

➤ Describe how you completed the code to obtain a working implementation.

1. `/dht/notify?failover=true`

As described in guide of assignment 4, “When a node detects that its successor has failed, it should contact the successor of its successor, to have it take over from the failed node with the bindings that it has backed up.”

So, the predecessor should detect its successor’s failure, and then call the `/dht/notify?failover=true` Web service method on its original `succ*2`.

In the method of `notify_failover` on the `succ*2`, two actions should be done:

First, add its backup bindings to its current bindings; second, replace its original backup bindings with the new backup bindings retrieved from `/dht/notify?failover=true` call of its new predecessor.

- In `dht.getSucc()`, I will add codes to detect the failure of its successor:

```

/*
 * This version gets the local successor from RMI server.
 */
// WebMethod
public NodeInfo getSucc() throws Error {
    try {
        // TODO
        // ADD, Ranger, Nov 29
        //System.out.println("Now start succCheck...");
        NodeInfo succ = routing.getSucc();
        if (succ != null) {
            //
            //
            System.out.println("CheckPredecessor: Predecessor's (id=" + pred.id
                               + ")");
            try {
                getPred(succ);
            } catch (Failed e) {
                info("CheckSuccessor: Successor has failed (id=" + succ.id
                    + ")");
                try {
                    setSucc(state.getBackupSucc());
                    info("Set succ's succ="+state.getBackupSucc()+" succeeded.");
                    succ=getSucc();
                    try {
                        client.notifyFailover(state.getBackupSucc(), state.extractBindings());
                    } catch (Failed e1) {
                        System.out.println("Notify failover to succ="+succ.id+" failed!");
                        e1.printStackTrace();
                    }
                } catch (RemoteException e1) {
                    e1.printStackTrace();
                    System.out.println("Failed: setPred(state.extractBindings().getSucc());");
                }
            }
        }
        // END-ADD
        return routing.getSucc();
    } catch (RemoteException e) {
        severe("GetSucc: RMI error in getSucc: " + e);
        throw new Error(e);
    }
}
}

```

- **notifyFailover** executes the function of `/dht/notify?failover=true`:

```

80 @PUT
81 @Path("notifyFailover")
82 @Consumes("application/xml")
83 /*
84  * Trigger failover in succ of succ
85  */
86 public Response notifyFailover(TableRep predDb) {
87     /*
88     * See the comment for WebClient::notify (the client side of this
89     * logic).
90     */
91     //if(failover==true){
92     new NodeService(uriInfo).notifyFailover(predDb);
93     //}
94     return Response.notModified().build();
95 }

```

I cannot name this function as `@PUT @Path("notify")` because the RESTFUL API doesn't allow two Web service method share same VERB and PATH.

- **Dht.notifyFailover(TableRep predDb):**

```
// WebMethod
public void notifyFailover(TableRep predDb) throws Error {
    info("Notify Failover is running...");
    try {
        // add original backup bindings to visible bindings
        state.failoverBindings();
        // replace original bindings with new predecessor's bindings
        state.backupBindings(predDb);
    } catch (RemoteException e) {
        log.severe("Remote exception while backing up bindings: " + e);
    }
}
```

- **state.failoverBindings():**

```
public synchronized void failoverBindings() throws RemoteException, Error{
    checkFailed();
    // add backup to dict
    Enumeration<String> keys = backup.keys();
    while (keys.hasMoreElements()) {
        String k = keys.nextElement();
        List<String> v = backup.get(k);
        dict.put(k, v);
    }
    // clear backup
    backup = Persist.newTable();
}
```

2. PUT & DELETE /dht/backup?key=KEY&val=VAL

- Add codes of addBackup in dht. **add(String k, String v) :**

```

public void add(String k, String v) throws Error, Invalid {
    try {
        /*
         * Validate that this binding can be stored here.
         */
        int kid = DHTBase.NodeKey(k);
        NodeInfo info = getNodeInfo();
        NodeInfo pred = getPred();

        System.out.println("k's hashCode: "
            + Math.abs(k.hashCode() % IRouting.NKEYS));

        if (pred != null && inInterval(kid, pred.id, info.id, true)) {
            /*
             * This node covers the interval in which k should be stored.
             */
            state.add(k, v);
            // TODO, add backup
            NodeInfo succ = this.getSucc();
            try {
                addBackup(succ, k, v);
            } catch (Failed e) {
                // TODO Auto-generated catch block
                e.printStackTrace();
            }
        } else if (pred == null && info.equals(getSucc())) {
            /*
             * Single-node network.
             */
            state.add(k, v);
            // TODO, add backup
            NodeInfo succ = this.getSucc();
            try {
                addBackup(succ, k, v);
            } catch (Failed e) {
                // TODO Auto-generated catch block
                e.printStackTrace();
            }
        } else if (pred == null && info.equals(getSucc())) {
            severe("Add: predecessor is null but not a single-node network.");
        } else {
            throw new Invalid("Invalid key: "+k+" (id="+kid+"");
        }
    } catch (RemoteException e) {
        severe("Add: RMI error: " + e);
        throw new Error(e);
    }
}

```

- The difference between add(k,v) and addBackup(k,v) is addBackup will do a Web service call to its successor, and then add the key-value pairs to state.bakup parameter. Show the codes of state.addBackup(String k, String v) :

```
public synchronized void addBackup(String k, String v) throws RemoteException, Error {  
    checkFailed();  
    List<String> vl = backup.get(k);  
    if (vl == null) {  
        vl = new ArrayList<String>();  
    }  
    vl.add(v);  
    backup.put(k, vl);  
}
```

➤ Describe how you tested the code.

I have two tests, the 1st one is among three nodes, and the 2nd one is adding a fourth node to the three nodes test after the second node has failed in the first node. Then fail the 3rd node.

1. Test One:

1.1. Link 1st to 3rd nodes together, show their routes.

```
ranger@ubuntu: ~/tmp/cs549/dht-test
10+2^0 11 [id=20,uri=http://localhost:8082/dht]
10+2^1 12 [id=20,uri=http://localhost:8082/dht]
10+2^2 14 [id=20,uri=http://localhost:8082/dht]
10+2^3 18 [id=20,uri=http://localhost:8082/dht]
10+2^4 26 [id=10,uri=http://localhost:8081/dht]
10+2^5 42 [id=10,uri=http://localhost:8081/dht]
dht<10> Notify is running in IF branch 1.
Dec 02, 2012 8:33:32 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Transferring bindings to node id=30
dht<10> routes
Predecessor: [id=30,addr=http://localhost:8083/dht]
Successor : [id=20,addr=http://localhost:8082/dht]
Succ's Succ: [id=30,addr=http://localhost:8083/dht]
Fingers:
Formula Key Succ
----- --
10+2^0 11 [id=20,uri=http://localhost:8082/dht]
10+2^1 12 [id=20,uri=http://localhost:8082/dht]
10+2^2 14 [id=20,uri=http://localhost:8082/dht]
10+2^3 18 [id=20,uri=http://localhost:8082/dht]
10+2^4 26 [id=30,uri=http://localhost:8083/dht]
10+2^5 42 [id=10,uri=http://localhost:8081/dht]
dht<10>

ranger@ubuntu: ~/tmp/cs549/dht-test
20+2^0 21 [id=10,uri=http://localhost:8081/dht]
20+2^1 22 [id=10,uri=http://localhost:8081/dht]
20+2^2 24 [id=10,uri=http://localhost:8081/dht]
20+2^3 28 [id=10,uri=http://localhost:8081/dht]
20+2^4 36 [id=10,uri=http://localhost:8081/dht]
20+2^5 52 [id=10,uri=http://localhost:8081/dht]
dht<20> Dec 02, 2012 8:33:33 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Joining succ as new, closer pred.
BackupSucc: succ=[id=10,addr=http://localhost:8081/dht]
dht<20> routes
Predecessor: [id=10,addr=http://localhost:8081/dht]
Successor : [id=30,addr=http://localhost:8083/dht]
Succ's Succ: [id=10,addr=http://localhost:8081/dht]
Fingers:
Formula Key Succ
----- --
20+2^0 21 [id=10,uri=http://localhost:8081/dht]
20+2^1 22 [id=10,uri=http://localhost:8081/dht]
20+2^2 24 [id=10,uri=http://localhost:8081/dht]
20+2^3 28 [id=10,uri=http://localhost:8081/dht]
20+2^4 36 [id=10,uri=http://localhost:8081/dht]
20+2^5 52 [id=10,uri=http://localhost:8081/dht]
dht<20>

ranger@ubuntu: ~/tmp/cs549/dht-test
Try out http://localhost:8083/dht
Entering command-line interface...
dht<30> join http://localhost:8082/dht
Dec 02, 2012 8:33:32 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Notifying succ that we are its pred.
BackupSucc: succ=[id=20,addr=http://localhost:8082/dht]
Notify is running in IF branch 1.
Dec 02, 2012 8:33:34 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Transferring bindings to node id=20
dht<30> routes
Predecessor: [id=20,addr=http://localhost:8082/dht]
Successor : [id=10,addr=http://localhost:8081/dht]
Succ's Succ: [id=20,addr=http://localhost:8082/dht]
Fingers:
Formula Key Succ
----- --
30+2^0 31 [id=10,uri=http://localhost:8081/dht]
30+2^1 32 [id=10,uri=http://localhost:8081/dht]
30+2^2 34 [id=10,uri=http://localhost:8081/dht]
30+2^3 38 [id=10,uri=http://localhost:8081/dht]
30+2^4 46 [id=10,uri=http://localhost:8081/dht]
30+2^5 62 [id=10,uri=http://localhost:8081/dht]
dht<30>
```

1.2. Add three key-value pairs, as each node has one in its binding. I print both the add(k,v) and addBackup(k,v) when they are running in nodes.


```

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<10> routes
Predecessor: [id=30,addr=http://localhost:8083/dht]
Successor : [id=20,addr=http://localhost:8082/dht]
Succ's Succ: [id=30,addr=http://localhost:8083/dht]
Fingers:
Formula Key Succ
-----
10+2^0 11 [id=20,uri=http://localhost:8082/dht]
10+2^1 12 [id=20,uri=http://localhost:8082/dht]
10+2^2 14 [id=20,uri=http://localhost:8082/dht]
10+2^3 18 [id=20,uri=http://localhost:8082/dht]
10+2^4 26 [id=30,uri=http://localhost:8083/dht]
10+2^5 42 [id=10,uri=http://localhost:8081/dht]
dht<10> add t1 v1
k's hashcode: 61
dht<10> add t11 v11
dht<10> add t19 v19
Dec 02, 2012 8:36:38 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 28
dht<10> bindings
KEYSTRING ID VALUES
t1 61 {v1}
dht<10>

```

```

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<20> Dec 02, 2012 8:33:33 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Joining succ as new, closer pred.
BackupSucc: succ=[id=10,addr=http://localhost:8081/dht]
dht<20> routes
Predecessor: [id=10,addr=http://localhost:8081/dht]
Successor : [id=30,addr=http://localhost:8083/dht]
Succ's Succ: [id=10,addr=http://localhost:8081/dht]
Fingers:
Formula Key Succ
-----
20+2^0 21 [id=10,uri=http://localhost:8081/dht]
20+2^1 22 [id=10,uri=http://localhost:8081/dht]
20+2^2 24 [id=10,uri=http://localhost:8081/dht]
20+2^3 28 [id=10,uri=http://localhost:8081/dht]
20+2^4 36 [id=10,uri=http://localhost:8081/dht]
20+2^5 52 [id=10,uri=http://localhost:8081/dht]
dht<20> Dec 02, 2012 8:36:27 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 61
k's hashcode: 20
bindings
KEYSTRING ID VALUES
t11 20 {v11}
dht<20>

```

```

ranger@ubuntu: ~/tmp/cs549/dht-test
Notify is running in IF branch 1.
Dec 02, 2012 8:33:34 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Transferring bindings to node id=20
dht<30> routes
Predecessor: [id=20,addr=http://localhost:8082/dht]
Successor : [id=10,addr=http://localhost:8081/dht]
Succ's Succ: [id=20,addr=http://localhost:8082/dht]
Fingers:
Formula Key Succ
-----
30+2^0 31 [id=10,uri=http://localhost:8081/dht]
30+2^1 32 [id=10,uri=http://localhost:8081/dht]
30+2^2 34 [id=10,uri=http://localhost:8081/dht]
30+2^3 38 [id=10,uri=http://localhost:8081/dht]
30+2^4 46 [id=10,uri=http://localhost:8081/dht]
30+2^5 62 [id=10,uri=http://localhost:8081/dht]
dht<30> Dec 02, 2012 8:36:34 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 20
k's hashcode: 28
bindings
KEYSTRING ID VALUES
t19 28 {v19}
dht<30>

```

1.3. Fail@2nd node, then succ's succ would change after 2nd node has failed, and the bindings of 3rd node's backup bindings would take place of 2nd node's bindings, as well.

```

ranger@ubuntu: ~/tmp/cs549/dht-test
INFO: CheckSuccessor: Successor has failed (id=20)
Dec 02, 2012 8:42:51 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Set succ's succ=[id=30,addr=http://localhost:8083/dht] succeeded.
Dec 02, 2012 8:42:54 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Joining succ with null pred.
BackupSucc: succ=[id=10,addr=http://localhost:8081/dht]
dht<10> routes
Predecessor: [id=30,addr=http://localhost:8083/dht]
Successor : [id=30,addr=http://localhost:8083/dht]
Succ's Succ: [id=10,addr=http://localhost:8081/dht]
Fingers:
Formula Key Succ
-----
10+2^0 11 [id=30,uri=http://localhost:8083/dht]
10+2^1 12 [id=30,uri=http://localhost:8083/dht]
10+2^2 14 [id=30,uri=http://localhost:8083/dht]
10+2^3 18 [id=30,uri=http://localhost:8083/dht]
10+2^4 26 [id=30,uri=http://localhost:8083/dht]
10+2^5 42 [id=10,uri=http://localhost:8081/dht]
dht<10> bindings
KEYSTRING ID VALUES
t1 61 {v1}
dht<10>

```

```

ranger@ubuntu: ~/tmp/cs549/dht-test
at org.glassfish.grizzly.filterchain.DefaultFilterChain.execute(DefaultFilterChain.java:134)
at org.glassfish.grizzly.filterchain.DefaultFilterChain.process(DefaultFilterChain.java:112)
at org.glassfish.grizzly.ProcessorExecutor.execute(ProcessorExecutor.java:78)
at org.glassfish.grizzly.nio.transport.TCPNIOTransport.fireIOEvent(TCPNIOTransport.java:816)
at org.glassfish.grizzly.strategies.AbstractIOStrategy.fireIOEvent(AbstractIOStrategy.java:111)
at org.glassfish.grizzly.strategies.WorkerThreadIOStrategy.run0(WorkerThreadIOStrategy.java:115)
at org.glassfish.grizzly.strategies.WorkerThreadIOStrategy.access$100(WorkerThreadIOStrategy.java:55)
at org.glassfish.grizzly.strategies.WorkerThreadIOStrategy$WorkerThreadRunnable.run(WorkerThreadIOStrategy.java:135)
at org.glassfish.grizzly.threadpool.AbstractThreadPool$Worker.doWork(AbstractThreadPool.java:566)
at org.glassfish.grizzly.threadpool.AbstractThreadPool$Worker.run(AbstractThreadPool.java:546)
at java.lang.Thread.run(Thread.java:722)
dht<20>

```

```

ranger@ubuntu: ~/tmp/cs549/dht-test
Dec 02, 2012 8:42:52 AM edu.stevens.cs549.dht.activity.DHT info
INFO: CheckPredecessor: Predecessor has failed (id=20)
Notify is running in IF branch 1.
Dec 02, 2012 8:42:54 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Transferring bindings to node id=10
dht<30> routes
Predecessor: [id=10,addr=http://localhost:8081/dht]
Successor : [id=10,addr=http://localhost:8081/dht]
Succ's Succ: [id=30,addr=http://localhost:8083/dht]
Fingers:
Formula Key Succ
-----
30+2^0 31 [id=10,uri=http://localhost:8081/dht]
30+2^1 32 [id=10,uri=http://localhost:8081/dht]
30+2^2 34 [id=10,uri=http://localhost:8081/dht]
30+2^3 38 [id=10,uri=http://localhost:8081/dht]
30+2^4 46 [id=10,uri=http://localhost:8081/dht]
30+2^5 62 [id=10,uri=http://localhost:8081/dht]
dht<30> bindings
KEYSTRING ID VALUES
t11 20 {v11}
t19 28 {v19}
dht<30>

```

k=t11 is the original bindings of 2nd node

Test Two:

2.1. Add the 4th node into the first three nodes DHT link (actually there are only two nodes alive for 2nd has failed), show their new routes and bindings.

```
ranger@ubuntu: ~/tmp/cs549/dht-test
dht<10> bindings
KEYSTRING ID VALUES
t1 61 {v1}
dht<10> Notify is running in IF branch 1.
Dec 02, 2012 8:48:33 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Transferring bindings to node id=40

dht<10> routes
Predecessor: [id=40,addr=http://localhost:8084/dht]
Successor : [id=30,addr=http://localhost:8083/dht]
Succ's Succ: [id=40,addr=http://localhost:8084/dht]
rangers:
Formula Key Succ
----- --
10+2^0 11 [id=30,url=http://localhost:8083/dht]
10+2^1 12 [id=30,url=http://localhost:8083/dht]
10+2^2 14 [id=30,url=http://localhost:8083/dht]
10+2^3 18 [id=30,url=http://localhost:8083/dht]
10+2^4 26 [id=30,url=http://localhost:8083/dht]
10+2^5 42 [id=10,url=http://localhost:8081/dht]
dht<10> bindings
KEYSTRING ID VALUES
t1 61 {v1}
dht<10>

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<20>
at org.glassfish.grizzly.filterchain.DefaultFilterChain.execute(DefaultF
ilterChain.java:134)
at org.glassfish.grizzly.filterchain.DefaultFilterChain.process(DefaultF
ilterChain.java:112)
at org.glassfish.grizzly.ProcessorExecutor.execute(ProcessorExecutor.jav
a:78)
at org.glassfish.grizzly.nio.transport.TCPNIOTransport.fireIOEvent(TCPNIO
Transport.java:816)
at org.glassfish.grizzly.strategies.AbstractIOStrategy.fireIOEvent(Abstr
actIOStrategy.java:111)
at org.glassfish.grizzly.strategies.WorkerThreadIOStrategy.run0(WorkerTh
readIOStrategy.java:115)
at org.glassfish.grizzly.strategies.WorkerThreadIOStrategy.access$100(Wo
rkerThreadIOStrategy.java:55)
at org.glassfish.grizzly.strategies.WorkerThreadIOStrategy$WorkerThreadR
unnable.run(WorkerThreadIOStrategy.java:135)
at org.glassfish.grizzly.threadpool.AbstractThreadPool$Worker.doWork(Abs
tractThreadPool.java:566)
at org.glassfish.grizzly.threadpool.AbstractThreadPool$Worker.run(Abstra
ctThreadPool.java:546)
at java.lang.Thread.run(Thread.java:722)

dht<20>

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<30>
t11 20 {v11}
t19 28 {v19}
dht<30> Dec 02, 2012 8:48:34 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Joining succ as new, closer pred.
BackupSucc: succ=[id=10,addr=http://localhost:8081/dht]
dht<30> routes
Predecessor: [id=10,addr=http://localhost:8081/dht]
Successor : [id=40,addr=http://localhost:8084/dht]
Succ's Succ: [id=10,addr=http://localhost:8081/dht]
rangers:
Formula Key Succ
----- --
30+2^0 31 [id=10,url=http://localhost:8081/dht]
30+2^1 32 [id=10,url=http://localhost:8081/dht]
30+2^2 34 [id=10,url=http://localhost:8081/dht]
30+2^3 38 [id=10,url=http://localhost:8081/dht]
30+2^4 46 [id=10,url=http://localhost:8081/dht]
30+2^5 62 [id=10,url=http://localhost:8081/dht]
dht<30> bindings
KEYSTRING ID VALUES
t11 20 {v11}
t19 28 {v19}
dht<30>

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<40> join http://localhost:8083/dht
dht<40> Dec 02, 2012 8:48:33 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Notifying succ that we are its pred.
BackupSucc: succ=[id=30,addr=http://localhost:8083/dht]
Notify is running in IF branch 1.
Dec 02, 2012 8:48:34 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Transferring bindings to node id=30

dht<40> routes
Predecessor: [id=30,addr=http://localhost:8083/dht]
Successor : [id=10,addr=http://localhost:8081/dht]
Succ's Succ: [id=30,addr=http://localhost:8083/dht]
rangers:
Formula Key Succ
----- --
40+2^0 41 [id=10,url=http://localhost:8081/dht]
40+2^1 42 [id=10,url=http://localhost:8081/dht]
40+2^2 44 [id=10,url=http://localhost:8081/dht]
40+2^3 48 [id=10,url=http://localhost:8081/dht]
40+2^4 56 [id=10,url=http://localhost:8081/dht]
40+2^5 8 [id=10,url=http://localhost:8081/dht]
dht<40> bindings
No entries.
dht<40>
```

2.2 Add some new key-value pairs to DHT circle, show it works all the same in bindings and backup bindings after 2nd node has failed.


```

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<10> add t22 v22
k's hashcode: 52
dht<10> add t191 v191
dht<10> add t1a v1a
k's hashcode: 4
dht<10> add t29 v29
k's hashcode: 59
dht<10> add t19a v1
k's hashcode: 5
dht<10> add ta9 va9
k's hashcode: 44
dht<10> add ta1 va1
Dec 02, 2012 8:51:16 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 36
dht<10> bindings
KEYSTRING ID VALUES
t19a 5 {v1}
ta9 44 {va9}
t22 52 {v22}
t1 61 {v1}
t29 59 {v29}
t1a 4 {v1a}
dht<10>

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<20>

ranger@ubuntu: ~/tmp/cs549/dht-test
30*2*3 38 [id=10,url=http://localhost:8081/dht]
30*2*4 46 [id=10,url=http://localhost:8081/dht]
30*2*5 62 [id=10,url=http://localhost:8081/dht]
dht<30> bindings
KEYSTRING ID VALUES
t11 20 {v11}
t19 28 {v19}
dht<30> Dec 02, 2012 8:50:09 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 52
k's hashcode: 21
Dec 02, 2012 8:50:39 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 4
Dec 02, 2012 8:50:48 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 59
Dec 02, 2012 8:50:55 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 5
Dec 02, 2012 8:51:06 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 44
dht<30> bindings
KEYSTRING ID VALUES
t11 20 {v11}
t191 21 {v191}
t19 28 {v19}
dht<30>

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<40> routes
Predecessor: [id=30,addr=http://localhost:8083/dht]
Successor : [id=10,addr=http://localhost:8081/dht]
Succ's Succ: [id=30,addr=http://localhost:8083/dht]
Fingers:
Formula Key Succ
-----
40*2*0 41 [id=10,url=http://localhost:8081/dht]
40*2*1 42 [id=10,url=http://localhost:8081/dht]
40*2*2 44 [id=10,url=http://localhost:8081/dht]
40*2*3 48 [id=10,url=http://localhost:8081/dht]
40*2*4 56 [id=10,url=http://localhost:8081/dht]
40*2*5 8 [id=10,url=http://localhost:8081/dht]
dht<40> bindings
No entries.
dht<40> Dec 02, 2012 8:50:26 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 21
k's hashcode: 36
dht<40> bindings
KEYSTRING ID VALUES
ta1 36 {va1}
dht<40>

```

2.3 fail@3rd node, then the bindings of 3rd node should be shown in 4th node with the original bindings on 4th node. Because the 4th node has backed up its predecessor's bindings, and will failover them after its predecessor fails.

```

ranger@ubuntu: ~/tmp/cs549/dht-test
BackupSucc: succ=[id=10,addr=http://localhost:8081/dht]
dht<10> routes
Predecessor: [id=40,addr=http://localhost:8084/dht]
Successor : [id=40,addr=http://localhost:8084/dht]
Succ's Succ: [id=10,addr=http://localhost:8081/dht]
Fingers:
Formula Key Succ
-----
10*2*0 11 [id=40,url=http://localhost:8084/dht]
10*2*1 12 [id=40,url=http://localhost:8084/dht]
10*2*2 14 [id=40,url=http://localhost:8084/dht]
10*2*3 18 [id=40,url=http://localhost:8084/dht]
10*2*4 26 [id=40,url=http://localhost:8084/dht]
10*2*5 42 [id=10,url=http://localhost:8081/dht]
dht<10> bindings
KEYSTRING ID VALUES
t19a 5 {v1}
ta9 44 {va9}
t22 52 {v22}
t1 61 {v1}
t29 59 {v29}
t1a 4 {v1a}
dht<10>

ranger@ubuntu: ~/tmp/cs549/dht-test
dht<40> Dec 02, 2012 8:50:26 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Add backup: k's hashcode: 21
k's hashcode: 36
dht<40> bindings
KEYSTRING ID VALUES
ta1 36 {va1}
dht<40> Dec 02, 2012 8:50:11 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Notify Failover is running....
Dec 02, 2012 8:56:11 AM edu.stevens.cs549.dht.activity.DHT info
INFO: CheckPredecessor: Predecessor has failed (id=30)
Dec 02, 2012 8:56:15 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Notify Failover is running....
Notify is running in IF branch 1.
Dec 02, 2012 8:56:15 AM edu.stevens.cs549.dht.activity.DHT info
INFO: Transferring bindings to node id=10
dht<40> bindings
KEYSTRING ID VALUES
t11 20 {v11}
ta1 36 {va1}
t191 21 {v191}
t19 28 {v19}
dht<40>

```

➤ Test Demo:

The video shows TWO tests:

First Test, three nodes and 2nd fail;

Second Test, add a 4th node to the First Test, then fail the 3rd node.

A4_Ranger_cs549_2012-02_2234 <http://screencast.com/t/GsUQ32AVDtk2>