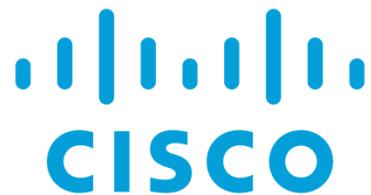




Smart Buildings with Cisco Catalyst 9000 Switches  
Certified Green Testing



October 2021

DR210709D

## Contents

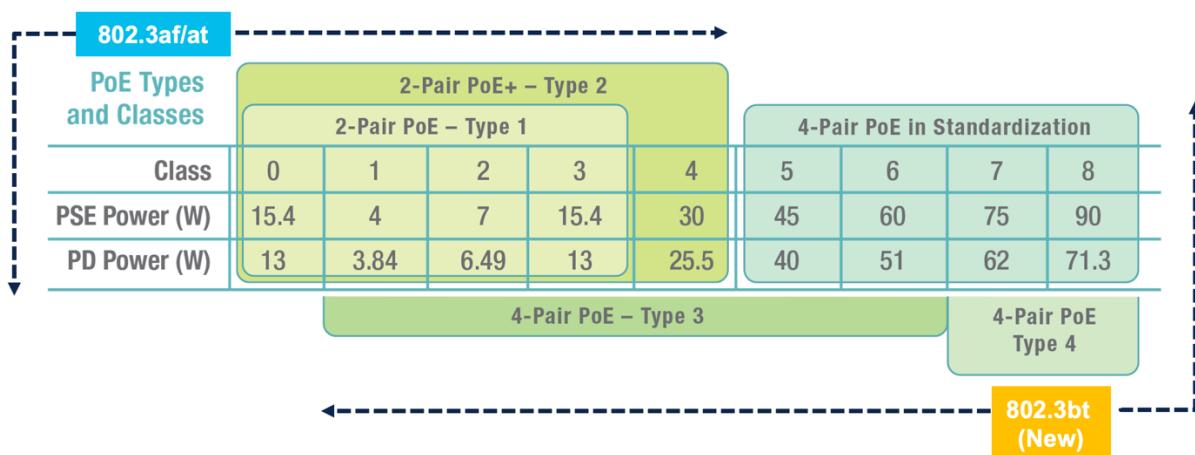
1.0 Executive Summary .....	3
2.0 Introduction .....	6
3.0 Cisco Smart Building Architecture .....	7
4.0 How We Did It.....	8
5.0 PoE Features .....	10
5.1 802.3 BT Negotiation .....	10
5.2 802.3 BT Negotiation and LLDP.....	13
5.3 Perpetual PoE .....	15
5.4 Fast PoE .....	16
5.5 Load Shedding.....	16
5.6 Static Power Configurations .....	19
5.7 PoE & Data Testing.....	20
5.7.1 Controlling Lights Powered by PoE.....	20
5.7.2 90W Capable USB-C Dongle.....	21
6.0 PoE Analytics and Assurance.....	23
6.1 Cisco DNA Center for PoE Assurance .....	23
6.2 PoE Operational State Distribution.....	24
6.3 PoE Powered Device Distribution .....	26
6.4 PoE Insights.....	28
6.5 Power Load Distribution .....	29
6.6 PoE Power Usage .....	30
6.7 PoE Port Verification on Switch .....	31
6.8 Troubleshooting PoE Catalyst 9000 Switches .....	31
7.0 Endpoint Analytics and Security.....	33
7.1 Endpoint Analytics.....	33
7.2 Secure Endpoints with ISE.....	37
8.0 Indoor IoT Services for Wired Endpoints with DNA Spaces .....	40
8.1 DNA Spaces.....	40
8.2 Indoor IoT Services for Wired Devices – Architecture .....	41
8.3 Test Topology.....	42
8.4 Test Results .....	43
9.0 Application Hosting Capabilities .....	48
9.1 Application Installation.....	48
About Miercom .....	51
Use of This Report.....	51

# 1.0 Executive Summary

We continue to see more and more endpoints onboarding the network using Power Over Ethernet (PoE). This standardized technology with evolving applications provides cost savings by powering endpoints at low voltage. The networking infrastructure can be leveraged to power the endpoints as well as provide network connectivity at the same time.

With the continued use of PoE powered lights, motorized shades, HVACs, USB-C dongles, large displays, high resolution cameras and other appliances using more than 60 watts (W), 90W is becoming more prevalent as the National Electric Code removes the 60W limitation for PoE. The increased use of USB-C dongles brings opportunity for providing power and network connectivity simultaneously to laptops and other devices that can be powered by USB-C ports. Moreover, 90W ports makes daisy chaining of lights possible, helping with energy savings where a single 90W port can be used to power multiple lights.

The latest standard for PoE, IEEE 802.3bt, introduces two new types, Type 3 and Type 4 for up to 90W of power, driving the new Internet of Things (IoT) use cases seen today in the rapidly evolving network landscape.



As a PoE industry leader, Cisco engaged Miercom to test new capabilities and features that its Catalyst 9000 Series switches offer for Smart Building Deployments. The Cisco Catalyst 9300 and Catalyst 9400 series switches both support Cisco Universal Power over Ethernet Plus (UPOE+) and are IEEE 802.3bt Type 3 and Type 4 compliant.

Cisco knows how important 90W PoE is, as it is rapidly becoming a utility. By switching to Catalyst 9000 Series UPOE/UPOE+ models, customers can benefit from cost savings and seamlessly converge IT and OT infrastructure. Direct current (DC) powering technology eliminates the need to invest in alternating current (AC) cabling conduits, and 90W PoE provides the ability to safely daisy chain multiple devices to a single port.

Cisco Catalyst 9000 Series switches with standards based 802.3bt capabilities provide densest PoE options to enable the next generation flexible workspace. Catalyst 9300 and 9400 UPOE/UPOE+ ports could scale up to 256 90W ports on a 9300 in a stacked environment and up to 260 90W ports on the 9400 Modular chassis, giving customers flexible options to choose for the PoE deployments. Its PoE power sources are reliable; PoE assurance is guaranteed by Cisco DNA Center, which provides a complete view of connected end points, PoE capabilities and troubleshooting tools from a single dashboard. Cisco AI End point Analytics auto profiles endpoints seamlessly as they on-board the network. ISE can use these end point profiles to provide customized policies to secure the end points. Lastly, Cisco DNA Spaces, a SaaS-based cloud platform, delivers new business outcomes by leveraging the Application Hosting framework of the Catalyst 9000 Series switches.

By looking at multiple common 90W use cases, we proved Cisco Smart Building with Catalyst 9000 Series switches provide feature rich PoE capabilities that are worth investing in. Below are our highlighted findings.

### **Key Findings:**

- **Superior Portfolio of UPOE and UPOE+ Capabilities:** With Cisco Smart Building, the Cisco Catalyst 9000 series switches successfully provide features such as UPOE+, Perpetual PoE, Fast PoE, Intelligent Load Shedding, Port priority.
- **Fast Power Restoration:** The Fast PoE feature helps restore power to end points within 23 seconds upon a power failure.
- **Highest Power Resiliency:** Catalyst 9000 switches provide seamless hardware redundancy with capabilities like 1+N, N+N redundant power supplies, mixed AC and DC sources, and StackPower (9300).
- **Seamless Integration with third-party endpoints:** The Cisco Catalyst 9000 Series switches work with a large ecosystem of PoE powered end points and their accompanying applications. Catalyst 9300 and 9400 Series switches are 802.3bt compliant up to 90W and seamlessly interoperate with IEEE 802.3bt compliant devices. The switches also interoperate with legacy PoE devices, covering all existing and new PoE devices as it supports a wide powering spectrum from 15W to 90W.
- **Simplified, Centralized Management via Cisco DNA Center:** Cisco DNA Center acts as a single pane-of-glass to onboard, provision and perform image upgrade at scale on the network devices. Assurance capabilities of DNA Center provide Network, Client and Application Assurance. PoE Assurance provides in-depth PoE network analysis and overview through a user-friendly interface to help customers plan, monitor, and troubleshoot the network.
- **Insightful Visual Aids for Quick Analysis:** Cisco DNA Center PoE Assurance shows powered endpoint device details, trends, event timelines, PoE categorization and classification. The PoE Insights highlights Perpetual PoE, Fast PoE, IEEE compliant and UPOE+ enabled devices.

- **AI Endpoint Analytics:** AI Endpoint Analytics provides users with additional benefits of auto profiling the endpoints by leveraging the Deep packet inspection capabilities of Catalyst 9000 switches. AI Endpoint Analytics combined with ISE provides seamless segmentation to secure the network.
- **Application Hosting:** Catalyst 9000 series switches application hosting is a key innovation and provides Edge computing at no additional cost to host third-party docker containers using Cisco Application Hosting Framework.
- **SaaS-based Cloud Integration to Deliver New Outcomes:** Cisco DNA Spaces, a SaaS-based platform, delivers new outcomes like Sustainable Buildings, Employee Health & Safety, Productivity improvements, and Building Analytics.

Based on our findings, we found the Cisco Smart Building solution to offer industry leading PoE capabilities. It impressed with its superior connectivity, assurance, and extension of environmentally friendly network power across multiple real-world scenarios. We proudly award the Cisco Smart Building solution, the ***Miercom Certified Green*** accreditation in recognition of its positive contribution to the environment.

Robert Smithers  
CEO, Miercom



## 2.0 Introduction

PoE is a widely used technology that provides electrical power to endpoints over twisted pair Ethernet cabling to power the endpoints in addition to the data that the cable usually carries. PoE powers numerous endpoints and removes the need for in-depth wiring or conversion. Additionally, it decreases the costs of deployments and ensures safety for both the endpoint and user when using standardized technologies.

In 2011, Cisco introduced UPOE (up to 60W) to leverage all four-twisted pairs on Category 5e and above cables. In 2018, the IEEE 802.3bt standard increased the maximum power to 90W which allows for Smart Building enablement where it is possible to power even more IoT devices.

The Smart Building features are supported on the Cisco Catalyst 9000 series, specifically the Cisco Catalyst 9300L, 9300, and 9400. UPOE+ is not supported on the 9300L and Fast PoE is not supported for the Catalyst 9400.

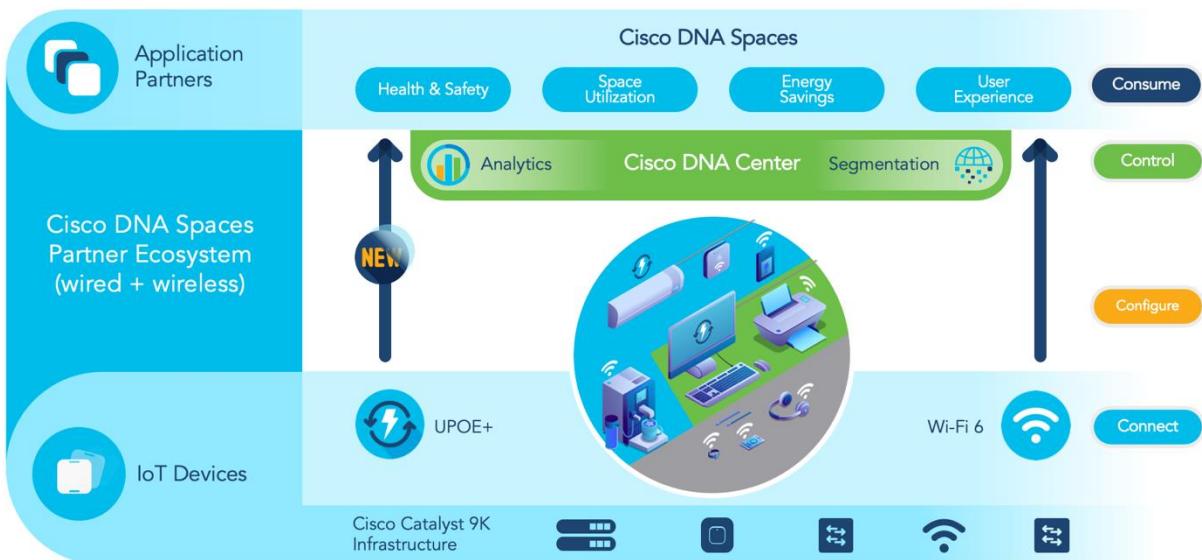
Capabilities	Catalyst 9300L	Catalyst 9300	Catalyst 9400	
UPOE+ (90W)	✗	✓	✓	Maximum Power Draw
UPOE (60W)	✓	✓	✓	
POE+ (30W)	✓	✓	✓	
802.3BT Type 3 (up to 60W)	✓	✓	✓	Standard Compliance
802.3BT Type 4 (up to 90W)	✗	✓	✓	
Perpetual PoE	✓	✓	✓	* High Availability
Fast PoE	✓	✓	✗	
2-event Classification (30W)	✓	✓	✓	
Multi-event Classification (60W & 90W)	✓	✓	✓	
LLDP Classification	✓	✓	✓	Power Negotiation

Flexibility / Density →

\* Dual Supervisors needed

The above displays the features supported by the Catalyst 9300L, 9300, and 9400. Note that UPOE+ is not supported on the 9300L and Fast PoE is not supported for the Catalyst 9400.

## 3.0 Cisco Smart Building Architecture



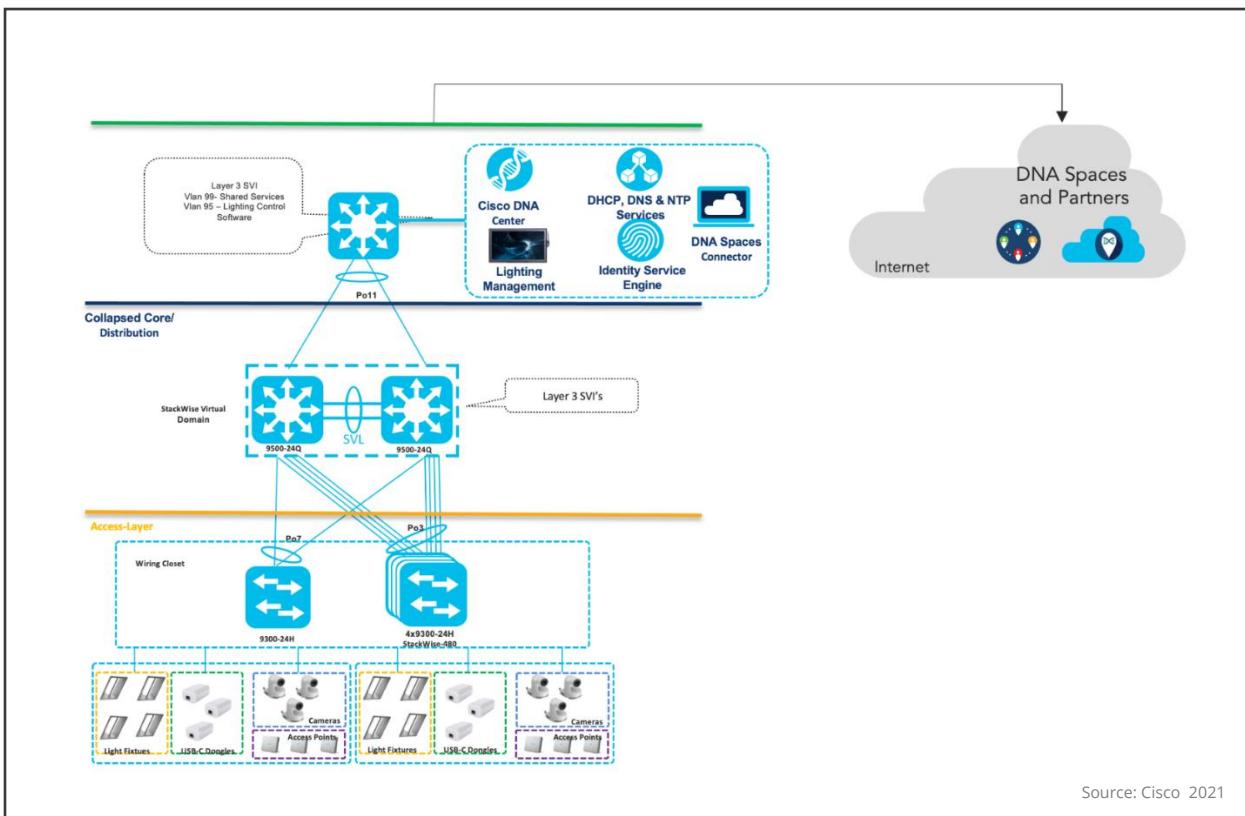
Cisco Smart Building Architecture consists of multiple features layered together, with Catalyst 9000 switching platforms and wireless access points acting as the backbone for the solution at the Access Layer. Cisco UPOE/UPOE+ and mGig capabilities of Catalyst 9000 switching platforms lay the foundation for this architecture. The Cisco DNA Center, a network controller and management dashboard, provides a single dashboard for every fundamental management task and provide Assurance at the same time. Cisco ISE enables a dynamic and automated approach to policy enforcement for simplified delivery of highly secure network access control. Cisco DNA Spaces, a SaaS-based platform, assists with location-based analytics to deliver new outcomes to the customer.

In this report, we analyzed the solution at each layer to determine the functionality, capability, and reliability of the solution.

## 4.0 How We Did It

By observing the Cisco Smart Building solution in many real-world use case scenarios, we validated features and performance for the Miercom Certified Green accreditation.

### Test Bed Overview



Source: Cisco 2021

*PoE device control was verified on a twisted pair Ethernet cable, up to 100 meters.*

A wide variety of PoE endpoints were connected at the Access Layer to the Catalyst 9300H models (9300-24H) which are 90W capable. Endpoint types included PoE lighting Fixtures from multiple third-party vendors, PoE sensors, PoE powered USB-C dongles, Cisco access points, Cisco and third-party PoE powered cameras, PoE powered Cisco IP Phones, Cisco UPOE passthrough switches, and Meraki cameras.

A pair of Cisco Catalyst 9500 switches (9500-24Q), configured in Stackwise Virtual mode (SV), acted as a collapsed core for this topology.

Services such as DHCP server, DNS Server, Cisco DNA Center, and Cisco ISE were connected at the Data Center Layer to provide centralized services to the endpoints connected at the Access Layer.

## Products Tested

Hardware/Software	Version
<b>Igor Lights</b>	
Igor Network Node	Rev 7: NP70-99-8-F Rev 8: NP60-99-T-F
<b>Igor Management Interface</b>	
Igor Gateway Software	Ver. 5.6.1
<b>MazeMap</b>	Ver. 5.2.23
<b>Molex PoE Node</b>	CoreSync PoE Gateway 2.0
<b>Molex Management Software</b>	CoreSync Manager V1 4.0.57
<b>PoE Endpoints</b>	Lighting endpoints, occupancy sensors, 4K cameras, IP phones, PoE passthrough switches
<b>Cisco Catalyst 9300H/9500-24Q Switches</b>	17.3.1
<b>Cisco DNA Center</b>	2.2.2.0
<b>Cisco ISE</b>	Release 2.7

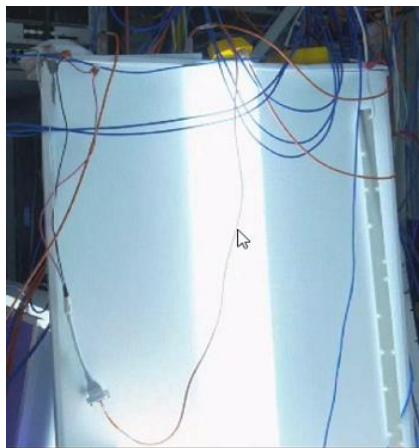
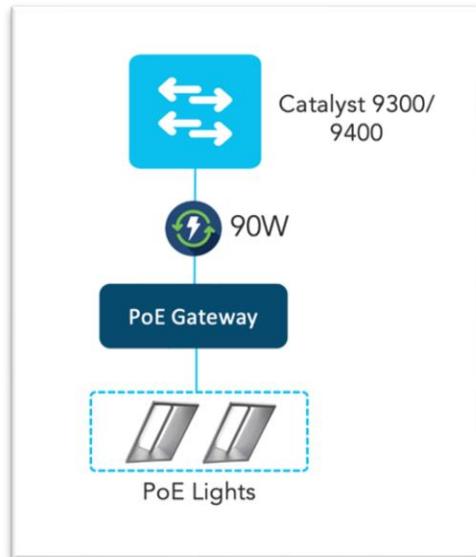
## 5.0 PoE Features

### 5.1 802.3 BT Negotiation

We observed how UPOE+ lights negotiate the appropriate power both at hardware, without LLDP (Link Layer Discovery Protocol), and software with LLDP enabled.

#### Test setup:

With LLDP disabled on the switch, 802.3bt, 90W capable PoE Gateways were connected to the Catalyst switches. Two daisy chained light fixtures were connected to the PoE Gateway – the Powered Device (PD). We saw Power successfully negotiated up to 90W (Class 8) between the switch – the Power Sourcing Equipment (PSE) and the PoE Gateway (PD). 802.3bt power negotiation happened successfully between the PoE Gateway and the Catalyst switch and lights were turned on successfully after the negotiation.



*We observed successful 802.3bt power negotiation between the PoE Gateway (PD) and the Catalyst switch (PSE) over Ethernet. Lights turned on successfully after the negotiation.*

```
C9300-Stack#sh power inline gigabitEthernet 2/0/11 detail
Interface: Gi2/0/11
Inline Power Mode: auto
Operational status (Alt-A,B): on,on
Device Detected: yes
Device Type: Ieee PD
Connection Check: SS
IEEE Class (Alt-A,B): 8
Physical Assigned Class (Alt-A,B): 8
Discovery mechanism used/configured: Ieee and Cisco
Police: off

Power Allocated
Admin Value: 90.0
Power drawn from the source: 90.0
Power available to the device: 90.0
Allocated Power (Alt-A,B): 90.0

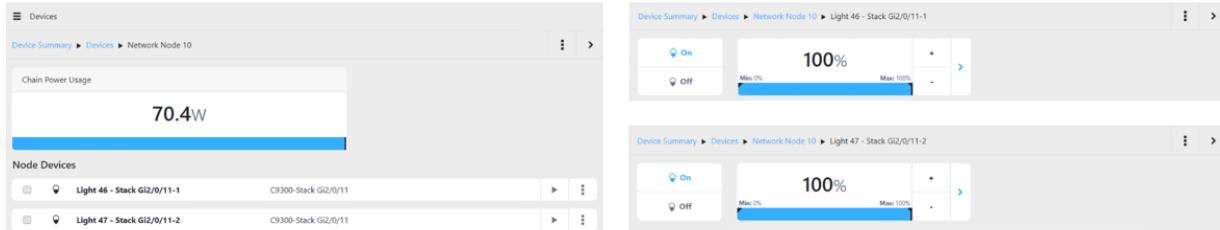
Actual consumption
Measured at the port(watts) (Alt-A,B): 72.0
Maximum Power drawn by the device since powered on: 72.0

Absent Counter: 0
Over Current Counter: 0
Short Current Counter: 0
Invalid Signature Counter: 0
Power Denied Counter: 0

Power Negotiation Used: None
LLDP Power Negotiation      --Sent to PD--      --Rcvd from PD--
Power Type: -
Power Source: -
Power Priority: -
Requested Power(W): -
Allocated Power(W): -

Four-Pair PoE Supported: Yes
Spare Pair Power Enabled: Yes
Four-Pair PD Architecture: Shared
C9300-Stack#
```

*Successful 802.3bt negotiation as seen from the switch. We observed that PoE negotiated to Class 8 and been allocated 90W by the switch (PSE).*



*Above shows both the light fixtures are at 100% brightness and the power at the PD.*

```

C9300-Stack#sh power inline gigabitEthernet 2/0/11 detail
Interface: Gi2/0/11
Inline Power Mode: auto
Operational status (Alt-A,B): on,on
Device Detected: yes
Device Type: Ieee PD
Connection Check: SS
IEEE Class (Alt-A,B): 8
Physical Assigned Class (Alt-A,B): 8
Discovery mechanism used/configured: Ieee and Cisco
Police: off

Power Allocated
Admin Value: 90.0
Power drawn from the source: 90.0
Power available to the device: 90.0
Allocated Power (Alt-A,B): 90.0

Actual consumption
Measured at the port(watts) (Alt-A,B): 27.3
Maximum Power drawn by the device since powered on: 72.0

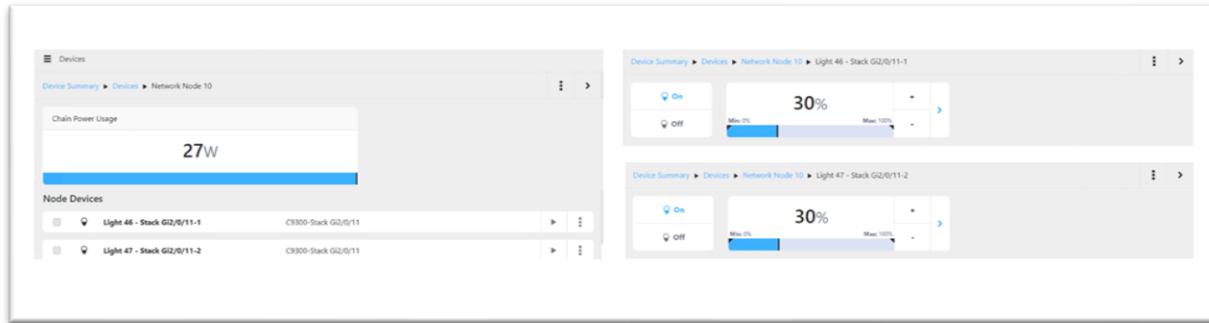
Absent Counter: 0
Over Current Counter: 0
Short Current Counter: 0
Invalid Signature Counter: 0
Power Denied Counter: 0

Power Negotiation Used: None
LLDP Power Negotiation      --Sent to PD--      --Rcvd from PD--
Power Type:                 -
Power Source:                -
Power Priority:              -
Requested Power(W):         -
Allocated Power(W):          -

Four-Pair PoE Supported: Yes
Spare Pair Power Enabled: Yes
Four-Pair PD Architecture: Shared
C9300-Stack#

```

We observed the brightness of the light fixtures being adjusted from the lighting controller software and were able to see the brightness change successfully on the lights. This change was reflected on the switch port, where the actual consumption measured at the port transitioned to 27.3W with a change in brightness of the lights.



Above shows both the light fixtures are at 30% brightness and the power at the PD.

## 5.2 802.3 BT Negotiation and LLDP

We observed how UPOE+ lights negotiate power after enabling LLDP (Link Layer Discovery Protocol). LLDP is a vendor neutral Layer 2 protocol used by network devices to advertise their identity, capabilities and neighborship. It provides the capability to exchange TLV's (Type-Length-Value) with a neighboring device. During testing, we viewed the ability of the switch to negotiate power at hardware and display additional information regarding the end point like PD class, Power Type, Product type, vendor information via LLDP protocol.

Similar activity as stated in 5.1 was carried out by enabling LLDP on the switch.

As seen from the output, PoE was negotiated as Type 4 PSE and Class 8, which is 90W. LLDP compliments the hardware negotiation by providing additional details like PD class, Power Type, Product type, vendor specific information along with the capability to negotiate at custom power values should the PD require lower power than initially negotiated.

```
C9300-Stack#sh power inline gigabitEthernet 2/0/11 detail
Interface: Gi2/0/11
Inline Power Mode: auto
Operational status (Alt-A,B): on,on
Device Detected: yes
Device Type: Ieee PD
Connection Check: SS
IEEE Class (Alt-A,B): 8
Physical Assigned Class (Alt-A,B): 8
Discovery mechanism used/configured: Ieee and Cisco
Police: off

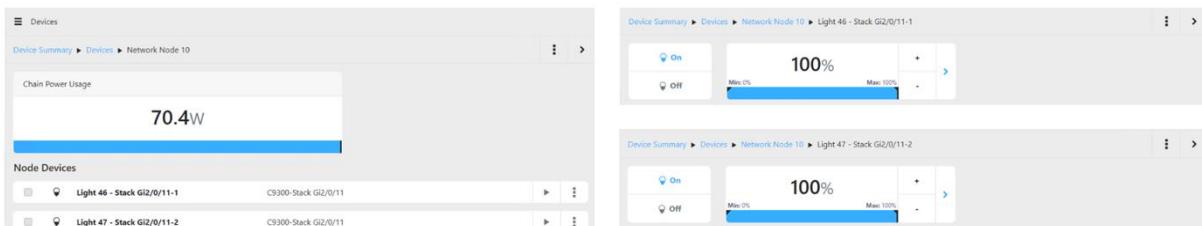
Power Allocated
Admin Value: 90.0
Power drawn from the source: 90.0
Power available to the device: 90.0
Allocated Power (Alt-A,B): 90.0

Actual consumption
Measured at the port(watts) (Alt-A,B): 72.0
Maximum Power drawn by the device since powered on: 72.0

Absent Counter: 0
Over Current Counter: 0
Short Current Counter: 0
Invalid Signature Counter: 0
Power Denied Counter: 0

Power Negotiation Used: IEEE 802.3bt LLDP
LLDP Power Negotiation --Sent to PD-- --Rcvd from PD--
Power Type: Type 2 PSE Type 2 PD
Power Source: Primary PSE
Power Priority: low critical
PD 4PID: 0 0
Requested Power(W): 71.3 71.3
Allocated Power(W): 71.3 71.3
Requested Power ModeA(W): 0.0 0.0
Allocated Power ModeA(W): 0.0 0.0
Requested Power ModeB(W): 0.0 0.0
Allocated Power ModeB(W): 0.0 0.0
PSE Powering Status: 4 pair SS PD Ignore
PD Powering Status: Ignore SS PD
PSE Power Pair ext: Both Alternatives Ignore
DS Class Mode A ext: SS PD SS PD
DS Class Mode B ext: SS PD SS PD
SS Class ext: Class 8 Class 8
PSE Type ext: Type 4 PSE Ignore
PSE Max Avail Power: 71.3 0.0
PSE Auto Class Supp: No No
PD Auto Class Req: No No
PD Power Down Req: No No
PD Power Down Time(sec): 0 0

Four-Pair PoE Supported: Yes
Spare Pair Power Enabled: Yes
Four-Pair PD Architecture: Shared
```



*Light fixtures are at 100% brightness, and the power at the PD has LLDP enabled on the switch.*

```
C9300-Stack#sh lldp neighbors g2/0/11 detail
-----
Local Intf: Gi2/0/11
Chassis id: 500b.9100.947c
Port id: 1
Port Description: 1
System Name: Igor Network Node

System Description:
Igor Node X.X.X

Time remaining: 157 seconds
System Capabilities: S
Enabled Capabilities: S
Management Addresses:
IP: 172.16.10.24
Other: 50 0B FF 00 FF 7C 00
Auto Negotiation - not supported
Physical media capabilities - not advertised
Media Attachment Unit type - not advertised
Vlan ID: - not advertised
PoE+ Power-via-MDI TLV:
Power Pair: Signal
Power Class: Class 4
Power Device Type: Type 2 PD
Power Source: PSE
Power Priority: critical
Power Requested: 71300 mW
Power Allocated: 71300 mW

MED Information:

MED Codes:
(NP) Network Policy, (LI) Location Identification
(PS) Power Source Entity, (PD) Power Device
(IN) Inventory

Inventory information - not advertised
Capabilities: PD
Device type: Network connectivity
Network Policies - not advertised
Power requirements - not advertised
Location - not advertised

Total entries displayed: 1
C9300-Stack#
```

*Additional information regarding the endpoint is displayed after turning on the LLDP protocol.*

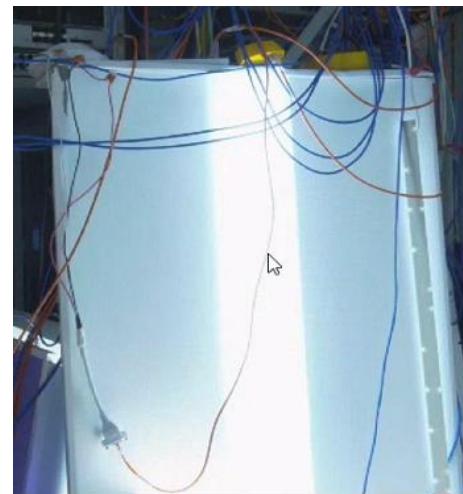
```
C9300-Stack#sh device-sensor cache interface g2/0/11
Device: 500b.9100.947c on port GigabitEthernet2/0/11
-----
Proto Type:Name Len Value Text
DHCP 52:option-overload 3 34 01 01 4...
DHCP 54:server-identifier 6 36 04 AC 10 63 35 6...c5
DHCP 6:domain-name-servers 10 06 08 AC 10 63 35 AC 1A CA ...,c5,.
35 5
DHCP 3:routes 6 03 04 AC 10 0A 01 .....
DHCP 1:subnet-mask 6 01 04 FF FF FF 00 .....
DHCP 50:requested-address 6 32 04 AC 10 0A 18 2.....
DHCP 0:<unknown> 2 00 00 ..
DHCP 255:end 5 FF 03 32 04 AC ..2..
DHCP 55:parameter-request-list 7 37 05 01 03 06 0F E5 7...,e
DHCP 51:lease-time 6 33 04 00 0A 8C 00 3...^L.
DHCP 53:message-type 3 35 01 03 5..
LLDP 0:<end-of-lldpdu 2 00 00 ..
LLDP 127:organizationally-specific 68 FE 42 00 00 5E 01 68 74 74 .B..^htt
70 73 3A 2F 2F 6D 75 64 2E ps://mud.
69 67 6F 72 2D 74 65 63 68 igor-tech
2E 63 6F 6D 2F 6D 75 64 2F .com/mud/
69 67 6F 72 2D 6E 65 74 77 igor-netw
6F 72 6B 6E 6F 64 65 2D 6D orknode-m
75 64 66 69 6C 65 2D 76 31 udfile-v1
2E 6A 73 6F 6E .json
LLDP 8:management-address 16 10 0E 07 06 50 08 91 00 94 ....P.^Q.^T
7C 02 00 00 00 01 00 |.....
LLDP 7:system-capabilities 6 0E 04 00 00 00 80 ...@.^@
LLDP 6:system-description 17 0C 0F 49 67 6F 72 20 4E 6F ..Igor No
64 65 20 58 2E 58 de X.X.X
LLDP 5:system-name 19 0A 11 49 67 6F 72 20 4E 65 ..Igor Ne
74 77 6F 72 6B 20 4E 6F 64 twork Nod
65 e
LLDP 4:port-description 3 08 01 31 ..1
LLDP 3:time-to-live 4 06 02 00 B4 ...4
LLDP 2:port-id 4 04 02 07 31 ...1
LLDP 1:chassis-id 9 02 07 04 50 08 91 00 94 7C ...P.^Q.^T|
```

*The switch learns the TLV's as advertised by the vendor. Some of these TLV's can be used for other features/functionalities. In above snapshot, TLV 127 is used for Manufacturer Usage Description (MUD) to create an Authorization policy in ISE and push a dynamic ACL or SGT to the port.*

### 5.3 Perpetual PoE

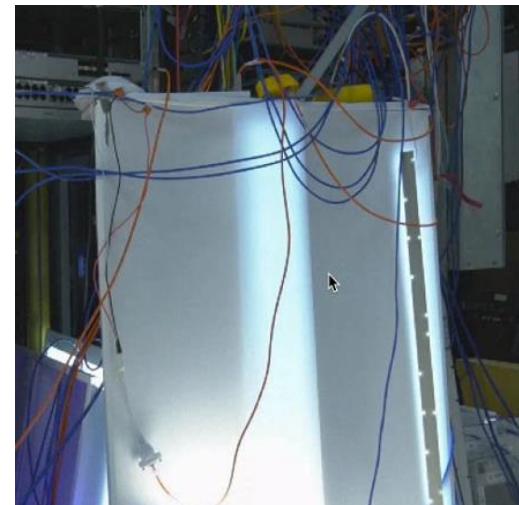
Perpetual PoE (PPoE) is a switch feature that allows clients to continue to receive *Last Negotiated Power* during a switch soft reload. Soft reloads include image upgrades, software crashes, and manual reboots. This feature is supported in both standalone and stacking deployment. This feature is not applicable to power outages, power supply removal, and switch hibernation mode.

During the live demonstration, a switch reload was performed and the behavior of the Igor lights were observed.



*Light is shown as on prior to switch reload.*

```
[C93-Standalone#reload  
Reload command is being issued on Active unit, this will reload the whole stack  
[Proceed with reload? [confirm]  
  
Chassis 1 reloading, reason - Reload command  
Apr 22 18:32:41.652: %PMAN-5-EXITACTION: F0/0: pvp: Process manager is exiting: reload fp action requested  
Apr 22 18:32:53.260: %PMAN-5-EXITvp: Process manager is exiting: process exit with reload stack code
```



*During the reload operation, the light was not switched off demonstrating PPoE feature.*

## 5.4 Fast PoE

Fast PoE remembers the last power drawn (in watts) from specific ports. This power is stored in the NVRAM, allowing the switch to remember and provide power to the endpoint as soon as the device is powered on. After a power failure, a switch in recovery recalls how many watts a particular endpoint on a port negotiated; thus, providing required power to endpoints. Fast PoE begins providing power to devices before IOS forwarding begins.

During testing, we viewed the ability of the Fast PoE to turn on the lights after turning the power supply from "off" to "on" within 23 seconds, which was higher than their datasheet claim.

*Note: This feature is not supported on the Catalyst 9400 platform.*

## 5.5 Load Shedding

Load shedding is the process of shutting down devices if a power supply, cable, or system fails. This feature ensures high priority ports are not denied power during a load shedding event upon a power failure. Any remaining power will be distributed to low priority ports. We observed this by first setting the port Gi1/0/10 to a high priority and viewed the changes to the available/remaining watts before and after one of the power supply (PS) failure.

Gi1/0/10 has been set to high priority port. The switch has two power supplies, a 1,100W PS and a 715W PS (see below).

SW	PID	Serial#	Status	Sys Pwr	PoE Pwr	Watts
1A	PWR-C1-1100WAC-P	DCC2402D1TQ	OK	Good	Good	1100
1B	PWR-C1-715WAC	DCB1837G2H0	OK	Good	Good	715

*Total Available PoE is 1,545W. 685.8W has been used to power multiple PoE endpoints.*

C93-Standalone#sh power inline			
Module	Available (Watts)	Used (Watts)	Remaining (Watts)
1	1545.0	685.8	859.2

*Available power was originally 1,545W prior to the power supply cut off.*

*Remaining power on the device is shown as 859.2W.*

The 1,100W PS was unplugged to create a load shedding event. Due to this the device was operating only on a single 715W power supply. In this scenario, available PoE now is only 445W.

C93-Standalone#sh power inline			
Module	Available (Watts)	Used (Watts)	Remaining (Watts)
1	445.0	420.8	24.2

Since the available PoE power is only 445W, and the device is operating in power shared strict mode, it must deny power to some low priority ports.

As soon as the 1,100W Power supply was taken down, we saw power denied to low priority ports due to insufficient power.

```
*Jul 29 16:43:34: %ILPOWER-5-DETECT: Interface Gi1/0/13: Power Device detected: IEEE PD
*Jul 29 16:43:34: %ILPOWER-5-ILPOWER_POWER_DENY: Interface Gi1/0/13: inline power denied. Reason: insufficient power
*Jul 29 16:43:34: %ILPOWER-5-DETECT: Interface Gi1/0/14: Power Device detected: IEEE PD
*Jul 29 16:43:34: %ILPOWER-5-ILPOWER_POWER_DENY: Interface Gi1/0/14: inline power denied. Reason: insufficient power
*Jul 29 16:43:36: %ILPOWER-5-DETECT: Interface Gi1/0/15: Power Device detected: IEEE PD
*Jul 29 16:43:36: %ILPOWER-5-DETECT: Interface Gi1/0/17: Power Device detected: IEEE PD
*Jul 29 16:43:36: %ILPOWER-5-ILPOWER_POWER_DENY: Interface Gi1/0/17: inline power denied. Reason: insufficient power
*Jul 29 16:43:36: %ILPOWER-5-DETECT: Interface Gi1/0/15: Power Device detected: IEEE PD
*Jul 29 16:43:36: %ILPOWER-5-ILPOWER_POWER_DENY: Interface Gi1/0/15: inline power denied. Reason: insufficient power
*Jul 29 16:43:37: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: netadmin] [Source: 172.16.99.97] [localport: 22] at
*Jul 29 16:43:36: %ILPOWER-5-IEEE_DISCONNECT: Interface Gi1/0/13: PD removed
*Jul 29 16:43:49: %ILPOWER-5-IEEE_DISCONNECT: Interface Gi1/0/14: PD removed
*Jul 29 16:43:51: %ILPOWER-5-IEEE_DISCONNECT: Interface Gi1/0/17: PD removed
```

*Power denied messages seen in log right after the PS failure.*

Interface	Admin State	Oper State	Admin Priority
Gi1/0/1	auto	off	low
Gi1/0/2	auto	on	low
Gi1/0/3	auto	off	low
Gi1/0/4	auto	on	low
Gi1/0/5	static	on	high
Gi1/0/6	auto	on	low
Gi1/0/7	auto	on	low
Gi1/0/8	auto	on	low
Gi1/0/9	auto	on	low
Gi1/0/10	auto	on	high
Gi1/0/11	auto	off	low
Gi1/0/12	auto	on	low
Gi1/0/13	auto	power-deny	low
Gi1/0/14	auto	power-deny	low
Gi1/0/15	auto	power-deny	low
Gi1/0/16	auto	off	low
Gi1/0/17	auto	power-deny	low
Gi1/0/18	auto	off	low
Gi1/0/19	auto	off	low
---More---			

*Port status of Gi1/0/10 is "on" as it is set as a high priority.*

We saw the port Gi1/0/10 maintain an “on” state during the load shedding event while other low priority ports transitioned to “off” due to insufficient power.

	(Watts)		(Watts)	(Watts)		
1	Interface	Admin	Oper	Power (Watts)	Device	Class Max
Gi1/0/1	auto	off	0.0	n/a	n/a	90.0
Gi1/0/2	auto	on	15.4	Ieee PD	3	90.0
Gi1/0/3	auto	off	0.0	n/a	n/a	90.0
Gi1/0/4	auto	on	90.0	Ieee PD	8	90.0
Gi1/0/5	static	on	30.0	Ieee PD	4	30.0
Gi1/0/6	auto	on	30.0	Ieee PD	4	90.0
Gi1/0/7	auto	on	30.0	WS-C3560CPD-8PT-S	4	90.0
Gi1/0/8	auto	on	90.0	Ieee PD	8	90.0
Gi1/0/9	auto	on	60.0	Ieee PD	4	90.0
Gi1/0/10	auto	on	60.0	Ieee PD	4	90.0
Gi1/0/11	auto	off	0.0	n/a	n/a	90.0
Gi1/0/12	auto	on	15.4	CIVS-IPC-6500PD	0	90.0
Gi1/0/13	auto	power-deny	0.0	n/a	n/a	90.0
Gi1/0/14	auto	power-deny	0.0	n/a	n/a	90.0
Gi1/0/15	auto	power-deny	0.0	n/a	n/a	90.0
Interface	Admin	Oper	Power (Watts)	Device	Class	Max
Gi1/0/16	auto	off	0.0	n/a	n/a	90.0
Gi1/0/17	auto	power-deny	0.0	n/a	n/a	90.0
Gi1/0/18	auto	off	0.0	n/a	n/a	90.0
Gi1/0/19	auto	off	0.0	n/a	n/a	90.0

*We observed Gi1/0/10 still “on”, even after the switch power supply was cut. Available watts decreased from 1,545W to 445W.*

## 5.6 Static Power Configurations

Static power configurations allow users to configure a maximum power that an endpoint is allowed to draw on a specific port up to 90W.

During observation, we observed the port Gi1/0/10 connected to a 90W capable endpoint being assigned a static power configuration of 60W and saw the switch trying to provide interface Gi1/0/10 60W power based on the specified configuration.

Module	Available (Watts)		Used (Watts)	Remaining (Watts)			
Interface	Admin	Oper	Power (Watts)	Device (Watts)		Class	Max
G11/0/1	auto	off	0.0	n/a		n/a	90.0
G11/0/2	auto	on	15.4	Ieee PD		3	90.0
G11/0/3	auto	off	0.0	n/a		n/a	90.0
G11/0/4	auto	off	0.0	n/a		n/a	90.0
G11/0/5	static	on	30.0	Ieee PD		4	30.0
G11/0/6	auto	on	30.0	Ieee PD		4	90.0
G11/0/7	auto	on	30.0	WS-C3560CPD-8PT-S		4	90.0
G11/0/8	auto	on	90.0	Ieee PD		8	90.0
G11/0/9	auto	on	90.0	Ieee PD		8	90.0
G11/0/10	auto	off	0.0	n/a		n/a	90.0
G11/0/11	auto	off	0.0	n/a		n/a	90.0
G11/0/12	auto	on	15.4	CIVS-IPC-6500PD		0	90.0
G11/0/13	auto	on	90.0	Ieee PD		8	90.0
G11/0/14	auto	on	90.0	Ieee PD		8	90.0
G11/0/15	auto	on	60.0	WS-C2960CPD-8PT-L		4	90.0

```
C93-Standalone(config-if)#
C93-Standalone(config-if)#
C93-Standalone(config-if)#int gi1/0/10
C93-Standalone(config-if)#
C93-Standalone(config-if)#
C93-Standalone(config-if)#power inline stat
C93-Standalone(config-if)#power inline static max 60000
```

*Interface Gi1/0/10 is given the static power configuration of 60,000 miliwatts (mW). This is possible because there are enough remaining watts to budget.*

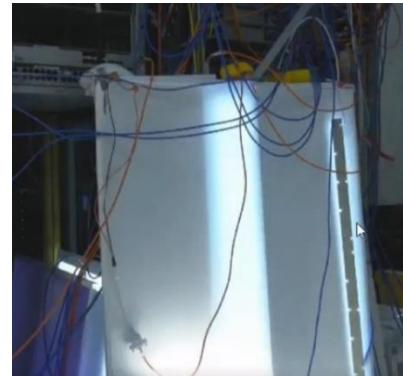
Module	Available (Watts)		Used (Watts)	Remaining (Watts)			
-----	-----	-----	-----	-----	-----	-----	-----
Interface	Admin	Oper		Power	Device	Class	Max
-----	-----	-----	(Watts)	-----	-----	-----	-----
Gi1/0/1	auto	off	0.0	n/a		n/a	90.0
Gi1/0/2	auto	on	15.4	Ieee PD		3	90.0
Gi1/0/3	auto	off	0.0	n/a		n/a	90.0
Gi1/0/4	auto	off	0.0	n/a		n/a	90.0
Gi1/0/5	static	on	30.0	Ieee PD		4	30.0
Gi1/0/6	auto	on	30.0	Ieee PD		4	90.0
Gi1/0/7	auto	on	30.0	WS-C3560CPD-8PT-S		4	90.0
Gi1/0/8	auto	on	90.0	Ieee PD		8	90.0
Gi1/0/9	auto	on	90.0	Ieee PD		8	90.0
Gi1/0/10	static	power-deny	60.0	n/a		n/a	60.0
Gi1/0/11	auto	off	0.0	n/a		n/a	90.0
Gi1/0/12	auto	on	15.4	CIVS-IPC-6500PD		0	90.0
Gi1/0/13	auto	on	90.0	Ieee PD		8	90.0
Gi1/0/14	auto	on	90.0	Ieee PD		8	90.0
Gi1/0/15	auto	on	60.0	WS-C2960CPD-8PT-L		4	90.0

*Observe interface Gi1/0/10 receiving a specific amount of power. Power-denied is shown because the device requires 90W but is only receiving 60W due to static power configuration.*

## 5.7 PoE & Data Testing

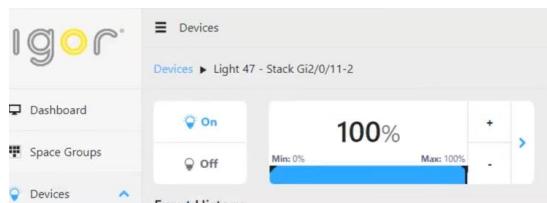
### 5.7.1 Controlling Lights Powered by PoE

We were given a brief tour and demonstration on the lighting management interface (third-party vendor). The application is vendor specific and works through the lighting itself. We saw the power usage of the lights increase as the light intensity was increased via the vendor management software. A single Ethernet cable, between the PoE node and the switch port, provided 90W of power to the lights/sensors. The lights/sensors were daisy chained to the PoE node and required data traffic to be discovered and managed from the vendor's controller software. Power efficiency is based on cable gauge, maximum power drawn by the PD, and cable distance.



Actual consumption  
Measured at the port(watts) (Alt-A,B): 10.6  
Maximum Power drawn by the device since powered on: 72.0

*Light displayed only utilizing 10.6 watts.*



*Using the IGOR management interface, we were able to increase the power to the device.*

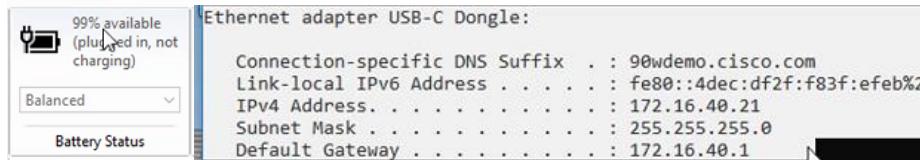


Actual consumption  
Measured at the port(watts) (Alt-A,B): 70.8  
Maximum Power drawn by the device since powered on: 72.0

*After increasing power, light intensity increased, and the switch recognized power usage – shown as 70W.*

## 5.7.2 90W Capable USB-C Dongle

With 802.3bt Type 4, 90W becoming a standard, USB-C dongles can be leveraged to provide network connectivity to the laptops, along with charging them at the same time via the Ethernet cables. This adapter provides the flexibility of charging the laptops, along with network connectivity. We observed the USB-C dongle successfully negotiating 90W and charging the laptop simultaneously. We also observed the laptop starting to discharge as soon as the USB-C dongle was disconnected.



*Laptop power is shown as plugged in and attempting to charge the laptop. The CLI (command line interface) displays the adapter being recognized by the laptop as shown by the assigned IP via DHCP.*

```
C9300-Stack#sh power inline g3/0/11 detail
Interface: Gi3/0/11
Inline Power Mode: auto
Operational status (Alt-A,B): on,on
Device Detected: yes
Device Type: Ieee PD
Connection Check: SS
IEEE Class (Alt-A,B): 8
Physical Assigned Class (Alt-A,B): 8
Discovery mechanism used/configured: Ieee and Cisco
Police: off

Power Allocated
Admin Value: 90.0
Power drawn from the source: 90.0
Power available to the device: 90.0
Allocated Power (Alt-A,B): 90.0

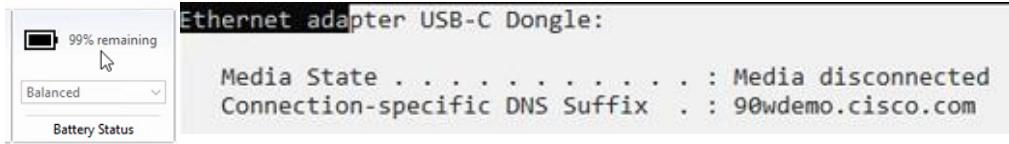
Actual consumption
Measured at the port(watts) (Alt-A,B): 13.1
Maximum Power drawn by the device since powered on: 66.9

Absent Counter: 0
Over Current Counter: 0
Short Current Counter: 0
Invalid Signature Counter: 0
Power Denied Counter: 0

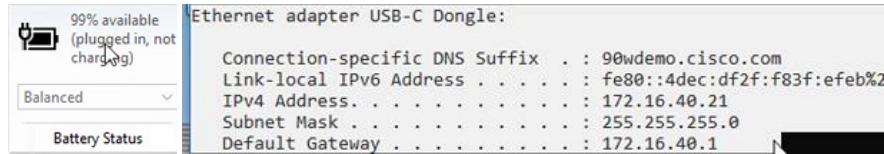
Power Negotiation Used: None
LLDP Power Negotiation      --Sent to PD--      --Rcvd from PD--
Power Type:                  -
Power Source:                 -
Power Priority:               -
Requested Power(W):          -
Allocated Power(W):           -

Four-Pair PoE Supported: Yes
Spare Pair Power Enabled: Yes
Four-Pair PD Architecture: Shared
```

*Successful 802.3bt negotiation between the USB-C dongle (PD) and the switch (PSE).*



*With the USB-C dongle turned off and removed from the laptop, we observed disconnection. The laptop was no longer charging.*



*The USB-C dongle was turned back on, as shown by the different assigned IP address. The laptop resumed charging and network connectivity was established.*

### Cisco Connectivity Advantages:

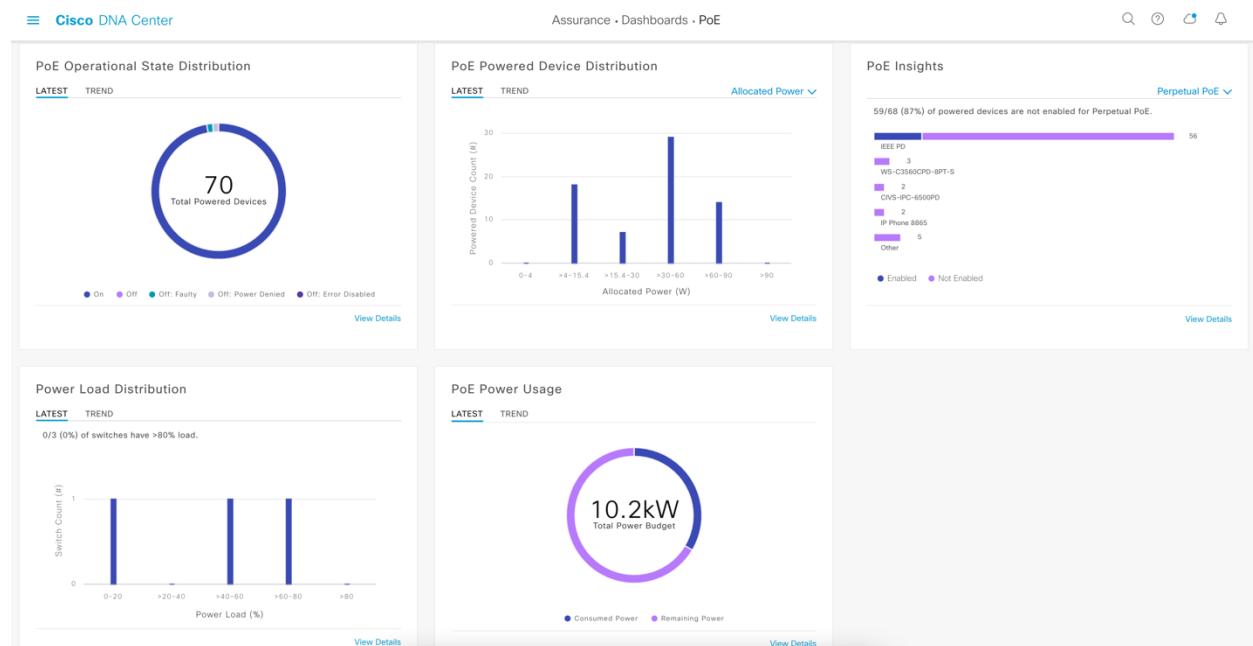
- Cisco UPOE+ negotiation occurs at the hardware. LLDP complements by adjusting the power as needed once the initial negotiation is done.
- Perpetual PoE continues to provide power to the endpoints during a soft reload (e.g., for an upgrade, during a crash).
- Fast PoE restores power to devices based on memory, observed within 23 seconds.
- Load Shedding prioritizes critically functioning end points to remain powered up during power failure events.
- Static Power configurations allows users to assign custom power limitations.
- Partnership and integration with third-party vendors provide granular control of power to the endpoints and intensity via the vendor management interface.
- The USB-C dongle provides both power and network connectivity to laptop devices.

## 6.0 PoE Analytics and Assurance

Network configuration and management is expensive. Manual Network Configuration and management can result in misconfigurations, inconsistencies and high risk environment leading to stalled digital transformation. The Cisco DNA Center is a network controller and management dashboard that can automate the deployment, connectivity, and lifecycle of the infrastructure. Cisco DNA Assurance enables every point on the network to become a sensor, sending continuous, streaming telemetry on application performance and user connectivity in real time. Telemetry with contextual data provides visibility to the network and analytic engines to find any anomalies and pinpoint causes of issues. Guided remediation is available to assist and guide users to resolve these issues. The dashboard is very user-friendly with graphical information. To utilize it, customers would need a Cisco DNA Center ready network and a Cisco Catalyst 9000.

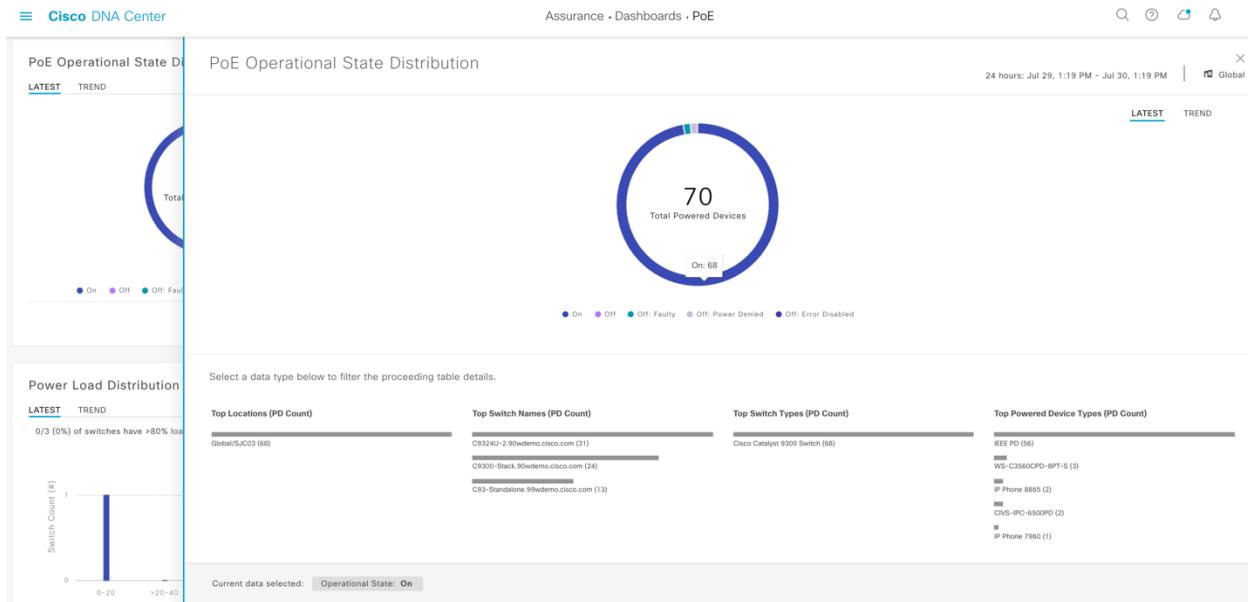
### 6.1 Cisco DNA Center for PoE Assurance

The Cisco DNA Center PoE Assurance dashboard provides overall PoE usage within the network to assist customers with planning, monitoring, and troubleshooting the network.



*The dashboard at the Cisco DNA Center provides a holistic view of the PoE usage within the network.*

## 6.2 PoE Operational State Distribution



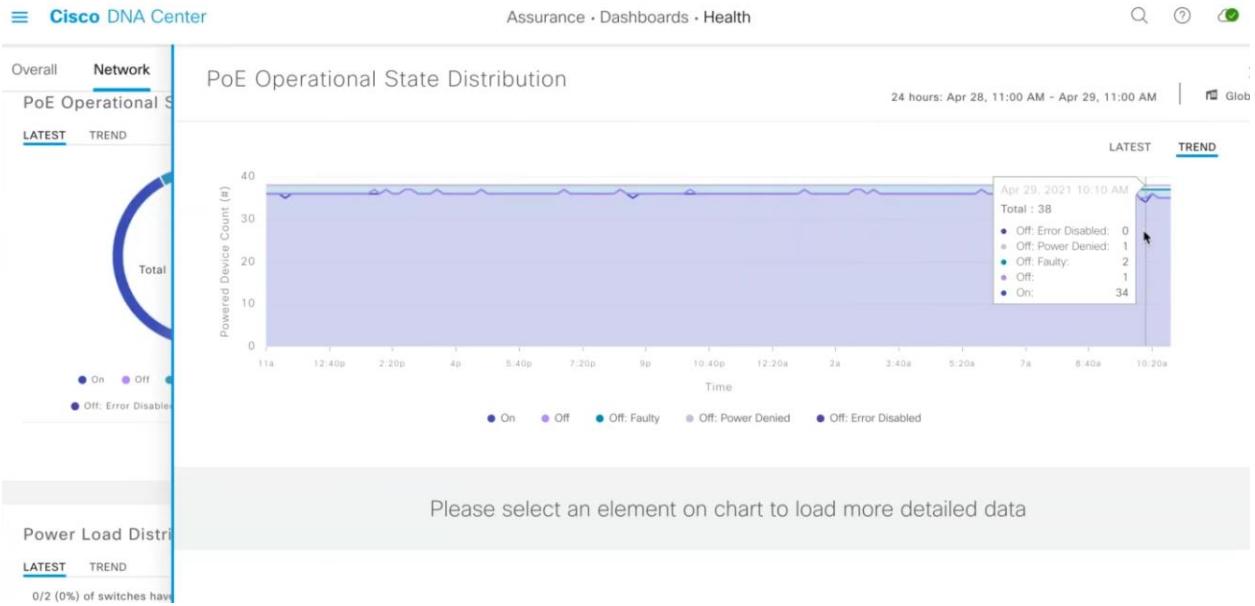
We were able to see total powered devices, along with trends and other details of connected devices. Interacting with the figure further displayed detailed device information.

The search table displays the following columns:

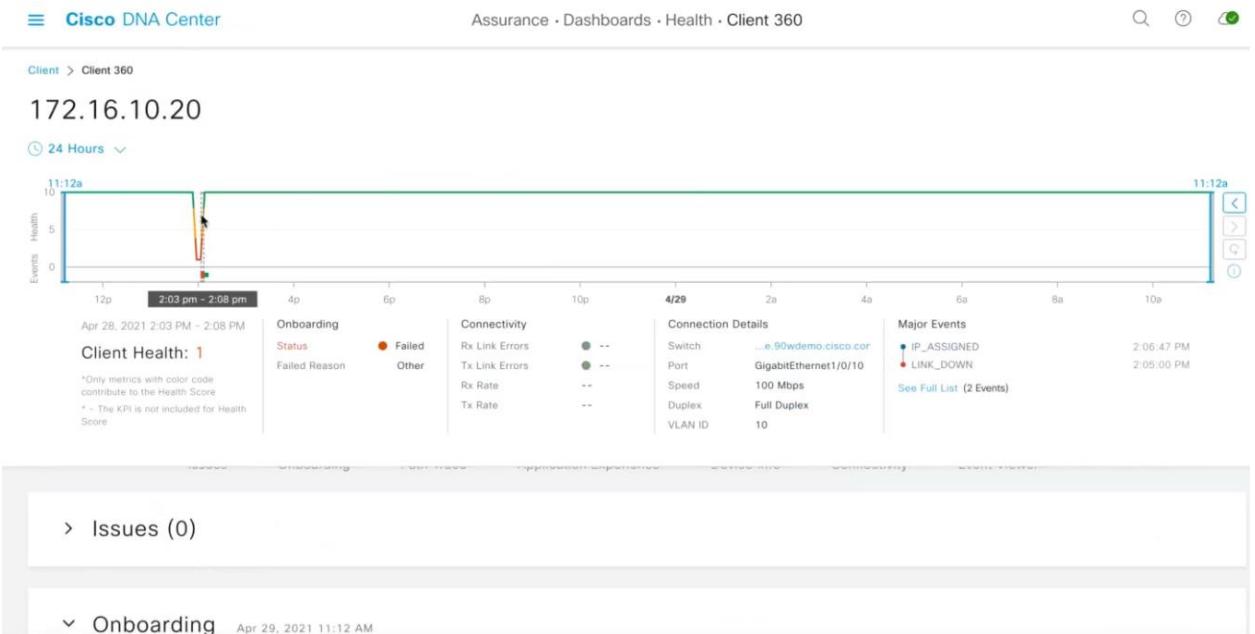
Identifier	Powered Device Model	Powered Device Type	Connected Switch	Switch Interface	IEEE Compliant	Location	Allocated Power	Consumed Power
00-k.90wdemo.cisco.com	IEEE PD	Switches and Hubs	C9300-Stack.90wdemo.cisco.com	GigabitEthernet4/0/4	Yes	Global/SJC03	90.0W	0.7W
	IEEE PD	IEEE PD	C93-Standalone.99wdemo.cisco.com	GigabitEthernet1/0/4	Yes	Global/SJC03	90.0W	0.8W
	IEEE PD	IEEE PD	C9300-Stack.90wdemo.cisco.com	GigabitEthernet1/0/9	Yes	Global/SJC03	90.0W	0.9W
	IEEE PD	IEEE PD	C9324U-2.90wdemo.cisco.com	GigabitEthernet1/0/5	Yes	Global/SJC03	59.0W	1.5W
	IEEE PD	IEEE PD	C9324U-2.90wdemo.cisco.com	GigabitEthernet2/0/14	Yes	Global/SJC03	59.0W	1.5W
	IEEE PD	IEEE PD	C9324U-2.90wdemo.cisco.com	GigabitEthernet1/0/2	Yes	Global/SJC03	59.0W	1.5W
	IEEE PD	IEEE PD	C9324U-2.90wdemo.cisco.com	GigabitEthernet1/0/1	Yes	Global/SJC03	59.0W	1.5W

More details are provided about the powered devices, including the device model, switch interface, IEEE compliance, allocated power, and location after interacting with the circle figure. Users can filter the device for a quick search.

Clicking on the device status showed all the endpoints in that status. Here clicking on the "on" state pulled up all the endpoints that are up and operational. This table also showed the Allocated Power (negotiated power) and Consumed Power (real time power usage) at the port.

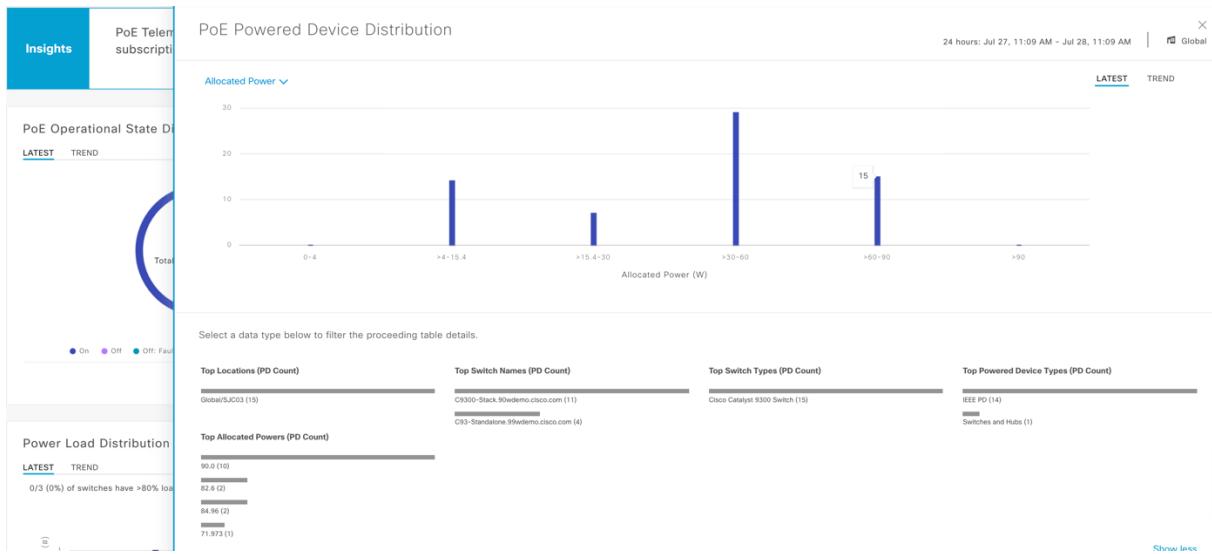


By clicking trends, users can view the snapshot of the total endpoints at any particular point of time. It also shows the status of devices over time and can help with quick glances of any device failures. As shown, we can view an instance during the timeline where a device was being denied power.

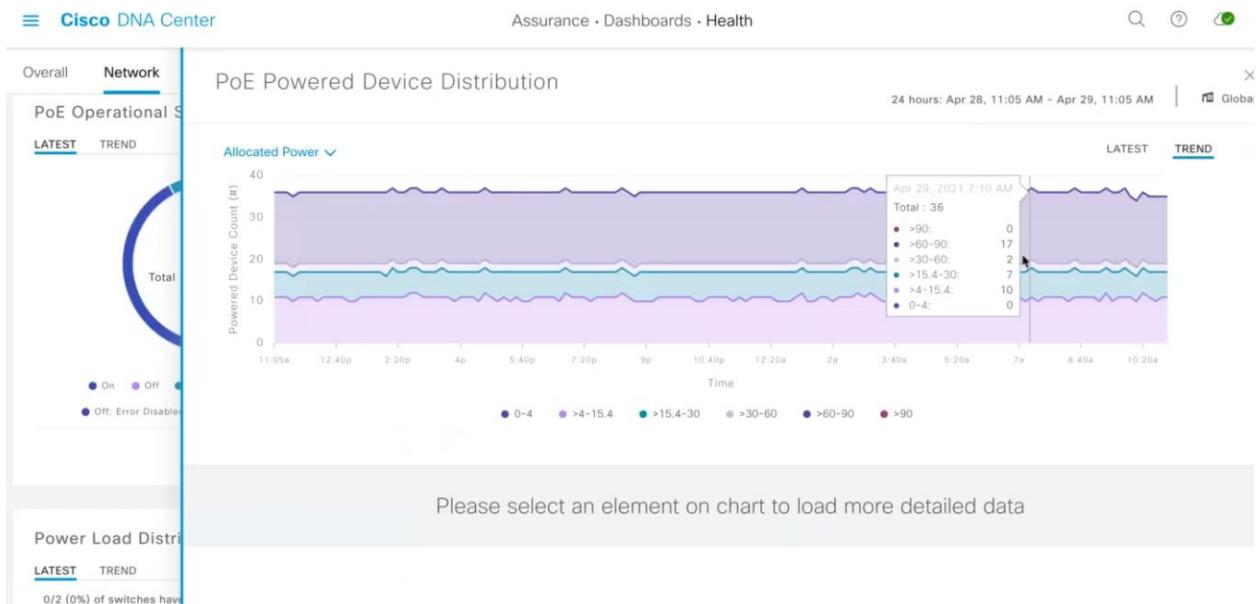


Clicking on individual devices gives a 'Client 360' timeline of events, path tracing, and logs. We can view a timeline of the device to view failed states and reasons behind it.

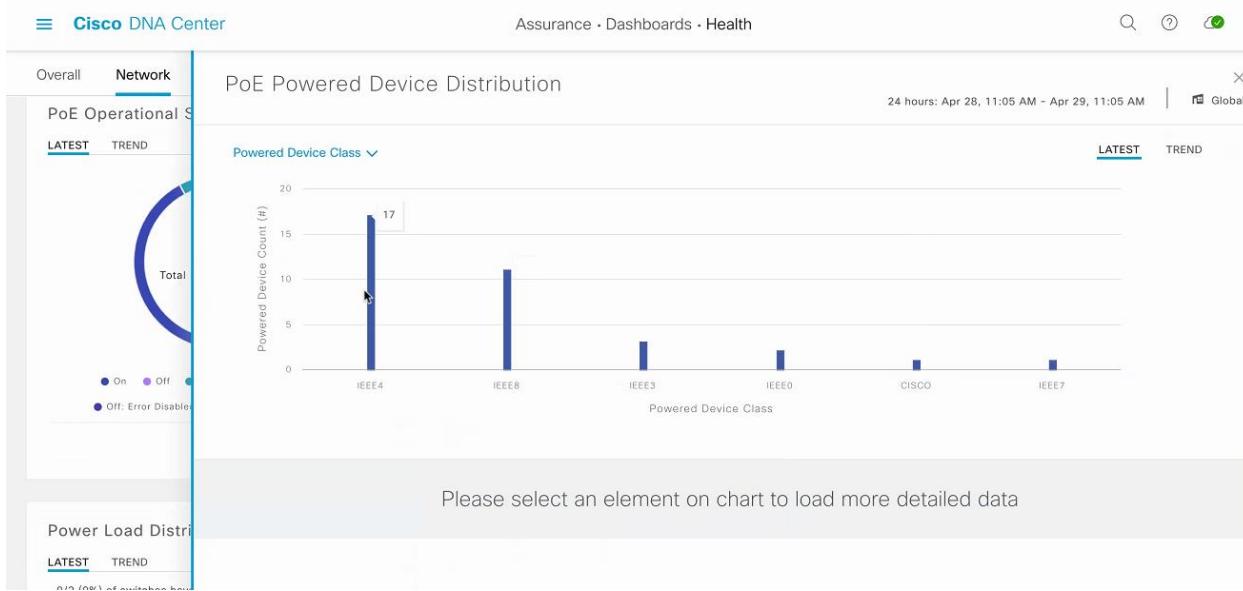
## 6.3 PoE Powered Device Distribution



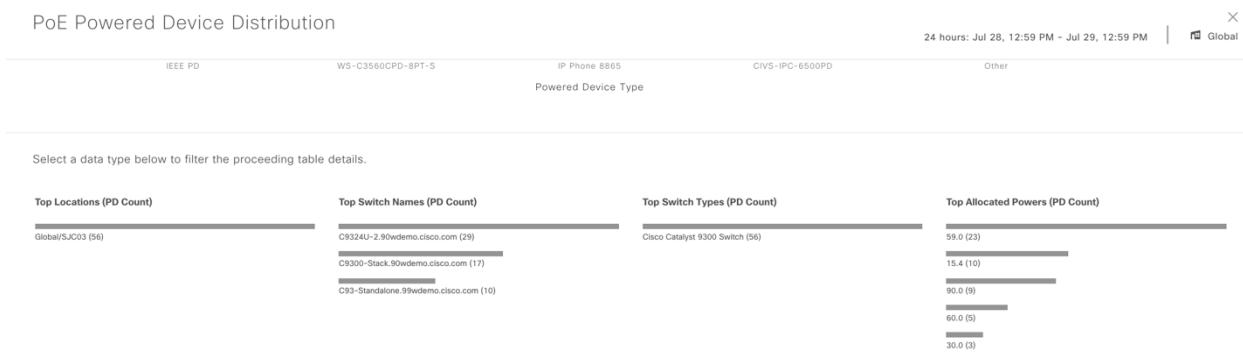
*Cisco DNA Center provides a view of PoE endpoints in terms of PoE that an endpoint negotiated during power-on. As shown, there are 15 devices that have power allocated between 60 to 90W. It showed the total count of all the endpoints based on the power allocated to them.*



*We were able to easily view trends and timelines on devices and instantly get a snapshot on the number of devices connected to the network and what class they negotiated.*



*In the PoE Powered Device Distribution, users can view a categorization of devices separated by classes defined in 802.3bt spec. Clicking on a category gives further detail of the devices.*

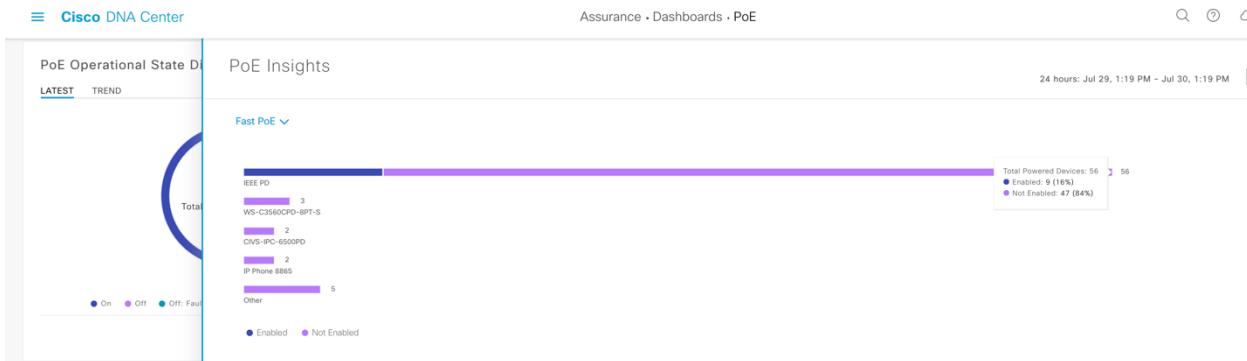


*Users can also see further details like top Location, top list of switches by number of endpoints, and power allocated data in ascending order.*

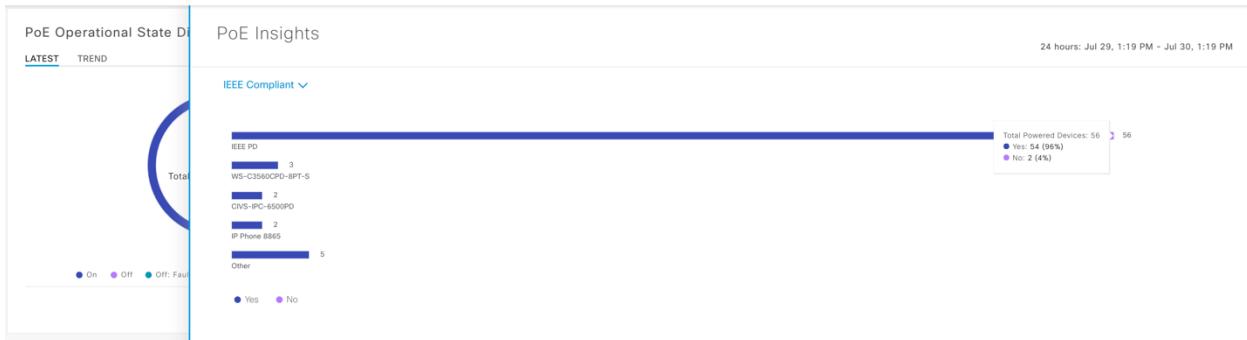
## 6.4 PoE Insights



PoE Insights offers a quick glance of which PoE devices are enabled with/without Perpetual PoE.

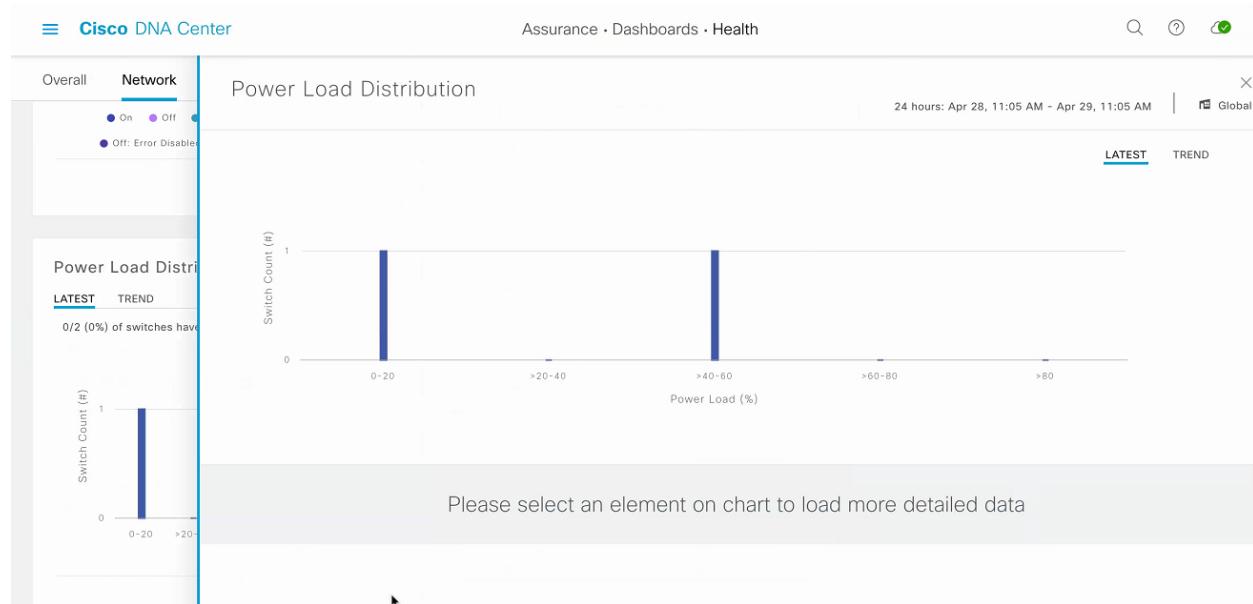


PoE Insights also provides an overview of PoE devices enabled with/without Fast PoE.

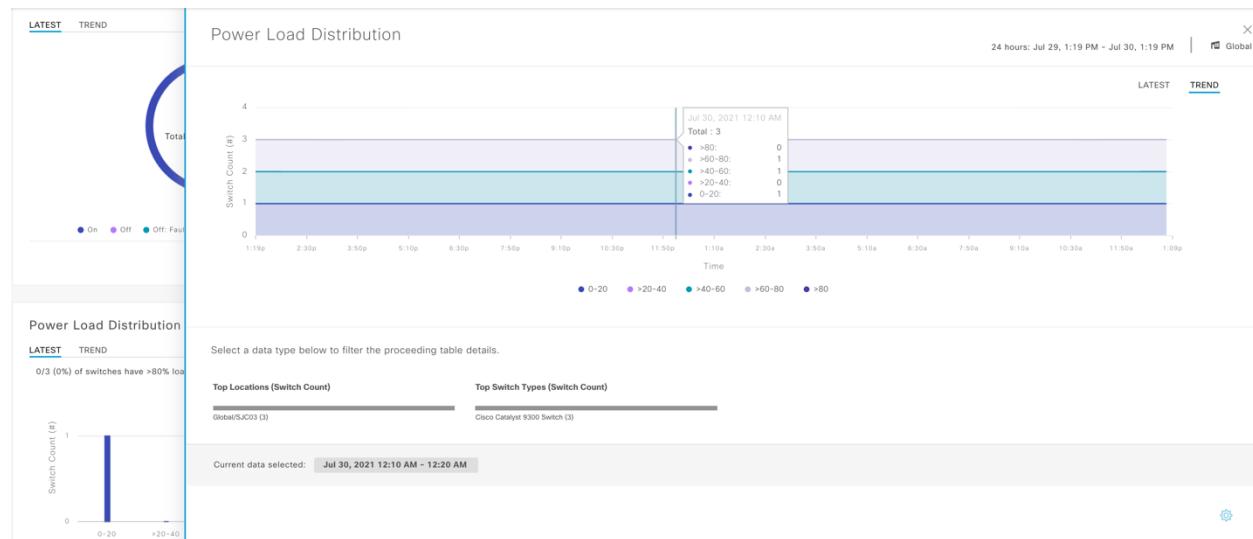


PoE devices can also be organized based on their IEEE Compliance status.

## 6.5 Power Load Distribution



*Users can view power load distribution across all switches within the network—useful for planning watt budget or the addition of PoE devices.*



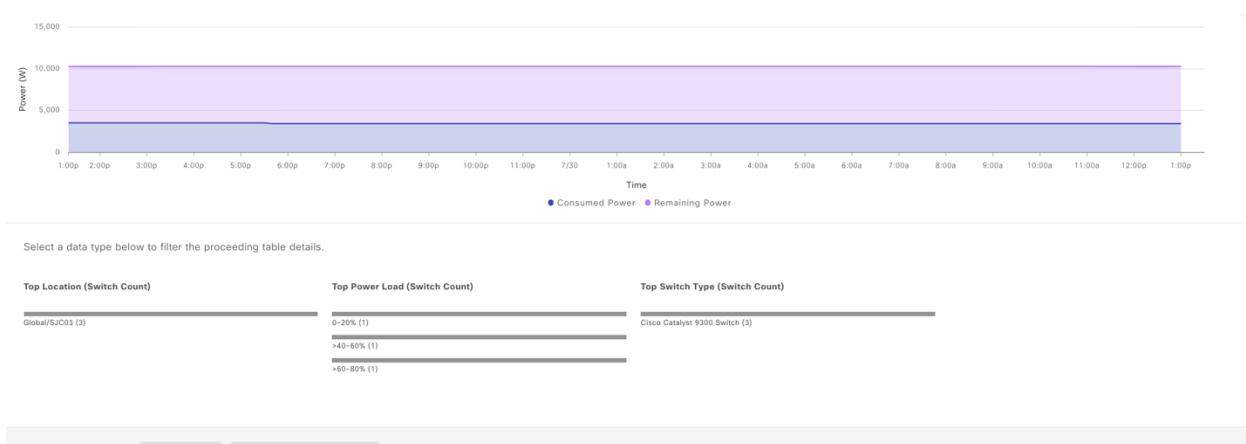
*The trend tab shows the history of the load distribution across the switches. Above, we see one 9300 switch taking over 20 percent load, another 9300 between 40-60 percent, and another 9300 between 60-80 percent load.*

## 6.6 PoE Power Usage

PoE Usage dashboard showed the Total Power Budget across all the switches in the network.



*The PoE power usage provided information about the Total PoE that has been consumed by all the switches and the available PoE.*



*The Trends options provided real-time Power Usage (available and consumed) snapshot at a particular point of time along with Power Budget of each switch.*

## 6.7 PoE Port Verification on Switch

The screenshot shows the Cisco DNA Center interface under the 'DETAILS' tab. The 'Interfaces' section is selected, and 'Ethernet Ports' is the sub-section. The main area displays three port status matrices:

- GigabitEthernet1/0/1 (0c:3f:0e:10:15:01)**: Shows ports G1/0/1 through G1/0/12. G1/0/1, G1/0/2, G1/0/3, and G1/0/12 are green (PoE enabled), while others are grey.
- GigabitEthernet2/0/1 (08:4f:a9:23:c6:01)**: Shows ports G2/0/1 through G2/0/24. G2/0/1, G2/0/2, G2/0/3, and G2/0/12 are green, while others are grey.
- GigabitEthernet3/0/1 (6c:31:0e:f6:11:81)**: Shows ports G3/0/1 through G3/0/16. G3/0/1, G3/0/2, G3/0/3, and G3/0/12 are green, while others are grey.

Below the matrices are two tables:

Port Name	Operational Status	Admin Status	Type	VLAN	MAC Address	PoE	Speed (Mbps)
GigabitEthernet0/0	●	●	Physical	-	6c:31:0e:f6:13:00	Disabled	1000

Under Interfaces → Ethernet Ports, users can visually capture how many PoE enabled devices are on the switch, navigating on the switch itself under "Provision". As shown, we observed the Ethernet ports of the switch, PoE ports, and which ports are providing PoE to the endpoints.

## 6.8 Troubleshooting PoE Catalyst 9000 Switches

The screenshot shows the Cisco DNA Center interface under the 'Network > Device 360' tab. The main area includes a timeline chart for 'Events Health' from April 28 to April 29, 2021, and a 'DEVICE DETAILS' section for a C9300-24H switch.

**DEVICE DETAILS:**

- Model: C9300-24H Management IP: 192.168.100.2 Location: Global / SJC03 Software: 17.4.1 Role: ACCESS HA Status: Non-redundant Uptime: 21 hours, 11 minutes
- Reachability Status: Reachable

**Issues:**

Category	Description	Timestamp
P3 Device	PoE powered device connected on C93-Standalone-90wdemo.cisco.com/G1/0/13 got power denied Instance Count: 3	Apr 29, 2021 11:07 AM
P3 Connected	High input/output error on interface 'GigabitEthernet1/0/12' Instance Count: 1	Apr 28, 2021 2:08 PM

Clicking on a network issue will bring up a log that details the problem.

The screenshot shows the Cisco DNA Center Assurance dashboard for a Device 360. A critical issue is displayed: "P3 PoE powered device connected on C93-Standalone.90wdemo.cisco.com Gi1/0/13 got power denied". The status is "Open". Below the issue details, there's a "DEVICE DETAILS" section for a C93-Standalone.90wdemo.cisco.com device with a model of C9300-24H. The "Issues" tab is selected, showing 2 issues: "P3 PoE powered instance count" and "P3 Connected High input/0 instance count". On the right, under "Suggested Actions", two steps are listed: 1. Check operational details of the affected interface Gi1/0/13. Compare actual consumption and negotiated values (with a "Run" button) and 2. Check inline power status (with a "Run" button). A tooltip for step 1 indicates "Detailed inline power status sh power inline Gi1/0/13 detail".

*Clicking on the specified issue will show the user any suggested actions that can be taken to resolve the issue and the steps to take to complete the actions.*

### Cisco Assurance Advantages:

- Cisco DNA Center dashboard provides a holistic view for planning, monitoring, and troubleshooting PoE devices and understanding PoE usage within the network.
- Cisco DNA Center allows users to view PoE Operational State Distribution with powered device details, trends, event timelines, PoE categorization, and classifications.
- The PoE Insights window offers quick glances at devices enabling PPoE, Fast PoE, IEEE compliance, and UPOE+.
- Users can view power load distribution for power budgeting and device additions.
- PoE devices are viewable by port on the switch via a color-coded visual map.
- Cisco DNA Center gives a detailed look at device issues and offers remediation suggestions.

# 7.0 Endpoint Analytics and Security

## 7.1 Endpoint Analytics

Cisco AI (Artificial Intelligence) Endpoint Analytics is a next generation endpoint visibility feature, equipped with AI-driven analytics and deep packet inspection. Endpoint Analytics uses deep packet inspection capabilities, available on the Catalyst 9300/9400 switches, to optimally profile endpoints using Multi-factor Classification – a distinctive approach to network segmentation through increased visibility. Users can also create custom profiles based on the attributes that Endpoint Analytics learns about a specific endpoint.

When classifying endpoints, Multi-factor Classification uses four independent labels: Device Type, Hardware Model, Hardware Manufacturer, and Operating System. When all four labels of an endpoint have been determined, the endpoint is classified and categorized as fully profiled.

This process is done using NBAR (Network Based Application Recognition) capabilities of the Catalyst 9300/9400 switches. Switches push this information to the Cisco DNA Center, along with other features such as LLDP. The Cisco DNA Center then correlates this information and provides suggested labels for the device type. Once it goes through the Cisco DNA Center, it will try and profile the device.

The screenshot shows the Cisco DNA Center interface with the title "Cisco DNA Center" and the page title "Policy • AI Endpoint Analytics". The dashboard includes a header with search, refresh, and notification icons. Below the header, a note states: "AI Endpoint Analytics works for endpoints coming to Cisco DNA Center from ISE running one of (2.4.0.357 Patch 11+ or 2.6.0.156 Patch 4+ or 2.7.0.356 Patch 1+ or 3.0 onwards) OR Cisco Catalyst 9000 series access devices, Cisco Traffic Telemetry Appliance running IOS-XE 17.3.1 or later." The main content area has tabs for "Overview", "Endpoint Inventory", "Profiling Rules", and "Hierarchy", with "Overview" selected. On the left, a bar chart titled "Total Endpoints" shows 152 total devices, with categories: Unknown (47, 31%), Missing Profiles (58, 38%), and Fully Profiled (47, 31%). A link "View Missing Profile Labels" is provided. In the center, there's a "Trust Score" section with a preview link, a "Manage sources" button, and a "0 Endpoints" count. A "Low" trust score is shown with a red dot. On the right, an "AI Proposals" section shows 0 proposals, with a note: "Using crowdsourcing data, we were able to put together some rule proposals that could improve your profile outcomes:". It lists three items: 1. New rule(s) for profiling endpoints that may be similar (Review), 2. Modification proposal(s) for previously accepted rule(s) (Review), and 3. Profiling Rule(s) is/are no longer needed (Review).

The Cisco DNA Center dashboard presents an overall network view. As shown on the left, we observed 152 total devices, and 47 devices fully profiled. AI Proposals use crowdsourcing data and provide suggestions based on similar data seen on other networks. The Trust Score gives the score on how credible each device is.

User Details			
User Name	04-91-62-88-A8-03	User Group ID	-
Endpoint details			
Endpoint Type	PoE Network Node - Molex	Authentication Status	STARTED
Hardware Manufacturer	Microchip Technology Inc.	Authorization Profile	MUD_MOLEX
Hardware Model	-	Scalable Group Tag	-
OS Type	-	Last Seen	Jul 22, 2021 04:41 AM
Connected Location	SJC03		
ATTRIBUTES			
> RADIUS			<a href="#">View Attribute Glossary</a>
> SNMP			
> LLDP			
> IOTAsset			
> CLS			
> NMAP			
> IP			
> ACIDEX			
> DHCP			
> MAC			
> MDM			

*Navigating to Endpoint Inventory provides more details on endpoints. By clicking on specific endpoints, customers can view all the attributes specific to the endpoint that Cisco DNA Center has learnt.*

Endpoint details		<a href="#">View Client 360</a>			
Endpoint Type	PoE Network Node - Molex	<input checked="" type="radio"/>	Authentication Status	STARTED	
Hardware Manufacturer	Microchip Technology Inc.	<input checked="" type="radio"/>	Authorization Profile	MUD_MOLEX	
Hardware Model	-		Scalable Group Tag	-	
OS Type	-		Last Seen	Jul 22, 2021 04:41 AM	
Connected Location	SJC03				
<b>ATTRIBUTES</b>		<a href="#">View Attribute Glossary</a>			
> RADIUS					
> SNMP					
▼ LLDP					
lldpCacheCapabilities		<input type="radio"/>			
lldpCapabilitiesMapSupported		<input type="radio"/>			
lldpChassisId	04:04:91:62:88:a8:03				
lldpManAddress	05:01:00:00-00:00:00:00:00:00:00:00:00:00				
lldpMedAssertId	00330219				
lldpMedCapabilities	49				
lldpMedDeviceType	Endpoint Class I				
lldpMedFwRevision	2.6.3.16.35				
lldpMedHwRevision	E				
lldpMedManufacture	MOLEX				
lldpMedModel	Gateway 2.0				
lldpMedSrNumber	e4c5-17-				
lldpMedSwRevision	1.1.11				
lldpPortDescription	VENDOR: MOLEX; MODEL: Gateway 2.0; LABEL:				
lldpPortId	05:70:6f:72:74:30				
lldpSystemDescription	sysDescr = STRING: <>Port_Desc: VENDOR: MOLEX; MODEL: Gateway 2.0; LABEL: 1; HW_REV: E;				
lldpSystemName	CoreSync				
lldpTimeToLive	00:78				

*Clicking on any specific attribute shows more information about the details.*

Clicking on each attribute further details that specific to the Endpoint that Cisco DNA Center has learnt:

	IP Address	Last Seen	Hostname	Endpoint Type	OS Type	Hardware Model	Hardware Manufacturer	Registered
<input type="checkbox"/>	172.26.202.169	May 26, 2021 06:19 AM	-	-	-	-	-	No
<input type="checkbox"/>	172.26.202.160	May 26, 2021 06:19 AM	-	-	-	-	-	No
<input type="checkbox"/>	52:54:DD:56:D9:AE	Jun 06, 2021 01:23 PM	-	-	-	-	-	No
<input checked="" type="checkbox"/>	52:54:DD:5F:08:D9	Jun 06, 2021 12:03 AM	-	-	-	-	-	No
<input type="checkbox"/>	52:54:DD:6E:BF:D9	May 26, 2021 06:19 AM	-	-	-	-	-	No
<input type="checkbox"/>	52:54:DD:84:D3:04	May 26, 2021 06:19 AM	-	-	-	-	-	No
<input type="checkbox"/>	52:54:DD:97:21:B8	May 26, 2021 06:19 AM	-	-	-	-	-	No

*Profiling Rules are auto-generated based on the attributes that the Cisco DNA Center learns specific to that endpoint. If the Endpoint Analytics application does not have enough information to profile the endpoint, the user has the flexibility of creating a custom profiling policy based on the attributes that the Endpoint Analytics application has already seen. Any subsequent endpoint that matches this custom rule will be profiled as such.*

## Add Logic to Conditions

Drag and drop AND/OR logic to connect the conditions and form a rule.

Rule Name	test-profile
Profile Label	Hardware Model
Hardware Model	HW-model

*To create a manual rule, customers can click on the device by navigating back to Endpoint Inventory → Actions → Profile with Custom Rule. From here, "AND" or "OR" logic is applied to attribute conditions and add other configurations.*

Cisco AI algorithms group unknown, but similar, endpoints in the network and may also suggest modifications or removals of older AI-based rules. These AI proposed rules are found in the AI Proposals section of the AI Endpoint Analytics page.

The screenshot shows the Cisco DNA Center AI Endpoint Analytics interface. On the left, a bar chart displays 'Total Endpoints' at 152, broken down into Unknown (47, 31%), Missing Profiles (58, 38%), and Fully Profiled (47, 31%). In the center, a 'Trust Score' section shows 0 Endpoints across Low, Medium, and High categories. On the right, the 'AI Proposals' section indicates 10 new rule(s) for profiling endpoints, 0 modification proposals for accepted rules, and 0 profiling rules no longer needed. A note states: 'Using crowdsourcing data, we were able to put together some rule proposals that could improve your profile outcomes.'

*10 new rules were suggested by the AI proposals.*

### Choose Suggested Endpoint Group

First, choose a group of endpoints you would like to profile.

This screenshot shows the 'Choose Suggested Endpoint Group' interface. On the left, a table lists 'Suggested Endpoint Groups' with columns for 'Endpoints' (6, 4, 7, 7, 5, 6, 3, 3, 3) and 'Number of common attributes'. On the right, a summary table shows 'Endpoints' (8) and 'Common attributes': OUI (SAMSUNG ELECTRO-MECHANICS(THAILAND)) and DHCP Class Identifier (android-dhcp-8.0.0 (63%)). Buttons for 'Reject Grouping' and 'Next' are at the bottom.

*Eight endpoints were suggested to be grouped with above attributes. User can either proceed next to create a profile or may reject as needed. This functionality saves customers time by auto-suggesting the profiles from the information that has been learnt via crowdsourcing.*

## 7.2 Secure Endpoints with ISE

Cisco demonstrated how the Endpoint Analytics profiling data can be used to secure the endpoints by segmenting the network.

Cisco ISE has been integrated with the Cisco DNA Center so that endpoint profiling information can be relayed to the ISE to create policies.

Cisco ISE allows customers to provide highly secure network access to users and devices. It helps customers gain visibility into what is happening in the network, such as who is connected, and which applications are installed and running.

To test this, we have used a lighting endpoint powered via UPOE+ on the switch.

Profiler Policy List > **IGOR-EA-DEMO**

**Profiler Policy**

* Name	IGOR-EA-DEMO	Description									
Policy Enabled <input checked="" type="checkbox"/>											
* Minimum Certainty Factor	200	(Valid Range 1 to 65535 )									
* Exception Action	NONE										
* Network Scan (NMAP) Action	NONE										
Create an Identity Group for the policy	<input checked="" type="radio"/> Yes, create matching Identity Group <input type="radio"/> No, use existing Identity Group hierarchy										
* Parent Policy	NONE										
* Associated CoA Type	Global Settings										
System Type	Administrator Created										
Rules	<table border="1"><thead><tr><th>Name</th><th>Expression</th><th>Operator</th></tr></thead><tbody><tr><td>IOTASSET:assetHwRevision</td><td>CONTAINS</td><td>AND</td></tr><tr><td>IOTASSET:assetVendor</td><td>CONTAINS</td><td></td></tr></tbody></table>		Name	Expression	Operator	IOTASSET:assetHwRevision	CONTAINS	AND	IOTASSET:assetVendor	CONTAINS	
Name	Expression	Operator									
IOTASSET:assetHwRevision	CONTAINS	AND									
IOTASSET:assetVendor	CONTAINS										
If Condition	IOTASSET_assetHwRevision_CONTAINS_... <input type="button" value="+"/>										
<input type="button" value="Save"/> <input type="button" value="Reset"/>											

**Conditions Details**

Name	Expression	Operator
IOTASSET:assetHwRevision	CONTAINS Igor-Device	AND
IOTASSET:assetVendor	CONTAINS Igor, Inc.	

*A policy was predefined on the Cisco ISE using the attributes that were learnt from Endpoint Analytics.*

The screenshot shows the Cisco ISE Policy Elements interface. At the top, there are tabs for Policy Sets, Profiling, Posture, Client Provisioning, and Policy Elements. Below the tabs, a search bar is present. The main area displays the 'Default' policy set, which includes sections for Authentication Policy (3), Authorization Policy - Local Exceptions, Authorization Policy - Global Exceptions, and a expanded section for Authorization Policy (17). The expanded section shows two rules: 'Molex\_EP' and 'Igor\_EP\_EA'. Each rule has conditions listed next to it. The 'Results' and 'Profiles' tabs are visible on the right side of the table.

An authorization profile was configured to dynamically push an access list onto the port of the connected lighting endpoint.

Initially the port was in shut down state:

```
C9300-Stack#sh int g4/0/12
GigabitEthernet4/0/12 is administratively down, line protocol is down (disabled)
  Hardware is Gigabit Ethernet, address is 6c31.0ef6.2e0c (bia 6c31.0ef6.2e0c)
  Description: IGOR 2 Nodes Daisy Chain
  MTU 9100 bytes, BW 100000 Kbit/sec, DLY 100 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, last clearing of queueing discipline at 00:00:00
  Queueing discipline: PQ (Priority Queue)
```

MAB (MAC Authentication Bypass) was used here for authentication. Upon successful authentication, we noticed the endpoint on the ISE Active endpoints dashboard:

The screenshot shows the Cisco ISE Active Endpoints dashboard. The top navigation bar includes buttons for Create, Edit, Delete, ANC, Change Authorization, Clear Threats & Vulnerabilities, Export, Import, MDM Actions, Release Rejected, and Revoke Certificate. The main table lists four active endpoints:

	MAC Address	Status	IP Address	Endpoint Type	Endpoint Profile	Authentication Policy	Authorization Policy
<input type="checkbox"/>	04:91:62:88:A8:03		172.16.30.24	Misc	IOT-MUD-cisco_mudservice_mud_v1_Molex-LEDlight-transcend	MAB	Molex_EP
<input type="checkbox"/>	50:0B:91:00:91:12		172.16.10.25	Misc	IGOR-EA-DEMO	MAB	Igor_EP_EA
<input type="checkbox"/>	50:0B:91:00:94:78		172.16.10.27	Misc	IGOR-EA-DEMO	MAB	Igor_EP_EA
<input type="checkbox"/>	50:0B:91:00:94:7C		172.16.10.24	Misc	IGOR-EA-DEMO	MAB	Igor_EP_EA

The ISE displays four active endpoints – the highlighted one is the lighting endpoint under test, and we see it successfully associated to the endpoint profile.

The associated profile was successfully pushed to the switchport where the endpoint was connected:

```
C9300-Stack#sh access-session interface g4/0/12 details
  Interface: GigabitEthernet4/0/12
    IIF-ID: 0x19BDFE73
  MAC Address: 500b.9100.947b
  IPv6 Address: fe80::520b:91ff:fe00:947b
  IPv4 Address: Unknown
  User-Name: 50-0B-91-00-94-7B
  Status: Authorized
  Domain: DATA
  Oper host mode: multi-auth
  Oper control dir: both
  Session timeout: N/A
  Common Session ID: 0364A8C00001FC08EFBCE89B
  Acct Session ID: 0x00000010
  Handle: 0x400034f
  Current Policy: mab

Server Policies:
  ACS ACL: xACSAACLx-IP-IGOR_ACL-60bdba40

Method status list:
  Method      State
    mab        Authc Success
```

We verified the ACL and a dynamic ACL was successfully pushed to the port, which limited access to one specific subnet and the controller:

```
C9300-Stack#sh ip access-lists xACSAACLx-IP-IGOR_ACL-60bdba40
Extended IP access list xACSAACLx-IP-IGOR_ACL-60bdba40
  1 permit ip any 172.16.10.0 0.0.0.255
  2 permit ip any host 172.16.95.101
C9300-Stack#
```

*Customers can customize their profiling policies based on the endpoint attributes. Cisco ISE will push the Authorization policy.*

# 8.0 Indoor IoT Services for Wired Endpoints with DNA Spaces

## 8.1 DNA Spaces

Cisco DNA Spaces is a SaaS-based cloud platform which provides location-based analytics to customers. Cisco has recently integrated Cisco DNA Spaces with the Catalyst 9300/9400 switches. The IoT Gateway is installed as part of this solution on the Catalyst 9300/9400 UPOE/UPOE+ switches. This IoT Gateway helps with relaying the sensor data and telemetry to the DNA Spaces Dashboard.

IoT Marketplace Dashboard on the Cisco DNA Spaces helps customer to find the supported wired or wireless endpoints that meet their use case.

The screenshot shows the Cisco DNA Spaces IoT Device Marketplace. On the left, there's a sidebar with filters for 'Industry' (set to 'Smart Building & Real Estate') and 'Use Case' (set to 'Space Occupancy'). Below these are sections for 'FILTER BY' Type (radio buttons for 'Wireless' and 'Wired', with 'Wired' selected), Price Range (radio buttons for price ranges like '< US \$100', 'US \$100 - \$150', etc.), Technology (checkboxes for Bluetooth, WiFi, UWB, Infrared, PoE, BLE, RFID, Zigbee, Camera), and Certifications (checkboxes for CE, ROHS, AIA:TEI, FCC, UL, ATTEV). The main content area displays four product cards:

- MHTI-OC-100** (Occupancy Sensor): MHTI-OC-100 by mhtlighting. Technology: Occupancy Sensor. Features: Occupancy Sensor. MSRP: US \$99.00. Discounts starting at 7%.
- MHTI-WS-100** (Scene Controller): MHTI-WS-100 by mhtlighting. Technology: Scene Controller. Features: Scene Controller. MSRP: US \$79.00. Discounts starting at 7%.
- molex CoreSync Advanced Light...** (Ambient Light, PIR): molex CoreSync Advanced Light... by molex. Technology: PoE. Features: Ambient Light, PIR. MSRP: US \$103.50. Discounts starting at 5%.
- MHTI-Node** (Node): MHTI-Node by mhtlighting. Technology: Node. Features: Node. MSRP: US \$185.00. Discounts starting at 7%.

Each product card has a 'View Details' button at the bottom.

Shown above is Cisco DNA Spaces IoT Device Marketplace. Customers have the flexibility of choosing an industry and use case to populate the supported IoT endpoints that solve that specific need.

Cisco DNA Spaces has a wide variety of partner applications that a customer can integrate the solution with, to deliver the outcomes based on the use case. The Application store is a third-party application integration system that the customer can use. Once the application is activated, the information will go to the third-party vendor.

**FILTER BY**

Industry	
<input type="checkbox"/> Real estate	<input type="checkbox"/> Venues
<input type="checkbox"/> Workspace	<input type="checkbox"/> Hospitality
<input type="checkbox"/> Retail	<input type="checkbox"/> Manufacturing
<input type="checkbox"/> Others	<input type="checkbox"/> Healthcare
<input type="checkbox"/> Education	

Category	
<input type="checkbox"/> Health and Safety	<input type="checkbox"/> Productivity
<input type="checkbox"/> Marketing	<input type="checkbox"/> Asset Management
<input type="checkbox"/> Mapping	<input type="checkbox"/> Analytics
<input type="checkbox"/> Experience	<input type="checkbox"/> Navigation
<input type="checkbox"/> Others	

Technology	
<input type="checkbox"/> Wireless Presence	<input type="checkbox"/> Telepresence
<input type="checkbox"/> BLE	<input type="checkbox"/> Wireless Location
<input type="checkbox"/> Zigbee	<input type="checkbox"/> Video

**Apps**

**IBM TRIRIGA**

**IBM TRIRIGA Building Insights**

ON-PREM IBM Labs

IBM TRIRIGA and Cisco's scalable workplace utilization and occupancy monitoring across your real estate...

**AeroScout® Links**

CLOUD STANLEYHealthcare

STANLEY Healthcare's cloud temperature monitoring solution.

**STANLEY Healthcare RTLS**

ON-PREM STANLEYHealthcare

Wi-Fi based solution for monitoring the location & status of people, assets and environments across ...

**Google's Orion Wifi**

CLOUD Google

Orion Wifi and Cisco's DNA Spaces: Seamless guest onboarding and Carrier Wifi Offload

**STARLING**

**Guest Experience & Insights by IPERA**

CLOUD IPERASolutions

AI-driven applications enhancing guest experience, improving visitor footfall for venues

**Hospitality IoT Solution by IPERA**

CLOUD IPERASolutions

Increase Efficiency & Improve Guest Experience

**Wired IoT Services by IPERA**

**Wireless IoT Services by IPERA**

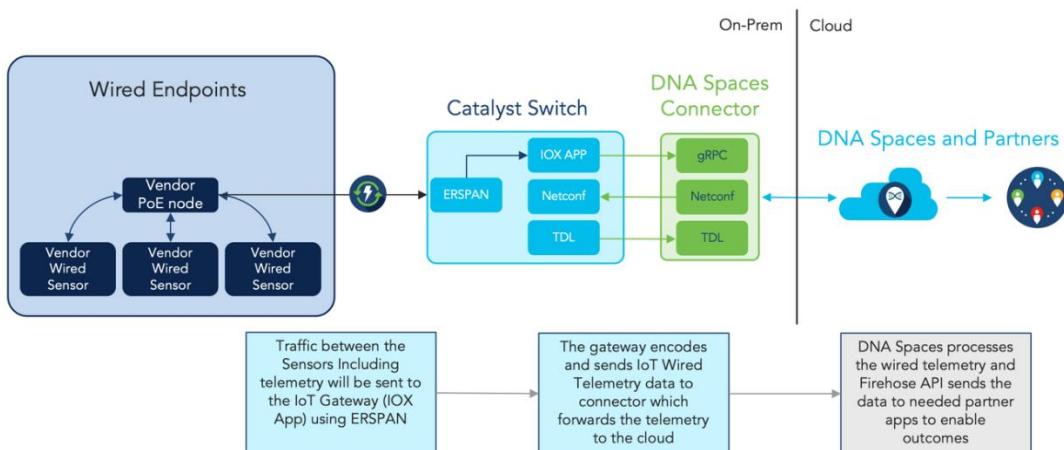
**Guest IoT Services by IPERA**

Shown above is DNA Spaces Partner App Eco System. Customers have the flexibility of viewing all partner applications based on Industry, Category and Technology. Supported partner applications will be displayed and customers can activate the partner application from the DNA Spaces Partner Application page.

## 8.2 Indoor IoT Services for Wired Devices – Architecture

Below is an end-to-end architecture of the Indoor IoT services for Wired devices as demonstrated by Cisco. The solution leverages the Application Hosting Framework available on the Catalyst 9300/9400 Series switches to install the IoT Gateway.

### End to End Architecture

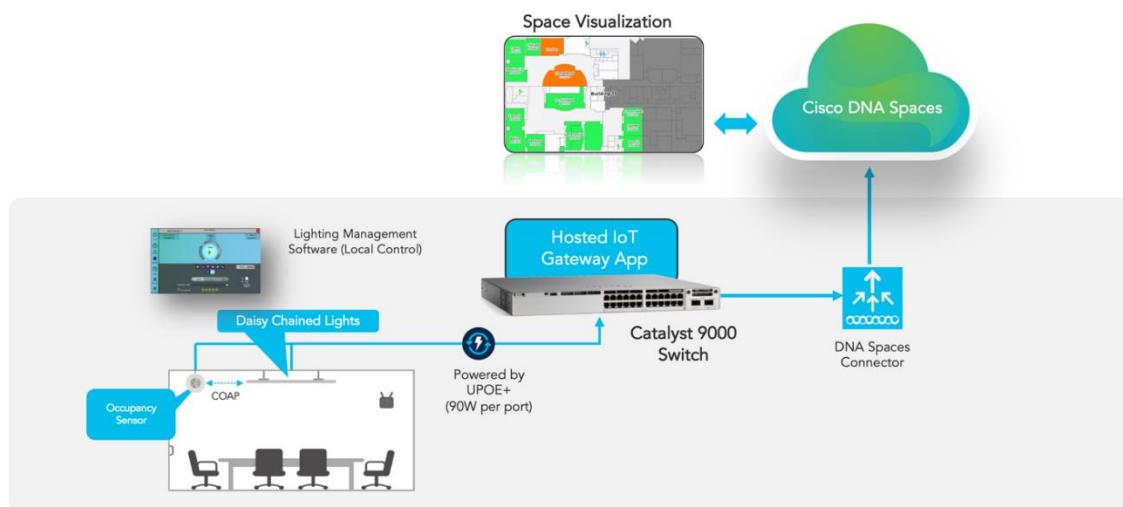


*Note: The solution is supported only on Catalyst 9300, 9300L and 9400 UPOE & UPOE+ capable switches with DNA-Advantage or DNA-Premier license.*

The traffic from the IoT endpoints is redirected to the IoT Gateway application that is hosted as a docker container on the Catalyst 9300/9400 switch. IoT Gateway sends this COAP traffic via gRPC to the DNA Spaces Connector that resides on-prem. In turn, the Spaces Connector sends this data to the DNA Spaces cloud where additional processing is done to unify and feed data into a Firehose API. Here the partners can request the data and work with customers to demonstrate various use cases.

## 8.3 Test Topology

Cisco demonstrated the end-to-end solution for room occupancy workflow. Daisy chained lights along with an Occupancy sensor were connected to a single 90W on the Catalyst 9000 switch. Below is the topology that was used to validate the end-to-end flow.



*Daisy chained lights with an Occupancy Sensor.*



*For the partner application, Mazemap was demonstrated where the occupancy of the conference room was dynamically changed based on the occupancy room.*

## 8.4 Test Results

The screenshot shows the Cisco DNA Spaces dashboard. On the left, there's a vertical navigation bar with steps: 1. Install Spaces Connector OVA, 2. Configure Spaces Connector, 3. Add Switch, and 4. Import Maps. Step 3 is currently active, showing '4 Switches added'. On the right, a modal window titled 'Add Switch' is open, prompting for a connector (Wired DNA Spaces Con...), switch name (C9300-Stack), switch IP (172.26.202.161), netconfig username (netadmin), and netconfig password. Buttons at the bottom of the modal are 'Save & Close' and 'Save & Add Next Switch'.

*First the switch is added to the DNA Spaces Dashboard.*

We observed how we can add the switch onto the DNA Spaces Dashboard, to enable the gateway, and relay the sensor information that is sitting on-premises on the Catalyst 9300/9400 to the cloud and view the status changes.

The screenshot shows the 'Manage IoT Services' interface. It displays a table of connectors: 'Wired DNA Spaces Connector' (Version: v2.0.33, IP Address: 172.26.202.165) and 'Sangfor Connector' (Version: v2.0.33, IP Address: 10.104.206.252). Below the table, a message says 'Manage Connector SUCCESS' and 'Enable IoT Services on Cisco DNA Spaces Connector'. A table lists switches: 'C9300-Standalone' (Connector IP: 172.26.202.165, Switch IP: 172.26.202.204, Status: NOT INITIATED) and 'C9300-Stack' (Connector IP: 172.26.202.165, Switch IP: 172.26.202.166, Status: SUCCESS). A 'Manage Switch' section allows setting up IoT services authentication and certificates. A 'Sample configuration' button is visible.

*The IoT service is enabled which gets the switch ready to receive information from the IoT sensor to the gateway and the gateway to the DNA Spaces dashboard.*

Stats

2/3  
Wired Gateways deployed

3  
All Switches

Wired Gateways (2) All Switches (3)

Filters Actions Bulk Request History As of: Jul 29, 2021 2:58 AM Refresh Export Add New Gateways

Mac Address	Name	Status	IP Address	IOx App Name	IOx App Version	IOx Last Heard	Last Seen	Mode	Product ID	Serial Number	SW Version	⋮
6c:31:0e:16:13:00	C9300-Stack	UP	172.26.202.166	cisco_dnas_wired_iox_app	1.0.24	Jul 29th, 2021 02:56:52 AM a minute ago	Jul 29th, 2021 02:57:52 AM a few seconds ago	-	C9300-24H	FOC2350L8EA	Cisco IOS Software [Am]	
6c:31:0e:16:13:80	C9300-Standalone	UP	172.26.202.204	cisco_dnas_wired_iox_app	1.0.24	Jul 29th, 2021 02:56:20 AM 2 minutes ago	Jul 29th, 2021 02:57:52 AM a few seconds ago	-	C9300-24H	FOC2350L4QA	Cisco IOS Software [Bw]	

Enabling the IoT Gateway application, by navigating to IoT Gateway, users can deploy the gateways by selecting from the added switches. The IoT gateway will now be installed on the selected switch.

IoT Gateway uses the Cisco Application Framework and has been installed seamlessly with a single click from the DNA spaces dashboard:

Home Devices Groups

Floor Beacons AP Beacons Wired Devices 1

All Campuses

All Wired Sensors 25

List View Map View Filters Actions As of: Jul 29, 2021 3:42 AM Refresh Export

Device ID	Node Mac Address	Label	Last Seen	Location	Group	Make	Type	Vendor	⋮
2205-17-682719295c56	68:27:19:29:5c:56	Occupancy Sensor	Jul 26th, 2021 02:27:01 PM 3 days ago	Global->SJC-19->Floor 2					
2005-17-04916288a003	04:91:62:88:a0:03	-	Jun 29th, 2021 09:37:36 PM a month ago	-	-	-	-	-	
2004-17-04916288a003	04:91:62:88:a0:03	-	Jun 29th, 2021 08:57:56 PM a month ago	-	-	-	-	-	
2104-17-04916288a003	04:91:62:88:a0:03	-	Jun 29th, 2021 08:57:56 PM a month ago	-	-	-	-	-	
0001-17-682719295c56	68:27:19:29:5c:56	-	Jul 26th, 2021 02:27:01 PM 3 days ago	-	-	-	-	-	

We could see 25 wired sensors auto discovered immediately after the IoT Gateway application installation. The highlighted sensor is the occupancy sensor and is part of the topology that we discussed earlier.

A user can further click on each sensor to get more details and the status of the sensor:

The screenshot shows the Cisco Smart Building interface. On the left, there's a navigation bar with 'Home', 'Devices' (which is selected), and 'Groups'. Below it, there are tabs for 'Floor Beacons', 'AP Beacons', and 'Wired Devices'. A dropdown menu 'All Campuses' is open, showing 'All Wired Sensors' with a count of '25'. The main area displays a table with columns: 'Device ID', 'Node Mac Address', and 'Label'. Three rows are listed:

Device ID	Node Mac Address	Label
2205-17-682719295c56	68:27:19:29:5c:56	Occupancy Sensor
2005-17-04916288a803	04:91:62:88:a8:03	-
2004-17-04916288a803	04:91:62:88:a8:03	-

To the right, a detailed view for 'Wired Device - 68:27:19:29:5c:56' is shown. It includes sections for 'Wired Device Information' (with fields like Label, Device ID, Last Seen, Group, Type, Node Mac Address, Location, Make, Vendor) and 'Sensor Information' (with a PIR State table showing Status OFF, updated at Jul 29th, 2021 03:03:33 AM). There's also an 'Edit' button.

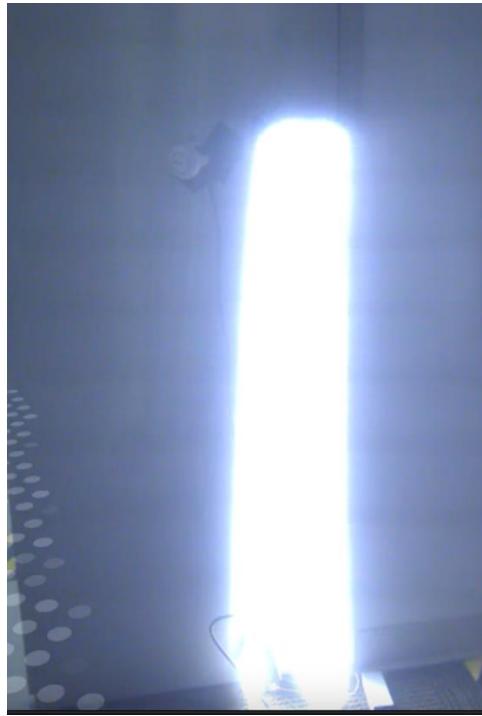
*Above, clicking on one sensor, we could see that this is an occupancy sensor, and the current status is off; which means that no presence has been detected (no occupancy in the room).*

This sensor can be easily mapped to a conference room on the floor plan by simply clicking the "Place Wired device" icon:

The screenshot shows the 'Map View' of a floor plan. The floor plan includes various rooms labeled: 'Ramen', 'Team Room 3', 'Team Room 1', 'Team Room 4', 'Team Room 6', 'Misoshiru', 'Open Office', 'Video Conference Room', and 'Conference Room'. A blue arrow points from the 'Occupancy Sensor' detail view on the left to the 'Conference Room' on the map. On the left side of the map, there's a sidebar with icons for zooming and a 'Place Wired Device' button.

*Above, we can see that the Occupancy sensor has been mapped to the conference room.*

Movement was simulated in the conference room via a robot that went past the Occupancy sensor. As soon as the sensor detected presence, lights were automatically turned on in the room:



*Lights status as soon as presence detected in the conference room.*

We noticed the status change of the sensor on the DNA spaces dashboard transition to "ON" state:

Wired Device - 68:27:19:29:5c:56

As of: Jul 29th, 2021 03:16:40 AM [Refresh](#)

▼ Wired Device Information

Label	Occupancy Sensor	Node Mac Address	68:27:19:29:5c:56
Device ID	2205-17-682719295c56	Location	Global->SJC-19->Floor 2
Last Seen	2021-07-26T21:27:01.638Z	Make	-
Group	-	Vendor	-
Type	-		

[Edit](#)

[Remove location](#)

▼ Sensor Information

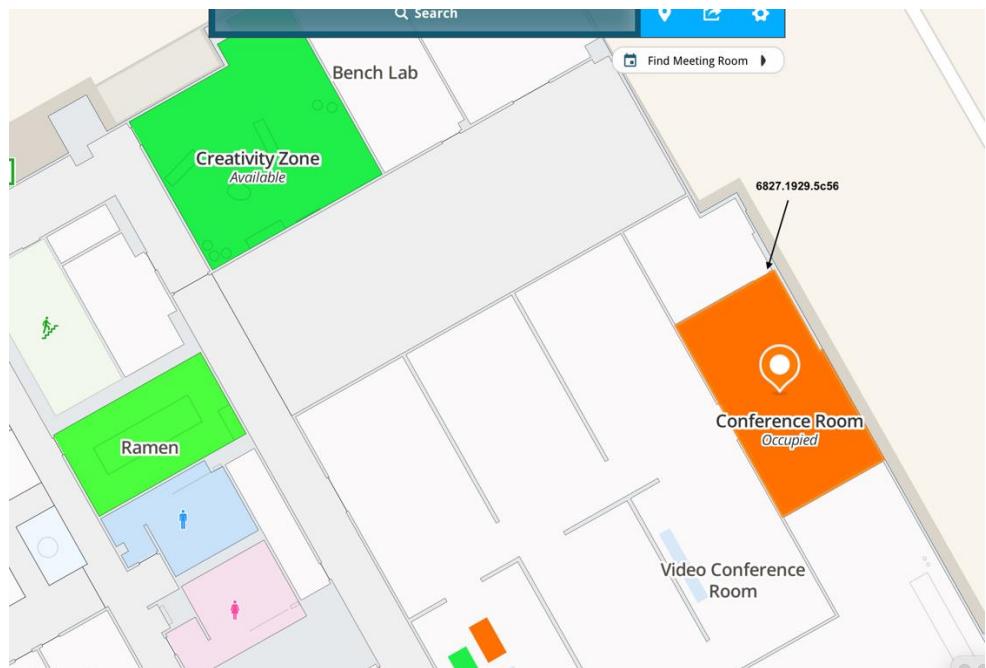
PIR State

Status	✓ ON
--------	------

Updated at: Jul 29th, 2021 03:16:40 AM  
a few seconds ago

*Occupancy sensor status on the DNA spaces dashboard upon detecting Occupancy.*

We observed the conference room status on the Mazemap application transition from "Available" to "Occupied". The Occupancy sensor detects the presence and triggers the lights to turn ON . This trigger has been picked up by the Catalyst 9000 switch and relayed to the IoT Gateway application. This info is sent to the DNA spaces cloud via the on-premises DNA Spaces Connector. Additional processing is done on this event and the information has been relayed to partner application (Mazemap) in a unified format via the Firehose API. Mazemap, the partner application in this scenario, picks up the coordinates of the sensor and transitions the state of the conference room from Available to Occupied. Customers can view this via a URL or an application and do additional integrations to use this data for on-demand conference room booking, get statistics/analysis around real estate usage per building/floor, or other details.

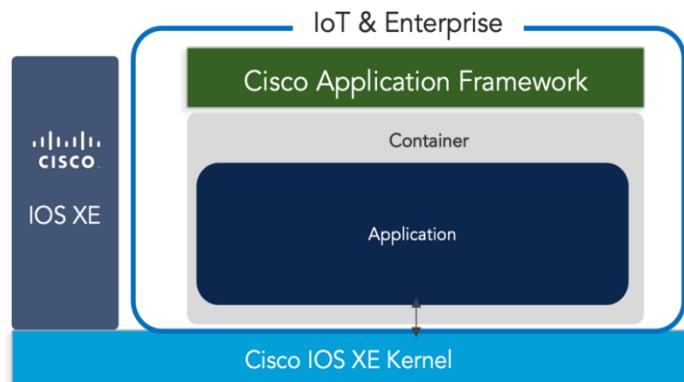


*Conference room status on the Mazemap (partner application) shows conference room status change from Available to Occupied.*

## 9.0 Application Hosting Capabilities

Enterprise networks are now dealing with massive volumes of data, and there is a critical need to collect and analyze this data to respond faster and deliver insightful context. Traditional approaches of processing in remote servers will no longer work as it can be burden to the network unless some context is known. Edge computing can greatly reduce the data sent to the cloud or a remote server.

Powered by an x86 CPU, the application hosting solution on the Cisco Catalyst 9000 series switches provide the required edge intelligence. This gives administrators a platform for leveraging their own tools and utilities, such as a security agent, IoT sensor, and traffic monitoring agent.



## 9.1 Application Installation

The applications can be installed on the Catalyst 9000 switches via CLI or DNA Center or Cisco DNA Spaces (IoT Gateway App). Cisco demonstrated hosting of IoT Gateway application on Catalyst 9300 via the Cisco DNA Spaces dashboard.

Deploy Wired Gateways

1 Choose Switches

Choose the Switches that you want to deploy the Wired Gateway

Switch Name	IP Address
<input type="checkbox"/> c9300-Stack	172.26.202.166
<input type="checkbox"/> C9300-Standalone	172.26.202.204
<input checked="" type="checkbox"/> C9300-UPOE	172.26.202.45

*Note: Only IoT Gateway application can be installed/managed via Cisco DNA Spaces. All other applications can be installed/managed from Cisco DNA Center.*

In the “Deploy Wired Gateway” section, DNA Spaces Dashboard lists available switches where you can host the IoT Gateway application.

## Deployment Status

The screenshot shows a deployment status summary at the top with counts: 2 Deployed (green checkmark), 1 In Progress (yellow exclamation mark), and 0 Failed (red X). Below is a table of deployment details:

Deployed At	OS Version	Deployment Status	Reason	More
Jul 29th, 2021 05:38:18 PM a few seconds ago	Cisco IOS Software [Bengaluru], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 17.4.1, RELEASE SOFTWARE (fc5)	IN PROGRESS	--	
Jul 20th, 2021 05:52:41 PM 9 days ago	Cisco IOS Software [Amsterdam], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 17.3.3, RELEASE SOFTWARE (fc7)	SUCCESS	--	
Jul 21st, 2021 04:26:14 PM 8 days ago	Cisco IOS Software [Bengaluru], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 17.4.1, RELEASE SOFTWARE (fc5)	SUCCESS	--	

3 Records Show Records: 10 1 - 3 < 1 >

*Above image shows two switches. The user can select any switch from the available list and click Deploy.*

Below we see a wired IoT Gateway deployment in progress. Once the application has been deployed, traffic is automatically redirected to the application. The application status can be checked directly via the Cisco DNA Spaces dashboard or via CLI:

```
C93-Standalone#sh app-hosting detail
App id          : cisco_dnas_wired_iox_app
Owner           : iox
State           : RUNNING
Application
  Type         : docker
  Name         : Cisco DNA Spaces Wired I0x Application
  Version      : 1.0.24
  Description   : The Cisco DNA Spaces Wired Manager app.
  Path          :
  URL Path     :
Activated profile name : custom

Resource reservation
  Memory        : 1024 MB
  Disk          : 10 MB
  CPU           : 3700 units
  CPU-percent   : 50 %
  VCPU          : 1
```

*Gateway application status via CLI commands.*

**Wired Gateways - C9300-Standalone**

As of: Jul 29th, 2021 05:53:34 PM [Refresh](#)

**Wired Gateway Information**

	Value		Value
Mac Address	6c:31:0e:f6:13:80	Name	C9300-Standalone
Status	UP	IP Address	172.26.202.204
IOx App Name	cisco_dnas_wired_iox_app	IOx App Version	1.0.24
IOx Last Heard	Jul 29th, 2021 05:44:43 PM 9 minutes ago	Last Seen	Jul 29th, 2021 05:44:52 PM 8 minutes ago
Mode	*	Product ID	C9300-24H
Serial Number	FOC2350L4QA	SW Version	Cisco IOS Software [Bengaluru], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 17.4.1, RELEASE SOFTWARE (fc5)
Type	CHASSIS		

**App Management**

Installed Apps

Category	App Name	Description	Actions
WIRED	Cisco DNA Spaces Wired App	Enable configuration of Wired Gateway within compatible switches	<a href="#">Edit</a> <a href="#">Delete</a>

**Request History**

Exp IoT

*Gateway application status via DNA Spaces dashboard.*

Lifecycle management of the application is done from the DNA Spaces (Day 0 to Day N related functionalities).

Cisco Application Hosting Framework can be used to install any third-party application in docker format. This gives customers access to Distributed Edge Computing resources, to deploy an application based on the use case.

## Key Advantages:

- AI Endpoint Analytics leverages capabilities of Catalyst 9000 to learn multiple attributes about the endpoints and profile them automatically.
- Users can view all the endpoints in the Endpoint Inventory and can manually add custom rules in addition to system and auto generated profiles.
- Visual aids give customers insight on active endpoints, allowing them to further customize profiling policies.
- SaaS-based cloud platform, DNA Spaces, provides seamless location-based analytics.
- Customers can purchase IoT endpoints from the IoT Device Marketplace of DNA Spaces dashboard based on the use case.
- DNA Spaces has a huge partner eco-system which can consume the data from firehose API to deliver new business outcomes.
- Application Hosting Infrastructure provides Distributed Edge Computing resources to install and manage dockerized applications.

## About Miercom

Miercom has published hundreds of network product analyses in leading trade periodicals and other publications. Miercom's reputation as the leading, independent product test center is undisputed.

Private test services available from Miercom include competitive product analyses, as well as individual product evaluations. Miercom features comprehensive certification and test programs including: Certified Interoperable™, Certified Reliable™, Certified Secure™ and Certified Green™. Products may also be evaluated under the Performance Verified™ program, the industry's most thorough and trusted assessment for product usability and performance.

## Use of This Report

Every effort was made to ensure the accuracy of the data contained in this report, but errors and/or oversights can occur. The information documented in this report may also rely on various test tools, the accuracy of which is beyond our control. Furthermore, the document relies on certain representations by the vendors that were reasonably verified by Miercom but beyond our control to verify to 100 percent certainty.

This document is provided "as is," by Miercom and gives no warranty, representation or undertaking, whether express or implied, and accepts no legal responsibility, whether direct or indirect, for the accuracy, completeness, usefulness, or suitability of any information contained in this report.

All trademarks used in the document are owned by their respective owners. You agree not to use any trademark in or as the whole or part of your own trademarks in connection with any activities, products or services which are not ours, or in a manner which may be confusing, misleading, or deceptive or in a manner that disparages us or our information, projects, or developments.

By downloading, circulating or using this report this report in any way you agree to Miercom's Terms of Use. For full disclosure of Miercom's terms, visit: <https://miercom.com/tou>.