VANIER COLLEGE – Computer Engineering Technology – Winter 2021

Telecommunications (247-410-VA)

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LABORATORY EXPERIMENT #10

Introduction to XBee

NOTE:

To be completed in 1 lab sessions of 3 hrs.

No formal report is required. Answers questions asked in the lab, includes screen shots, a final discussion and conclusion session.

This exercise is to be done **in group of 2, but result has to be done and submitted individually.**

OBJECTIVES:

After performing this experiment, the student will be able to discover and explore the basic operation of a Zigbee PAN system.

THEORY:

http://www.instructables.com/id/XBee-Mesh-Network-Construction/
https://learn.sparkfun.com/tutorials/exploring-xbees-and-xctu
https://cdn.sparkfun.com/learn/materials/29/22AT%20Commands.pdf

MATERIALS AND EQUIPMENT REQUIRED:

XBee S2 Module and USB Adaptor board	
XCTU software	

PROCEDURE:

Handle XBEE with care. Especially, the antenna!

Part A: Installation and test

1. You are required to perform basic communication via console mode of XBee module using XCTU software. What is the hardware version of your XBee module?

XBee Number	Hardware Version
1 (connected to COM3)	XB24-BWIT-004
2 (connected to COM4)	XB24-BWIT-004

2. Plug your XBee module into the corresponding development board. Connect the board to a USB port on your PC and launch the X-CTU. Click on **Discovery Devices** icon to connect to XBee module. Check the appropriate serial communication port. Use the default setting.

3. Click that new module, and wait a few seconds as X-CTU reads the configuration settings of your XBee. You should then be presented with the entire configuration of your XBee.

4. What is the **Product Family**, **Function set** and **Firmware version** of your module? Verify your configuration with your instructor.

XBee Number	Product Family	Function Set	Firmware Version
1 (connected to COM3)	XB24-ZB	ZigBee Router AT	28A7
2 (connected to COM4)	XB24-ZB	ZigBee Coordinator AT	20A7

In some case, a firmware update might be needed. The following list shows the correct firmware of the hardware:

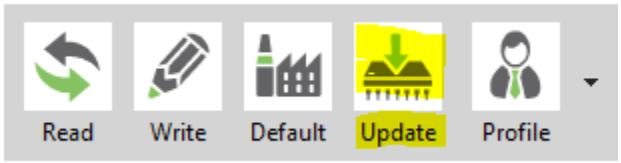
- For old version of hardware XB24-BWIT-004:

  Product family: XB24-ZB **Function set:** ZigBee Router AT

- For new version of hardware XB24CZPI*x*-004 :

  Product family: XB24C **Function set:** ZIGBEE Reg

If the firmware is not correct, you will need to perform an update and select the correct setting accordingly.



5. The serial port connection is used to configure the XBee module and to send text messages from one computer to another wirelessly between XBee modules.

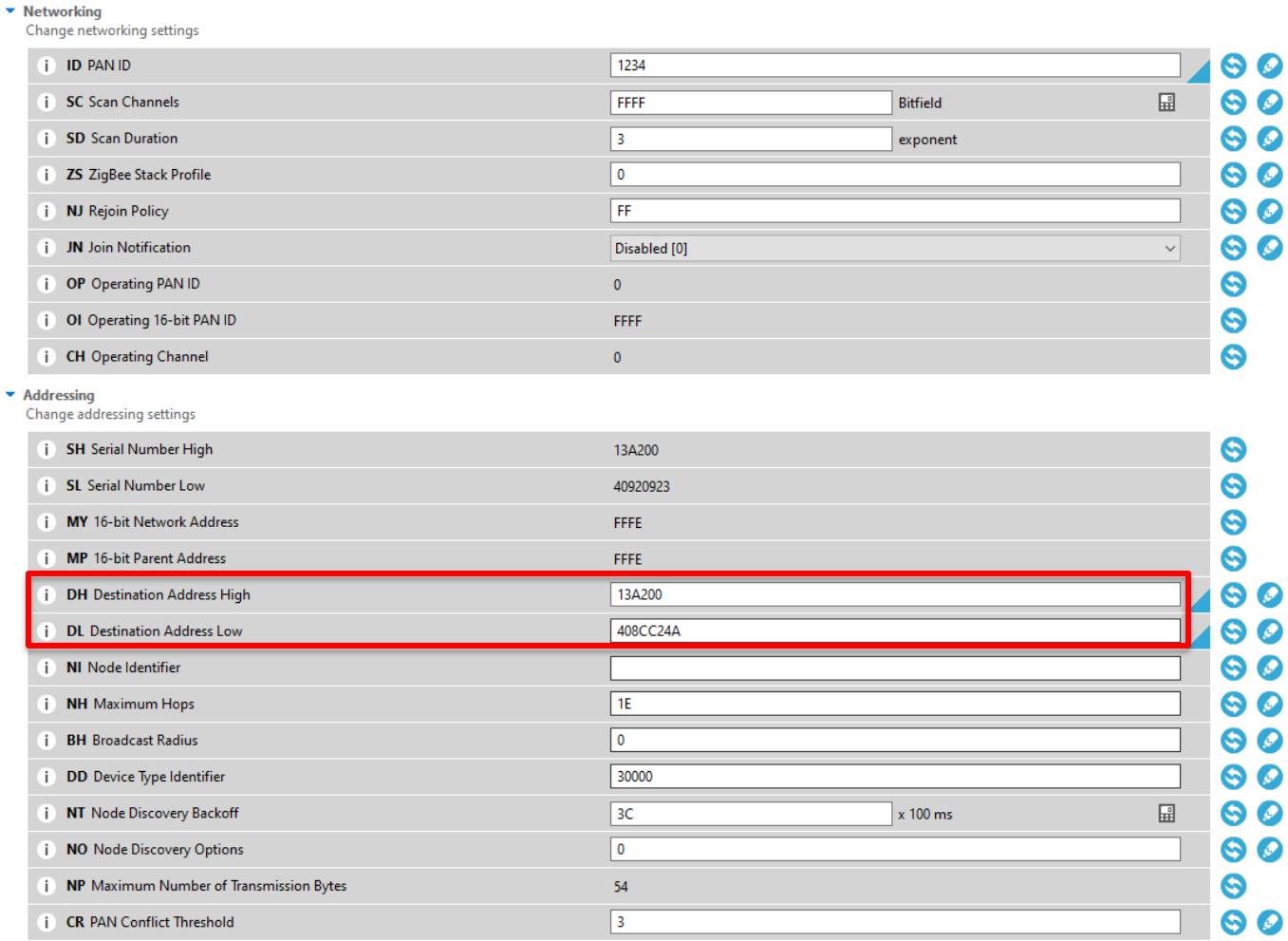
6. **PAN ID** (default 3332) is the ID of the network. Set it to "1234". Only modules with the same PAN ID can communicate with each other.

7. Serial Number Low (SL) and Serial Number High (SH) is the 64-bit address of your module. Note it down. Other XBee modules who wish to communicate with you will need this information.

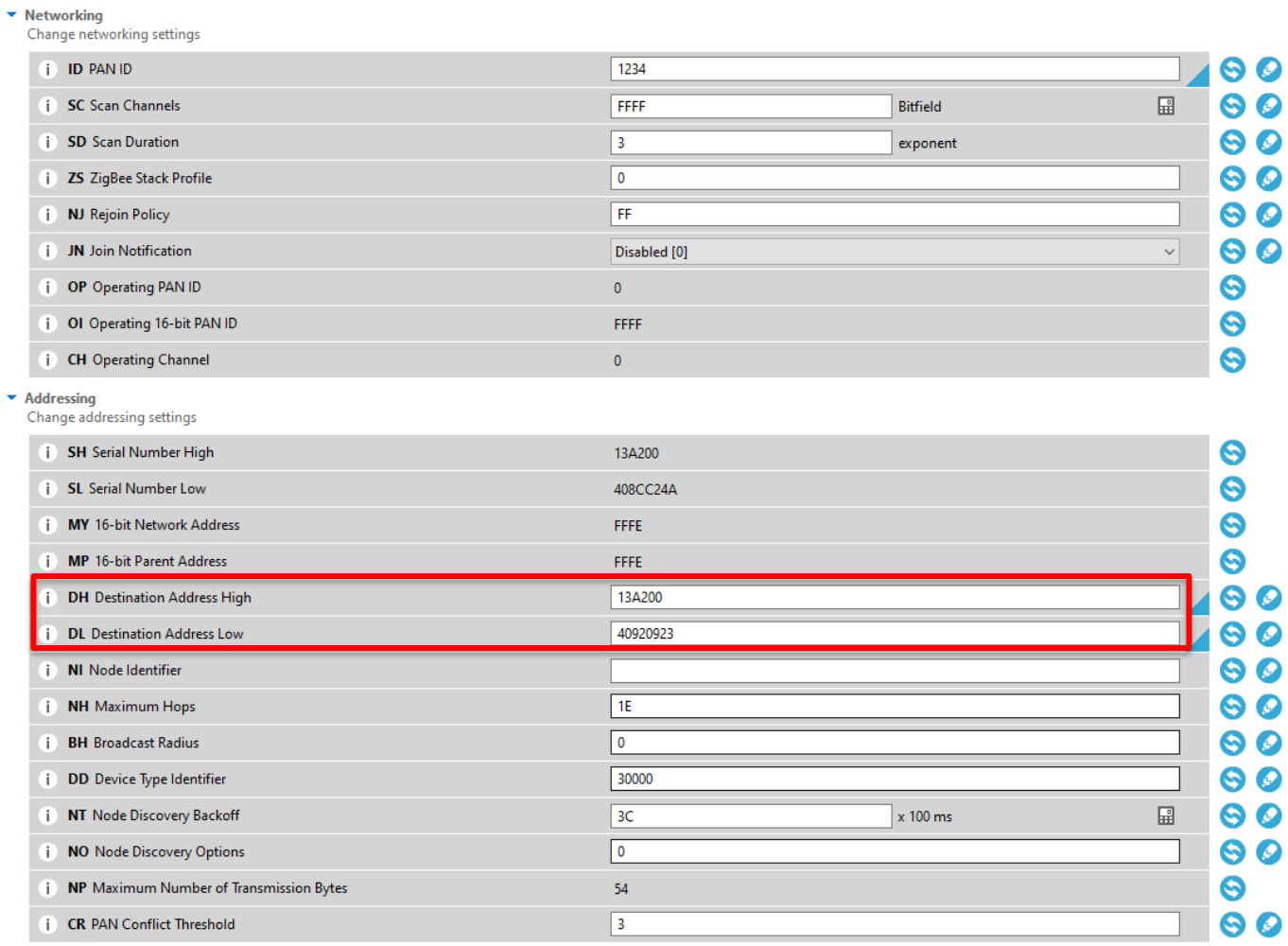
XBee Number	Serial Number Low (SL)	Serial Number High (SH)
1 (connected to COM3)	40920923	13A200
2 (connected to COM4)	408CC24A	13A200

8. Destination Address Low (DL) and Destination Address High (DH) is the 64-bit address of the other module with which you want to communicate. Check the default. It should be the destination address for coordinator 0 to broadcast and for router 0 and FFFF to communicate with coordinator only. Keep the default. When you are done, click the Write button.

   Perform a screen shot on your main parameter setting.

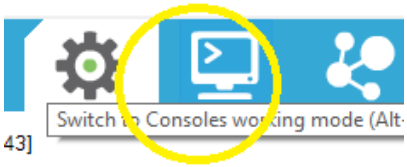


A portion of the configuration configured for XBee #1 - Router (connected to COM3) shown above. Red box shows the DH and the DL values; they are set for the other XBee module (XBee #2 – Coordinator). A portion of the configuration set on XBee #2 is shown on the next page. PAN ID is set to 1234.

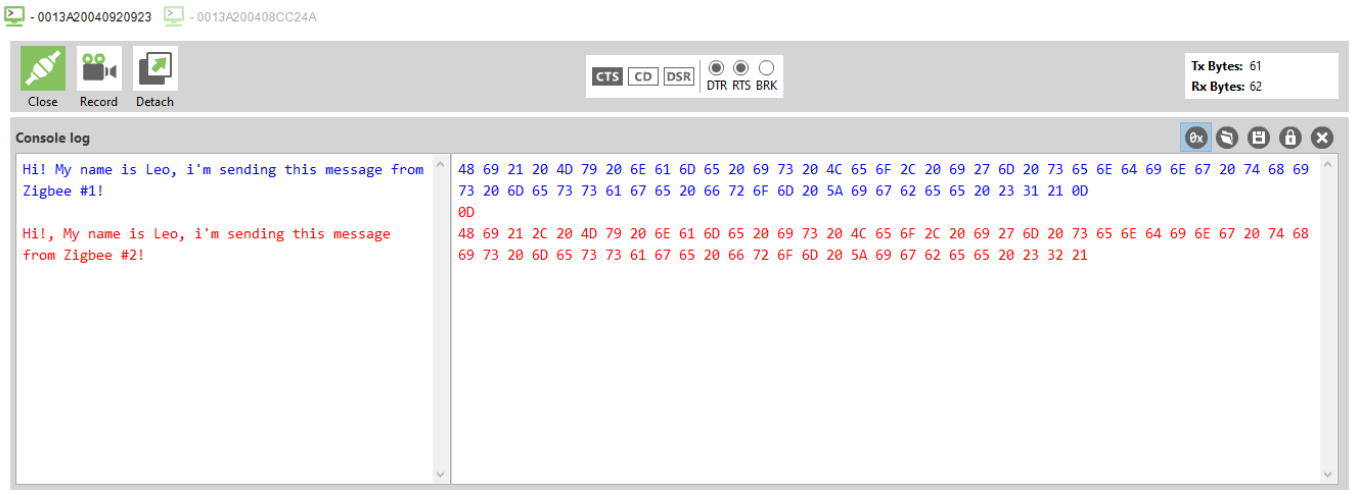


A portion of the configuration configured for XBee #2 - Coordinator (connected to COM4) shown above. Red box shows the DH and the DL values; they are set for the other XBee module (XBee #1 – Router). A portion of the configuration set on XBee #1 is shown on the previous page. PAN ID is still set to 1234.

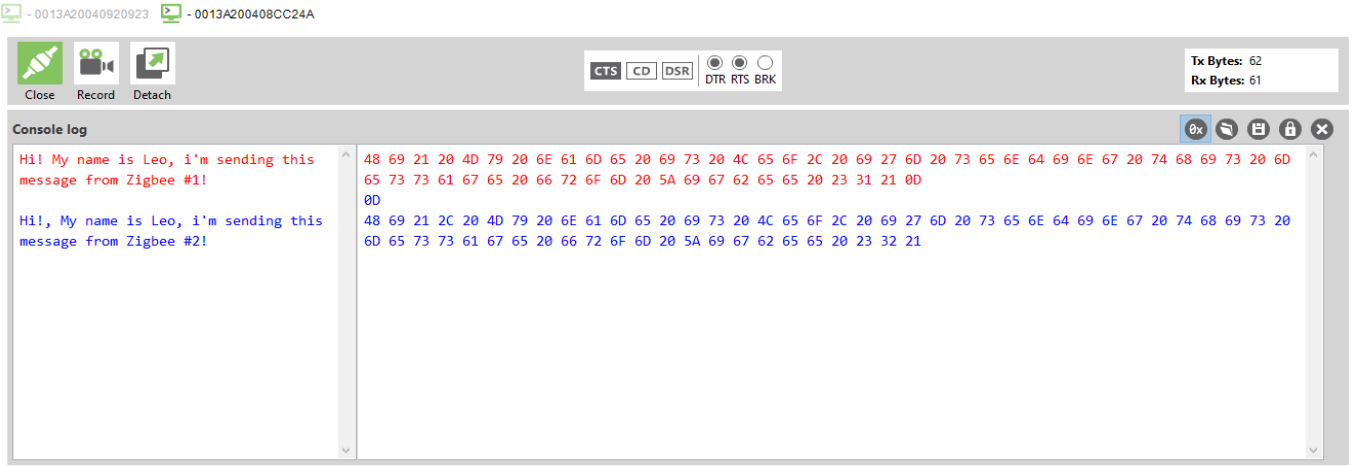
9. Go to the Console mode. You can use the console to send characters to an XBee, which will route that character over-the-air to any other XBee it's connected to.



10. Open a serial connection of the device by clicking the connect icon. 
11. Type a short text message. Note that blue text is what you sent and red text are characters that you receive from other XBee modules. Your neighbor should receive the message.
12. Note that the blue light indicates that your module is receiving a message (the brightness corresponds to the signal strength).
13. Perform a screen shot to show example of your communications.



Communication between XBee #1 and XBee #2 shown above. Blue text is message sent from XBee #1 to XBee #2 and red text is message received from XBee #2 to XBee #1. Left pane shows text being sent and right pane shows the equivalent in hex.



Communication between XBee #2 and XBee #1 shown above. Blue text is message sent to XBee #1 from XBee #2 and red text is message received from XBee #1 to XBee #2. Left pane shows text being sent and right pane shows the equivalent in hex.

14. Could not perform this part because experiment was done at home:

    Set the destination address to the neighbor's module. When you are done, click the Write button.

15. Repeat 9-13.

16. Could not perform this part because experiment was done at home with only 2 XBees:

    Now you can change the destination address to any other workstation in the room (they must be in your network) and send them a private text message. Make sure that your message includes who it is from because they will have to change their destination address to reply to you.

XBee modules do not only send text messages; they are most often used to communicate digital signals between microcontrollers to remotely sense things like switch settings, or remotely control lights and motors.

Part B: Serial communication

1. Open Teraterm or PuTTY, choose the appropriate serial port. Set Teraterm as follows:
    - Echo & Receive: CR+LF

2. Type "+++" to enter command mode. You should see the reply "OK."

    Note: By default, the XBee will automatically leave command mode if it does not receive any commands in a 10 second period.

    Here is a chart of the commands settings we are going to set:

Function	**Command**	**Parameter**
Enter command mode	+++	
PAN ID	ATID	(any address from 0 to FFFE will do)
Destination address high	ATDH	0013A200
Destination address low	ATDL	[see your recorded Router Address]
Exit Command Mode	ATCN	

3. Now we are going to do the same as Part A:

    a) Read the PAN ID by typing ATID

    - PAN ID: 1234 (result from using ATID command).

    b) Read your own address by typing ATSH and ATSL

XBee Number	**Serial Number High (ATSH)**	**Serial Number Low (ATSL)**
1 (connected to COM3)	13A200	40920923
2 (connected to COM4)	13A200	408CC24A

c) Also read the destination address by typing ATDH and ATDL:

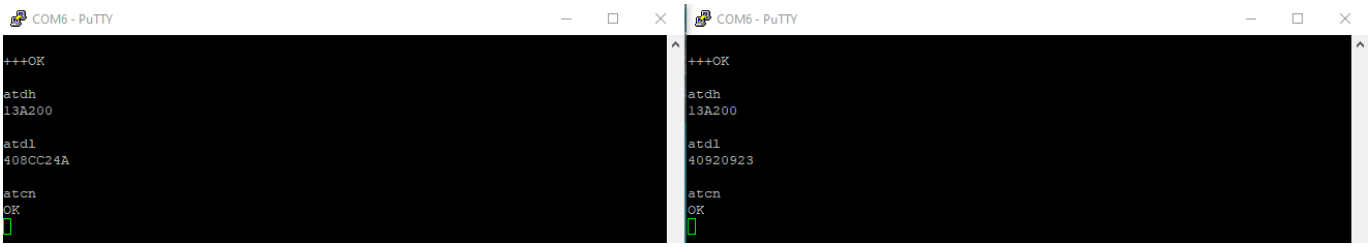
XBee Number	Destination Address High (ATDH)	Destination Address Low (ATDL)
1 (connected to COM3)	13A200	408CC24A
2 (connected to COM4)	13A200	40920923

d) Change destination high address by typing ATDH *address*

e) Change destination low address by typing ATDL *address*

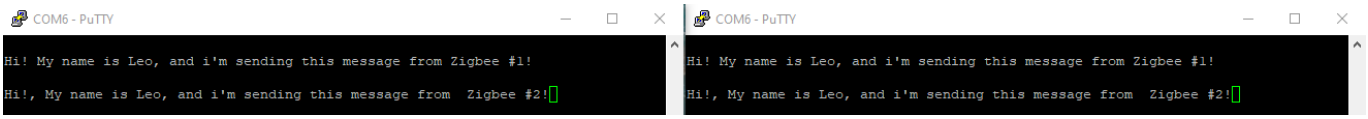
f) You can verify by typing ATDH, ATDL without parameter.

Perform a screen shot to show your commands and responses:



Verification of destination high address (ATDH) and destination low address (ATDL) that are set on both XBee #1 and XBee #2 shown above. Left window represents XBee #1 (should have shown COM3) and right window represents XBee #2 (should have shown COM4). Values shown correspond to table under c) shown above.

4. Type in a message, the destination module should receive it.



Communication between XBee #1 (left screen) and XBee #2 (right screen) shown above. From Each XBee, a message can be sent and received. Both can still be configured by entering the command mode (by typing +++).

5. Could not perform this part because experiment was done at home:

With the ZigBee protocol, you can broadcast messages to all radios on a particular PAN ID.

a) Set the destination high address to 0 (with ATDH 0) and set the destination low address on the broadcaster to FFFF (with ATDL FFFF).

b) Type in a message and you should see the text appear on all the other terminals.

6. You can also send message to coordinator by setting both DH and DL to 0.

Part C: Read the data from remote side *(see note below and under discussion section)*

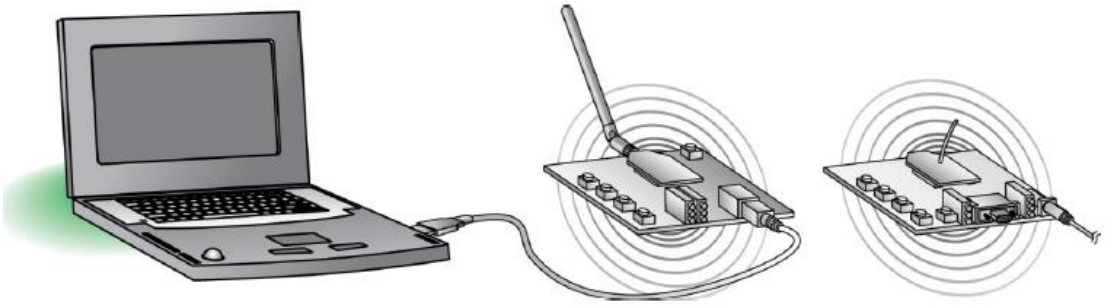
Use an Arduino and two XBees as coordinator (in API mode and router in AT mode to monitor a remote switch connected to the router). Show the position of switch in the serial monitor of Arduino.

1. Apply an Arduino and two XBees as coordinator and router to monitor a remote switch connected to the router. The position of switch will be shown in the serial monitor of Arduino.
2. To set up the configuration and establishment a simple communication, again two XBees should have the same PAN ID. One of the XBee should be in API mode, and performs as a coordinator, and the other one should be in AT mode and performs as a router.
3. In router set up, one of the I/O ports should be as input (e.g., D4), IC=0, and define the sample rate 3EB.
4. By changing the position of switch connected to router, observe the digital changes in console of XCTU in the other XBee (coordinator), and in serial monitor of Arduino.

- **This part could not be completed due to hardware issues with the XBee Adapter from Adafruit.**

Part D: Perform a range test

1. Team up with another XBee (a team of one old hardware and one new hardware). While one module (old hardware) remains plugged into the computer, power another module (new hardware) with on mobile unit (battery, laptop etc…). The mobile unit will be designated as your remote module.
2. Setup your local XBee into API mode. Enable hardware loopback on your remote module.



3. Select the Tool > Range Test tab.
4. Select the discovery device button (remote module).
5. Start the range test.
6. Monitor the link quality by reading the **Percent** section on the **Range Test** tab. This section displays the running percentage of good packets sent to the receiving module and looped back to the base.

   As your distance increases beyond the maximum range of the modules, you will start seeing greater packet loss.
7. Click **Stop** to end the range test. What is the maximum range?
   - The maximum range was between 30 meters and 40 meters.

Discussion:

- Most of the lab was able to be completed with a few exceptions. One part of the lab could not be done because there was a problem with the XBee Adapter from Adafruit. The problem was that the pin headers that are in place to hold the XBee S2 module were broken and the XBee S2 module could not be inserted properly. Some research also led me to believe that even if the XBee S2 module was to be properly inserted, some documentation indicated that the XBee Adapter from Adafruit may not work with the XBee S2 module as it was designed for the XBee S1 module only. Other problems that hindered my ability to complete parts of the lab was the lack of having more XBees. When the lab was started in school, many people were having problems configuring the XBees and getting them to communicate with other XBees. The parts that were done above were parts that could have be complete at home with two XBee S2 modules that I had loaned. The problems that were encountered at the lab in school were resolved when I had done this lab at home (the software needed to configure the XBees worked on my computer). Instead of having two computers (one for each XBee), both were connected to my computer and were assigned two different COM ports. The XBee S2 module connected to COM3 was the router and the XBee S2 module connected to COM4 was the coordinator. Other than the problems mentioned above, most of the lab was completed.

Conclusion:

- Able to configure XBee S2 modules as coordinator and router.
- Able to read/discover XBee S2 modules.
- Able to test basic communication between two XBees.
- Able to configure XBees using XCTU software.
- Able to configure XBees through command line interface.
- Able to perform various configuration options with XBees.
- Explored features in XCTU software.
- Explored features in PuTTY software.