Cisco Digital Building Cree Solution Implementation Guide

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Cisco Validated Design

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The CVD program consists of systems and solutions designed, tested, and documented to facilitate faster, more reliable, and more predictable customer deployments. For more information visit http://www.cisco.com/go/designzone.

Cisco Digital Building Cree Implementation Guide

CONTENTS

Preface

This document provides implementation details for Cisco Digital Building Cree Solution initial installation, migrating the lighting initial setup to different production network topologies and ongoing lighting system management and maintenance.

This document provides the implementation details for the solution topologies discussed in “Section 3.1, System Topologies,” of the *Cisco Digital Building Cree Design Guide*, which can be found at the following URL:

- https://docs.cisco.com/share/proxy/alfresco/url?docnum=EDCS-11343548

Note For power budgeting the Cree Lighting endpoints, please refer to the "SmartCast® PoE Required Switch Settings" section of the Cree SmartCast® PoE Technology Quick Start Deployment Guide, which can be found at the following URL:

- https://www.creelink.com/exLink.asp?32952792OR66B89I47749092&view=1

Audience and Scope

The audience of this guide comprises, but is not limited to, system architects, network/compute design engineers, systems engineers, field consultants, Cisco Advanced Services specialists, and customers who are deploying the Cisco Digital Building Cree Solution.

The Cisco Digital Building Cree Solution Cisco Validated Design (CVD) consists of a Design Guide, which provides overall guidance on the solution design and this Implementation Guide.

The detailed implementation of Cisco Campus Network architecture is beyond the scope of this document. Refer to the *Cisco Campus Network CVD* on Cisco’s Design Zone at the following URL:

- http://www.cisco.com/c/en/us/solutions/enterprise/design-zone-campus/index.html#~validate

Readers should be familiar with IPv4 networking concepts and protocols, Networking Layer 4 through Layer 7 services and Cisco Catalyst Series Switches, Cisco Unified Computing System (UCS), and VMware hypervisors.

Introduction

The Cisco Digital Building Cree Solution is an Over the Top (OTT) connected lighting system that uses the Cisco Universal Power over Ethernet (UPOE) switching products and Cree SmartCast® protocol to directly control networks of IP light fixtures and provide indoor lighting services on the enterprise network.

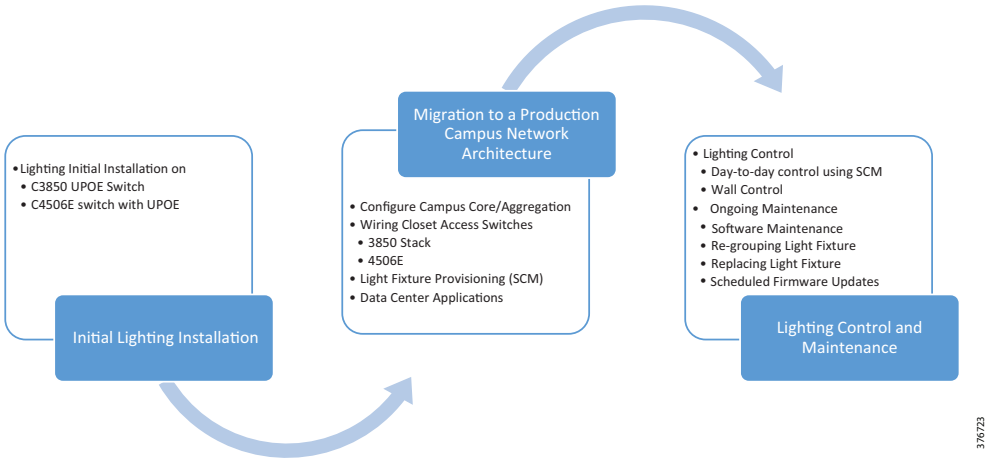
The scope of this document is limited to implementation of a lighting network for initial installation and migrating the lighting setup to system network topologies described in the *Cisco Digital Building Cree Design Guide*.

Note Detailed configuration steps for implementing Cree SmartCast lighting system are covered in the *Cree SmartCast PoE User Manual v1.2.2*, which is referenced in this document wherever applicable.

Implementation Workflow

This section provides the high level implementation flow, as shown in Figure 1-1, for deploying the Cisco Digital Building Cree Solution on a large scale system topology. We recommend following this implementation flow, when deploying the solution on system topologies with no Campus Network core and small site installation.

Figure 1-1 Cisco Digital Building Cree Solution Implementation Workflow



The Cisco Digital Building Cree Solution is based on a centralized model in which the light fixtures are connected to Cisco Catalyst 3850 UPOE standalone switches, Cisco Catalyst 3850 stack switches, or the Cisco Catalyst 4500E UPOE switch, which are deployed in the wiring closet. The Cisco Digital Building Cree Solution is deployed on a separate logical network. The lighting network has its own separate VLAN to communicate with lighting components such as fixtures and lighting management applications.

System Overview

This chapter, which provides an overview of the Cisco Digital Building Cree Solution implementation, includes the following major topics:

System Topology

The Cisco Digital Building Cree Solution can be deployed in multiple deployment topologies, based on the customer's requirements and the time when the installation will be done.

Refer to the *Cisco Digital Building Cree Design Guide* for more details on different deployment topologies.

Figure 2-1 and Figure 2-2 show physical network topologies for a large scale lighting network integration with a Campus Network, where wiring closet access switches (Cisco Catalyst 3850 stack or Cisco Catalyst 4506-E) connect to a Campus Network aggregation/distribution switch (Cisco Catalyst 4500-X). In this deployment, the aggregation switch aggregates lighting wiring closet switches and provides IP addressing to light fixtures using DHCP. An aggregation switch in a Campus Network collapsed core/distribution layer connects to the data center via a firewall. The firewall allows only management traffic from the lighting network to flow to the data center.

Figure 2-1and Figure 2-2 show the Cisco Catalyst 3850 switch as an example data center switch for the server farm network access. However, any data center switch as recommended or implemented in the campus data center design, can be leveraged to configure network access to servers.

Note The Campus Network topology shown in Figure 2-1 is one of the deployment models of Campus Network architectures (that is, using a Collapsed Core Network topology) considered for the system design and validation. The detailed implementation of a Campus Network for enterprise network services is beyond the scope of this document. For detailed implementation and best practices for deploying the Campus Network, refer to the *Cisco Campus Network CVD* at the following URL:

- http://www.cisco.com/c/dam/en/us/td/docs/solutions/CVD/Aug2014/CVD-CampusWiredLANDesignGuide-AUG14.pdf

Figure 2-1 Cisco Digital Building Cree Solution on a Campus Network—Physical Topology with Cisco Catalyst 3850 Stack in Wiring Closet

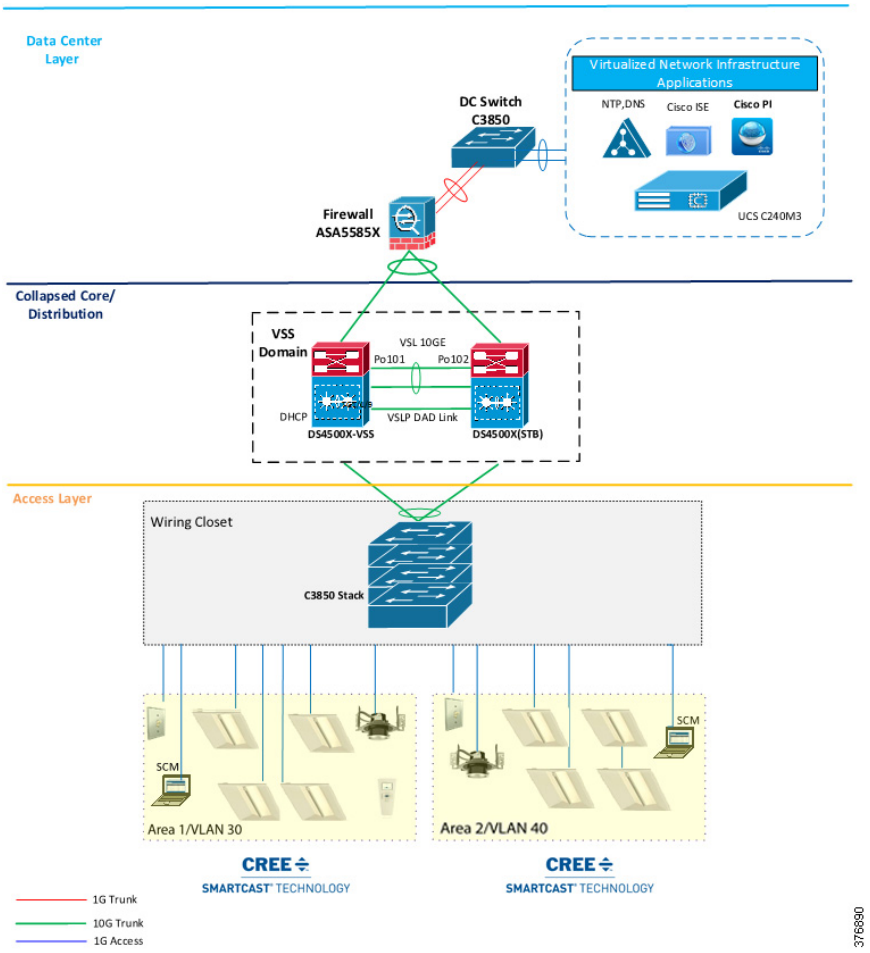
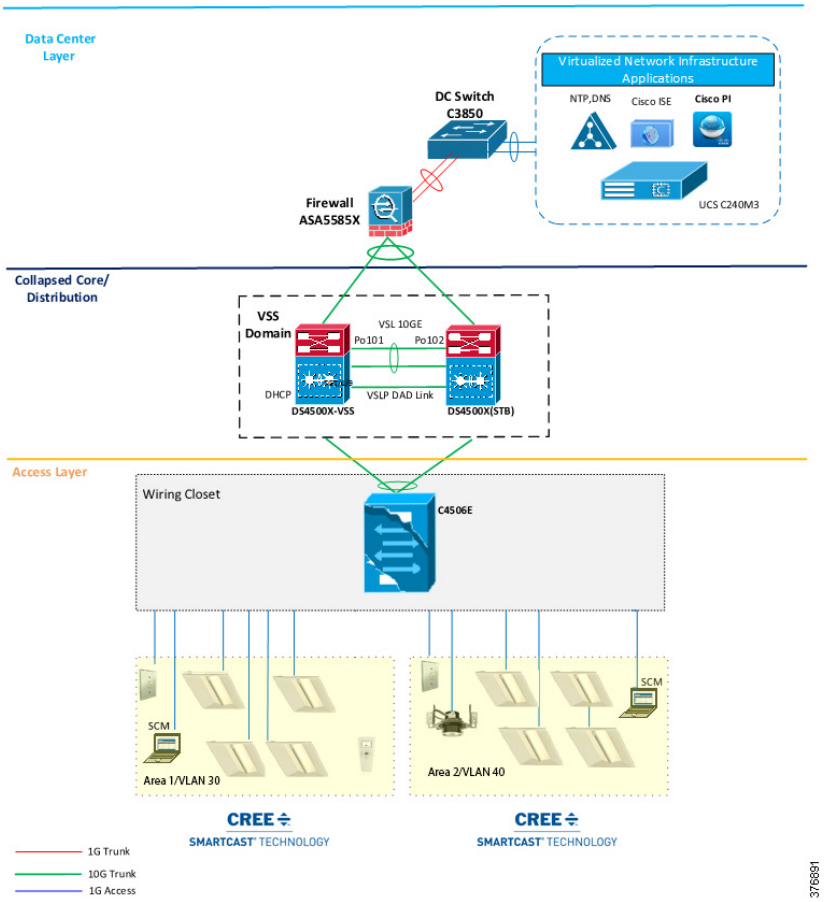


Figure 2-2 Cisco Digital Building Cree Solution on a Campus Network—Physical Topology with Cisco Catalyst 4506E in Wiring Closet



System Components

The components validated within this system consist of a mix of Cisco products (see Table 2-1) and Cree products (see Table 2-2).

Table 2-1 Cisco Components

Cisco Product	Software Release	Description
Cisco Catalyst 3850 Switch—Wiring Closet/Access Switch	3.7.0 EX	UPOE switch
Cisco Catalyst 4506-E Switch—Wiring Closet/Access Switch	15.2(3)E1	Wiring closet access switch with UPOE line cards
Cisco Catalyst 4500-X Switch—Core/Distribution Switch	03.07.01_15.2(3)E1	Campus network aggregation switch
Cisco Prime Infrastructure	3.0	Network Management and Syslog server

Table 2-1 Cisco Components (continued)

Cisco Product	Software Release	Description
Cisco Identity Server Engine (ISE)	2.0	TACACS+ authentication and authorization server for network devices
Cisco ASA 5585 Firewall	9.6.1	Firewall to protect server farm

Cree will provide the list of commercial names for the following products so that it is in line with the website and the ordering process. See Table 2-2.

Table 2-2 Cree Components

Vendor Product	Release	Description
Cree CR22,CR24 UPOE Troffers	1.2.2	Light fixture
Cree KR6	1.2.2	6" down light
Cree PoE Wall Dimmer	1.2.2	Wall control switch
Cree Configuration Tool	1.2.2	Wireless configuration tool for fixture selection
Cree SmartCast Manager	1.2.2	Light commissioning application

Table 2-3 is the list of third-party infrastructure components used in the system.

Table 2-3 Third-Party Components

Product	Purpose	Version
Virtualization Software for UCS	Hypervisor	VMware ESXi 5.5
SmartCast Manager OS Platform	Operating System	Microsoft Windows 7 Enterprise Release SP1

System Networking

The Digital Building system should deploy on a separate logical network (VLAN) with a limit of 1,000 lights fixtures per VLAN. A new VLAN is required to deploy more than 1,000 light fixtures, which will restrict the number of broadcast messages the light fixtures can process at a time. Each VLAN requires a SmartCast Manager to configure, calibrate and monitor the light fixtures.

This section summarizes the logical network (VLAN) configuration for the Cisco Digital Building Cree Solution network. In Table 2-4, which lists example implemented VLANs, the subnet mask 255.255.252.0 is used to allow up to 1000 light fixtures per VLAN, as recommended in the *Cisco Digital Building Cree Design Guide*, Section 4.2.

Table 2-4 Example List of VLANs

VLAN	Purpose	Network/Mask
30	VLAN for light fixtures and SmartCast Manager in the data network	10.30.0.0/22
40	VLAN for light fixtures and SmartCast Manager in the data network	10.40.0.0/22
50	Management VLAN for the network management traffic	10.50.0.0/22
70	Data VLAN in data center for applications	10.70.0.0/22

Note The VLANs shown in Table 2-4 are only examples that were used in this Cisco Digital Building Cree Solution validation. VLAN numbering may vary based on your actual deployment.

Initial Installation of Connected Lighting

This chapter, which covers implementation details for the initial installation (Day 0) of the Cisco Digital Building Cree Solution, using UPOE switches for the deployment scenarios discussed in the *Cisco Digital Building Cree Design Guide*, includes the following major topics:

During the initial installation, the electrician will install the light fixture on wiring closet switches (Cisco Catalyst 3850 or Cisco Catalyst 4506-E) with the default factory configuration to verify the light fixture's operation.

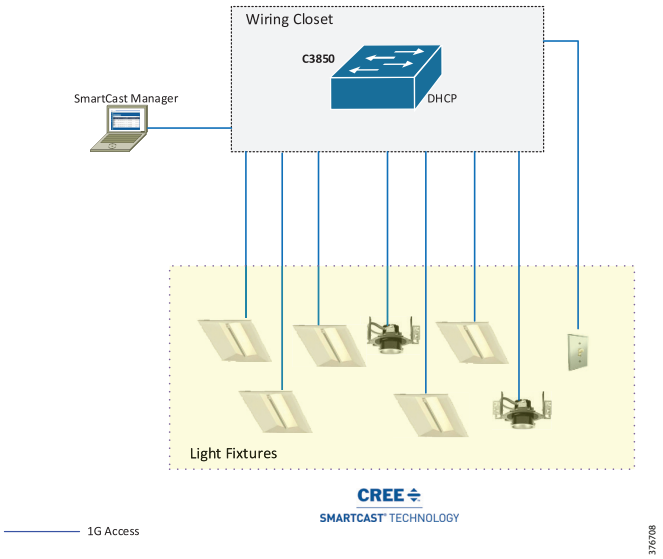
Initial Installation with Cisco Catalyst 3850 UPOE Switch

This section covers network topology and configuration required on Cisco Catalyst 3850 switches for the initial installation of light fixtures.

Network Topology

During the initial installation, light fixtures are connected to the wiring closet Cisco Catalyst 3850 UPOE access switch, as shown in the network topology depicted in Figure 3-1.

Figure 3-1 Cisco Digital Building Cree Solution Initial Setup with Cisco Catalyst 3850 Switch



Configuring Cisco Catalyst 3850 UPOE Switch for Initial Installation

Cree Light Fixtures Installation

The initial installation of Cree light fixtures at installation site is generally done by an electrician along with an UPOE switch. The CREE installation, which involves low voltage wiring, does not require an electrical contractor.

When the light fixtures are connected to Cisco Catalyst 3850 UPOE switch ports, the light fixtures turn on with low brightness (~15W of switch port PoE power); this verifies light fixtures' hardware operation by the electrician.

Initial Network Setup

The initial installation of lighting network is generally done by an IT network engineer or the commissioning engineer. Perform the following configuration steps to prepare the lighting network.

Prerequisite for Initial Installation

Complete the following prerequisite step for initial lighting network setup:

- The Cisco Catalyst 3850 switch supports Perpetual and Fast PoE features (described in Chapter 5, “Lighting Deployment without Campus Network Core”) on 3.7.0 EX switch IOS software release. Hence, it is suggested to upgrade the switch IOS image to 3.7.0 EX before beginning lighting network installation.

Step 1 Enable LLDP on the switch global configuration, as shown below. LLDP is required to be enabled on the switch for Cree lights fixtures' power negotiation. Additionally, static power configuration needs to be enabled per port.

```
3850-Switch(config)#lldp run
3850-Switch(config)#interface range gi 1/0/1-24
3850-Switch(config-if-range)# power inline static max 60000
```

Step 2 Configure SVI for default VLAN 1:

```
interface vlan 1
 ip address 10.1.0.1 255.255.255.0
!
```

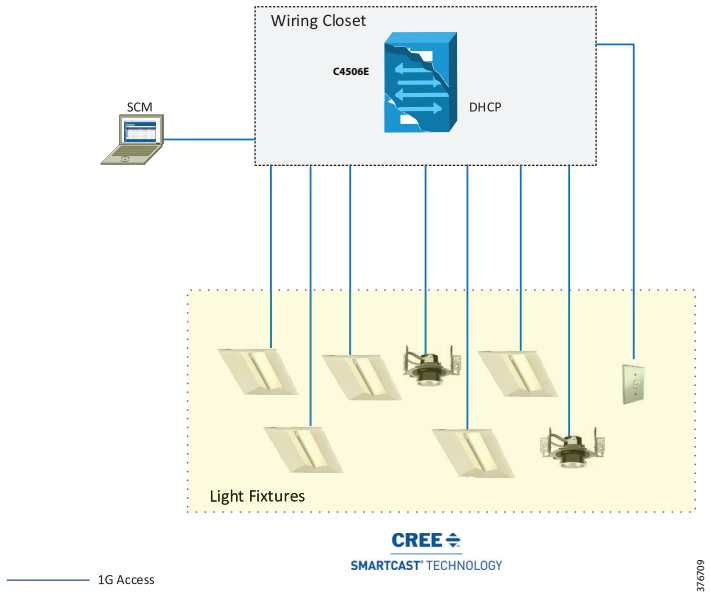
Initial Installation with Cisco Catalyst 4506-E UPOE Switch

This section covers the network topology and configuration required on a Cisco Catalyst 4506-E switch with UPOE line card for the initial installation of light fixtures.

Network Topology

During the initial installation, light fixtures are connected to wiring closet Cisco Catalyst 4506-E UPOE ports, as shown in Figure 3-2.

Figure 3-2 Cisco Digital Building Cree Solution Initial Setup with Cisco Catalyst 4506E Switch



Configuring Cisco Catalyst 4506-E UPOE Switch for Initial Installation

Cree Light Fixtures Installation

The initial installation of Cree light fixtures at an installation site can be done by a low voltage or high voltage electrician. The Cree fixtures will be connected to the Cisco UPOE switch.

When the light fixtures are connected to Cisco Catalyst 4506-E switch UPOE ports, the light fixtures turn on with low brightness (~15W of switch port PoE power); this verifies the light fixtures' hardware operation and connection.

Initial Network Setup

Step 1 Enable LLDP on the switch global configuration, as shown below. LLDP is required to be enabled on the switch for Cree lights fixtures' power negotiation and operation. Additionally, static power configuration is enabled per port connected to the light fixture.

```
4506E-Switch(config)#lldp run
4506E-Switch(config)#interface range gi 1/1-48
4506E-Switch(config-if-range)# power inline static max 60000
```

Step 2 Configure SVI for default VLAN, as shown below:

```
!
interface Vlan 1
ip address 10.1.0.1 255.255.255.0
!
```

Light Fixture Provisioning for Initial Installation

This section covers IP addressing using DHCP server and initial commissioning of light fixtures using Cree SCM.

Configuring DHCP Server for Light Fixture IP Addressing

Commissioning the Cree light fixtures for the initial installation verifies the light fixture discovery, calibration, auto-grouping, and wall dimmer operation, using OneButton™ Setup on the Cree SCM application. Light fixtures require IP addresses assigned in the network to perform OneButton Setup for initial provisioning.

During the initial installation, the DHCP server IP addressing pool for light fixtures and wall dimmers is configured on a Cisco Catalyst 3850 or a Cisco Catalyst 4506-E switch to assign IP addresses to Cree endpoints.

Table 3-1 shows an example DHCP pool range for Cree light fixtures.

Table 3-1 IPv4 DHCP Address Pool on Cisco Catalyst 3850/Cisco Catalyst 4506E

Pool Network	Excluded IP Range	Purpose
10.1.0.0/22	10.1.0.1-10.1.0.50	DHCP pool for Cree light fixtures in default VLAN 1

Configure the DHCP server on a Cisco Catalyst 3850 or a Cisco Catalyst 4506-E switch, where the light fixtures are connected. The following is an example:

```
3850-Switch (config)# ip dhcp pool Cree
                      network 10.1.0.0 255.255.252.0
                      default-router 10.1.0.1

3850-Switch (config)# ip dhcp excluded-address 10.1.0.1 10.1.0.50
!
```

Configuring SmartCast Manager for Light Fixture Provisioning

Complete the steps described in this section for installing and configuring Cree SmartCast Manager.

Installing Cree SCM

Refer to Section 3.1, “Installation Procedure” in *Cree SmartCast PoE User Manual v1.2.2* for installing Cree SCM.

Note The SCM application connects to the wiring closet switch in the same VLAN as the light fixtures. The switch access port configurations for SCM are similar to light fixture switch port configurations that are discussed in this guide.

Commissioning Light Fixtures

Complete the following steps to provision light fixtures. Refer to Section 3.2, “Walkthrough of the Screens" in the *Cree SmartCast PoE User Manual v1.2.2* for detailed step-by-step instructions for provisioning the light fixtures. The following is a summary of the steps:

1. Connect the SCM to an access port on the switch.
2. Launch the SCM application.
3. In the network interface selection, choose the PoE network.
4. Click **Continue**.
5. Once the devices are listed on the SCM, perform OneButton Setup.
6. Click **All** to start OneButton Setup.
7. Once the OneButton Setup completes, click **Settings**. Verify that the Occupancy Group and Switch Group is created.
8. Once OneButton Setup is complete, click **All Device**s under the **Settings** tab to verify that all devices in the lighting network are assigned to Occupancy Groups and Switch Groups.

Verifying and Upgrading Light Fixture Firmware

The firmware version of the light fixture can be verified on SCM after it is discovered by SCM. Complete the following steps to check the firmware version of the light fixture on SCM:

Step 1 Navigate to **Advanced > Firmware Versions**.

Step 2 Choose **Lighting Network** and then click **Show Versions**.

Step 3 Verify the version of the Primary, Secondary Firmware, and Firmware Upgrade application. Versions should be Cree endpoints firmware versions contained in the SmartCast PoE v1.2.2 release package.

Note Cree software release package SmartCast PoE v1.2.2 contains SCM v7.3.22, primary firmware v7.4.63, and secondary firmware v1.6.24, which are mapped to top level release packages.

If the light fixtures and wall dimmers are on different firmware versions than the SmartCast PoE v1.2.2 release, upgrading the endpoints to the v1.2.2 release firmware as suggested by Cree is required.

Refer to the Cree Firmware Update section in *Cree SmartCast PoE User Manual v1.2.2* for upgrading firmware on Cree endpoints. Also, verify the firmware version after the successful upgrade, by following Steps 1 to 3 above.

Lighting Migration to Campus Network Architecture

This chapter covers the implementation details for migrating a lighting deployment installed as an initial install to a converged Campus Network architecture. Lighting migration to multiple topologies are also discussed in more details in Section 3.1, “System Topologies” of the *Cisco Digital Building Cree Design Guide*.

Implementation of networking Layer 2, Layer 3, and security features required for Connected Lighting with Campus Network deployment is discussed in the following topics:

Network Topology

During migration, the access switches in the wiring closet (Cisco Catalyst 3850 stack and/or Cisco Catalyst 4506-E) connect to a production Campus Network core/aggregation switch with separate logical networks for Cree light fixtures, as shown in Figure 4-1.

Figure 4-1 Cisco Digital Building Cree Solution Large Scale Deployment on Campus Network Architecture with Cisco Catalyst 3850 Access Switch Stack

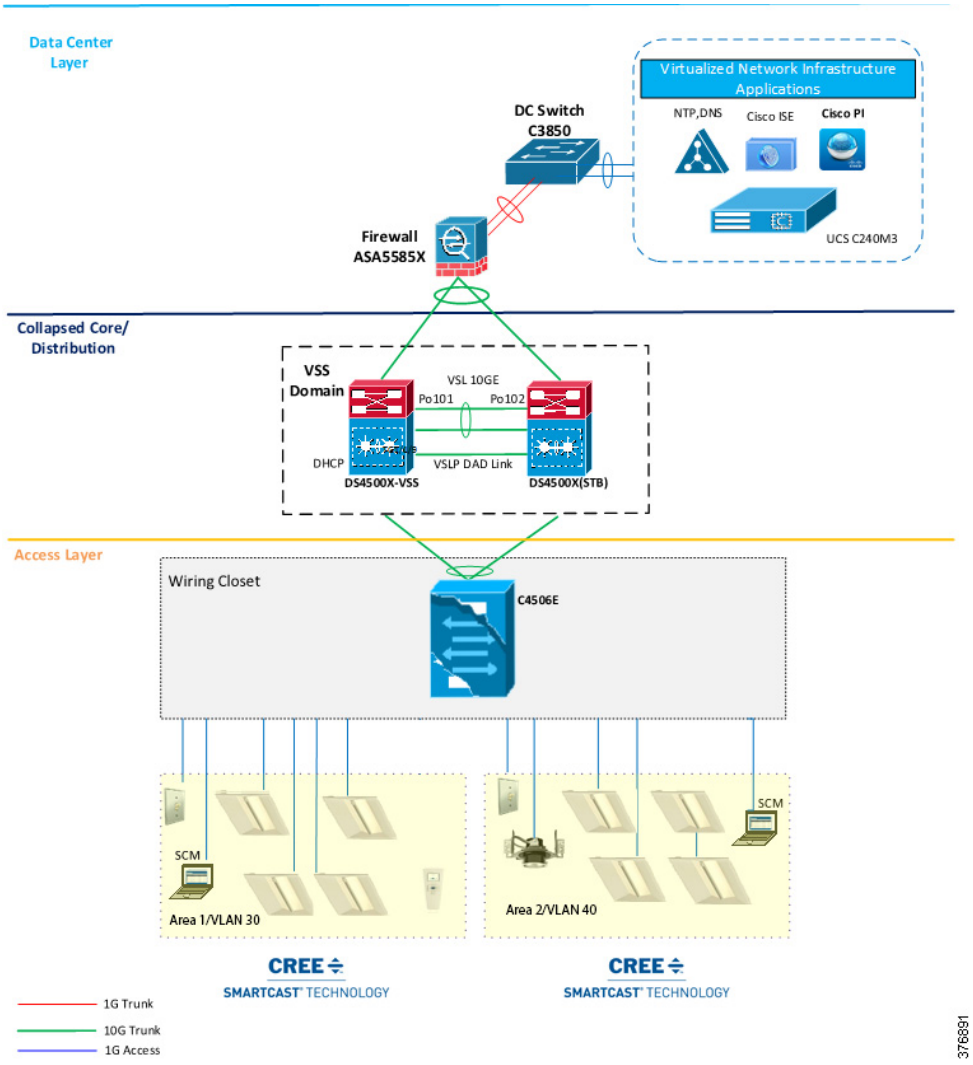
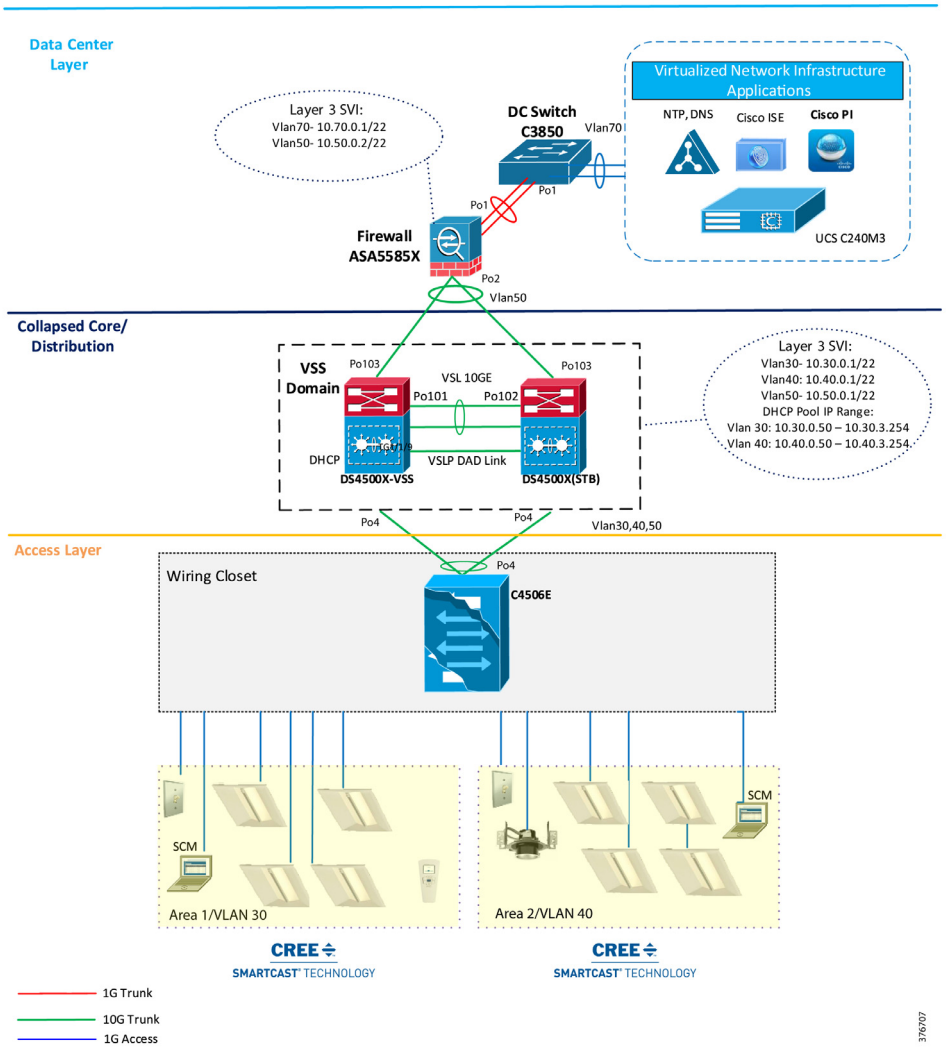


Figure 4-2 Cisco Digital Building Cree Solution Large Scale Deployment on Campus Network Architecture with Cisco Catalyst 4506E Access Switch



Campus Network Core/Aggregation Switch Cisco Catalyst 4500-X

The lighting network UPOE access switches (Cisco Catalyst 3850 Stack, Cisco Catalyst 4506-E) are connected to Campus Network aggregation switches when migrating from an initial lighting setup to a converged Campus Network/large scale deployment. The detailed implementation of Campus Network architecture is beyond the scope of this document.

The Campus Network aggregation switch Cisco Catalyst 4500-X provides Campus Network core/aggregation services and Layer 3 routing functionalities for the lighting network. The implementation of a Cisco Catalyst 4500-X switch in a Connected Lighting large scale deployment architecture, with security features for lighting, as described in Section 3.3, “System Design” of the *Cisco Digital Building Cree Design Guide*, is covered in this section.

Configuring Virtual Switching System

The system topology in Figure 3-1 on page 3-2 shows one of the implementations of a Campus Network aggregation as a collapsed core/distribution model for this Cisco Digital Building Cree Solution. The aggregation Cisco Catalyst 4500-X switches implement Virtual Switching System (VSS) to provide network redundancy at the aggregation layer.

A VSS combines a pair of Cisco Catalyst 4500-X series switches into a single network element. The VSS manages the redundant links, which externally act as a single port channel. The VSS simplifies network configuration and operation by reducing the number of Layer 3 routing neighbors and by providing a loop-free Layer 2 topology.

Note The lighting network converges to a production Campus Network where VSS may not be implemented at network aggregation. In this case, VSS configuration steps discussed in this section are not required.

Refer to the *Catalyst 4500 Series Switch Software Configuration Guide*, IOS XE 3.7.xE and IOS 15.2(3)Ex for a detailed step-by-step implementation of VSS on a Cisco Catalyst 4500-X switch

- http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst4500/XE3-7-0E/15-23E/configuration/guide/xe-370-configuration/vss.html

Configuring Network Layer 2 and Layer 3

This section defines the implementation of VLANs and Layer 3 logical interfaces on the Cisco Catalyst 4500-X switch.

Step 1 Enable LLDP on the switch:

```
CL-4500X(config)#lldp run
```

Step 2 Configure VLANs, which must be created along with ports assignment on the Cisco Catalyst 4500-X switch:

```
CL-4500X(config)#vlan 30,40,50
```

Step 3 Create a Layer 3 SVI for the lighting VLANs. The example configuration below shows SVIs for the lighting VLANs and network management VLAN on the Cisco Catalyst 4500-X switch:

```
interface Vlan30
 ip address 10.30.0.1 255.255.252.0
 !
interface Vlan40
 ip address 10.40.0.1 255.255.252.0
!
interface Vlan50
 ip address 10.50.0.1 255.255.252.0
!
```

Note When migrating the lighting initial setup to a converged Campus Network, remove SVIs of lighting VLANs that you may have created on wiring closet access switches (Cisco Catalyst 3850 stack/Cisco Catalyst 4506-E). SVIs for lighting VLANs are configured at core/aggregation switches, which provide Layer 3 services to lighting network.

Step 4 Create Port Channel interfaces on a Cisco Catalyst 4500-X to wiring closet switches (Cisco Catalyst 3850 stack and Cisco Catalyst 4506-E), and an ASA firewall in the network, as shown below:

```
interface Port-channel2
 description Etherchannel Link to 3850 Switch Stack
 switchport
 switchport mode trunk
 switchport trunk allowed vlan 30,40,50
end
!
interface Port-channel4
 description Etherchannel Link to 4506E Switch
 switchport
 switchport trunk allowed vlan 30,40,50
 switchport mode trunk
end
!
interface Port-channel103
 description Etherchannel Link to ASA5585 Firewall
 switchport
 switchport trunk allowed vlan 50
 switchport mode trunk
end
```

Step 5 Enable EtherChannel on the appropriate physical switch ports connected to the Cisco Catalyst 3850 stack, Cisco Catalyst 4506-E, and ASA. The following configuration shows the Port Channel assignment to switch physical ports:

Physical links to a Cisco Catalyst 3850 switch stack in a wiring closet:

```
interface TenGigabitEthernet1/1/11
 channel-group 2 mode active
interface TenGigabitEthernet2/1/11
 channel-group 2 mode active
```

Physical links to a Cisco Catalyst 4506-E switch in a wiring closet:

```
interface TenGigabitEthernet1/1/13
 channel-group 4 mode active
end
 !
interface TenGigabitEthernet2/1/13
 channel-group 4 mode active
end
```

Physical links to an Cisco ASA 5585 firewall switch:

```
interface TenGigabitEthernet1/1/3
 channel-group 103 mode active
end
!
interface TenGigabitEthernet2/1/3
 channel-group 103 mode active
end!
```

Step 6 The following commands add static default routes to the Cisco ASA 5585:

```
ip route 10.70.0.0 255.255.255.0 10.90.0.1
```

Step 7 Enable rapid per-vlan spanning tree:

```
!
spanning-tree mode rapid-pvst
```

Configuring DHCP Server for Light Fixture IP Addressing

When migrating the lighting initial setup to a converged Campus Network, the DHCP server IP addressing pool for light fixtures and wall dimmers is configured on a Cisco Catalyst 4500-X aggregation switch to assign IP addresses to Cree endpoints, as shown in Figure 4-1 on page 4-2.

Note Make sure to remove the DHCP server configuration on wiring closet access switches (Cisco Catalyst 3850 or Cisco Catalyst 4506-E), which was performed on initial lighting setup.

Table 4-1 shows an example DHCP pool range for Cree endpoints.

Table 4-1 IPv4 DHCP Address Pool on Cisco Catalyst 4500-X

Pool Network	Excluded IP Range	Purpose
10.30.0.0/22	10.30.0.1 - 10.30.0.50	DHCP pool for Cree light fixtures in VLAN 30
10.40.0.0/22	10.40.0.1 - 10.40.0.50	DHCP pool for Cree light fixtures in VLAN 40

Complete the following to configure DHCP server pool on Cisco Catalyst 4500-X aggregation switch for lighting network.

Configure DHCP pools for light fixtures on Cisco Catalyst 4500-X:

```
ip dhcp pool Cree
 network 10.30.0.0 255.255.252.0
 default-router 10.30.0.1
!
!
ip dhcp pool CREE-VLAN40
 network 10.40.0.0 255.255.252.0
 default-router 10.40.0.1
!
ip dhcp exclude-address 10.30.0.1 10.30.0.50
ip dhcp exclude-address 10.40.0.1 10.40.0.50
!
```

Configuring Security Features

Security features in the lighting network are important to protect light fixtures from network attacks, such as an IP address from untrusted DHCP servers, ARP attacks, denial-of-service attacks, broadcast storms, and so on. If proper security configurations are not implemented on switches, the light fixtures and the whole network becomes more susceptible to such attacks. Hence, features such as DHCP snooping, port security, ARP inspection, and ARP rate limiting will enable security on the switch and its ports to keep the network safe.

This section defines the recommended Layer 2 security features to be enabled within the Campus Network on the Cisco Catalyst 4500-X. For a detailed description of all the Layer 2 Security features, refer to the *Cisco Catalyst 4500X Configuration Guide* at the following link:

- Catalyst 4500 Series Switch Software Configuration Guide, IOS XE 3.7.xE and IOS 15.2(3)Ex

IP DHCP Snooping

DHCP snooping is a security feature that acts like a firewall between untrusted hosts and trusted DHCP servers. The DHCP snooping feature determines whether traffic sources are trusted or untrusted. An untrusted source may initiate traffic attacks or other hostile actions. To prevent such attacks, the DHCP snooping feature filters messages and rate-limits traffic from untrusted sources.

When lights are powered on, they request an IP address from a DHCP server. To make sure that the IP address is not provided by an untrusted DHCP server, IP DHCP snooping makes sure that DHCP packets sent by the server that are received only on the trusted ports are forwarded to the lights.

Complete the following steps on the Cisco Catalyst 4500-X switch to configure IP DHCP snooping:

Step 1 Configure the required port as DHCP snooping trusted port:

```
interface Port-channel103
 ip dhcp snooping trust
!
```

Step 2 Enable IP DHCP snooping globally for the per-port command to take effect:

```
ip dhcp snooping
!
```

IP Source Guard

IP Source Guard is a security feature that restricts IP traffic on untrusted Layer 2 ports by filtering traffic based on the DHCP snooping binding database or manually configured IP source bindings. This feature helps prevent IP spoofing attacks when a host tries to spoof and use the IP address of another host.

All of the IP to MAC bindings learned on the Cisco Catalyst 4500-X on trusted ports will only be allowed to send or receive traffic. All the packets received on trusted ports with a different binding to a particular MAC will be dropped.

To configure IP Source Guard on the Cisco Catalyst 4500-X switch, configure the IP Source Guard on the downlink port channel interfaces to Cisco Catalyst 3850 stack and Cisco Catalyst 4506-E switches, which have trusted IP to MAC bindings as shown below:

```
interface Port-channel2
 description Etherchannel Link to 3850 Switch Stack
 ip verify source
end
!
interface Port-channel4
 description Etherchannel Link to 4506E Switch
 ip verify source
end
```

ARP Inspection

Dynamic ARP Inspection (DAI) is a security feature that validates ARP packets in a network. DAI intercepts, logs, and discards ARP packets with invalid IP-to-MAC address bindings. This capability protects the network from some man-in-the-middle attacks.

Lights or any other devices connected on untrusted ports of Cisco Catalyst 4500-X will be automatically put in an error disabled state so that device won't be able to get access to the network.

Complete the following steps on the Cisco Catalyst 4500-X switch to configure ARP inspection:

Step 1 Configure the required port channels as ARP inspection trusted ports, as shown in the following example:

```
interface Port-channel2
 description Etherchannel Link to 3850 Switch Stack
 ip arp inspection trust
end
!
interface Port-channel4
 description Etherchannel Link to 4506E Switch
 ip arp inspection trust
end
```

Step 2 Enable ARP inspection globally for the required VLANs, so that the per-port command takes effect:

```
ip arp inspection vlan 30,50
```

Storm Control

A traffic storm occurs when packets flood the LAN, creating excessive traffic and degrading network performance. You can use the traffic storm control feature to prevent disruptions on Layer 2 ports by a broadcast, multicast, or unicast traffic storm on physical interfaces.

A broadcast or unicast storm is usually capable of creating a loss of access to the light fixtures and SCM, depending on the port bandwidth consumed by the storm. So keeping storm control limits the propagation of such packets to the light fixtures and maintains proper access to the light fixtures for the SCM.

Perform the following configuration on the 4500x switch to configure Storm Control:

Configure the Storm control for broadcast or unicast traffic, according to the maximum and minimum allowable threshold percentage of line rates:

```
interface Port-channel2
 description Etherchannel Link to 3850 Switch Stack
 storm-control broadcast level 20.00 10.00
 storm-control multicast level 50.00 30.00
end
!
interface Port-channel4
 description Etherchannel Link to 4506E Switch
 storm-control broadcast level 20.00 10.00
 storm-control multicast level 50.00 30.00
end
```

Disabling Telnet

Since Telnet is not secure, it should be disabled from accessing the device. The following command disables Telnet and enables only Secure Shell (SSH) access to the Cisco Catalyst 4500-X switch:

```
line vty 0 15
 transport input ssh
!
```

Configuring Network Management (Simple Network Management Protocol)

Simple Network Management Protocol (SNMP) is used in the lighting network to manage and monitor the switches in the lighting network.

SNMP traps are configured to send light fixtures ports up/down status alerts to a network management server (Cisco Prime Infrastructure 3.0) that helps monitor light fixture's port status.

Configuring Switch Network Management

SNMPv3 protocol configuration is used on the Cisco Catalyst 4500-X switch for Network Management. The flow is shown in Figure 4-3.

Figure 4-3 Network Management SNMP Configuration Flow

Complete the following steps to configure SNMP v3:

Step 1 Configure SNMP v3 view:

```
snmp-server view CREE iso included
```

Step 2 Configure SNMP v3 group:

```
snmp-server group CREE v3 auth read CREE write CREE
```

Step 3 Configure SNMP v3 user:

```
snmp-server user CREE CREE v3 auth md5 123456789012345 priv  aes 128 123456789012345
```

Step 4 Configure SNMP Traps:

```
snmp-server enable traps port-security
snmp-server enable traps snmp
```

Step 5 Verify that the SNMP user, group, and view have been created using the following CLI show commands:

```
CL-DS4500X-VSS#sh snmp user

User name: CREE
Engine ID: 8000000903001CE85D161A80
storage-type: nonvolatile        active
Authentication Protocol: MD5
Privacy Protocol: AES128
Group-name: CREE

CL-DS4500X-VSS#sh snmp group
groupname: CREE                             security model:v3 auth
contextname: <no context specified>         storage-type: nonvolatile
readview : CREE                             writeview: CREE
notifyview: <no notifyview specified>
row status: active


CL-DS4500X-VSS#sh snmp view
```

```
CREE iso - included nonvolatile active
cac_view ip - included read-only active
cac_view dot1dBridge - included read-only active
cac_view ipForward - included read-only active
cac_view ipTrafficStats - included read-only active
cac_view sysUpTime.0 - included read-only active
cac_view ciscoPingMIB - included read-only active
cac_view ciscoStpExtensionsMIB - included read-only active
cac_view ciscoIpSecFlowMonitorMIB - included read-only active
cac_view ciscoIPsecMIB - included read-only active
cac_view ifIndex - included read-only active
cac_view ifDescr - included read-only active
cac_view ifType - included read-only active
cac_view ifAdminStatus - included read-only active
cac_view ifOperStatus - included read-only active
cac_view snmpTraps.3 - included read-only active
cac_view snmpTraps.4 - included read-only active
cac_view snmpTrapOID.0 - included read-only active
cac_view snmpMIB.1.4.3.0 - included read-only active
cac_view lifEntry.20 - included read-only active
cac_view cciDescriptionEntry.1 - included read-only active
```

Configuring Logging (Syslog)

Syslog is a way for network devices to send event messages to a logging server. This logging server is known as a Syslog server. Cisco Prime Infrastructure is configured as a Syslog server in the lighting network to monitor the events, such as, light fixture port security violation, port up/down status, and so on.

Configure logging to a Syslog server (Prime Infrastructure) on the switch, as shown below:

```
logging host 10.70.0.150
logging trap
```

Note **10.70.0.150** is the IP address of the Prime Infrastructure (Syslog server).

Wiring Closet Access Switch (Cisco Catalyst 3850 Stack)

This section covers wiring a closet access switch Cisco Catalyst 3850 stack, Layer 2, Layer 3 networking, security configuration, and network management configurations.

Configure Cisco Catalyst 3850 Stack

A switch stack can have up to nine stacking-capable switches connected through their StackWise-480 ports. The stack members work together as a unified system. Layer 2 and Layer 3 protocols present the entire switch stack as a single entity to the network.

The switches in the stack are assigned roles as active, stand-by, and member. However, all the switches in the stack are operational. A switch stack always assigns one switch active role and one standby role. If the active switch becomes unavailable, the standby switch assumes the role of the active switch, and continues to keep the stack operational. The active switch controls the operation of the switch stack, and is the single point of stack-wide management.

In this system implementation, a stack of four Cisco Catalyst 3850 UPOE (24 UPOE ports per switch) switches are configured in the network topology according to system requirements. Since each of those switches have 24 UPOE ports, light fixtures connected to any of them can be configured via the active switch of the stack.

A higher priority value for a stack member increases the probability of it being elected active switch and retaining its stack member number. The priority value can be 1 to 15. The default priority value is *1*. You can display the stack member priority value by using the **show switch** EXEC command.

Note We recommend assigning the highest priority value to the switch that you prefer to be the active switch. This ensures that the switch is re-elected as the active switch if a re-election occurs.

The following configuration steps provide an example configuration needed to bring up the stack.

To install a Cisco Catalyst 3850 Switch Data Stack and Stack Manager, refer to the *C3850 Hardware Installation Guide* at the following URL:

- http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/hardware/installation/guide/b_c3850_hig/b_c3850_hig_chapter_010.html

To configure a switch stack, refer to the *High Availability Configuration Guide* at the following URL:

- http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/software/release/3se/ha_stack_manager/configuration_guide/b_hastck_3se_3850_cg/b_hastck_3se_3850_cg_chapter_010.html

When migrating a lighting initial setup on a Cisco Catalyst 3850 switch on a wiring closet, complete the following steps to configure the Cisco Catalyst 3850 switch as a member of the switch stack:

Step 1 Make sure that all four switches that are going to be part of the stack have the same boot configuration. Use the following show boot command to verify their boot parameters:

```
sh boot
---------------------------
Switch 4
---------------------------
Current Boot Variables:
BOOT variable = flash:cat3k_caa-universalk9.SPA.03.07.00.EX.152-3.EX.bin;

Boot Variables on next reload:
BOOT variable = flash:cat3k_caa-universalk9.SPA.03.07.00.EX.152-3.EX.bin;
Allow Dev Key = yes
Manual Boot = no
Enable Break = yes
```

Step 2 The boot variable for all the switches should be the same image file, as shown above. To configure it, use the command, as shown below:

```
boot system flash: cat3k_caa-universalk9.SPA.03.07.00.EX.152-3.EX.bin
no boot manual
```

Step 3 Once all the switches boot up with the same image and license, connect them in ring form to bring up the stack. Provision each of the switches from master, as shown below:

```
switch 1 provision ws-c3850-24u
```

```
switch 2 provision ws-c3850-24u
switch 3 provision ws-c3850-24u
switch 4 provision ws-c3850-24u
```

Step 4 The switch which is needed to be Active after a stack reload/reboot, should be configured with a higher stack priority value of 15. The priority of switch can be configured in the **Enable** mode as shown below:

```
switch 1 priority 15
```

Configuring Network Layer 2 and Layer 3

This section defines the implementation of VLANs and logical SVI for management traffic on the Cisco Catalyst 3850 switch stack.

Step 1 Enable LLDP on the switch stack and static power configuration as follows:

```
3850-switch (config)#lldp run
3850-Switch(config)#interface range gi 1/0/1-24
3850-Switch(config-if-range)# power inline static max 60000
```

Step 2 Configure VLANs, which must be created along with port assignments on the Cisco Catalyst 3850 switch stack. The following is an example VLAN configuration:

```
3850-switch (config)#vlan 30,50
```

Step 3 Configure switch ports connecting to light fixtures/wall dimmers on the appropriate lighting VLANs in access mode:

```
interface GigabitEthernet 1/1
 switchport mode access
 switchport access vlan 30
!
```

Step 4 Create Layer 3 SVI for the VLANs and default gateway, as required. The following configuration is an example configuration of management VLAN SVI on the Cisco Catalyst 3850 switch stack.

```
interface Vlan50
 ip address 10.50.0.11 255.255.252.0
 !
ip route 0.0.0.0 0.0.0.0 10.50.0.1
```

Step 5 Create Port Channel uplink interfaces on a Cisco Catalyst 3850 stack to Campus Network aggregation switch (Cisco Catalyst 4500-X), as shown in Figure 4-1 on page 4-2.

```
interface Port-channel2
 description Etherchannel Link to 4500X Switch
 switchport
 switchport mode trunk
 switchport trunk allowed vlan 30,40,50
end
```

Step 6 Enable Port Channel on the appropriate physical switch ports connected to the Cisco Catalyst 4500-X switch. The following configuration shows the Port Channel assignment to switch physical ports.

Physical links to Cisco Catalyst 4500-X active and standby VSS switches:

```
interface TenGigabitEthernet1/1
 channel-group 2 mode active
```

```
interface TenGigabitEthernet1/2
 channel-group 2 mode active
```

Step 7 Enable per-vlan spanning tree.

```
!
spanning-tree mode rapid-pvst
!
```

Configuring UPOE Features

All of the light fixtures receive power via the Universal Power over Ethernet (UPOE) ports of the Cisco Catalyst 3850 switch. Based on the type of light fixtures connected to the switch, the switch allocates power to them. Perpetual PoE and Fast PoE are the features that can help sustain the PoE under specific circumstances, where a switch may undergo a power failure or a soft reload.

The configurations shown below are not mandatory during initial installation. They only have to be configured on those access ports of the Cisco Catalyst 3850 switch on which certain light fixtures need to illuminate, even during a reload, or you want to them to turn on quickly after power restoration on the switch.

Perpetual PoE

Perpetual POE is a PoE enhancement feature on the Cisco Catalyst 3850 switch, which enables light fixtures connected on certain ports to continue to receive power during a soft reload of the switch.

For light fixture access ports to configure Perpetual POE, configure the required edge port on the Cisco Catalyst 3850 stack switch with the **poe-ha** command, which enables perpetual POE on that port:

```
interface GigabitEthernet2/1/1
 power inline port poe-ha
```

Fast PoE

The Fast PoE feature on the Cisco Catalyst 3850 switch ports enables Cree light fixtures to illuminate with low brightness within 10 seconds (~15W of power given via cable, two pair by switch hardware) after restoring the power on switch/stack of switches, where power interruption caused the switch to go down.

The same IOS configuration command used for Perpetual PoE feature enables Fast PoE as well for Cree light fixtures.

Note The light fixtures are initially at low brightness within 20 seconds after power restore, and turn into full brightness after the UPOE switch is fully up and operational (approximately at 6-8 minutes).

Configuring Security Features

Cisco Catalyst 3850 switch stack integrated security features can provide threat defense capabilities, for mitigating man-in-the-middle attacks and protecting the critical network infrastructure. This section details the switch configurations necessary for basic Layer 2 security features to be enabled as specified in the *Cisco Digital Building Cree Design Guide*.

For more security configuration, refer to the *Consolidated Platform Configuration Guide, Cisco IOS XE 3.7E and Later (Catalyst 3850 Switches)* at the following URL:

- http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/software/release/37e/consolidated_guide/b_37e_consolidated_3850_cg.html

IP DHCP Snooping

Complete the following steps on the Cisco Catalyst 3850 stack switch to configure IP DHCP snooping:

Step 1 Configure the required port as DHCP snooping trusted port:

```
interface Port-channel2
 ip dhcp snooping trust
!
```

Step 2 Enable IP DHCP snooping globally for the per-port command to take effect:

```
ip dhcp snooping
!
```

IP Source Guard

To configure IP Source Guard on the Cisco Catalyst 3850 stack switch, configure the IP source guard on the ports which have trusted IP to MAC bindings:

```
interface Port-channel2
 ip verify source
!
                    On luminaire access ports,
interface GigabitEthernet2/1/14
 ip verify source
!
```

ARP Inspection

Complete the following steps on the Cisco Catalyst 3850 stack switch to configure ARP Inspection:

Step 1 Configure the required port as an ARP inspection trusted port:

```
interface Port-channel2
 ip arp inspection trust
!
```

On light fixture access ports,

```
interface GigabitEthernet2/1/14
```

```
  ip arp inspection trust
!
```

Step 2 Enable ARP inspection globally for the required VLANs, so that the **per-port** command takes effect:

```
ip arp inspection vlan 30,50
```

ARP Rate Limiting

Complete the following on the Cisco Catalyst 3850 stack switch to configure ARP Rate Limiting:

Configure the ARP Rate limiting according to the maximum allowable packet rate on light fixture access ports. The following is an example:

```
interface GigabitEthernet2/1/14
 ip arp inspection limit rate 100
```

Port Security

You can use Port Security with dynamically learned and static MAC addresses to restrict a port's ingress traffic, by limiting the MAC addresses that are allowed to send traffic into the port. When you assign secure MAC addresses to a secure port, the port does not forward ingress traffic that has source addresses outside the group of defined addresses. If you limit the number of secure MAC addresses to one and assign a single secure MAC address, the device attached to that port has the full bandwidth of the port.

With port security, the MAC address of light fixtures that are learned on any secured port will be the only MAC address permitted on that port. If any other device is connected on that port, then it will throw a security violation alert.

Complete the following on the Cisco Catalyst 3850 stack switch to configure Port Security:

Configure Port Security on light fixture access ports in sticky mode, with the maximum allowable number of MAC address as one. Keep the violation as restrict. The following is an example:

```
interface GigabitEthernet2/1/14
 switchport access vlan 30
 switchport mode access
 switchport port-security violation restrict
 switchport port-security mac-address sticky
 switchport port-security aging type inactivity
 switchport port-security
```

Storm Control

Complete the following on the Cisco Catalyst 3850 stack switch to configure Storm Control:

Configure the Storm Control for broadcast or unicast traffic, according to the maximum and minimum allowable threshold percentage of line rates on light fixture access ports, as follows:

```
interface GigabitEthernet2/1/14
 storm-control broadcast level 20.00 10.00
 storm-control multicast level 50.00 30.00
```

PortFast and BPDU Guard

PortFast BPDU Guard prevents loops by moving a nontrunking port into an *errdisable* state when a BPDU is received on that port. When you enable BPDU Guard on the switch, the spanning tree shuts down PortFast-configured interfaces that receive BPDUs instead of putting them into the spanning tree blocking state.

The ports connected to lights don't have to do a BPDU check for spanning tree and hence those ports can be configured for PortFast BPDU Guard.

To configure PortFast and BPDU Guard on the Cisco Catalyst 3850 stack switch, enable PortFast on the light fixture access ports, since no BPDUs are expected on that port, and then enable BPDU Guard:

```
interface GigabitEthernet2/1/14
 spanning-tree portfast
 spanning-tree bpduguard enable
```

Port Access Lists

Port Access Lists (PACLs) filter incoming traffic on Layer 2 interfaces using Layer 3 information, Layer 4 header information, or non-IP Layer 2 information. The PACL feature uses standard or extended IP ACLs or named MAC-extended ACLs that you want to apply to the port.

The ports on which lights are connected should be able to filter packets based on specific Layer 4 port numbers, so that unwanted traffic doesn't reach the light. PACLs in this scenario specifically filter the port numbers that MA uses to communicate with lights.

Complete the following steps on the Cisco Catalyst 3850 stack switch to configure PACL:

Step 1 Configure the IP access list to permit the incoming traffic only for Layer 4 port numbers specific to communication between lights and SCM:

```
ip access-list extended 101
10 permit udp any eq 55004 any eq 55005
20 permit udp any eq bootpc any eq bootps
30 permit udp any eq bootps any eq bootpc
40 permit icmp any any
50 permit udp any eq 55004 any eq 55007
60 permit udp any any eq snmp
70 permit udp any eq snmp any
80 permit udp any eq 55004 any eq 55006
```

Step 2 Apply this IP access list for the ingress traffic on the light fixture access ports. The following is an example:

```
interface GigabitEthernet2/1/14
 ip access-group 101 in
ip access-group 101 out
```

Disabling Telnet

Telnet should be disabled for accessing the device since it is not secure. The following commands disable Telnet and enable only (SSH) access to the Cisco Catalyst 3850 switch:

```
line vty 0 15
```

```
 transport input ssh
!
```

Configuring Network Management (Simple Network Management Protocol)

SNMP is used for collecting information from network devices in order to manage the network. SNMP is also used by SCM for discovering the switch and its ports to control the switch ports through SCM. However, this SNMP Switch and Port Discovery feature available in SCM requires SCM to be directly connected to the switch that needs to be discovered.

Note The SNMP Switch and Ports Discovery feature in SCM requires an SVI with IP address configured on the switch for Cree light fixtures VLAN, to discover the switch and its ports. The configuration discussed in the next section is required, if you need to discover the switch and control switch ports through SCM only.

Note SNMP discovery of switch and its ports on SCM works with Cisco Catalyst 3850 Switch and SwitchStack only. It also requires SCM to be directly connected to the 3850 switches for its discovery.

Configuring Cisco Catalyst 3850 Switch for Device Discovery on SCM (Optional)

The device discovery on SCM enables users to control switch ports, as well as to know the interfaces to which the Cree endpoints are connected on the switch. Hence, the selective commissioning of the endpoints becomes easier, since the endpoints can be listed on SCM with the switch and port number to which they are connected.

Complete the following steps for enabling the device discovery using SNMP:

Step 1 Enable the SNMP service from Services on the PC running the SCM.

Step 2 Enable the SNMP trap from Services on the PC.

Step 3 Enable the Link-Layer Topology Mapper Services.

Step 4 Following are the SNMP commands required on the switch to enable the device discovery:

```
snmp-server community public RW
```

Step 5 Verify that the SNMP community string public is configured on the switch using the following CLI command:

```
CL-3850-1#sh run | i snmp-server community
snmp-server community public RW
```

Step 6 Configure SVI for light fixture VLANs, as shown in the example below:

```
CL-3850-1(config)# interface vlan 30
    ip address 10.30.0.5 255.255.252.0
```

Configuring Switch Network Management

Refer to Configuring Switch Network Management, page 4-9 for the Cisco Catalyst 4500-X switch for configuring network management on a Cisco Catalyst 3850 stack.

Configuring Logging (Syslog)

Refer to Configuring Logging (Syslog), page 4-10 for the Cisco Catalyst 4500-X switch, for configuring a logging server on a Cisco Catalyst 3850 switch stack.

Wiring Closet Access Switch (Cisco Catalyst 4506-E)

This section covers Cisco Catalyst 4506-E switch Layer 2, Layer 3 networking, security and network management configurations.

Configuring Layer 2 and Layer 3

Complete the following steps to implement VLANs and Layer 3 logical interfaces on the Cisco Catalyst 4506-E switch:

Step 1 Configure VLANs, which must be created along with ports assignment on the Cisco Catalyst 4506-E wiring closet switch:

```
CL-C4506E-1(config) #vlan 30, 40, 50
```

Step 2 Configure switch ports connecting to light fixture/wall dimmers on appropriate lighting VLAN in access mode. The following is an example:

```
interface GigabitEthernet 1/1
 switchport mode access
 switchport access vlan 40
!
```

Step 3 Create Layer 3 SVI for the management VLAN and default gateway:

```
interface Vlan50
 ip address 10.50.0.4 255.255.252.0
!
ip route 0.0.0.0 0.0.0.0 10.50.0.1
```

Step 4 Create Port Channel uplink interfaces on Cisco Catalyst 4506-E to Campus Network aggregation switch (Cisco Catalyst 4500-X), as shown in Figure 4-1 on page 4-2.

```
interface Port-channel4
 description Etherchannel Link to 4500X Switch
 switchport
 switchport mode trunk
 switchport trunk allowed vlan 30,40,50
end
```

Step 5 Enable Port Channel on the appropriate physical switch ports connected to the Cisco Catalyst 4500-X switch. The following configuration shows the Port Channel assignment to switch physical ports.

Physical Links to Cisco Catalyst 4500-X active and standby VSS switches:

```
interface TenGigabitEthernet1/1
```

```
 channel-group 4 mode active

interface TenGigabitEthernet1/2
 channel-group 4 mode active
```

Step 6 Enable rapid per-vlan spanning tree.

```
!
spanning-tree mode rapid-pvst
!
```

Configuring Security Features

This section covers security configurations on the Cisco Catalyst 4506-E switch for Cree light fixtures.

IP DHCP Snooping

Complete the following steps on the Cisco Catalyst 4506-E switch to configure IP DHCP snooping:

Step 1 Configure the required port as a DHCP snooping trusted port; for example, the uplink port channel interface to aggregation switch is configuration as trusted port:

```
interface Port-channel4
 ip dhcp snooping trust
!
```

Step 2 Enable IP DHCP snooping globally for the **per-port** command to take effect:

```
ip dhcp snooping
```

IP Source Guard

Complete the following configuration on the Cisco Catalyst 4506-E switch to enable IP Source Guard:

Step 1 Configure the IP source guard on the ports which have trusted IP to MAC bindings:

```
interface Port-channel2
 ip verify source
!
```

Step 2 On light fixture access ports:

```
interface GigabitEthernet1/1
 ip verify source
!
```

ARP Inspection

Complete the following steps on the Cisco Catalyst 4506-E switch to configure ARP Inspection:

Step 1 Configure the required port as ARP inspection trusted port:

```
interface Port-channel4
 ip arp inspection trust
!
```

On light fixture access ports:

```
interface GigabitEthernet1/1
  ip arp inspection trust
!
```

Step 2 Enable ARP inspection globally for the required VLANs so that the **per-port** command takes effect:

```
ip arp inspection vlan 30,50
```

ARP Rate Limiting

Complete the following on the Cisco Catalyst 4506-E switch to configure ARP Rate Limiting:

Configure the ARP Rate limiting according to the maximum allowable packet rate on all light fixture access ports, as provided in the example below:

```
interface GigabitEthernet1/1
ip arp inspection limit rate 100
```

Port Security

Complete the following on the Cisco Catalyst 4506-E switch to configure Port Security:

Configure the Port Security on light fixture access ports in sticky mode with the maximum allowable number of MAC addresses as one. Keep the violation as restrict:

```
interface GigabitEthernet2/1/14
 switchport access vlan 30
 switchport mode access
 switchport port-security violation restrict
 switchport port-security mac-address sticky
 switchport port-security aging type inactivity
 switchport port-security
```

Storm Control

Complete the following on the Cisco Catalyst 4506-E switch to configure Storm Control:

Configure the Storm Control for broadcast or unicast traffic, according to the maximum and minimum allowable threshold percentage of line rates on all light fixture access ports. The following is an example:

```
interface GigabitEthernet1/1
 storm-control broadcast level 20.00 10.00
 storm-control multicast level 50.00 30.00
```

PortFast and BPDU Guard

Complete the following on the Cisco Catalyst 4506-E switch to configure PortFast and BPDU Guard features:

Enable PortFast on all of the light fixture access ports, since as no BPDUs are expected on that port, and then enable BPDU Guard. The following is an example:

```
interface GigabitEthernet1/1
 spanning-tree portfast
 spanning-tree bpduguard enable
```

Port Access Lists

Complete the following steps on the Cisco Catalyst 3850 stack switch to configure PACL:

Step 1 Configure the IP access list to permit the incoming traffic only for Layer 4 port numbers specific to communication between lights and SCM:

```
ip access-list extended 101
10 permit udp any eq 55004 any eq 55005
20 permit udp any eq bootpc any eq bootps
30 permit udp any eq bootps any eq bootpc
40 permit icmp any any
50 permit udp any eq 55004 any eq 55007
60 permit udp any any eq snmp
70 permit udp any eq snmp any
```

Step 2 Apply this IP access list for the ingress traffic on the light fixture access ports. The following is an example:

```
interface GigabitEthernet2/1/14
 ip access-group 101 in
ip access-group 101 out
```

Disabling Telnet

Telnet should be disabled for accessing the device, since it is not secure. The following commands only enable SSH on the C4506E switch:

```
line vty 0 15
 transport input ssh
!
```

Configuring Network Management (Simple Network Management Protocol)

SNMP is used for collecting information from network devices, in order to manage the network.

Configuring Switch Network Management

Refer to the Configuring Switch Network Management, page 4-9 for the configuration.

Configuring Logging (Syslog)

Refer to the Configuring Logging (Syslog), page 4-10 for the configuration.

Provisioning Light Fixtures (SmartCast Manager)

This section describes how to commission the light fixtures using the SCM. The light fixture can be commissioned by running the OneButton Setup, which groups the endpoints automatically.

The light fixtures can then be controlled via the SCM and the wall dimmer. Complete the following steps to provision the light fixtures:

Step 1 Connect the SCM to an access port on the switch in the same VLAN as the lighting network.

Step 2 Launch the SCM application.

Step 3 In the network interface selection, if prompted to select the network interface, choose the PoE Network.

Step 4 Click **Continue**.

Step 5 If light fixtures are commissioned already from the initial installation, conduct a factory reset on them, and then allow them to be rediscovered for commissioning them on a new area, as per the requirement.

Step 6 Once the devices are listed on the SCM, complete OneButton Setup.

Step 7 Click **All**.

Step 8 Once OneButton Setup is complete, click **All Device**s under the **Settings** tab to verify that all devices in the lighting network are assigned to Occupancy Groups and Switch Groups..

Step 9 Click **Controls** and change the dim level to verify that the switch group brightness changes when controlling it via the control screen. This verifies that the light fixture is provisioned and controllable by SCM.

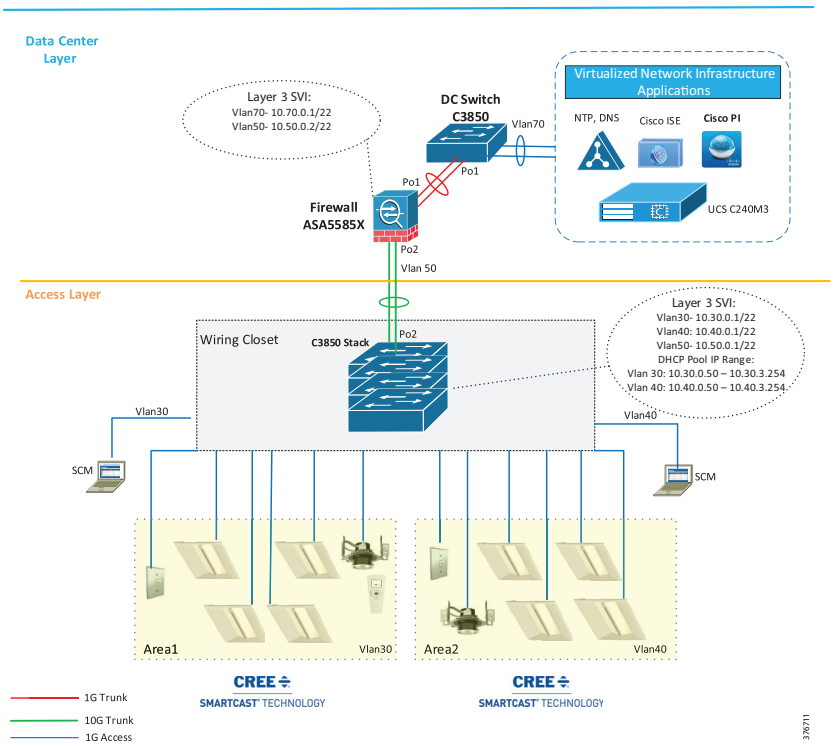
Lighting Deployment without Campus Network Core

This chapter, which covers the implementation details for migrating the lighting network to a Production Network without a Campus Network core architecture as described in Section 3.1, System Topologies of the *Cisco Digital Building Cree Design Guide*, includes the following major topics:

Network Topology

In this deployment, access switches are directly connected to data center via firewall as shown in Figure 5-1.

Figure 5-1 Cisco Digital Building Cree Solution Topology without Campus Network Core



Wiring Closet Access Switch (Cisco Catalyst 3850 Stack)

When migrating from initial lighting setup to a Production Network without network core, wiring closet switches (for example, Cisco Catalyst 3850 stack) are connected directly to the data center edge via the firewall in order to leverage data center application services for lighting network as discussed in Section 3.1, System Topologies of the *Cisco Digital Building Cree Design Guide*.

This section covers configuration required on Cisco Catalyst 3850 stack and ASA while connecting the switch stack to the firewall. The implementation of all other applications and devices is similar, as discussed in Chapter 4, "Lighting Migration to Campus Network Architecture."

Configuring DHCP Server for Light Fixture IP Addressing

During migration, the DHCP server IP addressing pool for light fixtures/wall dimmers is configured on the Cisco Catalyst 3850 switch stack to assign IP addresses to Cree endpoints, as shown in Figure 5-1.

Do the following to configure DHCP server pool on Cisco Catalyst 3850 stack for lighting network:

Configure DHCP server pool for lighting fixtures' IP addressing. For example:

```
ip dhcp pool CREE
 network 10.30.0.0 255.255.252.0
 default-router 10.30.0.1
ip dhcp excluded-address 10.30.0.1
!
```

Configuring Management VLAN Interface

Configure the management VLAN 50 interface for the management traffic to go through the ASA firewall to the data center:

```
interface  vlan 50
ip address 10.50.0.1 255.255.252.0
```

Configuring Network Uplink to Firewall

In this deployment, follow the steps below to configure networking port channel on 3850 stack to connect the Cisco Catalyst 3850 switch stack to the ASA firewall, as shown in Figure 5-1.

Step 1 Configure the Port Channel interface to ASA:

```
interface TenGigabitEthernet1/1/4
  channel-group 2 mode active
interface TenGigabitEthernet1/1/4
  channel-group 2 mode active
```

Step 2 Configure the Port Channel as a trunk port:

```
interface Port-channel2
switchport trunk allowed vlan 50
 switchport mode trunk
```

Follow the configuration steps described in Wiring Closet Access Switch (Cisco Catalyst 3850 Stack), page 4-10, to complete the Cisco Catalyst 3850 stack switch configuration for this deployment model.

Provisioning Light Fixtures using SmartCast Manager

This section describes how to commission the light fixtures using the SCM. The light fixture can be commissioned by running the OneButton Setup, which groups the endpoints automatically.

The light fixtures can then be controlled via the SCM and the Wall Dimmer. Following are the steps to be performed to provision the light fixtures:

Step 1 Connect the SCM to an access port on the switch, in the same VLAN as the lighting network.

Step 2 Launch the SCM application.

Step 3 In the Network Interface selection, if prompted to select the network interface, choose the PoE network.

Step 4 Click **Continue**.

Step 5 If light fixtures are commissioned already from the initial installation, do a factory reset on them, and then allow them to be rediscovered for commissioning on a new area as per the requirement.

Step 6 Once the devices are listed on the SCM, perform OneButton Setup.

Step 7 Click **ALL**.

Step 8 Once OneButton Setup is complete, click **All Device**s under the **Settings** tab to verify that all devices in the lighting network are assigned to Occupancy Groups and Switch Groups.

Step 9 Click **Controls** and change the dim level to verify that the Switch Group brightness changes when controlling it via the control screen. This verifies light fixture is provisioned and controllable by SCM.

Implementing Data Center Applications

Configuring Firewall

In this deployment, follow the steps below to configure firewall networking to connect the Cisco Catalyst 3850 switch stack as shown in Figure 5-1. The configuration of the firewall is same as described in Configuring Firewall, page 5-4 in this deployment.

Configuring Data Center Applications

Refer to Configuring Data Center Applications, page 5-4, for the configure data center application as shown Figure 5-1.

Lighting Small Scale Deployment

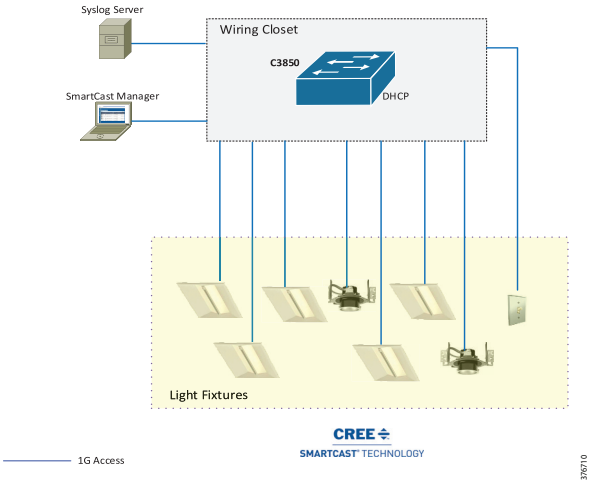
When a lighting solution needs to deploy in a small store/site where 20 or fewer number of light fixtures are required to be installed, a Cisco Catalyst 3850 standalone switch is sufficient, along with SCM, for the lighting network for provisioning light fixtures. In this small scale deployment, a Syslog server can also be connected to the same Cisco Catalyst 3850 switch to manage this small lighting network.

This chapter, which covers the implementation of networking Layer 2, Layer 3, and security features required for a small scale network powered lighting deployment as specified in the Design Guide, includes the following major topics:

Network Topology

In this deployment, one standalone Cisco Catalyst 3850 UPOE is sufficient to implement lighting in a small scale (for example, up to 20 lights in a small retail store) as shown in Figure 6-1.

Figure 6-1 Cisco Digital Building Cree Solution Small Scale Deployment Topology



Wiring Closet Access Switch (Cisco Catalyst 3850)

When migrating a lighting initial setup with a Cisco Catalyst 3850 standalone switch for a small scale deployment, SCM is connected directly to the Cisco Catalyst 3850 switch for provisioning light fixtures. Networking Layer 2, Layer 3, and UPOE and security features are also configured on the Cisco Catalyst 3850 switch.

Configuring DHCP Server for Light Fixture IP Addressing

When migrating the initial lighting setup to a small scale deployment, the DHCP server IP addressing pool for light fixtures and wall dimmers is configured on the Cisco Catalyst 3850 switch itself to assign IP addresses to Cree endpoints.

Table 6-1 shows an example DHCP pool range for Cree light fixtures.

Table 6-1 IPv4 DHCP Address Pool on Cisco Catalyst 3850

Pool Network	Excluded IP Range	Purpose
10.30.0.0/22	10.30.0.1 - 10.30.0.50	DHCP pool for Cree light fixtures in VLAN 30

Perform the following steps to configure DHCP server pool on Cisco Catalyst 3850/Cisco Catalyst 4506-E switches.

Step 1 Follow Configuring Network Layer 2 and Layer 3, page 4-12 from Steps 1 to 4 in the Wiring Closet Access Switch configuration section in Chapter 4.

Step 2 Configure DHCP server on the Cisco Catalyst 3850 switch. For example:

```
ip dhcp pool CREE
 network 10.30.0.0 255.255.252.0
 default-router 10.30.0.1
!
ip dhcp excluded-address 10.30.0.1 10.30.0.50
```

Configuring Cisco Catalyst 3850 Switch

The configuration of wiring closet access switch in this deployment for UPOE features, security and logging is same as described in Wiring Closet Access Switch (Cisco Catalyst 3850 Stack), page 4-10.

In that section, refer to Configuring UPOE Features, page 4-13, Configuring Security Features, page 4-14, and Configuring Logging (Syslog), page 4-18 to complete the Cisco Catalyst 3850 switch configuration for small scale deployment.

Provisioning Light Fixtures using SmartCast Manager

The light fixtures provisioning steps in this deployment are same as described in Provisioning Light Fixtures (SmartCast Manager), page 4-22, where you can refer to when migrating the lighting initial setup to deployment as shown in Figure 6-1.

Lighting Control and Maintenance

Please refer to the following Cree product documentation:

- Cree SmartCast® POE User Manual at the following URL:
  - http://lighting.cree.com/poe-user-manual
- Cree SmartCast POE Technology Quick Start Deployment Guide at the following URL:
  - http://lighting.cree.com/poe-deployment-guide

Caveats

Table 8-1 covers the list of open issues in the system and workarounds for open issues.

Table 8-1 Caveats and Workarounds

Open Issues	Workaround
In case of UPOE, even though Fast PoE is available on switch side, the Cree light fixtures may not be able leverage Fast UPOE, due to reliance on LLDP to signal the power availability. This reliance on LLDP requires that light fixtures still need to wait till the IOS comes up and LLDP exchanges can happen.	Not Available. Only Fast PoE is supported.
The C3850 switch stack and its ports discovery by SCM using SNMP does not work, if SVI is not configured for the light fixture's VLAN on wiring closet access switch stack (C3850).	Switch stack and ports discovery on SCM requires SVI for the light fixture's VLAN to be created on wiring closet access switch (C3850 stack) where SCM is directly connected.
Cree SCM does not support C4506E switch and its ports discovery using SNMP.	Feature is not supported on SCM.
Fast PoE feature does not work on Cisco Catalyst 3850 stack with power stacking cables connected. The 3850 stack will require 8-10 mins to power up. The Cree lights receive power and illuminate after the switch is up from power restore in power stack deployment.	No work around available for Fast PoE with 3850 switch power stack. If Fast PoE is required, configure only 3850 switches in data stack.

References

This appendix, which lists the documentation used in this implementation guide, includes the following major topics:

Cisco Documentation

- *Cisco Digital Building Cree Design Guide* at the following URL:
  - https://www.cisco.com/c/en/us/solutions/workforce-experience/digital-building/index.html?#~stickynav=1
- *Cisco Catalyst 3850 Series Switches Data Sheet* at the following URL:
  - http://www.cisco.com/c/en/us/products/collateral/switches/catalyst-3650-series-switches/datasheet-c78-729449.html
- *Catalyst 4500 Series Switch Software Configuration Guide, IOS XE 3.7.xE and IOS 15.2(3)Ex* at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst4500/XE3-7-0E/15-23E/configuration/guide/xe-370-configuration/vss.html
- *Catalyst 3850 Hardware Installation Guide, Chapter: Switch Installation* at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/hardware/installation/guide/b_c3850_hig/b_c3850_hig_chapter_010.html
- *Stack Manager and High Availability Configuration Guide, Cisco IOS XE Release 3SE (Catalyst 3850 Switches), Chapter: Managing Switch Stack*s at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/software/release/3se/ha_stack_manager/configuration_guide/b_hastck_3se_3850_cg/b_hastck_3se_3850_cg_chapter_010.html
- *Consolidated Platform Configuration Guide, Cisco IOS XE 3.7E and Later (Catalyst 3850 Switches)* at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/software/release/37e/consolidated_guide/b_37e_consolidated_3850_cg.html

- *Cisco UCS C240 M3 Server Installation and Service Guide* at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/c/hw/C240/install/C240.html
- *Cisco UCS C-Series Servers Integrated Management Controller GUI Configuration Guide, Release 2.0* at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/c/sw/gui/config/guide/2-0/b_Cisco_UCS_C-series_GUI_Configuration_Guide_201.html
- Cisco Prime Infrastructure (PI) Installation and Configuration Guide at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/net_mgmt/prime/infrastructure/3-0/quickstart/guide/cpi_qsg.html#pgfId-63672
- *Cisco Identity Services Engine (ISE) Installation and Configuration Guide, Chapter: Install ISE on a VMware Virtual Machine* at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/security/ise/2-0/installation_guide/b_ise_InstallationGuide20/Installing_ISE_on_a_VMware_Virtual_Machine.html
- *Cisco Prime Infrastructure 3.0 Quick Start Guide* at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/net_mgmt/prime/infrastructure/3-0/quickstart/guide/cpi_qsg.html
- *Cisco Prime Infrastructure 3.0 User Guide* at the following URL:
  - http://www.cisco.com/c/en/us/td/docs/net_mgmt/prime/infrastructure/3-0/user/guide/pi_ug.html

Cree Documentation

- SmartCast PoE User Manual v1.2.2
- *CREE SMARTCAST® TECHNOLOGY DEPLOYMENT GUIDE* at the following URL:
  - http://api.icentera.com/v2/getfile.aspx?f=49507BF3073245432BA72195539D0DDB05A36C93A577C51754CDB69013F37BD985ED939BFC239B2F

Third Party Documentation

- *Vmware vSphere Installation and Setup. vSphere 5.5* at the following URL:
  - http://pubs.vmware.com/vsphere-55/topic/com.vmware.ICbase/PDF/vsphere-esxi-vcenter-server-55-installation-setup-guide.pdf

Glossary

Table B-1 Acronyms and Initialisms

AAA	**Authentication, Authorization and Accounting**
ACL	Access Control List
ALS	Ambient Light Sensor
ARP	Address Resolution Protocol
ASA	Adaptive Security Appliance
CT	Configuration Tool
CVD	Cisco Validated Design
DAI	Dynamic ARP Inspection
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
HTTP	Hypertext Transfer Protocol
HTTPS	HTTP over SSL
IPv4	Internet Protocol Version 4
LACP	Link Aggregation Control Protocol
LAN	Local Area Network
LDAP	Lightweight Directory Access Protocol
LLDP	Link Layer Discovery Protocol
NTP	Network Time Protocol
OTT	Over the Top
PoE	Power over Ethernet
SCM	SmartCast Manager
SNMP	Simple Network Management Protocol
SSH	Secure Shell
SVI	Switched Virtual Interface
TACACS	Terminal Access Controller Access Control System
TCP	Transmission Control Protocol
TFTP	Trivial File Transfer Protocol

Table B-1 Acronyms and Initialisms (continued)

AAA	**Authentication, Authorization and Accounting**
UCS	Unified Computing System
UDP	User Datagram Protocol
UPOE	Universal Power over Ethernet
VLAN	Virtual Local Area Network
VM	Virtual Machine