Networking Technologies for ISPs

Static Routing

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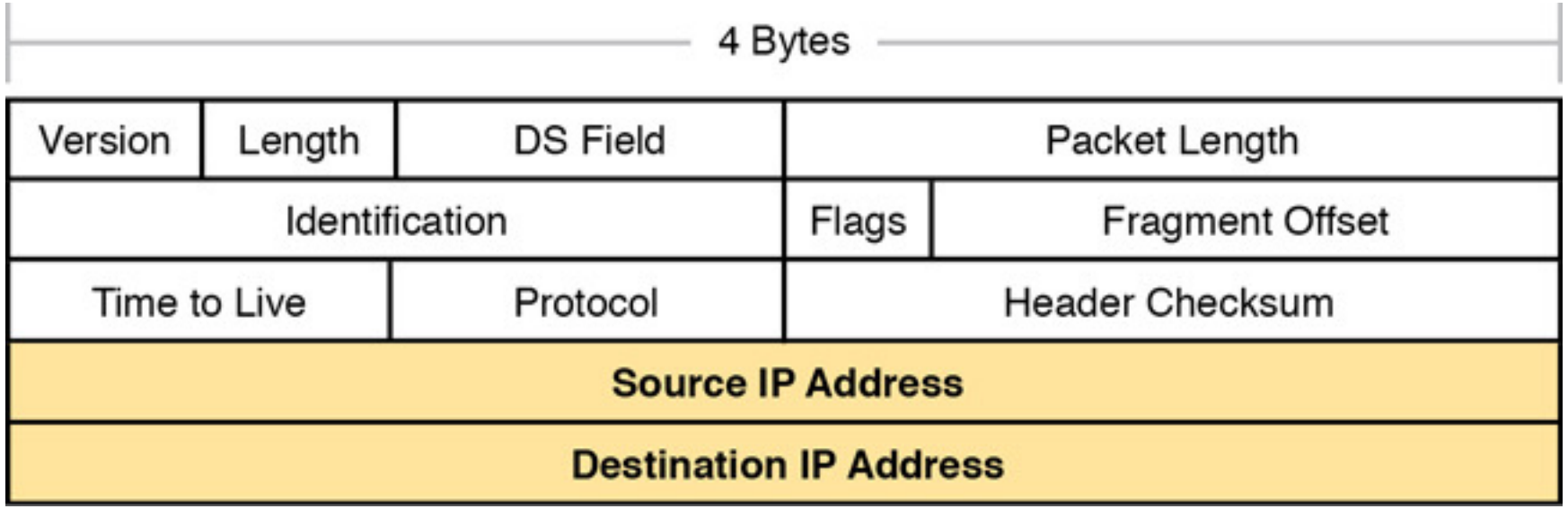
Agenda

- Postal service and Static Routing
- Static Routing Basics
- Practical do-along
- Distance and Route Flags
- Route Manipulations
- ECMP and PBRs

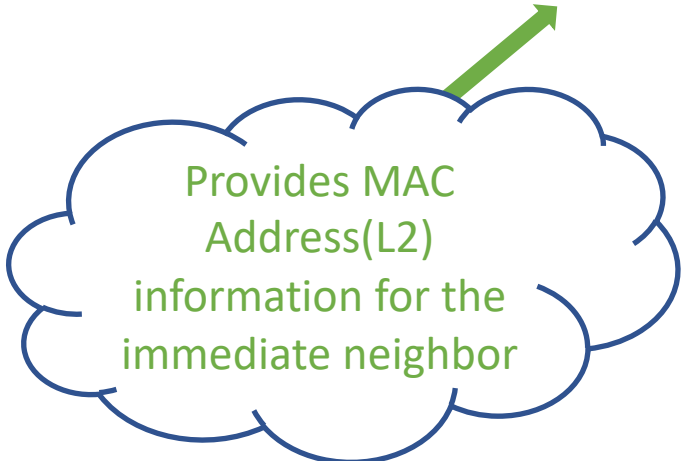
Routing

- Works in OSI Network Layer (Layer-3)
- Static Route is part of default package and you do not need routing package to be installed
- Routing rules define where the packet should be sent

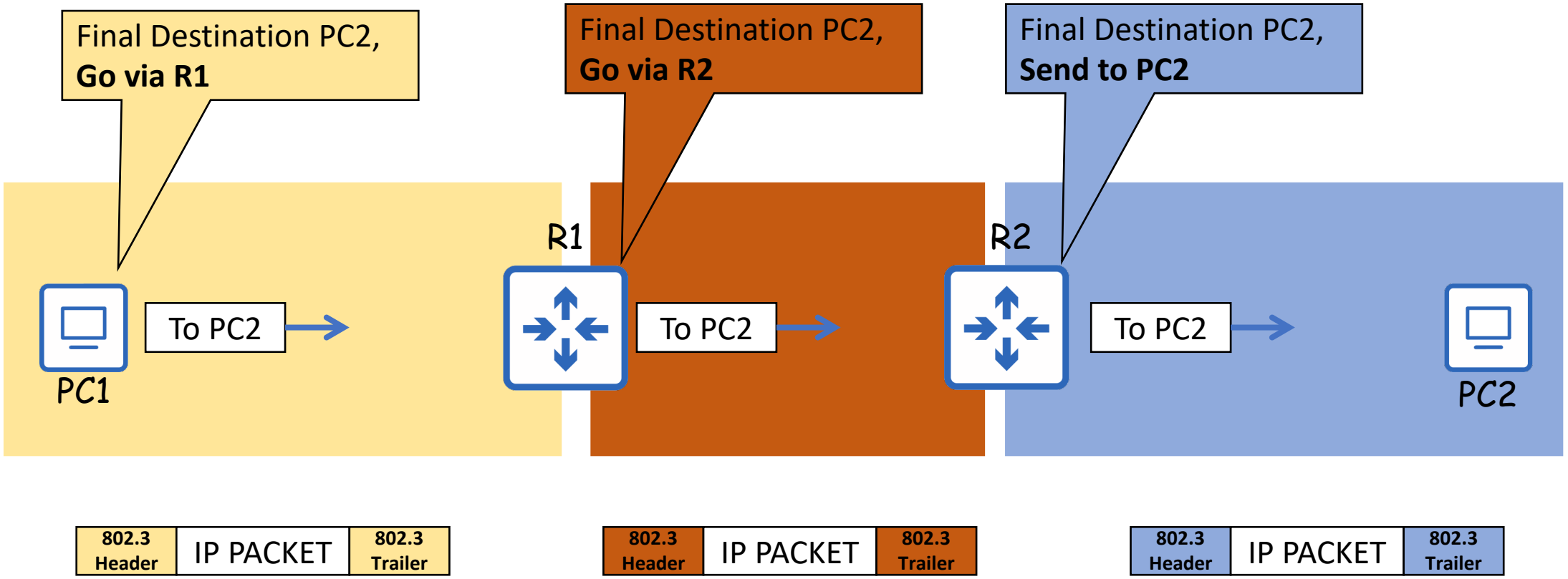
IP Header



- Note when Router, routes the packet the IP header remains the same only the ***data-link header/trailers*** are removed and added.

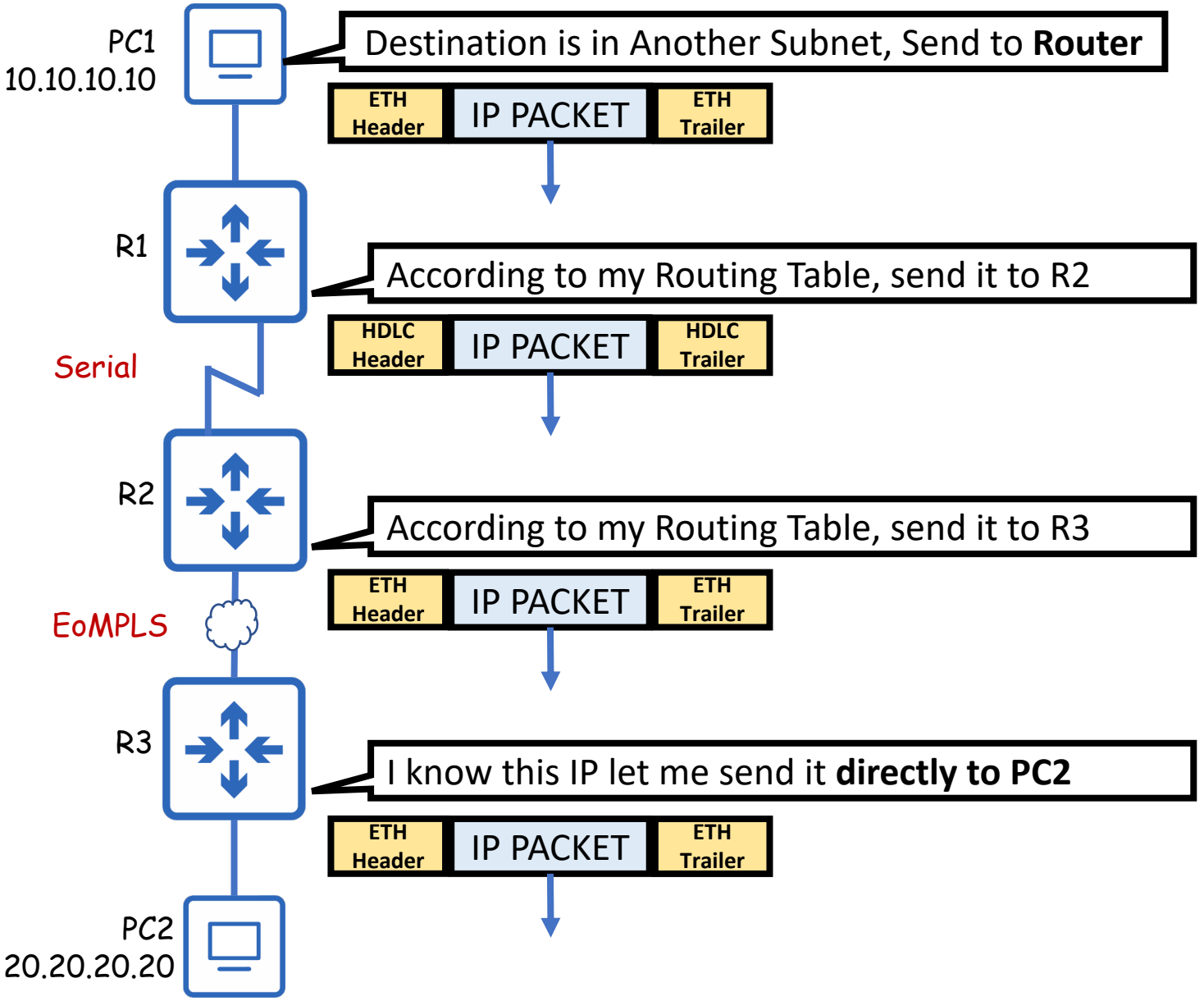


How Routers Use IP Packets Using Ethernet



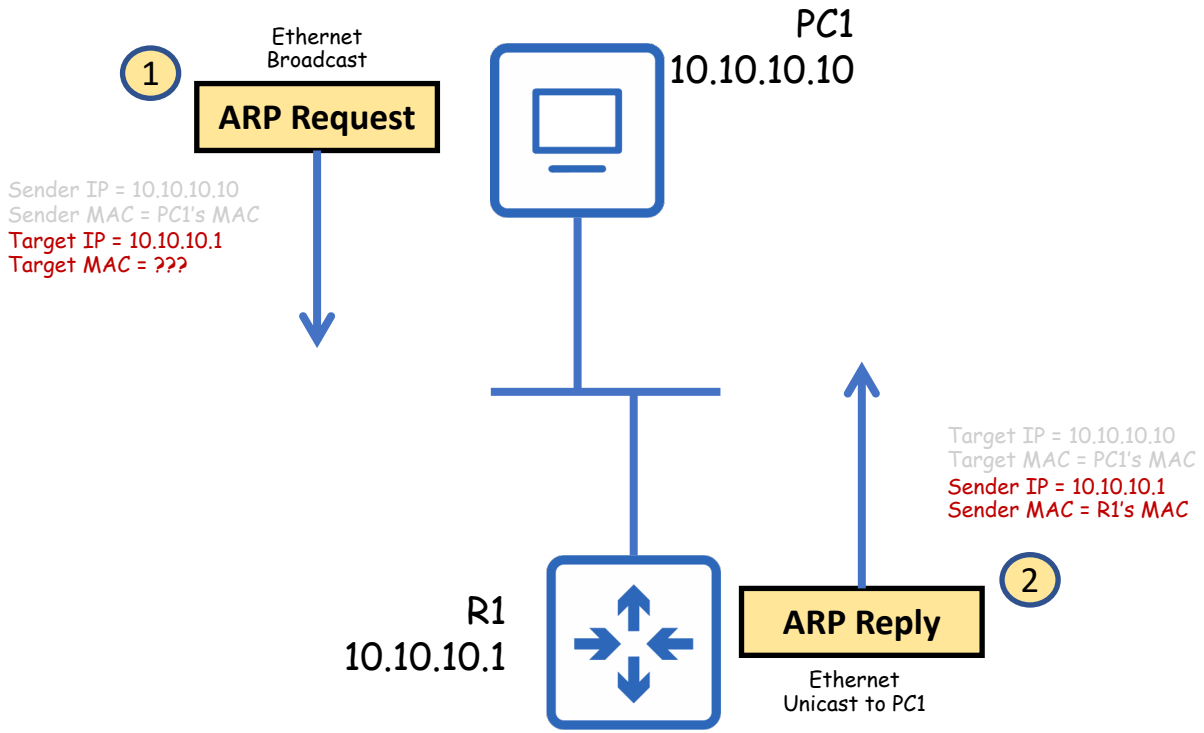
Note: The 802.3 header and trailer are different at each stage

IP Routing Basics how is Packet Forwarded



ARP

- Address Resolution Protocol
- MAC address for encapsulation at data-link layer is provided by ARP



How IP Routing Protocols help IP Routing

- For Routing logic to work each router in the network will have to know how to reach to the destination subnet
- Routing Protocols update routes dynamically from other routers.
- General steps that are followed to learn the routes:
  - Each router, independent of the routing protocol adds a route to its routing table of the connected subnets
  - Each router's routing protocol informs its neighbor of the routes in the routing table, including the connected routes and routes learnt from other routers
  - After learning a route from a neighbor, the router adds the subnet to its routing table and the next-hop to that subnet typically becomes the neighbor which has provided the subnet

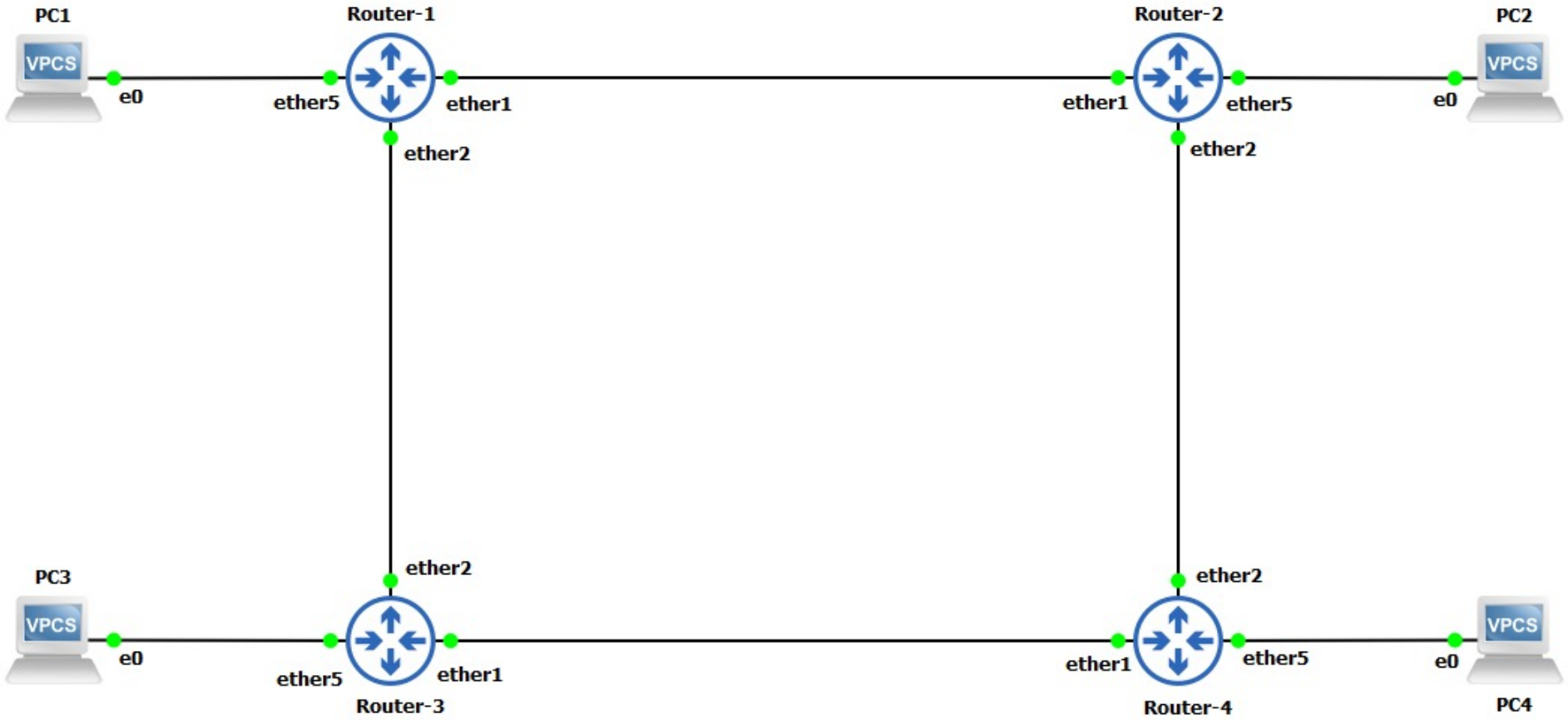
Note: Router may get several routes to same subnet from different sources, but only routes that it may seem the best will enter in the routing table

Essential Information for Static Routing

- **DST Address –** Address/Subnet to reach to by the packet
- **Gateway –** IP Address of the next-hop/next router to reach the **Destination**

Essentially we don’t need any more information other than this to create Static Route

Let’s work on a scenario



RIB Injection Rules

- **Rule 1 –** The most *Direct Route* will be *preferred*
  (if more than one route point to same address, the more precise route will be installed in RIB)
  - DST: 192.168.90.0/24, gateway:1.2.3.4
  - DST: 192.168.90.0/25, gateway:5.6.7.8

  Packet will be forwarded to 5.6.7.8 for all IPs between 0-127

- **Rule 2 –** *Lesser Distance* will be *preferred*
  - DST: 192.168.90.0/25, gateway:1.2.3.4, distance: 1
  - DST: 192.168.90.0/25, gateway:5.6.7.8, distance: 2

  Packet will be forwarded to 1.2.3.4 for all IPs between 0-127

Default Distance

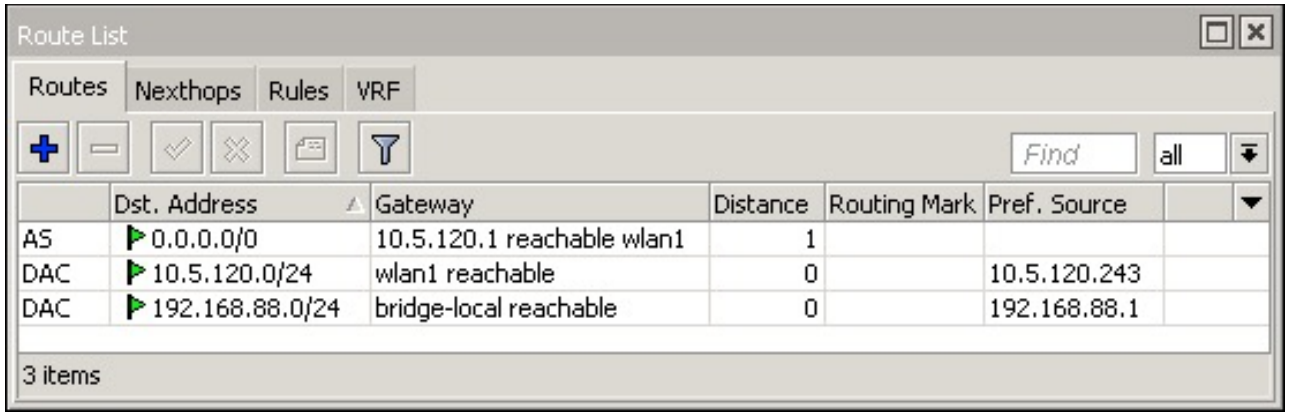
Routing Protocol	Default Administrative Distance
Directly Connected Routes	0
Static Route	1
eBGP	20
OSPF	110
RIP	120
iBGP	200
Unknown/Unused	255

Default Route

- A *fallback* route
- Distinguished by 0.0.0.0/0 in destination

Route Flags

- X – disabled
- A – active
- C – connected
- D – Dynamic
- S – Static
- b – BGP
- o – OSPF
- r – RIP
- B – Blackhole
- U – Unreachable
- P - Prohibit



Static Route Manipulation

- **Check Gateway –** *(ping/ARP)* every 10 seconds send ICMP echo request or ARP request, after 2 continuous timeouts Gateway is marked *unreachable*

- **Distance –** Define preferred route and failover statically

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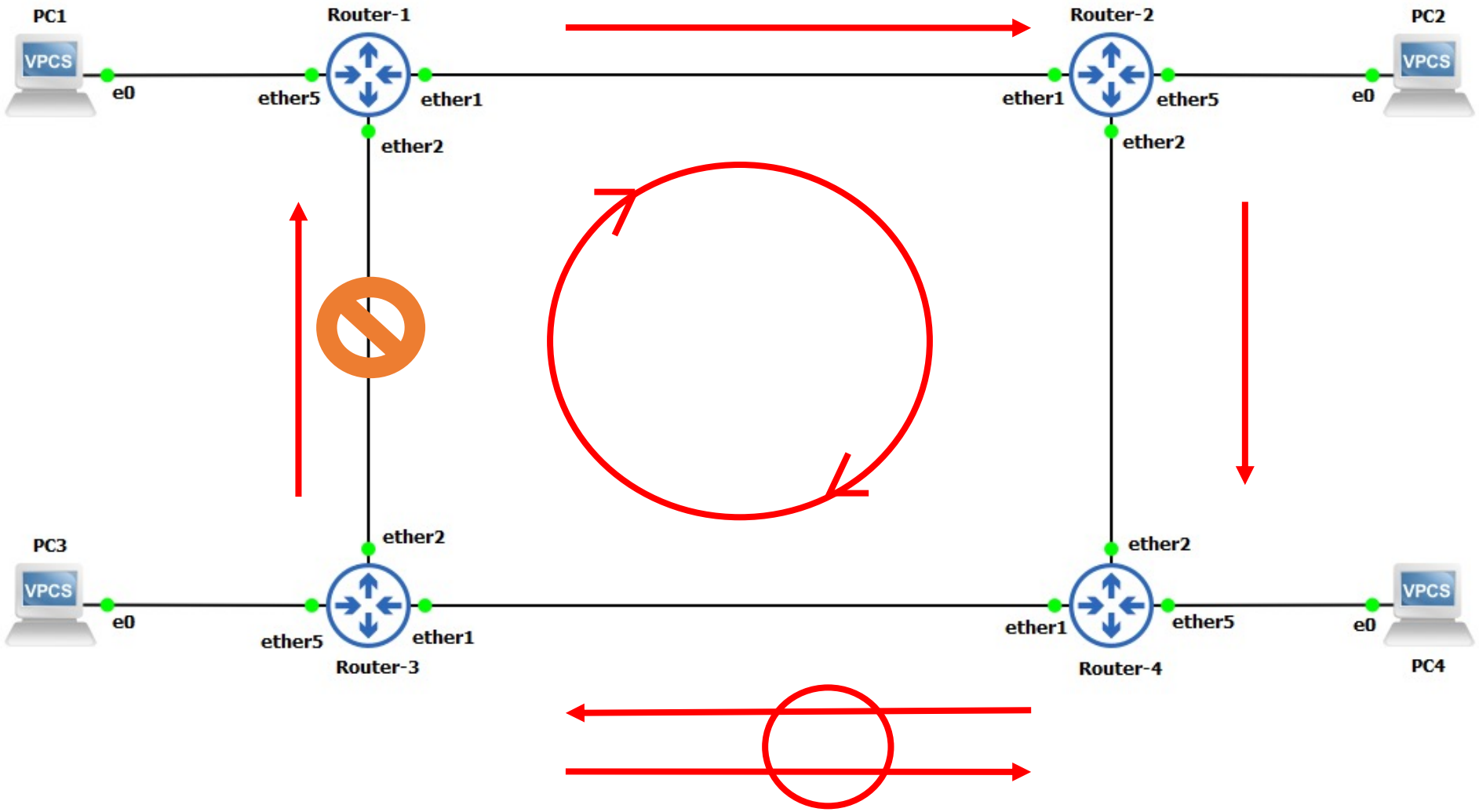
- To Block certain Dst-Address we can use:
  - ***Blackhole –*** Silently drop the packet
  - ***Unreachable –*** Discard but send ICMP unreachable(type 3 code 1)
  - ***Prohibit –*** Discard but send ICMP Prohibited message(type 3 code 13)

ECMP/Load Balancing

- Destination can be reachable from more than one route
- Normally adding multiple routes will create redundancies but not balance traffic
- ECMP – Equal Cost Multi Path
- Adding multiple gateways to same destination will use the gateway in round robin

ECMP balances only per connection basis and not per packet basis, that is src-dst combo takes same path every time

PBR Scenario



Policy Based Static Routing

- Conditional marking of Packets using *ip->firewall->mangle*
- Marking packets for routing purposes and force the packet to use different RIB
- You can have routes to same destination with different gateways but same distance installed over multiple RIBs. ***main*** RIB will act as catch-all.

Troubleshooting IP Routing

- ***Ping*** – Basic echo request tool for checking if the remote site is listening & responding.
  - Setting src-address
  - Sending TCP pings (use hping[3])

- ***Traceroute*** – Simple tool to trace the packet path
  - Perspective is the sender (REMEMBER)
  - Setting src-address
  - Sending TCP packets(for windows use winpcap library)

Limitations

- Not easy to implement in large networks
- Managing static routes can be time consuming
- If a link fails manual intervention is needed
- Human errors
- Inter-working with dynamic routing protocol is not good, as they are by default preferred routes s

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