EACH
CONNECTING SOLUTIONS

Beaglebone cape INTERNET HUB

INTERNET HUB

User Manual

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Revision History

Version	Changes	Date	Approved
1.0	Document creation	20/12/2014	DCarona

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1. INTRODUCTION

The INTERNET HUB Cape described in this document adds GSM/HSDPA, GPS, WiFi and extra USB ports capabilities to the BeagleBone making it suitable for tracking and for remote monitoring scenarios. The cape uses Huawei MU609, a high quality module with proven performance and reliability. This cape supports the Quad band GSM/GPRS (850 MHz, 900MHz, 1800MHz, 1900MHz and 2100MHz).

1.1. Scope

This document describes the cape's behaviors and features, and also how to interact with it.

1.2. Acronyms and Abbreviations

The acronyms and abbreviations used in the present document are:

Acronym	Description
BB	BeagleBone
BBB	BeagleBone Black
HSDPA	High-Speed Downlink Packet Access
GPS	Global Positioning System
I/O	Input/Output
RD	Reference Document

2. RELATED DOCUMENTS

2.1. Reference documents

Table 2-1 specifies which reference documents should be considered when following this document.

Table 2-1 – Related Documents

Reference	Title	Version	Date
[RD 1]	BeagleBone Black System Reference Manual	Rev A5.2	04/2013
[RD 2]	MU609 Hardware User Guide	Rev. 01	06-01-2014
[RD 3]	MU609 Application Guide	Rev. 01	04-08-2013

3. PIN DESCRIPTION

This cape has been developed to be fully compatible with BeagleBone Black, therefore based on **Error! Reference source not found.** the pin map **from BB perspective (I/O)** for BBB is the following:

Table 3-1 – P9 Header pin usage.

Pin	Name on Cape	Name on BBB	Pin to Export	Mode	Direction
P9.25	RESIN_IN	GPIO3_21	117	7	O
P9.27	$\overline{\text{W\_DISABLE}}$	GPIO3_19	115	7	O
P9.42	$\overline{\text{WAKE}}$	GPIO0_7	7	7	O
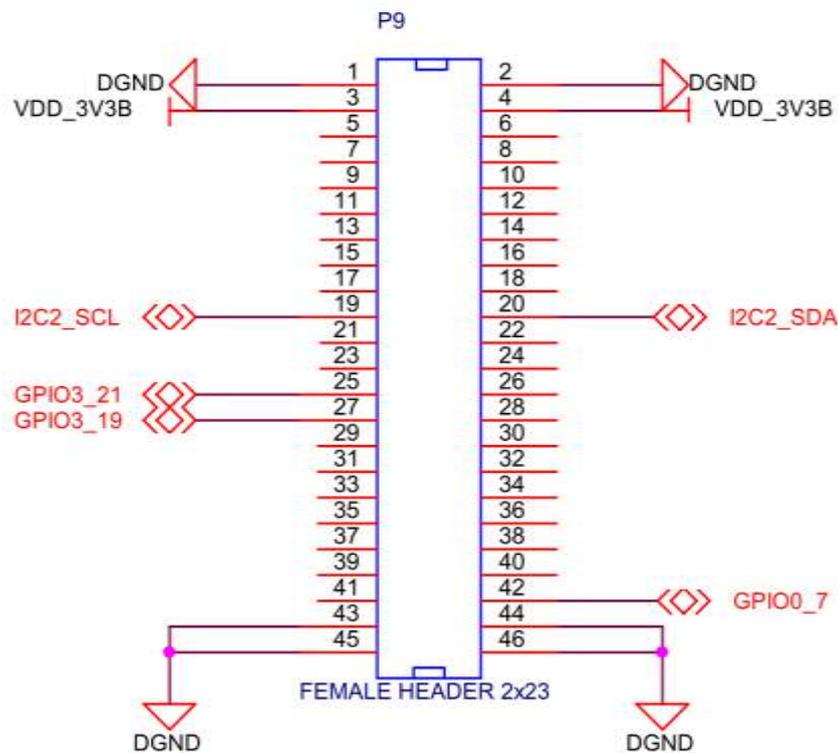
Fig. 3-1 – P9 Pin location in BeagleBone Black.

3.1. RESIN_IN

The MU609 module supports hardware reset function. If the software of the MU609 module stops responding, you can reset the hardware through the RESIN_N signal as shown in Fig. 3-2. When a low-level pulse is supplied through the RESIN_N pin, the hardware will be reset.

The RESIN_IN pin should not be pulled down more than 1s.
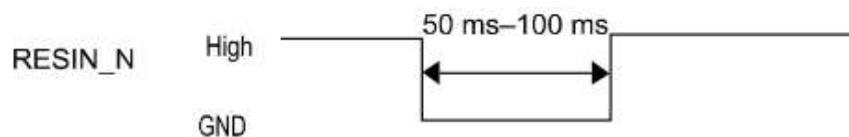
Fig. 3-2 – Reset pulse duration.

3.2. W_DISABLE

The W_DISABLE# signal is provided to allow users to disable wireless communications of the module. In this mode the power consumption of the module is about 2mA.

3.3. WAKE

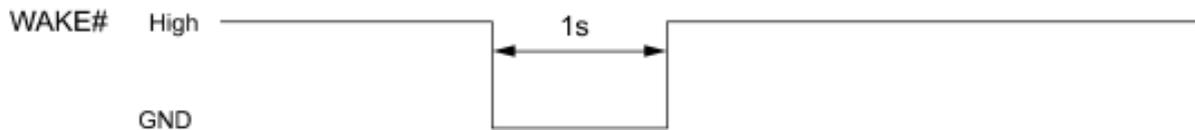WAKE# pin (signal that the module uses to wake up the host) supports software control. This signal is used for 3G module to wake up the host. It is designed as an OC gate, so the cape includes a pull up resistor of 10kΩ to ensure the high state. This pin is active-low.

When the module wakes up the host, the WAKE# pin will output low-level-voltage to wake the host.

Fig. 3-3 – WAKE pin pulse duration.

3.4. User Led

The led present on the cape is connected to the module and represents the state of the module depending on the mode enabled. Table 3-2 describes each state.

Table 3-2 – User Led state description.

State	Operating Status	Led Beahviour
1	No service/Restricted service	Outputs: low(0.1s)-high (0.1s)-low(0.1s)-high (1.7s) 2s cycle
2	Register to the network	Outputs: low (0.1s)-high (1.9s) 2s cycle
3	Dial-up successfully	Outputs: low

4. INTERACTING WITH GPIO'S

To interact with BB GPIO's, it is required to export the pin so the user can have access to it. In order to know the pin number that corresponds to a certain GPIO the following formula can be used:

$$GPIOx\_y = x*32 + y$$

Example:

GPIO1_6 = 1*32 + 6 = 38

The pin that has to be exported is "pin 38".

After discovering pin number the following procedure should be adopted:

1. Select the folder that controls GPIO's
    a. cd /sys/class/gpio/
2. Choose which pin to export
    a. echo 38 > export
3. Select the exported pin file
    a. cd /sys/class/gpio/gpio38
4. Set pin direction
    a. echo in > direction
5. Read pin
    a. cat value

If pin is set to work as output the procedure is the same but in direction file should be echoed "out" instead of "in" and to affect the pin "1" or "0" should be echoed to value file.

5. POWER

The INTERNET HUB cape has been developed to be powered only through USB, however we recommend the usage of external power supply of 5V @ 1A because in some cases the network connection might request a raise on the transmitting power of the module and cause some issues on the BBB power supply.

6. INITIAL SETUP

Before plug in BB-INTERNET-HUB cape into user beaglebone for the first time, some steps need to be followed:

6.1. WiFi USB Driver

The WiFi USB driver on BBB has some issues that need to be fixed in order the WiFi can work properly. Below are described the steps to fix the issues for Angstrom and Debian distributions.

Angstrom

```
apt-get update
apt-get upgrade
apt-get install kernel-dev
apt-get install kernel-headers
```

You may need to reboot.

```
cd /usr/src/kernel
make scripts
ln -s /usr/src/kernel /lib/modules/$(uname -r)/build
cd ~
git clone git://github.com/cmicali/rtl8192cu_beaglebone.git
cd rtl8192cu_beaglebone
make CROSS_COMPILE=""
```

Install the driver

```
mv 8192cu.ko /lib/modules/$(uname -r)
depmod -a
cd /etc/modules-load.d
echo "8192cu" > rtl8192cu-vendor.conf
```

Blacklist the old rtlwifi drivers

```
cd /etc/modprobe.d
echo "install rtl8192cu /bin/false" > wifi_blacklist.conf
echo "install rtl8192c_common /bin/false" > wifi_blacklist.conf
echo "install rtlwifi /bin/false" > wifi_blacklist.conf
```

Edit /var/lib/connman/settings and enable WIFI

```
[global]
OfflineMode=false

[Wired]
Enable=true
Tethering=false
```

```
[WiFi]
Enable=true
Tethering=false
```

Shutdown your BBB, plug in your INTERNET HUB cape along with the USB cable and reboot.

Debian

```
opkg update
opkg upgrade
opkg install kernel-dev
opkg install kernel-headers

cd /usr/src/linux-headers-3.8.13-bone47
make scripts
ln -s /usr/src/linux-headers-3.8.13-bone47 /lib/modules/$(uname -r)/build
cd ~
```

Fix a problem with the timex.h header

```
vi /usr/src/linux-headers-3.8.13-bone47/arch/arm/include/asm/timex.h
```

change line 18 from

```
#include <mach/timex.h>
```

To

```
#include </usr/src/linux-headers-3.8.12-bone17/arch/arm/include/asm/timex.h>
```

Get the new driver and compile it

```
git clone git://github.com/cmicali/rtl8192cu_beaglebone.git
cd rtl8192cu_beaglebone
make CROSS_COMPILE=""
```

Install the driver

```
mv 8192cu.ko /lib/modules/$(uname -r)/kernel/drivers/net/wireless/
depmod
cd /etc/modules-load.d
echo "8192cu" > rtl8192cu-vendor.conf
```

Blacklist the old rtlwifi drivers

```
cd /etc/modprobe.d
echo "blacklist rtl8192cu" > wifi_blacklist.conf
echo "blacklist rtl8192c_common" > wifi_blacklist.conf
echo "blacklist rtlwifi" > wifi_blacklist.conf
```
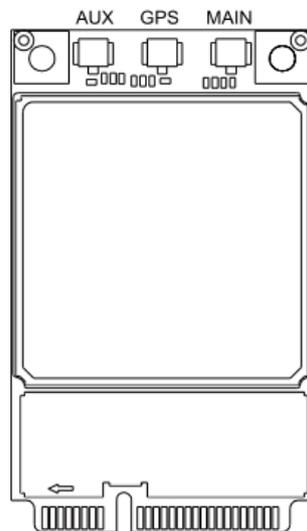
Shutdown your BBB, plug in your INTERNET HUB cape along with the USB cable and reboot.

6.2. Cape Firmware

➢ Insert the file *INTERNET-HUB-00A0.dtbo* supplied with the cape into the firmware folder:

```
cp INTERNET-HUB-00A0.dtbo /lib/firmware/
```

6.3. Antennas

Fig. 6-1 – Antennas connectors.

The module has three UF.L connectors for antennas and Table 6-1 describes each connector.

Table 6-1 – Module antenna connectors.

Label	Description
AUX	Auxiliary connector for range extender
GPS	GPS passive antenna connector
MAIN	GSM antenna connector

7. USING CAPE

When the cape is plugged in the BBB and connected to USB a list of several USB devices appears available according with Fig. 7-1 and typing "lsusb -t" in your BBB console.

Fig. 7-1 – List of devices of INTERNET HUB cape.

Each USB device has a role on the interaction with the module, as described on Table 7-1.

Table 7-1 – List of USB devices created by the module.

Port	Description
ttyUSB0	AT Commands for module
ttyUSB1	
ttyUSB2	GPS AT Commands
ttyUSB3	GPS NMEA messages
ttyUSB4	

7.1. Manual Process (every time BB boots up)

➢ **Enable cape:**

```
echo INTERNET-HUB > /sys/devices/bone_capemgr.*/slots
```

After, the cape is enabled on user BeagleBone and ready to be used.

To validate that operation has been succeeded you can type:

```
cat /sys/devices/bone_capemgr.*/slots
```

If the cape firmware is correctly loaded the cape name is shown.

7.1.1. HSDPA Communication protocol

IMPORTANT NOTE:

It is recommend that the SIM card used in your cape has its PIN code disabled. Some users reported problems when using PPPD with the SIM card PIN code active, so **for correct functioning your SIM card should have its PIN code disabled.**

In order to register the module in the network the user need to insert the SIM card on the connector and use a serial port tool like minicom to open /dev/ttyUSB0.

When ttyUSB0 is opened please type:

➢AT+COPS?   //check if has any network
➢AT^NDISDUP=1,1,"APN"   // dial-up, "APN" should be changed to the real settings

If success you should receive ^NDISSTAT:1,,,"IPV4"

After that minicom can be closed and using the command "ifconfig" is possible to check the name of the new interface created by the module, probably you will have a name like "rename3".

On the shell input of your BBB type:

➢ dhclient rename3 // Or other name

➢ ifconfig to check that the interface has a new IP address assigned. If it is only up without IP address and the led of the module is always ON, retype the same dhclient command and recheck.

For more options on how to configure the module please refer to [RD 3].

7.1.2. GPS Communication

Start GPS

To start GPS the user needs to open minicom with /dev/ttyUSB2 and type the following commands:

➢ AT^WPDOM=0   //Sets the positioning method to Standalone

➢ AT^WPDST=1   //Sets the session type to tracking positioning

➢ AT^WPDGP   //Starts positioning

Periodically this interface receives the position information, instead the user can open minicom with /dev/ttyUSB3 to get the NMEA messages produced by the module.

IMPORTANT NOTE:

Since the GPS antenna used by the module is passive, to get position the cape needs to be close to a window.

Stop GPS

To stop GPS acquisition the user only needs to execute the following AT command on /dev/ttyUSB2:

➢ AT^WPEND

For more options on how to configure the GPS please refer to [RD 3].

8. WIFI

8.1. Access Point

If the user decide to use the INTERNET HUB as an access point we suggest the installation of HostAPD to facilitate the configuration of the module.

8.1.1. HostAPD (Access Point Configuration)

1. Install the standard hostapd so you don't have to create your own startup script, etc..., you might get error here... just ignore them since you will compile your own version.
apt-get install hostapd

2. Get modified hostapd for Realtek
wget https://github.com/jenssegers/RTL8188-hostapd/archive/v1.1.tar.gz

3. Unzip
tar -zxvf v1.1.tar.gz

4. Build it
cd RTL8188-hostapd-1.1/hostapd
make

5. Install it
make install

6. Move it into the correct location and replace the old one
mv hostapd /usr/local/bin

7. Edit /etc/hostapd/hostapd.conf

```
# Basic configuration

interface=wlan0
ssid=BeagleBoneBlack
channel=1
#bridge=br0

# WPA and WPA2 configuration

macaddr_acl=0
auth_algs=1
ignore_broadcast_ssid=0
wpa=3
wpa_passphrase=AnhIsAwesome!
wpa_key_mgmt=WPA-PSK
wpa_pairwise=TKIP
```

```
rsn_pairwise=CCMP

# Hardware configuration

driver=rtl871xdrv
ieee80211n=1
hw_mode=g
device_name=RTL8192CU
manufacturer=Realtek
```

8. Edit /etc/default/hostapd

```
# Defaults for hostapd initscript
#
# See /usr/share/doc/hostapd/README.Debian for information about alternative
# methods of managing hostapd.
#
# Uncomment and set DAEMON_CONF to the absolute path of a hostapd configuration
# file and hostapd will be started during system boot. An example configuration
# file can be found at /usr/share/doc/hostapd/examples/hostapd.conf.gz
#
DAEMON_CONF="/etc/hostapd/hostapd.conf"

# Additional daemon options to be appended to hostapd command:-
#       -d   show more debug messages (-dd for even more)
#       -K   include key data in debug messages
#       -t   include timestamps in some debug messages
#
# Note that -B (daemon mode) and -P (pidfile) options are automatically
# configured by the init.d script and must not be added to DAEMON_OPTS.
#
#DAEMON_OPTS=""
```