



# Azure Networking vNext - How to build modern connectivity for IaaS, PaaS and SaaS

Eric Berg  
Microsoft MVP



# Eric Berg



Vice President Expert @ CGI



Cloud, Datacenter and Management



Azure, AWS, GCP



info@ericberg.de



@ericberg\_de | @GeekZeugs



www.ericberg.de | www.geekzeugs.de





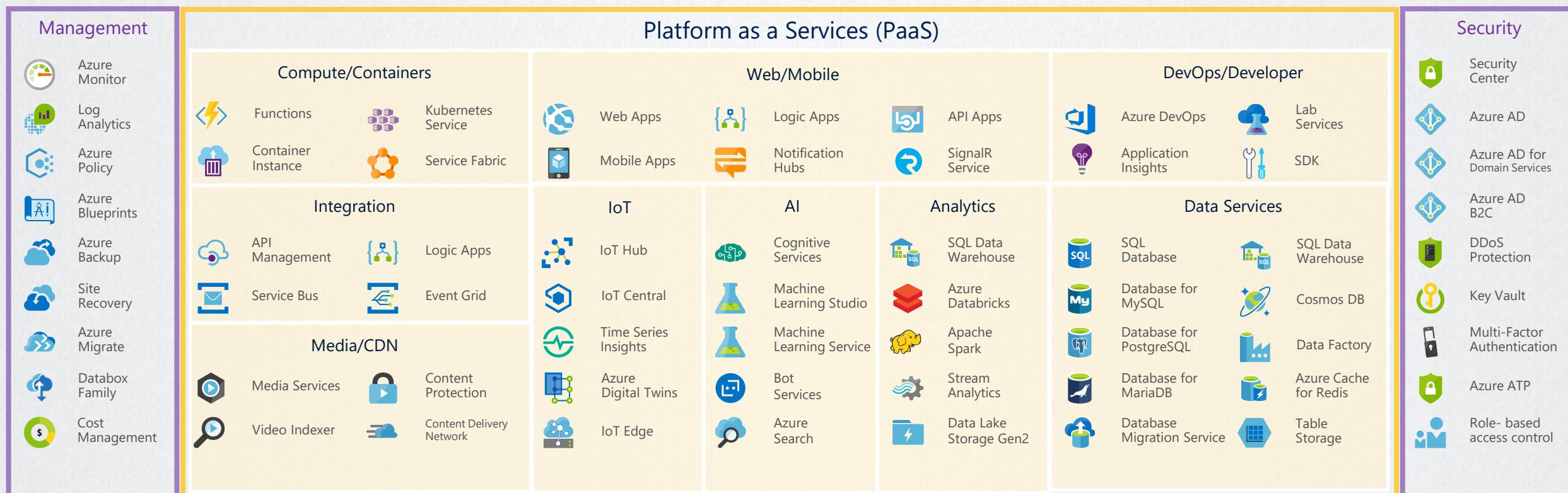
# Agenda



- Networking Overview
- Networking Recap
- Connectivity
- Integration
- DNS
- Build it
- Q&A

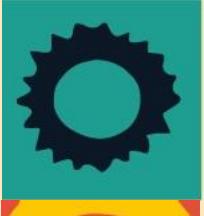
# Networking Overview

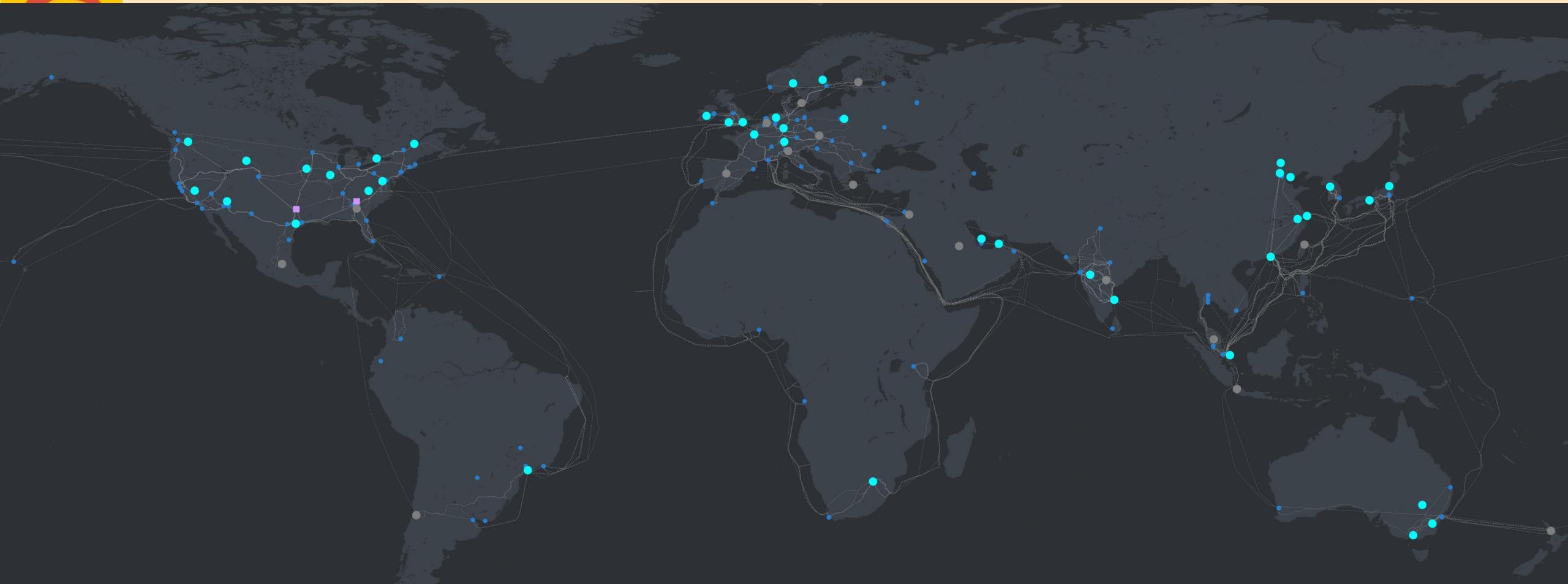
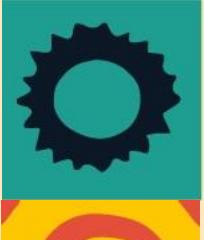
# High Level Azure Services

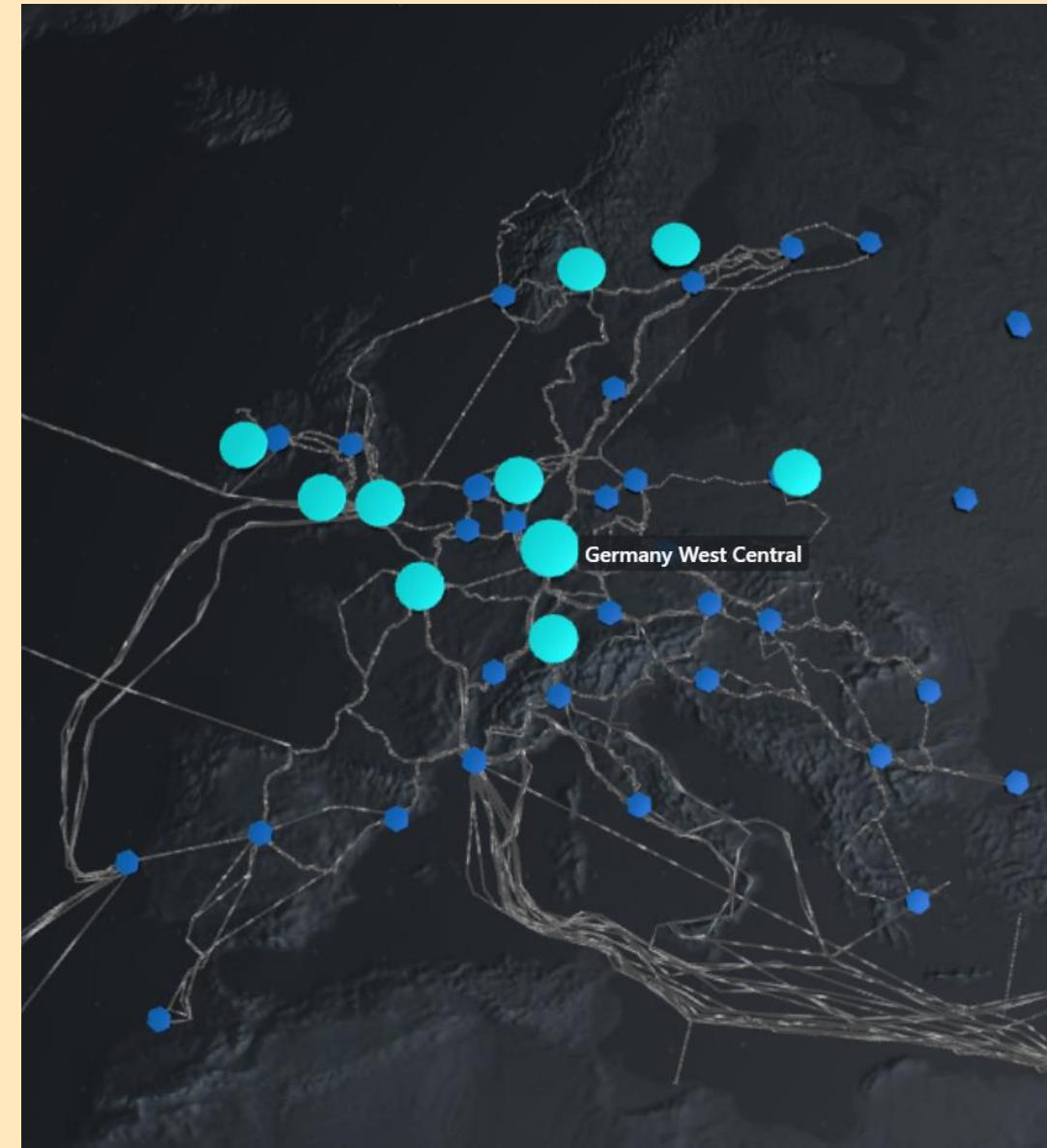


## Azure Datacenter Infrastructure

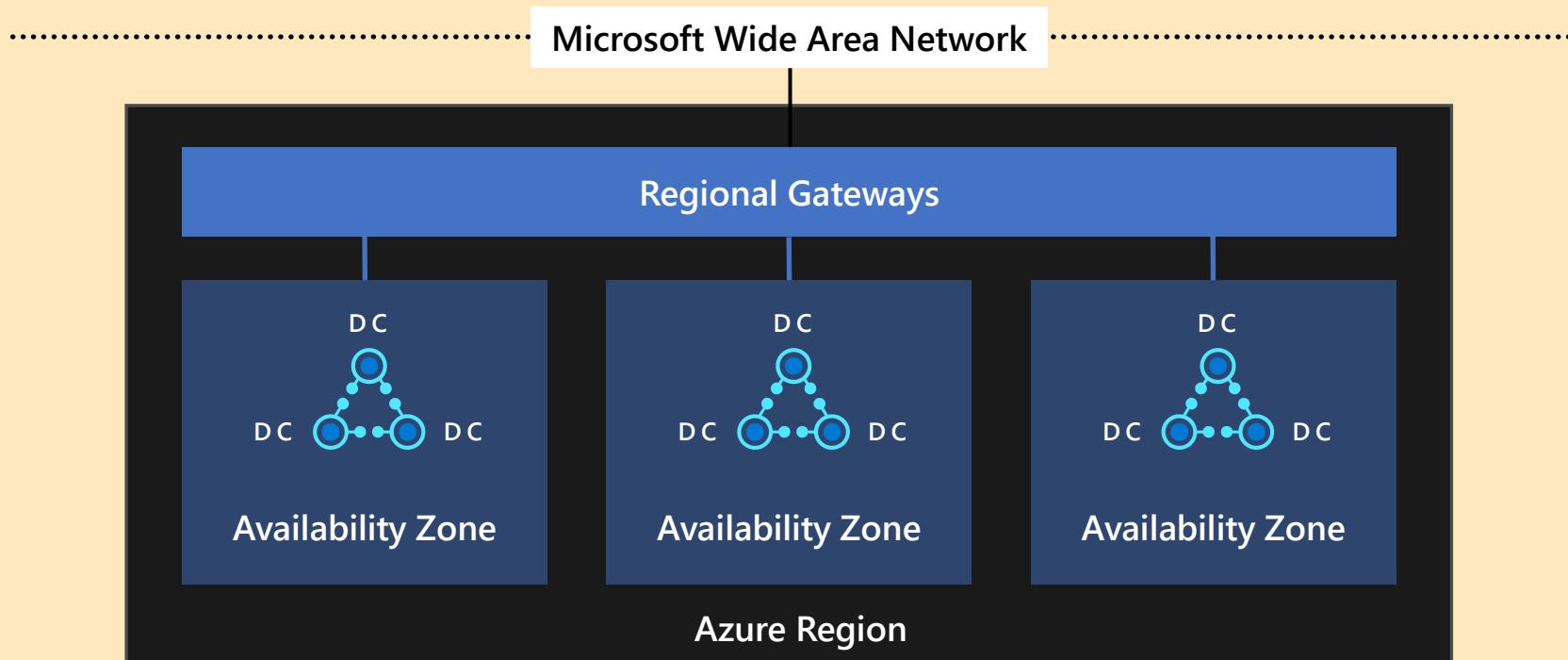
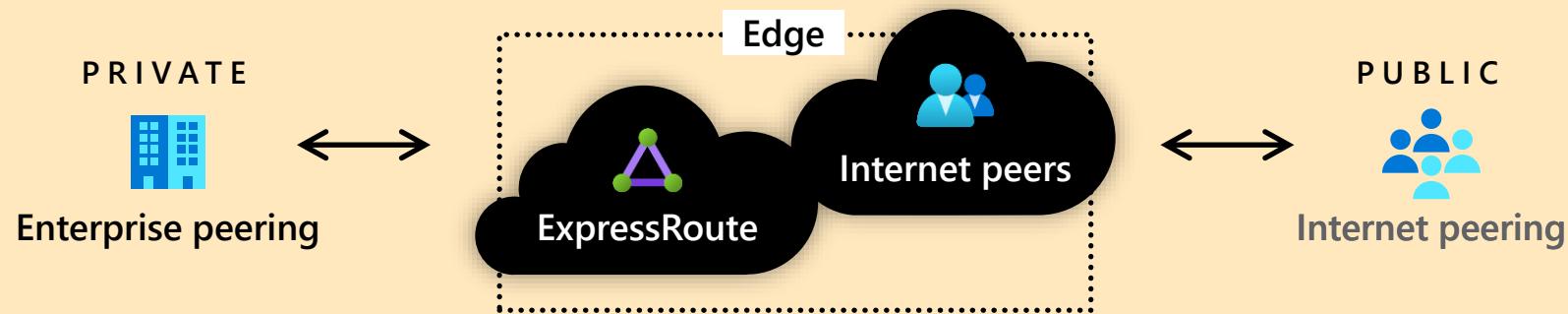




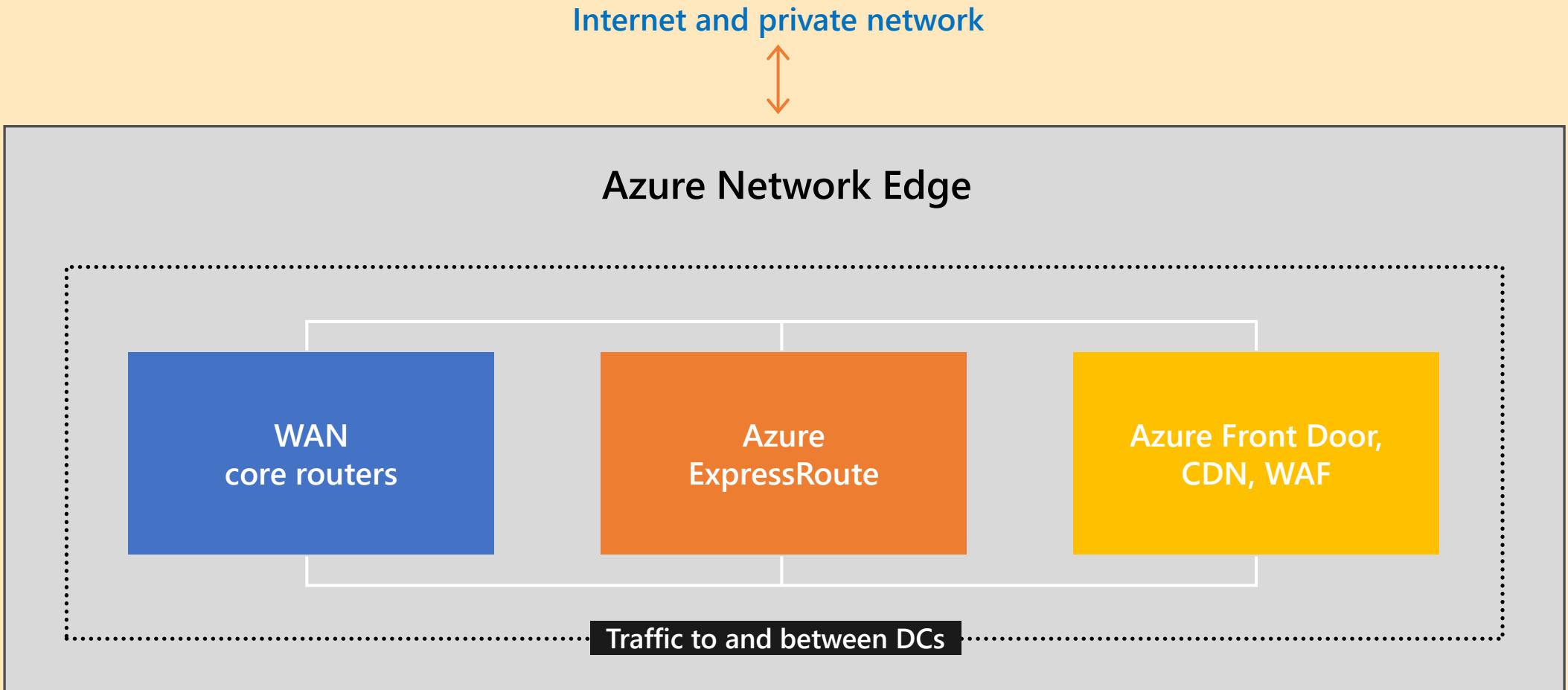




# Connecting Azure regions to the global network



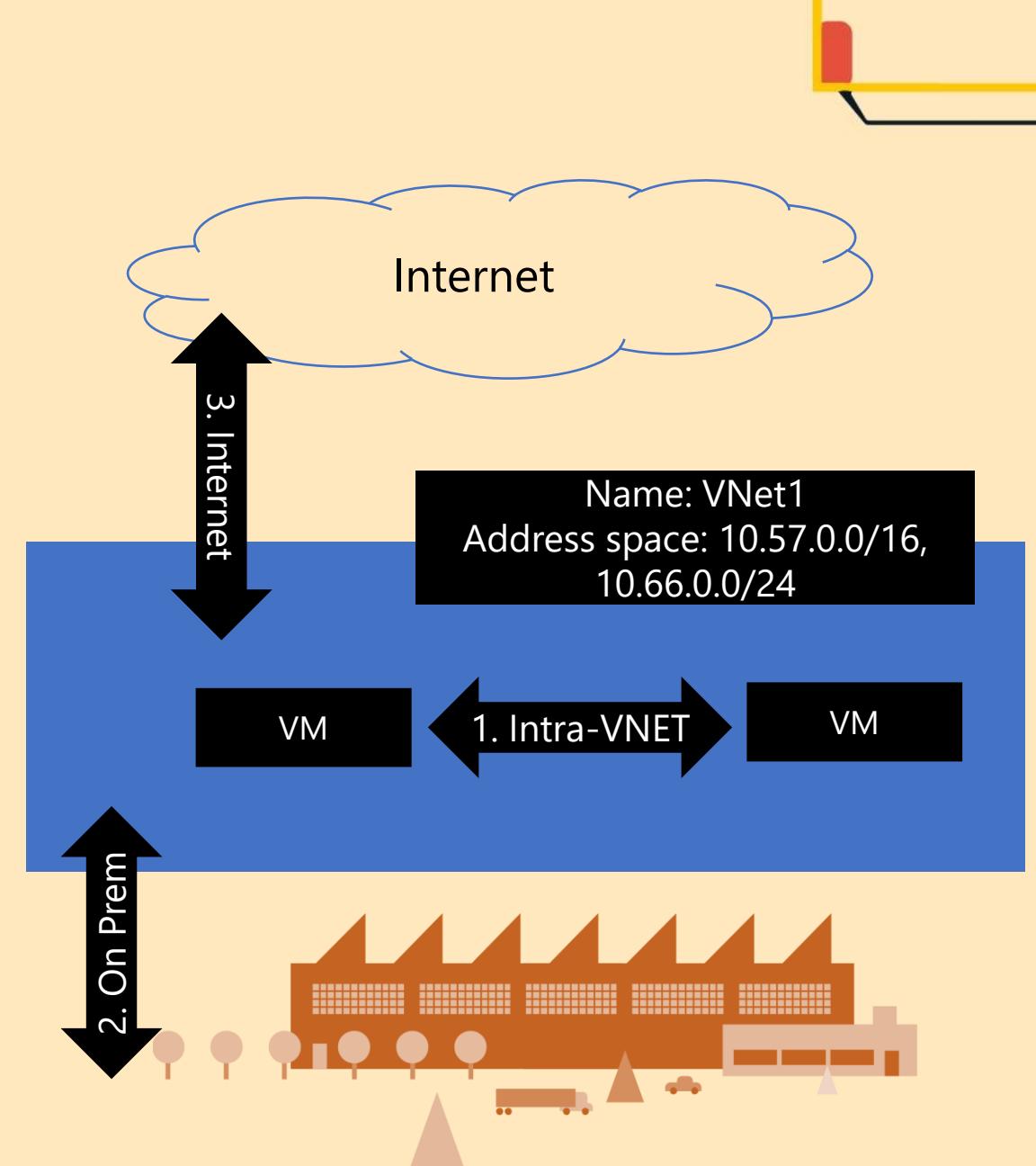
# The Azure Network Edge



# Networking Recap

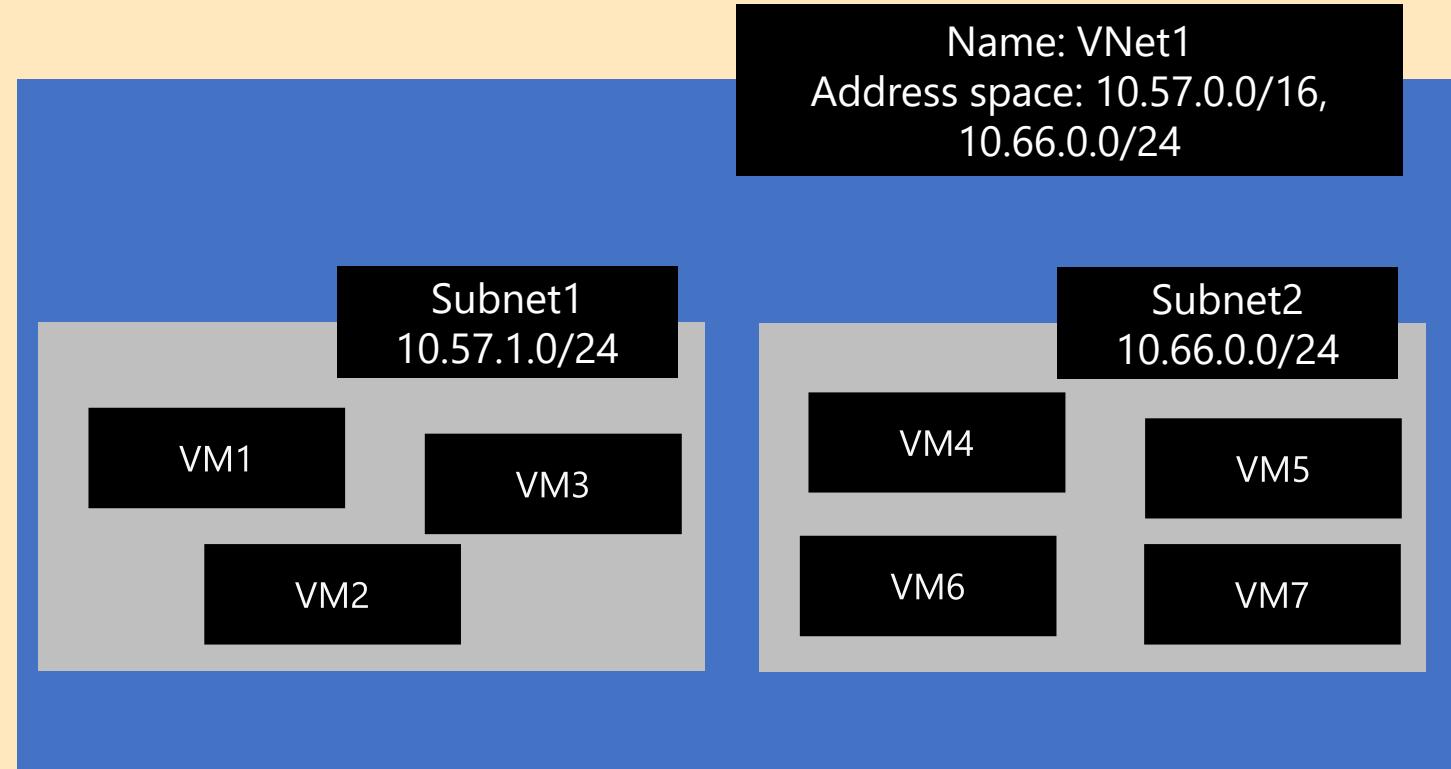
# Virtual Network

- Isolated, logical network that provides connectivity for Azure Resources
- User-defined address space (can be one or more IP ranges, not necessarily RFC1918)
  - Connectivity for VMs in the same VNET
  - Connectivity to external networks/on-prem DC's
  - Internet connectivity



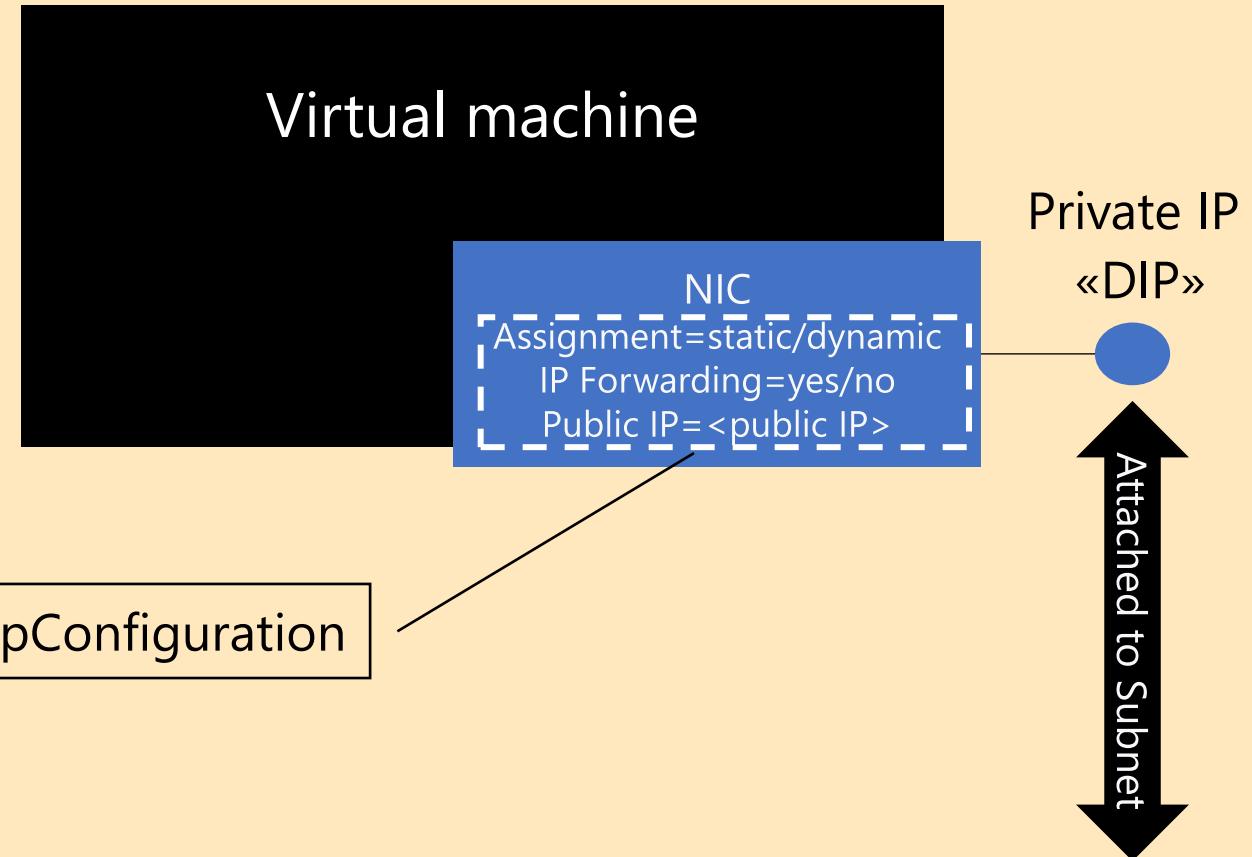
# Subnet

- Provides full layer-3 semantics and partial layer-2 semantics (DHCP, ARP, no broadcast / multicast)
- Subnets can span only one range of contiguous IP addresses
- VMs can be deployed only to subnets (not VNets)



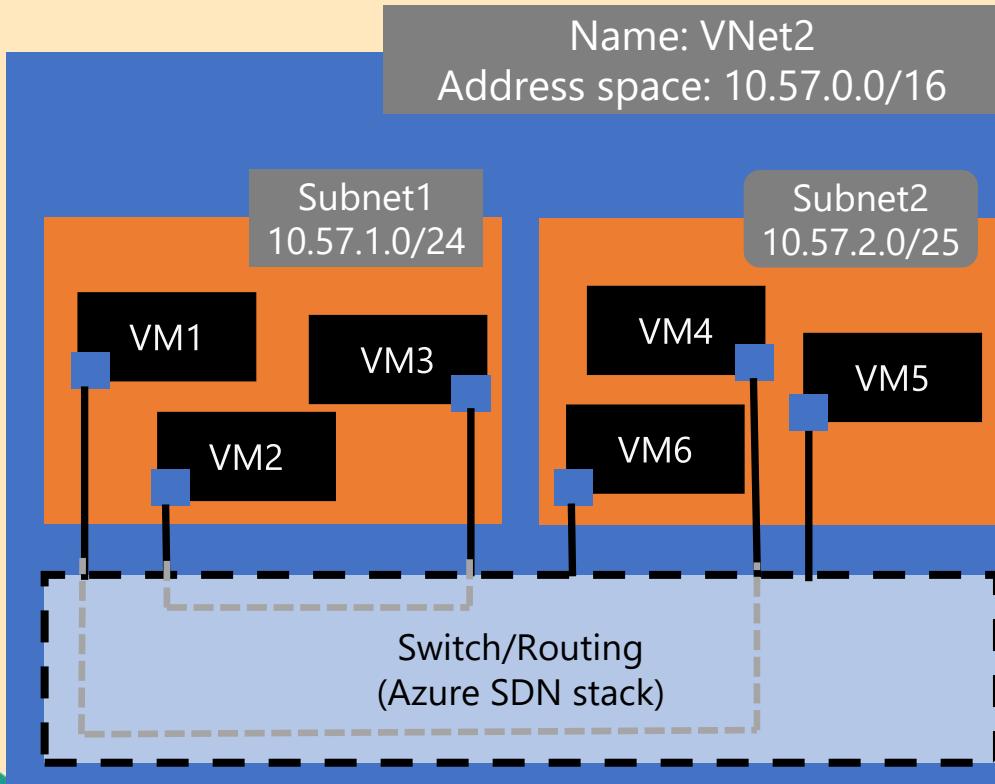
# Network Interface

- Virtual NIC that connects a VM to a Subnet
- One private IP address (private == included in the subnet's IP range, not necessarily RFC1918)
- Private IP address always assigned via Azure DHCP



# Switching/Routing in Azure VNETs

A VNET provides a switching/routing functionality that allows VMs to talk to each other



Please note that, in an Azure VNet, packets can flow between two different subnets without explicitly traversing any layer-3 device. Azure's network virtualization stack effectively works as a layer-3 switch

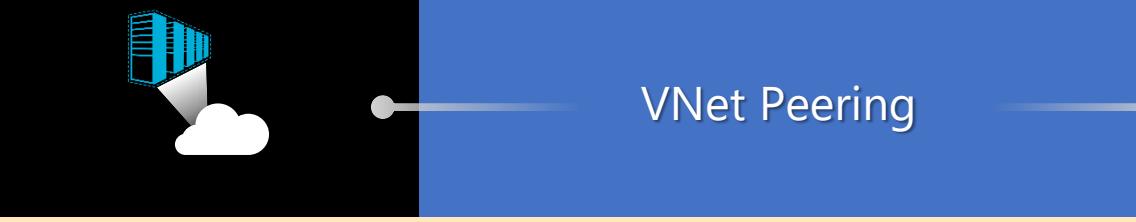


# Connectivity

# Connecting to Azure

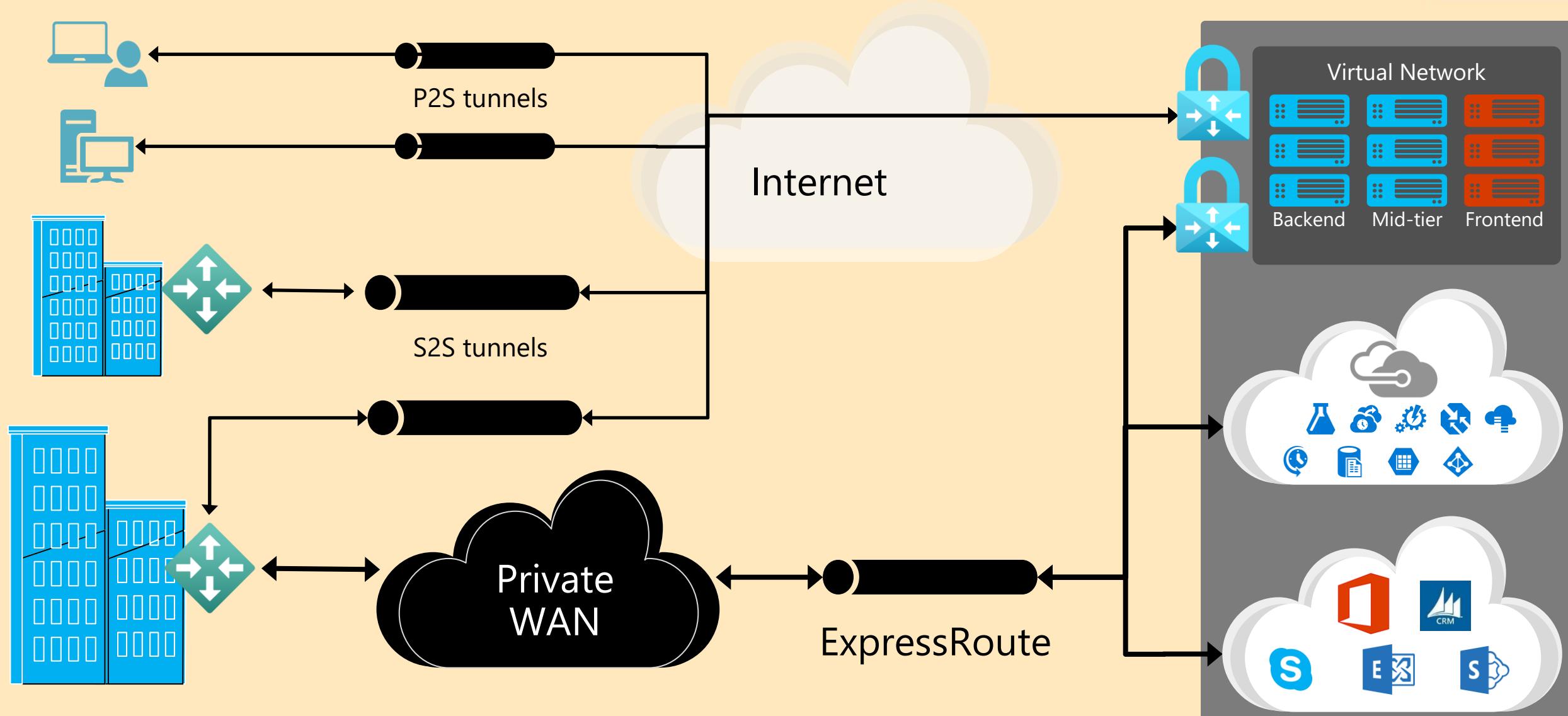
Cloud		Customer	Characteristics
	Internet Connectivity		<ul style="list-style-type: none"><li>Internet facing with public IP addresses in Azure</li><li>VPN connectivity with virtual appliances (Marketplace)</li></ul>
	Remote access point-to-site connectivity		<ul style="list-style-type: none"><li>Remote Access to VNet/On-prem</li><li>Connect from anywhere</li><li>Mac, Linux, Windows</li><li>Radius/AD authentication</li></ul>
	Site-to-site VPN connectivity		<ul style="list-style-type: none"><li>High throughput, secure cross-premises connectivity</li><li>BGP, active-active for high availability &amp; transit routing</li></ul>
	ExpressRoute private connectivity		<ul style="list-style-type: none"><li>Private connectivity to Microsoft services</li><li>Mission critical workloads</li></ul>

# Connecting *in* Azure

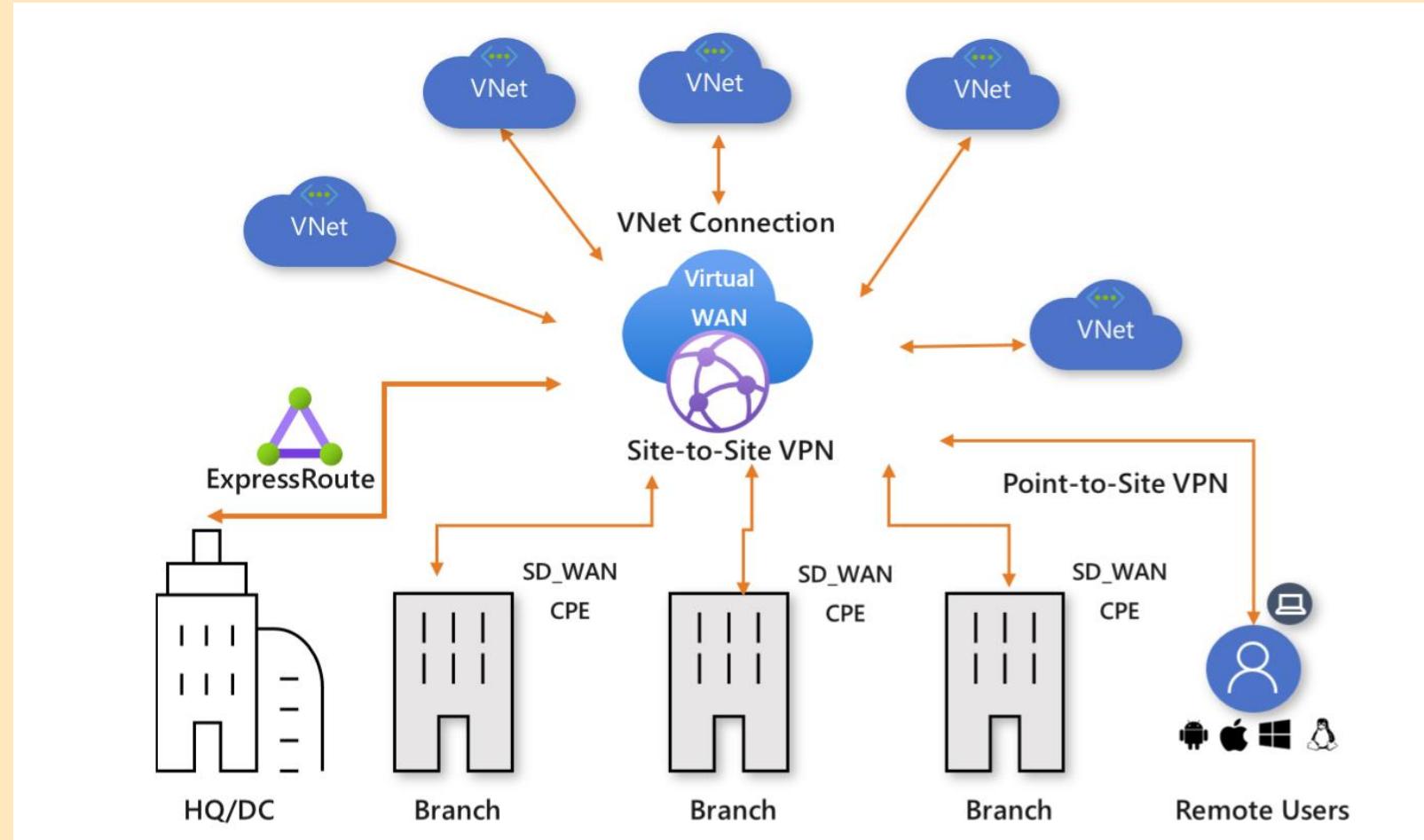
Cloud	Cloud	Characteristics
	VNet Peering	<ul style="list-style-type: none"><li>• Same-/cross-region direct, private VM-to-VM connectivity</li><li>• NSG &amp; UDR across VNets</li><li>• GatewayTransit for hub-and-spoke</li></ul>
	VNet-to-VNet via Gateways	<ul style="list-style-type: none"><li>• Transitive routing via BGP and VPN gateways</li><li>• Secure connectivity via IPsec/IKE across Azure WAN links</li></ul>
	VNet-to-VNet via ExpressRoute circuit	<ul style="list-style-type: none"><li>• Traverse ("hairpin") through ExpressRoute circuit &amp; gateways</li><li>• Traffic is not encrypted</li></ul>

# Cross premises connectivity overview

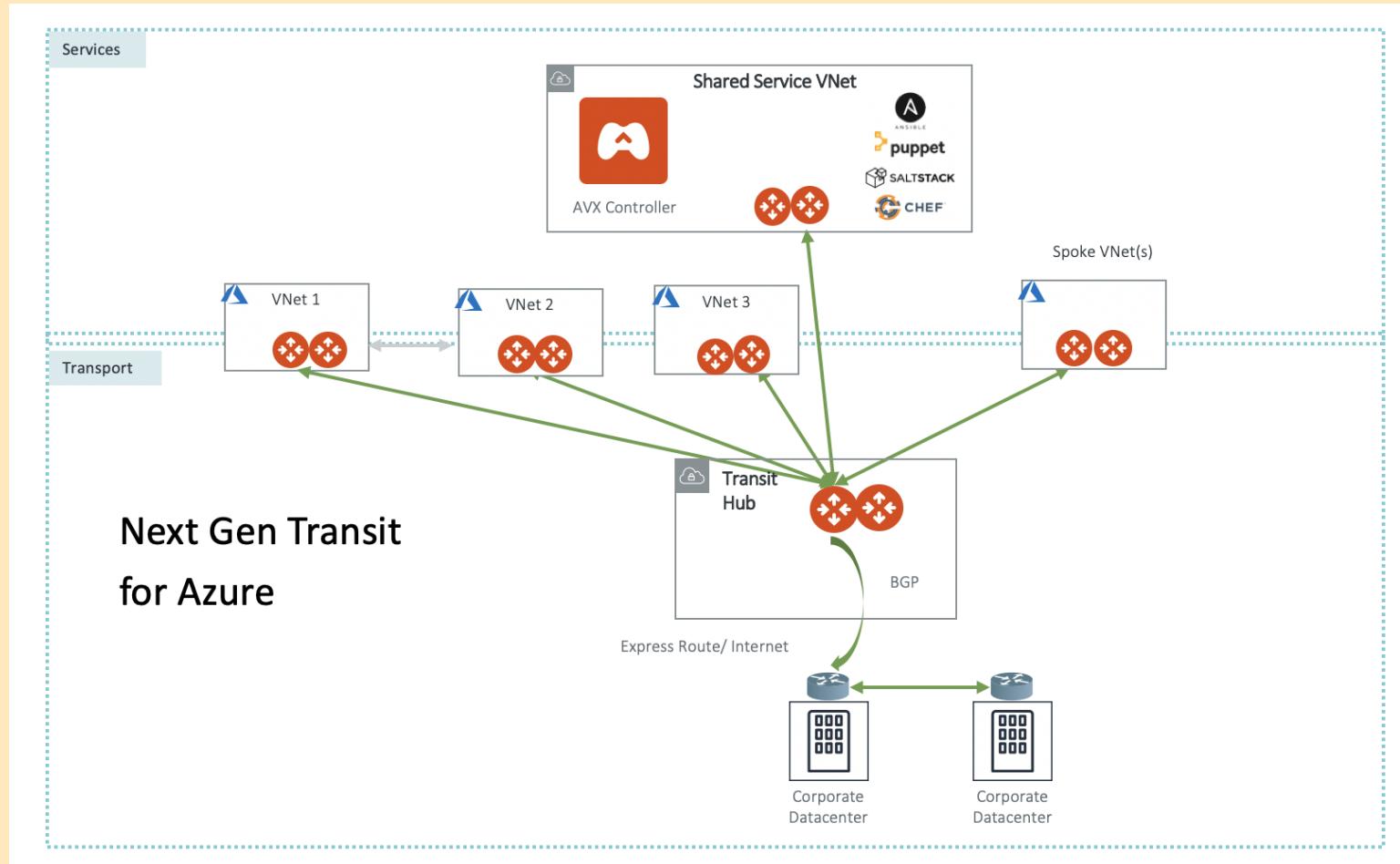
Microsoft



# Azure Virtual WAN



# NextGen Cloud Networking



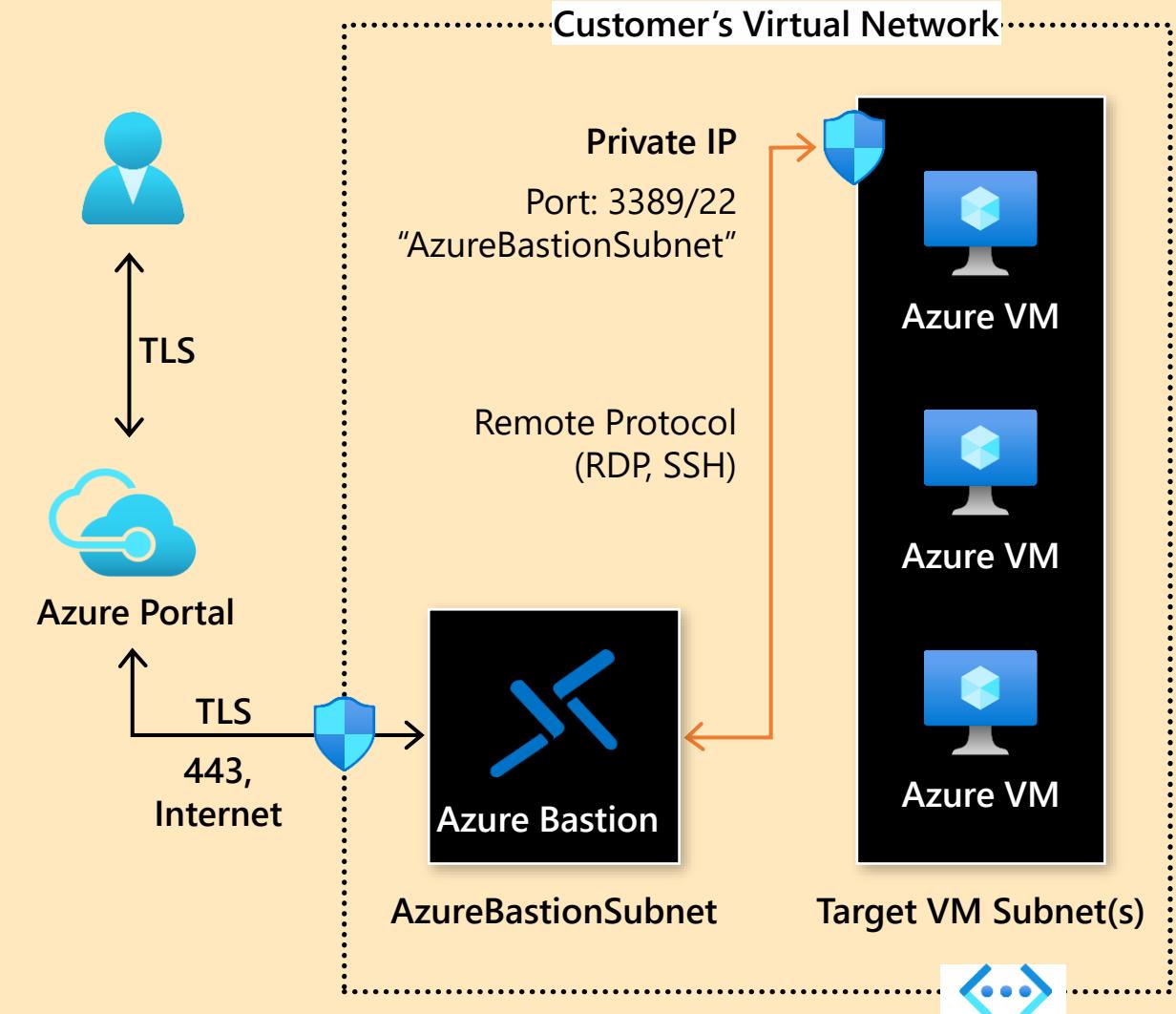
# Azure Bastion

Secure and seamless RDP and SSH access to your virtual machines

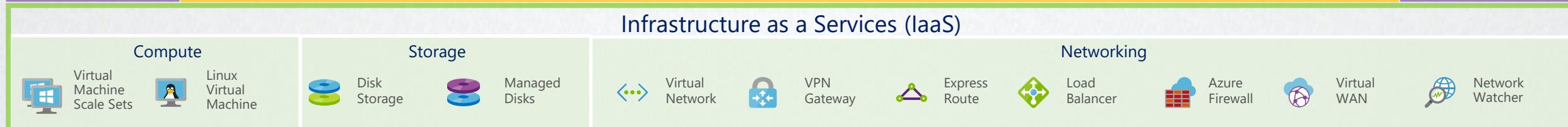
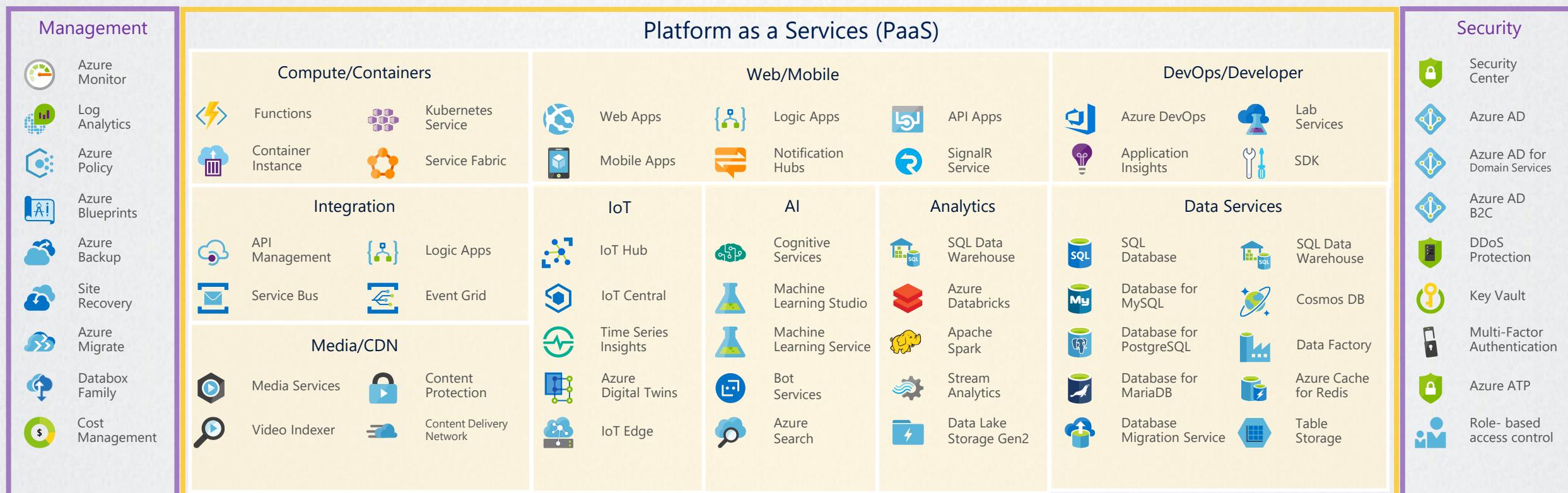
RDP/SSH to your workload using HTML5 standards-based web-browser, directly in Azure Portal

Resources can be accessed without public IP addresses

Supported Azure resources include VMs, VM Scale Sets, Dev-Test Labs

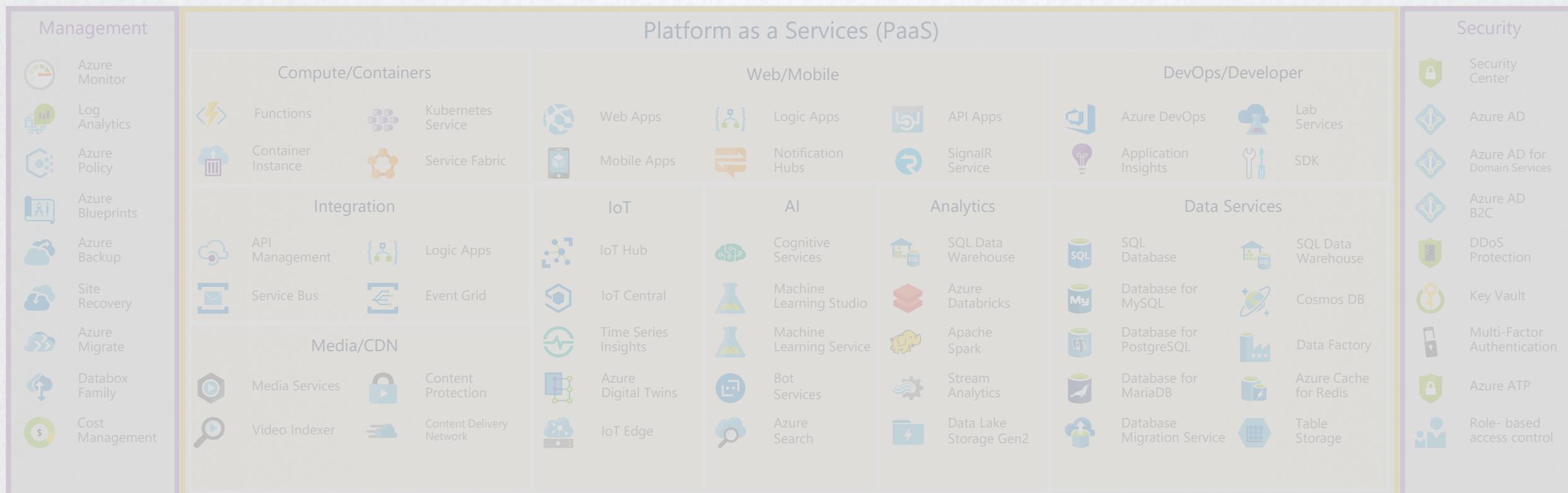


# High Level Azure Services



Azure Datacenter Infrastructure

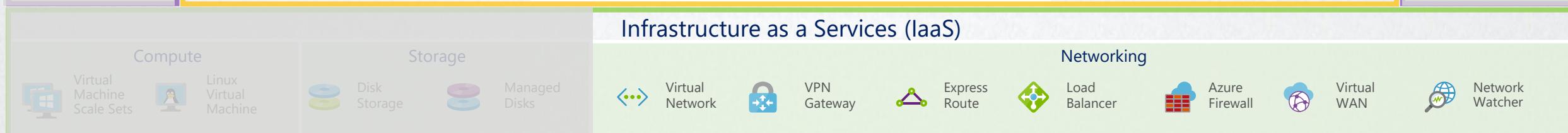
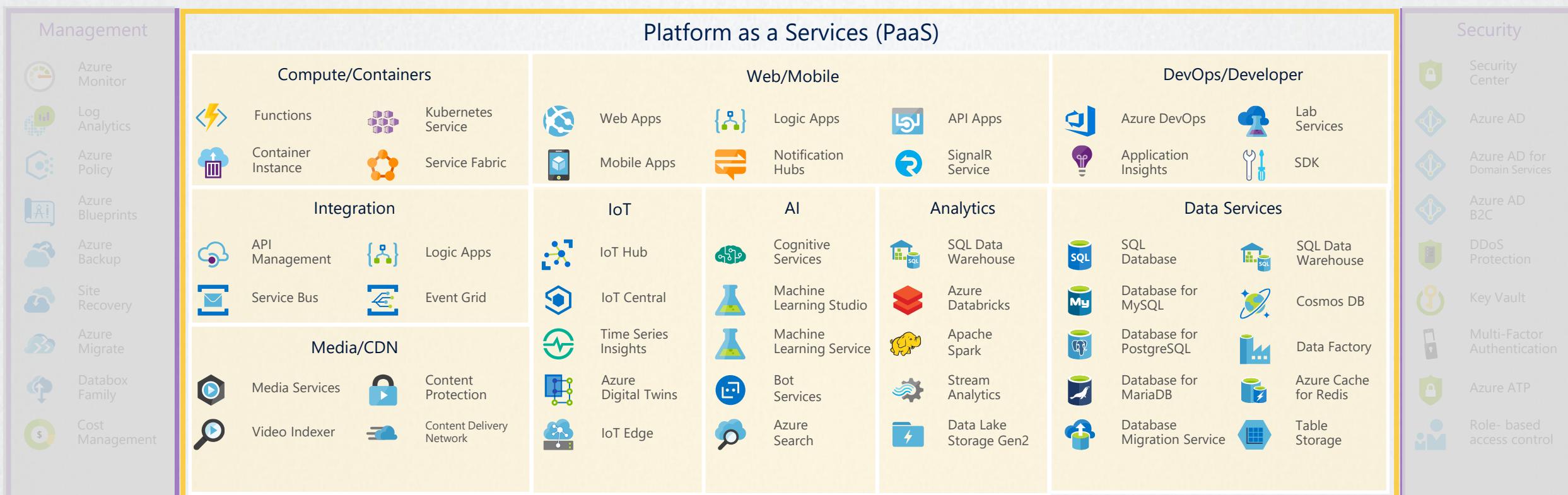
# High Level Azure Services



Azure Datacenter Infrastructure



# High Level Azure Services



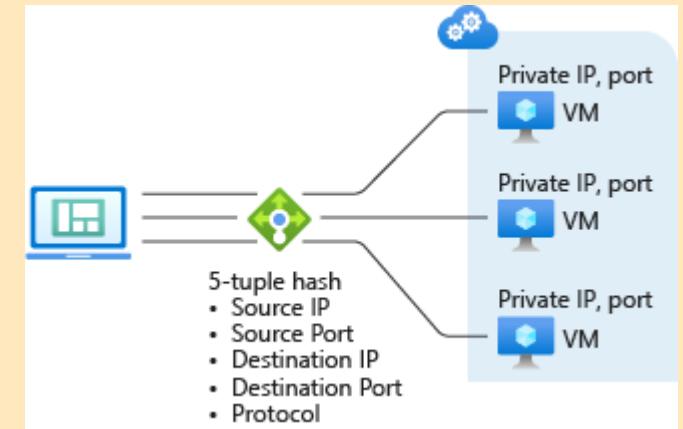
Azure Datacenter Infrastructure



# Azure Load Balancer

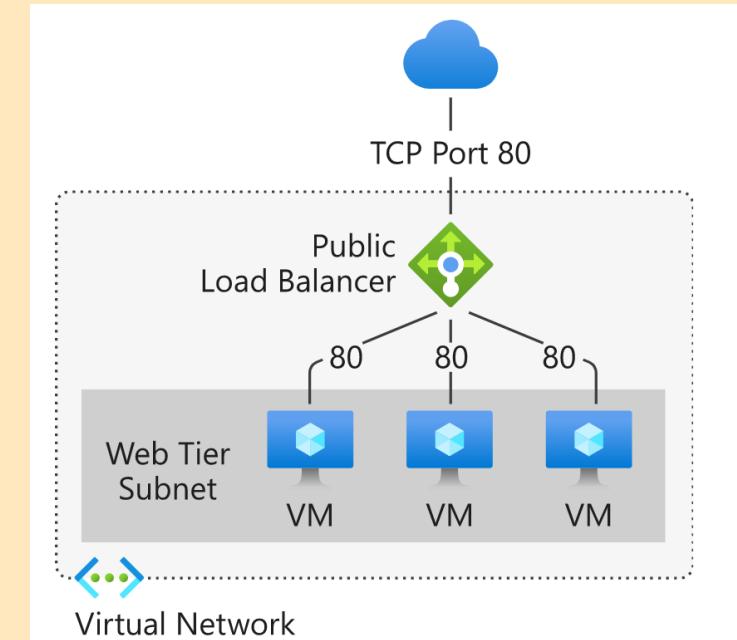
# Azure Load Balancer

- Allows you to scale your applications and create **high availability** and **resiliency** for your services and applications
- Public
  - A public Load Balancer maps the public IP address and port number of incoming traffic to the private IP address and port number of the VM and vice versa.
- Internal
  - An internal Load Balancer directs traffic only to resources that are inside a virtual network or that use a VPN to access Azure infrastructure.



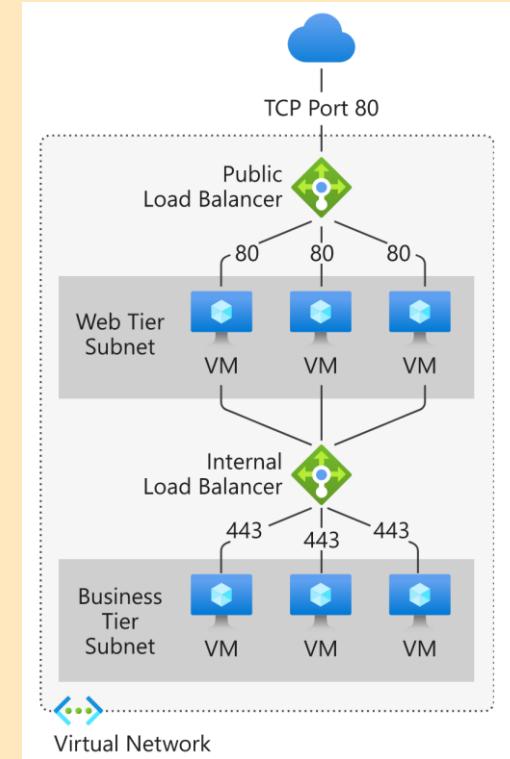
# Public Load Balancer

- A public Load Balancer maps **the public IP address** and port number of incoming traffic to the **private IP address** and port number of the VM
- *Automatic reconfiguration*
  - Instantly reconfigures itself as you scale instance up or down
- *Outbound connections (SNAT)*
  - All outbound flows from private IP addresses inside your virtual network to public IP addresses on the internet can be translated to a frontend IP address of the Load Balancer
- *Default Distribution Mode*
  - Azure Load Balancer distributes traffic evenly amongst multiple VM instance



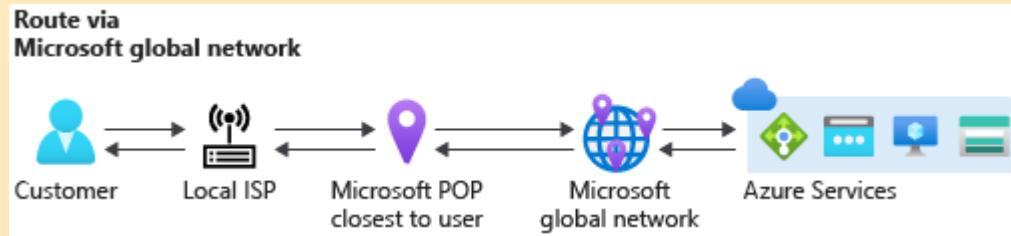
# Internal Load Balancer

- An internal Load Balancer directs traffic only to resources inside a virtual network or that use a VPN to access Azure infrastructure
- Within a virtual network
- Cross-premises virtual network
- Multi-tier applications
- Line-of-business applications

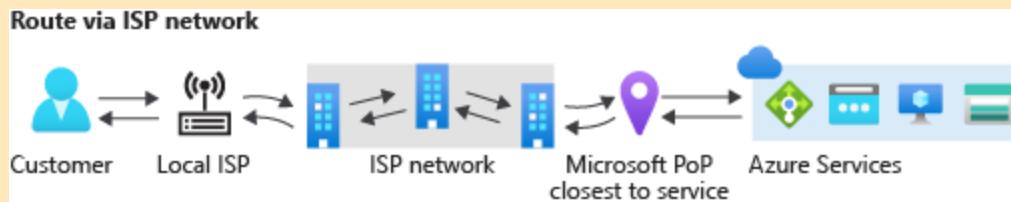


# Routing Preference

- Routing via Microsoft-Network

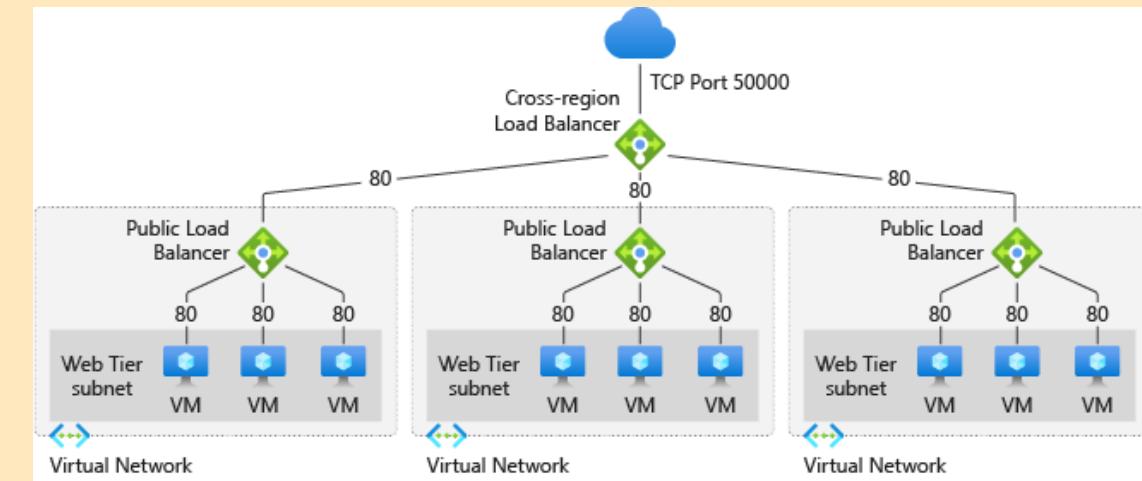


- Routing via Internet



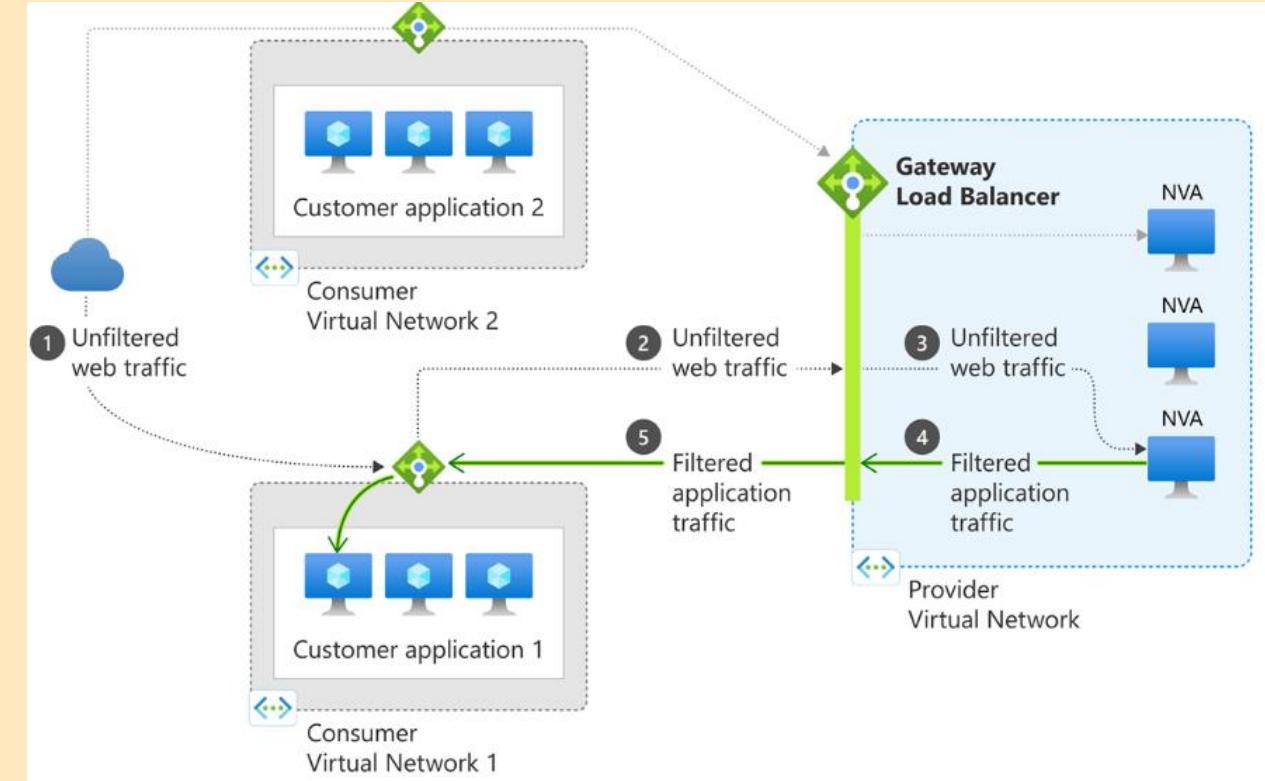
# Cross-Region Load Balancer

- Challenge with Load Balancers
  - Bound to a VNET
  - Bound to a region
  - Global Deployments have different Frontend IPs
  - Manual changes required in case of a disaster
- Cross-Region Load Balancer
  - Load Balancer of Load Balancers
  - Backends are regional public LBs
  - No private / internal LBs, no UDP



# Gateway Load Balancer

- Gateway Load Balancer allow to easily deploy, scale, and manage NVAs
- Benefits
  - integrate NVA transparently
  - Easy add or remove - scaling
  - Improve NVA availability
  - Chain applications across regions and subscriptions

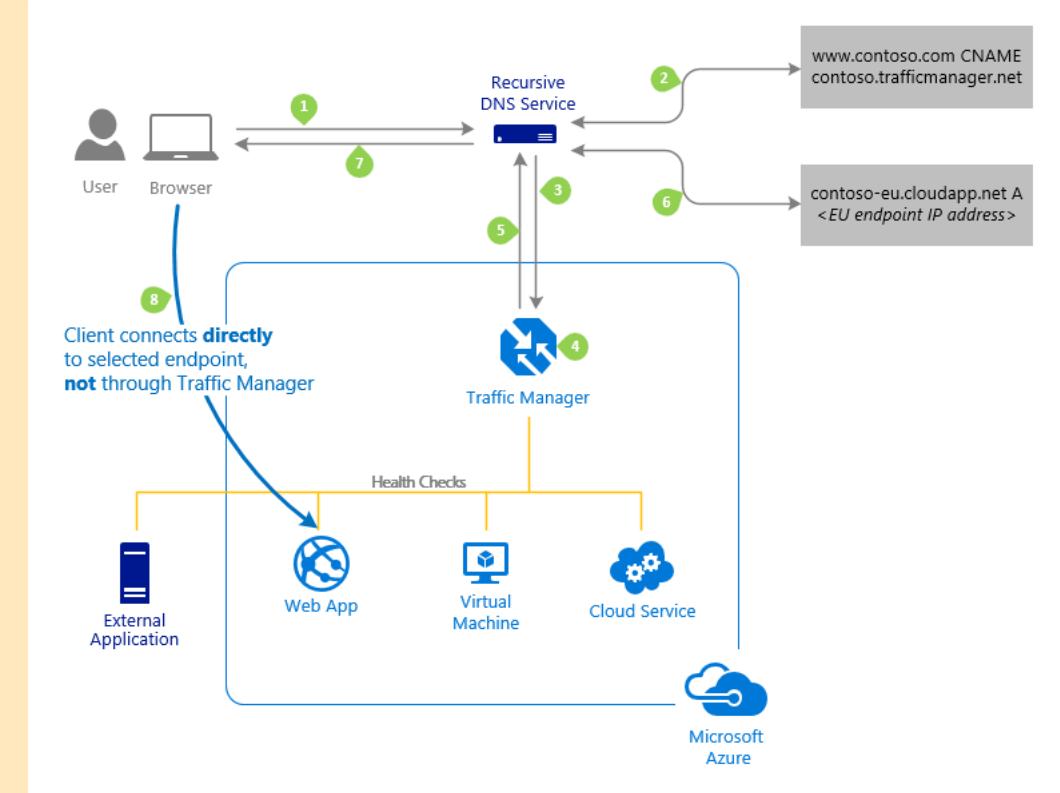


# DEMO – LOAD BALANCERS

# Azure Traffic Manager (TM) Azure Front Door (AFD)

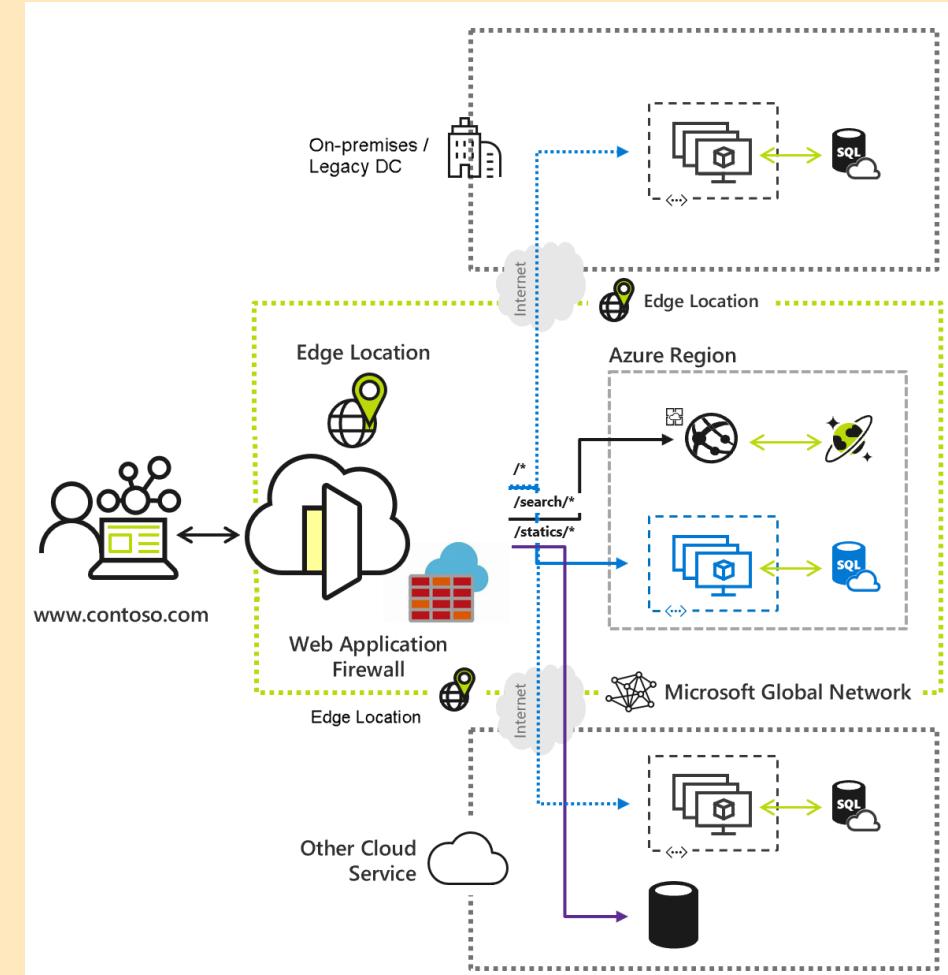
# Azure Traffic Manager

- Azure Traffic Manager is a DNS-based traffic load balancer that enables you to distribute traffic optimally to services across global Azure regions
- Global DNS load balancing
- Automatic failover when an endpoint goes down
- Combine with hybrid applications  
Supports external, non-Azure endpoints so that it can be used with hybrid cloud and on-premises deployments
- Distribute traffic for complex deployments  
Use nested Traffic Manager profiles for sophisticated, flexible rules for complex deployments



# Azure Front Door

- Azure Front Door Service provides a scalable and secure entry point for fast delivery of your global web applications
- SSL offload and application acceleration
- Global HTTP load balancing with instant failover
- Application Firewall and DDoS protection
- Centralized traffic orchestration view





# Azure Front Door

## Single or multi-region app and API acceleration

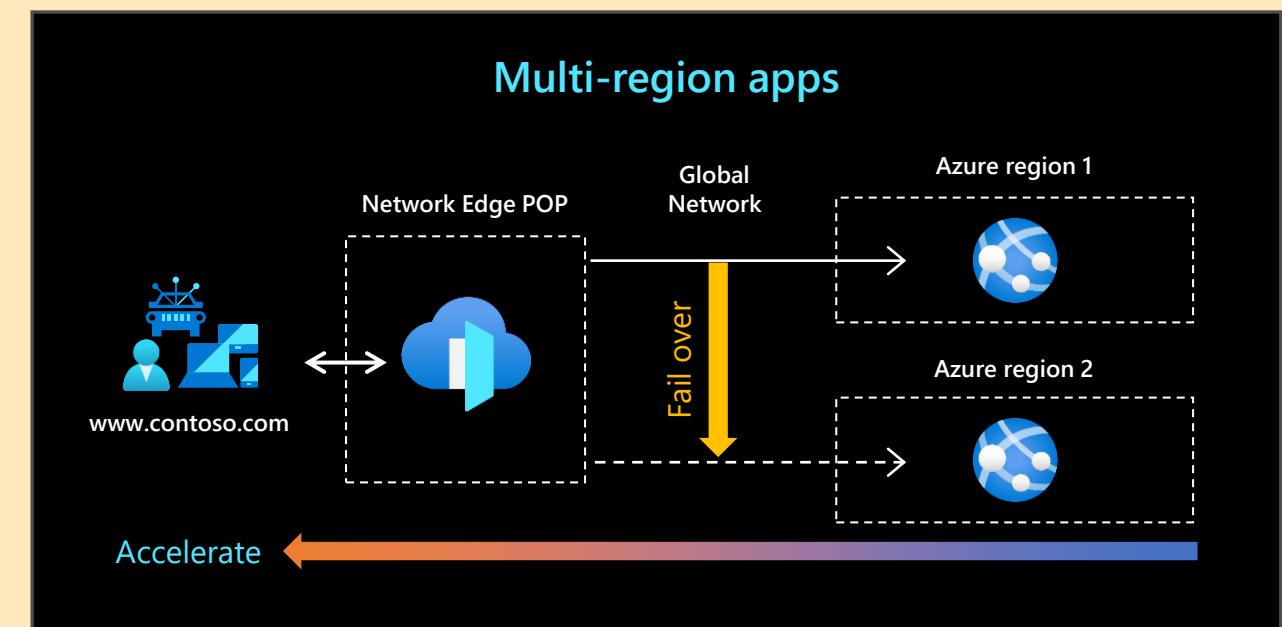
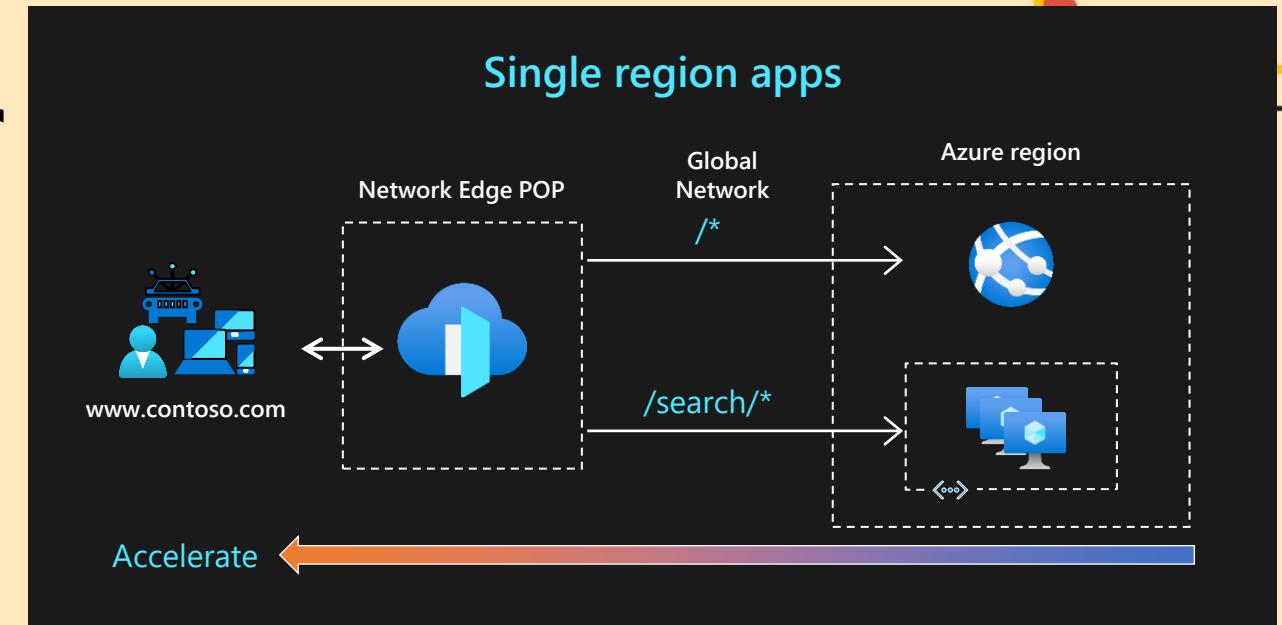
- Improve HTTP performance and reduce page load times

## Load balancing at the Edge and fast-failover

- Build always-on application experiences that fail-fast (safely)

## Integrated SSL, WAF and DDoS

- Protect and scale your application to global users, devices, traffic and attacks



# Traffic Manager or Front Door?

## Traffic Manager

**Any protocol:** Because Traffic Manager works at the DNS layer, you can route any type of network traffic; HTTP, TCP, UDP, etc.

**On-premise routing:** With routing at a DNS layer, traffic always goes from point to point. Routing from your branch office to your on-premises datacenter can take a direct path; even on your own network using Traffic Manager

**Billing format:** DNS-based billing scales with your users and for services with more users, plateaus to reduce cost at higher usage

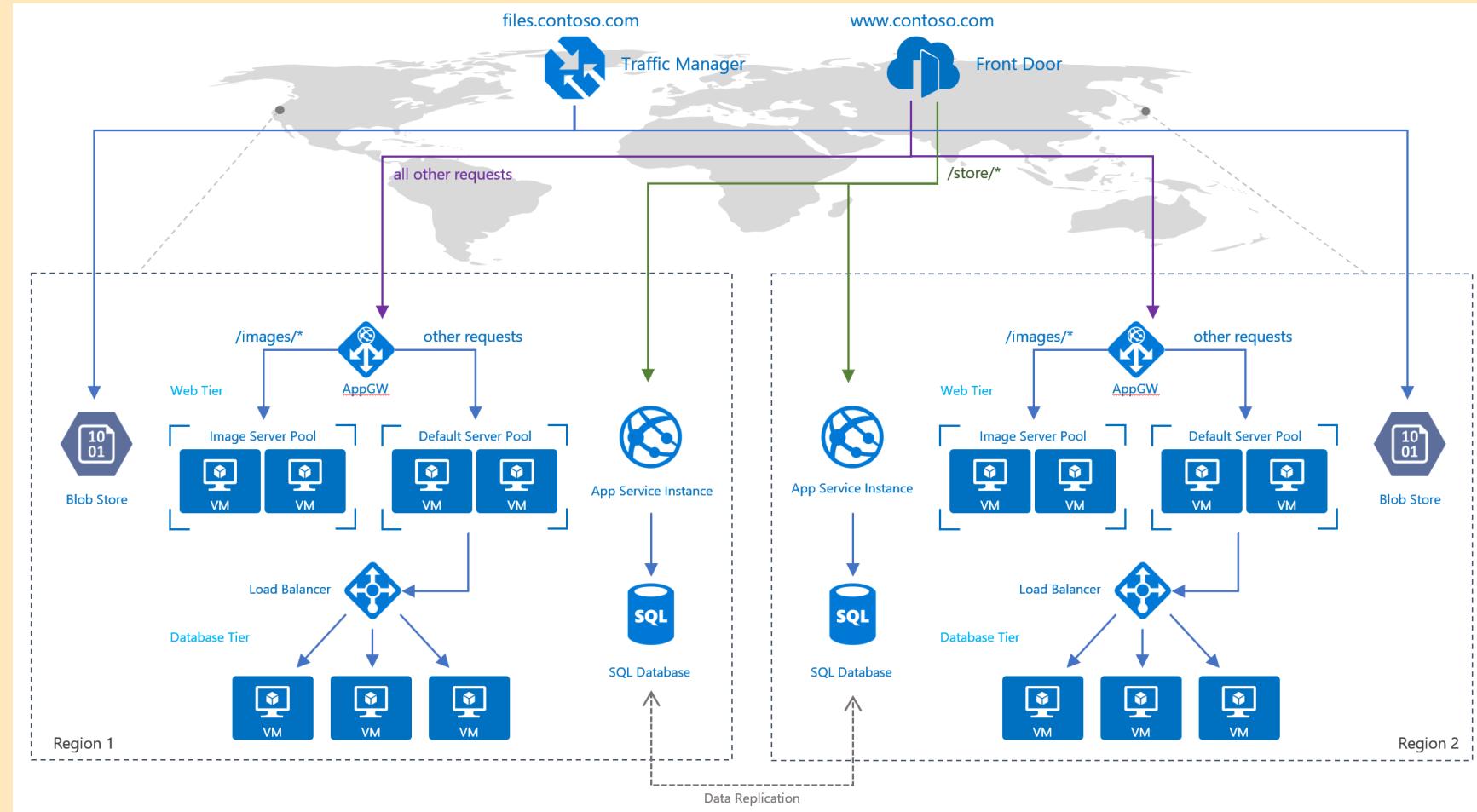
## Front Door

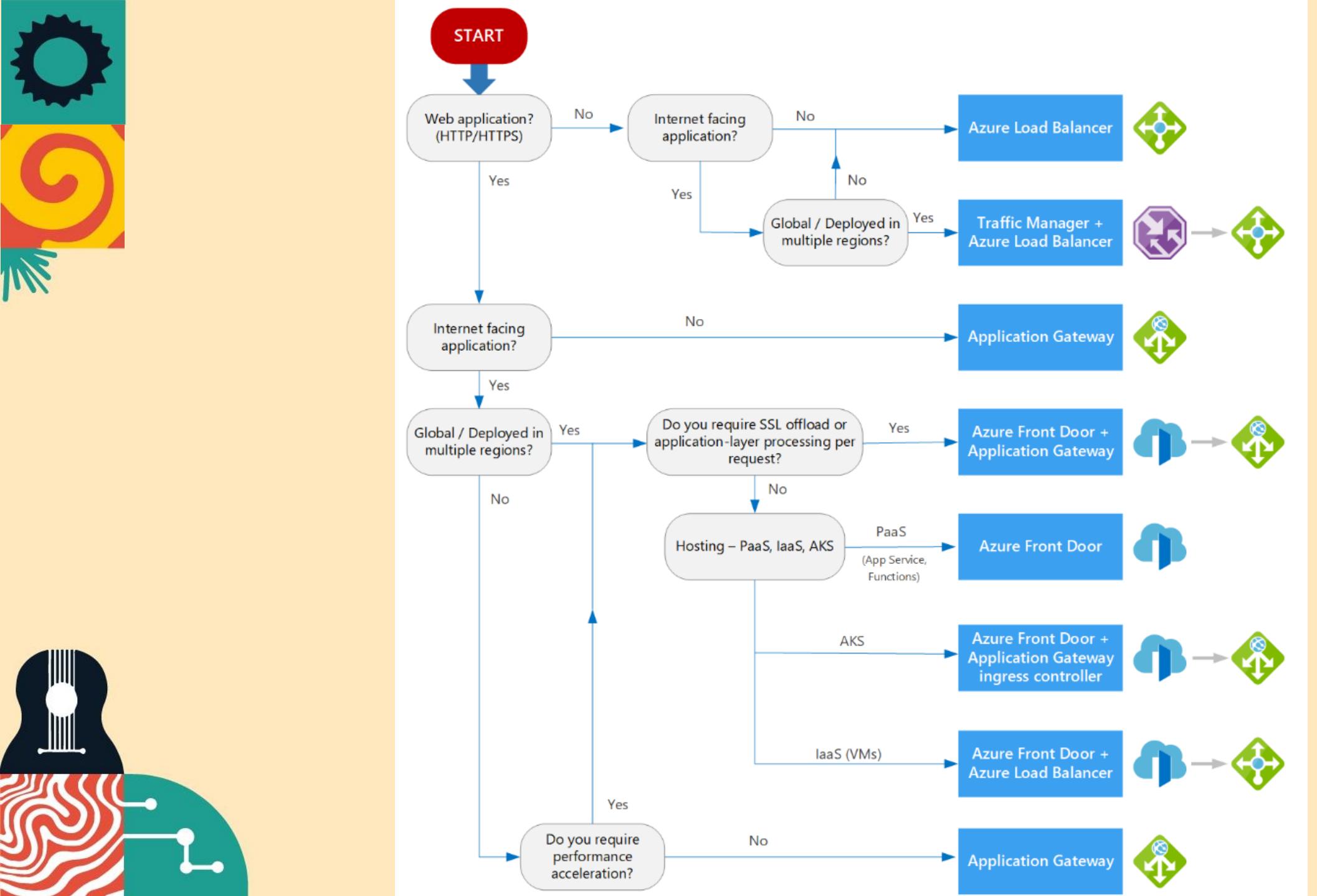
**HTTP acceleration:** With Front Door traffic is proxied at the Edge of Microsoft's network. Because of this, HTTP(S) requests see latency and throughput improvements reducing latency for SSL negotiation and using hot connections from AFD to your application

**Independent scalability:** Because Front Door works with the HTTP request, requests to different URL paths can be routed to different backend/regional service pools (microservices) based on rules and the health of each application microservice

**Inline security:** Front Door enables rules such as rate limiting and IP ACL-ing to let you protect your backends before traffic reaches your application

# Traffic Manager or Front Door?





# DEMO – LOAD BALANCING



OK ...

... but that's only outside networks



# Service Endpoints and Private Link



# PaaS Services and Networking



- PaaS Services are designed to be accessed via public endpoints
- Two main challenges
  - Access “internal” data sources from PaaS (e.g. present SAP data in Azure WebApp)
  - Access PaaS Services from “internal” Systems (e.g. use Azure SQL DB with an app running in a VM with no Internet access)
- Ways to integrate PaaS into networks

# PaaS Services and Networking

## Deploy a dedicated service

Deploy customer specific service instance into own VNET – also for 3<sup>rd</sup> Party  
Integrate PaaS Services into VNET

## Use Service Endpoints

Access to public endpoints via MS Backbone  
Private IP → Public IP allowed

## Utilize Private Links / Endpoints

Private Endpoint (NIC) for your PaaS providing private IP addresses

PaaS → VNET  
(VNET → PaaS)

App Service VNET Integration  
Integration Service Environments  
App Service Environment  
Azure Kubernetes Service (AKS)

...

Azure NetApp Files  
Dedicated HSM

VNET → PaaS

Azure Storage  
Azure Databases  
Azure KeyVault  
Azure Cognitive Services

...

Azure Container Registry (Preview)

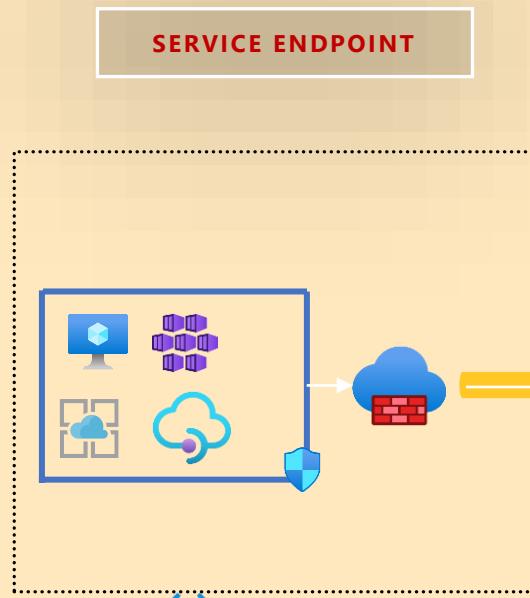
VNET → PaaS

Azure Automation  
Azure Data Factory  
Azure IoT Hub  
Azure Migrate

...

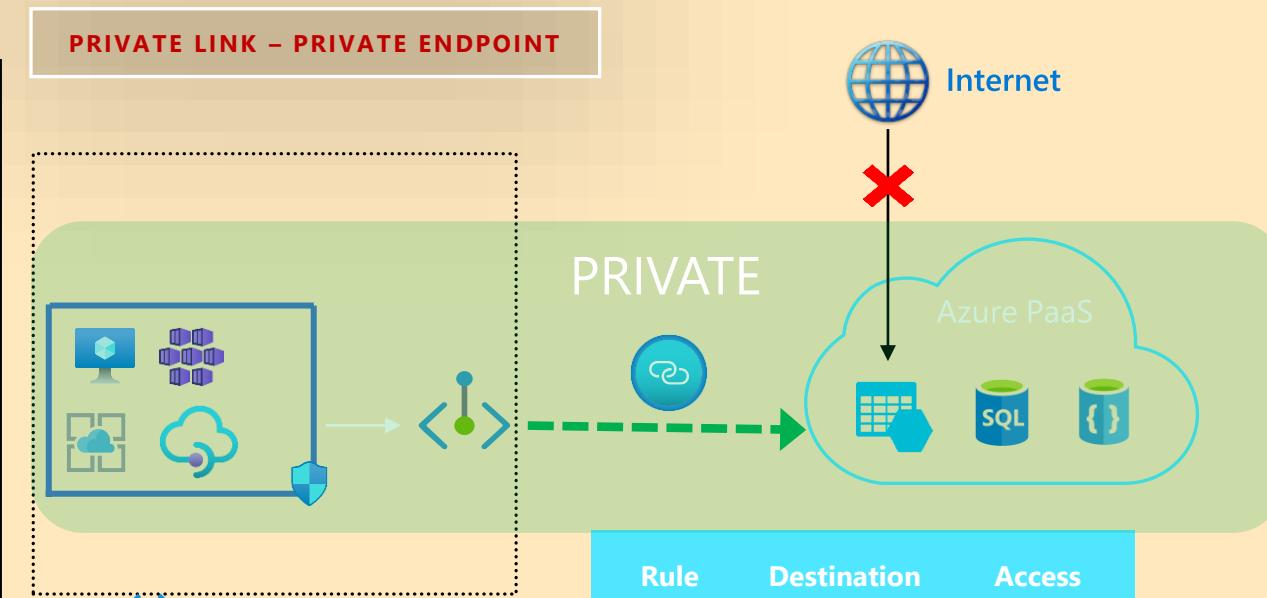
Azure Private Link Services (own)

# Private PaaS



Rule	Destination	Access
stg	STORAGE	Allow
vnet	VNET	Allow
internet	INTERNET	Deny

- VNet to PaaS service via the Microsoft backbone
- Destination is still a public IP address. NSG opened to Service Tags
- Need to pass NVA/Firewall for exfiltration protection

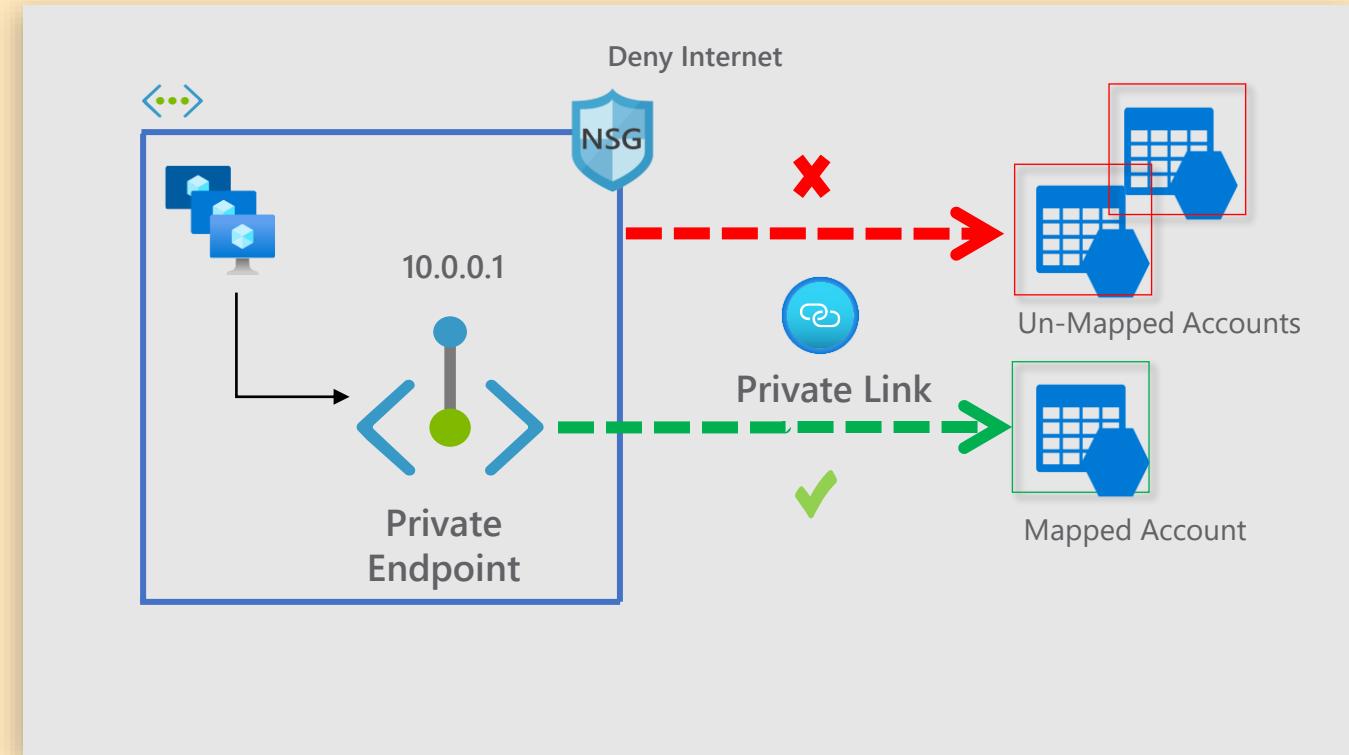


Rule	Destination	Access
vnet	VNET	Allow
internet	INTERNET	Deny

- VNet Paas via the Microsoft backbone
- PaaS resource mapped to Private IP Address. NSGs restricted to VNet space
- Built-in data exfiltration protection

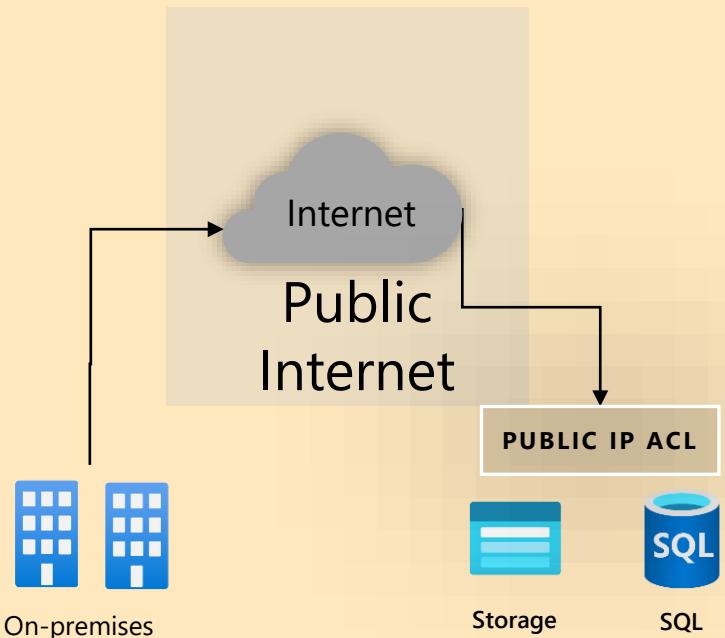
# Data Exfiltration Protection

- Private Endpoint maps specific PaaS resource to an IP address, not the entire service
- Access only to mapped PaaS resource
- Data exfiltration protection is in-built



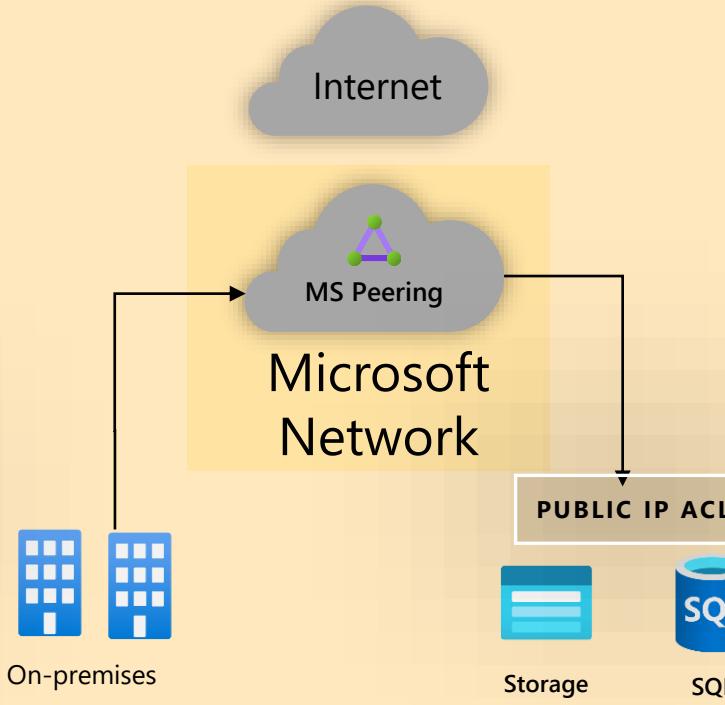
# Secure connectivity from on-premises

Good



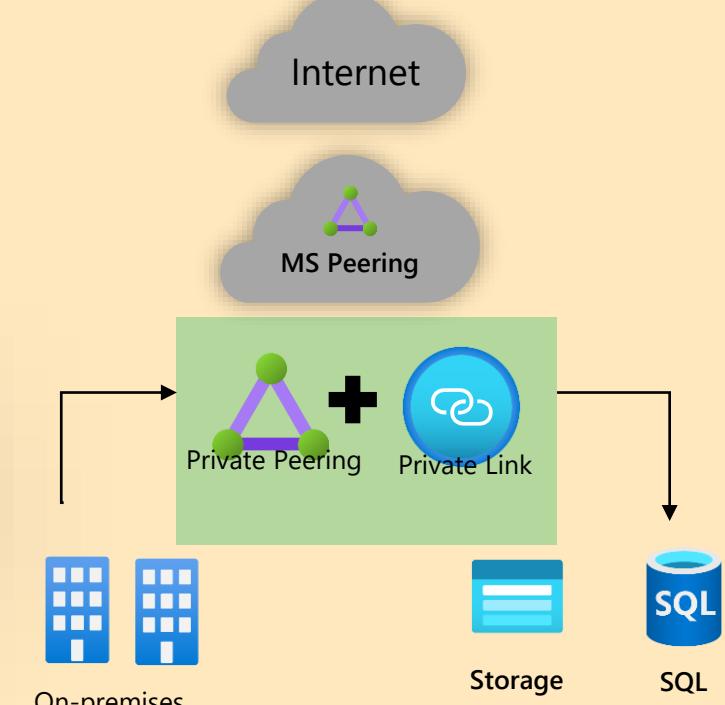
- Traffic traverses the Internet
- Secured using ACLs on Public IPs
- Corporate firewall open to Azure Public IPs

Better



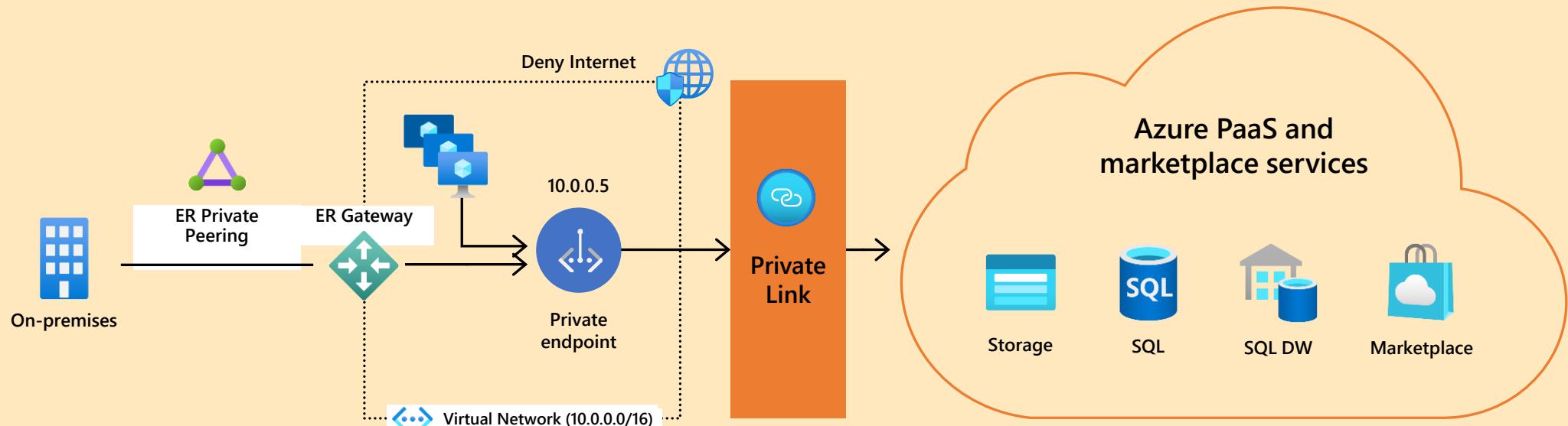
- Traffic stays within Microsoft and partner network
- MS Peering draws Microsoft Public IP traffic
- Corporate Firewall open to Azure Public IPs

Best



- Traffic is fully private traversing the Microsoft network
- No exposure of public IPs on either side
- Corporate Firewall open only to private

# Azure Private Link



## Private Link for Azure Storage, SQL DB and customer own service

Private access from Virtual Network resources, peered networks and on-premise networks

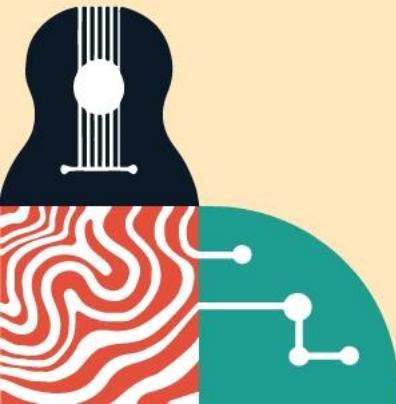
In-built Data Exfiltration Protection

Predictable private IP addresses for PaaS resources

Unified experience across PaaS, Customer Owned and marketplace Services



# There is even more ...



# Your Own Private Link Service

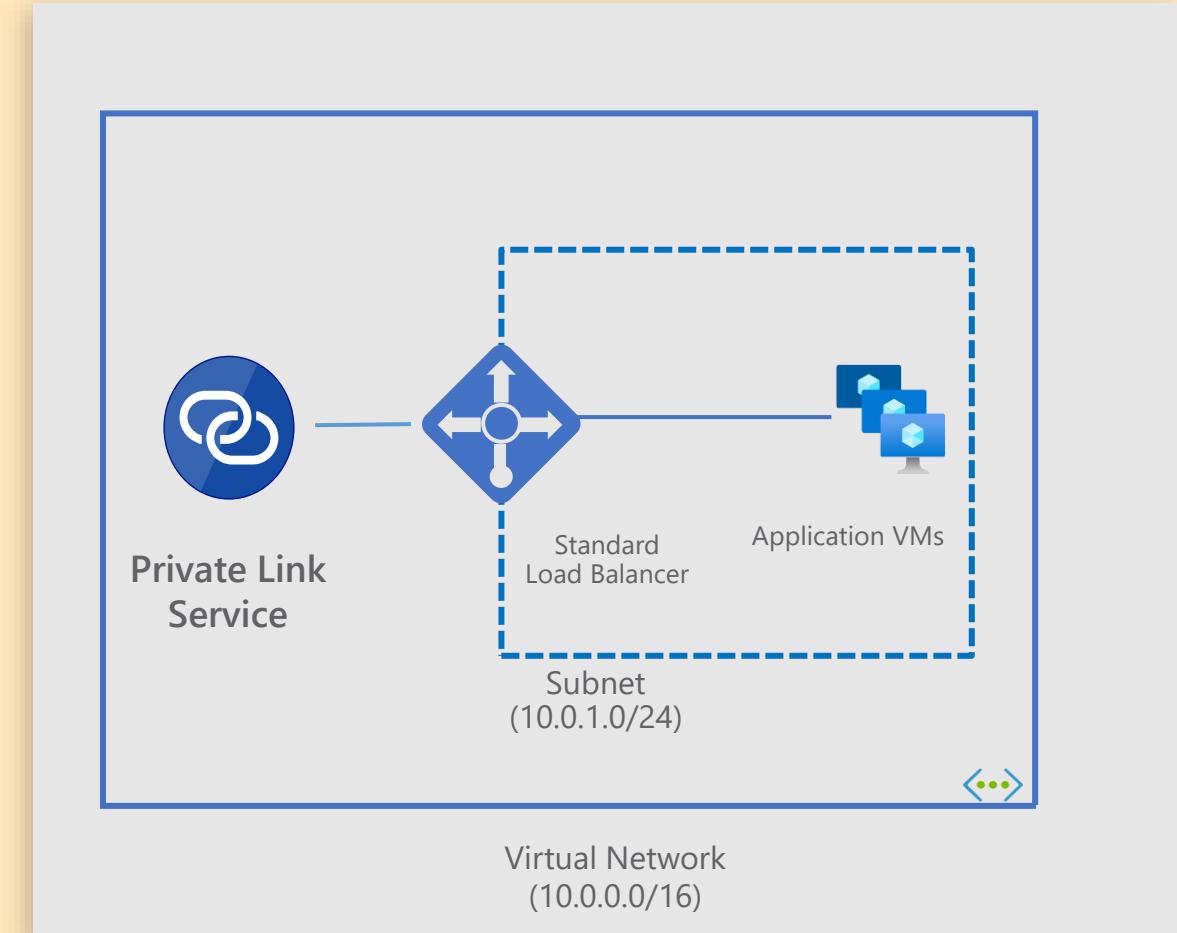
- Create or Convert your existing services into Private Link Service
- VNet-VNet Connectivity without worrying about overlapping IP Space
- No regional, tenant, subscription or RBAC restrictions
- Easily Scale and manage your service



Private Link  
Service

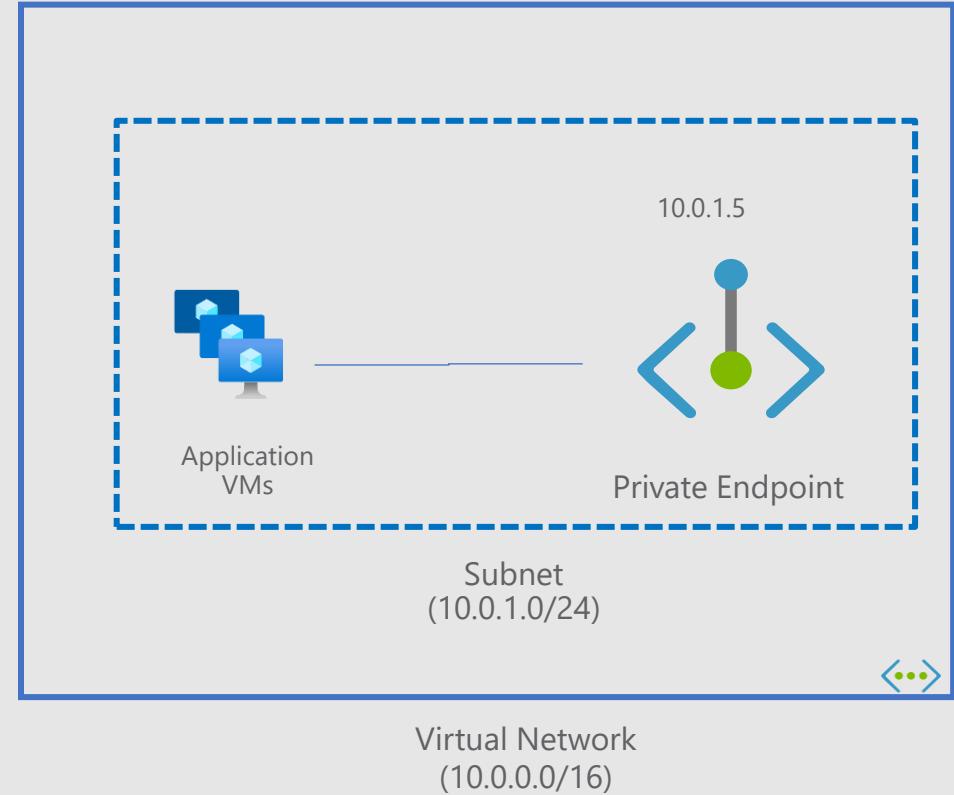
# Create Private Link Service

- Application running behind Standard Load Balancer can be converted into Private Link service with one click of a button/one API call
- Private Link Service tied to Frontend IP configuration of Standard Load Balancer
- Frontend IP Configuration can be either Public or Private

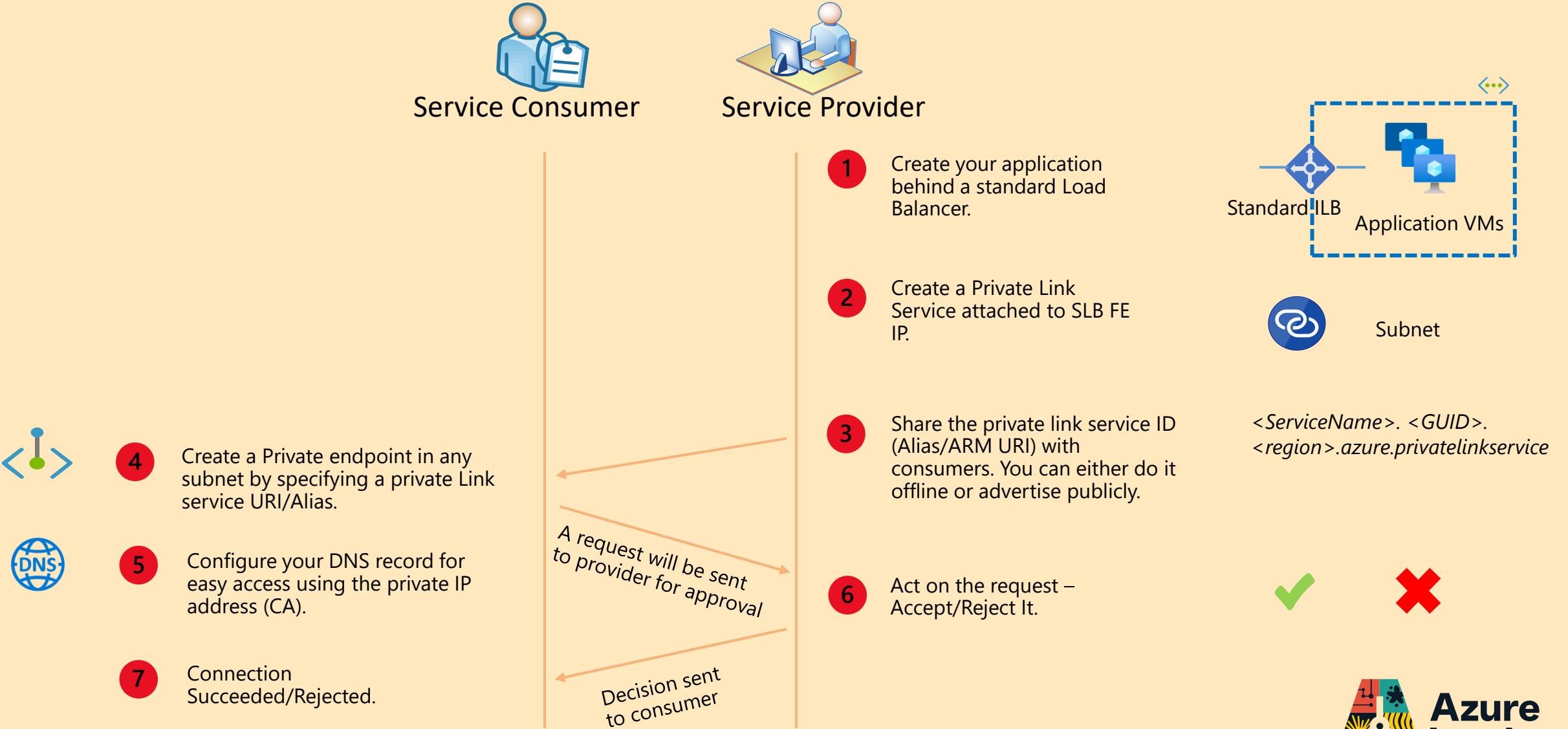


# Consume Private Link Service

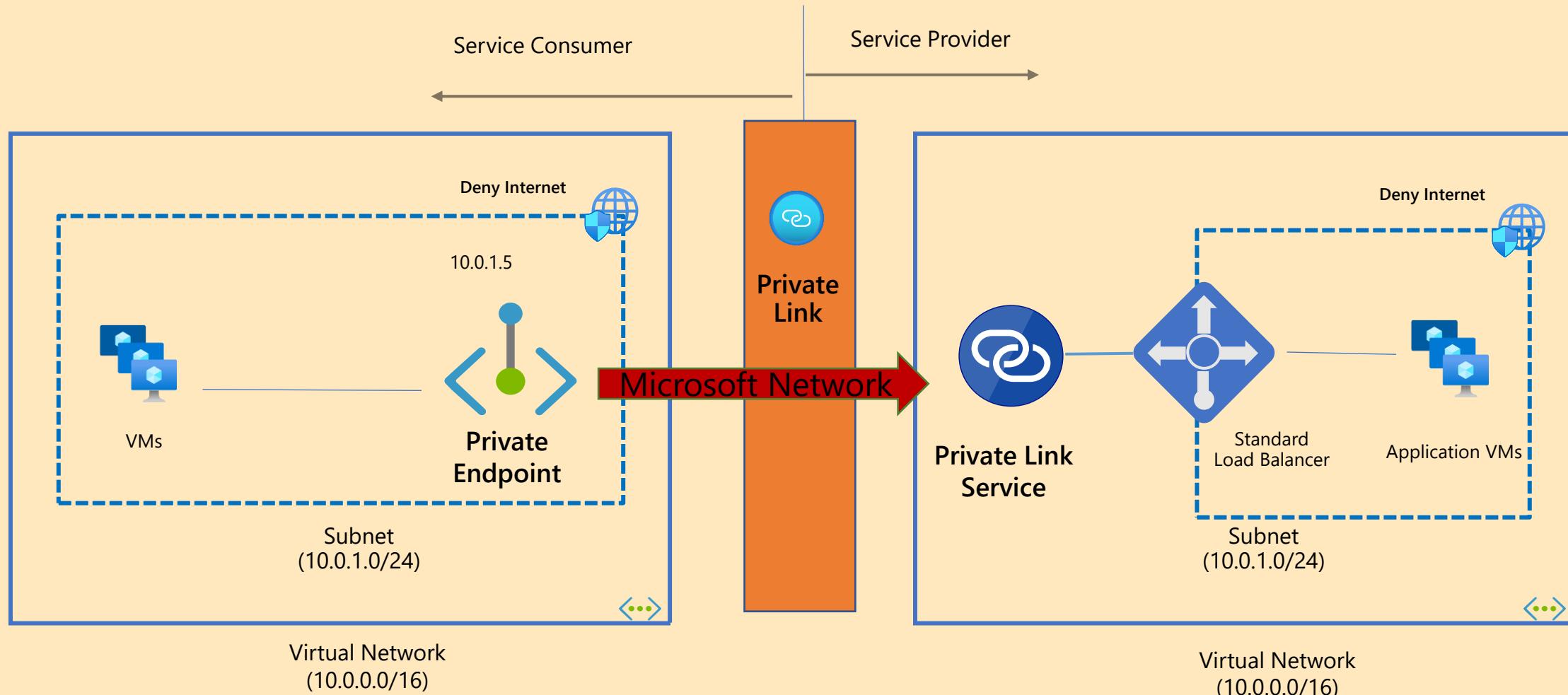
- Create a Private Endpoint in your VNet linking to Private Link Service.
- Multiple consumers can connect to same service. No RBAC restrictions.



# Approval Workflow



# Complete Picture



# DNS for PaaS?!



# What about DNS?



- Public DNS is “no longer working” when using Azure Private Endpoints! E.g. Storage Account:
- <https://demostordus2021.blob.core.windows.net>

```
C:\Users\EricBerg>nslookup demostordus2021.blob.core.windows.net
Server:  unifi.localdomain
Address: 192.168.1.1

Non-authoritative answer:
Name:      blob.ams07prdstr05a.store.core.windows.net
Address:   52.239.143.36
Aliases:   demostordus2021.blob.core.windows.net
```

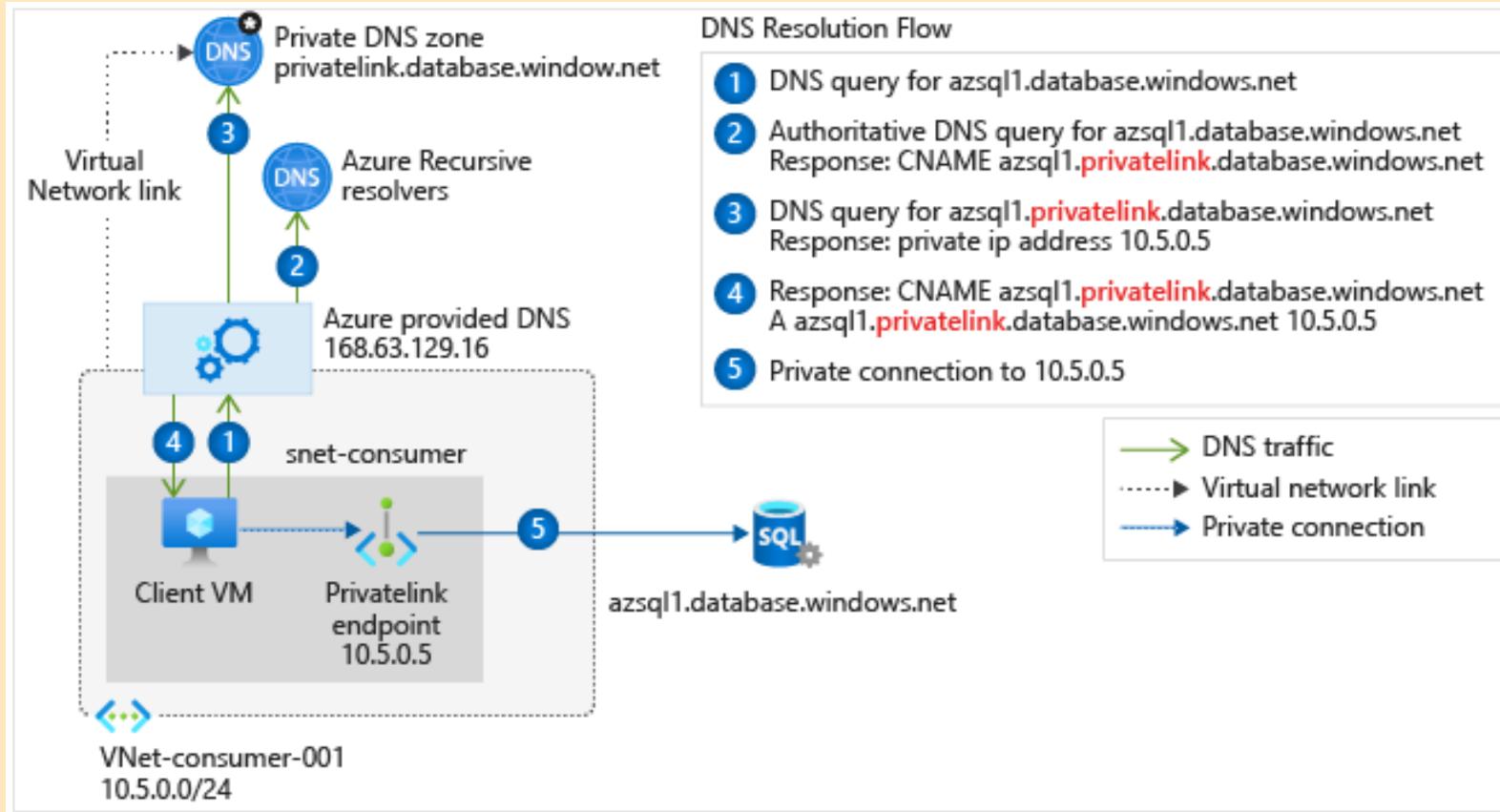
- <https://demostordus2021pep.blob.core.windows.net>

```
C:\Users\EricBerg>nslookup demostordus2021pep.blob.core.windows.net
Server:  unifi.localdomain
Address: 192.168.1.1

Non-authoritative answer:
Name:      blob.ams07prdstr02a.store.core.windows.net
Address:   20.150.37.228
Aliases:   demostordus2021pep.blob.core.windows.net
           demostordus2021pep.privatelink.blob.core.windows.net
```

# Azure Private DNS

Create Private DNS zones for your services (can be done at creation !!! ATTENTION)



# DEMO – Private Link / Endpoint

# Azure Private DNS at Scale

- Consider Enterprise CAF Solution
  - Prepare central private DNS zones
  - Deny creation of Private DNS zones in spokes via policy
  - Create Azure Policy to “DeployIfNotExists” a DNS Zone Group to Private Endpoints
- Solution will take care of everything
- BUT
  - bound to one tenant, as policy resides in one tenant
  - Only one DNS Zone supported per policy

# How are things built?



WestEurope

WestUS



WestEurope

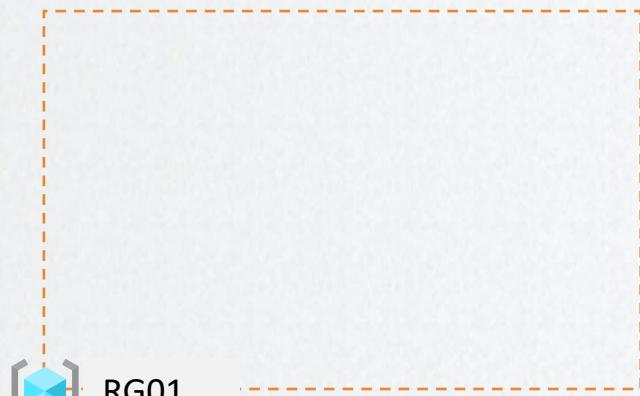


RG01

RG02

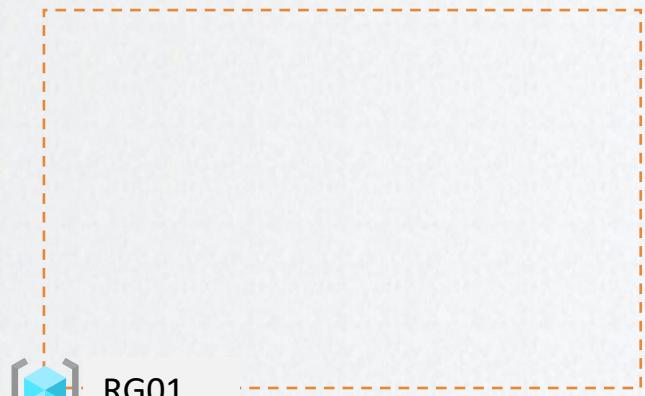
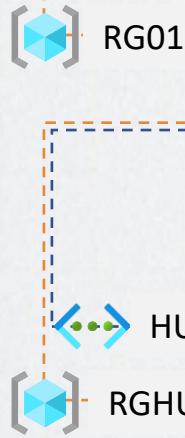
WestUS

RG03





WestEurope



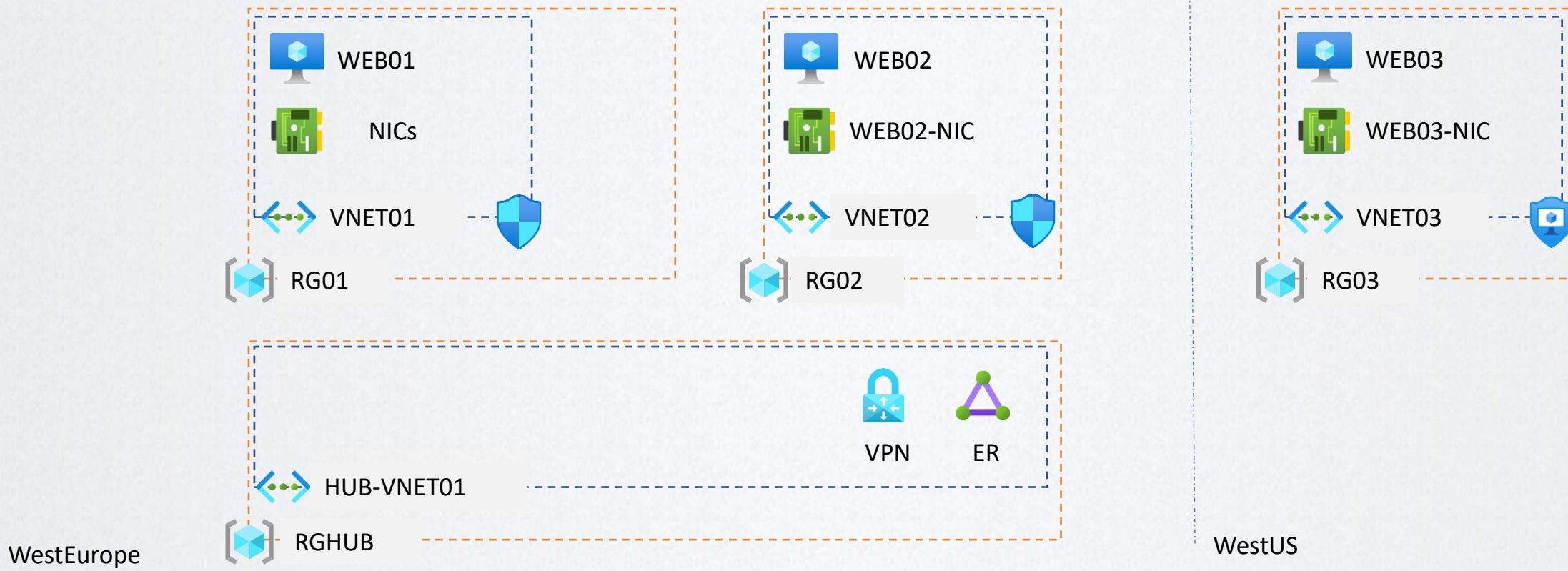
VPN

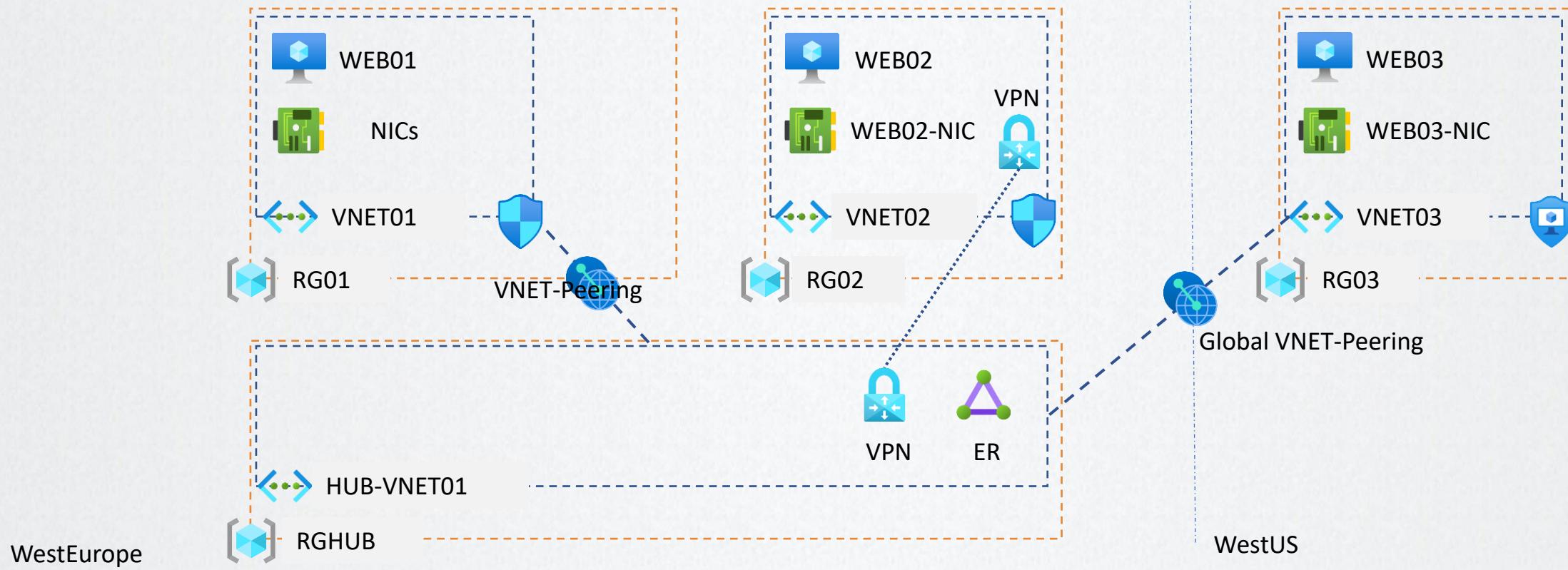


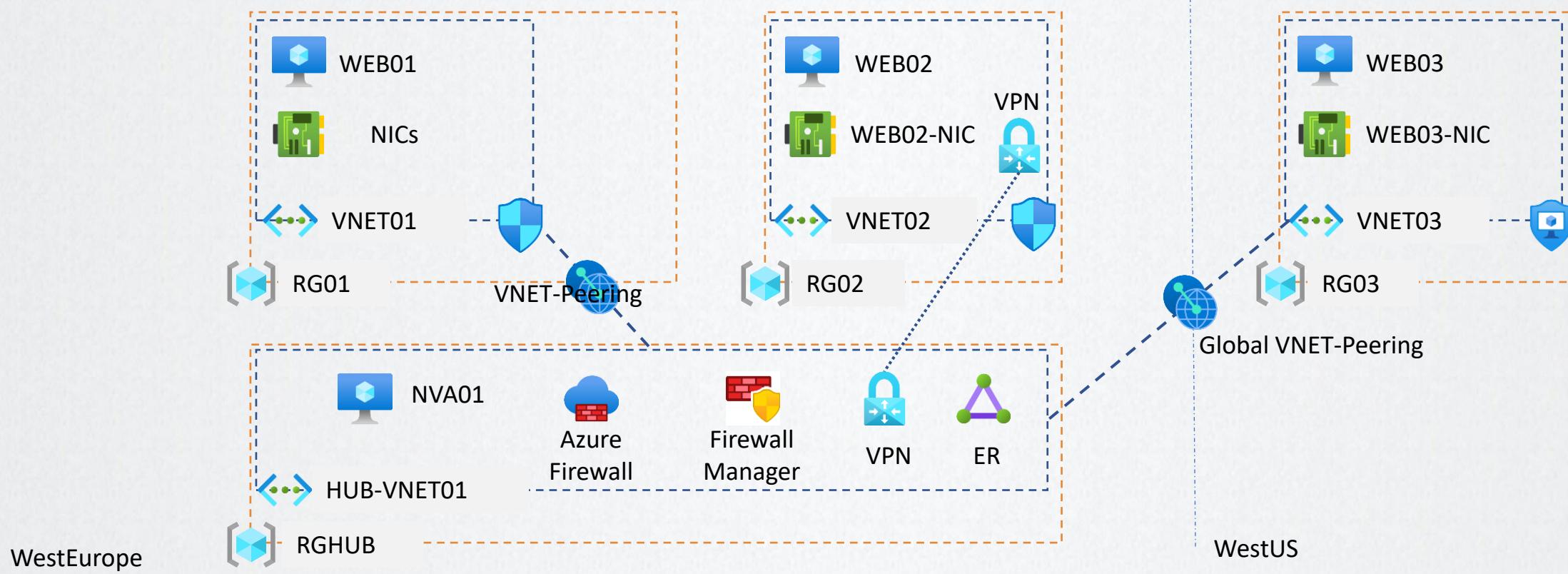
ER

WestUS



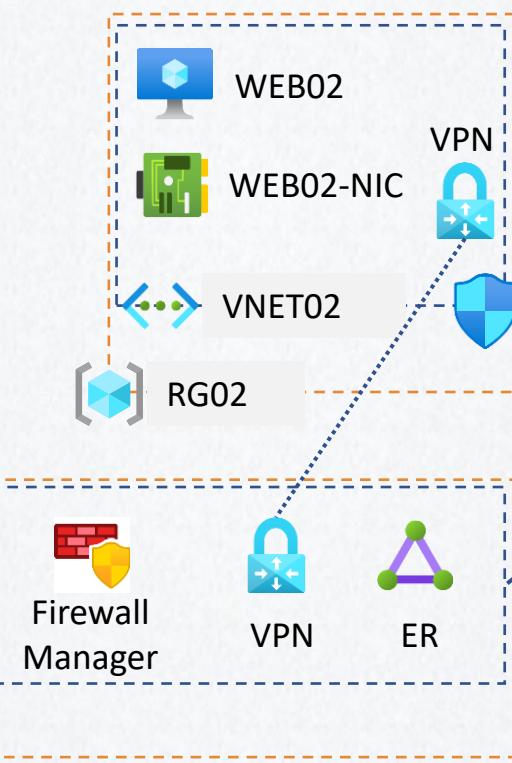
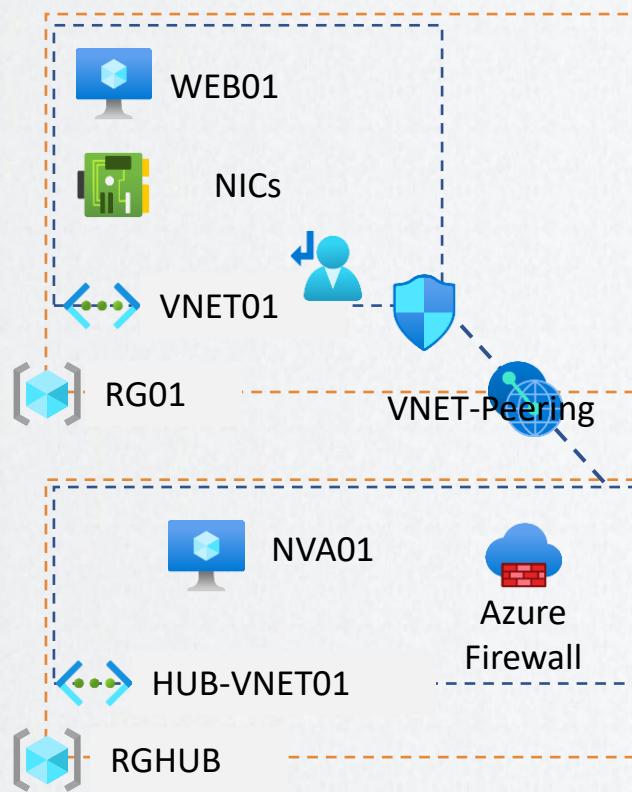




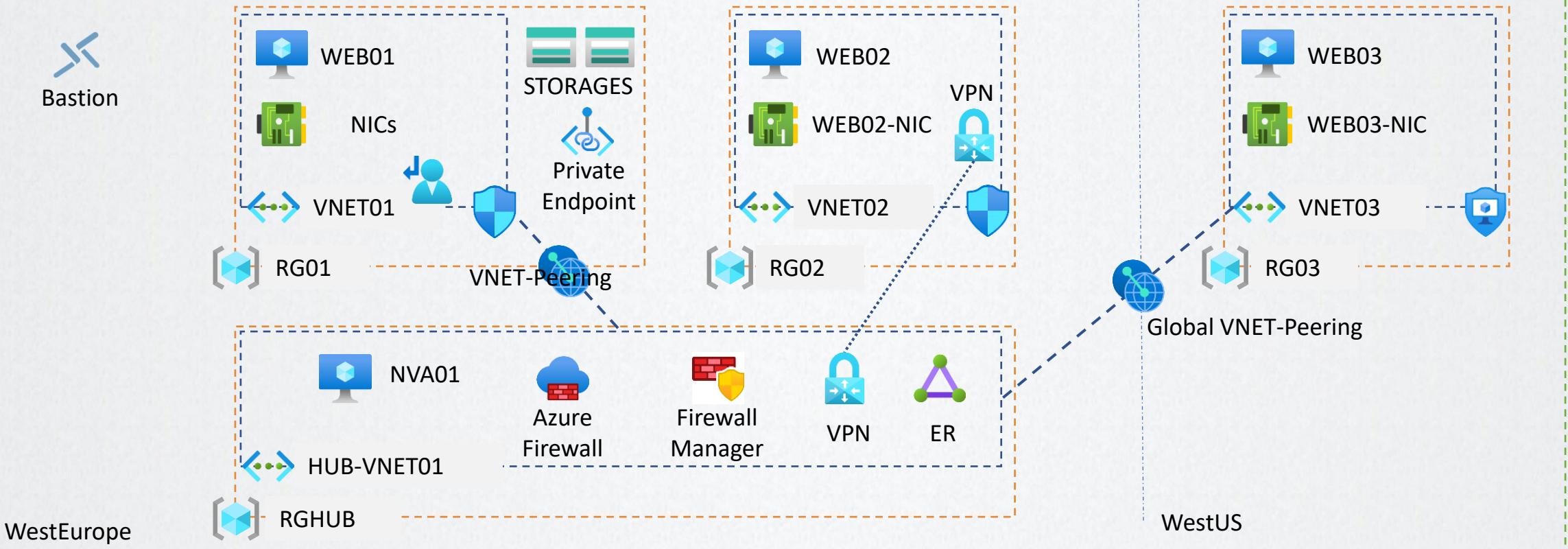




WestEurope



WestUS





Azure DNS



CDN



Bastion

WEB01

NICs



STORAGES

Private  
Endpoint



VNET01



RG01



HUB-VNET01



RGHUB

NVA01



Azure  
Firewall



Firewall  
Manager



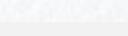
VPN



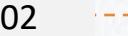
ER

WEB02

WEB02-NIC



VNET02



RG02



VPN



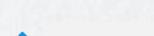
VNET03



RG03

WEB03

WEB03-NIC



VNET03



RG03

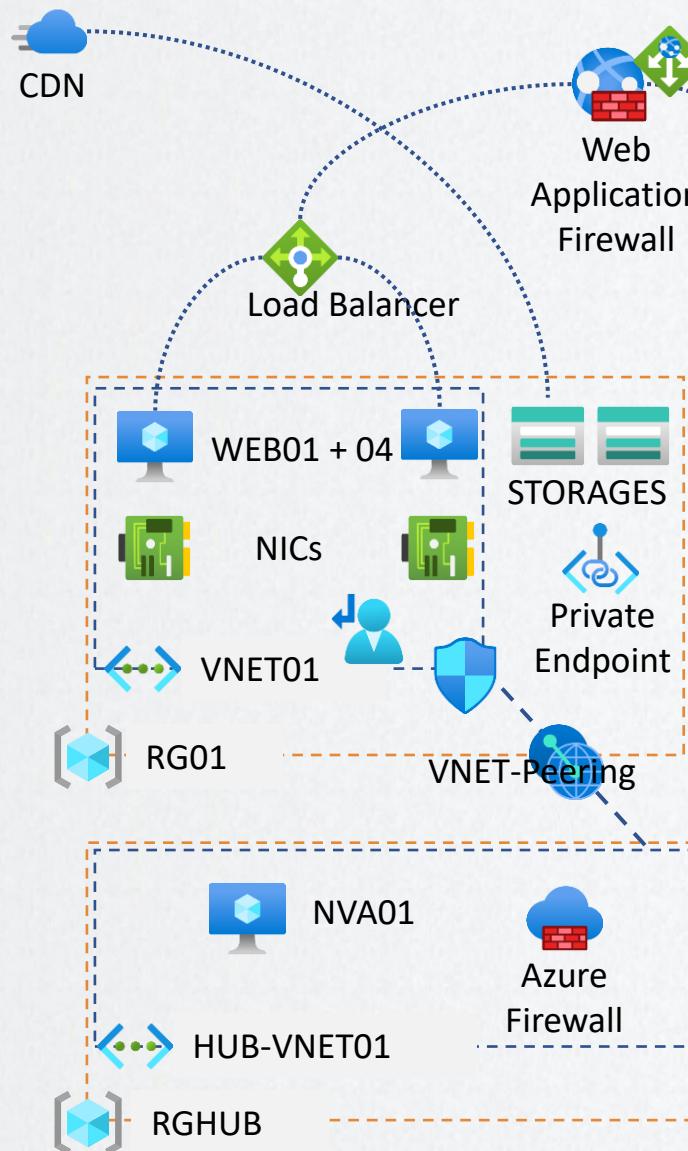
Global VNET-Peering

WestEurope

WestUS



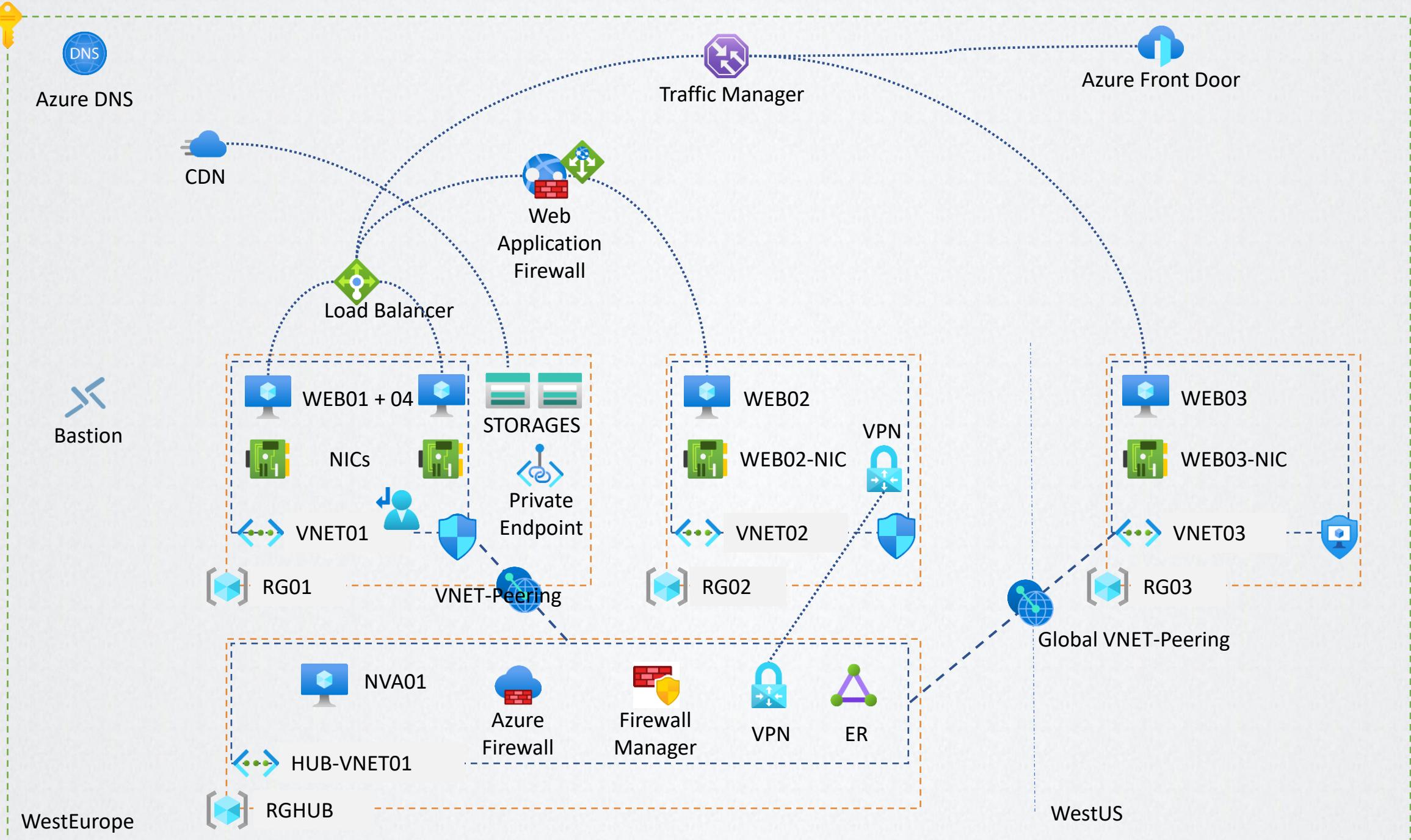
Azure DNS

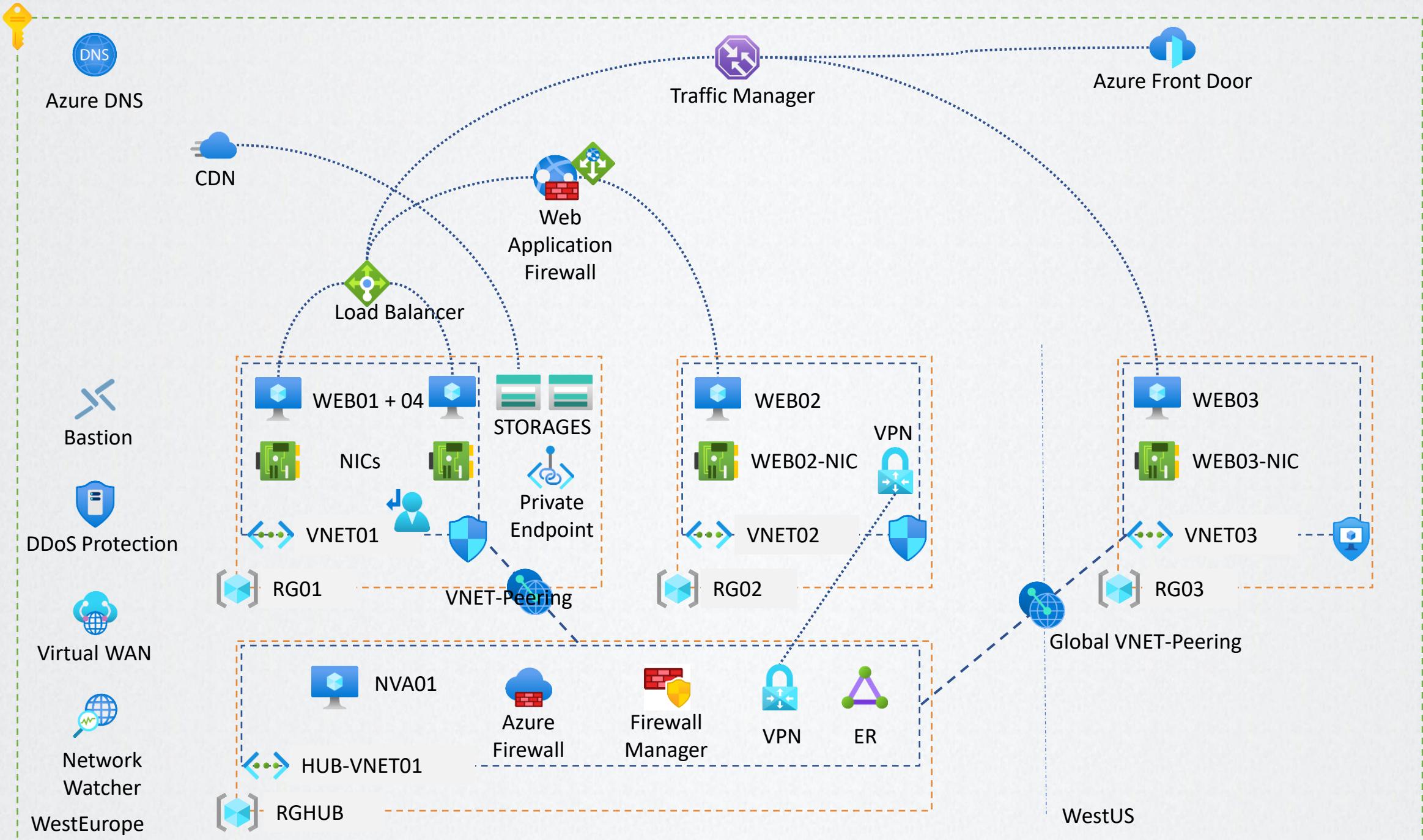


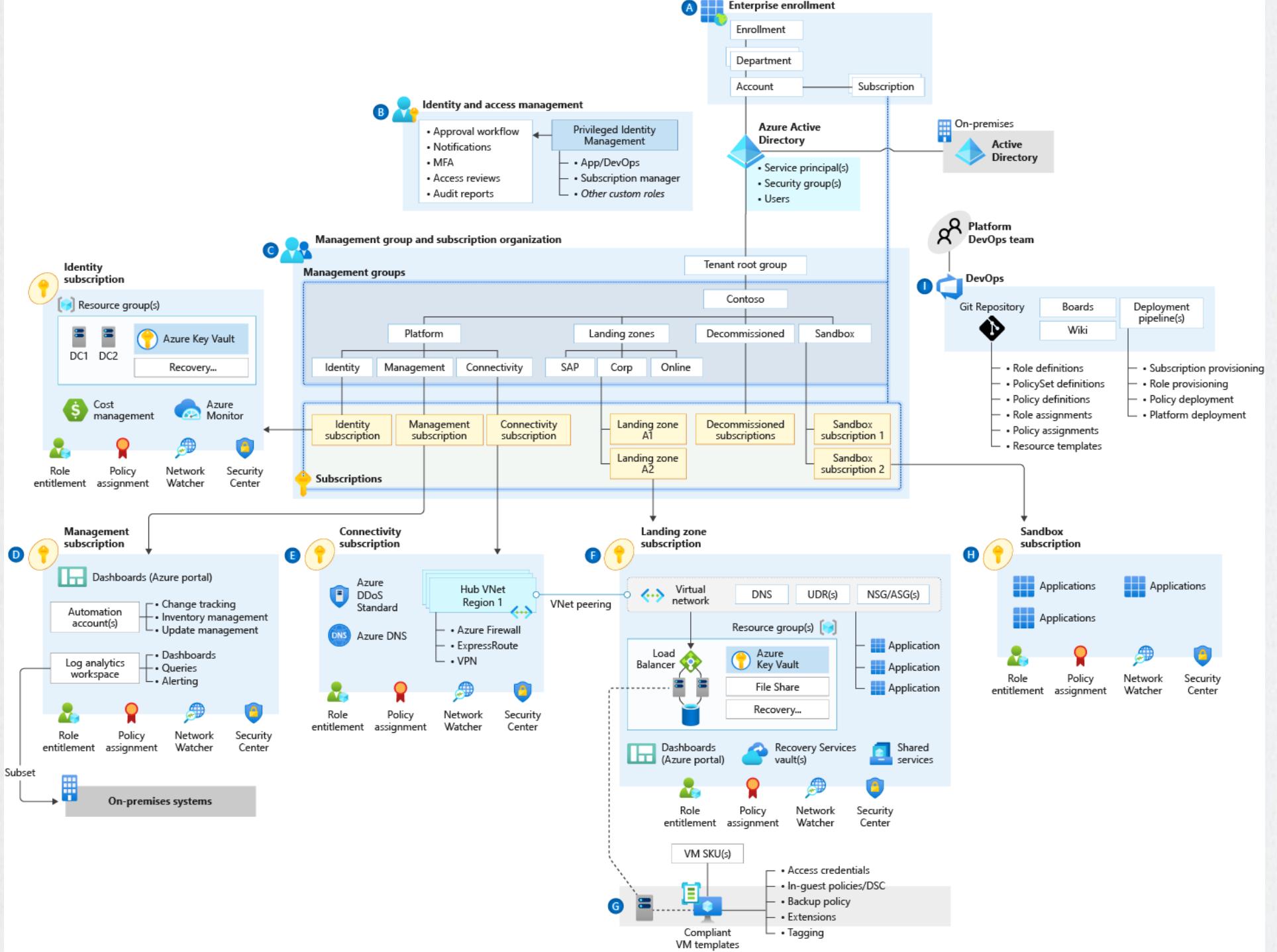
Bastion

WestEurope

WestUS









# Thank you! Questions?!

