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DIVIDE AND CONQUER:

RESOURCE SEGREGATION IN THE OPENSTACK CLOUD

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Why segregate resources?

- Infrastructure
  - Expose logical groupings of infrastructure based on physical characteristics
  - Expose logical groupings of infrastructure based on some abstract functionality/capability
  - “More-massive” horizontal scalability

Why segregate resources?

- Infrastructure
  - Expose logical groupings of infrastructure based on physical characteristics
  - Expose logical groupings of infrastructure based on some abstract functionality/capability
  - “More-massive” horizontal scalability
- Workloads
  - Ensure an even spread of a single workload
  - Ensure close placement of related workloads

Segregation in datacenter virtualization

- Infrastructure segregation:
  - Logical data center constructs
    - Contain some number of logical clusters
    - Clusters typically:
      - Are relatively small (0's to 00's of nodes per cluster)
      - Are tightly coupled to physical storage and network layout
- Workload segregation:
  - Host-level affinity/anti-affinity
  - CPU-level affinity/anti-affinity (pinning)

Segregation in an elastic cloud

- Amazon EC2:
  - Infrastructure segregation:
    - Regions – Separate geographic areas (e.g. us-east-1)
    - Availability Zones – Isolated locations within a region (e.g. us-east-1a)
  - Workload segregation:
    - Placement Groups – Workload affinity within an availability zone

Segregation in an elastic cloud

- Amazon EC2:
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  - Workload segregation:
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- OpenStack:
  - Overloads some of these terms (and more!)
  - Application is more flexible for deployers and operators

Segregation in an elastic cloud

- Wait a second...weren't we moving to the cloud to hide all this infrastructure stuff from the user?

Segregation in an elastic cloud

- Wait a second...weren't we moving to the cloud to hide all this stuff from the user?
  - Yes!
- Users and applications demand **some** visibility of:
  - Failure domains
  - Premium features
- Deployers and operators determine the level of granularity exposed.

Segregation in OpenStack

- Infrastructure segregation:
  - Regions
  - Cells
  - Host aggregates
  - Availability zones

Segregation in OpenStack

- Infrastructure segregation:
  - Regions
  - Cells
  - Host aggregates
  - Availability zones
- Workload segregation:
  - Server groups

REGIONS AND CELLS

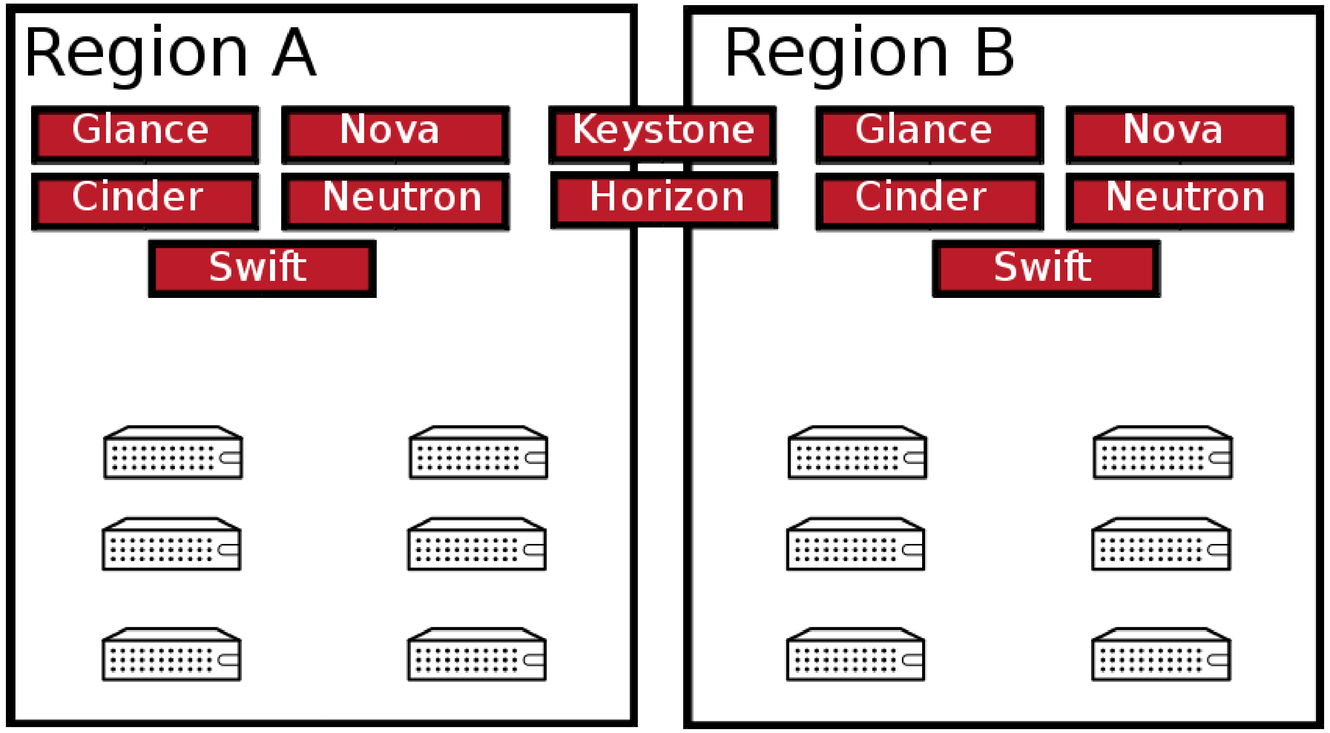
Regions

- Complete OpenStack deployments
  - Share at least a ~~Keystone and~~ Horizon installation
  - Implement their own targetable API endpoints
- In default deployment all services in one region – 'RegionOne'.
- New regions are created using Keystone:
  - `$ keystone endpoint-create --region “RegionTwo”`

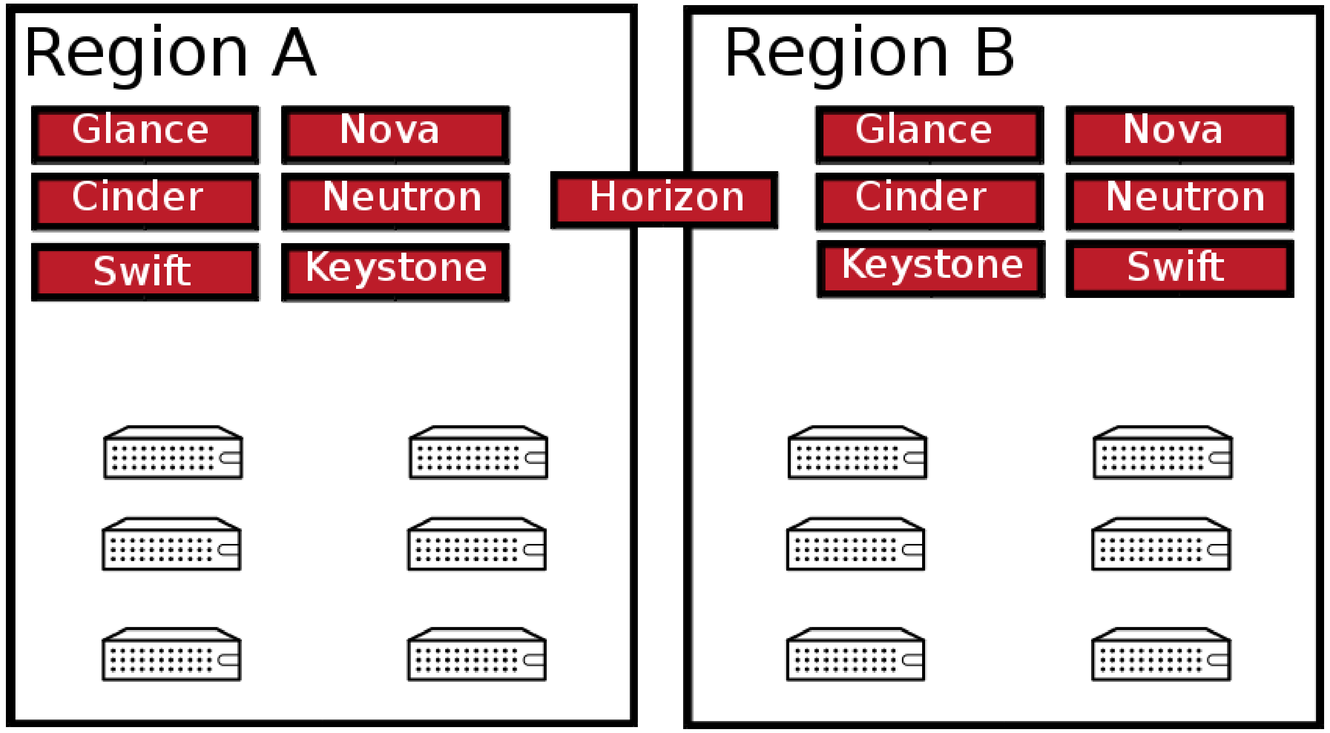
Regions

- Target actions at a region's endpoint (mandatory):
  - CLI:
    - $ nova --os-region-name “RegionTwo” boot …
  - Horizon:

Regions


Region A
Glance
Nova
Cinder
Neutron
Swift
Keystone
Horizon
Region B
Glance
Nova
Cinder
Neutron
Swift

Regions


Region A
Glance
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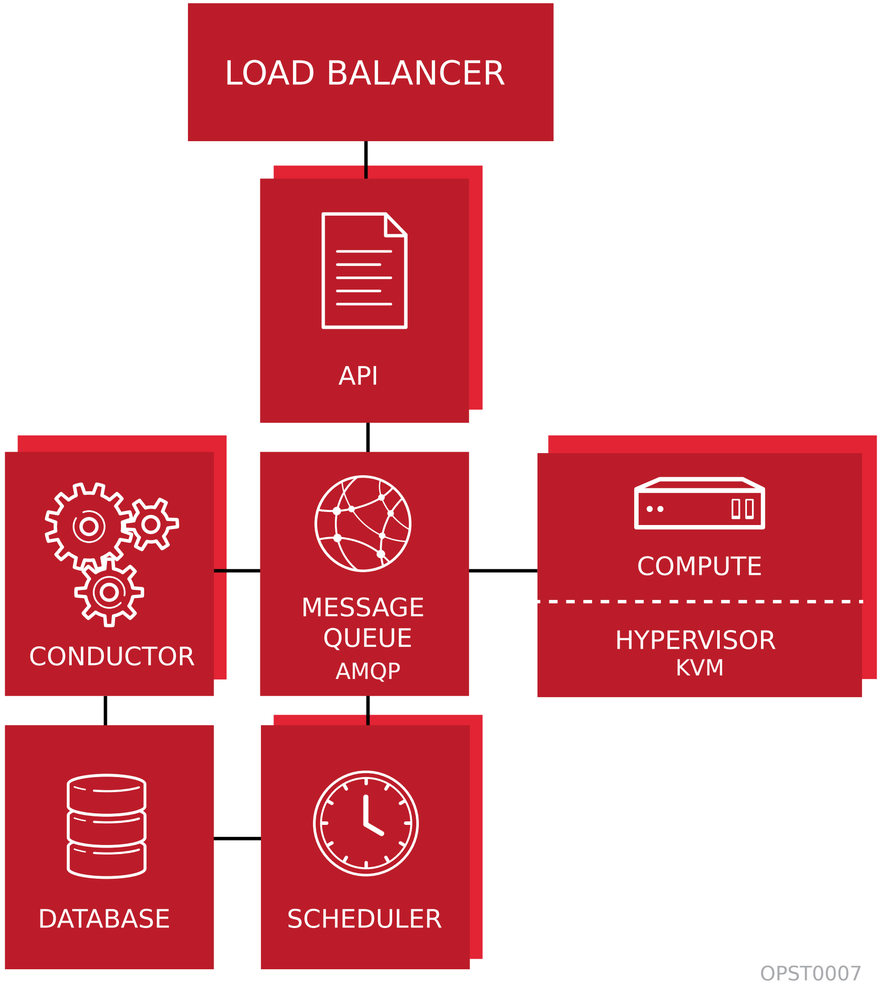
Swift

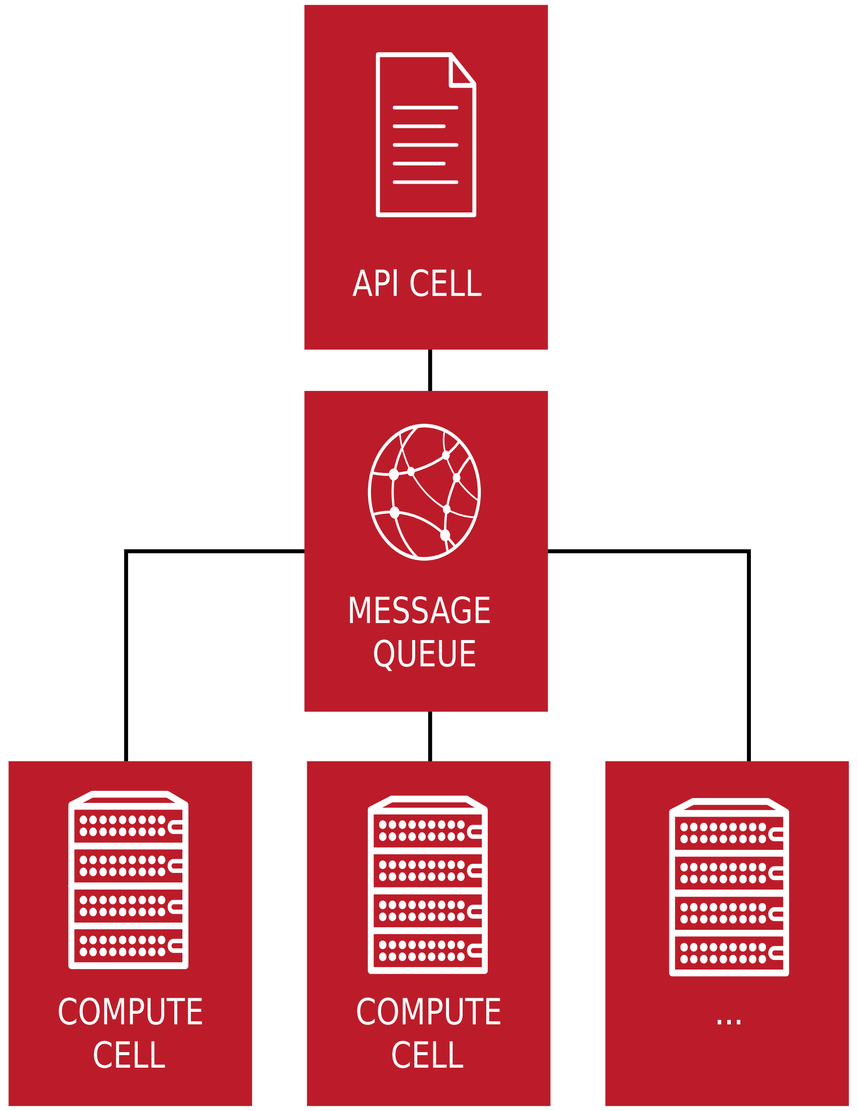
Cells

- Standard (simplified) compute deployment without Cells:



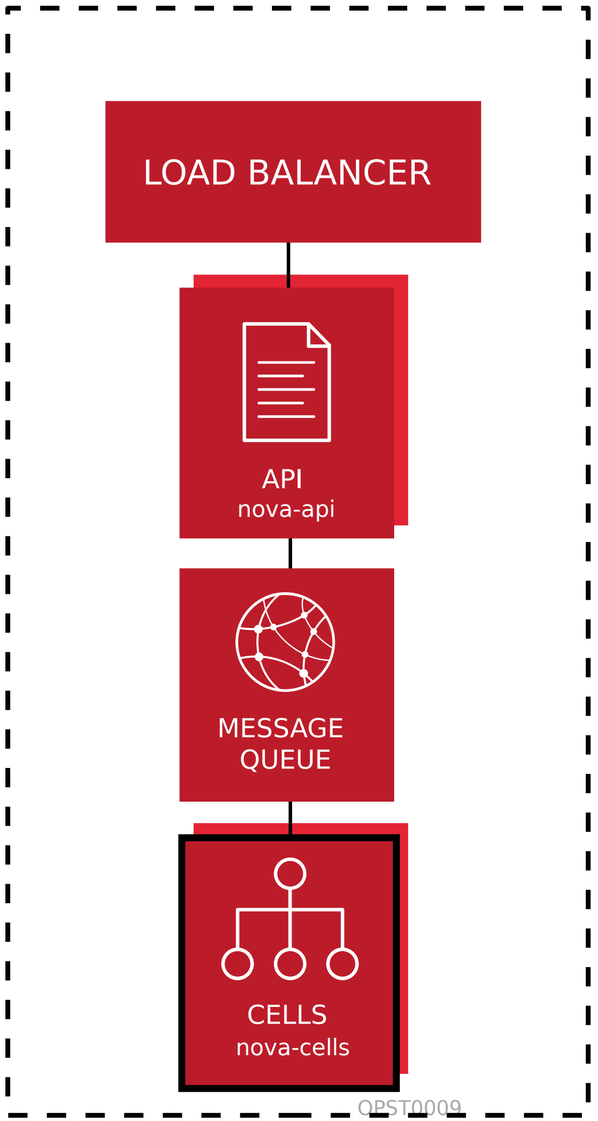
Cells

- Maintains a single compute endpoint
- Relieve pressure on queues database at scale (000's of nodes)
- Introduces the cells scheduler



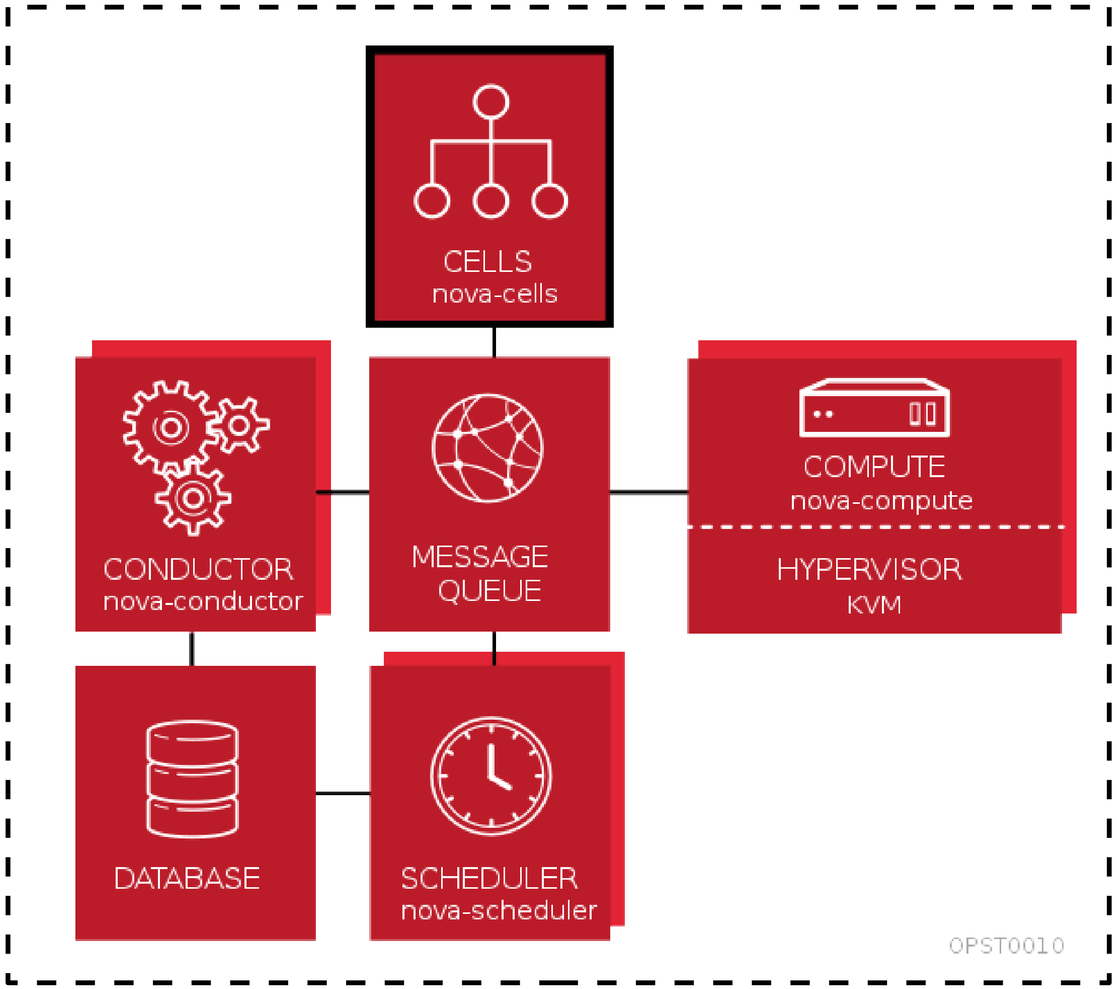
API (parent) cell

- Adds a load balancer in front of multiple instances of the API service
- Has its own message queue
- Includes a new service, **nova-cells**
  - Handles cell scheduling
  - Packaged as **openstack-nova-cells**
  - Required in every cell



Compute (child) cell

- Each compute cell contains:
  - Its own message queue and database
  - Its own scheduler, conductor, compute nodes



Common cell configuration

- Setup database and message broker for each cell
- Initialize cell database using nova-manage
- Optionally:
  - Modify scheduling filter/weight configuration for cells scheduler
  - Create cells JSON file to avoid need to avoid reloading from database

API (parent) cell configuration

- Nova.conf:
  - Change compute_api_class
  - Enable cells
  - Name the cell
  - Enable and start nova-cells

Compute (child) cell configuration

- nova.conf
  - Disable quota driver
  - Enable cells
  - Name the cell
  - Enable and start nova-cells

Cells pitfalls

- That all sounds pretty good – sign me up!
- Lack of “cell awareness” in other projects
- Minimal test coverage in the gate
- Some standard functionality currently broken with cells:
  - Host aggregates
  - Security groups

So how do they stack up?

Regions

- Supported by all services
- Separate endpoints
- Exist above scheduling
- Linked via REST APIs

Cells

- Supported by compute
- Common endpoint
- Additional scheduling layer
- Linked via RPC

HOST AGGREGATES AND AVAILABILITY ZONES

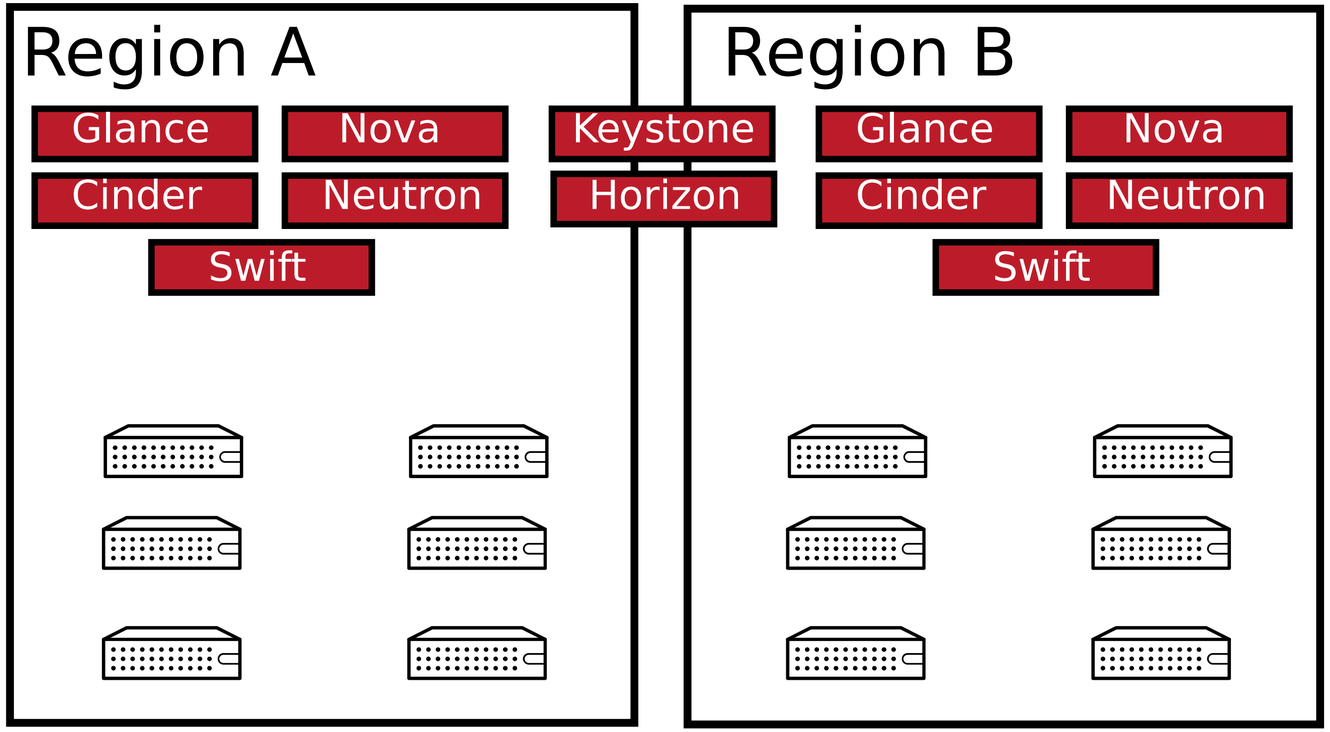
Host aggregates

- Logical groupings of hosts based on metadata
- Typically metadata describes special capabilities hosts share:
  - Fast disks for ephemeral data storage
  - Fast network interfaces
  - Etc.
- Hosts can be in multiple host aggregates:
  - “Hosts that have SSD storage and GPUs”

Host aggregates

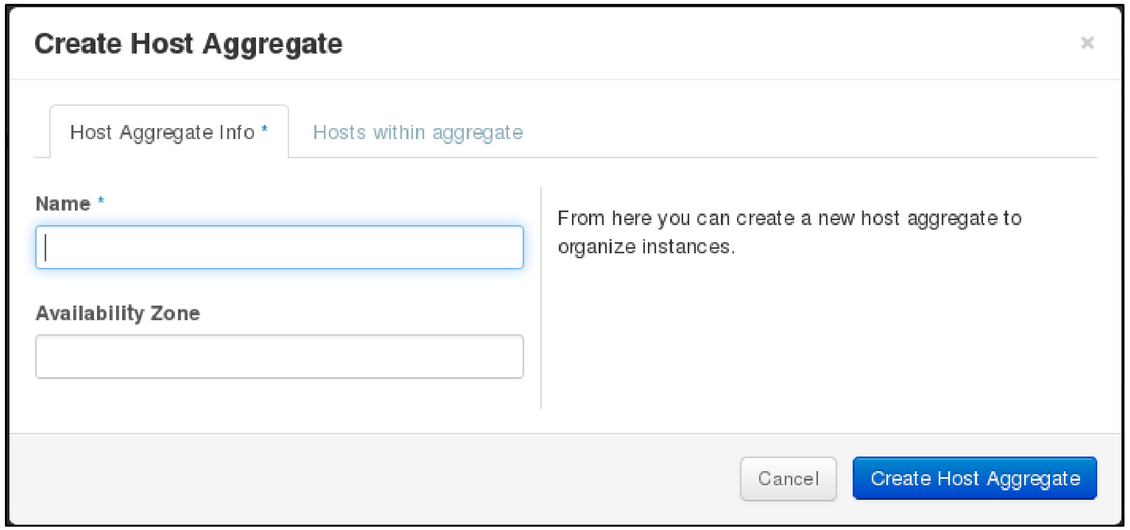
- **Implicitly** user targetable:
  - Admin defines host aggregate with metadata, and a flavor that matches it
  - User selects flavor with extra specifications when requesting instance
  - Scheduler places instance on a host in a host aggregate that matches (extra specifications to metadata)
  - User explicitly targets a capability, not an aggregate

Host aggregates (example)



Host aggregates (example)

- Create host aggregates:
  - `$ nova aggregate-create storage-optimized`
  - `$ nova aggregate-create network-optimized`
  - `$ nova aggregate-create compute-optimized`



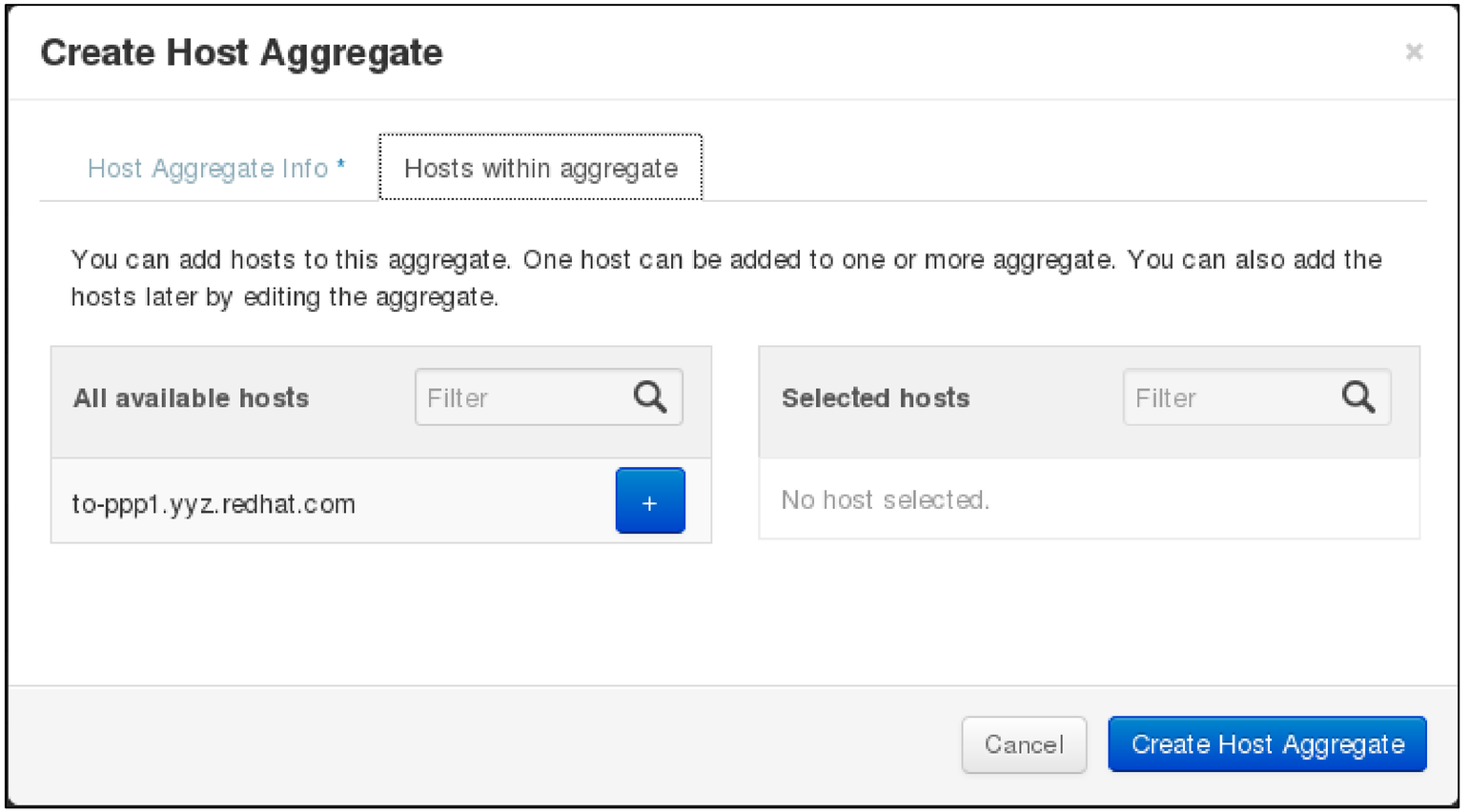
Host aggregates (example)

```
-$ nova aggregate-set-metadata 1 fast-storage=true
-$ nova aggregate-set-metadata 2 fast-network=true
-$ nova aggregate-set-metadata 3 high-freq-cpu=true
```

Host aggregates (example)

- Populate the aggregates:
  - `$ nova aggregate-add-host 1 host-1`
  - `$ nova aggregate-add-host 1 host-2`
  - `...`

Host aggregates (example)



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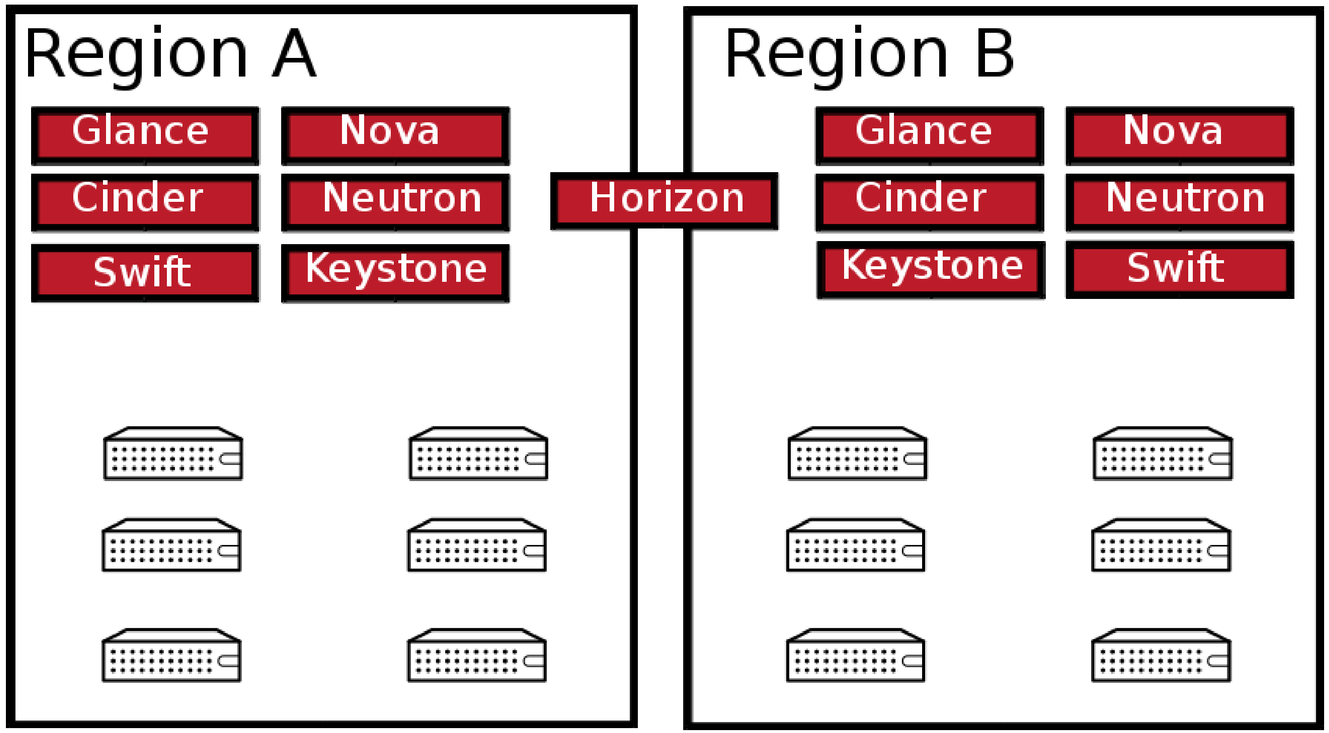

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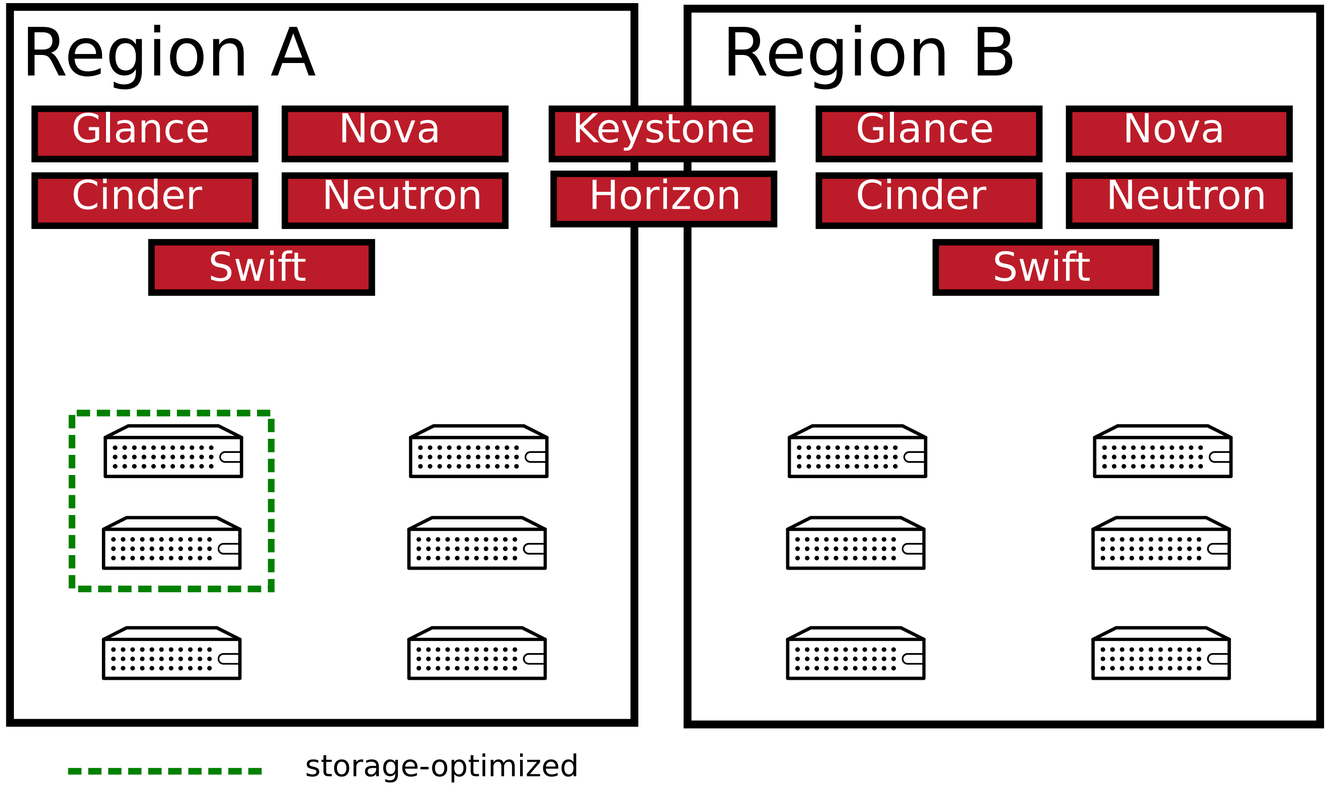

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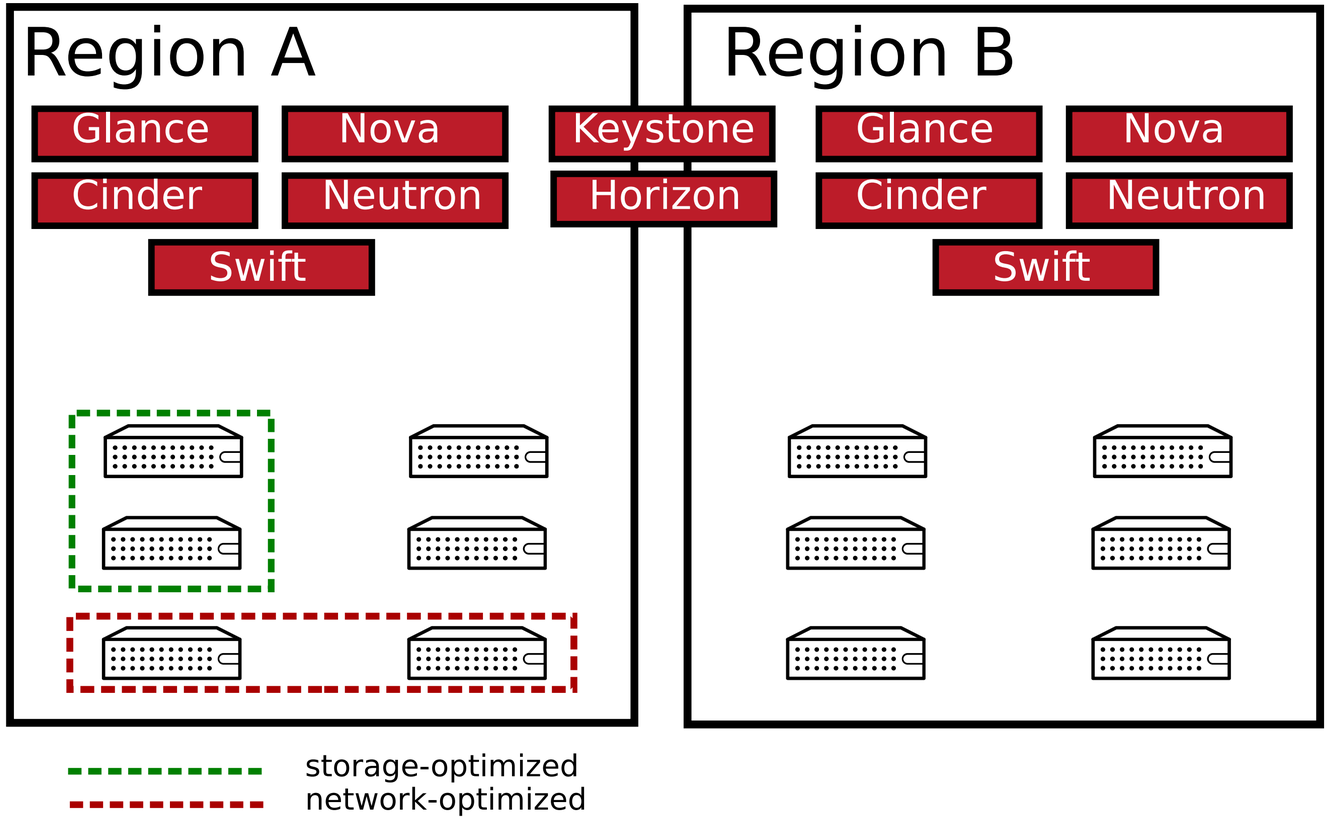

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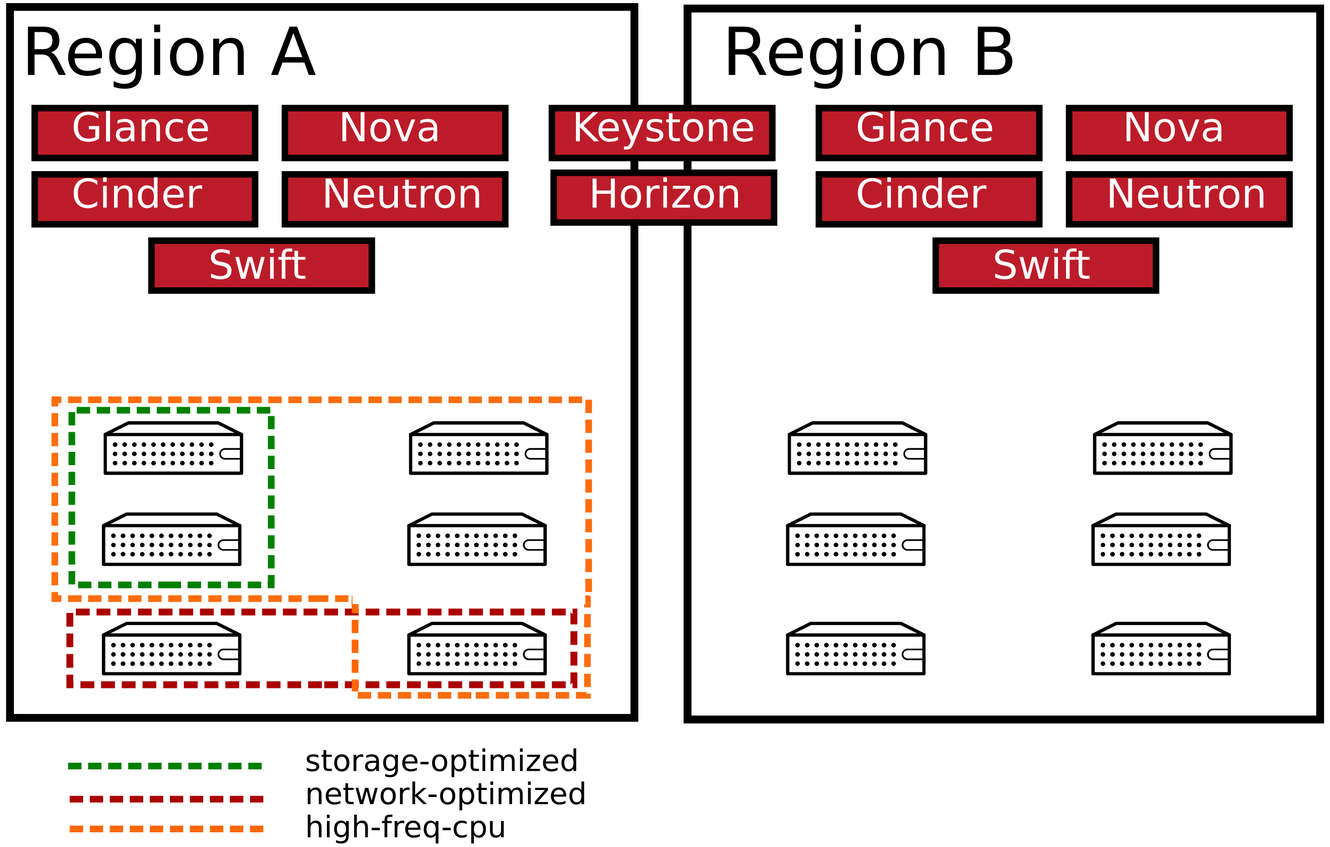
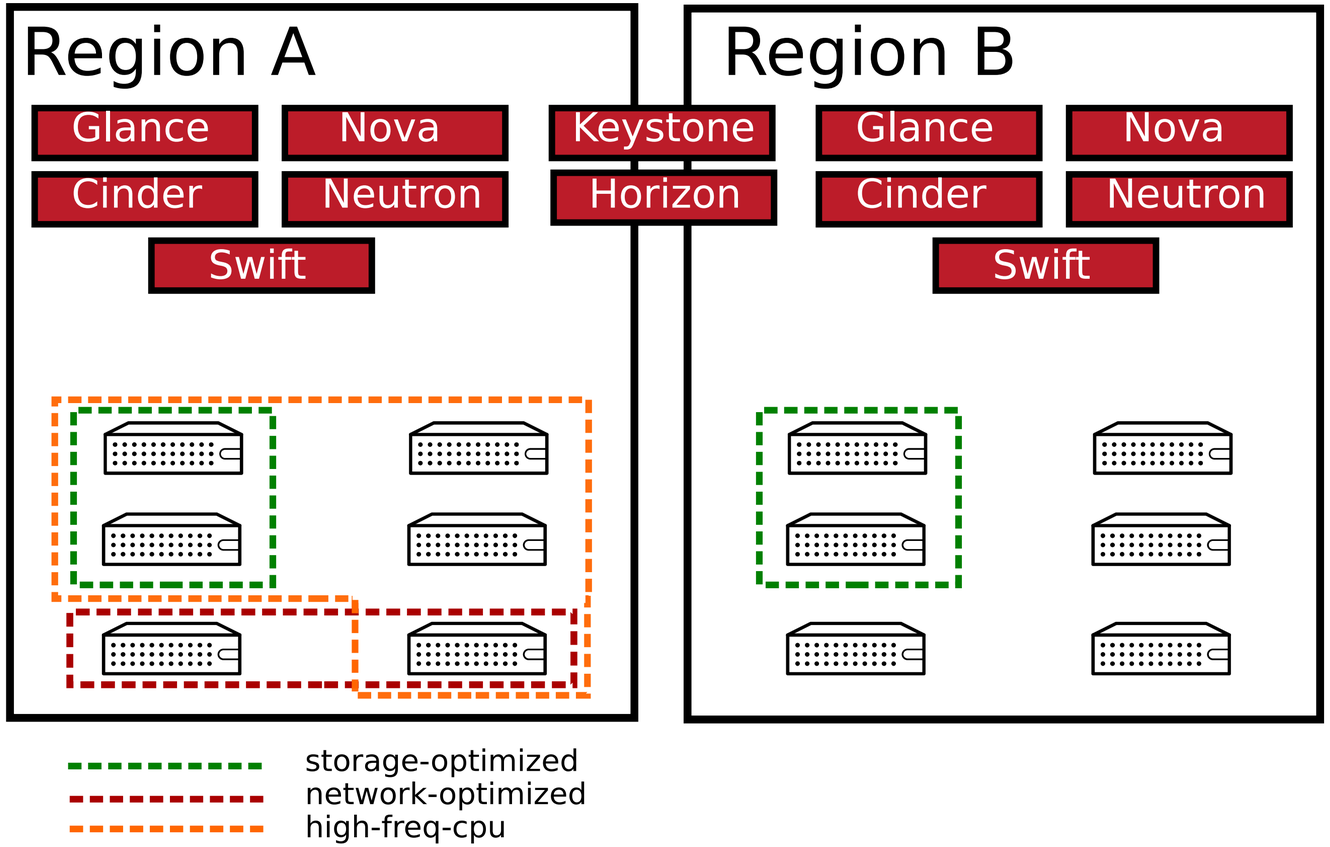


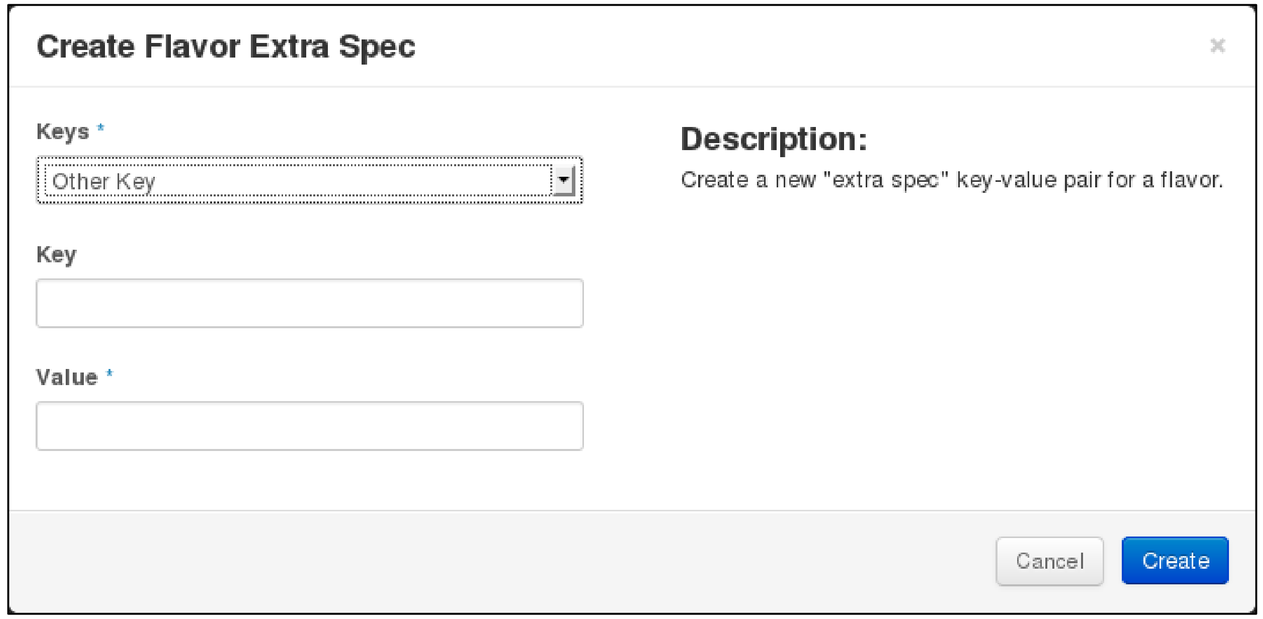
Host aggregates (example)



Host aggregates (example)

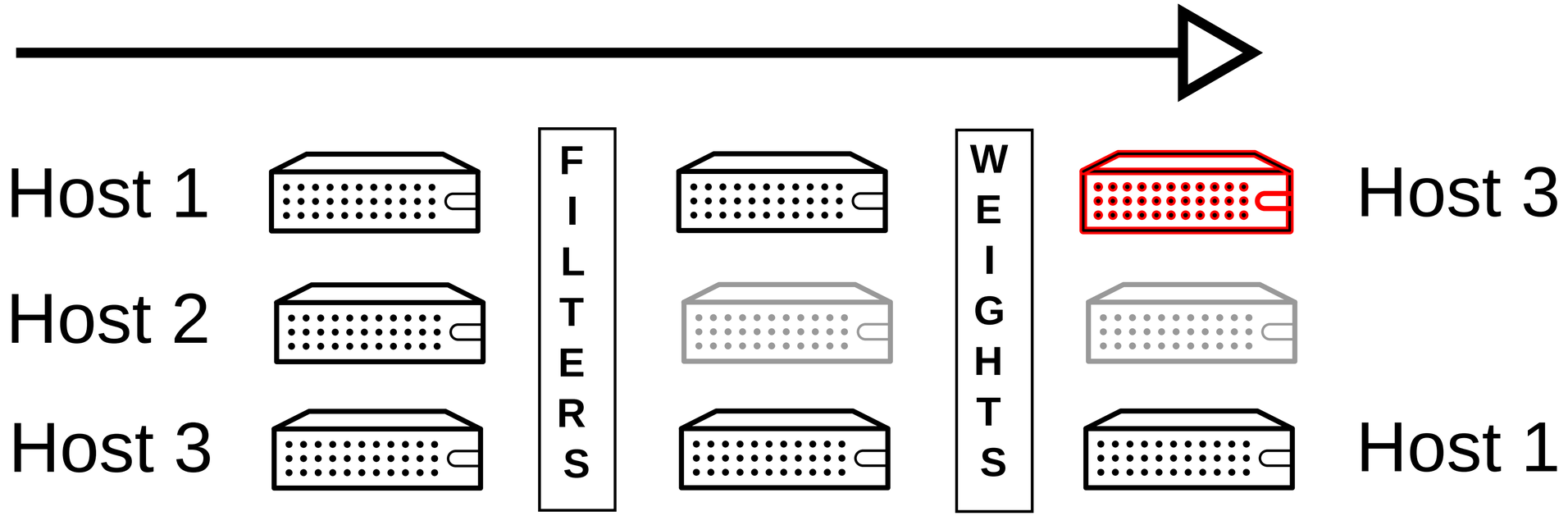
- Set flavor extra specifications:

```
-$ nova flavor-key 1 set fast-storage=true
-...
```



Host aggregates (example)

- Filter scheduler matches extra specifications of flavor to metadata of aggregate.



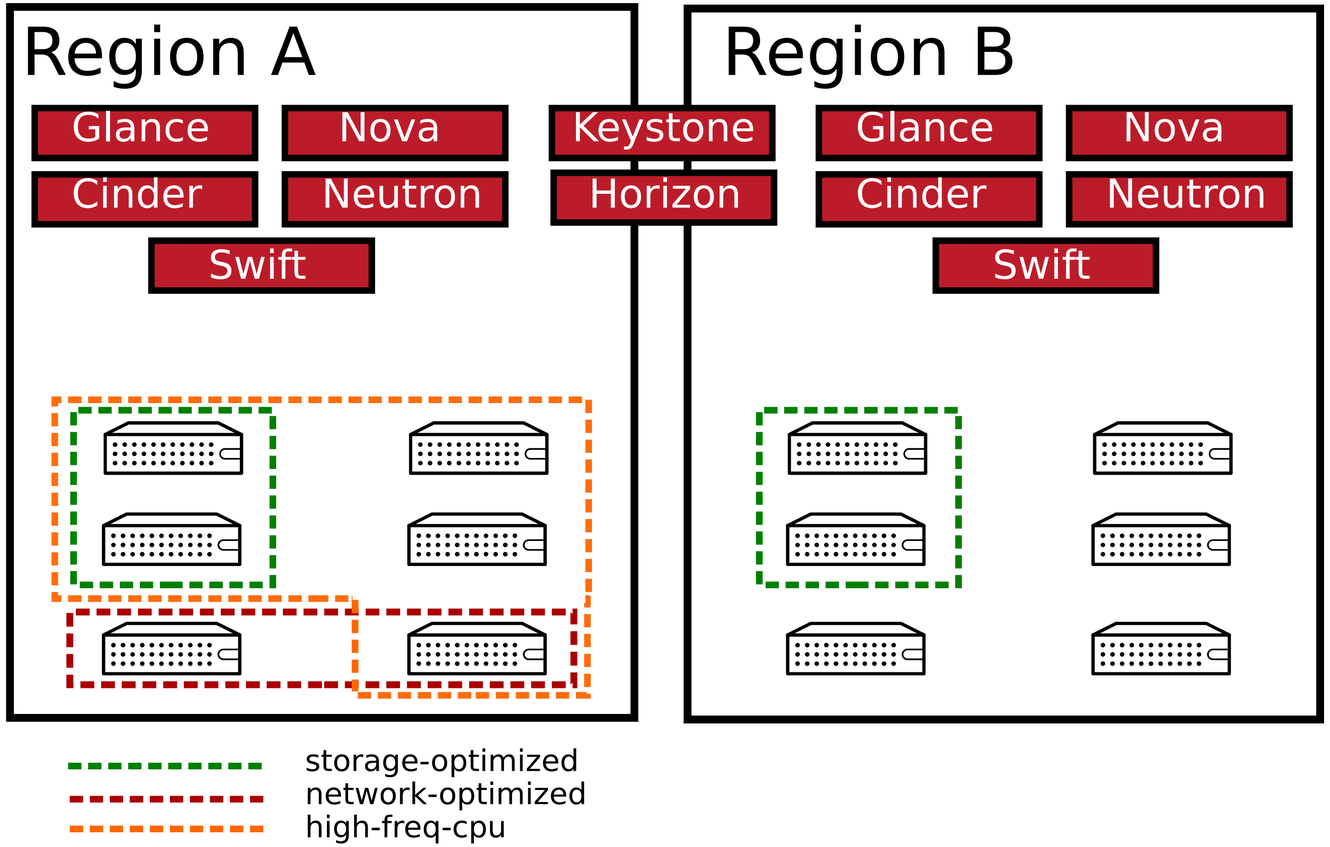
Availability zones

- Logical groupings of hosts based on arbitrary factors like:
  - Location (country, data center, rack, etc.)
  - Network layout
  - Power source
- **Explicitly** user targetable:
  - `$ nova boot --availability-zone “rack-1”`
- OpenStack Block Storage (Cinder) also has availability zones

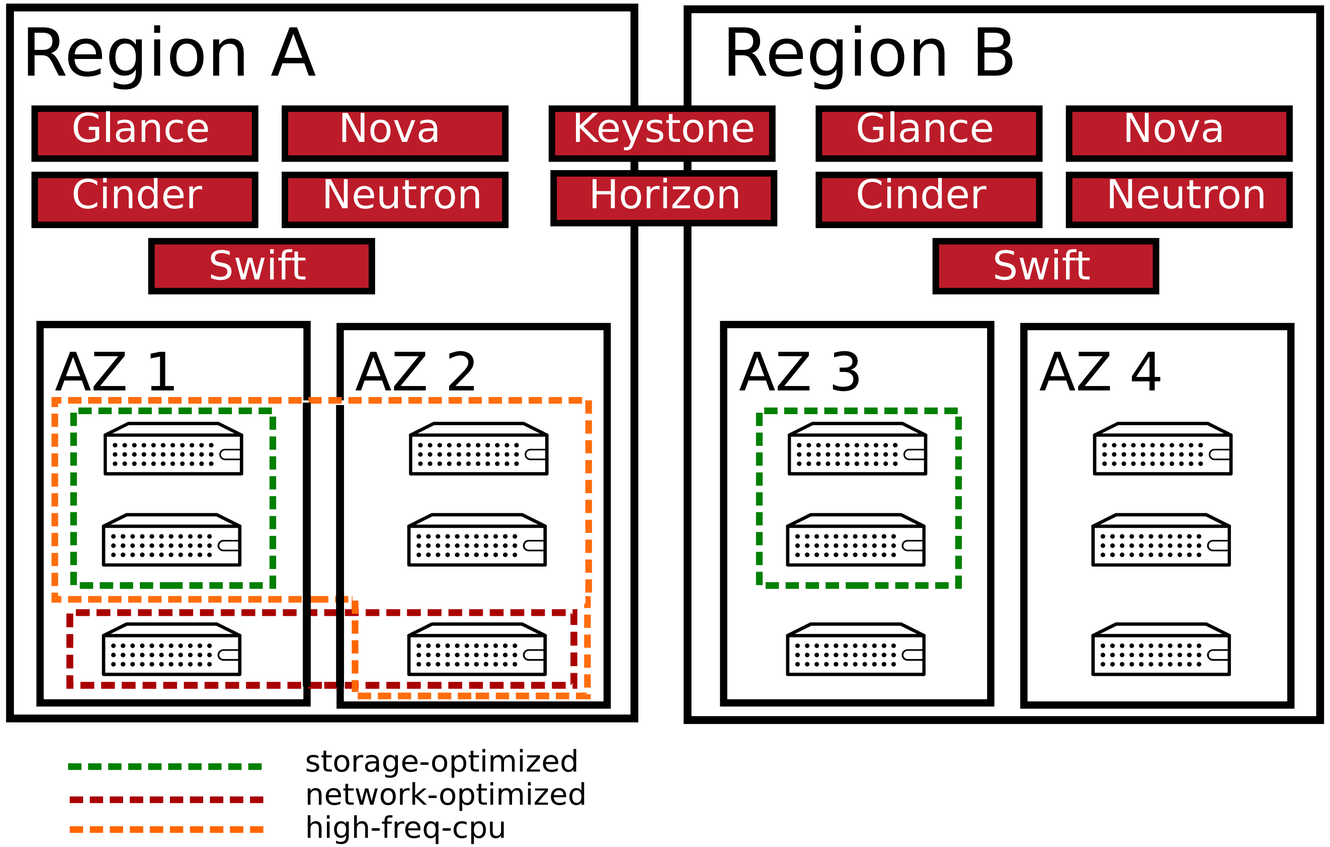
Availability zones

- Host aggregates are made **explicitly** user targetable by creating them as an AZ:
  - `$ nova aggregate-create tier-1 us-east-tier-1`
  - `tier-1` is the aggregate name, `us-east-tier-1` is the AZ name
- Host aggregate **is** the availability zone in this case
  - Hosts **can not** be in multiple availability zones
    - Well...sort of.
  - Hosts **can** be in multiple host aggregates

Availability zones (example)



Availability zones (example)



So how do they stack up?

Host Aggregates

- Implicitly user targetable
- Hosts can be in multiple aggregates
- Grouping based on common capabilities

Availability Zones

- Explicitly user targetable
- Hosts can not be in multiple zones (see previous disclaimer)
- Grouping based on arbitrary factors such as location, power, network

WORKLOAD SEGREGATION

Server groups

- Policies for defining workload placement rules for a group
  - Anti-affinity filter – Grizzly
  - Affinity filter – Havana
  - API – Icehouse
- Implemented via scheduler filters:
  - ServerGroupAffinityFilter
  - ServerGroupAntiAffinityFilter

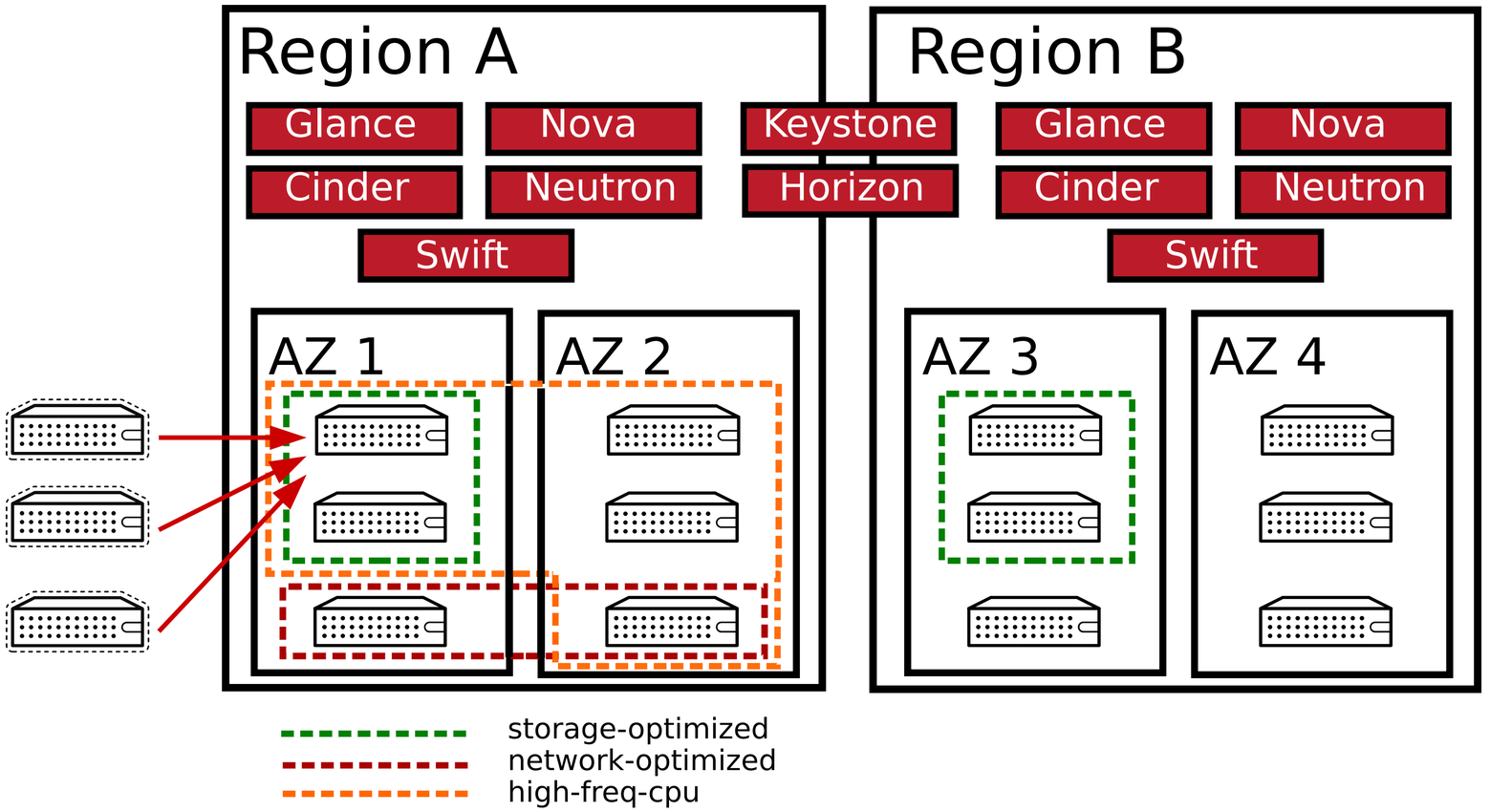
Server groups

- Affinity:
  - Places instances within the group on the same host
- Anti-affinity:
  - Places instances within the group on different hosts
- Not equivalent to AWS placement groups (host placement versus availability zone placement)

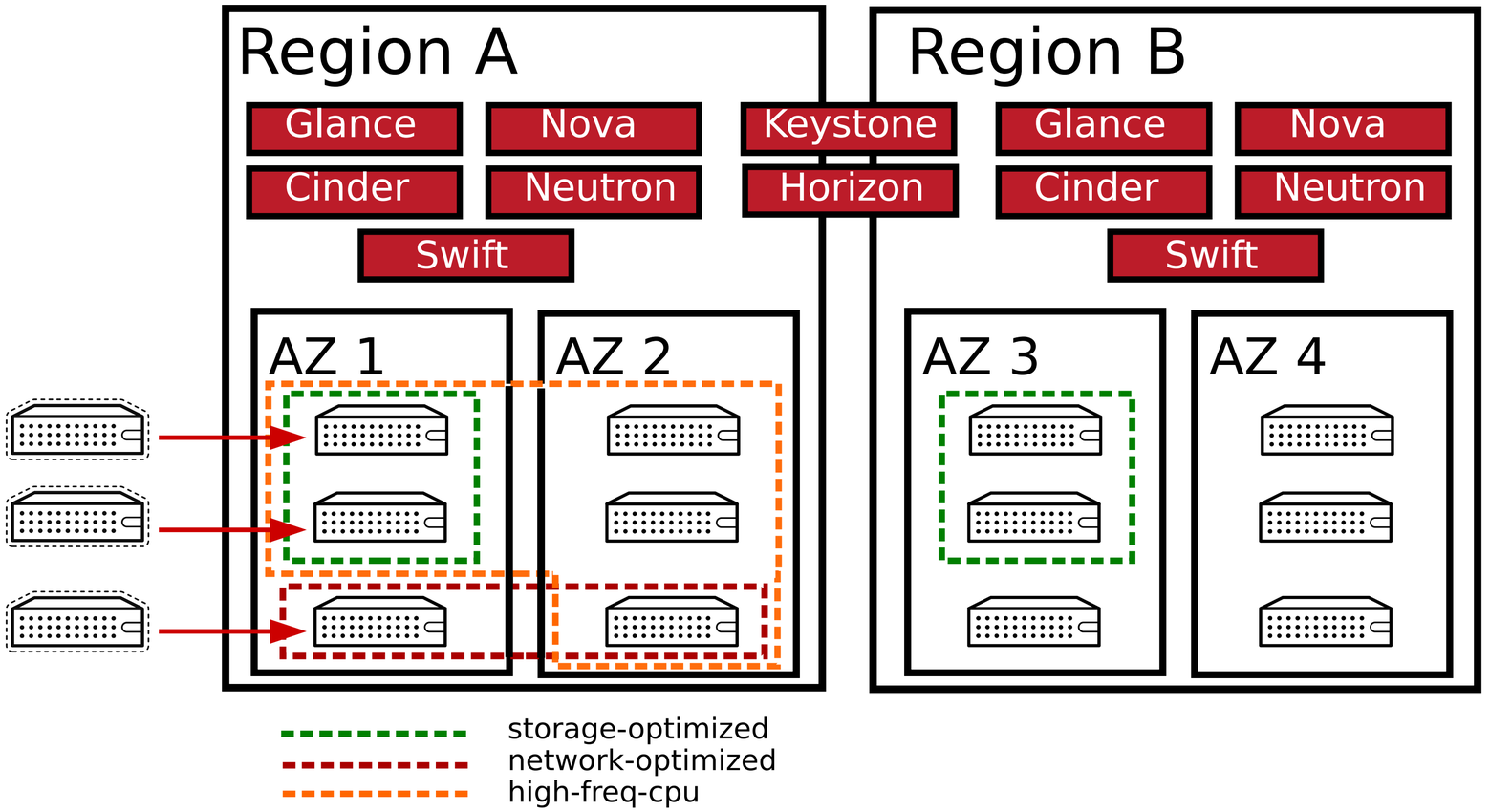
Server groups

- Create the server group:
  - `$ nova server-group-create --policy=anti-affinity` *`my_group`*
  - Really defining a policy rather than a group.
- Specify the group UUID or name when launching instances:
  - `$ nova boot --image ... --flavor … --hint group=group_id`

Server groups (affinity)



Server groups (anti-affinity)



What next?

- Relevant design sessions:
  - Simultaneous Scheduling for Server Groups
    - **Friday, May 16 • 1:20pm – 2:00pm**
  - Scheduler hints for VM life cycle
    - **Friday, May 16 • 2:10pm – 2:50pm**
  - Nova Dev/Ops Session
    - **Friday, May 16 • 3:00pm - 3:40pm**

Resources

- Operations Guide – Chapter 5 “Scaling”
  - http://docs.openstack.org/trunk/openstack-ops/content/scaling.html
- Configuration Reference Guide – Chapter 2 “Compute”
  - http://docs.openstack.org/trunk/config-reference/content/section_compute-cells.html
- OpenStack in Production Blog
  - http://openstack-in-production.blogspot.fr/

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