523454
Computer Network Programming

LAB6 - Network Automation with Nornir Framework

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What is Nornir?

Why nornir?

Nornir advantages

- Inventory
  - Groups and hosts information
- 100% python
- Concurrent
- Flexiblility
- Faster
- The ease of troubleshooting

Nornir disadvantages

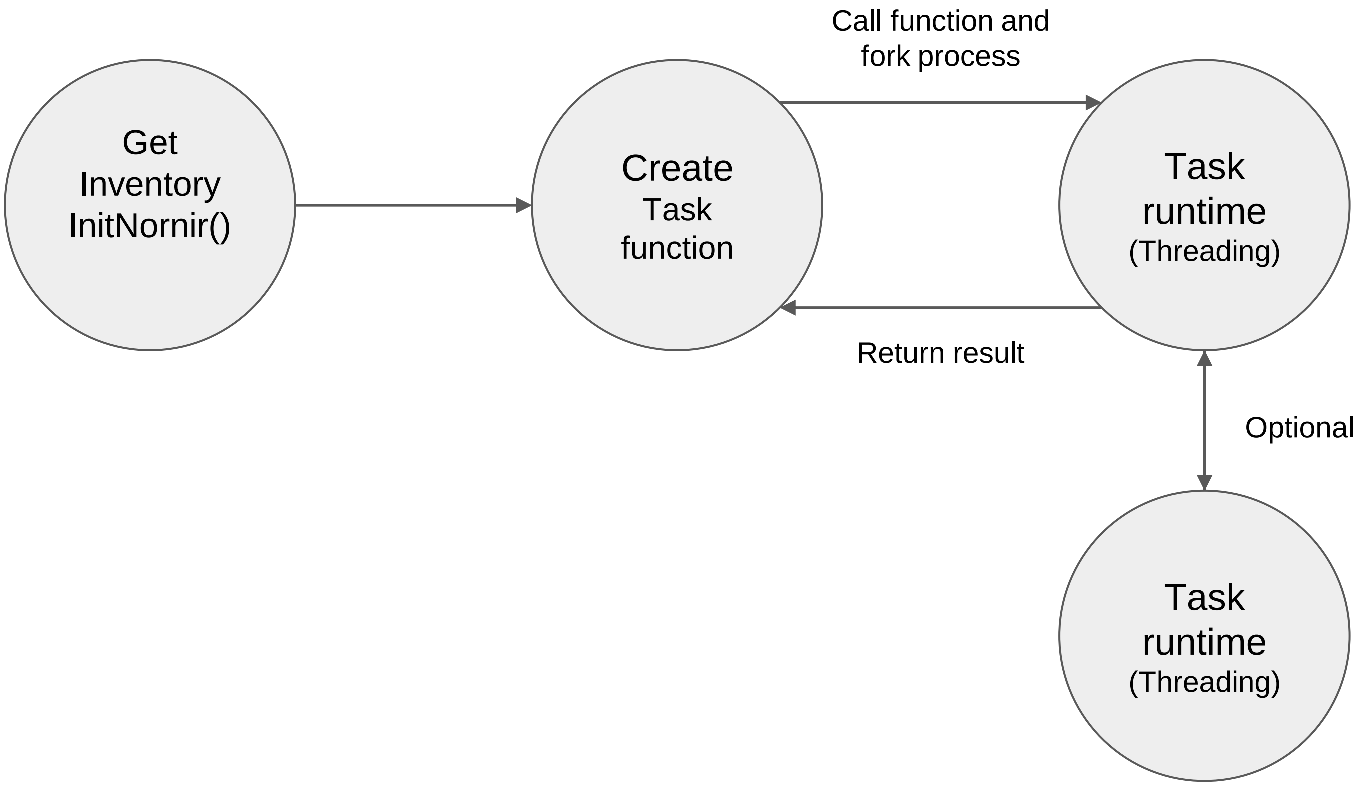
- Difficult coding (If compare with ansible)

Nornir plugin?

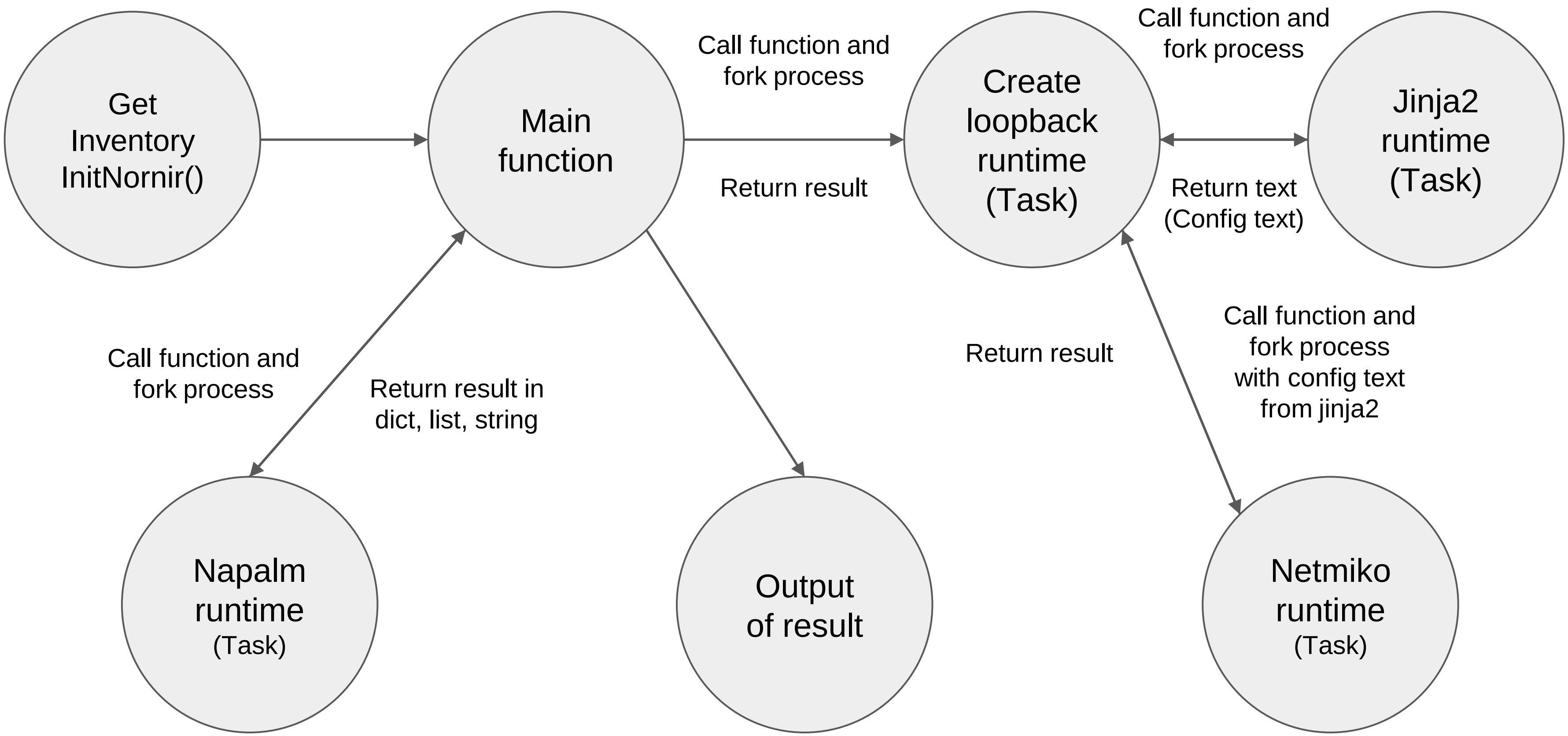
list of plugin

- *** nornir_napalm
- *** nornir_netmiko
- *** nornir_utils
- *** nornir_jinja2
- nornir_netbox
- nornir_ansible
- nornir_scrapli

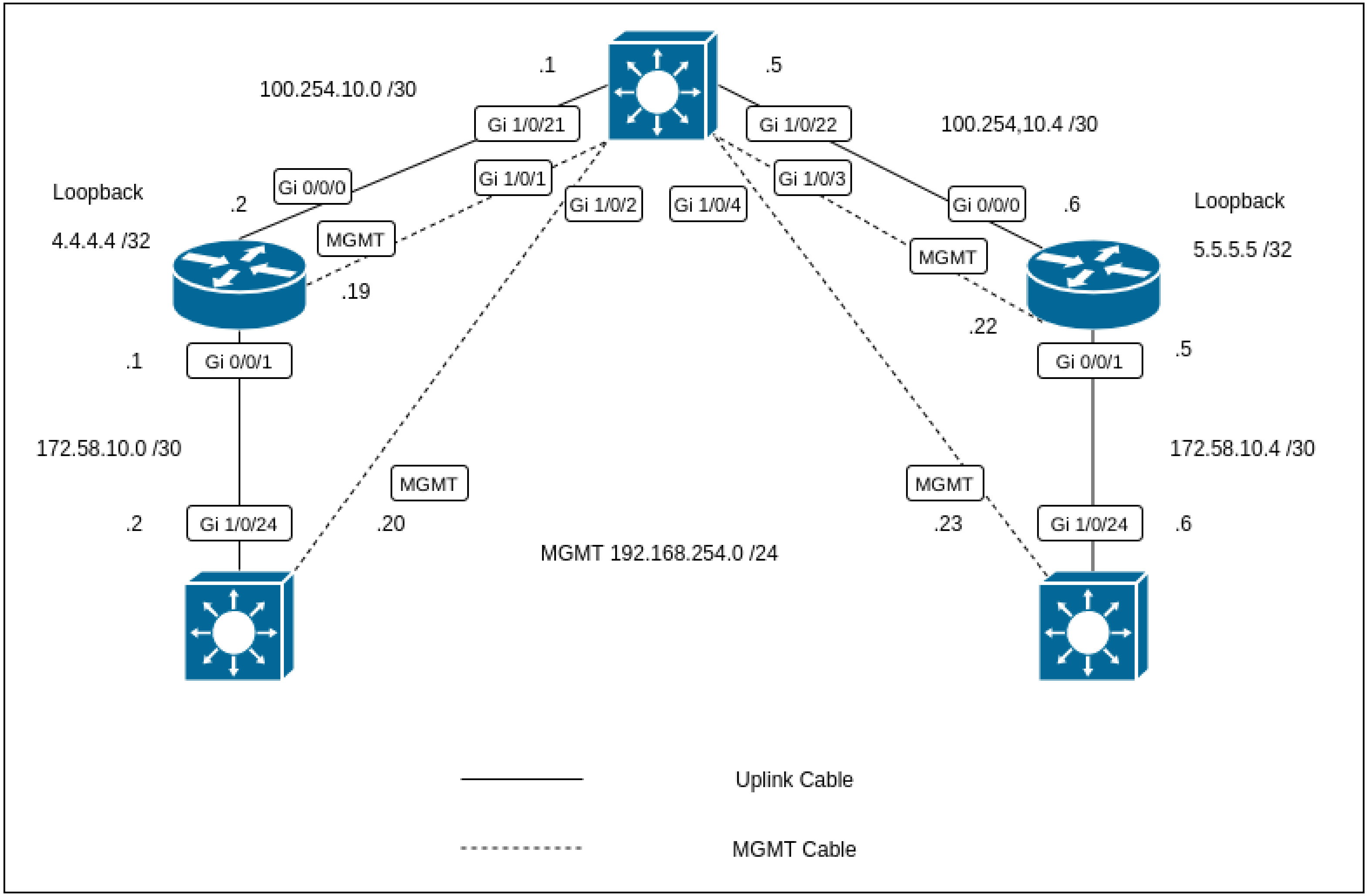
Nornir automation framework workflow



Nornir automation framework with plugin workflow


Get Inventory InitNornir()
Main function
Call function and fork process
Return result
Create loopback runtime (Task)
Call function and fork process
Return text (Config text)
Jinja2 runtime (Task)
Call function and fork process
Return result in dict, list, string
Return result
Call function and fork process with config text from jinja2
Napalm runtime (Task)
Output of result
Netmiko runtime (Task)

Topology overview



Create a config.yaml

```
---
inventory:
    plugin: SimpleInventory
    options:
        host_file: "inventory/hosts.yaml"
        group_file: "inventory/groups.yaml"
runner:
  plugin: threaded
  options:
    num_workers: 2
```

Create a inventory directory

1. Create inventory directory
2. Create inventory/groups.yaml

```
cisco_ios:
  platform: ios
  username: 'cpe'
  password: 'cpe'
  connection_options:
    napalm:
      extras:
        optional_args:
            secret: 'cpe'
    netmiko:
      extras:
          secret: 'cpe'

router:
  groups:
    - cisco_ios

switches:
  groups:
    - cisco_ios
```

Create inventory/hosts.yaml (Router)

```
router-4:
  hostname: 192.168.254.19
  data:
    loopback:
      0: 4.4.4.4

    interfaces:
        "Gig0/0/0":
          ipaddress: 100.254.10.2 255.255.255.252
          shutdown: false
        "Gig0/0/1":
          ipaddress: 172.58.10.1 255.255.255.252
          shutdown: false

    routes:
      - 100.254.10.4 255.255.255.252 100.254.10.1
      - 172.58.10.4 255.255.255.252 100.254.10.1

  groups:
    - router
```

Create inventory/hosts.yaml (Core-SW)

```yaml
c-switch-5:
  hostname: 192.168.254.23
  data:
    interfaces:
      "Gig1/0/24":
        ipaddress: 172.58.10.6 255.255.255.252

    routes:
      - 100.254.10.0 255.255.255.252 172.58.10.5
      - 100.254.10.4 255.255.255.252 172.58.10.5
      - 172.58.10.0 255.255.255.252 172.58.10.5
  groups:
    - switches
```

Create config templates

```
#Generate ip route [ iproute.j2 ]

{% for myRoute in host.data["routes"] %}
 ip route {{myRoute}}
{% endfor %}

--------------------------------------------------------------------------------------------------------------------------------

#Generate create loopback [ loopback.j2 ]

{% for loopback_id, interface_ip in host.data["loopback"].items() %}
 interface Loopback{{loopback_id}}
 ip address {{ interface_ip }} 255.255.255.255
{% endfor %}

--------------------------------------------------------------------------------------------------------------------------------

#Generate ip route [ iprouting.j2 ]

ip routing
```

Create python script

```
from nornir import InitNornir
from nornir_utils.plugins.functions import print_result
from nornir_jinja2.plugins.tasks import template_file
from nornir_napalm.plugins.tasks import napalm_get
from nornir_netmiko.tasks import netmiko_send_config, netmiko_send_command

nr = InitNornir(config_file="config.yaml") #Call config.yaml

def create_loopback(task):

                  # Generate create loopback task
    r = task.run(
           task=template_file,
            name='Generate configuration for create loopback interface',
            template='generate_create_loopback.j2',
            path=f'templates/ios/{hostType}'
        )
    config = r.result

    task.run(
        task=netmiko_send_config,
        name='Send config',
        config_commands=config.splitlines()
    )
```

Create python script (Continue)

```
if __name__ == '__main__':

    result = nr.run(task=create_loopback)
    print_result(result)
    shInterfaces = nr.run(task=napalm_get, getters=['interfaces_ip'])
    print_result(shInterfaces)
    #shIpRoute = nr.run(task=netmiko_send_command, command_string='sh ip route')
    #print_result(shIpRoute)
```

Traceroute script

```
from nornir import InitNornir
from nornir_utils.plugins.functions import print_result
from nornir_napalm.plugins.tasks import napalm_get

nr = InitNornir(config_file="config.yaml")

myDevice = nr.filter(name="router-4")
shRoute = myDevice.run(task=napalm_get, getters=['route_to'], destination="172.58.10.6")
print_result(shRoute)
```

Cisco IOS command suggestion

- **Routing enable**
  - ip routing
- **Disable enable**
  - no switchport
- **Assign static route**
  - ip route <network address> <netmask> <next hop address>
- **Create loopback**
  - int loopback <interface number>

Checkpoint 1 Router-4

```
* router-4 ** changed : True ***************************************************
vvvv create_loopback ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
---- Generate configuration for create loopback interface ** changed : False --- INFO
 interface Loopback0
 ip address 4.4.4.4 255.255.255.255

---- Generate configuration for assign interface ** changed : False ------------ INFO
 interface Gig0/0/0
    ip address 100.254.10.2 255.255.255.252
    no shutdown

 interface Gig0/0/1
    ip address 172.58.10.1 255.255.255.252
    no shutdown


---- Generate configuration for IP route ** changed : False -------------------- INFO
 ip route 100.254.10.4 255.255.255.252 100.254.10.1
 ip route 172.58.10.4 255.255.255.252 100.254.10.1

---- Send config ** changed : True --------------------------------------------- INFO
configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ROUTER-LAN-4(config)# interface Loopback0
ROUTER-LAN-4(config-if)# ip address 4.4.4.4 255.255.255.255
ROUTER-LAN-4(config-if)# interface Gig0/0/0
ROUTER-LAN-4(config-if)#    ip address 100.254.10.2 255.255.255.252
ROUTER-LAN-4(config-if)#    no shutdown
ROUTER-LAN-4(config-if)#
ROUTER-LAN-4(config-if)# interface Gig0/0/1
ROUTER-LAN-4(config-if)#    ip address 172.58.10.1 255.255.255.252
ROUTER-LAN-4(config-if)#    no shutdown
ROUTER-LAN-4(config-if)#
ROUTER-LAN-4(config-if)# ip route 100.254.10.4 255.255.255.252 100.254.10.1
ROUTER-LAN-4(config)# ip route 172.58.10.4 255.255.255.252 100.254.10.1
ROUTER-LAN-4(config)#end
ROUTER-LAN-4#
^^^^ END create_loopback ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Checkpoint 1 Router-4

```
* router-4 ** changed : False **************************************************
vvvv napalm_get ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
{ 'interfaces_ip': { 'GigabitEthernet0': { 'ipv4': { '192.168.254.19': { 'prefix_length': 24}}},
                     'GigabitEthernet0/0/0': { 'ipv4': { '100.254.10.2': { 'prefix_length': 30}}},
                     'GigabitEthernet0/0/1': { 'ipv4': { '172.58.10.1': { 'prefix_length': 30}}},
                     'Loopback0': {'ipv4': {'4.4.4.4': {'prefix_length': 32}}}}}
^^^^ END napalm_get ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Checkpoint 1 CORE-SW-4

```
* c-switch-4 ** changed : True *************************************************
vvvv create_loopback ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
---- Generate configuration for enable ip routing ** changed : False ----------- INFO
 ip routing

---- Generate configuration for assign interface ** changed : False ------------ INFO
 interface Gig1/0/24
    no switch
    ip address 172.58.10.2 255.255.255.252
    no shutdown

---- Generate configuration for IP route ** changed : False -------------------- INFO
 ip route 100.254.10.0 255.255.255.252 172.58.10.1
 ip route 100.254.10.4 255.255.255.252 172.58.10.1
 ip route 172.58.10.4 255.255.255.252 172.58.10.1

---- Send config ** changed : True --------------------------------------------- INFO
configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
CORE-SW-4(config)# ip routing
CORE-SW-4(config)#  interface Gig1/0/24
CORE-SW-4(config-if)#    no switch
CORE-SW-4(config-if)#    ip address 172.58.10.2 255.255.255.252
CORE-SW-4(config-if)#    no shutdown
CORE-SW-4(config-if)#
CORE-SW-4(config-if)# ip route 100.254.10.0 255.255.255.252 172.58.10.1
CORE-SW-4(config)# ip route 100.254.10.4 255.255.255.252 172.58.10.1
CORE-SW-4(config)# ip route 172.58.10.4 255.255.255.252 172.58.10.1
CORE-SW-4(config)#end
CORE-SW-4#
^^^^ END create_loopback ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Checkpoint 1 CORE-SW-4

```
* c-switch-4 ** changed : False *************************************************
vvvv napalm_get ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
{ 'interfaces_ip': { 'GigabitEthernet0/0': { 'ipv4': { '192.168.254.20': { 'prefix_length': 24}}},
                     'GigabitEthernet1/0/24': { 'ipv4': { '172.58.10.2': { 'prefix_length': 30}}}}}
^^^^ END napalm_get ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Checkpoint 1

Router-5

```
* router-5 ** changed : True **************************************************
vvvv create_loopback ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
---- Generate configuration for create loopback interface ** changed : False --- INFO
 interface Loopback0
 ip address 5.5.5.5 255.255.255.255

---- Generate configuration for assign interface ** changed : False ----------- INFO
 interface Gig0/0/0
    ip address 100.254.10.6 255.255.255.252
    no shutdown

 interface Gig0/0/1
    ip address 172.58.10.5 255.255.255.252
    no shutdown


---- Generate configuration for IP route ** changed : False ------------------- INFO
 ip route 100.254.10.0 255.255.255.252 100.254.10.5
 ip route 172.58.10.0 255.255.255.252 100.254.10.5

---- Send config ** changed : True -------------------------------------------- INFO
configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ROUTER-LAN-5(config)# interface Loopback0
ROUTER-LAN-5(config-if)# ip address 5.5.5.5 255.255.255.255
ROUTER-LAN-5(config-if)# interface Gig0/0/0
ROUTER-LAN-5(config-if)#    ip address 100.254.10.6 255.255.255.252
ROUTER-LAN-5(config-if)#    no shutdown
ROUTER-LAN-5(config-if)#
ROUTER-LAN-5(config-if)# interface Gig0/0/1
ROUTER-LAN-5(config-if)#    ip address 172.58.10.5 255.255.255.252
ROUTER-LAN-5(config-if)#    no shutdown
ROUTER-LAN-5(config-if)#
ROUTER-LAN-5(config-if)# ip route 100.254.10.0 255.255.255.252 100.254.10.5
ROUTER-LAN-5(config)# ip route 172.58.10.0 255.255.255.252 100.254.10.5
ROUTER-LAN-5(config)#end
ROUTER-LAN-5#
^^^^ END create_loopback ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Checkpoint 1 Router-5

```
* router-5 ** changed : False ****************************************************
vvvv napalm_get ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
{ 'interfaces_ip': { 'GigabitEthernet0': { 'ipv4': { '192.168.254.22': { 'prefix_length': 24}}},
                     'GigabitEthernet0/0/0': { 'ipv4': { '100.254.10.6': { 'prefix_length': 30}}},
                     'GigabitEthernet0/0/1': { 'ipv4': { '172.58.10.5': { 'prefix_length': 30}}},
                     'Loopback0': {'ipv4': {'5.5.5.5': {'prefix_length': 32}}}}}
^^^^ END napalm_get ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Checkpoint 1 CORE-SW-5

```
* c-switch-5 ** changed : True **************************************************
vvvv create_loopback ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
---- Generate configuration for enable ip routing ** changed : False ----------- INFO
 ip routing

---- Generate configuration for assign interface ** changed : False ------------ INFO
 interface Gig1/0/24
    no switch
    ip address 172.58.10.6 255.255.255.252
    no shutdown

---- Generate configuration for IP route ** changed : False -------------------- INFO
 ip route 100.254.10.0 255.255.255.252 172.58.10.5
 ip route 100.254.10.4 255.255.255.252 172.58.10.5
 ip route 172.58.10.0 255.255.255.252 172.58.10.5

---- Send config ** changed : True ---------------------------------------------- INFO
configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
CORE-SW-5(config)# ip routing
CORE-SW-5(config)#  interface Gig1/0/24
CORE-SW-5(config-if)#    no switch
CORE-SW-5(config-if)#    ip address 172.58.10.6 255.255.255.252
CORE-SW-5(config-if)#    no shutdown
CORE-SW-5(config-if)#
CORE-SW-5(config-if)# ip route 100.254.10.0 255.255.255.252 172.58.10.5
CORE-SW-5(config)# ip route 100.254.10.4 255.255.255.252 172.58.10.5
CORE-SW-5(config)# ip route 172.58.10.0 255.255.255.252 172.58.10.5
CORE-SW-5(config)#end
CORE-SW-5#
^^^^ END create_loopback ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Checkpoint 1 CORE-SW-5

```
* c-switch-5 ** changed : False ************************************************
vvvv napalm_get ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
{ 'interfaces_ip': { 'GigabitEthernet0/0': { 'ipv4': { '192.168.254.23': { 'prefix_length': 24}}},
                     'GigabitEthernet1/0/24': { 'ipv4': { '172.58.10.6': { 'prefix_length': 30}}}}}
^^^^ END napalm_get ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Checkpoint 2

****

```
* router-4 ** changed : False **************************************************
vvvv napalm_get ** changed : False vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv INFO
{ 'route_to': { '172.58.10.4/30': [ { 'age': '',
                       'current_active': True,
                       'inactive_reason': '',
                       'last_active': True,
                       'next_hop': '100.254.10.1',
                       'outgoing_interface': '',
                       'preference': 0,
                       'protocol': 'static',
                       'protocol_attributes': {},
                       'routing_table': 'default',
                       'selected_next_hop': True}]}}
^^^^ END napalm_get ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

References

- https://nornir.readthedocs.io/en/latest/