



Performance Routing (PfR) Overview



January 2008

What is Cisco Performance Routing?

- Cisco® Performance Routing (PfR) utilizes advanced path selection and adaptive routing techniques to enable a performance aware network

Best performing path selection

Application aware

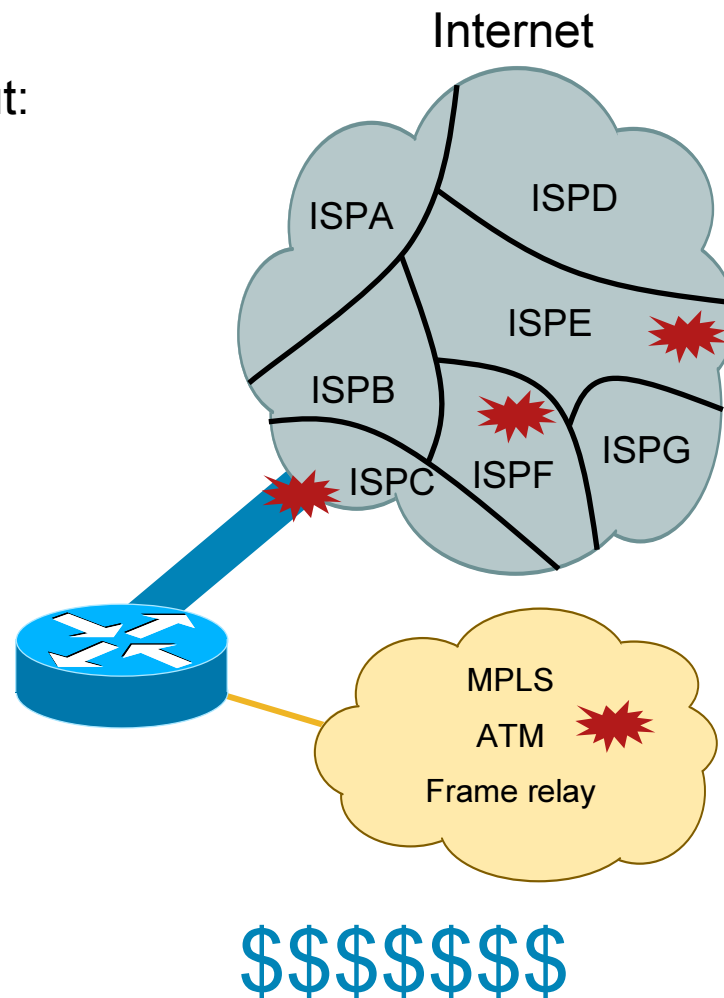
Soft error mitigation



Network Performance Challenge

“The network is **up**, but are applications working?”

- Network availability
 - Routing indicates reachability, but:
 - Black-holes
 - Brownouts
 - Congestion
- Network performance
 - Best path not always best performing path
- Load distribution
 - Over and under used links
- Cost management
 - Control transport cost and efficiently utilize all paths

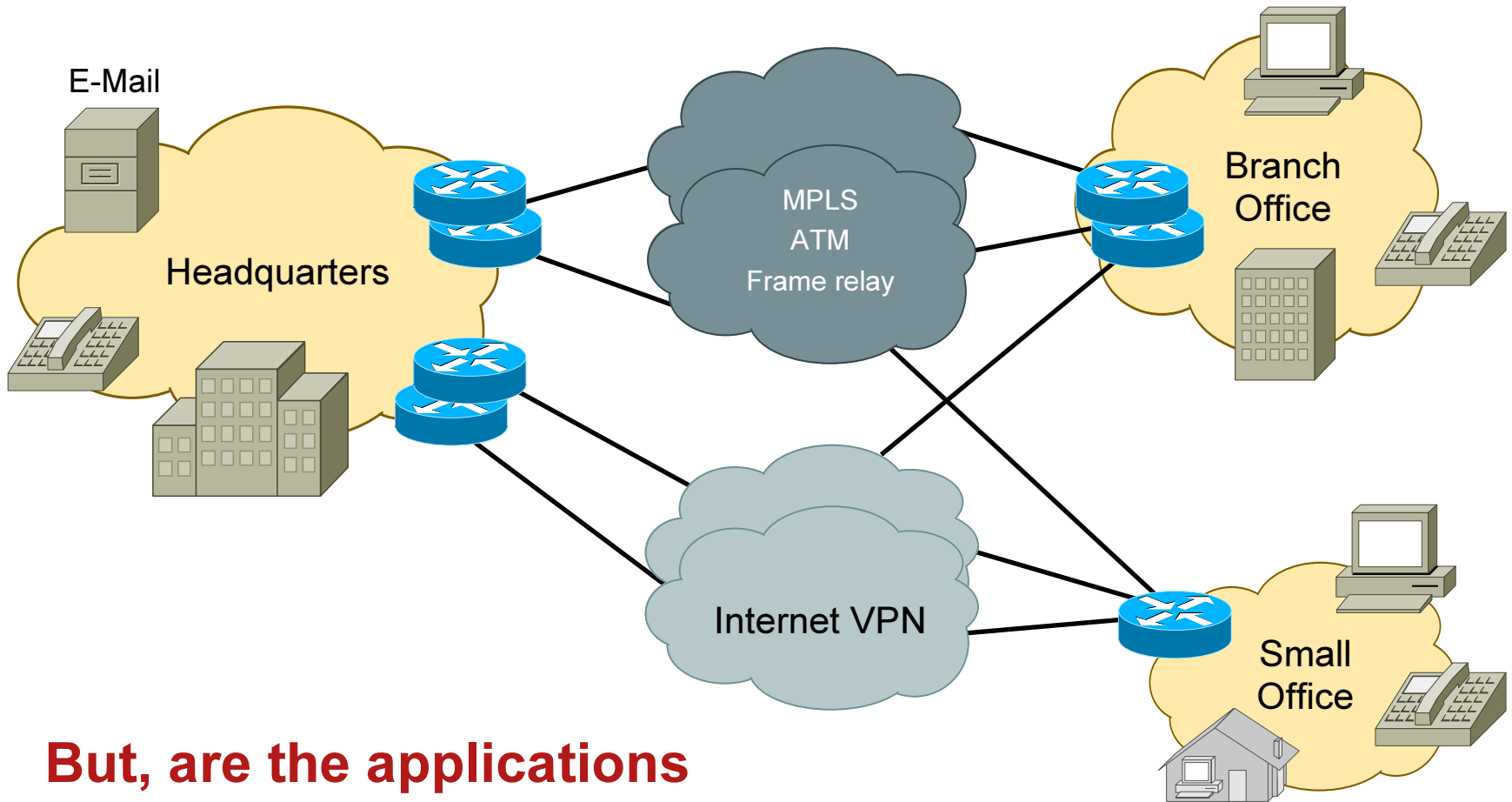


Enterprise WAN Challenge

Two paths, two providers



WAN availability

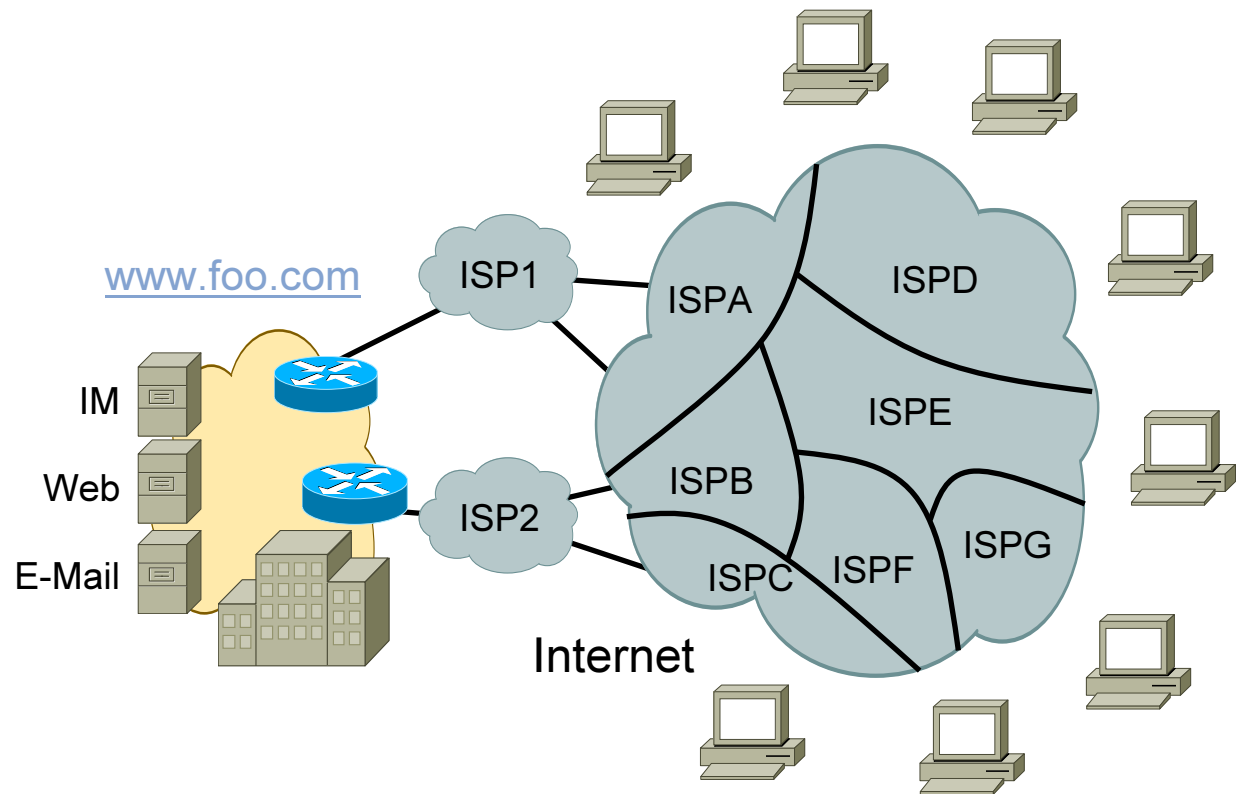


But, are the applications performing adequately?

Internet Presence Challenge

Multiple ISPs  Internet availability

- Online banking
- Customer service
- E-mail hosting
- Online ticketing
- Instant messaging
- Online catalog
- News and weather
- Internet voice
- Application hosting
- Online music
- Online video



But, is the user experience a good one?

Network and Application Evolution

	Historic	Current
Application requirements	Reachability is sufficient	Reachability and network performance required for application performance
	Network performance fluctuations were not of concern	Network performance fluctuations break applications
	Bandwidth conservative	Bandwidth hungry
	Noninteractive services	Interactive services
	Delayed, batched, or replayed	Live streaming
Backup	Out-of-band	Network diversity for backup
WAN	Basic telephone service, PSTN, ATM, frame relay, and PPP	Internet broadband, L3VPN, L2VPN, IPsec, and DMVPN

The Network is the platform for applications today

Application and Service Considerations for Business-Critical Networks Today

- **Avoidance** of network problems
 - Hotspots, congestion, failures, and suboptimal performance
- **Responsiveness** to critical applications
 - Time and delay sensitive: voice and industrial applications (ie: trading floor)
 - Loss sensitive: video and circuit emulation
 - Data center traffic: Storage Area Network (SAN) extension and Internet service provider load balancing
 - Transactional traffic: E-commerce transactions and automated business-to-business and Enterprise Resource Planning (ERP)
- **Full utilization** of network resources
 - Efficient distribution of traffic based upon load
 - Traffic optimized based upon circuit cost profiles
 - Minimization of underused expensive WAN paths

Enterprise Network Concerns

Soft Error Detection

- **Concern**
 - The network is slow
- **Why?**
 - Could be caused by brownouts, congestion, device anomaly, or service provider
- **Cisco® PfR solution**
 - Detect excessive loss:
Report and route around problem area
 - Detect excessive delay:
Report and reroute to lower delay path
 - Detect black hole routing:
Report and route around

Resource Usage

- **Concern**
 - Underused circuits and equipment
- **Why?**
 - Minimize effect of failure
 - Load balancing limitations
- **Cisco PfR solution**
 - Detect multiple paths and intelligently distribute the traffic based upon utilization and cost

Enterprise Network Concerns

Application Awareness

- **Concern**
 - My application requires a very responsive network
- **Why?**
 - The application is very sensitive to delay and loss
- **Cisco® PfR solution**
 - Application best path selection based upon advanced criteria: delay, jitter, MOS, loss, etc.

Performance Profile

- **Concern**
 - Not sure the network can accommodate a new application's performance requirements
- **Why?**
 - We don't know the network traffic profile
- **Cisco PfR solution**
 - Audit network performance
 - Applications, throughput, links
 - Frequency of out-of-policy
 - Provide a longer-term view of network capability

Traditional Routing

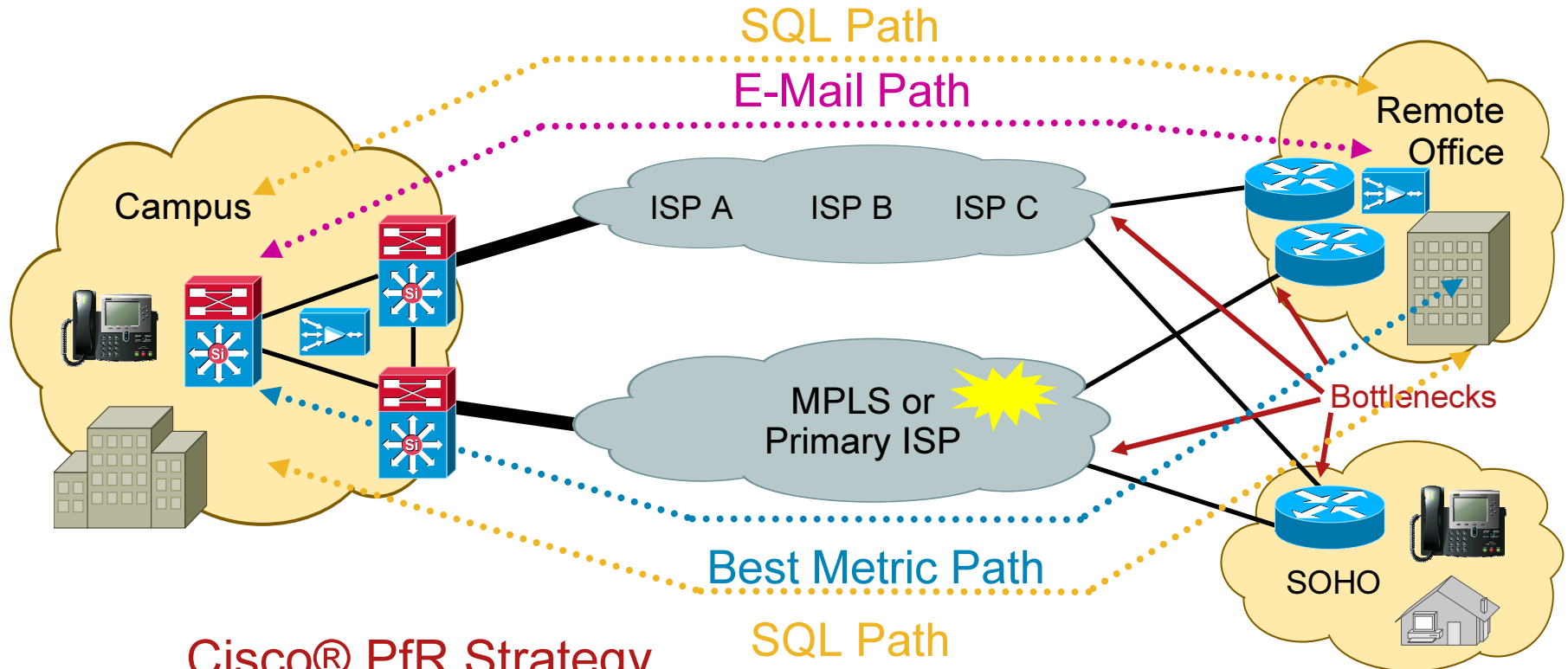
- Traditional routing uses static metrics to provide “reachability” information
 - No link utilization information
 - No Data Plane knowledge
- Network recovery based on neighbor and link failures (up/down)
 - No information on performance degradation or marginal performing links
- Provides destination based prefix reachability only
 - Not traffic class or application awareness

Cisco Performance Routing

- Cisco® PfR enhances routing in order to select the **best path based on measurements and defined policy**
- The Cisco PfR Policy can minimize cost, efficiently distribute traffic load, and select the optimum performing path for applications
- Cisco PfR helps enable **intelligent traffic management** that can dynamically route around soft errors in the enterprise WAN or Internet
- Cisco PfR makes **adaptive routing** adjustments based on advance criteria:
 - Response time, packet loss, jitter, Mean Opinion Score (MOS), path availability, traffic load and cost policies

Cisco Performance Routing Enterprise WAN

Optimize by:
Reachability, delay, loss, jitter*,
MOS*, throughput, load, and cost



Cisco® PfR Strategy

SQL Path

- Best path based upon policy and real-time performance metrics
- Adaptive routing based upon application performance criteria: voice, video, mission-critical applications, etc.

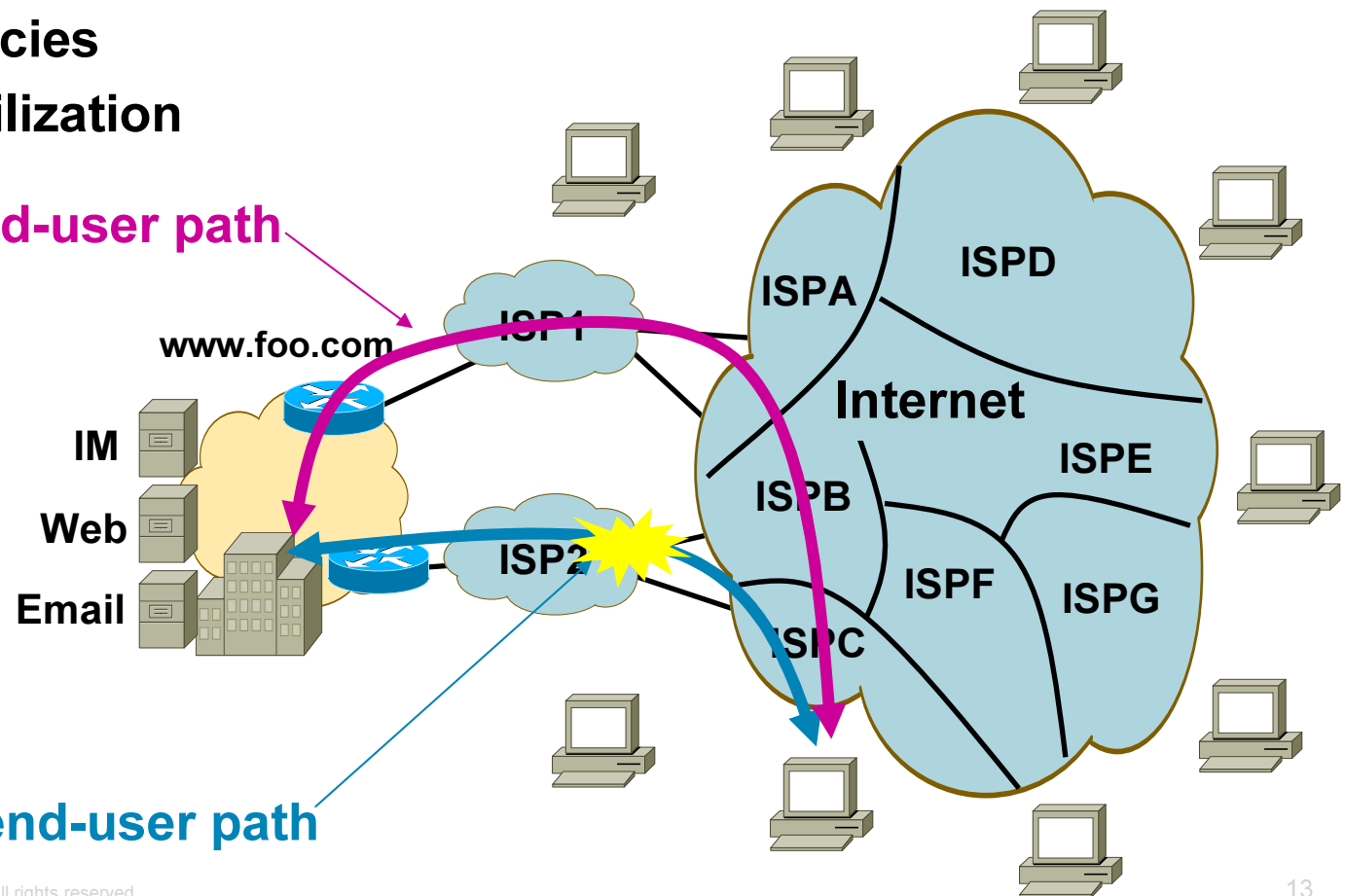
Performance Routing (PfR) Internet Presence

- Improved user experience
- Increased availability
- Cost management

Cost policies

Better utilization

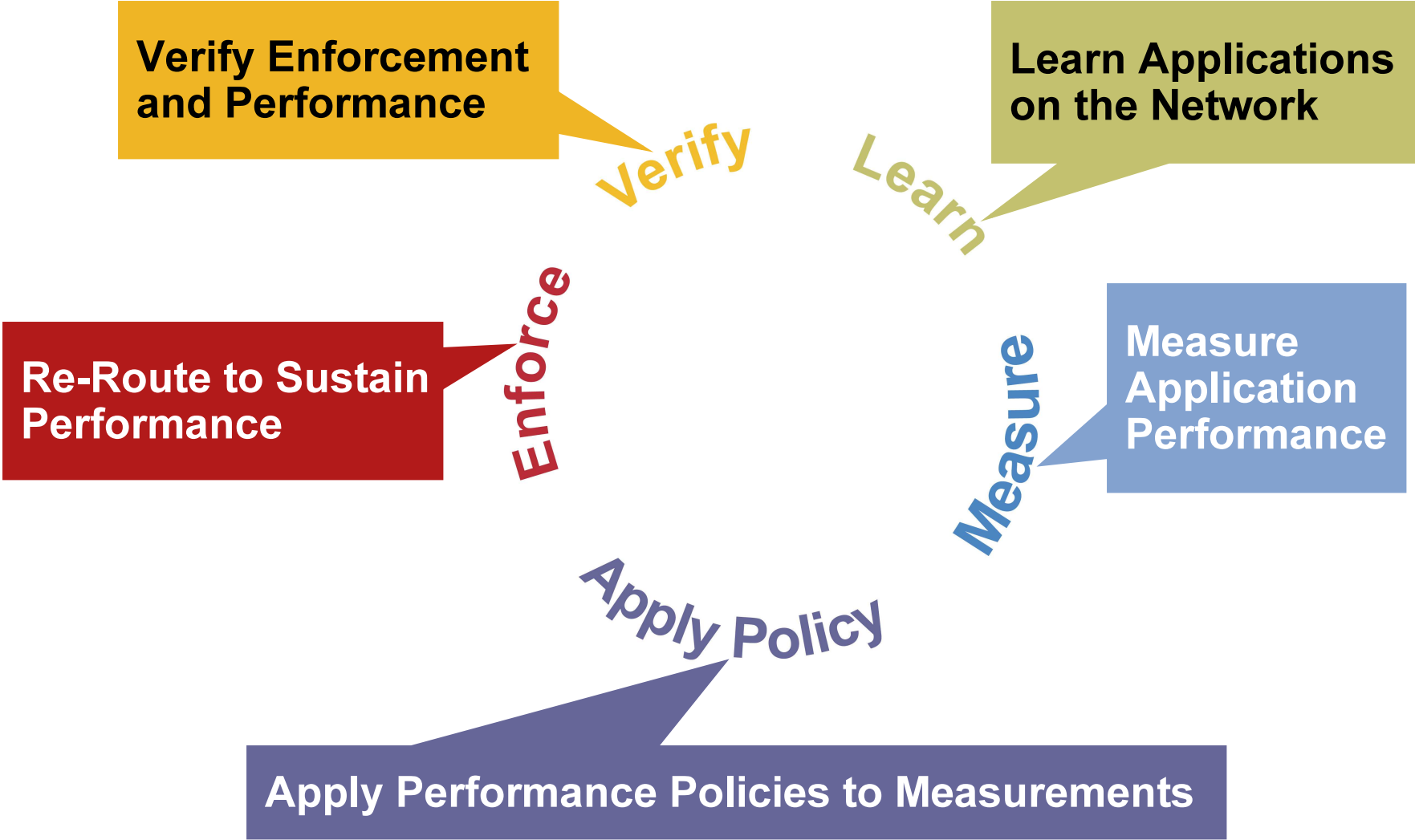
New end-user path



Initial end-user path

Managing Application Performance

PfR Control Loop



How to Verify Application Performance

- Is destination network reachable?
 - Examine routing information

Traditional
IP Routing

- Is application reachable?
 - Bidirectional traffic to or from application
- Is application performing?
 - Round-trip time
 - One-way delay
 - Loss
 - Jitter and MOS
 - Throughput

Performance
Routing



Soft Error Definition

Any issue which noticeably degrades application performance prior to convergence

Examples:

Unauthorized/unverified configuration change

Intermittent physical connection (flapping)

New application requirements (congestion)

Unforeseen hardware/software corner case

Routing protocols focus on prefix reachability

Not all issues are known ahead of time

May not force routing convergence

Convergence may not be fast enough

Impact depends on application



Specifying PfR Traffic Classes

Traffic Class Type		Example
Destination Prefix		10.0.0.0/8 20.1.1.0/24
Application	ACL	10.1.1.0/24 dscp ef 10.1.1.0/24 dst-port 50
	Well-known	10.1.1.0/24 telnet 20.1.0.0/16 ssh
	Dynamic Recognition	10.1.1.0/24 nbar RTP 20.1.1.0/24 nbar citrix



PfR Component Descriptions

- Master Controller (MC)

Cisco IOS® Software feature

Apply Policy, Verification, Reporting

Standalone or collocated with BR

No routing protocol required

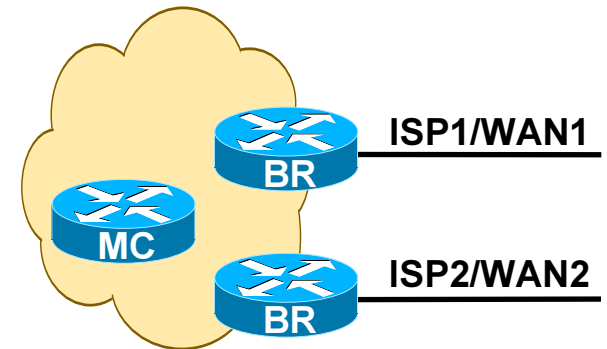
No packet forwarding/inspection required

- Border Router (BR)

Cisco IOS Software feature in forwarding router

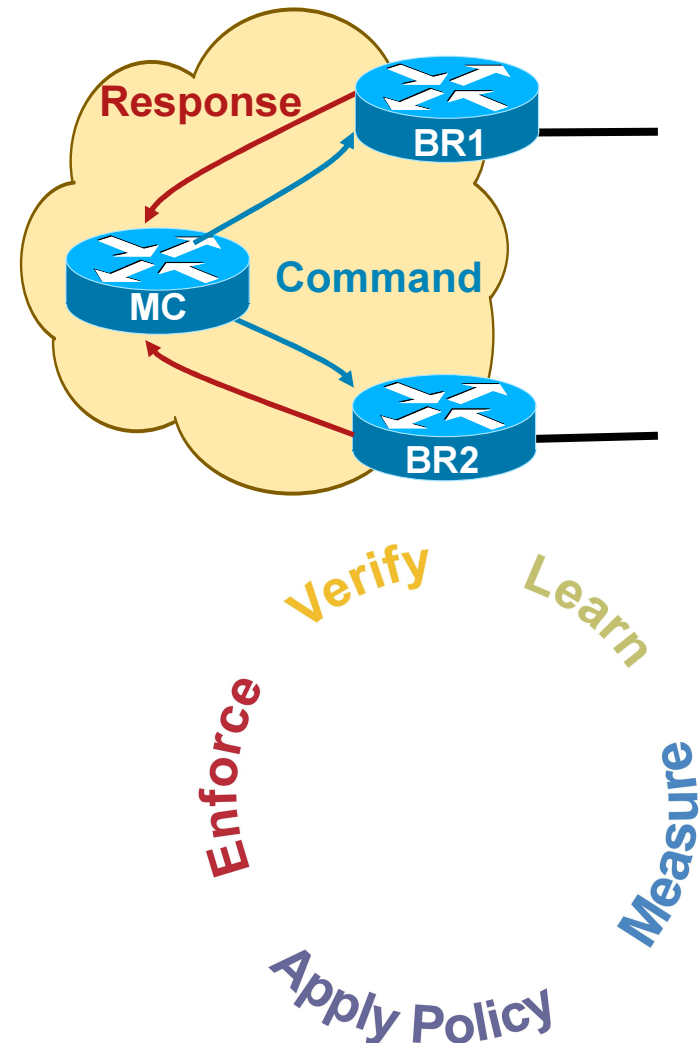
Learn, Measure, Enforcement

Uses embedded IOS technologies



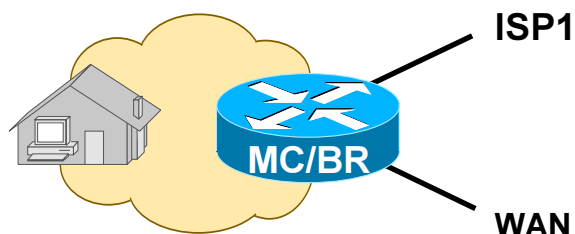
Information Flow

- MC controls all operation
 - Issues **commands** to BRs
 - Contains traffic class/link data
 - Reports events
 - Reports measurements
 - Makes **Policy** decisions
- BR responds to MC commands
 - Sends responses to MC
 - Uses embedded IOS technology
 - Measures** traffic class performance
 - Measures** link performance
 - Enforces** performance based routing

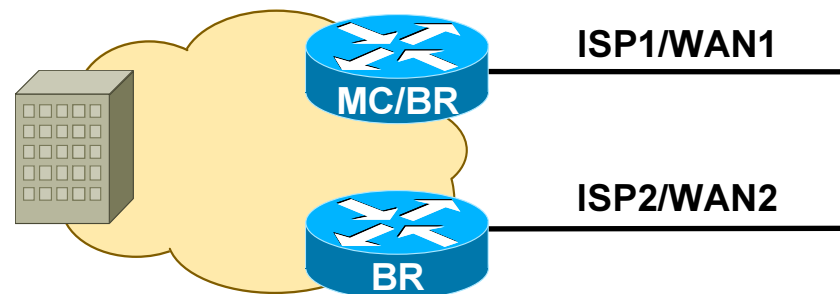


Solution Topologies

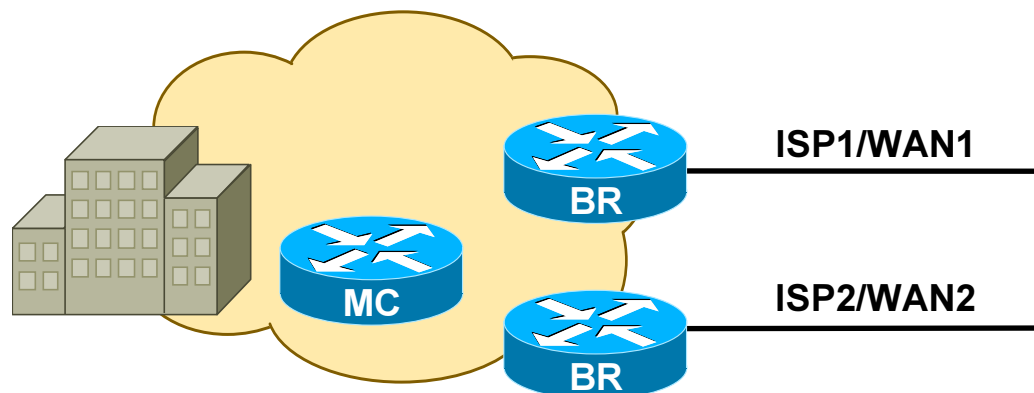
Small Office



Branch Office



Headquarters/Data Centers

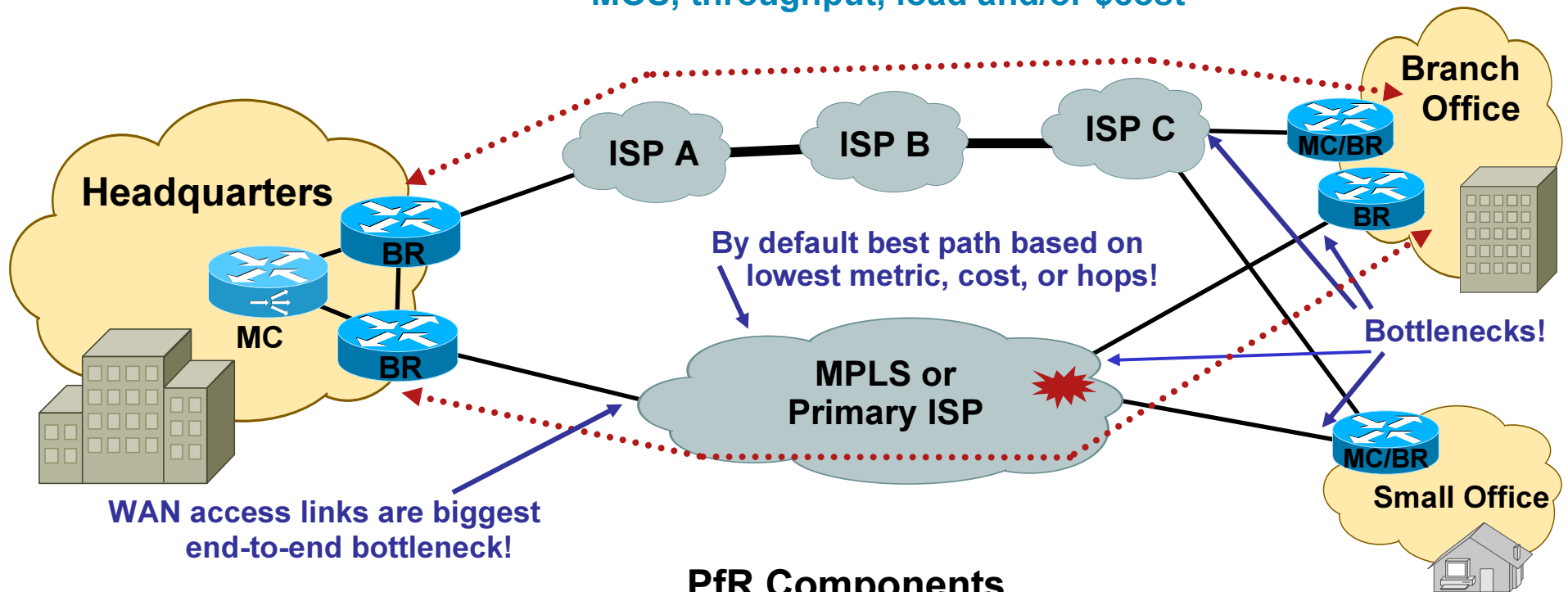


Components

- BR—Border Router (Forwarding Path)
- MC—Master Controller (Decision Maker)

Performance Routing (PfR) Enterprise WAN Design

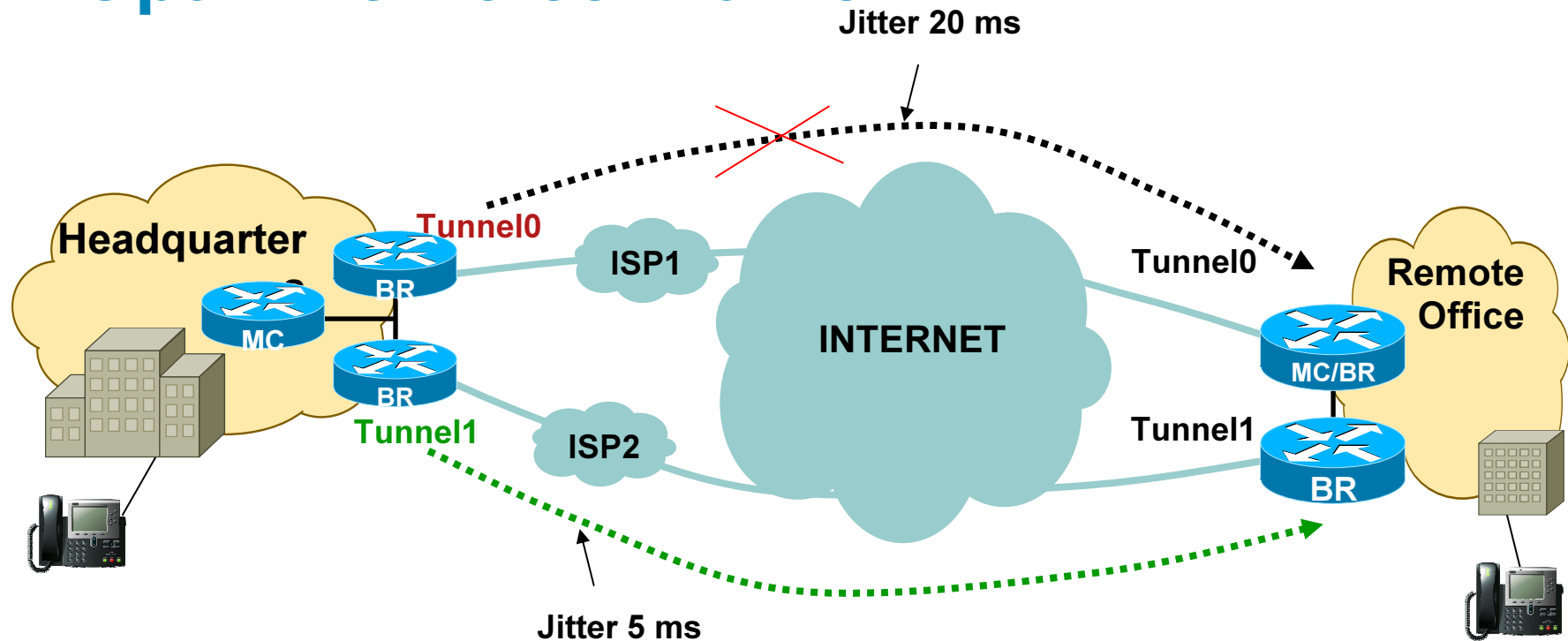
Traffic optimize by:
Reachability, delay, loss, jitter,
MOS, throughput, load and/or \$cost



PfR Components

- BR—Border Router
- MC—Master Controller

Enterprise VPN Deployment Optimize Voice Traffic



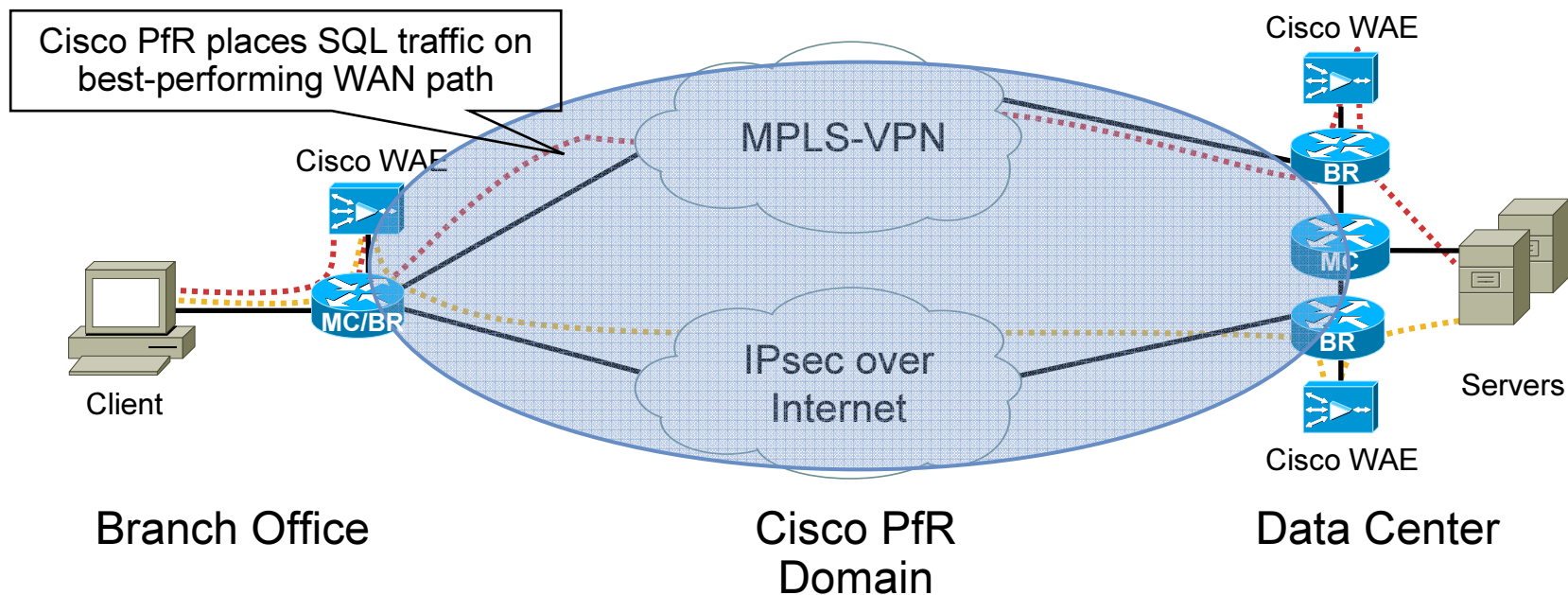
- Voice quality is based upon the Mean Opinion Score (MOS)
- MOS is calculated with jitter, delay and loss measurements
- PfR will select the path for VoIP with highest percentage MOS

Tunnel1 – 95 out of 100 samples had MOS \geq 4.00 ← Better

Tunnel0 – 80 out of 100 samples had MOS \geq 4.00

Cisco PfR and Cisco WAAS Integration Adaptive WAN-Optimized Network

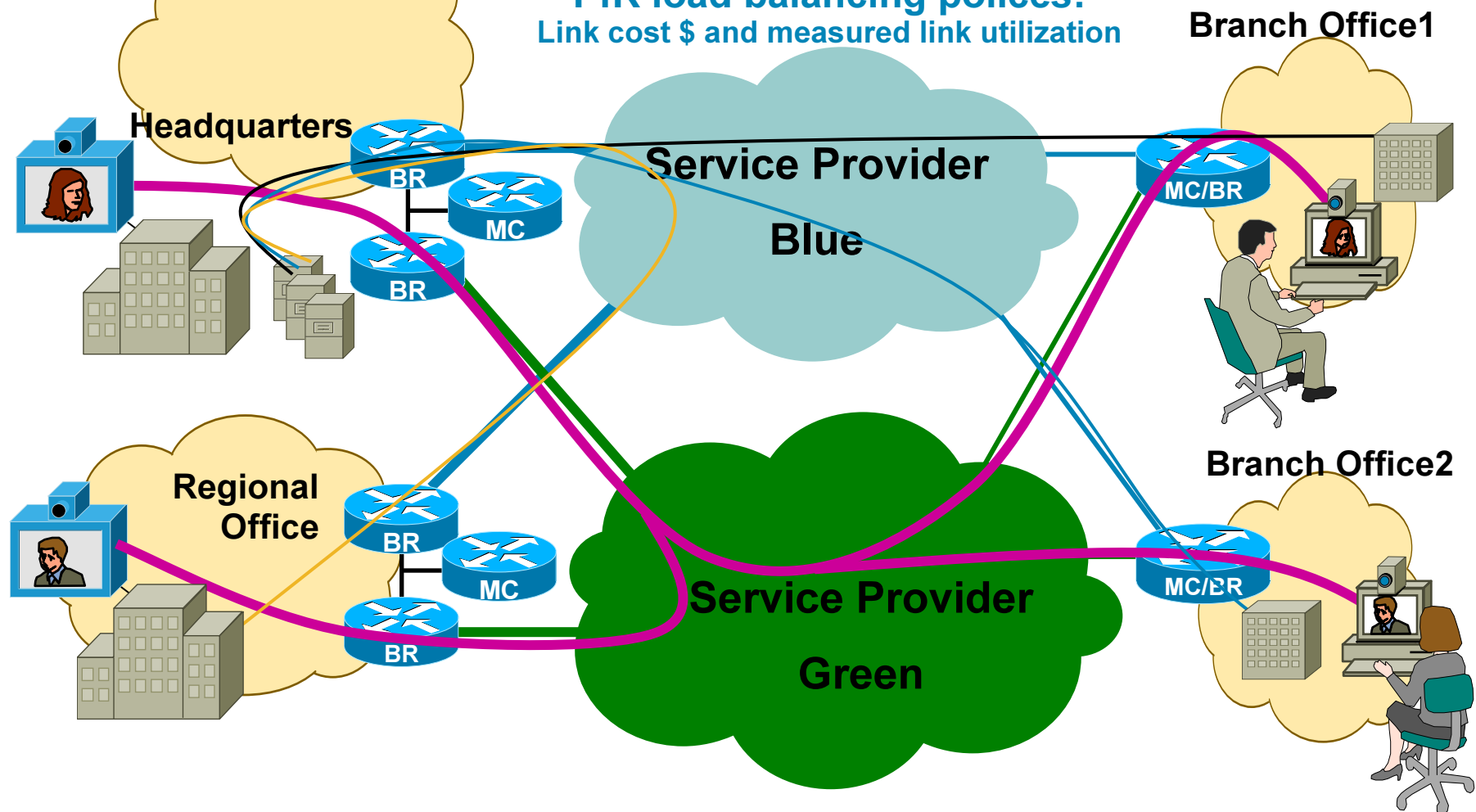
- Cisco® Wide Area Application Services (WAAS) optimizes the **TCP session**
 - Reduction in latency and data on the wire
- Cisco PfR monitors and optimizes WAN **path selection**
 - Not all WAN paths are equal: latency, loss, throughput, etc.
- Cisco WAAS network transparency allows PfR best path selection per TCP session



Performance Routing Intelligent Load Balancing

- 1) Video stream consumes a large amount of **SP Green** bandwidth
- 2) PfR moves other flows to the **SP Blue**

PfR load balancing polices:
Link cost \$ and measured link utilization



Cisco PfR Solution Deployment Methodology

Step 1

Monitoring Only

- Profile application performance
- Detect performance anomalies
- Inform network administrator

Step 2

Monitoring and Mitigation

- Cisco® PfR dynamically selects a path based on performance

Step 3

Monitoring, Mitigation, and Diagnoses

- Localize the performance anomaly

Typical Cisco PfR Customers

General Market Segments

- Large multinational enterprise
- Small and Medium-sized Business (SMB)
- Managed service provider or systems integrator

Industries

- Content provider
- Portal
- Hosting
- Energy
- Retail
- Bank
- Stock brokerage house

Application Influencers

- IP telephony
- Cisco® TelePresence
- Business-critical application: ERP, CRM, and finance
- Video on demand (unicast)

PfR Platform Support

Cisco 1800 - 7301

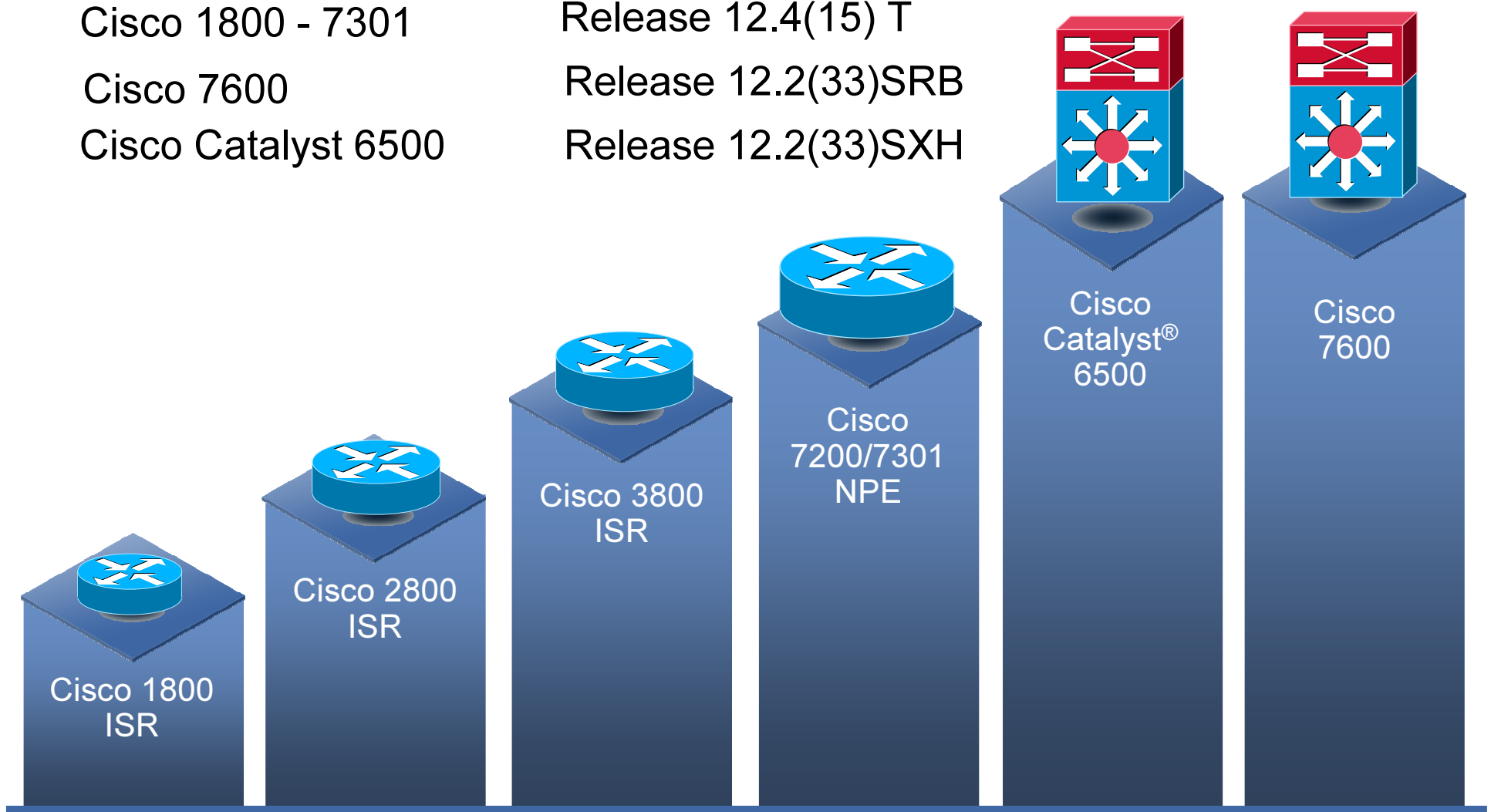
Cisco 7600

Cisco Catalyst 6500

Release 12.4(15) T

Release 12.2(33)SRB

Release 12.2(33)SXH



Key Features of Cisco PfR Manager by Fluke Networks



- **Executive**-level reports
- Network health reports
- Fully **web-based**
- **Reports** and **alerts** on network events
- Historical and **trending** graphical reports
- **Troubleshooting** analysis
- **Easy** traffic class and policy configuration
- Same design as NetFlow and IP SLA monitoring products

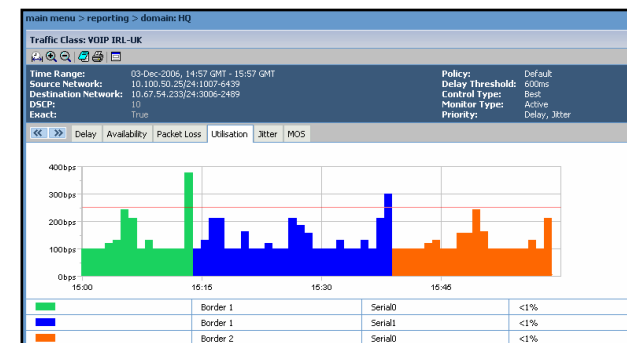
main menu > reporting > domain: HQ

HQ: Exit Links

Status	Exit Link	Device	Last Change	Threshold Utilisation	Total Utilisation
	Serial0	Border 1	02 Dec 2006, 09:12 (2 days)	80%	50%
	Serial1	Border1	02 Dec 2006, 09:12 (2 days)	30%	17%
	Serial0	Border2	04 Dec 2006, 12:05 (32 minutes)	0%	0%

HQ: Traffic Classes

Status	Description	Policy	Current Exit	Last Change	Delay	Util	Avail	Loss	Jitter	MOS
	VOIP IRL-UK	Critical VOIP	Border1/Serial0	02 Dec 2006, 09:12 (2 Days)	10ms	10%	100%	0%	5ms	4.85
	SAP-1	Priority 2 SAP	Border1/Serial1	04 Dec 2006, 11:15 (1:22 Hrs)	180ms	5%	100%	-	-	-
	HTTP	LOW Priority HTML	Border2/Serial0	02 Dec 2006, 09:12 (2 Days)	100 ms	30%	99.99%	-	-	-



PfR and OER

What's the difference?

- PfR has a broader technology scope
- PfR will greatly expand application intelligence
- PfR will leverage OER and other Cisco IOS Software technologies to enable adaptive routing throughout the Enterprise

OER

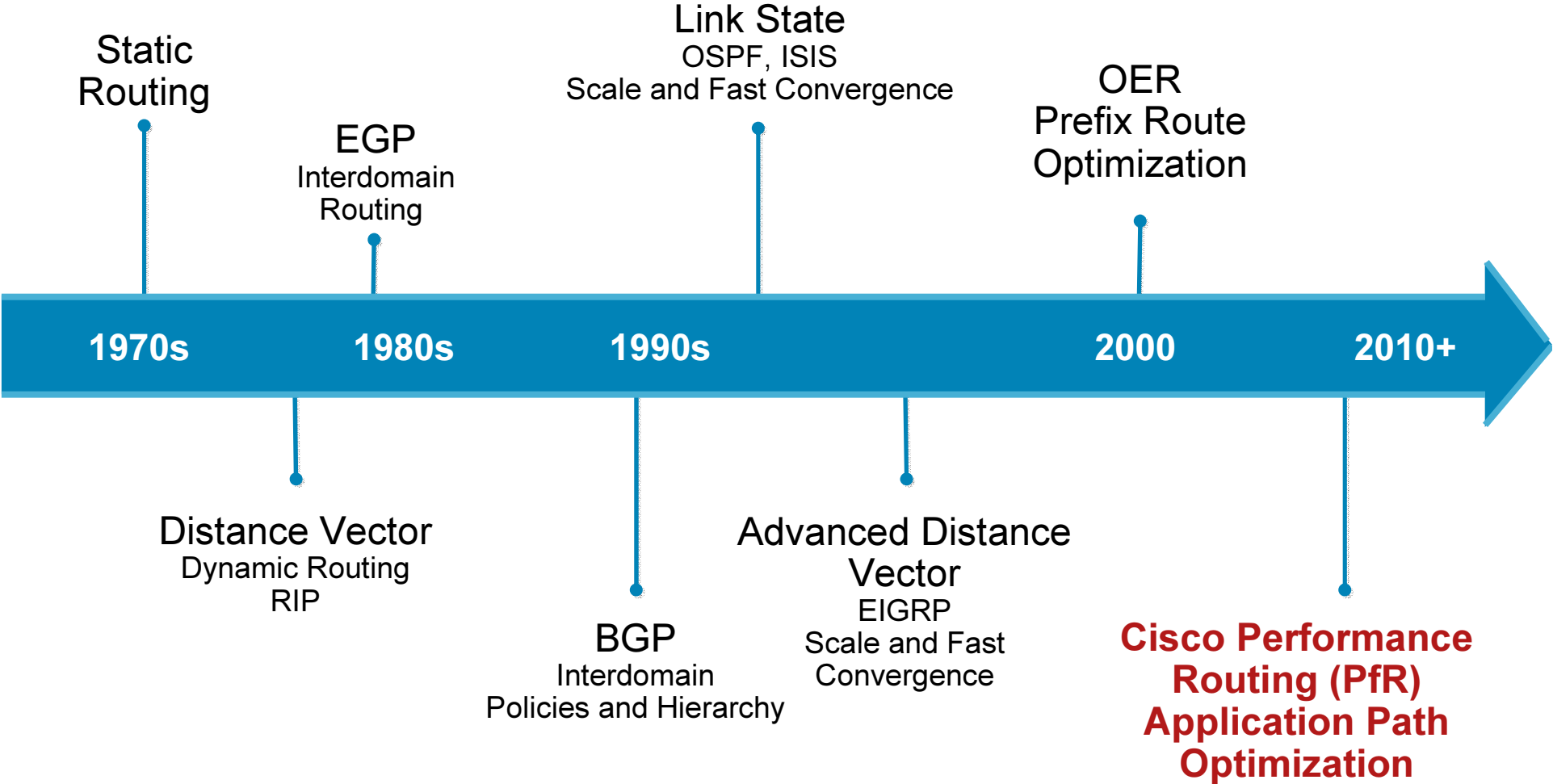
- Prefix
- WAN
- Network Selection
- Exit Routing



PfR

- ✓ Applications
- ✓ Private IP (MPLS)
- ✓ Path Selection
- ✓ Network Wide

IP Routing Evolution: From Static Routing to Performance Routing



Benefits of Cisco Performance Routing

- Application performance-aware network
 - Best path continuously reevaluated based upon network performance data: delay, loss, load, etc.
- Increased application availability
 - Route around at first sign of (soft error) trouble
- Cost minimization with advanced load balancing
 - Link usage
 - Circuit cost
 - Inbound and outbound Internet presence

Benefits of Cisco Performance Routing

- Capacity planning
 - Frequency of policy violations
 - Can the network maintain adequate performance?
 - Are links able to meet regular and peak traffic demands?
- Troubleshooting
 - Provides network **soft error** fault detection
- Ease of provisioning and management
 - Provisioning of network policies instead of device policies

Reference

- Cisco® PfR on Cisco.com
<http://www.cisco.com/go/pfr/>

