Performance and Scale

This chapter includes the following major topics:

- Internet Peering Application, page 6-2
- 100G Edge and Core-Facing Ports, page 6-5

Two types of scalability numbers exist for L3VPN: 1-Dimensional (1D) and Multi-Dimensional (MD). The 1D scale numbers only show scale of L3VPN as a single service running on ASR9000, which is not realistic from a deployment standpoint because a L3VPN PE in an Enterprise or service provider network would usually have mixed services and features, hence we tested and certified the MD scale profile for L3VPN PE.

Table 6-1 captures the MD scale numbers of L3VPN PE Profile with all services and features enabled simultaneously on a PE in a realistic deployment environment.

Table 6-1   ***ASR9k L3VPN PE Profile Multi-Dimensional Scale Numbers***

Feature	Parameters	Scale
L3 Interfaces	Qot1q, qinq, Ethernet	4k
	ATM, POS, FR, CE, TDM, HDLC, etc.	6k
MPLS VPNv4	IPv4 VRF Sessions (2 to 3 interfaces per VRF)	4k
	VPNv4 Prefixes	2M
	PE-CE Routing	
	eBGP with NSR, MD5, and lower KA-HT	4k
	OSPF with MD5 and sham links	1k
	Staticv4	4750
	EIGRPv4	250
MPLS VPNv6	IPv6 VRF Sessions (2 interfaces per VRF)	4k
	VPNv6 Prefixes	500k
	PE-CE Routing	
	eBGP with NSR, MD5, and lower KA-HT	4k
	OSPF with MD5 and sham links	1k
	Staticv6	4750
	EIGRPv6	250

Table 6-1   ASR9k L3VPN PE Profile Multi-Dimensional Scale Numbers (continued)

Feature	Parameters	Scale
MVPN	MVPN IPv4/IPv6	500
	IPv4 Mroutes, IPv6 Mroutes	32k, 16k
P2MP-TE	Headend LSP	1k
uRPF	Ipv4, IPv6	10k, 10k
IGMP Snooping	BDs, Snooping Entries	1k, 32k
MLD Snooping	BDs, Snooping Entries	1k, 32k
L2 Interfaces	Ethernet (Phy, Bundle-Ether, BVI, PW-HE)	
	POS and Serial	
L2VPN	AToM VPWS	1k
	FRoMPLS	1k
	FR to Eth IWoMPLS	1k
	VPWS PWs	15k
	VPWS ACs (1000 each on Eth, BE, PW-HE)	3k
	VPLS PWs (w/ 5 neighoring PEs)	15k
	VPLS ACs (1000 each on 10GigE, BE, PW-HE)	3k
	VPLS PWs to Simulated PEs	34k
	VPLS ACs for Simulated PEs (GigE, 10GigE)	2k
	MAC address	2M
QoS	Interfaces w/ Ingress Policy	10k
	Interfaces w/ Egress Policy	10k
ACLs	IPv4 ACLs on interface	10k
	IPv6 ACLs on interface	10k
MPLS TE	Headend LSP with FRR	3k
	Midpoint LSP	50k
BFD	IPv4 echo	10k
	IPv6 Async	10k

Internet Peering Application

ASR9K is used extensively in Internet Peering, Inter-Connect and RR applications because of its rich BGP features, stability of XR SW, and high scale. We have designed and tested the following profiles:

- ASR 9001 as RR

- ASR9k as peering and Enterprise, DC or SP inter-connect platform

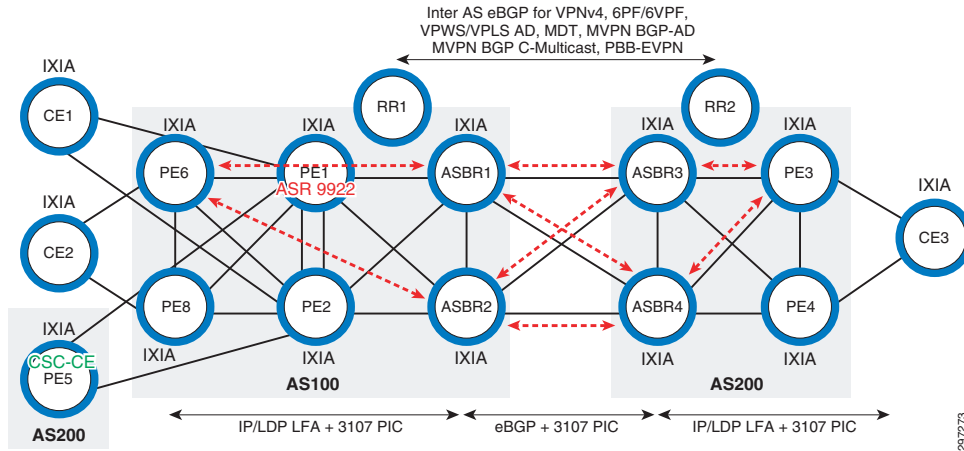ASR 9001 RR-tested scalability numbers are summarized in Table 6-2.

Table 6-2   ASR9k Route Reflector Scale Numbers

Feature	Scale
eBGP sessions with 3 BGP instances	5k
eBGP routes with 3 BGP instances	Total Route Scale = 14M routes
	IPv4 = 6M
	VPNv4 = 5M
	IPv6 = 1.5M
	VPNv6 = 1.5M
iBGP sessions with 2 BGP instances	5k
iBGP routes with 2 BGP instances	Total Route Scale = 10M
	Ipv4 = 402k
	VPNv4 = 7.6M
	VPNv6 = 2M

In the Internet Peering and Inter-Connect profile, we used the topology described in Figure 6-1 to test Enterprise, Data Center and SP peering and inter-connect use cases with scalability. The following key features were tested in this profile:

- Inter-AS option B and C Unicast Routing

- BGP Flowspec

- NetFlow 1:10k Sampling for IPv4, IPv6 and MPLS

- VXLAN L3VPN/L2VPN Gateway handoff between Inter-AS Core

- RFC 3107 PIC, BGP PIC edge for VPNv4, 6VPE, 6PE etc.

- LFA, rLFA

- Inter-AS option C L2VPN VPWS/VPLS with BGP AD,   Inter-AS MS-PW, FAT-PW

- Inter-Area/Inter-AS MPLS TE, P2MP TE

- Inter-AS Native IPv4/v6 Multicast, Rosen-mGRE-MVPNv4/v6, mLDP-MVPNv4/v6

- Native IPv4/v6, VPNv4/v6, VPWS/VPLS, Native IPv4/v6 Multicast, mGRE-MVPNv4/v6, PBB-EVPN over CsC

- Next-generation Routing LISP, LISP-MPLS Gateway

- Next-generation MVPN LSM with BGP C-mcast, Dynamic P2MP-TE MVPN, BGP SAFI 2, 129, 5

- Next-generation L2VPN PBB-EVPN

- Next-generation L2 Multicast: VPLS LSM

- TI-MoFRR, MPLS-TP, Bi-Directional TE LSPs (aka. Flex-LSP)

Figure 6-1   ASR9k Internet Peering and Inter-Connect Profile Topology

The ASR9k scalability test results of Internet Peering and Inter-Connect Profile are shown in Table 6-3.

Table 6-3   ASR9k Internet Peering and Inter-Connect Profile Scale Numbers

Feature	PE1	PE2	PE3	ASBR1	ASBR2	ASBR3	PE8
Global FIB v4	512k	512k	512k	512k	512k	512k	512k
Global FIB v6	18k	128k	128k	128k	128k	128k	128k
VRF (v4+v6)	4k	4k	4k				4k
VRF FIB v4	2M	2M	2M				2M
VRF FIB v6	256k	256k	256k				256k
LFIB					512k	512k	512k
L3 interfaces	8k	8k	8k				8k
ARP Adjacencies	32k	32k	32k	32k	32k	32k	32k
BGP session V4	3k	3k	3k	3k	3k	3k	3k
BGP session V6	256k	256k	256k	256k	256k	256k	256k
Labeled-BGP routes	10k	10k	10k	10k	10k	10k	10k
OSPFv2 adjacency	32k	32k	32k	32k	32k	32k	32k
OSPFv3 adjacency	32k	32k	32k	32k	32k	32k	32k
OSPFv2 routes	5k	5k	5k	5k	5k	5k	5k
OSPFv3 routes	10k	10k	10k	10k	10k	10k	10k
ISISv4 adjacency	32k	32k	32k	32k	32k	32k	32k
ISISv6 adjacency	32k	32k	32k	32k	32k	32k	32k
ISISv4 routes	5k	5k	5k	5k	5k	5k	5k
ISISv6 routes	10k	10k	10k	10k	10k	10k	10k
IGP LFA	10k	10k	10k	10k	10k	10k	10k
VRRP/HSRP	400k	400k	400k	400k	400k	400k	400k
ECMP	8k	8k	8k	8k	8k	8k	8k
MPLS label	512k	512k	512k	512k	512k	512k	512k

Table 6-3   ASR9k Internet Peering and Inter-Connect Profile Scale Numbers (continued)

Feature	PE1	PE2	PE3	ASBR1	ASBR2	ASBR3	PE8
Intra-Area MPLS TE	1k	1k	1k	1k	1k	1k	1k
Inter-Area MPLS TE	1k	1k	1k	1k	1k	1k	1k
Intra-AS MPLS TE	1k	1k	1k	1k	1k	1k	1k
ACL	10k	10k	10k	10k	10k	10k	10k
L2 interfaces (physical)	16k	16k	16k				16k
L2 interfaces (bundle)	16k	16k	16k				16k
PW	32k	32k	32k	32k	32k	32k	32k
MS-PW	4k	4k	4k	4k	4k	4k	4k
BD/VFI	4k	4k	4k	4k	4k	4k	4k
MAC	512k	512k	512k	512k	512k	512k	512k
CFM MEP	4k	4k	4k	4k	4k	4k	4k
CFM MIP	4k	4k	4k	4k	4k	4k	4k
MPLS-TP	1k	1k	1k	1k	1k	1k	1k
Policy-map	1k	1k	1k	1k	1k	1k	1k
Class-map	1k	1k	1k	1k	1k	1k	1k
Policers	32k	32k	32k	32k	32k	32k	32k
Ingress Queue	64k	64k	64k	64k	64k	64k	64k
Egress Queue	64k	64k	64k	64k	64k	64k	64k

100G Edge and Core-Facing Ports

ASR9k is being positioned as the 100G routing platform in Enterprise, SP, Data Center, and Public Sector segments as the de facto platform for UNI or edge services and NNI or core-facing connectivity.

Table 6-4 describes 100G density and performance testing results based on UNI and NNI testing configurations of ASR9k.

Table 6-4   Summary of 100G Support for UNI and NNI on ASR9K

Parameter	Typhoon
No. of 100G ports per slot	2X100G line rate
SW support	XR 4.2.1
No. of 100G ports per slice	1x100G
Bi-directional bandwidth	200Gbps 100Gbps per NPU
Bi-directional PPS	90Mpps/direction
UNI or Edge-facing service termination on 100G	Yes
NNI or Core-facing for 100G transport	Yes
nV cluster	Yes
nV satellite	Yes

Table 6-4   *Summary of 100G Support for UNI and NNI on ASR9K (continued)*

Parameter	Typhoon
MACSEC Suite B+	No
MACSEC over Cloud	No
100G Pro-active Protection	Yes
CPAK Optics	No
L2FIB MAC address	2M
L3FIB IPv4/IPv6 address	4M/2M
Bridge domain	64k

We have validated the 100G line card throughput and latency of ASR9k Typhoon line cards in the following two roles and summarized the performance in Table 6-5.

- UNI or edge-facing L2/L3/Multicast VPN services with features
- NNI or core-facing transport with features

The 100G deployment profiles we covered included MPLS, IPv4 and IPv6 in these applications: Internet Peering, DCI PE, SP Edge PE, Metro-Ethernet PE and P, Wan-Core PE and P router and general purpose Core P router.

Table 6-5   *Typhoon 100G Forwarding Chain Performance*

SW Ver	Feature	UNI/Edge or NNI/Core Facing Role	Sub-Feature	Linecard	Linerate Packet Size (bytes)	Min Latency (us)
5.1.0	MPLS	NNI/Core	mpls_swap	A9K-2x100GE-SE	130	15
5.1.0	MPLS	NNI/Core	mpls_depo	A9K-2x100GE-SE	176	14
5.1.0	MPLS	NNI/Core	mpls_impo	A9K-2x100GE-SE	175	14
5.1.0	IPv4	NNI/Core	IPv4 10K BGP route	A9K-2x100GE-SE	136	14
5.1.0	IPv4	NNI/Core	IPv4 500K BGP+uRPF	A9K-2x100GE-SE	212	15
5.1.0	IPv4	NNI/Core	IPv4 non recursive	A9K-2x100GE-SE	114	14
5.1.0	IPv4	NNI/Core	IPv4 500K BGP route	A9K-2x100GE-SE	160	16
5.1.0	IPv6	NNI/Core	IPv6_50K BGP route + QoS	A9K-2x100GE-SE	384	18
5.1.0	IPv6	NNI/Core	IPv6_nonrcur udp NH	A9K-2x100GE-SE	196	14
5.1.0	IPv6	NNI/Core	IPv6_50K BGP route	A9K-2x100GE-SE	361	17
5.1.0	IPv6	NNI/Core	IPv6_10K BGP route + QoS	A9K-2x100GE-SE	359	17
5.1.0	IPv6	NNI/Core	IPv6_50K BGP route + QoS	A9K-2x100GE-SE	384	18
5.1.0	L3VPN	NNI/Edge	L3VPN_30vrf	A9K-2x100GE-SE	232	15
5.1.0	IPv4 ACL	UNI/Edge	output_acl	A9K-2x100GE-SE	140	15
5.1.0	IPv4 ACL	NNI/Core	input_acl	A9K-2x100GE-SE	199	15
5.1.0	IPv4 ACL	NNI/Core	in+out_acl	A9K-2x100GE-SE	333	16
5.1.0	IPv4 QoS	NNI/Core	in+out_policy	A9K-2x100GE-SE	230	16

Table 6-5   *Typhoon 100G Forwarding Chain Performance (continued)*

SW Ver	Feature	UNI/Edge or NNI/Core Facing Role	Sub-Feature	Linecard	Linerate Packet Size (bytes)	Min Latency (us)
5.1.0	IPv4 QoS	NNI/Core	out shaper	A9K-2x100GE-SE	168	15
5.1.0	IPv4 QoS	NNI/Core	inpol+outshap	A9K-2x100GE-SE	218	16
5.1.0	IPv4 QoS	NNI/Core	IPv4 500K BGP route_inpol+outshap	A9K-2x100GE-SE	264	16
5.1.0	IPv4 QoS	NNI/Core	input_policy	A9K-2x100GE-SE	223	16
5.1.0	IPv4 QoS	NNI/Core	output_policy	A9K-2x100GE-SE	209	15
5.1.0	L2	UNI/Edge	Bridge	A9K-2x100GE-SE	129	14
5.1.0	L2	UNI/Edge	xconnect	A9K-2x100GE-SE	113	13
5.1.0	Multicast	UNI/Edge	mcast_IPv4	A9K-2x100GE-SE	277	15
5.1.0	Multicast	UNI/Edge	mcast_IPv6	A9K-2x100GE-SE	516	14
5.1.0	BVI	UNI/Edge	L2 EFP BVI L3_2K BVI	A9K-2x100GE-SE	592	17
5.1.0	mVPN	UNI/Edge	mVPN 12vrf_100mroute	A9K-2x100GE-SE	507	15
5.1.0	L2VPN	UNI/Edge	VPLS+qos	A9K-2x100GE-SE	596	17
5.1.0	L2VPN	UNI/Edge	VPWS 3ac+3pw	A9K-2x100GE-SE	319	15
5.1.0	L2VPN	UNI/Edge	VPLS_9BD+9ac+27pw	A9K-2x100GE-SE	374	16
5.1.0	L2VPN	UNI/Edge	VPWS_3ac+3pw+inpol+outshap	A9K-2x100GE-SE	326	15