Extreme IP Fabrics Deliver Automated Cloud Data Center Scale and Agility

Highlights

- Delivers superior scalability for large to mega-scale data centers—leveraging a cloud-proven, standard BGP-based architecture

- Optimizes agility with Extreme Workflow Composer, an automation platform that enables cross-domain integration with turnkey customizable automation suites or do-it-yourself network workflows for provisioning, validation, and event-driven troubleshooting and remediation

- Improves operations with pervasive traffic visibility to quickly identify problems, accelerate mean-time-to-resolution, and improve overall service levels

- Accelerates business innovation through dynamic IP fabrics built on adaptable switch and router platforms

- Enables workload mobility, security, and segmentation through standards-based, controller-less BGP-EVPN network virtualization or controller-based network virtualization options such as VMware NSX

- Leverages the power of DevOps methodologies, popular open source technologies, industry best practices, and a thriving technical community for peer collaboration and innovation

- Enables cloud orchestration and control through OpenStack integrations, VMware vRealize plugins, and OpenDaylight-based SDN controller support

Providing an Evolutionary Approach to Data Center Automation and Cloud Optimization

Organizations undergoing a digital transformation require flexible data center infrastructure to ensure business agility and achieve competitive advantage. Extreme® IP fabrics leverage proven, open standard protocols and deliver superior automation and scalability to address the rapidly changing requirements facing cloud data centers. Based on a cloud-proven, standard BGP-based design, these fabrics bring the best practices of mega-scale data center automation and expansion to any size data center.

IP fabrics enable open programmability and integration with commonly used open source tools, providing an evolutionary approach to data center automation and cloud optimization that allows organizations to move at their own pace. To ease the transition to IP fabrics and automation, organizations can leverage Workflow Composer™, powered by StackStorm. This automation platform enables cross-domain workflow automation with turnkey and customizable automation suites for IP fabric provisioning, validation, troubleshooting, and remediation.

As an integral part of the Extreme open, standards-based approach to data center design, IP fabrics are optimized for Layer 3 deployments with flexible network virtualization support options that enable seamless workload mobility, security, and segmentation within and across data centers.

## Enabling High Scalability and Resilience

IP fabrics deliver scalable performance with ease, leveraging the popular IP Clos architecture with Equal Cost Multi-Path (ECMP) routing. Extreme SLX® and Extreme VDX® flexible platforms deployed in a spine-leaf network are the building blocks of IP fabrics, providing a non-blocking and scalable framework. Based on open standards and a cloud-proven BGP architecture, IP fabrics offer flexibility for maximum interoperability. Data center administrators can easily add spine and leaf devices as needed to increase path diversity and bandwidth for east–west traffic, enabling higher application performance and resilience.

Spine-leaf Clos networks have three-stages—an ingress stage, a middle stage, and an egress stage—which provide multiple paths for traffic to be switched through the non-blocking spine, ensuring resilience and peak application performance.

Servers can be connected to the leaf switches in either a single-homed manner or, for additional resilience, in a dual-homed manner using virtual Link Aggregation Groups, or vLAGs (see Figure 1).

Organizations requiring even greater scale can build an IP fabric-optimized five-stage Clos super-spine network. A super-spine network consists of multiple spine-leaf data center pods that are connected through a third set of higher-level spine switches (see Figure 2). As with a standard IP fabric, a super-spine network supports highly resilient and redundant connections. In short, these are multiple three-stage Clos pods interconnected with a super spine, creating a larger, optimized five-stage Clos fabric with Layer 3 connectivity between pods.

IP fabrics built with SLX and VDX platforms deliver dynamic scale and agility, enabling cloud architects to design their networks for current usage as well as future growth. Fabric scale is determined by which Clos model is used and which platforms are deployed at the leaf, spine, and super-spine levels. Table 1 provides relative data center rack scale depending on the chosen Clos model and platforms. For more detailed information about Extreme IP fabric scale and platform design options, read the Data Center Fabric Architectures Solution Design Guide and the Extreme SLX Agile Data Center Portfolio At-a-Glance.
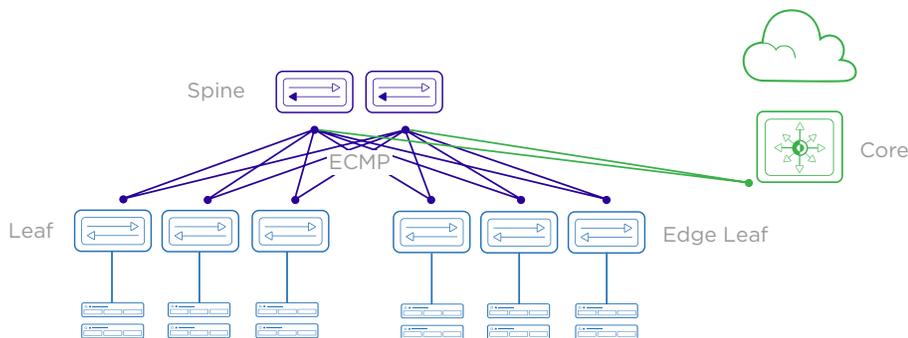
Figure 1: Extreme IP fabrics can be deployed in three-stage Clos networks with single-homed servers or, for additional resilience, with dual-homed servers using vLAGs.
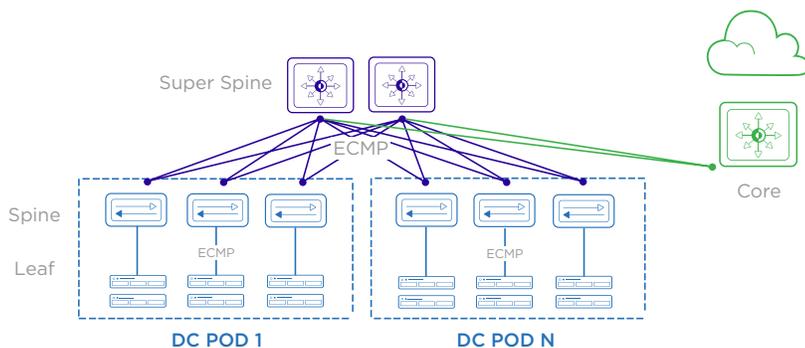
Figure 2: For maximum scale, Extreme IP fabrics can be deployed in optimized five-stage Clos networks with single-homed servers or with dual-homed servers using vLAGs, for additional resilience

3-Stage Topology				5-Stage Topology		
Rack Scale		16	72	144	228	576	2,592
10 GbE Fabric	Super-Spine				SLX 9850-04	SLX 9850-8	SLX 9850-8
	Spine	SLX 9240	SLX 9850-4	SLX 9850-8	SLX 9240	SLX 9240	SLX 9850-4
	Leaf	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S
Rack Scale		18	120	240	540	1,080	7,200
40 GbE Fabric	Super-Spine				SLX 9850-4	SLX 9850-8	SLX 9850-8
	Spine	SLX 9240 VDX 6940-36Q	SLX 9850-4	SLX 9850-8	SLX 9240 VDX 6940-36Q	SLX 9240 VDX 6940-36Q	SLX 9850-4
	Leaf	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S	SLX 9140 SLX 9540 VDX 6940-144S

Table 1: Extreme IP fabric scale with Extreme VDX and Extreme SLX flexible platform building blocks.

Adaptable Platform Building Blocks for Optimized IP Fabrics

Extreme flexible switch and router platforms are optimized for highly automated IP fabrics, providing network visibility and dynamic scale. SLX switches deliver flexible leaf, spine, and edge connectivity with programmable ASICs, open APIs, and designs that adapt to emerging speeds, standards, and protocols. They provide unparalleled network visibility with Extreme SLX Insight Architecture and Extreme SLX Visibility Services. These embedded capabilities allow organizations to achieve pervasive insight throughout the network to quickly identify problems, accelerate mean-time-to-resolution, and improve overall service levels. By using SLX technologies in concert with the Workflow Composer automation platform, organizations gain the agility they need to act quickly on network intelligence.

Workflow Composer Automation Suites

Figure 3: The Workflow Composer workflow-centric, cross-domain network automation architecture

Providing ultimate scalability and visibility, the SLX 9850 Router is ideal for IP fabric spine or super-spine capacity. It can easily aggregate high-performance leaf switches to support the rapid, continuous growth of network devices and services. VDX switches offer spine and leaf connectivity that is fully interoperable with SLX switches and routers in high-performance IP fabrics. Moreover, VDX switches offer an easy transition path from VCS® fabrics to IP fabrics by allowing organizations to leverage the same hardware. This helps ensure full investment protection as data center fabric needs evolve.

Turnkey Automation for the Entire Network Lifecycle

IP fabrics leverage Workflow Composer, an automation platform that enables cross-domain workflows using turnkey automation suites. These automation suites can be used as-is or customized based on customer needs. The Data Center Fabrics Automation Suite, for example, delivers workflows for IP fabric provisioning, validation, troubleshooting, and remediation. Workflow Composer automates the entire network lifecycle to accelerate time to value and reduce operational costs (see Figure 3).

With Workflow Composer, IP fabric and BGP-EVPN deployment times can be reduced from days to just minutes. The automated provisioning of network devices and network virtualization (see Figure 4) allows administrators to deploy services with minimal effort, out of the box. High availability and performance are ensured through automated validation of IP interfaces, BGP peers, and IP routes based on IP fabric best practices.
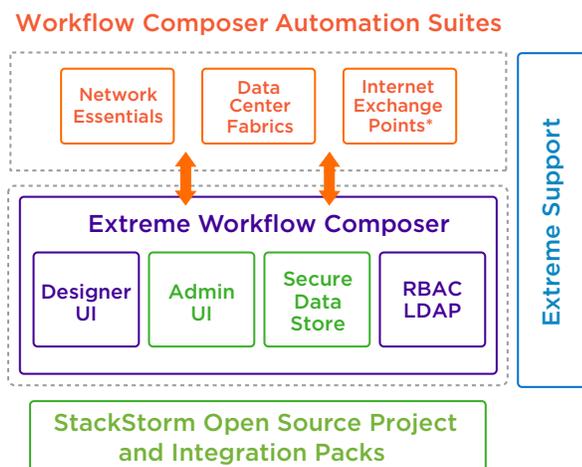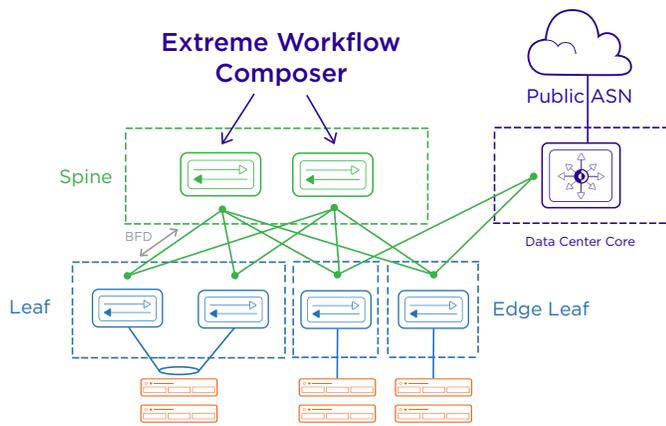
Figure 4: Workflow Composer leverages the Data Center Fabrics Automation Suite to provision and validate high-performance IP fabric spine and leaf connectivity.

Workflow Composer also delivers high levels of network resiliency with Data Center Fabrics Automation Suite troubleshooting and auto-remediation workflows in response to preconfigured sensors. For example, Workflow Composer can use a sensor to continually review switch port health in a data center IP fabric network. If a sensor detects an intermittent failure on a switch port, it triggers a corrective action workflow, achieving a closed loop remediation to eliminate any need for human involvement. Moreover, collective intelligence added over time empowers Workflow Composer to identify and seamlessly respond to known conditions, or deliver alerts for less common issues. Eliminating human involvement in time-consuming—and often error-prone—network changes enables IT operations to be more responsive and focus on innovation, rather than routine maintenance and troubleshooting.

Open Interfaces Enable Cloud Agility and Innovation

To optimize operations and improve agility, IP fabrics support open source, community-preferred technologies to deliver automation. Workflow Composer leverages the power of DevOps methodologies, popular open source technologies, industry best practices, and a thriving technical community for peer collaboration and innovation. With the highly extensible Workflow Composer framework, Extreme or third-party-developed workflows can be executed on multivendor physical or virtual networking platforms with commonly used technologies and services.

Extreme provides turnkey workflows in automation suites, along with support for community-preferred tools such as Python, Ansible, Puppet, Mistral, and YANG model-based REST and Netconf APIs.

Together, these automated workflows and open tools enable straightforward customization and extensibility for optimized delivery of current and future cross-domain IT services. Workflow Composer, powered by StackStorm, includes nearly 2,000 customizable sensors and actions for popular platforms and applications, allowing any IT organization to introduce automation quickly. Organizations that are further down the path of DevOps-style automation can use all of these open source tools, combined with the Workflow Composer platform, to build do-it-yourself workflows using their own expertise for completely customized automation.

Moreover, cloud orchestration and control through OpenStack integrations, VMware vRealize plugins, and OpenDaylight-based SDN Controller support enable full network integration with compute and storage resource provisioning and management.

Cross-Domain Network Automation for Multivendor Platforms

With its open, standards-based approach, Workflow Composer supports multivendor environments and enables IT organizations of all sizes to improve IT agility through automation, integration, and innovation. Workflow Composer includes integrations with popular applications and tools, enabling development of automation workflows that span multiple IT domains. These cross-domain workflows can fully integrate with existing IT services delivery tool chains and execute event-driven actions on any network device, application server, or storage platform.

Intelligent Automation on Your Terms

Automating infrastructure is a journey in which each step delivers greater value but requires advancements in technology, skills, and processes. It also requires pervasive network visibility to guide automation decisions. While some organizations are far along, many are seeking ways to get started using their existing skills, resources, or investments. Extreme enables IT organizations of any size to transition to automation at their own pace.

IP fabrics leverage Workflow Composer along with SLX Insight Architecture and SLX Visibility Services to drive agility within IT organizations. Key features and benefits include:

- **Automate cross-domain workflows** - Develop and execute an automation strategy at your own pace with customizable turnkey automation suites or do-it-yourself network workflows that easily integrate with existing tool chains—all supported in multivendor network environments.

- **Innovate and optimize operations** - Leverage pervasive traffic visibility for real-time network analytics, monitoring, and troubleshooting. IT organizations can maximize automation with the power of proven DevOps methods, popular open source technologies, industry best practices, and a thriving technical community for peer collaboration and innovation.

- **Accelerate time to value and reduce operational costs** - Easily automate the entire network lifecycle—including provisioning, configuration validation, troubleshooting, and remediation. Event-driven automation, informed by network visibility, enables fast problem identification, accelerated mean-time-to-resolution, and improved overall service levels.

Pervasive Network Visibility and Programmable Interfaces

By embedding network visibility on every router and switch, organizations can improve network operations and reduce operational costs. Pervasive, granular, real-time network monitoring and troubleshooting are enabled through dynamic traffic flow identification, intelligent pre-processing, and flexible data streaming. SLX Insight Architecture and SLX Visibility Services deliver a new approach to network monitoring and troubleshooting that makes it faster, easier, and more cost-effective to get the comprehensive, real-time visibility needed for network operations and automation.

SLX Insight Architecture

Organizations can improve operational efficiency and troubleshooting with SLX Insight Architecture. It features an open guest VM environment to run third-party monitoring and analytics applications on the switch or router, coupled with a dedicated, internal analytics path and high-performance data streaming options.

SLX Visibility Services

SLX Visibility Services enable organizations to collect physical and virtual network traffic data from multiple network layers to provide overlay and workload visibility across the network. In addition, rule-based actions can be automatically applied to incoming network traffic, and context-rich data can be delivered to SLX Insight Architecture, Workflow Composer, or third-party analytics and monitoring applications.

Extreme IP Fabric Specifications

General

- Operating Systems
  - Extreme Network OS (Extreme VDX leaf, spine, deployments)
  - Extreme SLX-OS (Extreme SLX leaf, spine, and super-spine deployments)

- Layer 2 Switching
  - Virtual Local Area Networks (VLANs)
  - QinQ
  - MCT
  - Link Aggregation Control Protocol (LACP) IEEE 802.3ad/802.1AX
  - Link Aggregation Group (LAG)
  - Conversational MAC Learning
  - Layer 2 Access Control Lists (ACLs)
  - Edge Loop Detection (ELD)
  - Address Resolution Protocol (ARP) RFC 826
  - ARP Suppression
  - High availability/In-Service Software Upgrade—hardware-enabled
  - IGMP v1/v2/v3 Snooping
  - MAC Learning and Aging
  - BFD/ARP Optimizations
  - Static MAC to VxLAN tunnels
  - L2 Loop prevention in an overlay environment
  - VLAN Encapsulation 802.1Q
  - Private VLANs
  - Per-VLAN Spanning Tree (PVST+/PVRST+)
  - Rapid Spanning Tree Protocol (RSTP) 802.1w
  - Multiple Spanning Tree Protocol (MSTP) 802.1s

- Layer 2 Switching
  - STP PortFast, BPDU Guard, BPDU Filter
  - STP Root Guard
  - Pause Frames 802.3x
  - Static MAC Configuration
  - Uni-Directional Link Detection (UDLD)
  - BUM Storm Control
  - 802.1ag
  - Service Node Load Balancing
  - VPLS,VLL Pseudowires
  - VRF Lite

- Layer 3 Switching
  - Border Gateway Protocol (BGP4+)
  - OSPF v2/v3
  - ISIS
  - GRE
  - MPLS
  - IPv4/IPv6 dual stack
  - Bidirectional Forwarding Detection (BFD)
  - VRF-aware OSPF, BGP, VRRP, static routes
  - 64-Way ECMP
  - DHCP Helper
  - Layer 3 ACLs
  - Multicast: PIM-SM, IGMPv2/v3
  - Static routes
  - Policy-Based Routing (PBR)
  - VRRP v2 and v3 , VRRP-E
  - IPv4/v6 ACL
  - IPv6 ACL packet filtering
  - BGP Additional Path
  - BGP GTSM
  - BGP Peer Auto Shutdown
  - Multicast refactoring
  - IPv6 routing
  - OSPF Type-3 LSA Filter
  - Wire-speed routing for IPv4 and IPv6 using any routing protocol
  - Multi-VRF
  - Inter VRF Routing
  - IP Unnumbered Interface
  - IP over Port Channel
  - Static Anycast Gateway
  - ARP Suppression
  - RSVP-TE
  - OSPF-TE
- Automation and Programmability
  - Workflow Composer
  - DHCP automatic fabric provisioning
  - OpenFlow 1.3
  - REST API with YANG data model
  - Puppet
  - Python PyNOS Libraries
  - Ansible
  - Mistral
  - vRealize Operations and vRealize Log Insight
  - NetConf API
  - ONIE
- Multitenancy and Virtualization
  - VxLAN
  - Extreme IP Fabric Gateway for NSX with VMware NSX Orchestration

- NSX-V Certification
- Multi-VRF
- Pseudowires – VPLL, VLL
- VRF Lite
- Third-party VM
- OpenFlow 1.3 Hybrid
- High Availability
  - ISSU L2 and L3
  - BFD
  - OSPF3-NSR
  - BGP4-GR
- QoS
  - ACL-based QoS
  - Eight priority levels for QoS
  - Class of Service (CoS) IEEE 802.1p
  - DSCP Trust
  - DSCP to Traffic Class Mutation
  - DSCP to CoS Mutation
  - DSCP to DSCP Mutation
  - Random Early Discard
  - Per-port QoS configuration
  - ACL-based Rate Limit
  - Dual-rate, three-color token bucket
  - ACL-based remarking of CoS/DSCP/Precedence
  - ACL-based sFlow
  - Scheduling: Strict Priority (SP), Deficit Weighted Round-Robin (DWRR), Hybrid Scheduling (Hybrid)
  - Queue-based Shaping
  - Flow-based QoS

Management

- Management and Monitoring
  - IPv4/IPv6 management
  - Industry-standard Command Line Interface (CLI)
  - Netconf API
  - REST API with YANG data model
  - Link Layer Discovery Protocol (LLDP) IEEE 802.1AB
  - Link OAM
  - MIB II RFC 1213 MIB
  - Switch Beaconing
  - Management VRF
  - Switched Port Analyzer (SPAN)
  - Telnet
  - SNMP v1, v2C, v3
  - sFlow RFC 3176
  - Out-of-band management
  - Remote SPAN (RSPAN)
  - RMON-1, RMON-2

- Management and Monitoring (cont.)
  - NTP
  - Management Access Control Lists (ACLs)
  - Role-Based Access Control (RBAC)
  - Range CLI support
  - UDLD
  - OpenStack Neutron ML2 plugin
  - Python
  - Puppet

- Security
  - ARP Guard
  - Port MAC Security
  - BUM Storm Control
  - DDoS Mitigation
  - Role-Based Access Control
  - Port-based Network Access Control 802.1X
  - RADIUS (AAA)
  - TACACS+
  - Secure Shell (SSHv2)
  - BPDU Guard
  - Lightweight Directory Access Protocol (LDAP)
  - Secure Copy Protocol

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