The bridge to possible

Network Transformation by Utilising Application Hosting Capabilities at the Edge

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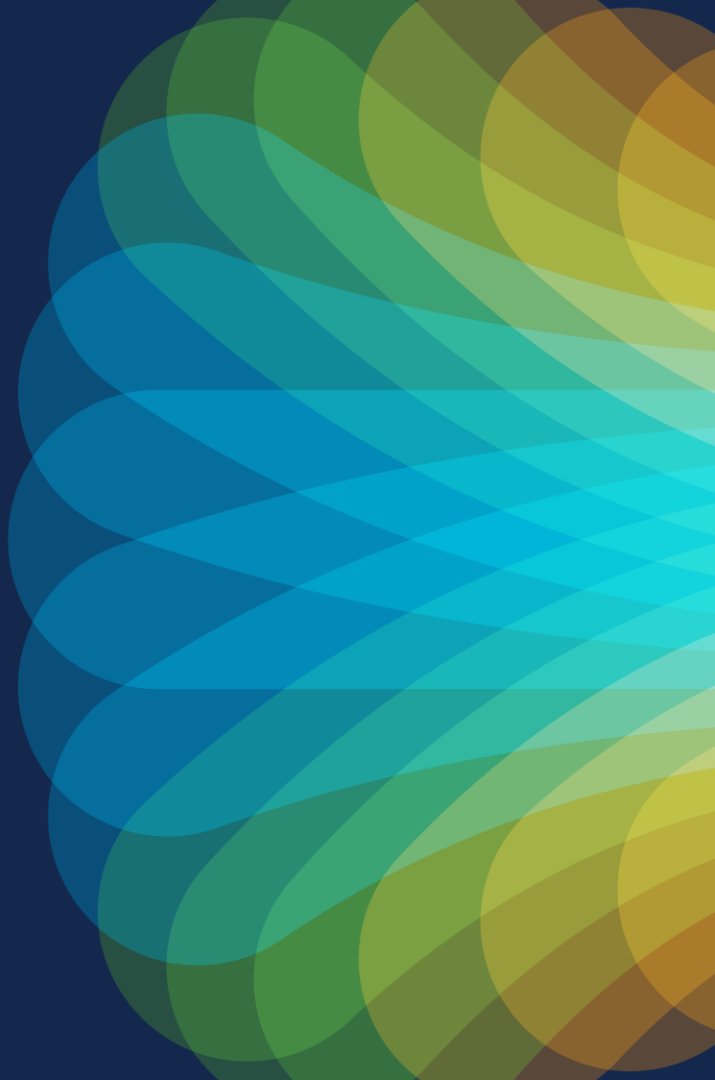
BRKENT-1908

Agenda

- Introduction
- App Hosting Basics
- Hosting on Catalyst Switches
- Hosting on Wireless AP’s
- Hosting on IOT routers

App Hosting Basics



Why App Hosting ?

- Adding monitoring or configuration capabilities to devices at the edge
- Having analytics to make a variety of business decisions
- Sensing the threat closer to source and preventing the threat from propagating into the network
- Distributed processing for IOT, bringing the cloud closer to edge

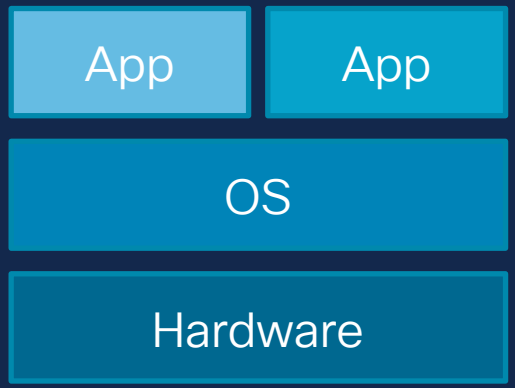
Application Deployment Types

- Bare-Metal Servers

- Virtual Machines

- Containers

Bare-Metal Servers

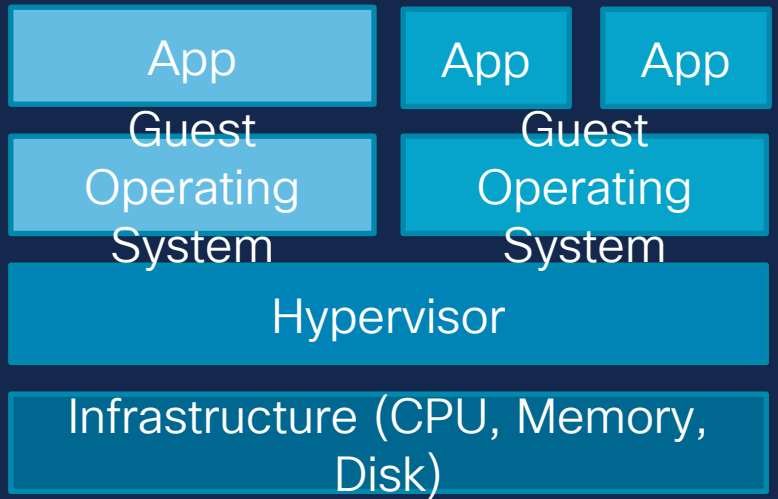


- A bare-metal server is a physical server that is dedicated to a single tenant.
- It can run multiple applications, but the resources are not shared with other tenants.

Bare-metal servers have these advantages:

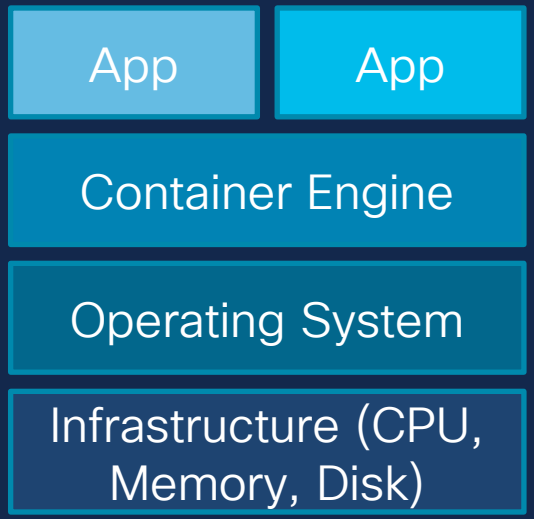
- Performance: Physical server resources can be optimized for a specific workload.
- Security: Data, applications, and other resources are physically isolated.
- Reliability: Physical resources are dedicated to a specific workload

Virtual Machine



- A virtual machine is an emulation of a computer system running on a shared host.
- Each virtual machine consists of its own environment (including operating system, libraries, and applications) and is not aware of other virtual machines running on the same physical host.
- Communication between applications inside a virtual machine and physical resources is through an abstraction layer called a hypervisor.
- This abstraction layer is responsible both for resource allocation and isolation.

Containers



- Container technology uses host operating system features to provide an isolated environment for multiple applications to run on the same server.

  The most widely used container solution used today is Docker. Docker enables users to package containers so that they can be moved between environments.

Docker

Portable deployments	• Docker to create a single object (image) containing all your bundled applications. The image can then be installed on any other Docker-enabled host
Versioning	• Docker can track versions of containers, inspect differences between versions, and commit new versions.
Component reuse	• Docker allows building and stacking of already created packages.
Shared images	• Anyone can upload new images to a public registry of Docker images

Edge Computing

- Today, more applications are moving to the cloud, and multiple clouds are being deployed.
- The increased number of endpoints dramatically increases the volumes of data that need to be processed and transporting the data to central locations for processing becomes expensive.
- To solve these issues, a new service architecture is being introduced: edge computing, which is based on distributing computing capacity to the edge of the network.
- Brings computing resources as close to the source of data as possible to reduce latency and bandwidth use.

Edge Computing

Better Performance

Lowering the latency between the end user device and a processing and storage unit to get better performance

Network Efficiency

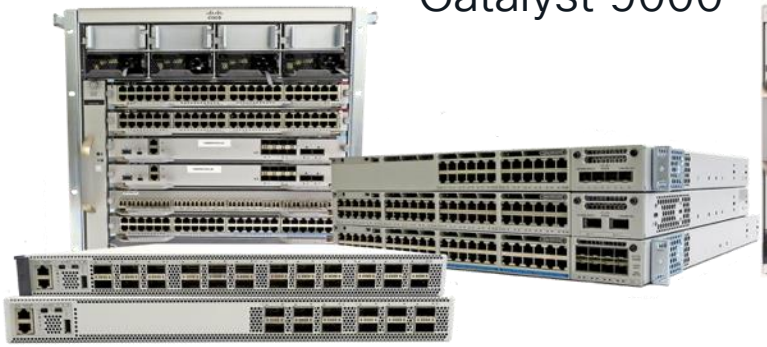
Implementing edge offloading for greater network efficiency

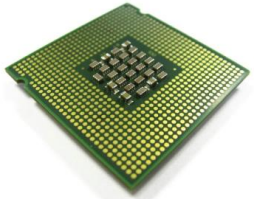
Reducing Transport Costs

Performing computations and reducing transport costs

Networking Today !!!

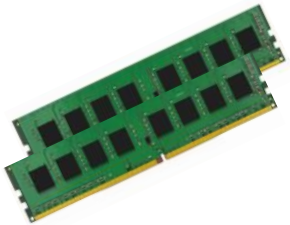
Catalyst 9000





x86 CPU

Linux-based OS



Memory/Storage

Enables hosting docker containers and 3rd party apps

New strategic capabilities with App Hosting on C9K Switches

Existing Hardware

Managed via CLI or DNA-C

Real Time Processing

Lower Latency

Save Bandwidth

IT Operations and Monitoring Tools

Consolidate Physical Infrastructure

ThousandEyes

kibana

WIRESHARK

perfSONAR powered

Security Agents and Functions

Enhance Visibility & Security Enforcement

Attivo NETWORKS.

TRAPX SECURITY

Cloud Gateways with Serverless Edge Compute

Reduce App Latency & Optimize App Traffic

Cybervision

Cisco DNA Spaces

NS1.

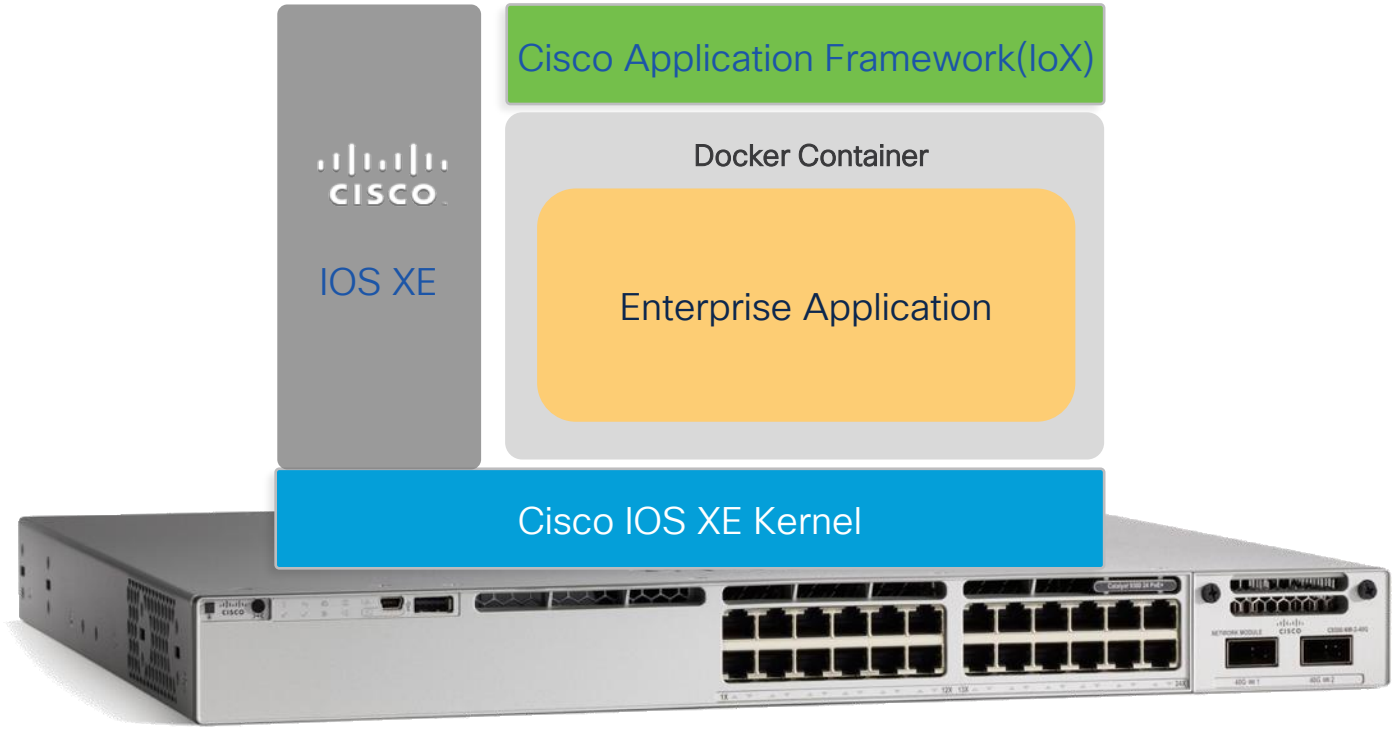
Alleantia

Customer Specific Applications

3rd Party App Hosting

Rich ecosystem partnership with 25+ certified apps and 200+ active customer

Catalyst 9000 App Hosting Architecture



HW resources for App Hosting

	Resource type	Catalyst 9300	Catalyst 9300-X	Catalyst 9400	Catalyst 9400-X	Catalyst 9500	Catalyst 9500-X	Catalyst 9600	Catalyst 9600-X
Networking	AppGig Port	1x1G	2x10G	1x1G	2x10G	Mgmt Port*	2x10G	Mgmt Port*	Mgmt Port* (2x10G CPU ports)
Resources	Memory	2GB	8GB	8GB	8GB	8GB	8GB	8GB	8GB
	CPU	1 core	2 core	1 core	1 core	1 core	1 core	1 core	1 core
	Storage	240GB (USB3.0/SSD)	240GB (USB3.0/SSD)	480-960GB (SATA)	480-960GB (SATA)	480-960GB (SATA)	480-960GB (SATA)	480-960GB (SATA)	480-960GB (SATA)

* Using loopback with any external ports

Catalyst 9300-X

USB 3.0
240GB

Back panel

Catalyst 9400-X

M2 SATA
480/960GB

Plug into removable SUP

Catalyst 9500-X

M2 SATA
480/960GB

Back panel

Catalyst 9600-X

M2 SATA
480/960GB

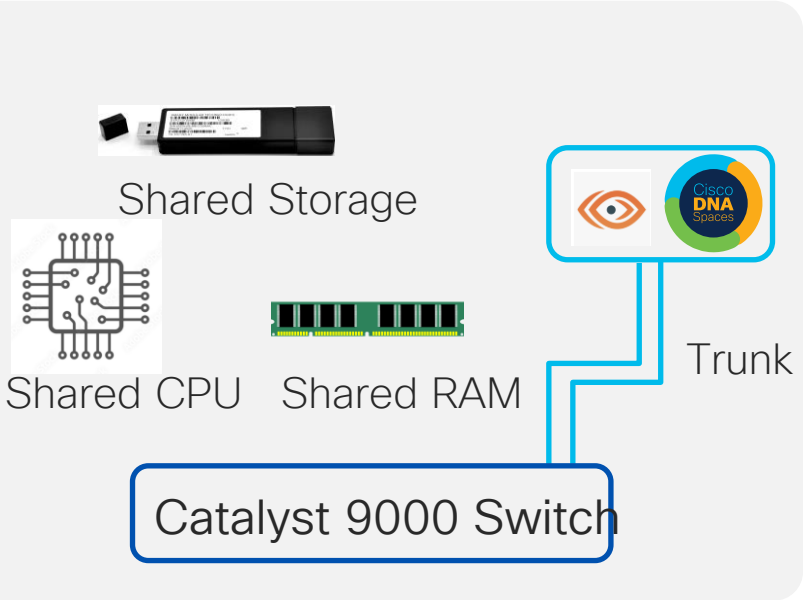
Plug into removable SUP

Multiple Applications Support on Catalyst 9K

17.5.1

Requirements :

- **Cisco Signed Applications Only**
  (ex. ThousandEyes, IoT Gateway)
- Must use SSD Storage
- Enough HW resources should be available to run all applications
- AppGigabitEthernet ports config must not create a conflict between the apps



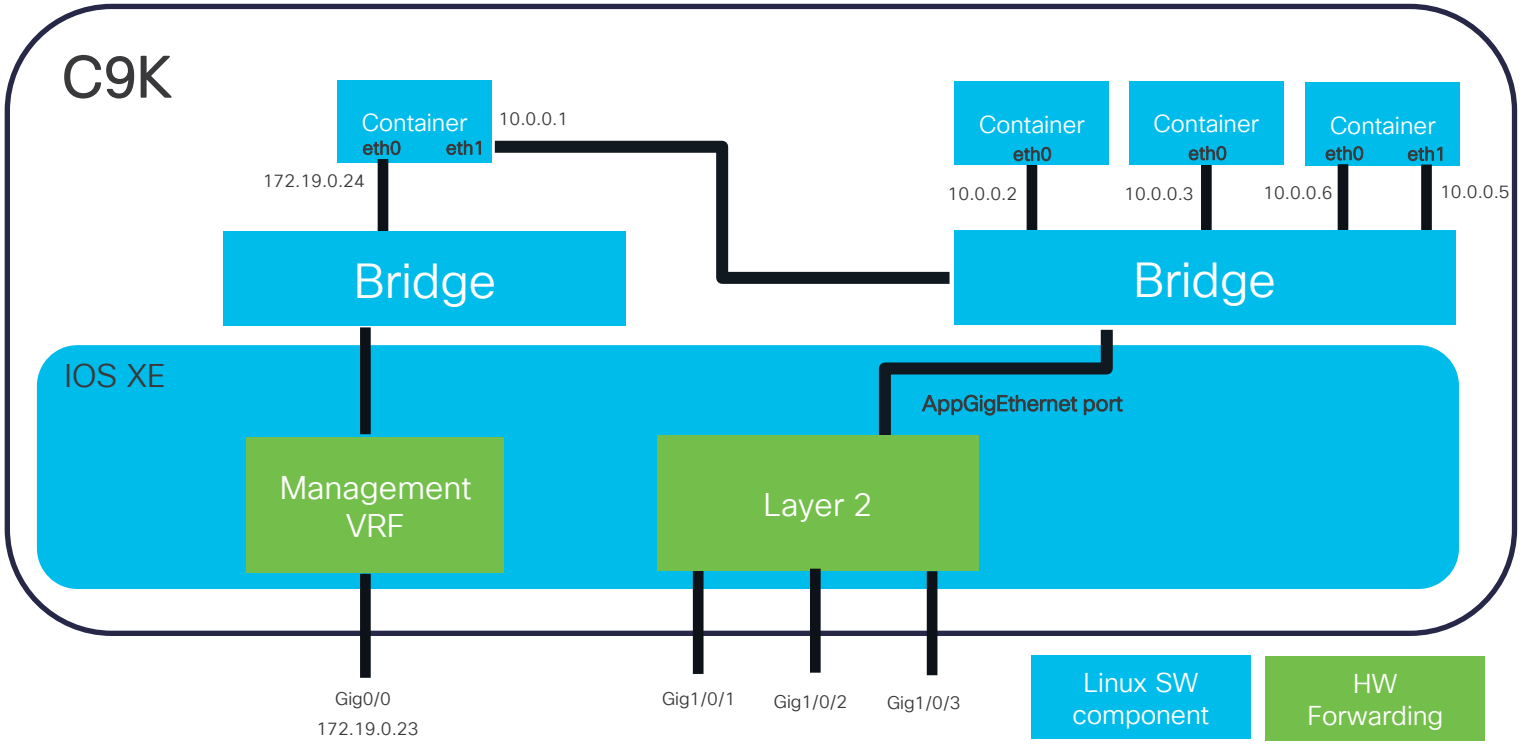
HW resource can be customized via DNA-C and CLI

IOS XE performance and security protection

- Memory and CPU usage for Apps are bounded using Control groups (cgroups).
- Process and files access for Apps are isolated and restricted (using user namespace)
- Disk usage is isolated using separate storage.

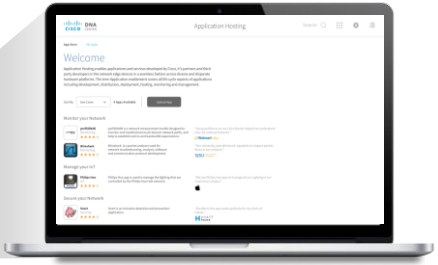
Catalyst 9000 Containers Networking

Catalyst 9000 Containers Networking



App Lifecycle Management

Application Management



Cisco DNA Center

REST

YANG

CLI

WebUI

REST

REST

REST

Cisco Application Framework

Docke r

Docker

Docker

Docker

Docker

3rd Party App

3rd Party App

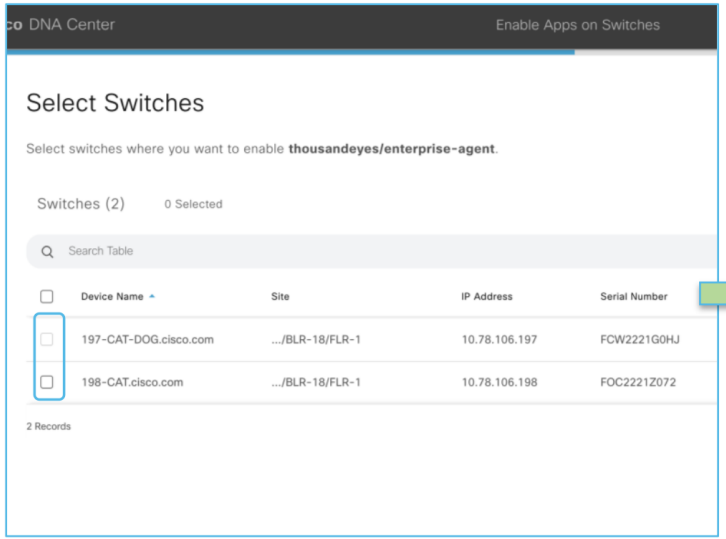
3rd Party App

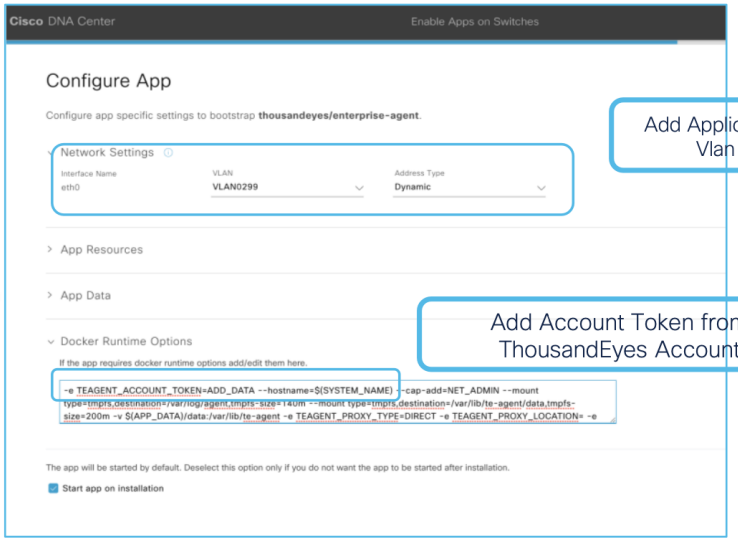
Custom App

Custom App

Host OS (IOS XE Kernel)

Application Management using Cisco DNA

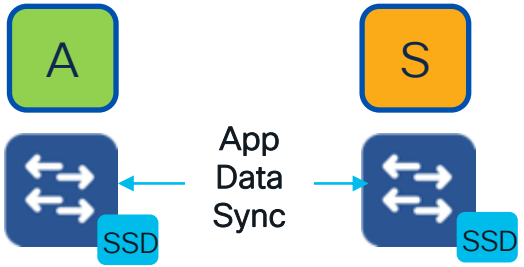




Application HA

App Hosting High Availability with **Auto-Restart**

- Provides cold restartability of application and the underlying app hosting framework
- Retain the last configured operational state of app in the event of system switchover or restart
- 1+1 redundancy mode
- Same storage type (Flash* or SSD) required on both Active and Standby
- Enabled by default

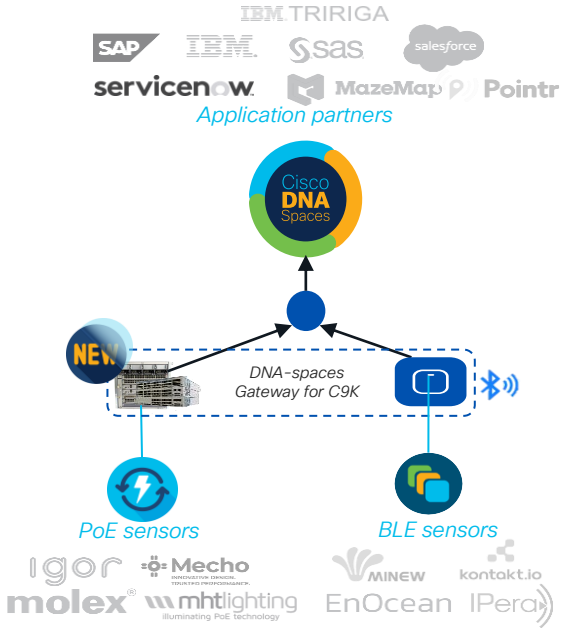


Supported Platforms	Release
9300 StackWise (1+1 mode only)	17.2.1
9400 Dual Sup (Single Chassis & StackWise Virtual)	17.5.1
9500H StackWise Virtual	17.5.1
9600 Dual Sup (Single Chassis & StackWise Virtual)	17.5.1

* Flash is only for Cisco Singed app

Catalyst 9K expands value for Smart buildings

Next: DNA-spaces gateway for Catalyst 9K will expand outcomes



New use cases

- Sustainable buildings
- Employee health & Safety
- Productivity Improvement
- Building Analytics

Unified Marketplace

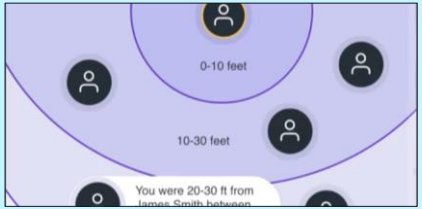
- Largest choice of IoT devices
- Unmatched solution scale
- Cisco validated

Lower TCO

- Automated workflows
- No vendor lock-ins
- Cloud based as-a-service

*Source: Cisco Smart building TCO calculator

Use Cases

User Experience	Safety & Compliance	Real Estate Utilization	Automation & Optimization
Conference Room Booking	Density Triggers	Device/People Counting	Environmental Monitoring & Asset location
GA			
			
Cisco Catalyst 9K			
Cisco DNA Spaces			
PoE lights & Sensors	Cisco Catalyst Wireless LAN Controller	Cisco Catalyst Wireless LAN Controller	POE sensors / HVAC

Validated Apps- DevNet Eco System Exchange

DevNet Eco System Exchange

- Cisco will not provide any support to third-party apps and open source apps unless specifically called out.
- Such apps, however, will be validated for compatibility on Cisco® Catalyst® 9000 switches.
- DevNet ecosystem will indicate the partners who have worked on Cisco Catalyst 9000 switches.

Application Hosting in Catalyst Access Points

cisco Live!

Partner Solution Use Case Segments

Electronic Shelf Label
Retail Management

- LCD price tags that can be updated remotely.

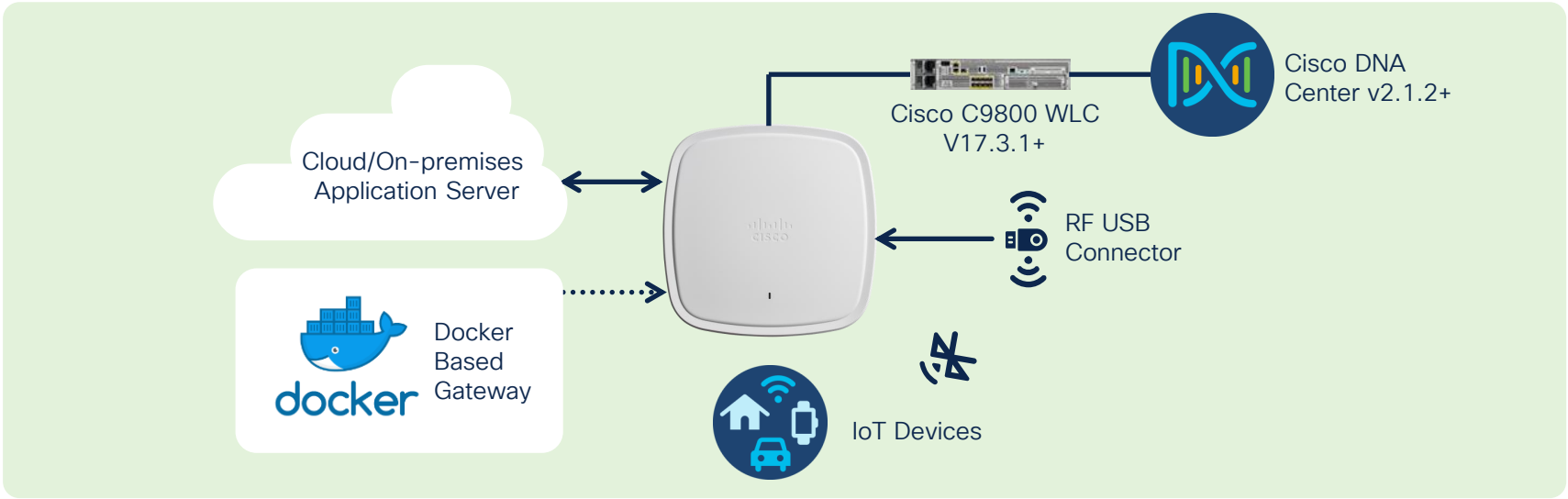
Asset Tracking
Building Management

- Sensors that track, movement, temperature, humidity, location, and many more.

Patient Tracking
Medical Management

- Sensor that track location, human vitals and many more for efficient medical operations.

IOx Application Hosting Topology

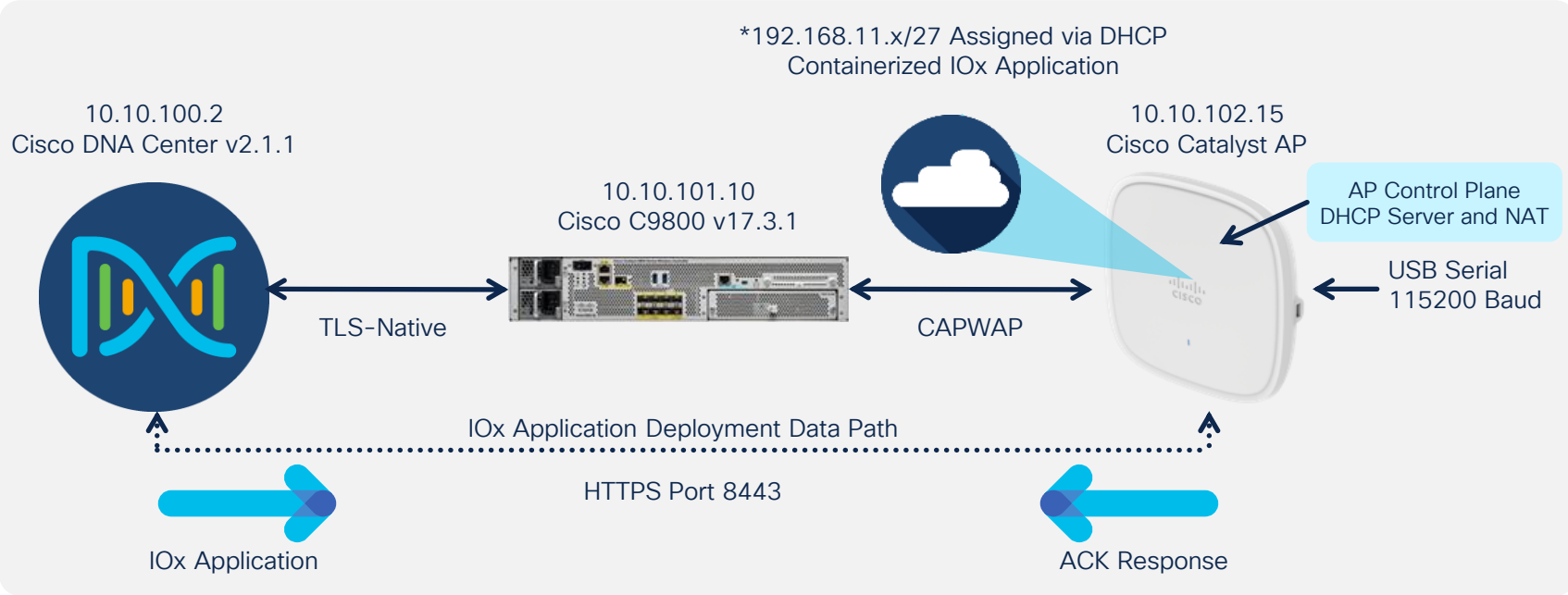


Cisco DNA Center deploys the app

RF USB Connector can be any RF

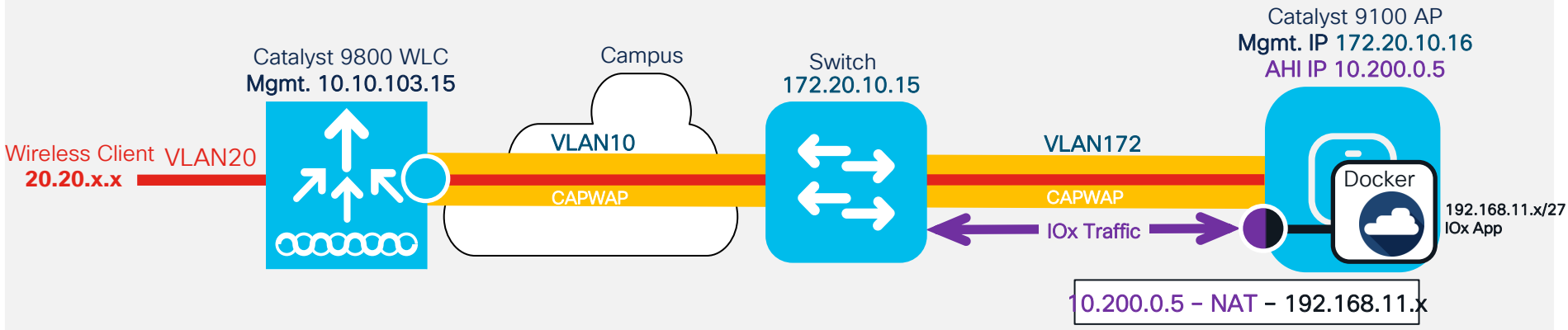
Catalyst AP acts as an IoT gateway

Application Hosting Network topology



*The IOx Application's traffic is locally switched and communicates to external sources through NATTing the AP's IP

IOx Traffic Segmentation with AHI on Local Mode AP

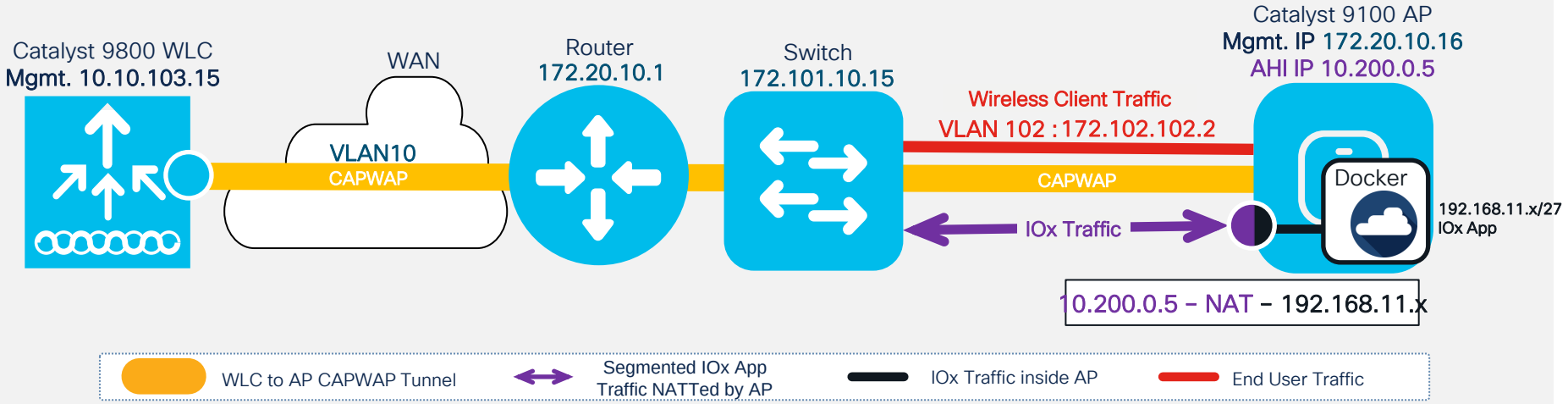


The IOX App cannot access AP data or management traffic with Auxiliary-Client Interface (AHI) enabled

The IOx App uses the AP's AHI IP address to communicate externally

The IOx App's traffic is always locally switched regardless of AP mode

IOx Traffic Segmentation with AHI on FlexConnect AP mode

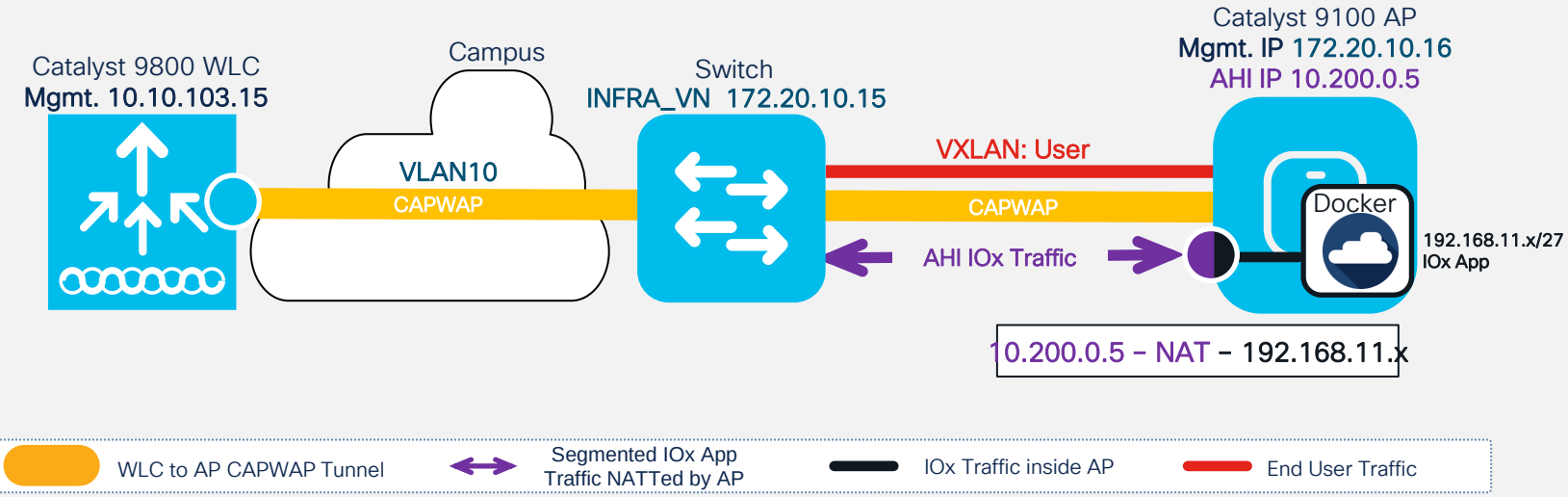


The IOX App cannot access AP data or management traffic with Auxiliary-Client Interface (AHI) enabled

The IOx App uses the AP's AHI IP address to communicate externally

The IOx App's traffic is always locally switched regardless of AP mode

IOx Traffic Segmentation with AHI on Fabric Wireless mode



The IOX App cannot access AP data or management traffic with Auxiliary-Client Interface (AHI) enabled

The IOx App uses the AP's AHI IP address to communicate externally

The IOx App's traffic is always locally switched regardless of AP mode

IOx Application Deployment Details

- Cisco DNA Advantage license required

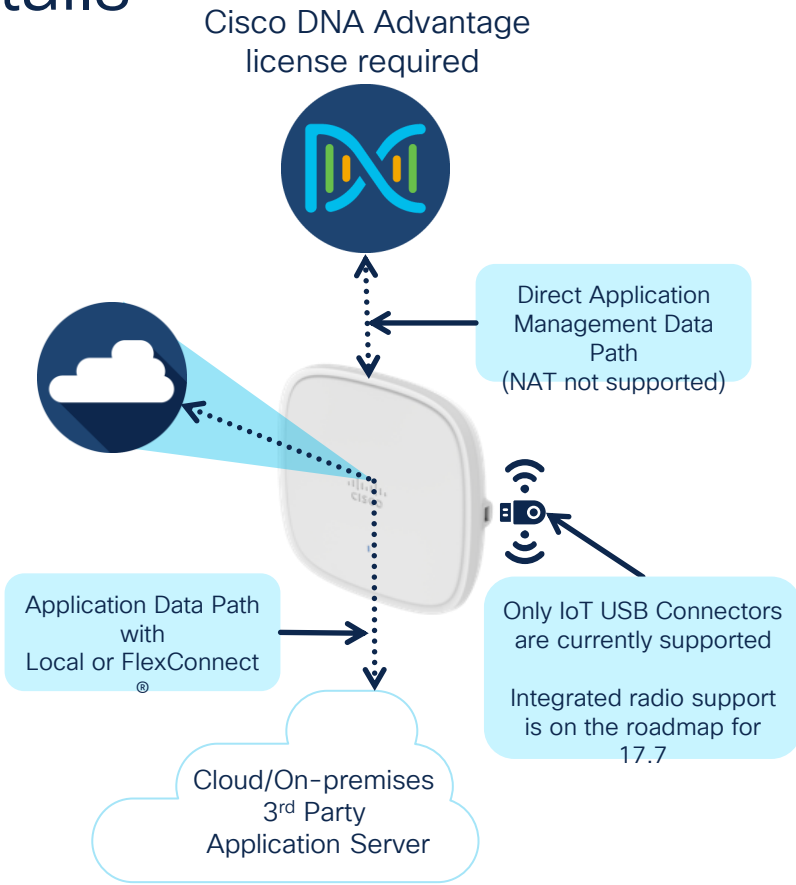
Licensing

- Supports up to 2 applications.

Compatibility

- Dedicated resources given to the application.
- Application security is dependent on the application developer.

Security



Application Hosting deployment workflow

Day 0 – Cisco DNA Center configurations

- Create a network hierarchy site
- Discover WLC and access points
- Assign WLC and access points to the network hierarchy

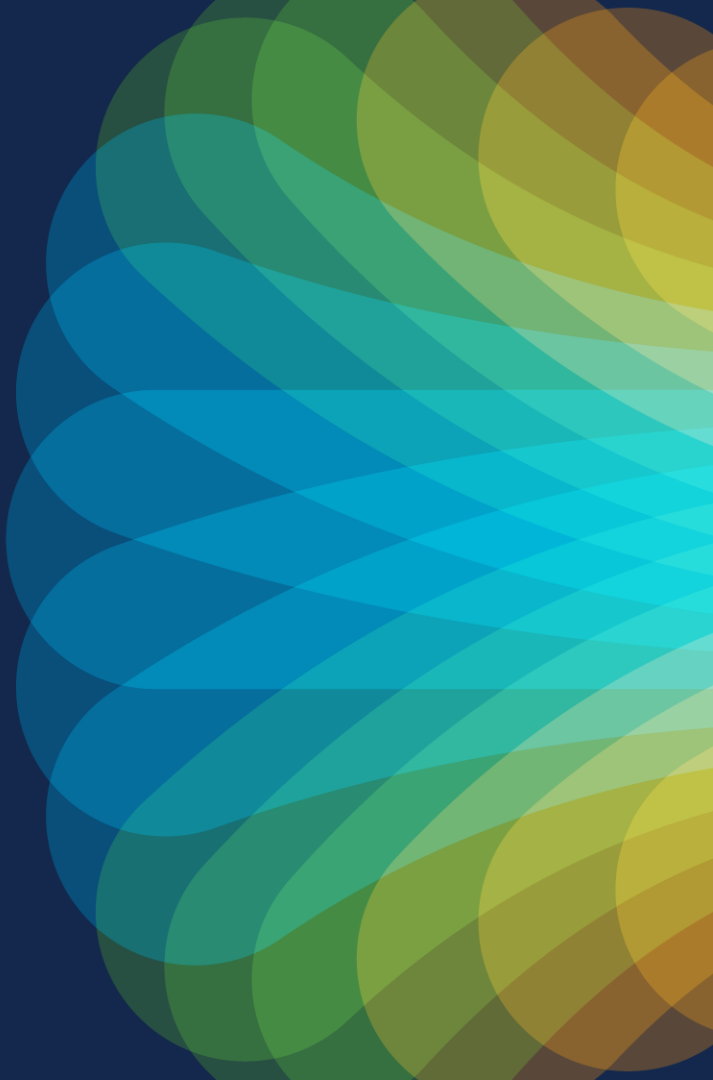
Day 1 – Upload and deploy IOx applications

- Upload IOx application to Cisco DNA Center
- Deploy uploaded application to specific access points

Day 2 – Manage and monitor IOx applications

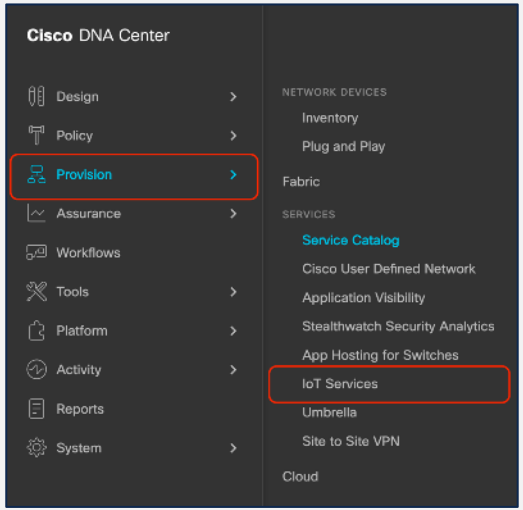
- Establish communication between IOx application and the application server
- Manage and monitor IOx application through the application server

Upload IOx Application



Step 1: Navigate to IoT Services

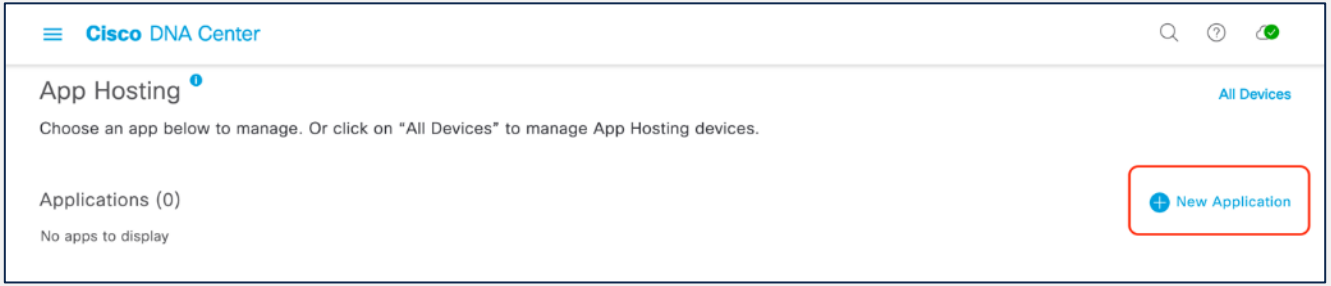
1 Open the menu, click on **Provision**, then **IoT Services to enter the App Hosting page.**



Cisco DNA Center's IoT Services page provides an intuitive graphical user interface for users to upload and manage a third-party application they would like to deploy onto their access points.

Step 2: Upload the IOx application to Cisco DNAC

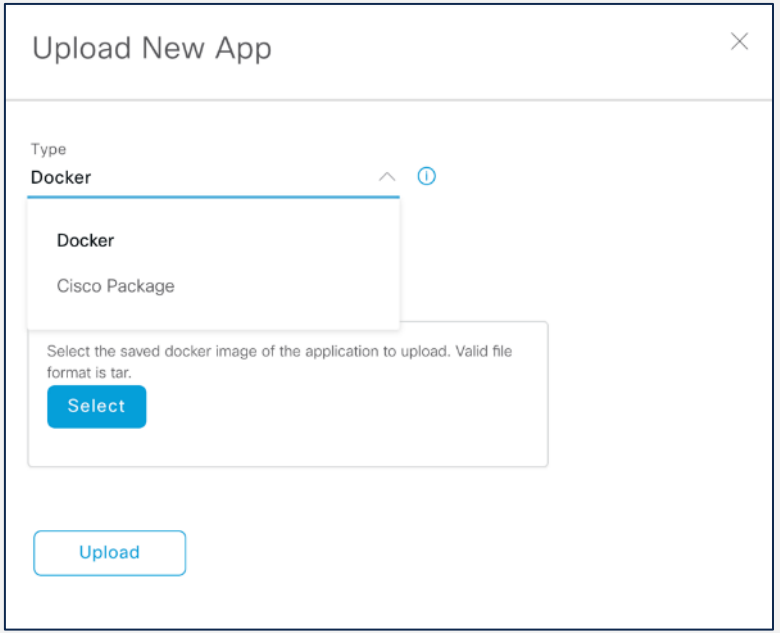
1 Click on **New Application** on the right side of the screen.



Step 2: Upload the IOx application to Cisco DNAC

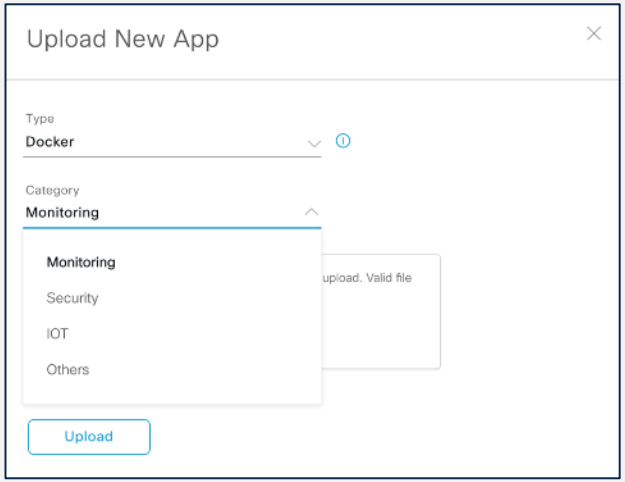
2 Click on the **Type** drop-down menu and select an application type:

- Option 1 – Docker
  - Choose this option if the app you are uploading is a Docker app saved as a tar file using the Docker save command.
- Option 2 – Cisco Package
  - Choose this option if the app you are uploading has been packaged using the Cisco app packaging toolchain.
- For more information regarding both package types, visit: https://developer.cisco.com/docs/iox/

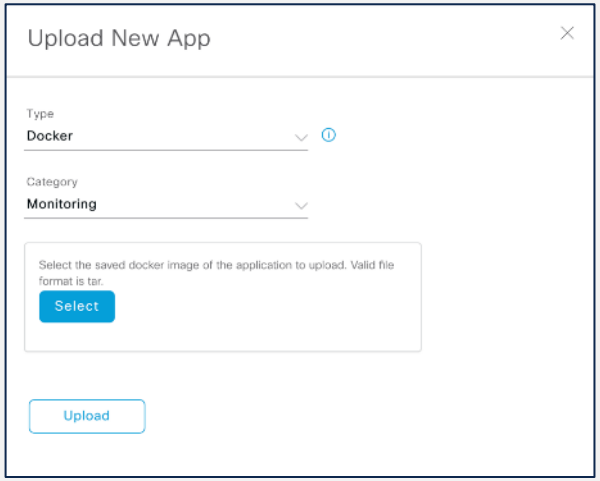


Step 2: Upload the IOx application to Cisco DNAC

3 Click the **Category** drop-down menu and select an application category: Monitoring, Security, IoT, etc.



4 Click the **Select** button to select a file to upload, then click **Upload** to upload the file.



Step 2: Upload the IOx application to Cisco DNAC

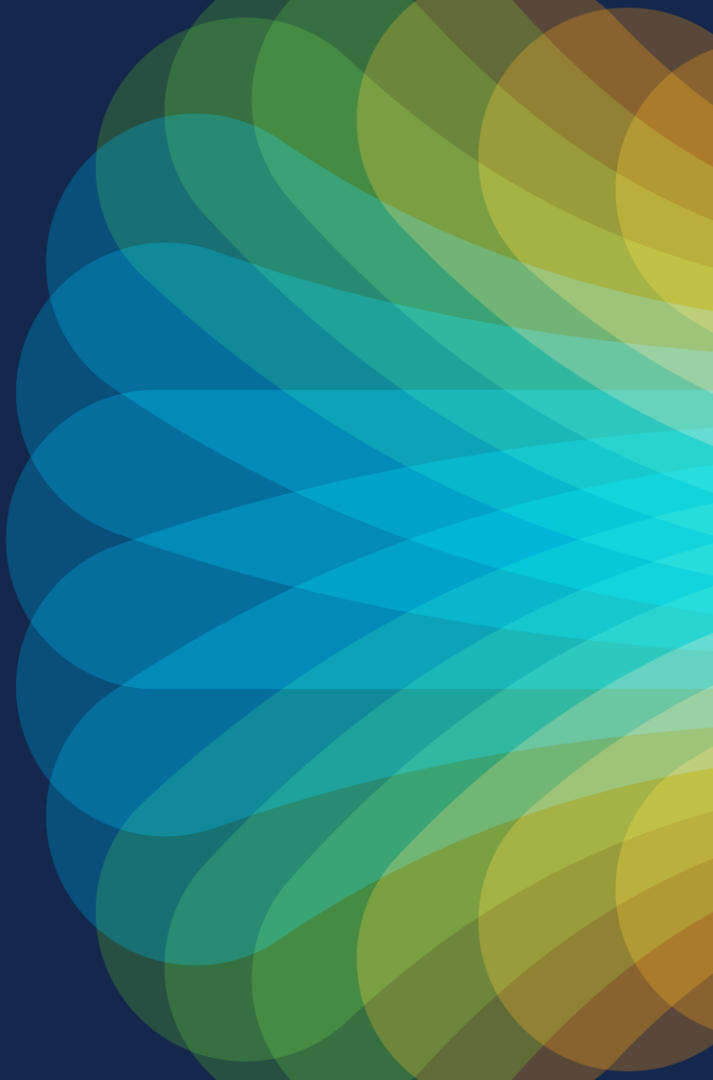
5 Ensure the application you've uploaded now appears within the App Hosting page.

6 Optional: If you would like to manage the application, click on the application to enter the application's management page.

Step 2: Upload the IOx Application to Cisco DNAC

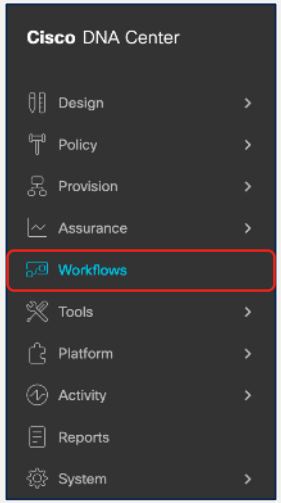
7 (1) To update the application, click on the **Update Application** button; (2) To delete the application, click on the **Delete Application** button; (3) To edit the application's description, click on the **Edit** button.

Deploy IOx Application



Step 1: Navigate to “Enable IoT Services Workflow”

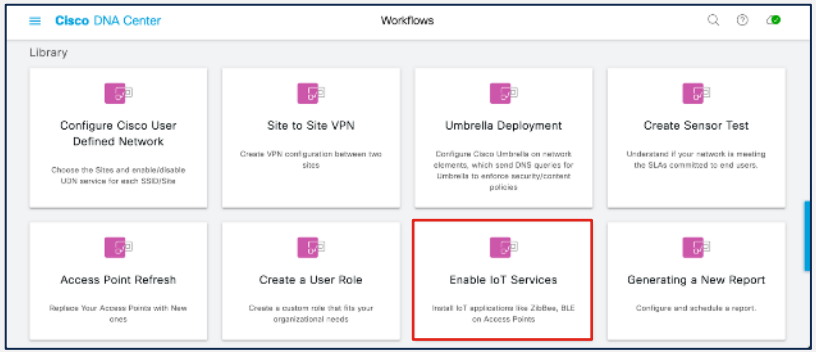
1 Open the menu, then click on **Workflows**.



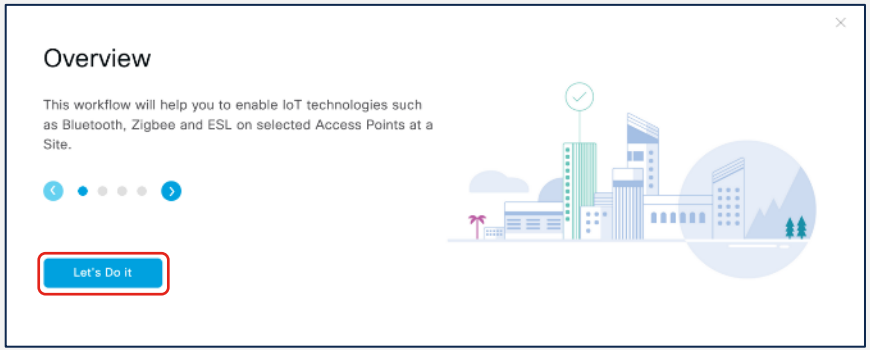
Cisco DNA Center’s “Enable IoT Services Workflow” function allows you to easily deploy your application to either a location or specific access point.

Step 1: Navigate to “Enable IoT Services Workflow”

2 Click on **Enable IoT Services** to begin the deployment workflow.

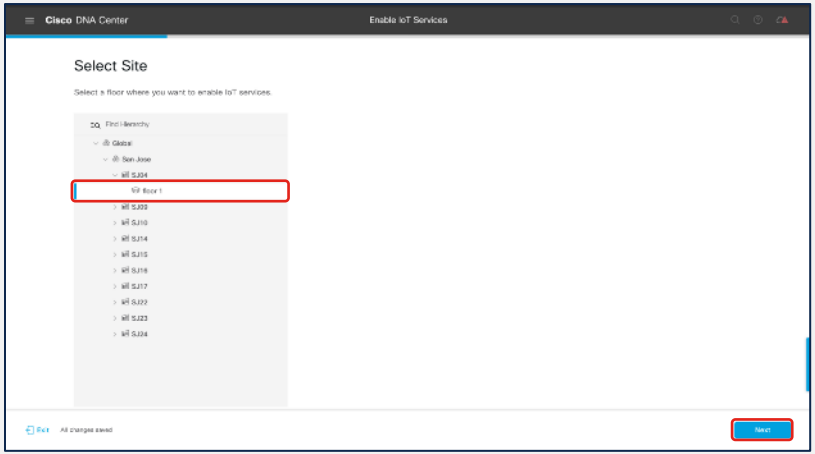


3 Click on the **Let’s Do it** button on the modal box that appears.

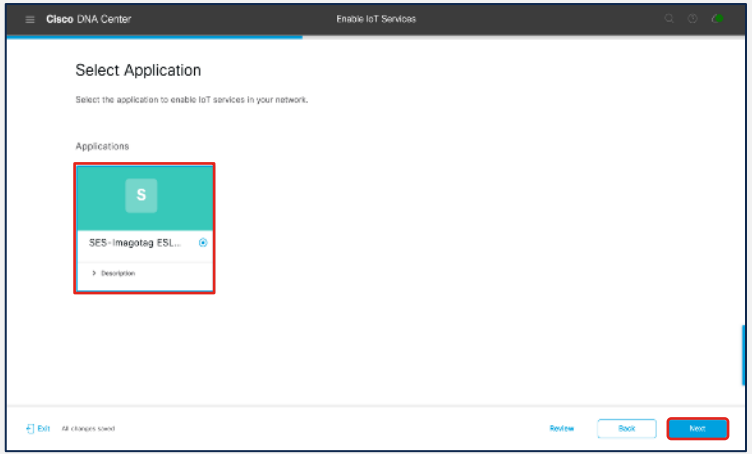


Step 2: Deploy the application to access points on a floor

1. Select a floor within the network hierarchy where you'd like to deploy the application, then hit **Next**.

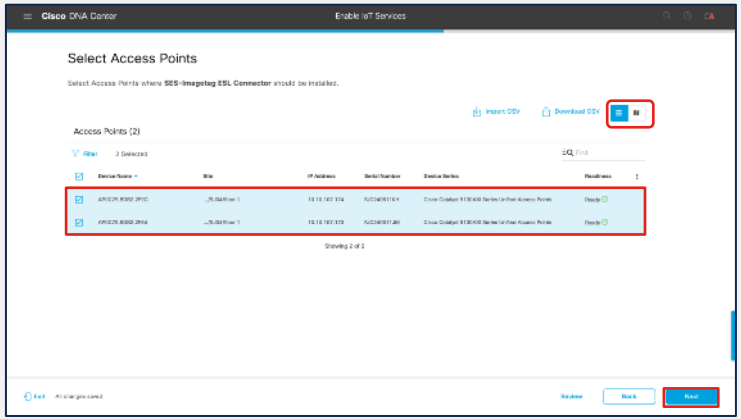


2. Select the image that you would like to deploy the device on that floor, then hit **Next**.

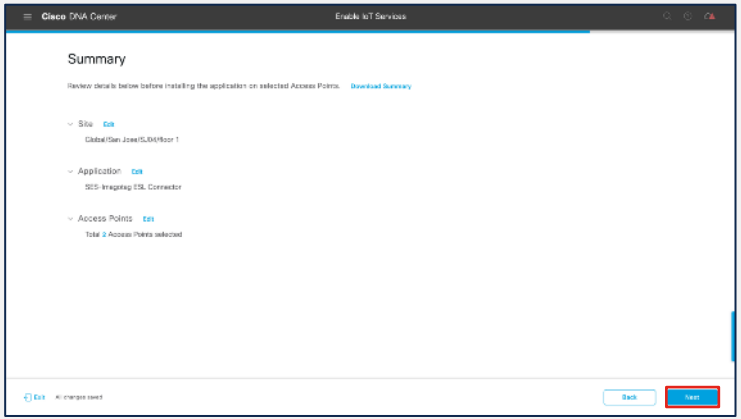


Step 2: Deploy application to access points on a floor

3 Select the AP(s) on this floor where you would like to deploy the image, then click **Next**.



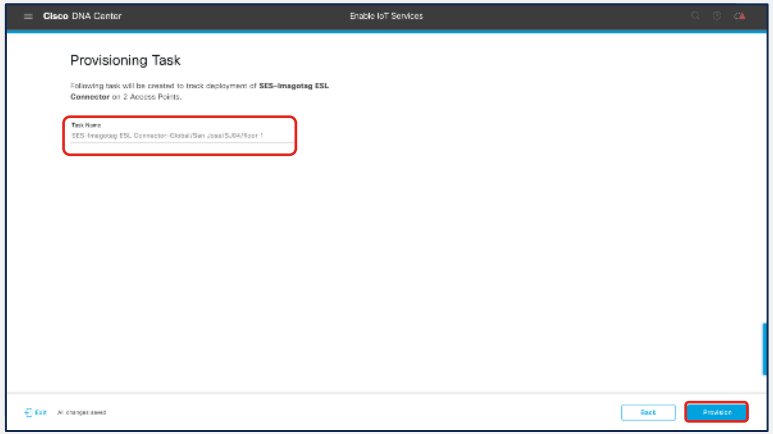
4 Review that the application is being deployed to the intended site and access point(s), then click **Next**.



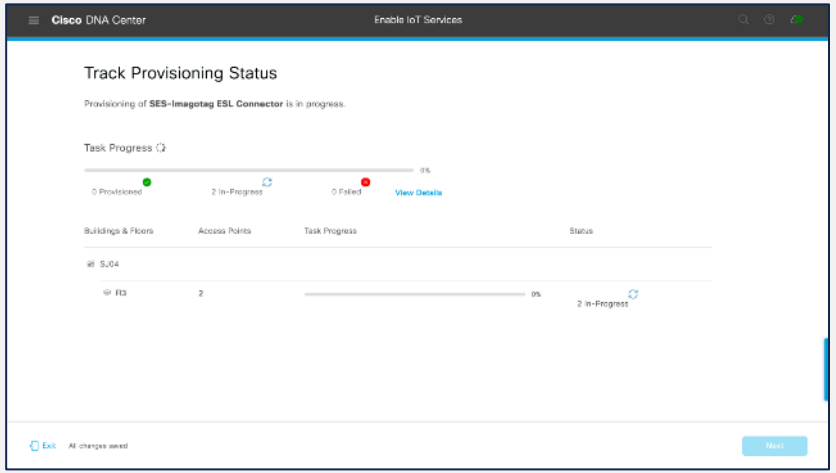
- Ensure the Readiness column says **Ready**
- By default, this page shows an AP list view; however, it can be toggled to a maps view via the map icon at the top right-side corner of the table.

Step 2: Deploy application to access points on a floor

5 Note the **Task Name** for reference, then hit **Provision.**



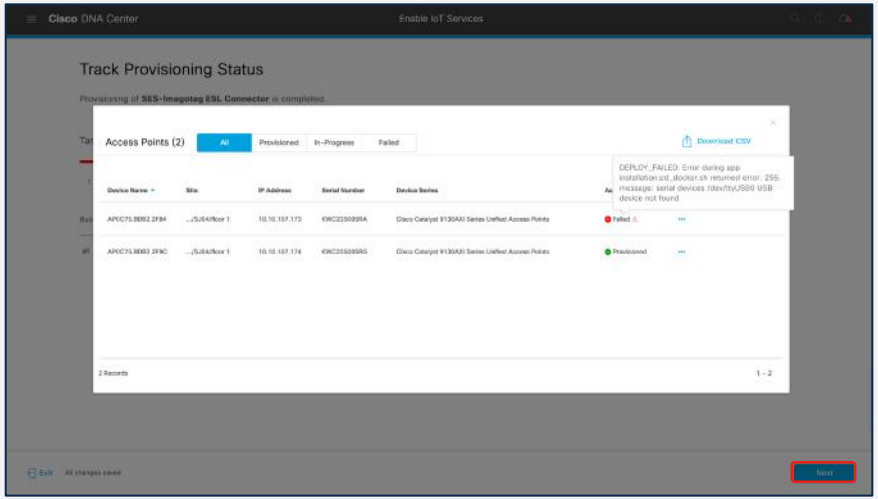
6 Observe that the application deployment process will begin.



Step 2: Deploy application to access points on a floor

7 If all previous steps were followed, you will observe a **Provisioned** message.

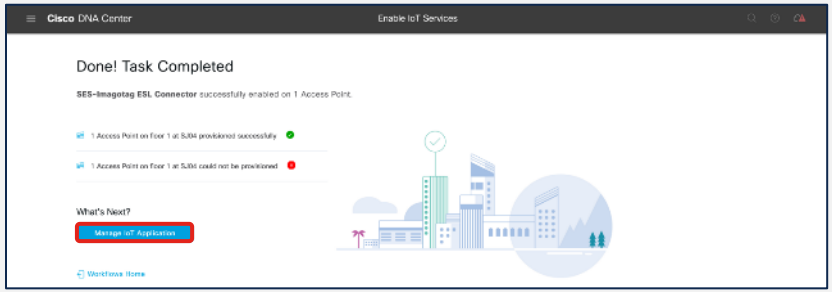
8 After reading through the provisioning status of your application deployment, hit **Next**.



Warning: If you attempt to deploy an application with a dependency on a USB attachment, and the attachment is not detected, you will receive a Failed message.

Step 2: Deploy application to access points on a floor

9 Click on the **Manage IoT Application** button to continue to the application's management page.



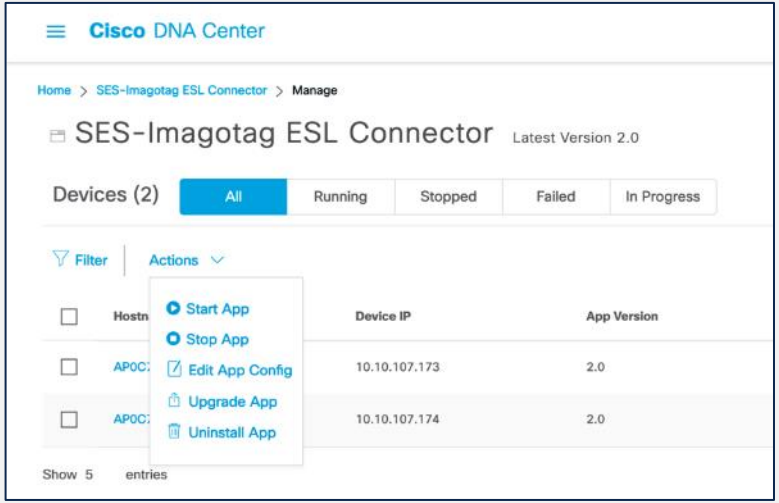
10 On this Application Management page, you're able to manage the status of the deployed applications.

Observe beneath the **App Status** column that you can monitor the status of your application.

Step 2: Deploy application to access points on a floor

11 In order to manage the application deployed to the access point, click on the **Actions** drop-down menu

1. **Start App** – If you stopped your app via the **Stop App** button, you could start it again via this button
2. **Stop App** – You can stop the loaded application from running. (Stopping an application does not delete or uninstall it.)
3. **Edit App Config** – If your application requires additional configurations, you can edit it via this button
4. **Upgrade App** – If you've uploaded a newer version of your use through the initial IoT Services Workflow, you can click on the **Upgrade App** button to upgrade the application running on the AP to the new version
5. **Uninstall App** – Click this button to remove the application from your access point entirely



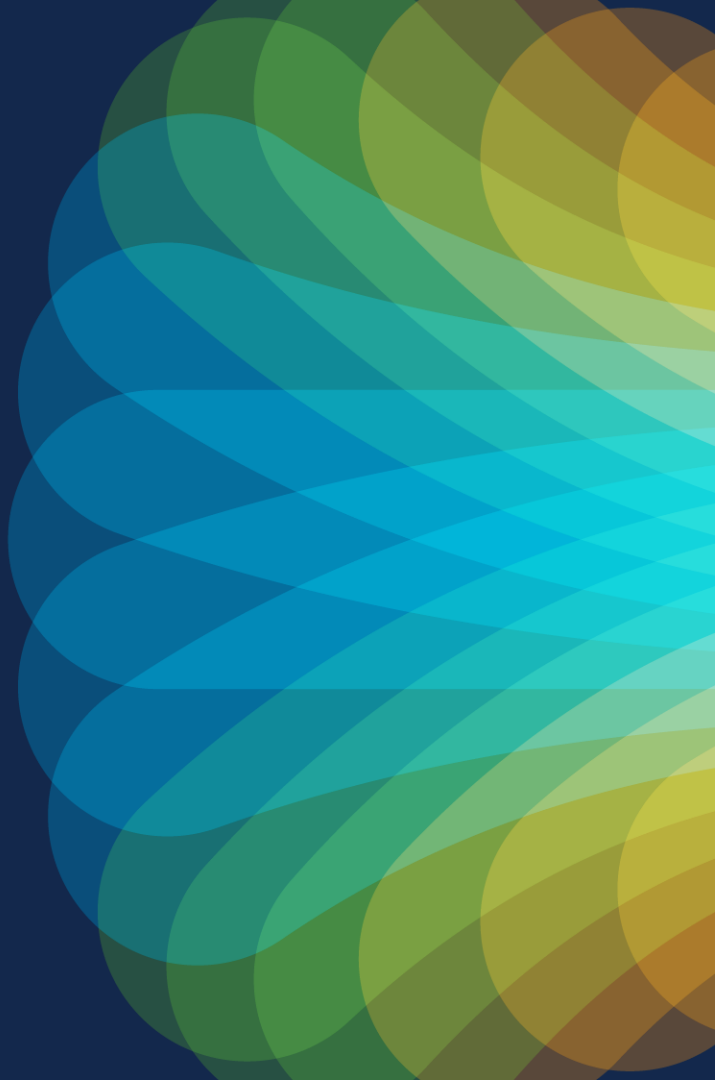
Step 2: Deploy application to access points on a floor

12 At this point, your application should be deployed successfully to your access point(s) and if desired, you can verify this via the following AP CLI command:

```
AP0C75.BDB2.2F9C#show iox applications
Total Number of Apps : 1
-------------------------
App Name                      : SES_Imagotag_ESL_Connector
   App Ip                     : 192.168.11.2
   App State                  : RUNNING
   App Token                  : 576fdae5-81a0-4e93-8093-afb050872c12
   App Protocol               : usb
   Number of Disconnects      : 0
   App Grpc Connection        : Down
   Rx Pkts From App           : 0
   Tx Pkts To App             : 0
   Tx Pkts To Wlc             : 0
   Rx Pkts From WLC           : 0
   Tx Data Pkts To DNASpaces  : 0
   Tx Cfg Resp To DNASpaces   : 0
   Rx KeepAlive from App      : 0
   Dropped Pkts               : 0
   App keepAlive Received On  : NA
```

Your application will, by default, receive an IP address from the 192.168.11.x/27 through DHCP, and can communicate externally from the AP through NAT. This means that the IOx app will, by default, have the same IP address as the AP from the perspective of external applications.

Useful CLI Commands



Catalyst Access Points CLI commands

1 Statistics of the loaded application:

```
Nolan_AP#show iox applications
Total Number of Apps : 1
--------------------------
App Name : communication_daemon
App Ip : 192.168.11.2
App State : RUNNING
App Token : 0f690ed5-c341-4342
App Protocol : usb
App Grpc Connection : Down
Rx Pkts From App : 0
Tx Pkts To App : 0
Tx Pkts To Wlc : 0
Tx Data Pkts To DNASpaces : 0
Tx Cfg Resp To DNASpaces : 0
Rx KeepAlive from App : 0
Dropped Pkts : 0
App keepAlive Received On : NA
```

2 AP and connected USB device info:

```
Nolan_AP#show inventory
NAME: C9130AX, DESCR: Cisco Catalyst 9130AX
Series Access Point
PID: C9130AXI-B , VID: V01, SN: FJC240511KH


Entity Name          : USB Module
Detected             : Yes
Status               : Enabled
Product ID           : ea60
Vendor ID            : 10c4
Manufacturer         : Silicon Labs
Description          : CP2102N USB to UART Bridge
Controller
Serial Number        : 0cd351d9f35
Max Power            : 100 mA
```

Catalyst Access Points CLI commands (continued)

3 Loaded IOx application status:

```
Nolan_AP#show iox status

IOx Status              : Enabled
CAF Status              : Up
CAF Token               : 9e054a32-d1ff-464e-aadd-6c5934959310
CAF Port                : 8443
```

Cisco IOS XE WLC CLI commands

1 Status of the USB modules connected to all joined access points:

```
Nolan_eWLC#show ap module summary

Output of show ap module summary:

 AP Name                External Module       External Module PID   External Module Description
-------------------------------------------------------------------------------------------------
Nolan_AP1               Enable                10c4/ea60/100         CP2102N USB to UART Bridge C
Nolan_AP2              Enable                10c4/ea60/100         CP2102N USB to UART Bridge C
```

2 State of the USB modules connected to all joined access points:

```
Nolan_eWLC #show ap config general
USB Module Type                                 : USB Module
USB Module State                                : Enabled
USB Operational State                           : Enabled
USB Override                                    : Disabled
```

Cisco IOS XE WLC CLI commands

3 Application Hosting status of each joined access point:

```
Nolan_eWLC#show ap apphost summary

AP Name     AP Mac           Apphost Status    CAF Port    Apphost HW capable
-------------------------------------------------------------------------------
SS-2027     00ee.ab18.b620   Up                8443        Yes
Axel-2036   04eb.409f.a000   Up                8443        Yes
```

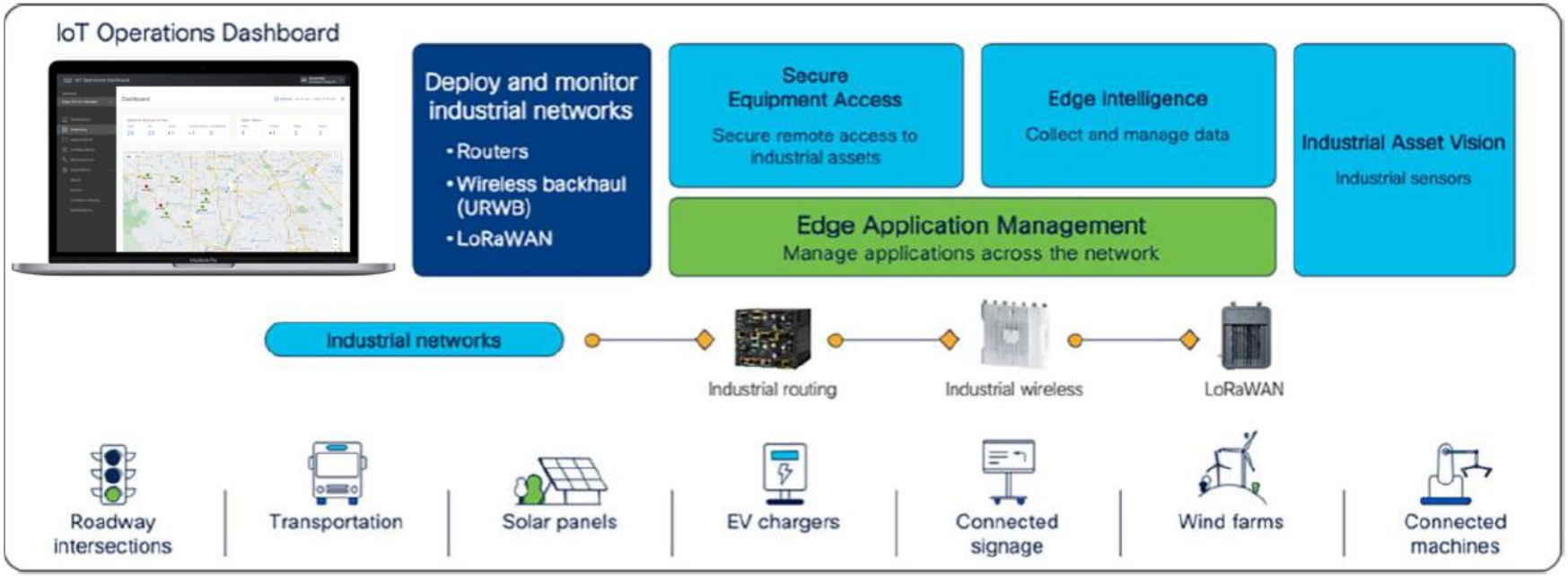
4 Configuring Auxiliary-Client Interface (AHI) for IOx app traffic segmentation:

```
Nolan_eWLC#config terminal
Nolan_eWLC(config)# <AP Join Profile Name>
Nolan_eWLC(config-ap-profile)# auxiliary-client interface vlan-id <VLAN ID>
```

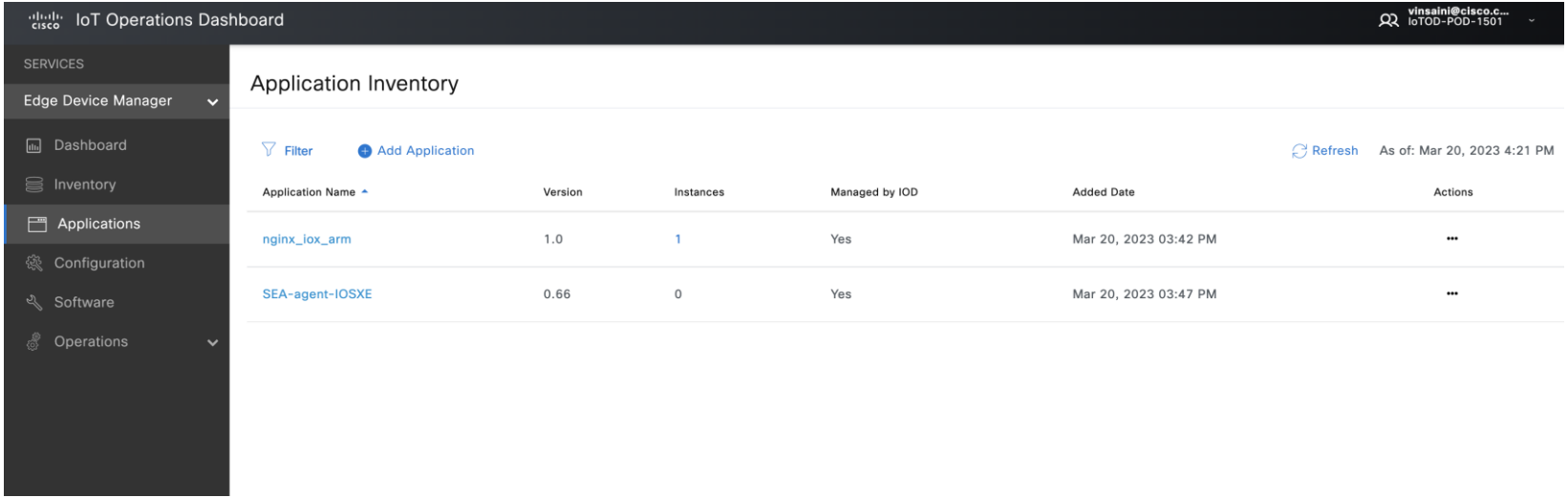
Note: Ensure that this VLAN exists within your 9800 controller

App hosting on Cisco IoT routers

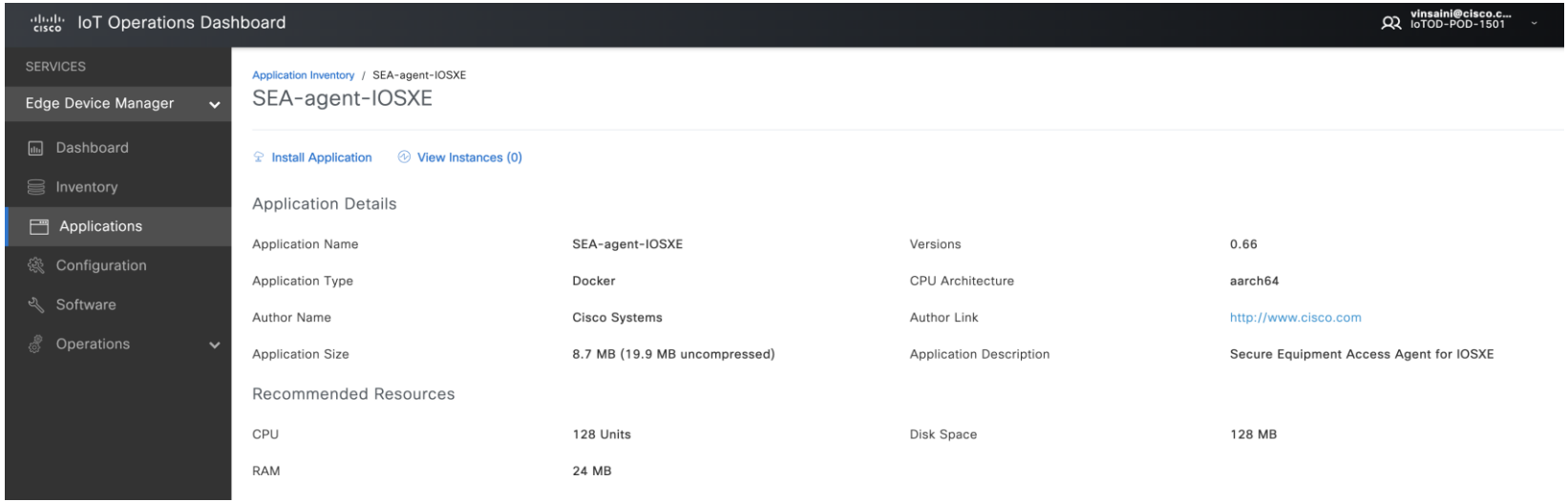
What is IoT-OD



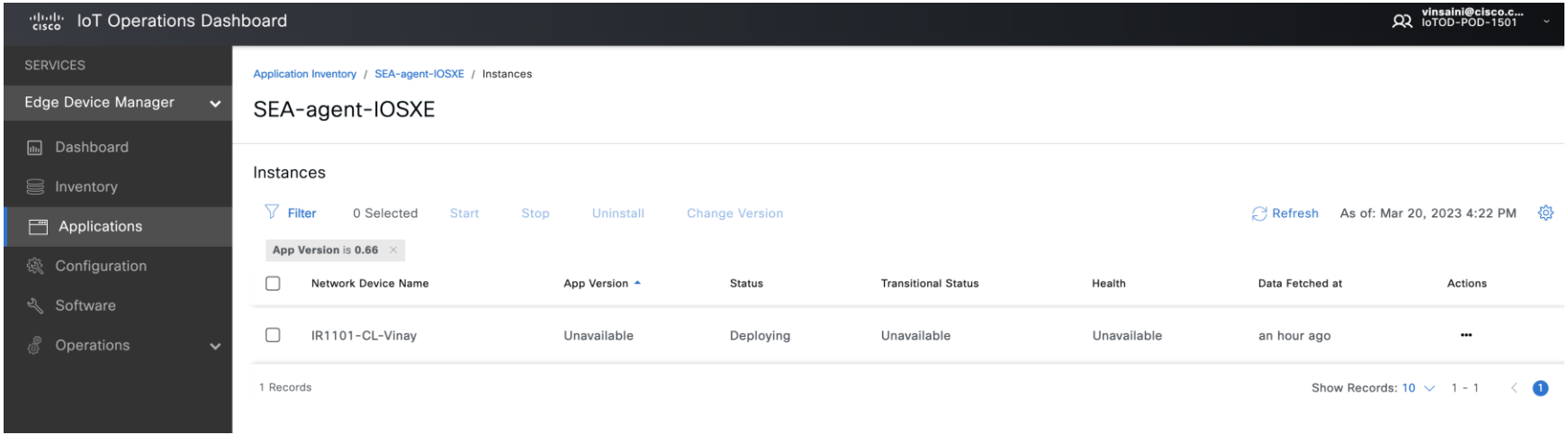
APP installation via IOT OD



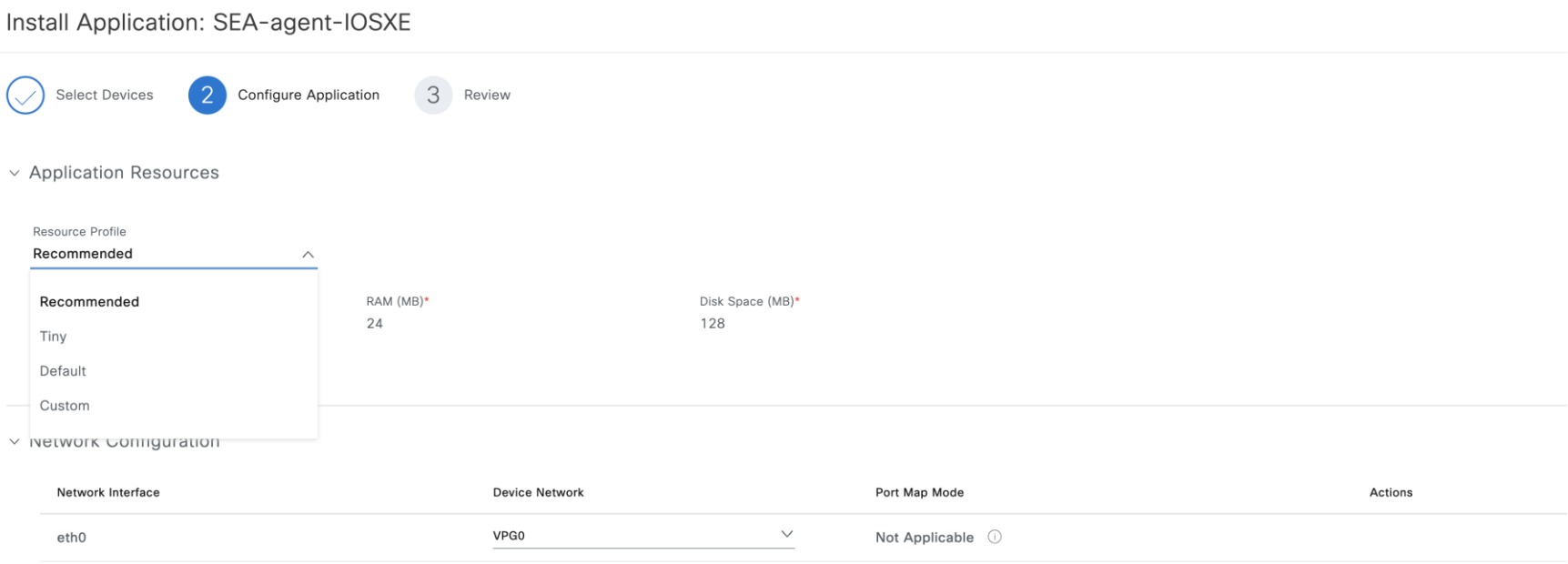
APP installation via IOT OD



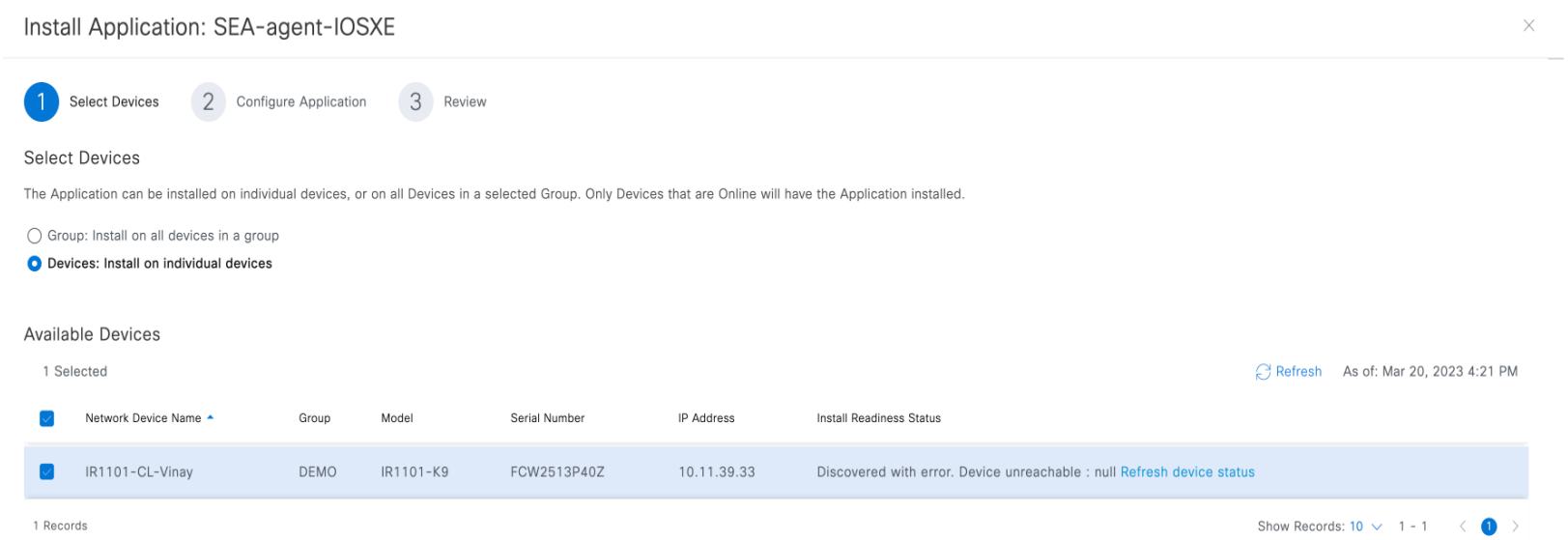
App Installation via IoT OD



APP installation via IOT OD



APP installation via IOT OD



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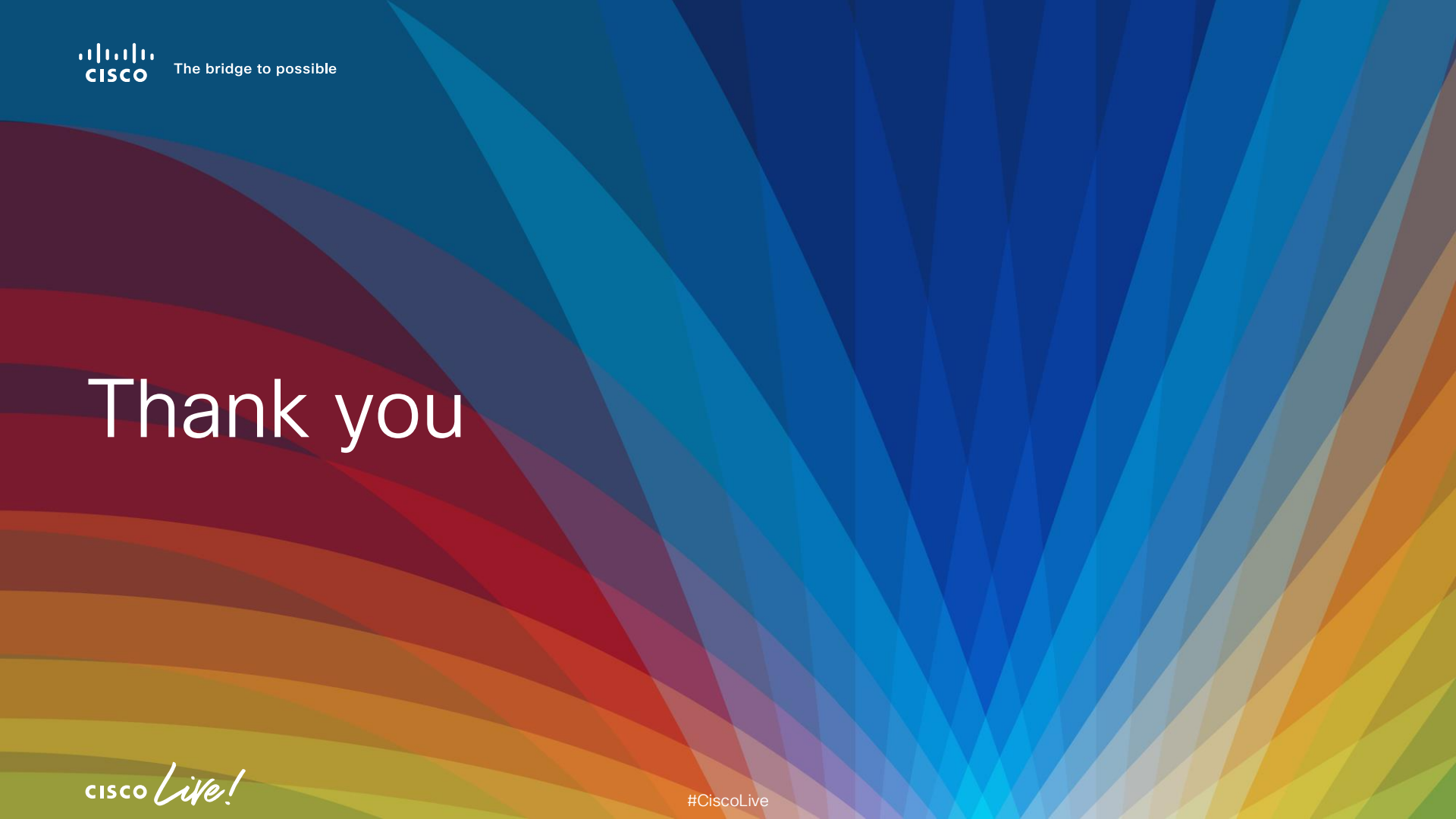
cisco
The bridge to possible
Thank you
cisco Live!
#CiscoLive


cisco Live!
Let's go
#CiscoLive