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

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

• 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