L13. Communicating wireless by XBee modules

1. Introduction

XBee and XBee-PRO ZB embedded RF modules provide cost-effective wireless connectivity to devices in ZigBee mesh networks. With the PRO Feature Set, these modules are interoperable with other ZigBee devices (even from other vendors). Products in the XBee family are easy to use and in addition they require no configuration or additional development, as it is presented in this paper.

There are also programmable versions of the XBee-PRO ZB module, which allows to program them directly on the module; this eliminates the need for a separate processor. Because the wireless software is isolated, applications can be developed with no risk to RF performance or security. ZigBee mesh networking protocol is used to improve data traffic management, remote firmware updates and self-heal and discover network stability.

XBee modules are available in a variety of protocols and frequencies, as Table 1 shows.

Platform	XBee® ZB	XBee-PRO® ZB	Programmable XBee-PRO® ZB
Performance			
RF Data Rate	250 Kbps		
Indoor/Urban Range	133 ft (40 m)	300 ft (90 m)	
Outdoor/RF Line-of-Sight Range	400 ft (120 m)	2 miles (3200 m) / Int'l 5000 ft (1500 m)	
Transmit Power	1.25 mW (+1 dBm) / 2 mW (+3 dBm) boost mode	63 mW (+18 dBm) / Int'l. 10 mW (+10 dBm)	
Receiver Sensitivity (1% PER)	-96 dBm in boost mode	-102 dBm	
Features			
Adjustable Power	Yes		
I/O Interface	3.3V CMOS UART, ADC, DIO		3.3V CMOS UART, SPI, I2C, PWM, DIO, ADC
Configuration Method	API or AT commands, local or over-the-air		
Frequency Band	2.4 GHz		
Interference Immunity	DSSS (Direct Sequence Spread Spectrum)		
Serial Data Rate	1200 bps - 1 Mbps		
ADC Inputs	(4) 10-bit ADC inputs		
Digital I/O	10		
Antenna Options	Chip, Wire Whip, U.FL, RPSMA	PCB Embedded Antenna, Wire Whip, U.FL, RPSMA	
Operating Temperature	-40° C to +85° C, 0-95% humidity non-condensing		
Programmability			
Memory	N/A		32 KB Flash / 2 KB RAM
CPU/Clock Speed	N/A		HCS08 / Up to 50.33 MHz
Networking & Security			
Encryption	128-bit AES		
Reliable Packet Delivery	Retries/Acknowledgments		
IDs and Channels	PAN ID, 64-bit IEEE MAC, 16 channels	PAN ID, 64-bit IEEE MAC, 15 channels	
Power Requirements			
Supply Voltage	2.1 - 3.6VDC	2.7 - 3.6VDC	
Transmit Current	35 mA / 45 mA boost mode @ 3.3VDC	205 mA	220 mA
Receive Current	38 mA / 40 mA boost mode @ 3.3VDC	47 mA	62 mA
Power-Down Current	<1 uA @ 25° C	3.5 uA @ 25° C	4 uA @ 25° C
Regulatory Approvals			
FCC, IC (North America)	Yes		
ETSI (Europe)	Yes		
C-TICK (Australia)	Yes		
TELEC (Japan)	Yes	Yes (Int'l unit only)	

Table 1. Features for different XBee modules [1]

In order to configure the XBee modules, one has to follow few simple steps: the XBee control software (X-CTU) from Digi (http://www.digi.com/) has to be installed on the computer and then, one of the modules has to be plugged in using the USB cable. When first starting, the setup of the XBees to send and receive from any other compatible device (running at the same frequencies, etc) has to be done. This is accomplished by setting the following parameters for each module: Destination Address High (DH), Destination Address Low (DL) and PAN ID. Then, these configuration changes have to be written to the XBee module.

For a second XBee module the same steps has to be followed and finally, one can use serial terminals to send packets between the modems for example.

Using the X-CTU software

The X-CTU software is only available for Windows. When the setup program asks for updating from Digi, the 'yes' option will download all the firmware versions for all the XBee modules.

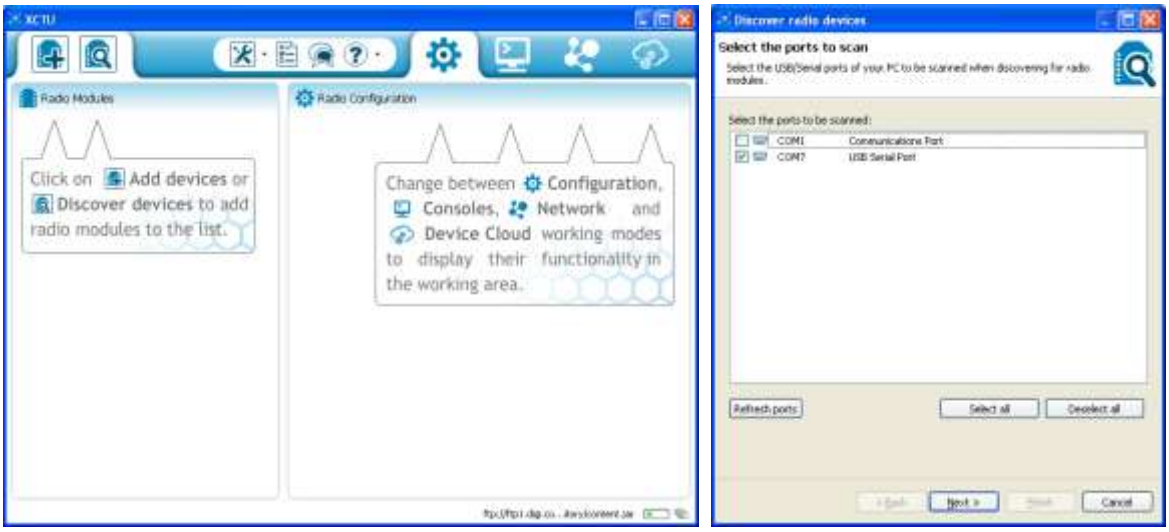

Figure 1. a) The X-CTU Software main window; b) Discover radio devices option

To configure the X-CTU software:

When X-CTU has been properly installed and started, a window like the one from Figure 1.a) will appear, and the XBee module can be connected to the computer. It will be recognized as a 'USB Serial Port'. We have to know the COM number given to this device in order to specify it in the X-CTU (in our test, COM7 was the value given by Windows, as seen in Figure 1.b).

Details for the X-CTU operation:

First, the XBee module you need to configure has to be placed in a USB port of the PC. Then, the X-CTU application has to be run, with the option "Discover radio modules connected". The appropriate communication port has to be selected and configured as shown in Figure 2.a) (if not sure, all options can be selected). The application will start to look for different devices connected to the PC and will deliver a message similar to the one from Figure 2.b).

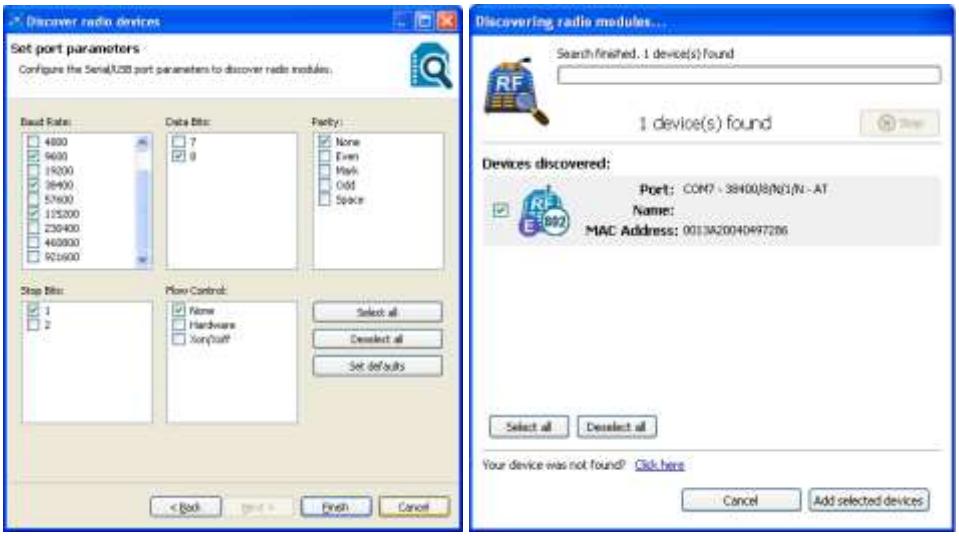

Figure 2. a) Set port parameters window; b) Finding connected devices.

Then go to the ***Configuration Working mode*** and click to select the device. We must check each parameter first.

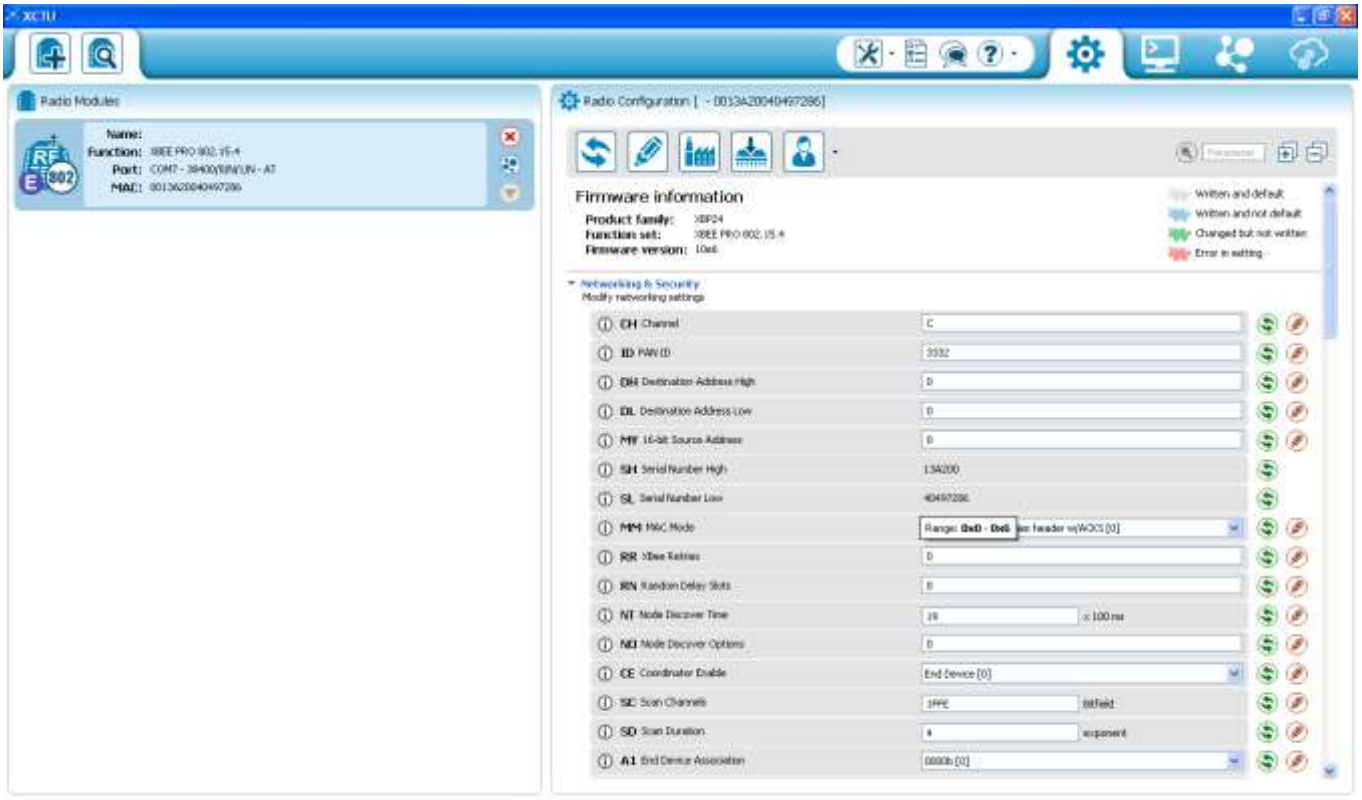

Figure 3. a) Configuration Working mode

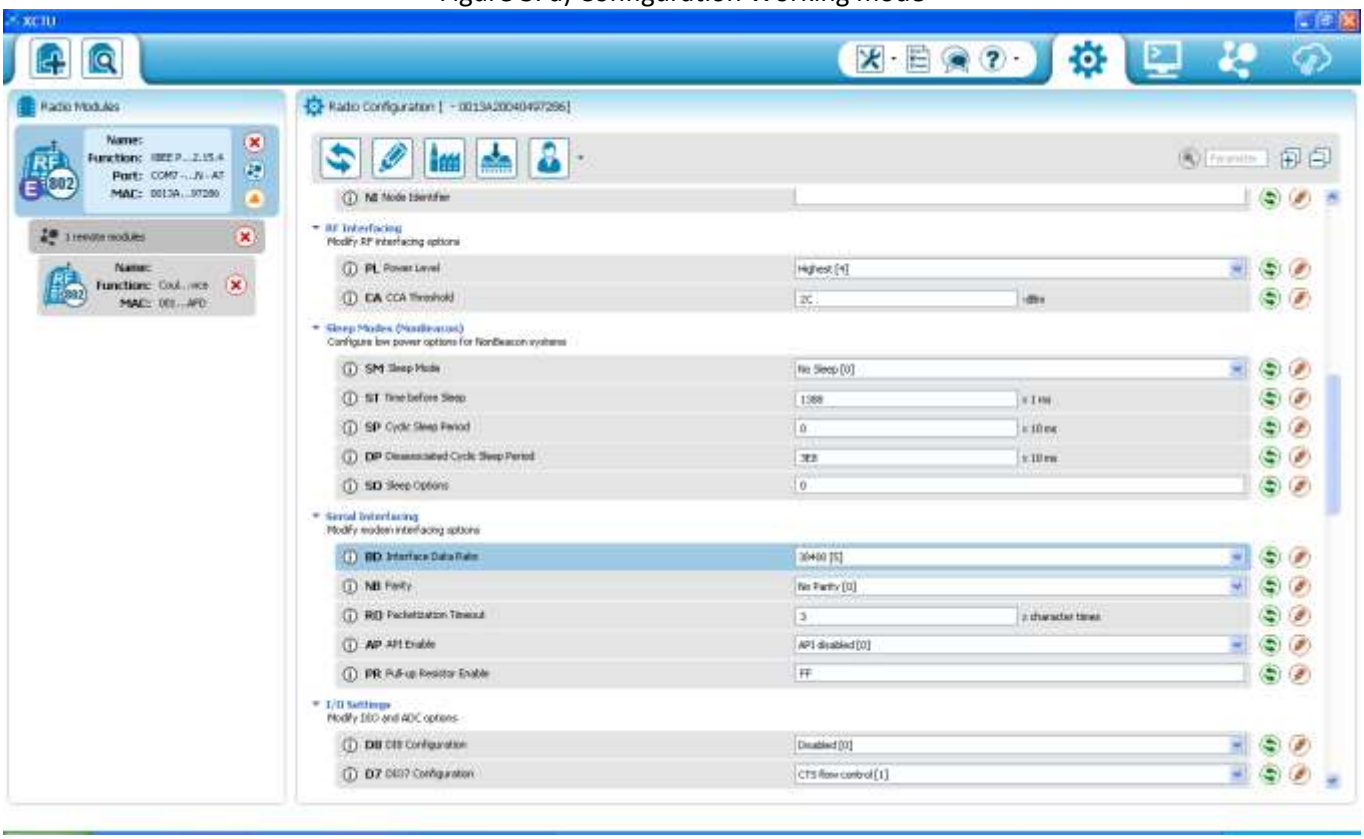

Figure 3. b) Configuration Working mode -continued

Some parameters should be checked in this stage: the first parameter, CH: C, the PAN ID: 3332, the destination address (2 parts): low part and high part, the KY parameter (if needed, it must be set as hexadecimal key: 32-32 hexadecimal characters), the serial interface baud rate: as chosen and the API options: API enabled w/PPP.

It is also possible to change the XBees configuration to the values by default set by Digi, but it is risky since you could let the XBee without communication. Still, to accomplished the change, from 'Tools', the 'XBee Recovery' option has to be selected. The product family of the device has to be chosen and after that you will probably have to reset the XBee. You can read again the radio parameters to check if the change occurred.

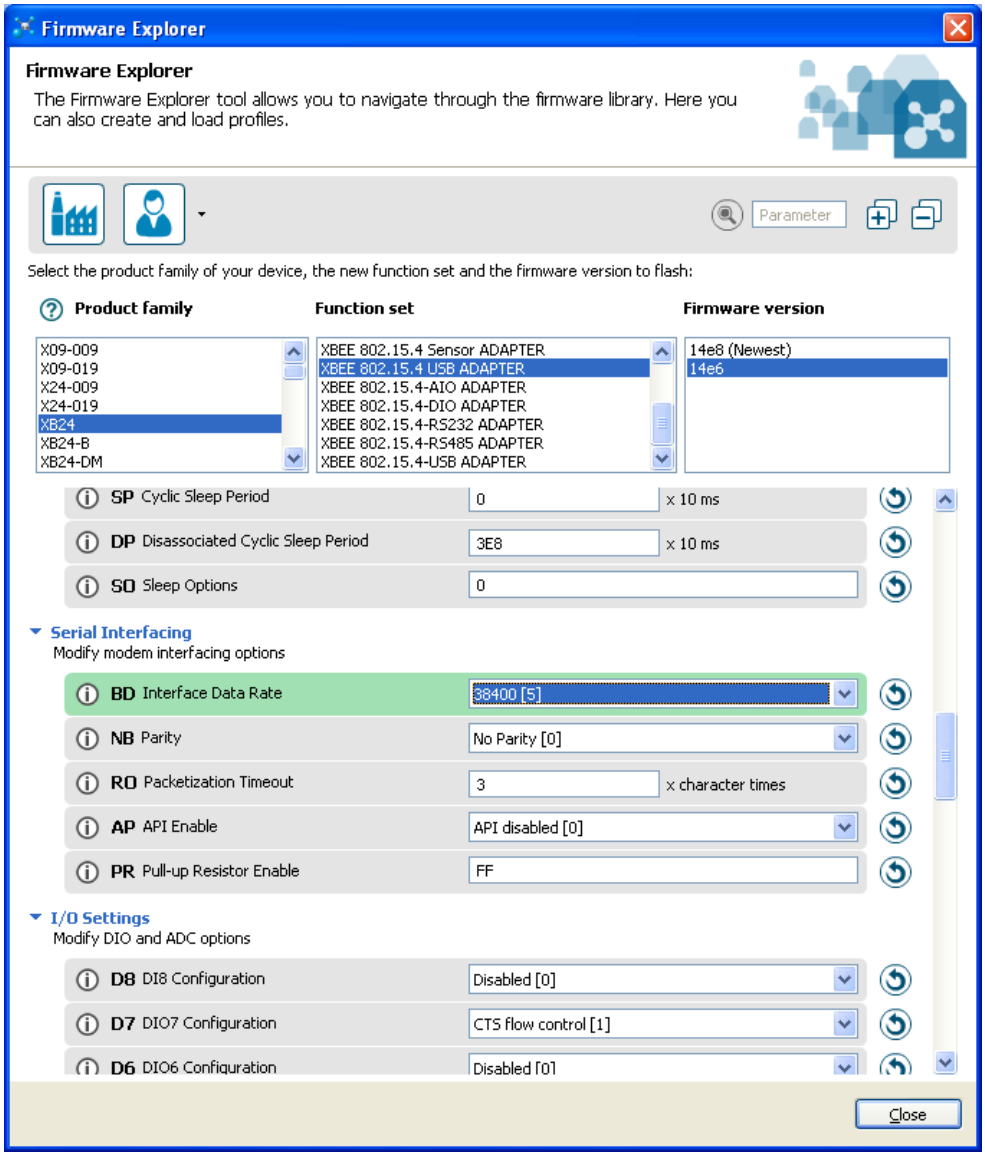

Figure 4. Firmware explorer option

Connecting several devices

All devices connected in the same network can be shown and configured.

Steps to follow:

Select ***Working Network mode***.

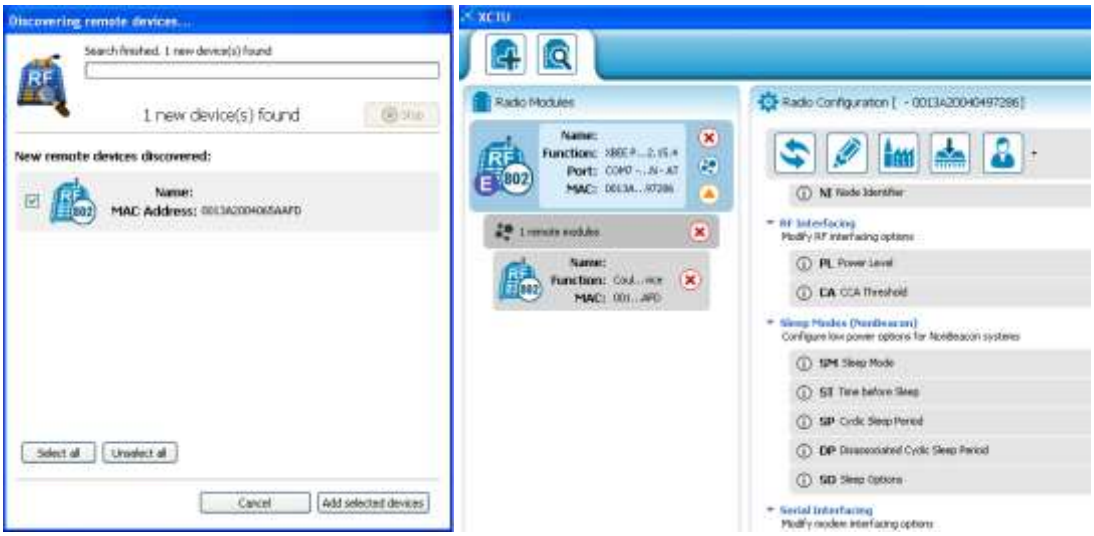

Figure 5. a) Discovering remote devices; b) Read Configuration parameters of the remote device.

With the ‘Scan the radio module network’ option, all connected devices will be shown, in its corresponding topology (P2P, tree or mesh).
Also, you can change the configuration of all devices pressing the ‘Discover radio nodes in the same network’ button.

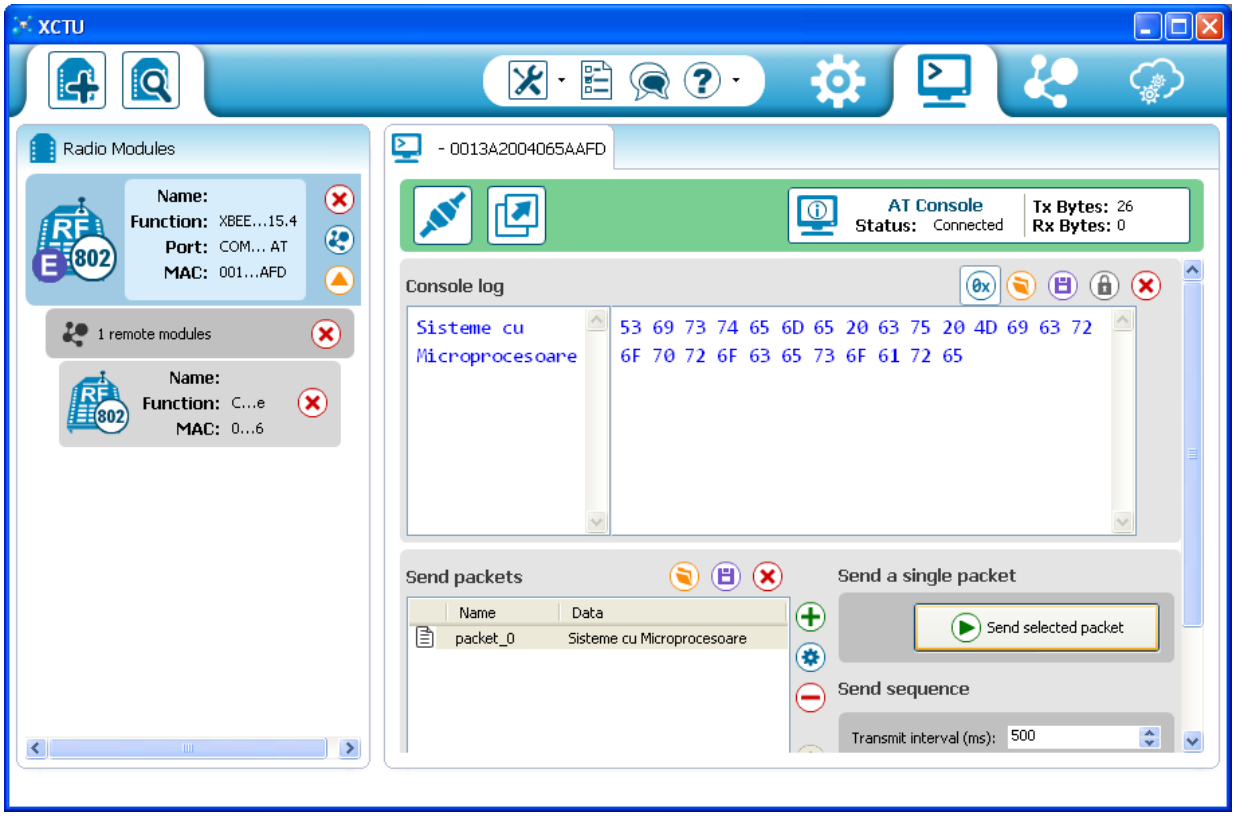

Figure 6. a) Sending packets by remote connection

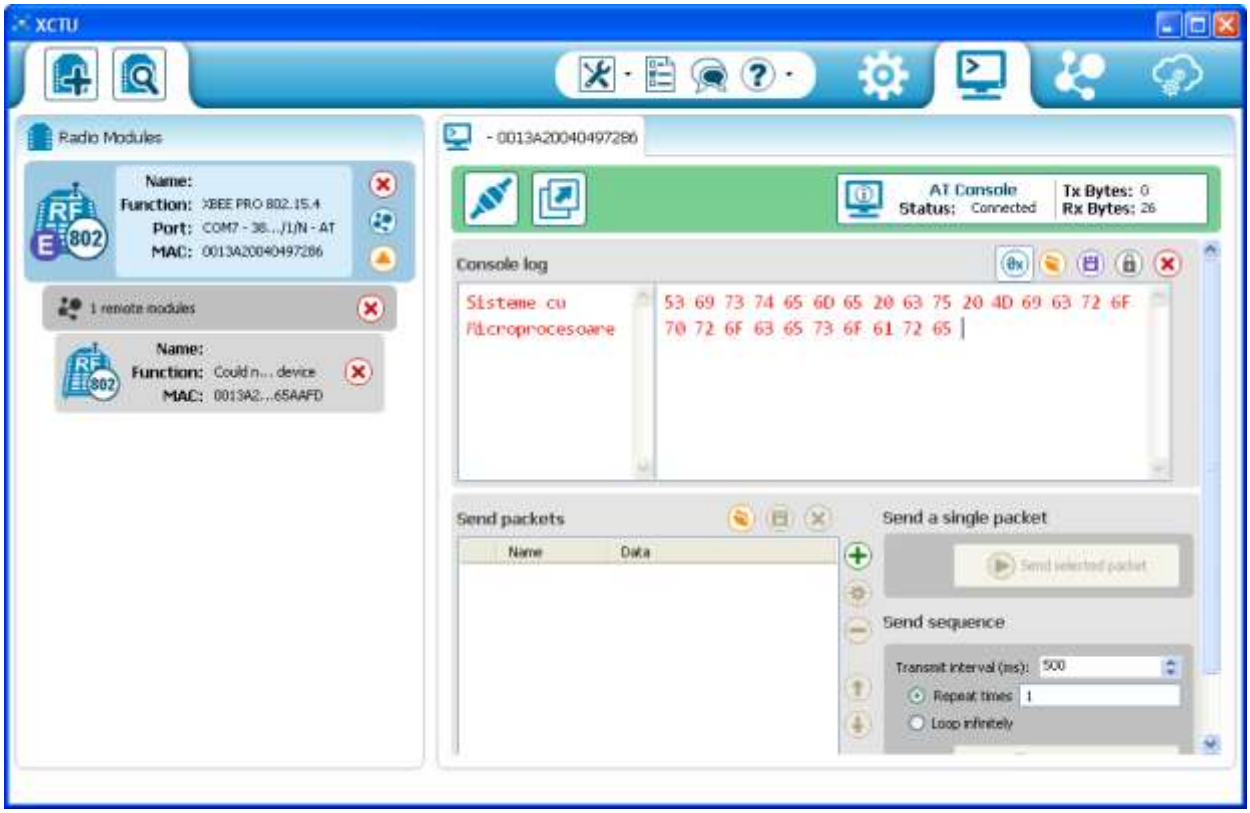

Figure 6. b) Receiving packets by remote connection

Range Test Tool

The Range Test tool has been included within the Tools drop-down menu of the main toolbar. This tool allows you to perform a range test between a local radio module and any of the remote modules working in the same network as the local one.

The highlights of the Range Test tool include the following features:

- The tool is able to perform range tests of 802.15.4, ZigBee and DigiMesh protocols regardless of the working mode (AT or API) of the modules.
- Chart control displaying the current and historic link qualities between modules.
- Different controls indicating the number of packets sent, lost, etc.

Steps to follow:

1 – Once your devices have been configured in the same network, you can go to 'Tools' → 'Radio Range Test'

2 – Next, click on the 'Discover radio nodes in the same network' button and your connected devices should be shown.

3 – Now, you can add the device and start to perform the range test.

Remote firmware update

The remote firmware update feature has been implemented, but this functionality is limited to ZigBee and XBee 900 series. Now you are able to update the firmware of a remote radio module the same way you do with a device physically connected to a PC host. In order to perform a remote firmware update, the local radio module must be configured in API mode (XBees for PC are shipped in AT mode and should not be changed).

References:

[1] http://www.digi.com/pdf/ds_xbeezbmodules.pdf