

Distributed Systems Lab

Car Hire Booking Distributed System

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Problem Statement:

The purpose of this system is to monitor and control the bookings of cars in a distributed environment. All the features of a typical Car Hire Booking System are discussed here by considering a distributed system.

DATA CONSISTENCY

Consistency in database systems refers to the requirement that any given database transaction must change affected data only in allowed ways. Any data written to the database must be valid according to all defined rules, including constraints, cascades, triggers, and any combination thereof. This does not guarantee correctness of the transaction in all ways the application programmer might have wanted (that is the responsibility of application-level code) but merely that any programming errors cannot result in the violation of any defined database constraints. Data Consistency refers to the usability of data. Data Consistency problems may arise even in a single-site environment during recovery situations when backup copies of the production data are used in place of the original data.

In order to ensure that your backup data is usable, it is necessary to understand the backup methodologies that are in place as well as how the primary data is created and accessed.

Another very important consideration is the consistency of the data once the recovery has been completed and the application is ready to begin processing.

Code:

ClientNew.java

```
ClientNew.java X IpPool.class RoundRobin.java RandomLoadBalance.java LoadBalanceMain.java LoadBalance.java
ClientNew.java > ClientNew > main(String[])
51     int choice =0;
52     while(choice!=1){
53
54         String answer;
55         System.out.println("Enter "+"\\n"+"1:Add Cars"+"\\n"+"2:View Car Details"+"\\n"+"3:Book Car"+"\\n"+"4:See I
56         choice = myObj.nextInt();
57         if (choice==1){
58             System.out.println("Enter Car Name");
59             // Calling the remote method using the obtained object
60             String carName = myObj.next();
61             stub.putCars(carName,0);
62             System.out.println(stub.printMsg());
63         }
64         else if(choice ==2){
65             System.out.println("The Cars available are:");
66             System.out.println(stub.printMsg());
67         }
68         else if (choice==3){
69             System.out.println("Enter the User's name");
70             String userName = myObj.next();
71             System.out.println("Enter the car name to book");
72             String carName = myObj.next();
73             System.out.println("Enter the date + time");
74             String time = myObj.next();
75             stub.bookCar(userName,carName,time,0);
76             // System.out.println(answer);
77         }
78         else if (choice ==4){
```

Implementation.java

```
RoundRobin.java RandomLoadBalance.java LoadBalanceMain.java LoadBalance.java IpPool.java
ImplExample.java > Rmi > putCars(String, int)
23     void bookCar(String userName, String carName, String time, int flag) throws RemoteException;
24 }
25
26 public class ImplExample implements Rmi {
27     private static Integer position = 1;
28     private static Integer limit = 0;
29     static HashMap<String, Integer> map = new HashMap<>();
30     static HashMap<String, ArrayList> bookingmap = new HashMap<>();
31     static int i = 0;
32
33     // Implementing the interface method
34     public String printMsg() {
35         return map.toString() + bookingmap.toString();
36     }
37
38     public void replicatePut(String car, int value) {
39         System.out.println("printing value" + value);
40         map.put(car, value);
41         this.i += 1;
42         System.out.println(map);
43     }
44
45     public void bookingPut(String car, ArrayList list) {
46         // System.out.println("printing value"+value);
47         bookingmap.put(car, list);
48         this.i += 1;
49         System.out.println(bookingmap);
50     }
51
52     public void putCars(String car, int flag) {
53         Iterator<Map.Entry<String, Integer>> iterator = map.entrySet().iterator();
54     }
```

```
RoundRobin.java RandomLoadBalance.java LoadBalanceMain.java LoadBalance.java
ImplExample.java > Rmi > putCars(String, int)
49     System.out.println(bookingmap);
50 }
51
52 public void putCars(String car, int flag) {
53     Iterator<Map.Entry<String, Integer>> iterator = map.entrySet().iterator();
54
55     // flag to store result
56     boolean isKeyPresent = false;
57
58     // Iterate over the HashMap
59     while (iterator.hasNext()) {
60
61         // Get the entry at this iteration
62         Map.Entry<String, Integer> entry = iterator.next();
63
64         // Check if this key is the required key
65         if (car == entry.getKey()) {
66
67             isKeyPresent = true;
68         }
69     }
70     System.out.println("Checking if present" + isKeyPresent);
71
72     int count = map.containsKey(car) ? map.get(car) : 0;
73     map.put(car, count + 1);
74     // map.put(car,i);
75
76     // else{
77     // map.put(car,1);
78     // }
79     // map.put(car,i);
80     System.out.println("I am here");
81     System.out.println(car);
}
```

ServerA.java

```
RandomLoadBalance.java LoadBalanceMain.java LoadBalance.java IpPool.java ImplExa
ServerA.java > ...
6 import java.rmi.registry.*;
7
8 public class ServerA extends ImplExample {
9     public ServerA() {}
10
11     Run | Debug
12     public static void main(String args[]) {
13         String objPath = "///localhost:1099/SystemTime";
14         try {
15             // Instantiating the implementation class
16             ImplExample obj = new ImplExample();
17
18             DefaultSystemTime obj1 = new DefaultSystemTime();
19             // Exporting the object of implementation class
20             SystemTime stub1 = (SystemTime) UnicastRemoteObject.exportObject(obj1, 0);
21             // Binding the remote object (stub) in the registry
22             Naming.bind(objPath, obj1);
23
24             // Exporting the object of implementation class
25             // (here we are exporting the remote object to the stub)
26             Rmi stub = (Rmi) UnicastRemoteObject.exportObject(obj, 0);
27
28             // Binding the remote object (stub) in the registry
29             Registry registry = LocateRegistry.getRegistry();
30
31             registry.rebind("ServerA", stub);
32             map = stub.getData(0);
33             stub.setData(map);
34             System.out.println("ServerA ready");
35
36             Naming.rebind("ServerA",obj);
37             LocateRegistry.createRegistry(1901);
38             Naming.rebind("rmi://localhost:1901+/pikachu",obj);
39         } catch (Exception e) {
40             e.printStackTrace();
41         }
42     }
43 }
```

Explanation of Implementation:

ServerA is the main server. Everytime a change is made to serverA, the same change is made to the other two servers that are serverB and serverC. In this way it is checked that data consistency is maintained. As observed in the screenshots below, any change made is replicated in all the servers and in this manner data consistency is maintained and all the three servers have the same data stored. When different clients request data at the same time, load balancing is implemented further for that which will be explained later.

Each time a change is made to the main server i.e serverA, like if a car is added or booking is done then that car has to be removed from the available cars, all these changes are reflected in all three servers and in this way consistency is maintained.

We can add new cars, view the cars stored in the database. When we make a booking, the user has to fill in their details and choose the car they would like to book. The availability of that car then reduces by 1. This happens in all three servers and hence data consistency is maintained.

Steps to run:

1. Start rmiregistry
2. Compile the files : `javac *.java`
3. Run the command:
`java ServerA` so that the serverA will be ready.
In a new window run :
`Java ServerB` so that serverB is ready.
In a new window run :
`Java ServerC` so that serverC is ready.
4. In a new window, run the command: `java ClientNew` to run the client side program. The client can then add new cars.

Screenshots:

The image displays three overlapping command prompt windows from a Windows 10 desktop. The top-left window, titled 'C:\Windows\System32\cmd.exe - java ServerA', shows the execution of 'java ServerA'. It prints a list of cars: {CarC=1, CarB=1, CarA=1}, {CarC=1, CarB=1, CarA=2}, and {CarC=1, CarB=1, CarA=3}. The top-right window, titled 'C:\Windows\System32\cmd.exe - java ServerB', shows 'java ServerB' outputting 'ServerB ready' and printing the same car list. The bottom window, titled 'C:\Windows\System32\cmd.exe - java ServerC', shows 'java ServerC' outputting 'ServerC ready' and printing the same car list. A fourth window, titled 'Select C:\Windows\System32\cmd.exe - java ClientNew', is partially visible in the foreground, showing a menu with options: 1:View Car Details, 2:Book Car, 3:See Bookings, and 4:See Bookings. The desktop taskbar at the bottom shows the time as 05:11 PM on 28-09-2020.

The new cars have been added to all the three servers and the data is consistent.

```
C:\Windows\System32\cmd.exe - java ServerA
{CarC=1, CarB=1, CarA=1}
{CarC=1, CarB=1, CarA=1}{}
{CarC=1, CarB=1, CarA=1}{}
Checking if presentfalse
I am here
CarA
1
{CarC=1, CarB=1, CarA=2}
{CarC=1, CarB=1, CarA=2}{}
{CarC=1, CarB=1, CarA=2}{}
Checking if presentfalse
I am here
CarA
2
{CarC=1, CarB=1, CarA=3}
{CarC=1, CarB=1, CarA=3}{}
{CarC=1, CarB=1, CarA=3}{}

C:\Windows\System32\cmd.exe - java ServerB
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

D:\SPIT\Trial>java ServerB
ServerB ready
printing value1
{CarA=1}
printing value1
{CarB=1, CarA=1}
printing value1
{CarC=1, CarB=1, CarA=1}
printing value2
{CarC=1, CarB=1, CarA=2}
printing value3
{CarC=1, CarB=1, CarA=3}

C:\Windows\System32\cmd.exe - java ClientNew
Enter Car Name
CarA
{CarC=1, CarB=1, CarA=3}{}
Enter
1:Add Cars
2:View Car Details
3:Book Car
4:See Bookings
2
The Cars available are:
{CarC=1, CarB=1, CarA=3}{}
Enter
1:Add Cars
2:View Car Details
3:Book Car
4:See Bookings
```

We can view the details of the cars that is stored in the hashmap that we created.

```
C:\Windows\System32\cmd.exe - java ServerA
{CarC=1, CarB=1, CarA=1}
{CarC=1, CarB=1, CarA=1}{}
{CarC=1, CarB=1, CarA=1}{}
Checking if presentfalse
I am here
CarA
1
{CarC=1, CarB=1, CarA=2}
{CarC=1, CarB=1, CarA=2}{}
{CarC=1, CarB=1, CarA=2}{}
Checking if presentfalse
I am here
CarA
2
{CarC=1, CarB=1, CarA=3}
{CarC=1, CarB=1, CarA=3}{}
{CarC=1, CarB=1, CarA=3}{}
I am here

C:\Windows\System32\cmd.exe - java ServerB
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

D:\SPIT\Trial>java ServerB
ServerB ready
printing value1
{CarA=1}
printing value1
{CarB=1, CarA=1}
printing value1
{CarC=1, CarB=1, CarA=1}
printing value2
{CarC=1, CarB=1, CarA=2}
printing value3
{CarC=1, CarB=1, CarA=3}
printing value2

C:\Windows\System32\cmd.exe - java ClientNew
4:See Bookings
3
Enter the User's name
Tania
Enter the car name to book
CarA
Enter the date + time
28/09/2020
Enter
1:Add Cars
2:View Car Details
3:Book Car
4:See Bookings
2
The Cars available are:
{CarC=1, CarB=1, CarA=2}{CarA=[Tania, 28/09/2020]}
Enter
1:Add Cars
2:View Car Details
3:Book Car
4:See Bookings
```

We can book a car for a particular day by filling in the details and choosing the car the user would like to book. This booking is stored in all the three servers and the data is consistent.


```
C:\Windows\System32\cmd.exe - java ServerA
{CarC=1, CarB=1, CarA=1}
{CarC=1, CarB=1, CarA=1}{}
{CarC=1, CarB=1, CarA=1}{}
Checking if presentfalse
I am here
CarA
1
{CarC=1, CarB=1, CarA=2}
{CarC=1, CarB=1, CarA=2}{}
{CarC=1, CarB=1, CarA=2}{}
Checking if presentfalse
I am here
CarA
2
{CarC=1, CarB=1, CarA=3}
{CarC=1, CarB=1, CarA=3}{}
{CarC=1, CarB=1, CarA=3}{}
I am here

C:\Windows\System32\cmd.exe - java ServerB
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

D:\SPIT\Trial>java ServerB
ServerB ready
printing value1
{CarA=1}
printing value1
{CarB=1, CarA=1}
printing value1
{CarC=1, CarB=1, CarA=1}
printing value2
{CarC=1, CarB=1, CarA=2}
printing value3
{CarC=1, CarB=1, CarA=3}
printing value2

C:\Windows\System32\cmd.exe - java ClientNew
2
The Cars available are:
{CarC=1, CarB=1, CarA=2}{CarA=[Tania, 28/09/2020]}
Enter
1:Add Cars
2:View Car Details
3:Book Car
4:See Bookings
4
{CarC=1, CarB=1, CarA=2}{CarA=[Tania, 28/09/2020]}
Enter
1:Add Cars
2:View Car Details
3:Book Car
4:See Bookings
```

We can see that since a booking for carA was done, the availability of carA has reduced by 1 and now only 2 cars of carA are available. It can be noticed that this change appeared in all three servers i.e serverA, serverB and serverC. Hence data consistency was maintained.

Conclusion:

Data consistency is important as if multiple requests are made at the same time, the data stored should be consistent and not lead to conflicts and loss of data later. Hence, all the servers should have the same data before a transaction is carried out. Our car booking system has all the modules integrated and data consistency is maintained throughout the system.