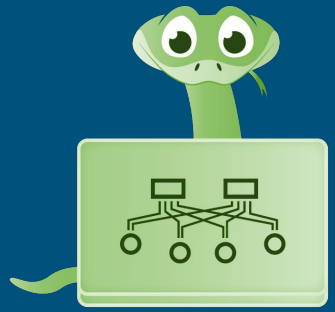

PYTHON

FOR NETWORK ENGINEERS

Onsite Training Session
July 2020

Day5 Schedule - Nornir

- Nornir Overview
- Inventory
- Nornir Tasks
- Results
- Nornir and Networking Plugins
- Custom Tasks and Grouped Tasks
- Nornir + Jinja2
- Using Netmiko and NAPALM Directly in Tasks
- Failed Tasks
- Debugging

PYTHON
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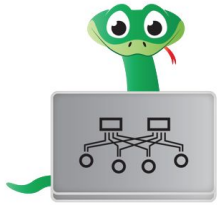

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Why was Nornir created? What problem is it trying to solve?

1. Systematic approach to inventory and data.
2. Concurrency
3. Using all Python

Why use a framework?

* Systematic Inventory Management
* Modular integration to other libraries
* Integrated Concurrency
* Systematizes automation in your organization

Ansible - Nornir Comparisons

Ansible Pluses

+ Easy getting started path
+ Use of SSH as a primary transport (familiarity)
+ Large community of network engineers using Ansible
+ Large organization behind it (Red Hat)

Nornir Pluses

+ All Python - Single, general purpose language
+ Easier debugging/troubleshooting
+ Use of Python Tool Chain (linters, debuggers, code testing)
+ Good performance
+ Tighter integrations to NAPALM and Netmiko

Ansible - Nornir Comparisons

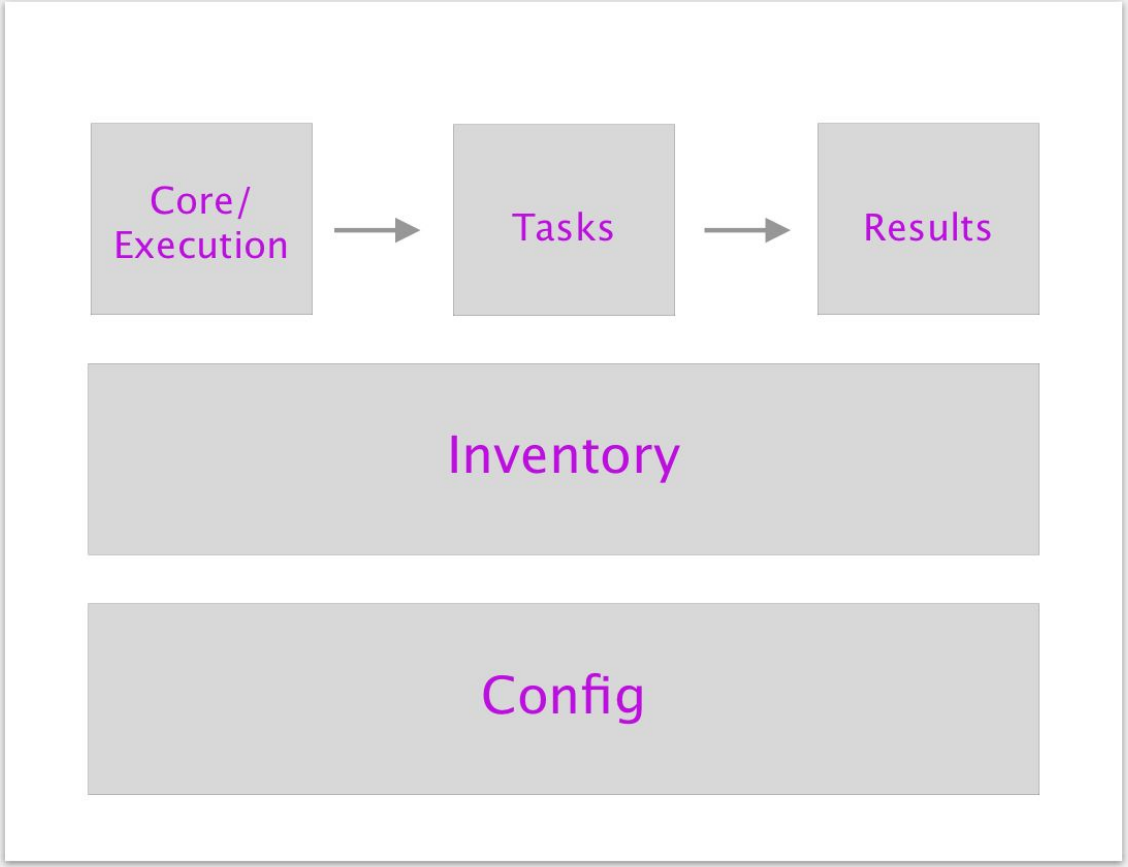
Ansible Minuses

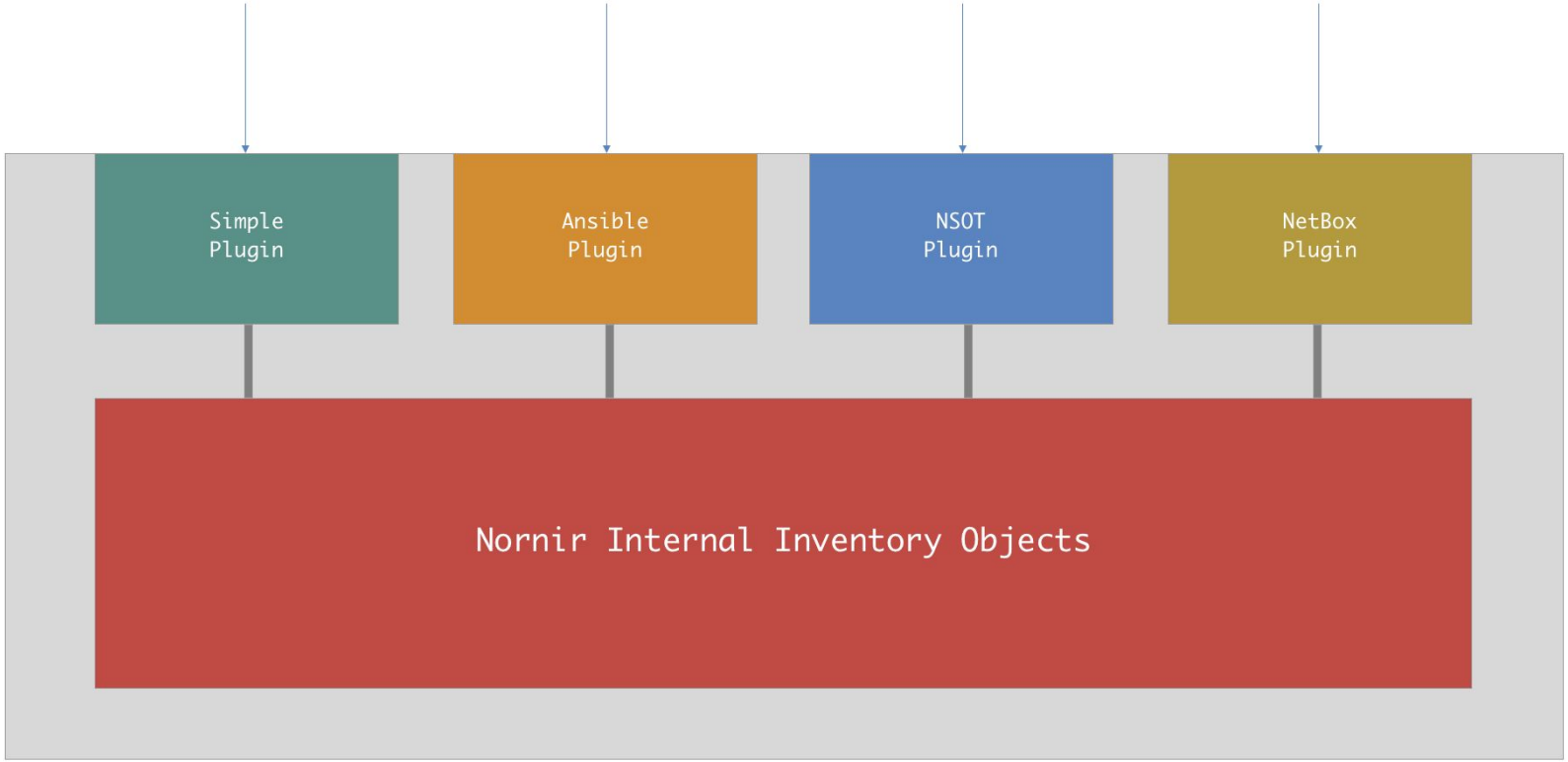
- Complex logic in Ansible is very painful
- Complex, nested data structures in Ansible are painful
- Troubleshooting can be unnecessarily difficult
- Easy things are easy, but somewhat difficult tasks get very hard quickly

Nornir Minuses

- You need to know Python
- Relatively new project/relatively small number of developers working on it
- Smaller community

Nornir Components




Simple
Plugin
Ansible
Plugin
NSOT
Plugin
NetBox
Plugin
Nornir Internal Inventory Objects

Nornir
SimpleInventory

```
logging:
  enabled: True
inventory:
  plugin: nornir.plugins.inventory.simple.SimpleInventory
  options:
    host_file: "~/nornir_inventory/hosts.yaml"
    group_file: "~/nornir_inventory/groups.yaml"
    defaults_file: "~/nornir_inventory/defaults.yaml"
```

Nornir SimpleInventory

```
sros1:
    hostname: sros.lasthop.io
    platform: nokia_sros
    connection_options:
      netmiko:
        extras:
          port: 2211
    groups:
      - sros
```

Inventory Attribute Traversal

Host -> Group1 -> Group2 -> GroupN -> Defaults

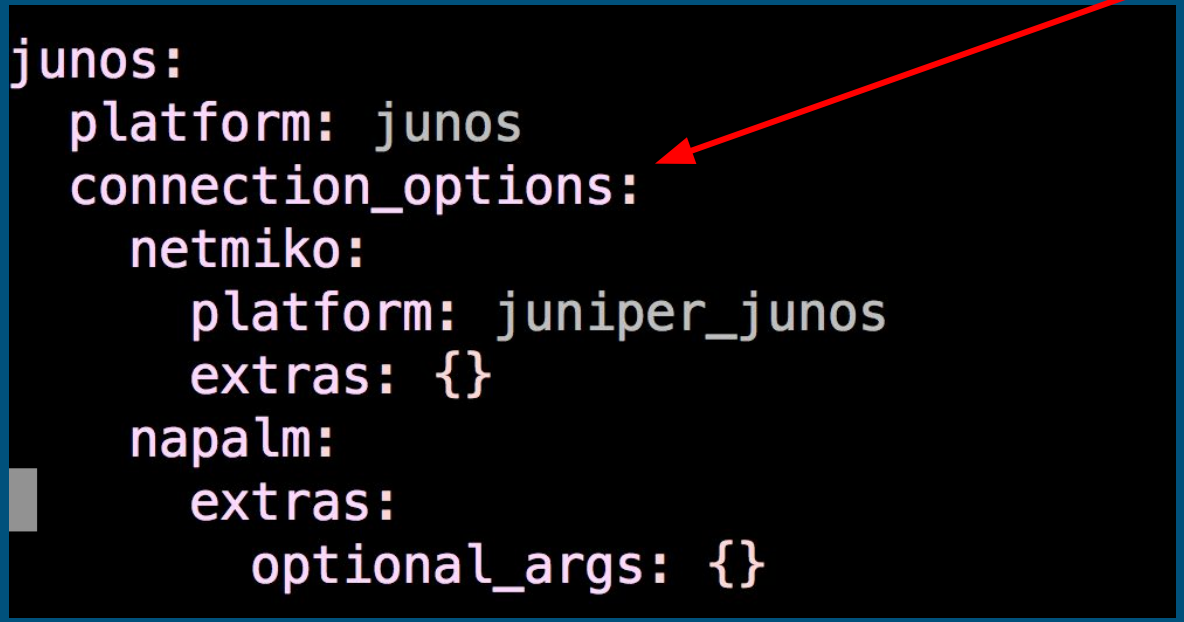
* the "data" exception

The *data inventory exception

```
ipdb> nr.inventory.hosts['sros2']['site']
'Freemont DC'
ipdb> nr.inventory.hosts['sros2'].data
{}
ipdb>
```

connection_options

What is going on here?



```
junos:
  platform: junos
  connection_options:
    netmiko:
      platform: juniper_junos
      extras: {}
    napalm:
      extras:
        optional_args: {}
```

Inventory filtering

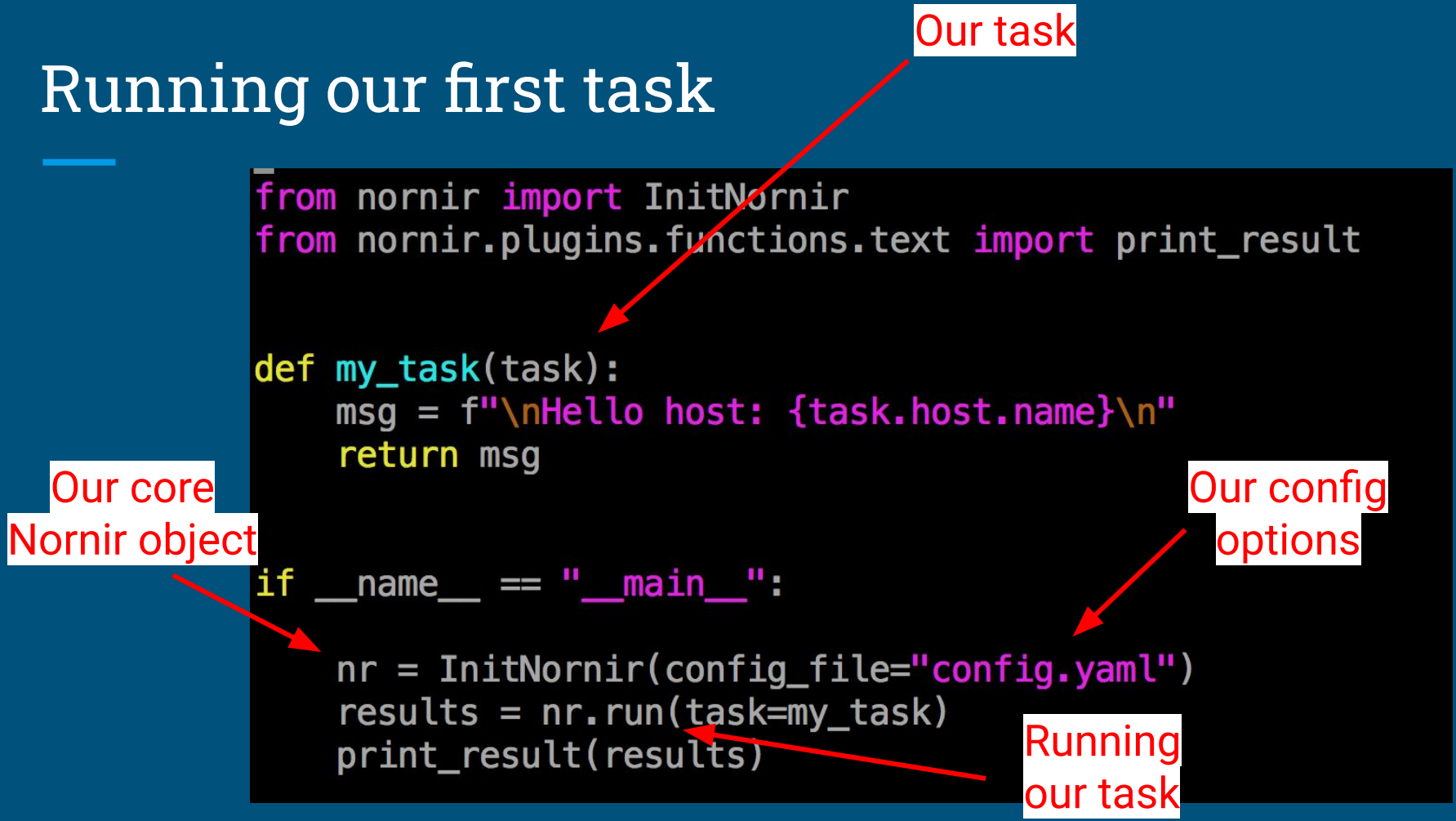
```
nr = InitNornir(config_file="config.yaml")
tmp_nr = nr.filter(name="sros1")
tmp_nr = nr.filter(platform="nokia_sros")
tmp_nr = nr.filter(hostname="vmx1.lasthop.io")

sros = nr.filter(F(groups__contains="sros"))

all_devices = nr.filter(F(groups__contains="sros") | F(groups__contains="junos"))
```

Exercises:
./day4/nornir_inventory/ex1.txt
./day4/nornir_inventory/ex2.txt
./day4/nornir_inventory/ex3.txt

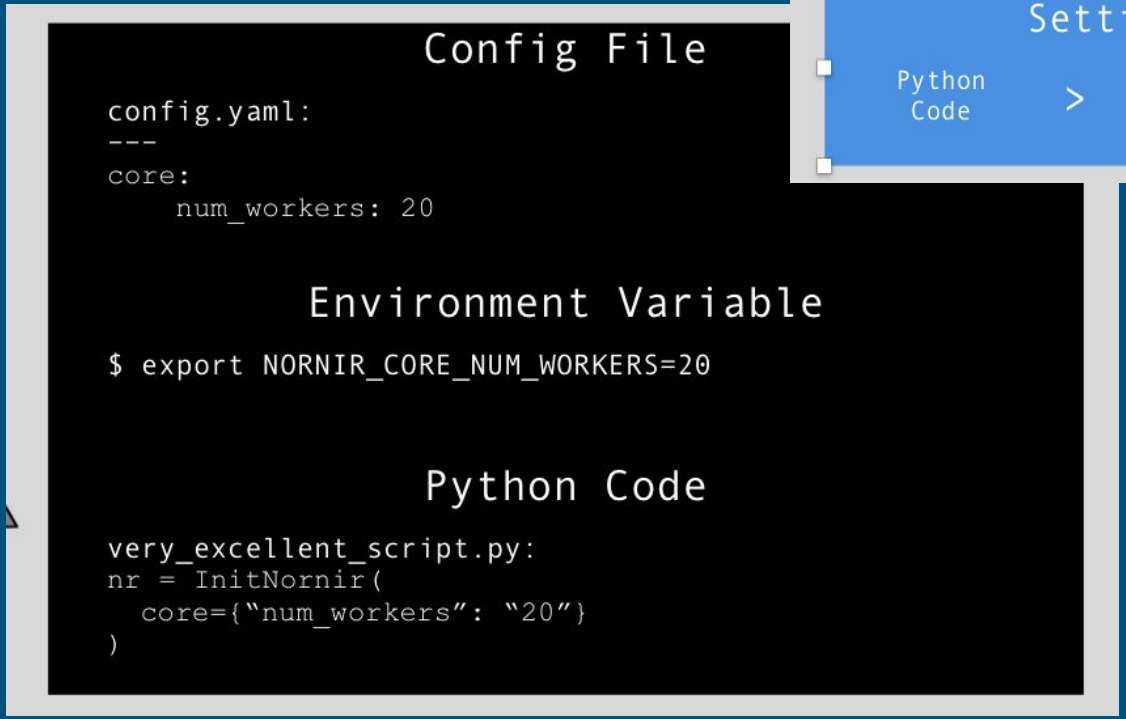
Running our first task



What can we specify in config.yaml?

```yaml
core:
  num_workers: 20
logging:
  enabled: True
inventory:
  plugin: nornir.plugins.inventory.simple.SimpleInventory
  options:
    host_file: "~/nornir_inventory/hosts.yaml"
    group_file: "~/nornir_inventory/groups.yaml"
    defaults_file: "~/nornir_inventory/defaults.yaml"
```

How can we specify configuration options?



First Task Exercise

Exercises:

./day5/nornir_simple_task/ex1.txt

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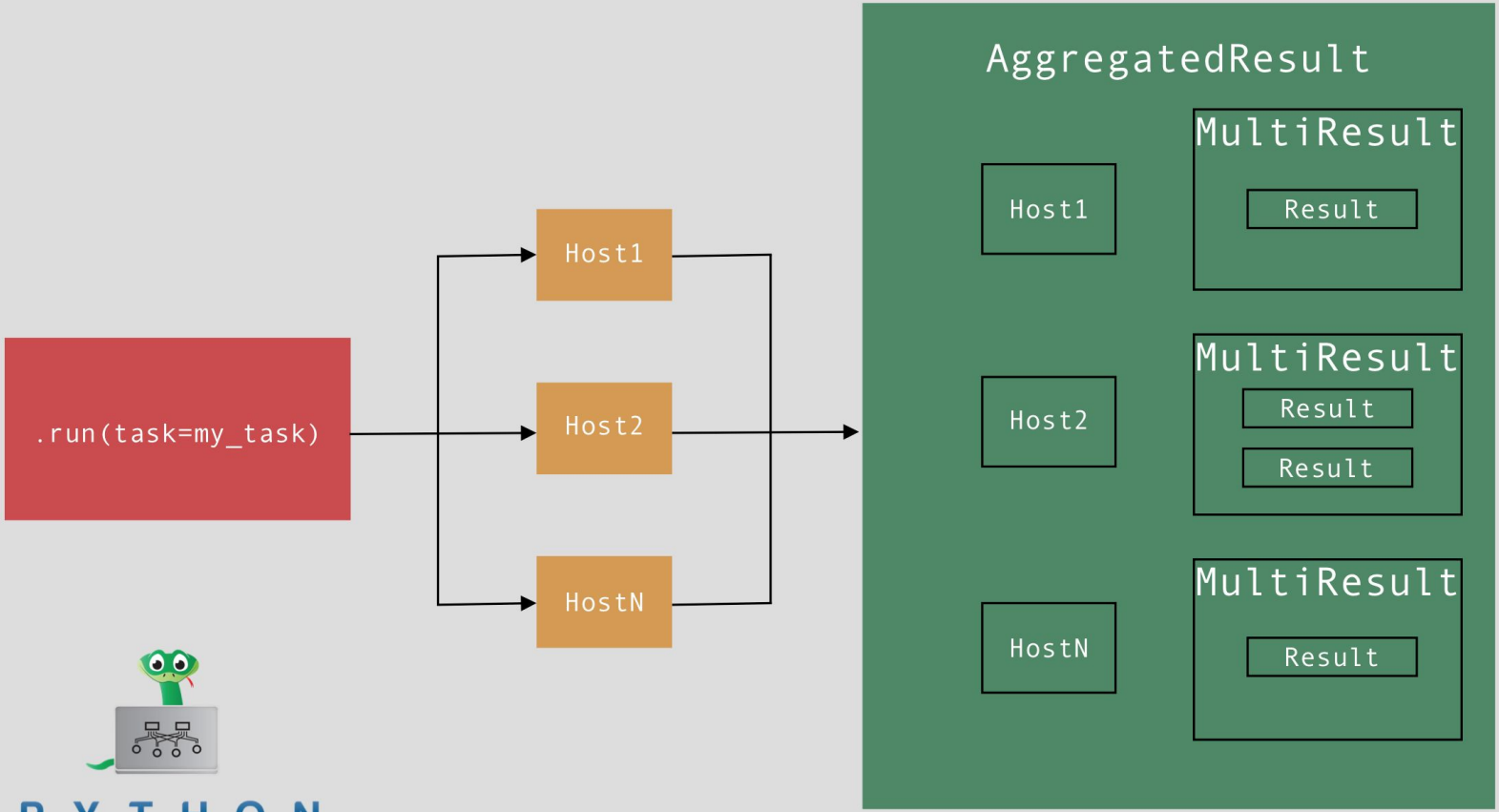

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Nornir Results - Aggregated Result Object

```
ipdb> type(agg_result)
nornir.core.task.AggregatedResult
ipdb> agg_result.keys()
dict_keys(['sros1', 'sros2', 'sros3', 'sros4'])
ipdb> agg_result['sros1']
MultiResult: [Result: "netmiko_send_config"]
ipdb>
```

Nornir Results - Multi-Result Object

```
ipdb> multi_result = agg_result['sros1']
ipdb> type(multi_result)
nornir.core.task.MultiResult
ipdb> multi_result
MultiResult: [Result: "netmiko_send_config"]
ipdb> len(multi_result)
1
ipdb> multi_result[0]
Result: "netmiko_send_config"
```

Nornir Results - Result Object

```
ipdb> result_obj = multi_result[0]
ipdb> type(result_obj)
<class 'nornir.core.task.Result'>
ipdb> result_obj
Result: "netmiko_send_config"
ipdb> print(result_obj.result)
/configure system time ntp peer 130.126.24.24
*A:sros1# /configure system time ntp peer 152.2.21.1
*A:sros1# exit all
*A:sros1#
```

Nornir Results Exercise

Exercises:

./day5/nornir_results/ex1.txt

PYTHON
FOR NETWORK ENGINEERS

Nornir and Networking Plugins

```
from nornir import InitNornir
from nornir.plugins.tasks.networking import netmiko_send_command
from nornir.plugins.functions.text import print_result


if __name__ == "__main__":

    nr = InitNornir(config_file="config.yaml")
    results = nr.run(task=netmiko_send_command, command_string="show version")
    print_result(results)
```

Netmiko task plugin - will automatically create Netmiko SSH connection

NETMIKO

Netmiko Task Plugins

```
$ tree -C plugins/tasks/networking/
plugins/tasks/networking/
├── __init__.py
├── napalm_cli.py
├── napalm_configure.py
├── napalm_get.py
├── napalm_ping.py
├── napalm_validate.py
├── netconf_capabilities.py
├── netconf_edit_config.py
├── netconf_get_config.py
├── netconf_get.py
├── netmiko_commit.py
├── netmiko_file_transfer.py
├── netmiko_save_config.py
├── netmiko_send_command.py
├── netmiko_send_config.py
└── tcp_ping.py

0 directories, 16 files
```

NETMIKO

Netmiko Config Changes


```
config_commands = ['/configure system location "San Francisco"']

# Initialize Nornir
nr = InitNornir(config_file="config.yaml")
nr = nr.filter(F(groups__contains="sros"))

# Send configuration
result = nr.run(task=netmiko_send_config, config_commands=config_commands)
print_result(result)

# Save running config to startup
nr.run(task=netmiko_save_config)
```

Nornir + Netmiko Task Exercises

Exercises:

./day5/nornir_netmiko_task/ex1.txt

./day5/nornir_netmiko_task/ex2.txt

NETMIKO

Nornir and NAPALM

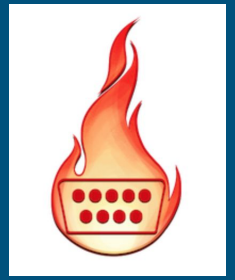
```
from nornir import InitNornir
from nornir.plugins.tasks.networking import napalm_get


if __name__ == "__main__":

    nr = InitNornir(config_file="config.yaml")
    nr = nr.filter(platform="junos")
    agg_result = nr.run(task=napalm_get, getters=["lldp_neighbors"])
    #agg_result = nr.run(task=napalm_get, getters=["facts"])
```

NAPALM task plugin - will automatically create underlying connection

NAPALM Getters



Getters support matrix

Note

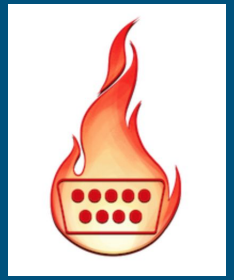
The following table is built automatically. Every time there is a release of a supported driver a built is triggered. The result of the tests are aggregated on the following table.

	EOS	IOS	IOSXR	JUNOS	NXOS	NXOS_SSH
get_arp_table	✅	✅	❌	❌	❌	✅
get_bgp_config	✅	✅	✅	✅	❌	❌
get_bgp_neighbors	✅	✅	✅	✅	✅	✅
get_bgp_neighbors_detail	✅	✅	✅	✅	❌	❌
get_config	✅	✅	✅	✅	✅	✅
get_environment	✅	✅	✅	✅	✅	✅
get_facts	✅	✅	✅	✅	✅	✅

Nornir and NAPALM

```
$ tree -C plugins/tasks/networking/
plugins/tasks/networking/
├── __init__.py
├── napalm_cli.py
├── napalm_configure.py
├── napalm_get.py
├── napalm_ping.py
├── napalm_validate.py
├── netconf_capabilities.py
├── netconf_edit_config.py
├── netconf_get_config.py
├── netconf_get.py
├── netmiko_commit.py
├── netmiko_file_transfer.py
├── netmiko_save_config.py
├── netmiko_send_command.py
├── netmiko_send_config.py
└── tcp_ping.py

0 directories, 16 files
```



NAPALM Configure

```
from nornir.plugins.tasks.networking import napalm_configure


def main():

    nr = InitNornir(config_file="config.yaml")
    nr = nr.filter(F(groups__contains="junos"))

    config = """
set system ntp server 130.126.24.24
set system ntp server 152.2.21.1
"""

    agg_result = nr.run(task=napalm_configure, configuration=config, dry_run=True)
    print_result(agg_result)
```

Nornir + NAPALM Exercises

Exercises:

./day5/nornir_napalm_task/ex1.txt

./day5/nornir_napalm_task/ex2.txt

./day5/nornir_napalm_task/ex3.txt

./day5/nornir_napalm_task/ex4.txt

Custom Tasks

```python
def my_task(task):
    print()
    print('-' * 40)
    print(f"Task: {task}")
    print(f"Host: {task.host.name}")
    print('-' * 40)
    print()


if __name__ == "__main__":

    nr = InitNornir(config_file="config.yaml")
    agg_result = nr.run(task=my_task)
```

Grouped Tasks

```
def my_task(task):
    config_commands = ['/configure system location "San Francisco"']

    # Send configuration
    task.run(task=netmiko_send_config, config_commands=config_commands)

    # Save running config to startup
    task.run(task=netmiko_save_config)

    return "whatever"
```

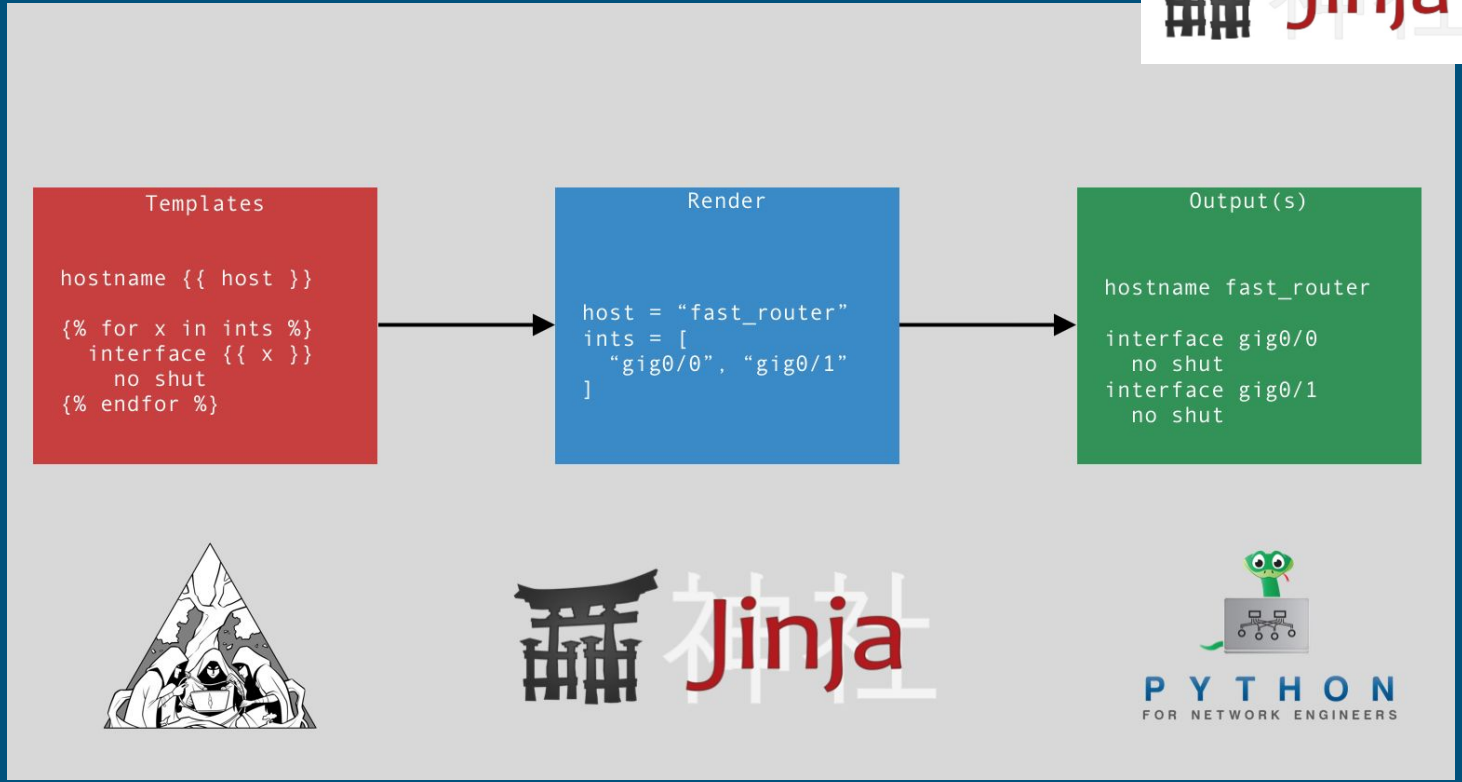
Grouped Tasks and effect on MultiResult

```
ipdb> sros1 = aggr_result['sros1']
ipdb> sros1
MultiResult: [Result: "my_task", Result: "netmiko_send_config", Result: "netmiko_save_config"]
ipdb> len(sros1)
3
ipdb> sros1[0].result
'whatever'
ipdb> sros1[1].result
'/configure system location "San Francisco"\nA:sros1# exit all \nA:sros1# '
ipdb> sros1[2].result
'Writing configuration to cf3:\\config.cfg\nSaving configuration ...   ... OK\nCompleted.'
```

The magic of MultiResult[0]

```
ipdb> sros1 = aggr_result['sros1']
ipdb> sros1
MultiResult: [Result: "my_task", Result: "netmiko_send_config", Result: "netmiko_save_config"]
ipdb> sros1.result
'whatever'
ipdb> sros1[0].result
'whatever'
```

Nornir + Jinja2



Nornir + Jinja2


```
    TEMPLATE_STR = """
interface loopback{{ int_num }}
  description {{ descr | lower }}
  no shut

"""

    nr = InitNornir(config_file="config.yaml", logging={"enabled": False})
    nr = nr.filter(name="srx2")

    my_vars = {
        "int_num": "99",
        "descr": "My Description",
    }

    agg_result = nr.run(task=template_string, template=TEMPLATE_STR, **my_vars)
```

Nornir + Jinja2


```
from nornir.plugins.tasks.text import template_file


def my_task(task):
    result = task.run(
        task=template_file, template="interfaces.j2", path=".", **task.host
    )
    print()
    print("-" * 40)
    print(result[0].result)
    print("-" * 40)
    print()
```

Nornir + Jinja2 Exercise

Exercises:

./day5/nornir_jinja2/ex1.txt

load_yaml / load_json

```python
from nornir.plugins.tasks.data import load_yaml # noqa
from nornir.plugins.tasks.data import load_json # noqa


def custom_task(task):
    import ipdb; ipdb.set_trace()
    # my_data = task.run(task=load_yaml, file=f"sros/{task.host.name}.yaml")
    my_data = task.run(task=load_json, file=f"sros/{task.host.name}.json")
    print(my_data.result)
```

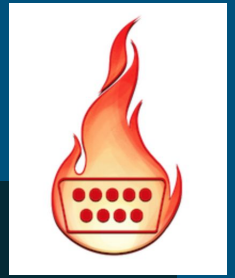
Direct Netmiko Connections


```
def netmiko_direct(task):

    # Manually create Netmiko connection
    net_connect = task.host.get_connection("netmiko", task.nornir.config)

    # Use the connection
    print()
    print("#" * 80)
    print(net_connect.find_prompt())
    output = net_connect.send_command("show system ntp")
    print(output)
    print("#" * 80)
    print()
```

Direct NAPALM Connections



```
def direct(task):

    # Manually create NAPALM connection
    napalm = task.host.get_connection("napalm", task.nornir.config)

    # PyEZ connection
    jnpr_conn = napalm.device

    # PyEZ RPC
    xml_output = jnpr_conn.rpc.get_software_information()
    print()
    print('-' * 40)
    print(etree.tostring(xml_output, encoding="unicode", pretty_print=True))
    print('-' * 40)
    print()
```

Direct Connection Exercises

Exercises:

./day5/nornir_direct/ex1.txt

./day5/nornir_direct/ex2.txt

NETMIKO

Failed Tasks

```
print(aggr_result.failed)
print(aggr_result.failed_hosts.keys())

vmx1 = aggr_result.failed_hosts["vmx1"]
print(vmx1.exception)

try:
    aggr_result.raise_on_error()
except NornirExecutionError:
    print("We can cause this exception to be raised")
```

Run task on failed hosts

```
# Run a task on the failed hosts
aggr_result = nr.run(
    task=failed_task,
    on_failed=True,
    on_good=False
)
```

Recover failed hosts

```
# Recover specific host
print(f"Failed Hosts: {nr.data.failed_hosts}")
nr.data.recover_host("vmx2")

# Reset failed hosts
print(f"Failed Hosts: {nr.data.failed_hosts}")
print("Reset failed hosts")
nr.data.reset_failed_hosts()
print(f"Failed Hosts: {nr.data.failed_hosts}")
```

Failed Task Exercises

Exercises:

./day5/nornir_failure/ex1.txt

./day5/nornir_failure/ex2.txt

NETMIKO

Debugging and Troubleshooting

1. Pdb is your friend.
2. Simplify the problem by setting num_workers=1
3. Look at your log file.
4. Netmiko debugging enable your session_log (or standard logging).
5. Try to isolate the problem to the part of the system that is causing the issue.

Nornir Version3 is Coming

Some Key Changes

- Moving to plugins hosted on external repositories (independent maintainers). Also affects your import references.
- “Runner” is now specified in config.yaml to indicate “threaded” or “serial” versus just controlling with num_workers.
- Change config.yaml references specifically for inventory plugins.
- num_workers eliminated as used inside of nr.run()
- Group behavior is slightly changed with respect to Group “refs” and group filtering.

Nornir Version3 is Coming

Some Changes

- Transform function requires an entry point.
- “log_file” replaces “file” reference in config.yaml.

Nornir Resources

Nornir Discourse Group:
https://nornir.discourse.group/

Nornir Tutorial:
https://nornir.readthedocs.io/en/latest/tutorials/intro/

Nornir Repository on GitHub:
https://github.com/nornir-automation/nornir

The end...

Questions?

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