

# Compute Infrastructure



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# Design Compute Infrastructure (20-25%)

- 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 Platform

<http://azureplatform.azurewebsites.net/>






## Compute

 Virtual Machines	 Virtual Machine Scale Sets
 Azure Container Service	 Azure Container Registry
 Functions	 Batch
 Service Fabric	 Cloud Services








## Networking

 Virtual Network	 Load Balancer
 Application Gateway	 VPN Gateway
 Azure DNS	 Traffic Manager
 ExpressRoute	 Network Watcher







## Storage

 Storage: Blobs, Tables, Queues, Files, Disks	 Data Lake Store
 StorSimple	 Azure Backup
 Site Recovery	








## Web & Mobile

 Web Apps	 Mobile Apps
 Logic Apps	 API Apps
 Content Delivery Network	 Media Services
 Search	








## Databases

 SQL Database	 SQL Data Warehouse
 SQL Server Stretch Database	 DocumentDB
 Redis Cache	 Data Factory




## Intelligence & Analytics

 HDInsight	 Machine Learning
 Cognitive Services	 Azure Bot Service*
 Data Lake Analytics	 Power BI Embedded
 Azure Analysis Services	








## Internet of Things & Enterprise Integration

 Azure IoT Hub	 Event Hubs
 Stream Analytics	 Notification Hubs
 BizTalk Services	 Service Bus
 Data Catalog	








## Security + Identity

 Security Center	 Key Vault
 Azure Active Directory	 B2C
 Domain Services	 Multi-Factor Authentication

## Developer Services

 Visual Studio Team Services	 Azure DevTest Labs
 VS Application Insights	 API Management
 HockeyApp	 Developer Tools
 Service Profiler*	

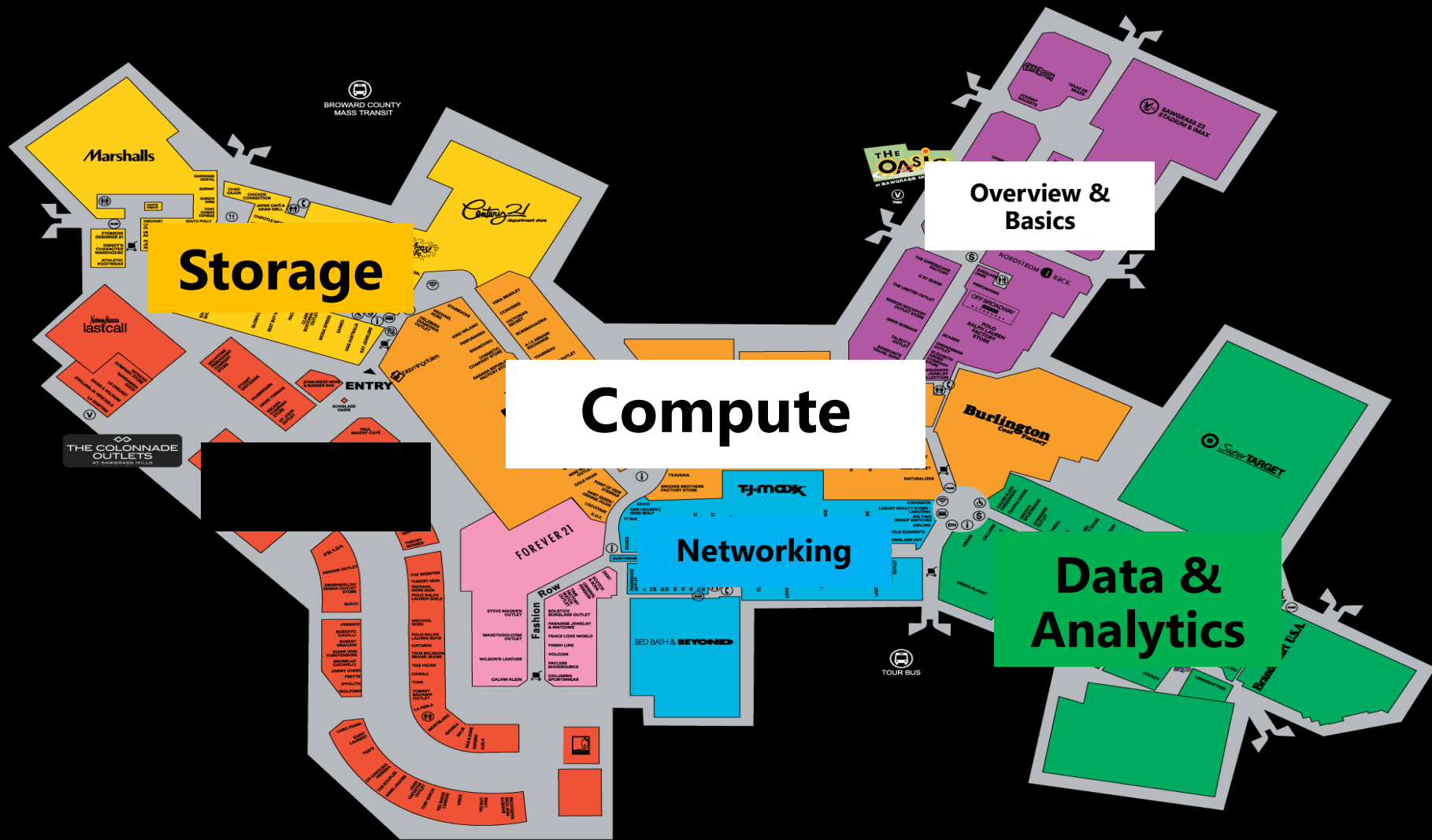
## Monitoring & Management

 Azure Portal	 Azure Resource Manager	 Azure Advisor	 Azure Monitor	 Log Analytics	 Automation	 Scheduler
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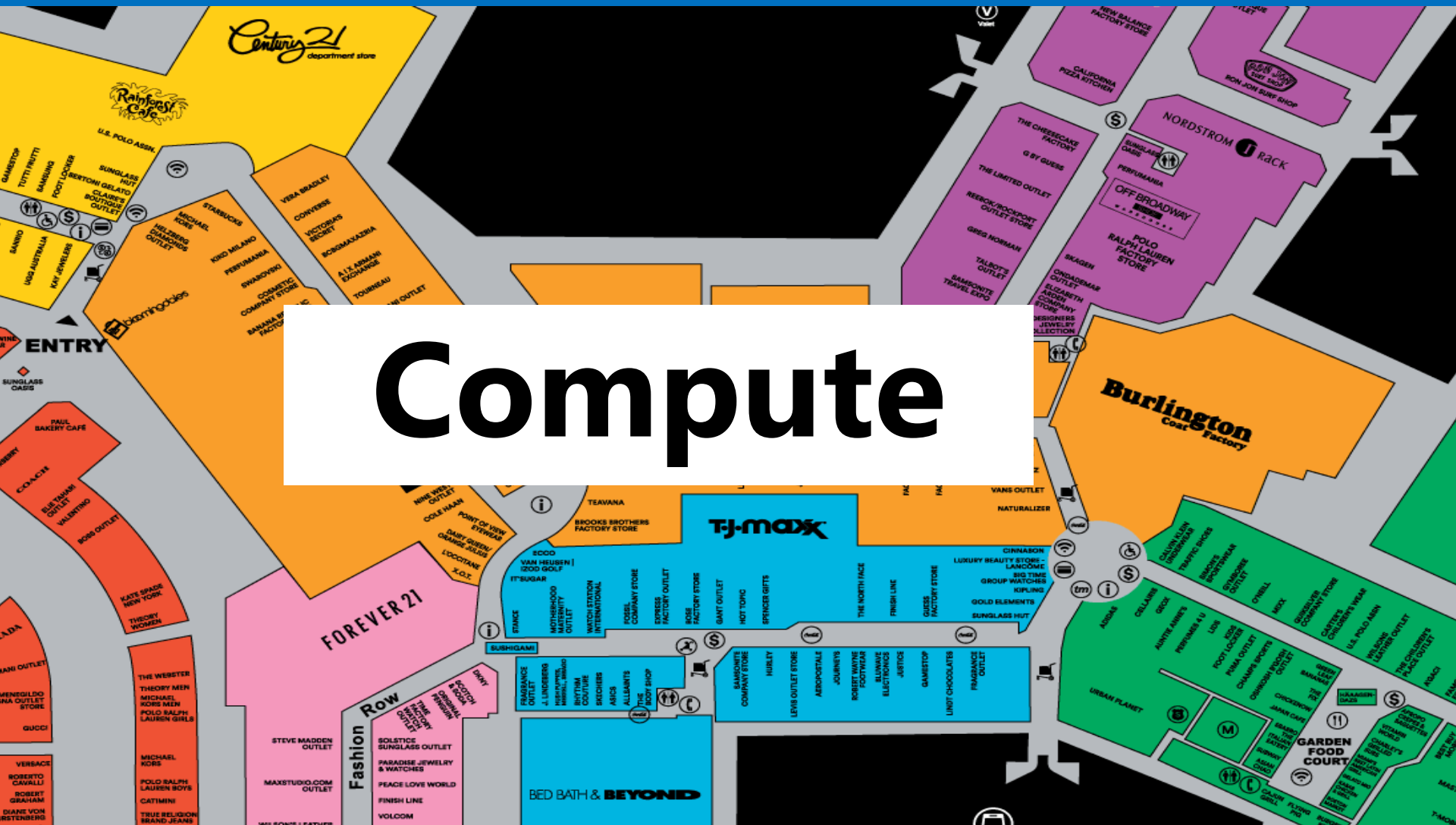
\* Preview Services

# The Mall





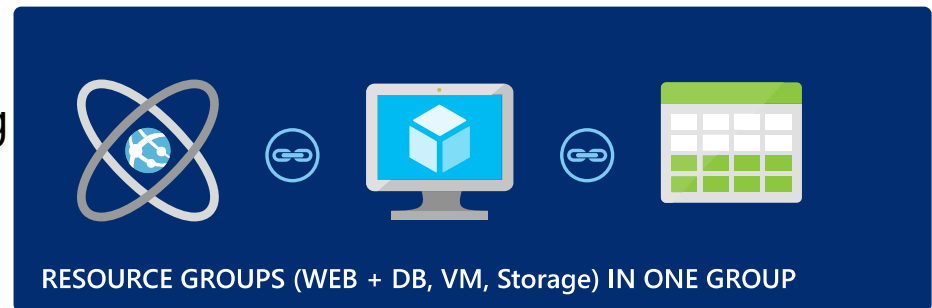
# An area within the mall



# Azure Resource Manager (ARM)

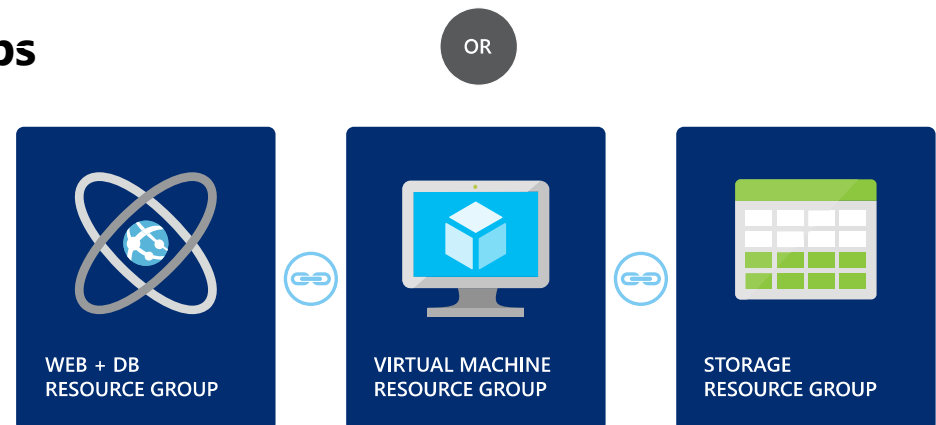
All services offered as **ARM resources**

- Consistent model for creating/managing Azure resources
- Based on declarative templates



Resources are managed in **resource groups**

- Deployed together
- Managed together
- Provides RBAC support



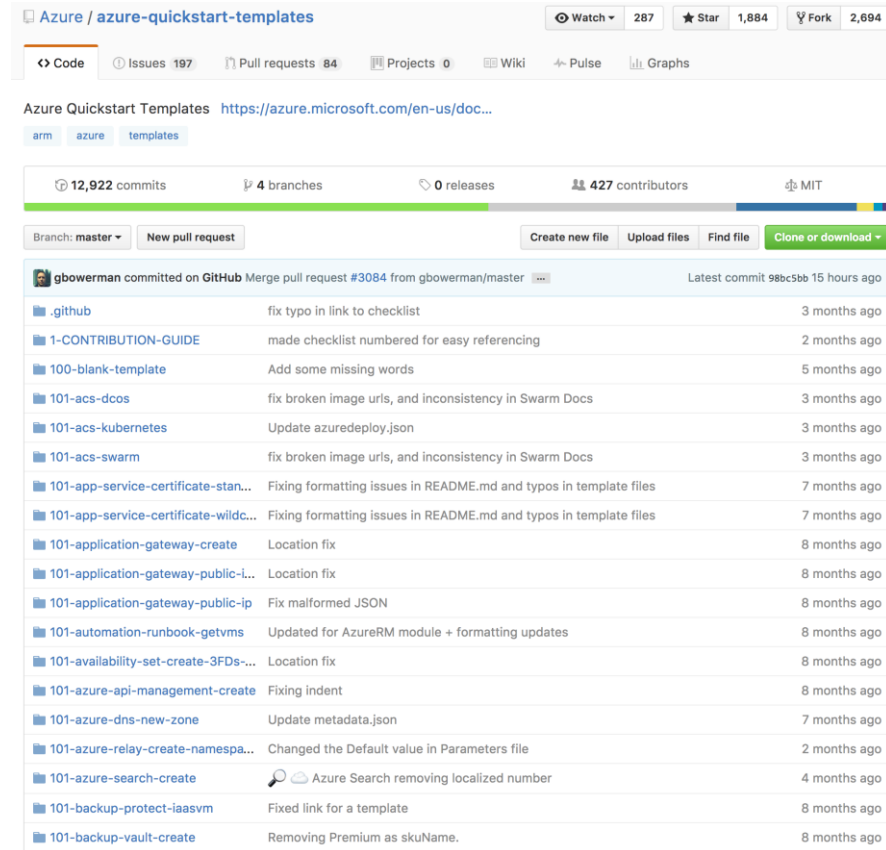
# Azure Resource Manager Terminology

- Resource
  - A manageable unit of Azure infrastructure
  - Examples: virtual machine, load balancer, storage account
- Resource provider
  - A service that allows for creation and management of resources
  - Examples: Compute Resource Provider, Storage Resource Provider
- Resource manager template
  - A declarative template for describing a resource group



# Reusable ARM templates

- A declarative template for describing a resource group
- Community offered or Build your own
- Learn about template here:  
<https://azure.microsoft.com/en-us/resources/templates/>



The screenshot shows the GitHub repository for 'Azure / azure-quickstart-templates'. The repository has 287 watches, 1,884 stars, and 2,694 forks. It contains 197 issues, 84 pull requests, 0 projects, and 0 wiki pages. The repository is managed by 427 contributors and has 12,922 commits, 4 branches, and 0 releases. The latest commit is by gbowerman, merged pull request #3084, 15 hours ago. The repository contains a list of templates, including .github, 1-CONTRIBUTION-GUIDE, 100-blank-template, 101-acs-dcos, 101-acs-kubernetes, 101-acs-swarm, 101-app-service-certificate-stan..., 101-app-service-certificate-wildc..., 101-application-gateway-create, 101-application-gateway-public-i..., 101-application-gateway-public-ip, 101-automation-runbook-getvms, 101-availability-set-create-3FDs..., 101-azure-api-management-create, 101-azure-dns-new-zone, 101-azure-relay-create-namespa..., 101-azure-search-create, 101-backup-protect-iaasvm, and 101-backup-vault-create.

File Name	Description	Last Commit
.github	fix typo in link to checklist	3 months ago
1-CONTRIBUTION-GUIDE	made checklist numbered for easy referencing	2 months ago
100-blank-template	Add some missing words	5 months ago
101-acs-dcos	fix broken image urls, and inconsistency in Swarm Docs	3 months ago
101-acs-kubernetes	Update azuredeploy.json	3 months ago
101-acs-swarm	fix broken image urls, and inconsistency in Swarm Docs	3 months ago
101-app-service-certificate-stan...	Fixing formatting issues in README.md and typos in template files	7 months ago
101-app-service-certificate-wildc...	Fixing formatting issues in README.md and typos in template files	7 months ago
101-application-gateway-create	Location fix	8 months ago
101-application-gateway-public-i...	Location fix	8 months ago
101-application-gateway-public-ip	Fix malformed JSON	8 months ago
101-automation-runbook-getvms	Updated for AzureRM module + formatting updates	8 months ago
101-availability-set-create-3FDs...	Location fix	8 months ago
101-azure-api-management-create	Fixing indent	8 months ago
101-azure-dns-new-zone	Update metadata.json	7 months ago
101-azure-relay-create-namespa...	Changed the Default value in Parameters file	2 months ago
101-azure-search-create	Azure Search removing localized number	4 months ago
101-backup-protect-iaasvm	Fixed link for a template	8 months ago
101-backup-vault-create	Removing Premium as skuName.	8 months ago

# 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)

# Compute



<https://aka.ms/comparecompute>

# Virtual Machines

Ubuntu, Red Hat, Windows, SUSE, CoreOS

DevOps Extensions with Chef and Puppet

Multiple sizes

Hundreds of items in marketplace





The Ultimate Driving Machine®

VEHICLES

BUILD YOUR OWN

SHOPPING TOOLS

Certified Pre-Owned

Ins

ALL SERIES

Sedans

Coupes

Convertibles

SAVs & Sports Wagons

Diesel

Hybrid

Electric

2 Series



**\$32,850** starting MSRP<sup>1</sup>

AVAILABLE IN  
Coupe, Convertible

3 Series



**\$33,150** starting MSRP<sup>1</sup>

AVAILABLE IN  
Sedan, Sports Wagon, Gran Turismo

4 Series



**\$41,650** starting MSRP<sup>1</sup>

AVAILABLE IN  
Coupe, Gran Coupe, Convertible

5 Series



**\$50,200** starting MSRP<sup>1</sup>

AVAILABLE IN  
Sedan, Gran Turismo

6 Series



**\$77,300** starting MSRP<sup>1</sup>

AVAILABLE IN  
Coupe, Gran Coupe, Convertible,  
ALPINA Gran Coupe

7 Series



**\$81,300** starting MSRP<sup>1</sup>

AVAILABLE IN  
Sedan

X Models



**\$34,800** starting MSRP<sup>1</sup>

AVAILABLE IN  
Sports Activity Vehicle, Sports  
Activity Coupe

Z4



**\$49,700** starting MSRP<sup>1</sup>

AVAILABLE IN  
Roadster

M Models



**\$63,500** starting MSRP<sup>1</sup>

AVAILABLE IN  
Sedan, Coupe, Gran Coupe,  
Convertible, Sports Activity Vehicle,  
Sports Activity Coupe

BMW i



**\$42,400** starting MSRP<sup>1</sup>

# Introducing the Latest Azure VM Line Up

# Azure VM Sizes



**Lowest Price**

**SSD Storage  
Fast CPUs**

**New generation  
of D family VMs**

**High memory and  
Large SSDs**

**New A-Series**



**Compute  
Intensive**

**NVIDIA GPUs  
K80 Compute**

**NVIDIA GPUs  
M60 Visualization**

**Fastest CPU  
IB Connectivity**

**Large SSDs**

**SAP Large  
Instances**



**Deep Learning** **New gen of N** **New generation of** **High mem**  
**NVIDIA P40s** **NVIDIA P100s** **D family**

# VM Sizes

Type	Sizes	Description
<a href="#">General purpose</a>	B (Preview), 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.
<a href="#">Compute optimized</a>	Fs, F	High CPU-to-memory ratio. Good for medium traffic web servers, network appliances, batch processes, and application servers.
<a href="#">Memory optimized</a>	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.
<a href="#">Storage optimized</a>	Ls	High disk throughput and IO. Ideal for Big Data, SQL, and NoSQL databases.
<a href="#">GPU</a>	NV, NC	Specialized virtual machines targeted for heavy graphic rendering and video editing. Available with single or multiple GPUs.
<a href="#">High performance compute</a>	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
<a href="#">A0</a>	50
<a href="#">A1-A4</a>	100
<a href="#">A5-A7</a>	100
<a href="#">A1_v2-A8_v2</a>	100
<a href="#">A2m_v2-A8m_v2</a>	100
<a href="#">A8-A11</a>	225*
<a href="#">D1-D14</a>	160
<a href="#">D1_v2-D15_v2</a>	210 - 250*
<a href="#">DS1-DS14</a>	160
<a href="#">DS1_v2-DS15_v2</a>	210-250*
<a href="#">D_v3</a>	160-190* **
<a href="#">Ds_v3</a>	160-190* **
<a href="#">E_v3</a>	160-190* **
<a href="#">Es_v3</a>	160-190* **
<a href="#">F1-F16</a>	210-250*
<a href="#">F1s-F16s</a>	210-250*
<a href="#">G1-G5</a>	180 - 240*
<a href="#">GS1-GS5</a>	180 - 240*
<a href="#">H</a>	290 - 300*
<a href="#">L4s-L32s</a>	180 - 240*
<a href="#">M</a>	160-180**

[illegible]

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sciencenotes.org

1 IA 1A	2 IIA 2A																	18 VIIIA 8A
1 H Hydrogen 1.008																		2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012																	
11 Na Sodium 22.990	12 Mg Magnesium 24.305																	
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996													
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94													
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84													
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]													
		57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967		
		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]		
		Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide							

## Periodic Table of the Elements

1  
St  
Storage

# 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: 4095GB

# Premium vs Standard (SSD vs HDD) Comparision

	Azure Premium Disk	Azure Standard Disk
<b>Disk Type</b>	Solid State Drives (SSD)	Hard Disk Drives (HDD)
<b>Overview</b>	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
<b>Scenario</b>	Production and performance sensitive workloads	Dev/Test, non-critical, Infrequent access
<b>Disk Size</b>	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
<b>Max Throughput per Disk</b>	250 MB/s	60 MB/s
<b>Max IOPS per Disk</b>	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**

**I DO NOT  
THINK  
THAT  
WORD  
MEANS  
WHAT YOU  
THINK IT  
MEANS**

# 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 & Recovery Point Objective



# Defining Disaster Recovery

- Disaster recovery is being able to recover your application into another Azure datacenter
- Keywords:
  - RTO: Recovery Time Objective
  - RPO: Recovery Point Objective
- Options range from:
  - Complete active/active deployment in multiple datacenters
  - Active/Passive deployment in multiple datacenters
  - Active deployment in one datacenter, with backups stored in 2<sup>nd</sup> datacenter

# Understanding Azure VM Availability

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

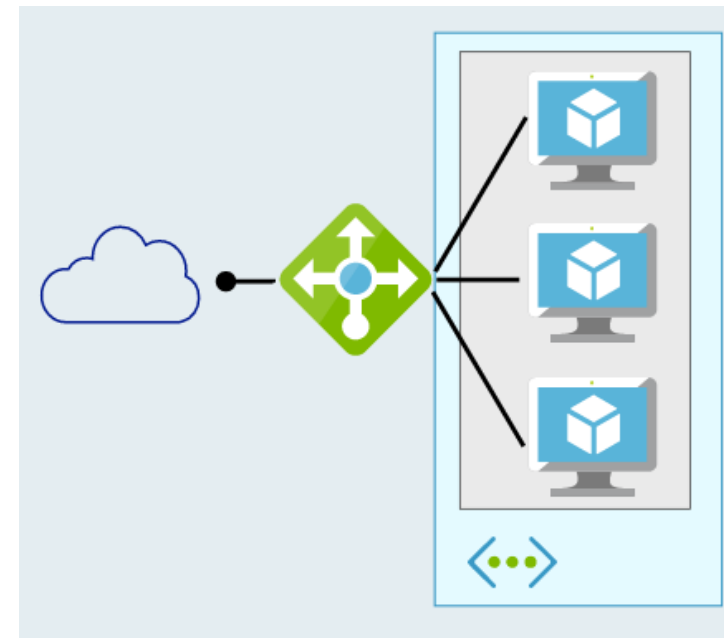
# Understanding Azure VM Availability

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

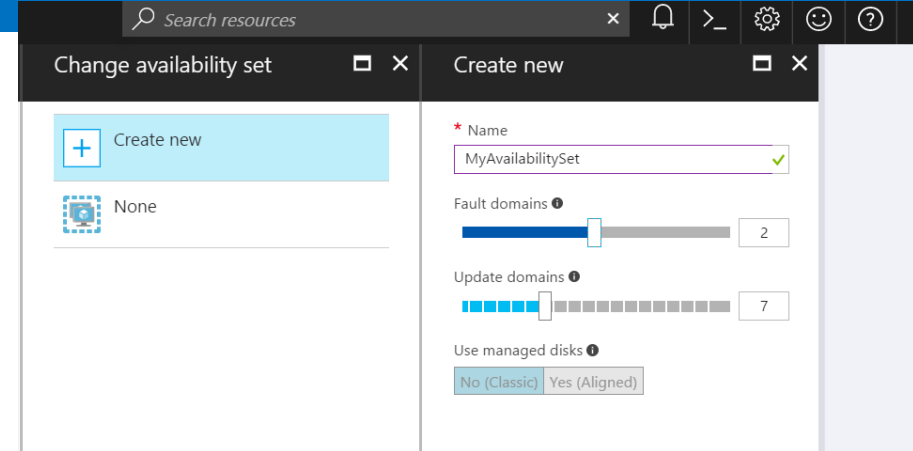
# Defining High Availability

- Multiple VMs can be configured in an “availability set”
- 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)

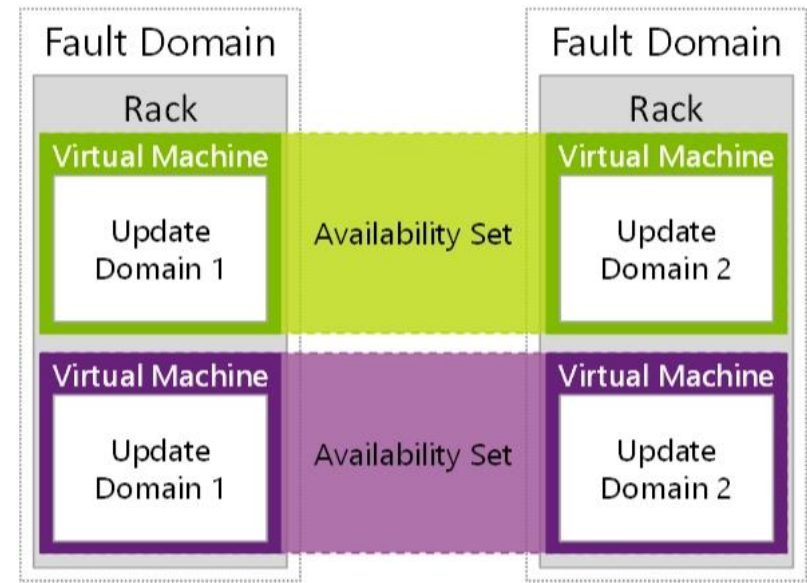


# Availability Sets

- Availability Sets are for Unplanned & Planned Maintenance
  - Fault Domains (2 default, some regions allow 3)
  - Upgrade Domains (5 default, 1-20 allowed)
- Front with Load Balancer, App Gateway



The screenshot shows the 'Create new' availability set page in the Azure portal. The left sidebar has a 'Create new' button and a 'None' option. The main area shows the configuration for a new availability set named 'MyAvailabilitySet'. The 'Fault domains' slider is set to 2, and the 'Update domains' slider is set to 7. The 'Use managed disks' option is set to 'Yes (Aligned)'.

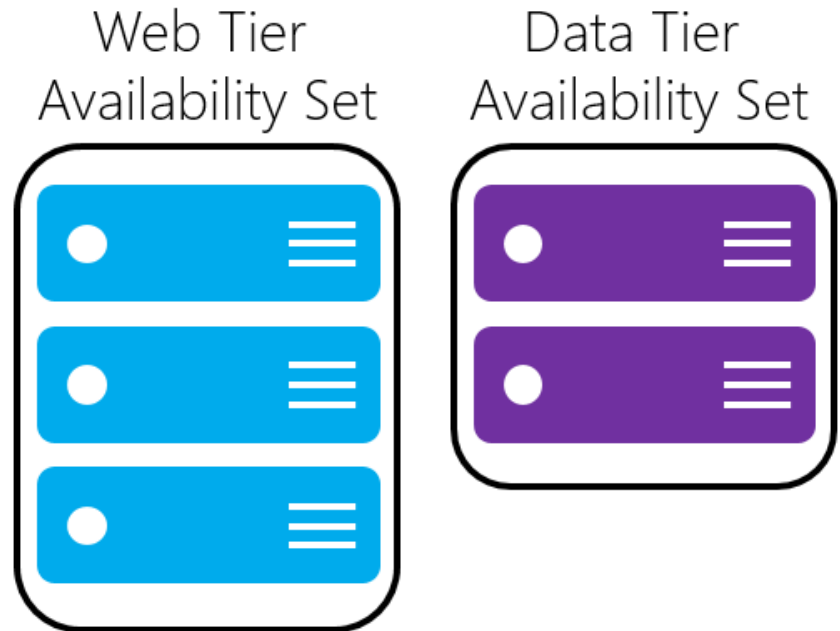


# Availability Sets

- Do NOT put a single VM in an Availability Set
- Example - for an application,
  - Place front-end virtual machines in the same availability set

AND

- Data-tier virtual machines in their own availability set



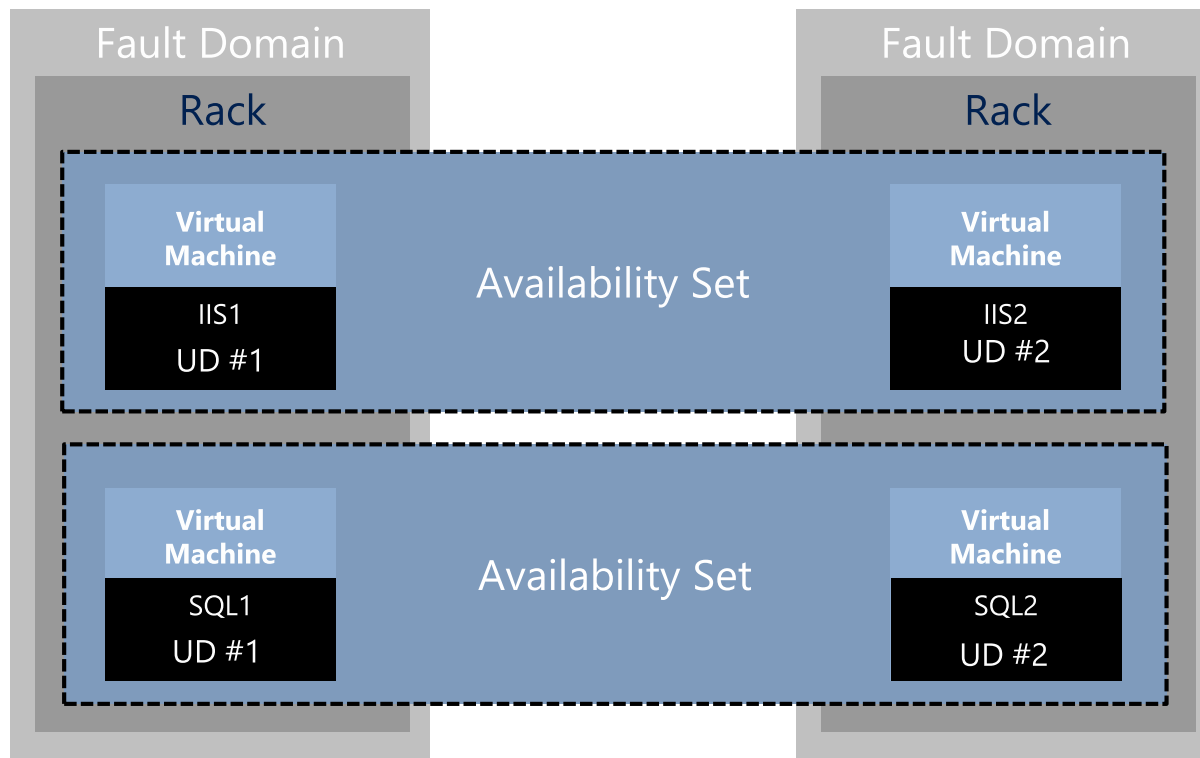
# Availability Sets: How Do We Do It?

## Fault and Update Domains

- Fault Domains
  - Represent groups of resources anticipated to fail together
  - i.e. Same rack, same server
  - Fabric spreads instances across fault at least 2 fault domains when two or more virtual machines are placed in an availability set
- Update Domains
  - Represents groups of resources that will be updated together
  - Host OS updates honor service update domains
  - Specified in service definition
  - Default of 5 (up to 20)
- Azure spreads role instances across Update Domains and Fault Domains

# Virtual Machine Availability Sets

Update Domains are honored by host OS updates





# VM Scale Sets

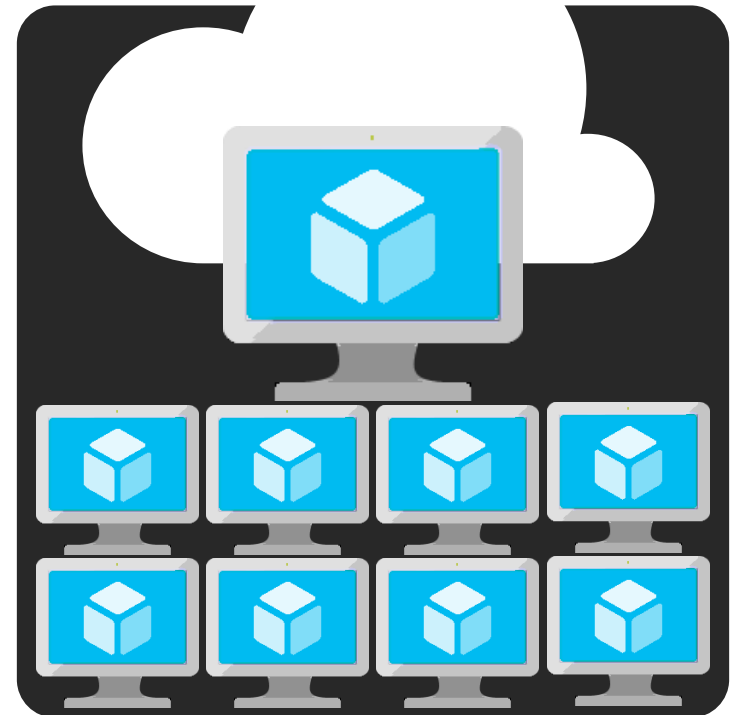
High performance provisioning of 1000+ VMs

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 (MDM pipeline) or diagnostic extensions
- Small buy-in: Deploy/manage sets of 0->100 identically configured VMs
- **Guest OS patching**: Patching primitives allow manually triggered rolling upgrades
- **High-availability** – implicit availability set with 5 FDs/5 UDIs

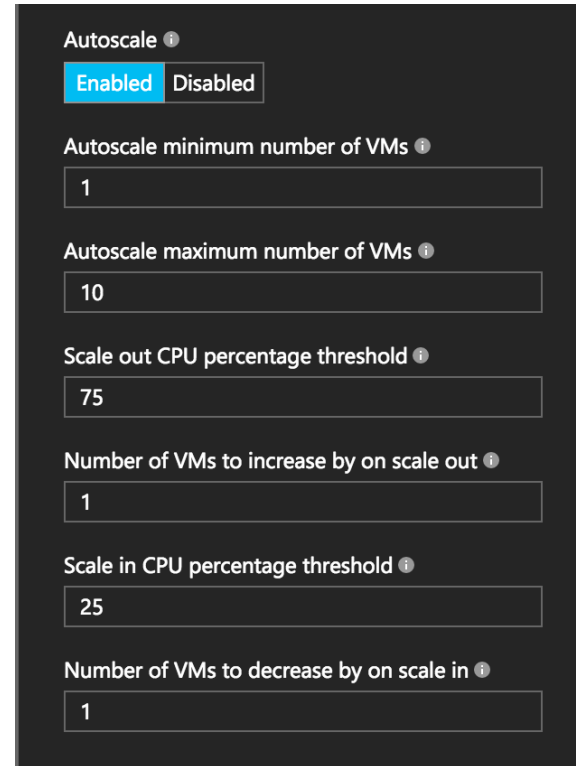
## Availability Sets vs Scale Sets

- Avail Set: Multiple different VMs (image, size, etc); managed separately
- Scale Set: Large count of the same VMs; managed together
- Scale set: Reliable rapid provisioning and scale utilizing similarity of the VMs

```
244 {
245   "type": "Microsoft.Compute/virtualMachineScaleSets",
246   "name": "[parameters('vmssName')]",
247   "location": "[parameters('resourceLocation')]",
248   "apiVersion": "[variables('computeApiVersion')]",
249   "dependsOn": [
250     "storageLoop",
251     "[concat('Microsoft.Network/loadBalancers/', variables('loadBalancerName'))]",
252     "[concat('Microsoft.Network/virtualNetworks/', variables('virtualNetworkName'))]"
253   ],
254   "sku": {
255     "name": "[parameters('vmSku')]",
256     "tier": "Standard",
257     "capacity": "[parameters('instanceCount')]"
258   },
259   "properties": {
260     "overprovision": "true",
261     "upgradePolicy": {
262       "mode": "Manual"
263     },
264     "virtualMachineProfile": {
265       "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)



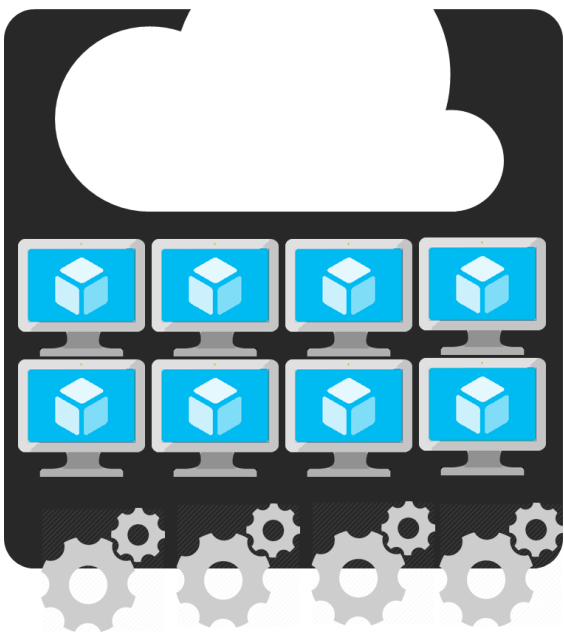
The image shows a screenshot of the 'Autoscale' configuration panel for a VM Scale Set in the Azure portal. The panel has a dark background. At the top, it says 'Autoscale' with an information icon. Below this are two buttons: 'Enabled' (highlighted in blue) and 'Disabled'. The configuration includes several input fields, each with a label and an information icon:

- 'Autoscale minimum number of VMs' with a value of '1'.
- 'Autoscale maximum number of VMs' with a value of '10'.
- 'Scale out CPU percentage threshold' with a value of '75'.
- 'Number of VMs to increase by on scale out' with a value of '1'.
- 'Scale in CPU percentage threshold' with a value of '25'.
- 'Number of VMs to decrease by on scale in' with a value of '1'.

# VM scale set app deployment models

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

# 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

# Design microservices-based solutions

# Azure: The Power Of Choice

## Application Hosting (today)

Virtual Machines



Containers



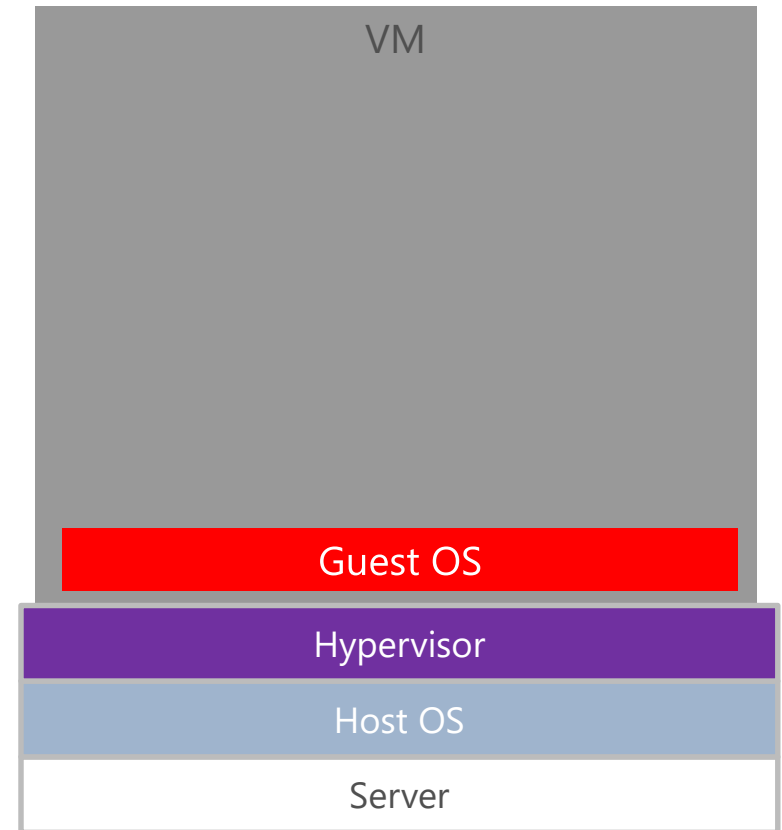
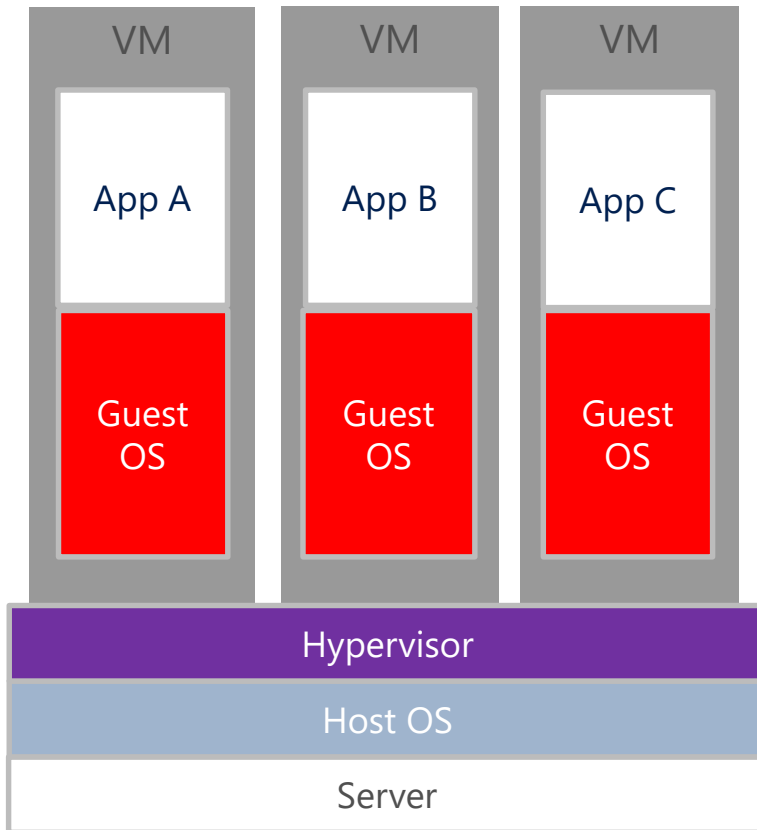
Customer-managed  
(IaaS)

- What is a Container?

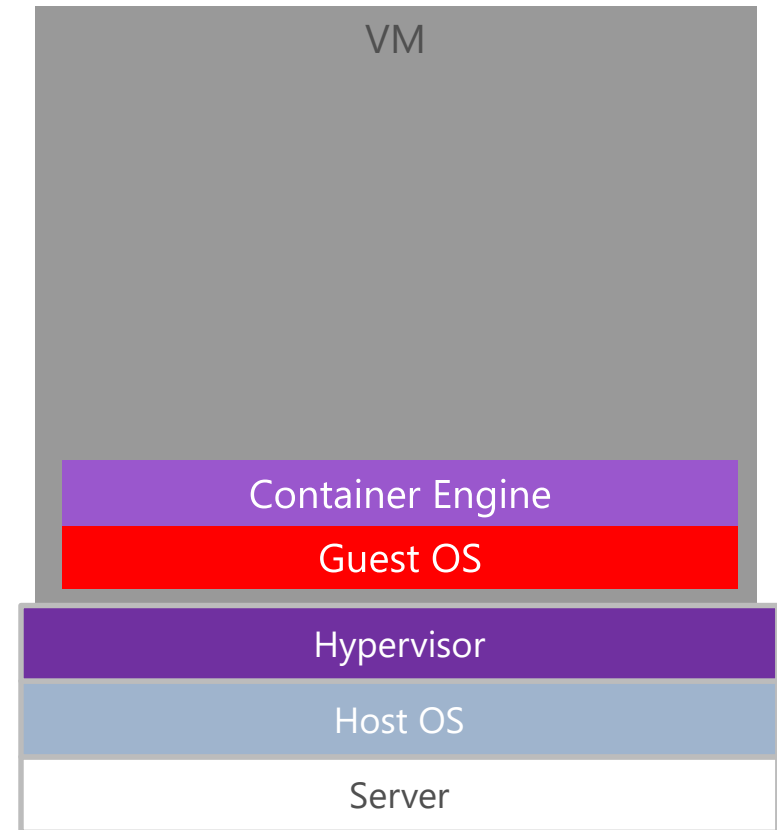
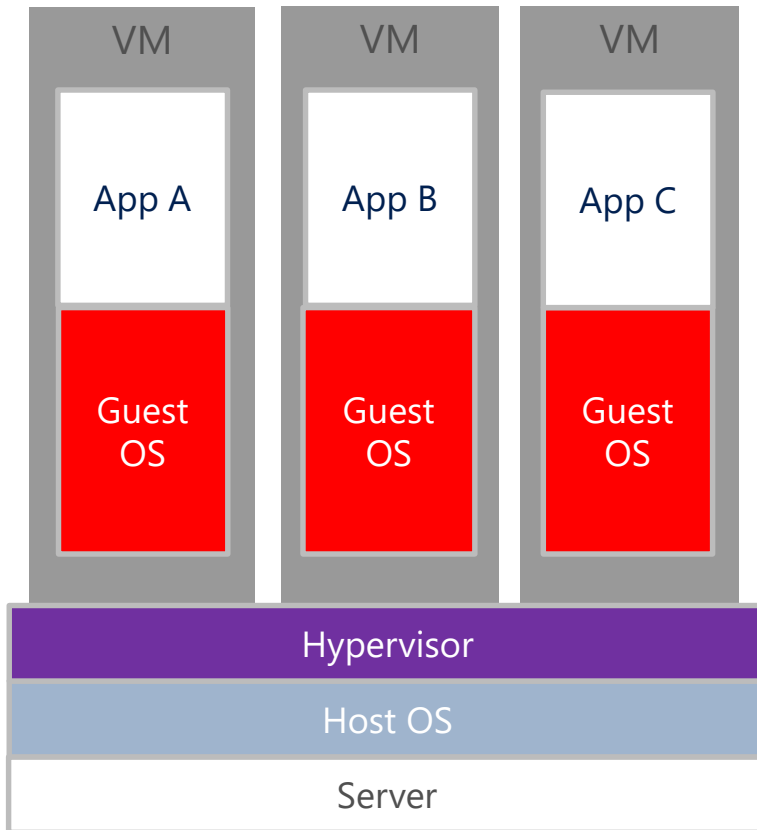




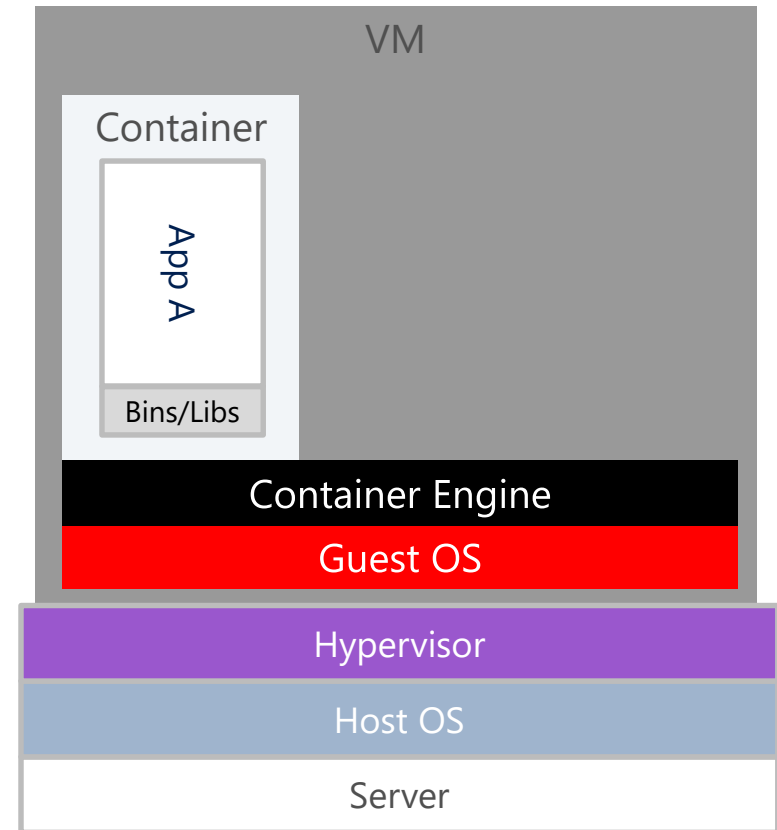
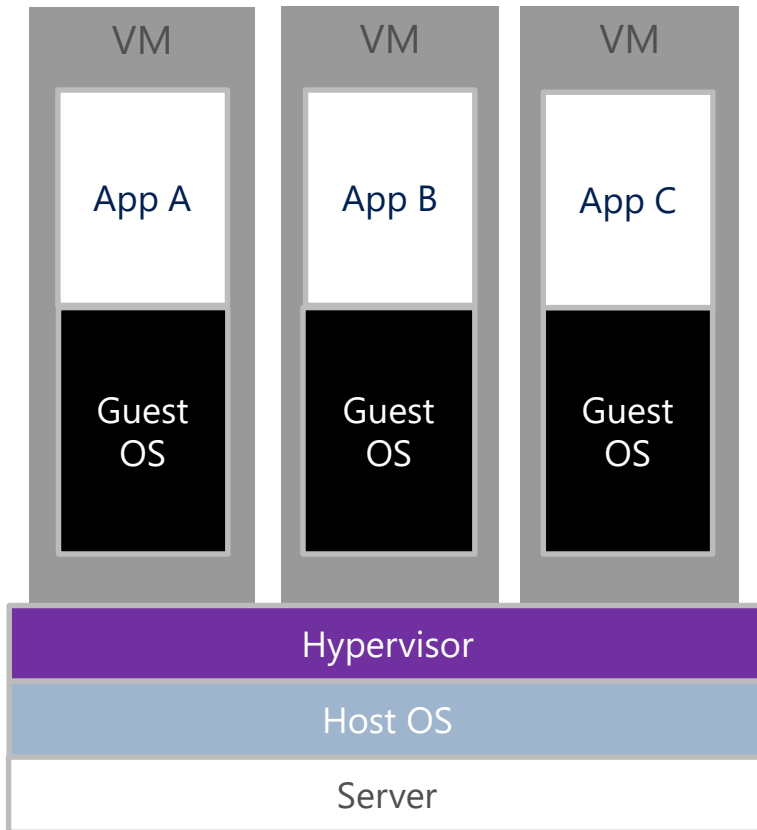
# What is a Container?



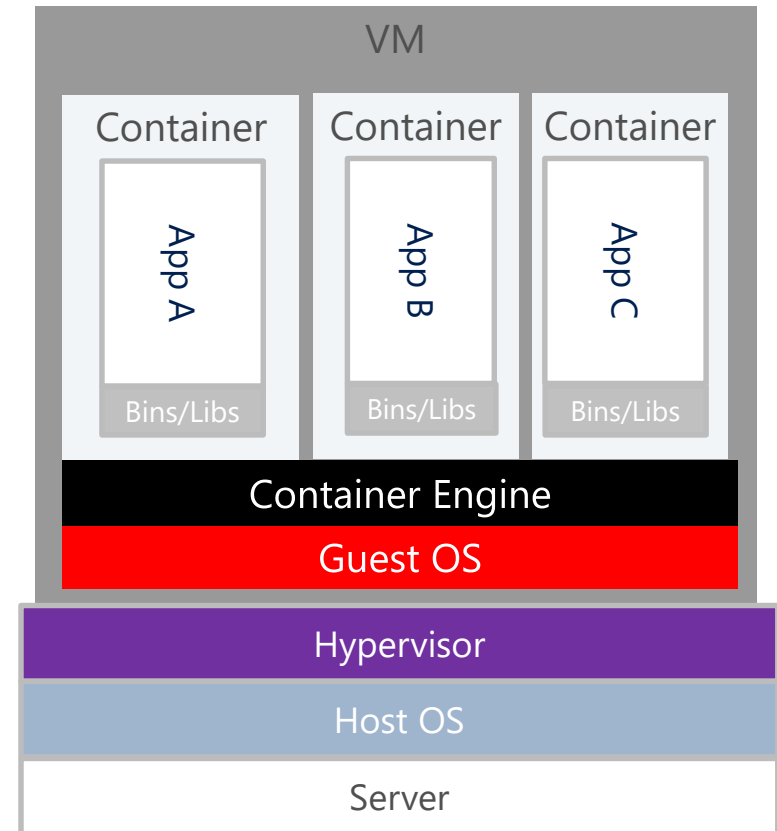
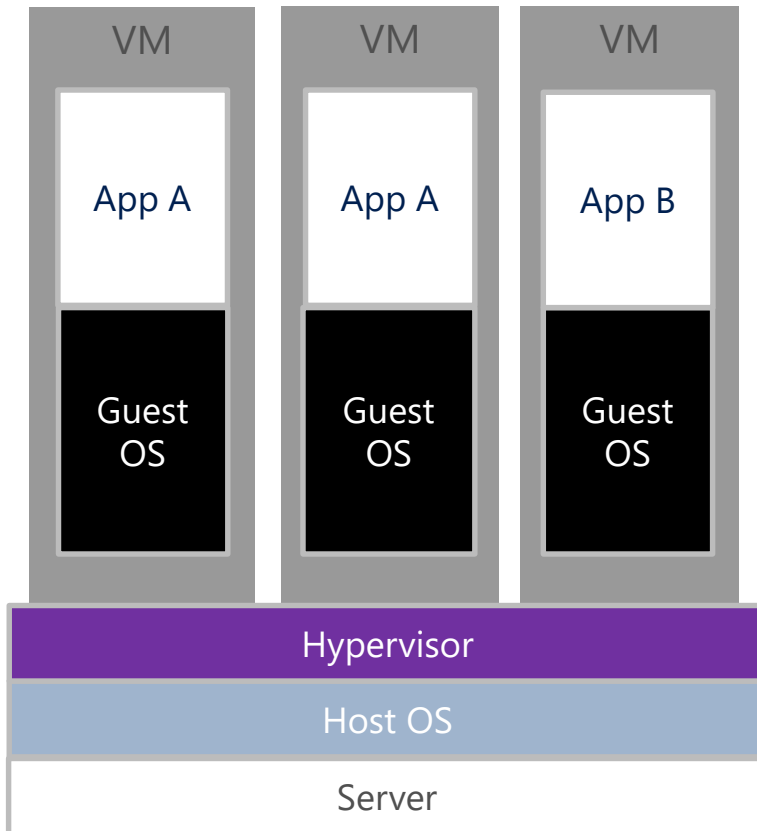
# What is a Container?



# What is a Container?



# What is a Container?



- Why?

- Lightweight

- Portable

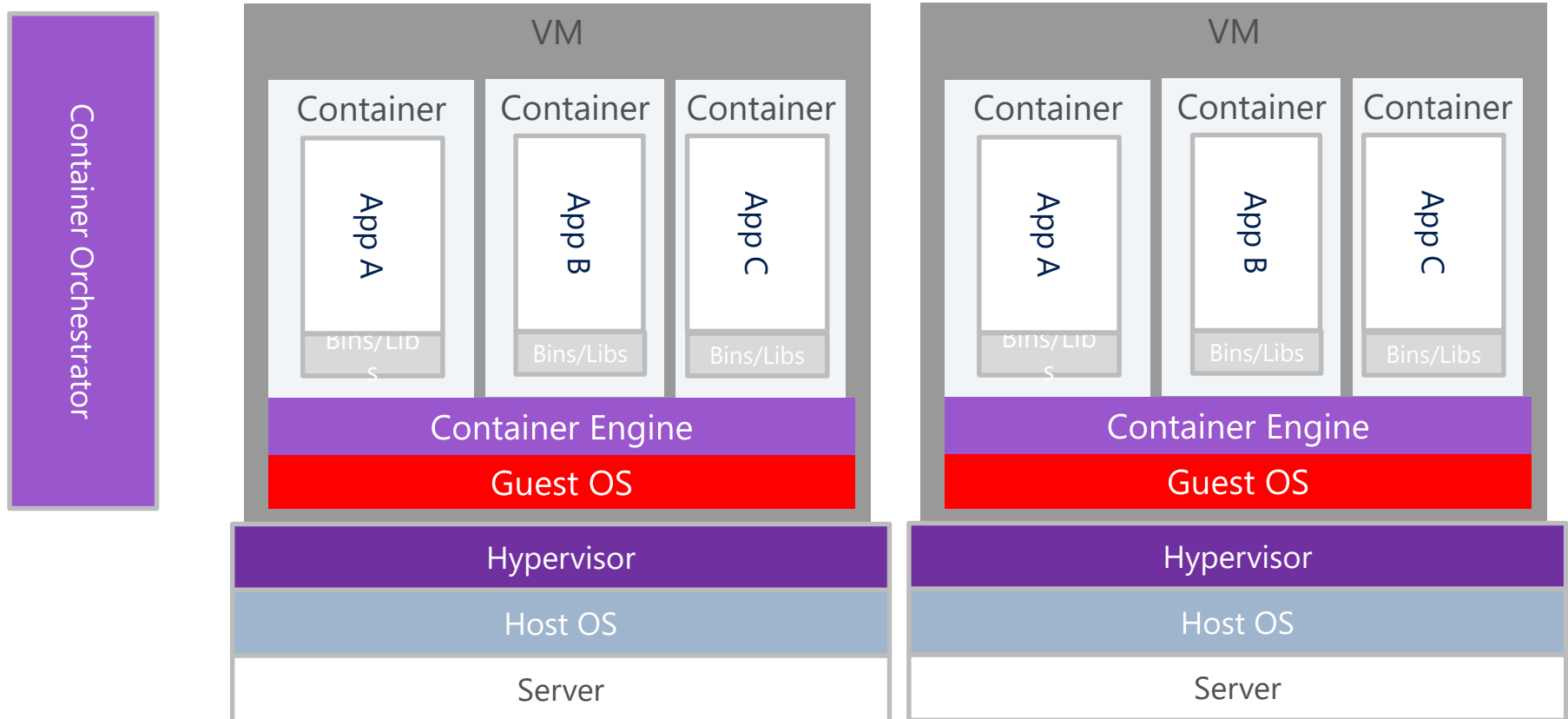




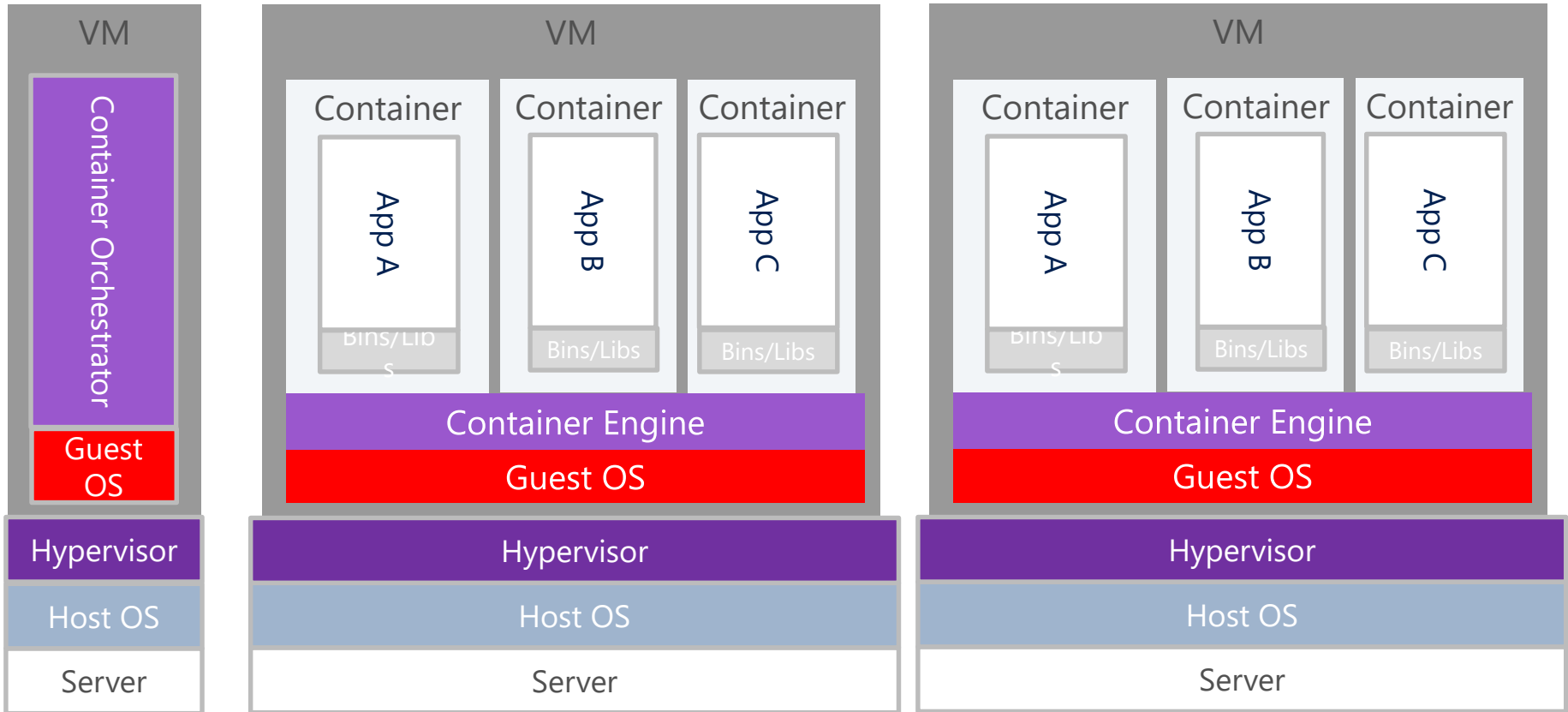
Ok, I've got containers.  
Now what?

# What is a Container Orchestrator?

# What is a Container Orchestrator?



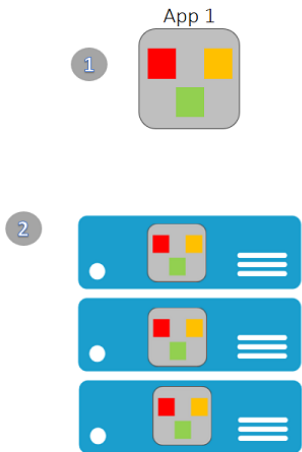
# What is a Container Orchestrator?



What is the point of all of this?!

# Microservices 101

Monolithic application approach



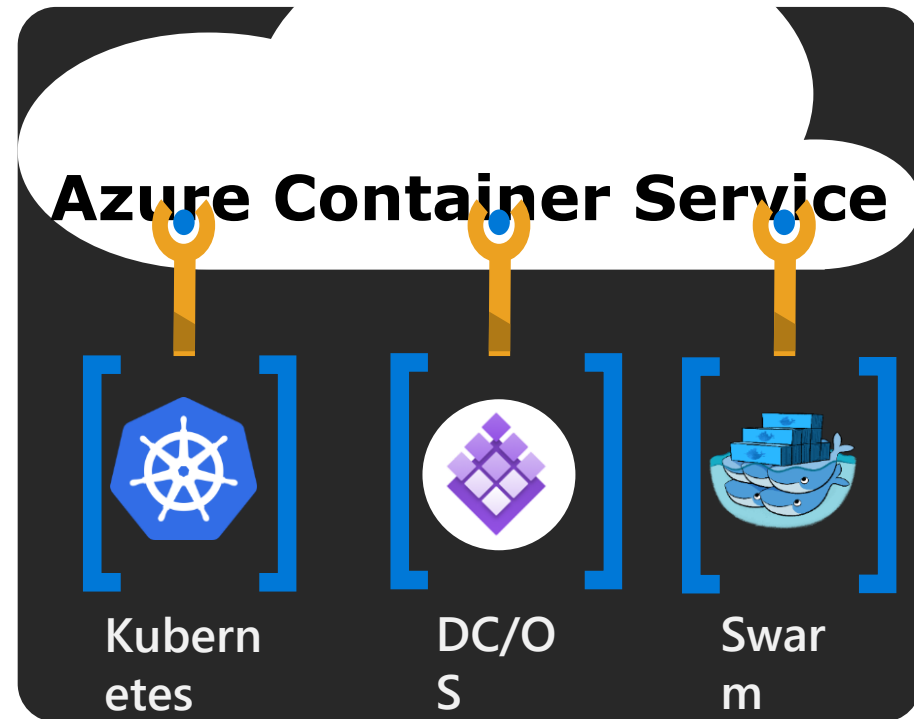
# Azure Container Service

Making containers in Azure EZ!

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

ACS --> AKS (Preview)

- Focus on Kubernetes
- Managed Orchestrator



# Azure Container Instances (Preview)

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  
(mlaaS/PaaS)

# Microsoft Azure Service Fabric

A platform for reliable, hyperscale, microservice-based applications

