Automated network OS testing

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Network OS testing at OBS

- Orange Business Services (OBS) – worldwide telecommunications operator and service provider for enterprise market
- main features of network: L3VPN, L2VPN, BGP, ISIS, MPLS, MPLS/TE, QoS, LAC, IPv6, LDP, etc…
- 3 labs with real and virtual devices simulating our network
- 3 locations and around 35 people working on tests and development
- usual test of network feature: prepare and check testbed, put configuration of feature, check state of device and feature, do some bad things if needed, check stability and finish
- 70% of checks and 30% of configuration

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Testing challenges

- increase of complexity of network and network OSes in order to provide more and more features to customers
- many recurring tests (small/mid complexity)
- isolation of human error / overlook
- people need to focus on development of new features rather than testing of old ones
- reduce time to test network OS before deployment on live network

=> WE SHOULD AUTOMATE

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Key factors of automation in OBS

- verification of operational state is key
- YANG models for operational state are still heavily evolving => not all monitored attributes covered, available only in newer OS releases / router platforms
- Netmiko – simple management of device via ssh, push command / get output
- NAPALM has support for configuration and operational state :
- CISCO IOS/IOS-XE - screen scrapping and parsing
- Juniper JunOS – processing of xml reply received over NETCONF
- Ansible – focus on provisioning and controlling
- - Junos PyEZ – configuration + operational state for JunOS only

NAPALM is the winner, because…

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NAPALM

- open source project
- implements a set of functions using a unified API to different router vendor network devices (ios, ios-xr, junos, nx-os,…)
- replacing/merging/comparing of configuration
- rollback of configuration
- retrieving operational data (interfaces' ip/state, BGP neighbors details, cpu, memory,…)
- can be integrated in ansible, SaltStack

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OBS NAPALM extension

- functions to provide operational data for IS-IS, LDP, BFD, BGP, PIM, MPLS TE, …
- created for ios-xe and junos
- tested on CISCO ASR1K, CISCO 76xx, Juniper MX480
- some functions are specific to one vendor or are platform specific
- unification of various output
- new code will be published as official napalm code or standalone extension, point to discuss with NAPALM maintainer

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functions added for Juniper platform:

- **get_redundancy_info**
- **get_card_type_info**
- **get_mx_re_memory_info**
- **get_mx_active_re_memory_info**
- **get_isis_neighbors_detail**
- **get_isis_topology**
- **get_bfd_neighbors_detail**
- **get_ldp_igp_sync**
- **get_ldp_neighbors**
- **get_pim_neighbors(_vrf)**
- **get_pim_joins(_vrf)**
- **get_multicast_route(_vrf)**
- **get_mvpn_info**
- **get_l2ckt_connections**
- **get_vpls_connections**
- **get_interfaces_rates**
- **get_route_summary(_vrf)**
- **get_fib_table(_vrf)**

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functions added for CISCO platform:

- **get_redundancy_info**
- **get_card_type_info**
- **get_asr1k_slot_memory_info**
- **get_isis_neighbors_detail**
- **get_isis_topology**
- **get_bfd_neighbors_detail**
- **get_ldp_igp_sync**
- **get_ldp_neighbors**
- **get_mpls_l2transport_summary**
- **get_mpls_te_tunnels_brief**
- **get_ip_route_summary(_vrf)**
- **get_ip_cef(_vrf)**
- **get_interfaces_rates**
- **get_xconnect_all**
- **get_bgp_all_summary**
- **get_pim_neighbors(_vrf)**
- **get_ip_mroute(_vrf)**
- **get_ip_mfib (_vrf)**
- **get_ip_mfib_active(_vrf)**
- **get_vrf**
- **get_bgp_vpnv4_vrf**

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NAPALM example

- Test name: Reload Test
- Test description: Connect to router, get global operational state of router, execute full reload, connect after 30minutes, get global operational state again and compare with outputs with state gathered before reload
- Pass criteria: Operational state before and after reload of device must be same, with some tolerance (memory, dynamic virtual interfaces name, routing protocol peers uptime,…)

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CISCO CLI:

```
Bnet-A1#sh isis neighbors detail
System Id       Type Interface     IP Address      State Holdtime Circuit Id
Bnet-P1         L2   Gi3/0/17      192.168.244.189 UP    29       00
  Area Address(es): 65.0421
  SNPA: e4c7.2259.96c5
  State Changed: 1d01h
  Format: Phase V
  Remote TID: 0
  Local TID:  0
  Interface name: GigabitEthernet3/0/17
  Neighbor Circuit Id: 78
  BFD enabled: (MTID:0, ipv4)
Bnet-P1         L2   Gi3/0/8.1308  192.168.244.109 UP    23       00
  Area Address(es): 65.0421
  SNPA: e4c7.2259.96b4
  State Changed: 1d01h
  Format: Phase V
  Remote TID: 0
  Local TID:  0
  Interface name: GigabitEthernet3/0/8.1308
  Neighbor Circuit Id: 116
  Remote BFD Support: (MTID:0, IPV4)
System Id       Type Interface     IP Address      State Holdtime Circuit Id
  BFD enabled: (MTID:0, ipv4)
Bnet-A1#
```

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- output from get_isis_neighbors from cisco platform:

```
'Bnet-P1': {u'Te3/1/0.1622': {u'area': u'65.0421',
                              u'bfd_enabled': u'(MTID:0, ipv4)',
                              u'circuit_id': u'00',
                              u'format': u'Phase V',
                              u'holdtime': u'24',     <==================== can be different after reload
                              u'ip_address': u'192.168.244.250',
                              u'level': u'L2',
                              u'local_tid': u'0',
                              u'remote_bfd_support': u'(MTID:0, IPV4)',
                              u'remote_tid': u'0',
                              u'snpa': u'e4c7.225b.8d2f',
                              u'state': u'UP',
                              u'state_changed': 80892}, <==================== can be different after reload
            u'Te3/1/1': {u'area': u'65.0421',
                         u'bfd_enabled': u'(MTID:0, ipv4)',
                         u'circuit_id': u'00',
                         u'format': u'Phase V',
                         u'holdtime': u'28', <==================== can be different after reload
                         u'ip_address': u'192.168.244.50',
                         u'level': u'L2',
                         u'local_tid': u'0',
                         u'remote_bfd_support': u'(MTID:0, IPV4)',
                         u'remote_tid': u'0',
                         u'snpa': u'70e4.2219.9f8f',
                         u'state': u'UP',
                         u'state_changed': 80895}}} <==================== can be different after reload
```

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- output from get_asr1k_slot_memory_info from cisco platform:

```
  '0': {u'state': u'ok', u'type': u'ASR1000-SIP40'},
'0/0': {u'state': u'ok', u'type': u'SPA-5X1GE-V2'},
'0/1': {u'state': u'ok', u'type': u'SPA-5X1GE-V2'},
'0/2': {u'state': u'ok', u'type': u'SPA-4XT3/E3-V2'},
'0/3': {u'state': u'ok', u'type': u'SPA-4X1FE-TX-V2'}
```

- output from get_environment from cisco platform:

```
u'cpu': {0: {u'%usage': 11.0}},
u'fans': {u'invalid': {u'status': True}},
u'memory': {u'available_ram': 8619809248, u'used_ram': 1632733416}, <====== +/- 5% tolerance
u'power': {u'invalid': {u'capacity': -1.0, u'output': -1.0, u'status': True}},
u'temperature': {u'invalid': {u'is_alert': False,
                              u'is_critical': False,
                              u'temperature': -1.0}}
```

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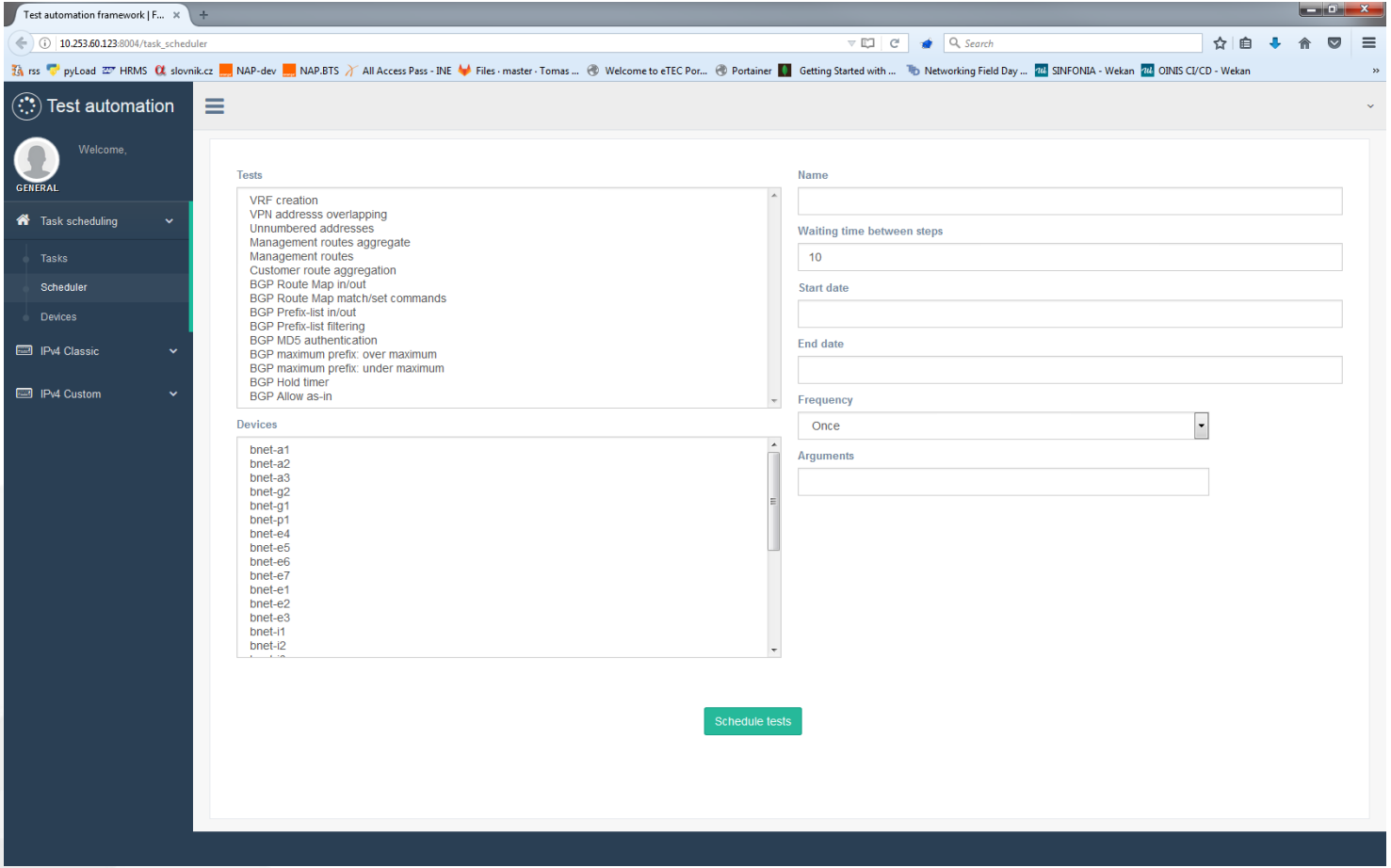

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Evolution?

- Robot Framework = generic open source automation framework for acceptance testing, acceptance test driven development and process automation
- high-level “keywords” instructs what to do, usually have input arguments and output value
- built- in keywords
- custom keywords directly in test suite or in external library (Python or Java)
- final test report generated in html
- easy integration into CI/CD

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Robot Framework test example - file *csnog-demo.robot*

```
*** Settings ***
Documentation    Demo script for CSNOG 2019:
...                - Requiremtns: NAPALM (pip install napalm)
...                - Please update SUT parameters

Library    OBSRobotNapalm.OBSRobotNapalm
Test setup   Connect device

*** Variables ***
${SUT}=    192.168.243.69
${LOGIN}=    auto_test_user
${PASSWORD}=    auto_test_user_password

*** Keywords ***
Connect device
    ${napalm-connection-SUT}=    Napalm Connect    ${SUT}    ${LOGIN}    ${PASSWORD}
    Set Suite Variable   ${napalm-connection-SUT}
```

< built-in keywords custom keywords from OBSNapalmRobot library >

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Robot Framework test description example

```
*** Test cases ***
TEST ISIS PEER FLAP
    [Documentation]    Check if ISIS peer is UP, clear ISIS process, check again
    ${isis_peer_ip}=    Set Variable    192.168.245.89
    ${command}=    Set Variable    clear isis *

    ${peer_state}=    Get ISIS Peer State    ${napalm-connection-SUT}    ${isis_peer_ip}
    Should Be Equal    UP    ${peer_state}

    Execute Operational Command    ${napalm-connection-SUT}    ${command}
    Sleep    100

    ${peer_state}=    Get ISIS Peer State    ${napalm-connection-SUT}    ${isis_peer_ip}
    Should Be Equal    UP    ${peer_state}

TEST BGP PEER FLAP
     <another test case>
```

< built-in keywords custom keywords from OBSNapalmRobot library >

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Robot Framework CLI output

```
(venv) tkubina@nap-dev:~/python/obs-eval-library$ robot csnog-demo.robot
==============================================================================
Csnog-Demo :: Demo script for CSNOG 2019:
==============================================================================
TEST ISIS PEER FLAP :: Check if ISIS peer is UP, clear ISIS proces... | PASS |
------------------------------------------------------------------------------
Csnog-Demo :: Demo script for CSNOG 2019:                             | PASS |
1 critical test, 1 passed, 0 failed
1 test total, 1 passed, 0 failed
==============================================================================
Output:  /home/tkubina/python/obs-eval-library/output.xml
Log:     /home/tkubina/python/obs-eval-library/log.html
Report:  /home/tkubina/python/obs-eval-library/report.html
(venv) tkubina@nap-dev:~/python/obs-eval-library$
```

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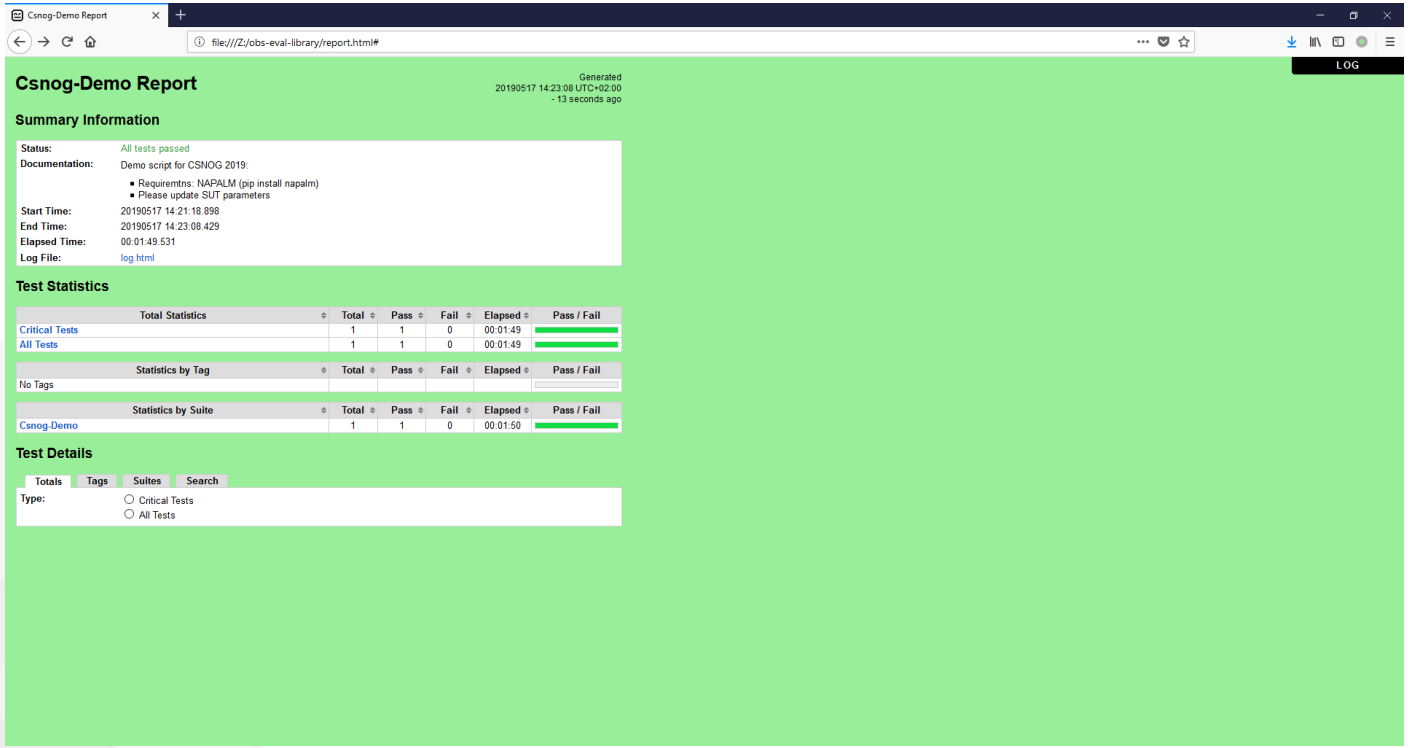
Robot Framework html report



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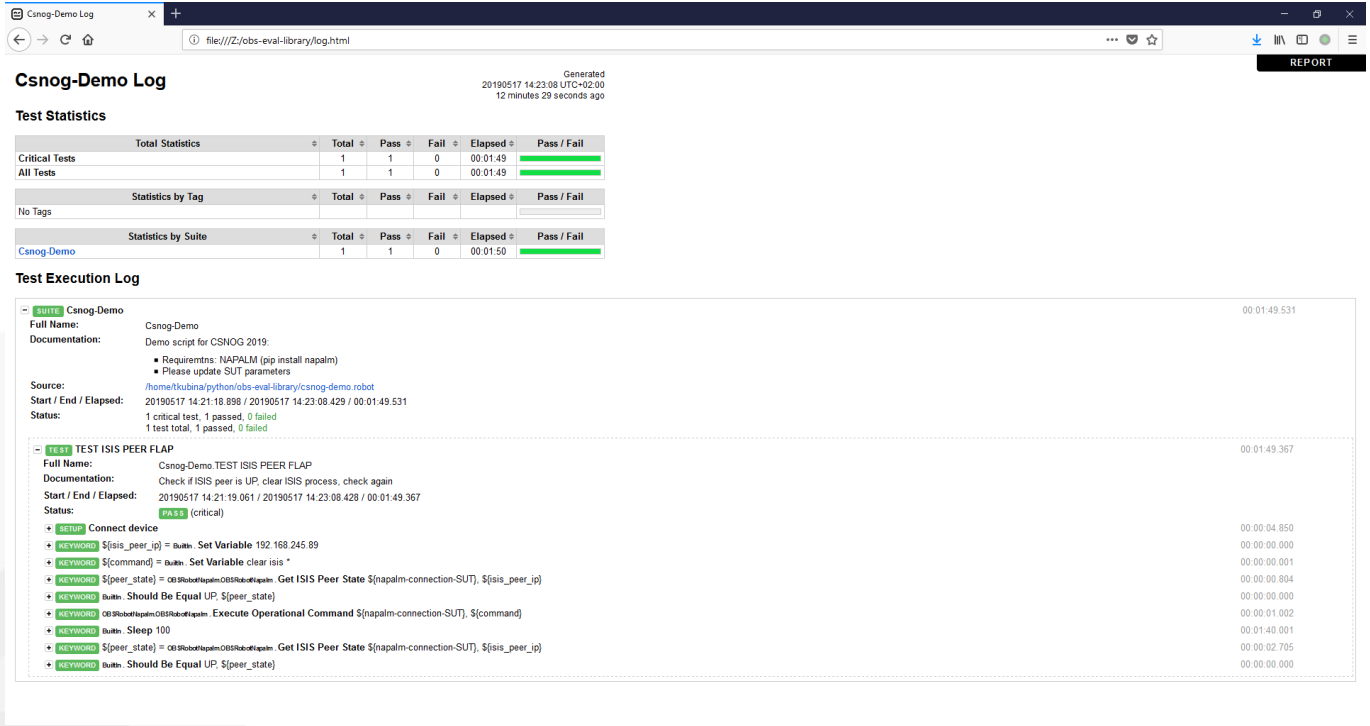
Robot Framework html report



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Robot Framework OBSRobotNapalm.py keyword library

```
from napalm import get_network_driver
from robot.api.deco import keyword

@keyword('Napalm Connect')
def napalm_connect(device, login, password):
    driver = get_network_driver('ios')
    device = driver(device, login, password)
    device.open()
    return device

@keyword('Get ISIS Peer State')
def get_isis_peer_state(device, peer_ip):
    isis_peers = device.get_isis_neighbors_detail()
    for peer_name in isis_peers:
        for interface in isis_peers[peer_name]:
            if isis_peers[peer_name][interface]['ip_address'] == \
               peer_ip:
                return isis_peers[peer_name][interface]['state']

    return 'None'
```

```
@keyword('Execute Operational Command')
def execute_op_command(device, command):

    return device._send_command(command)
```

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Thank you!

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Resources:

NAPALM *https://napalm-automation.net/*
Netmiko *https://github.com/ktbyers/netmiko*
Ansible *https://github.com/ansible*
YDK *http://ydk.cisco.com/py/docs/#*
Junos PyEZ *https://github.com/Juniper/py-junos-eznc*
NETCONF *https://tools.ietf.org/html/rfc6241*
YANG *https://napalm-automation.net/yang-for-dummies/*
Robot Framework *http://robotframework.org*

updated NAPALM repo:
https://github.com/tomaskubina/napalm/tree/obs_nie_experiment