The bridge to possible

Do's and Don'ts in Network Test Automation

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@oboehmer

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BRKOPS-2312

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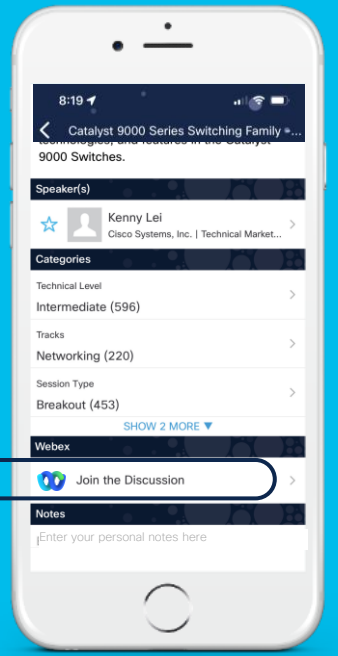

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Your Host for the Next 60 Minutes

- Joined Cisco in 2000
- Principal Architect in Cisco Services / CX
- Enterprise & SP Networking Background
- Automation Evangelist
- CX Test Automation Architect
- Active RobotFramework and Genie contributor

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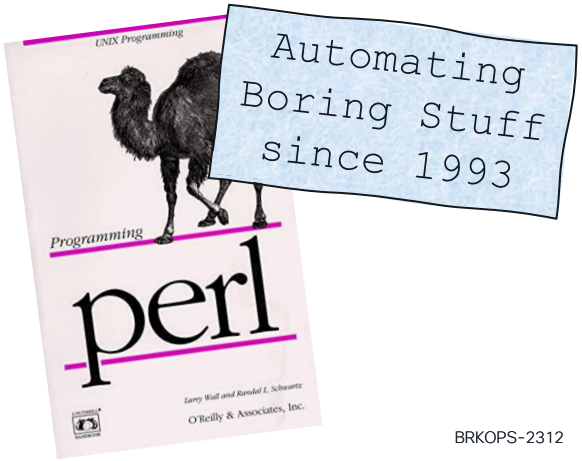


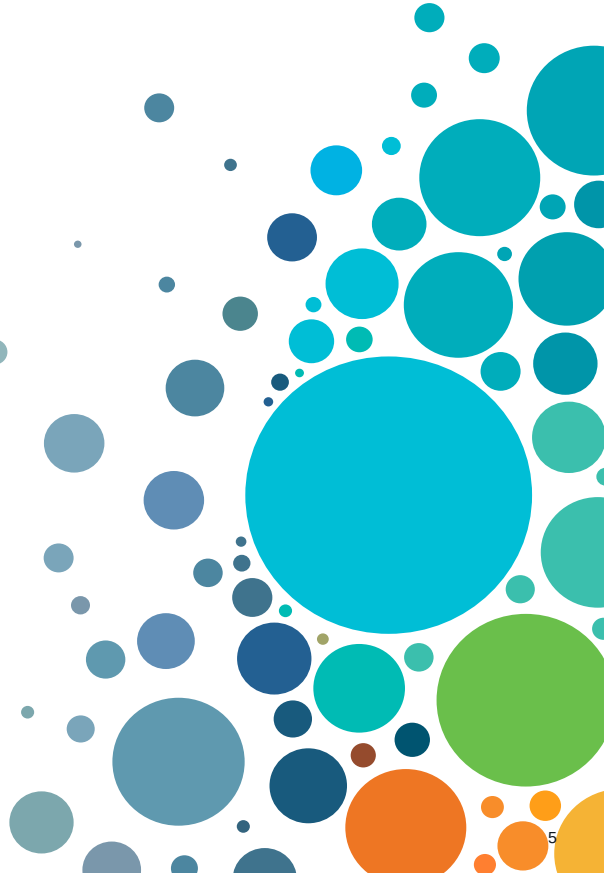
Test Automation is a Journey

We'll Cover a Few Steps Today

Examples @ https://github.com/oboehmer/BRKOPS-2312

Do Not Reinvent The Wheel:

Picking a Suitable Test Automation Framework



Main Functions of a Testing Framework

Running tests, filtering tests, re-running failed tests, etc.

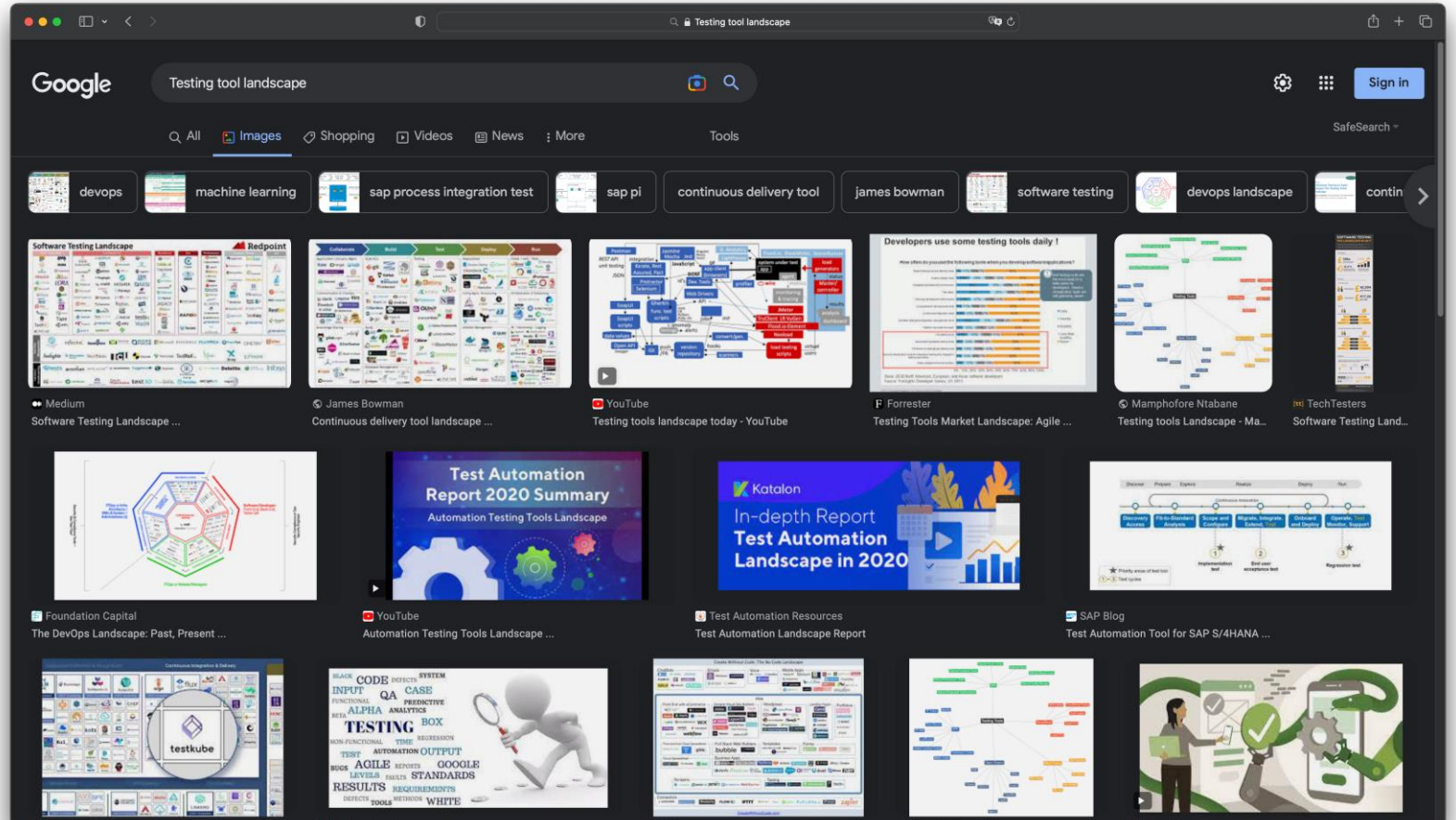
log.html Logging and reporting

import Integrate 3rd party libraries

$var Parameterization

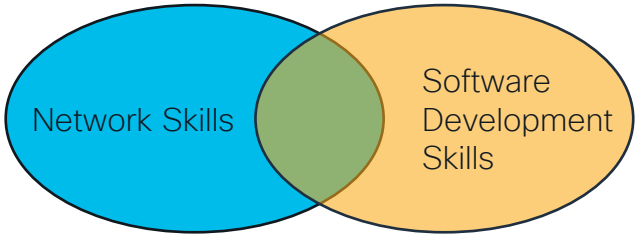
%include Re-use test cases / Macros

Plethora of Different Testing Tools and Frameworks

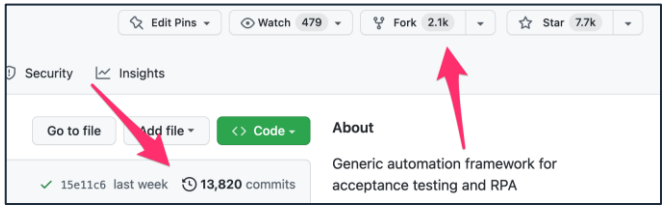


When Selecting a Network Testing Framework …

- Tailor to your audience (aka test case writers) and their skills



- Pick one with healthy ecosystem and community



- Pick one that handles CLI well

```
Router1>
Router1>show foo
```

If You Asked Me, Here Are My Favourites

RobotFramework

ROBOT
FRAME
WORK

- Low-code, Keyword-based framework
- Used by us Cisco Services (but also by Nokia, Juniper and many, many others)
- Large Ecosystem
- https://robotframework.org

If You Asked Me, Here Are My Favourites

RobotFramework

ROBOT FRAME WORK/

- Low-code, Keyword-based framework
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pyATS

- Python based framework
- simple test cases also in YAML
- Used by Cisco Engineering to validate IOS-XE, IOS-XR, NXOS
- https://developer.cisco.com/pyats/

Both freely available

RobotFramework Example

```
*** Settings ***
Library         pyats.robot.pyATSRobot
Library         unicon.robot.UniconRobot
Library         genie.libs.robot.GenieRobot
Suite Setup     setup test environment

*** Test Cases ***
Verify OSPF Neighbor
    ${result}=  parse "show ip ospf neighbor GigabitEthernet2 detail" on device "
    check neighbor id       ${result}    10.0.0.2
    check neighbor state    ${result}    full

*** Keywords ***
setup test environment
    use testbed "testbed.yaml"
    connect to device "r1"

check neighbor id
    [Arguments]    ${result}    ${id}
    ${nbr_id}=     dq query    data=${result}    filters=contains('neighbors').get_values('neighbor_router_id')
    Should be Equal    ${nbr_id}[0]    ${id}

check neighbor state
    [Arguments]    ${result}    ${state}
    ${nbr_state}=  dq query    data=${result}    filters=contains('neighbors').get_values('state')
    Should be Equal    ${nbr_state}[0]    ${state}
```

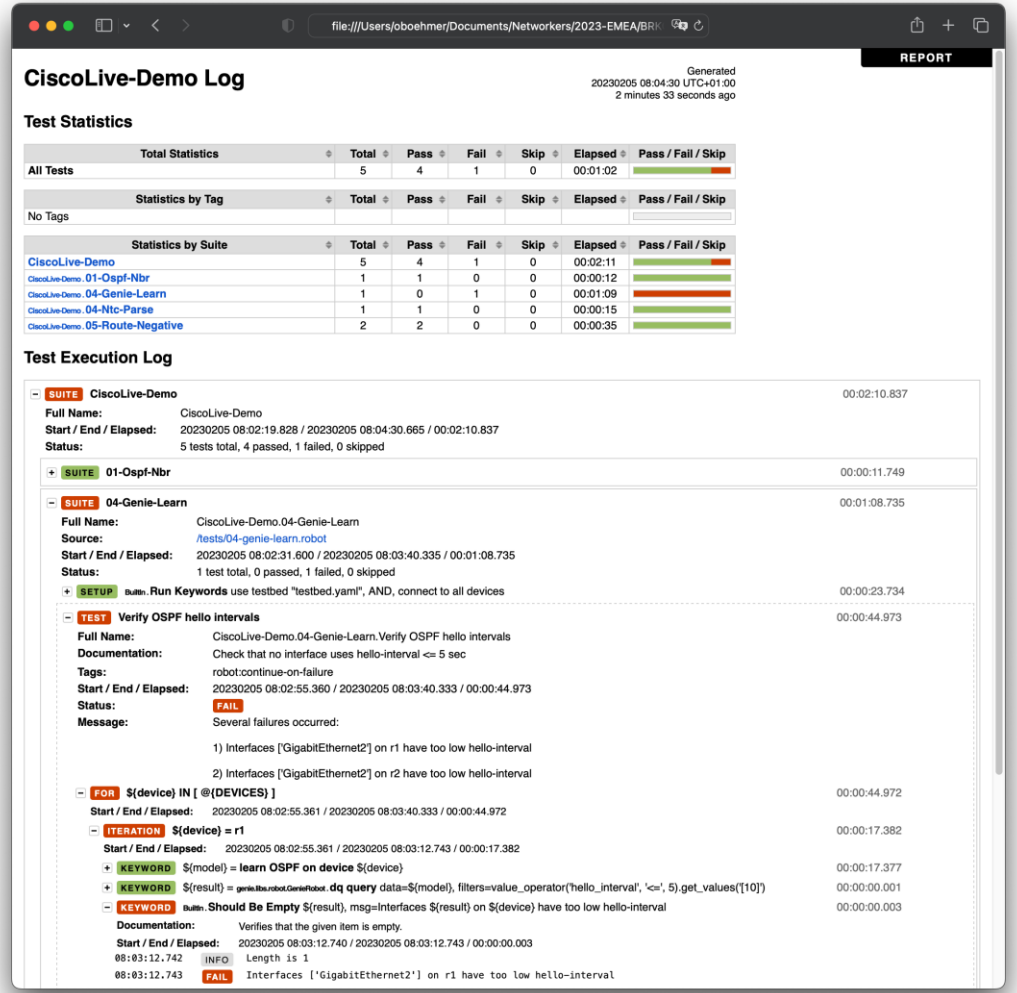
Import Keyword Libraries
(essentially python class whose methods are exposed as keywords)

A Test Case passes if all its keywords pass

Robot keywords for repeated steps or to hide complexity from test case definition

RobotFramework Logging

- Powerful logging capability
- All execution logs also available as XML



https://oboehmer.github.io/BRKOPS-2312/

pyATS Example – aetest (python)

```python
from pyats import aetest


class CommonSetup(aetest.CommonSetup):

    @aetest.subsection
    def connect(self, testbed):
        testbed.devices.r1.connect()
        self.parent.parameters['uut'] = testbed.devices.r1


class VerifyOspfNeighbors(aetest.Testcase):

    @aetest.test
    def verify_ospf_neighbors(self, uut):
        output = uut.parse('show ip ospf neighbor GigabitEthernet2 detail')
        neighbor_rid = output.q.contains('neighbors').get_values('neighbor_router_id')[0]
        if neighbor_rid != '10.0.0.2':
            self.failed(f'Neighbor router id {neighbor_rid} is unexpected')
        neighbor_state = output.q.contains('neighbors').get_values('state')[0]
        if neighbor_state != 'full':
            self.failed(f'Neighbor state {neighbor_state} is unexpected')
        self.passed(f'Neighbor router {neighbor_rid} and state {neighbor_state} as expected')


class CommonCleanup(aetest.CommonCleanup):

    @aetest.subsection
    def subsection_cleanup_one(self, testbed):
        testbed.disconnect()
```

pyATS Example – Blitz (yaml)

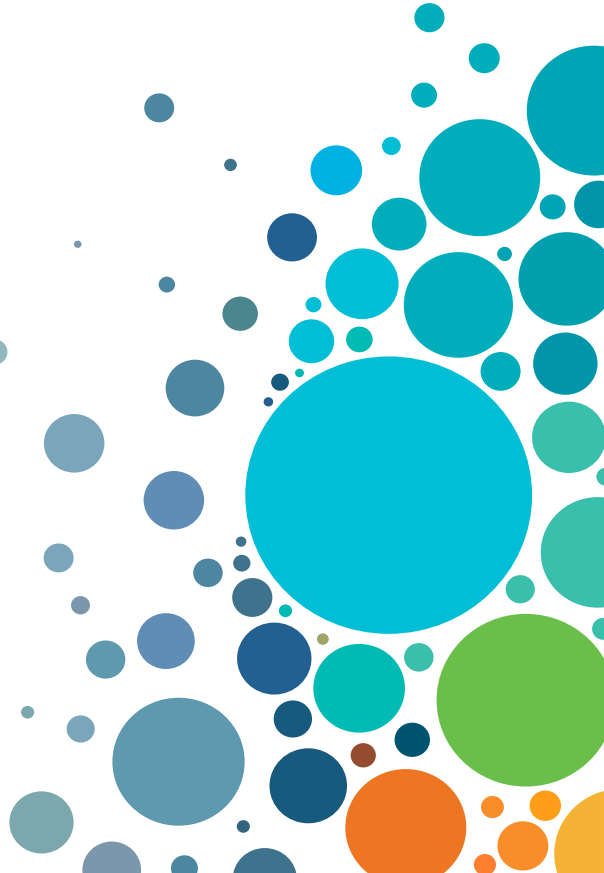
```yaml
# pyats Genie Blitz example
#
# run this via
#
#   pyats run genie --trigger-datafile 03-ospf-nbr-blitz.yaml --trigger-uids "Or('TestOspfNeighbors')" \
#                   --testbed-file testbed.yaml

TestOspfNeighbors:
  source:
    pkg: genie.libs.sdk
    class: triggers.blitz.blitz.Blitz

  test_sections:
    - test_ospf_neighbors:
      - parse:
          device: r1
          command: show ip ospf neighbor GigabitEthernet2 detail
          include:
          - contains('neighbors').contains('10.0.0.2').contains_key_value('neighbor_router_id', '10.0.0.2')
          - contains('neighbors').contains('10.0.0.2').contains_key_value('state', 'full')
```

DUT? What's a DUT?

Dealing with your (physical) Testbed



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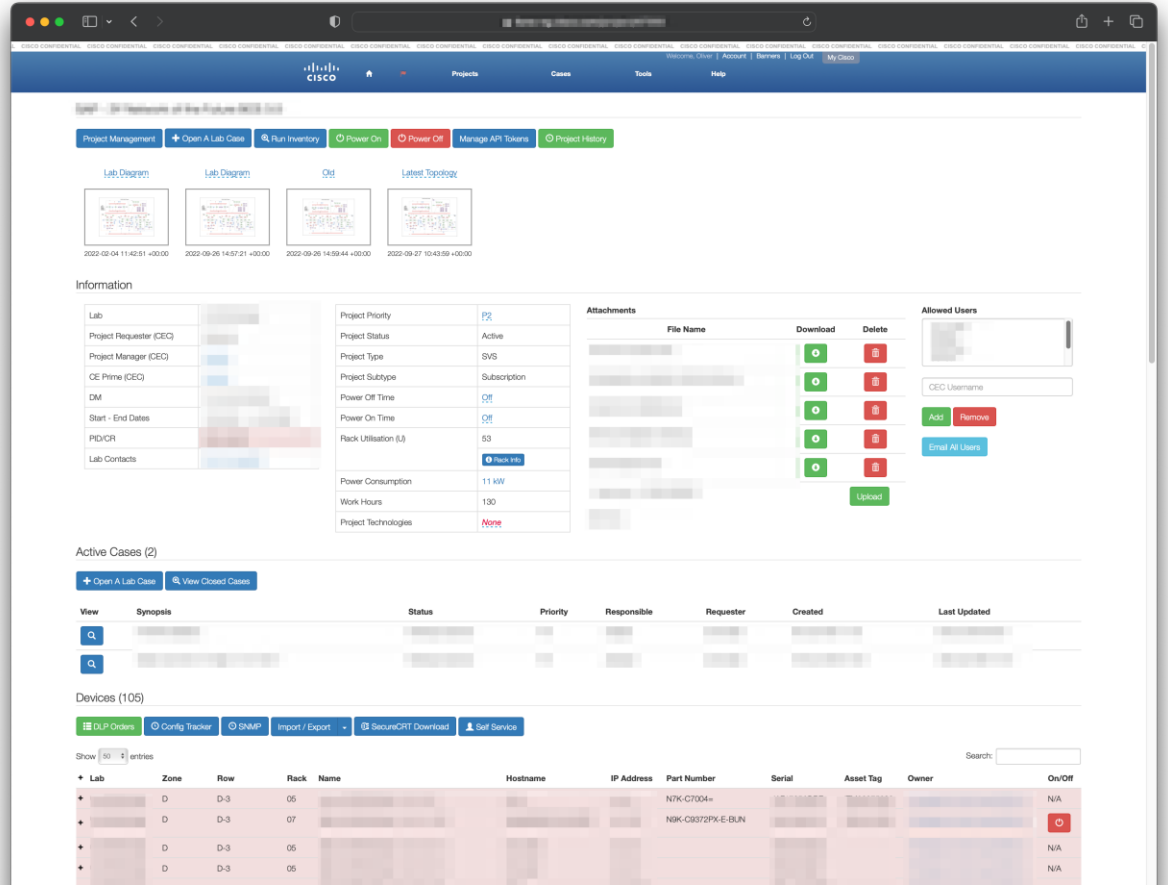
*) Device Under Test

Lab Device Inventory Management

- Not an easy task, but super-helpful for
  - Central repository
  - Lab Documentation
  - Device Reservation
  - Remote power-on/off
  - Scheduled power-off out-of-hours/weekends



Captain Obvious: Don't Hardcode Topology Info Within Your Test Cases

2

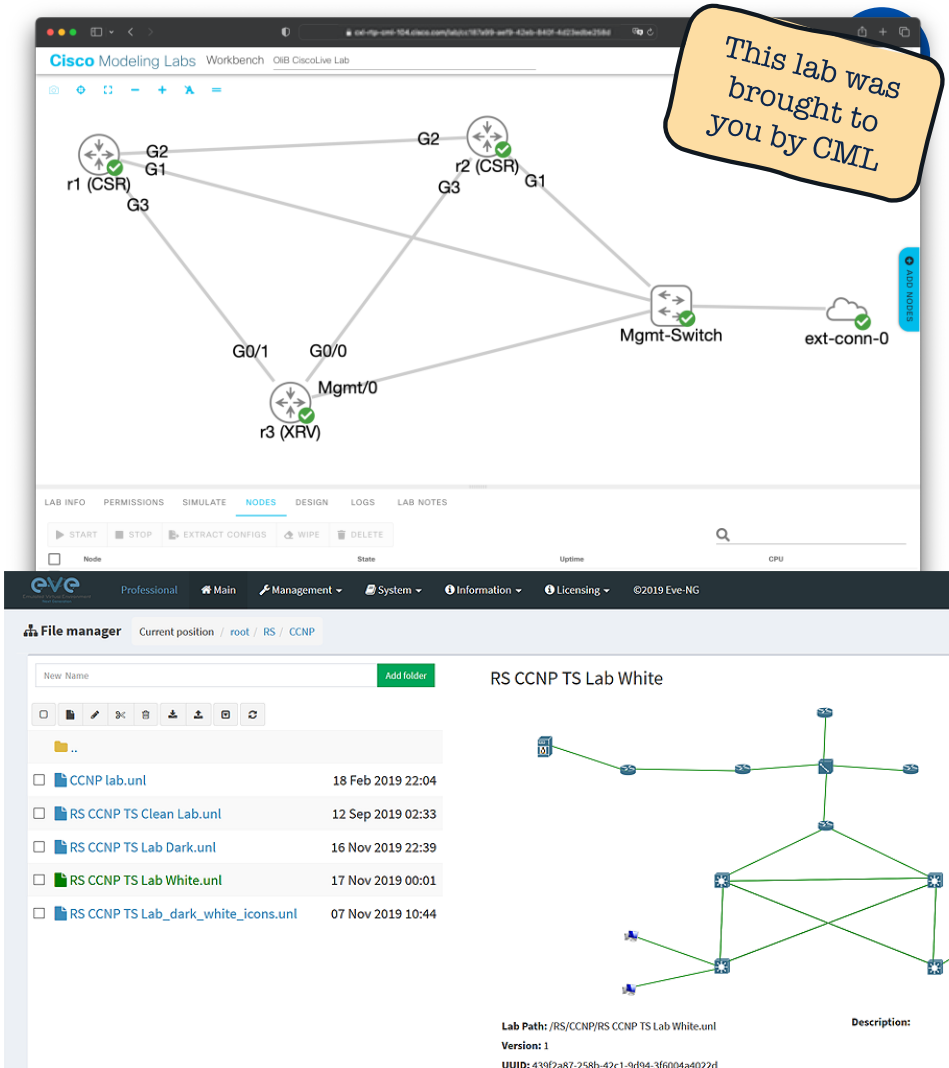
- All decent test frameworks support some form of external parameter definition
- Use it!
- Allows you to easily port your tests to a different environment
- Testbed.yaml (as shown here) required for pyATS

```yaml
testbed:
  credentials:
    default:
      username: cldemo
      password: "%ENV{DEVICE_PASSWORD}"

# Please note that the device names (i.e. r1, r2, etc. in below example)
# need to match the actual hostname configured on the device!!!
devices:
  r1:
    os: iosxe
    connections:
      cli:
        protocol: ssh
        ip: 10.12.63.11
  r2:
    os: iosxe
    connections:
      cli:
        protocol: ssh
        ip: 10.12.63.12
  r3:
    os: iosxr
    credentials:
      default:
        username: cisco
        password: cisco
    connections:
      cli:
        protocol: ssh
        ip: 10.12.63.13
```

Full pyATS Testbed Schema:
https://pubhub.devnetcloud.com/media/pyats/docs/topology/schema.html

Physical or Virtual Devices?

- Virtualisation rulez!
- Throw in a couple of “real” devices as device-under-test (DUT)
- Scale/stress testing typically demands physical kit



Prepare Your Testbed

- Don’t assume “your” routers are in the state you left them
- Set them to a well-defined state
- Verify the state before starting tests

pyATS
print(network.profile)

“Kleenex”

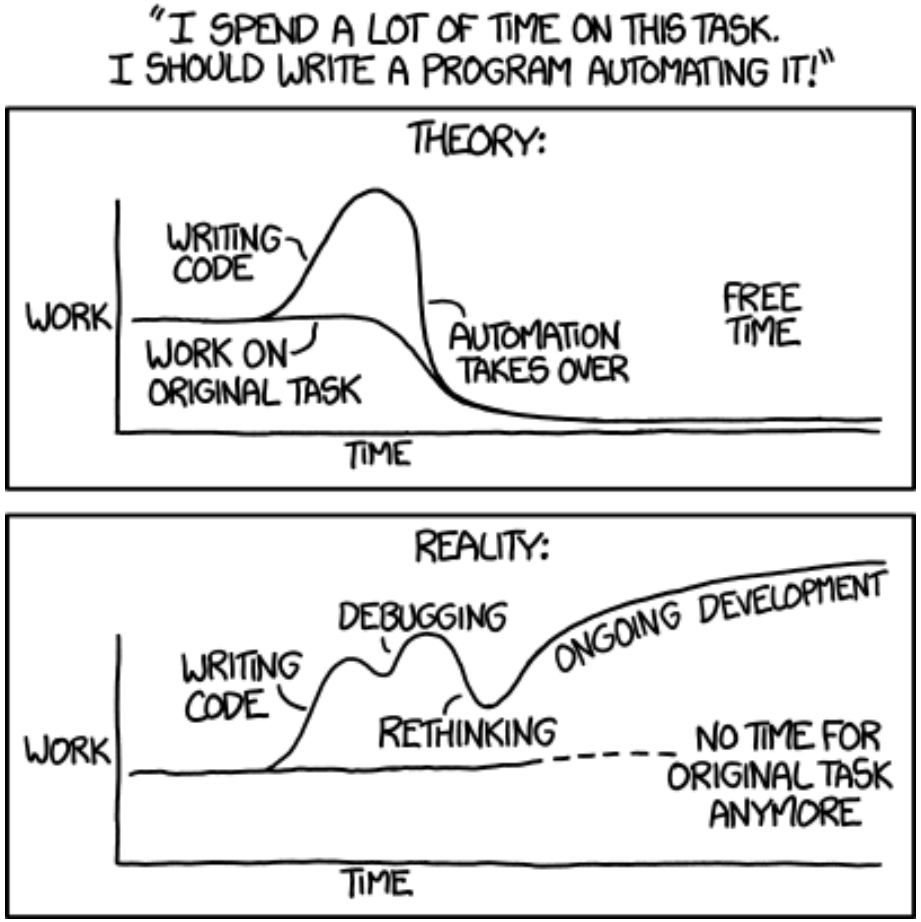
```yaml
cleaners:
  PyatsDeviceClean:
    module: genie.libs.clean
    groups: [WAN]

groups:
  WAN:
    devices: [router1, router2]
    order:
      - connect
      - copy_to_device
      - change_boot_variable
      - write_erase
      - reload
      - apply_configuration
      - verify_running_image
      - ping_server

    ####################

    connect:
      via: a

    ping_server:
      server: 10.2.0.254
      vrf: Mgmt-intf

    write_erase:

    copy_to_device:
      origin:
        hostname: ftp
        files:
          - isr4300-universalk9.16.06.05.SPA.bin
      destination:
        directory: 'bootflash:'
      protocol: ftp
      overwrite: True
      verify_num_images: False
      check_file_stability: True
      min_free_space_percent: 50
      vrf: Mgmt-intf

    change_boot_variable:
      images:
        - bootflash:/isr4300-universalk9.16.06.05.SPA.bi

    verify_running_image:
      images:
        - bootflash:isr4300-universalk9.16.06.05.SPA.bin

    reload:
      reconnect_via: a
      check_modules:
        check: False

    # apply basic configuration to startup, will be define
    # devices further down
    apply_configuration:

devices:
  router1:
    apply_configuration:
      configuration_from_file: configs/r-1.txt
  router2:
    apply_configuration:
      configuration_from_file: configs/r-2.txt
```

pyATS Clean Documentation:
https://pubhub.devnetcloud.com/media/genie-docs/docs/clean/index.html
Examples: https://github.com/CiscoTestAutomation/examples/blob/master/clean

Finally!

Writing *better* network device/ service tests

Been There, Done That???



https://xkcd.com/1319

- Start with things you do very often!
- Be pragmatic in your approach, network testing is no software-development contest
- Always prefer APIs over Web User Interfaces or CLI
- I feel a low-code approach with a suitable test framework helps to avoid this trap

Plan and Organize Your Test Cases

- Get an overview of your complete test plan to identify repetitive tasks
- Define and maintain your own library of re-usable tests / keywords
- Keep test cases short and concise, when possible
- Build self-contained tests: Avoid dependencies between test cases
- Maintain your test cases in Git, treat them like code (with pipeline, linter, dry-run, etc.)

```
# Sample directory structure for our projects
├── data
│   ├── common.yaml
│   └── topology
│       └── testbed.yaml
├── jobfiles
│   ├── asr9010
│   │   ├── 1.1_Router_Management
│   │   │   ├── 1.1.1.1_Initial_Hardware_ROMMON.robot
│   │   │   ├── 1.1.1.2_Software_Verification.robot
│   │   │   ├── …
│   │   ├── 1.2_Functional
│   │   │   ├── 1.2.1.3_Netflow_MPLS.robot
│   │   │   ├── 1.2.1.4_Netflow_IPv4.robot
│   │   │   ├── …
│   │   ├── 1.4_Network_Services
│   │   │   ├── …
│   │   ├── 1.5_Resiliency_and_HA
│   │   │   ├── …
│   │   ├── 1.6_Service_Availability
│   │   │   ├── …
│   │   └── 1.7_Stability
│   │   │   ├── …
└── resources
    ├── CX_Baseline_Robot
    │   ├── cx_baseline_robot.resource
    │   ├── keywords
    │   │   ├── baseline_bfd.resource
    ├── CX_SP_Robot
    │   ├── cx_sp_robot.resource
    │   ├── keywords
    │   │   ├── iosxr
    │   │   │   ├── compare_resources
    │   │   │   │   ├── compare_Parsed.py
    │   │   │   │   └── iosxr_compare_parsed.yaml
    │   │   │   ├── iosxr_bfd.resource
    └── project.resource
```

Parsing CLI Output

3

- Leverage pyATS Genie parsers when parsing command output
- Alternatively, Network-to-Code's (NTC) Texfsm templates*) are quite powerful too
  - Example in git repo (04-ntc-parse.robot)

04-genie-learn.robot

```
*** Settings ***
Library         pyats.robot.pyATSRobot
Library         unicon.robot.UniconRobot
Library         genie.libs.robot.GenieRobot
Library         Collections
Suite Setup     Run Keywords    use testbed "testbed.yaml"    AND    connect to all devices

*** Variables ***
&{OSPF_MODELS}                      # will contain parsed OSPF models from all devices
@{DEVICES}        r1    r2    r3      # r1,r2 are iosxe, r3 is iosxr device

*** Test Cases ***
Verify OSPF hello intervals
    [Documentation]    Check that no interface uses hello-interval <= 5 sec
    [Tags]    robot:continue-on-failure

    FOR    ${device}    IN    @{DEVICES}
        ${model}=     learn OSPF on device    ${device}
        ${result}=    dq query    data=${model}
        ...                       filters=value_operator('hello_interval', '<=', 5).get_values('[10]')

        Should Be Empty    ${result}    msg=Interfaces ${result} on ${device} have too low hello-interval
    END

*** Keywords ***
learn OSPF on device
    [Arguments]    ${device}
    ${result}=    learn "ospf" on device "${device}"
    # convert result to qdict.. a bit ugly
    ${qdict}=     Evaluate    genie.conf.base.utils.QDict($result.to_dict())
    Log Dictionary    ${qdict}
    RETURN    ${qdict}
```

*) https://github.com/networktocode/ntc-templates

Testing Negative Scenarios

- Testing negative scenarios is very common
- Often you can easily turn a positive test into a negative one

3

05-route-negative.robot

```
*** Settings ***
Library         pyats.robot.pyATSRobot
Library         unicon.robot.UniconRobot
Library         genie.libs.robot.GenieRobot

Suite Setup     Run Keywords    use testbed "testbed.yaml"    AND    connect to all devices

*** Variables ***
${edge_device}        r3
${core_device}        r1
${route_positive}     10.100.99.0/24
${route_negative}     192.168.99.0/24

*** Test Cases ***
Positive route distribution test
    ${cmd}=    Set Variable    router static address-family ipv4 unicast ${route_positive} Null0
    configure "${cmd}" on device "${edge_device}"
    Sleep    1
    validate route on device    ${core_device}    ${route_positive}
    [Teardown]    configure "no ${cmd}" on device "${edge_device}"



*** Keywords ***
validate route on device
    [Arguments]    ${device}    ${prefix}
    ${output}=      parse "show ip route ospf" on device "${device}"
    ${routes}=      dq query    data=${output}    filters=contains('${prefix}')
    Should Not Be Empty    ${routes}    msg=Route not found
```

Testing Negative Scenarios

- Testing negative scenarios is very common
- Often you can easily turn a positive test into a negative one

05-route-negative.robot

```
*** Settings ***
Library         pyats.robot.pyATSRobot
Library         unicon.robot.UniconRobot
Library         genie.libs.robot.GenieRobot

Suite Setup     Run Keywords    use testbed "testbed.yaml"    AND    connect to all devices

*** Variables ***
${edge_device}        r3
${core_device}        r1
${route_positive}     10.100.99.0/24
${route_negative}     192.168.99.0/24

*** Test Cases ***
Positive route distribution test
    ${cmd}=    Set Variable    router static address-family ipv4 unicast ${route_positive} Null0
    configure "${cmd}" on device "${edge_device}"
    Sleep    1
    validate route on device    ${core_device}    ${route_positive}
    [Teardown]    configure "no ${cmd}" on device "${edge_device}"

Negative route distribution test
    ${cmd}=    Set Variable    router static address-family ipv4 unicast ${route_negative} Null0
    configure "${cmd}" on device "${edge_device}"
    Sleep    1
    Run Keyword and Expect Error    Route not found
    ...    validate route on device    ${core_device}    ${route_negative}
    [Teardown]    configure "no ${cmd}" on device "${edge_device}"

*** Keywords ***
validate route on device
    [Arguments]    ${device}    ${prefix}
    ${output}=      parse "show ip route ospf" on device "${device}"
    ${routes}=      dq query    data=${output}    filters=contains('${prefix}')
    Should Not Be Empty    ${routes}    msg=Route not found
```

Sweet Spot for Automation: Convergence / Failure Tests

3

- Pain to do without automation help
- Some actions might require someone walking down to pull cables/linecards/etc.
- “Proper” Traffic Generators help, but simple ping on adjacent Linux VM also do good

```
*** Test Cases ***
Reload of A9K-24X10GE-1G-SE Linecard
    [Tags]    DUT=${DUT_1}    Test_type=Resilience    Disruptive=Yes
    clear snmp and syslog logs
    Step 1 - Start Ixia traffic and confirm no traffic drops
    Step 2 - Check status before down event
    Step 3 - Down event
    Step 4 - Check status after down event and before up event
    Step 5 - Get traffic stats from Ixia after down event
    Step 6 - Reset traffic statistics and confirm no traffic drops
    Step 7 - Up event
    Step 8 - Check status after up event
    Step 9 - Get traffic stats from Ixia after up event
    Step 10 - Reset traffic statistics and confirm no traffic drops
    Compare parsed outputs from before down event (step 2) and after
    Compare parsed outputs from before down event (step 2) and after
```

Full test in 06-Convergence-Reload_of_LC.robot

Wrapping Up

Key Take-Aways

- An **appropriate** testing framework for your organization makes ALL the difference

- Leverage virtualization
- Clean your test bed to ensure it is in a defined state

- Focus on repetitive task first
- Create re-usable test cases / test primitives
- Re-use existing parsers

Further Reading / Playing / Testing

- All examples from this session: https://github.com/oboehmer/BRKOPS-2312
- RobotFramework
  - Docs: https://docs.robotframework.org/
  - How to Write Good Test Cases: https://github.com/robotframework/HowToWriteGoodTestCases/blob/master/HowToWriteGoodTestCases.rst
  - Some sample robot tests from previous CiscoLive events: https://oboehmer.github.io/CLEUR20-CXTA/ https://developer.cisco.com/learning/labs/devwks-2155
- pyATS
  - Docs: https://developer.cisco.com/docs/pyats/
  - Many examples: https://github.com/CiscoTestAutomation/examples
  - DevNet Learning Labs:
    - Intro to pyATS: https://developer.cisco.com/learning/labs/intro-to-pyats
    - Introduction to NetDevOps using pyATS: for Non-programmers (DEVWKS-1749): https://developer.cisco.com/learning/labs/devwks-1749m/
    - Writing Reusable Libraries (Parsers/APIs) using pyATS (DEVWKS-3280): https://developer.cisco.com/learning/labs/devwks-3280m/

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	Tuesday	Wednesday	Thursday
08:30	Automated Testing for your Network LTRATO-2001, 4 hours		Test Automation for everyone using CXTA LTROPS-1964, 4 hours
14:00	You are here ☺ BRKOPS-2312 Significance of CX Test Automation Framework for Validating SP Technology DEVNET-2959, 45 mins		Robot Framework – Automated Cisco NSO Testing TSCSPG-2011, 30 mins
16:00		Building your Certification Test Suites using pyATS DEVNET-2744, 45 mins	

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