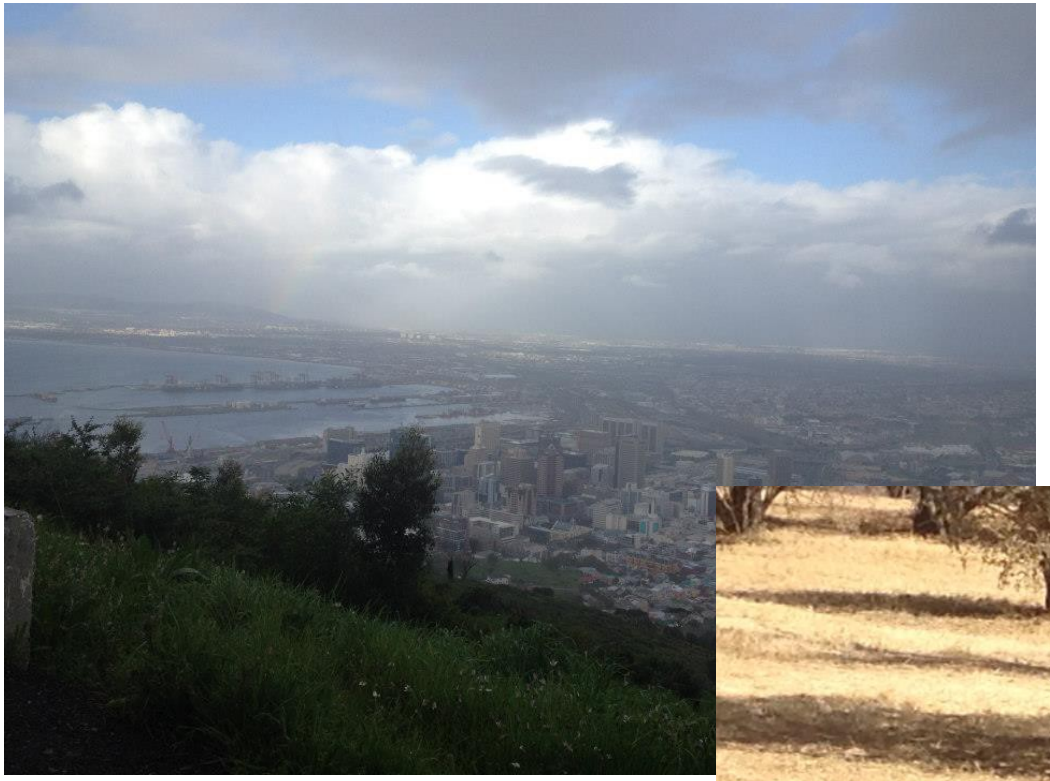
MPLS on practice with RouterOS

Case study. Implementation in the network of Skywire Technologies, Pty. South Africa

About me

- Alex Vishnyakov, Mikrotik trainer, Cisco CCNP, FreeBSD, Linux
- Main areas — BGP and dynamic routing, MPLS, security
- Currently working as ISP network team leader, Skywire Technologies Pty, South Africa

It's time for Africa



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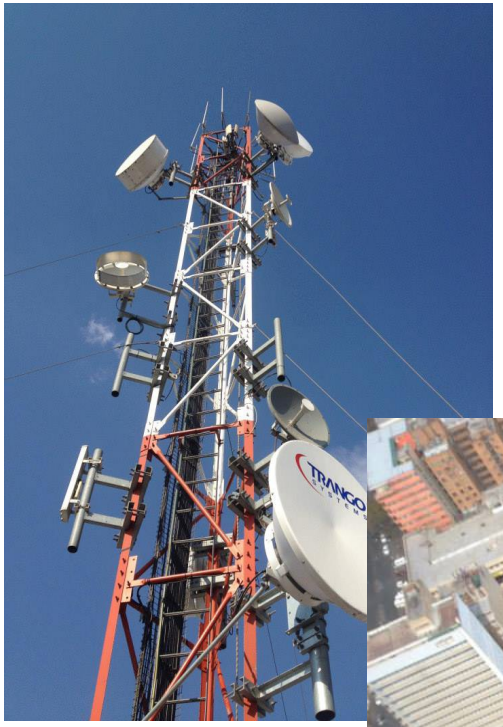
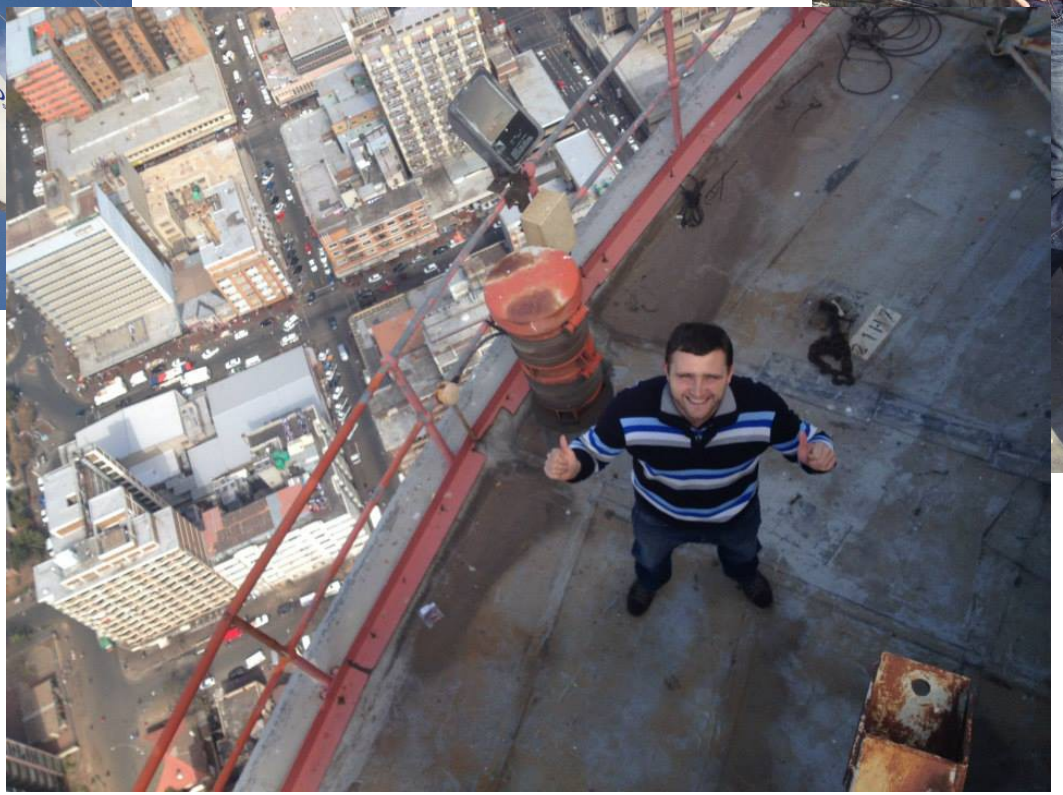




Network description

- B2B only services in SA
- Presence in all big cities of SA, more than 1500 Km wide network
- Over thousand of mid-size/large enterprises
- Last mile services for 2nd largiest Telco in SA
- Transit of IPv4, L2 and BGPv4 for small ISPs
- Many VPNs for corporates
- Over 100 big towers and several hundreds of APs

Tasks and goals

Transit and last mile services for ISPs :

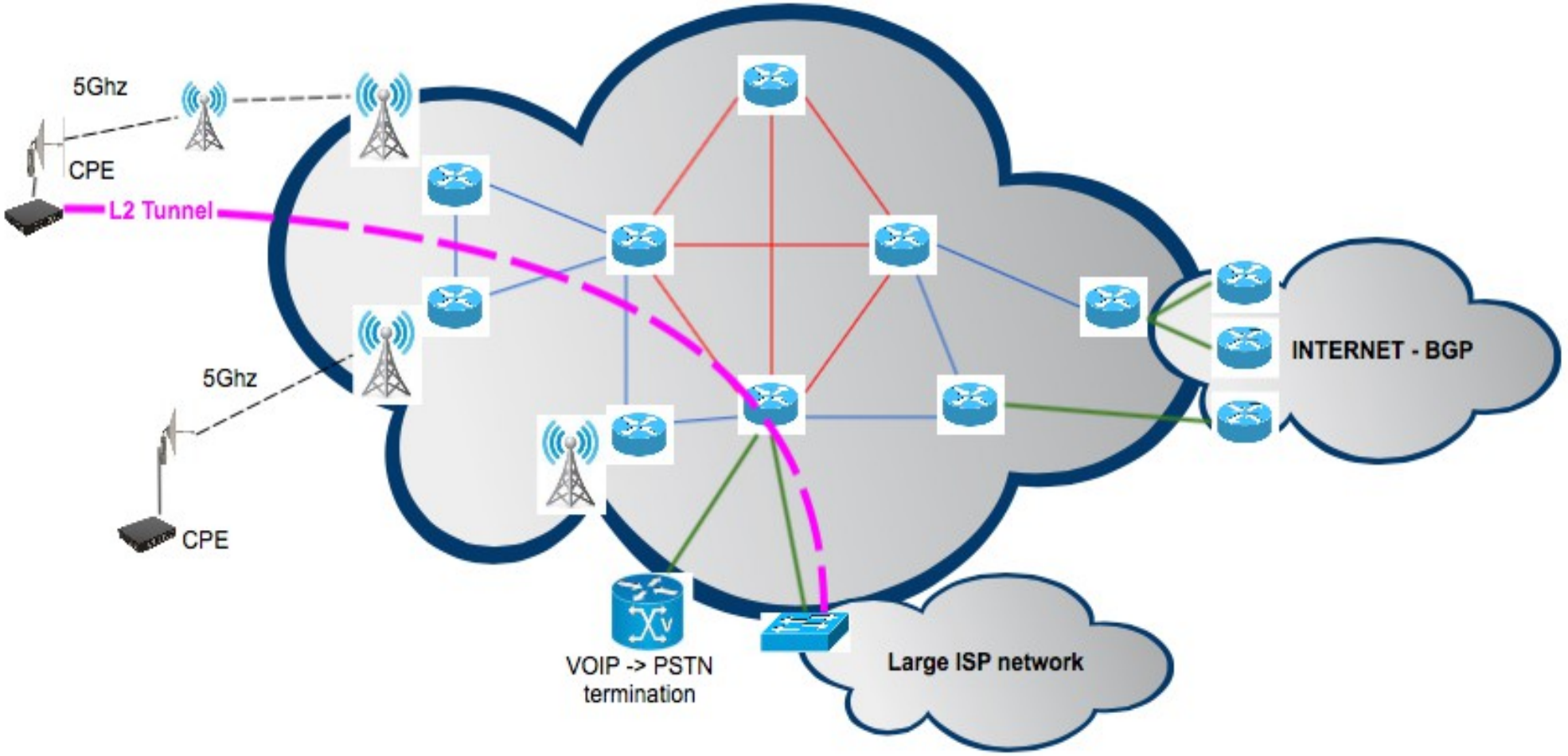
1. Provide hundreds of L2 tunnels for Large ISP
2. Provide L3 transit and BGPv4 transit for several smaller ISPs
3. Separate transit IPv4 traffic from our own IPv4 traffic

Internet and voice services for end users :

4. Provide VPN site to site tunnels for customers between branches. Point to point, point to multipoint.
5. Separate Voice, Internet and Management traffic and routing

Task 1 (solution: eoip, l2tp, vlans - ?)

1. Provide hundreds of L2 tunnels for Large ISP (last mile)



Task 1

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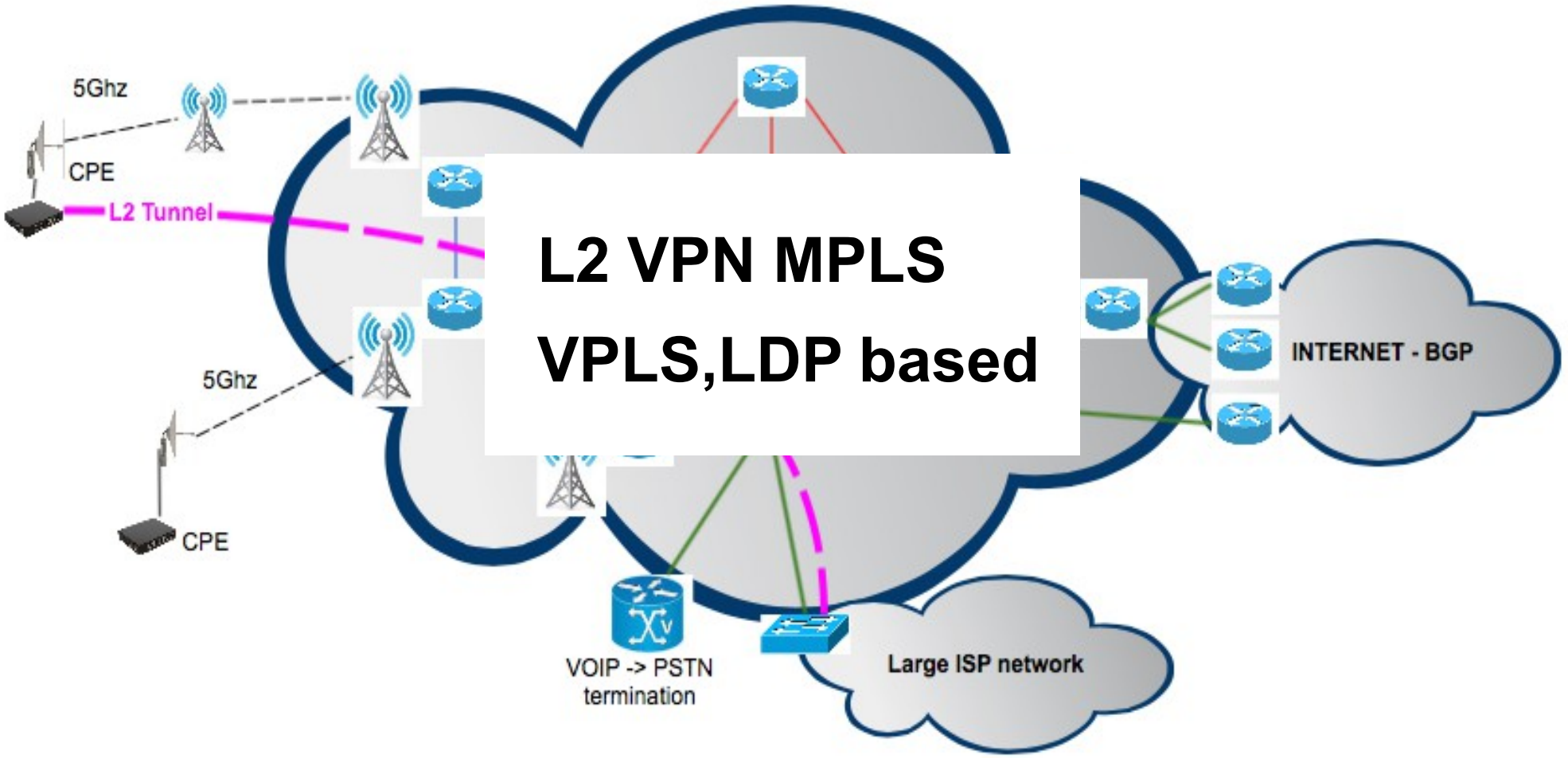
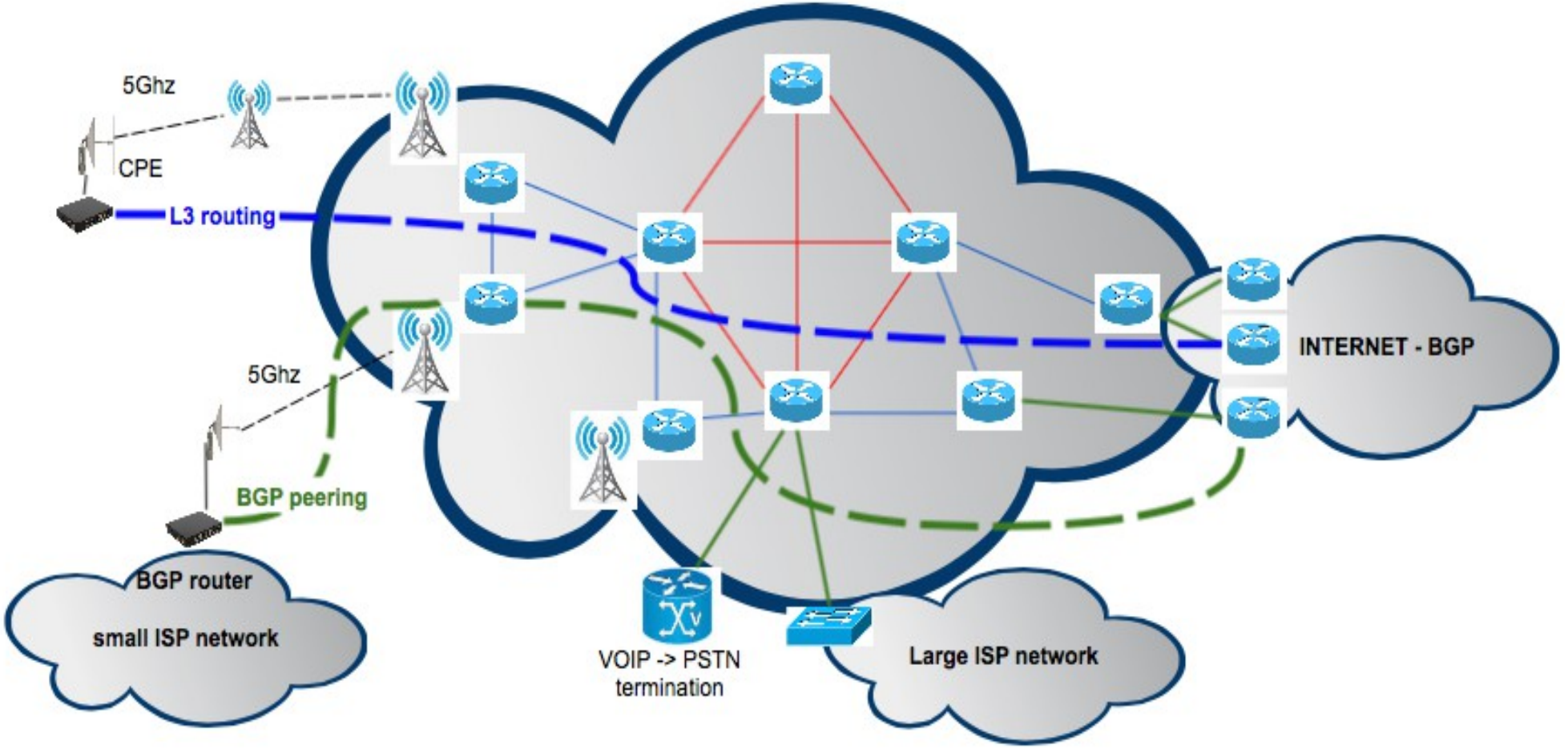


Task 2 (solution: static routes, ospf - ?)

2. Provide L3 transit(last mile) and BGPv4 transit for several smaller ISPs



Task 2

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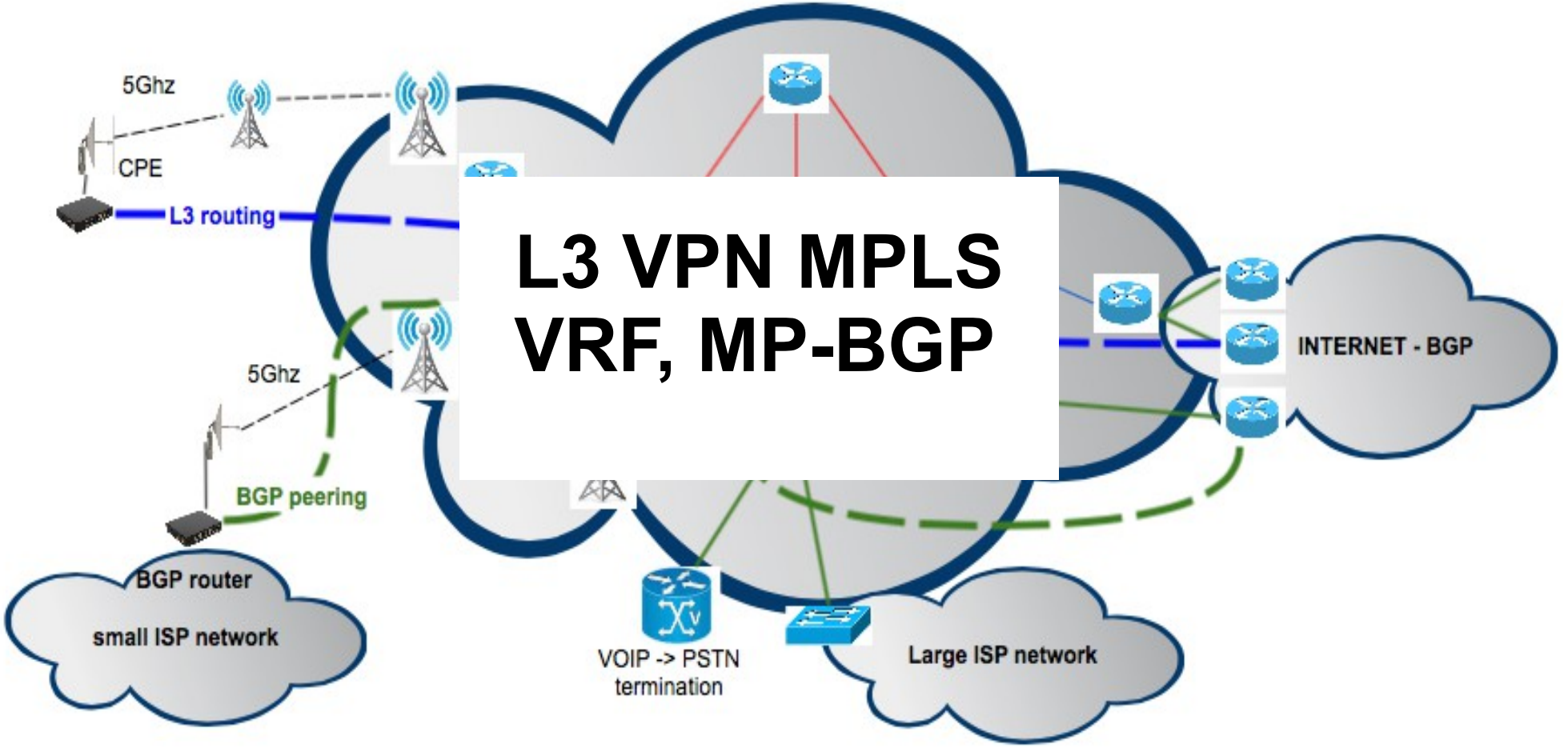
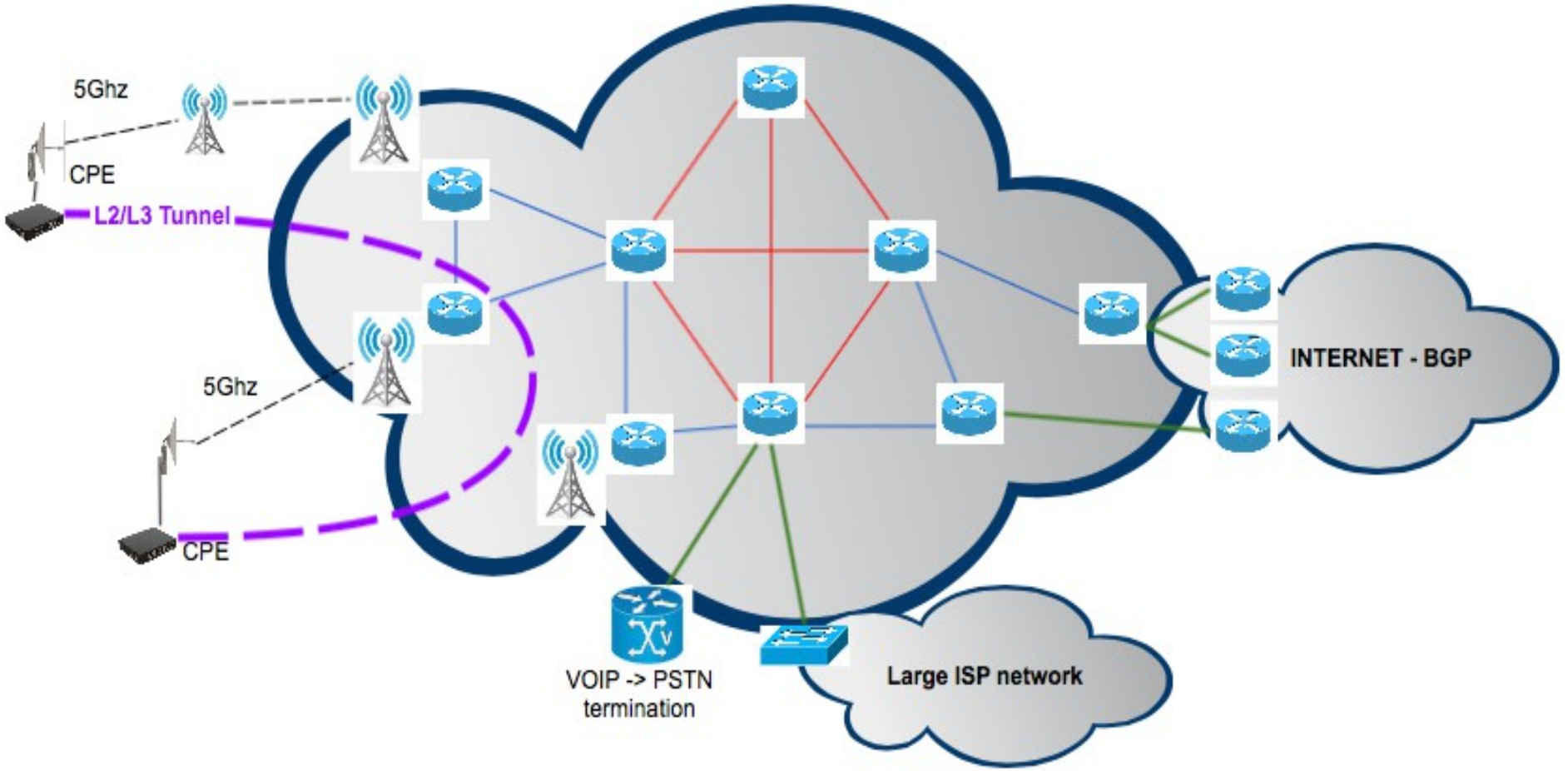


Task 4 (solution: eoip, l2tp, ipip, gre, pptp, ipsec - ?)

4. Provide VPN site to site tunnels for customers between branches. Point to point, point to multipoint



Task 4

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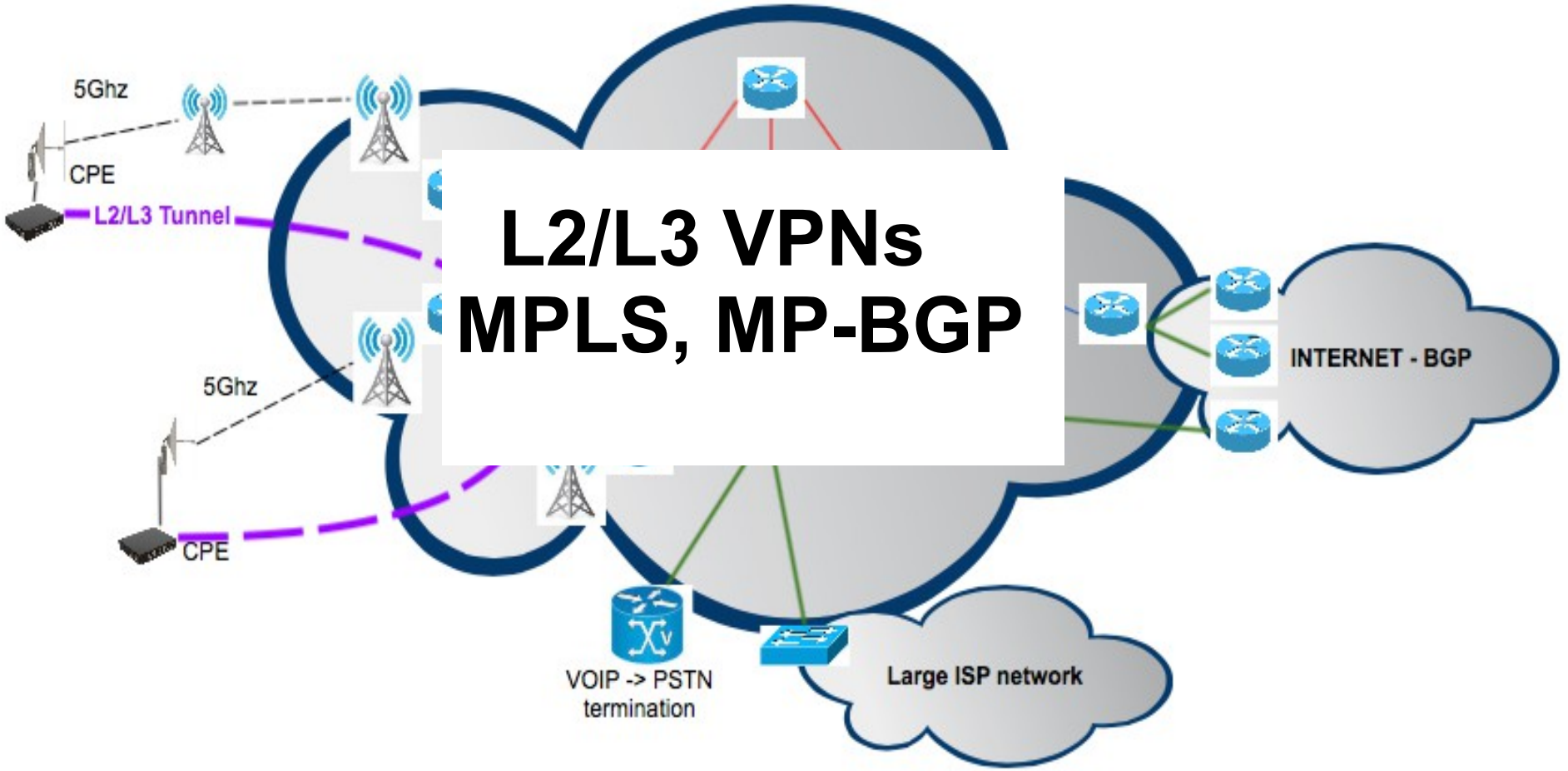
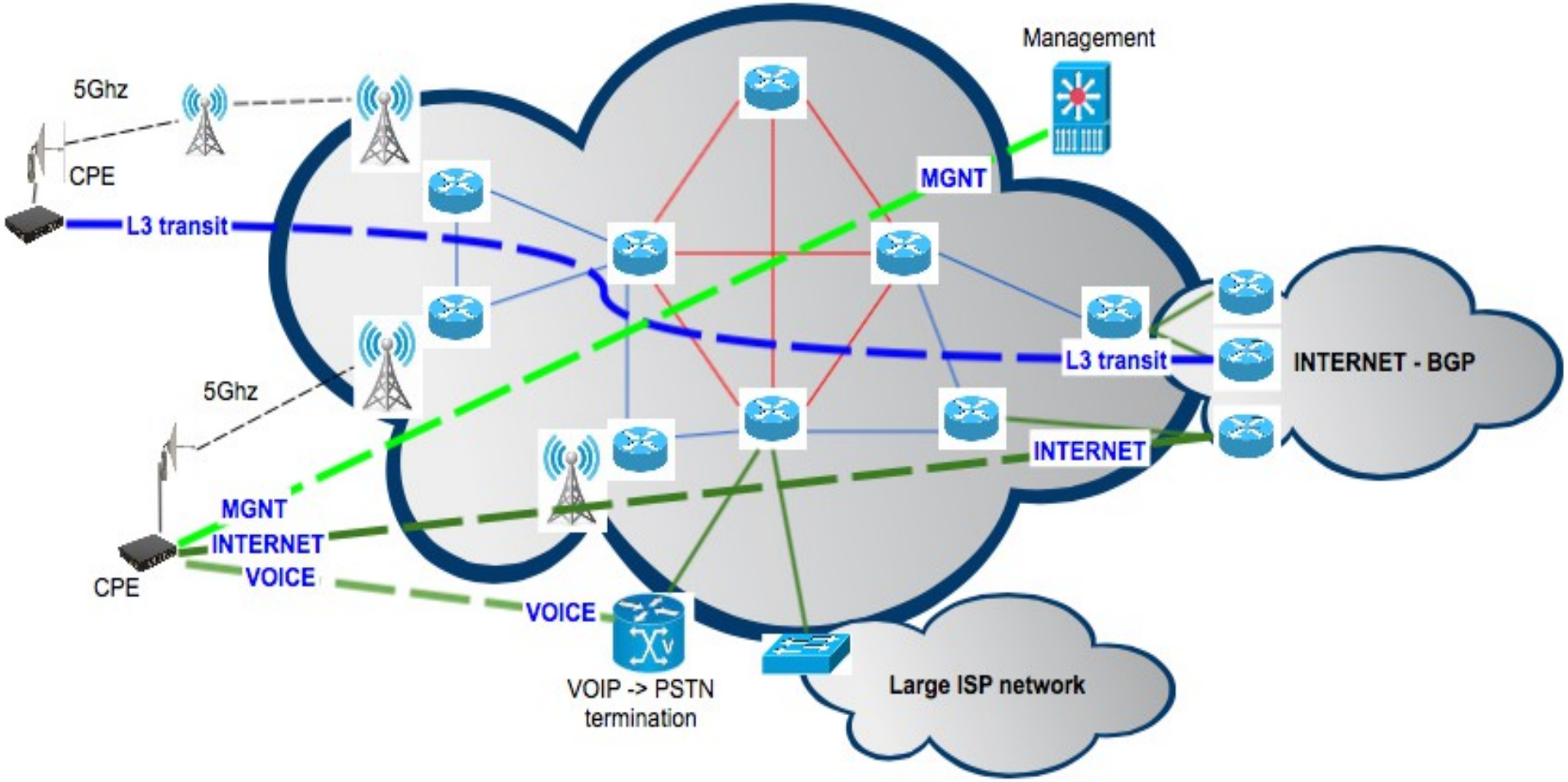


Task 3,5 (solution: different routers, PBR - ?)

3. Separate transit IPv4 traffic from our IPv4 customers

5. Separate Voice, Internet and Management traffic and routing



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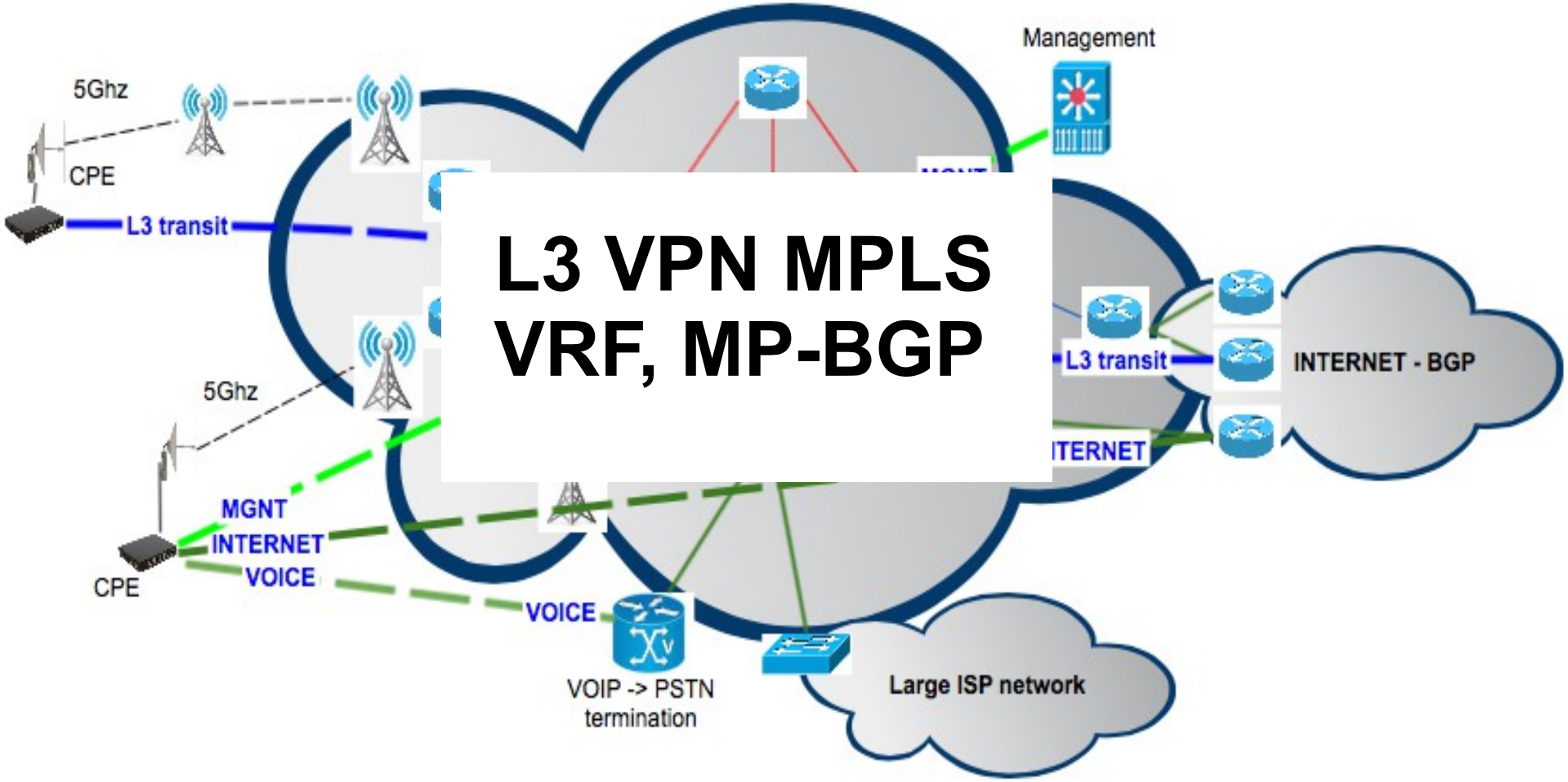


MPLS is the solution

One common, vendor-independent, strong technology for tunnels = MPLS

P and PE routers

Cisco, Juniper — not cheap at all

Linux, BSD — no stable implementation

Mikrotik — CCR routers

MPLS on Mikrotik (before we started ...)

Results of tests and case studies :

- Stable VPLS, MPLS switching, L2 tunnels

Presentations from MUMs of Tierry Wehr (2014), Tomas Kirnak (2013), Pat Harris (2013)

- Unstable VRFs ?

http://forum.mikrotik.com/viewtopic.php?t=73820

Implementation output (… after we finished)

VPLS

- L2 tunnels are stable, both MP-BPG and LDP based

- Be careful with MTU on switches

VRF

- By itself is stable in latest RouterOS version (>6.5)

- PPPoE cannot bind to VRF dynamically → we use DHCP

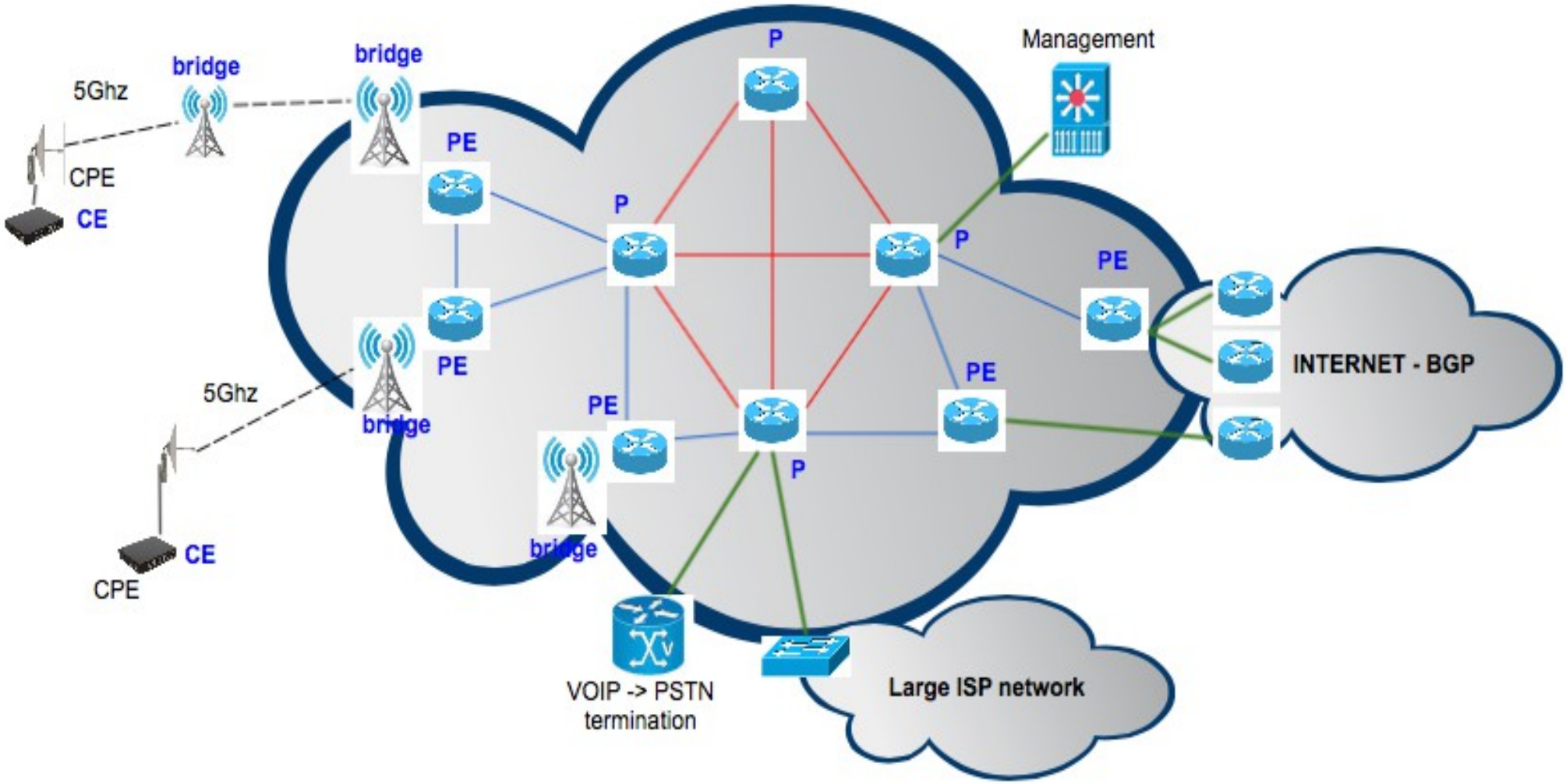
- Traceroute inside VRFs not shown→ we don't propogate TTL

- VRF route leaking issues → we use additional routers

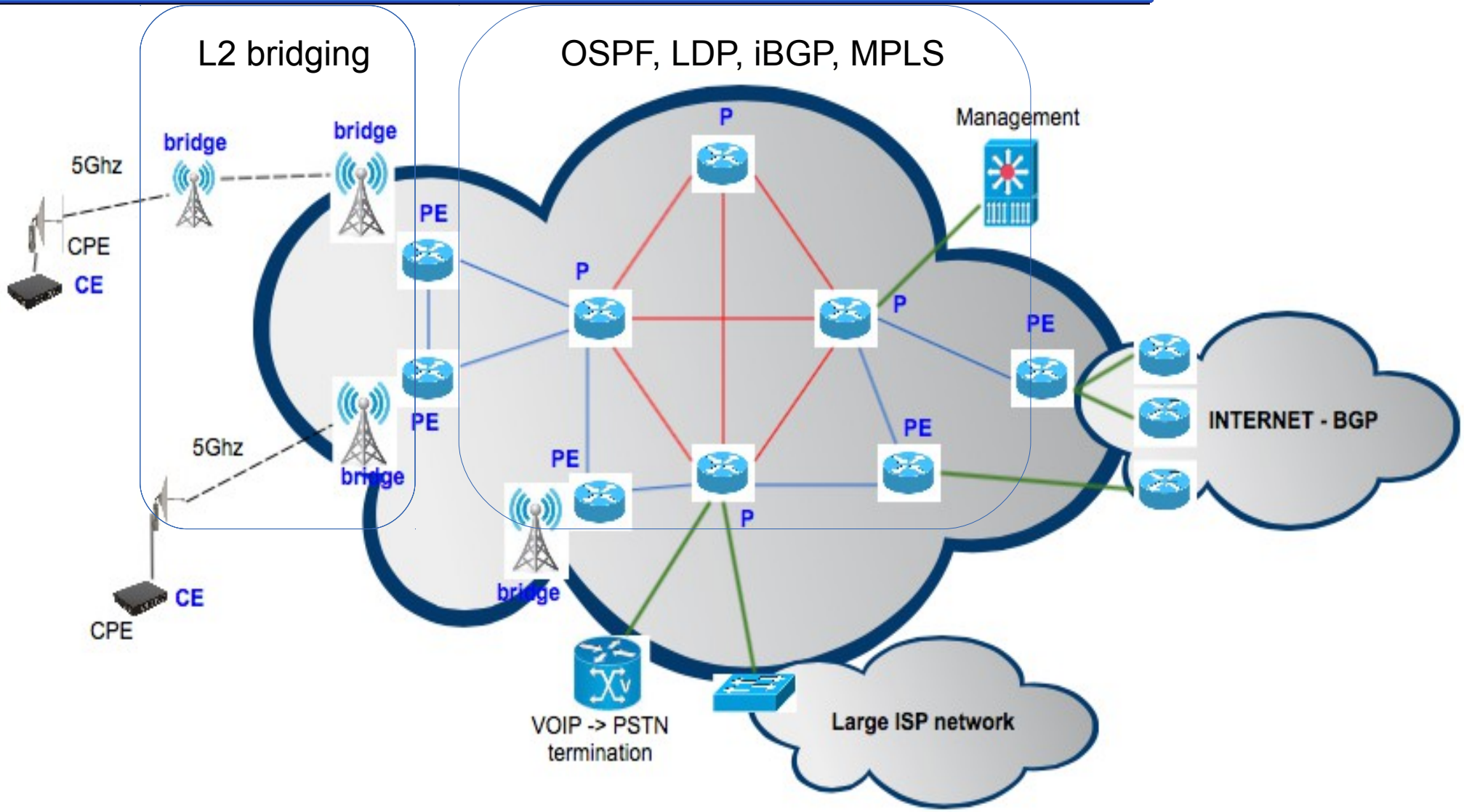
- Route withdraw. Sometimes VRF has static/dynamic routes withdraw problem … (we don't use dynamic routing between PE-CE). → we have connected routes mainly + work carefully with redistribution of static

- VRF BGP path selection has issues with choosing right BGP metric → we use filter with distance manipulation

MPLS topology



MPLS topology



Let's implement MPLS

Steps :

1. Bring customer on L2 to PE router
2. OSPF on Distribution/Core layer
3. LDP activation between PE, P routers, MPLS tags
4. iBGP, Route reflectors configuration
5. MP-BGP activation
6. L2 VPLS configuration (LDP based)
7. VRF configuration(L3 tunnels, isolation of traffic)

Step 1 — L2 bridging

Bring customer on L2 to PE router

Advantages:

- no need for /30 networks, can be used /24 for all users on one PE
- each customer appear on PE as interface, so we can put him to VPLS or VRF
- different VLANs for different services
- VRF works fine in that setup :-)

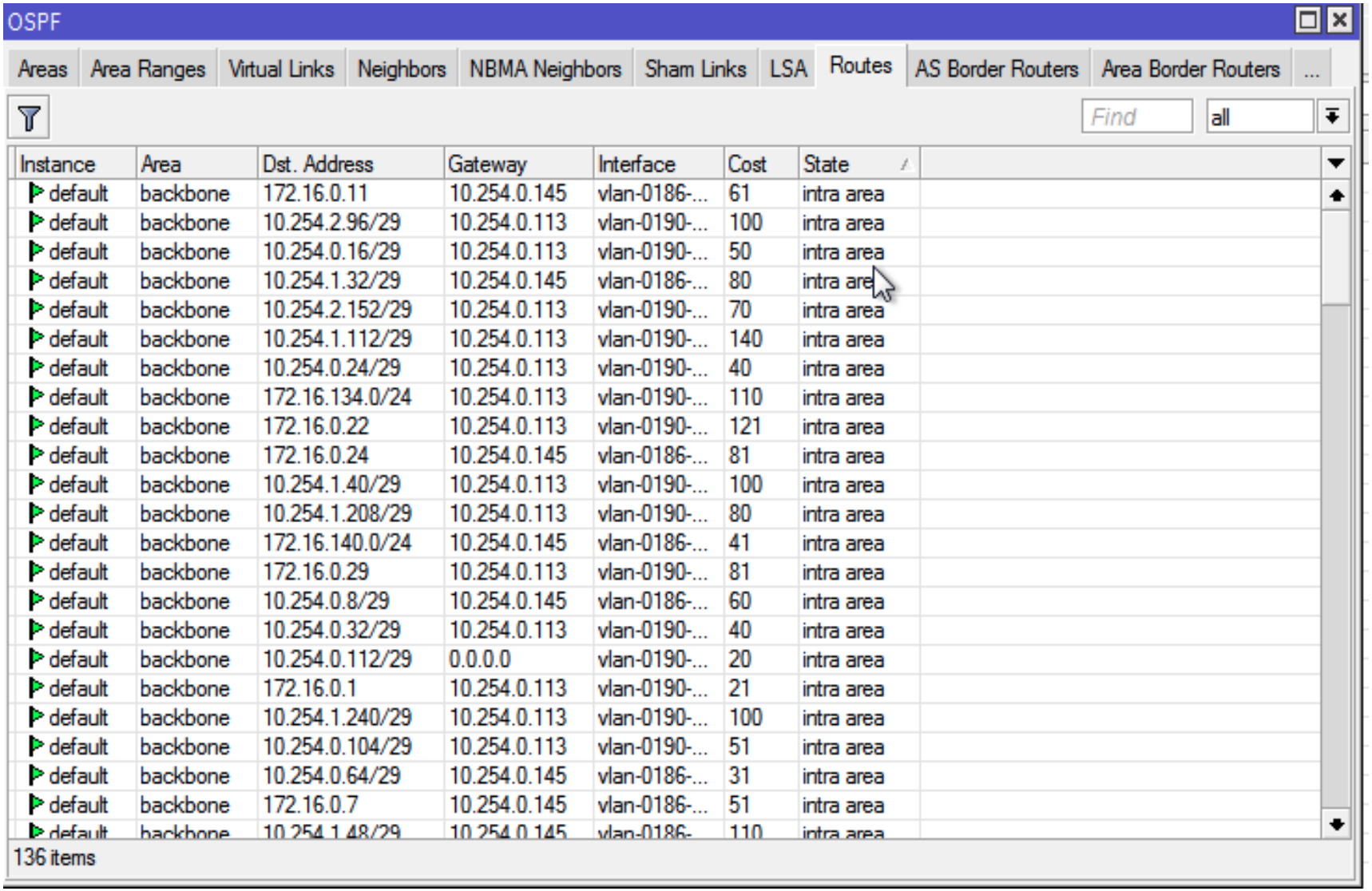
Disadvantages:

- Large L2 domains (broadcasts)
- CPEs on one L2 line (can see each other)

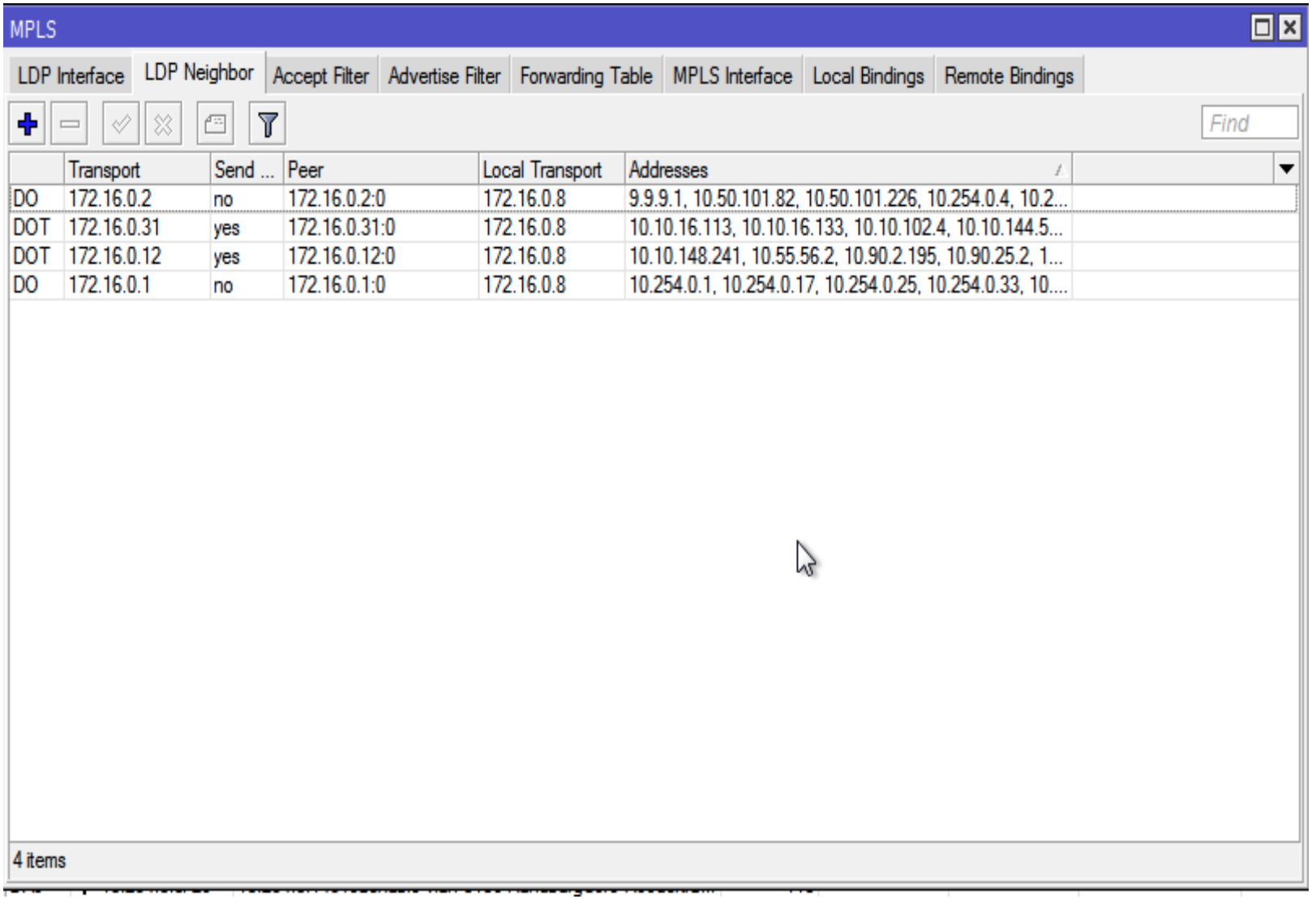
ToDo:

- No «default forward» on wireless
- Port isolation (PVLAN isolated) on switches, split horizon on bridges

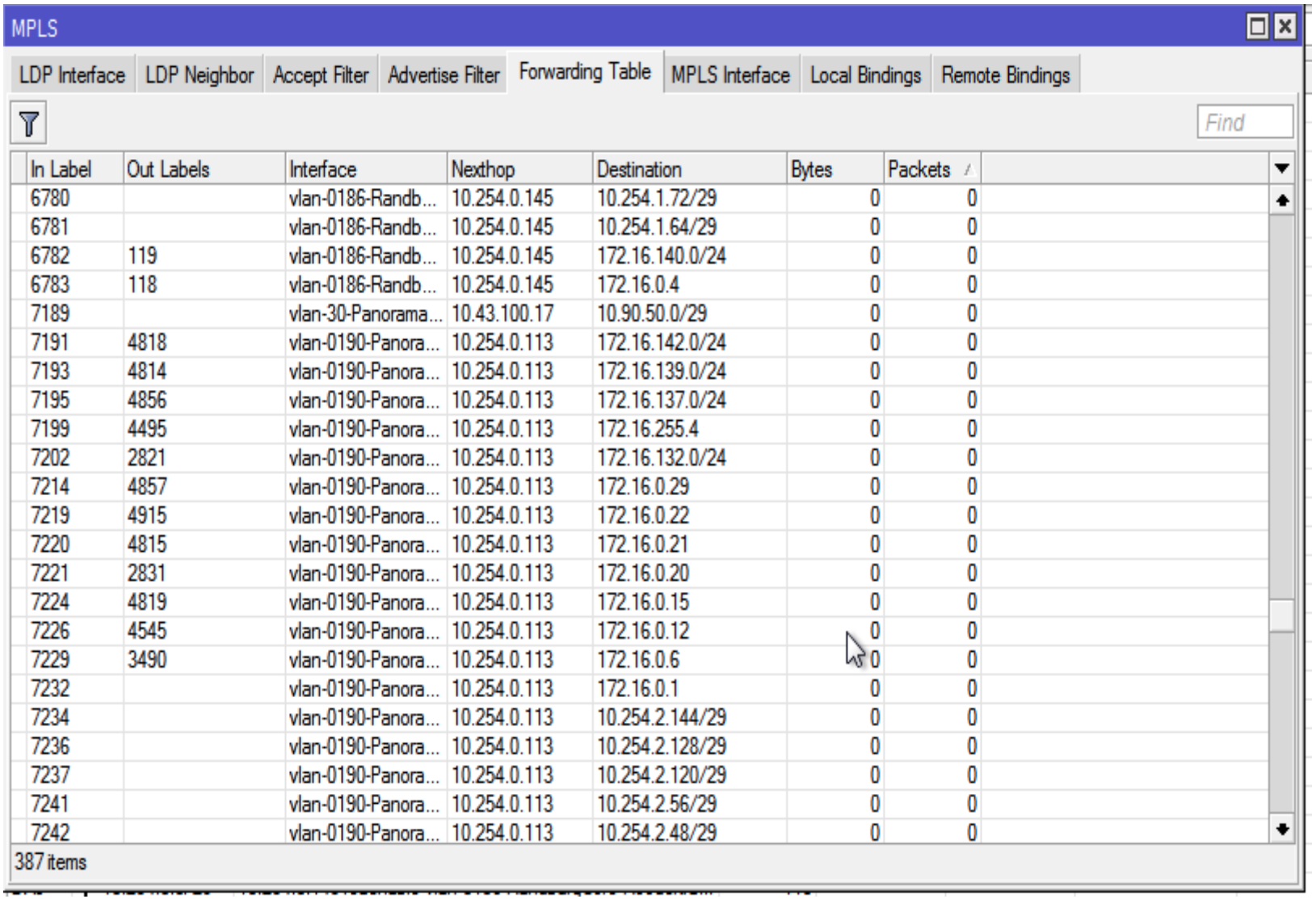
Step 2 — OSPF in core/distribution



Step 3 — LDP activation



Step 3 — MPLS tags

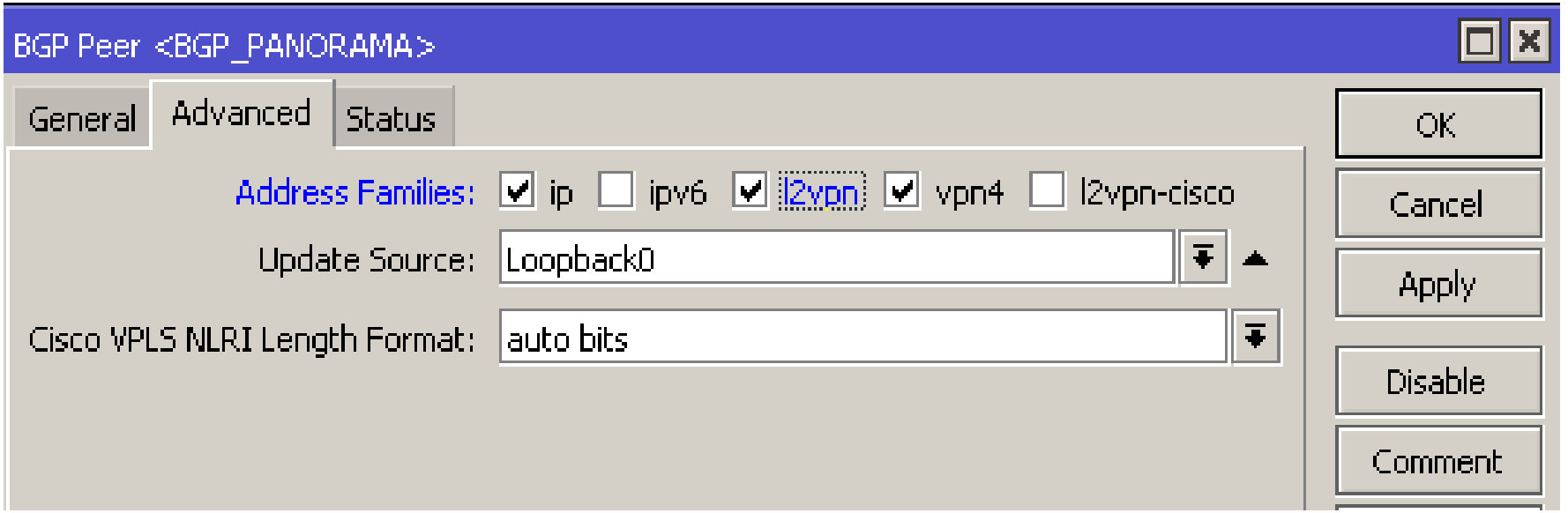


In Label	Out Labels	Interface	Nexthop	Destination	Bytes	Packets
6780		vlan-0186-Randb...	10.254.0.145	10.254.1.72/29	0	0
6781		vlan-0186-Randb...	10.254.0.145	10.254.1.64/29	0	0
6782	119	vlan-0186-Randb...	10.254.0.145	172.16.140.0/24	0	0
6783	118	vlan-0186-Randb...	10.254.0.145	172.16.0.4	0	0
7189		vlan-30-Panorama...	10.43.100.17	10.90.50.0/29	0	0
7191	4818	vlan-0190-Panora...	10.254.0.113	172.16.142.0/24	0	0
7193	4814	vlan-0190-Panora...	10.254.0.113	172.16.139.0/24	0	0
7195	4856	vlan-0190-Panora...	10.254.0.113	172.16.137.0/24	0	0
7199	4495	vlan-0190-Panora...	10.254.0.113	172.16.255.4	0	0
7202	2821	vlan-0190-Panora...	10.254.0.113	172.16.132.0/24	0	0
7214	4857	vlan-0190-Panora...	10.254.0.113	172.16.0.29	0	0
7219	4915	vlan-0190-Panora...	10.254.0.113	172.16.0.22	0	0
7220	4815	vlan-0190-Panora...	10.254.0.113	172.16.0.21	0	0
7221	2831	vlan-0190-Panora...	10.254.0.113	172.16.0.20	0	0
7224	4819	vlan-0190-Panora...	10.254.0.113	172.16.0.15	0	0
7226	4545	vlan-0190-Panora...	10.254.0.113	172.16.0.12	0	0
7229	3490	vlan-0190-Panora...	10.254.0.113	172.16.0.6	0	0
7232		vlan-0190-Panora...	10.254.0.113	172.16.0.1	0	0
7234		vlan-0190-Panora...	10.254.0.113	10.254.2.144/29	0	0
7236		vlan-0190-Panora...	10.254.0.113	10.254.2.128/29	0	0
7237		vlan-0190-Panora...	10.254.0.113	10.254.2.120/29	0	0
7241		vlan-0190-Panora...	10.254.0.113	10.254.2.56/29	0	0
7242		vlan-0190-Panora...	10.254.0.113	10.254.2.48/29	0	0

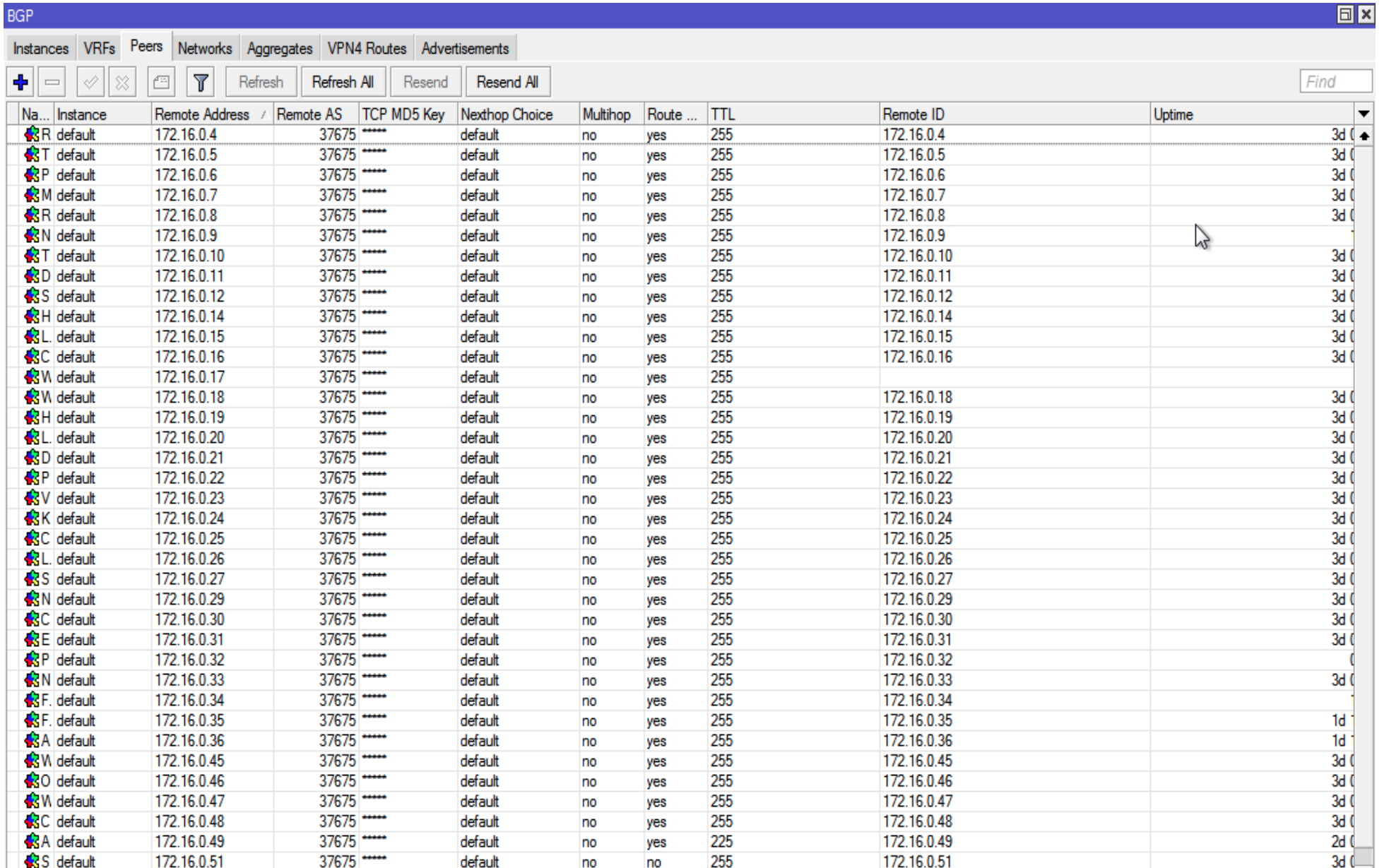
387 items

Step 4 — Address family

MP-BGP configuration

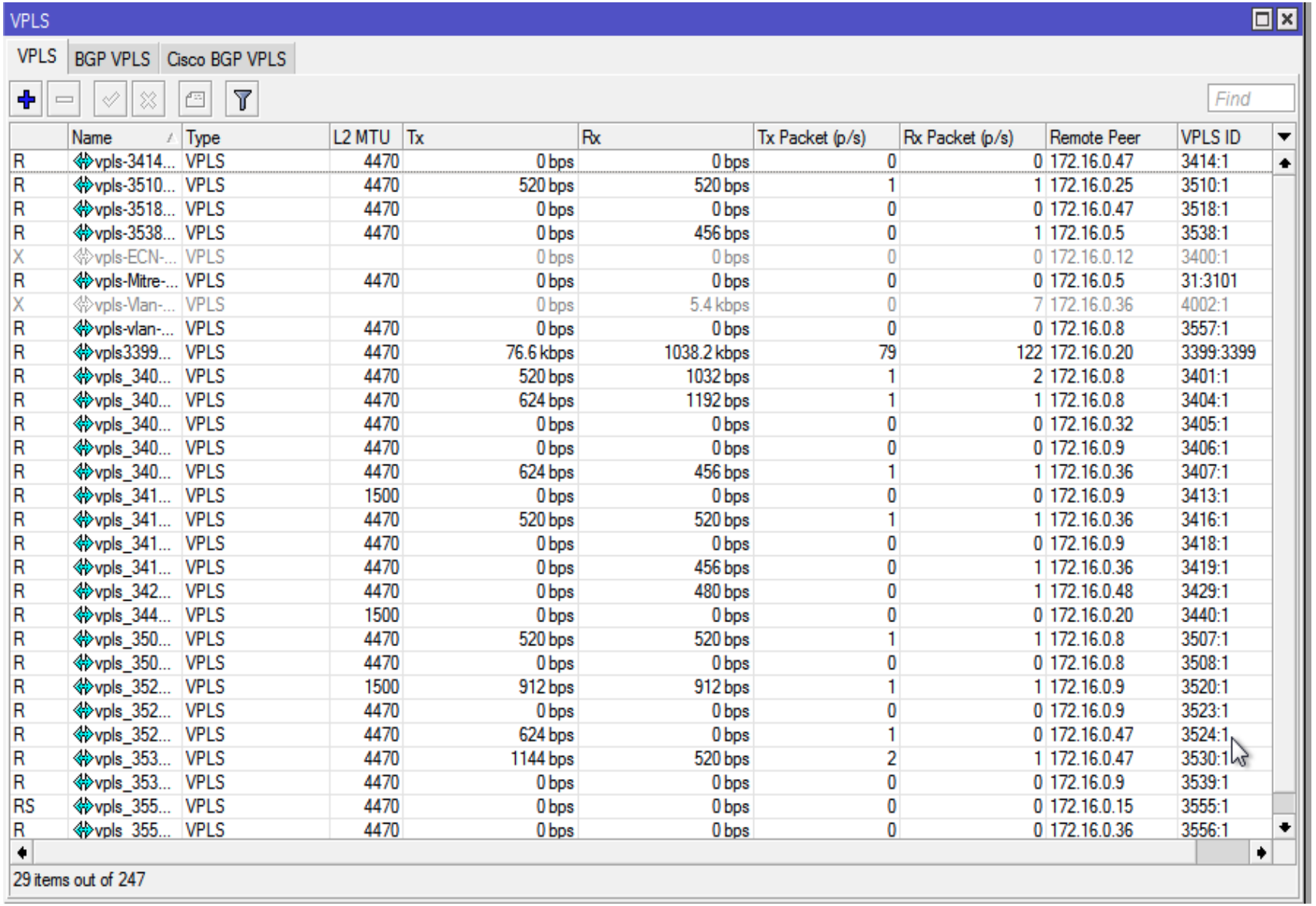


Step 5 — iBGP RR



Na...	Instance	Remote Address	Remote AS	TCP MD5 Key	Nexthop Choice	Multihop	Route ...	TTL	Remote ID	Uptime
R	default	172.16.0.4	37675	*****	default	no	yes	255	172.16.0.4	3d 0
T	default	172.16.0.5	37675	*****	default	no	yes	255	172.16.0.5	3d 0
P	default	172.16.0.6	37675	*****	default	no	yes	255	172.16.0.6	3d 0
M	default	172.16.0.7	37675	*****	default	no	yes	255	172.16.0.7	3d 0
R	default	172.16.0.8	37675	*****	default	no	yes	255	172.16.0.8	3d 0
N	default	172.16.0.9	37675	*****	default	no	yes	255	172.16.0.9	
T	default	172.16.0.10	37675	*****	default	no	yes	255	172.16.0.10	3d 0
D	default	172.16.0.11	37675	*****	default	no	yes	255	172.16.0.11	3d 0
S	default	172.16.0.12	37675	*****	default	no	yes	255	172.16.0.12	3d 0
H	default	172.16.0.14	37675	*****	default	no	yes	255	172.16.0.14	3d 0
L.	default	172.16.0.15	37675	*****	default	no	yes	255	172.16.0.15	3d 0
C	default	172.16.0.16	37675	*****	default	no	yes	255	172.16.0.16	3d 0
W	default	172.16.0.17	37675	*****	default	no	yes	255		
W	default	172.16.0.18	37675	*****	default	no	yes	255	172.16.0.18	3d 0
H	default	172.16.0.19	37675	*****	default	no	yes	255	172.16.0.19	3d 0
L.	default	172.16.0.20	37675	*****	default	no	yes	255	172.16.0.20	3d 0
D	default	172.16.0.21	37675	*****	default	no	yes	255	172.16.0.21	3d 0
P	default	172.16.0.22	37675	*****	default	no	yes	255	172.16.0.22	3d 0
V	default	172.16.0.23	37675	*****	default	no	yes	255	172.16.0.23	3d 0
K	default	172.16.0.24	37675	*****	default	no	yes	255	172.16.0.24	3d 0
C	default	172.16.0.25	37675	*****	default	no	yes	255	172.16.0.25	3d 0
L.	default	172.16.0.26	37675	*****	default	no	yes	255	172.16.0.26	3d 0
S	default	172.16.0.27	37675	*****	default	no	yes	255	172.16.0.27	3d 0
N	default	172.16.0.29	37675	*****	default	no	yes	255	172.16.0.29	3d 0
C	default	172.16.0.30	37675	*****	default	no	yes	255	172.16.0.30	3d 0
E	default	172.16.0.31	37675	*****	default	no	yes	255	172.16.0.31	3d 0
P	default	172.16.0.32	37675	*****	default	no	yes	255	172.16.0.32	0
N	default	172.16.0.33	37675	*****	default	no	yes	255	172.16.0.33	3d 0
F.	default	172.16.0.34	37675	*****	default	no	yes	255	172.16.0.34	
F.	default	172.16.0.35	37675	*****	default	no	yes	255	172.16.0.35	1d 1
A	default	172.16.0.36	37675	*****	default	no	yes	255	172.16.0.36	1d 1
W	default	172.16.0.45	37675	*****	default	no	yes	255	172.16.0.45	3d 0
O	default	172.16.0.46	37675	*****	default	no	yes	255	172.16.0.46	3d 0
W	default	172.16.0.47	37675	*****	default	no	yes	255	172.16.0.47	3d 0
C	default	172.16.0.48	37675	*****	default	no	yes	255	172.16.0.48	3d 0
A	default	172.16.0.49	37675	*****	default	no	yes	225	172.16.0.49	2d 0
S	default	172.16.0.51	37675	*****	default	no	no	255	172.16.0.51	3d 0

Step 6 — VPLS setups



	Name	Type	L2 MTU	Tx	Rx	Tx Packet (p/s)	Rx Packet (p/s)	Remote Peer	VPLS ID
R	vpls-3414...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.47	3414:1
R	vpls-3510...	VPLS	4470	520 bps	520 bps	1	1	172.16.0.25	3510:1
R	vpls-3518...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.47	3518:1
R	vpls-3538...	VPLS	4470	0 bps	456 bps	0	1	172.16.0.5	3538:1
X	vpls-ECN-...	VPLS		0 bps	0 bps	0	0	172.16.0.12	3400:1
R	vpls-Mitre-...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.5	31:3101
X	vpls-Vlan-...	VPLS		0 bps	5.4 kbps	0	7	172.16.0.36	4002:1
R	vpls-vlan-...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.8	3557:1
R	vpls3399...	VPLS	4470	76.6 kbps	1038.2 kbps	79	122	172.16.0.20	3399:3399
R	vpls_340...	VPLS	4470	520 bps	1032 bps	1	2	172.16.0.8	3401:1
R	vpls_340...	VPLS	4470	624 bps	1192 bps	1	1	172.16.0.8	3404:1
R	vpls_340...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.32	3405:1
R	vpls_340...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.9	3406:1
R	vpls_340...	VPLS	4470	624 bps	456 bps	1	1	172.16.0.36	3407:1
R	vpls_341...	VPLS	1500	0 bps	0 bps	0	0	172.16.0.9	3413:1
R	vpls_341...	VPLS	4470	520 bps	520 bps	1	1	172.16.0.36	3416:1
R	vpls_341...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.9	3418:1
R	vpls_341...	VPLS	4470	0 bps	456 bps	0	1	172.16.0.36	3419:1
R	vpls_342...	VPLS	4470	0 bps	480 bps	0	1	172.16.0.48	3429:1
R	vpls_344...	VPLS	1500	0 bps	0 bps	0	0	172.16.0.20	3440:1
R	vpls_350...	VPLS	4470	520 bps	520 bps	1	1	172.16.0.8	3507:1
R	vpls_350...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.8	3508:1
R	vpls_352...	VPLS	1500	912 bps	912 bps	1	1	172.16.0.9	3520:1
R	vpls_352...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.9	3523:1
R	vpls_352...	VPLS	4470	624 bps	0 bps	1	0	172.16.0.47	3524:1
R	vpls_353...	VPLS	4470	1144 bps	520 bps	2	1	172.16.0.47	3530:1
R	vpls_353...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.9	3539:1
RS	vpls_355...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.15	3555:1
R	vpls_355...	VPLS	4470	0 bps	0 bps	0	0	172.16.0.36	3556:1

29 items out of 247

Step 7 — VRF setup

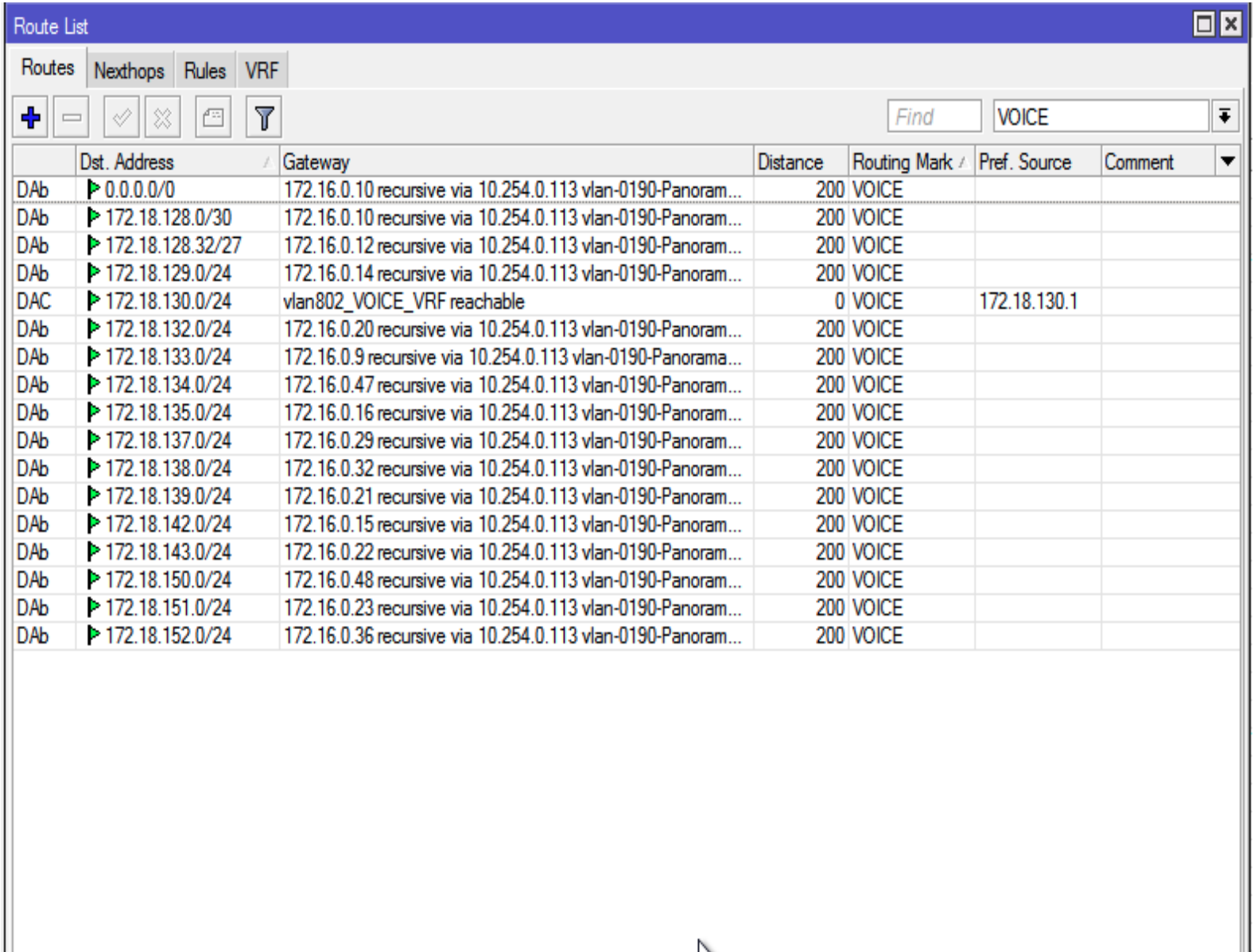
Route List

Routes | Nexthops | Rules | VRF

Find: INTERNET

	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source	Comment
DAb	0.0.0.0/0	172.16.0.6 recursive via 10.254.0.113 vlan-0190-Panorama...	200	INTERNET		
DAb	10.55.56.0/24	172.16.0.12 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.184.0/30	172.16.0.6 recursive via 10.254.0.113 vlan-0190-Panorama...	200	INTERNET		
DAC	41.78.184.28/30	vlan-222-Weame-Cresta-Internet reachable	0	INTERNET	41.78.184.29	
DAb	41.78.184.32/30	172.16.0.51 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.184.56/30	172.16.0.21 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.184.60/30	172.16.0.21 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.184.72/30	172.16.0.26 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.184.76/30	172.16.0.26 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAC	41.78.184.128/29	vlan803_INTERNET_VRF reachable	0	INTERNET	41.78.184.129	
DAb	41.78.184.136/30	172.16.0.21 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.184.140/30	172.16.0.9 recursive via 10.254.0.113 vlan-0190-Panorama...	200	INTERNET		
DAC	41.78.184.144/30	vlan803_INTERNET_VRF reachable	0	INTERNET	41.78.184.145	
DAb	41.78.184.148/30	172.16.0.5 recursive via 10.254.0.113 vlan-0190-Panorama...	200	INTERNET		
DAb	41.78.184.152/29	172.16.0.12 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.184.160/30	172.16.0.11 recursive via 10.254.0.145 vlan-0186-Randburg...	200	INTERNET		
DAb	41.78.184.176/29	172.16.0.16 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAC	41.78.184.184/29	vlan-4021-IntuateInternet reachable	0	INTERNET	41.78.184.185	
DAb	41.78.184.212/30	172.16.0.24 recursive via 10.254.0.145 vlan-0186-Randburg...	200	INTERNET		
DAb	41.78.184.240/30	172.16.0.19 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.184.248/30	172.16.0.5 recursive via 10.254.0.113 vlan-0190-Panorama...	200	INTERNET		
DAb	41.78.185.20/30	172.16.0.51 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.185.24/30	172.16.0.51 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.185.28/30	172.16.0.21 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
AS	41.78.185.32/30	41.78.187.136 on INTERNET reachable vlan803_INTERN...	1	INTERNET		
DAb	41.78.185.48/29	172.16.0.14 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.185.76/30	172.16.0.19 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.185.80/29	172.16.0.23 recursive via 10.254.0.113 vlan-0190-Panoram...	200	INTERNET		
DAb	41.78.185.96/28	172.16.0.9 recursive via 10.254.0.113 vlan-0190-Panorama...	200	INTERNET		
DAb	41.78.185.112/29	172.16.0.5 recursive via 10.254.0.113 vlan-0190-Panorama...	200	INTERNET		
DAb	41.78.185.216	172.16.0.9 recursive via 10.254.0.113 vlan-0190-Panorama...	200	INTERNET		

Step 7 — VRF setup



	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source	Comment
DAb	0.0.0.0/0	172.16.0.10 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.128.0/30	172.16.0.10 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.128.32/27	172.16.0.12 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.129.0/24	172.16.0.14 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAC	172.18.130.0/24	vlan802_VOICE_VRF reachable	0	VOICE	172.18.130.1	
DAb	172.18.132.0/24	172.16.0.20 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.133.0/24	172.16.0.9 recursive via 10.254.0.113 vlan-0190-Panorama...	200	VOICE		
DAb	172.18.134.0/24	172.16.0.47 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.135.0/24	172.16.0.16 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.137.0/24	172.16.0.29 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.138.0/24	172.16.0.32 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.139.0/24	172.16.0.21 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.142.0/24	172.16.0.15 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.143.0/24	172.16.0.22 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.150.0/24	172.16.0.48 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.151.0/24	172.16.0.23 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		
DAb	172.18.152.0/24	172.16.0.36 recursive via 10.254.0.113 vlan-0190-Panoram...	200	VOICE		

Conclusion

Prerequisites

- At lease MTCINE training

Advantages:

- Not expensive solid MPLS solution
- Fast, reliable L2 tunnels
- Use VRF if you have similar setup to ours
- Smart routing and TE can be implemented

Disadvantages:

- Not full L3 VRF features (route leaking, route withdraw)
- Don't provide L3 site to site tunnels over MPLS yet

MPLS on practice

Thank you

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