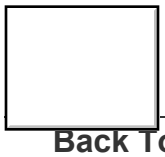


Back To Course Home

Grokking Modern System Design Interview for Engineers & Managers

0% completed

System Design Interviews

Introduction

Abstractions

Non-functional System Characteristics

Back-of-the-envelope Calculations

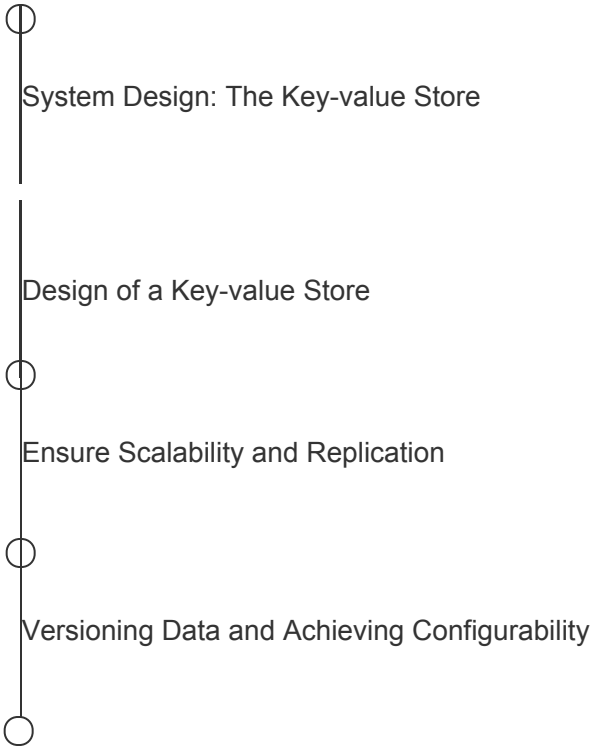
Building Blocks

Domain Name System

Load Balancers

Databases

Key-value Store



Content Delivery Network (CDN)

Sequencer

Distributed Monitoring

Monitor Server-side Errors

Monitor Client-side Errors

Distributed Cache

- [ ]

Distributed Messaging Queue

- [ ]

Pub-sub

- [ ]

Rate Limiter

- [ ]

Blob Store

- [ ]

Distributed Search

- [ ]

Distributed Logging

- [ ]

Distributed Task Scheduler

- [ ]

Sharded Counters

- [ ]

Concluding the Building Blocks Discussion

- [ ]

Design YouTube

- [ ]

Design Quora

- [ ]

Design Google Maps

- [ ]

Design a Proximity Service / Yelp

☐

Design Uber

☐

Design Twitter

☐

Design Newsfeed System

☐

Design Instagram

☐

Design a URL Shortening Service / TinyURL

☐

Design a Web Crawler

☐

Design WhatsApp

☐

Design Typeahead Suggestion

☐

Design a Collaborative Document Editing Service / Google Docs

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Spectacular Failures

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Concluding Remarks

☐

Course Certificate

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Design of a Key-value Store

Learn about the functional and non-functional requirements and the API design of a key-value store.

We'll cover the following

Requirements#

Let’s list the requirements of designing a key-value store to overcome the problems of traditional databases.

Functional requirements#

The functional requirements are as follows:

- **Configurable service**: Some applications might have a tendency to trade strong consistency for higher availability. We need to provide a configurable service so that different applications could use a range of consistency models. We need tight control over the trade-offs between availability, consistency, cost-effectiveness, and performance.
- **Ability to always write**: The applications should always have the ability to write

into the key-value storage. If the user wants strong consistency, this requirement might not always be fulfilled due to the implications of the CAP theorem.

- **Hardware heterogeneity**: The system shouldn't have distinguished nodes. Each node should be functionally able to do any task. Though servers can be heterogeneous, newer hardware might be more capable than older ones.

Non-functional requirements#

The non-functional requirements are as follows:

- **Scalable**: Key-value stores should run on tens of thousands of servers distributed across the globe. Incremental scalability is highly desirable. We should add or remove the servers as needed with minimal to no disruption to the service availability. Moreover, our system should be able to handle an enormous number of users of the key-value store.
- **Available**: We need to provide continuous service, so availability is very important. This property is configurable. So, if the user wants strong consistency, we'll have less availability and vice versa.
- **Fault tolerance**: The key-value store should operate uninterrupted despite failures in servers or their components.

Point to Ponder

Question

Why do we need to run key-value stores on multiple servers?

Show Answer

Assumptions#

We'll assume the following to keep our design simple:

- The data centers hosting the service are trusted (non-hostile).
- All the required authentication and authorization are already completed.
- User requests and responses are relayed over HTTPS.

API design#

Key-value stores, like ordinary hash tables, provide two primary functions, which are `get` and `put`.

Let's look at the API design.

The `get` function

The API call to get a value should look like this:

```
get(key)
```

We return the associated value on the basis of the parameter `key`. When data is replicated, it locates the object replica associated with a specific key that's hidden from the end user. It's done by the system if the store is configured with a weaker data consistency model. For example, in eventual consistency, there might be more than one value returned against a key.

Parameter	Description
`key`	It's the `key` against which we want to get `value`.

The `put` function

The API call to put the value into the system should look like this:

```
put(key, value)
```

It stores the `value` associated with the `key`. The system automatically determines where data should be placed. Additionally, the system often keeps metadata about the stored object. Such metadata can include the version of the object.

Parameter	Description
`key`	It's the `key` against which we have to store `value`.
`value`	It's the object to be stored against the `key`.

Point to Ponder

Question

We often keep hashes of the value (and at times, value + associated key) as metadata for data integrity checks. Should such a hash be taken after any data compression or encryption, or should it be taken before?

Show Answer

Data type#

The key is often a primary key in a key-value store, while the value can be any arbitrary binary data.

> **Note:** Dynamo uses MD5 hashes on the key to generate a 128-bit identifier. These identifiers help the system determine which server node will be responsible for this specific key.

In the next lesson, we'll learn how to design our key-value store. First, we'll focus on adding scalability, replication, and versioning of our data to our system. Then, we'll ensure the functional requirements and make our system fault tolerant. We'll fulfill a few of our non-functional requirements first because implementing our functional requirements depends on the method chosen for scalability.

> **Note:** This chapter is based on Dynamo, which is an influential work in the domain of key-value stores.

System Design: The Key-value Store

Next

Ensure Scalability and Replication

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