CPE Based VPN + SD-WAN

https://datatracker.ietf.org/doc/draft-dm-net2cloud-problem-statement/
https://datatracker.ietf.org/doc/draft-dm-net2cloud-gap-analysis/

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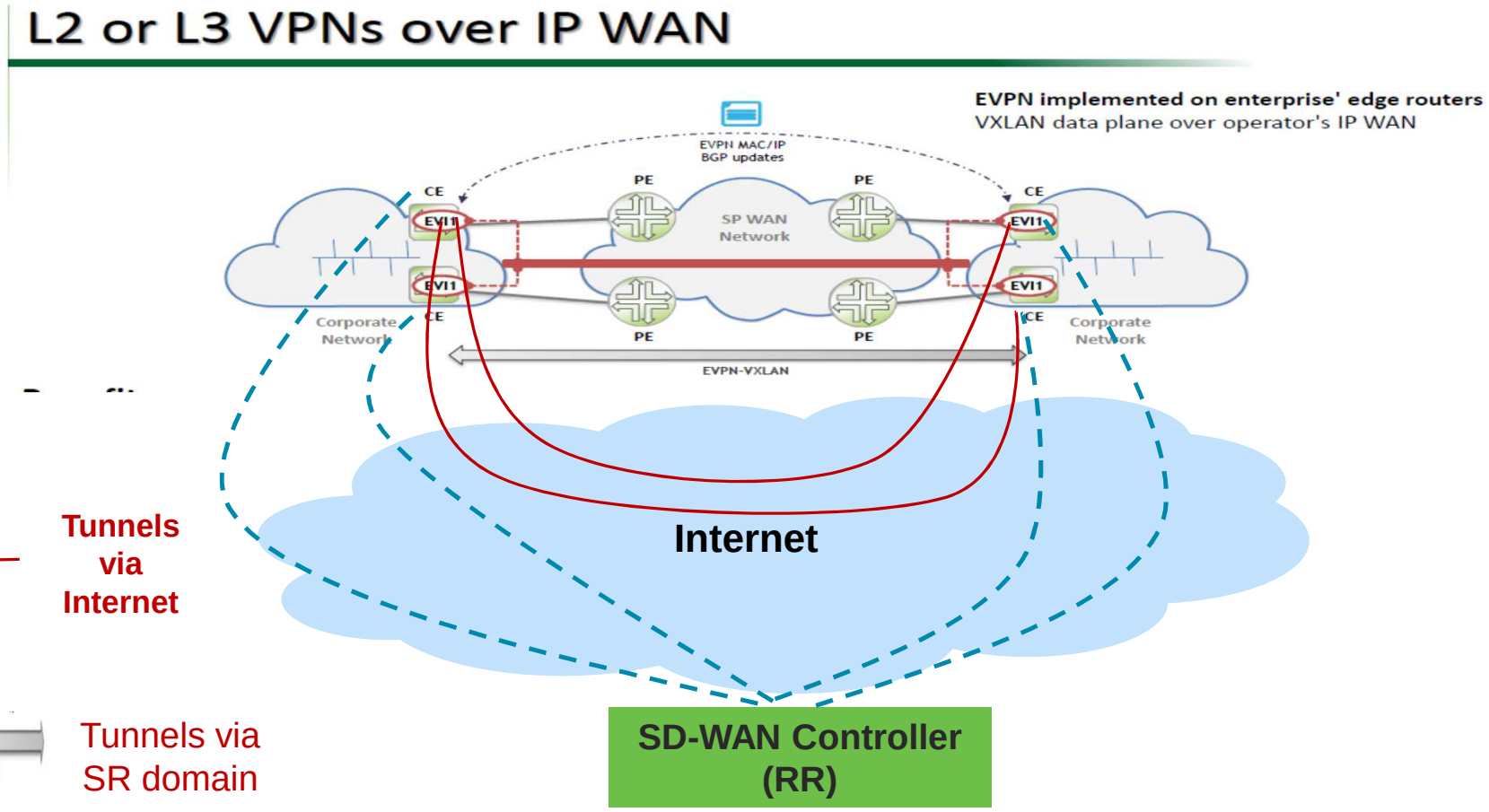
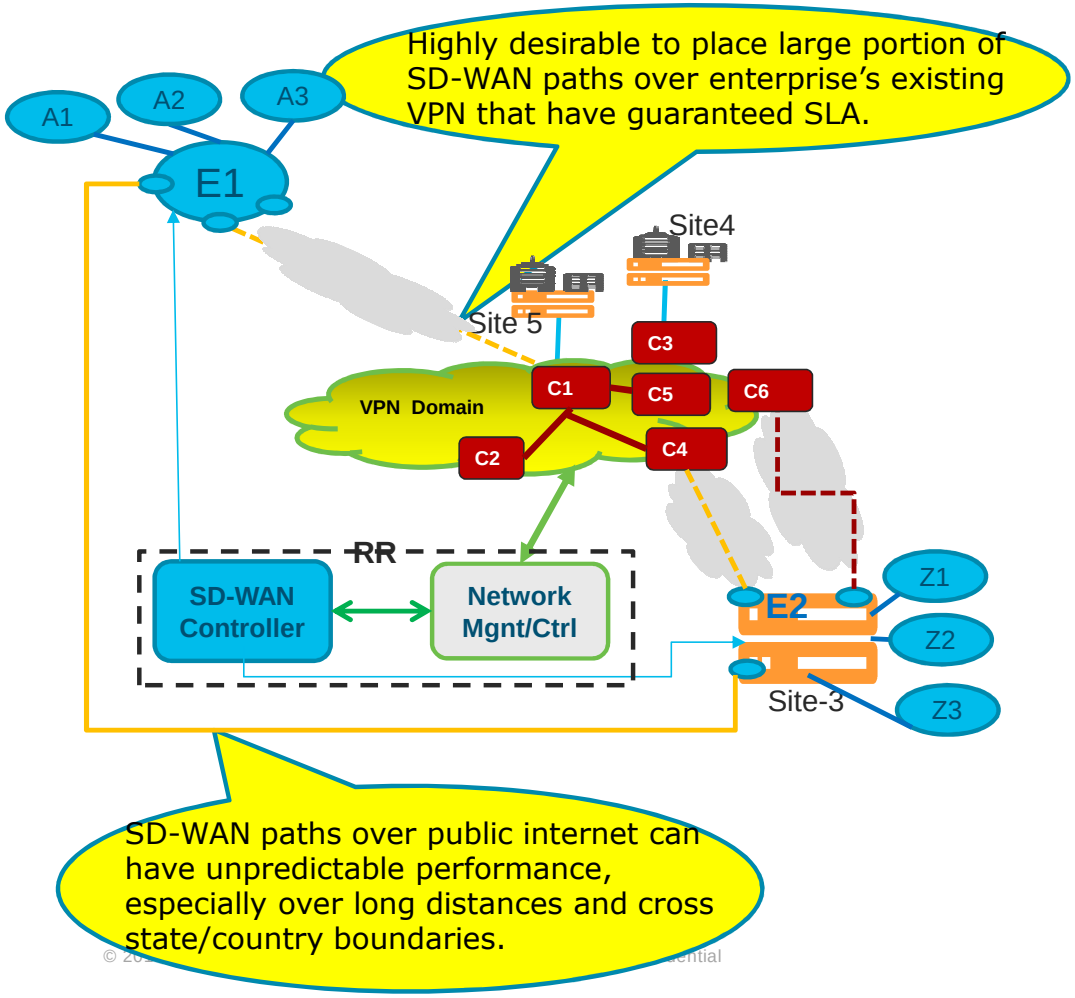
Use Case 1: Classic SD-WAN
CPE based VPN: Integrating SR Routes & Internet Routes



Use Cases 2: SD-WAN end points are far apart, Different apps need different paths



For communication between "A1" <-> "Z1":

Optimal path: "A1"<-> E1 <–> C1<->C4 <–> "E2"<->Z1 (at Site-3)

Problems:

- It is very difficult, if even possible, for PEs to determine which egress PEs is optimal for flows between "E1" <-> "E2" (as multiple PEs can reach E2 via SD-WAN paths).
- Steer the SD-WAN path over the Enterprise VPN as much as possible for better quality & control (cost, traffic management, delay, etc)

Gap: RFC5512 & draft-ietf-idr-tunnel-encaps-09

- Tunnel-Encap removed SAFI =7 for distributing encapsulation tunnel information.
  - Tunnels are associated with routes. The SD-WAN paths need to be established before data arrival. There is no Routes to associate with the Tunnel
  - Using a “Fake Route” for tunnel end point: create deployment complexity.
    - Each CPE has many tunnels to all their peers: therefore need many “fake address” .
    - 10000 CPEs will need 10’s thousands of “fake address” → difficult to manage
- The BGP Route Update doesn’t have enough fields to carry detailed information of the remote CPEs: such as
  - Site-ID, System-ID, Port-ID
  - IPsec configuration information sent by the “Controller (RR)” to the CPEs.
  - for two peer CPEs to negotiate IPSec keys, based on the configuration sent from the Controller.
  - UDP NAT private address <-> public address mapping
  - CPEs tend to communicate with a few other CPEs, not all the CPEs need to form mesh connections . Using BGP, CPEs can easily get dumped with too much information of other CPEs that they never need to communicate with.
    - NHRP only sends the relevant information for the interested end points for establishing tunnels. Therefore, there is a need for some form of “Registration” methods.

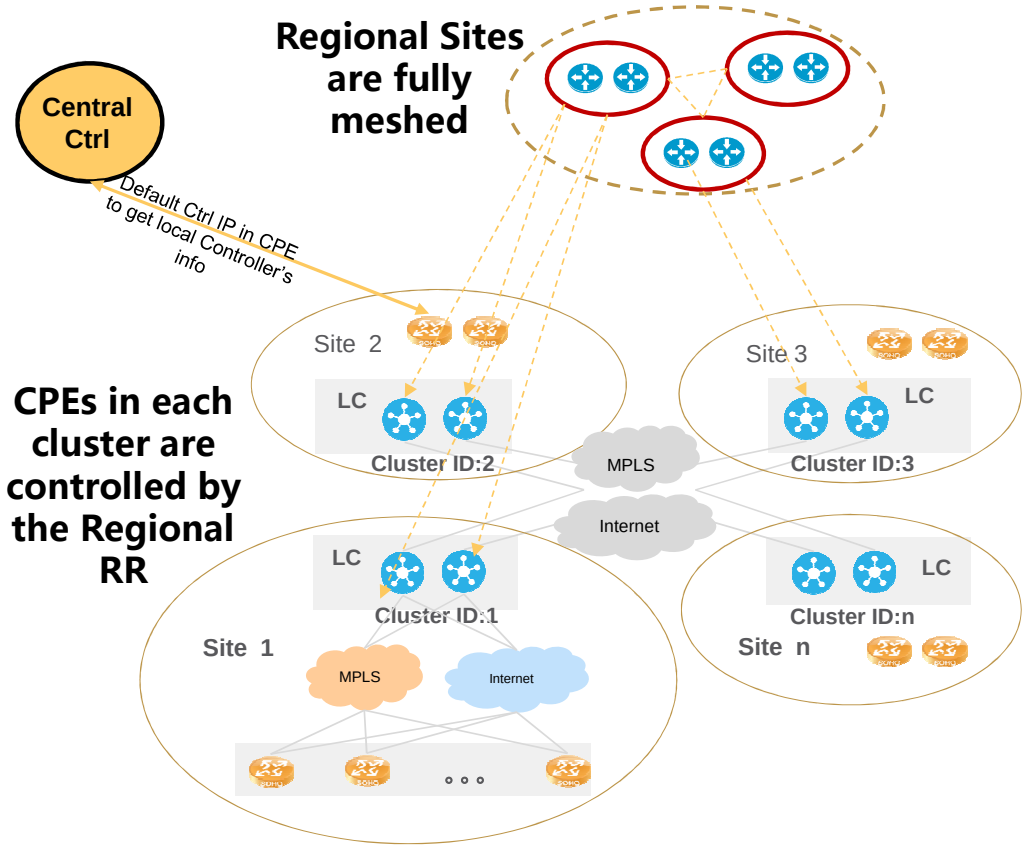
Gap of draft-rosen-bess-secure-l3vpn-01

- [Secure-l3vpn] is for limited number of remote C-PEs, whereas SD-WAN overlay deployment may have over 1000s of nodes
- [Secure-l3vpn] needs heavy configuration, whereas SD-WAN needs Zero touch provisioning, i.e. auto synchronize Ipsec config,
- For RR communication with CPE, this draft only mentioned IPSEC. Needs lightweight secure connection for Zero touch provisioning.
- Multiple WAN port per CPE, need way to distinguish different Tunnels from one CPE. Just Red & Black is not enough
- The draft assumes that C-PE “register” with the RR. But it doesn’t say how
- IPsec requires periodic refreshment of the keys. How to synchronize the refreshment among multiple nodes?
- IPsec usually only send configuration parameters to two end points and let the two end points to negotiate the KEY. Large scale SD-WAN needs Controller to authenticate Peers.

To stimulate the discussions…..

PROTOCOLS WORK FOR IETF?

Managed Overlay WAN Services: 100's or 1000's CPEs



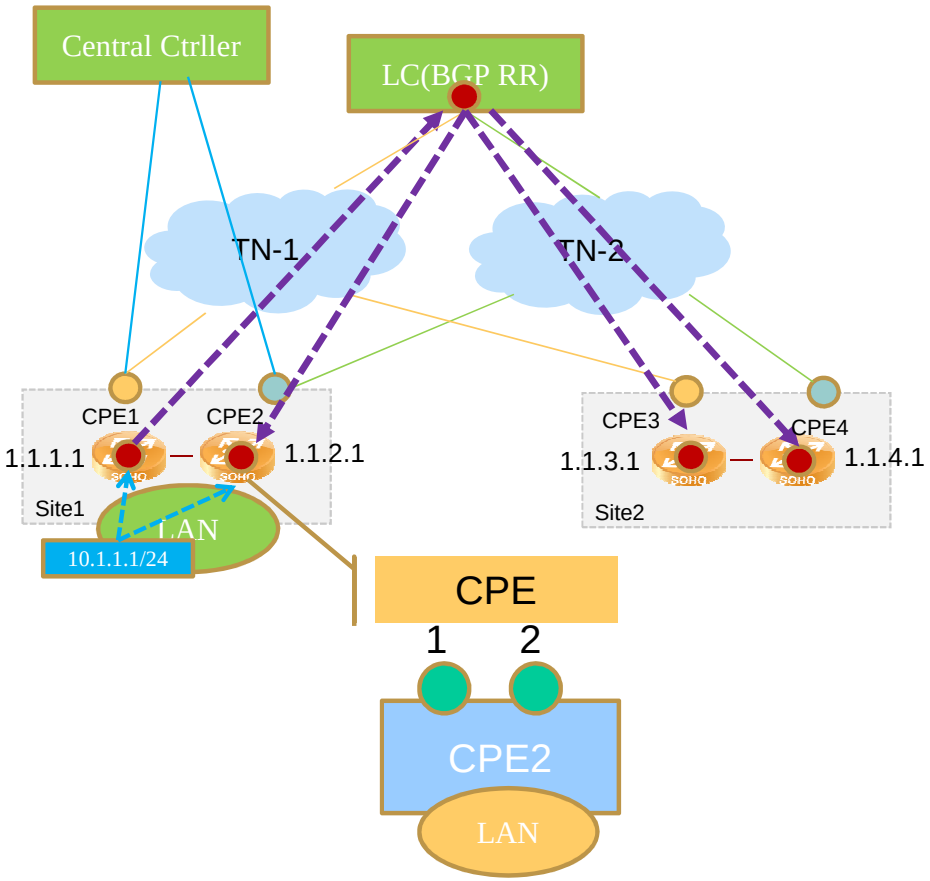
Goals:

- **Zero Touch Provisioning for CPEs**
  - Upon powered up, CPE sends request to its factory default Central Controller address to retrieve its local RR address.
- **Large scale number of CPEs overlay existing networks**
  - Allow controller to change routes to traverse specific sites (instead of through specific CPEs)
  - E.g. instead of Site 2 -> Site 1, use Site2 -> Site 3 -> Site 1 (for performance, cost, or temporary detour).
  - To simplify complex full mesh of too many CPEs

How: Hierarchical management

- **Partition CPEs into Sites, each Site is a logical entity for remote sites**
- **Why:**
  - Enable detour based on sites, instead of CPEs,
  - Avoid complexity of managing full mesh of all CPEs.
  - Hide CPE identity from others (some deployment needs this feature)

More details:



- Each CPE registers with LC (RR) to establish secure connection for BGP over TLS/DTLS
- CPE WAN Ports information are advertised via LC to all other CPEs
- Each CPEs need to inform its LC on its targeted Sites to establish Tunnels
- CPE receives Tunnel information for the targeted CPEs to establish tunnel
  - CPE Tunnel Key：LinkId、SystempIP、SiteId
- Route Advertisement will carry CPE Tunnel Key，Tunnels are aggregated per Tunnel Key
- Vrf is represented by using VN ID to replace MPLS Label

Desired BGP Extension

- **New SD-WAN Path SAFI and NLRI**
  - Need a new SAFI to be defined to represent SA-WAN paths (IANA). The SD-WAN SAFI use a new NLRI defined here
- **SD-WAN Path Attributes**
  - IPsec Attributes :
    - configuration parameters from Controller to CPEs
    - IPsec Key exchange between CPEs
  - NAT Private address <-> Public address mapping for remote CPEs
- **SD-WAN Remote Endpoint: Site ID (+optional CPE ID and Port ID)**
- **SD-WAN Path Policy Sub-TLVs**

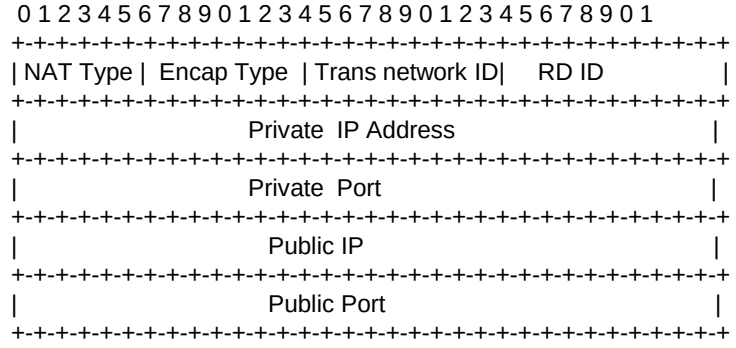

```
+------------------+
| NLRI Length      | 1 octet
+------------------+
| Tunnel Type      | 2 octets
+------------------+
|Path Distinguisher| 4 octets
+------------------+
| Side ID (Color)  | 4 octets
+------------------+
| Endpoint         | 4 or 16 octets
+------------------+
where:
New Tunnel Type: SD-WAN


The Remote Endpoint and Color sub-
TLVs, as defined in
[I-D.ietf-idr-tunnel-encaps] are
used to represent Site ID and CPE
System ID.

Path Distinguisher is to
differentiate multiple SD-WAN paths
terminated at one CPE
```

BGP extension to distribute IPsec attributes

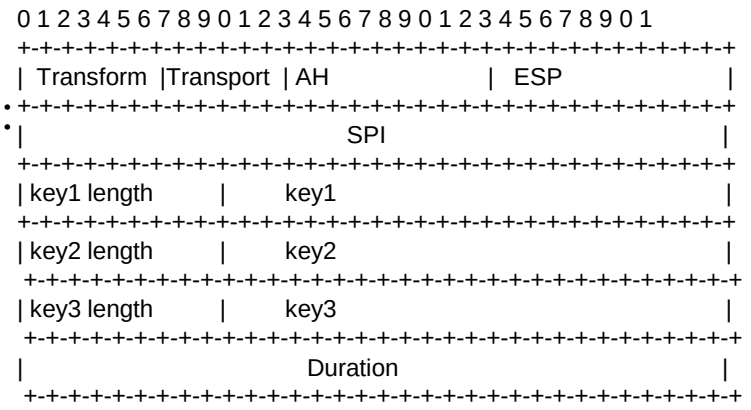
- Detailed Tunnel information advertisement :



NAT Type Include：
- without NAT
- 1:1 Static NAT
- Full Cone
- Restricted Cone
- Port Restricted Cone
- Symmetric

Encap Type include：
- SD-WAN IPSEC,GRE

Transport Network ID：Global Unique value for each CPE；LD1
RD ID：Routing Domain ID，global unique。
Private IP：WAN private IP；
Private Port：The destination Port number for Remote CPE to establish IPsec to the local CPE。
Public IP：The IP after NAT
Public Port：The Port after NAT。



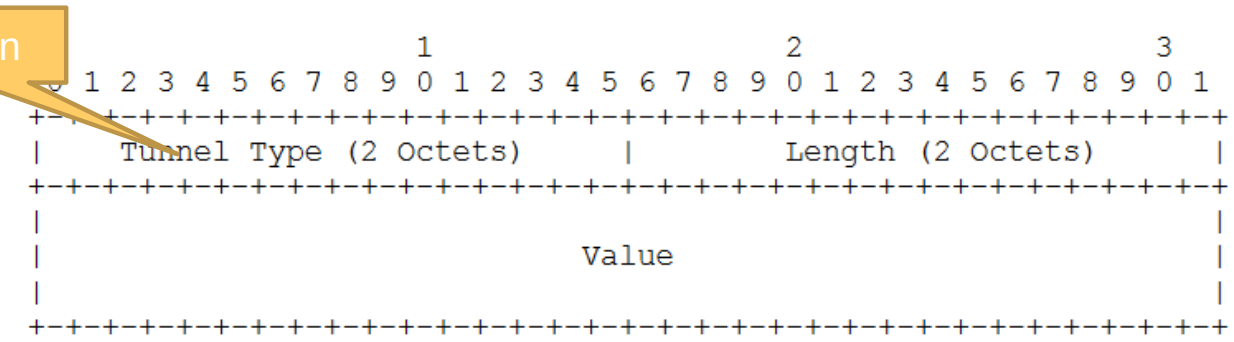
Transform: 1 byte
AH | ESP | AH+ESP
Transport : 1 byte
tunnel mode | transport mode
AH: 1 byte
Ah authentication algorithm ：
md5 | sha1 | sha2-256 | sha2-384 | sha2-512 | sm3 , Local can have multiple Authentication methods. Local & Remote CPE negotiate for the strongest one.
ESP : 2 bytes
ESP认 Authentication method（High 4bits）：
md5 | sha1 | sha2-256 | sha2-384 | sha2-512 | sm3 ，Local can have multiple Authentication methods. Local & Remote CPE negotiate for the strongest one。
Default，ESP uses SHA2-256认 method
ESP Encryption（High 4bits）：
3des | des | aes-128 | aes-192 | aes-256 | sm1 | sm4
Default，ESP uses AES-256 encryption
Reserve: 1 byte
SPI: 4 bytes
Key1：AH authentication key
Key2：ESP authentication key
Key3：ESP encryption key
Duration: SA lifespan

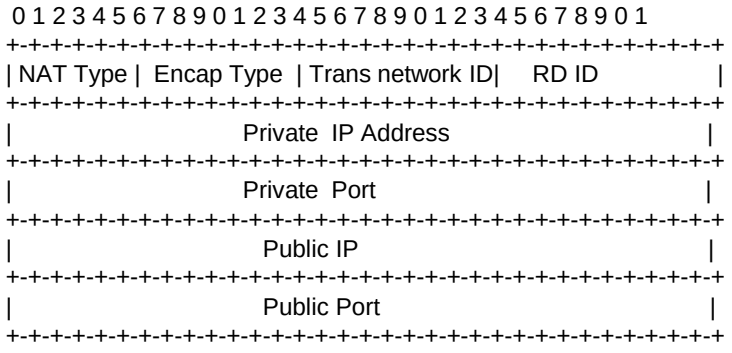
Slide 10

LD1 What is the difference between Transport netowrk ID and RD ID?
Linda Dunbar, 6/22/2018

Tunnel encap

Sd-wan

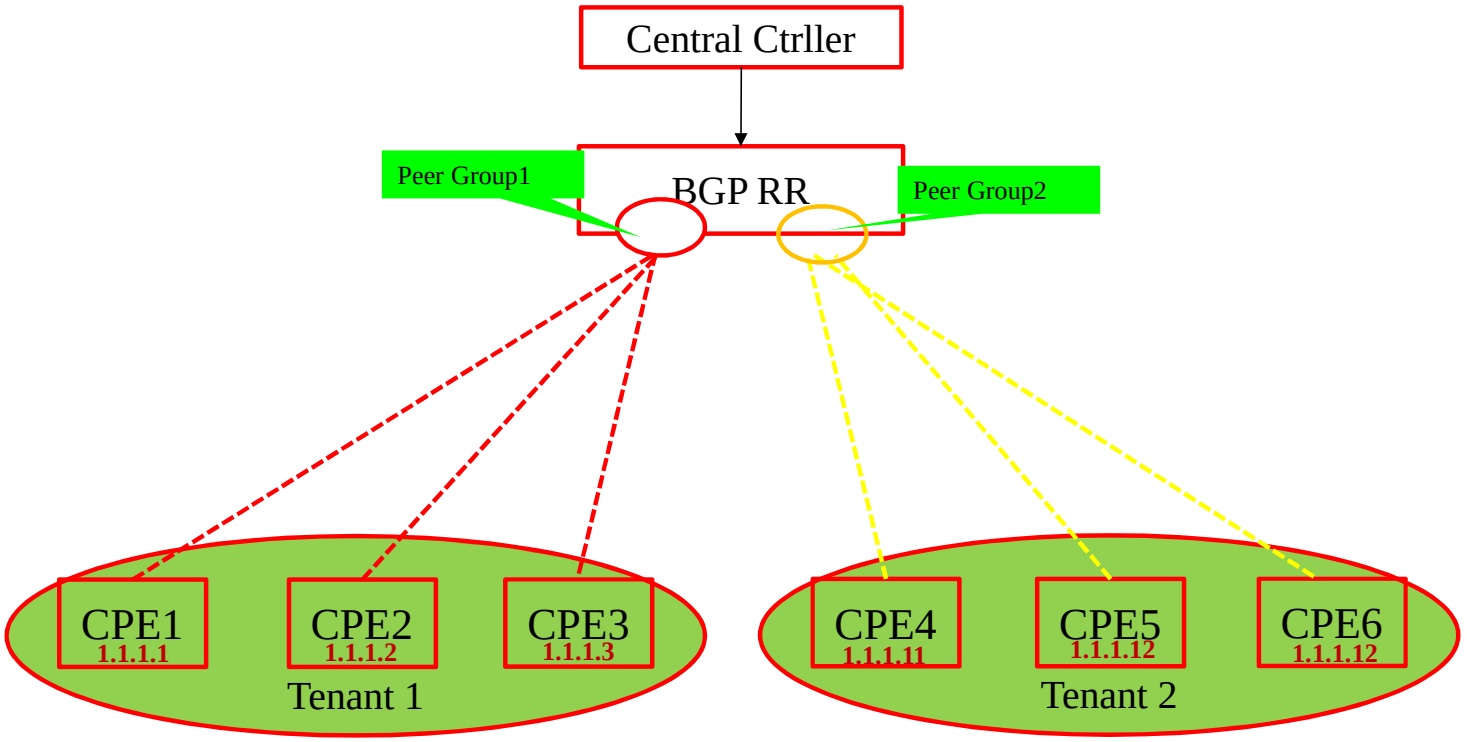




Used when Tunnel is established

Tunnel Information Advertisement Method

- Tenant Separation Method ：



CPE1：
- Receiving SD-WAN IPSEC infor、report WAN ports information to Controller via SD-WAN SAFI
- RR send to CPE2、CPE3 （using Policy Filtering to only send to Peers belong to same tenant)
- CPE2、CPE3 upon receiving SD-WAN IPSEC config information, start to negotiate with peers on IPsec tunnel establishing and establish the key.
- SD-WAN IPSEC tunnel is added to the Service Tunnel (IDR-Tunnel-encap) to be used for Route Advertisement

For Tenant Separation: CPEs belonging to same Tenant are added to a Peer Group

```
peer group1 route-policy tenant1-in import
peer group1 route-policy tenant1-out export
route-policy tenant1-in permit node 10
  apply community 100:1 addtitive
route-policy tenant1-out permit node 10
  if-match community-filter 1
ip community-filter 1 permit 100:1
```

Others are configured in similar way

Thank you

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