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The bridge to possible

Infrastructure as Code (IAC)

with Catalyst 9000

Story DeWeese, Technical Marketing Engineer
@Story DeWeese

DEVNET-2119

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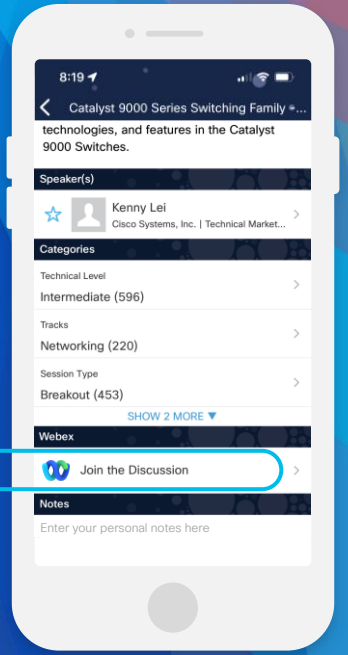
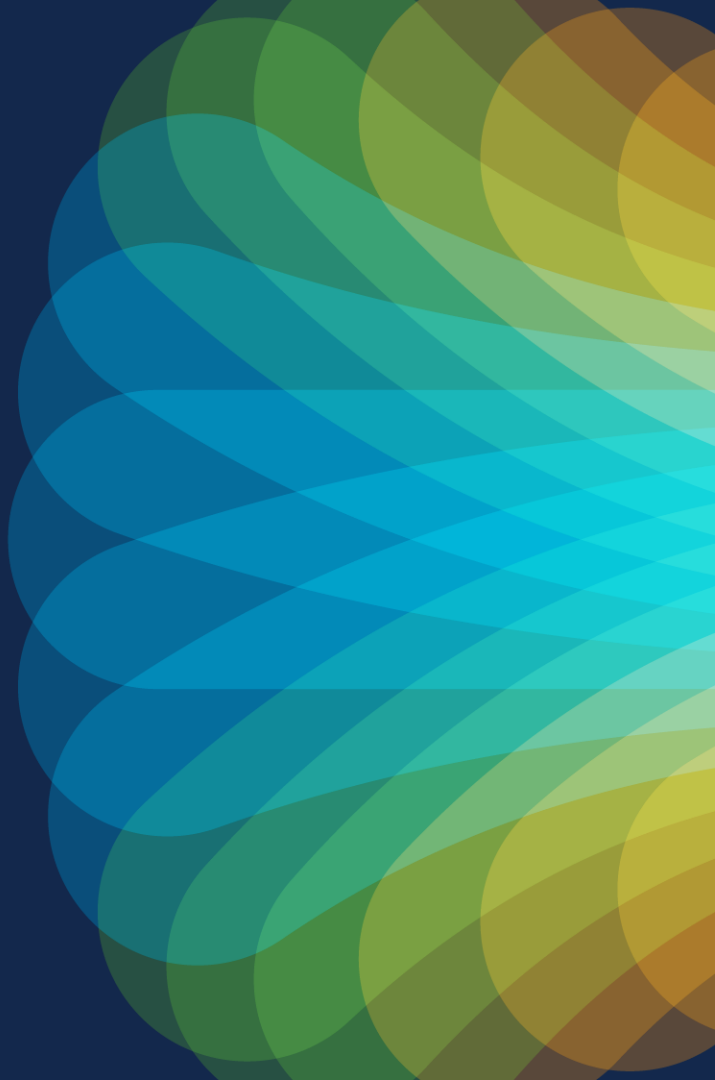


https://ciscolive.ciscoevents.com/ciscolivebot/#DEVNET-2119

Agenda

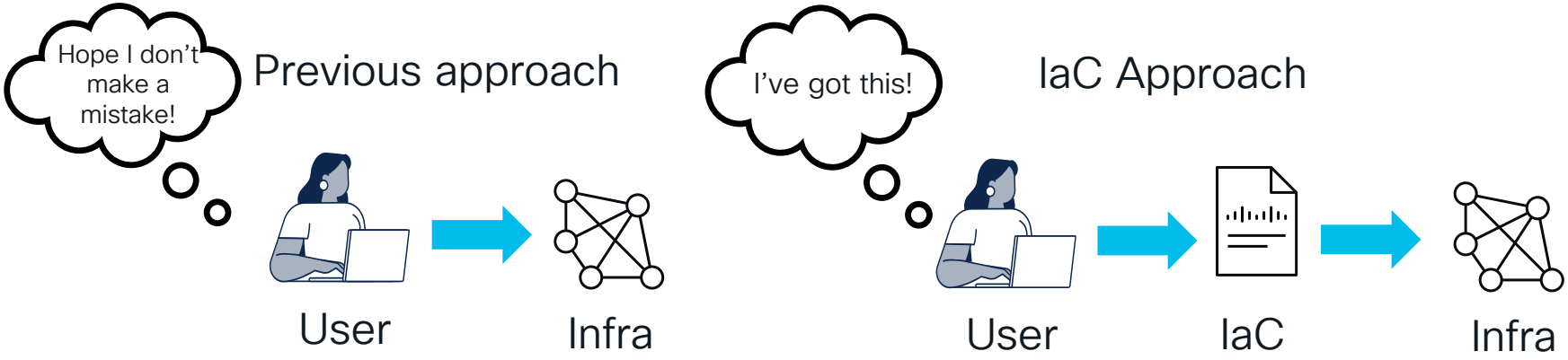
- Introduction to IAC and Terraform
- Using the IOS XE Terraform Provider
- Getting Started
- Use Cases & Demos
- Resources

Intro to AIC and Terraform



What's IaC?

Infrastructure as Code (IaC) is the process of managing changes through code, rather than a manual process



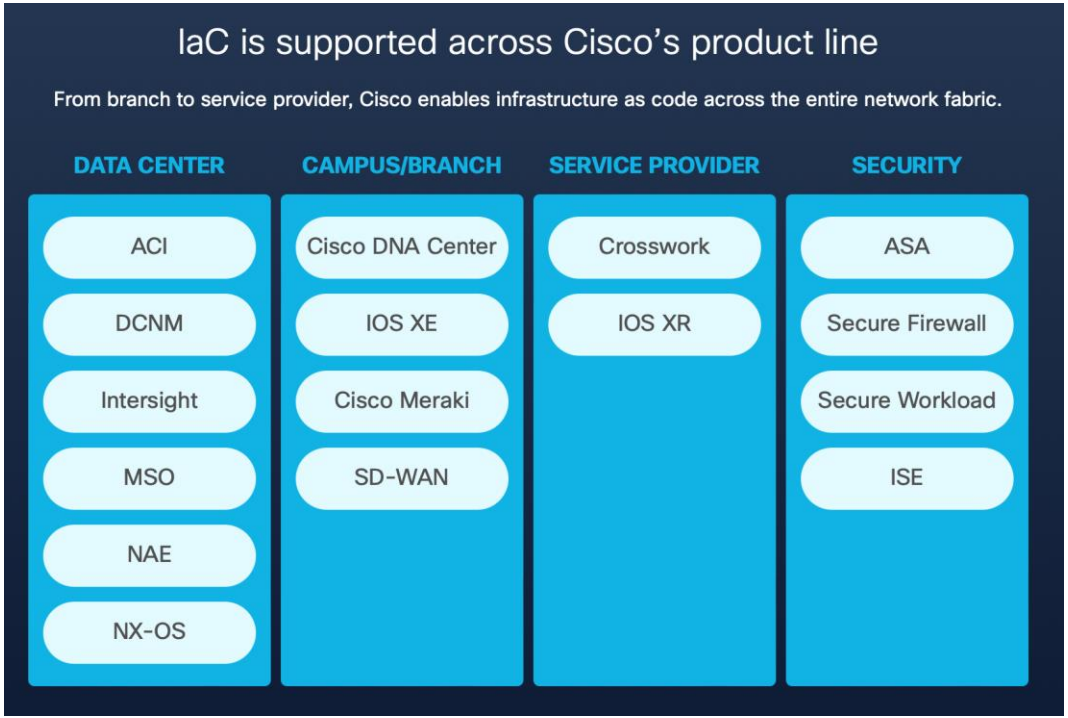
Learn more about IaC here:
https://developer.cisco.com/iac/#:~:text=Adopting%20Infrastructure%20as%20Code%20allows,data%20center%20to%20the%20edge.

Terraform One Slide

- **HCL** (HashiCorp Configuration Language) – Establishes the syntax Terraform uses for things like arguments, blocks, literal values, and expressions, and writing plans.
- **Provider** – Plugins responsible for understanding API interactions with other platforms and exposing resources based on their APIs.
- **Data Source** – Allows Terraform to use (read) information defined outside of Terraform. Example: providers, local-only
- **Resource** – Are the most important element in the Terraform language. Each resource block describes one or more infrastructure objects – devices, interfaces, operations.
- **Init** – The command is used to initialize a working directory containing Terraform configuration files. This is the first command that should be run, and it is safe to run this command multiple times. It will install the required providers and modules.
- **Plan** – compares the managed infrastructure state to the configuration, and it determines which changes are necessary. It presents a human-readable summary to the user.
- **Apply** – Makes changes to real infrastructure in order to make it match the desired state. It may use saved plans or creates a new plan and asks for approval.

Ref: https://www.terraform.io/docs

Where can I use IaC?



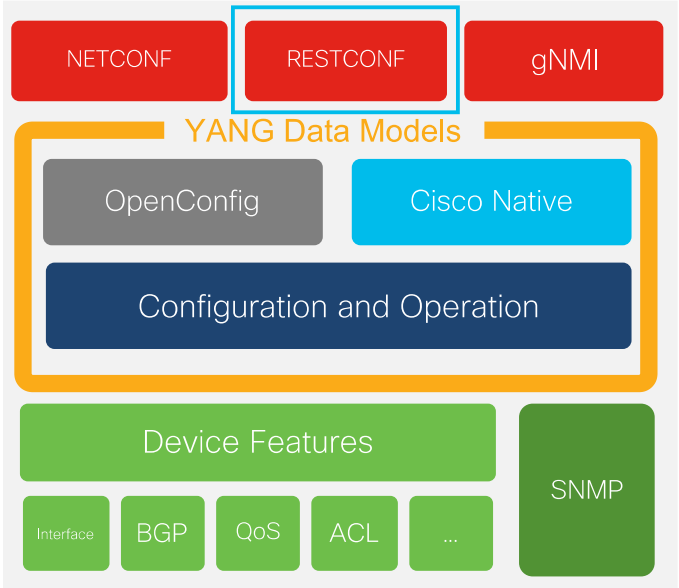
Terraform is...

Open-source Infrastructure as Code (IaC) Software Tool providing a consistent CLI workflow to manage hundreds of cloud services. Terraform codifies cloud APIs into declarative configuration files.

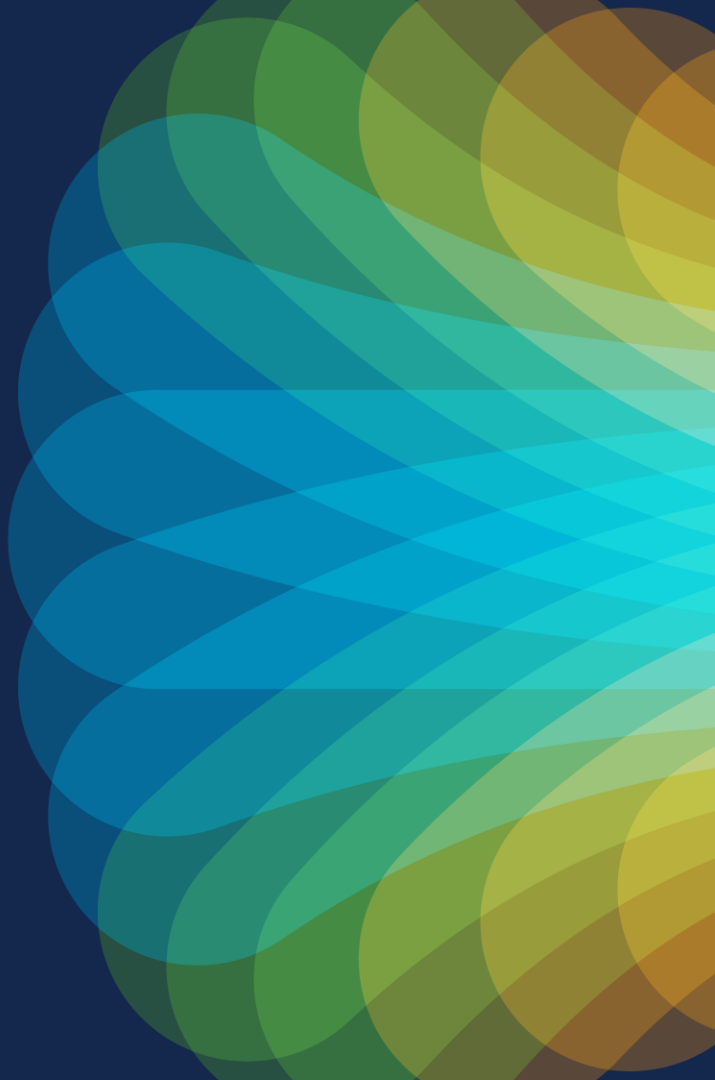
- Cloud Native Tooling circa 2014 from HashiCorp
- Agentless, single binary file
- Zero server-side dependencies

Resources:
Ask IOS XE Terraform Provider Webex space: https://eurl.io/#PtsT8eJFI
GitHub Provider Examples: https://github.com/CiscoDevNet/terraform-provider-iosxe/
Provider Binary: https://registry.terraform.io/search/providers?namespace=CiscoDevNet
Go Client: https://github.com/CiscoDevNet/iosxe-go-client
Blogs at https://blogs.cisco.com/tag/terraform

Terraform uses the RESTCONF API



Using the IOS XE Terraform Provider



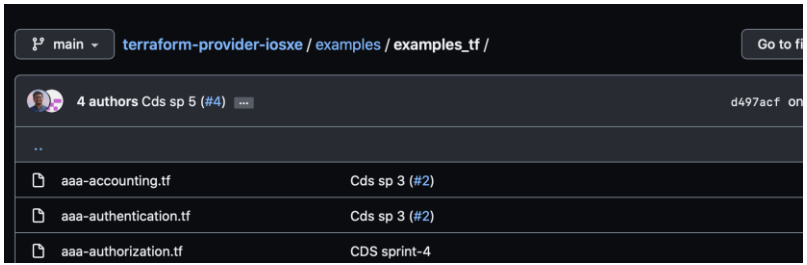
IOS XE Programmability integration with Terraform

Terraform is supported on all IOS XE platforms

Phase I: *imperative* for 100% feature coverage (available today) The following features are delivered:

- This Terraform provider is a generic REST resource for IOS XE RESTCONF YANG
- Hashicorp Config Language (HCL) support for management of IOS XE
- RESTCONF operations for PUT/PATCH/POST etc still must be followed for iterative management
- Examples and JSON mappings for top features are shared in GitHub
- Any feature supported by RESTCONF/YANG is supported iteratively by this Terraform provider

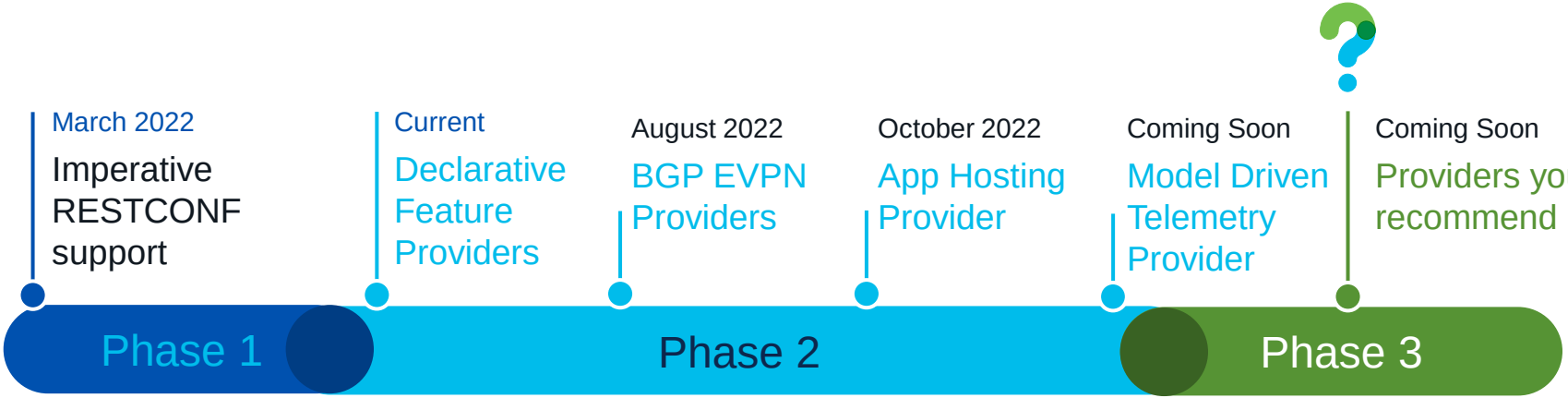
L3 subinterface	Authentication AAA	IGMP
VLAN	MDT	IPsec
Voice VLAN Trunk	SPAN and RSPAN	NAT
VTP	SNMP	NTP
Line	CDP	HSRP
ACL	EtherChannel	DHCP
RADIUS	OSPF	Ethernet Management
Accounting AAA	BGP	Port
Authorization AAA	IGMP Proxy	POE



Resources:
GitHub Provider Examples: https://github.com/CiscoDevNet/terraform-provider-iosxe/
Provider Binary: https://registry.terraform.io/search/providers?namespace=CiscoDevNet
Go Client: https://github.com/CiscoDevNet/iosxe-go-client
Blogs at https://blogs.cisco.com/tag/terraform

Phase II: new *declarative* features

Evolution of Terraform Provider



Declarative providers leverage the SDK from the Phase 1 imperative provider

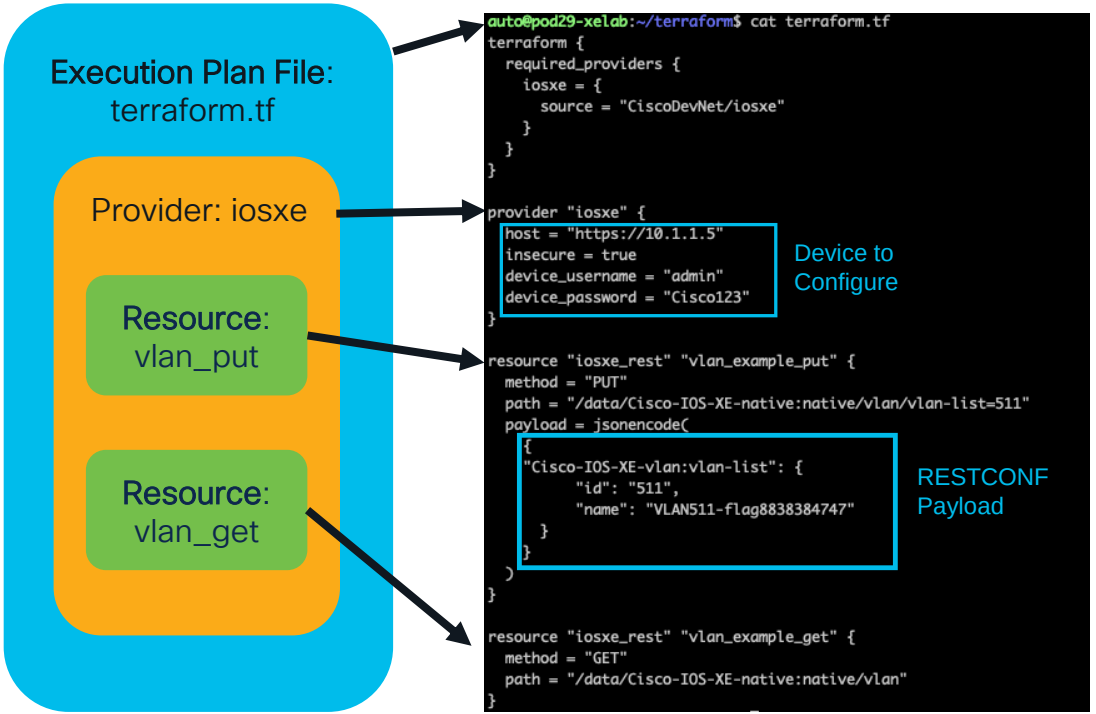
Terraform Terminology

Terraform uses an execution plan file with a provider and resource definitions.

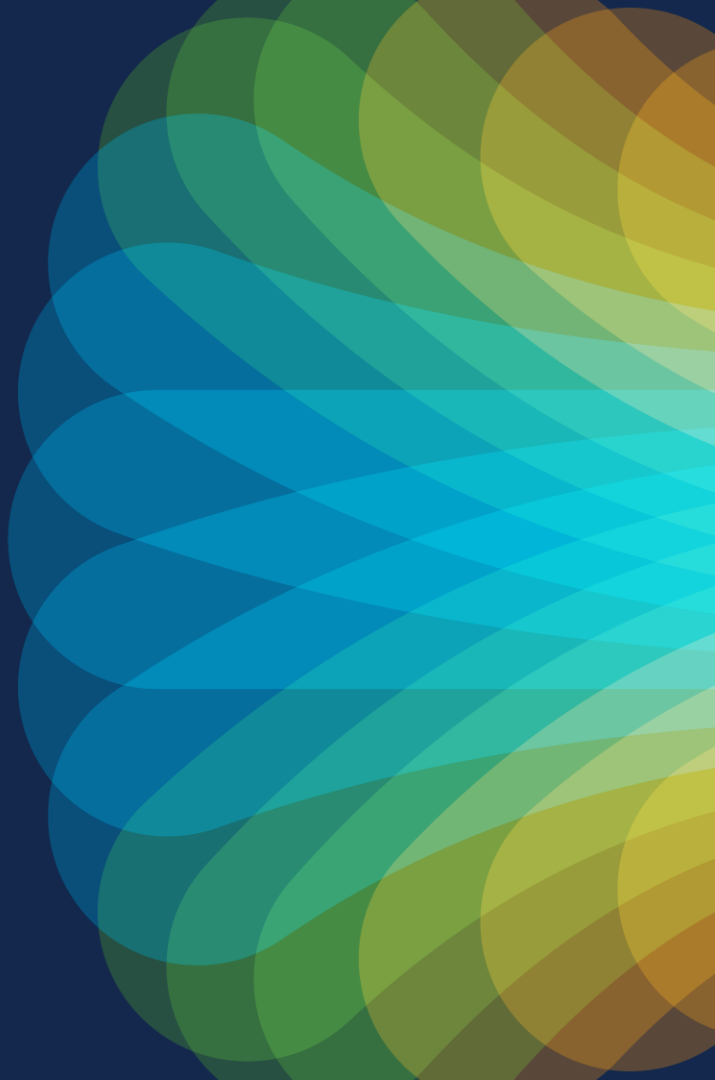
An **execution plan file** defines the provider and resources. It is written in HashiCorp Configuration Language (HCL), similar to JSON, and stored with a .tf extension

A **provider** is a plugin to make a collection of resources accessible

A **resource** (or infrastructure resource) describes one or more infrastructure objects managed by Terraform. With the IOS XE Terraform provider, resources can be considered the same as a configurable feature



Getting Started



Prerequisites: Enable AAA, NETCONF & RESTCONF

```
Cat9k-1#conf t
Enter configuration commands, one per line.  End with
CNTL/Z.
Cat9k-1(config)#aaa new-model
Cat9k-1(config)#aaa authentication login default local
Cat9k-1(config)#aaa authorization exec default local
Cat9k-1(config)#username admin privilege 15 password cisco

Cat9k-1(config)#netconf-yang

Cat9k-1(config)#restconf
```

Enable AAA

Enable NETCONF

Enable RESTCONF

Getting Started with Terraform + IOS XE Provider

1. Enabling the RESTCONF API on the switch

```
Switch# conf t
Switch(config)# restconf
```

2. Install Terraform

```
$ apt install terraform
```

3. Clone the IOS XE Terraform Provider GitHub repository

```
$ git clone https://github.com/CiscoDevNet/terraform-provider-iosxe
```

4. Apply Terraform VLAN example

```
$ terraform apply acl_and_vlan.tf
```

CLI to YANG

This new CLI addition to “show run | format” brings additional visibility into the YANG modelled configuration, either for NETCONF with XML or JSON with RESTCONF
Easily convert CLI into YANG to re-use in tooling, scripts, and automation and orchestration systems

```
show run | format netconf-xml
show run | format restconf-json
```

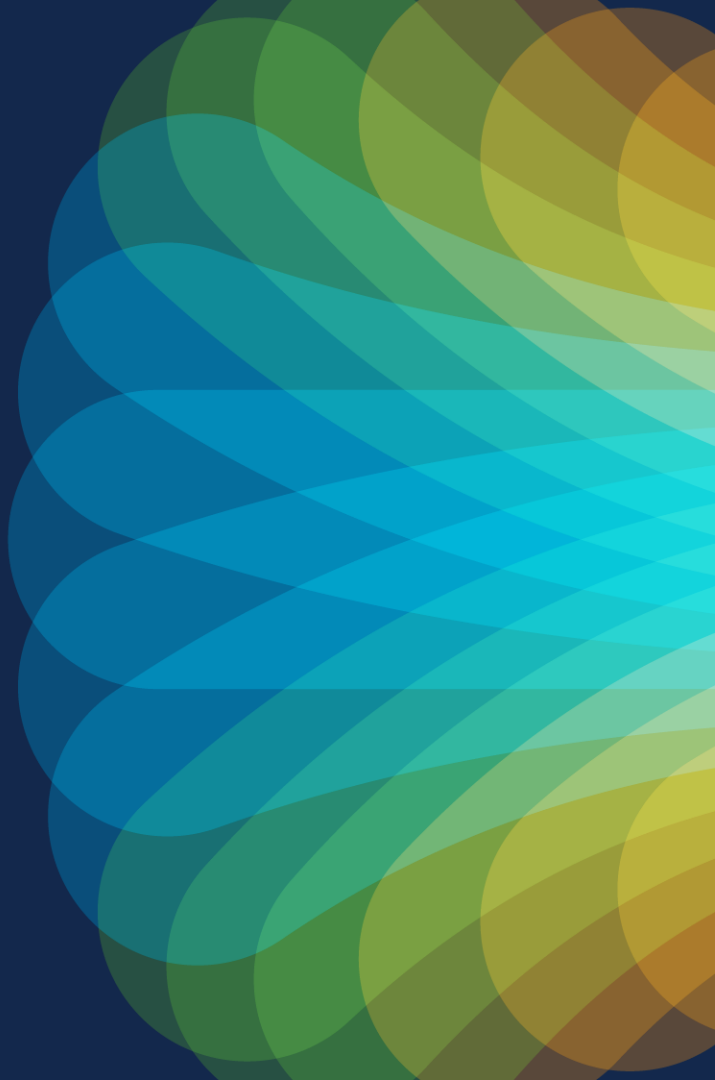
```
C9300#show run | format netconf-xml
<config xmlns="http://tail-f.com/ns/config/1.0">
  <native xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-native">
    <version>17.7</version>
    <memory>
      <free>
        <low-watermark>
          <processor>131752</processor>
        </low-watermark>
```

```
C9300#show run | format restconf-json
{
  "data": {
    "Cisco-IOS-XE-native:native": {
      "version": "17.7",
      "memory": {
        "free": {
          "low-watermark": {
            "processor": 131923
```

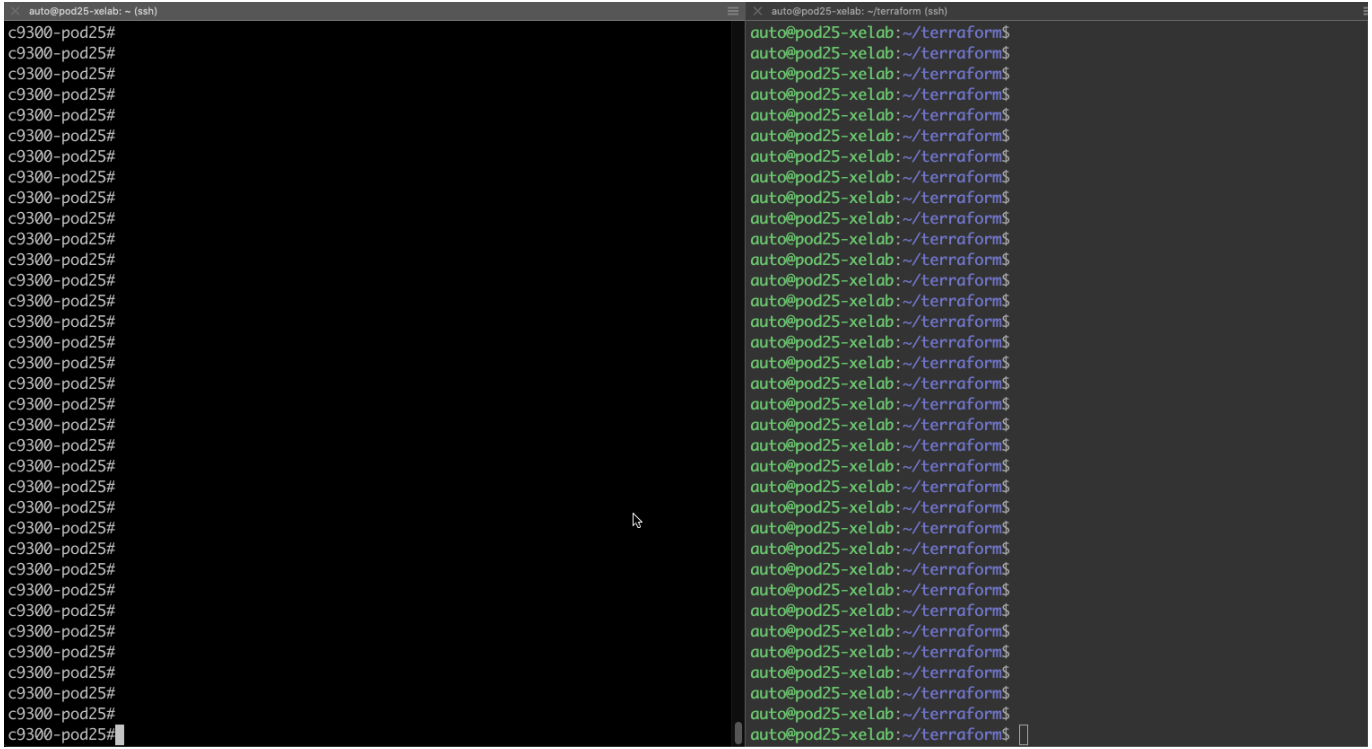
```
C9300#
C9300#show run | i netconf-yang
netconf-yang
C9300#
```


Requires `netconf-yang` Data Model Interfaces to be enabled
CLIs with corresponding native YANG and modeled in show run are returned

Use Cases & Demos

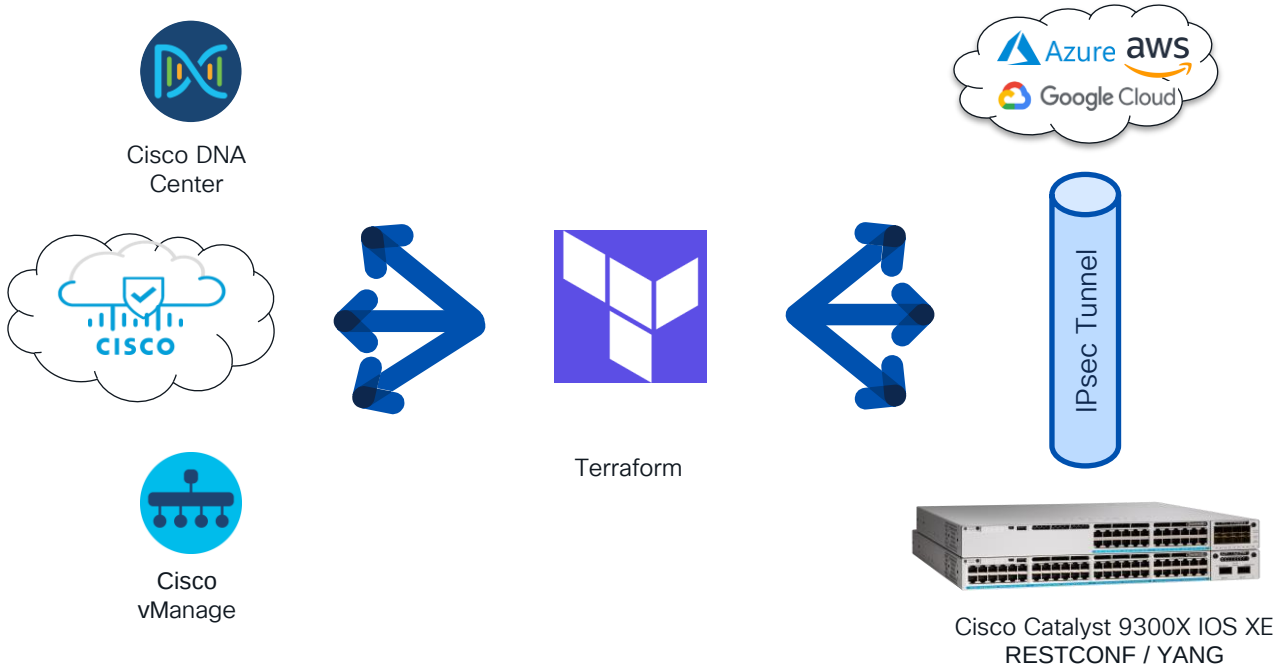


Configure ACL & VLAN

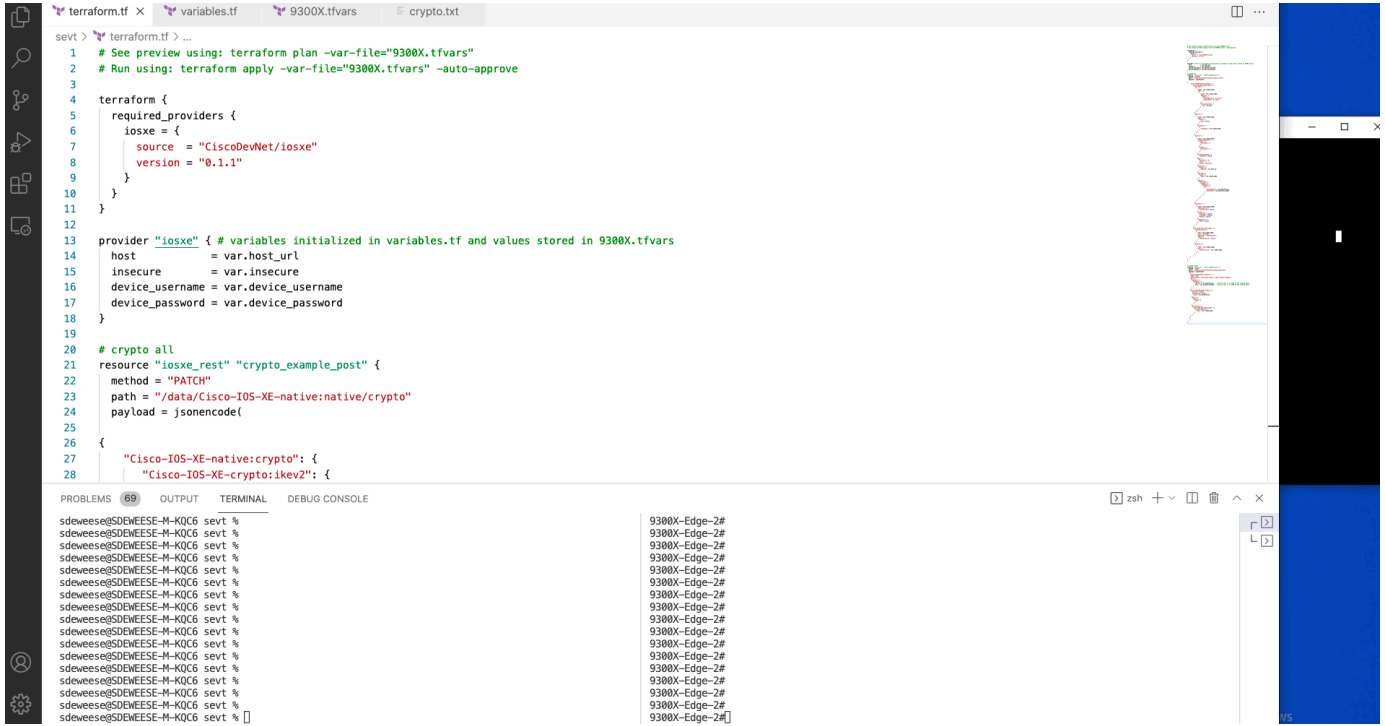


https://github.com/CiscoDevNet/terraform-provider-iosxe/tree/main/examples/tutorials/acl_and_vlan

What can Terraform do?



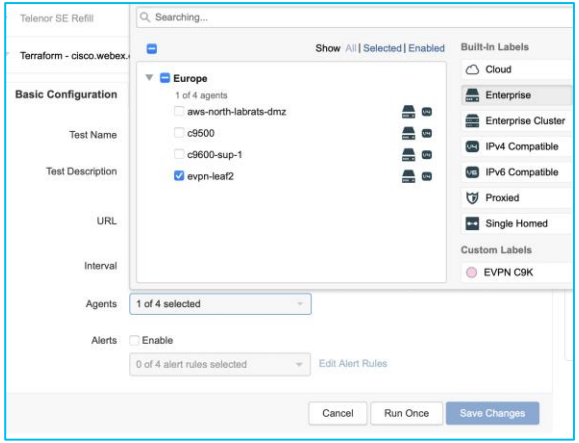
Terraform + Crypto IPsec Demo



Terraform ThousandEyes lifecycle management

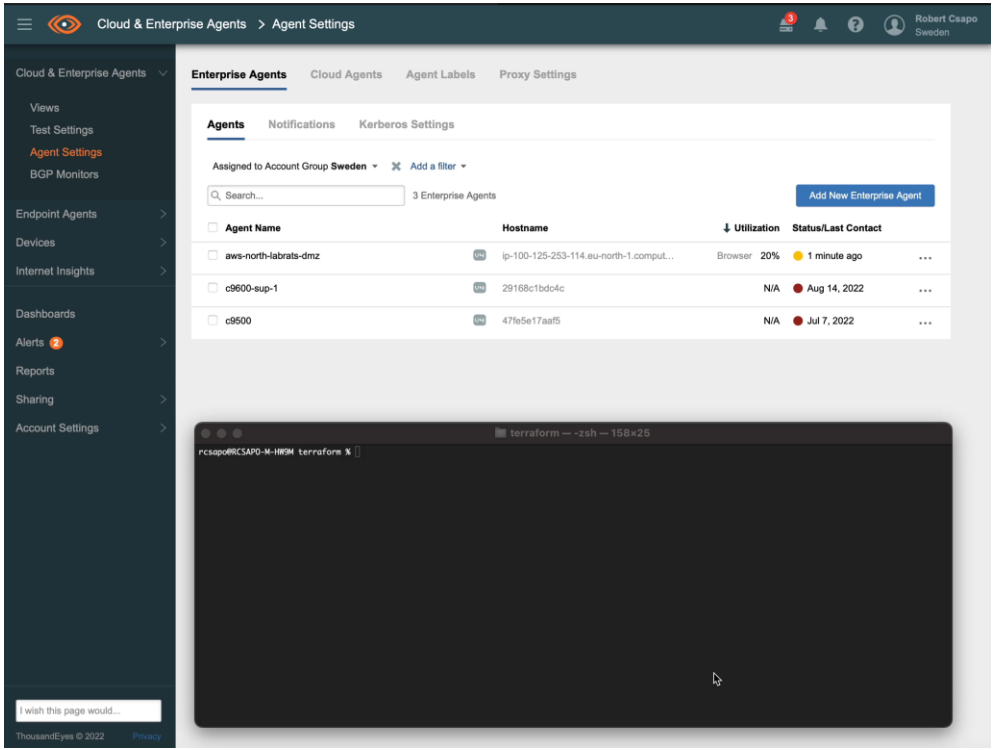
1. Deploy TE agent on switch Catalyst 9000
2. Pass variables including the the Agent ID to the ThousandEyes API
3. Create test and attach the Catalyst 9000 TE Agent ID to the test
4. Trigger test to run

```
terraform {
  required_providers {
    ciscoapphosting = {
      source  = "robertcsapo/ciscoapphosting"
      version = "1.0.0"
    }
  }
}

provider "ciscoapphosting" {
  username = var.username
  password = var.password
  insecure = var.insecure
  timeout  = var.timeout
}

resource "ciscoapphosting_app" "app" {
  host = "127.0.0.1"
  image = "https://downloads.thousandeyes.com/enterprise-agent/thousandeyes-enterprise-agent-4.2.2.cisco.tar"
  app_gigabit_ethernet = "1/0/1"
  vlan_trunk = false
  vlan = 1
  env = {
    TEAGENT_ACCOUNT_TOKEN = "token"
  }
}
```



https://github.com/robertcsapo/terraform-provider-ciscoapphosting
https://registry.terraform.io/providers/robertcsapo/ciscoapphosting/

Terraform + ThousandEyes Demo

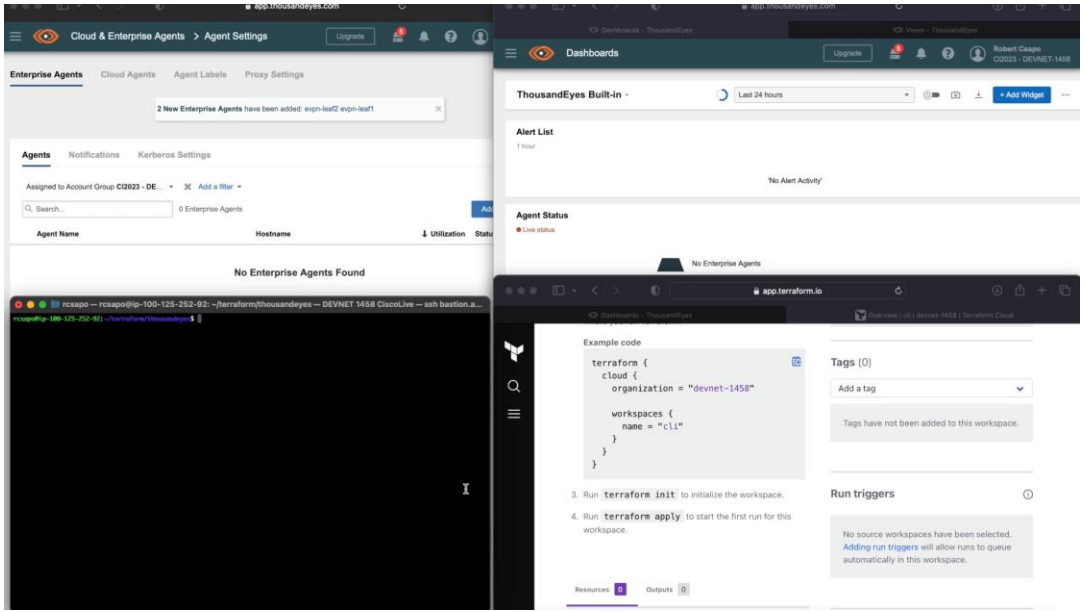


Steps:

1. Test App Hosting Terraform Provider
2. Apply App Hosting Terraform Provider on C9300 switches
3. Verify new Enterprise Agents has been added in ThousandEyes Dashboard
4. Run the current test
5. Destroy Terraform to delete the Enterprise Agents and Test

Multihost example:
https://github.com/robertcsapo/terraform-provider-ciscoapphosting/tree/main/examples/thousandeyes-multihosts

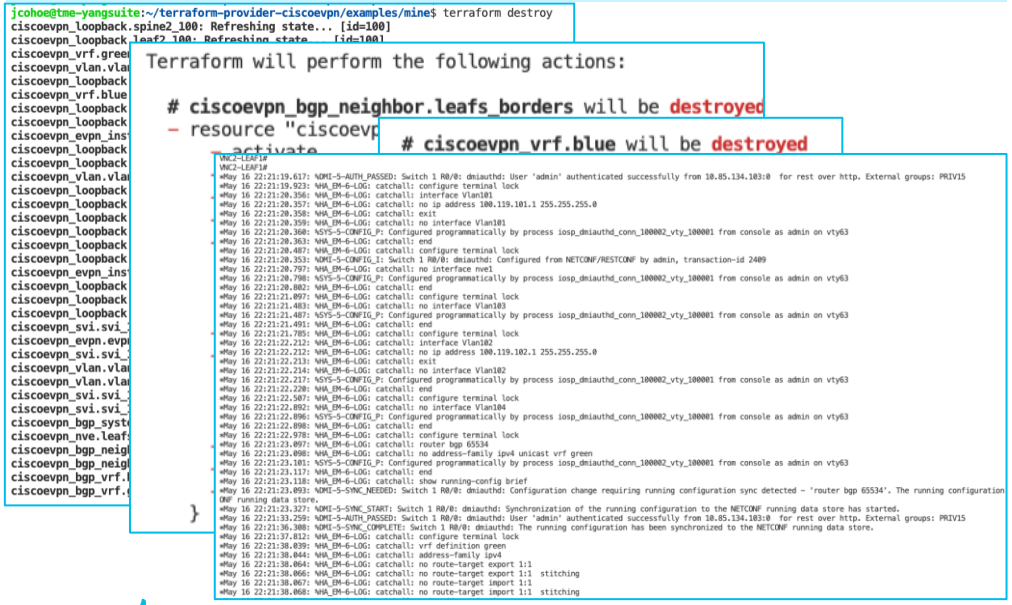
Terraform + ThousandEyes Demo #2

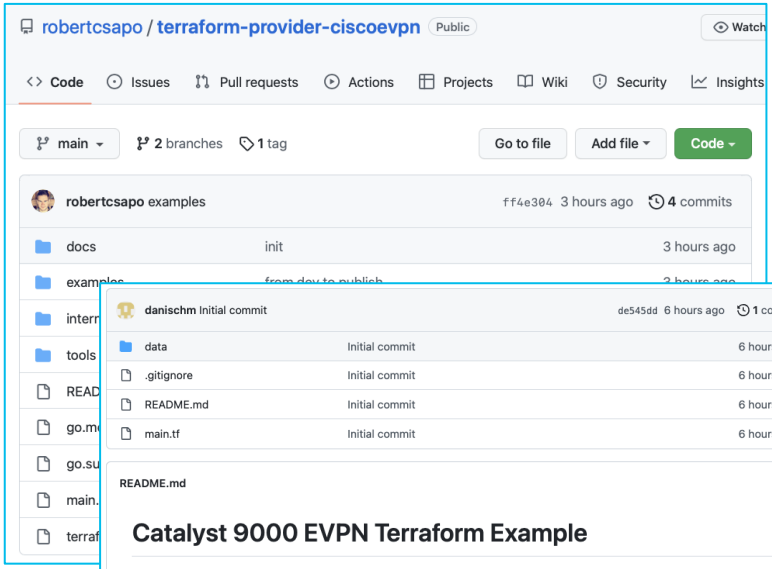


Declarative EVPN management with Terraform

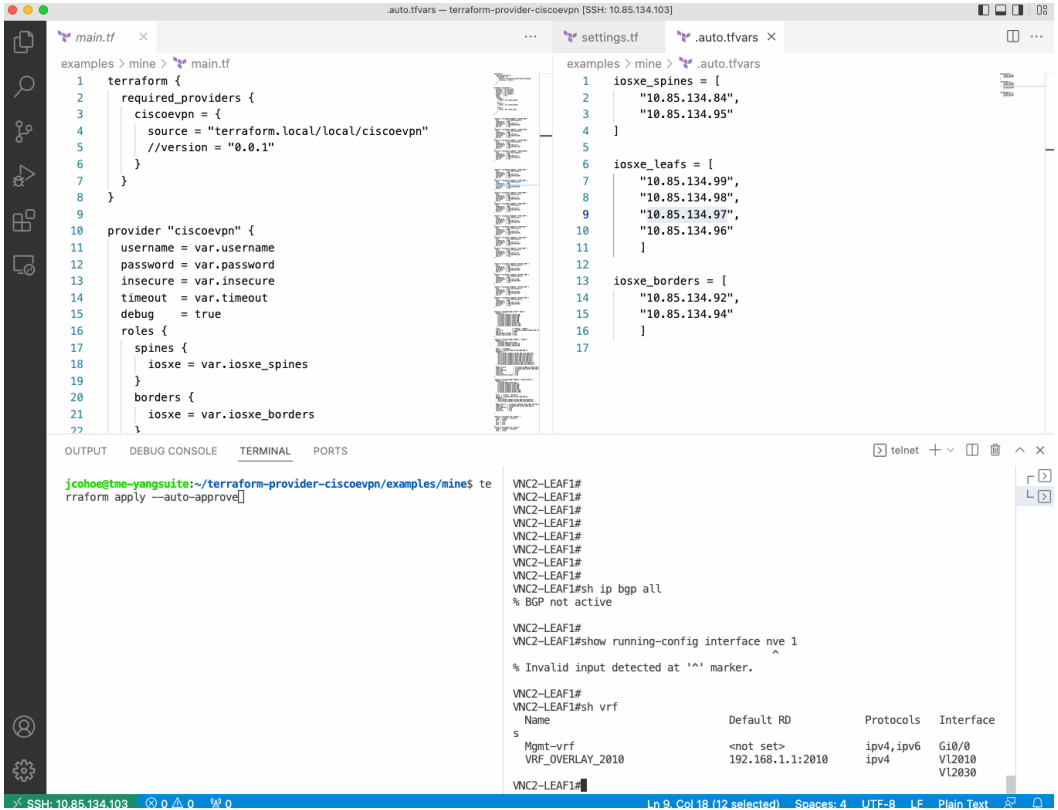
Both Declarative providers leverage the ios-xe-go client that was developed in Terraform Phase 1:

Robert: https://github.com/robertcsapo/terraform-provider-ciscoevpn/
https://registry.terraform.io/providers/robertcsapo/ciscoevpn/latest
Daniel: https://github.com/netascode/terraform-iosxe-evpn-example
EVPN OSPF Underlay Module: https://registry.terraform.io/modules/netascode/evpn-ospf-underlay/iosxe/latest
EVPN Overlay Module: https://registry.terraform.io/modules/netascode/evpn-overlay/iosxe/latest





EVPN with Terraform Demo

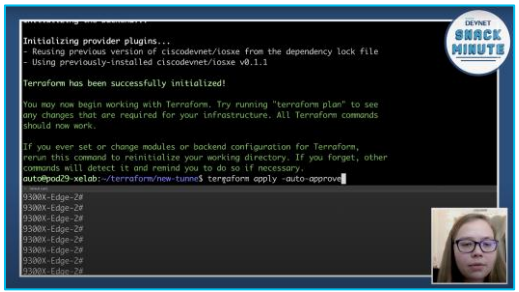


Resources

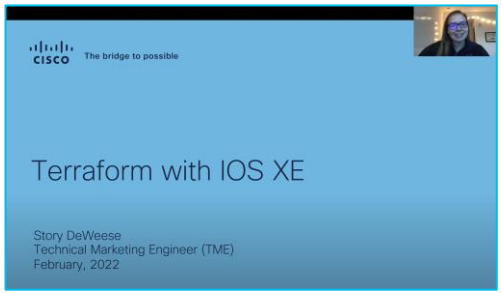
Terraform Blog and Resources

Questions? Join the Ask IOS XE Terraform Provider Webex space: https://eurl.io/#PtsT8eJFI

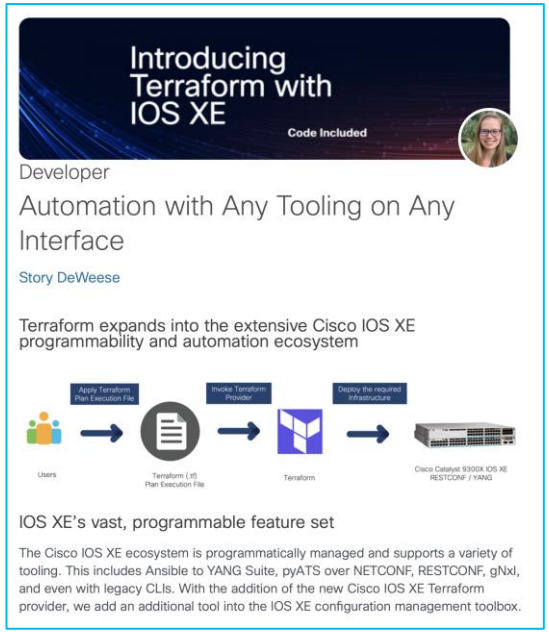
https://github.com/CiscoDevNet/terraform-provider-iosxe/
https://registry.terraform.io/search/providers?namespace=CiscoDevNet
https://developer.cisco.com/automation-terraform/



Demo Create a Crypto Tunnel Video:
https://www.youtube.com/watch?v=bPS0bhPacDw



Intro to IOS XE Terraform Provider Video:
https://www.youtube.com/watch?v=GEY_hyXimbA



https://blogs.cisco.com/developer/terraformiosxe01

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- getting started with programmability and automation
- tooling with YANG Suite and Terraform
- gaining hands-on experience with open source solutions for model driven telemetry and machine learning

https://blogs.cisco.com/developer/iosxeclemea01

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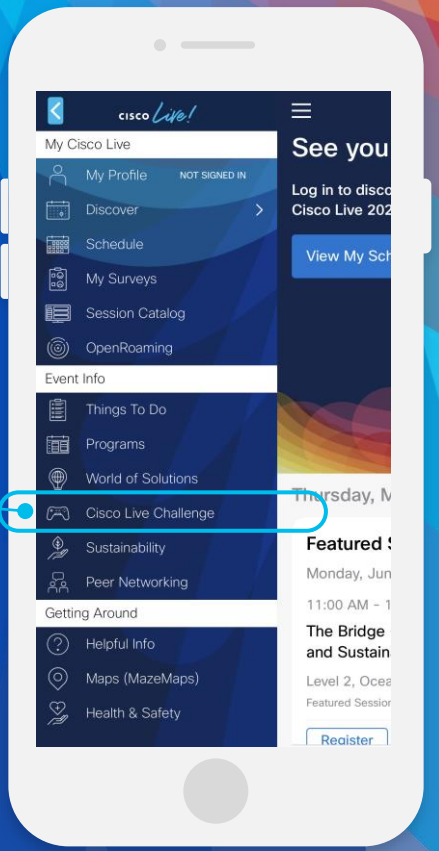


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