Continuous Integration and Continuous Delivery for Networks

Pete Lumbis - @PeteCCDE

Cumulus Networks Systems Engineer
CCIE #28677, CCDE 2012::3
Continuous Integration (CI):
A system where all changes are automatically tested before pushed to production or seen by others.
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Continuous Delivery (CD):
Built on a CI system where changes are made multiple times a day.
WTF is CI/CD?

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**Continuous Delivery (CD):**
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Why aren’t you doing this?
Agenda

Change Management Today

The Problems Today

NetDevOps Toolkit
Pete Who?

CCIE R&S, CCDE

Former Cisco TAC Routing Escalation

Current Cumulus Networks SE

Network Engineer, Not a Programmer
Leading Questions

Who thinks their change system works well?
Leading Questions

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- I assume your manager is here
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Who lab tests 100% of changes?
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Who checks servers + apps on changes?
Leading Questions

Who thinks their change system works well?
- I assume your manager is here

Who lab tests 100% of changes?

Who checks servers + apps on changes?
- Why is it your users?
Change Management Today

int Eth0/0
ipv6 address 2001:db8::1/127
!
router bgp 65535
  address-family ipv6 unicast
  neighbor 2001:db8:2 remote-as 65534
  neighbor 2001:db8:2 prefix-list internet-routes in
!
ipv6 prefix-list internet-routes seq 10 permit ::/0
!
Monday, 9:30am:
Write Change, Email Team
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Thursday, 9:00am:
Ask team if they read email
Monday, 9:30am:  
Write Change, Email Team

Thursday, 9:00am:  
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Friday, 11:00am:  
Receive “looks good” from lead
Monday, 9:30am: Write Change, Email Team

Thursday, 9:00am: Ask team if they read email

Friday, 11:00am: Receive “looks good” from lead

Saturday, 10:00pm: Implement Change in 2hr window
Monday, 9:30am:
Write Change, Email Team

Thursday, 9:00am:
Ask team if they read email

Friday, 11:00am:
Receive “looks good” from lead

Saturday, 10:00pm:
Implement Change in 2hr window

Sunday, 8:30am:
Notice Typo, Fix. Go home.
Change Validation
Change Validation
Validation? What Validation?
Best Case

- 30 person bridge
- Every department signs off
Validation? What Validation?

Best Case
- 30 person bridge
- Every department signs off

Worst Case
- Ping some things
- Watch for tickets
Validation? What Validation?
Validation? What Validation?

Is ping your business application?
Recap: What’s Broken?
Recap: What’s Broken?

Poor change communication
Recap: What’s Broken?

- Poor change communication
- Difficult to test outside of production
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- Little change validation
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- Poor change communication
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- Manual validation doesn’t scale
Recap: What’s Broken?

- Poor change communication
- Difficult to test outside of production
- Little change validation
- Manual validation doesn’t scale
- Silos of Excellence
Imagine a World...
Imagine a World...

Configs are easily shared
Imagine a World...

- Configs are easily shared
- All changes are automatically tested
Imagine a World...

- Configs are easily shared
- All changes are automatically tested
- Tests include servers and apps
Imagine a World...

- Configs are easily shared
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- Tests include servers and apps
- Tests must pass to reach approvers
Imagine a World...

- Configs are easily shared
- All changes are automatically tested
- Tests include servers and apps
- Tests must pass to reach approvers
- More drinks with umbrellas
NetDevOps Toolbox
NetDevOps Toolbox

Git – Provides config management and collaboration
Automation Tools - Git

Source Code text file repository

Automatic file revision/change management

Built for teams to work on the same files

Easy to get started, lots of knobs for advanced users
Remote Repository – Central Server hosting files

Local Repository – Your local copy of the remote. Where you change things

Branch – Isolated copy for new features, risky changes

Merge – Apply branch changes to master repository copy (see also: “Pull Request”)
Create Changes in Branches

Merge and Review Changes

Use merge/pull request as an opportunity to review impact of changes
Automation Tools – Git Cont’d

Rollback failures after merge

Fork for new project/datacenter/office
NetDevOps Toolbox Alternatives

- Git
- GitLab
- Bitbucket
- GitHub
GitLab – Change management and automated testing
Add Server Support
Currently the network doesn’t have servers. That’s not very useful, now is it?

Pete Lumbis @plumbis 4 months ago
mentioned in commit 5567fe3c

Pete Lumbis @plumbis 4 months ago
Status changed to closed
GitLab Ticketing

Closed  Issue #2 opened 4 months ago by Pete Lumbis

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Add Server Support
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Edited

- 1 like, 0 dislikes

- Pete Lumbis @plumbis 4 months ago mentioned in commit 5567fe3c
- Pete Lumbis @plumbis 4 months ago Status changed to closed
Servers added as CumulusVx Nodes. Each server runs apache and BGP unnumbered.

Resolves #2

Showing 5 changed files with 11 additions and 25 deletions
Servers added as CumulusVx Nodes. Each server runs apache and BGP unnumbered. Resolves #2

Showing 5 changed files with 11 additions and 25 deletions
Servers added as CumulusVx Nodes. Each server runs apache and BGP unnumbered. Resolves #2

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<tbody>
<tr>
<td>49</td>
<td>46</td>
<td>leaf4:</td>
<td></td>
<td>lo:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>47</td>
<td></td>
<td>lo:</td>
<td>ipv6: &quot;fd::1:4/128&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>48</td>
<td></td>
<td>ipv4: &quot;172.16.0.44/32&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td></td>
<td>-</td>
<td>ipv4: &quot;172.16.0.4/32&quot;</td>
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<td></td>
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<td>49</td>
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NetDevOps Toolbox

Virtual Box – Hypervisor for lab network + server VMs

Vagrant – Simplifies large Virtual Box environments
NetDevOps Toolbox Alternatives

Virtual Box  →  VMware  →  Microsoft Hyper-V  →  KVM
Ansible – Applies configuration and manages automation
Automation Tools - Ansible

Configuration Management Software

Manages SSH connections

Large collection of libraries for common tasks

Human Readable
NetDevOps Toolbox Alternatives

- Ansible
- Puppet
- SaltStack
- Chef
NetDevOps Toolbox

Git
GitLab
Virtual Box
VAGRANT
ANSIBLE

Behave – English based testing language
Behave Overview

```
plumbis:validation plumbis$ behave
Feature: Validate BGP # bgp.feature:1
  Scenario: Check BGP Neighbors  # bgp.feature:3
    Given BGP is enabled  # steps/bgp.py:219 1.760s
    When neighbors are configured  # steps/bgp.py:243 0.001s
    Then the neighbors should be up  # steps/bgp.py:341 0.000s

Feature: Validate Interfaces are up and IPs are applied # interfaces.feature:1
  Scenario: Check interfaces are up  # interfaces.feature:3
    Given an interface is configured  # steps/interfaces.py:156 1.889s
    Then the interfaces should be up  # steps/interfaces.py:180 0.001s

Feature: Validate the webservers can be reached. # website.feature:1
  This will validate each server has apache2 configured and running.
  Then each server will try to reach every other server and fetch the index page
  Scenario: Validate Web Server Access  # website.feature:5
    Given a webserver is configured  # steps/website.py:225 0.596s
    When apache is running  # steps/website.py:237 0.577s
    Then the website should be accessible  # steps/website.py:245 4.564s

3 features passed, 0 failed, 0 skipped
3 scenarios passed, 0 failed, 0 skipped
8 steps passed, 0 failed, 0 skipped, 0 undefined
Took 0m9.388s
```
Behave Overview

plumbis:validation plumbis$ behave

Feature: Validate BGP # bgp.feature:1

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3 features passed, 0 failed, 0 skipped
3 scenarios passed, 0 failed, 0 skipped
8 steps passed, 0 failed, 0 skipped, 0 undefined
Took 0m9.388s
Behave Overview

- Human readable policy checking
- Calls Python code under the covers
- Network engineers are policy experts
- Treat it as a back office application
- Works on network and systems
NetDevOps Toolbox Alternatives

Beaker

puppet

Matt Oswalt’s ToDD

KitchenCI
NetDevOps Toolbox – How It Happens

Git

GitLab

Virtual Box

VAGRANT

ANSIBLE
NetDevOps Toolbox – How It Happens

Configuration Saved to GitLab (git push)
GitLab Launches Lab with new configs
NetDevOps Toolbox – How It Happens

Vagrant configures lab with Ansible

GitLab
GitLab
VirtualBox
Vagrant
Ansible
GitLab runs Behave tests against infrastructure
NetDevOps Toolbox – Automated Validation

GitLab executes behave checks automatically

Only checks that pass are merged in for others to see

<table>
<thead>
<tr>
<th>Status</th>
<th>Commit</th>
</tr>
</thead>
</table>
| ![Passed](https://example.com/pass.png) | #3753351 <span>master</span> → f1a4ebef   ![Latest](https://example.com/latest.png)  
Correcting BGP configuration mistake |
| ![Failed](https://example.com/fail.png) | #3753256 <span>master</span> → 66be74eb  
Modifying BGP peer settings |
NetDevOps Toolbox – Automated Validation

Build #2513447 for commit 66be74eb from master by @plumbis about an hour ago

Feature: Validate BGP # bgp.feature:1
Scenario: Check BGP Neighbors # bgp.feature:3
  Given BGP is enabled # steps/bgp.py:219 1.777s
  When neighbors are configured # steps/bgp.py:243 0.001s
  Then the neighbors should be up # steps/bgp.py:341 0.000s

Feature: Validate Interfaces are up and IPs are applied # interfaces.feature:1
Scenario: Check interfaces are up # interfaces.feature:3
  Given an interface is configured # steps/interfaces.py:156 1.947s
  Then the interfaces should be up # steps/interfaces.py:180 0.001s

Feature: Validate the webservers can be reached. # website.feature:1
  This will validate each server has apache2 configured and running.
  Then each server will try to reach every other server and fetch the index page
Scenario: Validate Web Server Access # website.feature:5
  Given a webservice is configured # steps/website.py:225 0.609s
  When apache is running # steps/website.py:237 0.583s
  Then the website should be accessible # steps/website.py:245 5.181s

Assertion Failed: Error on server1 trying to access http://10.0.0.2 : Status code was not [200]: Request failed
  : <urlopen error [Errno 101] Network is unreachable>

Failing scenarios:
  website.feature:5 Validate Web Server Access
### Modifying BGP peer settings

<table>
<thead>
<tr>
<th>Changes</th>
<th>Builds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Showing 1 changed file with 0 additions and 1 deletions

```plaintext
roles/spines/templates/Quagga.conf.j2

<table>
<thead>
<tr>
<th>@@ -25,7 +25,6 @@ router bgp {{ bgpvars.asn }}</th>
</tr>
</thead>
<tbody>
<tr>
<td>25:25</td>
</tr>
<tr>
<td>neighbor fabric timers 1 3</td>
</tr>
<tr>
<td>26:26</td>
</tr>
<tr>
<td>neighbor fabric timers connect 3</td>
</tr>
<tr>
<td>27:27</td>
</tr>
<tr>
<td>neighbor fabric remote-as external</td>
</tr>
<tr>
<td>28:28</td>
</tr>
<tr>
<td>- neighbor fabric capability extended-nexthop</td>
</tr>
<tr>
<td>29:28</td>
</tr>
<tr>
<td>{### Configure prefix lists ###}</td>
</tr>
<tr>
<td>30:30</td>
</tr>
<tr>
<td>{% if bgpvars.fabric_prefix_list_out is defined %}</td>
</tr>
<tr>
<td>31:30</td>
</tr>
<tr>
<td>neighbor fabric prefix-list {{bgpvars.fabric_prefix_list_out}} out</td>
</tr>
<tr>
<td>...</td>
</tr>
</tbody>
</table>
```
Wrap Up
Wrap Up

There’s a better way!
Wrap Up

There’s a better way!

Infrastructure as code
Wrap Up

There’s a better way!
Infrastructure as code
Automate all the things
Wrap Up

There’s a better way!

Infrastructure as code

Automate all the things

Testing must include applications
There’s a better way!

Infrastructure as code

Automate all the things

Testing must include applications

Push your vendor. Vote with $$
Questions?
Thank You!

@PeteCCDE