MPLS Layer 3 VPN Overview

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How MPLS Layer 3 VPNs Work

- MPLS L3VPNs have two basic components…
- Separation of customer routing information
  - VRF – Virtual Routing and Forwarding Instance
  - Different customers have different “virtual” routing tables
  - IGP/BGP run inside the VRF between the customer and SP
- Exchange of customer’s routing info inside SP
  - MP-BGP through the SP network
  - Traffic is label switched towards BGP next-hops

VRF Lite vs. MPLS VPNs

- In VRF lite all devices in transit path must carry all routes in all VRF tables
- In MPLS VPNs only PE routers need customer routes
- Accomplished through…
  - VPNv4 BGP
    - RD + Prefix makes VPN routes globally unique
  - MPLS VPN tag/label
    - P routers only need to know how to reach BGP next-hop
    - Uses “BGP free core” logic

MPLS L3VPN High Level Steps

- Establish an LSP between PEs
  - E.g. IGP + LDP
- Exchange routes with customer
  - PE-CE IGP or BGP
- Exchange customer routes between PEs
  - iBGP + MPLS VPN Label
- Label switch between PEs
  - Data follows the IGP + LDP transport label

Multiprotocol BGP

- How do PE routers exchange VRF info?
  - RFC 4364 - BGP/MPLS IP Virtual Private Networks (VPNs)
- MP-BGP defines AFI 1 & SAFI 128 as VPN-IPv4 or "VPNv4"
  - 8 byte Route Distinguisher (RD)
    - Unique per VPN or per VPN site
    - ASN:nn or IP-address:nn
  - 4 byte IPv4 address
    - Unique per VPN
  - Implies globally unique routes
- VPNv4 includes MPLS VPN label

VPNv4 NLRI Format

- **VPNv4 NLRI main attributes include…**
  - 8 byte Route Distinguisher (RD)
    - Unique per VPN or per VPN site
    - ASN:nn or IP-address:nn
  - IPv4 prefix & len
    - Unique per VPN because of RD
  - Next Hop
  - MPLS VPN label
- **Regular BGP attributes stay the same**

Controlling VPNv4 Routes

- Route distinguisher used solely to make route unique
  - Allows for overlapping IPv4 addresses between customers
- New BGP extended community “route-target” used to control what enters/exits VRF table
  - “export” route-target
    - What routes will be go from VRF into BGP
  - “import” route-target
    - What routes will go from BGP into VRF
- Allows granular control over what sites have what routes
  - “import map” and “export map” allow control on a per prefix basis

Route Distinguisher vs. Route Target

- **Route Distinguisher**
  - Makes the route unique
  - Only one RD per VPNv4 route
- **Route Target**
  - Controls the route's VPN membership(s)
  - Can be multiple RTs per VPNv4 route

VPNv4 Route Targets

- 8 byte field
  - RFC 4360 - BGP Extended Communities Attribute
- Format similar to route distinguisher
  - ASN:nn or IP-address:nn
- VPNv4 speakers only accept VPNv4 routes with a route-target matching a local VRF
  - Some exceptions, e.g. route reflectors

VPNv4 Route Targets (cont.)

- VPNv4 routes can have more than one RT
- Allows complex VPN topologies
  - Full mesh
  - Hub and Spoke
  - Central services

Transport Label vs. VPN Label

- **L3VPN needs at least 2 labels to deliver traffic**
  - Can be more with applications like MPLS TE, FRR, etc.
- **Transport Label**
  - Tells the SP core routers which PE traffic is destined to
    - I.e. who is the exit point
  - Typically derived from LDP
    - Sometimes called the IGP label
- **VPN Label**
  - Tells the PE router which CE traffic is destined to
  - Derived from VPNv4 advertisements of PEs

Q&A