CI/CD For Networks

Myth or Reality?

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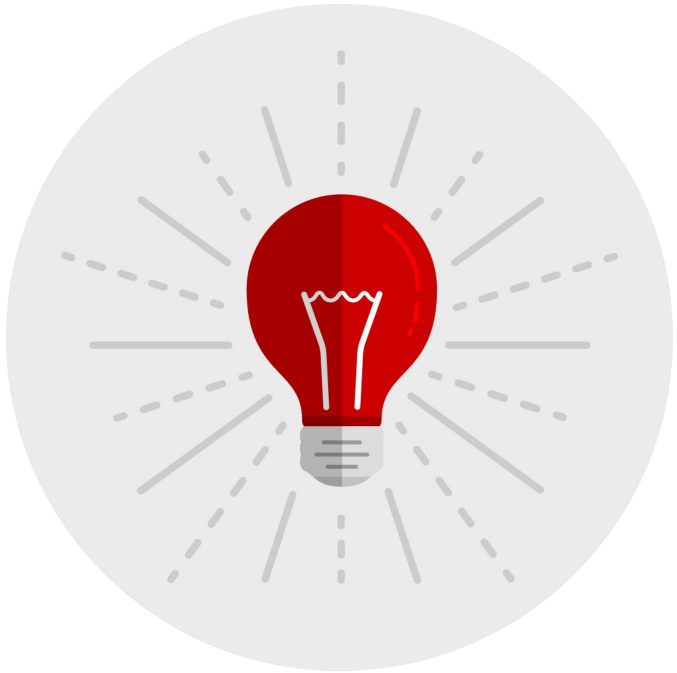
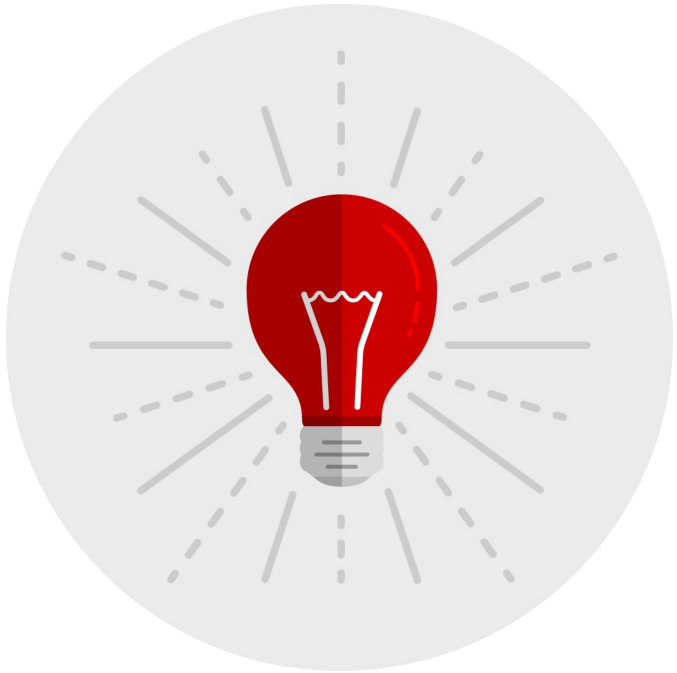
The idea of DevOps



Wikipedia

DevOps (a portmanteau of "development" and "operations") is a software development method that stresses communication, collaboration and integration between software developers and Information Technology(IT) professionals. DevOps is a response to the interdependence of software development and IT operations.

The idea of DevOps



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CI/CD

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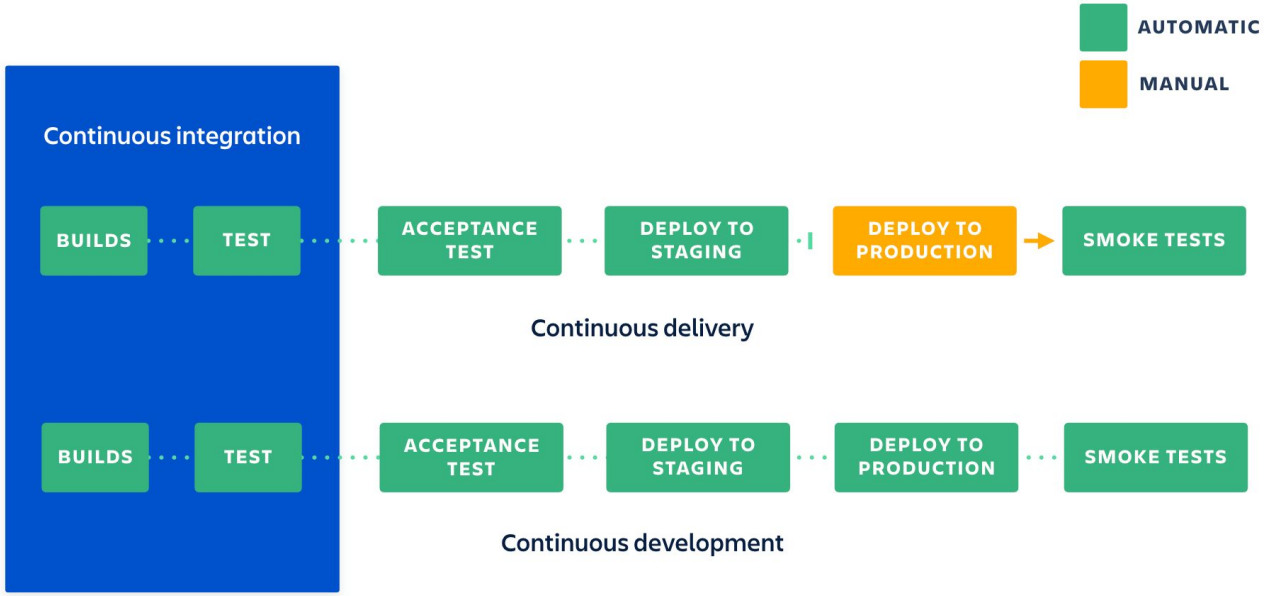

*Image source: https://www.atlassian.com/continuous-delivery/principles/continuous-integration-vs-delivery-vs-deployment

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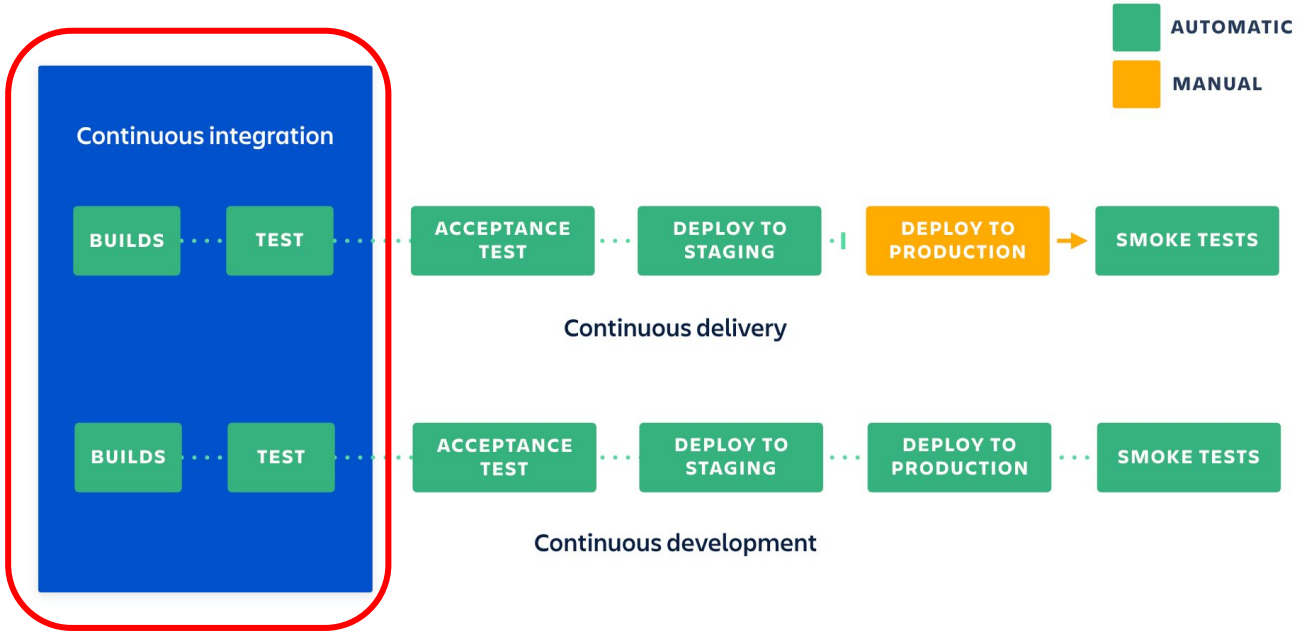

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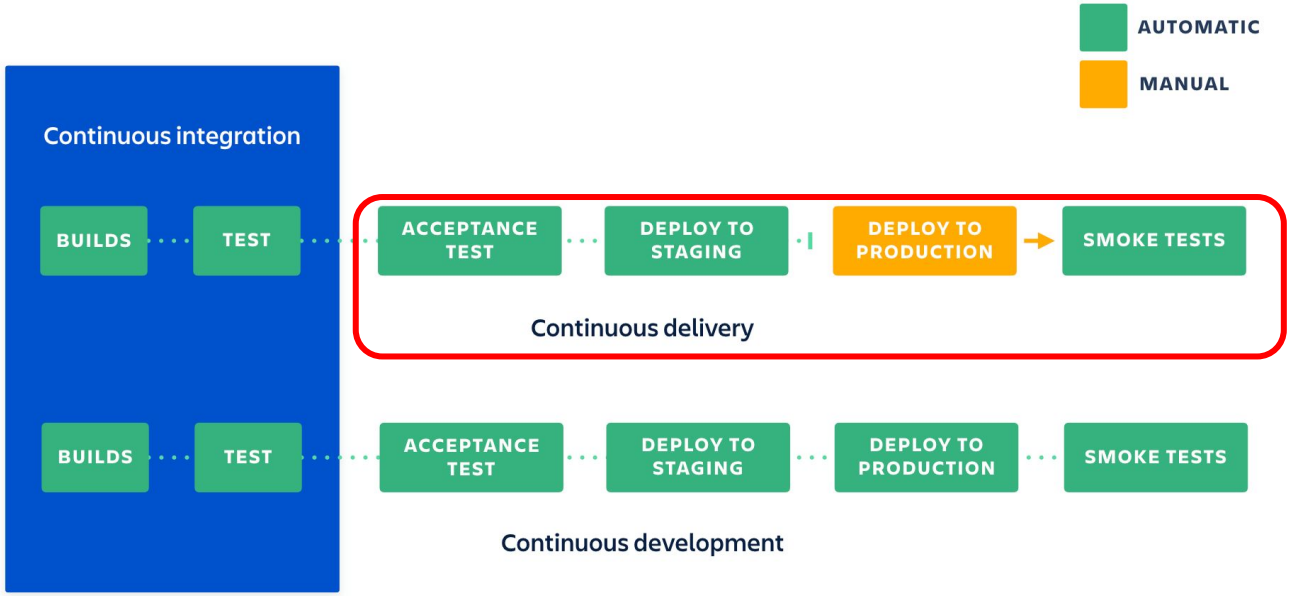

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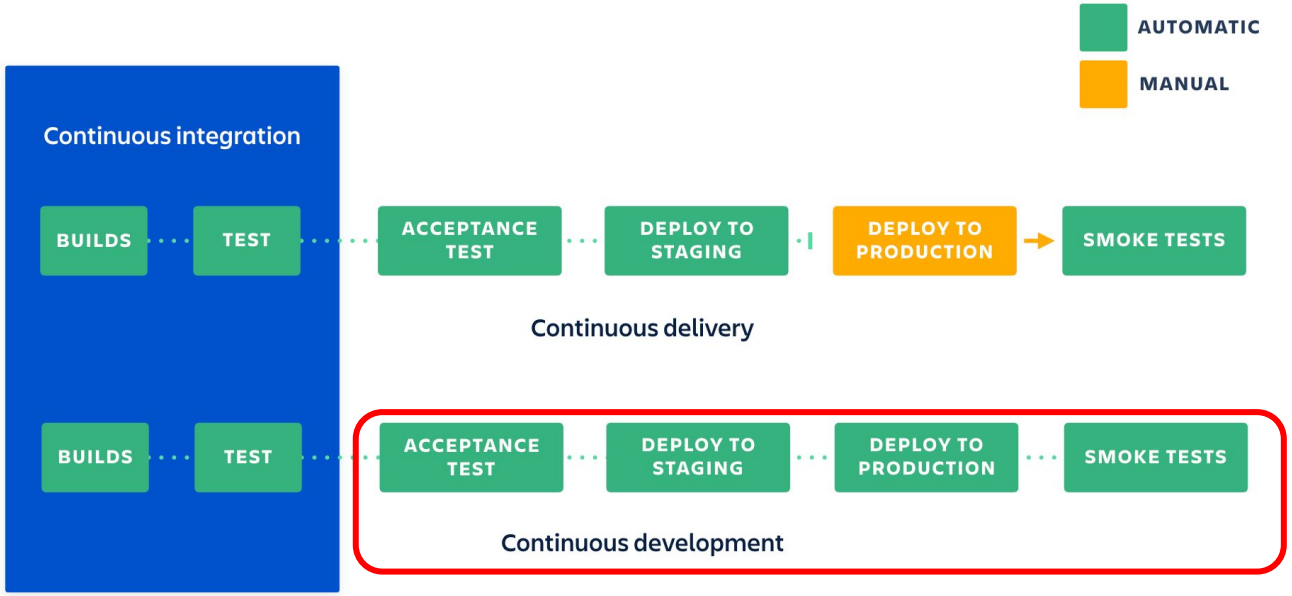

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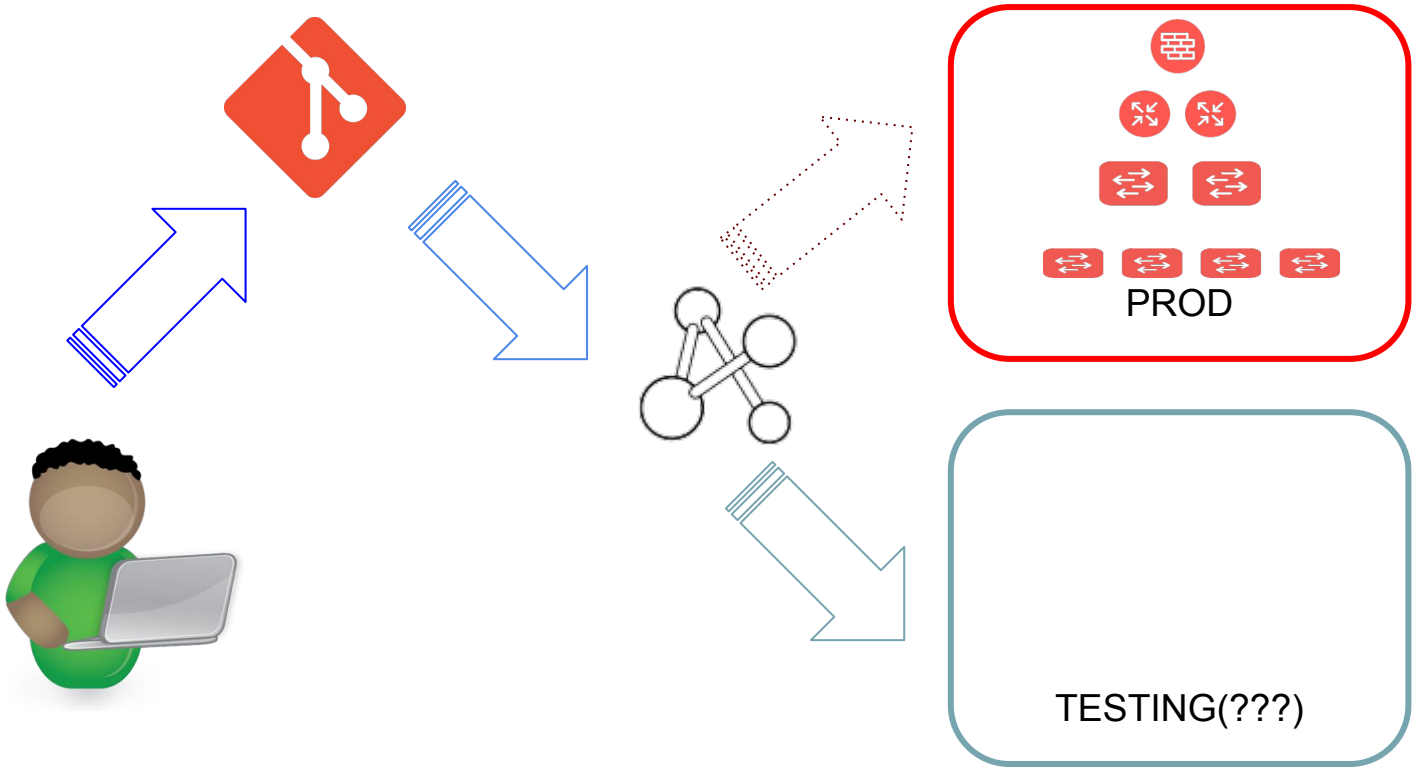
A CI/CD Walkthrough for a network change



1. When a new change to network Infrastructure as Code(IaC) repo is available, merge it to the main branch of the IaC repo
2. Generate device/vendor specific configuration out of this code
3. Deploy this configuration (entire network config and not just the partial config) “**somewhere**”
4. Deploy the application infrastructure on top of this infrastructure

Test....

.....that the new configurations

- ★ Did not break the app
- ★ Did not impact existing High Availability(HA)
- ★ Did not impact performance
- ★ Did in fact achieve the end goal

Testing

Testing on staged production(or a representative subset)

Pros:

- ➔ Great for validating HA, convergence, failures
- ➔ Ensures hardware/software compatibility with production
- ➔ Allows for testing one-off, ‘significant’ changes with confidence

Cons:

- ➔ Cost
- ➔ Configuration overhead
- ➔ Potential manual overhead

Testing on virtualized devices

Pros:

- ➔ Great for configuration linting
- ➔ Cost

Cons:

- ➔ Impossible to properly test throughput & convergence in a virtual environment
- ➔ Hardware/software differences with virtual devices
- ➔ Manual gate for many virtual devices (bootstrapping, initial setup, etc...)
- ➔ Many vendors do not offer 'true' virtual devices

Limitations of virtual devices

Network hardware is built on this premise: does hardware support feature X and does software take advantage of it? Therefore, software based devices/virtual machines are:

➔ Greate for management plane simulation
➔ Good for control plane
➔ Ok for very little data plane purposes.

Some examples:

- Not always able to test production versions on VMs
- No way to test in-line security appliances (bump in the wire)
- No way to map physical modules/ports to match production.
- No way to test hardware specific features:
  - 802.1x, Traffic Engineering, QinQ , QoS
- No way to test anything that requires buffer optimizations
- No way to test impact to application performance
- No way to test for link failures
- No way to replicate live production flows(Policy based routing)

Testing on production devices ?

Pros:

➔ Realistic

Cons:

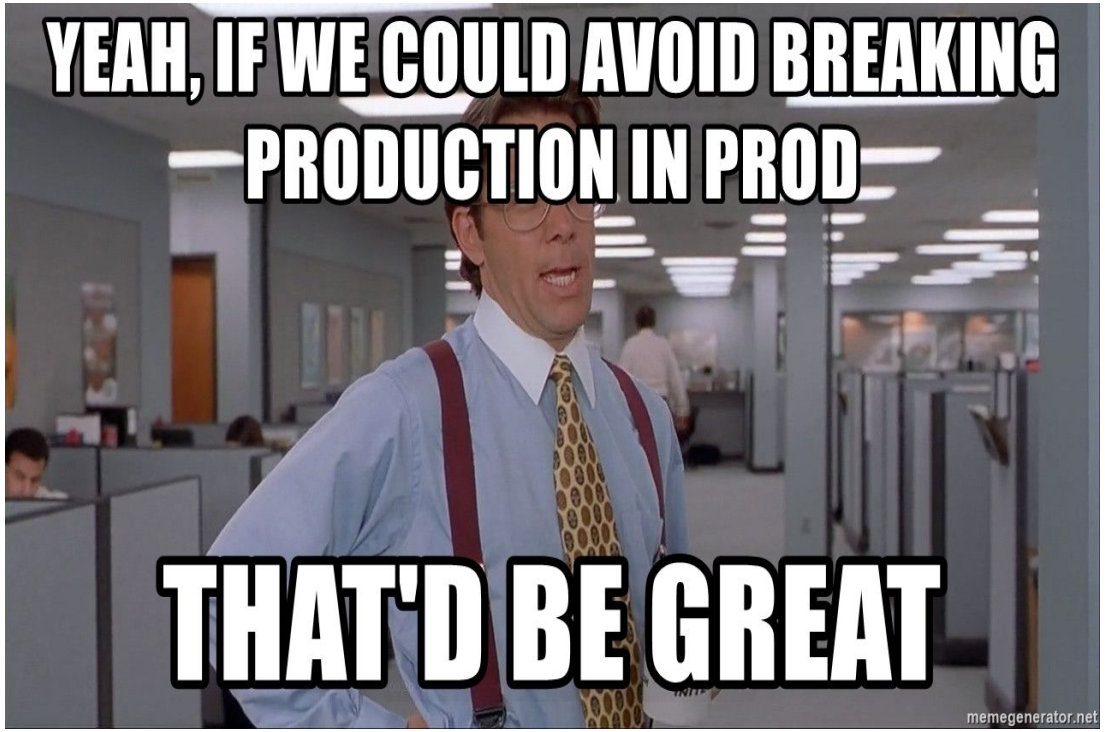
➔ Production!

However....

- ❑ Engineers have been doing it for ever
- ❑ Smarter tests
- ❑ Smaller changes more often over large changes every X weeks/months
- ❑ Controlled, periodic failure tests

Testing on production devices ?

… Don’t do it*



** Understand the limitations. Limit the scope*

Smarter testing: Linting the automation artifacts

- Yamllint
- Yanglint
- Ansible-lint
- Molecule
- Black
- Flake8
- Etc….

```
(myvenv) ~/P/m/3/playbooks ››› ansible-lint f5_init.yml
[206] Variables should have spaces before and after: {{ var_name }}
f5_init.yml:24
          provider: "{{rest}}"

[206] Variables should have spaces before and after: {{ var_name }}
f5_init.yml:32
          provider: "{{rest}}"

[206] Variables should have spaces before and after: {{ var_name }}
f5_init.yml:38
          provider: "{{rest}}"

(myvenv) ~/P/m/3/playbooks ›››
```

Smarter testing: Linting configuration

```
[ec2-user@ansible tmp]$ ansible-playbook network_system.yml -v --check --limit rtr1
Using /home/ec2-user/.ansible.cfg as config file
/home/ec2-user/hosts did not meet host_list requirements, check plugin documentation if th
is is unexpected
/home/ec2-user/hosts did not meet script requirements, check plugin documentation if this
is unexpected

PLAY [CONFIGURE SYSTEM CONFIGURATIONS] ***************************************************
****

TASK [CONFIGURE THE HOSTNAME AND DOMAIN NAME] ********************************************
****
changed: [rtr1] => {"ansible_facts": {"network_os": "ios"}, "changed": true, "commands": [
"ip domain name example.net", "ip domain list example.net", "ip name-server 8.8.8.8", "ip
name-server 8.8.4.4"]}

TASK [CONFIGURE HOST LOGGING] ************************************************************
****
skipping: [rtr1] => {"changed": false, "skip_reason": "Conditional result was False"}

TASK [CONFIGURE SNMP] ********************************************************************
****
changed: [rtr1] => {"banners": {}, "changed": true, "commands": ["snmp-server community an
sible-public RO", "snmp-server private-community ansible-private RW"], "updates": ["snmp-s
erver community ansible-public RO", "snmp-server private-community ansible-private RW"]}

PLAY RECAP *******************************************************************************
****
rtr1                       : ok=2    changed=2    unreachable=0    failed=0

[ec2-user@ansible tmp]$
```

Smarter testing: Linting configuration

```
[ec2-user@ansible tmp]$ ansible-playbook network_system.yml -v --limit rtr1
Using /home/ec2-user/.ansible.cfg as config file
/home/ec2-user/hosts did not meet host_list requirements, check plugin documentation if this is unexpecte
d
/home/ec2-user/hosts did not meet script requirements, check plugin documentation if this is unexpected

PLAY [CONFIGURE SYSTEM CONFIGURATIONS] *****************************************

TASK [CONFIGURE THE HOSTNAME AND DOMAIN NAME] **********************************
changed: [rtr1] => {"ansible_facts": {"network_os": "ios"}, "changed": true, "commands": ["ip domain name
 example.net", "ip domain list example.net", "ip name-server 8.8.8.8", "ip name-server 8.8.4.4"]}

TASK [CONFIGURE HOST LOGGING] **************************************************
skipping: [rtr1] => {"changed": false, "skip_reason": "Conditional result was False"}

TASK [CONFIGURE SNMP] **********************************************************
An exception occurred during task execution. To see the full traceback, use -vvv. The error was: rtr1(con
fig)#
fatal: [rtr1]: FAILED! => {"changed": false, "module_stderr": "Traceback (most recent call last):\n  File
 \"/home/ec2-user/.ansible/tmp/ansible-local-29655Il0vxK/ansible-tmp-1557251316.62-34108056203227/Ansibal
lZ_ios_config.py\", line 113, in <module>\n    _ansiballz_main()\n  File \"/home/ec2-user/.ansible/tmp/an
sible-local-29655Il0vxK/ansible-tmp-1557251316.62-34108056203227/AnsiballZ_ios_config.py\", line 105, in
_ansiballz_main\n    invoke_module(zipped_mod, temp_path, ANSIBALLZ_PARAMS)\n  File \"/home/ec2-user/.ans
ible/tmp/ansible-local-29655Il0vxK/ansible-tmp-1557251316.62-34108056203227/AnsiballZ_ios_config.py\", li
ne 48, in invoke_module\n    imp.load_module('__main__', mod, module, MOD_DESC)\n  File \"/tmp/ansible_io
s_config_payload_PvDHYL/__main__.py\", line 541, in <module>\n  File \"/tmp/ansible_ios_config_payload_Pv
DHYL/__main__.py\", line 472, in main\n  File \"/tmp/ansible_ios_config_payload_PvDHYL/__main__.py\", lin
e 333, in edit_config_or_macro\n  File \"/tmp/ansible_ios_config_payload_PvDHYL/ansible_ios_config_payloa
d.zip/ansible/module_utils/connection.py\", line 173, in __rpc__\nansible.module_utils.connection.Connect
ionError: snmp-server private-community ansible-private RW\r\n                                          ^\r\n% Invalid
input detected at '^' marker.\r\n\r\nrtr1(config)#\n", "module_stdout": "", "msg": "MODULE FAILURE\nSee s
tdout/stderr for the exact error", "rc": 1}
        to retry, use: --limit @/tmp/network_system.retry

PLAY RECAP *********************************************************************
rtr1                       : ok=1    changed=1    unreachable=0    failed=1

[ec2-user@ansible tmp]$
```

Smarter testing: Testing policy artifacts

- ❏ Engineers have been doing it for ever
- ❏ Smarter tests
- ❏ Smaller changes more often over large changes every X weeks/months
- ❏ Controlled, periodic failure tests

Tools: iperf/jperf, icmp, command-line tools like curl/wget, Ansible assertions

```
## POLICYXYZ.123
- name: "POLICYXYZ.123: Validates that the same community is not defined for both read-only and read-write."
  delegate_to: localhost
  no_log: yes
  assert:
    that:
      - snmp_ro_community not in snmp.rw
  loop: "{{ snmp.ro }}"
  loop_control:
    loop_var: snmp_ro_community

## POLICYXYZ.123MW
- name: "POLICYXYZ.123MW: Validates strenght of read-only communities"
  delegate_to: localhost
  no_log: yes
  assert:
    that:
      # At least 10 characters long
      - snmp_ro_community is match('(?=.{10,}).*')
      # At least one lower-case
      - snmp_ro_community is match('(?=.*[a-z]).*')
      # At least one digit
      - snmp_ro_community is match('(?=.*[0-9]).*')
      # At least one upper-case
      - snmp_ro_community is match('(?=.*[A-Z]).*')
  loop: "{{ snmp.ro }}"
  loop_control:
    loop_var: snmp_ro_community
```

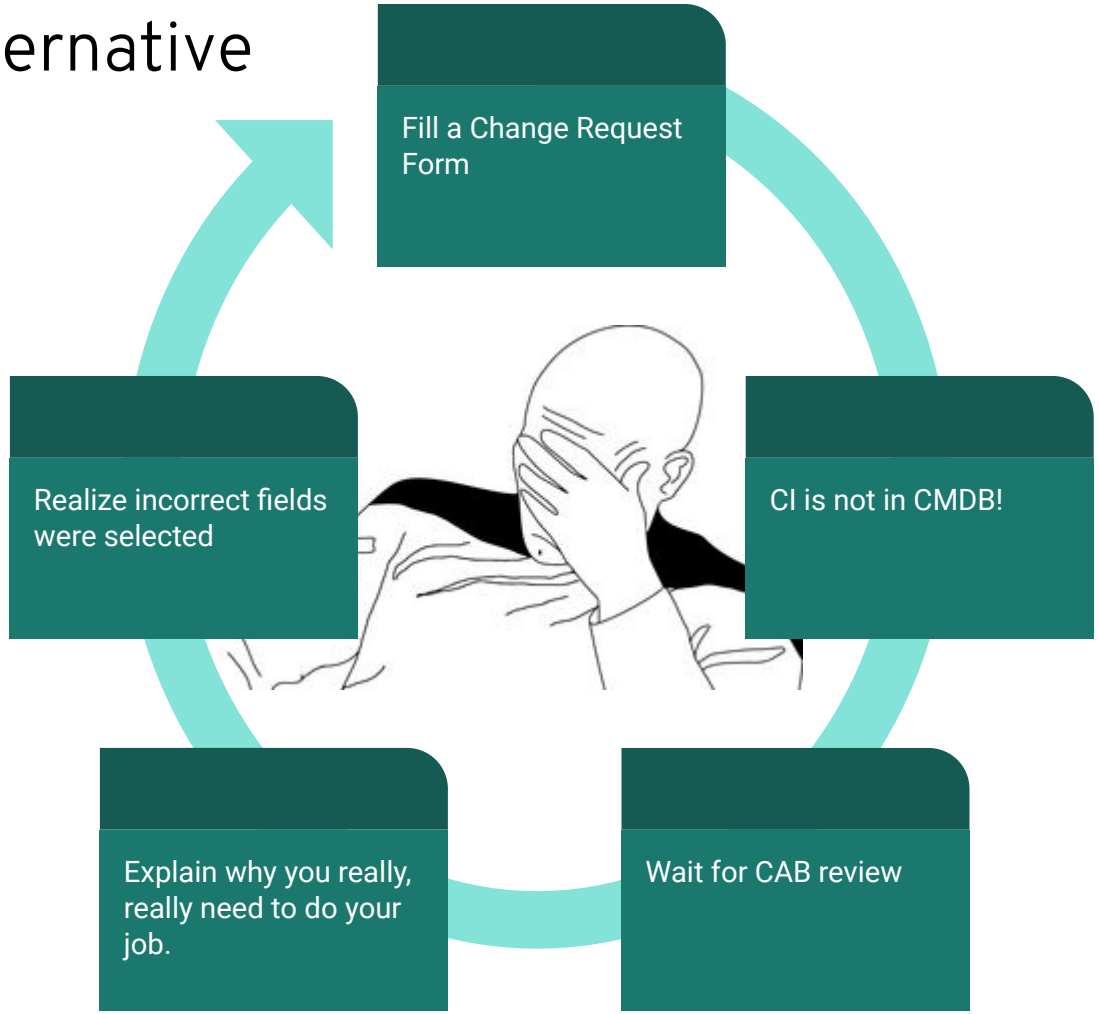
Addressing Process

GitOps as a process alternative

Requirements:

- ❏ Understanding version control
- ❏ Unlearn

(If large open source projects can be successful…)



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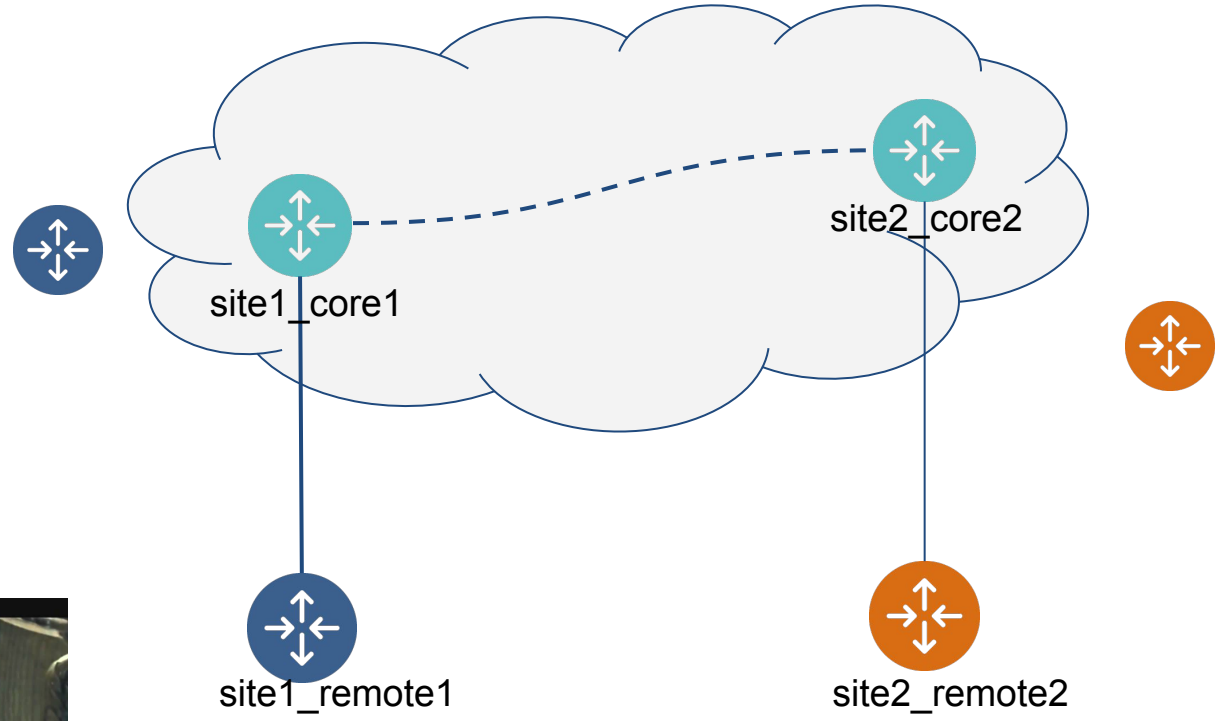
Adopt branching strategies

Tags are immutable

- **release-X.Y.Z:** Release tag.
- **master:** Latest stable.
- **full:** Entire topology.
- **site-X:** Partial topology.
- **issue-X:** Standard fix.
- **hotfix-X:** Urgent fix.



PROTECTED BRANCHES
YOU HAVE NO POWER HERE!

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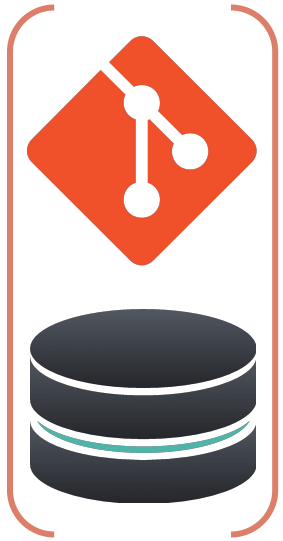
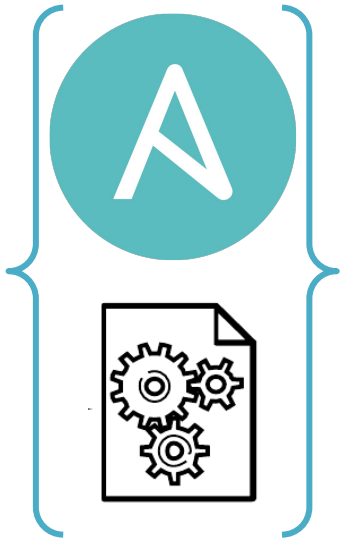
Infrastructure as Code

SPECIFICATIONS



IMPLEMENTATION

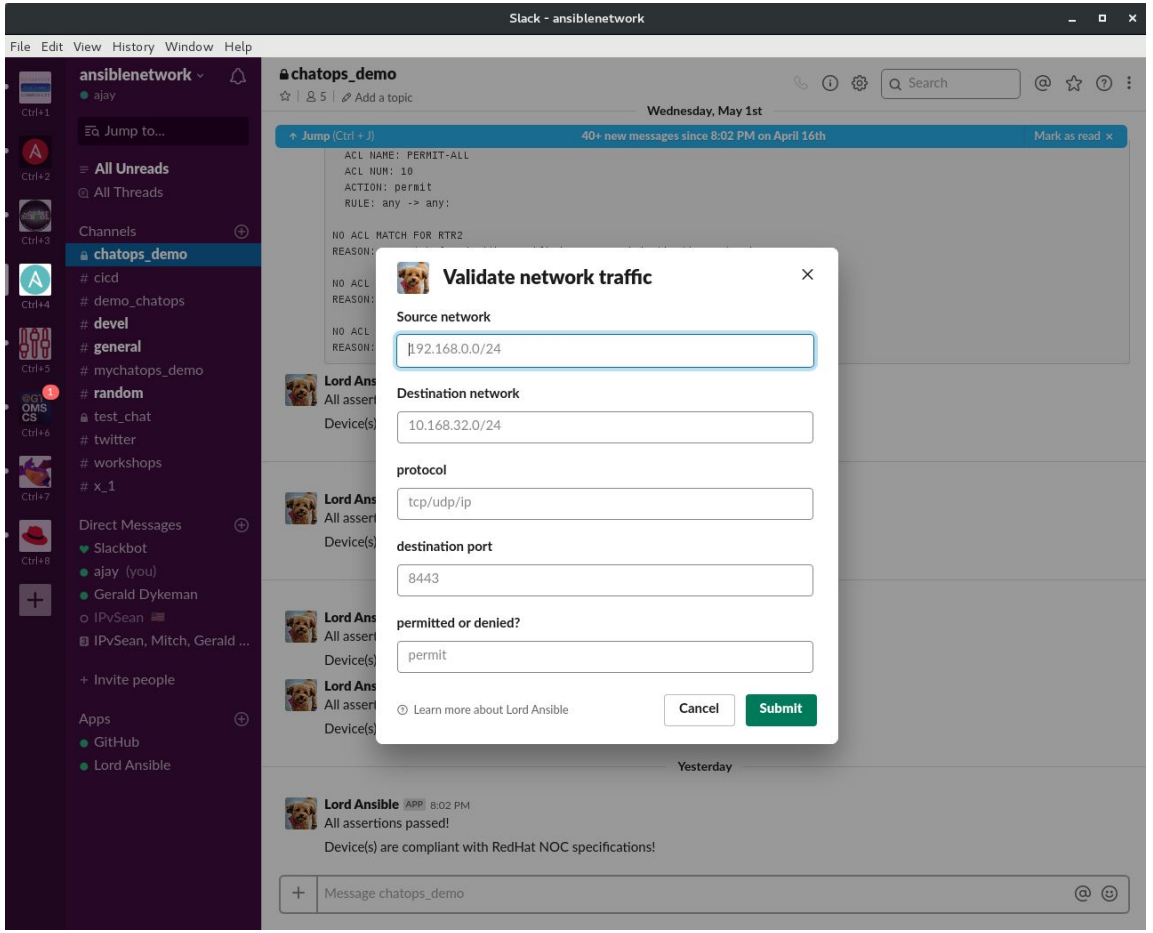


DESIRED CONFIG

Addressing Communications

Smarter communications: ChatOps

- ChatOps
  - Git hooks
  - Automation tests
  - Chat enabled troubleshooting



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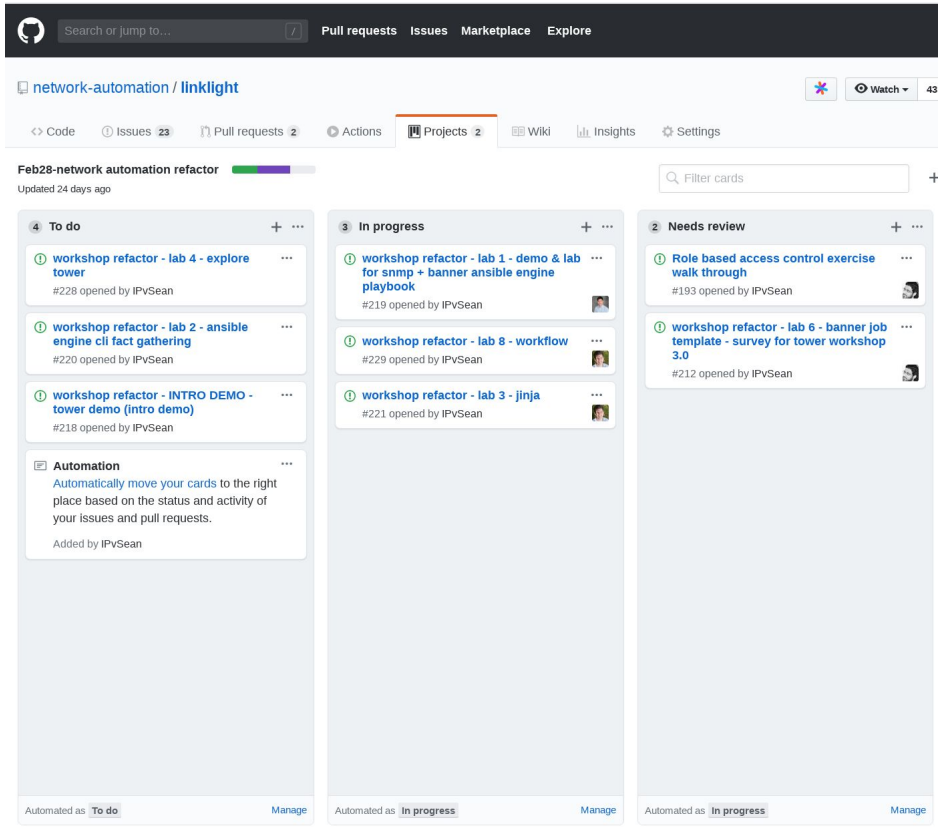
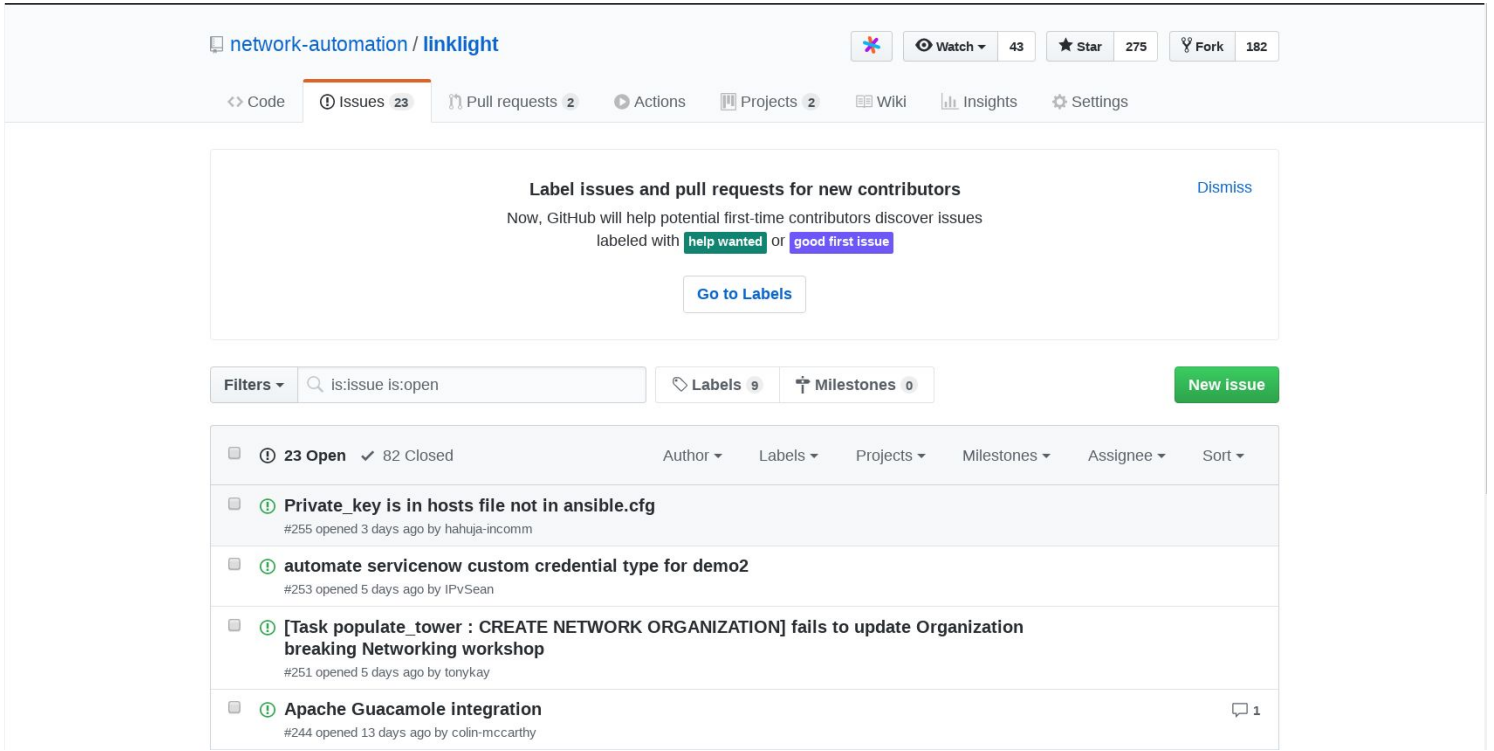
Smarter communications : GitOps





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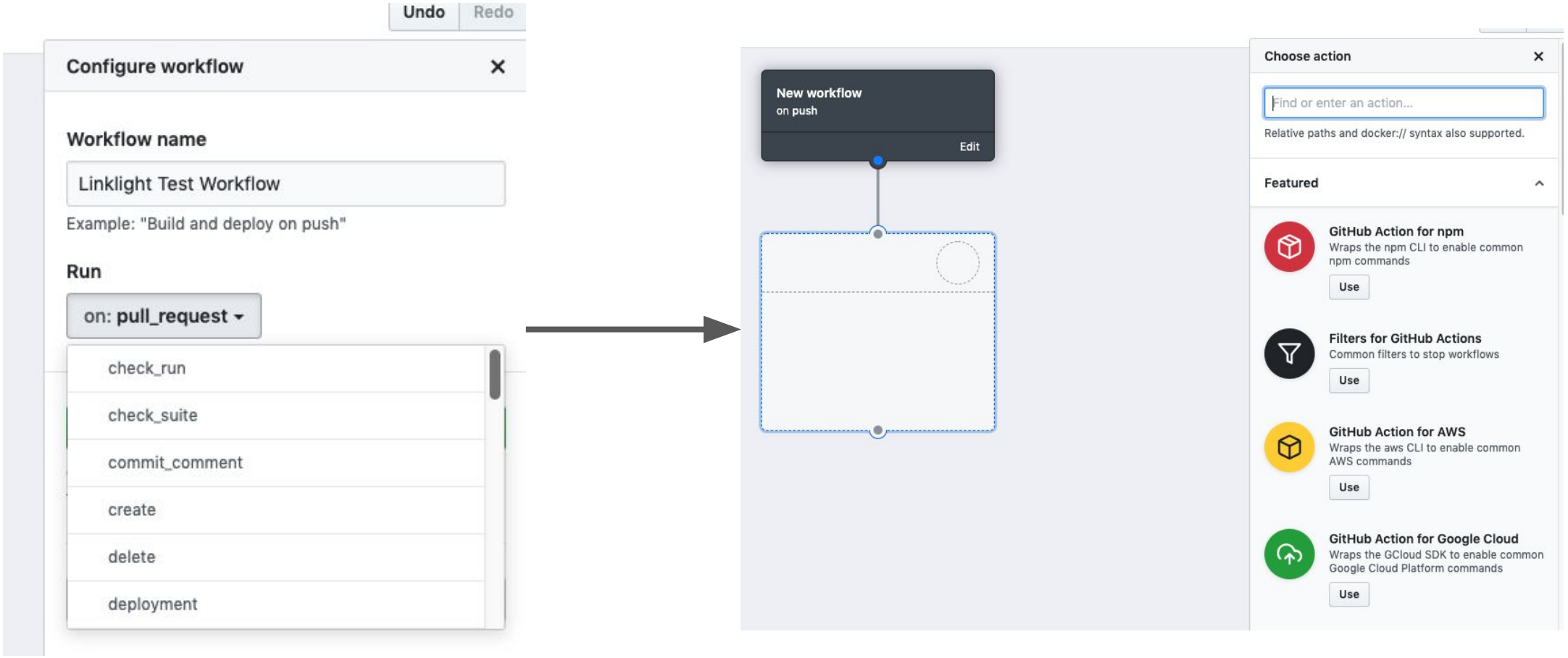

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Looking forward

Opinion

- Some vendors have embraced the open source model and are emulating the success of Linux
- Proprietary vendors systems are trending towards being more open (Shell access)
- Mathematical models / Formal methods of testing
- Status of decoupling the control and data plane

A note on formal methods for testing network infrastructure

Promising/exciting development in our industry space. At a high level these tools take in configuration (and some even take in operational state) of the network and builds a mathematical representation of the network. In theory this allows operators to simulate network changes in a more realistic way.

Reasons to be excited about this technology:

- ❏ More realistic than virtual machines to simulate complex topologies
- ❏ More cost effective than replicating physical devices
- ❏ Ability to represent different vendor OS versions

Potential roadblocks(while the technology evolves):

- ❏ Learning curve
- ❏ Keeping up with hardware vendor features/bugs
- ❏ Potential limitations to simulate hardware features/bugs
- ❏ Potential Service Level Agreement(SLA) ambiguity

In conclusion…

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Takeaways

- Continuous Integration as defined is not a practical reality today for network operators
- Address Infrastructure as Code; leverage version control
- Adapt nimble processes and communications
- Take advantage of available tools and resources to move towards smarter testing
- Stay open to emerging and alternative testing methods

Thank you

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