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The bridge to possible

Build a Simple yet Powerful CI/CD Pipeline with Cisco ACI and Nexus Dashboard Insights

Alejandro de Alda, Technical Marketing Engineer

Agenda

- What is a CI/CD Pipeline?
- Why do I need pre/post-change validations?
- How can I build a simple yet powerful CI/CD Pipeline?
- Conclusion

Webex App

Questions?

Use the Webex App to chat with the speaker after the session

How

1. Find this session in the Cisco Events Mobile App
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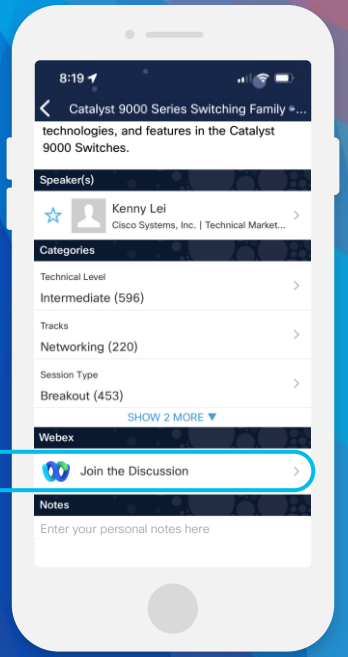
3. Install the Webex App or go directly to the Webex space
4. Enter messages/questions in the Webex space



https://ciscolive.ciscoevents.com/ciscolivebot/#DEVNET-2473

Webex spaces will be moderated by the speaker until February 23, 2024.

What is a CI/CD Pipeline?

What is a CI/CD Pipeline?

- A networking CI/CD Pipeline is a process that deploys network infrastructure through a series of steps that include building, testing and deploying infrastructure as code.

Build Test Release Deploy Verify

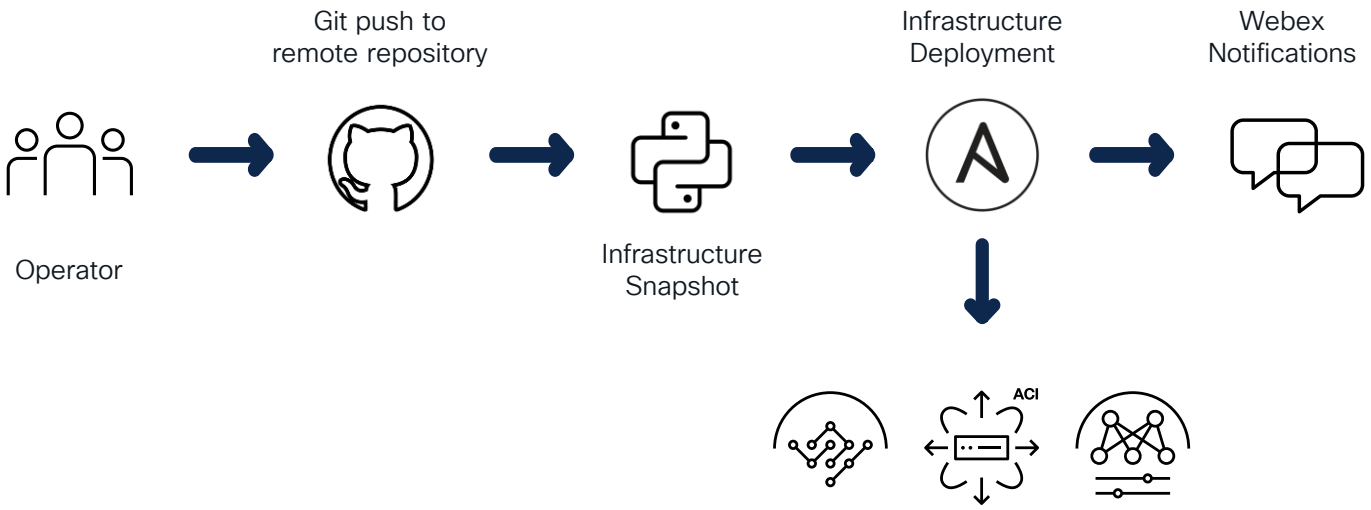
Why do I need a CI/CD Pipeline?

- Pipelines implement the process in a consistent and automated way
- Some of the benefits:
  - Increases efficiency and speed
  - Saves time, effort and cost
  - Minimizes human error
  - Maintains consistency
  - Reduces risk

Even simple pipelines will bring most of these benefits to your processes

A Simple CI/CD Pipeline

Example



Why do I need pre/post-change validations?

Most of incidents are caused by change activities

Verifying the impact of changes before and after deployment is critical to avoid incidents and increase the success rate of changes

* Source: ITSM.tools, figures from Gartner and Forrester, 2017

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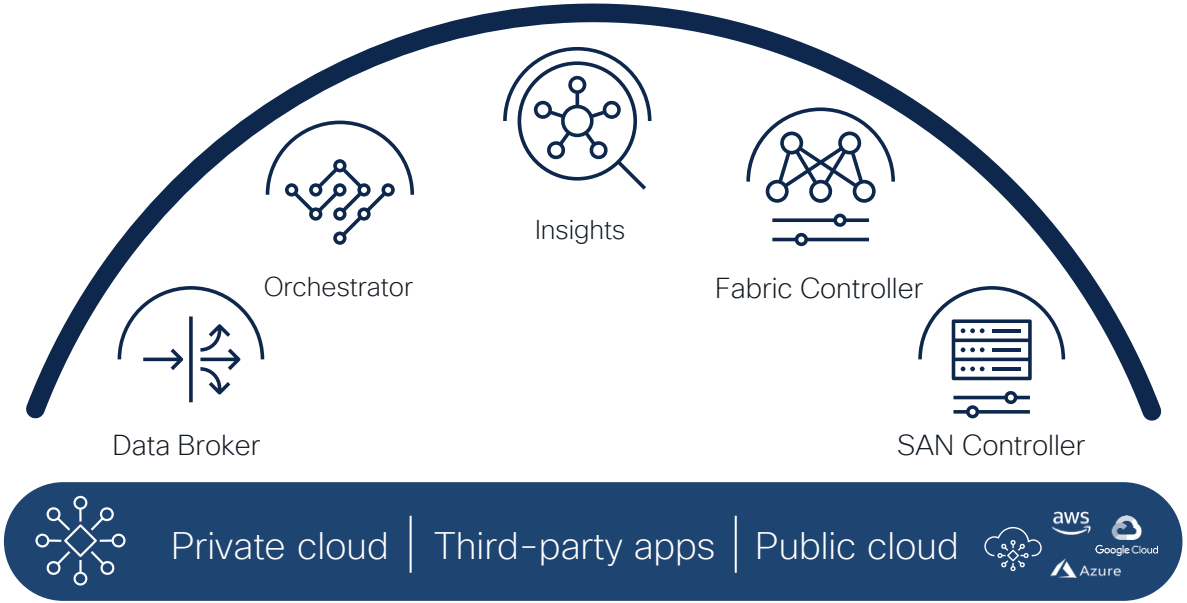
Verifying the impact of changes before and after deployment is critical to avoid incidents and increase the success rate of changes

Nexus Dashboard Insights can help us here! ☺

* Source: ITSM.tools, figures from Gartner and Forrester, 2017

Cisco Nexus Dashboard

Simple to automate, simple to consume



Consume all services in one place

Cisco Nexus Dashboard Insights

Your Centralized Day-2 Operations Tool

Nexus Dashboard Insights

Assurance
Compliance
Visibility
Troubleshooting
Proactive Advisories
and much more...

Private cloud | Third-party apps | Public cloud

aws Google Cloud Azure

Consume all services in one place

Cisco Nexus Dashboard Insights

Current Feature Set

Visibility and monitoring

- Topology
- Microburst detection
- Capacity planning
- Explorer queries
- Control plane statistics
- Interface statistics

Analytics and Correlation

- Flow telemetry
- Integrations
- Assurance
- Delta and pre-change analysis
- Endpoint analytics
- Anomalies

Advisories and tools

- Conformance and lifecycle
- Upgrade analysis
- PSIRT notification
- Field notices
- TAC assist
- Bug scan

Cisco Nexus Dashboard Insights

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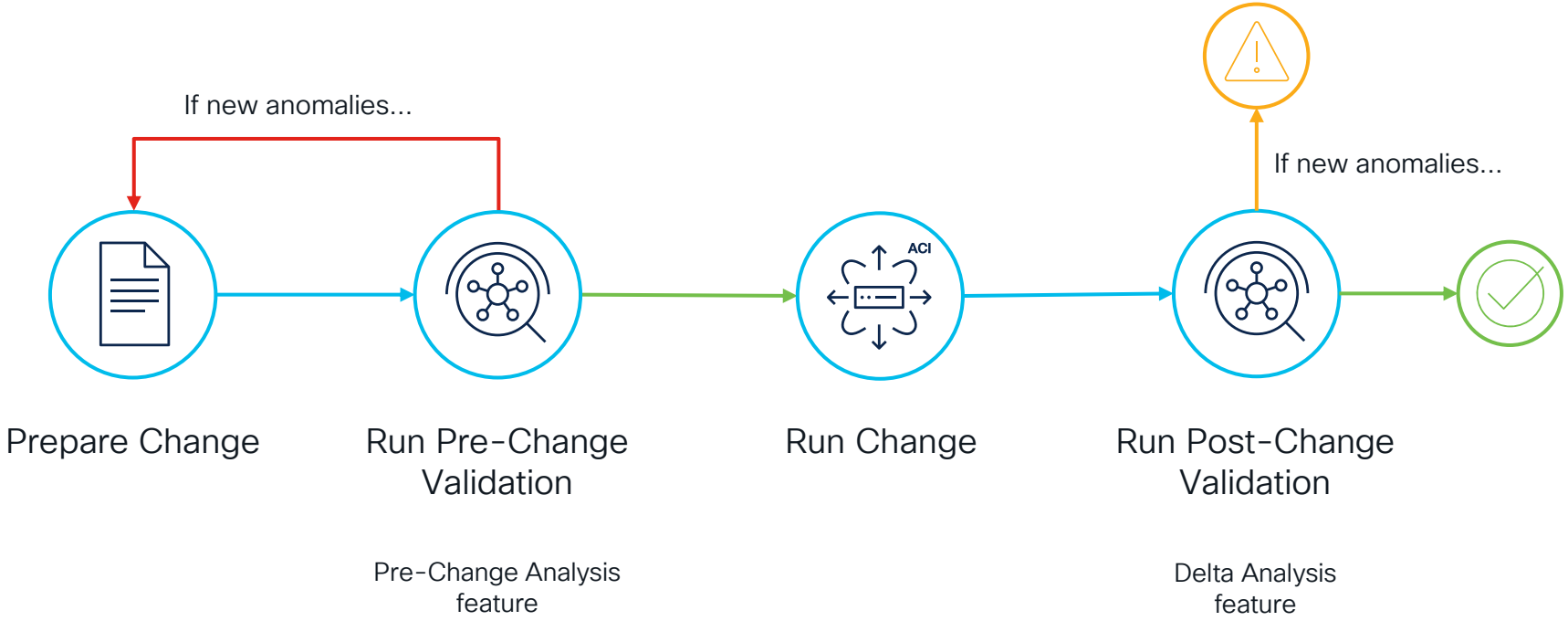
This is our focus today

Verify your changes before and after

With Nexus Dashboard Insights



How can I build a simple yet powerful CI/CD Pipeline?

Our CI/CD toolset

The tools we will use for today's session

GitHub Actions

Version Control System

SaaS-based CI engine

Ansible

Deployment tool

Support for check-only mode

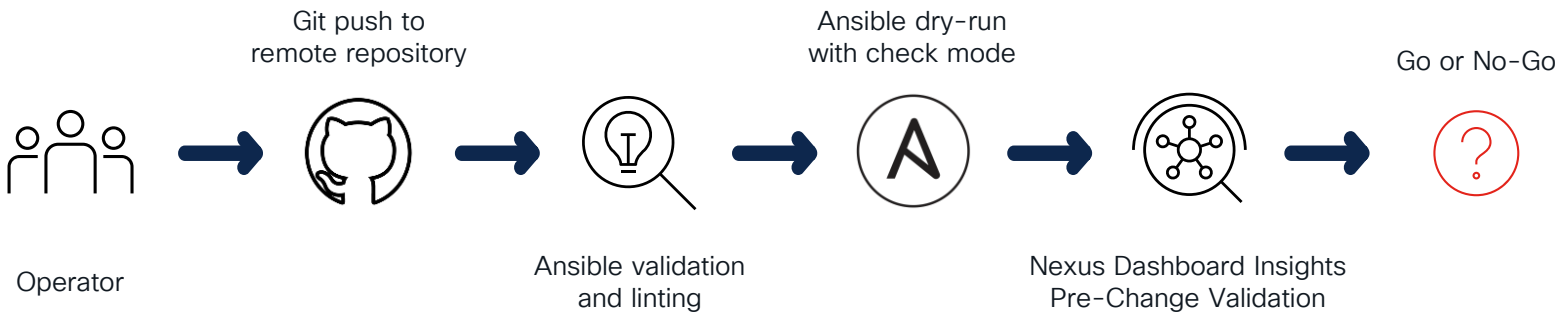
Nexus Dashboard Insights

Pre-change Validation

Post-Change validation

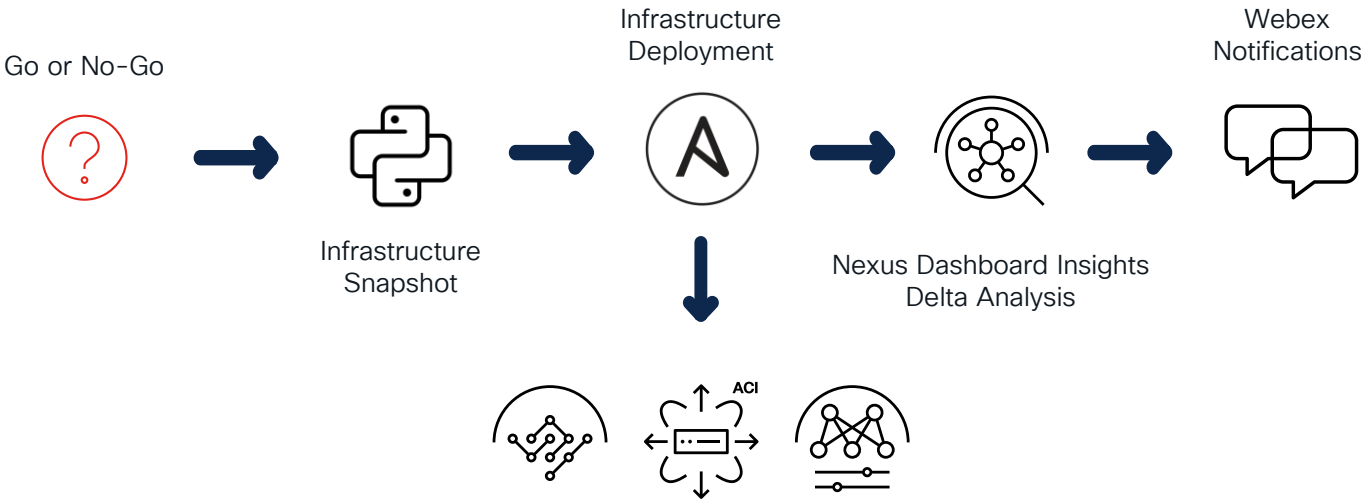
Our target CI/CD Pipeline

The goal for today's session



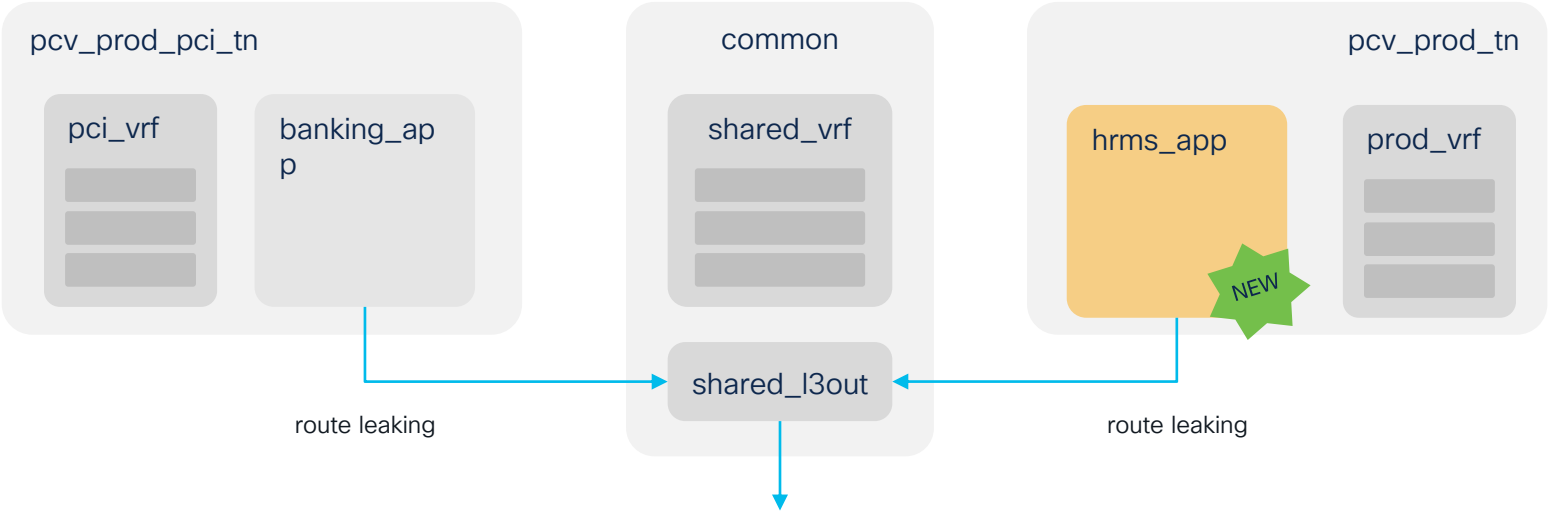
Our target CI/CD Pipeline

The goal for today's session



Demo

Demo Scenario



Conclusion

Key points to remember

- Networking CI/CD Pipelines are fundamental to implement the network provisioning process in a consistent and automated way
- A high percentage of incidents are caused due to change activities
  - Hence, including pre/post-change validations in your pipeline is strongly recommended
- Nexus Dashboard Insights can be integrated in your pipeline for pre-change and post-change validations in a very simple way

Key points to remember

- Networking CI/CD Pipelines are fundamental to implement the network provisioning process in a consistent and automated way
- A high percentage of incidents are caused due to change activities
  - Hence, including pre/post-change validations in your pipeline is strongly recommended
- Nexus Dashboard Insights can be integrated in your pipeline for pre-change and post-change validations in a very simple way

TIP

Building a powerful CI/CD Pipeline is simple
if you have Nexus Dashboard Insights

Next Steps

What to do during and after Cisco Live

Download this code from GitHub and get familiar with it

Code in GitHub

Test the code in your lab (or use DevNet Sandbox)

DevNet ACI Sandboxes

Explore more about Nexus Dashboard Insights in Cisco Live

BRKDCN-2626 | BRKDCN-2673

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Thank you

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Let's go

Appendix I
Building the Pipeline

Building the Pipeline

How to get started

- The pipeline is defined in a YAML file created in:

🗁 Project-X
  🗁 .github
    🗁 workflows

validate-and-deploy.yml — aci-ansible-change-validation-demo

EXPLORER
OPEN EDITORS
validate-and-deploy.yml .gi... M
ACI-ANSIBLE-CHANGE-VALIDATION-DEMO
.github / workflows
validate-and-deploy.yml M
cisco_aci_preparation
playbooks
tools
.gitignore
README.md
OUTLINE
TIMELINE
TERRAFORM PROVIDERS
TERRAFORM MODULE CALLS

validate-and-deploy.yml M
.github > workflows > validate-and-deploy.yml > {} on > {} push
GitHub Workflow (github-workflow.json)

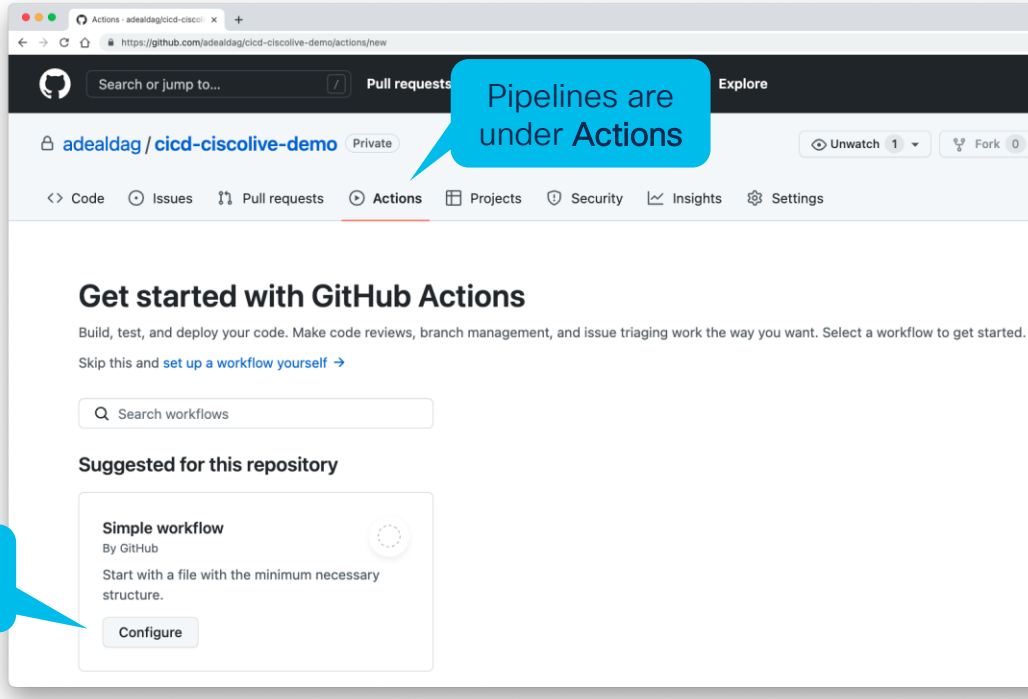
```yaml
# Networking CICD Pipeline with pre-change and post-change validation powered by Nexus Dashboard
name: pipeline-validate-and-deploy

# Controls when the workflow will run
on:
  # Triggers the workflow on push (and merge) events on the master branch
  push:
    branches: [main]

# Environment variables
env:
  IG_NAME: dc_spain
  SITE_NAME: MLG01
  PYTHONWARNINGS: "ignore:Unverified HTTPS request"

jobs:
  # Run ansible lint on the complete directory
  ansible-lint: …

  # Run ansible dry-run using check mode. Result is uploaded as artifact
  ansible-dry-run: …

  # Run pre-change validation on Nexus Dashboard Insights. Uses the artifact saved previously
  pre-change-validation: …

  # Take a snapshot of the ACI fabric
  snapshot: …

  # Deploy changes in production
  ansible-deploy: …

  # Run post-change validation on Nexus Dashboard Insights
  post-change-validation:
    runs-on: self-hosted
```

main* | 0 0 | Git Graph | You, 2 weeks ago | Ln 7, Col 8 | Spaces: 2 | UTF-8 | LF | YAML

Building the Pipeline

How to get started

- The pipeline can also be created from GitHub
  - From there you can get a basic workflow template to get started
  - Documentation is presented in a side panel on the right



Click here to get started

Building the Pipeline

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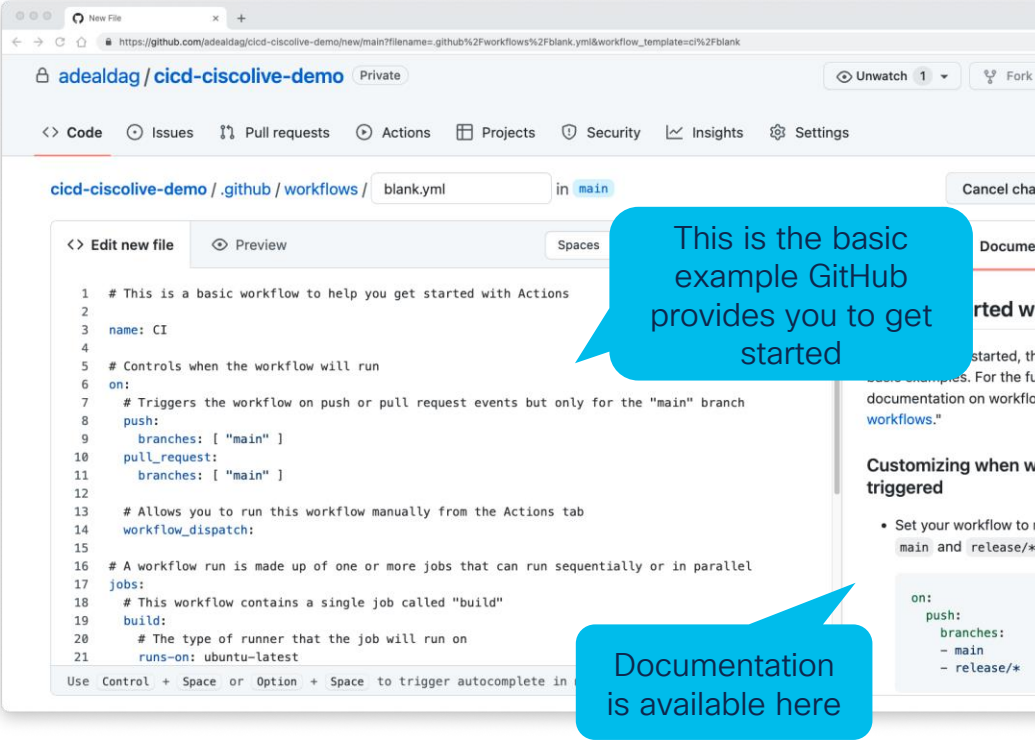

Building the Pipeline

Configuring our pipeline

```
# Networking CICD Pipeline with pre-change and post-c[illegible]shboard
name: pipeline-validate-and-deploy

# Controls when the workflow will run
on:
  # Triggers the workflow on push (and merge) events on the “main” branch
  push:
    branches: [main]

  # Allows you to run this workflow manually from the Actions tab
  # workflow_dispatch:

# Environment variables
env:
  PYTHONWARNINGS: "ignore:Unverified HTTPS request”

# A workflow run is made up of one or more jobs that can run sequentially or in parallel
jobs:
  [...]
```

Workflow (or pipeline) name

Defines when the workflow will get triggered

If you need to run the workflow manually, uncomment this

Include any required environment variable here

Building the Pipeline

Configuring the “jobs”

```
jobs:
  # Run ansible lint on the complete directory
  ansible-lint:
    [...]
  # Run ansible dry-run using check mode. Result is uploaded as artifact
  ansible-dry-run:
    [...]
  # Run pre-change validation on Nexus Dashboard Insights. Uses the artifact saved previously
  pre-change-validation:
    [...]
  # Take a snapshot of the ACI fabric
  snapshot:
    [...]
  # Deploy changes in production
  ansible-deploy:
    [...]
  # Run post-change validation on Nexus Dashboard Insights
  post-change-validation:
    [...]
```

These are the different stages in our pipeline or workflow

Jobs can run in parallel or sequentially, based on dependencies configured

Building the Pipeline

Job: ansible-lint

```yaml
# Run ansible lint on the complete directory
ansible-lint:
  runs-on: ubuntu-latest

steps:
  - uses: actions/checkout@v2

  - name: Set up Python
    uses: actions/setup-python@v2
    with:
      python-version: 3.8

  - name: Install yamllint
    run: pip install yamllint

  - name: Lint YAML files
    run: yamllint ./playbooks

  - name: Send Webex Notification
    [...]
```

Runs in a cloud-hosted runner maintained by GitHub

Checks-out your repository under $GITHUB_WORKSPACE, so your workflow can access it

Installs and sets-up a version of python, add it to the PATH and more

With “run” you can run any command on the runner. Here we install *yamllint* and then run against our playbooks

More about Webex notifications later!

Building the Pipeline

Job: ansible-dry-run

```
# Run ansible dry-run using check mode. Result
ansible-dry-run:
  runs-on: self-hosted
  needs: ansible-lint
  container: adealdag/ansible:latest

  steps:
   - uses: actions/checkout@v2

   - name: Run ansible playbook dry-run
     env:
       VAULT_KEY: ${{ secrets.VAULT_KEY }}
     run: |
       ansible --version
       echo $VAULT_KEY > vault.key
       ansible-playbook -i inventory.yaml --vault-password-file vault.key deploy.yaml --check
       rm vault.key
     working-directory: playbooks

  [...]
```

Runs in a **self-hosted runner**, installed in our **on-prem infrastructure**

With **needs** dependencies can be defined.
This job will not run until 'ansible-lint' completes

If the self-hosted runner has docker installed, you can **run each job in a container**, that gets destroyed after execution **(recommended)**

Building the Pipeline

Job: ansible-dry-run (continuation)

```yaml
steps:
 - uses: actions/checkout@v2

 - name: Run ansible playbook dry-run
  env:
   VAULT_KEY: ${{ secrets.VAULT_KEY }}
  run: |
   ansible --version
   echo $VAULT_KEY > vault.key
   ansible-playbook -i inventory.yaml --vault-password-file vault.key deploy.yaml --check
   rm vault.key
  working-directory: playbooks

 - name: Upload artifact
  uses: actions/upload-artifact@v2
  with:
   name: config-dump
   path: playbooks/dryrun_data.json

 - name: Send Webex Notification
  [...]
```

Inventory is encrypted using ansible vault. Vault key is stored as an **action secret.** More on secrets later!

Directory from where these commands are run

Saves output file from previous step in an artifact. Artifacts are the way to share data between jobs.

Building the Pipeline

Dissecting ansible-playbook command

Inventory is encrypted using **Ansible Vault** not to disclose sensitive information in GitHub repo

Our playbook.
It contains a series of "import_playbook" statements to combine multiple playbooks in a single one

```
ansible-playbook -i inventory.yaml  --vault-password-file vault.key  deploy.yaml  --check
```

Ansible Vault password is provided in a file.
This file contains the password stored in GitHub action secret

Runs ansible in '**check mode**' *

In 'check mode', no changes are made on remote systems, it is just a simulation, or 'dry-run'

* More info here

Building the Pipeline

Job: pre-change-validation

```yaml
# Run pre-change validation on Nexus Dashboard Insights. Uses the artifact saved previously
pre-change-validation:
  runs-on: self-hosted
  needs: ansible-dry-run
  container: adealdag/ansible:latest

  steps:
   - uses: actions/checkout@v2

   - name: Download artifact
     uses: actions/download-artifact@v2
     with:
       name: config-dump
       path: tools/change-validation

   - name: Run pre-change analysis playbook
     [...]
```

Runs in a **self-hosted runner**, in a **container**, and needs previous job to be completed

Downloads output file from previous step, saved on an artifact called ‘config-dump’, into folder specified in ‘path’

adealdag/ansible container have required ansible collections pre-installed

Building the Pipeline

Job: pre-change-validation (continuation)

```
# Run pre-change validation on Nexus Dashboard Insights. Uses the artifact saved previously
pre-change-validation:
  [...]
  steps:
    [...]

    - name: Run pre-change analysis playbook
      env:
        VAULT_KEY: ${{ secrets.VAULT_KEY }}
      run: |
        ansible --version
        rm -rf $HOME/.ansible/pc
        echo $VAULT_KEY > vault.key
        ansible-playbook -i inventory.yaml --vault-password-file vault.key pre-change-validation.yaml
        rm vault.key
      working-directory: tools/change-validation

    - name: Send Webex Notification
      [...]
```

Runs pre-change-validation on Nexus Dashboard Insights **using cisco.nd Ansible Collection**

This is a workaround to avoid issues with ansible control plane sockets seen when running from a workflow runner

Building the Pipeline

Job: snapshot

```yaml
# Take a snapshot of the ACI fabric
snapshot:
  runs-on: self-hosted
  needs: pre-change-validation
  container: adealdag/aci_cobra:5.2.4e

  steps:
   - uses: actions/checkout@v2

   - name: Take an aci snapshot
     env:
       APIC_HOST: ${{ secrets.APIC_HOST }}
       APIC_USERNAME: ${{ secrets.APIC_USERNAME }}
       APIC_PASSWORD: ${{ secrets.APIC_PASSWORD }}
     run: |
       export no_proxy=$APIC_HOST,$no_proxy
       python ./tools/trigger_backup/py_trigger_backup.py
```

Runs in a **self-hosted runner**, in a **container**, and needs previous job to be completed

Runs a python script to take an ACI snapshot
The script uses Cobra SDK

adealdag/cobra container have Cobra SDK pre-installed

Building the Pipeline

Job: ansible-deploy

```yaml
# Deploy changes in production
ansible-deploy:
  runs-on: self-hosted
  needs: snapshot
  container: adealdag/ansible:latest

  steps:
   - uses: actions/checkout@v2

   - name: Run ansible playbook
     env:
       VAULT_KEY: ${{ secrets.VAULT_KEY }}
     run: |
       ansible --version
       echo $VAULT_KEY > vault.key
       ansible-playbook -i inventory.yaml --vault-password-file vault.key deploy.yaml
       rm vault.key
     working-directory: playbooks

   - name: Send Webex Notification
     [...]
```

Runs in a **self-hosted runner**, in a **container**, and needs previous job to be completed

Runs Ansible playbook, now **without -check**

Building the Pipeline

Job: post-change-validation

```yaml
# Run post-change validation on Nexus Dashboard Insights
post-change-validation:
  runs-on: self-hosted
  needs: ansible-deploy
  container: adealdag/ansible:latest

  steps:
   - uses: actions/checkout@v2

   - name: Run post-change analysis playbook
     env:
       VAULT_KEY: ${{ secrets.VAULT_KEY }}
     run: |
       ansible --version
       rm -rf $HOME/.ansible/pc
       echo $VAULT_KEY > vault.key
       ansible-playbook -i inventory.yaml --vault-password-file vault.key post-change-validation.yaml
       rm vault.key
     working-directory: tools/change-validation

   - name: Send Webex Notification
     [...]
```

Runs in a **self-hosted runner**, in a **container**, and needs previous job to be completed

Runs post-change-validation on Nexus Dashboard Insights **using cisco.nd Ansible Collection**

This is a workaround to avoid issues with ansible control plane sockets seen when running from a workflow runner

Building the Pipeline

Webex: Sending notifications in Webex

```yaml
- name: Send Webex Notification
  uses: adealdag/action-webex-notification@python-v1
  if: always()
  with:
  webexToken: ${{ secrets.WEBEX_TOKEN }}
  roomID: ${{ secrets.ROOM_ID }}
  markdownMsg: |
    ### [${{ github.job }}] ${{ github.repository }} - ${{ github.event.head_commit.message }}
    * Trigger: ${{ github.event_name }}
    * Git SHA: ${{ github.sha }}
    * Status: ${{ job.status }}
    * Details URL:
    [Job Results](https://github.com/${{ github.repository }}/actions/runs/${{ github.run_id }})
```

This uses a **custom action.**
It is publicly available, code can be checked **here**

Runs always, regardless if previous steps succeeded or failed

It is recommended to use this action together with a Webex Bot.

Building the Pipeline

Webex: Sending notifications in Webex

```
- name: Send Webex Notification
  uses: adealdag/action-webex-notification@python-v1
  if: always()
  with:
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  markdownMsg: |
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    * Git SHA: ${{ github.sha }}
    * Status: ${{ job.status }}
    * Details URL:
    [Job
```

This uses a **custom action.**
It is publicly available, code can be checked **here**

Runs always, regardless if previous steps succeeded or failed

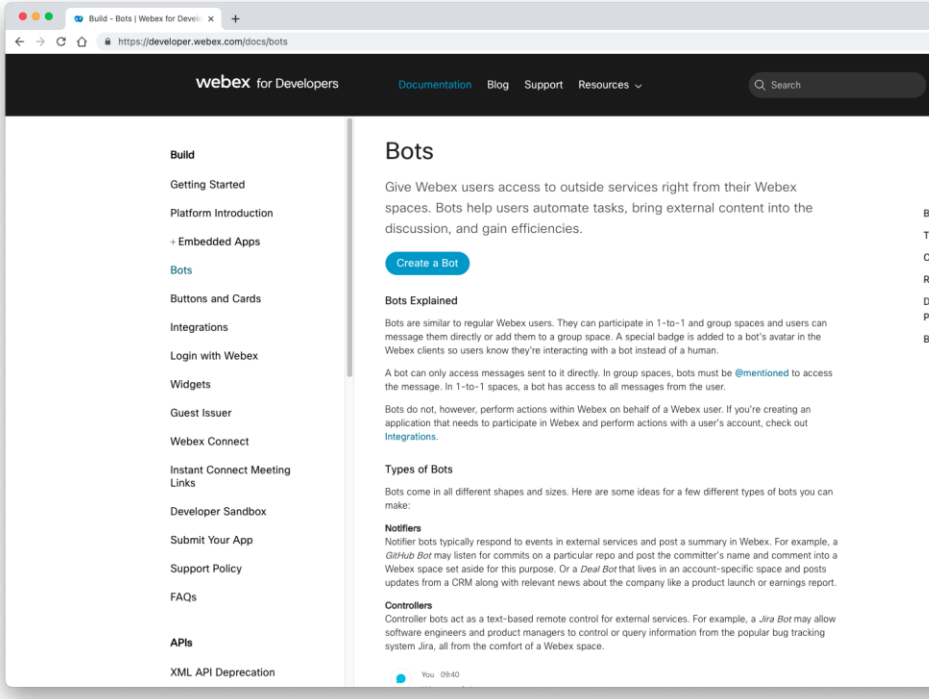
TIP

You can also create and publish your own actions

Building the Pipeline

Webex: Creating your bot

- Create your bot in:
  - https://developer.webex.com/docs/bots
- After creating your bot, you will get your Webex Token
  - Store this safely, we'll need it for authenticating REST API calls
- Now add your bot to a Webex Room, and you are ready to go



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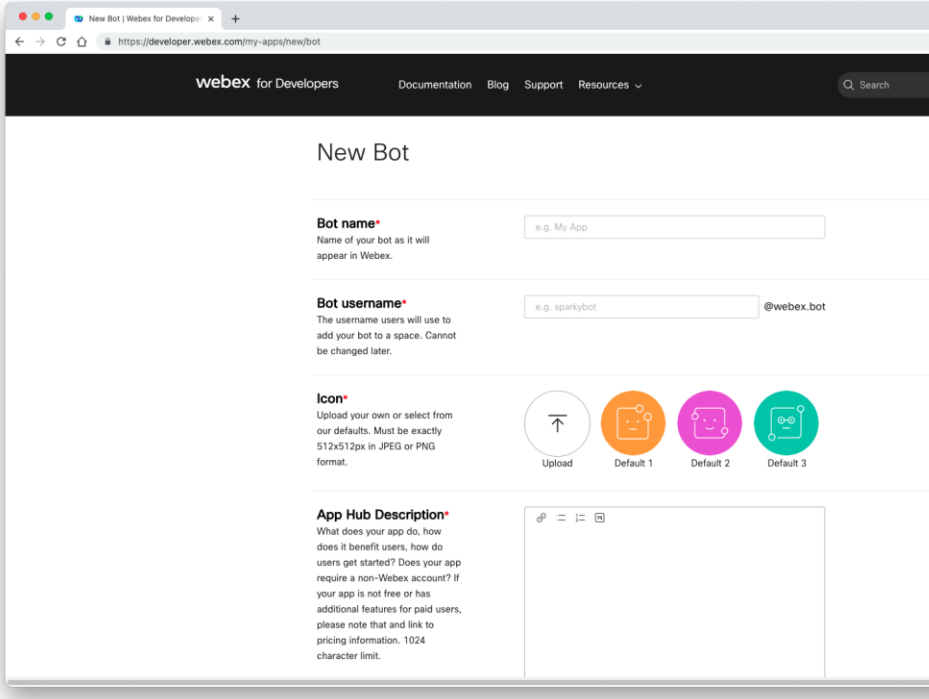

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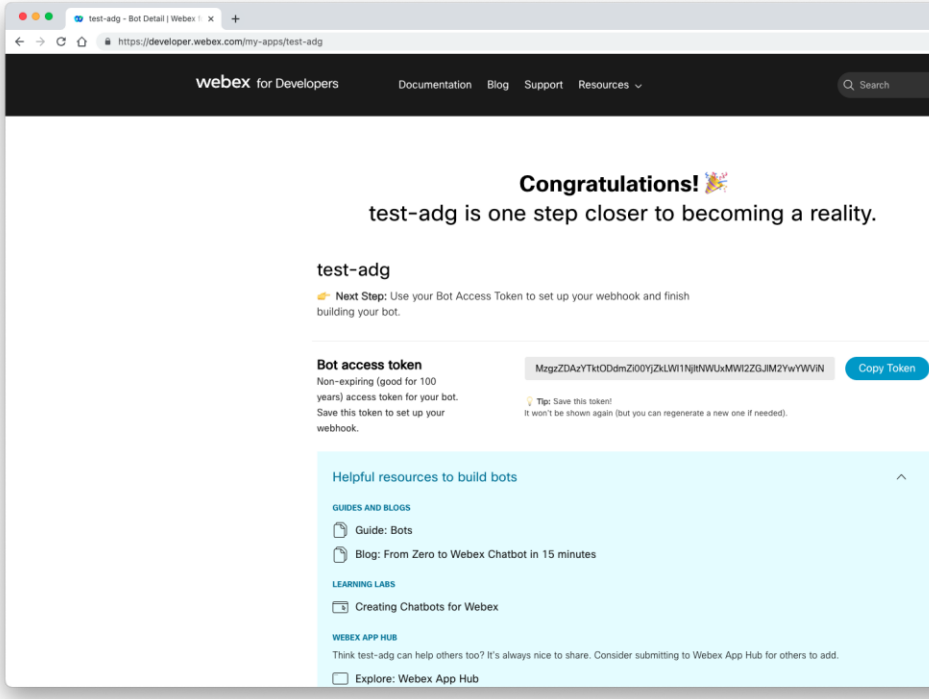
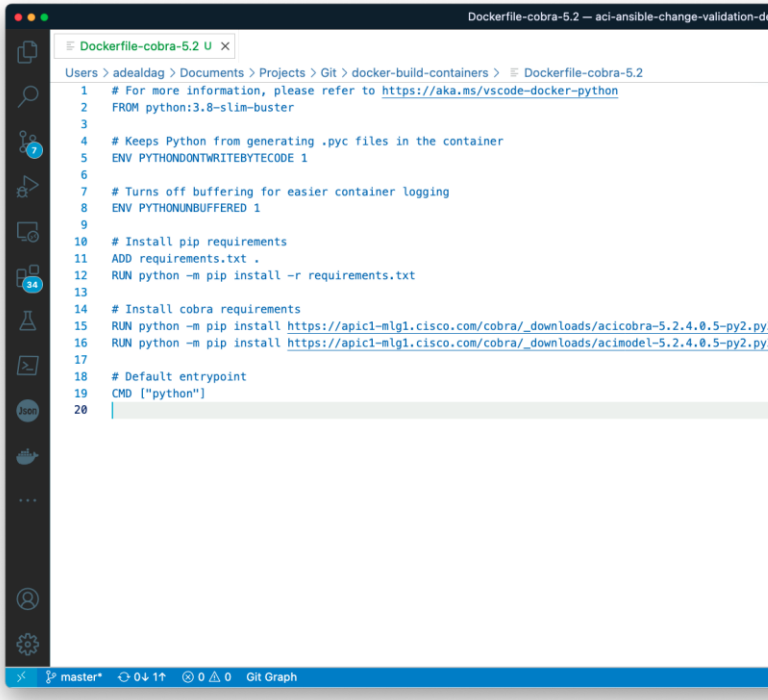


Building the Pipeline

A look at the containers used

- You can build your own containers for GitHub Actions workflows
- Steps:
  - Write your Dockerfile
  - Build your container locally
    - docker build -t adealdag/ansible:v2 --platform linux/amd64 .
  - Push the container to Docker Hub
    - docker push adealdag/ansible:v2
  - Your container is ready to use



Building the Pipeline

A look at the containers used – aci_cobra:xxx

```
# For more information, please refer to https://aka.ms/vscode-docker-python
FROM python:3.8-slim-buster

# Keeps Python from generating .pyc files in the container
ENV PYTHONDONTWRITEBYTECODE 1

# Turns off buffering for easier container logging
ENV PYTHONUNBUFFERED 1

# Install pip requirements
ADD requirements.txt .
RUN python -m pip install -r requirements.txt

# Install cobra requirements
RUN python -m pip install https://apic1-mlg1.cisco.com/cobra/_downloads/acicobra-5.2.4.0.5-py2.py3-none-any.whl --trusted-host apic1-mlg1.cisco.com
RUN python -m pip install https://apic1-mlg1.cisco.com/cobra/_downloads/acimodel-5.2.4.0.5-py2.py3-none-any.whl --trusted-host apic1-mlg1.cisco.com

# Default entrypoint
CMD ["python"]
```

Replace with your cobra SDK version.

In this example, it gets downloaded directly from APIC

Building the Pipeline

A look at the containers used – ansible:xxx

```
# For more information, please refer to https://aka.ms/vscode-docker-python
FROM python:3.8-slim-buster

# Keeps Python from generating .pyc files in the container
ENV PYTHONDONTWRITEBYTECODE 1

# Turns off buffering for easier container logging
ENV PYTHONUNBUFFERED 1

# Install packages
RUN apt-get update
RUN apt-get --yes --force-yes install build-essential

# Install pip requirements
ADD requirements.txt .
RUN python -m pip install -r requirements.txt

# Install collections
RUN ansible-galaxy collection install cisco.aci -p /usr/share/ansible/collections
RUN ansible-galaxy collection install cisco.mso -p /usr/share/ansible/collections
RUN ansible-galaxy collection install cisco.nd -p /usr/share/ansible/collections

# Default entrypoint
CMD ["ansible-playbook", "--version" ]
```

requirements.txt

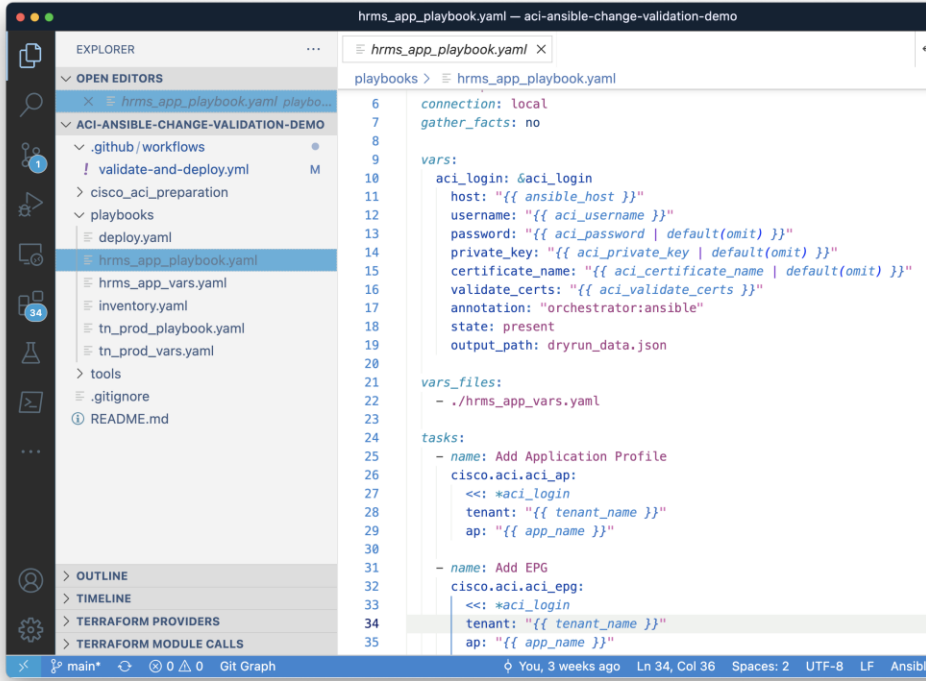
```
setuptools
ansible
paramiko
requests
requests-toolbelt
jsonpath_ng
pathlib
filelock
lxml
xmljson
```

Appendix II
Cisco ACI Playbooks

Cisco ACI Playbook

How to prepare them for dry-run

- Cisco ACI modules in Ansible support check mode
  - When using check mode…
    - Changes are not pushed to the fabric
    - Changes are populated in an output file



Cisco ACI Playbook

How to prepare them for dry-run

```yaml
tasks:
 - name: Add Application Profile
  cisco.aci.aci_ap:
    host: "{{ ansible_host }}"
    username: "{{ aci_username }}"
    password: "{{ aci_password }}"
    validate_certs: "{{ aci_validate_certs }}"
    tenant: "{{ tenant_name }}"
    ap: "{{ app_name }}"
    annotation: "orchestrator:ansible"
    output_path: dryrun_data.json
    state: present
```

Include **output_path** attribute in every task

Value is the path to the JSON file where changes will be saved

Cisco ACI Playbook

How to prepare them for dry-run

```yaml
---
- name: Create HRMS App Profile (prod)
  [...]

  vars:
    aci_login: &aci_login
      host: "{{ ansible_host }}"
      username: "{{ aci_username }}"
      password: "{{ aci_password }}"
      validate_certs: "{{ aci_validate_certs }}"
      annotation: "orchestrator:ansible"
      output_path: dryrun_data.json

  tasks:
    - name: Add Application Profile
      cisco.aci.aci_ap:
        <<: *aci_login
        tenant: "{{ tenant_name }}"
        ap: "{{ app_name }}"
        state: present
```

Recommended

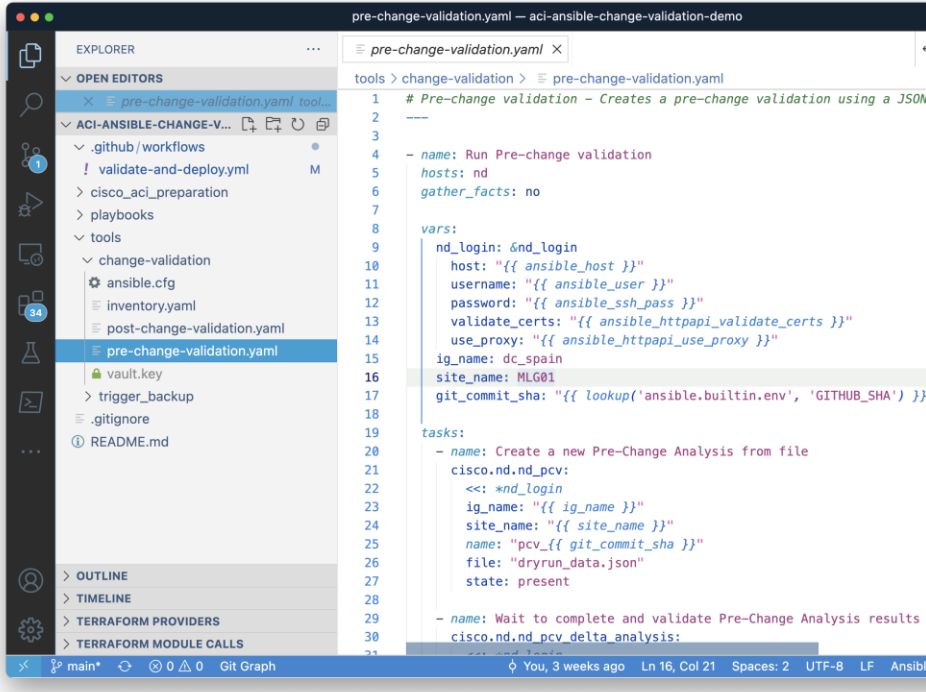
Use an **anchor** to apply this to every task in one single action

Appendix III
Cisco ND Playbooks

Cisco Nexus Dashboard Playbooks

Introducing cisco.nd collection

- Cisco Nexus Dashboard collection allows you automate Nexus Dashboard and Nexus Dashboard Insights
- More info in:
  - Ansible Galaxy
  - GitHub



Cisco Nexus Dashboard Playbooks

Pre-Change Validation Playbook

```yaml
tasks:
 - name: Create a new Pre-Change Analysis from file
   cisco.nd.nd_pcv:
     <<: *nd_login
     ig_name: "{{ ig_name }}"
     site_name: "{{ site_name }}"
     name: "pcv_{{ git_commit_sha }}"
     file: "dryrun_data.json"
     state: present

 - name: Wait to complete and validate Pre-Change Analysis results
   cisco.nd.nd_pcv_delta_analysis:
     <<: *nd_login
     insights_group: "{{ ig_name }}"
     site_name: "{{ site_name }}"
     name: "pcv_{{ git_commit_sha }}"
     state: validate
     exclude_ack_anomalies: yes
     epoch_choice: epoch2
   register: pcv_result
```

Creates a new pre-change analysis using the file provided

Wait until the pre-change analysis finishes, pulls the number of new anomalies and validate no new anomalies has been raised

Acknowledged anomalies (using alert rules) can be ignored

Cisco Nexus Dashboard Playbooks

Post-Change Validation Playbook

```
tasks:
 - name: Query Pre-Change Analysis performed before
   cisco.nd.nd_pcv:
     <<: *nd_login
     ig_name: "{{ ig_name }}"
     site_name: "{{ site_name }}"
     name: "pcv_{{ git_commit_sha }}"
     state: query
   register: pre_change_validation_info

 - name: Trigger instant assurance analysis job
   cisco.nd.nd_instant_assurance_analysis:
     <<: *nd_login
     insights_group: "{{ ig_name }}"
     site_name: "{{ site_name }}"
     state: present
   register: instant_analysis_triggered

 [...]
```

Queries past pre-change validation to get base epoch

Triggers an assurance analysis (a.k.a. epoch collection)

Cisco Nexus Dashboard Playbooks

Post-Change Validation Playbook

```
tasks:
 [...]
 - name: Wait until instant assurance analysis is completed
   cisco.nd.nd_instant_assurance_analysis:
     <<: *nd_login
     insights_group: "{{ ig_name }}"
     site_name: "{{ site_name }}"
     job_id: "{{ instant_analysis_triggered.current.jobId }}"
     state: query
   register: instant_analysis_info
   until: instant_analysis_info.current.operSt == "COMPLETE"
   retries: 200
   delay: 6

 [...]
```

Waits until the instant assurance analysis has completed

Cisco Nexus Dashboard Playbooks

Post-Change Validation Playbook

```yaml
tasks:
 [...]
 - name: Trigger delta analysis
   cisco.nd.nd_delta_analysis:
     <<: *nd_login
     insights_group: "{{ ig_name }}"
     site_name: "{{ site_name }}"
     name: "delta_{{ git_commit_sha }}"
     earlier_epoch_id: "{{ pre_change_validation_info.current.baseEpochId }}"
     later_epoch_id: "{{ instant_analysis_info.current.epochInfo.epochId }}"
     state: present
   register: delta_analysis_info

 - name: Validate delta analysis
   cisco.nd.nd_delta_analysis:
     <<: *nd_login
     insights_group: "{{ ig_name }}"
     site_name: "{{ site_name }}"
     name: "delta_{{ git_commit_sha }}"
     state: validate
   register: delta_analysis_results
```

Creates a delta analysis comparing the base epoch used in PCV (before) and the epoch just created from instant analysis (after)

Wait until completed, pulls the number of new anomalies and validate no new anomalies has been raised

cisco Live!

Let's go