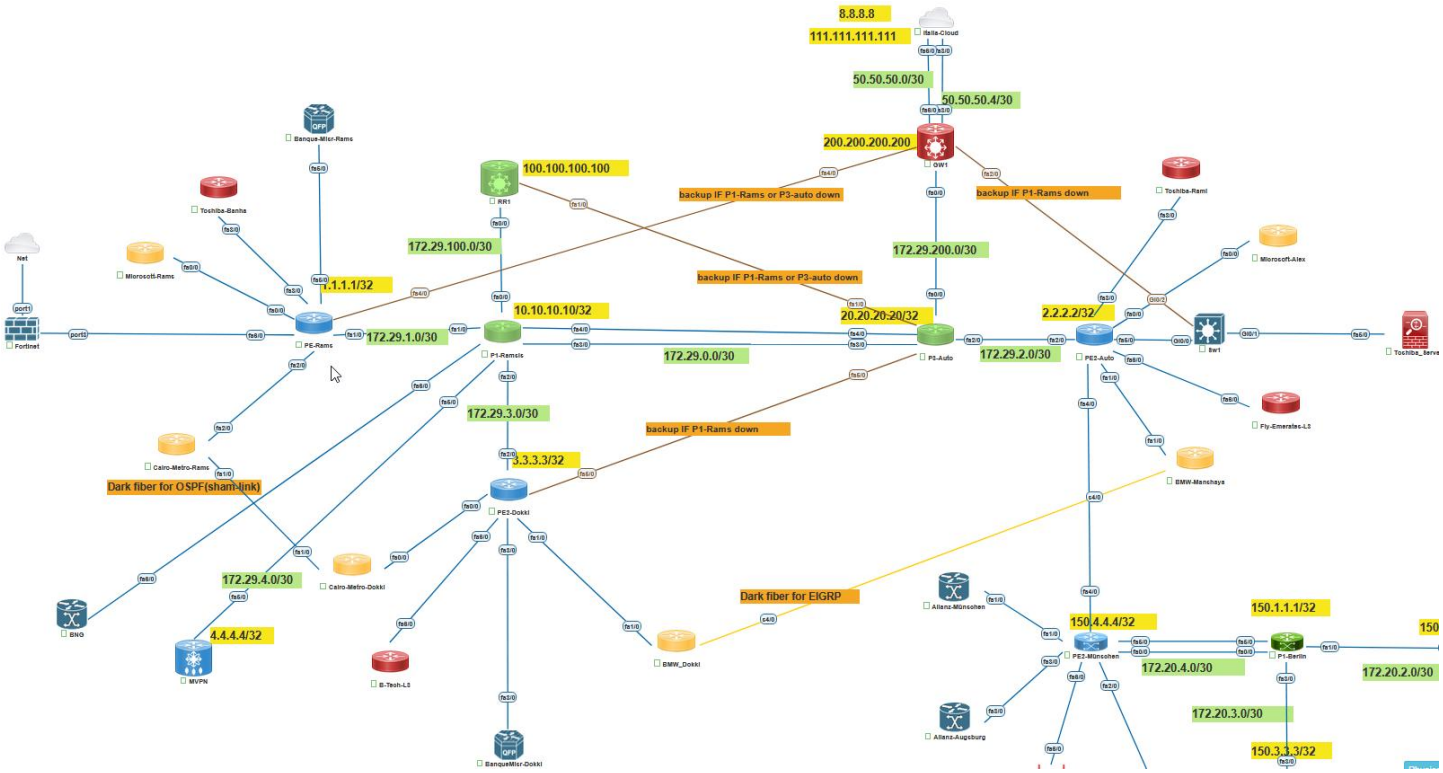
Traffic Engineering (TE):



Why TE?

- **Manupilate Traffic Better**
- **Manage the Load of my Network to use all the resources of my network**
- **Prevent Over and under Utilization**
- **Solve Long-Term Congesion Problems**

TE:

- **it create Logical tunnels from the SRC (head) to Destination (tail)**
- **this tunnel appear in Routing Table as Connected routing interface**
- **Unidirection Connection**
- **depend on Protocol RSVP (Resorce Reservation Protocol) to be created.**

Tunnel Build Based on:

- **Tunnel Attibutes**
- **Ingress-Egress point (src and dst)**
- **Bandwidth**
- **Latency**

- **CoS (the Type of Traffic such audo , video , …)**

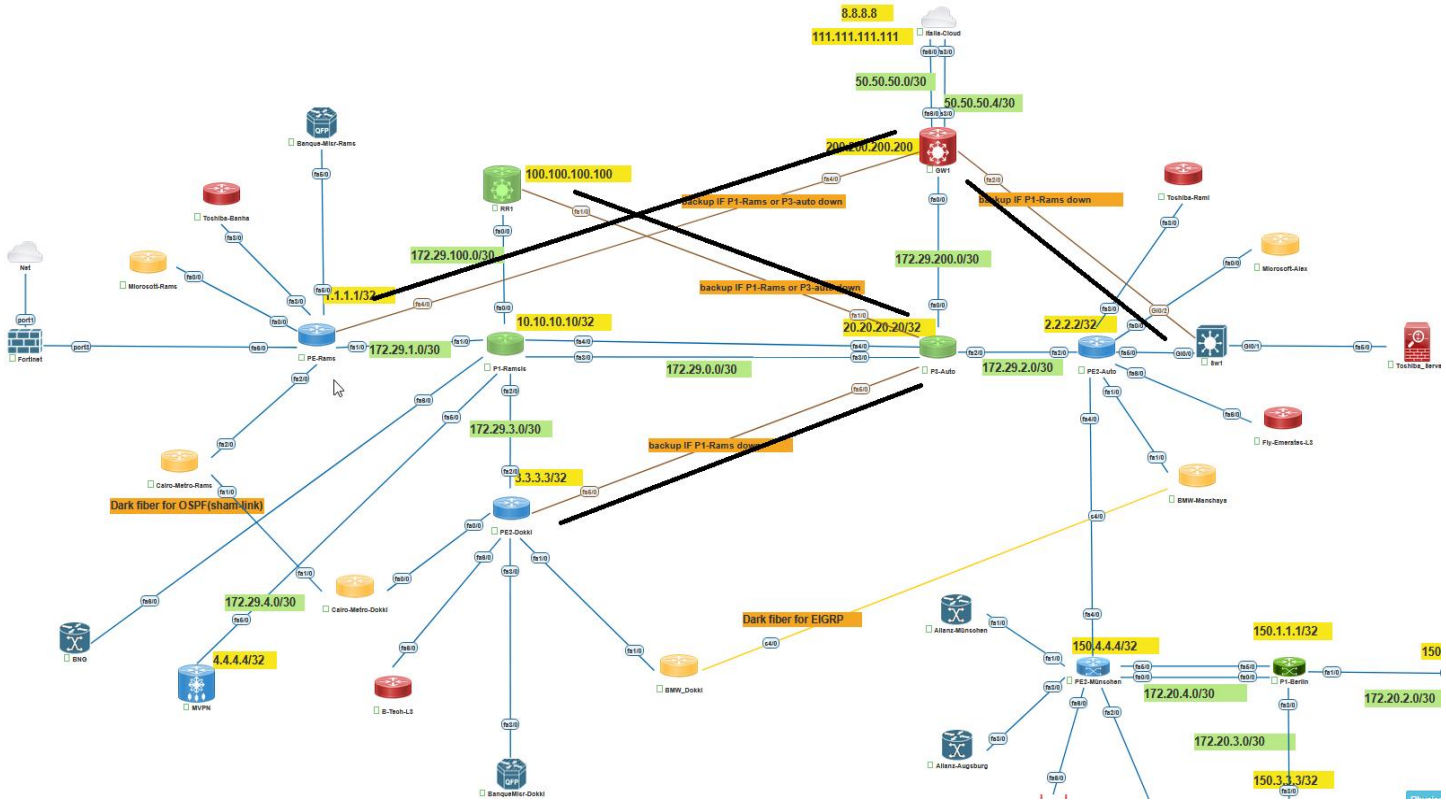
RSVP:

- **Management reservation on my interface**
- **Like ICMP (not UDP or TCP)**

We can use TE To do:

1- **Connect PE's Use**
   - **Autoroute Announce**
   - **Static through the tunnel**
2- **Connect CE's**
   - **L3VPN (using bgp next-hop loopback51 (under VRF) and static through the tunnel to reach the loopback in addition to use mpls ip under the tunnel)**
   - **L2VPN (using Xconnect and use Pseudowire use preferred-path interface Tunnel….)**

Configure the New Links between Core Routers[used as backup links (Brown Links)



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RR1	PE-Rams	PE2-Dokki	P3-Auto	PE2-Auto	GW1	SW1
int fa1/0 no sh description Connect RR1 to P3 auto as if P1-Rams down ip add 172.29.120.2 255.255.255.252 ip router isis ngn mpls ip mpls label protocol ldp mpls ldp igp sync isis metric 50 !	int fa4/0 no sh description Another path to get GW as if P1-Rams is down ip add 172.29.201.2 255.255.255.252 ip router isis ngn mpls ip mpls label protocol ldp mpls ldp igp sync isis metric 50 !	int fa5/0 no sh description Connect to P3-Auto as if P1-Rams down ip add 172.29.203.2 255.255.255.252 ip router isis ngn mpls ip mpls label protocol ldp mpls ldp igp sync isis metric 30 !	int fa5/0 no sh description Connect to PE2-Dokki as if P1-Rams down ip add 172.29.203.1 255.255.255.252 ip router isis ngn mpls ip mpls label protocol ldp mpls ldp igp sync isis metric 30 ! ! ! int fa1/0 no sh description Connect P3-auto to RR1 as if P1-Rams down ip add 172.29.120.1 255.255.255.252 ip router isis ngn mpls ip mpls label protocol ldp mpls ldp igp sync isis metric 50 ! ! !	int fa5/0 no sh no ip add 172.29.33.1 255.255.255.252 ! ! ! int fa5/0.10 encapsulation dot1q 10 description Connect PE2-Auto to Router Toshiba to connect servers ip add 172.29.33.1 255.255.255.252 ! ! ! int fa5/0.20 encapsulation dot1q 20 description Connect PE2-Auto to Gateway as if P3-Auto down ip add 172.29.202.2 255.255.255.252 ip router isis ngn mpls ip mpls label protocol ldp mpls ldp igp sync isis metric 30 ! !	int fa4/0 no sh description GW to PE Rams To get PE-Rams and PE-Dokki if PE2-Auto Down ip add 172.29.201.1 255.255.255.252 ip router isis ngn mpls ip mpls label protocol ldp mpls ldp igp sync isis metric 50 ! ! int fa2/0 no sh description Connect to PE2-auto as if P3-Auto down ip add 172.29.202.1 255.255.255.252 ip router isis ngn mpls ip mpls label protocol ldp mpls ldp igp sync isis metric 30 !	hostname Sw1 ! interface GigabitEthernet0/0 switchport trunk encapsulation dot1q switchport mode trunk no shutdown ! ! interface GigabitEthernet0/1 switchport access vlan 10 switchport mode access no shutdown ! ! ! ! interface GigabitEthernet0/2 switchport access vlan 20 switchport mode access no shutdown !

Note:

Interface Fa5/0 on PE2-Auto was connect to Toshiba data center that was used to inject global sources into VRF

So we insert switch on this link and created subinterface one to do the Old option (VRF leaking) and the new subinterface to connect GW1 to be backup if Main Connection went down.

Note:

because of the metric on every node in ISIS =10 so the new interfaces that we created should be the main Links not the old interfaces (so we increase the metric on this interfaces to make it the backup links and the Blue interfaces be the main)

Shows after New Interfaces:

```
pe-rams#sh ip route 200.200.200.200
*Jul  4 04:18:42.439: %SYS-5-CONFIG_I: Configured from console by console
Routing entry for 200.200.200.200/32
  Known via "isis", distance 115, metric 20, type level-1
  Redistributing via isis ngn
  Last update from 172.29.201.1 on FastEthernet4/0, 00:00:13 ago
  Routing Descriptor Blocks:
  * 172.29.201.1, from 200.200.200.200, 00:00:13 ago, via FastEthernet4/0
      Route metric is 20, traffic share count is 1
pe2-auto#sh ip route isis
Gateway of last resort is 200.200.200.200 to network 0.0.0.0
      1.0.0.0/32 is subnetted, 1 subnets
i L1     1.1.1.1 [115/40] via 172.29.2.1, 00:03:14, FastEthernet2/0
      3.0.0.0/32 is subnetted, 1 subnets
i L1     3.3.3.3 [115/40] via 172.29.2.1, 00:03:14, FastEthernet2/0
      10.0.0.0/32 is subnetted, 1 subnets
i L1     10.10.10.10 [115/30] via 172.29.2.1, 00:03:14, FastEthernet2/0
      20.0.0.0/32 is subnetted, 1 subnets
i L1     20.20.20.20 [115/20] via 172.29.2.1, 00:03:24, FastEthernet2/0
      100.0.0.0/32 is subnetted, 1 subnets
i L1     100.100.100.100 [115/40] via 172.29.2.1, 00:03:14, FastEthernet2/0
      172.29.0.0/16 is variably subnetted, 12 subnets, 2 masks
i L1     172.29.0.0/30 [115/20] via 172.29.2.1, 00:03:24, FastEthernet2/0
i L1     172.29.1.0/30 [115/30] via 172.29.2.1, 00:03:14, FastEthernet2/0
i L1     172.29.3.0/30 [115/30] via 172.29.2.1, 00:03:14, FastEthernet2/0
i L1     172.29.100.0/30 [115/30] via 172.29.2.1, 00:03:14, FastEthernet2/0
i L1     172.29.200.0/30 [115/20] via 172.29.2.1, 00:03:24, FastEthernet2/0
      192.168.4.0/30 is subnetted, 1 subnets
i L1     192.168.4.0 [115/30] via 172.29.2.1, 00:03:14, FastEthernet2/0
      192.168.5.0/30 is subnetted, 1 subnets
i L1     192.168.5.0 [115/40] via 172.29.2.1, 00:03:14, FastEthernet2/0
      200.200.200.0/32 is subnetted, 1 subnets
i L1     200.200.200.200 [115/30] via 172.29.2.1, 00:03:14, FastEthernet2/0
```

Configure TE on all Core interfaces with reserved Bandwidth 20M/S

Steps:

under Global :

1- enable mpls traffic-eng tunnels

Under ISIS:

1- Enable metric-style wide

2- Enable MPLS traffic-eng level1 and L2 as I use[is-type level-1-2]

   a. (or only L2 if you use [is-type level-2-only])

Under Interfaces connect Core:

1- enable mpls traffic-eng tunnels

2- reserve the wanted bandwidth

RR1	PE-Rams	PE2-Dokki	P1-Ramsis	P3-Auto	PE2-Auto	GW1
mpls traffic-eng tunnels ! router isis ngn metric-style wide mpls traffic-eng router-id loopback0 mpls traffic-eng level-1 mpls traffic-eng level-2 ip route priority high tag 5 max-lsp-lifetime 65535 lsp-refresh-interval 65000 spf-interval level-1 5 250 250 spf-interval level-2 5 250 250 prc-interval 5 250 250 ! int range fa1/0,fa0/0 mpls label protocol ldp mpls traffic-eng tunnels isis network point-to-point ip rsvp bandwidth 20000 !	mpls traffic-eng tunnels ! router isis ngn metric-style wide mpls traffic-eng router-id loopback0 mpls traffic-eng level-1 mpls traffic-eng level-2 ip route priority high tag 5 max-lsp-lifetime 65535 lsp-refresh-interval 65000 spf-interval level-1 5 250 250 spf-interval level-2 5 250 250 prc-interval 5 250 250 ! int range fa1/0,fa4/0 mpls label protocol ldp mpls traffic-eng tunnels isis network point-to-point ip rsvp bandwidth 20000 !	mpls traffic-eng tunnels ! router isis ngn metric-style wide mpls traffic-eng router-id loopback0 mpls traffic-eng level-1 mpls traffic-eng level-2 ip route priority high tag 5 max-lsp-lifetime 65535 lsp-refresh-interval 65000 spf-interval level-1 5 250 250 spf-interval level-2 5 250 250 prc-interval 5 250 250 ! int range fa5/0,fa2/0 mpls label protocol ldp mpls traffic-eng tunnels isis network point-to-point ip rsvp bandwidth 20000 !	mpls traffic-eng tunnels ! router isis ngn metric-style wide mpls traffic-eng router-id loopback0 mpls traffic-eng level-1 mpls traffic-eng level-2 ip route priority high tag 5 max-lsp-lifetime 65535 lsp-refresh-interval 65000 spf-interval level-1 5 250 250 spf-interval level-2 5 250 250 prc-interval 5 250 250 ! int range fa0/0,fa1/0,fa2/0,fa3/0,fa5/0 mpls label protocol ldp mpls traffic-eng tunnels isis network point-to-point ip rsvp bandwidth 20000 !	mpls traffic-eng tunnels ! router isis ngn metric-style wide mpls traffic-eng router-id loopback0 mpls traffic-eng level-1 mpls traffic-eng level-2 ip route priority high tag 5 max-lsp-lifetime 65535 lsp-refresh-interval 65000 spf-interval level-1 5 250 250 spf-interval level-2 5 250 250 prc-interval 5 250 250 ! int range fa0/0,fa1/0,fa2/0,fa3/0,fa5/0 mpls label protocol ldp mpls traffic-eng tunnels isis network point-to-point ip rsvp bandwidth 20000 !	mpls traffic-eng tunnels ! router isis ngn metric-style wide mpls traffic-eng router-id loopback0 mpls traffic-eng level-1 mpls traffic-eng level-2 ip route priority high tag 5 max-lsp-lifetime 65535 lsp-refresh-interval 65000 spf-interval level-1 5 250 250 spf-interval level-2 5 250 250 prc-interval 5 250 250 ! int fa5/0.20 mpls label protocol ldp mpls traffic-eng tunnels isis network point-to-point ip rsvp bandwidth 20000 ! int fa2/0 mpls label protocol ldp mpls traffic-eng tunnels isis network point-to-point ip rsvp bandwidth 20000 !	mpls traffic-eng tunnels ! router isis ngn metric-style wide mpls traffic-eng router-id loopback0 mpls traffic-eng level-1 mpls traffic-eng level-2 ip route priority high tag 5 max-lsp-lifetime 65535 lsp-refresh-interval 65000 spf-interval level-1 5 250 250 spf-interval level-2 5 250 250 prc-interval 5 250 250 ! int range fa0/0,fa2/0,fa4/0 mpls label protocol ldp mpls traffic-eng tunnels isis network point-to-point ip rsvp bandwidth 20000 !

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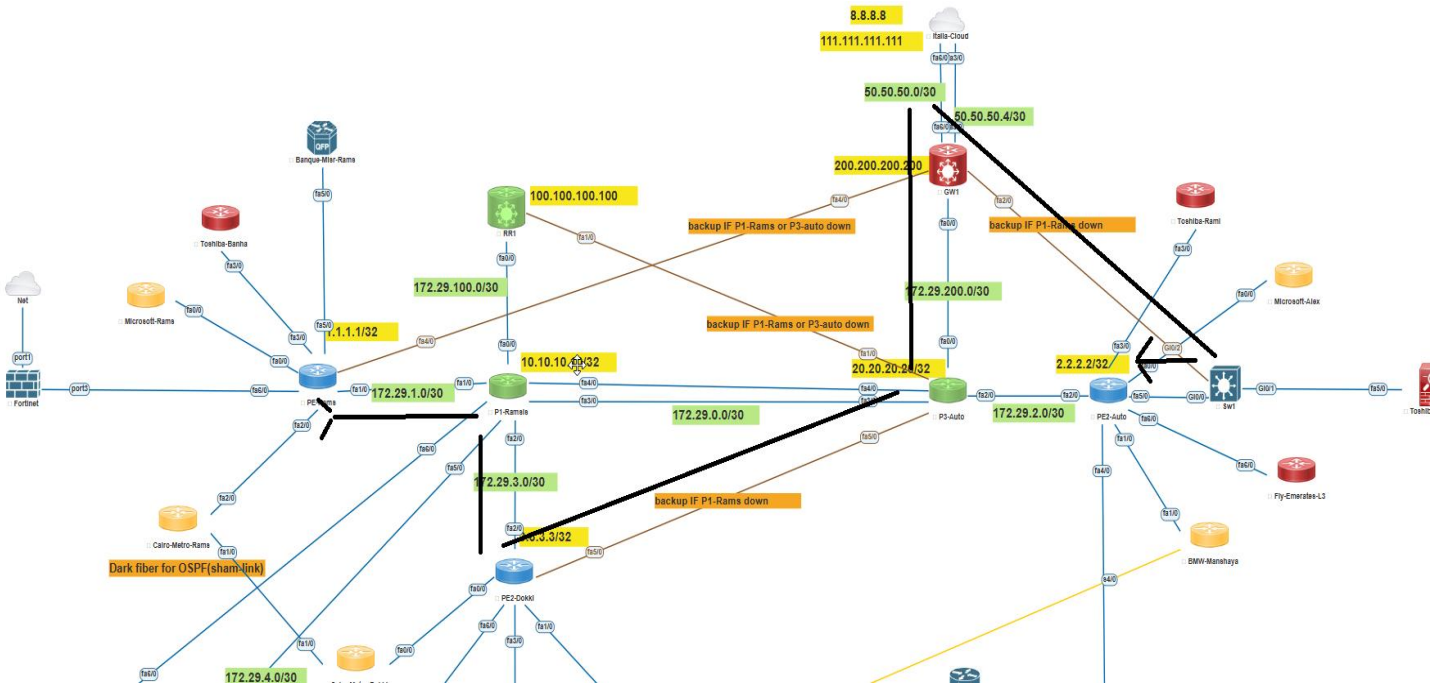
TE Tunnel with autoroute announce:

There is two types of TE Tunnel Pathes :

1- **Dynamic (Go with IGP)**

2- **Explicit (that is Manual Configure)**

Here We create Tunnel1111 to connect PE-Rams by PE2-Auto With explicit-path to use the backup links to reach the destination (PE2-Auto) and reserve 10240KB to this tunnel.



PE-Rams

```
interface Tunnel1111
 ip unnumbered Loopback0
tunnel mode mpls traffic-eng
 tunnel destination 2.2.2.2
tunnel mpls traffic-eng bandwidth 10240          ! 10M reserved for this tu
tunnel mpls traffic-eng priority 0 0             ! to be preferred ( as low is more preferred > it's range 0 to 7)
tunnel mpls traffic-eng autoroute announce       ! if not exist tunnel 'll not up
 tunnel mpls traffic-eng path-option 10 explicit name PE2-Auto>Dokki-GW
 tunnel mpls traffic-eng path-option 20 dynamic
end
!
!
ip explicit-path name PE2-Auto>Dokki-GW  enable
 index 1 next-address 172.29.1.1
 index 2 next-address 172.29.3.2
 index 3 next-address 172.29.203.1
 index 4 next-address 172.29.200.2
 index 5 next-address 172.29.202.2
!
!
```

Shows After TE Tunnel1111:

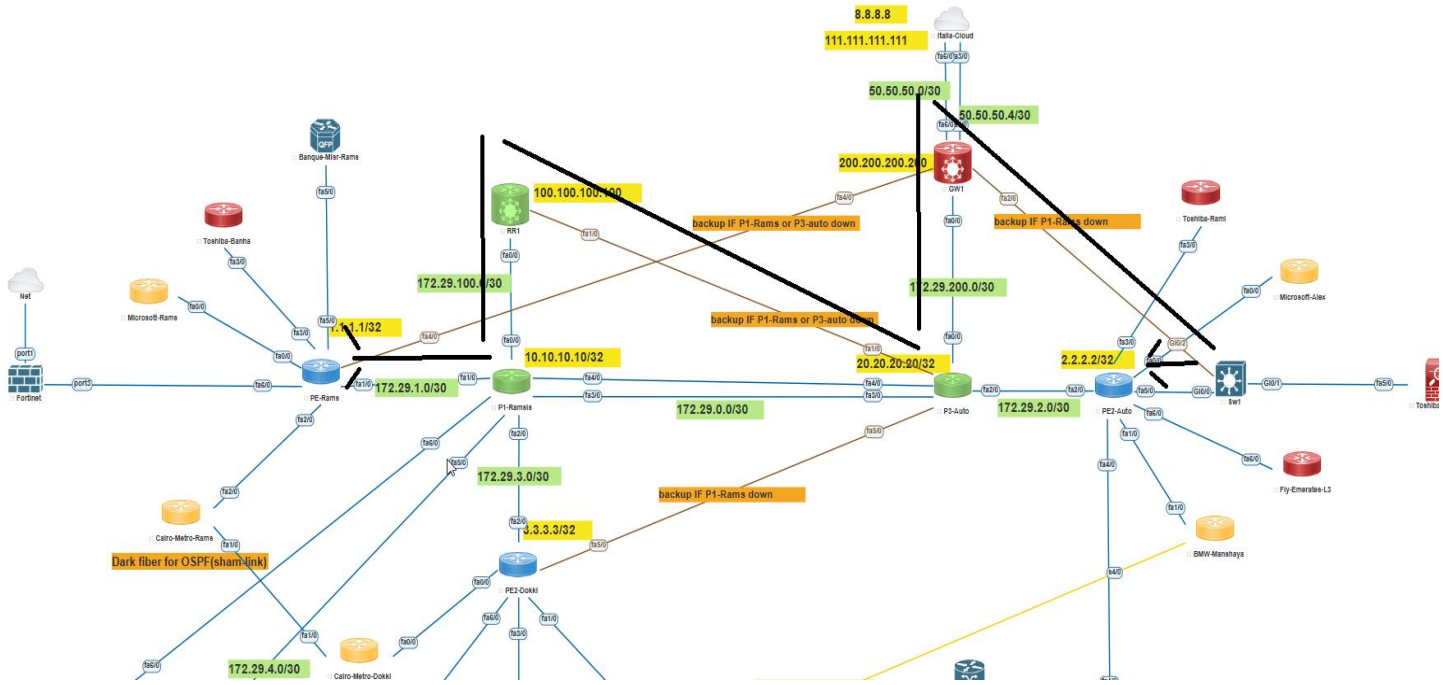
```
pe-rams#sh ip rsvp interface
interface    rsvp       allocated  i/f max  flow max sub max  VRF
Fa1/0        ena        10240K     20M      20M      0
Fa4/0        ena        0          20M      20M      0
pe-rams#traceroute 2.2.2.2
Type escape sequence to abort.
Tracing the route to 2.2.2.2
VRF info: (vrf in name/id, vrf out name/id)
  1 172.29.1.1 [MPLS: Label 16 Exp 0] 108 msec 72 msec 64 msec
  2 172.29.3.2 [MPLS: Label 36 Exp 0] 72 msec 56 msec 52 msec
  3 172.29.203.1 [MPLS: Label 29 Exp 0] 60 msec 148 msec 252 msec
  4 172.29.200.2 [MPLS: Label 32 Exp 0] 216 msec 76 msec 92 msec
  5 172.29.202.2 88 msec 60 msec *
pe-rams#sh mpls traffic-eng  tunnels  brief
Signalling  Summary:
    LSP Tunnels Process:            running
    Passive LSP Listener:           running
    RSVP Process:                   running
    Forwarding:                     enabled
    Periodic reoptimization:        every 3600 seconds, next in 807 seconds
    Periodic FRR Promotion:         Not Running
    Periodic auto-bw collection:    every 300 seconds, next in 207 seconds
P2P TUNNELS/LSPs:
TUNNEL NAME                     DESTINATION      UP IF      DOWN IF    STATE/PROT
pe-rams_t1111                   2.2.2.2          -          Fa1/0      up/up
Displayed 1 (of 1) heads, 0 (of 0) midpoints, 0 (of 0) tails
P2MP TUNNELS:
Displayed 0 (of 0) P2MP heads

P2MP SUB-LSPS:
Displayed 0 P2MP sub-LSPs:
          0 (of 0) heads, 0 (of 0) midpoints, 0 (of 0) tails
```

```
pe-rams#sh mpls traffic-eng  tunnels summary
Signalling  Summary:
    LSP Tunnels Process:            running
    Passive LSP Listener:           running
    RSVP Process:                   running
    Forwarding:                     enabled
    Periodic reoptimization:        every 3600 seconds, next in 678 seconds
    Periodic FRR Promotion:         Not Running
    Periodic auto-bw collection:    every 300 seconds, next in 78 seconds
    P2P:
      Head: 1 interfaces,   1 active signalling attempts, 1 established
            7 activations,  6 deactivations
            0 SSO recovery attempts, 0 SSO recovered
      Midpoints: 0, Tails: 0
    P2MP:
      Head: 0 interfaces,   0 active signalling attempts, 0 established
            0 sub-LSP activations,  0 sub-LSP deactivations
            0 LSP successful activations,  0 LP deactivations
            0 SSO recovery attempts, LSP recovered: 0 full, 0 partial, 0 fail
      Midpoints: 0, Tails: 0
 pe-rams#sh mpls traffic-eng  tunnels  | sec Tunnel1111
Name: pe-rams_t1111                       (Tunnel1111) Destination: 2.2.2.2
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 10, type explicit PE2-Auto>Dokki-GW (Basis for Setup, path weight 90)
    path option 20, type dynamic
pe-rams#sh mpls interfaces
Interface              IP            Tunnel   BGP Static Operational
FastEthernet1/0        Yes (ldp)     Yes      No  No     Yes
FastEthernet4/0        Yes (ldp)     Yes      No  No     Yes
FastEthernet6/0.1      Yes (ldp)     No       No  No     Yes
Tunnel1111             No            No       No  No     Yes
```

TE Tunnel with Static to dst through the tunnel

Here We don't use Autoroute Announce and rather than that use Static route to reach the destination through the Tunnel that we created.



PE-Rams

```
! Here we don't use tunnel mpls traffic-eng autoroute announce
interface Tunnel2222
 ip unnumbered Loopback0
tunnel mode mpls traffic-eng
 tunnel destination 2.2.2.2
tunnel mpls traffic-eng bandwidth 5120    ! 5M reserved for this tu
tunnel mpls traffic-eng priority 2 2   ! Tunnel1111 prefered rather than that
 tunnel mpls traffic-eng path-option 10 explicit name PE2-Auto>RR>P3-Auto>GW
 tunnel mpls traffic-eng path-option 20 dynamic
end
!
ip explicit-path name PE2-Auto>RR>P3-Auto>GW  enable
 index 1 next-address 172.29.1.1
 index 2 next-address 172.29.100.2
 index 3 next-address 172.29.120.1
 index 4 next-address 172.29.200.2
 index 5 next-address 172.29.202.2
!
ip route 2.2.2.2 255.255.255.255 tunnel2222
!
```

Shows After TE Tunnel2222:

```
pe-rams#sh ip rsvp interface
interface     rsvp       allocated  i/f max   flow max sub max   VRF

Fa1/0         ena        15360K     20M       20M       0
```

```
Fa4/0        ena        0          20M      20M      0
pe-rams#sh mpls traffic-eng tunnels
P2P TUNNELS/LSPs:
Name: pe-rams_t1111                        (Tunnel1111) Destination: 2.2.2.2
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 10, type explicit PE2-Auto>Dokki-GW (Basis for Setup, path weight 90)
    path option 20, type dynamic
  Config Parameters:
    Bandwidth: 10240    kbps (Global)  Priority: 0  0   Affinity: 0x0/0xFFFF
    Metric Type: TE (default)
    AutoRoute: enabled  LockDown: disabled Loadshare: 10240 [195312] bw-based
    auto-bw: disabled
  Active Path Option Parameters:
    State: explicit path option 10 is active
    BandwidthOverride: disabled  LockDown: disabled  Verbatim: disabled
  InLabel  :  -
  OutLabel : FastEthernet1/0, 31
  Next Hop : 172.29.1.1
  RSVP Signalling Info:
       Src 1.1.1.1, Dst 2.2.2.2, Tun_Id 1111, Tun_Instance 23
    RSVP Path Info:
      My Address: 172.29.1.2
      Explicit Route: 172.29.1.1 172.29.3.2 172.29.203.1 172.29.200.2
                      172.29.202.2 2.2.2.2
      Record   Route:   NONE
      Tspec: ave rate=10240 kbits, burst=1000 bytes, peak rate=10240 kbits
    RSVP Resv Info:
      Record   Route:   NONE
      Fspec: ave rate=10240 kbits, burst=1000 bytes, peak rate=10240 kbits
  History:
    Tunnel:
      Time since created: 52 minutes, 44 seconds
      Time since path change: 3 minutes, 43 seconds
```

```
      Number of LSP IDs (Tun_Instances) used: 23
    Current LSP: [ID: 23]
      Uptime: 3 minutes, 43 seconds
    Prior LSP: [ID: 22]
      ID: path option unknown
      Removal Trigger: tunnel shutdown
Name: pe-rams_t2222                       (Tunnel2222) Destination: 2.2.2.2
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 10, type explicit PE2-Auto>RR>P3-Auto>GW (Basis for Setup, path weight 110)
    path option 20, type dynamic
  Config Parameters:
    Bandwidth: 5120     kbps (Global)  Priority: 2  2   Affinity: 0x0/0xFFFF
    Metric Type: TE (default)
    AutoRoute: disabled LockDown: disabled Loadshare: 5120 [390625] bw-based
    auto-bw: disabled
  Active Path Option Parameters:
    State: explicit path option 10 is active
    BandwidthOverride: disabled  LockDown: disabled  Verbatim: disabled
  InLabel  :  -
  OutLabel : FastEthernet1/0, 29
  Next Hop : 172.29.1.1
  RSVP Signalling Info:
       Src 1.1.1.1, Dst 2.2.2.2, Tun_Id 2222, Tun_Instance 30
    RSVP Path Info:
      My Address: 172.29.1.2
      Explicit Route: 172.29.1.1 172.29.100.2 172.29.120.1 172.29.200.2
                      172.29.202.2 2.2.2.2
      Record   Route:   NONE
      Tspec: ave rate=5120 kbits, burst=1000 bytes, peak rate=5120 kbits
    RSVP Resv Info:
      Record   Route:   NONE
      Fspec: ave rate=5120 kbits, burst=1000 bytes, peak rate=5120 kbits
History:
```

```
    Tunnel:
      Time since created: 41 minutes, 2 seconds
      Time since path change: 3 minutes, 30 seconds
      Number of LSP IDs (Tun_Instances) used: 30
    Current LSP: [ID: 30]
      Uptime: 3 minutes, 30 seconds
    Prior LSP: [ID: 29]
      ID: path option unknown
      Removal Trigger: tunnel shutdown
P2MP TUNNELS:
P2MP SUB-LSPS:
pe-rams#sh ip route 2.2.2.2
Routing entry for 2.2.2.2/32
  Known via "static", distance 1, metric 0 (connected)
  Routing Descriptor Blocks:
  * directly connected, via Tunnel2222
      Route metric is 0, traffic share count is 1
pe-rams#traceroute 2.2.2.2 source lo0 numeric
Type escape sequence to abort.
Tracing the route to 2.2.2.2
VRF info: (vrf in name/id, vrf out name/id)
  1 172.29.1.1 [MPLS: Label 29 Exp 0] 196 msec 136 msec 84 msec
  2 172.29.100.2 [MPLS: Label 33 Exp 0] 76 msec 80 msec 96 msec
  3 172.29.120.1 [MPLS: Label 16 Exp 0] 104 msec 84 msec 84 msec
  4 172.29.200.2 [MPLS: Label 35 Exp 0] 84 msec 72 msec 84 msec
  5 172.29.202.2 84 msec *  112 msec
```

Note:

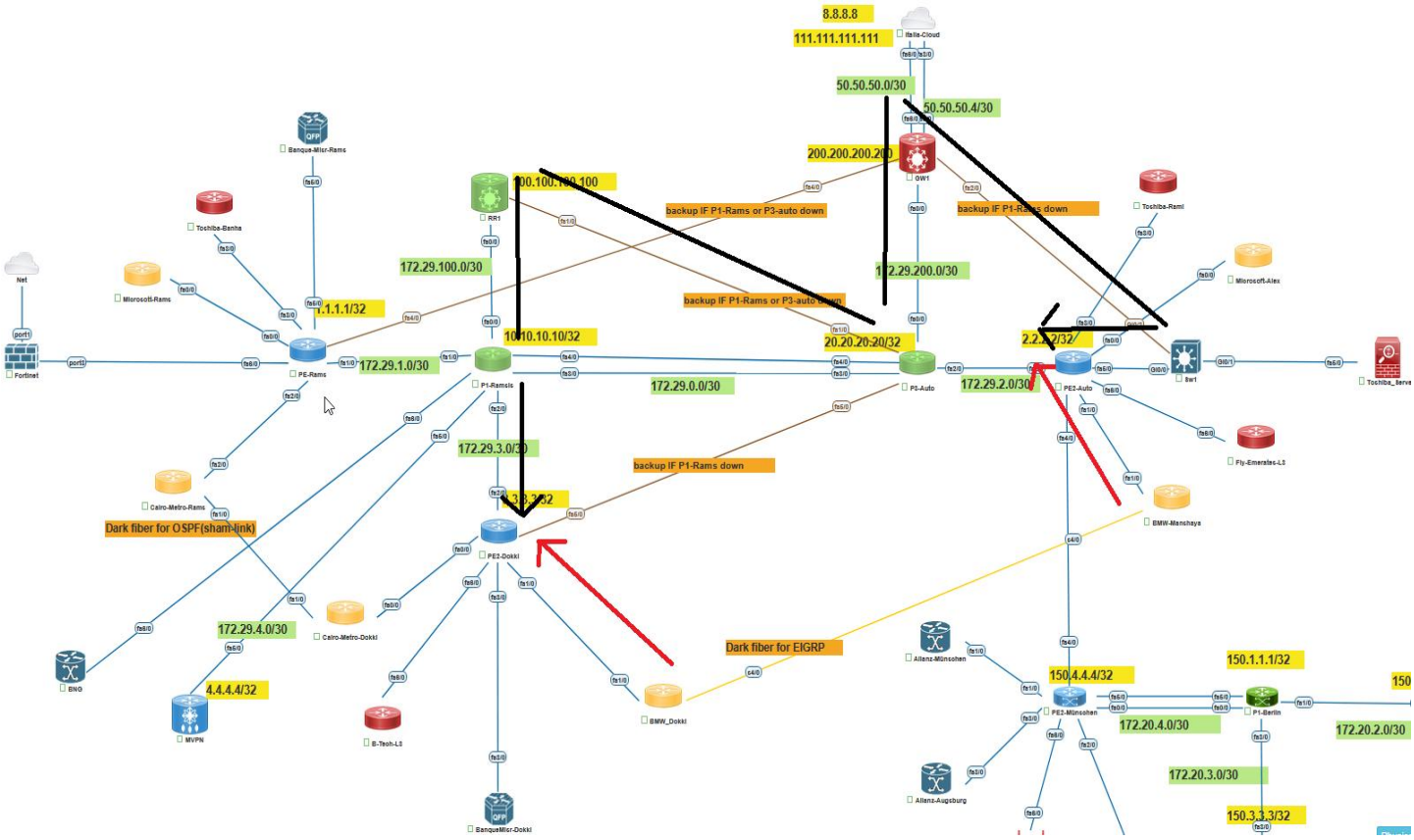
- **During use both interfaces types Use autoroute announce and use static through the tunnel >> without looking to the Priority >> the Router prefer that come through static.**
- **in case we use two tunnels : one use autoreroute announce and the secound use static to reach the dst through the tunnel >> tunnel that use static route is prefered even if the tunnel use autoreroute has low priority (prefered)**
- **وده static route، ودايمًا بياخد أولوية أعلى من أي route injected بـ autoroute announce (اللي بيعتبر نوع من الـ connected routes).**

- **Also When look to sh ip rsvp interfaces >> we found the bandwidth of two tunnels be reserved of the 20M that reserved to TE on the physical interface that connect to the core.**

TE CE to CE using L3VPN:

Steps:

- **Create new Loopback4444 to be used with the targeted VRF**
- **under ip vrf bmw , use bgp next-hop loopback4444**
- **create Bi-direction Tunnels (connect the two PE's use two tunnels to reach each other)**
- **Make static route to reach the new loopback of remote PE through the tunnel**
- **Use mpls ip under the tunnel to make the connection between the two loopbacks Labeled**
- **Don't use under the tunnel autoroute announce or use static route to reach the destination PE through the created tunnels**
- **here we'll use explicit-path to create manual configure tunnels in the two directions**



PE2-Dokki	PE2-Auto
interface Tunnel4444 ip unnumbered Loopback0 tunnel mode mpls traffic-eng tunnel destination 2.2.2.2 tunnel mpls traffic-eng bandwidth 2048 ! 2048M reserved for this tu tunnel mpls traffic-eng priority 0 0 tunnel mpls traffic-eng path-option 10 explicit name PE2-Dokki>P1-rams>RR>P3-Auto>GW>P2-auto tunnel mpls traffic-eng path-option 20 dynamic ! ! ! ip explicit-path name PE2-Dokki>P1-rams>RR>P3-Auto>GW>P2-auto enable index 1 next-address 172.29.3.1 index 2 next-address 172.29.100.2 index 3 next-address 172.29.120.1 index 4 next-address 172.29.200.2 index 5 next-address 172.29.202.2 ! ! ! int lo4444 ip add 44.44.44.3 255.255.255.255 ! ! ip route 44.44.44.2 255.255.255.255 tunnel4444 ! ! ! ip vrf bmw bgp next-hop lo4444 ! ! int tunnel4444 mpls ip !	interface Tunnel4444 ip unnumbered Loopback0 tunnel mode mpls traffic-eng tunnel destination 3.3.3.3 tunnel mpls traffic-eng bandwidth 2048 ! 2048M reserved for this tu tunnel mpls traffic-eng priority 0 0 tunnel mpls traffic-eng path-option 10 explicit name PE2-auto>GW>P3-auto-RR>P1-Rams>PE2-Dokki tunnel mpls traffic-eng path-option 20 dynamic ! ! ! ip explicit-path name PE2-auto>GW>P3-auto-RR>P1-Rams>PE2-Dokki enable index 1 next-address 172.29.202.1 index 2 next-address 172.29.200.1 index 3 next-address 172.29.120.2 index 4 next-address 172.29.100.1 index 5 next-address 172.29.3.2 ! ! ! int lo4444 ip add 44.44.44.2 255.255.255.255 ! ! ip route 44.44.44.3 255.255.255.255 tunnel4444 ! ! ! ip vrf bmw bgp next-hop lo4444 ! ! int tunnel4444 mpls ip !

Shows:

```
pe2-dokki#sh ip rsvp interface

interface     rsvp       allocated  i/f max   flow max sub max  VRF

Fa2/0         ena        2048K      20M       20M       0

Fa5/0         ena        0          20M       20M       0

pe2-dokki#sh mpls traffic-eng tunnels

P2P TUNNELS/LSPs:

Name: pe2-dokki_t4444                     (Tunnel4444) Destination: 2.2.2.2

  Status:

    Admin: up         Oper: up     Path: valid       Signalling: connected

    path option 10, type explicit PE2-Dokki>P1-rams>RR>P3-Auto>GW>P2-auto (Basis for Setup,
path weight 110)

    path option 20, type dynamic

  Config Parameters:
```

```
    Bandwidth: 2048     kbps (Global)  Priority: 0  0   Affinity: 0x0/0xFFFF
    Metric Type: TE (default)
    AutoRoute: disabled LockDown: disabled Loadshare: 2048 [976562] bw-based
    auto-bw: disabled
  Active Path Option Parameters:
    State: explicit path option 10 is active
    BandwidthOverride: disabled  LockDown: disabled  Verbatim: disabled
   InLabel  :  -
  OutLabel : FastEthernet2/0, 32
  Next Hop : 172.29.3.1
  RSVP Signalling Info:
       Src 3.3.3.3, Dst 2.2.2.2, Tun_Id 4444, Tun_Instance 2
    RSVP Path Info:
      My Address: 172.29.3.2
      Explicit Route: 172.29.3.1 172.29.100.2 172.29.120.1 172.29.200.2
                      172.29.202.2 2.2.2.2
      Record   Route:   NONE
      Tspec: ave rate=2048 kbits, burst=1000 bytes, peak rate=2048 kbits
    RSVP Resv Info:
      Record   Route:   NONE
      Fspec: ave rate=2048 kbits, burst=1000 bytes, peak rate=2048 kbits
  History:
    Tunnel:
      Time since created: 19 minutes, 48 seconds
      Time since path change: 17 minutes, 12 seconds
      Number of LSP IDs (Tun_Instances) used: 2
    Current LSP: [ID: 2]
      Uptime: 17 minutes, 12 seconds
    Prior LSP: [ID: 1]
      ID: path option unknown
      Removal Trigger: tunnel shutdown
LSP Tunnel pe2-auto_t4444 is signalled, connection is up
  InLabel  : FastEthernet2/0, implicit-null
```

```
  Prev Hop : 172.29.3.1
  OutLabel :  -
  RSVP Signalling Info:
       Src 2.2.2.2, Dst 3.3.3.3, Tun_Id 4444, Tun_Instance 2
    RSVP Path Info:
      My Address: 3.3.3.3
      Explicit Route:  NONE
      Record   Route:   NONE
      Tspec: ave rate=2048 kbits, burst=1000 bytes, peak rate=2048 kbits
    RSVP Resv Info:
      Record   Route:   NONE
      Fspec: ave rate=2048 kbits, burst=1000 bytes, peak rate=2048 kbits
P2MP TUNNELS:
P2MP SUB-LSPS:
pe2-dokki#trace 44.44.44.2 numeric
Type escape sequence to abort.
Tracing the route to 44.44.44.2
VRF info: (vrf in name/id, vrf out name/id)
  1 172.29.3.1 [MPLS: Label 32 Exp 0] 276 msec 76 msec 76 msec
  2 172.29.100.2 [MPLS: Label 32 Exp 0] 104 msec 76 msec 64 msec
  3 172.29.120.1 [MPLS: Label 32 Exp 0] 72 msec 80 msec 72 msec
  4 172.29.200.2 [MPLS: Label 32 Exp 0] 72 msec 28 msec 192 msec
  5 172.29.202.2 196 msec *  108 msec
pe2-dokki#ping 44.44.44.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/116/240 ms
```

ON CE's:

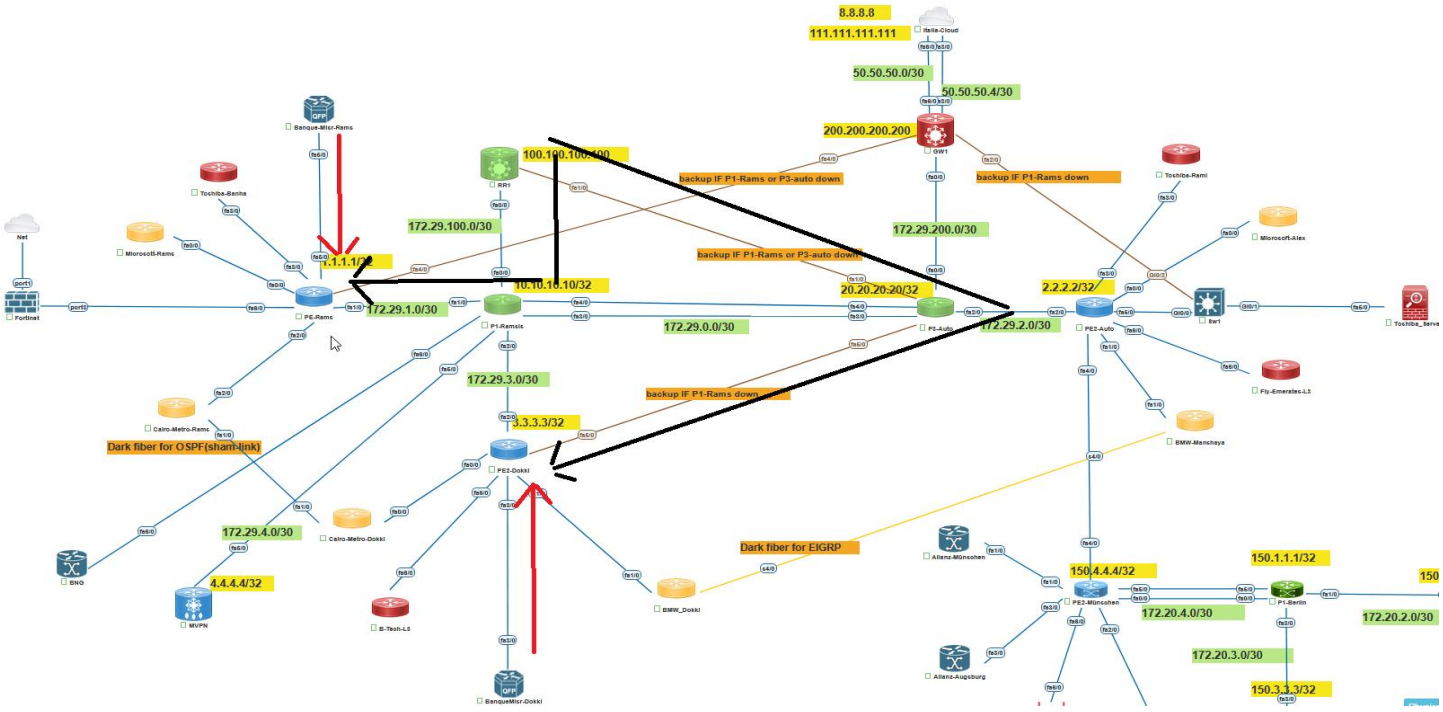
```
BMW-Dokki#trace 2.10.10.10
Type escape sequence to abort.
Tracing the route to 2.10.10.10
```

```
VRF info: (vrf in name/id, vrf out name/id)
  1 192.168.2.1 12 msec 44 msec 52 msec
  2 172.29.3.1 [MPLS: Labels 34/35 Exp 0] 136 msec 152 msec 124 msec
  3 172.29.100.2 [MPLS: Labels 35/35 Exp 0] 148 msec 124 msec 332 msec
  4 172.29.120.1 [MPLS: Labels 34/35 Exp 0] 124 msec 152 msec 140 msec
  5 172.29.200.2 [MPLS: Labels 35/35 Exp 0] 176 msec 164 msec 112 msec
  6 192.168.200.1 [MPLS: Label 35 Exp 0] 200 msec 116 msec 136 msec
  7 192.168.200.2 464 msec 364 msec *
BMW-Dokki#ping 2.10.10.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.10.10.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 96/148/248 ms
```

TE CE to CE using L2VPN:

Steps:

- create Bi-direction Tunnels (connect the two PE's use two tunnels to reach each other)
- Create pseudowire-class and under it use preferred-path interface Tunnel5555
- under the interface that connect the customer , after create the xconnec >> use with it pw-class > the pseudowire that I created up



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PE2-Dokki	PE-Rams
interface Tunnel5555 ip unnumbered Loopback0 tunnel mode mpls traffic-eng tunnel destination 3.3.3.3 tunnel mpls traffic-eng bandwidth 1024 ! 1M reserved for this tu tunnel mpls traffic-eng priority 0 0 tunnel mpls traffic-eng path-option 10 explicit name PE-Rams>P1-Rams>RR>P3-Auto>PE2-Dokki tunnel mpls traffic-eng path-option 20 dynamic ! ! ip explicit-path name PE-Rams>P1-Rams>RR>P3-Auto>PE2-Dokki enable index 1 next-address 172.29.1.1 index 2 next-address 172.29.100.2 index 3 next-address 172.29.120.1 index 4 next-address 172.29.203.2 ! ! int fa5/0 no sh duplex full ! ! int fa5/0.100 encapsulation dot1q 50 xconnect 1.1.1.1 100 encapsulation mpls pw-class Banque-Misr-HQ no sh ! ! pseudowire-class Banque-Misr-HQ encapsulation mpls interworking ethernet preferred-path interface Tunnel5555 ! !	interface Tunnel5555 ip unnumbered Loopback0 tunnel mode mpls traffic-eng tunnel destination 1.1.1.1 tunnel mpls traffic-eng bandwidth 1024 ! 1M reserved for this tu tunnel mpls traffic-eng priority 0 0 tunnel mpls traffic-eng path-option 10 explicit name PE2-Dokki>P3-Auto>RR>P1-Rams>PE-Rams tunnel mpls traffic-eng path-option 20 dynamic ! ! ip explicit-path name PE2-Dokki>P3-Auto>RR>P1-Rams>PE-Rams enable index 1 next-address 172.29.203.1 index 2 next-address 172.29.120.2 index 3 next-address 172.29.100.1 index 4 next-address 172.29.1.2 ! ! int fa3/0 no sh duplex full ! ! int fa3/0.100 encapsulation dot1q 50 xconnect 3.3.3.3 100 encapsulation mpls pw-class Banque-Misr-Dokki no sh ! ! pseudowire-class Banque-Misr-Dokki encapsulation mpls interworking ethernet preferred-path interface Tunnel5555 !

Shows:

```
pe-rams#sh ip rsvp interface

interface     rsvp       allocated  i/f max   flow max sub max   VRF

Fa1/0         ena        16384K     20M       20M       0

Fa4/0         ena        0          20M       20M       0

pe-rams#sh mpls  traffic-eng tunnels  tu5555

Name: pe-rams_t5555                        (Tunnel5555) Destination: 3.3.3.3

  Status:

    Admin: up         Oper: up     Path: valid       Signalling: connected

    path option 10, type explicit PE-Rams>P1-Rams>RR>P3-Auto>PE2-Dokki (Basis for Setup, path weight 100)

    path option 20, type dynamic

  Config Parameters:

    Bandwidth: 1024     kbps (Global)  Priority: 0  0   Affinity: 0x0/0xFFFF
```

```
  Metric Type: TE (default)
  AutoRoute: disabled LockDown: disabled Loadshare: 1024 [1953125] bw-based
  auto-bw: disabled
Active Path Option Parameters:
  State: explicit path option 10 is active
  BandwidthOverride: disabled  LockDown: disabled  Verbatim: disabled
InLabel  :  -
OutLabel : FastEthernet1/0, 30
Next Hop : 172.29.1.1
RSVP Signalling Info:
     Src 1.1.1.1, Dst 3.3.3.3, Tun_Id 5555, Tun_Instance 2
  RSVP Path Info:
    My Address: 172.29.1.2
    Explicit Route: 172.29.1.1 172.29.100.2 172.29.120.1 172.29.203.2
                    3.3.3.3
    Record   Route:   NONE
    Tspec: ave rate=1024 kbits, burst=1000 bytes, peak rate=1024 kbits
  RSVP Resv Info:
    Record   Route:   NONE
    Fspec: ave rate=1024 kbits, burst=1000 bytes, peak rate=1024 kbits
Shortest Unconstrained Path Info:
  Path Weight: 20 (TE)
  Explicit Route: 172.29.1.1 172.29.3.2 3.3.3.3
History:
  Tunnel:
    Time since created: 1 minutes, 44 seconds
    Time since path change: 45 seconds
    Number of LSP IDs (Tun_Instances) used: 2
  Current LSP: [ID: 2]
    Uptime: 45 seconds
    Selection: reoptimization
  Prior LSP: [ID: 1]
    ID: path option unknown
```

```
Removal Trigger: configuration changed
```

Some shows:

- **sh ip ospf database**
- **sh isis database**
- **sh ip rsvp interface**
- **sh cdp neighbor**
- **sh ip ospf database ipaque-area adv-router 100.0.0.6**
- **sh mpls traffic-eng tunnels**
- **sh mpls traffic-eng tunnels brief**
- **sh mpls traffic-eng tunnels summary**
- **sh mpls traffic-eng tunnels | sec Tunnel1111**
- **sh mpls interfaces**

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