Inter Device and Serial Communication

ZIGBEE (Xbee)

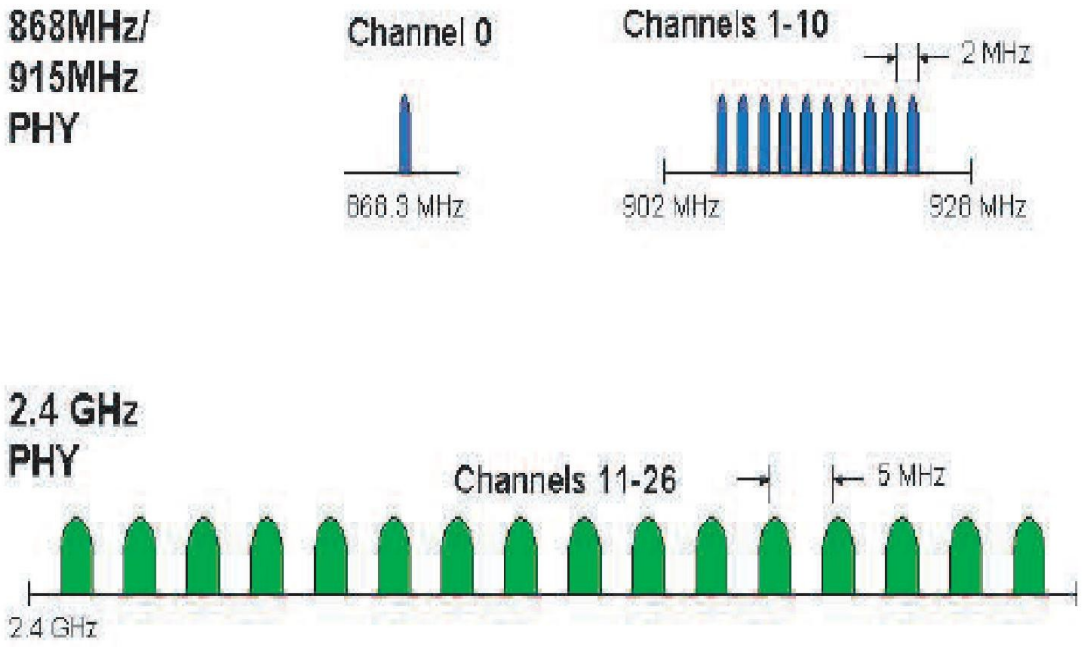
What is ZigBee?

- ZigBee is a standard wireless network protocol designed for low data rate control networks.
- It is layered on top of the IEEE 802.15.4 specification and provides a standard methodology for functions, including network formation, messaging and device discovery.
- for the unique needs of remote monitoring and control applications, including simplicity, reliability, low-cost and low-power.

Zigbee characteristics

- 2.4GHz and 868/915 MHz
- The number of channels allotted to each frequency band is fixed at 16 channels in the 2.45 GHz band, 10 channels in the 915 MHz band, and 1 channel in the 868 MHz band.
- Maximum data 250 kbps @2.4 GHz, 40 kbps @ 915 MHz, and 20 kbps @868 MHz.
- Allocation of guaranteed time slots (GTSs).
- Carrier sense multiple access with collision avoidance (CSMA-CA) channel access Yields high throughput and low latency for low duty cycle devices like sensors and controls.
- Low power consumption with battery life ranging from months to years. Energy detection (ED).Link quality indication (LQI).

CHANNELS


868MHz/
915MHz
PHY
Channel 0
868.3 MHz
Channels 1-10
2 MHz
902 MHz
928 MHz
2.4 GHz
PHY
Channels 11-26
5 MHz
2.4 GHz

What Does ZigBee Do?

- Designed for wireless controls and sensors
- Operates in Personal Area Networks (PAN's) and device-to-device networks
- Connectivity between small packet devices
- Control of lights, switches, thermostats, appliances, etc.

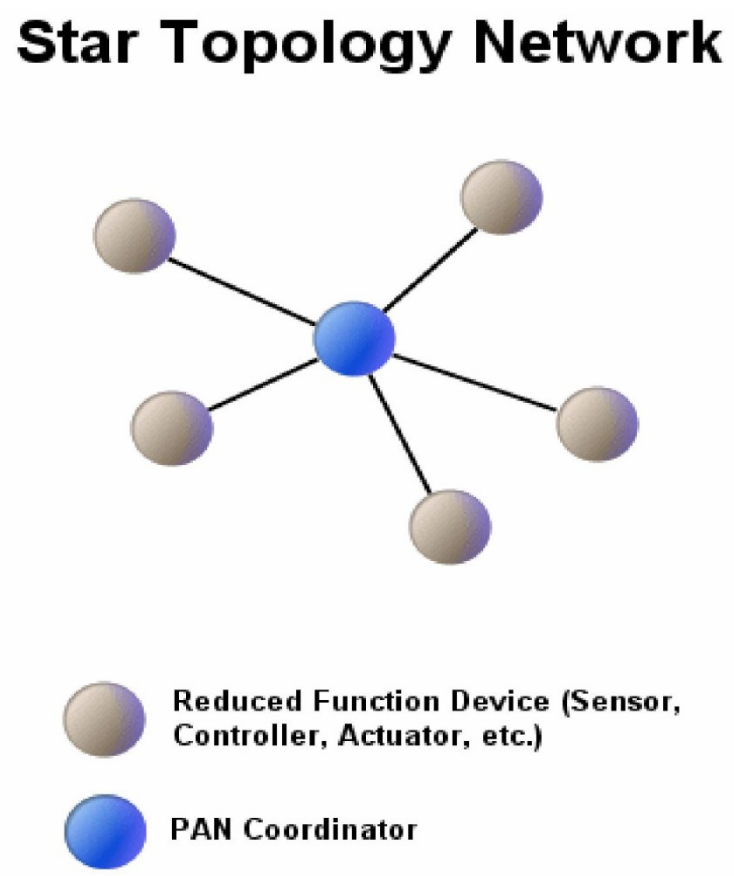
802.15.4

- Low Power
- Low bandwidth
- Addressing
- Affordable
- Small
- Standardized
- Popular

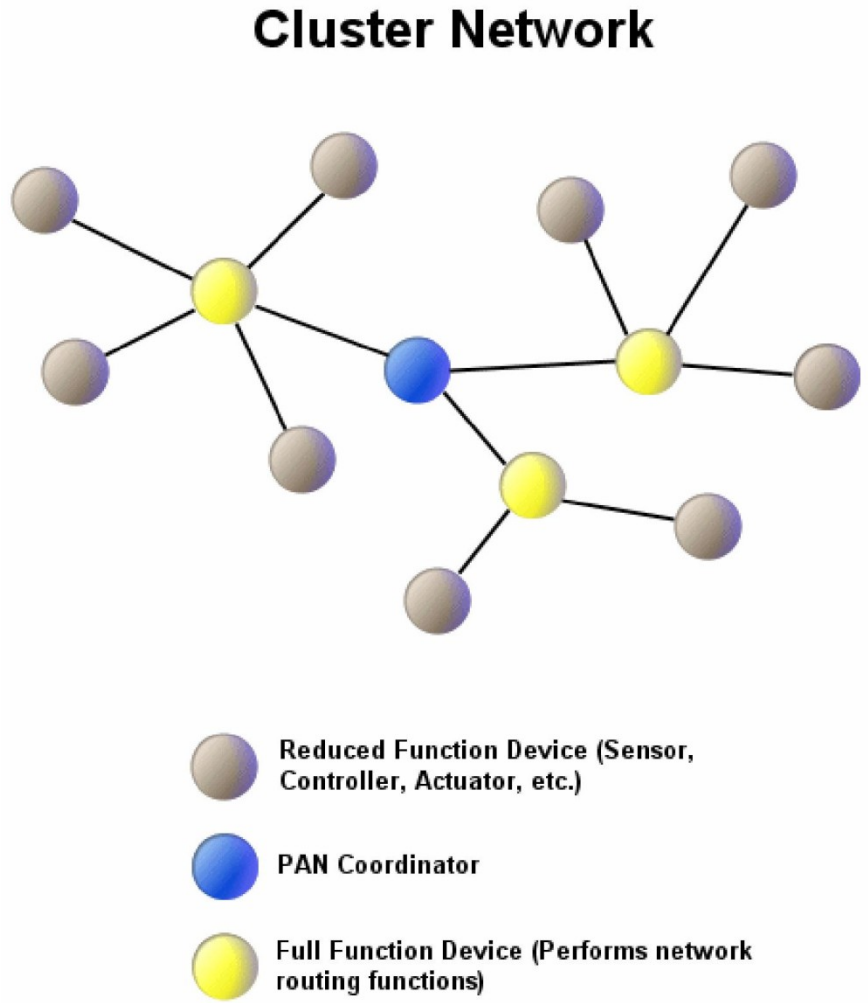
How ZigBee Works

- Topology
  - Star
  - Cluster Tree
  - Mesh

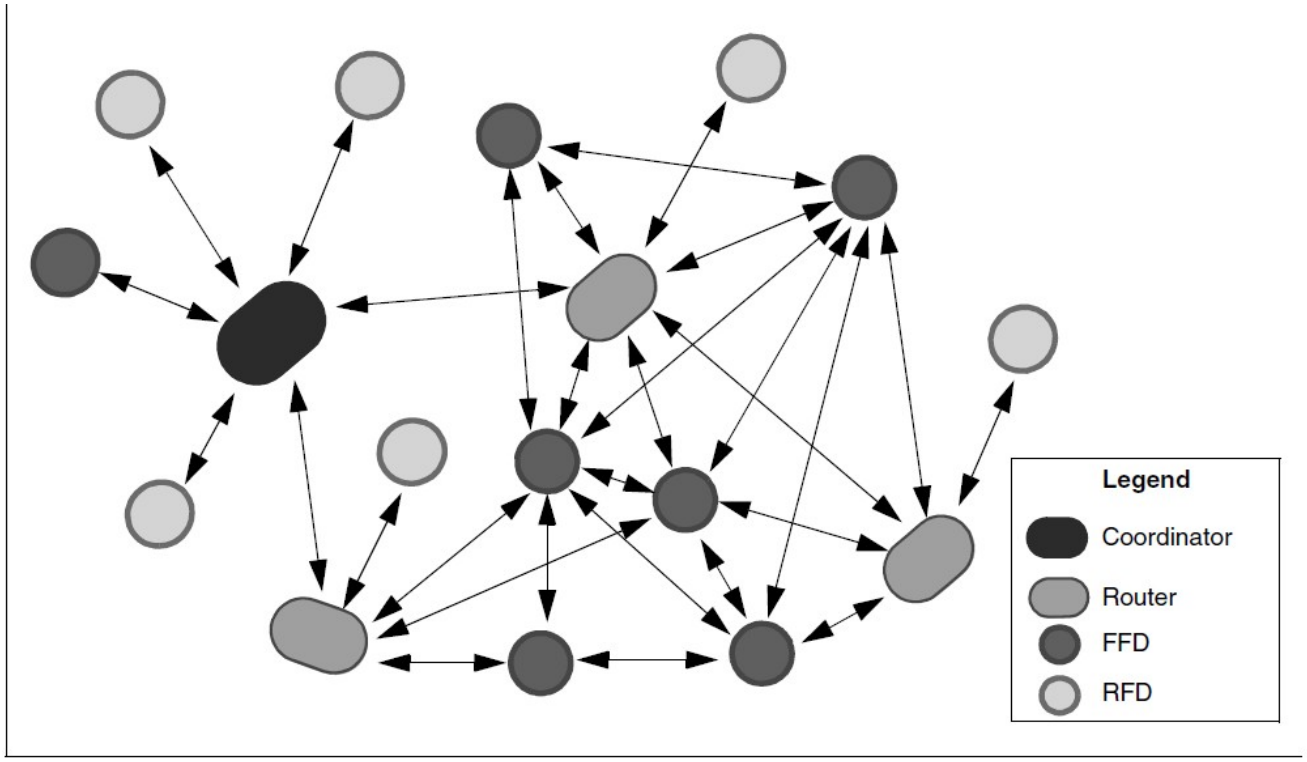
STAR TOPOLOGY



CLUSTER NETWORKS

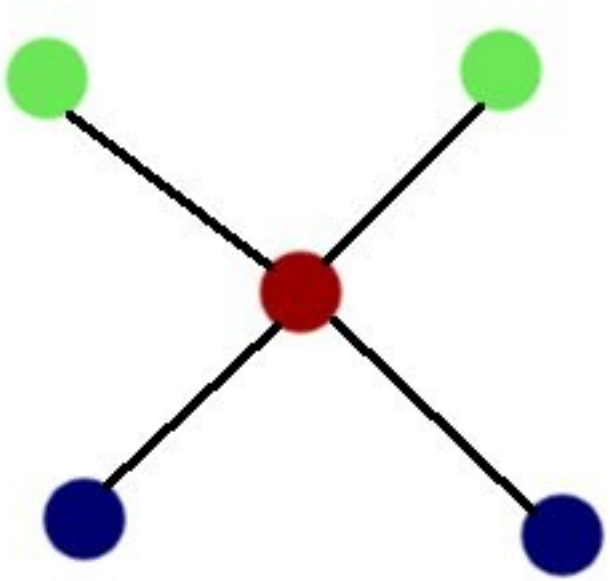


Zigbee mesh network

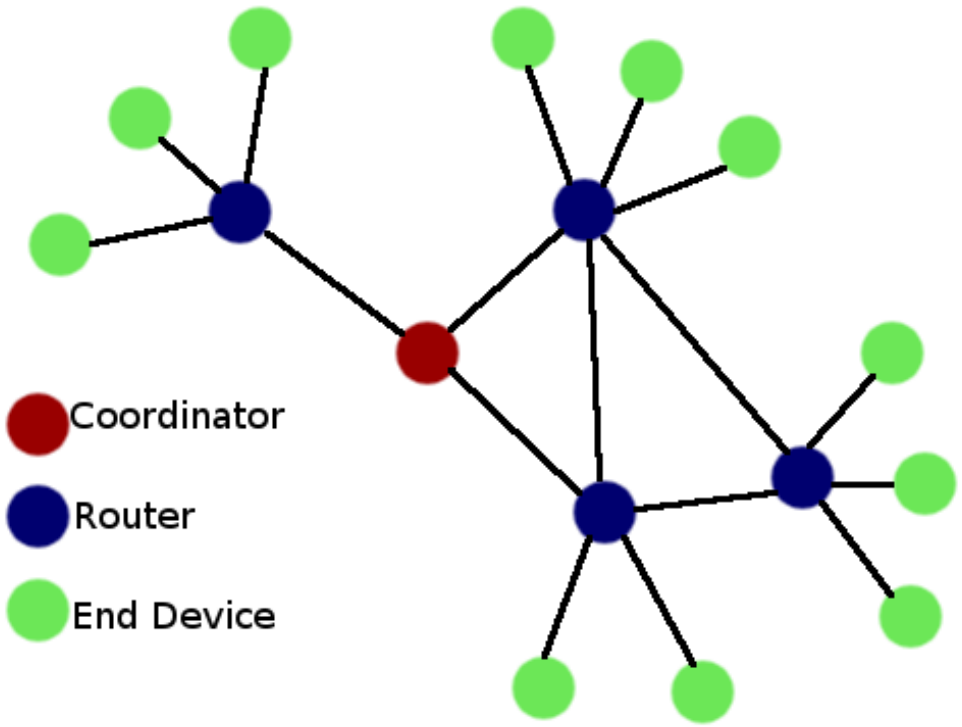


Zigbee Configurations

- Star



- Mesh

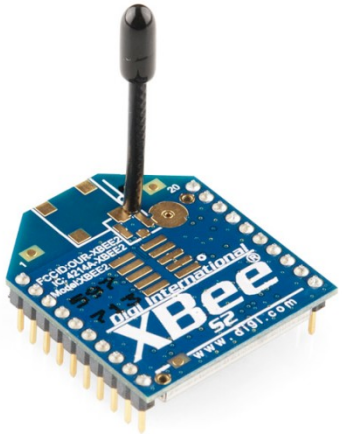


Antennas

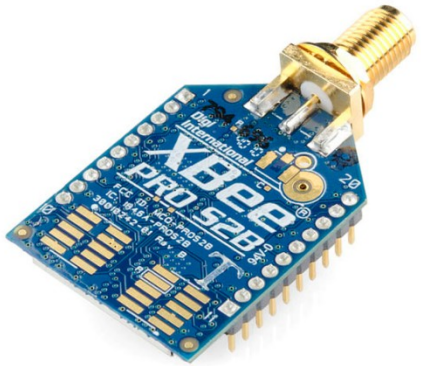
- Chip

- u.FL

- Whip



- RPSMA (reverse-polarity SubMiniature version A)

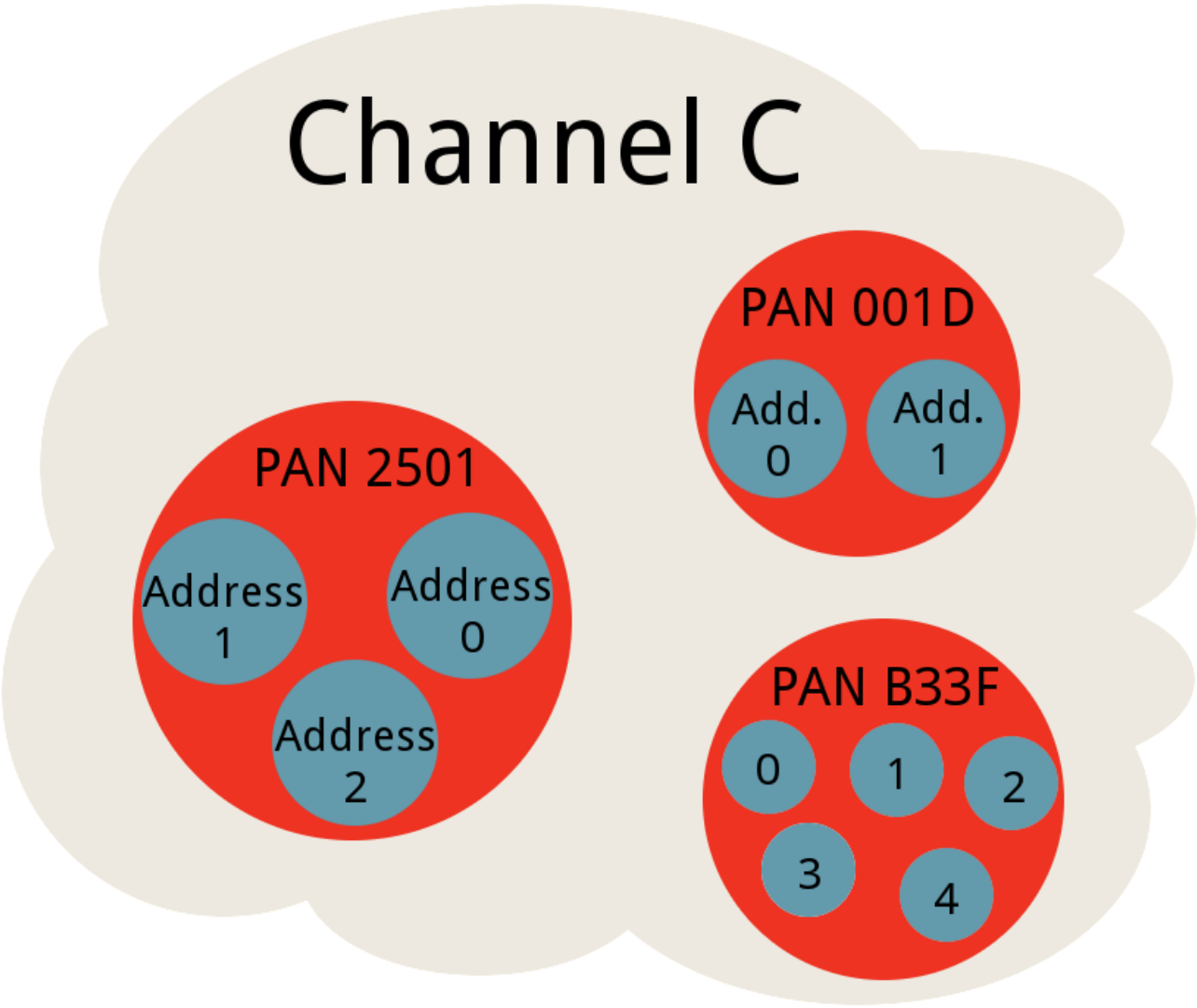


Regular vs. Pro

- 1-2mW
- Smaller
- Shorter range (100m)
- Cheaper

- 50-60mW
- Longer
- Longer range (300m)
- More expensive

Addressing


Channel C
PAN 001D
Add. 0
Add. 1
PAN 2501
Address 1
Address 0
Address 2
PAN B33F
0
1
2
3
4

Addressing

- Channels
- PAN
- 64-bit address
- High - same for all XBees
- Low – each XBee has its own address
- 16-bit address (configurable on Series 1)

Scan Channels Values

Scan Channel Value	Channels Allocated
0x0001	11 (0x0B)
0x0002	12 (0x0C)
0x0004	13 (0x0D)
0x0008	14 (0x0E)
0x0010	15 (0x0F)
0x0020	16 (0x10)
0x0040	17 (0x11)
0x0080	18 (0x12)
0x0100	19 (0x13)
0x0200	20 (0x14)
0x0400	21 (0x15)
0x0800	22 (0x16)
0x1000	23 (0x17)
0x2000	24 (0x18)
0x4000	25 (0x19)
0x8000	26 (0x1A)

Coordinators

- Each network has 1 coordinator
- Coordinator selects channel and PAN ID
- Other devices then join the PAN
- Usually powered by something stable
- 16-bit address is always 0
- Assigns 16-bit address for the router and end devices

Routers

- Optional
- Often powered by something stable
- Can have as many as you want
- Issues a request on startup to find a coordinator/ network it can join
- Can talk to any device
- If an end device is sleeping it stores its data
- Coordinator can act as a “super router”

End Devices

- Optional
- Usually battery powered
- Can have as many as you want
- Issues a request on startup to find a network it can join and a parent device (router or coordinator)
- Can only communicate with its parent

Firmware

- Must upload with X-CTU (on Windows)
- AT firmware vs API firmware
- Coordinator, Router, End Device
- Other
- Each Firmware has different settings

Serial Communication - Features

	Parallel Communication	Serial Communication
Cable	Use large number of wires	Use less number of wires
Cable length	Can't use lengthy cables. EMI limits data rate	Use long shield cables, protected from EMI
Communication modes	Only single shared path is available. Hence, can be only half-duplex	Can have separate paths for transmission and reception. Hence, can be full-duplex
Communication error	Bits get corrupted due to capacitance effects between cable wires	Only one bit is communicated at a time
Data rate	It is faster.	Latest techniques offer faster / comparable rates. E.g.: PCI-Ex, SATA

Introduction

- For wireless transmission of data transmitters are used. Transmitters are of many types some in the form antennas and dish.
- One way to transmit the data is through Xbees pronounced as zigbees and also know as Waspmotes.
- ZigBee is based on an IEEE 802.15.4 standard.
- Xbee is a small device working at 3.3volts, this device is a transceiver and can be used as a transmitter and receiver as per choice. Xbee transmits and receives data at Radio Frequency. Transmitter unit of Xbee is known as coordinator and receivers are known as routers.

- Xbee can be used at places where continuous data is not required and a very small bits are transmitting through the channel for example heat and pressure sensors etc. They are compatible with both computers and micro controllers.
- . ZigBee is simpler and less expensive than other wireless personal area networks(WPANs), such as Bluetooth or Wi-Fi. For indoor applications at 2.4 GHz transmission distance is around 10–20 m, depending on the construction materials used.

- In this report we will focus on the functions of Digi's X-CTU software. Allowing a better understanding of the program and how it is used.

How to use Xbee!

- To connect an XBee to Arduino or computer XBee Explorer or XBee Shield is used. With the help of these tools we can configure our Xbees and will be able to establish connections between remote RF modules.
- The explorer board has a USB-to-Serial converter. Which translates data betw ee

Xbee Shield

Xbee Explorer

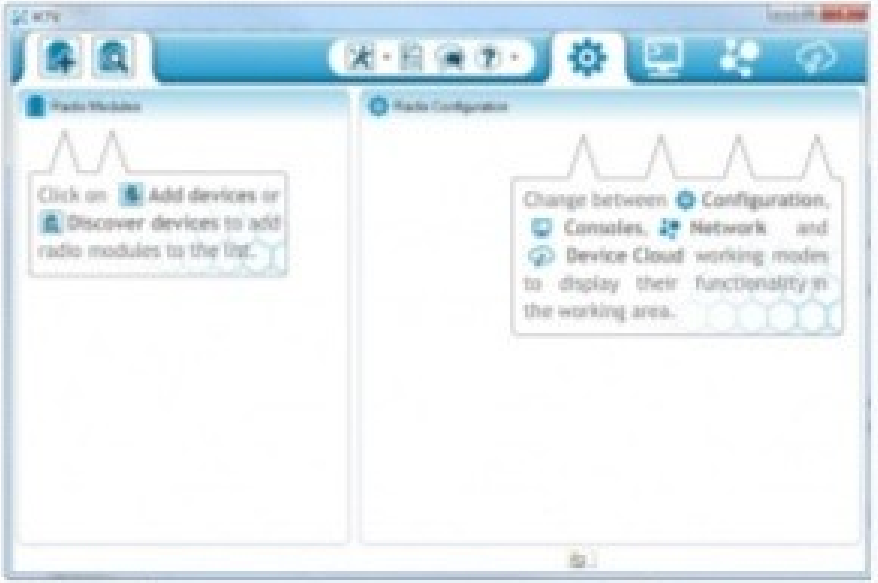
- Connect the Xbee module onto the Explorer and connect with computer and run the X-CTU software.

Benefits of X-CTU

- It has many advantages like
- Automatically detect module type.
- Display both ASCII and hexadecimal characters in terminal window.
- Upgrade RF module firmware in the field on all Digi RF Products.
- Display of Receive Signal Strength Indictator (RSSI).
- It is used to configure and test Digi RF products.
- Easy to use loopback range test.
- Compose test packets in either ASCII or hexadecimal for transmitting in terminal interface.
- Save and retrieve commonly used module configurations (profiles).
- Display help about each of the radio parameters.
- Program radio profiles in a production environment using command line interface.
- Integrates with Lab view and other production test software through command line interface.
- The software allows to test the radio modems in the actual environment with just a computer and the items included with the radio modems.

X-CTU Software

- Opening X-CTU this window will appear:



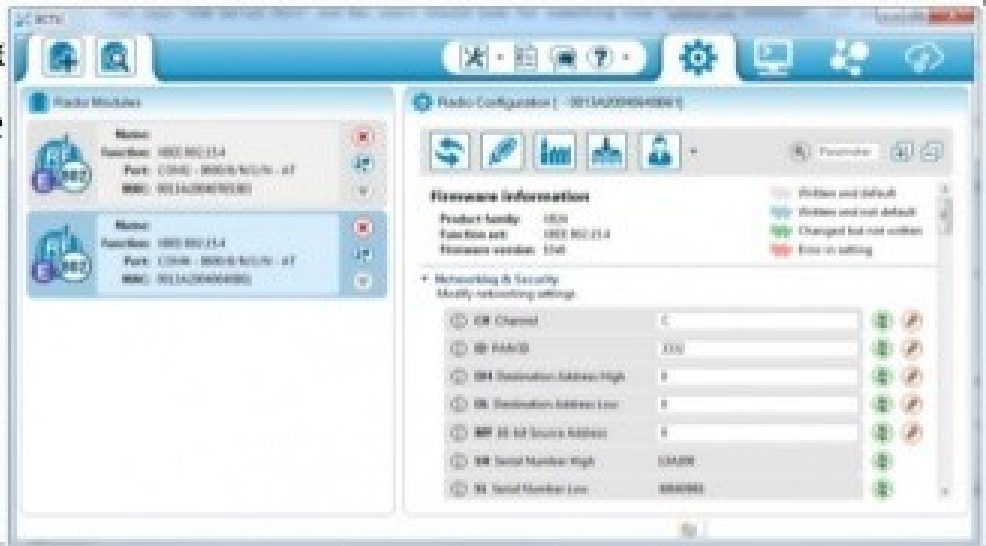
- The application will start a search for different connected devices:

- To add your XBee modules, click the "Add device" icon in the upper-left part of the window this screen will appear

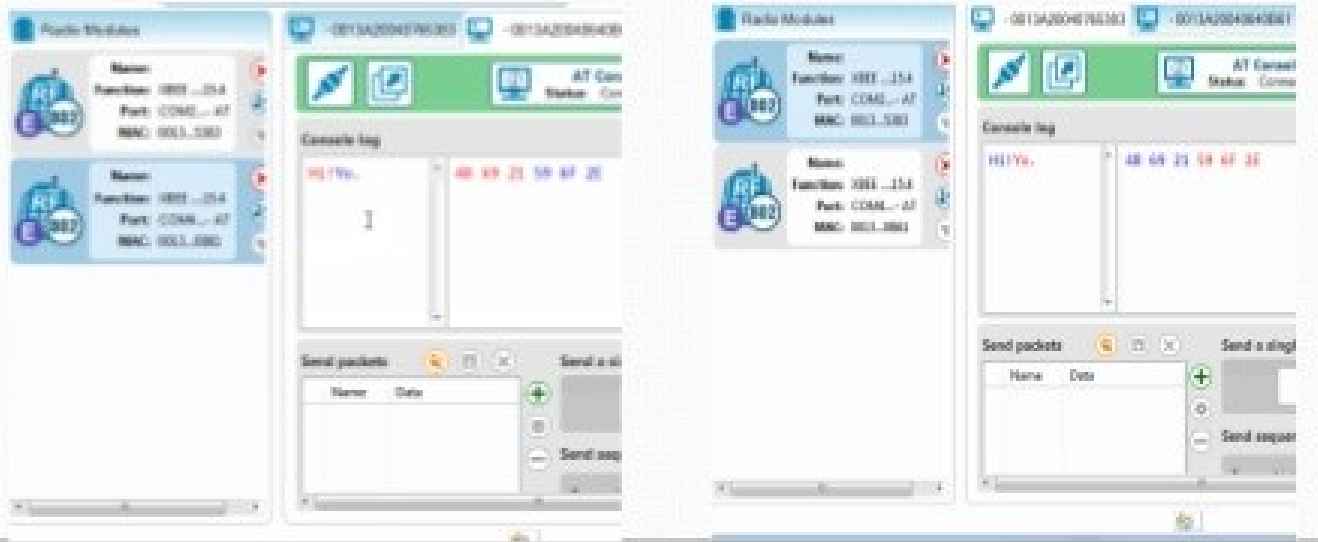
- Select communication port and for Serial Explorer board, pick the "Communications Port" option. This window also allows to modify specific serial characteristics like baud rate, data bits, and stop bits.

- Click the add modules, and then click on the module that appeared at left after a few seconds as X-CTU reads the configuration settings of XBee. The entire configuration of XBee will be shown.

- To test the communication between XBee's second XBee needs to be connected to the computer and for that click the 'add device' button on left. If second XBee is also connected to the same computer, a second entry will be added to the "Radio Modules" list. Selecting any one of those entries will display its configuration settings.



- Click the “Switch to Consoles” icon in the upper-right part of the window. This will switch from the configuration tab to the console mode. We can use the console to send data to other remote XBeez.
- If two XBees are connected to computer, each radio’s console can be selected by clicking the device on the left. Open a serial connection of each device by clicking the connect icon it will turn the console’s border to green.
- Once all Gateway and devices are configured in the same network, switch to Working Network mode. Press the ‘Scan the radio module network’ button and all connected devices will be shown, in its corresponding topology (P2P, tree or mesh).
- Now write anything in console log and notice that data is transmitted or not. Red and blue letters denotes the successful transmission link is created.

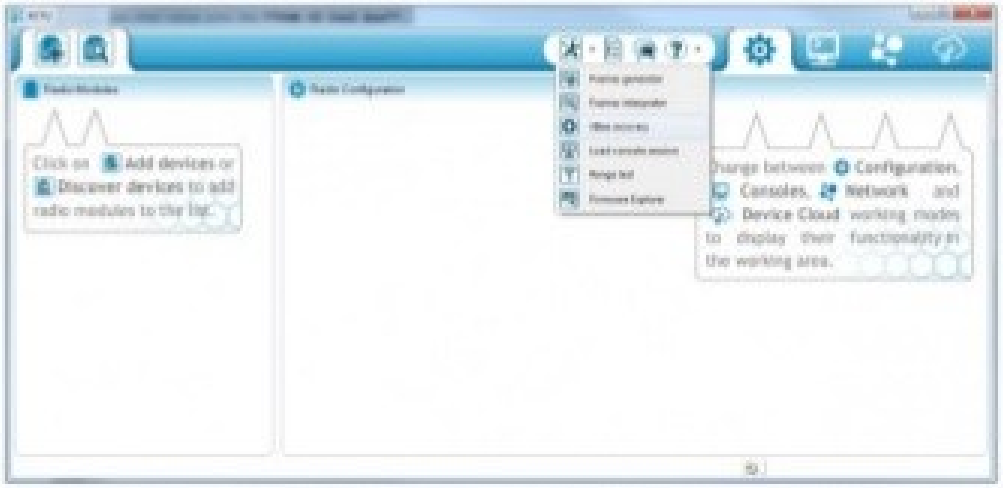


- Range test tool allows to perform a range test between a local radio module and any of the remote modules working in the same network.

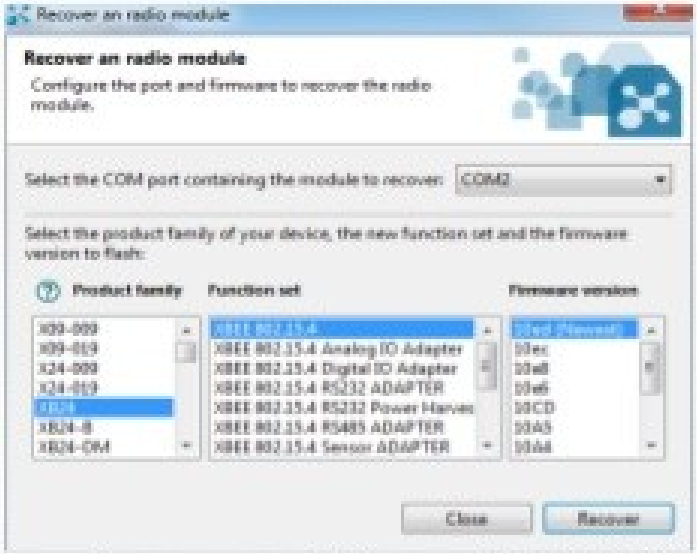
- Click the 'Discover radio nodes in the same network' button and connected devices will appear.

- Add the device and start the range test.

- If XBee is not working properly click the Tools icon, and select XBee Recovery:



- Select COM port and product family. This can be found on the bottom sticker of your XBee. For series 1 module, the family should be XB24. Beyond that you'll need to select a "Function Set" and "Firmware Version".



- Radio Configuration: Connect one XBee to X-CTU. Click back over to the Configuration tab. CH, ID, DH, DL, and MY. Beside each of those blocks is a text box – that's where new settings are typed.
- Network ID (ID): Begin by coming up with a unique network ID number i.e 3345 convert it to hexadecimal. Or if you don't want to put that much effort into it, use a random value like J7U1.
- Type your 16-bit network ID into the white text box next to PAN ID.
- MY Address (MY): Create addresses for each XBee in network. These values should be unique to each XBee in a network. The MY address can be any value between 0x0000 and 0xFFFF. Type this address into the text box next to "MY 16-bit Source Address".

- For two XBees, assign the first an MY address of 0, and the other an address of 1. (XBee's can share the same MY address, they'll both receive the same data if it's broadcast ed to that address.)
- Destination Address (DH & DL): The destination address defines with which XBee, source XBee is talking to. There are actually two values used to set the destination: destination high (DH) and destination low (DL).
- Leave DH set to 0, and set DL to the MY address of the receiving XBee.
- Set DH to the Serial Number High (SH) and DL to the Serial Number Low (SL) of destination XBee.
- Either method works, but the former – setting DH to 0 and DL to the destination's MY address – is usually easier.
- Example for setting up the ID, DH, DL, and MY values for a pair of XBees:

Setting	Acronym	XBee 1	XBee 2
Channel	CH	C	C
PAN ID	ID	A1B7	A1B7
Destination Address High	DH	0	0
Destination Address Low	DL	1	0
16-bit Source Address	MY	0	1

Youtube Tutorial

https://www.youtube.com/watch?v=uBkQUph9EKM