



**ĐẠI HỌC HỌC BÁCH KHOA TP.HCM  
KHOA ĐIỆN - ĐIỆN TỬ  
BỘ MÔN VIỄN THÔNG**

## **Wireless Sensor Network IPv6 and 6LoWPAN**

**\*\*\***

**MẠNG CẢM BIẾN KHÔNG DÂY ZIGBEE  
SỬ DỤNG SoC CC2530 TRÊN NỀN TẢNG CONTIKI OS**

**GVHD: TS. VÕ QUẾ SƠN**

**SVTH: CAO XUÂN THIỆN – 41303839**

**NGUYỄN SƠN TÙNG – 41304696**

**TP. Hồ Chí Minh, Tháng 4/2017**



## **NỘI DUNG**

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**1.CÁC CÔNG CỤ CẦN THIẾT**

**2.THỰC HIỆN DEMO**

**3.THAM KHẢO**



## **1. CÁC CÔNG CỤ CẦN THIẾT**

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1. Module CC2530
2. Mạch nạp SmartRF04EB
3. Module Uart – USB PL2303
4. SmartRF Flash Programmer
5. VMWare
6. Instant Contiki 3.0
7. Small Device C Compiler (SDCC)
8. Contiki Sensinode (George Oikonomou)
9. CC-tool

## 1. CÁC CÔNG CỤ CẦN THIẾT

### Mạch Nạp SmartRF04EB



Nhà sản xuất: Import

Giá bán

**250,000đ**

### Mạch Thu Phát RF Zigbee CC2530 Mini



Nhà sản xuất: Import

Giá bán

**180,000đ**

### Mạch Chuyển USB UART PL2303



Nhà sản xuất: Import

Giá bán

**30,000đ**

# 1. CÁC CÔNG CỤ CẦN THIẾT

Sơ đồ mạch nạp và chân Uart CC2530 được define trong Contiki

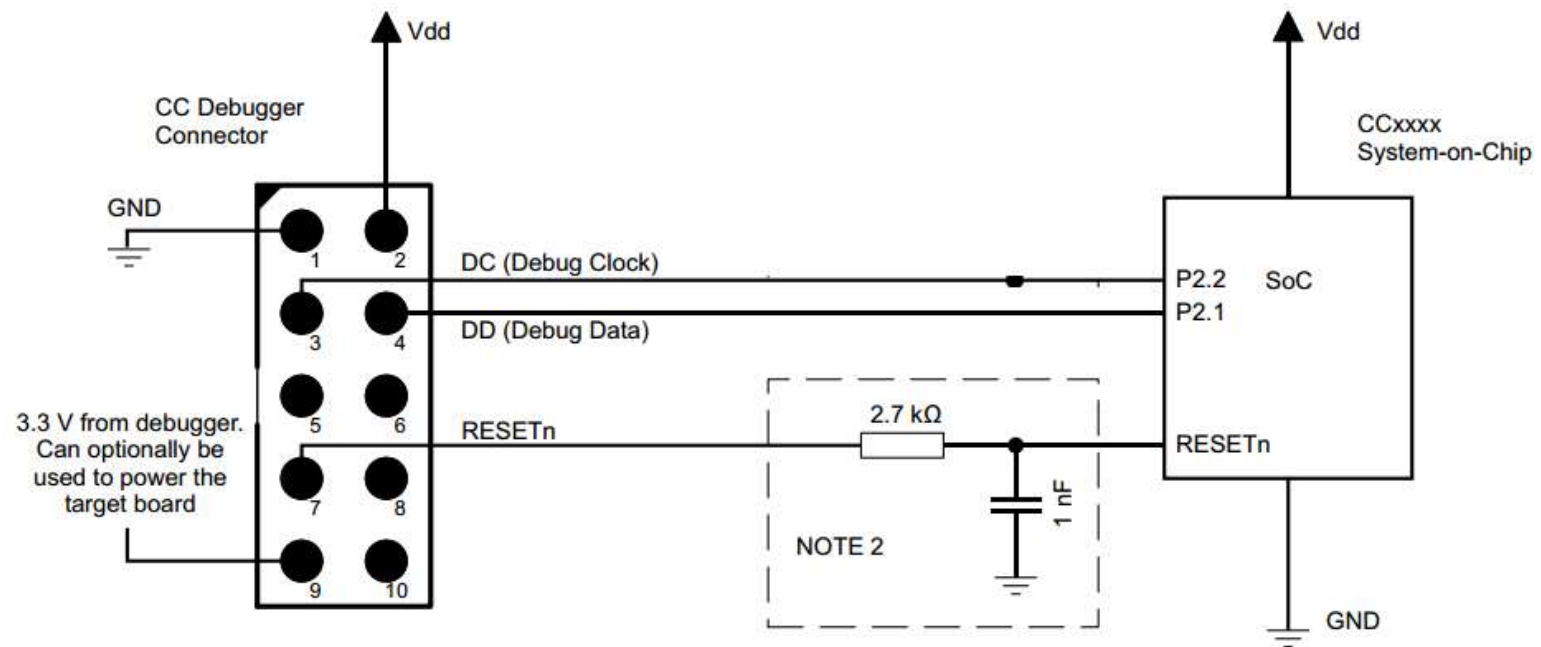


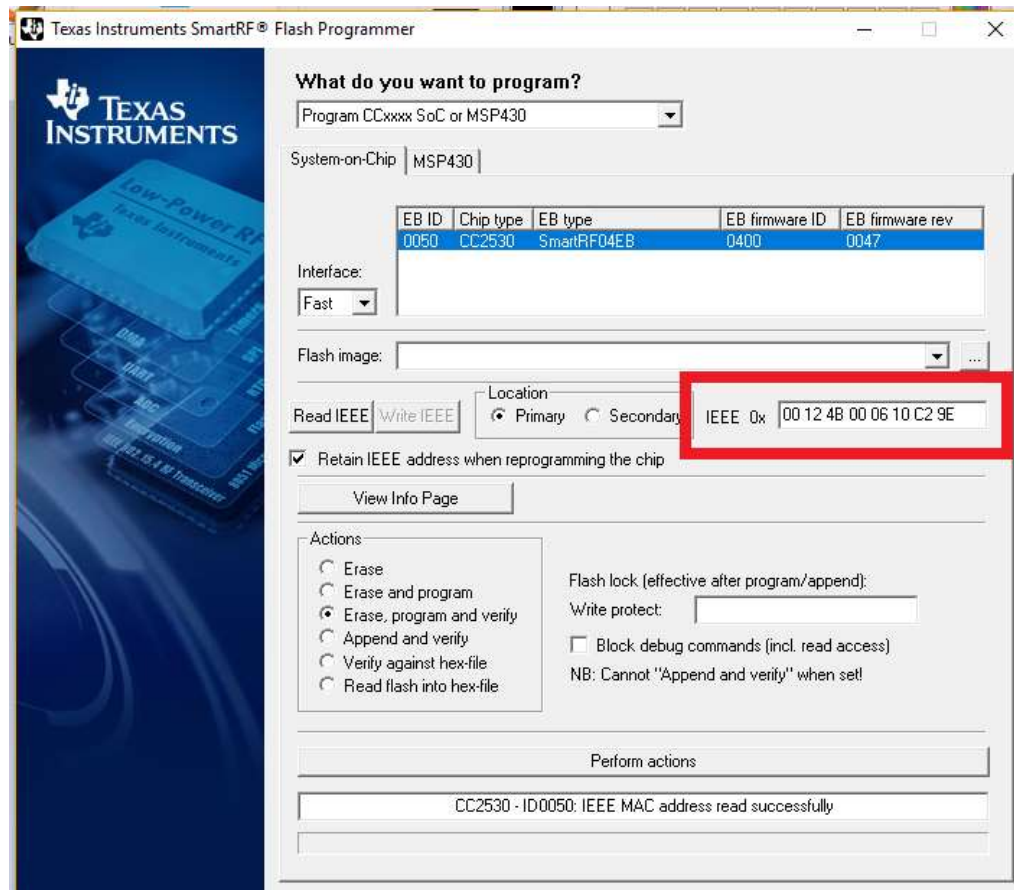
Figure 6. Minimum Connection for Debugging of 8051 SoC

UART0 -- P0\_2(RX), P0\_3(TX) ,

UART1 -- P1\_6(TX), P1\_7(RX)

## 1. CÁC CÔNG CỤ CẦN THIẾT

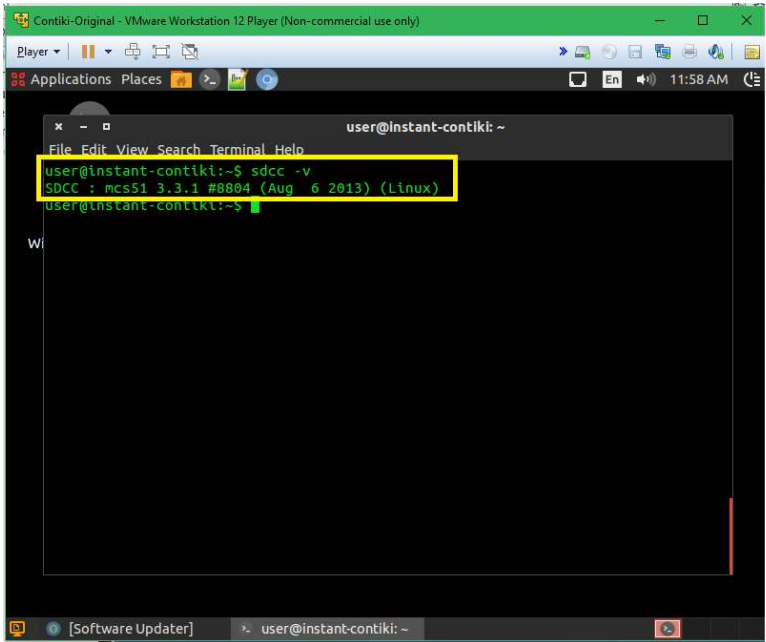
Dùng SmartRF Flash Programmer để đọc địa chỉ MAC sau khi cắm mạch nạp





# 1. CÁC CÔNG CỤ CẦN THIẾT

## VMWare + Instant Contiki 3.0 + SDCC



## Contiki Sensinode (George Oikonomou)

g-oikonomou Merge branch 'master' into cc-ports		Latest commit 872366b on 10 Jan, 2013
apps	Updated to the latest uip-ds6-route API	4 years ago
core	Merge branch 'master' into cc-ports	4 years ago
cpu	Merge pull request #74 from malvira/maca-dummy-rx	4 years ago
doc	Define IPv6 and RPL related macros in Doxygen config	5 years ago
examples	Code style fixes; sensinode examples	4 years ago
platform	minor corrections to adhere contiki code style guidelines	4 years ago
regression-tests	Added rtests for 8051 ports	4 years ago
tools	Moved the Contiki tests from the tools/cooja directory into the regre...	4 years ago
.gitattributes	Adding a gitattributes file. .git* will no longer be included in exports	6 years ago
.gitignore	Added SDCC compile artifacts to gitignore	4 years ago
.travis.yml	Explicitly count the number of failed tests; test equality with 0, an...	4 years ago
LICENSE	Removed the explicit year 2012 to make it more generic	5 years ago
Makefile.include	Add the uipv6 route function uip-ds6-route.c	4 years ago
README	Updated README with new website and shorter text	5 years ago
README-BUILDING	Add some info on the DEFINES= / savedefines mechanism.	9 years ago
README-EXAMPLES	Added CTK standalone FTP client example.	7 years ago



## 1. CÁC CÔNG CỤ CẦN THIẾT

### CC - tool

**Fix lỗi không tìm thấy TARGET BOARD :** Chỉnh sửa file cctool/ src/ programmer/ cc\_programmer.cpp

```
01. Src / programmer / cc_programmer.cpp
02. @@ -278,7 +278,7 @@ void CC_Programmer :: enter_debug_mode ()
03.     Malloc (& command [0x15], programmer_info_.debugger_id.c_str (), programmer_info_.debugger_id.size ());
04.
05.     Usb_device_.control_write (LIBUSB_REQUEST_TYPE_VENDOR | LIBUSB_ENDPOINT_OUT,
06.     - USB_SET_CHIP_INFO, 1, 1, & command [0], command.size ());
07.     + USB_SET_CHIP_INFO, 1, 0, & command [0], command.size ());
08. }
```

#### Cài đặt cc-tool:

```
01. User @ instant-contiki: ~ $ cd cc-tool /
02. User @ instant-contiki: ~ / cc-tool $ ./configure
03. User @ instant-contiki: ~ / cc-tool $ make
04. User @ instant-contiki: ~ / cc-tool $ sudo make install
```

#### Cài đặt thư viện USB:

```
01. Sudo apt-get install libusb-1.0
02. Sudo apt-get install libboost-all-dev
```

**Sau khi gắn mạch nạp với máy tính và nhận mạch nạp trong VMWare gõ lệnh sau để connect:**

```
01. User @ instant-contiki: ~ / contiki-2.7 / examples / cc2530dk $ sudo cc-tool -t
```

#### Nạp file hex đã compile

```
01. User @ instant-contiki: ~ / contiki-2.7 / examples / cc2530dk $ sudo cc-tool -v -e -w blink-hello.hex
```





## 1. CÁC CÔNG CỤ CẦN THIẾT

### CC - tool

```
user@instant-contiki:~$ cctool
[sudo] password for user:
Programmer: SmartRF04EB
Target: CC2530
Device info:
  Name: SmartRF04EB
  Debugger ID: 0050
  Version: 0x0400
  Revision: 0x0047

Target info:
  Name: CC2530
  Revision: 0x24
  Internal ID: 0xA5
  ID: 0x2530
  Flash size: 256 KB
  Flash page size: 2
  RAM size: 8 KB
  Lock data size: 16 B
```

Connect TARGET BOARD

```
HOME,CSEG,CONST,XINIT,GS*      00000000    00007FF7 =      32759. bytes (R
EL,CON,CODE)
BANK1                          00018000    00007FFE =      32766. bytes (R
EL,CON,CODE)
BANK2                          00028000    00007FF8 =      32760. bytes (R
EL,CON,CODE)
BANK3                          00038000    00006470 =      25712. bytes (R
EL,CON,CODE)
Other memory:
  Name          Start      End      Size      Max
  -----
  PAGED EXT. RAM          0          256
  EXTERNAL RAM    0x0000    0x16f1    5874     7936
  ROM/EPROM/FLASH 0x0000    0x3e46f 123997  262144
rm border-router.flags border-router.banked-hex obj_cc2530dk/border-router.app.r
el
user@instant-contiki:~/contiki-sensinode/examples/cc2530dk/border-router$ loadcc border-
router.hex
Programmer: SmartRF04EB
Target: CC2530
Erasing flash...
Completed
Writing flash (121 KB)...
Completed (6.58 s.)
Verifying flash...
Completed (4.76 s.)
user@instant-contiki:~/contiki-sensinode/examples/cc2530dk/border-router$
```

Load file hex

## 2. THỰC HIỆN DEMO

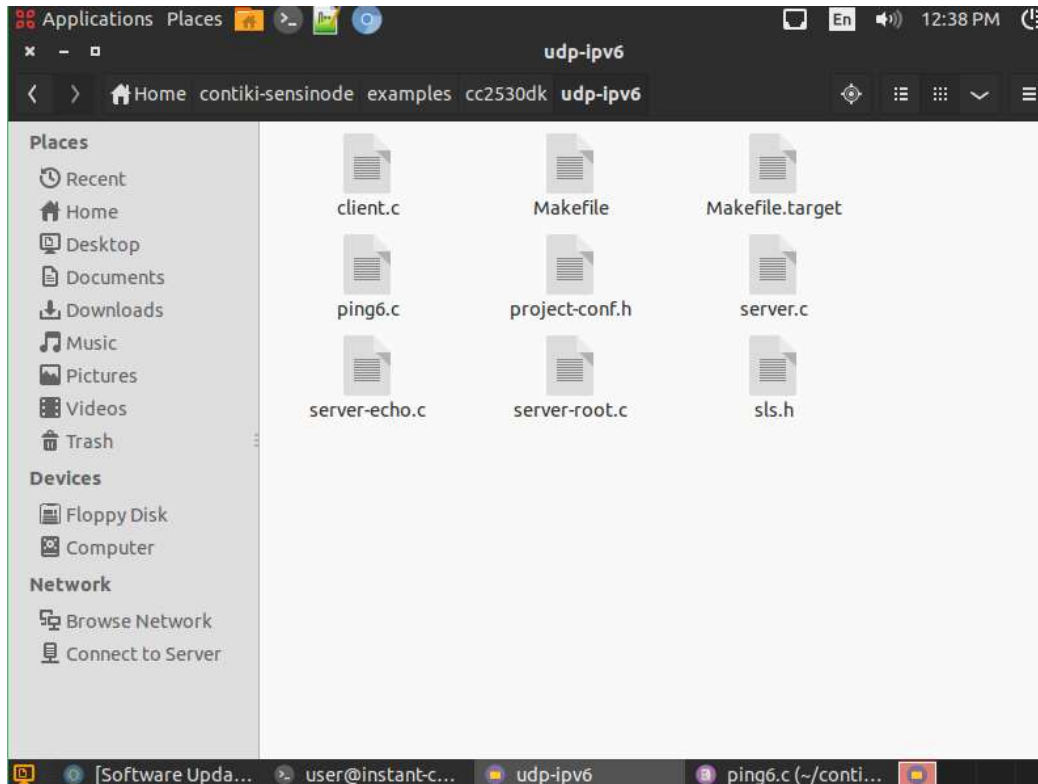
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**UDP Server – Clients**

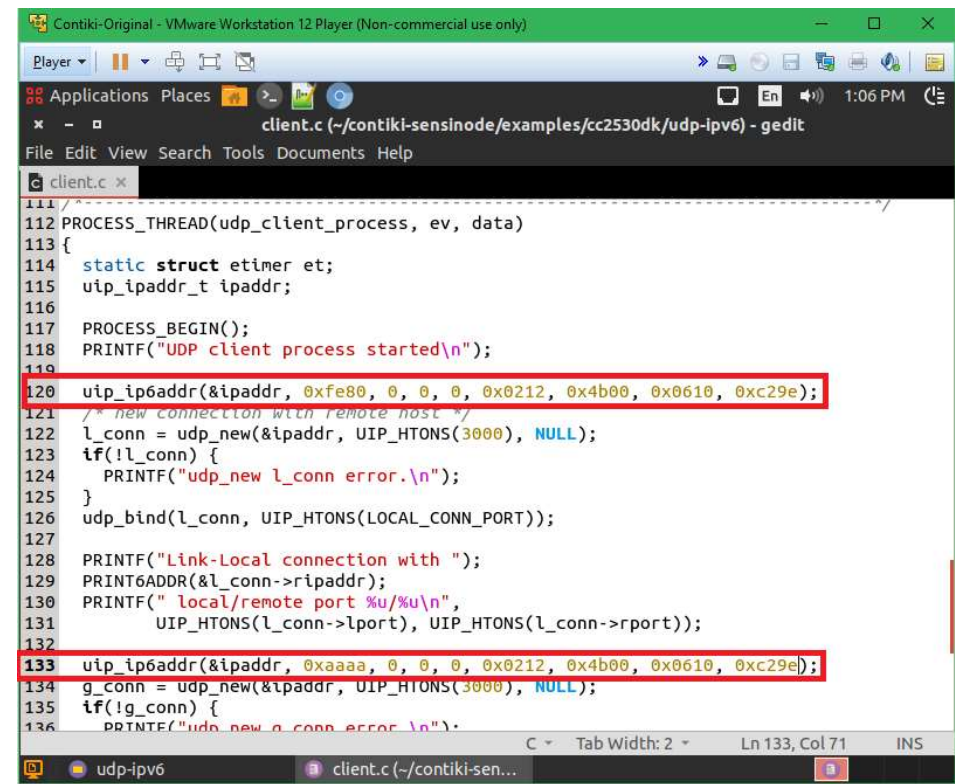
**Border Router**

## 2. THỰC HIỆN DEMO

### UDP Server - Clients



Source code udp – ipv6



Chỉnh sửa địa chỉ đích trong client.c

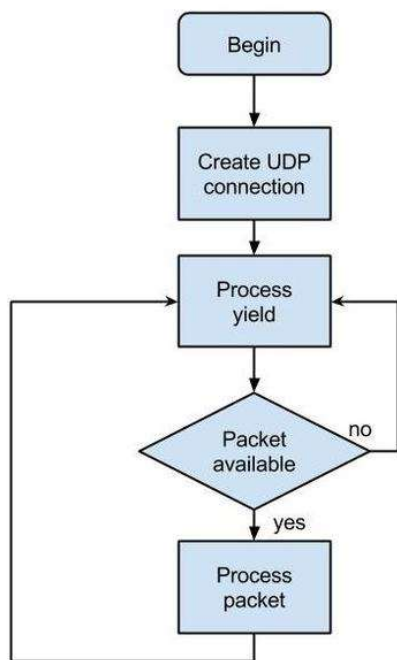
Tham khảo thêm tại [http://anrg.usc.edu/contiki/index.php/RPL\\_UDP](http://anrg.usc.edu/contiki/index.php/RPL_UDP)

## 2. THỰC HIỆN DEMO

### UDP Server

In the example, UDP server does three tasks primarily.

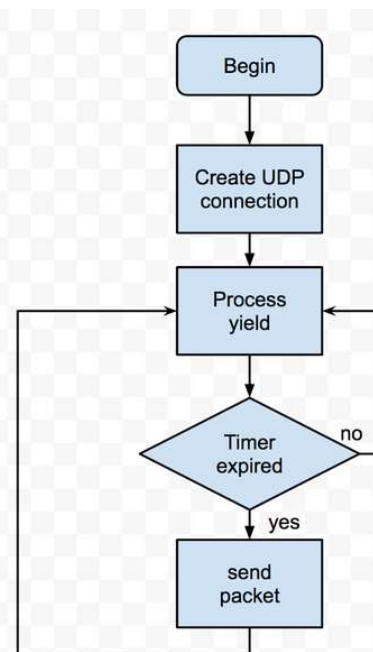
1. Initializes RPL DAG;
2. Sets up UDP connection;
3. Waits for packets from client, receives and print them on stdout.



### UDP Client

In the example, UDP server does two tasks primarily.

1. Sets up UPD connection;
2. Sends packet to UDP server periodically.





## 2. THỰC HIỆN DEMO

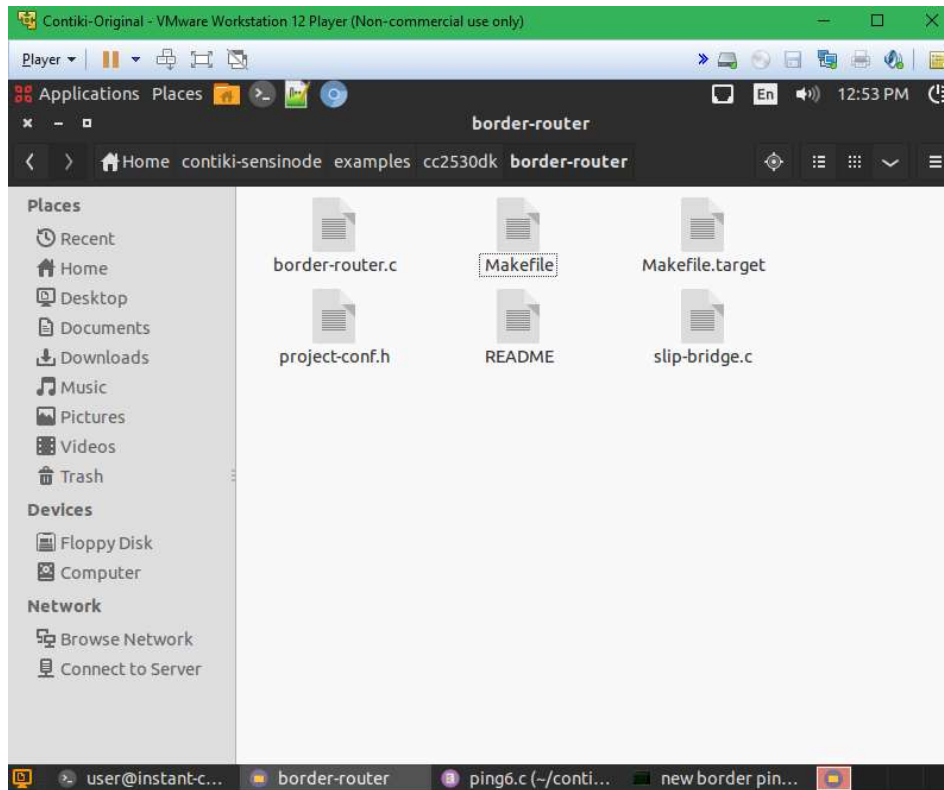
### UDP Server - Clients

```
/dev/ttyUSB0 - PuTTY
2 bytes from [aaaa::0212:4b00:072b:f6ef]:3002
2 bytes from [fe80::0212:4b00:072b:f6ef]:3001
2 bytes from [aaaa::0212:4b00:072b:f6ef]:3002
2 bytes from [fe80::0212:4b00:072b:f6ef]:3001
2 bytes from [aaaa::0212:4b00:072b:f6ef]:3002
2 bytes from [fe80::0212:4b00:072b:f6ef]:3001
2 bytes from [aaaa::0212:4b00:072b:f6ef]:3002
2 bytes from [fe80::0212:4b00:072b:f6ef]:3001
2 bytes from [aaaa::0212:4b00:072b:f6ef]:3002
2 bytes from [fe80::0212:4b00:072b:f6ef]:3001
2 bytes from [aaaa::0212:4b00:072b:f6ef]:3002
2 bytes from [fe80::0212:4b00:072b:f6ef]:3001
```

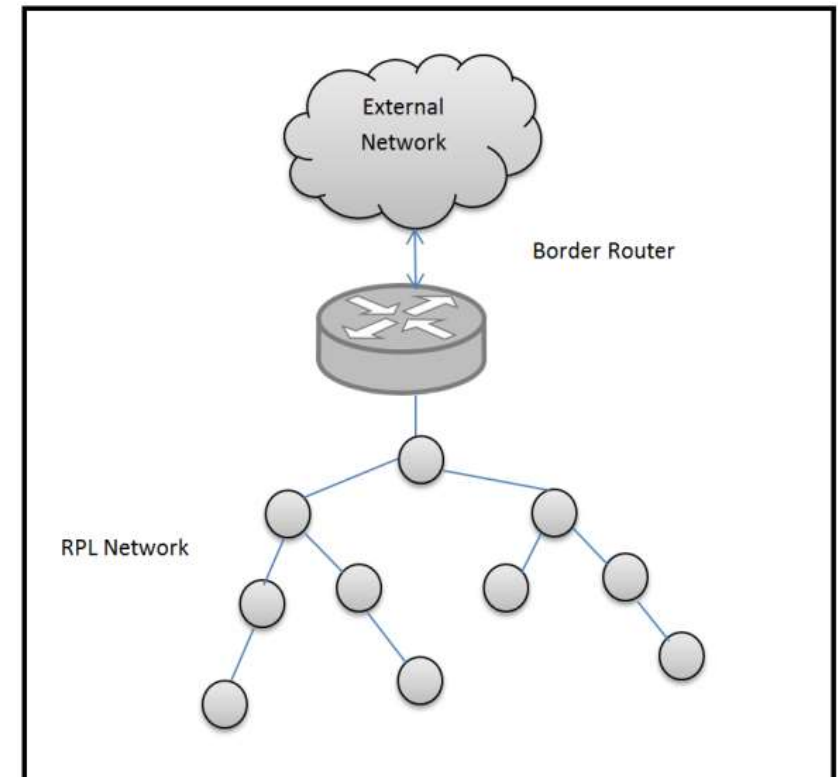
Client sẽ ping liên tục Server với chu kỳ được define trong client.c

## 2. THỰC HIỆN DEMO

### Border Router



Source code Border router



Mô hình RPL Border Router

Tham khảo thêm tại [http://anrg.usc.edu/contiki/index.php/RPL\\_Border\\_Router](http://anrg.usc.edu/contiki/index.php/RPL_Border_Router)

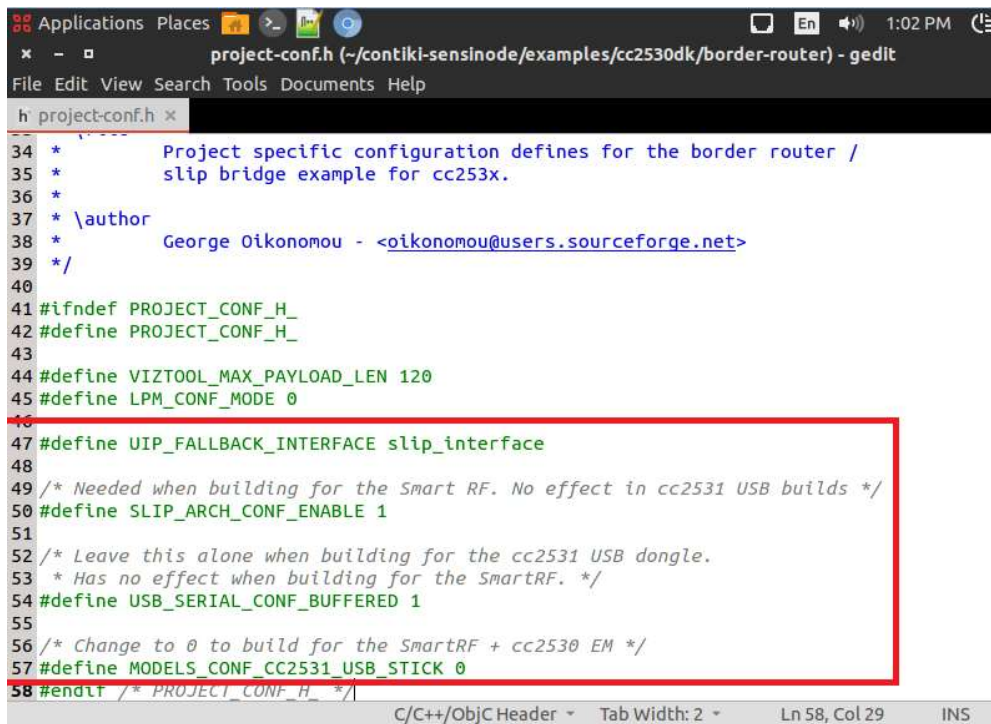




## 2. THỰC HIỆN DEMO

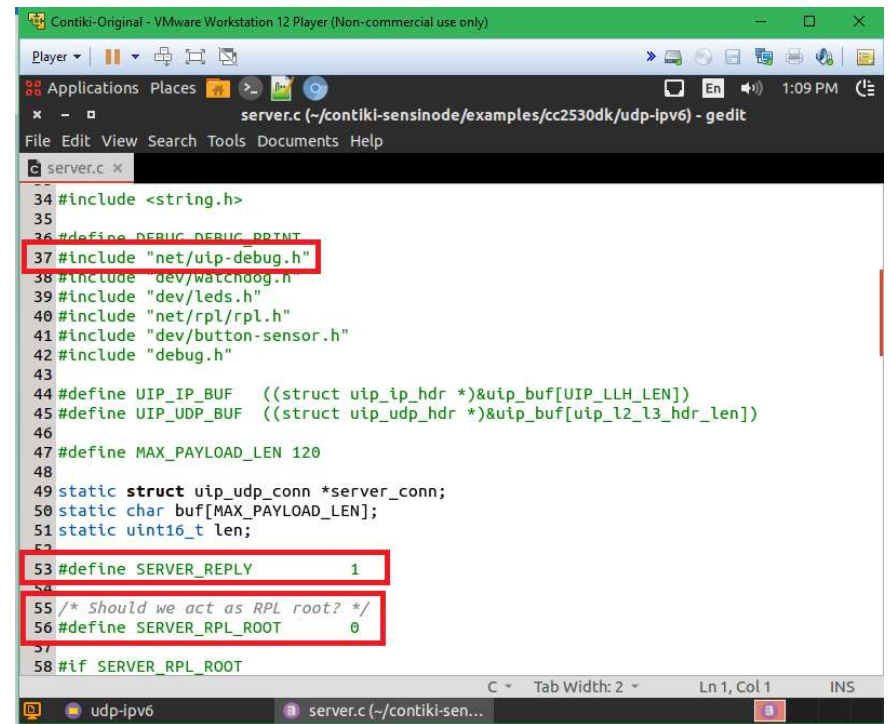
### Border Router

#### Chỉnh sửa file project-conf.h trong thư mục border-router



```
Applications Places 1:02 PM
project-conf.h (~/contiki-sensinode/examples/cc2530dk/border-router) - gedit
File Edit View Search Tools Documents Help
h project-conf.h x
34 * Project specific configuration defines for the border router /
35 * slip bridge example for cc253x.
36 *
37 * \author
38 * George Oikonomou - <oikonomou@users.sourceforge.net>
39 */
40
41 #ifndef PROJECT_CONF_H_
42 #define PROJECT_CONF_H_
43
44 #define VIZTOOL_MAX_PAYLOAD_LEN 120
45 #define LPM_CONF_MODE 0
46
47 #define UIP_FALLBACK_INTERFACE slip_interface
48
49 /* Needed when building for the Smart RF. No effect in cc2531 USB builds */
50 #define SLIP_ARCH_CONF_ENABLE 1
51
52 /* Leave this alone when building for the cc2531 USB dongle.
53 * Has no effect when building for the SmartRF. */
54 #define USB_SERIAL_CONF_BUFFERED 1
55
56 /* Change to 0 to build for the SmartRF + cc2530 EM */
57 #define MODELS_CONF_CC2531_USB_STICK 0
58 #endif /* PROJECT_CONF_H_ */
C/C++/ObjC Header Tab Width: 2 Ln 58, Col 29 INS
```

#### Chỉnh sửa file server.c trong thư mục udp – ipv6



```
Contiki-Original - VMware Workstation 12 Player (Non-commercial use only)
Player 1:09 PM
server.c (~/contiki-sensinode/examples/cc2530dk/udp-ipv6) - gedit
File Edit View Search Tools Documents Help
server.c x
34 #include <string.h>
35
36 #define DEBUG DEBUG_RPRINT
37 #include "net/uiplib.h"
38 #include "dev/watchdog.h"
39 #include "dev/leds.h"
40 #include "net/rpl/rpl.h"
41 #include "dev/button-sensor.h"
42 #include "debug.h"
43
44 #define UIP_IP_BUF ((struct uip_ip_hdr *)&uip_buf[UIP_LLH_LEN])
45 #define UIP_UDP_BUF ((struct uip_udp_hdr *)&uip_buf[uip_l2_l3_hdr_len])
46
47 #define MAX_PAYLOAD_LEN 120
48
49 static struct uip_udp_conn *server_conn;
50 static char buf[MAX_PAYLOAD_LEN];
51 static uint16_t len;
52
53 #define SERVER_REPLY 1
54
55 /* Should we act as RPL root? */
56 #define SERVER_RPL_ROOT 0
57
58 #if SERVER_RPL_ROOT
C Tab Width: 2 Ln 1, Col 1 INS
udp-ipv6 server.c (~/contiki-sen...
```



## 2. THỰC HIỆN DEMO

### Border Router

```
HOME,CSEG,CONST,XINIT,GS* 00000000 00007FF7 = 32759. bytes (R
EL,CON,CODE)
BANK1 00018000 00007FFE = 32766. bytes (R
EL,CON,CODE)
BANK2 00028000 00007FF8 = 32760. bytes (R
EL,CON,CODE)
BANK3 00038000 00006470 = 25712. bytes (R
EL,CON,CODE)
Other memory:
  Name      Start    End      Size    Max
  -----
  PAGED EXT. RAM      0      256
  EXTERNAL RAM 0x0000 0x16f1 5874 7936
  ROM/EPROM/FLASH 0x0000 0x3e46f 123997 262144
rm border-router.flags border-router.banked-hex obj_cc2530dk/border-router.app.r
el
user@instant-contiki:~/contiki-sensinode/examples/cc2530dk/border-router$ loadcc border-
router.hex
Programmer: SmartRF04EB
Target: CC2530
Erasing flash...
Completed
Writing flash (121 KB)...
Completed (6.58 s.)
Verifying flash...
Completed (4.76 s.)
user@instant-contiki:~/contiki-sensinode/examples/cc2530dk/border-router$
```

Compile + load file hex border – router vào 1 node

```
HOME,CSEG,CONST,XINIT,GS* 00000000 00007FF7 = 32759. bytes (REL,CON,C
ODE)
BANK1 00018000 00007FF6 = 32758. bytes (REL,CON,C
ODE)
BANK2 00028000 00007FF6 = 32758. bytes (REL,CON,C
ODE)
BANK3 00038000 00007FF5 = 32757. bytes (REL,CON,C
ODE)
BANK4 00048000 0000035C = 860. bytes (REL,CON,C
ODE)
Other memory:
  Name      Start    End      Size    Max
  -----
  PAGED EXT. RAM      0      256
  EXTERNAL RAM 0x0000 0x1716 5911 7936
  ROM/EPROM/FLASH 0x0000 0x4835b 131892 262144
rm server.banked-hex server.flags obj_cc2530dk/server.app.rel
user@instant-contiki:~/contiki-sensinode/examples/cc2530dk/udp-ipv6$ loadcc server.hex
Programmer: SmartRF04EB
Target: CC2530
Erasing flash...
Completed
Writing flash (128 KB)...
Completed (9.97 s.)
Verifying flash...
Completed (5.01 s.)
user@instant-contiki:~/contiki-sensinode/examples/cc2530dk/udp-ipv6$
```

Compile + load file hex server vào 1 node khác



## 2. THỰC HIỆN DEMO

### Border Router

```
Applications Places [Icons] [Terminal] user@instant-contiki: ~
File Edit View Se Use the command line
user@instant-contiki:~$ tunslip6
*****SLIP started on `/dev/ttyUSB0'
opened tun device `/dev/tun0'
ifconfig tun0 inet 'hostname' up
ifconfig tun0 add aaaa::1/64
ifconfig tun0 add fe80::0:0:0:1/64
ifconfig tun0

tun0      Link encap:UNSPEC  HWaddr 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00
-00

      inet addr:127.0.1.1  P-t-P:127.0.1.1  Mask:255.255.255.255
      inet6 addr: fe80::1/64 Scope:Link
      inet6 addr: aaaa::1/64 Scope:Global
      UP POINTOPOINT RUNNING NOARP MULTICAST  MTU:1500  Metric:1
      RX packets:0 errors:0 dropped:0 overruns:0 frame:0
      TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
      collisions:0 txqueuelen:500
      RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

Prefix request.
*** Address:aaaa::1 => aaaa:0000:0000:0000
Created a new RPL dag with ID: aaaa::0212:4b00:0610:c29e
On Channel 25
Router's IPv6 addresses:
  aaaa::0212:4b00:0610:c29e
  fe80::0212:4b00:0610:c29e
```

Sử dụng tunslip6



## 2. THỰC HIỆN DEMO

### Border Router

```
user@instant-contiki:~$ ping-s1
PING aaaa::0212:4b00:072b:f6ef(aaaa::212:4b00:72b:f6ef) 56 data bytes
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=1 ttl=63 time=103 ms
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=2 ttl=63 time=77.5 ms
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=3 ttl=63 time=78.0 ms
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=4 ttl=63 time=78.2 ms
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=5 ttl=63 time=78.1 ms
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=6 ttl=63 time=78.1 ms
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=7 ttl=63 time=78.2 ms
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=8 ttl=63 time=78.2 ms
64 bytes from aaaa::212:4b00:72b:f6ef: icmp_seq=9 ttl=63 time=78.1 ms
^C
--- aaaa::0212:4b00:072b:f6ef ping statistics ---
9 packets transmitted, 9 received, 0% packet loss, time 8096ms
rtt min/avg/max/mdev = 77.581/80.916/103.275/7.912 ms
user@instant-contiki:~$
```

Kiểm tra node có hoạt động không = ping6 node đó

```
user@instant-contiki:~$ nc-s1
led_on
led_on
-----
led_off
led_off
-----
check_adc
check_adc
█
```

Netcat node server = echo lại gói tin đã gửi



### 3. THAM KHẢO

---

#### Các alias command line đã sử dụng

```
alias ping-bor='ping6 aaaa::0212:4b00:0610:c29e'
```

```
alias ping-s1='ping6 aaaa::0212:4b00:072b:f6ef'
```

```
alias nc-s1='nc -u6 aaaa::0212:4b00:072b:f6ef 3000'
```

```
alias cctool='sudo cc-tool -t'
```

```
alias loadcc='sudo cc-tool -v -e -w '
```

```
alias suputty='sudo putty'
```



### 3. THAM KHẢO

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1. CC2530EB Contiki 笔记 <https://goo.gl/dJnGaz>
2. Contiki Tutorials [http://anrg.usc.edu/contiki/index.php/Contiki\\_tutorials](http://anrg.usc.edu/contiki/index.php/Contiki_tutorials)
3. How to install CC-tool <http://forum.banana-pi.org.cn/thread-365-1-1.html>
4. Contiki - sensinode <https://github.com/g-oikonomou/contiki-sensinode>
5. CC-tool <https://sourceforge.net/projects/cctool/>
6. Blog của Xukai bàn về cc2530 contiki <http://blog.csdn.net/xukai871105/article/details/9204101>
7. 8051 Requirements <https://github.com/contiki-os/contiki/wiki/8051-Requirements>
8. Getting start with cc2530 + contiki <http://swannonline.co.uk/node/60>
9. Contiki cc2530 demo test <https://goo.gl/iBVDST>
10. Slides Wireless Sensor Network, Dr. –Ing. Vo Que Son



Thank you!

