Cyborg Teams

Training Machines to be Contributors

Stef Walter

Red Hat

redhat

Cyborg Teams

A team that is part human, part machine

[We] ate all the low-hanging fruit of modern history ...

— Tyler Cowen

Major reason for stagnation: High complexity of unsolved problems

— Zi Shui Dong Liu

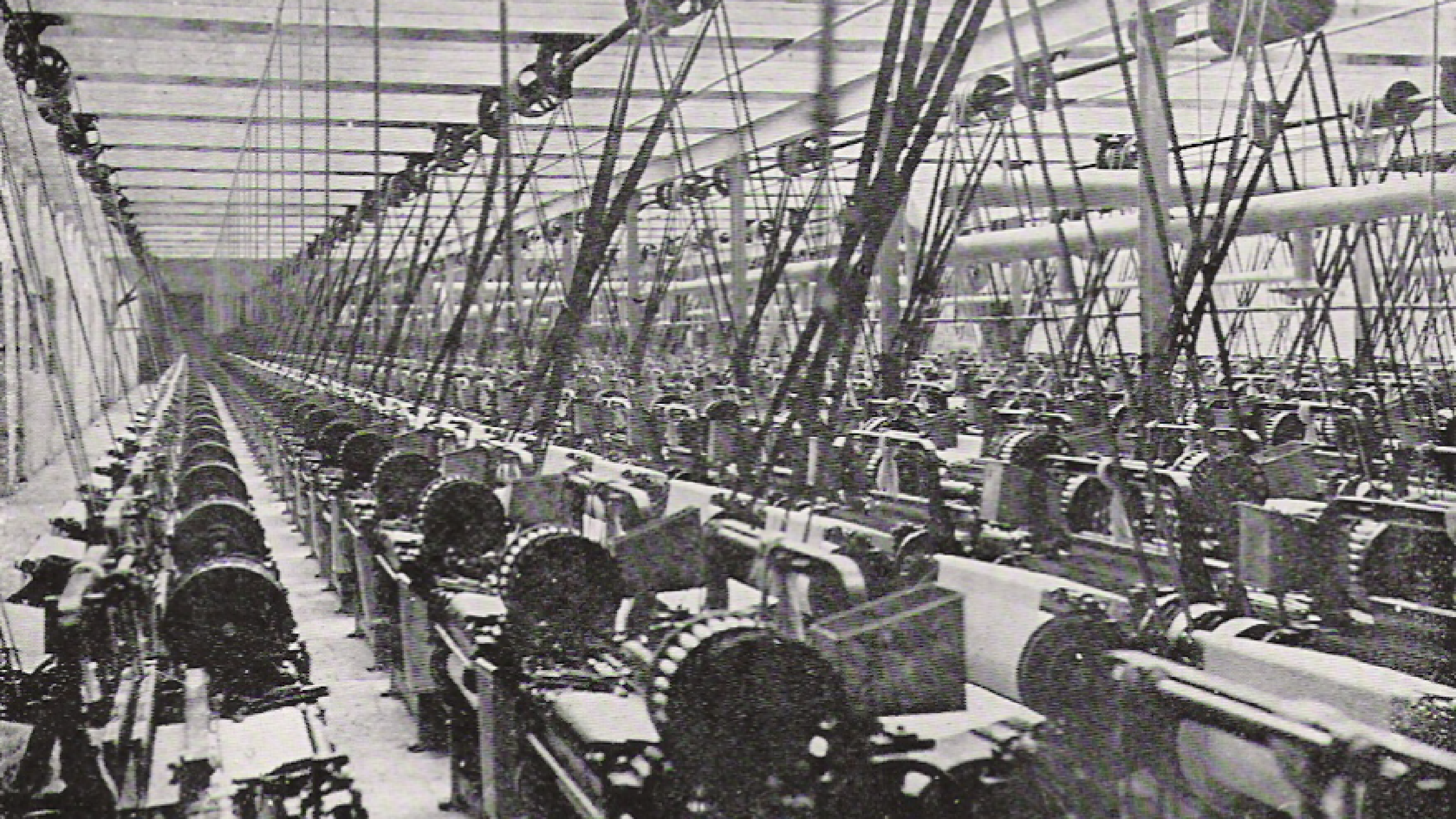
The effort of a solely human team **does not scale**
past a certain complexity point


MACHINES!

"But we use machines!"

You see the computer age everywhere but in the productivity statistics.

— Robert Solow

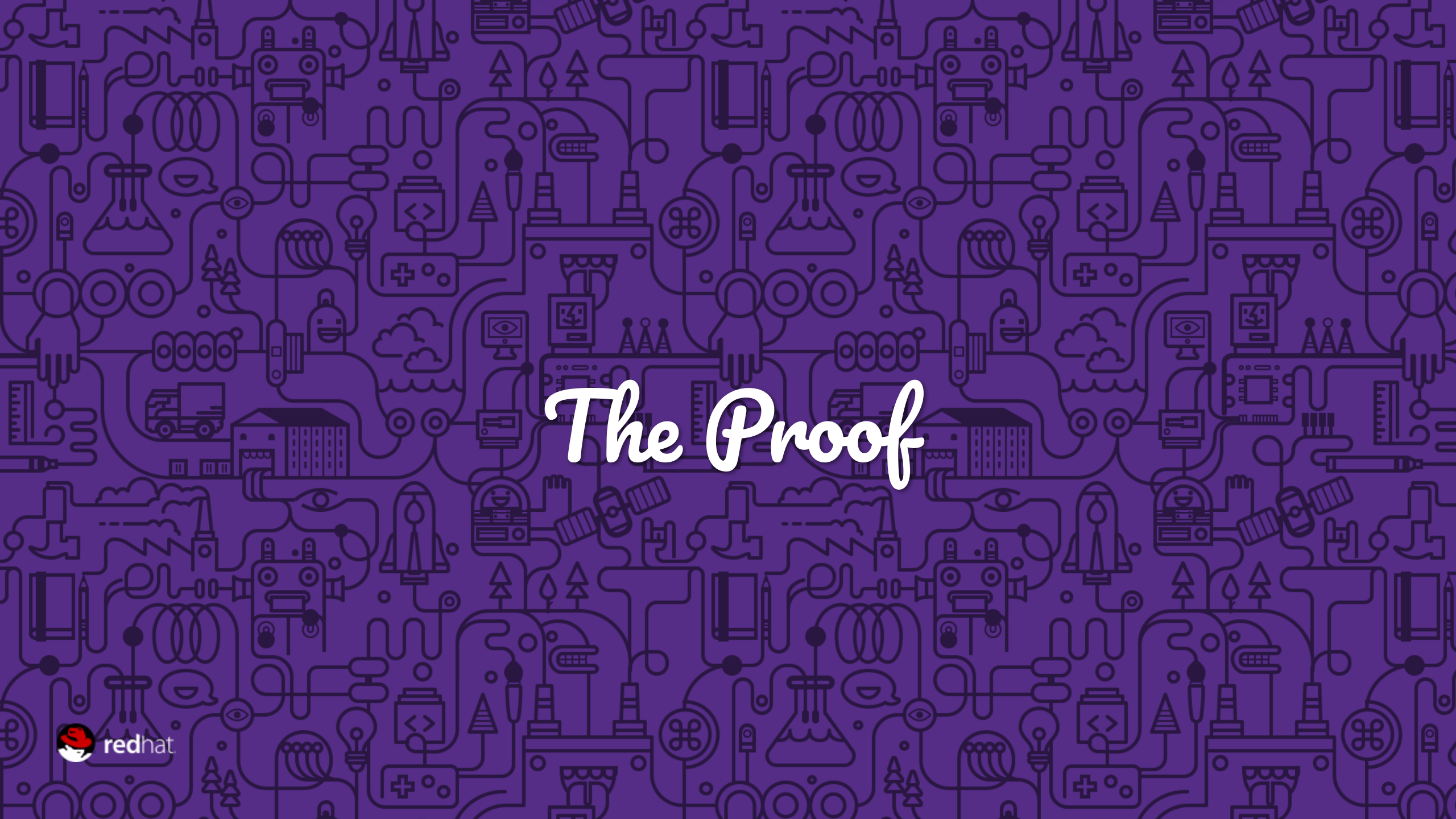


Cyborg Teams

Machines as contributors, not tools

We speak "machine"!

This is why its a low hanging fruit


The Proof
redhat

System - Falcon

localhost:9090/system

RED HAT ENTERPRISE LINUX SERVER | Unlocked | Stef

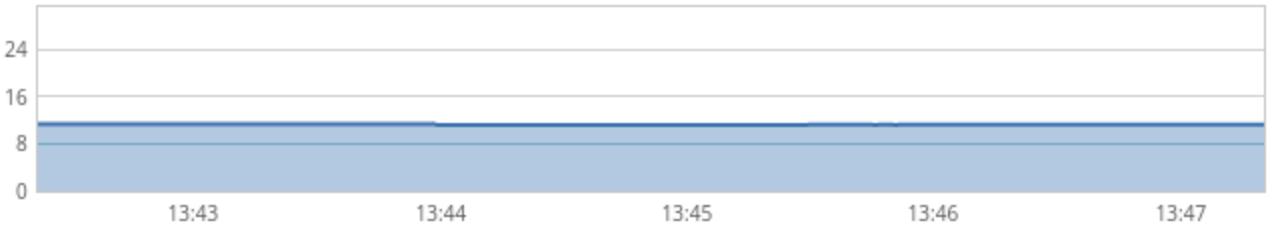
Falcon | Dashboard | Cluster | Image Registry

- System
- Logs
- Storage
- Networking
- Containers
- oVirt Machines
- Accounts
- Services
- Applications
- Diagnostic Reports
- Kernel Dump
- SELinux
- Software Updates
- Subscriptions
- Terminal

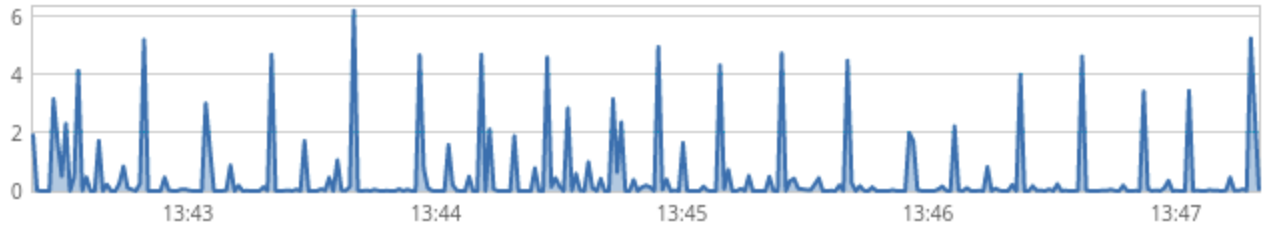
Hardware	TAROX Basic 7000BD
Asset Tag	1437471
Machine ID	a20c82e128524937ad8...
Operating System	Employee SKU
Secure Shell Keys	Show fingerprints
Host Name	Falcon (falcon.thewalter...
Domain	Join Domain
System Time	2017-10-17 13:47
Power Options	Restart
Performance Profile	none
Store Performance Data	OFF

% CPU

GiB Memory



MiB/s Disk I/O



Mbps Network Traffic

Cluster - Falcon

localhost:9090/kubernetes#/topology

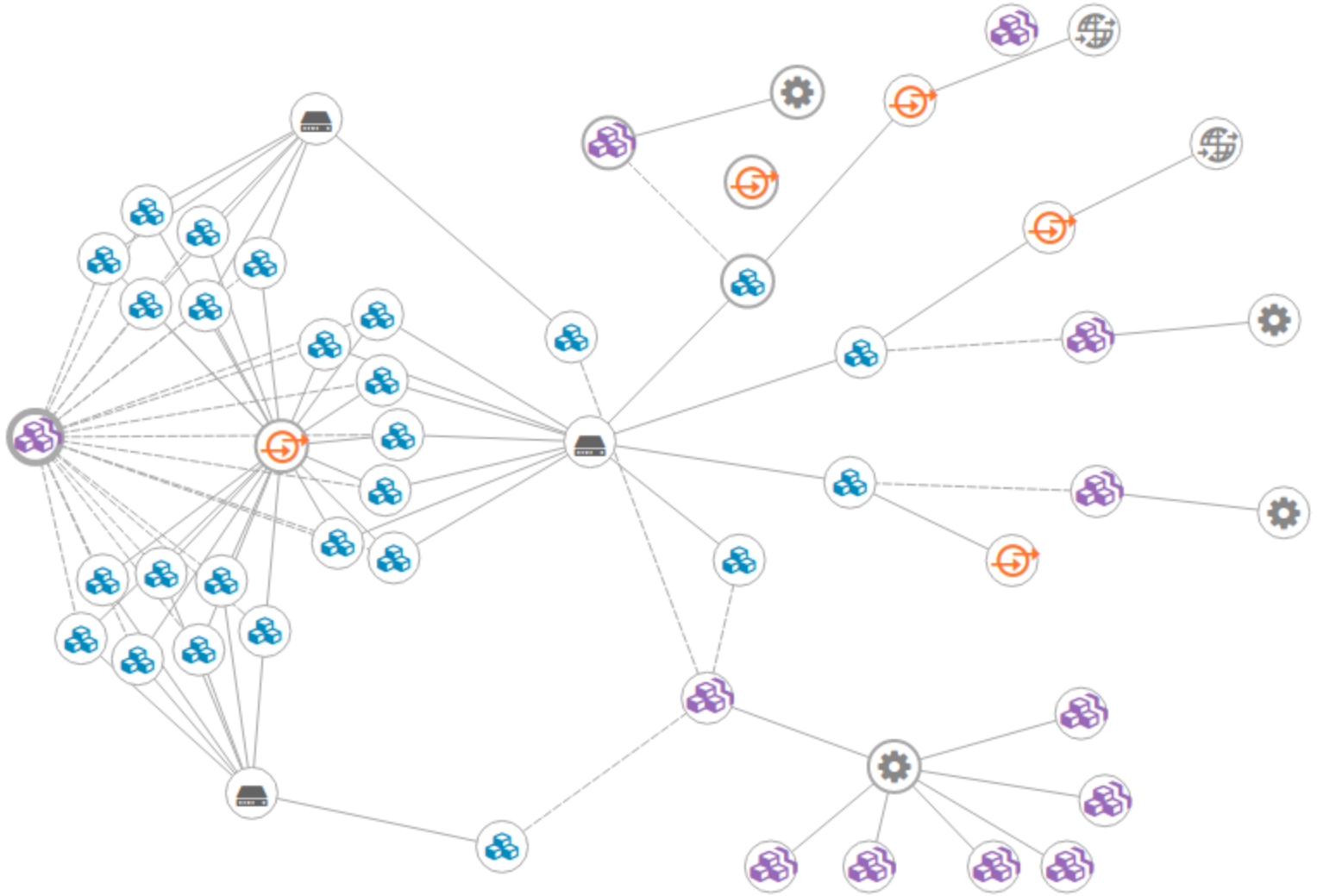
RED HAT ENTERPRISE LINUX SERVER

Unlocked | Stef

Falcon | Dashboard | Cluster | Image Registry

- Overvi...
- Nodes
- Contai...
- Topolo...
- Details
- Volumes
- Images
- Projects

All Projects



ReplicationController

Name	cockpit-tasks
Namespace	verify
Created	Sep 20, 2017 10:42:49 AM
Replicas	20

Selector

infra	cockpit-tasks

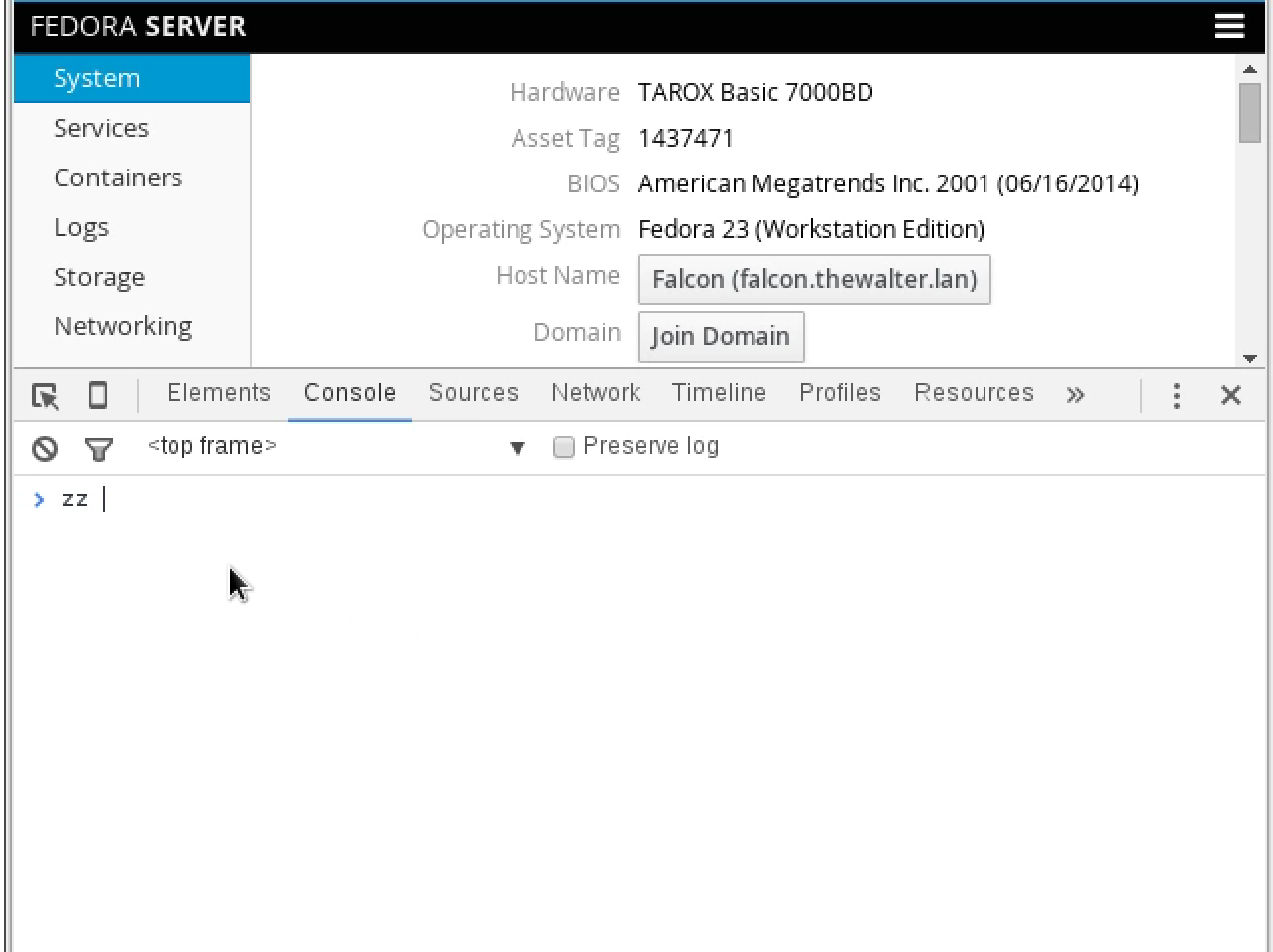
Pod Template

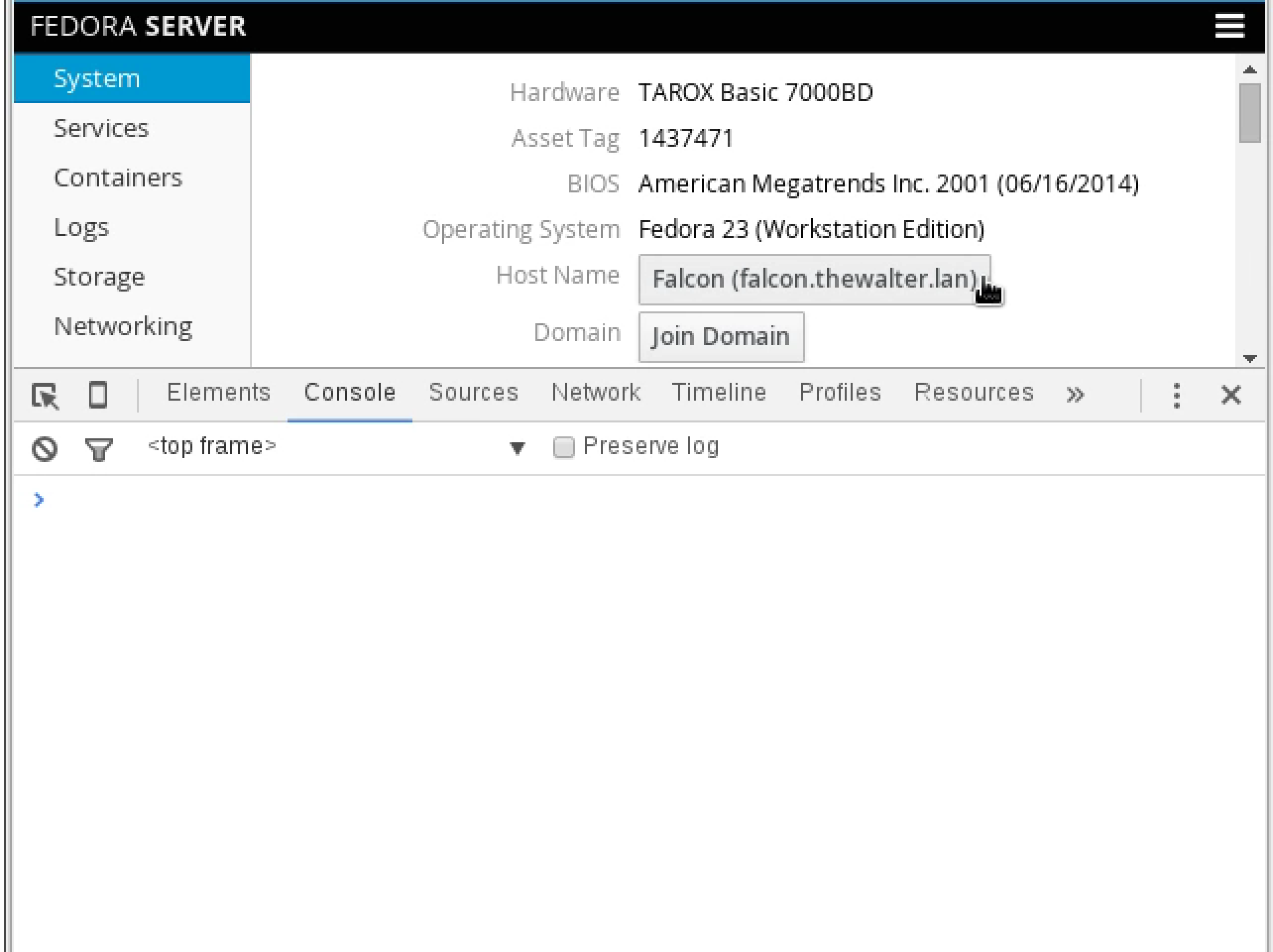
Restart policy	Always
DNS policy	ClusterFirst
Service acco...	cockpituous

Containers

Name	cockpit-tasks
Image	docker.io/cockpit/tests
Ports	*none*
Env vars	TEST_JOBS=8
	TEST_PUBLISH=sink

Name	cockpit-images
Image	docker.io/cockpit/images
Ports	80/TCP


FEDORA SERVER
System
Services
Containers
Logs
Storage
Networking
Hardware
TAROX Basic 7000BD
Asset Tag
1437471
BIOS
American Megatrends Inc. 2001 (06/16/2014)
Operating System
Fedora 23 (Workstation Edition)
Host Name
Falcon (falcon.thewalter.lan)
Domain
Join Domain
Elements
Console
Sources
Network
Timeline
Profiles
Resources
<top frame>
Preserve log
zz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Profiles
Resources
<top frame>
Preserve log

90+ APIs: File, Command, REST, DBus, Socket

abrt	AppStream	apt-get	atomic	Candlepin /candlepin/
chpasswd	CloudForms	cryptsetup	curl	dbus-daemon
device-mapper	docker-storage-setup	docker	e2fsprogs	etcd
/etc/kdump.conf	/etc/passwd	firewalld	FreeIPA	GnuTLS
GSSAPI	hostnamed	ipa-client	ipa-client	iproute
iptables	iscsi-tools	journalctl	kdump	klist
krb5	Kubernetes /api/	lastlog	libvirt	loginctl
lvm	mdadm	NetworkManager	NetworkManager-te...	oddjob
Openshift /oapi/	Openshift OAuth2	openssl	ostree	oVirt /api/
PackageKit	passwd	PCP	PolicyKit	/proc/meminfo...
/proc/mounts	/proc/net/dev...	procps-ng	/proc/stat	pwquality
qemu	realmd	rm ...	rpmostreed	rpm
selinux-policy-target...	selinux-utils	setenforce	Setroubleshootd	shadow-utils
shutdown	sosreport	ssh-agent	sshd	ssh-keygen
ssh	sssd	storaged	subscription-manager	sudo
/sys/fs/cgroup	/sys/kernel	/sys/power	systemd	timedated
Tuned	udev	UDisks2	/usr/bin/kubectl	/usr/bin/timedatectl
/usr/bin/virt-install	/var/log/wtmp	/var/run/utmp	virsh	who/w
xfsprogs	yum			

15+ Linuxes and Products

- CentOS (7.x, Atomic)
- Fedora (26, 27, 28, Atomic)
- Ubuntu (stable, 16.04)
- RHEL (7.4, 7.5, Extras, Atomic)
- Debian (stable, testing)
- Openshift
- RHEV Hypervisor
- Cloudforms

3 maintained branches

master
rhel-7.5
rhel-7.4

5 browsers

Firefox

Google Chrome

Internet Explorer

Safari

Edge

Release every two weeks








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Cyborg Teams

Machines as team members

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Bots own **mundane work**

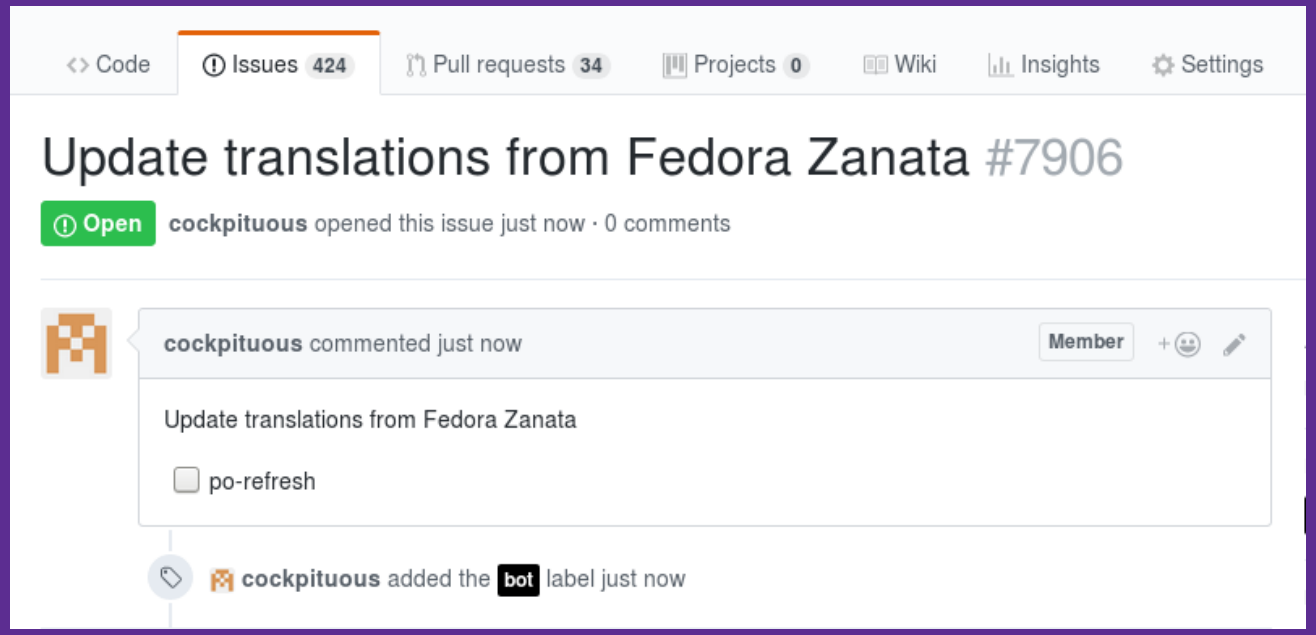
Humans train the bots

Bots learn from humans

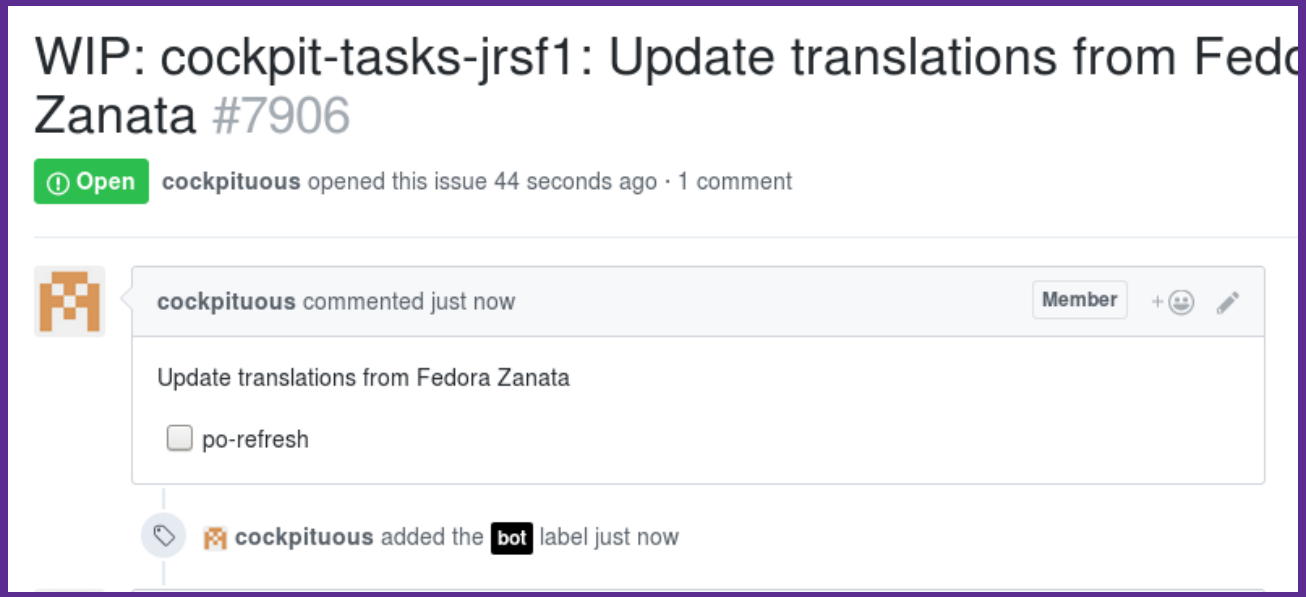
Bots ship Cockpit

Bots as committers

Bots own **mundane work**

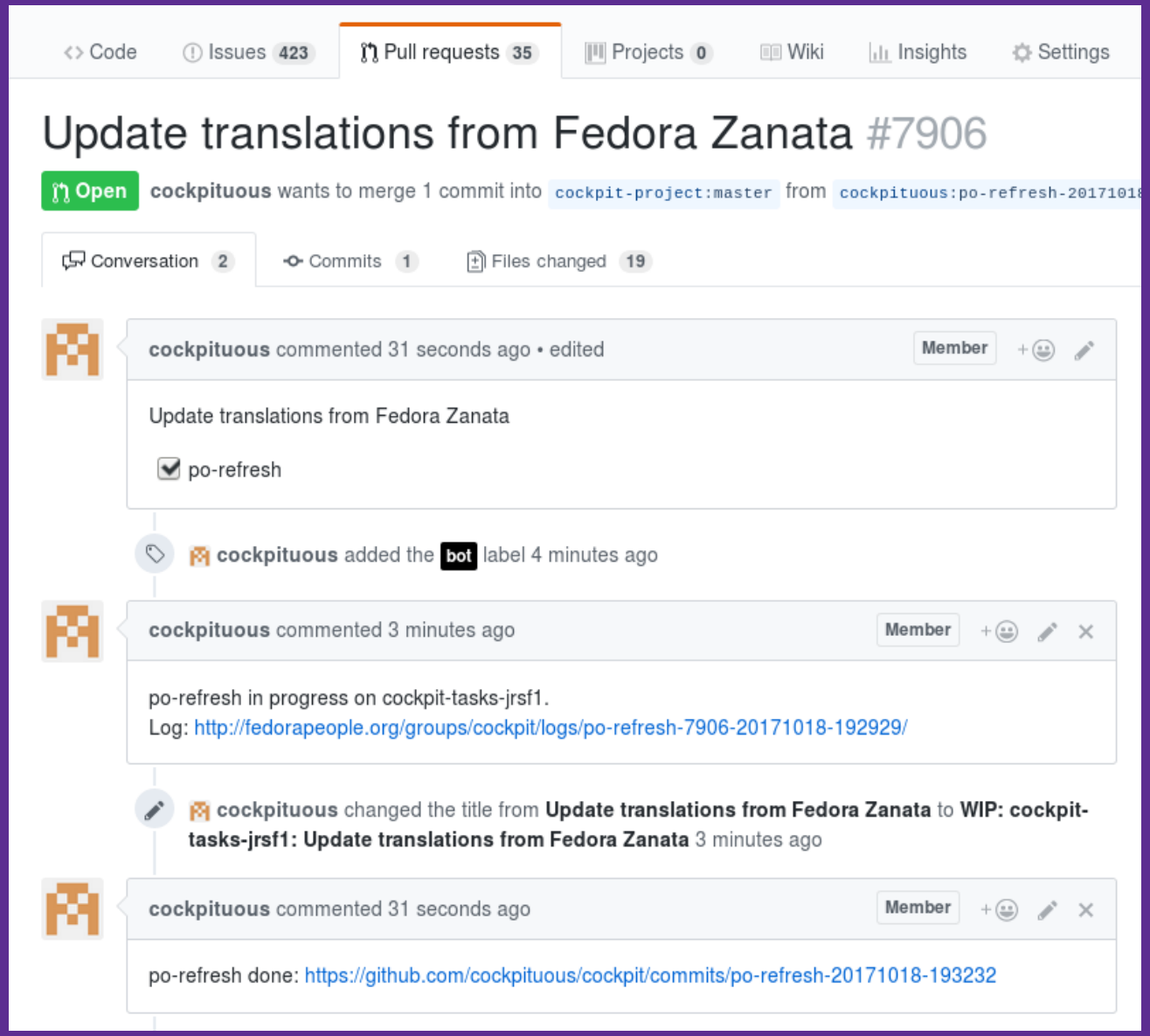

Code
Issues 424
Pull requests 34
Projects 0
Wiki
Insights
Settings
Update translations from Fedora Zanata #7906
Open
cockpituous opened this issue just now · 0 comments
cockpituous commented just now
Member
Update translations from Fedora Zanata
po-refresh
cockpituous added the bot label just now

redhat

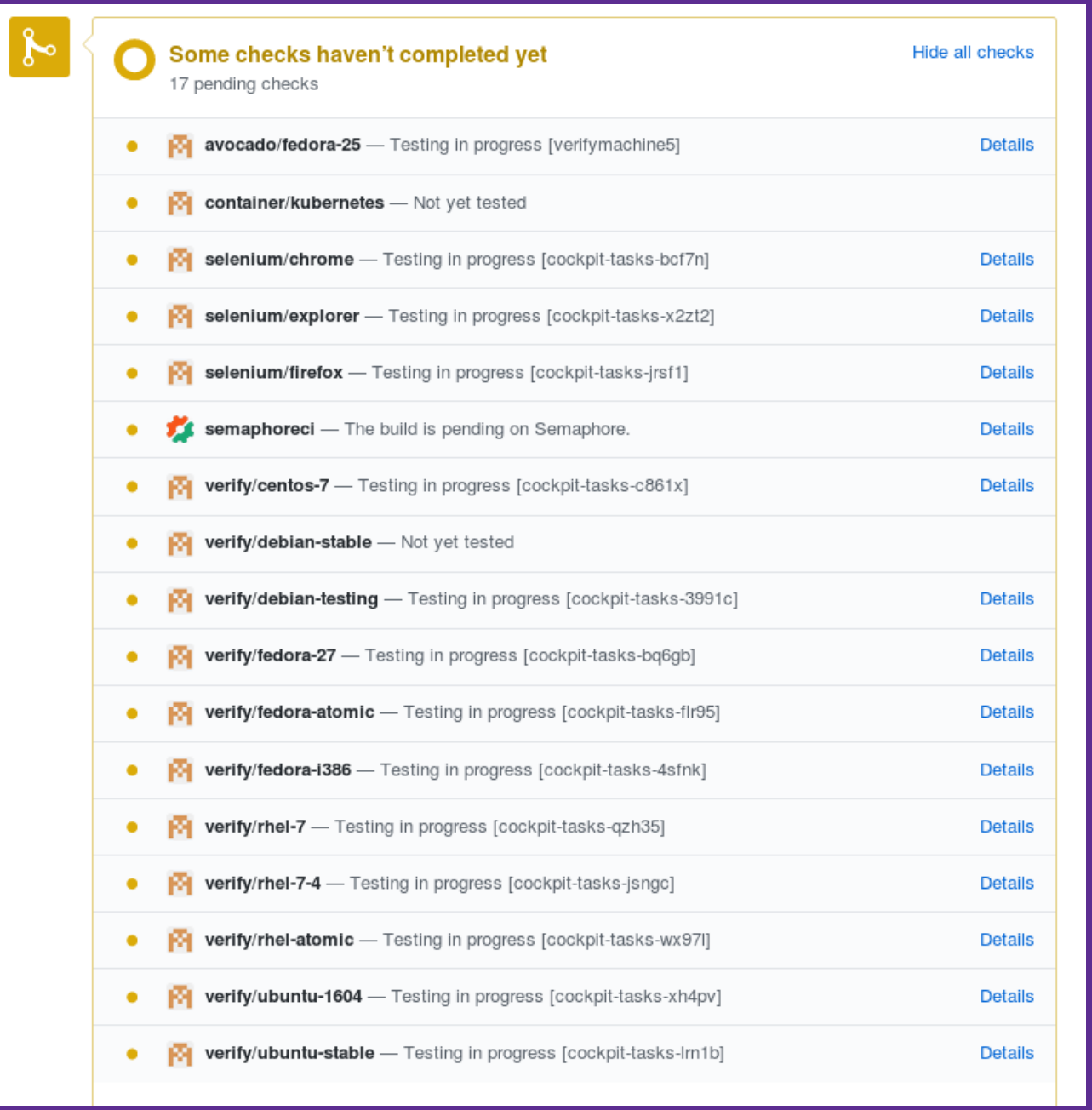

WIP: cockpit-tasks-jrsf1: Update translations from Fedo
Zanata #7906
Open
cockpituous opened this issue 44 seconds ago · 1 comment
cockpituous commented just now
Member
Update translations from Fedora Zanata
po-refresh
cockpituous added the bot label just now

redhat

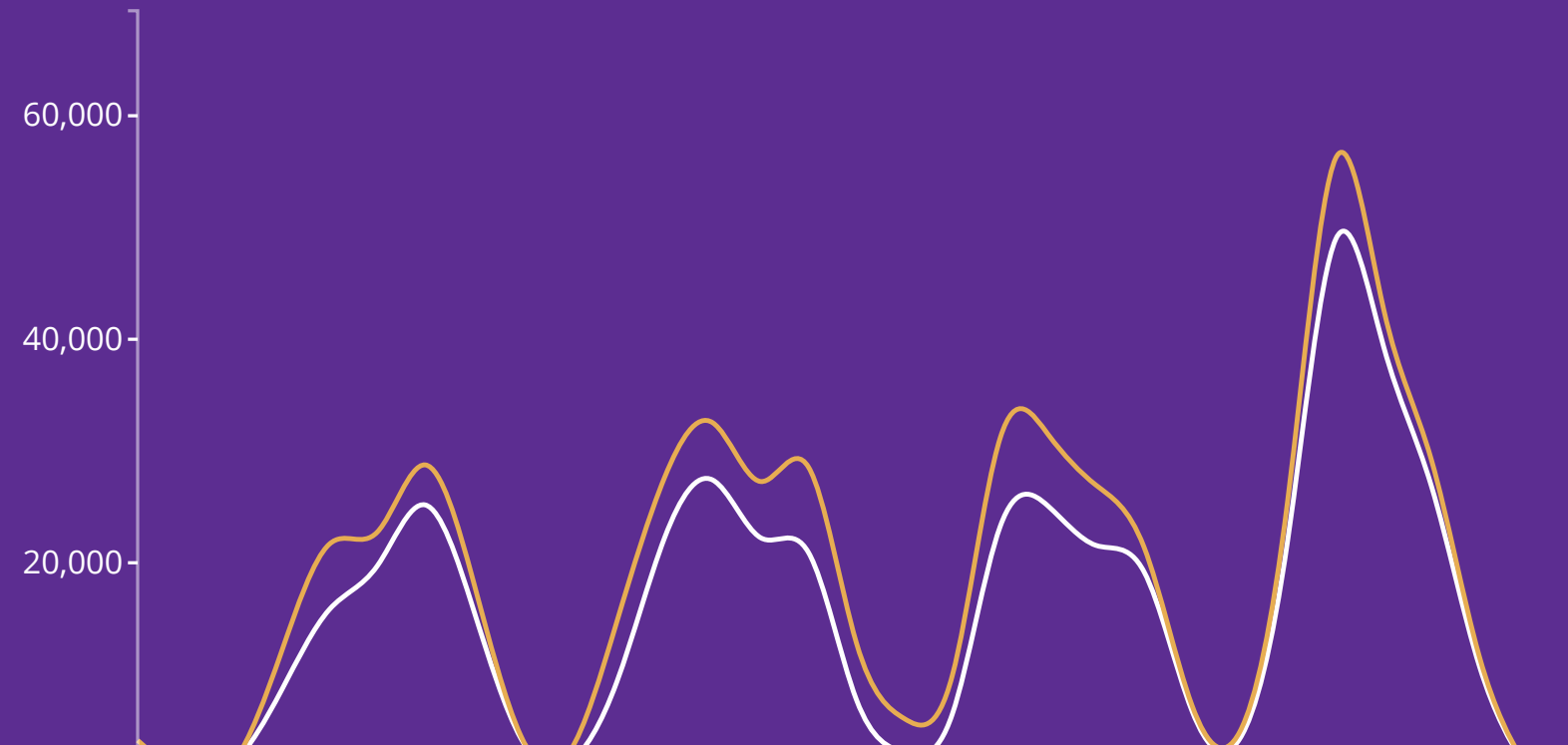
```
$ make po/cockpit.pot

$ make upload-pot
$ make download-po
$ git add po/
$ git checkout -b po-refresh-xxx
$ git commit -m "po: Update from Fedora Zanata"
$ git push cockpitous po-refresh-xxx
```


Code
Issues 423
Pull requests 35
Projects 0
Wiki
Insights
Settings
Update translations from Fedora Zanata #7906
Open
cockpituous wants to merge 1 commit into cockpit-project:master from cockpituous:po-refresh-20171018
Conversation 2
Commits 1
Files changed 19
cockpituous commented 31 seconds ago • edited
Member
Update translations from Fedora Zanata
po-refresh
cockpituous added the bot label 4 minutes ago
cockpituous commented 3 minutes ago
Member
po-refresh in progress on cockpit-tasks-jrsf1.
Log: http://fedorapeople.org/groups/cockpit/logs/po-refresh-7906-20171018-192929/
cockpituous changed the title from Update translations from Fedora Zanata to WIP: cockpit-tasks-jrsf1: Update translations from Fedora Zanata 3 minutes ago
cockpituous commented 31 seconds ago
Member
po-refresh done: https://github.com/cockpituous/cockpit/commits/po-refresh-20171018-193232

redhat


Some checks haven't completed yet
17 pending checks
Hide all checks
avocado/fedora-25 — Testing in progress [verifymachine5] Details
container/kubernetes — Not yet tested
selenium/chrome — Testing in progress [cockpit-tasks-bcf7n] Details
selenium/explorer — Testing in progress [cockpit-tasks-x2zt2] Details
selenium/firefox — Testing in progress [cockpit-tasks-jrsf1] Details
semaphoreci — The build is pending on Semaphore. Details
verify/centos-7 — Testing in progress [cockpit-tasks-c861x] Details
verify/debian-stable — Not yet tested
verify/debian-testing — Testing in progress [cockpit-tasks-3991c] Details
verify/fedora-27 — Testing in progress [cockpit-tasks-bq6gb] Details
verify/fedora-atomic — Testing in progress [cockpit-tasks-flr95] Details
verify/fedora-i386 — Testing in progress [cockpit-tasks-4sfnk] Details
verify/rhel-7 — Testing in progress [cockpit-tasks-qzh35] Details
verify/rhel-7-4 — Testing in progress [cockpit-tasks-jsngc] Details
verify/rhel-atomic — Testing in progress [cockpit-tasks-wx97l] Details
verify/ubuntu-1604 — Testing in progress [cockpit-tasks-xh4pv] Details
verify/ubuntu-stable — Testing in progress [cockpit-tasks-lrn1b] Details

redhat



redhat.

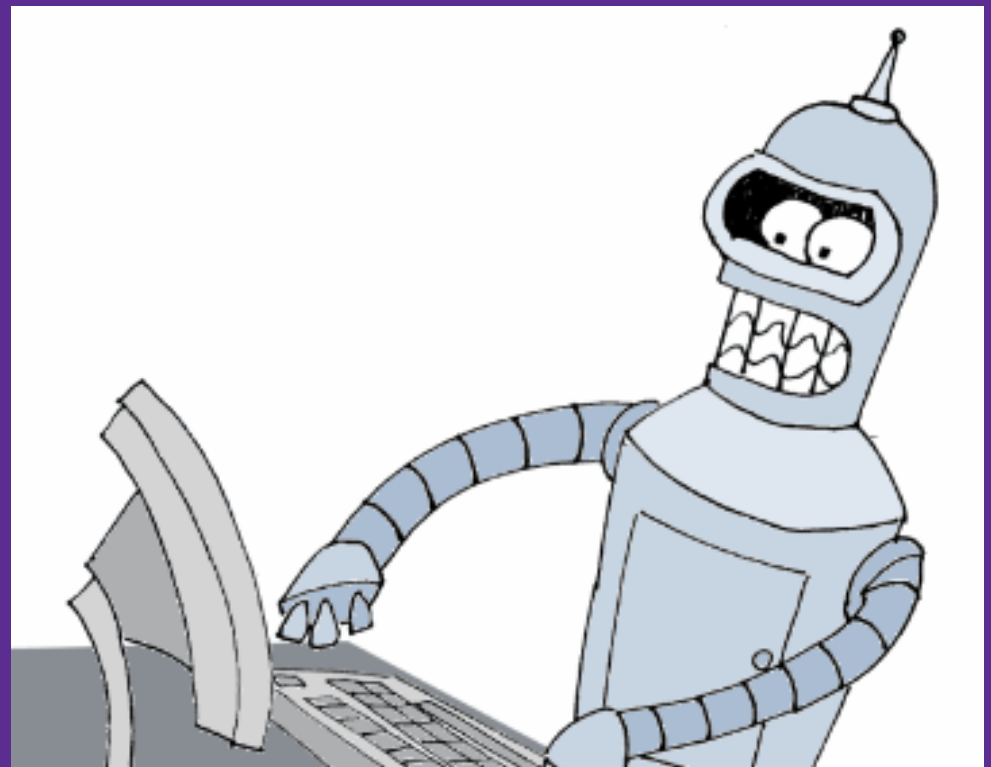
```
$ zcat tests-train-1.jsonl.gz | wc
  867590 67669917 1317326557
$ zgrep -f '"failure"' tests-train-1.jsonl.gz | wc
   12407 2142463 86009034
```

Humans train the bots

redhat.

```
$ git shortlog --summary -- bots/ test/
  Marius Vollmer
  Dominik Perpeet
  Peter Volpe
  Stef Walter

  Martin Pitt
  Jan Scotka
  Lars Karlitski
  Subin M
  Marek Libra
  Andreas Nilsson
  Matej Marusak
  Stephen Gallagher
...
```

Bots learn from humans



redhat.

85: testSuper (check_reauthorize.TestReauthorize) # duration: 25s screenshot journal

```
# testSuper (check_reauthorize.TestReauthorize)
#
ftruncate() failed: Permission denied

DevTools listening on ws://127.0.0.1:9832/devtools/browser/28132994-84e8-492a-bda1-07059595e814
[0123/152927.820842:ERROR:zygote_host_impl_linux.cc(268)] Failed to adjust OOM score of renderer with pid 123004: Permission denied (13)
[0123/152928.864472:ERROR:zygote_host_impl_linux.cc(268)] Failed to adjust OOM score of renderer with pid 123081: Permission denied (13)
> log: done
> log: fail
Traceback (most recent call last):
  File "/build/cockpit/bots/../test/verify/check-reauthorize", line 84, in testSuper
    self.assertEqual(b.text(".super-channel span"), 'result: access-denied')
AssertionError: u'result: disconnected' != 'result: access-denied'

not ok 85 testSuper (check_reauthorize.TestReauthorize) # duration: 25s
Wrote screenshot to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.png
Wrote HTML dump to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.html
Wrote JS log to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.js.log
Journal extracted to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.log


# Flake probability: 72.5% (neural network)

# Flake likely 66.2% (clustering)
```

Bots ship Cockpit

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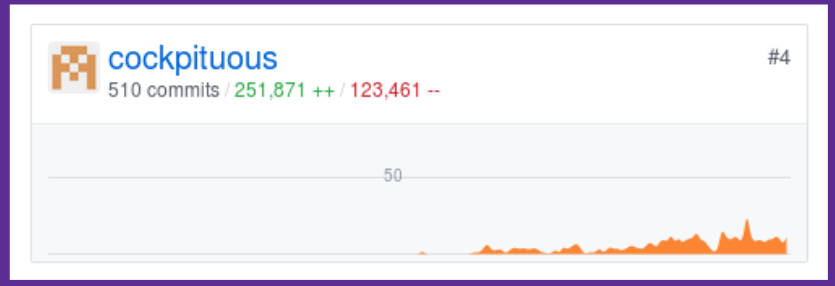
Human signs a tag in git

Bots scurry about

- Make **tarballs and patches**
- Update RPM spec files and Debian control files
- **Release** preview builds
- Update and push **Fedora** packages
- Upload packages into **Ubuntu**
- Upload packages into **Debian**
- Upload **tarballs**
- Container rebuilds on **Docker Hub**
- Online documentation update

Bots as committers

redhat

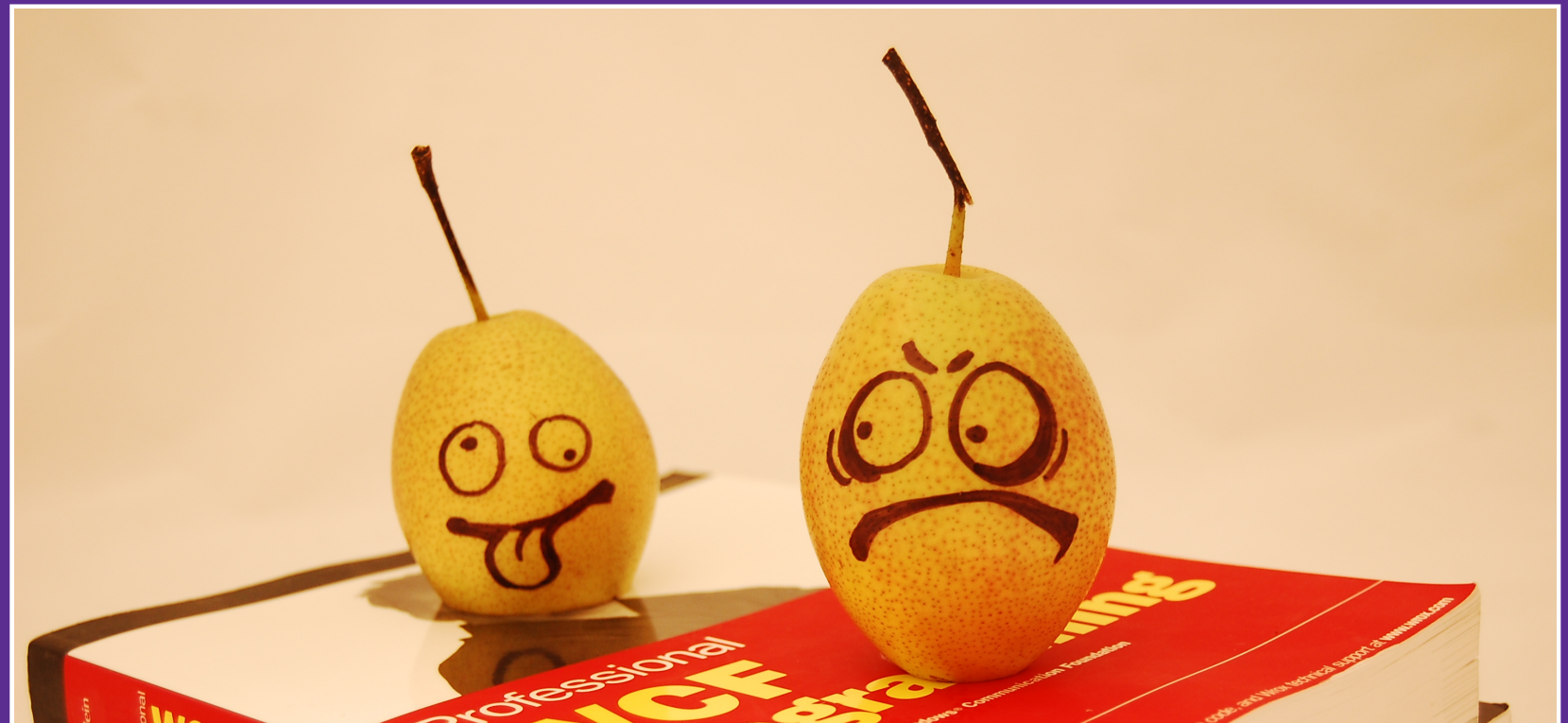



```
$ git shortlog -ns | head -n10 | cut -c8-30 | nl | grep Cockpit
     4  Cockpituous
```

redhat

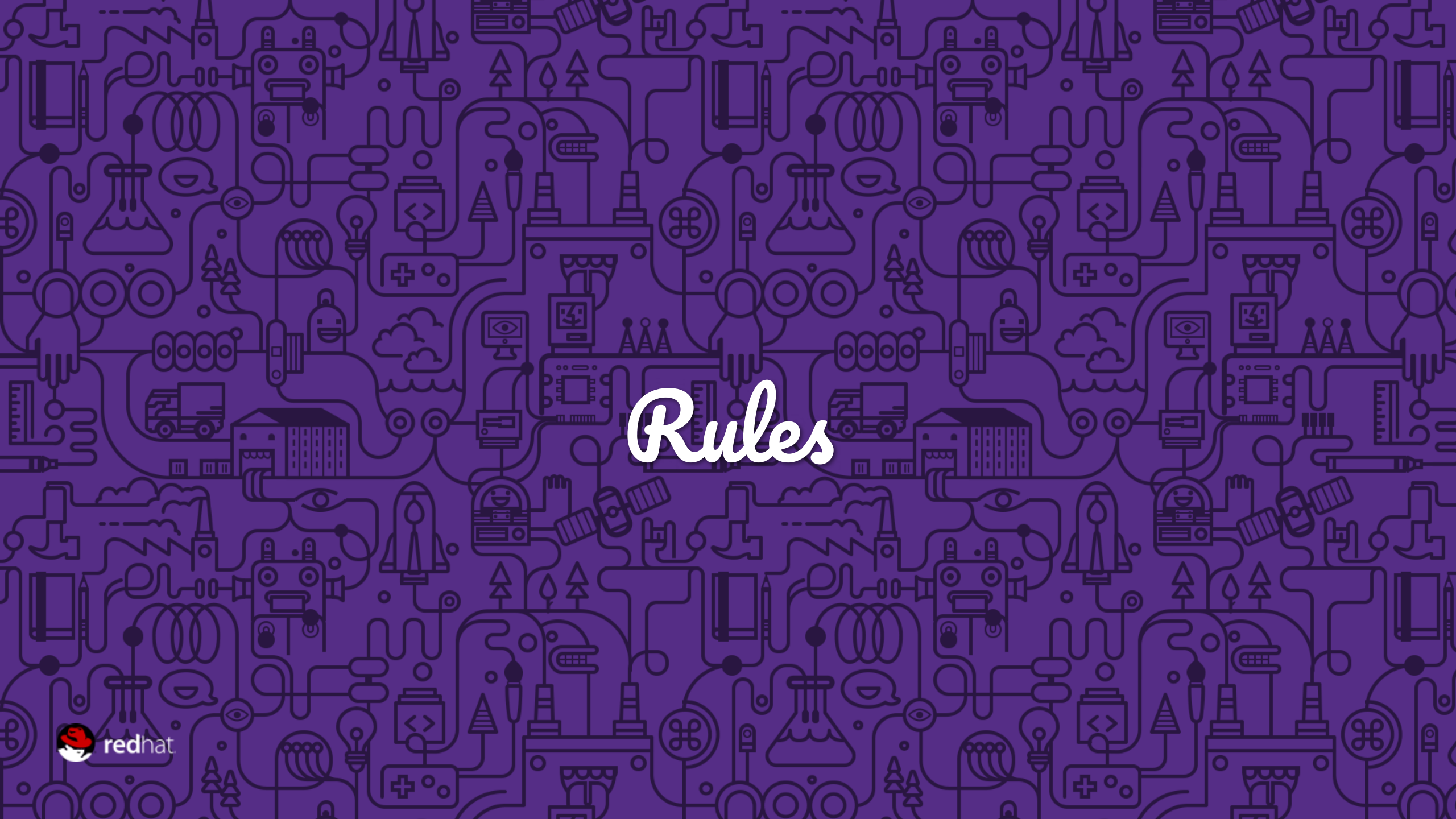
Pair programming with bots

redhat



redhat

Team stops without bots


Rules
redhat

Behavior is driven by two forces

1. Driving forces
   Push you in a specific direction

2. Restraining forces
   Prevent you from going there

First: **Diminish restraining forces**
Second: **Increase the driving forces**

— Kurt Lewin

So why don't we see Cyborg Teams everywhere?

Laws of Cyborg Teams

1. Teaching a machine must be as easy as teaching a human
2. Machines must produce feedback into the team's workflow
3. A human should be able to impersonate a machine, and

Tests: The Soul of a Robot

Teaching machines right and wrong, good and evil

Techniques

Make bots and tests reproducible, changeable

Don't fix process in order to automate it.

Organic and distributed bots

Self-validating and self-aware bots

Machine learning: Test flakes are food

Make bots and tests reproducible, changeable

redhat.

Bots and tests should be
discoverable, reproducible and contributable
by anyone on the team

Put **bots and tests together with the code**
or content they most affect.

Everyone affected by
Continuous Integration
must be able to fix it rapidly

Don't fix process in order to automate it

redhat

Bots excel at doing shit work
Don't feel bad about making them do it

Don't assume bots can't

Moravec's Paradox

Organic and distributed bots

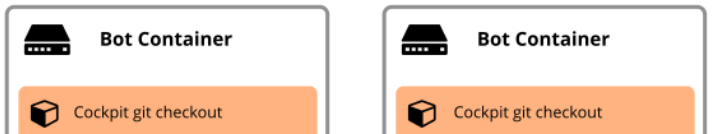
Cockpit Task Bots

Task system is distributed with GitHub as the single point of failure

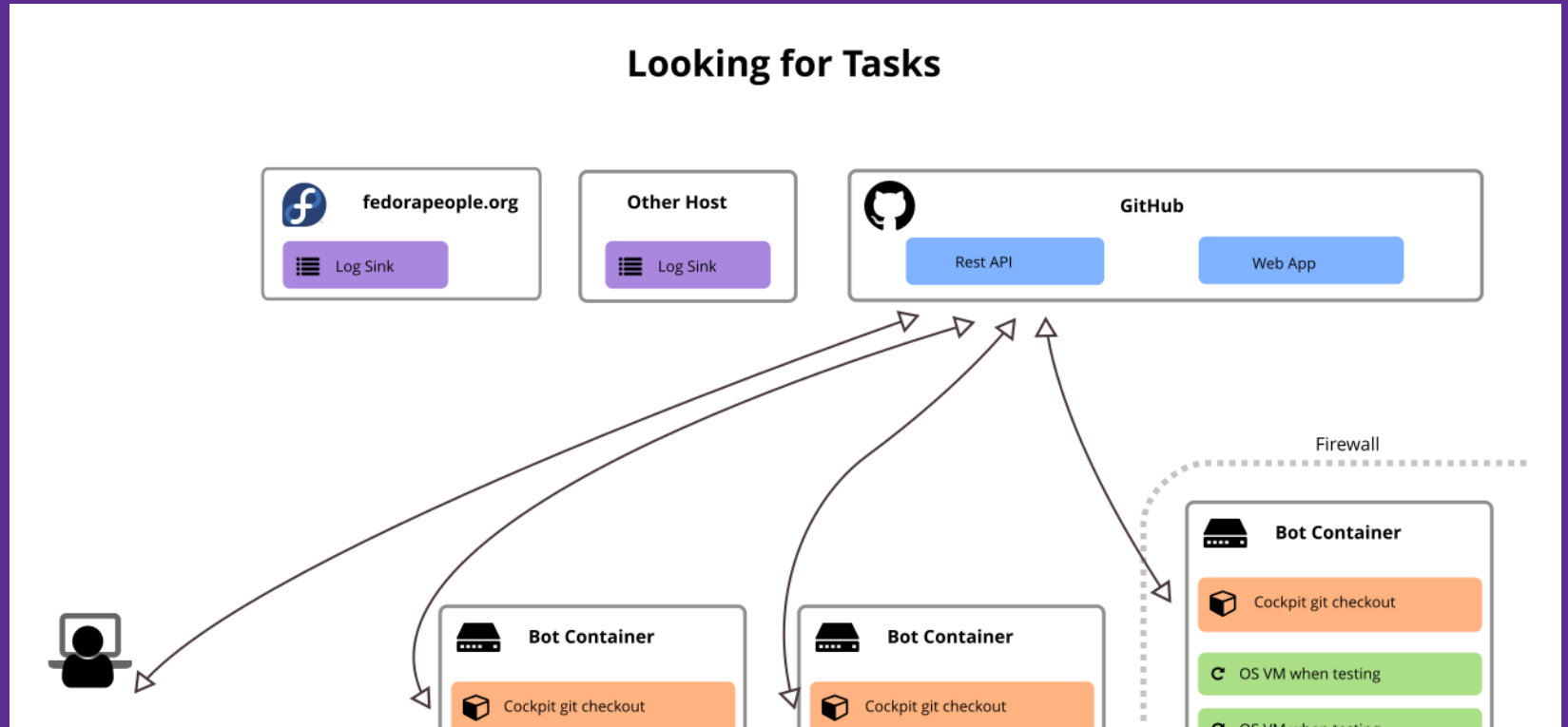
Every pull request is booted 100's of times
in Atomic, Debian, Fedora, RHEL, before it hits master.

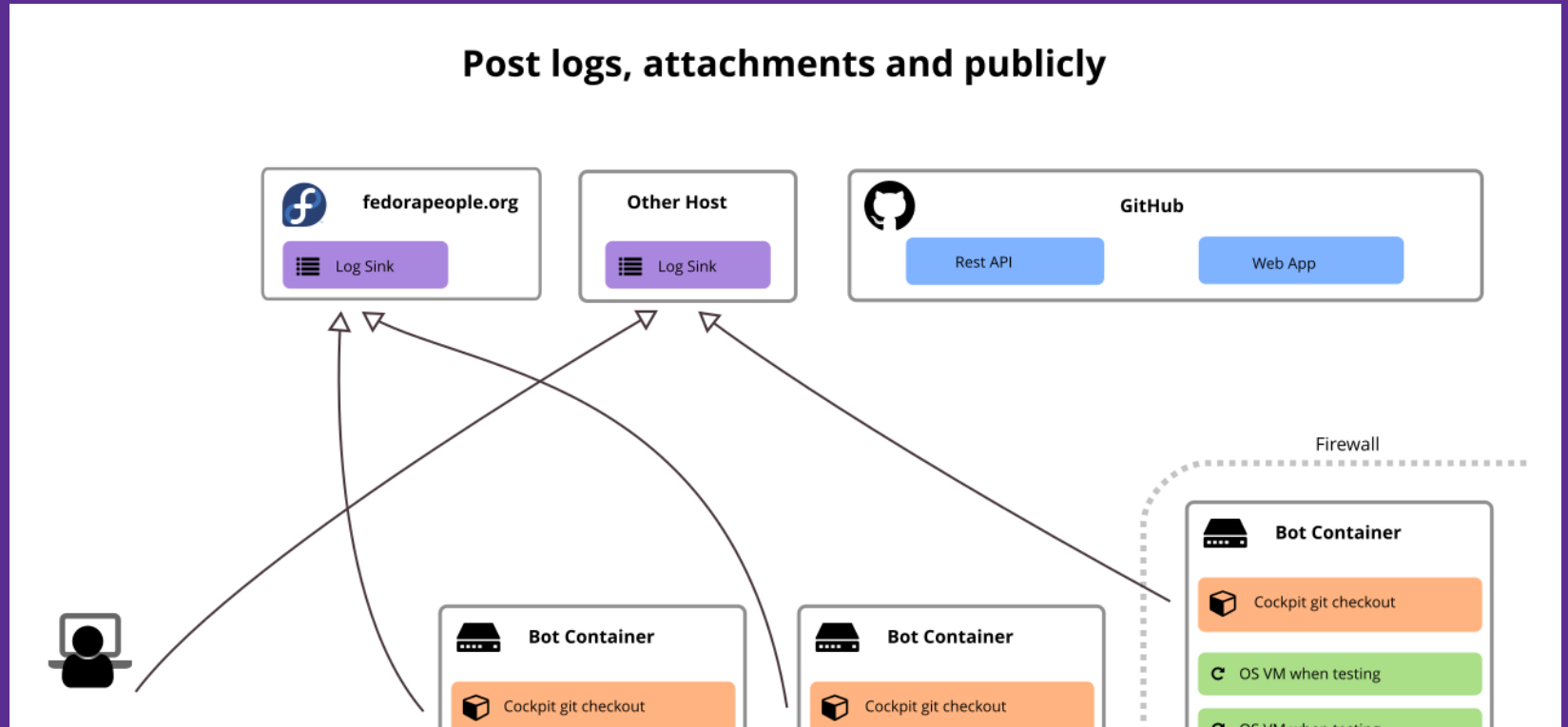
Containers that start
1,000 - 10,000 test VMs a day

These containers can run anywhere



redhat


Looking for Tasks
fedorapeople.org
Log Sink
Other Host
Log Sink
GitHub
Rest API
Web App
Firewall
Bot Container
Cockpit git checkout
OS VM when testing
Bot Container
Cockpit git checkout
Bot Container
Cockpit git checkout


Post logs, attachments and publicly
fedorapeople.org
Log Sink
Other Host
Log Sink
GitHub
Rest API
Web App
Firewall
Bot Container
Cockpit git checkout
OS VM when testing
Bot Container
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Bot Container
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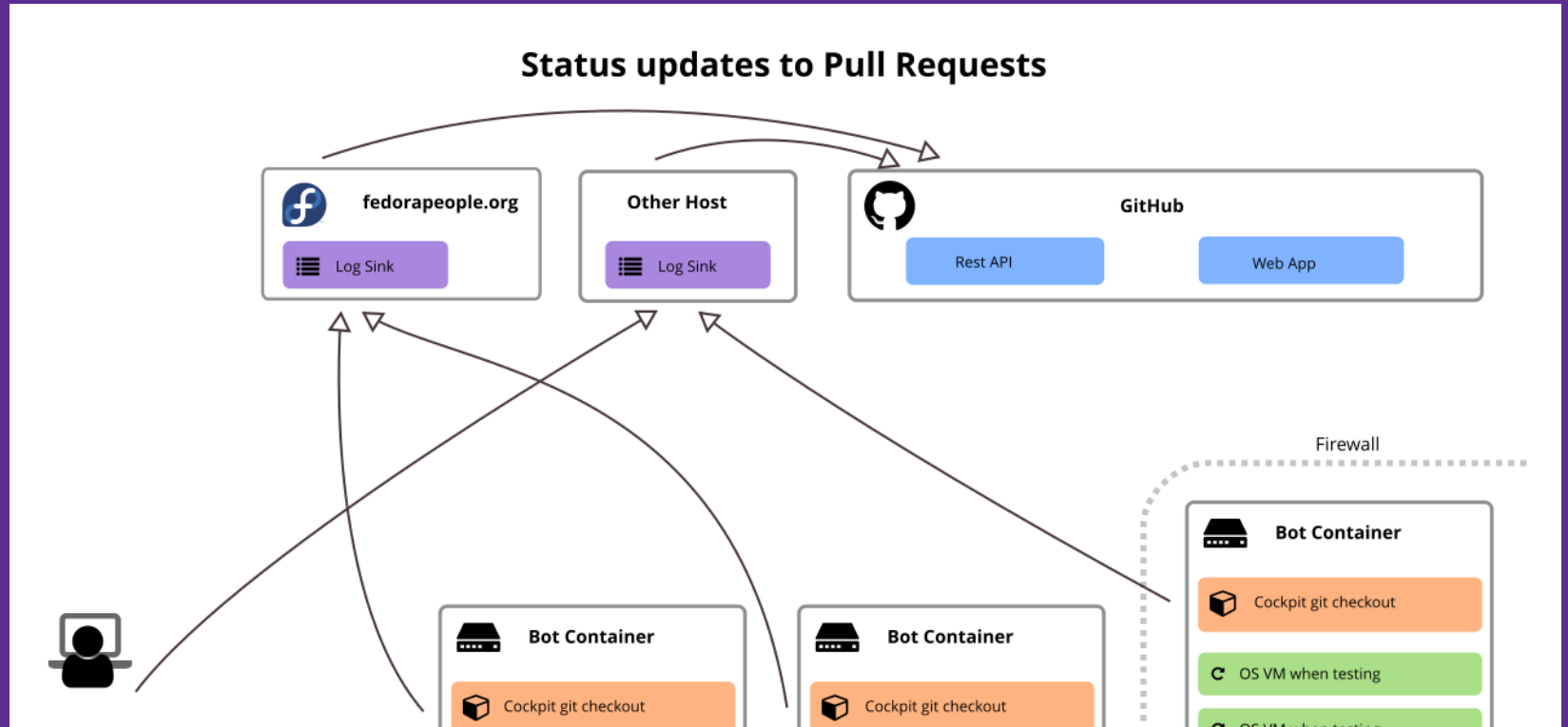
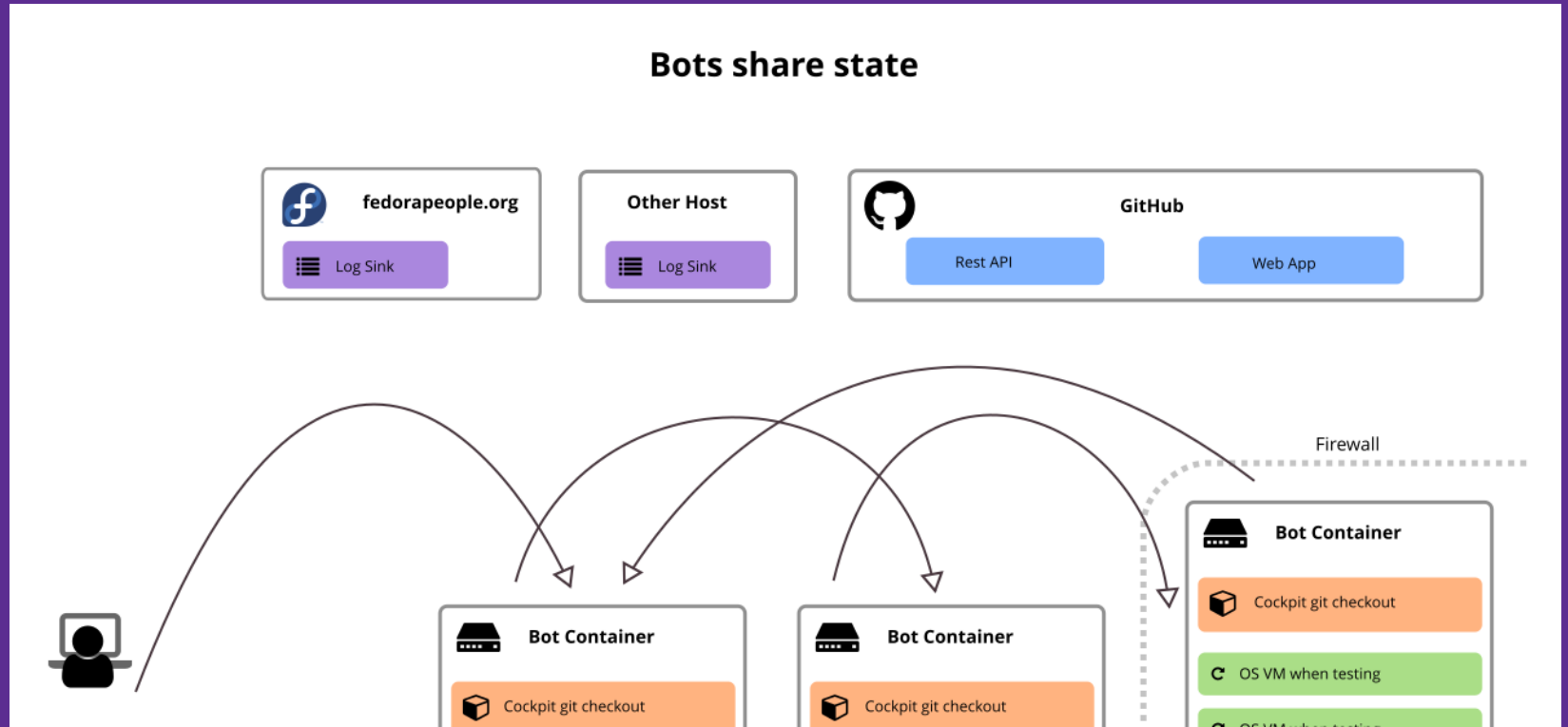
redhat


Status updates to Pull Requests
fedorapeople.org
Log Sink
Other Host
Log Sink
GitHub
Rest API
Web App
Firewall
Bot Container
Cockpit git checkout
OS VM when testing
Bot Container
Cockpit git checkout
Bot Container
Cockpit git checkout


Bots share state
fedorapeople.org
Log Sink
Other Host
Log Sink
GitHub
Rest API
Web App
Firewall
Bot Container
Cockpit git checkout
Bot Container
Cockpit git checkout
Bot Container
Cockpit git checkout
OS VM when testing

redhat

Testing **containers**

in **Virtual Machines**
in **container** bots
running on **virtual machines**
on turtles

redhat

Collision avoidance and detection

```
# Scan for all tests
bots/tests-scan


# File issues for these tasks
bots/po-trigger
bots/image-trigger
bots/npm-trigger
bots/naughty-trigger

# Any tasks related to issues
bots/issue-scan
```

```
PRIORITY=0009 bots/image-refresh --issue='7950' debian-testing
PRIORITY=0009 bots/image-refresh --issue='7949' rhel-7-4
PRIORITY=0009 bots/image-refresh --issue='7948' ubuntu-1604
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4
PRIORITY=0005 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4
PRIORITY=0000 touch /tmp/cockpit-image-prune.stamp && bots/image-prune
...
```

redhat

```
  GEN      dist/ostree/Makefile.deps
  GEN      dist/networkmanager/Makefile.deps

  GEN      dist/machines/Makefile.deps
  GEN      dist/kubernetes/Makefile.deps
  GEN      dist/kdump/Makefile.deps
  GEN      dist/docker/Makefile.deps
  GEN      dist/dashboard/Makefile.deps
  GEN      dist/apps/Makefile.deps
Expecting "WIP: cockpit-tasks-3991c: Update translations from Fedora Zanata'
State not as expected. Possible collision. Aborting.
```

Self-validating self-aware bots

Make your bots try out changes to the bots

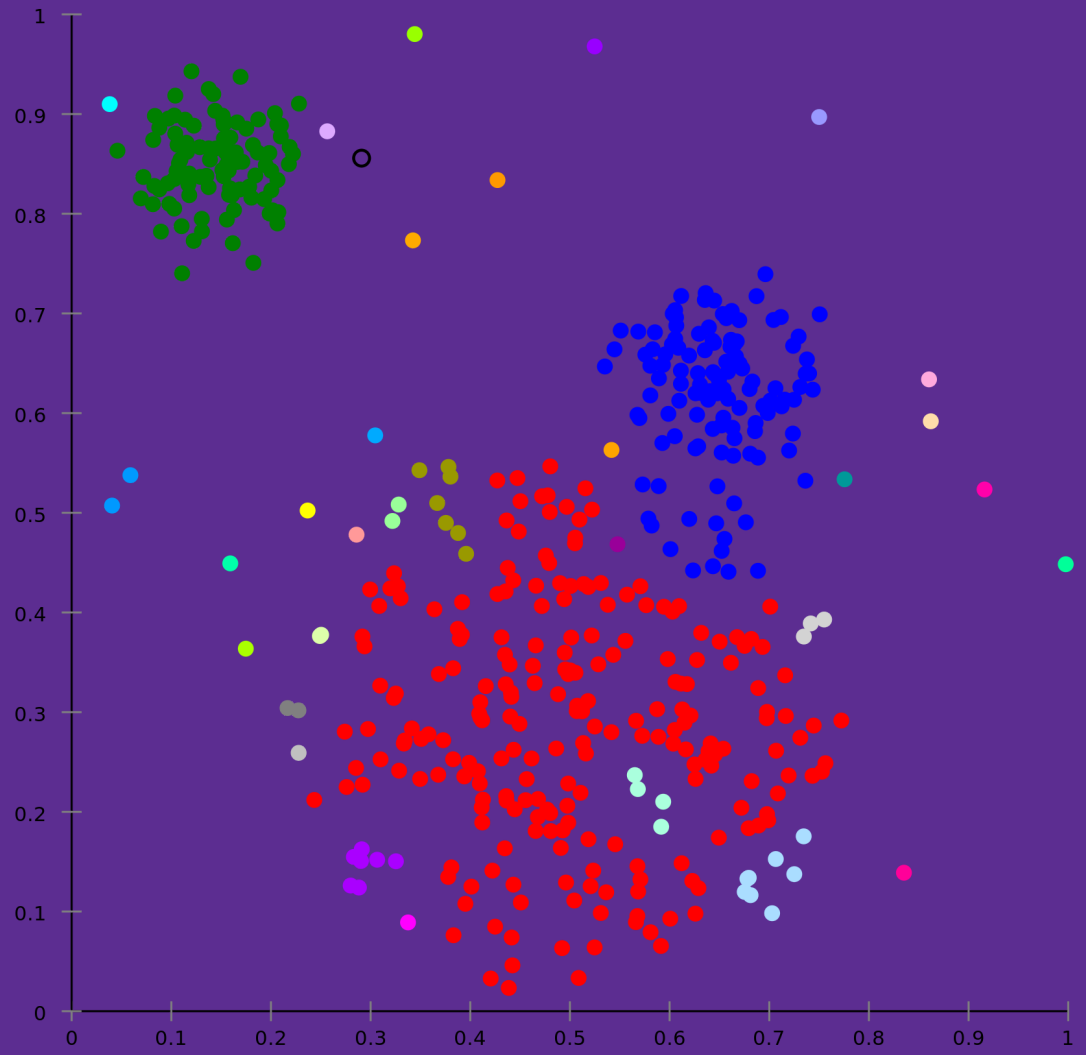
Example: Jenkins Continuous Infra pipeline

```
kvm = os.access("/dev/kvm", os.R_OK | os.W_OK)


try:
    urllib.urlopen(REDHAT_PING).read()
    redhat = os.path.exists(os.path.expanduser(REDHAT_CREDS))
except IOError:
    redhat = False
```

Machine learning: Test flakes are food

Flakes are just fuzzing mutations



redhat

ML techniques in use

- Term Frequency - Inverse Document Frequency
- Normalized Compression Distance
- DBSCAN unsupervised clustering
- K-nearest Neighbors classification

85: testSuper (check_reauthorize.TestReauthorize) # duration: 25s screenshot journal

```
# testSuper (check_reauthorize.TestReauthorize)
#
ftruncate() failed: Permission denied

DevTools listening on ws://127.0.0.1:9832/devtools/browser/28132994-84e8-492a-bda1-07059595e814
[0123/152927.820842:ERROR:zygote_host_impl_linux.cc(268)] Failed to adjust OOM score of renderer with pid 123004: Permission denied (13)
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AssertionError: u'result: disconnected' != 'result: access-denied'

not ok 85 testSuper (check_reauthorize.TestReauthorize) # duration: 25s
Wrote screenshot to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.png
Wrote HTML dump to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.html
Wrote JS log to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.js.log
Journal extracted to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.log


# Flake probability: 72.5% (neural network)

# Flake likely 66.2% (clustering)
```

Term Frequency - Inverse Document Frequency

```
# ----------------------------------------------------------------------
# testTeam (check_networking_team.TestNetworking)
#
NAME          UUID                                   TYPE             DEVICE
System eth0   5fb06bd0-0bb0-7ffb-45f1-d6edd65f3e03   802-3-ethernet   eth0
virbr0        82404faf-cb6b-4f4c-8eb6-65fc1a2ff8da   bridge           virbr0

System eth1   9c92fad9-6ecb-3e6c-eb4d-8a47c6f50c04   802-3-ethernet   --


52:54:01:00:00:03 -> eth2
52:54:01:00:00:03 -> eth2
52:54:01:00:00:04 -> eth3
52:54:01:00:00:04 -> eth3
not ok 139 testTeam (check_networking_team.TestNetworking) duration: 106s
Traceback (most recent call last):
  File \"/build/cockpit/bots/../test/verify/check-networking-team\", line 8
    b.wait_present(\"#network-interface-slaves tr[data-interface='%s']\" % i
```

```
# testTeam (check_networking_team.TestNetworking)
NAME          UUID                                   TYPE             DEVICE
System eth000   000fb000bd000-000bb000-000ffb-000f000-d000edd000f000e000  000
virbr000        000faf-cb000b-000f000c-000eb000-000fc000a000ff000da  bridge
System eth000   000c000fad000-000ecb-000e000c-eb000d-000a000c000f000c000  000
File "check-networking-team", line 000, in testTeam
b.wait_present("#network-interface-slaves tr[data-interface='%s']" % iface0
```

redhat

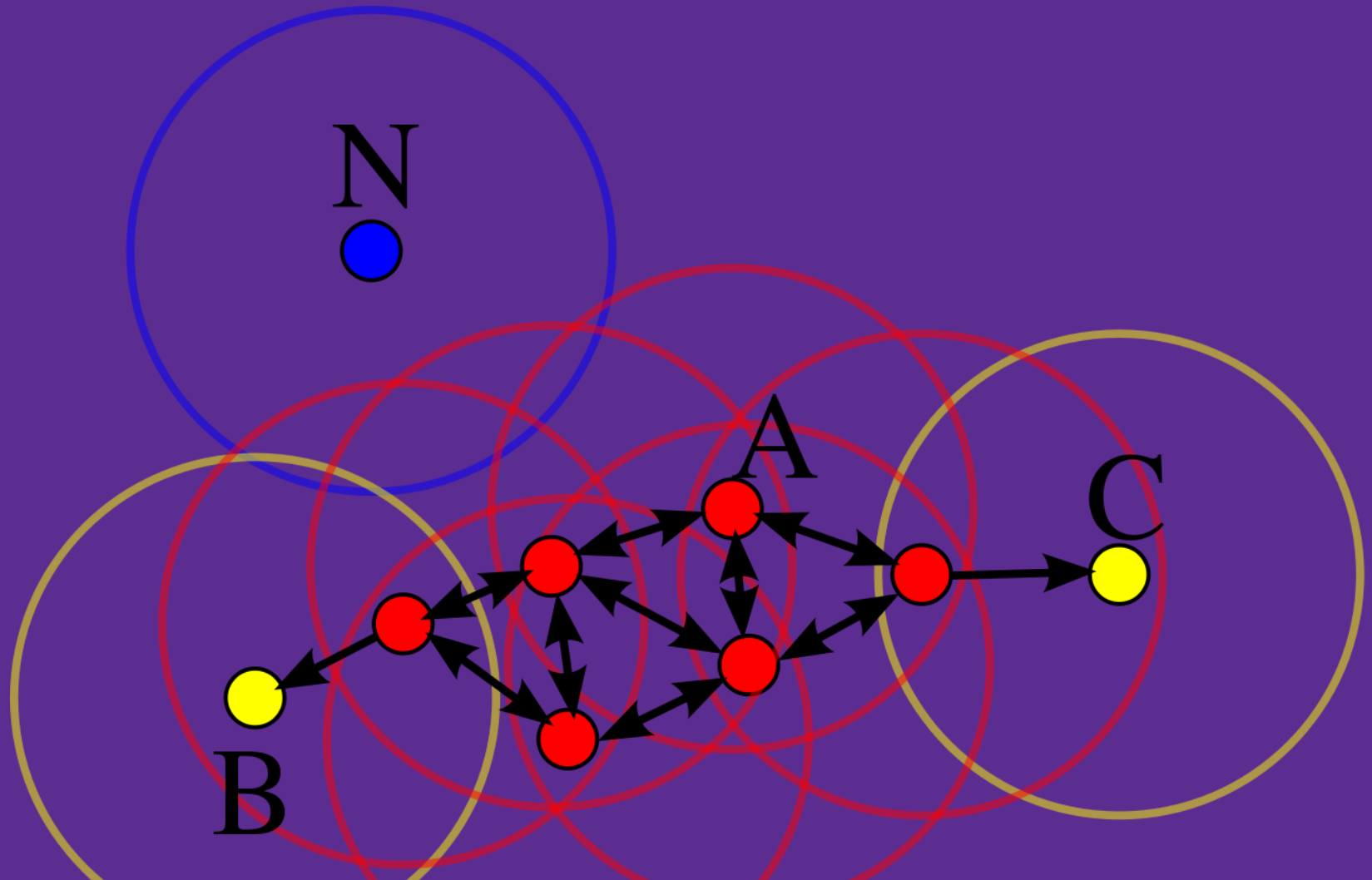
Normalized Compression Distance

$$NCD_Z(x,y) = \frac{Z(xy) - \min\{Z(x), Z(y)\}}{\max\{Z(x), Z(y)\}}.$$

```
Z = lambda v: len(zlib.compress(v))
```

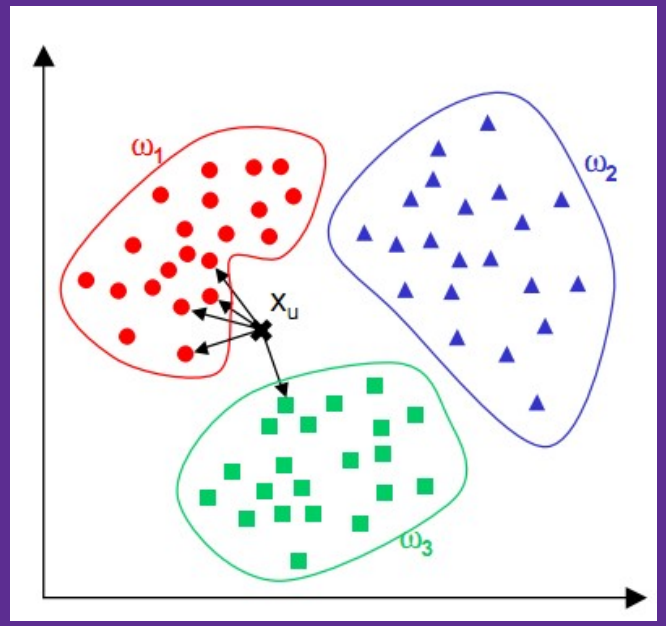
DBSCAN

Density-based spatial clustering of applications with noise



redhat

k-nearest neighbor



redhat

I want!

```
$ bots/image-download --state tests-learn-1.gz
...
$ bots/learn-tests --dry
Loading existing tests data
14208: Items to train

...
100933632: Computed distances in 1181 seconds on 32 cores
332: Clusters (13962 items, 246 noise)
```

```
$ cat example-test.log | bots/tests-policy fedora-27
...
...
# Flake probability: 100.0% (neural network)
# Flake likely 58.6% (clustering)
```

redhat.

Add tests to my Fedora package

fedoraproject.org/wiki/CI/Tests

Run simple tests on GitHub pull requests

Add `.travis.yml` and use Travis CI

Run a full userland for integration tests

Semaphore CI and `example`

github.com/cockpit-project/cockpituous

Run my CI in Openshift

Contact CentOS CI for an account

Copy pipelines built in Openshift/Jenkins

Continuous Infra team at Red Hat, speaking at DevConf

Run VMs in Openshift for testing

Look at how Linux System Roles did it really simply

Bots for delivery, dist-git, Bodhi, Koji

Look at `cockpit/release` container

Try out Machine Learning

Use `scikit-learn`

Cyborg Teams

Happy humans, tired machines

Questions?

RED HAT SUMMIT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Credits:
Machines: tt2times on Flickr
Pear Programming: mendhak on Flickr
Shut up and Take my Money: liliana_von_k on Flickr
Clusters: Chire on Wikipedia

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