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How to set up and configure StarEast in Access Point mode with Intel 2200 wireless network interfaces

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1 Introduction

This report is meant to explain how to set up and configure the StarEast platform with SnapGear Linux and Intel Pro Wireless 2200BG in order to obtain a configurable Access Point.

As reported in [8] "StarEast is a stackable system with three kinds of modified PCI Mezzanine Cards. One is a baseboard, and the other two are adapter daughter cards to provide miniPCI and CardBus interfaces. The baseboard is based on an Intel IXP425 network processor. It provides two fast Ethernet ports, one UART, and two mirror PMC PCI interfaces to connect the two daughter cards for miniPCI, CardBus or other customizing functions. To support large applications, the baseboard includes 133MHz, 256Mbytes of on-board SDRAM, and 32Mbytes of on-board Intel StrataFlash memory. With two PMC2miniPCI daughter cards, StarEast supports four wireless Type IIIA miniPCI cards."

As for the SnapGear Operating System, in [7] it is reported that "SnapGear's embedded Linux distribution represents state-of-the-art embedded Linux technology for deeply embedded microprocessors with or without MMU (memory management unit), an important advantage in allowing developers more choice in selection of processors for producing vertical ranges of products. SnapGear embedded Linux is unique in providing commercial quality tool chains and processor support in a freely downloadable open source format."

This report is structured as follows. In the remainder of this section we report the hardware and software configuration we used. In Section 2 we report the easiest way to reach our objective which is not correctly reported in [1] and which uses a precompiled SnapGear version provided with the StarEast board. Section 3 provides insights related to loading the Operating System and ram disk images onto the board. In Section 4 we illustrate how to configure the wireless network settings. Section 5 provides information useful for compiling a new SnapGear kernel. In Section 6 we illustrate how to add custom files to the ram disk previously created. Finally Section 7 describes how to recompile the wireless network drivers.

1.1 Hardware Setup

Below it is reported the configuration we used in our laboratory. All the following explanations are related to such configuration.

- Development host: 3 GHz Intel Pentium 4 with 2GB of RAM, 250 GB of Hard Disk, a serial port and a 100 Mbps Ethernet port, and running Kubuntu Dapper Linux operating system with 2.6.15.26 kernel.

- StarEast board: 533 MHz Intel IXP425, 16 MB of Strata Flash memory and 256 of RAM, 2 100 Mbps Ethernet ports, 1 Serial port, 1 daughter board with 2 Mini PCI slots.

- Mini PCI Intel IPW2200BG wireless network interface.
- Ethernet cable.
- RJ45 Serial-to-Ethernet cable (normally provided with StarEast).

The connections between the development host and the StarEast board are explained in the following Sections 3.1 and 3.2.

1.2 Overview of the software provided with the board

Below we report the directory structure of the compact disk provided with the StarEast board.

```
stareast
|-- drivers
|   |-- cardbus
|   |   |-- ixdp425-pci.c
|   |   |-- madwifi.tar.gz
|   |   `-- pcmcia-cs-3.2.7.tar.gz
|   `-- minipci
|   |-- gemtek-minipci
|   |   `-- gemtek-config-readme
|   `-- calexico2
|   |-- clx2_st.tar.gz
|   `-- hostap_st.tar.gz
|-- redboot
|   |-- i686-pc-linux-gnulibc2.2-x-xscale-elf.tar.Z
|   |-- npe-1.1.epk
|   |-- patch.128-16
|   |-- patch.128-32
|   |-- patch.256-32
|   |-- redboot-intel-xscale-031212.tar
|-- snapgear
|   |-- pci-auto.c
|   |-- arm-linux-tools-20030927.tar.gz
|   |-- ixp400AccessLibrary-1_4.zip
|   |-- snapgear-3.1.1.tar.gz
|   `-- snapgear-3.1.x-ixp400-v1.4.2-support.tar.gz
`-- tools
    |-- pci-utility.tar.gz
    `-- we26.tar.gz
```

2 Installing and setting up SnapGear on StarEast using precompiled images [1]

The fastest way to go is using precompiled kernel (referred to as 2.4.x kernel) and ram disk image found on the StarEast CD, as suggested in the NOTES file at point II:

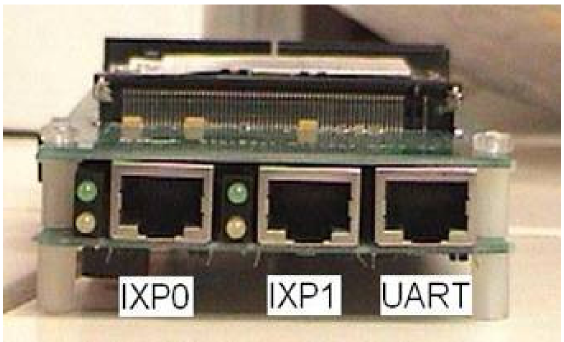
> “Ready-to-load "ramdisk.4cards.gz" and "zImage", are in folder /drivers/minipci/calexico2.”

These two files include the wireless interface drivers; we only need to load them onto the platform as explained in Section 3. Otherwise, if you want to recompile the kernel, go to Section 5. In this case you may need also to recompile the drivers of the wireless interface as explained in Section 7.

3 Loading Linux images onto StarEast [1][2]

There are two different ways to load images onto StarEast:

1. via Ethernet using *tftp* (fastest) as explained in Section 3.1
2. via serial port using *ymodem* (simplest) as explained in Section 3.2



3.1 Loading Linux images via Ethernet

To load Linux images via Ethernet we must enable *tftp* (Trivial File Transfer Protocol).
To install *tftpd* and related packages, use the following command:

```
sudo apt-get install xinetd tftpd tftp
```

Create file /etc/xinetd.d/tftp and put this entry:

```
service tftp
{
protocol       = udp
port           = 69
socket_type    = dgram
wait           = yes
user           = nobody
server         = /usr/sbin/in.tftpd
server_args    = /tftpboot
```

```
        disable         = no
        }
```

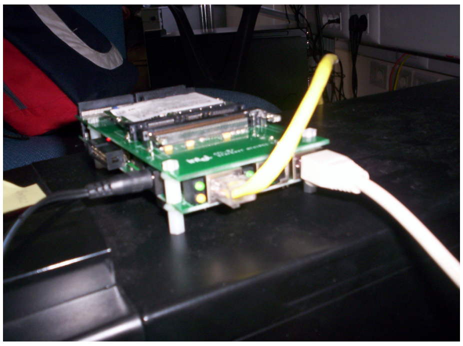
Create /tftpboot directory

```
        sudo mkdir /tftpboot
        sudo chmod -R 777 /tftpboot
        sudo chown -R nobody /tftpboot
```

Copy the image files, *Ramdisk.4cards* e *zImage* from */drivers/minipci/calexico2* directory on CD, into it. The file named *zImage* is the Linux kernel while *ramdisk.gz* is a compressed ram disk containing all the binaries and other files that are used by Linux.
Start *tftpd* through *xinetd*

```
        sudo /etc/init.d/xinetd start
```

Connect platform to PC using the RJ45 Serial-to-Ethernet cable (the white one in the following Figure).



Open a terminal program to communicate with the StarEast board (we use *minicom*):

```
          chmod 666 /dev/ttyS      (to set the permissions on the serial port)
          minicom –s
```

Make the following changes in *minicom* configuration:

--> *Serial port setup*
--> *A - Serial Device : /dev/ttyS0*
--> *E - Bps/Par/Bits : 115200 8N1*
--> *Save as default*

Turn on the power of the StarEast board and wait until the RedBoot prompt appears.

```
          Redboot>
```

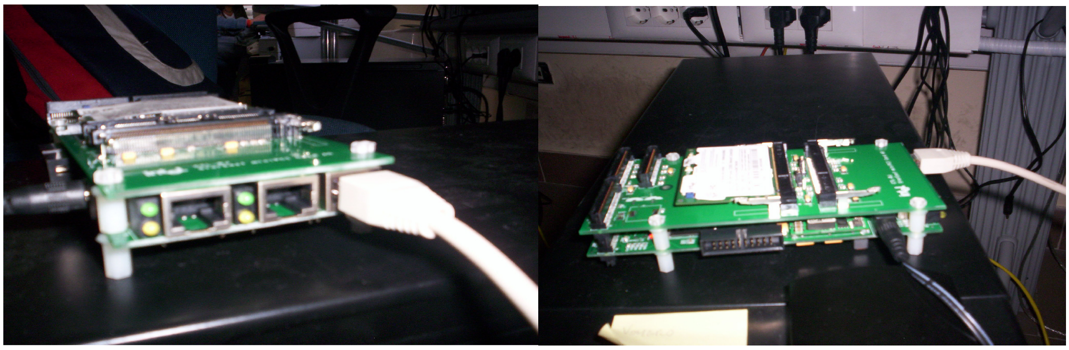
Connect platform to PC using Ethernet cables too.

Using *minicom* terminal, execute *fconfig* on RedBoot to set the proper client and server IP addresses. Once updated RedBoot, to load and execute SnapGear issue the following commands

```
load -r -v -b 0x01600000 zImage
load -r -v -b 0x00800000 ramdisk.gz
exec 0x01600000
```

3.2 Loading Linux images via serial port

To load Linux images via serial port we must install *X/Y/Z Modem* (*Lrsz* package). Than connect platform to PC using the RJ45 Serial-to-Ethernet cable.



Open a terminal program to communicate with the StarEast board (we use *minicom*):

```
chmod 666 /dev/ttyS        (to set the permissions on the serial port)
minicom –s
```

Make the following changes:

--> *Serial port setup*
--> *A - Serial Device : /dev/ttyS0*
--> *E - Bps/Par/Bits : 115200 8N1*
--> *Save ad default*

Turn on the power of the StarEast board and wait until the RedBoot prompt appears.

```
Redboot>
```

Execute the following command:

```
load –r –v –m ymodem –b 0x01600000
```

Then press CTRL+A and then S, to send *zImage* file. Once finished, execute:

```
load –r –v –m ymodem –b 0x00800000
```

And press CTRL+A and S, to send *ramdisk.gz*.

Now you have a kernel and a ram disk loaded on the processor. To load up Linux there is a quick command:

```
exec 0x01600000
```

These will load SnapGear and you will get a prompt that is a hash (#). There is a directory structure and a small amount of standard Linux commands available to you.

4 Wireless network configuration

In this section we explain how to configure the wireless network of the StarEast in AP mode. There are 2 possibilities:

1. using the script contained in the precompiled ram disk as explained in Section 4.1
2. manually configuring the parameters provided by HostAP driver as explained in Section 4.2

4.1 Configuring the wireless network with automatic script

If you have followed the instructions of Section 2 and 3, you have loaded two files (called *zImage* and *ramdisk.4cards.gz* respectively) onto the board. The file named *ramdisk.4cards.gz* contains four scripts. They are called *clx_first.sh*, *clx_second.sh*, *clx_third.sh*, *clx_fourth.sh* and are meant to configure up to four wireless network cards in AP mode. They execute some *iwconfig* and *ifconfig* commands in order to set up the right configuration.

Once your SnapGear Linux is up and running, you will find those scripts in the */bin* folder. All you have to do is launch the correct one (depending on which slot your wireless card is connected). Afterwards, your StarEast board will start to behave as an access point with ESSID ctl_bj11, ctl_bj12, ctl_bj13, or ctl_bj14 respectively. Now, other stations can associate with the AP. Since there is no DHCP configured on the board, you have to set up an IP address on the client station to be able to ping the StarEast.

4.2 HostAP configuration [3]

To configure the StarEast board in AP mode the most important tool is *iwconfig* (it is similar to *ifconfig* used to set up Ethernet interface). You will use *iwconfig* to set the operating mode of your card (Master, Managed, and Ad-Hoc), the wireless channel, and ESSID. Anyway, you will still need to set an IP address for you card using the traditional *ifconfig*.

To configure the wireless part issue the following commands (wlan0 is the name of your wireless network inteface):

```
# ifconfig wlan0 192.168.11.1
# iwconfig wlan0 essid ctl_bj11
# iwconfig wlan0 channel 6
# iwconfig wlan0 mode master
```

Then look at your new software based access point:

```
# iwconfig wlan0

wlan0     IEEE 802.11b  ESSID: "ctl_bj11"
Mode:Master  Frequency:2.412GHz  Access Point: 00:11:11:11:11:00
```

```
Bit Rate:11Mb/s   Sensitivity=1/242700000
Retry min limit:8   RTS thr:off    Fragment thr:off
Encryption key:off
Power Management:off
Link Quality:0  Signal level:0  Noise level:0
Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
Tx excessive retries:0  Invalid misc:0   Missed beacon:0
```

Most of the items are self explanatory. Link quality, signal, and noise won't show up when in Master mode. In any event, with the above configuration, client stations can now associate with your new access point. Simply tell each station your ESSID ("ctl_bj11" in this case). They should associate without incidents. Since DHCP is not setup, you will need to manually assign an IP address. Once that's done, your client station should be able to ping your access point.

On another machine, put the wireless interface into managed mode by using the following commands:

```
# iwconfig wlan0 mode managed
# iwconfig wlan0 essid ctl_bj11
# ifconfig wlan0 192.168.11.2
```

The station will associate with the AP. In order to verify the correct operation issue the command:

```
# ping 192.168.11.1

PING 192.168.11.2 (192.168.1.1): 56 data bytes
64 bytes from 192.168.11.1: icmp_seq=0 ttl=64 time=81.6 ms
64 bytes from 192.168.11.1: icmp_seq=1 ttl=64 time=2.6 ms
64 bytes from 192.168.11.1: icmp_seq=2 ttl=64 time=2.5 ms
--- 192.168.11.1 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 2.5/28.9/81.6 ms
```

And the command:

```
# iwconfig wlan

wlan0     IEEE 802.11b  ESSID:"ctl_bj11"
Mode:Managed  Frequency:2.412GHz  Access Point: 00:11:11:11:11:00
Bit Rate:11Mb/s   Sensitivity=1/242700000
Retry min limit:8   RTS thr:off    Fragment thr:off
Encryption key:off
Power Management:off
Link Quality:92/1  Signal level:-40 dBm  Noise level:-99 dBm
Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
Tx excessive retries:4  Invalid misc:4   Missed beacon:0
```

5 Compiling SnapGear kernel 2.6 for the StarEast [4][5][6]

Download the *snapgear-3.3.0.tar.gz* and *snapgear-modules-20051115.sh* files from http://ftp.snapgear.org:9981/pub/snapgear/src.

Decompress the SnapGear source code:

```
tar xvzf snapgear-3.3.0.tar.gz
```

This will create a *snapgear* directory that contains the source code. Now change to the SnapGear directory that was just created:

```
cd snapgear
```

If the *sharutils* are installed on your machine, to extract patch files to a folder run:

```
sh snapgear-modules-20051115.sh
```

There should be a file "README" to tell you how to install SnapGear and how to patch the IAL patch into SnapGear:

```
patch -p1 < snapgear-20051115.patch
mkdir -p modules/ixp425/ixp400-2.0
cd modules/ixp425/ixp400-2.0
```

Download from the address "http://www.intel.com/design/network/products/npfamily/ixp400_archives.htm" the *IPL_ixp400AccessLibrary-2_0.zip* and *IPL_ixp400NpeLibrary-2_0_5.zip* libraries and unzip them into the new folder:

```
unzip IPL_ixp400AccessLibrary-2_0.zip
unzip IPL_ixp400NpeLibrary-2_0_5.zip
```

Copy the file *modules-csr2.0-20051115.patch* in the current directory and patch it:

```
cp/(your snapgear directory)/modules-csr2.0-20051115.patch ./
patch -p1 < modules-csr2.0-20051115.patch
```

To fix a bug on serial port 1, edit the file *linux-2.6.x/arch/arm/mach-ixp4xx/ixdp425-setup.c* and replace

```
irq = IRQ_IXP4XX_UART1 → irq = IRQ_IXP4XX_UART2
```

Now we need the tools for compiling the images. We can download the package *arm-linux-tools-20061213.tar.gz* from "http://www.snapgear.org/snapgear/downloads.html" that contains needed compiler and libraries.
Decompress the file in SnapGear directory and it will create a new directory called *usr*.

```
tar xvzf arm-linux-tools-20061213.tar.gz
```

Move this directory to your home directory and add it to your path:

```
export PATH=(your home directory)/usr/local/bin:${PATH}
```

Now we need to configure the kernel. From the decompressed SnapGear directory, issue the command:

```
make menuconfig
```

Make the following changes in the displayed menu (changes are in **bold**):

Vendor/Product Selection →
Select the Vendor you wish to target
Intel
Select the Product you wish to target
IXDP425
EXIT
Kernel/Library/Defaults Selection →
(**linux-2.6.x**) Kernel Version
(uclibc) Libc Version
[*****]Customize Kernel Settings
[*****]Customize Module Settings
[*****]Customize Vendor/User Settings
EXIT

Exiting and saving, a new window will appear, make the following changes in that window:

System Type →
ARM system type→
IXP4xx-based
[*****]Build big-endian kernel
EXIT
Boot Options →
Default kernel command string
"console=ttyS1,115200 root=/dev/ram0 initrd=0x00800000,16M mem=256M@0x00000000"

The commands below are what is changed from the original string in the string above.

```
"ttyS0 -> ttyS1"
"8M -> 16M"
"64M -> 256M"
```

These particular modifications are done because my IXP425 network processor has 256MB SDRAM (generally it ranges between 8 and 256 MB) and 16MB of flash memory (generally it ranges from 8 to 16 MB). If you've a different configuration, replace values on purpose. Then:

EXIT
Devices Drivers→
Generic Driver Options →
<*****> Hotplug firmware loading support
EXIT
Block devices →
<*****> Loopback device support
(**16384**) Default RAM disk size (Kbytes)

```
EXIT
Networking support →
Networking options →
<*> 802.1d Ethernet Bridging
EXIT
Wireless LAN (non-hamradio)→
[*] Wireless LAN drivers (non-hamradio) & Wireless Extensions
EXIT
EXIT
Input device support →
Unselect all input device to reduce size of kernel
EXIT
EXIT
File systems →
Network File Systems→
[*] Provide NFSv3 client support
[*] Provide NFSv4 client support
EXIT
EXIT
Kernel hacking →
"Options in this folder can be used to print more debugging information of kernel!"
EXIT
```

Exit and save setting. Then go to modules setup GUI.

```
XSCALE/IXP400 Modules →
(2.0) Intel Access Library version
[] Names network interfaces as eth, not ixp (Unselect for convenience)
EXIT
```

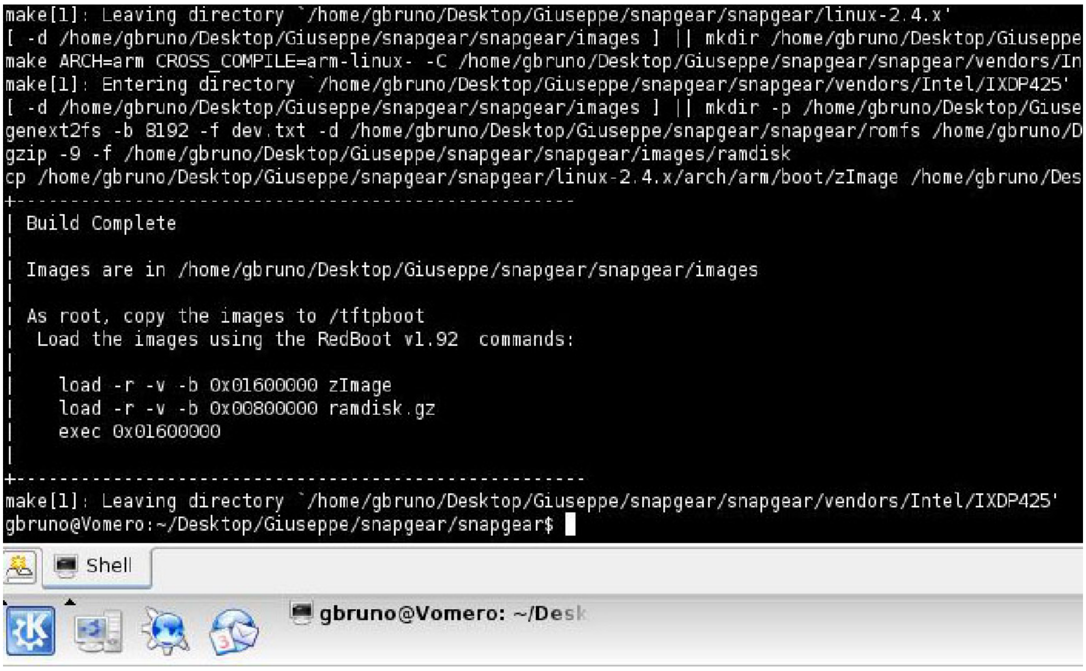
Exit and save setting. Then go to User apps setup GUI.

```
Network Applications →
[*] bridge utils - Net-tools
[*] arp - Wireless-tools
[*] wireless_tools support
[*] iwconfig
[*] iwgetid
[*] iwlist
[*] iwpriv
[*] iwspy
EXIT
```

Exit and save. The kernel configuration is done.
Now change back to the SnapGear directory and build the images:

```
make dep
make
```

At the end of make process we have the images in *(your snapgear directory)/images* (i.e. on my PC images were in */home/gbruno/Desktop/snapgear/snapgear/images*).



```
make[1]: Leaving directory `/home/gbruno/Desktop/Giuseppe/snapgear/snapgear/linux-2.4.x'
[ -d /home/gbruno/Desktop/Giuseppe/snapgear/snapgear/images ] || mkdir /home/gbruno/Desktop/Giuseppe
make ARCH=arm CROSS_COMPILE=arm-linux- -C /home/gbruno/Desktop/Giuseppe/snapgear/snapgear/vendors/In
make[1]: Entering directory `/home/gbruno/Desktop/Giuseppe/snapgear/snapgear/vendors/Intel/IXDP425'
[ -d /home/gbruno/Desktop/Giuseppe/snapgear/snapgear/images ] || mkdir -p /home/gbruno/Desktop/Giuse
genext2fs -b 8192 -f dev.txt -d /home/gbruno/Desktop/Giuseppe/snapgear/snapgear/romfs /home/gbruno/D
gzip -9 -f /home/gbruno/Desktop/Giuseppe/snapgear/snapgear/images/ramdisk
cp /home/gbruno/Desktop/Giuseppe/snapgear/snapgear/linux-2.4.x/arch/arm/boot/zImage /home/gbruno/Des
+-----------------------------------------------------
| Build Complete
|
| Images are in /home/gbruno/Desktop/Giuseppe/snapgear/snapgear/images
|
| As root, copy the images to /tftpboot
|  Load the images using the RedBoot v1.92  commands:
|
|    load -r -v -b 0x01600000 zImage
|    load -r -v -b 0x00800000 ramdisk.gz
|    exec 0x01600000
|
+------------------------------------------------------
make[1]: Leaving directory `/home/gbruno/Desktop/Giuseppe/snapgear/snapgear/vendors/Intel/IXDP425'
gbruno@Vomero:~/Desktop/Giuseppe/snapgear/snapgear$ █
```

6 Adding drivers and tools to ram disk [4]

If you want to add files to ram disk, you can unzip it and execute a mount in a folder (e.g. */mnt/ramdisk*).

```
cd /tmp
gunzip -d ramdisk.gz
mkdir /mnt/ramdisk
mount ramdisk  -o loop /mnt/ramdisk
```

In this case ram disk will be mounted in */mnt/ramdisk*. Now you can copy the files onto the appropriate directory. Once you have added files, it is necessary to *unmount* and compress ram disk again for loading onto StarEast board:

```
umount /mnt/ramdisk
gzip -vf9 your_ramdisk_image
```

7 Sources and firmware for the IPw2200 driver in AP mode [4][7]

Download the AP driver *ipw2200-ap-0.2* and the firmware for StarEast AP driver *ipw2200-ap-fw-2.2.3* from the website http://sourceforge.net/projects/ipw2200-ap/. Assuming that you have downloaded everything to /tmp directory, *untar* IPw2200 sources:

```
cd /tmp
tar xvfz ipw2200-ap-0.2.tgz
tar xvfz ipw2200-ap-fw-2.2.3.tgz
cd ipw2200-ap-0.2
```

Than apply the following patch to the file *ipw2200.c*

```
--- ipw2200_before_IRQ_change.c  2006-10-20 11:35:21.000000000 +0200
+++ ipw2200.c    2006-10-20 11:42:46.000000000 +0200
@@ -73,6 +73,7 @@ static int associate = 1;
 static int auto_create = 1;
 static int led = 0;
 static int disable = 0;
+static int irq = 0;
 static const char ipw_modes[] = {
         'a', 'b', 'g', '?'
 };
@@ -10293,6 +10294,12 @@ static int ipw_pci_probe(struct pci_dev
       priv->power_mode = IPW_POWER_AC;
         priv->tx_power = IPW_DEFAULT_TX_POWER;

+        if (irq) {
+                printk(KERN_INFO "Override default irq from %d to %d.\n",
+                       pdev->irq, irq);
+                pdev->irq = irq;
+        }
+
         err = request_irq(pdev->irq, ipw_isr, SA_SHIRQ, DRV_NAME,
                           priv);
         if (err) {
@@ -10962,5 +10969,8 @@ module_param(mode, int, 0444);
 MODULE_PARM_DESC(mode, "network mode (0=BSS,1=IBSS)");
 #endif

+module_param(irq, int, 0444);
+MODULE_PARM_DESC(irq, "override defualt irq assigned by the system");
+
 module_exit(ipw_exit);
 module_init(ipw_init);
```

It is necessary in order to avoid the following error:

```
ipw2200: Detected Intel PRO/Wireless 2200BG Network Connection
ipw2200: failed to send MAC_MODE command
```

Now we can compile IPw2200 sources:

```
export PATH=/home/gbruno/Desktop/usr/local/bin:${PATH}
make KSRC=(snapgear directory)
```

At the end of this process we can add the object files (*.ko for 2.6.x kernel version) to update ram disk as explained in Section 6. Than, once mounted ram disk in */mnt/ramdisk* execute the following commands:

```
mkdir /mnt/ramdisk/lib/modules/2.6.12-
uc0/kernel/drivers/net/wireless/ipw2200

cp -Rvf *.ko /mnt/ramdisk/lib/modules/2.6.12
uc0/kernel/drivers/net/wireless/ipw2200

cd /tmp
cp -R hotplug/etc /mnt/ramdisk
cp -R hotplug/sbin /mnt/ramdisk
tar -xovf hotplug-scripts.tar
cp -Rvf hotplug_scripts/* /mnt/ramdisk/etc/
```

```
mkdir -p /mnt/ramdisk/usr/lib/hotplug/firmware/
cp -Rvf *.fw /mnt/ramdisk/usr/lib/hotplug/firmware/
```

Finally, to enable the Ethernet and the wireless at the start of Stareast with SnapGear 3.3.0, we must update the /etc/rc file so that it appears:

```
hostname IXDP425
mount -t proc proc /proc
mount -o remount,rw /dev/root /
mkdir /sys
mount -t sysfs /sys /sys

ifconfig lo 127.0.0.1
modprobe ixp400
cat /etc/IxNpeMicrocode.dat > /dev/ixNpe
modprobe ixp400_eth
ifconfig ixp0 192.168.0.1 broadcast 192.168.0.255 netmask 255.255.255.0
route add -net 127.0.0.0 netmask 255.255.255.0 lo


insmod /lib/modules/2.6.12-uc0/kernel/drivers/net/wireless/ipw2200/ieee80211_crypt.ko
insmod /lib/modules/2.6.12-uc0/kernel/drivers/net/wireless/ipw2200/ieee80211.ko
insmod /lib/modules/2.6.12-uc0/kernel/drivers/net/wireless/ipw2200/ipw2200.ko irq=28

#dhcpcd &
cat /etc/motd
```

Unmount ram disk and recompress it as described at the end of Section 6.

8 References

[1] "StarEast Multi-Radio Wireless Platform Reference Manual"
[2]http://www.idav.ucdavis.edu/~atm/tutorial/StareastTutorial.htm
[3]http://www.trekweb.com/~jasonb/articles/hostap_20030727.shtml
[4] http://commnet.ee.washington.edu/funlab/
[5] http://www.snapgear.org/
[6] http://www.intel.com/
[7] http://sourceforge.net/
[8] http://www.flexcomm.com.cn/products_details.asp?RecordID=91&CategoryName