Service Overview and Implementation

Section 1

Telecommunication Services Technologies

Service Provider Telecommunications Network:

- Internet Protocol (IP) is now the most used
- Ethernet Layer 2 transportation is also common
- Frame Relay and Asynchronous Transfer Mode (ATM) are less common
- Time Division Multiplexing (TDM) technologies are used in older networks.
- Sonet transportation is not common, now replaced with direct optical networks.

Converged Network Infrastructure Requirements

Service providers consolidate the delivery of multiple service types onto a single network technology because of:

- High cost of maintaining and operating legacy networks
- The need to continue support high revenue legacy services (Frame Relay , Sonet, TDM)
- Consumer demand for new services that require higher bandwidth service at decreasing prices.

Nokia solution: Nokia 7750 Service Router

A single network device using IP/MPLS core network to support a range of Virtual Private Network (VPN) services.

VPN Service

VPN is a network built over a shared infrastructure to provide private services to its users.

- Virtual - VPN to service provider is a virtual Network
- Private - VPN to customer is a private Network
- Network - A collection of devices that communicate with each other

Service:

- Logical entity that refers to a type of connectivity
- Each service is uniquely identified by a service ID.

Provider Terminology CE, PE and P

Customer Edge (CE) Routers:

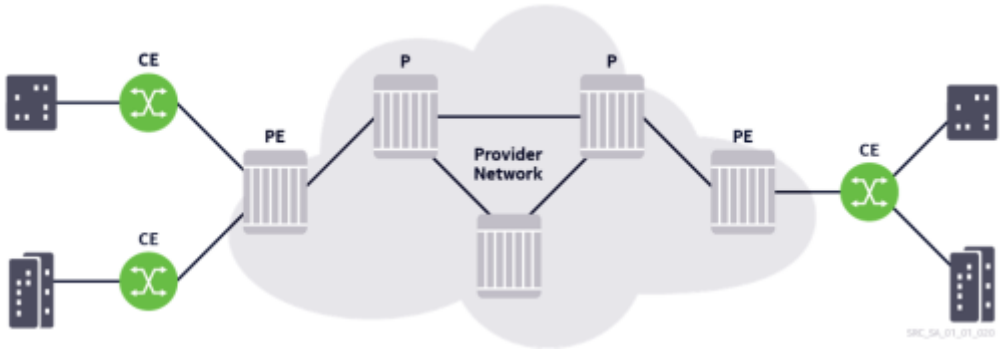
- Located at customer premises
- Service unaware

Provider Edge Routers (PE):

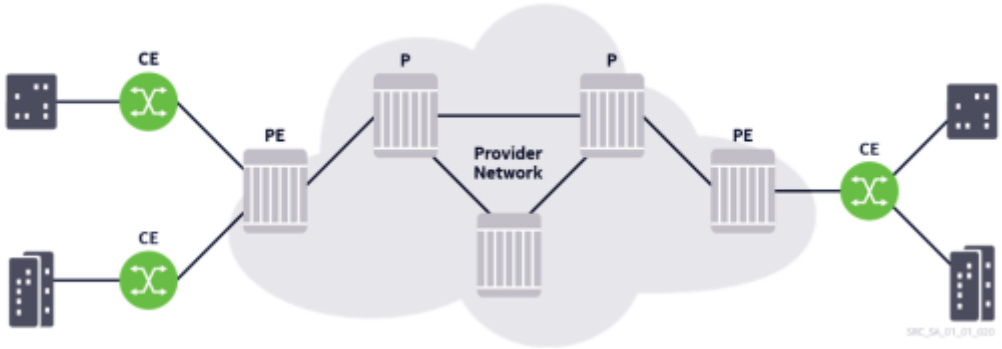
- Have at least one interface outside the provider domain facing the customer

Provider Core (P) Routers:

- Have all interfaces internal to the provider domain
- Service unaware, focus on forwarding packets through the tunnel with minimal configuration



Typical IP/MPLS Serice Network Components



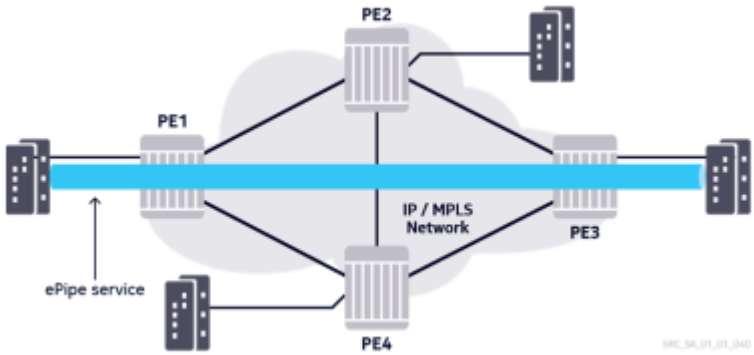
- Service router functions as the PE router in a service Network
- PE router provides the itnerface beteween the customer network and the core service provider network.

Nokia 7750 SR Service types

- VPN services:
  - Virtual private wire service (VPWS) - provides point-to-point service that emulates a leased line
  - Virtual private LAN services (VPLS) - provides a multipoint Ethernet service similar to an Ethernet switch
  - Virtual private router network services (VPRN) - provides a multipoint IP routed service
- Internet Enhanced Service (IES)
  - Provides the customer with a Layer 3 IP int to send and receive internet traffic
- Mirroring Services

Virtual private wire service (VPWS)

- Layer 2 point-to-point service also known as Virtual Leased Line (VLL) Service
- defines a virtual point-to-point service that emulates a private leased line connection
- encapsulates customer data and transports it across the service provider's network in a Generic Routing Encapsulation (GRE) or MPLS tunnel



Types of VPWS:

- ePipe - emulates a point-to-point Ethernet service
- aPipe - emaulates a point-to-point ATM service
- fPipe - emulates a point-to-point Frame Relay circuit
- cPipe - emulates a point-to-point TDM circuit
- iPipe - provides IP interworking capabilities between different L2 technologies.

VPWS Advantages: Customer perspective:

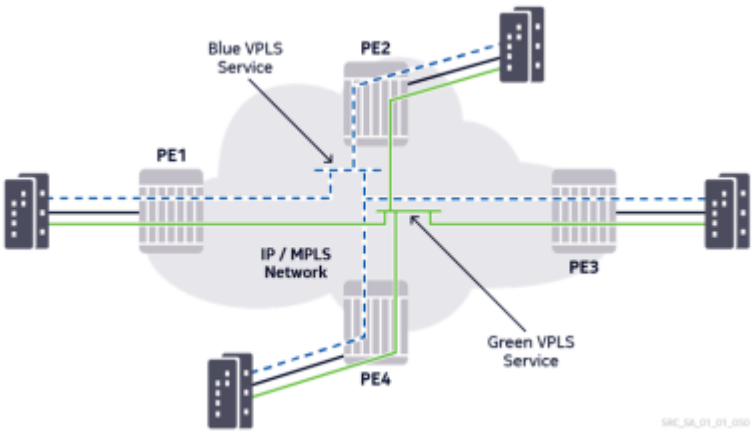
- Supports ATM, Frame Relay, TDM or Ethernet
- Service provider (SR) network appears as a leased line between the two customer locations
- Transparent to customer data.

Service provider perspective:

- Only the PE device is aware of the service
- Scalability & flexibility
- Apply QoS, billing, ingress/egress traffic shaping, and policing on a per-service basis.

Virtual Private LAN Service

VPLS is an Ethernet service that connects multiple sites in a single switched domain over a provider-managed IP/MPLS network.



VPLS Advantages: Customer perspective:

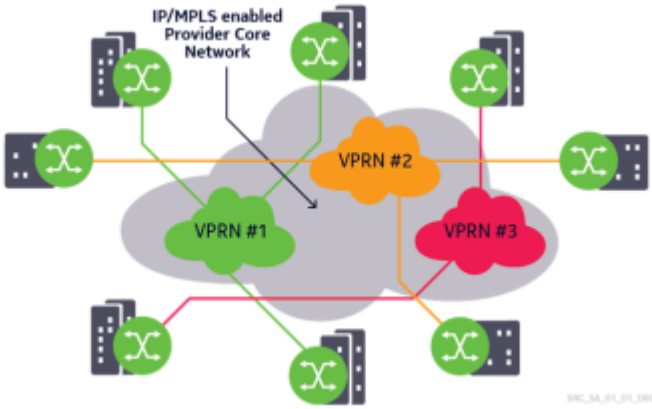
- It appears as if all sites are connected to a single-switched VLAN
- Transparent to the customer's data
- Can operate over a single local site or over multiple sites in different geographic locations
- Frames are only forwaded across the required links in the network

Service Provider's perspective:

- Similar to VPWS

Virtual Private Router Network (VPRN)

Layer 3 service that connects multiple sites in a routed domain over a provider-managed IP/MPLS network.



VPLS Advantages: Customer perspective:

- Sites are connected to a private routed network that is administered by the service provider for that custmer only.
- There are separate and independent IP address plans for each VPRN

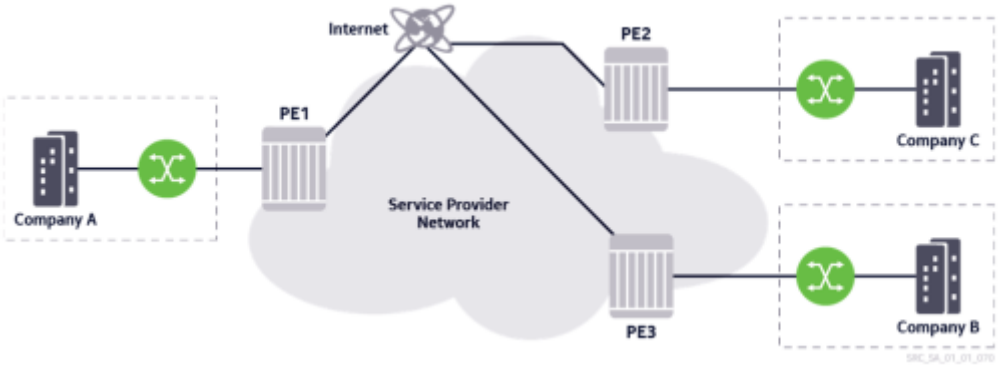
- VPRN can operate over a single local site or over multiple sites in different geographic locations.

Service Provider's perspective:

- Similar to VPWS or VPLS service

Internet Enhances Service (IES)

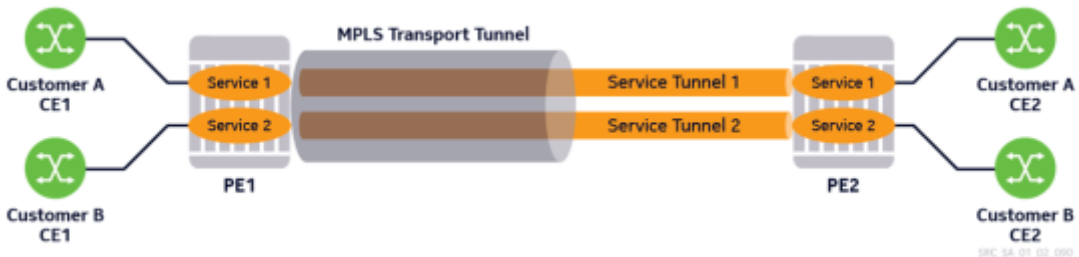
- IES provides customers with direct Internet access through a Layer 3 IP interface
- Customers see IES as providing a direct connection to the Internet
- Service provider can apply all billing, ingress/egress shaping, and policing to the customer.



Section 2

Transport Tunnels and Service Tunnels

- Transport tunnels are used to transmit customer data acros the service provider Network
- Either MPLS or GRE tunnels can be used as transport tunnels
- Service tunnels are used to transmit customer data for a specific service
- Multiple transport tunnels can be carried over a single network port
- Multiple service tunnels can be bound to the same transport tunnel



Transport tunnels: MPLS

- Labels are signaled using the Resrouce Reservation Protocol - Traffic Engineering (RSVP-TE) or Label Distribution Protocol (LDP)
- Customer Data is MPLS encapsulated and forwarded to egress PE

GRE

- Customer Data is IP encapsulated and forwarded to egress PE
- The source IP address is the ingress PE router, and the destination address is the egress PE router
- this is typically used when some routers in the transport network do not support MPLS

Service tunnels

- Multiprotocol-Border Gateway Protocol (MP-BGP)
- Targeted-Label Distribution Protocol (T-LDP)

Transport and Service Label Encapsulation

MPLS Encapsulation of VPN Service Traffic

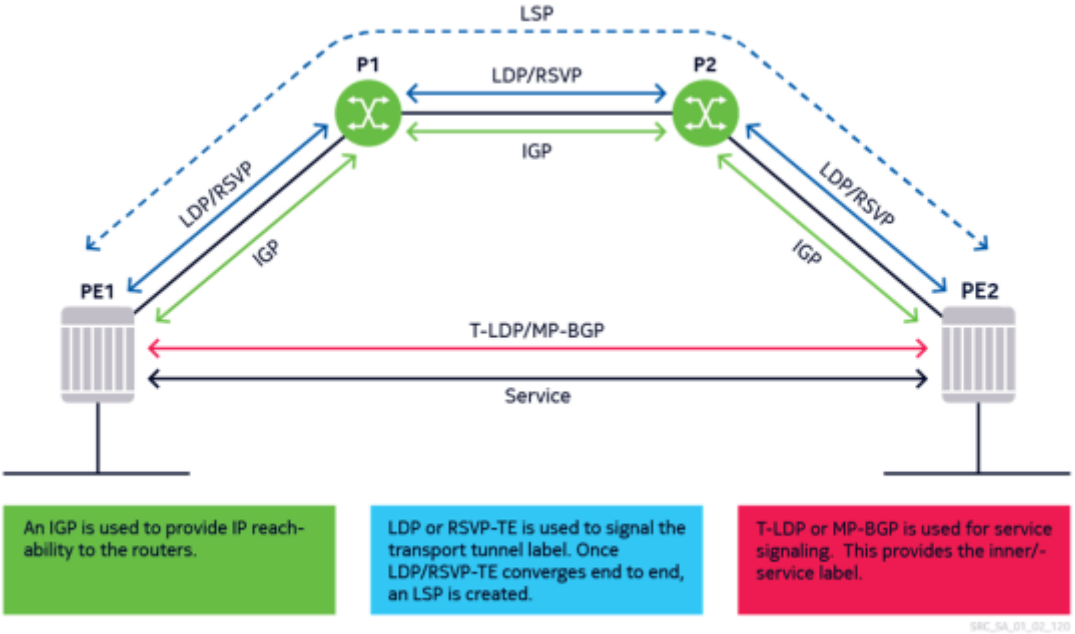
- DLC header - Layer 2 header used to transport the MPLS packet
- MPLS transport (outer) label - label signaled by the next-hop router
- Service (inner) label - The service, or virtual circuit (VC) label identifies the service that the packet belongs to
- Control word - optional and primarily used for ATm or Frame Relay services
- Service packet - The customer data being transported by the service

GRE encapsulation of VPN service traffic

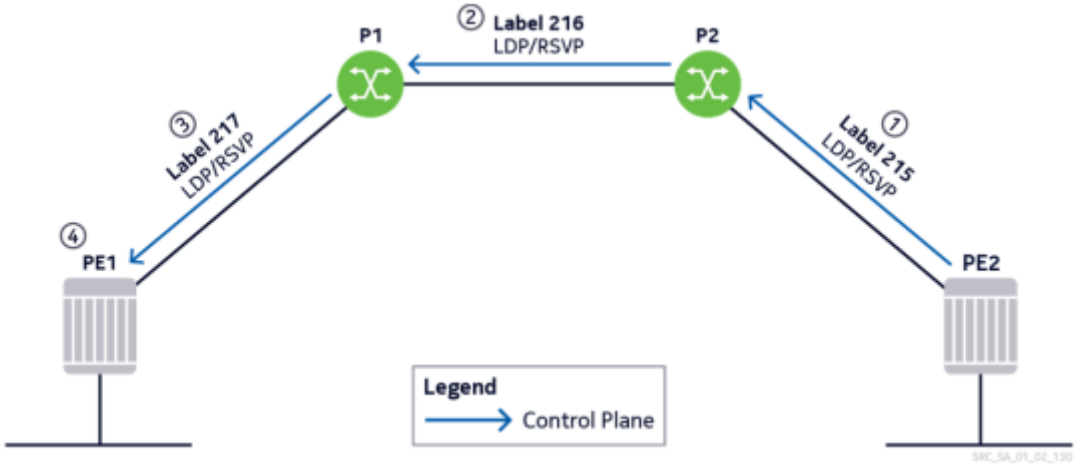
- IP header and the GRE header are used instead of the MPLS transport label
- A service label is still required to demultiplex the packet to the appropriate service.
- The service provider routers use the IP header to route the packet across the network.

MPLS Transport and Service Label Signaling

- LDP or RSVP-TE is used to establish label-switched paths (LSPs)
- LSPs can carry multiple service tunnels
- Service labels, or VL labels, are used to encapsulate and identify customer traffic that belongs to a particular service
- A service label is applied to the customer traffic before the transport label, or LSP label, is applied
- VPLS and VPWS service labels are signaled using T-LDP
- VPRN service labels are signaled using MP-BGP



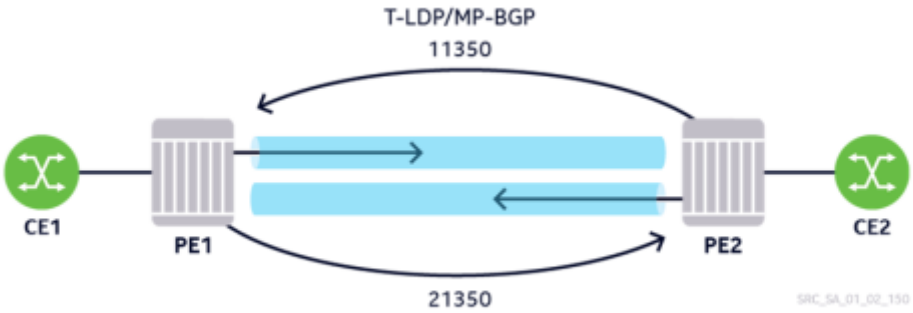
Transport Label Signaling PE2 to PE1



Transport labels are exchanged when the MPLS protocol (LDP/RSVP) is enabled:

1. PE2 advertises Label 215 to P2
2. P2 advertises Label 216 to P1
3. P1 advertises Label 217 to PE1
4. A unidirectional LSP is now established from PE1 to PE2

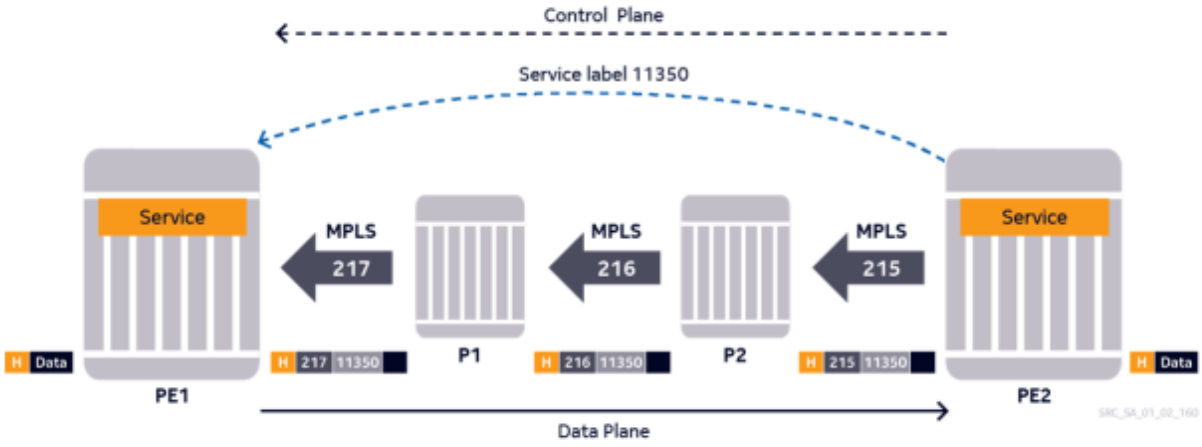
Service Label Signaling



Service labels are exchanged when the service is created:

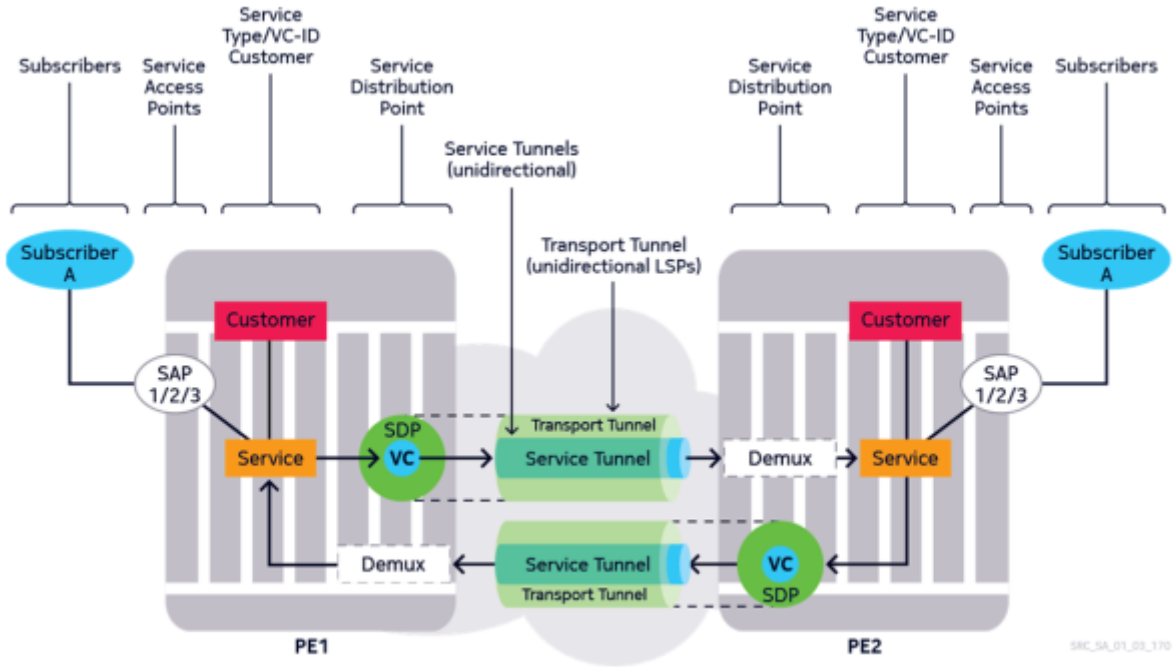
1. PE2 sends PE1 a service label (11350)
2. PE1 sends PE2 a service label (21350)
3. Unidirectional service tunnels are created

Transport Label and Service Label Use Case



Section 3

Service Components

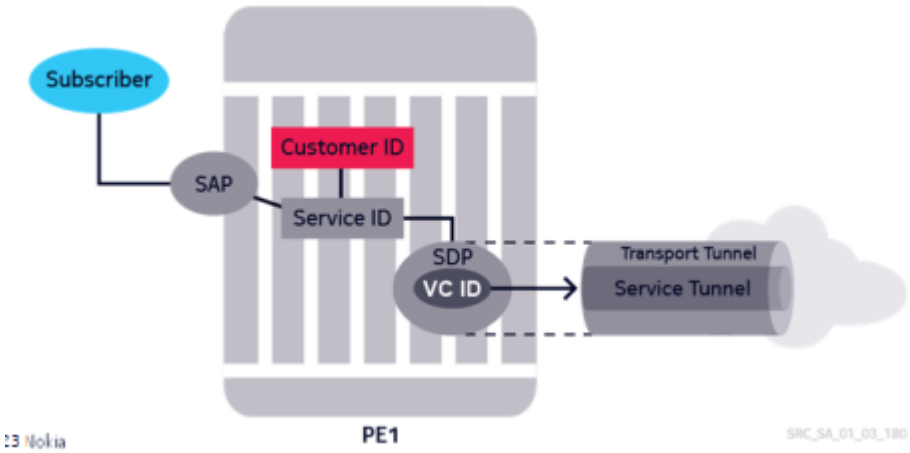


Customers and Subscribers

Customers: those responsible for the service from an administrative standpoint.

- Customer ID is assigned when the account is created
- ID must be associated with the service at the time-of-service creation
- can be associated with multiple services
- ID *CANNOT* be changed once the service is created

Subscribers: users of the service (CE)



Customer Creation Configuration

```
(MD-CLI)
*(gl)[/configure]
service customer 100
```

```
*(gl)[/configure service customer '100']
description *VPWS_Customer"

*(gl)[/configure service customer '100']
phone 1-111-111-1111

*(gl)[/configure service customer '100']
commit

(My Guess on Classic CLI)

configure service customer 100

description VPWS_Customer

phone 1-111-111-1111

exit

admin save

(SHOW COMMAND)

show service customer
```

Service Identifiers

- Service ID - numeric value used on the Nokia router to identify the service
  - A service is associated with a customer ID
  - Service must be created unsing a unqieu service ID on that router

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Service creation

```
(MD-CLI)
*(gl)[/configure]
service epipe 50

*(gl)[/configure service epipe '50']
customer 100

*(gl)[/configure service epipe '50']
admin-state enable

*(gl)[/configure service epipe '50']
commit

(My Guess on Classic CLI)
```

```
configure service epipe 50

customer 100

no shutdown

exit

admin save

(SHOW COMMAND)

show service id 50 base
```

Service Access Point (SAP)

- SAP is the Subscribers point of interface to the service network
- Belongs to a single service
- Specified as a physical port and an encapsulation identifier
- To be used, a port must be configured as an access or hybrid port

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SAP ID (page 52 on architectures PDF)

An SAP is a local entity to teh service router and is uniquely identified by the following:

- Physcial Ethernet port, or SOI IET/SDH or TDM port and channel
- Encapsulation identifier (ID)

Depending on teh encapsulation, a physcial port or channel can have more than one SAP associated with it.

SAPs can be created on ports or channels designated as "access" or "hybrid" in the physical port configuration.

- SAPs cannot be created on ports designated as core-facing "network" ports.

Ethernet Encapsulations

1. NULL - supports a single service on the prot
2. Dot1Q - supports multiple services for one customer or multiple services for multiple customers.
3. Q-in-Q - adds an IEE 802.1Q tag to the 802.1Q-tagged packets entering the network to expand VLAN space by tagging tagged packets (produces a double-tagged frame)

Ethernet port encapsulation can be set using the following command:

```
configure port x/y/z ethernet encap-type
```

```
*(gl)[/configure]
A:admin@PE1# port 1/1/1
*(gl)[/configure port 1/1/1]
A:admin@PE1# ethernet
*(gl)[/configure port 1/1/1 ethernet]
A:admin@PE1# mode access
A:admin@PE1# encap-type dotlq
A:admin@PE1# back
*(gl)[/configure port 1/1/1]
A:admin@PE1# admin-state enable
A:admin@PE1# commit
```

```
[]
A:admin@PE1# /show port

===============================================================================
Ports on Slot 1
===============================================================================
Port          Admin Link Port    Cfg  Oper LAG/ Port Port Port   C/QS/S/XFP/
Id            State      State   MTU  MTU  Bndl Mode Encp Type   MDIMDX
-------------------------------------------------------------------------------
1/1/1         Up    Yes  Up      1518 1518    - accs dotq vspeed
1/1/2         Up    Yes  Up      9212 9212    - netw null vspeed
1/1/3         Up    Yes  Up      9212 9212    - netw null vspeed
1/1/4         Up    Yes  Up      9212 9212    - netw null vspeed
1/1/5         Down  No   Down    9212 9212    - netw null vspeed
1/1/6         Down  No   Down    9212 9212    - netw null vspeed
1/1/7         Down  No   Down    9212 9212    - netw null vspeed
1/1/8         Down  No   Down    9212 9212    - netw null vspeed
1/1/9         Down  No   Down    9212 9212    - netw null vspeed
1/1/10        Down  No   Down    9212 9212    - netw null vspeed
1/1/11        Down  No   Down    9212 9212    - netw null vspeed
1/1/12        Down  No   Down    9212 9212    - netw null vspeed
1/1/13        Down  No   Down    9212 9212    - netw null vspeed
1/1/14        Down  No   Down    9212 9212    - netw null vspeed
1/1/15        Down  No   Down    9212 9212    - netw null vspeed
…

===============================================================================
```

You have to configure the por to be an access or hybrid port

SAP Configuration Considerations

- SAP ID is locally unique (the same SAP ID value can be used on another service router)
    - A port or channel can have more than one SAP configured on it.
- SAP can be configured with any of the following
    - Ingress and egress filter policy
    - Ingress and egress QoS policy
    - Ingress and egress scheduler poliy
    - Accounting policy

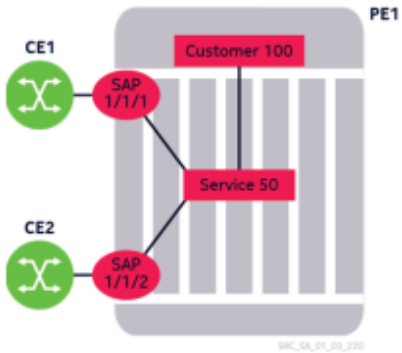
Local Service

In alocal service, all components reside on a single router.

Local ePipe service configuration on a single router:

```
*A:CE1# configure router interface "toCE2"
*(gl)[/configure router "Base" interface "toCE2"]
*A:CE1>config>router>if# port 1/1/1
*A:CE1>config>router>if# ipv4 primary address 192.168.1.1 prefix-length 24
*A:CE1# admin-state enable
```

```
*A:CE2# configure router interface "toCE1"
*(gl)[/configure router "Base" interface "toCE1"]
*A:CE2>config>router>if# port 1/1/1
*A:CE2>config>router>if# ipv4 primary address 192.168.1.2 prefix-length 24
*A:CE2# admin-state enable
```




```
*(gl)[/configure]
A:admin@PE1# service epipe 50
*(gl)[/configure service epipe "50"]
A:admin@PE1# sap 1/1/1
*(gl)[/configure service epipe "50" sap 1/1/1]
A:admin@PE1# back
*(gl)[/configure service epipe "50"]
A:admin@PE1# sap 1/1/2
*(gl)[/configure service epipe "50" sap 1/1/2]
A:admin@PE1# back
A:admin@PE1# commit
```

```
A:admin@PE1# /show service id 50 base

-------------------------------------------------------------------------------
Service Basic Information
-------------------------------------------------------------------------------
Service Id        : 50                  Vpn Id            : 0
Service Type      : Epipe
MACSec enabled    : no
Name              : 50
Description       : (Not Specified)
Customer Id       : 100                 Creation Origin   : manual
Last Status Change: 09/15/2022 16:37:33
Last Mgmt Change  : 11/07/2022 19:32:49
Test Service      : No
Admin State       : Up                  Oper State        : Up
MTU               : 1514
Vc Switching      : False
SAP Count         : 2                   SDP Bind Count    : 0
Per Svc Hashing   : Disabled            Lbl Eth/IP L4 TEID: Disabled
Ignore MTU Mismat*: Disabled
Vxlan Src Tep Ip  : N/A
Force QTag Fwd    : Disabled
Lcl Switch Svc St : sap
Oper Group        : <none>

-------------------------------------------------------------------------------
Service Access & Destination Points
-------------------------------------------------------------------------------
Identifier                              Type         AdmMTU  OprMTU  Adm   Opr
-------------------------------------------------------------------------------
sap:1/1/1                               null         1514    1514    Up    Up
sap:1/1/2                               null         1514    1514    Up    Up
-------------------------------------------------------------------------------
```

Distributed Service

Distributed service as components on multiple routers and uses the IP/MPLS network to connect the service and deliver data.

SDP binding is required to signal the service labels and define the transport to the remote router.

Service Distribution Point (SDP) Characteristics

- Logical entity used to direct traffic between routers
- Locally unique (Same SDP IP can be used on another router)
- SDPs use the system IP address to identify far-end destinations
- SDP is not specific to one service; many services can use the same SDP

- All services bound to an SDP use the same encapsulation
- Operations on an SDP will affect all services bound to that SDP.

Binding an SDP to a service

- SDP provide binding between the service labls and transport tunnels (LDP/RSVP or GRE), which are performing control plane signaling.
- To direct a service to use an SDP for distribution, the service is joined to the SDP using SDP binding
- A service label is not signaled unless the service is bound to an SDP
- Because data forwarding in distributed services relies on SDP, transport tunnel should be protected.

SDP Encapsulation Types

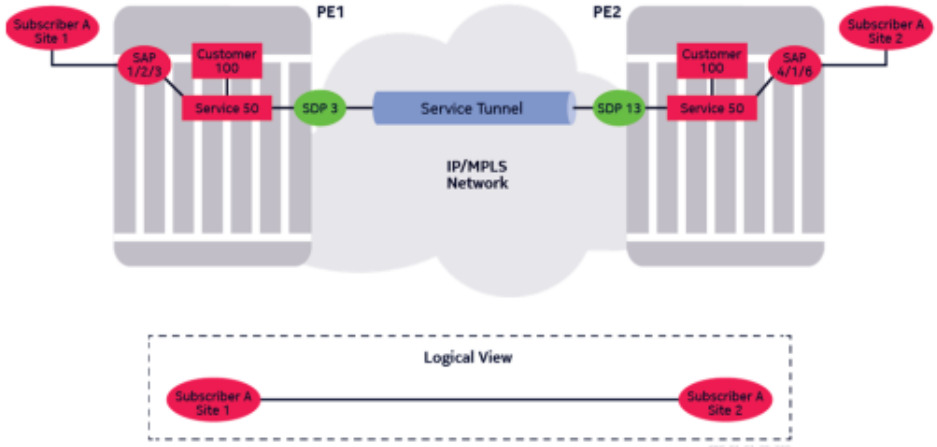
MPLS encapsulation:

- Uses LDP or RSVP-TE for label signaling
- LDP relies on an IGP to find its path
- RSVP-TE requires additional configurations & allows finer control of paths.

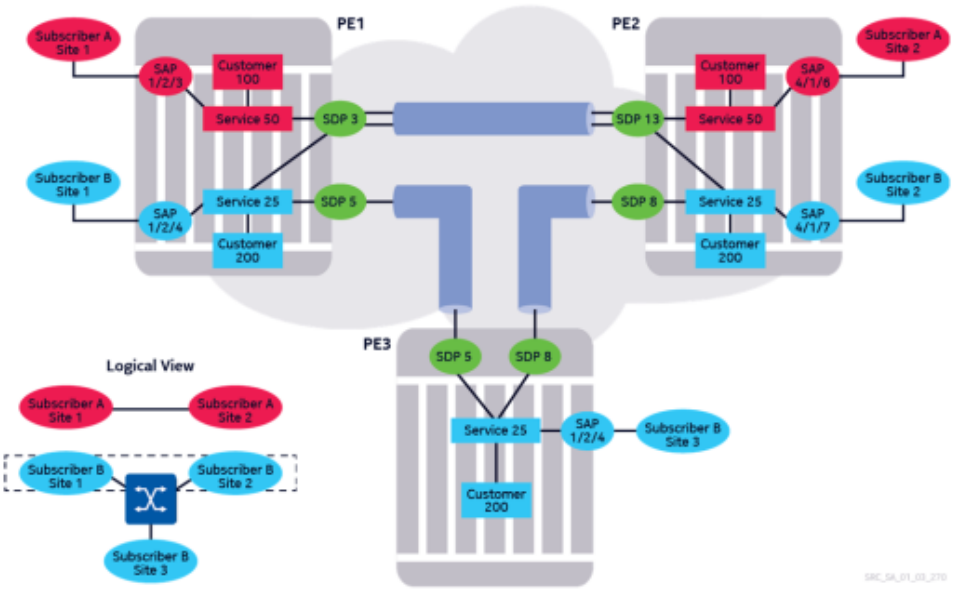
GRE encapsulation:

- Encapsulates traffic in an IP/GRE header, appears as an IP packet.
- Low control plane overhead
- GRE uses normal IP routing to find a path

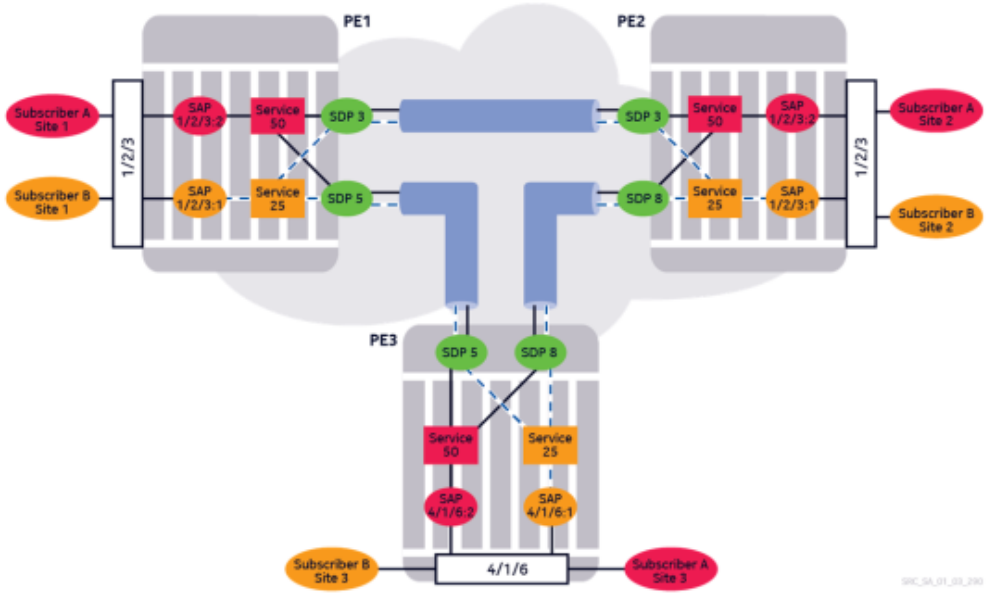
Single Subscriber — Distributed VPWS Service



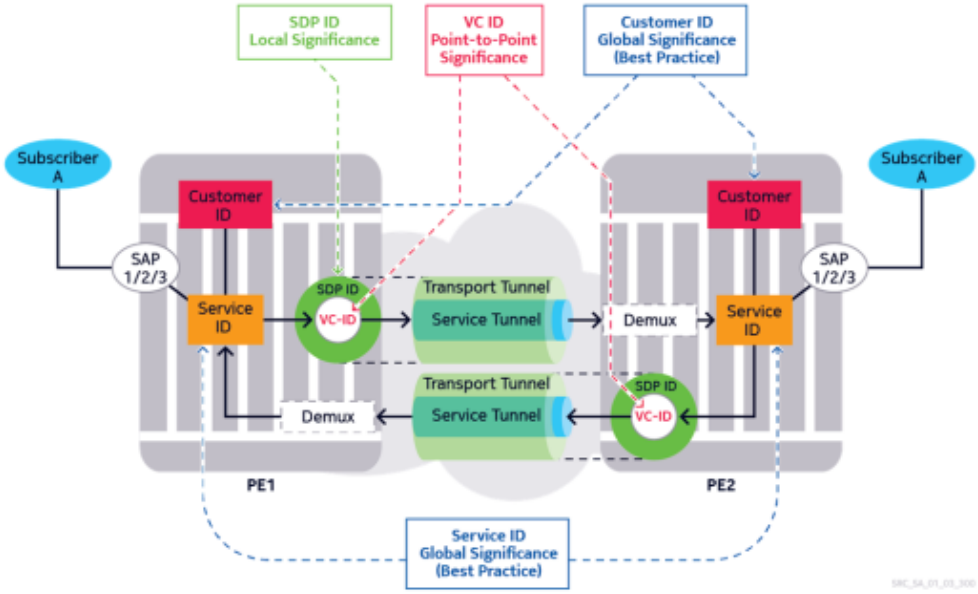
Multiple Subscribers



Multiple SAPs on a Single Port



Logical Service-Level Connectivity



Page 73 to 87 for cast study with examples