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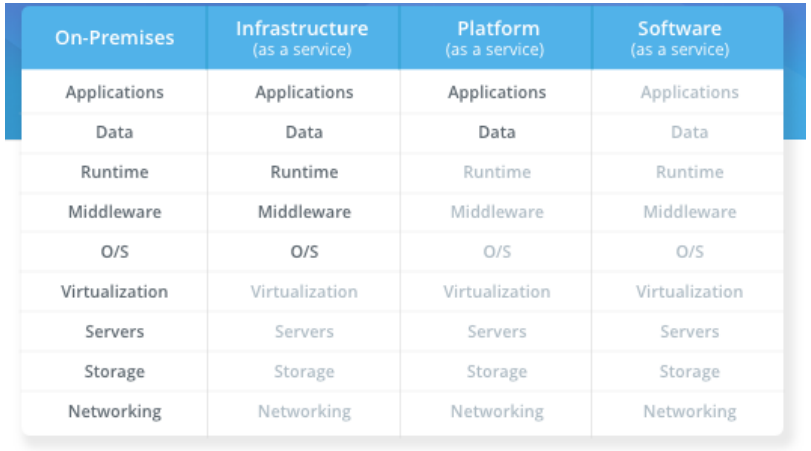
CLOUD TECHNOLOGY

An introduction to cloud computing and OpenStack

Steffen Thielemans

CLOUD SERVICE MODELS

Three different types



On-Premises	Infrastructure (as a service)	Platform (as a service)	Software (as a service)
Applications	Applications	Applications	Applications
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
O/S	O/S	O/S	O/S
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking

- Infrastructure as a Service (IaaS)
  - The elementary building blocks of cloud computing.
  - Compute, storage, networking components can be customized to accomodate the client's needs
  - E.g. A variety of AWS EC2 compute instances with S3, EFS and EBS storage.
- Platform as a Service (PaaS)
  - Full control over the application while the underlying infrastructure is already taken care of
  - Features like automated provisioning, scaling and monitoring
  - E.g. Web services deployed on AWS Elastic Beanstalk
- Software as a Service (SaaS)
  - E.g. Office 365

CLOUD COMPUTING DEPLOYMENT MODELS

Public, private and hybrid cloud

- Public cloud
  - The physical resources used for cloud infrastructure are shared among the cloud customers
  - Proprietary or open source software and APIs
  - Amazon Web Services, Microsoft Azure, Google Cloud, Rackspace (OpenStack), etc.
- Private cloud
  - Physical cloud infrastructure completely dedicated for a company or organization
  - On-premise datacenter or remotely hosted
  - OpenStack, possibly behind commercial solution (e.g. Huawei Fusionsphere)
- Hybrid cloud
  - A combination of public cloud and private cloud, or dedicated hardware infrastructure
  - *The best of both worlds?*

PUBLIC AND PRIVATE CLOUD

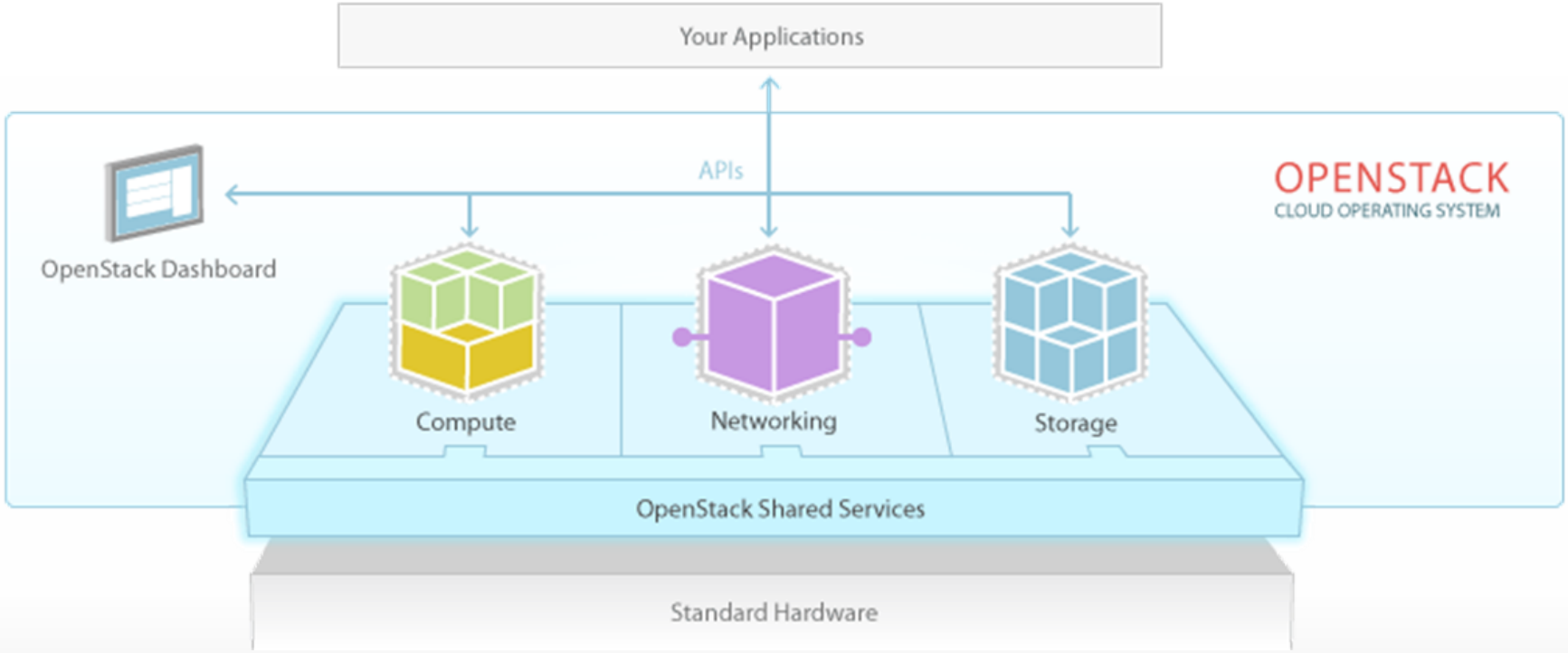
A brief comparison

	Public cloud	Private cloud
Popular solutions	Amazon Web Services (AWS) Microsoft Azure Google Cloud	**OpenStack**
Flexibility & scalability	Restricted to provided solutions Virtually endless resource scalability	You are in full control Bound by hardware limitations
Security	Specialists on board Shared physical environment with potential malicious users and speculative execution threats (Zombieload, Meltdown, etc.)	Open source community (or commercial solution) Knowledge & capabilities of the cloud administrators. In control of access control policies, no internal threats
Privacy (GDPR)	Privacy statement must mention sensitive data is stored/processed at a third party. Not a big issue for data centers inside EEA	Sensitive data is stored and processed within the organization itself (when deployed on-premise).
Availability	SLA at least 99,99% uptime (AWS) Multiple data centers and availability zones	Depends on the on-premise data center(s)
Cost	Pay as you go without upfront costs Not necessarily cheaper in the long term	Significant upfront cost for hardware (on-premise) Potentially cheaper TCO

OPENSTACK FOR PRIVATE CLOUD

What is OpenStack?

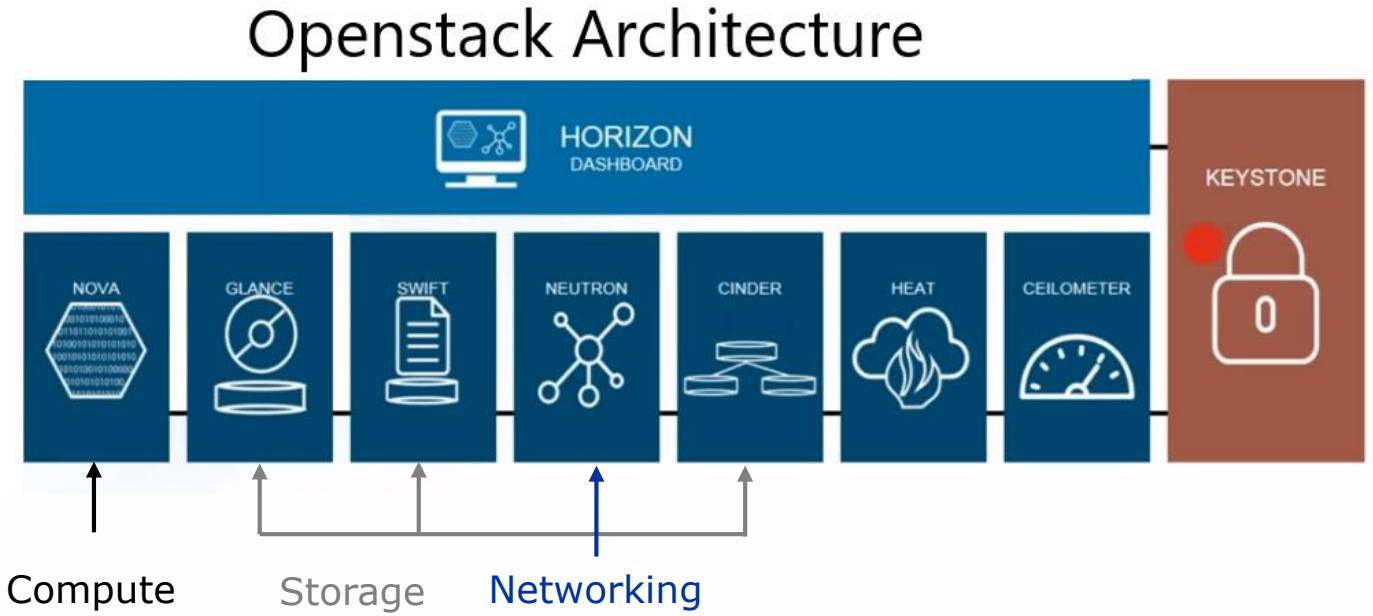
- OpenStack is an open source cloud environment developed for Infrastructure as a Service



OPENSTACK BUILDING BLOCKS

A brief introduction to the IaaS components

- **Compute**: Nova
- **Networking**: Neutron
- **Storage**:
  - Block storage: Cinder
  - Object storage: Swift
  - Instance storage: Glance
- Other services:
  - Authentication: Keystone
  - Graphical management interface: Horizon
  - Orchestration: Heat, Magnum
  - Metering: Ceilometer



OPENSTACK COMPUTE

Nova

- Nova instances are provisioned according to '**flavors**'
  - Number of virtual CPU cores
  - Amount of allocated RAM
  - Root disk storage capacity
  - Optional settings (I/O and network bandwidth limitations, PCIe passthrough, etc.)
- Nova functions as abstraction layer for underlying hypervisor
  - Default: **Kernel-based Virtual Machine (KVM)** via libvirt
  - Xen, QEMU and LXC via libvirt
  - VMware vSphere via VMware vCenter
  - Hyper-V
  - OpenStack ***Ironic*** allows provisioning bare-metal machines instead of virtual machines
- Public cloud counterpart (AWS): Elastic Compute Cloud (EC2)

OPENSTACK NETWORKING

Neutron

- (Virtual) Network configuration component
- Private subnets between compute instance groups
- Configuration of (Virtual) Routers to link private subnets with the Internet
- **Floating IP addresses** link public routable IPv4 addresses with instances in private subnets via DNAT
- **Security groups** provide firewall rules on in/outbound, src/dest IP addresses and TCP/UDP ports
- IPv6 is supported but not yet tested by us (IPv6 is a requirement for our IoT communication)
- Public cloud counterpart (AWS): Virtual Private Cloud (VPC)

OPENSTACK STORAGE

Cinder, Swift and Glance

- Block storage (Cinder)
  - Network-attached storage (default: iSCSI, optional NFS) for consistent low-latency I/O operations
  - Accessible as mounted volume within nova instances
  - Example: storage location of a database, file system with many write operations
  - Public cloud counterparts (AWS): Elastic Block Storage (EBS), Elastic File Storage (EFS)
- Object storage (Swift)
  - Particularly beneficial as a WORM (Write Once, Read Many) data store
  - Each object has a unique ID and can be accessed via API or URL.
  - Example: static content like media files, backups, versioned data files
  - Public cloud counterpart (AWS): Simple Storage Service (S3)
- Image storage (Glance)
  - Storage for virtual machine images and their metadata

OPENSTACK AS PAAS

Magnum

- OpenStack focusses on Infrastructure as a Service (IaaS)
  - This provides the foundation for Platform as a Service (PaaS)

- **Magnum** is OpenStack container orchestration engine
  - Supports Kubernetes, Docker Swarm and Apache Mesos

- Not yet investigated; will be reported in a next project meeting

- Public cloud counterparts (AWS): Elastic Beanstalk, Elastic Kubernetes Service (EKS), Elastic Container Service (ECS), Fargate, Lambda

DEPLOYING OPENSTACK

Releases, installation scripts and supported operating systems

- New Openstack versions are released ± every 6 months

SERIES	STATUS	RELEASE DATE
Ussuri	In development	2020-05-13 (estimate)
Train	Maintained	2019-10-16
Stein	Maintained	2019-04-10
Rocky	Maintained	2018-08-30

- Supported operating systems with OpenStack installation guides
  - Red Hat Enterprise Linux & CentOS
  - SUSE Linux Enterprise Server & openSUSE
  - Ubuntu (& Debian)
- DevStack & PackStack
  - Configurable installation scripts simplify deploying OpenStack environments