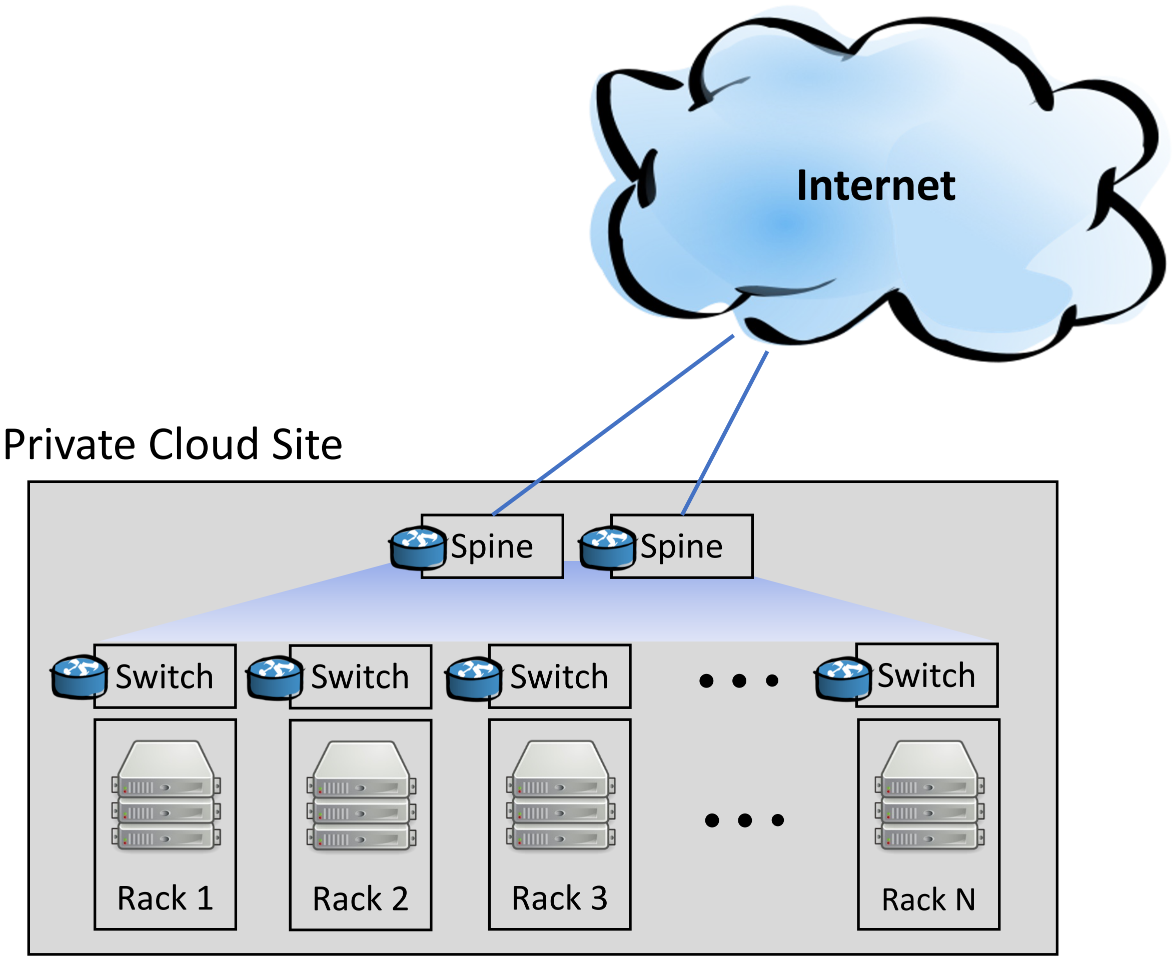
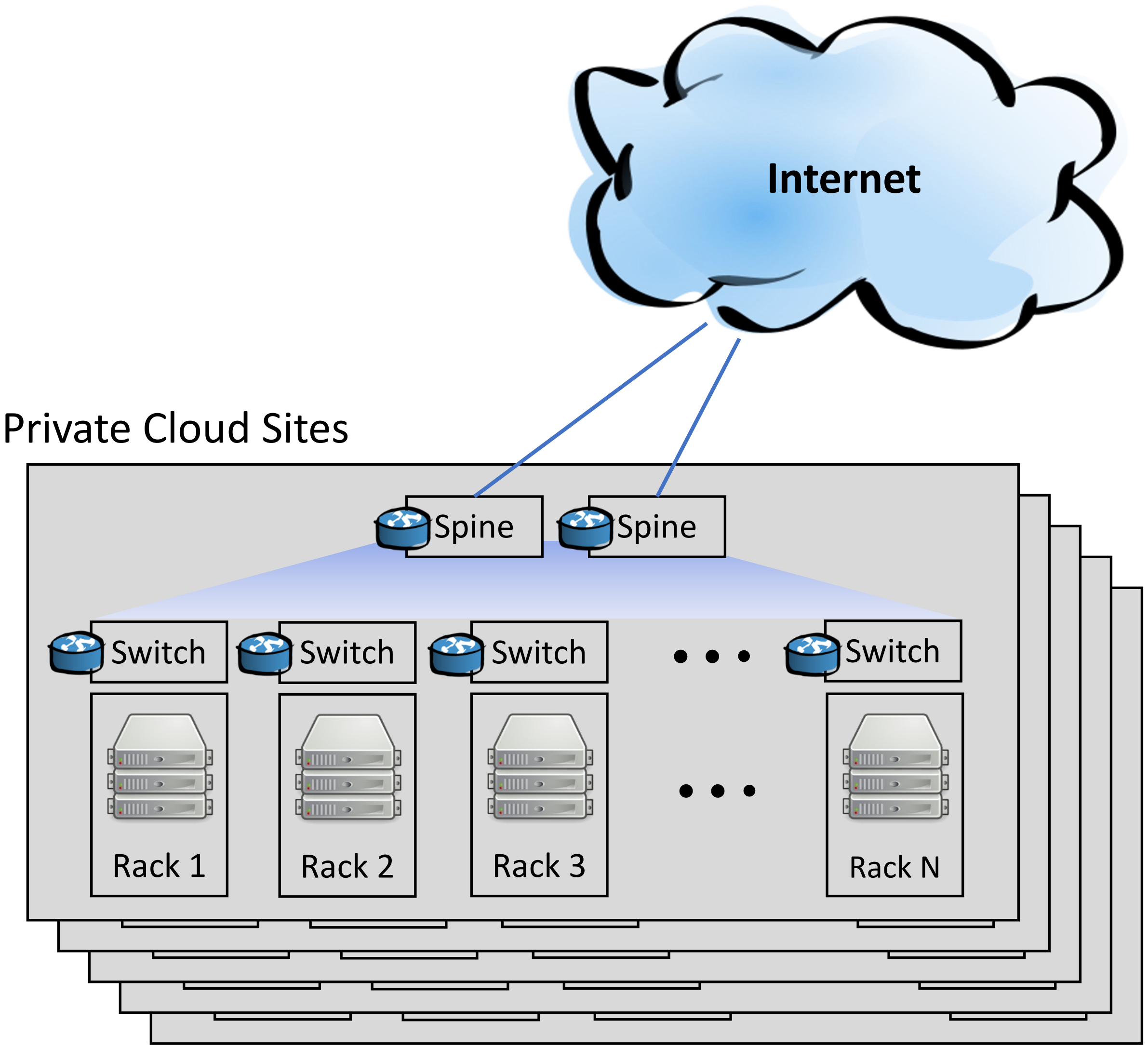
Provisioning Private Clouds

Prof. Ítalo Cunha

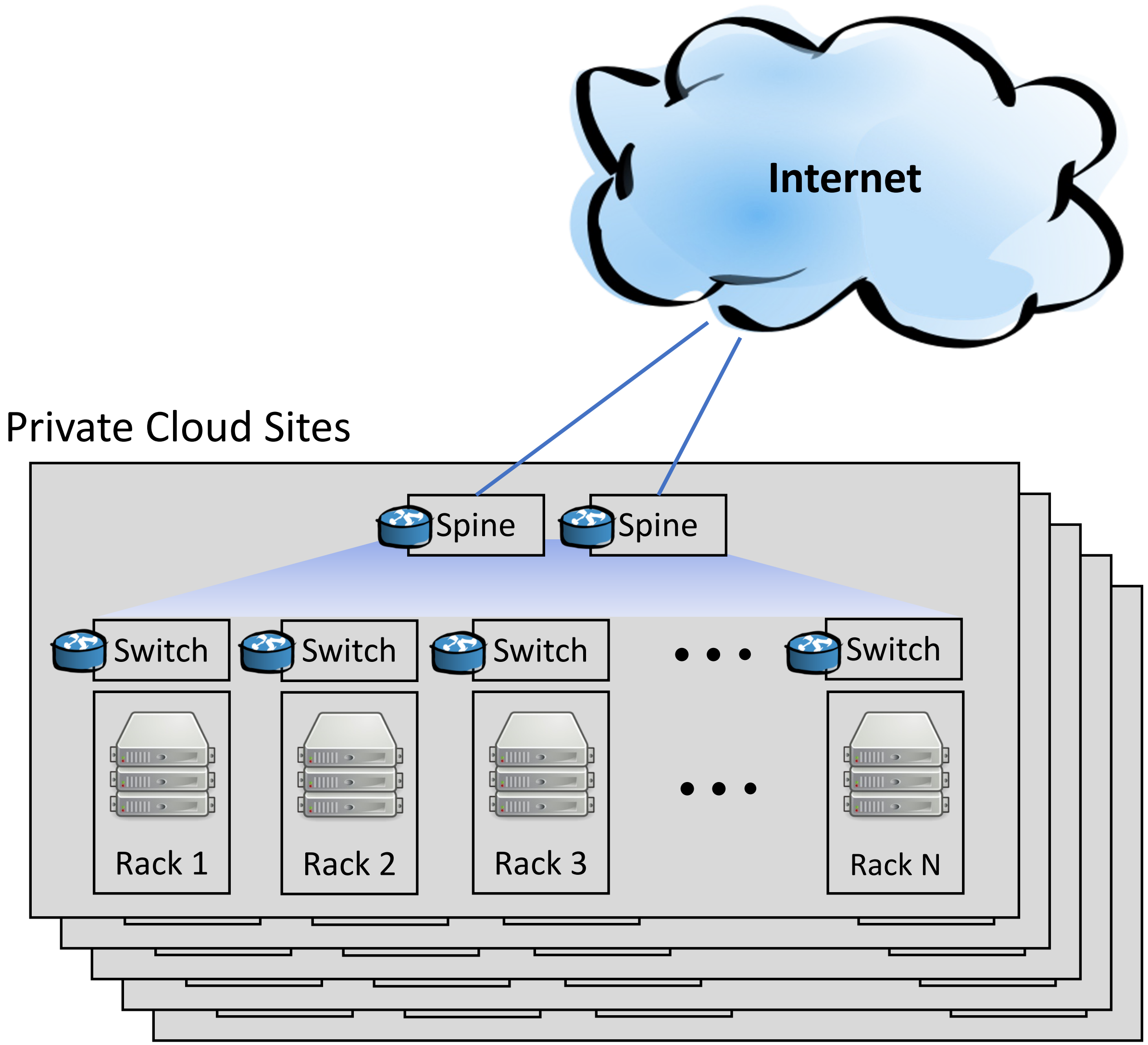
Control and Management

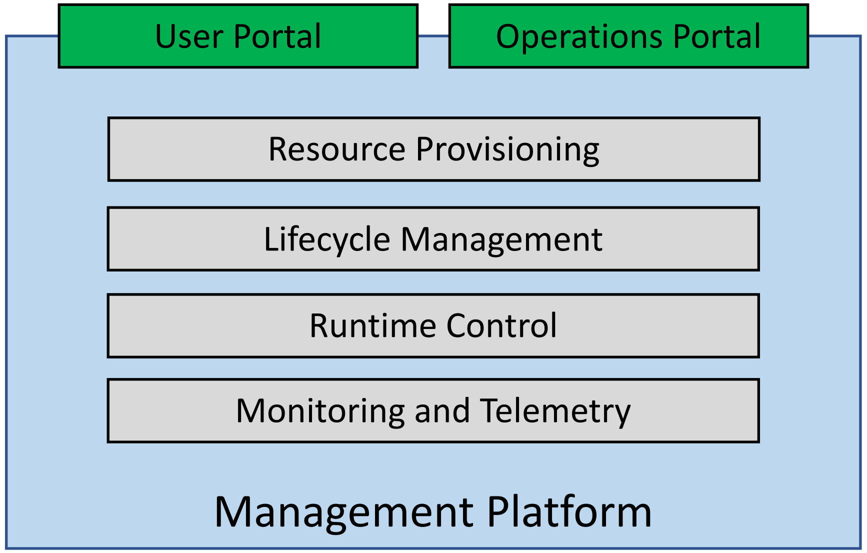


Control and Management



Control and Management




User Portal

Operations Portal

Resource Provisioning

Lifecycle Management

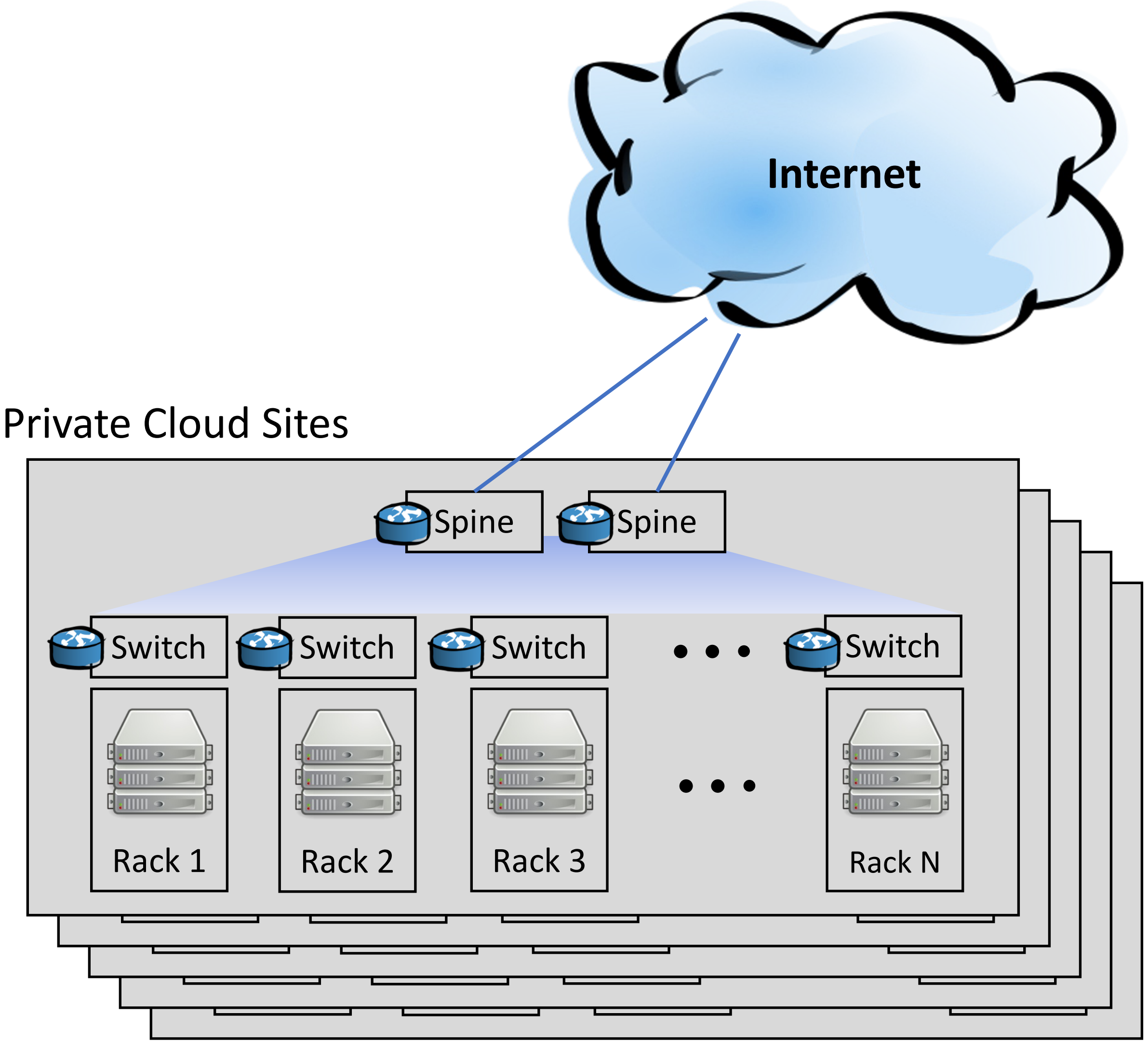
Runtime Control

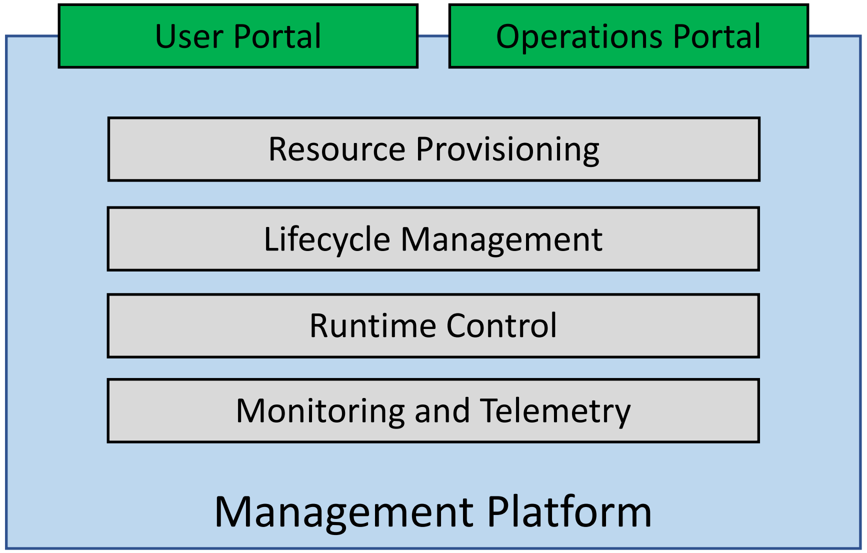
Monitoring and Telemetry

Management Platform

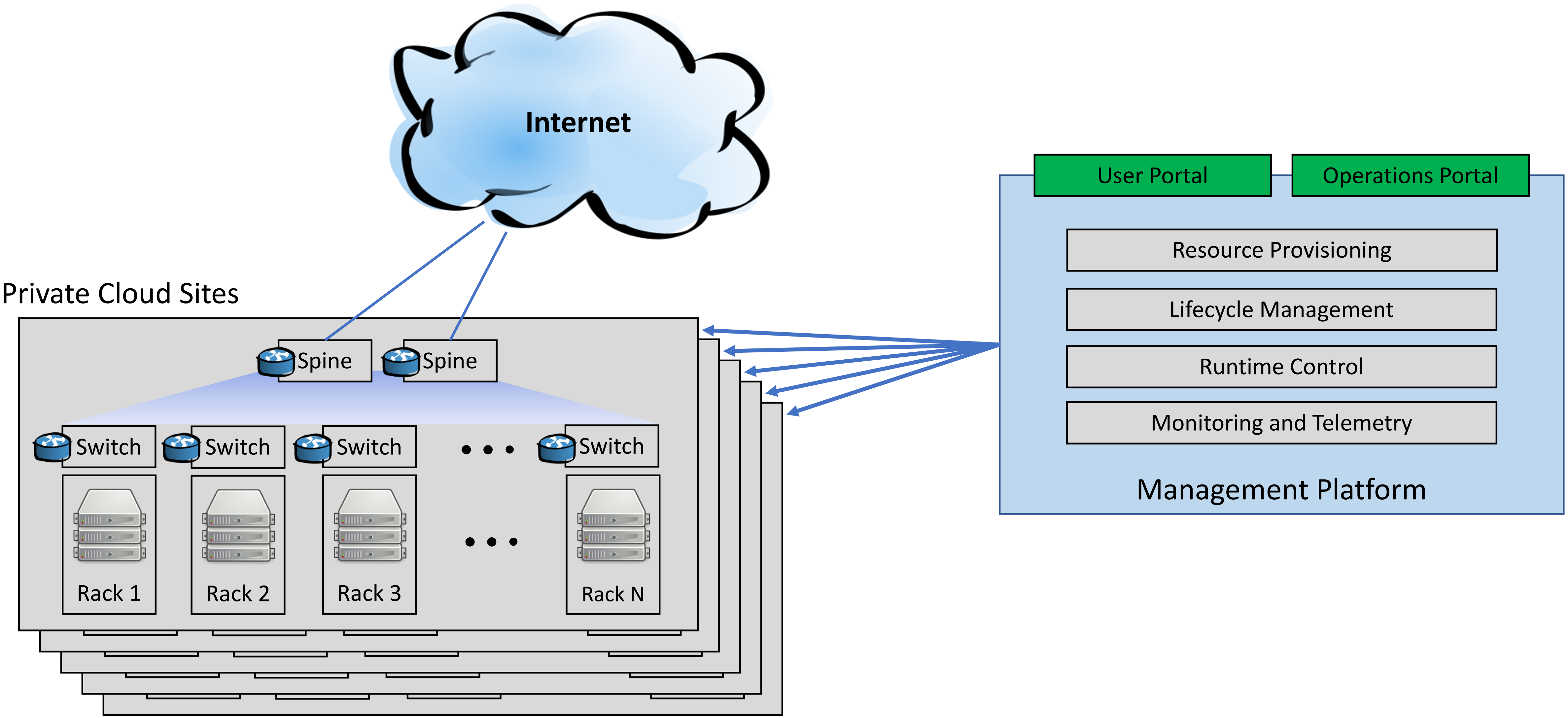
Control and Management

Stakeholders:
- Users
- Operators
- Service providers

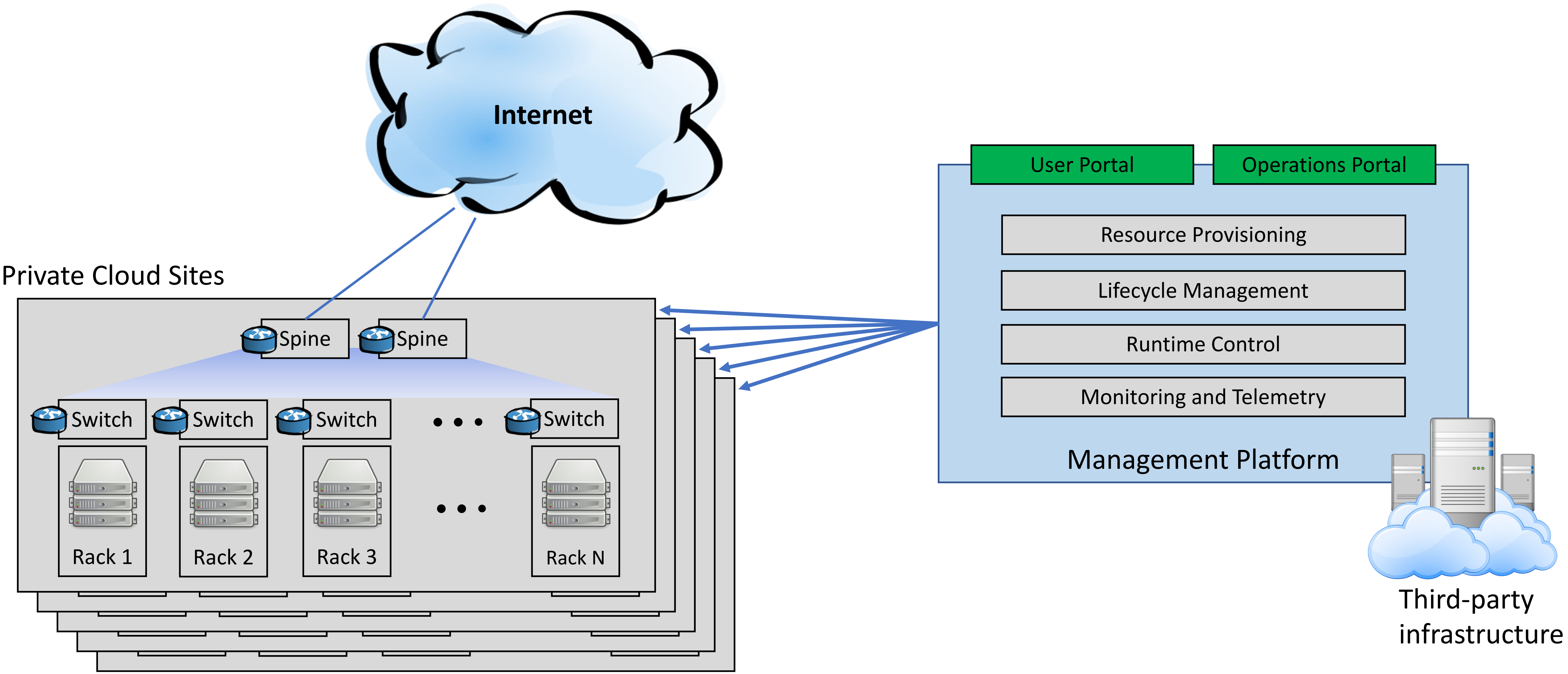




Control and Management



Control and Management



Resource Provisioning

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Resource provisioning

- Bringing virtual and physical resources online
    - Hands-on deployment for physical resources
        - “Racking” and connecting power and network cables
    - Bootstrapping
        - Getting resources into a “ready” state (e.g., reachable over the network)

Resource provisioning

- Bringing virtual and physical resources online
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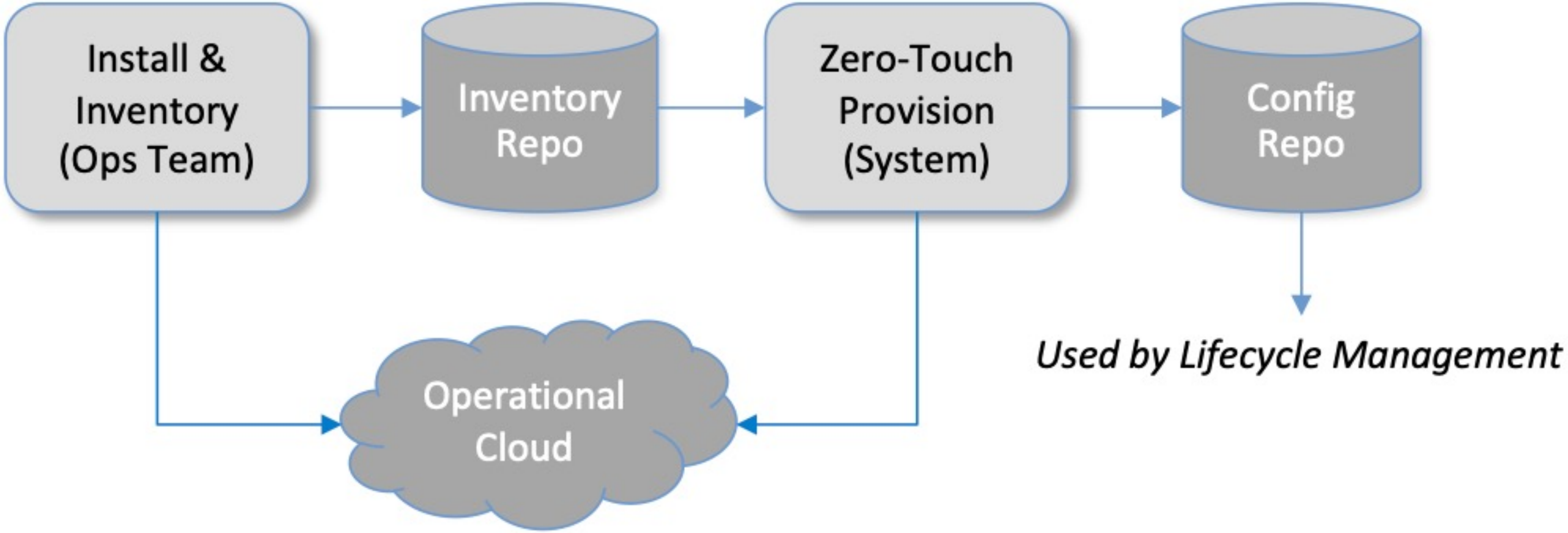
- Resource provisioning also happens incrementally over time
  - Upgrades, removal of obsolete resources, deployment of new resources

Overview of resource provisioning



Install & Inventory (Ops Team)

Inventory Repo

Zero-Touch Provision (System)

Config Repo

Used by Lifecycle Management

Operational Cloud

"Day 0 operations"

Installation and Inventory

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Installation and inventory

- Cannot be entirely zero-touch for physical infrastructures
  - Assume we are dealing with commodity general-purpose resources
  - For virtual infrastructures, cloud provider APIs are used to provision resources
    - “Infrastructure as Code”
  - For plug-and-play appliances, configuration may be preinstalled

Installation and inventory

- Cannot be entirely zero-touch for physical infrastructures
  - Assume we are dealing with commodity general-purpose resources
  - For virtual infrastructures, cloud provider APIs are used to provision resources
    - “Infrastructure as Code”
  - For plug-and-play appliances, configuration may be preinstalled
- Goal is to minimize the amount of manual handling
  - Focus on getting the device connected and reachable
  - Zero-touch provisioning tools take it from there

Documenting the infrastructure

- Managing infrastructure requires ground truth about it
    - Organizations
    - Sites
    - Racks
        - Switches
        - Servers
        - Storage
        - Other equipment
    - Deployment
    - Power and networking

Documenting the infrastructure

- Managing infrastructure requires ground truth about it
  - Organizations
  - Sites
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    - Switches
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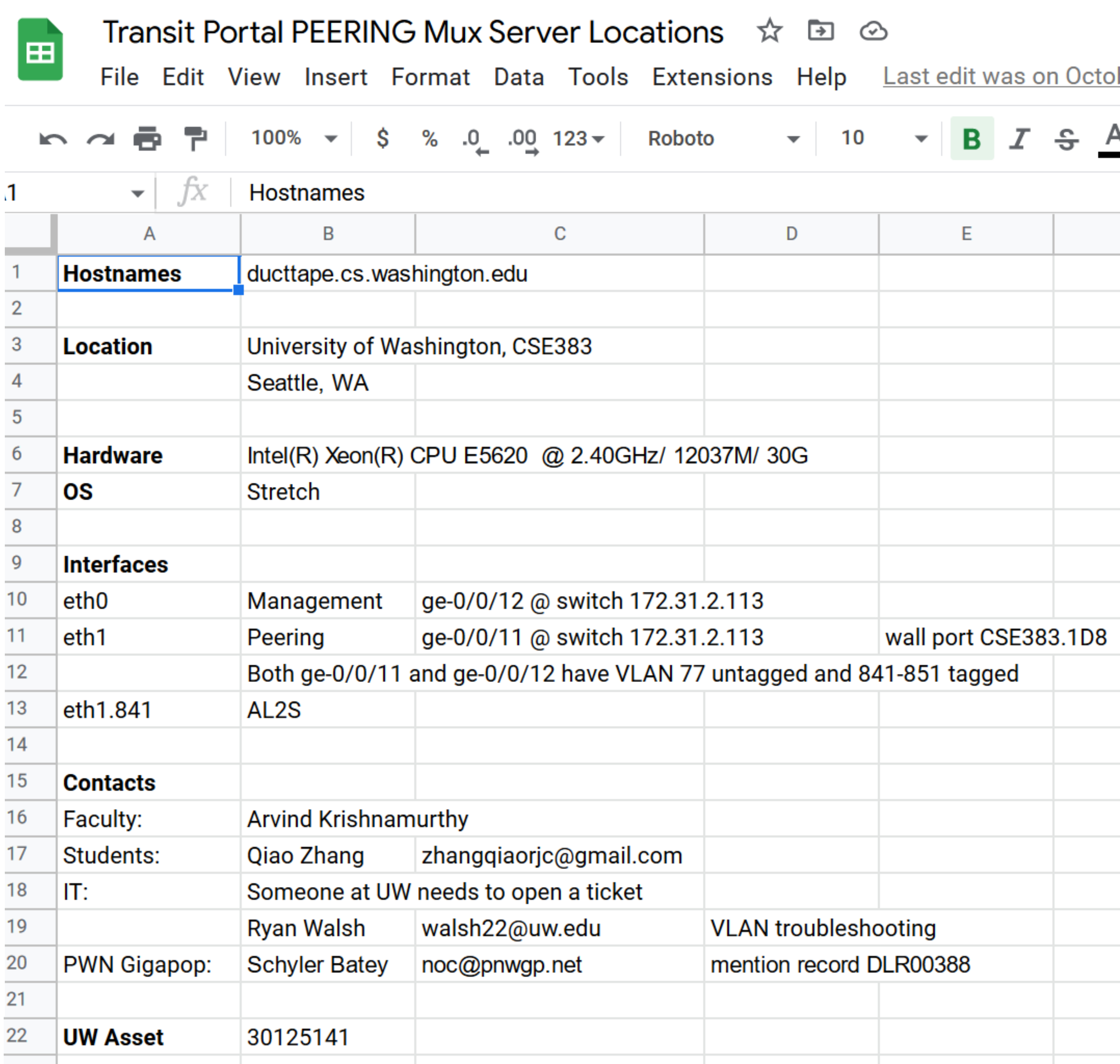
    - Storage
    - Other equipment
  - Deployment
  - Power and networking

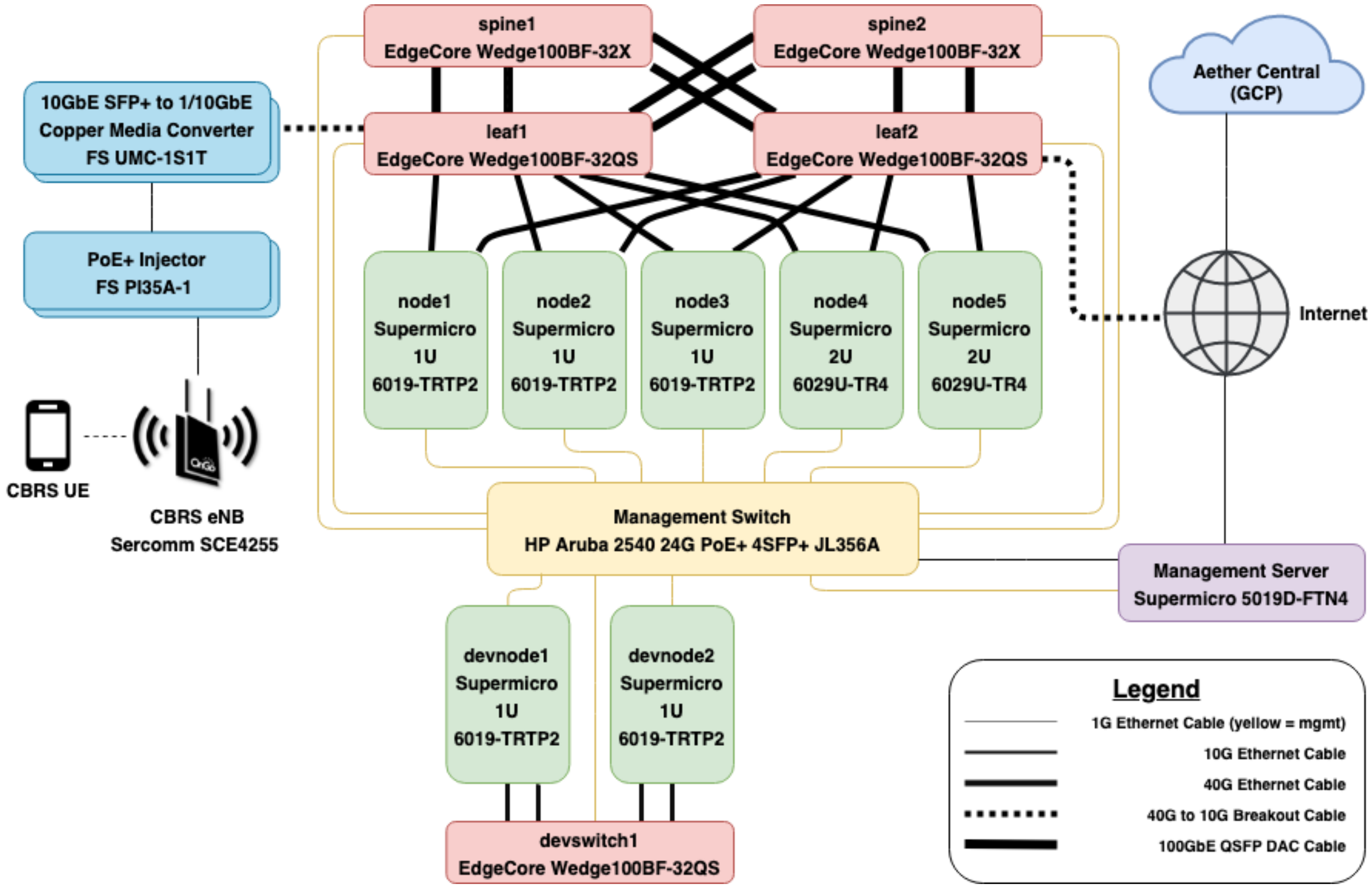
Device:

- Rack and rack position
- Manufacturer
- Model
- Serial number
- Device type
- MAC addresses
- Power outlet
- Switch ports and VLANs



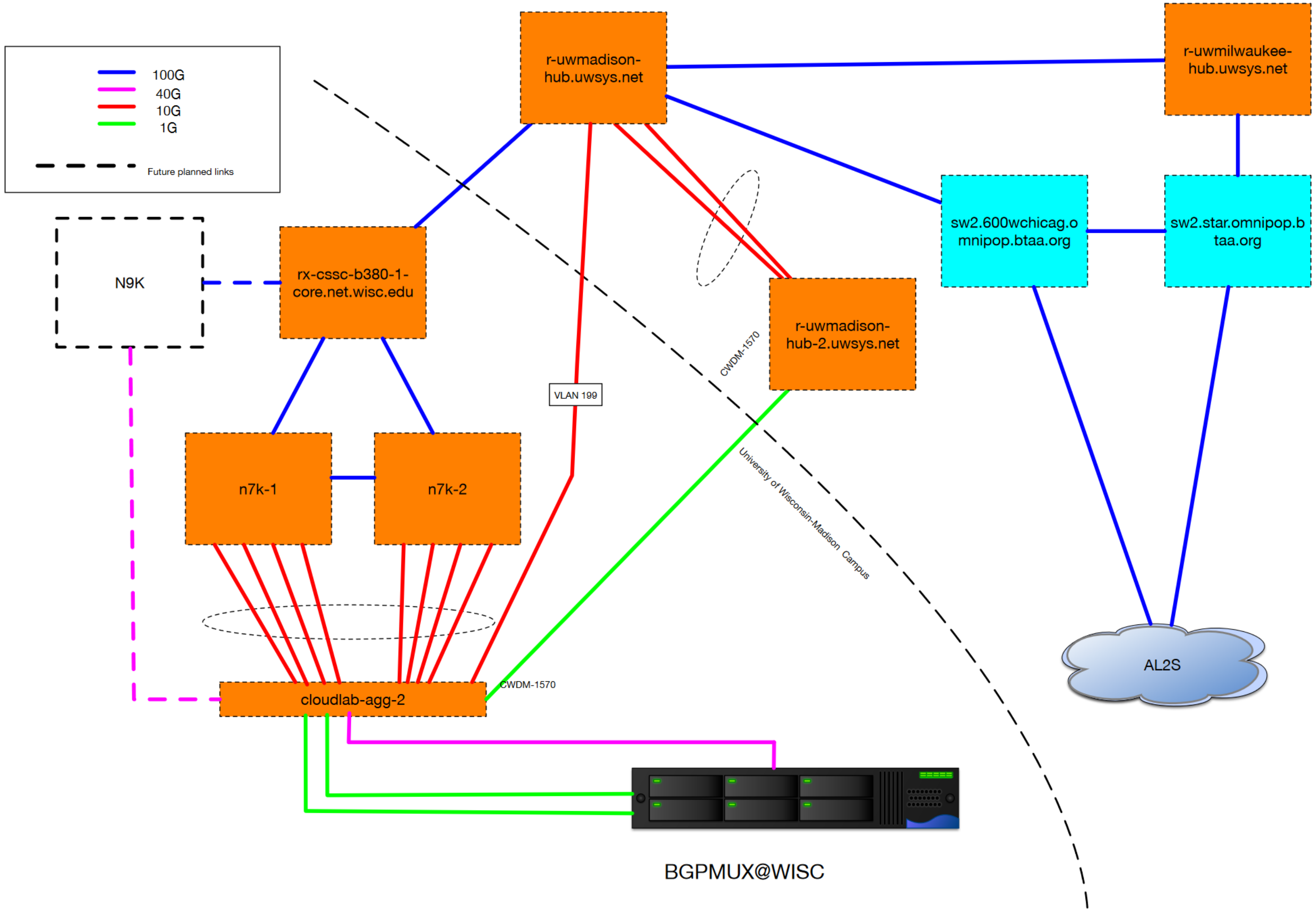
	A	B	C	D	E
1	**Hostnames**	ducttape.cs.washington.edu			
2					
3	**Location**	University of Washington, CSE383			
4		Seattle, WA			
5					
6	**Hardware**	Intel(R) Xeon(R) CPU E5620 @ 2.40GHz/ 12037M/ 30G			
7	**OS**	Stretch			
8					
9	**Interfaces**				
10	eth0	Management	ge-0/0/12 @ switch 172.31.2.113		
11	eth1	Peering	ge-0/0/11 @ switch 172.31.2.113		wall port CSE383.1D8
12		Both ge-0/0/11 and ge-0/0/12 have VLAN 77 untagged and 841-851 tagged			
13	eth1.841	AL2S			
14					
15	**Contacts**				
16	Faculty:	Arvind Krishnamurthy			
17	Students:	Qiao Zhang	zhangqiaorjc@gmail.com		
18	IT:	Someone at UW needs to open a ticket			
19		Ryan Walsh	walsh22@uw.edu	VLAN troubleshooting	
20	PWN Gigapop:	Schyler Batey	noc@pnwgp.net	mention record DLR00388	
21					
22	**UW Asset**	30125141			

Infrastructure planning



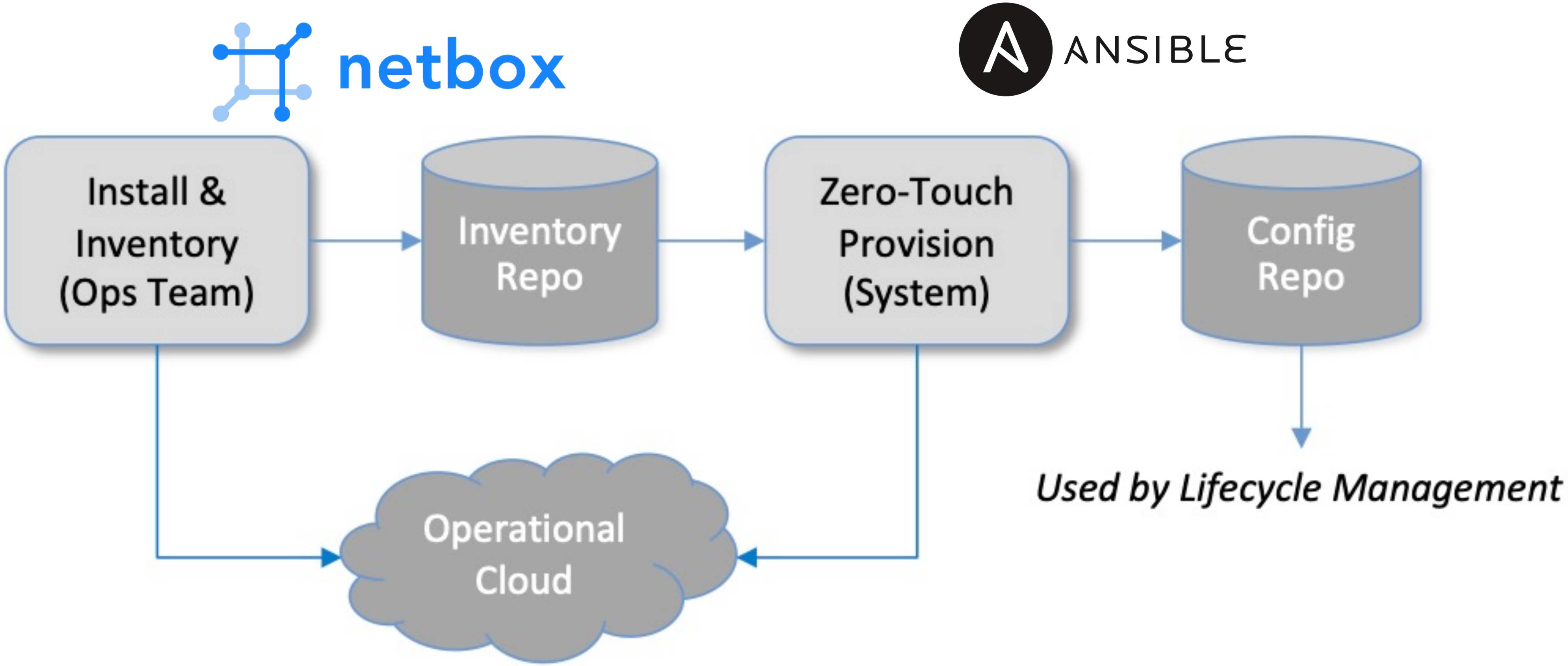
Infrastructure documentation (after the fact)

BGP-MUX @ Univ. of Wisconsin - Michael Blodgett Tue Jan 23 2018 - r1.2



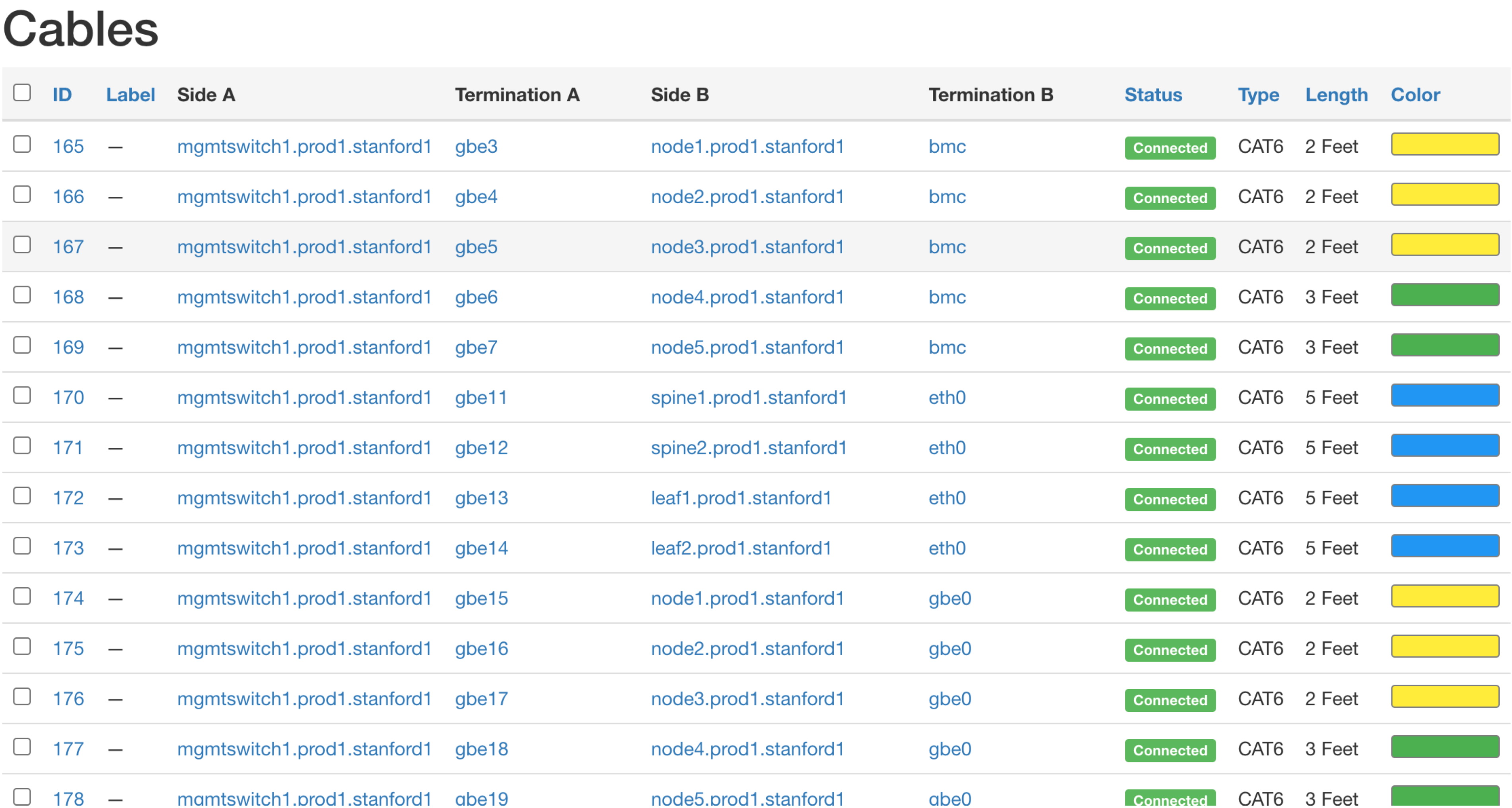
100G
40G
10G
1G
Future planned links
N9K
rx-cssc-b380-1-core.net.wisc.edu
r-uwmadison-hub.uwsys.net
r-uwmilwaukee-hub.uwsys.net
sw2.600wchicag.omnipop.btaa.org
sw2.star.omnipop.btaa.org
r-uwmadison-hub-2.uwsys.net
CWDM-1570
VLAN 199
n7k-1
n7k-2
University of Wisconsin-Madison Campus
AL2S
cloudlab-agg-2
CWDM-1570
BGPMUX@WISC

Overview of resource provisioning



Used by Lifecycle Management

Example: Cabling in NetBox



Cables

□	ID	Label	Side A	Termination A	Side B	Termination B	Status	Type	Length	Color
□	165	—	mgmtswitch1.prod1.stanford1	gbe3	node1.prod1.stanford1	bmc	Connected	CAT6	2 Feet	🟨
□	166	—	mgmtswitch1.prod1.stanford1	gbe4	node2.prod1.stanford1	bmc	Connected	CAT6	2 Feet	🟨
□	167	—	mgmtswitch1.prod1.stanford1	gbe5	node3.prod1.stanford1	bmc	Connected	CAT6	2 Feet	🟨
□	168	—	mgmtswitch1.prod1.stanford1	gbe6	node4.prod1.stanford1	bmc	Connected	CAT6	3 Feet	🟩
□	169	—	mgmtswitch1.prod1.stanford1	gbe7	node5.prod1.stanford1	bmc	Connected	CAT6	3 Feet	🟩
□	170	—	mgmtswitch1.prod1.stanford1	gbe11	spine1.prod1.stanford1	eth0	Connected	CAT6	5 Feet	🟦
□	171	—	mgmtswitch1.prod1.stanford1	gbe12	spine2.prod1.stanford1	eth0	Connected	CAT6	5 Feet	🟦
□	172	—	mgmtswitch1.prod1.stanford1	gbe13	leaf1.prod1.stanford1	eth0	Connected	CAT6	5 Feet	🟦
□	173	—	mgmtswitch1.prod1.stanford1	gbe14	leaf2.prod1.stanford1	eth0	Connected	CAT6	5 Feet	🟦
□	174	—	mgmtswitch1.prod1.stanford1	gbe15	node1.prod1.stanford1	gbe0	Connected	CAT6	2 Feet	🟨
□	175	—	mgmtswitch1.prod1.stanford1	gbe16	node2.prod1.stanford1	gbe0	Connected	CAT6	2 Feet	🟨
□	176	—	mgmtswitch1.prod1.stanford1	gbe17	node3.prod1.stanford1	gbe0	Connected	CAT6	2 Feet	🟨
□	177	—	mgmtswitch1.prod1.stanford1	gbe18	node4.prod1.stanford1	gbe0	Connected	CAT6	3 Feet	🟩
□	178	—	mgmtswitch1.prod1.stanford1	gbe19	node5.prod1.stanford1	gbe0	Connected	CAT6	3 Feet	🟩

Bootstrapping

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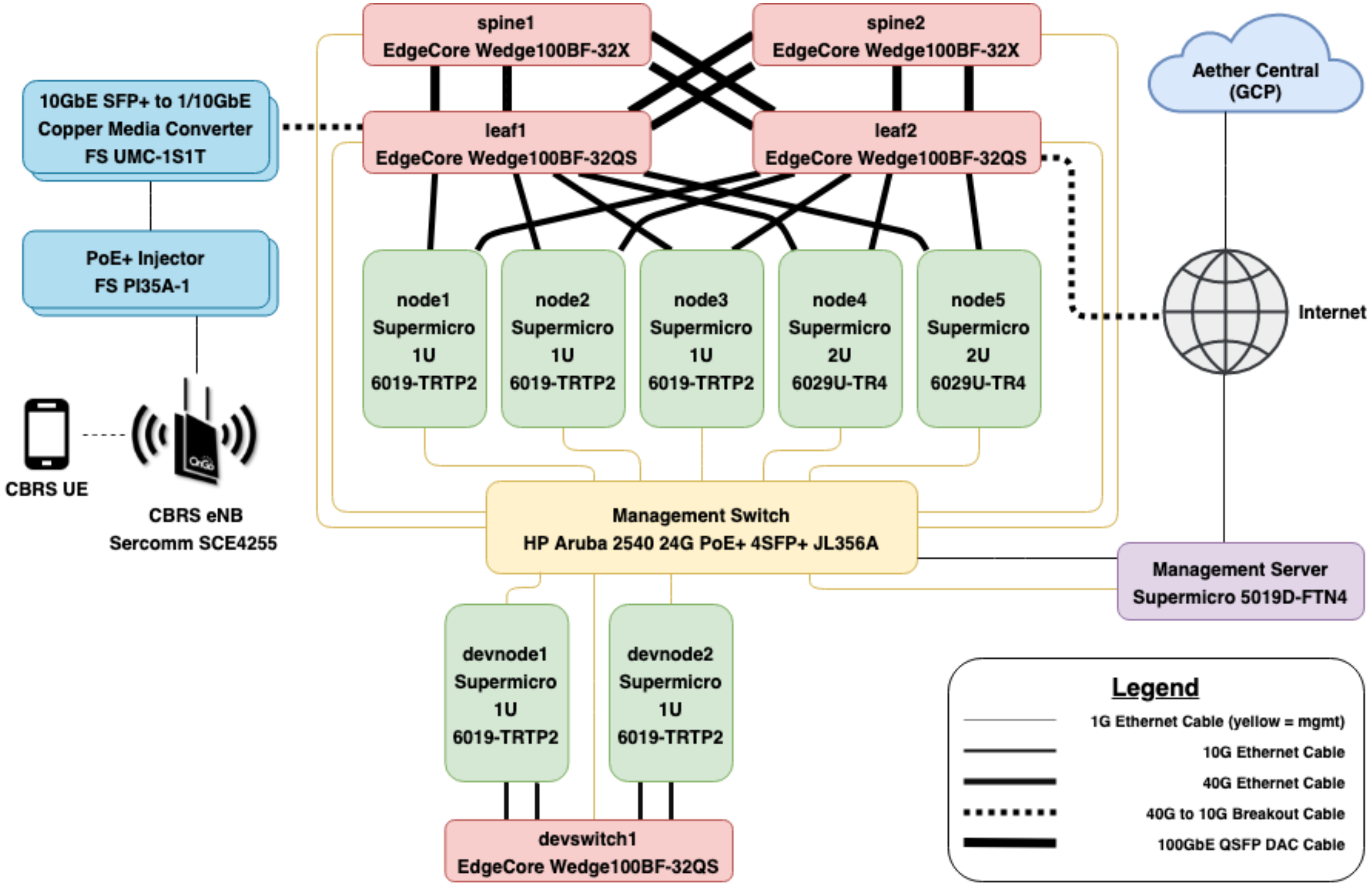
Bootstrapping → From bricks to “ready”

- Goal: Minimize amount of manual configuration
  - Want to get devices manageable over the network
- Cannot avoid manual configuration

Bootstrapping



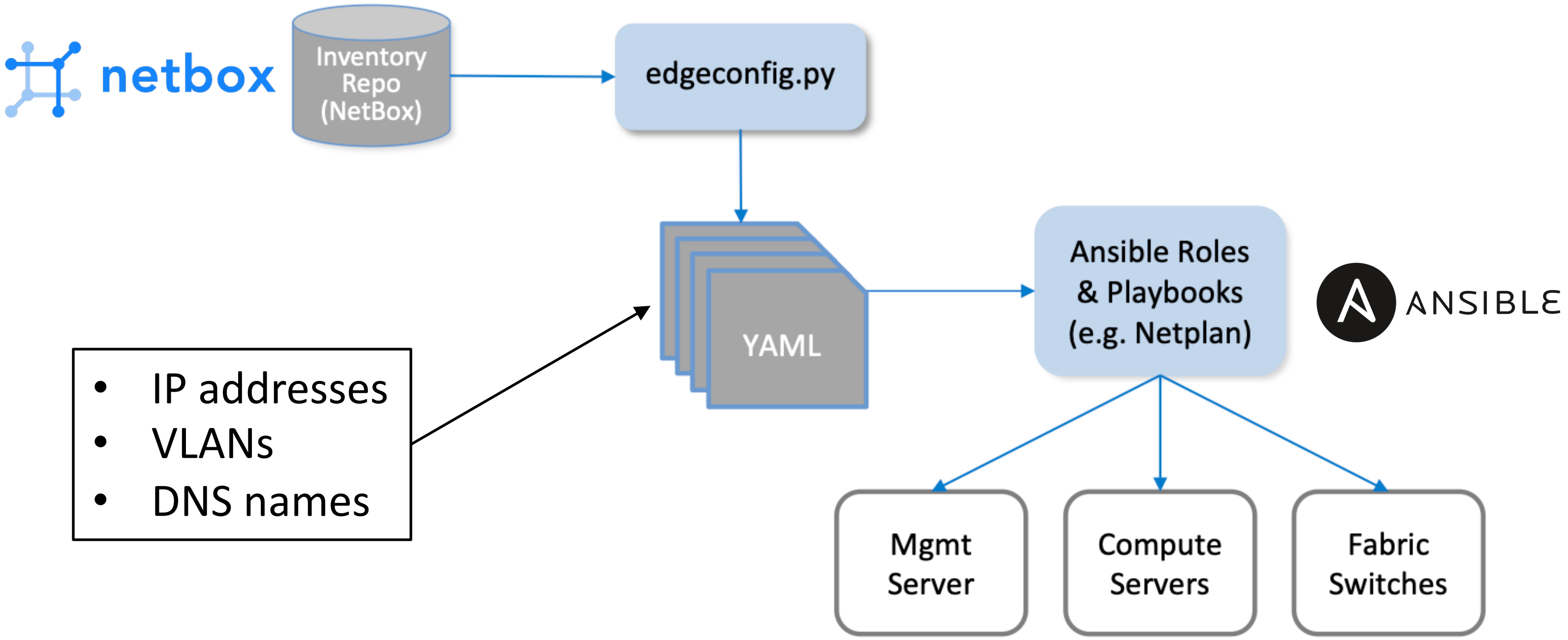
- Configure VLANs on management switch
- Configure management server needs to boot from USB stick
- Configure management services on management server using Ansible
- Configure Compute Servers to boot from the mgmt server via iPXE
- Configure fabric switches to boot from the mgmt server via Nginx

Bootstrapping → From bricks to “ready”

- Goal: Minimize amount of manual configuration
  - Want to get devices manageable over the network
- Cannot avoid manual configuration
  - But can still try to minimize work
  - Preconfigure as much as possible locally before shipping devices to the field
  - Use DHCP with MAC addresses to avoid configuring interfaces on hosts

Automated configuration

- Automate configuration as soon as machines are reachable
  - Ansible, Puppet, Chef
- Generate inputs to configuration system from inventory



netbox

Inventory Repo (NetBox)

edgeconfig.py

YAML

- IP addresses
- VLANs
- DNS names

Ansible Roles & Playbooks (e.g. Netplan)

ANSIBLE

Mgmt Server

Compute Servers

Fabric Switches

Automated configuration

- Automate configuration as soon as machines are reachable
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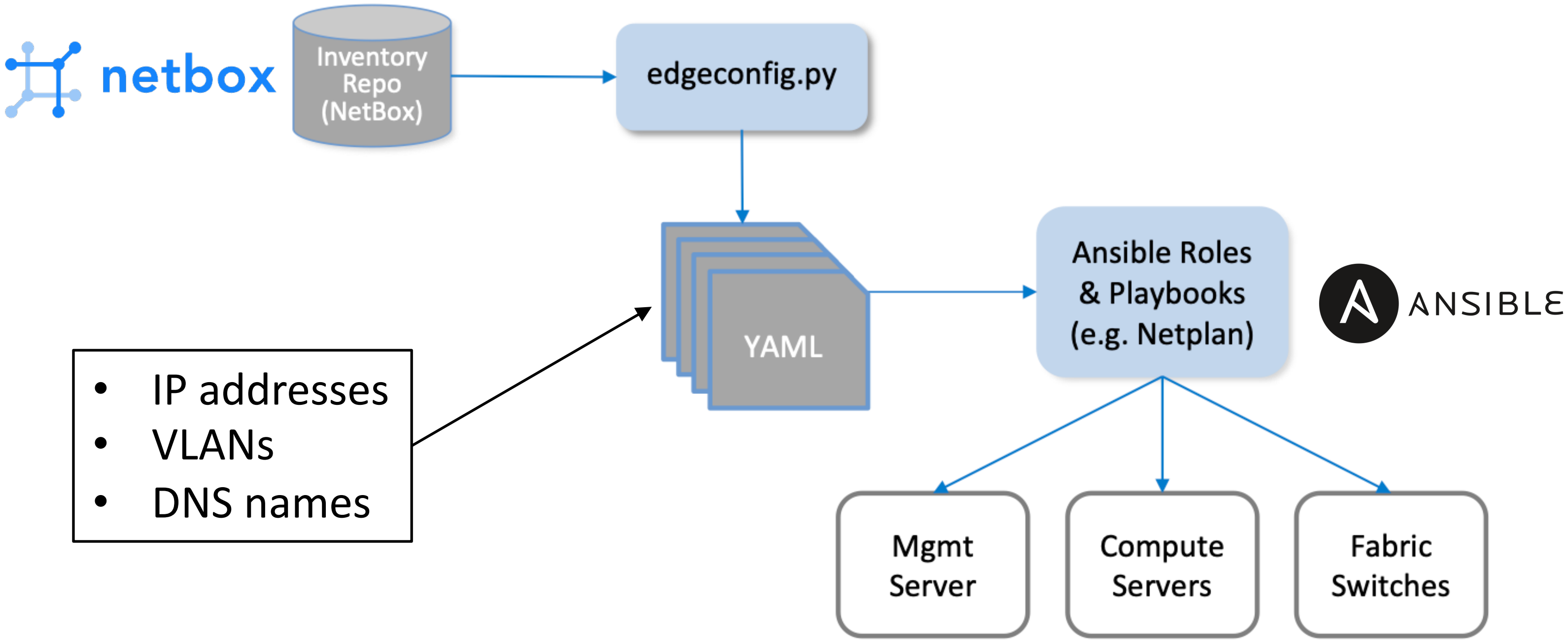
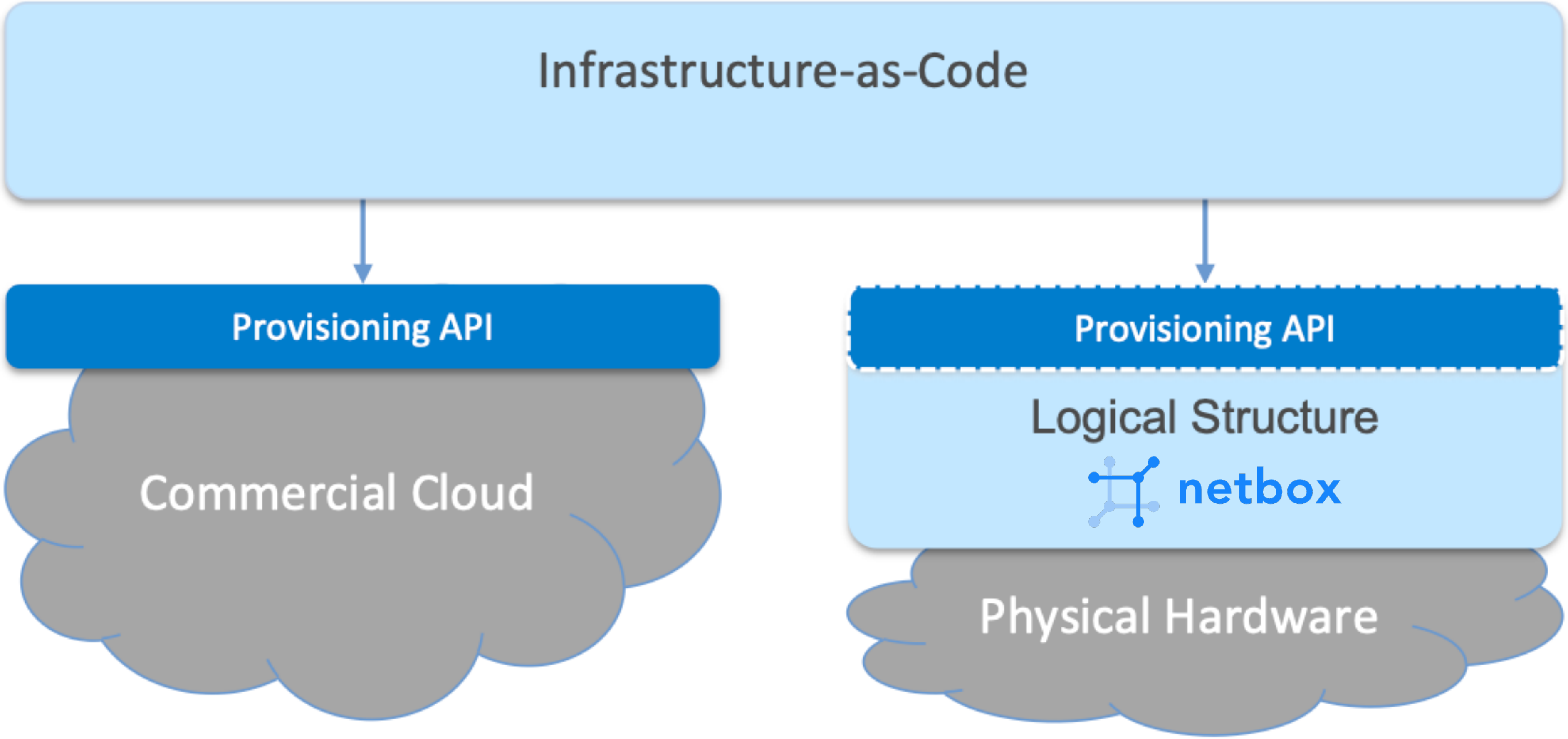


- IP addresses
- VLANs
- DNS names

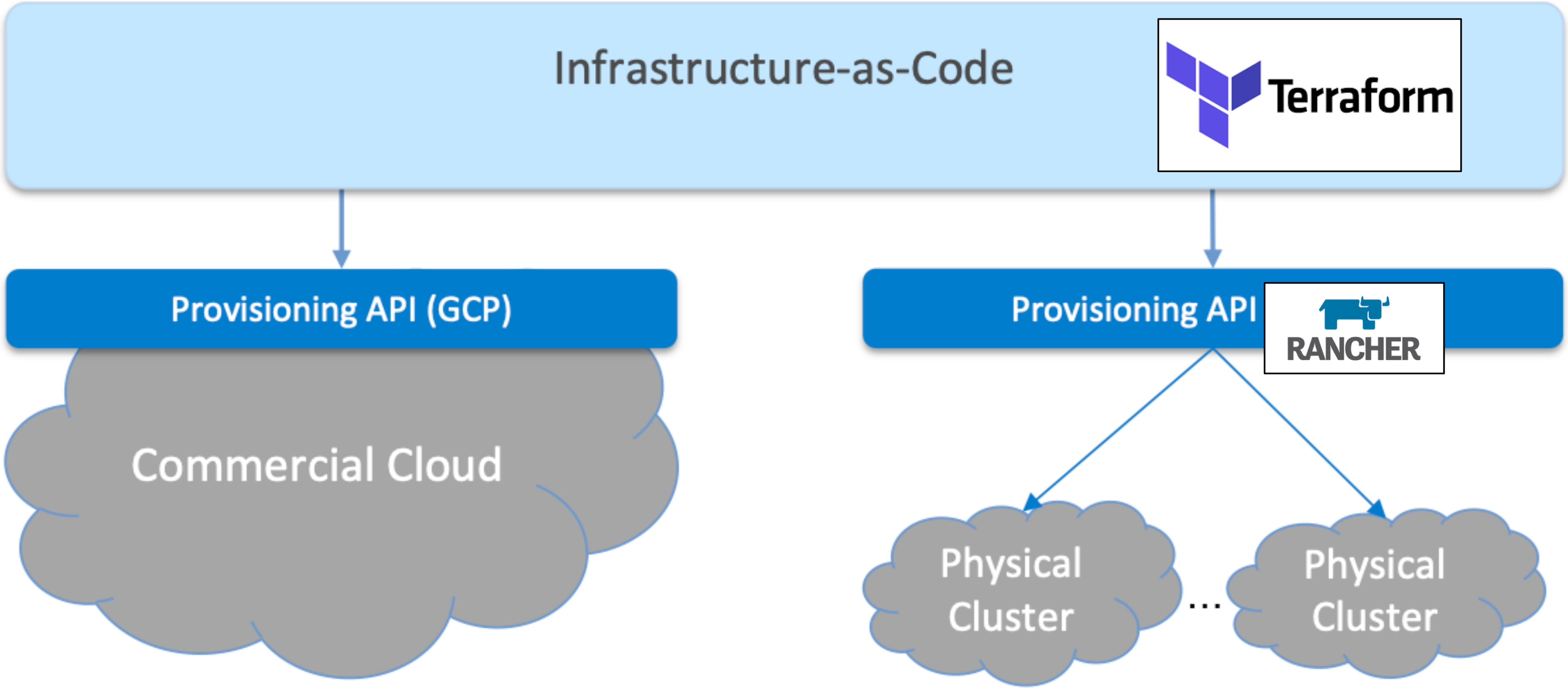
Provisioning

- After servers are configured, we need to provision the cluster
    - Kubernetes deployment
    - OpenStack deployment
- Automation during the provisioning phase
    - Require a provisioning API
        - Like the ones provided by cloud providers

Provisioning APIs



Provisioning APIs



Provisioning in the public vs private clouds

Public clouds

- On-demand capacity
- Untrusted tenants and apps

Private clouds

- Planned capacity
- Trusted tenants and applications

Infrastructure as Code

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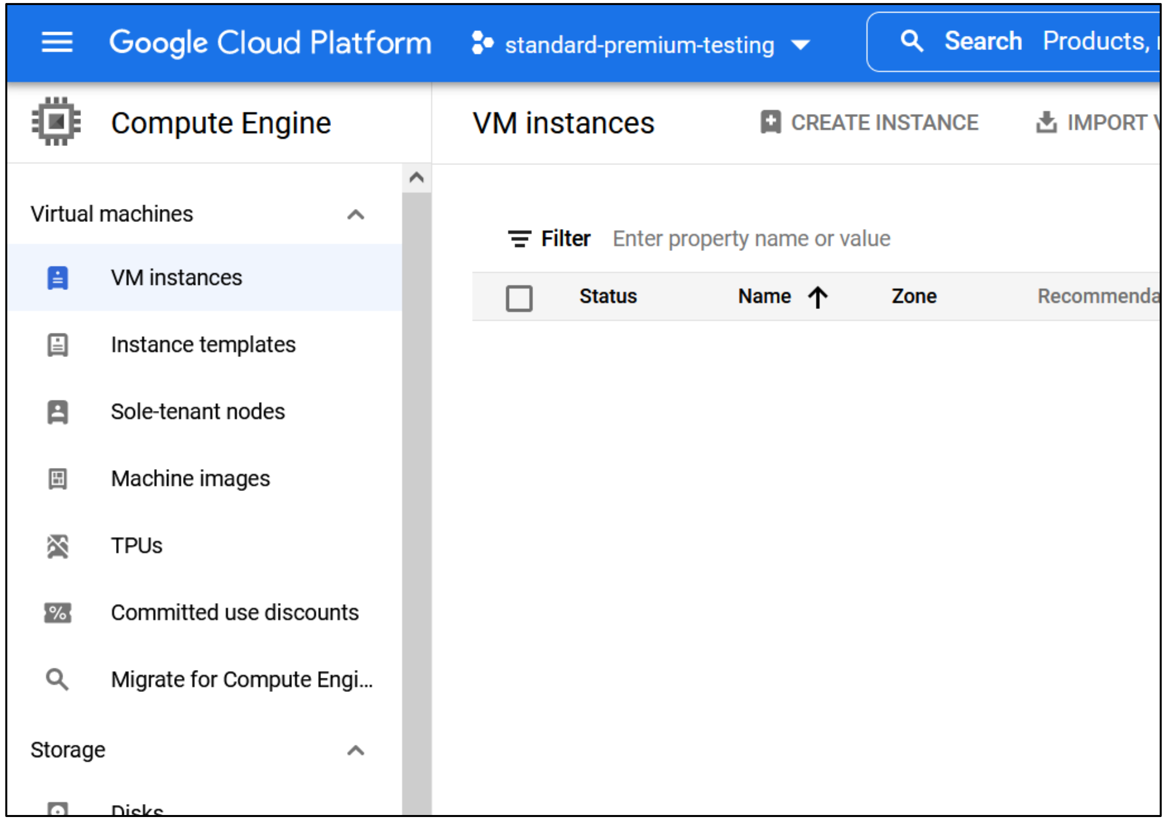
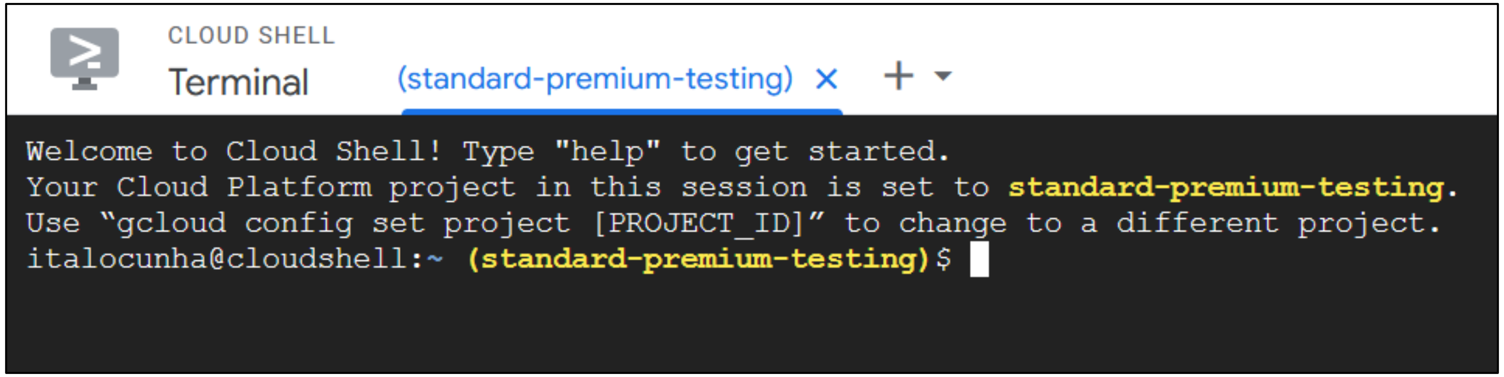
Provisioning

- Command-line interface
- Graphical user interface
- Programmatic API

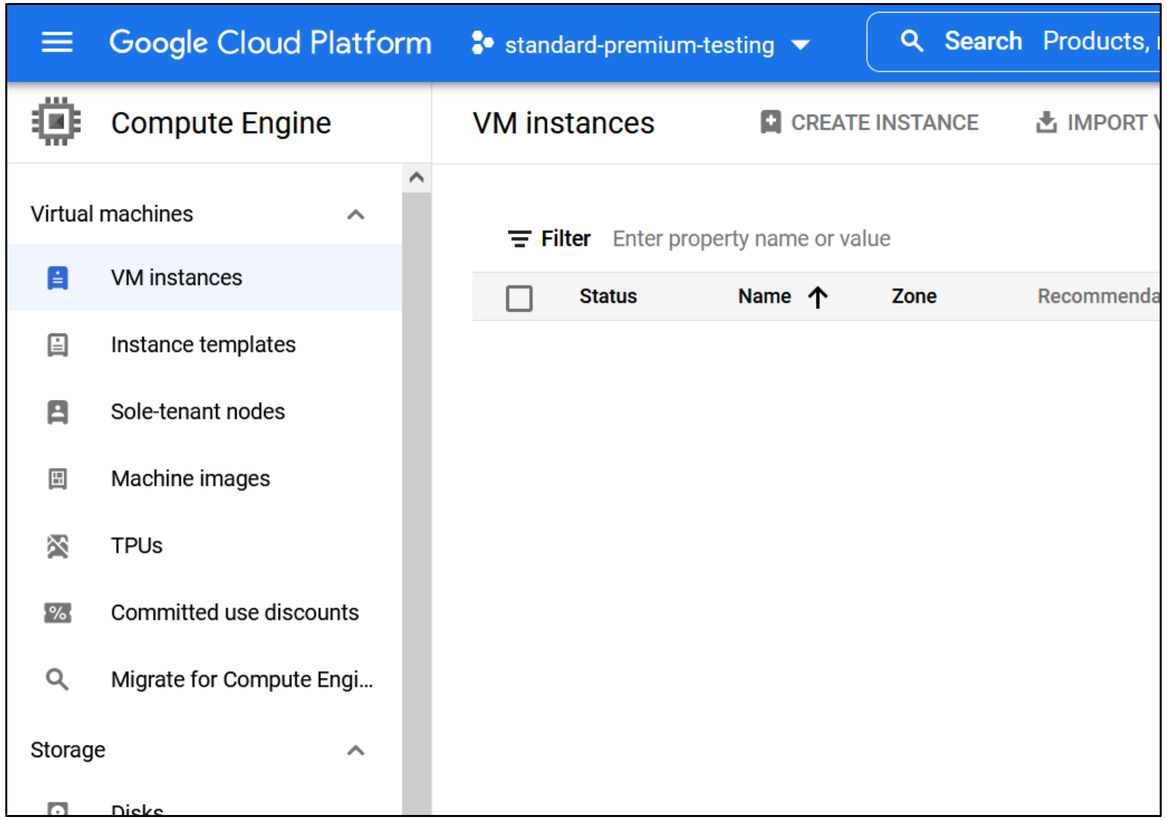




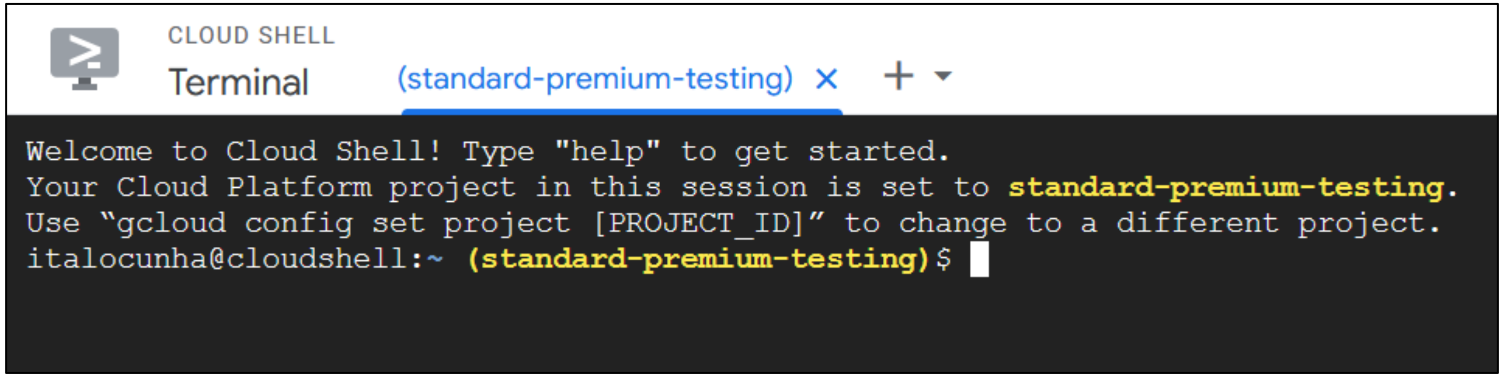
```
Welcome to Cloud Shell! Type "help" to get started.
Your Cloud Platform project in this session is set to standard-premium-testing.
Use “gcloud config set project [PROJECT_ID]” to change to a different project.
italocunha@cloudshell:~ (standard-premium-testing)$
```

Provisioning

- Command-line interface
- Graphical user interface
- Programmatic API



Human interaction with a CLI or GUI is time-consuming and error prone.



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Declarative interface to provisioning

- Specify provisioning in a declarative language
  - What Kubernetes clusters should be instantiated
  - On which resources
  - And specific configuration
- Automate calls to programmatic provisioning API

Declarative interface to provisioning

Terraform

- Specify provisioning in a declarative language
  - What Kubernetes clusters should be instantiated
  - On which resources
  - And specific configuration
- Automate calls to programmatic provisioning API

Terraform

- Declare infrastructure providers (GCP, Rancher)
- For each provider
    - Declare resources and their baseline configuration
        - IP addresses, VLANs, access keys, roles
    - Declare Kubernetes configuration
        - Controller nodes, worker nodes, CNI plugin (container network interface), proxies

Terraform

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- Files containing these declarative commands are checked into code repositories → Infrastructure as Code

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- Files containing these declarative commands are checked into code repositories → Infrastructure as Code
  - Changes to configuration trigger execution of the provisioner

Platform Definition

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What is a platform?

Applications

kubernetes

Physical Resources

Terraform

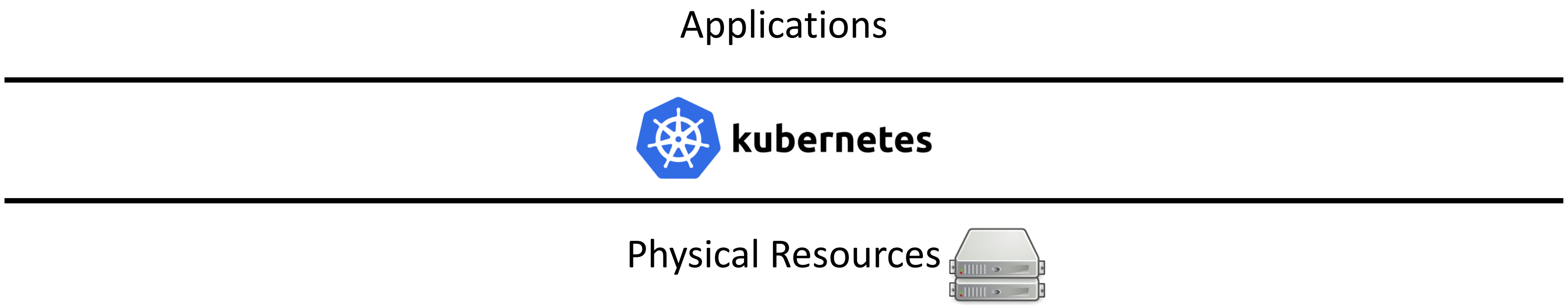
RANCHER

netbox

ANSIBLE

What is a platform?

- What about providing additional functionality for applications?



Applications

kubernetes

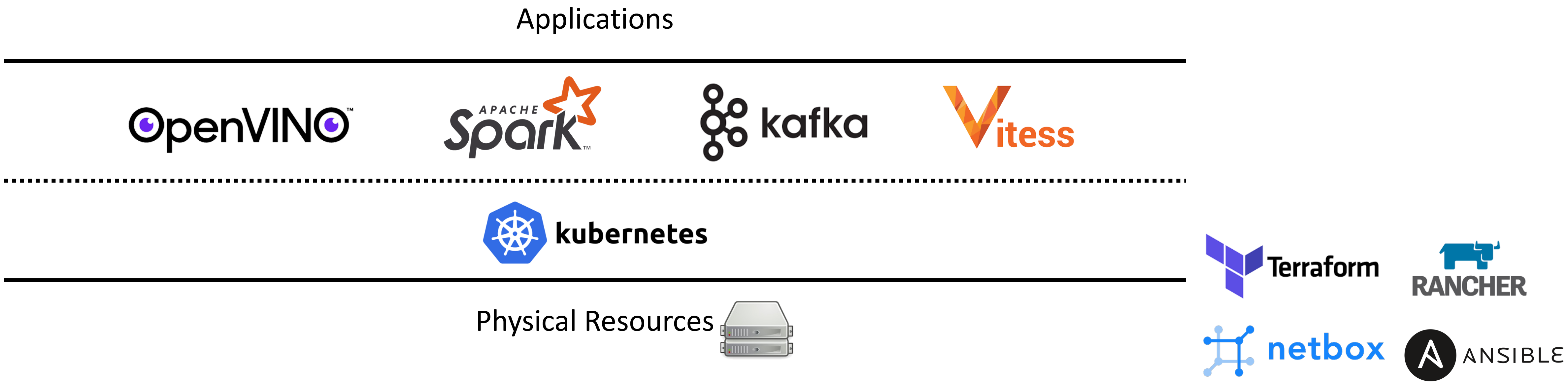
Physical Resources

Terraform RANCHER

netbox ANSIBLE

What is a platform?

- What about providing additional functionality for applications?


Applications
OpenVINO
APACHE Spark
kafka
Vitess
kubernetes
Physical Resources
Terraform
RANCHER
netbox
ANSIBLE