



DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

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Experiment: 1

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Subject Name: System Design

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1. Aim: To design, implement, and evaluate a simple URL redirection system that converts long URLs into short URLs, and to measure system performance (latency and throughput) under varying request loads.

2. Objective:

1. To understand the basic working of a URL shortening service.
2. To implement a functional URL redirection mechanism.
3. To measure and analyze latency and throughput under different simulated user loads.
4. To correlate system design choices with observed non-functional metrics (performance under load).

3. Requirements (Tools): Postman - test the Api, draw.io, excalidraw, lucid charts, python libraries / frameworks.

4. Procedure and Output:

1. Functional Requirements:

A. Given a long url -> short url

Premium user:

A. Custom url (optional)

B. Expiry date

B. Given a short url -> redirect to the -> long url

2. Non-functional requirements:

100 million daily active user -> 1 million users are actually doing shorting of url

1. Latency: 20ms (on url shortening, on url redirection)
2. Availability: 24 x 7

3. Consistency

4. Scalability: Vertical or horizontal

5. The generated short url -> always unique

3. Api design (url shorter):

Pre-defined functions:

1. Get: Fetch some data from db.

2. Post: When you want to insert some data into db.

3. Put / Patch: Update

4. Delete: Remove the data

Local host server: <Https://127.0.0.1/shorten>

App.route(/)

1. Post Api call - Req

{

Logic:

Url: "Long url "

Custom url: "Custom"

Expiry date:

}

Res:

{

Short_url: "Short url "

Short_code: "123abc"

}

<Https://127.0.0.1/123abc>

2. Get api call (</short_code?>)

[Https://127.0.0.1/get_employee\(empid\)](Https://127.0.0.1/get_employee(empid))

4. Database schema design:

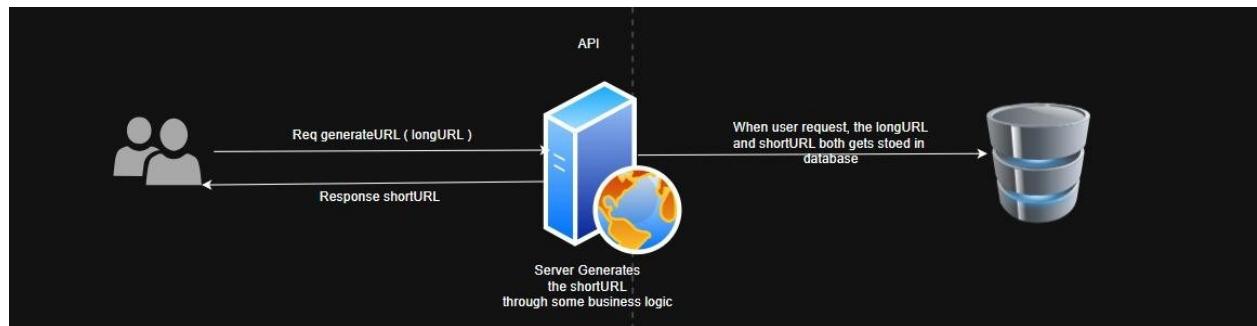
T1 user (id, name, phone etc.)

T2 url_mapping (id, longurl, shorturl, expiry date, customurl)

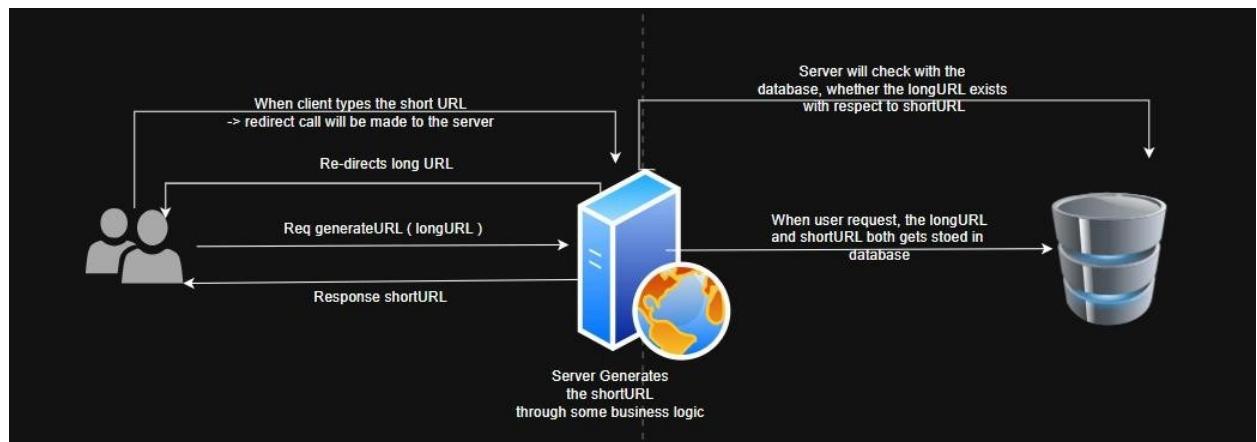
5. High Level Design:

Now according to the functional requirement of the system, we can identify that: There will be a client who is requesting, then there will be a server upon which computation will be going on, and lastly there will be a database in which storage will be done.

1. shortURL Generation:



2. Re-direction: When user enters shortURL in browser:



3. We need to have REST APIs for client registration and login as well.

6. Low Level Design:

Now if you see in HLD we have only specified the specific things like the database, the server, but we haven't talked about:

1. Which type of database is needed??
2. Which type of server is needed and what sort of computation has been done inside the server.

Let's begin with the SERVER: how longURL is converted into shortURL

longURL: <https://www.amazon.com/rehan.products.catalog/orders/cart/payment>

shortURL: <https://bit.ly/5PLcymn>

{5PLcymn} - shortened URL

LONGurl - BASE10 - LARGE STRING

BASE 64 - HDGB25

Approach 01: Encryption

encrypt(longURL) = shortURL

Most Popular algorithm for encryption lib is: MD5, SHA1, BASE64 Problem

in this approach:

1. Encrypted length is very large & the req was of short length url
2. To resolve this, what we can do is we can take first 4 letters from encrypted text. But in this also a problem can occur.

Link 1:

https://www.youtube.com/watch?v=HHUi8F_qAXM&t=1s06e2116c3e064129e81226fb7b57502c

Link 2:

<https://www.youtube.com/watch?v=jhsdbi8793hch?2fdgv06e265f903040b075b90ed40ad15a4f6e5a184a2>

[both starting 4 char are same, pointing to same link in DB Duplication of links]

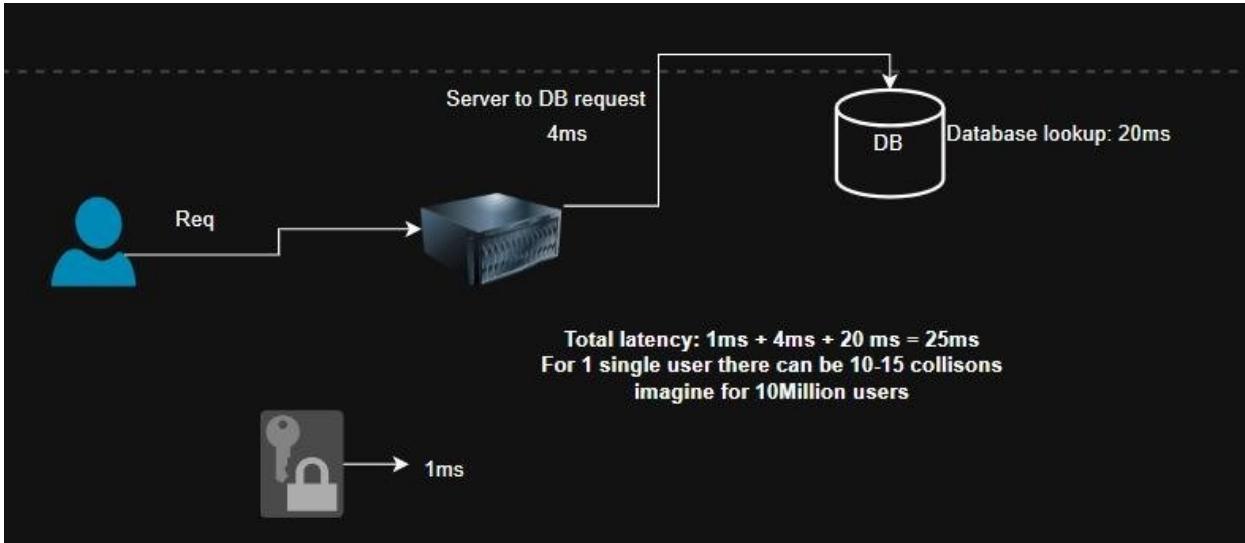
Resolution:

At first, we can store the 4byte code & corresponding longURL in DB. Second time, if same 4byte code is generate, it will be compared in the DB, if code already exist -> again generate a MD5, 4byte unique code.

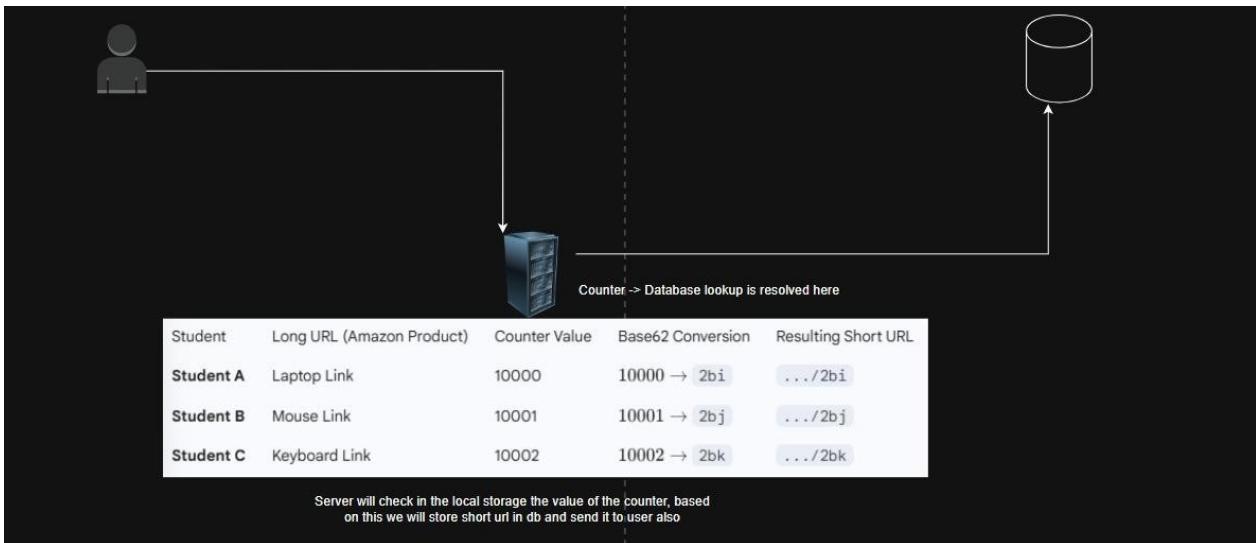
[This results into high latency issue = 16ms + 16ms]

Possible Problems:

1. Full table scan in database.
2. More number of collisions
3. These collisions will result into latency issue



Approach 02: Counter Approach

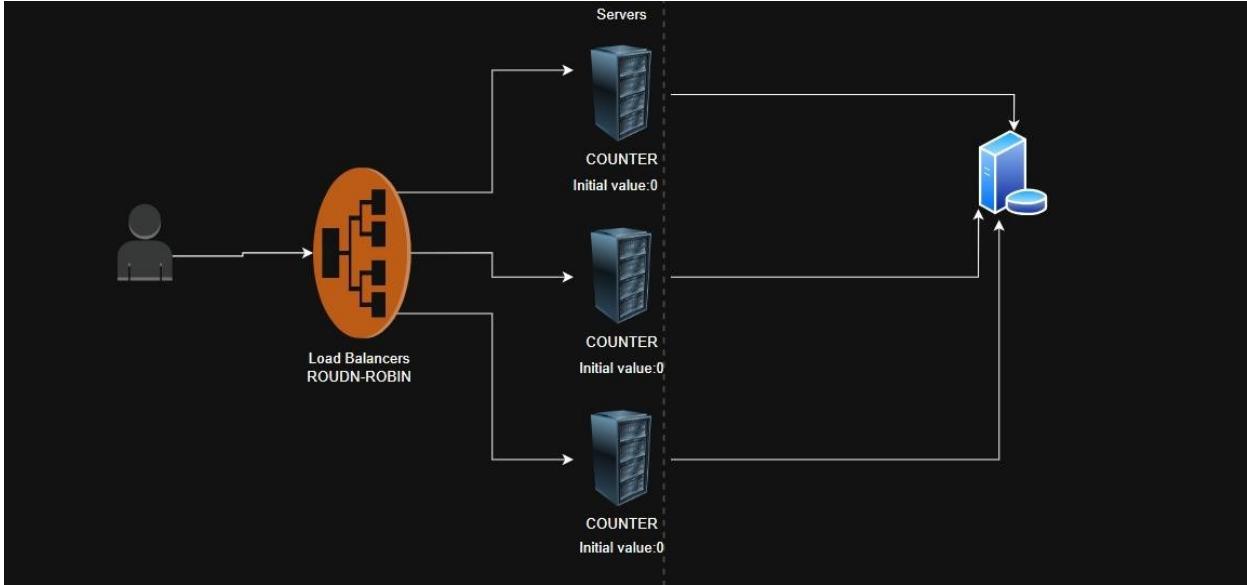
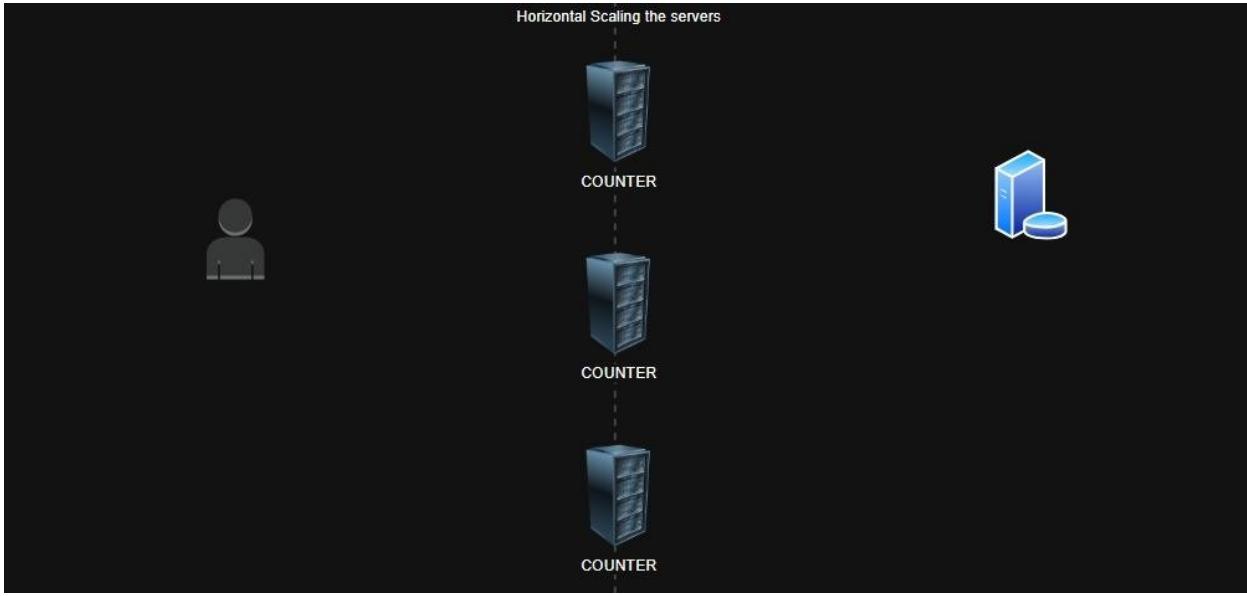


Problem with this approach:

Server follows monolithic architecture, it can process the request for 1 user easily by managing counter value, but what happens when 100 million user comes.

Resolution: Scaling

- Vertical scaling here is not possible as number of users are 100 M
- We will do the horizontal scaling over here



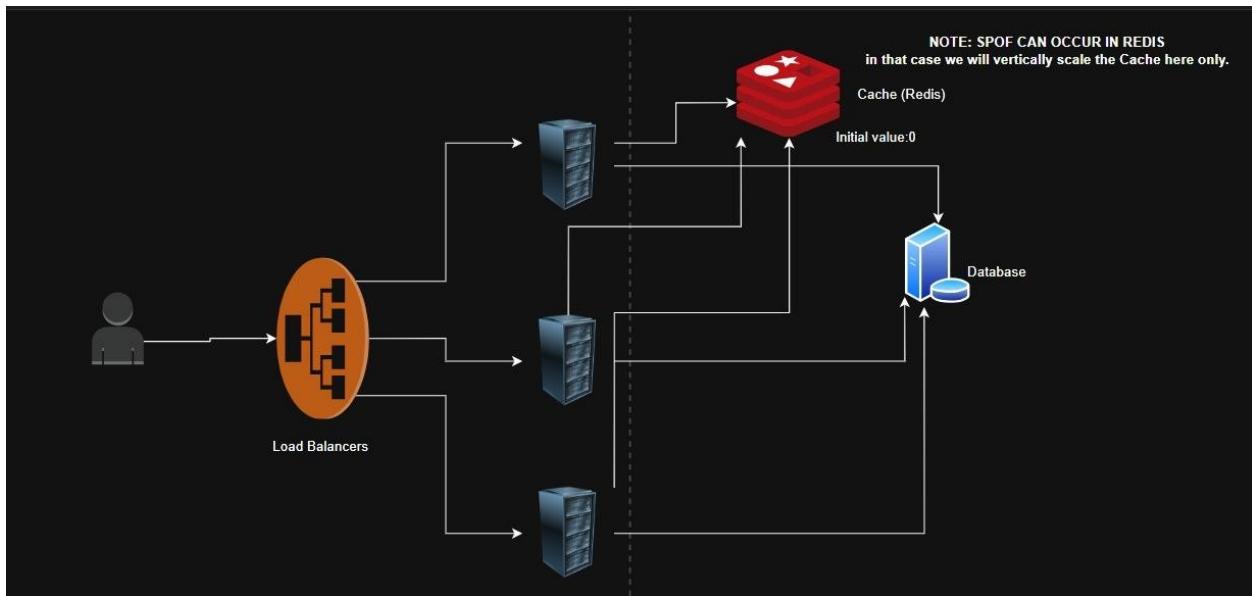
Problem:

Now in this method there can be a problem of dirty read that is server 1's counter may have some other value and server 2's counter may have some other value

Resolution:

Rather than storing the counter in the server itself, we can make the counter variable globally available using a CACHE

Final Low-level Design:



5. Learning Outcomes:

- a. Understood and differentiated functional and non-functional requirements for designing a URL shortener system.
- b. Designed and tested RESTful APIs for URL shortening and redirection using Flask and Postman.
- c. Created high-level and low-level system designs to ensure scalability, availability, and performance.
- d. Designed database schemas and implemented backend logic for URL mapping and user management.