Cloud Computing

Software Defined Storage (SDS):

OpenStack Swift

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Available Object Storages in Open source

- SWIFT
- CEPH
- JETS3T

Swift Use Cases

- What is it?
    - Object Storage System.
    - Massively Scalable.
    - Runs on commodity hardware.
    - An S3 like solution
- What is not?
    - Hard drive / File system.
    - NFS / SMB share
    - Block Storage.
    - Any SAN/NAS/DAS
    - Not even a CDN ????

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Swift Use Cases contd.

- Multi-tenancy
  - Ideal for Public or Private Clouds
  - Different URLs, groups of users, access codes, fine-grained privileges.
- Backups
  - Write-once, read-never (long-term archiving).
  - Disaster recovery.
- Web content
  - Write many, read many
  - File sharing websites (temporary access)
  - Static websites or media focused blogs (i.e. Imgur)
- Large Objects
  - Medical / Scientific Images
  - Store your fancy Images from the moon (i.e. NASA)

History

- Rackspace Cloud Files V1
  - Distributed Storage
  - Centralized Metadata
  - PostgreSQL DB
- 2009 : Rackspace Cloud Files V2 (SWIFT)
  - Full redesign and rewrite, opensource
  - API compatible with Amazon S3
  - Worked Closely with ops
  - Distributed storage and metadata
  - Logical placement, based on Algorithm

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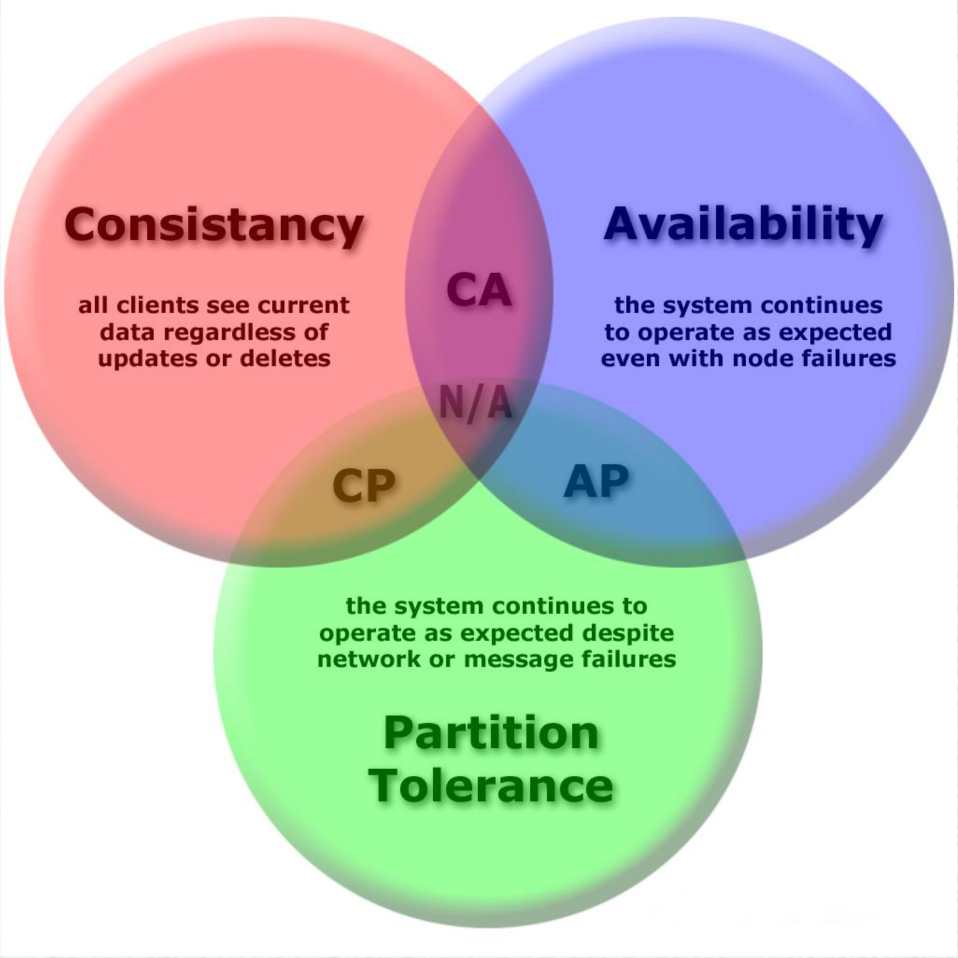
CAP Theorem

It is impossible for a distributed computer system to simultaneously provide all three of C, A, P.



In 2012 Brewer clarified some of his positions, including why the oft-used "two out of three" concept can be misleading or misapplied, and the different definition of consistency used in CAP relative to the one used in ACID.

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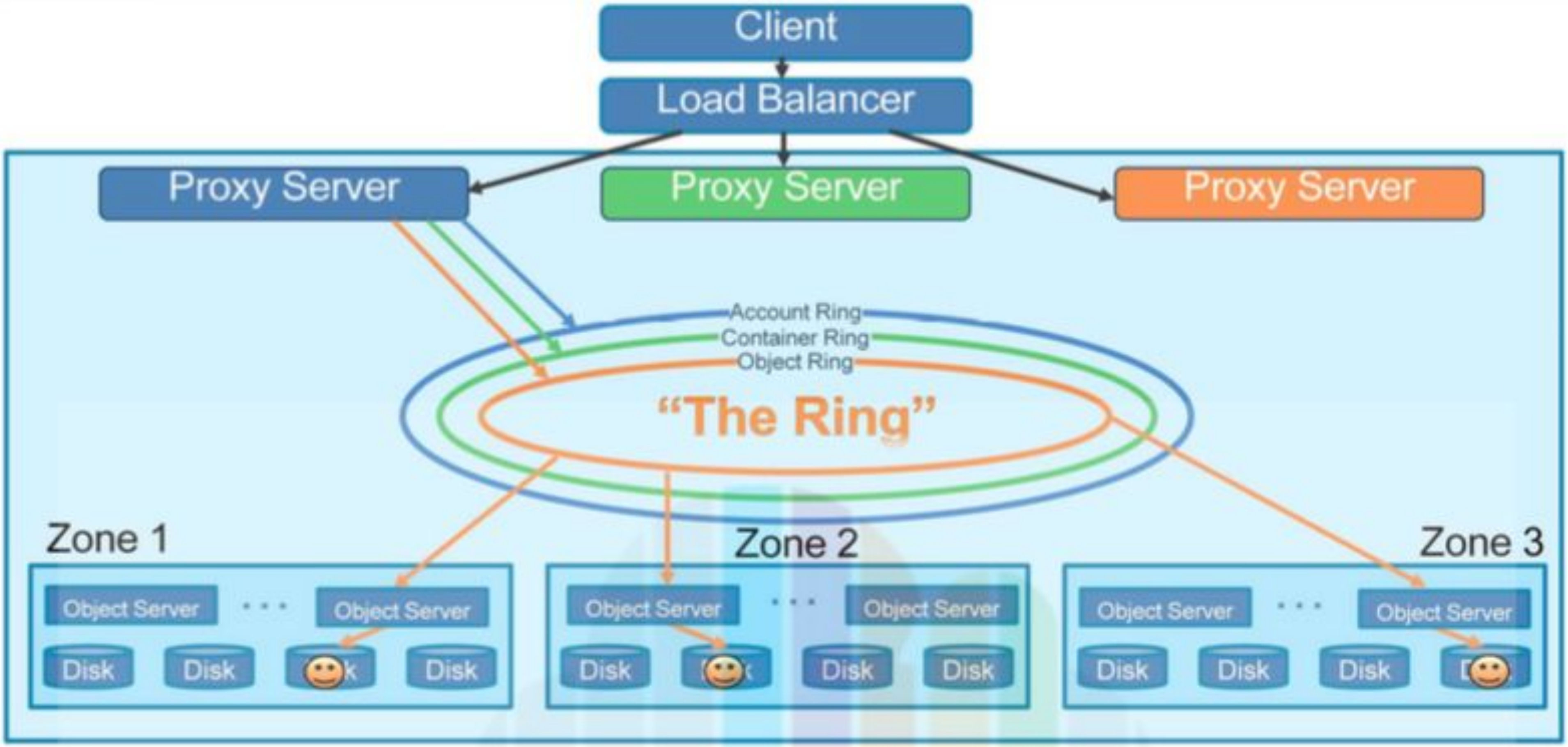
Swift Architecture



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Swift Architecture contd.
Components

- **Proxy Servers**: handle all incoming API Requests.
- **Rings**: mapping between the logical location of data to locations on particular disks.
- **Zones**: represent a location that can isolate data. This could be a drive, a server, a cabinet, a switch, or even a datacenter.
- **Partition**: store Objects, Account databases and Container databases.

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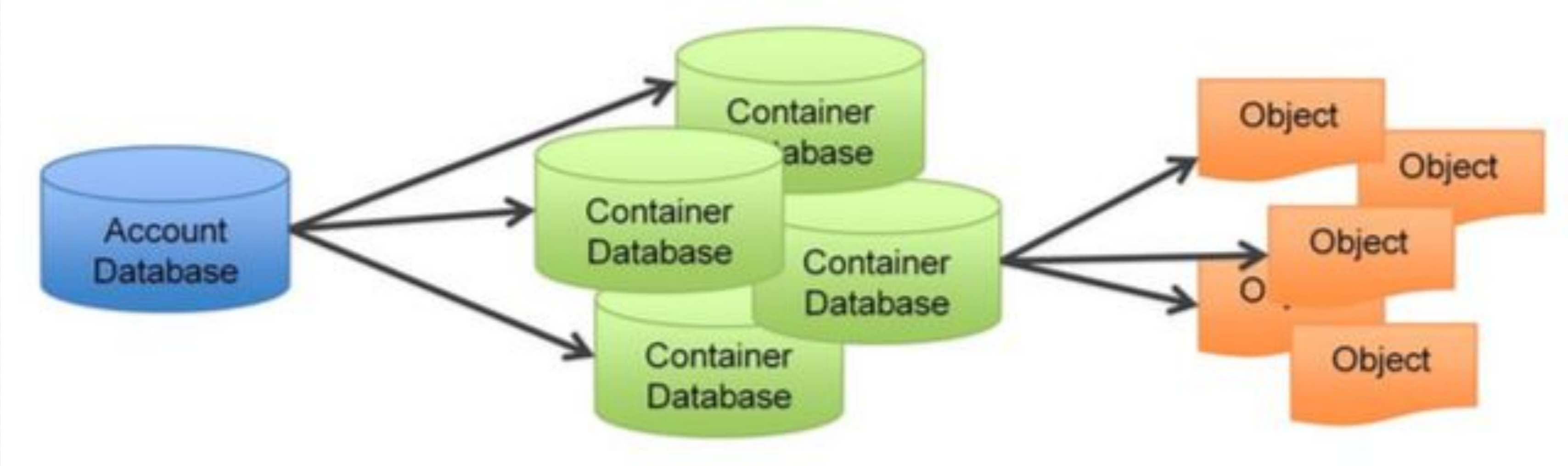
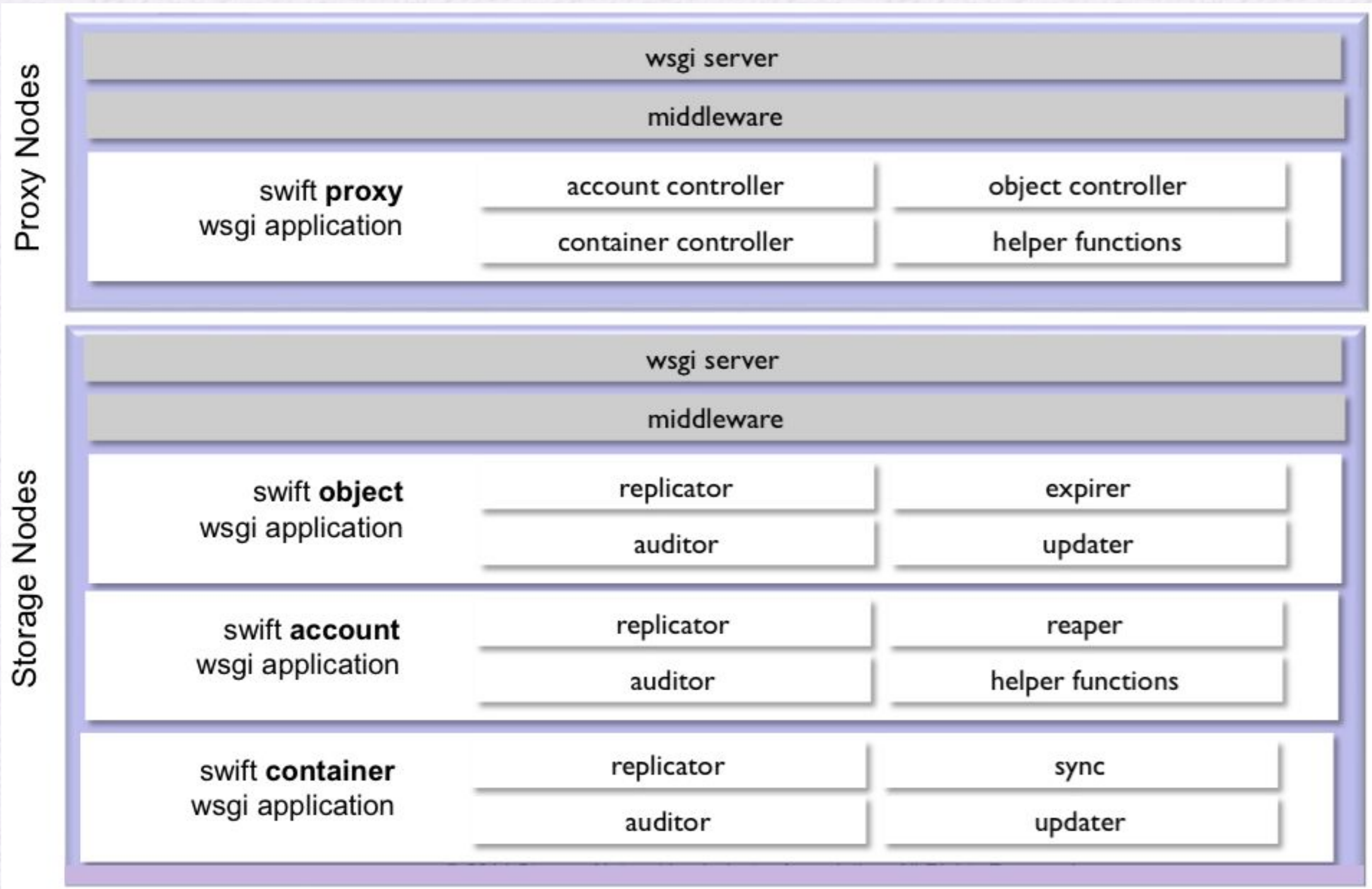
Swift Architecture contd.
Components contd.

- **Account:** determines rights to **Containers and Objects.**
- **Account Database**: a list of all Containers spread throughout the cluster that are usable by an Account.
- **Container**: a logical storage space.
- **Container Database:** handles listings of what objects are in which container.
- **Object**: the data to be stored, such as documents or images.



Swift Architecture contd.
Services



Swift Architecture contd.
Consistency Process

- ***Auditor:***
  - Scan the disks on their node to ensure that the stored data has not suffered file system corruption.

- ***Replicator:***
  - Ensure that enough copies of the most recent version of the data are stored where they should be in the cluster.
  - Handle object and container deletions

- ***Account reaper:***
  - When the account reaper locates an account marked as deleted, it begins stripping out all objects and containers associated with the account, ultimately removing the account record itself.
  - To provide a buffer against error, the reaper can be configured with a delay so that it will wait for a specified period of time before it starts deleting data.

- ***Container and object updaters:***
  - Container updater consistency process is responsible for keeping the container listings in the accounts up-to-date. Additionally, it updates the object count, container count, and bytes used in the account metadata.
  - Object updater updates the container listing as well as the object count and bytes used in the container metadata.

Object expirer:

- Allows designated objects to be automatically deleted at a certain time.

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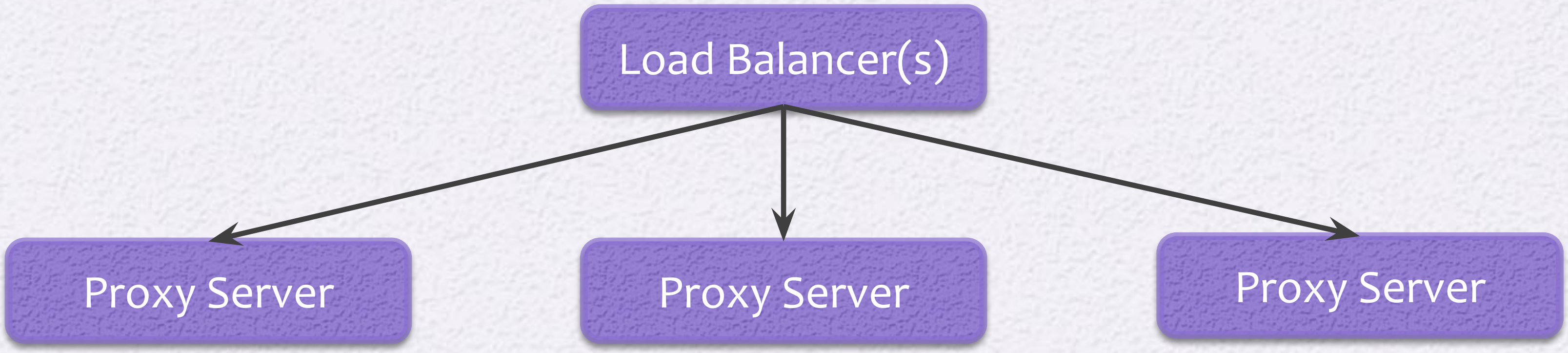
Swift Architecture contd.
Proxy Servers



- Handle all incoming API requests.
- Will determine the storage node based on the URL of the objects.
- Use a shared-nothing architecture and can be scaled as needed based on projected workloads.
- A large number of failures are also handled in the Proxy Server. For example, if a server is unavailable for an object PUT, it will ask the ring for a handoff server and route there instead.
- Also coordinates responses, and coordinates timestamps.

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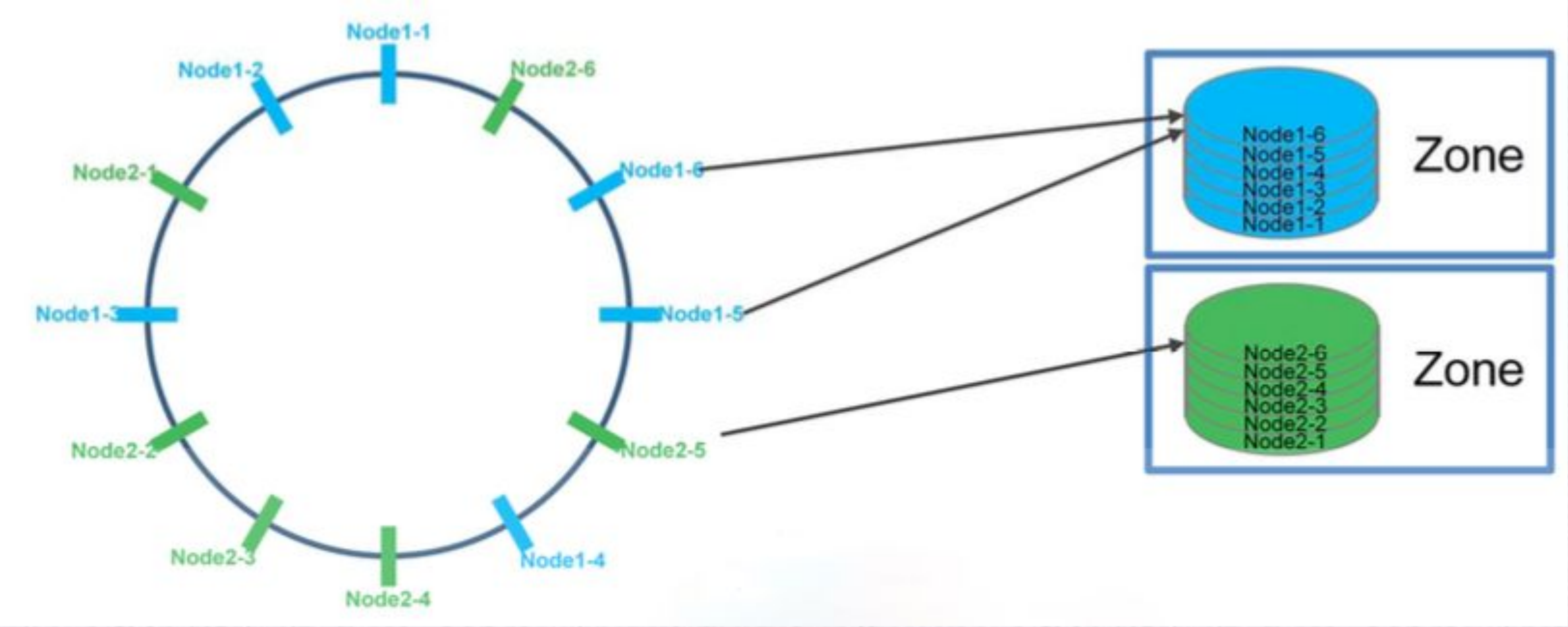
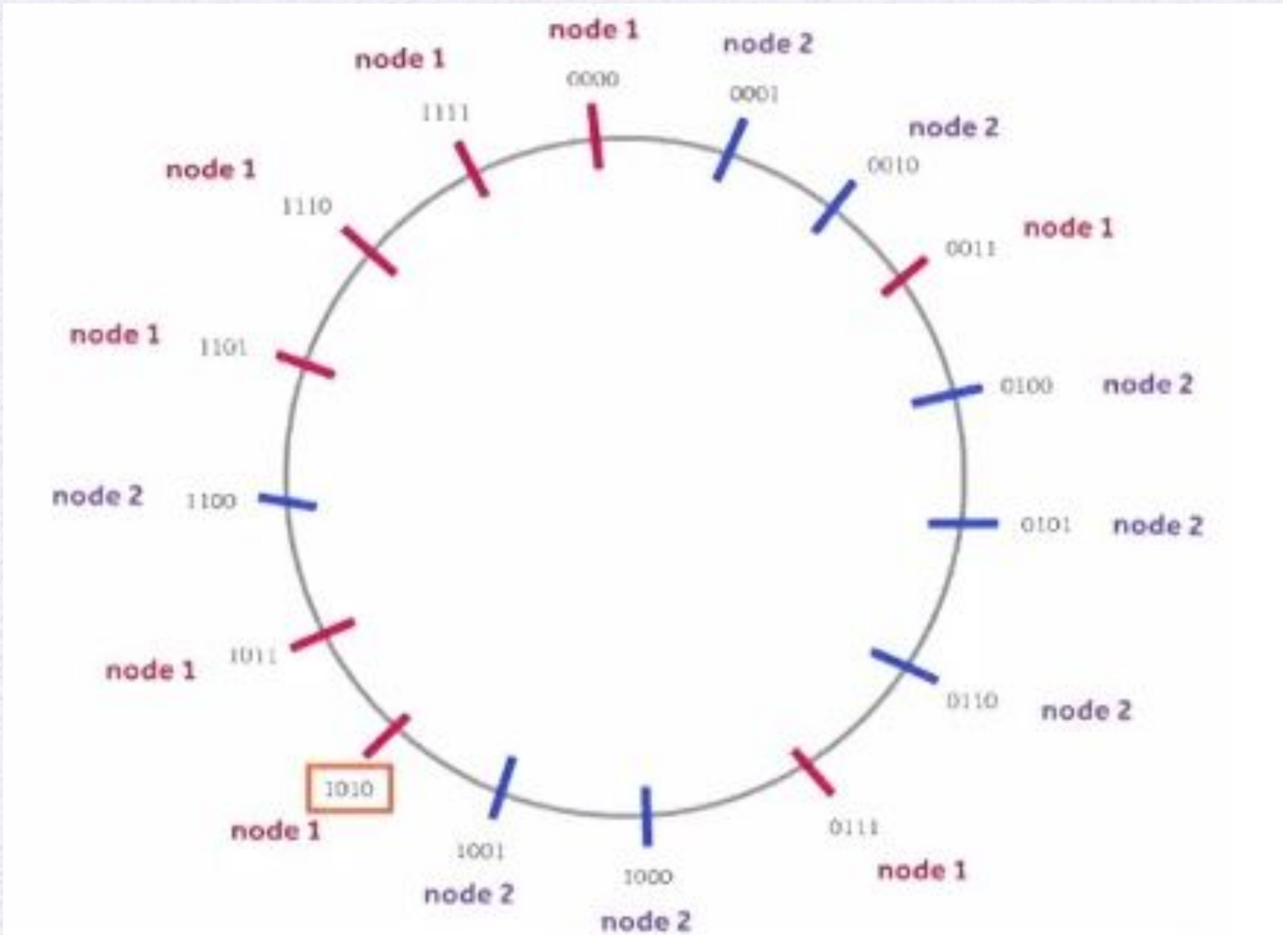
Swift Architecture contd.
The Ring



- Mapping between entities stored and their physical locations on disk, an index.
- The Ring maintains this mapping with zones, devices, partitions and replicas.
- Each partition in the Ring is replicated three times across the cluster in different zones.
- Rings are built through consistent hashing algorithm. The ring is used by the Proxy server and several background processes (like replication).
- The ring is also responsible for determining which devices are used for handoff in failure scenarios.

Swift Architecture contd.
The Ring contd.



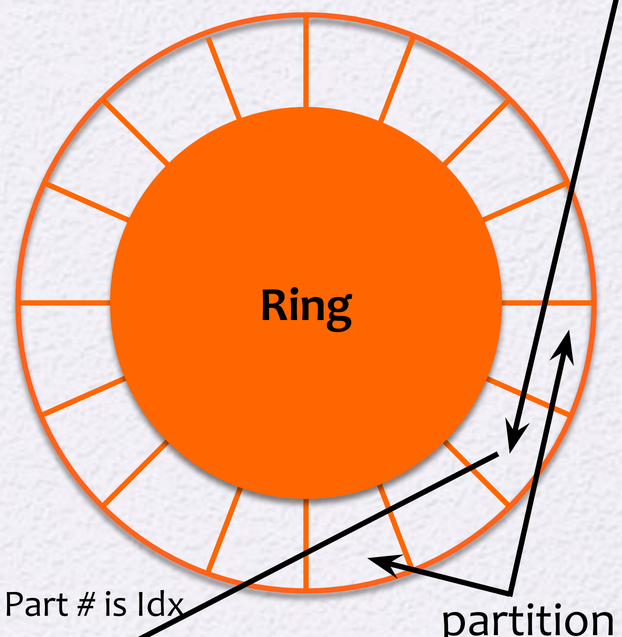
Hash(suffix + “v1/user1/container1/image.jpg” + prefix) = 1010 1011001101 … ➔ node 1

Swift Architecture contd.

The Ring contd.

- The ring is a static data structure maintained external to the cluster (tools provided)
- Devices are assigned to partitions with several policies (regions, zones, etc.) and constraints to assure fault tolerance and load balancing

Md5*(suffix + name + prefix) = index



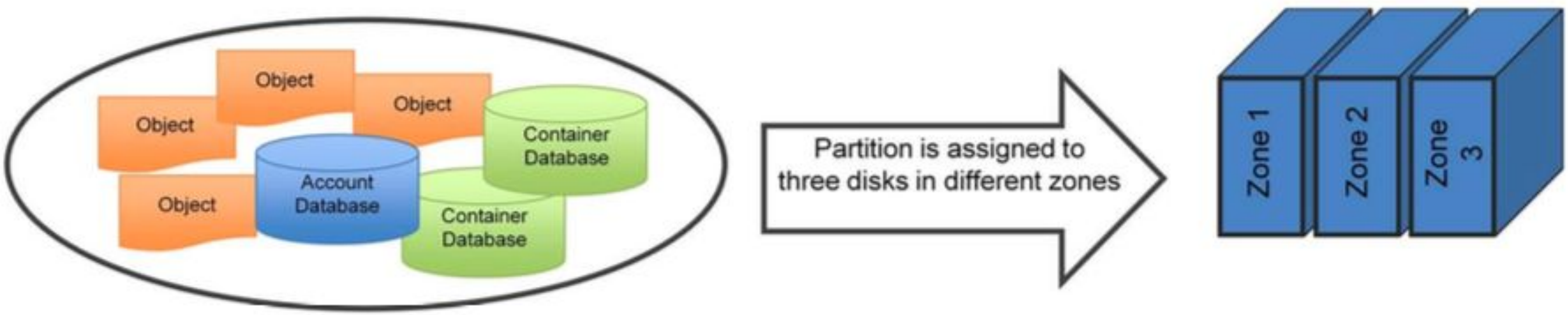
Idx	0	1	2	3	…
Device	Region 1 Zone 2 Weight 1 …	Region 1 Zone 2 Weight 1 …	Region 1 Zone 2 Weight 1 …	Region 1 Zone 2 Weight 1 …	…

lookup val is Idx

Idx	0	1	3	4	5	…
Copy 0	11	21	23	14	20	…
Copy 1	22	89	35	40	54	…
Copy 2	49	71	93	67	33	…

e.g.,
_replica2part2dev[2][7956] =
device of 3^{rd} replica of part 7956

Swift Architecture contd.
Partitions



- A partition is a collection of stored data, including Account, Container & Object Servers.
- The System Replicator and Object upload / download operate on Partitions.
- Num of partitions stored in one node = (num of replicas * total num of partions) / num of nodes.
- Choosing part_power :
  - Immutable once chosen.
  - At least 100 per disk
  - Bigger part_power -> bigger lookup table -> more memory used (but lookups stay fast)

Swift API

- Simple Rest API
  - GET, POST, DELETE, HEAD, OPTIONS
- Simple Response Code
  - 2xx is good
  - 3xx redirect
  - 4xx is bad client
  - 5xx is bad servers etc
- Binding for different languages : python, ruby, java …
- Multiple CLI tools: python-swiftclient, jcloud, log
- Example of metadata (Headers) :

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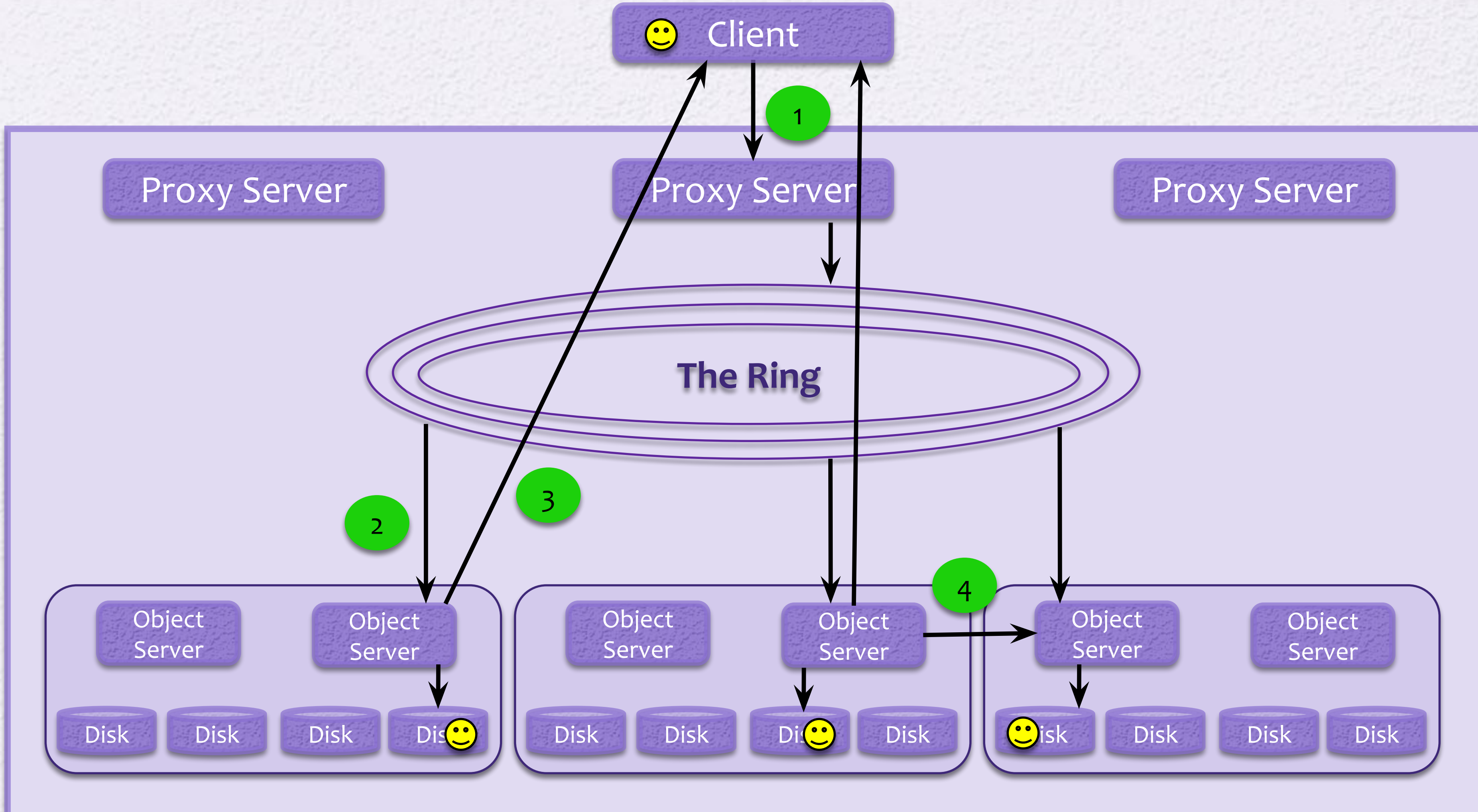
Swift Architecture contd.

Process for a PUT



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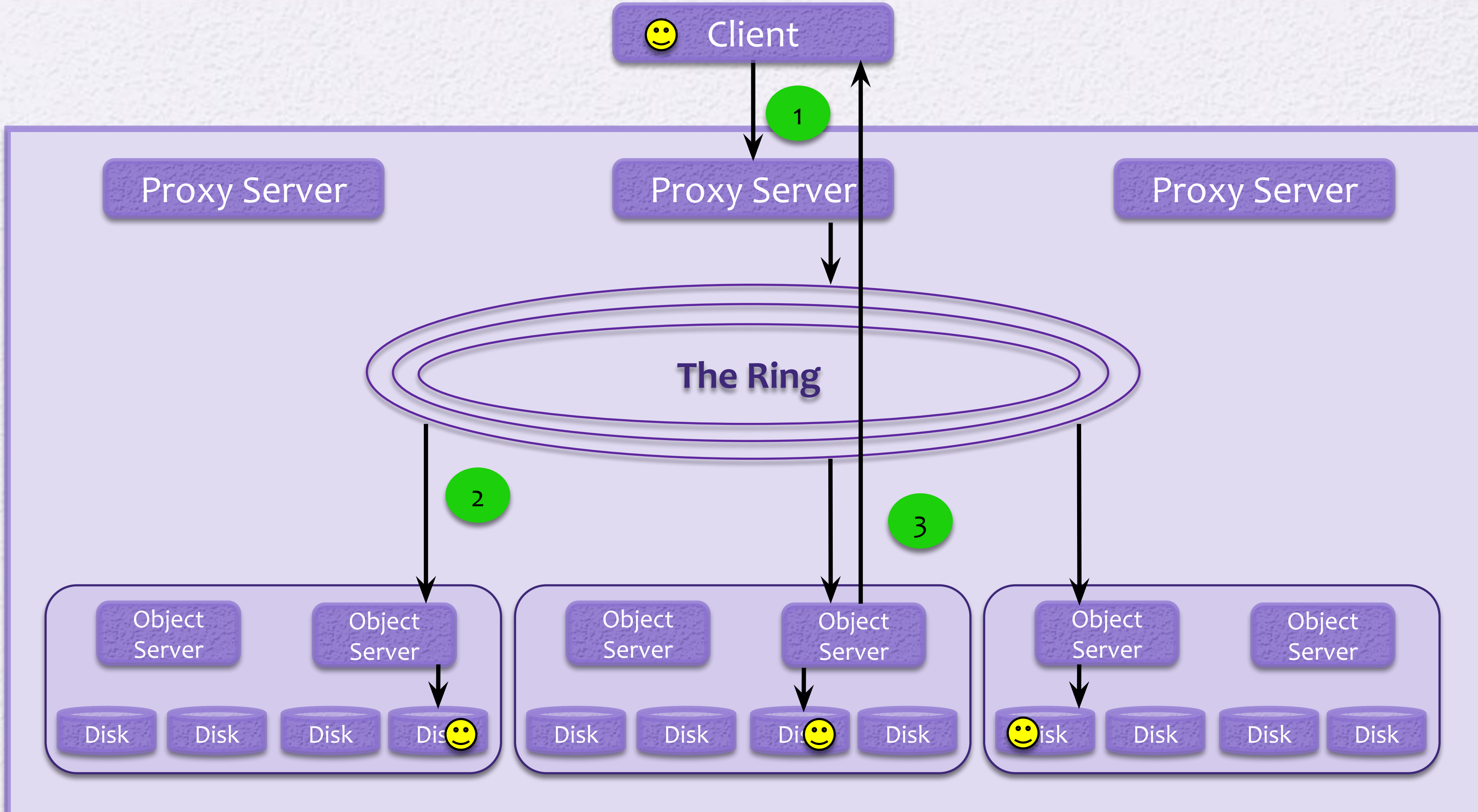
Swift Architecture contd.

Process for a GET



Swift Architecture contd.

Process for a DELETE