SEL-5056 Software-Defined Network (SDN) Flow Controller

SDN Configuration, Orchestration, and Monitoring Software

Key Features and Benefits

The SEL-5056 SDN Flow Controller is designed to optimize SDN configuration and management for critical infrastructure. The SEL-5056 is designed to work collectively with the SEL SDN switches to provide a complete traffic-engineering solution for Ethernet-based local-area networks (LANs). Traffic engineering with the SEL-5056 enables flexible configuration of each communications flow path and the ability to proactively engineer fault-tolerant deny-by-default networks, resulting in greater performance, improved reliability, and more deterministic packet delivery.

➤ **Robust Topology Discovery and Management.** Automated, directed, and offline topology discovery and management capabilities provide full control of situational awareness and programmability with simplified network deployment options.

➤ **Circuit Provision Orchestration.** Provides circuit provisioning through simply selecting the source and destination, as well as automated flow configuration and redundancy path planning.

➤ **Ease of Use.** Simplifies complex settings by using an application-focused design to construct each network according to the applications running on the network.

➤ **Holistic Network Visibility.** Allows viewing and management of network appliances as a single asset. Automated network topology discovery allows for near real-time situational awareness.

➤ **Learn and Lock.** Fully automate commissioning and unicast circuit provisioning.

➤ **Scalable Network Deployments.** Manages small or large networks with a single SEL-5056 installation.

➤ **Secure Configuration.** Provides situational awareness and strong cybersecurity through user-based access controls, encrypted communication, and detailed audit logging.

➤ **Syslog.** Performs log management through Syslog for centrally automated collection and redundancy.

➤ **Supported Operating Systems.** Provides embedded operations with SEL Blueframe or service-focused operations with Microsoft Windows 2016.

➤ **X.509 Certificate.** Supports secure, mutually authenticated communication between the switch and the flow controller, manages keys through X.509 certificates, and centrally supports certificate revocation through the use of Certificate Revocation Lists (CRLs).

➤ **Central Authentication.** Uses Lightweight Directory Access Protocol (LDAP) to centrally manage and authenticate authorized users.

➤ **Back Up and Restore.** Generates backup images for incident recovery and quickly restores the system to the saved backup.

➤ **Secure Application Registration.** Scale out the software ecosystem safely with secure application registration to the northbound API.

➤ **Timed Conversations.** Provision communication circuits that automatically time out and disable after a predefined countdown timer. Reuse these circuits by enabling them again, resetting the timer.

➤ **Authenticated Controller Time Synchronization (ACTS).** Time-synchronize all SDN switches to the flow controller's time through cryptographically protected time synchronization distribution.

Functional Overview

The SEL-5056 is the central interface for commissioning, configuring, and monitoring all SEL SDN-enabled network appliances on its LAN. An SDN is a network architecture that centralizes packet forwarding control configuration into a central software application. This control centralization enables the LAN to be managed as a single asset, simplifying deployment, scalability, and operational tasks, all while improving performance. The SEL-5056 is a standards-based flow controller, compatible with OpenFlow 1.3, designed to optimize the specific tasks of control systems for proactive traffic engineering of high-reliability networks. With the SEL-5056, users can design a deny-by-default network, while considering fault tolerance, by instructing each network appliance how to forward packets and how to respond to a network fault.

Topology

Hypertext Transfer Protocol Secure (HTTPS) provides encryption and authentication for secure management of SEL-5056 web browser communication. The SEL-5056 communication to all SEL SDN switches occurs through encrypted and authenticated Transport Layer Security (TLS) communication. Touchless topology management and switch discovery ease commissioning and deployment efforts. Touchless node discovery enables new switches and hosts to be discovered and shown in the graphic display before they are added to the inventory, enabled to communicate with the SEL-5056, and prepared for configuration.
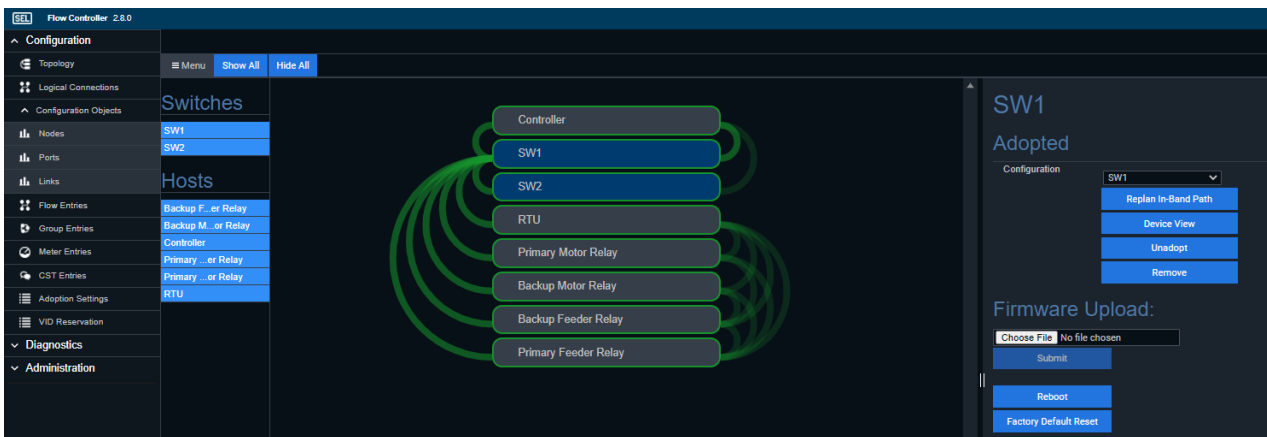

Figure 1   SEL-5056 Displaying SDN Switch Dashboard

Management

The SEL-5056 centrally manages its LAN as a single asset, controlling traffic flow access to the network and determining the path each flow takes. The SEL-5056 improves network performance by using predetermined failover conditions and eliminating the need for dynamic convergence protocols such as Rapid Spanning Tree Protocol (RSTP). The southbound interface is a standards-based OpenFlow 1.3 interface.
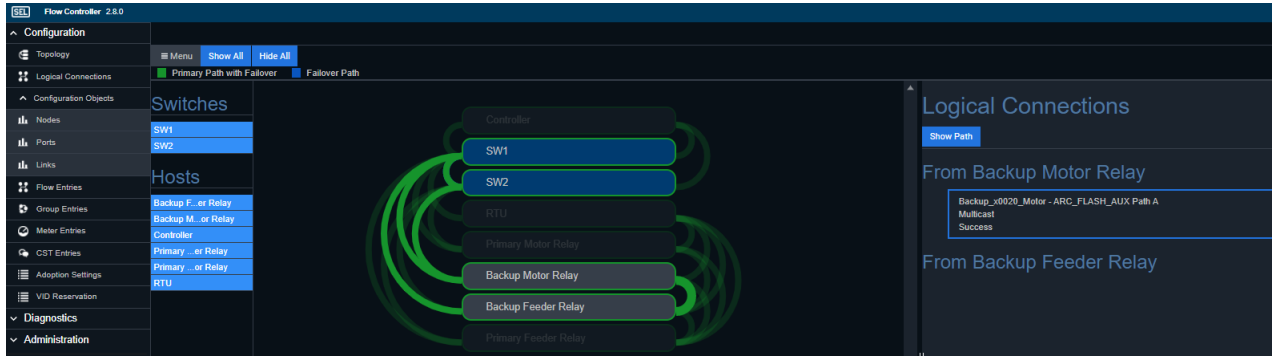
Figure 2   SEL-5056 Topology View

The SEL-5056 provides a system-wide change management capability so users can plan changes without interrupting service. The software is designed with a cybersecurity focus. The controller has a whitelisting architecture and deny-by-default network management at each hop. Operational diagnostics collected from all network assets provide superior situational awareness and detailed audit logging of users. Access control to change management is user-based and centrally controlled and logged.

Application Examples

The SEL-5056 is ideally suited for the commissioning, configuration, and management of an SDN for a substation LAN.

Traffic Engineering

The SEL-5056, coupled with an SEL SDN switch, provides touchless device discovery and topology management. The SEL-5056 can discover network topologies, track host locations, and provide a user interface from which you can configure communications between devices while enabling network-wide visualization of each conversation.

The flow controller binds securely to switches and facilitates the easy discovery and addition of new switches to the inventory. Automatic discovery does not impede operational data flows, thus enabling network scalability without interruption. Upon the addition of a switch to the inventory, the SEL-5056 begins the passive automatic discovery of hosts on the network. Flow configuration occurs either through automatically created host-based logical paths or by direct flow entry into the switch tables. This traffic engineering focuses on improving the ability to proactively design the network for any failure case. Logical flow path configuration allows users to select the end points for each flow, the match criteria, and the action set. This way, every forwarding hop that the packet traverses is automatically programmed. This removes the need to configure flows in each switch individually, and it eliminates many tedious configuration tasks.

Traffic engineering is made simple through the use of aliases for any host, port, link, flow, meter, or group. This allows the engineer to reference friendly names rather than identifier numbers. Counters are also referenced by these aliases, simplifying troubleshooting.
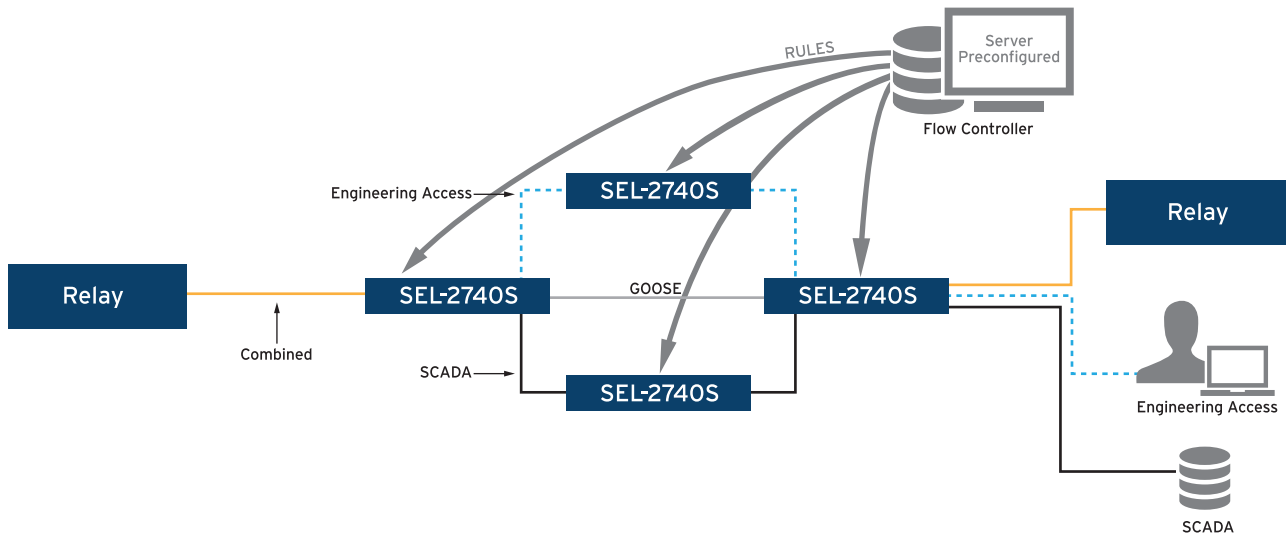
Figure 3   Configured Network Diagram

The SEL-5056 provides a global view of the entire network, showing the communications health and diagnostics information for each flow, and enabling system operators to understand what is happening on the communications infrastructure. The SEL-5056 also provides device views of the network so that the configuration of each individual network appliance and the configuration of all allowed host traffic can be centrally controlled and monitored.

Central Management and Monitoring

The SEL-5056 manages and monitors its LAN as a single asset. SEL SDN switches work with the SEL-5056 to provide communications flow configuration and monitoring capabilities. This allows operators to monitor all flows and their attributes from a single location. No engineering access interface is necessary on the individual SEL SDN switches. The entire LAN is conveniently and centrally managed by the SEL-5056, greatly simplifying field deployment. In addition, the SEL-5056 provides backup and restore features for maintaining high reliability. Operators can take a snapshot of the system and use any backup as a restore point for recovery.

Figure 4   SEL-5056 Software Banner

Learn and Lock Extension

The Learn and Lock extension provides the functionality to help simplify the network topology discovery and communications circuit provisioning. This extension commissions and adopts switches; discovers and adopts hosts and links; and provisions Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Address Resolution Protocol (ARP) and Internet Control Message Protocol (ICMP) communications with minimal user interaction. The primary functions automated in the Learn and Lock extension include the following:

➤ **Network reset:** Removes all user configurations and returns the system and devices to their initial default states.

➤ **Topology management:** This is called Auto Adoption, and this feature adopts discovered switches, hosts, and links.

➤ **Communication circuit provisioning:** This is called Logical Connection Learning, and this feature learns what ARP, TCP, UDP, and ICMP conversations each adopted host is attempting to have and provisions logical connections.

The Learn and Lock extension is initiated by an authorized user with Permission Level 3 privileges. Use caution when using the SEL-5056 features during the Learn and Lock session because changes may impact the operations of the Learn and Lock extension. Only one Learn and Lock session can run at a time and only one of the three Learn and Lock functions can operate in the session at a time. A Learn and Lock session allows the user to choose which of the three functions to run as part of the session. When running multiple functions in a single session, the session starts with the Network Reset, followed by the Auto Adoption, and finally ends with the Logical Connection Learning. You can start, stop, and manage Learn and Lock sessions through the menu on the Topology page, as shown in *Figure 5*.
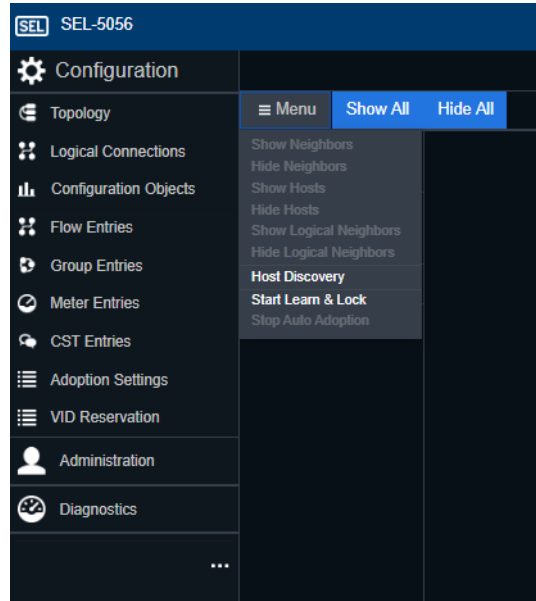
Figure 5   Learn and Lock Menu

Requirements

The SEL-5056 is the preferred OpenFlow controller for the SEL SDN switches. All network configurations and settings are managed through the SEL-5056. The SEL-5056 is available as an application for SEL Blueframe or Microsoft Windows Server 2016.

Table 2.1   Minimum System Requirements

Operating system	SEL Blueframe Microsoft Windows Server 2016
Hard disk drive	250 GB
Processor speed	2.5 GHz
RAM	8 GB
Screen resolution[a]	1920 x 1080
Browser	Google Chrome version 80

[a] Recommended.

Specifications

Operating System Support

SEL Blueframe Software
Microsoft Windows Server 2016

General

Protocols

OpenFlow 1.3
Transport Layer Security (TLS)
Syslog (UDP and TLS)
Hypertext Transfer Protocol Secure (HTTPS)
Secure REST
Lightweight Directory Access Protocol (LDAP) over StartTLS

Security

X.509 certificate
User-based accounts

Monitoring

Syslog
Local system event store

Browser

Google Chrome version 80 and higher (recommended)

Notes

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