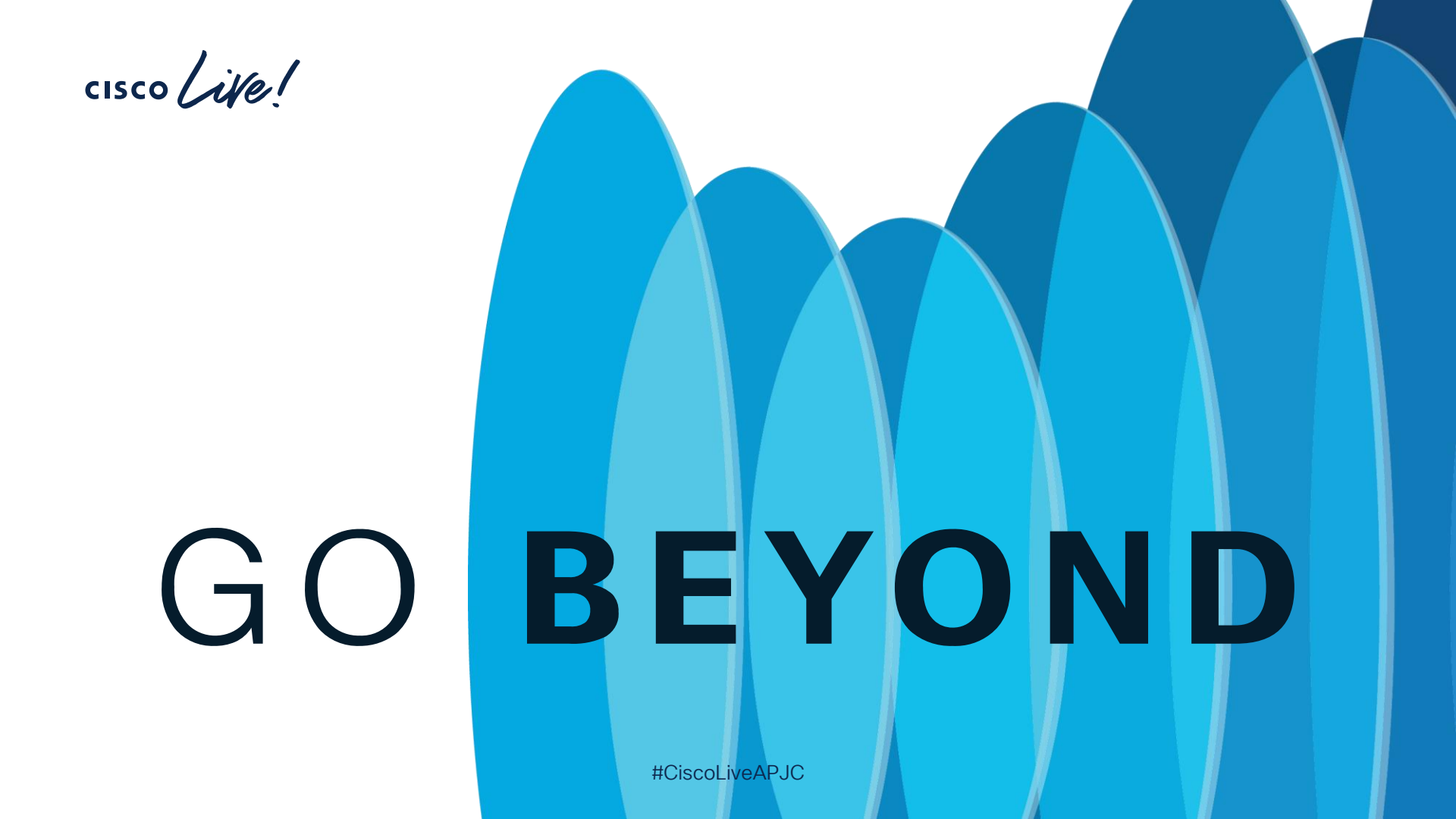
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GO BEYOND
#CiscoLiveAPJC

DevOps Tools Fight for Relevance!

Adrian ILIESIU, Developer Advocate
@aidevnet

DEVNET-1280

Cisco Webex App

https://ciscolive.ciscoevents.com/ciscolivebot/#DEVNET-1280

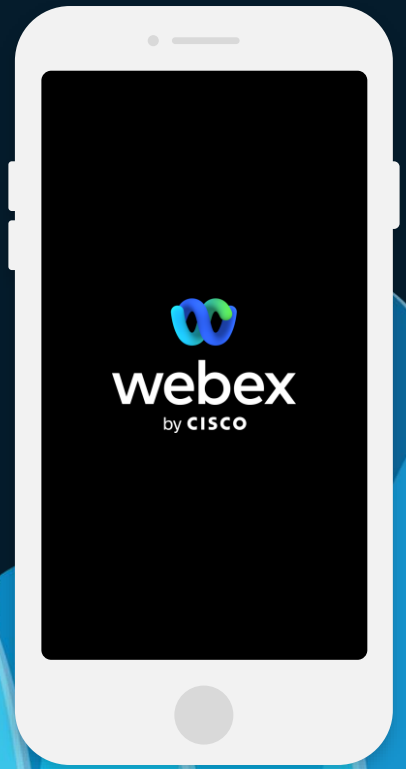
Questions?

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

How

1. Find this session in the Cisco Live Mobile App
2. Click “Join the Discussion”
3. Install the Webex App or go directly to the Webex space
4. Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until November 15, 2024.



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Agenda

- What is Infrastructure as Code (IaC)?
- Ansible
  - Ansible Collections
  - Ansible Concepts
- Terraform
  - Terraform Concepts
- Ansible and Terraform Comparison
- Next Steps
- Resources

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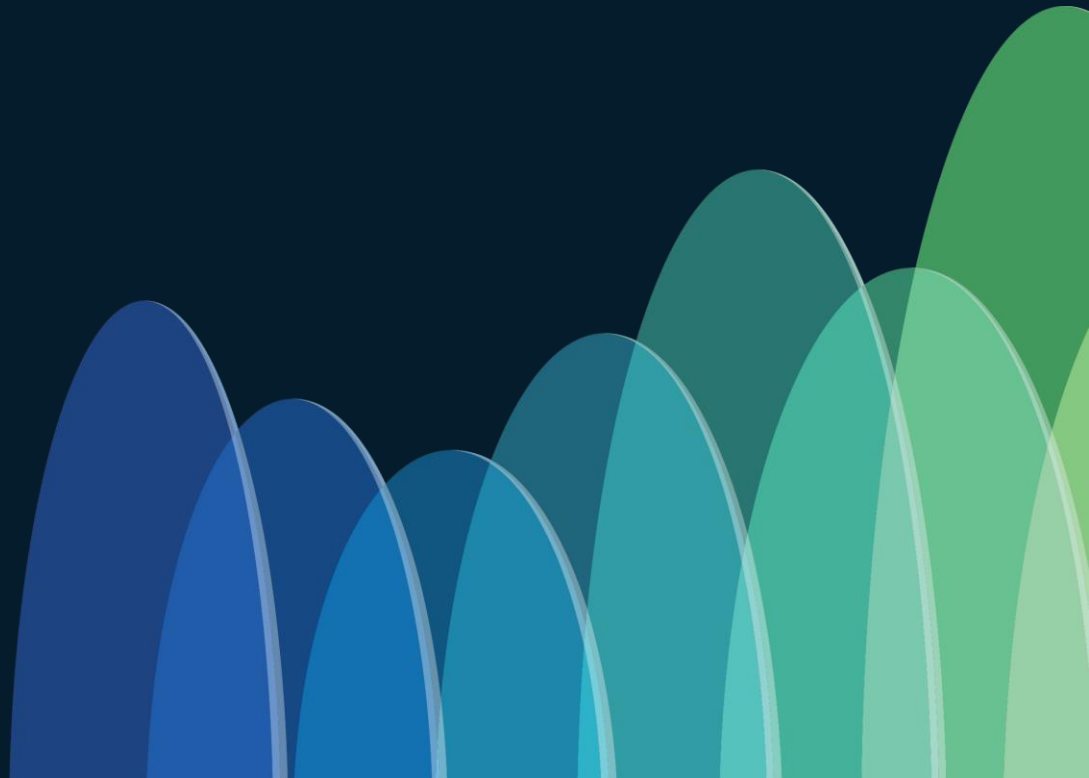
What is Infrastructure as Code (IaC)?



What is Infrastructure as Code (IaC)?

- Managing infrastructure can be tedious
- Network operators connect to devices and make changes to the configuration
  - CLI – “finger net”
  - Web browser – “point and click” aka “ClickOps”
- Most think of building/managing Cloud Infrastructure
- Define what the intended state of infrastructure should be
- Automation tools read & apply changes to devices to match the intended state

The management & provisioning of computer infrastructure through code and data structures instead of direct device management.

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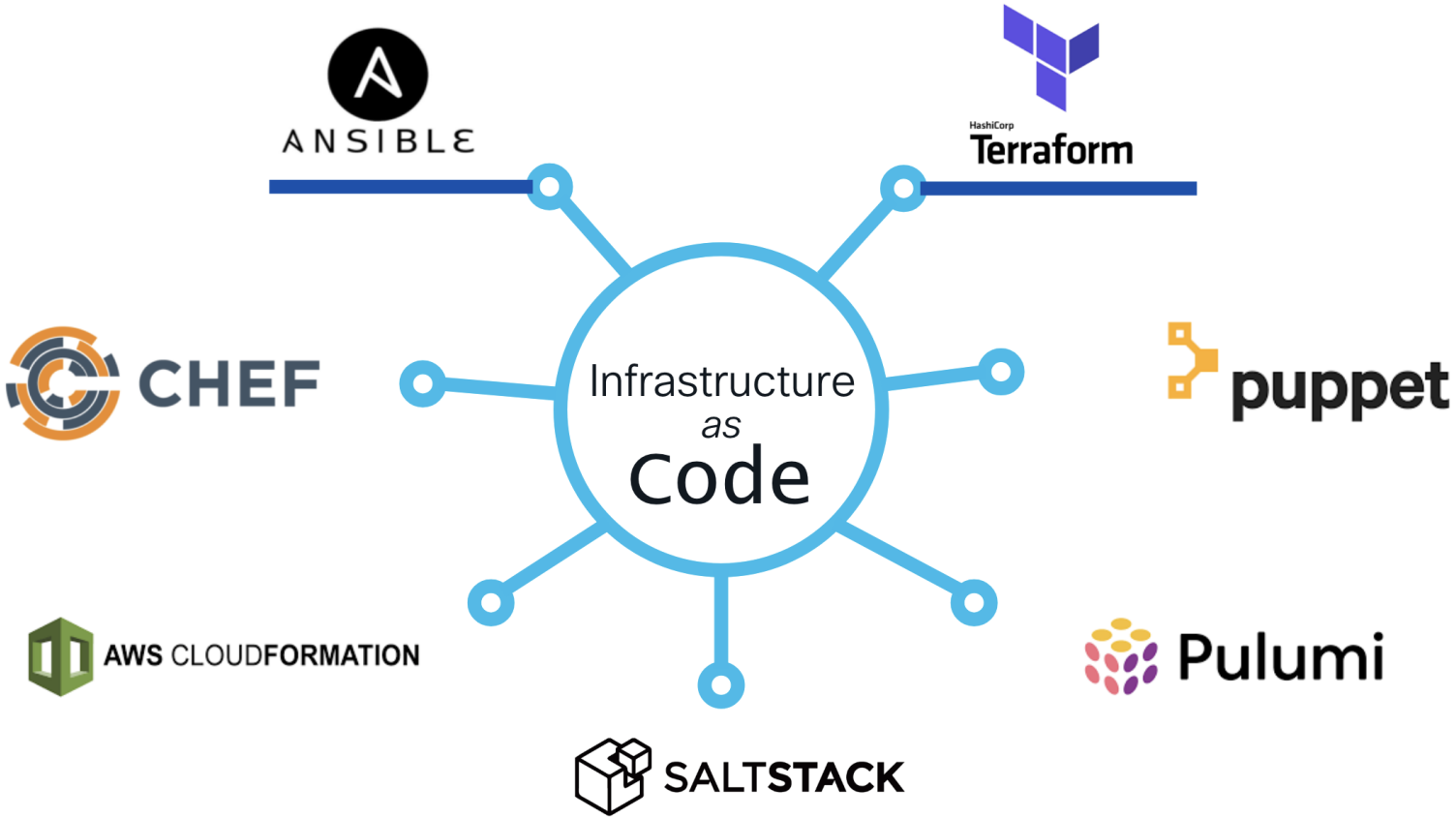
Infrastructure as Code Tools



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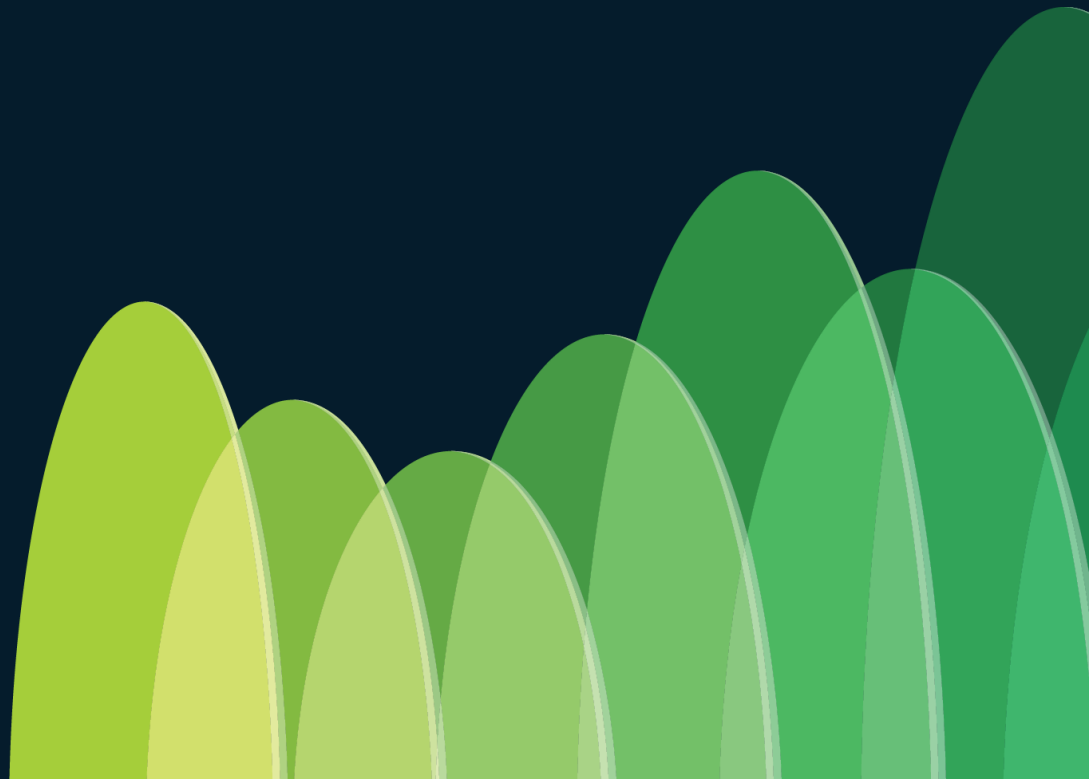
Ansible



What is Ansible?

- Automation / Configuration / Orchestration tool
- Open Source
- Agentless Push Model
- Produces the same results no matter how many times it is executed*
- No programming knowledge required
- Requires only data-structure manipulation knowledge
- CLI / NETCONF / REST API

*idempotent

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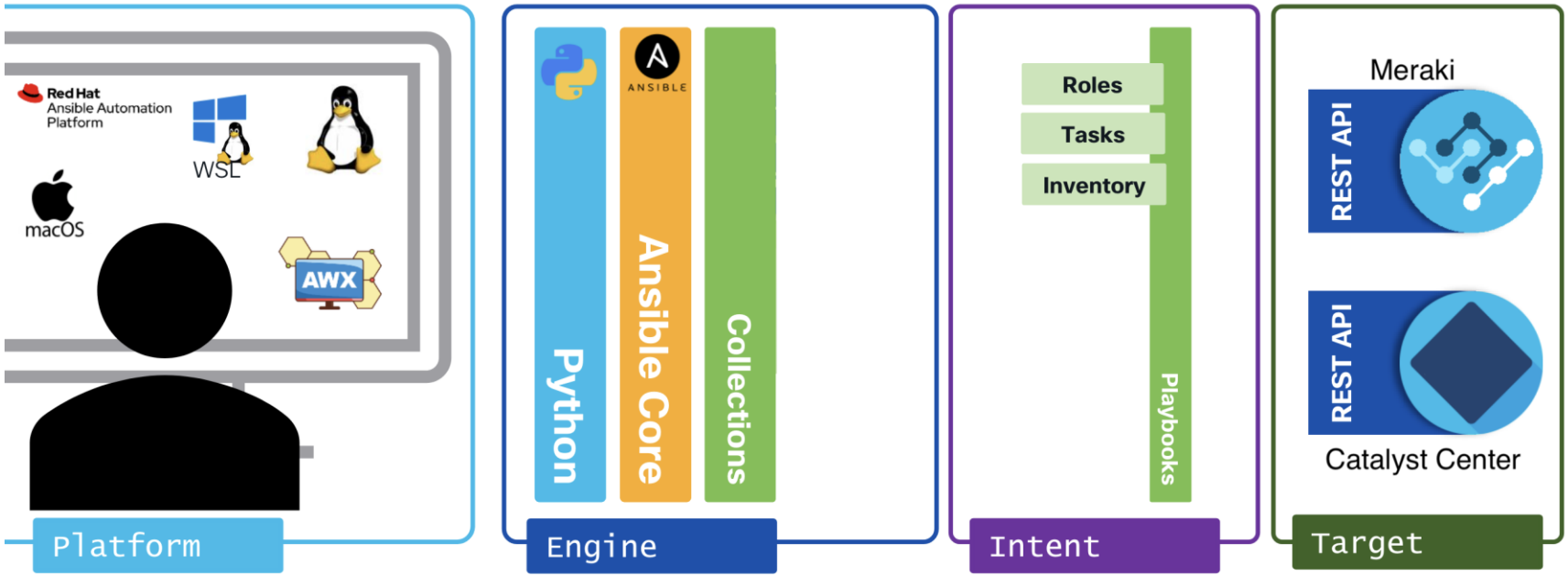
What makes up Ansible?



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Installing Ansible
Python Virtual Environments

- You should use a **virtual environment**
- Virtual environments allow for installing Ansible inside a contained area with a specific version of Python
- Makes it possible to run different Python scripts that require different versions of Python and libraries

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Ansible Install

Core or Everything

```
$ pip install ansible-core
```

- Ansible installs only the **core components**
- Collections must be installed separately
- Smaller footprint and more control
- Assures install of latest collections versions

```
$ pip install ansible
```

- Ansible installs **all collections**
- Complete package consumes much more disk space
- Might not install the latest version of the collection

https://docs.ansible.com/ansible/latest/installation_guide/intro_installation.html

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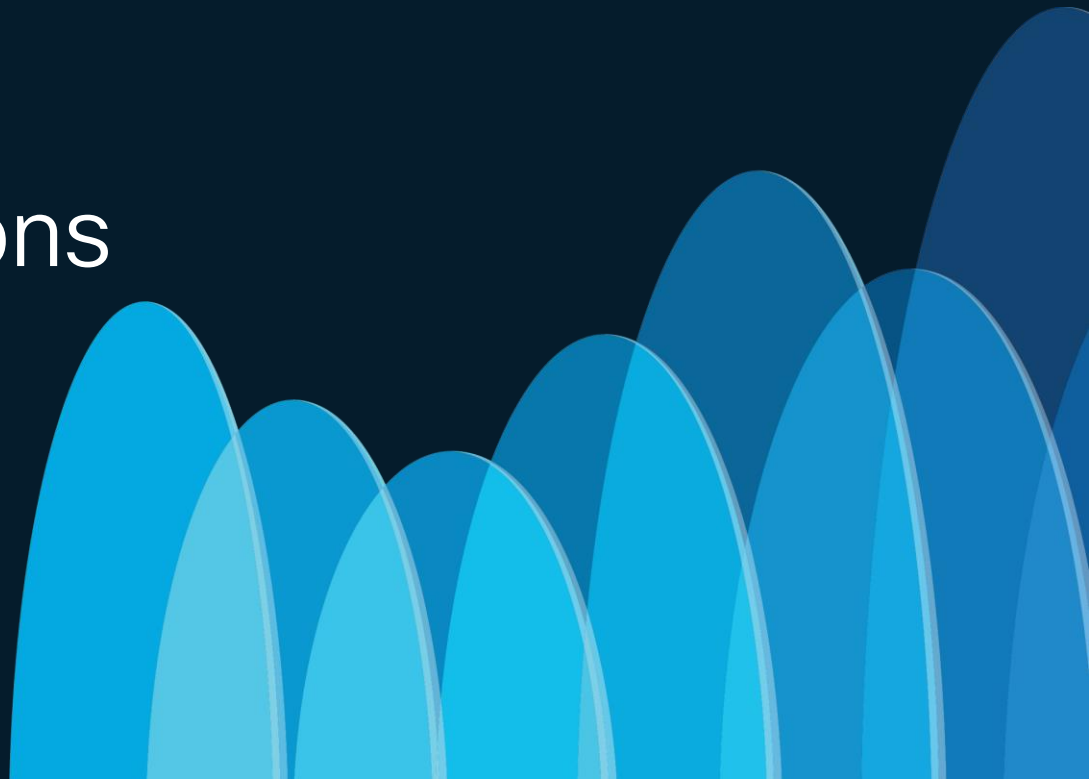
Ansible Collections



What are Ansible collections?

- Introduced in Ansible 2.9
- Collections allow vendors to de-couple their Ansible capabilities from the core Ansible release schedule
- Uses Ansible Galaxy as delivery method
- Collections can be installed in any location with the -p flag

```
$ ansible-galaxy collection install cisco.meraki cisco.dnac cisco.ios
```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Installing Ansible Collections

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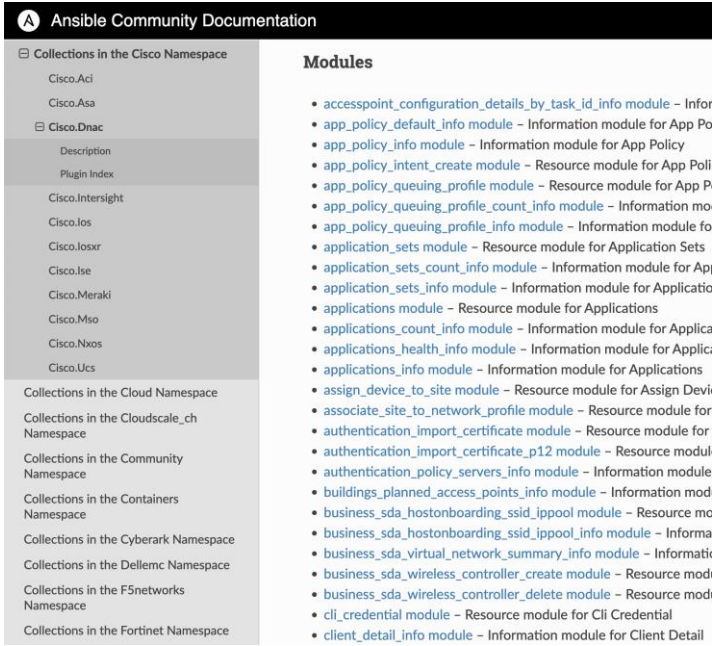
Ansible Catalyst Center

Collection Modules

- Primary reason they are called collections is because they are a collection of modules
- Modules perform a specific task like create templates, configure interfaces, etc.
- Actively maintained with regular cadence that increases module count and capabilities



https://docs.ansible.com/ansible/latest/collections/cisco/dnac/index.html

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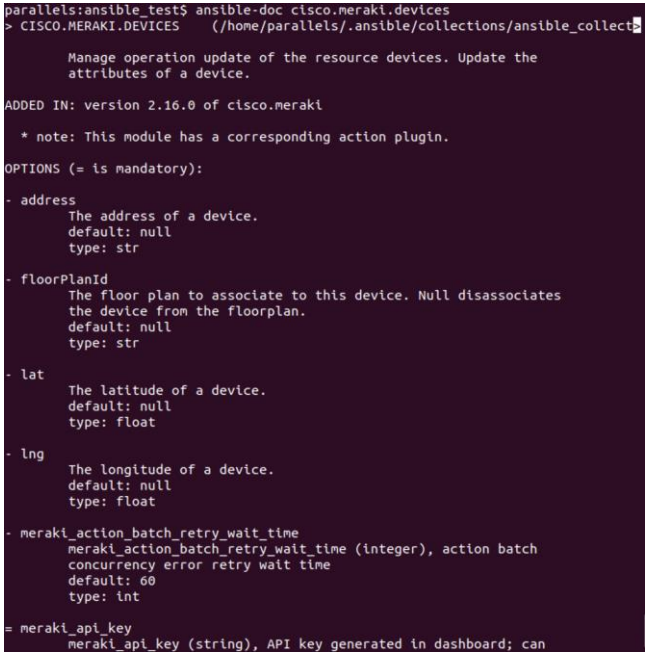
Ansible Cisco Meraki

Collection Modules (CLI)

The command: ansible-doc <module_name> will present the CLI version of the doc. Matches what is on the web.



Use the CLI to access the module documentation

Grep can be used to filter through all the documentation installed

```
parallels:ansible_test$ ansible-doc -l | grep cisco.meraki.devices
cisco.meraki.devices
cisco.meraki.devices_appliance_performance_info
cisco.meraki.devices_appliance_radio_settings
cisco.meraki.devices_appliance_radio_settings_info
cisco.meraki.devices_appliance_uplinks_settings
cisco.meraki.devices_appliance_uplinks_settings_info
cisco.meraki.devices_appliance_vmx_authentication_token
cisco.meraki.devices_blink_leds
```

https://docs.ansible.com/ansible/latest/collections/cisco/meraki/index.html

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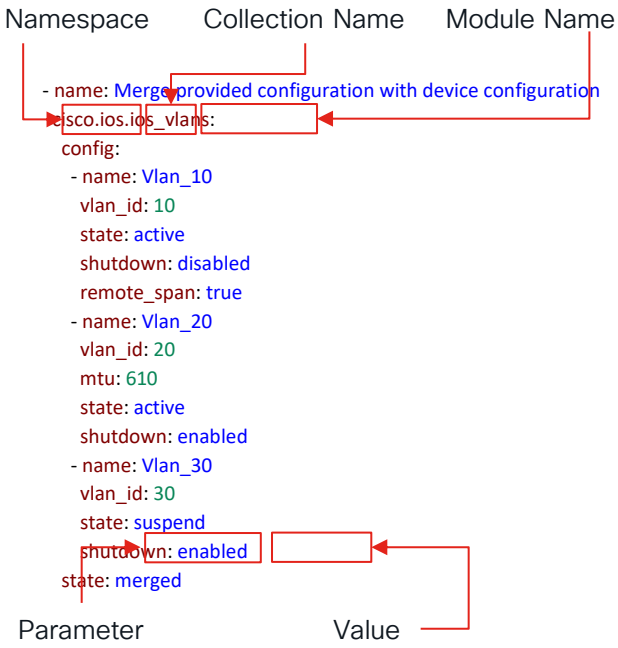
Modules

Used by tasks

- Always use the fully qualified name for the module.
- The modules require values assigned to the parameters that define how you wish to configure IOS XE.
- Documentation provides details as to default values and required values.
- No programming knowledge required. Just data structure build out.



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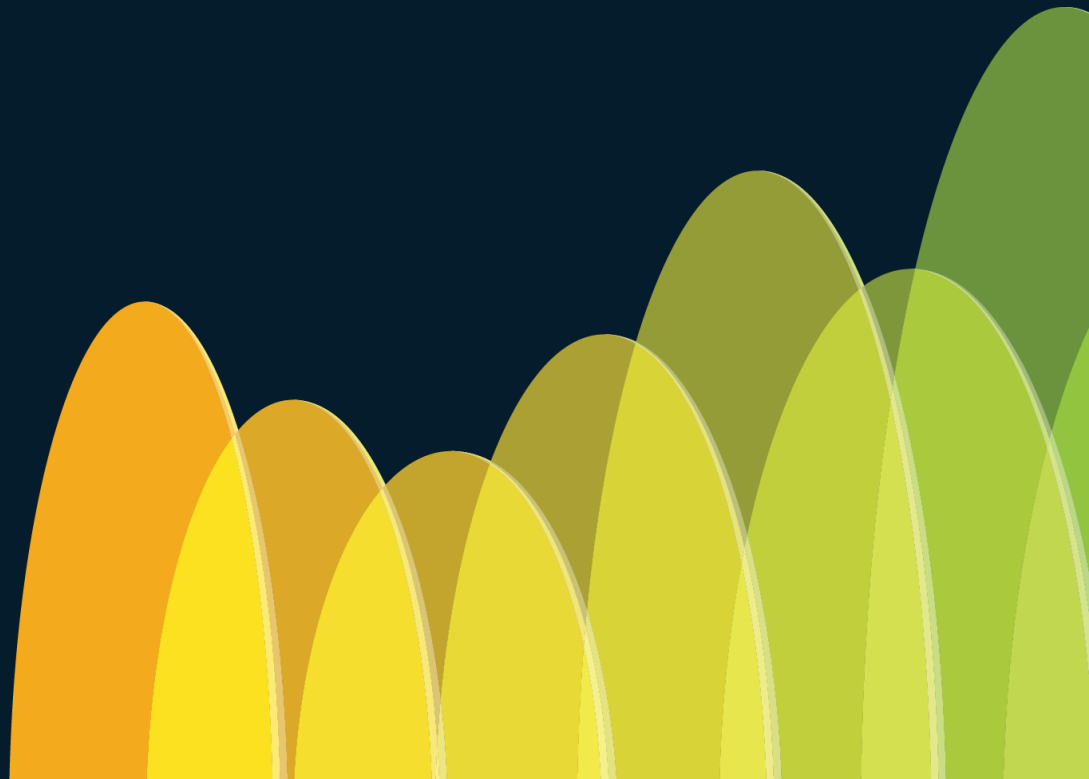
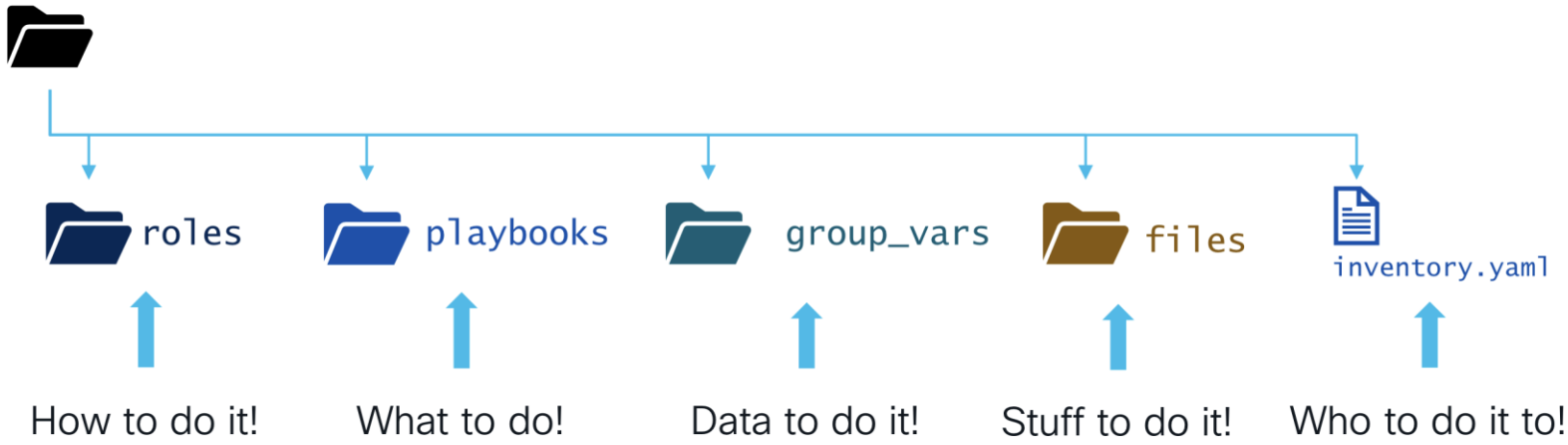
Ansible concepts



Ansible Directory Structure

Best Practice for Growth!



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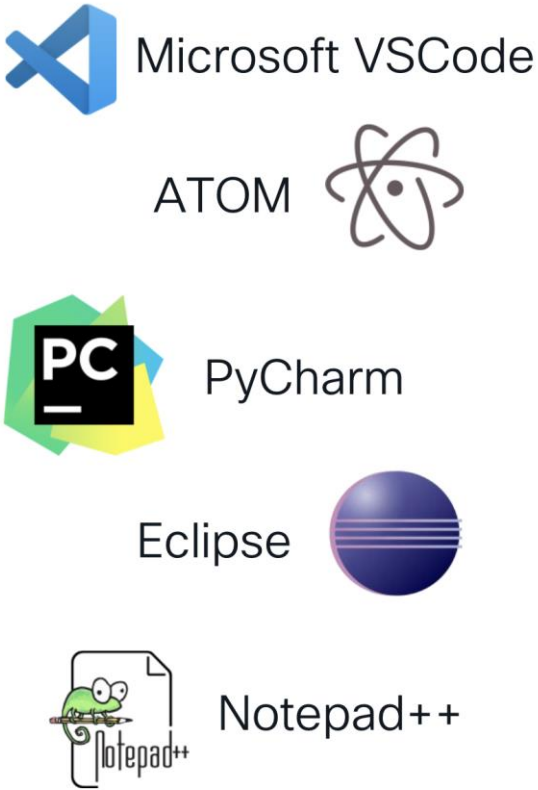
Ansible Data Structures

Yet Another Markup Language

- Human readable data serialization language
- Used in playbooks and inventory files
- Best practice is to use a software focused text editor (e.g. Notepad++) or IDE (e.g. Visual Studio Code) with language assistant support of YAML data structures
  - Indentation is very important and a proper editor will simplify this for you



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Ansible Roles

How to do it!

- Roles are content directories that are structured in a conventional way to enable simple reuse
- Roles let you automatically load related vars, files, tasks, handlers and other Ansible artifacts based on a known file structure
- This allows for better data organization in the repository
- You use roles to combine tasks to complete an objective

```
parallels:ansible_test$ ansible-galaxy init ospf_config
- Role ospf_config was created successfully
parallels:ansible_test$ ls -lR
.:
total 4
drwxrwxr-x 10 parallels parallels 4096 May 25 15:39 ospf_config

./ospf_config:
total 36
-rw-rw-r-- 1 parallels parallels 1328 May 25 15:39 README.md
drwxrwxr-x 2 parallels parallels 4096 May 25 15:39 defaults
drwxrwxr-x 2 parallels parallels 4096 May 25 15:39 files
drwxrwxr-x 2 parallels parallels 4096 May 25 15:39 handlers
drwxrwxr-x 2 parallels parallels 4096 May 25 15:39 meta
drwxrwxr-x 2 parallels parallels 4096 May 25 15:39 tasks
drwxrwxr-x 2 parallels parallels 4096 May 25 15:39 templates
drwxrwxr-x 2 parallels parallels 4096 May 25 15:39 tests
drwxrwxr-x 2 parallels parallels 4096 May 25 15:39 vars

./ospf_config/defaults:
total 4
-rw-rw-r-- 1 parallels parallels 36 May 25 15:39 main.yml

./ospf_config/files:
total 0

./ospf_config/handlers:
total 4
-rw-rw-r-- 1 parallels parallels 36 May 25 15:39 main.yml

./ospf_config/meta:
total 4
-rw-rw-r-- 1 parallels parallels 1635 May 25 15:39 main.yml

./ospf_config/tasks:
total 4
-rw-rw-r-- 1 parallels parallels 33 May 25 15:39 main.yml

./ospf_config/templates:
total 0

./ospf_config/tests:
total 8
-rw-rw-r-- 1 parallels parallels 11 May 25 15:39 inventory
-rw-rw-r-- 1 parallels parallels 70 May 25 15:39 test.yml

./ospf_config/vars:
total 4
-rw-rw-r-- 1 parallels parallels 32 May 25 15:39 main.yml
```

```
$ ansible-galaxy init <role-name>
```


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Ansible Playbooks

What to do!

- Playbooks define the set of actions that you want Ansible to complete
- Can contain specific tasks or reference roles that contain the tasks
  - Best practice is to use roles!

```
---
- name: Configure OSPF on IOS XE example
  hosts: iosxe
  gather_facts: false

  roles:
    - roles/ospf_config
```


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Ansible Inventory

Who to do it to!

- Ansible inventory allows you to build data structures that correlate host specific variables
- Allows for grouping and variable inheritance
- Two formats are common: INI and YAML. Best practice is to use YAML.

```
[iosxe]
10.10.20.175
10.10.20.176

[iosxe:vars]
ansible_network_os=ios
ansible_user=cisco
ansible_password=cisco
ansible_connection=network_cli
```


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Using Environment Variables

- Instead of inserting credentials that are very difficult to remove from a version control system (git) you can use environment variables.
- Set environment variables before ansible-playbook execution

```
[iosxe]
10.10.20.175
10.10.20.176

[iosxe:vars]
ansible_network_os=ios
ansible_user='{{ lookup("env", "IOSXE_USERNAME") }}'
ansible_password='{{ lookup("env", "IOSXE_PASSWORD") }}'
ansible_connection=network_cli
```

```
export IOSXE_USERNAME=cisco
export IOSXE_PASSWORD=cisco
```


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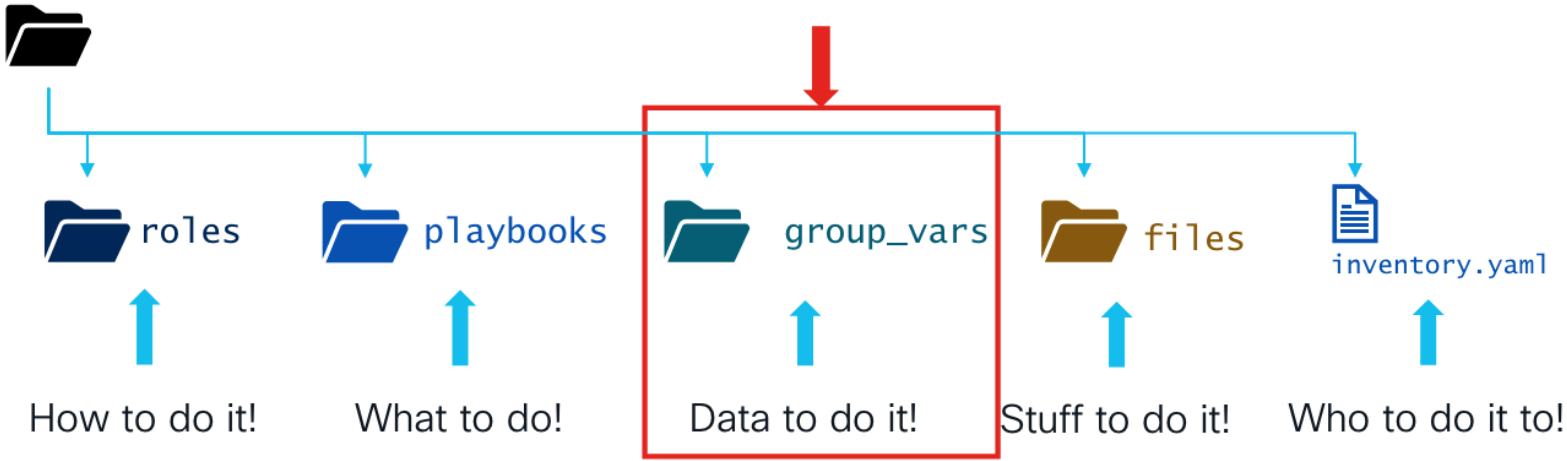
Better variables

Placement matters!

- Including the variables with the role can result in variable duplication
- A better approach is to move the variables to a location that can be structured with the inventory for better organization



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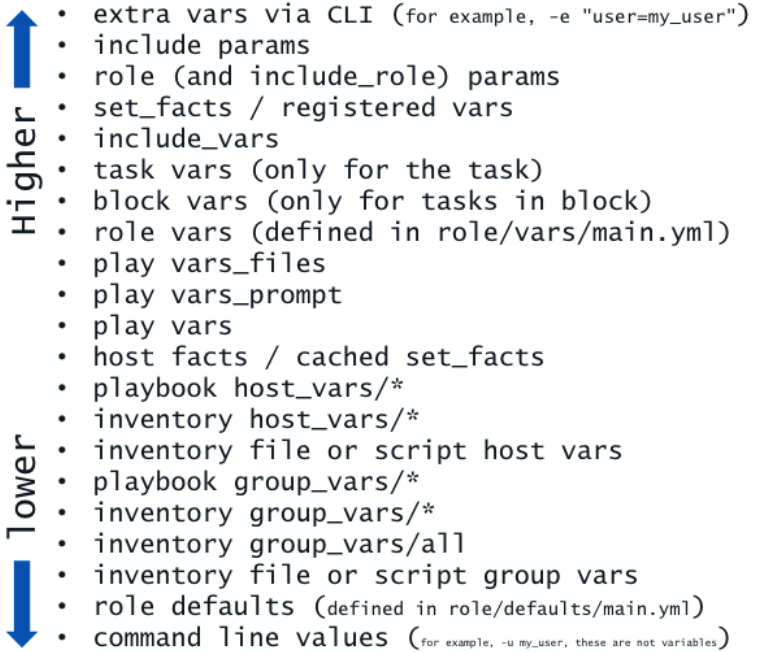
Ansible Variable Precedence

Placement matters!

- Ansible provides variable precedence, which is important when you build your data structure.
- This allows for having default behavior that is then changed by just including the variable in higher precedence.
- Using the **group_vars** folder tied to inventory is very useful.



https://docs.ansible.com/ansible/latest/playbook_guide/playbooks_variables.html

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Putting it all together

Ansible-playbook -i inventory/hosts-file playbooks/config_ospf.yaml

playbooks

```
---
- name: Configure OSPF on IOS XE example
  hosts: iosxe
  gather_facts: false

  roles:
    - roles/ospf_config
```

inventory

```
[iosxe]
10.10.20.175
10.10.20.176

[iosxe:vars]
ansible_network_os=ios
ansible_user='{{ lookup("env", "IOSXE_USERNAME") }}'
ansible_password='{{ lookup("env", "IOSXE_PASSWORD") }}'
ansible_connection=network_cli
```

group_vars

```
---
configure_ospf:
  - ospf_process_id: 1
    ospf_network_address: 172.16.252.0
    ospf_wildcard_bits: 0.0.3.255
    ospf_area: 0
  - ospf_process_id: 1
    ospf_network_address: 192.168.0.0
    ospf_wildcard_bits: 0.0.255.255
    ospf_area: 0
```

roles

```
---
- name: Role to remove OSPF configuration and reapply it

  tasks:
  - name: Delete all OSPF processes
    cisco.ios.ios_ospfv2:
      state: deleted

  - name: Configure OSPF V2 on IOS XE
    loop: "{{ configure_ospf }}"
    cisco.ios.ios_ospfv2:
      config:
        processes:
          - process_id: "{{ item.ospf_process_id }}"
            network:
              - address: "{{ item.ospf_network_address }}"
                wildcard_bits: "{{ item.ospf_wildcard_bits }}"
                area: "{{ item.ospf_area }}"
      state: present
```


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Terraform

What is Terraform?

- Business Source Licensing v1.1
- Infrastructure Provisioning
- Single Binary (Windows, Mac, Linux, Solaris, FreeBSD)
- Declarative and Stateful
- HashiCorp Configuration Language (HCL)
- REST API Interaction
- No programming knowledge required

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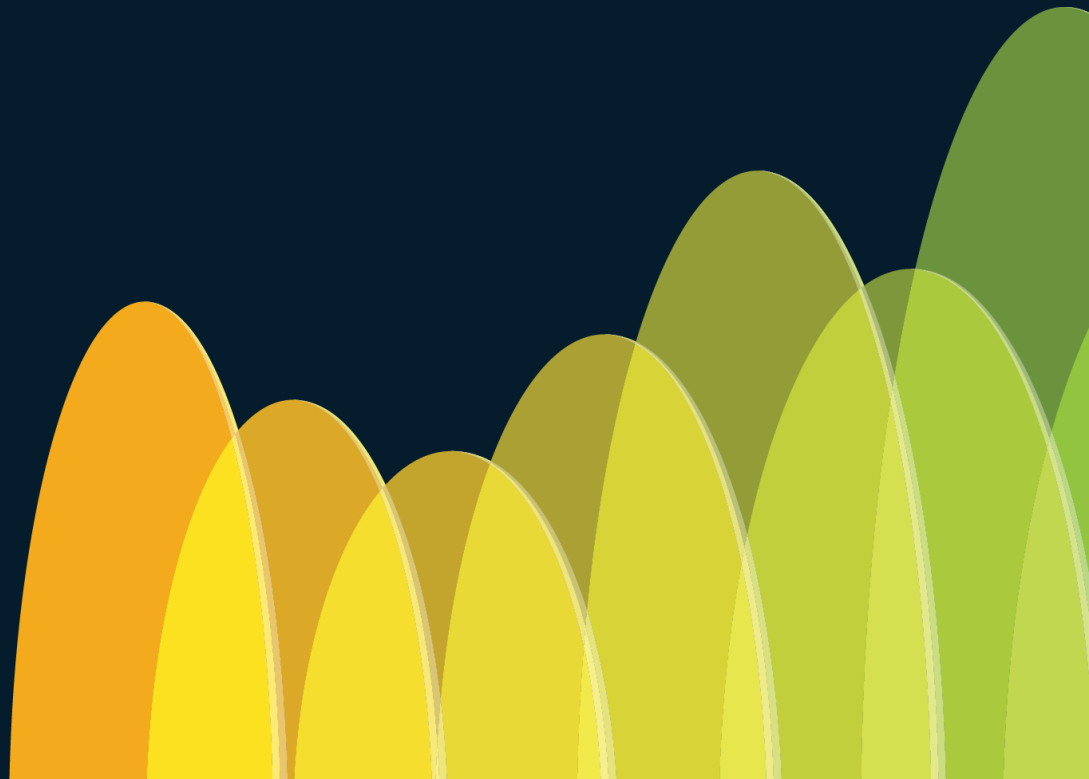
Terraform Concepts



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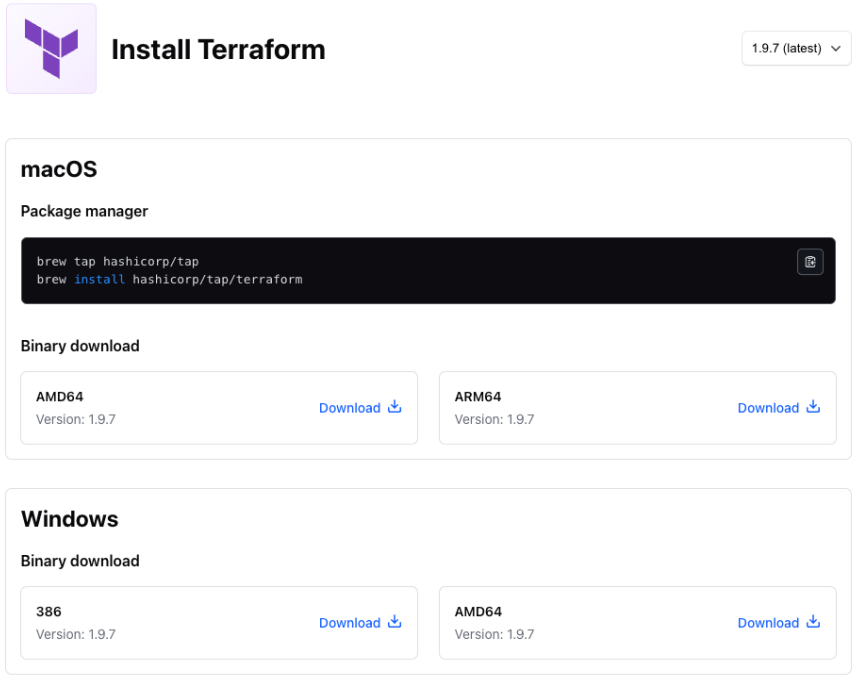
Terraform
(Version 1.9.7 - latest)

- Runs as single binary (Core)
- Command line executable
  - Reading configuration files
  - State management
  - Graph
  - Plan execution

Installation
https://developer.hashicorp.com/terraform/install



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Terraform providers

- Terraform binary doesn’t know Meraki/Catalyst Center/Catalyst SDWAN/IOS XE
- Relies on specific plugins
  - Downloaded dynamically via initialization (via terraform init command)
- Providers understand API interactions
  - Meraki, Catalyst Center, Catalyst SDWAN and IOS XE API calls

```
terraform {
        required_providers {
                iosxe = {
                        source = "CiscoDevNet/iosxe"
                        version = "0.5.5"
                }
        }
}
```


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Types of Terraform Providers

https://registry.terraform.io/namespaces/CiscoDevNet

```
terraform {
  required_providers {
    sdwan = {
      source = "CiscoDevNet/sdwan"
      version = "0.3.9"
    }
  }
}
```

```
terraform {
  required_providers {
    catalystcenter = {
      source = "CiscoDevNet/catalystcenter"
      version = "0.1.9"
    }
  }
}
```


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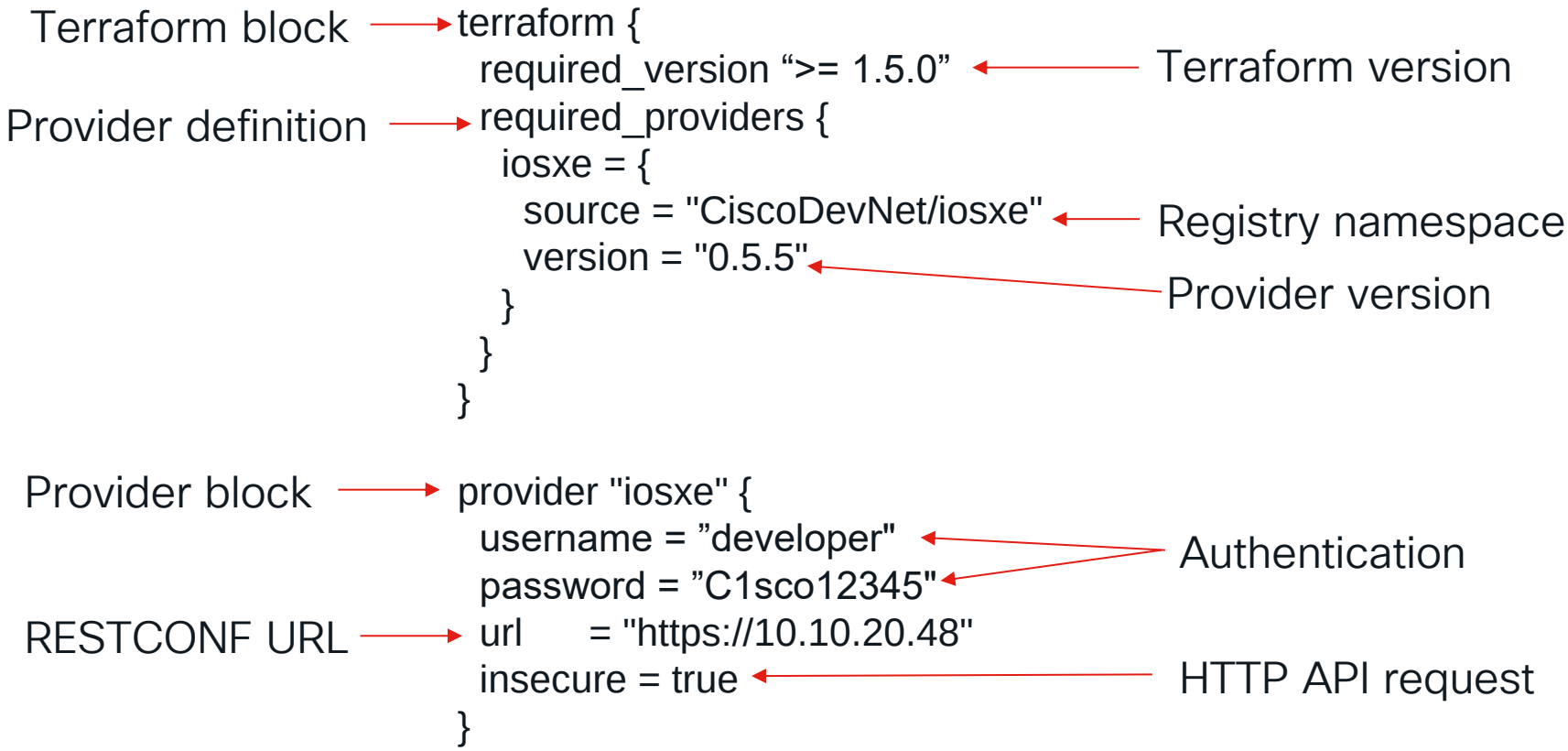
Terraform Provider configuration



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Terraform Resources & Data Sources

Resources

- Specific to a given provider
- apply/destroy/modifies infrastructure
- Accepts arguments
- Describes your intent for infrastructure

```
resource "iosxe_interface_vlan" "vlan_10" {
  name                  = 10
  autostate             = false
  description           = "Production data VLAN"
  shutdown              = false
}
```

Data Sources

- Allow data to be fetched or computed for use elsewhere in Terraform configuration
- Terraform apply/destroy does not modify data source

```
data "iosxe_interface_ethernet" "gi3" {
  type          = "GigabitEthernet"
  name          = "3"
}

data "iosxe_interface_vlan" "vlan_10" {
  name          = 10
}
```


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Terraform Plans/Configuration Files

- Collection of HCL instructions
  - What you want to provision (intent)
- .tf extension
  - Terraform scans directory
    - Directory that Terraform is run in
  - Can be a singular file – main.tf
  - Can be broken up into smaller *.tf files

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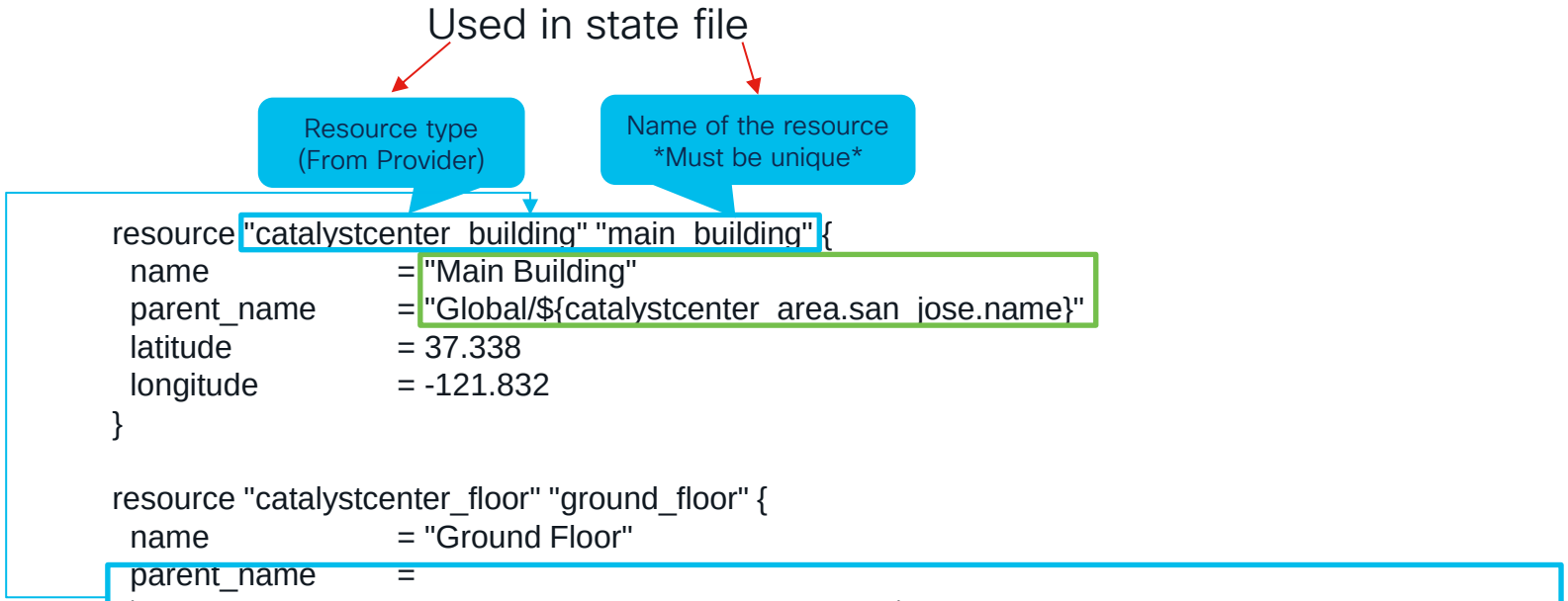
Terraform Configuration Example



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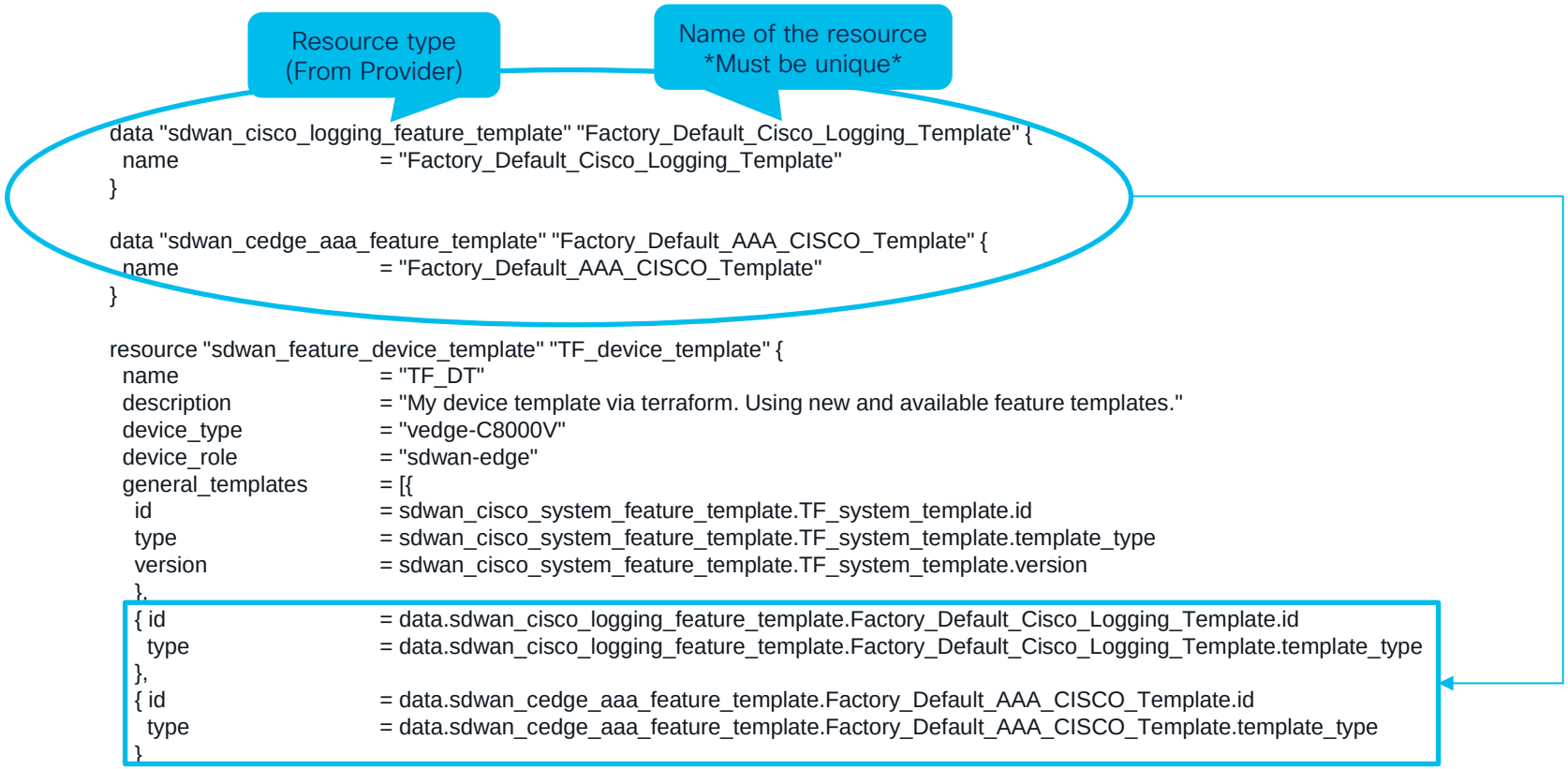
Terraform Data Source Example




```
data "sdwan_cisco_logging_feature_template" "Factory_Default_Cisco_Logging_Template" {
  name                       = "Factory_Default_Cisco_Logging_Template"
}

data "sdwan_cedge_aaa_feature_template" "Factory_Default_AAA_CISCO_Template" {
  name                       = "Factory_Default_AAA_CISCO_Template"
}

resource "sdwan_feature_device_template" "TF_device_template" {
  name                       = "TF_DT"
  description                = "My device template via terraform. Using new and available feature templates."
  device_type                = "vedge-C8000V"
  device_role                = "sdwan-edge"
  general_templates          = [{
    id                       = sdwan_cisco_system_feature_template.TF_system_template.id
    type                     = sdwan_cisco_system_feature_template.TF_system_template.template_type
    version                  = sdwan_cisco_system_feature_template.TF_system_template.version
    },
    { id                     = data.sdwan_cisco_logging_feature_template.Factory_Default_Cisco_Logging_Template.id
      type                   = data.sdwan_cisco_logging_feature_template.Factory_Default_Cisco_Logging_Template.template_type
    },
    { id                     = data.sdwan_cedge_aaa_feature_template.Factory_Default_AAA_CISCO_Template.id
      type                   = data.sdwan_cedge_aaa_feature_template.Factory_Default_AAA_CISCO_Template.template_type
    }
  ]
}
```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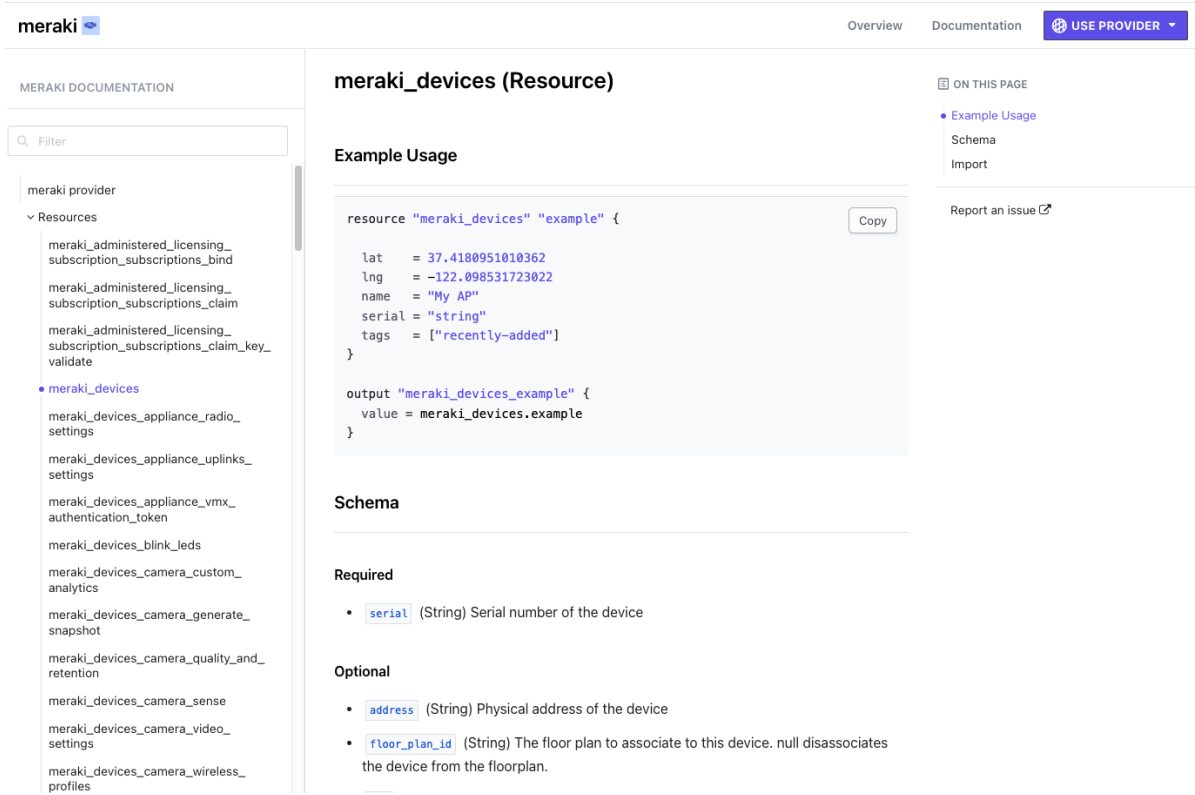
Terraform Registry – Documentation



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Terraform State

- Terraform is stateful
  - Tracks objects it builds (terraform.tfstate)
  - Source of everything it knows about
- Stored inside working directory
  - Can use backend – AWS, Terraform Cloud
  - Do not modify state file directly


```
{
  "version": 4,
  "terraform_version": "1.8.1",
  "serial": 1,
  "lineage": "f92f5848-b96b-acf6-1e92-10972bb456bb",
  "outputs": {},
  "resources": [
    {
      "mode": "data",
      "type": "iosxe_restconf",
      "name": "example",
      "provider": "provider[\"registry.terraform.io/ciscodevnet/iosxe\"]",
      "instances": [
        {
          "schema_version": 0,
          "attributes": {
            "attributes": {
              "poe-module": "[\n      {\n        \"module\": 1,\n        \"available-power\": \"370.0\",\n        \"used-power\": \"0.0\",\n        \"remaining-power\": \"370.0\",\n        \"chassis-num\": 1,\n
\"power-pool-idx\": 1,\n        \"num-ports\": 24,\n        \"used-ports\"
```


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Brownfield Infrastructure

- Import Infrastructure for Terraform to manage
  - Import CLI command
  - import blocks (version 1.5)

```
terraform import iosxe_static_route.static_route "Cisco-IOS-XE-native:native/ip/route/ip-route-interface-forwarding-list=10.20.0.0,255.255.255.0”
```

```
import {
 id = "Cisco-IOS-XE-native:native/interface/GigabitEthernet=3"
 to = iosxe_interface_ethernet.gi3
}
import {
 id = "Cisco-IOS-XE-native:native/interface/Vlan=10"
 to = iosxe_interface_vlan.vlan10
}
```


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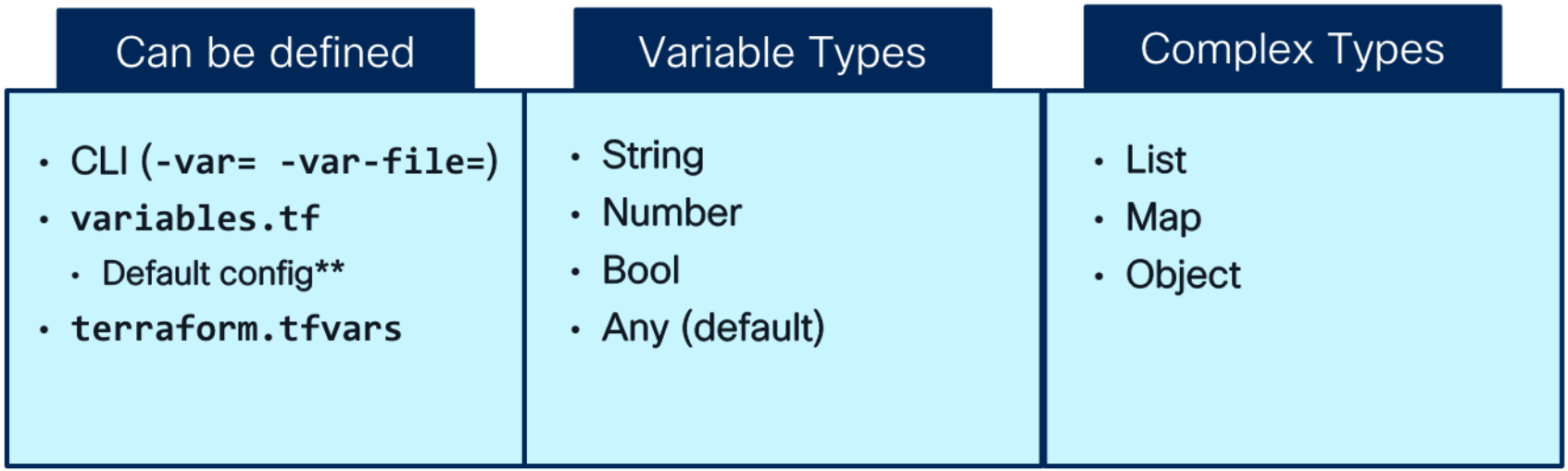
Variables in Terraform

- Value substitution – makes code reusable



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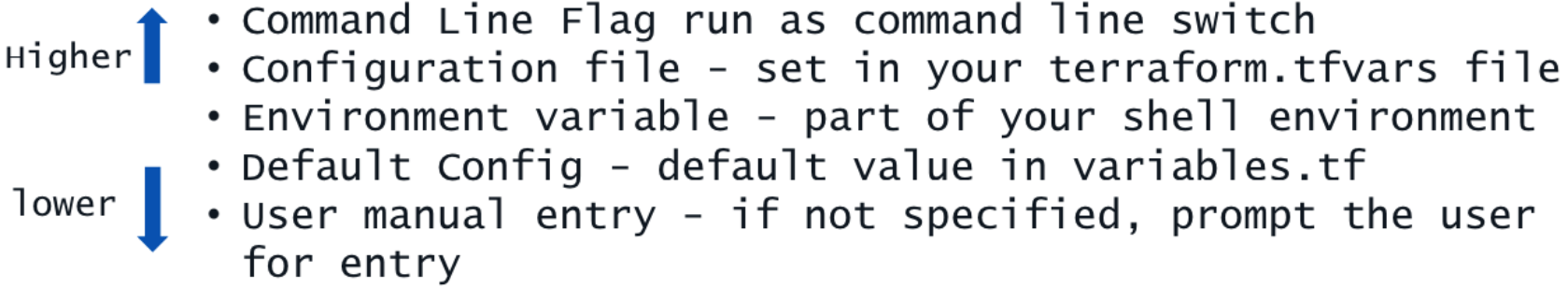
Terraform Variable Precedence

- Variables have precedence
- Variables can be set, but overridden



https://developer.hashicorp.com/terraform/language/values/variables

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Terraform – CLI commands

terraform init

- Download and Install plugins for configured providers
- Must initialize before plan/apply
- Creates a provider “lock” file

terraform plan

- Scans the current directory for the configuration (.tf & .tfvars extensions)
- Determines what actions are necessary to achieve the desired state
- Preview your changes – no changes made

terraform apply

- Scans the current directory for the configuration (.tf & .tfvars files)
- Preview your changes (can bypass with –auto-approve)
- Applies the configuration to targets (upon approval “yes”)

terraform destroy

- Scans the state file for what to ”destroy”
- Preview your deletions
- Infrastructure is destroyed
- Can be specific with “-target”

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Terraform – CLI commands

terraform fmt

- Formats Terraform configuration files in directory

terraform show

- Show the state file in a readable format
- Can also read a specific state file (path)

terraform state

- Advanced State Management
- **show <resource>** – shows a particular resource
- **list** – lists all resources in current state file
- **rm <instance>** – remove an instance from the state file
- **mv** – move an item. Good for renaming resources

terraform validate

- Verifies correctness of Terraform configuration files (*.tf)
- Checks syntax
- Can be used to solve configuration errors

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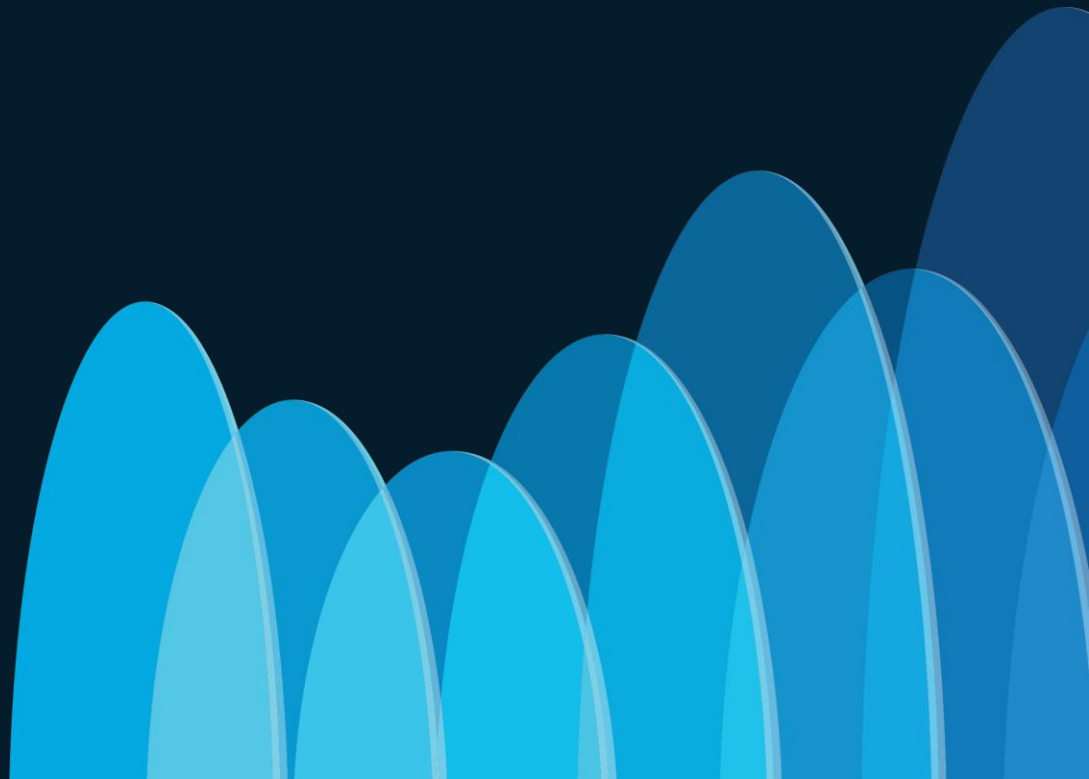
Ansible and Terraform Comparison



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Ansible/Terraform comparison

Source	Open Source	Business Source Licensing
IaC Type	Configuration Management	Provisioning
Language Type	Procedural	Declarative
Stateful	No	Yes
Written in	Python	Go
Cisco commitment	Yes	Yes

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Cisco Ansible Collections

Collections in the Cisco Namespace

These are the collections with docs hosted on docs.ansible.com in the **cisco** namespace.

- cisco.aci
- cisco.asa
- cisco.dnac
- cisco.intersight
- cisco.ios
- cisco.iosxr
- cisco.ise
- cisco.meraki
- cisco.mso
- cisco.nxos
- cisco.ucs

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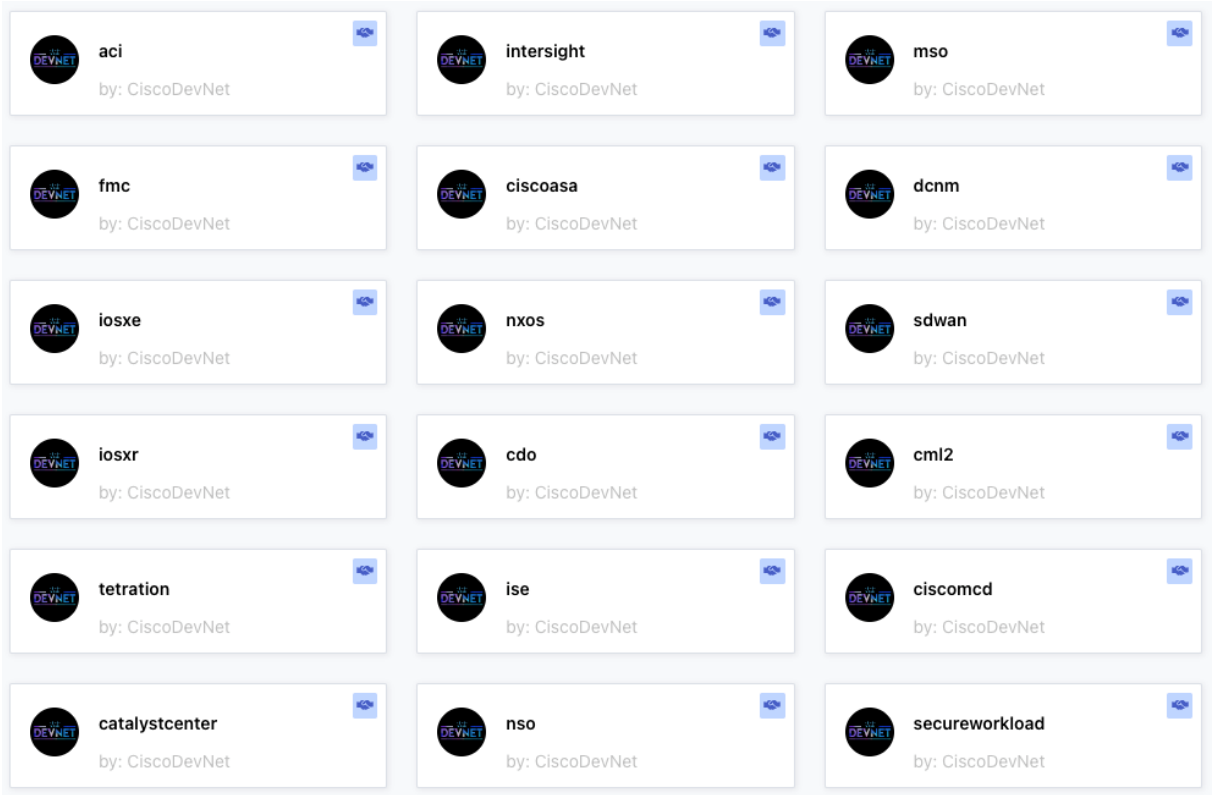
Cisco Terraform Providers



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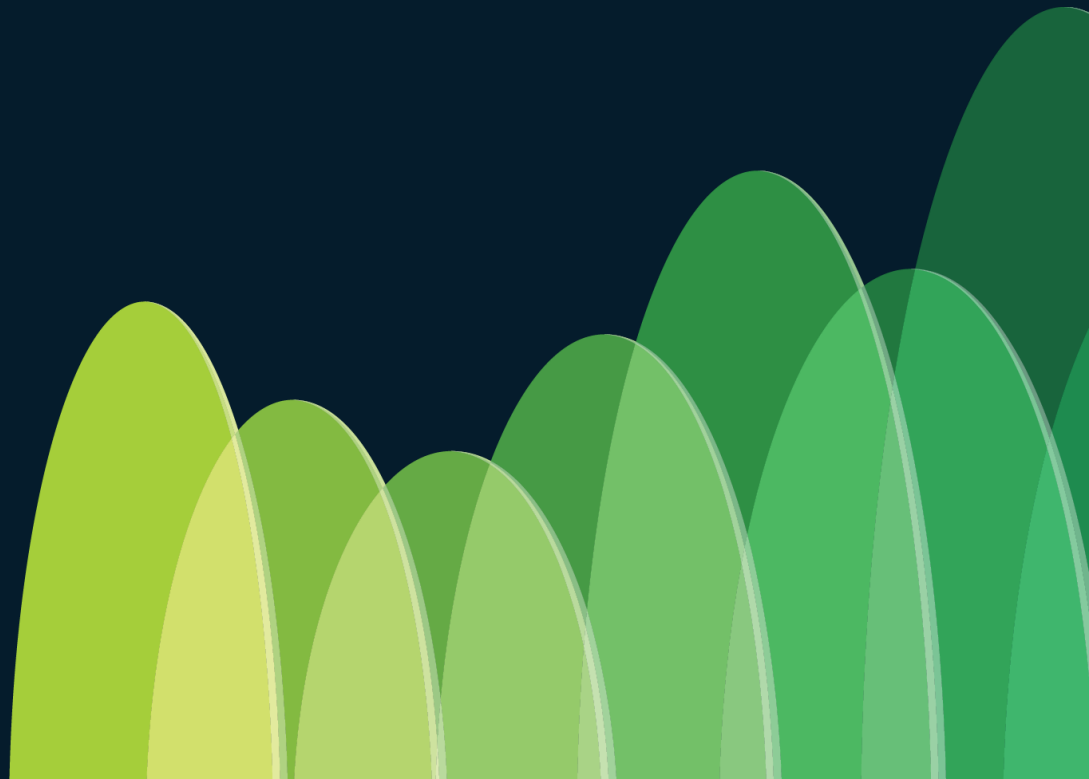
Next Steps



Infrastructure as Code with Terraform and Ansible

- Install and test Terraform and Ansible
  - Available for most platforms
  - Which one works better for you?
  - What are you currently using?
- Think big...start small
  - Automate the simple, then build into more complex tasks
- Ease of writing Infrastructure as Code with Terraform and Ansible
  - No special programming skills needed
- Ansible Modules/Terraform Resources for most common tasks
- Robust REST APIs make automation easy and scalable

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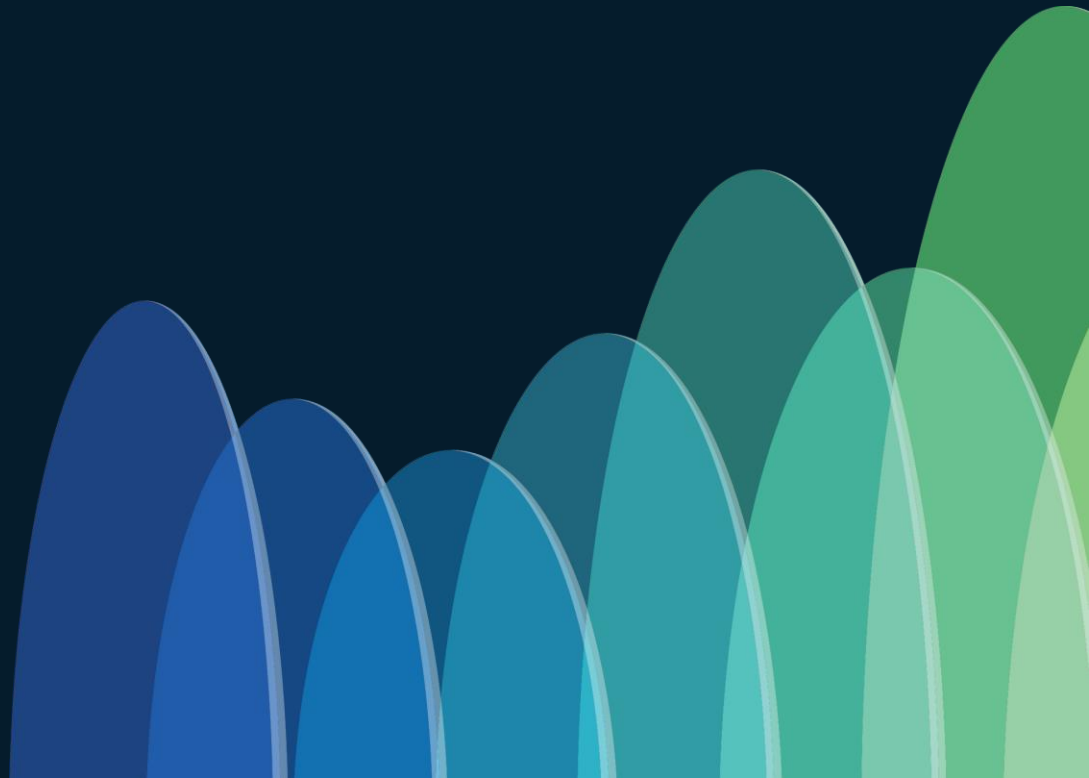
Resources



More information – Ansible/Terraform

- https://www.terraform.io/
- https://www.ansible.com/
- https://developer.cisco.com/automation-terraform/
- https://registry.terraform.io/namespaces/CiscoDevNet
- https://docs.ansible.com/ansible/latest/collections/cisco/index.html

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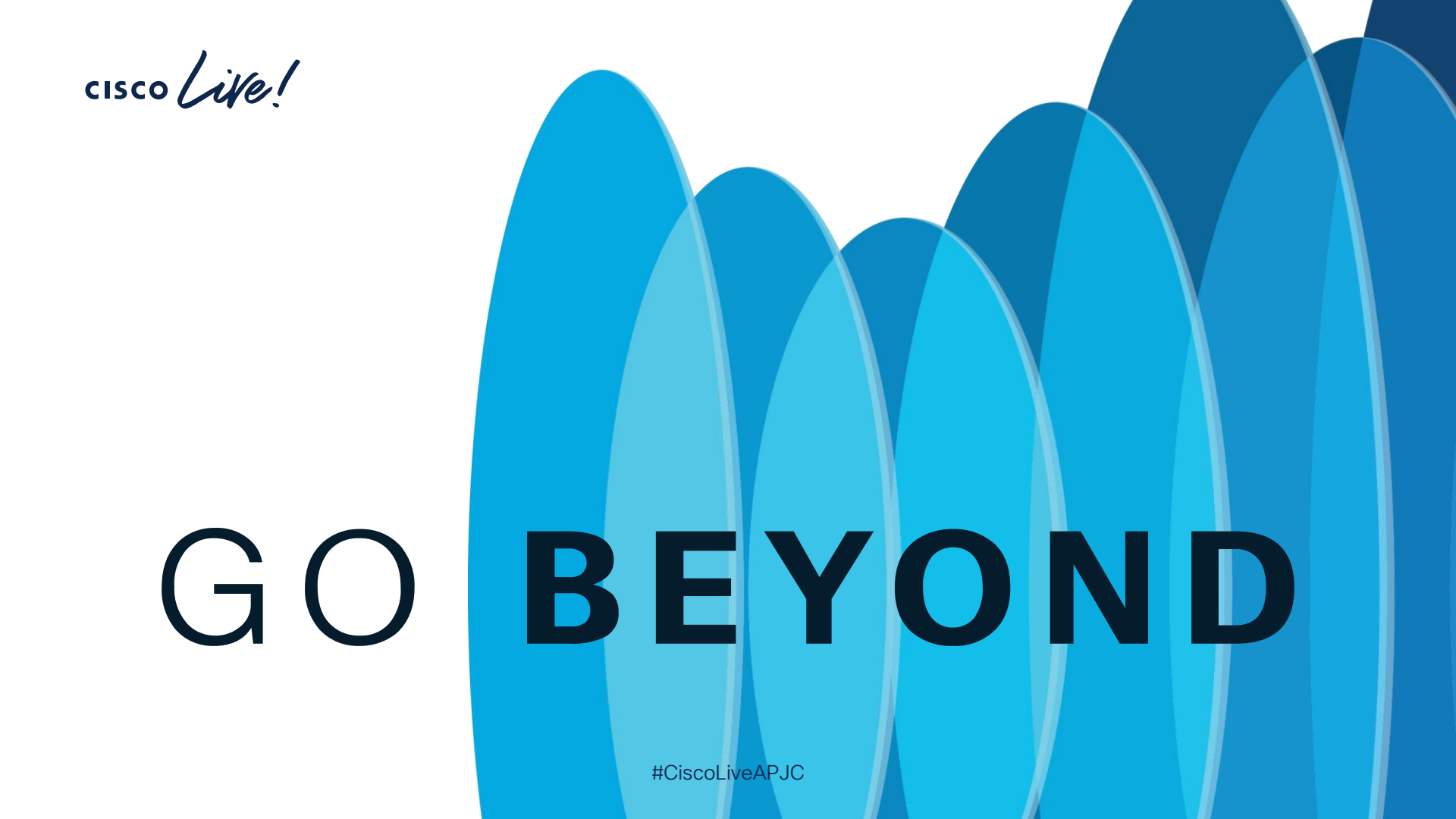
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