

Agenda



starting at 9:10

1. What & Why of HLD support@scaler.com
2. Case Study - [del.icio.us](#) — Case Study +91-7351769221
3. Scaling challenges
4. Stateful vs Stateless servers
5. Consistent Hashing
6. HLD curriculum overview

50% understanding → okay.



Del.icio.us Case Study

Online bookmarking Service

? Launched in

Joshua



2004



2005



2006

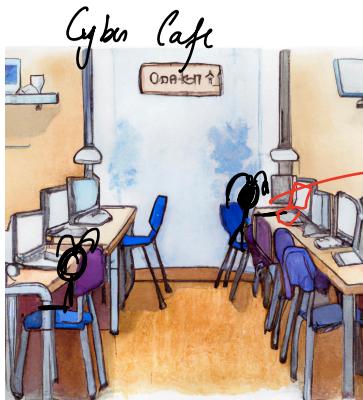


2008

Motivation

no internet at home

is the bookmark
available? X



Scaln.com ✓

now → bookmarks

Synched → on cloud

Features (MVP) Minimal Viable Product

1. Sign Up / Login (user-id)
2. Add Bookmark (user-id, URL)
3. Get Bookmarks (user-id) → [URL]
list of strings

to be continued..

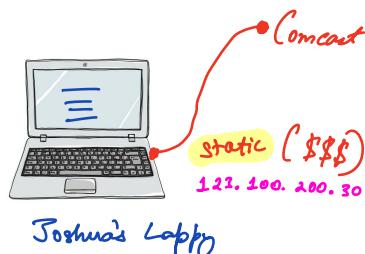
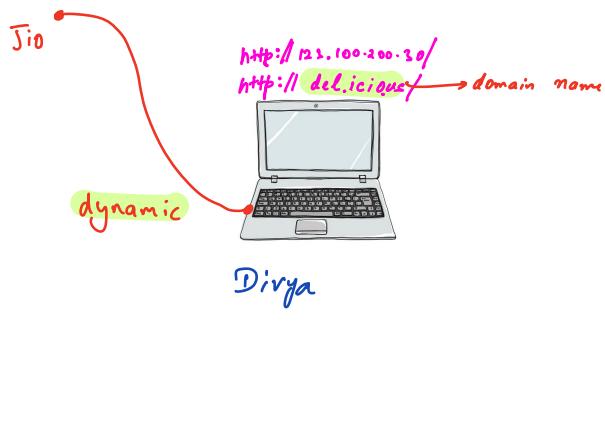


<http://localhost:1234/>
(127.0.0.1)

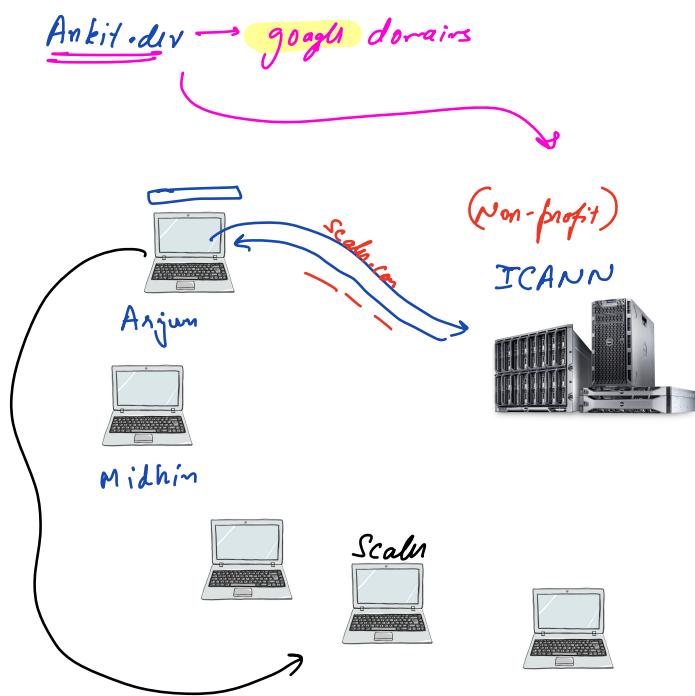


Fantastic websites & where to find them

IP Addresses → Unique → any machine connected to
Domain Names in front



? Quiz - how does the browser know? what is the ip address corresponding to a domain?



DNS Mapping

Domain	Ip Address
delicious	123.100.200.30
scaln.com	_____
google.com	_____
ankit.dev	_____

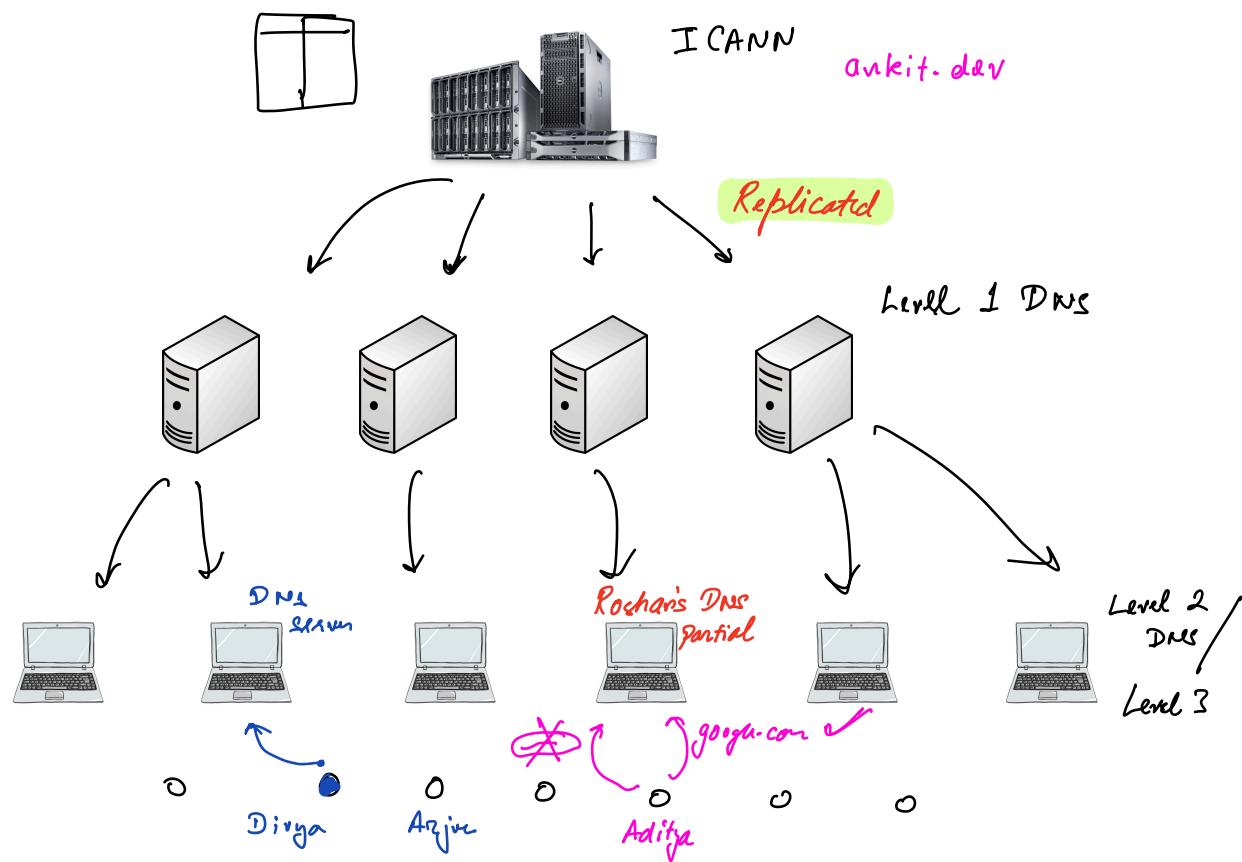
- ① I CANN → I Can't! Crash
- ② Single point ?

failure



Domain Name Service

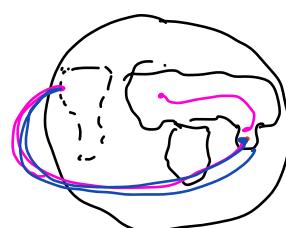
<https://www.cloudflare.com/en-gb/learning/dns/what-is-dns/>



Who maintains the DNS?

Google.com
Microsoft.com
ISP (Airtel / Jio / Comcast)

} they want instant
to be fault-tolerant
& fast



Demos

HLD → estimations

$$\text{Circumference of Earth} \approx 4\pi \times 10^7 \text{ m}$$

$$C = 3 \times 10^8 \text{ m/s (vacuum)} \\ \approx 2 \times 10^8 \text{ m/s (fiber)}$$

$$\text{Time} = \frac{\text{distance}}{\text{speed}}$$

$$= \frac{4\pi \times 10^7 \text{ m}}{2 \times 10^8 \text{ m/s}} \approx 200 \text{ ms}$$

$$\text{Round trip latency} =$$

$$\left\{ \begin{array}{l} \text{Mumbai} \rightarrow SF \\ \text{SF} \rightarrow Mumbai \\ \text{Mumbai} \rightarrow \text{website} \end{array} \right\} \text{DNS}$$

Samsung → Mumbai
Jio → Mumbai → DNS Router
DNS → San Francisco

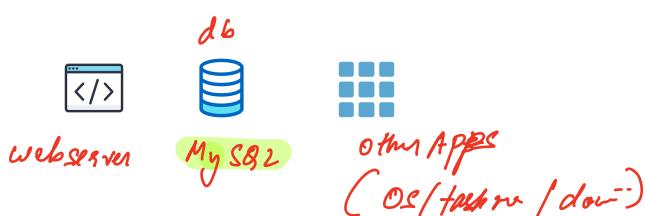


Del.icio.us

continued..

2007 → 35,000 Rs

Joshua's Machine



System Configuration

RAM	128 MB
Disk	40 GB
CPU	Intel Pentium Core 2 duo 2.3 GHz, 2 cores



Issues

① Joshua goes to sleep → Shutdown PC
website goes down

② Downloading Movie / Playing game
website is slow

Dedicated

Server

b

Just another computer

Connected to internet

sole responsibility

to provide some internet service

?

Quiz-space

1 Million bookmarks per day.

bookmarks	URL
1035	http://google.com
1025	scala.com/-
200	chess.com
200	tic-tac-toe.com-

int(64bit) vonchon(1000) text

1 row ≈ 1Kb in size

1M per day $\Rightarrow 10^6$

1Kb per item

total = $10^6 * 1Kb$

4bytes (32 bits)

$$\# \text{ values} = 2^{32} = 4B$$

$$2^{10} = 1024$$

$$2^{20} = 10^3$$

$$2^{30} = 10^6$$

$$2^{32} = 4 \times 10^6 = 4B$$

just like → 32 bit

C view count

C - rc

64 bit

ascii

$$= 10^6 \times 10^3 \text{ bytes} = 10^9 \text{ bytes}$$

= 1 GB



Quiz-time

1 GB per day

90 GB space

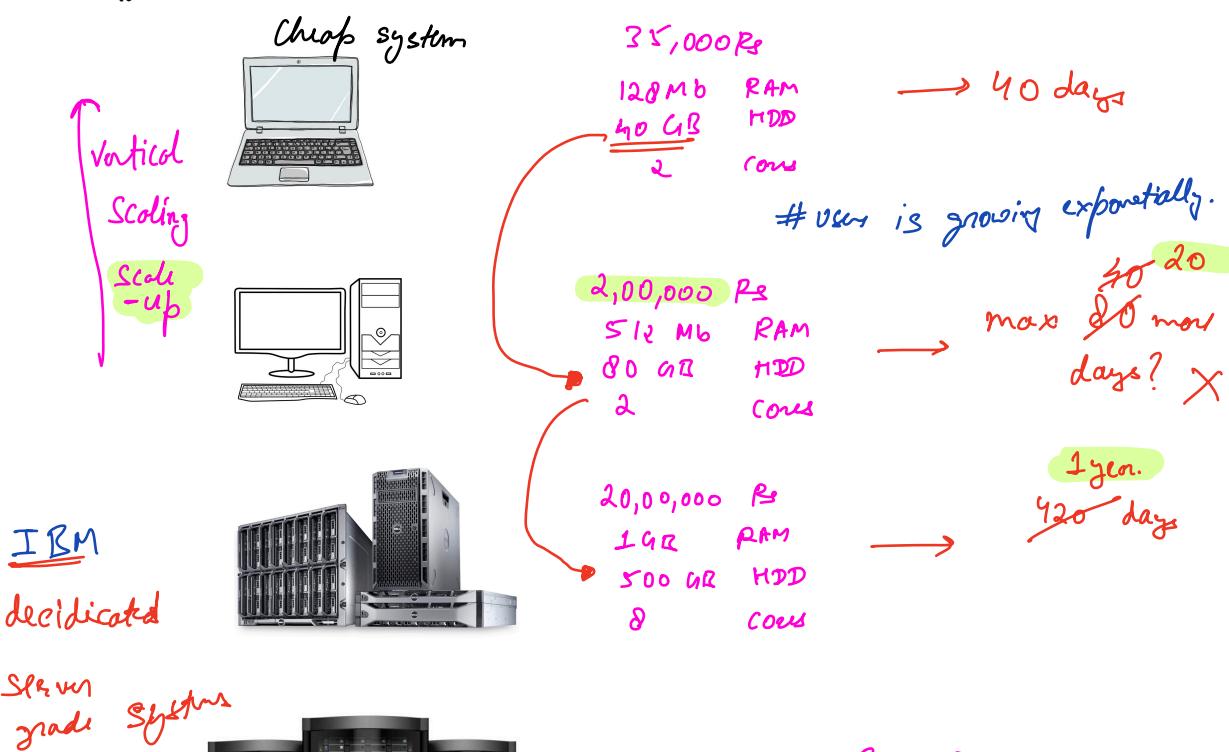
$$\text{Time} = \frac{90 \text{ GB}}{1 \text{ GB/day}} = 90 \text{ days}$$



Solutions

Buy more powerful & expensive system

1.



custom build

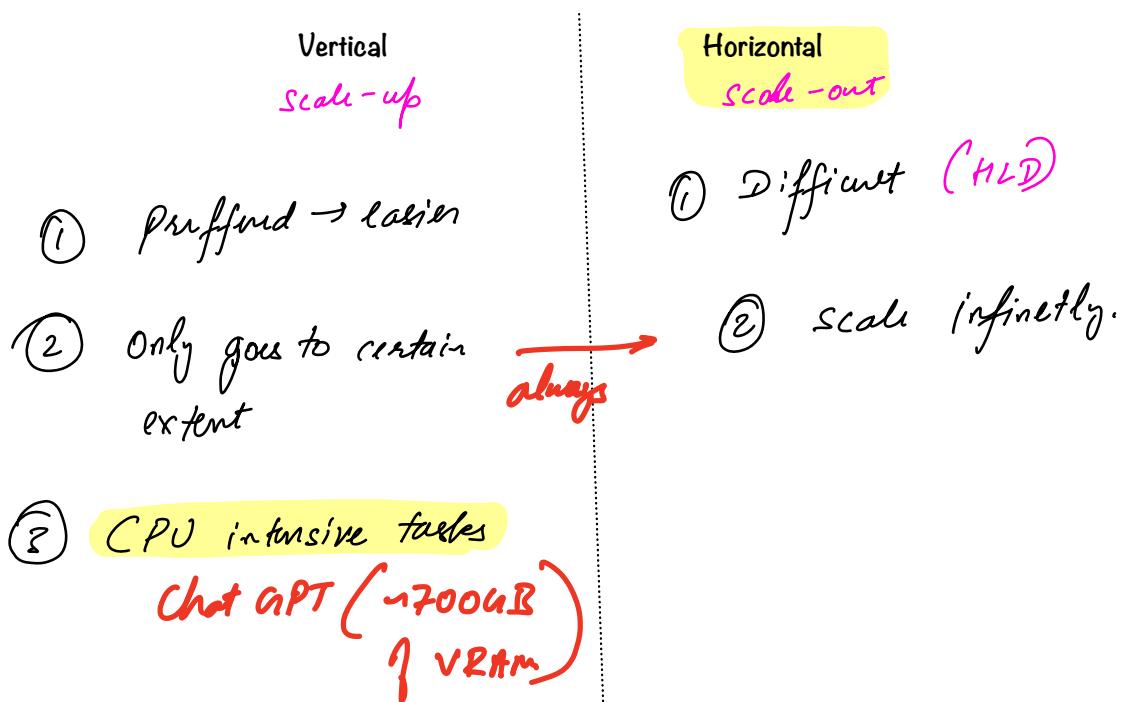
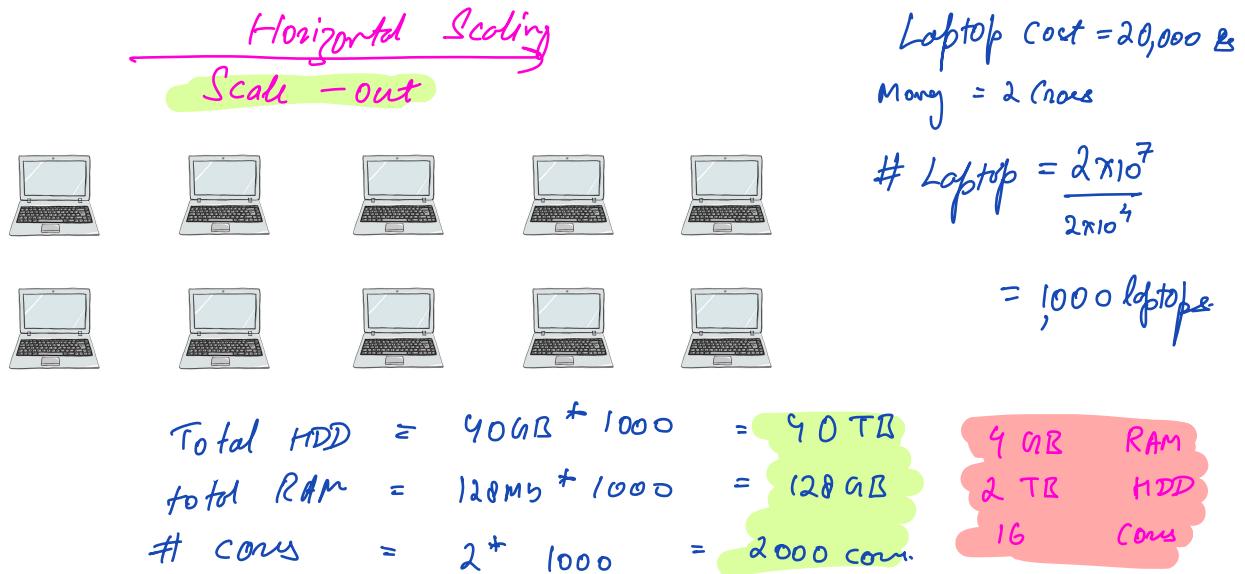


2,00,00,000 Rs (2cores)

4 GB RAM
2 TB HDD
16 Cores

→ 2 years

2. Buy multiple cheap systems



Typical modern server hardware

RAM : 8 GB → 128 GB
HDD : 1 TB → 8 TB
 $\# \text{ cores}$: 2 → 32
bandwidth : 100 MBps → 10 GBps

Rest (costly) current hardware (2023)

RAM : 12 TB
HDD : 1 PB
 $\# \text{ cores}$: 250
bandwidth : 100 GB/s

$\approx 2,000 \text{ } \$ / \text{hour}$

AMD CPU Ryzen
96 Cores
390 MB L3 cache

Spaced Repetition → algorithm to remember things **FOREVER**

- ↳ Medical flow → flashcards
 - ↳ Duolingo / KhanAcademy / Quizlet
- minimize effort you put in



f1 → 10 times

MindWiki → Instructor will provide high quality notes & **flashcards**
 20 mins/day.

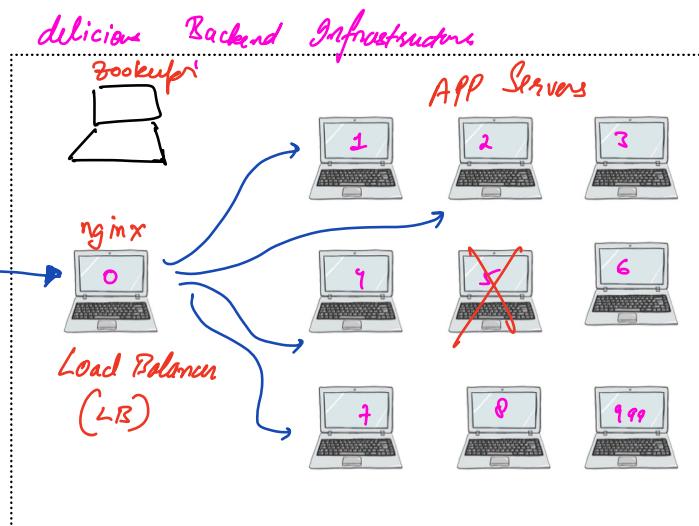
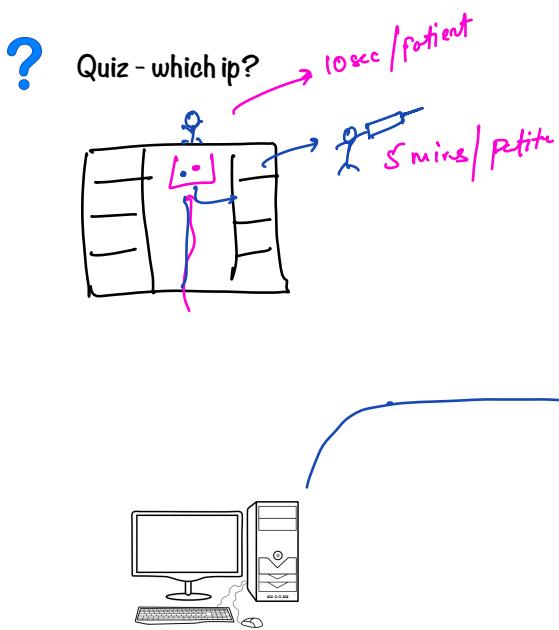
always start with vertical scaling → super easy.

↳ horizontal
layout

typical modern system → 10M users
Bookmarking Service

} 1 single SQL
design

10:30 → 10:40



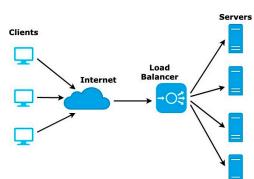
App Server → 100 req/sec

Load Balancer → 100,000 req/sec

API gateway / Reverse Proxy / Load Balancer

Eureka / nginx / Kong / --

Elastic Load Balancer (ELB → AWS)



Load Balancing

https://docs.google.com/document/d/1DxQzLpu1XPe_mRWsewNWtKL6E4uwKHqhBp7GX6Sg7qI/edit

→ LB does NOT perform any fancy computation

Sole responsibility of forwarding requests to the appropriate APP server

- ① Equal load distribution
- ② Help track which servers are online (∴ added/removed)

? How does the Load Balancer track which servers are up & running? → Zookeeper

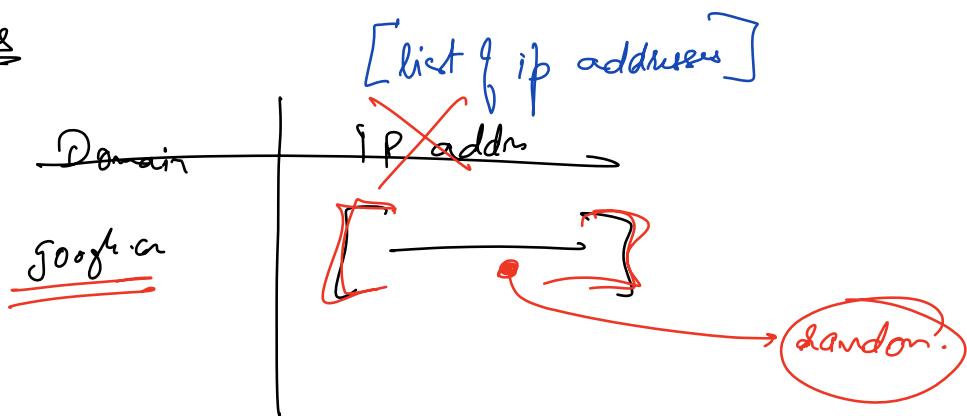
Heartbeat (push)



Health-check (pull)

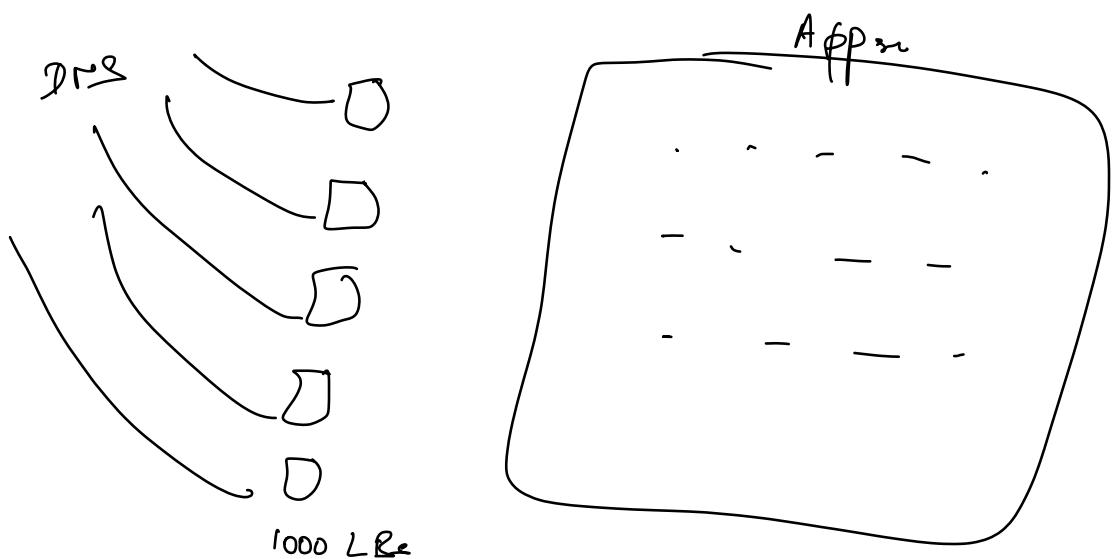


DNS



DNS can also act as a load
Balancer!!

GeoDNS



HLD Curriculum

HLD → SDE 2⁺ position

SDE1 → watch movie

- ① Intro + Consistent Hashing

extra class

- ② Caching (2) → DNS cache / CDN / global/local / invalidation / eviction /
Code judge → DSA Case studies

- ③ CAP theorem / Master-Slave Replication

- ④ SQL vs NoSQL → Key-Value / Doc / Col / Graph → Sharding / LSM Tree
(3) Tunable Consistency / Multi-Master

- ⑤ Case Studies → Typerahead / Messaging / Uber - Zant / Elastic Search
FB / WhatsApp / Slack QuadTree
Hotspot / Booking System
(video stream) IRCTC

- ⑥ Zookeeper / Kafka (Msg Queue)

- ⑦ S2 / Hbase

- ⑧ Microservice Architect → Event driven / Saga flow /
distributed transactions.

1.5 months

in Majority → I/O bound (DB / VM / network)

v. few → CPU bound (DSA problems / video encoding /
compression / AI / Analytics)

4TB of HDD → 5,000B

perf

Further Challenges



What if the Load Balancer goes down?

?

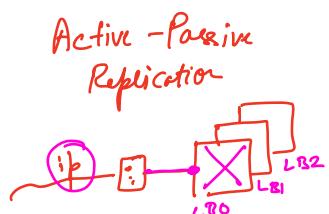
Which machine should we send the request to?

?

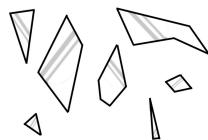
Routing Algorithm

<https://docs.nginx.com/nginx/admin-guide/load-balancer/http-load-balancer/>

single point of failure?



How to store the data?



Sharding?

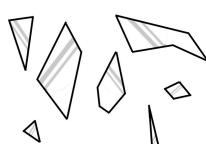
Can we store all data on 1 machine?

?

Split randomly?

?

sharding



%

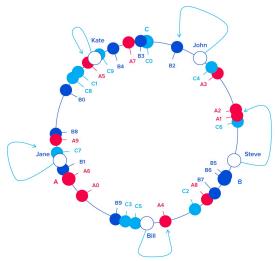
Simple mod



Mapping Table

Range





Consistent Hashing

