Building and adapting a multihop Wireless Sensor Network

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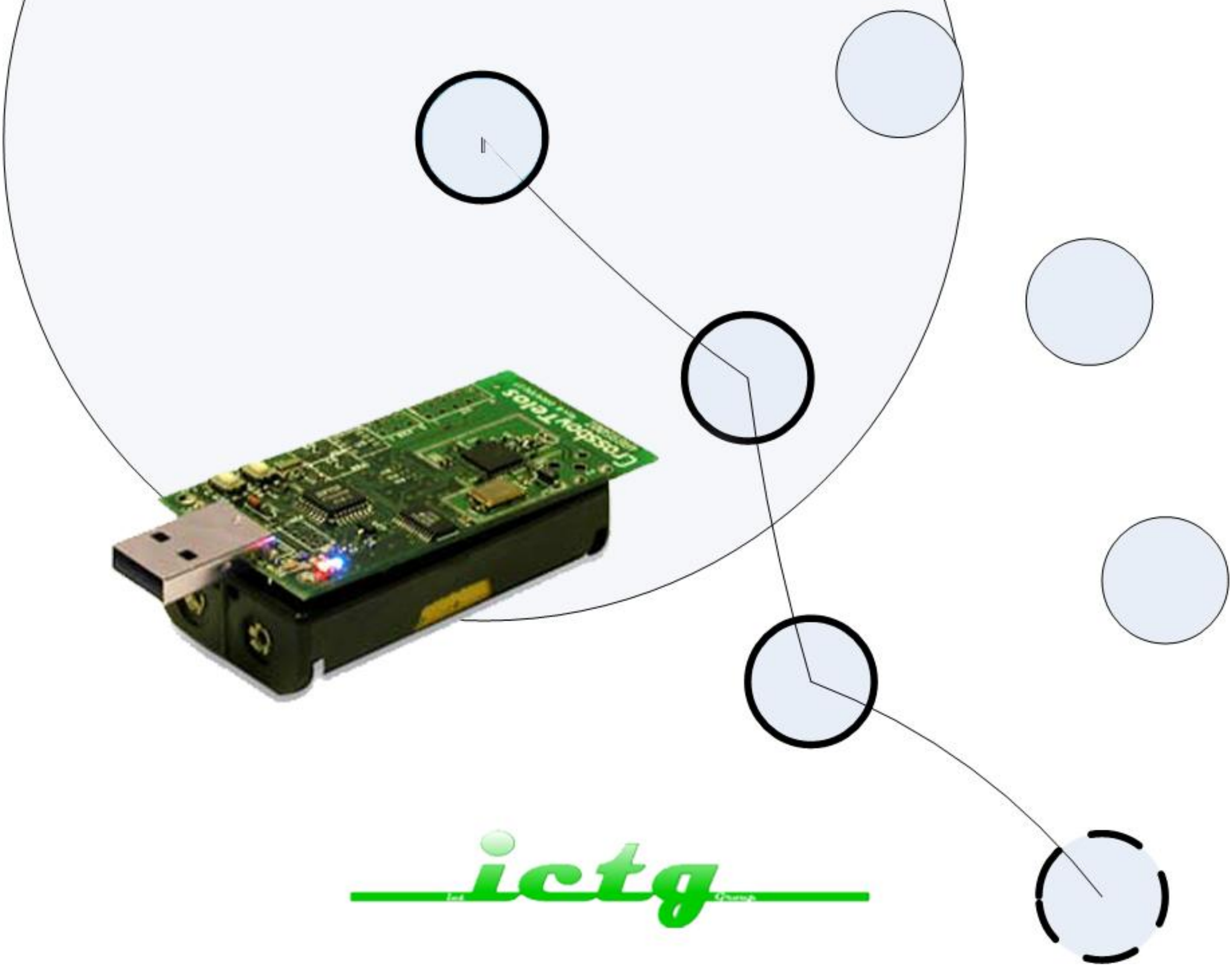
3EA-ICT



RESULTS

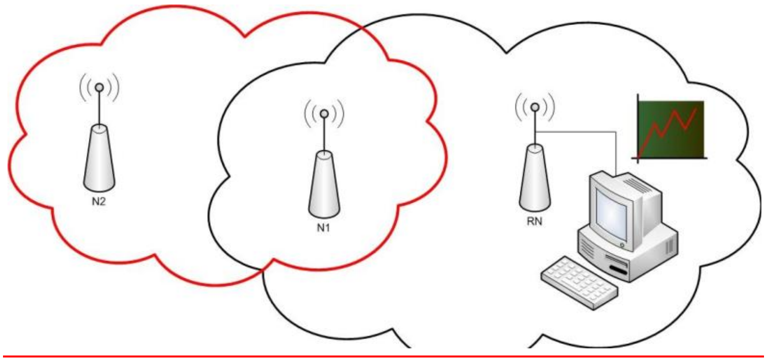
MULTIHOPOSCILLOSCOPE

Our first application is called multihoposcilloscope. Basically it is an application which implements multihop routing. It makes use of 1 sensor. That data is being transmitted to the root node in the network.

TEST SITUATION

We have 3 wireless TelosB sensors with an assigned ID of 10(N1), 11(N2) and 500 (RN).
The TelosB has the following specifications about range:

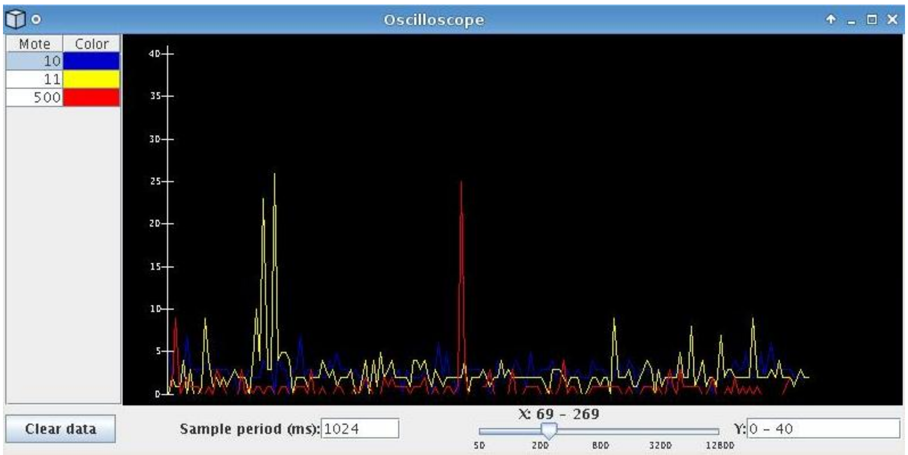
range (outdoor)	75m to 100m
range (indoor)	20m to 30m



We have tested the application in an apartment building, so the range was limited. The root has 500 as ID, so it normally receives all transmitted packets from the nodes. Node 11 was dropped 2 floors lower than the root, so it was out of range. We placed mote 10 one floor lower, so it is in range of the root and node 11.

RESULT

On the graphical java GUI we can see that all the nodes were detected by the root, so the multihop network is successful.



Mote	Color
10	🟦
11	🟨
500	🟥

Sample period (ms): 1024

X: 69 - 269

Y: 0 - 40

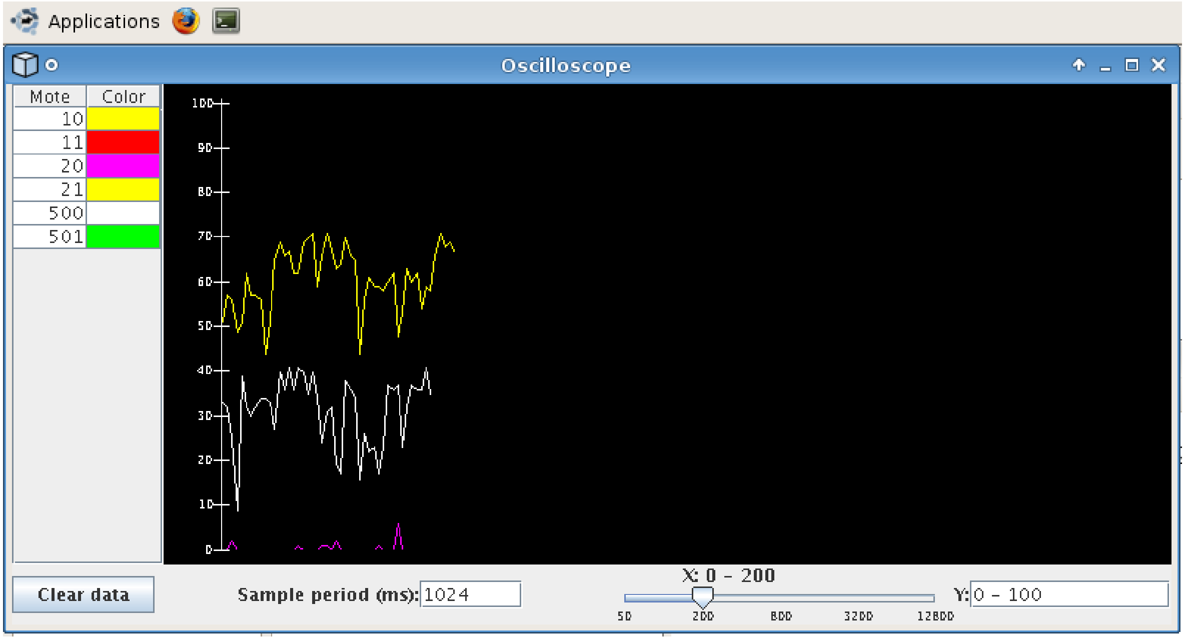
MULTI HOP/SENS OSCILLOSCOPE (PETER)

The multihop/sens oscilloscope application is an extension to the multihoposcilloscope application. It implements 2 readings from 2 different sensors (light & voltage). It is compatible with the Java GUI supplied by TinyOS.

TEST SITUATION

We have 2 wireless TelosB sensors. Each node has 2 different ID's, one for each sensor. So, the root node(RN) has the ID's 500 and 501. The second node(N1) has the ID's 10 and 11. Note that the values from RN are not correct. This is because the mote has no sensors except for a voltage sensor. The data it sends is therefore erroneous.

RESULTS



Mote	Color
10	🟨
11	🟥
20	🟪
21	🟨
500	⬜
501	🟩

Sample period (ms): 1024

X: 0 - 200

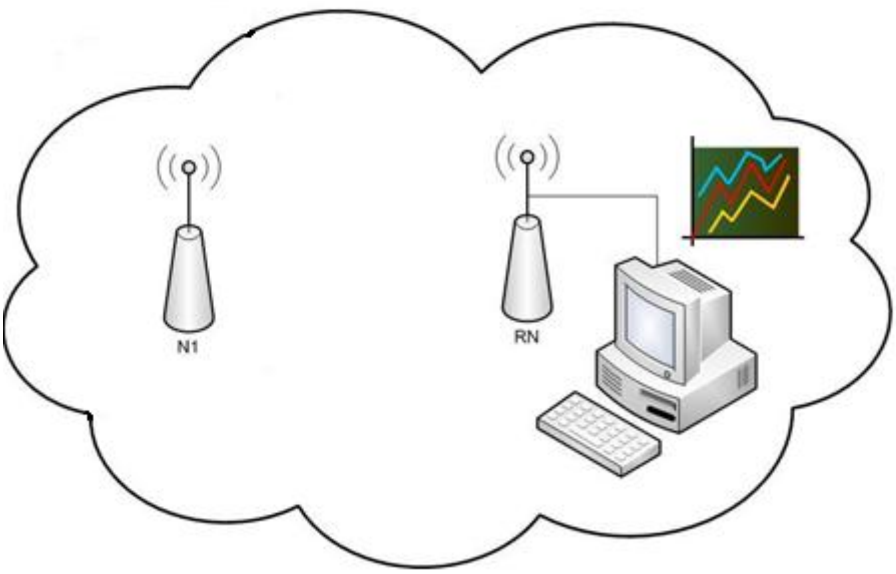
Y: 0 - 100

MULTI HOP/SENS OSCILLOSCOPE (TIM)

The multihop/sens oscilloscope application is an extension to the multihoposcilloscope application. It implements 2 readings from 2 different sensors (light & voltage). It is compatible with the Java GUI supplied by TinyOS.

TEST SITUATION

We have 2 wireless TelosB sensors. Each node has 2 different ID's, one for each sensor. So, the root node(RN) has the ID's 500 and 501. The second node(N1) has the ID's 400 and 401.



RESULTS

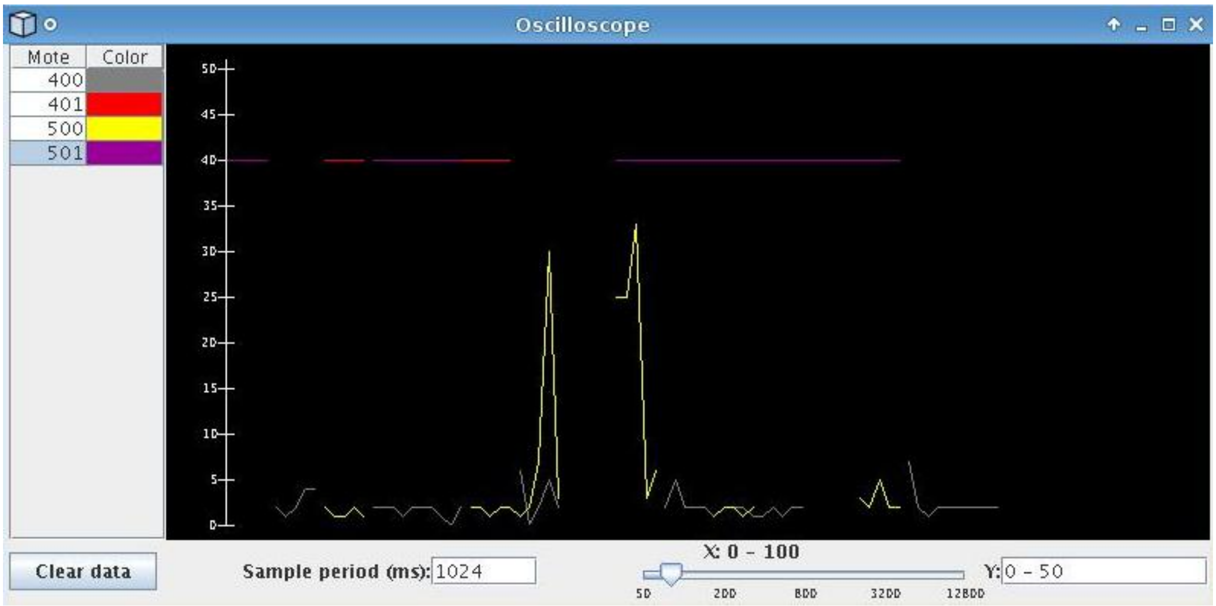
We have added the printf library to help us to debug the program. The log:

```
start of readL!
start with the measurement of the lightsensor
measurement 1 of het light: 2
start of readL!
start with the measurement of the lightsensor
measurement 2 of het light: 2
start of readL!
start with the measurement of the lightsensor
measurement 3 of het light: 2
start of readL!
start with the measurement of the lightsensor
measurement 4 of het light: 2
start of readL!
start with the measurement of the lightsensor
measurement 5 of het light: 2
NEXTREADINGREADY is TRUE
There are 5 readings of the lightsensor
The send is free for the transmission of the lightmeasurements
transmitting of the measurements of het light is successfull
```

```
lightmeasurement is transmitted with mote ID: 500
start of readD!
start of readD!
start with the measurement of the themosensor
measurement 2 of het themosensor: 40
start of readD!
start with the measurement of the themosensor
measurement 3 of het themosensor: 40
start of readD!
start with the measurement of the themosensor
measurement 4 of het themosensor: 40
start of readD!
start with the measurement of the demosensor
measurement 5 of the themosensor: 40
There are 5 readings of the demosensor
The send is free for the transmission of the themomeasurement
transmitting of the measurements of the demo is successful
demomeasurement is sent with mote ID: 501
```

We can conclude that the application sends the readings of the 2 sensor concurrently.

Next step is checking if we can display the data on a graph:



Mote	Color
400	⬜
401	🟥
500	🟨
501	🟪

Sample period (ms): 1024

X: 0 - 100

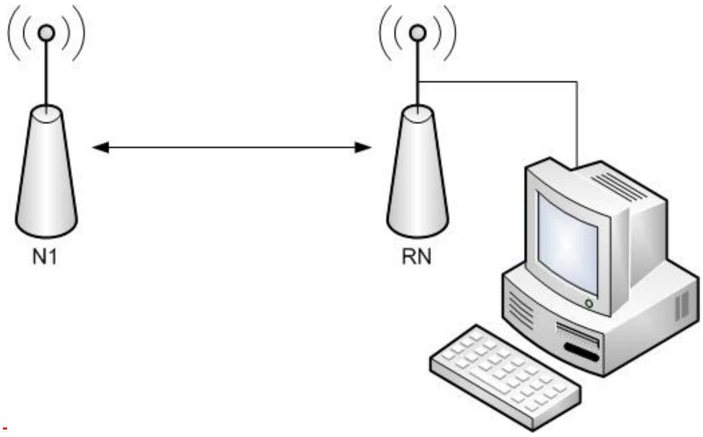
Y: 0 - 50

We can conclude that the application works fine.

RSSI

TEST SITUATION

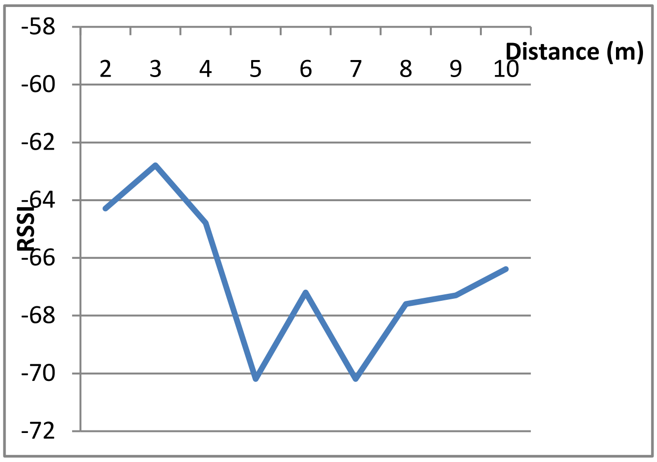
We have 2 nodes: one (RN) connected to a computer to get the RSSI and one(N1) as a reference at certain distances.

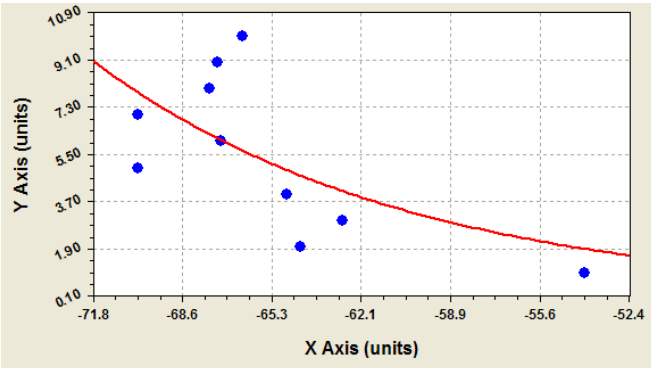


RESULTS

Distance (m)	Measurement 1	Measurement 2	Measurement 3	Measurement 4	Measurement 5	Average	to Dbm
1							-51
2	-31	-28	-17	-19	-28	-24,6	-69,6
3	-24	-10	-23	-13	-10	-16	-61
4	-19	-26	-21	-26	-17	-21,8	-66,8
5	-25	-33	-32	-28	-28	-29,2	-74,2
6	-18	-29	-22	-21	-22	-22,4	-67,4
7	-25	-21	-25	-30	-31	-26,4	-71,4
8	-16	-19	-29	-27	-25	-23,2	-68,2
9	-23	-23	-23	-24	-28	-24,2	-69,2
10	-25	-32	-21	-17	-11	-21,2	-66,2

Distance (m)	Measurement 1	Measurement 2	Measurement 3	Measurement 4	Measurement 5	Average	To dBm
1							-51
2	-19	-12	-15	-13	-11	-14	-59
3	-22	-25	-19	-16	-16	-19,6	-64,6
4	-18	-16	-16	-18	-21	-17,8	-62,8
5	-16	-20	-30	-20	-20	-21,2	-66,2
6	-20	-24	-24	-24	-18	-22	-67
7	-26	-25	-22	-27	-20	-24	-69
8	-23	-21	-22	-22	-22	-22	-67
9	-22	-37	-1	-23	-19	-20,4	-65,4
10	-20	-20	-20	-22	-26	-21,6	-66,6

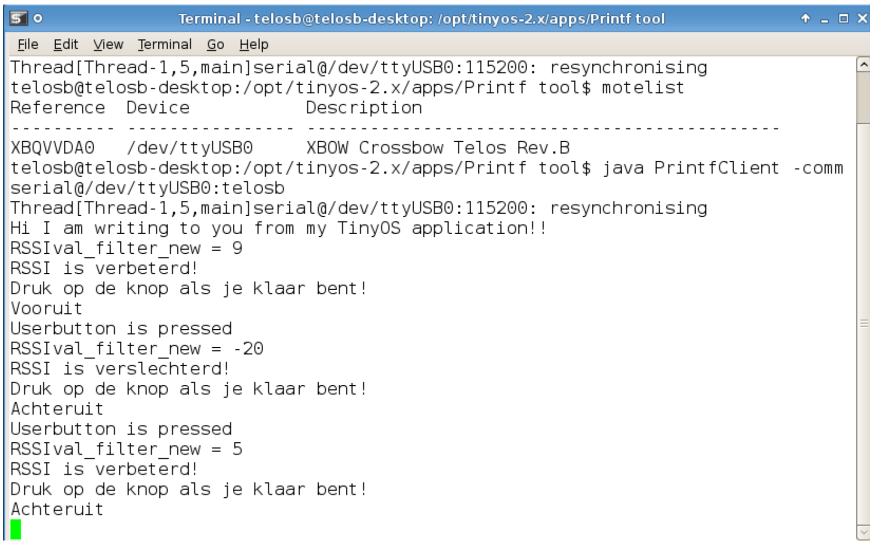




The equation for this graph is: $y = a(1-e^{-bx})$ with

- a = -0.017352956
- b = 0.087152976

We get the following output from the PrintfClient:


Terminal - telosb@telosb-desktop: /opt/tinyos-2.x/apps/Printf tool
File Edit View Terminal Go Help

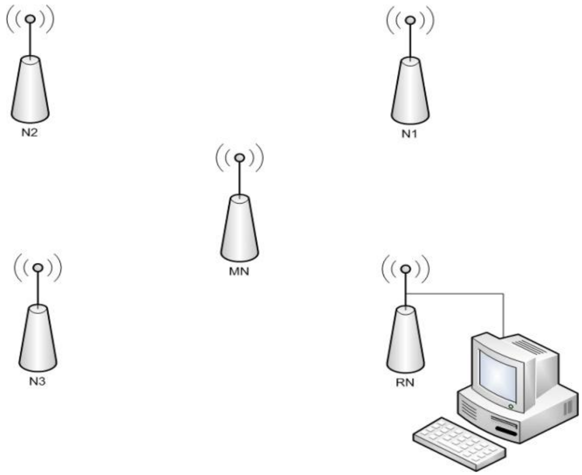
```
Thread[Thread-1,5,main]serial@/dev/ttyUSB0:115200: resynchronising
telosb@telosb-desktop:/opt/tinyos-2.x/apps/Printf tool$ motelist
Reference  Device           Description
---------- ---------------- ---------------------------------------------
XBQVVDA0   /dev/ttyUSB0     XBOW Crossbow Telos Rev.B
telosb@telosb-desktop:/opt/tinyos-2.x/apps/Printf tool$ java PrintfClient -comm
serial@/dev/ttyUSB0:telosb
Thread[Thread-1,5,main]serial@/dev/ttyUSB0:115200: resynchronising
Hi I am writing to you from my TinyOS application!!
RSSIval_filter_new = 9
RSSI is verbeterd!
Druk op de knop als je klaar bent!
Vooruit
Userbutton is pressed
RSSIval_filter_new = -20
RSSI is verslechterd!
Druk op de knop als je klaar bent!
Achteruit
Userbutton is pressed
RSSIval_filter_new = 5
RSSI is verbeterd!
Druk op de knop als je klaar bent!
Achteruit
```

VISUALISATION WITH RSSI

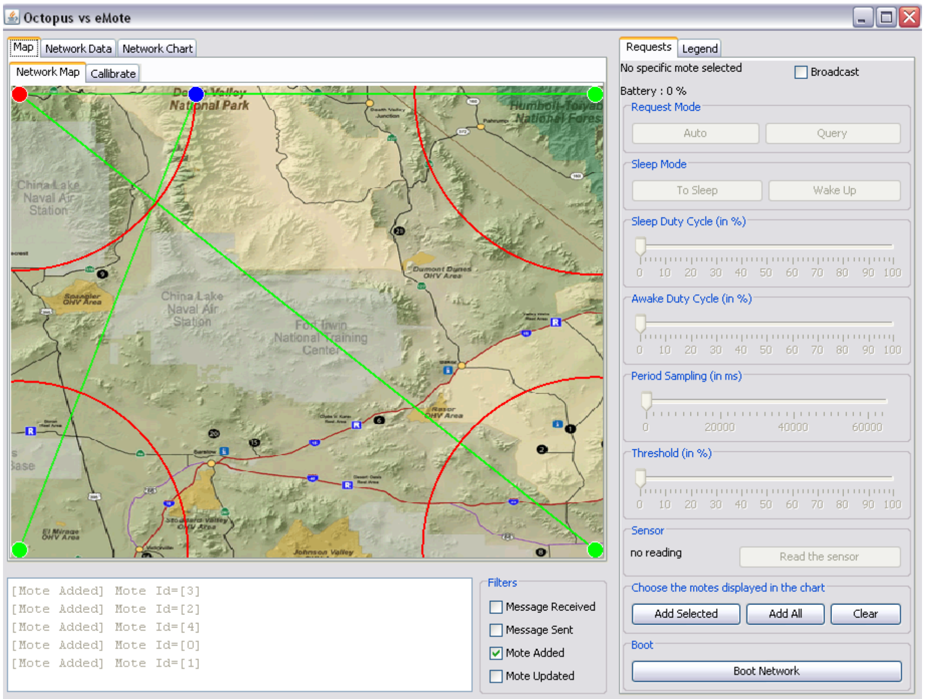
This application is compatible with the Java GUI of the master students Nick and David. So, all the nodes can be visualized on a computer. The benefit of this application is that it directs u to an alarming node in the network through the printf interface.

TEST SITUATION

We build a network with 5 nodes: 1 acts as the root node (RN) and is connected to a computer, nodes N1, N2 and N3 function as anchor points, so they are reference points in the network. The last node is a mobile node (MN) and its position is localized by RSSI from the anchor points.



RESULTS



No specific mote selected

□ Broadcast

Battery : 0 %

Sleep Duty Cycle (in %): 0

Awake Duty Cycle (in %): 0

Period Sampling (in ms): 0

Threshold (in %): 0

Sensor: no reading

Choose the motes displayed in the chart

Boot

```
[Mote Added] Mote Id=[3]
[Mote Added] Mote Id=[2]
[Mote Added] Mote Id=[4]
[Mote Added] Mote Id=[0]
[Mote Added] Mote Id=[1]
```

Filters

- □ Message Received
- □ Message Sent
- ☑ Mote Added
- □ Mote Updated

The blue dot is our mobile node, the green ones are our anchor nodes and the red dot is our root node. We can see that all the nodes are visualized.