System Design Cheatsheet - Numbers and Approximations - v1

Users to Volume

x Million users * y KB ..... xy GB
x Million users * y MB ..... xy TB

Period Numbers

per Month	1 Billion	1 Million	1 Thousand
per Day	32 M	32 K	32
per Hour	1.3 M	1.3 K	1.3
per Minute	22 K	22	0.02
per Second	400	0.4	0.0004

per Day	1 Billion	1 Million	1 Thousand
per Hour	42 M	42 K	42
per Minute	700 K	700	0.7
per Second	12 K	12	0.01

Example 1: If a server has a million requests per day, it will need to handle 12 requests per second.

Example 2: 100M photos (200KB) are uploaded daily to a server. 100 (number of millions) * 12 (the number per second for 1M) = 1200 uploads a second. 1200 (uploads) * 200KB (size of photo) = 240MB per second.

Number Sizes

Kilo ..... Thousands (3 zeros)
Mega ..... Millions (6 zeros)
Giga ..... Billions (9 zeros)
Tera ..... Trillions (12 zeros)
Peta ..... Quadrilions (15 zeros)

Service Limitations

These are very rough estimations on throughput, requests, and connections (Conn.) that certain services can handle.

-	Storage	Conn.	Requests
SQL DB	60 TB	30 K	25 K/sec
Cache (Redis).	300 GB	10 K	100 K/sec

-	Throughput	Requests
Web Server	-	5-10 K/sec
Queues/Streams	1-100 MB/s	1-3 K/sec

Throughput

Read sequentially from memory ..... 4 GB/s
Read sequentially from SSD ..... 1 GB/s
Read sequentially from HDD ..... 30 MB/s
Read sequentially from 1Gbps Ethernet 100 MB/s

Latency

Read 1 MB sequentially from RAM ..... 0.25 ms
Read 1 MB sequentially from SSD ..... 1 ms
Read 1 MB sequentially from HDD ..... 20 ms

HDD disk seek ..... 10 ms
Tape seek ..... 1-2 minutes

Roundtrip within datacenter ..... 0.5 ms (500 us)
Send packet CA → NL → CA ..... 150 ms

Data Sizes

char ..... 1 Byte (8 Bit)
char (Unicode) ..... 2 Byte (16 Bit)
short ..... 2 Byte (16 Bit)
int or float ..... 4 Byte (32 Bit)
long or double ..... 8 Byte (64 Bit)

Approximate Object Sizes

File ..... 100 KB
Web Page w/o a lot of magic and images 100 KB
Picture (jpeg, ...) ..... 200 KB
Short Posted Video ..... 2 MB
Streaming Video ..... 50 MB/s

Costs

RAM (hot) ..... $ 1000-4000 / TB
SSD (warm) ..... $ 70 / TB
HDD (cold) ..... $ 12 / TB
Tape (glacial) ..... $ 5 / TB

CDN Traffic (depends on features) .. $ 5-40 / TB
Cloud Egress ..... $ 20-100 / TB

Mobile Bandwidth and Latency

5G Bandwidth ..... 10-30 Gb/s
5G Latency ..... 1-15 ms
4G Bandwidth ..... 100-300 Mb/s
4G Latency ..... 50-200 ms
3G Bandwidth ..... 14 Mb/s