Skynet your Infrastructure with QUADS

Pycon SK 2018

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What do we do? A race car analogy.

- High performance computer servers are race cars.
- High performance networks are race tracks.
- Race car races are performance/scale product testing.
- Race car drivers are performance/scale engineers.
- We are the Pit crew/track engineers.

Track Conditions

There are many races happening all the time with different sets of race cars on different race tracks, scheduled as efficiently as possible for as far out in the future as possible.

QUADS helps us automate and document the scheduling, management and mayhem of the races, race cars and race tracks.

What do we do? *(readers digest version)*

- 2-person DevOps / Sysadmin Team
    - Manage 400+ high-performance servers, switches, infra
        - Accommodates many parallel perf/scale product testing workloads and isolated scale & performance tests
        - Sets of machines, network/VLAN change hands constantly, spin-up / spin-down

- **We have automated our jobs with Python**
- **We spend our time improving the automation and tools**

How did we DevOps?

- Embed small Sysadmin/DevOps team *(2 people)* with a much larger Performance/Systems Engineering group *(160 people)*.
- Attend relevant development syncs/scrums
- Become intimately familiar with development needs and workflow
- Make transparency paramount (break down silos where possible)
- Develop tooling and automation to get things done better
- Contribute code to core development (if relevant)
- *Team rotation:* development staff come into the DevOps team for 2-month periods.

What Now? Sharing is Caring.

- All code and tools in public repositories (we use Git)
- Flexible, transparent Kanban task and priority system (Trello)
- Bi-weekly collaboration with DevOps people in similar roles inside of the company.
- Regular communication, demos, knowledge transfer of tooling.
- Be flexible to adjust priorities based on need
- Celebrate successes, learn from failures.
- Document everything!

You are the pit crew, track engineer and enabler.

But basically ..

QUADS - What it is *(and is not).*

- QUADS is not an installer
- QUADS is not a provisioning system
- QUADS bridges several interchangeable tools together
- QUADS uses Foreman (or something else)
- QUADS can prep systems/networks for OpenStack deployment.
- QUADS helps us automate boring, manual things
- QUADS documents things for us that we might mess up.

Don’t build the systems, build the system that builds the systems.

QUADS - What is it?

Set of tools to help automate the scheduling, management and end-to-end provisioning of servers and networks.

- Programmatic, YAML-driven scheduling
- Automated systems provisioning
- Automated network/VLAN provisioning
- Automated documentation / visualizations
- Automated usage and status generation

QUADS - How is it used?

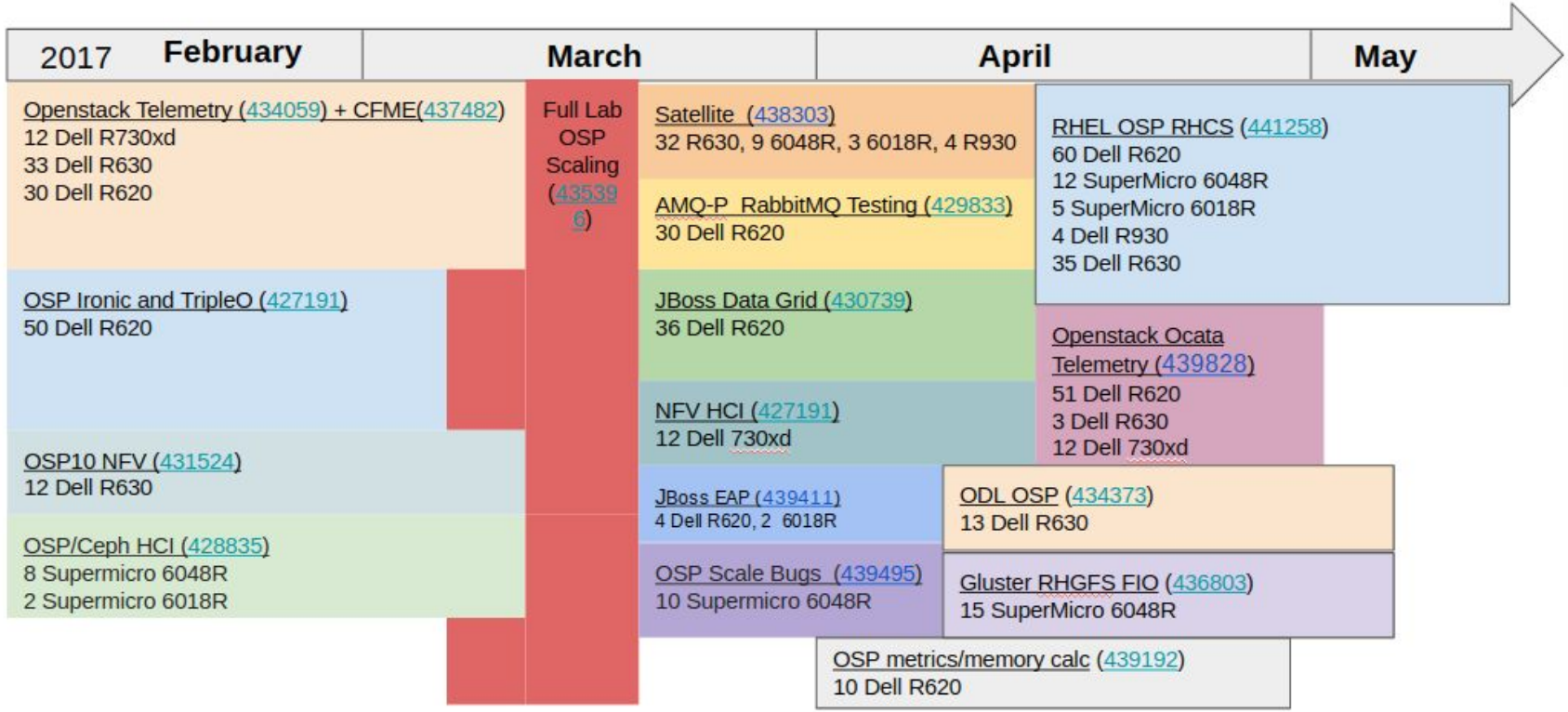
Red Hat Scale Lab



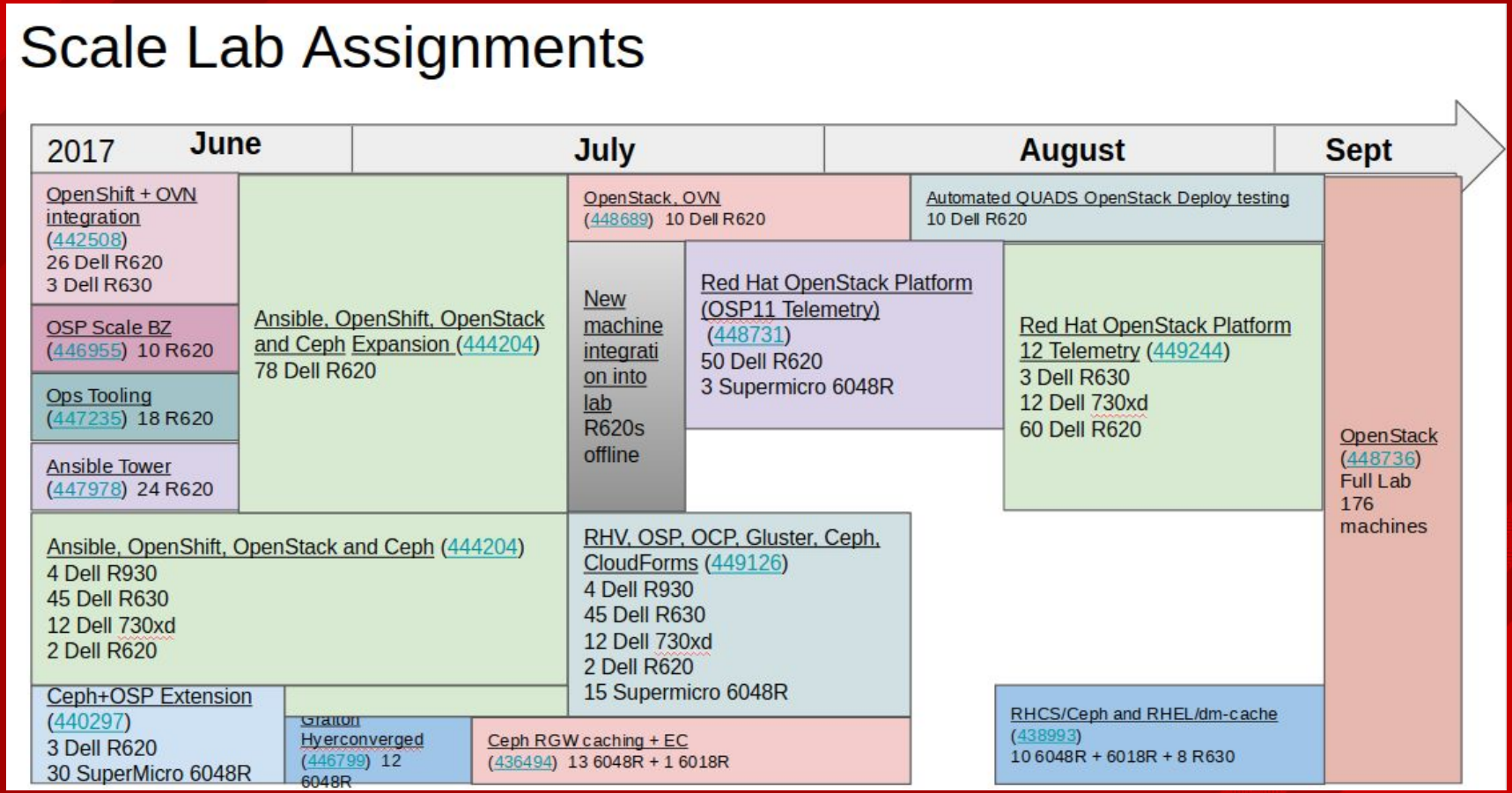
- 400+ bare-metal system high-performance R&D lab
- Testing/vetting upstream, Red Hat and partner products at scale
- Demanding spin-up/down requirements
- Rapid provisioning for short-term usage *(1 to 4 week maximum)*
- 25+ isolated, parallel systems assignments ongoing 24/7

QUADS - Scheduling in Action

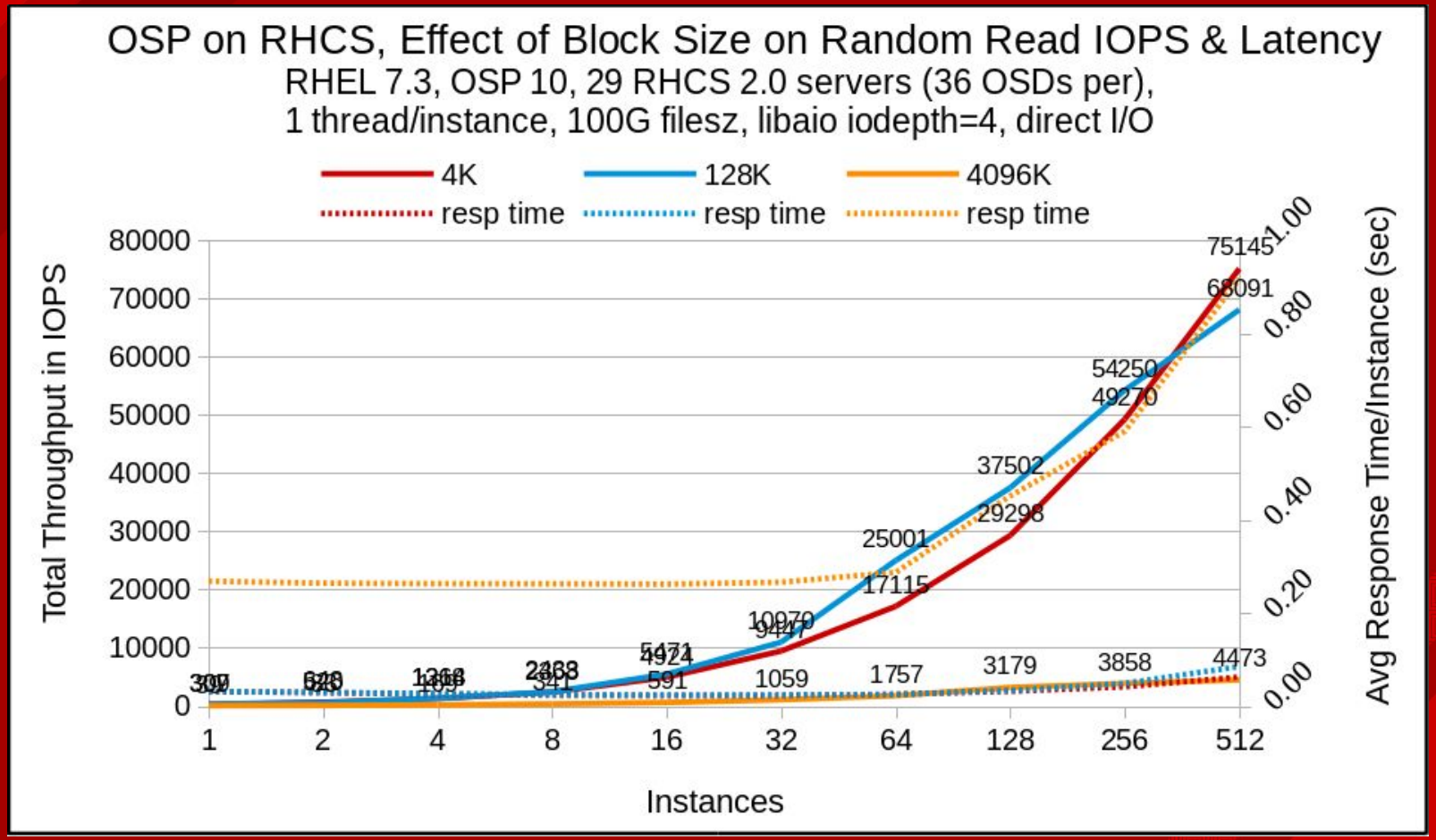
Scale Lab Assignments



QUADS - Scheduling in Action



QUADS - Scale Lab Workload Result Example



What problems are we solving?

QUADS - What does it solve?

No more server hugging

- Greater desire for hardware resources than hardware resources
- Clearly defined scheduling for server assignment and reclamation
- Published future schedule and visualizations for planning and audit

QUADS - What does it solve?

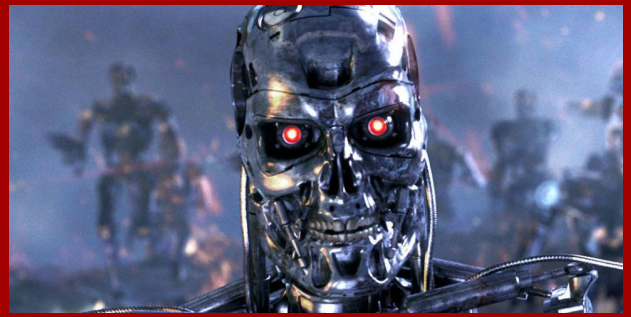
Less human error, more automation.

Give control over to the machines, what's the worst that can happen?

- Automated documentation
- Programmatic scheduling and provisioning
- Automatic network switch changes

QUADS - What does it solve?

Maximize idle machine cycles.



Automated spin-up of machines to run weekend workloads/tests.

- YAML-based scheduling maximizes computing cycles
- Machines can power down when not in active use.

QUADS - What does it solve?

More airbnb, less hobo house.

Clearly defined operating guidelines, maximum residency limit.

- Maximum reservation of 4 weeks.
- Uniform hardware specs/sizes
- Must have proven workload at smaller scale elsewhere.

QUADS - What does it solve?

Significant time savings: time is money friend.

What if 100 servers change hands and we did everything manually?

- ~ 90 hours of work
  - Current 2 person team: ~ 45 hours
  - Triple staff: 6 person team: ~ 15 hours (2 working days)
  - Full Ops team: 12 person team: ~ 7.5 hours (1 working day)

QUADS - What does it solve?

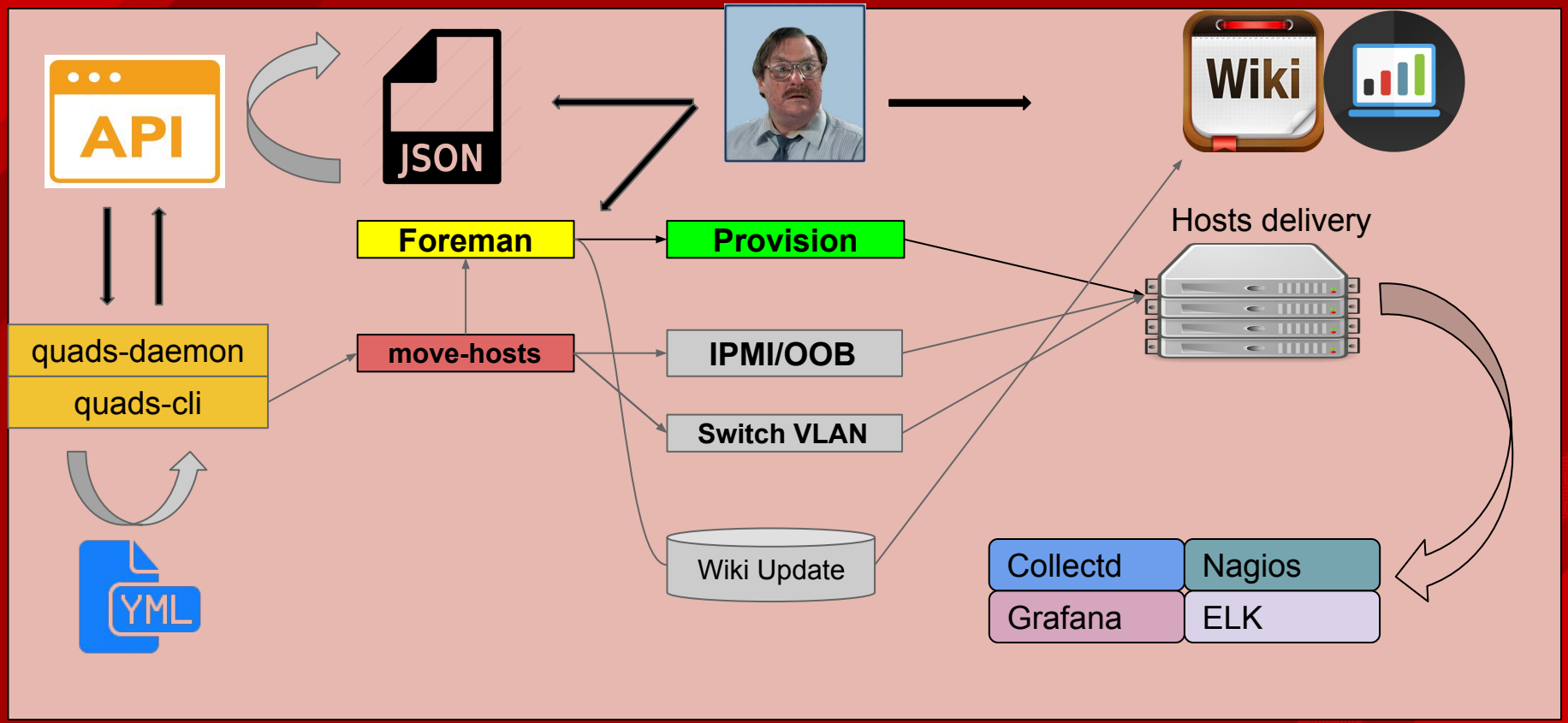
Significant time savings: time is money friend. (continued)

What if 100 servers change hands and we did everything manually?

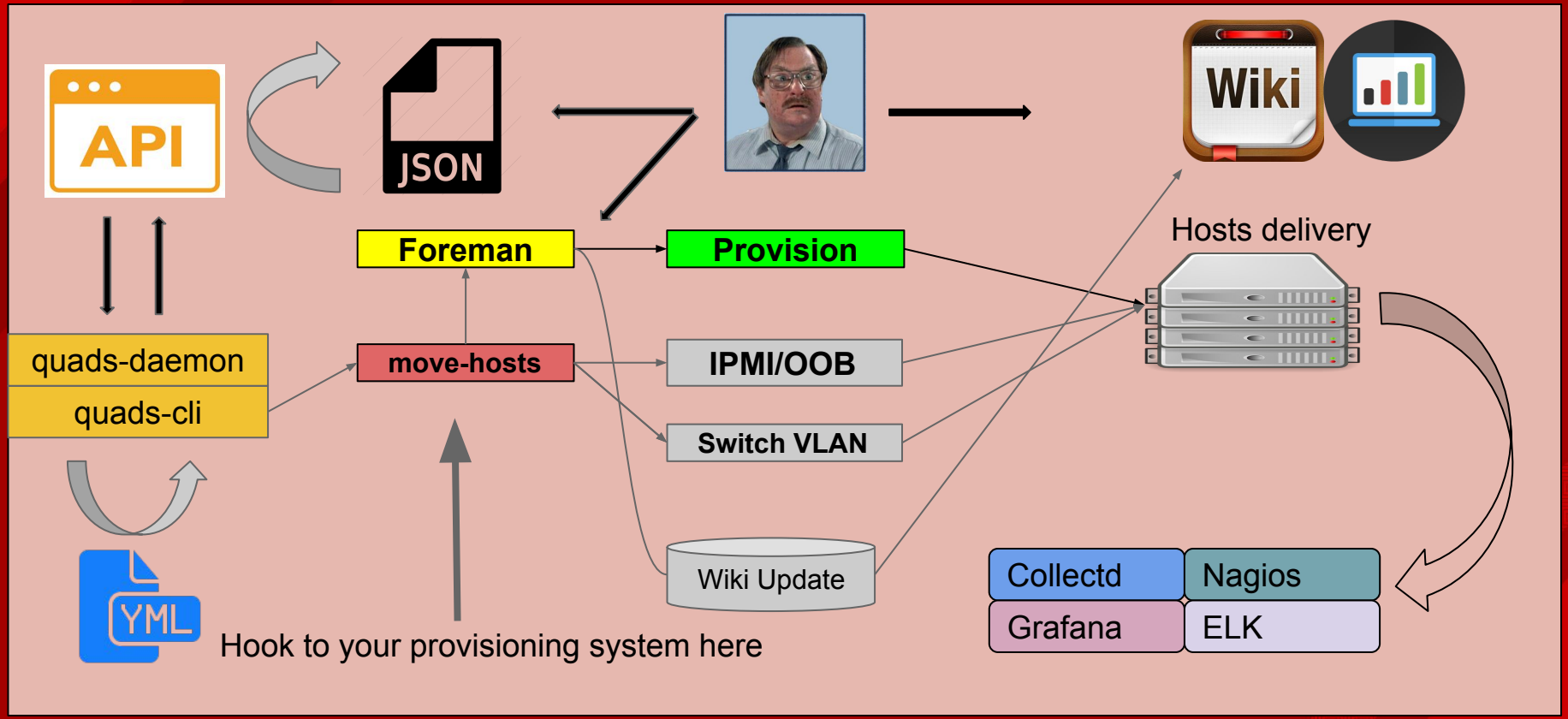
- Switchport reconfiguration (2 min/port; 4 ports per server)
- Reprovision servers (5 min/server)
- Setup foreman accounts per environment (20 min / environment)
- Reconfigure each server boot order (15 min / server)
- Change iDrac password (1 min / server)
- Update wiki docs / inventory (5 min / server)
- Validate systems / networks (5 min / server)
- Send notifications (15 min / environment)
- Update notifications (15 min / environment)

Let’s look at some pictures. (QUADS arch)

QUADS Scheduler Workflow



QUADS Scheduler Workflow



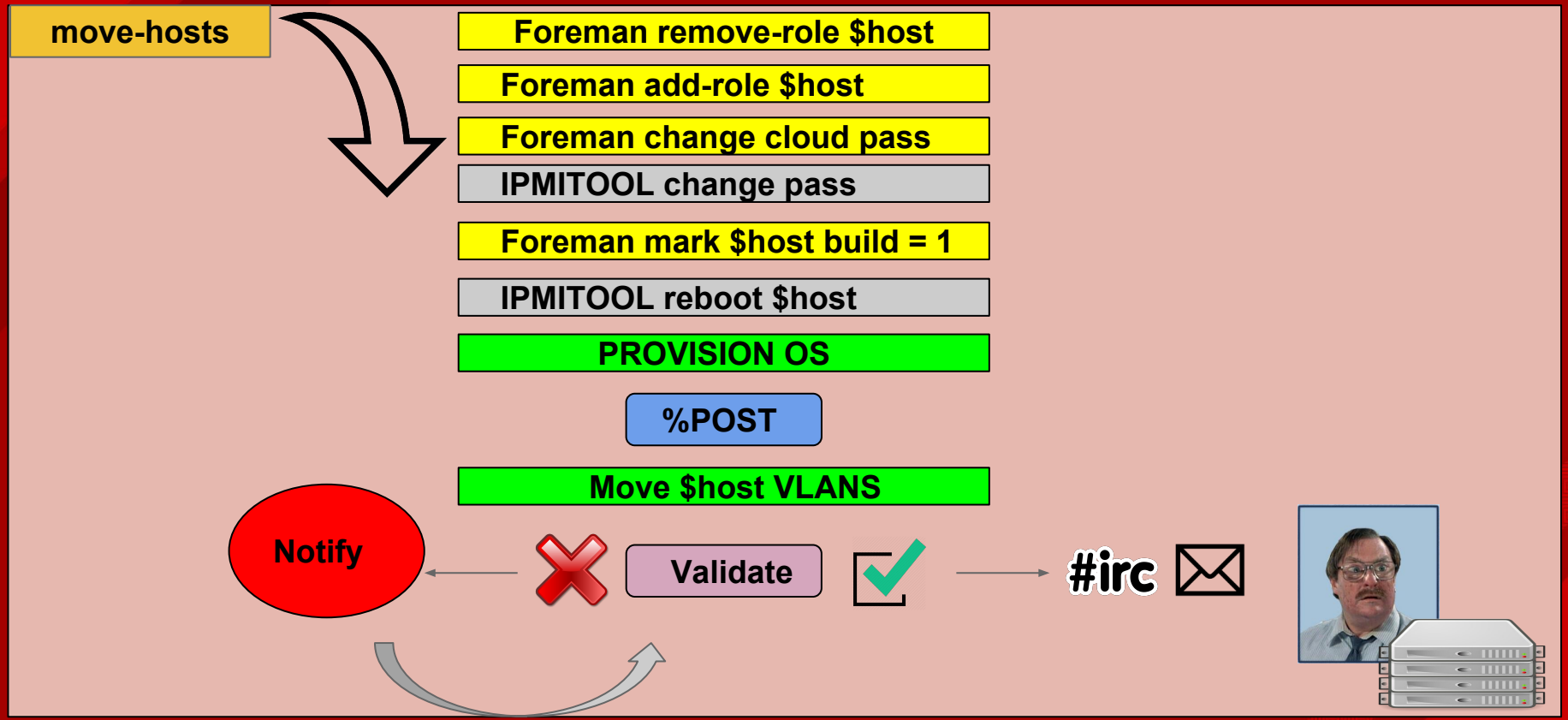
quads --move-hosts

- Execute host migration or provisioning based on schedule
- Only executes an action if one is needed
- Fires off all backend provisioning
  - Use Foreman or plug into an existing provisioning backend

```
quads-cli --move-hosts
```

```
quads.Quads - INFO: Moving c08-h21-r630.example.com from cloud01 to cloud02
```

QUADS Provisioning (move-hosts)



quads --ls-schedule

- List scheduling information for a given host

```
quads-cli --ls-schedule --host c08-h21-r630.example.com
```

```
Default cloud: cloud01
Current cloud: cloud02
Current schedule: 5
Defined schedules:
  0| start=2016-07-19 18:00,end=2016-07-20 18:00,cloud=cloud02
  1| start=2016-08-15 08:00,end=2016-08-16 08:00,cloud=cloud02
  2| start=2016-10-12 17:30,end=2016-10-26 18:00,cloud=cloud02
  3| start=2016-10-26 18:00,end=2017-01-09 05:00,cloud=cloud10
  4| start=2017-02-06 05:00,end=2017-02-27 05:00,cloud=cloud05
  5| start=2017-11-15 22:00,end=2017-12-06 22:00,cloud=cloud02
```

Network Design / VLAN Automation

- We support automated setup of two types of VLAN designs
  - *qinq: 0 mode:* (default)
    - Each interface across all hosts in environment in it's own VLAN
      - NIC1 across all hosts in environment = VLAN1
      - NIC2 across all hosts in environment = VLAN2 etc.
  - *qinq: 1 mode:*
    - All interfaces across all hosts in environment in same VLAN

Network Design / VLAN Automation

- Automated deployment of public, routable VLAN *(coming soon!)*
  - Map & assign any number of pre-created networks
  - Metadata managed per cloud assignment
  - Public, routable VLANs tagged on last interface of each host.

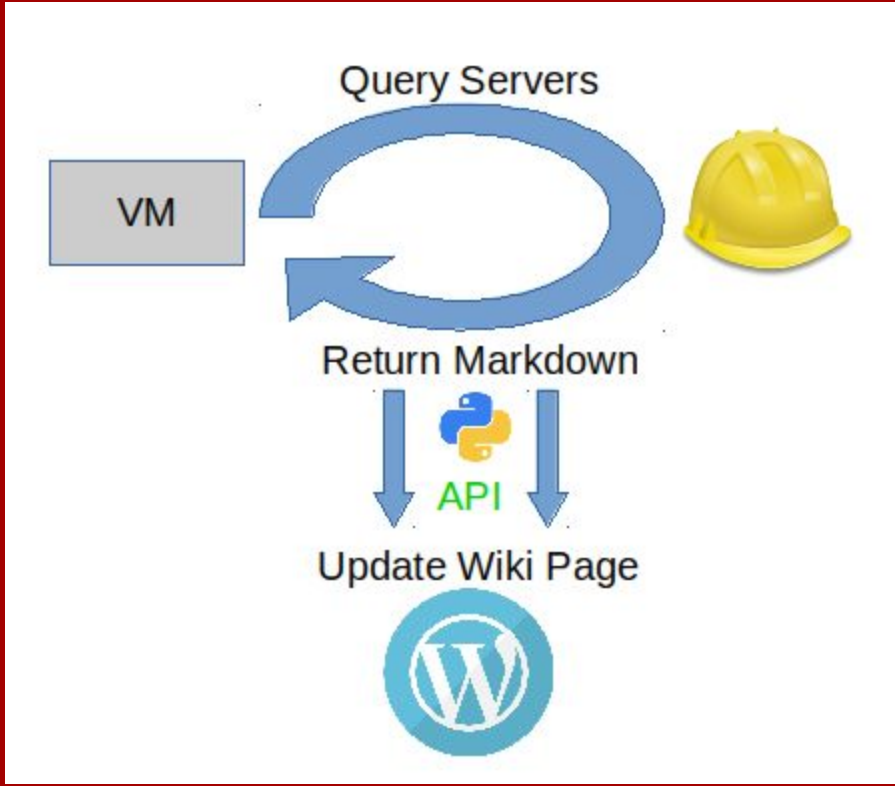
```
quads-cli --define-cloud cloud02 --name “OpenStack 32” --cloud-owner jdoe --extnet 4
```

Network Design / Host Interfaces

System Type	Network 1	Network 2	Network 3	Network 4	Public Network
Dell R620	p2p3	p2p4	em1	em2	em3
Dell R630	em1	em2	em3	em4	p2p1
Dell R720xd	p4p1	p4p2	em1	em2	em3
Dell R730xd	em1	em2	p4p1	p4p2	em3
Dell R930	em1	em2	p1p1	p1p2	em3
SuperMicro 6018r	enp4s0f0	eno2	enp4s0f1	enp4s0f2	eno1
SuperMicro 1028r	ens2f0	ens2f1	ens2f2	ens2f3	eno1
SuperMicro 1029p	enp94s0f0	enp94s0f1	enp94s0f2	enp94s0f3	eno1
SuperMicro 1029u	enp175s0f0	enp175s0f1	enp216s0f0	enp216s0f1	eno1
SuperMicro 6048r	ens3f0	ens3f1	enp131s0f0	enp131s0f1	enp5s0f0

Automated Documentation with QUADS

QUADS Dynamic Wiki Auto-generation



QUADS Dynamic Wiki Auto-generation

RDU Scale Lab Dynamic Inventory

Scale Calendar | Support | Docs | Usage | FAQ | Request Tracker | Assignments | QUADS | Monitoring | System Logs

Rack B09

U	ServerHostname	Serial	MAC	IP	IPMIADDR	IPMIURL	IPMIMAC	Workload	Owner	Graph
01	b09-h01-r620	HLPQM02	ec:f4:bb:c1:db:38	10.12.66.225	10.12.66.193	console	f8:bc:12:44:75:dc	cloud06	rbryant	
02	b09-h02-r620	HLPPM02	ec:f4:bb:c1:c7:a8	10.12.66.227	10.12.66.195	console	f8:bc:12:44:75:da	cloud06	rbryant	
03	b09-h03-r620	HLQYL02	ec:f4:bb:c1:ce:88	10.12.66.229	10.12.66.197	console	f8:bc:12:44:70:2a	cloud06	rbryant	
05	b09-h05-r620	6F987Y1	b8:ca:3a:62:81:38	10.12.66.231	10.12.66.199	console	e0:db:55:15:ca:52	cloud06	rbryant	
06	b09-h06-r620	CQWW6X1	b8:ca:3a:5f:ae:d8	10.12.66.233	10.12.66.201	console	e0:db:55:15:ca:e2	cloud06	rbryant	
07	b09-h07-r620	H5SW6X1	b8:ca:3a:5f:ad:c0	10.12.66.235	10.12.66.203	console	e0:db:55:15:ca:72	cloud06	rbryant	
09	b09-h09-r620	G2TW6X1	b8:ca:3a:61:45:38	10.12.66.237	10.12.66.205	console	e0:db:55:15:c8:c2	cloud06	rbryant	
10	b09-h10-r620	1GWW6X1	b8:ca:3a:61:42:20	10.12.66.239	10.12.66.207	console	e0:db:55:14:e2:7a	None		

QUADS Dynamic Wiki - Assignment Summary

SUMMARY

NAME	SUMMARY	OWNER	REQUEST	INSTACKENV	HWFACTS	DELLCFG
cloud01	45 (Available servers)	nobody				
cloud02	36 (Alderaan Allocation)	smalleni	456512	download	inventory	view
cloud03	50 (OpenStack/Director)	jkilpatr	452743	download	inventory	view
cloud07	35 (ODL SDN Controller)	sgaddam	455851	download	inventory	view
cloud17	5 (CEPH IOPS)	acalhoun	461418	download	inventory	view
cloud18	64 (A-MQ Messaging)	mwagner	457259	download	inventory	view
cloud19	37 (Satellite 6.3)	sbadhwar	459829	download	inventory	view
cloud20	6 (TripleO, Open Stack, RHEL)	trwilson	460910	download	inventory	view
cloud22	10 (ODL SDN Controller)	sgaddam	455851	download	inventory	view

QUADS Dynamic Wiki - Assignment Details

cloud02 : 9 (OSP Newton Testing) — jtaleric

SystemHostname	OutOfBand	DateStartAssignment	DateEndAssignment	TotalDuration	TimeRemaining
b10-h06-r620	console	2016-11-22 16:30	2016-12-16 08:00	23 day(s), 15 hour(s)	8 day(s), 07 hour(s)
b10-h10-r620	console	2016-11-22 16:30	2016-12-16 08:00	23 day(s), 15 hour(s)	8 day(s), 07 hour(s)
b10-h13-r620	console	2016-11-22 16:30	2016-12-16 08:00	23 day(s), 15 hour(s)	8 day(s), 07 hour(s)

QUADS Dynamic Wiki Auto-generation

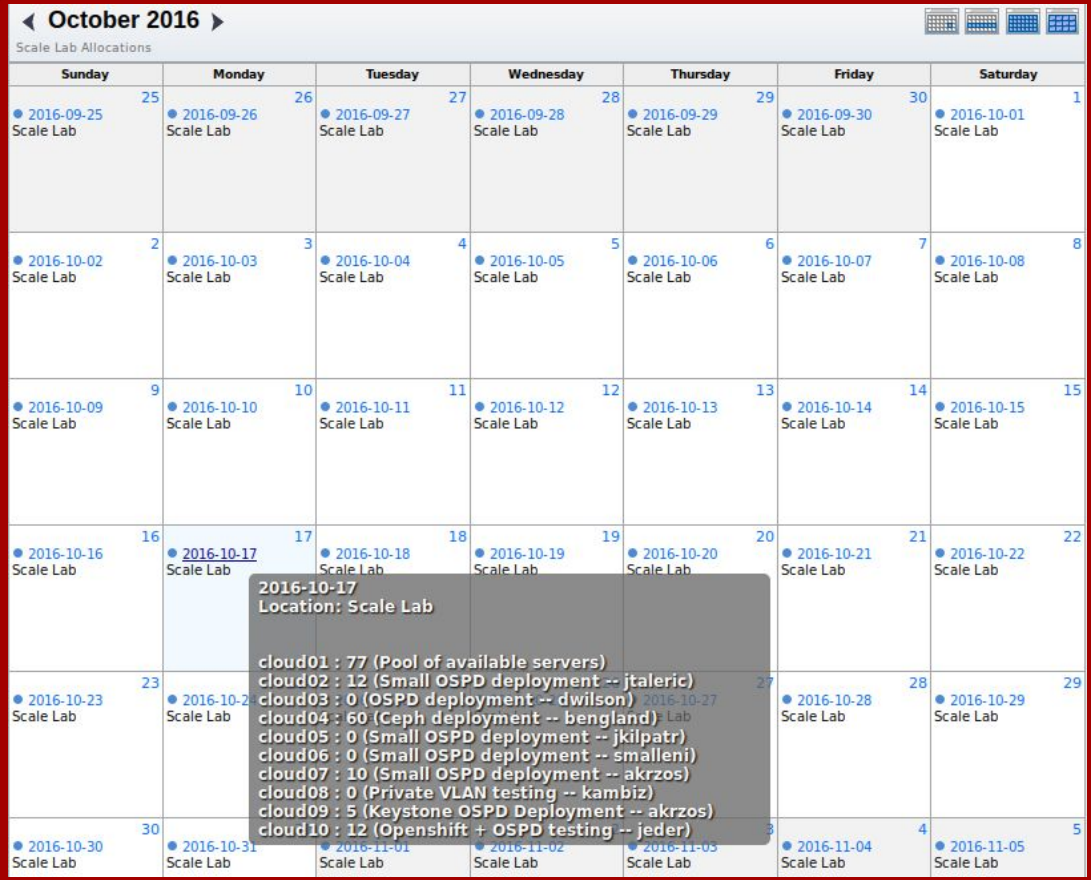
Unassigned systems

SystemHostname	OutOfBand

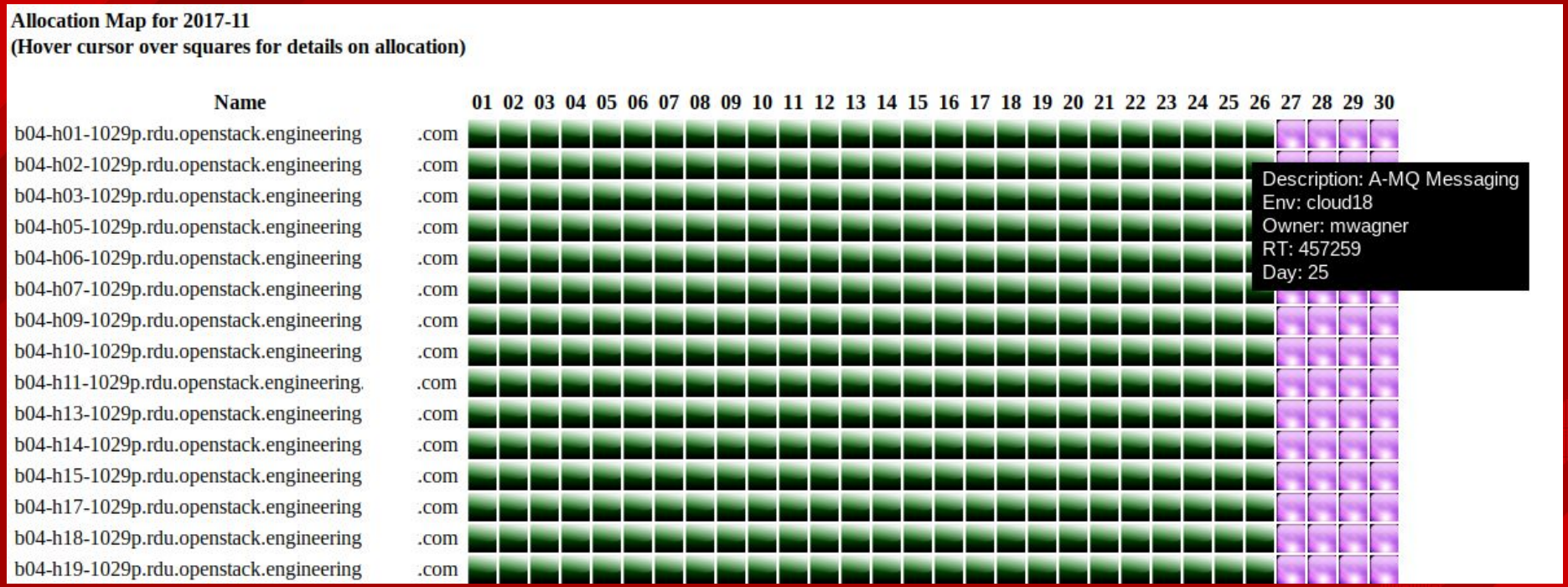
Faulty systems

SystemHostname	OutOfBand
b09-h10-r620	console
b09-h13-r620	console
b09-h21-r620	console

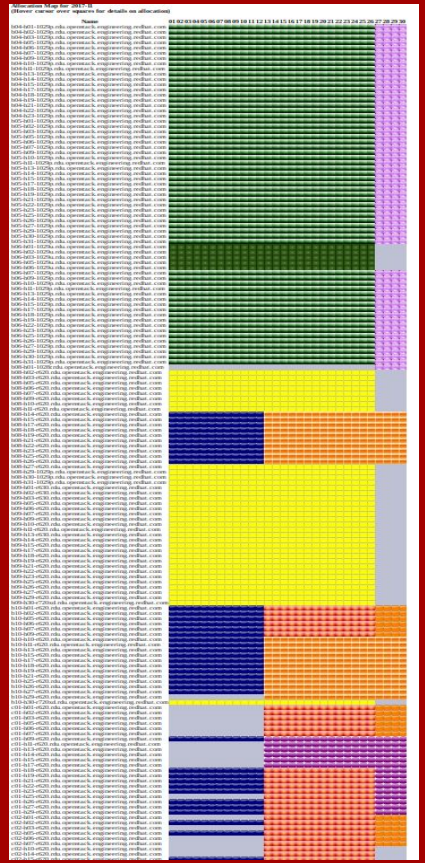
QUADS Dynamic Wiki - Calendar View



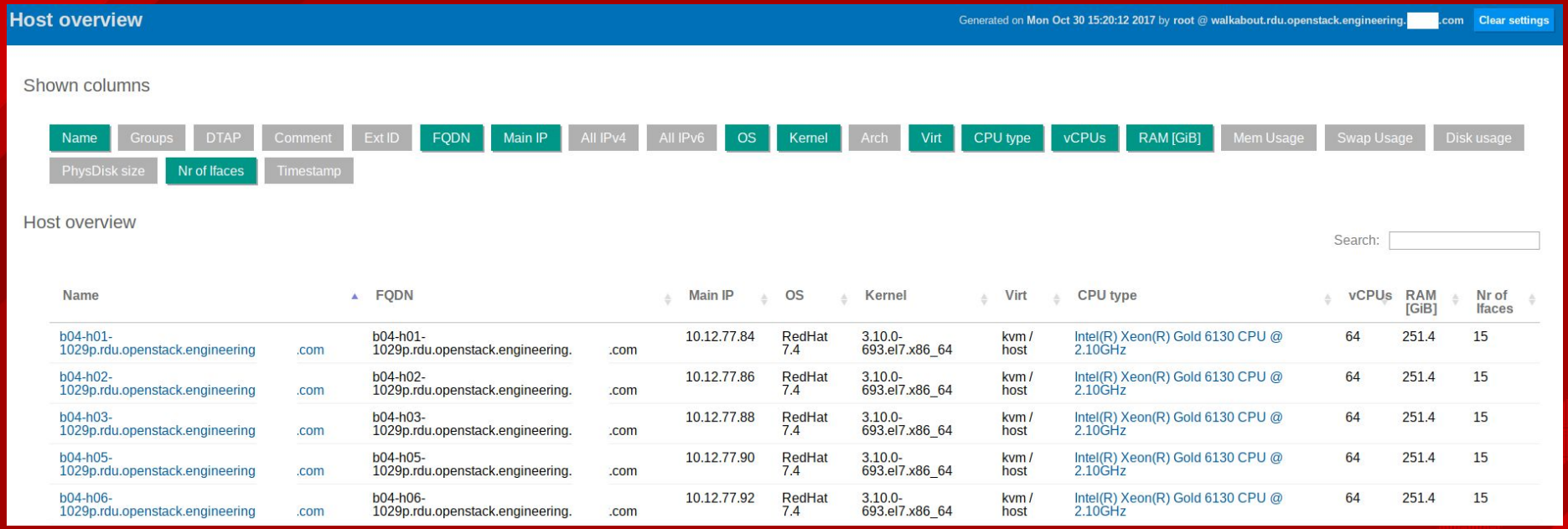
QUADS Dynamic Wiki - Map Visualization



QUADS Dynamic Wiki - Map Visualization



Ansible Facts Per Host (Ansible CMDB)



Host overview

Generated on **Mon Oct 30 15:20:12 2017** by **root @ walkabout.rdu.openstack.engineering.[redacted].com** Clear settings

Shown columns

Name | Groups | DTAP | Comment | Ext ID | FQDN | Main IP | All IPv4 | All IPv6 | OS | Kernel | Arch | Virt | CPU type | vCPUs | RAM [GiB] | Mem Usage | Swap Usage | Disk usage | PhysDisk size | Nr of Ifaces | Timestamp

Host overview

Search:

Name	FQDN	Main IP	OS	Kernel	Virt	CPU type	vCPUs	RAM [GiB]	Nr of Ifaces
b04-h01-1029p.rdu.openstack.engineering.com	b04-h01-1029p.rdu.openstack.engineering.com	10.12.77.84	RedHat 7.4	3.10.0-693.el7.x86_64	kvm / host	Intel(R) Xeon(R) Gold 6130 CPU @ 2.10GHz	64	251.4	15
b04-h02-1029p.rdu.openstack.engineering.com	b04-h02-1029p.rdu.openstack.engineering.com	10.12.77.86	RedHat 7.4	3.10.0-693.el7.x86_64	kvm / host	Intel(R) Xeon(R) Gold 6130 CPU @ 2.10GHz	64	251.4	15
b04-h03-1029p.rdu.openstack.engineering.com	b04-h03-1029p.rdu.openstack.engineering.com	10.12.77.88	RedHat 7.4	3.10.0-693.el7.x86_64	kvm / host	Intel(R) Xeon(R) Gold 6130 CPU @ 2.10GHz	64	251.4	15
b04-h05-1029p.rdu.openstack.engineering.com	b04-h05-1029p.rdu.openstack.engineering.com	10.12.77.90	RedHat 7.4	3.10.0-693.el7.x86_64	kvm / host	Intel(R) Xeon(R) Gold 6130 CPU @ 2.10GHz	64	251.4	15
b04-h06-1029p.rdu.openstack.engineering.com	b04-h06-1029p.rdu.openstack.engineering.com	10.12.77.92	RedHat 7.4	3.10.0-693.el7.x86_64	kvm / host	Intel(R) Xeon(R) Gold 6130 CPU @ 2.10GHz	64	251.4	15

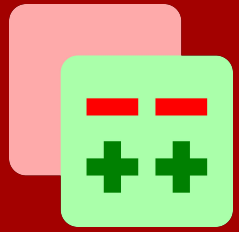
BIOS, CPU Perf, Boot Order (Dell Only)

Name	CPU Setting	Boot Order
c08-h24-r630.rdu.openstack.engineering. .com	PerfOptimized	**NET 5 (Foreman),Hard Drive,NET 2 (Director)**
c08-h25-r630.rdu.openstack.engineering. .com	PerfOptimized	**Hard Drive,NET 2 (Director),NET 5 (Foreman)**
c08-h26-r630.rdu.openstack.engineering. .com	PerfOptimized	**Hard Drive,NET 2 (Director),NET 5 (Foreman)**
c08-h27-r630.rdu.openstack.engineering. .com	PerfOptimized	**Hard Drive,NET 2 (Director),NET 5 (Foreman)**
c08-h28-r630.rdu.openstack.engineering. .com	PerfOptimized	**Hard Drive,NET 2 (Director),NET 5 (Foreman)**
c08-h29-r630.rdu.openstack.engineering. .com	PerfOptimized	**Hard Drive,NET 2 (Director),NET 5 (Foreman)**
c09-h11-r630.rdu.openstack.engineering. .com	PerfOptimized	**Hard Drive,NET 2 (Director),NET 5 (Foreman)**

Oh no, one of the CPU settings isn't optimized!

Name	CPU Setting	Boot Order
c01-h09-r620.rdu.openstack.engineering. .com	PerfPerWattOptimizedOs	**NET 5 (Foreman),Hard Drive,NET 2 (Director)**,NIC.Slot.2-1,NIC.Slot.2-2,NIC.Slot.2-3
c01-h11-r620.rdu.openstack.engineering. .com	PerfPerWattOptimizedOs	**NET 2 (Director),Hard Drive**,NIC.Slot.2-1,NIC.Slot.2-2,NIC.Slot.2-3,**NET 5 (Foreman)**
c01-h13-r620.rdu.openstack.engineering. .com	PerfPerWattOptimizedDapc	**NET 2 (Director),Hard Drive**,NIC.Slot.2-1,NIC.Slot.2-2,NIC.Slot.2-3,**NET 5 (Foreman)**
c01-h14-r620.rdu.openstack.engineering. .com	PerfPerWattOptimizedOs	**NET 2 (Director),Hard Drive**,NIC.Slot.2-1,NIC.Slot.2-2,NIC.Slot.2-3,**NET 5 (Foreman)**
c01-h15-r620.rdu.openstack.engineering. .com	PerfPerWattOptimizedOs	**NET 2 (Director),Hard Drive**,NIC.Slot.2-1,NIC.Slot.2-2,NIC.Slot.2-3,**NET 5 (Foreman)**
c01-h17-r620.rdu.openstack.engineering. .com	PerfPerWattOptimizedOs	**NET 2 (Director),Hard Drive**,NIC.Slot.2-1,NIC.Slot.2-2,NIC.Slot.2-3,**NET 5 (Foreman)**

QUADS Code Review and CI



- Gerrit Code Review
  - IRC: Freenode #quads : announces new reviews
- Jenkins: (automated testing of new gerrit reviews/patchsets)
  - Votes on all commits in gerrit
    - All CI Tests must pass to get +1
      - Functional tests (quads commands)
      - Shellcheck
      - Flake8 for Python

QUADS CI / CD Pipeline

- Successful merge to master git branch auto-creates RPM
  - COPR service uses webhooks to auto-build versions

Build 661847

Resubmit | Delete

General Information

Status:	succeeded - Successfully built.
Submitted:	2017-11-14 17:44 UTC (14 minutes ago)
Started:	2017-11-14 17:47 UTC
Finished:	2017-11-14 17:51 UTC
Build time:	3 minutes
Networking enabled:	True
Built by:	quadsdev

Source

Package:	quads
Version:	0.99.2-20171114
Source Type:	Build from a SCM repository
SCM type:	git
Clone URL:	https://github.com/redhat-performance/quads
Committish:	master
Subdirectory:	rpm
Path to .spec file:	quads.spec
Build SRPM with:	rpkg

Engineering Challenges / QUADS 2.0

- Using flat file architecture provides a simplistic design but comes with downsides. This is on purpose (for now).
    - *Positive:* Easy to debug, test, replicate schedule.yaml
    - *Positive:* Simplistic codebase, system calls are fast *(but don't scale - more on that later).*
    - *Negative:* Systems/Network provisioning done sequentially
    - *Negative*: HTTP API does not provide distributed scale
        - 2-3 hours to deploy 500+ machines/networks
            - We don't care, automated deployments go Sunday
            - Not everyone needs to be Facebook or Google

Code Example #1: Read without a Database

- Python method ensures routine syncing to disk, checks before every query

```
def config_newer_than_data(self):
    if os.path.isfile(self.config):
        if os.path.getmtime(self.config) > self.loadtime:
            return True
    return False
```

- Force data integrity by writing in-memory data to disk then query with system calls

```
#return hosts
def get_hosts(self):
    if self.config_newer_than_data():
        self.read_data()
    return self.quads.hosts.get()
```

Code Example #2: Write Data without a Database

- Python thread locking is required to ensure write integrity.

```
# define a schedule for a given host
def add_host_schedule(self, schedstart, schedend, schedcloud, host):
    # add a scheduled override for a given host
    self.thread_lock.acquire()
```

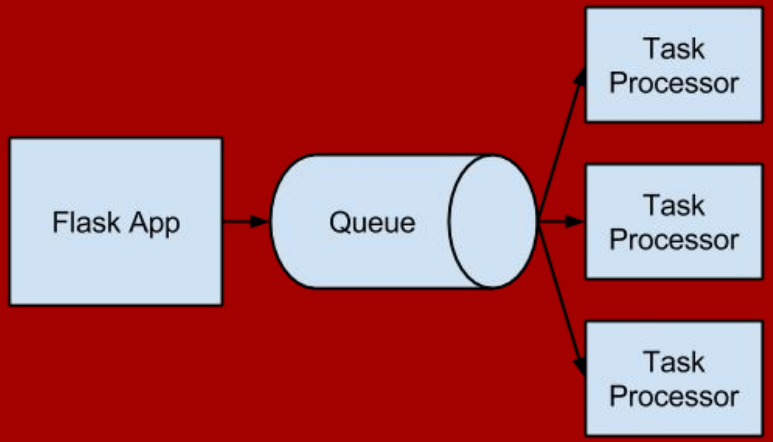
- Threads are released when data is written, command successful *(quads-cli output)*
- System calls are very fast in singular operation, they just don't scale in parallel

```
if self.write_data():
    self.thread_lock.release()
    return ["OK"]
else:
    self.thread_lock.release()
    return ["ERROR"]
```

QUADS Milestone 2.0

Future move to an asynchronous architecture in milestone 2.0

- Flask UI & self-service front-end in milestone 1.1
- Flask / sqlite / mq / celery backend in milestone 2.0



QUADS Methodology

- Share a pool of hardware across different development groups
  - Cost savings, re-usability

- The QUADS parts may be more useful than the sum of its parts
  - Production bare-metal hardware may not move often but automated documentation is always useful
  - Keep it modular

- Stick to K.I.S.S. principles because they work

- Spend your time building/improving a system that builds the systems, don’t just build the systems (and networks, over and over).

Question - Comments - Feedback?

https://github.com/redhat-performance/quads

Will Foster • @sadsfae • hobo.house • github.com/sadsfae

If we have time, let’s look at some commands

quads-cli --define-host

- Define a host to manage in the scheduler, and specify its cloud.
  - Example: place two hosts in the same cloud

```
quads-cli --define-host c08-h21-r630.example.com --default-cloud cloud01 --host-type general
quads-cli --define-host c08-h22-r630.example.com --default-cloud cloud01 --host-type general
```

quads-cli --ls-host

- Lists all the current hosts managed by QUADS

```
quads-cli --ls-hosts
```

```
c08-h21-r630.example.com
c08-h22-r630.example.com
```

quads-cli --add-schedule

- Create a schedule for the host to perform workloads/tasks.
- Set current future workloads/tests of machines based on date
- Unlimited, consecutive future schedules are supported

```
quads-cli --add-schedule --host c08-h21-r630.example.com --schedule-start "2016-07-11 08:00" --schedule-end "2016-07-12 08:00" --schedule-cloud cloud02
```

quads-cli --ls-schedule

- List scheduling information for a given host

```
quads-cli --ls-schedule --host c08-h21-r630.example.com
```

```
Default cloud: cloud01
Current cloud: cloud02
Current schedule: 5
Defined schedules:
  0| start=2016-07-19 18:00,end=2016-07-20 18:00,cloud=cloud02
  1| start=2016-08-15 08:00,end=2016-08-16 08:00,cloud=cloud02
  2| start=2016-10-12 17:30,end=2016-10-26 18:00,cloud=cloud02
  3| start=2016-10-26 18:00,end=2017-01-09 05:00,cloud=cloud10
  4| start=2017-02-06 05:00,end=2017-02-27 05:00,cloud=cloud05
  5| start=2017-01-28 12:00,end=2017-01-29 05:00,cloud=cloud02
```

quads-cli --summary

- Provide a summary of current system allocations

```
quads-cli --summary
```

```
cloud01 : 9  (Unallocated hardware)
cloud02 : 198 (Openshift on OpenStack)
cloud03 : 22 (OSP Newton)
```

quads-cli --move-hosts

- Execute host migration or provisioning based on schedule
- Only executes an action if one is needed
- Fires off all backend provisioning
  - Use Foreman or plug into an existing provisioning backend

```
quads-cli --move-hosts
```

```
INFO: Moving c08-h21-r630.example.com from cloud01 to cloud02
c08-h21-r630.example.com cloud01 cloud02
```

Auditing Tools

- We include additional auditing tools like find-available
  - Searches for availability based on days needed, machines needed and optionally limit by type

```
bin/find-available.py -c 3 -d 10 -l “620|630”
```

```
First available date = 2016-12-05 08:00
Requested end date = 2016-12-15 08:00
hostnames =
c03-h11-r620.rdu.openstack.example.com
c03-h13-r620.rdu.openstack.example.com
c03-h14-r620.rdu.openstack.example.com
```

Common Configuration File

- We try to make everything a variable in quads.yml

```
cat conf/quads.yml
```

```
install_dir: /opt/quads
data_dir: /opt/quads/data
domain: example.com

email_notify: true
irc_notify: true
ircbot_ipaddr: 192.168.0.100
ircbot_port: 5050
ircbot_channel: #yourchannel
```