



LARGE SCALE DYNAMIC MULTIPOINT VPN

NOVEMBER 2004

INTRODUCTION

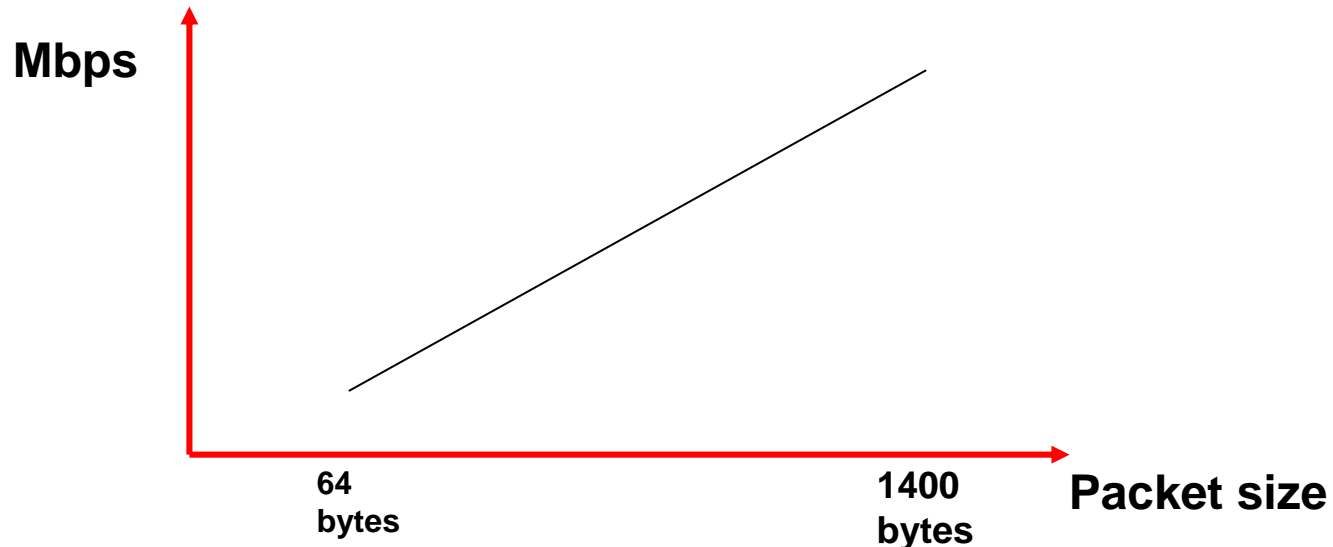


Dynamic Multipoint VPN Facts

- Dynamic Multipoint VPN (DMVPN) can work with static routes but shows its power with **routing protocols**
- The routing protocol consumes a lot of **CPU** with so many neighbors
- Resource consumption increases with the **number of tunnels**

IPsec facts

- **IPsec maximum throughput is better with large packets**
- **On medium and low platforms, CPU is impacted by large SADB**
- **Cisco recommends that users keep a DMVPN hub within reasonable limits**
- **Consult your Account Team about platform details**



Example – Cisco 7200 Series/VAM2

- The Cisco 7200 Series Router is a popular platform for DMVPN
- It can accept **a maximum of 375 tunnels** without particular attention (EIGRP)
- In that case, the max throughput would be
 - 42,000 pps for 64 bytes packets
 - 22,000 pps for 1400 bytes packets

Scaling the Cisco 7200 Series/VAM2 Further

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- If a second mGRE interface is set up on the Cisco 7200 Series Router, it can accept **a maximum of 350 tunnels per interface (700 total)**
- In that case the max throughput is:
 - 40,000 pps for 64 bytes packets
 - 22,000 pps for 1400 bytes packets
- A third interface does **not** improve things

Is This Low?

- Yes and no
- The theoretical maximum number of tunnels (Cisco 7200 Series / VAM2) is 5,000 so DMVPN looks bad
- The theoretical max speed is 250Mbps so DMVPN looks the same
- **250Mbps/700 = 350Kbps per spoke**
- Not very useful below that throughput anyway

- **This presentation describes current performance**
- **Performances change every day and protocols evolve**
- **Check with your account team to evaluate the best DMVPN platform for your needs**
- **It is possible to scale DMVPN very high**
Just wait for the next chapter...

Summary on DMVPN Fitness

- If many spokes with very low IPsec throughput, DMVPN may not be a good fit
- DMVPN **starts** to become useful at the edge between remote-access and lan-to-lan
- **DMVPN works best for spokes that need statistically constant equal access to central resources**
 - Small offices, branch offices, hot-spots, administrations, schools
- Many existing remote-access or LAN to LAN solutions **should** actually be DMVPN like networks
- DMVPN shows a network with **integrated** security

APPLICATION TO LARGE SCALE IPSEC



Problem description

- **Need to deploy a large DMVPN network**
Any number 700+ ; tens of thousands allowed
More than just basic connectivity needed
- **Limited to hub and spoke**
- **Spoke to spoke via the hub is allowed**

Requirements

- **Constraints**

LAN to LAN

Dynamic IP addresses

- **Solution must:**

Be easy to manage (deployment and monitoring)

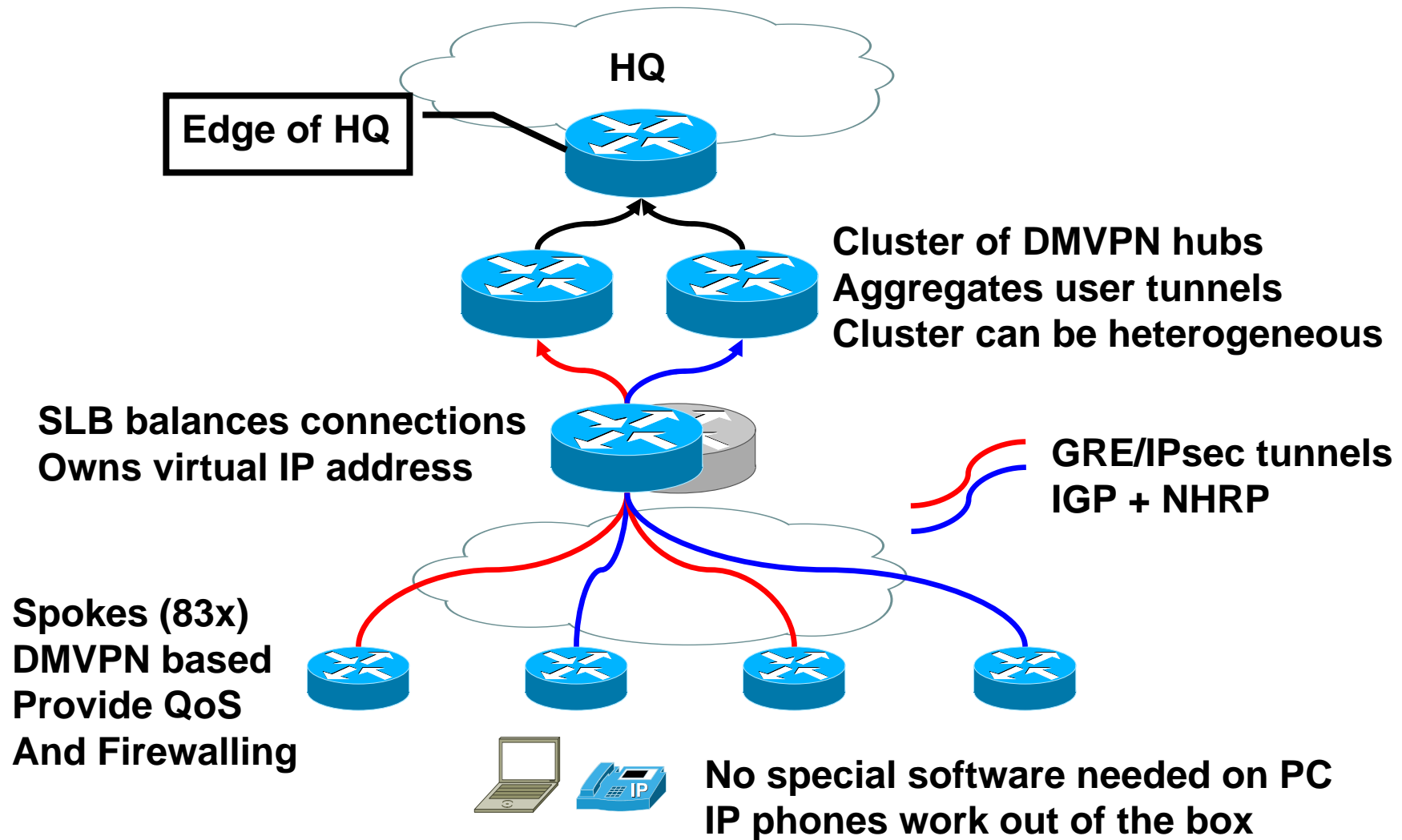
Recover by itself

Scale to thousands of spokes

Allow Cisco rich features (ie: Cisco IOS® Intrusion Prevention System (IPS), Cisco IOS Firewall)

Overall Solution

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The Load Balancer In General

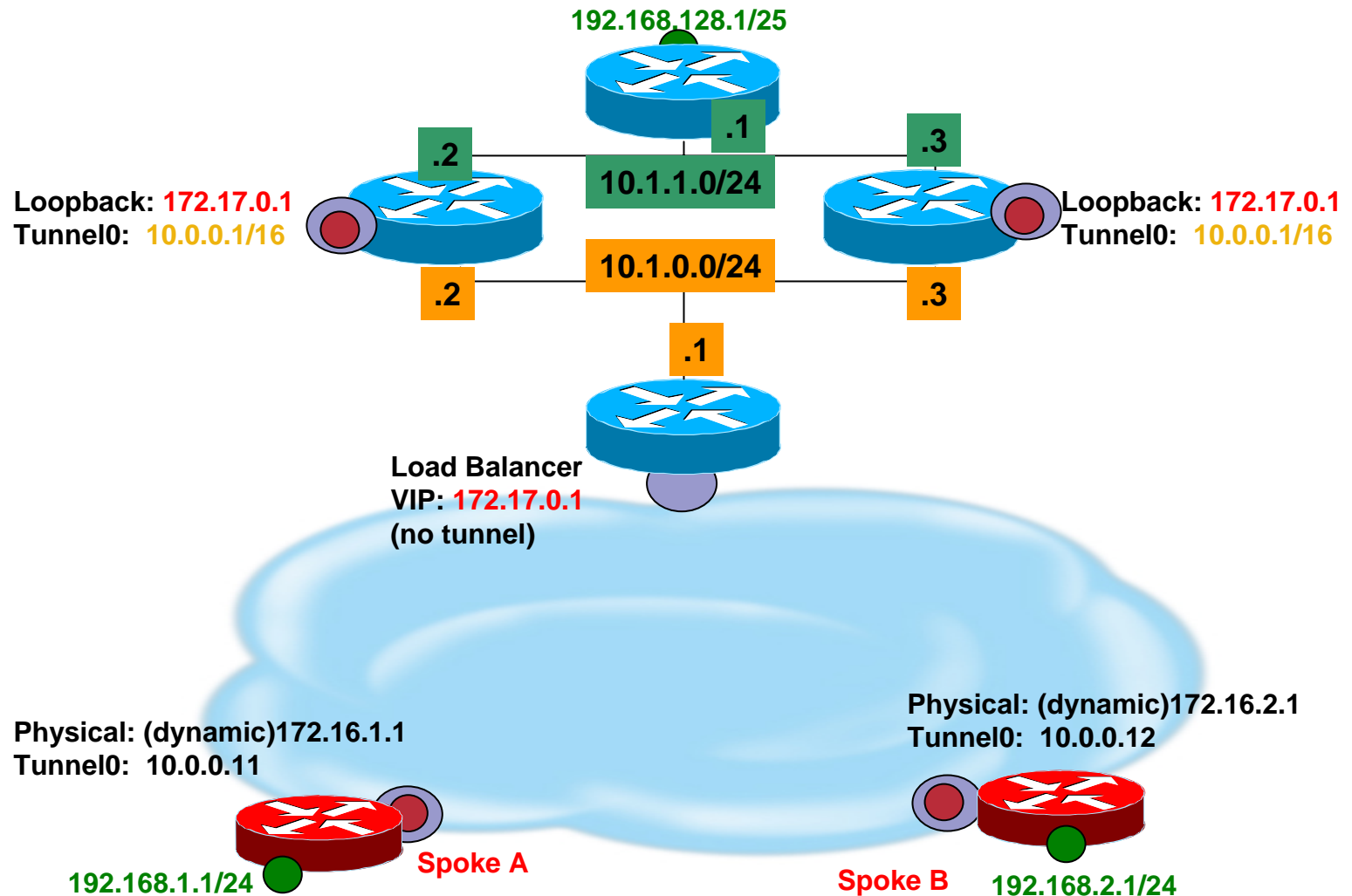
- Load Balancer owns a **Virtual IP Address (VIP)**
- When IKE or ESP packets are targeted at the **VIP**, the LB chooses a hub
- The hub choice is policy **(predictor)** based:
 - Weighted round-robin
 - Least-connections
- Once a decision is made for a “tunnel”, all subsequent packets go to the same hub **(stickyness)**
- Once a decision is made for IKE, the same is made for ESP **(buddying)**

High Level Description

- Spokes think there is a single hub
- They have an NHRP map pointing to the Load Balancer's **Virtual IP Address**
- The Load Balancer is configured in forwarding mode (no NAT)
- All the hubs have the same configuration
 - Same Tunnel interface address
 - Same Loopback address (= VIP)

Topology with Addresses

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Spoke Configuration

- The spoke configuration is the same as with a single hub
- It has an NHRP map

```
ip nhrp map 10.0.0.1 172.17.0.1
```

Load Balancer

- We will study Cisco IOS Software SLB

Runs on most **Cisco IOS Software platforms**, including the Cisco Catalyst® 6500 Series Switch

Opt for **Releases 12.2S or 12.1E**

- CSM 3.1 or above should work too but we do not need most of its features (useless)
- Load balancing must be able to do **Layer 3 and 4** load balancing

Upper layers are useless (encrypted)

Cisco IOS Software SLB performances

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- **Cisco IOS Software SLB on a Cisco Catalyst 6500 Series Switch (MSFC-2)**
 - Can manage 1M connections w/ 128MB RAM**
 - Can create 20,000 connections per second**
 - Switches packets at 10Gbps (64 bytes)**
- **Cisco IOS Software SLB on a Cisco 7200 Series Router (NPE-400)**
 - Can create 5,000 connections per second**
 - Switches packets at ½ the Cisco Express Forwarding rate (depending on other features)**
- **Should not be a bottleneck**

Cisco IOS Software SLB cluster definition

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```
ip slb probe PINGREAL ping  
faildetect 2
```

```
ip slb serverfarm HUBS  
failaction purge  
probe PINGREAL  
! predictor round-robin
```

Weighted round-robin
This is the default

```
real 10.1.0.2  
weight 4  
inservice
```

If all the hubs are equivalent,
the weight is the same

```
real 10.1.0.3  
weight 4  
inservice
```

Cisco IOS Software SLB VIP definition

```
ip slb vsrver ESPSLB
  virtual 172.17.0.1 esp
  serverfarm HUBS
  sticky 60 group 1
  idle 30
  inservice
```

Same farm

```
ip slb vsrver IKESLB
  virtual 172.17.0.1 udp isakmp
  serverfarm HUBS
  sticky 60 group 1
  idle 30
  inservice
```

Buddying

Monitoring and managing

```
SLB-7200#sh ip slb connections
```

vserver	prot	client	real	state	nat
IKESLB	UDP	64.103.8.8:500	10.1.0.2	ESTAB	none
ESPSLB	ESP	217.136.116.189:0	10.1.0.2	ESTAB	none
IKESLB	UDP	213.224.65.3:500	10.1.0.2	ESTAB	none
ESPSLB	ESP	80.200.49.217:0	10.1.0.2	ESTAB	none
ESPSLB	ESP	217.136.132.202:0	10.1.0.3	ESTAB	none

```
SLB-7200#clear ip slb connections ?
```

```
  firewallfarm  Clear connections for a firewallfarm
```

```
  serverfarm    Clear connections for a specific serverfarm
```

```
  vserver       Clear connections for a specific virtual server
```

```
<cr>
```

```
SLB-7200#sh ip slb reals
```

real	farm name	weight	state	conns
10.1.0.2	HUBS	4	OPERATIONAL	4
10.1.0.3	HUBS	4	OPERATIONAL	1

Hub Tunnel configuration

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```
interface Tunnel0
  bandwidth 10000
  ip address [redacted]
  no ip redirects
  ip mtu 1350
  ip nhrp map multicast dynamic
  ip nhrp network-id 1
  ip nhrp holdtime 3600
  no ip split-horizon
  no ip mroute-cache
  tunnel source Loopback0
  tunnel mode gre multipoint
  tunnel key 1
  tunnel protection ipsec profile tp
end
```

```
interface Loopback0
  ip address [redacted]
end
```

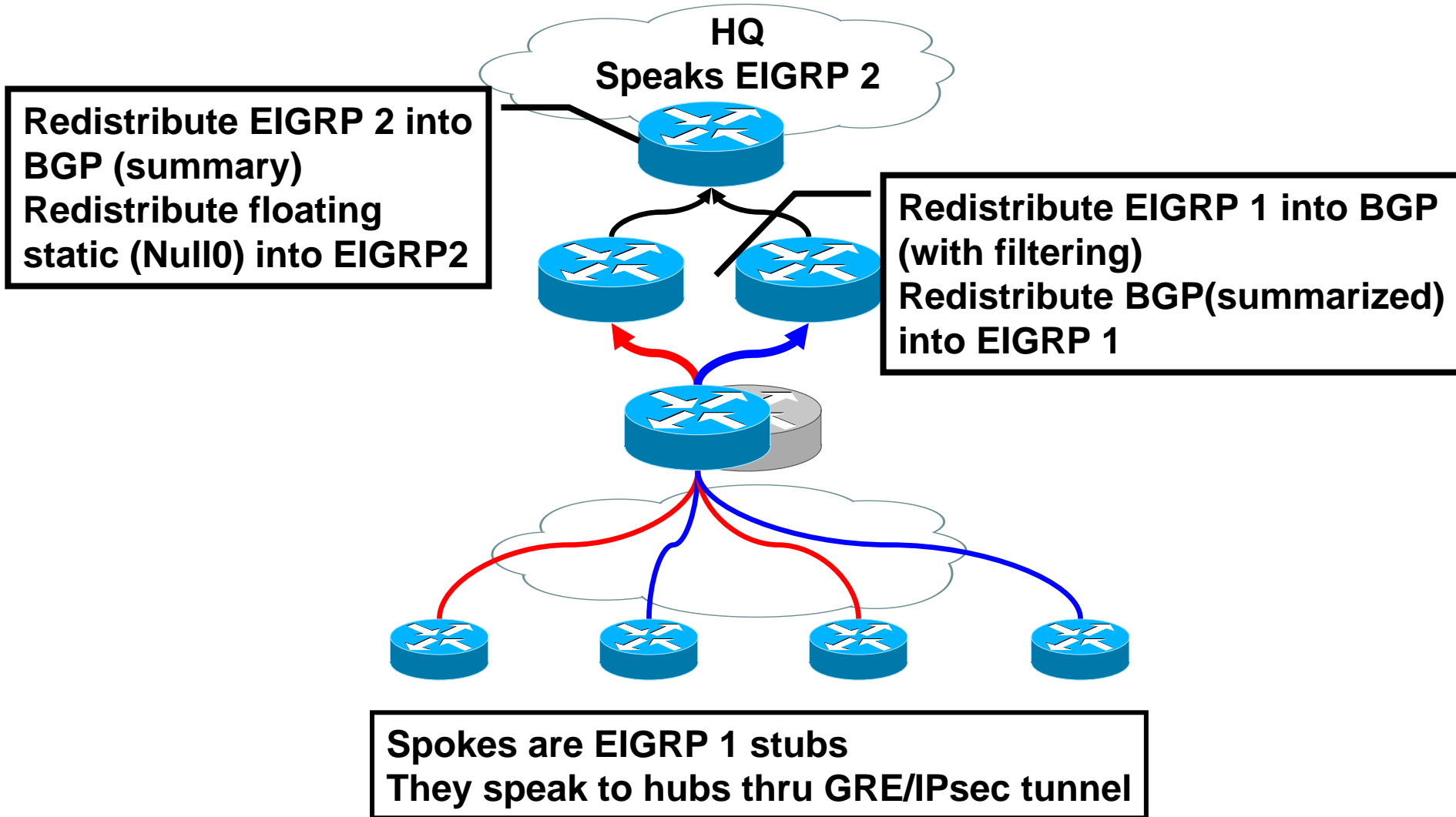
**Must be same on all
Mask allows $2^{16}-2$ nodes**

**Must be same on all
Mask is /32**

```
interface FastEthernet0/0
  ip address 10.1.0.{2,3} 255.255.255.0
interface FastEthernet0/1
  ip address 10.2.0.{2,3} 255.255.255.0
```

Routing protocols

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Hub Routing protocol configuration

```
router eigrp 1
  redistribute bgp 1 metric 1 0 255 20 1400
  network 10.0.0.0 0.0.255.255
  default-metric 64 2000 255 1 1400
  no auto-summary
router bgp 1
  bgp router-id 10.2.0.{2,3}
  bgp log-neighbor-changes
  neighbor 10.0.0.1 remote-as 1

  address-family ipv4
    redistribute eigrp 1 route-map <IGPREDIST>
    neighbor 10.2.0.1 activate
    neighbor 10.2.0.1 next-hop-self
    no auto-summary
    no synchronization
    bgp redistribute-internal
  exit-address-family
```

Edge router BGP configuration

```
router bgp 1
  no synchronization
  bgp log-neighbor-changes
  aggregate-address 10.0.0.0 255.0.0.0 summary-only
  aggregate-address 192.168.0.0 255.255.0.0 summary-only
  redistribute eigrp 2
  neighbor HUB peer-group
  neighbor HUB remote-as 1
  neighbor HUB next-hop-self
  neighbor 10.0.0.2 peer-group HUB
  neighbor 10.0.0.3 peer-group HUB
  no auto-summary
```

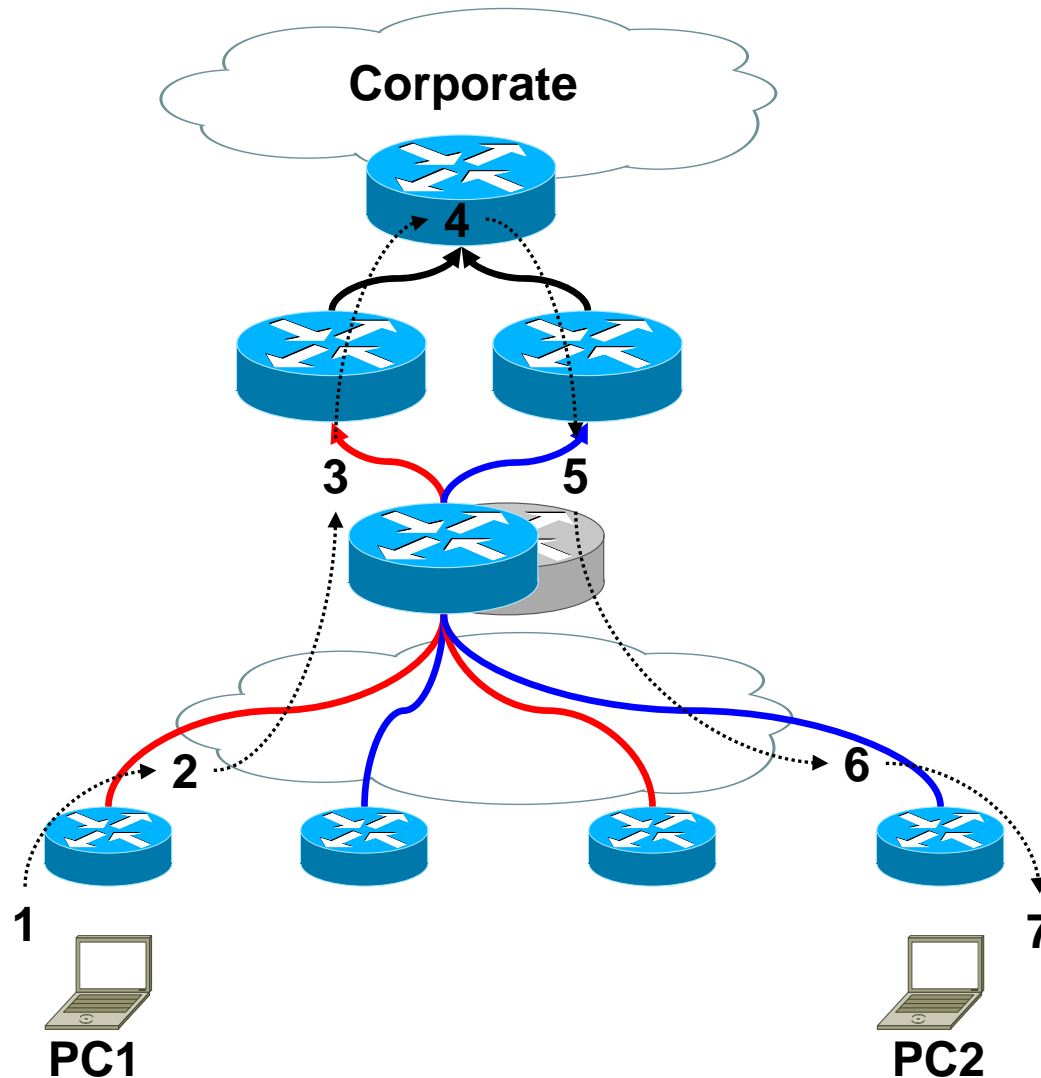
Edge router EIGRP configuration

- EIGRP 2 attracts spoke subnets to the edge router
- Floating static route to Null0 discards packets to unconnected spokes

```
ip route 192.168.0.0 255.255.255.127 Null0 254
```

```
router eigrp 2
 redistribute static
 network 192.168.1.0 0.0.0.128
 no auto-summary
 no eigrp log-neighbor-changes
```

Packet Flow



Result

- **Tunnels reconnect automatically**
- **Working sessions are not lost**
- **QoS allocates bandwidth to voice**
- **All other features are available**
- **No need to touch the hubs while adding a spoke**
- **New hubs can be added/removed on the fly**
- **Simple to deploy**
- **Leverages monitoring infrastructure (interfaces, CDP)**

Support

- **Each feature has plenty of nerd knobs for tuning**
- **Each feature has advanced debugging capabilities**
- **Each feature can be troubleshot independently**

IGP choices

- **BGP** between Hubs and Edge is good due to number of prefixes and flexibility
- **Scaling the IGP between hubs and spokes is the hardest part**
- **A distance vector is recommended**
- **EIGRP shows best results so far but ODR is under test (lightweight)**

Positioning

- The main advantages of the solution are:

Virtually **limitless** scaling

Can be deployed in zero touch with ISC and Intelligent Engine

Automatic load management

Load balancing **AND** resilience

Multiply performances by number of hubs (creation rate, speed, max SA's)

No forklift when upgrading

Resilience in **N+1**

Improvements

- It is **possible to collapse** the Load balancer and the edge router (hubs in lollipop)
- If the load balancer is a Cisco Catalyst 6500 Series Switch, this is even recommended as **Layer 3 switching** will accelerate spoke to spoke traffic

Routing Protocols

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