University of Zurich[UZH]

S^{3}IT: Services and Support for Science IT

IaaS Cloud (OpenStack) overview

Antonio Messina <antonio.messina@s3it.uzh.ch>

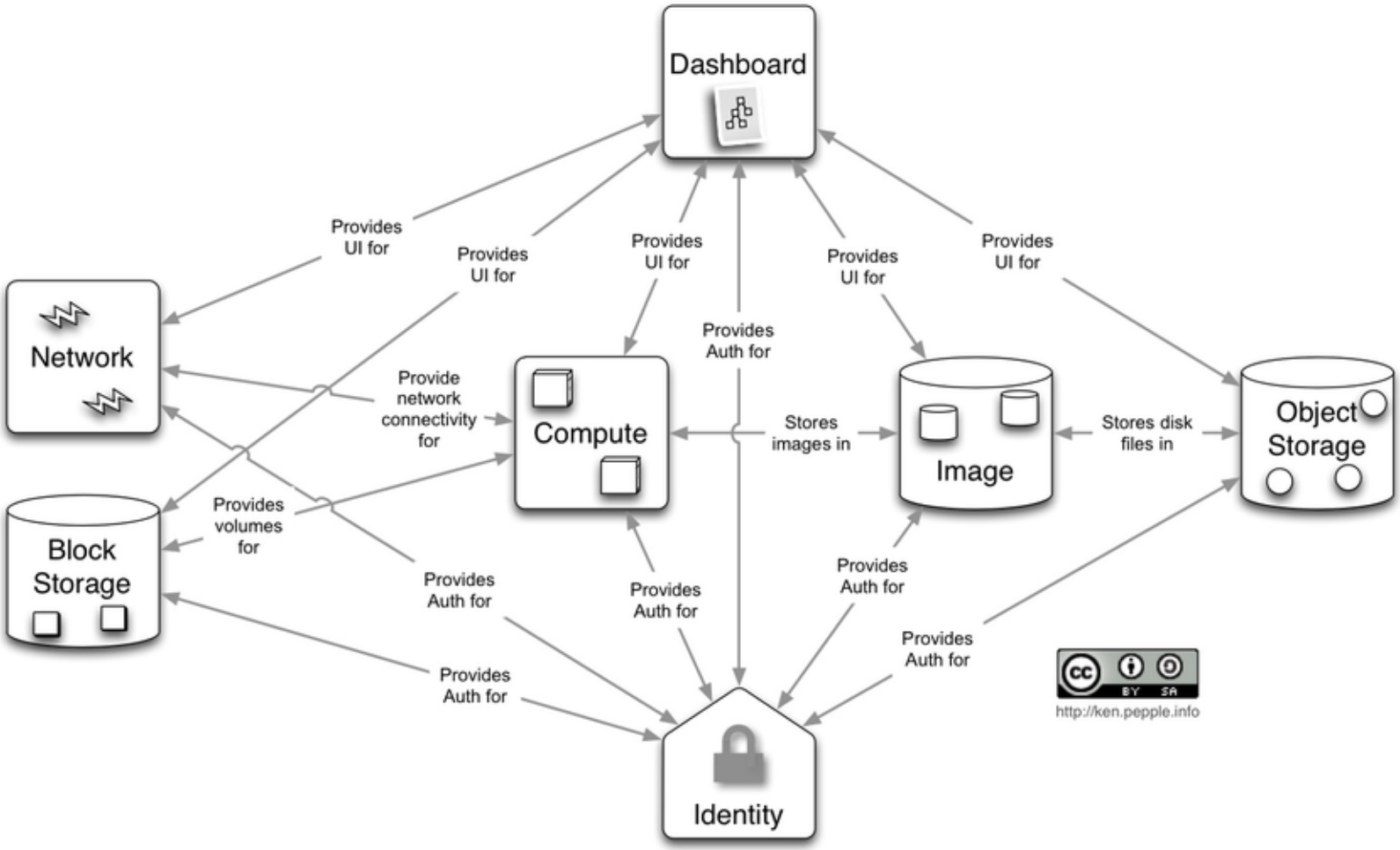
S^{3}IT - Services and Support for Science IT, University of Zurich

2 December 2015

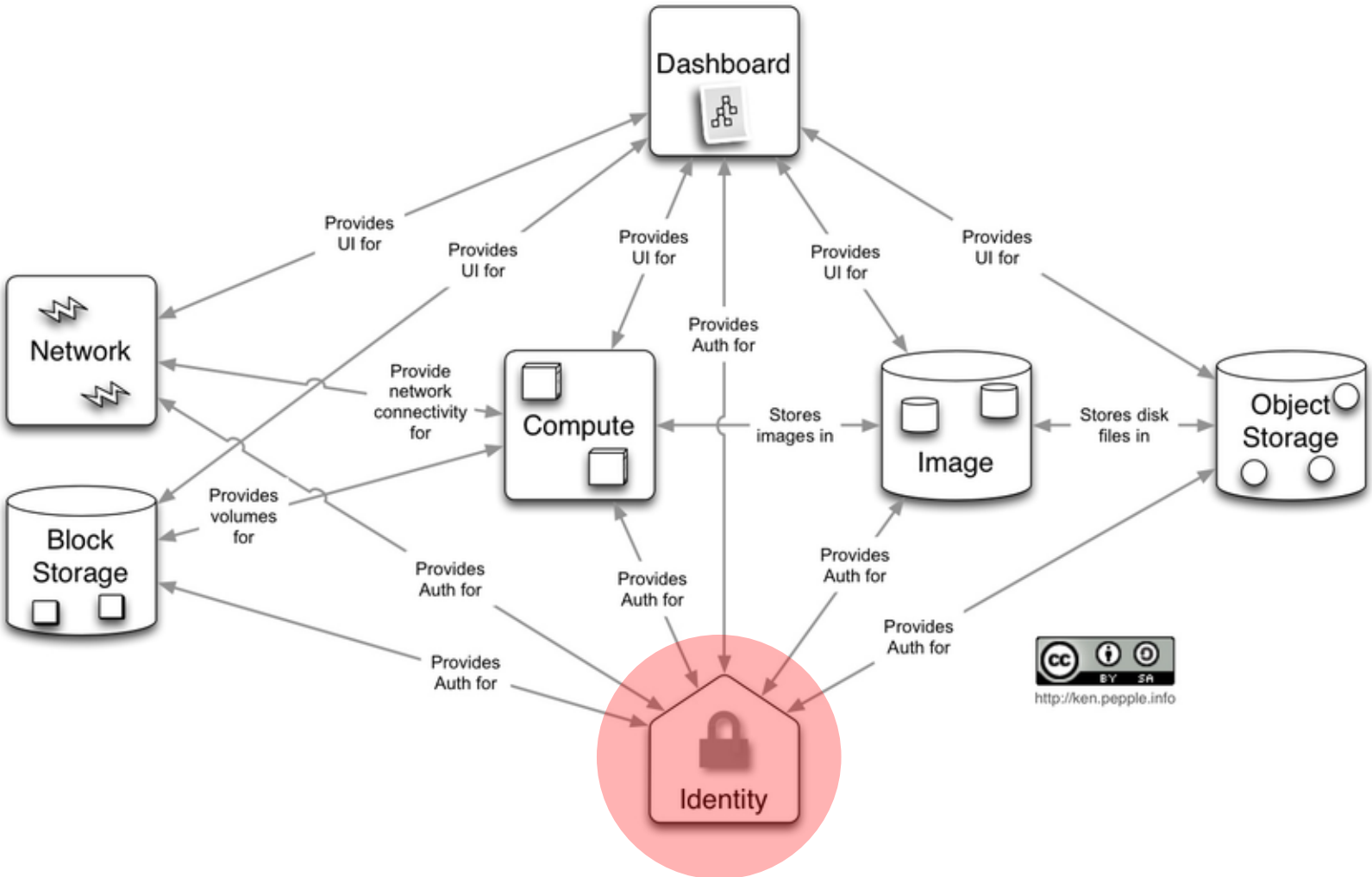
OpenStack Architecture

- written in Python (plus auxiliary shell scripts)
- built around **independent components**
- **highly distributed** architecture
  - designed for very big installations
- **intrinsic HA** of *most* OpenStack services (MySQL and RabbitMQ have to be properly configured)
- ***SQL** database used to store persistent data
- **RabbitMQ** used for RPC and notification
- **RESTful APIs** for all the services

OpenStack logical view

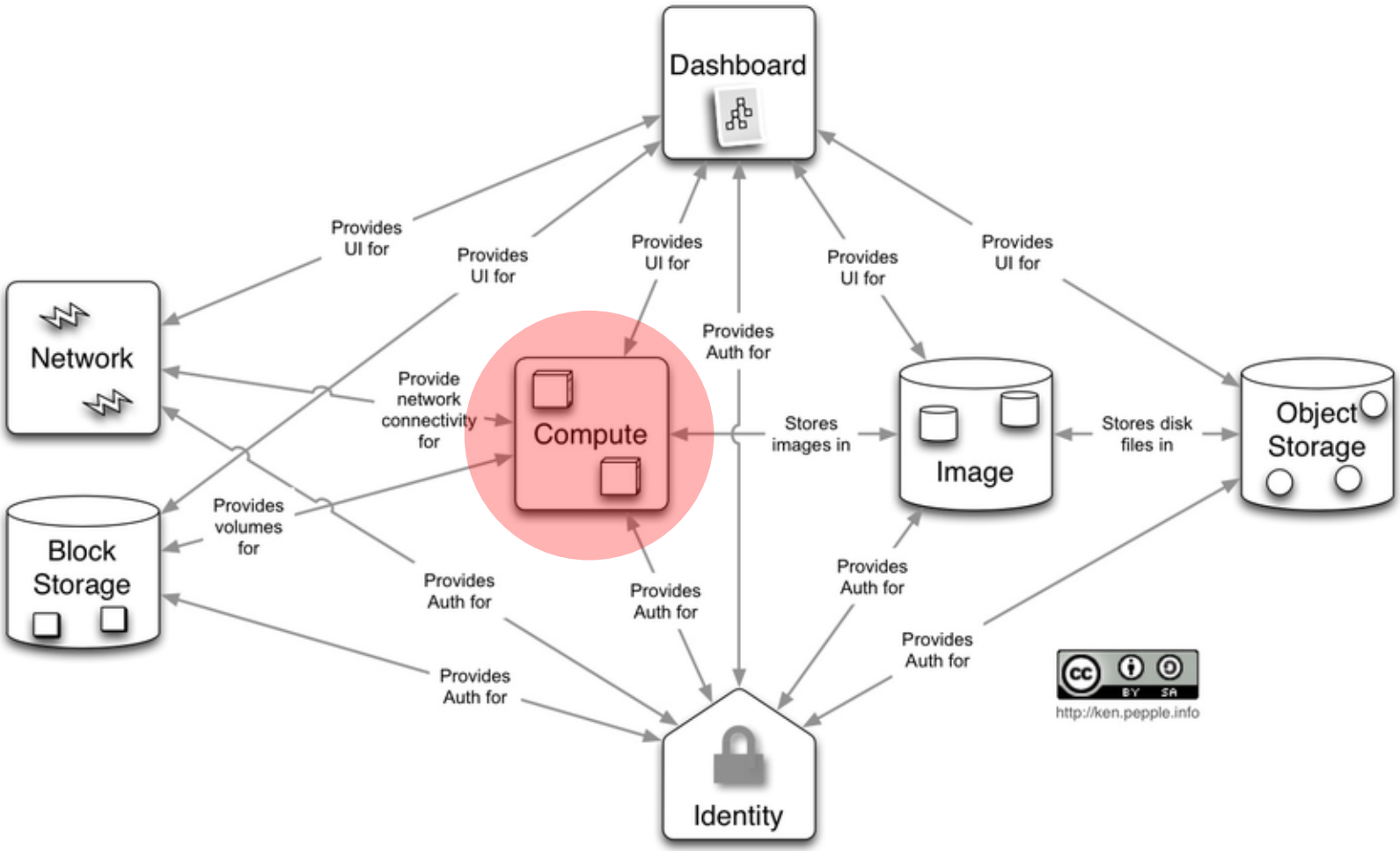


OpenStack logical view



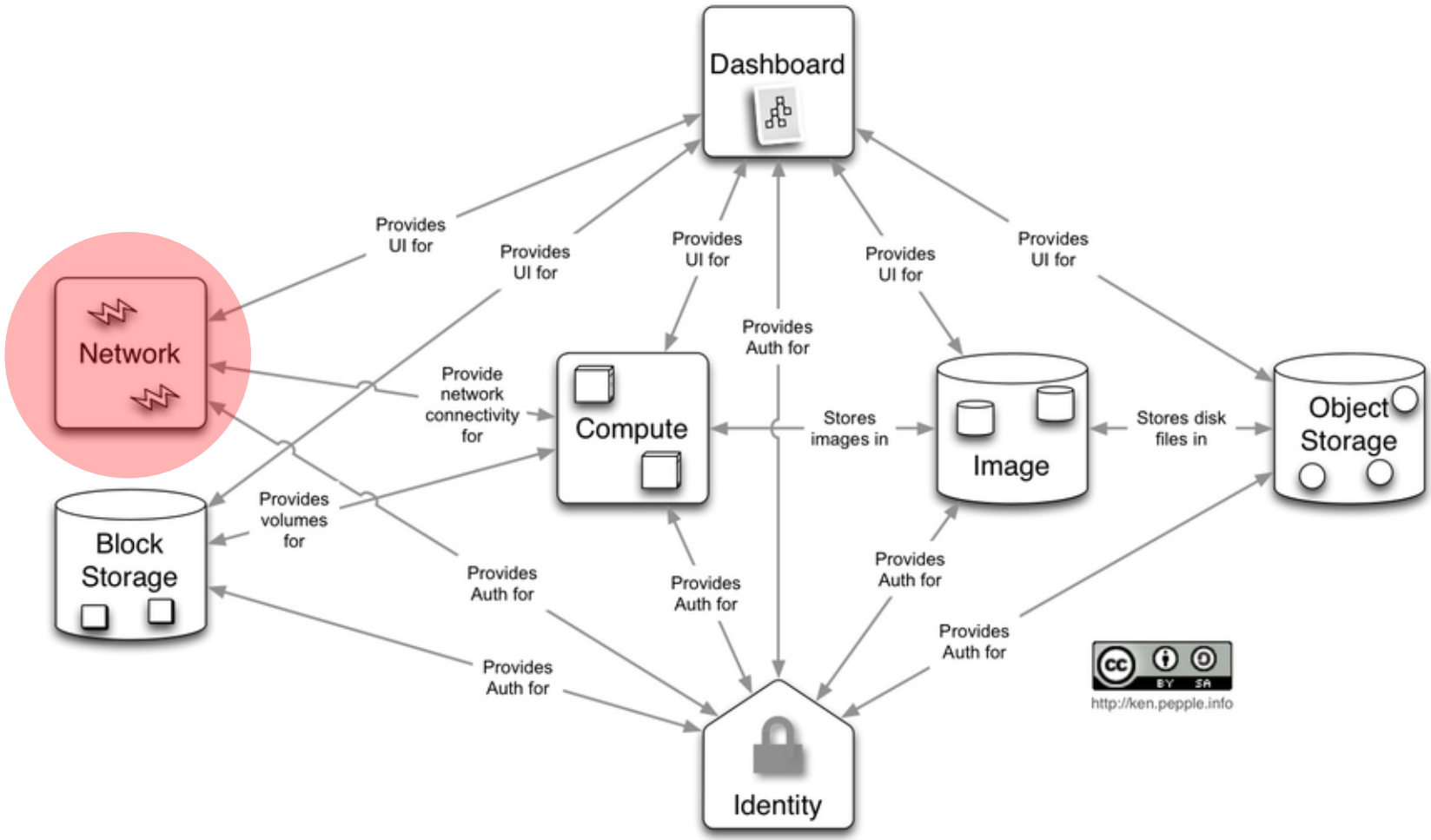
Keystone provides the authentication service

OpenStack logical view



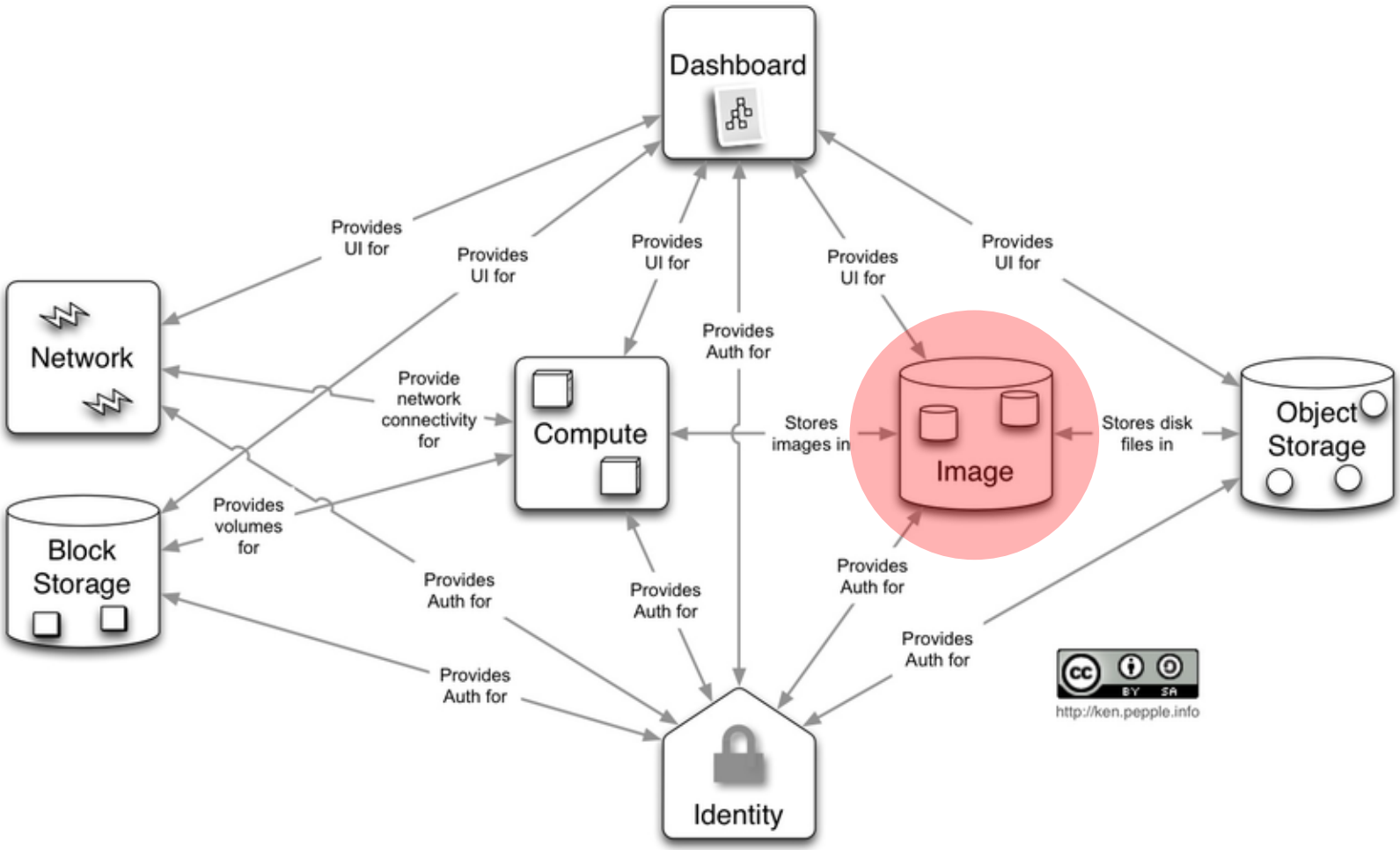
Nova provides computational services

OpenStack logical view



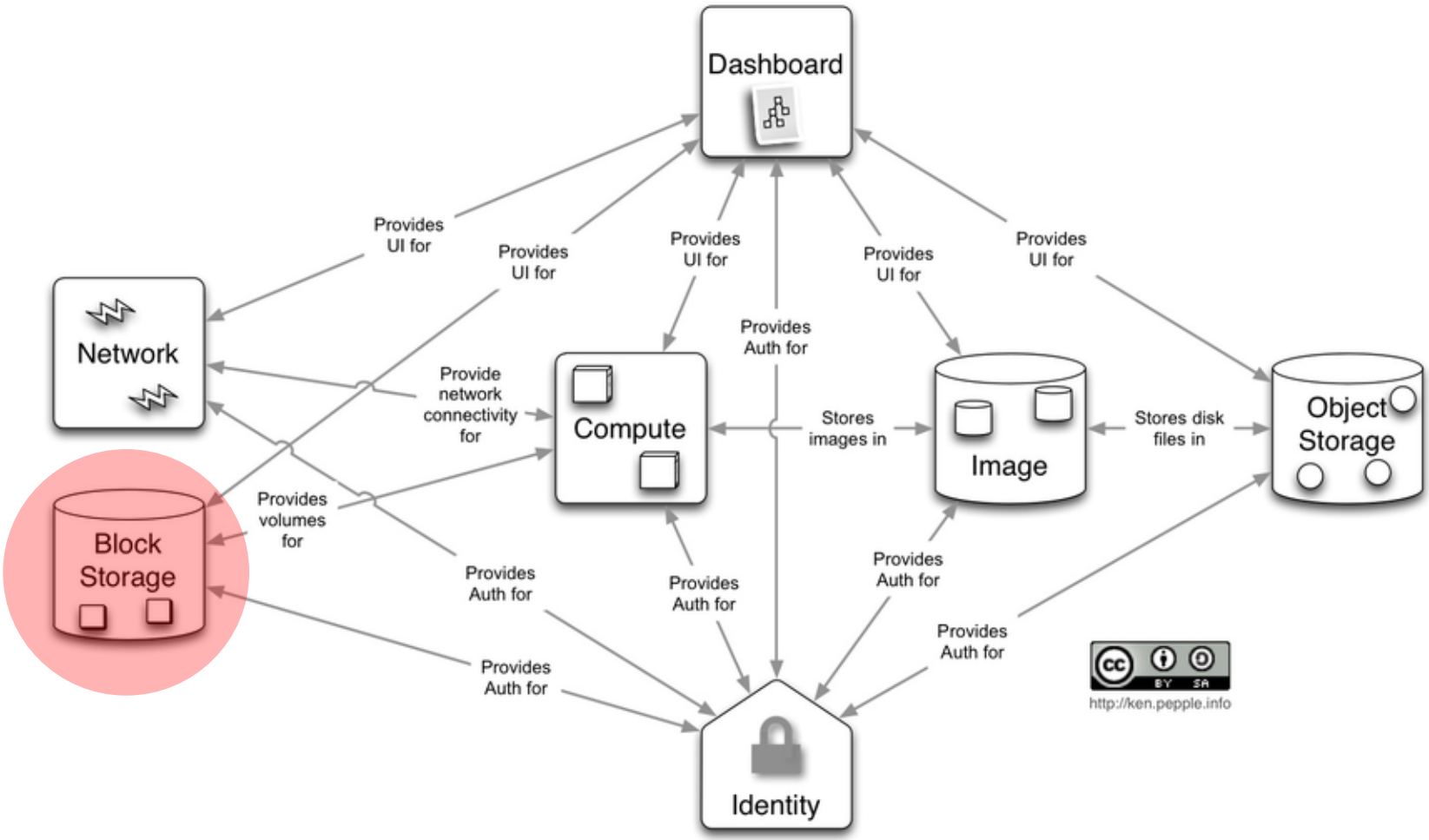
Neutron provides network services

OpenStack logical view



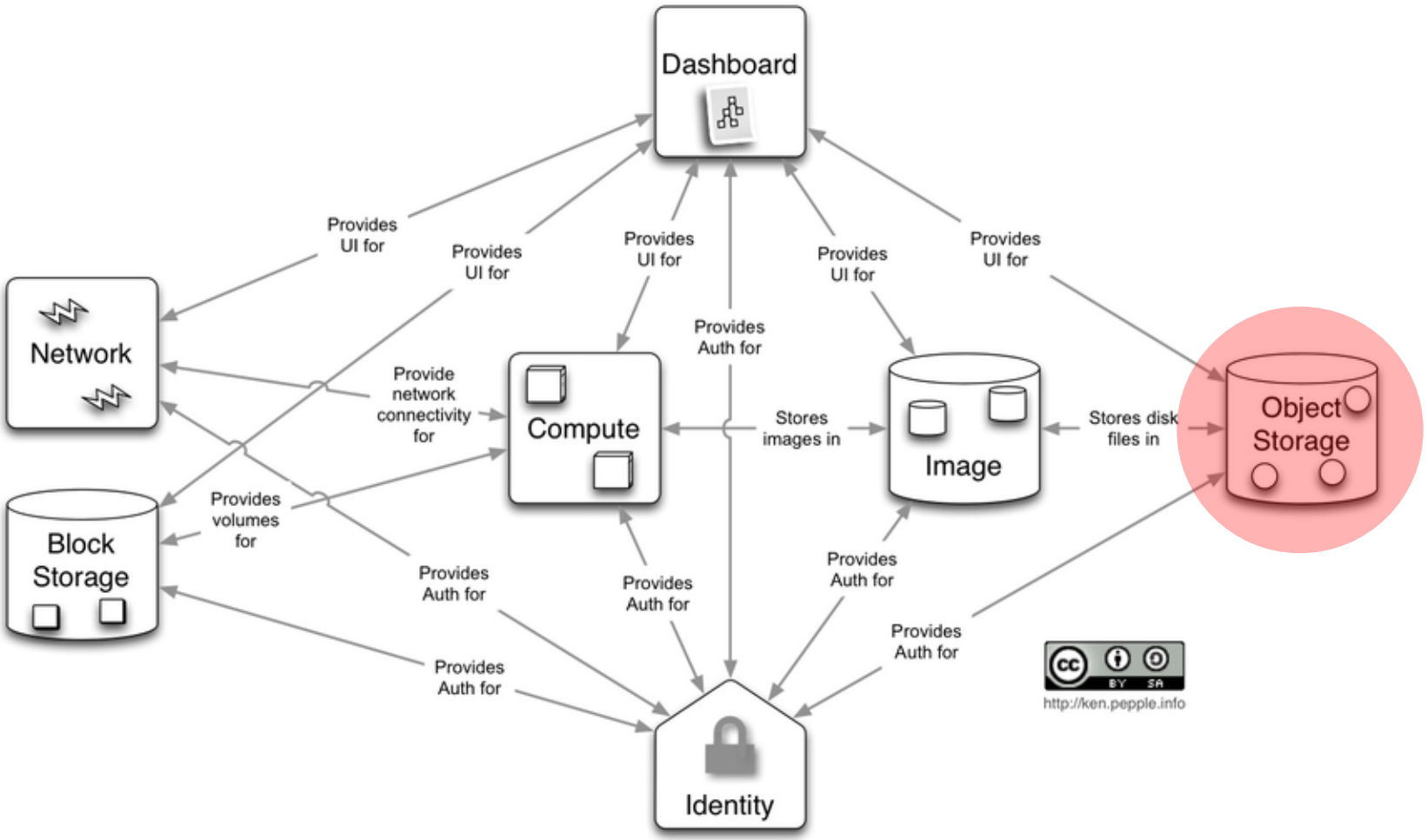
Glance provides image store

OpenStack logical view



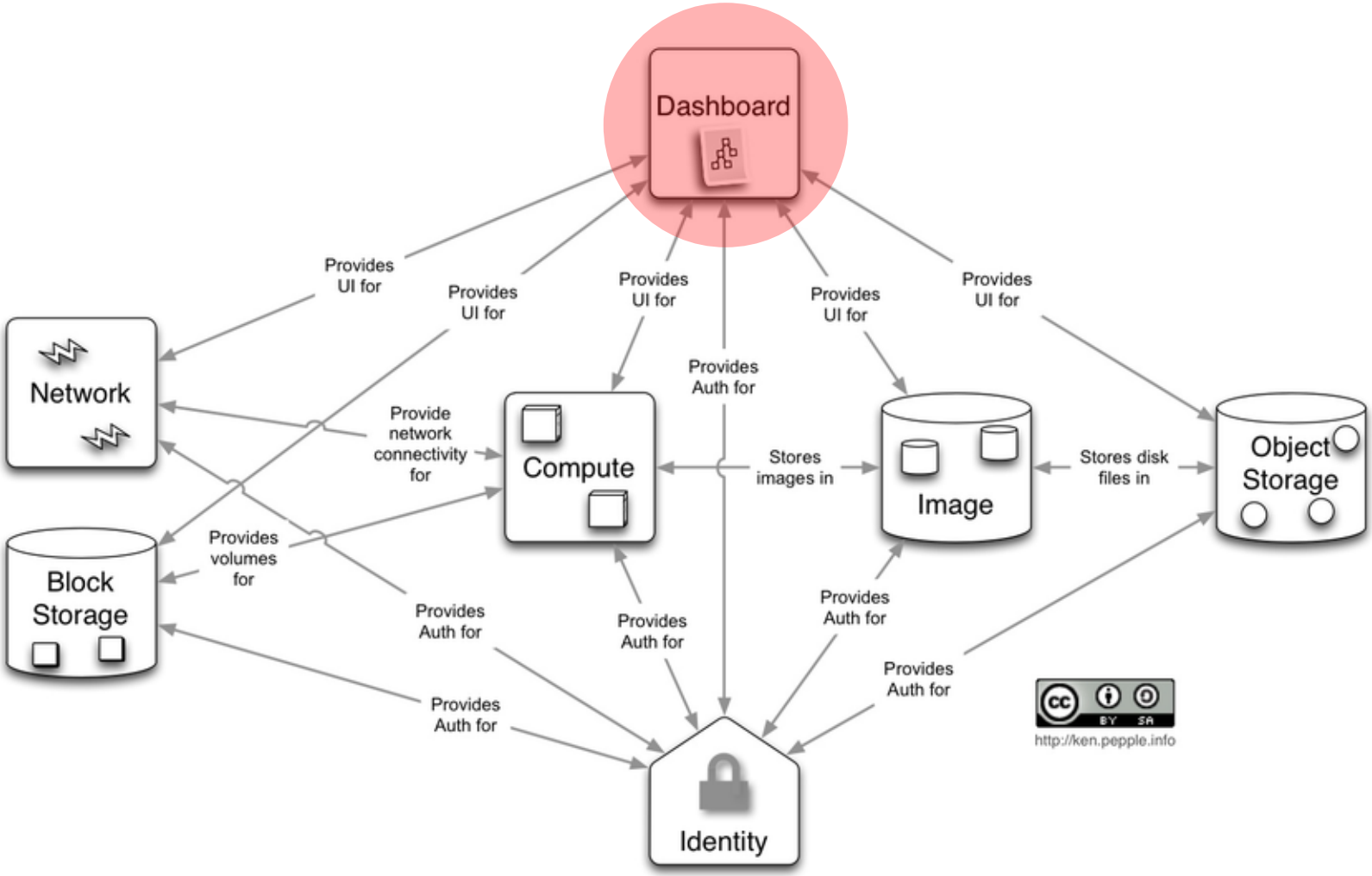
Cinder provides block persistent store

OpenStack logical view



Swift provides object persistent store

OpenStack logical view



Horizon provides web user interface

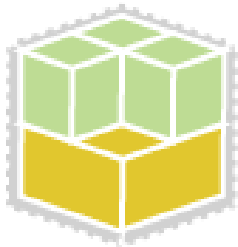
keystone - authentication service

- It's the **entry point** for OpenStack API.
- Stores authentication information (*users*, *passwords*, *tokens*, *projects*, *roles*)
- Holds a catalog of available services and their endpoints.
- Can use different backends (SQL database, LDAP)
- Supports concept of *domains* and Federation

keystone & AAA

- An **User** authenticates against Keystone with login and password and gets a **token**
- API nodes accepts the token and check its validity with **keystone**
- Every API service has a `policy.json` file to define the authorization
- **Project/tenant** (group of *trusted* users)
- **Role**: mapping between an user and a project
  - **admin** is the *Cloud* administrator
  - **_member_** is a *regular* member
  - others can be created (need to customize `policy.json`)

nova - compute service



Service responsible of managing virtual instances.

nova-api Web API frontend, accepts requests, validates them and contact other services if needed.

nova-scheduler decides where to start an instance

nova-compute running on each compute node, interacts with the hypervisor and actually starts the vm.

nova - less known services

nova-conductor RPC server for nova: basically a proxy for the SQL database.

nova-novncproxy provides http access to the VNC console

nova-consoleauth manages tokens used to authenticate to the vnc console

nova-cert only needed for EC2 APIC

nova - notes on scheduling

- *"FIFO"* scheduler with filters and weight
- can take decisions based on
  - available cpus/ram/disk
  - availability zones
  - image properties
  - hypervisor capabilities
  - aggregate metadata
  - iops
- Can take *hints* from the client
- Manage resource oversubscription
- *scheduling* problems can be hard to debug (`No valid host was found`)

glance - image service

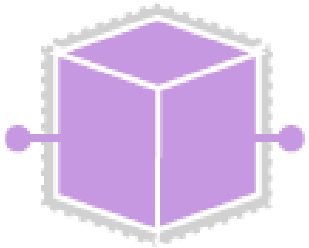
Service responsible of storing image informations and, optionally, image files.

- Holds information about available images.
- Optionally allow to download and upload images.
- Images can be stored on **different backends** (RDB, S3, Swift, filesystem)

glance-api main API service

glance-registry v1.0 metadata api

neutron - network service



Service responsible of creating and managing networks. It is supposed to replace.

Still not widely used, but very feature rich.

- L2 and L3 networks.
- Allow creation of multiple networks and subnets.
- Plugin architecture.
- Supports advanced network services (Load Balancer, Firwall, DNS as a service)
- Integrates with network devices (Cisco, Brocade. . .)

cinder - block storage

- Creates and export volumes via iSCSI to the compute node.
- Volumes are mounted **transparently** from the virtual machines.
- Supports **multiple storage backends** (NFS, LVM, Ceph, GlusterFS but also SAN/NAS devices from IBM, NetApp etc. . .)

composed of **multiple services**:

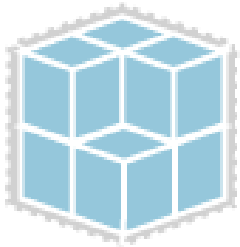
cinder-api Web API frontend.

cinder-volume Manages block storage devices. You can have many of these.

cinder-scheduler Decides which cinder-volume has to provide the volume for an instance.

cinder-backup optinal service to raw copy a volume to a different location (e.g. Swift or Tivoli)

swift - object storage



Distributed Object Storage service
(*not covered in this worhsop*)

- Redundant, scalable object storage on commodity hardware.
- Not a POSIX filesystem.
- Scales horizontally
- Data locality
- Multi region, georeplication
- (very simple architecture!)
- **AP** in the CAP Theorem

It's not the only choice: **Ceph**, **GlusterFS** and others can be used instead.

Life of a virtual machine

1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
2. **nova-api** is contacted and a new request is created:
3. **nova-scheduler** find an appropriate host
4. **nova-compute** reads the request and start an instance:
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
6. **neutron** configure the network
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Life of a virtual machine

1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
   1.1 keystone is contacted and authentication is performed
   1.2 a **token** is saved in the database and returned to the client to be used with later interactions with OpenStack services for this request.
2. **nova-api** is contacted and a new request is created:
3. **nova-scheduler** find an appropriate host
4. **nova-compute** reads the request and start an instance:
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
6. **neutron** configure the network
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Life of a virtual machine

1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
2. **nova-api** is contacted and a new request is created:
   - 2.1 checks via **keystone** the validity of the token
   - 2.2 checks the authorization of the user
   - 2.3 validates parameters and create a new request in the database
   - 2.4 calls the scheduler via queue
3. **nova-scheduler** find an appropriate host
4. **nova-compute** reads the request and start an instance:
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
6. **neutron** configure the network
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Life of a virtual machine

1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
2. **nova-api** is contacted and a new request is created:
3. **nova-scheduler** find an appropriate host
   - 3.1 reads the request
   - 3.2 find an appropriate host via filtering and weighting
   - 3.3 calls the chosen **nova-compute** host via queue
4. **nova-compute** reads the request and start an instance:
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
6. **neutron** configure the network
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Life of a virtual machine

1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
2. **nova-api** is contacted and a new request is created:
3. **nova-scheduler** find an appropriate host
4. **nova-compute** reads the request and start an instance :
   - 4.1 generates a proper configuration for the hypervisor
   - 4.2 get image URI via image id
   - 4.3 download the image
   - 4.4 request to allocate network via queue
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
6. **neutron** configure the network
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Life of a virtual machine

1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
2. **nova-api** is contacted and a new request is created:
3. **nova-scheduler** find an appropriate host
4. **nova-compute** reads the request and start an instance:
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
   - 5.1 gets connection parameters from cinder
   - 5.2 uses iscsi to make the volume available on the local machine
   - 5.3 asks the hypervisor to provision the local volume as virtual volume of the specified virtual machine
6. **neutron** configure the network
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Life of a virtual machine

1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
2. **nova-api** is contacted and a new request is created:
3. **nova-scheduler** find an appropriate host
4. **nova-compute** reads the request and start an instance:
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
6. **neutron** configure the network
   - 6.1 allocates a valid private ip
   - 6.2 configures the host as needed (dnsmasq, iptables, Open VSwitch. . .)
   - 6.3 updates the request status
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Life of a virtual machine

1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
2. **nova-api** is contacted and a new request is created:
3. **nova-scheduler** find an appropriate host
4. **nova-compute** reads the request and start an instance:
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
6. **neutron** configure the network
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Life of a virtual machine

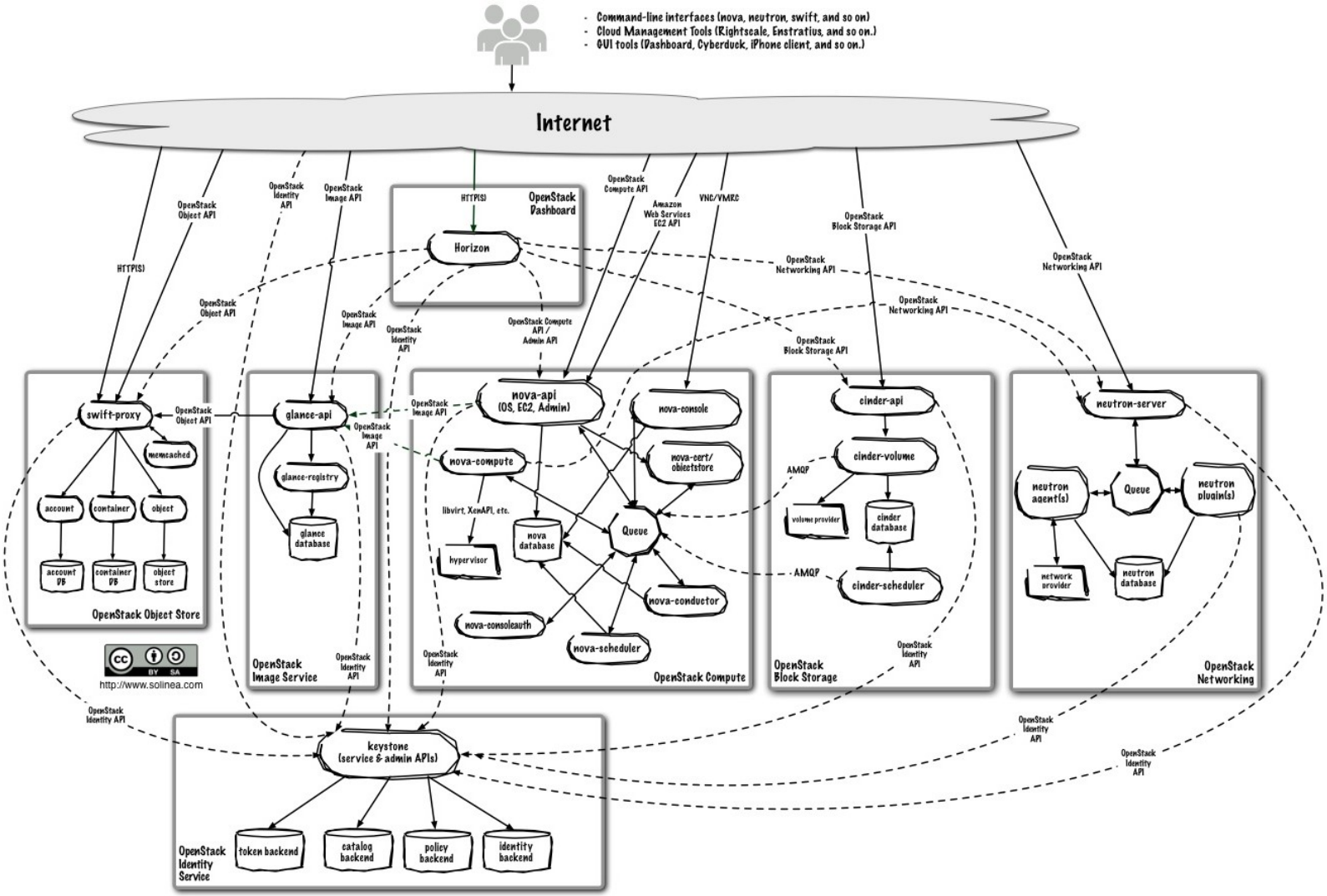
1. Authentication is performed either by the web interface **horizon** or **nova** command line tool:
2. **nova-api** is contacted and a new request is created:
3. **nova-scheduler** find an appropriate host
4. **nova-compute** reads the request and start an instance:
5. **nova-compute** contacts **cinder** to provision the volume (if needed)
6. **neutron** configure the network
7. **nova-compute** starts the virtual machine
8. **horizon/nova** poll **nova-api** until the VM is ready.

Notes on installation

- Please, please, please, use a **deployment and configuration manager**. There are many: Puppet, Chef, CFEngine, Ansible, SaltStack... Just pick the one you like most.
- Do not underestimate the **complexity** of the system.
- Plan in advance, and **plan for failures**.
- RTFM: the OpenStack website is now plenty of documentation[1]
  - Install Guide (for Ubuntu 12.04/14.04)
  - Architecture Design Guide
  - Cloud Administrator Guide
  - Training guide
  - Operations Guide
  - High Availability Guide
  - Security Guide

[1] it wasn't like this 2 years ago...

OpenStack software overview



OpenStack software overview

Other OpenStack services

Projects **integrated** in Icehouse:

- Ceilometer (Metering)
- Heat (Orchestration)
- Trove (Database as a service)
- Sahara (Data Processing - Hadoop)

Projects in **incubation**:

- Ironic (Bare metal provisioning)
- Zaqar (aka *Marconi*) (Messaging service)
- Barbican (Secure storage of secrets)
- Designate (DNSaaS)
- TripleO (OpenStack-on-OpenStack)