Router Virtualization Protocols

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These slides and audio/video recordings of this class lecture are at:

http://www.cse.wustl.edu/~jain/cse570-15/

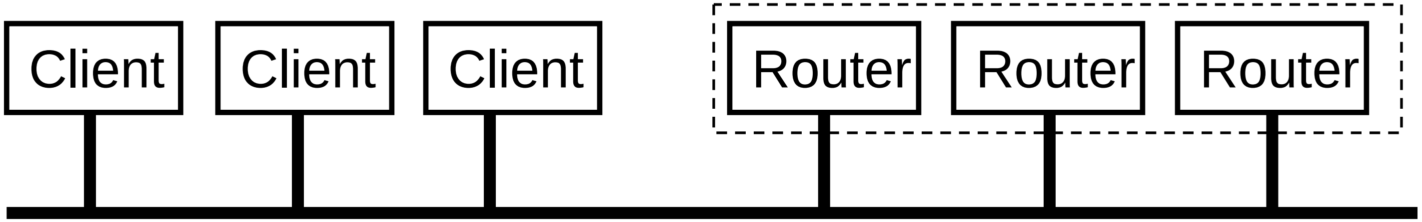
1. Hot Standby Router Protocol (HSRP)
2. Virtual Router Redundancy Protocol (VRRP)
3. Virtual Routing and Forwarding (VRF)
4. Virtual Device Context (VDC)

Router Virtualization

- Multiple routers act as one router
  - Hot Standby Router Protocol (HSRP) and Virtual Router Redundancy Protocol (VRRP)
  - Virtual Routing and Forwarding (VRF)
- One router acts as multiple routers
  - Virtual Device Context (VDC)

Hot Standby Router Protocol (HSRP)

- Problem: What to do if default gateway fails?
- Solution: Multiple default gateways act as one virtual default gateway.
- All routers have a real-IP (RIP) and a virtual IP (VIP). Clients send to VIP
- Only active/master router forwards packets.
- Standby routers keeps track of the active/master router. Elect a new active router if the current active router fails.
- Hot Standby Router Protocol (HSRP) is described in RFC 2281.



Ref: Javvin Technologies, "Network Protocols Handbook," Javvin Press, 2007, 380 pp., Chapter 5 and 55, ISBN:0974094528

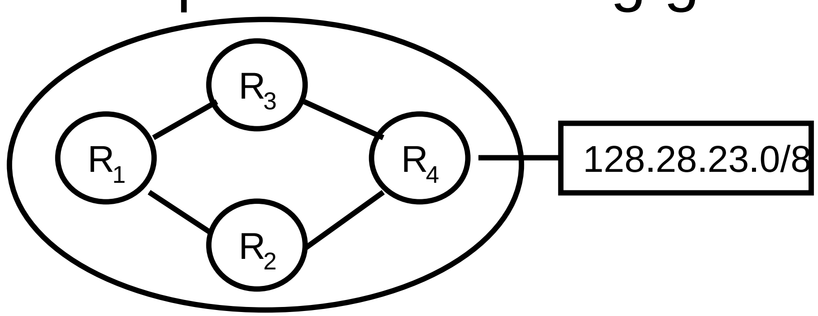
Virtual Router Redundancy Protocol (VRRP)

- HSRP is Cisco proprietary.
- Virtual Router Redundancy Protocol (VRRP) described in RFC 5798 is the IETF standard version and similar.
- Each VRRP is limited to a single subnet. Does not advertise routes beyond that subnet. Does not affect routing tables.

Ref: http://en.wikipedia.org/wiki/Virtual_Router_Redundancy_Protocol

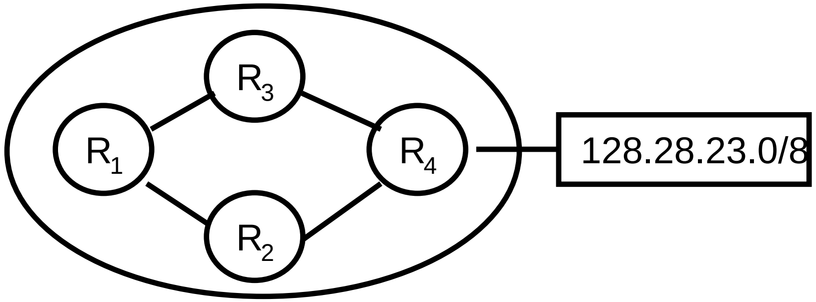
Routing Information Base (RIB)

- RIB: Routing table constructed by various routing protocols, such as, Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), Routing Information Protocol (RIP)
- For each destination prefix, RIB entries point to which router the packet should be sent to. The router may or may not be adjacent (particularly for BGP).
- Example: R_1's RIB will show R_4 as the path to 128.28.23.0/8
- RIB preparation is a control plane activity.
- Control plane is implemented using general purpose processors

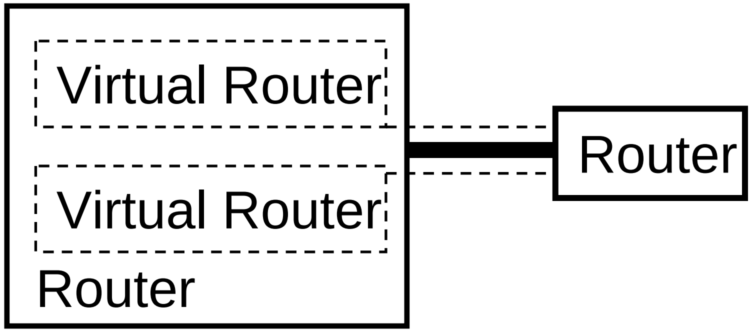


Forwarding Information Base (FIB)

- FIB: The table used to forward packets. It lists the next hop for each destination prefix.
- FIB is used in data plane and hence it has to be fast.
- Data plane is implemented using special purpose network processors.
- FIB is constructed from RIB. When the entries are copied, the next hop is resolved, outgoing interfaces are computed, and multiple entries are created if there are multiple paths to the destination prefix.
  - Example: R_1's FIB will have 2 entries for 128.28.23.0/8 via R_2 and R_3.



Virtual Routing and Forwarding (VRF)

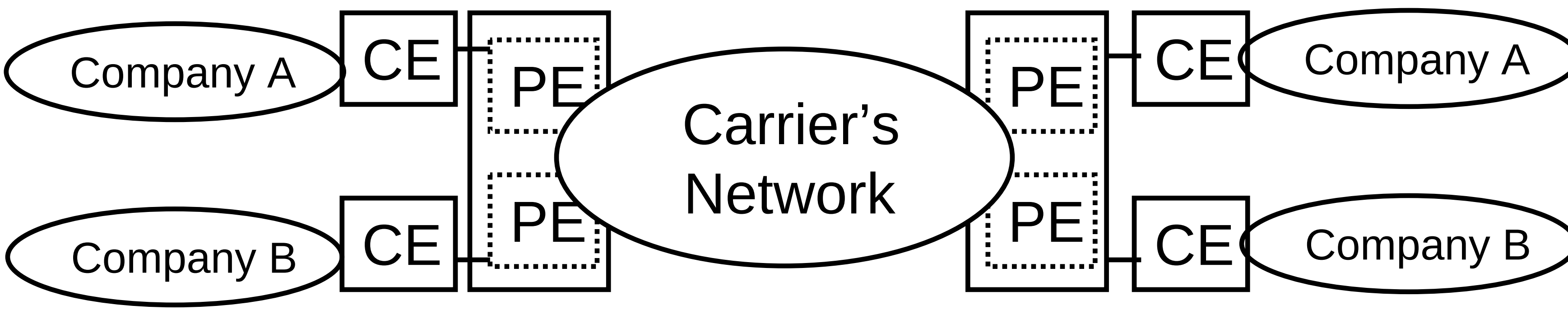


‰ Allows multiple virtual routers within a single physical router.
  - ¾ Each virtual router has its own routing table, network interfaces, and routing protocols
  - ¾ Each virtual router has its own forwarding information base (FIB) and routing information base (RIB)
  - ¾ VRFs exchange routing (e.g., OSPF) information with other virtual and physical routers.
  - ¾ Users of one VRF cannot communicate with users of another VRFs unless explicitly configured.

Ref: http://en.wikipedia.org/wiki/Virtual_Routing_and_Forwarding

VRF (Cont)

- Originally designed for carrier networks to allow enterprises to have a virtual WAN using MPLS.
- Customer edge (CE) routers forward to provider edge (PE) rou
  Entry PE routers encapsulate packets and forward to exit-PE.
  Exit PE decapsulate and give it to CE.
- PE routers use virtual routing table containing only routes to th customer's virtual PE's.
  Core routers in the carrier's network are unchanged.



VRF Tunneling

‰ VRFs connected over multiple hops require tunneling. GRE and MPLS are two tunneling techniques used in WANs.

‰ VRF Lite = w/o MPLS = hop-by-hop

‰ VRF now used in data centers. Multiple VRFs can share an interface using VLANs.