CCIE Service Provider v4 Advanced Technologies Class

MPLS Traffic Engineering (TE)

Why MPLS Traffic Engineering?

- RFC 2702 - Requirements for Traffic Engineering Over MPLS
  - *"A major goal of Internet Traffic Engineering is to facilitate efficient and reliable network operations while simultaneously optimizing network resource utilization and traffic performance"*
  - *"The control capabilities offered by existing Internet interior gateway protocols are not adequate for Traffic Engineering."*
  - *"These protocols are topology driven, so bandwidth availability and traffic characteristics are not factors considered in routing decisions. Consequently, congestion frequently occurs…"*

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What is MPLS TE?

- **MPLS TE makes forwarding decisions based on additional metrics such as…**
  - Bandwidth Availability
  - Shared Risk Link Groups (SRLG)
  - Affinity (Link Coloring)
  - Manual Path Selection
  - Service Type (QoS based forwarding)

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What is MPLS TE? (cont.)

- **MPLS TE also offers fast reconvergence around failures**
  - Fast Reroute (FRR) link and node protection
  - I.e. make before break

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How Does MPLS TE Work?

- MPLS TE creates unidirectional P2P LSPs
  - Unlike LDP & BGP MP2P tunnels
- Tunnels are calculated based on constraints
  - Bandwidth, affinity, QoS, explicit path, etc.
- LSPs are signaled with RSVP
  - RFC 3209 - RSVP-TE: Extensions to RSVP for LSP Tunnels

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MPLS TE and IGP

- MPLS TE does not build its own topology information
  - Instead it relies on underlying IGP (OSPF/IS-IS)
  - Analogous to PIM for multicast
- IGPs were extended to encode TE attributes
  - OSPF Opaque LSA
  - IS-IS TLVs
- IGP calculation is now Constrained Shortest Path First (CSPF)
  - Constraints are bandwidth, affinity, QoS, explicit path, etc.

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MPLS TE Configuration Workflow

- **Globally enable MPLS TE**
  - mpls traffic-eng tunnels
- **Enable IGP support for TE**
  - OSPF mpls traffic-eng area <area-id>
  - IS-IS mpls traffic-eng [level-1 | level-2]
    - *Requires wide metrics*

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MPLS TE Configuration Workflow (cont.)

- Enable TE per link
  - mpls traffic-eng tunnels
- Enable RSVP per link
  - ip rsvp bandwidth [max-reserved-bw]
- Configure TE tunnel
  - interface tunnel X
  - tunnel mode mpls traffic-eng
  - tunnel mpls traffic-eng path-option…
  - tunnel mpls traffic-eng autoroute…

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Routing over MPLS TE

- **Tunnel signaling does not imply routing**
  - Signaling just brings the interface up
  - Works like any other interface that requires routing configuration
- **Routing over TE can be through…**
  - Static routing
  - Autoroute announce
  - Autoroute destination
  - Forwarding adjacency
  - Policy Routing (DiffServ TE)

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MPLS TE Path Options

- CSPF path calculation can be one of two ways
  - Dynamic calculation
  - Explicit calculation
- Dynamic uses constraints
  - Bandwidth, affinity, QoS, etc.
- Explicit is manually defined
  - List of included or excluded next-hops
  - Exclude used for TE FRR link & node protection
- Tunnels can use more than one path option
  - E.g. prefer an explicit path but fall back to a dynamic path if not available

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MPLS TE Tunnel Priorities

- **Tunnels include two priority values**
  - Setup priority
  - Hold priority
- **Setup priority**
  - Can I preempt other tunnels during initial calculation?
- **Hold priority**
  - Can other tunnels preempt me once I'm already up?

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Troubleshooting MPLS TE Establishment

- Two main steps in troubleshooting TE
  - Did the tunnel properly calculate its path?
    - debug mpls traffic-eng path lookup
  - Did the tunnel properly signal a label?
    - debug mpls traffic-eng tunnels signaling
- Verifying the TE database
  - show mpls traffic-eng topology | include TE Id|Intf Address
- Was the tunnel able to signal with no options?
  - Fallback dynamic path option

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Q&A

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