COMPSCI 677: Lab III-Test Document

Part 1: Testing Load Balancing

1) Running two servers and four sensors

```
<Pyro4.core.Proxy at 0x7f32b5984690, connected, for PYRONAME:example.network.server1@128.119.243.175:9090>
2017-04-23 22:41:17,353 - INFO - Registered with server
Enter new temperature:
```

```
<Pyro4.core.Proxy at 0x7f9bdf692890, connected, for PYRONAME:example.network.server2@128.119.243.175:9090>
2017-04-23 22:41:19,359 - INFO - Registered with server
Door close. Change?
```

```
<Pyro4.core.Proxy at 0x7f839117d690, connected, for PYRONAME:example.network.server1@128.119.243.175:9090>
2017-04-23 22:41:21,363 - INFO - Registered with server
Detect Motion?
```

```
<Pyro4.core.Proxy at 0x7f2aeab59690, connected, for PYRONAME:example.network.server2@128.119.243.175:9090>
2017-04-23 22:41:23,370 - INFO - Registered with server
Press Enter if you have presence key?
```

Two sensors register with server1 and two sensors register with server2 as expected.

2) Running two servers and five sensors

```
<Pyro4.core.Proxy at 0x7f32b5984690, connected, for PYRONAME:example.network.server1@128.119.243.175:9090>
2017-04-23 22:41:17,353 - INFO - Registered with server
Enter new temperature:
```

```
<Pyro4.core.Proxy at 0x7f9bdf692890, connected, for PYRONAME:example.network.server2@128.119.243.175:9090>
2017-04-23 22:41:19,359 - INFO - Registered with server
Door close. Change?
```

```
<Pyro4.core.Proxy at 0x7f839117d690, connected, for PYRONAME:example.network.server1@128.119.243.175:9090>
2017-04-23 22:41:21,363 - INFO - Registered with server
Detect Motion?
```

```
<Pyro4.core.Proxy at 0x7f2aeab59690, connected, for PYRONAME:example.network.server2@128.119.243.175:9090>
2017-04-23 22:41:23,370 - INFO - Registered with server
Press Enter if you have presence key?
```

```
<Pyro4.core.Proxy at 0x7f150da376d0, connected, for PYRONAME:example.network.server1@128.119.243.175:9090>
2017-04-23 22:58:10,168 - INFO - Registered with server
Light Bulb off. Change?
```

Three sensors/devices (temperature, motion, lightbulb) register with server1 while two sensors/devices (door, presence) register with server2 as expected.

Part 2: Cache Performance Results

1) Without Caching

```
2017-04-23 23:30:04,018 - INFO - Stored event data of tempsensor: -1
2017-04-23 23:30:06,271 - INFO - Stored latest event data of motionsensor: motion
2017-04-23 23:30:06,274 - INFO - Getting latest event data of doorsensor
2017-04-23 23:30:06,276 - INFO - Getting latest event data of motionsensor
2017-04-23 23:30:06,296 - INFO - Stored event data of tempsensor: -1
2017-04-23 23:30:06,297 - INFO - Stored event data of doorsensor: open
2017-04-23 23:30:07,304 - INFO - Stored event data of presencesensor: yes
2017-04-23 23:30:07,305 - INFO - Stored latest event data of presencesensor: yes
2017-04-23 23:30:07,307 - INFO - Getting latest event data of presencesensor
```

```
017-04-23 23:30:11,297 - INFO - Stored event data of motionsensor: motion
017-04-23 23:30:11,299 - INFO - Stored latest event data of motionsensor: motion
017-04-23 23:30:11,301 - INFO - Getting latest event data of doorsensor
017-04-23 23:30:11,302 - INFO - Getting latest event data of motionsensor
017-04-23 23:30:16,311 - INFO - Getting latest event data of presencesensor
```

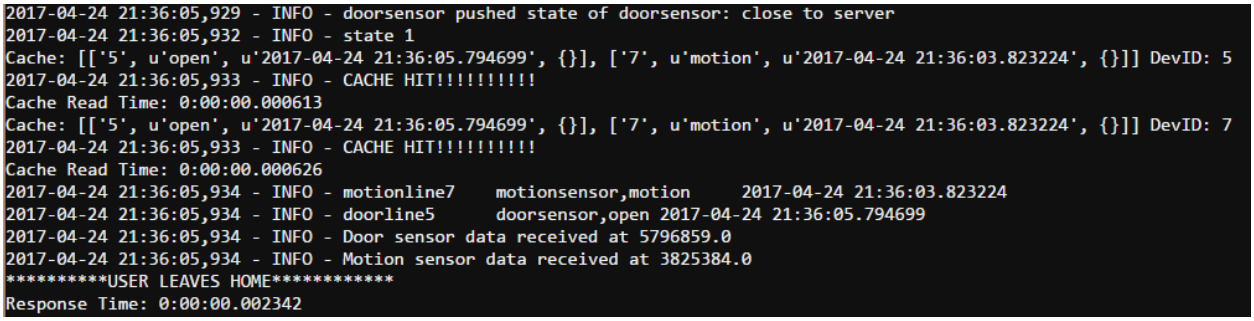
As shown above, system works perfectly fine without caching. Both gateway 1 and gateway 2 get latest events of door, motion and presence sensors in the same order.

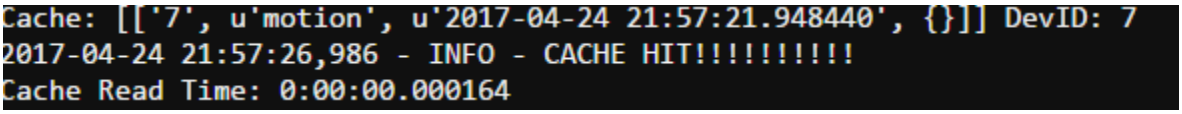
```
(0, u'open')
2017-04-23 23:30:04,007 - INFO - state 0
2017-04-23 23:30:04,007 - INFO - Door sensor data received
2017-04-23 23:30:04,016 - INFO - 6-open-2017-04-23 23:30:04.002857
2017-04-23 23:30:04,017 - INFO - 5--1-2017-04-23 23:30:04.002177
2017-04-23 23:30:06,268 - INFO - motionsensor pushed state of motionsensor: motion to server
(7, u'motion')
2017-04-23 23:30:06,272 - INFO - state 1
2017-04-23 23:30:06,273 - INFO - Motion sensor data received
2017-04-23 23:30:06,276 - INFO - motionline7    motionsensor,motion     2017-04-23 23:30:06.266544
2017-04-23 23:30:06,277 - INFO - doorline6      doorsensor,open 2017-04-23 23:30:03.984183
2017-04-23 23:30:06,278 - INFO - Door sensor data received at3985983.0
2017-04-23 23:30:06,278 - INFO - Motion sensor data received at6268344.0
2017-04-23 23:30:07,303 - INFO - 8-yes-2017-04-23 23:30:07.287160
(8, u'yes')
2017-04-23 23:30:07,306 - INFO - state 2
2017-04-23 23:30:07,306 - INFO - Presence sensor data received
**********USER ENTERS HOME***********
2017-04-23 23:30:17,055 - INFO - 6-open-2017-04-23 23:30:17.044316
2017-04-23 23:30:21,060 - INFO - 5--1-2017-04-23 23:30:21.049126
```

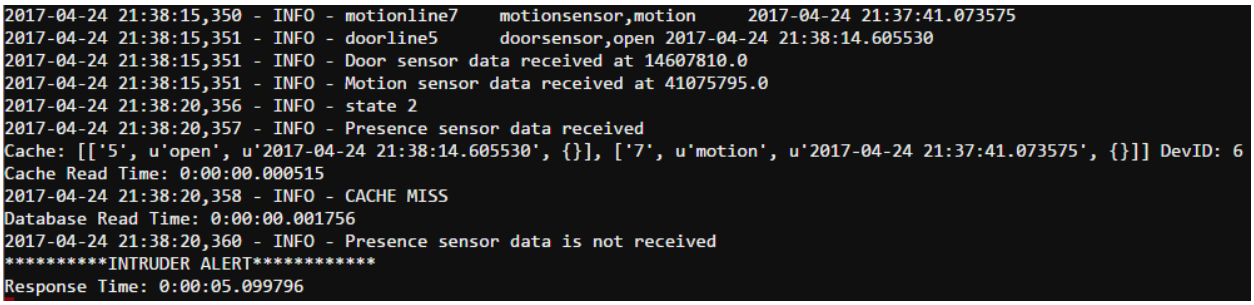
```
2017-04-23 23:30:03,989 - INFO - state 0
2017-04-23 23:30:03,990 - INFO - Door sensor data received
2017-04-23 23:30:06,293 - INFO - 5--1-2017-04-23 23:30:06.283966
2017-04-23 23:30:06,294 - INFO - 6-open-2017-04-23 23:30:06.282919
2017-04-23 23:30:07,288 - INFO - presencesensor pushed state of presencesensor: yes to server
(8, u'yes')
2017-04-23 23:30:07,290 - INFO - state 1
2017-04-23 23:30:11,295 - INFO - 7-motion-2017-04-23 23:30:06.266544
(7, u'motion')
2017-04-23 23:30:11,299 - INFO - state 1
2017-04-23 23:30:11,300 - INFO - Motion sensor data received
2017-04-23 23:30:11,303 - INFO - motionline7    motionsensor,motion     2017-04-23 23:30:06.266544
2017-04-23 23:30:11,303 - INFO - doorline6      doorsensor,open 2017-04-23 23:30:03.984183
2017-04-23 23:30:11,303 - INFO - Door sensor data received at3985983.0
2017-04-23 23:30:11,304 - INFO - Motion sensor data received at6268344.0
(1, 'open')
2017-04-23 23:30:16,309 - INFO - state 2
2017-04-23 23:30:16,310 - INFO - Presence sensor data received
**********USER ENTERS HOME***********
2017-04-23 23:30:19,320 - INFO - 6-open-2017-04-23 23:30:19.309838
2017-04-23 23:30:23,336 - INFO - 5--1-2017-04-23 23:30:23.325376
2017-04-23 23:30:32,360 - INFO - 6-open-2017-04-23 23:30:32.349774
2017-04-23 23:30:40,382 - INFO - 5--1-2017-04-23 23:30:40.371376
```

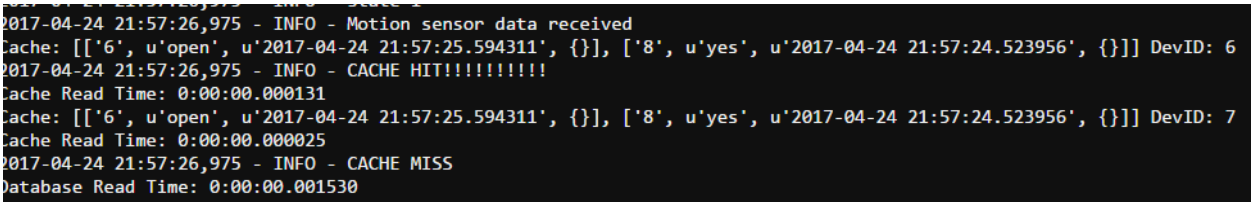
The first image shows server1 while the second shows server2. Temperature and Motion sensors are connected to server1 while Door sensor and Presence sensor are connected to server2. We see that both the servers reach the same stage by getting events from database in the same order, thereby maintaining consistency when cache is not used. Response time without cache = 1.5 milliseconds

2) Cache Hit and Miss times









Because the response time of a request depends on the state we are at in our state machine and the process to be carried out, the response time showed a lot of variation for different requests.

But the read times of cache and database are roughly coherent.

Time taken by requests when cache hits for door sensor = 0.5 milliseconds.

Time taken by requests when cache misses = 1.6 milliseconds.

Our system provides strict consistency guarantees. So, no cache inconsistency ever happens.

3) Failure recovery

```
2017-04-24 00:00:58,419 - INFO - Door sensor data received at57396217.0
2017-04-24 00:00:58,420 - INFO - Motion sensor data received at58404839.0
2017-04-24 00:01:00,670 - INFO - 8-yes-2017-04-24 00:01:00.652171
(8, u'yes')
2017-04-24 00:01:00,674 - INFO - state 2
2017-04-24 00:01:00,675 - INFO - Presence sensor data received
**********USER ENTERS HOME************
2017-04-24 00:01:10,469 - INFO - 6-open-2017-04-24 00:01:10.457664
2017-04-24 00:01:14,472 - INFO - 5--1-2017-04-24 00:01:14.461786
```

```
2017-04-24 00:01:08,452 - INFO - state 2
2017-04-24 00:01:08,452 - INFO - Presence sensor data received
**********USER ENTERS HOME************
2017-04-24 00:01:11,477 - INFO - 6-open-2017-04-24 00:01:11.466695
2017-04-24 00:01:15,484 - INFO - 5--1-2017-04-24 00:01:15.472536
2017-04-24 00:01:24,500 - INFO - 6-open-2017-04-24 00:01:24.493179
```

Both servers are in the same state initially, all events are synchronized at both servers.

```
**********USER ENTERS HOME************
2017-04-24 00:01:11,477 - INFO - 6-open-2017-04-24 00:01:11.466695
2017-04-24 00:01:15,484 - INFO - 5--1-2017-04-24 00:01:15.472536
2017-04-24 00:01:24,500 - INFO - 6-open-2017-04-24 00:01:24.493179
2017-04-24 00:01:32,861 - INFO - 5--1-2017-04-24 00:01:32.853372
2017-04-24 00:01:37,533 - INFO - 6-open-2017-04-24 00:01:37.524420
2017-04-24 00:01:49,905 - INFO - 5--1-2017-04-24 00:01:49.892956
2017-04-24 00:01:50,572 - INFO - 6-open-2017-04-24 00:01:50.561845
2017-04-24 00:02:03,611 - INFO - 6-open-2017-04-24 00:02:03.602056
2017-04-24 00:02:05,706 - INFO - Other server crashed
2017-04-24 00:02:05,706 - INFO - Initiating failure recovery
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 6: u'doorsensor'}
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 6: u'doorsensor'}
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 5: u'tempsensor', 6: u'doorsensor'}
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 5: u'tempsensor', 6: u'doorsensor'}
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'}
Failure recovery time 0:00:00.016738
2017-04-24 00:02:23,827 - INFO - doorsensor pushed state of doorsensor: close to server
(6, u'close')
2017-04-24 00:02:23,831 - INFO - **********STATE IDLE***********
2017-04-24 00:02:34,484 - INFO - motionsensor pushed state of motionsensor: motion to server
(7, u'motion')
2017-04-24 00:02:34,486 - INFO - state 0
2017-04-24 00:02:34,487 - INFO - Motion sensor data received
2017-04-24 00:02:36,126 - INFO - doorsensor pushed state of doorsensor: open to server
(6, u'open')
2017-04-24 00:02:36,128 - INFO - state 1
2017-04-24 00:02:36,129 - INFO - Door sensor data received
2017-04-24 00:02:36,132 - INFO - motionline7    motionsensor,motion     2017-04-24 00:02:34.474825
2017-04-24 00:02:36,132 - INFO - doorline6      doorsensor,open 2017-04-24 00:02:36.125017
2017-04-24 00:02:36,132 - INFO - Door sensor data received at36125137.0
2017-04-24 00:02:36,132 - INFO - Motion sensor data received at34474945.0
**********USER LEAVES HOME************
```

User is at home but the door is left unclosed when the crash occurs. Failure recovery is started by the other server. Door is registered at the server which is crashed. Now door re-registers to this server and when it is closed, the state goes back to IDLE. This shows that the failure recovery process was successful.

```
6, u'open')
017-04-24 00:05:00,014 - INFO - state 0
017-04-24 00:05:00,015 - INFO - Door sensor data received
017-04-24 00:05:20,888 - INFO - Other server crashed
017-04-24 00:05:20,888 - INFO - Initiating failure recovery
8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
6: u'doorsensor'}
8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
6: u'doorsensor'}
8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
5: u'tempsensor', 6: u'doorsensor'}
8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
5: u'tempsensor', 6: u'doorsensor'}
8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'}
ailure recovery time 0:00:00.022719
2017-04-24 00:05:29,482 - INFO - motionsensor pushed state of motionsensor: motion to server
7, u'motion')
017-04-24 00:05:29,485 - INFO - state 1
017-04-24 00:05:29,485 - INFO - Motion sensor data received
017-04-24 00:05:29,489 - INFO - motionline7    motionsensor,motion     2017-04-24 00:05:29.471964
017-04-24 00:05:29,489 - INFO - doorline6      doorsensor,open 2017-04-24 00:05:00.008370
017-04-24 00:05:29,490 - INFO - Door sensor data received at8670.0
017-04-24 00:05:29,490 - INFO - Motion sensor data received at29472264.0
017-04-24 00:05:30,881 - INFO - presencesensor pushed state of presencesensor: yes to server
8, u'yes')
017-04-24 00:05:30,883 - INFO - state 2
017-04-24 00:05:30,884 - INFO - Presence sensor data received
*********USER ENTERS HOME************
```

Here failure recovery occurs in IDLE state, door and presence server are registered at this server while temperature and motion sensors are registered at the crashed server. But after failure recovery takes place, door sensor, motion sensor and presence sensor data is recorded and decision is taken.

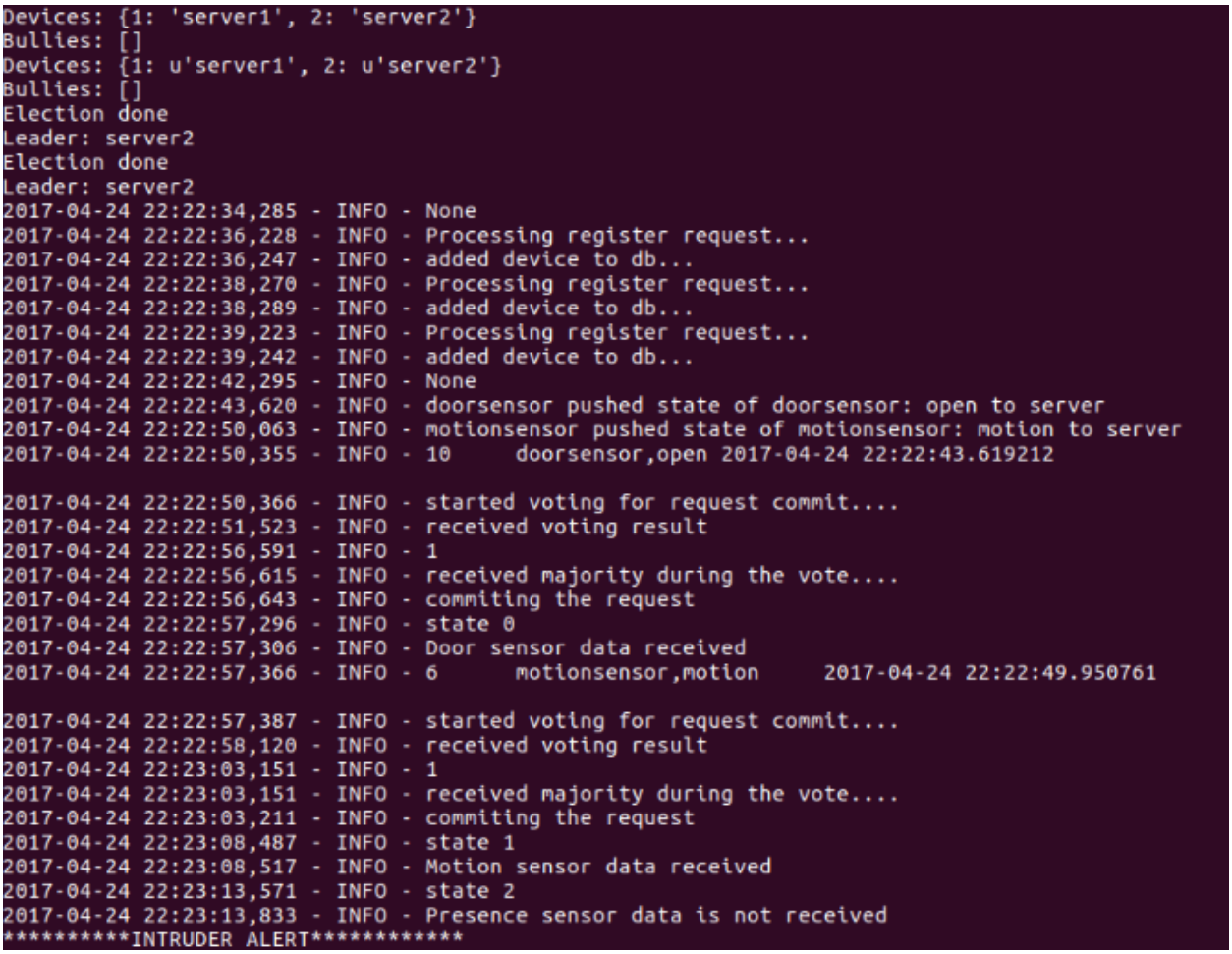
```
2017-04-24 00:06:17,869 - INFO - added device to db...
2017-04-24 00:06:41,273 - INFO - Other server crashed
2017-04-24 00:06:41,273 - INFO - Initiating failure recovery
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 6: u'doorsensor'}
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 6: u'doorsensor'}
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 5: u'tempsensor', 6: u'doorsensor'}
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 5: u'tempsensor', 6: u'doorsensor'}
{8: u'presencesensor', 4: 'serverbackend2', 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'} {8: u'presencesensor', 4: 'serverbackend2',
 5: u'tempsensor', 6: u'doorsensor', 7: u'motionsensor'}
Failure recovery time 0:00:00.020675
2017-04-24 00:06:47,136 - INFO - doorsensor pushed state of doorsensor: open to server
(6, u'open')
2017-04-24 00:06:47,141 - INFO - state 0
2017-04-24 00:06:47,142 - INFO - Door sensor data received
2017-04-24 00:06:47,859 - INFO - motionsensor pushed state of motionsensor: motion to server
(7, u'motion')
2017-04-24 00:06:47,861 - INFO - state 1
2017-04-24 00:06:47,862 - INFO - Motion sensor data received
2017-04-24 00:06:47,865 - INFO - motionline7    motionsensor,motion     2017-04-24 00:06:47.847193
2017-04-24 00:06:47,865 - INFO - doorline6      doorsensor,open 2017-04-24 00:06:47.134930
2017-04-24 00:06:47,866 - INFO - Door sensor data received at47135290.0
2017-04-24 00:06:47,866 - INFO - Motion sensor data received at47847553.0
2017-04-24 00:06:48,775 - INFO - presencesensor pushed state of presencesensor: yes to server
(8, u'yes')
2017-04-24 00:06:48,777 - INFO - state 2
2017-04-24 00:06:48,777 - INFO - Presence sensor data received
**********USER ENTERS HOME************
```

Here, server crashes on startup (after all devices are recorded). But after failure recovery, all devices re-register to this server and decisions are taken as if there was only one server.

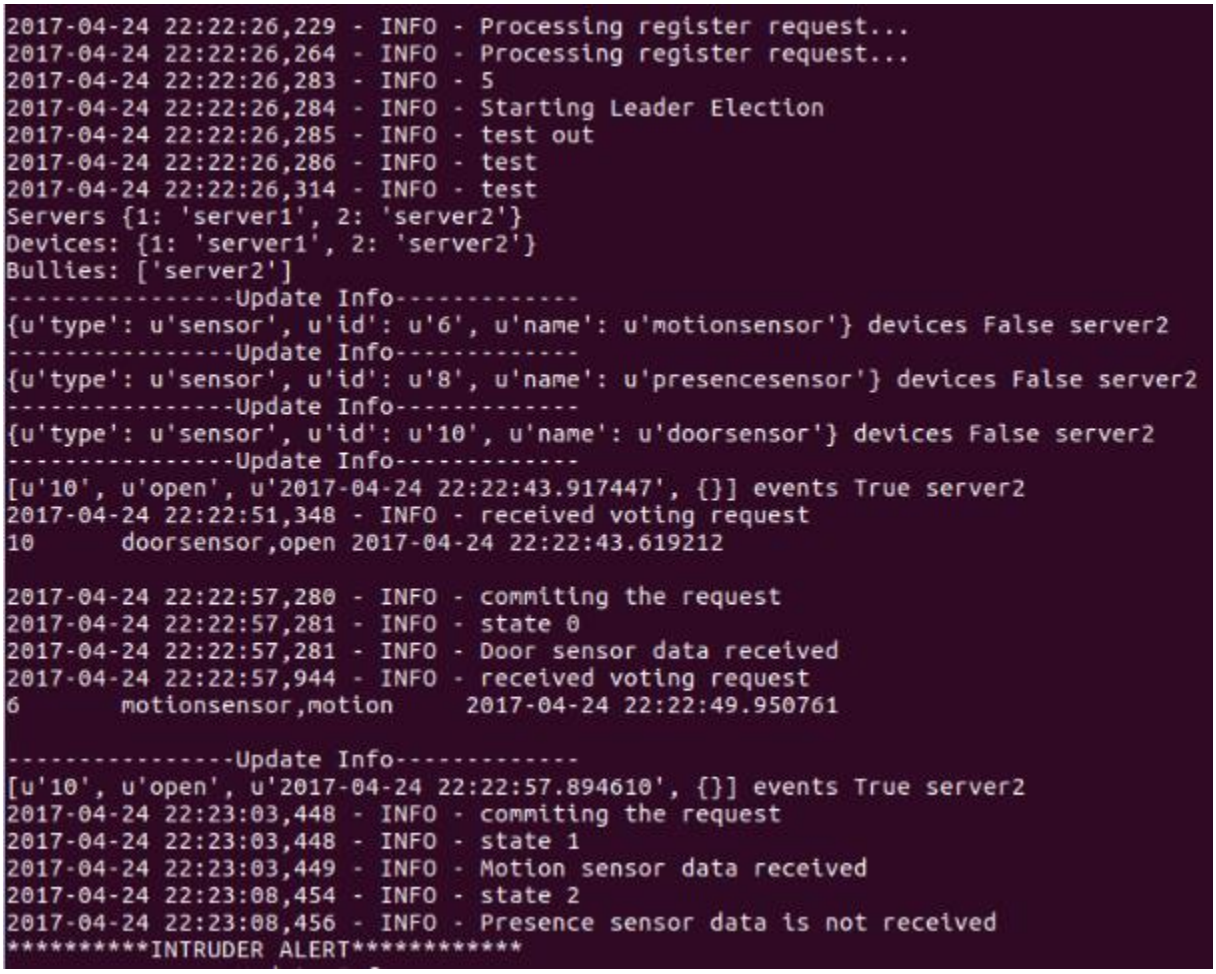
Time taken for failure detection is guaranteed to be less than a second. This is the polling time for heartbeat messages. Time taken for failure recovery is around 20 milliseconds. Push/pull messages are lost when the server enters it in its database but crashes before sending it to the other gateway.

4) **Design for consensus:**

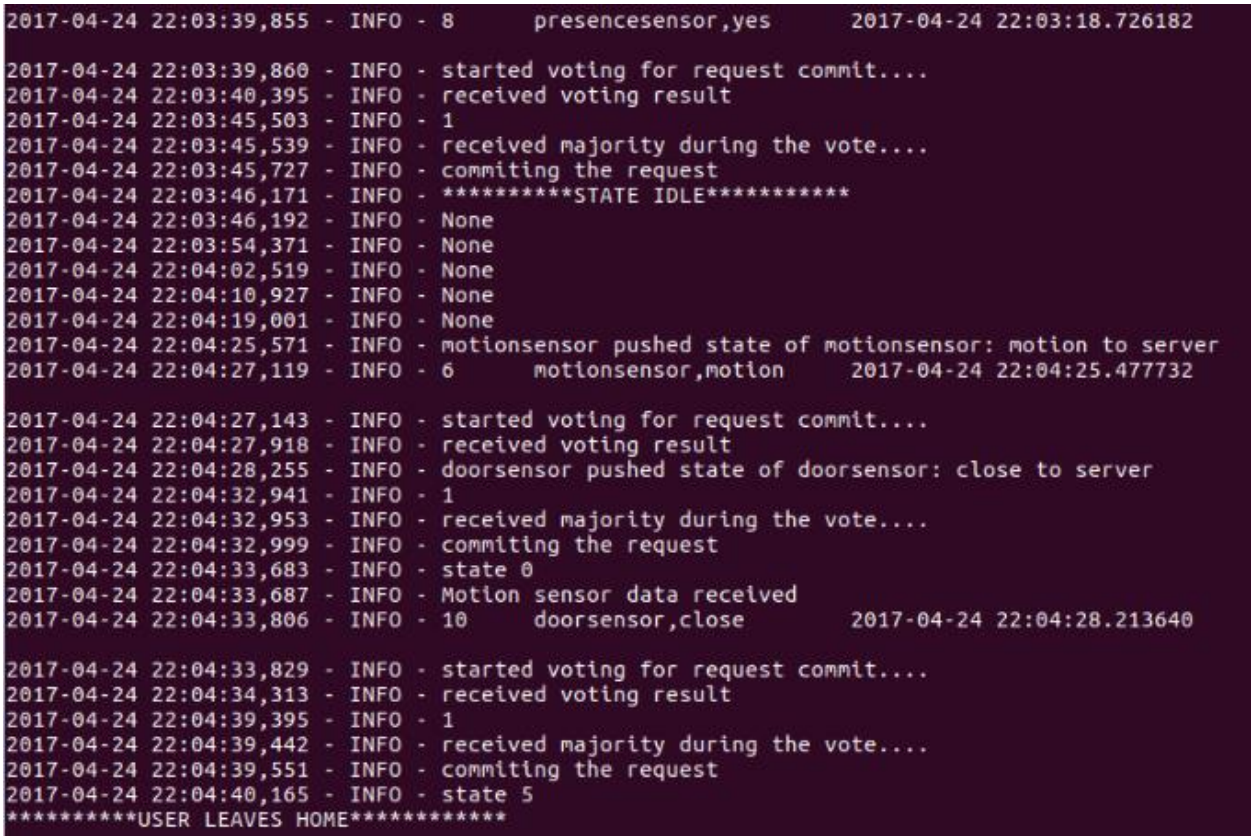
Raft consensus mechanism is used for replicating the state diagram across multiple server nodes. In the test case output below for server node which is elected as leader. First door open is detected and voting is performed to commit the request or not, as the voting received majority the message is committed and state machine process the request, meanwhile the motion detection is added to the request queue and after committing the door open request voting is conducted for motion detection. After receiving majority vote this message is committed and state machine process this request and state change is observed in the output. Since no presence sensor output is received by state machine, intruder alert state is reached by state machine which can be seen in output.



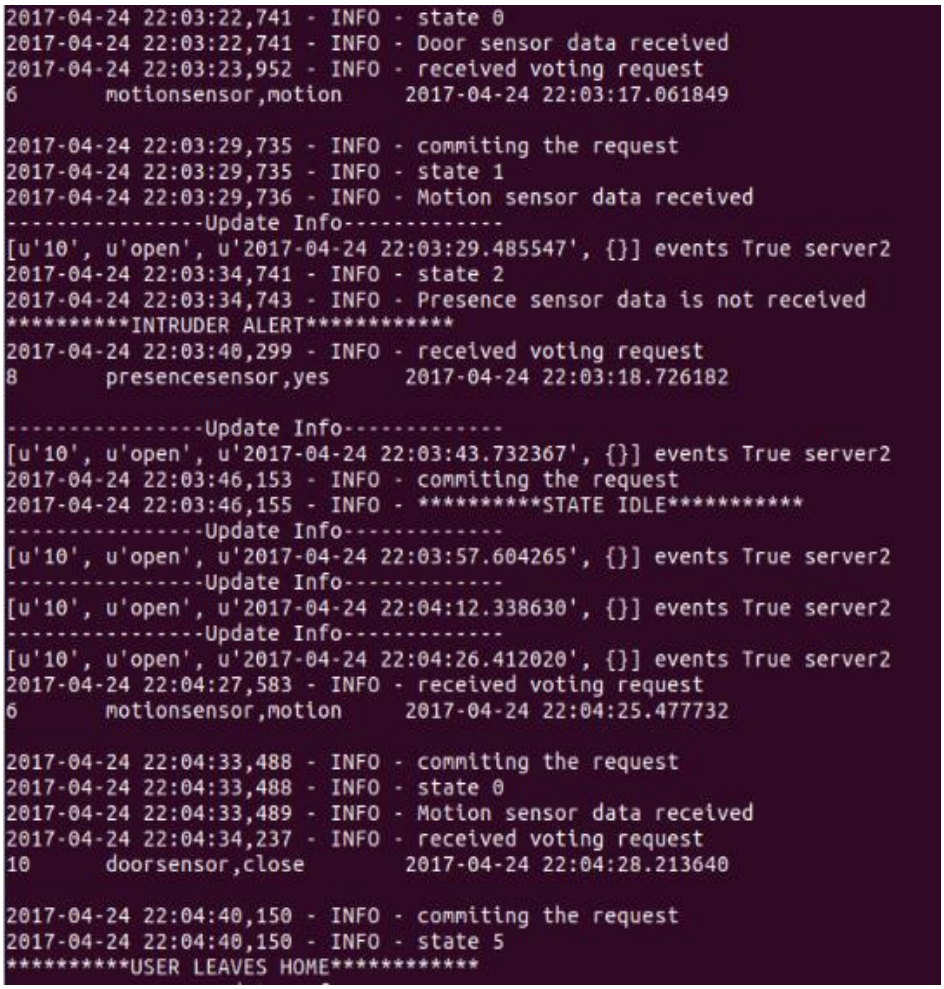
In the following figure, output of a server node which is acted as a follower is shown, in this case it is server 1, state changes can be clearly observed when it receives commit message from leader when it voted yes for commit.



Another test case, in which user leaves home is shown in the following figure. For the same system above, inputs are given such that the state machine will evaluate state to user leaves home.



For the same test case above follower server node output is shown in figure below-


2017-04-24 22:03:22,741 - INFO - state 0
2017-04-24 22:03:22,741 - INFO - Door sensor data received
2017-04-24 22:03:23,952 - INFO - received voting request
6 motionsensor,motion 2017-04-24 22:03:17.061849
2017-04-24 22:03:29,735 - INFO - commiting the request
2017-04-24 22:03:29,735 - INFO - state 1
2017-04-24 22:03:29,736 - INFO - Motion sensor data received
----------Update Info----------
[u'10', u'open', u'2017-04-24 22:03:29.485547', {}] events True server2
2017-04-24 22:03:34,741 - INFO - state 2
2017-04-24 22:03:34,743 - INFO - Presence sensor data is not received
**********INTRUDER ALERT**********
2017-04-24 22:03:40,299 - INFO - received voting request
8 presencesensor,yes 2017-04-24 22:03:18.726182
----------Update Info----------
[u'10', u'open', u'2017-04-24 22:03:43.732367', {}] events True server2
2017-04-24 22:03:46,153 - INFO - commiting the request
2017-04-24 22:03:46,155 - INFO - **********STATE IDLE**********
----------Update Info----------
[u'10', u'open', u'2017-04-24 22:03:57.604265', {}] events True server2
----------Update Info----------
[u'10', u'open', u'2017-04-24 22:04:12.338630', {}] events True server2
----------Update Info----------
[u'10', u'open', u'2017-04-24 22:04:26.412020', {}] events True server2
2017-04-24 22:04:27,583 - INFO - received voting request
6 motionsensor,motion 2017-04-24 22:04:25.477732
2017-04-24 22:04:33,488 - INFO - commiting the request
2017-04-24 22:04:33,488 - INFO - state 0
2017-04-24 22:04:33,489 - INFO - Motion sensor data received
2017-04-24 22:04:34,237 - INFO - received voting request
10 doorsensor,close 2017-04-24 22:04:28.213640
2017-04-24 22:04:40,150 - INFO - commiting the request
2017-04-24 22:04:40,150 - INFO - state 5
**********USER LEAVES HOME**********