# This document exists in MS Word format because standard ASCII text does not support typographical emphasis (bold, specific fonts, headers, titles, etc.

# Expanding the Beagle Bone Black SD Card Image

## Background

All SD Cards, like hard disk drives, have some percentage of bad sectors. As an example, a 4GB card may actually be 3.99GB, a second card might be 3.98GB, every SD card is slightly different size.

When BBB SD Images are created, they are purposely created 'very small' so that the image can be placed on any 4GB SD Card (or the on board Flash Memory) then expanded as needed.

In total there is about 300MB of free space. That is not enough space to install & build the OpenThread Border Router using the BBB (One could cross compile, but doing so is beyond the scope of this document).

Thus:

1) A larger (at least 8GB) SD Card must be used and

2) The image must be expanded to fit the card.

An important point to consider: These instructions below describe expanding the image to slightly less than the entire SD Card. This leaves unused space at the end of the SD Card. The resulting image can then be read back, and truncated to size and used to create other images as needed.

## Overview:

In these steps we will:

* Write the image to an SD Card
* Start with a 4GIG partition.
* Expand this partition to about 7GIG
* Leaving quite a bit of space free.

## Alternate Reading

This document is based on several excellent web resources:

* http://www.kd0cq.com/2014/08/expand-partition-and-create-swap-file-on-beaglebone-black-ubuntu-sdr-img/
* http://elinux.org/Beagleboard:Expanding\_File\_System\_Partition\_On\_A\_microSD
* http://www.berriman.co.uk/bbb-mount-and-shrink-a-disk-image/

## How does this work?

To help understand the process, it is helpful to use an analogy - in this case we'll use a picture frame around your data.

The data on the SD Card is effectively a continuous array of data sectors. The sectors are numbered starting with 0 and ending at Sector (N) somewhere around XX GB, the exact last number is dependent upon the actual SD Card.

Sector 0 always contains an MS-DOS Partition table. An MS-DOS partition table can hold between 1 and 4 partition entries. Each partition is a continuous series of sectors from (X) to (Y) somewhere within the bounds of the SD Card. This repeats for each of the 4 possible partitions. Typically partitions are located in order, with some number (0 to N) of unused sectors at the very end. This “some number of unused sectors” can be used to your advantage later.

The largest partition should be a Linux Partition, and for this scheme to work it must the very last partition. If the Linux Partition is not the last partition these instructions will not work.

When writing an image to an SD Card, writing begins at Sector 0 and progress to SOME\_N which depends on the size of the image.

What we cannot do is stretch the partition - that's not possible. We instead at a high level do the following:

Step 1: Delete the existing Linux Partition – but do not delete the data. Following the analogy: We have removed the picture frame the picture is still present on the canvas.

Step 2: Create a new Linux Partition that starts exactly where the old one started, but ends some place closer to the end of the SD Card. Effectively a larger picture frame. The data, or picture, is still there on the canvas it has not moved and it was not corrupted by this operation.

Step 3: Using a filesystem specific tool grow the file system within the bounds of the new picture frame.

The detailed steps follow.

## Step 1 Boot the BBB, and login as ROOT

Boot the BBB from the SD Card

## Step 2 Determine the current data partition, and start location

The goal is to device name that is the root partition, type the command: **df -Th /** The result will look like this:

**$ df -hT /**

**Filesystem Type Size Used Avail Use% Mounted on**

**/dev/mmcblk0p1 ext4 3.3G 2.8G 295M 91% /**

In this example, the image starts a 3.3Gig and is basically full, (only 9%, or 295Mbytes) free – this is why the image must be expanded to the full size of your SD Card. Otherwise the border router cannot build.

**Important Findings:**

* We find the data partition is: **/dev/mmcblk0p1**
* The device as a whole is: **/dev/mmcblk0**
* The **p1** suffix is the naming convention for Partition 1.
* Note: This image has a single partition, other images may additional partitions

## Step 3 Become Root

Become root if not already

**debian@beaglebone:~$ sudo bash**

**Note: default password is: temppwd**

**root@beaglebone:/home/debian#**

## Step 4 Start fdisk

Type the command **fdisk /dev/mmcblk0**

## Step 5 Print the current partition table

The fdisk **p** command prints the current partition table. Note: In this example, there is a single partition. Your image may be configured differently.

**root@beaglebone:/home/debian# fdisk /dev/mmcblk0**

**Welcome to fdisk (util-linux 2.25.2).**

**Changes will remain in memory only, until you decide to write them.**

**Be careful before using the write command.**

**Command (m for help): p**

**Disk /dev/mmcblk0: 7.2 GiB, 7744782336 bytes, 15126528 sectors**

**Units: sectors of 1 \* 512 = 512 bytes**

**Sector size (logical/physical): 512 bytes / 512 bytes**

**I/O size (minimum/optimal): 512 bytes / 512 bytes**

**Disklabel type: dos**

**Disk identifier: 0xca52207f**

**Device Boot Start End Sectors Size Id Type**

**/dev/mmcblk0p1 \* 8192 6963199 6955008 3.3G 83 Linux**

**Important findings:**

* **First:** the Start Sector number is **8192** (we will use this number below).
  + This image, the one and only data partition starts at 8192
  + Your image may have multiple partitions or start at a different location.
  + You are looking for the "Linux" partition.
* **Second:** The End Sector, in this example there is a single partition. Recall the first sector is sector 0, thus we take this value and add **1 (6963199+1) \* 512 = 3565158400**, which is the exact size of the original 'img' file we wrote to the SD CARD.

## Step 6 Delete the partition

**Command (m for help): d**

**Selected partition 1**

**Partition 1 has been deleted.**

**Important:**

* Do not remove the existing ext4 file system signature doing so would corrupt the data.

## Step 8 Create the new (replacement) partitions

Type the command: **n** to create the replacement partition.

**Important Notes:**

1. When creating the new partition is it critical to use the **SAME FIRST SECTOR** (see above) as the old partition.
2. Newer versions of the “fdisk” application, when creating the new partition will ask if it should ERASE the old disk ext4 signature (older versions do not) – Do not erase this signature. (Answer **n**) Otherwise the entire image becomes useless.

This example uses an 8Gig card, thus we use **+7G** for the partition size.

**Command (m for help): n**

**Partition type**

**p primary (0 primary, 0 extended, 4 free)**

**e extended (container for logical partitions)**

**Select (default p): p**

**Partition number (1-4, default 1): 1**

**First sector (2048-15126527, default 2048): 8192**

**Last sector, +sectors or +size{K,M,G,T,P} (8192-15126527, default 15126527): +7G**

**Created a new partition 1 of type 'Linux' and of size 7 GiB.**

**Partition #1 contains a ext4 signature.**

**Do you want to remove the signature [Y]/No: n**

## Step 9 Write the partition table to the disk

Use the **w** command to write the partition table to the disk.

**Command (m for help): w**

**The partition table has been altered.**

**Calling ioctl() to re-read partition table.**

**Re-reading the partition table failed.: Device or resource busy**

**The kernel still uses the old table. The new table will be used at the next reboot or after you run partprobe(8) or kpartx(8).**

## Step 10 Reboot & Error: fsck exited with status code 8.

Some images will have this error, other images will not. To fix this error, do the following:

Reboot the BBB

During the next boot - the BBB might complain as follows:

**Loading, please wait...**

**[ 4.873285] remoteproc1: failed to load am335x-pru0-fw**

**[ 4.918852] remoteproc1: request\_firmware failed: -2**

**[ 4.924046] pru-rproc 4a334000.pru0: rproc\_boot failed**

**[ 5.052414] remoteproc1: failed to load am335x-pru1-fw**

**[ 5.069652] remoteproc1: request\_firmware failed: -2**

**[ 5.074889] pru-rproc 4a338000.pru1: rproc\_boot failed**

**fsck: error 2 (No such file or directory) while executing fsck.ext4 for /dev/mmcblk0p1**

**fsck exited with status code 8**

After a short 20 second pause, the login prompt appears.

For now - Ignore this error, the error will be fixed in a few steps.

## Step 11 - Grow (resize) the actual file system.

In the previous step, and using the "picture frame" analogy - we have removed and replaced the smaller picture frame with a much larger picture frame. However we have not yet made the additional space within the frame available to the file system.

Once the BBB has rebooted, login and become root.

In this example the data partition is: **/dev/mmcblk0p1**, if it where partition 2, the parameter would be **/dev/mmcblk0p2**.

The resize command resizes the filesystem.

**(if needed, "sudo bash" to get the root prompt)**

**root@beaglebone:/home/debian# resize2fs /dev/mmcblk0p1**

**resize2fs 1.43 (17-May-2016)**

**Filesystem at /dev/mmcblk0p1 is mounted on /; on-line resizing required**

**old\_desc\_blocks = 1, new\_desc\_blocks = 1**

**The filesystem on /dev/mmcblk0p1 is now 1835008 (4k) blocks long.**

Note: The resize2fs command can also shrink a file system, which is beyond the scope of this document.

## Step 12 Reboot!

Reset and Reboot the Beagle Bone Black.

## Step 13 Fix the "fsck" problem (see above)

Once the BBB has rebooted, login.

We now solve the 'fsck' error we ignored above. The details are discussed in this Debian Form posting:

<http://forums.debian.net/viewtopic.php?f=17&t=127039>

The solution is to run this command:

**debian@beaglebone:~$ sudo update-initramfs -u**

**(Enter password if needed)**

**update-initramfs: Generating /boot/initrd.img-4.4.54-ti-r93**

## Step 14 To Clone the Card - Determine the last sector

This step is optional and used only if in the future you wish to “clone” a completed (pre-configured) SD Card and distribute it to your co-workers you will need to follow these steps. You do not need to perform this step now (and remember the number below) because you can always run the fdisk command again when needed.

The steps are:

* Run the fdisk command
* Use the p command to print the partition table.
* Calculate the end sector, and the total byte size
* Using an SD Card tool read the SD Card into a file, ie: “foobar.img”
* Use a tool to “truncate” the file: “foobar.img” at the calculated total byte size
* In the future, use an SD Card tool to write the new “foobar.img” file to various SD Cards.

See below for details:

**Command (m for help): p**

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**Disklabel type: dos**

**Disk identifier: 0xca52207f**

**Device Boot Start End Sectors Size Id Type**

**/dev/mmcblk0p1 8192 14688255 14680064 7G 83 Linux**

The important number above is the end sector: **14688255**.

In the future, you can use various tools to read the SD Card and save the image to share others.

**The problem:** Many GUI tools that read the entire SD card including the free area after the end of the partition up until the last sector of your specific SD Card and do not offer a means to read only a portion of the image. When writing to a new SD Card (which is a physically different card) there will probably be a different number of good & bad sectors. Thus the total byte size of the new SD Card might be smaller (7.999GB) than the image (8.0GB) and it will not fit on your new SD Card.

**The solution:**  Because (above) we used **+7G** as the new partition size, the data portion is not the entire SD Card image. Because we know the last used sector of the data partition we can calculate the entire byte size of the “data image” and truncate the IMG file at that byte offset.

The simplest method is to use the truncate command. The truncate command is a standard Unix command line tool, and it is also present in the MS-Windows Git Bash distribution of MSYS.

In this example:

* The last partition ends at sector: **14,688,255** (see above)
* Each sector is **512** bytes:
* Remember to add **+1**, to account for sector 0.
* The total size is: **(14,688,255+1) \* 512 = 7,520,387,072**

To truncate this example image use this command:

**truncate -s 7520387072 myimage.img**

## The End