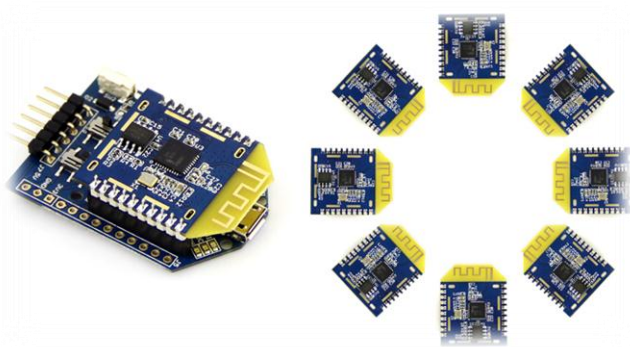




# MeshBee® Open Source ZigBee RF Module CookBook



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# Chapter 1: Getting Started

## 1.0 Introduction

MeshBee<sup>®</sup> is a 2.4 GHz wireless zigbee RF module. It use microchip JN516x from NXP that enables several different flavors of standards-based zigbee mesh networking. Our released firmware fully supports **Zigbee Pro** stack. You can use MeshBee<sup>®</sup> in three different ways:

Master Mode: the factory firmware warps the complicated Zigbee stack operation into a few easy to use serial commands(AT commands).

Slave Mode: for a complex mesh network, a host application can send API frames to the MeshBee<sup>®</sup> that contain short address and payload information instead of using AT command.

Transparent Mode: MeshBee<sup>®</sup> can also work as a transparent serial communication node that can be part of a simple point-to-point connection. When operating in this mode, the modules act as a serial line replacement - all UART data received through UART1 is directly send to a specified remote node.

## 1.1 Installing IDE

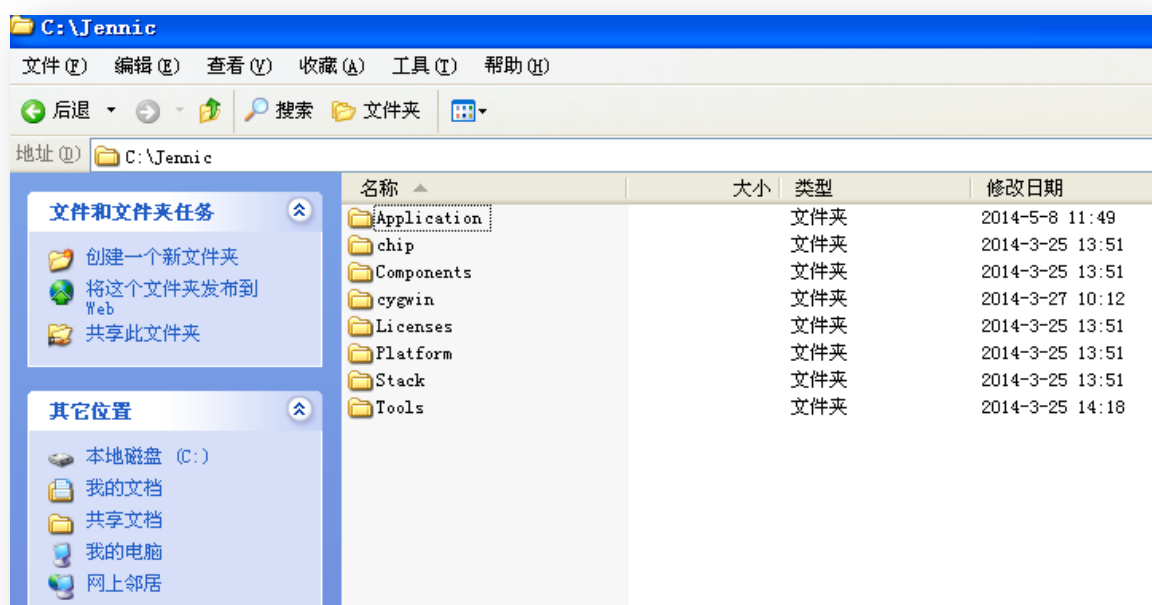
NXP provides full-scale development environment, tools and documents. The development environment consists of the SDK toolchain and the ZigBee stack SDK. Please visit NXP's website to get some detailed description: <http://www.nxp.com/techzones/wireless-connectivity/smart-energy.html>



**Note:** MeshBee's factory firmware is developed on top of the smart energy profile.

To create the development environment, perform these steps:

- 1) Install [JN-SW-4041](#) SDK Toolchain to default disk: C:/
- 2) Install [JN-SW-4064](#) ZigBee Smart Energy SDK to default disk: C:/





**Note:** The developing toolchain supports windows only. For Linux and Mac users, a windows VM is recommended.

When finished the installing, you can test the tool chain if you are not sure whether it is successful or not. Perform these steps:

- 1) Clone the latest firmware source code from github.
- 2) Copy the source code folder to C:/Jennic/Application/.
- 3) Open Jennic Bash Shell.
- 4) Type these shell commands:

```
cd MeshBeeMasterBranch
cd build
./build.sh
```

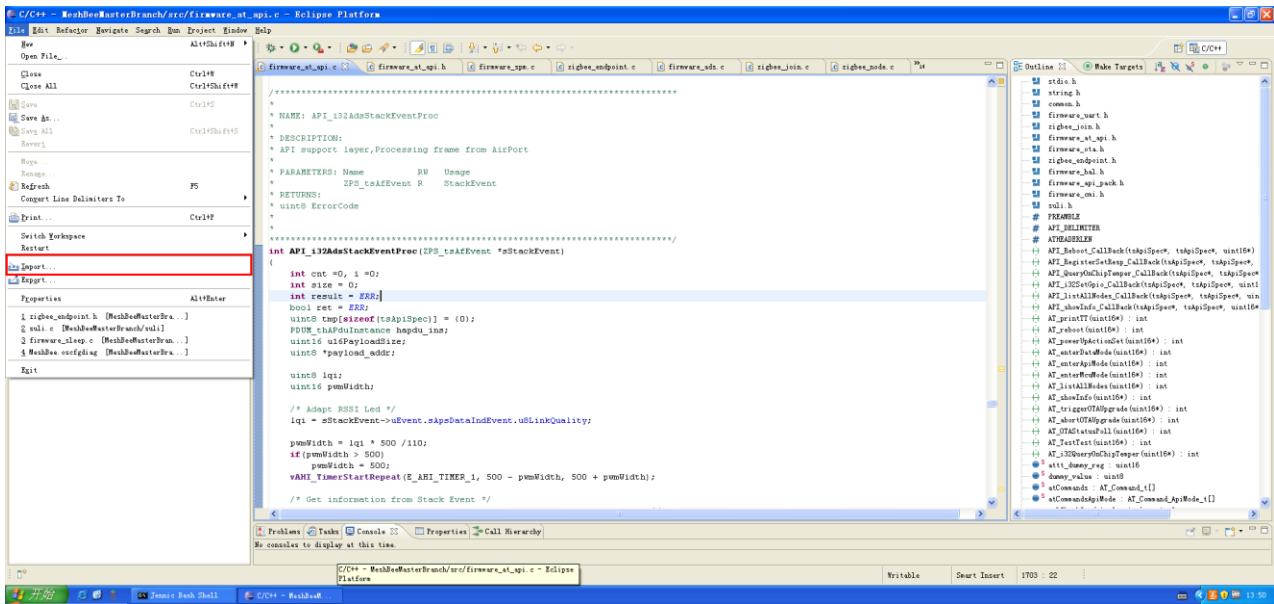
```
Jennic Bash Shell
igbee_join.o /cygdrive/C/Jennic/Application/MeshBeeMasterBranch/build/obj/zigbee
_main.o /cygdrive/C/Jennic/Application/MeshBeeMasterBranch/build/obj/zigbee_node
.o /cygdrive/C/Jennic/Application/MeshBeeMasterBranch/build/obj/zigbee_zbp_utili
ties.o /cygdrive/C/Jennic/Application/MeshBeeMasterBranch/build/obj/ACC_Adx1345_
Suli.o /cygdrive/C/Jennic/Application/MeshBeeMasterBranch/build/obj/suli.o -lRec
al_JN516x -lOS_JN516x -lPWRM_JN516x -lZPSMAC_JN5168 -lZPSTSV_JN516x -lAES_SW_JN5
16x -lPDM_JN516x -lZPSAPL_JN5168 -lRandom_JN516x -lPDM_EEPROM_JN516x -lDBG_JN51
6x -lAppApi_ZIGBEE_JN516x -lMac_ZIGBEE_JN516x -lTof_JN516x -lXcv_JN516x -lAES_CC
M_SW_PATCH_JN516x -lAes_JN516x -lTimerServer_JN516x -lHardwareApi_JN516x -lMicro
Specific_JN516x -lBoot_JN516x -lZPSNWK_ZED_JN5168 -lm -Wl,--end-group -Wl,-Map,/
cygdrive/C/Jennic/Application/MeshBeeMasterBranch/build/output/END_JN5168.map
/cygdrive/C/Jennic/Tools/ba-elf-ba2/bin/ba-elf-size /cygdrive/C/Jennic/Applicati
on/MeshBeeMasterBranch/build/output/END_JN5168.elf
  text    data    bss    dec    hex filename
 160887   4264   21464 186615 2d8f7 /cygdrive/C/Jennic/Application/MeshBeeMa
sterBranch/build/output/END_JN5168.elf
Generating binary ...
/cygdrive/C/Jennic/Tools/ba-elf-ba2/bin/ba-elf-objcopy -j .version -j .bir -j .f
lashheader -j .vsr_table -j .vsr_handlers -j .ro_mac_address -j .ro_ota_header
-j .ro_se_lnkKey -j .ro_se_cert -j .ro_se_pvKey -j .ro_se_customData -j .rodata -
j .text -j .data -j .bss -j .heap -j .stack -S -O binary /cygdrive/C/Jennic/Appli
cation/MeshBeeMasterBranch/build/output/END_JN5168.elf /cygdrive/C/Jennic/Appli
cation/MeshBeeMasterBranch/build/output/END_JN5168.bin
bash-3.2$
```

If three binary files are generated successfully, congratulations, you have finished all the

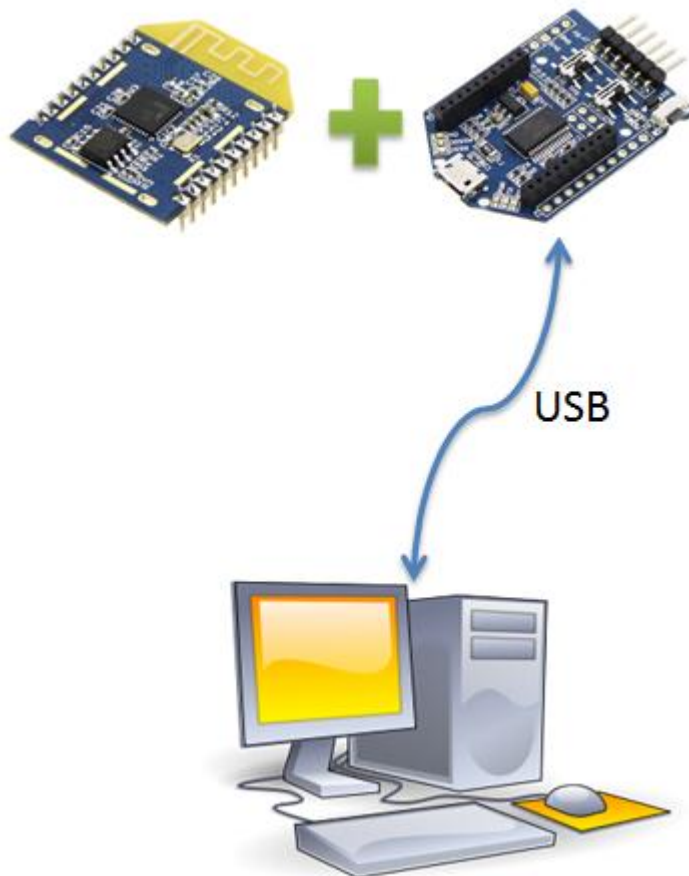
## Installing IDE

preparation work.

Open eclipse IDE and import the project, you can catch a glimpse of the firmware:



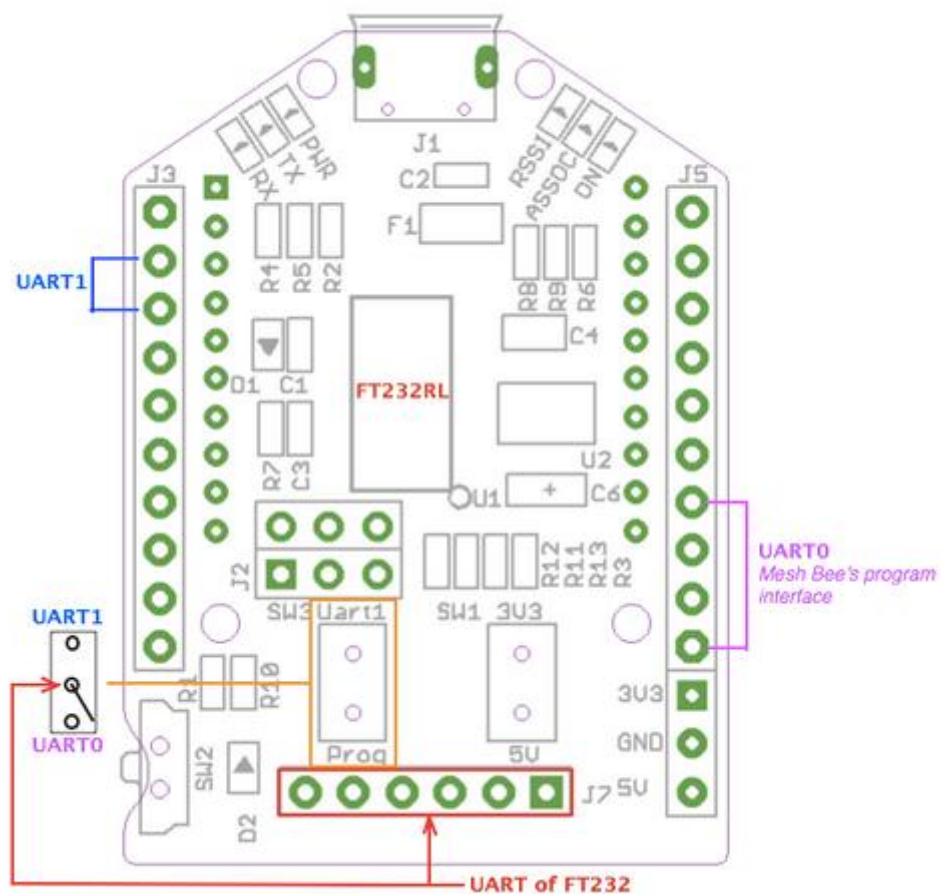
## 1.2 Setting up the MeshBee



To assemble your experimental environment, perform the following steps:

- 1) Step1: Insert MeshBee into the socket of UartBeeV5;
- 2) Step2: Connecting UartBeeV5 with PC by USB port;





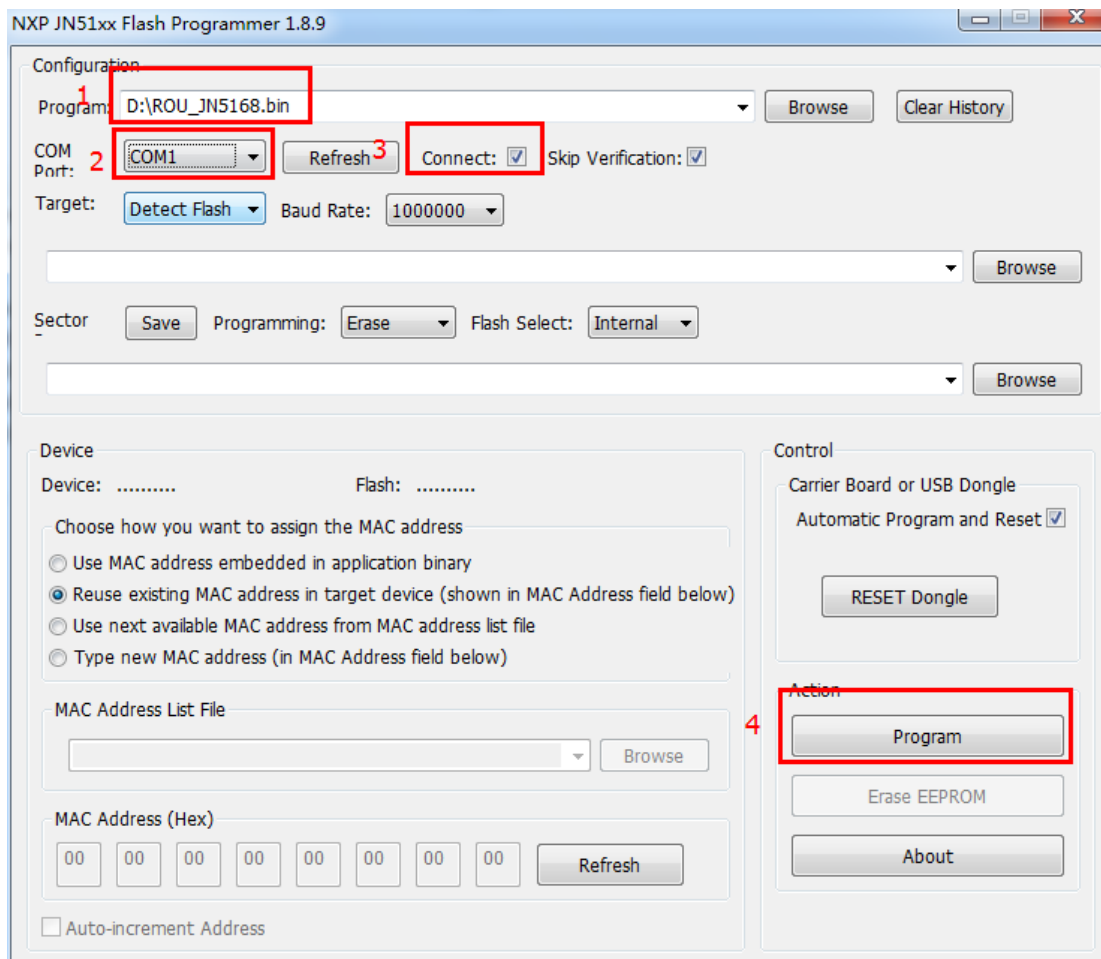
**Note:** Switch the SW to “3V3” and SW3 to “Prog” position at first.

## 1.3 Upgrade firmware

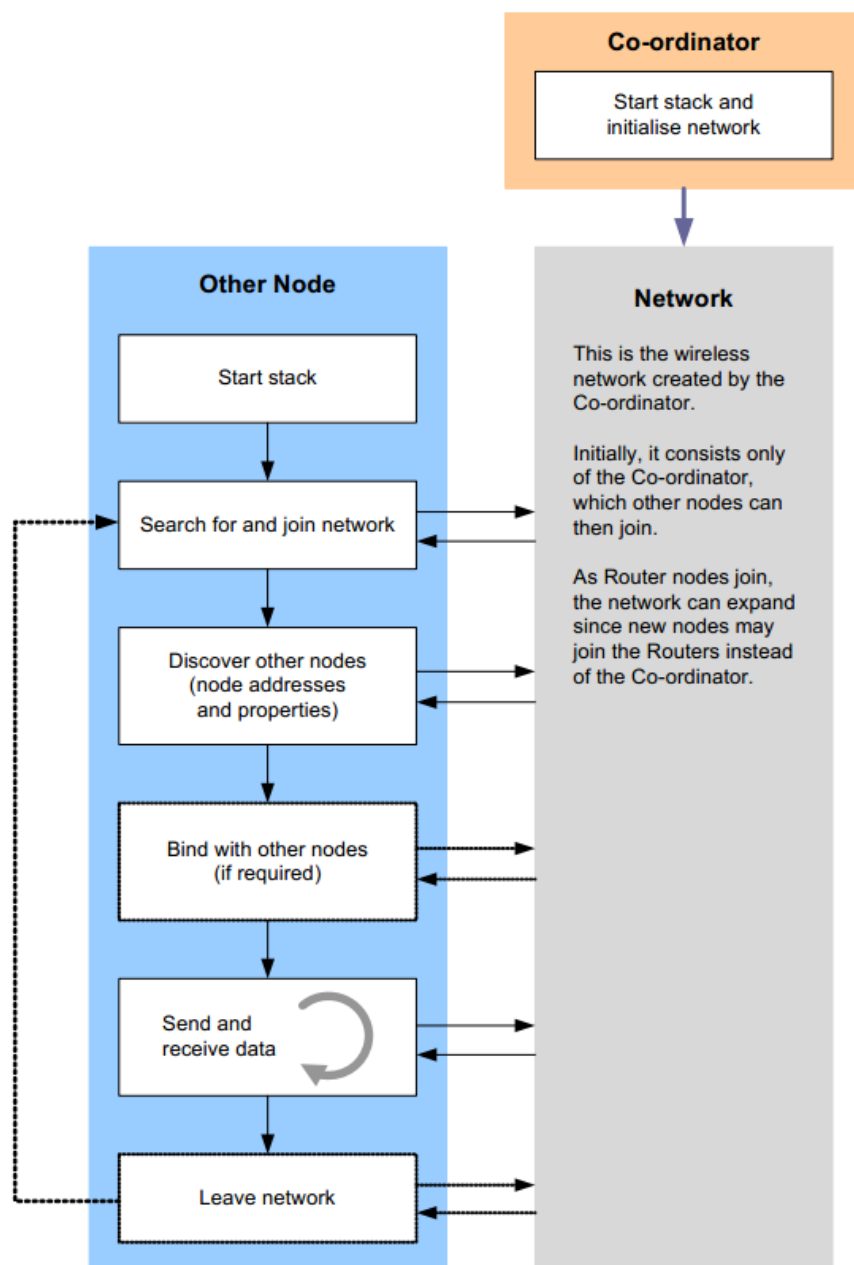
A wireless network comprises a set of nodes that can communicate with each other by means of radio transmissions according to a set of routing rules (for passing messages between nodes). ZigBee network includes three types of node:

- 1) **Coordinator:** This is the first node to be started and is responsible for forming the network by allowing other node to join the network through it.
- 2) **Router:** This is the node with routing capability, and is also able to send/receive data.
- 3) **End device:** Only capability to send/receive data.

Different device role should burn different image. Burn the latest firmware using [JN51xx Flash Programmer](#). Four steps are required as below:



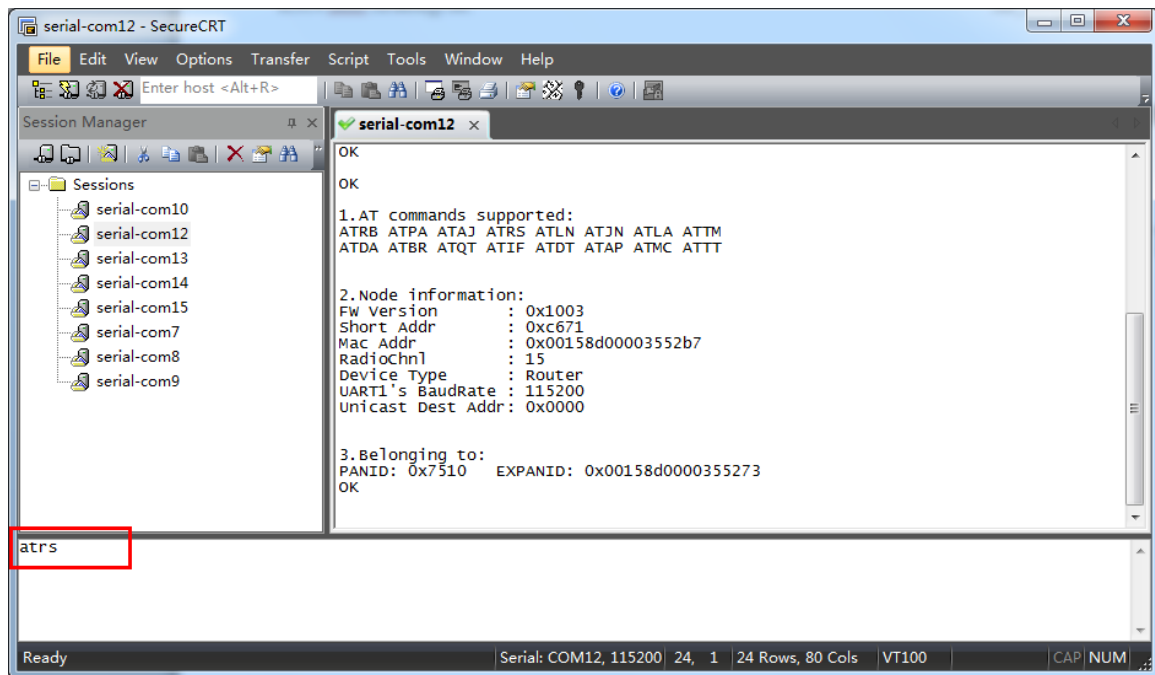
## 1.4 Setting up the network



*Zigbee network lifecycle*

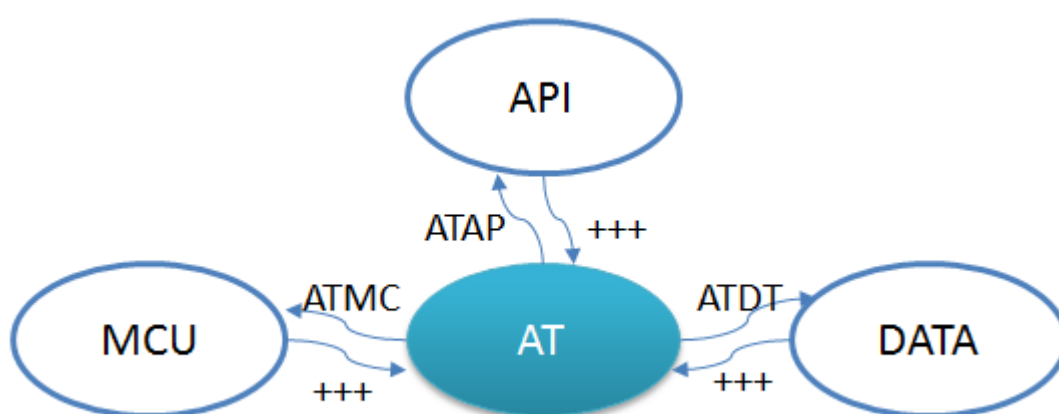
Normally, MeshBee will form the Network automatically. If a router or end device failed to join network, you can use command “ATRS” to rescan and perform network actions again.

## Setting up the network



## Chapter 2: Example of Mode Operation

MeshBee has four different types of mode: AT, API, DATA, MCU, illustrated in figure below:

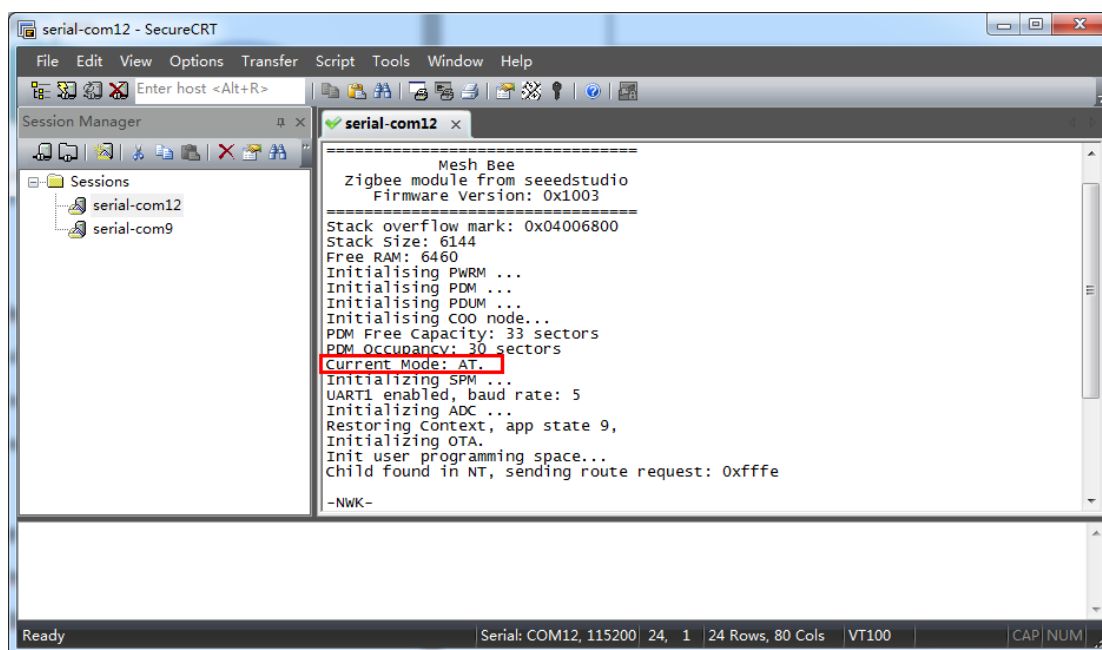


*No matter which mode MeshBee works in, input “+++” can go back to AT command mode.*

### 2.1 AT mode

The AT commands that MeshBee radios use for interactive are a descendant of Hayes command set. Every AT command starts with “AT”, and followed by two characters that indicate which command is being executed, then by some optional configuration values.

To communicate with MeshBee from Win7, we will use SecureCRT. In CoolTerm on a Mac, the procedure works pretty much the same.



```
Mesh Bee
Zigbee module from seeedstudio
Firmware Version: 0x1003
-----
Stack overflow mark: 0x04006800
Stack size: 6144
Free RAM: 6460
Initialising PWRM ...
Initialising PDM ...
Initialising PDUM ...
Initialising COO node...
PDM Free Capacity: 33 sectors
PDM Occupancy: 30 sectors
Current Mode: AT.
Initializing SPM ...
UART1 enabled, baud rate: 5
Initializing ADC ...
Restoring Context, app state 9,
Initializing OTA.
Init user programming space...
Child found in NT, sending route request: 0xfffe
-NWK-
```



**Note:** The baud-rate must be set to 115200 in SecureCRT.  
Make sure MeshBee works in AT mode.

Use AT commands is very easy. Here are the steps:

- 1) Input “+++” to go to AT command mode.
- 2) Wait for a MeshBee “ok” response.
- 3) To read a register, just typing an AT command.
- 4) To set a register, type an AT command followed by the register value.

AT command contain three different types:

### *Additional Documentation*

For more information about the AT command operations, please refer to the MeshBee [User's manual v0.1](#).

## 2.2 API Mode

API is simply a set of standard interfaces created to allow other MCU to interact with MeshBee. For our purposes, API supports local operation and remote operation. For example, a host application can send an “ATIO” frame to Coordinator A, A will set its GPIO when it receives this frame. The most important thing to note is that APIs are specifically engineered to enable MeshBee to talk efficiently to other MCU. The target of API-mode is to transmit highly structured data quickly and reliably.

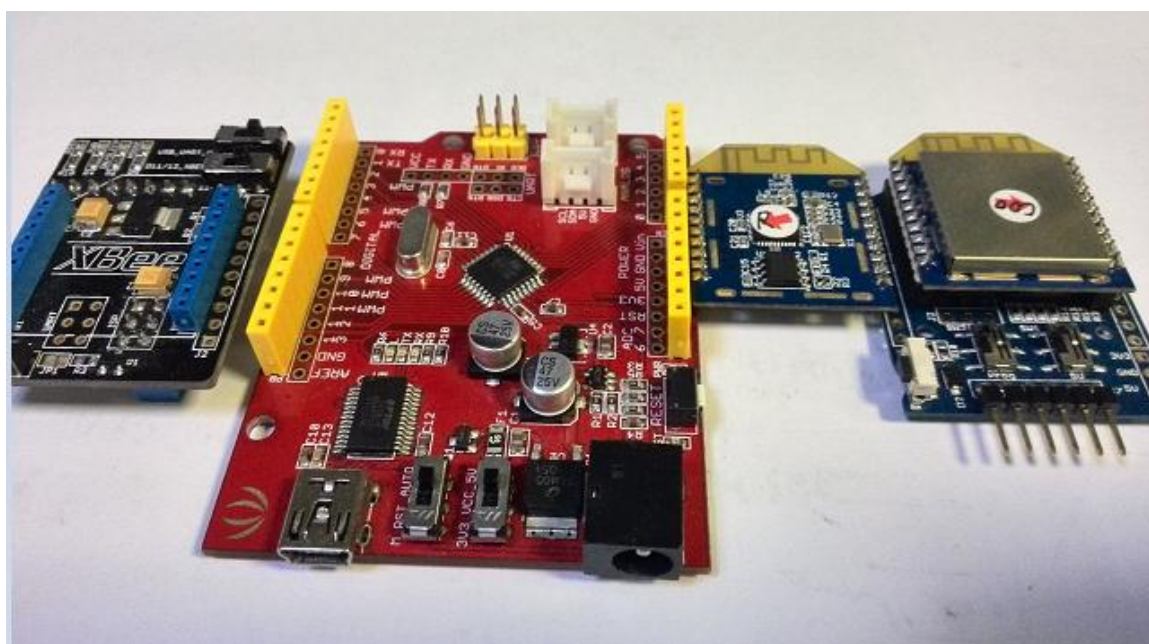
### *Remote led blink example*

Sending commands over the wireless network to control the remote device is kind of exhilarating, it is something you can accomplish in API mode.

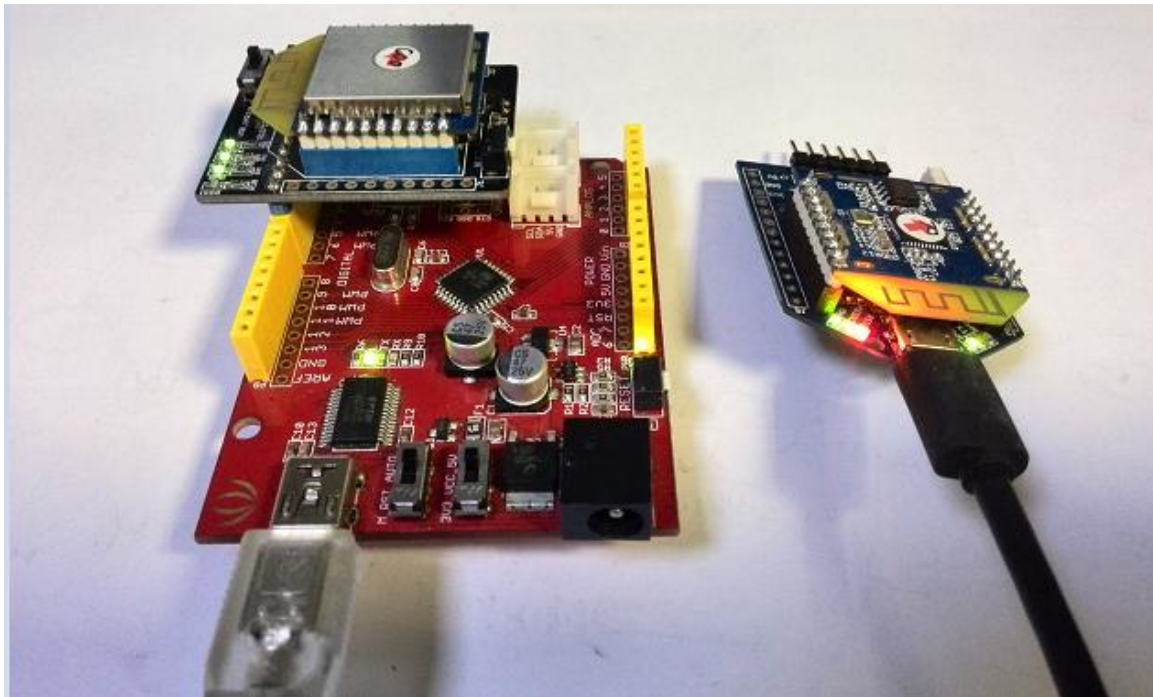
Some kinds of AT commands can also be sent wirelessly for execution on remote device. Here, we implement a remote IO control demo.

Hardware list:

Arduino	X1
MeshBee	X2
XBee shield	X1
UartBeeV5	X1



Install hardware like that:



- 1) Connect Arduino with MeshBee's Coordinator through UART.
- 2) Connect MeshBee's Router with UartBeeV5.

### *Arduino sketch:*

*/\**

*Remote LED control sketch*

*Send remote AT request frame to Coordinator(short address is 0x0000)*

*Router should enter API mode at first*

*On/Sleep Led on remote device will blink*

*\*/*

*#include <Arduino.h>*

*#include <Serial.h>*

*/\* LED Pin \*/*

*int led = 13;*

*/\* declaration \*/*

*void remoteATIO\_Off();*

*void remoteATIO\_On();*



```
void setup() {
    pinMode(led, OUTPUT);

    /* open the serial port at 115200 bps */
    Serial.begin(115200);
}

void loop() {
    remoteATIO_On();
    digitalWrite(led, LOW);
    delay(500);
    remoteATIO_Off();
    digitalWrite(led, HIGH);
    delay(500);
}

/* Turn off remote Led */
void remoteATIO_Off()
{
    Serial.write(0x7e); //start delimiter
    Serial.write(0x0d); //length
    Serial.write(0x17); //API identifier: remote AT require
    Serial.write(0xec); //frame ID
    Serial.write(0x00); //option
    Serial.write(0x70); //AT cmd index
    Serial.write(0x09); //IO pin No
    Serial.write(0x00); //State: Off
    Serial.write(0x00); //none
    Serial.write(0x00); //none
    Serial.write(0x00); //none
    Serial.write(0x00); //none
    Serial.write(0x00); //none
    Serial.write(0x00); //none
    Serial.write(0xc6); //unicast address low
    Serial.write(0x71); //unicast address high
    Serial.write(0x9c); //check sum: payload byte[4-16]
```

```
}  
/* Turn on remote Led */  
void remoteATIO_On()  
{  
    Serial.write(0x7e);  
    Serial.write(0x0d);  
    Serial.write(0x17);  
    Serial.write(0xec);  
    Serial.write(0x00);  
    Serial.write(0x70);  
    Serial.write(0x09);  
    Serial.write(0x01); //State: On  
    Serial.write(0x00);  
    Serial.write(0x00);  
    Serial.write(0x00);  
    Serial.write(0x00);  
    Serial.write(0x00);  
    Serial.write(0x00);  
    Serial.write(0x00);  
    Serial.write(0x00);  
    Serial.write(0x00);  
    Serial.write(0x9d);  
}
```

### ***Sending Data packets example***

Now that you may understand how API mode works. It's pretty simple to write your own MCU code to work with API mode.

Sometimes, you want to send some data packet in your protocol. For example, in many sensor network applications, the data samples are a series of data set, like:

```
typedef struct  
{  
    uint8 verifyByte;        //verify, avoiding mistakes when take serial transmission  
    uint8 dataType;          // maybe temperature or humility  
    uint16 dataPointCnt;     // number of data point
```

```
int16 datapoint[DATA_POINT_NUM]; //a series of data points
}tsDataStream;
```

API data packet can meet your demands.

### *Arduino sketch:*

```
/*
  Sending data packet demo
  Coordinator will receive "seed" in its uart.
*/
#include <Arduino.h>
#include <Serial.h>

/* LED Pin */
int led = 13;

/* declaration */
void sendDataPacket();

void setup() {
  pinMode(led, OUTPUT);
  Serial.begin(115200); // open the serial port at 115200 bps:
}

void loop() {
  sendDataPacket();;
  digitalWrite(led, LOW);
  delay(500);
  sendDataPacket();
  digitalWrite(led, HIGH);
  delay(500);
}

/* Send data packet */
void sendDataPacket()
```

```

/
Serial.write(0x7e); //start delimiter
Serial.write(0x19); //length
Serial.write(0x02); //Api identifier API_DATA_PACKET
Serial.write(0xec); //frameId, any number
Serial.write(0x00); //option 0x00 indicate NO-ACK
Serial.write(0x06); //data length: 2 byte
/* Has 20 bytes to hold your data */
Serial.write(0x73); // data[0] = 's'
Serial.write(0x65); // data[1] = 'e'
Serial.write(0x65); // data[2] = 'e'
Serial.write(0x65); // data[3] = 'e'
Serial.write(0x64); // data[4] = 'd'
Serial.write(0x00); // none
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00);
Serial.write(0x00); // unicast address Low, we send to 0x0000(Coordinator)
Serial.write(0x00); // unicast address High
Serial.write(0xf8); // checksum: sum of payload
}

```

In order to taking advantage of the API mode, a software library written by C was developed. This library presents the internal information in a human-friendly format. You can package the API frame by functions it provides.

## 2.3 MCU Mode

In order to simplify the development of application for user, we create an Arduino-ful user programming space(AUPS). The most important thing to note is AUPS is not a real Arduino because it doesn't support Arduino-IDE. We only present two Arduino style functions:

```
/* arduino setup */
void arduino_setup(void)
{
    /**/
}
/*arduino loop*/
void arduino_loop(void)
{
    /**/
}
```

### ***Mechanism***

Experienced C/C++ programmers may wonder where the program's main() entry point function has gone. It's there, but it's hidden under the covers by a task of JenOS.

A task called "*Arduino\_Loop*" was running on background. There are several other tasks created on MeshBee too. So *Arduino\_Loop* should release CPU periodically to let other task use it.

A software timer was created to activate *Arduino\_Loop*. You must set repeat time in *arduino\_setup()* by calling *setLoopIntervalMs* at first. The repeat time is similar to crystal oscillator frequency of Arduino.

```
void ups_init(void)
{
    /* Init ringbuffer */
    UPS_vInitRingbuffer();
    //init suli
    suli_init();
    //init arduino sketch with arduino-style setup function
    arduino_setup();
    //start arduino loops, Arduino_LoopTimer is bound with Arduino_Loop task
}
```

```
    OS_eStartSWTimer(Arduino_LoopTimer, APP_TIME_MS(1), NULL);
}

OS_TASK(Arduino_Loop)
{
    if(E_MODE_MCU == g_sDevice.eMode)
    {
        /* Back-Ground to search AT delimiter */
        uint8 tmp[AUPS_UART_RB_LEN];
        uint8 *Device = NULL;
        uint16 DeviceId = 0;
        uint32 avlb_cnt = suli_uart_readable(Device, DeviceId);
        uint32 min_cnt = MIN(AUPS_UART_RB_LEN, avlb_cnt);

        /* Read, not pop, make sure we don't pollute user data in AUPS ringbuffer */
        vHAL_UartRead(tmp, min_cnt);
        if (searchAtStarter(tmp, min_cnt))
        {
            /* Set AT mode */
            setNodeState(E_MODE_AT);
            suli_uart_printf(Device, DeviceId, "Enter AT Mode.\r\n");
            /* Clear ringbuffer of AUPS */
            OS_eEnterCriticalSection(mutexRxRb);
            clear_ringbuffer(&rb_uart_aups);
            OS_eExitCriticalSection(mutexRxRb);
        }
        else
        {
            arduino_loop();
        }
    }
    if(_loopInterval > 0)
    {
        OS_eStartSWTimer(Arduino_LoopTimer, APP_TIME_MS(_loopInterval), NULL);
    } else
    {

```

```
        OS_eActivateTask(Arduino_Loop);  
    }  
}
```

Write your own code in “[ups\\_arduino\\_sketch.c](#)”, then compile and upload the image to MeshBee.

In AT mode, using “ATMC” to enter MCU mode.

### ***Additional documentation:***

For more information about the function list that AUPS can call, please refer to the [MeshBee User’s manual v0.1](#).

### ***Blink example in AUPS***

```
/*  
    Blink demo in AUPS  
    UartBeeV5’s Sleep/On Led will blink  
*/  
IO_T led_io;  
int16 state = HAL_PIN_HIGH;  
void arduino_setup(void)  
{  
    setLoopIntervalMs(1000);           //set loop period  
    sul_i_pin_init(&led_io, 9);        //init led  
    sul_i_pin_dir(&led_io, HAL_PIN_OUTPUT);  
}  
  
void arduino_loop(void)  
{  
    sul_i_pin_write(&led_io, state);    //set led  
    if(state == HAL_PIN_HIGH)  
        state = HAL_PIN_LOW;  
    else  
        state = HAL_PIN_HIGH;  
}
```

# 2.4 Data Mode

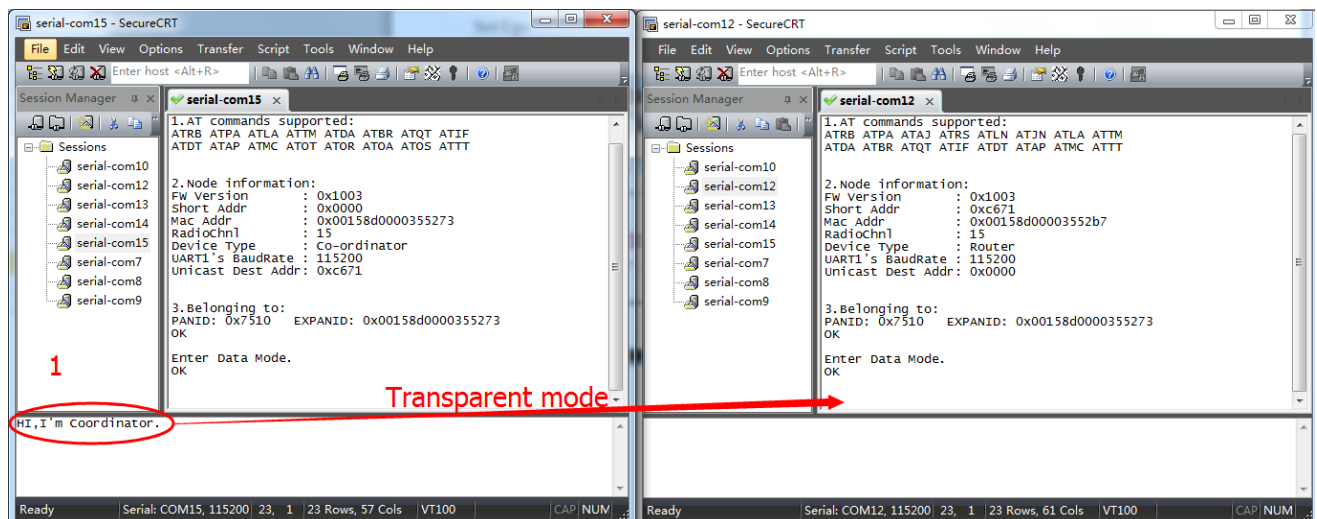
When operating in Data mode, the modules act as a serial line. All UART data received through the UART1 is transmitted to a specified remote device.

To use a transparent connection, take the following steps:

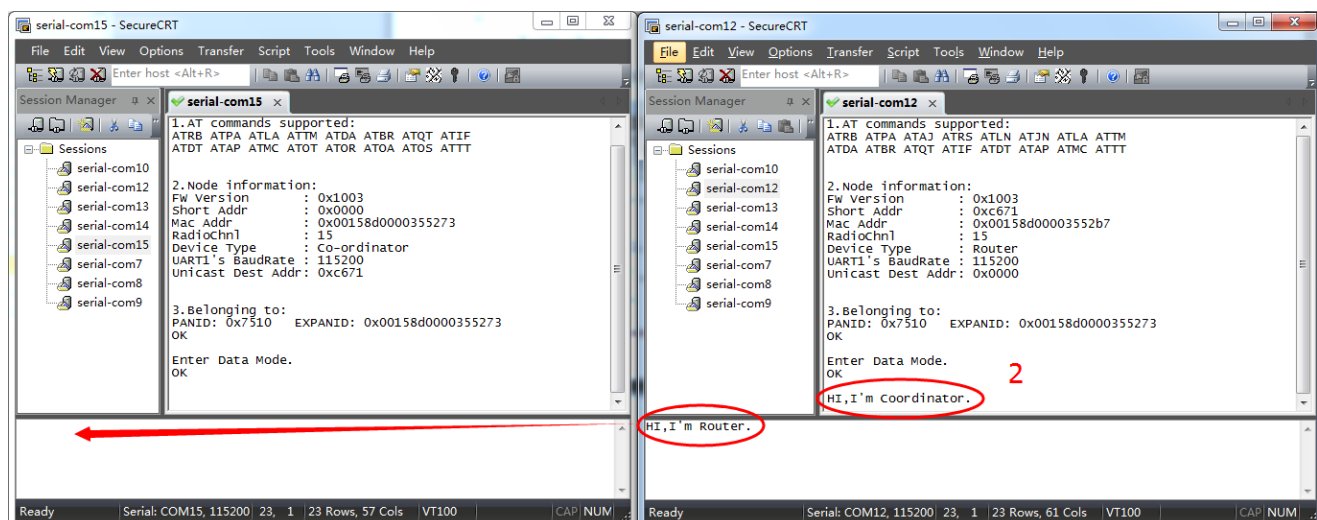
- 1) Set unicast address: *ATDAxxx*
- 2) Enter Data Mode: *ATDT*

## Chat example

Coordinator say HI to Router:



Router receives Coordinator's greeting and reply to it:





## Example of Mode Operation

Coordinator receives Router's reply:

