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L. Dunbar
J. Guichard
Futurewei
Ali Sajassi
Cisco
J. Drake
Juniper
B. Najem
Bell Canada
Ayan Barnerjee
D. Carrel
Cisco

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BGP Usage for SDWAN Overlay Networks
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Abstract

The document describes three distinct SDWAN scenarios and discusses the applicability of BGP for each of those scenarios. The goal of the document is to demonstrate how BGP-based control plane is used for large scale SDWAN overlay networks with little manual intervention.

SDWAN edge nodes are commonly interconnected by multiple underlay networks which can be owned and managed by different network providers.

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1. Introduction

Here are some key characteristics of "SDWAN" networks:

- Augment of transport, which refers to utilizing overlay paths over different underlay networks. Very often there are multiple parallel overlay paths between any two SDWAN edges, some of which are private networks over which traffic can traverse with or without encryption, others require encryption, e.g. over untrusted public networks.
- Enable direct Internet access from remote sites, instead hauling all traffic to Corporate HQ for centralized policy control.
- Some traffic are routed based on application IDs instead of based on destination IP addresses.
- The Application Routing can also be based on specific performance criteria (e.g. packets delay, packet loss, jitter) to provide better application performance by choosing the right underlay that meets or exceeds the specified criteria.

[Net2Cloud-Problem] describes the network related problems that enterprises face to connect enterprises' branch offices to dynamic workloads in different Cloud DCs, including using SDWAN to aggregate

multiple paths provided by different service providers to achieve better performance and to accomplish application ID based forwarding.

Even though SDWAN has been positioned as a flexible way to reach dynamic workloads in third party Cloud data centers over different underlay networks, scaling becomes a major issue when there are hundreds or thousands of nodes to be interconnected by an SDWAN overlay networks.

BGP is widely used by underlay networks. This document describes using BGP for edge nodes to exchange information across the SDWAN overlay networks.

2. Conventions used in this document

Cloud DC: Third party data centers that host applications and workloads owned by different organizations or tenants.

Controller: Used interchangeably with SDWAN controller to manage SDWAN overlay path creation/deletion and monitor the path conditions between sites.

CPE: Customer Premise Equipment

CPE-Based VPN: Virtual Private Secure network formed among CPEs. This is to differentiate from more commonly used PE-based VPNs [[RFC 4364](#)].

Homogeneous SDWAN: A type of SDWAN network in which all traffic to/from the SDWAN edge nodes has to be encrypted regardless of underlay networks. For lack of better terminology, we call this Homogeneous SDWAN throughout this document.

ISP: Internet Service Provider

NSP: Network Service Provider. NSP usually provides more advanced network services, such as MPLS VPN, private leased lines, or managed Secure WAN connections, many

times within a private trusted domain, whereas an ISP usually provides plain internet services over public untrusted domains.

PE: Provider Edge

SDWAN Edge Node: an edge node, which can be physical or virtual, maps the attached clients' traffic to the wide area network (WAN) overlay tunnels.

SDWAN: Software Defined Wide Area Network. In this document, "SDWAN" refers to the solutions of pooling WAN bandwidth from multiple underlay networks to get better WAN bandwidth management, visibility & control. When the underlay networks are private, traffic can traverse without additional encryption; when the underlay networks are public, such as the Internet, some traffic may need to be encrypted when traversing through (depending on user provided policies).

SDWAN IPsec SA: IPsec Security Association between two SDWAN ports or nodes.

SDWAN over Hybrid Networks: SDWAN over Hybrid Networks typically have edge nodes utilizing bandwidth resources from multiple service providers. In Hybrid SDWAN network, packets over private networks can go natively without encryption and are encrypted over the untrusted network, such as the public Internet.

WAN Port: A Port or Interface facing an ISP or Network Service Provider (NSP), with address (usually public routable address) allocated by the ISP or the NSP.

C-PE: SDWAN Edge node, which can be CPE for customer managed SDWAN, or PE that is for provider managed SDWAN services).

ZTP: Zero Touch Provisioning

3. Use Case Scenario Description and Requirements

SDWAN networks can have different topologies and have different traffic patterns. To make it easier for the focused discussion in subsequent drafts on SDWAN control plane and data plane, this section describes several SDWAN scenarios that may have different impact on their corresponding control planes & data planes.

3.1. Requirements

3.1.1. Supporting Multiple SDWAN Segmentations

The term "network segmentation", a.k.a. SDWAN instances, is referring to the process of dividing the network into logical sub-networks using isolation techniques on a forwarding device such as a switch, router, or firewall. For a homogeneous network, such as MPLS VPN or Layer 2 network, VRF or VLAN are used to achieve the network segmentation.

As SDWAN is an overlay network arching over multiple types of networks, MPLS L2VPN/L3VPN or pure L2 underlay can continue using the VRF, VN-ID or VLAN to differentiate SDWAN network segmentations. For public internet, the IPsec inner encapsulation header can carry the SDWAN Instance Identifier to differentiate the packets belonging to different SDWAN instances.

BGP already has the capability to differentiate control packets for different network instances. When using BGP for SDWAN, the SDWAN segmentations can be differentiated by the SDWAN Target ID in the BGP Extended Community in the same way as VPN instances being represented by the Route Target. Same as Route Target, need to use a different name to differentiate from VPN if a CPE supports traditional VPN with multiple VRFs and supports multiple SDWAN Segmentations (instances). The actual SDWAN Target ID encoding is proposed by [[SDWAN-EDGE-Discovery](#)].

3.1.2. Client Service Requirement

Client interface of SDWAN nodes can be IP or Ethernet based.

For Ethernet based client interfaces, SDWAN edge should support VLAN-based service interfaces (EVI100), VLAN bundle service interfaces (EVI200), or VLAN-Aware bundling service interfaces. EVPN service requirements are applicable to the Client traffic, as described in the [Section 3.1 of RFC8388](#).

For IP based client interfaces, L3VPN service requirements are applicable.

3.1.3. Application Flow Based Segmentation

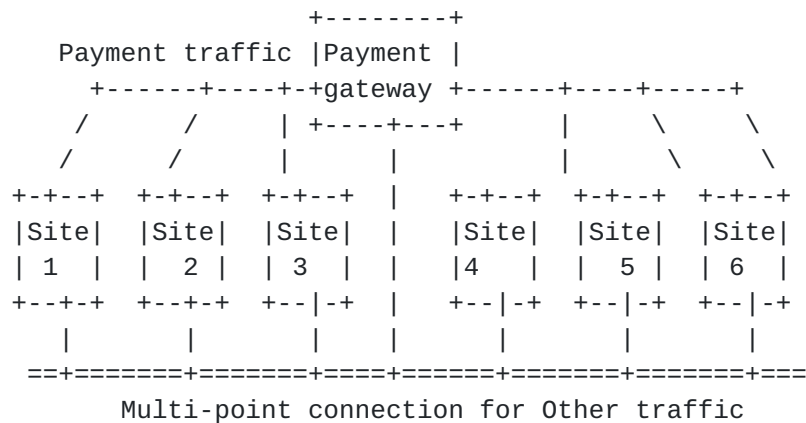
Application Flow based Segmentation, also known as SDWAN Traffic Segmentation, enables the separation of the traffic based on the business and the security needs for different users' groups and/or application requirements. Each user group and/or applications may need different isolated topology and/or policies to fulfill the business requirements.

The Application Flow based Segmentation concept is analogous to VLAN (in L2 network) and VRF (in L3 network).

One can think about the Application Flow based Segmentation as a feature that can be provided or enabled on a single SDWAN service (or domain) to a single Subscriber. Each SDWAN Service can have one or more overlay Segments to support the business requirement; each Segment has its own policy, topology and application/user groups. Applications/users' group can belong to more than one Segment.

For example, a retail business requires the point-of-sales (PoS) application in all stores to be isolated from other applications AND routed only to the payment processing entity at a hub site (i.e. hub and spoke); however, the same retail business requires the other applications to be routed to all sites (i.e. multipoint-to-multipoint) AND isolated from the PoS application.

In the figure below, the traffic from the PoS application follows a Tree topology, whereas other traffic can be multipoint-to-multipoint topology.



Another example is an enterprise who wants to isolate the traffic for each department and have different topology and policy for different department; the HR department may need to access certain applications that are NOT accessible by the engineering department. In addition, the contractors may have a limited access to the enterprise resources.

3.1.4. Zero Touch Provisioning

Unlike traditional EVPN or L3VPN whose PEs are deployed for long term, SDWAN edge nodes (virtual or physical) deployment at a specific location can be ephemeral. Therefore, Zero Touch Provisioning (ZTP), or Plug and Play, is a common requirement for SDWAN. When an SDWAN edge is physically installed at a location or instantiated on a VM in a Cloud DC, ZTP automates follow-up steps, including updates to the OS, software version, and configuration prior to connection. From network control perspective, ZTP includes the following:

- Upon power up, an SDWAN node can establish transport layer secure connection (such as TLS, SSL, etc.) to its controller whose address can be burned or preconfigured on the device.
- The SDWAN Controller can designate a Local Network Controller in the proximity of the SDWAN node; the Local Network Controller manages and monitor the communication policies of the edge node.

3.1.5. Constrained Propagation of SDWAN Edge Properties

One SDWAN edge node may only be authorized to communicate with a small number of other SDWAN edge nodes. Under this circumstance, the property of the SDWAN edge node cannot be propagated to any other nodes who are not authorized to communicate. But a remote SDWAN edge node upon powering up might not have the proper policies to know who the authorized peers are. Therefore, it is very essential for SDWAN deployment have a central point to distribute the properties of each SDWAN edge node to its authorized peers.

BGP is well suited for this purpose. [RFC 4684](#) has specified the procedure to constrain the distribution of BGP UPDATE to only a subset of SDWAN edges. Basically, each edge node informs the Route Reflector (RR) [[RFC4456](#)] on its interested SDWAN instances. The RR only propagates the BGP UPDATE for the relevant SDWAN instances to the edge.

Usually the connection between a SDWAN edge node and its RR is over insecure network. Therefore, upon power up, a SDWAN node needs to establish a secure transport layer connection (TLS, SSL, etc.) to its designated RR. The BGP UPDATE messages need to be sent over the secure channel (TLS, SSL, etc.) to the RR.

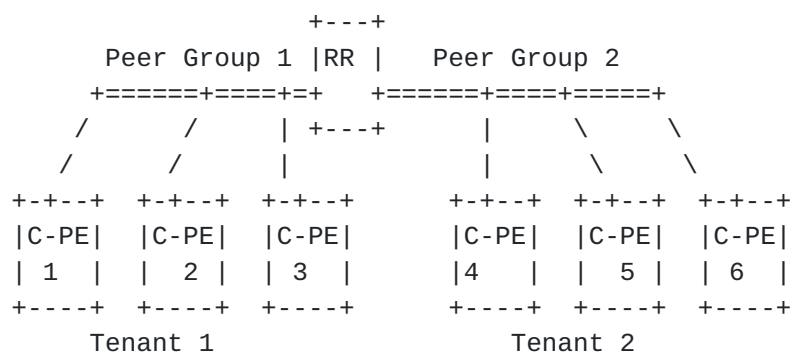


Figure 1: Peer Groups managed by RR

Tenant separation is achieved by the SDWAN instance identification represented in control plane and data plane, respectively.

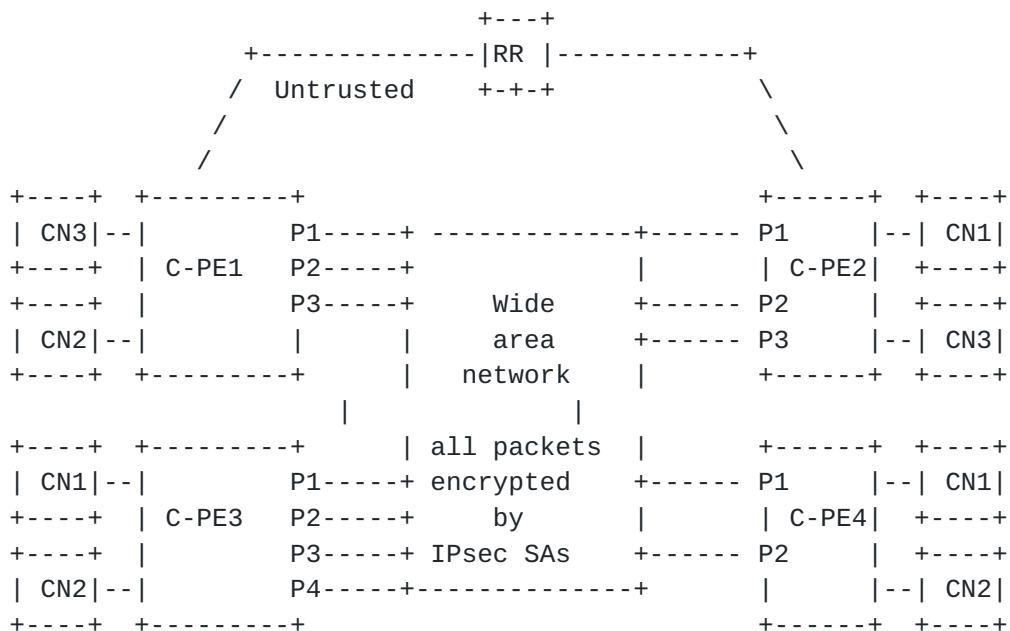
3.2. Scenarios #1: Homogeneous WAN

This is referring to a type of SDWAN network with edge nodes encrypting all traffic over WAN to other edge nodes, regardless of whether the underlay is private or public. For lack of better terminology, we call this Homogeneous SDWAN throughout this document.

Some typical scenarios for the use of a Homogeneous SDWAN network are as follows:

- A small branch office connecting to its HQ offices via the Internet. All sensitive traffic to/from this small branch office has to be encrypted, which is usually achieved using IPsec SAs.
- A store in a shopping mall may need to securely connect to its applications in one or more Cloud DCs via the Internet. A common way of achieving this is to establish IPsec SAs to the Cloud DC gateway to carry the sensitive data to/from the store.

As described in [[SECURE-EVPN](#)], the granularity of the IPsec SAs for Homogeneous SDWAN can be per site, per subnet, per tenant, or per address. Once the IPsec SA is established for a specific subnet/tenant/site, all traffic to/from the subnets/tenants/site are encrypted.



CN: Client Networks, which is same as Tenant Networks used by NVo3

Figure 2: Homogeneous SDWAN

One of the key properties of homogeneous SDWAN is that the SDWAN Local Network Controller (RR) is connected to C-PEs via untrusted public network, therefore, requiring secure connection between RR and C-PEs (TLS, DTLS, etc.).

Homogeneous SDWAN has some similarity to commonly deployed IPsec VPN, albeit the IPsec VPN is usually point-to-point among a small number of nodes and with heavy manual configuration for IPsec between nodes, whereas an SDWAN network can have a large number of edge nodes with an SDWAN controller to manage requiring zero touch provisioning upon powering up.

Existing Private VPNs (e.g. MPLS based) can use homogeneous SDWAN to extend over public network to remote sites to which the VPN operator does not own or lease infrastructural connectivity, as described in [[SECURE-EVPN](#)] and [[SECURE-L3VPN](#)]

3.3. Scenario #2: CPE based SDWAN over Hybrid WAN Underlay

In this scenario, SDWAN edge nodes (a.k.a. C-PEs) have some WAN ports connected to PEs of Private VPNs over which packets can be forwarded natively without encryption, and some WAN ports connected to the public Internet over which sensitive traffic have to be encrypted (usually by IPsec SA).

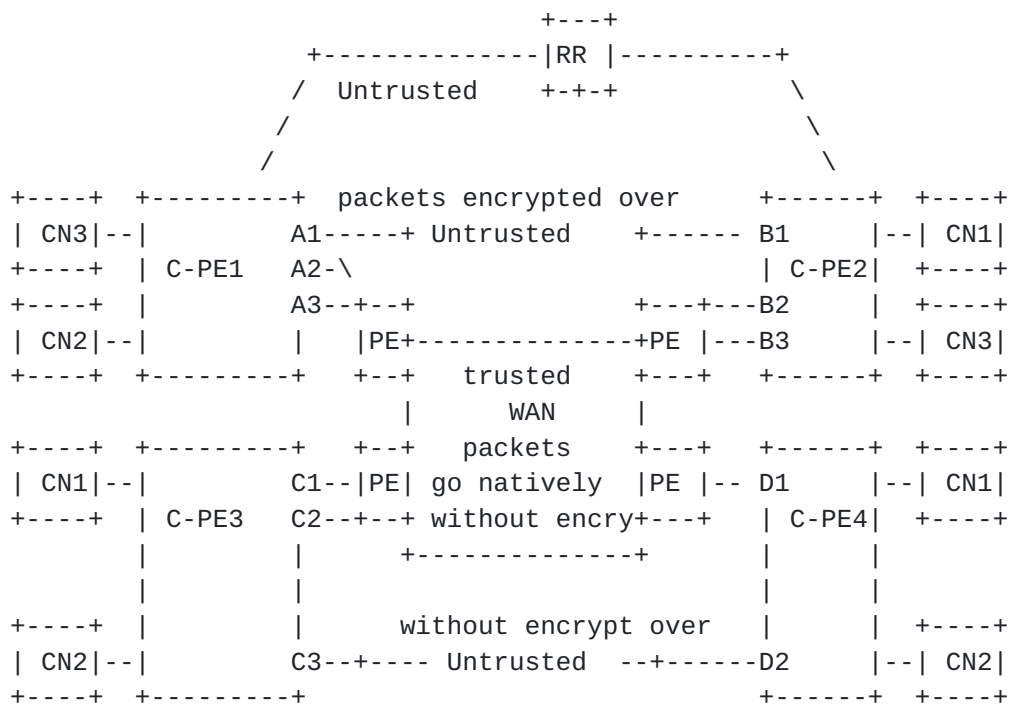
In this scenario, the SDWAN edge nodes' egress WAN ports are all IP/Ethernet based, either egress to PEs of the VPNs or egress to the public Internet. Even if the VPN is a MPLS network, the VPN's PEs have IP/Ethernet links to the SDWAN edge (C-PEs). Throughout this document, this scenario is also called CPE based SDWAN over Hybrid Networks.

Even though IPsec SA can secure the packets traversing the Internet, it does not offer the premium SLA commonly offered by Private VPNs, especially over long distance. Clients need to have policies to specify criteria for flows only traversing private VPNs or traversing either as long as encrypted when over the Internet. For example, client can have those policies for the flows:

1. A policy or criteria for sending the flows over a private network without encryption (for better performance),
2. A policy or criteria for sending the flows over any networks as long as the packets of the flows are encrypted when traversing untrusted networks, or
3. A policy of not needing encryption at all.

If a flow traversing multiple segments, such as A<->B<->C<->D, has either Policy 2 or 3 above, the flow can traverse different underlays in different network segments, such as over Private network underlay between A<->B without encryption, or over the public internet between B<->C in an IPsec SA.

As shown in the figure below, C-PE-1 has two different types of interfaces (A1 to Internet and A2 & A3 to VPN). The C-PEs' loopback addresses and addresses attached to C-PEs may or may not be visible to the ISPs/NSPs. The addresses for the WAN ports can have addresses allocated by service providers or dynamically assigned (e.g. by DHCP). One WAN port shown in the figure below (e.g. A1, A2, A3 etc.) is a logical representation of potential multiple physical ports on the C-PEs.



CN: Client Network

Figure 3: Hybrid SDWAN

Some key characteristics of a Hybrid SDWAN overlay network are as follows:

- one C-PE may be connected to different ISPs/NSPs, with some of its WAN ports addresses being assigned by different ISPs/NSPs.
- The WAN ports connected to PEs of trusted private networks (e.g. MPLS VPN) hand off IP/Ethernet packets, just like today's CPE that do not handle MPLS packets and do not participate in the underlay VPN networks' control plane. Traffic can flow natively without encryption when be forwarded out through those WAN ports for better performance.
- The WAN ports connected to untrusted networks, e.g. the Internet, requires sensitive traffic to be encrypted, i.e. encrypted by IPsec SA.
- An SDWAN local Network Controller (RR) is connected to C-PEs via the untrusted public network, therefore, requiring secure connection between RR and C-PEs via TLS, DTLS, etc.
- The SDWAN nodes' [loopback] addresses might not be routable nor visible in the underlay ISP/NSP networks. Routes & services attached to SDWAN edges at the SDWAN overlay layer are in different address spaces than the underlay networks.
- There could be multiple SDWAN devices sharing a common property, such as a geographic location. Some applications over SDWAN may need to traverse specific geographic locations for various reasons, such as to comply with regulatory rules, to utilize specific value added services, or others.
- The underlay path selection between sites can be a local decision. Some policies allow one service from C-PE1 -> C-PE2 -> C-PE3 using one ISP/NSP underlay in the first segment (C-PE1 -> C-PE2) and using a different ISP/NSP in the second segment (C-PE2-> CPE3).
- Services may not be congruent, i.e. the packets from A-> B may traverse one underlay network, and the packets from B -> A may traverse a different underlay.
- Different services, routes, or VLANs attached to SDWAN nodes can be aggregated over one underlay path; same service/routes/VLAN can spread over multiple SDWAN underlays at different times depending on the policies specified for the service. For example, one tenant's packets to HQ need to be encrypted when sent over the Internet or have to be sent over private networks, while the same

tenant's packets to Facebook can be sent over the Internet without encryption.

3.4. Scenario #3: Private VPN PE based SDWAN

This scenario refers to existing VPN (e.g. MPLS based VPN, such as EVPN or IPVPN) adding extra ports facing untrusted public networks allowing PEs to offload some low priority traffic to ports facing public networks when the VPN MPLS paths are congested. Throughout this document, this scenario is also called Internet Offload for Private VPN, or PE based SDWAN.

In this scenario, the packets offloaded to untrusted public network must be encrypted.

PE based SDWAN can be used by VPN service providers to temporarily increase bandwidth between sites when they are not sure if the demand will sustain for long period of time or as a temporary solution before the permanent infrastructure is built or leased.

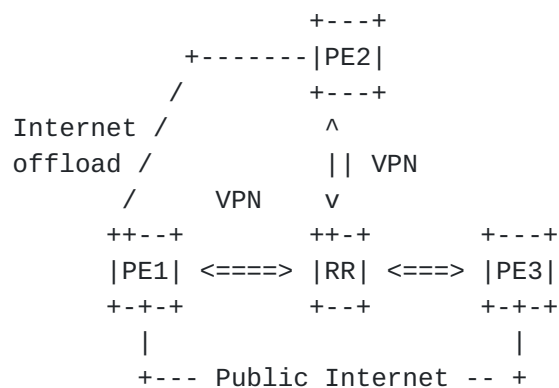


Figure 4: Additional Internet paths added to the VPN

Here are some key properties for PE based SDWAN:

- For MPLS based VPN, PEs continue having MPLS encapsulation handoff to existing paths.

- The BGP RR is connected to PEs in the same way as VPN, i.e. via the trusted network.
- For the added Internet ports, PEs have IP packets handoff, i.e. sending and receiving IP data frames. Internally, PEs can have the option to encapsulate the MPLS payload in IP, as specified by [RFC4023](#).
- The ports facing public internet might get IP addresses assigned by ISPs, which may not be in the same address domain as PEs'.
- Ports facing public internet are not as secure as the ports facing private infrastructure. There could be spoofing, or DDOS attacks to the ports facing public internet. Extra consideration must be given when injecting the new routes learned from public network into VRFs.
- Even though packets are encrypted over public internet, the performance SLA is not guaranteed over public internet. Therefore, clients may have policies only allowing some flows to be offloaded to internet path.

[4. BGP Walk Through](#)

[4.1. BGP Walk Through for Homogeneous SDWAN](#)

In the figure below, packets destined towards multiple routes attached to the C-PE2 can be carried by one IPsec tunnel. Then one BGP UPDATE can be announced by C-PE2 to its RR.

There could be policies governing the topologies of a client's different routes attached to an edge node. For example, VLAN #25 and

route 22.1.1.x/24 could be the Payment Applications described in the [Section 3.1.2](#) that can only communicate with Payment Gateway attached to C-PE3. If C-PEs don't have the policy to govern the communication peers, RR can take over the responsibility of only send BGP UPDATE to the authorized peers.

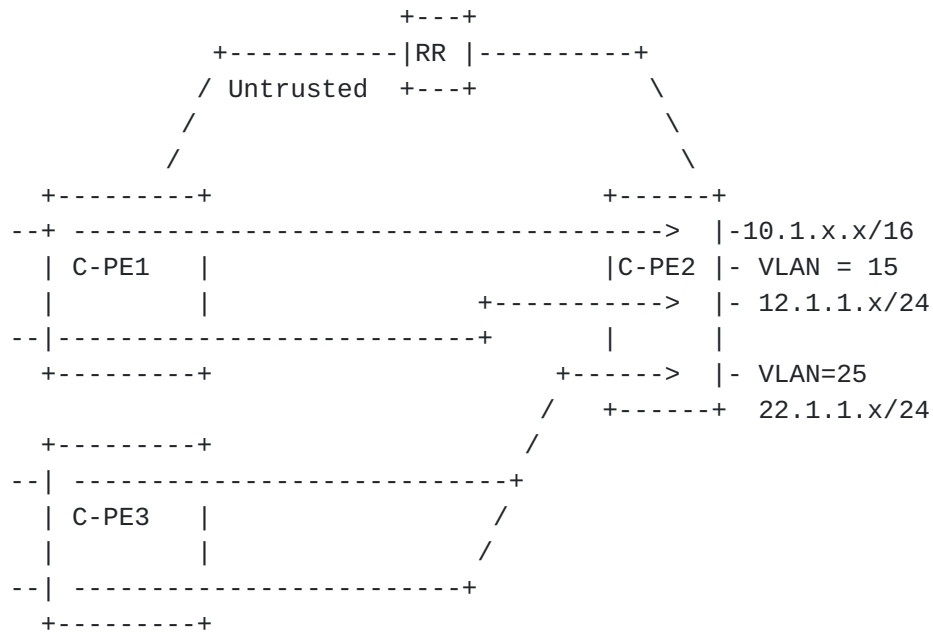


Figure 6: (see *.pdf for more accurate figure)

UPDATE 1:

- MP-NLRI Path Attribute:
 - 10.1.x.x/16
 - VLAN #15
 - 12.1.1.x/24
- Tunnel-Encap Path Attribute:
 - IPsec SA attributes for IPsec tunnels to C-PE2 from any node for reaching 10.1.x.x/16, VLAN #15, and 12.1.1.x/24.

UPDATE 2 (only sent to C-PE3)

- MP-NLRI Path Attribute:
 - VLAN #25
 - 22.1.1.x/24
- Tunnel-Encap:

IPsec SA attributes for IPsec tunnels to C-PE2 from C-PE3 for reaching VLAN #25 and subnet 22.1.1./24.

4.2. BGP Walk Through for Application Flow Based Segmentation

If the applications are assigned with unique IP addresses, the Application Flow based Segmentation described in [Section 3.1.2](#) can be achieved by advertising different BGP UPDATE messages to different nodes. In the Figure below, the following BGP Updates can be advertised to ensure that Payment Application only communicates with the Payment Gateway:

BGP UPDATE #1 from C-PE2 to RR for the P2P topology that is only propagated to Payment GW node:

- MP-NLRI Path Attribute:
 - 30.1.1.x/24
- Tunnel Encap Path Attribute
 - IPsec Attributes for PaymentGW ->C-PE2

BGP UPDATE #2 from C-PE2 to RR for the routes to be reached by C-PE1 and C-PE2:

- MP-NLRI Path Attribute:
 - 10.1.x.x
 - 12.4.x.x
- Tunnel-Encap Path Attribute:
 - Any node to C-PE2

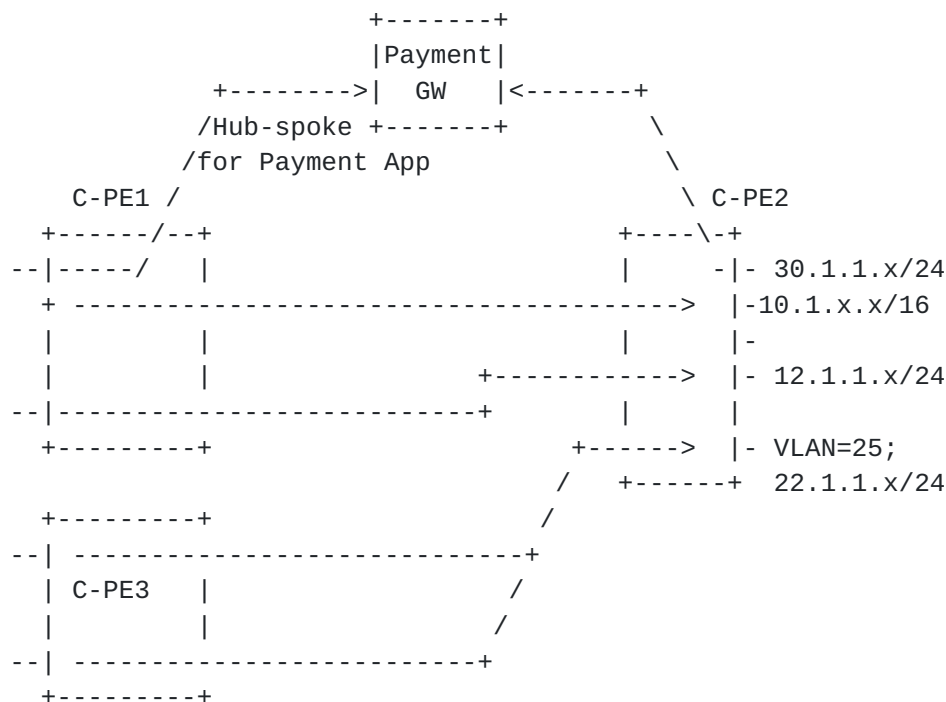


Figure 7: Application Based SDWAN Segmentation

4.3. Client Service Provisioning Model

The provisioning tasks described in [Section 4 of RFC8388](#) are the same for the SDWAN client traffic. When client traffic is multi-homed to two (or more) C-PEs, the Non-Service-Specific parameters need to be provisioned per the [Section 4.1.1 of RFC8388](#).

Since some SDWAN nodes are ephemeral and have small number of IP subnets or VLANs attached to their client ports, it is recommended to have default and simplified Service-specific parameters for each client port, remotely managed by the SDWAN Network Controller via the secure channel (TLS/DTLS) between the controller and the C-PEs.

4.4. WAN Ports Provisioning Model

Since the deployment of PEs to MPLS VPN are for relatively long term, the common provisioning procedure for PE's WAN ports is via CLI.

A SDWAN node deployment can be ephemeral and its location can be in remote locations, manual provisioning for its WAN ports is not acceptable. In addition, a SDWAN WAN port's IP address can be dynamically assigned or using private addresses. Therefore, it is necessary to have a separate control protocol; something like NHRP did for ATM, for a SDWAN node to register its WAN property to its controller dynamically.

Unlike a PE to MPLS based VPN where its WAN ports are homogeneously facing MPLS private network and all traffic are egressed in MPLS data frames through its WAN ports, the WAN ports of a SDWAN node can be connected to a PE of VPN with Ethernet/IP, MPLS private network directly via MPLS headers, or the public Internet.

For Scenario #1 described in [Section 3.2](#), the WAN ports can face public internet or VPN.

For Scenario #2 described in [Section 3.3](#), WAN ports are either configured as connecting to PEs of VPN where traffic can be sent as IP/Ethernet without encryption, or configured as connecting to public Internet that requires encryption for packets egress out.

For Scenario #3 described in [Section 3.4](#), the WAN ports are either configured as VPN egress ports (hand off MPLS data frames), or as connecting to the public internet that requires MPLS in IP in IPsec encapsulation.

4.5. Why BGP as Control Plane for SDWAN?

For a small sized SDWAN network, traditional hub & spoke model using NHRP or DSVPN/DMVPN with a hub node (or controller) managing SDWAN node WAN ports mapping (e.g. local & public addresses and tunnel identifiers mapping) can work reasonably well. However, for a large SDWAN network, say more than 100 nodes with different types of topologies, the traditional approach becomes very messy, complex and error prone.

Here are some of the compelling reasons of using BGP instead of extending NHRP/DSVPN/DMVPN. (Same as the reasons quoted by LSVR on why using BGP):

- BGP has the built-in capability to constrain the propagation of SDWAN edge node properties to a small number of edge nodes [[RFC4684](#)].
- RR already has the capability to apply policies to communications among peers.
- BGP is widely deployed as sole protocol (see [RFC 7938](#))
- Robust and simple implementation
- Wide acceptance - minimal learning
- Reliable transport
- Guaranteed in-order delivery
- Incremental updates
- Incremental updates upon session restart
- No flooding and selective filtering

[5. SDWAN Traffic Forwarding Walk Through](#)

BGP based EVPN control plane are still applicable to routes attached to the client ports of SDWAN nodes. [Section 5 of RFC8388](#) describes the BGP EVPN NLRI Usage for various routes of client traffic. The procedures described in the [Section 6 of RFC8388](#) are same for the SDWAN client traffic.

The only additional consideration for SDWAN is to control how traffic egress the SDWAN edge node to various WAN ports.

[5.1. SDWAN Network Startup Procedures](#)

A SDWAN network can add or delete SDWAN edge nodes on regular basis depending on user requests.

- For Scenario #1: a SDWAN edge node in a shopping mall or Cloud DC can be added or removed on demand. The Zero Touch Provisioning described in 3.1.2 are required for the node startup.
- For Scenario #2: this can be Data Centers or enterprises upgrading their CPEs to add extra bandwidth via public internet in addition to VPN services that they already purchased. Before the node powers up

or upgraded, there should be links connected to the PEs of a provider VPNs.

- For Scenario #3, the Internet facing WAN ports are added to (or removed from) existing VPN PEs.

5.2. Packet Walk-Through for Scenario #1

Upon power up, a SDWAN node can learn client routes from the Client facing ports, in the same way as EVPN described in [RFC8388](#). Controller facilitates the IPsec SA establishment and rekey management as described in [[SECURE-EVPN](#)]. Controller manages how client's routes are associated with individual IPsec SA.

[SECURE-EVPN] describes a solution for SDWAN Scenario #1. It utilizes the BGP RR to facilitate the key and policy exchange among PE devices to create private pair-wise IPsec Security Associations without IKEv2 point-to-point signaling or any other direct peer-to-peer session establishment messages.

When C-PEs do not support MPLS, the approaches described by [RFC8365](#) can be used, with addition of IPsec encrypting the IP packets when sending packets over the Black Interfaces.

5.3. Packet Walk-Through for Scenario #2

In this scenario, C-PEs have some WAN ports connected to the public internet and some WAN ports with direct connect to PEs of trusted VPN. The C-PEs in Scenario #2 have the plain IP/Ethernet data frames egress to the PEs of the VPN, encrypted data frames egress the WAN ports facing the public Internet.

Users specify the policy or criteria on which flows can only egress WAN ports facing the trusted VPN without encryption, which can egress the WAN ports facing the public Internet with encryption, or which can egress WAN ports facing the public Internet without encryption.

The internet facing WAN ports can face potential DDoS attacks, additional anti-DDoS mechanism has to be enabled on those WAN ports and the Control Plane should not learn routes from the Public Network facing WAN ports.

For the Scenario #2, if a client route can be reached by MPLS VPN and IPsec Tunnel via public network, the BGP UPDATE for the client

route should indicate all available tunnels in the Tunnel Path Attribute of the BGP NLRI.

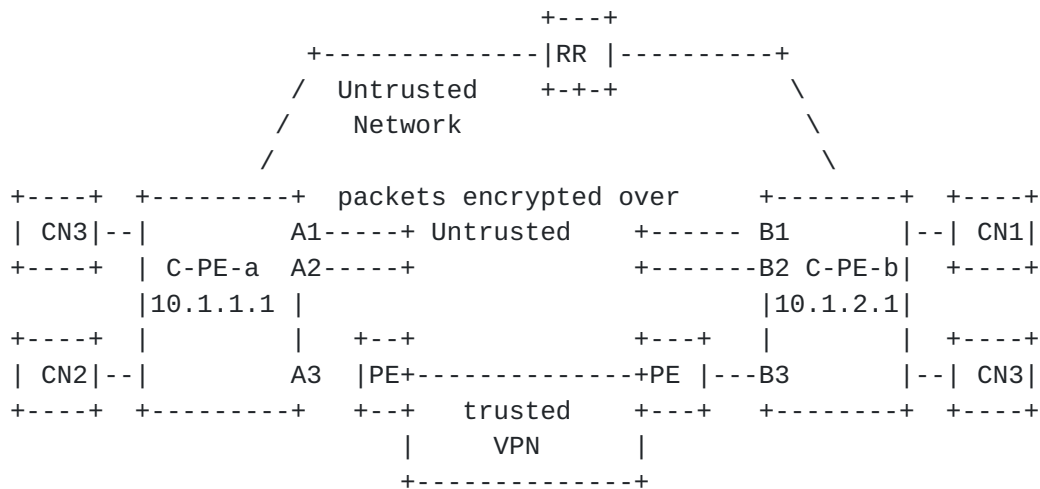


Figure 8: SDWAN Scenario #2

For example, if the CN1 route can be reached by both VPN and Public internet, the CN1's BGP route UPDATE should include the following:

- MP-NLRI Path Attribute:

CN1

- Tunnel-Encap Path Attribute:

Tunnel 1: MPLS-in-GRE encapsulation

With the MPLS-in-GRE Sub-TLV specified by Tunnel-Encap;

Tunnel 2: IPsec-GRE encapsulation

With the IPsec Sub-TLVs specified by the [[SECURE-EVPN](#)] and [[BGP-EDGE-DISCOVERY](#)]

There could be multiple IPsec SA tunnels terminated at the edge node loopback address or terminated at WAN ports. For the Scenario #2, there can be policies to determine which IPsec SA tunnels that the client route can be carried. When a client route can be carried by multiple IPsec SA tunnels terminated by two different WAN ports, multiple Tunnel Path Attributes with different Tunnel-end-point Sub-TLVs need to be included in the NLRI of the BGP UPDATE for the client route.

5.4. Packet Walk-Through for Scenario #3

The behavior described in [[SECURE-L3VPN](#)] applies to this scenario.

[[SECURE-L3VPN](#)] describes how to extend the [RFC4364](#) VPN to allow some PEs being connected to other PEs via public networks. In this scenario, the PEs is the SDWAN Edge nodes. [[SECURE-L3VPN](#)] introduces the concept of RED Interface & Black Interface on those PEs. RED interfaces face the VPN over which packets can be forwarded natively without encryption. Black Interfaces face public network over which only IPsec-protected packets are forwarded. [[SECURE-L3VPN](#)] assumes PEs terminate MPLS packets, and use MPLS over IPsec when sending over the Black Interfaces.

The C-PEs not only have RED interfaces facing clients but also have RED interface facing MPLS backbone, with additional BLACK interfaces facing the untrusted public networks for the WAN side. The C-PEs cannot mix the routes learned from the Black Interfaces with the Routes from RED Interfaces. The routes learned from core-facing RED interfaces are for underlay and cannot be mixed with the routes learned over access-facing RED interfaces that are for overlay. Furthermore, the routes learned over core-facing interfaces (both RED and BLACK) can be shared in the same GLOBAL route table.

There may be some added risks of the packets from the ports facing the Internet. Therefore, special consideration has to be given to the routes from WAN ports facing the Internet. [RFC4364](#) describes using an RD to create different routes for reaching same system. A similar approach can be considered to force packets received from the Internet facing ports to go through special security functions before being sent over to the VPN backbone WAN ports.

6. Manageability Considerations

SDWAN overlay networks utilize the SDWAN controller to facilitate route distribution, central configurations, and others. SDWAN Edge nodes need to advertise the attached routes to their controller (i.e. RR in BGP case).

7. Security Considerations

Having WAN ports facing the public Internet introduces the following security risks:

- 1) Potential DDoS attack to the C-PEs with ports facing internet.
- 2) Potential risk of provider VPN network being injected with illegal traffic coming from the public Internet WAN ports on the C-PEs.

8. IANA Considerations

None

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Authors' Addresses

Linda Dunbar
Futurewei
Email: ldunbar@futurewei.com

James Guichard
Futurewei
Email: james.n.guichard@futurewei.com

Ali Sajassi
Cisco
Email: sajassi@cisco.com

John Drake
Juniper
Email: jdrake@juniper.net

Basil Najem
Bell Canada
Email: basil.najem@bell.ca

David Carrel
Cisco
Email: carrel@cisco.com

Ayan Banerjee
Cisco
Email: ayabaner@cisco.com