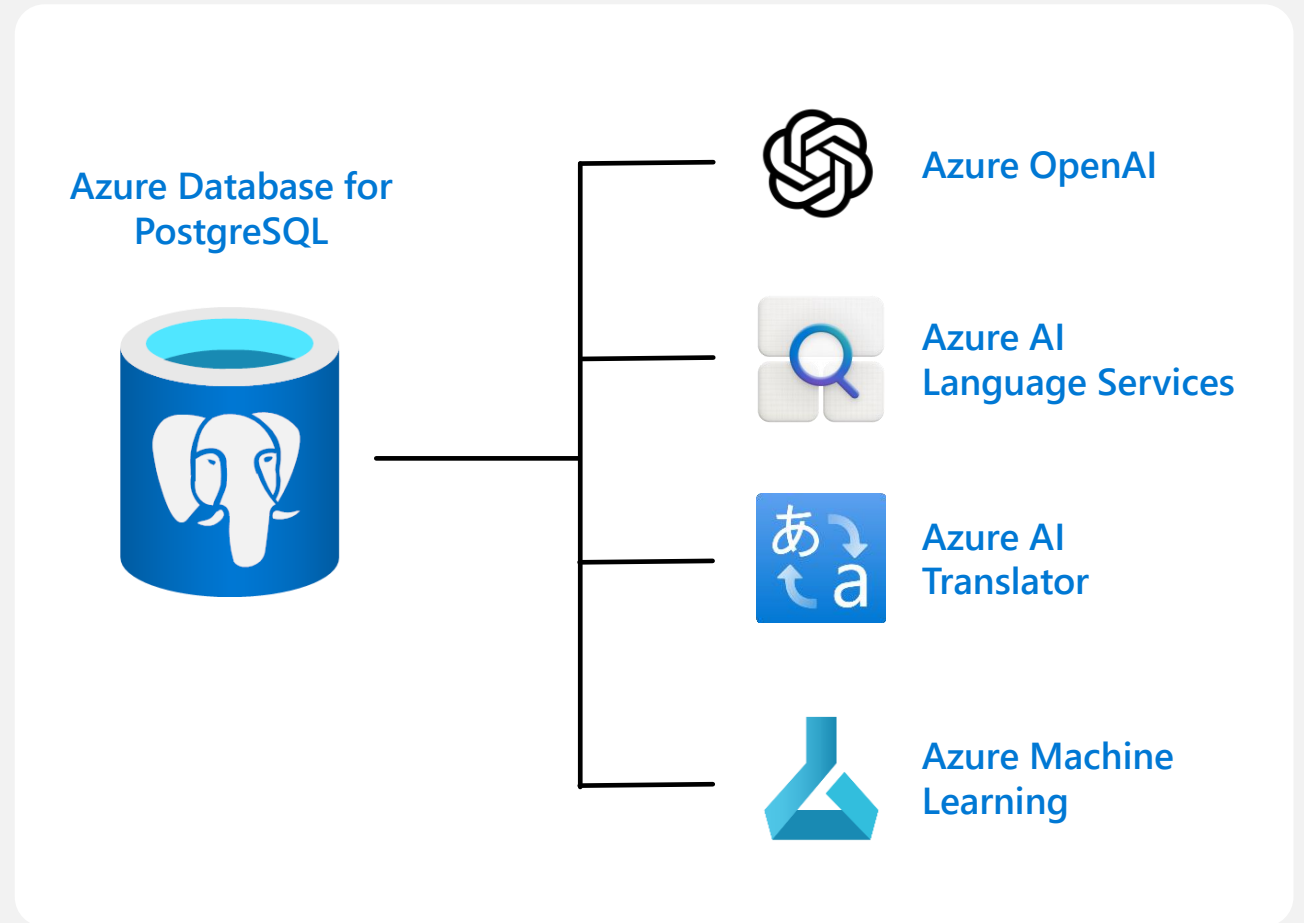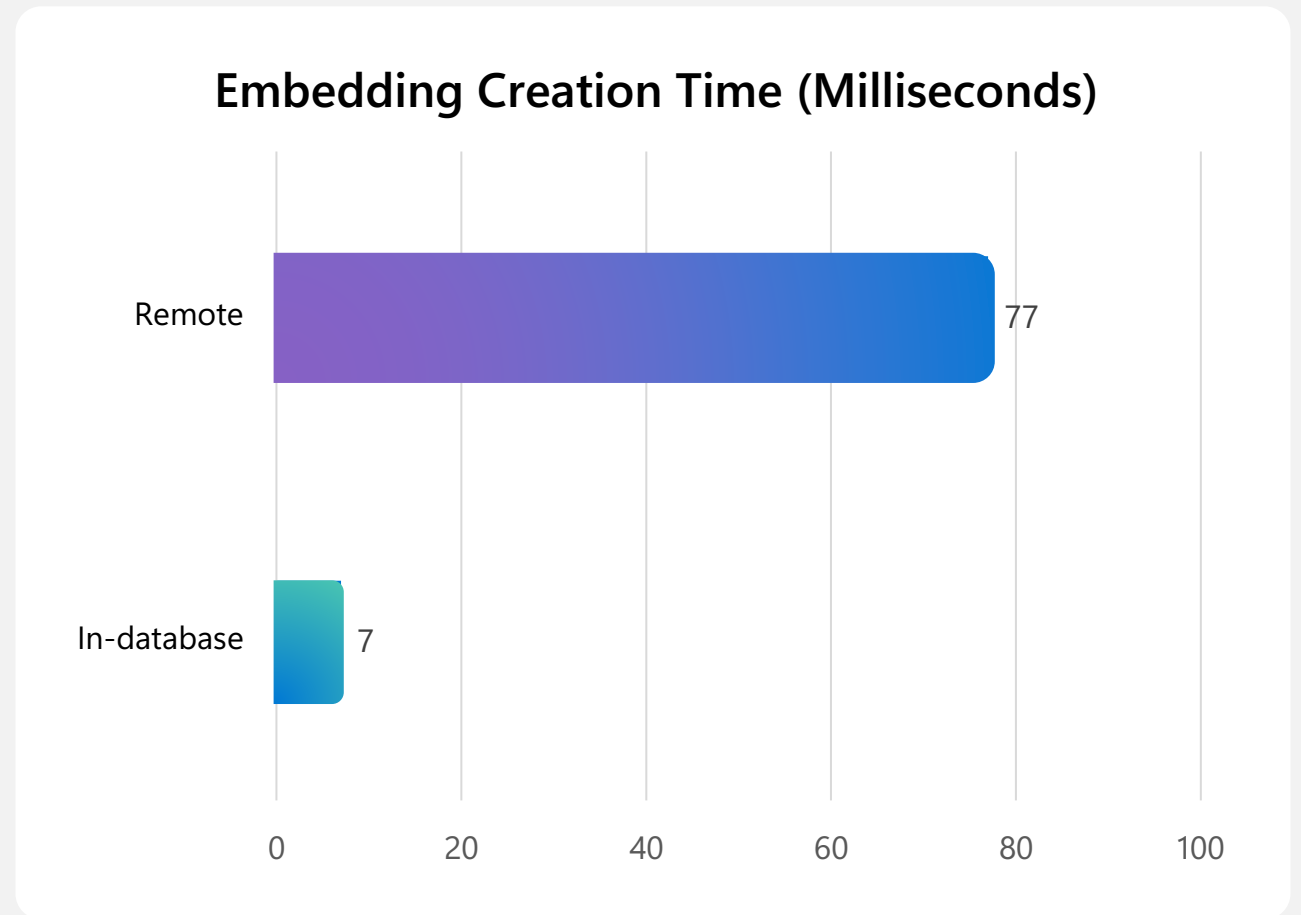
In-Database Embedding Models

Low-latency embedding creation for OLTP workloads

The **azure_local_ai extension** enables vector embeddings to be generated locally within the Postgres server

Based on the Microsoft **open-source E5** embedding model

Benefits:

- **~10x faster** creation time
- No external service setup, maintenance, or transaction costs
- All data remains **within Postgres**
- Perfect for workloads where the **underlying data changes frequently**

Embedding Creation Time (Milliseconds)

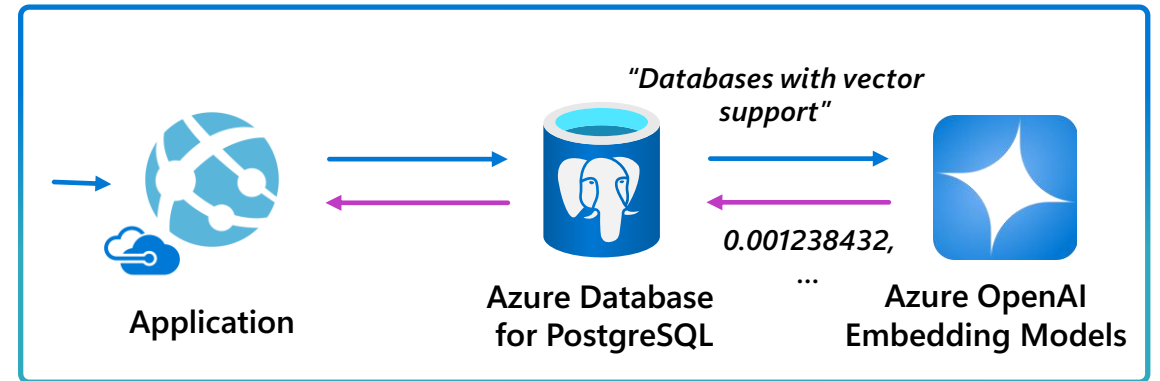|	
Remote	77
In-database	7

0   20   40   60   80   100

Vector Generation
Unique Remote + In-Database Embedding Models
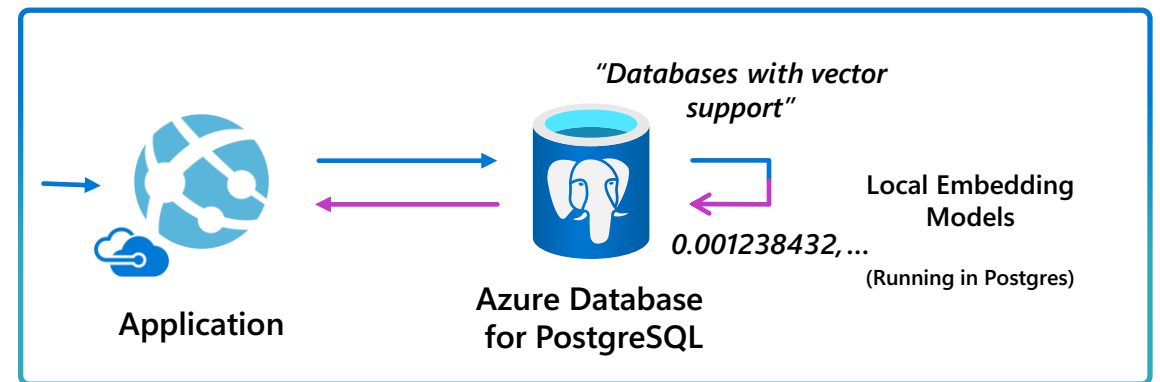
Remote Embedding Models

```
SELECT * FROM <table>
ORDER BY
database_description <->
azure_openai.create_embeddings(
'text-embedding-ada-002',
'Databases with vector support')
```

Application → Azure Database for PostgreSQL → "Databases with vector support" → Azure OpenAI Embedding Models

0.001238432, …

In-Database Embedding Models
(Preview)

```
SELECT * FROM <table>
ORDER BY
recipe_embedding <#>
azure_local_ai.create_embeddings(
'multilingual-e5-small:v1',
'Databases with vector support')
```

Application → Azure Database for PostgreSQL → "Databases with vector support"

0.001238432, …

Local Embedding Models
(Running in Postgres)

Azure Copilot for PostgreSQL Flexible Server

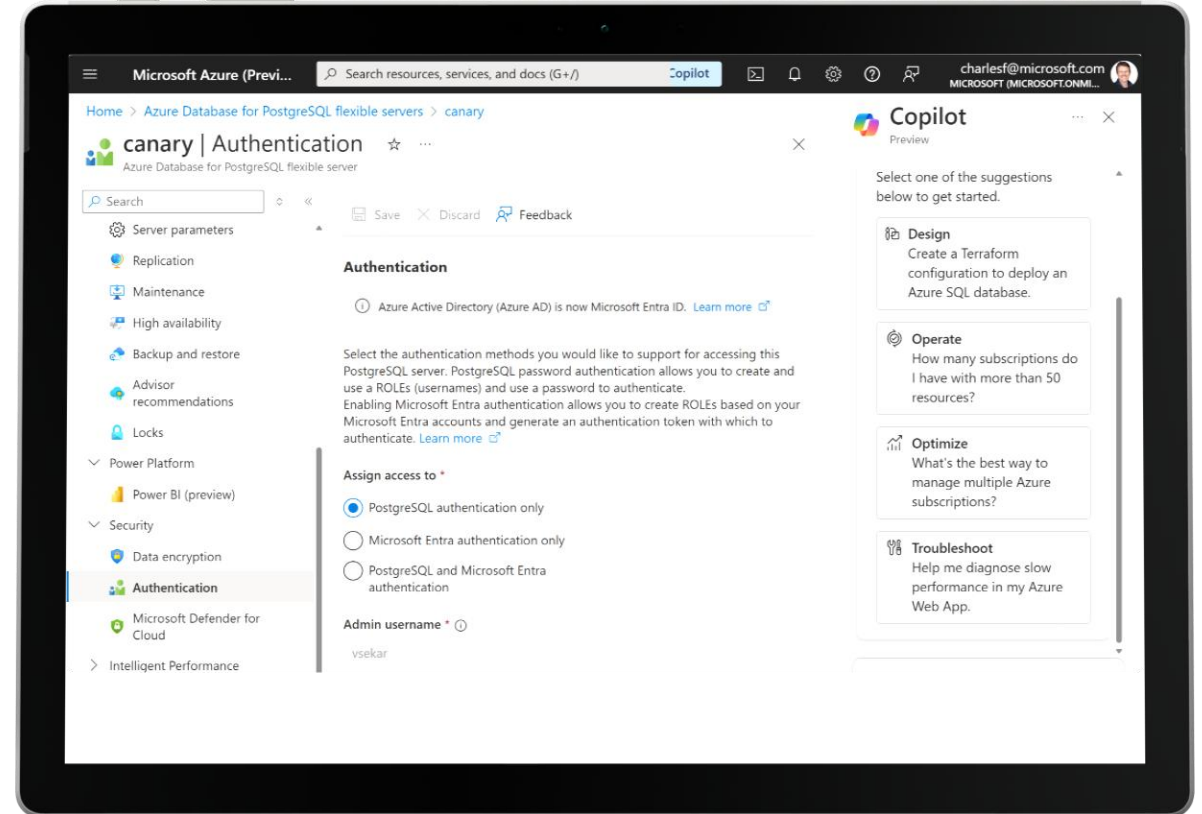**Expert advice when you need it**

Chat-based interface for **analyzing or debugging** the Flexible Server with the Azure portal

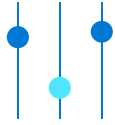**Contextual awareness** of the individual server

Knowledge based on both **Flexible Server and Postgres community documentation** to provide service and database engine specialization

Migration resources

PostgreSQL Migration has never been easier

100% compatible, built on open source Postgres

Major versions of PostgreSQL available within weeks

No application code changes needed to migrate

List of **supported extensions**

Free migration service built into Azure Database for PostgreSQL

Migrate from directly within the database with one-click

'"**With Azure, we've doubled if not tripled the performance of our applications.** *We were able to handle 200,000 transactions per second during our performance tests. We decreased latency by 50% across the networks, all the while decreasing infrastructure costs by 40%, amounting to millions in Turkish Lira.*" **Conversions also increased by 20%, and Boyner saw a 190% rise in revenue from online channels.'**

- Boyner Group (Microsoft Customer Story)

Comprehensive Pre-migration Validation

Rules-based assessment of source systems to determine compatibility for migration for Azure Database for PostgreSQL

No impact to existing source system running

Provides compatibility recommendation for Online vs. Offline migration

Recommended to run prior to migration to identify and remediate issues

AuthenticationAndConnectivityValidation

SourceVersionValidation –

Server Parameters validation –

SKU validation –

Extensions validation

Schema validation

Collation validation –

Microsoft Entra Id Validation -

AuthPermissionsValidation

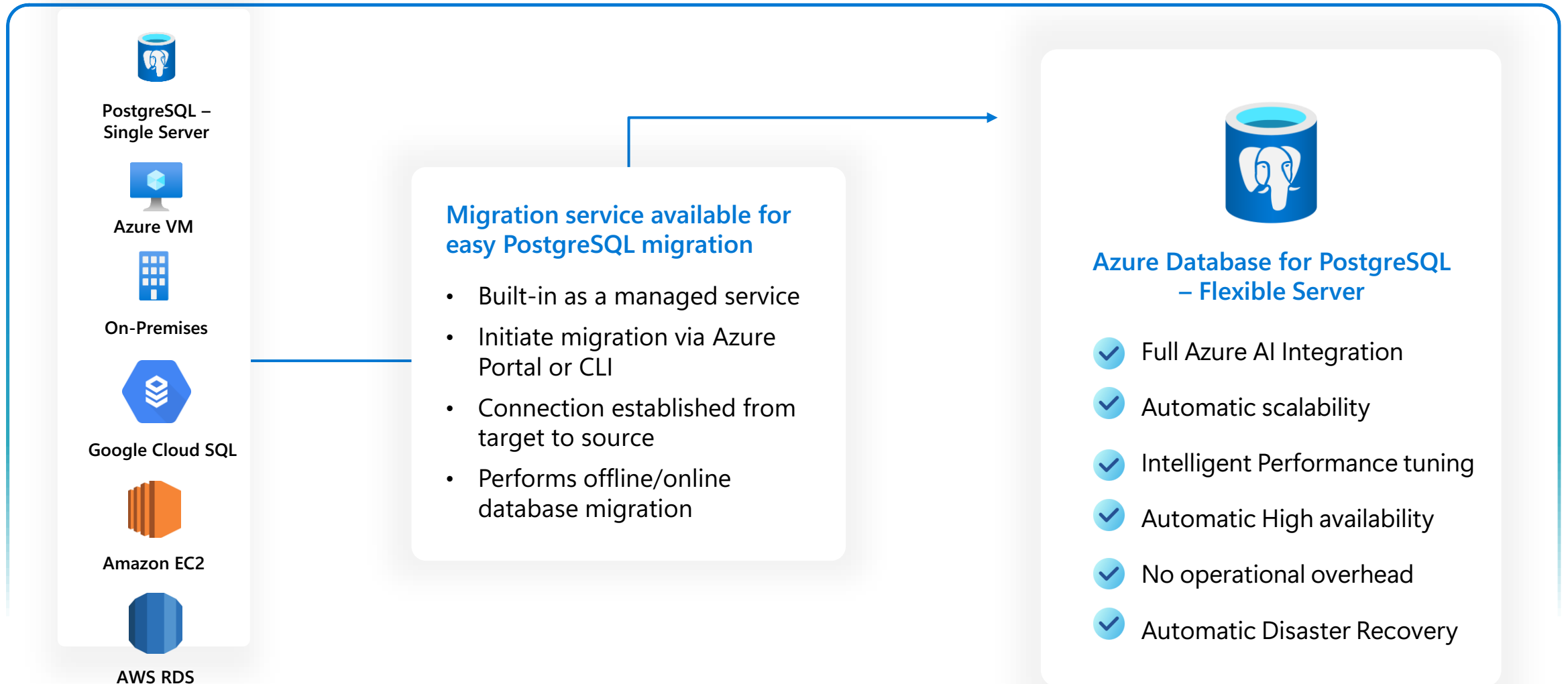**Offline Migration Checks**

Online Settings Validation

Replication Role Permission Validation:

Missing Primary Keys Validation

Additional Online Migration Checks

Modernize using fully managed, AI-ready PostgreSQL

Migration made easy with built-in tools

PostgreSQL –
Single Server

Azure VM

On-Premises

Google Cloud SQL

Amazon EC2

AWS RDS

Migration service available for easy PostgreSQL migration

- Built-in as a managed service
- Initiate migration via Azure Portal or CLI
- Connection established from target to source
- Performs offline/online database migration

Azure Database for PostgreSQL – Flexible Server

- ✔ Full Azure AI Integration
- ✔ Automatic scalability
- ✔ Intelligent Performance tuning
- ✔ Automatic High availability
- ✔ No operational overhead
- ✔ Automatic Disaster Recovery

Modes of migration supported using migration service in Azure Database for PostgreSQL

Mode	PROs	CONs	Recommended For
Offline	• Simple, easy, and less complex to execute. • Very fewer chances of failure. • No restrictions regarding database objects it can handle	• Downtime to applications.	• Best for scenarios where simplicity and a high success rate are essential. • Ideal for scenarios where the database can be taken offline without significant impact on business operations. • Suitable for databases when the migration process can be completed within a planned maintenance window.
Online	• Very minimal downtime to application. • Ideal for large databases and customers having limited downtime requirements.	• Replication used in online migration has multiple restrictions (e.g. Primary Keys needed in all tables). • Complex to execute than offline migration. • Greater chances of failure due to the complexity of migration. • There's an impact on the source instance's storage and computing if the migration runs for a long time.	• Best suited for businesses where continuity is critical, and downtime must be kept to an absolute minimum.

Migration service in Azure Database for PostgreSQL

Benefits:

✔ Fast, Reliable Migration.

✔ Simple UI Wizard in Azure Portal with minimum parameters.

✔ Automation via CLI/ARM Templates

✔ Comprehensive Migration: Schema, Data, Users/Roles, Privileges, etc.

✔ Offline and Online Migration Options Available.

✔ Validation Feature to Assess Business Rules and Identify Limitations.

Cons:

Couple of scenarios are restricted:

✘ 4 extensions which broke backward compatibility are restricted and only migrated on case by case basis unless they are being migrated to the same version.

✘ Only 8 databases can be migrated at a time through portal (any number of databases can be scheduled through CLI).

Azure Migrate and Modernize & Azure Innovate

Comprehensive resources in one place

- Extensive guidance optimized approach from start to finish with assessments, proof of concepts, pilots, tooling, deployment
- Free automated tooling provides you with discovery, assessment, business case analysis, planning, migration, and modernization capabilities
- Proven technical frameworks to help design optimized workloads with security and cost recommendations built throughout

Direct access to experts and funding

- Access to validated, specialized partners with advanced capabilities to help with all stages from planning to deployment
- Benefit from funding for specialized partners to help offset your project costs

Extensive coverage - from migration to innovation

- End-to-end coverage including migrating or modernizing Windows Server & SQL Server, PostgreSQL, MySQL, Linux, Oracle, SAP, HPC, analytics, AI and more
- Microsoft-led delivery for rapid rehost migrations, and specialized partners for more complex workloads.

Learn more!

aka.ms/AzureHeroOfferings

Azure PostgreSQL Resources

Azure Database for Postgres homepage
http://aka.ms/postgres

Azure Database for Postgres Docs
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Thank you

Microsoft