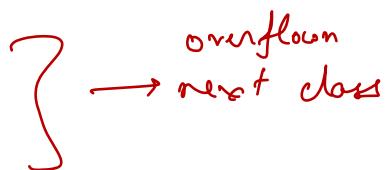


Agenda

1. What & Why of HLD ✓
2. Case Study - [del.icio.us](#) ✓
3. Scaling challenges ✓
4. Stateful vs Stateless servers
5. Consistent Hashing
6. HLD curriculum overview

support@scaler.com

+91 7351769231
(whatsapp)



Traditionally write & execute code on 1 machine (your machine)

↳ handle 100s of requests / sec

How do you scale to million / billion users

↳ how to architect the solution

For senior roles

HLD is a must!!

Google's Staff Soft Eng position.

↳ file → a bunch of strings (search queries)

↳ sort this file in asc.

There is 50 Peta Bytes of data.

10^3 - KB
 10^6 - MB
 10^9 - GB
 10^{12} - TB
 10^{15} - PB

50 Million GB
of data.



Del.icio.us Case Study

Bookmarking Service.

? Launched in

Joshua, 2003



2003



2005



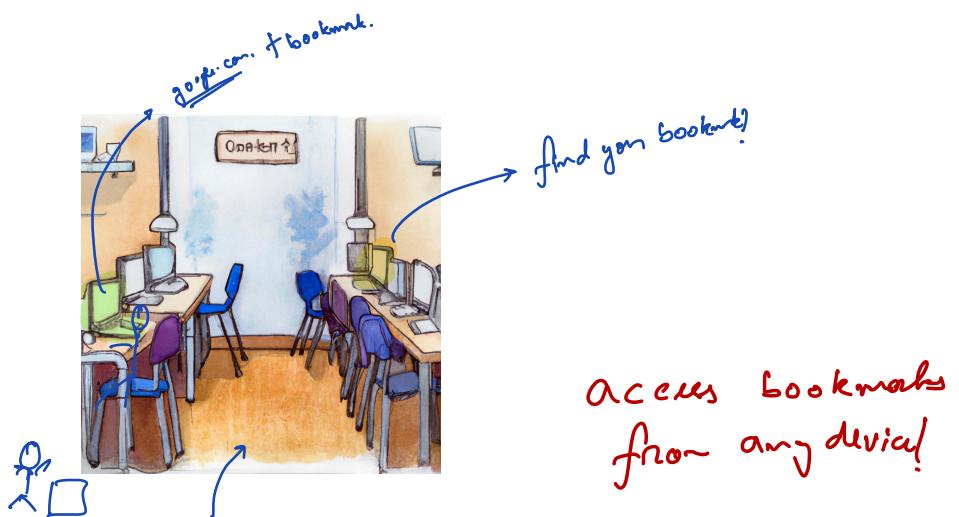
2006



2008

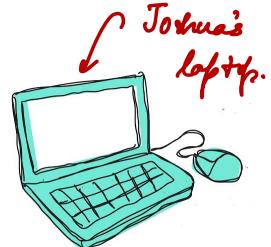


Motivation



Features → Minimal Viable Product (MVP)

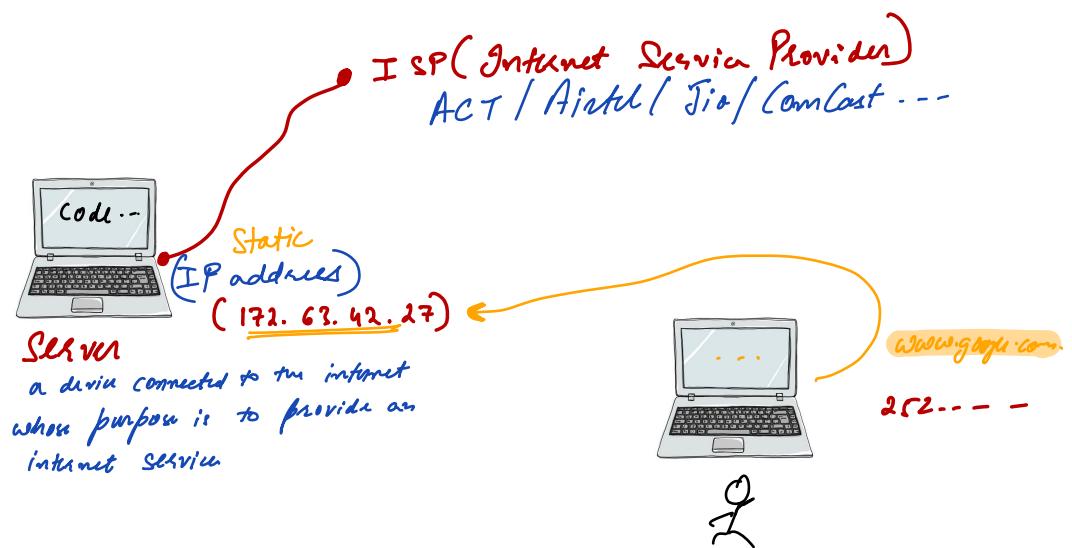
1. User registration & Login (Auth)
2. add-bookmark (url, user-id)
3. get-all-my-bookmarks (user-id)



to be continued..

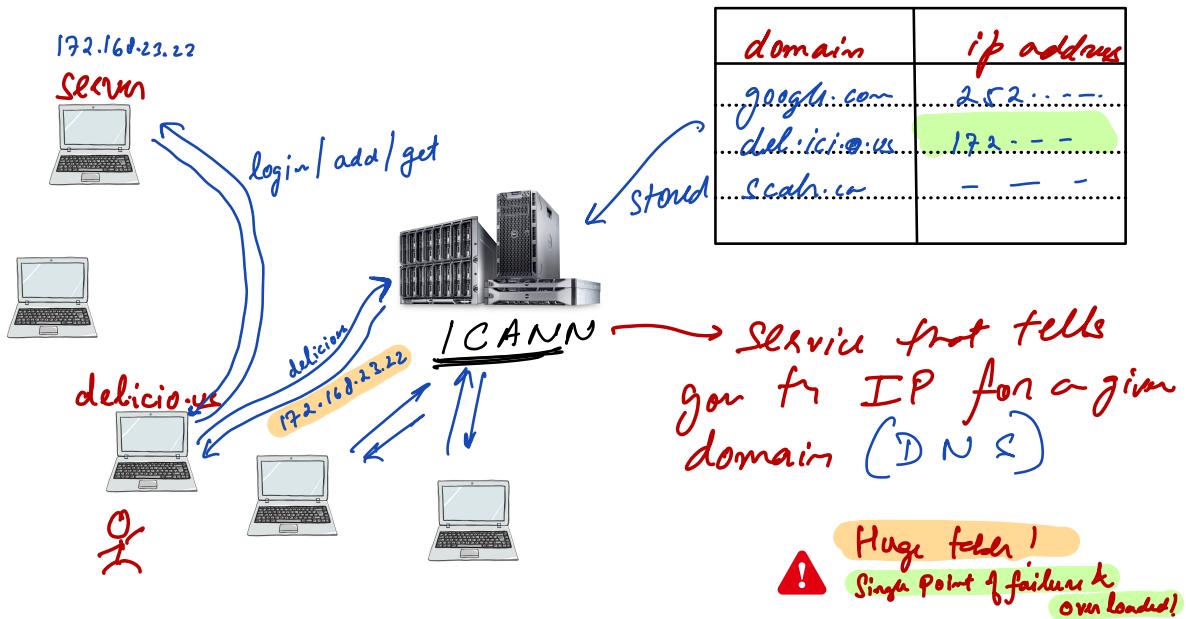


Fantastic websites & where to find them



? Quiz - how does the browser know?

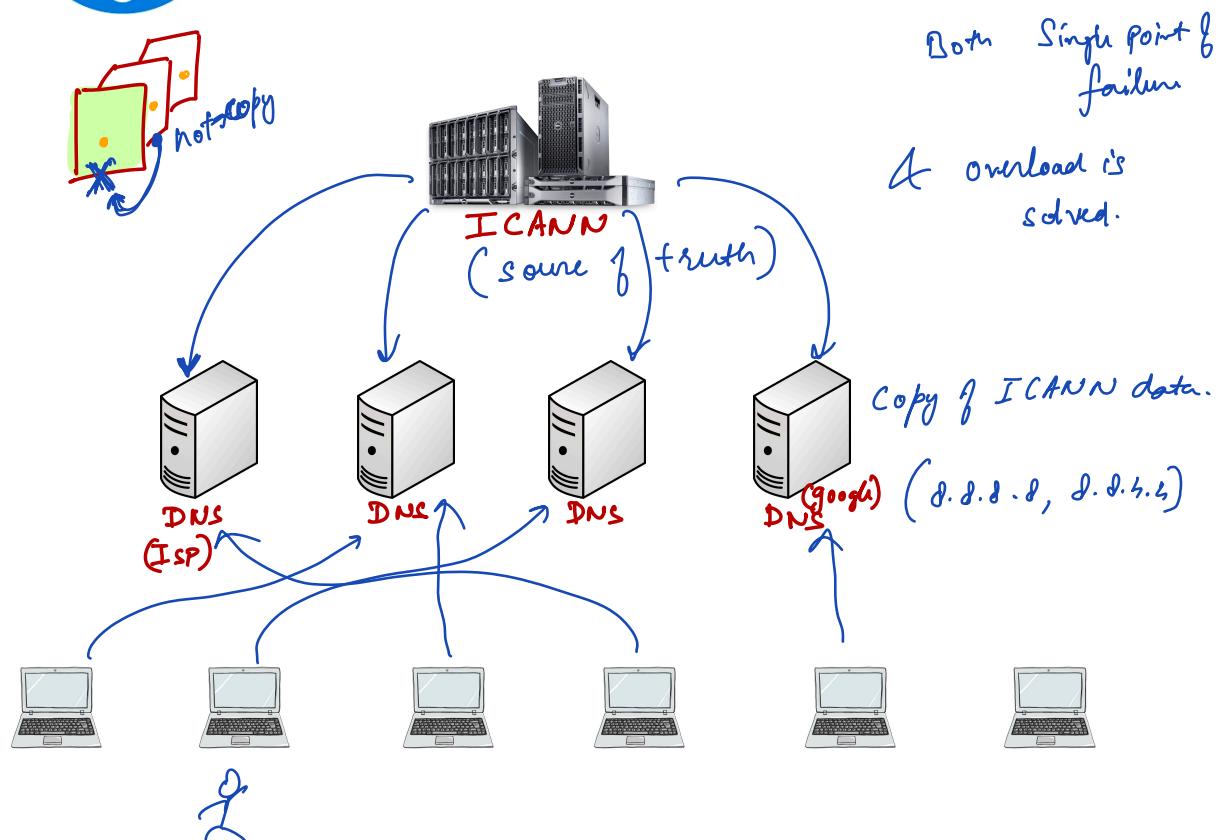
↳ somewhere there is a mapping





Domain Name Service

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

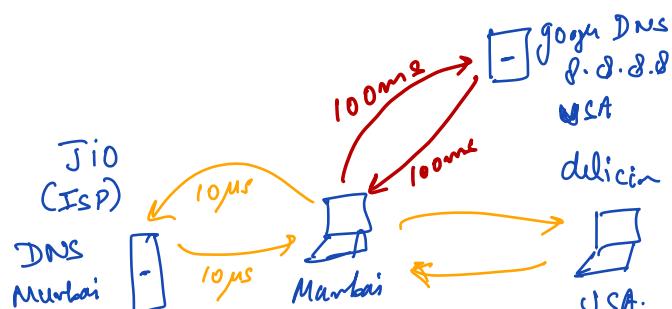


Who maintains the DNS?

domain registrar

godaddy
namecheap
google domains

Demos





Del.icio.us

continued..

loop?

System Configuration



RAM 128 MB RAM

Disk 50GB

CPU Intel Pentium Dual Core
3.2 GHz.

Postgres



del.icio.us DB



App/OS/take



Issues

① goes to sleep? System is shutdown
website goes down!!

② game / downloading website runs slow

③ Power outage website goes down

?

(disk)

Quiz - space

$$\begin{aligned} 2^{30} \text{bytes} &\rightarrow \# 2^{16} = 65536 \text{ values} \\ 4 \text{bytes} &\rightarrow \# 2^{32} \approx 4 \text{ Billion} \\ 8 \text{bytes} &\rightarrow \# 2^{64} \approx 16 \text{ BB} \end{aligned}$$

user-bookmarks	
4 bytes	1000 chars
user-id	url
2	google.com
21	dbdb.io
2	Scaln.com
101	netflix.com

index

1 KB per bookmark

1 Million bookmarks / day

amount of data / day

$$= 1 \text{ KB} + 1 \text{ M}$$

$$= 1 \text{ GB of data}$$

1 row $\approx 1 \text{ KB}$
(1000 bytes)

? Quiz-time

1 GB data/day

40 GB HDD available

$$\text{time to run out} = \frac{40 \text{ GB}}{1 \text{ GB/day}} = 40 \text{ days}$$



Solutions

1.

Upgrade Machine



128 Mb
40 GB
duo-con

30,000 Rs

Personal
Computing



512 Mb
100 GB
duo-con

2 lakh Rs

≈ 100 days (3 months)

dedicated
IBM
hardware



2 GB
500 GB
duo-con

10 Lakh Rs

≈ 500 days (< 2 years)



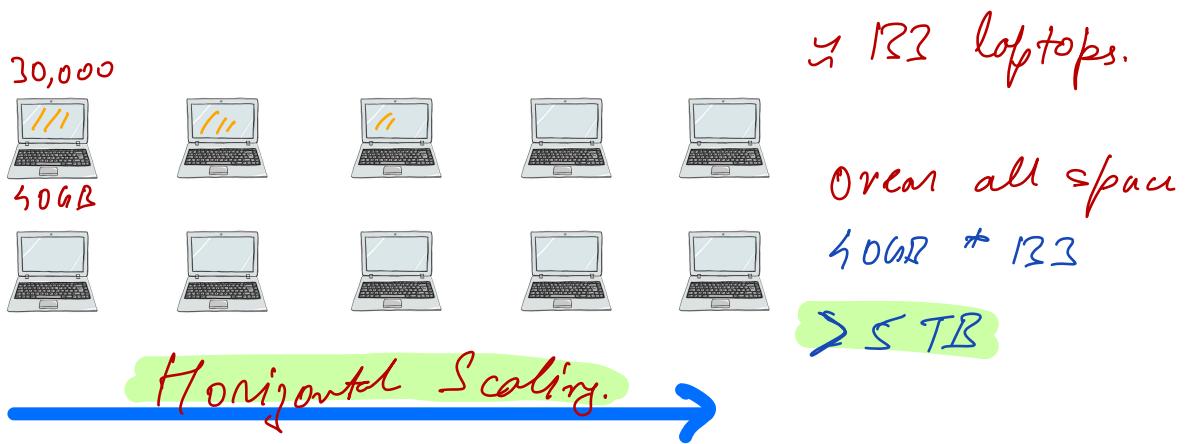
500
1 TB
20 duo-con

2 crore Rs

a few years.

↑
SCALING
VR T1 CAV

2. Buy a lot of cheap laptops.



scale-up

Vertical

scale-out

Horizontal

- simple

- difficult to manage

- hard limit
to how much

- unlimited

we can scale

① technology is
not there

Price grows sub-linearly
∴ economy of scale.

② Price will grow
exponentially.

- first choice

- last choice

- AWS (0-12+6-112x log₂)

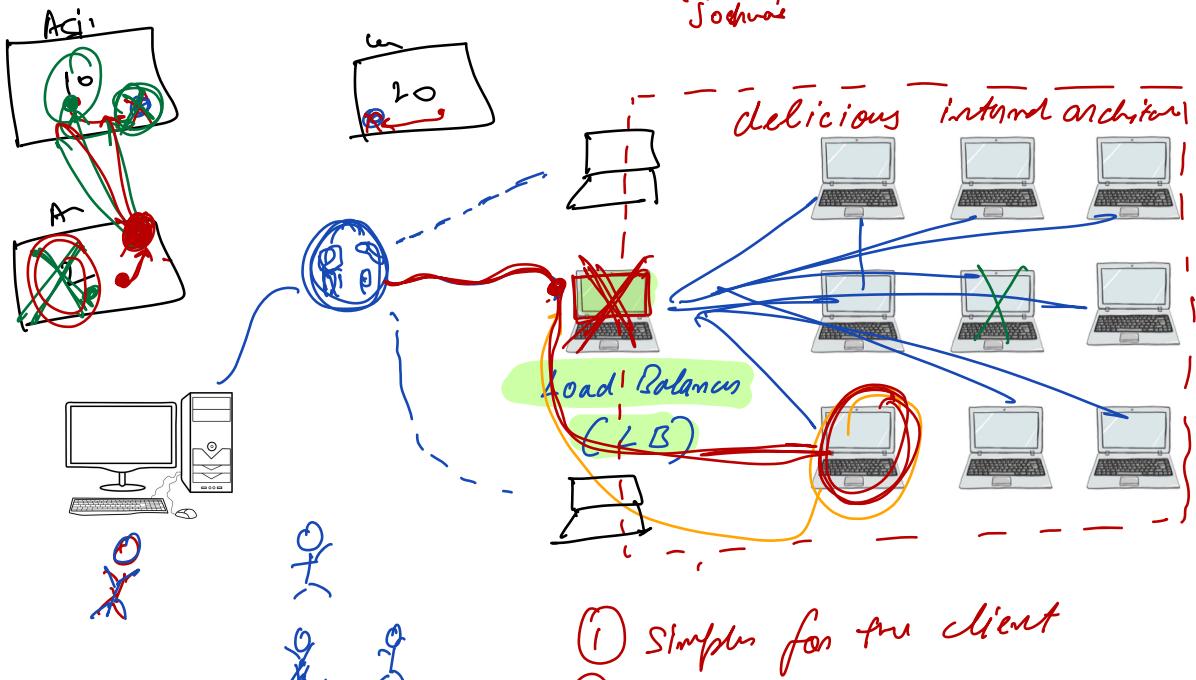
448 GPU
12 TB of RAM
100 Gbit/s

1 million user

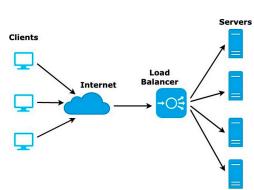
109 \$ per hour

10:55 → 11:00

Quiz - which ip?



- ① simpler for the client
- ② better security
- ③ possible to change & scale internal architecture freely.



Load Balancing

<https://docs.google.com/document/d/1DxQzLpu1XPemRWsewNWtKL6E4uwKHQhBp7GX6Sg7qI/edit>

① Load Balancer!
 → reroutes requests to the appropriate server.
 → distributes load evenly across servers.

- ② isn't the LB a single point of failure?? Not really
 → easily switchable.
- ③ isn't the LB overloaded? → ① simple computation. → 10 million req/sec
 → ② multiple load balancers

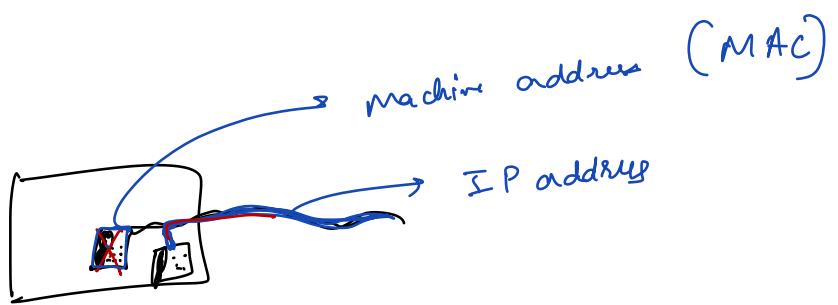
④ How does the Load Balancer track which servers are up & running? & ip mappings in DNS.



Heartbeat (push-based) → servers send a periodic signal to LB → "I am alive!!"



Health check (pull-based) → LB sends requests to each server periodically to check if it is alive.





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/>



How to store the data?

? Can we store all data on 1 machine?

? Split randomly?



Sharding



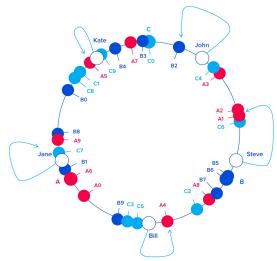
Simple mod



Mapping Table



Range



Consistent Hashing



- ① HLD 101 & consistent Hashing
 - ② Caching
 - ③ Caching contd.
 - ④ CAP theorem & Master Slave
 - ⑤ SQL vs NoSQL
 - ⑥ NoSQL
 - ⑦ Case Study — Type ahead
 - ⑧ Multi-master
 - ⑨ Case study — Messaging.
Notification.
 - ⑩ Zookeeper + Kafka
 - ⑪ Case study — Elastic Search
 - ⑫ Nearest neighbor — Quad Trees
file storage (ss)
 - ⑬ Case study — Uber
 - ⑭ Popular Interview Question
 - ⑮ Hotstar
 - ⑯ Microservices
- ① Delicious
- ② theoretical
- ③ ⇒ Andrew
- ④
- ⑤
- ⑥ ⇒ Murdit

① Consts — IRCTC concurred.

②

Cheat Sheets → when to choose what Database
Common Cloud Provider

8+ years to explain for SDE3 role.

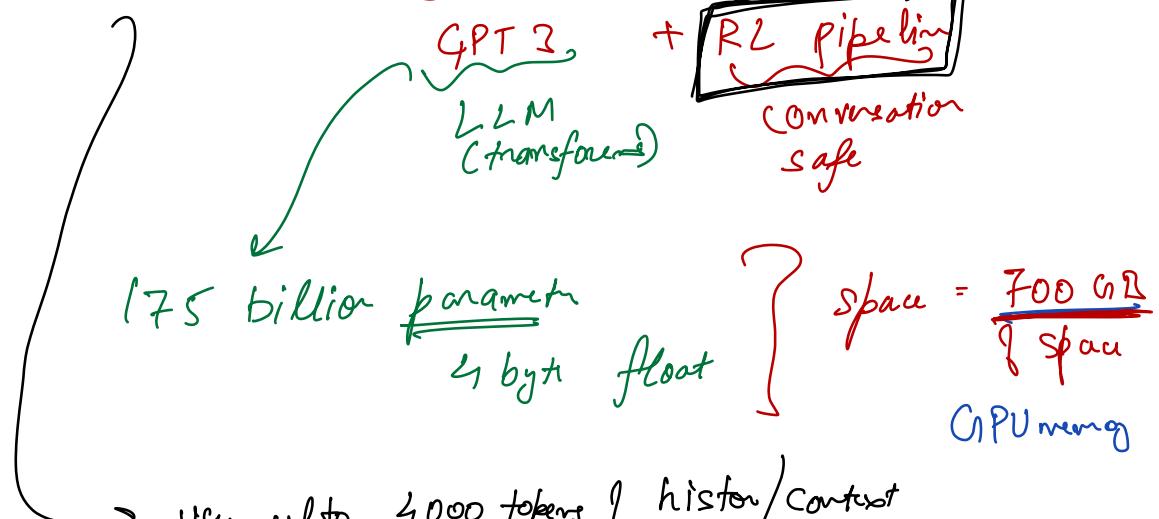
Chat GPT → GPT 3.5 architecture

GPT 3

LLM
(transformer)

+ RL Pipeline

conversation
safe



every req can take $\frac{1s}{\text{CPU}}$ compute time
↳ 0.04 \$ per req.
100 million req / day.

OpenAI was burning 5M \$ per day.

git / docker

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