

# Configure PfRv2 Performance Monitoring Methods

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## Introduction

This document describes the methods used in Performance Routing version 2 (PfRv2) to monitor the performance of the Wide Area Network (WAN) links on the branch routers.

## Prerequisites

### Requirements

Cisco recommends that you have basic knowledge of Performance Routing (PfR).

### Components Used

This document is not restricted to specific software and hardware versions.

**Note:** PFRv2 is not supported in Polaris code 16.x.x.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

# Background Information

PfRv2 uses three methods to measure performance of the Border Routers (BRs) links. The information collected is used by Master Controller (MC) for PfR policy implementation. The three methods are passive monitoring, active monitoring, and hybrid mode.

## Passive Monitoring

In this mode, Netflow enabled (by default with PfR) on the BR collects this information regarding the traffic class and sends it back to the Master controller.

This information is applicable for TCP flows passing through BR:

- **Reachability:** This is calculated based on TCP SYN for which corresponding TCP ACK have not being received.
- **Delay:** Time calculated between TCP SYN and TCP ACK messages during TCP 3-way handshake. The total value is then divided by two.
- **Loss:** Measured on the basis of TCP sequence numbers. For example, when the received TCP sequence number is higher or lower than the expected, loss is reported.

This information is applicable for all flows (which include TCP) passing through BR:

- **Egress Bandwidth:** Throughput for traffic class egressing the BRs (calculated in bits per second using Netflow).
- **Ingress Bandwidth:** Throughput for traffic class ingressing the BRs (calculated in bits per second using Netflow).

## Active Monitoring

In this mode, the BR sends out IP SLA probes over its WAN interface to measure several parameters regarding the traffic class. Information collected is sent back to the Master controller. These parameters are measured:

- Reachability
- Delay
- Loss
- Egress Bandwidth
- Ingress Bandwidth

These probes are generated automatically when the monitoring method configured on the Master controller is Active and can also be configured manually. By default, the probes sent are ICMP echo but can be changed to TCP or UDP probes depending upon the type of traffic being sent over the WAN links.

While the Exit BR selection is ongoing, all the BRs will send active probes for the Netflow-learned prefixes. Upon selection of the Exit BR, other BRs will stop sending active probes. The selected BR will continue to send active probes.

## Hybrid Mode

Hybrid mode uses both the Netflow statistics and IP Service Level Agreement (SLA) to decide on

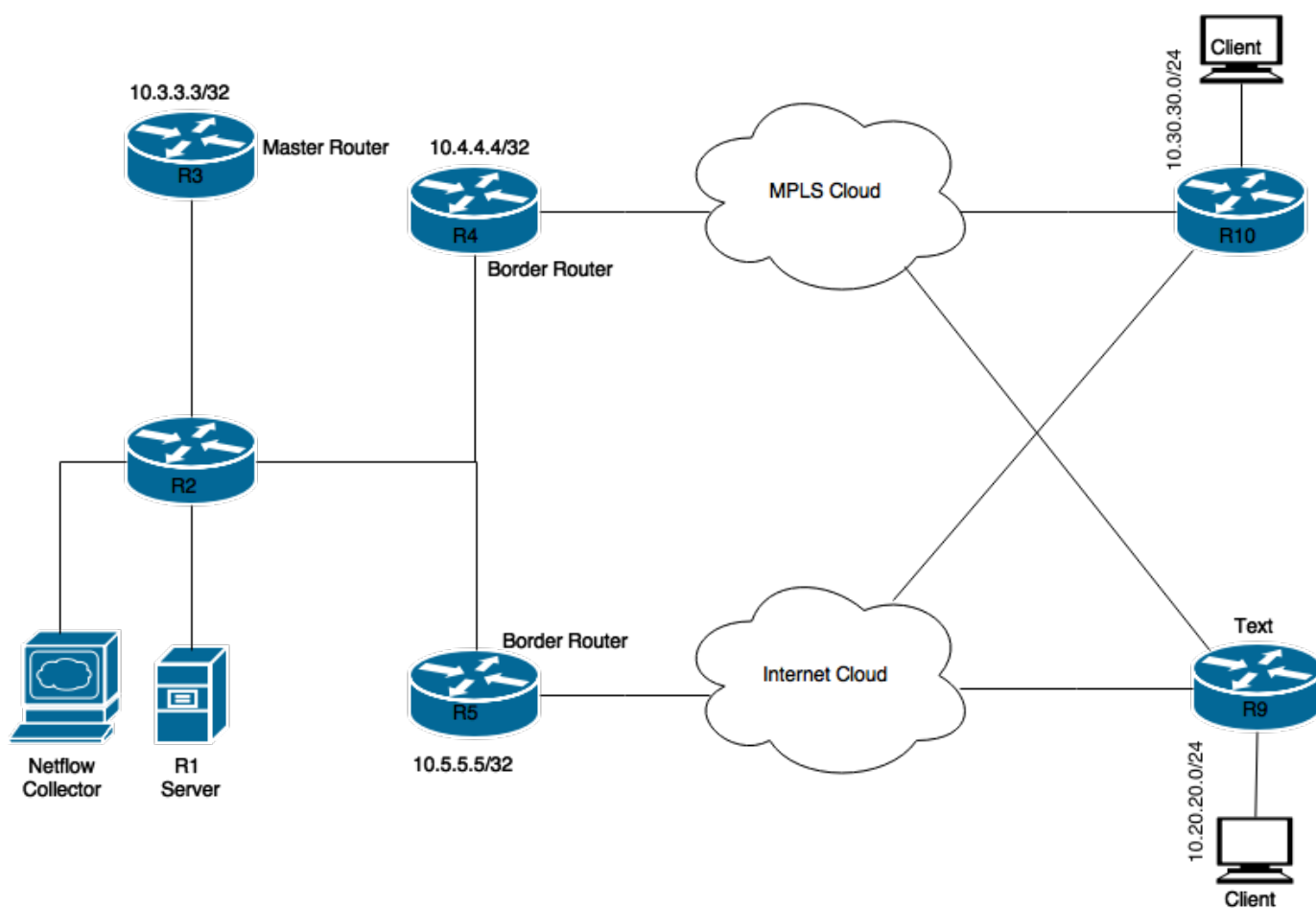
exit point (BR) and link monitoring. In this mode, IP SLA probe information is used to select the exit point and then Netflow statistics are used to monitor that BR's WAN connection towards the destination.

While PfR is in the learning state and has not yet moved into the "INPOLICY" state, all the BRs will send active probes for the prefixes collected from Netflow. This is to determine respective link conditions. When an MC state changes to "INPOLICY", all the BRs will stop sending active probes and now monitoring will be done passively (using Netflow).

## Configure

This image can be used as a sample topology for rest of the document:

## Network Diagram



## Relevant Configuration

This basic configuration is required for using different modes. R3 is configured as MC so these configurations will have to be completed on R3:

### Passive Mode

```
pfr master  
!
```

```
border 10.4.4.4 key-chain pfr
interface Ethernet0/1 external
interface Ethernet0/0 internal
!
border 10.5.5.5 key-chain pfr
interface Ethernet0/0 internal
interface Ethernet0/1 external
!
mode monitor passive
```

## Active Mode

```
pfr master
!
border 10.4.4.4 key-chain pfr
interface Ethernet0/1 external
interface Ethernet0/0 internal
!
border 10.5.5.5 key-chain pfr
interface Ethernet0/0 internal
interface Ethernet0/1 external
!
mode monitor active
```

## Hybrid Mode

This is the default mode. If no mode command is mentioned, Hybrid mode will be activated or the command **mode monitor both** can be used to enable it.

```
pfr master
!
border 10.4.4.4 key-chain pfr
interface Ethernet0/1 external
interface Ethernet0/0 internal
!
border 10.5.5.5 key-chain pfr
interface Ethernet0/0 internal
interface Ethernet0/1 external
```

**Note:** If the command **mode monitor both** is given manually, then it will not be shown in the configuration as it is a default command.

## Verify

Most verification commands are executed on MC. These commands can be used to verify working of different modes.

## Passive Mode

```
R3#show pfr master
<Output suppressed>
Default Policy Settings:
  backoff 90 900 90
  delay relative 50
  holddown 90
  periodic 0
```

```

probe frequency 56
number of jitter probe packets 100
mode route control
mode monitor passive
loss relative 10
jitter threshold 20
mos threshold 3.60 percent 30
unreachable relative 50
trigger-log percentage 30

```

## Test 1 - Initiate TCP Stream From the Server

```
R3#show pfr master traffic-class
```

```
OER Prefix Statistics:
```

```

Pas - Passive, Act - Active, S - Short term, L - Long term, Dly - Delay (ms),
P - Percentage below threshold, Jit - Jitter (ms),
MOS - Mean Opinion Score
Los - Packet Loss (percent/10000), Un - Unreachable (flows-per-million),
E - Egress, I - Ingress, Bw - Bandwidth (kbps), N - Not applicable
U - unknown, * - uncontrolled, + - control more specific, @ - active probe all
# - Prefix monitor mode is Special, & - Blackholed Prefix
% - Force Next-Hop, ^ - Prefix is denied

```

DstPrefix	Appl_ID		Dscp	Prot	SrcPort	DstPort	SrcPrefix		
	Flags		State	Time		CurrBR	CurrI/F	Protocol	
	<b>PasSDly</b>	<b>PasLDly</b>	<b>PasSUn</b>	<b>PasLUn</b>	<b>PasSLos</b>	<b>PasLLos</b>	<b>EBw</b>	<b>IBw</b>	
	ActSDly	ActLDly	ActSUn	ActLUn	ActSJit	ActPMOS	ActSLos	ActLLos	
10.20.20.0/24			N	N	N		N	N	
			INPOLICY		0	10.4.4.4	Et0/1		BGP
	<b>46</b>	<b>46</b>	<b>0</b>	<b>0</b>	<b>35502</b>	<b>35502</b>	<b>2</b>	<b>1</b>	
	N	N	N	N	N	N			
10.30.30.0/24			N	N	N		N	N	
			INPOLICY		0	10.5.5.5	Et0/1		BGP
	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>14</b>	<b>1</b>	
	N	N	N	N	N	N			

## Test 2 - Initiate UDP Stream From the Server

```
R3#show pfr master traffic-class
```

```
OER Prefix Statistics:
```

```

Pas - Passive, Act - Active, S - Short term, L - Long term, Dly - Delay (ms),
P - Percentage below threshold, Jit - Jitter (ms),
MOS - Mean Opinion Score
Los - Packet Loss (percent/10000), Un - Unreachable (flows-per-million),
E - Egress, I - Ingress, Bw - Bandwidth (kbps), N - Not applicable
U - unknown, * - uncontrolled, + - control more specific, @ - active probe all
# - Prefix monitor mode is Special, & - Blackholed Prefix
% - Force Next-Hop, ^ - Prefix is denied

```

DstPrefix	Appl_ID		Dscp	Prot	SrcPort	DstPort	SrcPrefix		
	Flags		State	Time		CurrBR	CurrI/F	Protocol	
	<b>PasSDly</b>	<b>PasLDly</b>	<b>PasSUn</b>	<b>PasLUn</b>	<b>PasSLos</b>	<b>PasLLos</b>	<b>EBw</b>	<b>IBw</b>	
	ActSDly	ActLDly	ActSUn	ActLUn	ActSJit	ActPMOS	ActSLos	ActLLos	
10.20.20.0/24			N	N	N		N	N	
			INPOLICY		0	10.5.5.5	Et0/1		BGP
	<b>U</b>	<b>U</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>13</b>	<b>0</b>	
	N	N	N	N	N	N			
10.30.30.0/24			N	N	N		N	N	

```

                INPOLICY          0          10.5.5.5 Et0/1          BGP
    U          U          0          0          0          0          14          0
    N          N          N          N          N          N

```

As shown previously, for TCP traffic, you can see Delay and Unreachable counters also getting populated but in case of UDP stream you can only see Bandwidth counters getting populated.

## Active Mode

```

R3#show pfr master
<Output suppressed>
Default Policy Settings:
backoff 90 900 90
delay relative 50
holddown 90
periodic 0
probe frequency 56
number of jitter probe packets 100
mode route control
mode monitor active
loss relative 10
jitter threshold 20
mos threshold 3.60 percent 30
unreachable relative 50
trigger-log percentage 30

```

## Test - Initiate TCP Stream From the Server

On Master Controller:

```

R3#show pfr master traffic-class
OER Prefix Statistics:
Pas - Passive, Act - Active, S - Short term, L - Long term, Dly - Delay (ms),
P - Percentage below threshold, Jit - Jitter (ms),
MOS - Mean Opinion Score
Los - Packet Loss (percent/10000), Un - Unreachable (flows-per-million),
E - Egress, I - Ingress, Bw - Bandwidth (kbps), N - Not applicable
U - unknown, * - uncontrolled, + - control more specific, @ - active probe all
# - Prefix monitor mode is Special, & - Blackholed Prefix
% - Force Next-Hop, ^ - Prefix is denied

```

DstPrefix	Appl_ID	Dscp	Prot	SrcPort	DstPort	SrcPrefix	Flags	State	Time	CurrBR	CurrI/F	Protocol
							PasSDly	PasLDly	PasSUn	PasLUn	PasSLos	PasLLos
							ActSDly	ActLDly	ActSUn	ActLUn	ActSJit	ActPMOS
											ActSLos	ActLLos
10.10.20.0/24		N	N	N		N N						
		INPOLICY		0		10.4.4.4 Et0/1						BGP
	N	N	N	N	N	N	N	N	N	N	N	N
	54	54	0	0	N	N	N	N	N	N	N	N
10.30.30.0/24		N	N	N		N N						
		INPOLICY		0		10.4.4.4 Et0/1						BGP
	N	N	N	N	N	N	N	N	N	N	N	N
	54	54	0	1000	N	N	N	N	N	N	N	N

On BR1:

```

R4#show pfr border active-probes
OER Border active-probes

```

Type = Probe Type  
 Target = Target IP Address  
 TPort = Target Port  
 Source = Send From Source IP Address  
 Interface = Exit interface  
 Att = Number of Attempts  
 Comps = Number of completions  
 N - Not applicable

Type	Target	TPort	Source	Interface	Att	Comps
DSCP						
echo	10.10.20.11	N	192.168.1.1	Et0/1	3	3
0						
echo	10.30.30.12	N	192.168.1.1	Et0/1	3	3
0						

On BR2:

R5#show pfr border active-probes

OER Border active-probes

Type = Probe Type  
 Target = Target IP Address  
 TPort = Target Port  
 Source = Send From Source IP Address  
 Interface = Exit interface  
 Att = Number of Attempts  
 Comps = Number of completions  
 N - Not applicable

Type	Target	TPort	Source	Interface	Att	Comps
DSCP						
echo	10.10.20.11	N	192.168.2.1	Et0/1	3	3
0						
echo	10.30.30.12	N	192.168.2.1	Et0/1	3	3
0						

Once the Traffic classes on MC move into "INPOLICY" state and BR1 is selected as the BR for sending all traffic, BR2 will stop sending probes :

R4#show pfr border active-probes

OER Border active-probes

Type = Probe Type  
 Target = Target IP Address  
 TPort = Target Port  
 Source = Send From Source IP Address  
 Interface = Exit interface  
 Att = Number of Attempts  
 Comps = Number of completions  
 N - Not applicable

Type	Target	TPort	Source	Interface	Att	Comps
DSCP						
echo	10.10.20.11	N	192.168.1.1	Et0/1	10	10
0						
echo	10.30.30.12	N	192.168.1.1	Et0/1	10	10
0						

R5#show pfr border active-probes

OER Border active-probes

Type = Probe Type  
 Target = Target IP Address  
 TPort = Target Port

Source = Send From Source IP Address  
 Interface = Exit interface  
 Att = Number of Attempts  
 Comps = Number of completions  
 N - Not applicable

Type	Target	TPort	Source	Interface	Att	Comps
DSCP						

<No Active Probes>

## Hybrid Mode

```
R3#show pfr master
OER state: ENABLED and ACTIVE
<Output Suppressed>
Default Policy Settings:
  backoff 90 900 90
  delay relative 50
  holddown 90
  periodic 0
  probe frequency 56
  number of jitter probe packets 100
  mode route control
  mode monitor both
  loss relative 10
  jitter threshold 20
  mos threshold 3.60 percent 30
  unreachable relative 50
  trigger-log percentage 30
```

## Test - Initiate TCP Stream From the Server

While Traffic Class (TC) is being measured and the state is not yet "INPOLICY", both the BRs will send active probes to the prefixes collected from Netflow. This is to determine respective link conditions.

On MC:

```
R3#show pfr mas traffic-class
OER Prefix Statistics:
Pas - Passive, Act - Active, S - Short term, L - Long term, Dly - Delay (ms),
P - Percentage below threshold, Jit - Jitter (ms),
MOS - Mean Opinion Score
Los - Packet Loss (percent/10000), Un - Unreachable (flows-per-million),
E - Egress, I - Ingress, Bw - Bandwidth (kbps), N - Not applicable
U - unknown, * - uncontrolled, + - control more specific, @ - active probe all
# - Prefix monitor mode is Special, & - Blackholed Prefix
% - Force Next-Hop, ^ - Prefix is denied
```

DstPrefix	Flags	Appl_ID	Dscp	Prot	SrcPort	DstPort	SrcPrefix	CurBR	CurI/F	Protocol
	PasSDly	PasLDly	PasSun	PasLUn	PasSLos	PasLLos	EBw	IBw		
	ActSDly	ActLDly	ActSun	ActLUn	ActSJit	ActPMOS	ActSLos	ActLLos		
10.20.20.0/24			N	N	N		N	N		
			<b>HOLDDOWN</b>		61		<b>10.5.5.5</b>	Et0/1		BGP
	1	1	0	0	0	0	16	1		
	1	1	0	0	N	N	N	N		



```

10.30.30.0/24          N   N   N           N           N N
                     HOLDDOWN          61          10.5.5.5 Et0/1          BGP
1                   1   0   0           0           0           16           1
4                   4   0   0           N           N           N           N

```

**On BR1:**

**R4#show pfr border active-probes**

```

OER Border active-probes
Type      = Probe Type
Target    = Target IP Address
TPort     = Target Port
Source    = Send From Source IP Address
Interface = Exit interface
Att       = Number of Attempts
Comps    = Number of completions
N - Not applicable

```

Type	Target	TPort	Source	Interface	Att	Comps
DSCP						
echo	10.20.20.1	N	192.168.1.1	Et0/1	1	1
0						
echo	10.30.30.1	N	192.168.1.1	Et0/1	1	1
0						

**On BR2:**

**R5#show pfr border active-probes**

```

OER Border active-probes
Type      = Probe Type
Target    = Target IP Address
TPort     = Target Port
Source    = Send From Source IP Address
Interface = Exit interface
Att       = Number of Attempts
Comps    = Number of completions
N - Not applicable

```

Type	Target	TPort	Source	Interface	Att	Comps
DSCP						
echo	10.20.20.1	N	192.168.2.1	Et0/1	1	1
0						
echo	10.30.30.1	N	192.168.2.1	Et0/1	1	1

When on MC the state changes to "INPOLICY", both the BRs will stop sending active probes and the respective monitoring will switch to passive mode (using Netflow).

**R3#show pfr master traffic-class**

```

OER Prefix Statistics:
Pas - Passive, Act - Active, S - Short term, L - Long term, Dly - Delay (ms),
P - Percentage below threshold, Jit - Jitter (ms),
MOS - Mean Opinion Score
Los - Packet Loss (percent/10000), Un - Unreachable (flows-per-million),
E - Egress, I - Ingress, Bw - Bandwidth (kbps), N - Not applicable
U - unknown, * - uncontrolled, + - control more specific, @ - active probe all
# - Prefix monitor mode is Special, & - Blackholed Prefix
% - Force Next-Hop, ^ - Prefix is denied

```

DstPrefix	Flags	Appl_ID	Dscp	Prot	SrcPort	DstPort	SrcPrefix	Protocol
	PasSDly	PasLDly	PasSun	PasLUn	PasSLos	PasLLos	EBw	IBw

	ActSDly	ActLDly	ActSUn	ActLUn	ActSJit	ActPMOS	ActSLos	ActLLos
10.20.20.0/24			N	N	N		N N	
			INPOLICY		0	10.5.5.5	Et0/1	BGP
	1	1	0	0	0	0	3	1
	1	1	0	0	N	N	N	N
10.30.30.0/24			N	N	N		N N	
			INPOLICY		0	10.5.5.5	Et0/1	BGP
	1	1	0	0	0	0	14	1
	1	1	0	0	N	N	N	N

As shown, you can see counters for both the Passive and Active components. Also, the probes will stop on BRs once the TCs move to the "INPOLICY" state.

R4#show pfr border active-probes

OER Border active-probes

Type = Probe Type  
 Target = Target IP Address  
 TPort = Target Port  
 Source = Send From Source IP Address  
 Interface = Exit interface  
 Att = Number of Attempts  
 Comps = Number of completions  
 N - Not applicable

Type	Target	TPort	Source	Interface	Att	Comps
DSCP						

<No Active Probes>

R5#show pfr border active-probes

OER Border active-probes

Type = Probe Type  
 Target = Target IP Address  
 TPort = Target Port  
 Source = Send From Source IP Address  
 Interface = Exit interface  
 Att = Number of Attempts  
 Comps = Number of completions  
 N - Not applicable

Type	Target	TPort	Source	Interface	Att	Comps
DSCP						

<No Active Probes>

**Note:** PfrV2 is not supported in Releases 15.6(3)M, 15.7(3)M, and later T-train releases. Also Release 16.3.1 has PfrV2 CLIs, but functionality is not supported. Functionality was broken when the code moved from MCP to Polaris, and this will not be fixed in Polaris releases.

## Troubleshoot

There is currently no specific troubleshooting information available for this configuration.