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INTEROP22 TOKYO TEST REPORT

Juniper demonstrates SRv6 interoperability and more in multivendor ShowNet at Interop Tokyo 2022

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White Paper

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EXECUTIVE SUMMARY

This white paper focuses on Juniper Networks successes at Interop Tokyo 2022. It highlights the multivendor SRv6 live demonstration of the Juniper Networks® ACX7100 series during the event and describes other Juniper activities. The Juniper Networks MX304 Universal Router, PTX10001-36MR Packet Transport Router, and ACX7100-48L router were showcased on the Interop network, ShowNet, which tested the latest technologies including L3VPN over SRv6 interop and 400G-ZR+ interop test, Juniper Wi-Fi services, and Juniper® Connected Security.

Juniper initiated this document and developed it with NOC members' approvals. Every reasonable effort was made to ensure that the data is both accurate and complete.

Introduction

Launched in 1994, Interop Tokyo is one of the largest and most prestigious exhibitions for the latest communications and networking solutions. Each year, top technology companies from around the globe demonstrate their leading technological solutions to exhibit sustainability in a multivendor network, compete for awards, and receive reviews and recognition from analysts and the press.

ShowNet, a live network demonstration, has had an ongoing and vital role at Interop Tokyo since the event began. Designed as a multivendor environment and used as an access network for exhibitors and visitors, ShowNet aims to prove that the latest technologies and products work in multivendor scenarios. It demonstrates the latest concepts such as high resolution (4K) live video streaming over IP, and it tests the interoperability of the latest technologies, such as Ethernet VPN, SRv6, and more. Service providers and enterprises hold a high regard for achievements earned at ShowNet. Additionally, the demonstrations raise awareness of the state of implementation for innovative networking concepts.

Juniper participates in this event every year and attended this year's Interop Tokyo 2022 from June 15 to June 17 at Makuhari Messe, Chiba, Japan.

Participating Vendors and Devices

Table 1: Participants in L3VPN Over SRv6 Live Demonstration

Product Name	Vendor Name	Notation on Topology
MX204 Universal Routing Platform	Juniper Networks	mx204
NetEngine 8000 X4	Huawei	ne8000-x4
NCS57C3-MOD	Cisco Systems	ncs57c3
NCS55A1-36H	Cisco Systems	ncs55a1
FX2	Furukawa Electric	fx2
NetEngine 8000 F1A-8H20Q	Huawei	ne8000-f1a
ACX7100-48L Router	Juniper Networks	ACX7100
NCS57B1-6D24H	Cisco Systems	ncs57b1
MX304 Universal Routing Platform	Juniper Networks	mx304

Juniper Interoperability Test Results

Juniper's successful live demonstration of the multivendor SRv6 (L3VPN over SRv6 core and SRv6 Flex-Algo) was a highlight at this year's event. In addition, Juniper demonstrated its latest products, Juniper MX304 Universal Router, PTX10001-36MR Packet Transport Router, and ACX7100-48L router, and tested the latest technologies including L3 VPN over SRv6 interop and 400G-ZR+ interop test, within a multivendor environment. For this white paper, the L3VPN over SRv6 and SRv6 Flexible Algorithm (Flex-Algo) demonstration is described in detail.

The ShowNet topology for year 2022 was built from scratch to provide Internet connectivity for exhibitors and visitors of Interop Tokyo (Figure 1). Unlike a typical tradeshow network, ShowNet deploys both simple access switches and access points that provide Wi-Fi services, and it builds a network that simulates a backbone network that includes external connectivity contributed by ISPs (NTTCOM, KDDI, Softbank, and JGN) and IXPs (JPNAP, JPIX, BBIX, and others) located throughout Japan. In addition, ShowNet builds a data center fabric and 5G core network to support a variety of innovative live demonstrations.

To build a network at this scale, Juniper added MX Series, PTX Series, and ACX Series platforms to the network backbone. In addition, an MX10003 router provided a live demonstration as a user plane function (UPF) for 5G core networks. Juniper Networks SRX Series Firewalls and Juniper Advanced Threat Prevention Cloud were featured in a live demonstration of the Juniper security solution. Also on the network, Juniper AP33 High Performance Access Points and Juniper Mist™ Cloud showcased Wi-Fi services. Lastly, Corero SmartWall Threat Defense Director (TDD), cRPD, QFX Series Switches, and EX Series Ethernet Switches highlighted how to build a massive and complex network.

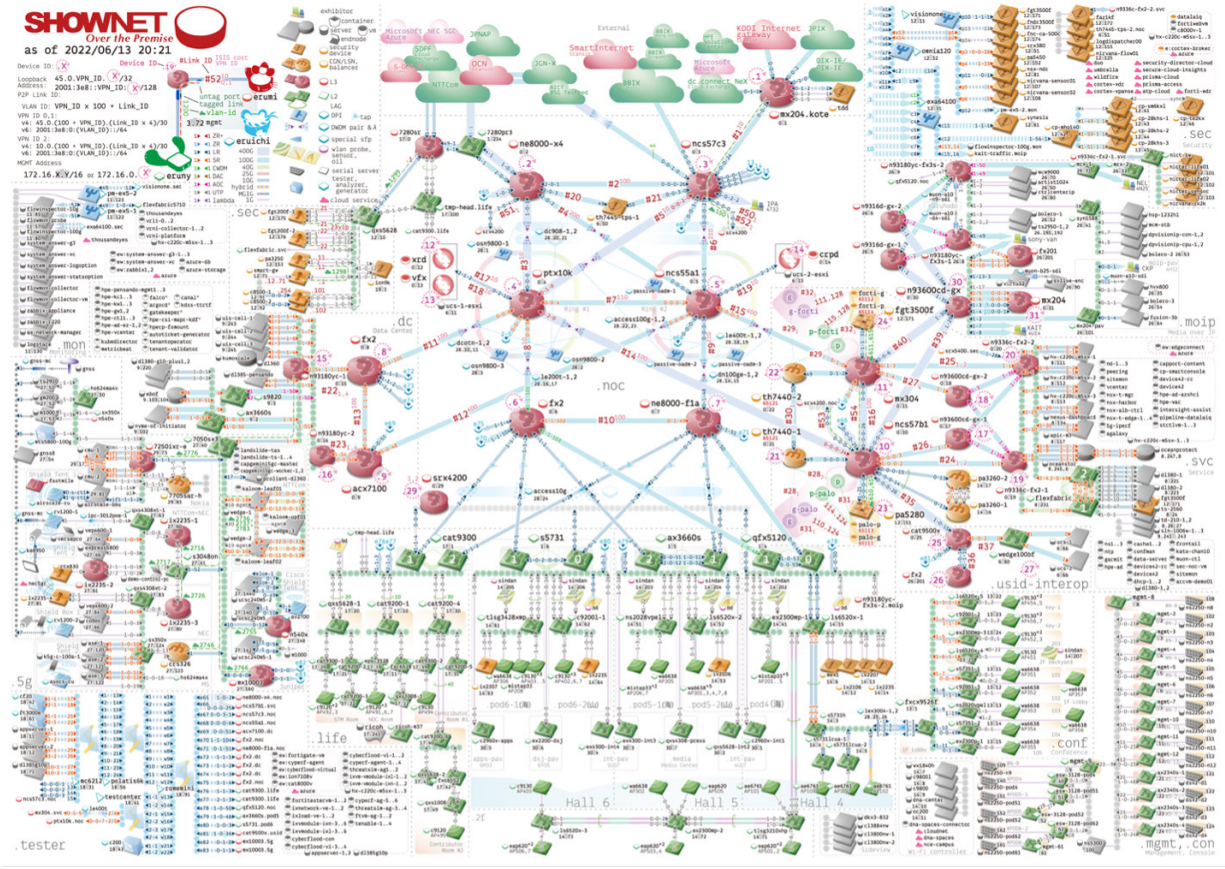

Figure 1: Interop Tokyo 2022, ShowNet Topology[i]

L3VPN Over SRv6 Interop in ShowNet

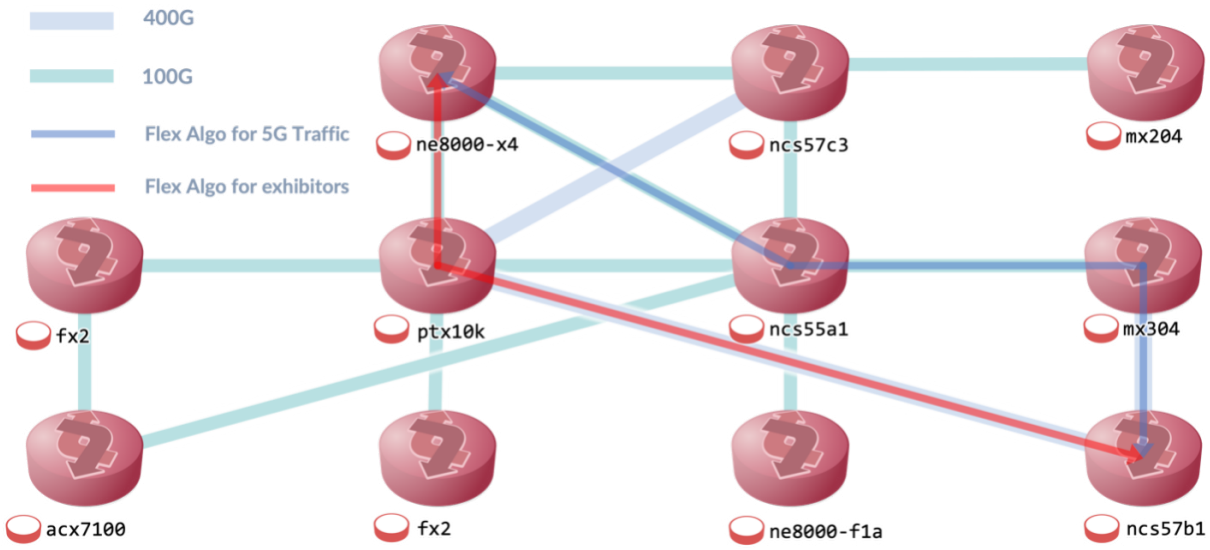

Figure 2: Backbone Network Topology (L3VPN over SRv6 and SRv6 Flex-Algo)

***NOTE**: PTX10001-36MR router listed in Figure 2, was used as a P router to forward the packet with 400G-ZR+ optics (QDD-400G-ZR-M).*

Figure 2 is the extraction of the backbone network topology from ShowNet. For Interior Gateway Protocol (IGP), IS-IS was used. ShowNet has been working on SRv6 interoperability under a multivendor environment since 2018, and this year, SRv6 was fully adopted as a backbone network core technology to carry both IPv4 and IPv6 traffic for the first time.[ii] The unique feature in this environment is that only the IPv6 link local addresses were used between routers in the backbone, meaning IPv6 is a single stack and there is no addressing configuration on links between routers. (IPv6 link local addresses are automatically generated.)

In the ShowNet demonstration, Juniper tested BGP overlay services based on segment routing over IPv6 (IPv4 and IPv6 VPN over SRv6 core) among multivendor systems.[iii] BGP-based L3 service over SRv6 is signaled by a Service SID enclosed in an SRv6 L3 Service type, length, and value (TLV) within the BGP Prefix-SID Attribute from an egress provider edge (PE) device that supports SRv6-based L3 services. Next, the ingress PE device receiving this route performs IPv6 encapsulation and inserts a segment routing header (SRH) when required. This enables the SRv6 capable routers to exchange SRv6 SID and serve overlay services.

With the IPv4/IPv6 VPN over SRv6 core demonstration, SRv6 Flex-Algo interoperability was also tested on the previously described topology[iv]. Flex-Algo allows IGPs to compute constraint-based paths over the network by advertising the TLVs that identify calculation-type, specify a metric-type, and describe a set of constraints on the topology to compute the best paths along the constrained topology. In the SRv6 Flex-Algo demonstration, Flex-Algo separated the 5G traffic, also being live demonstrated at ShowNet, from the exhibitors' corporate booth traffic participating in Interop Tokyo 2022 and calculated the best path respectively. In addition, the demonstration confirmed that Flex-Algo's Locator was successfully advertised on routers not associated to the topology defined by Flex-Algorithms.

ACX7100-48L Configuration for L3VPN Over SRv6

Below is the SRv6-related configuration example for the ACX7100-48L router. For SRv6-related configurations, it is the same as the configuration for the MX Series.

***NOTE**: The configuration code is for illustration only. The actual username, network management information (for instance, SNMP community), and addressing information (AS number and network prefix) from the actuals has been modified per guidance from NOC. In the example, the IPv6 prefix is set within "2001:db8::/32"; IPv4 prefix for IPv4 routing within "192.168.0.4"; and IPv4 management prefix within "172.27.0.0/16."*

```
root@acx7100.dc> show configuration | except SECRET-DATA | display omit

## Last commit: 2022-07-21 13:54:21 JST by root
version 22.4-202206050600.0-EVO;
system {
    host-name acx7100.dc;
    root-authentication {
    }
    login {
        class shownet-ro {
            idle-timeout 20;
            permissions [ view view-configuration ];
        }
        class shownet-rw {
            idle-timeout 20;
            permissions all;
        }
        user user-ro {
            uid 2001;
            class shownet-ro;
            authentication {
            }
        }
        user user-rw {
            uid 2000;
            class shownet-rw;
            authentication {
            }
        }
    }
    services {
        ssh {
            root-login allow;
            protocol-version v2;
            sftp-server;
            connection-limit 250;
        }
        telnet {
            connection-limit 250;
        }
        netconf {
            ssh;
        }
    }
    time-zone Asia/Tokyo;
    management-instance;
    syslog {
        user * {
            any emergency;
        }
```

```
            host 172.27.255.120 {
                any info;
                facility-override local1;
                routing-instance mgmt_junos;
                management-interface;
            }
            host 172.27.255.121 {
                any info;
                facility-override local1;
                routing-instance mgmt_junos;
                management-interface;
            }
            file interactive-commands {
                interactive-commands any;
            }
            file messages {
                any notice;
                authorization info;
            }
            time-format millisecond;
            source-address 172.27.0.9;
        }
        packet-forwarding-options {
            no-ip-tos-rewrite;
            hw-db-profile {
                l3-xl;
            }
        }
        processes {
            routing force-32-bit;
        }
        ntp {
            server 172.27.255.240 routing-instance mgmt_junos;
            server 172.27.255.250 routing-instance mgmt_junos;
            source-address 172.27.0.9;
        }
        trace application {
            rmopd {
                node {
                    re0 {
                        level debug;
                    }
                }
            }
        }
    }
    chassis {
        network-services enhanced-ip;
    }
    services {
        monitoring {
            twamp {
                server {
                    light {
                        port 862;
                    }
                }
            }
```

```
        }
    }
    interfaces {
        et-0/0/48 {
            traps;
            flexible-vlan-tagging;
            speed 100g;
            mtu 9216;
            unit 12 {
                vlan-id 12;
                family iso {
                    mtu 9000;
                }
                family inet6 {
                    mtu 9000;
                }
            }
        }
        et-0/0/49 {
            traps;
            flexible-vlan-tagging;
            speed 100g;
            mtu 9216;
            unit 13 {
                vlan-id 13;
                family iso {
                    mtu 9000;
                }
                family inet6 {
                    mtu 9000;
                }
            }
        }
        et-0/0/50 {
            traps;
            flexible-vlan-tagging;
            speed 100g;
            mtu 9216;
            unit 4 {
                vlan-id 4;
                family inet {
                    mtu 9000;
                    address 10.0.104.93/30;
                }
            }
        }
        et-0/0/51 {
            traps;
            flexible-vlan-tagging;
            speed 100g;
            mtu 9216;
            unit 1804 {
                vlan-id 1804;
                family inet {
                    mtu 9000;
                    address 192.168.200.193/26;
                }
                family inet6 {
```

```
                mtu 9000;
                address 2001:db8:0:1804::1/64;
            }
        }
    }
    et-0/0/53 {
        flexible-vlan-tagging;
        speed 100g;
        mtu 9216;
        unit 4000 {
            vlan-id 4000;
            family inet6 {
                mtu 9000;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                filter {
                    input local-access;
                }
            }
            family iso {
                address 49.0001.0000.0000.0009.00;
            }
            family inet6 {
                filter {
                    input local-access-v6;
                }
                address 2001:db8::9/128;
            }
        }
        unit 1 {
            family inet {
                address 192.168.1.9/32;
            }
            family inet6 {
                address 2001:db8::1:9/128;
            }
        }
        unit 4 {
            family inet {
                address 192.168.4.9/32;
            }
            family inet6 {
                address 2001:db8::4:9/128;
            }
        }
    }
    re0:mgmt-0 {
        unit 0 {
            family inet {
                address 172.27.0.9/22;
            }
        }
    }
}
```

```
snmp {
    community public {
        authorization read-only;
        routing-instance vrf-global {
            clients {
                192.168.0.0/16;
                2001:db8::/48;
            }
        }
        routing-instance mgmt_junos {
            clients {
                172.27.0.0/16;
            }
        }
    }
    trap-options {
        source-address 172.27.0.9;
        routing-instance vrf-global {
            source-address 192.168.0.9;
        }
    }
    trap-group triple {
        version v2;
        categories {
            chassis;
            link;
            startup;
        }
        targets {
            172.27.255.120;
            172.27.255.121;
        }
        routing-instance mgmt_junos;
    }
    routing-instance-access {
        access-list {
            mgmt_junos;
            vrf-global;
        }
    }
}
policy-options {
    prefix-list ntp-servers_v4 {
        apply-path “system ntp server <*.*>”;
    }
    prefix-list snmp-clients_v4 {
        apply-path “snmp community <*> clients <*.*/*>”;
    }
    prefix-list snmp-clients_v6 {
        apply-path “snmp community <*> clients <*:*/*>”;
    }
    policy-statement nh-self {
        then {
            next-hop self;
        }
    }
    policy-statement permit-all {
        then accept;
```

```
        }
        policy-statement pplb {
            then {
                load-balance per-packet;
            }
        }
    }
    firewall {
        family inet {
            filter local-access {
                interface-specific;
                term telnet-ssh {
                    from {
                        source-address {
                            192.168.0.0/16;
                            172.27.0.0/16;
                        }
                        protocol tcp;
                        destination-port [ telnet ssh ];
                    }
                    then accept;
                }
                term telnet-ssh-deny {
                    from {
                        protocol tcp;
                        destination-port [ ssh telnet ];
                    }
                    then {
                        discard;
                    }
                }
                term ntp-accepts {
                    from {
                        source-prefix-list {
                            ntp-servers_v4;
                        }
                        protocol udp;
                        destination-port ntp;
                    }
                    then accept;
                }
                term ntp-discard {
                    from {
                        protocol udp;
                        destination-port ntp;
                    }
                    then {
                        discard;
                    }
                }
                term else {
                    then accept;
                }
            }
        }
        family inet6 {
            filter local-access-v6 {
                interface-specific;
```

```
                term permit-access {
                    from {
                        source-address {
                            2001:db8::/48;
                        }
                        next-header [ tcp udp ];
                        destination-port [ telnet ssh ntp ];
                    }
                    then accept;
                }
                term discard-access {
                    from {
                        next-header udp;
                        destination-port [ telnet ssh ntp ];
                    }
                    then discard;
                }
                term else {
                    then accept;
                }
            }
        }
    }
    routing-instances {
        mgmt_junos {
            routing-options {
                static {
                    route 0.0.0.0/0 next-hop 172.27.0.1;
                }
            }
        }
        vrf-aci-underlay {
            instance-type vrf;
            protocols {
                bgp {
                    group ACI {
                        type external;
                        family inet {
                            unicast;
                        }
                        export [ nh-self permit-all ];
                        peer-as 65201;
                        neighbor 10.0.104.94;
                    }
                    source-packet-routing {
                        srv6 {
                            locator loc-acx7100 {
                                end-dt4-sid 2001:db8:fa00:9:404::;
                                end-dt6-sid 2001:db8:fa00:9:406::;
                            }
                        }
                    }
                    advertise-peer-as;
                }
            }
            forwarding-options {
                dhcp-relay {
                    server-group {
```

```
                    aci-dhcp-server {
                        10.31.0.1;
                    }
                }
                active-server-group aci-dhcp-server;
                group aci-relay {
                    interface et-0/0/50.4;
                }
            }
        }
        interface et-0/0/50.4;
        interface lo0.4;
        route-distinguisher 192.168.0.9:4;
        vrf-target target:65000:4;
        vrf-table-label;
    }
    vrf-global {
        instance-type vrf;
        protocols {
            bgp {
                source-packet-routing {
                    srv6 {
                        locator loc-acx7100 {
                            end-dt4-sid 2001:db8:fa00:9:104::;
                            end-dt6-sid 2001:db8:fa00:9:106::;
                        }
                    }
                }
            }
        }
        interface et-0/0/51.1804;
        interface lo0.1;
        route-distinguisher 192.168.0.9:1;
        vrf-target target:65000:1;
        vrf-table-label;
    }
}
routing-options {
    flex-algorithm 128 {
        definition {
            metric-type delay-metric;
        }
    }
    source-packet-routing {
        srv6 {
            locator loc-acx7100 {
                2001:db8:fa00:9::/64;
                block-length 40;
                function-length 16;
            }
            locator loc-128 {
                algorithm 128;
                2001:db8:fa80:9::/64;
                block-length 40;
                function-length 16;
            }
        }
    }
```

```
        resolution {
            preserve-nexthop-hierarchy;
        }
        router-id 192.168.0.9;
        autonomous-system 65000;
        forwarding-table {
            export pplb;
        }
    }
    protocols {
        bgp {
            group RR {
                type internal;
                local-address 2001:db8::9;
                family inet-vpn {
                    unicast {
                        extended-nexthop;
                        advertise-srv6-service;
                        accept-srv6-service;
                    }
                }
                family inet6-vpn {
                    unicast {
                        advertise-srv6-service;
                        accept-srv6-service;
                    }
                }
                neighbor 2001:db8::12;
                neighbor 2001:db8::13;
                neighbor 2001:db8::14;
                vpn-apply-export;
            }
            rfc8950-compliant;
        }
        isis {
            interface et-0/0/48.12 {
                level 2 {
                    ipv6-unicast-metric 400;
                    hello-interval 1;
                    hold-time 4;
                }
                delay-measurement {
                    probe-interval 60;
                    probe-count 1;
                    advertisement {
                        periodic {
                            threshold 50;
                        }
                    }
                }
                point-to-point;
            }
            interface et-0/0/49.13 {
                level 2 {
                    ipv6-unicast-metric 100;
                    hello-interval 1;
                    hold-time 4;
                }
```

```
                point-to-point;
            }
            interface lo0.0 {
                level 2 {
                    ipv6-unicast-metric 1;
                    passive;
                }
            }
            source-packet-routing {
                flex-algorithm 128;
                srv6 {
                    locator loc-acx7100;
                    locator loc-128;
                }
            }
            level 1 disable;
            level 2 wide-metrics-only;
            traffic-engineering {
                l3-unicast-topology;
                advertisement always;
            }
            topologies ipv6-unicast;
        }
        lldp {
            port-id-subtype interface-name;
            interface all;
        }
    }
```

Conclusion

This white paper documents Juniper's achievement of multivendor SRv6 (IPv4/IPv6 L3VPN over SRv6 core, and SRv6 Flex-Algo) in the live demonstration conducted for the Interop Tokyo 2022's ShowNet program. This live demonstration proved that the Juniper SRv6 solution in ACX7100 router successfully works with other vendors' routers in an actual live network. Table 2 summarizes the test case and Juniper results.

Table 2: Test Case and Its Results Conducted in ShowNet Live Demonstration

Test Case	Result
SRv6 locator SID advertisement by IS-IS	PASS
Signaling BGP-based L3 services over SRv6 core and verifying BGP peer establishment	PASS
IPv6 segment routing header (SRH) encapsulation to the packet	PASS
Forwarding both IPv4 and IPv6 packets over SRv6 core (End.DT4/End.DT6)	PASS
Flex-Algo Locator advertisement and reception	PASS

Acknowledgement

Gratefully acknowledge the Juniper WAN Automation Solutions Product Line Management and the Engineering team for offering their support in testing the ACX7100 series used in this live demonstration.

Citation

i Topology diagram is cited from https://www.interop.jp/2022_common/assets/file/topology.pdf.

ii The first interoperability verification was performed in 2018 (no user traffic was forwarded) and a live demonstration of Service Function Chaining using SRv6 was performed in 2019 including user traffic forwarding. After the cancellation of Interop Tokyo (due to COVID-19) in 2020, SRv6 was adopted only for IPv6 traffic forwarding in 2021 (SR-MPLS was used for IPv4 traffic).

iii The specification was based on I-D (draft-ietf-bess-srv6-services). On July 2022, this draft was published as RFC9295: BGP Overlay Services Based on Segment Routing over IPv6 (SRv6).

iv IS-IS Extensions to Support Segment Routing over IPv6 Data plane (I-D. draft-ietf-lsr-isis-srv6-extensions).

About Juniper Networks

At Juniper Networks, we are dedicated to dramatically simplifying network operations and driving superior experiences for end users. Our solutions deliver industry-leading insight, automation, security and AI to drive real business results. We believe that powering connections will bring us closer together while empowering us all to solve the world's greatest challenges of well-being, sustainability and equality.

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