Design for Compute

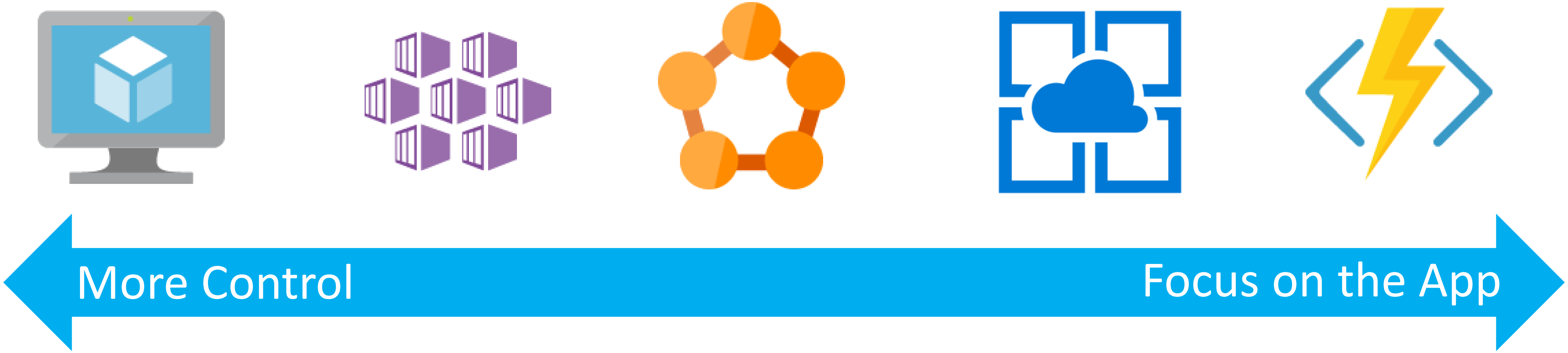
Design Compute Infrastructure (20-25%)

From https://www.microsoft.com/en-us/learning/exam-70-535.aspx

- Design solutions using virtual machines
  - Design VM deployments by leveraging availability sets, fault domains, and update domains in Azure; use web app for containers; design VM Scale Sets; design for compute-intensive tasks using Azure Batch; define a migration strategy from cloud services; recommend use of Azure Backup and Azure Site Recovery
- Design solutions for serverless computing
  - Use Azure Functions to implement event-driven actions; design for serverless computing using Azure Container Instances; design application solutions by using Azure Logic Apps, Azure Functions, or both; determine when to use API management service
- Design microservices-based solutions
  - Determine when a container-based solution is appropriate; determine when container-orchestration is appropriate; determine when Azure Service Fabric (ASF) is appropriate; determine when Azure Functions is appropriate; determine when to use API management service; determine when Web API is appropriate; determine which platform is appropriate for container orchestration; consider migrating existing assets versus cloud native deployment; design lifecycle management strategies
- Design web applications
  - Design Azure App Service Web Apps; design custom web API; secure Web API; design Web Apps for scalability and performance; design for high availability using Azure Web Apps in multiple regions; determine which App service plan to use; design Web Apps for business continuity; determine when to use Azure App Service Environment (ASE); design for API apps; determine when to use API management service; determine when to use Web Apps on Linux; determine when to use a CDN; determine when to use a cache, including Azure Redis cache
- Create compute-intensive application
  - Design high-performance computing (HPC) and other compute-intensive applications using Azure Services; determine when to use Azure Batch; design stateless components to accommodate scale; design lifecycle strategy for Azure Batch

Azure: The Power Of Choice

Compute



Virtual Machines

Container Service

Service Fabric

App Service

Functions

More Control

Focus on the App

Customer-managed
(IaaS)

Platform-managed
(PaaS)

Code-only
(serverless)

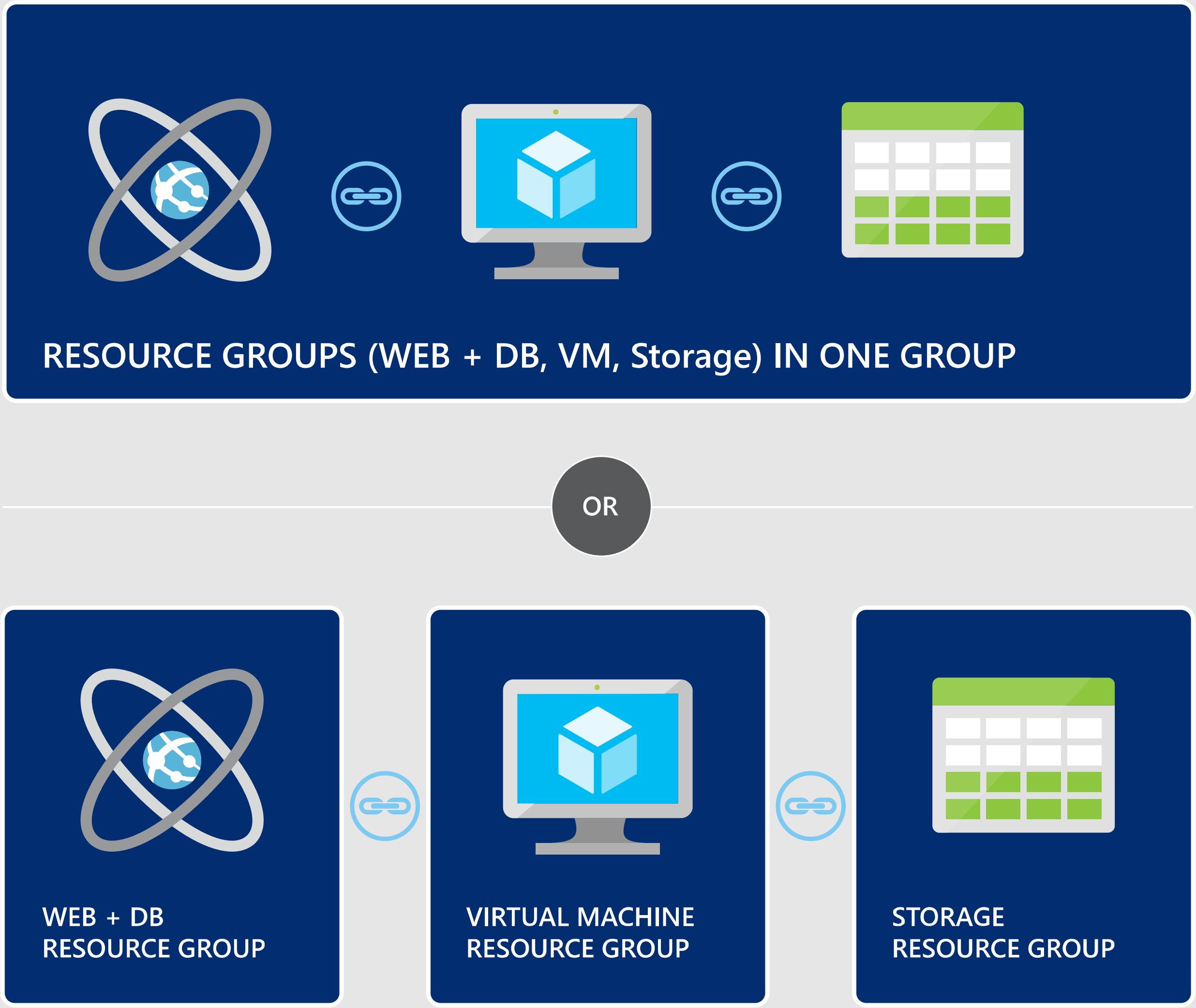
Azure Resource Manager (ARM)

All services offered as **ARM resources**

- Consistent model for creating/managing Azure resources
- Relies on **Resource Providers**, services that can manage a set of resources
- Supports declarative templates

Resources are managed in **resource groups**

- Deployed together
- Managed together
- Provides RBAC support



RESOURCE GROUPS (WEB + DB, VM, Storage) IN ONE GROUP

OR

WEB + DB
RESOURCE GROUP

VIRTUAL MACHINE
RESOURCE GROUP

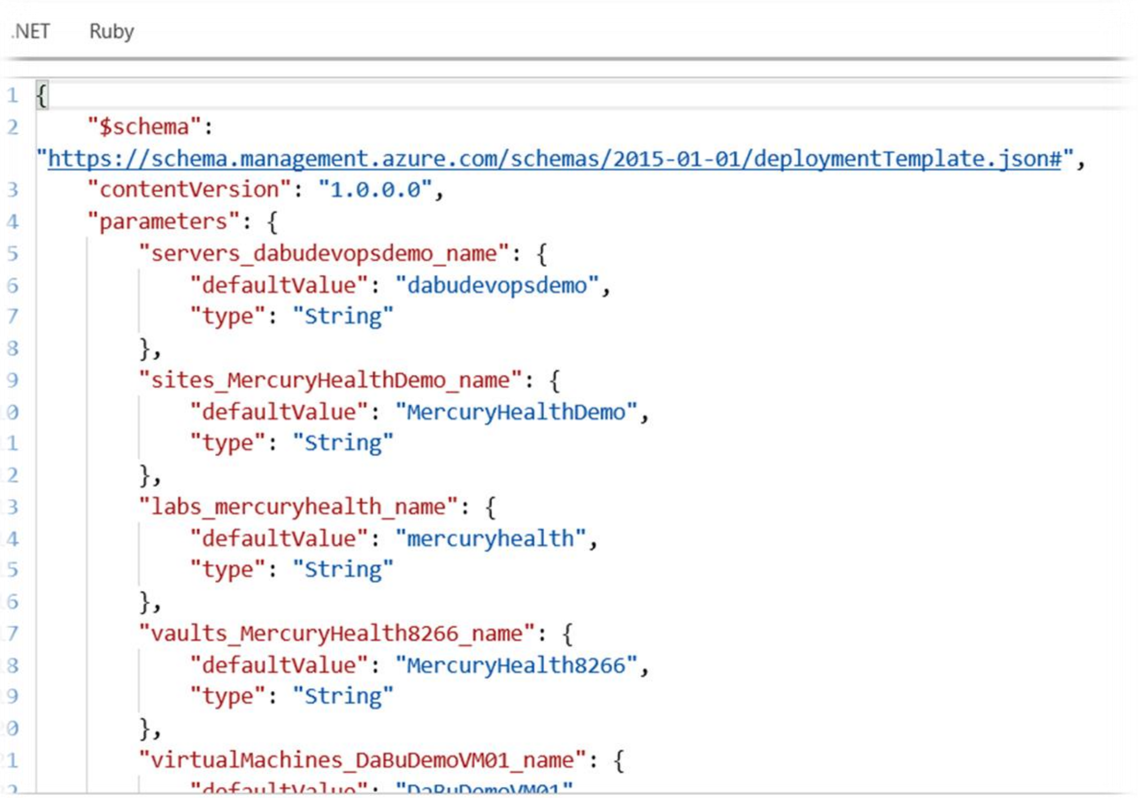
STORAGE
RESOURCE GROUP

ARM Templates

- A declarative JSON template for describing resources
- Community offered or build your own

Documentation
https://azure.microsoft.com/en-us/resources/templates/

Samples
https://github.com/azure/azure-quickstart-templates
https://azure.microsoft.com/en-us/resources/templates/



```
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            "type": "String"
        },
        "sites_MercuryHealthDemo_name": {
            "defaultValue": "MercuryHealthDemo",
            "type": "String"
        },
        "labs_mercuryhealth_name": {
            "defaultValue": "mercuryhealth",
            "type": "String"
        },
        "vaults_MercuryHealth8266_name": {
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            "type": "String"
        },
        "virtualMachines_DaBuDemoVM01_name": {
            "defaultValue": "DaBuDemoVM01"
```
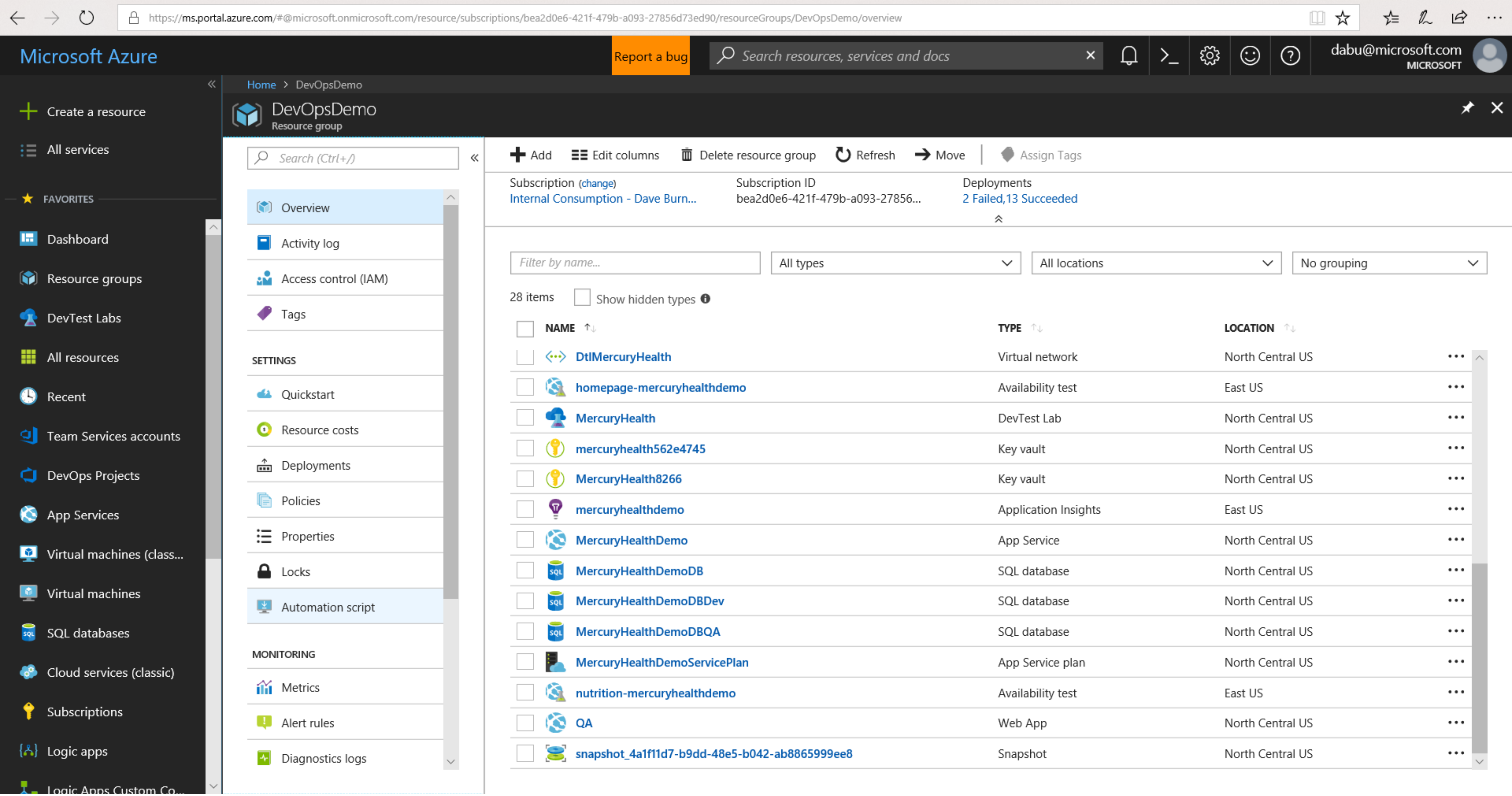



https://ms.portal.azure.com/#@microsoft.onmicrosoft.com/resource/subscriptions/bea2d0e6-421f-479b-a093-27856d73ed90/resourceGroups/DevOpsDemo/overview

Home > DevOpsDemo

DevOpsDemo
Resource group

Subscription (change): Internal Consumption - Dave Burn...

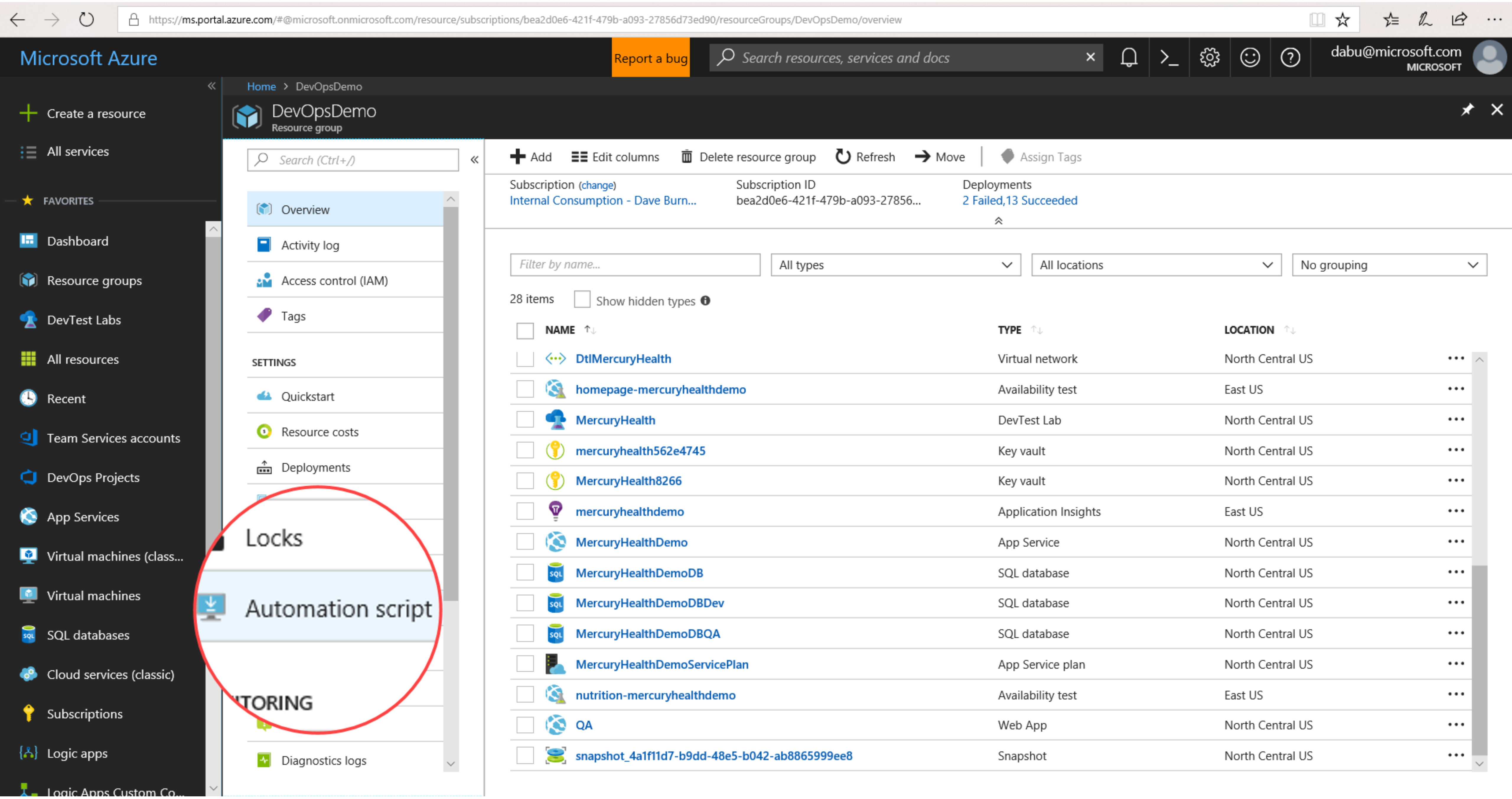
Subscription ID: bea2d0e6-421f-479b-a093-27856...

Deployments: 2 Failed,13 Succeeded

All types | All locations | No grouping

28 items

NAME	TYPE	LOCATION
DtlMercuryHealth	Virtual network	North Central US
homepage-mercuryhealthdemo	Availability test	East US
MercuryHealth	DevTest Lab	North Central US
mercuryhealth562e4745	Key vault	North Central US
MercuryHealth8266	Key vault	North Central US
mercuryhealthdemo	Application Insights	East US
MercuryHealthDemo	App Service	North Central US
MercuryHealthDemoDB	SQL database	North Central US
MercuryHealthDemoDBDev	SQL database	North Central US
MercuryHealthDemoDBQA	SQL database	North Central US
MercuryHealthDemoServicePlan	App Service plan	North Central US
nutrition-mercuryhealthdemo	Availability test	East US
QA	Web App	North Central US
snapshot_4a1f11d7-b9dd-48e5-b042-ab8865999ee8	Snapshot	North Central US



https://ms.portal.azure.com/#@microsoft.onmicrosoft.com/resource/subscriptions/bea2d0e6-421f-479b-a093-27856d73ed90/resourceGroups/DevOpsDemo/overview

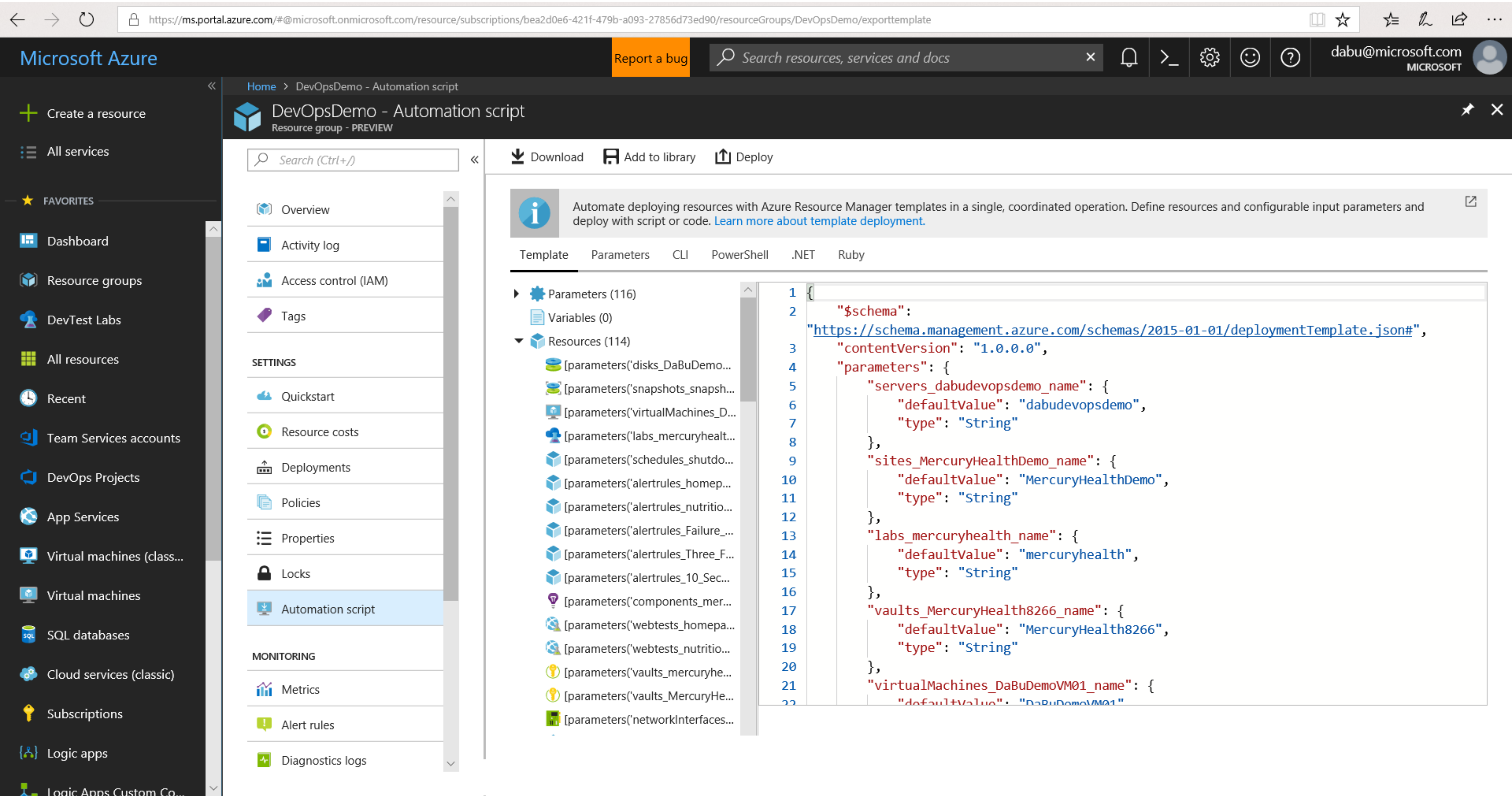
Subscription (change)
Internal Consumption - Dave Burn...

Subscription ID
bea2d0e6-421f-479b-a093-27856...

Deployments
2 Failed,13 Succeeded

28 items □ Show hidden types

NAME	TYPE	LOCATION
DtlMercuryHealth	Virtual network	North Central US
homepage-mercuryhealthdemo	Availability test	East US
MercuryHealth	DevTest Lab	North Central US
mercuryhealth562e4745	Key vault	North Central US
MercuryHealth8266	Key vault	North Central US
mercuryhealthdemo	Application Insights	East US
MercuryHealthDemo	App Service	North Central US
MercuryHealthDemoDB	SQL database	North Central US
MercuryHealthDemoDBDev	SQL database	North Central US
MercuryHealthDemoDBQA	SQL database	North Central US
MercuryHealthDemoServicePlan	App Service plan	North Central US
nutrition-mercuryhealthdemo	Availability test	East US
QA	Web App	North Central US
snapshot_4a1f11d7-b9dd-48e5-b042-ab8865999ee8	Snapshot	North Central US


https://ms.portal.azure.com/#@microsoft.onmicrosoft.com/resource/subscriptions/bea2d0e6-421f-479b-a093-27856d73ed90/resourceGroups/DevOpsDemo/exporttemplate
Microsoft Azure
Report a bug
Search resources, services and docs
dabu@microsoft.com
MICROSOFT
Home > DevOpsDemo - Automation script
DevOpsDemo - Automation script
Resource group - PREVIEW
Create a resource
All services
FAVORITES
Dashboard
Resource groups
DevTest Labs
All resources
Recent
Team Services accounts
DevOps Projects
App Services
Virtual machines (class...
Virtual machines
SQL databases
Cloud services (classic)
Subscriptions
Logic apps
Logic Apps Custom Co...
Search (Ctrl+/)
Overview
Activity log
Access control (IAM)
Tags
SETTINGS
Quickstart
Resource costs
Deployments
Policies
Properties
Locks
Automation script
MONITORING
Metrics
Alert rules
Diagnostics logs
Download
Add to library
Deploy
Template
Parameters
CLI
PowerShell
.NET
Ruby
Parameters (116)
Variables (0)
Resources (114)
[parameters('disks_DaBuDemo...
[parameters('snapshots_snapsh...
[parameters('virtualMachines_D...
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[parameters('schedules_shutdo...
[parameters('alertrules_homep...
[parameters('alertrules_nutritio...
[parameters('alertrules_Failure_...
[parameters('alertrules_Three_F...
[parameters('alertrules_10_Sec...
[parameters('components_mer...
[parameters('webtests_homepa...
[parameters('webtests_nutritio...
[parameters('vaults_mercuryhe...
[parameters('vaults_MercuryHe...
[parameters('networkInterfaces...

Automate deploying resources with Azure Resource Manager templates in a single, coordinated operation. Define resources and configurable input parameters and deploy with script or code. Learn more about template deployment.

```
{
    "$schema":
"https://schema.management.azure.com/schemas/2015-01-01/deploymentTemplate.json#",
    "contentVersion": "1.0.0.0",
    "parameters": {
        "servers_dabudevopsdemo_name": {
            "defaultValue": "dabudevopsdemo",
            "type": "String"
        },
        "sites_MercuryHealthDemo_name": {
            "defaultValue": "MercuryHealthDemo",
            "type": "String"
        },
        "labs_mercuryhealth_name": {
            "defaultValue": "mercuryhealth",
            "type": "String"
        },
        "vaults_MercuryHealth8266_name": {
            "defaultValue": "MercuryHealth8266",
            "type": "String"
        },
        "virtualMachines_DaBuDemoVM01_name": {
            "defaultValue": "DaBuDemoVM01"
```

Virtual Machines

Ubuntu, Red Hat, Windows, SUSE, CoreOS

DevOps Extensions with Chef and Puppet

Multiple sizes

Hundreds of items in marketplace

Azure VM Sizes

A

Lowest Price

D

SSD Storage
Fast CPUs

Dv2

New generation
of D family VMs

G

High memory and
Large SSDs

Av2

New A-Series

New
F

Compute Intensive

New
NC

NVIDIA GPUs
K80 Compute

New
NV

NVIDIA GPUs
M60 Visualization

New
H

Fastest CPU
IB Connectivity

New
L

Large SSDs

New
SAP

SAP Large Instances

ND
Soon

Deep Learning
NVIDIA P40s

NCv2
Soon

New gen of NC
NVIDIA P100s

Dv3
Soon

New generation of D
family

Ev3
Soon

High memory

VM Sizes

Type	Sizes	Description
General purpose	B Dsv3, Dv3, DSv2, Dv2, DS, D, Av2, A0-7	Balanced CPU-to-memory ratio. Ideal for testing and development, small to medium databases, and low to medium traffic web servers.
Compute optimized	Fs, F	High CPU-to-memory ratio. Good for medium traffic web servers, network appliances, batch processes, and application servers.
Memory optimized	Esv3, Ev3, M, GS, G, DSv2, DS, Dv2, D	High memory-to-CPU ratio. Great for relational database servers, medium to large caches, and in-memory analytics.
Storage optimized	Ls	High disk throughput and IO. Ideal for Big Data, SQL, and NoSQL databases.
GPU	NV, NC	Specialized virtual machines targeted for heavy graphic rendering and video editing. Available with single or multiple GPUs.
High performance compute	H, A8-11	Our fastest and most powerful CPU virtual machines with optional high-throughput network interfaces (RDMA).

VM Azure Compute Unit (ACU)

- Provide a way of comparing compute (CPU) performance across Azure SKUs

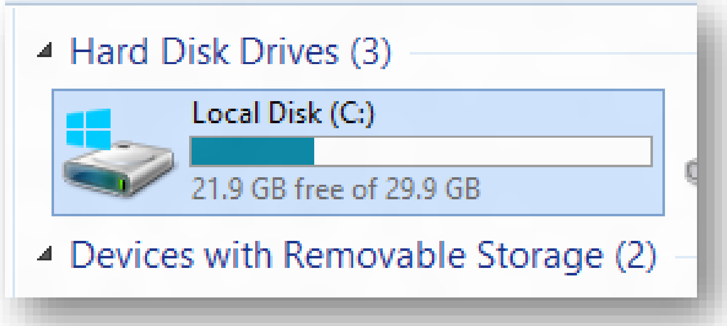
- Not all Azure Cores are created equal!
  - A1 Core != F1 Core

- Compare compute (CPU) performance across SKUs.

SKU Family	ACU \ vCPU
A0	50
A1-A4	100
A5-A7	100
A1_v2-A8_v2	100
A2m_v2-A8m_v2	100
A8-A11	225*
D1-D14	160
D1_v2-D15_v2	210 - 250*
DS1-DS14	160
DS1_v2-DS15_v2	210-250*
D_v3	160-190* **
Ds_v3	160-190* **
E_v3	160-190* **
Es_v3	160-190* **
F1-F16	210-250*
F1s-F16s	210-250*
G1-G5	180 - 240*
GS1-GS5	180 - 240*
H	290 - 300*
L4s-L32s	180 - 240*
M	160-180**

VM Disks

- OS Disk (attached via SATA)
  - VHD based
  - Persists
  - Separate storage cost
- Temporary Disk
  - Doesn’t persist - SSD
  - No Separate storage cost
- Data Disk (SCSI)
  - VHD based
  - Persists
  - Separate storage cost
  - Current Max Data Disk Size: 4,095 GB

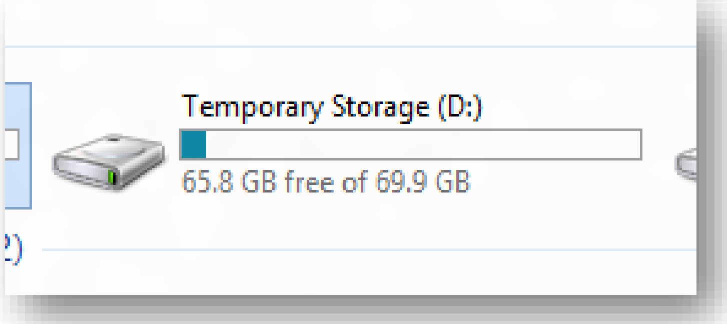


Hard Disk Drives (3)

Local Disk (C:)

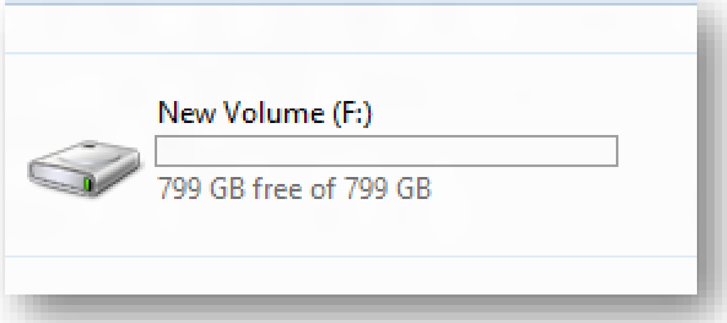
21.9 GB free of 29.9 GB

Devices with Removable Storage (2)



Temporary Storage (D:)

65.8 GB free of 69.9 GB



New Volume (F:)

799 GB free of 799 GB

	Azure Premium Disk	Azure Standard Disk
Disk Type	Solid State Drives (SSD)	Hard Disk Drives (HDD)
Overview	SSD-based high-performance, low-latency disk support for VMs running IO-intensive workloads	HDD-based cost effective disk support for Dev/Test VM scenarios
Scenario	Production and performance sensitive workloads	Dev/Test, non-critical, Infrequent access
Disk Size	P4: 32 GB (Managed Disks only) P6: 64 GB (Managed Disks only) P10: 128 GB P20: 512 GB P30: 1024 GB P40: 2048 GB P50: 4095 GB	Unmanaged Disks: 1 GB – 4 TB (4095 GB) Managed Disks: S4: 32 GB S6: 64 GB S10: 128 GB S20: 512 GB S30: 1024 GB S40: 2048 GB S50: 4095 GB
Max Throughput per Disk	250 MB/s	60 MB/s
Max IOPS per Disk	7500 IOPS	500 IOPS

VM Recommendations

- **Premium Storage for Production Workloads (Storage SLAs)**
- **Choose a VM Size that works with premium storage for production**
- **Use Managed Disks over Unmanaged Disks**
- Scaling Up/Down is just resizing the VM
- **Scaling In/Out – the VMs should be in an availability set**
- Use VM reboot logs to determine if VM was rebooted by planned maintenance
- Use snapshots to prevent accidental data loss
- Enable VM diagnostics for production (includes boot diagnostics)
- **Stopped** VMs are still charged for use. VMs need to be **deallocated** to stop charges. **Stopping through OS does not deallocate! Stop with portal or CLI.**

High Availability & Disaster Recovery

in Azure

- High Availability
  - Availability within a single Azure region or datacenter*
  - Expectation is little or no downtime (99.x % uptime)
- Disaster Recovery
  - Recover into a secondary datacenter if outage in primary datacenter
  - Acceptable downtime has a greater range
  - Quantified by Recovery Time Objective (RTO) & Recovery Point Objective (RPO)

Understanding Azure VM Availability

Single VM

Azure SLA guarantees no data loss, 99.9% uptime SLA*

- Subject to *un-planned maintenance* events due to physical failures
  - If VM becomes unavailable, Azure migrates VM and restarts in another host
  - ~10-15 minutes to complete this process
- Subject to *planned maintenance* events due to host OS servicing
  - All VMs on host are shut down.
  - Host OS is serviced and rebooted
  - All VMs on host are restarted
  - ~10-15 minutes to complete this process
- Subject to in-memory *planned maintenance* events
  - All VMs on host are paused, Host patched, VMs un-paused. 30 seconds downtime

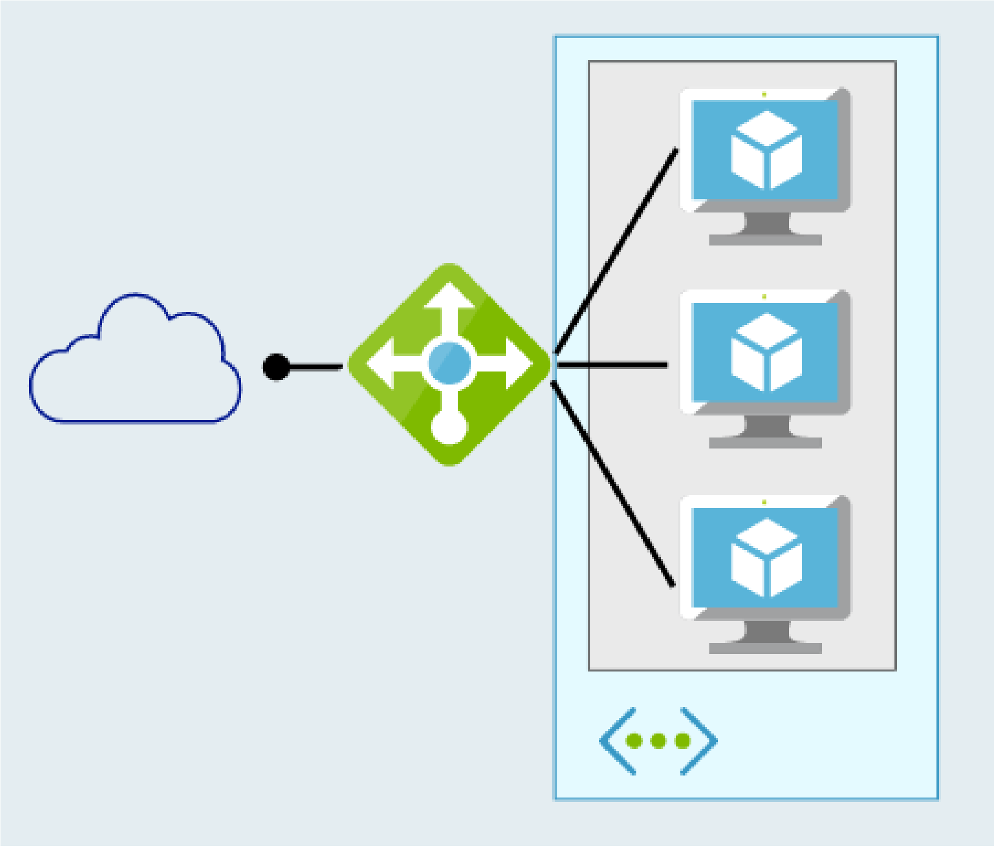
Defining High Availability

2 or more Azure VMs

- Multiple VMs can be configured to reduce downtime
- Workload is load balanced across the VMs

Azure SLA: 2 (or more) VMs in Availability Set:

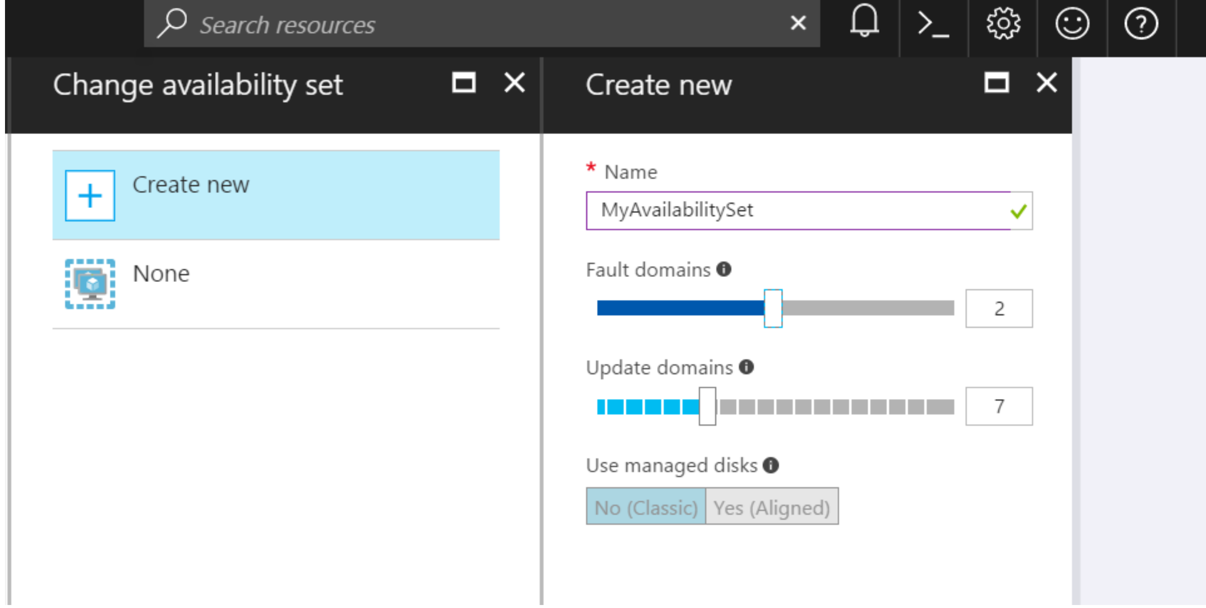
- 99.95% (<22 min downtime p/month)
- Includes
  - Planned downtime due to host OS servicing
  - Unplanned downtime due to physical failures
- Doesn’t include servicing of guest OS or software inside (e.g. SQL)



Availability Sets

- Availability Sets are for Unplanned & Planned Maintenance
  - Fault Domains - 2 default (some regions 3)
  - Upgrade Domains (5 default, 1-20 allowed)

- Front with Load Balancer, App Gateway



Search resources

Change availability set

Create new

None

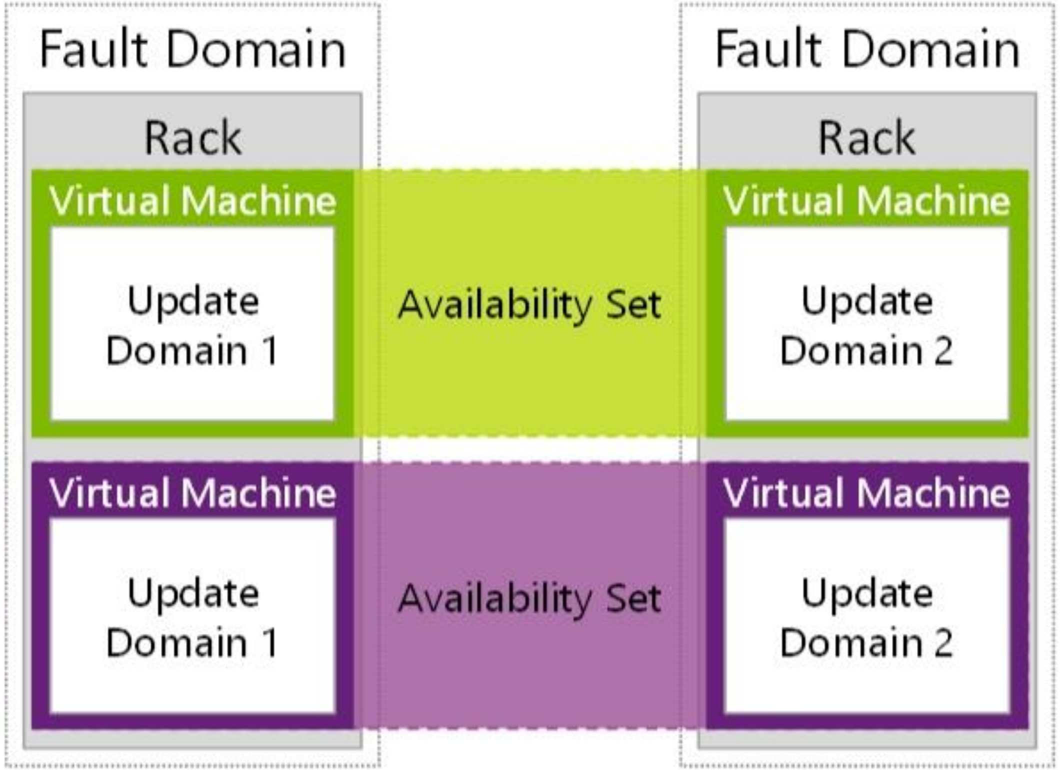
Create new

* Name: MyAvailabilitySet

Fault domains: 2

Update domains: 7

Use managed disks: No (Classic) | Yes (Aligned)



VM Scale Sets

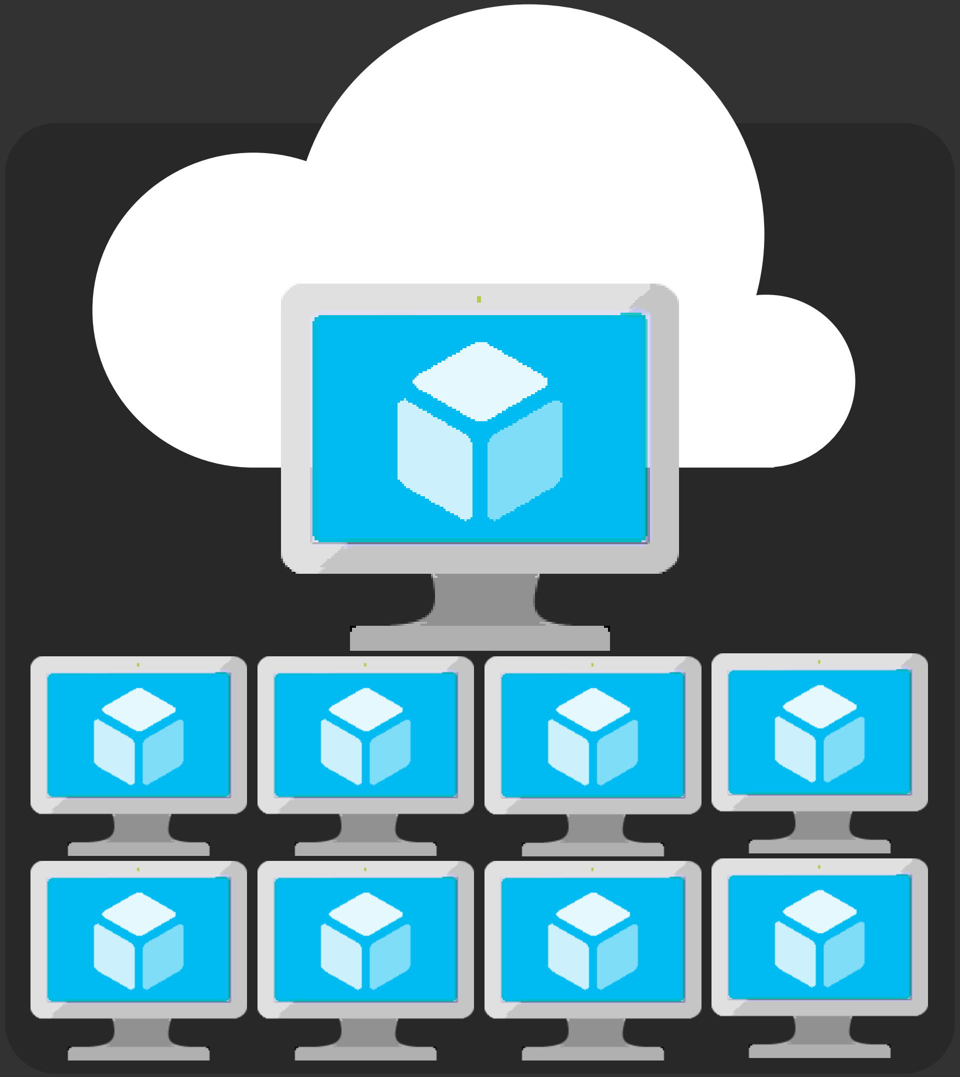
High performance provisioning of 1000+ VMs

Auto-configuration at scale

Auto-scale based on schedule and resource metrics

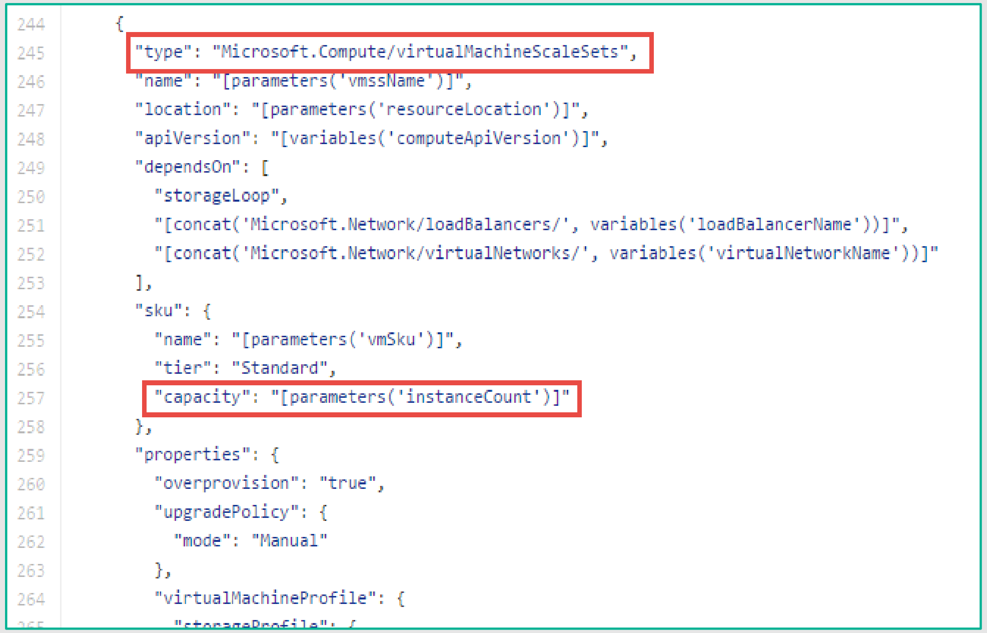
Easy updates at scale

Simple Portal Integration



Why VM Scale Sets?

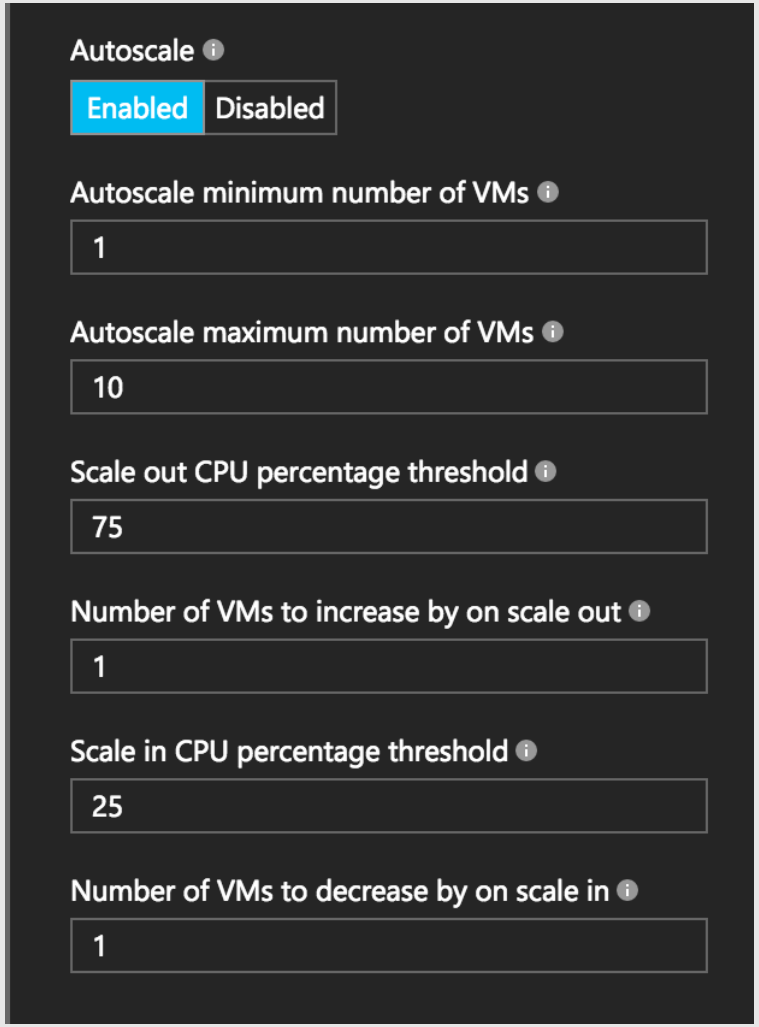
- Manually **scale** with ‘capacity’ property
- **Autoscale** with host metrics or diagnostic extensions
- Small buy-in: Deploy/manage sets identically configured VMs
- **Guest OS patching**: Patching primitives allow manually triggered rolling upgrades
- **High-availability** – implicit availability set with 5 FDs/5 UDs



```
    {
      "type": "Microsoft.Compute/virtualMachineScaleSets",
      "name": "[parameters('vmssName')]",
      "location": "[parameters('resourceLocation')]",
      "apiVersion": "[variables('computeApiVersion')]",
      "dependsOn": [
        "storageLoop",
        "[concat('Microsoft.Network/loadBalancers/', variables('loadBalancerName'))]",
        "[concat('Microsoft.Network/virtualNetworks/', variables('virtualNetworkName'))]"
      ],
      "sku": {
        "name": "[parameters('vmSku')]",
        "tier": "Standard",
        "capacity": "[parameters('instanceCount')]"
      },
      "properties": {
        "overprovision": "true",
        "upgradePolicy": {
          "mode": "Manual"
        },
        "virtualMachineProfile": {
          "storageProfile": {
```

Autoscale with VM Scale Sets

- Define Max – Min VMs
- Define trigger and action rules
- Standard audit / email notifications
- Define webhooks for custom notifications and actions (e.g. runbooks)



Autoscale

Autoscale minimum number of VMs: 1

Autoscale maximum number of VMs: 10

Scale out CPU percentage threshold: 75

Number of VMs to increase by on scale out: 1

Scale in CPU percentage threshold: 25

Number of VMs to decrease by on scale in: 1

VM scale set app deployment models

Model	When to use
Marketplace	Off the shelf solutions.
VM Extensions	Full control over app lifecycle management.
Custom data/unattend	Install custom app independently of external network.
Configuration manager	Centrally managed app installation, credentials & maintenance.
Containerized	Abstract app management from infrastructure. Cloud/DC agnostic.
Custom image	Small self-contained apps. Fast deploy. Immutable build, test, deploy pipelines.

VMSS vs AS

Availability Set

- Multiple different VMs (image, size, etc)
- Machines managed separately

VMSS

- Same VMs
- Managed together
- Reliable rapid provisioning and scale utilizing similarity of the VMs

Azure Batch

Compute pools for job processing

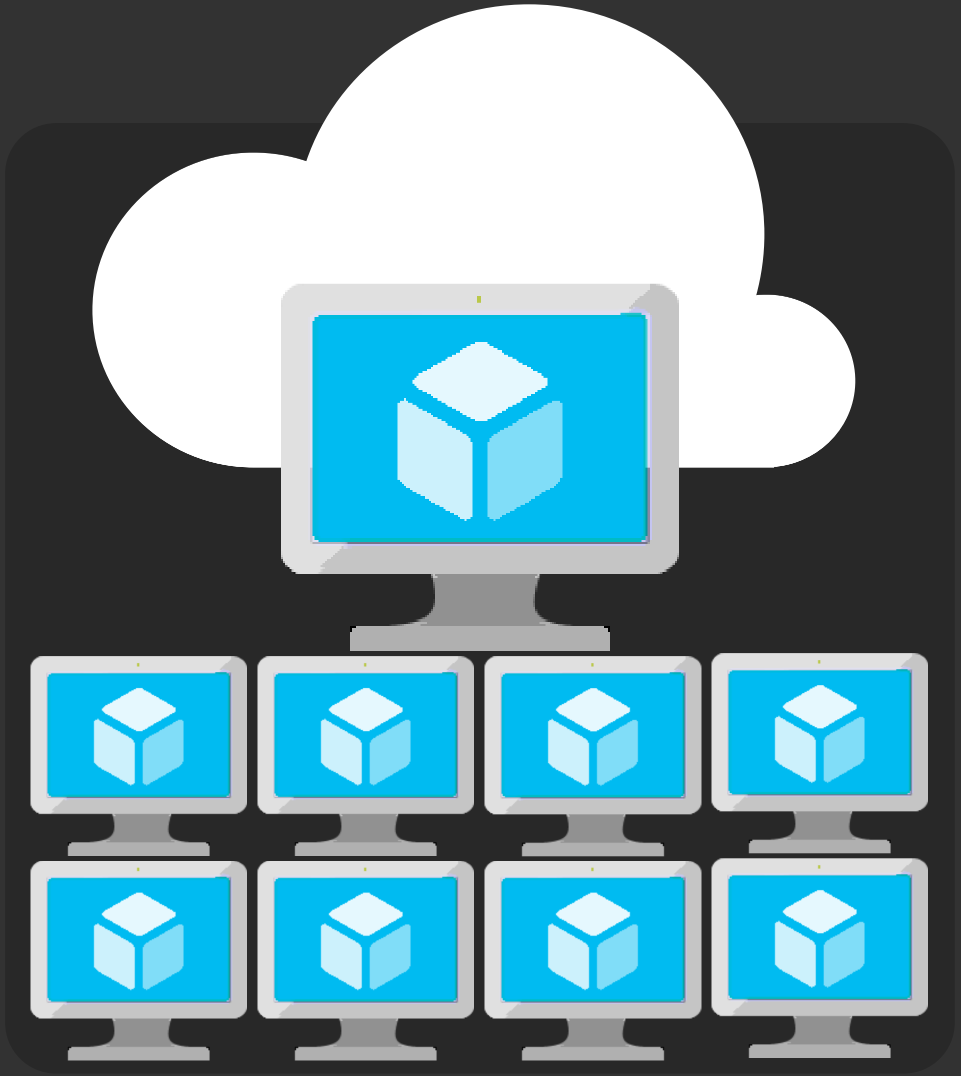
Automatic scaling and regional coverage

Linux and Windows

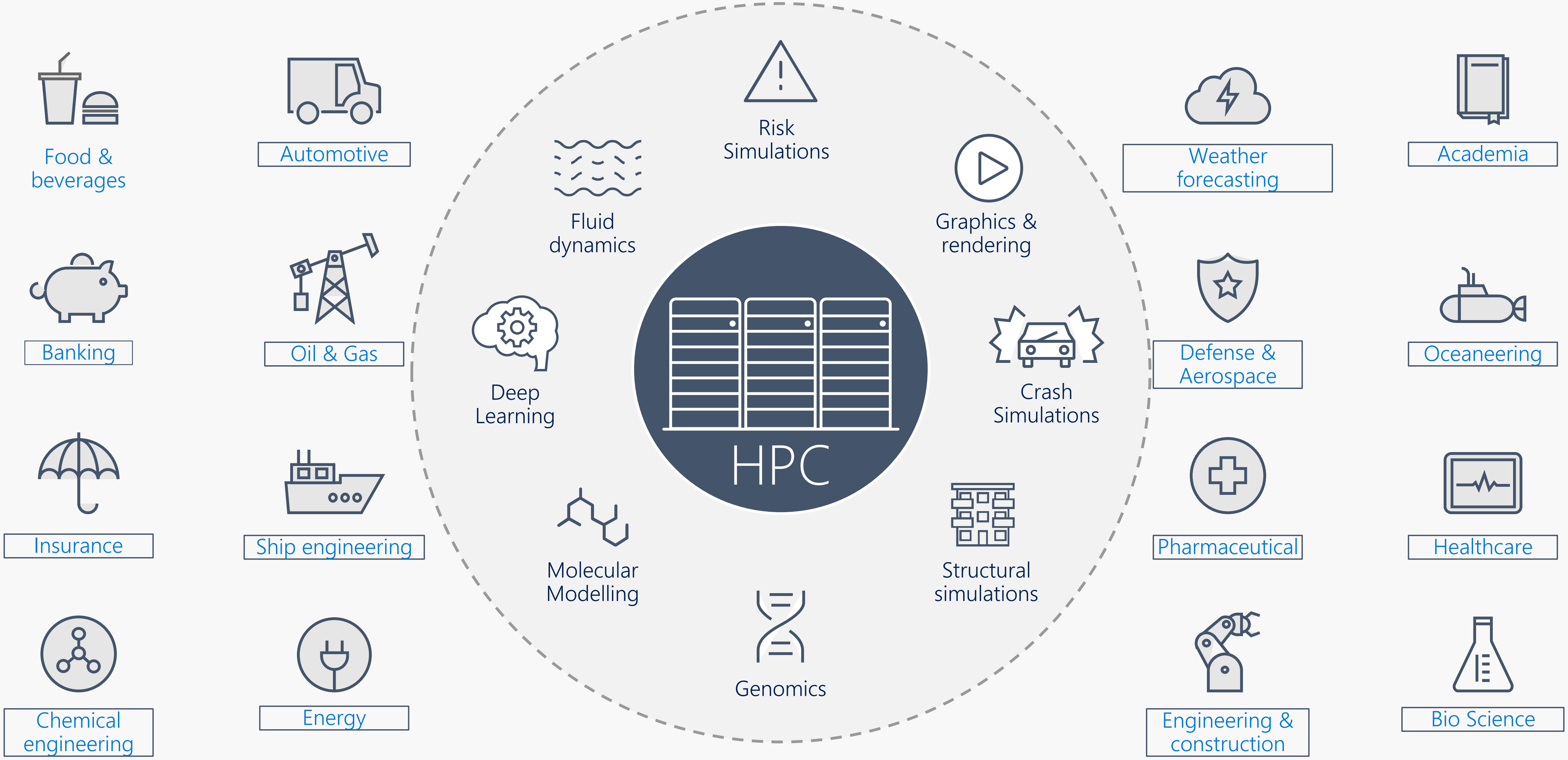
Automatically recover failed tasks

Input/Output handling

Low-Priority (discounted) option



WHAT IS HIGH PERFORMANCE COMPUTING?



HPC

Risk Simulations

Fluid dynamics

Graphics & rendering

Deep Learning

Crash Simulations

Molecular Modelling

Structural simulations

Genomics

Food & beverages

Automotive

Banking

Oil & Gas

Insurance

Ship engineering

Chemical engineering

Energy

Weather forecasting

Academia

Defense & Aerospace

Oceaneering

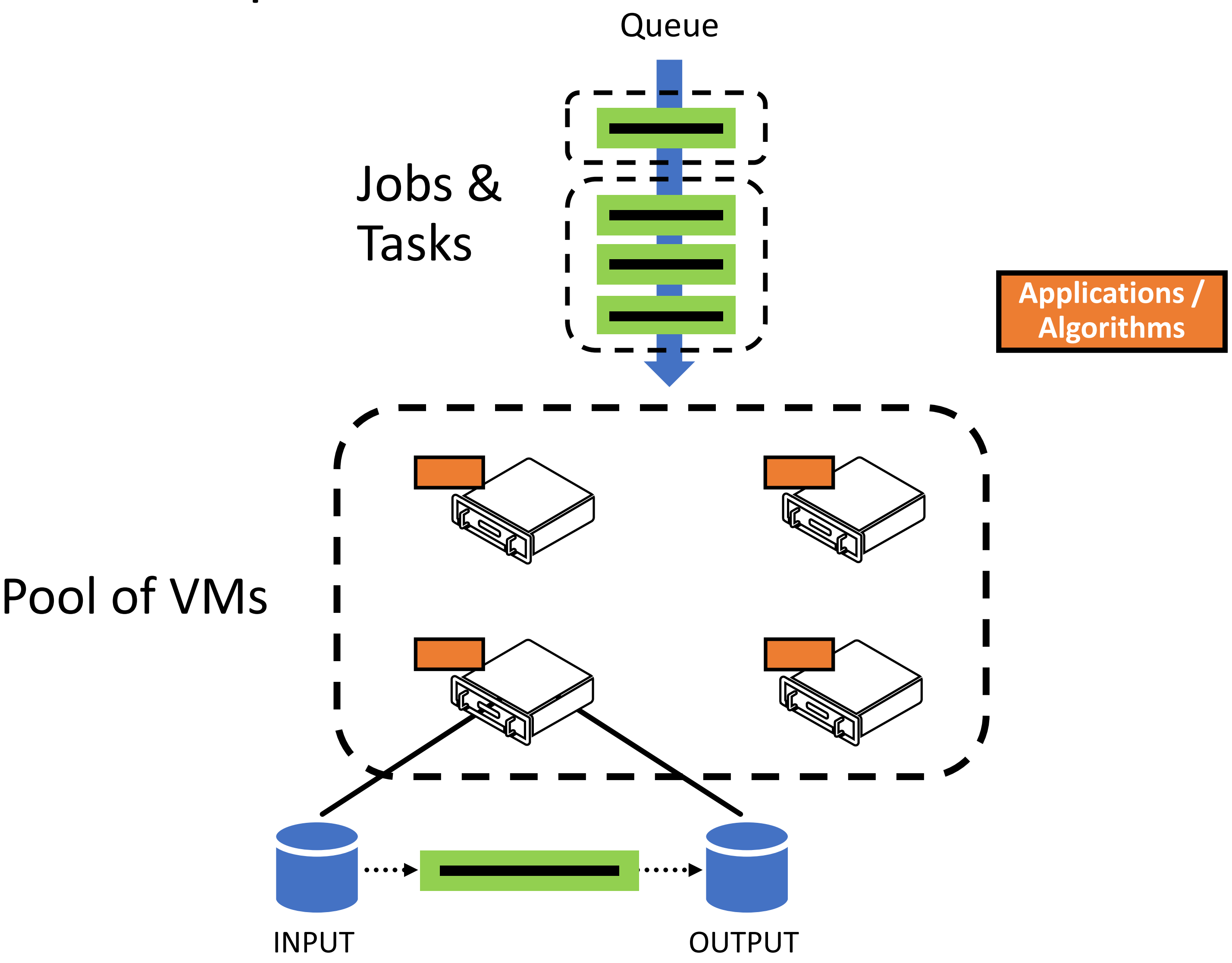
Pharmaceutical

Healthcare

Engineering & construction

Bio Science

Azure Batch Concepts

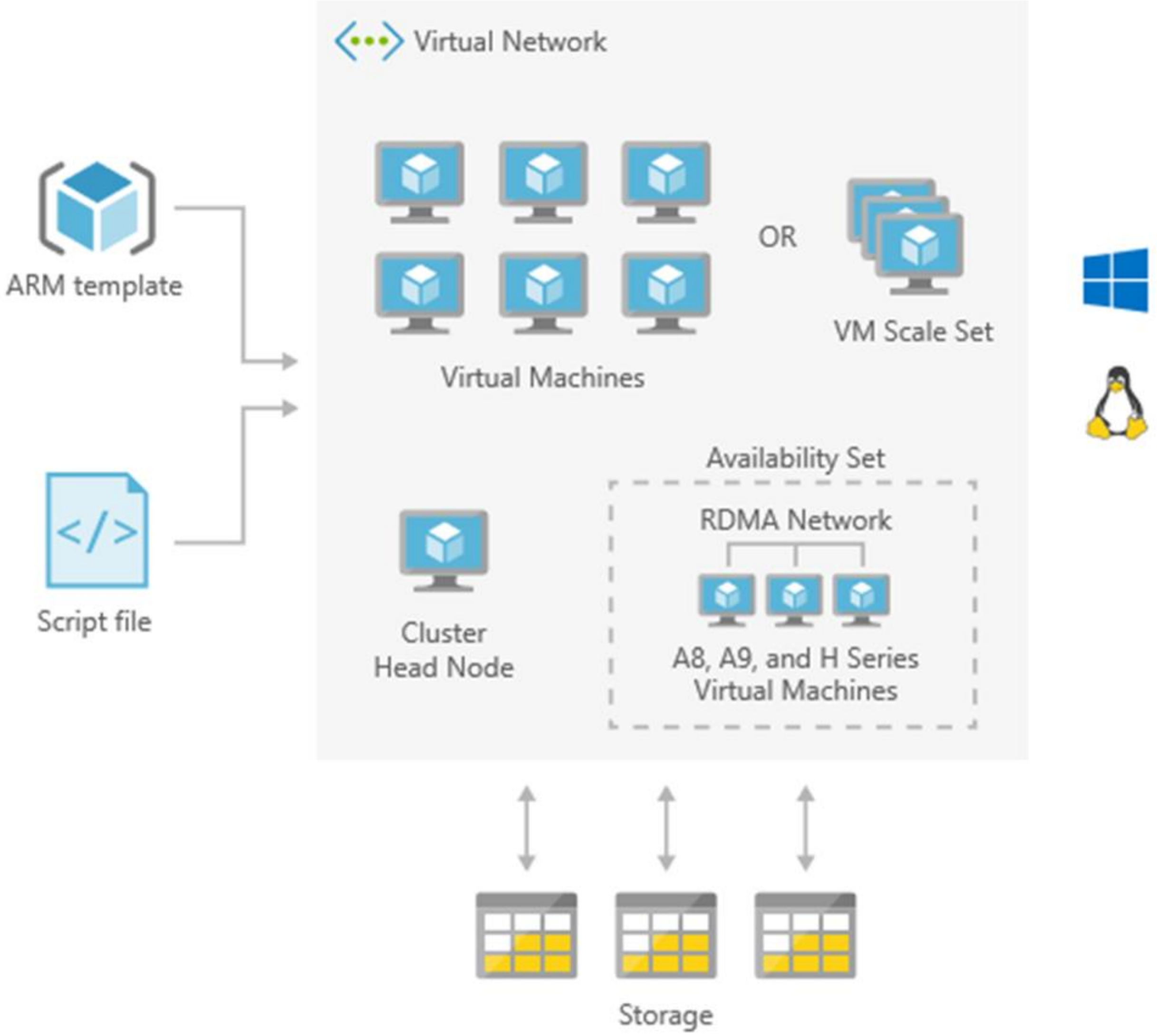


HPC cluster deployed in the cloud

Solution architecture

High performance computing (HPC) applications can scale to thousands of compute cores that run as a 100% cloud native solution. This HPC solution including the head node, compute nodes, and storage nodes, runs in Azure with no hardware infrastructure to maintain.

This solution is built on the Azure managed services: [Virtual Machine Scale Sets](), [Virtual Network]() and [Storage](). These services run in a high-availability environment, patched and supported, allowing you to focus on your solution instead of the environment they run in.

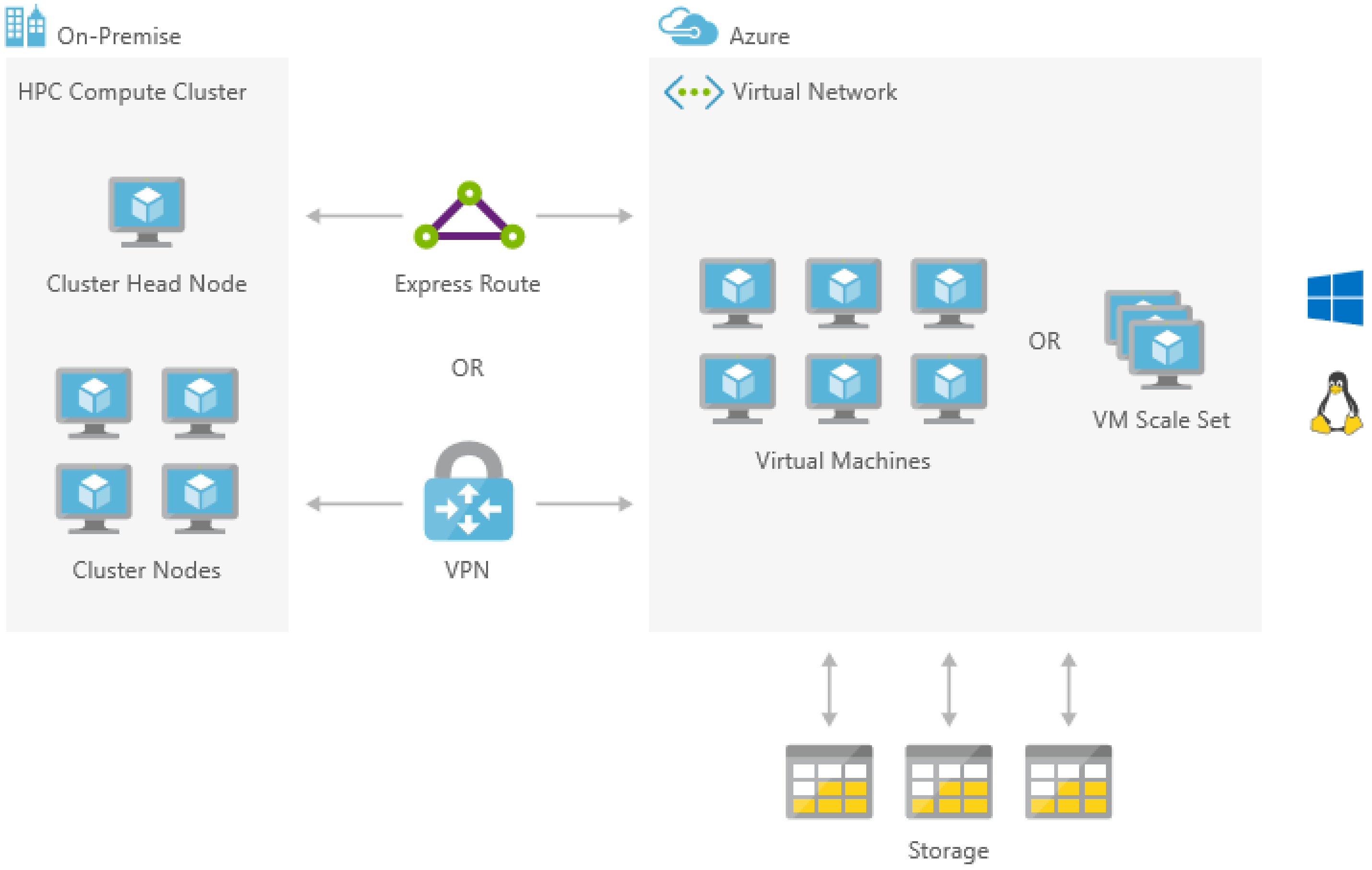


On-premises HPC implementation bursting to Azure

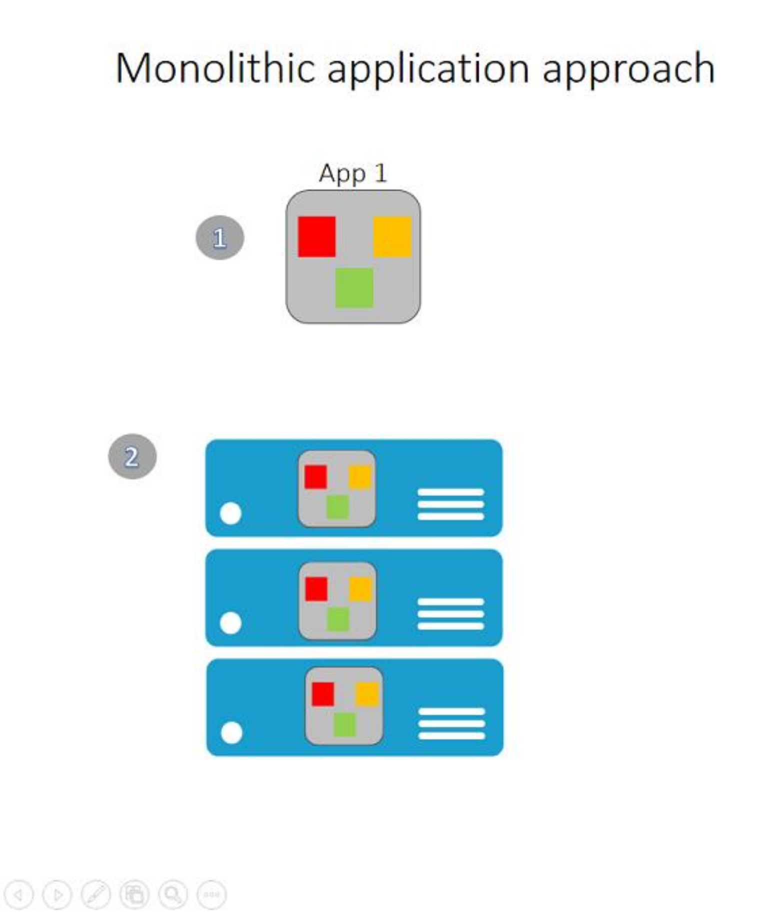
Solution architecture

High performance computing (HPC) applications can extend on-premises big compute. This HPC solution can extend its computational capacity by leveraging the compute-intensive instances of Virtual Machines running in Azure and accessed via Express Route or VPN.

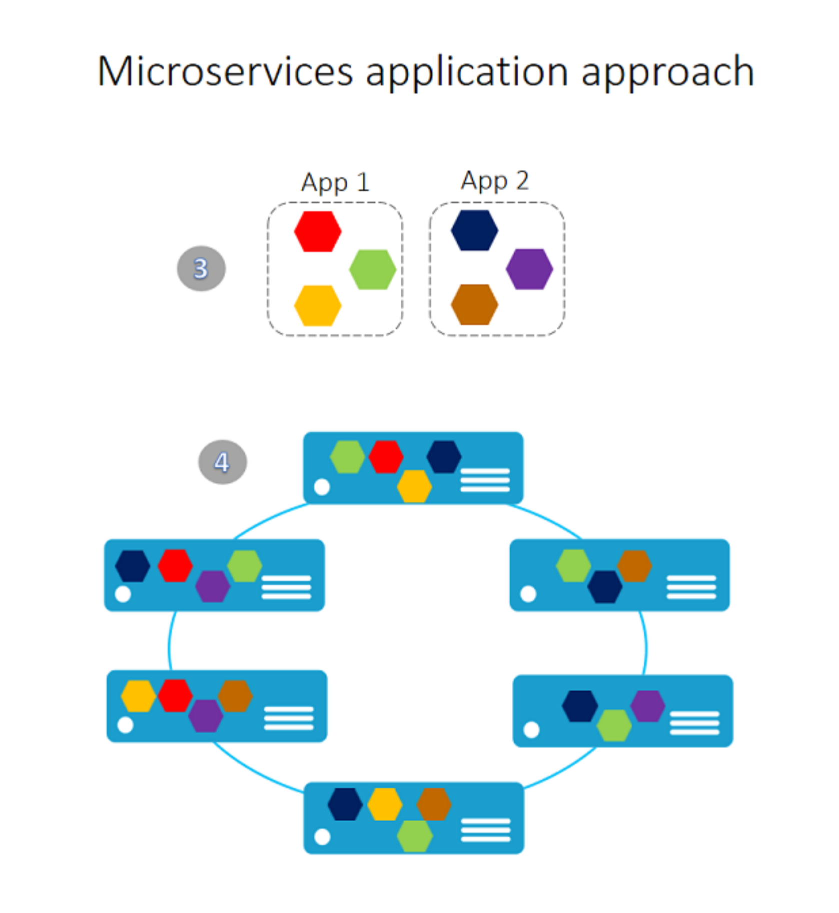
This solution is built on the Azure managed services: Virtual Machines, Virtual Network, VPN Gateway, ExpressRoute and Storage. These services run in a high-availability environment, patched and supported, allowing you to focus on your solution instead of the environment they run in.



Microservices



Monolithic application approach



Microservices application approach

Azure: The Power Of Choice

Application Hosting (today)

Virtual Machines

Containers

Customer-managed
(IaaS)

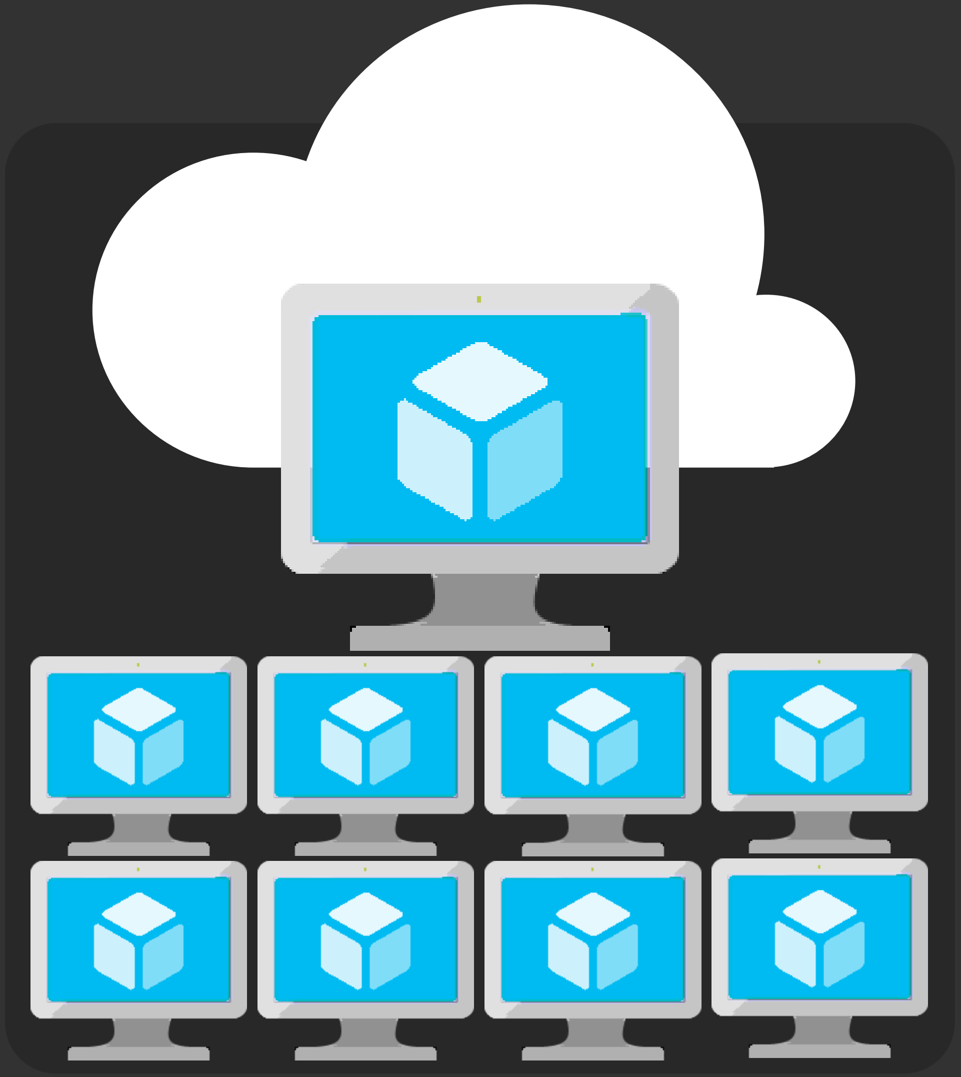
Platform-managed
(mIaaS/PaaS)

Containers

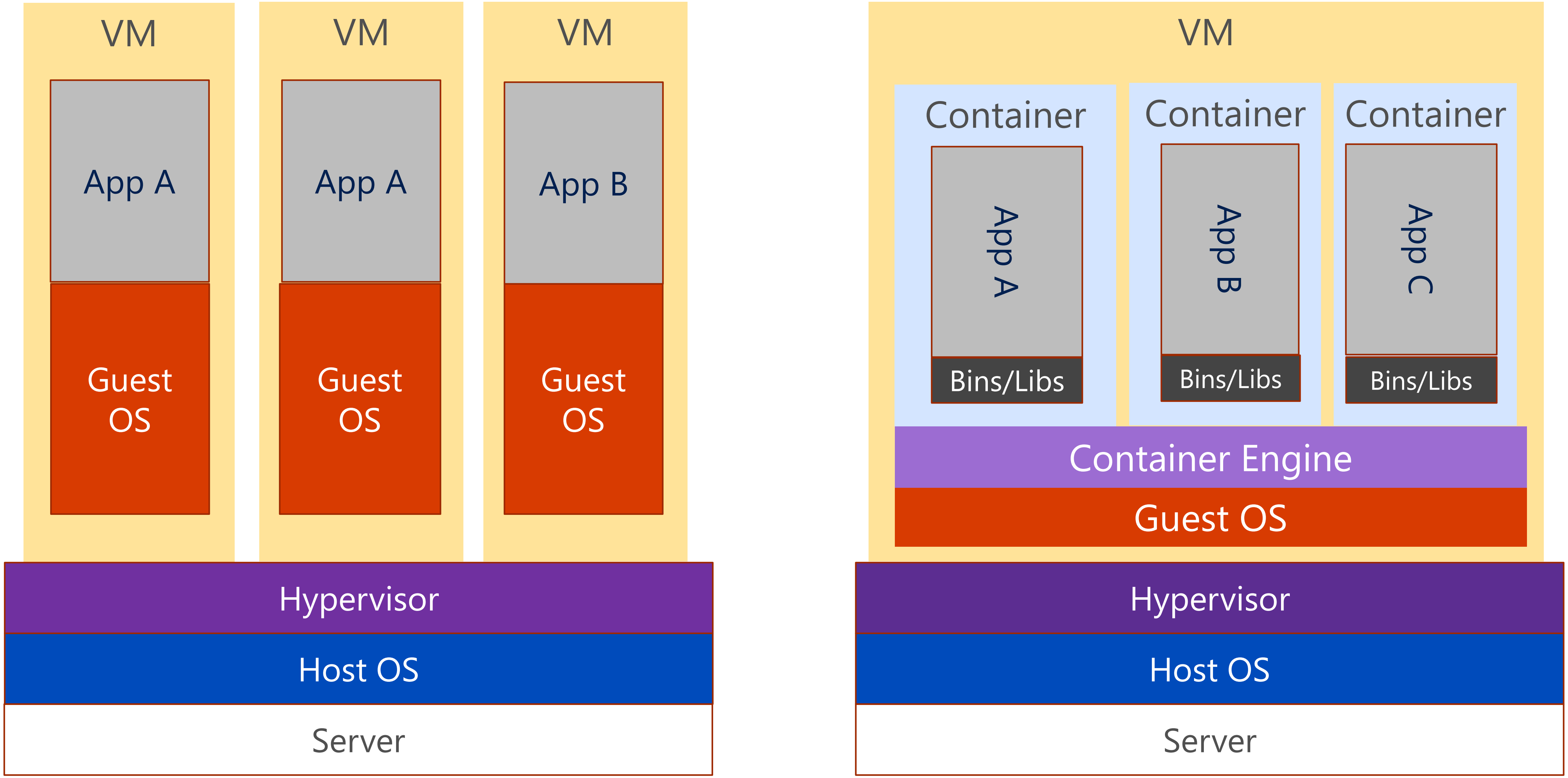
Lightweight

Portable

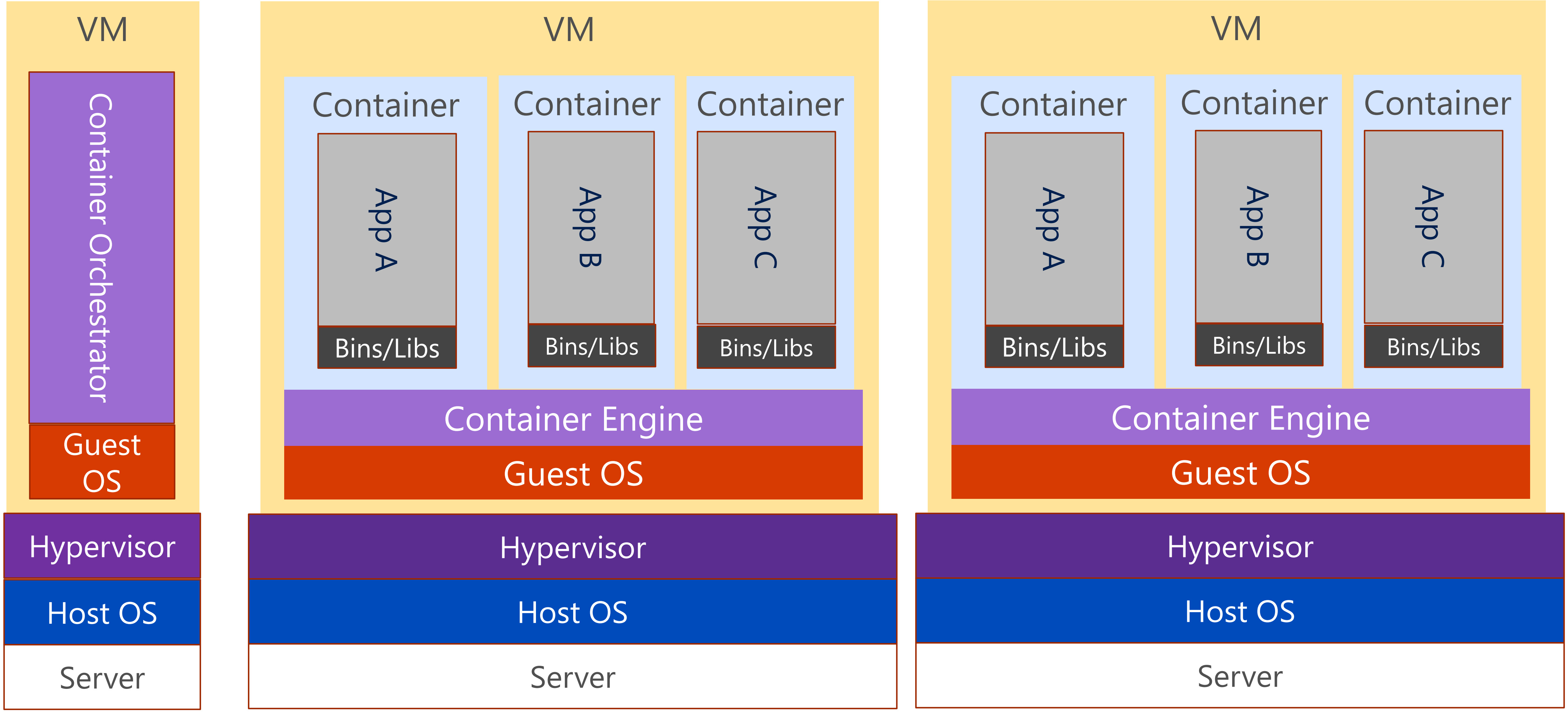
Scalable



What is a Container?



What is a Container Orchestrator?



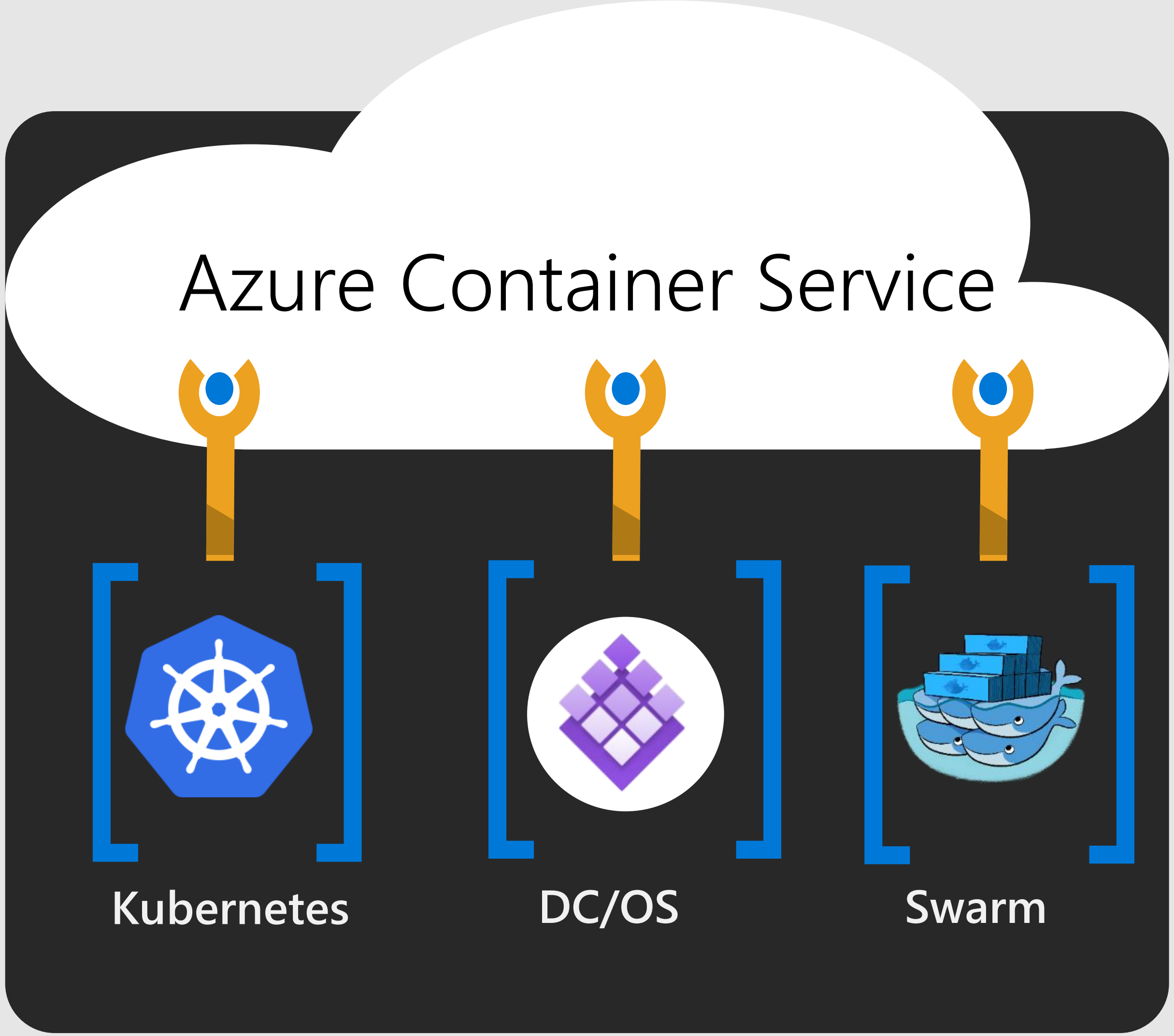
Azure Container Service

Making containers in Azure easy!

- Standard Docker tooling & API Support
- Streamlined provisioning of K8S, DCOS, and Docker Swarm
- Linux & Windows Server Containers
- Azure & Azure Stack

ACS --> AKS

- Focus on Kubernetes
- Managed Orchestrator



Azure Container Instances

Simplest and easiest way to run individual containers in the cloud

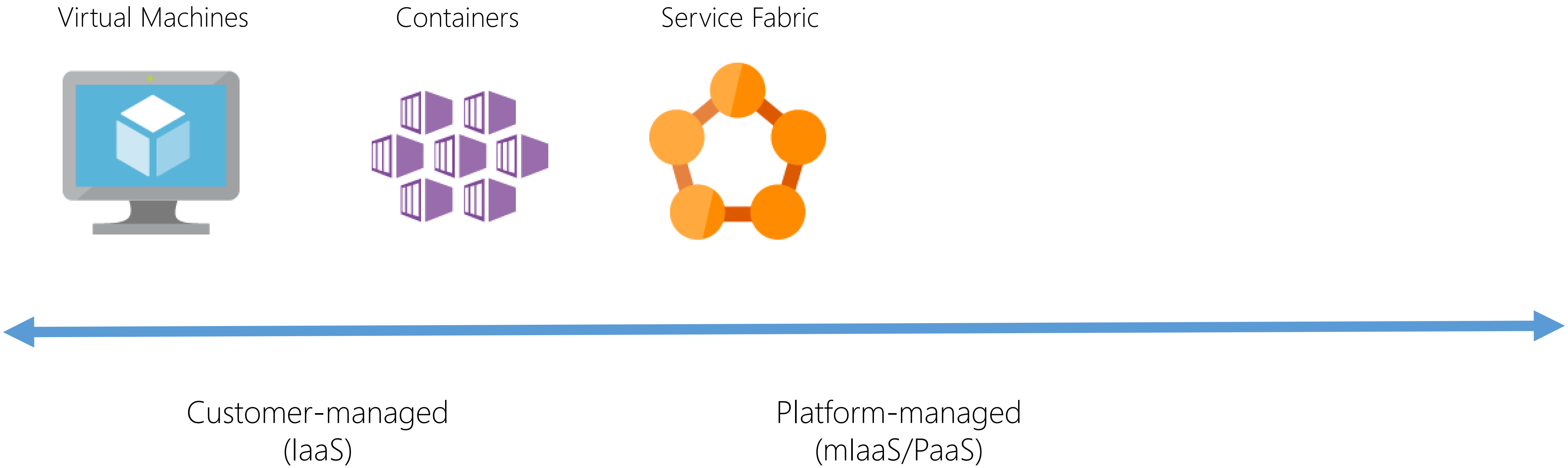
No VM management

Per-second billing with customized resource requests

Linux and Windows Server containers

Azure: The Power Of Choice

Application Hosting (today)



Virtual Machines

Containers

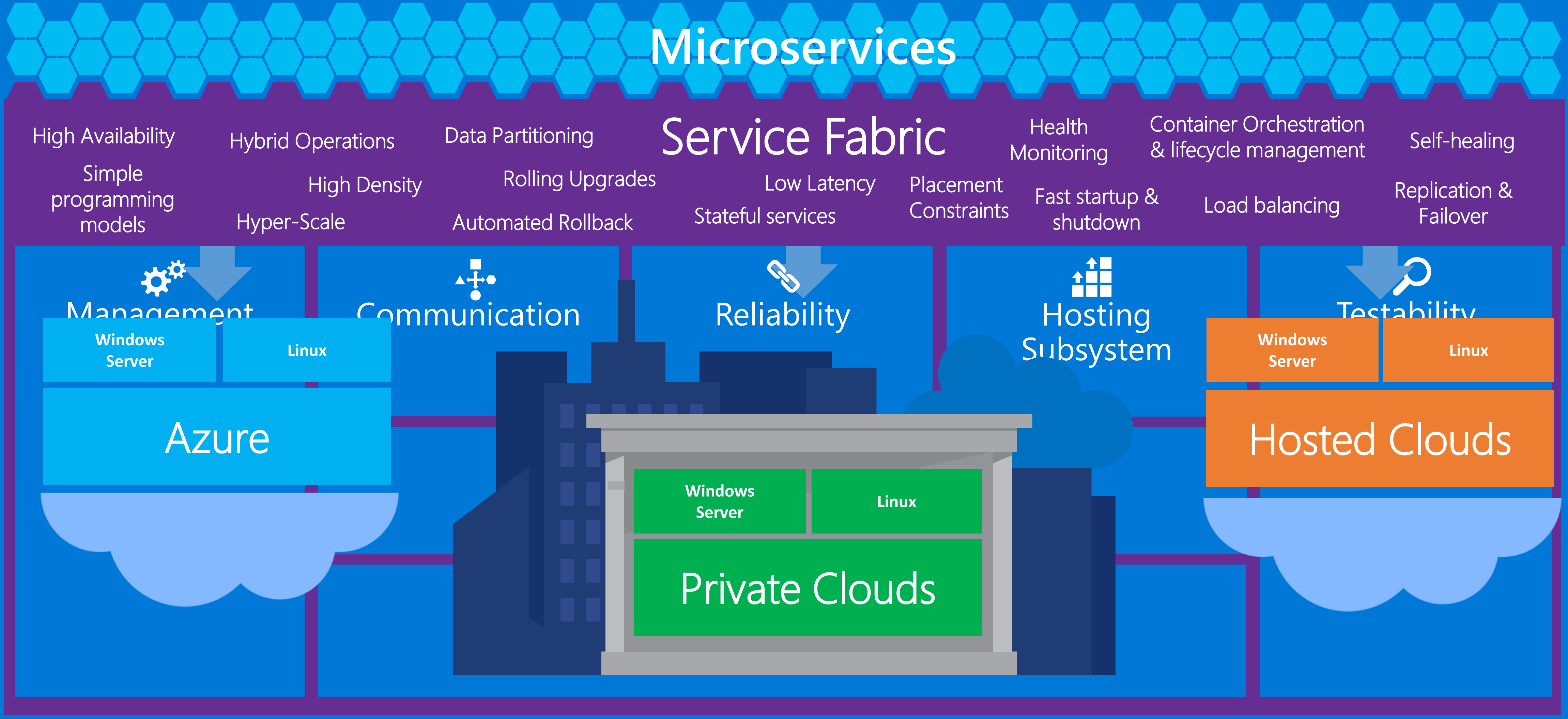
Service Fabric

Customer-managed
(IaaS)

Platform-managed
(mIaaS/PaaS)

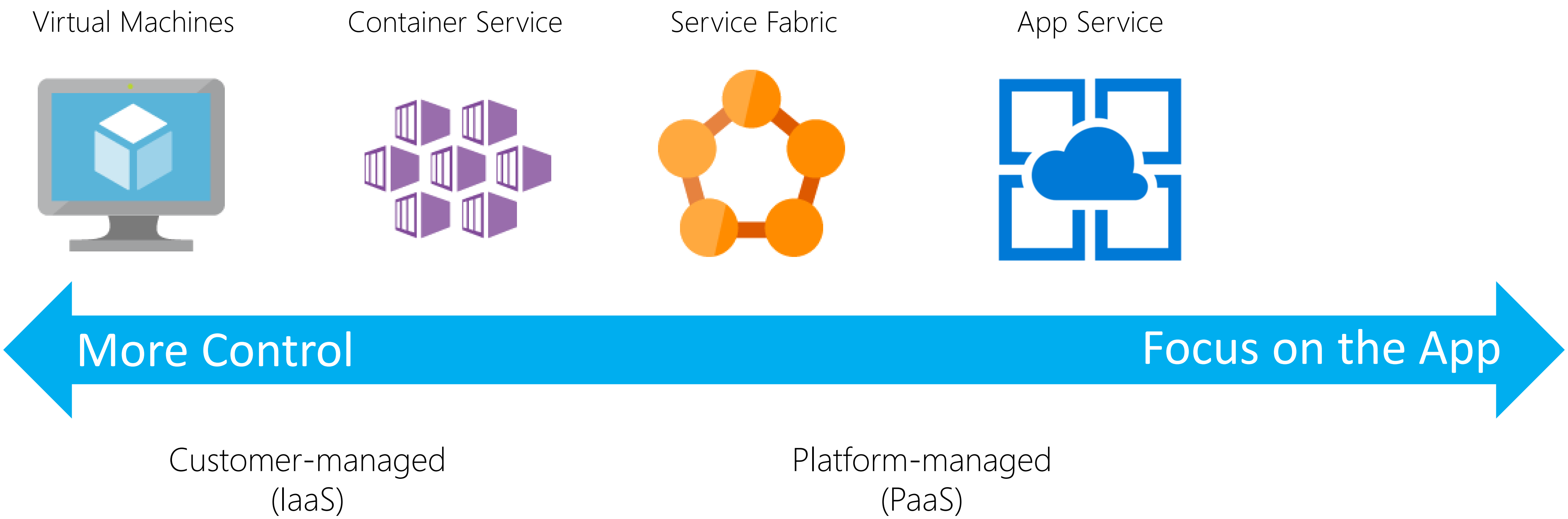
Microsoft Azure Service Fabric

A platform for reliable, hyperscale, microservice-based applications



Azure: The Power Of Choice

Compute



Virtual Machines

Container Service

Service Fabric

App Service

More Control

Focus on the App

Customer-managed
(IaaS)

Platform-managed
(PaaS)

Azure App Service

Enterprise-grade apps

Global data center footprint

Hybrid support

AAD integrated

Secure + compliant

Fully managed platform

Built-in auto scale and load balancing

High availability with auto-patching

Reduced operations costs

Backup and recovery

High productivity development

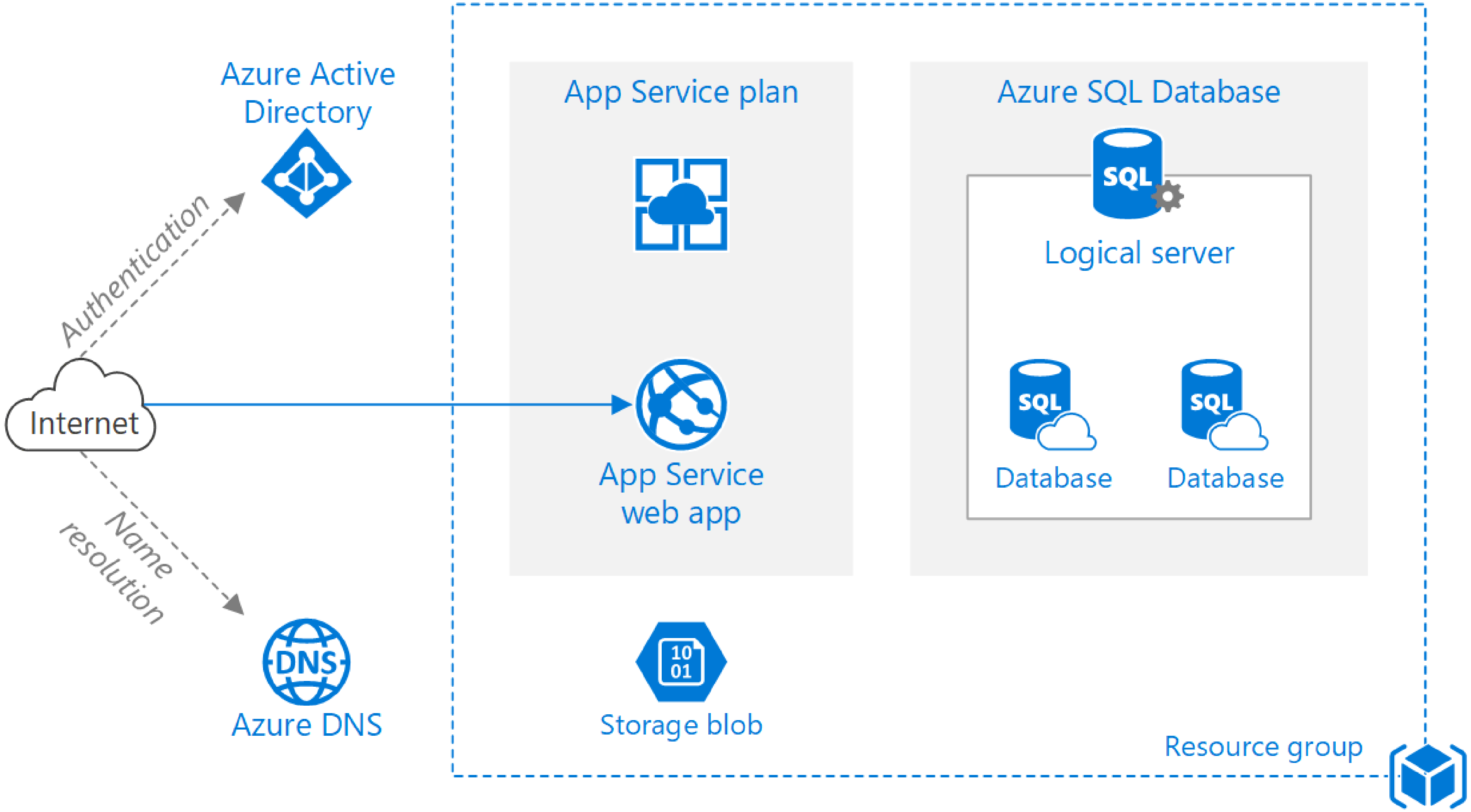
.NET, Java, PHP, Node, and Python

Staging and deployment

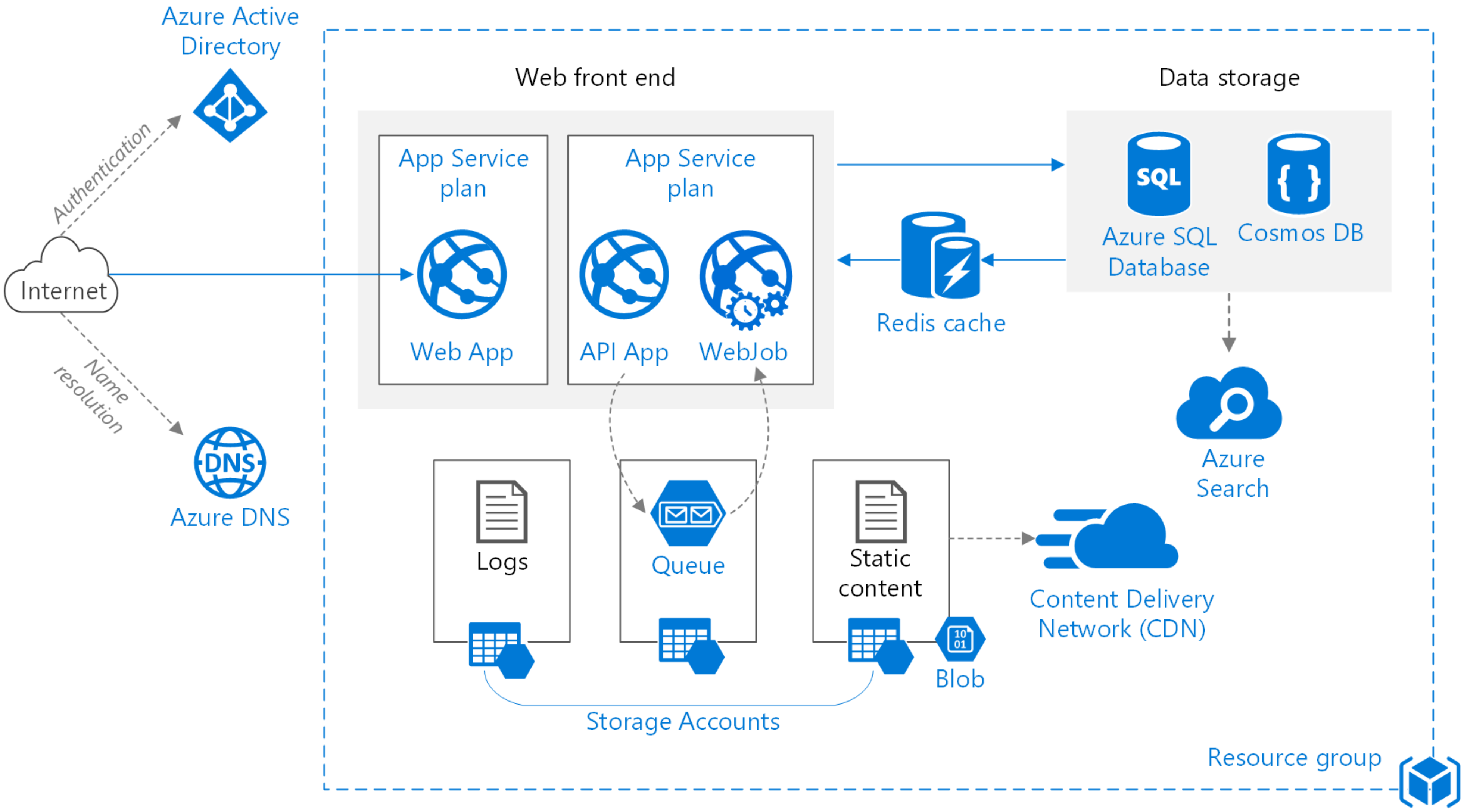
Source code control integration

App gallery marketplace

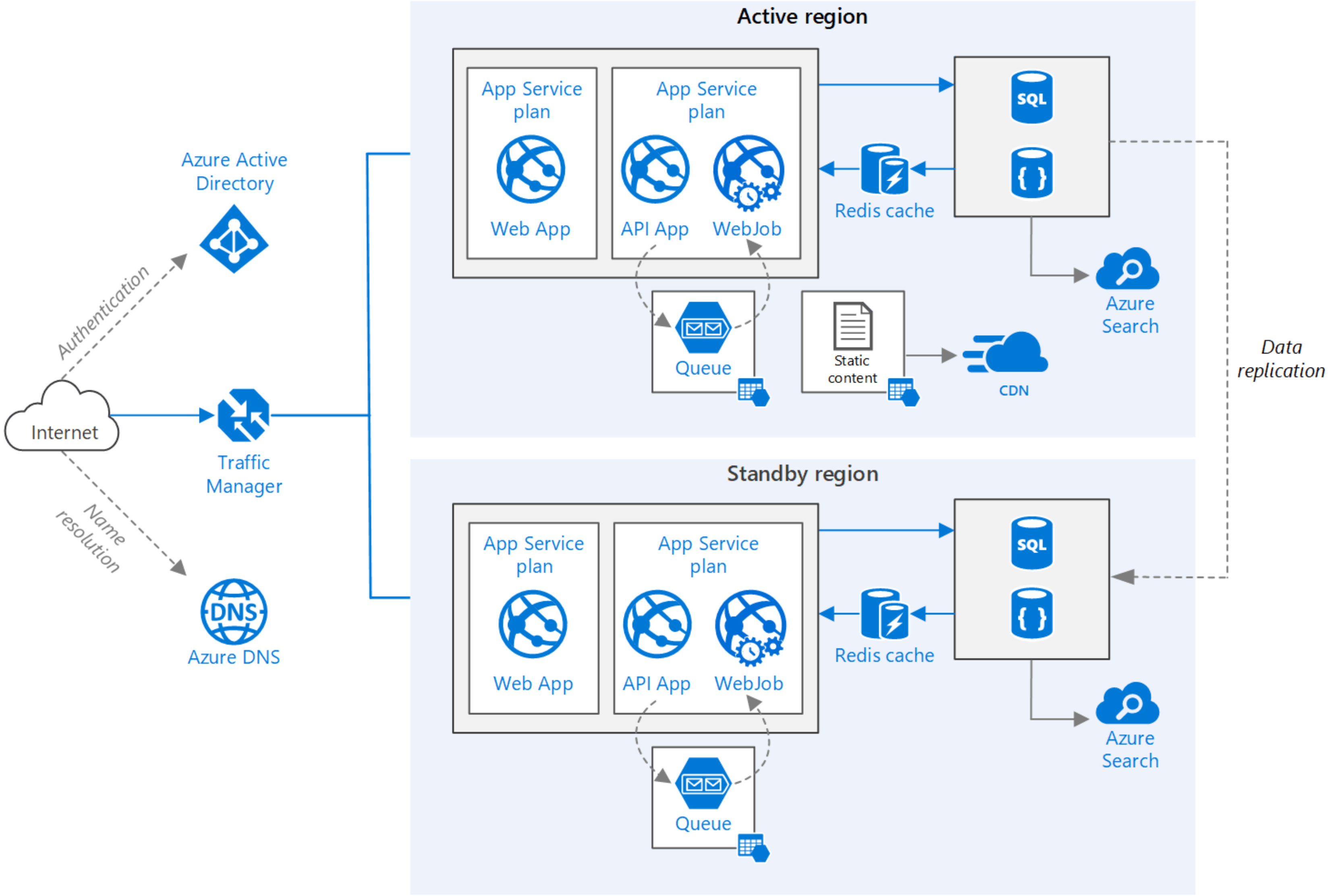
Basic


Azure Active Directory
Authentication
Internet
Name resolution
Azure DNS
App Service plan
App Service web app
Azure SQL Database
Logical server
Database
Database
Storage blob
Resource group

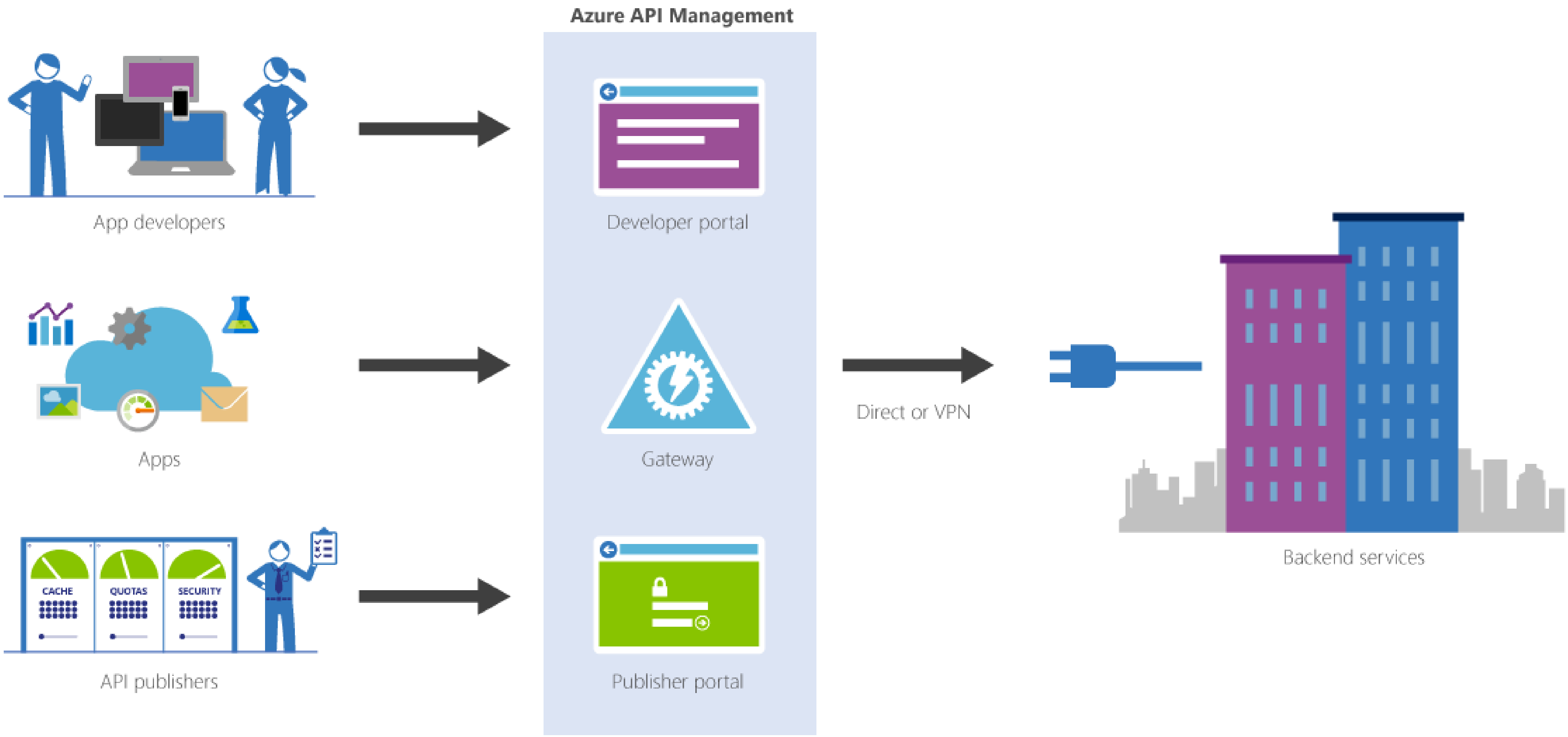
Improved Scalability



Multi-region

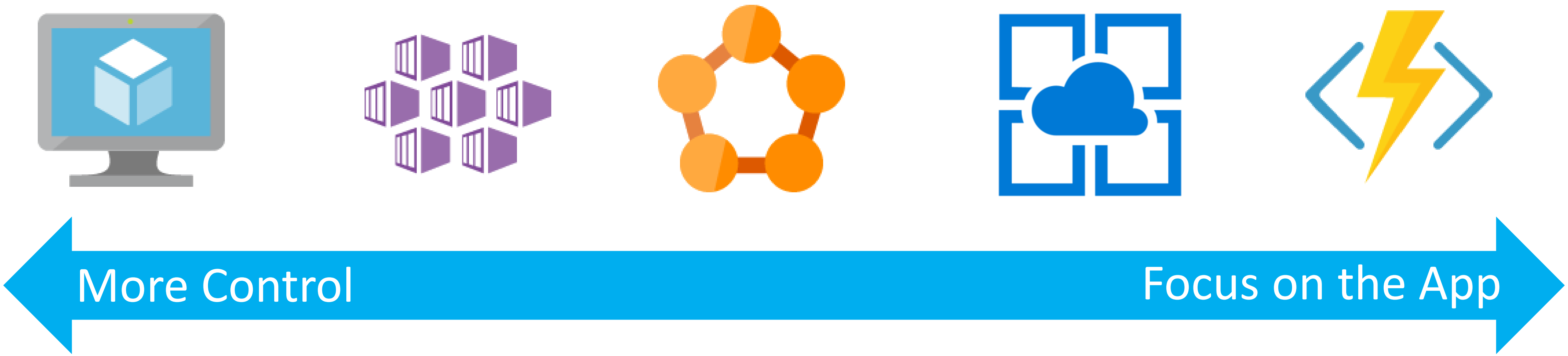


Azure API Management



Azure: The Power Of Choice

Compute



Virtual Machines

Container Service

Service Fabric

App Service

Functions

More Control

Focus on the App

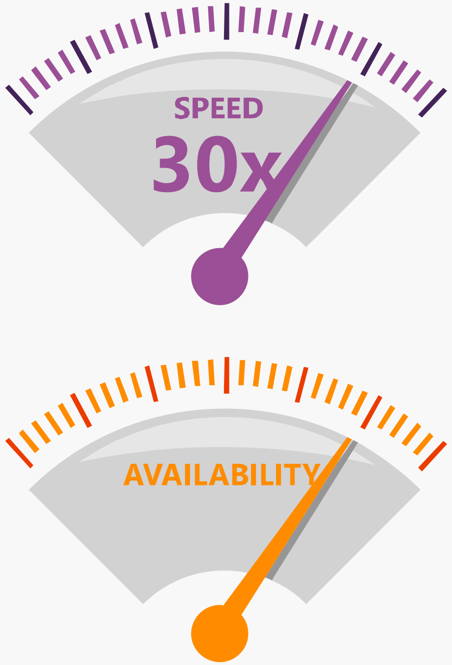
Customer-managed
(IaaS)

Platform-managed
(PaaS)

Code-only
(serverless)

What is “serverless” and proposed Benefits

Abstraction of servers

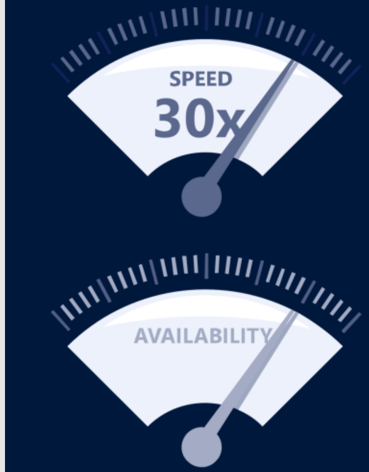


Event-driven scale

Sub-second billing

Azure Functions

Serverless



Event-driven scale

Reduced Dev Ops

Accelerate development

nodeJS

C#

Develop your way

Local development

Bind into services

Azure Service Bus

Azure Event Hub

Azure Storage

Dropbox

Sendgrid

AzureDocDb

OneDrive

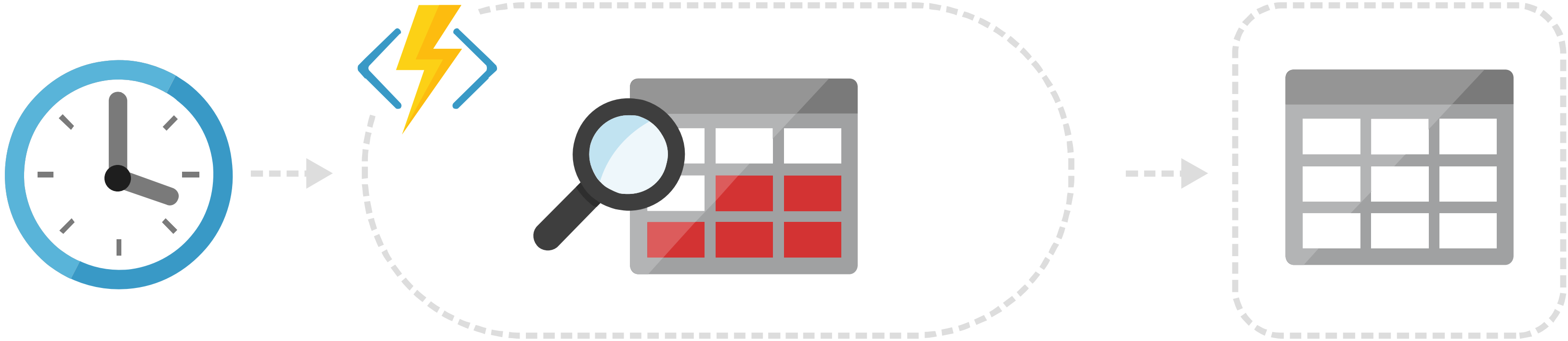
box

Box

Twilio

Applications

Example: Timer based processing



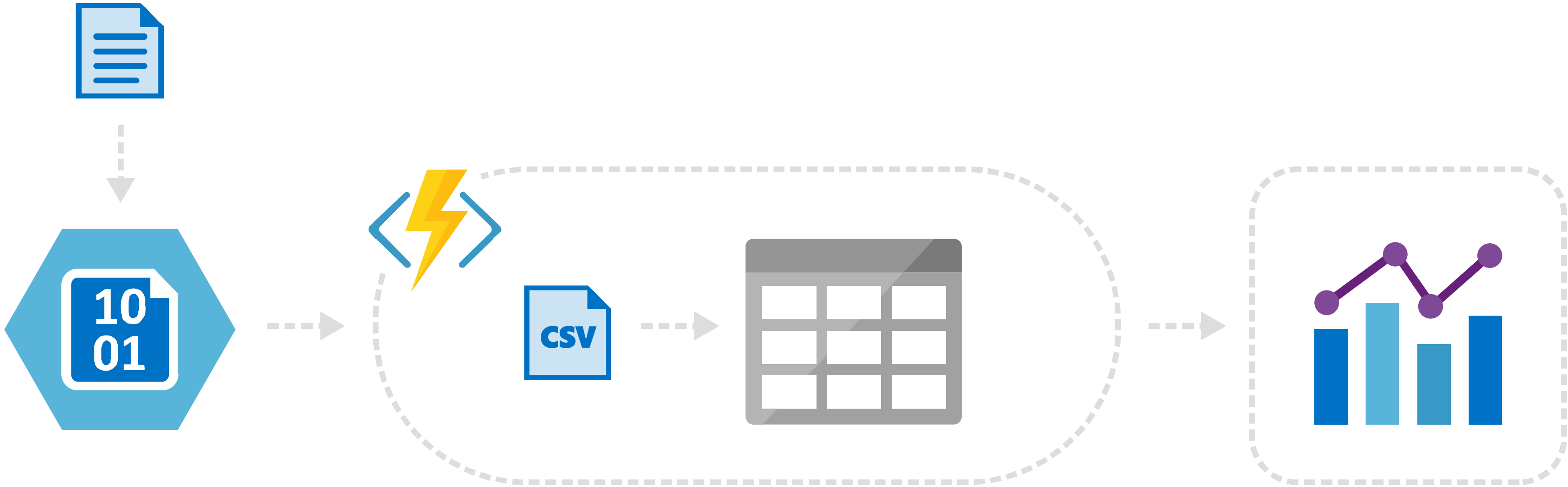
Every 15 minutes

Find and clean invalid data

Clean table

Applications

Example: Azure service event processing



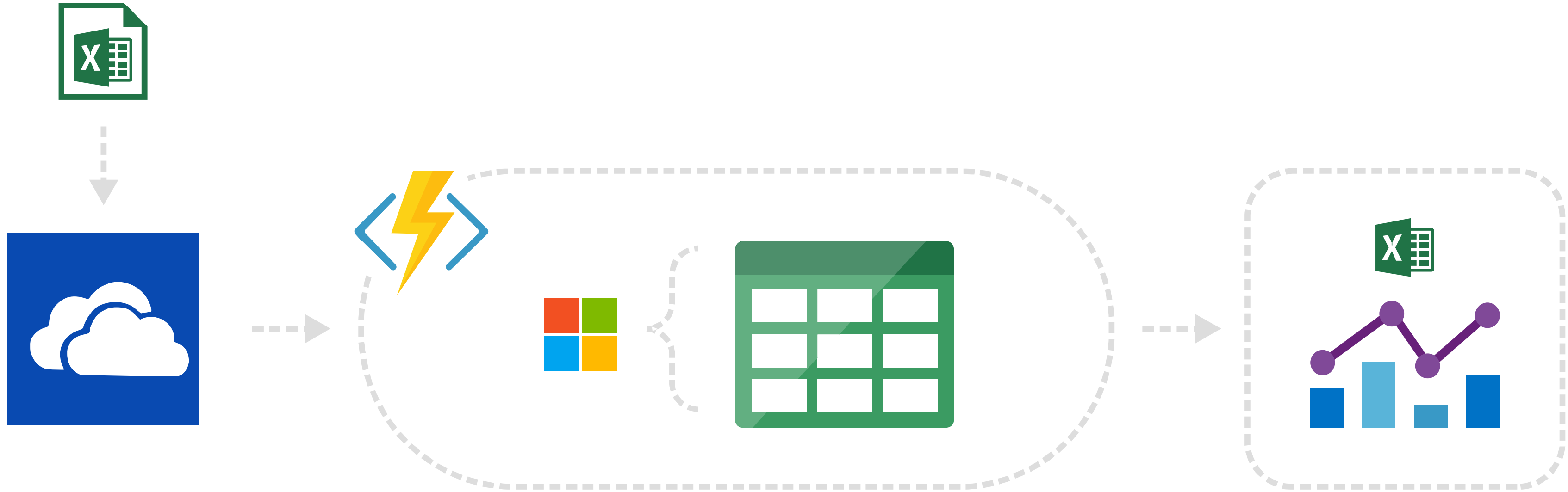
File added to
Blob Storage

Transform CSV to data rows

Power BI
Chart graphic

Applications

Example: SaaS event processing



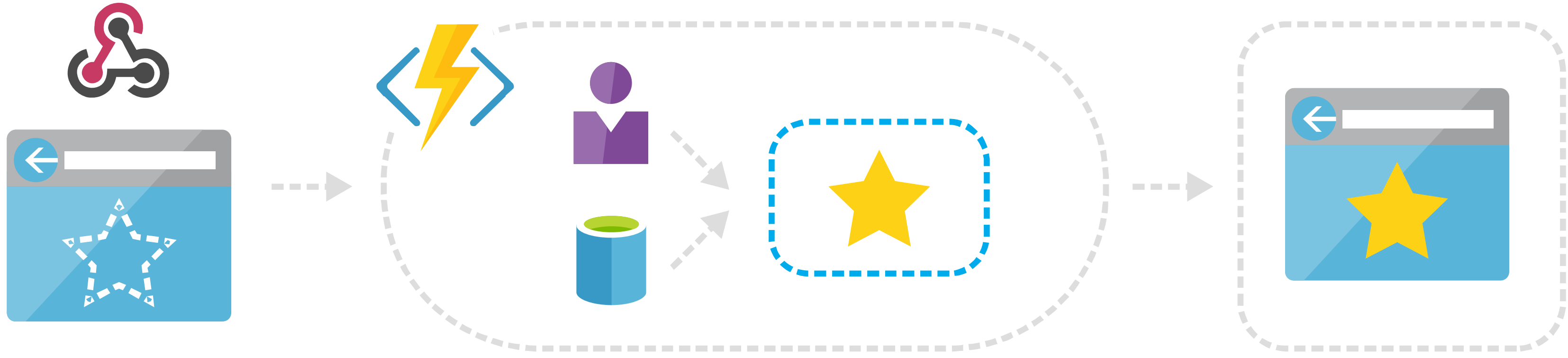
Excel file saved to OneDrive

Microsoft Graph API analyzes content

Creates new sheets with charts

Applications

Example: Serverless Web Applications architectures



Loaded web page
calls WebHook

Create ad based on user p rofile

Completed page

Async background processing

Example: Serverless Mobile back ends

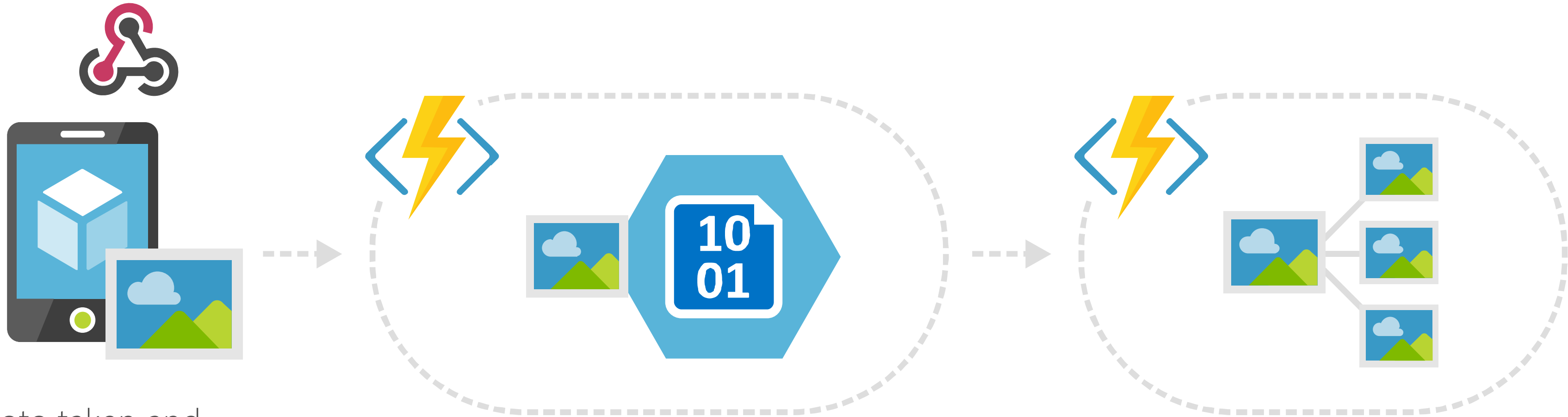


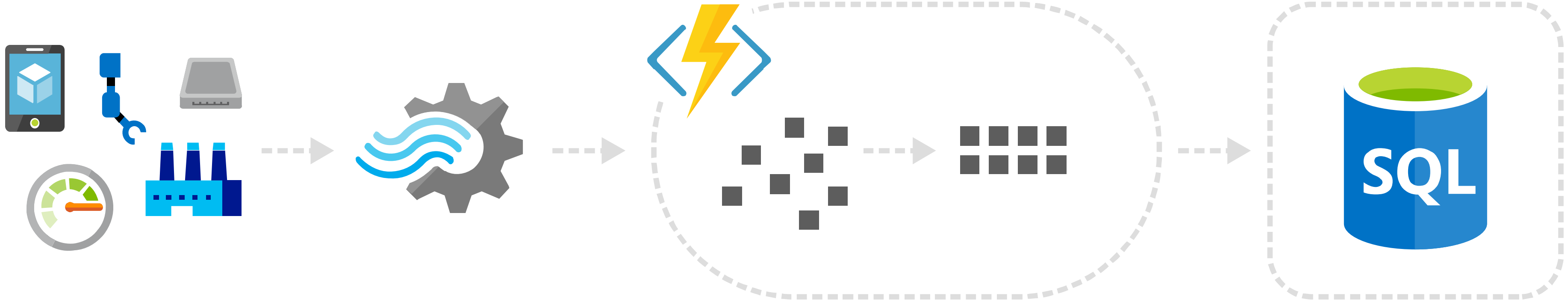
Photo taken and
WebHook called

Stores in blob storage

Produces scaled images

Applications

Example: Real-time stream processing



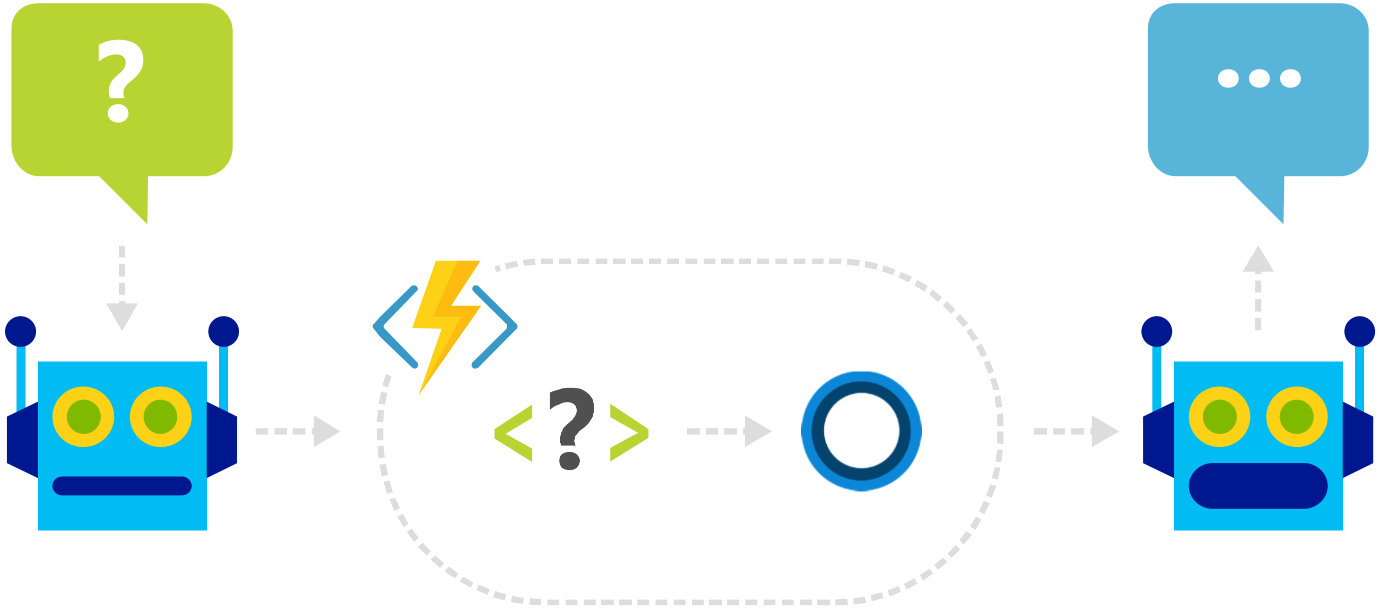
Millions of devices feed
into Stream Analytics

Transform to structured data

Store data in
SQL Online

Applications

Example: Real-time bot messaging



Message sent to Chatbot

Cortana Analytics answe rs questions

Chatbot sends response

Azure: The Power Of Choice

Compute

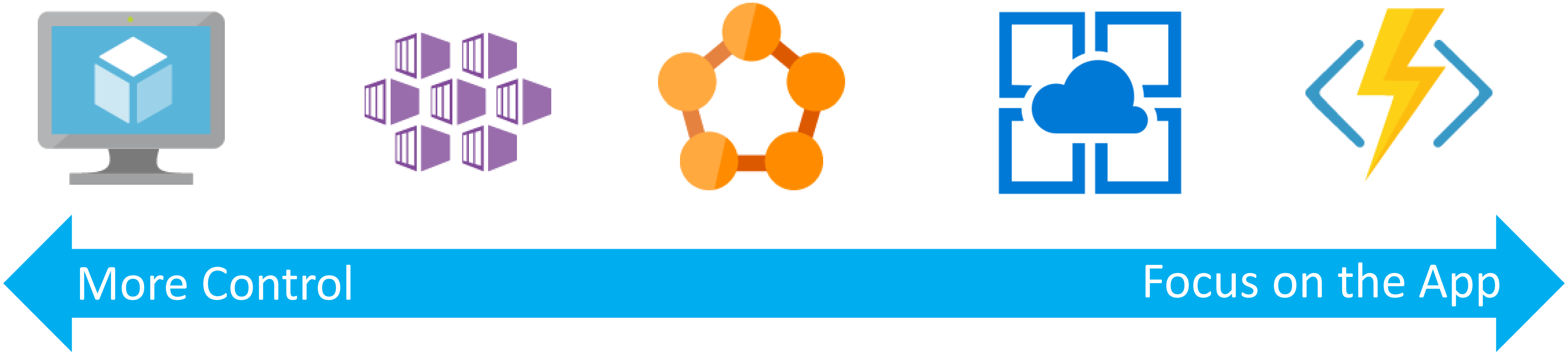
Virtual Machines

Container Service

Service Fabric

App Service

Functions



More Control

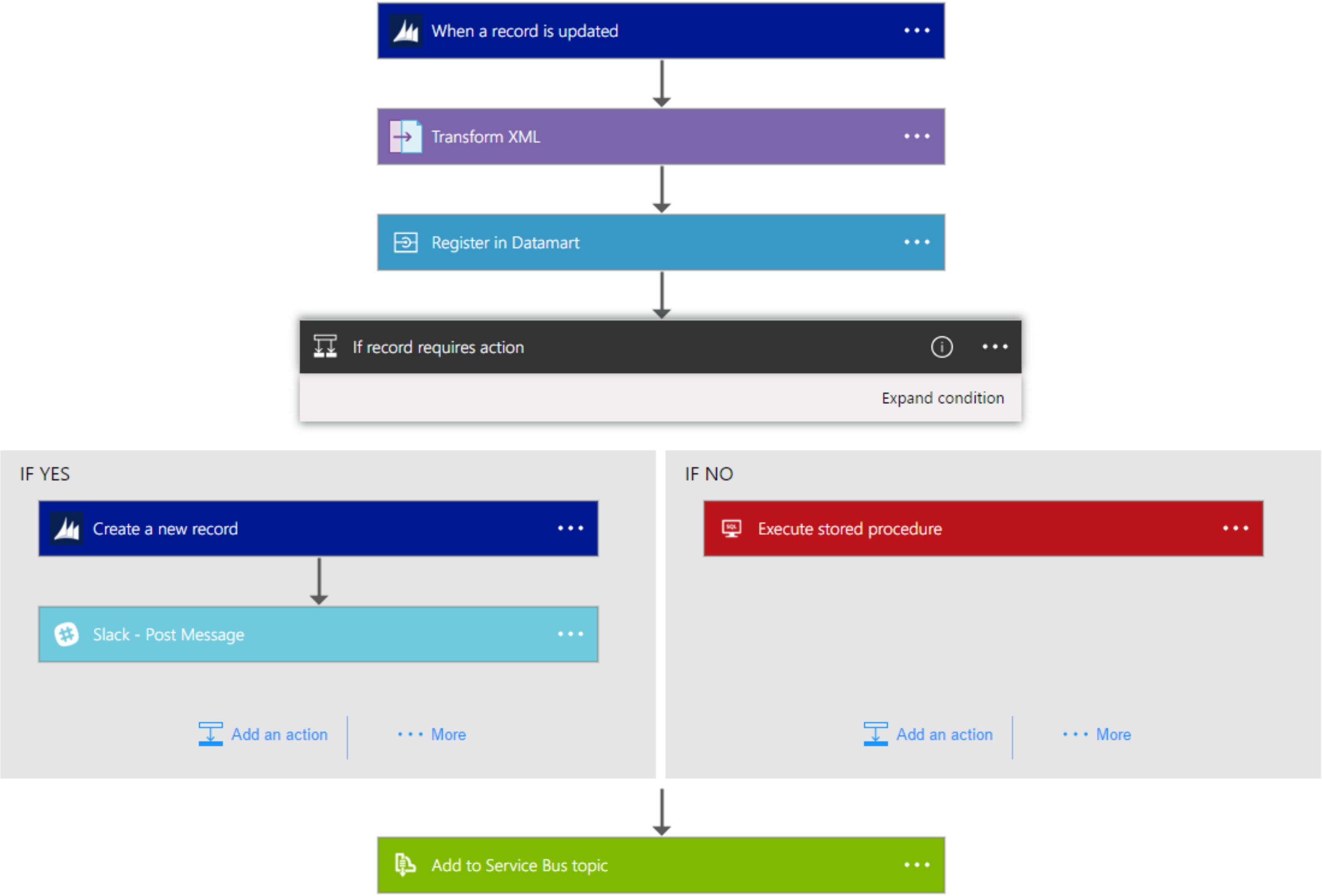
Focus on the App

Customer-managed
(IaaS)

Platform-managed
(PaaS)

Code-only
(serverless)

Azure Logic Apps



Summarizing the options

Service	Best used for…
VMs	Lift-and-shift for a set of “pets”
VM Scale Sets	Scaling and managing a set of identical VMs
Batch	Highly parallelized computation
Container Service	Deploying and managing a set of arbitrary Linux containers
Container Instances	Running individual containers with low overhead and no VM management
Service Fabric	Building microservice-based applications on Windows using .NET
App Service	Building standard web and mobile apps with limited management responsibilities
Functions	Building small, event-driven software with granular auto-scale

Design for Compute