

LAB GUIDE

Voice-driven network operations for an integrated and programmable SDN

DEVWKS-1908

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Learning Objectives

Upon completion of this lab, you will be able to use APIs to orchestrate multi-domain:

- Health checks
- Macro-segmentation
- Micro-segmentation

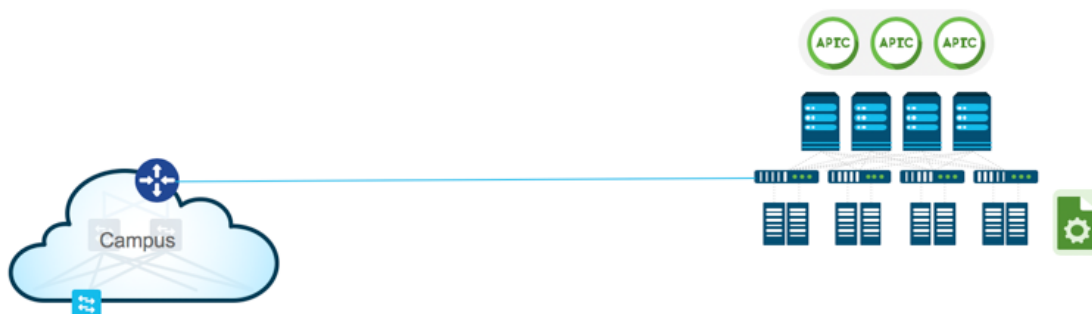
Requirements

- Laptop with Google Chrome browser.
- Cisco AnyConnect Client.
- Postman
- A Postman collection and environment created for [DEVWKS-1908](#)
- Lab Information Sheet with credentials, IPs and URLs of Lab components

Components

- Cisco DNA Center 1.3.0
- Cisco ACI 4.0(3d)
- VMware vCenter 6.0.0

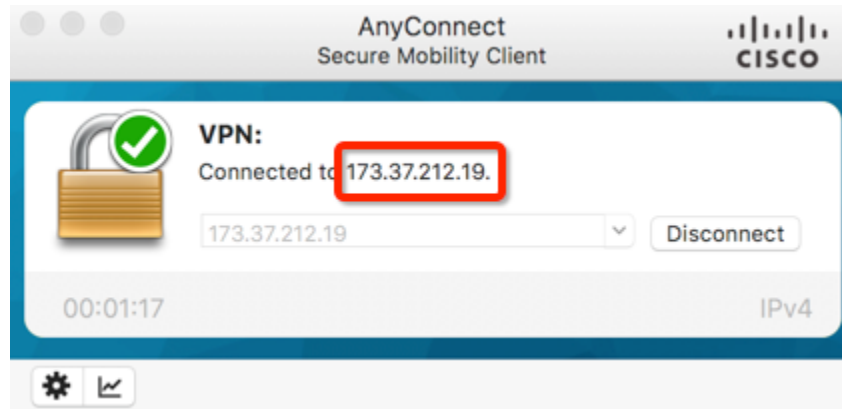
Network Diagram



Lab Access

In order to access this Lab, you need to establish a VPN connection using the Cisco AnyConnect Client which is already installed on your laptop.

Check if AnyConnect Client is already connected to the LAB VPN, if so, you can skip this section and go to **LAB1**.



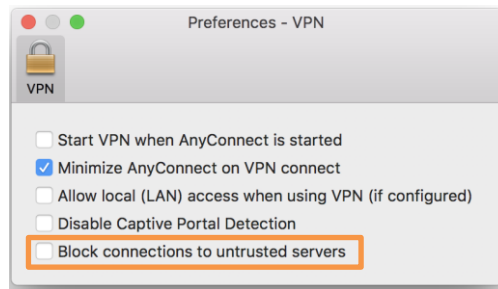
Please, follow these steps to connect to the VPN:

*Note: The required VPN information is provided in the **Lab Information Sheet***

1. Open Cisco AnyConnect on your laptop.
2. Enter the IP address of the VPN server, click on the small **gear icon** located at the bottom left corner of the window:



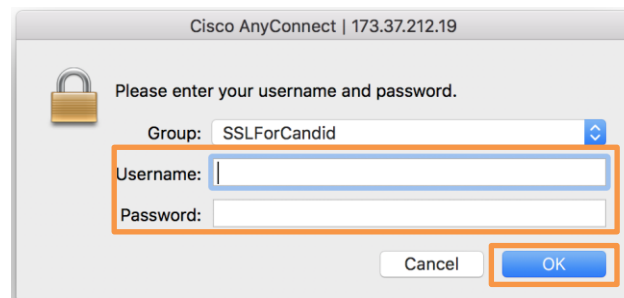
3. Un-check the **Block connections to untrusted servers** option:



4. Close Preferences window and click **Connect**.
5. If the following security warning appears, click **Connect Anyway**:



6. Enter your username and password and click **OK**:



At this point you should be connected the Lab VPN.

Prepare Lab environment

Intent based networking controllers have open northbound API's that enable the voice driven operations demonstrated during the session.

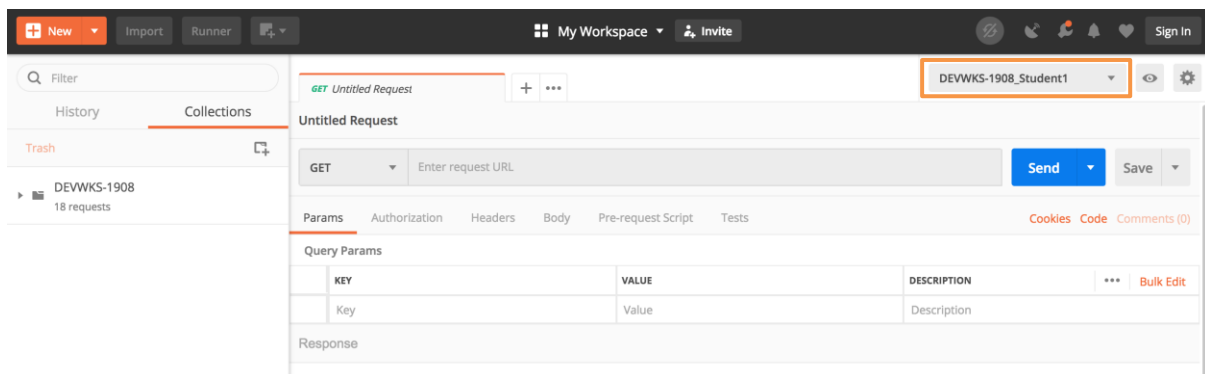
In this task you will setup Postman, login into SDN controllers UI, and test the connection to them via APIs that enable these voice driven operations.

If you would like to test out these voice commands, feel free to step over to the speaker desk where we have an Echo to allow you to test this. The Appendix 2 has a list of supported commands for the skill at this time.

Adding new commands is as easy as figuring out the API call for your intent and simply mapping it to a new skill.

Step 1 Setup Postman environment

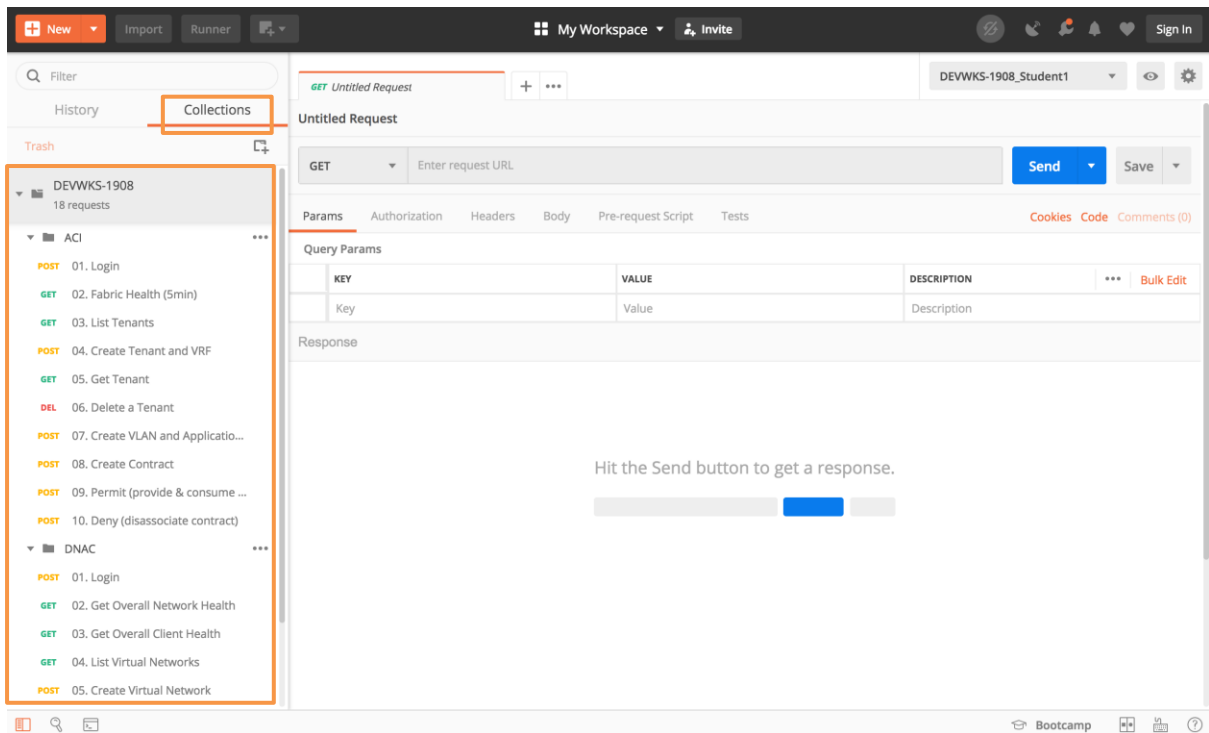
Open Postman and select the **Environment** called “DEVWKS-1908_StudentX”, where X is your assigned student number. This environment contains a set of key-value pairs that will be used in API requests and will save you time running the Lab.



You can click on the **Eye** button to see the content of the variables.

Step 2 Setup Postman collection

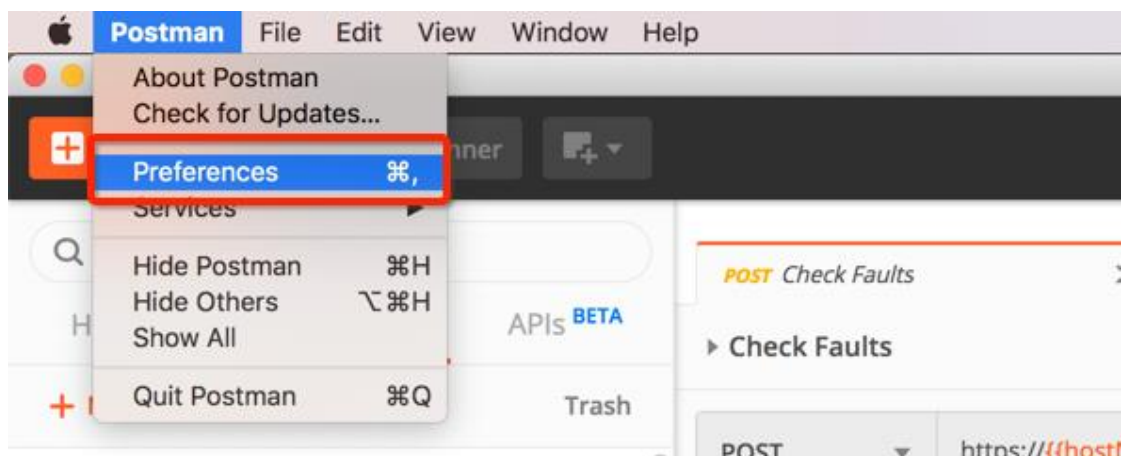
Click the **Collections** tab in the left panel and open the collection called “DEVWKS-1908”:



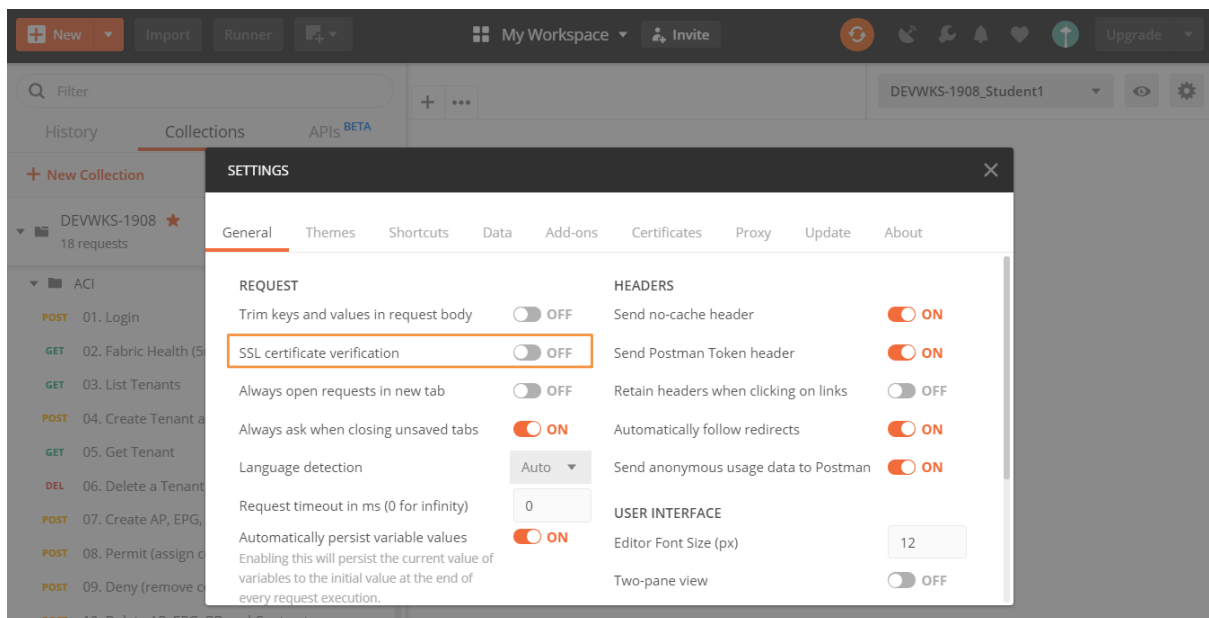
Inside each folder, the requests are sequential. **Don't** run them yet, we will run them one by one during the Lab and check on the UI for the controllers to see the effect of the requests.

Step 3 Disable SSL certificate verification

Open **Postman>Preferences**:

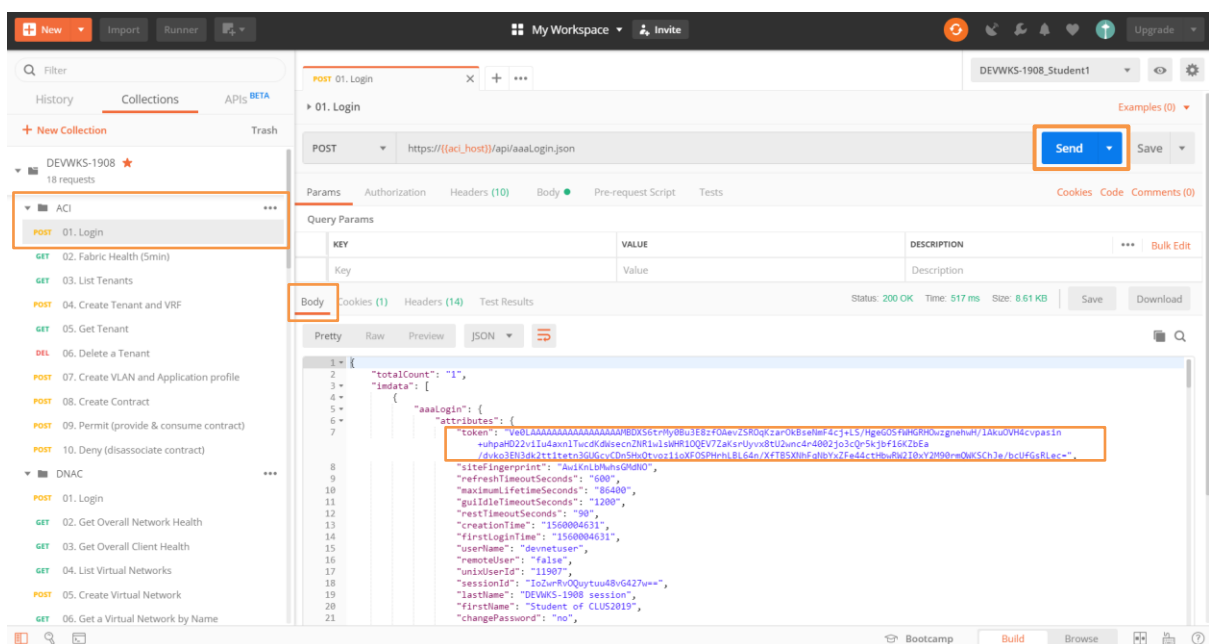


Make sure that SSL certificate verification is **OFF**:



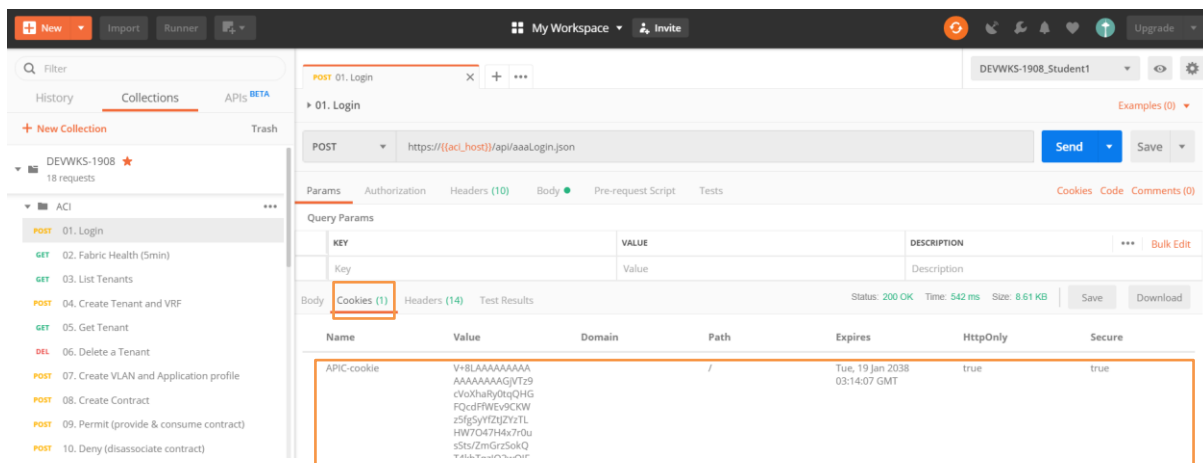
Step 4 Test connection to APIC

Let's check the connection to APIC controller. Within the **ACI** folder, open the POST request called **"01. Login"** and click **Send**:



You just sent a POST request to authenticate with APIC. The body of the response should include an authentication **token** as shown above.

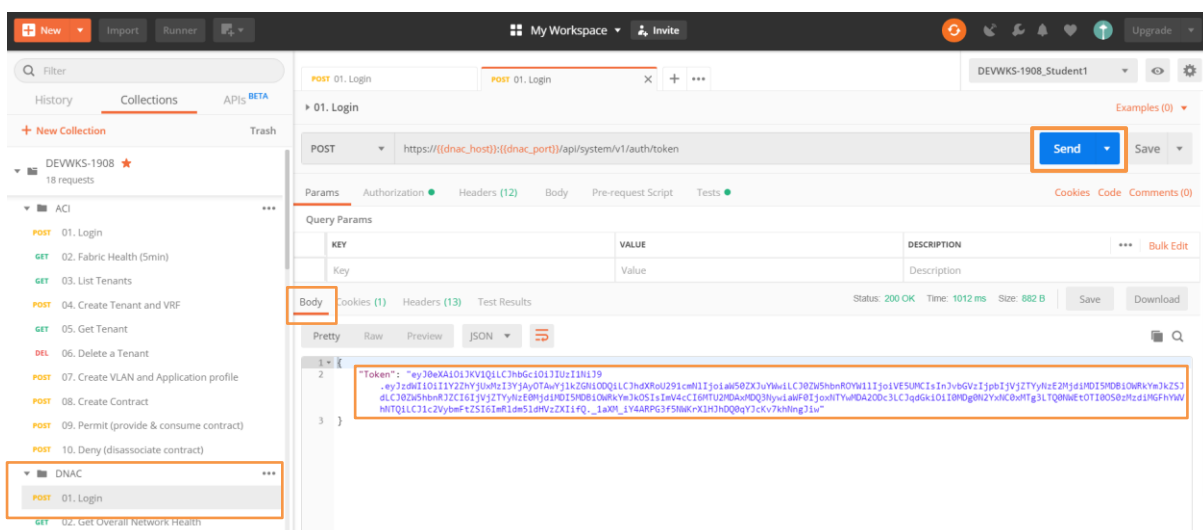
The response has also a **cookie** that Postman will automatically use to authenticate subsequent requests.



NOTE: If this request fails you may need to accept the certificate from the controller in your browser <http://blog.getpostman.com/2014/01/28/using-self-signed-certificates-with-postman/>

Step 5 Test connection to DNAC

Let's check the connection to DNAC controller. Within the **DNAC** folder, open the POST request called **"01. Login"** and click **Send**:



The body of the response should include an authentication **token** as shown above. This token is stored in an environment variable and used in subsequent requests.

Step 6 Open SDN controllers UI

Open Google Chrome browser and navigate to the APIC and DNAC URLs provided in the Lab Information Sheet.

If the following warning appears in your browser, click **Advanced**:



Your connection is not private

Attackers might be trying to steal your information from **10.201.146.32** (for example, passwords, messages, or credit cards). [Learn more](#)

NET::ERR_CERT_AUTHORITY_INVALID

☐ Help improve Safe Browsing by sending some [system information and page content](#) to Google.
[Privacy policy](#)

Advanced

Back to safety

and then click on **Proceed to <IP> (unsafe)** link:

Hide advanced

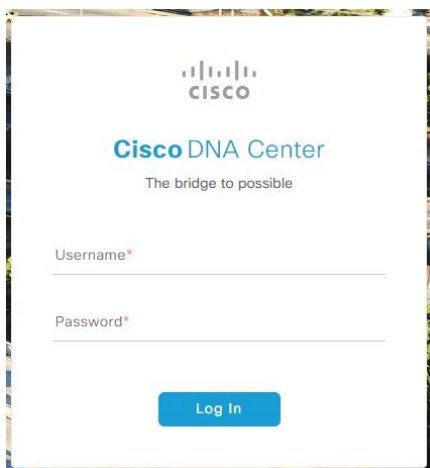
Back to safety

This server could not prove that it is **10.201.146.32**; its security certificate is not trusted by your computer's operating system. This may be caused by a misconfiguration or an attacker intercepting your connection.

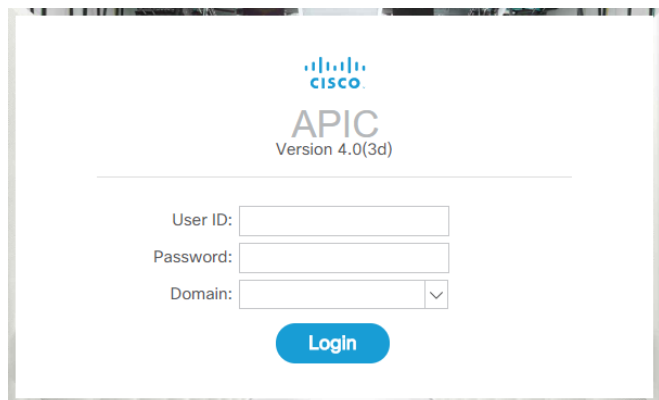
[Proceed to 10.201.146.32 \(unsafe\)](#)

Step 7 Provide credentials

Enter your credentials in the login screens (you can leave APIC Domain in blank) and click **Login**:



The screenshot shows the Cisco DNA Center login page. At the top is the Cisco logo and the text 'Cisco DNA Center' with the tagline 'The bridge to possible'. Below this are two input fields: 'Username*' and 'Password*'. At the bottom is a blue 'Log In' button.



The screenshot shows the Cisco APIC login page. At the top is the Cisco logo and the text 'APIC Version 4.0(3d)'. Below this are three input fields: 'User ID:', 'Password:', and 'Domain:'. At the bottom is a blue 'Login' button.

You should the now be in the home page of Cisco APIC and Cisco DNAC controllers.

LAB1: Network Health Check

Task 1: Check the status of the Software Defined Network

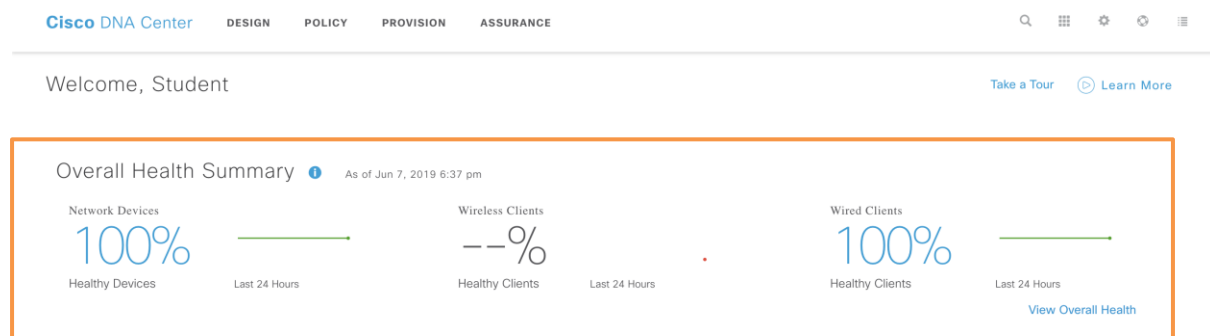
In this task you will check the health of the Software-defined Access (SDA) network and Software-defined DC Fabric in two ways:

1. Using the UI of Cisco APIC and Cisco DNAC controllers
2. Making RESTful API requests from Postman

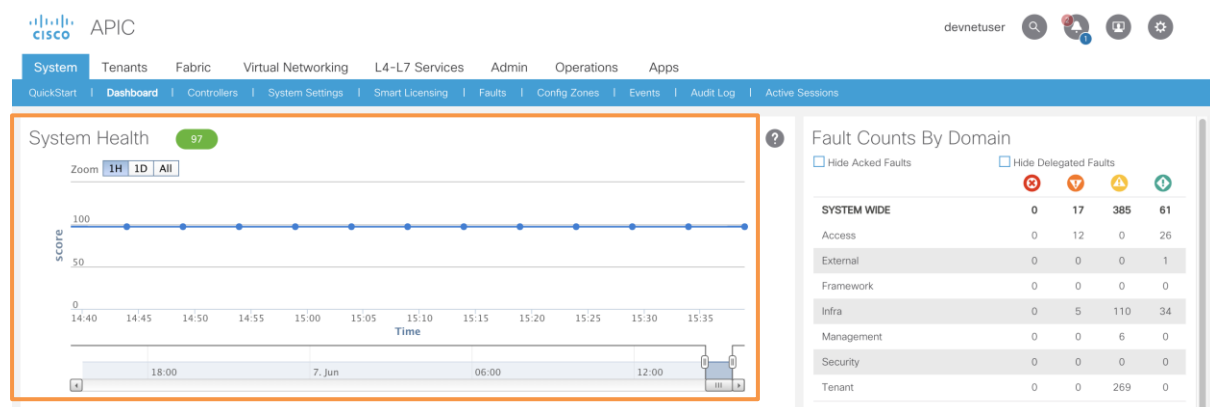
This was done by the Alexa Robot skill when we asked her **“What is the current status of the network?”**.

Step 1 Check network health on controllers UI

Switch to the Cisco DNAC and Cisco APIC home pages you opened in Google Chrome in the previous task, check the Overall Health of DNAC:



And the System Health of ACI:



Step 2 Get the SDA network health via API

Open Postman, within the folder **DNAC**, open the GET request called **“Get Overall Network Health”** and click **Send**:

The screenshot shows the Postman interface with a GET request to the DNAC API. The request is sent, and the response is displayed in JSON format. The response includes a healthScore of 100, totalCount of 2, and goodCount of 2.

```

1 {
2   "version": "1.0",
3   "response": [ {
4     "time": "2019-06-08T00:15:00.000+0000",
5     "healthScore": 100,
6     "totalCount": 2,
7     "goodCount": 2,
8     "unmonCount": 0,
9     "failCount": 0,
10    "badCount": 0,
11    "entity": null,
12    "timeInMillis": 1559952900000
13  } ],
14  "measuredBy": "global",
15  "latestMeasuredByEntity": null,
16  "latestHealthScore": 100,
17  "monitoredDevices": 2,
18  "monitoredHealthyDevices": 2,
19  "monitoredUnhealthyDevices": 0,
20  "unmonitoredDevices": 0,
21  "healthDistribution": [ {

```

As shown above, the response includes the same overall network health value you just saw in DNAC UI.

Repeat the same with the request called “**Get Overall Client Health**”.

Step 3 Get the DC fabric health through API

Open the folder **ACI**, and send the GET request called “**Fabric Health (5min)**”:

The screenshot shows the Postman interface with a GET request to the ACI API. The request is sent, and the response is displayed in JSON format. The response includes fabricOverallHealthHistMin values.

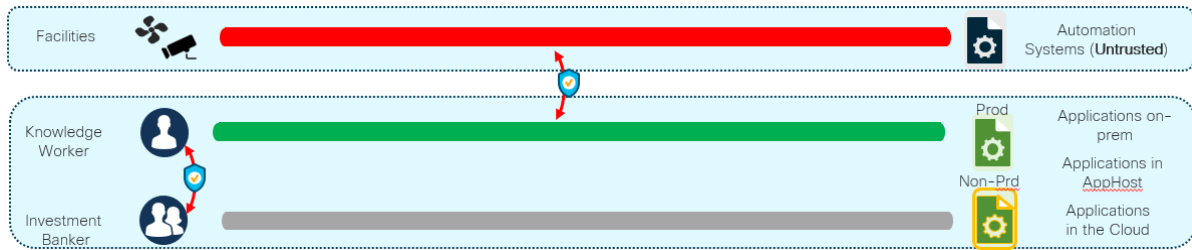
```

1 {
2   "totalCount": "1",
3   "imdata": [
4     {
5       "fabricOverallHealthHistMin": {
6         "attributes": {
7           "childAction": "",
8           "cnt": "30",
9           "dn": "topology/HDFabricOverallHealth5min-0",
10          "healthAvg": "97",
11          "healthMax": "97",
12          "healthMin": "97",
13          "healthSpec": "0",
14          "healthThr": "0",
15          "healthTr": "0",
16          "index": "0",
17          "lastCollOffset": "300",
18          "repIntvEnd": "2019-06-08T08:38:58.529-07:00",
19          "repIntvStart": "2019-06-08T08:33:58.420-07:00",
20          "status": ""
21        }
22      }
23    ]
24  }

```

As shown above, the response includes the fabric health values you just saw in the UI.

LAB2: Macro Segmentation



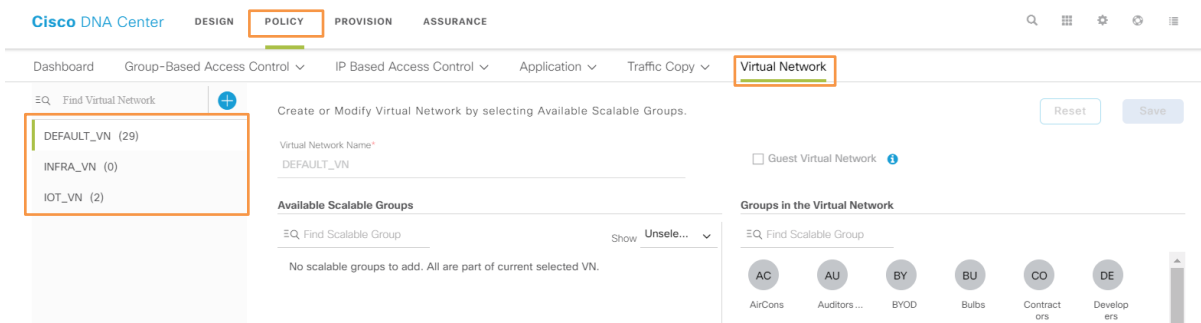
Task 1: Create a Macro-segment in Cisco DNAC

In this task and the next one, you will isolate Untrusted IoT devices by creating a Virtual Network in Cisco DNAC and a Tenant in Cisco ACI. This was done by the Alexa Robot skill when we asked her “**Create a new segment called Untrusted**”.

You will perform these tasks by making API requests from Postman. The results will be verified on the UI of each controller.

Step 1 Check Virtual Networks on DNAC UI

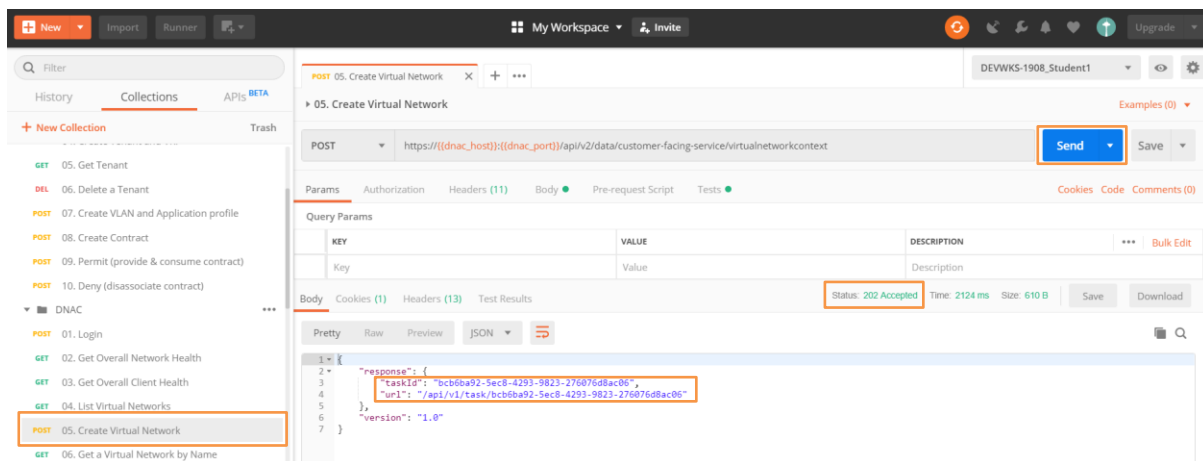
Open **DNAC UI**, go to **Policy > Virtual Network** and check the existing Virtual Networks:



In the following steps we will check, through the DNAC API, the same information and will create a new Virtual Network.

Step 2 Create a new Virtual Network via DNAC API

Let's now create a new Virtual Network (VN) called “**Sx_Untrusted**” in DNAC (x = Student number). You don't need to set the VN name, there is already a variable with this value in your Postman environment. Send to **DNAC** the POST request called “**Create Virtual Network**”:

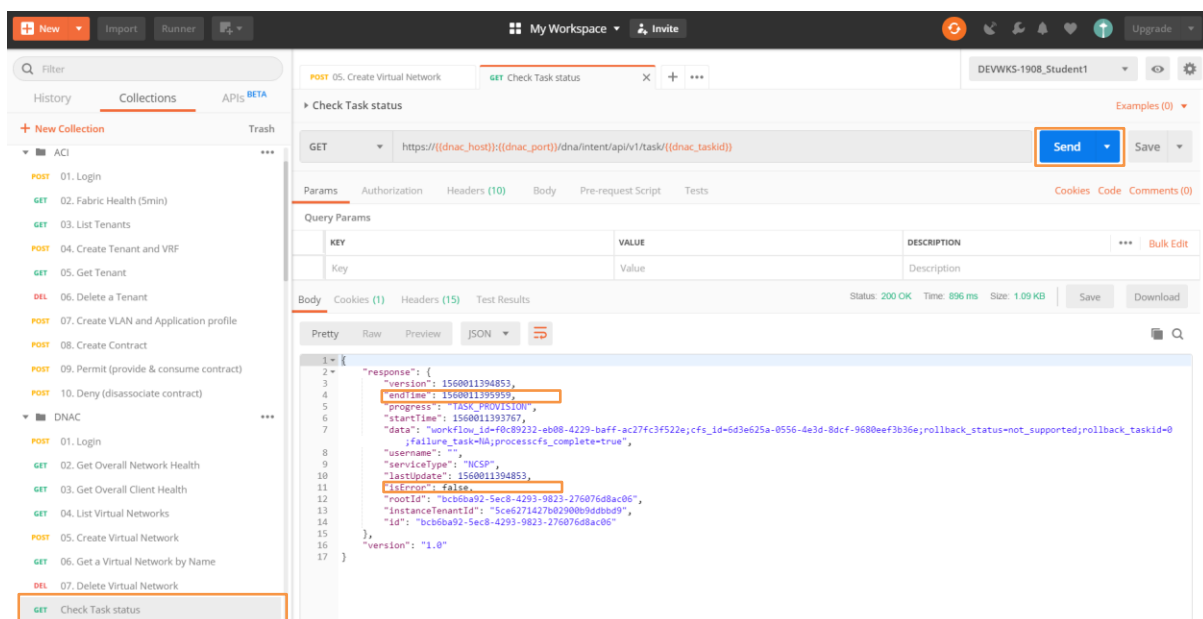


Most of the calls on DNAC controller are **asynchronous** (PUT/POST/DELETE). Accepted asynchronous requests will return the HTTP status code **202 Accepted**, and as shown above, a **taskId** is provided in the response.

You need to poll the task status to find out if the creation was successful. The next step shows how to do this.

Step 3 Check DNAC task status

To check the status of the previous task, send to **DNAC** the request called “**Check Task Status**”:



The presence of "**endTime**" in the response means the task has finished. "**isError**" being false means the task was successful.

Notice there is a **{{dnac_taskid}}** in the URL being called. Anything inside the **{{}}** is a variable. In this case dnac_taskid. This was set behind the scenes in the previous API call.

Once the task finishes, you should be able to see the newly created Virtual Network **“Sx_Untrusted”** by running from Postman GET requests **“Get a Virtual Network by Name”** or **“List Virtual Networks”** provided in the DEWKS-1908 > DNAC folder.

Step 4 Confirm Virtual Network creation on DNAC UI

Open **DNAC** UI, refresh the page **Policy > Virtual Network** and confirm that the Virtual Network was created.

Task 2: Create a Macro-segment in Cisco ACI

In this task, you will isolate Untrusted devices by creating a Tenant in Cisco ACI. This was done by the Alexa Robot skill when we asked **“Create a new segment called Untrusted”**.

You will perform these tasks making API requests from Postman. The results will be verified on the UI of APIC.

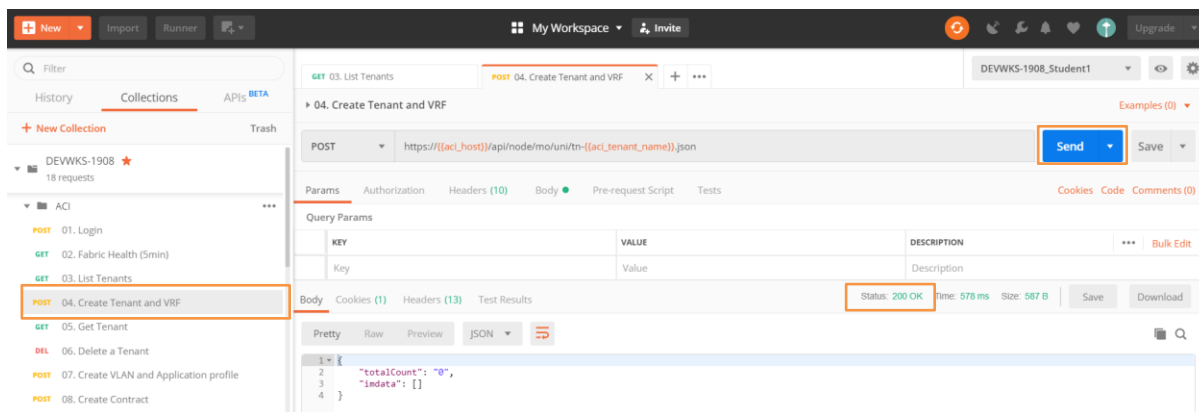
Step 1 Check ACI tenants on APIC UI

Open **APIC** UI, click on the **Tenants** tab and check the existing Tenants (you may need to scroll down or change the number of Objects Per Page to see the full list):

Name	Alias	Description	Bridge Domains	VRFs	EPGs	Health Score
common			1	2	0	100
infra			2	2	2	100
iot			2	1	3	100
mgmt			1	2	0	100
POD1			3	1	3	99
POD10			3	1	3	99
POD11			3	1	3	99
POD12			3	1	3	99
POD13			3	1	3	99
POD14			3	1	3	99
POD15			3	1	3	99
POD16			3	1	3	99
POD17			3	1	3	99
POD18			3	1	3	99

Step 2 Create a new Tenant and VRF via APIC API

Let's now create a new Tenant called **“Sx_Untrusted”** in ACI (x = Student number) and within this tenant a VRF called **“Sx_Untrusted-VRF”**. You don't need to set the tenant/VRF name, there are already variables with these values in your Postman environment. Send to **APIC** the POST request called **“Create Tenant and VRF”**:



If the HTTP response status is **200 OK**, you should now be able to see the new tenant and VRF by running from Postman the GET request called **“Get Tenant”**.

Step 3 Confirm tenant and VRF creation on APIC UI

Open **APIC** UI, click on the **Tenants** tab and confirm that the new tenant and VRF were created:

The screenshot shows the Cisco APIC (Application Policy Infrastructure Controller) user interface. The 'Tenants' tab is selected and highlighted with an orange box. Below the navigation bar, there is a table titled 'All Tenants'. The table has columns for Name, Alias, Description, Bridge Domains, VRFs, EPGs, and Health Score. The row for 'S1_Untrusted' is highlighted with an orange box, and its 'VRFs' value of '1' is also highlighted with an orange box. The table shows a list of tenants with their respective metrics.

Name	Alias	Description	Bridge Domains	VRFs	EPGs	Health Score
POD25			3	1	3	99
POD26			3	1	3	99
POD27			3	1	3	99
POD28			3	1	3	99
POD29			3	1	3	99
POD3			3	1	3	99
POD30			3	1	3	99
POD4			3	1	3	99
POD5			3	1	3	99
POD6			3	1	3	99
POD7			3	1	3	99
POD8			3	1	3	99
POD9			3	1	3	99
S1_Untrusted			0	1	0	100

Task 3: Delete a Macro-segment from Cisco DNAC

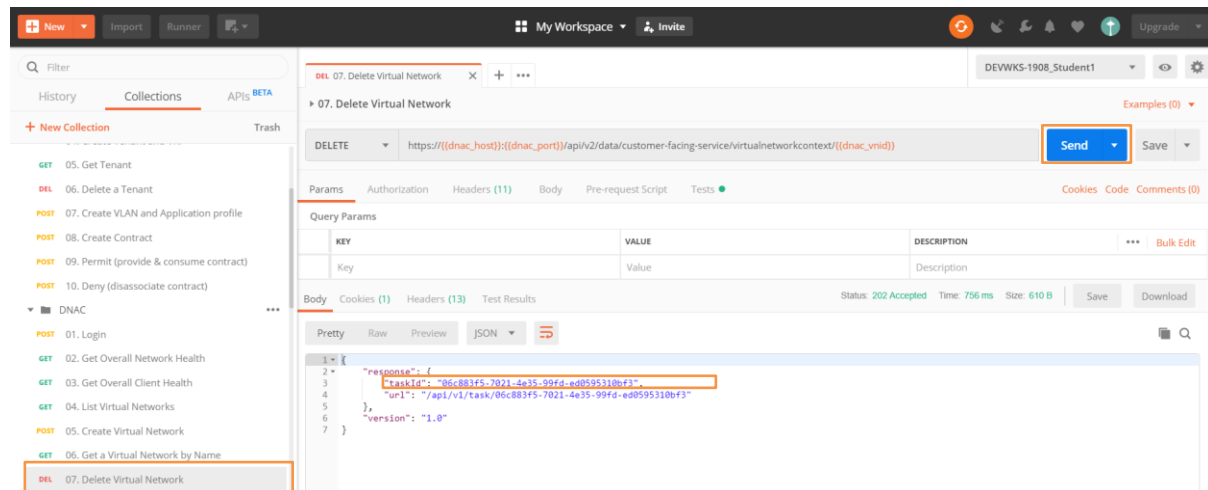
In this task you will delete the previously created Macro-Segment. This was done by the Alexa Robot skill when we asked her **“Delete the segment called Untrusted”**.

You will perform this task making API requests from Postman. The results will be verified on the DNAC UI.

Step 1 Delete a Virtual Network from DNAC via API

Let's delete the previously created Virtual Network (VN). Open Postman and send to **DNAC** the GET request called "**Get Virtual Network by Name**". Behind the scenes, this will take the VN id from the response and assign it to an environment variable that will be used in the next API call.

Now send to **DNAC** the DELETE request called "**Delete Virtual Network**".



This is an **asynchronous** call. Check that the HTTP status code is **202 Accepted** as shown above. The **taskId** provided in the response will be used in the next step to poll the task status to find out if the deletion was successful.

Step 2 Confirm that the VM was deleted on DNAC UI

Open **DNAC** UI, refresh the page **Policy > Virtual Network** and confirm that the Virtual Network was deleted.

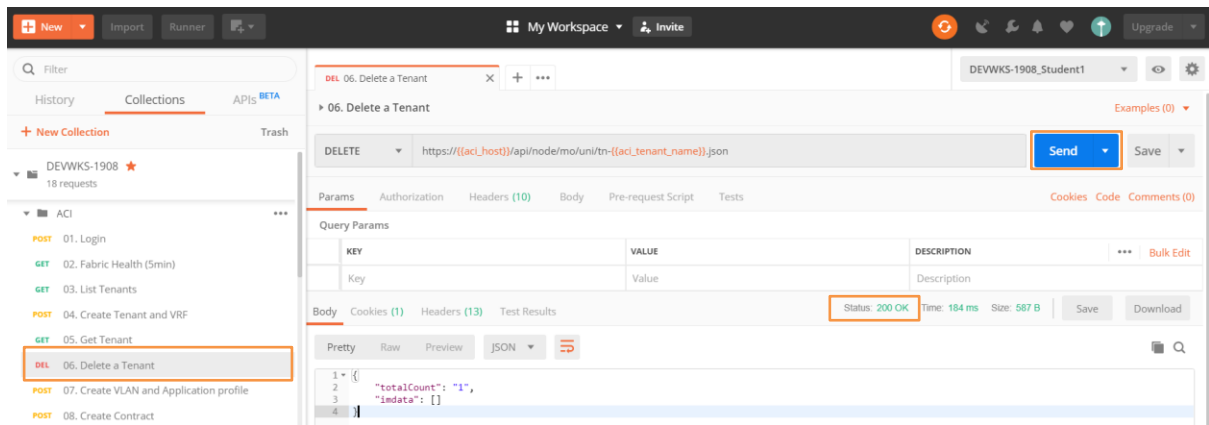
Task 4: Delete a Macro-segment from Cisco ACI

In this task you will delete the previously created Macro-Segment. This was done by the Alexa Robot skill when we asked her "**Delete the segment called Untrusted**".

You will perform this task making API requests from Postman. The results will be verified on the APIC UI.

Step 1 Delete Tenant from ACI via API

Let's delete the previously created Tenant. Open Postman and send to **APIC** the DELETE request called "**Delete Tenant**".



Step 2 Confirm tenant deletion on APIC UI

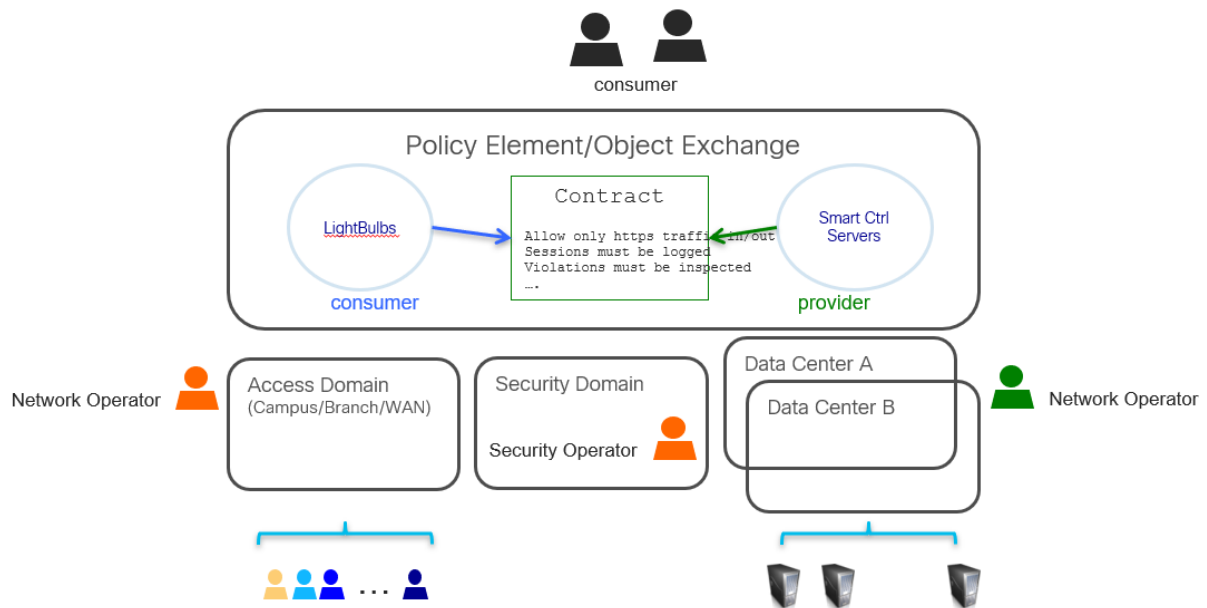
Open **APIC UI**, click on the **Tenants** tab and confirm that the tenant was deleted.

LAB3: Micro Segmentation

Task 1: Enabling Micro-segmentation in Cisco ACI

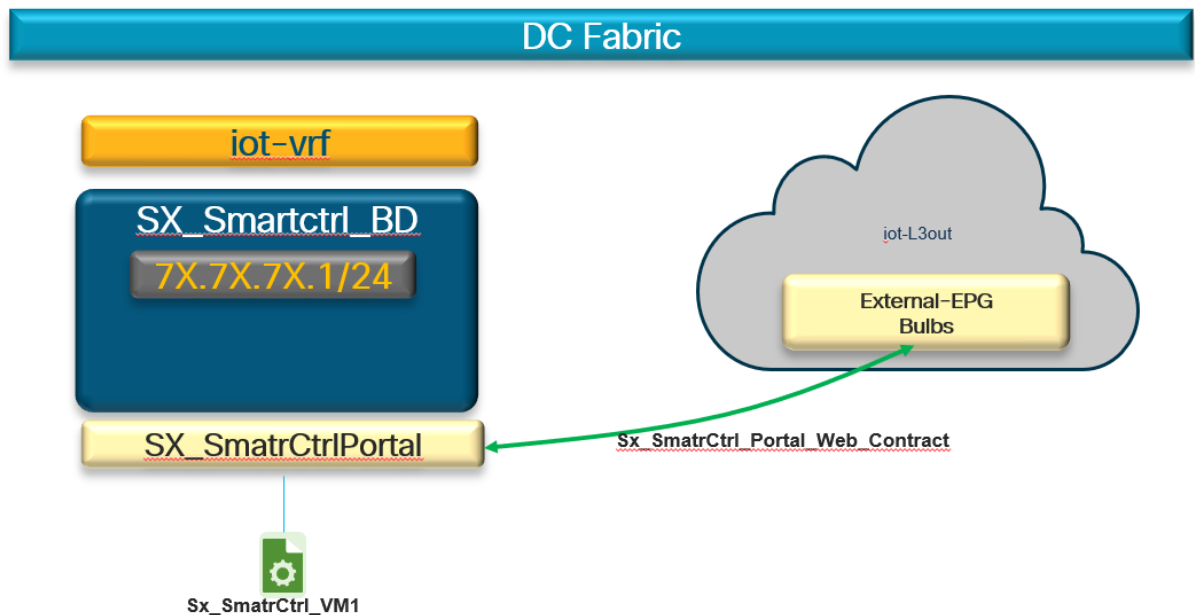
In this task we will create a series of ACI logical constructs in order to segment and secure the IoT application and then allow specific traffic from Smart Controller servers to light bulbs.

This was done by the Alexa Robot skill when we asked her “**Allow light bulbs to talk to smart controller servers**”.



The following logical constructs will be created within the IoT tenant:

- One **Application Profile** (AP) within the IoT tenant. An AP is a collection of different EPGs and policies needed to communicate between them.
- One application **Endpoint Group** (EPG) within the AP for the Web servers. An EPG is a collection of endpoints requiring the same policy treatment. i.e. app tiers, or services.
- One **Bridge Domain** (BD) and one **Subnet**. BDs are used to define a L2 boundary (Flood Domain) and impose additional constraints (such as no broadcast) within that L2 boundary. Not a VLAN, simply a container for subnets. EPGs can only be a member of a single BD. The BD also acts as the default gateway for the subnet.
- One **Contract** to permit HTTP and ICMP traffic. Contracts specify how an EPG communicates or interact with other EPGs using dynamically assigned ACLs. All Contracts consists of 1 or more Subjects, where each Subject contains 1 or more Filters, where each Filter contains 1 or more Entries. Each Entry is equivalent to a line in an ACL applied on the Leaf switch that the EP (within the EPG) is attached to.



Step 1 Open the IoT tenant on APIC GUI

Open APIC GUI, click on **Tenants** tab and then double-click on “**iot**” tenant:

APIC

System **Tenants** Fabric Virtual Networking L4-L7 Services Admin Operations Apps

ALL TENANTS | Add Tenant | Tenant Search: name or descr | common | **iot** | POD1 | mgmt | infra

All Tenants

Name	Alias	Description	Bridge Domains	VRFs	EPGs	Health Score
common			1	2	0	100
infra			2	2	2	100
iot			2	1	3	100
mgmt			1	2	0	100
POD1			3	1	3	99
POD10			3	1	3	99
POD11			3	1	3	99
POD12			3	1	3	99
POD13			3	1	3	99
POD14			3	1	3	99
POD15			3	1	3	99
POD16			3	1	3	99
POD17			3	1	3	99
POD18			3	1	3	99

Page 1 Of 1 | Objects Per Page: 100 | Displaying Objects 1 - 34 Of 34

Step 2 Verify the Application Profiles for IoT tenant

On the left panel menu, open the **Application Profiles** folder, you will see some Application Profiles (AP) there, each of them has one EPG.

The screenshot shows the Cisco APIC interface with the 'Tenants' tab selected. In the left-hand navigation pane, the 'Application Profiles' folder under the 'IoT' tenant is highlighted with an orange box. The main content area displays 'Application Profiles' for the IoT tenant, showing three profiles: HVAC-AP, Patch-AP, and SmartCtrl-AP. Each profile is represented by a purple circle with 'AP' and a green plus sign, connected by a vertical line to a blue circle with 'E' representing an EPG (x 1).

Step 3 Verify the Bridge Domains for IoT tenant

On the left panel menu, navigate to **Networking>Bridge Domains** to see the list of BDs:

The screenshot shows the Cisco APIC interface with the 'Networking - Bridge Domains' page. In the left-hand navigation pane, the 'Bridge Domains' folder under the 'Networking' section is highlighted with an orange box. The main content area displays a table of bridge domains for the IoT tenant.

Name	Alias	Type	Segment	Multicast Address	Custom MAC Address	L2 Unknown Unicast	ARP Flooding	Unicast Routing	Subnet
HVAC-BD		regular	16121805	225.1.79....	00:22:BDc...	Hardware...	True	True	41.41.41.1/24
SmartCtrl...		regular	16482213	225.1.21....	00:22:BDc...	Hardware...	True	True	40.40.40.1/24

Step 4 Verify the Contracts for IoT tenant

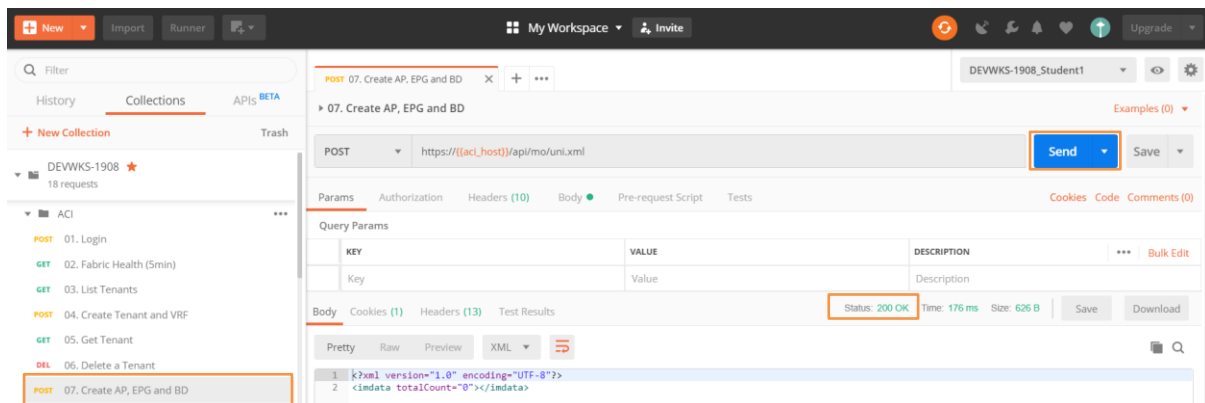
On the left panel menu, navigate to **Contracts>Standard** folder to see the list of contracts:

The screenshot shows the Cisco APIC interface with the 'Contracts - Standard' page. In the left-hand navigation pane, the 'Standard' folder under the 'Contracts' section is highlighted with an orange box. The main content area displays a table of contracts for the IoT tenant.

Name	Alias	Scope	QoS Class	Target DSCP	Subjects	Tags	Exported Tenants	Description
Allow_Web		VRF	Unspecif...	Unspecif...	HTTP, ICMP			
HVAC_Po...		VRF	Unspecif...	Unspecif...	HTTP_ICMP			
SmartCtrl...		VRF	Unspecif...	Unspecif...	HTTP_ICMP			

Step 5 Create a new AP, EPG, BD and Contract for tenant IoT via APIC API

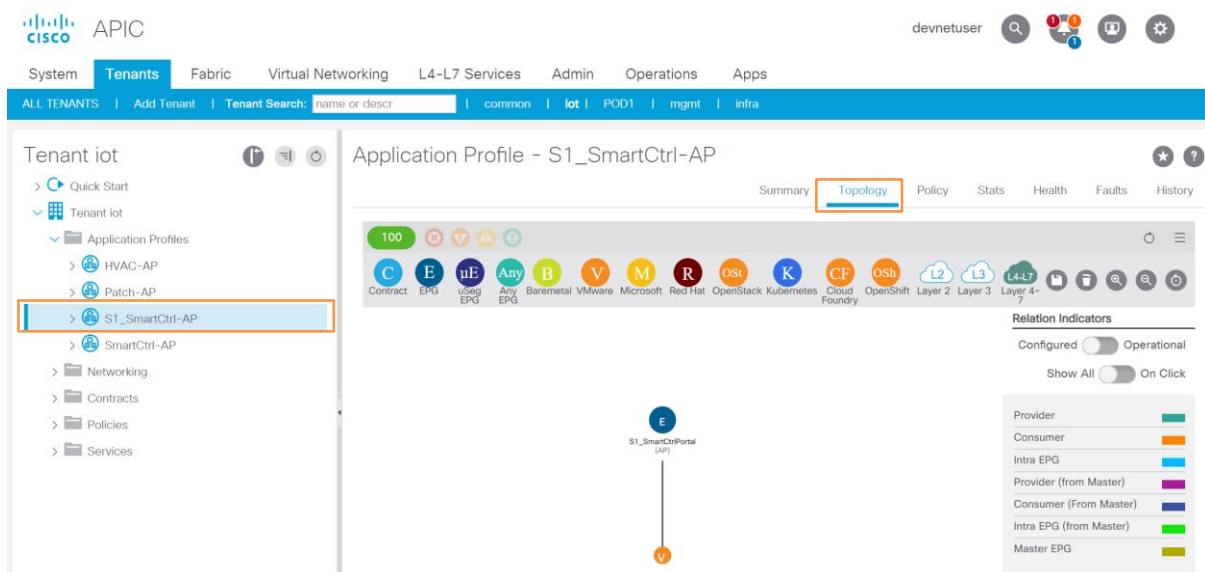
In this step you will create a new AP called “**Sx_SmartCtrl-AP**”, an application EPG called “**Sx_SmartCtrlPortal**”, a BD called “**Sx_SmartCtrl-BD**” and a contract called “**Sx_SmartCtrl_Portal_Web_Contract**”. Open Postman and send to **APIC** the POST request called “**Create AP, EPG, BD and Contract**”:



Confirm that HTTP response status is **200 OK** and repeat steps 2, 3 and 4 of this task to confirm that the logical constructs were created.

Step 6 Visualize the application topology on APIC UI

In this step you will see the relationship between different EPGs of your application. Open APIC UI, click on your new AP called “**Sx_SmartCtrl-AP**”, then click on the **Topology** tab as shown below:



In the next steps we will provide a contract from this EPG and consume the contract from the Light Bulbs external EPG.

Step 7 Establish a contract between EPGs via APIC API

In ACI, by default, endpoints within different EPGs can't talk to each other. In order to allow HTTP and ICMP traffic from Smart Controller servers to light bulbs, we have to provide the contract called “**Sx_SmartCtrl_Portal_Web_Contract**” from the application EPG called “**Sx_SmartCtrl-AP**” and consume it from the external EPG called

The screenshot displays the Postman REST client interface. On the left, a collection named 'DEVWKS-1908' is open, showing a list of 10 requests. The 9th request, 'POST 09. Permit (assign contract to EPGs)', is highlighted with a red box. The main panel shows the details of this request, including the URL 'https://([aci_host])/api/mo/unl.xml', the 'Send' button (highlighted with a red box), and the response body in XML format. The response body is shown in a light blue box with the following content:

```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <imdata totalCount="0"></imdata>

```

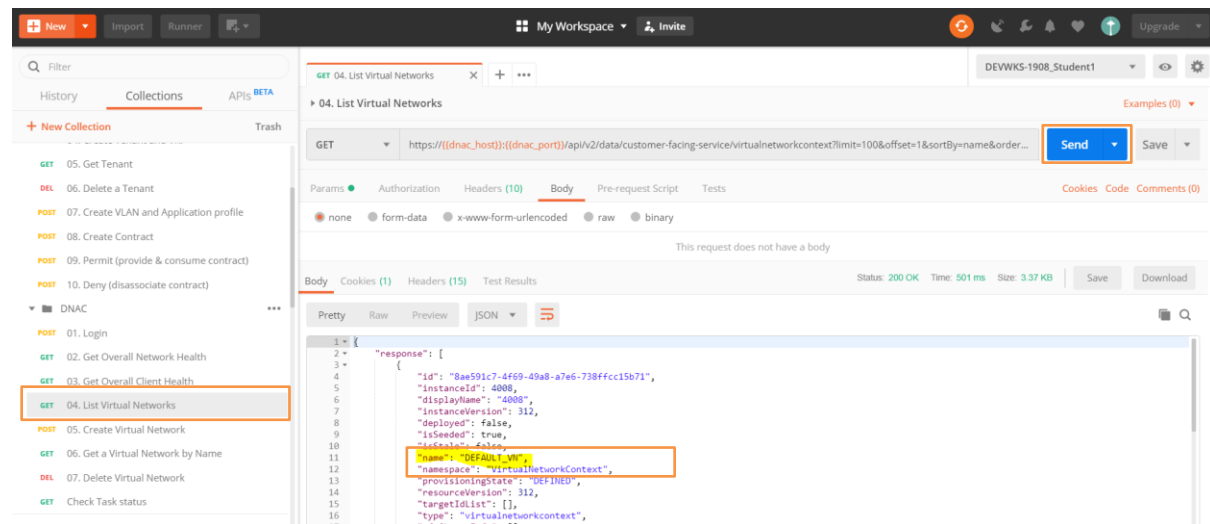
If you go back to the APIC UI, and click the **refresh** icon the topology menu bar, you will see a relationship between the application EPG (Smart Controller servers) and the external EPG (Bulbs), where the 1st provides the contract and the 2nd consumes it.



Appendix 1 Extra API calls

Check Virtual Networks in DNAC via API

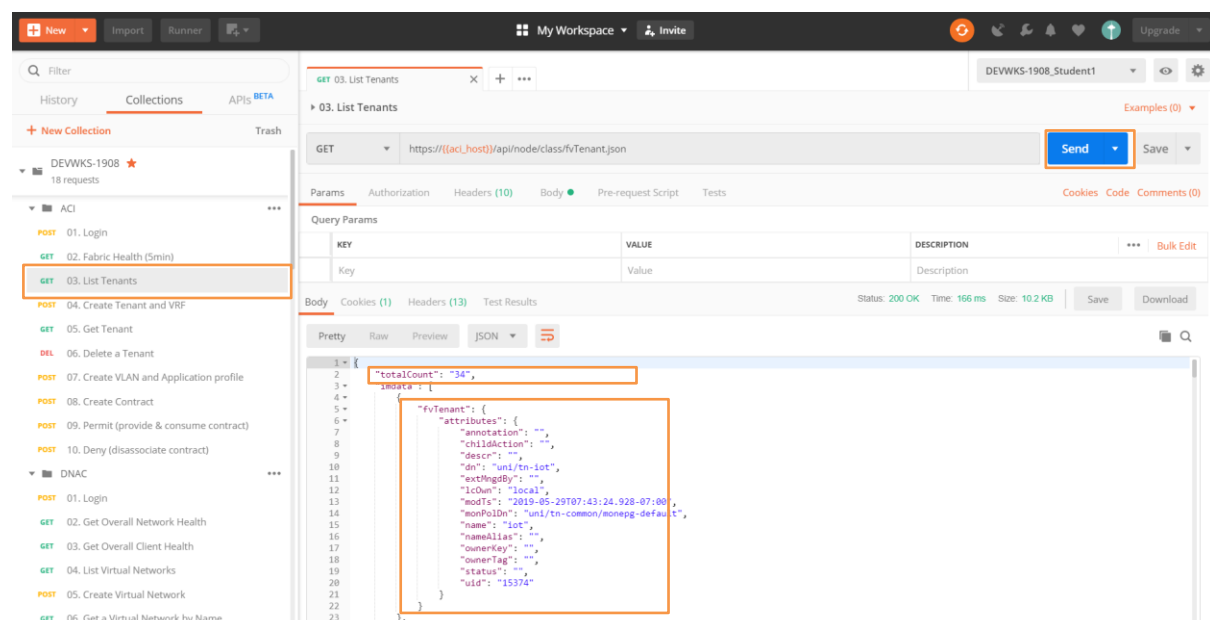
To get the list of virtual networks via APIs, open Postman and send to **DNAC** the GET request called “**List Virtual Networks**”:



A full list of Virtual Networks is received in the response.

Check ACI tenants via API

To get the list of tenants via API, open Postman and send to **APIC** the GET request called “**List Tenants**”:



Delete AP, EPG, BD and Contract

Open Postman and send to **APIC** the POST request called “**Delete AP, EPG, BD and Contract**”:

My Workspace Invite Upgrade

Filter History Collections APIs BETA

New Collection Trash

DEVWKS-1908 18 requests

ACI

- POST 01. Login
- GET 02. Fabric Health (5min)
- GET 03. List Tenants
- POST 04. Create Tenant and VRF
- GET 05. Get Tenant
- DEL 06. Delete a Tenant
- POST 07. Create AP, EPG, BD and Contract
- POST 08. Permit (assign contract to EPGs)
- POST 09. Deny (remove contract from EPGs)
- POST 10. Delete AP, EPG, BD and Contract

POST 07. Create AP, EPG, BD and Contract POST 01. Login POST 10. Delete AP, EPG, BD and Contract

DEVWKS-1908_Student1

10. Delete AP, EPG, BD and Contract Examples (0)

POST https://{{aci_host}}/api/mo/uni.xml Send Save

Params Authorization Headers (10) Body Pre-request Script Tests Cookies Code Comments (0)

Query Params

KEY	VALUE	DESCRIPTION	...	Bulk Edit
Key	Value	Description		

Body Cookies (1) Headers (13) Test Results Status: 200 OK Time: 95 ms Size: 626 B Save Download

Pretty Raw Preview XML Copy

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <imdata totalCount="0"></imdata>
```

Appendix 2 Alexa Robot Skill Intents

If you would like to test out Alexa voice commands, feel free to step over to the speaker desk where we have an Echo Dot to allow you to test this. This Appendix has a list of supported commands for the skill at this time.

- Alexa, ask Robot **what is the status of my network?**
- Alexa, ask Robot to **create a new segment**
(Accepted segments names are: trusted, untrusted, production)
- Alexa, ask Robot to **delete the segment called { }**
(Accepted segments names are: trusted, untrusted, production)
- Alexa, ask Robot to **allow light bulbs to talk to smart controllers**
- Alexa, ask Robot to **reset communications for light bulbs and smart controllers**
- Alexa, ask Robot **where is my smart controller server?**

Appendix 3 Reference links

- Step-by-Step guide to build a custom Alexa Skill in Python:
<https://github.com/alexa/skill-sample-python-helloworld-classes>

- Look in your Cisco Event app for these Walk-in Self-paced Labs:

LABCRS-3000: DNA Center: SD-Access/TrustSec/ACI Integration Lab

LABCRS-2003: DNA Center: SD-Access Distributed Campus Lab

LABACI-1234: ACI Micro-Segmentation Lab

LABACI-2148: ACI Monitoring, Stats, Analytics and notifications

LABSEC-1011: Cisco DNAC and ISE integration