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The bridge to possible

Create Intelligent Ansible Playbooks for Process Automation

Weigang Huang, Senior Software Architect

BRKATO-2103

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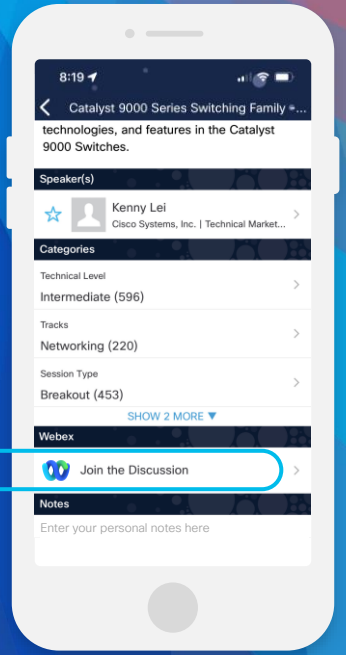

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Agenda

- Ansible And Process Automation
- Working With Crosswork Network Controller (CNC) Using Ansible
  - Challenges
  - How Ansible Helps
- Bring Intelligent to Ansible Plays
  - Smart Templating
  - Effective Flow Control
- Use Cases and Demos

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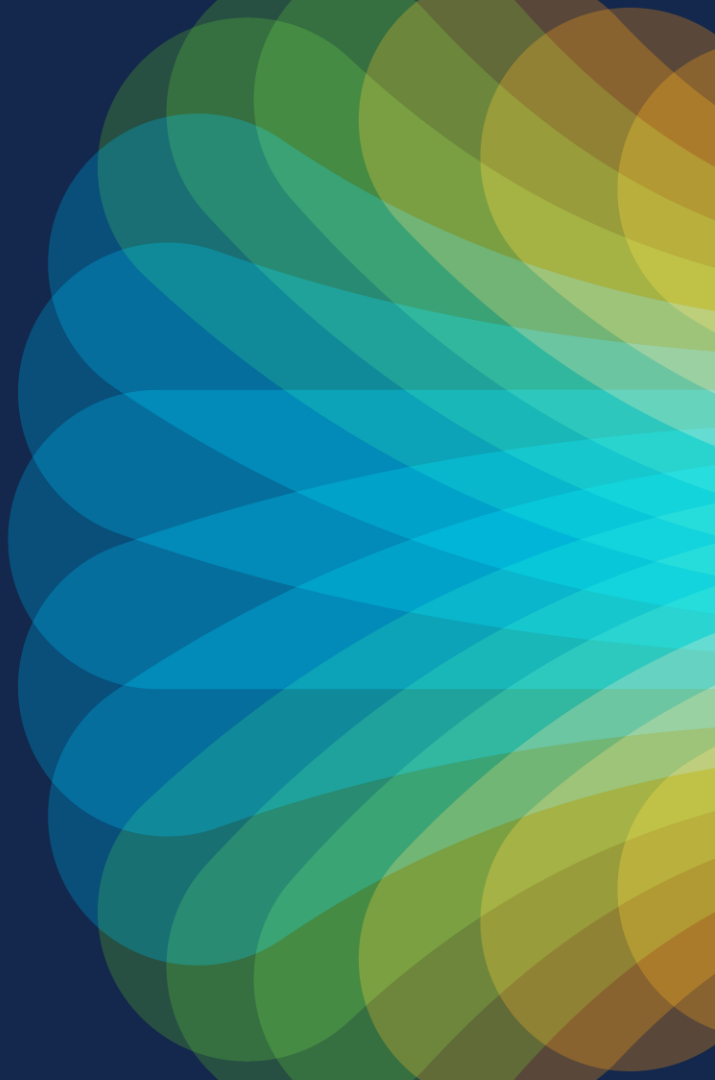
CNC Overview



Crosswork Network Controller (CNC)

Benefits | Success Stories | Resources | Support | Partner Help

Transform operations of your converged SDN transport network

Crosswork Network Controller provides high-performance SDN automation to achieve up to 90% faster service deployment, 70% quicker remediation of service-impacting issues and 66% lower operational expense.

Automate service and network provisioning

Expedite and simplify network services deployment with intent-based provisioning and dynamic traffic engineering policies.

Operational simplicity and agility

Improve productivity with single pane of glass visibility and integrated workflows.

Improve service delivery

Enhance end-user experience with integrated service health monitoring, policy-based optimization, and effective mitigation of network congestion.

Multivendor capable

Deploy SDN controller in a heterogenous network environment leveraging open, standards-based interfaces for data collection, network control, and configuration.

Read data sheet

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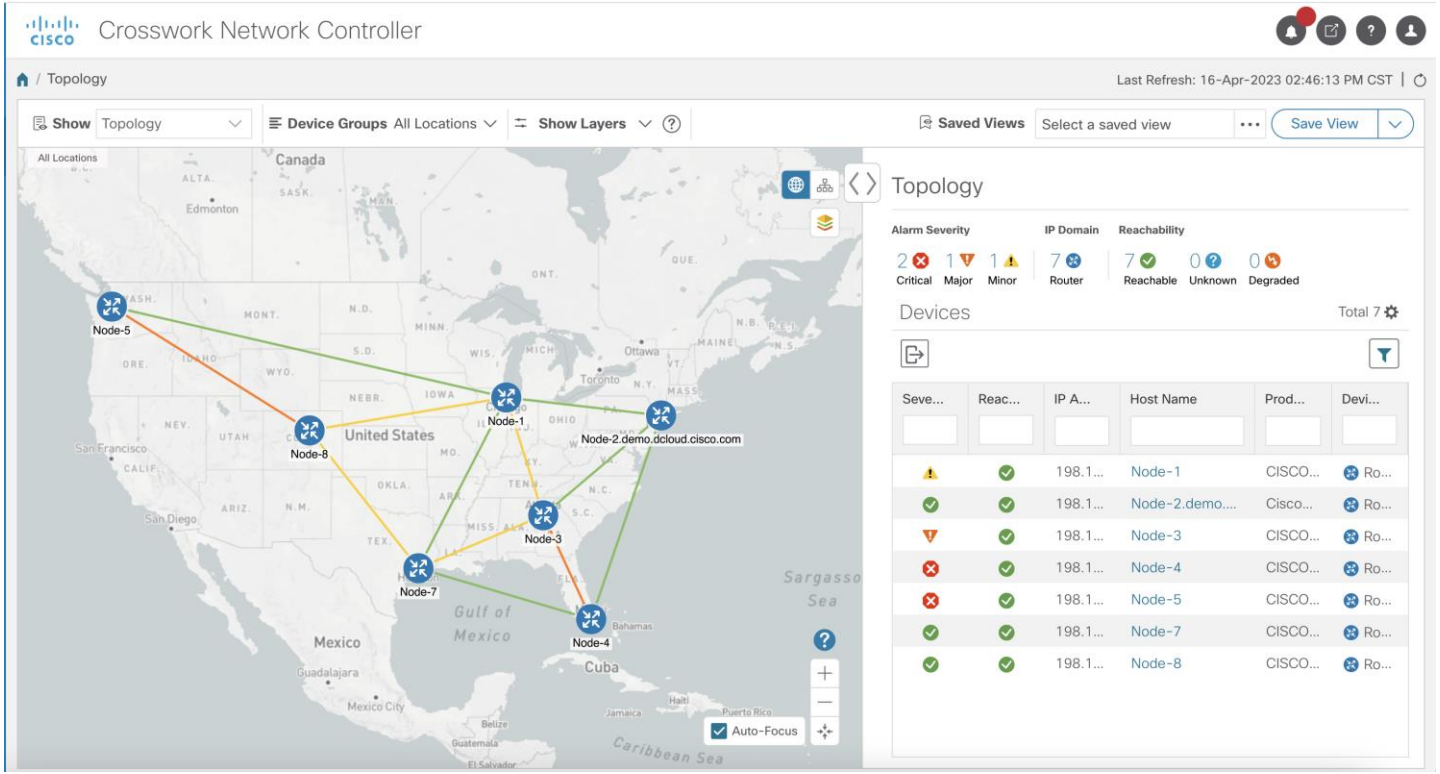
CNC – Topology



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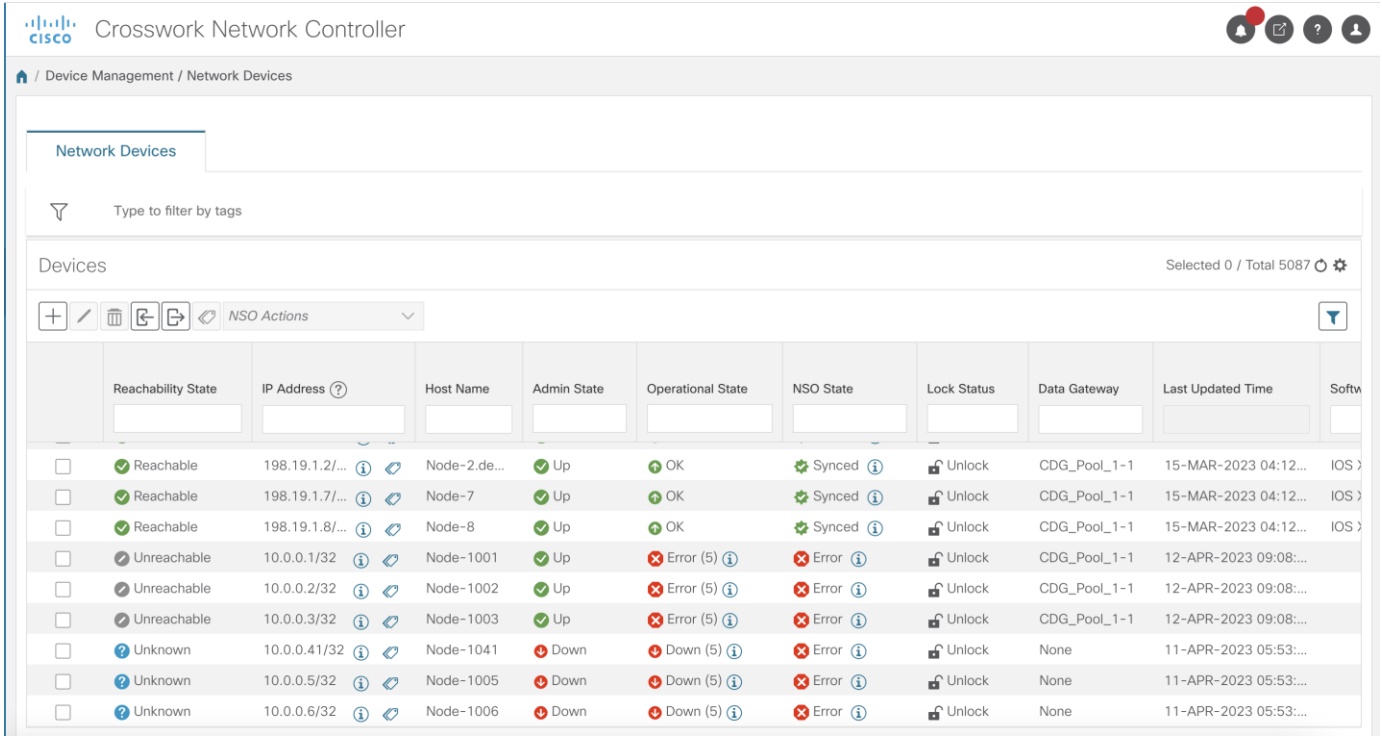
CNC – Devices



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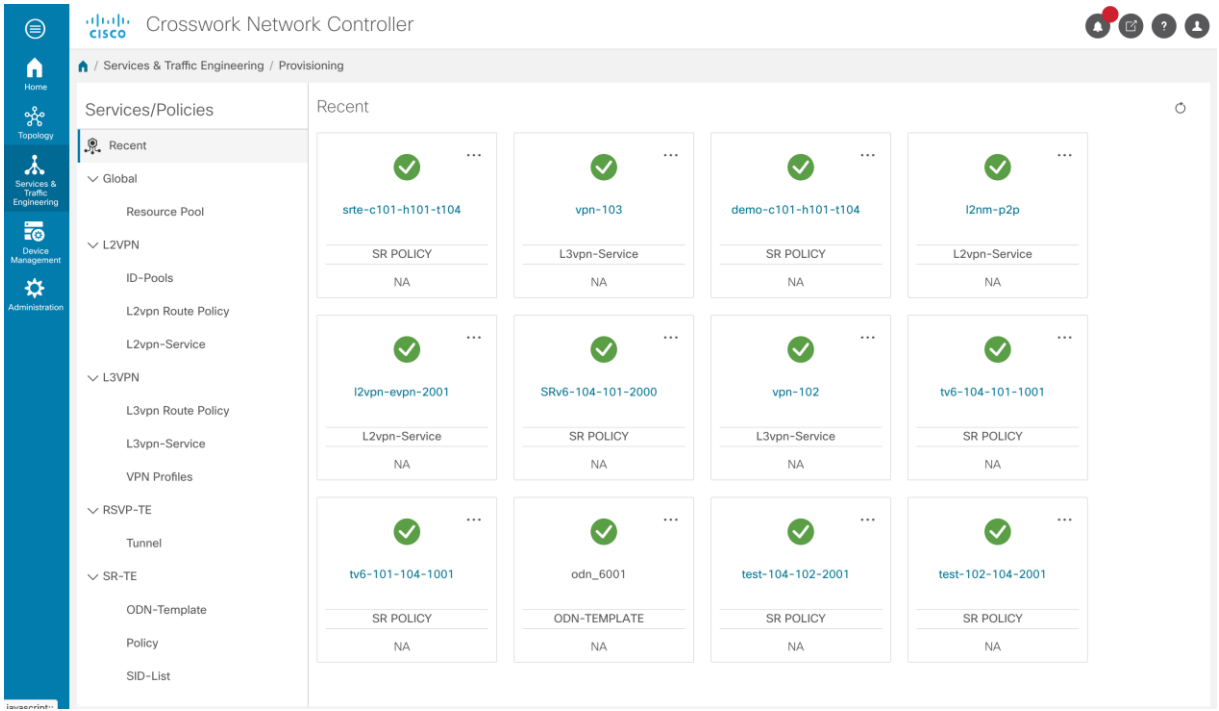
CNC- Provisioning for SR-TE , RSVP-TE or VPNs



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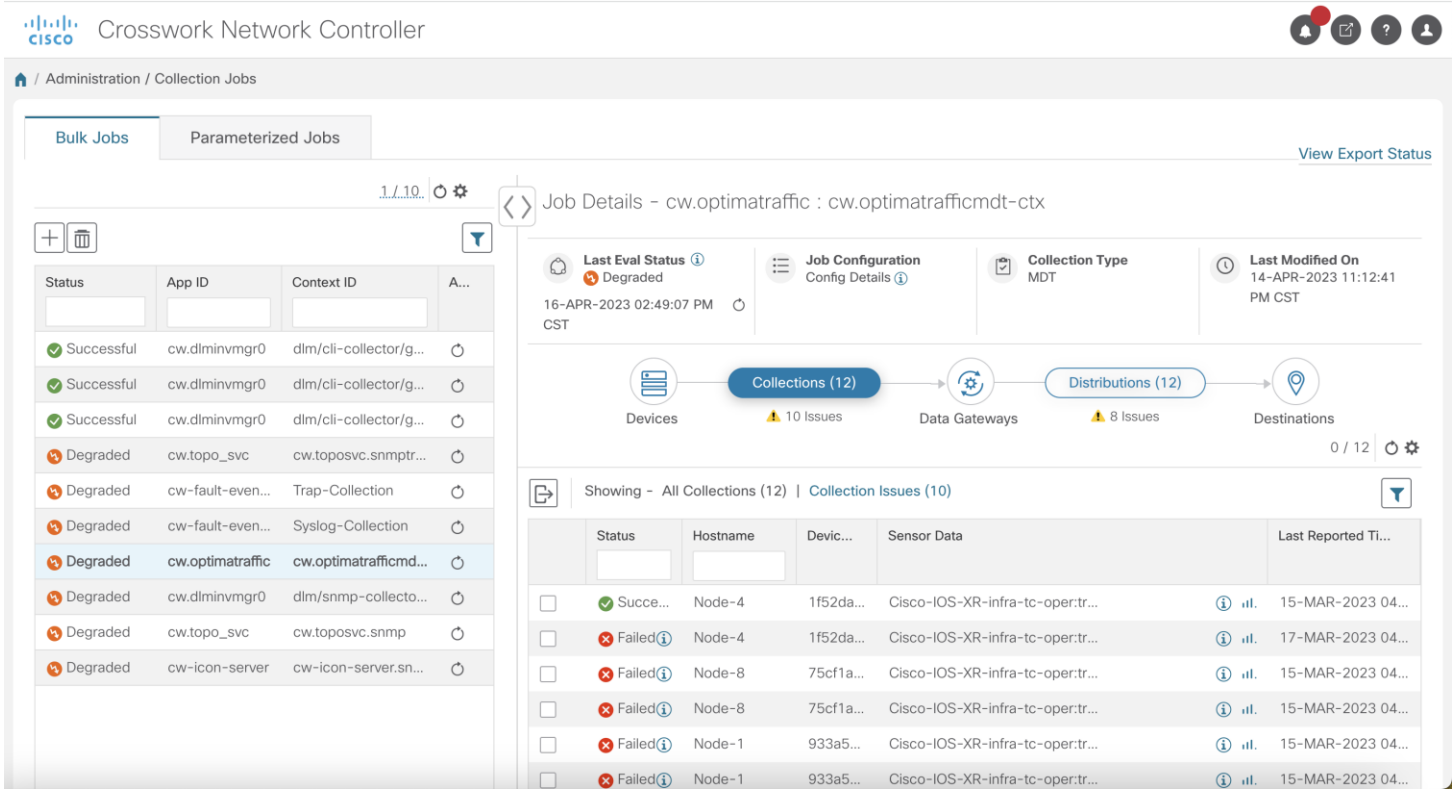
CNC – Collection Jobs



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The Challenges

Lifecycle of CNC

- Installation environments
- Large scale installation

- CNC components integration
- User management
- Device onboarding
- Customization
- .....

- Status report
- VPN service orchestration
- Additional customization
- Device management

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Challenges

- Multiple installation environments
- Large scale production rollout
  - 6 hybrid nodes + 30 CDG + 6 SR-PCE's + 2 NSO nodes per region
  - Add multiple regions into consideration: 132 + installations
- Additional effort required for initial setup
  - App install, device on boarding, ……
- Operation cost
  - Inventory management, status reports, service creation, customization…..

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Challenges

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repetitive

error prone

manual

tedious

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Challenges

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Process Automation?

- What is process automation
  - Automate manual, repetitive, and time-consuming tasks
  - Recall previous slides? Manage CNC is like some processes can be automated?
- Introduce Ansible to automate CNC management
- Ansible as a tool for process automation
  - Server provisioning
  - Application deployment
  - Configuration management

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Ansible Helped!

- Large scale production rollout
  - Customer installation scale per region, across multiple AZ's
    - 6 hybrid nodes + 30 CDG + 6 SR-PCE's + 2 NSO nodes
  - Add multiple regions into consideration: 132 + ...
- Additional effort required for initial setup
  - App install, device on boarding, ……
- Operation cost
  - Inventory management, status reports, service creation, customization.....

automated

less error prone

scalable

maintainable

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The Outcomes

Acceleration Through Automation

Improve the deployment and validation of a fully productive CNC instance from 6 MW to **1 MW**, saving time and $.

Jue ‘22 | Oct ‘22 | Nov ‘22 | Dec ‘22

Manual Installation

Not feasible for production

Basic Ansible Playbooks

6+ MW for production deployment

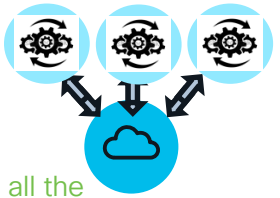
Add Smart Templating

6 MW for production deployment with manual initial configuration

Intelligent Ansible

2 MW per region with automatic initial setup

Install and initial config Multi-Region / Multi-CNC



1 MW for all the regions followed by fully automated post-installation setup

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The Approaches

Build Intelligent Ansible Play For Automation

Ansible Basics

- Plays and Playbook
- Modules
- Variables
- Facts
- Configuration Filles
- Templates
- Handlers

- Roles
- Ansible Vault
- Ansible Galaxy
- Ansible Tower

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Smart Templating

jinjia2 templating

- Long form:
  - Creation of text-based documents where some of the content can be dynamically generated. Resulting files can be HTML, JSON, XML, or anything that uses pure text as the encoding. The idea is to capture business logic in the code while giving template designer tools to control flow and layout of the end document.
- Short form:
  - Templating tool. Excellent for large scale variable replacing of files, Largely used in configurations, and others

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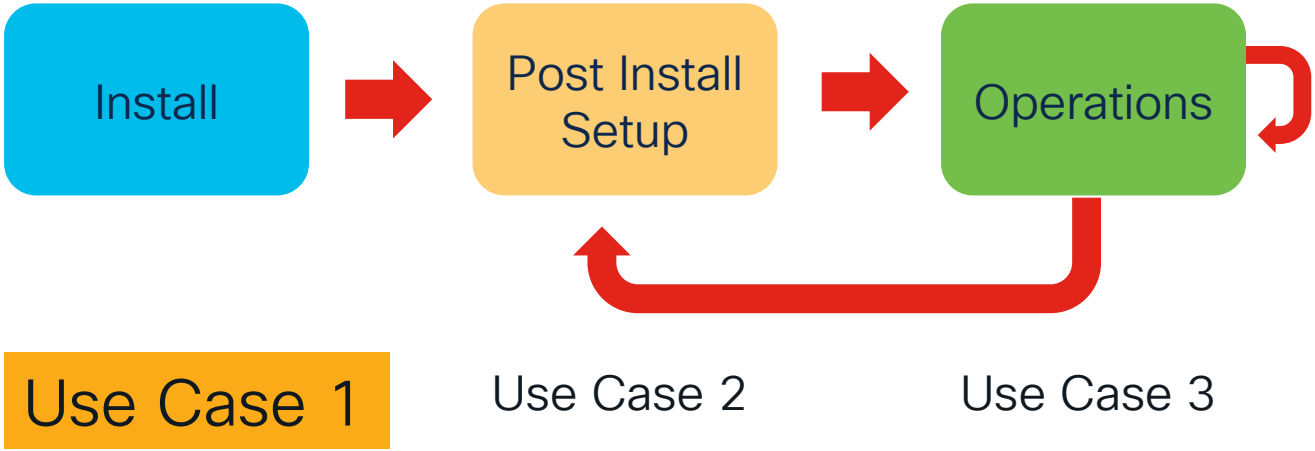
Use Cases

Lifecycle of CNC and Auto Manage CNC



All examples are available at the public github repo of https://github.com/weiganghuang/BRKATO-2103

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Use Case 1: Automate CNC/CDG Installation

- Problem description

  Install environment varies (lab, staging, production)

  Manual CNC installation does not scale

- Goal
  - Build intelligent and secure Ansible playbooks to automate CDG deployment with flexibility to support multiple environments
- jinjia2 templates are used for easy variable replacement
  - Very effective for large number of CDG devices

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Design the Playbooks

- Create roles to achieve modularity
- Dynamically generating CDG ova shell files through templating
- Simple loop to achieve scalability
- Ansible vault to protect sensitive information

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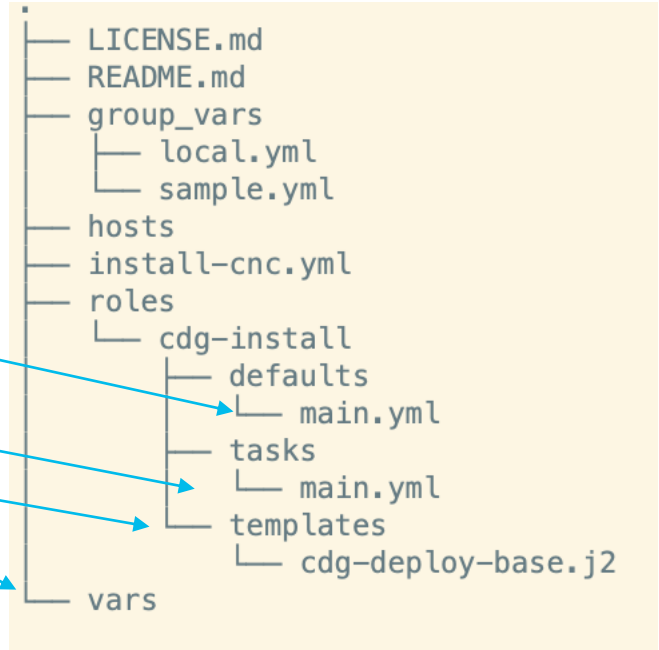
Roles and Playbook Structure

Playbook structure is boot strapped through "`ansible-galaxy <project> init`"

- variables
- roles: cdg-install
- role tasks
- templates
- main playbook

Available at (https://github.com/weiganghuang/BRKATO-2103/blob/main/InstallUseCase/roles/cdg-install/defaults/main.yml)

and (https://github.com/weiganghuang/BRKATO-2103/blob/main/InstallUseCase/roles/cdg-install/templates/cdg-deploy-base.j2)



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Dynamic Variable Replacement

Improve the deployment and validation of a fully productive CNC instance from 6 MW to 1 **MW,** saving Customer/CX $.

```yaml
vms:
  - vm1:
    vm_name: CDG3-CCO-DEMO-1
    host_name: CDG3-CCO-DEMO-1
    vnic0_ip: 10.140.131.61
    vnic0_gw: 10.140.131.1
    vnic0_mask: 255.255.255.0
    vnic1_ip: 172.26.240.61
    vnic1_gw: 172.26.240.1
    vnic1_mask: 255.255.255.0
    ds: "{{ds1}}"
    vcenter_path: "{{vcenter_root}}",
    active_vnics: 2
    nics:
      nic0: Application Network
      nic1: VLAN1
      nic2: Application Network
```

```
VM_NAME="{{ item.vm_name }}"
ActiveVnics="{{ item.active_vnics }}"

Hostname="{{ item.host_name }}"
Vnic0IPv4Address="{{ item.vnic0_ip }}"
Vnic0IPv4Gateway="{{ item.vnic0_gw  }}"
Vnic0IPv4Netmask="{{ item.vnic0_mask }}"
Vnic1IPv4Address="{{ item.vnic1_ip }}"
Vnic1IPv4Gateway="{{ item.vnic1_gw  }}"
Vnic1IPv4Netmask="{{ item.vnic1_mask }}"
VCENTER_PATH="{{ item.vcenter_path }}"
DS="{{ item.ds }}"
NIC0="{{item.nics.nic0 }}"
NIC1="{{ item.nics.nic1}}"
NIC2="{{ item.nics.nic2}}"


ROBOT_OVA_PATH="{{cdg_ova }}"
DM="{{deploy_mode}}"
Deployment="{{deploy_option}}"
```


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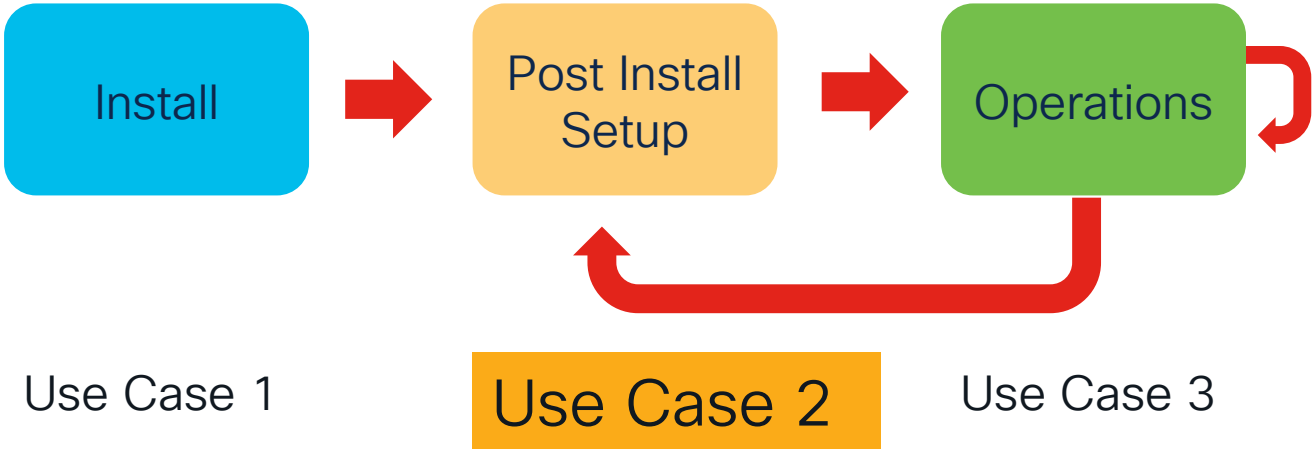
Lifecycle of CNC and Auto Manage CNC



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Use Case 2 CNC Post Installation Config

- Problem description

  One of the post installation activates is to onboard devices to CNC
- Options
  - Through device import feature (csv files)
  - Through CNC's REST API's
- Challenges
  - Large number of devices (hundreds to thousands)
- Goal
  - Build intelligent and secure ansible playbooks to automate the process

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Design the Playbooks

- Create roles to achieve modularity
- Dynamically generating payloads through templating
- Ansible vault to protect sensitive information
- Loop flow control
  - For large number of devices
- Leverage REST API
  - Common tasks for JWT, ……,

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Design the Playbooks

- Create roles to achieve modularity
- Dynamically generating payloads through templating
- Ansible vault to protect sensitive information
- Loop flow control (smart templating)
  - For large number of devices
- Leverage REST API
  - Common tasks for JWT, ……,

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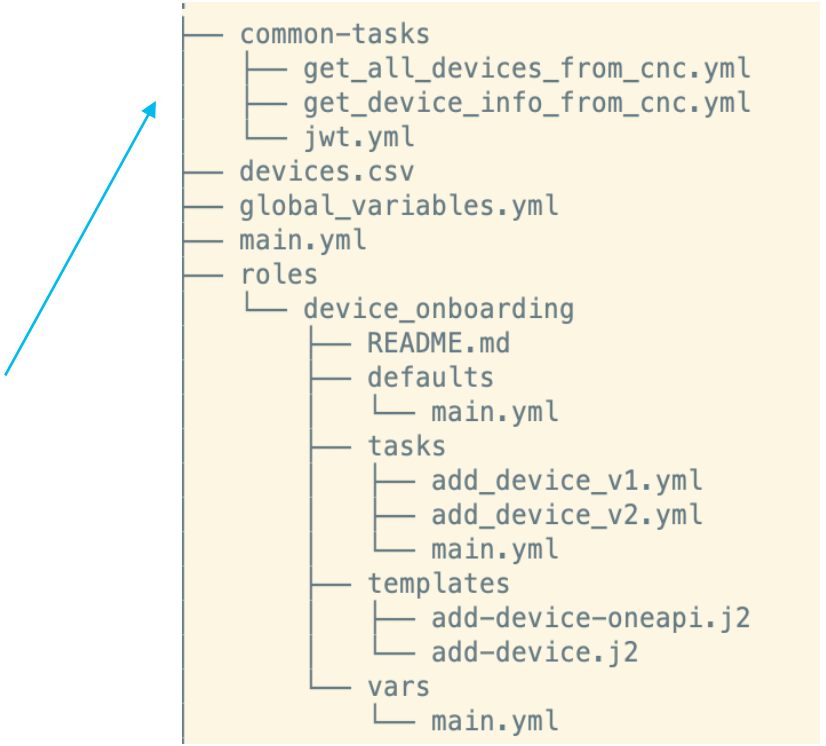
Roles and Playbook Structure

Role: device_onboarding

- default variables
- variables
- tasks
- templates

Common tasks predefined for creating JWT to invoke REST API's

Main playbook to import common tasks and specify roles in play



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Main Playbook and Common Task

Main Playbook

main.yml
(https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/main.yml)

Common task

jwt.yml
(https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/common-tasks/jwt.yml)

```
1  ---
2
3  - hosts: localhost
4    gather_facts: false
5    connection: local
6    vars_files:
7      - "{{playbook_dir}}/global_variables.yml"
8      - "{{playbook_dir}}/vault_variables.yml"
9
10   roles:
11     - device_onboarding
12
```


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Role Tasks Deep Dive

[roles/device_onboarding/tasks/main.yml](https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/roles/device_onboarding/tasks/main.yml)
(https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/roles/device_onboarding/tasks/main.yml)

- Import common tasks
- Invoke role tasks
  - Use template to generate API payload

```yaml
---
# tasks file for device_onboarding

# import a common task to do jwt
- name: get into JWT
  import_tasks: ../../../common-tasks/jwt.yml

- name: invoke add nodes API using lookup template
  uri:
    validate_certs: no
    status_code: [200, 201, 202]
    method: POST
    url: "https://{{cnc_ip}}:{{cnc_port}}/crosswork/inventory/v1/nodes"
    return_content: yes
    headers:
      Content-Type: application/yang-data+json
      Accept: application/yang-data+json
      Authorization: "Bearer {{ myJWT.content }}"
    body_format: json
    body: "{{ lookup('template', '../templates/add-device.j2') }}"
  register: addNodeAPIOoutput
  loop: "{{devices}}"
  loop_control:
    pause: 1
```


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Template - add-devce.j2

- add-device.j2 (https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/roles/device_onboarding/templates/add-device.j2)
- Leverage the variables in the scope of playbooks
  - Playbook variables
  - Loop variables: item

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Role Task Revisit

roles/device_onboarding/tasks/main.yml (https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/roles/device_onboarding/tasks/main.yml)

Loop control and flow

- Possible Improvement
  - On-boarding all devices using one API call?
  - Easy debugging?

```yaml
---
# tasks file for device_onboarding

# import a common task to do jwt
- name: get into JWT
  import_tasks: ../../../common-tasks/jwt.yml

- name: invoke add nodes API using lookup template
  uri:
    validate_certs: no
    status_code: [200, 201, 202]
    method: POST
    url: "https://{{cnc_ip}}:{{cnc_port}}/crosswork/inventory/v1/nodes"
    return_content: yes
    headers:
      Content-Type: application/yang-data+json
      Accept: application/yang-data+json
      Authorization: "Bearer {{ myJWT.content }}"
    body_format: json
    body: "{{ lookup('template', '../templates/add-device.j2') }}"
  register: addNodeAPIOoutput
  loop: "{{devices}}"
  loop_control:
    pause: 1
```


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Improvement: Convert to One API Call

Possible Improvement

- On-boarding all devices using one API call.
  - move looping to jinjia2 template

[add_device_v2.yml](https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/roles/device_onboarding/tasks/add_device_v2.yml)

```
---
# tasks file for device_onboarding

# import a common task to do jwt
- name: get into JWT
  import_tasks: ../../../common-tasks/jwt.yml

- name:  payload file
  template:
    src: "add-device-oneapi.j2"
    dest: "{{playbook_dir}}/tmp/add-device-oneapi.json"

- name: invoke add nodes API using the template file
  uri:
    validate_certs: no
    status_code: [200, 201, 202]
    method: POST
    url: "https://{{cnc_ip}}:{{cnc_port}}/crosswork/inventory/v1/nodes"
    return_content: yes
    headers:
      Content-Type: application/yang-data+json
      Accept: application/yang-data+json
      Authorization: "Bearer {{ myJWT.content }}"
    body_format: json
    body: "{{ lookup('file', '{{playbook_dir}}/tmp/add-device-oneapi.json')}}"
  register: myOutput
  register: addNodeAPIOoutput
```


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Template - add-devce-oneapi.j2

[add-device-oneapi.j2](https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/roles/device_onboarding/templates/add-device-oneapi.j22)
(https://github.com/weiganghuang/BRKATO-2103/blob/main/AddDevice/roles/device_onboarding/templates/add-device-oneapi.j22)

- Move loop to template
- Special handling to for the last element

```
{% for item in devices %}
        {



{% if loop.index == loop.length %}
        }
{% else %}
        },
{% endif %}
{% endfor %}
```


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Quick Recap

Bring Intelligent to Ansible Playbooks

- Modular and reusable plays
  - Leverage groups, roles
  - Define reusable common tasks
- Smart jinjia2 templating
  - Variable replacement
  - Loops and conditions
- Loop controls
  - At task vs at jinjia2 template

- Keep a good balance:
  - Maintainability
  - Extensibility
  - Performance

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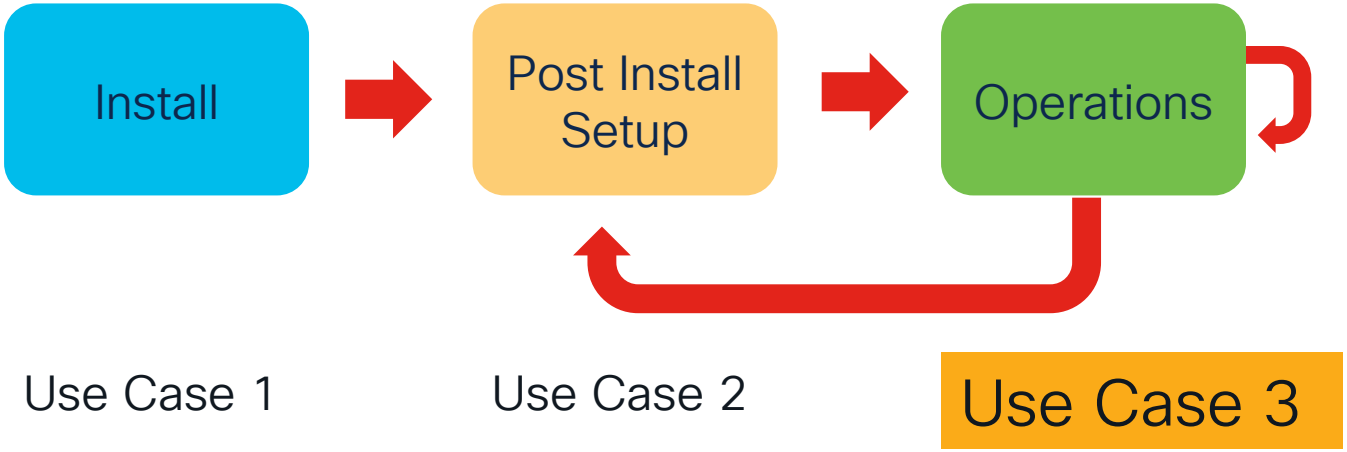
Lifecycle of CNC and Auto Manage CNC



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Use Case 3 Update Devices

- Problem description

  As one of CNC on-going management activities, update devices to enable additional features

- Challenges
  - Large device numbers, fluctuates
  - Requires inspect device configurations
- Goal
  - Build intelligent and secure ansible playbooks to automate the process

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Update Devices

- Enable telemetry data collection (enable gnmi)
  - Update requires device UUID (common task: get device info)
  - Additional data: Loopback IP (get from device configuration)
  - Multiple operations required
    - Admin down; enable telemetry; admin up;
- Data Validation
- Loop Control
  - Loop over multiple Ansible tasks

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Update Devices

- Enable telemetry data collection (enable gnmi)
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    - Admin down; enable telemetry; admin up;
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Design the Playbooks

- Create roles to achieve modularity
- Dynamically generating payloads through templating
- Ansible vault to protect sensitive information
- Common tasks
  - JWT, get device information from CNC
- Zero trust to input data source
- Loop flow control
  - Multiple operations for each device

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Design the Playbooks

- Create roles to achieve modularity
- Dynamically generating payloads through templating
- Ansible vault to protect sensitive information
- Common tasks
  - JWT, get device information from CNC
- Zero trust to input data source (data validation)
- Loop flow control
  - Multiple operations for each device (loop over blocks of tasks)

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Deep Dive get device info

get_device_info_from_cnc.yml (https://github.com/weiganghuang/BRKATO-2103/blob/main/UpdateDevices/common-tasks/get_device_info_from_cnc.yml)

- Defined as common tasks
- REST API output handling
  - Add protection when API output does not match the expectation
  - Save output to device info dictionaries through Ansible set_fact
- Input and output validation (zero trust of expected input)

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Deep Dive – Get Device Info Code Snippets

- Add loop control when there are large number of devices
- Save query output
  - Only when output data is valid (zero trust of expected data)

```
loop: "{{devices}}"
when: (i>=0) and (i< upper_limit )
loop_control:
  index_var: i


- name: save device output
set_fact:
    device_uuids: "{{device_uuids | default
    device_ips: "{{device_ips | default({})
    device_ip_to_uuids: "{{device_ip_to_uui
when: (item.json.data[0] is defined)
loop: "{{ device_ids.results }}"
```


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Ansible Task Blocks and Loop

- Blocks in Ansible
  - Logical grouping of tasks
  - Example usage: common error checking applies to multiple tasks
- Unfortunately, current version does not support loop over blocks
- Solution
  - Define blocks of tasks in a separate yml file
  - Use include_tasks module to include the blocks
  - Loop over include_tasks

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Deep Dive – Enable GNMI For Devices

- https://github.com/weiganghuang/BRKATO-2103/blob/main/UpdateDevices/roles/enable_gnmi/tasks/enable_gnmi_block.yml
- https://github.com/weiganghuang/BRKATO-2103/blob/main/UpdateDevices/roles/enable_gnmi/tasks/main.yml

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Variables

- “group_vars/” or “host_vars/”
- Inventory variables
- Variables loaded by “include_vars” or “vars_files”,
- “group_vars/” or “host_vars/”
- Inventory variables
- Variables loaded by “include_vars” or “vars_files”,
- Variable files passed on the ansible-playbook command line with -e @file.yml or -e @file.json.

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Variables Precedence

- How the precedence is defined
  - Ansible Variables Procedence
    (https://docs.ansible.com/ansible/latest/user_guide/playbooks_variables.html#variable-precedence-where-should-i-put-a-variable)
  - In general, Ansible gives precedence to variables that were defined more recently, more actively, and with more explicit scope.
- Tips
  - Understand how the precedence works
  - Keep it simple, leverage multiple levels of variables only when it is necessary
  - Have default variables defined
  - Use Ansible vault to protect

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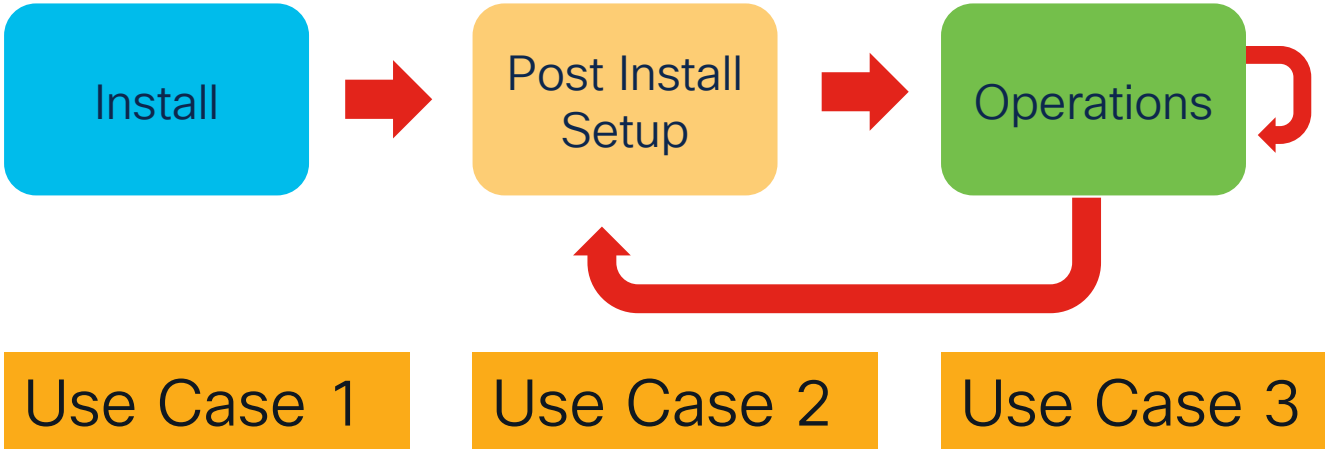
Demo

Summary

Lifecycle of CNC and Auto Manage CNC



All examples are available at the public github repo of https://github.com/weiganghuang/BRKATO-2103

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Bring Intelligent to Ansible Playbooks

- Modular and reusable
  - Leverage groups, roles
  - Define reusable common tasks
- Smart Templating: Add logics to Jinjia2 templates
  - Loop controls, string manipulations, condition checks
- Add data validation
- Use Ansible vault to protect sensitive data
- More examples available at https://github.com/weiganghuang/BRKATO-2103

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Power of Auto-managing CNC

Category	# of Tools	Hours Saved Per Use	Hours Saved Yearly (Estimated)
 Installation and Onboarding (CA, CF AWS gen, NSO 576, InfoBlox, Onboarder)	5	20	40 (2 Upgrades a year)
 Health Reporting (conn-check, device-exporter)	2	2	500
 Customization & Maintenance (col-job, tagger, process restarter, topo remediation)	3	3	750
 Product Data (CNC container, topo query, CAS Login)	3	1	250
 Job Aids (AWS uploader, local-driver expansion, end to end pipeline)	3	1	250
Totals:	16	27	1790

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...it's not the big fish which eats the small fish, it's the fast fish which eats the slow fish.

Klaus Schwab, Founder and Executive Chairman,
World Economic Forum

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The bridge to possible

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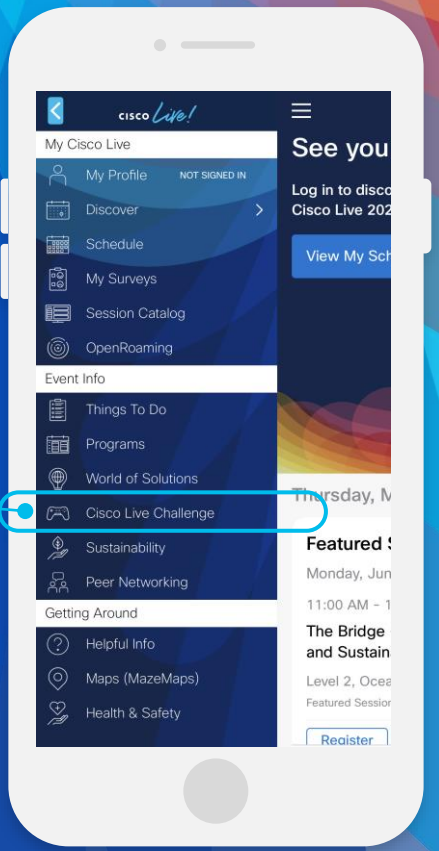

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