# Integrating the Sona TI351 Wi-Fi with the BeagleBone Black (BBB)

## Purpose

The purpose of this document is to provide step-by-step instructions for integrating a TI AM3358-based BeagleBone black SBC with Ezurio's Sona-TI351 Wi-Fi module. We do this through the Sona TI351 DVK via a Yocto Scarthgap-based Linux image.

## Hardware

- Linux-based PC
- BeagleBone black, MicroSD card, cables, and power supplies
- Sona TI351 DVK (P/N 453-00200-K1)

453-00200-K1 | Ezurio

Ezurio turns design possibility into reality with a comprehensive range of RF modules, system-on-modules, single board computers, internal antennas, IoT devices, and custom solutions. With decades of engineering expertise, Ezurio provides solutions...

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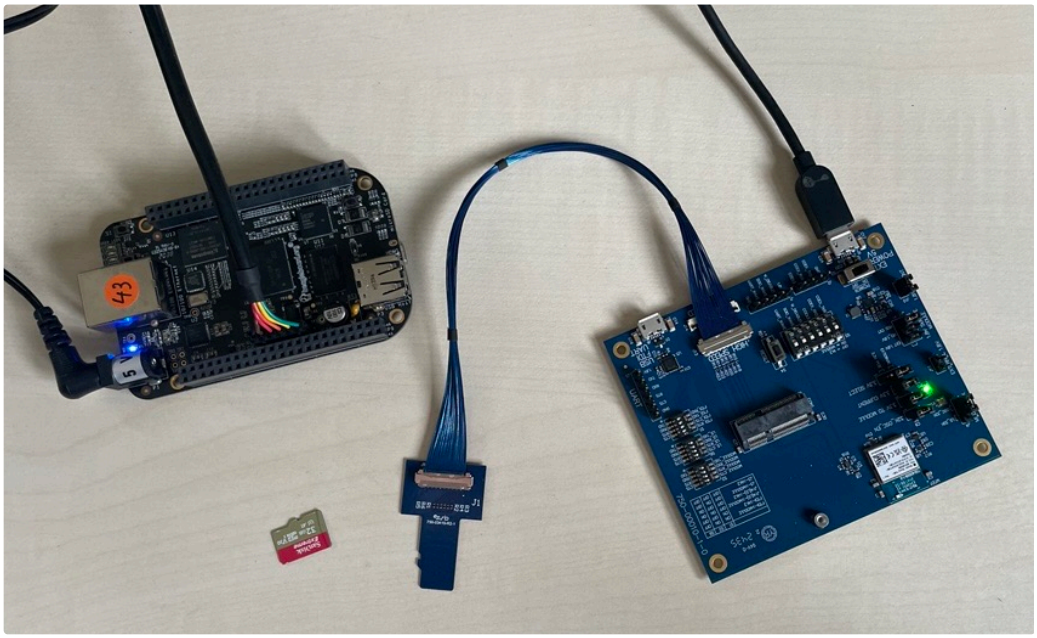


## Building and Running the Yocto Image

### Prerequisites on build machine

```
sudo apt-get install bc gawk wget git diffstat unzip texinfo gcc-multilib \
build-essential chrpath socat cpio python3 python3-pip python3-pexpect \
xz-utils debianutils iputils-ping libsdl1.2-dev xterm libncurses5-dev \
pkg-config socat subversion texi2html texinfo u-boot-tools\
```

### Download Yocto

```
mkdir bbb
cd bbb
git clone git://git.yoctoproject.org/poky
cd poky
git checkout scarthgap
```

### Download BeagleBone black BSP

```
git clone git://git.yoctoproject.org/meta-ti
cd meta-ti
git checkout scarthgap
cd ..
```

### Initialize environment

```
source oe-init-build-env build_bbb
```

**Note**: This creates a build directory (build_bbb) and changes to it.

### Adjust bblayers.conf

```
cd conf
nano bblayers.conf
```

Add the path to TI's meta-ti layer via the BBLAYERS variable:

```
# POKY_BBLAYERS_CONF_VERSION is increased each time build/conf/bblayers.conf
# changes incompatibly
POKY_BBLAYERS_CONF_VERSION = "2"

BBPATH = "${TOPDIR}"
BBFILES ?= ""

BBLAYERS ?= " \
  /home/alex/Projects/yocto/bbb/poky/meta \
  /home/alex/Projects/yocto/bbb/poky/meta-poky \
  /home/alex/Projects/yocto/bbb/poky/meta-yocto-bsp \
  /home/alex/Projects/yocto/bbb/poky/meta-ti \
  "
```

**Note**: Save the changes!

### Adjust local.conf

Find the following passage in *local.conf* and remove the '#' in front of the **beaglebone-yocto** line (line 5 below).

`MACHINE ?= "beaglebone-yocto"`

```
 …
There are also the following hardware board target machines included for
demonstration purposes:

MACHINE ?= "beaglebone-yocto"
#MACHINE ?= "genericarm64"
#MACHINE ?= "genericx86"
#MACHINE ?= "genericx86-64"
…
```

**Note**: Save the changes!

### Troubleshooting: Fixing missing layer.conf file error in 'meta-ti' layer

You may witness the following error:

```
FileNotFoundError: [Errno 2] file /home/alex/Projects/yocto/bbb/poky/meta-ti/conf/layer.conf not found
```

The solution to the above is as follows:

```
mkdir <poky-dir>/meta-ti/conf
touch <poky-dir>/meta-ti/conf/layer.conf
```

### Build first image

```
cd ..
bitbake core-image-base
```

**Note**: In our testing, we initially found a fetch error (gperf). The solution was to start a bitbake process again, which overcame the issue.

### Flashing image to SD card

The newly built image can be found at:

```
../poky/build_bbb/tmp/deploy/images/beaglebone-yocto
```

Flash this image to an SD card with Linux tool "dd:"

**Note**: Be VERY careful to select the correct target (denoted in the of= argument below)

```
sudo dd if=core-image-base-beaglebone-yocto.rootfs.wic of=/dev/mmcblk0 bs=1M conv=sync
```

Insert the SD card into the BeagleBone and push the boot switch while applying power. This ensures the BeagleBone will boot from the SD card.

### Gaining console access on BeagleBone black

You can use the information on the following page to gain console access to the BeagleBone Black:

https://www.dummies.com/article/technology/computers/hardware/beaglebone/how-to-connect-the-beaglebone-black-via-serial-over-usb-144981/

**Note**: Other USB/Serial converters might work as well.

### Flashing internal eMMC of the Beaglebone to free the SD card slot for the Sona TI351

The following command shows the available block devices on the BBB:

```
root@beaglebone-yocto:~# ls /dev/mmc* -al
brw-rw----    1 root     disk      179,   8 Jan  1  2000 /dev/mmcblk0
```

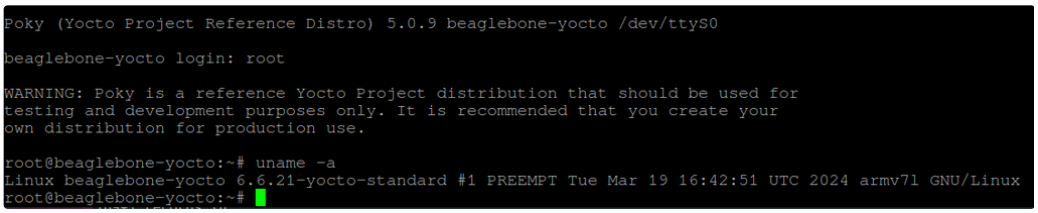
```
brw-rw----    1 root     disk      179,   9 Jan  1  2000 /dev/mmcblk0p1
brw-rw----    1 root     disk      179,  10 Jan  1  2000 /dev/mmcblk0p2
brw-rw----    1 root     disk      179,   0 Jan  1  2000 /dev/mmcblk1
brw-rw----    1 root     disk      179,  16 Jan  1  2000 /dev/mmcblk1boot0
brw-rw----    1 root     disk      179,  24 Jan  1  2000 /dev/mmcblk1boot1
brw-rw----    1 root     disk      179,   1 Jan  1  2000 /dev/mmcblk1p1
crw-------    1 root     root      247,   0 Jan  1  2000 /dev/mmcblk1rpmb
```

Line 5 above, *mmcblk1,* is the internal eMMC memory.

Write the contents of the SD card (mmcbkl0) to the internal emmc memory (mmcblk1) as follows:

```
root@beaglebone-yocto:~# dd if=/dev/mmcblk0 of=/dev/mmcblk1 bs=1M
```

**Note**: Power off the Beaglebone, remove the microSD card, and restart the Beaglebone:




## Adding software for the Sona-IF351 Wi-Fi module

### Adding Ezurio's Yocto meta layer to the build environment

Back on the build machine, in the Poky layer, execute the following command:

```
alex@bigNUC:~/Projects/yocto/bbb/poky$ git clone https://github.com/Ezurio/meta-summit-radio/
Cloning into 'meta-summit-radio'...
remote: Enumerating objects: 4715, done.
remote: Counting objects: 100% (229/229), done.
remote: Compressing objects: 100% (96/96), done.
remote: Total 4715 (delta 164), reused 171 (delta 128), pack-reused 4486 (from 1)
Receiving objects: 100% (4715/4715), 936.14 KiB | 5.38 MiB/s, done.
Resolving deltas: 100% (3003/3003), done.

alex@bigNUC:~/Projects/yocto/bbb/poky$ cd meta-summit-radio/
alex@bigNUC:~/Projects/yocto/bbb/poky/meta-summit-radio$ git checkout lrd-12.103.8.x
Branch 'lrd-12.103.8.x' set up to track remote branch 'lrd-12.103.8.x' from 'origin'.
Switched to a new branch 'lrd-12.103.8.x'
```

### Adjust bblayer.conf to add ‘meta-summit-radio’ layer

```
alex@bigNUC:~/Projects/yocto/bbb/poky/build_bbb/conf$ nano bblayers.conf
```

```
POKY_BBLAYERS_CONF_VERSION is increased each time build/conf/bblayers.conf
changes incompatibly

POKY_BBLAYERS_CONF_VERSION = "2"

BBPATH = "${TOPDIR}"
BBFILES ?= ""

BBLAYERS ?= " \
  /home/alex/Projects/yocto/bbb/poky/meta \
```

```
  /home/alex/Projects/yocto/bbb/poky/meta-poky \
  /home/alex/Projects/yocto/bbb/poky/meta-yocto-bsp \
  /home/alex/Projects/yocto/bbb/poky/meta-ti \
  /home/alex/Projects/yocto/bbb/poky/meta-summit-radio/meta-summit-radio \
  "
```

**Note**: Save the changes!

### Adjust local.conf file to include Ezurio and other required or useful recipes

Add to *local.conf*:

```
# added by user for Ezurio:
CORE_IMAGE_EXTRA_INSTALL += "\
pulseaudio \
ethtool \
iw \
openssh \
kernel-module-ti-backports \
ti351-firmware \
summit-supplicant-ti \

PREFERRED_RPROVIDER_wpa-supplicant = "summit-supplicant-ti"
PREFERRED_RPROVIDER_wpa-supplicant-cli = "summit-supplicant-ti"
PREFERRED_RPROVIDER_wpa-supplicant-passphrase = "summit-supplicant-ti"
PREFERRED_RPROVIDER_wireless-regdb-static = "wireless-regdb"
```

**Note**: Save the changes!

### Fixing missing layer.conf file error in 'meta-summit-radio' layer

You may witness the following error:

```
FileNotFoundError: [Errno 2] file /home/alex/Projects/yocto/bbb/poky/meta-summit-radio/conf/layer.conf
not found
```

The solution to the above is as follows::

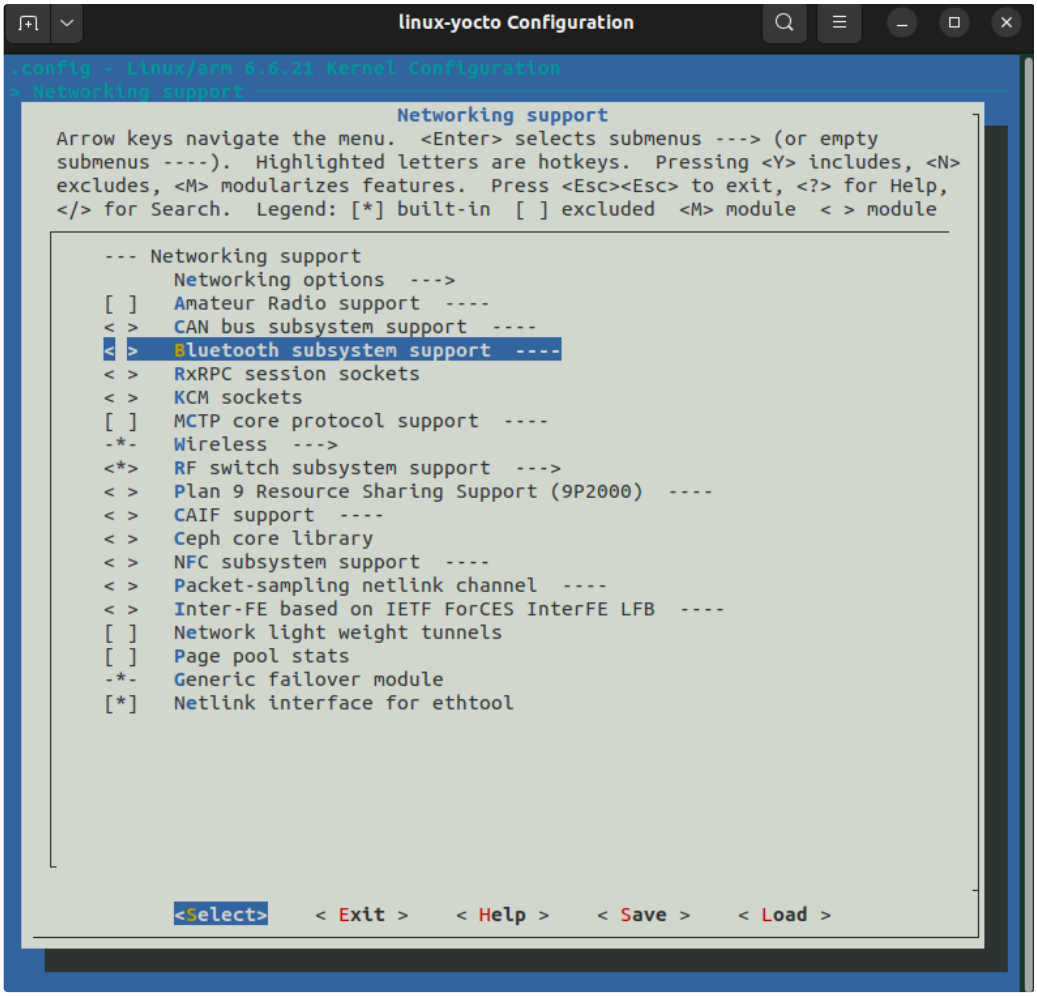
```
mkdir <poky-dir>/meta-summit-radio/conf
touch <poky-dir>/meta-summit-radio/conf/layer.conf
```

### Prepare kernel config for Ezurio backports

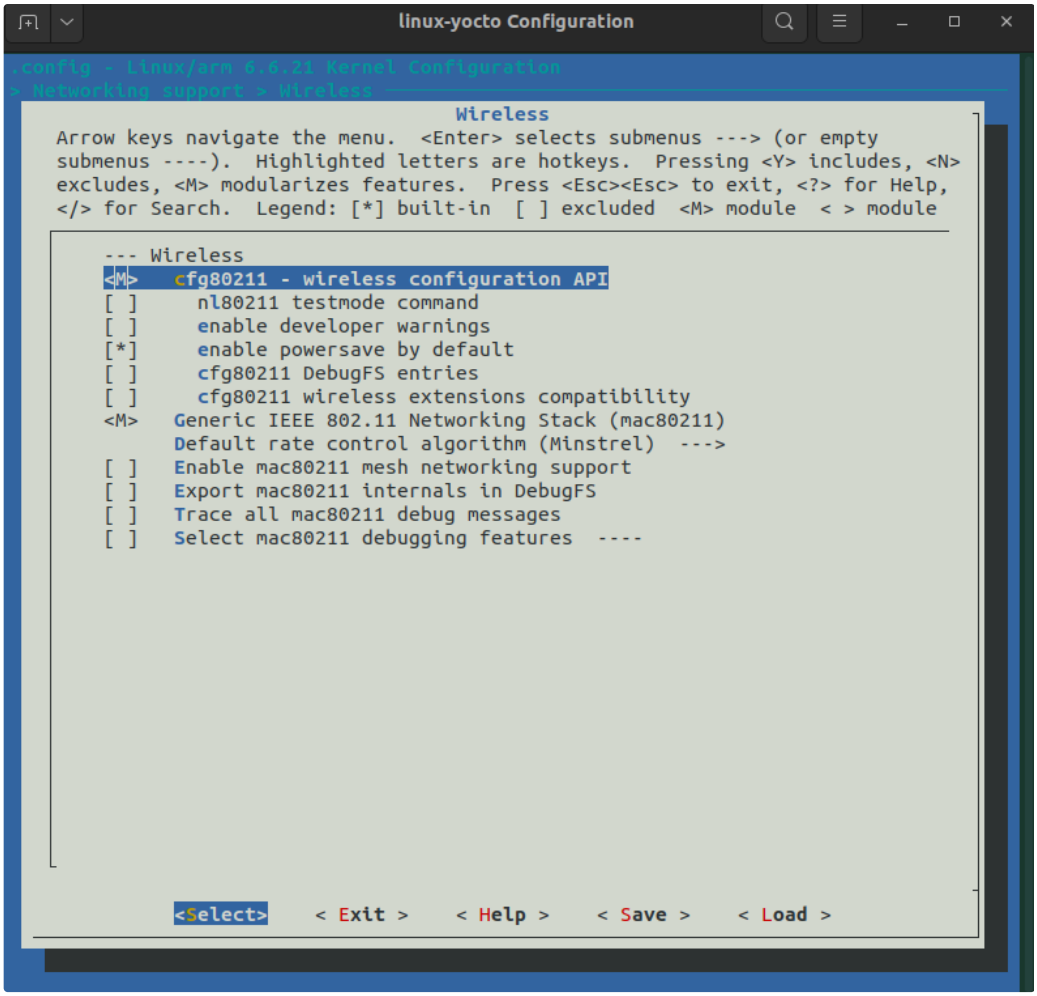
Run the following command:

```
bitbake -c menuconfig virtual/kernel
```

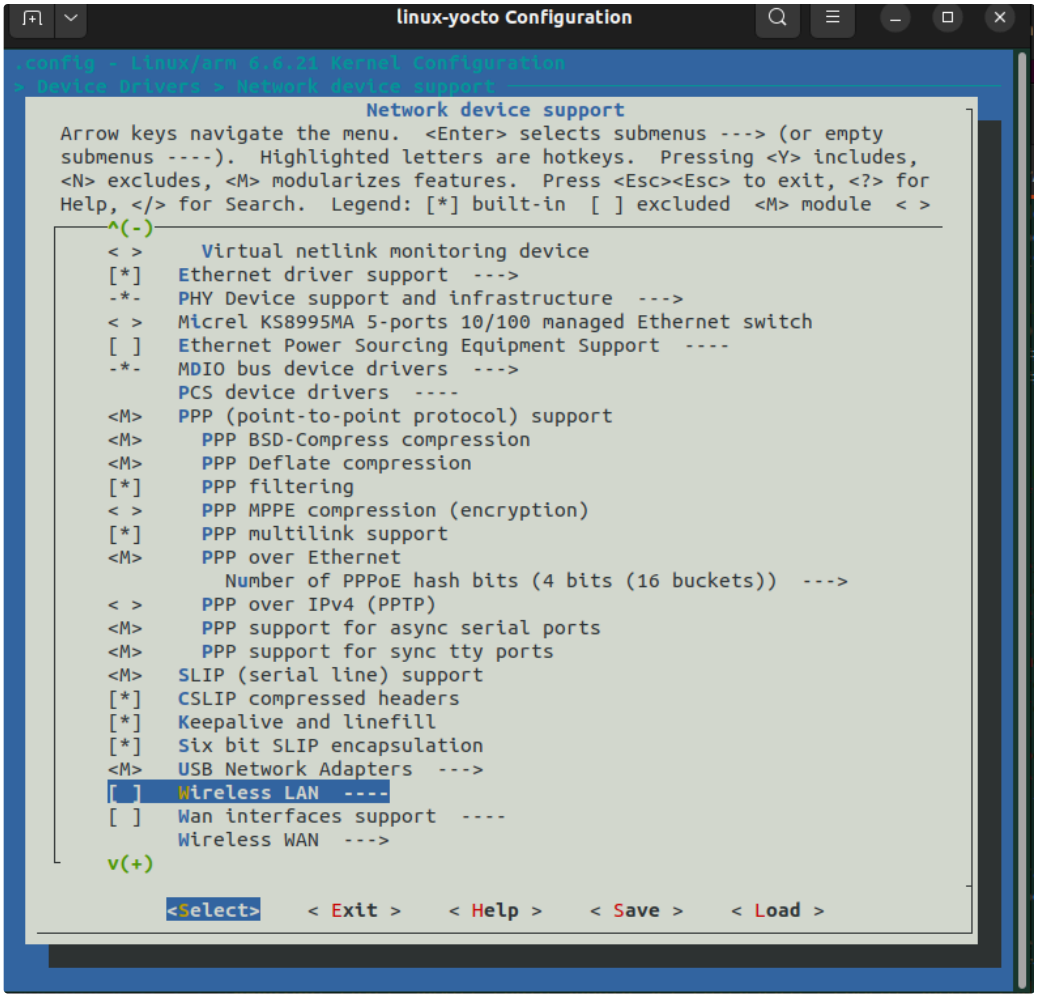
Remove the Bluetooth subsystem:



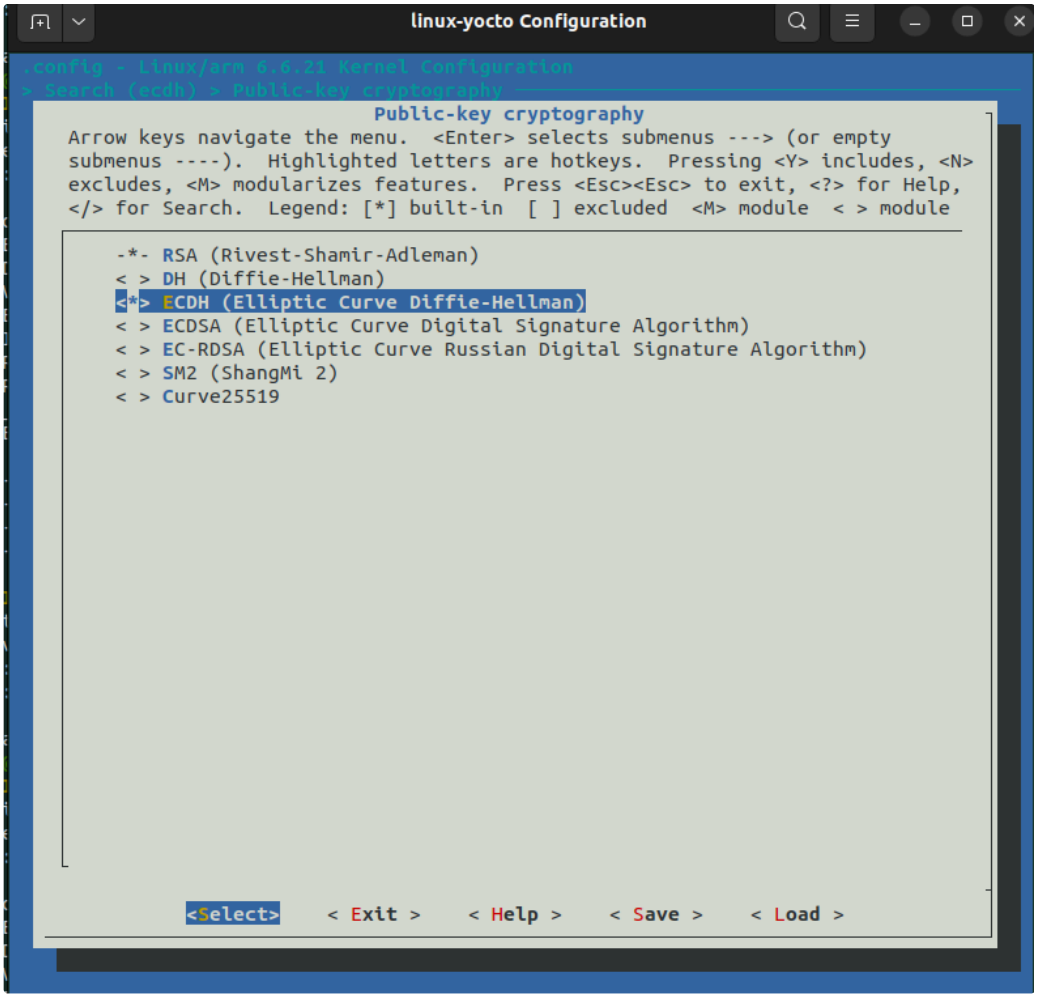

Set ‘Wireless’ to <M>:




Remove Wireless LAN driver as highlighted below:




Add ECDH support as highlighted below:




**Note**: Save the changes!

### Adjust BBB device tree for TI351

In the following directory:

*../poky/build_bbb/tmp/work-shared/beaglebone-yocto/kernel-source/arch/arm/boot/dts/ti/omap$*

...add this to the file 'am335x-bone-common.dtsi'

```
    vmmc-supply = <&reg_usdhc1_vmmc>;
    max-frequency = <50000000>;
    cap-power-off-card;

    #address-cells = <1>;
    #size-cells = <0>;

    wlcore: wlcore@2 {
            compatible = "ti,cc33xx";
            reg = <2>;
    };
```

under node:

```
&mmc1 {
        status = "okay";
        bus-width = <0x4>;
```

```
        pinctrl-names = "default";
        pinctrl-0 = <&mmc1_pins>;
        cd-gpios = <&gpio0 6 GPIO_ACTIVE_LOW>;

        vmmc-supply = <&reg_usdhc1_vmmc>;
        max-frequency = <50000000>;
        cap-power-off-card;

        #address-cells = <1>;
        #size-cells = <0>;

        wlcore: wlcore@2 {
                compatible = "ti,cc33xx";
                reg = <2>;
        };
};

```

### Build the image that includes Sona-TI351 software and adjusted device tree

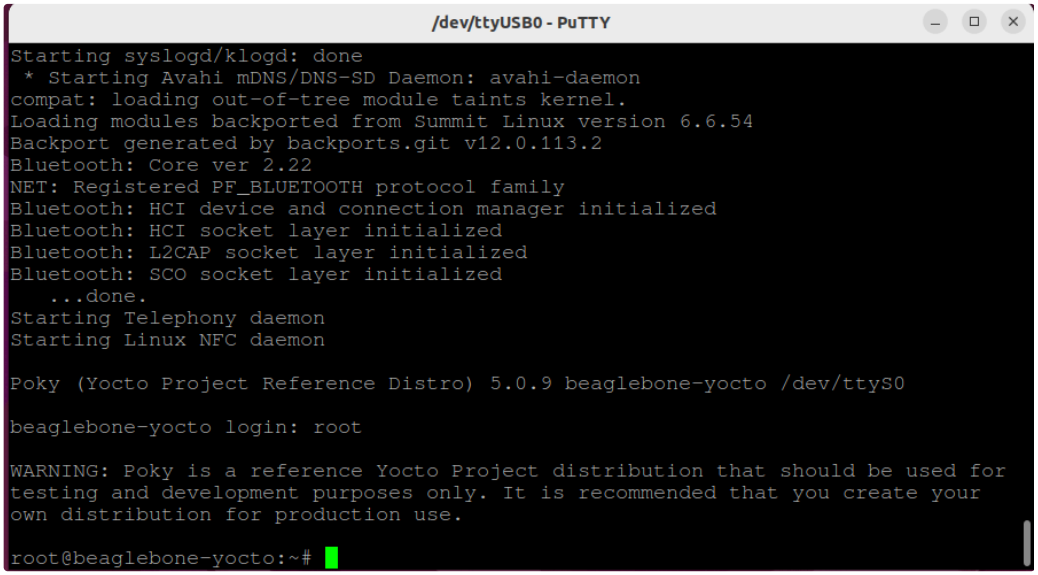
Compile the device tree as follows:

```
alex@bigNUC:~/Projects/yocto/bbb/poky/build_bbb$ bitbake linux-yocto -f -c compile
```

Repeat the steps for building the Yocto image, and flashing the emmc memory of the BB via SD card.

### Final results

Boot the BeagleBone and log in:

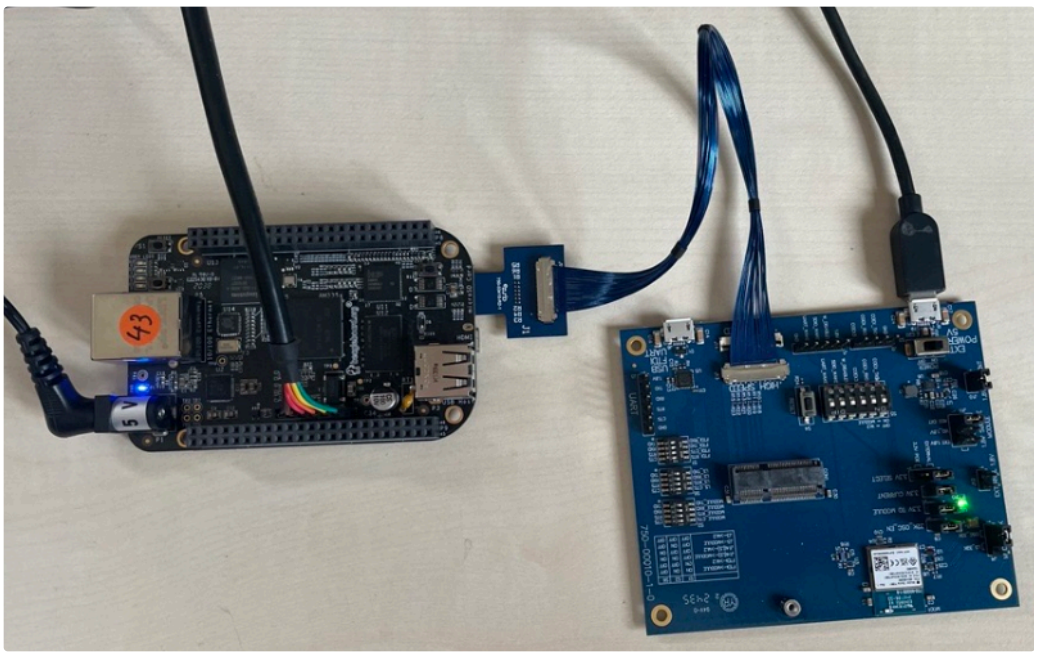



Observe the correct placement of the TI351 firmware:

```
/dev/ttyUSB0 - PuTTY
Bluetooth: HCI socket layer initialized
Bluetooth: L2CAP socket layer initialized
Bluetooth: SCO socket layer initialized
   ...done.
Starting Telephony daemon
Starting Linux NFC daemon

Poky (Yocto Project Reference Distro) 5.0.9 beaglebone-yocto /dev/ttyS0

beaglebone-yocto login: root

WARNING: Poky is a reference Yocto Project distribution that should be used for
testing and development purposes only. It is recommended that you create your
own distribution for production use.

root@beaglebone-yocto:~# ls /lib/firmware/ti-connectivity/ -al
drwxr-xr-x    2 root     root          1024 Mar  9 12:34 .
drwxr-xr-x    3 root     root          1024 Mar  9 12:34 ..
lrwxrwxrwx    1 root     root            17 Mar  9 12:34 cc33xx-conf.bin -> ti35
1-conf_WW.bin
-rw-r--r--    1 root     root         70212 Mar  9 12:34 cc33xx_2nd_loader.bin
-rw-r--r--    1 root     root        514080 Mar  9 12:34 cc33xx_fw.bin
-rw-r--r--    1 root     root          1129 Mar  9 12:34 ti351-conf_WW.bin
root@beaglebone-yocto:~#
```

Insert the TI351 DVK into the microSD card slot and observe the following console output:

```
/dev/ttyUSB0 - PuTTY
WARNING: Poky is a reference Yocto Project distribution that should be used for
testing and development purposes only. It is recommended that you create your
own distribution for production use.

root@beaglebone-yocto:~#
root@beaglebone-yocto:~#
root@beaglebone-yocto:~#
root@beaglebone-yocto:~#
root@beaglebone-yocto:~#
root@beaglebone-yocto:~#
root@beaglebone-yocto:~# sdhci-omap 48060000.mmc: card claims to support voltages below defi
ned range
mmc0: new high speed SDIO card at address 0001
cc33xx_sdio mmc0:0001:2: Using SDIO in-band IRQ
cc33xx_driver cc33xx.2.auto: Direct firmware load for ti-connectivity/cc33xx-nvs.bin failed
with error -2
wlcore: Wireless driver version 1.7.0.128
wlcore: Wireless firmware version 1.7.0.188
wlcore: Wireless PHY version 1.2.39.5.44.67
wlcore: loaded

root@beaglebone-yocto:~#
root@beaglebone-yocto:~#
```



Verify the availability of the wlan0 interface: