ZNP Host Framework User's Guide

Document Number: SWRU401

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Revision	Description	Date
1.0	Initial release.	12/17/2014

Contents

1 Introduction

The ZNP Host Framework contains a library of examples which are built on top of a cross platform framework designed to run in a companion host MCU/MPU, and will be used in combination with the embedded Z-Stack ™ ZNP products.
The main focus of these examples is to show the simplicity of this framework as well as familiarize users with the usage of ZNP commands.

1.1 Scope

This document describes how to use the ZNP Host Framework Examples and discuss their theory of operation.
There are four examples included in the ZNP Host Example Library:

- cmdLineTrainer
- dataSendRcv
- nwkTopology
- serviceDiscovery.

Unless specifically mentioned otherwise, the guidelines in this document refer to the CC2538EM, while similar approaches can be used for other CC253X platforms.

1.2 Examples

Following Examples are part of the library:

a. **Command Line Trainer**

   Command line application which provides all ZNP commands, such that the user can send any ZNP command and parameters to learn the usage of the ZNP interface.

b. **Data Send/Receive**

   Provides a command line interface which allows ZNP devices to send and receive text messages from each other.

c. **Network Topology**

   Provides a description of the network topology in which the ZNP device is part of.

d. **Service Discovery**

   Displays a description of the endpoints from the devices that join the network.

1.3 Applicable Documents

[1] ZNP Interface Specification

2 Setup

2.1 Required Software Tools

Software tools needed:

a. IAR Embedded Workbench, provides a tool for compiling, linking, debugging and loading applications on the target device.

   EWARM (for CC2538)

   http://www.iar.com/Products/IAR-Embedded-Workbench/ARM/

   This is optional, in case you want to build the ZNP FW.

b. SmartRF Flash Programmer 2 for programming the ZNP hex file.

   http://www.ti.com/tool/flash-programmer

c. Code Composer Studio, provides a tool for compiling, linking, debugging and loading applications on TI-RTOS devices. This is not required for the Linux platform builds.

   http://processors.wiki.ti.com/index.php/Download_CCS

2.2 Supported Platforms

2.2.1 Host Platforms

The host platforms supported by the ZNP Host Framework are:

- Posix compliant platforms.
- TI-RTOS platforms such as Tiva Launchpad.

2.2.2 ZNP Hardware Platforms

The ZNP Host Framework supports any CC253x ZNP platform. This document focuses on the CC2538 ZNP, and SmartRF06 board which is required to flash the CC2538EM.

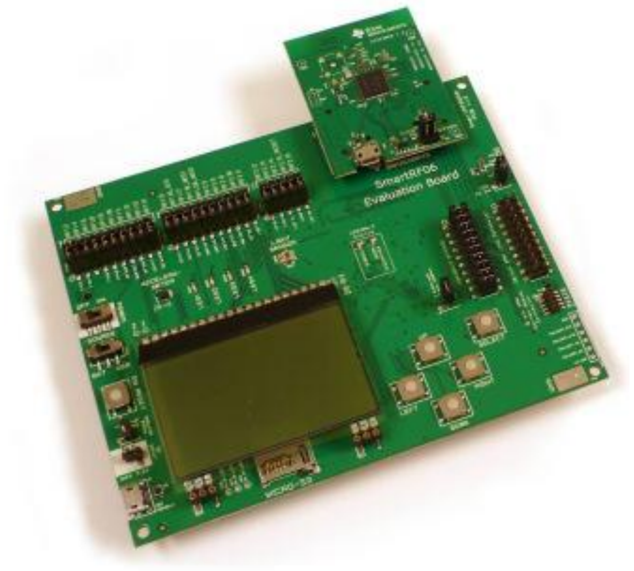


Figure 1 SmartRF06EB with CC2538EM

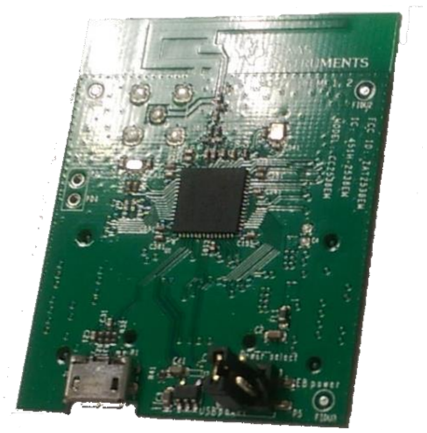


Figure 2 CC2538EM

There are three ways to power SmartRF06EB; batteries, USB bus and external power supply. Power source can be selected using the power source selection switch (S502), seen below in **Figure 3**. Main power supply switch (S501) cuts power to the SmartRF06EB.
For Flashing and Debugging: Make sure USB cable is connected to the PC.

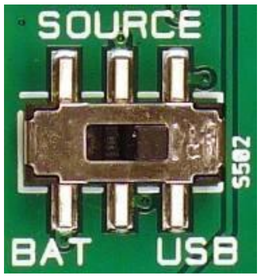


Figure 3 S501 and S502

3 Getting Started

3.1 Downloading the ZNP Host Framework

The ZNP Host Framework project can be found at https://git.ti.com/znp-host-framework/znp-host-framework. An account is required in order to clone this repository, please create an account at https://git.ti.com if you don't have an account.

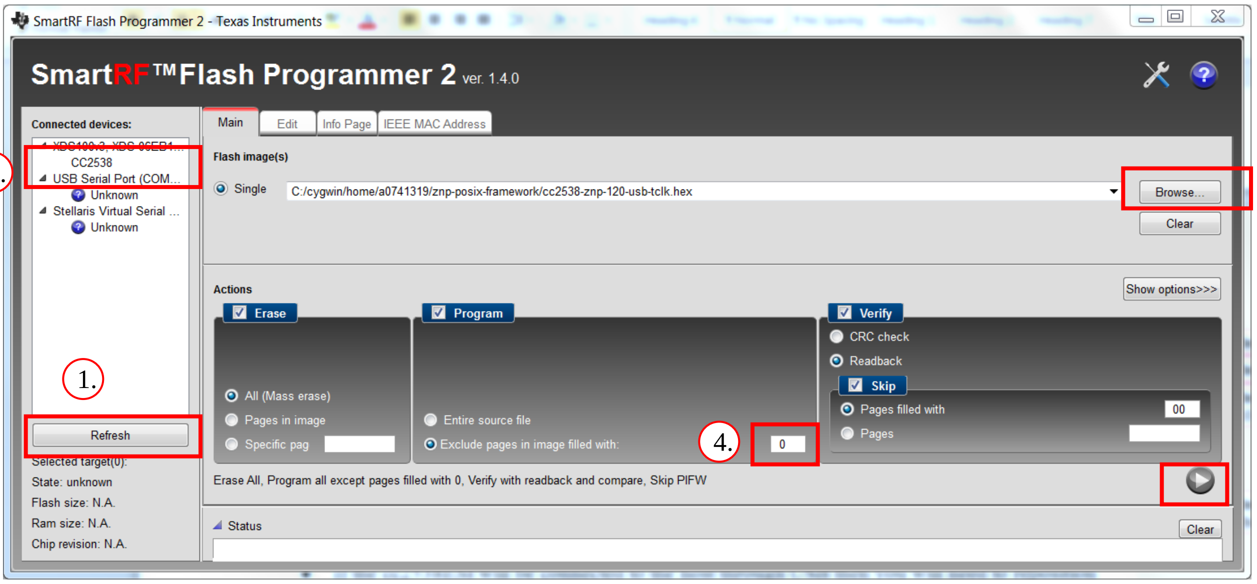
3.2 Programming the CC2538 with the ZNP Firmware

Fit the CC2538 EM on the SmartRF06 and insure the P5 header of the CC2538EM is set to the default position of VDD -> EB Power, so that the EM is powered from the SmartRF06.

Connect the SmartRF06 USB to your PC and Open the SmartRF Flash Programmer 2.

In SmartRF Flash Programmer 2:

1. Press Refesh to discover the CC2538
2. Select the CC2538
3. Browse the the ZNP Hex image
4. Exclude pages filled with 0
5. Click to Erase, Program and Varify.



Single: C:/cygwin/home/a0741319/znp-posix-framework/cc2538-znp-120-usb-tclk.hex

[✓] Erase: [✓ All (Mass erase)] Pages in image Specific pag

[✓] Program: Entire source file [✓ Exclude pages in image filled with:] 0

[✓] Verify: CRC check [✓ Readback]

[✓] Skip: [✓ Pages filled with] 00 Pages

Erase All, Program all except pages filled with 0, Verify with readback and compare, Skip PIFW

Figure 4 - SmartRF Programmer 2

The cc2538EM must be detached from the SmartRF06 board after the firmware image is flashed. If the cc2538EM will be connected to the host through USB then you will need to reposition the jumper link to the position shown in red in the picture below.

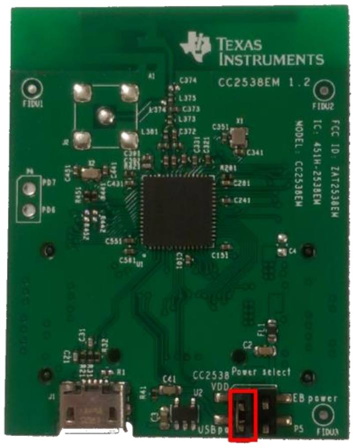


Figure 5 Jumper position for USB connection

3.3 Modifying the BoosterPack

The booster pack requires modifying to allow UART Flow control to be used. The CCxxxxEM Adaptor booster pack connects the TIVA processors UART7 to the CCxxxx EM UART, UART 7 of the TIVA does not support flow control. The mod connects TIVA UART 4 Tx, Rx, CTS and RTS on pins K0, K1, K2 and K3 to the UART port on the CCxxxx EM UART.

The following steps show how to make the HW modifications required.

1. Remove R3, R4 and R7

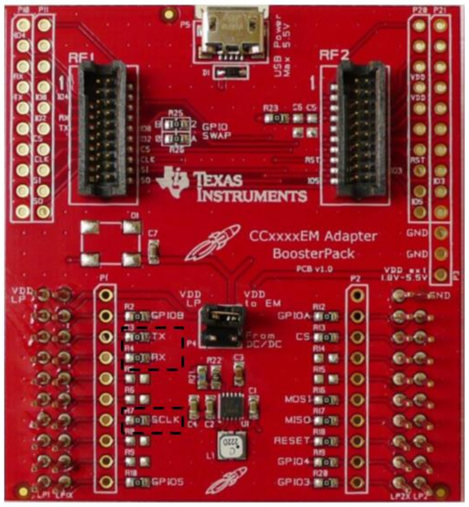


Figure 6 - Resistors to be removed

2. Connect LP1X pin 5 to TX
3. Connect LP1X pin 6 to RX
4. Connect LP1X pin 7 to P11 pin 7
5. Connect LP1X pin 8 to P21 pin 9
6. Connect pull up 10k Ω R between P11 pin 7 and P20 pin 4
7. Connect pull up 10k Ω R between P21 pin 9 and P20 pin 5

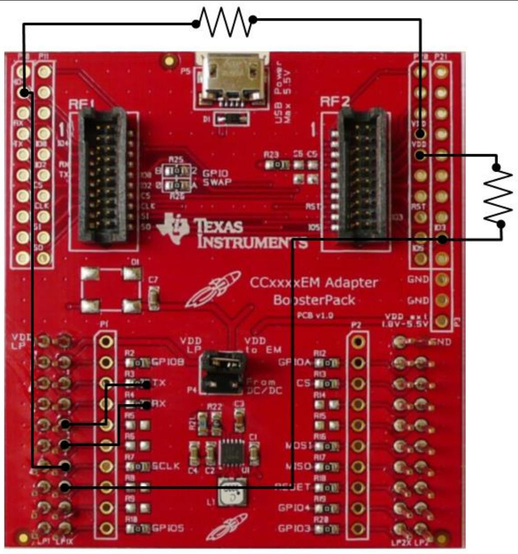


Figure 7 - Diagram for the new connections

3.4 Compiling and Running Examples

After flashing the CC2538EM with the ZNP firmware, the examples will need to be compiled.

3.4.1 Linux

To compile the examples, open a terminal window go to the directory where the example is located i.e. “<Installation Directory>/examples/dataSendRcv/build/gnu” if you are using a Linux platform. While you are in this directory type ***make*** to compile the example.

If the example has been already compiled then in the same directory enter the following command.

```
./<Executable> <Port assigned to ZNP Device>
```

Example**:**

```
./dataSendRcv.bin /dev/ttyACM0
```

3.4.2 TI-RTOS

To use the examples with TI-RTOS follow the steps below:

- Open Code Composer Studio.
- Go to menu *View* and click on *CCS App Center*. Once the App Center is open, type TI-RTOS on the search bar.

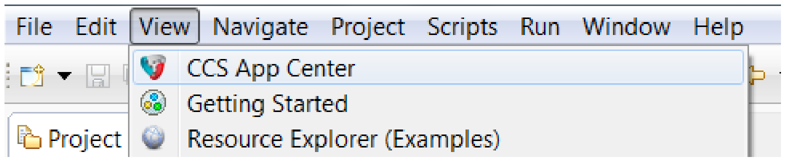


Figure 8 Opening App Center

- Select and download TI-RTOS for TivaC.

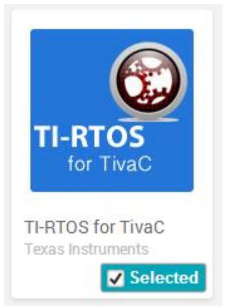


Figure 9 TI-RTOS CCS add-on

- After installing TI-RTOS go to the following link, to download and install TI-RTOS 2.00.02.36 for TivaC http://software-dl.ti.com/dsps/dsps_public_sw/sdo_sb/targetcontent/tirtos/index.html

- Restart CCS after installing TI-RTOS 2.00.02.36.

- Now that the environment is set up you will need to import the example that you wish to run. To import the project go to *File* then *Import*, in the Import window, click the *Code Composer Studio* folder to expand the options and click on *CCS Projects* and click on next.

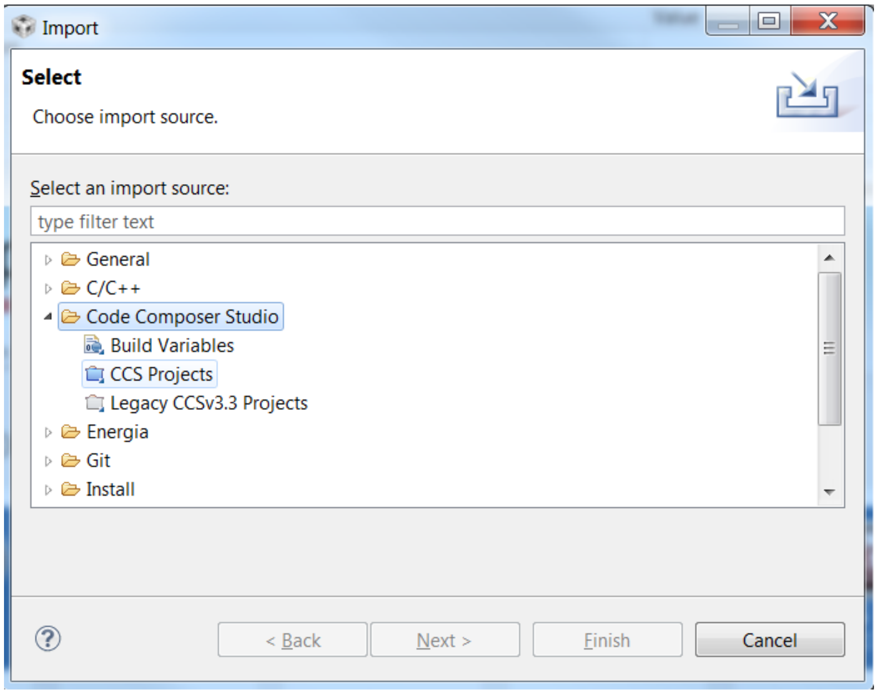
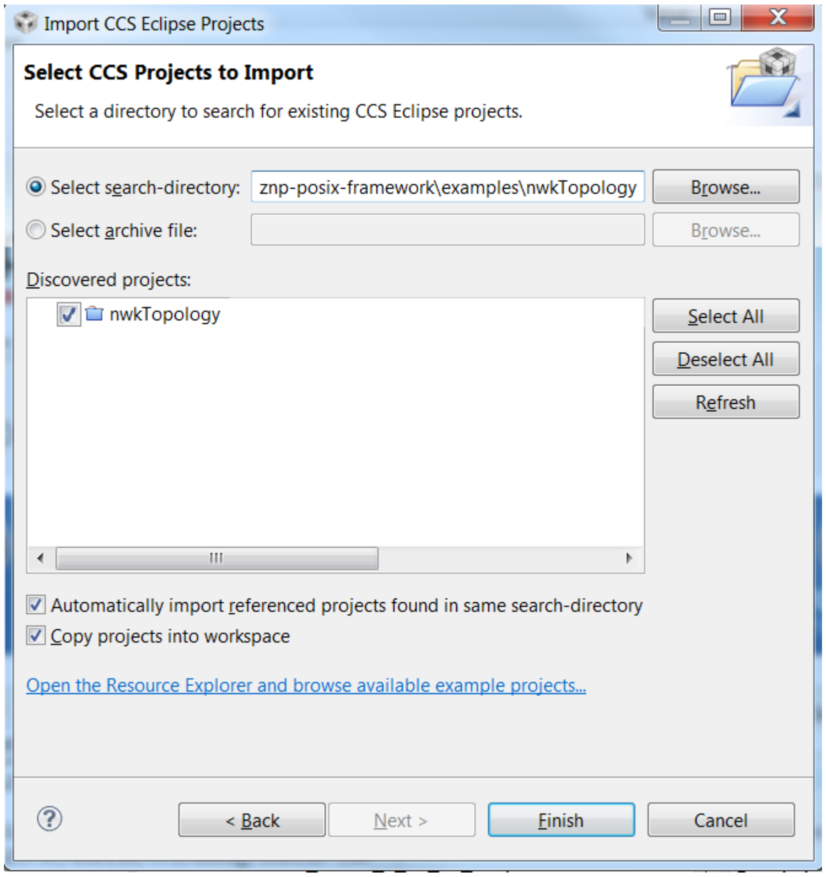


Figure 10 Import window

- Click on *Select search-directory* then click the *Browse* button and go to the path <framework installation dir>/examples/<Name of Example>
click Ok, make sure that both options at the bottom of the window are checked and press Finish.


Import CCS Eclipse Projects

Select CCS Projects to Import

Select a directory to search for existing CCS Eclipse projects.

(●) Select search-directory: znp-posix-framework\examples\nwkTopology

( ) Select archive file:

Discovered projects:

[✓] nwkTopology

[✓] Automatically import referenced projects found in same search-directory

[✓] Copy projects into workspace

Open the Resource Explorer and browse available example projects...

Figure 11 Import Options

- Now connect the BoosterPack and CC2538EM to the Tiva LaunchPad and connect it to your computer.

- Using the serial console of your preference(i.e. Putty) open the serial port assigned to the Launchpad. After opening the serial port, go to CCS and press the *debug* button and then *Resume*.

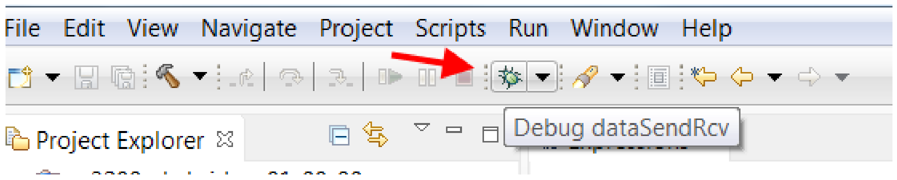


Figure 12 Debug

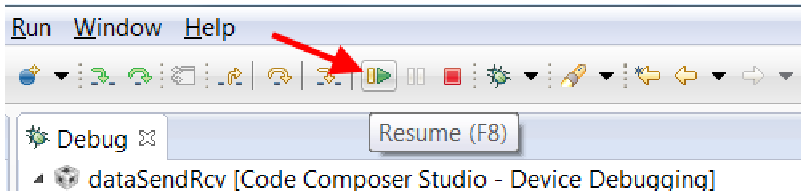
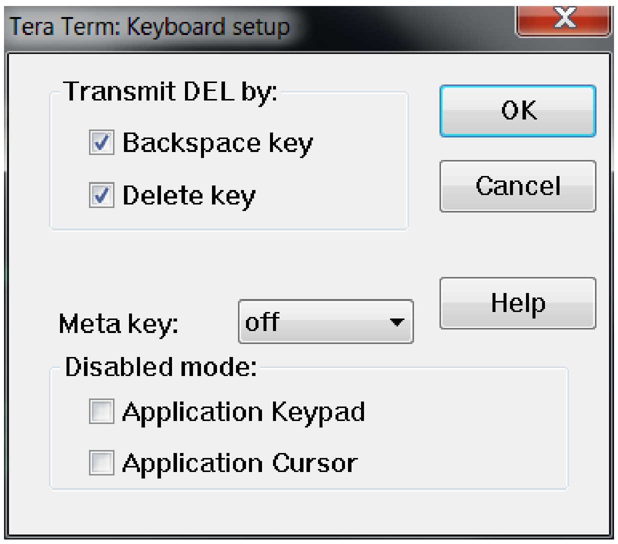


Figure 13 Resume

- Proceed to the serial console to use the example.

3.5 Examples

Please note, the console allows the user to use backspace, this is particular useful in the command line example. However on TI RTOS platform the console is accessed via a terminal emulator which requires configuring to send backspace correctly. In Tera Term this is done through Setup→Keyboard:


Tera Term: Keyboard setup

Transmit DEL by:
- [✓] Backspace key
- [✓] Delete key

Meta key: off

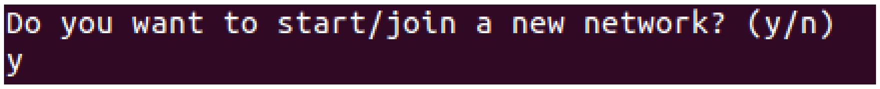
Disabled mode:
- [ ] Application Keypad
- [ ] Application Cursor

Figure 14 Terminal emulator Backspace settings

Ensure that the "Backspace key" is selected. Other terminal emulators may have similar setting that need to be configured to make backspace work correctly.

3.5.1 Creating or Joining a new Network

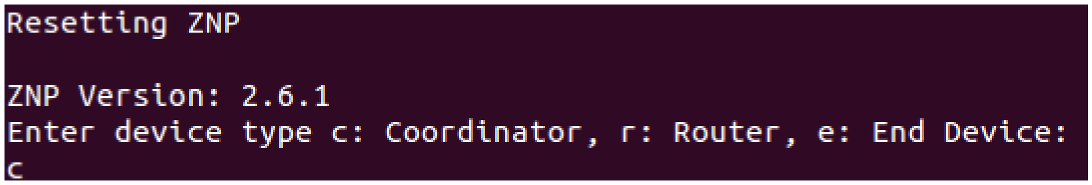
Whenever you run any of the examples in the library, you will be prompted if you will like to start a new network. If your ZNP device has not joined a network or you want to start a new network then type **y** and press enter.



```
Do you want to start/join a new network? (y/n)
y
```

Figure 15 New network prompt

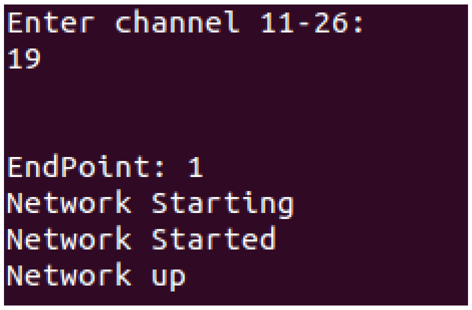
Starting a new network will reset the configuration in the ZNP. You will be then prompted to select what type of device you want your ZNP to be coordinator, router, or end device.



```
Resetting ZNP

ZNP Version: 2.6.1
Enter device type c: Coordinator, r: Router, e: End Device:
c
```

Figure 16 Device type

After this, you will need to enter the channel in which you want your device to operate in, and the device will start or join a new network.



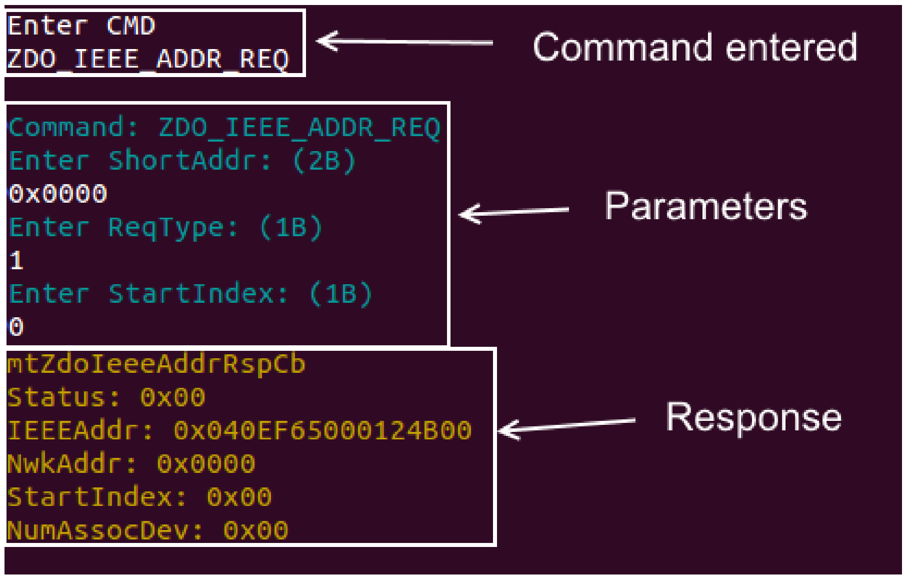
```
Enter channel 11-26:
19


EndPoint: 1
Network Starting
Network Started
Network up
```

Figure 17 Channel selection

3.5.2 Command Line Trainer

After the network has been set up, you will be able to enter the commands that you wish to send. Some of the features of this example are:
-Press the Tab key twice to see all the available commands.
-Press Tab once to autocomplete the command that you are entering.
-Press Enter to display any incoming messages in queue.
-Use the up and down arrow keys to see the history of commands previously entered.
-After typing the full command name, you can press tab twice and a description of the command

will be displayed.
-Press enter after typing the command name to select the command and fill out the values for the parameters.



```
Enter CMD
ZDO_IEEE_ADDR_REQ
Command: ZDO_IEEE_ADDR_REQ
Enter ShortAddr: (2B)
0x0000
Enter ReqType: (1B)
1
Enter StartIndex: (1B)
0
mtZdoIeeeAddrRspCb
Status: 0x00
IEEEAddr: 0x040EF65000124B00
NwkAddr: 0x0000
StartIndex: 0x00
NumAssocDev: 0x00
```

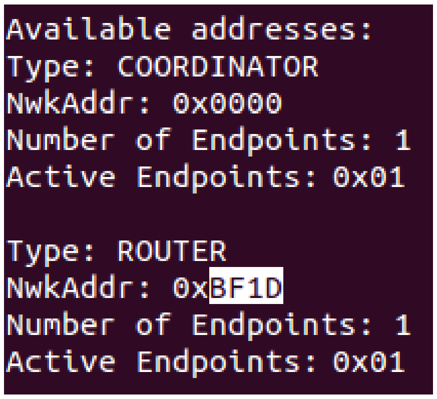
Figure 18 Command example

The color key is:

- White: User input
- Green: Help (when tab is entered)
- Blue: Parameter request
- Yellow: incoming messages from ZNP.

3.5.3 Data Send/Receive

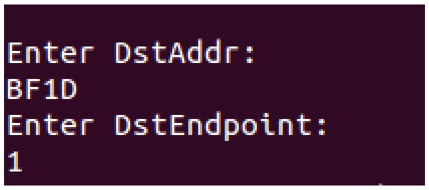
After the network is set up, a list of available addresses and endpoints, to send messages to, will be displayed.



```
Available addresses:
Type: COORDINATOR
NwkAddr: 0x0000
Number of Endpoints: 1
Active Endpoints: 0x01

Type: ROUTER
NwkAddr: 0xBF1D
Number of Endpoints: 1
Active Endpoints: 0x01
```

Figure 19 List of available devices

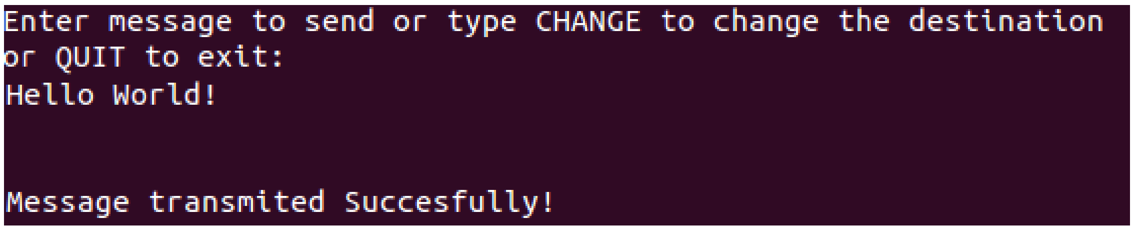
Fill in the destination address and the destination endpoint for the device that you want to exchange messages with.



```
Enter DstAddr:
BF1D
Enter DstEndpoint:
1
```

Figure 20 and endpoint of destination

Then you will be able to exchange messages with the selected device. To change the destination of the messages type `CHANGE` to select a different device as a destination or `QUIT` to terminate the program.

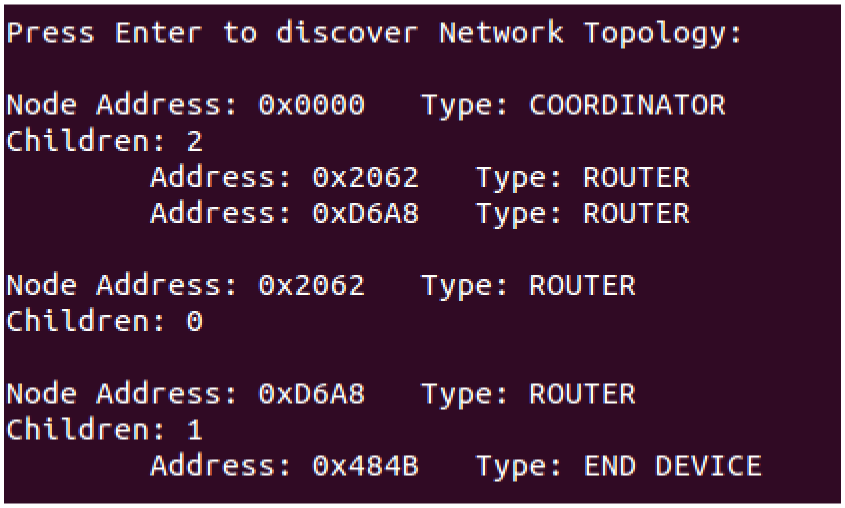


```
Enter message to send or type CHANGE to change the destination
or QUIT to exit:
Hello World!


Message transmited Succesfully!
```

Figure 21 Example of message transmission

3.5.4 Network Topology

After the network is set up press enter whenever you want the network topology to be displayed.

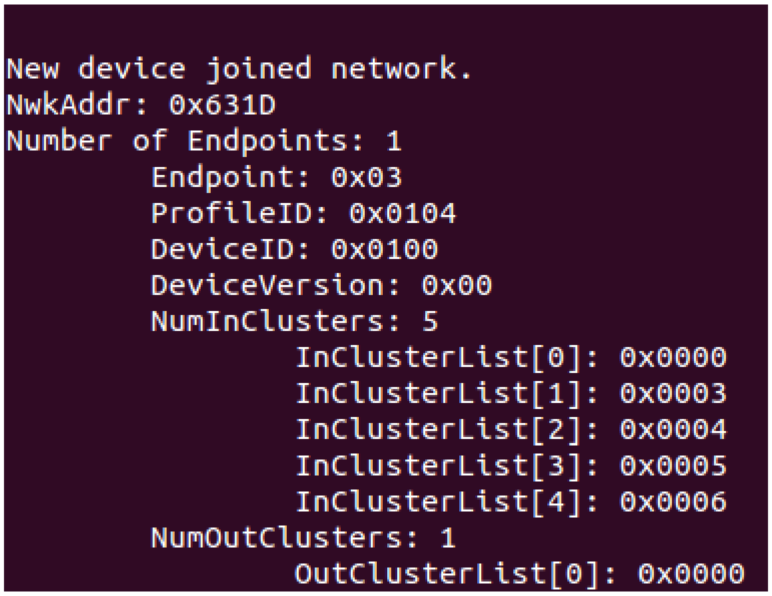


```
Press Enter to discover Network Topology:

Node Address: 0x0000   Type: COORDINATOR
Children: 2
        Address: 0x2062   Type: ROUTER
        Address: 0xD6A8   Type: ROUTER

Node Address: 0x2062   Type: ROUTER
Children: 0

Node Address: 0xD6A8   Type: ROUTER
Children: 1
        Address: 0x484B   Type: END DEVICE
```

Figure 22 Nwk topology example

3.5.5 Service Discovery

Run the serviceDisc example, wait for a device to join the network and the description of the new device will be displayed automatically.



```
New device joined network.
NwkAddr: 0x631D
Number of Endpoints: 1
        Endpoint: 0x03
        ProfileID: 0x0104
        DeviceID: 0x0100
        DeviceVersion: 0x00
        NumInClusters: 5
                InClusterList[0]: 0x0000
                InClusterList[1]: 0x0003
                InClusterList[2]: 0x0004
                InClusterList[3]: 0x0005
                InClusterList[4]: 0x0006
        NumOutClusters: 1
                OutClusterList[0]: 0x0000
```

Figure 23 Service discovery example