Software Architecture

Intro

Who are you?

Who I am

What we'll learn

- Several Architectures and trade-offs
- From Monolith to Micro services & reactive programming
  - Circuit breakers, gateways, ES,CQRS , Sagas, ..

  Distributed systems concepts with use cases:
  - Persistence (Cassandra)
  - Config and Service Discovery (Consul)
  - Secret Management (Vault)
  - Queue/log (Kafka)
  - Cluster Deployment (Kubernetes)
- Basics of Platform engineering
- If you're still alive!
  - Real time processing

You’ll need

- Unix based OS (e.g. Linux)
- In Microservices, you can pick different stacks!
  - **Java Path**: Java 8+, Spring framework (cloud,data, batch, web services,..)
  - NodeJS, Go , ...
  - You’re an explorer?! → Scala and Lagom
- Time, we’ll watch several videos!

Optional Books

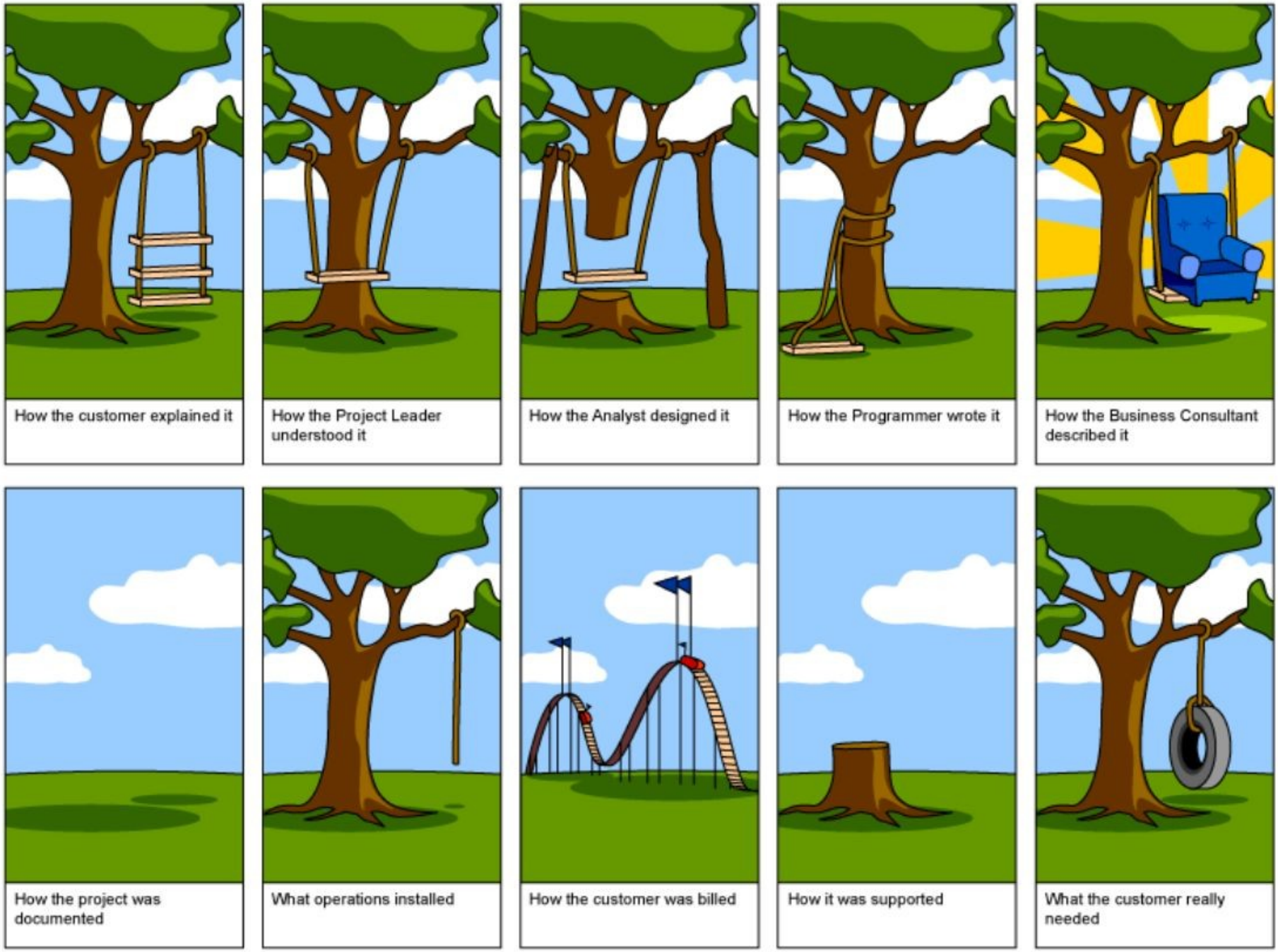
- Free Book:
  - Microservices: From Design to Deployment from Chris Richardson and Floyd Smith
    - https://www.nginx.com/blog/microservices-from-design-to-deployment-ebook-nginx/

- Building Microservices | Sam Newman
- Beyond the 12 Factor App | Kevin Hoffman
- Domain driven design distilled | Vaughn Vernon.

Grading

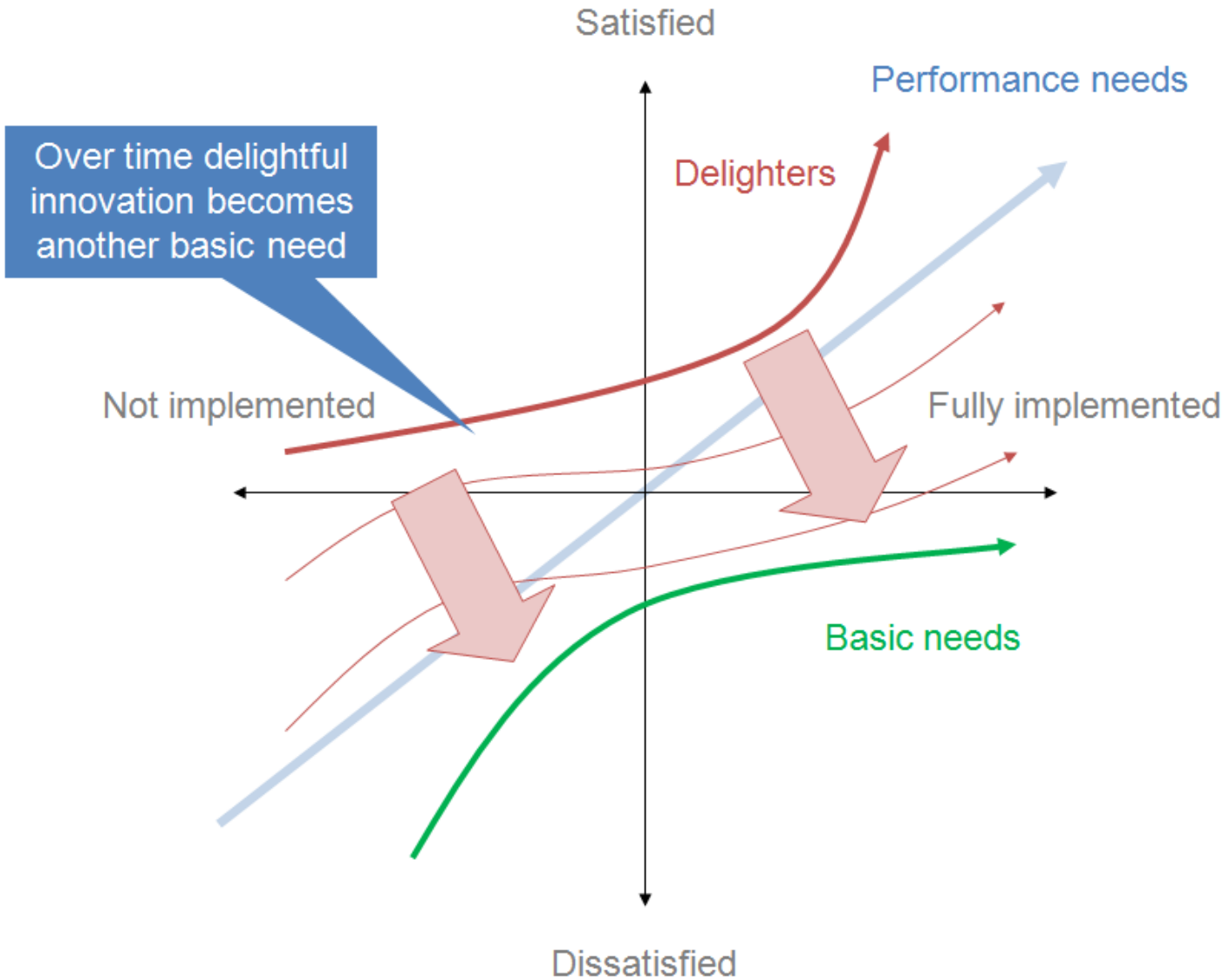
- 10% final
- 10% Midterm
- 20% labs (individual Mini projects), quiz ,..
- 50% group project
- Note: Understanding is our highest priority→ I'll <u>downgrade a grade letter up to 10%</u> if you don't show a solid understanding, or good participation
  - *By continuing in this class you agree to these terms..*

Let’s get started



https://www.briisk.co/wp-content/uploads/2019/01/tree-swing-analogy-1.jpg

The Kano Model



The Kano Model

- Professor Noriaka Kano, a Japanese expert in customer satisfaction
  - Basic Features: Expected, frustrating when missing but not exciting when exists
  - Performance Features
  - Attractive Features: Going the extra mile!
- Read:
  - https://articles.uie.com/kano_model/

Can you think of the 3 types of features in a system ?

What’s software Architecture ?

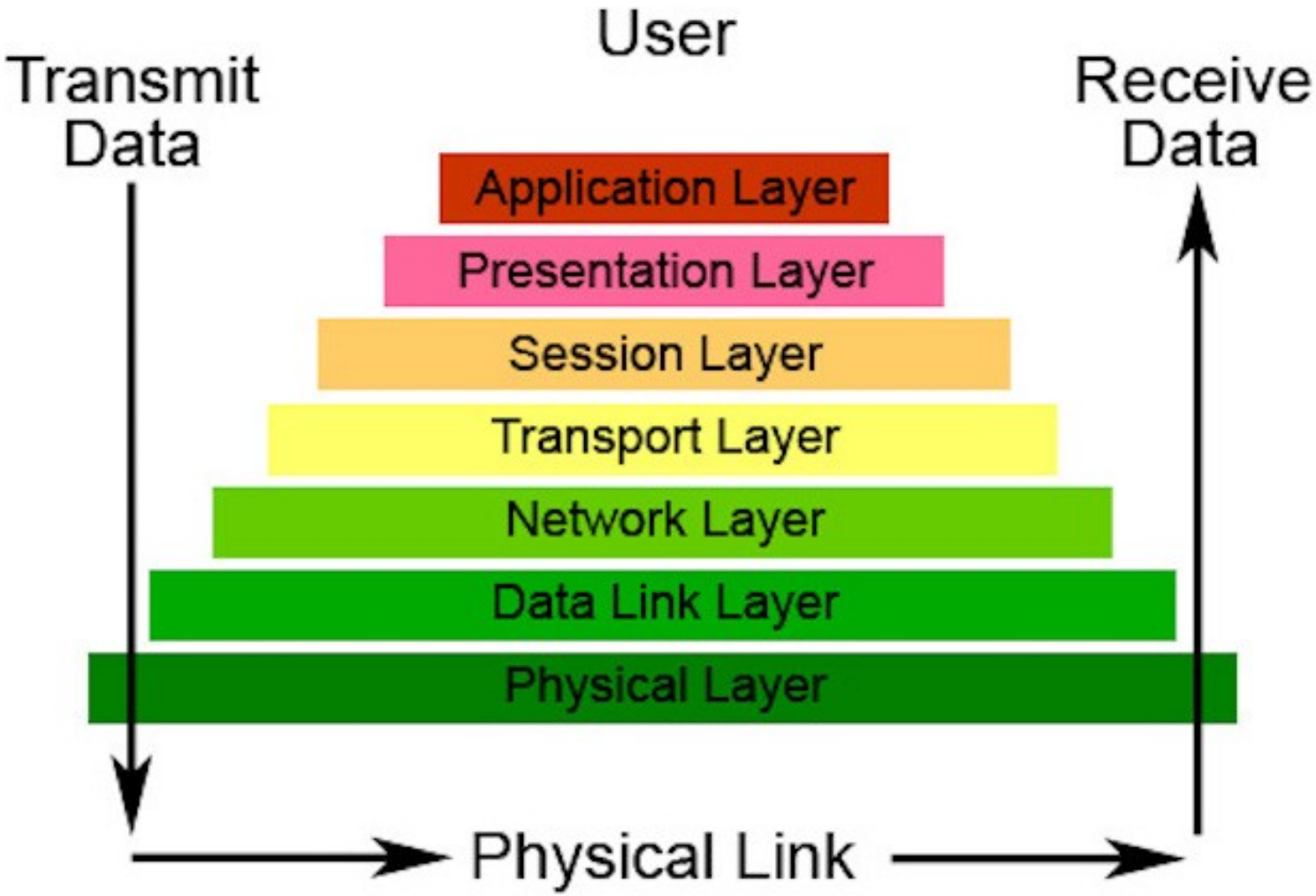
From Wikipedia

- Software architecture is about making fundamental structural choices that are costly to change once implemented.

https://en.wikipedia.org/wiki/Software_architecture

What’s the architecture behind the internet ?

The Seven Layers of OSI



http://techgenix.com/network-troubleshooting-osi/

7 Layers of the OSI Model

Application	• End User layer • HTTP, FTP, IRC, SSH, DNS
Presentation	• Syntax layer • SSL, SSH, IMAP, FTP, MPEG, JPEG
Session	• Synch & send to port • API's, Sockets, WinSock
Transport	• End-to-end connections • TCP, UDP
Network	• Packets • IP, ICMP, IPSec, IGMP
Data Link	• Frames • Ethernet, PPP, Switch, Bridge
Physical	• Physical structure • Coax, Fiber, Wireless, Hubs, Repeaters

https://medium.com/@int0x33/day-51-understanding-the-osi-model-f22d5f3df756

Every arch makes compromises

- IP protocol is best effort routing (packet loss, out of order,...)
- The Internet is not secure by design!
- IPv4 isn’t scalable (NAT, IPv6 ,...)
  - But IP layer is implemented everywhere, and we can’t change it easily!

Architectural pattern

- Wiki:
  - A general, reusable solution to a commonly occurring problem in software architecture within a given context

Tell me some of the architectures that you know?

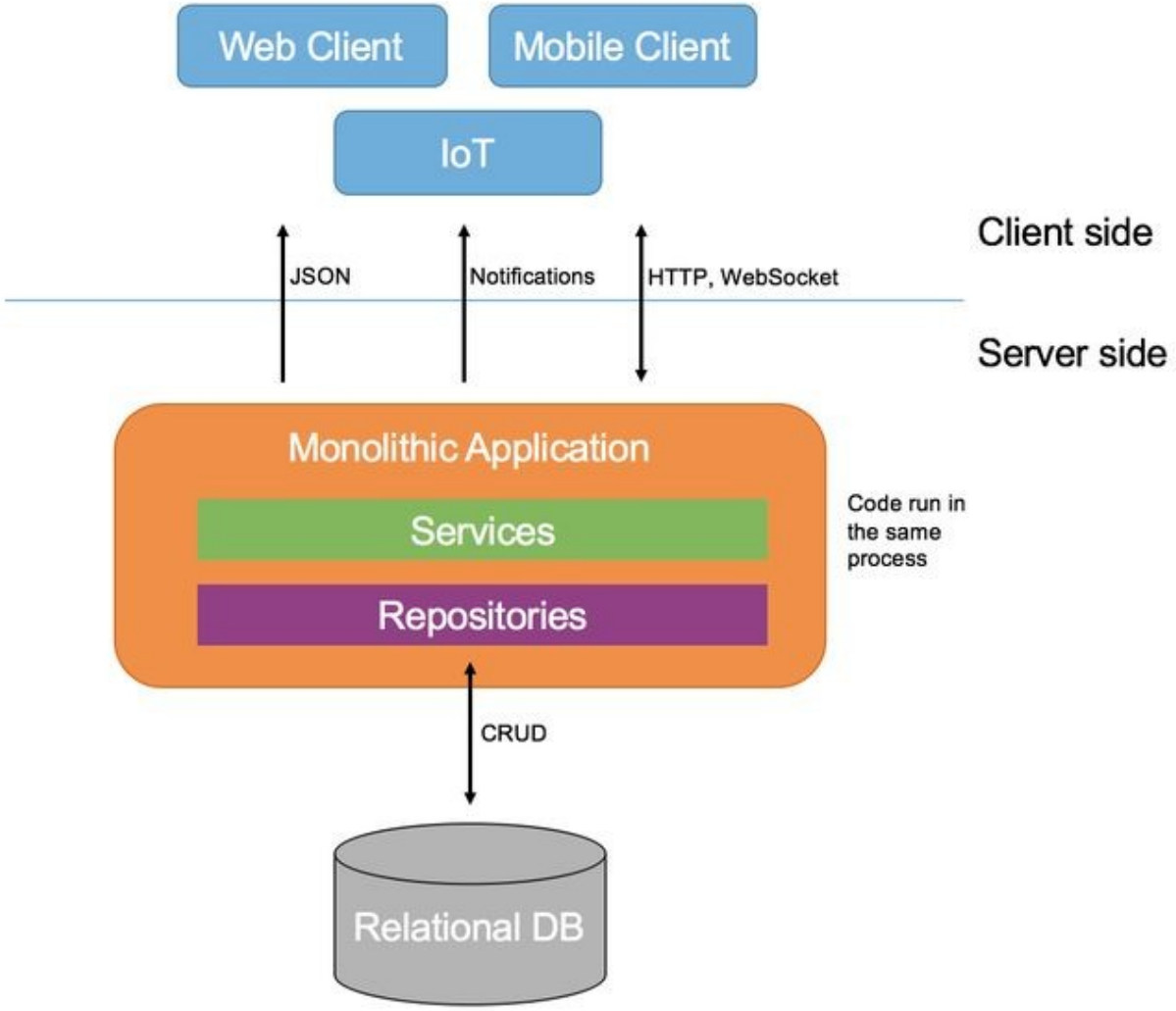
Architectural patterns

- Plugin/Micro kernel (browser plugins, IDE plugins,..)
- Layered (n-tier e.g. MVC)
- Event Driven (messages, Pub/Sub, ES,..)
- Services (SOA, Restful, Micro-services,..)
- Client-server vs Peer to peer
- Pipe and filter
- Serverless ..and a lot more!

Let’s watch

- Software Architecture | Architectural patterns | Architecture vs Design pattern
  - https://www.youtube.com/watch?v=lTkL1oIMiaU

A sample Architecture



https://www.pinterest.com/khoadinh290/software-architecture/

It’s simple :)

- Simple to develop & test
- Simple to deploy. You just have to copy a jar/war to a server.
- Maybe run DB on a separate server.
- Data is consistent/transactions
- Simple method calls between different classes/modules

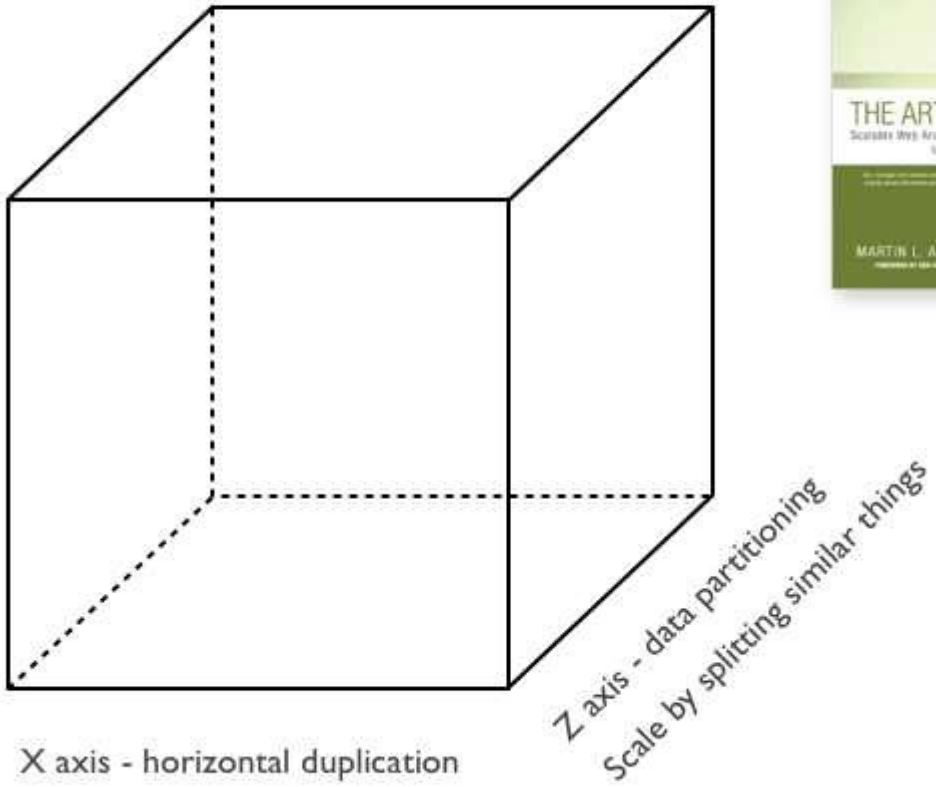
But

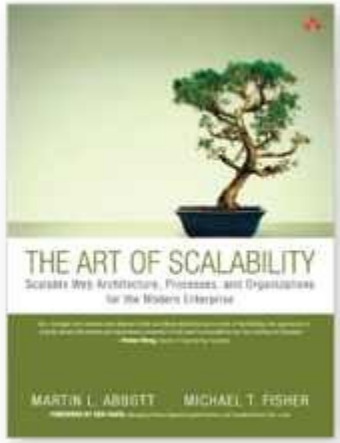
- What can we do to make our single node (app or database) serve:
  - A lot more reads?
  - A lot more writes ?
  - Many locations around the globe ?
- What to do when the node fails ?

Any ideas?!

We need to scale

3 dimensions to scaling



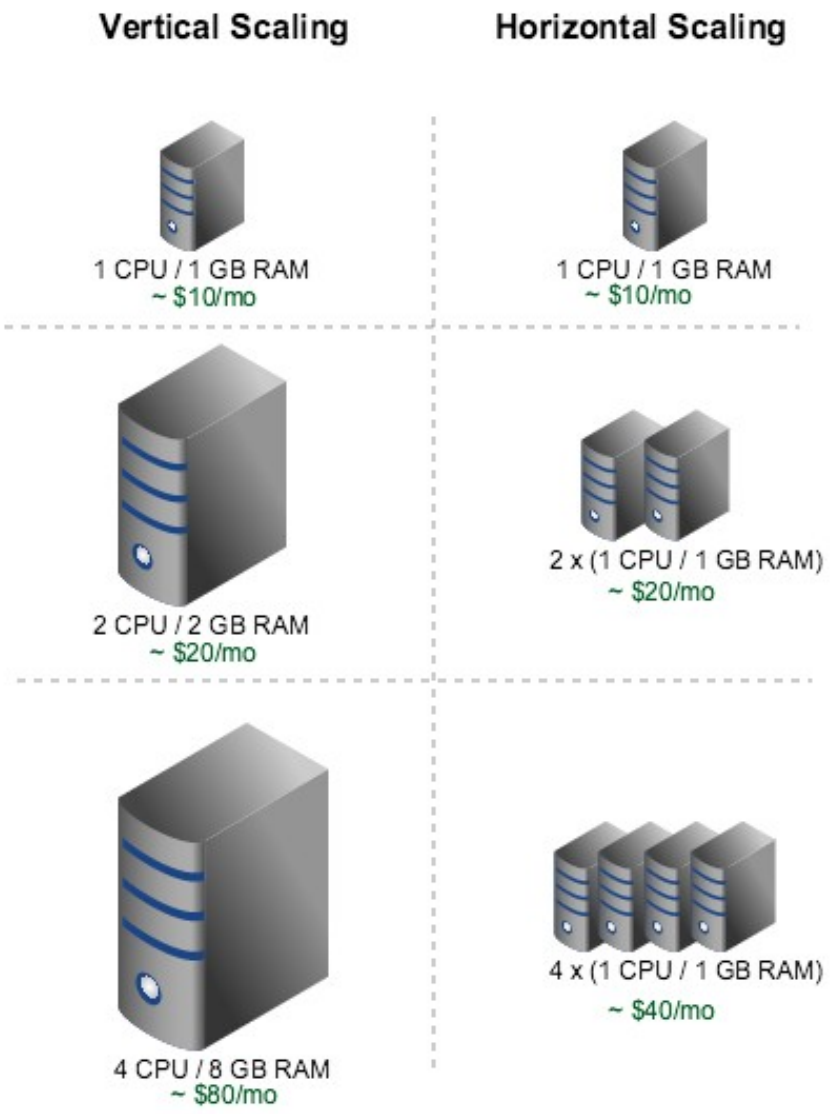


https://microservices.io/articles/scalecube.html

Scaling axis

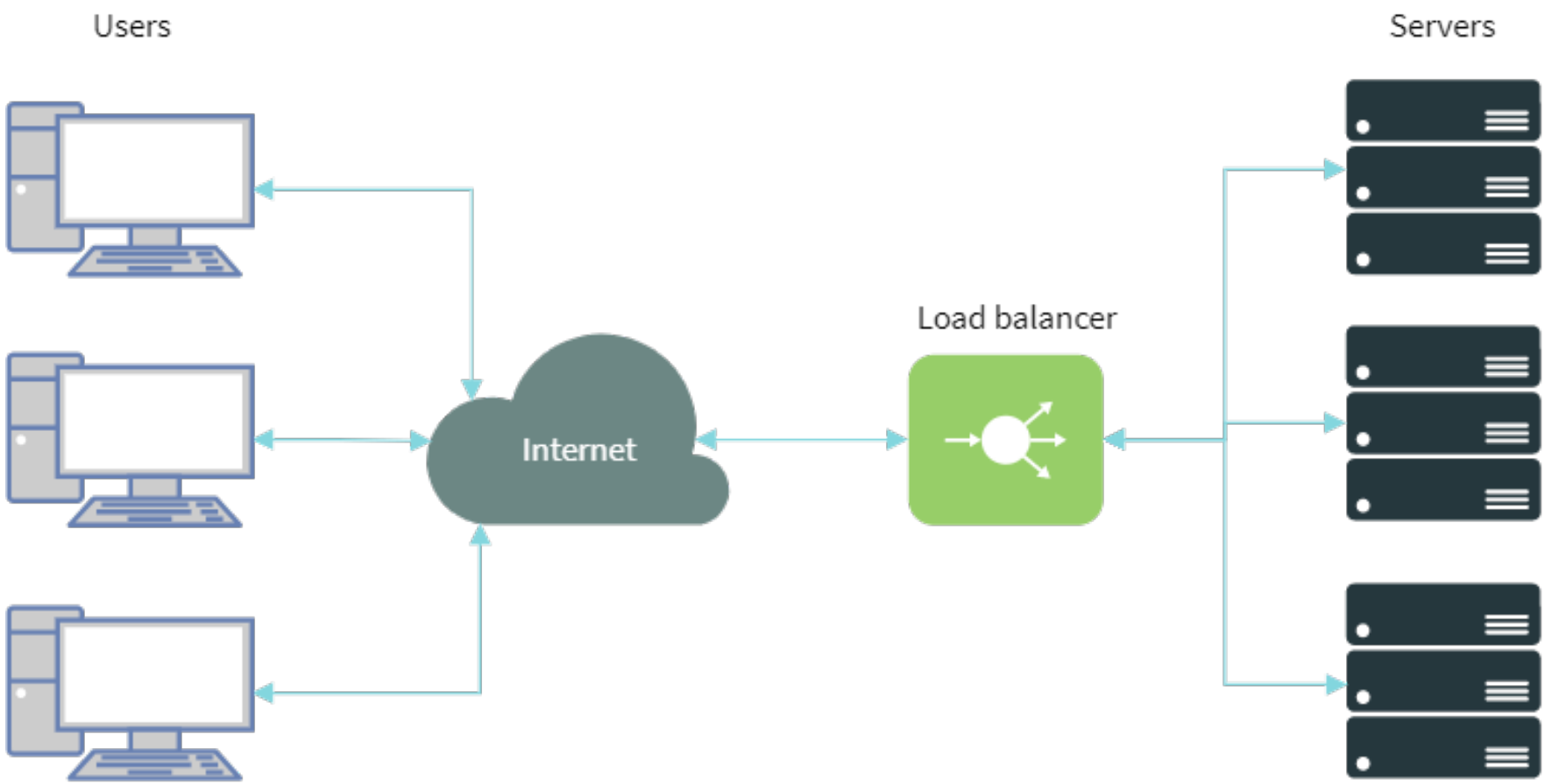
- Let’s read:
  - https://akfpartners.com/growth-blog/scaling-your-systems-in-the-cloud-akf-scale-cube-explained

Horizontal scaling (X-Axis)



http://adrianmejia.com/blog/2016/03/23/how-to-scale-a-nodejs-app-based-on-number-of-users/

Load Balancer

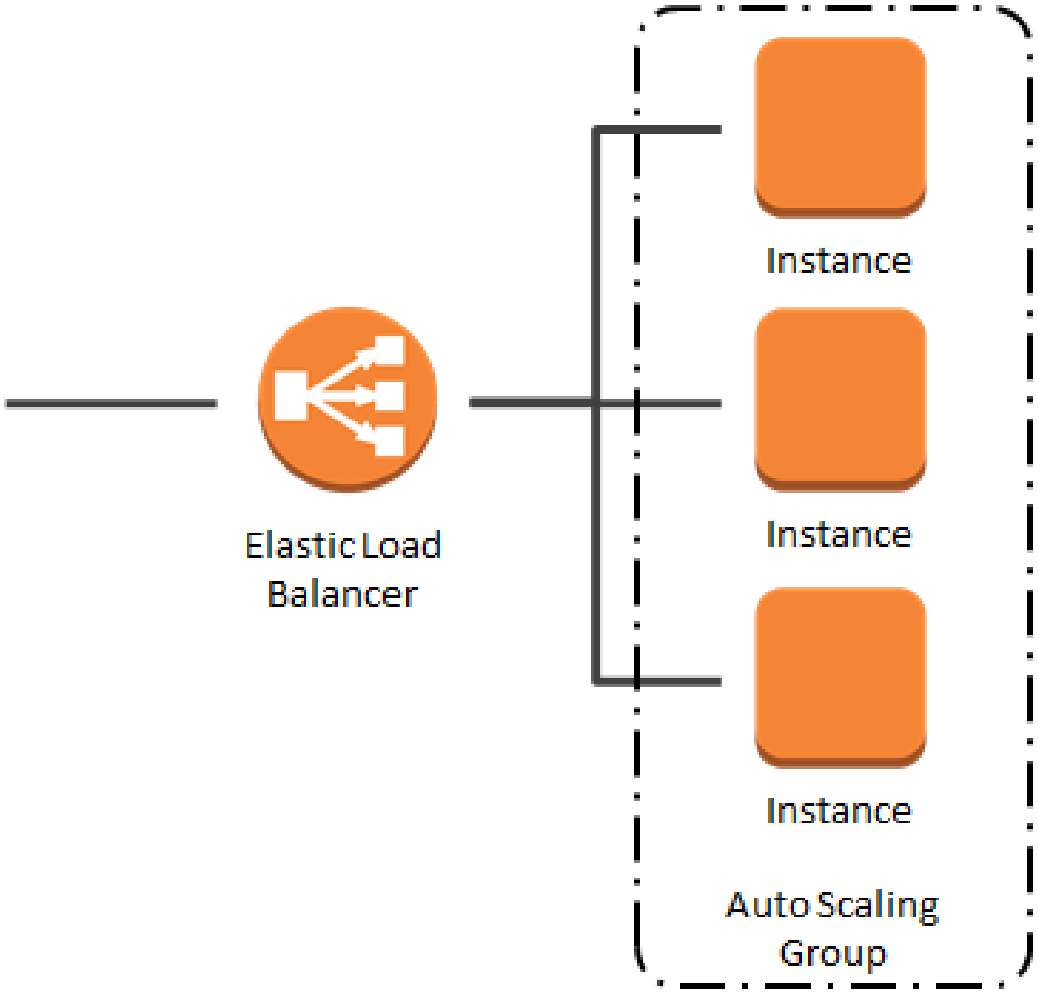


https://www.booleanworld.com/configure-nginx-load-balancer/

Load Balancer

- How many servers do I need ?
- The traffic load changes a lot (during the day or seasons like black Friday/Christmas ,..)
- It costs money to buy servers , also what if we rent → cloud ?

Auto-scaling

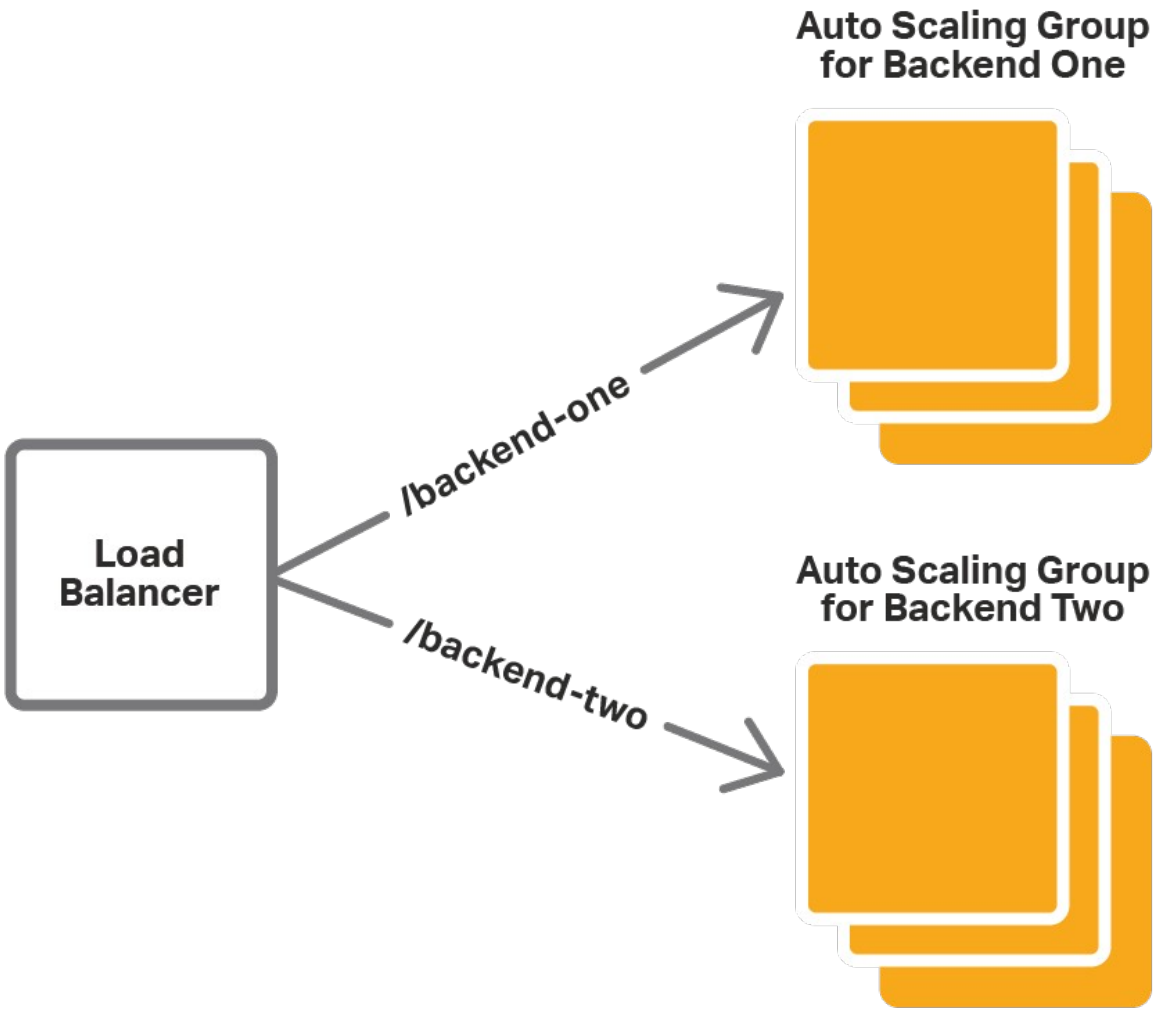


Cloud

Scale up/down based on a metric e.g. #connections

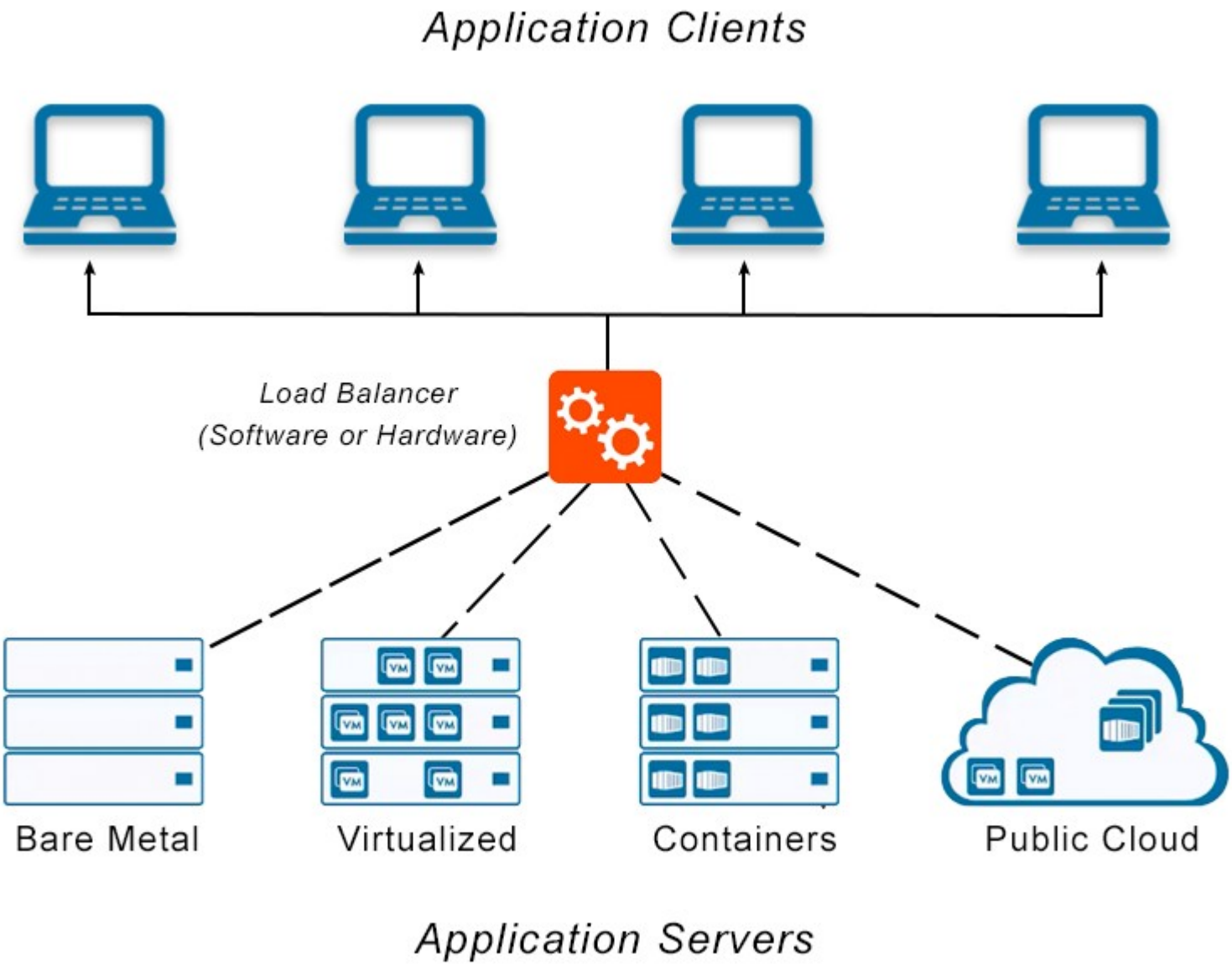
https://aws.amazon.com/blogs/aws/elb-connection-draining-remove-instances-from-service-with-care/

Can Be layered



https://www.nginx.com/blog/load-balancing-aws-auto-scaling-groups-nginx-plus/

In Real life

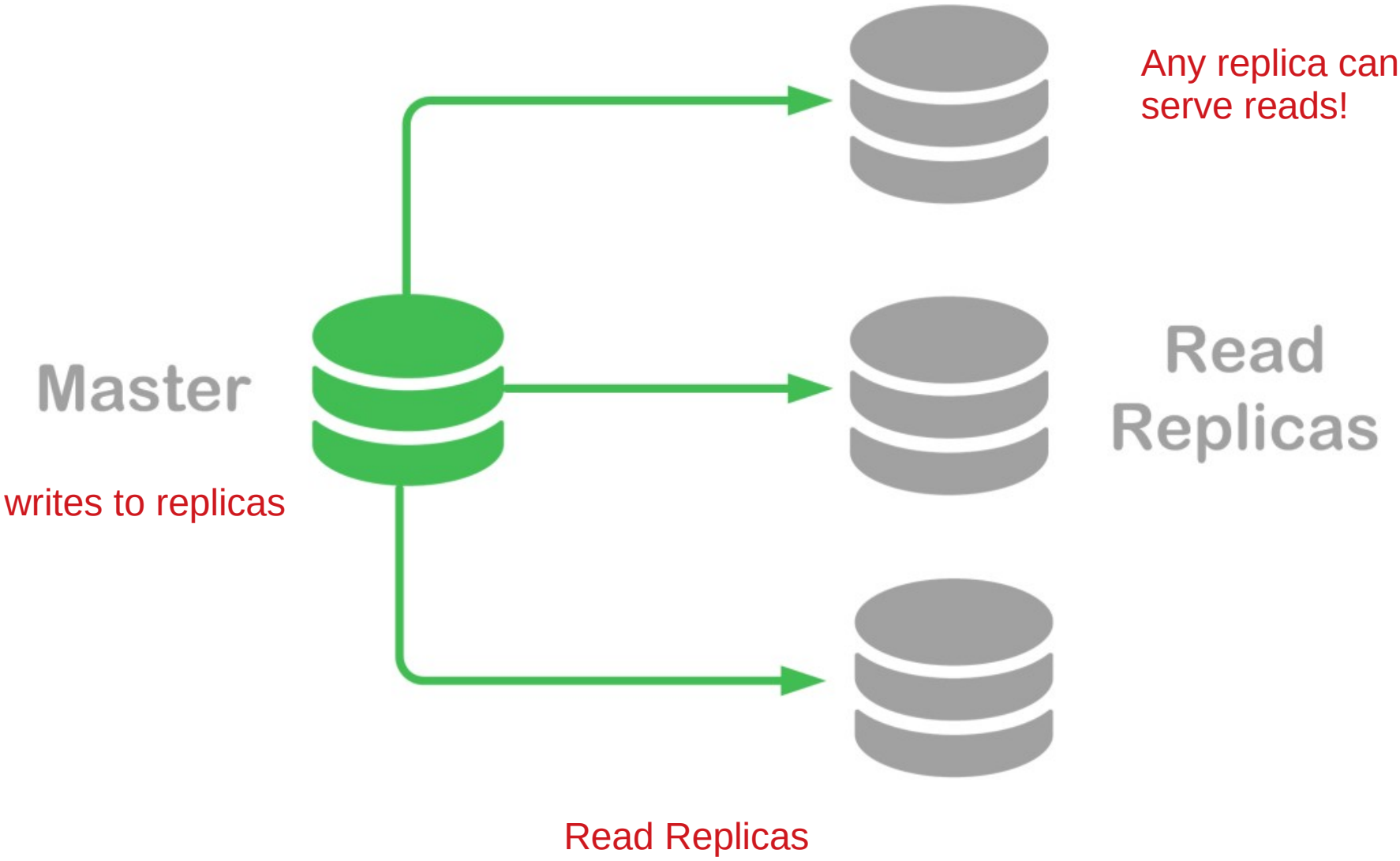


https://avinetworks.com/glossary/load-balancer/

Wait a minute

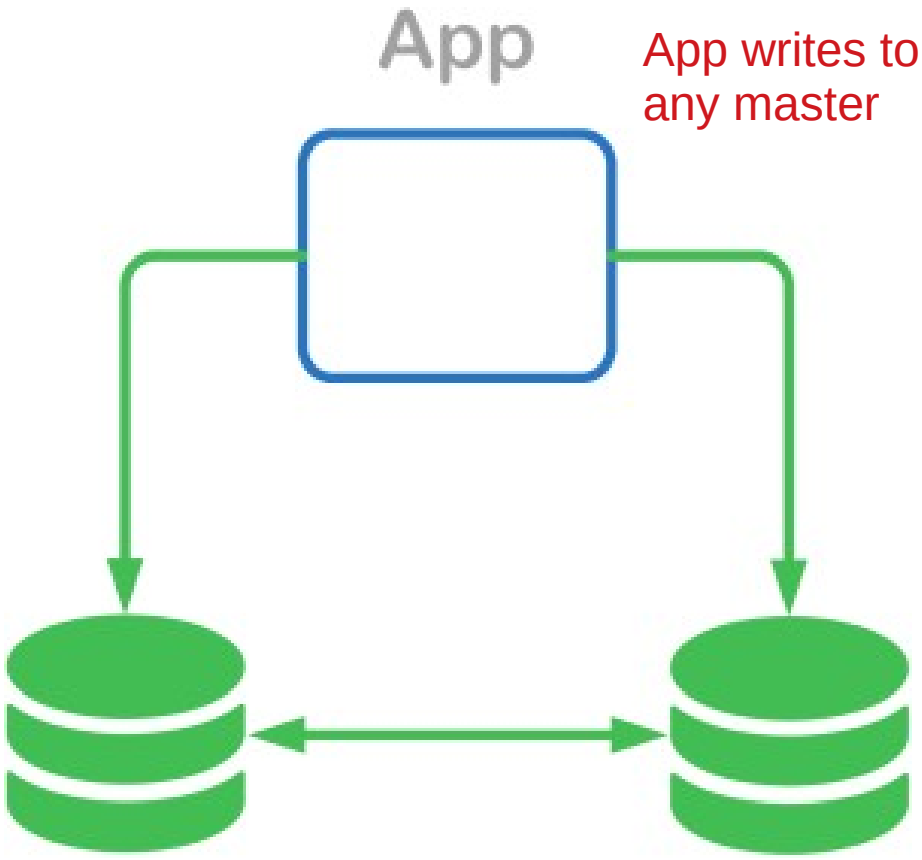
- Horizontal scaling behind LB is fine for stateless services (API servers)
- What about database server ?
  - We must scale it , but LB won’t work :(

serve more reads?



Serve more writes ?

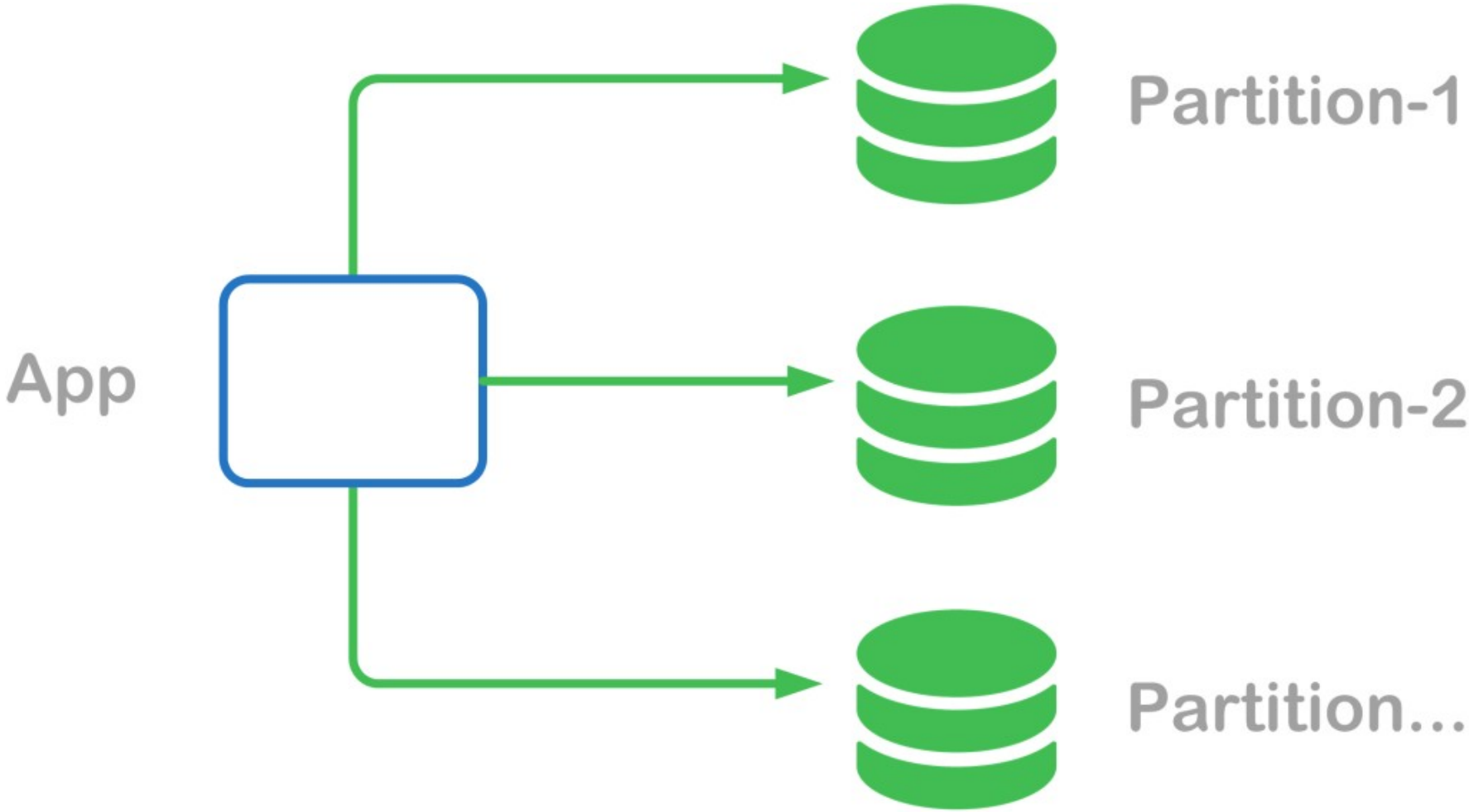
Collisions during sync
Not Simple :(



App writes to
any master

Multi-Master

Store more data



Partitioning

Sharding

- Select an attribute to shard with
- A shard is determined by hash value
- Can cause skews
  - e.g. shard users by country_code
    - Think China and sweden!

Read more

- There are better options, we'll cover later
- Check:
  - http://realscale.cloud66.com/database-server-scaling-strategies/

What we just did?

- We made several servers act like they are just one service to the client
  - Distributed system!

No big deal

- Let’s use more servers and connect them together..
  - What can go wrong?!

Fallacies of Distributed computing

1. The network is reliable.
2. Latency is zero.
3. Bandwidth is infinite.
4. The network is secure.
5. Topology doesn't change.
6. There is one administrator.
7. Transport cost is zero.
8. The network is homogeneous.

Fallacies of Distributed computing

- Got some time? , check
  - https://medium.com/baseds/foraging-for-the-fallacies-of-distributed-computing-part-1-1b35c3b85b53

Our objectives

- Depends on the problem
  - Scale across the globe
  - High availability
  - Resiliency, disaster recovery and fail over
  - Low latency
  - Security
  - Cost
  - ....

Many things to consider

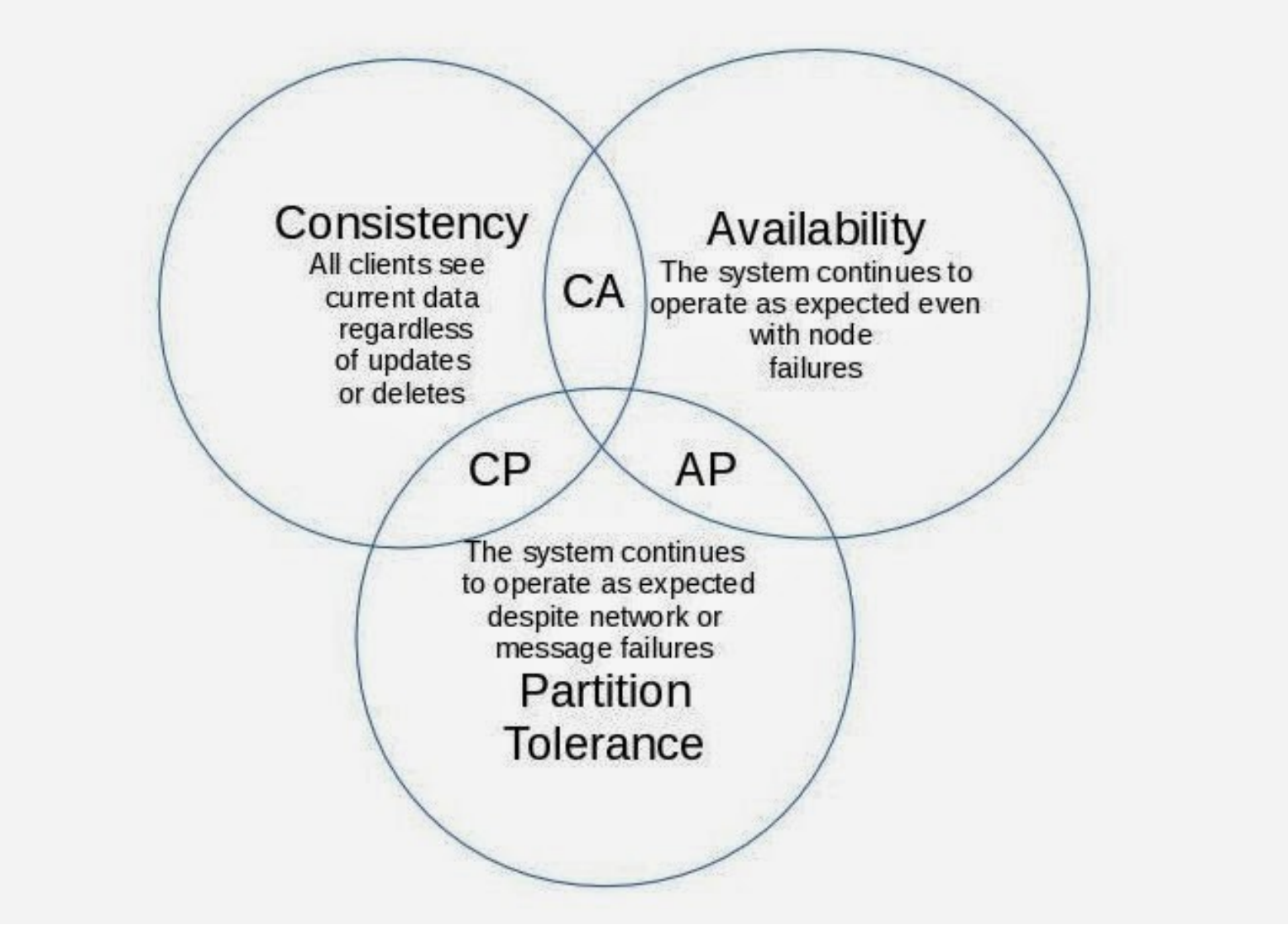
- Computation and Storage
- Discovery and Communication
- Configuration management
- Storing secrets
- Deployment
- logging/monitoring

We need to understand our problem and make the right compromises !

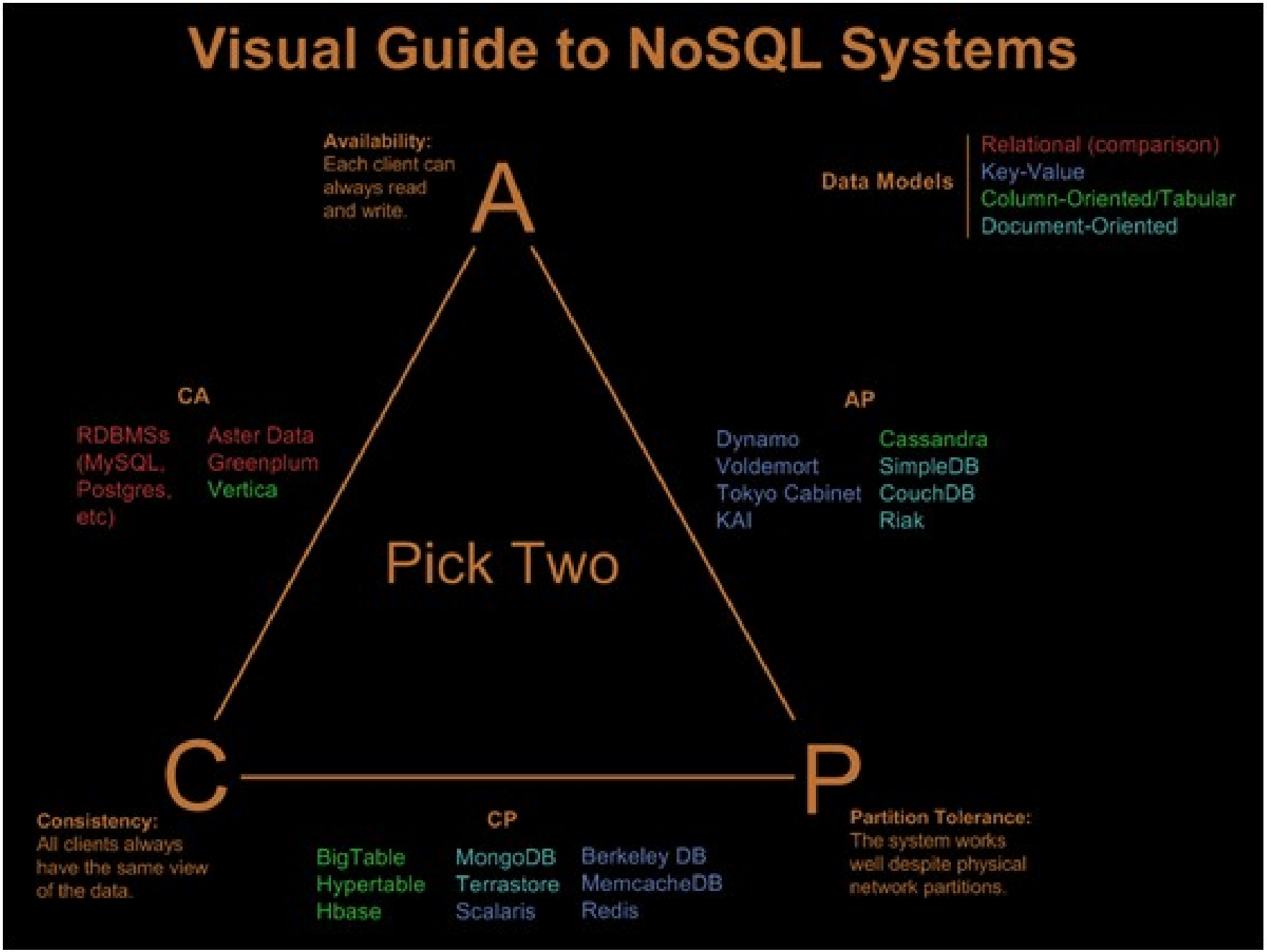
Let’s watch

- Pat Helland | Kafka Summit 2017 Keynote (Standing on the Distributed Shoulders of Giants)
  - https://www.youtube.com/watch?v=p9LBi11KR2c

CAP Theorem



http://remotemysqldba.blogspot.com/2014/06/cap-theorem-on-clusters-in-mysql.html



http://stackoverflow.com/questions/11292215/where-does-mongodb-stand-in-the-cap-theorem

PACELC theorem

- Extension to CAP:
  - When the system is running normally in the absence of partitions, one has to choose between latency (L) and consistency (C)

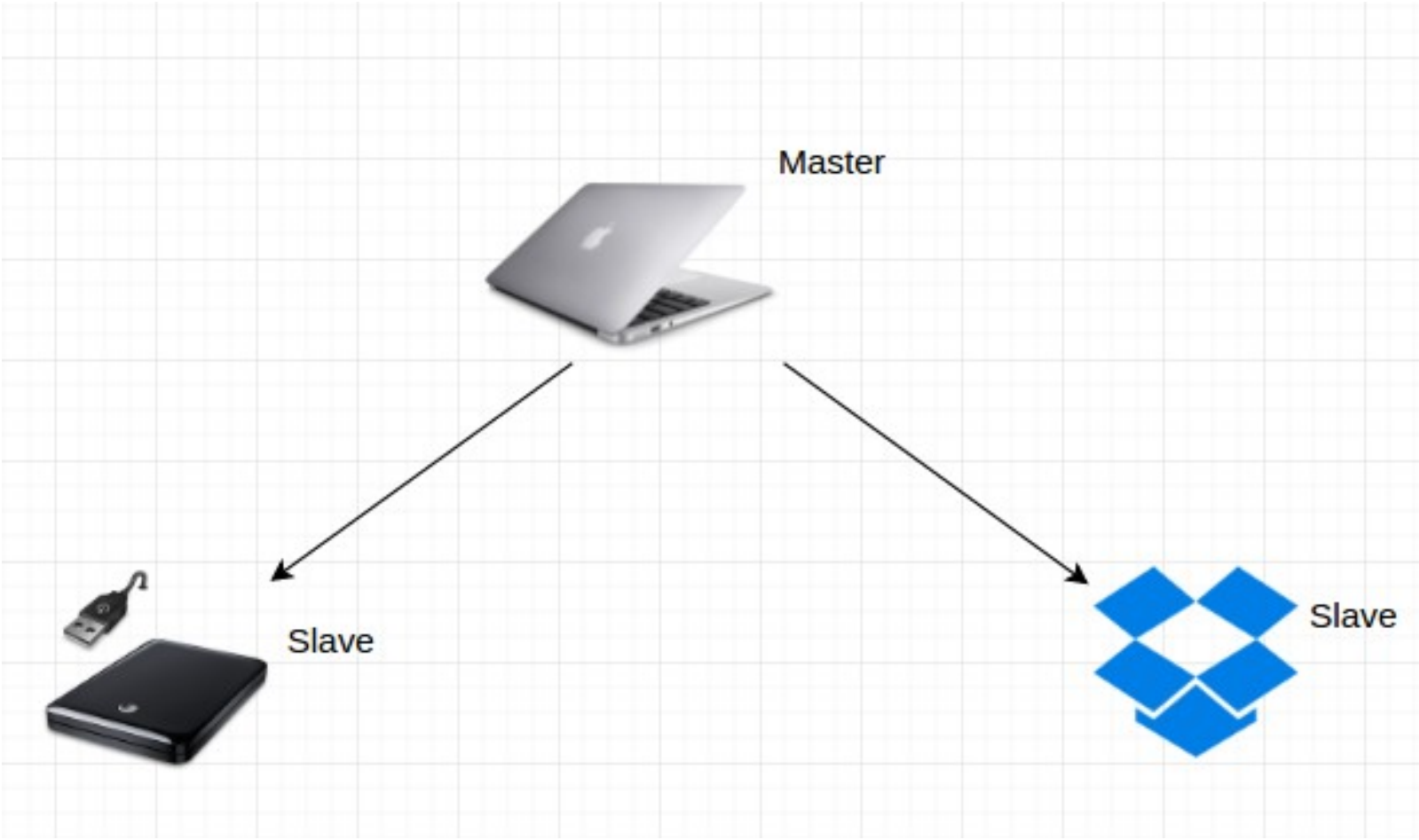
Consistency vs Latency

- Strong Consistency offers up-to-date data but at the cost of high latency (ACID).
- Eventual consistency offers low latency at the risk of returning stale data

Eventual consistency

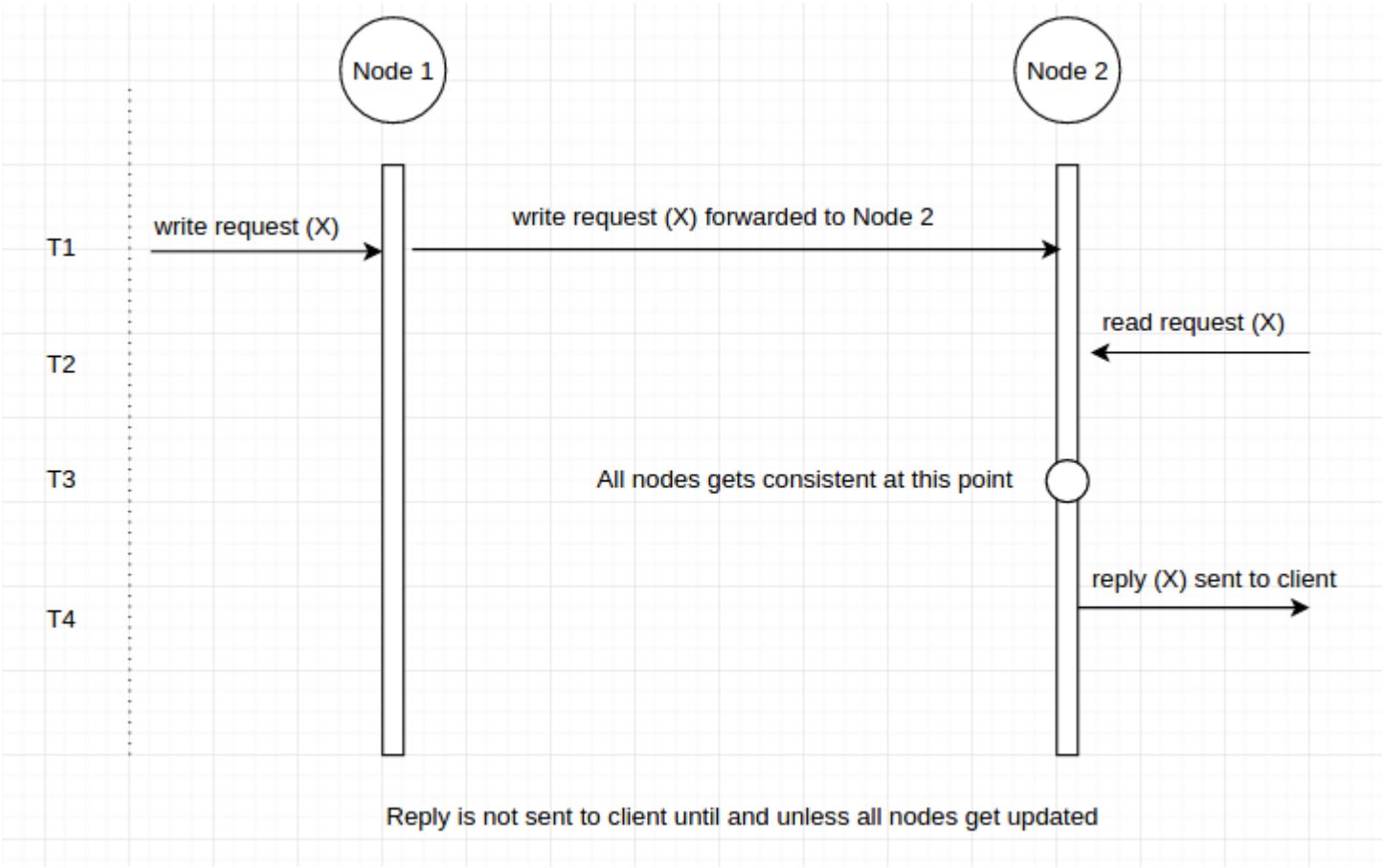
- Expect high availability, In CAP terms : (AP)
- Hint: BASE as opposed to ACID
  - Basically Available, Soft state, Eventual consistency
    - System will respond, sometimes with outdated data, but eventually it’ll converge!

Replication & consistency



https://hackernoon.com/eventual-vs-strong-consistency-in-distributed-databases-282fdad37cf7

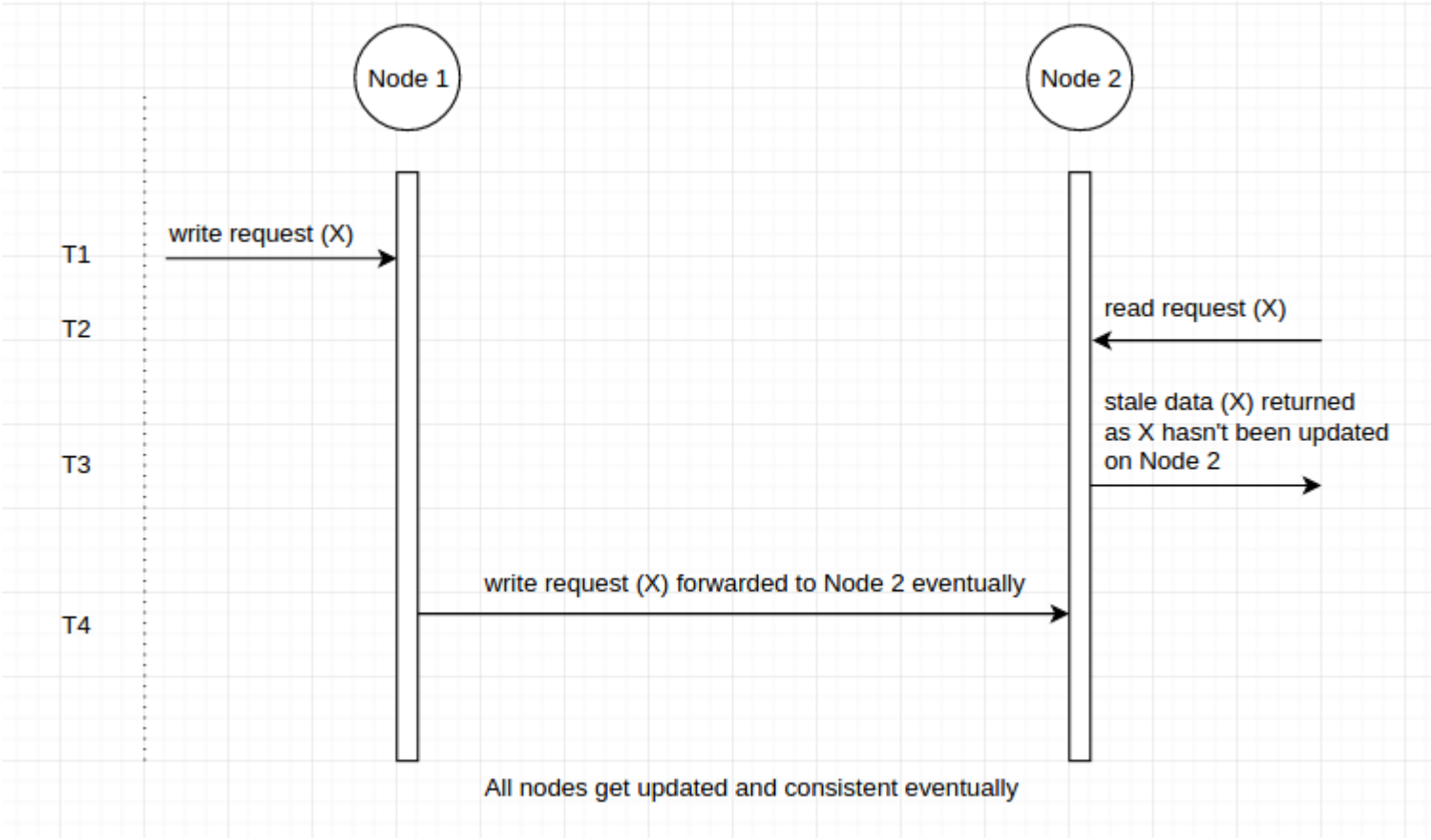
Replication & consistency



Strong consistency

Wait until all replicas are in sync!

Replication & consistency



Eventual consistency

No wait but maybe old data!

Check this out

- Read:
  - https://hackernoon.com/eventual-vs-strong-consistency-in-distributed-databases-282fdad37cf7