

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

Service Delivery in MPLS Network

- 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

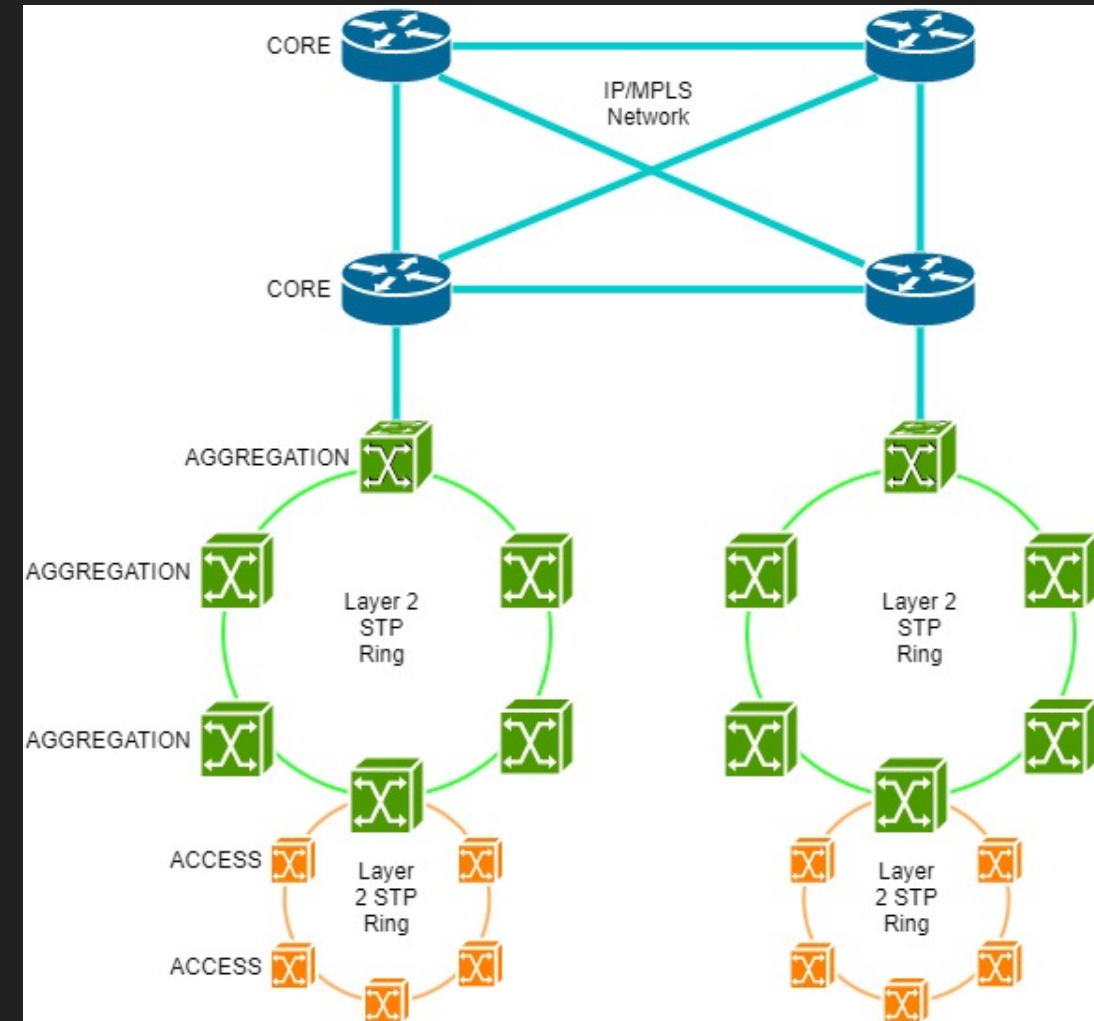
- Customer end points peer with Service provider's PE Router
- As per requirement, the customer can run OSPF, ISIS, BGP or any routing protocol with PE
- PEs maintain separate routing tables called VRF for each VPN
- VPN policies established by VPN customers
- Routing from one customer is isolated from 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

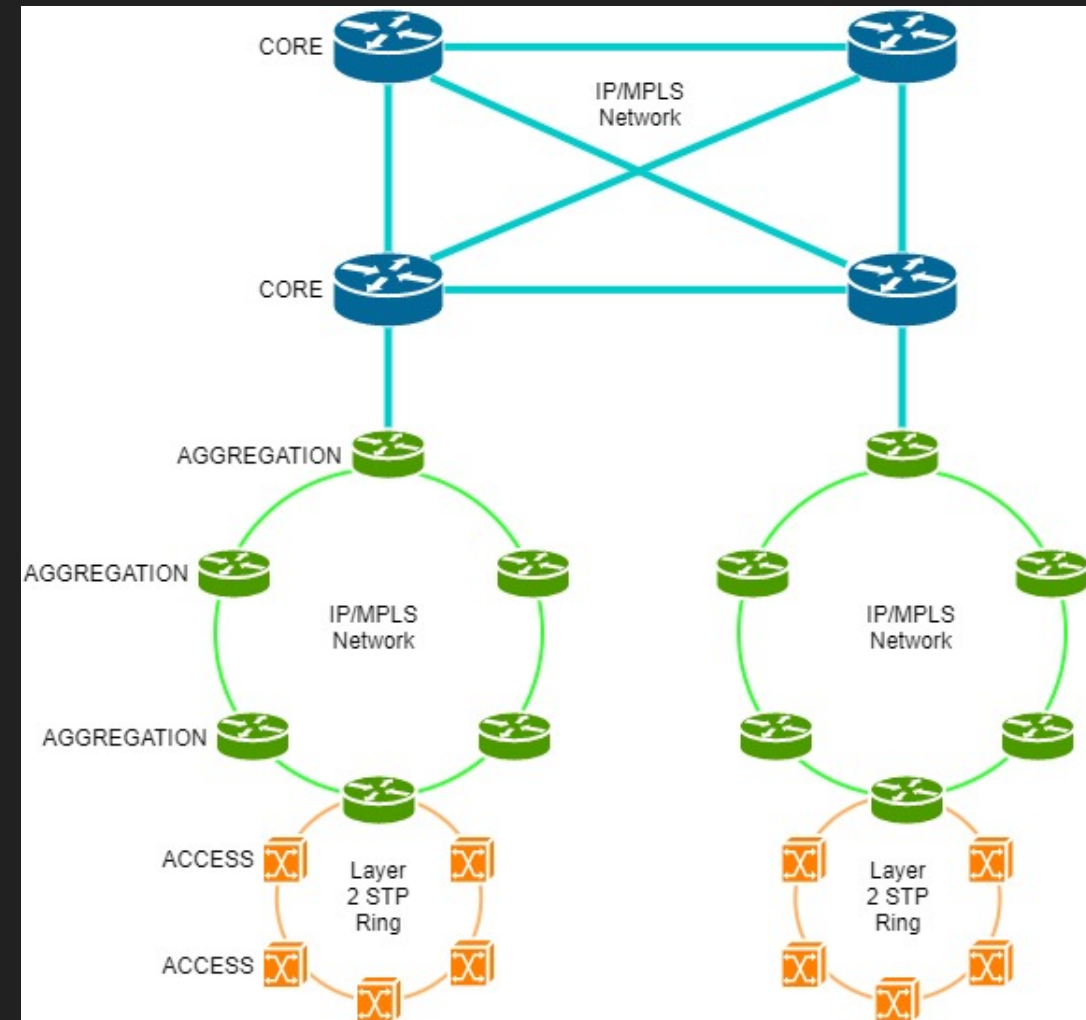
IP Network Evolution - I

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



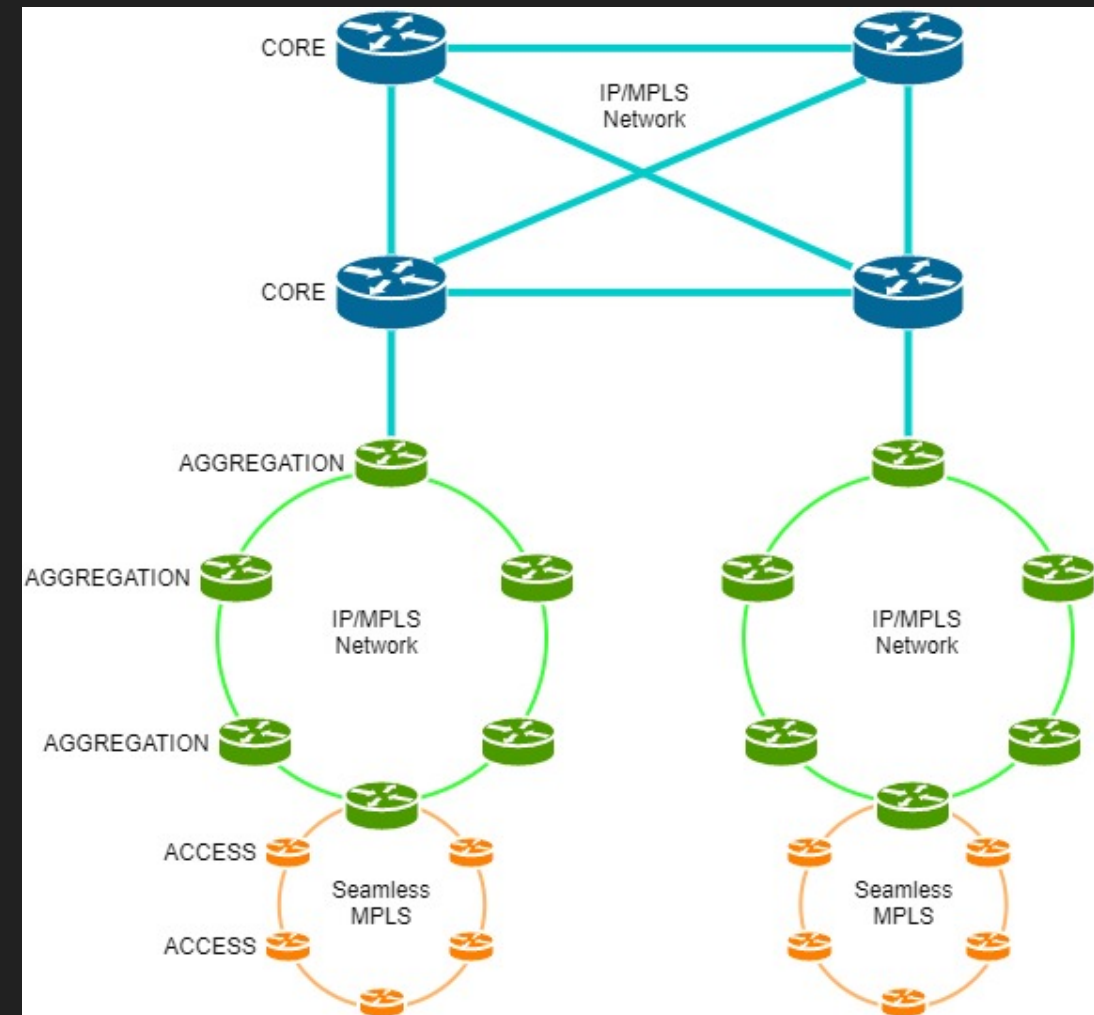
IP Network Evolution - II

- Aggregation Switches replaced with Routers
- IP/MPLS Network expanded up-to Aggregation
- Broadcast traffic reduced in Aggregation
- Layer 2 Network confined to Access Network



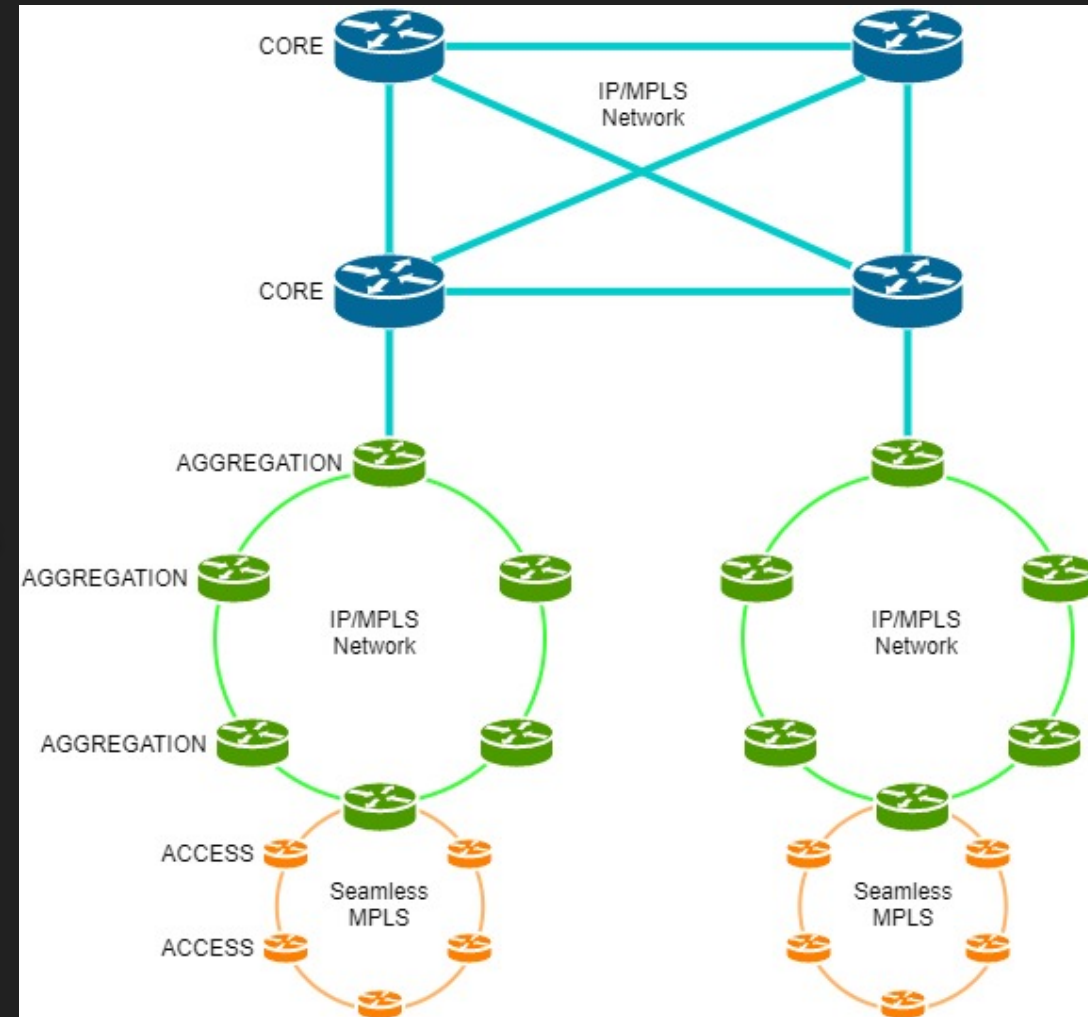
IP Network Evolution - III

- 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



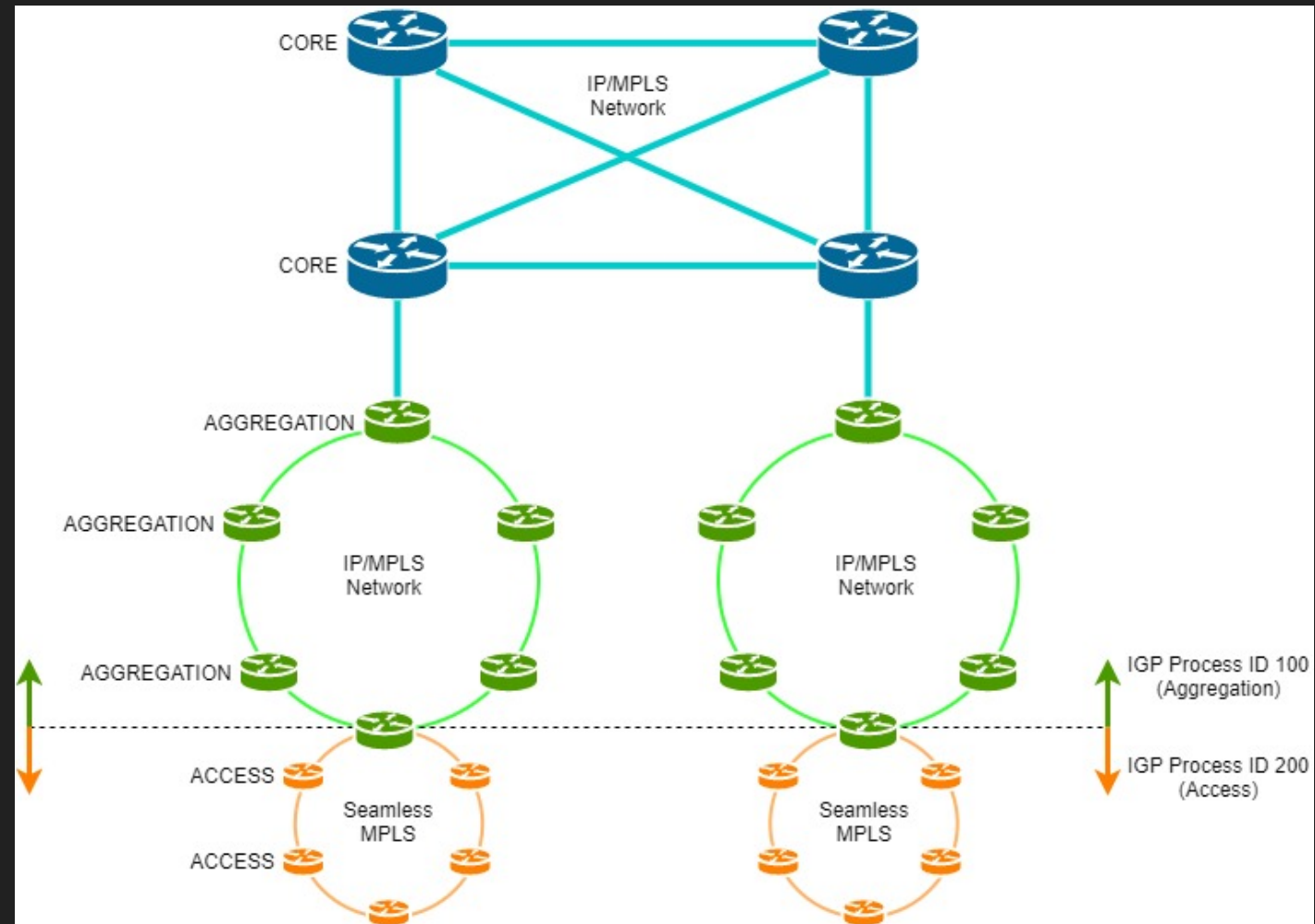
Problem with Evolution - III

- 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**'

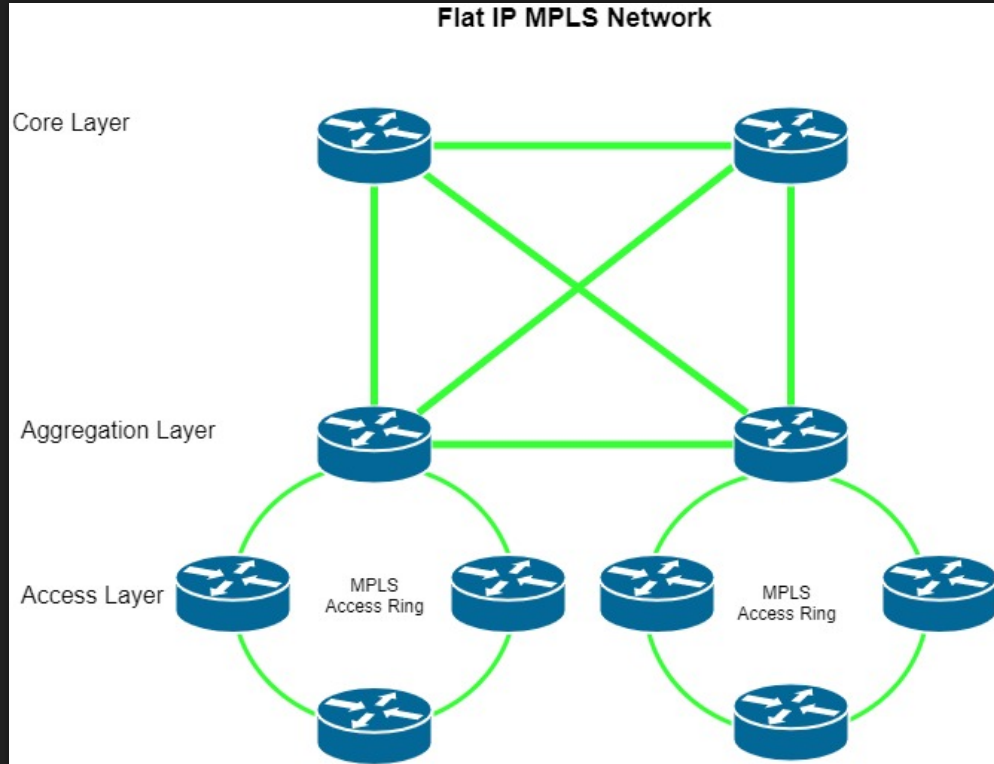


Basics on Hierarchical VPN

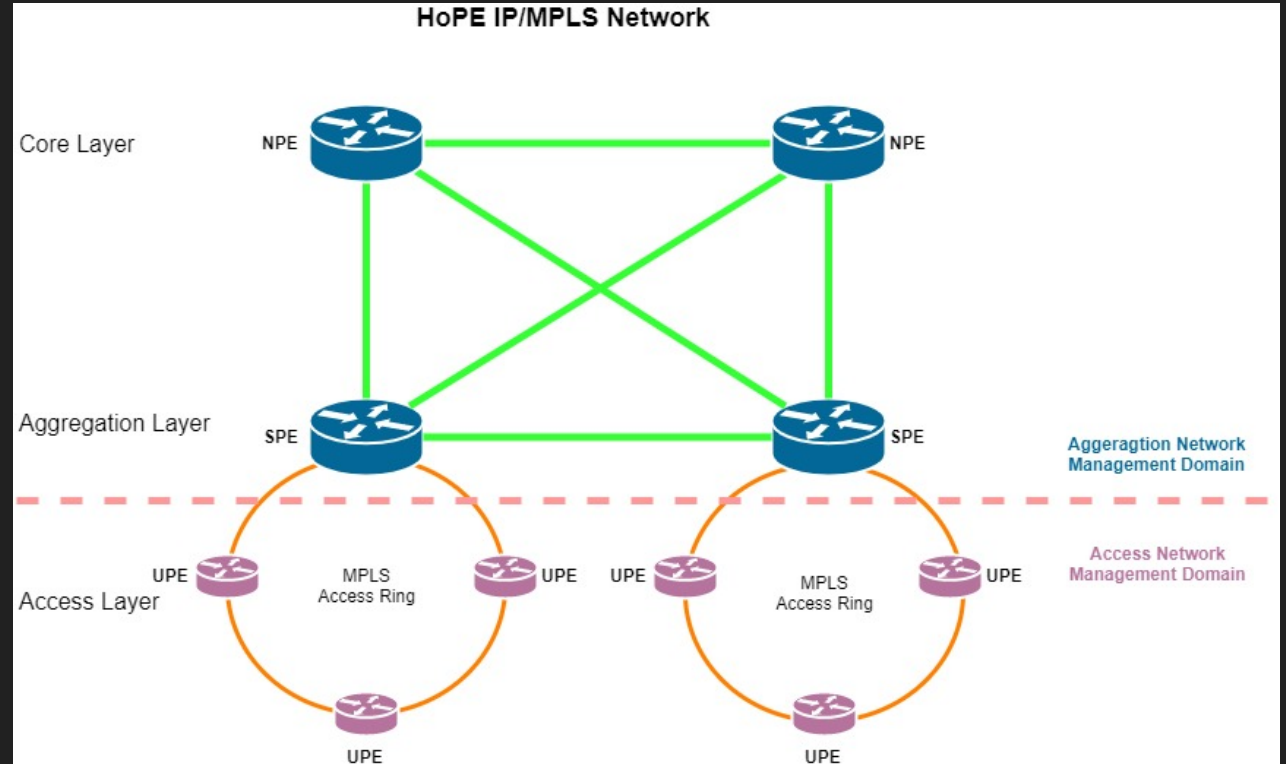
- The PE devices have three roles:
 - UPE, SPE, NPE
- Changes in the Access Layer not protruded to Aggregation and Core Layer
- Stitch the VPN services from Access to Aggregation
- A flavour of Carrier Supporting Carrier
- Nesting of Hierarchical PE possible

Flat Topology vs Hierarchical Topology

Flat IP MPLS Network



HoPE IP/MPLS Network

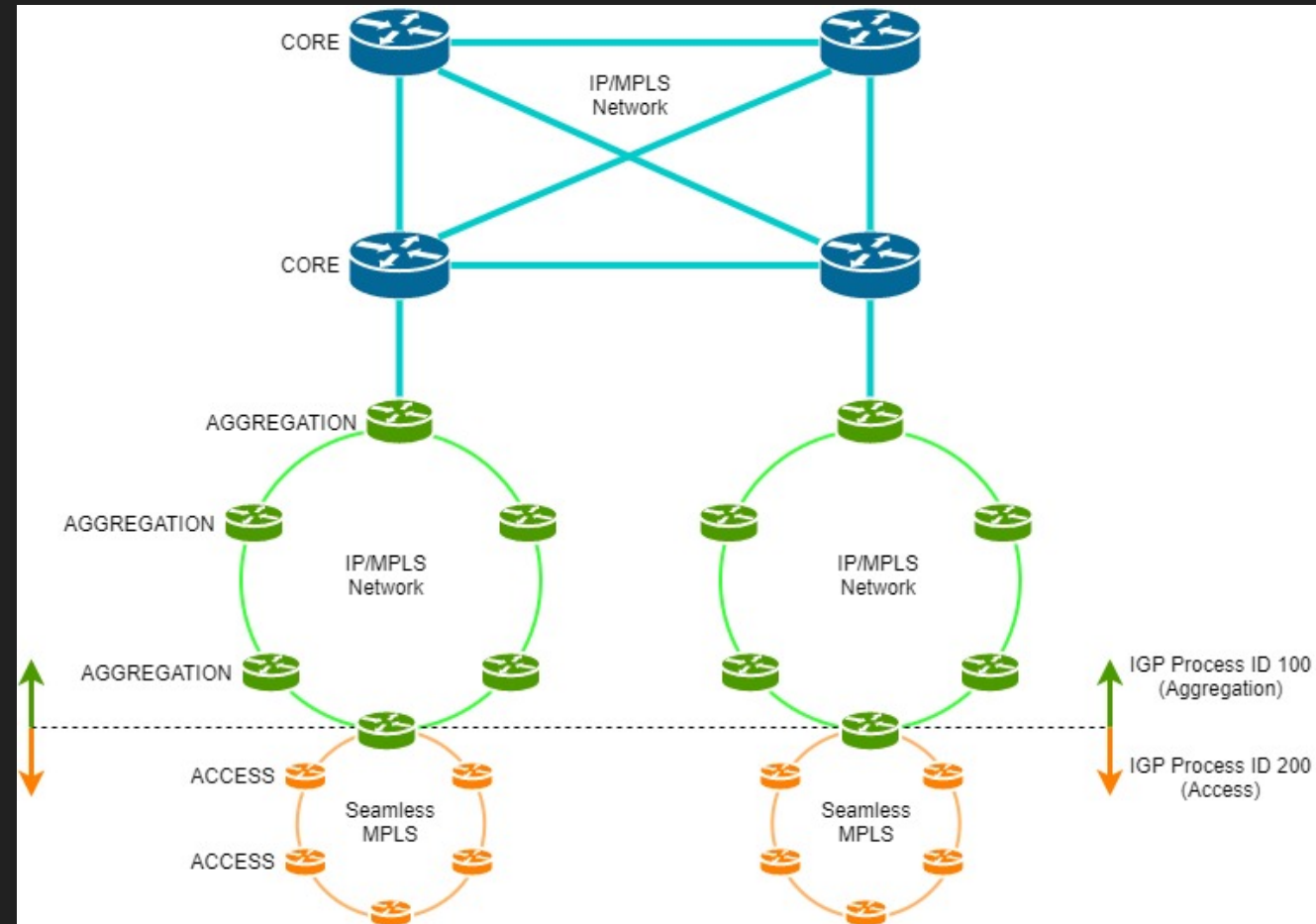


Benefits of Hierarchical VPN

- 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

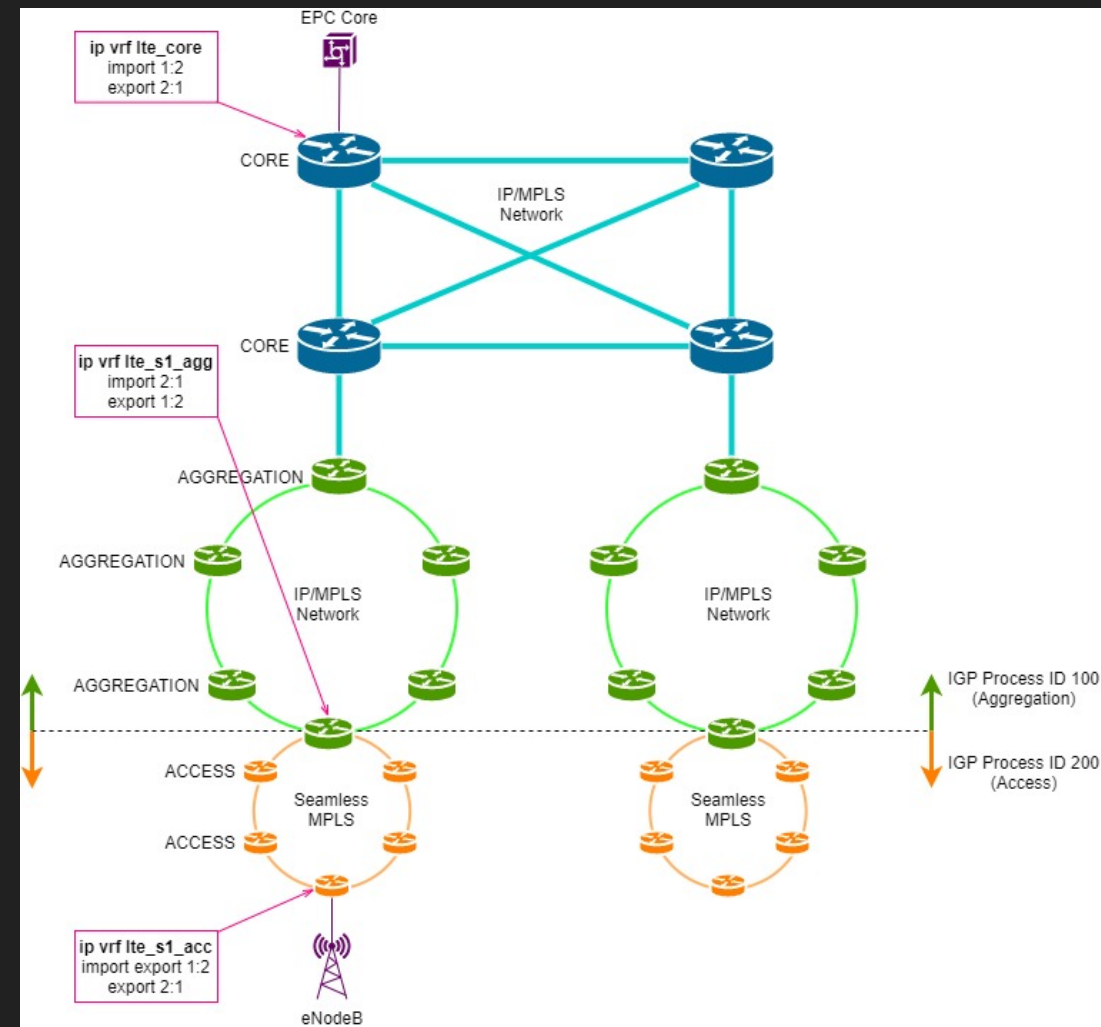
Configuration of Hierarchical Network

- 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



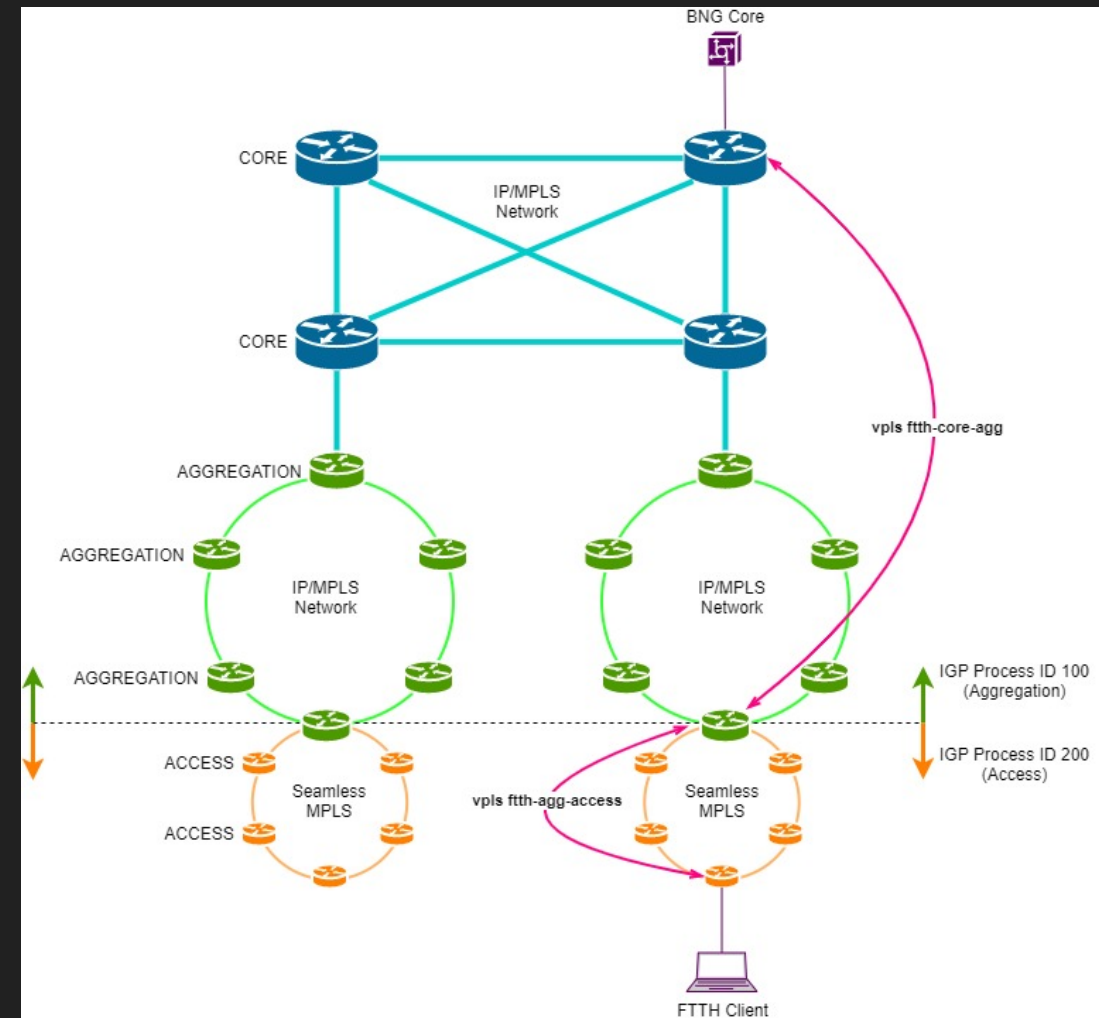
Hierarchical L3VPN

- 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

- HoPE Technology White Paper, Hangzhou H3C Technologies Co., Ltd., 2008
- BGP/MPLS IP Virtual Private Networks (VPNs), IETF RFC 4364, Rosen & Rekhter, February 2006
- Hierarchy of Provider Edge Device in BGP/MPLS VPN, Libin, et al. Network Working Group, Internet Draft <draft-libin-Hierarchy-pe-bgp-mpls-vpn-02.txt>, May 2003
- Hierarchical VPN over MPLS Transport, Kathirvelu, et al., IETF Draft <draft-ietf-ppvvpn-hiervpn-corevpn-00.txt>, July 2001



Thank You

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Q & A