Day 10 Capacity estimation & design

Networking

Transport layer
TCP - Stateful
UDP - stateless

Stateful
- Sticky sessions
- Sticky load balancing
- Sticky cookies
- Sticky headers

Stateless
- Stateless
- JWT
- Cookies
- Redis

Application layer: HTTP/HTTPS, etc.

HTTP 1 - persistent connections

TCP closing connections - sticky load balancing

HTTP 2 - multiplexing, server push, header compression

HTTP 3 - multiplexing, no head-of-line blocking

HTTP method: GET, POST, PUT, DELETE, PATCH, HEAD, OPTIONS, TRACE, CONNECT → safe, idempotent

Rest API Communication
1) Short polling
2) Long polling
3) Web sockets
4) Server Sent Event

Monolithic vs Microservices

1) Strangler - Fig pattern
2) Branch by Abstraction pattern

RPC (Remote Procedure Call)

Gossiping

CAP Theorem

Consistency
Availability
Partition Tolerance (Pick 2 out of 3)

Message Queues

Kafka - Brokers
- Clusters
- Producers
- Consumers
- Consumer group
- Topic
- Topic partition - Replication
- Replicas

Messaging: Topic → Pub/Sub messaging
Message queue → Point to point

Caching

Cache eviction policy
- LRU
- LFU
- FIFO
- LIFO
- MRU

Cache invalidation

Write through cache
Write back cache
Write around cache

Proxy
- Forward proxy
- Reverse proxy

Load balancing strategy

Consistent hashing
- Strategy to minimize redistribution among nodes when servers
- Scalability

Scaling: Horizontal, vertical

Partitioning - Pattern fixed partitioning
- Dynamic partitioning

Capacity Estimation

Traffic estimation
Storage estimation
Bandwidth estimation

1 Million = 10^6
1 Billion = 10^9
1 Trillion = 10^{12}

$1 KB = 10^3 B$
$1 MB = 10^6 B$
$1 GB = 10^9 B$
$1 TB = 10^{12} B$
$1 PB = 10^{15} B$
$1 EB = 10^{18} B$
$1 ZB = 10^{21} B$

Any

$2^0 = 1$
$2^1 = 2$
$2^2 = 4$
$2^3 = 8$
$2^4 = 16$
$2^5 = 32$
$2^6 = 64$
$2^7 = 128$
$2^8 = 256$
$2^9 = 512$
$2^{10} = 1024$
$2^{32} = 4 \times 10^9$

Twitter - 2 billion
Image - 1 TB MB
Video - 3 TB MB
Video - 10 MB - 15 min → 1 hour → 600 MB/min

$365 \times 8 \approx 2000$
1 Million/day ≈ 12 /sec → Round off to 100 per sec

World population - 8 Billion
Indian population - 1.5 Billion

DAU - Daily Active User
MAU - Monthly Active User

Whatsapp/Youtube DAU ≈ 2 Billion users
Twitter DAU ≈ 200 Million
↳ Challenge
↳ 500 Million

(In interviews always give a number to ask for confirmation from interviewer)

Storage Estimation (I need to know how much data I need to store on a given)

Data entry (Write) changes every day

Image → 1 TB per 365 days

Video → 1 TB per 365 days

Only only → 100 Bytes

1 day of only → $100 \times 10 \times 100 B \approx 10^3 B = 1 KB$

→ 3 years of only → $10 TB \times 365 \times 3 = 10^3 \times 3000$
$= 30 PB$

Right now only considering text messages - image to consider later

Bandwidth Estimation - incoming - outgoing

Consider public, outgoing bandwidth is more higher which is round of but than incoming bandwidth as it is replicated

→ for whatsapp both outgoing & incoming bandwidth are same at 8 PB

Twitter DAU ≈ 100 M

Read/Write Ratio:
- Youtube - 95 : 5
- Twitter - 80 : 15
- Insta - 80 : 20
- LinkedIn - 75 : 25

Typically we can take 4 : 1
6 : 1
1 : 1
80 : 20
90 : 10

Ingress/Egress:

→ 140 char
→ 2 Bytes per character
→ 20 Bytes for Metadata (use this to round of numbers)

220 Bytes

300 Bytes : Data per tweet

100 Million tweets × 300 Bytes

$= 100 \times 10^6 \times 300 Bytes$

$= 30 \times 10^8 B$

$= 30 GB$ → storage per day for text tweets

Today's system design discussion:

Every 1/4th tweet has a photo
Every 10th tweet has a video

$\left(\frac{100 \text{ Million tweets}}{4} \times 200 \times B\right) + \left(\frac{100 M}{10} \times 2 MB\right)$

$= (30 \times 200 \times B \times 10^6) + (10 \times 2 MB \times 10^6)$

$= (4 \times 10^6 \times 200 B) + (10 \times 2 \times 10^6)$

$= (4 \times 10^8 B) + (20 \times 10^6)$

$= (4 + 20) TB$

$= 24 TB$ → Store Images & videos per day

$\therefore$ 300 MB/sec Ingress

4 : 1
Read : Write

$4 \times 300 = 1200$

→ 1200 MB/sec Egress

Users
200 DAU
5M Drivers → 3M rides / day

Update Driver location for every 3 sec

Driver ID - 2 bytes
Latitude - 8 Bytes
Longitude - 8 Bytes
18 bytes

18 bytes × 5 M Drivers

$\frac{18 \times 5 \times 10^6 \text{ Bytes/sec}}{3}$

$= 30 \times 10^6$ Bytes/sec

$= 30 MB/sec$

(We are taking 3 sec, that is why bytes will be every 3/4/5 sec, then appear for 20 bytes)

Capacity Estimation

Youtube:

1) Velocitations:

Traffic estimation → Capacity Estimation needs

Storage estimation

Bandwidth estimation