OpenStack = Linux of the Cloud?

Ingo Gering, Fujitsu
Dirk Müller, SUSE

- Introduction to OpenStack
- Software Defined Anything (SDx)
- Containers and container orchestration with OpenStack Magnum
- Providing Bare Metal Compute Nodes with OpenStack Ironic
- Monitoring and logging based on OpenStack Monasca
- Summary / Discussion

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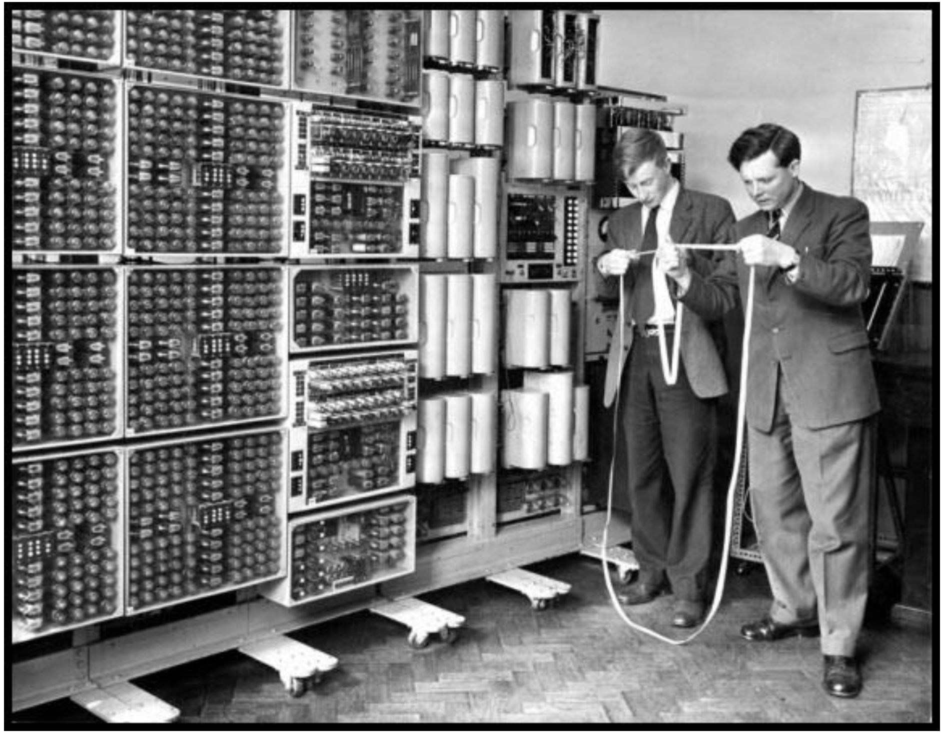
Introduction to OpenStack

- 60 years in 60 minutes

DC Computing 65 years ago



WITCH
Year: 1951

Short for the **W**olverhampton **I**nstrument for **T**eaching **C**omputing from **H**arwell, the WITCH was also known as The Harwell Dekatron Computer. It was slow (a multiplication took 5-10 seconds), but this was justified by its ability to run long periods of time unattended. It could therefore be left on its own with a large amount of input data. At one point it was left running over the Christmas and New Year holiday and was still working when the staff came back 10 days later.

DC Computing 6 months ago

- *„OpenStack is not (only) a* ***Cloud****, a* ***Project****, a* ***Product****, an* ***API****, a* ***user interface****, a set of* ***standards****. It is a* ***framework*** *for doing IT* ***infrastructure*** *as* ***interoperable*** *and* ***interchangeable*** *as possible.“*
- http://www.theregister.co.uk/2015/07/09/openstack_overview/

OpenStack = „Linux of the Cloud?"

- Replicating the success of Linux as operating system for **cloud management**
- **Universal, open cloud management** platform for public and private clouds
  - Free Open Source Software under the terms of the **Apache License**
  - IaaS cloud services from the beginning and more and more additional services (IaaS+)
- A compilation of various related technology projects / services
  - Currently 6 Core Services: Nova, Neutron, Swift, Cinder, Keystone and Glance
  - Currently 13 Optional Services: Horizon, Ceilometer, Heat, Sahara, Ironic, Manila,... → **Big Tent – Model**
- Development by a **global community of 850+ companies with 19000+ individuals**
  - Started as a joint project by Rackspace Hosting and NASA (2010)
  - Governed since 2012 by the non-profit **OpenStack Foundation**, promoting Software & Community
  - Agile and fast innovation with a **6-month release cycle** and appropriate Design Summits for developers
  - 13 releases since 2010 newest with the "**Mitaka**" community release in April 2016
  - OpenStack Summit in Austin End of April 2016 for the "**Newton**" design: about 7500 participants
  - End of October Design Summit in Barcelona for the **"Ocata"** release in Barcelona, Spain
  - **Has reached the level of maturity for productive use in enterprises**

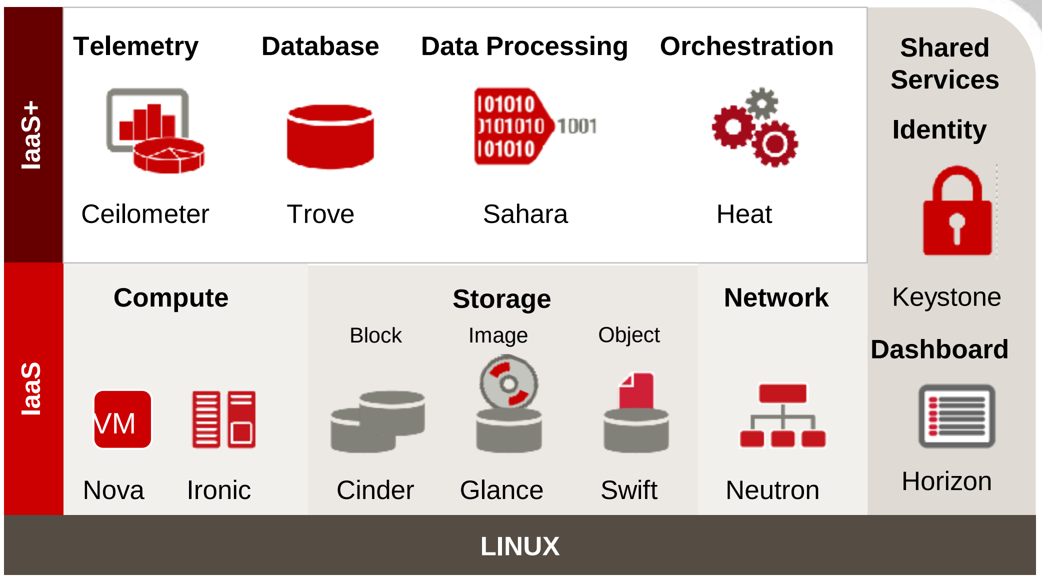
OpenStack =
Linux of the Cloud with a similar success!

- Speed of innovation
  - Community development
- Cost-effective
  - No license costs, commodity HW
- No vendor lock-in
  - Flexibility to customize and interoperate
- Massively scalable
  - Highly modular design
- Easy path to hybrid cloud
  - Standardized APIs enable easy integration of different cloud deployment models

Promise of OpenStack is to be the only cloud management platform that offers real possibilities for private cloud usage and standardization of hybrid clouds

OpenStack projects providing modular services

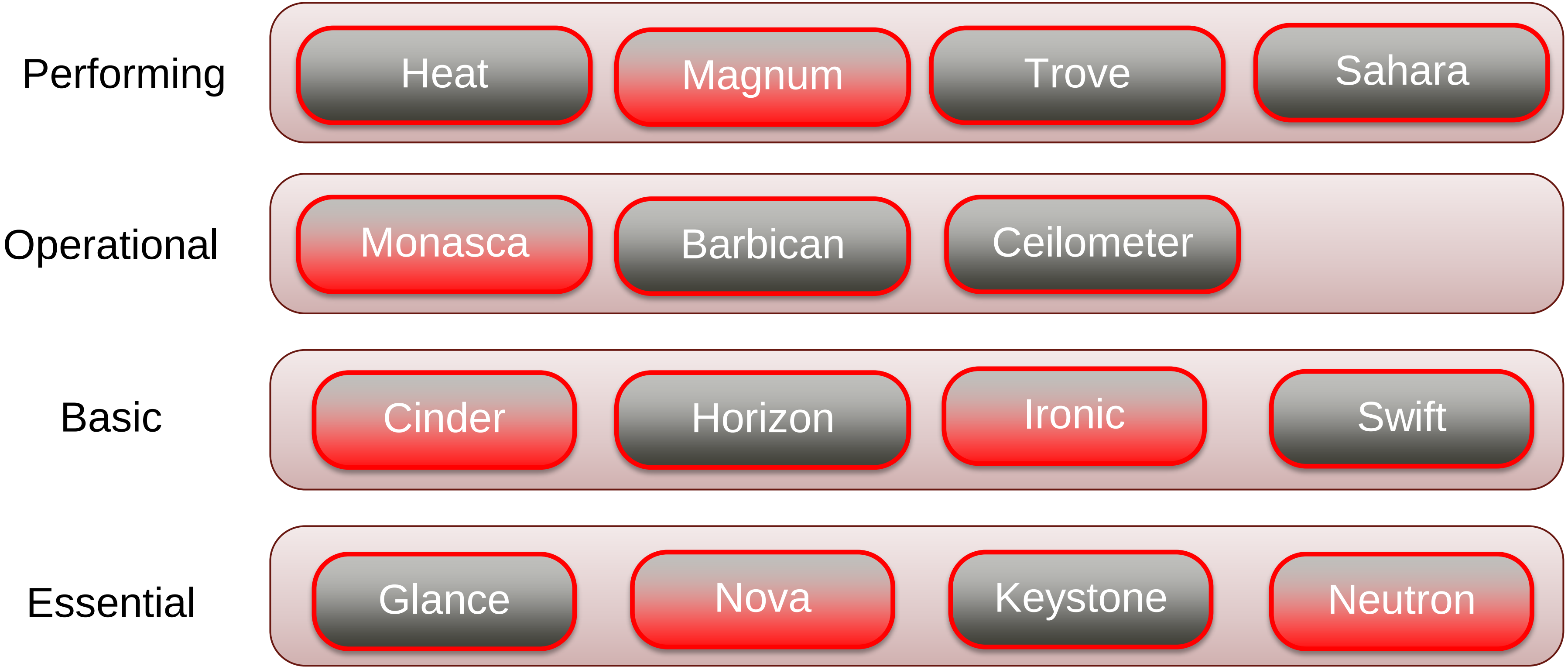
- **Base:** Set of interrelated well structured software modules to control large pools of compute, storage, and networking resources using common shared services
- **Additional:** More and more IaaS+ services for Database management and Data Processing of application clusters as 2 examples…
- Users can manage their resources through a self-service dashboard (Horizon), a more user-friendly portal as an alternative or general usage the the well and public documented OpenStack APIs
- No need to use all OpenStack services



*) Graphics are based on the OpenStack Kilo release;
Up-to-date at https://www.openstack.org/software/project-navigator

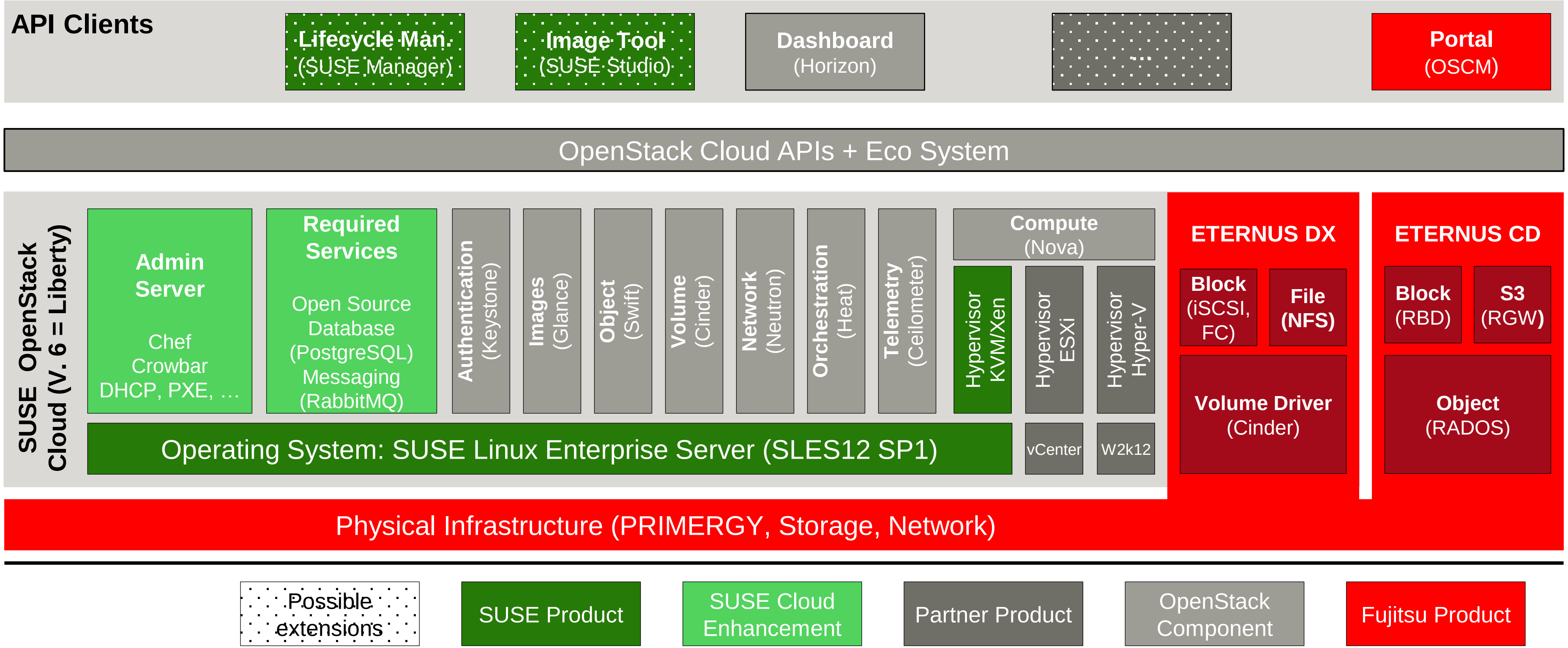
Fastest growing open source cloud management platform with broadest industry support

OpenStack – project / service classification



Performing	Heat	Magnum	Trove	Sahara
Operational	Monasca	Barbican	Ceilometer	
Basic	Cinder	Horizon	Ironic	Swift
Essential	Glance	Nova	Keystone	Neutron

SUSE OpenStack Cloud distribution provided by the Fujitsu OpenStack Services (FOS) as an example



API Clients

- Lifecycle Man. (SUSE Manager)
- Image Tool (SUSE Studio)
- Dashboard (Horizon)
- …
- Portal (OSCM)

OpenStack Cloud APIs + Eco System

SUSE OpenStack Cloud (V. 6 = Liberty)

- Admin Server: Chef, Crowbar, DHCP, PXE, …
- Required Services: Open Source Database (PostgreSQL), Messaging (RabbitMQ)
- Authentication (Keystone)
- Images (Glance)
- Object (Swift)
- Volume (Cinder)
- Network (Neutron)
- Orchestration (Heat)
- Telemetry (Ceilometer)
- Compute (Nova)
  - Hypervisor KVM/Xen
  - Hypervisor ESXi
  - Hypervisor Hyper-V
- Operating System: SUSE Linux Enterprise Server (SLES12 SP1)
- vCenter
- W2k12

ETERNUS DX

- Block (iSCSI, FC)
- File (NFS)
- Volume Driver (Cinder)

ETERNUS CD

- Block (RBD)
- S3 (RGW)
- Object (RADOS)

Physical Infrastructure (PRIMERGY, Storage, Network)

Possible extensions | SUSE Product | SUSE Cloud Enhancement | Partner Product | OpenStack Component | Fujitsu Product

Software Defined Anything (SDx)

Software Defined Anything (SDx)

Moving control and management functionality from the hardware into an independent software layer

Orchestration of the infrastructure is no longer reliant on the many and varied proprietary embedded capabilities and delivers an high degree of autmation

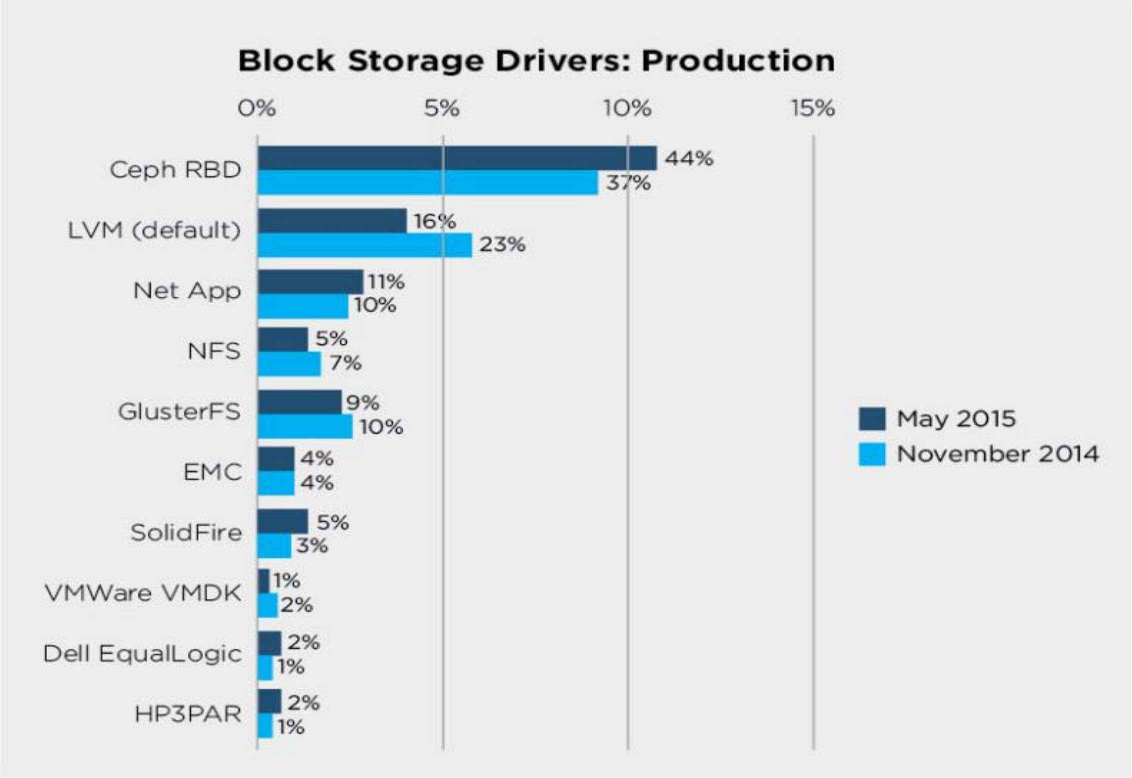
Everything from policy definition, though resource provisioning & configuration, to ongoing optimization, monitoring & administration can be done centrally in a more joined up and flexible manner

Using mainly Industry standard servers (x86 servers, …) as a hardware base for everything in the data center; also for Software Defined Storage (SDS) and Software defined Networking (SDN)

Software Defined Storage (SDS)

Block storage within OpenStack is SDS based on Open Source Ceph as a common standard!

- Ceph is used in more than 40% of productive OpenStack clouds for Cinder managed persistent Block storage
- Ceph is also very well integrated with OpenStack Keystone, Swift, Glance and Nova
- Traditional block storage usage in OpenStack is rather uncommon



Source: http://superuser.openstack.org/articles/openstack-users-share-how-their-deployments-stack-up, 05/2015

Foundations of Ceph

Build for new challenges

- Every component must scale
- No single point of failure
- Run on readily-available, commodity hardware
- Everything must self-manage wherever possible

Driven by a new philosophy

- Open Source
- Complete software-based
- Community-focused equals strong, sustainable ecosystem
- Driven by big players e.g. Red Hat, Mirantis, SUSE, Fujitsu and others

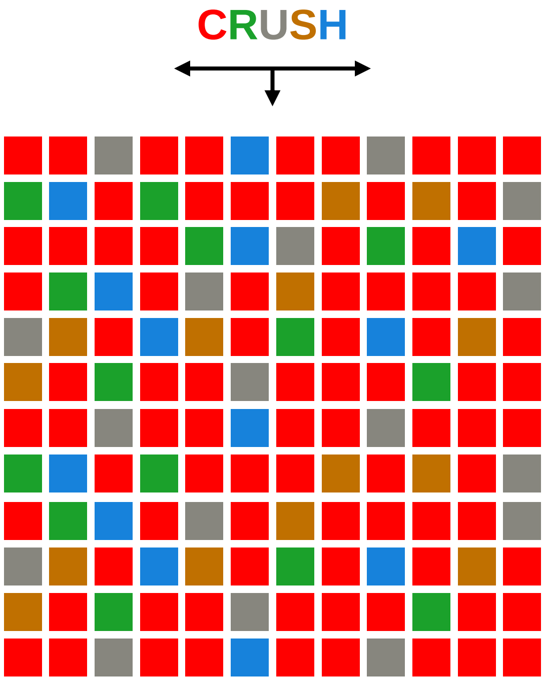
Works with a new design

- Scalable in capacity and performance
- Self-managing / Self-healing
  - Automatically place & replicate
  - Automatically balance & migrate data
- Calculate instead of lookup
- Use objects instead of blocks or files

CRUSH algorithm – the crown jewel of Ceph

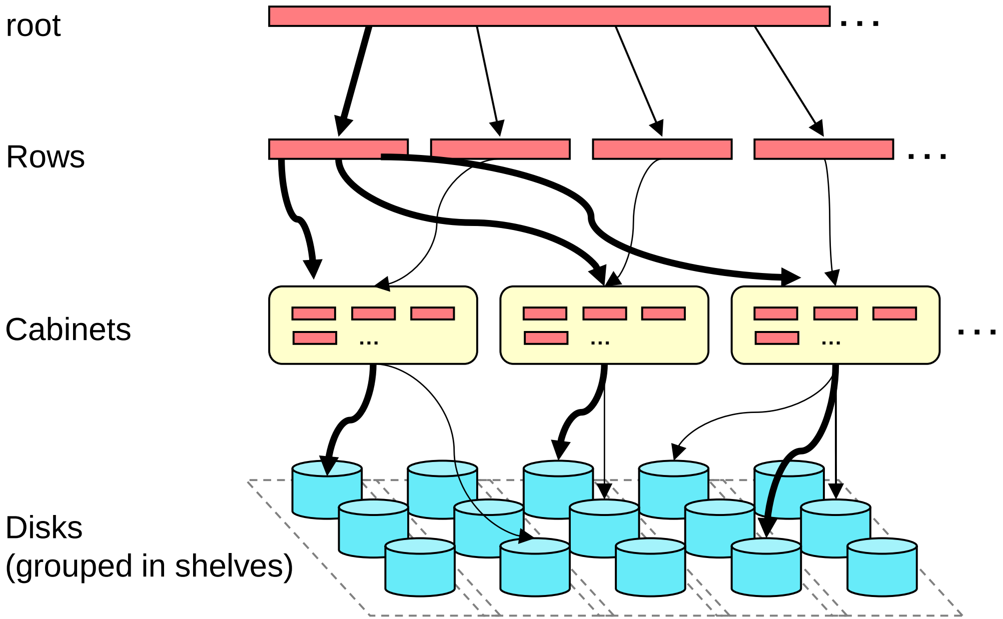
CRUSH - Controlled Replication Under Scalable Hashing

- Calculate placement instead of stored
  - No meta data necessary
  - Almost no central lookups
  - Infrastructure aware algorithm
  - Easy and flexible placement rules
  - Placement based on physical infrastructure
- Automatically place, replicate, balance, and migrate data
  - No hot spots
  - Quickly adjusts to failure
  - Pseudo-random, uniform distribution
  - Dynamic adaption to infrastructure changes
  - Automatic and fast recovery from lost disks



CRUSH algorithm – the crown jewel of Ceph

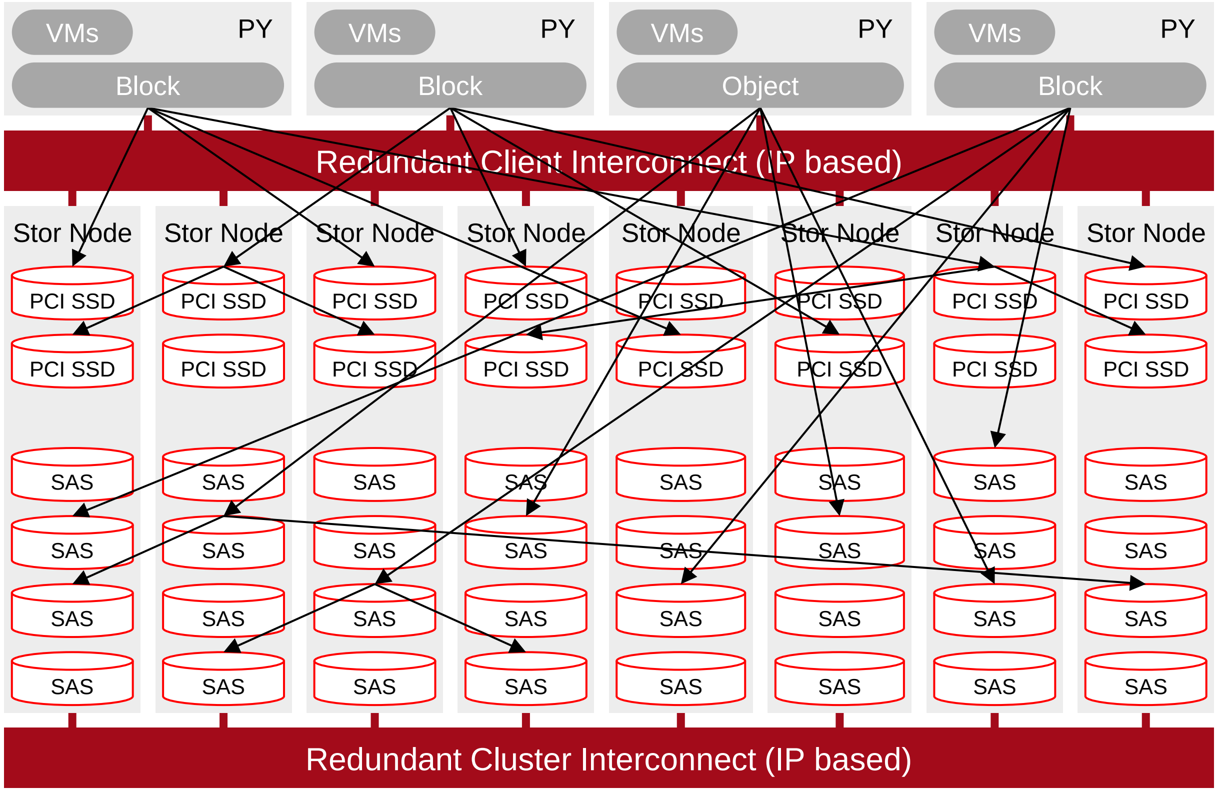
CRUSH – Infrastructure / topology aware algorithm



Every copy of an object should be placed in a different cabinet.

Cluster map hierarchy consisting of rows, cabinets, and shelves of disks

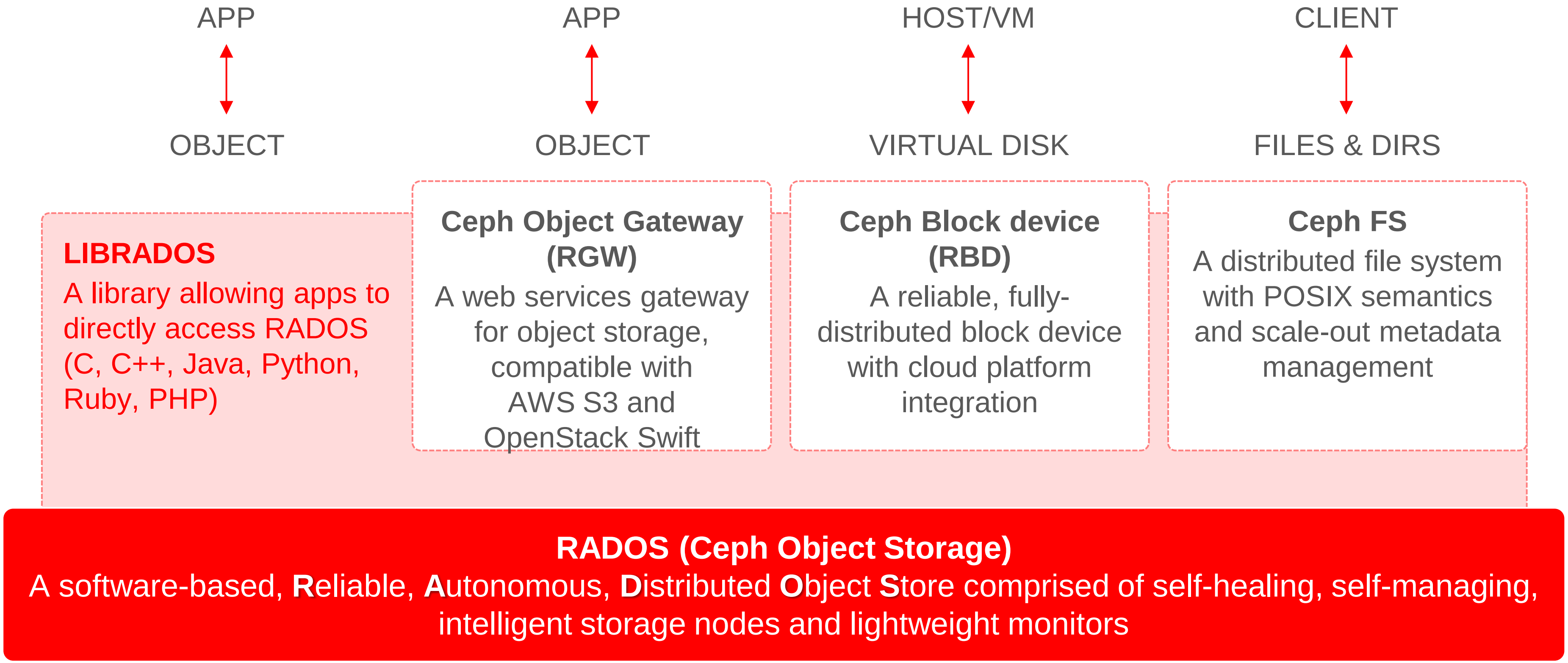
Scalability and Reliability



Distributed Redundant Storage

- Intelligent data **Distribution** across all nodes and spindles = wide striping (64KB – 16MB)
- **Redundancy** with replica = 2, 3 … 8
- Thin provisioning
- Fast distributed rebuild
- Availability, Fault tolerance
  - Disk, Node, Interconnect
  - Automatic rebuild
  - Distributed HotSpare Space
- Transparent Block, File access
- Reliability and Consistency
- Scalable Performance
- Pure PCIe-SSD for extreme Transaction processing

Ceph – Architectural components and interfaces



APP ↔ OBJECT

LIBRADOS

A library allowing apps to directly access RADOS (C, C++, Java, Python, Ruby, PHP)

APP ↔ OBJECT

Ceph Object Gateway (RGW)

A web services gateway for object storage, compatible with AWS S3 and OpenStack Swift

HOST/VM ↔ VIRTUAL DISK

Ceph Block device (RBD)

A reliable, fully-distributed block device with cloud platform integration

CLIENT ↔ FILES & DIRS

Ceph FS

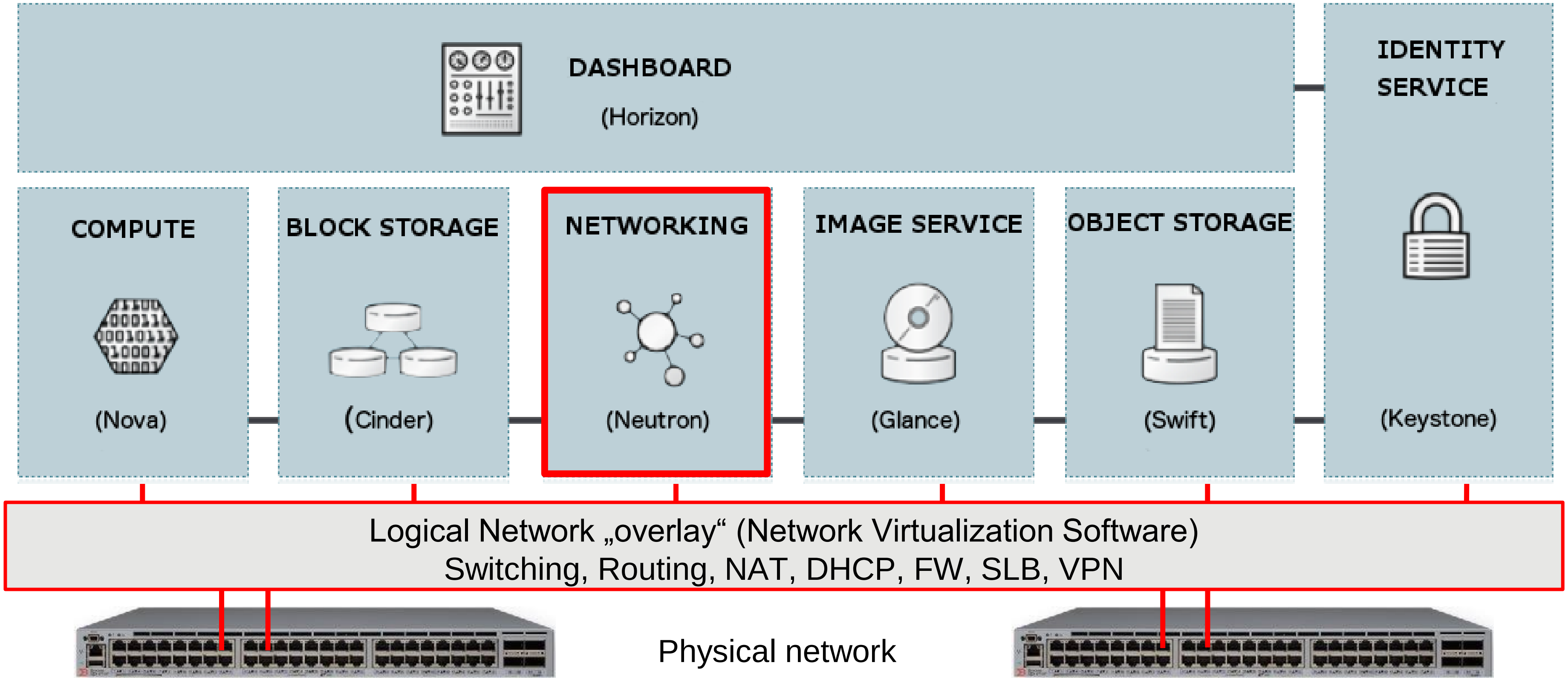
A distributed file system with POSIX semantics and scale-out metadata management

RADOS (Ceph Object Storage)

A software-based, **R**eliable, **A**utonomous, **D**istributed **O**bject **S**tore comprised of self-healing, self-managing, intelligent storage nodes and lightweight monitors

Software Defined Networking (SDN)

OpenStack Networking in general

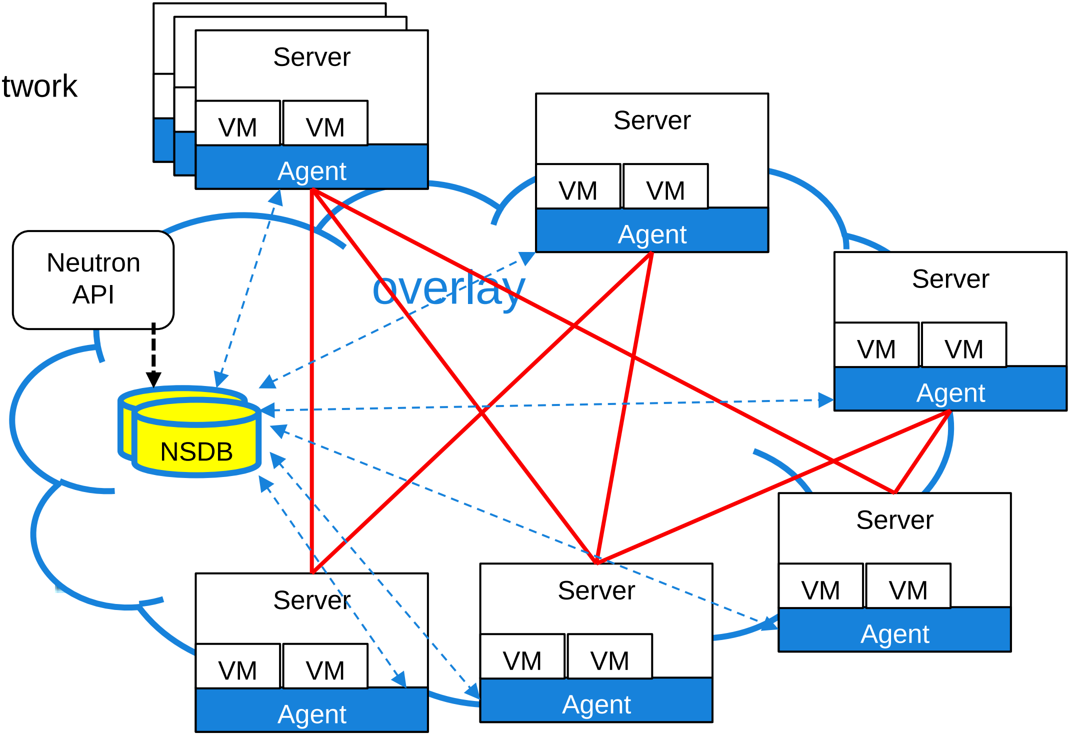


OpenStack native SDN implementation

- Based on OVS – **Open vSwitch**
- Limitation in scalability and robustness
  - … due to centralized controller approach (central Control- and Network Nodes)
  - Scales up to ~30-150 compute nodes (depends on #VM, load, agility)
  - Single failure domain: Layer 2 network (switching) connectivity only (provider network)
- Limited functionality for example…
  - No possibility to offer secured shared services, no common DC security (3-tired FW design)
    - one single Firewall per tenant, N/S traffic only
  - Limited redundancy
    - Not possible to scale out compute nodes (with DVR) in combination with redundancy (L3HA)
- High complexity
  - Multiple services, multiple bridges, IP tables, namespaces

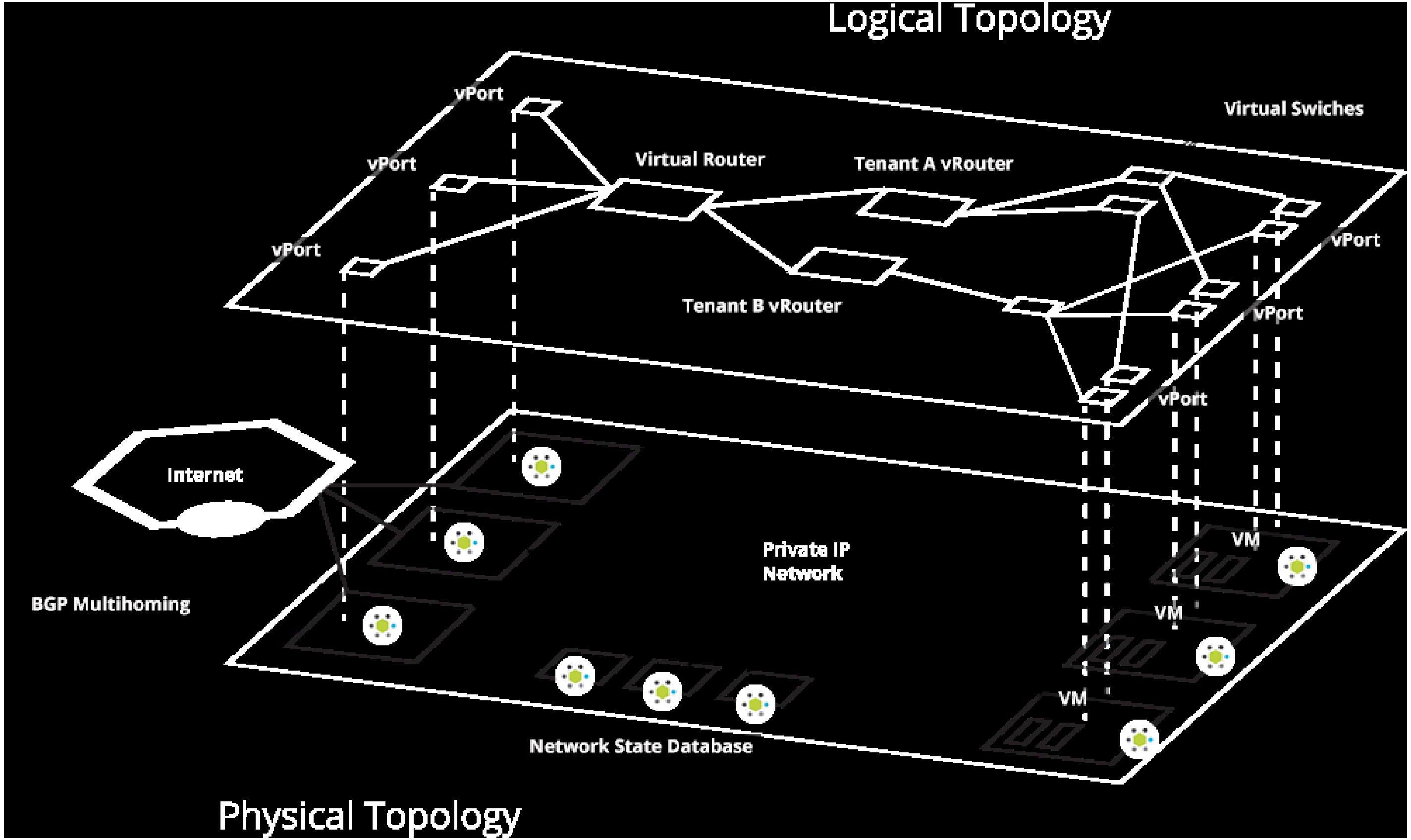
MidoNet as one example for a stable and well scaling overlay network solution

- MidoNet „overlay“ network
  - Software defined - decoupled from physical network
  - „Cloud-admin“ responsibility
- High scalable and redundant services
  - Distributed agents on each hypervisor
  - Common database for network states (NSDB)



- *Typical „underlay“ Data-Center physical Network*
  - *„Spine-Leaf“ architecture*
- *Static, Stable, performant*
- *„Network-admin“ responsibility*

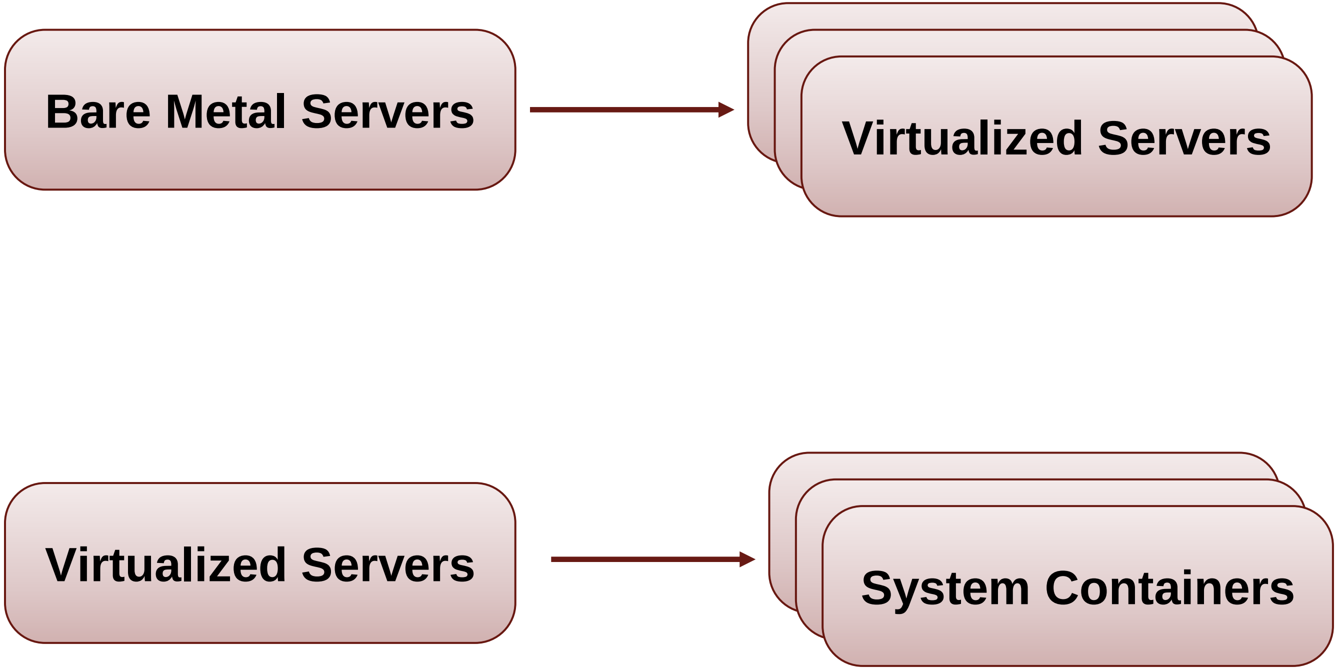
MidoNet –
Decoupling logical topology from physical



Container Orchestration with Magnum

Why Container Orchestration?

The Road to Container Orchestration



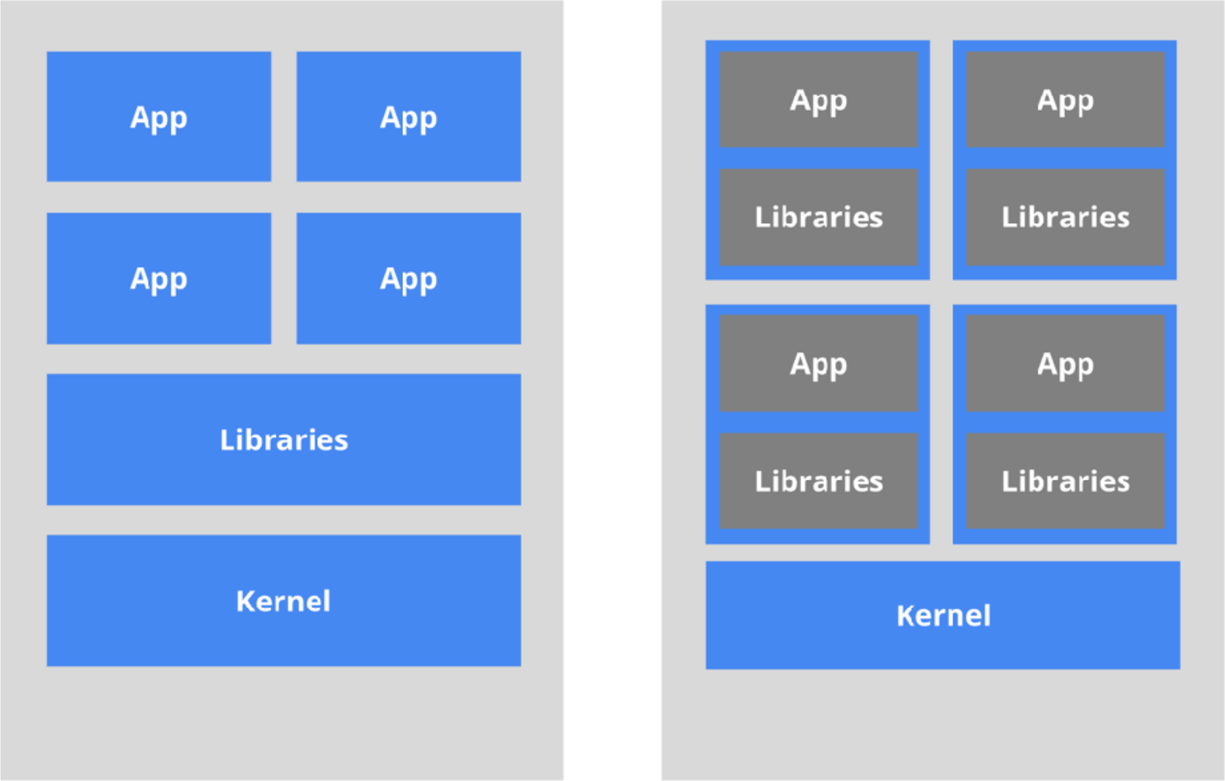
Bare Metal Servers → Virtualized Servers

VM Sprawl

Virtualized Servers → System Containers

Container Sprawl

Container Sprawl



Different Container Types

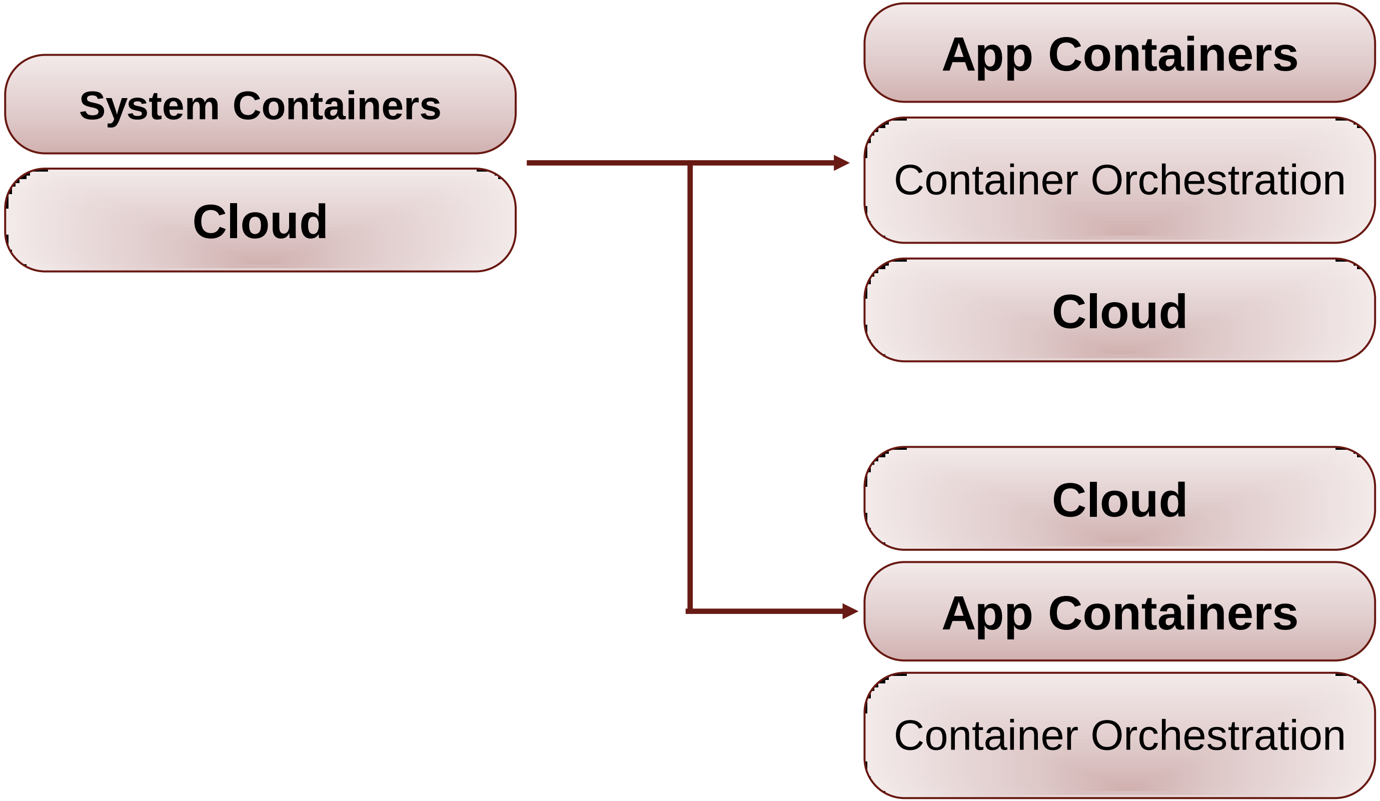
System Containers

- „Lightweight OS“
- Usually either manually maintained or using config management
- OpenStack support via „Nova-Docker“

Application Containers

- Application centric
- Micro Services
- Layered deployment
- Container Orchestration Engines
- OpenStack support via „Magnum“

Introducing Container Orchestration



System Containers

Cloud

App Containers

Container Orchestration

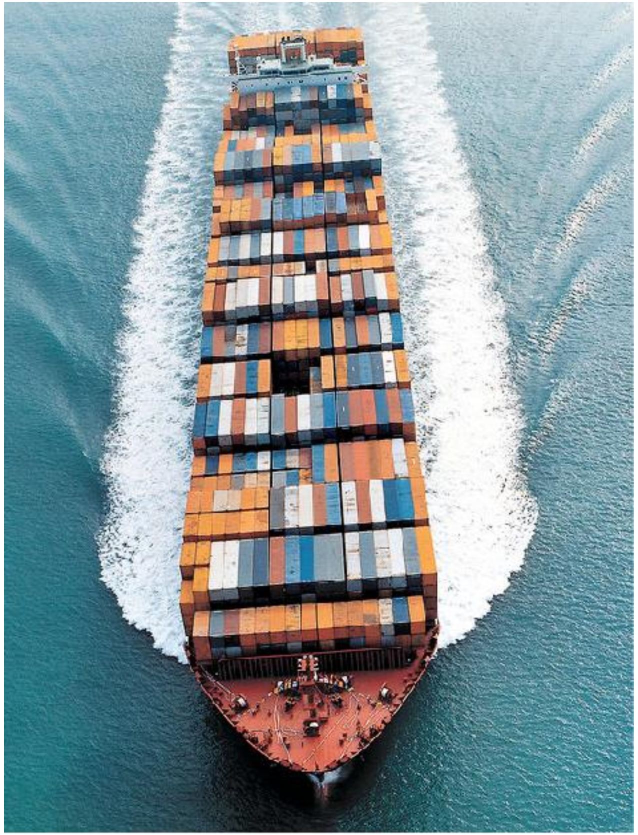
Cloud

Cloud

App Containers

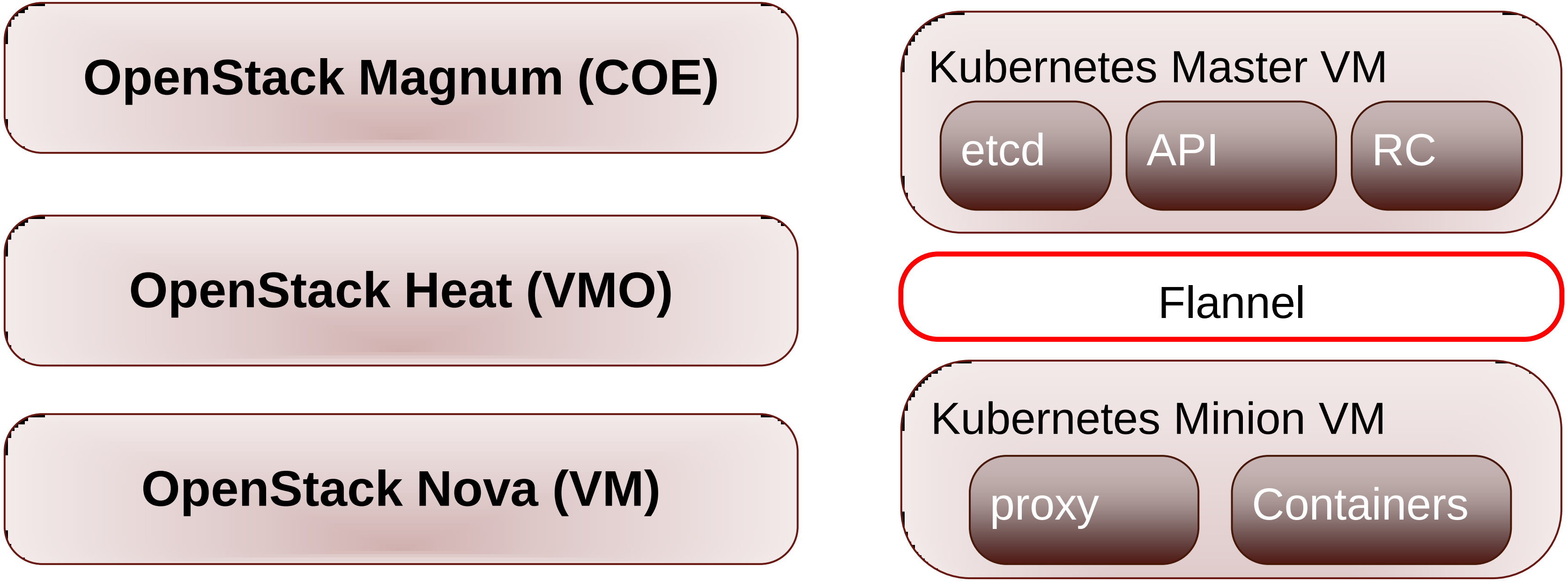
Container Orchestration

Containers and Cloud



- Containers **do not** replace VMs
- VMs allow tenant isolation and hardware abstraction
  - Live Migration
  - Snapshotting
- Containers allow for better orchestration
  - Replication
  - Layering
  - Service Isolation

Magnum with Kubernetes



OpenStack Magnum (COE)

OpenStack Heat (VMO)

OpenStack Nova (VM)

Kubernetes Master VM

etcd

API

RC

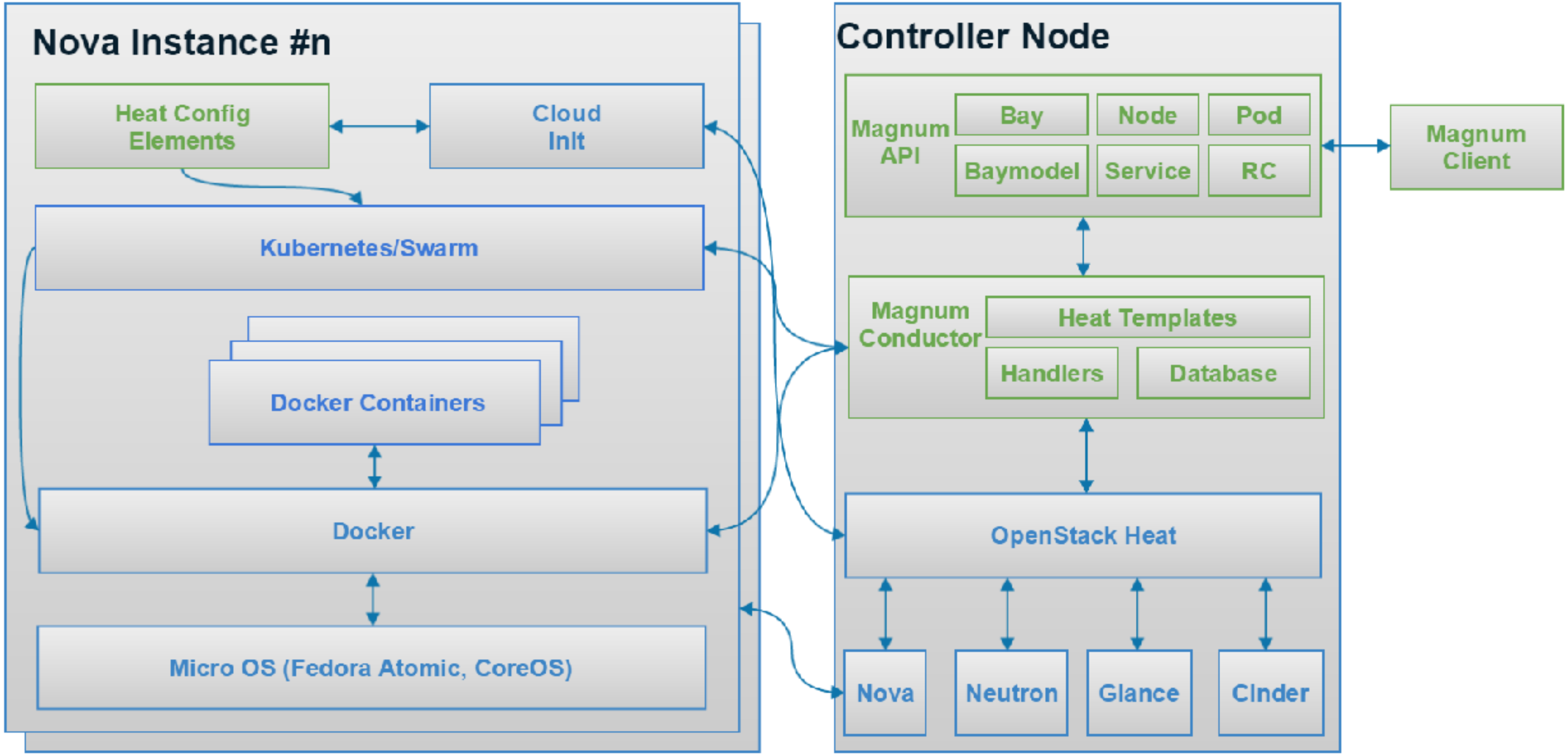
Flannel

Kubernetes Minion VM

proxy

Containers

OpenStack Magnum Architecture



OpenStack Ironic

- Why use OpenStack with Bare Metal?

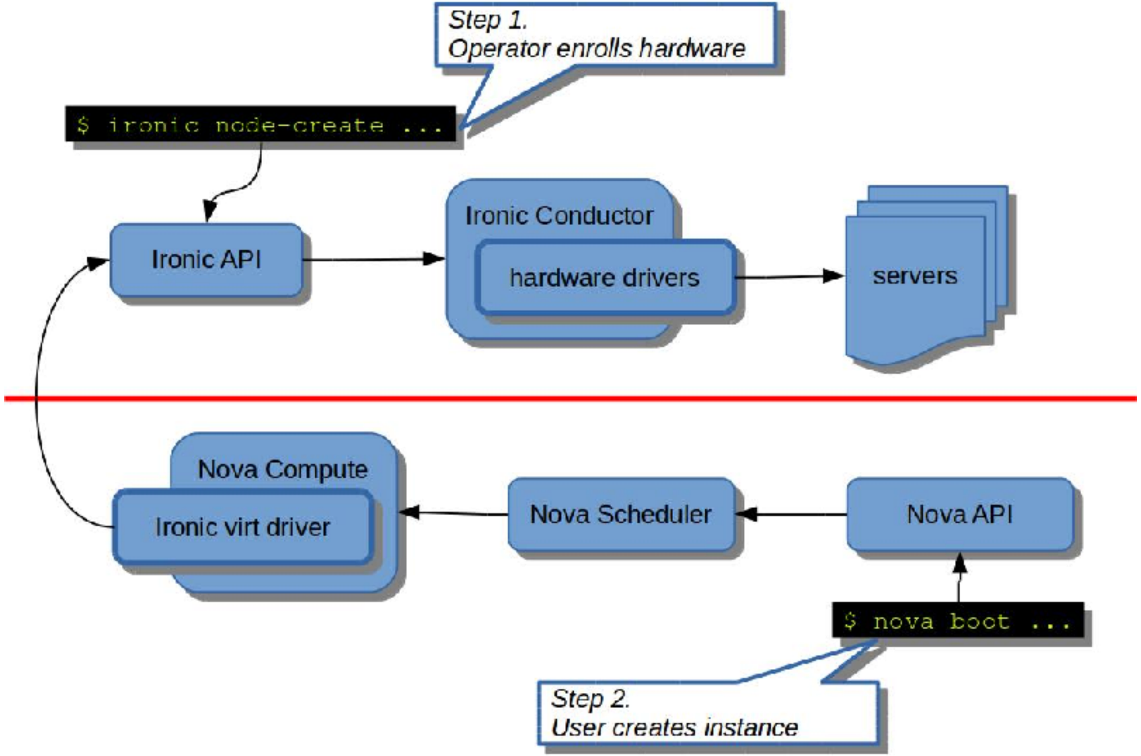
Bare Metal Use Cases

- High Performance Computing (HPC)
- Workload can not be effectively virtualized (access to specific peripherals, not certified)
- Big In Memory Databases
- Tenant isolation is unnecessary
- Workload by itself wants to virtualize
  - OpenStack on OpenStack (OoO)
  - Test Automation for Operating Systems :)

OpenStack Compute on Bare Metal

- Scheduling workload on a physical machine
  - Heterogeneous hardware can be selected via flavor properties
- Single tenant - maybe just use Flat + Standalone OpenStack Ironic?
- Multiple tenants
  - Network isolation is only partially possible
  - Tenant isolation via secure-erasing disks on redeploy
  - (Firmware-reflash between uses)

OpenStack Ironic – 2 views



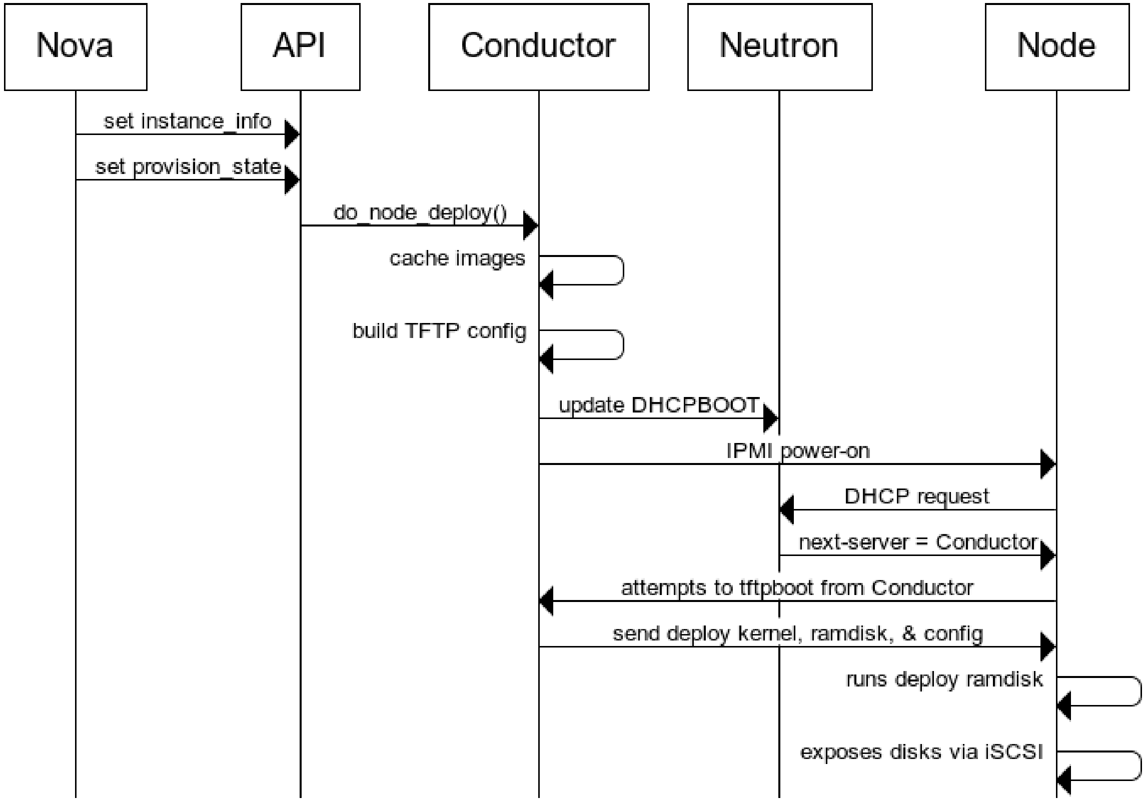
Step 1.
Operator enrolls hardware

```
$ ironic node-create ...
```

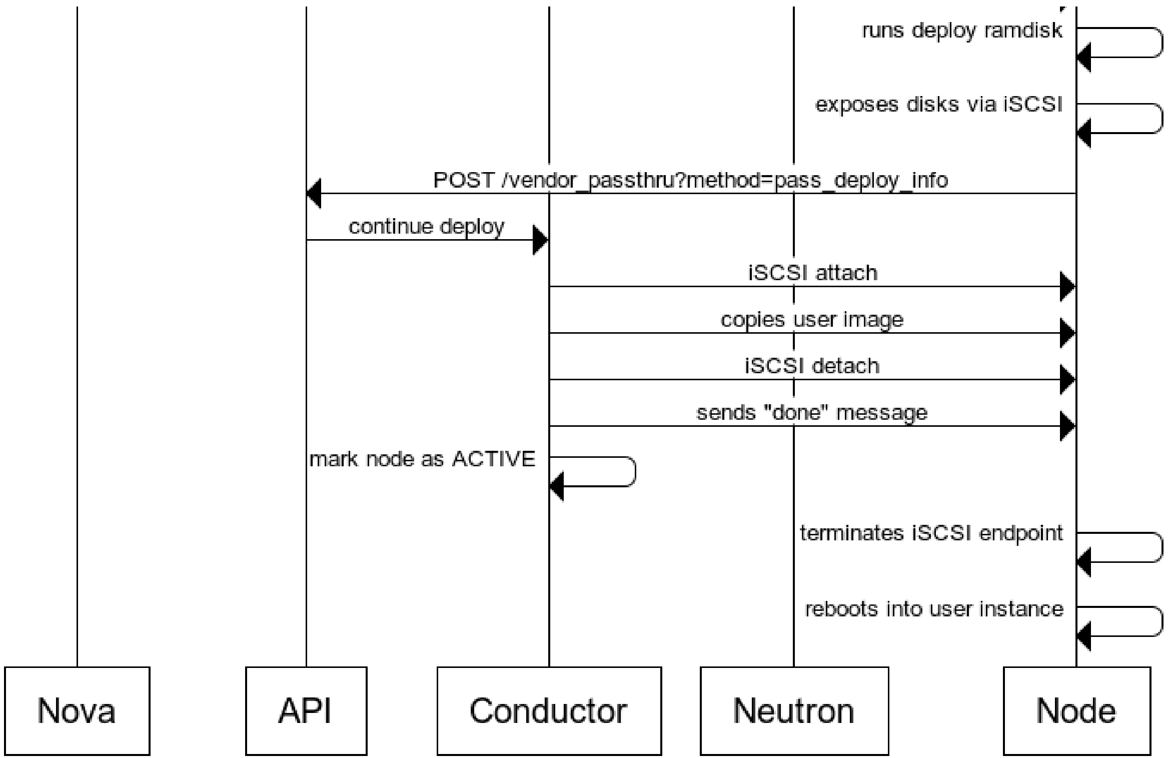
```
$ nova boot ...
```

Step 2.
User creates instance

PXE deployment process (I)



PXE deployment process (II)



Monitoring and Logging based on OpenStack Monasca

- Mission:

  Standardized OpenStack project instead of vendor specific solutions
- Logging-as-a-Service
- Monitoring-as-a-Service
- Multi-Tenancy, RBAC

Monasca - Functions and Technologies

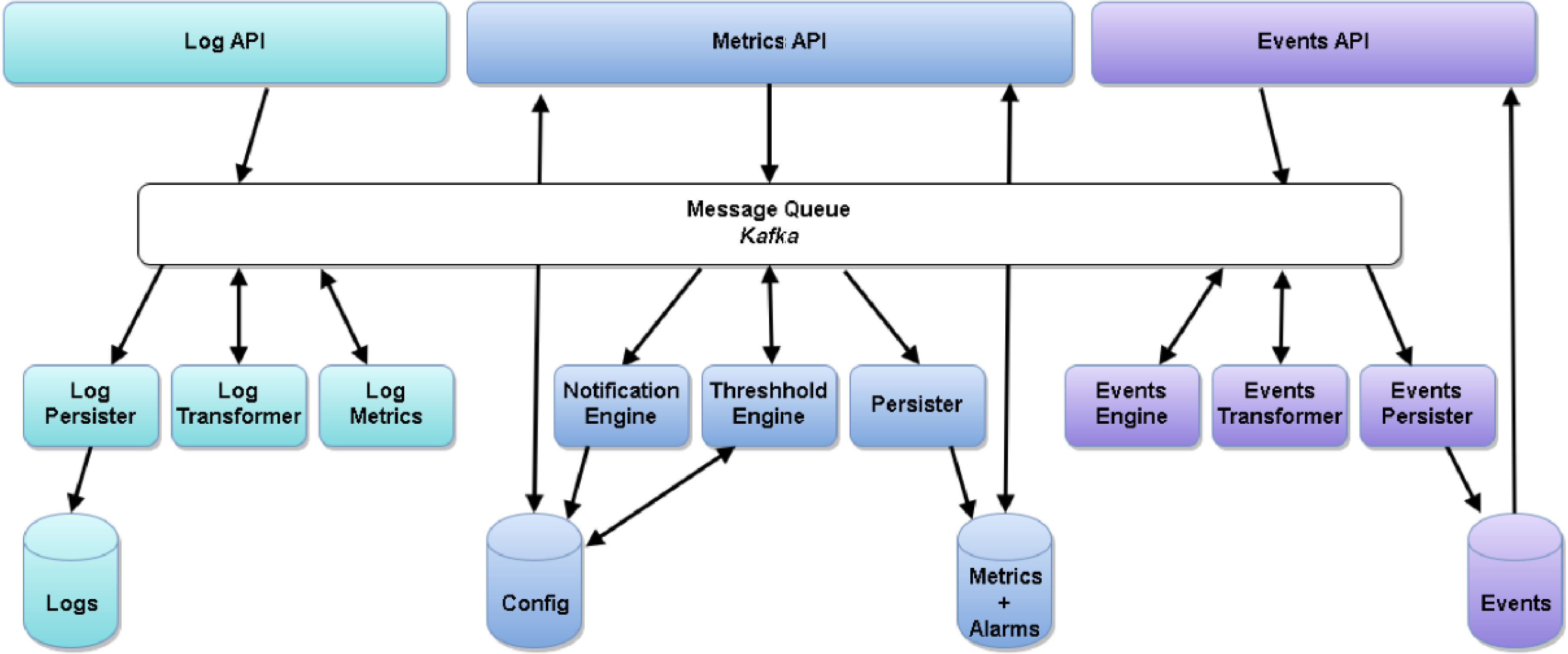
- **Monasca**:
  - Metrics / Monitoring
  - Logging
  - Alarming

- **ElasticSearch:** Search Engine
- **Logstash:** Collection, Parsing and optionally Transformation
- **Kibana:** Dashboard Graphing/Trending

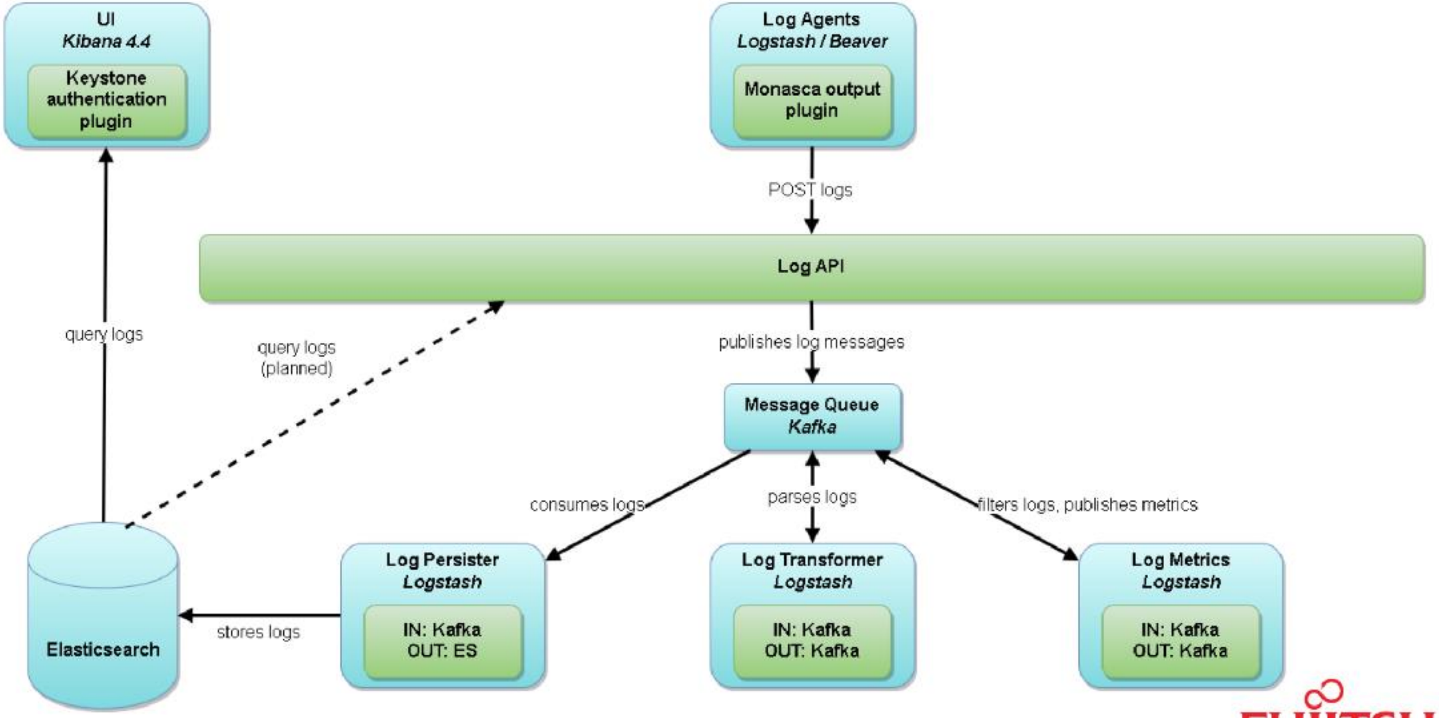
Monasca – some details

- Metrics
  - Supervise health status of your infrastructure
  - Alert on Service Unavailability
- Logging
  - Root cause analysis, Correlation analysis
- Extensions over standard ELK
  - Multi-Tenancy
  - Focus on Scalability / Performance

Monasca Architecture



Monasca Logging



Summary / Discussion

OpenStack and Linux – common features

- Success based on Open Source
- Efficient Resource Management
- Mechanism of Abstraction
- Sharing and Multitasking
- Manageable Complexity (Modularity, APIs, …)
- Scalability
- Similar definitions

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