



# Deploying Optimized Edge Routing

BRKIPM-2015



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**Cisco Networkers**  
poweredbycisco.  
**2007**

# HOUSEKEEPING

- We value your feedback, don't forget to complete your online session evaluations after each session and complete the Overall Conference Evaluation which will be available online from Friday.
- Visit the World of Solutions on Level -01!
- Please remember this is a 'No Smoking' venue!
- Please switch off your mobile phones!
- Please remember to wear your badge at all times including the Party!
- Do you have a question? Feel free to ask them during the Q&A section or write your question on the Question form given to you and hand it to the Room Monitor when you see them holding up the Q&A sign.

# Agenda

- OER Overview
- Deployment
- Troubleshooting
- Performance
- Conclusion
- Q & A

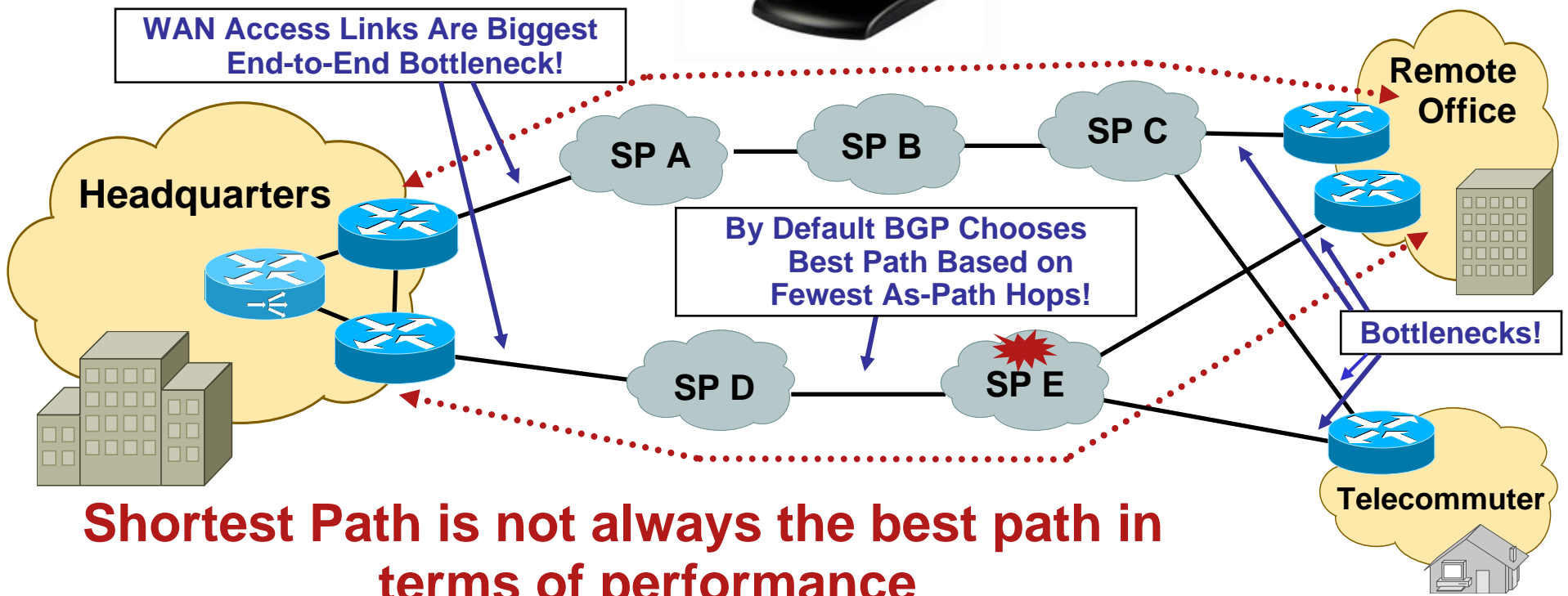
# WHAT IS OER?

Real-time Route Selection  
based on performance

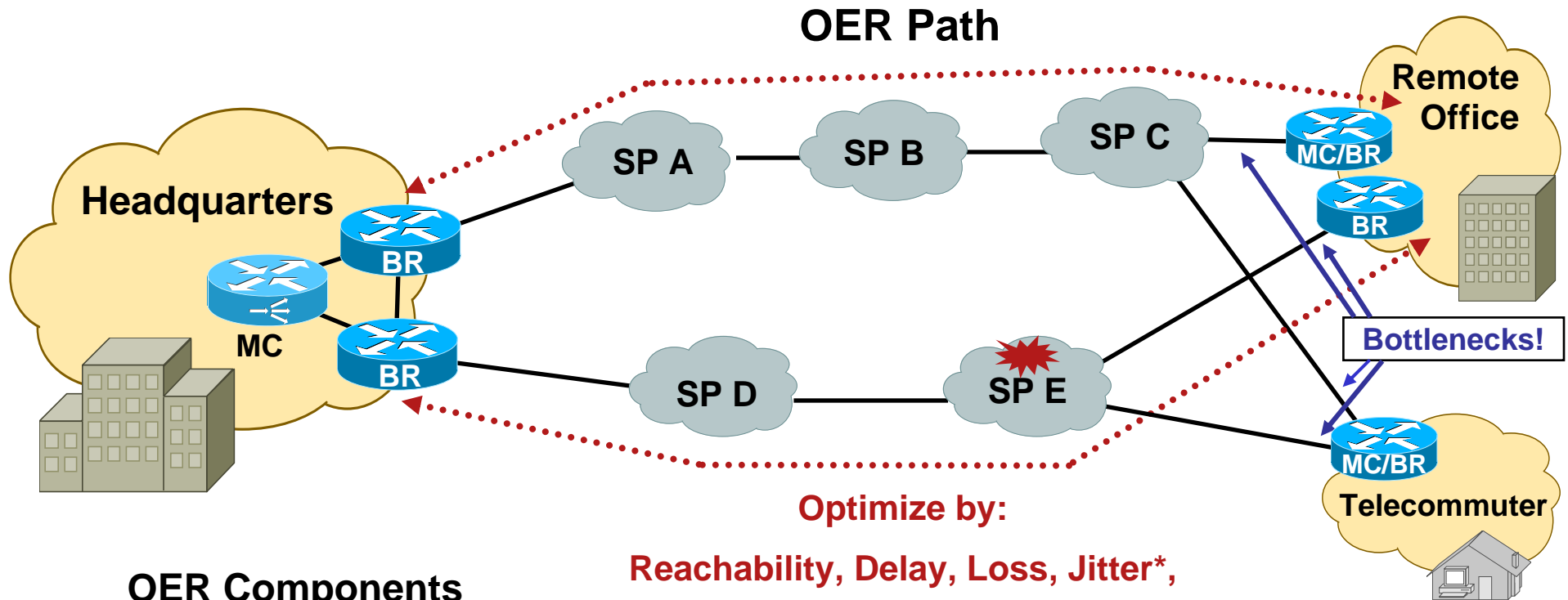
- delay, loss, jitter,  
unreachable, mos, load  
and \$cost



# Best path selection per prefix, 2 or more Paths



# OER Best Path



## OER Components

- BR—Border Router
- MC—Master Controller (decision maker)

Optimize by:  
Reachability, Delay, Loss, Jitter\*,  
MOS\*, Throughput, Load and/or \$Cost

# OVERVIEW

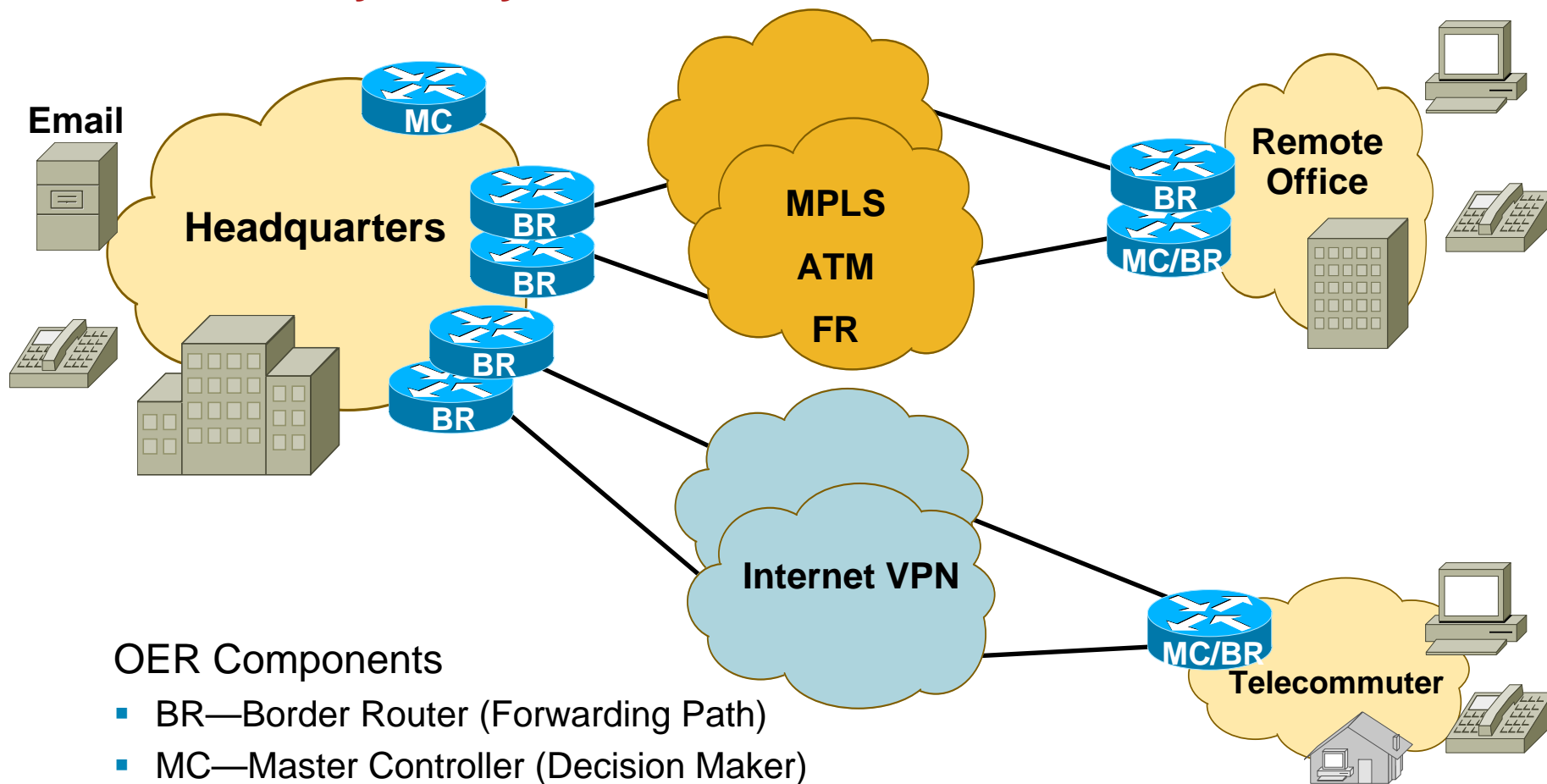


# Optimized Edge Routing (OER)

## Performance Based Routing for Enterprise WAN Edge

### Exit Selection Criteria

Reachability, Delay, Loss, Jitter, MOS, Load, \$Cost





# Component Description

- Master Controller (MC)

Cisco IOS® software feature

Apply Policy, Verification, Reporting

Standalone or collocated with BR

No routing protocol required

No packet forwarding/inspection required

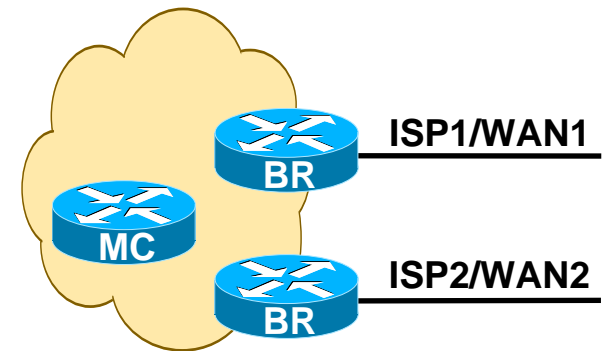
- Border Router (BR)

Cisco IOS software feature in forwarding router

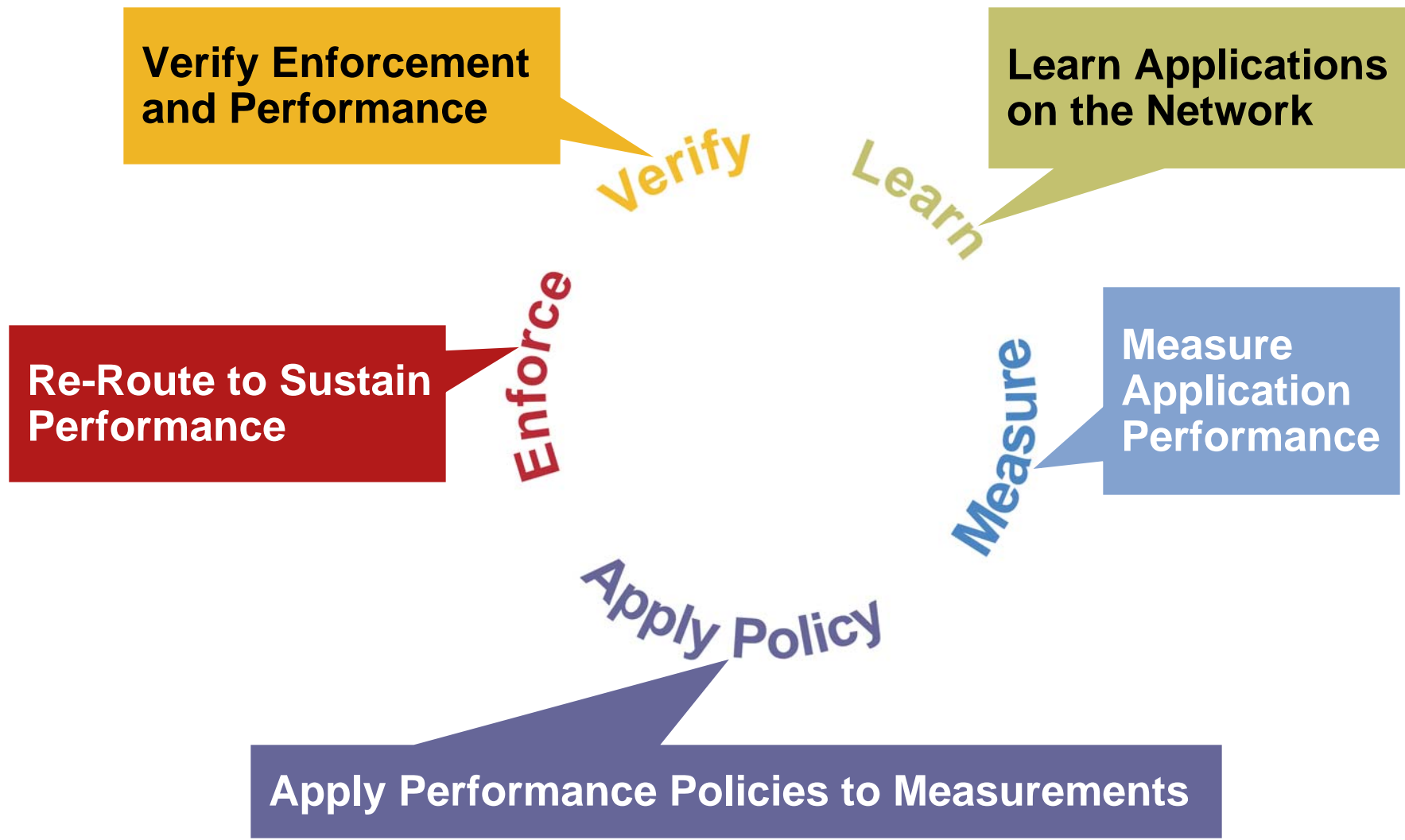
Learn, Measure, Enforcement

Netflow Collector

Probe Source (IP SLA Client)



# Performance Based Routing Control Loop



# Types of Traffic Class

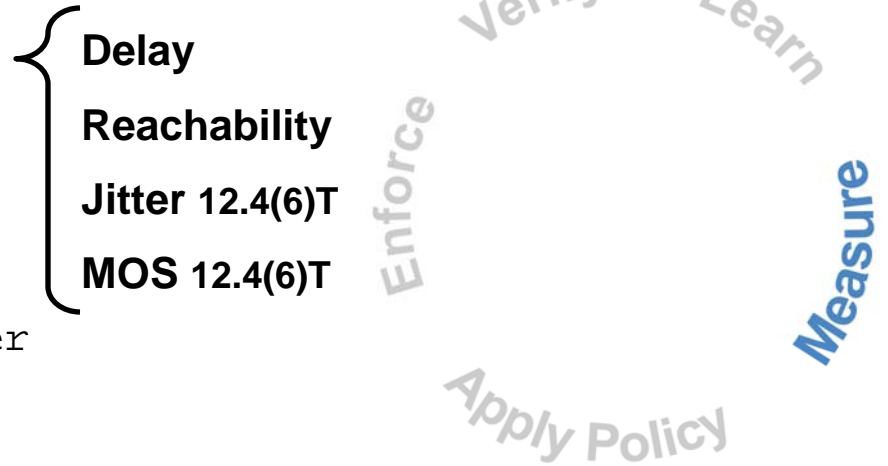
Type		Example*
<b>Destination</b>		10.0.0.0/8 20.1.1.0/24
<b>Application</b>	<b>ACL</b>	10.1.1.0/24 dscp ef 10.1.1.0/24 dst-port 50
	<b>Well-known</b>	10.1.1.0/24 telnet 20.1.0.0/16 ssh
	<b>NBAR**</b>	10.1.1.0/24 nbar RTP 20.1.1.0/24 nbar citix

\* Not an exact CLI

\*\* To be Released

# Measuring Traffic Class Performance

- Active
  - OER enables IP SLA feature
  - Probes sourced from BRs
  - icmp probes learned or configured
  - tcp, udp, jitter need ip sla responder



- Passive
  - OER Netflow monitoring of traffic classes

- Both Mode
- Fast Mode
  - Probes all path all the time

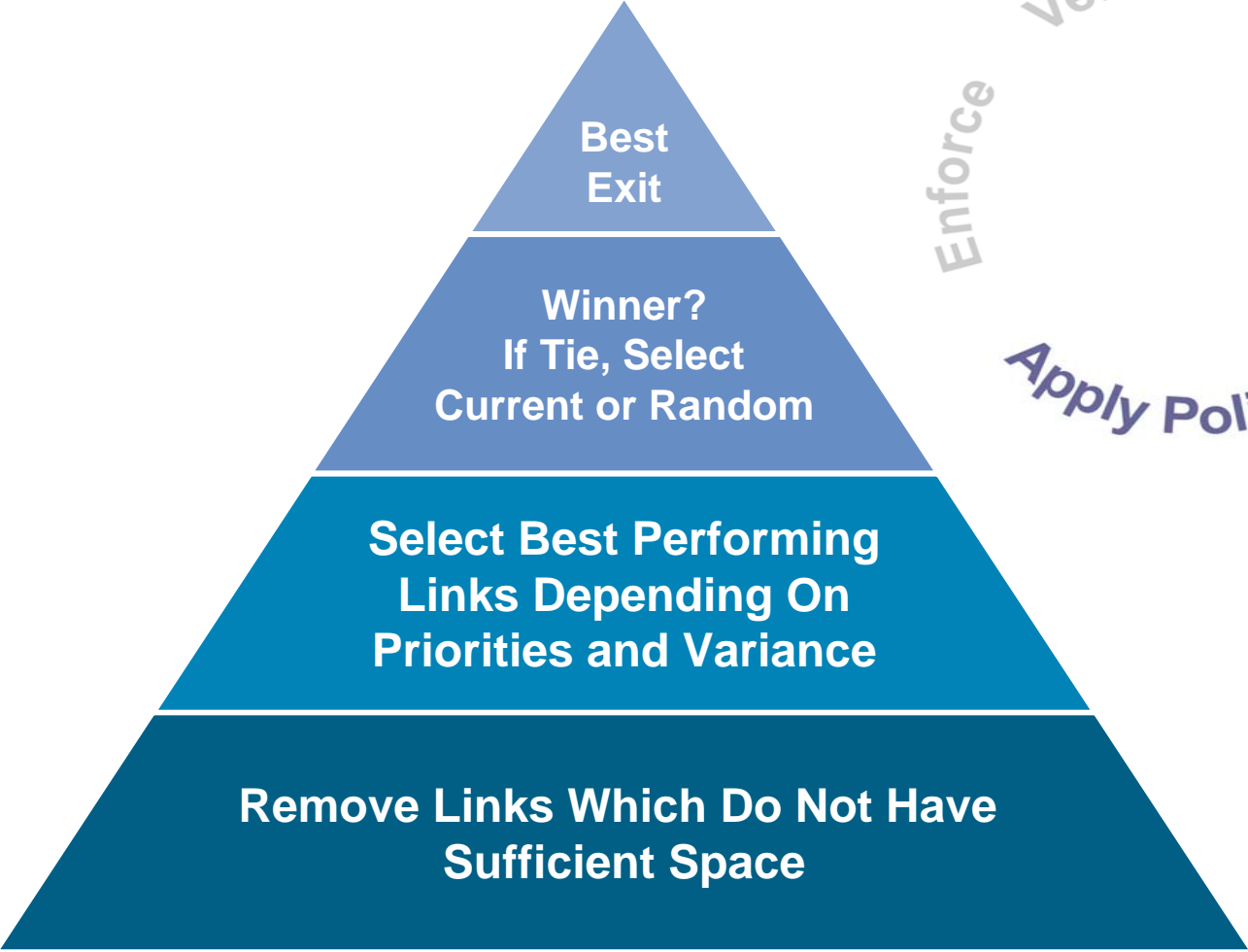
- Delay
- Loss
- Reachability
- Egress BW
- Ingress BW



# OER Policy

Traffic-Class		Link	
<b>Performance</b> <ul style="list-style-type: none"><li>• Delay</li><li>• Loss</li><li>• Reachability</li><li>• MOS</li><li>• Jitter</li></ul>	<b>Security</b> <ul style="list-style-type: none"><li>• Sinkhole</li><li>• Blackhole</li></ul>	<b>Performance</b> <ul style="list-style-type: none"><li>• Load Balancing</li><li>• Max Utilization</li></ul>	<b>Administrative</b> <ul style="list-style-type: none"><li>• Link Grouping</li></ul>
<b>Scope</b>	Global or Per Policy		

# Selecting “BEST” Traffic Class Exit



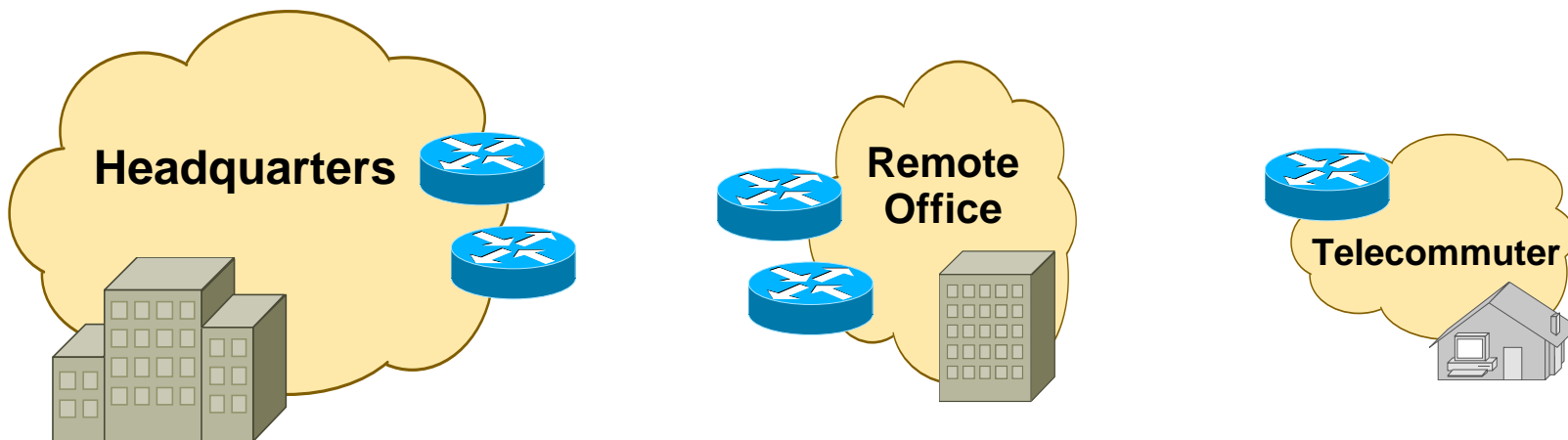
# Selecting “Best” Traffic Class Exit

Link	Utilization	Delay (ms)	
		Priority 1	Priority 2
<del>Serial1</del>	89%	100	30
Serial2	50%	113	30
Serial3	60%	119	32



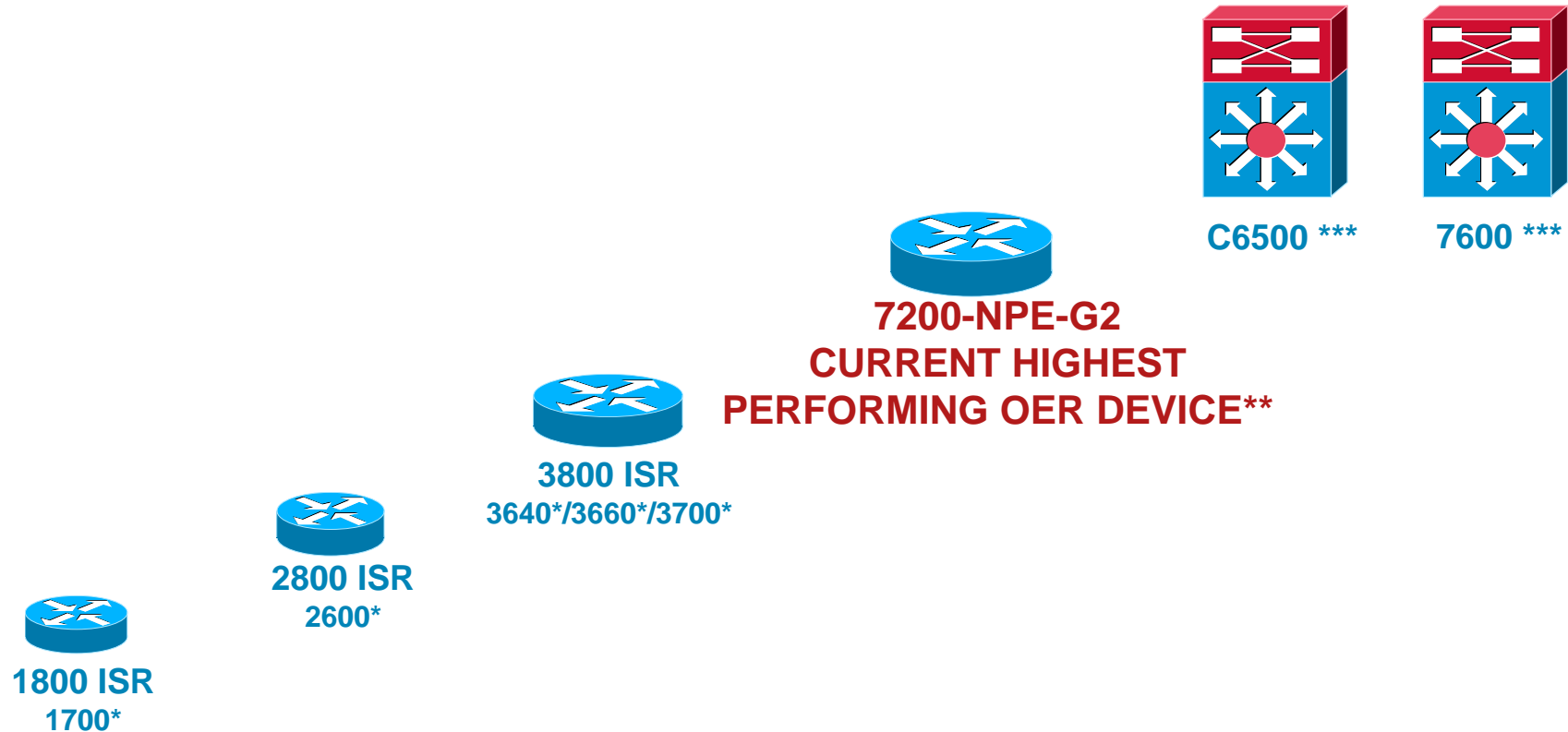
# OER Typical Customers

- Large, medium, and small enterprises with **mission critical internet presence**
- Enterprises with redundant WAN networks
- Enterprises with **remote offices**
- **Home office** with dual internet connections





# OER Platform Support



- \* Announced/Reached End-of-Sale (EoS)
  - \*\* 7301 with fixed NPE-G1 also supports OER
  - \*\*\* C6500/7600 support in 12.2S – target: 1QCY07
- NOTE:** Cisco 7500 has been announced EoS

# Agenda

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# Design Questions

1. Do I have redundant WAN connections ?
  - Internet, IPSEC/GRE, MPLS, ATM, Frame Relay
  - Configure as OER external interfaces
2. Which routers terminate the WAN ?
  - These are OER border routers
3. What routing protocols over WAN ?
  - BGP, Static covered by OER
  - All others, cfg static and filtering
4. Which router is OER master controller ?
  - Up to 5000 prefixes, dedicated 7200 or 3800 MC
  - For a few prefixes, configure MC on BR



# Design Questions

5. What policy is important ?
  - Exit Performance
    - Delay, loss, reachability, throughput
    - Jitter, MOS
  - Entrance Performance - 12.4T
    - Delay, Loss, Reachability, Throughput
  - Load distribution
  - Cost minimization
  - Backup
  - Path discovery
  - Security 12.4T
  - **Default** priority is performance then load



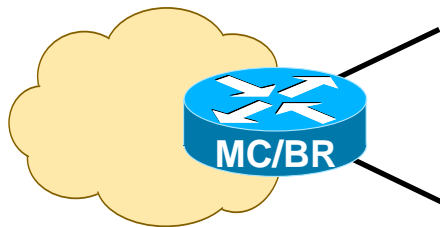
# Design Questions

## 6. Determine interesting traffic class by:

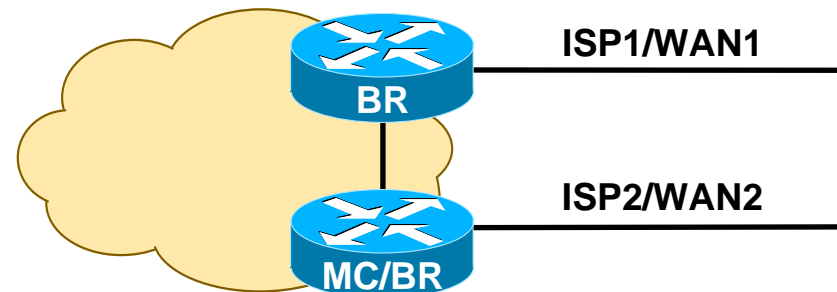
- Configure Prefix
- Configure Application
- Configure Full ACL
- Learn interesting prefixes
- Learn interesting Traffic Classes
- Learn eBGP advertised Prefixes
- Learn Application

# Solution Topologies

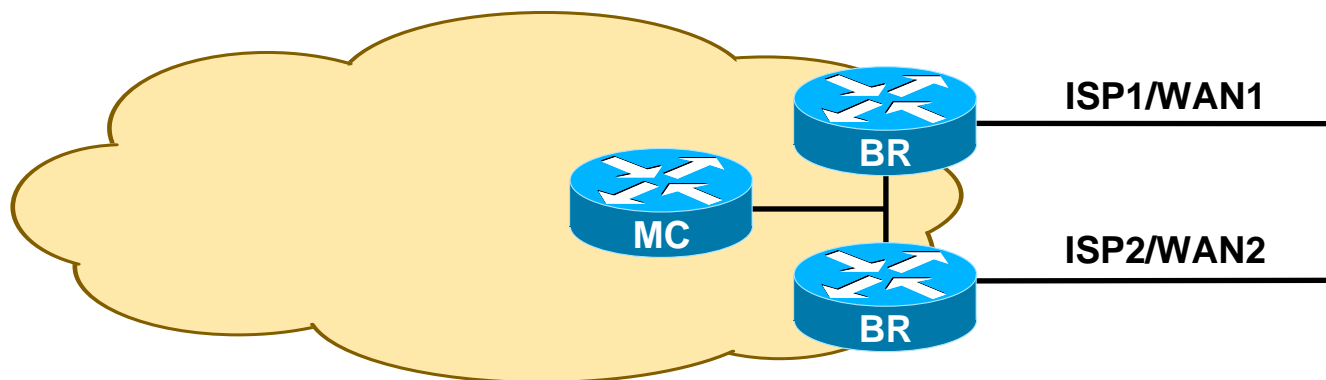
## 1) SOHO/Broadband



## 2) Remote Office



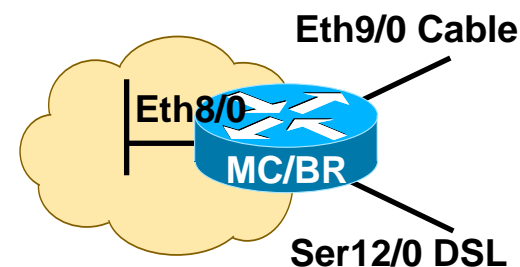
## 3) Headquarters/Content/Hosting/Data Centers



**BR—Border Router, MC—Master Controller**

# SOHO/Broadband Deployment

1. Cable and DSL WAN interfaces
  - Eth8/0—OER Internal
  - Eth9/0—OER External
  - Ser12/0—OER External
2. ISR router terminates WAN
  - ISR is OER BR
3. Static default routing
4. 10 to 100 traffic-classes
  - ISR is also MC
  - 12.4
5. Performance is most important
  - Use OER default policy
6. Learn throughput and delay to get prefixes



**BR—Border Router, MC—Master Controller**

# SOHO/Broadband Configuration

```

key chain key1
key 1
  key-string oer
oer master
logging
mode route control
max prefix total 100
backoff 90 3000 300
border 10.10.10.1 key-chain key1
  interface Ethernet8/0 internal
  interface Ethernet9/0 external
    max-xmit-utilization absolute 1000
  interface Ser12/0 external
    max-xmit-utilization absolute 300
learn
throughput
delay
monitor-period 1
periodic-interval 0
oer border
logging
local Ethernet8/0
master 10.10.10.1 key-chain key1
interface Ethernet8/0
ip address 10.10.10.1 255.255.255.0
interface Ethernet 9/0
load-interval 30
interface Serial 12/0
load-interval 30
  
```

Enable Logging

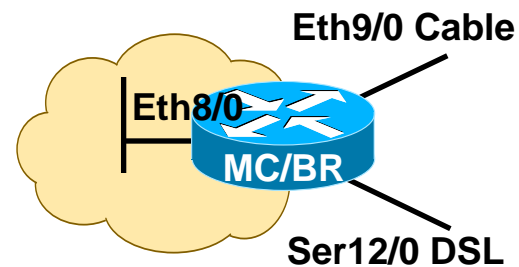
Enforce Routing Changes

Authentication Required

Limit Cable and DSL Throughput

Learn Delay and Throughput Prefixes Every Minute

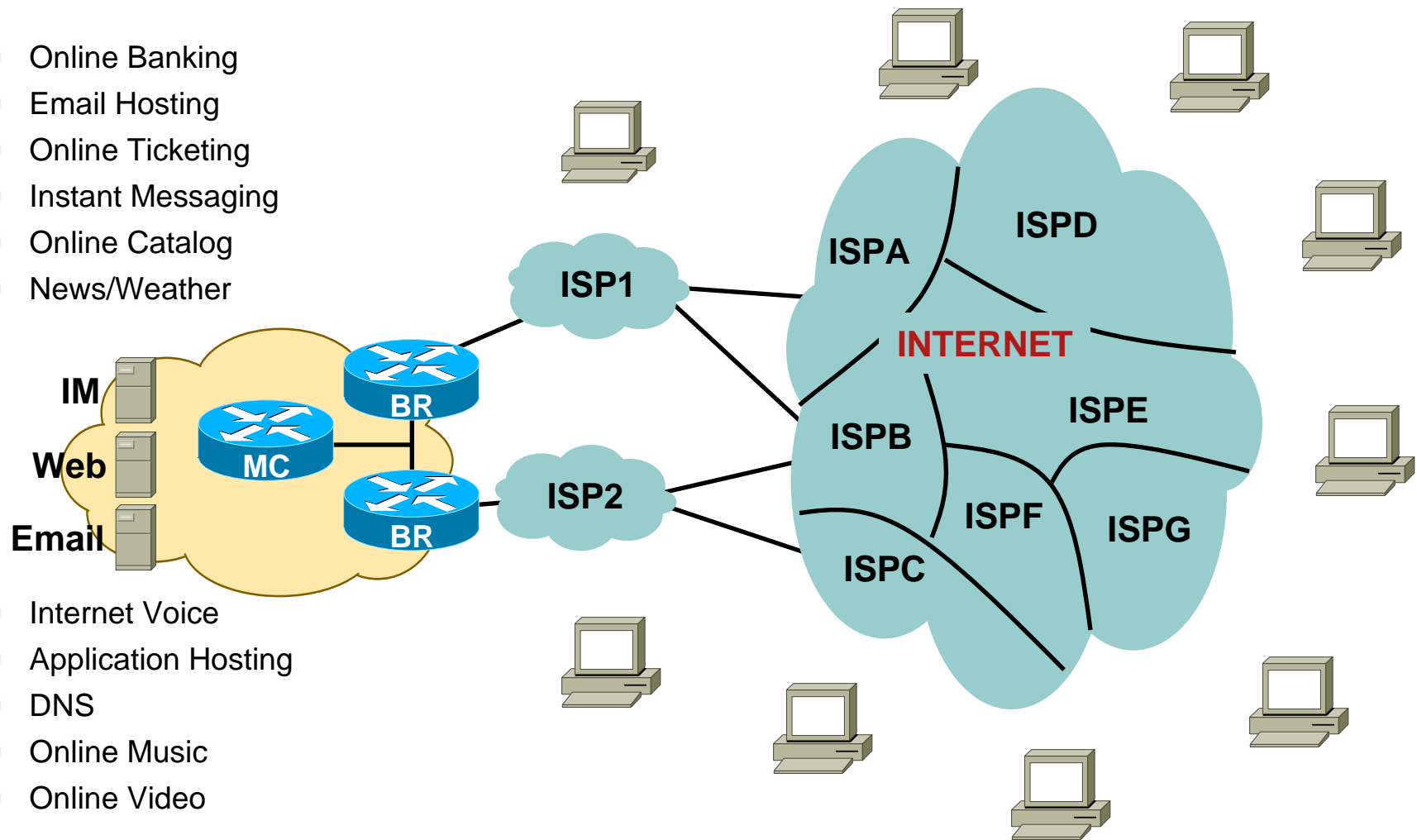
MC and BR on Same Router





# Mission-Critical Internet Presence

- Online Banking
- Email Hosting
- Online Ticketing
- Instant Messaging
- Online Catalog
- News/Weather



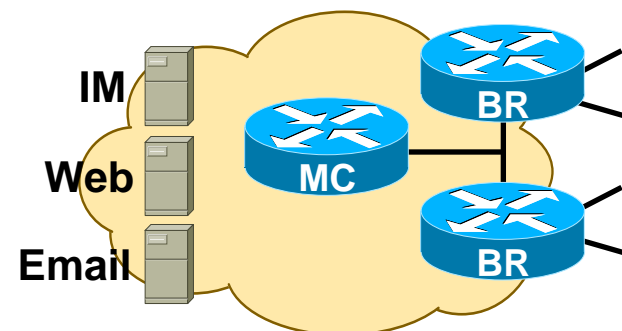
- Internet Voice
- Application Hosting
- DNS
- Online Music
- Online Video

**BR—Border Router, MC—Master Controller**

# Internet Presence Deployment

1. DS3 Interfaces  
Ser12/0, Ser13/0, ...
2. Cisco 7200 & Cisco 3800 are typical BR/MC with BR terminating WAN connections
3. BGP Routing
  - BRs must be iBGP peers
  - Default Routing
  - Partial Routes
  - Full Routes
4. Support of up to 15,000 Prefixes (w/ Cisco 7200-NPE-G2)
  - 12.4T/12.4M
  - Entrance Optimization
5. Customers differ on Policy priority
6. Learn prefixes by Throughput and Delay

**Same OER config for all**



**BR: Border Router**  
**MC: Master Controller**

# Internet Presence Configuration

## Default Policy: Performance then Load

```

key chain key1
  key 1
    key-string oer
oer master
  logging
  mode route control
  mode select-exit best
  backoff 90 3000 300
  periodic 600
border 10.1.1.2 key-chain key1
  interface Ethernet8/0 internal
  interface Serial12/0 external
  interface Serial13/0 external
border 10.1.1.3 key-chain key1
  interface Ethernet 8/0 internal
  interface Serial12/0 external
  interface Serial13/0 external
learn
  throughput
  delay
  monitor-period 1
  periodic-interval 0
  prefixes 500
  expire after time 240
  
```

**MC 10.1.1.1**

**Choose Best Exit  
Regardless of in or out  
of Policy**

**Reevaluate Exit  
10 Minutes**

**Learn 500  
Prefixes**

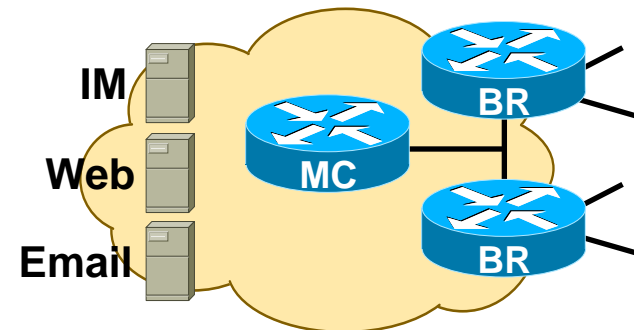
**Delete Prefix if Not Re-Learned  
in 240 Minutes**

```

key chain key1
  key 1
    key-string oer
oer border
  logging
  local loopback 1
  master 10.10.10.1 key-chain key1
interface ser12/0
  load-interval 30
interface ser13/0
  load-interval 30
  
```

**BR 10.10.10.2**

**BR 10.10.10.3**



# Internet Presence Configuration

## Load Balancing Only

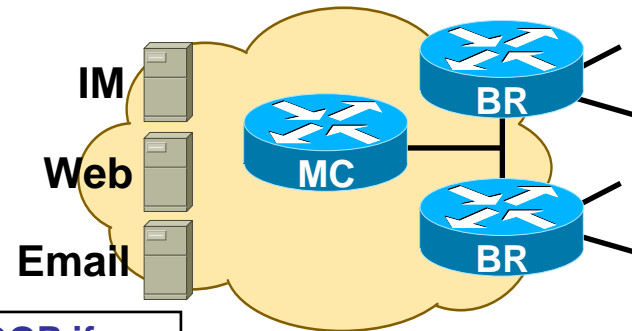
- Add to Default Policy Configuration

Disable Periodic Prefix Evaluation

```
oer master
no periodic
resolve utilization priority 1 variance 5
resolve range priority 2
no resolve delay
no resolve loss
max-range-utilization percent 50
border 10.1.1.2
  interface Serial12/0 external
    max-xmit-utilization percent 90
  interface Serial13/0 external
    max-xmit-utilization percent 90
border 10.1.1.3
  interface Serial12/0 external
    max-xmit-utilization percent 90
  interface Serial13/0 external
    max-xmit-utilization percent 90
```

MC 10.1.1.1

Link OOP if :  
% util > lowest +  
50  
% util > 90



# Internet Presence Configuration

## \$Cost Minimization Only

- Add to Default Policy Configuration

```

oer master
no periodic
resolve cost priority 1
no resolve delay
no resolve utilization
border 10.1.1.2
  interface Serial12/0 external
    cost-minimization tier 100 fee 10000
    cost-minimization tier 75 fee 8000
    cost-minimization tier 40 fee 4000
    cost-minimization end day-of-month 31
  interface Serial13/0 external
    cost-minimization fixed fee 3000
border 10.1.1.3
  interface Serial12/0 external
    cost-minimization fixed fee 3000
  interface Serial13/0 external
    cost-minimization fixed fee 3000
  
```

### MC 10.1.1.1



# Internet Presence Configuration

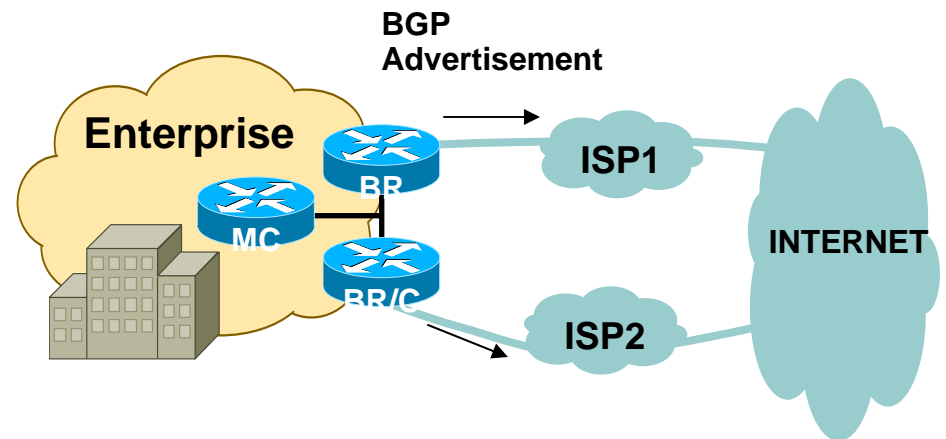
## OER Inbound

### Learning inside prefix

```
oer master
learn
  inside bgp
oer-map MAP 10
match oer learn inside
```

### Configuring inside prefix

```
ip prefix-list INSIDE permit 10.1.1.0/24
oer-map MAP 10
ip address prefix-list INSIDE inside
```



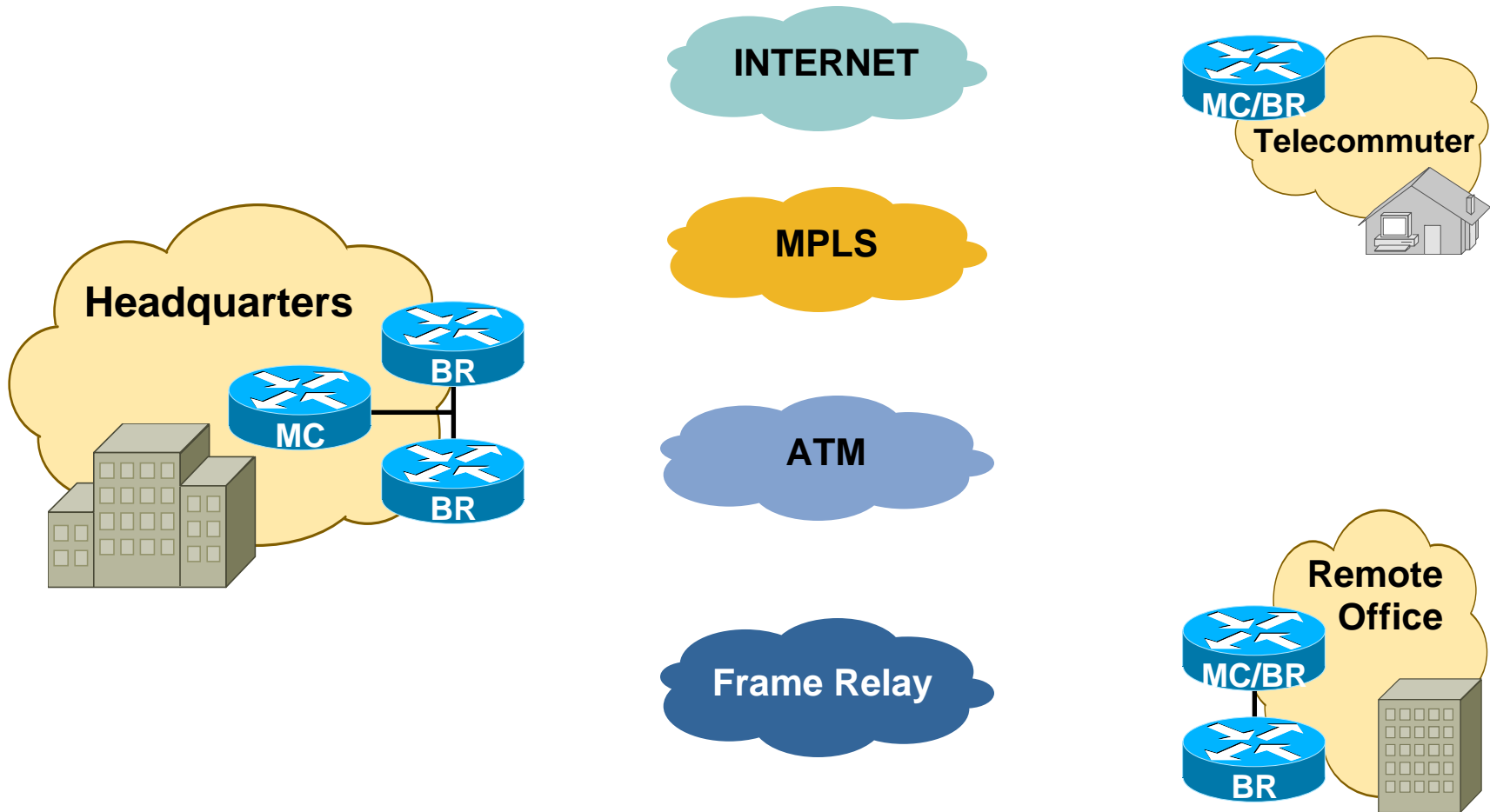
### Choosing Downgrading Method

AS prepend – No Configuration required

BGP Community

```
Oer master
border 10.1.1.1 key-chain oer
interface ethernet1/0 external
  downgrade bgp community 3:2
```

# Enterprise VPN Deployment



**BR—Border Router, MC—Master Controller**

# Enterprise VPN Deployment

## OER EIGRP, ...

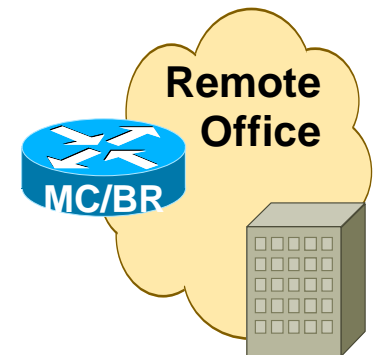
### 1. Configure Default to each external interface

```
ip route 0.0.0.0 0.0.0.0 eth 9/0 50.50.50.2 tag 10
ip route 0.0.0.0 0.0.0.0 ser12/0 tag 10
ip route 0.0.0.0 0.0.0.0 tunnel0 tag 10
ip route 0.0.0.0 0.0.0.0 tunnel1 tag 10
```

OER External  
Interfaces

### 2. Block redistribution of Default

```
router eigrp 100
 redistribute static route-map block-def
route-map block-def deny 20
 match tag 10
route-map block-def permit 30
```





# Enterprise VPN Deployment

## OER with EIGRP, ...

### 3. Configure OER Learn

```
oer master  
learn  
throughput  
delay
```

### 4. Block redistribution of OER statics over Externals

```
router eigrp 100  
  distribute-list route-map block-oer out eth0/1  
  distribute-list route-map block-oer out ser12/0  
  distribute-list route-map block-oer out tunnel0  
  distribute-list route-map block-oer out tunnel1  
route-map block-oer deny 10  
  match tag 5000  
route-map block-oer permit 20
```

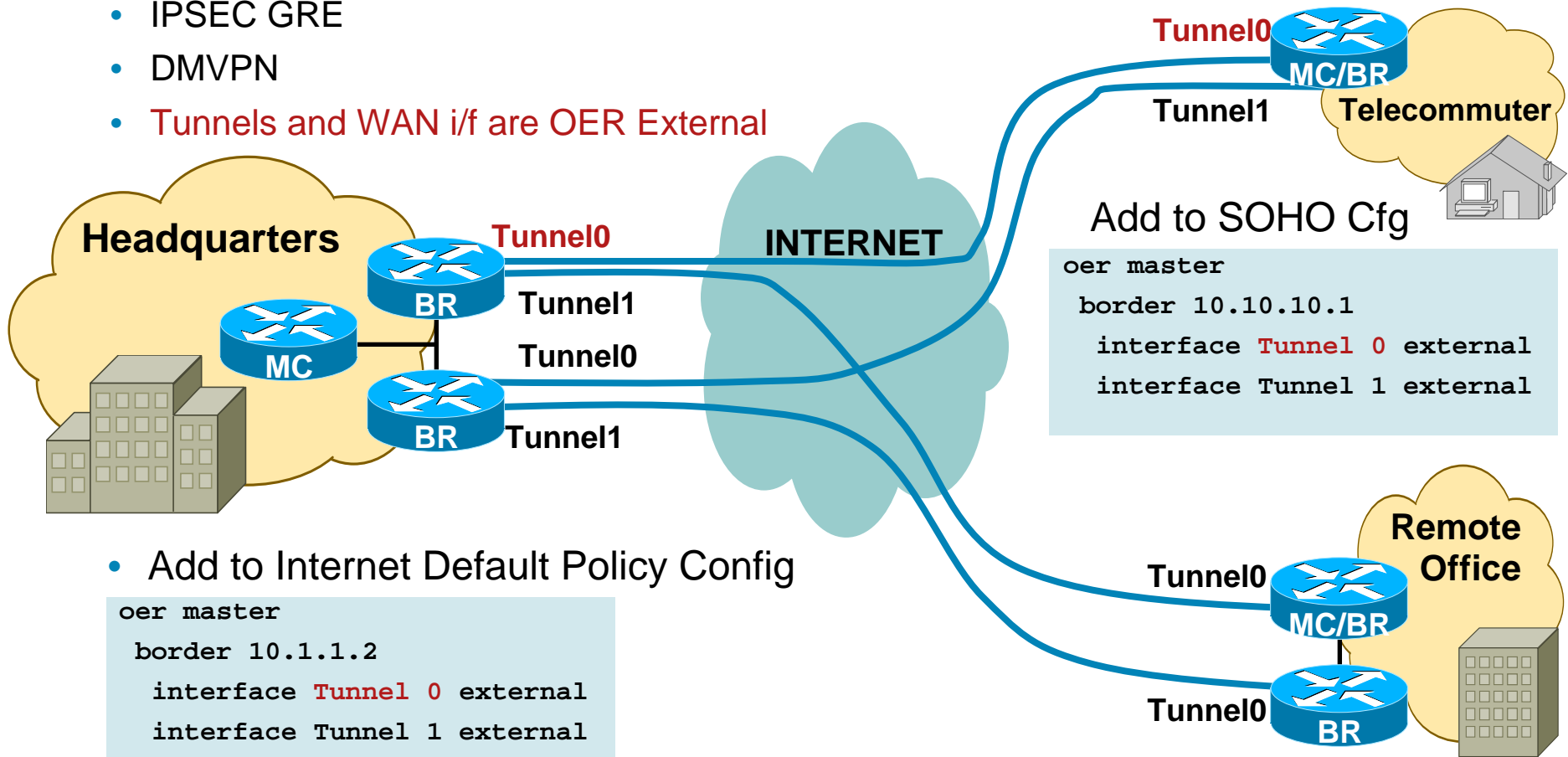
OER External  
Interfaces

Default Tag for OER  
Statics

# Enterprise VPN Deployment

## Dual IPSEC/GRE Tunnels

- IPSEC GRE
- DMVPN
- Tunnels and WAN i/f are OER External



Add to SOHO Cfg

```
oer master
border 10.10.10.1
interface Tunnel 0 external
interface Tunnel 1 external
```

- Add to Internet Default Policy Config

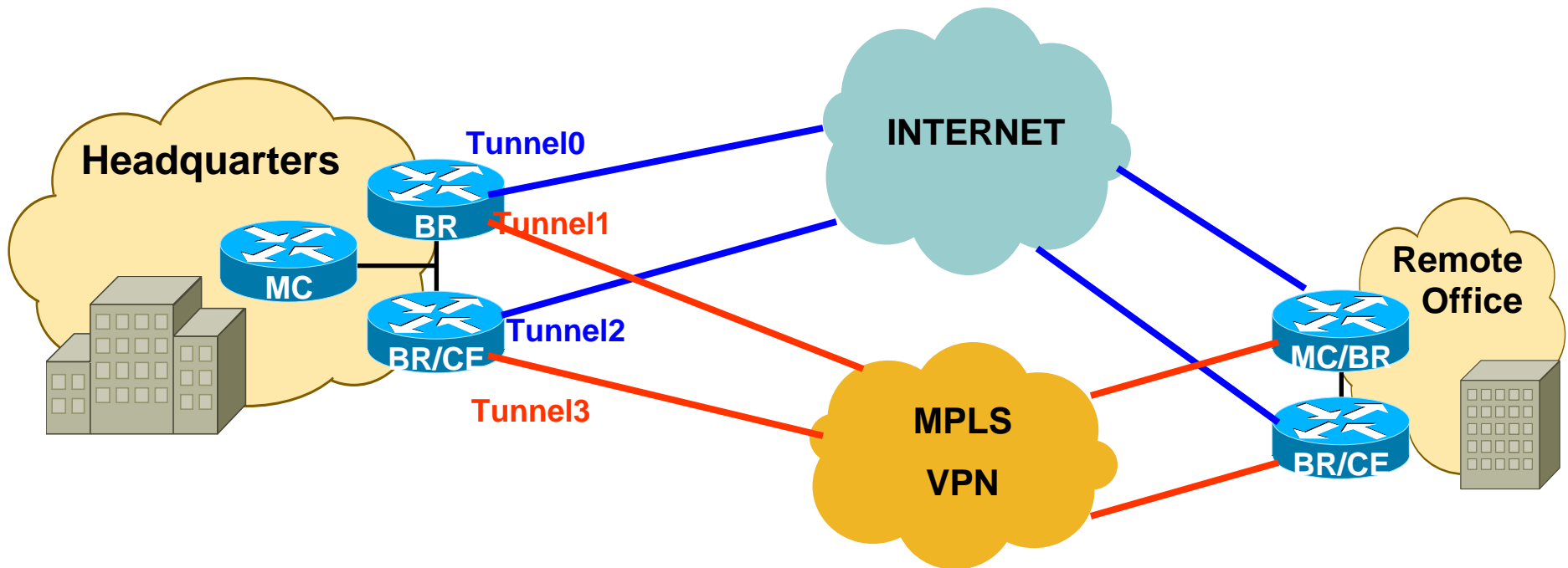
```
oer master
border 10.1.1.2
interface Tunnel 0 external
interface Tunnel 1 external
border 10.1.1.3
interface Tunnel 0 external
interface Tunnel 1 external
```

BR—Border Router, MC—Master Controller

# Enterprise VPN Deployment

## MPLS and IPSEC/GRE

- Combines Internet and IPSEC/GRE
- Tunnel and MPLS I/F are OER External
- Backup then Performance Policy



BR—Border Router, MC—Master Controller

# Enterprise VPN Deployment

## Primary and Backup

### Group Links

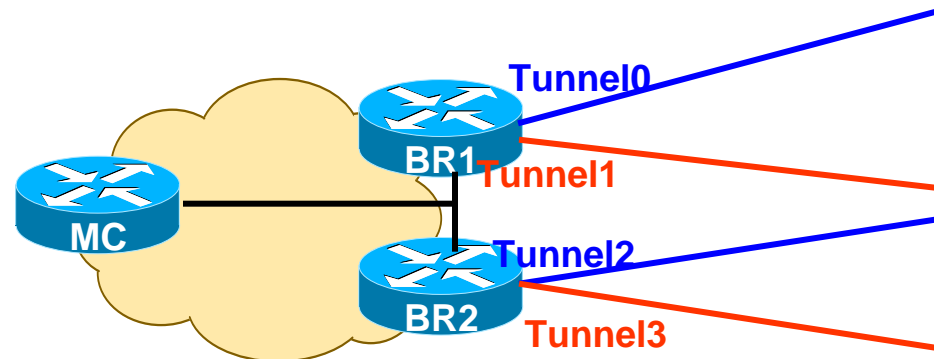
```
oer master
border 1.1.1.1 key-chain key1
  interface Tu1 external
    link-group RED
  interface Tu0 external
    link-group BLUE
  interface eth1/1 internal

border 1.1.1.2 key-chain key2
  interface Tu3 external
    link-group RED
  interface Tu2 external
    link-group BLUE
  interface et3/1 internal
```

### Specify Link Preference

```
oer-map MAP 10
match Appl1
set delay threshold 100
set link-group RED fallback BLUE

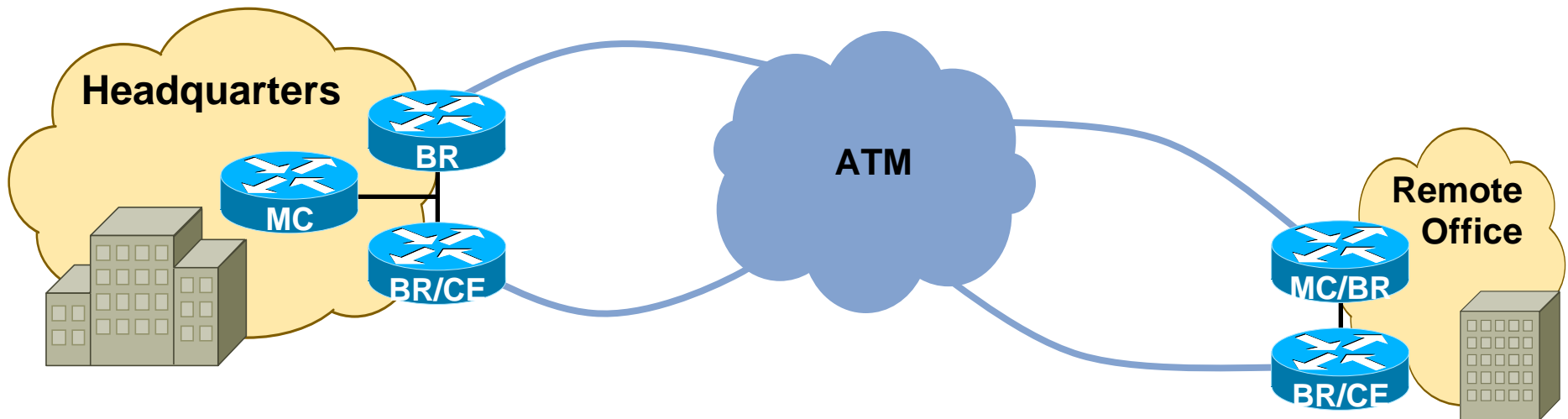
oer-map MAP 20
match Appl2
set link-group BLUE
```



# Enterprise VPN Deployment

## Dual ATM Links

- EIGRP
- Use OER Static w/ redistribute static
- Load Balancing is Primary Policy
- Use Load Balancing Only Config

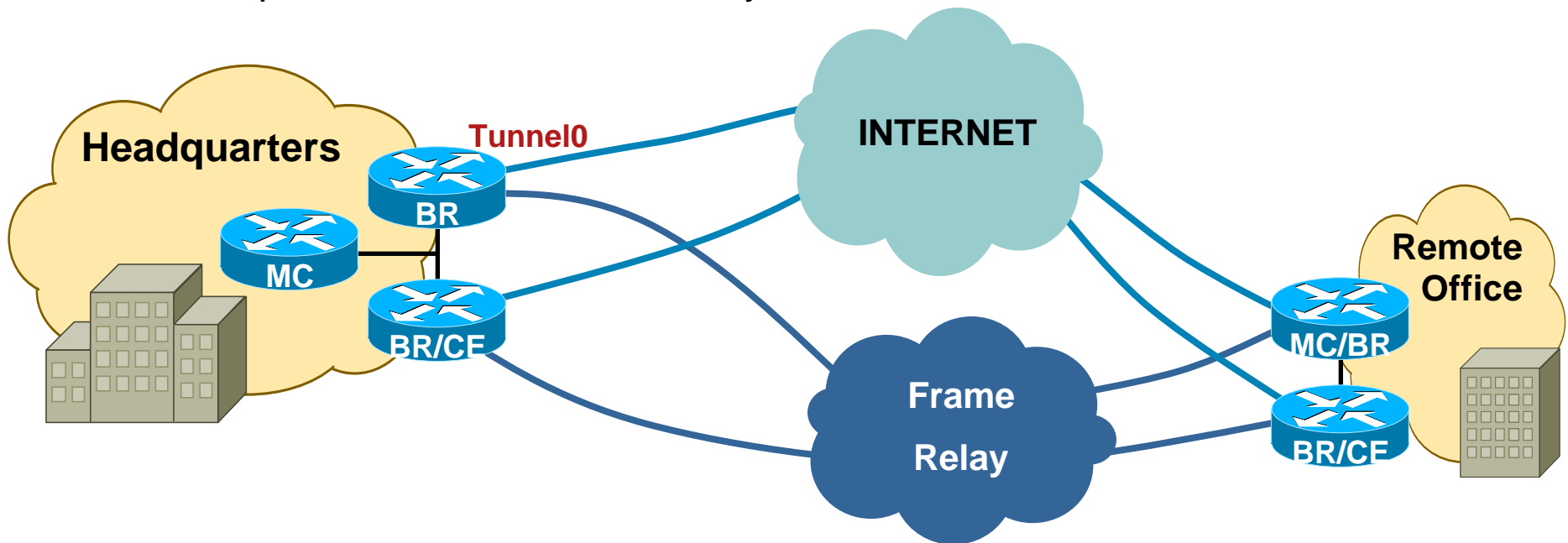


**BR—Border Router, MC—Master Controller**

# Enterprise VPN Deployment

## IPSEC/GRE and Frame Relay

- Quadruple Redundancy
- EIGRP or OSPF
- Tunnel and FR I/F are OER External
- Backup, Performance, Load Policy

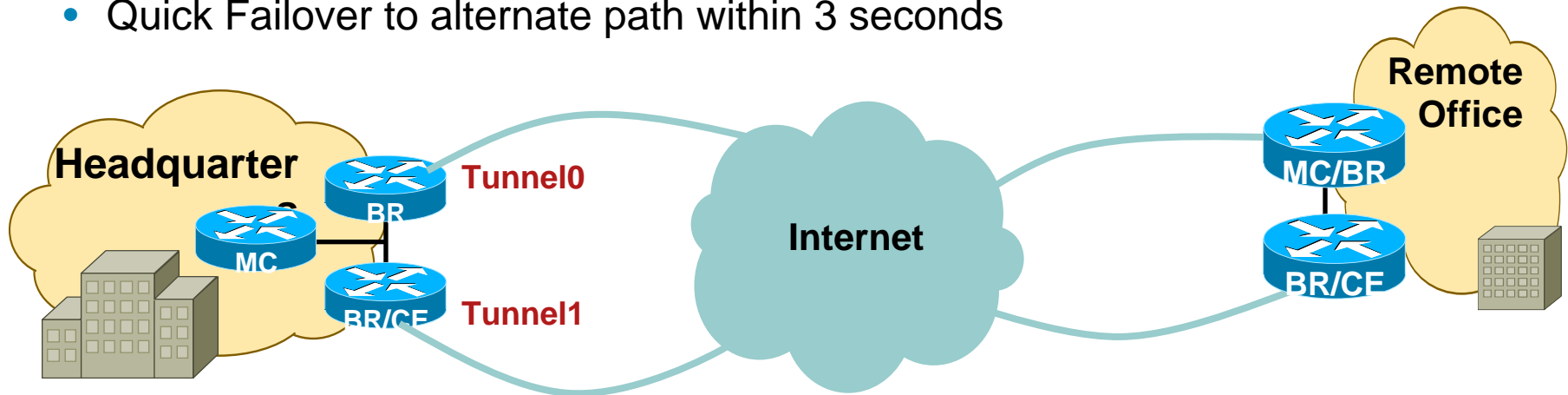


BR—Border Router, MC—Master Controller

# Enterprise VPN Deployment

## Fast Failover and Load Balancing

- Simultaneous probing on all Exits
- Quick Failover to alternate path within 3 seconds



Oer master

**max-range-utilization** percent 10

learn

**list sequence 10** rename REM\_OFC

traffic-class prefix-list REM\_OFC\_LIST

throughput

Ip prefix-lst REM\_OFC\_LIST **permit 10.1.0.0/16**

Ip prefix-lst REM\_OFC\_LIST **deny 0.0.0.0/0**

oer-map MAP 10

match oer learn list REM\_OFC

set mode monitor **fast**

set **unreachable threshold 5**

set active-probe echo 10.1.1.1

set active-probe echo 10.1.1.2

set probe **frequency 2**

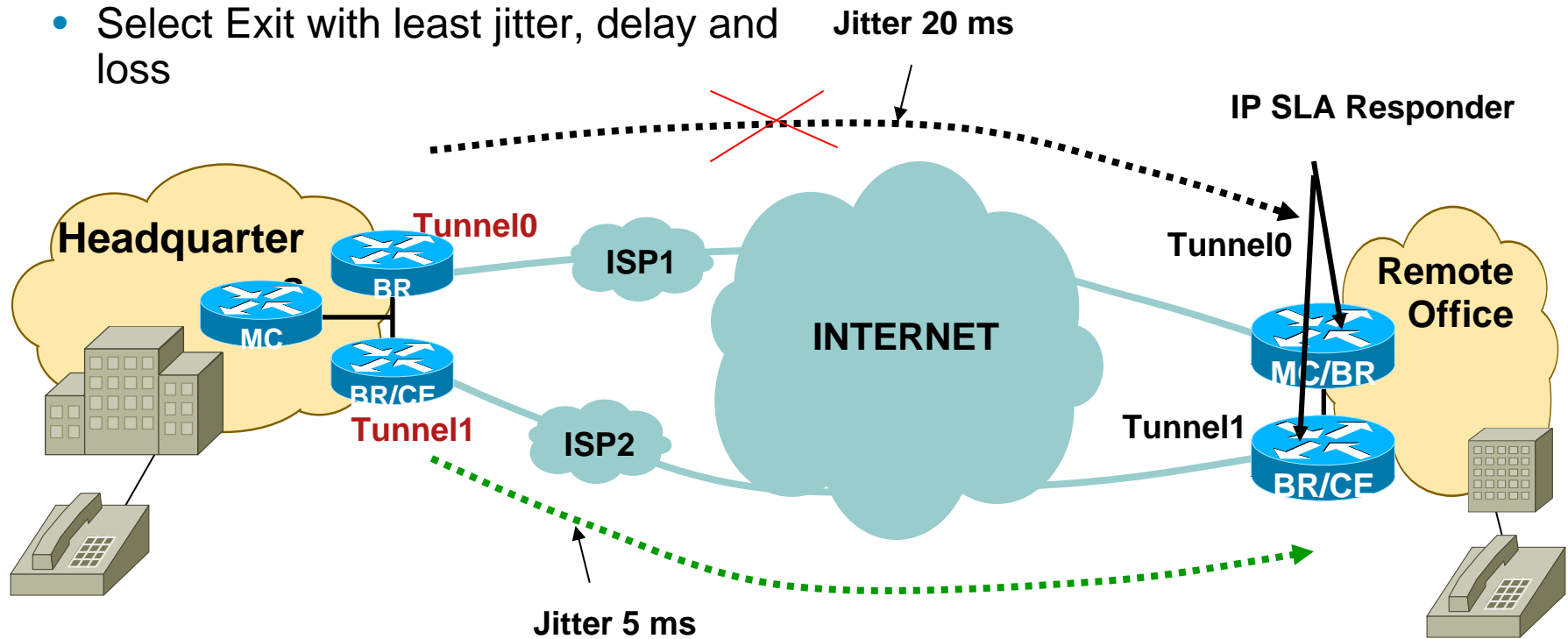
set resolve **range priority 1**

**BR—Border Router, MC—Master Controller**

# Enterprise VPN Deployment

## Optimize Voice Traffic between two sites

- Select Exit with least jitter, delay and loss



- Select Exit with highest percentage of Estimated MOS above threshold

Tunnel1 – 5 out of 100 sample had MOS < 4.00 ← Better

Tunnel0 – 20 out of 100 sample had MOS < 4.00

**BR—Border Router, MC—Master Controller**



# Enterprise VPN Deployment

## Optimize Voice Traffic between two sites

### Identify voice traffic

- Packets marked with DSCP bits

```
ip access-list extended VOICE-LIST
permit ip any 10.1.1.0 0.0.0.255 dscp ef
```

OR

- UDP port range

```
ip access-list extended VOICE-LIST
permit udp any 10.1.1.0 0.0.0.255
range x y
```

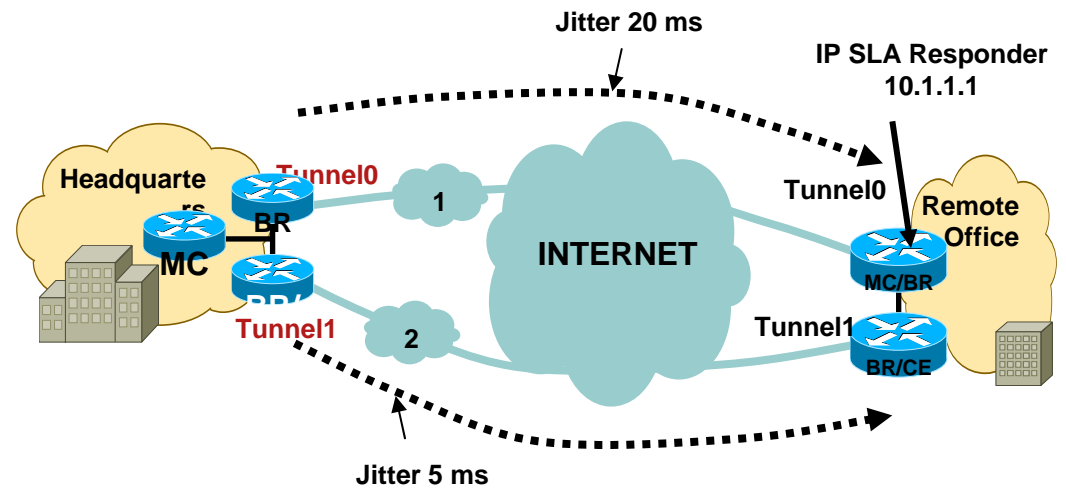
### Configure voice policy

```
policy-map MAP 20
match traffic-class access-list
VOICE-LIST
set jitter threshold 15
set mos percent 20 threshold 4.00
set resolve mos priority 1
set resolve jitter priority 2
set mode monitor fast
```

### Configure Jitter Probe

```
policy-map MAP 20
set active-probe jitter 10.1.1.1
target-port 2000 codec g729a
set probe frequency 2
```

```
ip sla responder
```



# Enterprise VPN Deployment

## Optimize Application

### Traffic to Branch Office

Latency sensitive Application – telnet, ssh

Latency tolerant – other

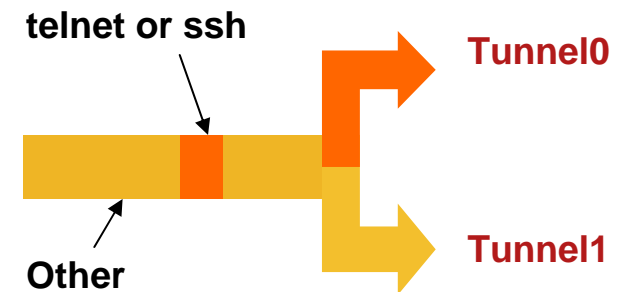
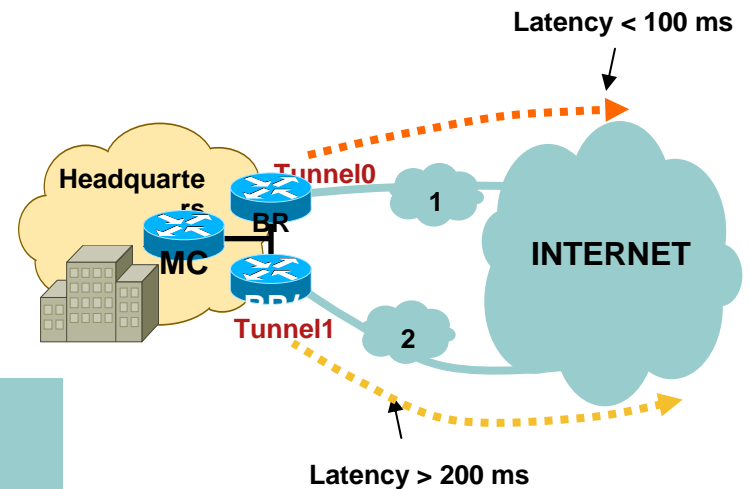
### Learn Application Traffic

```
Ip prefix-list BRANCH_PFX permit 10.1.0.0/16
!
oer master
learn
list sequence 10 refname BRANCH_APPL
traffic-class application telnet ssh filter
BRANCH_PFX
throughput
list sequence 20 refname BRANCH_PFX
traffic-class prefix-list BRANCH_PFX
throughput
```

### Configure Policy

```
oer-map MAP 10
match oer learn list BRANCH_APPL
set delay threshold 100
set resolve delay priority 1 variance 5
```

```
oer-map MAP 20
match oer learn list BRANCH_PFX
set delay threshold 400
set resolve utilization priority 1
variance 5
```



# Enterprise VPN Deployment

## Optimize Application – Define your own application

### Define application using access-list

```
Ip access-list extended APPL1_DEF
  permit tcp any eq 200 any
  permit tcp any any eq 200
```

```
Ip access-list extended APPL2_DEF
  permit ip any any dscp af12
```



### Add application definition to OER database

```
Oer master
  application define APPL1 access-list APPL1_DEF
  application define APPL2 access-list APPL2_DEF
```

### Learning user defined applications

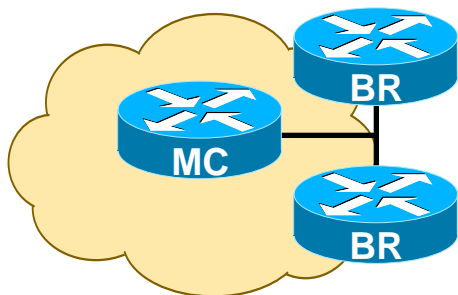


```
Oer master
  learn
    list seq 30 refname LISTA
    traffic-class application APPL1
  list seq 40 refname LISTB
  traffic-class application APPL2
```

### Apply Policy to Learned Application



```
oer-map MAP 10
  match traffic-class learn list LISTA
  set resolve delay priority 1 variance 5
oer-map MAP 20
  match traffic-class learn list LISTB
  set resolve range priority 1
```



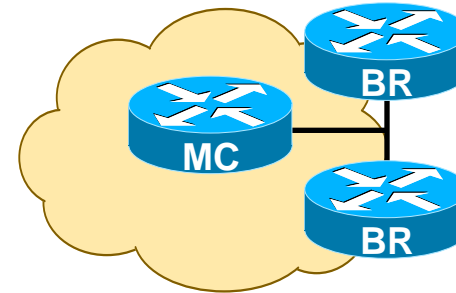
# Enterprise VPN Deployment

## Optimize Application identified by NBAR\*

- Use NBAR to identify Application Traffic
- NBAR is activated automatically on BR

### Learning NBAR identified applications

```
Oer master
learn
  list seq 30 refname LISTA
  traffic-class application nbar rtp-audio
  list seq 40 refname LISTB
  traffic-class application nbar citrix
```



### Configure NBAR identified applications

```
Ip prefix-list LIST1 permit 10.1.1.0/24
Ip prefix-list LIST1 permit 10.1.2.0/24

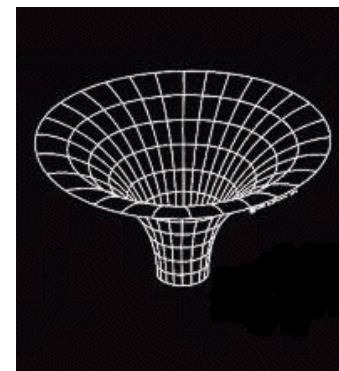
Oer-map MAP 10
  match traffic-class application nbar citrix prefix-list LIST1
```

\* To be Release in 12.5 (1<sup>st</sup>) T

# Security Policy – Ignore Performance

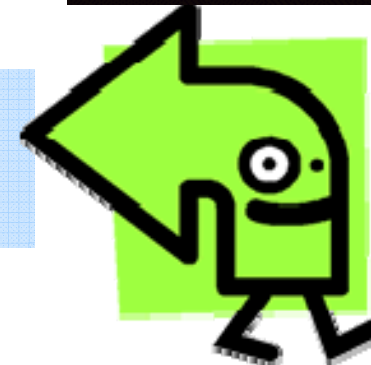
## Identify Blackhole Traffic Class

```
ip prefix-list BLACKHOLE permit 100.1.1.0/24
ip access-list extended BLACKHOLE
permit tcp 10.10.10.0 0.0.0.255 any eq www
```



## Identify Sinkhole Traffic Class

```
ip prefix-list SINKHOLE permit 9.1.1.1/32
ip access-list extended SINKHOLE
permit udp 10.10.10.0 0.0.0.255 any eq domain
permit ip any any dscp cs4
```

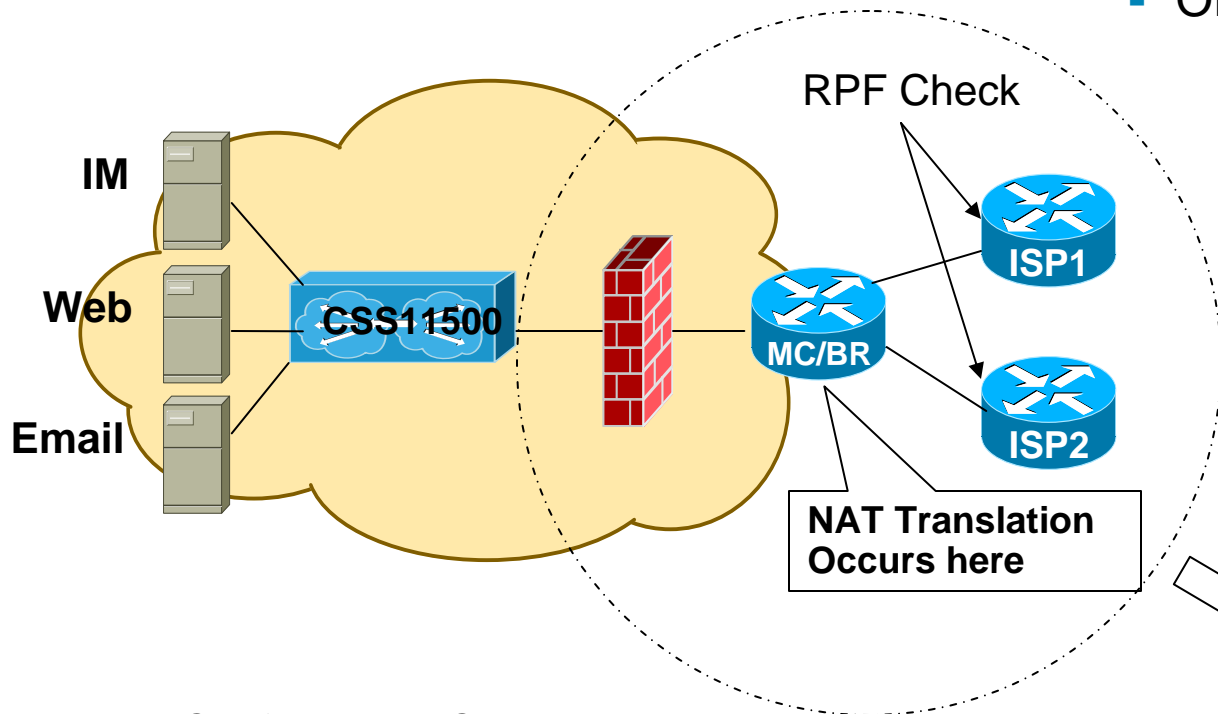


## Apply Policy

```
oer master
policy-rules SECURITY
oer-map SECURITY 10
match ip address prefix-list BLACKHOLE
set interface Null0
oer-map SECURITY 40
match ip address access-list SINKHOLE
set next-hop 10.10.10.4
```

# OER with NAT

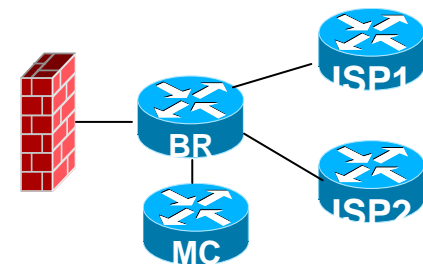
## MC/BR Router Combined



- OER and NAT

Existing flow continues on same Exit. No sessions are dropped.

New flow goes out via new Exit.



With Separate MC and BR

Minimal Configuration Change

```
interface virtual-template 1  
ip nat inside source <x> interface Virtual-Template 1 overload OER
```

# OER with NAT – Configuration Example

## Identify traffic to be NAT translated

```
access-list 1 permit 10.1.0.0  
0.0.255.255
```

```
route-map isp-1 permit 10  
match ip address 1  
match interface Se1/0  
route-map isp-2 permit 10  
match ip address 1  
match interface Se2/0
```

```
interface Eth3/0  
ip nat inside  
interface Se1/0  
ip nat outside  
interface Se2/0  
ip nat outside
```

OER Internal  
Interface

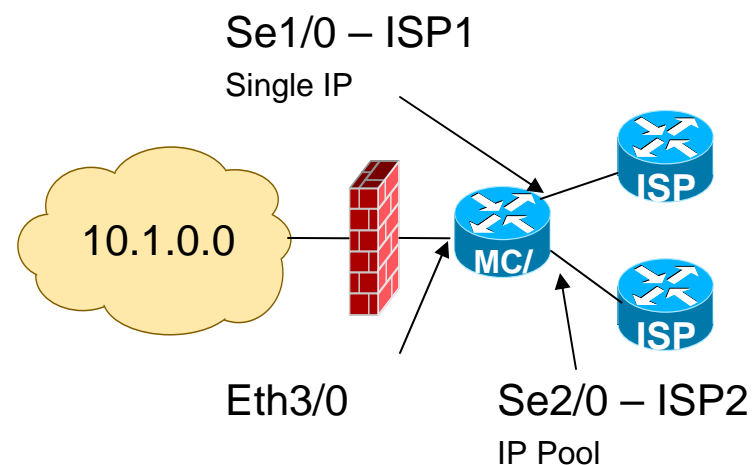
OER External  
Interface

## Single IP

```
interface virtual-template 1  
ip nat inside source route-map isp-1 interface  
Virtual-Template1 overload oer
```

## IP Pool

```
ip nat pool ISP-2 <min-ip-addr> <max-ip-addr>  
prefix-length <len>  
ip nat inside source route-map isp-2 pool ISP-2  
oer
```



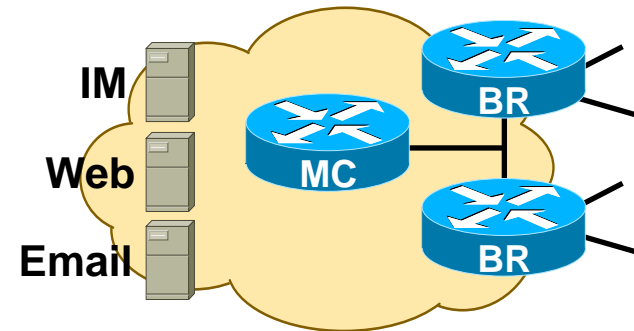
# Security Considerations



- Deploy MC behind Firewall
- Separate Private VLAN for MC and BR
- Private Addressing for MC and BR Communication
- No Routing on MC

```
no ip routing  
no router ...
```

**Routing not required on MC**

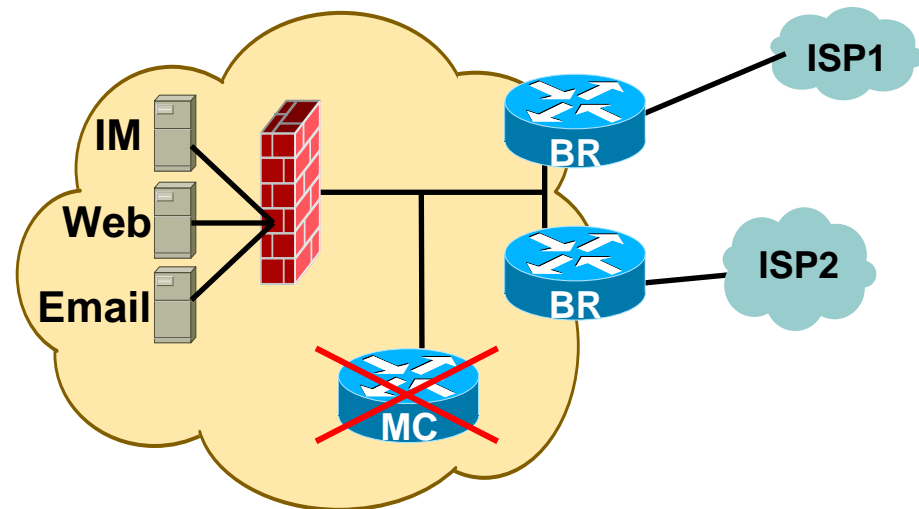


**BR—Border Router, MC—Master Controller**



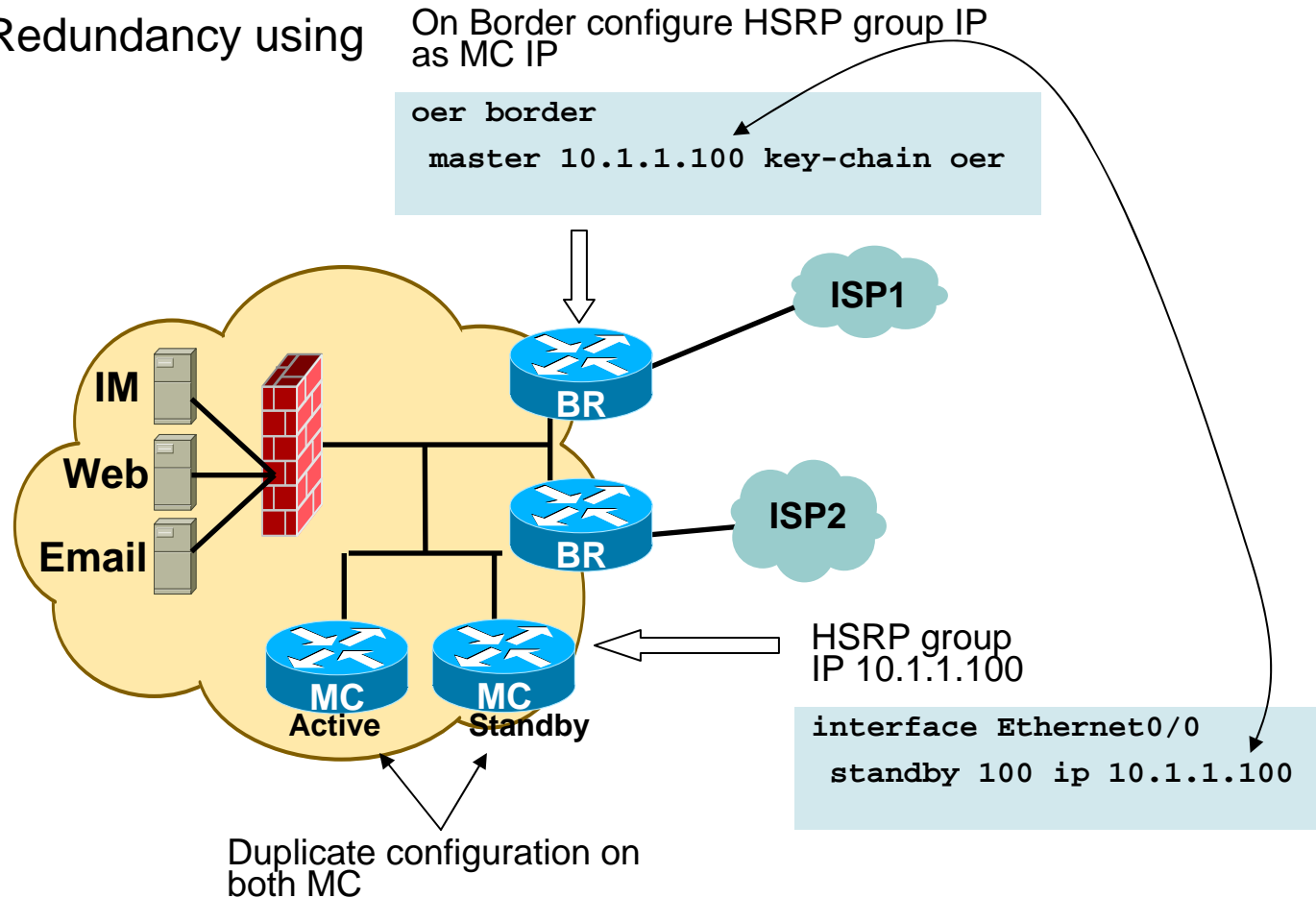
# OER MC Redundancy

- What if MC goes down?
  - Routing defaults to normal as if OER was not configured
- Still need MC Redundancy?
  - Available:
    - Stateless redundancy without configuration synchronization available using HSRP.
  - On Roadmap
    - Stateless Redundancy with synchronized configuration and Stateful Redundancy.



# OER MC Redundancy

- Stateless Redundancy using HSRP



# Agenda

- OER Overview
- Deployment
- Troubleshooting
- Performance
- Conclusion
- Q & A

# How to Discover Current Path?

```
show oer master prefix 100.1.1.0/24 traceroute current [now]
```

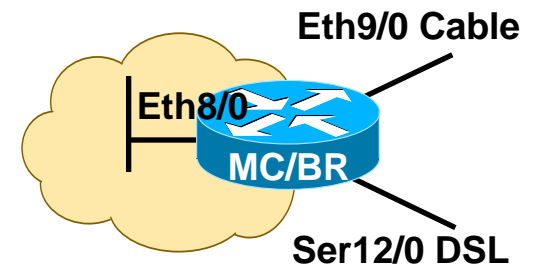
- Displays current path of prefix
- Uses responding target
- If `now`, generate new result
- Otherwise, display most recent result

```
sh oer master prefix 100.1.1.0/24 traceroute current now
Path for Prefix: 100.1.1.0/24          Target: 100.1.1.1
Exit ID: 2, Border: 10.10.10.1       External Interface: Se12/0
Status: DONE, How Recent: 00:00:00 minutes old
```

Hop	Host	Time(ms)	AS
1	30.30.30.2	24	0
2	60.60.60.4	12	0
3	100.0.0.2	20	0

**DONE or INPROGRESS**

**AS Is Unknown  
Likely Not Using BGP**



# How to Discover All Paths?

```
show oer master prefix 100.1.1.0/24 traceroute [now]
```

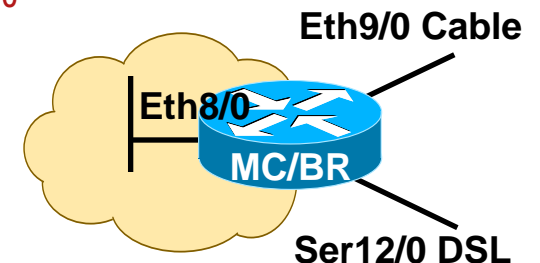
- Displays Path over Each External Interface
- Uses Responding Target

```
-----  
Path for Prefix: 100.1.1.0/24          Target: 100.1.1.1  
Exit ID: 1, Border: 10.10.10.1        External Interface: Et9/0  
Status: DONE, How Recent: 00:01:04 minutes old
```

Hop	Host	Time(ms)	AS
1	40.40.40.2	4	0
2	60.60.60.4	4	0
3	100.0.0.2	20	0

```
-----  
Path for Prefix: 100.1.1.0/24          Target: 100.1.1.1  
Exit ID: 2, Border: 10.10.10.1        External Interface: Se12/0  
Status: DONE, How Recent: 00:05:44 minutes old
```

Hop	Host	Time(ms)	AS
1	30.30.30.2	12	0
2	60.60.60.4	16	0
3	100.0.0.2	32	0



# How to Discover Path on OOP?

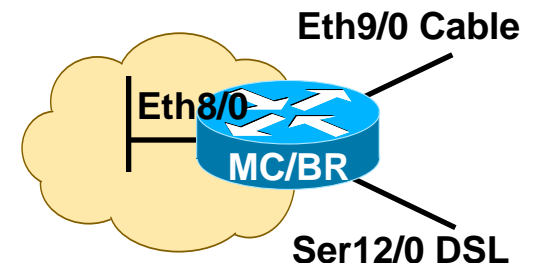
```
oer-map foo 10
match oer learn throughput
set traceroute reporting policy delay
set traceroute reporting policy loss
set traceroute reporting policy unreachable
```

Learned Top Throughput Prefixes,  
Discover Path on Delay OOP  
Discover Path on Loss OOP  
Discover Path on Unreachable OOP

- To display traceroute result

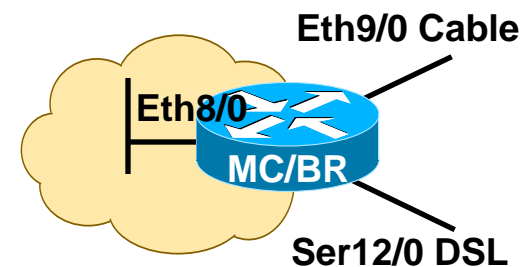
```
sh oer master prefix 100.1.1.0/24 traceroute current now
Path for Prefix: 100.1.1.0/24      Target: 100.1.1.1
Exit ID: 2, Border: 10.10.10.1     External Interface: Se12/0
Status: DONE, How Recent: 00:00:00 minutes old
```

Hop	Host	Time(ms)	AS
1	30.30.30.2	24	0
2	60.60.60.4	12	0
3	100.0.0.2	20	0



# Troubleshooting

1. Verify Master to Border Connection
2. Verify Master is Operational
3. Verify Internal/External Interfaces Operational
4. Verify Traffic class Learning
5. Verify Traffic class Monitoring
6. Verify Traffic class Control
7. Investigate Traffic-class History



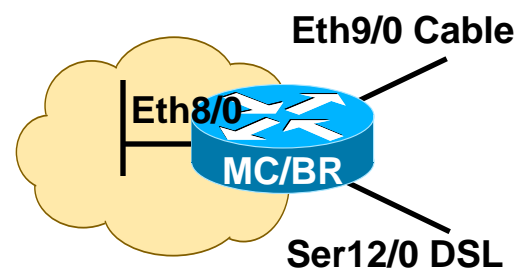
**BR—Border Router, MC—Master Controller**

# Verify Master to Border Connection

```
sh oer master border
```

Border	Status	UP/DOWN	AuthFail
10.10.10.1	INACTIVE	<b>DOWN</b>	0

- Key chain not configured or misconfigured
- OER Border local interface IP address and Master IP address mismatch
- OER Border master IP address not reachable or not Master



**BR—Border Router, MC—Master Controller**



# Verify Master Operational

- At least 1 internal, and 2 external must be UP

```
sh oer master border
```

Border	Status	UP/DOWN		AuthFail
10.10.10.1	INACTIVE	UP	00:00:28	0

```
sh oer master border detail | i Down
```

Se12/0	EXTERNAL	Admin	Down		
Se12/0	1544	300	0	0	Admin Down

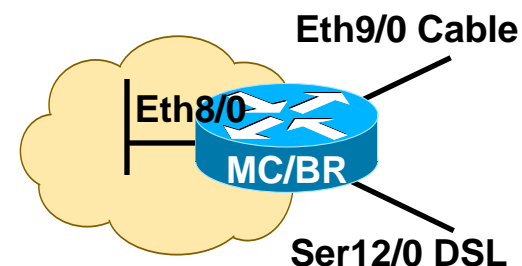
- No shutdown Serial 12/0

```
sh oer master border
```

Border	Status	UP/DOWN		AuthFail
10.10.10.1	ACTIVE	UP	00:17:06	0

```
sh oer master | i OER state
```

```
OER state: ENABLED and INACTIVE
```

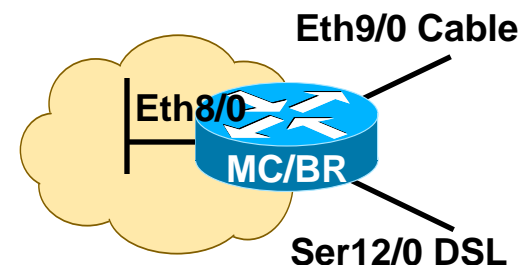


BR—Border Router, MC—Master Controller

# Verify Internal and External Interfaces Operational

```
sh oer master border detail
```

```
Border          Status  UP/DOWN          AuthFail
10.10.10.1      ACTIVE  UP               00:10:32      0
  Se12/0        EXTERNAL UP
  Et9/0         EXTERNAL UP
  Et8/0         INTERNAL UP
```



External Interface	Capacity (kbps)	Max BW (kbps)	BW Used (kbps)	Load (%)	Status	Exit Id
Se12/0	1544	300	120	7	UP	4
		300	78	3		
Et9/0	10000	1000	338	3	UP	2
		1000	150	1		

← Egress (from Se12/0 and Et9/0)
   
← Ingress (to Et9/0)

**BR—Border Router, MC—Master Controller**

# Verify Traffic Class Learning

- Learning Running on MC

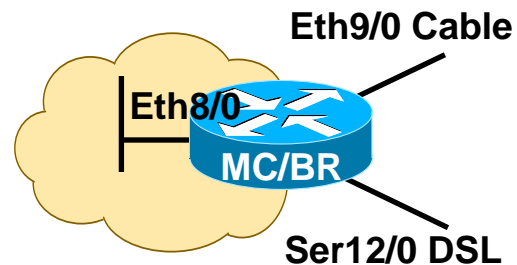
```
sh oer master | b Learn
```

```
Learn Settings:
```

```
current state : STARTED
```

```
time remaining in current state : 93 seconds
```

```
aggregation-type prefix-length 22
```



**BR—Border Router, MC—Master Controller**

# Verify Traffic Class Learning

- Learning running on BR (configuration)

OER Border Learn Configuration :

State is enabled

Measurement type: **throughput**, Duration: 5 min

Aggregation type: prefix-length, Prefix length: 24

No port protocol config

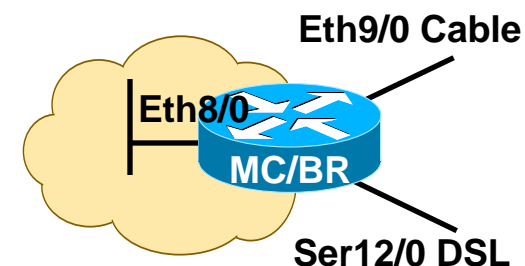
**Learn List 10**

Measurement type: **throughput**

Session count: 50

Aggregation type: prefix-length, Prefix length: 24

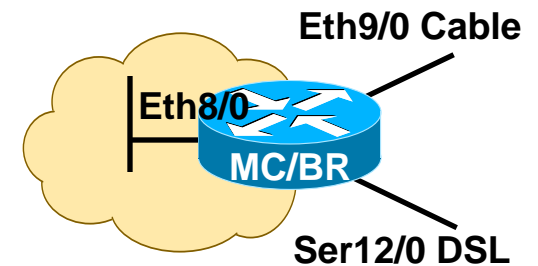
Appl ID: **telnet**



**BR—Border Router, MC—Master Controller**

# Verify Traffic Class Learning

- Learning running on BR



```
sh oer border pass cache learn traffic-class
```

```
OER Learn Cache:
```

```
State is enabled
```

```
Measurement type: throughput and delay, Duration: 1 min
```

```
Aggregation type: prefix-length, Prefix length: 24
```

```
4096 oer-flows per chunk,
```

```
12 chunks allocated, 32 max chunks,
```

```
1 allocated records, 49151 free records, 5767680 bytes allocated
```

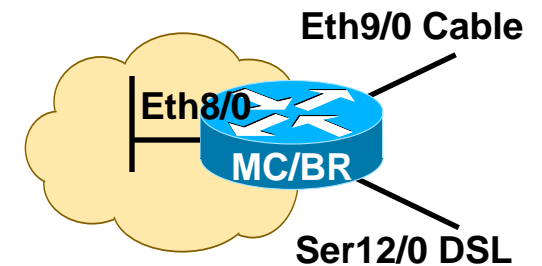
DstPrefix	Appl_ID	Dscp	Prot	SrcPort	DstPort	SrcPrefix	Pkts	B/Pk	Delay	Samples	Active
	Host1	Host2	Host3	Host4	Host5		Host1	Host2	Host3	Host4	Host5
	dport1	dport2	dport3	dport4	dport5						
-----											
10.1.15.0/24	telnet	defa	N	N	N	0.0.0.0/0	38	49	0	0	72.7
							10.1.15.2	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0
							1005	0	0	0	0
10.1.15.0/24	N	defa	N	N	N	N	84	634	0	0	45.2
							10.1.15.2	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0
							1006	0	0	0	0

**BR—Border Router, MC—Master Controller**

# Verify Traffic Class Learning ...

- Learned Traffic Class in MC

```
MC#show oer master traffic-class
OER Prefix Statistics
...
```



DstPrefix	Apppl_ID	Dscp	Prot	SrcPort	DstPort	SrcPrefix			
Flags	State	Time	CurrBR	CurrI/F	Protocol				
PasSDly	PasLDly	PasSUn	PasLUn	PasSLos	PasLLos	EBw	IBw		
ActSDly	ActLDly	ActSUn	ActLUn	ActSJit	ActPMOS				
-----									
10.1.15.0/24	telnet	defa	N	N	N	0.0.0.0/0			
	INPOLICY		0		10.1.1.2	Et2/0	PBR		
	22	22	0	0	1749	1395	1	1	
	U	U	0	0	N	N			
10.1.15.0/24		N defa	N	N	N	0.0.0.0/0			
	INPOLICY*		0		10.1.1.2	Et2/0	U		
	14	13	0	0	0	0	14	1	
	U	12	0	0	N	N			

**BR—Border Router, MC—Master Controller**

# Verify Traffic Class Monitoring

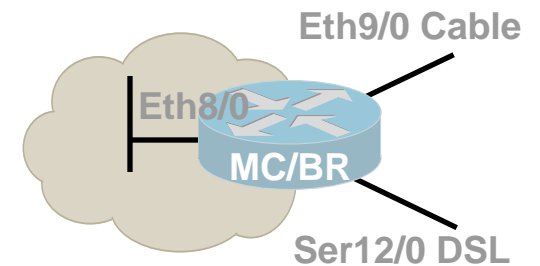
- Passive monitoring on BR

```
show oer border passive cache traffic-class
```

```
OER Passive Prefix Cache, State: enabled, 278544 bytes
```

```
...
```

DstPrefix	Appl_ID	Dscp	Prot	SrcPort	DstPort	SrcPrefix	Active
Flows	Nexthop	sDl	#Dly	Pkts	B/Pk	DstIf	#UnRch
						PktLos	
-----							
10.1.15.0/24		N defa	N	N	N	0.0.0.0/0	
	10.1.7.2					Et0/0	56.3
		0	0	150	620	0	0
10.1.15.0/24	telnet	defa	N	N	N	0.0.0.0/0	
	10.1.7.2					Et0/0	30.4
		0	0	27	49	1	0



BR—Border Router, MC—Master Controller

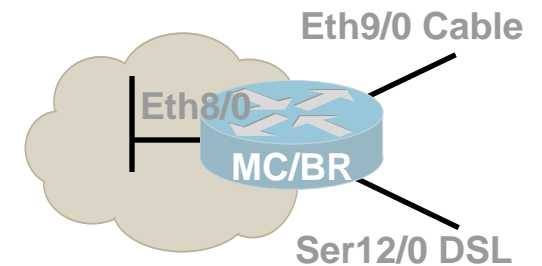
# Verify Traffic Class Control

- Traffic Class control on MC

```
show oer master traffic-class
```

```
OER Prefix Statistics:
```

```
...
```



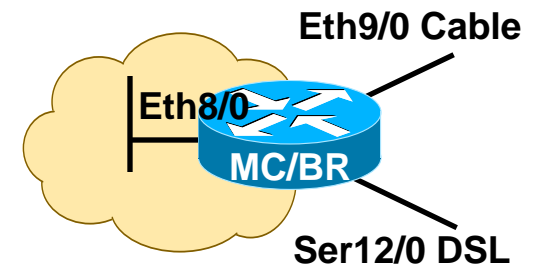
DstPrefix	Flags	Appl_ID	Dscp	Prot	SrcPort	DstPort	SrcPrefix	Protocol
	PasSDly	PasLDly	PasSUn	PasLUn	PasSJos	PasLJos	EBw	IBw
	ActSDly	ActLDly	ActSUn	ActLUn	ActSJit	ActPMOS		
10.1.15.0/24		telnet	defa	N	N	N	0.0.0.0/0	
			INPOLICY	0		10.1.1.2	Eth2/0	PBR
	22	22	0	0	1749	1395	1	1
	U	U	0	0	N	N		
10.1.15.0/24			N defa	N	N	N	0.0.0.0/0	
			INPOLICY	0		10.1.1.2	Eth2/0	BGP
	14	13	0	0	0	0	14	1
	U	12	0	0	N	N		

BR—Border Router, MC—Master Controller



# Verify Traffic-class Control

- Verify Traffic-class Control on BR



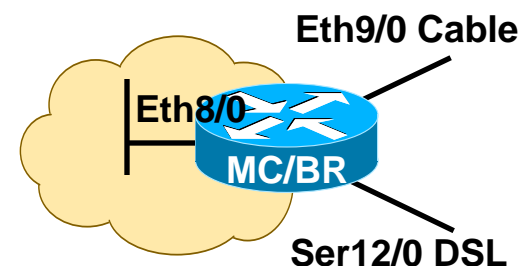
```
show oer border routes Static or bgp
BGP table version is 88, local router ID is 10.1.4.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
               internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
OER Flags: C - Controlled, X - Excluded, E - Exact, N - Non-exact, I -
            Injected
```

Network	Next Hop	OER	LocPrf	Weight	Path
*> 10.1.15.0/24	10.1.4.2	CE	0	300	50 ?

**BR—Border Router, MC—Master Controller**

# Verify Traffic Class Controlled

- Verify Application Traffic class control on BR



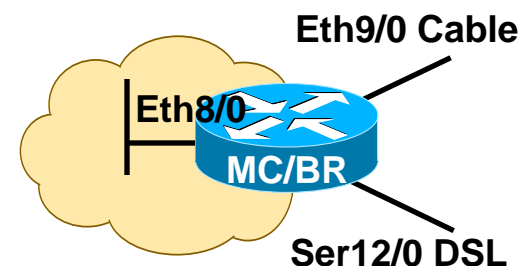
```
show ip access-list dynamic
Extended IP access list oer#1
    536870911 permit tcp any 10.1.15.0 0.255.255.255 eq telnet
    536870912 permit tcp any eq telnet 10.1.15.0 0.255.255.255
```

```
show route-map dynamic
route-map OER-02/21/06-04:27:44.419-1-OER, permit, sequence 0, identifier 1706070788
  Match clauses:
    ip address (access-lists): oer#1
  Set clauses:
    interface Ethernet2/0 ← External Interface
    ip next-hop 10.1.4.2
Policy routing matches: 0 packets, 0 bytes
Current active dynamic routemaps = 1
```

**BR—Border Router, MC—Master Controller**

# Investigate Traffic-class History

- Traffic-class Log



```
sh log | i 10.1.15.0
```

```
*Apr 26 22:58:20.919: %OER_MC-5-NOTICE: Discovered Exit for prefix  
10.1.15.0/24, BR 10.10.10.1, i/f Et9/0  
  
*Apr 26 23:03:14.987: %OER_MC-5-NOTICE: Route changed 10.1.15.0/24, BR  
10.10.10.1, i/f Se12/0, Reason Delay, OOP Reason Timer Expired  
  
*Apr 26 23:09:18.911: %OER_MC-5-NOTICE: Passive REL Loss OOP  
10.1.15.0/24, loss 133, BR 10.10.10.1, i/f Se12/0, relative loss  
23, prev BR Unknown i/f Unknown  
  
*Apr 26 23:10:51.123: %OER_MC-5-NOTICE: Route changed Appl  
10.1.15.0/24 telnet, BR 10.10.10.1, i/f Et9/0, Reason Delay, OOP  
Reason Loss  
  
*Apr 26 23:19:18.919: %OER_MC-5-NOTICE: Passive REL Loss OOP  
10.1.15.0/24, loss 138, BR 10.10.10.1, i/f Et9/0, relative loss  
66, prev BR Unknown i/f Unknown
```

**BR—Border Router, MC—Master Controller**

# Investigate Traffic-class History

- Detailed Traffic-class History

```
sh oer master traffic-class prefix 10.1.15.0/24 detail
```

```
Prefix: 10.1.15.0/24
```

```
State: INPOLICY      Time Remaining: 0
```

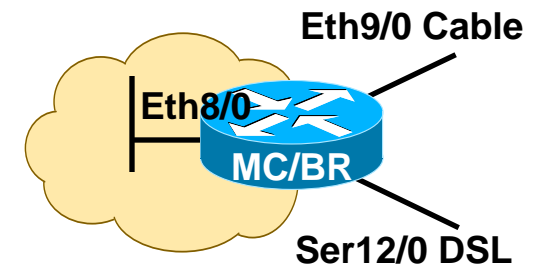
```
Policy: Default
```

```
Most recent data per exit
```

Border	Interface	PasSDly	PasLDly	ActSDly	ActLDly
*10.10.10.1	Et9/0	0	16	35	35
10.10.10.1	Se12/0	0	0	38	38

```
Latest Active Stats on Current Exit:
```

Type	Target	TPort	Attem	Comps	DSum	Min	Max	Dly
echo	100.1.1.1	N	2	2	88	40	48	44



**BR—Border Router, MC—Master Controller**

# Why Is Traffic-class Always in Default State ?

## Active Probes Are Not Responding

- Verify Active Probes Enabled

```
sh oer master | i mode monitor
```

```
mode monitor both
```

Should Be Both or Active

- clear oer master traffic-class prefix 10.1.15.0/24

This will remove learned prefixes

- Wait for probe all to complete
- Verify active probes responding

```
sh oer master traffic-class prefix 10.1.15.0/24 detail
```

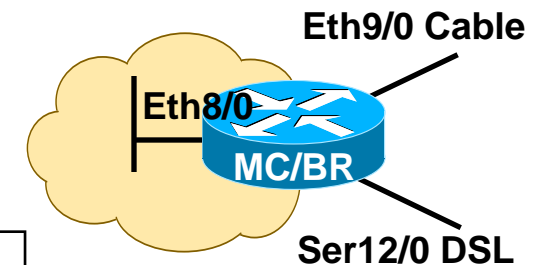
```
Prefix: 10.1.15.0/24
```

```
State: DEFAULT*   Time Remaining: @65
```

```
Policy: Default
```

Most recent data per exit

Border	Interface	PasSDly	PasLDly	ActSDly	ActLDly
*10.10.10.1	Et9/0	0	0	0	0
10.10.10.1	Se12/0	0	0	0	0



@ Indicates Probe All

No Probes Responding

# Why Are Active Probes Not Responding?

- Is Prefix Configured?

Probes must be configured for configured prefixes

Probe assigned to prefix with longest match of probe target

```
oer master
```

```
    active-probe echo 10.1.15.9
```

```
sh oer master active-probes
```

State	Prefix	Type	Target	TPort	How	Codec
Assigned	10.1.15.0/24	echo	10.1.15.9	N	Cfgd	N

- No Parent Route for Prefix

BGP or static tables must include a route which includes prefix

- Target is Turned Off, Disabled

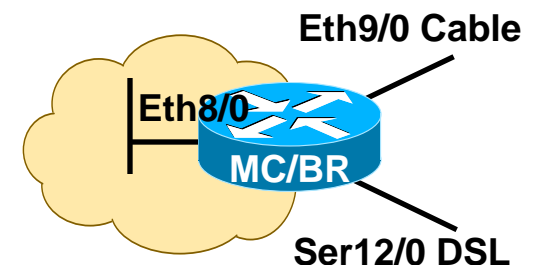
- Target does not respond to echo probes

Try configuring `tcp-conn` or `udp-echo` probes

- Firewall is blocking probes

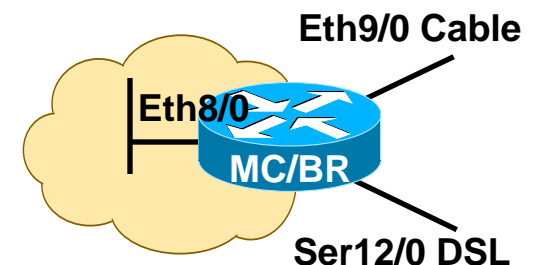
Try traceroute to determine block point

```
show oer master prefix 10.1.15.0/24 traceroute now
```



# Why No Passive Measurements ?

- No Traffic
  - Check EBw in show oer master prefix
- No TCP traffic
  - Passive Delay, Loss, and Reachability rely on TCP traffic
- Long lived TCP flows
  - Passive Delay and Reachability rely on TCP SYN, TCP ACK



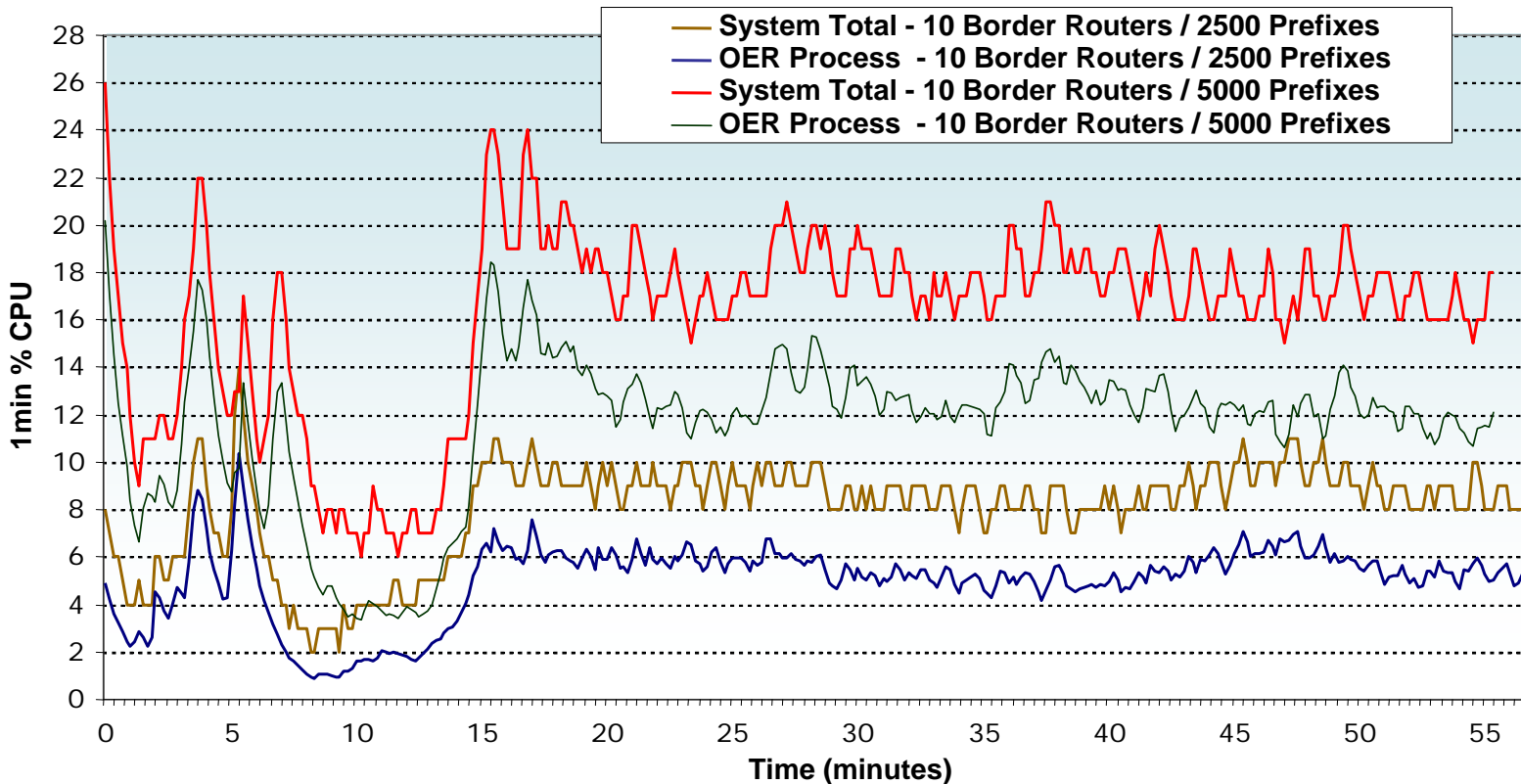
# Agenda

- OER Overview
- Deployment
- Troubleshooting
- Performance
- Conclusion
- Q & A



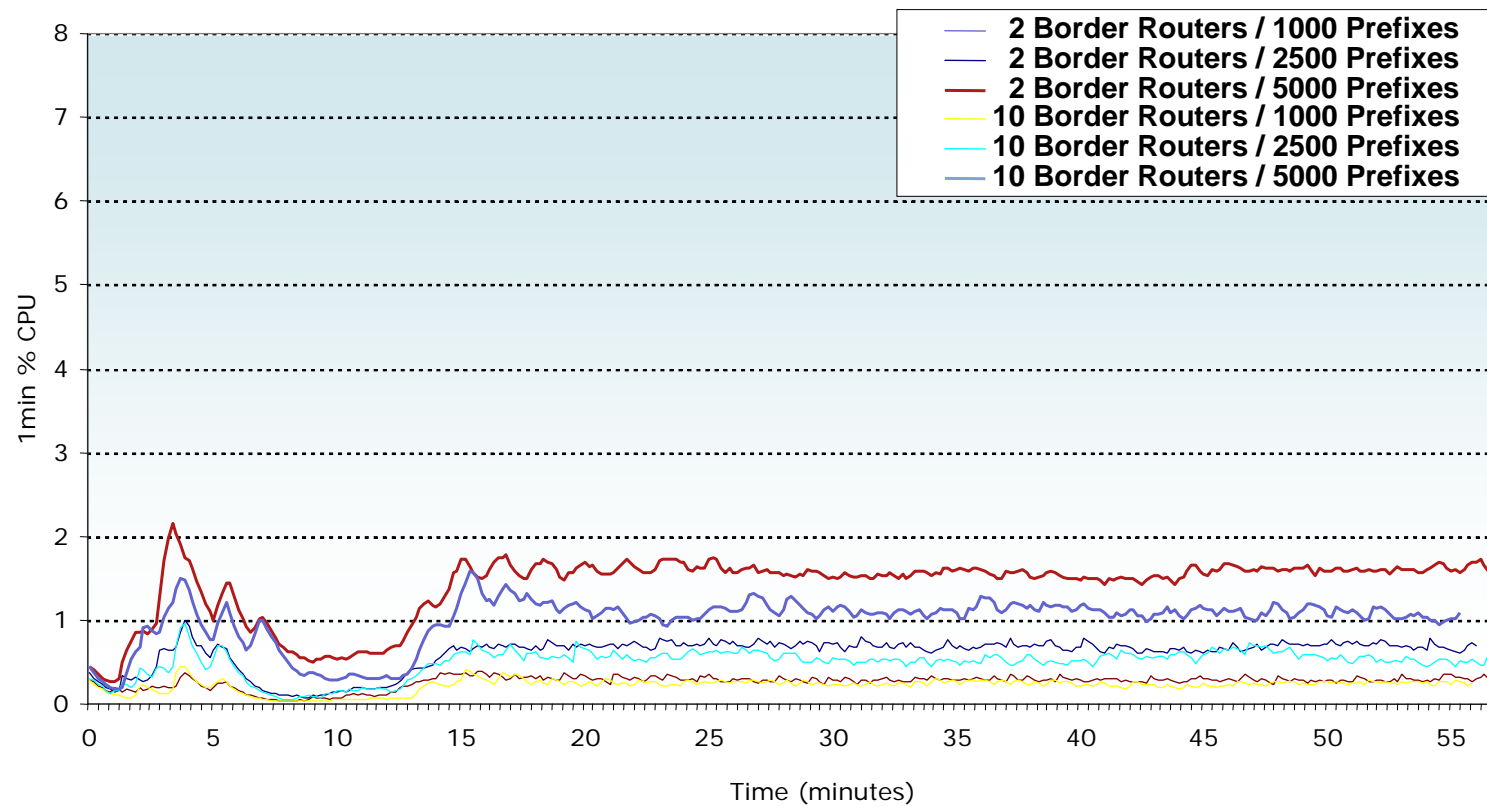
# OER MC Process vs. Total System CPU

12.3(11)T CPU Usage IOS Master Controller  
Comparing OER Process to Total System CPU  
Active + Learning Mode Enabled (2500 Prefixes)



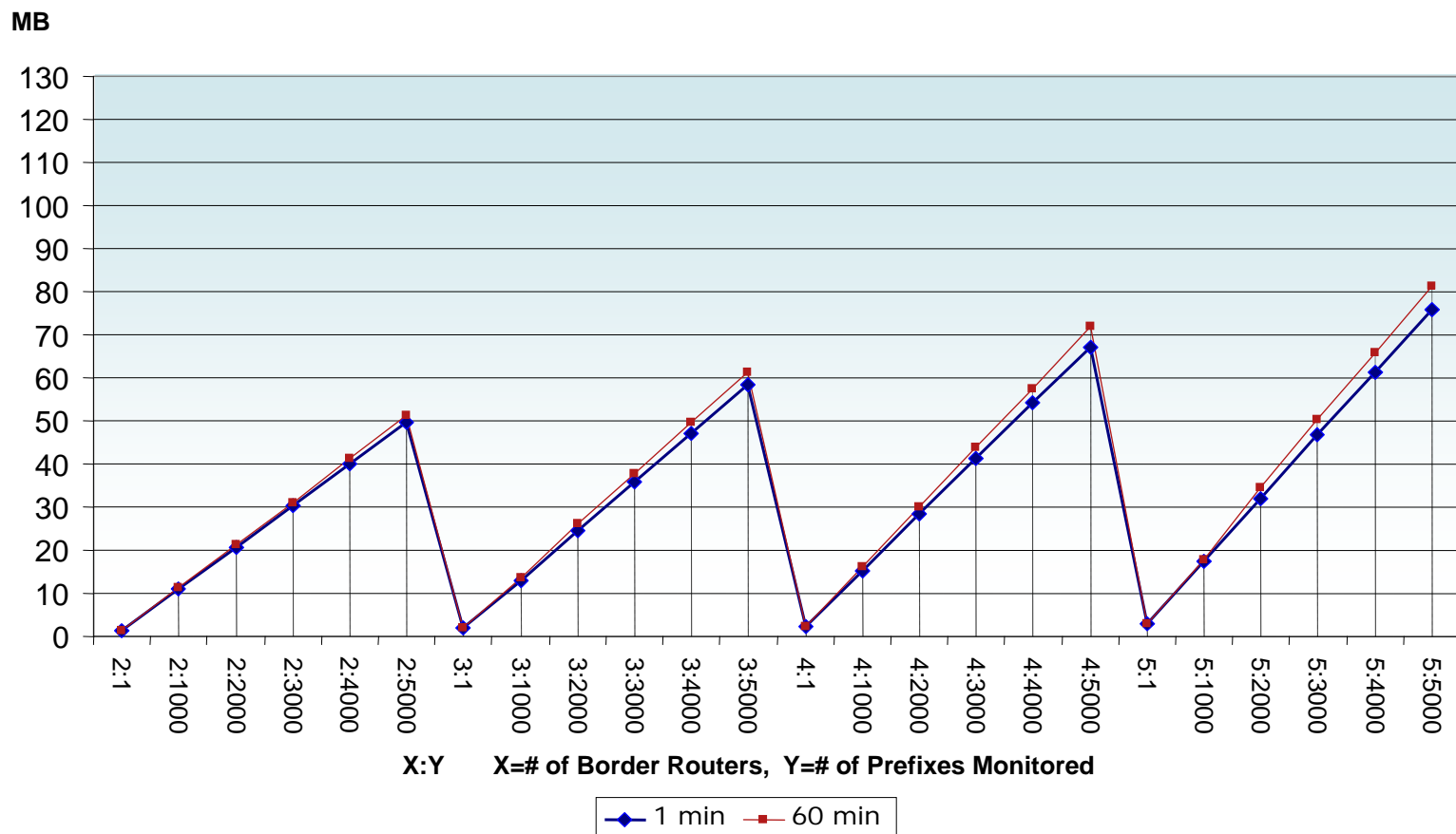
# OER BR Learning Enabled

12.3(11)T CPU Usage IOS Border Router  
OER BR Process Only  
Active + Learning Mode Enabled (2500 Prefixes)



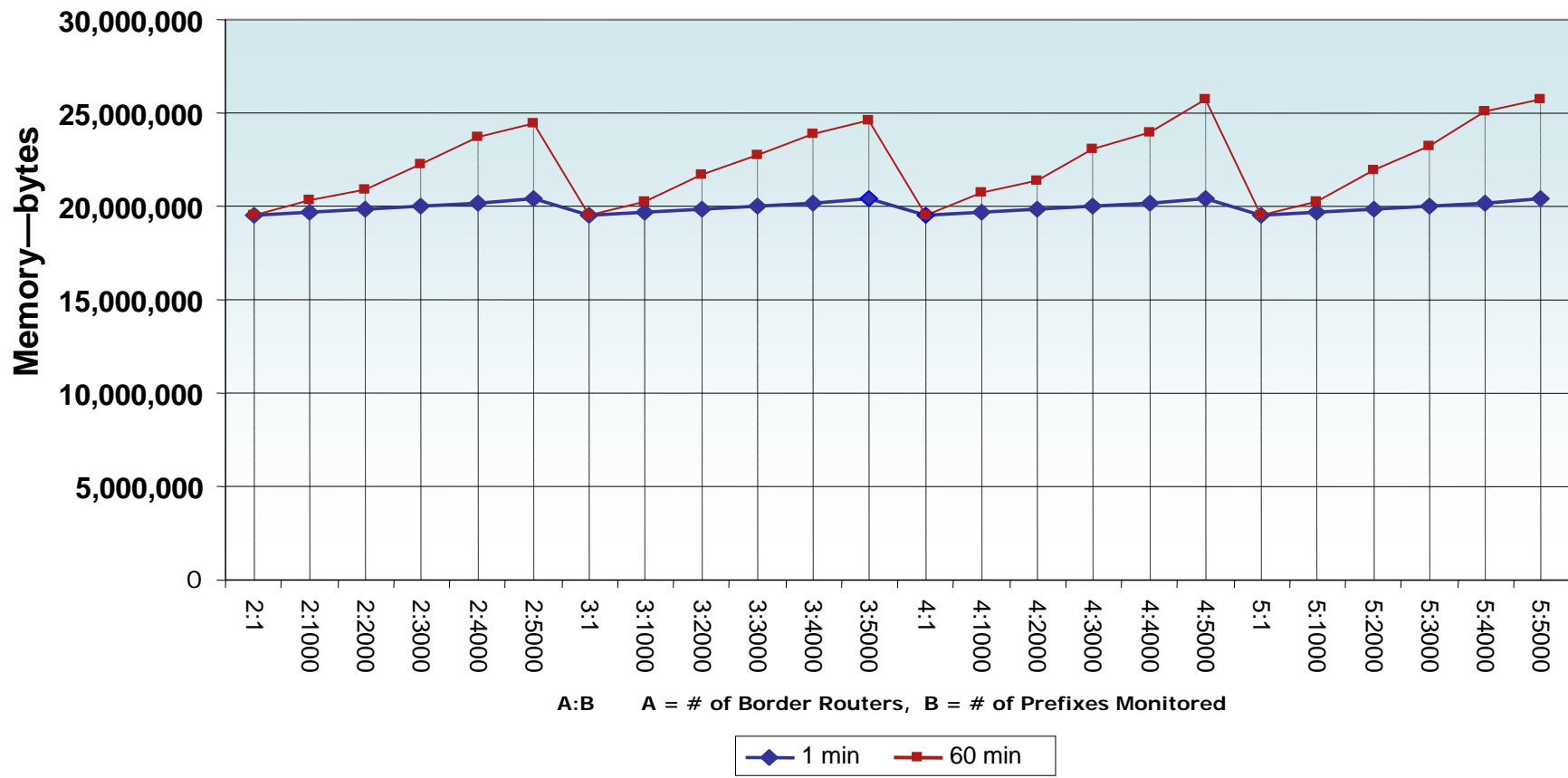
# Master Controller Memory Usage

Memory Usage OER Master Router  
2-5 Border Routers  
1-5000 Prefixes



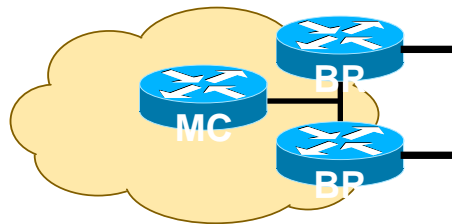
# Border Router Memory Usage

**Memory Usage OER Border Router**  
**2–5 Border Routers**  
**1–5000 Prefixes**

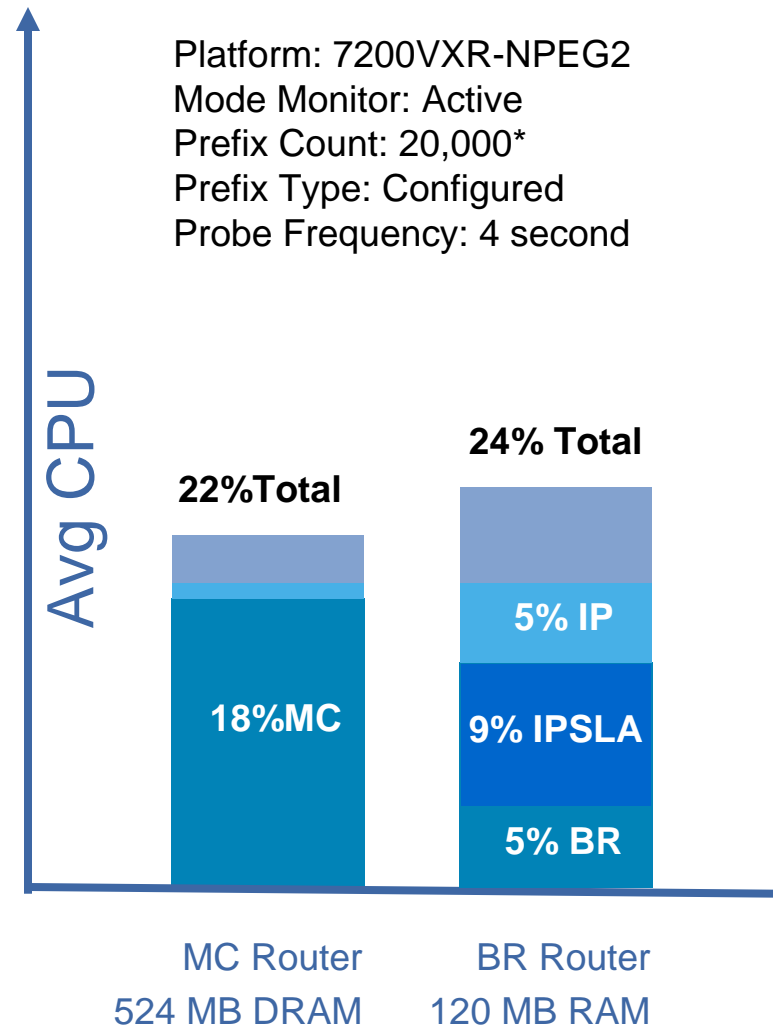


# 7200-NPE-G2 OER Performance

- Cisco's highest performing OER solution
- Ideal for Enterprise OER Solution
- Supports up to 15,000 prefixes



\*12.4(6<sup>th</sup>)T pre-release image



# Overall Performance Tests Summary

- MC needs higher performing CPU & more memory compared to BR
- In general, Cisco OER platforms show very favorable OER performance
- **7200-NPE-G2** is Cisco's **highest performing** OER platform

# Deployment Suggestions



- Measure performance impact on production BR during peak time (midday on a week day):
  - CPU: “show processes cpu”
  - Memory: “show memory summary”
- Determine viability of co-located MC/BR by
  - a) referencing peak time data, and b) referencing graph test results from earlier

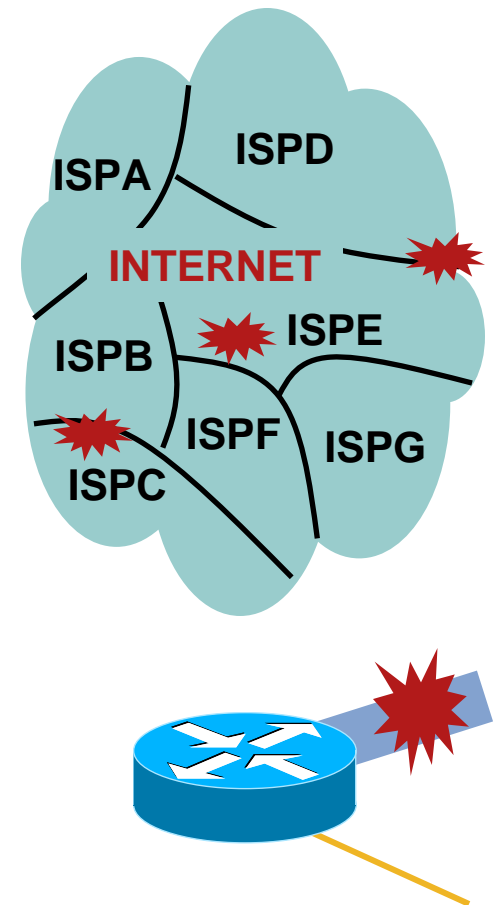
# Agenda

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# Conclusions

- OER Choose Best Performing Path
  - Delay, MOS
  - Load Balancing
  - For prefix, traffic-class and application
- OER works around network issues
  - Blackouts
  - Brownouts
- OER Reports Issues
  - Syslog
  - Show oer master prefix
  - Troubleshoot issues during workaround instead of fire fighting
- \$ Cost Management
  - OER saves \$ on Tiered Pricing Links



\$\$\$\$\$\$\$\$

# New Features

## Not released

- NBAR Aware – Dynamic Application Identification
- Fast Mode – Reroute within 3 seconds
- GUI – Easy Configuration & Detailed Reporting

# Agenda

- OER Overview
- Deployment
- Troubleshooting
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- Conclusion
- **References**
- Q & A

# Reference

- OER CCO

[www.cisco.com/univercd/cc/td/doc/product/software/ios124/124tcg/toer\\_c/index.htm](http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124tcg/toer_c/index.htm)

- Cisco IOS® Software Release 12.3 12.4 12.4T

[www.cisco.com/go/release124t/](http://www.cisco.com/go/release124t/)

# Meet the Experts

## IP and MPLS Infrastructure Evolution

- Andy Kessler  
Technical Leader
- Beau Williamson  
Consulting Engineer
- Benoit Lourdelet  
IP services Product manager
- Bertrand Duvivier  
Consulting Systems Engineer
- Bruce Davie  
Cisco Fellow
- Bruce Pinsky  
Distinguished Support Engineer



# Meet the Experts

## IP and MPLS Infrastructure Evolution

- Gunter Van de Velde  
Technical Leader
- John Evans  
Distinguished Systems Engineer
- Oliver Boehmer  
Network Consulting Engineer
- Patrice Bellagamba  
Consulting Engineer
- Shannon McFarland  
Technical Leader



# Meet the Experts

## IP and MPLS Infrastructure Evolution

- Andres Gasson  
Consulting Systems Engineer



- Steve Simlo  
Consulting Engineer



- Toerless Eckert  
Technical Leader



- Dino Farinacci  
Cisco Fellow & Senior Software Engineer



# Q and A





