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UID	2023301018, 2023301005, 2022300100, 2022300091
Subject	Distributed Computing
Experiment No.	5
Project title	Social Media System
Problem Statement	To implement data consistency and replication in social media platform.
Objectives	To ensure seamless user experience, maintain real-time interactions and data accuracy across the social media platform using balanced data consistency models and efficient replication strategies.
Theory	<p>What is replication?</p> <p>The first thing is that it makes our system more stable because of node replication. It is good to have replicas of a node in a network due to following reasons:</p> <ul style="list-style-type: none">● If a node stops working, the distributed network will still work fine due to its replicas which will be there. Thus it increases the fault tolerance of the system.● It also helps in load sharing where loads on a server are shared among different replicas.● It enhances the availability of the data. If the replicas are created and data is stored near to the consumers, it would be easier and faster to fetch data. <p>Types of Replication</p> <ul style="list-style-type: none">● Active Replication● Passive Replication <p><u>Active Replication:</u></p> <p>The request of the client goes to all the replicas.</p> <p>It is to be made sure that every replica receives the client request in the same order else the system will get inconsistent.</p> <p>There is no need for coordination because each copy processes the same request in the same sequence.</p> <p>All replicas respond to the client's request.</p> <p><i>Advantages:</i></p> <ol style="list-style-type: none">1) It is really simple. The codes in active replication are the same throughout.2) It is transparent.



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- 3) Even if a node fails, it will be easily handled by replicas of that node.

Disadvantages:

- 1) It increases resource consumption. The greater the number of replicas, the greater the memory needed.
- 2) It increases the time complexity. If some change is done on one replica it should also be done in all others.

Passive Replication:

The client request goes to the primary replica, also called the main replica.

There are more replicas that act as backup for the primary replica. Primary replica informs all other backup replicas about any modification done.

The response is returned to the client by a primary replica.

Periodically primary replica sends some signal to backup replicas to let them know that it is working perfectly fine.

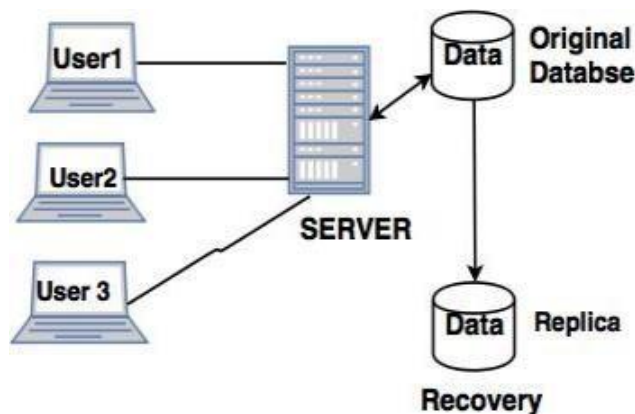
In case of failure of a primary replica, a backup replica becomes the primary replica.

Advantages:

- The resource consumption is less as backup servers only come into play when the primary server fails.
- The time complexity of this is also less as there's no need for updating in all the nodes replicas, unlike active replication.

Disadvantages:

- If some failure occurs, the response time is delayed.



Full Replication Process In Distributed System

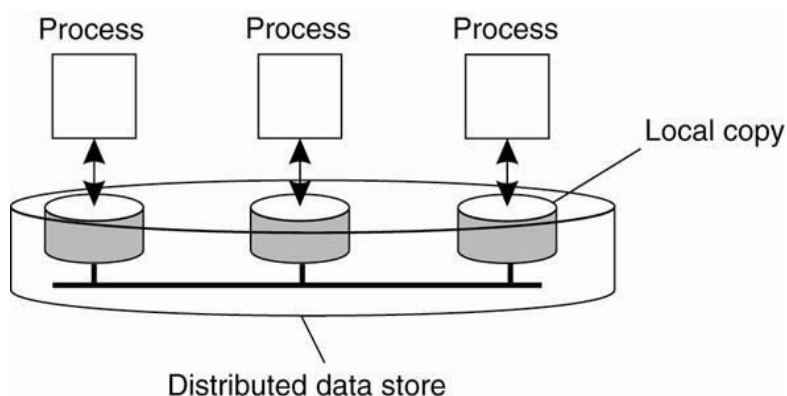


Consistency in Social Media Platform

The choice of a consistency model for a social media platform depends on various factors, including the nature of interactions, user expectations, and trade-offs between consistency, availability, and partition tolerance.

- 1) **Eventual Consistency:** Social media platforms often prioritize availability and responsiveness. Eventual consistency allows for faster updates and responsiveness to users. It might result in temporary inconsistencies, like seeing different likes or comments on different devices for a short period. However, it ensures that eventually, all replicas converge to the same state.
- 2) **Causal Consistency:** This model maintains a causal relationship between related events. In a social media context, it ensures that if a user comments on a post, that comment will appear before any subsequent actions related to it. It strikes a balance between strong consistency and eventual consistency.
- 3) **Session Consistency:** This model guarantees consistency for a particular user session. Within a session, a user's interactions are consistent and ordered, providing a better user experience without sacrificing too much on performance.

Ultimately, social media platforms often prioritize user experience and responsiveness over strict consistency. They might choose a consistency model that allows for quick updates and interactions while ensuring that eventual consistency or a similar model converges all data to a consistent state over time. Balancing these factors is crucial to creating an engaging and reliable platform for users.



Code:

```
import threading
import socket
import pickle
import random
from datetime import datetime
```



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```
class DistributedStorage:
    def __init__(self, num_nodes):
        self.num_nodes = num_nodes
        self.user_profiles = {}
        self.lock = threading.Lock()
        self.node_sockets = {}
        self.quorum_size = num_nodes // 2 + 1
        self.initialize_sockets()

    def initialize_sockets(self):
        for node_id in range(1, self.num_nodes + 1):
            self.node_sockets[node_id] = socket.socket(socket.AF_INET,
socket.SOCK_STREAM)
            self.node_sockets[node_id].bind(('127.0.0.1', 9000 + node_id))
            self.node_sockets[node_id].listen()

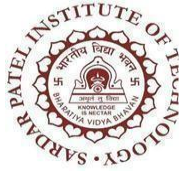
    def put_user_profile(self, user_id, profile):
        with self.lock:
            profile['created_at'] = datetime.now().strftime("%Y-%m-%d %H:%M:%S")
            self.user_profiles[user_id] = profile
            print(f"User profile replicated: {user_id} -> {profile}\n")

    def get_user_profile(self, user_id):
        with self.lock:
            return self.user_profiles.get(user_id, None)

    def perform_replication(self, user_id, profile):
        replication_nodes = random.sample(range(1, self.num_nodes + 1), self.quorum_size)
        successful_replications = 0

        for node in replication_nodes:
            print(f"Replicating user profile to Node {node}-----")
            if self.replicate_user_profile_to_node(node, user_id, profile):
                successful_replications += 1

        if successful_replications >= self.quorum_size:
            print(".....QUORUM ACHIEVED!!!!!! User profile replicated successfully.....")
        else:
            print("Quorum not achieved. Rolling back the update.")
```



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```
def replicate_user_profile_to_node(self, target_node, user_id, profile):
    try:
        with socket.create_connection(('127.0.0.1', 9000 + target_node)) as s:
            data_to_send = {'user_id': user_id, 'profile': profile}
            s.sendall(pickle.dumps(data_to_send))
            print(f"Replicated user profile to Node {target_node}: {user_id} -> {profile}\n")
        return True
    except Exception as e:
        print(f"Failed to replicate user profile to Node {target_node}: {e}")
        return False

def node_listener(storage, node_id):
    while True:
        connection, _ = storage.node_sockets[node_id].accept()
        data = connection.recv(1024)
        if data:
            received_data = pickle.loads(data)
            storage.put_user_profile(received_data['user_id'], received_data['profile'])

num_nodes = 3
distributed_storage = DistributedStorage(num_nodes)

for node_id in range(1, num_nodes + 1):
    threading.Thread(target=node_listener, args=(distributed_storage, node_id),
                    daemon=True).start()

user_id = "user" + str(random.randint(10000000, 99999999))
username = input("Enter username: ")
bio = input("Enter bio: ")
profile_pic = input("Enter profile picture URL: ")

user_profile = {"username": username, "bio": bio, "profile_pic": profile_pic}
distributed_storage.put_user_profile(user_id, user_profile)
distributed_storage.perform_replication(user_id, user_profile)

random_node = random.randint(1, distributed_storage.num_nodes)
retrieved_profile = distributed_storage.get_user_profile(user_id)
print(f"\nRetrieved user profile from Node {random_node}: {user_id} ->
{retrieved_profile}")
```



```
print("=" * 30)
```

Output:

```

PS C:\Users\visheh\OneDrive\Desktop\DC Codes\Experiment 5> python experiment_5.py
Enter username: vishesh
Enter bio: machine learning engineer
Enter profile picture URL: https://imgs.search.brave.com/kyH8cdRs04aecKl0Kbf_GJ47PvjJlIw0vjItrn_bgds/rs:fit:500:0:0:8/g:ce/aHR0cHM6Y9tZWRp/YS5pc3RvY2twag90/bys5jb2vaWV0OTMy/MTUzNzcvcGhvdG8v/bGlvb1liYW50aG9y/YS1sZW8uanBnP3M9/NjEyYDh0cDc0aW90/az0yMCZjPW9ELXR5/ZjlZLTBIMUSkQ2Zq/UUF0ZGx5w1GTXlJ/Rm5HRm84TU84SEYX/WFU9'
User profile replicated: user27996304 -> {'username': 'vishesh', 'bio': 'machine learning engineer', 'profile_pic': 'https://imgs.search.brave.com/kyH8cdRs04aecKl0Kbf_GJ47PvjJlIw0vjItrn_bgds/rs:fit:500:0:0:8/g:ce/aHR0cHM6Y9tZWRp/YS5pc3RvY2twag90/bys5jb2vaWV0OTMy/MTUzNzcvcGhvdG8v/bGlvb1liYW50aG9y/YS1sZW8uanBnP3M9/NjEyYDh0cDc0aW90/az0yMCZjPW9ELXR5/ZjlZLTBIMUSkQ2Zq/UUF0ZGx5w1GTXlJ/Rm5HRm84TU84SEYX/WFU9', 'created_at': '2024-10-02 19:36:29'}

Replicating user profile to Node 2-----
Replicated user profile to Node 2: user27996304 -> {'username': 'vishesh', 'bio': 'machine learning engineer', 'profile_pic': 'https://imgs.search.brave.com/kyH8cdRs04aecKl0Kbf_GJ47PvjJlIw0vjItrn_bgds/rs:fit:500:0:0:8/g:ce/aHR0cHM6Y9tZWRp/YS5pc3RvY2twag90/bys5jb2vaWV0OTMy/MTUzNzcvcGhvdG8v/bGlvb1liYW50aG9y/YS1sZW8uanBnP3M9/NjEyYDh0cDc0aW90/az0yMCZjPW9ELXR5/ZjlZLTBIMUSkQ2Zq/UUF0ZGx5w1GTXlJ/Rm5HRm84TU84SEYX/WFU9', 'created_at': '2024-10-02 19:36:29'}

Replicating user profile to Node 3-----
Replicated user profile to Node 3: user27996304 -> {'username': 'vishesh', 'bio': 'machine learning engineer', 'profile_pic': 'https://imgs.search.brave.com/kyH8cdRs04aecKl0Kbf_GJ47PvjJlIw0vjItrn_bgds/rs:fit:500:0:0:8/g:ce/aHR0cHM6Y9tZWRp/YS5pc3RvY2twag90/bys5jb2vaWV0OTMy/MTUzNzcvcGhvdG8v/bGlvb1liYW50aG9y/YS1sZW8uanBnP3M9/NjEyYDh0cDc0aW90/az0yMCZjPW9ELXR5/ZjlZLTBIMUSkQ2Zq/UUF0ZGx5w1GTXlJ/Rm5HRm84TU84SEYX/WFU9', 'created_at': '2024-10-02 19:36:29'}

.....QUORUM ACHIEVED!!!!!! User profile replicated successfully.....

Retrieved user profile from Node 2: user27996304 -> {'username': 'vishesh', 'bio': 'machine learning engineer', 'profile_pic': 'https://imgs.search.brave.com/kyH8cdRs04aecKl0Kbf_GJ47PvjJlIw0vjItrn_bgds/rs:fit:500:0:0:8/g:ce/aHR0cHM6Y9tZWRp/YS5pc3RvY2twag90/bys5jb2vaWV0OTMy/MTUzNzcvcGhvdG8v/bGlvb1liYW50aG9y/YS1sZW8uanBnP3M9/NjEyYDh0cDc0aW90/az0yMCZjPW9ELXR5/ZjlZLTBIMUSkQ2Zq/UUF0ZGx5w1GTXlJ/Rm5HRm84TU84SEYX/WFU9', 'created_at': '2024-10-02 19:36:29'}
=====
User profile replicated: user27996304 -> {'username': 'vishesh', 'bio': 'machine learning engineer', 'profile_pic': 'https://imgs.search.brave.com/kyH8cdRs04aecKl0Kbf_GJ47PvjJlIw0vjItrn_bgds/rs:fit:500:0:0:8/g:ce/aHR0cHM6Y9tZWRp/YS5pc3RvY2twag90/bys5jb2vaWV0OTMy/MTUzNzcvcGhvdG8v/bGlvb1liYW50aG9y/YS1sZW8uanBnP3M9/NjEyYDh0cDc0aW90/az0yMCZjPW9ELXR5/ZjlZLTBIMUSkQ2Zq/UUF0ZGx5w1GTXlJ/Rm5HRm84TU84SEYX/WFU9', 'created_at': '2024-10-02 19:36:29'}

```

```

Enter username:
Enter bio:
Enter profile picture URL:
User profile replicated: user46766567 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:31'}

Replicating user profile to Node 1-----
Replicated user profile to Node 1: user46766567 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:31'}

User profile replicated: user46766567 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:31'}

Replicating user profile to Node 3-----
Replicated user profile to Node 3: user46766567 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:31'}

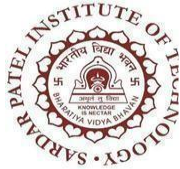
....QUORUM ACHIEVED!!!! User profile replicated successfully.....

=====
User profile replicated: user27996304 -> {'username': 'vishesh', 'bio': 'machine learning engineer', 'profile_pic': 'https://imgs.search.brave.com/kyH0cdRs04aeCk0lOKbf_GJ47PvjIw0wjItrn_bqds/rs:fit:500:0:0:0/g:ce/aHR8cHM6Ly9tZWRp/YS5pc3RvY2twaG90/by5jb20vaWQvOTMy/MTUzNzcvcGhvdG8v/bGlvb1lWY50aG9v/YS1sZW8uanBnP3M9/njEyedYxMiZ3PTAm/az0yMCIzPjw9ELXRs/ZjlZLTBIMUskQ2Zq/UUF0ZGx5wM1GTxlj/Rm5Hcm84TU84SEYx/WFU9', 'created_at': '2024-10-02 19:36:31'}
Enter username:
User profile replicated: user46766567 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:31'}

Enter bio:
Enter profile picture URL:
User profile replicated: user19270428 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:36'}

Replicating user profile to Node 1-----

```

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```
=====
User profile replicated: user27996304 -> {'username': 'vishesh', 'bio': 'machine learning engineer', 'profile_pic': 'https://imgs.search.brave.com/kyH8cdR
aeCk0lOKbf_GJ47PvjIWowjItrn_bqds/rs:fit:500:0:0:0/g:ce/aHR0cHM6Ly9tZWRp/YS5pc3RvY2twaG90/by5jb28vaWQvOTMy/MTUzNzcvcGhvdG8v/bGlvb1lWY50aGly/YS1sZW8uanBn
/NjEyeDYxMiZ3PTAm/az8yWCZjPW9ELXRs/Zj1ZLTBIMU5kQ2Zq/UUF0ZGxswM1GTX1J/Rm5HRm84TU84SEYx/WFU9', 'created_at': '2024-10-02 19:36:31'}
Enter username:
User profile replicated: user46766567 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:31'}

Enter bio:
Enter profile picture URL:
User profile replicated: user19270428 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:36'}

Replicating user profile to Node 1-----
Replicated user profile to Node 1: user19270428 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:36'}

User profile replicated: user19270428 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:36'}

Replicating user profile to Node 2-----
Replicated user profile to Node 2: user19270428 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:36'}
User profile replicated: user19270428 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:36'}

.....QUORUM ACHIEVED!!!!!! User profile replicated successfully.....

Retrieved user profile from Node 3: user19270428 -> {'username': '', 'bio': '', 'profile_pic': '', 'created_at': '2024-10-02 19:36:36'}
=====
PS C:\Users\vishe\OneDrive\Desktop\DC Codes\Experiment 5>
PS C:\Users\vishe\OneDrive\Desktop\DC Codes\Experiment 5> █
```

Conclusion:

Hence by completing we came to about implementation of data consistency and replication in social media platform.