Experiment No: 2

Student Name: Sai Tharun UID: 23BCS13208

Branch: BE CSE Section/Group: 23BCS_KRG-2_B

Semester: 6th Date of Performance: 14/01/2026

Subject Name: System Design Subject Code: 23CSH-314

1- **Aim** - Design an Online shopping platform similar to Amazon / Flipkart that will allow users to purchase mobiles, laptops, cameras, clothes etc.

2- **Requirements**: Functional & Non-Functional

A- Functional Requirement ○ User should be able to search and find the products based on product title or names.

- ○ User should be able to view the details of the product llike description, image, available quantity, review.
- ○ User should be able to select the quantity and move the product/item into the cart.
- ○ User should be able to make the payment and should be able to perform the check out.
- ○ User should be able to check the status of the order.
- ○ System should be able to manage purchase of items having limited stocks.

Race condition happens during a flash sale when inventory has limited stock, and the system must handle multiple transactions occurring at the same time.

B- Non-Functional Requirement ○ The system is designed for 100 million daily active users with around 10 orders handled per second. ○ Consistency & Availability: Based on the target scale, both are required, but at different system levels.

i. According to functional requirements, users must search products smoothly, so product search needs high availability.

ii. Strong consistency is required for critical components such as payment processing, order placement, and inventory management.

- ○ Expected response time is approximately 200 ms.
- ○ Scaling will be done either Horizontally or vertically wherever applicable.

3- **Core-entities of System** ○ User/Client ○ Products ○ Cart ○ Orders
○ Checkout followed by Payment

4- **API endpoint creation a) GET API Call: Prod_Search**

Https://Local_Host/products/search_item = {Search_keywords}

HTTP Req
{

```
        GET: <iPhone 16>

}
HTTP Res
{
        List<ProductID:iPhone>
}
```

Now, on front-end if multiple data of respective product is coming in that case the FE becomes faulty thus ultimately increasing the Latency.
So we will be using Pagination (1,2,3,….next)

b) GET API Call: View Product Details

Https://Local_Host/products/{product_id}

```
HTTP Req
{
    GET: <Product_id=17>
}
HTTP Res
{
    Product_id=17,
    Name: iPhone17,
    Color: Navy Blue,
    Price: $1009,
    Image_URL: URL_image
}
```

c) POST API Call: Item add in cart

Https://Local_Host/cart/add_products

```
HTTP Req
{
    Product_id:17,
    Product_id:16
}
HTTP Req Header
{
    User_id: 04

}
```

```
HTTP Res
{
    Cart_id: 101
}
```

d) PUT API Call: To update any order in the cart

e) DELETE API Call: To remove any item from the cart

f) POST API Call: for check out & Payement

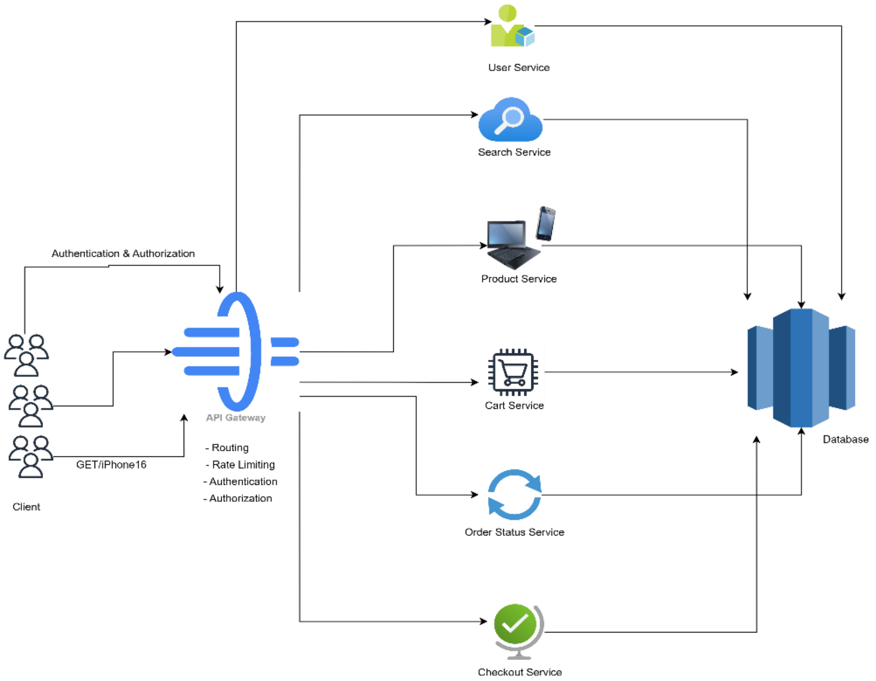
```
Https://Local_Host/checkout -> {post body}

HTTP Req
{
    All Product Id's,
    Total Quantity,
    Total Price
}
HTTP Res
{
    Order_id
}

Https://Local_Host/payment -> {post body}
HTTP Req
{
    Order_id,
    Payment Type,
    Payment_Mode
}
HTTP Res
{
    Confirmation_Status: Succes / Fail
}
```

g) GET API Call: Order Status

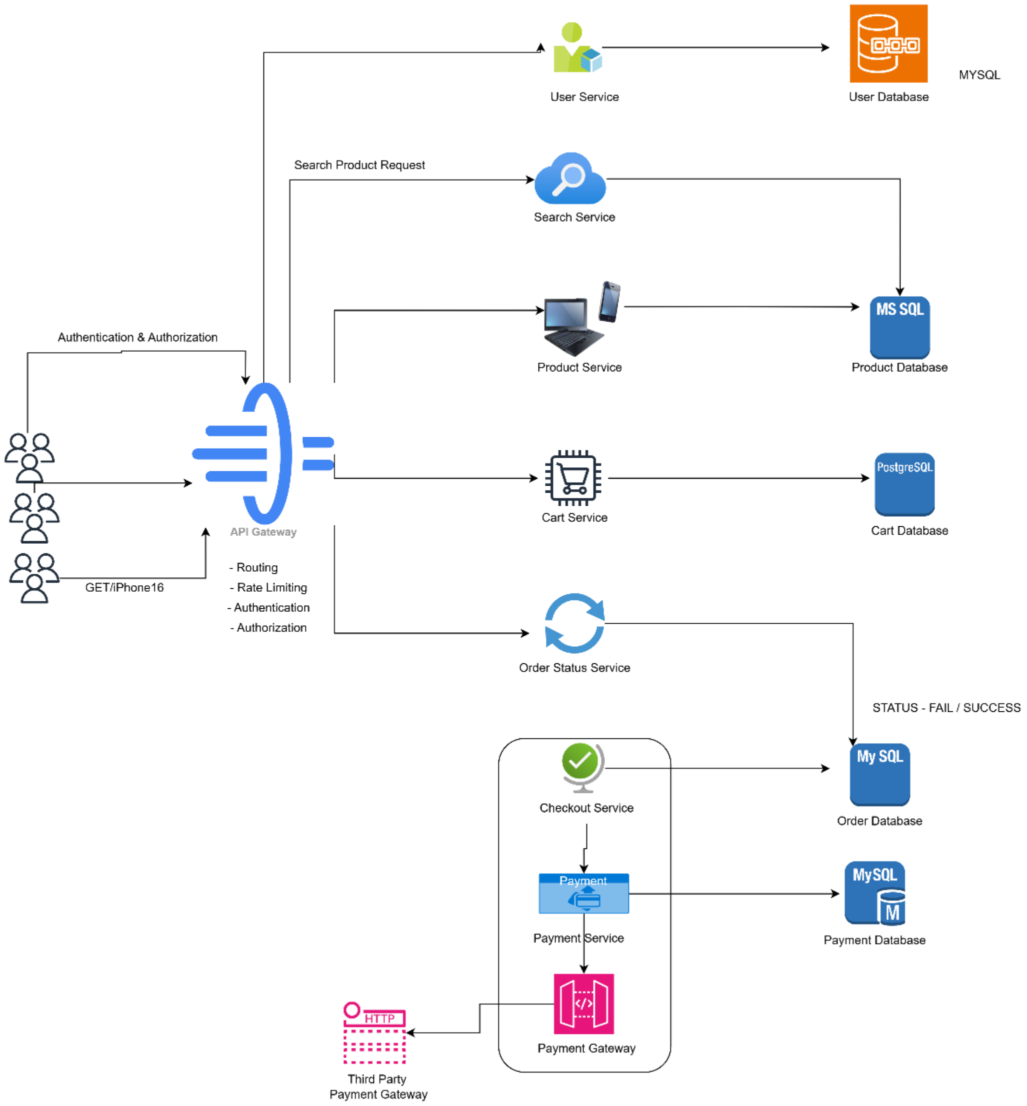
```
Https://Local_Host/orde_status = {order_id}
```

5- High-Level Design

Now According to the functional requirement of the system, we can identify that : We have to follow a distributed / micro-services approach not the monolithic one.



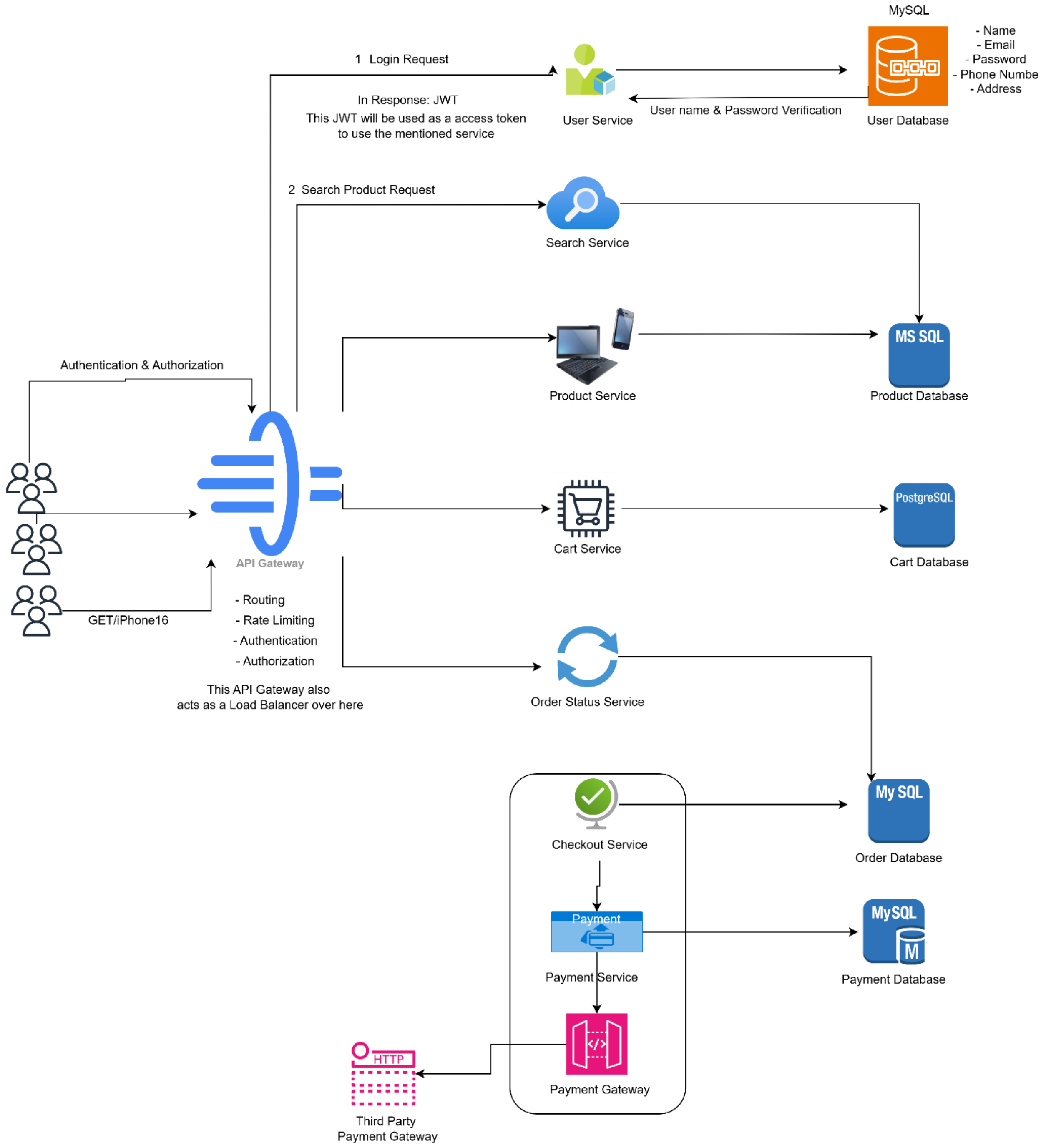
Drawbacks: Multiple-Database calls are being done and single database is being used to handle every service which increases the latency.



This will fullfill all the functional requirements that were listed. Now, we will see the internal implementations of each one of these components in LLD.

6- Low- Level Design

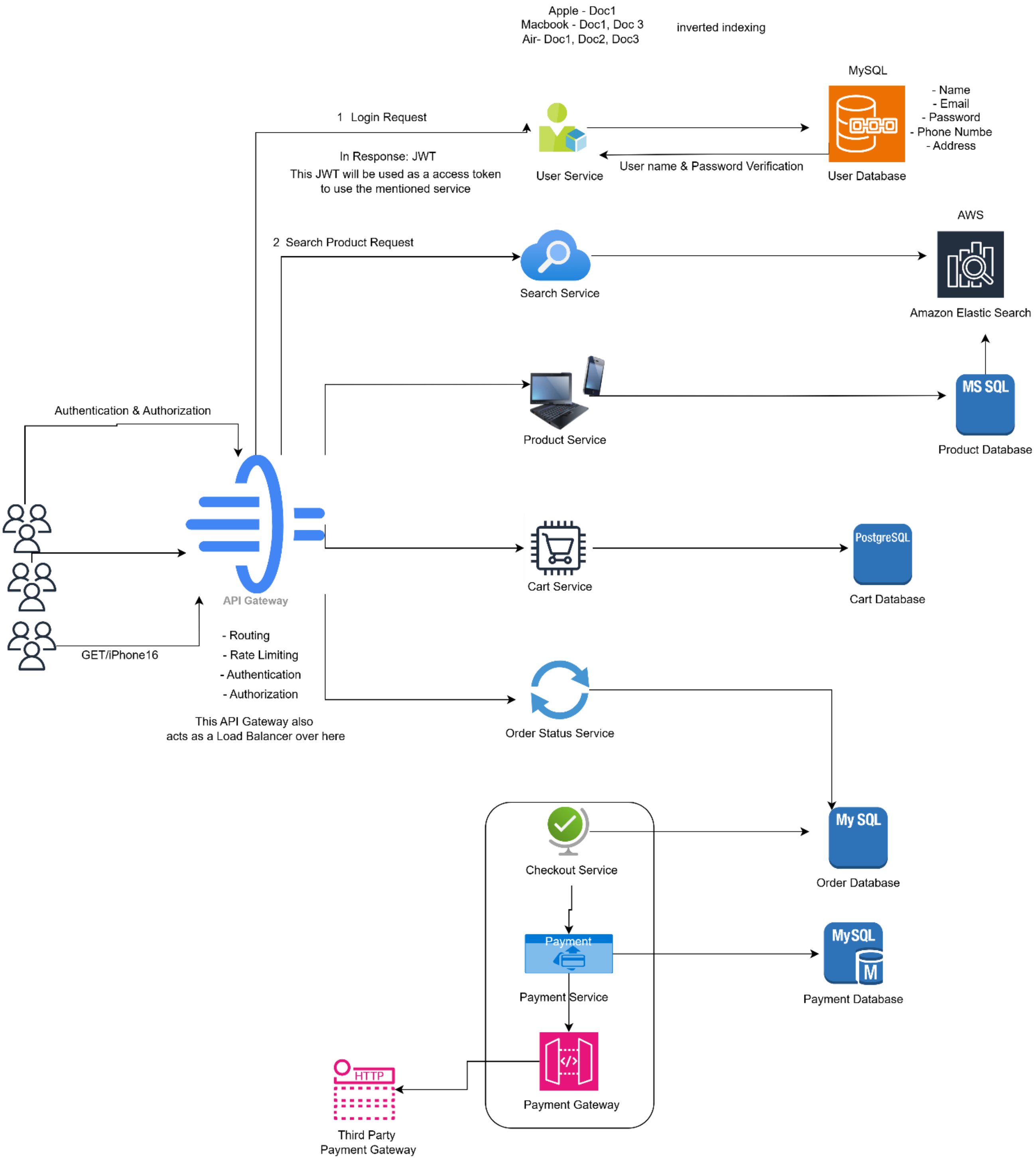
1- User Login and Search Functionality

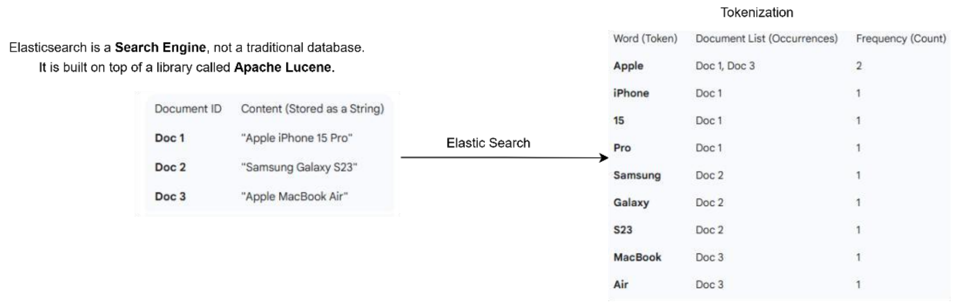


Drawbacks-

- As per NFR, 10 million DAU, which means searching the entire DB is very nonoptimized here
- As a solution we can implement INDEXING here, but still database scanning is not prevented.
- O(n) – time

Solution to search functionality problem: **ELASTIC SEARCH.**


Apple - Doc1
Macbook - Doc1, Doc 3
Air- Doc1, Doc2, Doc3
inverted indexing
MySQL
- Name
- Email
- Password
- Phone Numbe
- Address
1 Login Request
User Service
User name & Password Verification
User Database
In Response: JWT
This JWT will be used as a access token
to use the mentioned service
AWS
2 Search Product Request
Search Service
Amazon Elastic Search
Authentication & Authorization
Product Service
MS SQL
Product Database
API Gateway
Cart Service
PostgreSQL
Cart Database
GET/iPhone16
- Routing
- Rate Limiting
- Authentication
- Authorization
This API Gateway also
acts as a Load Balancer over here
Order Status Service
Checkout Service
My SQL
Order Database
Payment
Payment Service
MySQL
M
Payment Database
HTTP
Third Party
Payment Gateway
Payment Gateway



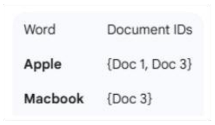
Elasticsearch is a **Search Engine**, not a traditional database.
It is built on top of a library called **Apache Lucene**.

Document ID	Content (Stored as a String)
Doc 1	"Apple iPhone 15 Pro"
Doc 2	"Samsung Galaxy S23"
Doc 3	"Apple MacBook Air"

Tokenization

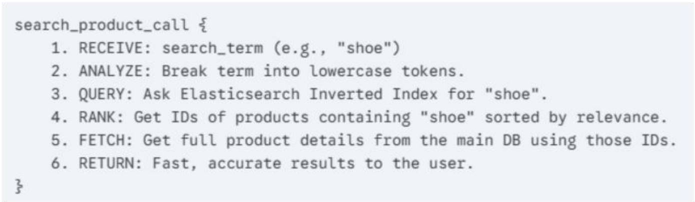
Word (Token)	Document List (Occurrences)	Frequency (Count)
Apple	Doc 1, Doc 3	2
iPhone	Doc 1	1
15	Doc 1	1
Pro	Doc 1	1
Samsung	Doc 2	1
Galaxy	Doc 2	1
S23	Doc 2	1
MacBook	Doc 3	1
Air	Doc 3	1

Multi-term Logic



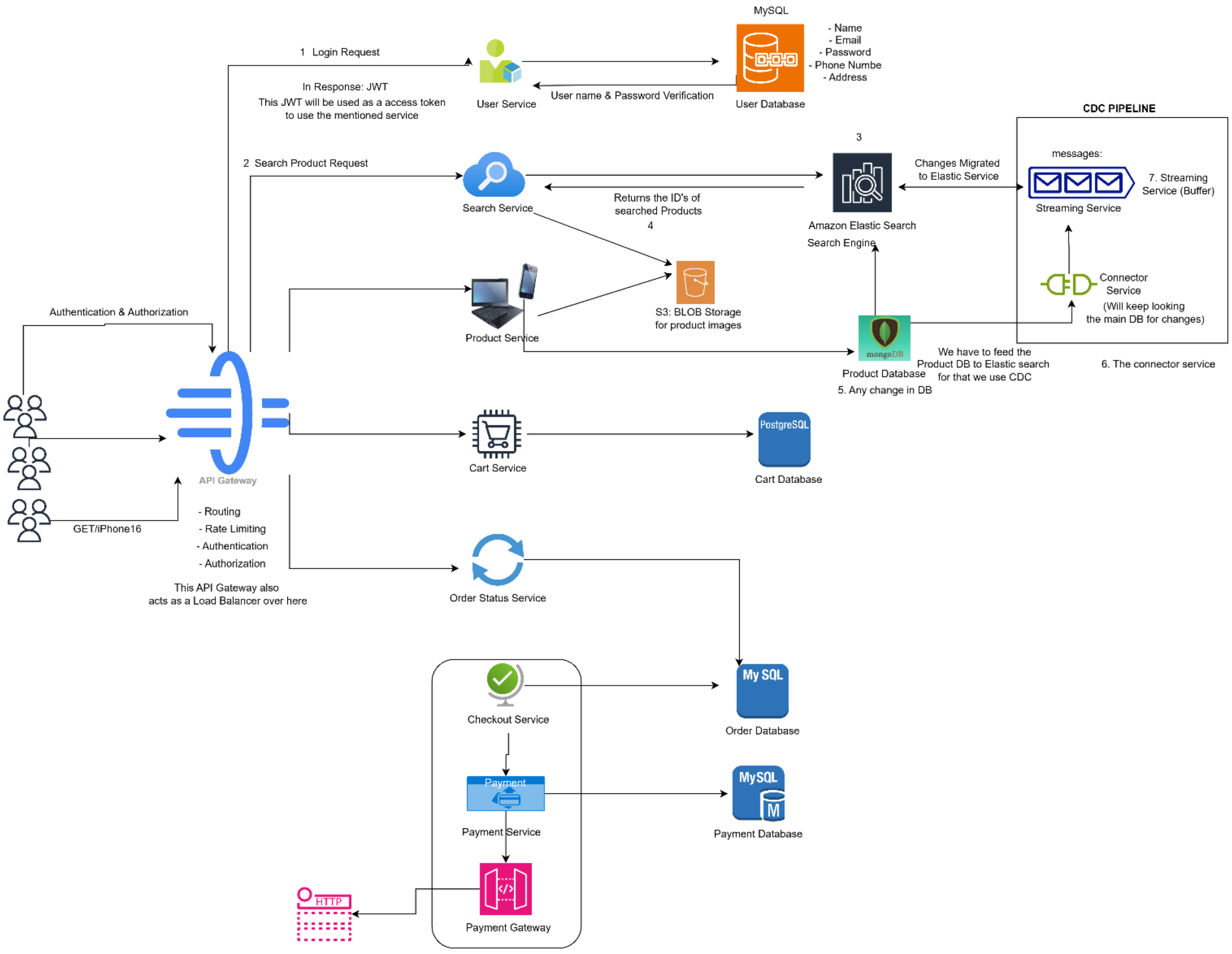
Word	Document IDs
Apple	{Doc 1, Doc 3}
Macbook	{Doc 3}

o(1)

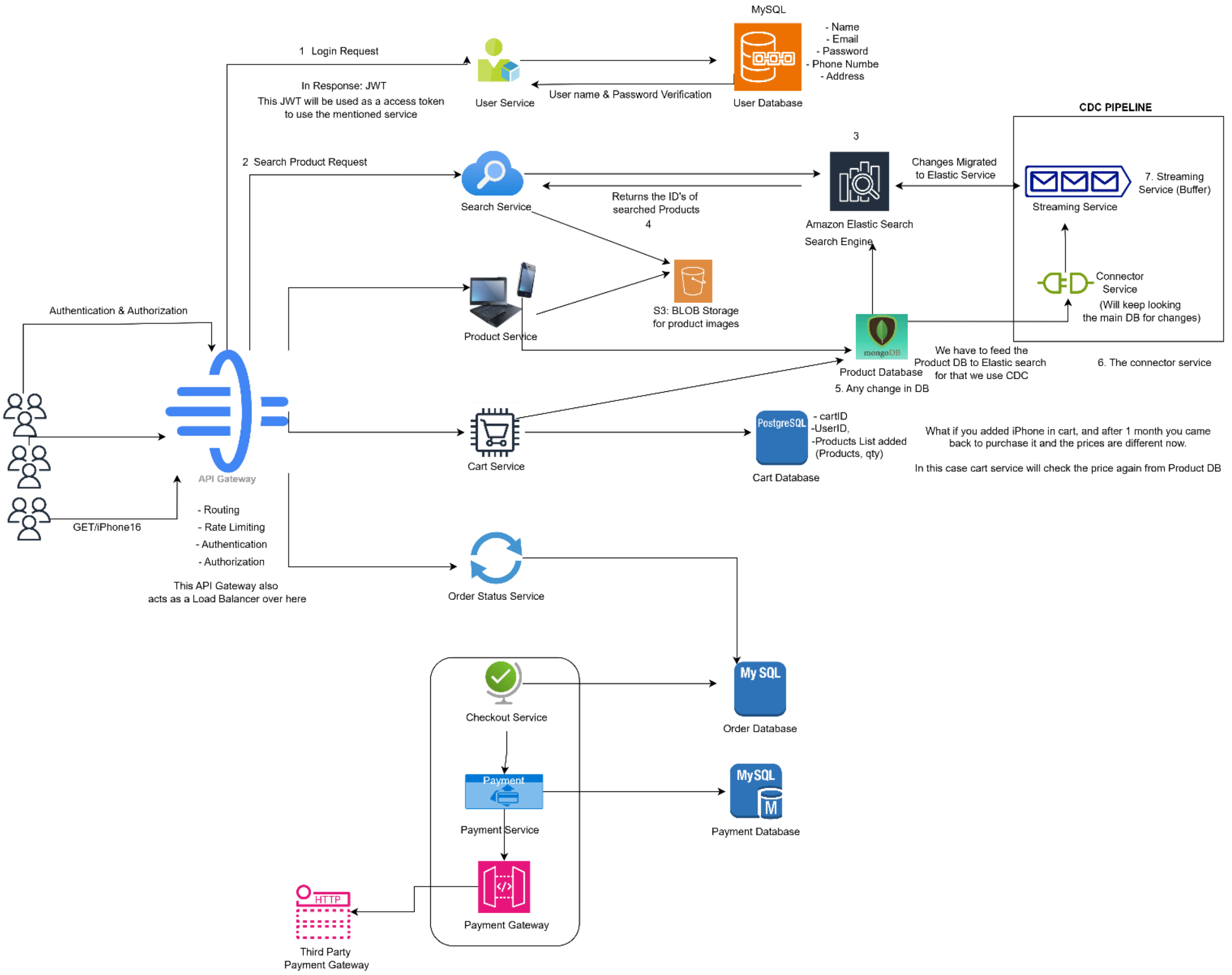


```
search_product_call {
    1. RECEIVE: search_term (e.g., "shoe")
    2. ANALYZE: Break term into lowercase tokens.
    3. QUERY: Ask Elasticsearch Inverted Index for "shoe".
    4. RANK: Get IDs of products containing "shoe" sorted by relevance.
    5. FETCH: Get full product details from the main DB using those IDs.
    6. RETURN: Fast, accurate results to the user.
}
```

We will use CDC (Change Data Capture) to send data from original database to ES in real time.



2- Cart Service



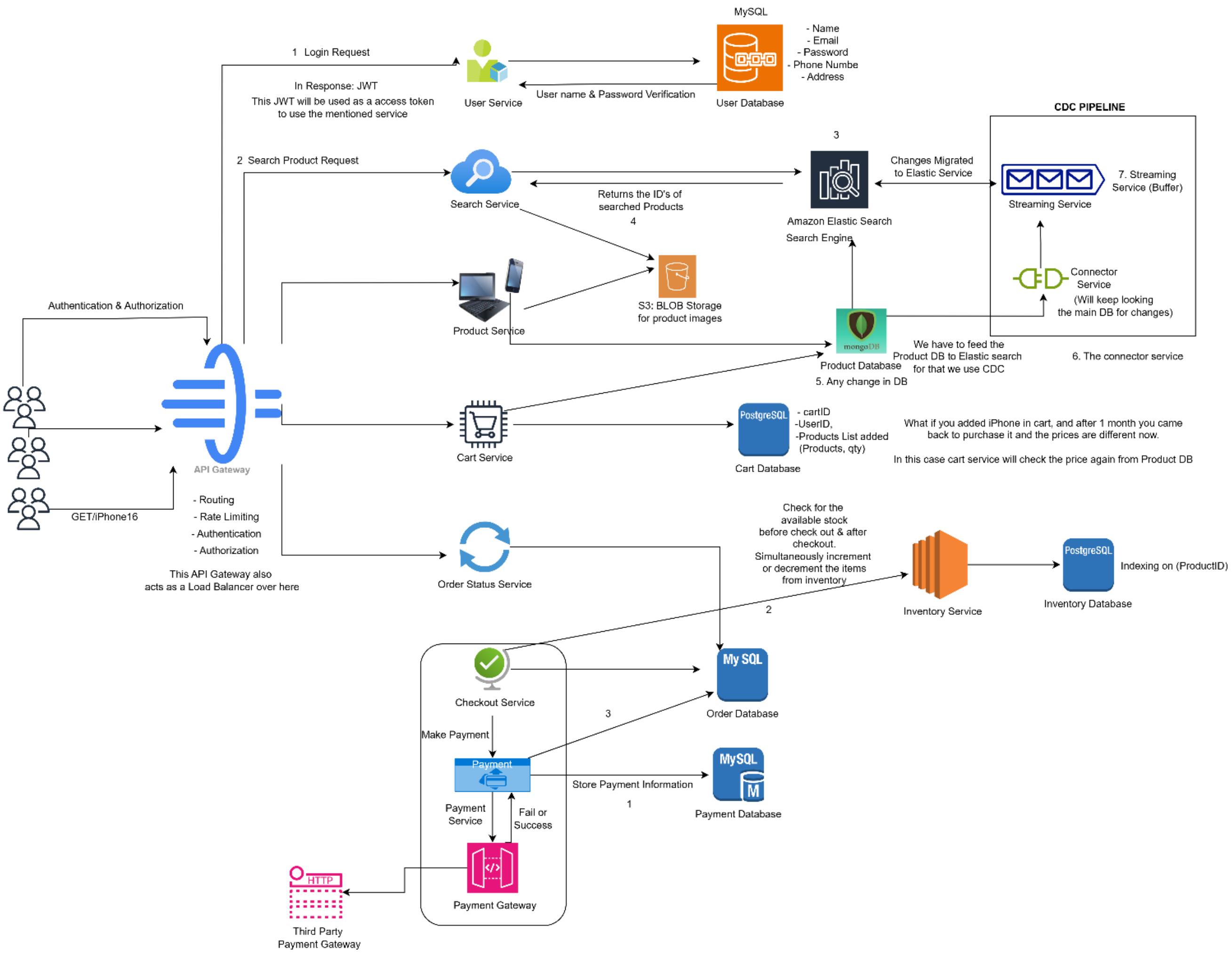
3- Checkout Service

For a user to do the checkout, the quantities in real-time from the DB should be verified, i.e., whether we have the requested amount of qty available in the inventory or not?

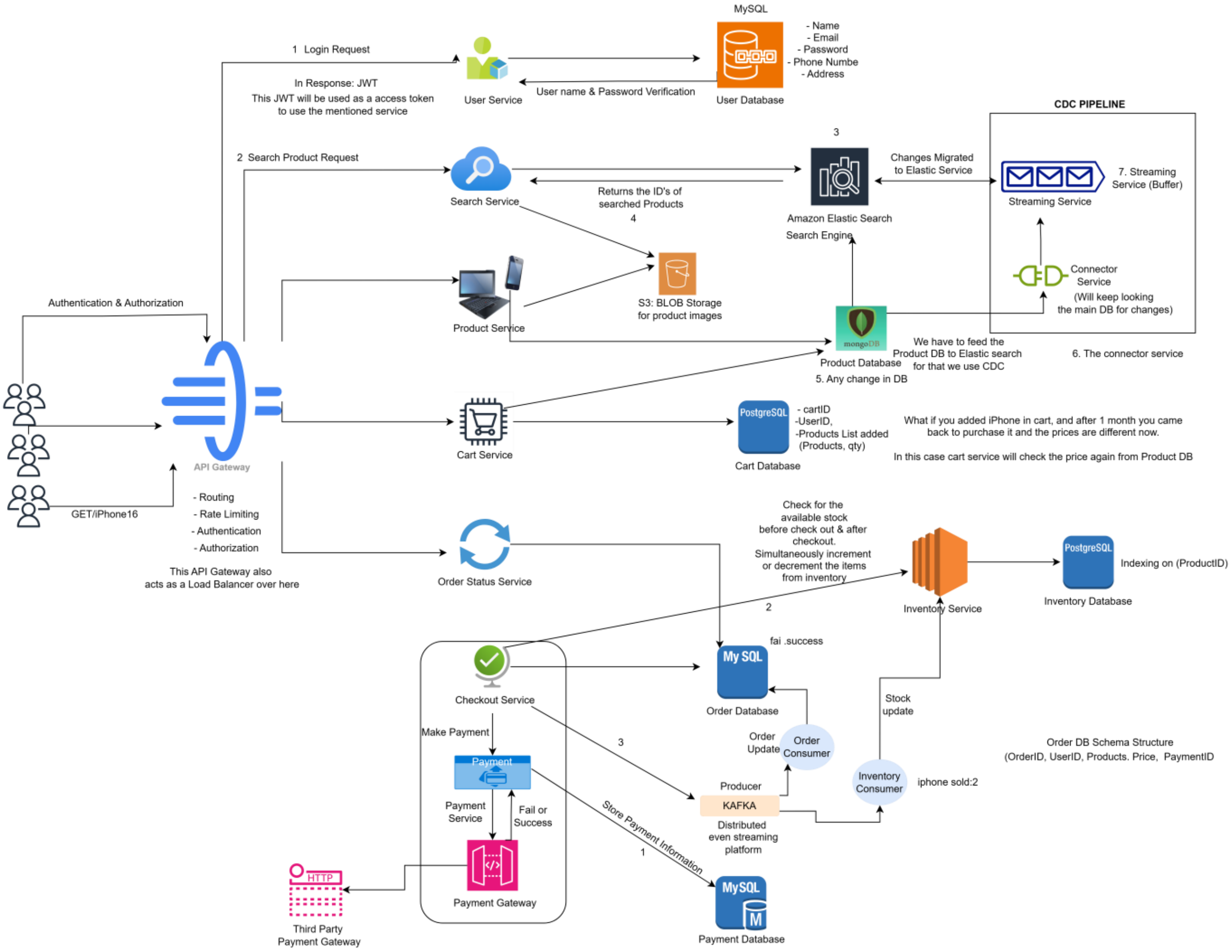
For that we will use a seperate service: Inventory Service: For Concurrecy

DRAWBACKS –

- 3 API calls are there to perform a single transaction
- Now For this single transaction, it can happen that payment done successfully, inventory was not updated.
  This is a very critical issue w.r.t consistency
- Rate of failure is very high over here



Solutions for above drawbacks is to introduce **Producer-Consumer architecture** using KAFKA.


1 Login Request
In Response: JWT
This JWT will be used as a access token to use the mentioned service
User Service
User name & Password Verification
MySQL
User Database
- Name
- Email
- Password
- Phone Numbe
- Address
CDC PIPELINE
2 Search Product Request
Search Service
Returns the ID's of searched Products
4
3
Amazon Elastic Search
Search Engine
Changes Migrated to Elastic Service
Streaming Service
7. Streaming Service (Buffer)
Connector Service
(Will keep looking the main DB for changes)
Product Service
S3: BLOB Storage for product images
Product Database
We have to feed the Product DB to Elastic search for that we use CDC
5. Any change in DB
6. The connector service
Authentication & Authorization
API Gateway
GET/iPhone16
- Routing
- Rate Limiting
- Authentication
- Authorization
This API Gateway also acts as a Load Balancer over here
Cart Service
PostgreSQL
Cart Database
- cartID
-UserID,
-Products List added (Products, qty)
What if you added iPhone in cart, and after 1 month you came back to purchase it and the prices are different now.
In this case cart service will check the price again from Product DB
Order Status Service
Check for the available stock before check out & after checkout. Simultaneously increment or decrement the items from inventory
2
Inventory Service
PostgreSQL
Indexing on (ProductID)
Inventory Database
fai .success
My SQL
Order Database
Checkout Service
Make Payment
Payment
Payment Service
Fail or Success
Payment Gateway
HTTP
Third Party Payment Gateway
3
Order Update
Order Consumer
Producer
KAFKA
Distributed even streaming platform
Store Payment Information
1
MySQL
Payment Database
Stock update
Inventory Consumer
iphone sold:2
Order DB Schema Structure
(OrderID, UserID, Products. Price, PaymentID