Scalability Considerations for Enhanced VPN (VPN+)

draft-dong-teas-enhanced-vpn-vtn-scalability

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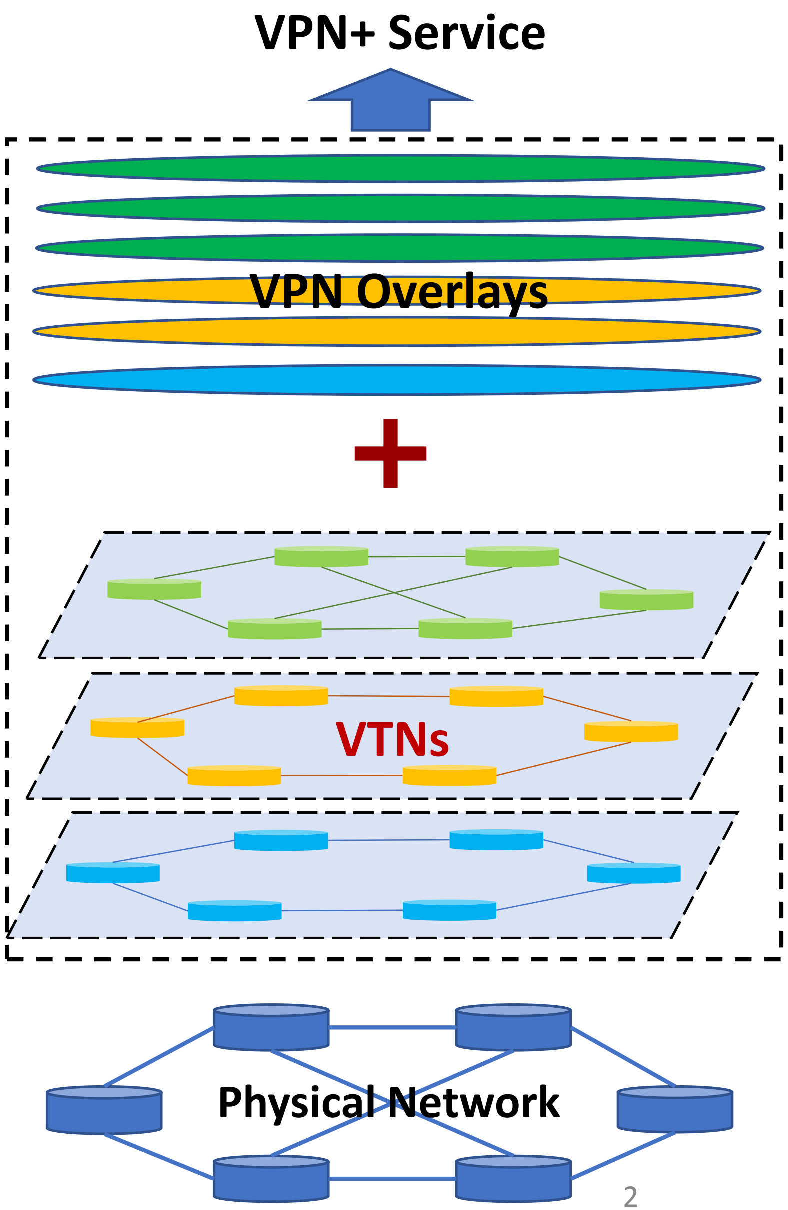
Background

- VPN+ framework is described in *draft-ietf-teas-enhanced-vpn*
  - A layered architecture and technologies to provide VPN+ service, such as network slices
- VTN is a virtual underlay network with the customized topology and a set of dedicated or shared network resources
  - VPN+ service is enabled by integrating overlay VPN and underlay VTN
- With the demand for VPN+ service increases, scalability becomes an important factor in both the solution design and deployment
- This document analyses the scalability considerations of VPN+
  - The control plane and data plane scalability of the VTN layer
  - Optimization suggestions are provided



Scalability Requirements

- One typical use case of VPN+ is to deliver IETF network slices
  - The number of IETF network slices needed reflects the requirements on VPN+
- Possible network slice scenarios and the number of slices required

Scenarios	Network slice for operator’s internal use	Network slice for vertical industry tenants	Network slice for both vertical and enterprise
Example	Mobile, Fixed Broadband, Enterprise	Smart grid, manufacturing, Health care, public safety, etc.	Vertical and enterprise tenants
Expected number of network slices	**~ 10**	**~ 100**	**~ 1000 or more**

- VPN+ needs to meet the requirement of different network scenarios
  - A solution for small number of VPN+/VTNs can help the initial deployment
  - A high scalable solution is needed to enable massive VPN+ services in the future

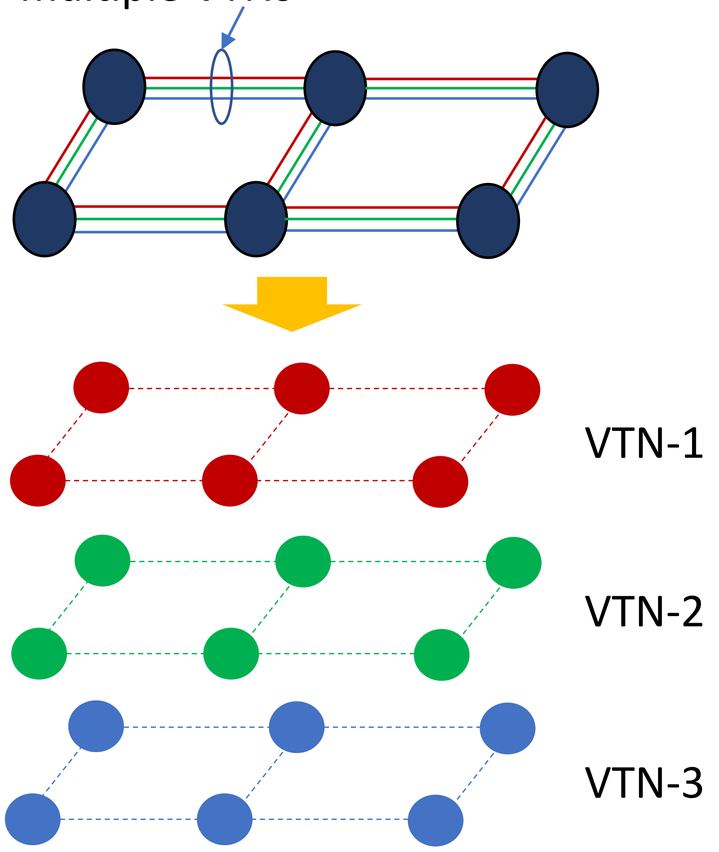
Control Plane Scalability Considerations

- The scalability of distributed control plane is related to the following aspects:
  - The number of protocol instances maintained on each node
  - The number of protocol sessions on each link
  - The number of routes advertised by each node
  - The amount of attributes associated with each route
  - The number of route computation (e.g. SPF) executed on each node
- The scalability of centralized controller may also be a concern
  - The load on the communication channels for VTN information exchange with network nodes
  - The processing burden of global computation and optimization for VTNs

Control Plane Optimization Suggestions

- Use a shared protocol instance/session for the information distribution of multiple VTNs
  - Avoid the overhead of increased protocol instances/sessions
  - Need a VTN identifier in control message to distinguish the information of different VTNs
- Decouple the advertisement and processing of different types of attributes, e.g. topology and resource information
  - Allows sharing of SPF computation among multiple VTNs
  - Reduce the overhead in duplicated attribute advertisement
- Divide up the computation load between the centralized controller and distributed control plane
  - A hybrid mode is recommended

- 1 IGP instance, 1 IGP adjacency for multiple VTNs



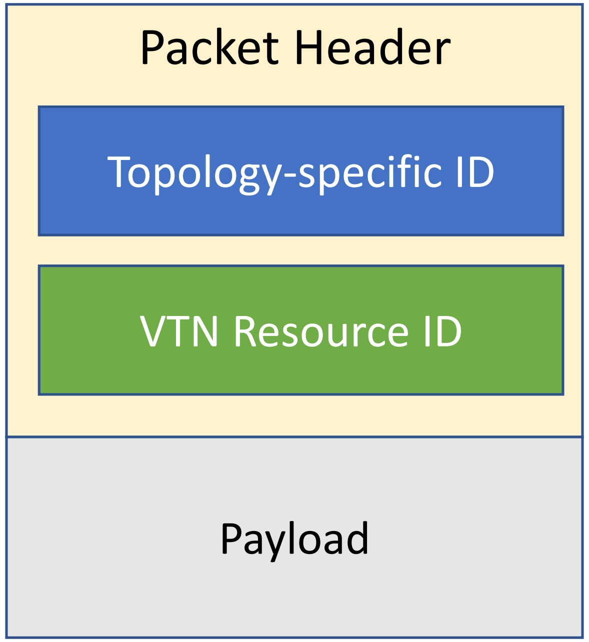
- Shared SPF computation between VTNs

Data Plane Scalability Considerations

- The identifier of VTN needs to be carried in data packet
  - Allow network nodes to perform VTN-specific packet processing and forwarding
  - Different options of carrying VTN information in data packet have different scalability implications
- Option 1: reuse existing fields in data packet to identify a VTN
  - Examples: SR SIDs, IP addresses, existing special purpose label
  - Pros: no need of introducing new fields to data packet
  - Cons: changes the semantics, processing behavior and scalability of the existing fields
- Option 2: introduce a dedicated field in data packet for VTN ID
  - Examples: extension headers, dedicated labels, etc.
  - Pros: avoids the impacts to the existing fields
  - Cons: possible difficulty in introducing a new field in data plane, which is processed hop-by-hop

Data Plane Optimization Suggestions

- The data plane identifiers used for topology-based forwarding and the identifier used for VTN resource-specific processing can be decoupled
  - IPv6 data plane
    - Destination IP address is used to determine the next-hop
    - A dedicated VTN ID is used to identify the set of resources allocated to the VTN for packet processing
  - MPLS data plane
    - The top MPLS label is used to determine the next-hop
    - A dedicated label or header is used to identify the set of resources used for packet processing



Draft History and Updates

- Version -00 submitted in Feb. 2020
  - Analysis about the control plane and data plane scalability, and optimization suggestions
- Version -01 submitted in Nov. 2020
  - Add new coauthor
  - Mainly editorial changes
- Version -02 submitted in Feb. 2021
  - Add new coauthor
  - Add further analysis about the data plane options
  - Align the terminology with draft-ietf-teas-ietf-network-slice-definition

Conclusions

- Scalability needs to be considered in the design of VPN+ control plane and data plane
- Mechanisms with different scalability may be provided for different scenarios
- The control plane scalability can be improved by sharing of protocol instance, session and SPF computation
- The data plane scalability can be improved by introducing dedicated VTN IDs in data packet, while the cost needs to be understood

Next Steps

- Solicit comments and feedbacks
- Coordinate on the data plane and control plane mechanisms in relevant WGs