# Geo Redundant VPN in Azure

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# Demonstration Objectives

- Geo Redunant VPN, based on BGP routing
- Over 2 Azure Regions and 3 sites:
  - Head Quarters (HQ), On Premise Network, VPN enabled
  - West Europe, a hub-and-spoke configuration in The Netherlands
  - North Europe, a hub-and-spoke configuration in Ireland
- BGP Routing behaviour
- Setup monitoring for BGP Peers

Source available: https://github.com/aggerritsen/georedundantvpn

# Classless Inter-Domain Routing (CIDR)

- IP addresses are described as consisting of two groups of bits in the address: the most significant bits are the **network prefix**, which identifies a whole network or subnet,
  - eg. **10.0.0.0/24**
    defines network with 256 IP addresses
    between 10.0.0.0 and 10.0.0.255. (10.0.0.4-10.0.0.254 useable in Azure)
  - The /24 is the Network Prefix
  - See https://cidr.xyz for range calculation

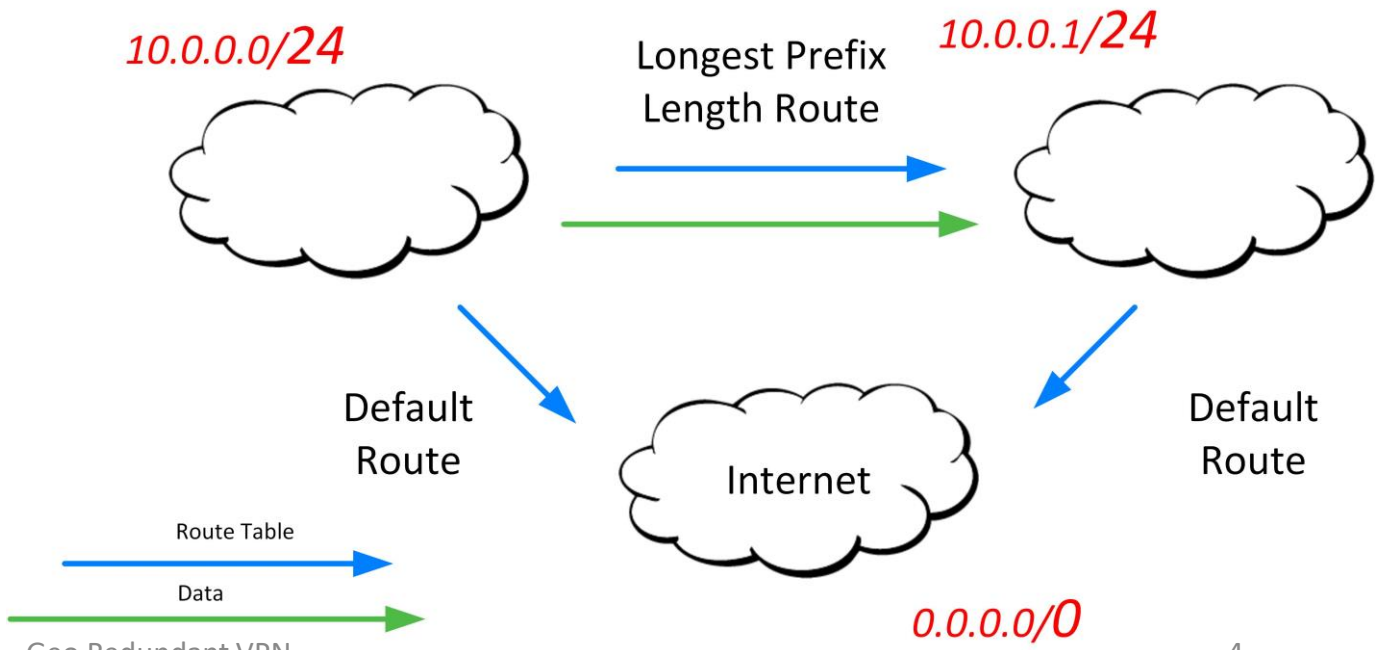
# Longest Prefix Length Routing Order

- This method defines a routing order based on :

  *"When a particular destination IP address matches more than one route in a router's routing table, the router uses the most specific route - in other words, the route with the **longest prefix length**."*

Example:

a route defined for **10.0.0.0/24**
gets priority over
a *default route* defined
for **0.0.0.0/0**



# Azure Routing Priority

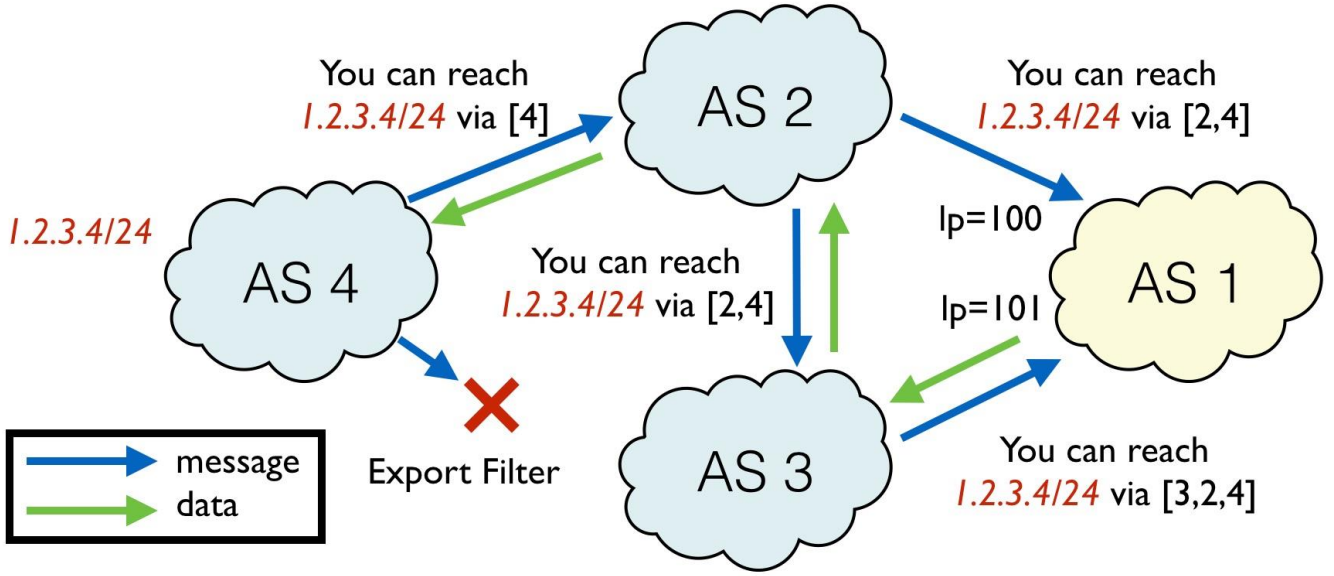
- Longest Prefix Length gets evaluated.
- If multiple routes contain the same address prefix, Azure selects the route type, based on the following priority:

    1. User-defined route
    2. BGP route
    3. System route

- System Routes are derived from VNets, VNet Peerings, Local Network Gateway Connections, Azure Service Endpoints and other Azure Backbone routes like Internet.

# Border Gateway Protocol

- Border Gateway Protocol (**BGP**) is a standardized exterior gateway protocol designed to exchange routing and reachability information between autonomous systems (AS) on the Internet.



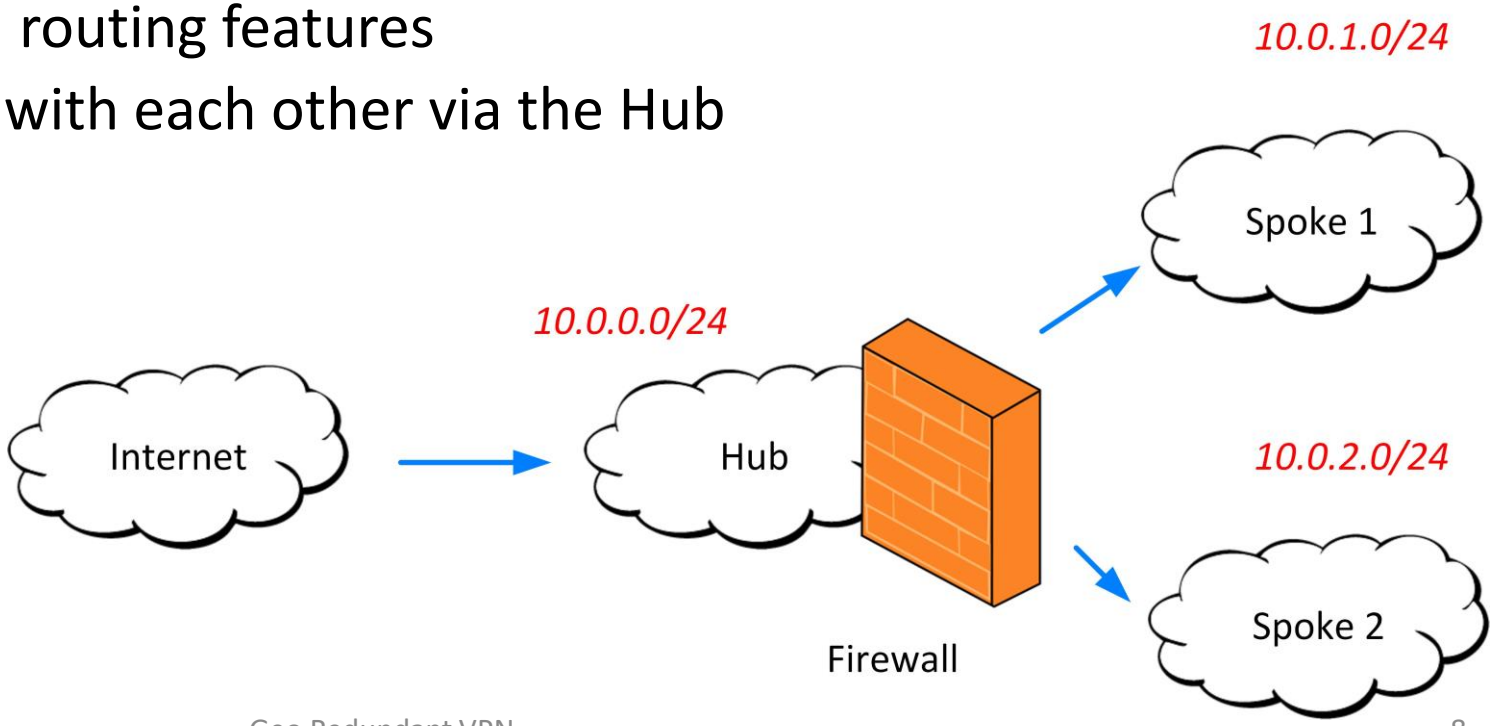
# Azure Route Tables

- When you exchange routes with Azure using BGP, a separate route is added to the route table of all subnets in a virtual network for each advertised prefix.
- The route is added with *Virtual network gateway* listed as the source and next hop type.

See https://docs.microsoft.com/en-us/azure/virtual-network/virtual-networks-udr-overview

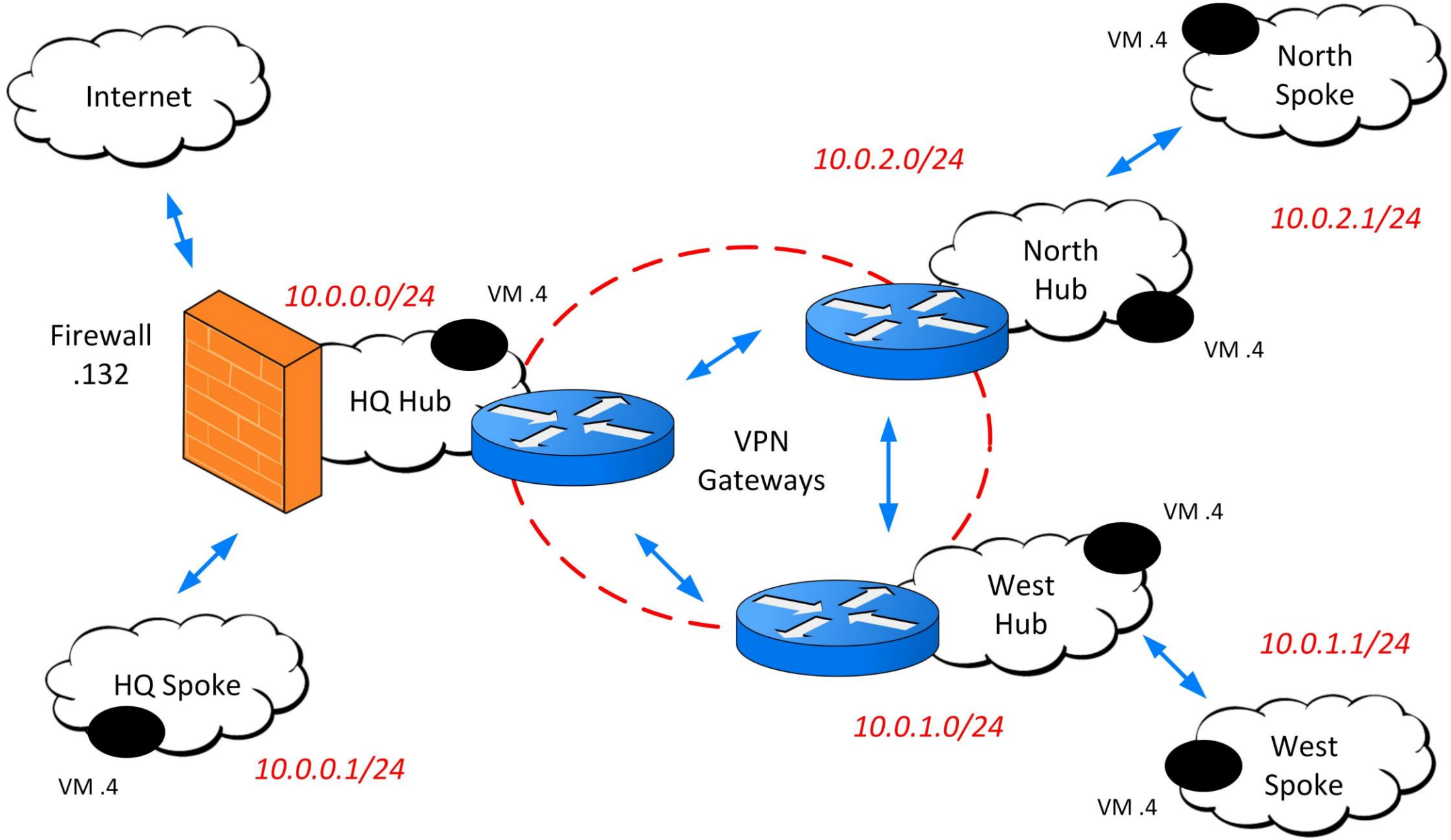
# Hub-and-Spoke topology

- Hub-and-Spoke networks ar a common architecture pattern in cloud
  - A Hub Network acts as ‘egde’ for a region or tenant
  - Hubs are used to connect other regions/tenants, providing firewall and routing features
  - Spokes communicate with each other via the Hub



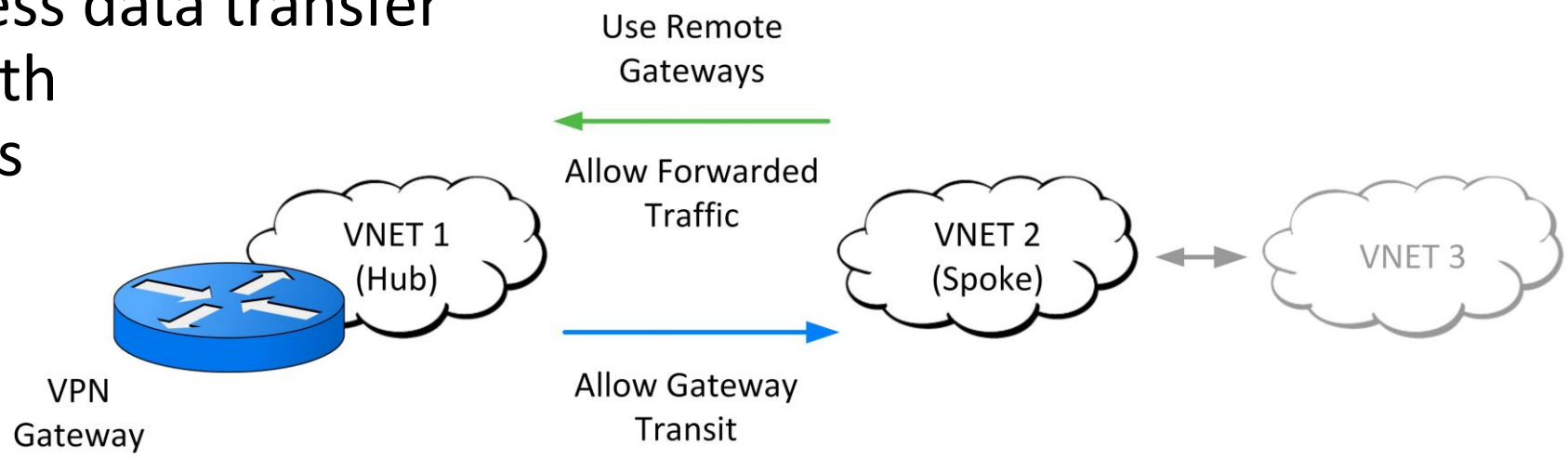
# Demo environment

- We are going to use 6 Virtual Network
  - HQ-Hub: 10.0.0.0/24, HQ-Spoke: 10.0.1.0/24, with firewall setup
  - West-Hub: 10.1.0.0/24, West-Spoke: 10.1.1.0/24
  - North-Hub: 10.2.0.0/24, North-Spoke: 10.2.1.0/24
- Having each 1 or 2 subnets:
  - DefaultSubnet x.x.x.x./26, eg. 10.0.0.0/26 (64 IP adresses)
  - GatewaySubnet x.x.x.64/26, eg. 10.0.0.64/26 (64 IP adresses)
- Each subnet having a Virtual Machine
  - Jumphost-[XXX]-vm, with Internal and Public IP address,
    eg. JumphostHub-HQ-vm, 10.0.0.4 and 51.124.79.159


Internet
VM .4
North Spoke
10.0.2.0/24
10.0.2.1/24
North Hub
VM .4
10.0.0.0/24
VM .4
Firewall .132
HQ Hub
VPN Gateways
VM .4
West Hub
10.0.1.1/24
HQ Spoke
10.0.1.0/24
West Spoke
VM .4
10.0.0.1/24
VM .4

# Virtual Network Peering

- Routing between two Virtual Network in the same region
  - Peering enables the use of the peered VNet's gateways
  - Allow or disallows forwarding from other peered networks
- Exists of a set of 2 peered connections
- Ingress and egress data transfer cost apply to both Virtual Networks



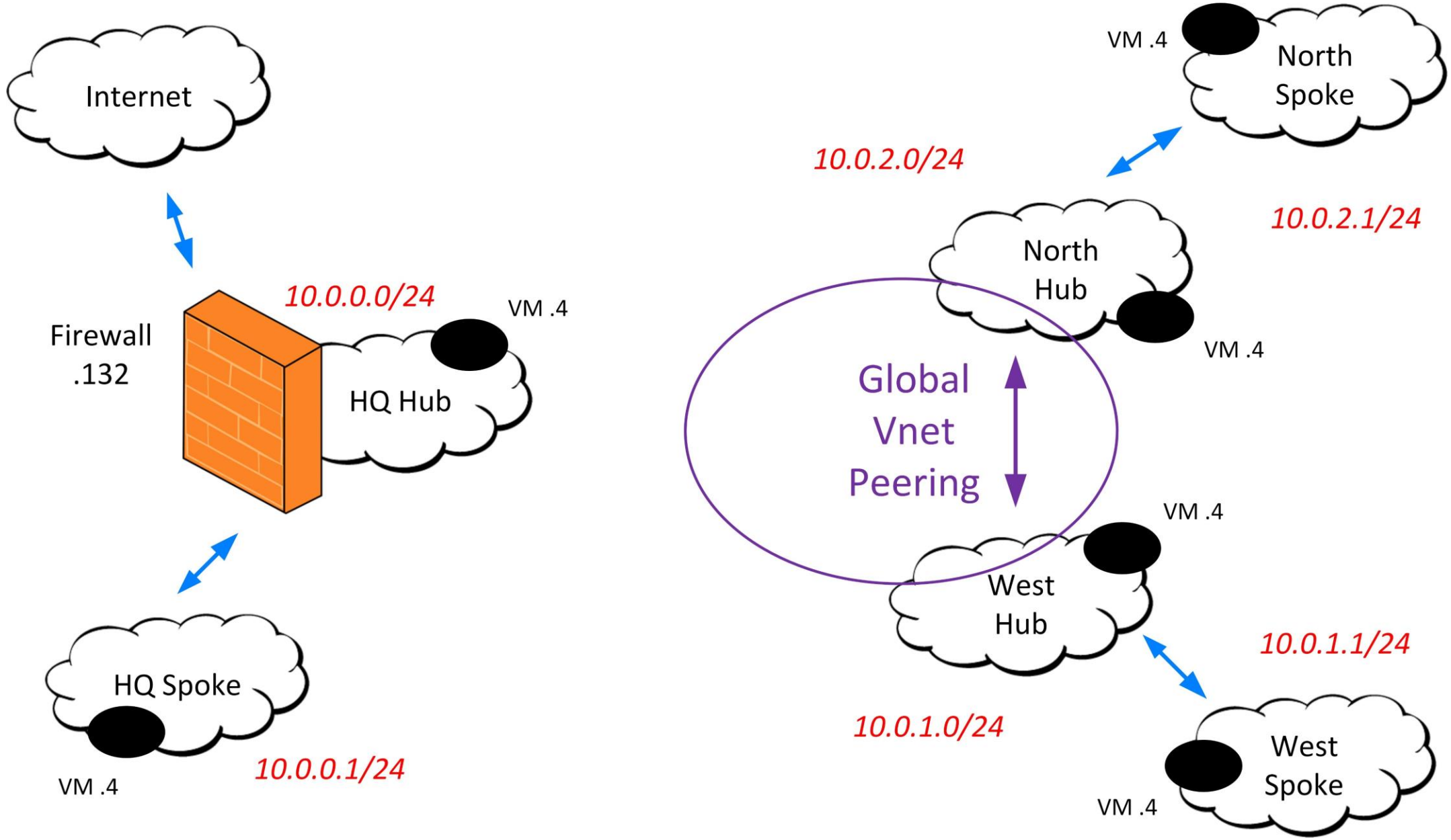
# Options for connecting two regions

- Global VNet Peering
  - Runs over Azure backbone network
  - For peering two regions, use Global Vnet Peering
  - Peering two Azure Tenants, two accounts with permissions are required
- VNet-to-VNet Virtual Network Gateway
  - Runs over Azure backbone network
- Site-to-Site (IPSEC) Virtual Network Gateways
  - Runs over Internet
- Express Routes (not covered in this demonstration)
  - Runs over leased/dedicated lines, through listed service providers

# Global VNet Peering

- Exist of a set of 2 connections
- Azure Backbone ensures connection with low and stable latency
- Ingress and Egress Data transfer costs are billed to each site
- Routing solely based on connected Virtual Networks,
  not on the spokes connected to the hub.
- Does not support BGP

► Create Global VNet Peering (between West and North Hub)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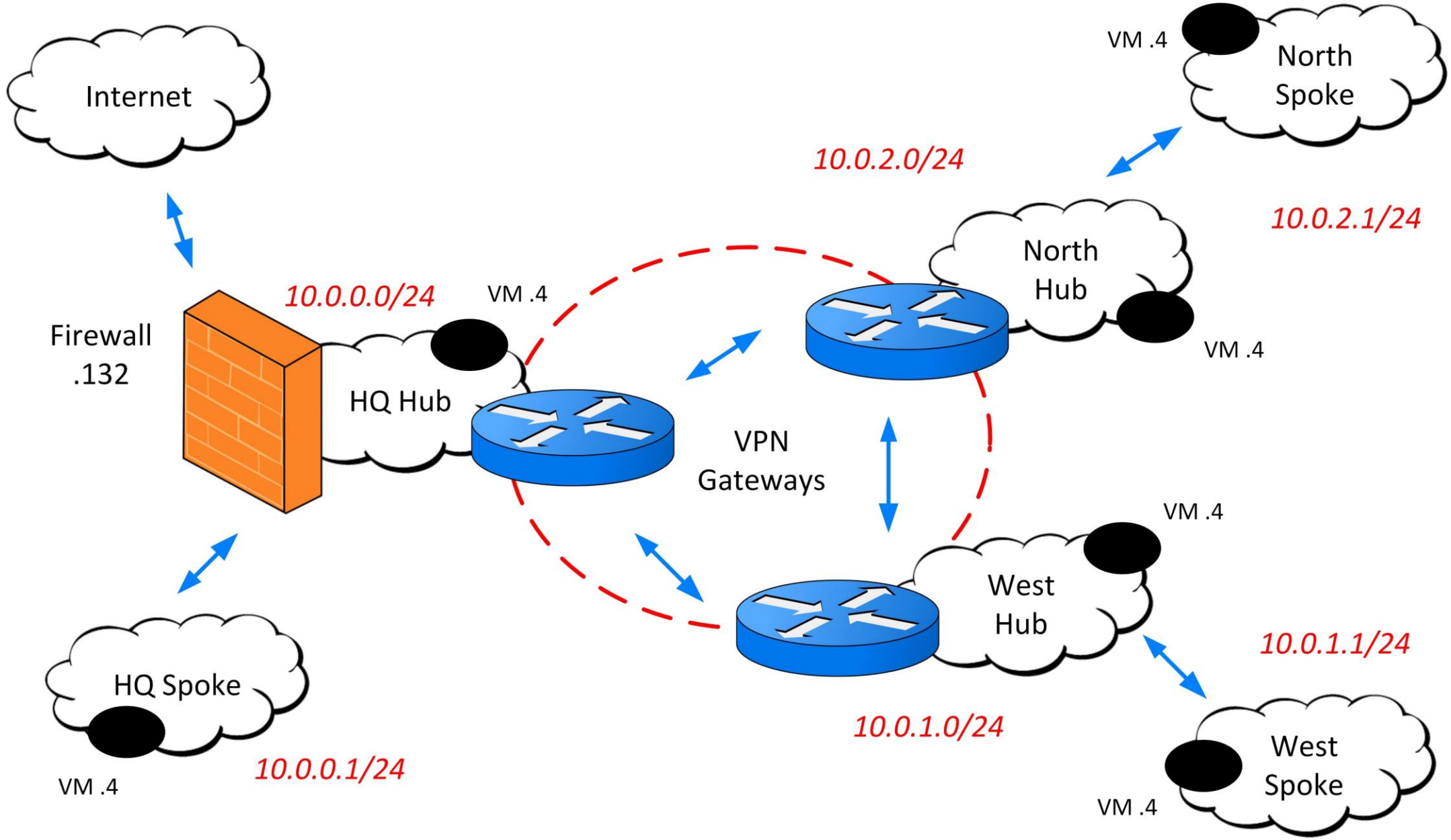
HQ Hub
HQ Spoke
VM .4
10.0.0.1/24
VM .4
North
Spoke
10.0.2.0/24
10.0.2.1/24
North
Hub
VM .4
Global
Vnet
Peering
VM .4
West
Hub
10.0.1.1/24
10.0.1.0/24
West
Spoke
VM .4

# VNet-to-VNet VPN

- Has paired connections using the same preshared key
- Uses Azure Backbone connection with low and stable latency
- In the same region, there are no transfer cost,
  between regions ingress and egress transfer cost are billed.
- Routing based on known System Routes of peers
-

► Create Full Mesh VNet-to-VNet VPN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VM .4

# Redundancy issues

- Supports fully propgated routing and transparent connectivity
- Fails to guarentee connectivity in case of loss of one link

►Start PING form West Spoke to HQ Spoke

10.1.1.4 (ifconfig) to 10.0.1.4

►Break West European Connection (HQ-West)

# Full Mesh with BGP on VNet-to-VNet VPN

- With BGP, routes are automatically added to route table
- BGP only works on Route Based VPN’s
- Routing to BGP Peer is added to route table
- Guarentees connectivity by dynamic routing in case of loss of one link

►Enable BGP on connection (using resource manager)

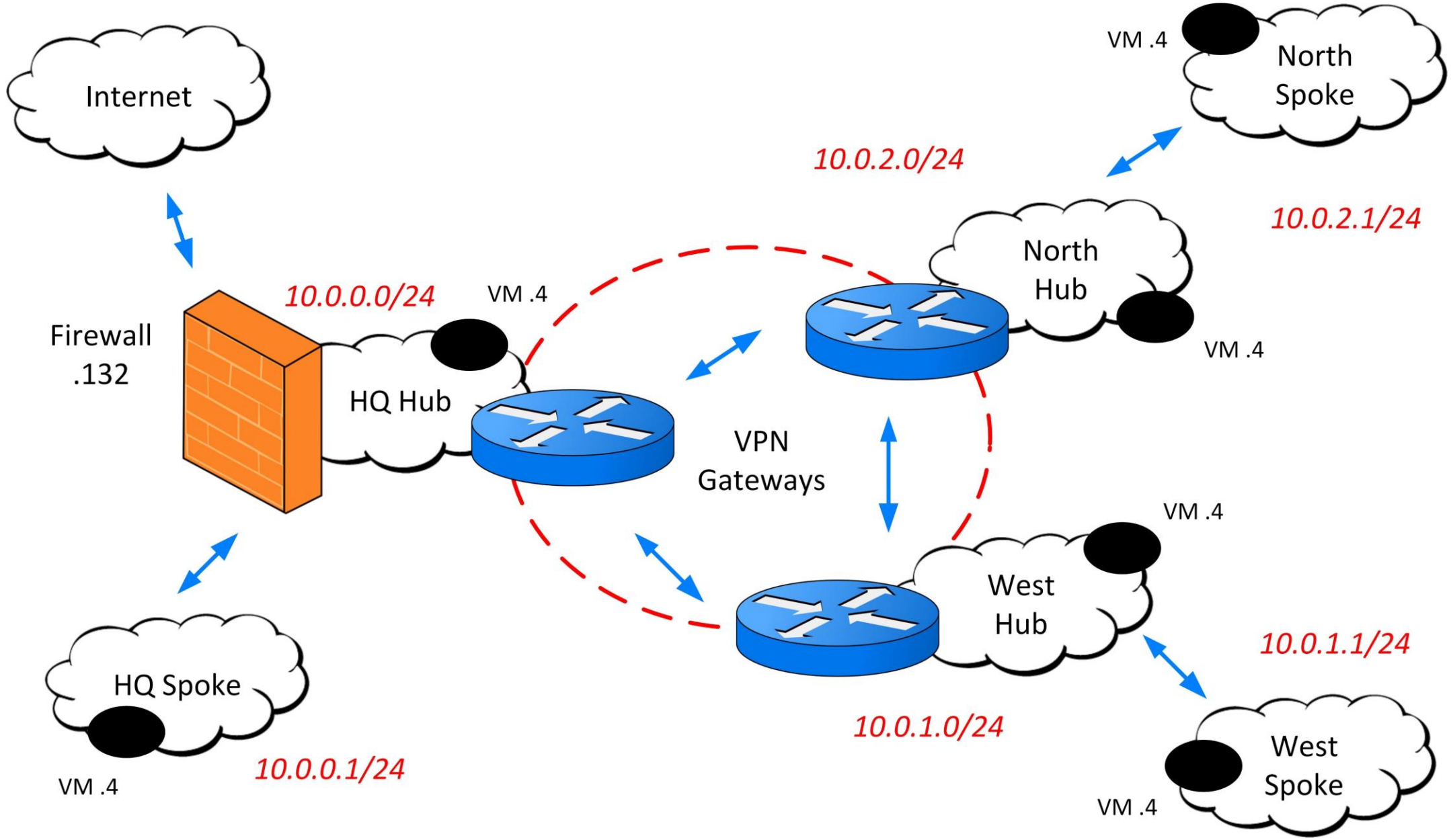
►Start PING form West Spoke to HQ Spoke (with Link broken)

# Site-to-Site VPN with BGP (IPSEC)

- Uses Local Network Gateways to connect to Non-Azure VPN, mandatory approach for connection On Premise networks
- Connects via Internet with possible bandwith and latency limitations
- Transfer costs billed for egress data only, for every site.
- S2S connection allows specific IPSEC settings for Non-Azure VPN
- Same functionality as VNet-to-VNet VPN, with or without BGP

►Build full Mesh Site-to-site VPN using Local Network Gateways

►Start PING form West Spoke to HQ Spoke, and break the link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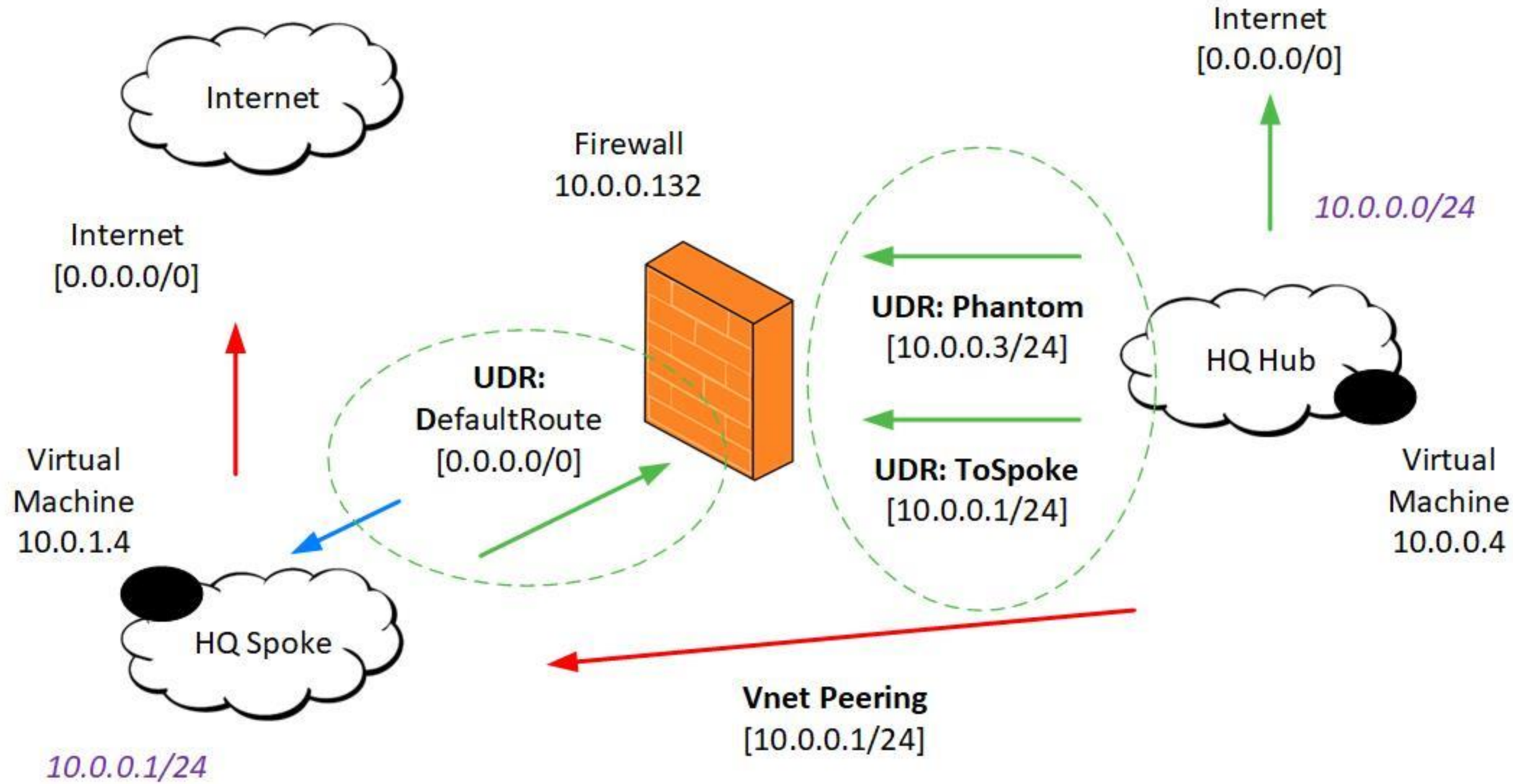
VM .4
10.0.0.1/24
VM .4

# BGP and User Defined Routes (UDR)

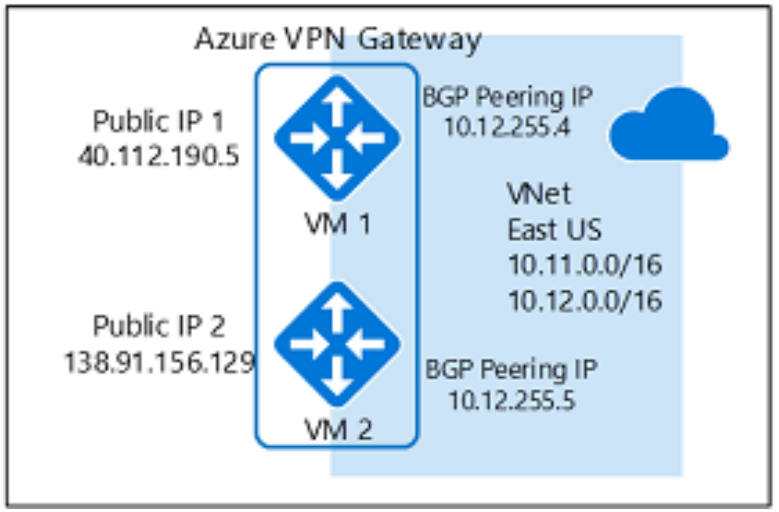
- User Defined Routes take priority over System Routes in routing, but
- User Defined Routes are not taken into account by BGP

►Traceroute and Effective Routes from West Spoke to HQ Spoke

►Effective Routes to Phantom CIDR from West Spoke


Internet
Internet
[0.0.0.0/0]
Firewall
10.0.0.132
Internet
[0.0.0.0/0]
10.0.0.0/24
UDR: Phantom
[10.0.0.3/24]
HQ Hub
UDR:
DefaultRoute
[0.0.0.0/0]
UDR: ToSpoke
[10.0.0.1/24]
Virtual
Machine
10.0.1.4
Virtual
Machine
10.0.0.4
HQ Spoke
Vnet Peering
[10.0.0.1/24]
10.0.0.1/24

# BGP Considerations




- BGP offers redundant VPN connectivity, in a full mesh multi-site setup. For VPN to 1 site use Active-Active Virtual Network Gateways[1]
- To connect to On Premise networks, use Local Network Gateways
- Between Azure Regions, VNet-to-VNet VPN is a better choice
- User Defined Routes are not progated by BGP
  - When you needs to propagate routes in your hybrid network, use Next Generation Firewall that can export and/or advertise specific routes
  - Even then the **default route** 0.0.0.0/0 is not propgated by BGP, split in 2 parts (0.0.0.0/1 and 128.0.0.0/1)

[1] https://docs.microsoft.com/en-us/azure/vpn-gateway/vpn-gateway-activeactive-rm-powershell

# Monitoring BGP Peers

- Network Wachter monitor requires agent on Virtual Machine
- Peer IP’s can be reached via TCP 179
- Monitoring on Round Trip Times may leads to too many false positives
- As BGP Peers keep being accessible via the redundant routes, alerts only occur when there is a total outage

►Create Network Watcher Monitoring