ENTERPRISE ROUTING IMPLEMENTATION GUIDE: IS-IS (USING EX SERIES ETHERNET SWITCHES)

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Introduction

This document provides implementation guidance for Layer 3 campus environments using IS-IS. It is targeted for layer 3 deployments in campus networks where Juniper Networks® EX Series Ethernet Switches are used in the access layer while core and aggregation are collapsed into one layer using either the EX Series Switches or the Juniper Networks MX Series 3D Universal Edge Routers. This document provides general design considerations and configuration guidelines, as well as verification and troubleshooting procedures. An implementation example is included with detailed topology and configurations.

Scope

This document focuses on implementing a campus network using IS-IS and does not discuss Layer 2 protocols implementation or designs including multiple Layer 3 protocols.

Targeted Audiences: This document is intended for network design and operation engineers or other technical audiences who require implementation guidelines for Layer 3 campus deployments using the EX Series Switches.

Design Considerations

IS-IS Areas and Levels

IS-IS is a hierarchical Link State protocol that supports the partitioning of a routing domain into multiple levels: level 1, level 2 and level1/level2 routers. Level 1 routers never form an adjacency with a level 2 router, but the reverse is true. Therefore, Level1/Level2 routers fulfill the same role as an area border router in OSPF. Note that the links between routers (and not the routers themselves – as in OSPF) define the area boundaries.

Partitioning an IS-IS network into areas by using multiple levels improves scalability since Level 2 (backbone) Link State Protocol (LSP) Data Units are normally not flooded into a level 1 area. An IS-IS level 2 area is in a way analogous to the OSPF backbone area, while a level 1 area operates much like an OSPF totally stubby Area.

Addressing and Summarization

CLNS addressing: IS-IS uses ISO NSAP (Network Service Access Point) addressing. Even in an IP-only environment, each router must have an ISO address called a Network Entity Title (NET).

Summarization: Summarization is important when implementing IS-IS to provide network scalability. IS-IS protocol does not offer support of area-range statements. Route summarization for IS-IS is configured by defining an aggregate route and applying a policy that advertises this aggregate while suppressing the more specific prefixes.

Route Selection

Redistribution and Route Leaking: IS-IS does not support import policies. Export policies can be applied at the L1/L2 routers to redistribute routes into IS-IS. They can also be used to manipulate the metrics or to allow route leaking. Route leaking consists into injecting routing information from the IS-IS backbone into a level 1 area instead of relying on the default route.

Load balancing: When multiple routes to the same destination exist with equal metrics, IS-IS performs Equal-Cost Multipath (ECMP) load balancing between these routes.

IS-IS Timers

Unlike OSPF, IS-IS permits adjacency formation between systems that have been configured to use different hello timers. The hold interval is used to inform the remote system how long the adjacency can be considered valid in the absence of received hello LSPs. The IS-IS hold times can be set to different values for each level. By default, the hold value is three times the configured hello interval, but both parameters can be set independently. The default ratio means that an adjacency can be maintained even if two out of three hello packets are lost.

Implementation

Configuration Guidelines

IS-IS campus design implementation using the EX Series for access and aggregation is demonstrated in the following configuration examples:

Interface and Virtual Local Area Network (VLAN) Configuration: The examples below show two methods of assigning a VLAN to an interface: the first method consists into adding the VLAN under the interface stanza while the second one adds the interface under the VLAN stanza.

```
EX:
interfaces{
  ge-0/0/23 {
    unit 0 {
      family ethernet-switching {
        port-mode access;
        vlan {
          members HR;
        }
      }
    }
  }
```

```
EX:
vlans {
  HR {
    vlan-id 100;
    interface {
      ge-0/0/23.0;
    }
  }
}
```

Some users may be more familiar with the first form of configuration. The second method is more aligned with Juniper Networks Junos® operating system configuration on other platforms as functionalities are grouped by feature rather than per interface. Both methods result into the same configuration from a software perspective.

RVI Configuration: The example below shows a Routed VLAN Interface (RVI) configuration on the EX Series. An l3-interface is added to the VLAN configuration and an IP address is assigned to the VLAN under the interface stanza.

```
EX:
vlans {
  HR {
    l3-interface vlan.100;
  }
}

interfaces{
  vlan {
    unit 100 {
      family inet {
        address 172.18.9.1/24;
      }
    }
  }
}
```

ISO Configuration: A NET interface must be configured on each router running IS-IS. The ISO family is configured on all interfaces running IS-IS:

```
EX:
ae0 {
    unit 0 {
        family inet {
            address 172.18.16.18/30;
        }
        family iso;
    }
}
ae1 {
    unit 0 {
        family inet {
            address 172.18.16.26/30;
        }
        family iso;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 172.18.12.1/32;
        }
        family iso {
            address 49.0001.0172.0018.1201.00;
        }
    }
}
vlan {
    unit 400 {
        family inet {
            address 172.18.13.1/24;
        }
        family iso;
    }
}
```

IS-IS Protocol Configuration: The example below shows IS-IS configuration on an EX Series as a level 1 only router. By default, all interfaces specified as IS-IS interface are level 1 and level 2 interfaces. The “disable level 2” command ensures that the interface is a level 1 only. In this example, the Aggregated Ethernet interfaces are included in the level 1 area. The loopback and VLAN interfaces are “passive”: they do not run IS-IS, but they are advertised.EX:

```
routing-options {
    router-id 172.18.8.1;
}
interfaces {
    lo0 {
        unit 0 {
            family inet {
                address 172.18.8.1/32;
            }
        }
    }
}
protocols {
    isis {
```

```
interface ae0.0 {
            level 2 disable;
        }
        interface ae1.0 {
            level 2 disable;
        }
        interface lo0.0 {
            passive;
            level 2 disable;
        }
        interface vlan.400 {
            passive;
            level 2 disable;
        }
    }
}
```

Route Redistribution: Route redistribution is performed by creating a policy statement and applying it to the IS-IS routing instance. Below is an example where a redistribution policy from static routes to level 1 areas is applied to IS-IS. The static route with destination address "200.0.1.0/24" or "200.0.2.0/24" was defined to point to "reject" so that trace routes to this address return a "destination unreachable" message. This is done for verification purpose.

Note: The term "export" in the isis protocol configuration is relative to the routing table. An export statement implies that routes are exported from the routing table to the dynamic routing protocol it is applied to. In the example below, the static route is exported from the routing table into IS-IS, hence redistribution of the static route into IS-IS.

```
EX:
policy-statement stat_isis {
    from protocol static;
    to level 1;
    then accept;
}
routing-options {
    static {
        route 200.0.1.0/24 reject;
        route 200.0.2.0/24 reject;
    }
}
protocols {
    isis {
        export stat_isis;
}
```

Route Summarization: Route summarization with IS-IS is applied by:

- Defining an aggregate routes in the "routing-options" stanza
- Defining a policy statement for these aggregate routes
- Applying the policy as export policy to IS-IS protocol

An example is included below:

```
EX:
routing-options {
    aggregate {
        route 172.18.16.0/27;
        route 172.18.8.0/21;
    }
policy-statement summ {
    term 1 {
        from protocol aggregate;
        to level 2;
        then accept;
    }
    term 2 {
        from {
            protocol isis;
            level 1;
        }
        to level 2;
        then reject;
    }
}
protocols {
    isis {
        export summ;
}
```

GRES: Graceful Routing Engine Switchover is enabled at the "chassis redundancy" hierarchy level. Once GRES is enabled, the "commit synchronize" command must be issued so that the master and backup routing engines are synchronized.

```
EX:
chassis {
    redundancy {
        graceful-switchover;
    }
}
```

Protocol Graceful Restart: Graceful Restart is disabled by default. It is enabled globally for all routing protocols under the "routing-options" hierarchy level as shown below. Note that each neighbor of the restarting router must also support Graceful Restart.

```
EX:
routing-options {
    graceful-restart;
}
```

Bidirectional Forwarding Detection: To enable BFD, the "bfd-liveness-detection" statement is added at the protocol interface configuration level. The minimum-interval parameter indicates the minimum time interval (in milliseconds) between hello packets sent to and received from a neighbor with which a BFD session has been established. Below is a BFD configuration example with IS-IS:

```
EX:
protocols {
    isis {
        interface ae0.0 {
            bfd-liveness-detection {
                minimum-interval 100;
            }
        }
        interface ae1.0 {
            bfd-liveness-detection {
                minimum-interval 100;
            }
        }
    }
}
```

Authentication: This example shows simple authentication with IS-IS where the level 1 area was configured with simple-password authentication and a password of "juniper1":

```
EX:
protocols {
    isis {
        level 1 {
            authentication-key "$9$XIYNVYJGifT3goT369OBxNdbgo"; ## SECRET-DATA
            authentication-type simple;
        }
    }
}
```

IS-IS MD5 authentication configuration requires only an authentication key (as opposed to OSPF which defines a key-id and a key). The example below shows message digest authentication: the level 2 area was configured with MD5 authentication using "juniper0" as key-id.

```
EX:
protocols {
    isis {
        level 2 {
            authentication-key "$9$z5zkn9pIEyWLN0BLNdboaFn/9uO"; ## SECRET-DATA
            authentication-type md5;
        }
    }
}
```

Note: It is also possible to configure authentication for IS-IS per interface. Level authentication affects all IS-IS PDUs while interface configuration secures only hello PDUs. If both are configured, interface level authentication takes precedence as it is more specific.

Load Balancing: Per-Prefix load balancing is enabled by default and does not require additional configuration. Configuration of per-flow load balancing can be done by including the "load-balance per-packet" action in a "then" statement in a routing policy and applying the policy as export to the forwarding table under "routing-options forwarding-table" stanza. An example is shown below:

```
routing-options {
    forwarding-table {
        export PPpolicy;
    }
}
policy-options {
    policy-statement PPpolicy {
        then {
            load-balance per-packet;
            accept;
        }
    }
}
```

Note: The configuration above results into per-flow behavior even though it refers to the "per-packet" action. This is because historically, platforms with Internet Processor I ASIC applied per-packet load balancing which introduced the potential that packets arrive out of order at the destination because of differential delay within the network. Newer Juniper Networks platforms apply per-flow load balancing.

Verification

Below are some of the commands that can be used to verify the IS-IS setup:

- show isis interface
- show isis adjacency
- show isis spf log
- show isis statistics
- show isis route
- show isis database
- show route protocol isis
- traceroute

The following command can be used to restart the RPD (Routing Protocol Process) and verify graceful restart:

- restart routing

One of the following commands can be used for testing purpose to cause a routing engine switchover:

- request chassis routing-engine master switch
- request system reboot member <member>

The following procedure can be followed to verify if the backup RE is ready for GRES:

request session member <id>
show system switchover
start shell
sysctl –a | grep gres
exit

Troubleshooting

The following commands can be used for troubleshooting:

- clear isis database
- clear isis adjacency
- clear isis overload
- set protocols isis traceoptions file <filename>
- set protocols isis traceoptions flag isis-trace
- set protocols isis traceoptions flag error detail
- set protocols isis traceoptions flag hello detail
- set protocols isis traceoptions flag lsp detail
- monitor start
- monitor stop
- show log messages | match “to Down”
- show log mastership
- show system core-dumps
- show log ksyncd

Implementation Example

Network Topology

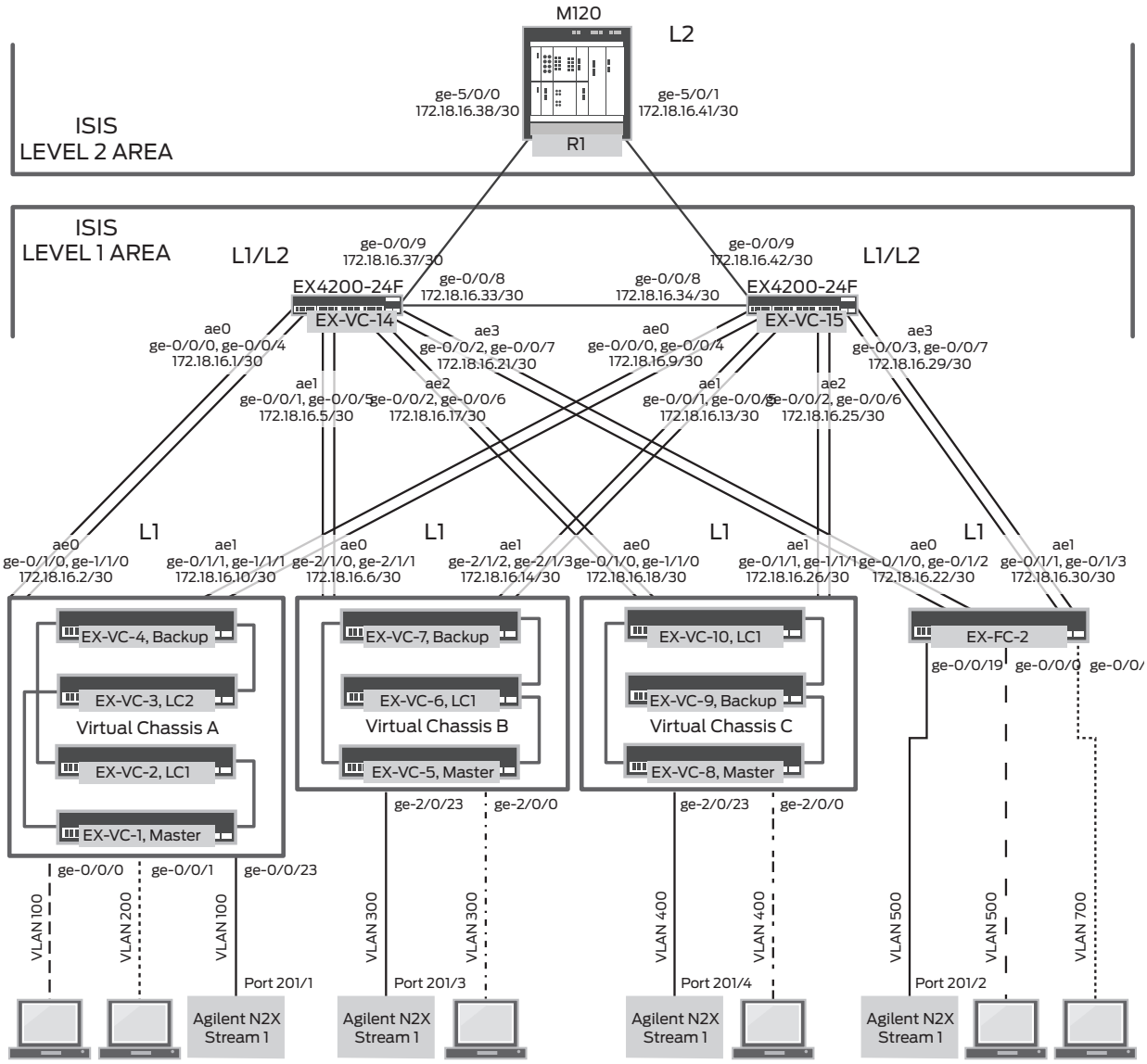

Figure 1: IS -IS Network Topology

RVIS		
Virtual Chassis A:	vlan.100:	172.18.9.1/24
	vlan.200:	172.18.10.1/24
Virtual Chassis B:	vlan.300:	172.18.11.1/24
Virtual Chassis C:	vlan.400:	172.18.13.1/24
Fixed Configuration Chassis:	vlan.500:	172.18.14.1/24
	vlan.700:	172.18.15.1/24
LOOPBACKS		
EX-VC-14: 172.18.19.1	EX-VC-15: 172.18.19.2	R1: 172.18.19.3
EX-VC-5: 172.18.19.2	EX-VC-1: 172.18.8.1	EX-VC-8: 172.18.12.1
EX-FC-2: 172.18.12.2		
STATIC ROUTES		
EX-VC14 and EX-VC-15:	200.0.1.0/24	
	200.0.2.0/24	
AUTHENTICATION		
Level 2 Area:	MD5 Key=juniper0	
Level 1 Area:	Text password=juniper1	
N2X TRAFFIC STREAMS		
Stream 1:	201/1 -> 201/2	
Stream 2:	201/2 -> 201/1	
Stream 3:	201/3 -> 201/4	
Stream 4:	201/4 -> 201/3	

Hardware Used for Validation

EQUIPMENT	COMPONENTS
1 x Juniper Networks EX3200 Ethernet Switch	• 6 x 4-port uplink 1GbE module (EX-UM-4SFP)
12 x Juniper Networks EX4200 Ethernet Switch	• 36 SFPs
	• 10 x VCP cables
M-120	• 1 x 10 port 1GbE (1000 BASE) PIC
	• 2 SFPs
Agilent N2X tester	• 4 x 10/100/1000Mb ports

Software Used for Validation

EQUIPMENT	COMPONENTS
EX Series and Juniper Networks M Series Multiservice Edge Routers	Junos OS 9.2

Detailed Configurations

The detailed configurations for EX-VC-1 and EX-VC-5 are listed below. The rest of the configurations is included in Appendix B.

EX-VC-1

…truncated

```
chassis {
    redundancy {
        graceful-switchover;
    }
    aggregated-devices {
        ethernet {
            device-count 2;
        }
    }
}
interfaces {
    ge-0/0/0 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members HR;
                }
            }
        }
    }
    ge-0/0/1 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members ENG;
                }
            }
        }
    }
    ge-0/0/23 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members HR;
                }
            }
        }
    }
    ge-0/1/0 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-0/1/1 {
        ether-options {
            speed {
```

EX-VC-14

…truncated

```
chassis {
    aggregated-devices {
        ethernet {
            device-count 4;
        }
    }
}
interfaces {
    ge-0/0/0 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-0/0/1 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
    ge-0/0/2 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae2;
        }
    }
    ge-0/0/3 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae3;
        }
    }
    ge-0/0/4 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-0/0/5 {
        ether-options {
            speed {
                1g;
```

```
                1g;
            }
            802.3ad ae1;
        }
    }
    ge-1/0/23 {
        unit 0 {
            family ethernet-switching {
                port-mode trunk;
                vlan {
                    members [ HR ENG ];
                }
            }
        }
    }
    ge-1/1/0 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-1/1/1 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
    ae0 {
        unit 0 {
            family inet {
                address 172.18.16.2/30;
            }
            family iso;
        }
    }
    ae1 {
        unit 0 {
            family inet {
                address 172.18.16.10/30;
            }
            family iso;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 172.18.8.1/32;
            }
            family iso {
                address
49.0001.0172.0018.0801.00;
            }
        }
    }
    vlan {
        unit 100 {
            }
            802.3ad ae1;
        }
    }
    ge-0/0/6 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae2;
        }
    }
    ge-0/0/7 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae3;
        }
    }
    ge-0/0/8 {
        unit 0 {
            family inet {
                address 172.18.16.33/30;
            }
            family iso;
        }
    }
    ge-0/0/9 {
        unit 0 {
            family inet {
                address 172.18.16.37/30;
            }
            family iso;
        }
    }
    ae0 {
        unit 0 {
            family inet {
                address 172.18.16.1/30;
            }
            family iso;
        }
    }
    ae1 {
        unit 0 {
            family inet {
                address 172.18.16.5/30;
            }
            family iso;
        }
    }
    ae2 {
        unit 0 {
            family inet {
                address 172.18.16.17/30;
            }
            family iso;
        }
    }
```

```
            family inet {
                address 172.18.9.1/24;
            }
            family iso;
        }
        unit 200 {
            family inet {
                address 172.18.10.1/24;
            }
            family iso;
        }
    }
    vme {
        unit 0 {
            family inet {
                address 172.19.59.190/24;
            }
        }
    }
}
routing-options {
    graceful-restart;
}
protocols {
    isis {
        level 1 {
            authentication-key "$9$PTF/
uORlK8CtK8X7sYfTz3Ct"; ## SECRET-DATA
            authentication-type simple;
        }
        interface ae0.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae1.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface lo0.0 {
            level 2 disable;
        }
        interface vlan.100 {
            passive;
            level 2 disable;
        }
        interface vlan.200 {
            passive;
            level 2 disable;
        }
    }
}
vlans {
    ENG {
        vlan-id 200;
        l3-interface vlan.200;
    }
```

```
    ae3 {
        unit 0 {
            family inet {
                address 172.18.16.21/30;
            }
            family iso;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 172.18.19.1/32;
            }
            family iso {
                address
49.0001.0172.0018.1901.00;
            }
        }
    }
    me0 {
        unit 0 {
            family inet {
                address 172.19.59.192/24;
            }
        }
    }
}
routing-options {
    graceful-restart;
    static {
        route 200.0.1.0/24 reject;
        route 200.0.2.0/24 reject;
    }
    aggregate {
        route 172.18.16.0/27;
        route 172.18.8.0/21;
    }
}
protocols {
    isis {
        export [ summ stat_isis ];
        level 1 {
            authentication-key
"$9$OqisIhrWLNYgJevgJGDmPBIEcev"; ## SECRET-
DATA
            authentication-type simple;
        }
        level 2 {
            authentication-key
"$9$XjSNVYJGifT3goT369OBxNdV24"; ## SECRET-DATA
            authentication-type md5;
        }
        interface ge-0/0/8.0 {
            level 2 disable;
        }
        interface ge-0/0/9.0 {
            level 1 disable;
        }
        interface ae0.0 {
```

```
    HR {
        vlan-id 100;
        l3-interface vlan.100;
    }
}
virtual-chassis {
    preprovisioned;
    /* ex-vc-1 */
    member 0 {
        role routing-engine;
        serial-number BM0208105257;
    }
    /* ex-vc-4 */
    member 1 {
        role routing-engine;
        serial-number BP0208137931;
    }
    /* ex-vc-2 */
    member 2 {
        role line-card;
        serial-number BR0208138123;
    }
    /* ex-vc-3 */
    member 3 {
        role line-card;
        serial-number BR0208112075;
    }
}
```

```
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae1.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae2.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae3.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface lo0.0 {
            level 2 disable;
        }
    }
}
policy-options {
    policy-statement stat {
        from protocol static;
        then accept;
    }
    policy-statement stat_isis {
        from protocol static;
        to level 1;
        then accept;
    }
    policy-statement summ {
        term 1 {
            from protocol aggregate;
            to level 2;
            then accept;
        }
        term 2 {
            from {
                protocol isis;
                level 1;
            }
            to level 2;
            then reject;
        }
    }
}
```

Summary

In layer 2 environments, network administrators are faced with the task of preventing and possibly troubleshooting loops and broadcast storms. The EX Series offers OSPF as part of the base Junos OS and IS-IS with an additional license. This makes Layer 3 a compelling alternative for campus deployments.

The present document provided configuration, verification and troubleshooting procedures for a routed campus network using the EX Series platforms for access and aggregation with IS-IS as the routing protocol. An implementation example with detailed topology and configurations was also included.

Juniper customers can take advantage of the implementation example provided in this document to integrate the EX Series into their campus network and implement a design that provides optimal performance and flexibility as the business requirements of their network infrastructure evolve.

Appendix A: Conventions/Glossary

CLNS	Connectionless Network Protocol
BFD	Bi-Directional Forwarding Detection
DPC	Dense Port Concentrator
ECMP	Equal Cost Multi-Path
GRES	Graceful Routing Engine Switchover
IS-IS	Intermediate System to Intermediate System
ISO	International Organization for Standardization
LAG	Link Aggregation Group
MD5	Message Digest 5
OSPF	Open Shortest Path First
RE	Routing Engine
RVI	Routed VLAN Interface
OSI	Open Systems Interconnection
SFP	Small Form-factor Pluggable
VC	Virtual Chassis
VLAN	Virtual Local Area Network
XFP	10 Gigabit Small Form-factor Pluggable

Appendix B: Configurations

EX-VC-5

...truncated

```
chassis {
    redundancy {
        graceful-switchover;
    }
    aggregated-devices {
        ethernet {
            device-count 2;
        }
    }
}
interfaces {
    ge-2/0/0 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members SALES;
                }
            }
        }
    }
    ge-2/0/23 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members SALES;
                }
            }
        }
    }
    ge-2/1/0 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-2/1/1 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-2/1/2 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
```

```
    }
    ge-2/1/3 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
    ae0 {
        unit 0 {
            family inet {
                address 172.18.16.6/30;
            }
            family iso;
        }
    }
    ae1 {
        unit 0 {
            family inet {
                address 172.18.16.14/30;
            }
            family iso;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 172.18.8.2/32;
            }
            family iso {
                address 49.0001.0172.0018.0802.00;
            }
        }
    }
   vlan {
        unit 300 {
            family inet {
                address 172.18.11.1/24;
            }
            family iso;
        }
    }
    vme {
        unit 0 {
            family inet {
                address 172.19.59.195/24;
            }
        }
    }
routing-options {
    graceful-restart;
}
protocols {
    isis {
        level 1 {
            authentication-key "$9$A0X6uBElK8db2cyb24aiHtuO1cy"; ## SECRET-DATA
            authentication-type simple;
        }
        interface ae0.0 {
```

```
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae1.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface lo0.0 {
            level 2 disable;
        }
        interface vlan.300 {
            passive;
            level 2 disable;
        }
    }
}
vlans {
    SALES {
        vlan-id 300;
        l3-interface vlan.300;
    }
}
virtual-chassis {
    preprovisioned;
    /* ex-vc-5*/
    member 0 {
        role routing-engine;
        serial-number BP0208180059;
    }
    /* ex-vc-7 */
    member 1 {
        role routing-engine;
        serial-number BP0208180087;
    }
    /* ex-vc-6 */
    member 2 {
        role line-card;
        serial-number BQ0208189143;
    }
}
```

EX-VC-8

...truncated

```
chassis {
    redundancy {
        graceful-switchover;
    }
    aggregated-devices {
        ethernet {
            device-count 2;
        }
    }
}
interfaces {
    ge-0/1/0 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-0/1/1 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
    ge-1/1/0 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-1/1/1 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
    ge-2/0/0 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members SUPPORT;
                }
            }
        }
    }
    ge-2/0/23 {
        unit 0 {
            family ethernet-switching {
```

```
                port-mode access;
                vlan {
                    members SUPPORT;
                }
            }
        }
    }
    ae0 {
        unit 0 {
            family inet {
                address 172.18.16.18/30;
            }
            family iso;
        }
    }
    ae1 {
        unit 0 {
            family inet {
                address 172.18.16.26/30;
            }
            family iso;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 172.18.12.1/32;
            }
            family iso {
                address 49.0001.0172.0018.1201.00;
            }
        }
    }
    vlan {
        unit 400 {
            family inet {
                address 172.18.13.1/24;
            }
            family iso;
        }
    }
    vme {
        unit 0 {
            family inet {
                address 172.19.59.198/24;
            }
        }
    }
}
routing-options {
    graceful-restart;
}
protocols {
    isis {
        level 1 {
            authentication-key “$9$UHiqf36A1RSTzRSreXxDik.Tz”; ## SECRET-DATA
            authentication-type simple;
        }
        interface ae0.0 {
            bfd-liveness-detection {
```

```
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae1.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface lo0.0 {
            level 2 disable;
        }
        interface vlan.400 {
            passive;
            level 2 disable;
        }
    }
}
vlans {
    SUPPORT {
        vlan-id 400;
        l3-interface vlan.400;
    }
}
virtual-chassis {
    preprovisioned;
    /* ex-vc-8 */
    member 0 {
        role routing-engine;
        serial-number BN0208189106;
    }
    /* ex-vc-9 */
    member 1 {
        role routing-engine;
        serial-number BP0208180160;
    }
    /* ex-vc-10 */
    member 2 {
        role line-card;
        serial-number BP0208180149;
    }
}
```

EX-FC-2

...truncated

```
chassis {
    aggregated-devices {
        ethernet {
            device-count 2;
        }
    }
}
interfaces {
    ge-0/0/0 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members FINANCE;
                }
            }
        }
    }
    ge-0/0/1 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members MARKETING;
                }
            }
        }
    }
    ge-0/0/23 {
        unit 0 {
            family ethernet-switching {
                port-mode access;
                vlan {
                    members FINANCE;
                }
            }
        }
    }
    ge-0/1/0 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }

    ge-0/1/1 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
    ge-0/1/2 {
```

```
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-0/1/3 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
    ae0 {
        unit 0 {
            family inet {
                address 172.18.16.22/30;
            }
            family iso;
        }
    }
    ae1 {
        unit 0 {
            family inet {
                address 172.18.16.30/30;
            }
            family iso;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 172.18.12.2/32;
            }
            family iso {
                address 49.0001.0172.0018.1202.00;
            }
        }
    }
    me0 {
        unit 0 {
            family inet {
                address 172.19.59.212/24;
            }
        }
    }
   vlan {
        unit 500 {
            family inet {
                address 172.18.14.1/24;
            }
            family iso;
        }
        unit 700 {
            family inet {
                address 172.18.15.1/24;
            }
            family iso;
```

```
        }
    }
}
routing-options {
    graceful-restart;
    router-id 172.18.12.2;
}
protocols {
    isis {
        level 1 {
            authentication-key "$9$tuPL01hevLVwgSrwgoJHkp0BISr"; ## SECRET-DATA
            authentication-type simple;
        }
        interface ae0.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae1.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface lo0.0 {
            level 2 disable;
        }
        interface vlan.500 {
            passive;
            level 2 disable;
        }
        interface vlan.700 {
            passive;
            level 2 disable;
        }
    }
}
vlans {
    FINANCE {
        vlan-id 500;
        l3-interface vlan.500;
    }
    MARKETING {
        vlan-id 700;
        l3-interface vlan.700;
    }
}
poe {
    interface all;
}
```

EX-VC-15

...truncated

```
chassis {
    aggregated-devices {
        ethernet {
            device-count 4;
        }
    }
}
interfaces {
    ge-0/0/0 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-0/0/1 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
    ge-0/0/2 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae2;
        }
    }
    ge-0/0/3 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae3;
        }
    }
    ge-0/0/4 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae0;
        }
    }
    ge-0/0/5 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae1;
        }
    }
```

```
ge-0/0/6 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae2;
        }
    }
    ge-0/0/7 {
        ether-options {
            speed {
                1g;
            }
            802.3ad ae3;
        }
    }
    ge-0/0/8 {
        unit 0 {
            family inet {
                address 172.18.16.34/30;
            }
            family iso;
        }
    }
    ge-0/0/9 {
        unit 0 {
            family inet {
                address 172.18.16.42/30;
            }
            family iso;
        }
    }
    ae0 {
        unit 0 {
            family inet {
                address 172.18.16.9/30;
            }
            family iso;
        }
    }
    ae1 {
        unit 0 {
            family inet {
                address 172.18.16.13/30;
            }
            family iso;
        }
    }
    ae2 {
        unit 0 {
            family inet {
                address 172.18.16.25/30;
            }
            family iso;
        }
    }
    ae3 {
        unit 0 {
            family inet {
                address 172.18.16.29/30;
```

```
            }
            family iso;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 172.18.19.2/32;
            }
            family iso {
                address 49.0001.0172.0018.0902.00;
            }
        }
    }
    me0 {
        unit 0 {
            family inet {
                address 172.19.59.193/24;
            }
        }
    }
}
routing-options {
    graceful-restart;
    static {
        route 200.0.1.0/24 reject;
        route 200.0.2.0/24 reject;
    }
    aggregate {
        route 172.18.16.0/27;
        route 172.18.8.0/21;
    }
}
protocols {
    isis {
        export [ summ stat_isis ];
        level 1 {
            authentication-key "$9$XIYNVYJGifT3goT369OBxNdbgo"; ## SECRET-DATA
            authentication-type simple;
        }
        level 2 {
            authentication-key "$9$z5zkn9pIEyWLN0BLNdboaFn/9uO"; ## SECRET-DATA
            authentication-type md5;
        }
        interface ge-0/0/8.0 {
            level 2 disable;
        }
        interface ge-0/0/9.0 {
            level 1 disable;
        }
        interface ae0.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae1.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
```

```
            level 2 disable;
        }
        interface ae2.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface ae3.0 {
            bfd-liveness-detection {
                minimum-interval 300;
            }
            level 2 disable;
        }
        interface lo0.0 {
            level 2 disable;
        }
    }
}
policy-options {
    policy-statement stat {
        from protocol static;
        then accept;
    }
    policy-statement stat_isis {
        from protocol static;
        to level 1;
        then accept;
    }
    policy-statement summ {
        term 1 {
            from protocol aggregate;
            to level 2;
            then accept;
        }
        term 2 {
            from {
                protocol isis;
                level 1;
            }
            to level 2;
            then reject;
        }
    }
}
```

R1

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```
interfaces {
    ge-5/0/0 {
        unit 0 {
            family inet {
                address 172.18.16.38/30;
            }
            family iso;
        }
    }
    ge-5/0/1 {
        unit 0 {
            family inet {
                address 172.18.16.41/30;
            }
            family iso;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 172.18.19.3/32;
            }
            family iso {
                address 49.0002.0172.0018.1903.00;
            }
        }
    }
}
routing-options {
    graceful-restart;
}
protocols {
    isis {
        level 2 {
            authentication-key "$9$rzEKWxbs4Di.Ndi.P56/lKMW7-"; ## SECRET-DATA
            authentication-type md5;
        }
        interface ge-5/0/0.0 {
            level 1 disable;
        }
        interface ge-5/0/1.0 {
            level 1 disable;
        }
        interface lo0.0 {
            level 1 {
                disable;
                passive;
            }
        }
    }
}
```

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