Back To Module Home

System Design Essentials

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Search Module

Introduction

Abstractions

Non-functional System Characteristics

Back-of-the-envelope Calculations

Put Back-of-the-envelope Numbers in Perspective

Examples of Resource Estimation

Conclusion

Mark Module as Completed

Examples of Resource Estimation

Try your hand at some of the back-of-the-envelope numbers.

We'll cover the following

Introduction#

Now that we've set the foundation for resource estimation, let's make use of our background knowledge to estimate resources like servers, storage, and bandwidth. Below, we consider a scenario and a service, make assumptions, and based on those assumptions, we make estimations. Let's jump right in!

Number of servers required#

Let's make the following assumptions about a Twitter-like service.

Assumptions:

- There are 500 million (M) daily active users (DAU).
- A single user makes 20 requests per day on average.
- Recall that a single server can handle 8,000 RPS.

Estimating the Number of Servers

Daily active users (DAU)	500	M
Requests on average / day	20	

Total requests / day	*f* 10	Billion
Total requests / second	*f* 115	K
Total servers required	*f* 15	

Indeed, the number above doesn't seem right. If we only need 15 commodity servers to serve 500M daily users, then why do big services use millions of servers in a data center? The primary reason for this is that the RPS is not enough to estimate the number of servers required to provide a service. Also, we made some underlying assumptions in the calculations above. One of the assumptions was that a request is handled by one server only. In reality, requests go through to web servers that may interact with application servers that may also request data from storage servers. Each server may take a different amount of time to handle each request. Furthermore, each request may be handled differently depending upon the state of the data center, the application, and the request itself. Remember that we have a variety of servers for providing various services within a data center.

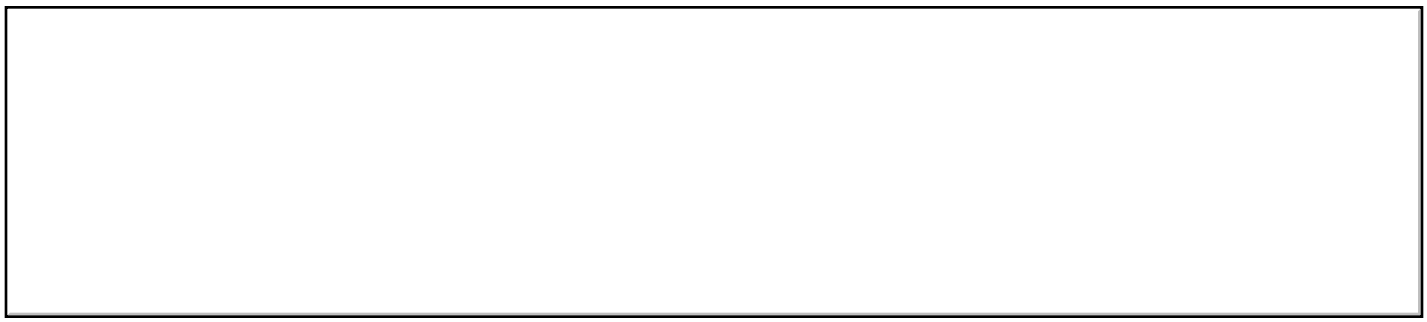
Therefore, we approximate the number of servers by depicting how many clients a server handles on a given day:

$$\frac{\textit{Number of daily active users}}{\textit{RPS of a server}}$$

In this case, it's equal to: $\frac{500M}{8000}$ = 62,500.

> **Note:** This may not be an accurate estimation, but it's a realistic one. Therefore, we use this approach in estimating the number of servers in our design problems. Informally, the equation given above assumes that one server can handle 8,000

> users. We use this reference in the rest of the course as well.



Number of servers required for a Twitter-like service

Storage requirements#

In this section, we attempt to understand how storage estimation is done by using Twitter as an example. We estimate the amount of storage space required by Twitter for new tweets in a year. Let's make the following assumptions to begin with:

- We have a total of 250 M daily active users.
- Each user posts three tweets in a day.
- Ten percent of the tweets contain images, whereas five percent of the tweets contain a video. Any tweet containing a video will not contain an image and vice versa.
- Assume that an image is 200 KB and a video is 3 MB in size on average.
- The tweet text and its metadata require a total of 250 Bytes of storage in the database.

Then, the following storage space will be required:

Estimating Storage Requirements

Daily active users (DAU)	250	M
Daily tweets	3	
Total requests / day	*f* 750	M

Storage required per tweet	250	B
Storage required per image	200	KB
Storage required per video	3	MB
Storage for tweets	*f* 187.5	GB
Storage for images	*f* 15	TB
Storage for videos	*f* 112.5	TB
Total storage	*f* 128	TB

- Total storage required for one day = $0.1875TB + 15TB + 112.5TB \approx 128TB$
- Storage required for one year = $365 \times 128TB = 46.72PB$

The total storage required by Twitter in a year

Bandwidth requirements#

In order to estimate the bandwidth requirements for a service, we use the following

steps:

1. Estimate the daily amount of incoming data to the service.
2. Estimate the daily amount of outgoing data from the service.
3. Estimate the bandwidth in Gbps (gigabits per second) by dividing the incoming and outgoing data by the number of seconds in a day.

Incoming traffic: Let's continue from our previous example of Twitter, which requires 128 TBs of storage each day. Therefore, the incoming traffic should support the following bandwidth per second:

$$\frac{128 \times 10^{12}}{86400} \times 8 \approx 12 Gbps$$

> **Note:** We multiply by 8 in order to convert Bytes into bits because bandwidth is measured in bits per second.

Outgoing traffic: Assume that a single user views 50 tweets in a day. Considering the same ratio of five percent and 10 percent for videos and images, respectively, for the 50 tweets, 2.5 tweets will contain video content whereas five tweets will contain an image. Considering that there are 250 M active daily users, we come to the following estimations:

Estimating Bandwidth Requirements

Daily active users (DAU)	250	M
Daily tweets viewed	50	per user
Tweets viewed / second	*f* 145	K
Bandwidth required for tweets	*f* 0.3	Gbps
Bandwidth required for images	*f* 23.2	Gbps

Bandwidth required for videos	*f* 174	Gbps
Total bandwidth	*f* 197.5	Gbps

> Twitter will need a total of 12 *Gbps* of incoming traffic and 197.5 *Gbps* of outgoing, assuming that the uploaded content is not compressed. Total bandwidth requirements = 12 + 197.5 = 209.5 *Gbps*.

The total bandwidth required by Twitter

Put Back-of-the-envelope Numbers in…

Next

Final Remarks

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