Automatically Build, Test and Deploy Your Network Configurations

NANOG 63

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Dyn

Project name: Kipper

- Very mellow dog
- Likes an easy, simple life

Can automation do that for us network engineers?

The problems

- Copy-pasting and hand-crafting configurations at the command line:
  - Is very error-prone
  - Leads to inconsistencies
  - Takes too long
  - Does not scale!
- No formal approval process
  - Bad changes can be introduced without review

The goals

- Facilitate consistency
  - Use templates to ensure:
    - standardization, accuracy and predictability
- Minimize errors
  - Avoid direct CLI access
  - Formal review/approval process
  - Automated tests
- Increase speed
  - Handle bulk changes

More goals

- Use open source when possible
  - Build on community efforts
  - Don’t break the bank
  - Well known, well tested
- Use open standards when possible
  - Don’t reinvent the wheel
  - More chances of reusing solution for multiple platforms/vendors

Learn from software engineers

- Continuous Integration and Delivery (CI/CD)
  - Frequent individual integrations into master repository
  - Automated build, test, deploy
  - Identify errors as quickly as possible
  - Many tools already available
    - Git, Jenkins, TravisCI, etc.

Learn from sysadmins

- Many config management tools available
  - Chef, Puppet, Ansible, Salt, etc.
- Domain-specific languages (DSLs) to specify desired state
  - Minimal or no programming required
  - Combined with version control/ distributed workflows
  - Install packages, generate configs, automate checks

What about networks?

- These concepts, processes and tools are still very much missing from network environments
  - Can we use what’s already available?

Dyn case

- ~20 data centers in 5 continents
- Hundreds of network devices
- Multiple teams
- Fast growth
- Automation is a main priority
  - Existing automation of servers and applications
  - Little or no network automation as of last year

NETCONF

- IETF standard for network configuration management
  - RFC 6241
  - Concept of “candidate” configuration
  - XML encoding of data and operations
  - Secure transport (SSH)
- Good support on Juniper
  - Not so on other platforms, unfortunately

Ansible

- Open source IT automation tool
- Focused on simplicity
- Agentless!
  - Uses SSH
- *Push* instead of *pull* model
- Extensible (with modules)
  - Juniper wrote NETCONF module:
    - https://github.com/Juniper/ansible-junos-stdlib

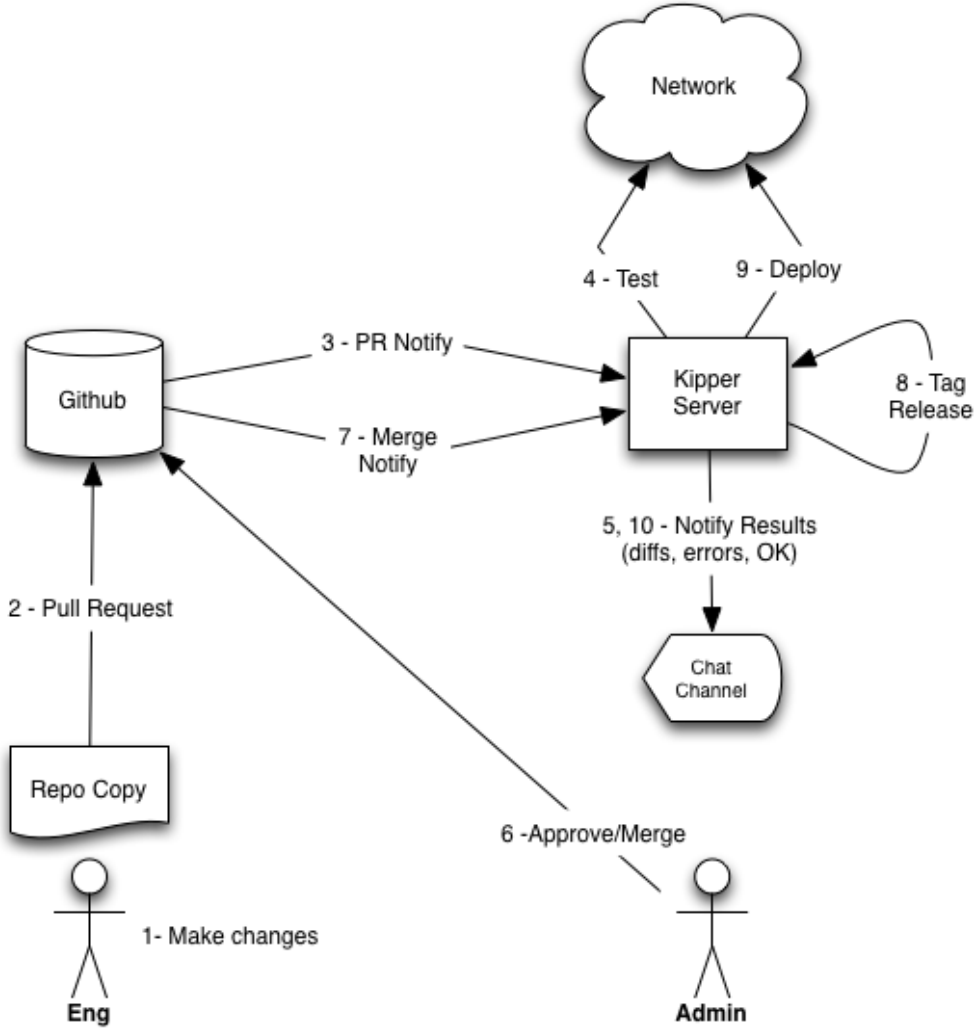
Github

- Collaboration tool based on Git
- Adds important features
  - *Forks* and *pull requests*
  - Useful web interface
  - *Gists*
  - many more
- Free hosted use for public repos
  - Can do private repos or appliances for a fee

Jenkins

- Popular open source CI/CD tool
  - Many plugins available
- Automates the execution of tasks
  - Cron jobs
  - Events
    - Integrates with external version control
      - Triggers jobs when things change (e.g. pull requests, merges)

Concept


Network
4 - Test
9 - Deploy
Github
3 - PR Notify
7 - Merge Notify
Kipper Server
8 - Tag Release
5, 10 - Notify Results (diffs, errors, OK)
Chat Channel
2 - Pull Request
Repo Copy
6 -Approve/Merge
1- Make changes
Eng
Admin

Organization

- Inventory
  - All devices grouped by function and by location
- Variables
  - Applying to groups or individual nodes
- Roles
  - Tie groups to templates and variables
  - Common or by function (edge routers, firewalls, etc.)

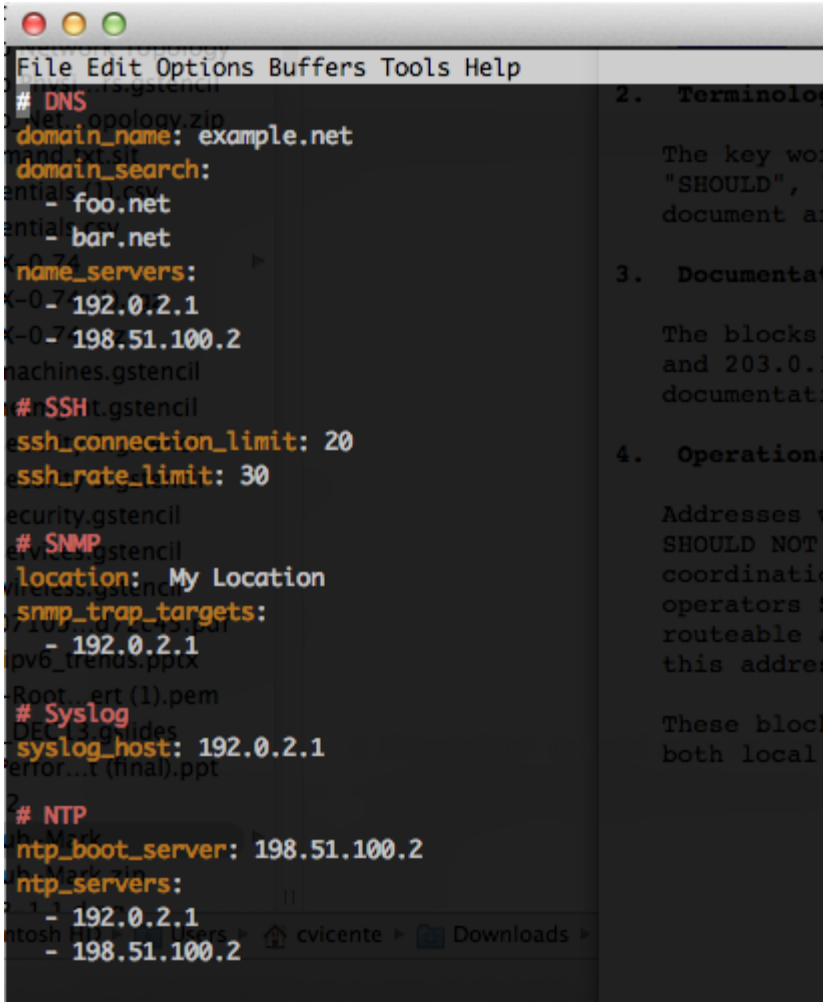
Variables

```
group_vars/

    all.yml
    ams.yml
    iad.yml
    edge.yml

host_vars/

    edge-01-ams.yml
    vpn-01-iad.yml
```



Templates

- Ansible uses Jinja2
  - Configuration text with embedded code (Python)
    - Conditionals, loops, etc.
- XML format
  - Because we had to
    - better support across versions of JunOS
  - But also allows for advanced checks
    - Easy to parse
    - Could use XSD schemas to validate

Template example

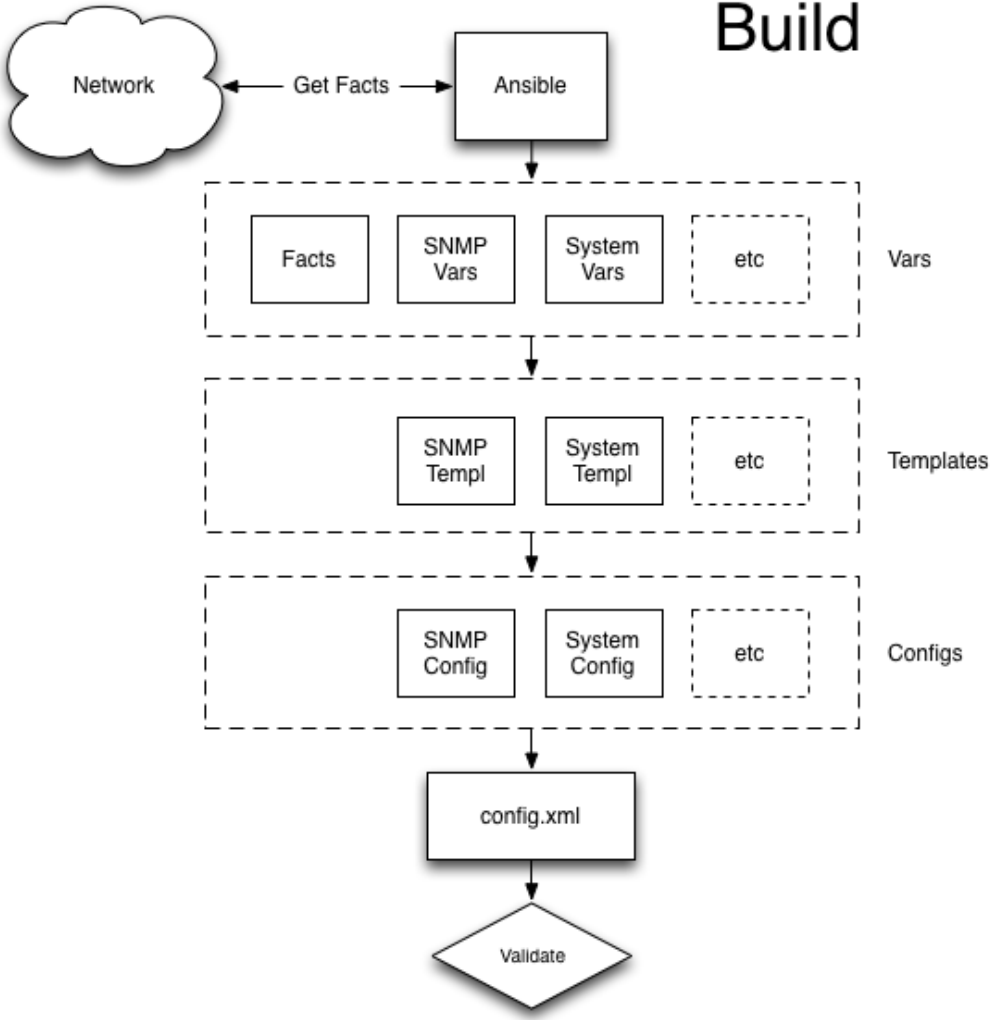
```
<host-name>{{ host_basename }}</host-name>
<domain-name>{{ domain_name }}</domain-name>
{% for domain in domain_search %}
  <domain-search>{{ domain }}</domain-search>
{% endfor %}
{% if backup_router is defined %}
  <backup-router>
      <address>{{ backup_router }}</address>
      <destination>0.0.0.0/0</destination>
  </backup-router>
{% endif %}
  <root-authentication>
    <encrypted-password>{{ root_password_hash }}</encrypted-password>
  </root-authentication>
{% for name_server in name_servers %}
  <name-server>
    <name>{{ name_server }}</name>
  </name-server>
{% endfor %}
```

Access

- Enable NETCONF everywhere
  - Enable detailed logging
- Set up SSH public keys in every device
  - Read-only account (for collecting “facts”)
    - Allows non-admins to test their builds
  - Read-write account (for deploying)
  - Always encrypt private keys!

Operations: `build`

- Runs Ansible playbook that:
  - Gets “facts” from each device
    - Model, OS version, hardware info.
  - Renders each template using variables and facts
  - Combines multiple outputs into a single file
  - Validates XML
    - Basic parsing check at the moment
    - Plan to add more elaborate checks
      - Does every interface description match the naming convention?


Build
Network
Get Facts
Ansible
Facts
SNMP Vars
System Vars
etc
Vars
SNMP Templ
System Templ
etc
Templates
SNMP Config
System Config
etc
Configs
config.xml
Validate

Operations: `test`

- Take each configuration file and perform a *dry run*
  - aka `commit-check` in JunOS
  - Gather *diffs* from each device
    - or report errors!
  - Combine *diffs* to create a pretty *Gist*
  - Send Gist URL to net admins

Operations: `deploy`

- Runs Ansible playbook that:
  - Sends configs to all devices
    - using NETCONF in our case
  - If there are changes, commits those
    - If there are no changes, device is unaffected
  - Notifies NOC
  - Triggers audit
    - Run RANCID, for example

Customizations

- We modified the Ansible Junos module to:
  - Allow us to do dry-runs
    - `--check` in Ansible
    - `commit-check` in Junos
  - Specify an external file to save *diffs*
  - Changes incorporated into v1.1.0

Deploy enhancements

- Plan to use the Ansible API to add some smarts to the deploy operation
  - Handle changes to multiple data centers
  - Exploring the use of *Rundeck* to handle the deploy job, instead of running directly from Jenkins
    - More control, flexibility

Implementation Approach

- Start simple
  - Cover the most common parts first:
    - e.g. User accounts, NTP, DNS, SNMP, common prefix lists, etc.
  - Work towards 100% coverage incrementally
    - Slow process until everything is standardized
- The template becomes the policy
  - Perform periodic dry-runs and notify of any *diffs*

Challenges

- Cultural change
  - Requires us to think differently
  - Familiarity with source control, Ansible, etc.
- Dry-runs fail because someone has the lock
  - Nuisance until 100% templated
- Approval while network admins are not around?
  - Off hours emergencies, etc.

Limitations

- Platform APIs not standard (yet)
  - Will they ever be?
  - Much more challenging in multi-vendor environments
- Probably can’t do network-wide atomic changes
  - Network state is inter-dependent
  - Not good to leave in inconsistent state

To Consider

- Staging environment
  - Physical vs. Virtual
  - How to *really* test network configs?
- Explore
  - Inventory from database
  - Variables from database
  - REST API

Looking ahead

- Watch new tools
  - e.g. Schprokits (Jeremy Schulman)
    - Like Ansible, but more network-focused
    - Solves the problem of multiple APIs
- Things will likely change dramatically
  - Open platforms
    - Software not tied to hardware
  - Overlay vs. Underlay
    - Increasingly dumber network and more intelligent hypervisor, etc.

A note on network design

- Automation is great, but...
  - Can we avoid touching the network in the first place?
  - Is there tight coupling between the network and the servers/services?
  - Design with this in mind

Sharing

https://github.com/dyninc/kipper-demo

Thank you

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