# Configure and Verify Path Control Using PBR

**Aim:** To configure and verify path control using Policy Based Routing (PBR)

**Theory:**
In traditional IP routing, routers forward packets based only on the destination IP address, using the longest prefix match from their routing table.

Policy-Based Routing (PBR) allows you to override this behavior by defining custom routing policies based on other criteria like:
1) Source IP address
2) Protocol
3) Packet size
4) Incoming interface

This gives network administrators greater flexibility in managing traffic flow based on business or technical policies.

PBR is commonly used when you need to:
1) Route specific users or devices through different ISPs or firewalls
2) Apply different Quality of Service (QoS) or bandwidth policies to selected traffic
3) Bypass certain links for sensitive data
4) Perform load balancing or failover routing between multiple paths

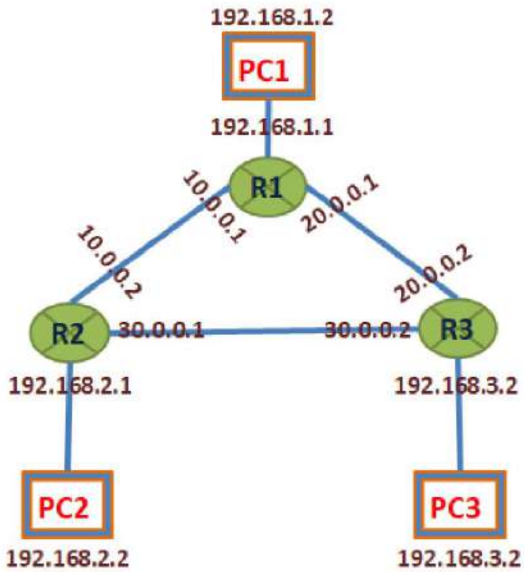
PBR uses three main configuration components on a router:
1) Access Control List (ACL): Used to match the traffic that should be treated differently (e.g., match source IPs).
2) Route Map: Defines the policy for matched traffic, such as setting a specific next-hop IP.
3) IP Policy Statement: Applied to an interface using the ip policy route-map command, telling the router to evaluate and apply the route map to incoming traffic on that interface.

Example Use Case
You have two exit routers (R2 and R3).
You want a specific PC (e.g., 192.168.1.2) to reach the internet only through R2, even though R3 is the default route.
PBR allows you to match traffic from that PC and force it through R2, regardless of the routing table.

Benefits of PBR
1) Granular control over traffic flows
2) Can enforce security, compliance, and routing policies
3) Useful in multi-homed networks (with multiple ISPs)

Limitations of PBR
1) It only applies to incoming packets on the interface where the policy is configured.
2) Requires careful design to avoid routing loops or black holes
3) Adds some processing overhead on routers (not recommended on low-end devices for high-volume traffic)

We use the following topology




We do the configuration using the following steps

**Step 1:** Configure the IP addresses on all the Routers and PCs

**Router 1**

R1#
R1#configure terminal
R1(config)#
R1(config)#interface fastEthernet 0/0
R1(config-if)#
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#

R1(config)#interface fastEthernet 1/0
R1(config-if)#
R1(config-if)#ip address 10.0.0.1 255.0.0.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#

R1(config)#interface fastEthernet 2/0
R1(config-if)#
R1(config-if)#ip address 20.0.0.1 255.0.0.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#

**Router 2**

R2#
R2#configure terminal
R2(config)#
R2(config)#interface fastEthernet 0/0
R2(config-if)#
R2(config-if)#ip address 192.168.2.1 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#exit
R2(config)#

R2(config)#interface fastEthernet 1/0
R2(config-if)#
R2(config-if)#ip address 10.0.0.2 255.0.0.0
R2(config-if)#no shutdown
R2(config-if)#exit
R2(config)#

R2(config)#interface fastEthernet 2/0
R2(config-if)#
R2(config-if)#ip address 30.0.0.1 255.0.0.0
R2(config-if)#no shutdown
R2(config-if)#exit
R2(config)#

**Router 3**

R3#
R3#configure terminal
R3(config)#
R3(config)#interface fastEthernet 0/0
R3(config-if)#
R3(config-if)#ip address 192.168.3.1 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#exit
R3(config)#

R3(config)#interface fastEthernet 2/0
R3(config-if)#
R3(config-if)#ip address 30.0.0.2 255.0.0.0
R3(config-if)#no shutdown
R3(config-if)#exit
R3(config)#

R3(config)#interface fastEthernet 1/0
R3(config-if)#
R3(config-if)#ip address 20.0.0.2 255.0.0.0
R3(config-if)#no shutdown
R3(config-if)#exit
R3(config)#

**Configuring PC1**
PC1>ip 192.168.1.2 255.255.255.0 192.168.1.1

**Configuring PC2**
PC2>ip 192.168.2.2 255.255.255.0 192.168.2.1

**Configuring PC3**
PC3>ip 192.168.3.2 255.255.255.0 192.168.3.1

**Step 2:** Checking the connectivity between the networks using ping

```
R1#ping 192.168.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)


R1#ping 192.168.3.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)


R1#ping 192.168.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/63/88 ms
```

As seen from the above that ping is only successful within the network and fails for the hosts in other networks, hence we need to set the routing path using a suitable routing protocol.

**Step 3:** Setting up the Routing path using RIPv2 in all the Routers

**Router 1**
R1(config)#
R1(config)#router rip
R1(config-router)#
R1(config-router)#version 2
R1(config-router)#network 10.0.0.0
R1(config-router)#network 20.0.0.0
R1(config-router)#network 192.168.1.0
R1(config-router)#no auto-summary
R1(config-router)#exit
R1(config)#exit

**Router 2**

R2(config)#
R2(config)#router rip
R2(config-router)#
R2(config-router)#version 2
R2(config-router)#network 10.0.0.0
R2(config-router)#network 30.0.0.0
R2(config-router)#network 192.168.2.0
R2(config-router)#exit
R2(config)#

**Router 3**

R3(config)#
R3(config)#router rip
R3(config-router)#
R3(config-router)#version 2
R3(config-router)#network 20.0.0.0
R3(config-router)#network 30.0.0.0
R3(config-router)#network 192.168.3.0
R3(config-router)#exit
R3(config)#

**Step 4:** Checking the connectivity after setting the RIP

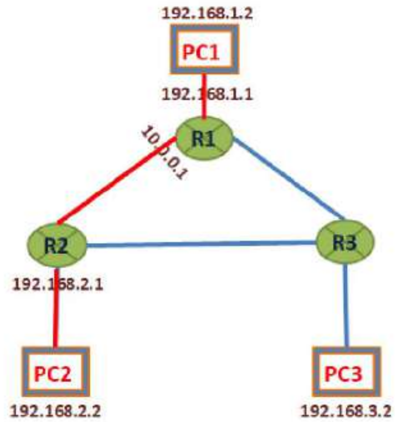
```
R1#ping 192.168.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/63/88 ms


R1#ping 192.168.3.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/63/88 ms


R1#ping 192.168.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/63/88 ms
```

The ping is indeed successful and hence all the hosts are reachable from any host.

**Step 5:** Checking the path before setting Policy Based Routing (PBR)
Now we trace the route the packets traverse when passing from PC1 to PC2 and PCI to PC3
**From PC1 to PC2**

```
PC1> trace 192.168.2.2
trace to 192.168.2.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   35.841 ms  4.254 ms  23.860 ms
 2   10.0.0.2   130.033 ms  66.677 ms  72.610 ms
 3     *  *  *
 4   *192.168.2.2   75.028 ms (ICMP type:3, code:3, Destination port unreachable)
```

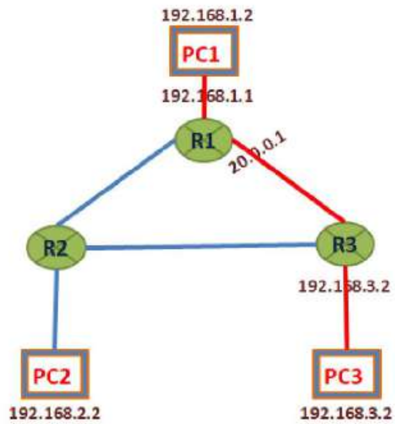
The above route can be visualized as (shown by red lines)




**From PC1 to PC3**

```
PC1> trace 192.168.3.2
trace to 192.168.3.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   37.195 ms  28.602 ms  36.704 ms
 2   20.0.0.2   80.154 ms  117.582 ms  110.090 ms
 3     *  *  *
 4   *192.168.3.2   77.879 ms (ICMP type:3, code:3, Destination port unreachable)
```

The above route can be visualized as (shown by red lines)




The given outputs are obvious as the best possible routes from PC1 to PC2 and also for PC1 to PC3

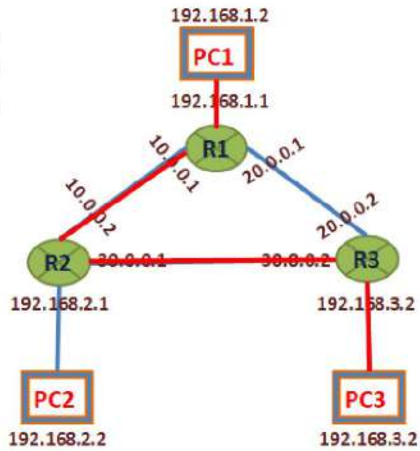
**Step 6:** Setting Policy Based Routing (PBR) in Router1

R1#
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#
R1(config)#access-list 10 permit 192.168.1.2
R1(config)#route-map SMILE permit 10
R1(config-route-map)#
R1(config-route-map)#match ip address 10
R1(config-route-map)#set ip next-hop 10.0.0.2
R1(config-route-map)#exit
R1(config)#
R1(config)#interface fastEthernet 0/0
R1(config-if)#
R1(config-if)#ip policy route-map SMILE
R1(config-if)#exit
R1(config)#

**Step 7:** Verifying the route from PC1 to PC3

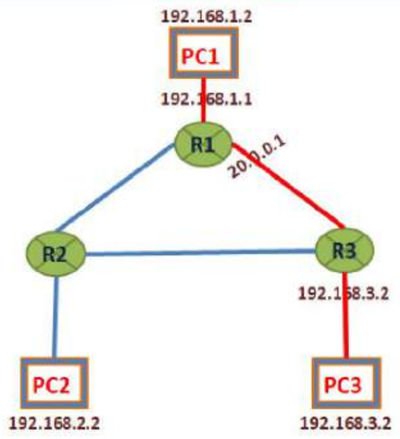
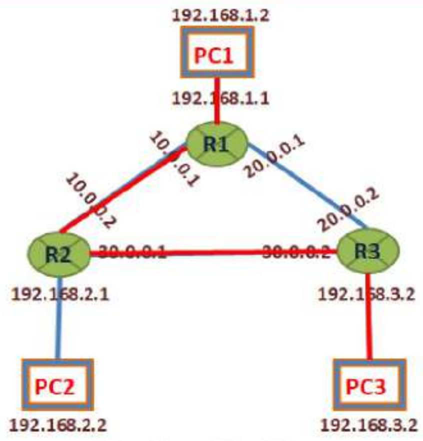
```
PC1> trace 192.168.3.2
trace to 192.168.3.2, 8 hops max, press Ctrl+C to stop
 1  192.168.1.1   9.682 ms  30.054 ms  20.347 ms
 2  10.0.0.2   79.511 ms  70.173 ms  89.750 ms
 3  30.0.0.2   100.528 ms  80.136 ms  109.753 ms
 4    *  *  *
 5  *192.168.3.2   160.514 ms (ICMP type:3, code:3, Destination port unreachable)
```

The above route can be visualized as (shown by red lines)




The packets from PC1 to PC3 are not forwarded directly from R1 to R3 but they take a long route due to the Policy Based Routing, they are forwarded from PC1 to R1 and from R1 to R2 and then from R2 to R3 and finally to PC3

The following gives the comparison between routes from PC1 to PC3 without and with PBR

<table>
<tr><th>Without PBR</th><th>With PBR</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>The routing path PC1-R1-R3-PC3</td><td>The routing path PC1-R1-R2-R3-PC3</td></tr>
</table>

**For video demonstration of the given practical click on the link below or scan the QR-code**

https://youtu.be/3M1sUhMg6YU