Wi-Fi automation lab

Lab Guide - Day 1

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telenor

References / inspiration

https://github.com/CiscoDevNet/yangsuite/
https://postman.com
https://docs.ansible.com/ansible/latest/collections/cisco/ios/ios_facts_module.html
https://www.wifireference.com/2020/01/14/viewing-network-telemetry-from-the-catalyst-9800-with-grafana/
https://grafana.com/grafana/dashboards/13462-device-health-monitoring/
https://grafana.com/grafana/dashboards/12468-catalyst-9800-client-stats/
https://wirelessisfun.wordpress.com/2020/12/10/network-telemetry-data-and-grafana-part-1-the-advanced-netconf-explorer/
https://python.org
https://codeium.com

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Prerequisites

- Cisco Meraki account (https://dashboard.meraki.com)
- Juniper MIST account (https://manage.mist.com)
- Postman account (https://postman.com)
- Complete the pre-lab exercises before the deep dive labs
- Bring an Ethernet dongle if you don't have built-in port
- (optional) Bring an extra screen to show lab guide (or prepare to Alt-Tab)

Communications

- WebEx space: Wi-Fi automation lab
- Please help each other
- Sharing is caring ☺

Agenda

Pre-lab

- Choose your hypervisor
- Install Ubuntu Server w/Docker
- Install Postman
- Install VS Code
- (optional) install 9800-CL

Day 1

- Sort out pre-lab task problems
- Get to know the lab environment
- Connect VS Code to Ubuntu
- Install and explore Ansible
- Explore Python automation
- Install and explore YANG Suite
- Explore Postman
- Install and explore Grafana

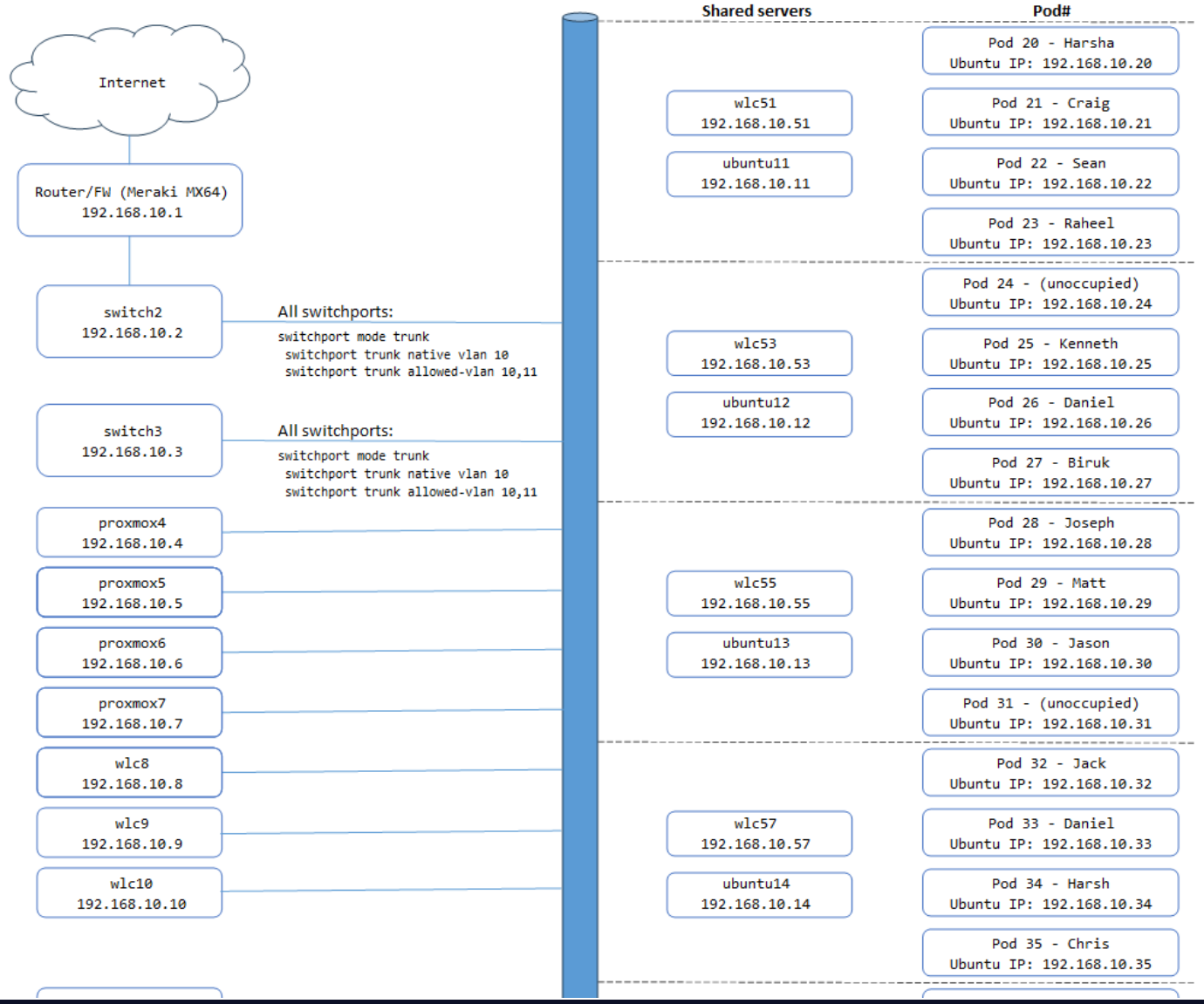
Day 2

- In-depth explore a topic of choice
  - Grafana / TIG-stack
  - Grafana Cloud
  - Ansible
  - Python
  - Cloud vendor automation (MIST or Meraki)

Scope

- In scope
  - Getting started with various systems/languages/solutions for lab purposes
  - Set up your own Ubuntu Linux server on your own laptop. It will be possible to use a shared server if you do not want or have possibility to install an Ubuntu VM on your laptop
  - Some nice examples to try various aspects of automation
  - Inspiring you to explore deeper on your own
- Out of scope topics
  - Git
  - Learning the languages (Ansible, Python, InfluxQL, etc)
  - Learning Linux
  - Deploying the systems for production use
  - Troubleshooting WLC/AP connection

Wi-Fi Automation deep dive - Lab topology



- Each student have an assigned Pod number. When using static IP, their Ubuntu Server should have the same last octet as the Pod#
- 2 students share a preconfigured WLC, as assigned in the topology map
- Everyone is connected to VLAN 10
- All switchports on all switches are trunk ports with VLAN 10 as native, and allowed vlan as VLAN 10 and 11
- For Wi-Fi clients on your SSIDs you can use VLAN 11 to not fill up VLAN 10

Login to shared devices

User: devnet-adm
Pass: ChangeMe2025!

IP Plan (VLAN 10)

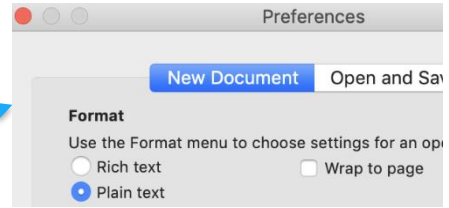
Static adm IPs: 192.168.10.1 - 19
Ubuntus (per pod): 192.168.10.20 - 50
WLCs (shared): 192.168.10.51 - 70
DHCP range: 192.168.10.71 - 250

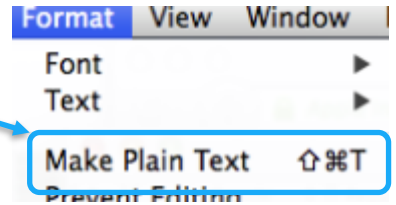
IP Plan (VLAN 11)

Static adm IPs: 192.168.11.1 - 10
DHCP range: 192.168.10.11 - 250

Notes for Mac users - TextEdit

- TextEdit (the default text editor on OS X) use rich text formatting by default. This is not a great idea when copy-pasting stuff to the command line, so there is a couple of things you must keep in mind
  - If you want, you can change a setting in TextEdit to make all new documents plain text
  - To change the current document to plain text go to Format -> Make Plain Text
  - Shortcut is: Shift-Cmd-T





Building your own lab

- Based on feedback from running this deep dive on previous events, if you are going to build and troubleshoot the full lab setup, it will take most or all of the time (2x 3h)
- The deep dive itself will have pre-built and pre-configured+tested WLAN Controllers (1 WLC per 2-4 students) for you to use. If you want to install your own WLC by following the optional part of this pre-lab guide that is OK, but we strongly encourage you to use the deep dive time to do actual automation exercises and not troubleshooting your WLC
- There will also be pre-built Ubuntu servers to use, running on our servers, for those who want to use that instead of their own laptop.
- If you have a mini computer or an old laptop to spare, you could install Proxmox on that and use for your VMs. Unfortunately it is outside the scope of this deep dive and this pre-lab guide to give detailed instructions on the Proxmox installation itself, outside what is described in task 1d. It is also outside the scope of the deep dive to help troubleshoot your Proxmox. But our servers run on that, so we are somewhat familiar with it and might answer some simple questions ☺
- We will also provide pre-built images with a finished installation of Ubuntu Server for Hyper-V and Virtualbox
- We encourage you to install your own Ubuntu Server, since it will give you more experience building the items yourself when you get home or need it in some other situation.

Tentative schedule for day 1

- Hour 1
  - Introductions and getting started
  - Finish the pre-lab tasks
  - Get to know the lab environment
  - Install and explore Ansible
- Hour 2
  - Explore Python automation
  - Explore YANG models
  - Explore Postman
- Hour 3
  - Install and explore TIG-stack / Grafana

Lab exercise #0: Finish the pre-lab tasks

- Get help to whatever you did not finish
- There will probably (always) be some cases which falls outside what is tested

Lab exercise #1: Connect your laptop and Ubuntu

- Connect your laptop to the wired network
  - Ensure you get DHCP in the range 192.168.10.71-250 /24
  - Ensure you get internet access through the wired connection
- Boot up your Ubuntu VM
  - If the Ubuntu have DHCP configured, follow the next slide to change it to static IP

Change from DHCP to static IP

- When you come to WLPC you would need to use a static IP in the lab range. Before WLPC you might just keep the server in DHCP mode, and come back to this slide during the deep dive.
- This will show one method to permanently change the IP of your server

1. Check your adapter name

```
devnet-adm@ubuntu-devnet:~$ netplan status | grep network
    2: ens18 ethernet UP (networkd: ens18)
```

2. Create a new file **/etc/netplan/99_config.yaml**

```
devnet-adm@ubuntu-devnet:~$ sudo nano /etc/netplan/99_config.yaml
devnet-adm@ubuntu-devnet:~$ sudo chmod 600 /etc/netplan/99_config.yaml
```

3. Delete the auto-created **/etc/netplan/50-cloud-init.yaml**

```
devnet-adm@ubuntu-devnet:~$ sudo rm /etc/netplan/50-cloud-init.yaml
```

4. Run "sudo netplan apply" to use the new config file

```
devnet-adm@ubuntu-devnet:~$ sudo netplan apply
```

5. Check that you have the new IP

```
devnet-adm@ubuntu-devnet:~$ sudo netplan apply
```

6. Reboot the server and you're good to go ☺

```
devnet-adm@ubuntu-devnet:~$ sudo reboot now
```

!!! In YAML, indentation is REALLY important !!!
In this file I use 2, 4, 6 or 8 spaces (multiple of 2).
It would be valid to use multiple of 3 or 4 instead.

Get this value from "netplan status". Enter it into 99_config.yaml
Probable values:
- Proxmox: ens18
- Hyper-V: eth0
- VirtualBox: enp0s3

Change to YOUR Ubuntu IP

/etc/netplan/99_config.yaml

```
network:
  ethernets:
    ens18:
#       dhcp4: true
      dhcp6: false
      dhcp4: false
      addresses:
      - 192.168.10.{YOUR_POD_IP}/24
      routes:
      - to: default
        via: 192.168.10.1
      nameservers:
        addresses:
        - 1.1.1.1
```

Most Common errors:
1. Wrong file permissions (step 2)
2. Errors in the indentation in the YAML file

To easily change between static and DHCP, I just comment/uncomment the lines. To change this to DHCP, just unncomment the "dhcp4: true" line, and comment the rest

Lab exercise #2: Test the lab environment

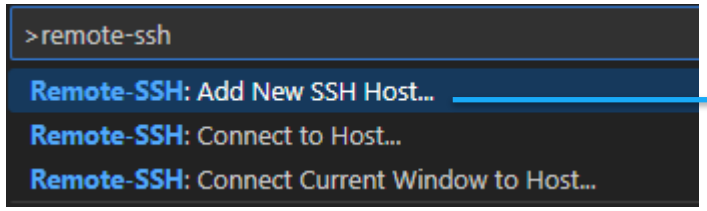
1. Access from your computer to the devices
   - SSH to one or more of the shared Ubuntu servers (192.168.10.11 up to .18)
   - SSH and HTTPS to your designated WLC (192.168.10.51, 53, 55, etc) shared with 3 other students
   - You have admin access to all shared devices, please don't mess up for each other ☺
2. Access from your Ubuntu Server to the devices
   - Ping from your Ubuntu VM to your designated WLC
   - Ping from your Ubuntu VM to the Internet
3. Access in to your Ubuntu Server
   - Ping from your designated WLC to your Ubuntu VM

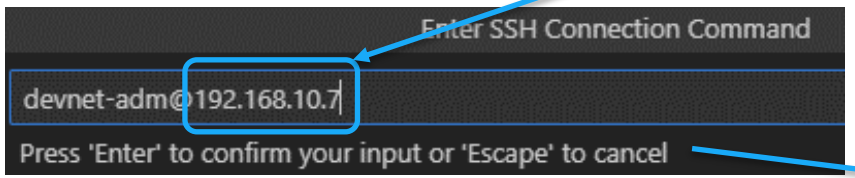
Lab exercise #3: Explore VS Code

- We will now use our VS Code installation to open a directory on the Ubuntu server
- Instructions will follow to
  - Open the "Remote-SSH" extension
  - Create new host
  - Connect current window to remote host
  - Install local extensions in remote host
  - Open a remote folder as workspace
  - Open some example files from the downloaded GIT repository

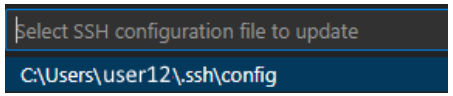
VS Code - Connect to... Remote SSH

- Command Palette (F1)
  - Type "remote-ssh", select "Add New SSH Host...", type "devnet-adm@192.168.10.7"

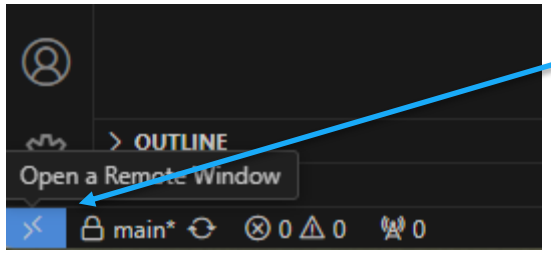


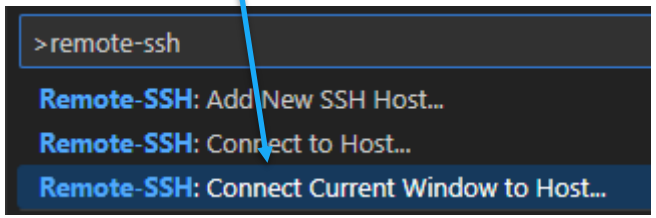


- Replace with your Ubuntu IP

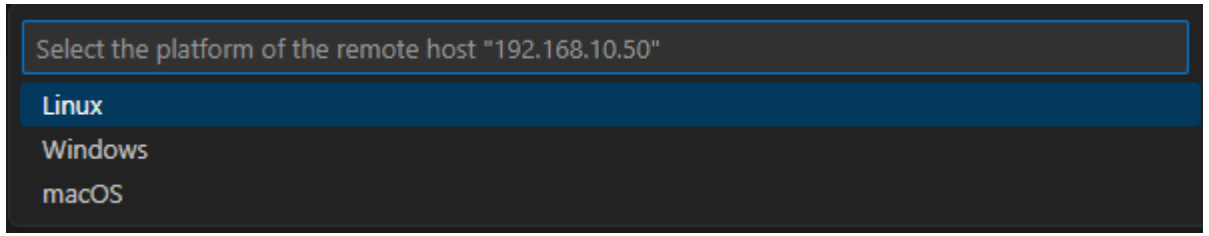


- Connect to the new Host, either using lower left corner of VS Code window or Command Palette (F1)



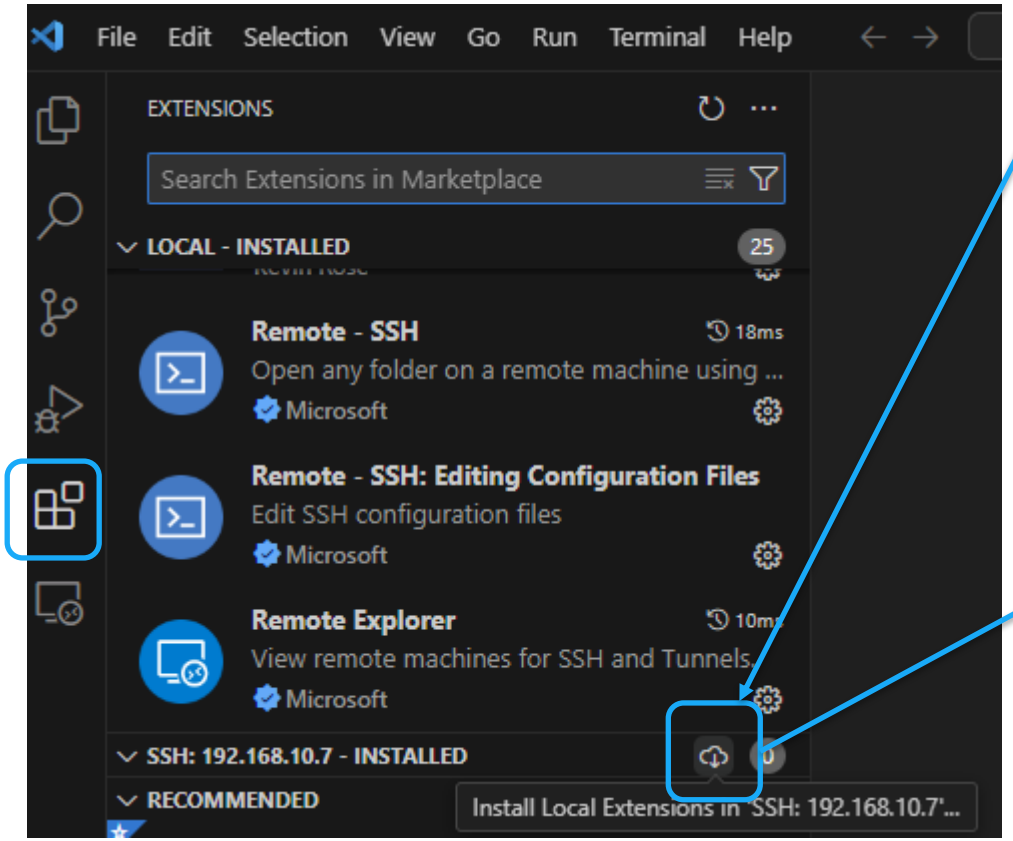


- When asked about platform type, select Linux

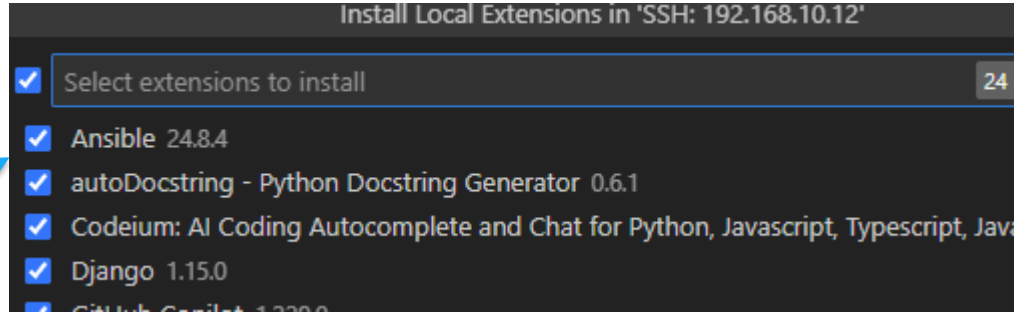


VS Code - Install Extensions in Remote SSH

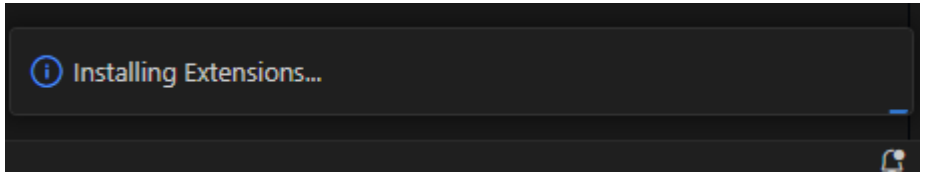
- The extensions have to be installed in each remote environment



When asked which ones to install, you can select everything, or select some of them if you have a lot of extensions

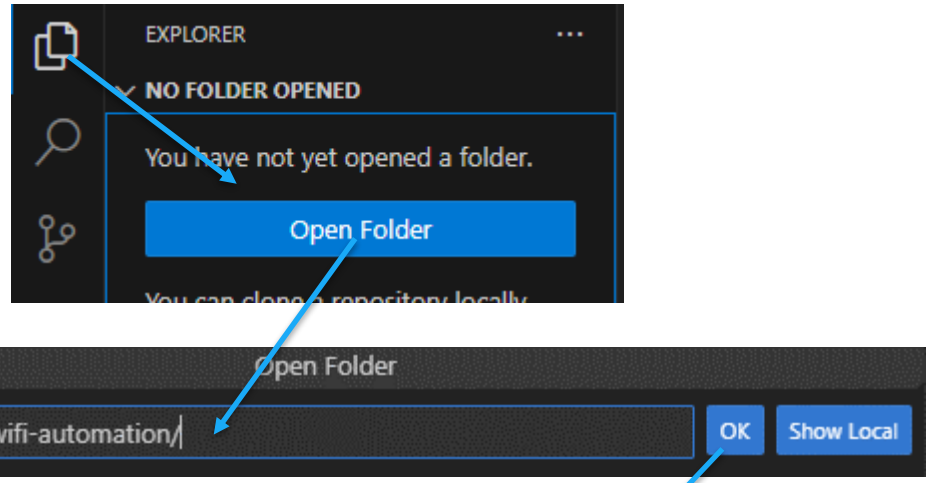


It will take a minute or so to install the extensions in the server

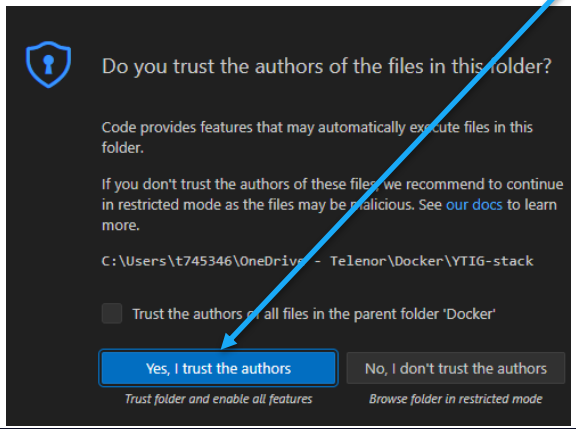


VS Code

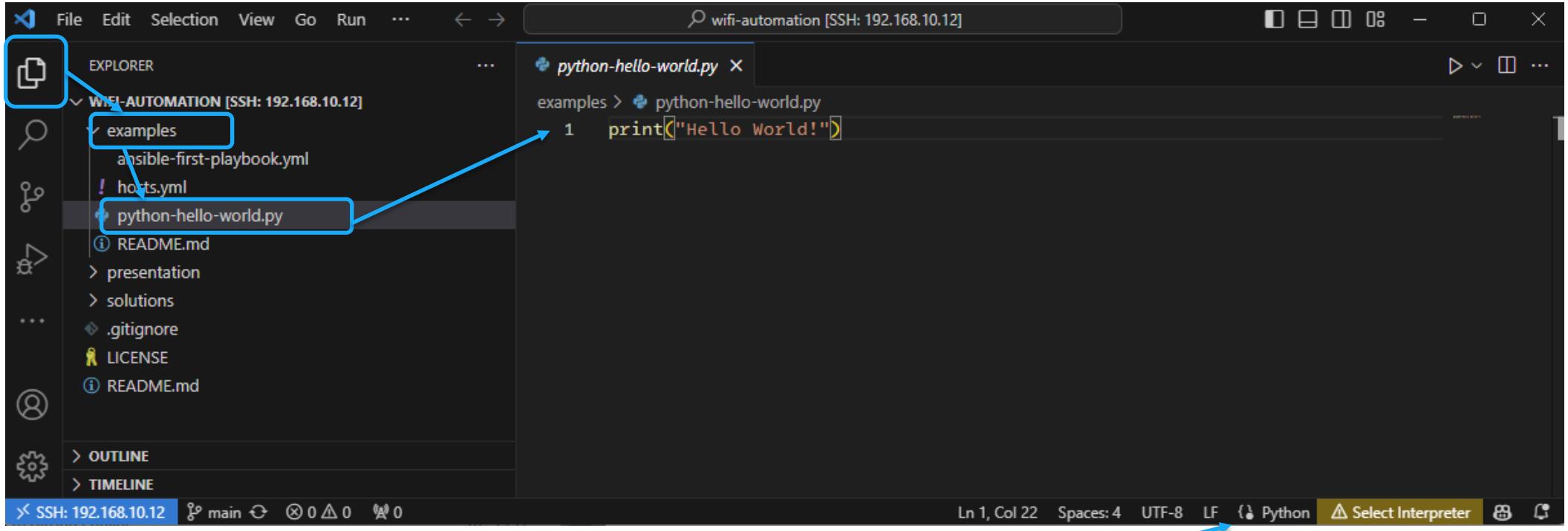
- Open Folder



- Trust authors

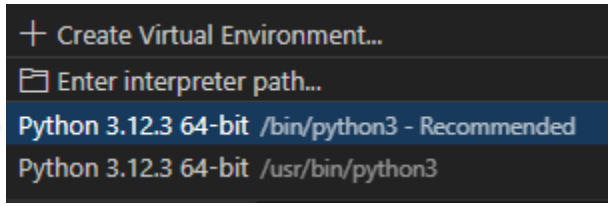


- Using Explorer in VS Code, open the example file `python-hello-world.py`

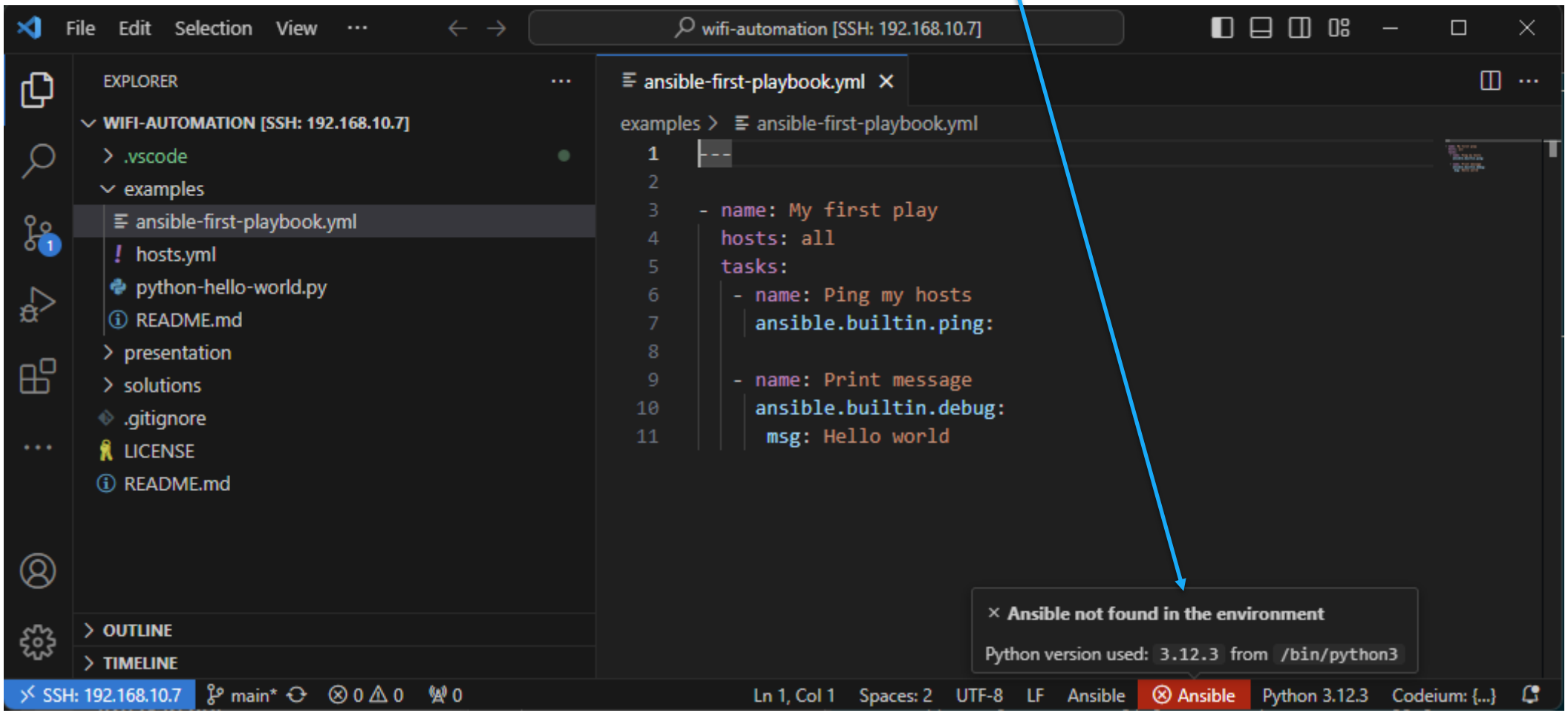


Detected language for active file
(can be manually overridden)

Active Python environment
for active file. Press here, and
for now select one of the options,
like /bin/python3

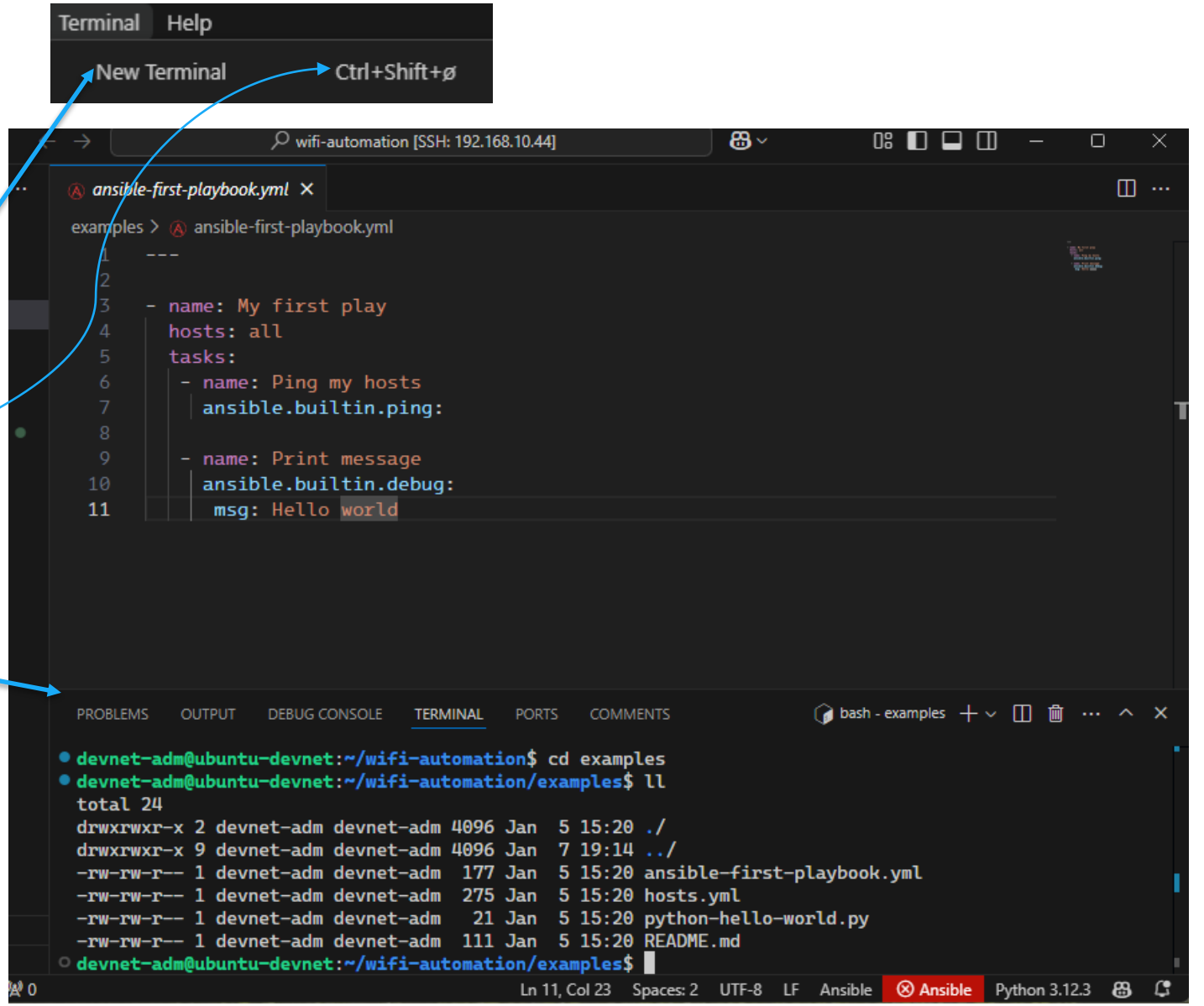


- If you open the Ansible file `ansible-first-playbook.yml` some errors will show. We will fix this later in the lab, after installing Ansible



Terminal in VS Code

- VS Code has an integrated terminal you can use. In many cases this is a convenient way to SSH to your server when working on projects in VS Code
- Select "Terminal" and "New Terminal" You can also use the shortcut (sorry again for the stupid Norwegian characters ☺)
- The code window will split, and you will have a terminal in the lower half (I usually use a larger window than in this screenshot, it's just resized to show it all on the same screenshot



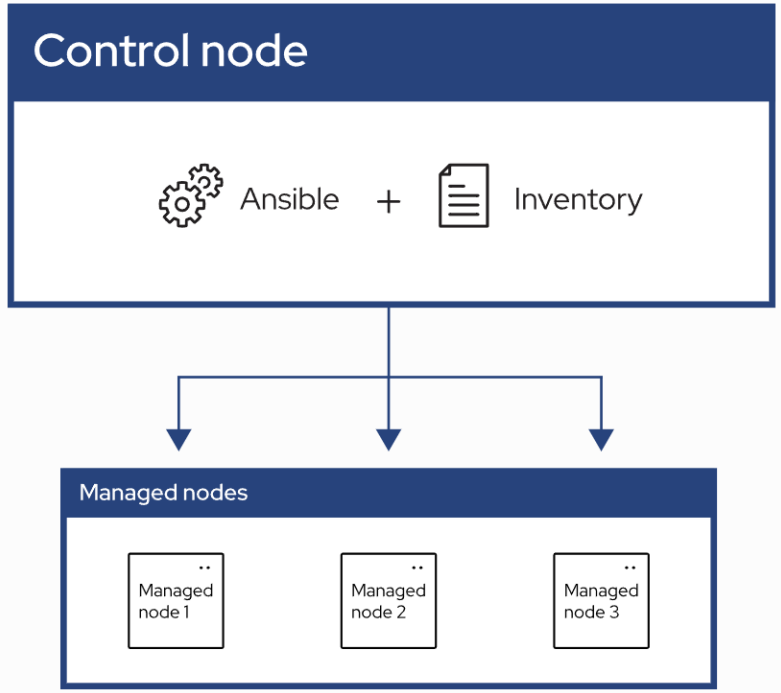
Lab exercise #4: Install Ansible

- In this exercise, we will
  - Create a Python virtual environment to use for Ansible stuff
  - Install Ansible on the Ubuntu Server
  - Configure VS Code to use Ansible on the remote server
- The first couple of slides will explain briefly about Ansible (for your reference)
- Then the installation process is explained step by step, before re-opening the first playbook example

What is Ansible

- Automation using "playbooks" written in YAML format
- Agent-less architecture
  - No installation on the managed nodes
- Idempotency
  - Does not change/write if target is already in state described by playbook

- Control node
  - System where Ansible is installed and runs the playbooks
- Inventory
  - List of managed nodes where the playbook will affect
- Managed nodes
  - Remote systems that are the targets of your playbooks



Plugins and modules

- Plugins
  - Extends the core functionality of Ansible
  - Examples
    - cisco.ios.ios cliconf - To run CLI commands on Cisco IOS device
    - Become plugins, how to get write access on various systems ("sudo", "enable" etc)
    - Connection plugins, like SSH
- Modules
  - Built-in or custom code snippets to perform various tasks
  - A special type of plugin
  - Examples
    - cisco.ios.ios_config
    - cisco.ise.endpoint

```
- name: Configure interface settings
  cisco.ios.ios_config:
    lines:
      - description test interface
      - ip address 172.31.1.1 255.255.255.0
    parents: interface Ethernet1
```

```
- name: Delete by id
  cisco.ise.endpoint:
    ise_hostname: "{{ise_hostname}}"
    ise_username: "{{ise_username}}"
    ise_password: "{{ise_password}}"
    ise_verify: "{{ise_verify}}"
    state: absent
    id: string
```


Ansible installation

- Installing in a Python VENV (Virtual Environment)

```
devnet-adm@ubuntu-devnet:~$ sudo apt install pip python3-venv
devnet-adm@ubuntu-devnet:~$ mkdir ~/automation-venv
devnet-adm@ubuntu-devnet:~$ python3 -m venv ~/automation-venv/
devnet-adm@ubuntu-devnet:~$ source ~/automation-venv/bin/activate
(automation-venv) devnet-adm@ubuntu-devnet:~$ pip install ansible ansible-lint
```

```
(automation-venv) devnet-adm@ubuntu-devnet:~$ ansible --version
ansible [core 2.17.1]
  config file = None
  configured module search path = ['/home/devnet-adm/.ansible/plugins/modules', '/usr/share/ansible/plugins/modules']
  ansible python module location = /home/devnet-adm/automation-venv/lib/python3.12/site-packages/ansible
  ansible collection location = /home/devnet-adm/.ansible/collections:/usr/share/ansible/collections
  executable location = /home/devnet-adm/automation-venv/bin/ansible
  python version = 3.12.3 (main, Apr 10 2024, 05:33:47) [GCC 13.2.0] (/home/devnet-adm/automation-venv/bin/python3)
  jinja version = 3.1.4
  libyaml = True
(automation-venv) devnet-adm@ubuntu-devnet:~$
```

- (optional info) Ansible could be installed globally. But by using VENV we can control the environment more closely. Most projects will have some dependencies, and by controlling the environment you ensure that the packages in the environment are ones that is tested to be compatible with the project. Here we just use the latest, but it is shared to list ("freeze") the currently installed packages and versions from an environment when tested OK, and use this as a requirements input when reproducing the environment

Ansible Collections

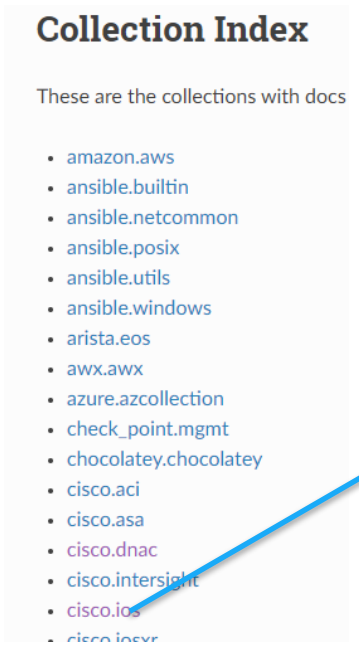
- A collection is a premade collection of playbooks, roles, modules and plugins, usually for a specific purpose or type of devices
  - https://docs.ansible.com/ansible/latest/collections/index.html#list-of-collections
- This is how to look up which collections you have installed in your environment

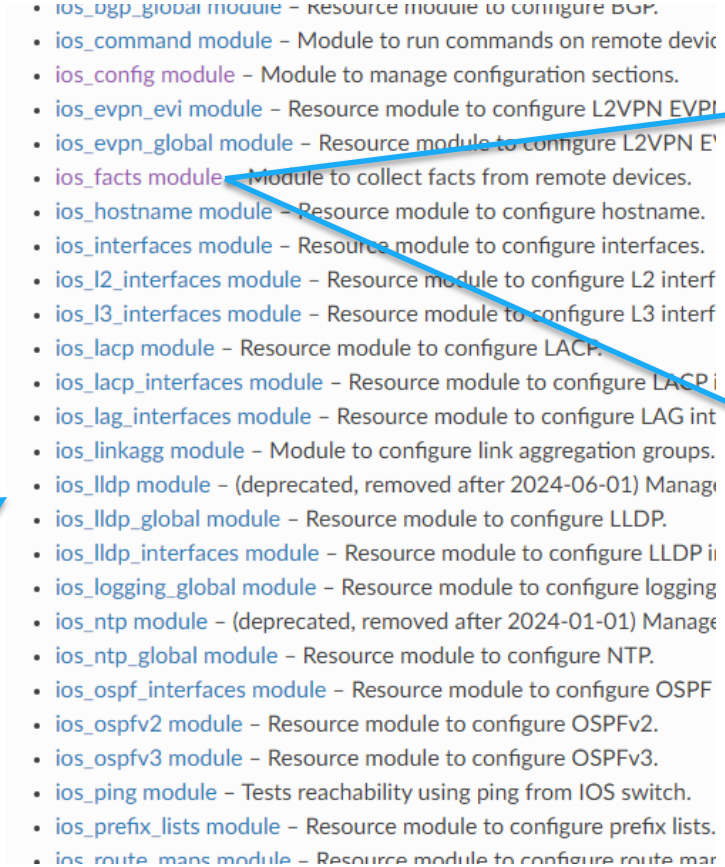
```
(ansible-venv) devnet-admin@ubuntu-devnet:~$ ansible-galaxy collection list

# /home/devnet-admin/ansible-venv/lib/python3.12/site-packages/ansible_collections
Collection                              Version
--------------------------------------- -------
amazon.aws                              8.0.1
ansible.netcommon                       6.1.3
ansible.posix                           1.5.4
ansible.utils                           4.1.0
ansible.windows                         2.4.0
```

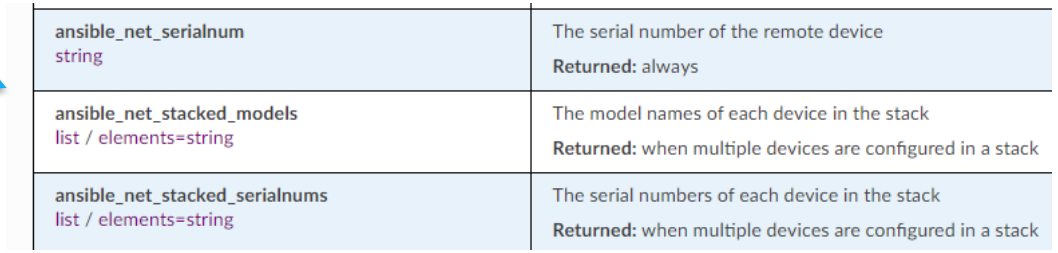
```
(ansible-venv) devnet-admin@ubuntu-devnet:~$ ansible-galaxy collection list | grep "cisco"
cisco.aci                               2.9.0
cisco.asa                               5.0.1
cisco.dnac                              6.16.0
cisco.intersight                        2.0.9
cisco.ios                               8.0.0
cisco.iosxr                             9.0.0
cisco.ise                               2.9.2
cisco.meraki                            2.18.1
cisco.mso                               2.6.0
cisco.nxos                              8.1.0
cisco.ucs                               1.10.0
community.ciscosmb                      1.0.9
(ansible-venv) devnet-admin@ubuntu-devnet:~$
```


Ansible Collections

- Navigating the documentation
- https://docs.ansible.com/ansible/latest/collections/index.html#list-of-collections







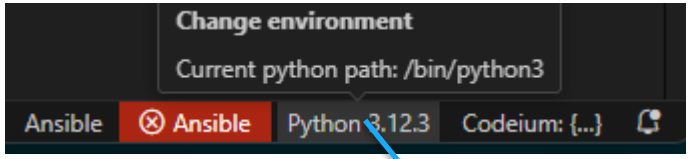
ansible_net_serialnum string	The serial number of the remote device **Returned:** always
ansible_net_stacked_models list / elements=string	The model names of each device in the stack **Returned:** when multiple devices are configured in a stack
ansible_net_stacked_serialnums list / elements=string	The serial numbers of each device in the stack **Returned:** when multiple devices are configured in a stack

VS Code - Python environment for Ansible

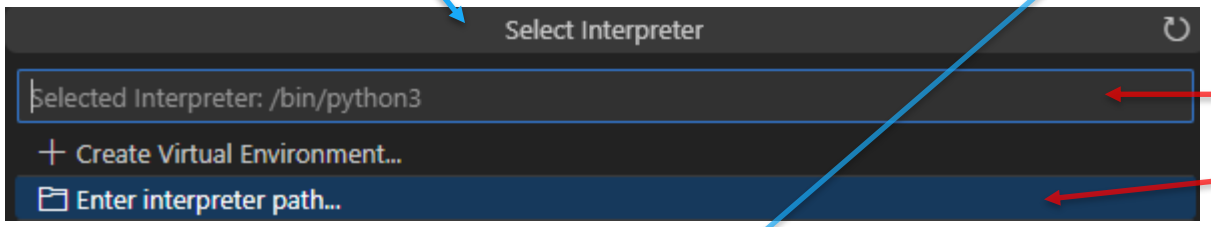
- Check which Python environment is used by Ansible

```
devnet-adm@ubuntu-devnet:~$ source ~/automation-venv/bin/activate
(automation-venv) devnet-adm@ubuntu-devnet:~$ ansible --version | grep "python version"
  python version = 3.12.3 (main, Apr 10 2024, 05:33:47) [GCC 13.2.0] (/home/devnet-adm/automation-venv/bin/python3)
```

- Select python environment (VS Code, bottom line)

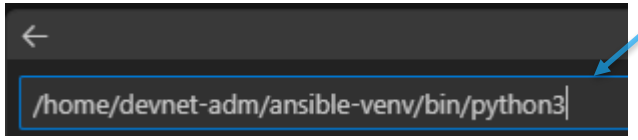


- Select «Enter interpreter path...»



!! Common mistake: !!
Do not type here…
Press here.
Then type here…

- Enter the python environment that Ansible use, into this line and press Enter

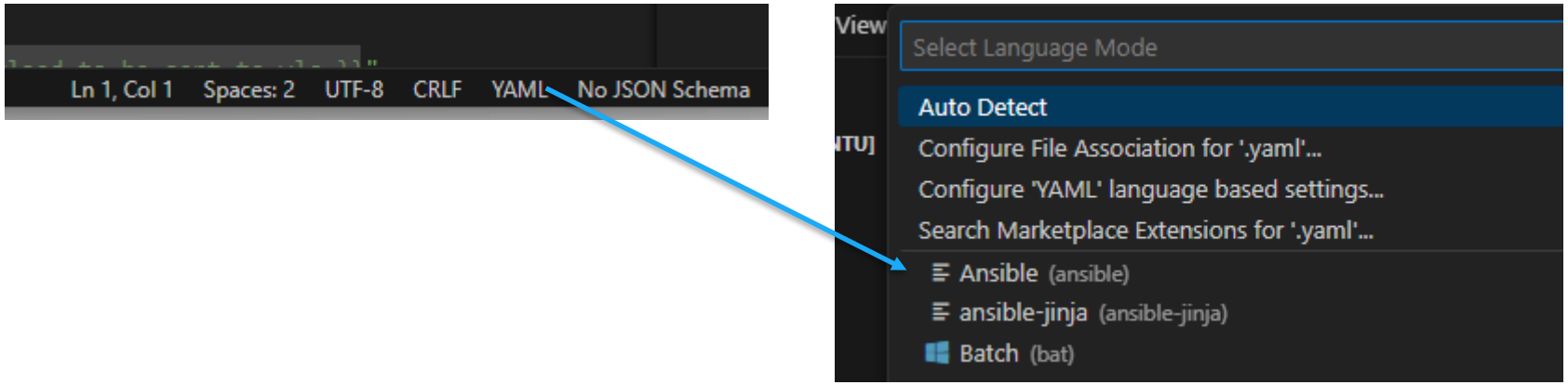



```
/home/devnet-adm/automation-venv/bin/python3
```

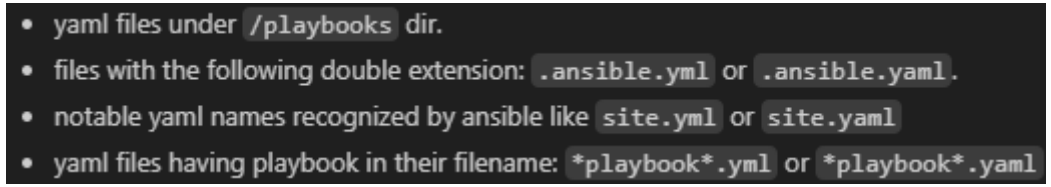
- Bottom line should now show the Ansible version (2.18.1) and Python version and venv

VS Code - Choose file type

- If not auto detected, file type can be changed for open files

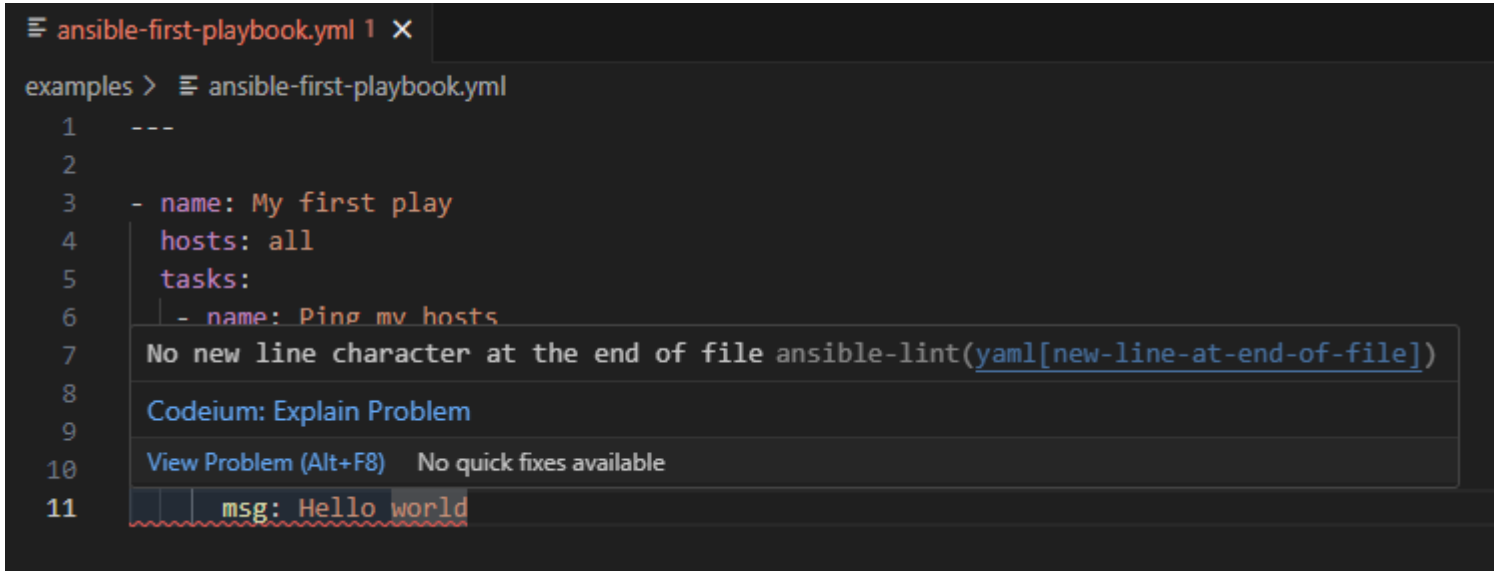


- Pro tip: If the file name contains the word «playbook», it will *automatically* be recognized as Ansible by VS Code (and not general YAML)
  - interface-playbook.yaml
  - demo-playbook.yaml
- There are also other ways to get VS Code to auto recognize playbooks, like putting them in a "playbooks" subfolder

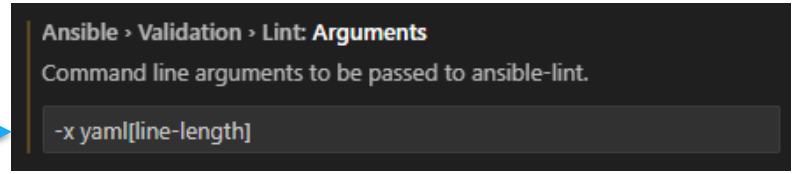


Ansible-lint

- Linting (syntax checking) is done on file save
- The «`ansible-first-playbook.yml`» should have an error that shows on first save, when ansible-lint runs in the background



- (optional info) You can also specify ansible-lint to exclude certain errors, like the "line too long" error.
  - Open Settings (Ctrl-,) and search for "ansible-lint"
    Enter `-x yaml[line-length]`



Lab exercise #5: Explore Ansible

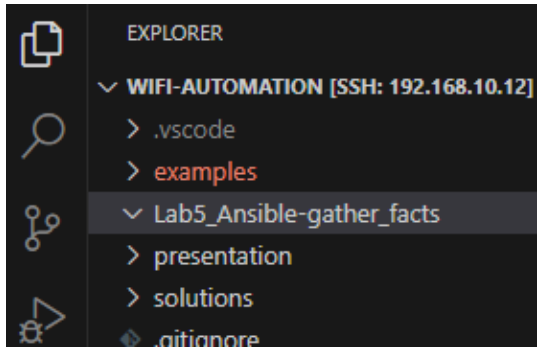
- In this lab, you will be given a simple example to get you started with Ansible
- The Ansible section of Day2 will include more exercises for you to do, including example solutions

Gather facts

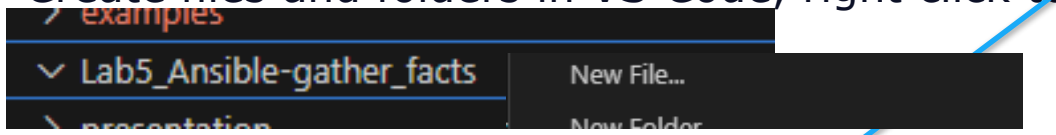
- Create a folder

```
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation$ mkdir Lab5_Ansible-gather_facts
```

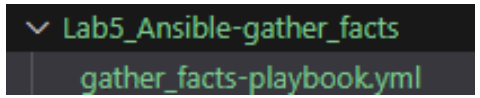
- Shows up automatically in VS Code



- Create files and folders in VS Code, right click to get menu



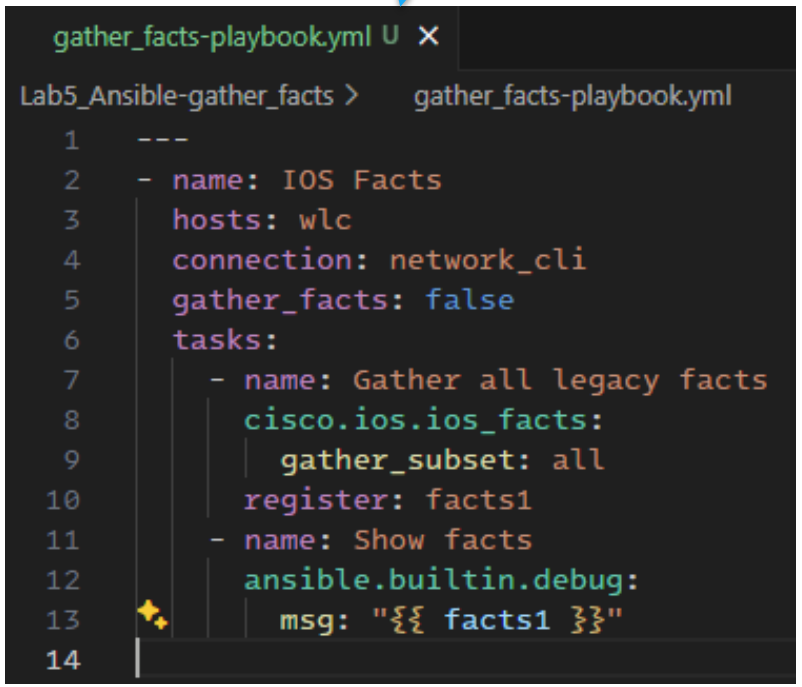
- Create the file "gather_facts-playbook.yml"



- Copy-paste from this textbox to VS Code

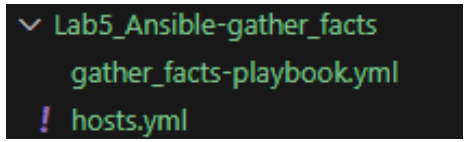
gather_facts-playbook.yml

```
---
- name: IOS Facts
  hosts: wlc
  connection: network_cli
  gather_facts: false
  tasks:
    - name: Gather all legacy facts
      cisco.ios.ios_facts:
        gather_subset: all
      register: facts1
    - name: Show facts
      ansible.builtin.debug:
        msg: "{{ facts1 }}"
```



Ansible hosts file

- Let's create a file named hosts.yml



- It shows up in the folder as well

```
(ansible-venv) devnet-adm@ubuntu-devnet:~/wifi-automation$ cd Lab5_Ansible-gather_facts/
(ansible-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$ ls -l
total 4
-rw-rw-r-- 1 devnet-adm devnet-adm 285 Aug 24 18:06 gather_facts-playbook.yml
-rw-rw-r-- 1 devnet-adm devnet-adm   0 Aug 24 18:14 hosts.yml
(ansible-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$
```

hosts.yml

```
wlc:
  hosts:
    192.168.10.{WLC-IP}:
  vars:
    ansible_connection: network_cli
    ansible_network_os: ios
    ansible_ssh_pass: ChangeMe2025!
    ansible_password: ChangeMe2025!
    ansible_user: devnet-adm
```

Change to YOUR WLC IP

```
1  wlc:
2    hosts:
3      192.168.10.{WLC-IP}:
4    vars:
5      ansible_connection: network_cli
6      ansible_network_os: ios
7      ansible_ssh_pass: ChangeMe2025!
8      ansible_password: ChangeMe2025!
9      ansible_user: devnet-adm
```


Fix dependencies

- Try to run the playbook with the following command. Something is missing.

```
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$ ansible-playbook -i hosts.yml gather_facts-playbook.yml

PLAY [IOS Facts] ***************************************************************************************************************************************

TASK [Gather all legacy facts] *************************************************************************************************************************
[WARNING]: ansible-pylibssh not installed, falling back to paramiko
fatal: [192.168.10.30]: FAILED! => {"changed": false, "msg": "paramiko is not installed: No module named 'paramiko'"}

PLAY RECAP *********************************************************************************************************************************************
192.168.10.30              : ok=0    changed=0    unreachable=0    failed=1    skipped=0    rescued=0    ignored=0

(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$
```

- Let's install "ansible-pylibssh"
  - First, make sure you are in your automation-venv
  - If it is not showing (automation-venv) at the start of the line, enter `source ~/automation-venv/bin/activate`
  - Then install the package in your venv by using "pip install {package name}

```
(automation-venv) devnet-adm@ubuntu-devnet:~$ pip install ansible-pylibssh
Collecting ansible-pylibssh
  Downloading ansible_pylibssh-1.2.2-cp312-cp312-manylinux_2_28_x86_64.whl.metadata (36 kB)
Downloading ansible_pylibssh-1.2.2-cp312-cp312-manylinux_2_28_x86_64.whl (2.9 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.9/2.9 MB 7.1 MB/s eta 0:00:00
Installing collected packages: ansible-pylibssh
Successfully installed ansible-pylibssh-1.2.2
(automation-venv) devnet-adm@ubuntu-devnet:~$
```


SSH host key checking

- Try running again. The SSH connection is failing

```
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$ ansible-playbook -i hosts.yml gather_facts-playbook.yml

PLAY [IOS Facts] ***************************************************************************************************************************

TASK [Gather all legacy facts] *************************************************************************************************************
fatal: [192.168.10.30]: FAILED! => {"changed": false, "msg": "\nlibssh: The authenticity of host '192.168.10.30' can't be established due to 'Host is
unknown: 41:86:3e:e4:fb:9f:de:06:5b:72:f3:ce:75:f1:da:ad:e7:a5:13:c0'.\nThe ssh-rsa key fingerprint is SHA1:QYY+5Puf3gZbcvPOdfHareelE8A."}

PLAY RECAP *********************************************************************************************************************************
192.168.10.30              : ok=0    changed=0    unreachable=0    failed=1    skipped=0    rescued=0    ignored=0
```

- Update the hosts.yml file

```
1  wlc:
2    hosts:
3      192.168.10.{WLC-IP}:
4    vars:
5      ansible_connection: network_cli
6      ansible_network_os: ios
7      ansible_ssh_pass: ChangeMe2025!
8      ansible_password: ChangeMe2025!
9      ansible_user: devnet-adm
10     ansible_host_key_checking: False
11
```

Change to YOUR WLC IP

hosts.yml

```
wlc:
  hosts:
    192.168.10.{WLC-IP}:
  vars:
    ansible_connection: network_cli
    ansible_network_os: ios
    ansible_ssh_pass: ChangeMe2025!
    ansible_password: ChangeMe2025!
    ansible_user: devnet-adm
    ansible_host_key_checking: False
```


Gather facts

- Successful play

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS bash - Lab5_Ansible-gather_facts

```
(ansible-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$ ansible-playbook -i hosts.yml gather_facts-playbook.yml

PLAY [IOS Facts] ***************************************************************************************************************************************************************

TASK [Gather all legacy facts] *************************************************************************************************************************************************
ok: [192.168.10.30]

TASK [Show facts] **************************************************************************************************************************************************************
ok: [192.168.10.30] => {
    "msg": {
        "ansible_facts": {
            "ansible_net_all_ipv4_addresses": [
                "192.168.10.30"
            ],
            "ansible_net_all_ipv6_addresses": [],
            "ansible_net_api": "cliconf",
            "ansible_net_config": "Building configuration...\n\nCurrent configuration : 20628 bytes\n!\n! Last configuration change at 20:45:02 CEST Sat Aug 24 2024
by devnet-adm\n!\nversion 17.15\nservice tcp-keepalives-in\nservice tcp-keepalives-out\nservice timestamps debug datetime msec localtime\nservice timestamps log date
```


Use parts of return values

- The returned facts1 is a dictionary
  - You can use dot notation
  - Edit the "Show facts" task, to show only some subset of the info

```
- name: Show facts
  debug:
    msg: "{{ facts1.ansible_facts.ansible_net_interfaces }}"
```


```
- name: Show facts
  debug:
    msg: "{{ facts1.ansible_facts.ansible_net_interfaces }}"
```


```
(ansible-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$ ansible-playbook -i hosts.yml gather_facts-playbook.yml

PLAY [IOS Facts] ***************************************************************************************************************************

TASK [Gather all legacy facts] *************************************************************************************************************
ok: [192.168.10.30]

TASK [Show facts] **************************************************************************************************************************
ok: [192.168.10.30] => {
    "msg": {
        "GigabitEthernet1": {
            "bandwidth": 1000000,
            "description": "Uplink",
            "duplex": "Full",
            "ipv4": [],
            "lineprotocol": "up",
            "macaddress": "0800.2712.7826",
            "mediatype": "Virtual",
            "mtu": 1500,
            "operstatus": "up",
```

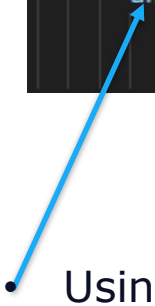
gather_facts-playbook.yml

```
---
- name: IOS Facts
  hosts: wlc
  connection: network_cli
  gather_facts: no
  tasks:
    - name: Gather all legacy facts
      cisco.ios.ios_facts:
        gather_subset: all
      register: facts1
    - name: Write run-config to file
      ansible.builtin.copy:
        content: "{{ facts1.ansible_facts.ansible_net_config }}"
        dest: "{{ './' + facts1.ansible_facts.ansible_net_hostname + '-run-conf.txt' }}"
```

Use return values

- We will use the returned facts, to write the run-config to a file
- Remove the "Show facts" task, and replace it with a new task

```
- name: Write run-config to file
  ansible.builtin.copy:
    content: "{{ facts1.ansible_facts.ansible_net_config }}"
    dest: "{{ './' + facts1.ansible_facts.ansible_net_hostname + '-run-conf.txt' }}"
```



- Using the "copy" module
- Content is using parts of the return values, this time we use "ansible_net_config"
- Dest is where to write the content. Here are some simple examples on Jinja syntax

- (optional info)
- Jinja2 is integrated in Ansible and widely used
- "Everything inside double curly brackets" = Jinja2

gather_facts-playbook.yml

```
---
- name: IOS Facts
  hosts: wlc
  connection: network_cli
  gather_facts: false
  tasks:
    - name: Gather all legacy facts
      cisco.ios.ios_facts:
        gather_subset: all
      register: facts1
    - name: Write run-config to file
      ansible.builtin.copy:
        content: "{{ facts1.ansible_facts.ansible_net_config }}"
        dest: "{{ './' + facts1.ansible_facts.ansible_net_hostname + '-run-conf.txt' }}"
        mode: "0600"
```

Linting errors, and fixing them

- When saving this file you should get two linting errors

```
5   gather_facts: no
6   tasks:
7     - name: Gather all legacy facts
8       cisco.ios.ios_facts:
9         gather_subset: all
10      register: facts1
11    - name: Write run-config to file
```

```
Truthy value should be one of \[false, true] ansible-lint(yaml[truthy])
Codeium: Explain Problem
A boolean that controls if the play will automatically run the 'setup' task to gather facts for the hosts.
```

- We fix this with using "false" instead of "no"
- Both will work, but correct YAML syntax is "false"

```
File permissions unset or incorrect. ansible-lint(risky-file-permissions)
```

- When writing files (like using the "copy" module), you should always explicitly specify the file permissions
- We add the line: mode: "0600"

```
1   ---
2   - name: IOS Facts
3     hosts: wlc
4     connection: network_cli
5     gather_facts: false
6     tasks:
7       - name: Gather all legacy facts
8         cisco.ios.ios_facts:
9           gather_subset: all
10        register: facts1
11      - name: Write run-config to file
12        ansible.builtin.copy:
13          content: "{{ facts1.ansible_facts.ansible_net_config }}"
14          dest: "{{ './' + facts1.ansible_facts.ansible_net_hostname + '-run-conf.txt' }}"
15          mode: "0600"
16
```

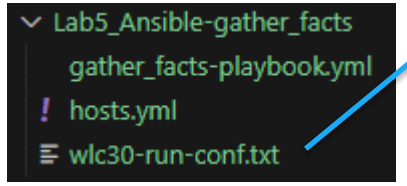

Run the playbook

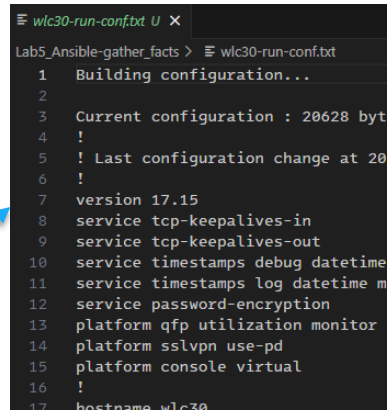
```
(ansible-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$ ansible-playbook -i hosts.yml gather_facts-playbook.yml

PLAY [IOS Facts] ***************************************************************************************************************************************

TASK [Gather all legacy facts] *************************************************************************************************************************
ok: [192.168.10.30]

TASK [Write run-config to file] ************************************************************************************************************************
changed: [192.168.10.30]

PLAY RECAP *********************************************************************************************************************************************
192.168.10.30              : ok=2    changed=1    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0

(ansible-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$
```

- List the files, and you can see the file that was created

```
(ansible-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab5_Ansible-gather_facts$ ls -l
total 32
-rw-rw-r-- 1 devnet-adm devnet-adm   445 Aug 24 18:54 gather_facts-playbook.yml
-rw-rw-r-- 1 devnet-adm devnet-adm   245 Aug 24 18:41 hosts.yml
-rw------- 1 devnet-adm devnet-adm 20689 Aug 24 18:54 wlc30-run-conf.txt
```

- You can view the file contents in the Linux terminal by running "cat", "more", "nano" or similar
- You will also see the file in VS Code explorer and can open it from there





Lab exercise #6: Explore YANG models

- First there will be a couple of slides to explain what YANG models are
- Then you will explore some of the YANG models of the 9800 WLAN Controller by using the https://yangcatalog.org website
- Lab 7 will explore YANG models using another tool (YANG Suite)
- Some of the later labs will have optional parts where you can look up RESTCONF paths that you need using one of these tools

What is a YANG-model?

```
module: Cisco-IOS-XE-wireless-client-oper
  +--ro client-oper-data
     +--ro common-oper-data* [client-mac]
     |  +--ro client-mac                      yang:mac-address
     |  +--ro ap-name?                        string
     |  +--ro ms-ap-slot-id?                  uint8
     |  +--ro ms-radio-type?                  wireless-client-types:ms-phy-radio-ty
     |  +--ro wlan-id?                        uint32
     |  +--ro client-type?                    wireless-client-types:ms-client-type
     |  +--ro co-state?                       wireless-client-types:client-co-state
     |  +--ro aaa-override-passphrase?        boolean
     |  +--ro is-tvi-enabled?                 boolean
     |  +--ro wlan-policy
     |  |  +--ro current-switching-mode?      wireless-client-oper:client-switching-m
     |  |  +--ro wlan-switching-mode?         wireless-client-oper:client-switching-m
     |  |  +--ro central-authentication?      wireless-client-oper:client-authenticat
     |  |  +--ro central-dhcp?                boolean
     |  |  +--ro central-assoc-enable?        boolean
     |  |  +--ro vlan-central-switching?      boolean
```

- Structured representation of cfg og oper data
- Used primarily with NETCONF & RESTCONF
- Do you recognize what the tree is showing?

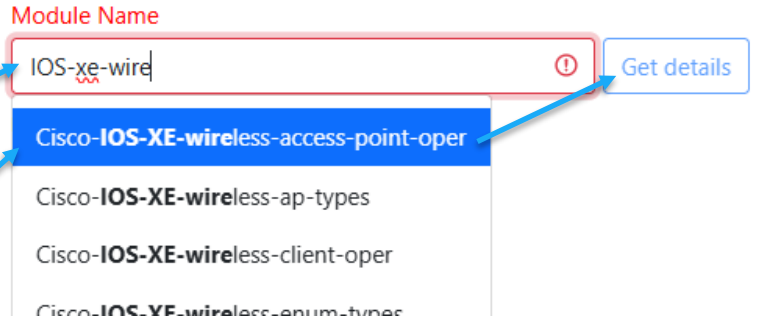
Reference/download: https://github.com/YangModels/yang/tree/main/vendor/cisco/xe/1751

yangcatalog

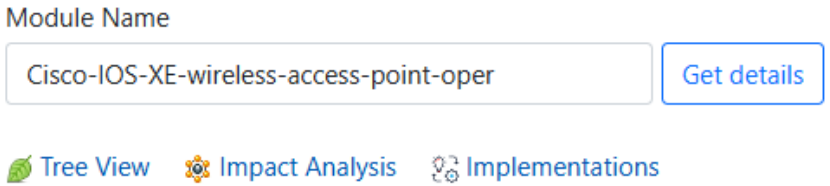
- Open the following website: https://www.yangcatalog.org/

- Select "Module Detail Viewer"

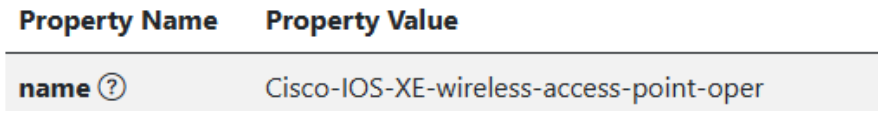
- Here you can start typing parts of available YANG modules.
  Start by typing "IOS-XE-wireless".
  It is not case sensitive by the way



- Select the AP oper module "Cisco-IOS-XE-wireless-access-point-oper" and click "Get details"



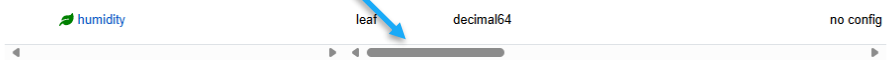
- Then click "Tree View"



YANG Catalog - Navigating the Tree View

- Expand/collapse all nodes
- Expand/collapse this branch
- This is a container/list node
  - Contains other nodes
- Hover the mouse over an element name to get the description popup
- This is a leaf node
  - Contains a single value

- !! There are lots of info to the right of this screenshot. Sometimes the horizontal scroll bar is trying to hide, scroll down to the bottom to find it !!



Element	Schema	Type
Cisco-IOS-XE-wireless-access-point-oper	module	module
access-point-oper-data	container	container
ap-radio-audit-info	list	list
wtp-mac	leaf	yang:mac-address
radio-slot-id	leaf	uint8
channel-sync	leaf	empty
bandwidth-sync	leaf	empty
tx-power-sync	leaf	empty

AP radio audit info

Using values from YANG Catalog

- When navigating the tree view, here is where you find the values you will typically use, with examples
  - "Path": Used when configuring 9800 to send values as streaming telemetry. We will use this in lab 10 & 11 to configure WLC to send specific data to be visualized in Grafana
  - "Sensor Path": Used when you need a RESTCONF path. We will use this in the labs 8 (Postman), 9 (Python) and in many of the Day 2 labs (both Python and Ansible labs)

YANG Catalog

Home | About | Use cases | Contribute | Query | YANG M

YANG Search | YANG Module Detail Viewer | YANG Validator | YANG Impact A

Module: Cisco-IOS-XE-wireless-access-point-oper@2022-07-01

Namespace: http://cisco.com/ns/yang/Cisco-IOS-XE-wireless-access-point-oper

Prefix: wireless-access-point-oper

Module details Impact Analysis

Use this for WLC telemetry config

Use this for RESTCONF path

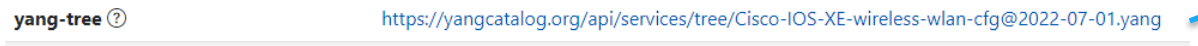
Element	Schema	Type	Flags	Opts	Status	Path	Sensor Path
Cisco-IOS-XE-wireless-access-point-oper	module	module					
access-point-oper-data	container	container	no config		current	/wireless-access-point-oper:access-point-oper-data	/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data
ap-radio-audit-info	list	list	no config		current	/wireless-access-point-oper:access-point-oper-data/wireless-access-point-oper:ap-radio-audit-info	/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/ap-radio-audit-info
radio-oper-data	list	list	no config		current	/wireless-access-point-oper:access-point-oper-data/wireless-access-point-oper:radio-oper-data	/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/radio-oper-data

```
no telemetry ietf subscription 4
telemetry ietf subscription 4
 encoding encode-kvgpb
 filter xpath /wireless-access-point-oper:access-point-oper-data/wireless-access-point-oper:radio-oper-data
 stream yang-push
 update-policy periodic 500
 receiver ip address 192.168.10.7 57000 protocol grpc-tcp
 do show telemetry ietf subscription 4
```

```
GET  https:// {{host}} /restconf/data/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/radio-oper-data
```


yangcatalog

- You can also get the tree view in a text form like this
- Go to YANG Module Detail Viewer again,
  Search and find your module, and select "Get details"
- A way down in the details table you will find "yang-tree",
  click the link there



- The tree will open in a separate page

```
module: Cisco-IOS-XE-wireless-access-point-oper
  +--ro access-point-oper-data
     +--ro ap-radio-audit-info* [wtp-mac radio-slot-id]
     |  +--ro wtp-mac                yang:mac-address
     |  +--ro radio-slot-id          uint8
     |  +--ro channel-sync?          empty
     |  +--ro bandwidth-sync?        empty
     |  +--ro tx-power-sync?         empty
     |  +--ro admin-state-sync?      empty
     |  +--ro oper-state-sync?       empty
     |  +--ro radio-role-sync?       empty
     |  +--ro radio-role-oper-sync?  empty
     +--ro ap-wlan-audit-info* [wtp-mac slot-id wlan-id]
     |  +--ro wtp-mac             yang:mac-address
     |  +--ro slot-id             uint8
     |  +--ro wlan-id             uint8
     |  +--ro vlan-id-sync?       empty
     |  +--ro state-sync?         empty
     |  +--ro ssid-sync?          empty
     |  +--ro auth-type-sync?     empty
     |  +--ro other-flags-sync?   empty
     +--ro ap-audit-summary-info* [wtp-mac]
     |  +--ro wtp-mac             yang:mac-address
     |  +--ro radio-audit-sync?   empty
     |  +--ro wlan-audit-sync?    empty
     |  +--ro ipv4-acl-sync?      empty
     |  +--ro ipv6-acl-sync?      empty
     |  +--ro last-report-time?   yang:date-and-time
     +--ro ap-mac-ssid-info* [ap-mac wlan-id]
     |  +--ro ssid-clients-list-data* [client-mac-address]
     |  |  +--ro client-mac-address    yang:mac-address
     |  +--ro ap-mac                    yang:mac-address
     |  +--ro wlan-id                   uint32
     +--ro ssid-counters* [wtp-mac slot-id wlan-id]
     |  +--ro bssid-mac?              yang:mac-address
     |  +--ro vap-id?                 uint16
     |  +--ro tx-mgmt?                uint64
     |  +--ro rx-mgmt?                uint64
     |  +--ro tx-bytes-data?          uint64
     |  +--ro tx-data-dist
     |  |  +--ro bytes-0-64?             uint64
     |  |  +--ro bytes-65-128?           uint64
```

Lab exercise #7: Explore YANG Suite

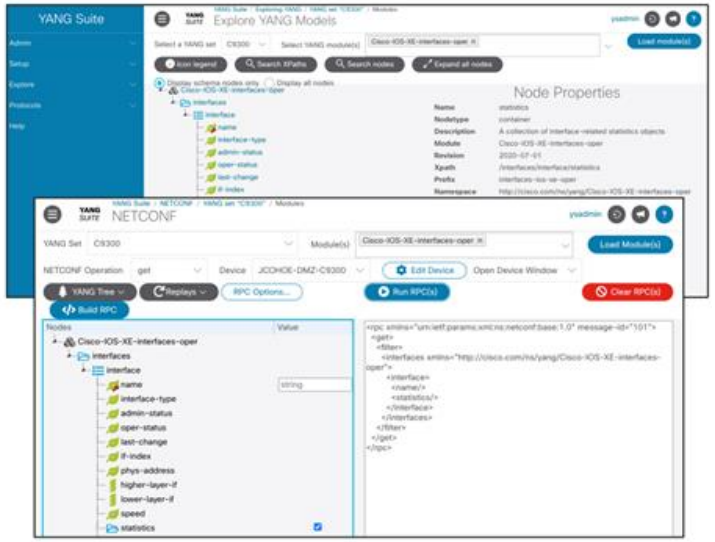
- YANG Suite is an installable tool that can be used to pull supported YANG models directly from the actual devices
- You can also use it to test communication to your device using RESTCONF and more

Cisco YANG Suite

YANG API Testing and Validation Environment

Construct and test YANG based APIs over NETCONF, RESTCONF, gRPC and gNMI

IOS XE / IOS XR / NX OS platforms



Now Available !

developer.cisco.com/yangsuite

github.com/CiscoDevNet/yangsuite

Cisco-IOS-XE-wireless: Modules

Config		Oper	
ap	mesh	access-point	mesh
apf	mobility	ap	mobility
cts-sxp	mstream	awips	nmsp
dot11	radio	ble-ltx	rfid
dot15	rf	ble-mgmt	rogue
fabric	Rfid	client	rrm
file-transfer	rlan	cts-sxp	rule-mdns
flex	rogue	events	
fqdn	rrm	general	
general	rule	hyperlocation	
hotspot	security	lisp-agent	
image-download	site	location	
location	tunnel	mcast	
me-general	wlan	mdns	

Lab exercise #7: Explore YANG Suite

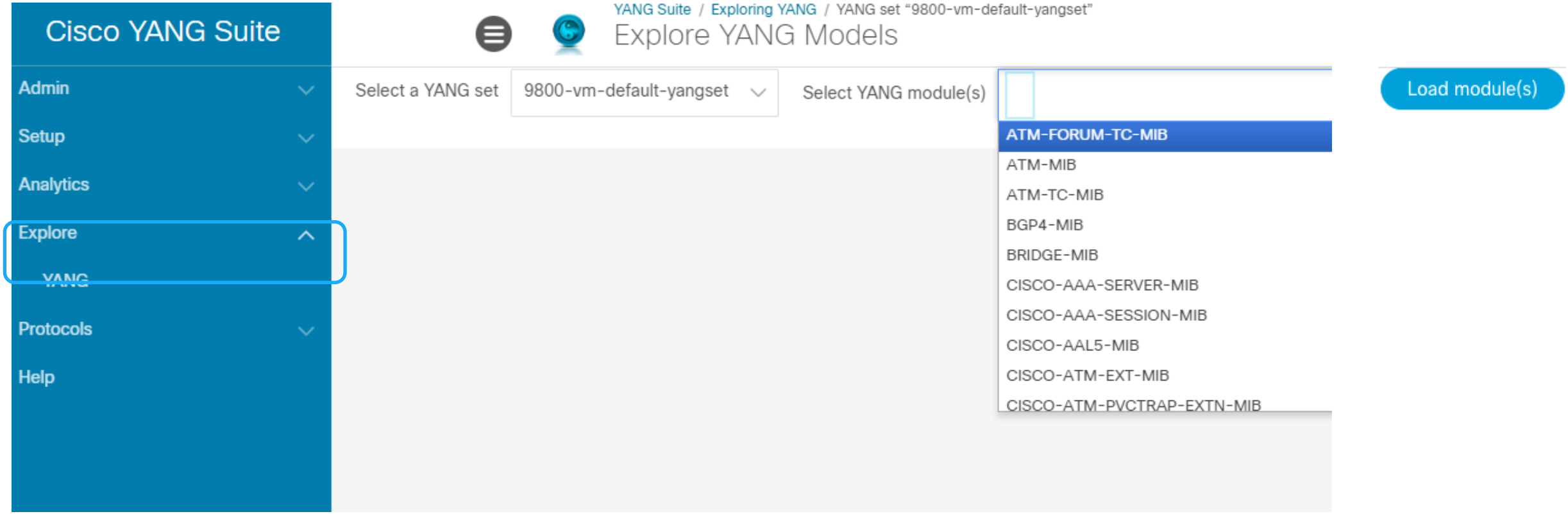
- !!! NOTE !!! You will explore YANG Suite using one of the servers where it is pre-installed. The installation has some bindings to the IP of the server, so it should be installed when you have the permanent static IP of your server
- If you want to install it on your own VM, the instructions are included in the optional Lab Exercise #12, beware that it will take a little while so you might want to do it later instead of during the deep dive
- In the pre-installed servers, YANG models will already be pulled from one of the pre-installed WLCs
- To get an even distribution, you can spread so that if you have the following WLC, use the following Ubuntu Servers to explore YANG Suite:

Shared WLC	Shared Ubuntu Server	YANG Suite URL
wlc51 (192.168.10.51)	ubuntu11 (192.168.10.11)	https://192.168.10.11:8443
wlc53 (192.168.10.53)	ubuntu12 (192.168.10.12)	https://192.168.10.12:8443
wlc55 (192.168.10.55)	ubuntu13 (192.168.10.13)	https://192.168.10.13:8443
wlc57 (192.168.10.57)	ubuntu14 (192.168.10.14)	https://192.168.10.14:8443
wlc59 (192.168.10.59)	ubuntu15 (192.168.10.15)	https://192.168.10.15:8443
wlc61 (192.168.10.61)	ubuntu16 (192.168.10.16)	https://192.168.10.16:8443

YANG Suite

- «oper» -> Operational data
- «cfg» -> Configuration and config data

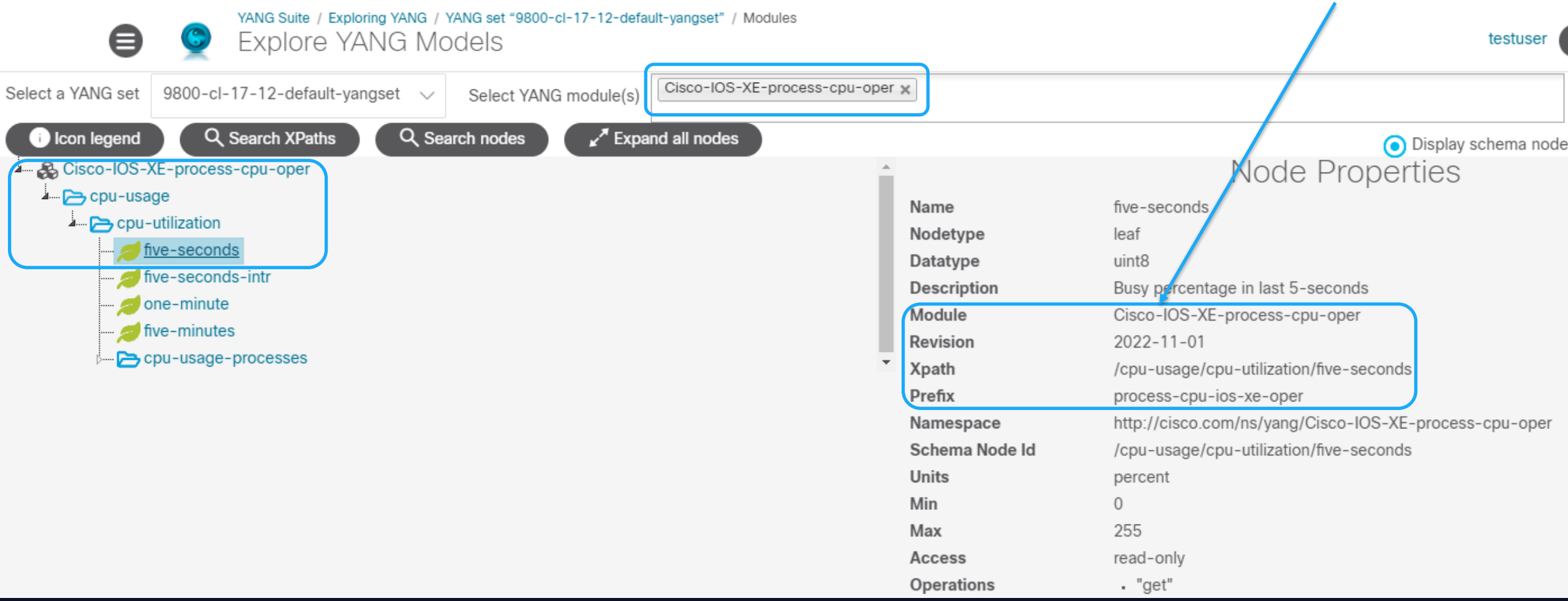
- Log in to a YANG Suite (URL on previous slide)
- Go to Explore -> YANG -> Select a YANG. Select a YANG model and click the "Load module(s)" button



Lab exercise #7: Explore YANG Suite

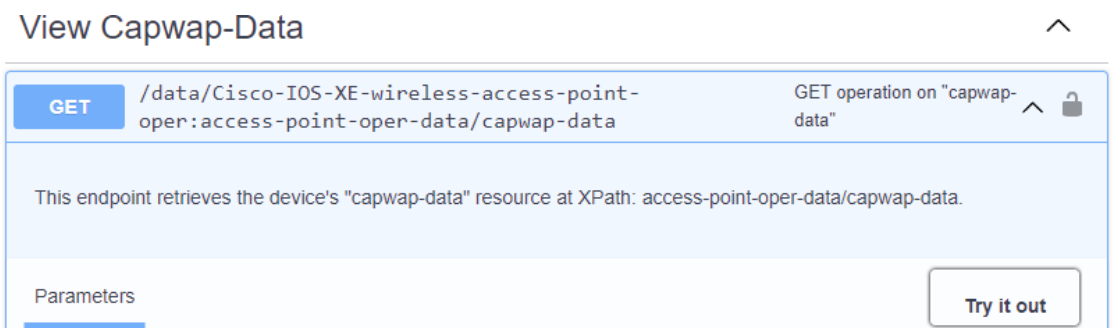
- Explore YANG Models

This is the info you typically use to craft RESTCONF calls (Postman, Python, Ansible, etc) or streaming telemetry subscriptions (from WLC)

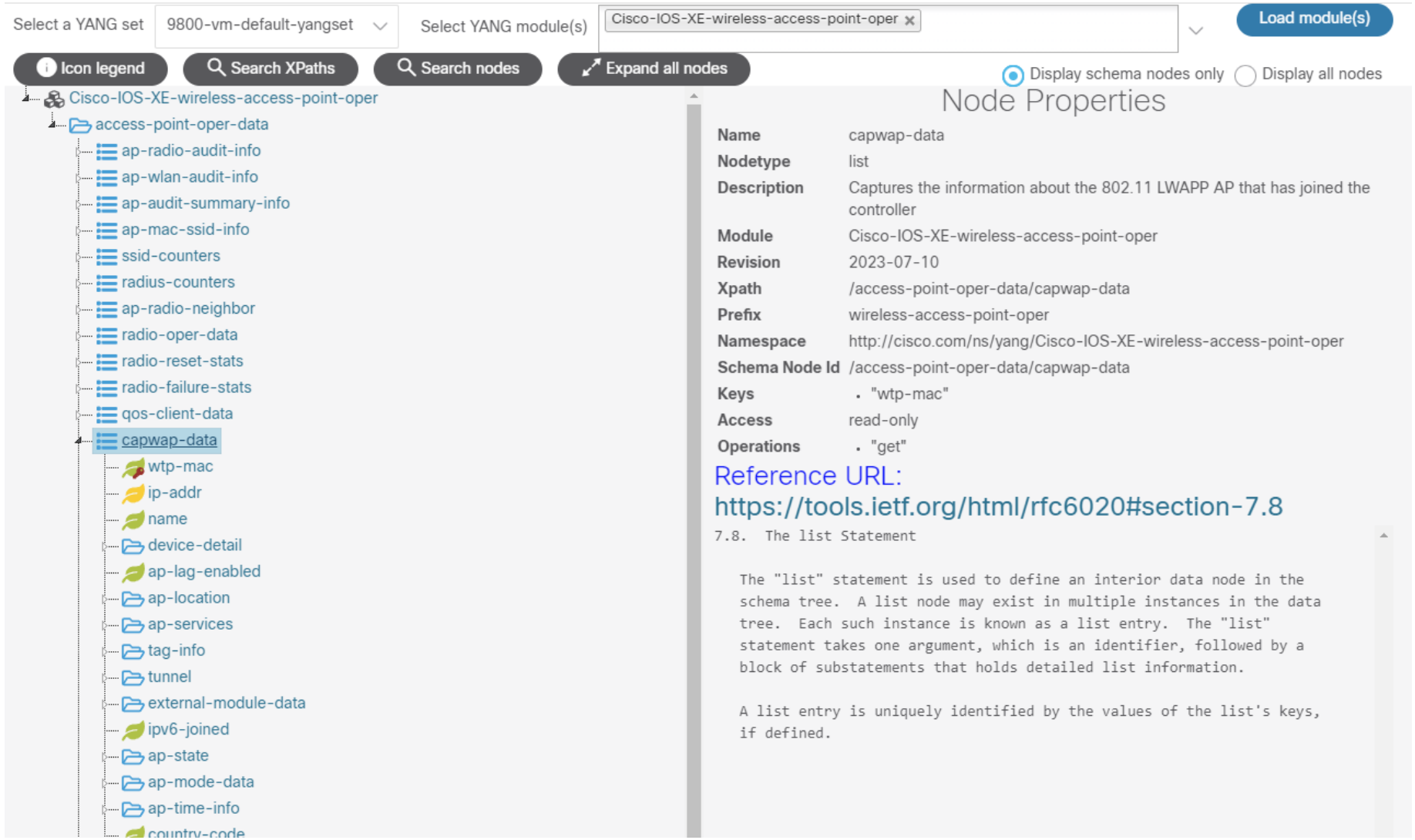


Lab exercise #7: Explore YANG Suite

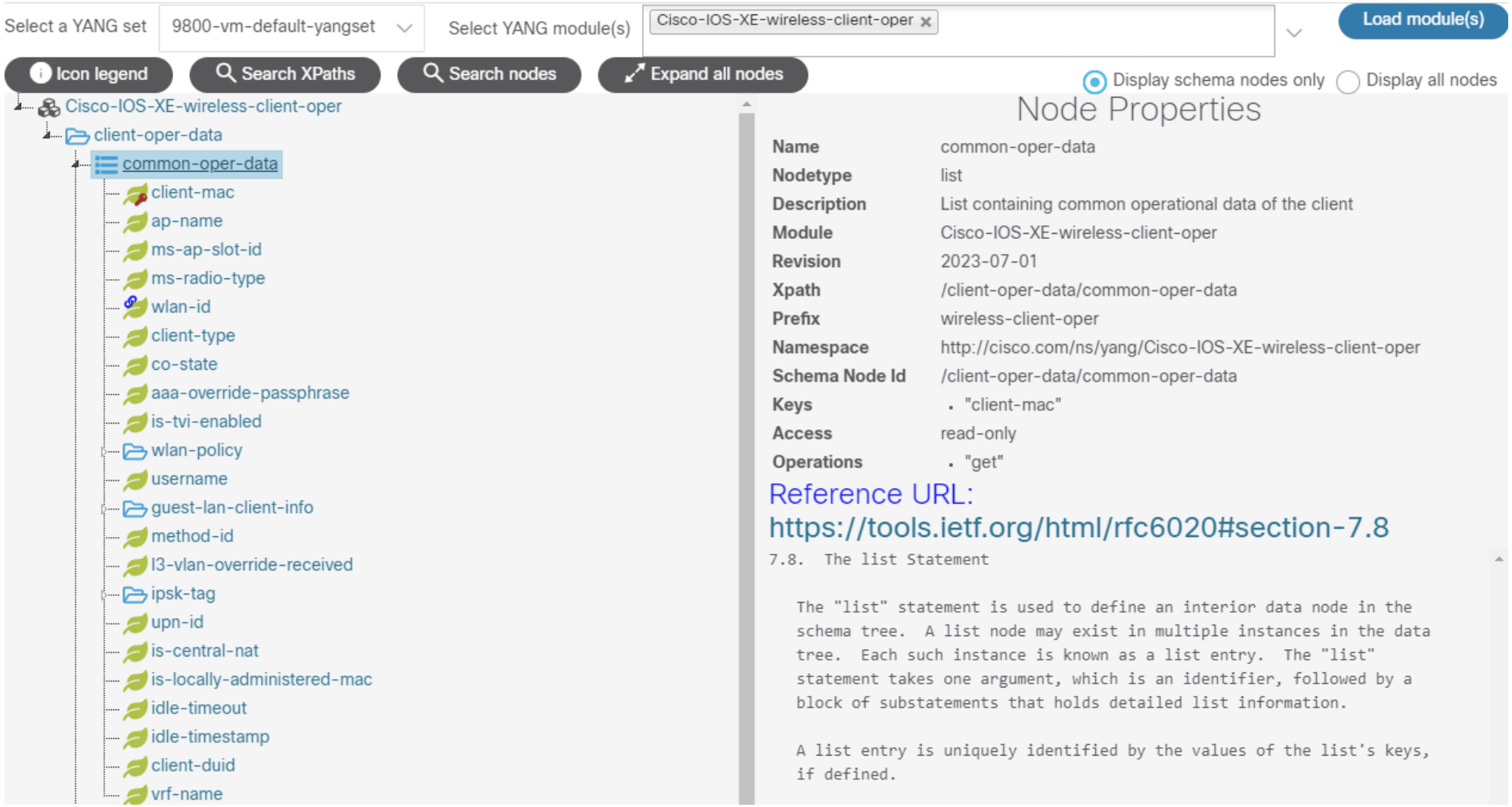
- Over the next pages is examples on a couple more YANG models you can check out
  - Get AP summary
  - Get Clients
- Just get somewhat familiar, you will use these in the next lab exercises (Postman, Python, Ansible, Grafana)
- This will show you the model, not pull the actual data
- To pull data we will use these models i Postman and Grafana later
- (optional) You can also do RESTCONF and NETCONF calls to the device from YANG Suite
  - Protocols -> RESTCONF -> Find your module -> Generate API(s) -> Authorize -> Try it out -> Execute



Get AP summary



Get Client summary



Lab exercise #8: Explore Postman

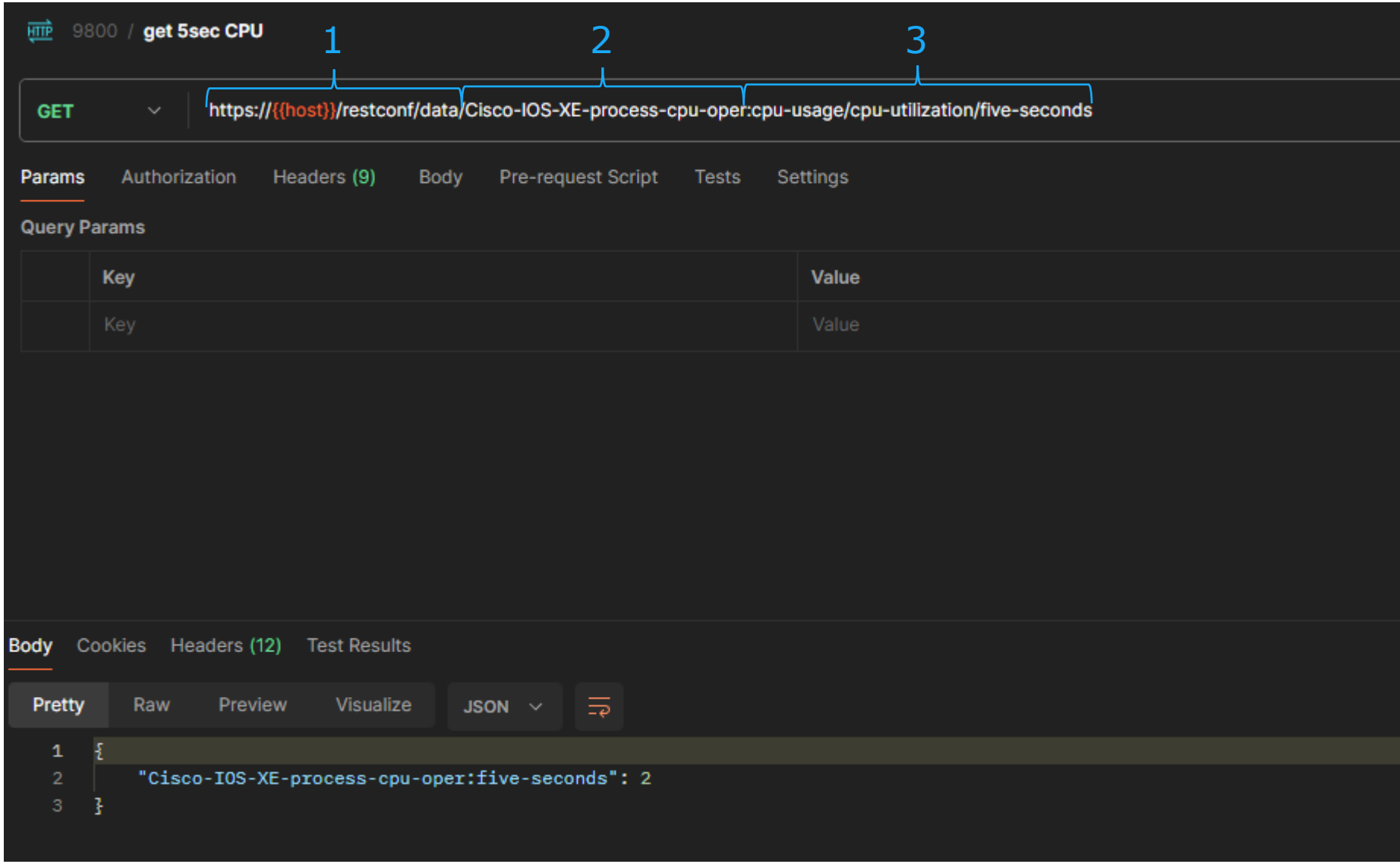
- In this lab exercise we will
  - Create a Workspace
  - Create an Environment
  - Create a Collection
  - Test some queries found from yangcatalog.org or YANG Suite (any of your choice)
  - Output to CURL or Python

Overview

Here is an example view of Postman and how the YANG modules from previous exercises can look here. We will test and explain this in more detail in this exercise

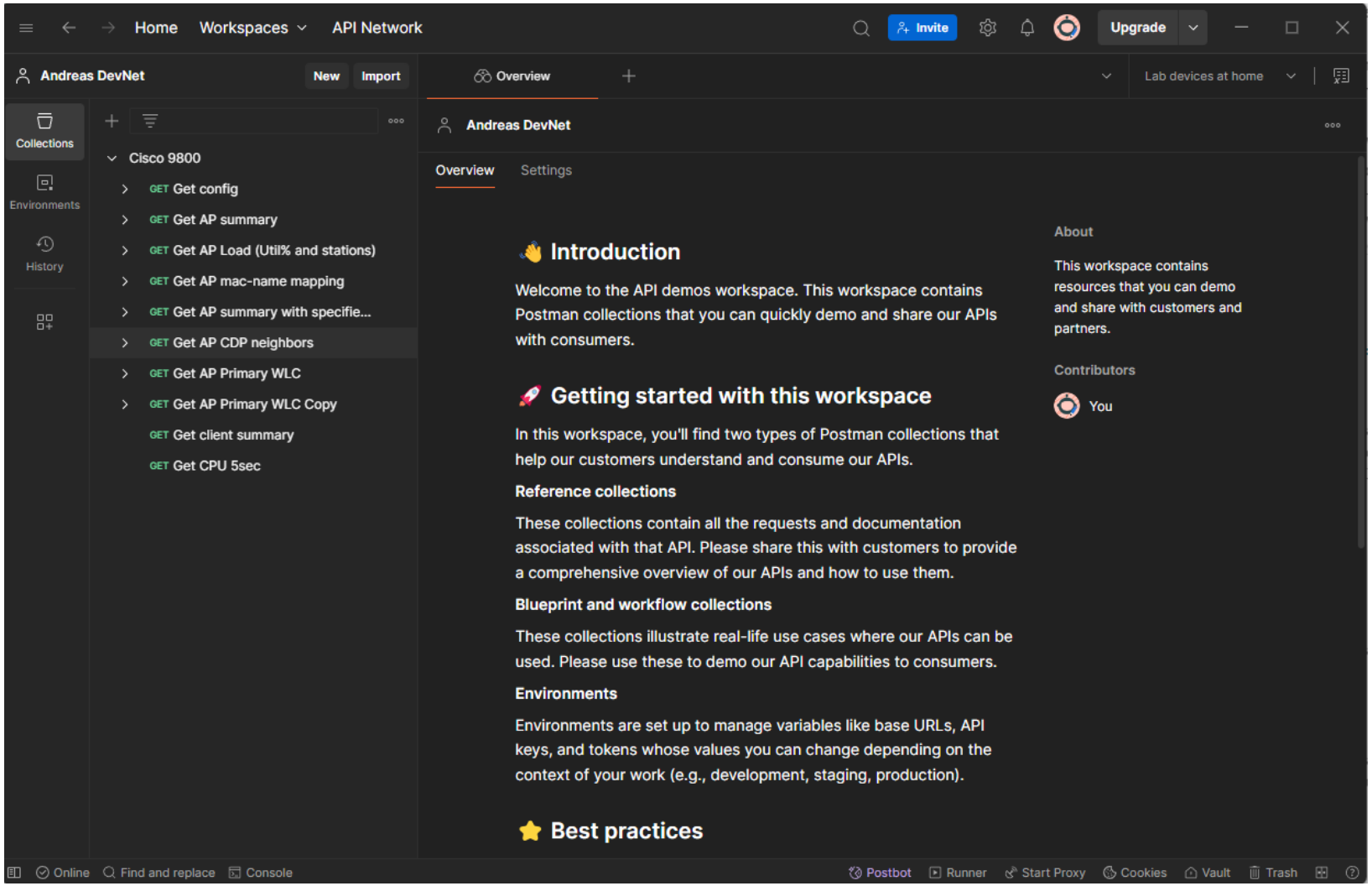
1. RESTCONF path
2. YANG module
3. Xpath

Postman is a "go-to" tool for RESTCONF APIs. Some examples for automation is testing and validating RESTCONF calls to IOS-XE devices before implementing in Python, Ansible, etc.

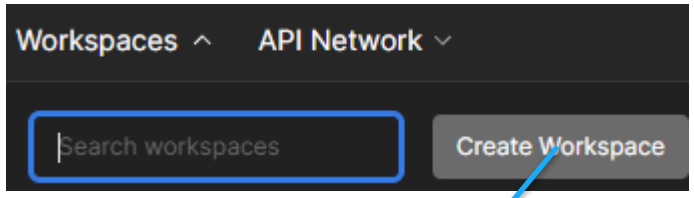


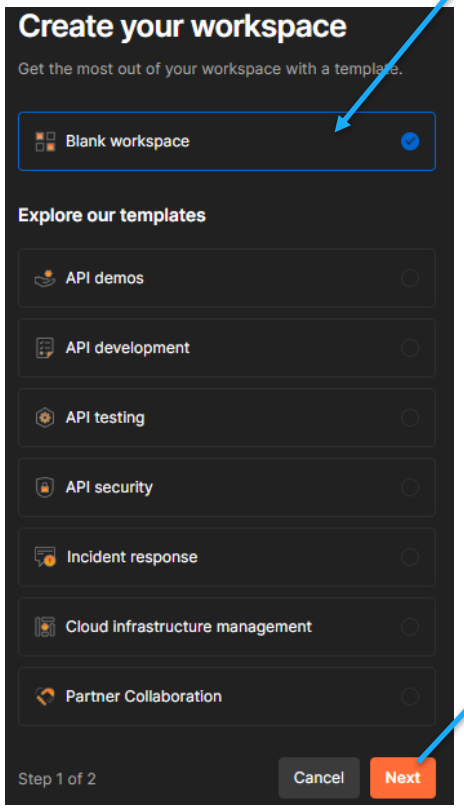
Launching Postman

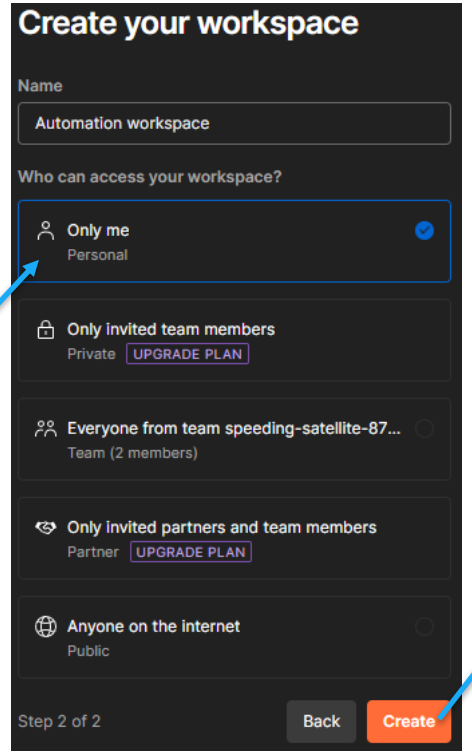
Start by launching Postman. You should already be logged in from the pre-lab task. If not, log in now. It might look something like this

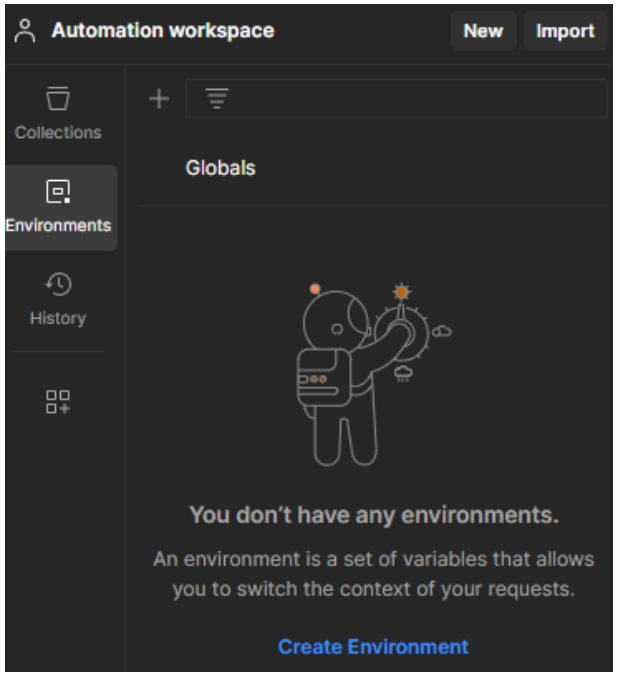


Create Workspace

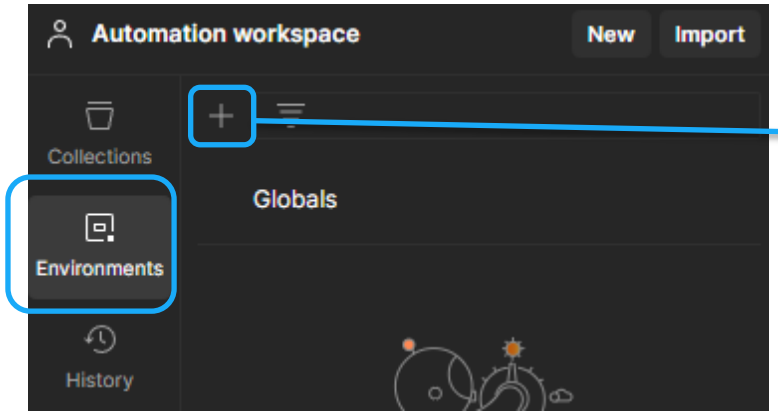


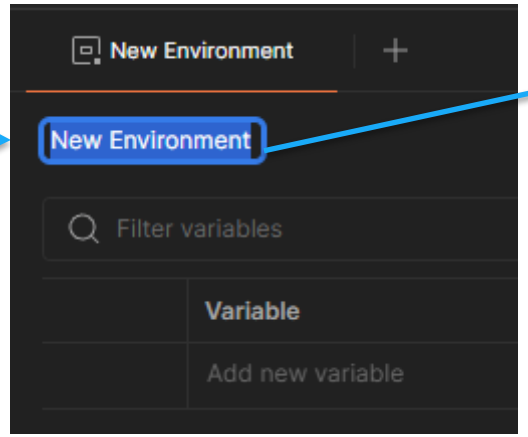


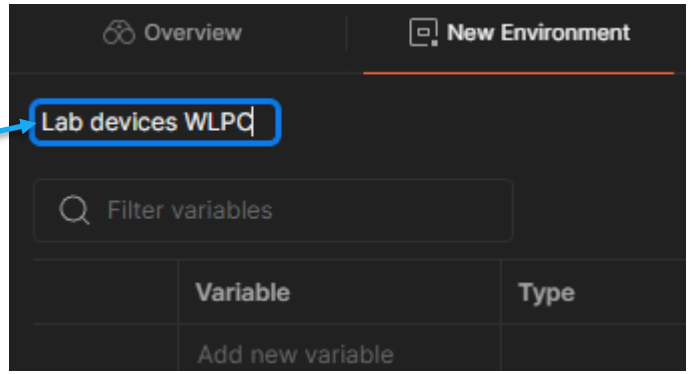




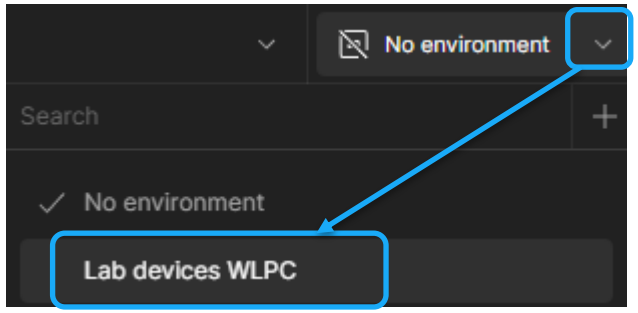
Create Environment





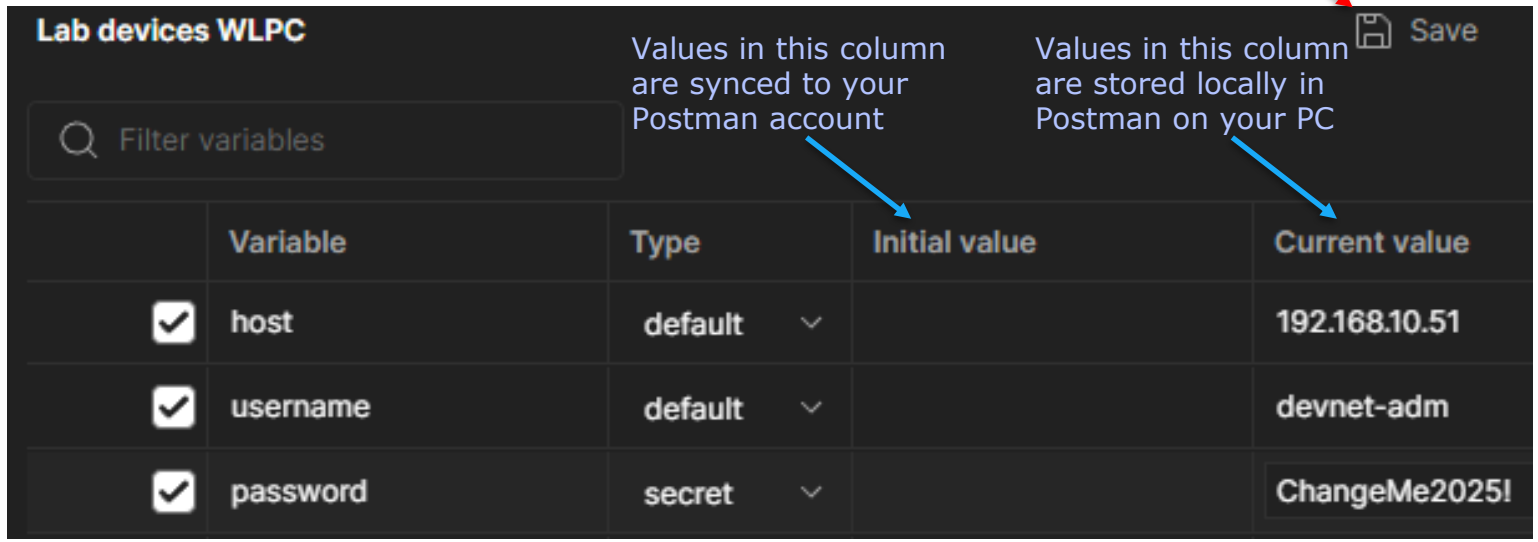


- Activate the new environment

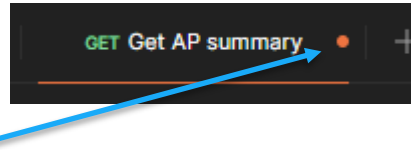


... and create some variables

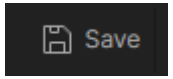
!! Remember to save !!



A word about saving



- This little orange dot means the file/tab/whatever is not saved

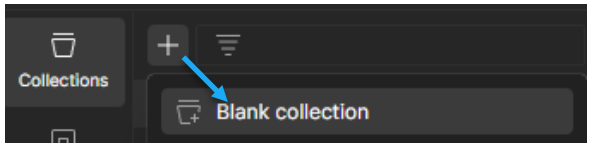
- Use Ctrl+S to save the current tab, or click this icon 

- An example: When you run a RESTCONF call with variables from an environment, like {{host}} or {{password}} it will use the value from your SAVED file. So if you do changes in the environment, remember to save the tab

Create Collection

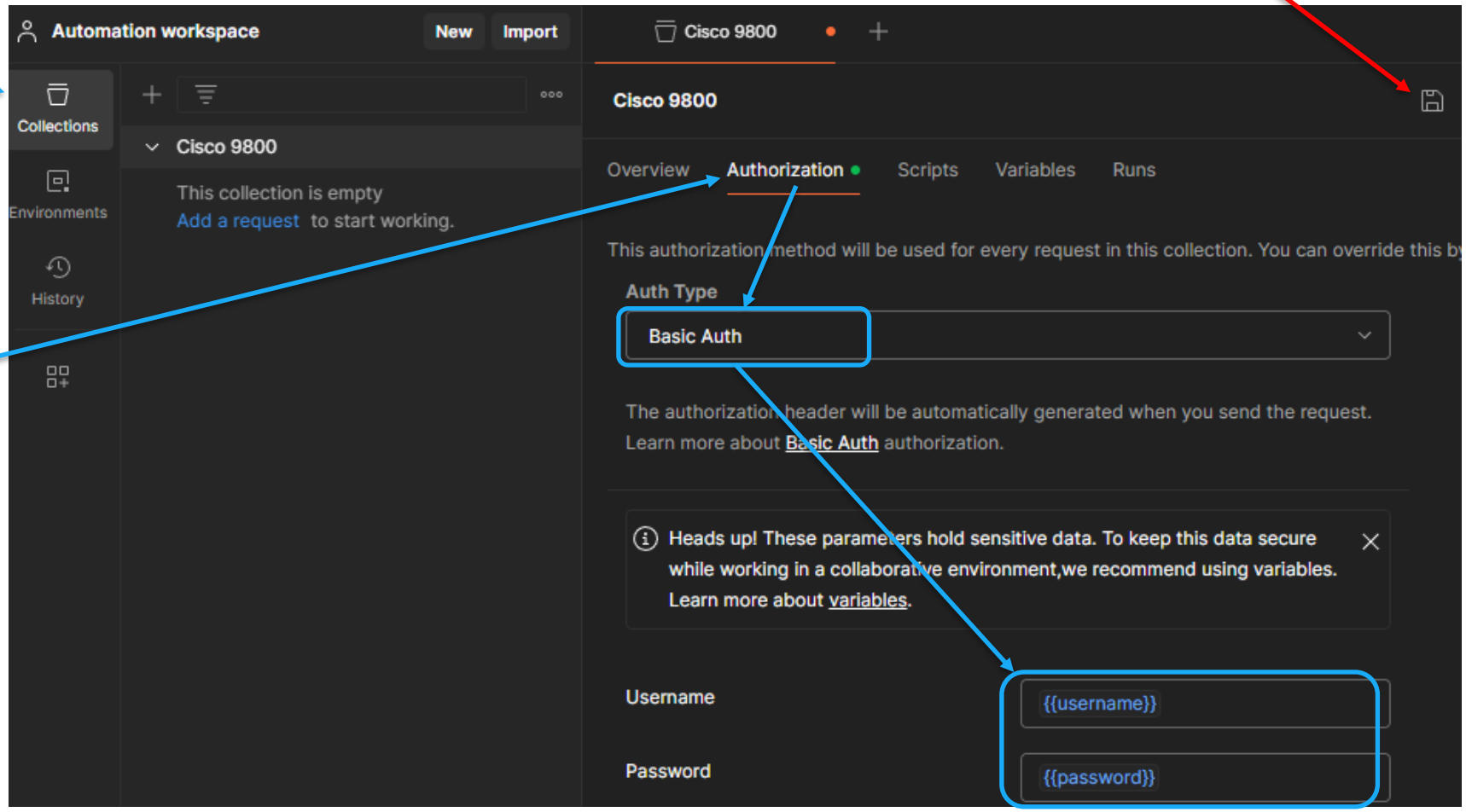
!! Remember to save !!

- Select "Collections"
- Click the +, create a Blank collection



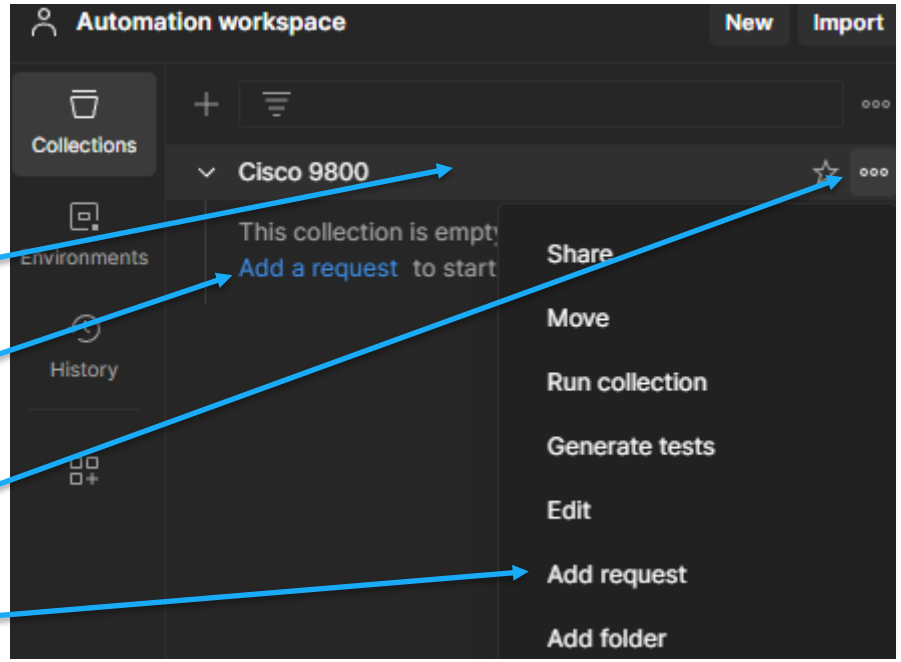
- Rename the collection

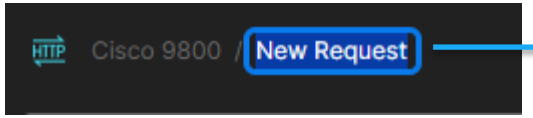
- Click "Authorization"
  select "Basic Auth"
  Enter Username and Password like this
- Creating the variables like this will make Postman get them from the current active environment (that we just created)

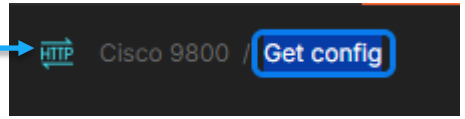


Creating your first Request

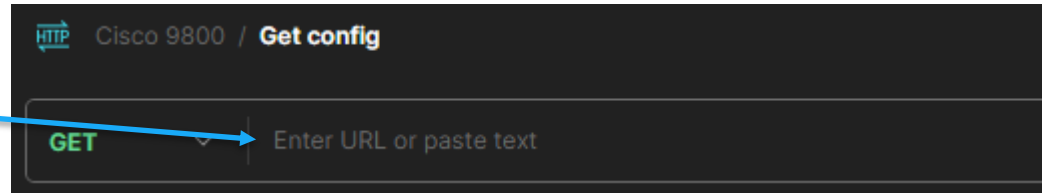
- In the "Collections" tab and on the "Cisco C9800" collection you created in last step, Add a new request by either
  - Right clicking "Cisco C9800"
  - Clicking "Add a request" if you haven't created any before
  - Clicking the three dots on the "Cisco C9800" line
- Then select "Add request"
- Name the new request "Get config"





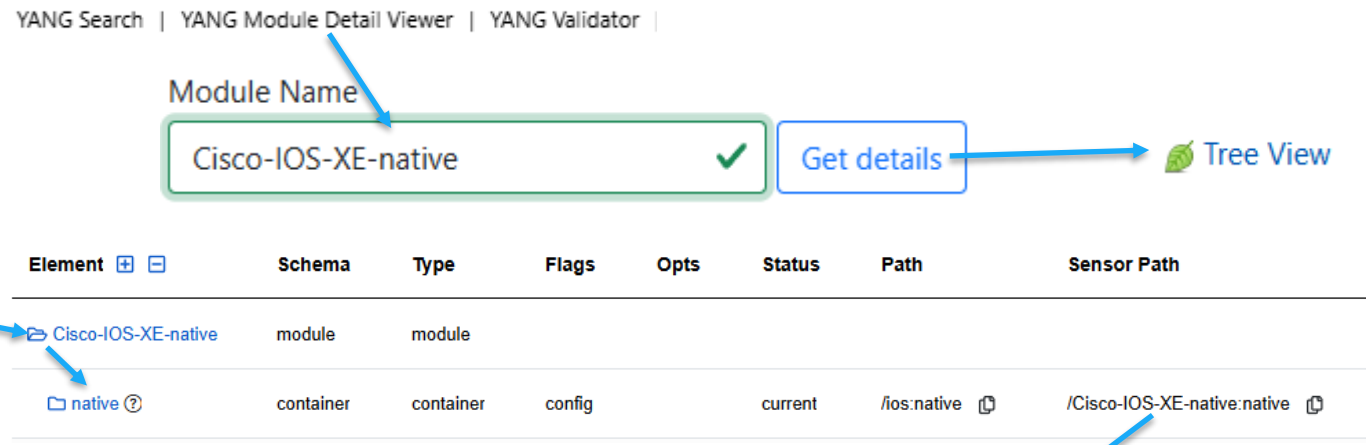


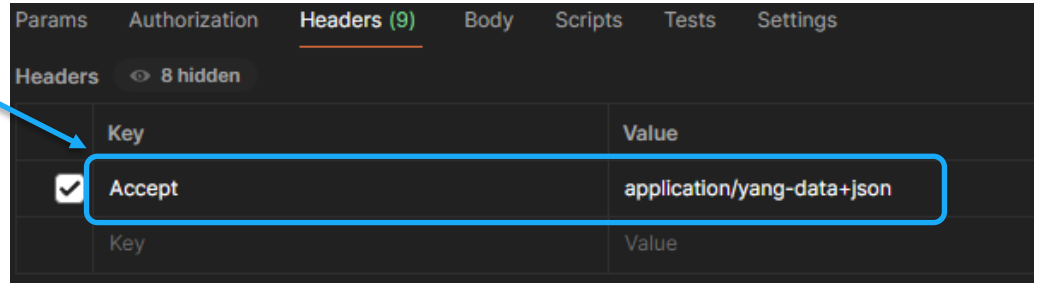
- Write your Request on the top line, default starting with "GET" and empty line
- The next slides will give example of creating requests using yangcatalog and YANG Suite, with some alternative slide layouts/explanations

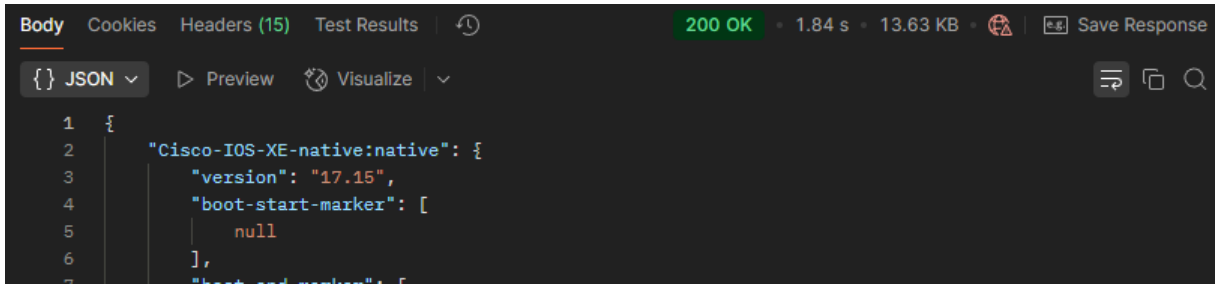


Get config

- Create the Request based on the information explored from https://yangcatalog.org
  - Expand the tree until you find your module
  - Base restconf path: https://{{host}}/restconf/data
  - Add the "Sensor Path" to the base path
  - Write the path in Postman
  - Go to "Headers" and enter the following
  - Press "Send" and you should get a response similar to this





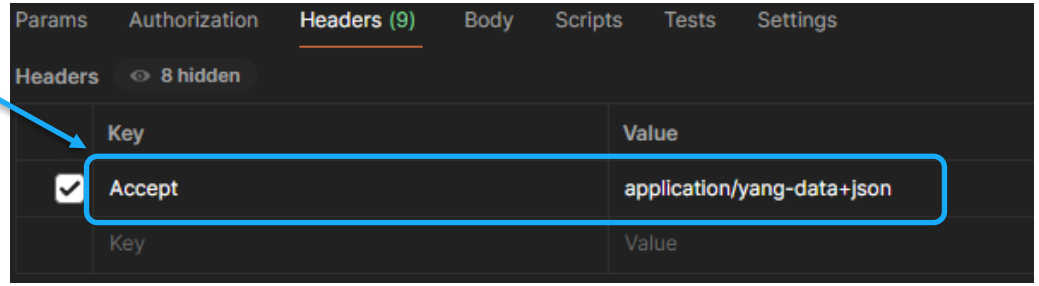


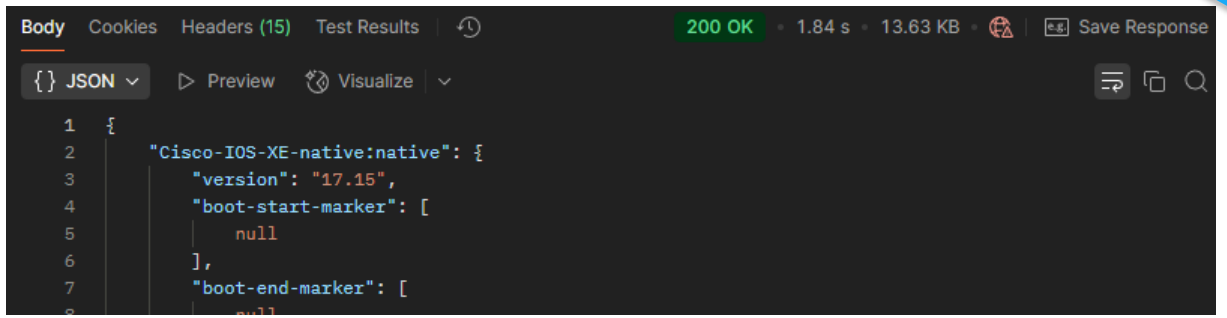
Get config (YANG Suite alternative)

- Here is an example of how to craft the same Request based on info you find in YANG Suite
  - Base Restconf path: https://{{host}}/restconf/data/
  - YANG-module: Cisco-IOS-XE-native
  - Xpath: native
  - Combined request path for copy-paste: `https://{{host}}/restconf/data/Cisco-IOS-XE-native:native`
  - Write the path in Postman
  - Go to "Headers" and enter the following
  - Press "Send" and you should get a response similar to this

Use colon (:) instead of forward slash (/) in the Xpath

You may get some line breaks at the end. Remove them before sending the request



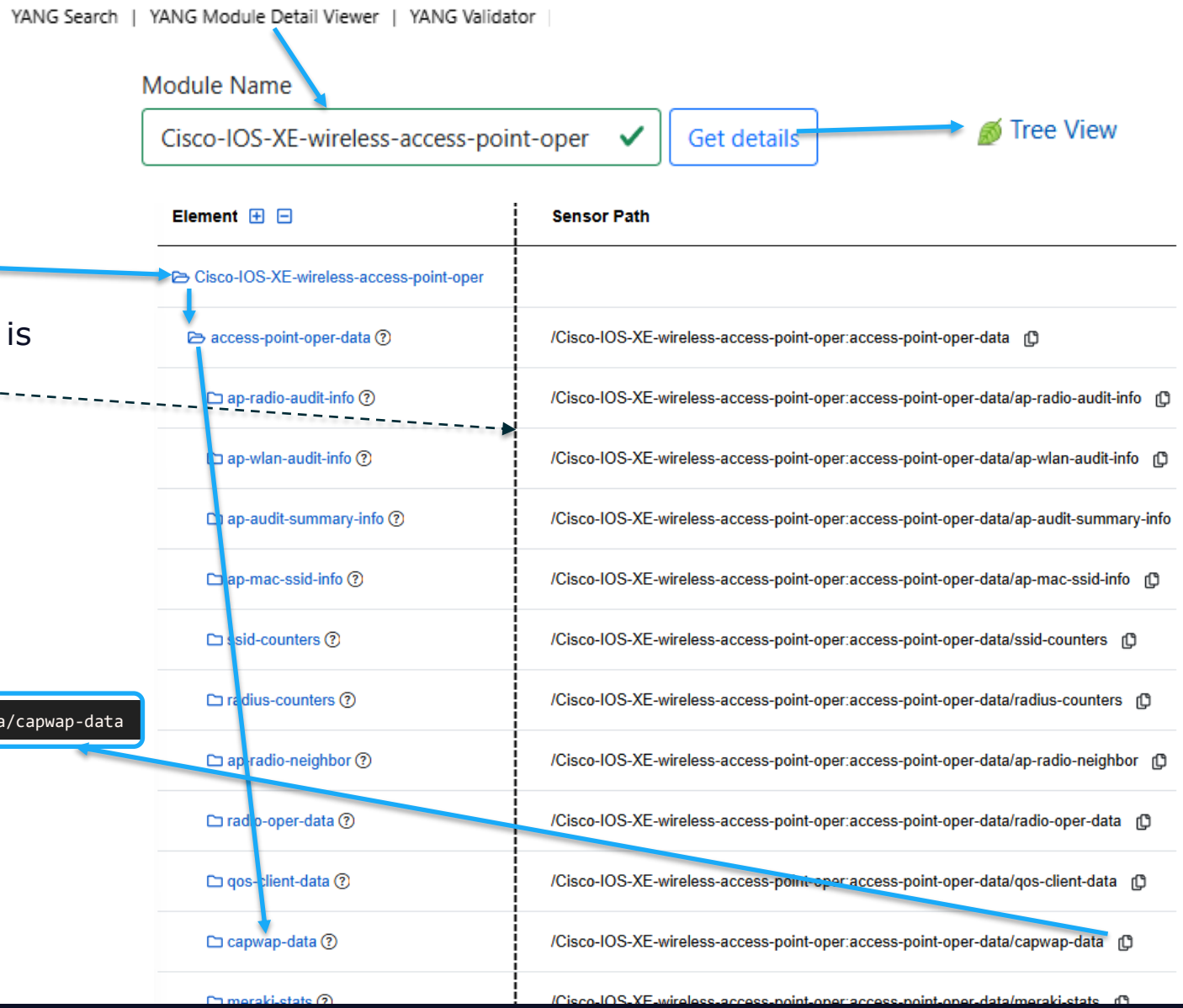


Get AP Summary (yangcatalog)

- Create the Request based on the information explored from https://yangcatalog.org
  - Expand the tree until you find your module
  - The middle of the webside is cut away, since it is too wide to show on this slide
  - Base restconf path: https://{{host}}/restconf/data

```
https://{{host}}/restconf/data/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/capwap-data
```

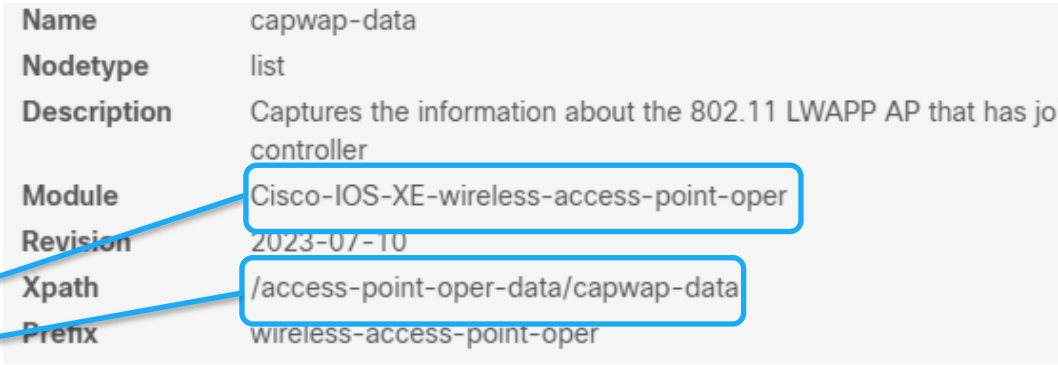
  - Copy the Sensor Path after the base restconf path, then create the rest of the query as the instructions from the previous slides

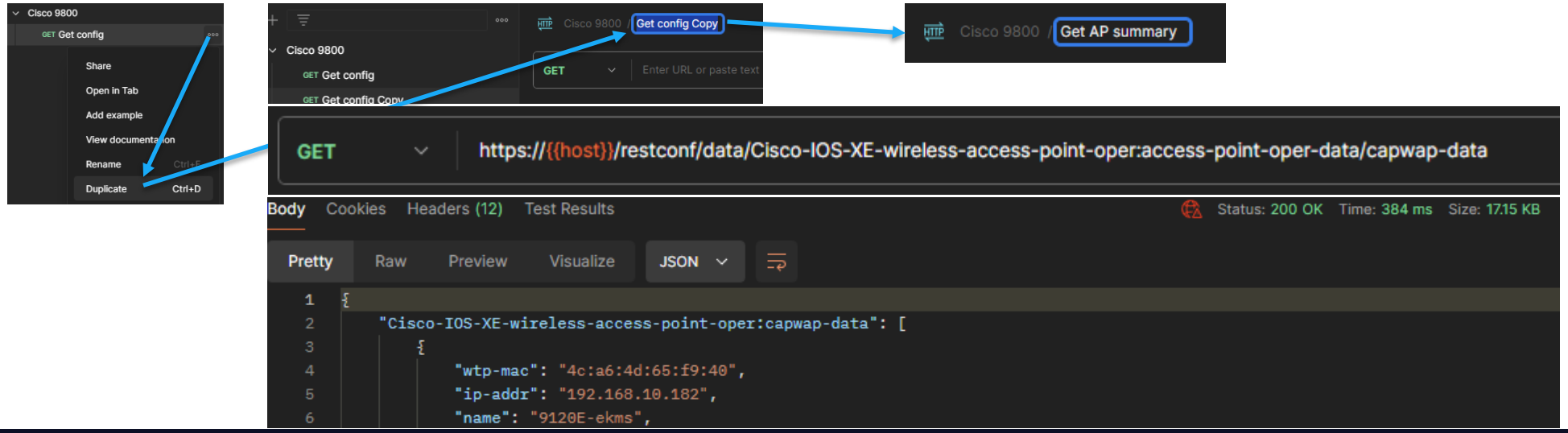


Get AP summary (YANG Suite)

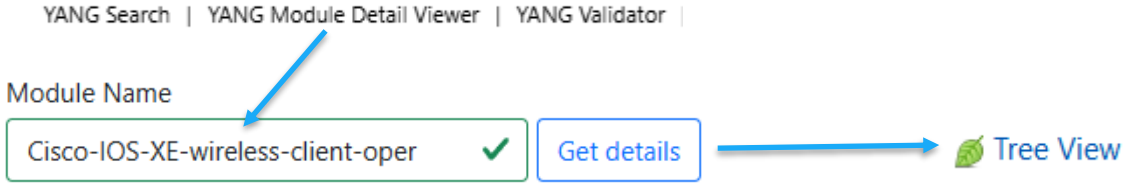
- Here is an example of how to craft the same Request based on info you find in YANG Suite
  - Restconf path: https://{{host}}/restconf/data/
  - YANG-module: Cisco-IOS-XE-wireless-access-point-oper
  - Xpath: access-point-oper-data/capwap-data
  - Combined request path for copy-paste:

```
https://{{host}}/restconf/data/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/capwap-data
```





Get Client Summary (yangcatalog)



- Create the Request based on the information explored from https://yangcatalog.org
  - Expand the tree until you find your module

Element	Schema	Type	Flags	Opts	Status	Path	Sensor Path
Cisco-IOS-XE-wireless-client-oper	module	module					
client-oper-data	container	container	no config		current	/wireless-client-oper:client-oper-data	/Cisco-IOS-XE-wireless-client-oper:client-oper-data
common-oper-data	list	list	no config		current	/wireless-client-oper:client-oper-data/wireless-client-oper:common-oper-data	/Cisco-IOS-XE-wireless-client-oper:client-oper-data/common-oper-data

  - Base restconf path: https://{{host}}/restconf/data

```
https://{{host}}/restconf/data/Cisco-IOS-XE-wireless-client-oper:client-oper-data/common-oper-data
```

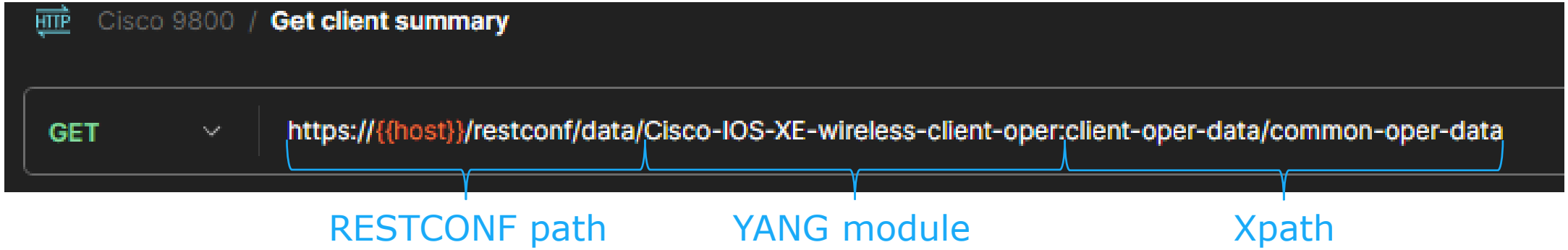
  - Copy the Sensor Path after the base restconf path, then create the rest of the query as the instructions from the previous slides

Get client summary (YANG Suite)

- Here is an example of how to craft the same Request based on info you find in YANG Suite
  - Restconf path: https://{{host}}/restconf/data/
  - YANG-module: Cisco-IOS-XE-wireless-client-oper
  - Xpath: client-oper-data/shared-oper-data
  - Combined request path for copy-paste:

```
https://{{host}}/restconf/data/Cisco-IOS-XE-wireless-client-oper:client-oper-data/common-oper-data
```

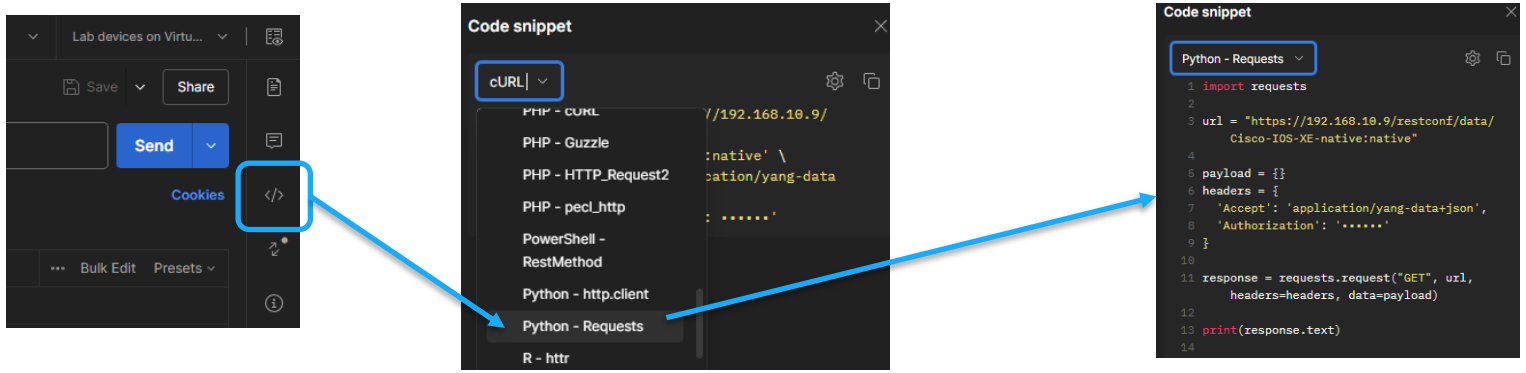
Name	common-oper-data
Nodetype	list
Description	List containing common operational data of the client
Module	Cisco-IOS-XE-wireless-client-oper
Revision	2023-07-01
Xpath	/client-oper-data/common-oper-data
Prefix	wireless-client-oper
Namespace	http://cisco.com/ns/yang/Cisco-IOS-XE-wireless-clien



- If no users are connected, the return is "No Content" (status code 204)

Output to Python

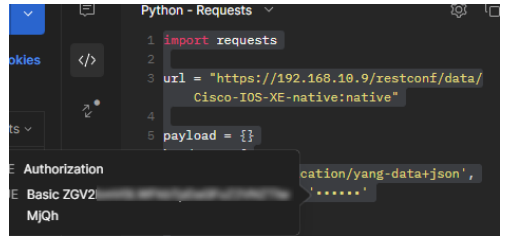
- You can output the RESTCONF call as various code snippets by clicking the "Code" button



- This can be used in your favorite Python editor, or just run it to test

```
PS H:\> python
Python 3.12.3 (tags/v3.12.3:f6650f9, Apr  9 2024, 14:05:25) [MSC v.1938 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> import requests
>>>
>>> url = "https://192.168.10.9/restconf/data/Cisco-IOS-XE-native:native"
>>>
>>> payload = {}
>>> headers = {
...    'Accept': 'application/yang-data+json',
...    'Authorization': 'Basic ZGV2bmV0
... }
>>> response = requests.request("GET", url, headers=headers, data=payload, verify=False)
C:\Users\                                  \Python312\site-packages\urllib3\connectionpool.py:1103: Insecure
n is strongly advised. See: https://urllib3.readthedocs.io/en/latest/advanced-usage.html#tls-warnings
  warnings.warn(
>>> print(response.text)
{
  "Cisco-IOS-XE-native:native": {
    "version": "17.12",
```

- You get this by hovering the mouse over the **** text in the Code snippet



- Add "verify= False" to skip certificate checking on the host

Lab exercise #9: Explore Python automation

- In this exercise we will
  - Use the virtual environment "automation-venv" created in Lab 4
  - Connect VS Code to the Ubuntu server
  - Create a Python script that
    - Connects to the WLC using RESTCONF
    - Gets a table of currently connected APs on the WLC
    - Saves the AP list as an Excel file

Create Python venv

- This lab will use the same venv for Python and Ansible automation. It could be different, and scaling to production and prototyping could often mean having a venv per project

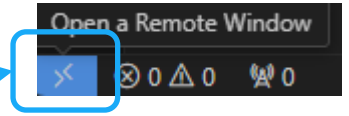
```
devnet-adm@ubuntu-devnet:~$ source ~/automation-venv/bin/activate
(automation-venv) devnet-adm@ubuntu-devnet:~$ python --version
Python 3.12.3
(automation-venv) devnet-adm@ubuntu-devnet:~$ cd wifi-automation
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation$
```

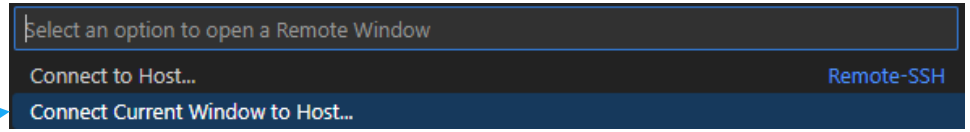
- If you did not do Lab 4, here is a copy of the commands where we created the venv. If you have created and activated your venv already these commands will not do anything (except throw some error messages)

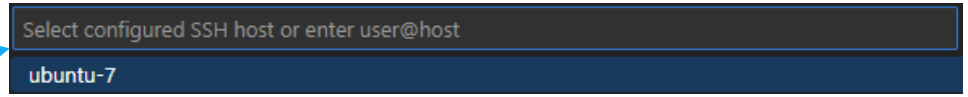
```
devnet-adm@ubuntu-devnet:~$ sudo apt install pip python3-venv
devnet-adm@ubuntu-devnet:~$ mkdir ~/automation-venv
devnet-adm@ubuntu-devnet:~$ python3 -m venv ~/automation-venv/
devnet-adm@ubuntu-devnet:~$ source ~/automation-venv/bin/activate
(automation-venv) devnet-adm@ubuntu-devnet:~$ python --version
```

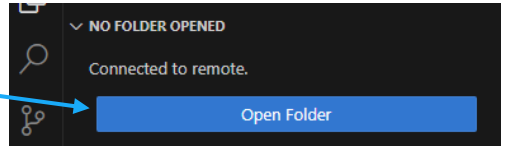

Connect VS Code to the Ubuntu Server

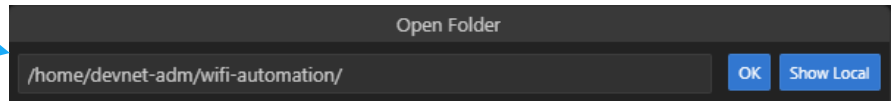
- Use VS Code remote to the Ubuntu Server (if you are not connected already)
  - Press the Remote SSH icon (lower left corner)
  - Then, in the top line, select "Connect current window to Host..."
  - Select your host, or configure a new (see Lab 3)
  - Select "Open Folder" in the Explorer section
  - Select "/home/devnet-adm/wifi-automation/" and click OK
  - Open the "examples/python-hello-world.py"
  - Select the "automation-venv" venv:
    Click the Python version area on the bottom line

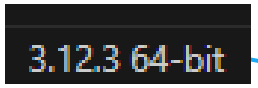


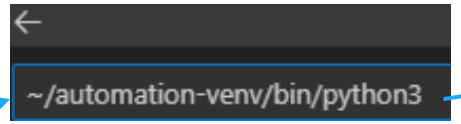


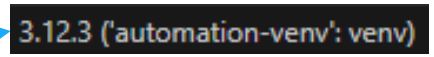






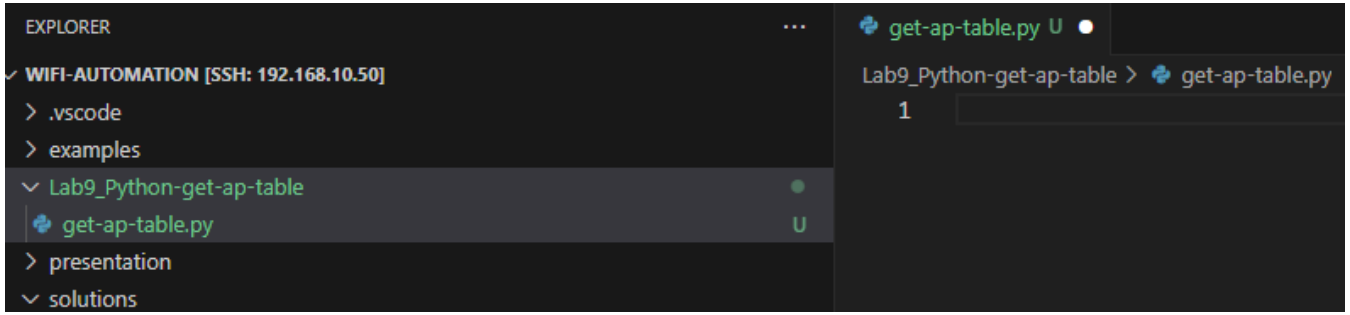






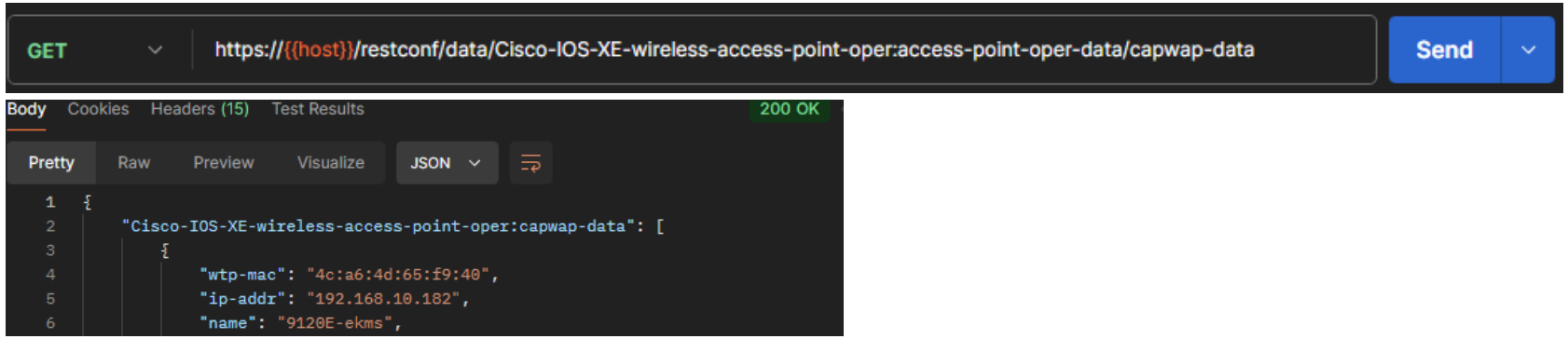
Create the Python file

- Create a folder "Lab9_Python-get-ap-table" and a python file "get-ap-table.py"
- The new file will automatically open in the editor window



Prepare the RESTCONF calls

- Using Postman, test the RESTCONF calls to get this info from your WLC
  - This is the URL of the RESTCONF call we will be using in this exercise
    - `https://{{host}}/restconf/data/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/capwap-data`



  - You can try specifying some fields to reduce the data size
    - `https://{{host}}/restconf/data/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/capwap-data?fields=wtp-mac;wtp-ip;name;ap-state;device-detail/static-info/board-data/wtp-serial-num;device-detail/static-info/board-data/wtp-enet-mac;device-detail/static-info/ap-models/model;tag-info/tag-source;tag-info/policy-tag-info;tag-info/site-tag;tag-info/rf-tag;tag-info/filter-info/filter-name;ap-time-info/boot-time;ap-time-info/join-time`

Prepare Python packages

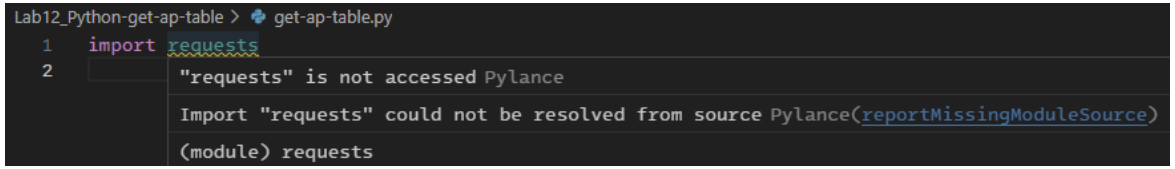
- For this exercise, we will use the following modules
  - requests
  - pandas
  - openpyxl
- To install these, use the command "pip install requests pandas openpyxl"

Make sure you are in the "automation-venv", indicating by the text (automation-venv) before each line in the terminal. If not, you will get an error message

```
error: externally-managed-environment
```

```
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation$ cd Lab9_Python-get-ap-table
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab9_Python-get-ap-table$ pip install requests pandas openpyxl
Collecting requests
  Downloading requests-2.32.3-py3-none-any.whl.metadata (4.6 kB)
Collecting pandas
  Downloading pandas-2.2.2-cp312-cp312-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (19 kB)
Collecting openpyxl
(...)
Successfully installed certifi-2024.7.4 charset-normalizer-3.3.2 et-xmlfile-1.1.0 idna-3.8 numpy-2.1.0 openpyxl-3.1.5 pandas-2.2.2 python-dateutil-
2.9.0.post0 pytz-2024.1 requests-2.32.3 six-1.16.0 tzdata-2024.1 urllib3-2.2.2
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab9_Python-get-ap-table$
```

- If you want, you can wait installing these until you see the errors highlighted in VS Code when we try to use them



Get AP table

```python
import requests
import pandas as pd
import getpass

wlc = input("Enter WLC IP: ")
user = input("Enter user: ")
password = getpass.getpass("Enter password: ")
url = f"https://{wlc}/restconf/data/Cisco-IOS-XE-wireless-access-poin

payload = {}
headers = {
  'Accept': 'application/yang-data+json',
  'Content-Type': 'application/yang-data+json'
  }

response = requests.get(url, auth=(user, password), headers=headers,

if (response.status_code==200):
    ap_table = pd.json_normalize(response.json()['Cisco-IOS-XE-wirele
    print(ap_table)
    ap_table.to_excel('ap_table.xlsx')
    ap_table.to_csv('ap_table.csv')
else:
    print(f"Status code: {response.status_code}: {response.reason}")
```

- Import the modules we will use
- WLC IP, username and password as input fields, it will be asked when running the script
- Create the RESTCONF call using the IP of your WLC, and the path you tested with Postman
- Make the call and save the response
- Some very basic error checking
- The response is given as JSON. We use a pandas function "json_normalize" to flatten parts of the JSON object to present it in a table
- Print the table in the terminal
- Save the table to Excel and CSV

get-ap-table.py

```
import requests
import pandas as pd
import getpass

wlc = input("Enter WLC IP: ")
user = input("Enter user: ")
password = getpass.getpass("Enter password: ")
url = f"https://{wlc}/restconf/data/Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/capwap-data?fields=wtp-mac;wtp-ip;name;ap-state;device-detail/static-info/board-data/wtp-serial-num;device-detail/static-info/board-data/wtp-enet-mac;device-detail/static-info/ap-models/model;tag-info/tag-source;tag-info/policy-tag-info;tag-info/site-tag;tag-info/rf-tag;tag-info/filter-info/filter-name;ap-time-info/boot-time;ap-time-info/join-time"

payload = {}
headers = {
  'Accept': 'application/yang-data+json',
  'Content-Type': 'application/yang-data+json'
  }

response = requests.get(url, auth=(user, password), headers=headers, data=payload, verify=False)

if (response.status_code==200):
    ap_table = pd.json_normalize(response.json()['Cisco-IOS-XE-wireless-access-point-oper:capwap-data'])
    print(ap_table)
    ap_table.to_excel('ap_table.xlsx')
    ap_table.to_csv('ap_table.csv')
else:
    print(f"Status code: {response.status_code}: {response.reason}")
```

Running the Python script from terminal

- One way to run a Python script, is by using the terminal. When in the folder of the script, run using "python" and the filename

```
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation$ cd Lab9_Python-get-ap-table
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab9_Python-get-ap-table$ ls -l
total 4
-rw-rw-r-- 1 devnet-adm devnet-adm 978 Aug 25 19:24 get-ap-table.py
(automation-venv) devnet-adm@ubuntu-devnet:~/wifi-automation/Lab9_Python-get-ap-table$ python get-ap-table.py
Enter WLC IP: 192.168.10.30
Enter user: devnet-adm
Enter password:
```

Use YOUR WLC IP

- If there are no APs on the WLC it will have status code 204 (No Content). So it will not print the table etc, if it tried it would produce an error on the "json()[blablabla] part"

```
Status code: 204: No Content
```

- Successful run will look something like this:

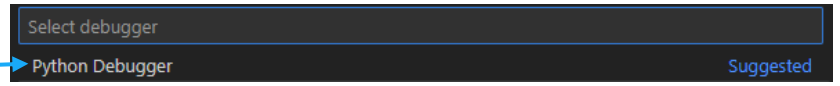
```
             wtp-mac              name          wtp-ip  ... ap-state.ap-operation-state     ap-time-info.boot-time           ap-time-info.join-time
0  4c:a6:4d:65:f9:40        9120E-ekms  192.168.10.182  ...                  registered  2024-07-25T00:28:12+00:00  2024-07-25T00:30:04.335182+00:00
1  d4:2c:44:d9:24:40  APD42C-44D8-2F38  192.168.10.177  ...                  registered  2024-07-31T19:22:07+00:00  2024-07-31T19:23:42.643078+00:00
```

- Wrong username/password will look something like this:

```
Status code: 401: Unauthorized
```


Running the Python script from VS Code

- Press Ctrl+F5 to run the script in VS Code
  - Select "Python Debugger" if asked




```
(python-lab-venv) devnet-adm@ubuntu-devnet:~/wifi-automation$  /usr/bin/env /home/devnet-adm/python-lab-venv/bin/python3 /home/devnet-adm/.vscode-
server/extensions/ms-python.debugpy-2024.10.0-linux-x64/bundled/libs/debugpy/adapter/../../debugpy/launcher 57251 -- /home/devnet-adm/wifi-automat
ion/Lab6_Python-get-ap-table/get-ap-table.py
Enter WLC IP: 192.168.10.30
Enter user: devnet-adm
Enter password:
/home/devnet-adm/python-lab-venv/lib/python3.12/site-packages/urllib3/connectionpool.py:1099: InsecureRequestWarning: Unverified HTTPS request is
being made to host '192.168.10.30'. Adding certificate verification is strongly advised. See: https://urllib3.readthedocs.io/en/latest/advanced-us
age.html#tls-warnings
  warnings.warn(
Status code: 204: No Content
(python-lab-venv) devnet-adm@ubuntu-devnet:~/wifi-automation$
```

- The Excel file will contain the info, but will be otherwise unformatted. You can download the file by right-clicking it and selecting "Download…" and save to a folder of your choice on your local machine.

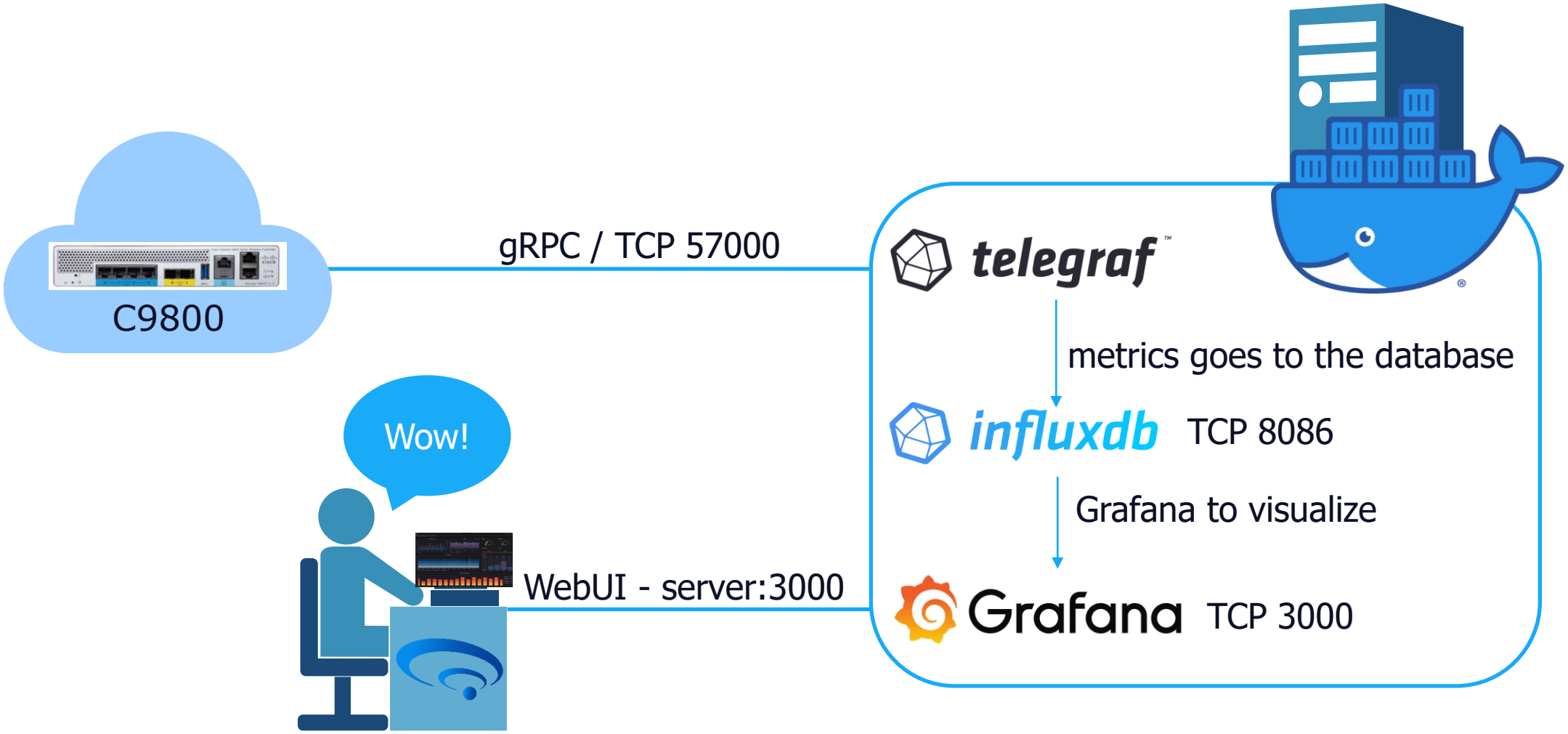
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
		wtp-mac	name	wtp-ip	nfo.board	info.board	atic-info.a	nfo.tag-so	tag-info.pt	te-tag.site	site-tag.a	site-tag.fl	rf-tag.rf-t	lter-info.fi	e.ap-admi	ap-operat	e-info.boo	e-info.join-time		
0		4c:a6:4d:6	9120E-ekn	192.168.1(	FGL2417LS	a4:b4:39:2	C9120AXE	tag-source	k32-stand	k32	koksrud-a	koksrud-fl	k32-rf	Staging-re	adminstat	registerec	2024-07-2	2024-07-25T00:30:04.335182		
1		d4:2c:44:d	APD42C-4	192.168.1(	KWC2038(	d4:2c:44:d	AIR-AP183	tag-source	Empty	k32	koksrud-a	koksrud-fl	k32-rf	Empty	adminstat	registerec	2024-07-3	2024-07-31T19:23:42.643078		

- You can open the CSV file in VS Code, or in the terminal using "cat ap_table.csv" (or several alternatives)

Lab exercise #10: Install TIG stack (optional)

- !!! NOTE !!!
  - This exercise is marked as optional. However, if you plan on doing more Grafana stuff on day to we highly recommend that you do this, even if it will take some extra time today, or continue on to day 2
  - If you plan doing primarily Python or Ansible stuff on day 2, you can skip exercise 10 (installing TIG stack) and skip to Lab exercise 11. You can then use the installation on one of the pre-installed Ubuntu Servers.
- In this lab exercise, we will install "TIG Stack" as a Docker container on the Ubuntu Server
- As part of the installation we will
  - Create .env file containing variables
  - Ensure persistant storage
  - Create new bucket and adapt it so we can use InfluxDB
- The next slides will give some basic overview of the TIG Stack, and how all fits together
  - T = Telegraf
  - I = InfluxDB
  - G = Grafana

TIG Stack overview



The TIG in the TIG stack

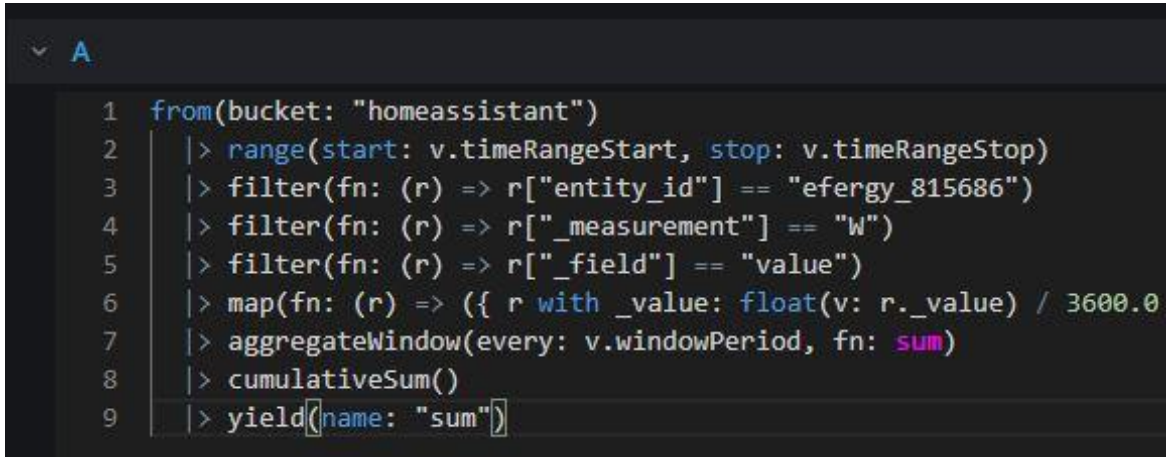
- **Open Source Agent:** Collects and sends metrics from databases, systems, and IoT devices
- **Versatile Monitoring:** Works with databases, systems, and IoT sensors

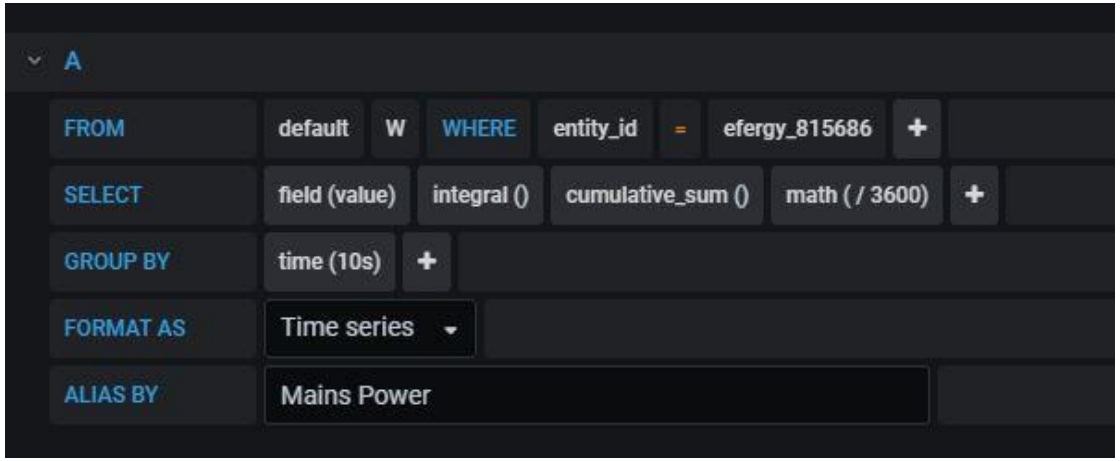
- **Time Series Data at Scale:** Store and query large volumes of time-stamped data
- **Real Time Analytics:** Fast processing for immediate insights
- **Seamless Integration:** Compatible with various tools and platforms

- **Visualize Anything:** Create dashboards for any data
- **Real Time Insights:** Customizable, interactive visuals
- **Flexible Integration:** Connects to multiple data sources

Different flavours of Influx

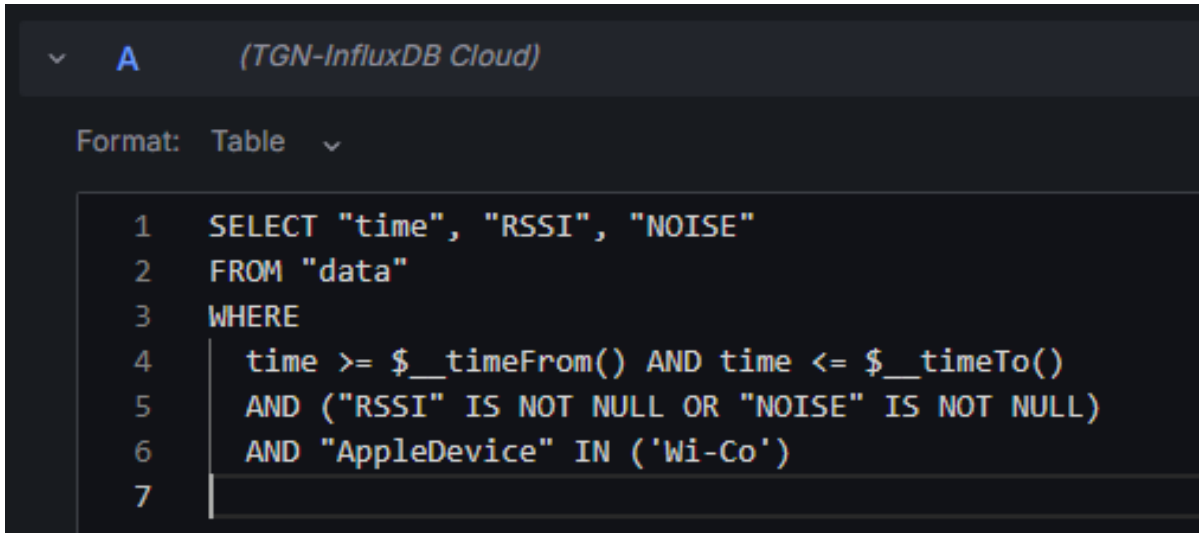
InfluxDB 2.x - FLUX





InfluxDB 1.x - InfluxQL

We will use InfluxDB 2.x but query data using InfluxQL



InfluxDB 3.x – InfluxQL (v2)

Make some notes

- There are some variables that need to be typed later, so to save time you can make a .txt file while we continue in this lab

Lab10_Notes.txt

```
Admin token: {we will fill in this later}
Org ID: {we will fill in this later}
Container ID: {we will fill in this later}
```

- Even better, you could use your favorite password manager (KeePass etc)

TIG stack installation

1. Create a .env file to store variables

```
devnet-adm@ubuntu-devnet:~$ cd ~
devnet-adm@ubuntu-devnet:~$ mkdir tig-stack
devnet-adm@ubuntu-devnet:~$ cd tig-stack
devnet-adm@ubuntu-devnet:~/tig-stack$ nano .env

#add the following, and change the variables if needed
```

.env

```
INFLUXDB_ADMIN_USER=devnet-adm
INFLUXDB_ADMIN_PASSWORD=ChangeMe2025!
INFLUXDB_ORG=devnet
INFLUXDB_BUCKET=c9800-bucket
INFLUXDB_ADMIN_TOKEN=ChangeMe2025!
GF_SECURITY_ADMIN_USER=devnet-adm
GF_SECURITY_ADMIN_PASSWORD=ChangeMe2025!
```

   - Add the INFLUXDB_ADMIN_TOKEN to your .txt file

lab10_notes.txt

```
1  Admin token: ChangeMe2025!
```

2. Create persistent storage

```
devnet-adm@ubuntu-devnet:~/tig-stack$ docker volume create grafana-data
devnet-adm@ubuntu-devnet:~/tig-stack$ docker volume create influxdb-data
```

3. Create the Telegraf config file

```
devnet-adm@ubuntu-devnet:~/tig-stack$ mkdir -p telegraf/conf
devnet-adm@ubuntu-devnet:~/tig-stack$ nano telegraf/conf/telegraf.conf
```

telegraf.conf

```
[global_tags]
  host = "My-Telegraf"
[agent]
  interval = "10s"
  round_interval = true
  metric_batch_size = 1000
  metric_buffer_limit = 10000
  collection_jitter = "0s"
  flush_interval = "10s"
  flush_jitter = "0s"
  precision = ""
  debug = false
  quiet = false
  logfile = ""
  hostname = "My-Telegraf"
  omit_hostname = false


###############################################################################
#                            OUTPUT PLUGINS                                   #
###############################################################################

# Configuration for influxdb server to send metrics to


[[outputs.influxdb_v2]]
urls = [ "http://influxdb:8086" ]
  token = "${INFLUXDB_ADMIN_TOKEN}"
  organization = "${INFLUXDB_ORG}"
  bucket = "${INFLUXDB_BUCKET}"
# tagexclude = ["influxdb_database"] ### Optional: Exclude specific tags if needed
 [outputs.influxdb_v2.tagpass]
  influxdb_database = ["${INFLUXDB_BUCKET}"]


###############################################################################
#                            INPUT PLUGINS                                    #
###############################################################################

[[inputs.cisco_telemetry_mdt]]
  transport = "grpc"
  service_address = ":57000"
 [inputs.cisco_telemetry_mdt.tags]
  influxdb_database =  "${INFLUXDB_BUCKET}"
```

TIG stack installation

1. Configure docker-compose.yml

```
devnet-adm@ubuntu-devnet:~$ cd ~/tig-stack
devnet-adm@ubuntu-devnet:~$ nano ./docker-compose.yml
```

Add the following config to `docker-compose.yml`

2. Docker compose

```
devnet-adm@ubuntu-devnet:~$ docker compose up -d
```

- This will take a few seconds to download all images.
- To view logs from a service (telegraf, influxdb, grafana) use this

```
devnet-adm@ubuntu-devnet:~$ docker logs telegraf
```

3. Connect to Grafana using web browser

- Notice we use HTTP, not HTTPS for this lab install
- http://192.168.10.{your Ubuntu IP}:3000
- For now, just test that you can log in using the username and password from the .env file we created earlier. For this lab it will be the same as everywhere else unless you changed it ☺

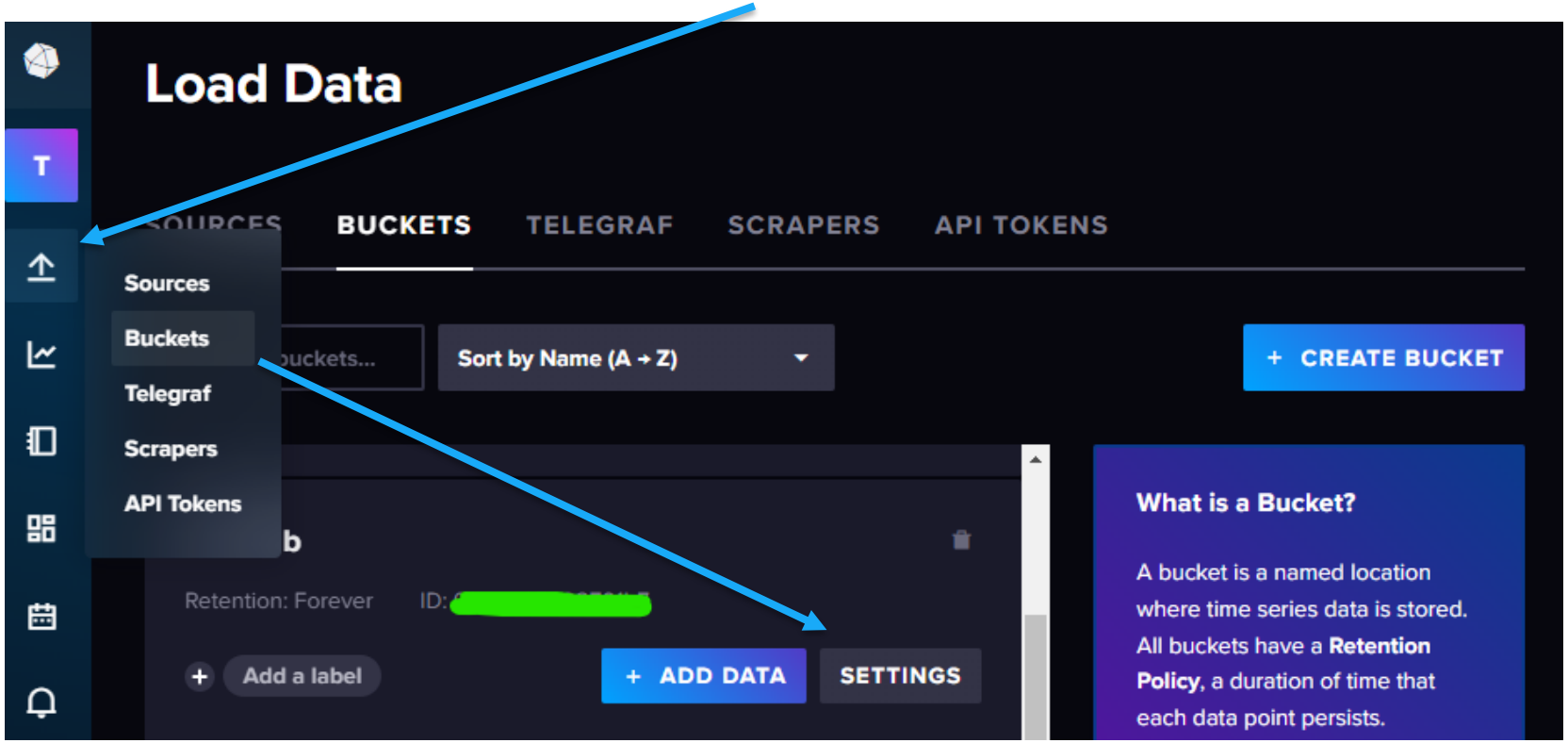
`docker-compose.yml`

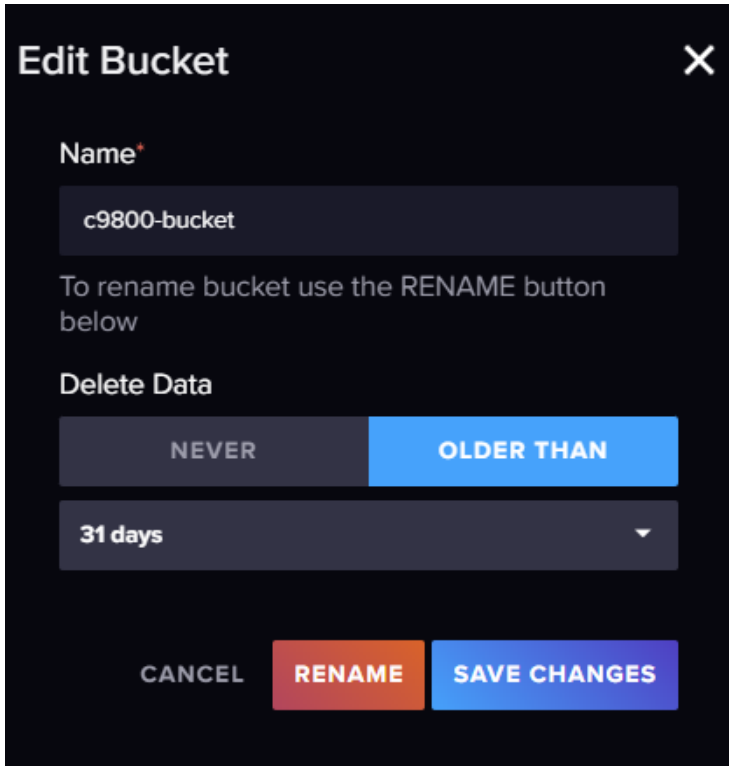
```
services:
  influxdb:
    container_name: influxdb
    image: influxdb:2.7.10
    expose:
      - 8086
    restart: always
    volumes:
      - influxdb-data:/var/lib/influxdb2
    ports:
      - 8086:8086
    environment:
      - DOCKER_INFLUXDB_INIT_MODE=setup
      - DOCKER_INFLUXDB_INIT_USERNAME=${INFLUXDB_ADMIN_USER}
      - DOCKER_INFLUXDB_INIT_PASSWORD=${INFLUXDB_ADMIN_PASSWORD}
      - DOCKER_INFLUXDB_INIT_ORG=${INFLUXDB_ORG}
      - DOCKER_INFLUXDB_INIT_BUCKET=${INFLUXDB_BUCKET}
      - DOCKER_INFLUXDB_INIT_RETENTION=2w
      - DOCKER_INFLUXDB_INIT_ADMIN_TOKEN=${INFLUXDB_ADMIN_TOKEN}

  telegraf:
    container_name: telegraf
    image: telegraf:1.32.0
    restart: always
    ports:
      - 57000:57000
    env_file:
      - .env
    environment:
      - INFLUXDB_TOKEN=${INFLUXDB_ADMIN_TOKEN}
      - INFLUXDB_ORG=${INFLUXDB_ORG}
      - INFLUXDB_BUCKET=${INFLUXDB_BUCKET}
    volumes:
      - ./telegraf/conf/telegraf.conf:/etc/telegraf/telegraf.conf:ro
      - /var/run/docker.sock:/var/run/docker.sock
    depends_on:
      - influxdb

  grafana:
    container_name: grafana
    image: grafana/grafana:11.1.4
    expose:
      - 3000
    restart: always
    ports:
      - 3000:3000
    environment:
      - GF_SECURITY_ADMIN_USER=${GF_SECURITY_ADMIN_USER}
      - GF_SECURITY_ADMIN_PASSWORD=${GF_SECURITY_ADMIN_PASSWORD}
      - GF_INSTALL_PLUGINS=
    volumes:
      - grafana-data:/var/lib/grafana
      #- ./grafana/grafana.ini:/etc/grafana/grafana.ini:ro
    depends_on:
      - influxdb
      - telegraf

volumes:
  grafana-data:
    external: true
  influxdb-data:
    external: true
```

InfluxDB 2.X

http://192.168.10.{your Ubuntu IP}:8086

- Username/password from .env file (same as always unless changed)
- Notice that we here also use HTTP, not HTTPS
- Change retention on your bucket to f.ex 31 days.

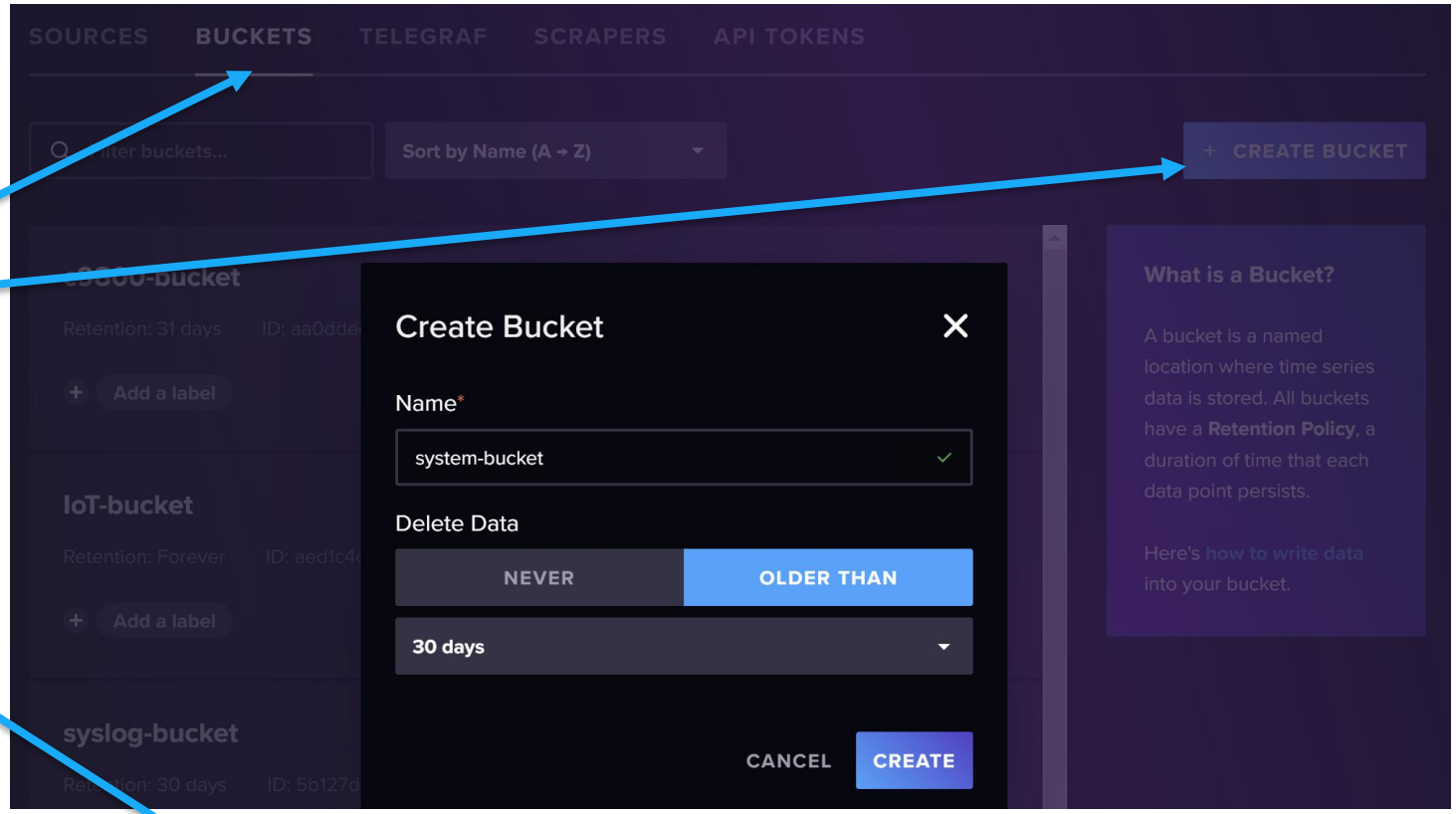


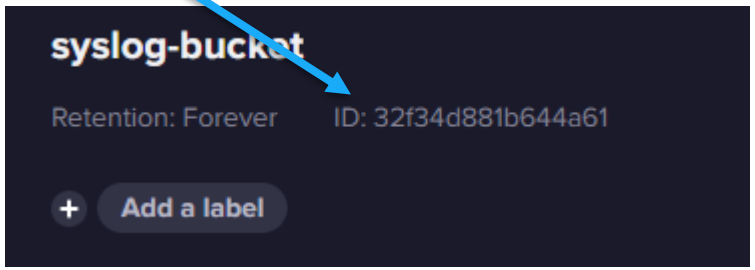


InfluxDB 2.X

http://192.168.10.{your Ubuntu IP}:8086

- Create a an additonal bucket
  - Name it: **syslog-bucket**
- Set retention to 30 days
- You can find the bucket-ID here



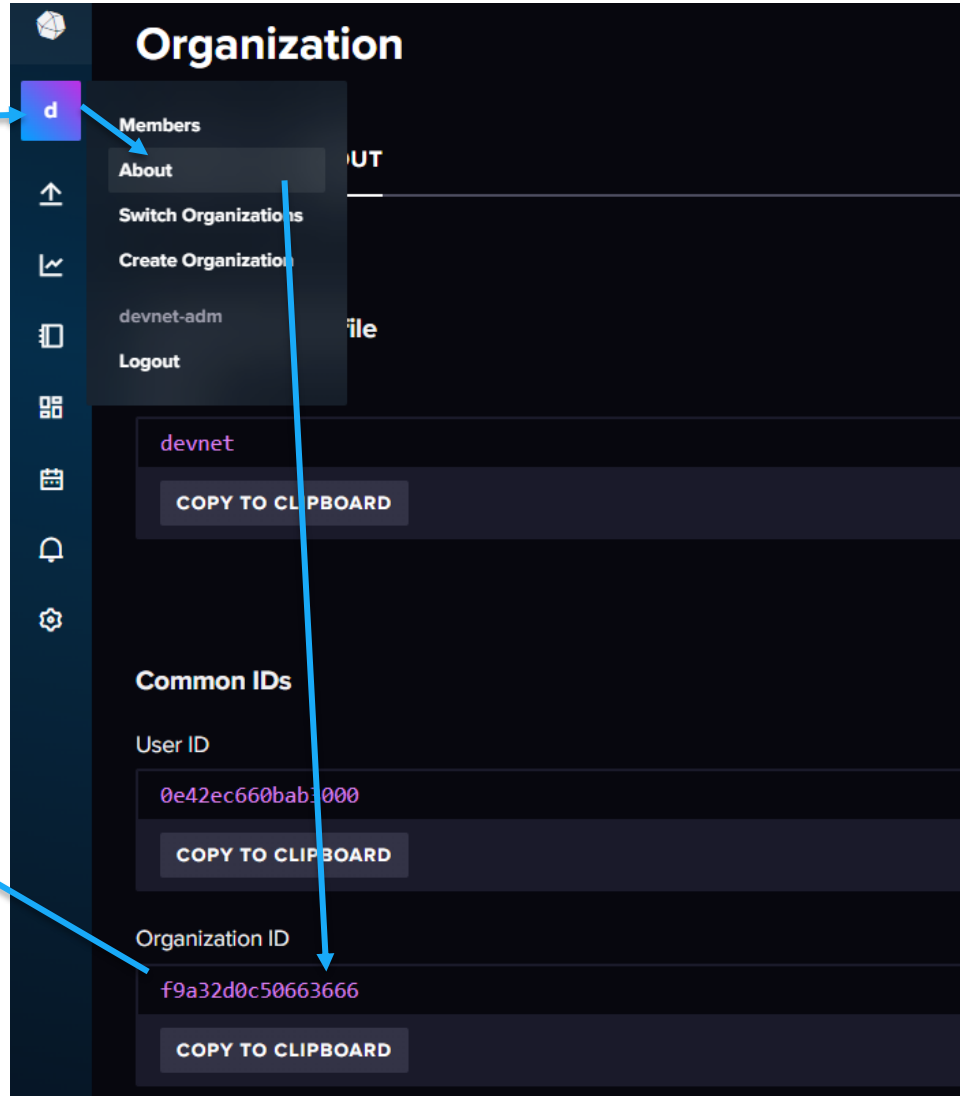


Locate your Organization ID

- InfluxDB > About
- Note this down in the Lab10_notes.txt file

lab10_notes.txt

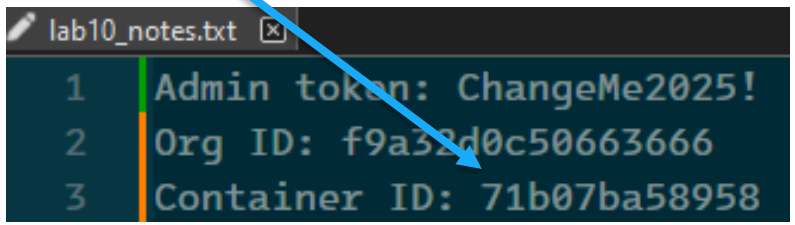
```
1  Admin token: ChangeMe2025!
2  Org ID: f9a32d0c50663666
3  Container ID: {we will finn in this later}
```



Locate your InfluxDB Docker container ID

- Note this down in the Lab10_notes.txt file

```
devnet-adm@ubuntu-devnet:~/tig-stack$ docker ps -a --filter name=influxdb
CONTAINER ID   IMAGE             COMMAND                  CREATED         STATUS         PORTS                                       NAMES
71b07ba58958   influxdb:2.7.10   "/entrypoint.sh infl…"   2 minutes ago   Up 2 minutes   0.0.0.0:8086->8086/tcp, :::8086->8086/tcp   influxdb
devnet-adm@ubuntu-devnet:~/tig-stack$
```



- In the notes, you will then have
  - Admin token
  - Org ID
  - Container ID
- For a live installation you should have at least one RO token, or separate tokens for each bucket. Not use the admin token for everything like we do here ☺

InfluxDB 2.X: Query data in Grafana with InfluxQL

- We will use the values from our lab notes
  - In v1 mode, it is called a "database"

Insert YOUR container-id

Insert YOUR org-id

Insert YOUR admin token

```
devnet-adm@ubuntu-devnet:~/tig-stack$ docker exec -it <your_container-id> bash
root@71b07ba58958:/# influx v1 dbrp list
Error: must specify org ID or org name
root@71b07ba58958:/# influx v1 dbrp list --org-id <your_org-id> --token <your_admin_token>
ID      Database        Bucket ID       Retention Policy        Default Organization ID

VIRTUAL DBRP MAPPINGS (READ-ONLY)
---------------------------------
ID                      Database        Bucket ID               Retention Policy        Default Organization ID
b53d2ec9d932635a        _monitoring     b53d2ec9d932635a        autogen                 true    6a6f13e3a65de450
09aac3a6cee8ab99        _tasks          09aac3a6cee8ab99        autogen                 true    6a6f13e3a65de450
574c74f705d86be2        syslog-bucket   294c74f678d86ab3        autogen                 true    6a6f13e3a65de450
574c74f705d86be2        c9800-bucket    574c74f705d86be2        autogen                 true    6a6f13e3a65de450

root@71b07ba58958:/# influx v1 dbrp create --db c9800-db --rp c9800-rp --bucket-id 574c74f705d86be2 --default --org-id <your_org-id> --token <your_admin_token>
root@71b07ba58958:/# influx v1 dbrp create --db syslog-db --rp syslog-rp --bucket-id 294c74f678d86ab3 --default --org-id <your_org-id> --token <your_admin_token>

ID                      Database        Bucket ID               Retention Policy        Default Organization ID
0d94a420be168000        c9800-db        bc926b463de1d39a        c9800-rp                true    6a6f13e3a65de450

root@71b07ba58958:/# exit
devnet-adm@ubuntu-devnet:~/tig-stack$
```

- We now have
  - a c9800-bucket where we can query using FLUX
  - a c9800-db where we can query the same data, using InfluxQL
  - See earlier slide "Different flavors of InfluxDB"

Repeat this step for the syslog-bucket

A bit about telemetry subscriptions

- Below are a couple of sample "telemetry subscriptions"'
- Telemetry subscriptions are the same as Catalyst Center use to get telemetry data from IOS-XE devices
- We will use telemetry subscriptions to get data from the 9800 over to our TIG stack
  (9800 -> Telegraf -> InfluxDB -> Grafana)
- The syntax is inside configuration mode (conf t) on 9800
  - Each subscription has an ID
  - The filter is built from the YANG model
  - Update policy decide how often 9800 will push this to Telegraf (in 100ths of a second -> 500 = 5 sec)
  - Receiver IP is the IP of Telegraf (in this lab: your Ubuntu server)
- You will not configure these now, they are only examples. We will use some other data ☺

```
telemetry ietf subscription 101
 encoding encode-kvgpb
 filter xpath /ios:native/version
 stream yang-push
 update-policy periodic 30000
 receiver ip address 192.168.10.7 57000 protocol grpc-tcp
```

```
telemetry ietf subscription 102
 encoding encode-kvgpb
 filter xpath /process-cpu-ios-xe-oper:cpu-usage/cpu-utilization/five-seconds
 stream yang-push
 update-policy periodic 500
 receiver ip address 192.168.10.7 57000 protocol grpc-tcp
```


Lab exercise #11: Build your first Grafana Dashboard

- In this exercise you will be hand-held to build your first dashboard in Grafana
- The dashboard will be an AP Dashboard
- More dashboards to be explored on day 2
- !!! A word of caution when making your first dashboards... don't use "Esc" key without saving, you might have to do some work again. You will probably do just that, and THEN learn it the hard way ☺ !!!

- If you are doing this lab exercise using TIG Stack on a shared server, use your shared Ubuntu Server referring to the Lab topology:

Students	Shared Ubuntu Server	Grafana URL	InfluxDB URL
Harsha, Craig, Sean, Raheel	ubuntu11 (192.168.10.11)	http://192.168.10.11:3000	http://192.168.10.11:8086
Kenneth, Daniel J, Biruk	ubuntu12 (192.168.10.12)	http://192.168.10.12:3000	http://192.168.10.12:8086
Joseph, Matt, Jason	ubuntu13 (192.168.10.13)	http://192.168.10.13:3000	http://192.168.10.13:8086
Jack, Daniel W, Harsh, Chris	ubuntu14 (192.168.10.14)	http://192.168.10.14:3000	http://192.168.10.14:8086
Brian, James, Szymon, Todd	ubuntu15 (192.168.10.15)	http://192.168.10.15:3000	http://192.168.10.15:8086
Terry, Eddie, Sitarama, Francois	ubuntu16 (192.168.10.16)	http://192.168.10.16:3000	http://192.168.10.16:8086

Add the following telemetry subscriptions on the WLC

```
wlc9# conf t
```

```
telemetry ietf subscription 105
 encoding encode-kvgpb
 filter xpath /wireless-access-point-oper:access-point-oper-data/wireless-access-point-oper:ap-name-mac-map
 stream yang-push
 update-policy periodic 30000
 receiver ip address 192.168.10.7 57000 protocol grpc-tcp
 do show telemetry ietf subscription 105
```

Change this to your Ubuntu IP (or IP of the TIG stack you are using)

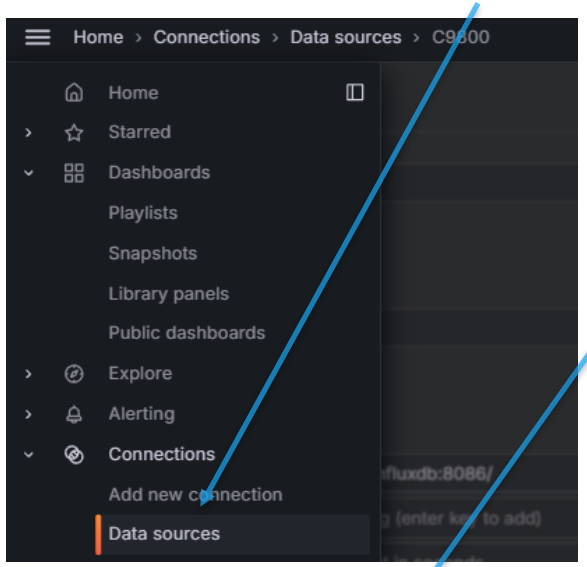
```
telemetry ietf subscription 106
 encoding encode-kvgpb
 filter xpath /wireless-rrm-oper:rrm-oper-data/wireless-rrm-oper:rrm-measurement/wireless-rrm-oper:load
 stream yang-push
 update-policy periodic 5000
 receiver ip address 192.168.10.7 57000 protocol grpc-tcp
 do show telemetry ietf subscription 106
```

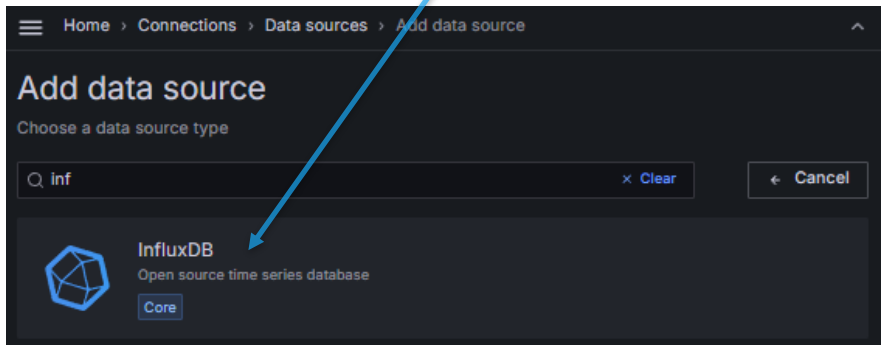
Change this to your Ubuntu IP (or the IP of the TIG stack you are using)

```
telemetry ietf subscription 107
 encoding encode-kvgpb
 filter xpath /wireless-access-point-oper:access-point-oper-data/wireless-access-point-oper:radio-oper-data/wireless-access-
point-oper:phy-ht-cfg
 stream yang-push
 update-policy periodic 5000
 receiver ip address 192.168.10.7 57000 protocol grpc-tcp
 do show telemetry ietf subscription 107
```

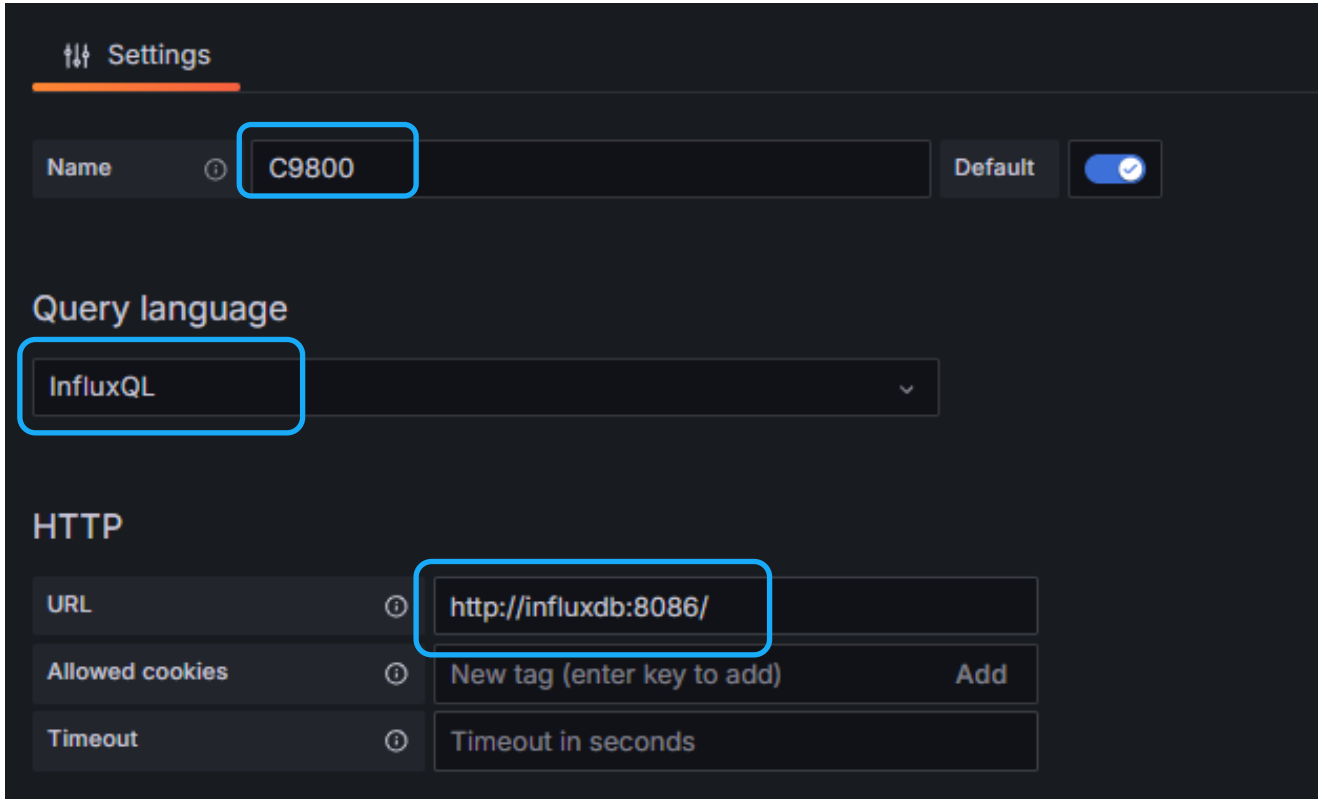
Grafana (http://{Ubuntu-IP}:3000)

- Add your first data source -> InfluxDB

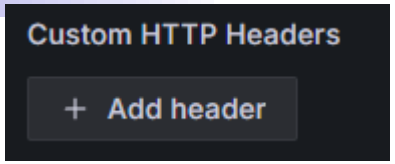




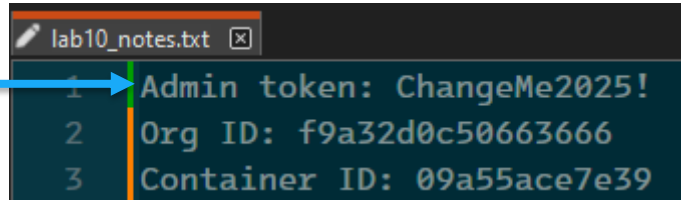
- Set a name for your database
- Set Query language to InfluxQL
- URL: http://influxdb:8086



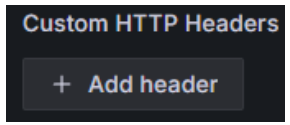
Grafana (http://{Ubuntu-IP}:3000)

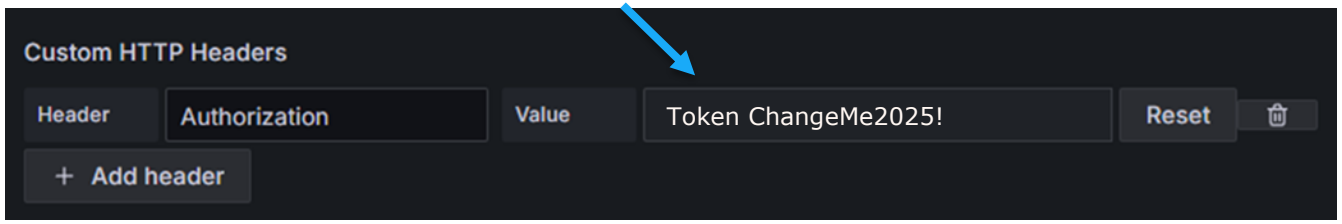


- Grafana needs to use a token to be able to read from the database, and InfluxDB password.
  - For this lab we will use the Admin token
  - In a live system, create a RO token and use it here

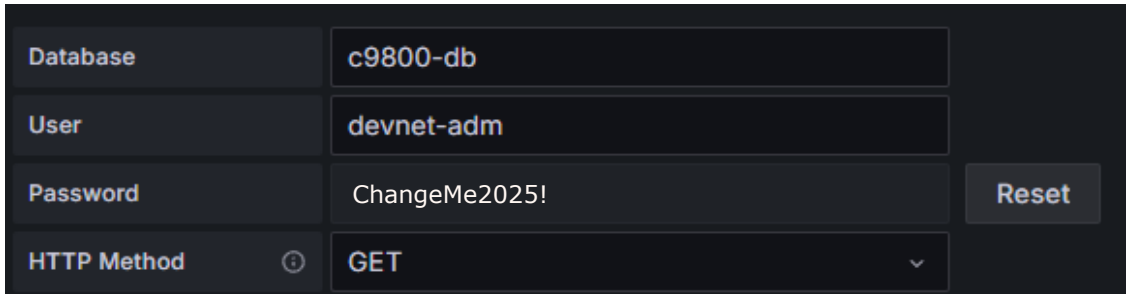


- Add a custom HTTP Headers
  - Header: Authorization
  - Value: **Token <API-TOKEN>**
  - **There is a space between Token and <token>**

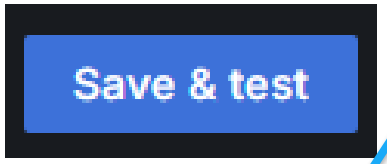


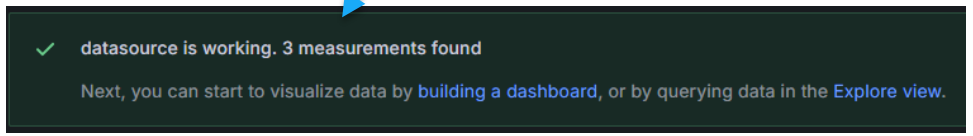


- Database: c9800-db
  - User/Pass: devnet-adm / ChangeMe2025!



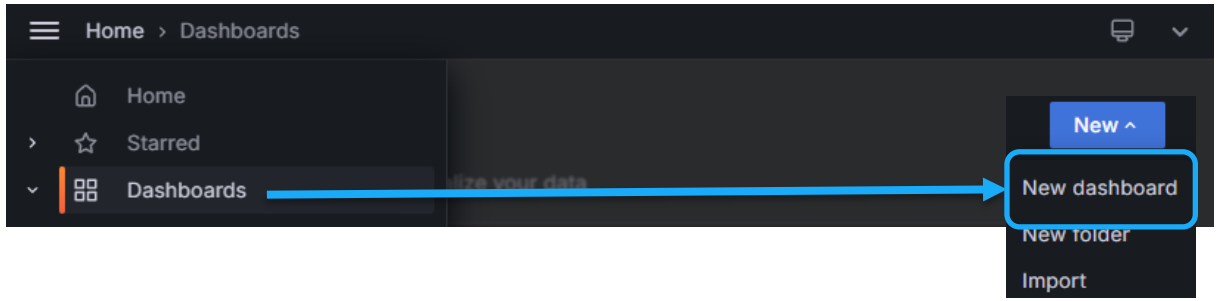
!!! You should have 3 measurements found !!!

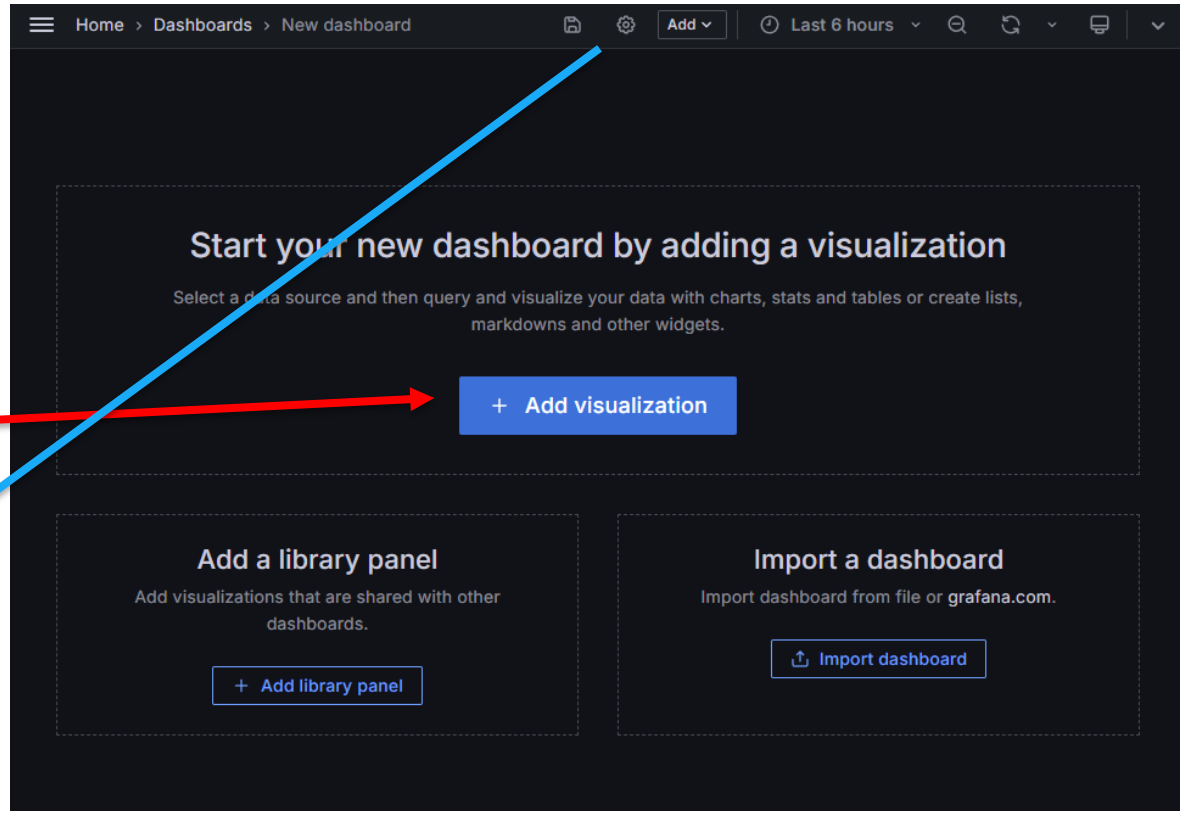




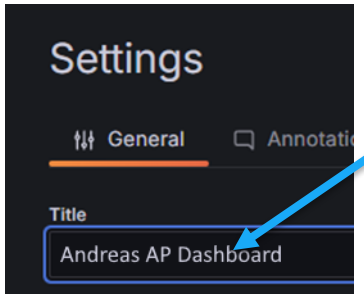
Create your first dashboard

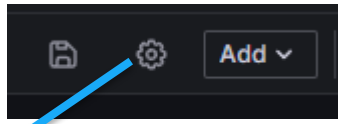
- Go to "Dashboards" in the left menu, then create a new dashboard





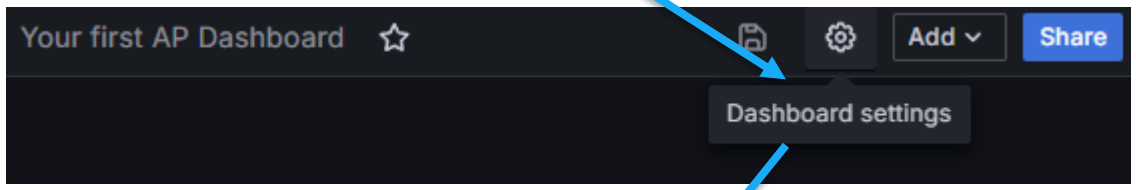
- !!! Don't press the very tempting "+Add Visualization" button yet, we will do some pre-work first ☺
- Start by giving the new dashboard a name

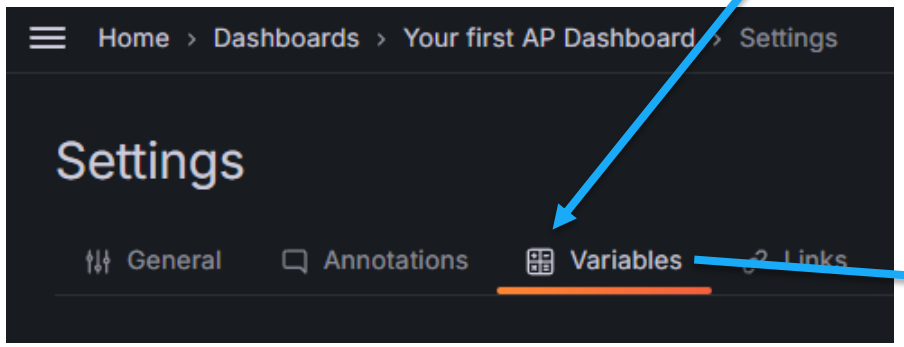


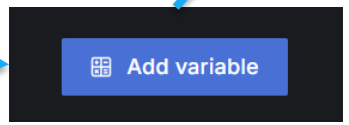


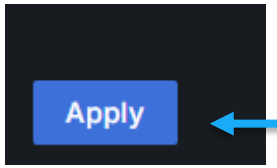
Grafana

- We will create a variable that gets all AP names
- Go to Dashboard settings -> Variables

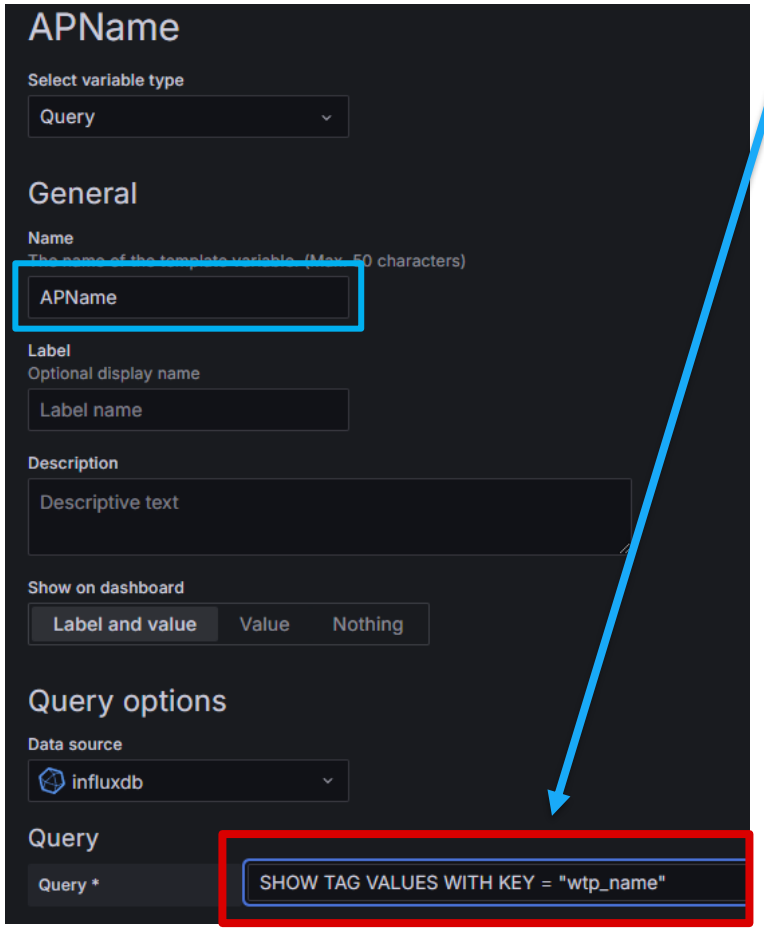








- Name: APName
- Query: `SHOW TAG VALUES WITH KEY = "wtp_name"`



When copy-pasting this, make sure to remove the extra line break if it occurs

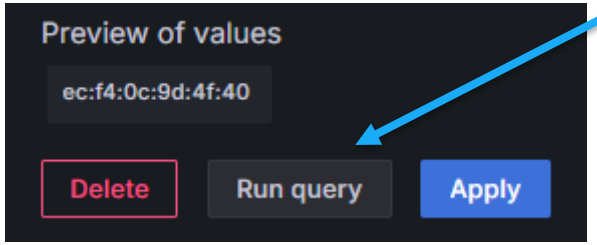
Grafana

We create a second variable, the AP MAC address

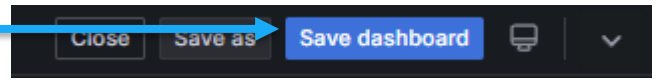
- Name: APMac
- Show on dashboard: Nothing
- Query: (when copy-pasting, make sure to remove the extra line-break if it occurs)

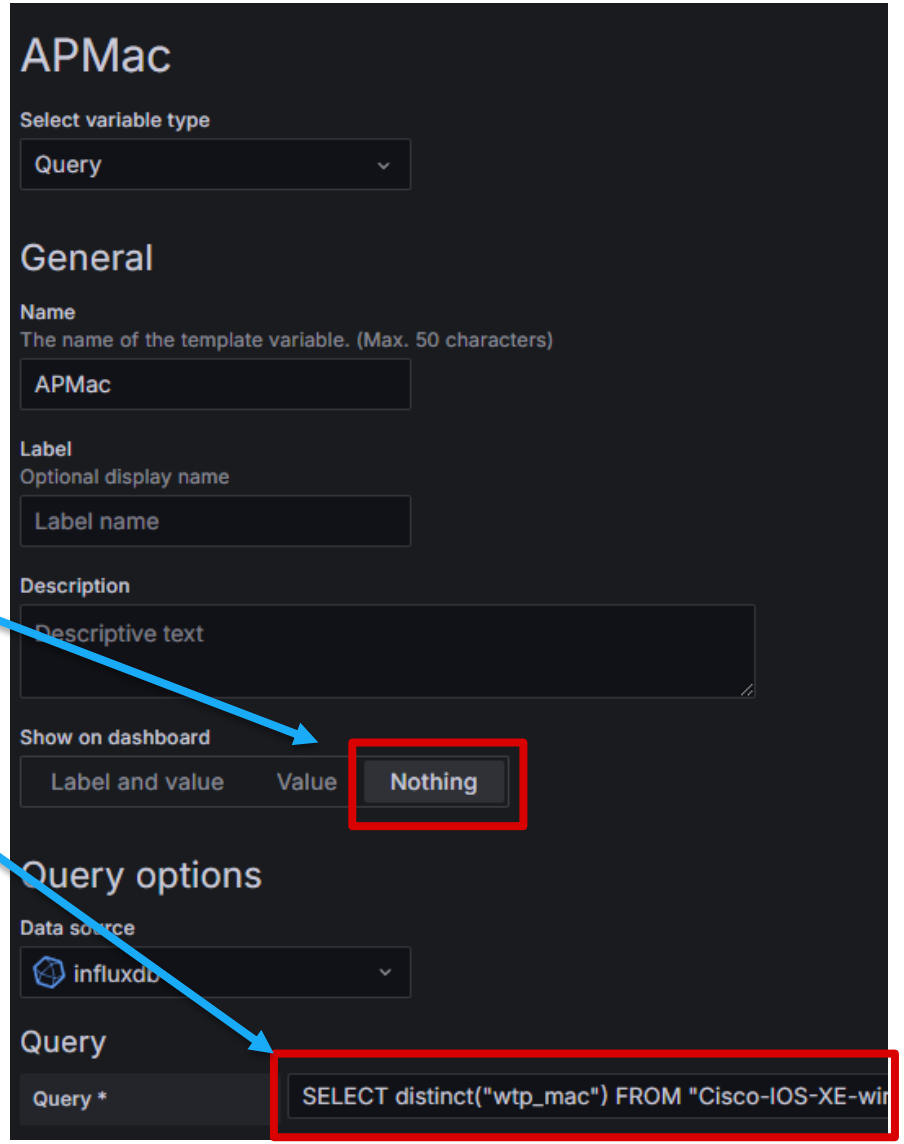
```
SELECT distinct("wtp_mac") FROM "Cisco-IOS-XE-wireless-access-point-oper:access-point-oper-data/ap-name-mac-map" WHERE ("wtp_name" =~ /^$APName$/)
```

- Check if it is working with Run query



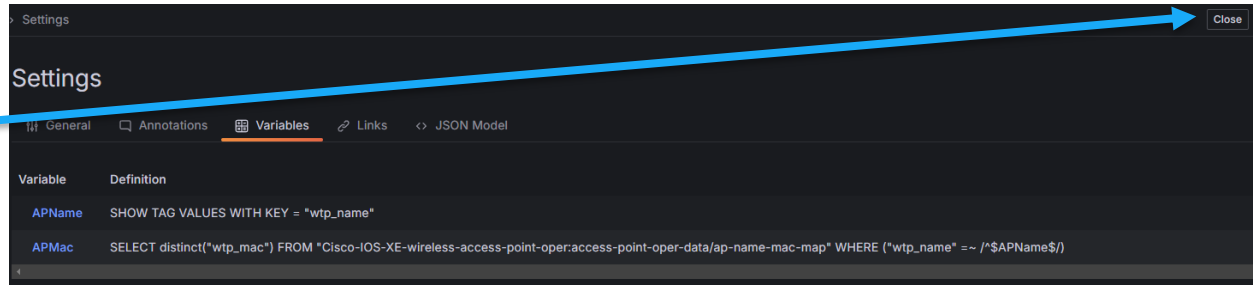
- Press Apply
- Then save your dashboard



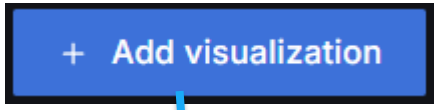


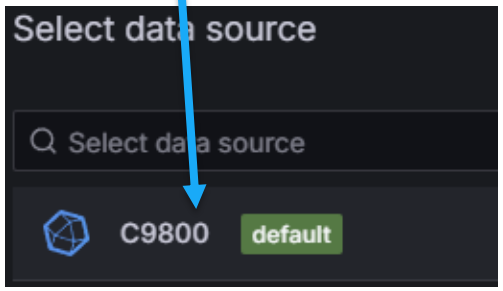
Grafana

- Go back to the Dashboard main page

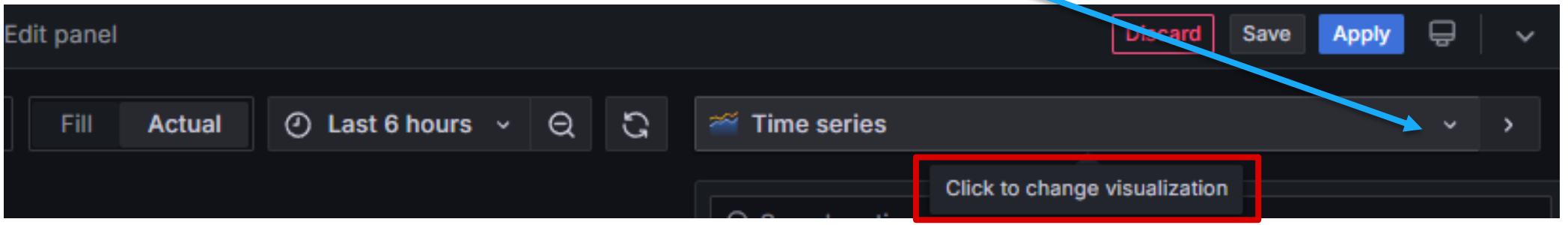


- Add visualization and make one using time series



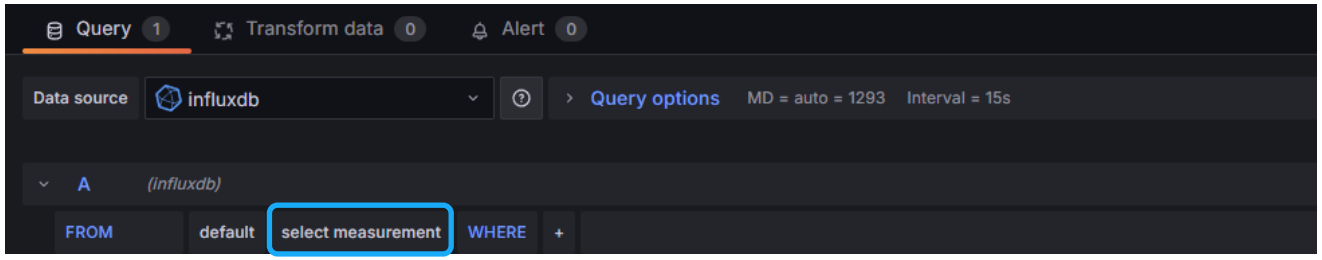


- "Time series" is automatically selected. If not, select it here

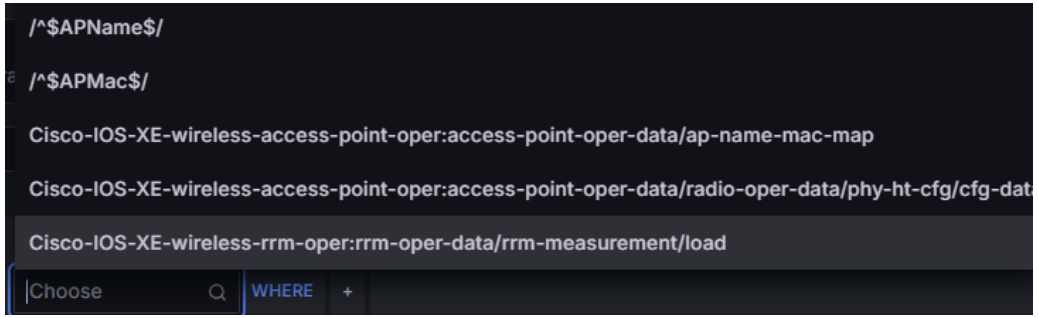


Grafana

- In the lower part of the screen, edit the query

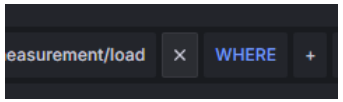


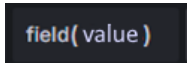
- Click "select measurement", you will get a menu of all measurements



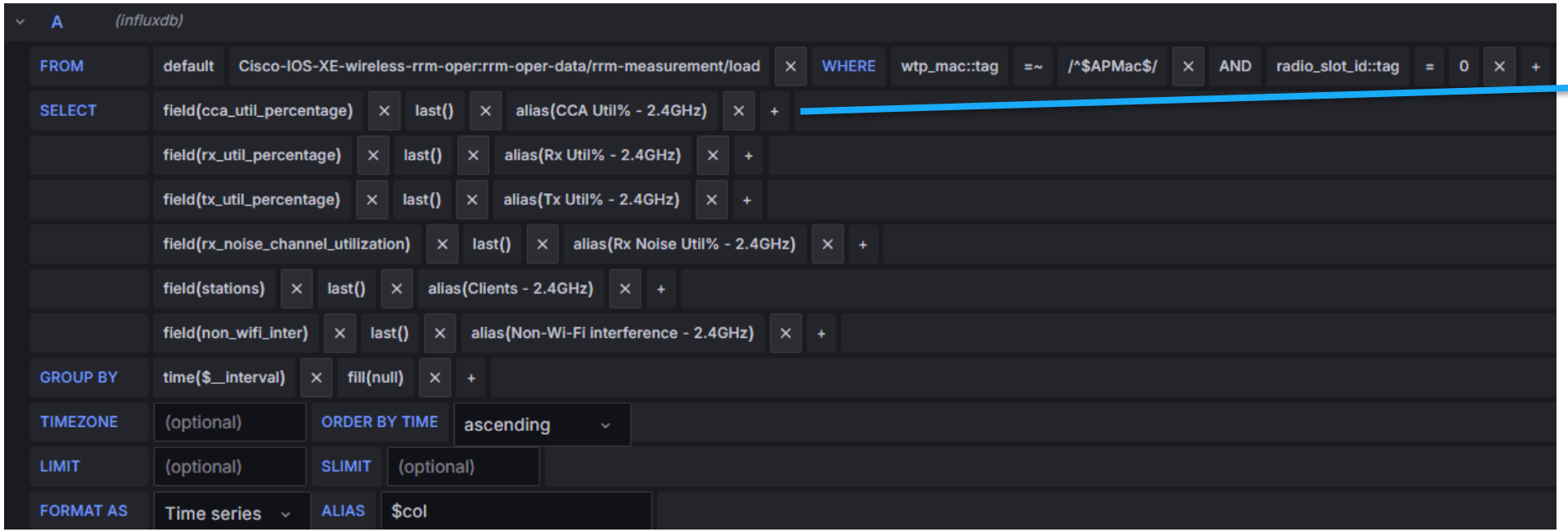
- Choose the *Cisco-IOS-XE-wireless-rrm-oper:rrm-oper-data/rrm-measurement/load*
- **(Optional)** You can enter yangcatalog.org, find the Cisco-IOS-XE-wireless-rrm-oper module and explore which values you could get from this YANG model

Grafana

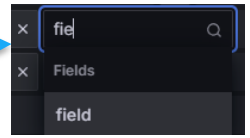
- To get the options, click the "+" signs, like here 

- You can search in the "Choose" field over the options
- To specify the value inside the "field(value)" click it 

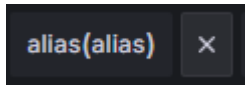
- Try to make the screen match this image



Add another row



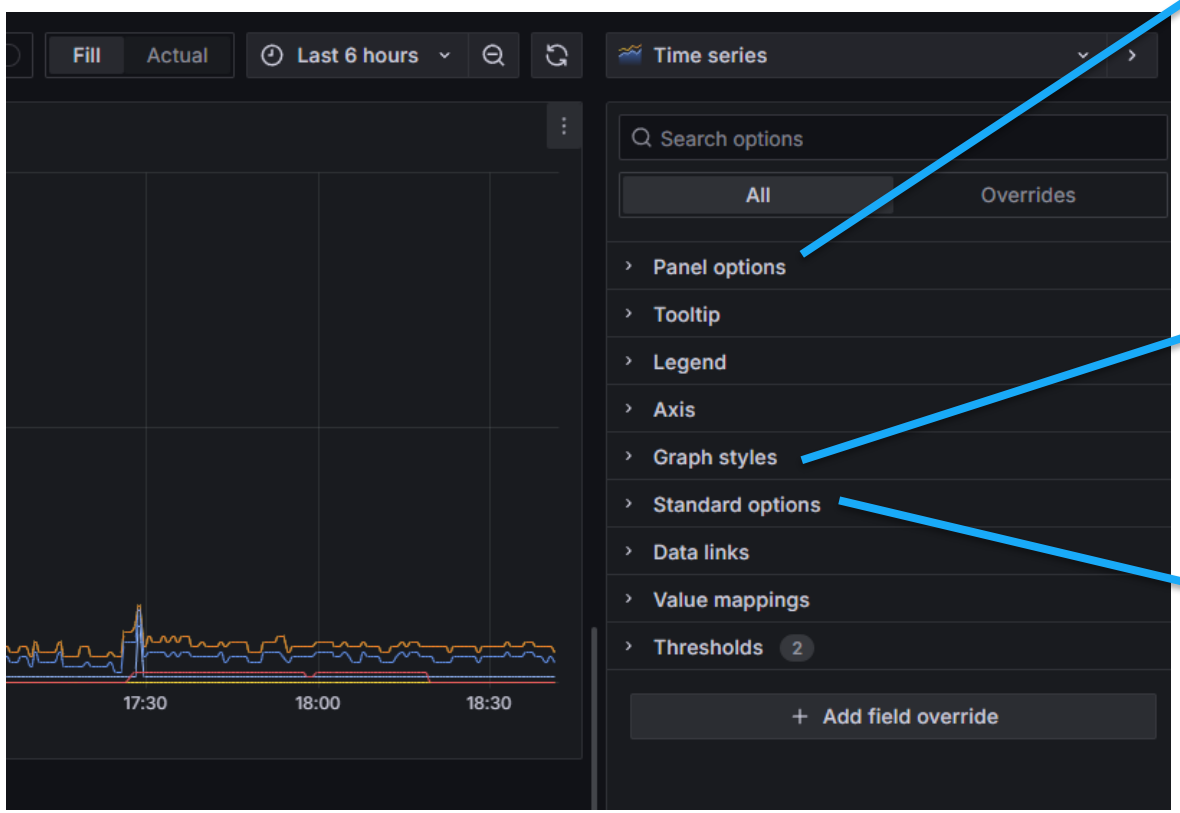
To create an alias, choose "alias" and click the alias(alias) button



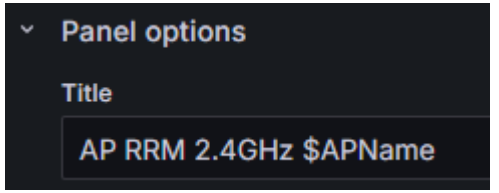
Type the name and press Enter

Grafana

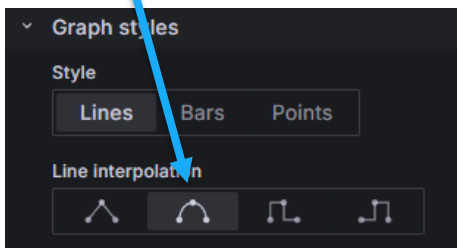
- In the field to the right, you have lots of options

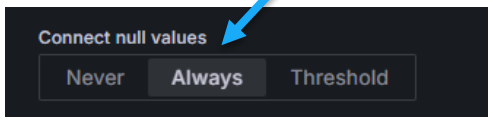


- Set the panel title

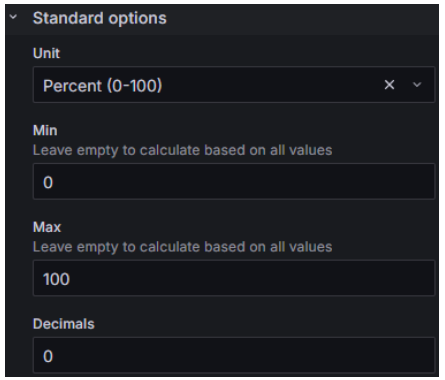


- Under graph styles you can make it look like you want ☺ Set Connect null values to always



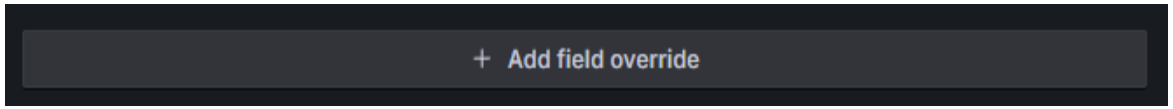


- Fix values to percent

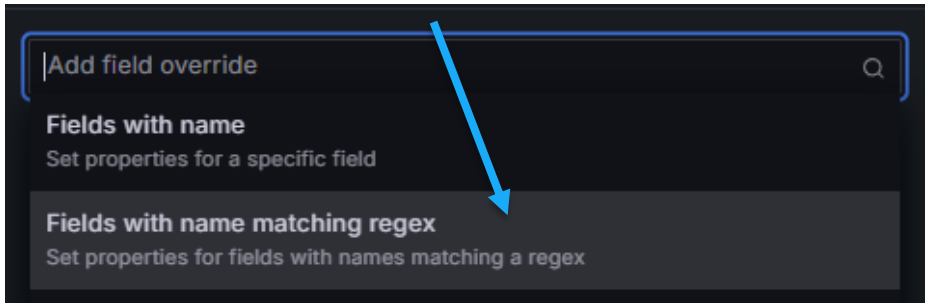


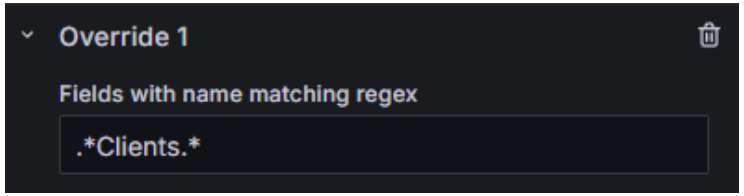
Grafana

- You do not want number of clients to show as percent
- We use an override for the Clients graph

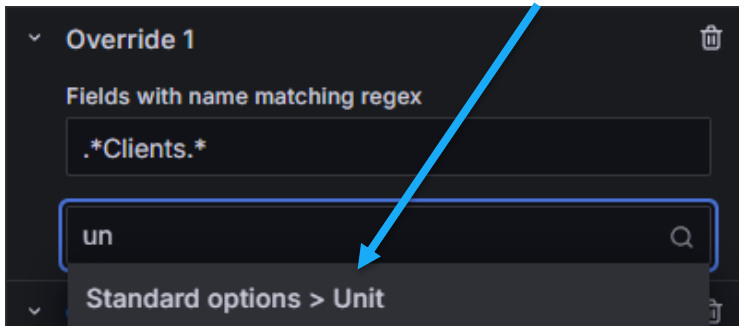


- Select the regex-override

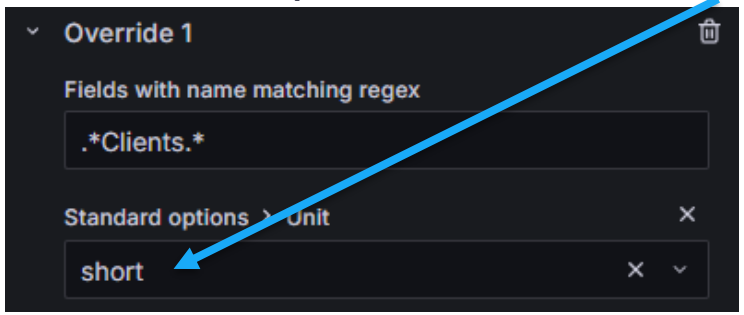




Standard options > Unit

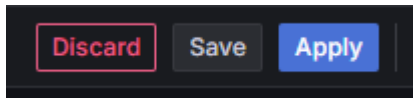


Standard options > Unit = short

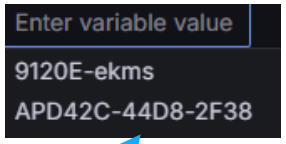


Grafana

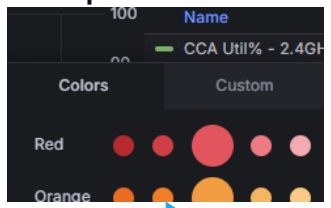
- **(Optional)** Tooltip -> Tooltip mode: All
- **(Optional)** Legend
  - Mode: Table
  - Placement: Right
  - Values: Last*, Min & Max
- **(Optional)** Thresholds
  - 35% (Red)
  - Percentage
  - As lines (dashed)
- **(Optional)** Graph styles
  - Fill opacity: 10
- Remember to apply changes



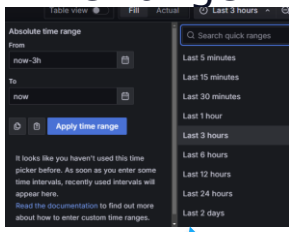
Select variable



Graph colors

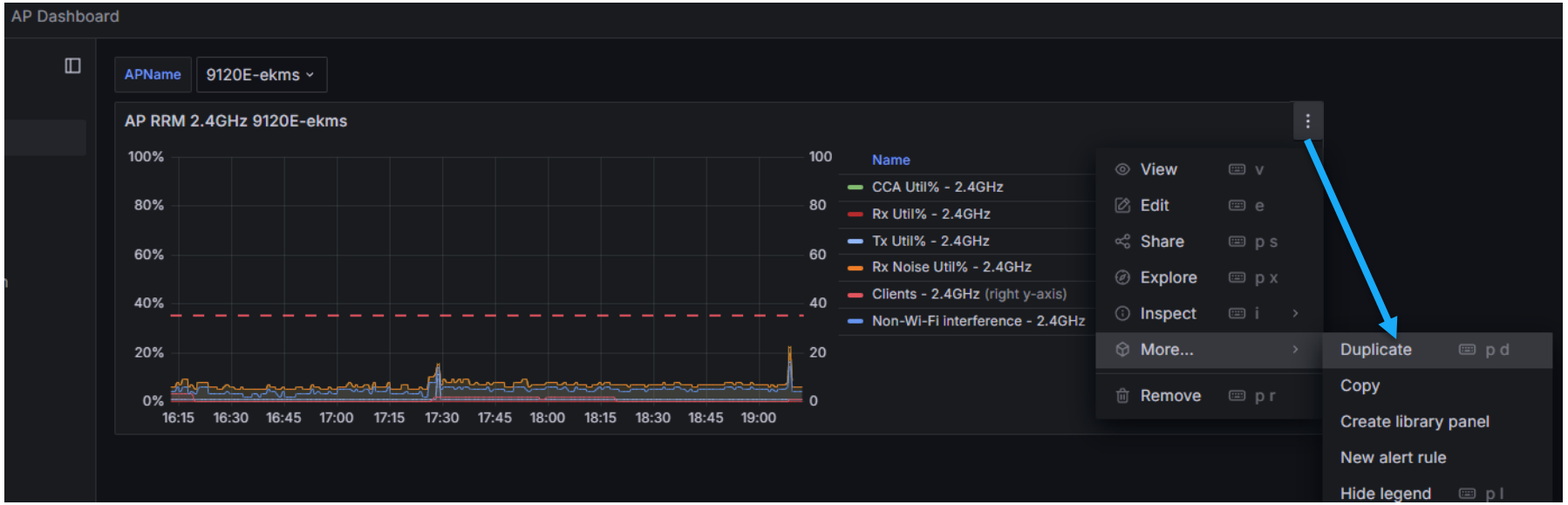


Time range

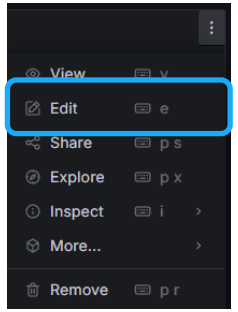


Duplicate dashboards

- You can duplicate the visualization, then edit the second one to create a 5GHz variant

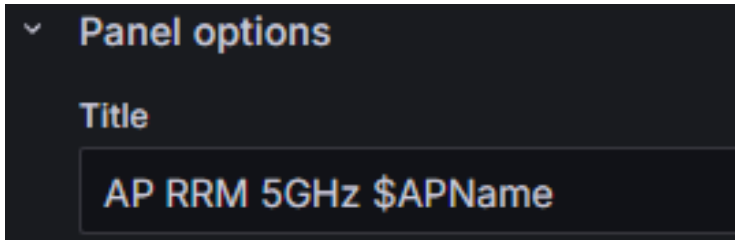


- Edit the duplicated visualization

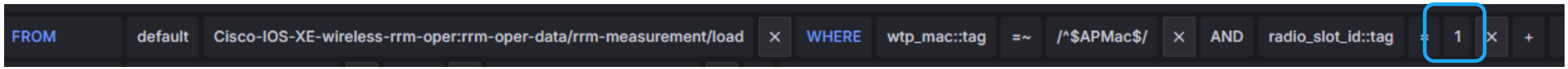


Edit the values for the 5GHz visualization

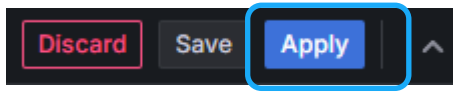
- Panel Options: Title



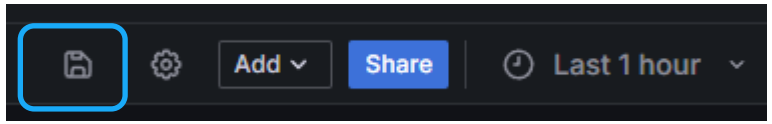
- FROM in Query: radio_slot_id::tag =1
  - If the AP is dual 5GHz (for example 9136, 9166) 5GHz is at 1 and 2



- Apply to go back to the Dashboard

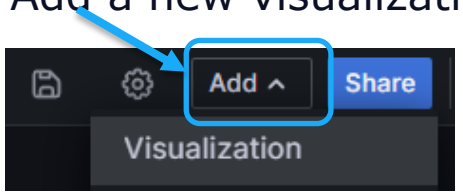


- Save the Dashboard

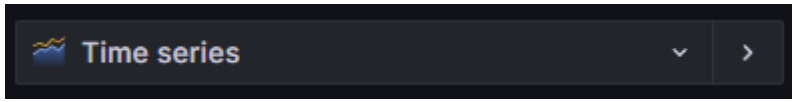


Grafana

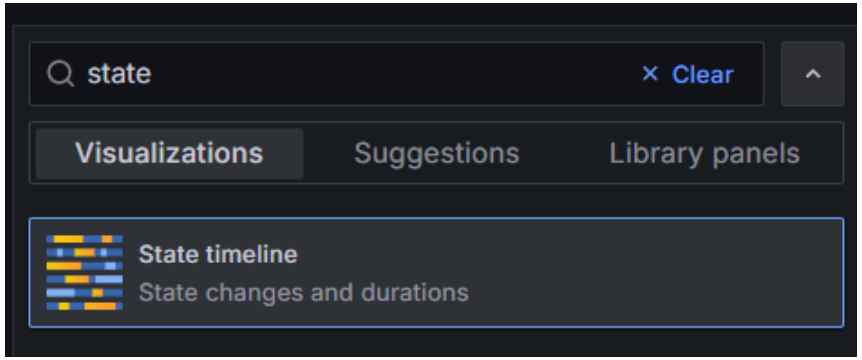
- Add a new visualization to your AP Dashboard



- Press the field where it defaults to "Time series"

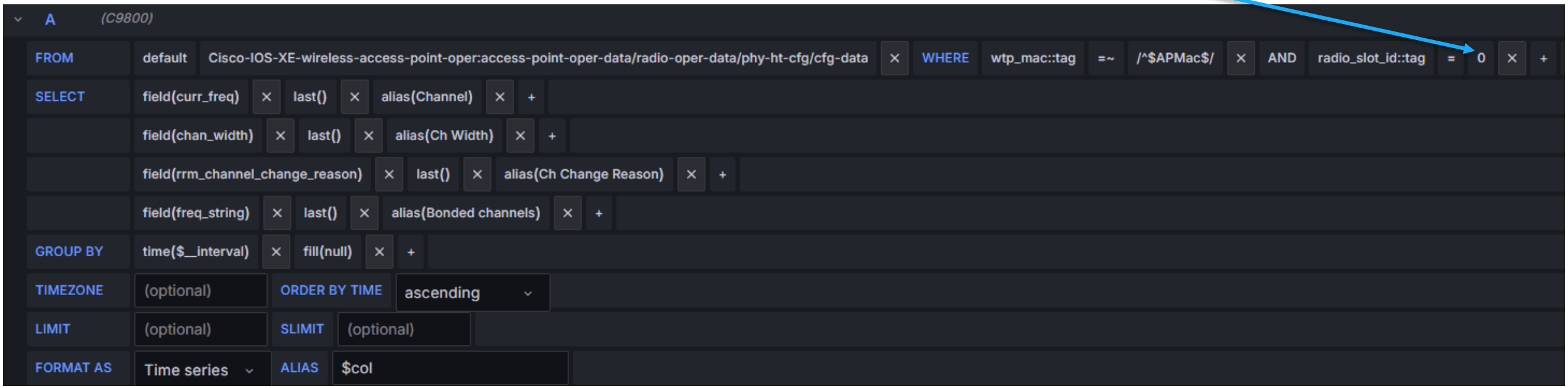


- Search for and select "State timeline "

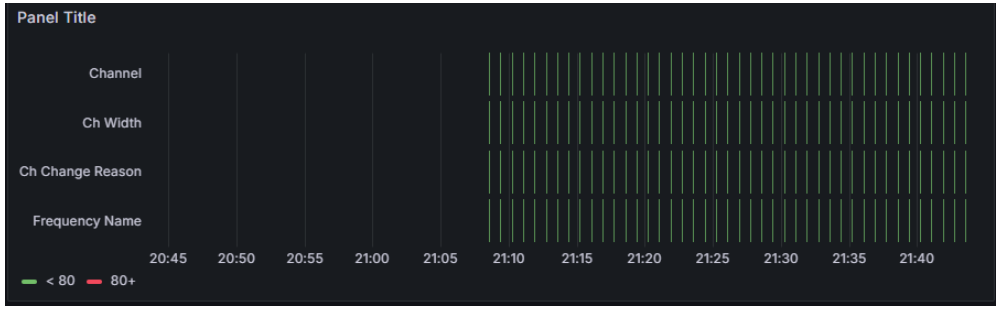


Grafana

- First we create this visualization for 2.4GHz. To do this we select radio_slot_id 0

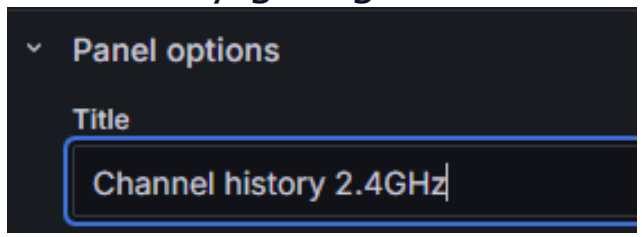


- It doesn't look impressive yet:

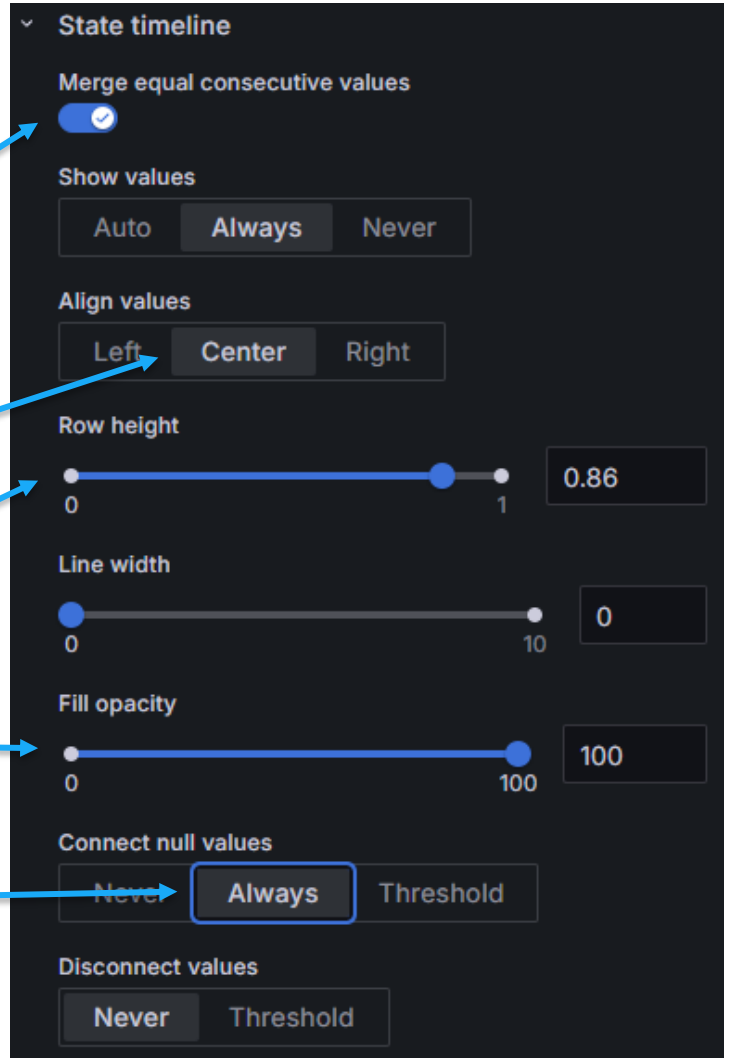


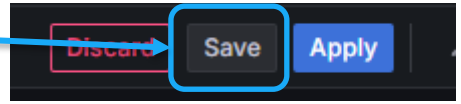
Grafana

- We will edit the options
  Start by giving it a name



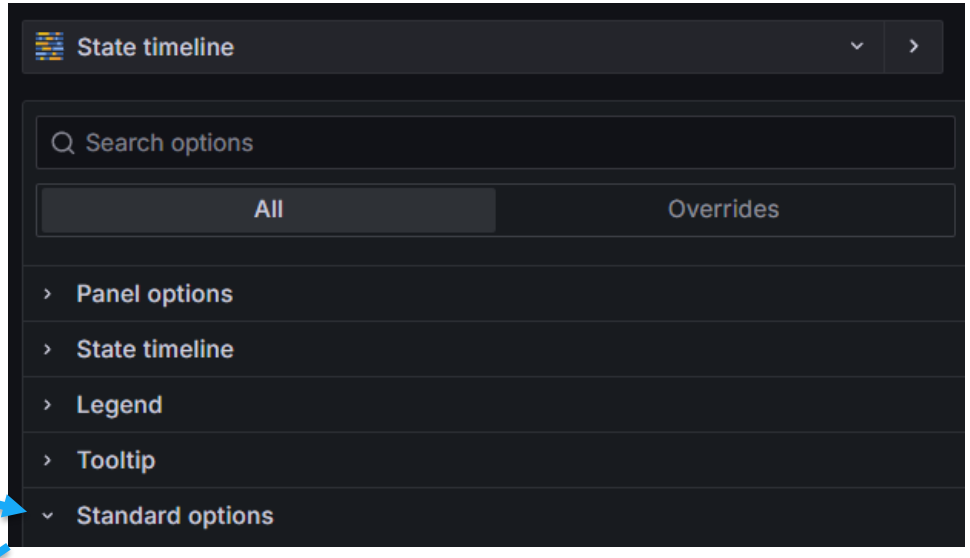
- Merge consecutive values
- Align to text to center
- Change row hight and fill opacity
- Conect null values
- Remember to save

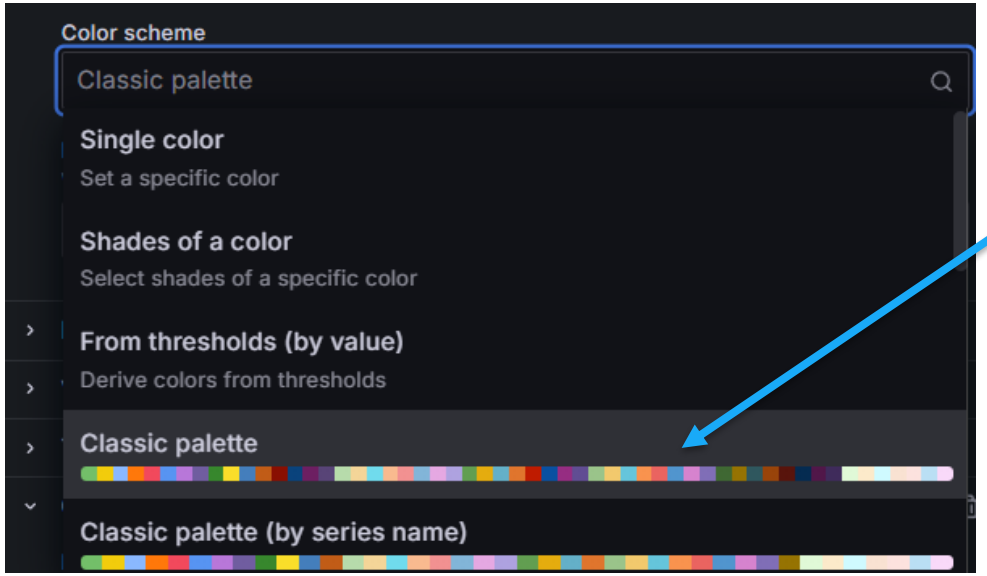




Grafana

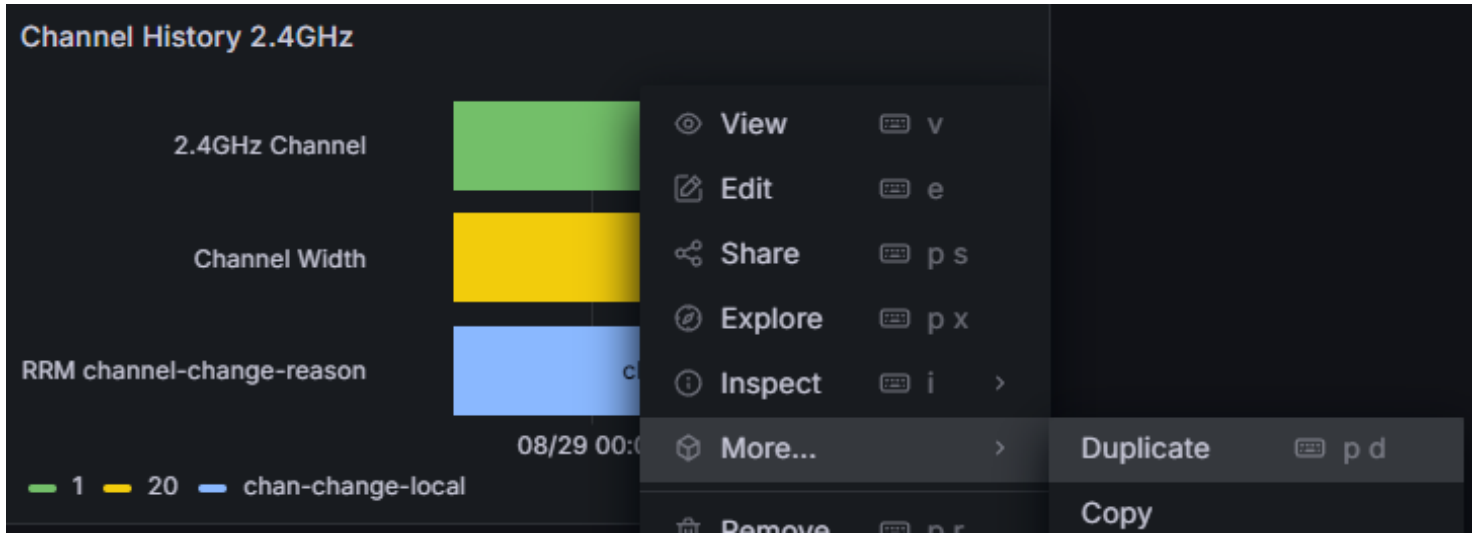
- The current color scheme derive colors from thresholds. The values also look a bit weird. We will change this to a scheme which give each bar a separate fixed color
- Naviagate to Standard Options
  - At the bottom you will find Color scheme
  - Change it to f.ex classic palette



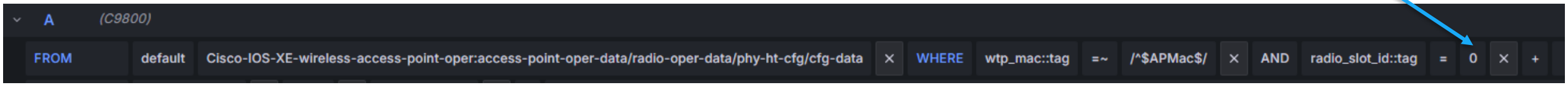


Grafana

- Apply to get back to your Dashboard
- Duplicate the panel (top right corner and duplicate) and make one for 2.4, 5 and 6GHz (radio-slot)



- Slot 0 = 2.4GHz
- Slot 1 = 5GHz
- Slot 2 (if AP is dual 5GHz) = 5GHz
- Slot 3 = 6GHz

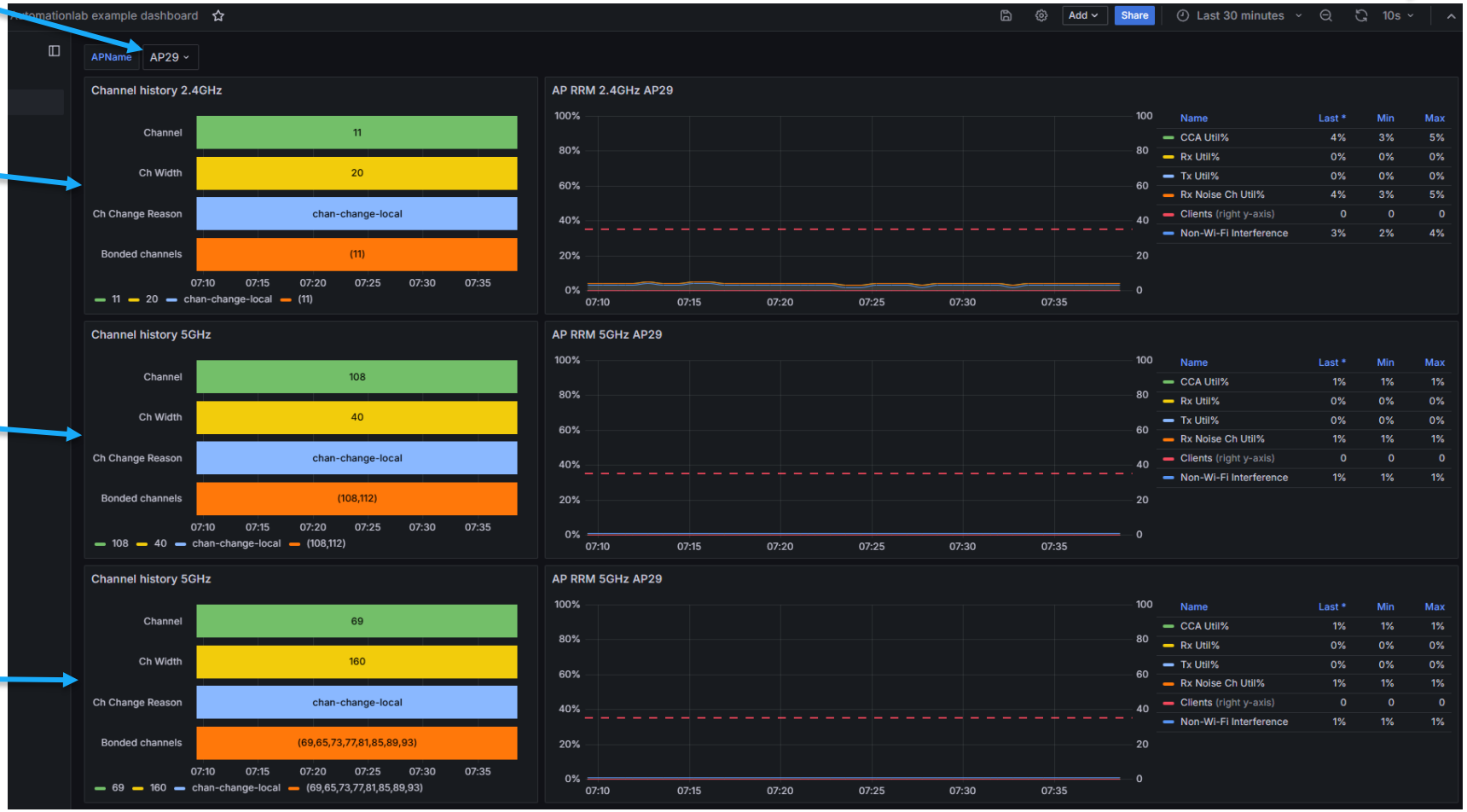


My first AP Dashboard (example)

Time window

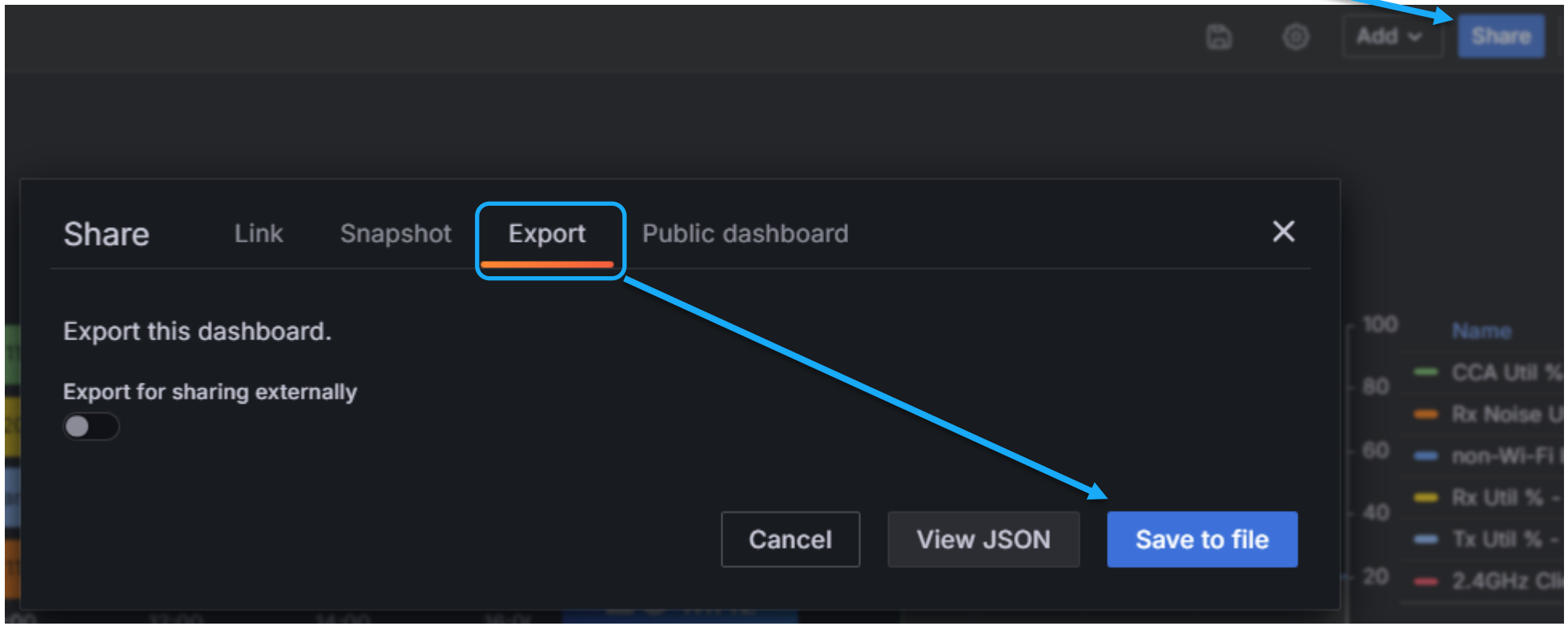
Auto refresh interval

- Select AP
- 2.4GHz
- 5GHz
- 6GHz



My first AP Dashboard (example 2)

Save your dashboard to JSON



grafana-dashboard.json

Lab exercise #12: Install YANG Suite (optional)

- This exercise shows how to install YANG Suite yourself, as a Docker container
- After successful installation, you can connect to YANG Suite on
  - https://{your Ubuntu IP}:8443
- Note that there is a binding to the servers IP that you specify as part of the installation script. So if you change IP you will have to reconfigure (or just delete and reinstall)

YANG Suite installation

- Installation (requires Docker installed)

```
devnet-adm@ubuntu-devnet:~$ cd ~
devnet-adm@ubuntu-devnet:~$ git clone https://github.com/CiscoDevNet/yangsuite
devnet-adm@ubuntu-devnet:~$ cd yangsuite/docker/
devnet-adm@ubuntu-devnet:~/yangsuite/docker$ ./start_yang_suite.sh
Hello, please setup YANG Suite admin user.
username: devnet-adm
password: ChangeMe2025!
confirm password: ChangeMe2025!
Will you access the system from a remote host? (y/n): y
Enter local host FQDN or IP: 192.168.10.7
Setup test certificates? (y/n): y
################################################
## Generating self-signed certificates         ##
(....)
email: devnet-adm@test.com
Setup test certificates? (y/n): y
(...blah blah blah)
```

- !!! Note: This will create problems if you try to use YANG Suite if you have changed the IP of your Ubuntu server to something else. In that case, delete YANG Suite and reinstall !!!
- To delete, use `rm -R ~/yangsuite`
- Change this to your Ubuntu IP
- From here you can just press Enter-Enter-Enter

- (...appx 4-5min depending on your VM speed)
- While waiting, please carry on to the next slides ☺
- Reference: https://developer.cisco.com/yangsuite/

Run in detached mode

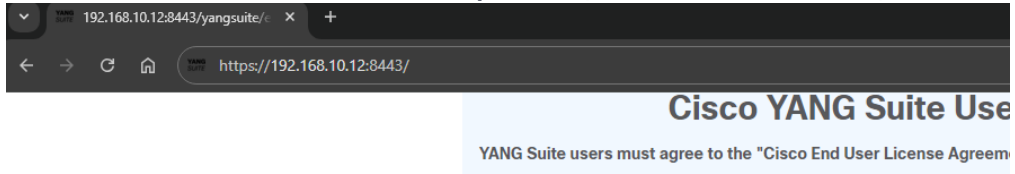
- When you get this output, it is ready to run

```
docker-yangsuite-1  | *** WARNING: you are running uWSGI as root !!! (use the --uid flag) ***
docker-yangsuite-1  | your server socket listen backlog is limited to 100 connections
docker-yangsuite-1  | your mercy for graceful operations on workers is 60 seconds
docker-yangsuite-1  | mapped 609456 bytes (595 KB) for 5 cores
docker-yangsuite-1  | *** Operational MODE: preforking ***
docker-yangsuite-1  | WSGI app 0 (mountpoint='') ready in 1 seconds on interpreter 0x56119e608280 pid: 27 (default app)
docker-yangsuite-1  | uWSGI running as root, you can use --uid/--gid/--chroot options
docker-yangsuite-1  | *** WARNING: you are running uWSGI as root !!! (use the --uid flag) ***
docker-yangsuite-1  | *** uWSGI is running in multiple interpreter mode ***
docker-yangsuite-1  | spawned uWSGI master process (pid: 27)
docker-yangsuite-1  | spawned uWSGI worker 1 (pid: 29, cores: 1)
docker-yangsuite-1  | spawned uWSGI worker 2 (pid: 30, cores: 1)
docker-yangsuite-1  | spawned uWSGI worker 3 (pid: 31, cores: 1)
docker-yangsuite-1  | spawned uWSGI worker 4 (pid: 32, cores: 1)
docker-yangsuite-1  | spawned uWSGI worker 5 (pid: 33, cores: 1)
```

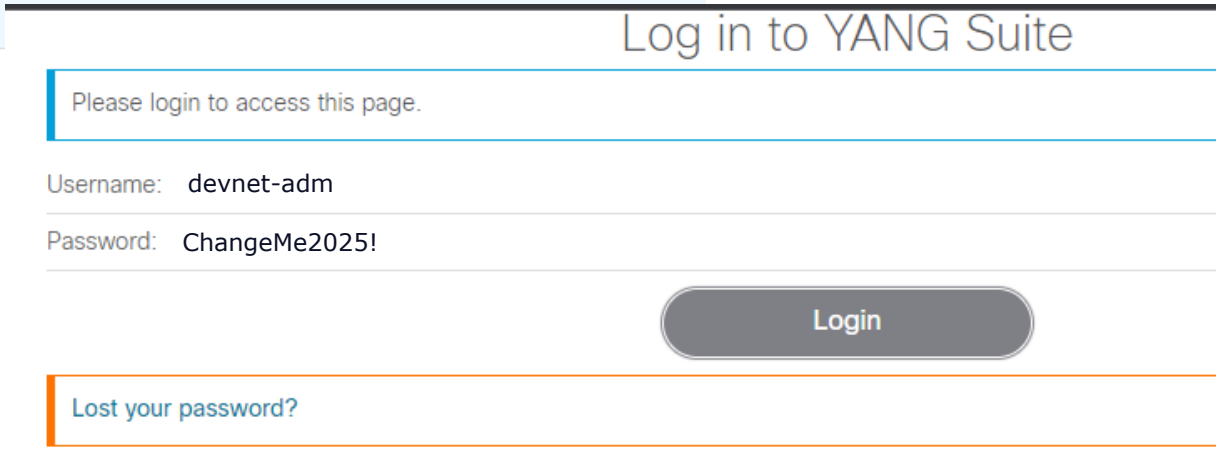
- To "free up" the command line, press Ctrl+C to stop YANG Suite
- Then, to start the container in "detached" mode:

```
devnet-adm@ubuntu-devnet:~$ cd ~/yangsuite/docker/
devnet-adm@ubuntu-devnet:~/yangsuite/docker/$ docker compose up -d
```

- Access via HTTPS: https://{Your Ubuntu IP}:8443

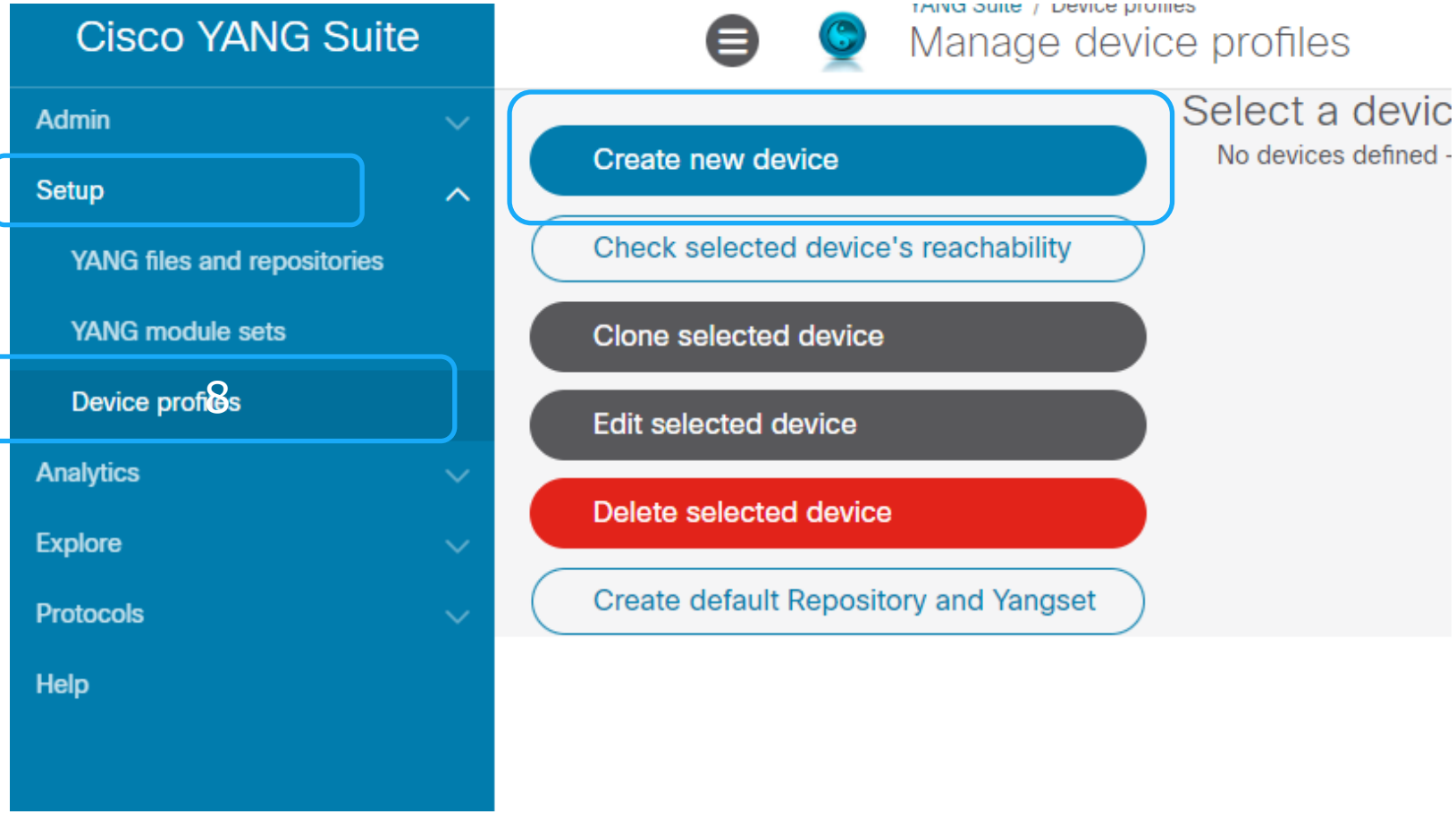


YANG Suite EULA



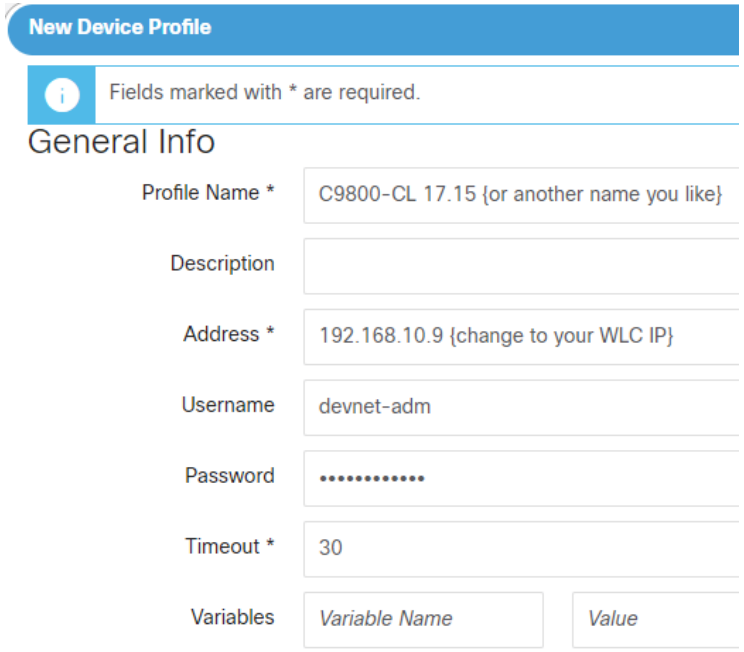
Create new device

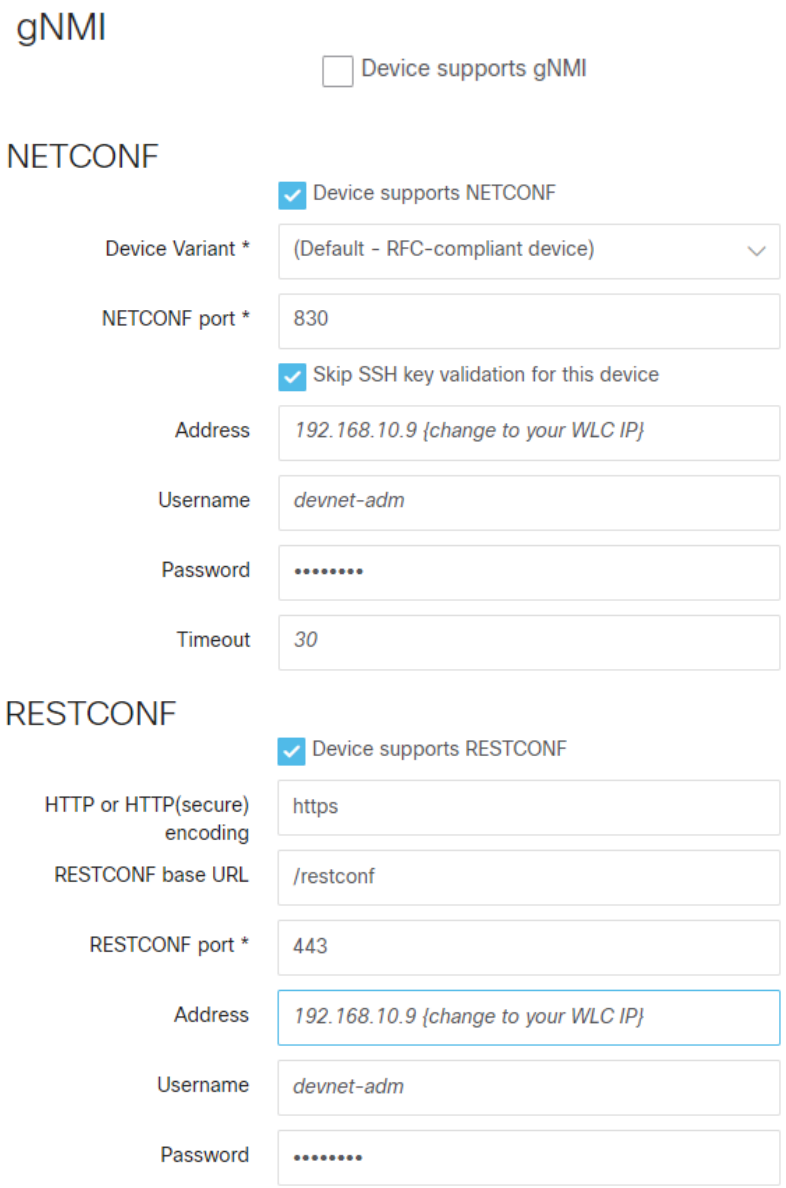
- Create new device

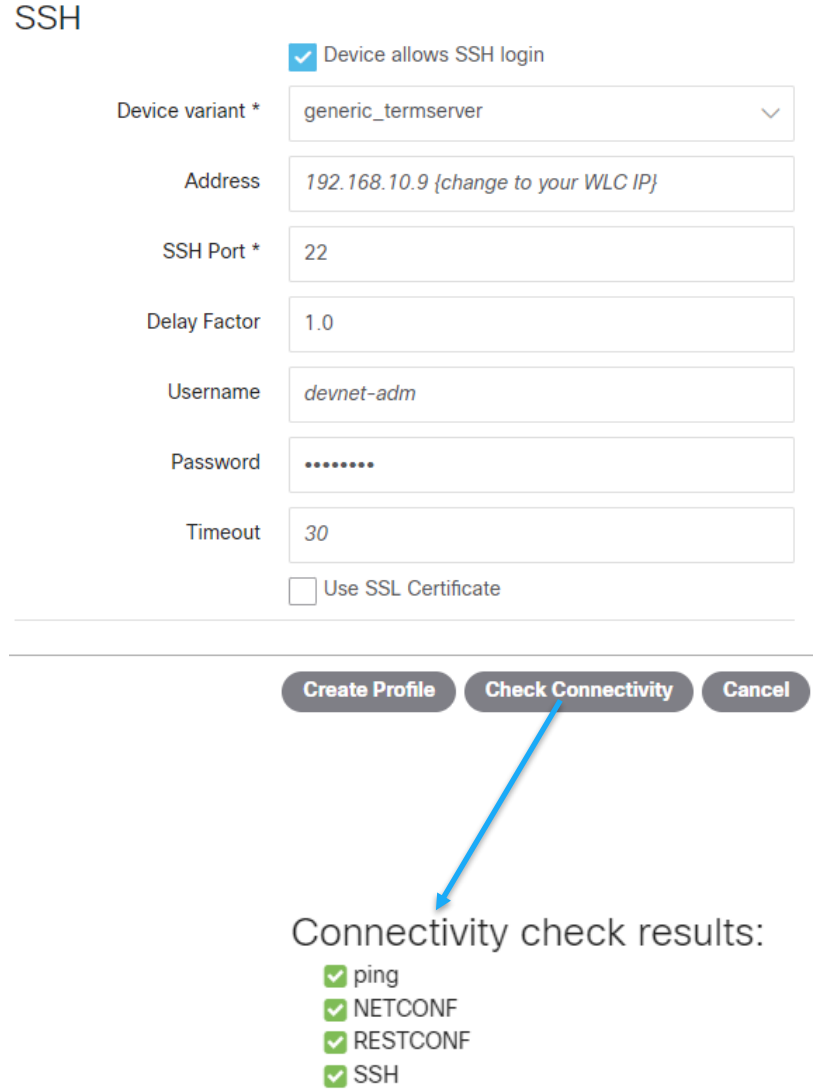


Create new device

- Create new device
- Use your WLC IP

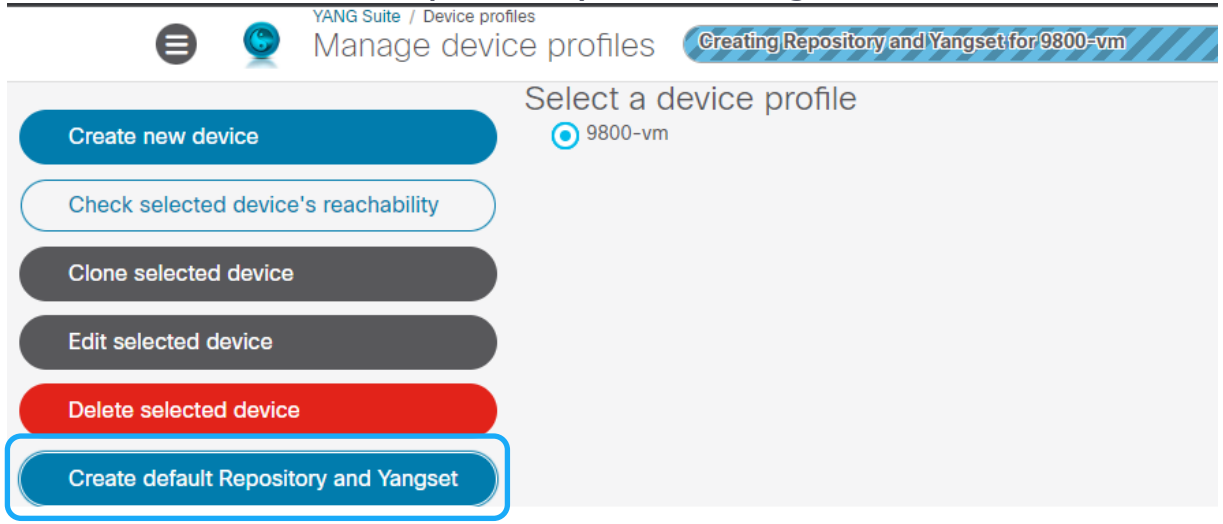






Create repository and Yangset

- Create default repository and Yangset



- (this will take a couple of minutes, so just be patient)