Optimizing Service Provider’s MPLS Network with Hierarchical VPN

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Outlines

- Service Delivery in MPLS Network
- IP network evolutions and the associated problems
- The Solution
- Basics on Hierarchical VPN
- H-VPN Configuration and Network Management
- Real World Deployment
In MPLS Network, services are catered with VPN:
- Isolated tunnel created for each service
- Services in the VPN are allowed to communicate with each other
- Provides flexible inter-connectivity ranging from partial to full mesh
- VPN services delivered using:
  - L3VPN for Layer 3 connectivity requirement
  - L2VPN for Layer 2 service inter-connectivity
Layer 3 VPN

- Customer end points peer with Service provider’s PE Router
- As per requirement, the customer can run OSPF, ISIS, BGP or any routing protocol with PE
- PEs maintain separate routing tables called VRF for each VPN
- VPN policies established by VPN customers
- Routing from one customer is isolated from other customers
- No constrains on IP addressing plans used by VPN
Layer 2 VPN

- In L2VPN, Service Provider emulates the behavior of Layer 2 LAN across IP/MPLS network
- No routing between Customer and Service Provider
- Provide point-to-point or point-to-multipoint Layer 2 connectivity to the customer
IP Network Evolution - 1

- Routers in the Core Layer only
- STP activated in the Layer 2 ring
- Broadcast and network re-convergence
- Limited Layer 3 domain
IP Network Evolution - II

- Aggregation Switches replaced with Routers
- IP/MPLS Network expanded up-to Aggregation
- Broadcast traffic reduced in Aggregation
- Layer 2 Network confined to Access Network
○ Routers in Core, Aggregation and Access Layer
○ Flat IP/MPLS Network extended up-to Access
○ Substantial growth in Layer 3 Network
○ Layer 3 Network starting right from the Access
Problem with Evolution - III

- Rise in IGP domain
- Network is not scalable
- Network became large and un-manageable
- Each network element act as a PE and maintains all VPN routes
The Solution

- Isolate Aggregation and Access Layer like two different networks
- The VPN deployment in this type of Hierarchical PE network is ‘Hierarchical VPN’
Basics on Hierarchical VPN

- The PE devices have three roles:
  - UPE, SPE, NPE
- Changes in the Access Layer not protruded to Aggregation and Core Layer
- Stitch the VPN services from Access to Aggregation
- A flavour of Carrier Supporting Carrier
- Nesting of Hierarchical PE possible
Flat Topology vs Hierarchical Topology

Flat IP MPLS Network

Hierarchical IP/MPLS Network

Core Layer

Aggregation Layer

Access Layer

MPLS Access Ring

NPE

SPE

Access Network Management Domain
Benefits of Hierarchical VPN

- Operation domain separated
  - Aggregation – Vital
  - Access – Less Critical
- The PEs in the Access Layer only have to maintain local routes
- Network scalable
- Services running from Access Layer are controlled by Aggregation Layer
Configuration of Hierarchical Network

- IGP
  - Establish IGP between UPE and SPE: ISIS Process 200
- BGP
  - Establish IBGP between UPE and SPE
- MPLS LSP
  - Establish LSP between UPE and SPE
Hierarchical L3VPN

- **VRF**
  - Create VRF in NPE: lte_core
    - Import/Export RT with SPE
    - Import RT from UPE
  - Create VRF in SPE: lte_s1_agg
    - Import/Export RT with NPE
    - Import RT from UPE
  - Create VRF in UPE: lte_s1_acc
    - Import RT from SPE
    - Export RT to SPE and NPE
- **VPN Stitching**
- **Routing from SPE (lte_s1_agg) to UPE (lte_s1_acc)**
  - Default route
  - Aggregated route
Hierarchical VPLS

- VPLS
  - Configure LDP VPLS between NPE and SPE
    - Ex: vpls ftth-core-agg
  - Create VPLS in UPE, specify SPE as normal PE peer
    - Ex: vpls ftth-agg-acc
  - In SPE, peer UPE as lower-layer UPE peer
Network Management and Monitoring

- Separate management domain
- Access Layer devices can be accessed via Aggregation IGP
  - Management VRF created to manage Access Layer devices
- One time configuration at Aggregation Layer
  - For service additions, configuration required at Access Layer only
Real World Deployment

- Hierarchical Network deployed with 250 Aggregation Nodes and 800 Access Nodes
- L3VPN service operated
  - GSM 2G, UMTS 3G, LTE 4G
  - IMS / MSAN / MSAG
- H-VPLS service operated
  - FTTH / ADSL Internet Services
  - Internet / Intranet Dedicated Leased Lines
- Configuration job significantly eased and distributed
- Efficient use of Aggregation and Access nodes
- Separate O&M for Aggregation and Access Network
  - Different Access Network managed by Different Regional Team
References

- BGP/MPLS IP Virtual Private Networks (VPNs), IETF RFC 4364, Rosen & Rekhter, February 2006
Thank You

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Q & A