How to Boot Linux on the Beagleboard
# Linux + BeagleBoard in 40 minutes

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Total: 40 minutes
What is a BeagleBoard?

General-Purpose Small System Reference Platform for OMAP3

Single-Board Computer

- Fully self-contained
- USB 2.0, DVI-D
- SD/MMC+ expansion
- ARM Cortex-A8
- 3D HD video (720p)
- 128MB – 512MB RAM
- operates on 2W, no fan needed
What is a BeagleBoard?

Community-driven
- Portal
- Discussion groups
- Wiki
- IRC
- Google Summer of Code mentorship

Open hardware
- Gerbers, schematics, BOM freely available
- Opportunities for expansion & redevelopment
What is a BeagleBoard?

For Hobbyists:
Cheap, powerful, hackable computer

- Lots of memory
- Runs Linux out of the box
- Supports tons of peripherals
- Interfaces easily with microcontrollers like the Arduino
- Can be powered via USB, no fan
- Easily restored from “brick” status
- Friendly, highly accessible community
- Lots of add-on toys available

The BeagleBot
What is a BeagleBoard?

For Embedded & Mobile Developers: OMAP3 Reference Platform

Revision C:
- OMAP3530
- ARM Cortex-A8 @600MHz
- PowerVR SGX530 OpenGL/ES 3D
- TMS320C64x+ DSP
- 256MB LPDDR
- USB2 OTG, JTAG, expansion area
- SD/MMC+
- 1200 DMIPS

BeagleBoard Rev. C
What is a BeagleBoard?

For Embedded & Mobile Developers: OMAP3 Reference Platform

Revision xM:
- OMAP3630
- ARM Cortex-A8 @1GHz
- PowerVR SGX530 OpenGL/ES 3D
- TMS320C64x+ DSP
- 512MB LPDDR
- USB2 OTG, USB2 x4, JTAG
- microSD
- I²C/I²S/SPI/MMC expansion area
- onboard ethernet
- 2000 DMIPS

BeagleBoard Rev. xM
What can I do with it?

For Hobbyists: Inexpensive DIY High Technology

- Robotics
- DIY Drones (unmanned aerial vehicles)
- DIY tablet PCs, laptops, mobile phones
- Solar powered computing
- Gaming
- Introduction to ARM-based SOCs, TI OMAP programming, embedded Linux, digital signal processing, 3D video accel
- Homemade video player
- Extremely low-power home server

- Over 160 projects registered

LiquidWare BeagleTouch Gadget Pack
What can I do with it?

For Embedded & Mobile Developers: Basis for custom ARM-based projects

- Put one on every developer’s desk
- Run Angstrom, Android, MeeGo
- Schematics available – redesign to suit
- Ubiquitous & inexpensive

Always Innovating
TouchBook
What about community?

established, vibrant community

http://beagleboard.org

- official home
- news & blog feeds
- documentation & schematics
- project portal
- resources & links to distributors
- TI-sponsored project contest
- support
What about community?

wiki

http://eLinux.org/BeagleBoard

- wiki sponsored by CE Linux Forum
- community-created documentation
- examples, advice, discussions in comments
- links to other resources
What about community?

discussion groups & code repositories

BeagleBoard group on code.google.com

also:
• BeagleBoard Japan
• BeagleBoard Brazil
What about community?

live chat (IRC)

http://beagleboard.org/chat  or  
http://webchat.freenode.net/?channels=beagle  or  
#beagle on irc.freenode.net

- chat live with community & maintainers
- ask questions, get answers
What about community?

professional & social communities

- **Texas Instruments focus & gforge**
  - focus: E2E discussion groups
  - gforge: project code repository

- **Meld**
  - embedded Linux discussion groups
  - specific group on TI platforms

- **BeagleBoard on Facebook, Twitter**
  - social media & news aggregation
How do I make it go?

Obtain Stuff

• Hardware
  – the board itself
  – cables & connectors
  – SD card
• Peripherals (optional)
  – powered USB hub with Ethernet
  – USB keyboard, mouse
  – touchscreen
• Software & Documentation
  – operating system: start with Ångström
How do I make it go?

The board itself

Official distributors:

• Digi-Key (World-wide)
• Mouser (World-wide)
• IDA Systems (India)
• SparkFun
• Special Computing
• Watterott Electronic (Germany)
• Liquidware
How do I make it go?

cables & connectors

• Serial cables – connect to your host PC
  – IDC10 – DB9
  – DB9 null modem
  – optional: DB9 – USB A

• Power connectors
  – USB A – mini-B
  – 5mm USB barrel connector
    or 5W/2.5A power supply
How do I make it go?

cables & connectors

- **USB & networking**
  - USB A – USB mini-B OTG
  - 3-port powered USB hub with integrated Ethernet & power supply

- **Keyboard, video, mouse**
  - USB keyboard & mouse
  - HDMI to DVI-D cable
  - DVI-D display or touchscreen
How do I make it go?

software & documentation

• Operating system
  – start with Ångström:
    - ordered on SD card
    - downloaded
    - included (on rev. xM)
  – other operating software discussed shortly...

• Documentation
  – System Reference Manual (download)
  – scour the wiki at eLinux.org/BeagleBoard
How do I make it go?

format the SD card

• Boot partition
  FAT16 filesystem:
  – MLO (X-loader)
  – u-boot.bin (U-boot)
  – uImage (Linux kernel)
  – boot.scr (boot script)

  *jefro@pleiades:*~$ ls -l /media/boot
  total 2688
  -rwx------ 1 jefro root 20392 2010-07-10 14:54 mlo
  -rwx------ 1 jefro root 726608 2010-07-10 14:54 u-boot.bin
  -rwx------ 1 jefro root 2004680 2010-07-10 14:54 uImage

  *jefro@pleiades:*~$ ls -l /media/root
  total 52
  drwxr-xr-x 2 root root 4096 2010-07-06 14:19 bin
  drwxr-xr-x 3 root root 4096 2010-07-06 14:19 boot
  drwxr-xr-x 2 root root 4096 2010-07-06 14:19 dev
  drwxr-xr-x 67 root root 4096 2010-07-06 14:19 etc
  drwxr-xr-x 3 root root 4096 2010-07-06 14:19 home
  drwxr-xr-x 6 root root 4096 2010-07-06 14:19 lib
  drwxr-xr-x 10 root root 4096 2010-07-06 14:19 media
  drwxr-xr-x 3 root root 4096 2010-07-06 14:19 mnt
  drwxr-xr-x 2 root root 4096 2010-07-06 14:19 proc
  drwxr-xr-x 3 root root 4096 2010-07-06 14:19 sbin
  drwxr-xr-x 2 root root 4096 2010-07-06 14:19 sys
  drwxr-xr-t 2 root root 4096 2010-07-06 14:19 tmp
  drwxr-xr-x 12 root root 4096 2010-07-06 14:25 usr

• Root filesystem partition
  – ext2, JFFS2, SQUASHFS
  – Linux root filesystem
How do I make it go?

Connect Stuff

to display

serial to host PC
optionally via DB9-USB

Ethernet
keyboard
mouse
How do I make it go?

set up serial console

• Linux hosts: minicom
  – minicom -s to set up serial port
  – serial = /dev/ttyS0
  – serial-USB = /dev/ttyUSB0
  – 115200 8N1, no flow control

• Windows hosts:
  – PuTTY (or HyperTerminal 😞)

• Mac hosts:
  – screen
How do I make it go?

Power up! Boot to the bootloader

- Rev C loads MLO & u-boot from NAND by default
  - hold down user button to boot from SD
- xM has no NAND
  - boots from SD
  - card must have MLO & u-boot

Texas Instruments X-Loader 1.4.2 (Jan 19 2010 - 02:16:08)
Reading boot sector
Loading u-boot.bin from mmc

U-Boot 2009.08 (Jan 26 2010 - 17:13:54)
OMAP3530-GP ES2.1, CPU-OPP2 L3-165MHz
OMAP3 Beagle board + LPDDR/NAND
DRAM: 128 MB
NAND: 256 MiB
In: serial
Out: serial
Err: serial
Board revision Ax/Bx
Die ID #19ea00020000000004013ef108019005
Hit any key to stop autoboot: 0
How do I make it go?

set boot arguments

- **U-boot process driven by environment variables**
  - `printenv` lists all env vars
  - `bootargs` lists all kernel arguments
  - `bootcmd` is the default boot command
  - can customize different boot setups
  - `saveenv` saves variables to flash for next boot

```bash
setenv bootargs 'console=ttyS0,115200n8 root=/dev/mmcblk0p2 rw rootwait'
setenv bootcmd 'mmcinit; fatload mmc 0 80200000 uImage; bootm 80200000'
```

- **Complex boot scripts can be saved & invoked on boot**
  - `boot.scr` invoked by default, see env var
    - `loadbootscript`
How do I make it go?

boot Ångström Linux

```
OMAP3 beagleboard.org # boot
mmc1 is available
reading uImage

3189432 bytes read
## Booting kernel from Legacy Image at 80200000 ...
   Image Name: Angstrom/2.6.32/beagleboard
   Image Type: ARM Linux Kernel Image (uncompressed)
   Data Size: 3189368 Bytes = 3 MB
   Load Address: 80008000
   Entry Point: 80008000
   Verifying Checksum ... OK
   Loading Kernel Image ... OK
OK

Starting kernel ...

Uncompressing Linux............................................................

[ 0.000000] Linux version 2.6.32 (koen@dominion) (gcc version 4.3.3 (GCC) ) 0
[ 0.000000] CPU: ARMv7 Processor [411fc082] revision 2 (ARMv7), cr=10c53c7f
[ 0.000000] CPU: VIPT nonaliasing data cache, VIPT nonaliasing instruction ce
[ 0.000000] Machine: OMAP3 Beagle Board
[ 0.000000] Memory policy: ECC disabled, Data cache writeback
```
Let’s see it run!

Ångström Linux
MontaVista Linux
Ubuntu Linux
Android
MeeGo
Let’s see it run!

Ångström Linux

• Created by OpenEmbedded, OpenZaurus, & OpenSimpad developers
• Uses OpenEmbedded
• Very small footprint
• Full desktop
• De facto BeagleBoard Linux
• Supports all hardware revs
• Ships on SD card with BeagleBoard xM
Let’s see it run!

MontaVista Linux

- Professional embedded Linux distribution with toolchains, BitBake-based build tools, DevRocket IDE, guaranteed content repository
- Highly scalable: CGE, RTOS, Mobile
- Commercial support & PS
- Dozens of supported platforms
- Basis for many, many products, including Dell Latitude ON
- Sponsored embedded Linux community: meld.mvista.com
Let’s see it run!

Ubuntu 10.04

• Most popular Linux desktop system
• Well-understood
• Extremely large community
• Port is ongoing by professional team at Canonical
Let’s see it run!

Android

• Ubiquitous mobile platform
• Inexpensive full development platform on real ARM Cortex-A8 hardware
• Three active ports:
  - Emunix
  - oxdroid
  - rowboat (Mentor Graphics)
Let’s see it run!

MeeGo

• Awesome offspring of Nokia’s Maemo and Intel’s Moblin
• Hosted & shepherded by the Linux Foundation
• Very interesting fully-open challenger to Android
• BeagleBoard port in progress
Resources

Operating Systems

• Ångström: http://angstrom-distribution.org (2GB minimum)

• MontaVista Linux (Montabello): http://mvista.com


• MeeGo: http://wiki.meego.com/ARM/MeeGo_on_the_Beagle (4GB)
Jeffrey Osier-Mixon
408 MR OSIER
jefro@jefro.net
http://www.jefro.net