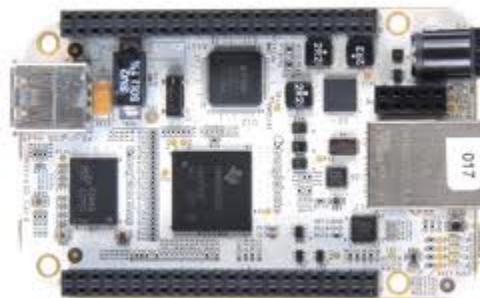




The Beagle Workshop

Teaching with Embedded Linux



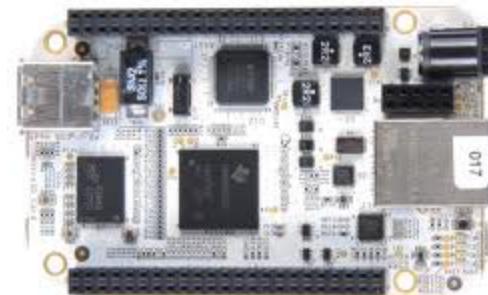
By

Mark A. Yoder

Rose-Hulman Institute of Technology

Outline

- Introductions
- Out-of-the-box
- Flash built-in LEDs
- Wiring other devices
- Beagle Community
- Button Box Demo
- Wrap Up



Introductions

- You
- Me
- Beagle

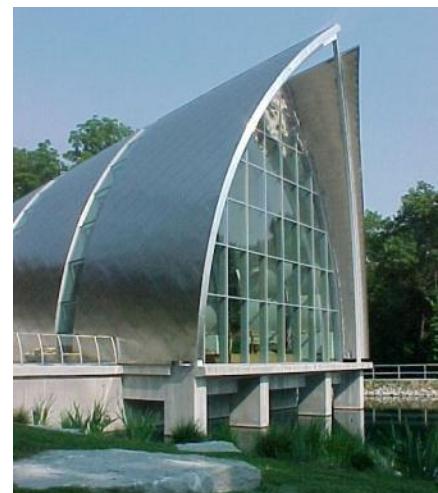
You

- Who is analog
- Who is digital
- Who has worked with microprocessors
- Who has worked with Linux

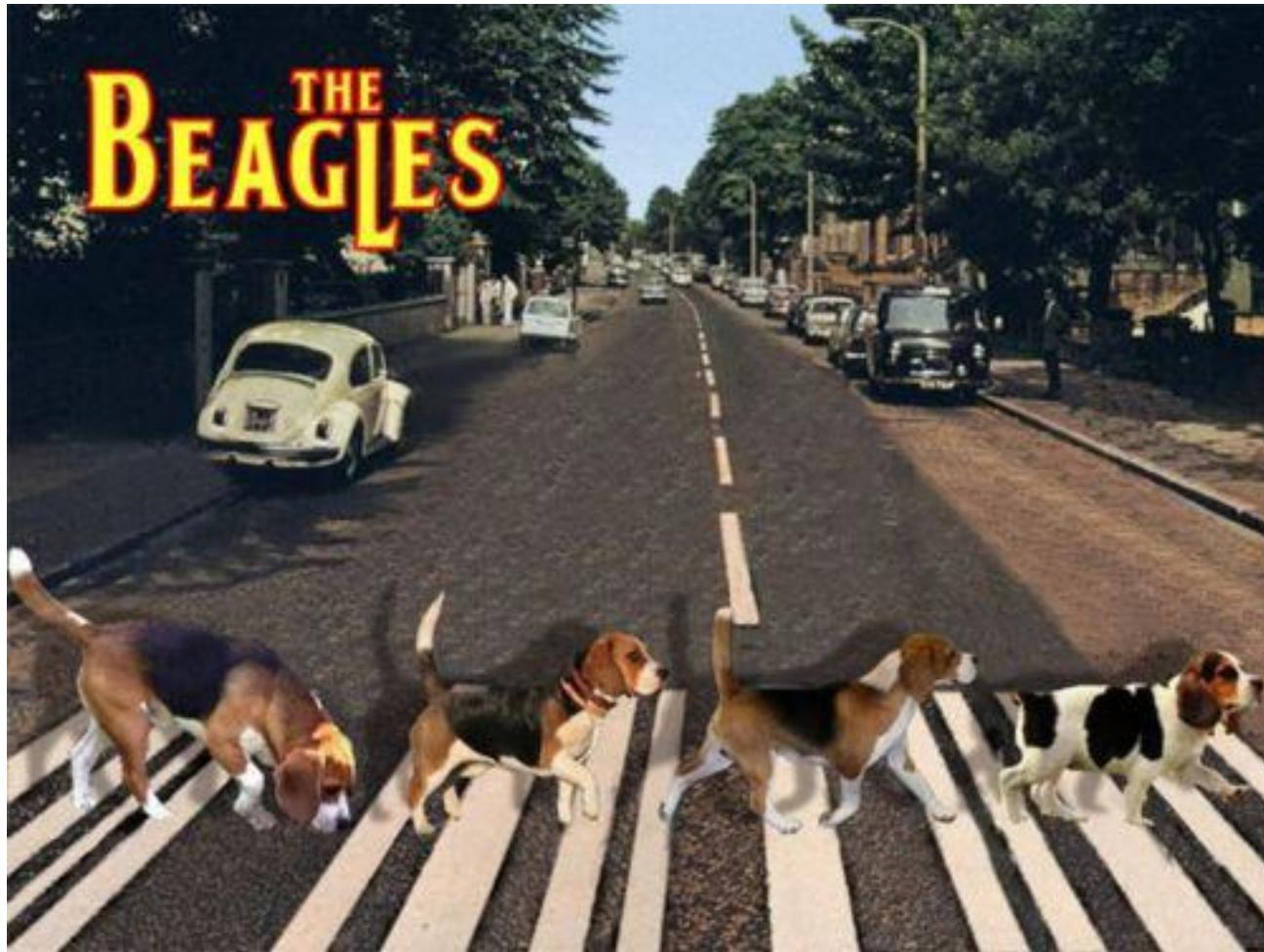


Rose-Hulman Institute of Technology

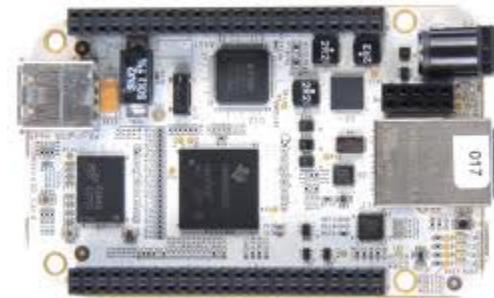
- Private engineering school
- About 2000 students
- Teaching
- No PhDs – Small masters program
- Terre Haute, Indiana, USA
- #1 ranking 13 years running
 - US News & World Report
- All students have laptops



Introducing...



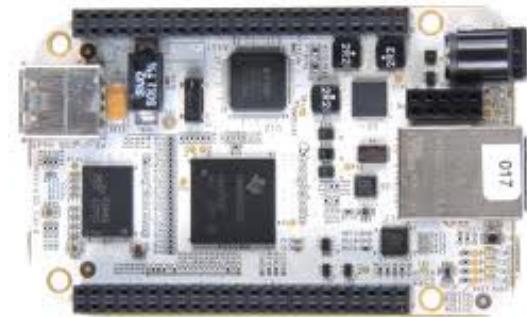
The Beagles



- Original
- 720MHz
- 256M RAM
- 1.8V
- \$120
- xM
- 1GHz
- 512M RAM
- 1.8V
- \$150
- Bone
- 720MHz
- 256M RAM
- 3.3V
- \$90

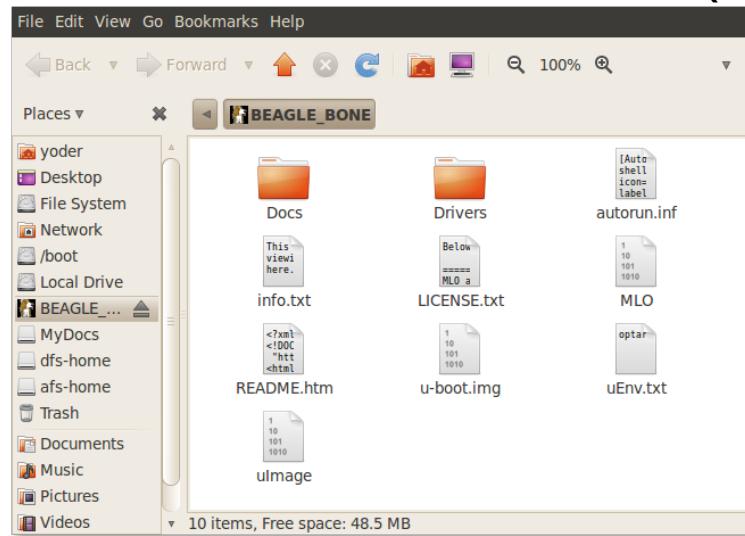
Outline

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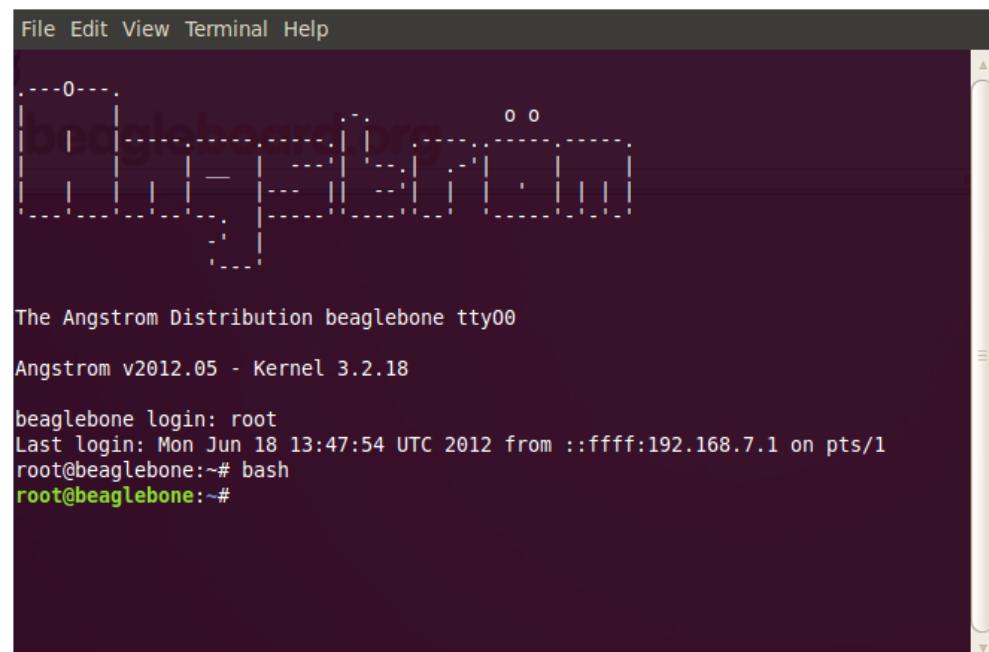
Out-of-the-box

- Attach the Beagle to the host via USB
- BEAGLE_BONE folder appears on host
- Open and explore
- Eject BEAGLE_BONE
- Open terminal on host (Ctrl-Alt-T)



Out-of-the-box

- Eject BEAGLE_BONE
- Open terminal on host (Ctrl-Alt-T)
- Enter: **screen /dev/ttyUSB1 115200**
- Login is **root**
- Explore
- Try: **gedit**



The screenshot shows a terminal window with a dark background and a light gray border. The window title is "File Edit View Terminal Help". The terminal content is as follows:

```
The Angstrom Distribution beaglebone tty00
Angstrom v2012.05 - Kernel 3.2.18
beaglebone login: root
Last login: Mon Jun 18 13:47:54 UTC 2012 from ::ffff:192.168.7.1 on pts/1
root@beaglebone:~# bash
root@beaglebone:~#
```

Out-of-the-box

- Open Firebox on host
- Browse: 192.168.7.2
- Explore



Out-of-the-box

- Open another terminal on host
- Enter:

```
host$ cd exercises/setup
```

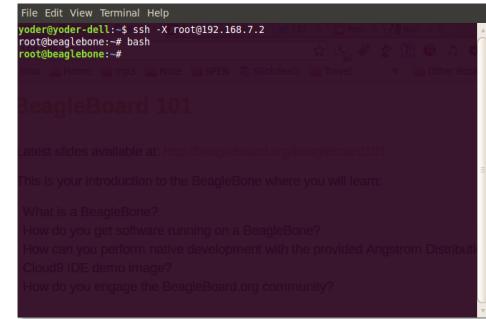
```
host$ ls
```

```
host$ ./host.ipForward.sh
```

```
host$ ssh -X root@192.168.7.2
```

- No password
- Explore

```
beagle$ ping google.com
```



A screenshot of a terminal window titled "BeagleBoard 101". The window shows a slide with the following content:

```
File Edit View Terminal Help
yoder@yoder-dell:~$ ssh -X root@192.168.7.2
root@beaglebone:~# bash
root@beaglebone:~#
```

BeagleBoard 101

latest slides available at: <http://beagleboard.org/beagleboard101>

this is your introduction to the BeagleBoard where you will learn:

- What is a BeagleBoard?
- How do you get software running on a BeagleBoard?
- How can you perform native development with the provided Angstrom Distribution?
- Cloud9 IDE demo image?
- How do you engage the BeagleBoard.org community?

Getting course materials

- On host run

```
host$ cd exercises
```

```
host$ git pull
```

- On the beagle run (optional)

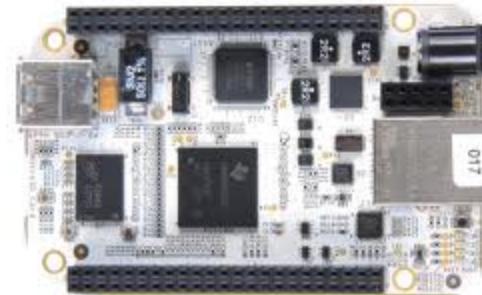
```
beagle$
```

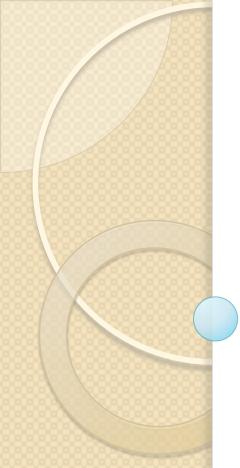
```
git clone git://github.com/MarkAYoder/BeagleBoard-exercises  
exercises
```

- This will copy my exercises on your beagle

Outline

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In Linux, everything is a file

Learning about Linux through SYSFS

Thanks to Bill Gatliff

What is SYSFS?

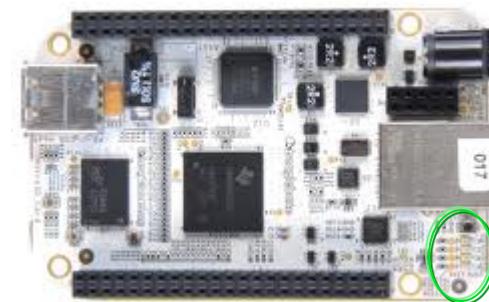
- Virtual file system that exposes drivers to userspace
- beagle\$ **cd /sys/class**
- beagle\$ **ls**

backlight	firmware	lcd	net	scsi_device	tty
bdi	gpio	leds	power_supply	scsi_disk	udc
block	graphics	mbox	pwm	scsi_generic	usb_device
bluetooth	hwmon	mdio_bus	regulator	scsi_host	vc
bsg	i2c-adapter	mem	rfkill	sound	video4linux
devfreq	i2c-dev	misc	rtc	spi_master	vtconsole
display	input	mmc_host	scsi_changer	spidev	

- Let's go through some examples...

Hands On: Test USR2 LED

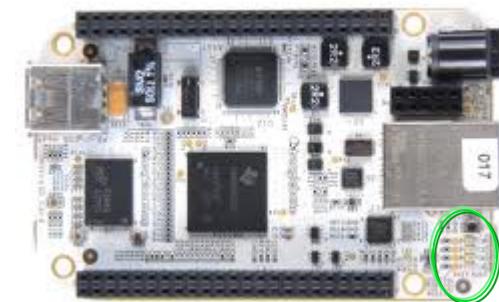
```
beagle$ cd /sys/class/leds  
beagle$ ls  
beagle$ cd "beaglebone::usr2"  
beagle$ ls  
brightness device  
max_brightness power subsystem  
trigger uevent  
beagle$ cat brightness  
0  
beagle$ echo 1 > brightness  
beagle$ cat brightness  
1
```



USR2 LED will Turn on and off.

Hands On: Test USR0 LED

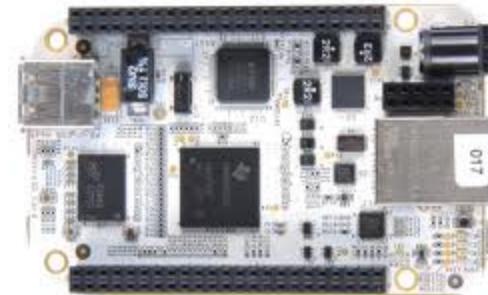
```
beagle$ cd /sys/class/leds
beagle$ ls
beagle$ cd "beaglebone::usr0"
beagle$ ls
brightness  device
max_brightness  power  subsystem
trigger  uevent
beagle$ cat trigger
none mmc0 timer [heartbeat]
backlight gpio default-on
beagle$ echo none > trigger
beagle$ echo timer > trigger
beagle$ ls
beagle$ echo timer > trigger
brightness  delay_on  max_brightness
subsystem  uevent
delay_off  device  power  trigger
```



USR0 LED will Turn on and off.

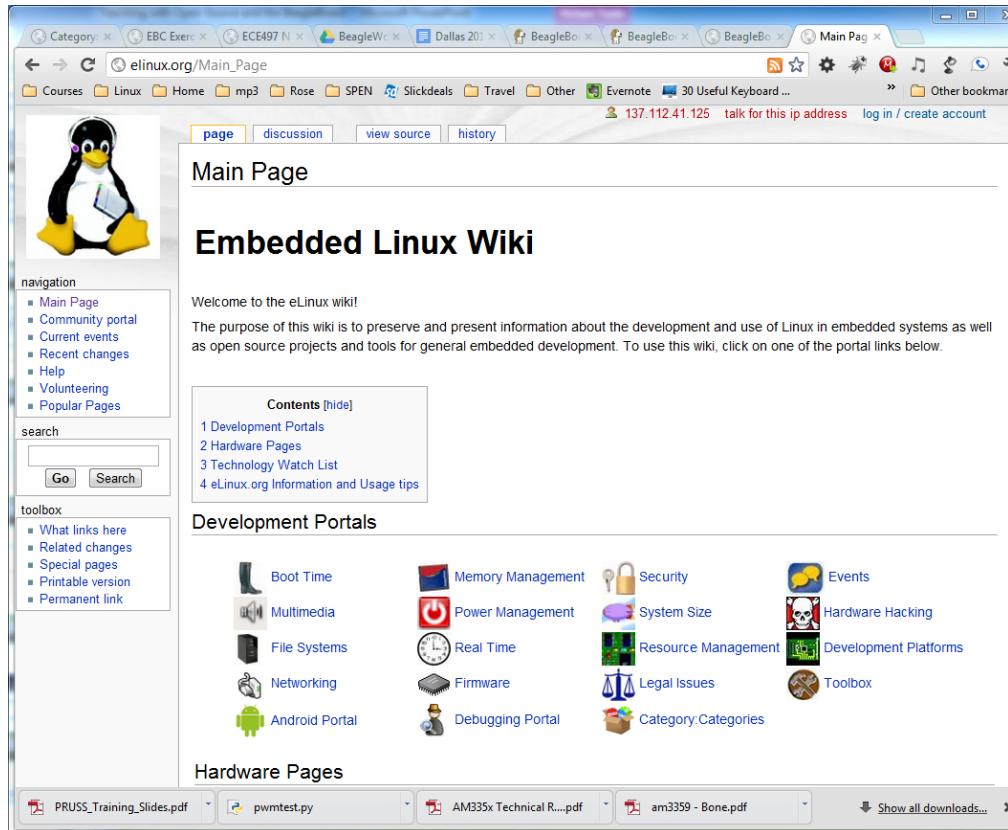
Outline

- Introductions
- Out-of-the-box
- Flash built-in LEDs
- Wiring other devices
 - LED
 - Switch
 - Analog In
- Beagle Community
- Button Box Demo
- Wrap Up



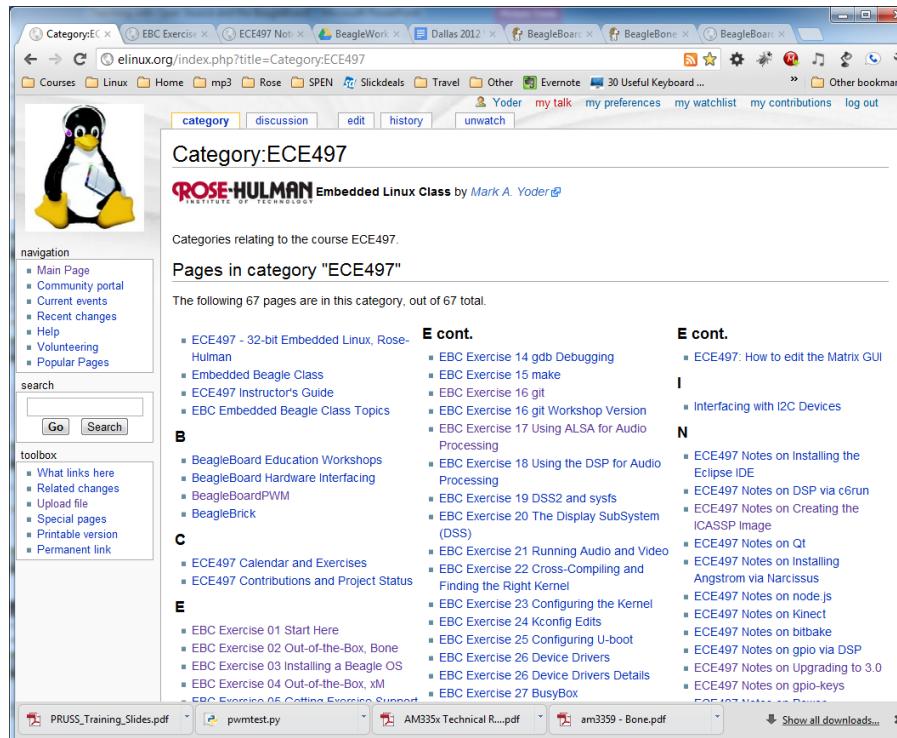
Wire Your Own

- On your host, browse to
- <http://eLinux.org>



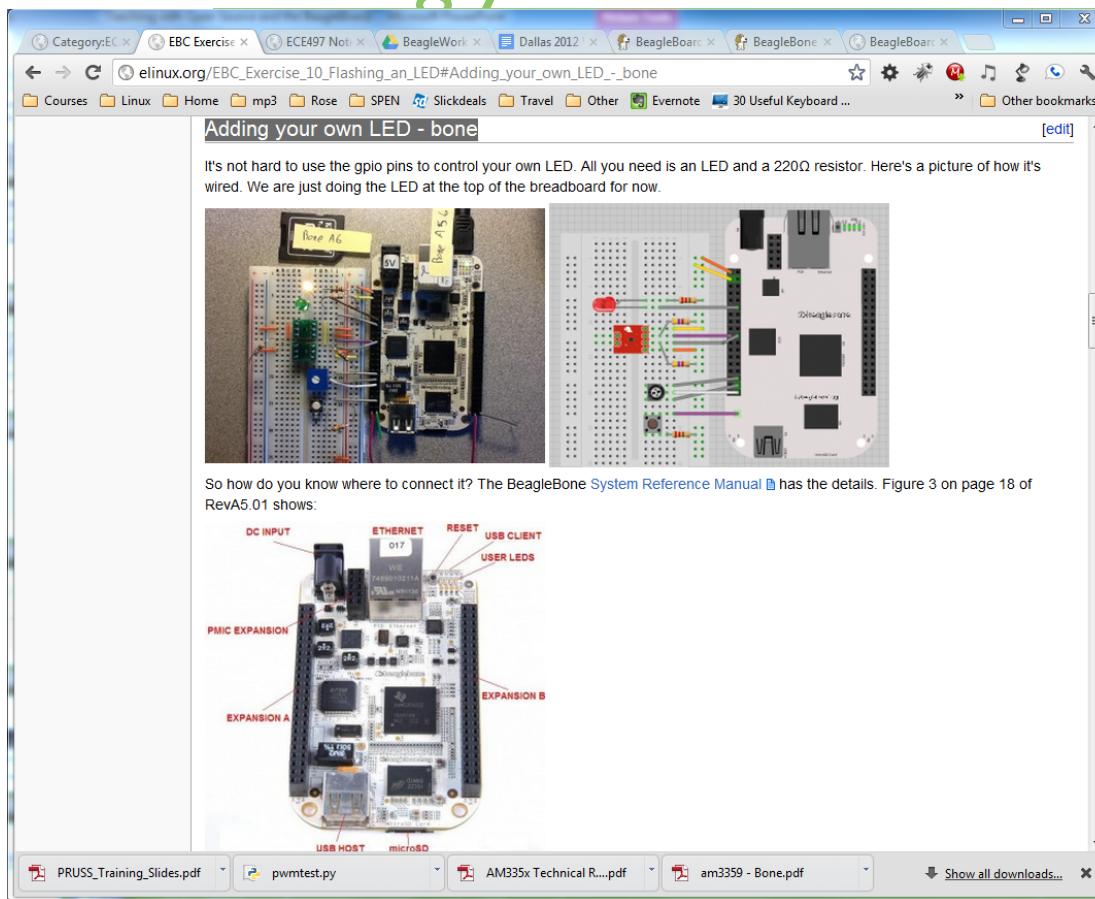
Wire Your Own

- On your host, browse to
- <http://elinux.org/index.php?title=Category:ECE497>
- Most of my course materials are here



Wire Your Own

- Click on EBC Exercise 10 Flashing an LED
- Click on Adding your own LED - bone



Wire Your Own

- Follow the directions for the
 - LED
 - Switch and
 - Analog in

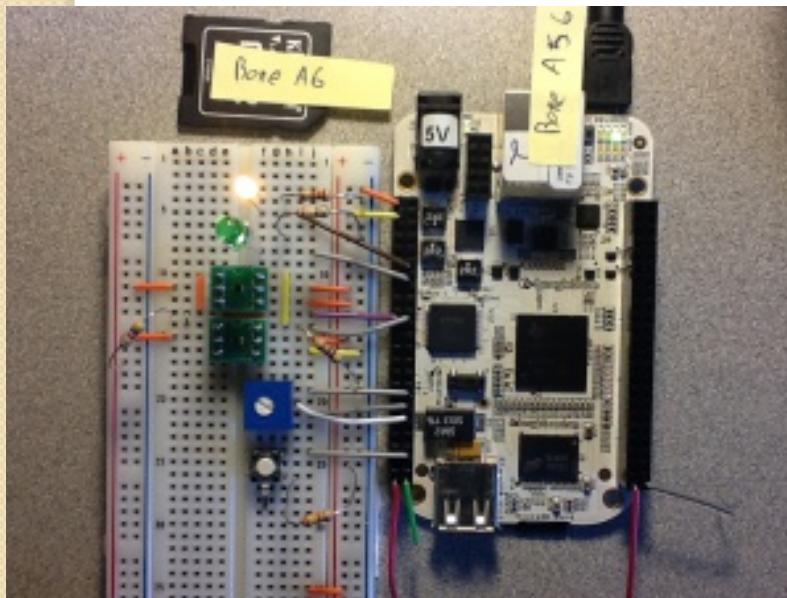


Table 11. Expansion Header P9 Pinout

SIGNAL NAME	PIN	CONN	PIN	SIGNAL NAME
	GND	1	2	GND
	VDD_3V3EXP	3	4	VDD_3V3EXP
	VDD_5V	5	6	VDD_5V
	SYS_5V	7	8	SYS_5V
PWR_BUT*	9	10	A10	SYS_RESETn
UART4_RXD	T17	11	U18	GPIO1_28
UART4_TXD	U17	13	U14	EHRPWM1A
GPIO1_16	R13	15	T14	EHRPWM1B
I2C1_SCL	A16	17	B16	I2C1_SDA
I2C2_SCL	D17	19	D18	I2C2_SDA
UART2_TXD	B17	21	A17	UART2_RXD
GPIO1_17	V14	23	D15	UART1_TXD
GPIO3_21	A14	25	D16	UART1_RXD
GPIO3_19	C13	27	C12	SPI1_CS0
SPI1_D0	B13	29	D12	SPI1_D1
SPI1_SCLK	A13	31	VDD_ADC(1.8V)	
AIN4	C8	33	GNDA_ADC	
AIN6	A5	35	A5	AIN5
AIN2	B7	37	A7	AIN3
AIN0	B6	39	C7	AIN1
CLKOUT2	D14	41	C18	GPIO0_7
	GND	43	GND	
	GND	45	GND	

If time permits...

- Try the i2c exercise
- [http://elinux.org/EBC Exercise 12 I2C](http://elinux.org/EBC_Exercise_12_I2C)

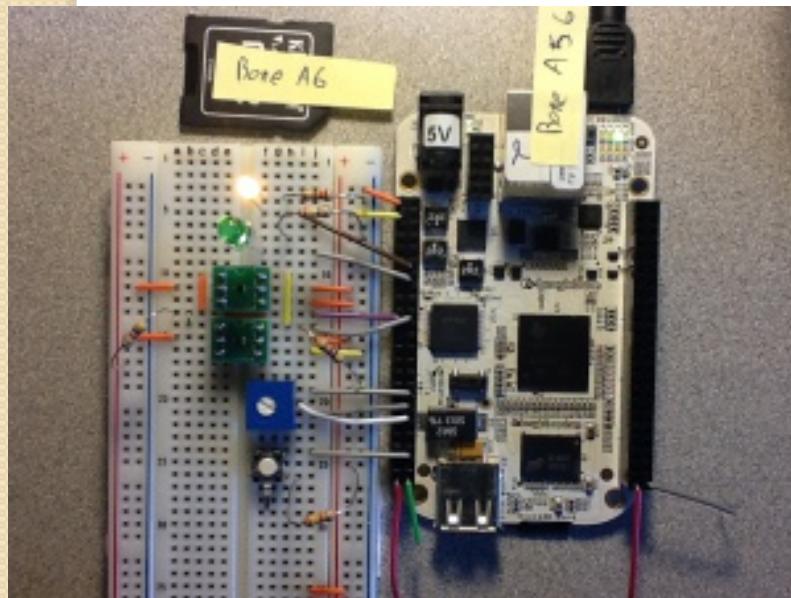
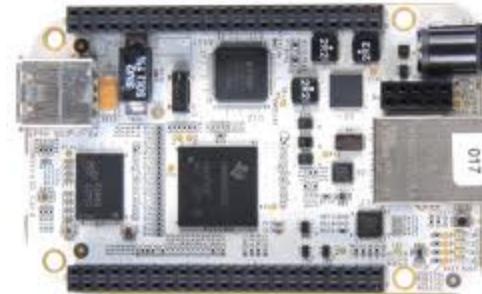


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UART4_TXD	U17	13	U14	EHRPWM1A
GPIO1_16	R13	15	T14	EHRPWM1B
I2C1_SCL	A16	17	B16	I2C1_SDA
I2C2_SCL	D17	19	D18	I2C2_SDA
UART2_TXD	B17	21	A17	UART2_RXD
GPIO1_17	V14	23	D15	UART1_TXD
GPIO3_21	A14	25	D16	UART1_RXD
GPIO3_19	C13	27	C12	SPI1_CS0
SPI1_D0	B13	29	D12	SPI1_D1
SPI1_SCLK	A13	31	VDD_ADC(1.8V)	
AIN4	C8	33	GNDA_ADC	
AIN6	A5	35	A5	AIN5
AIN2	B7	37	A7	AIN3
AIN0	B6	39	C7	AIN1
CLKOUT2	D14	41	C18	GPIO0_7
	GND	43	GND	
	GND	45	GND	

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The Community

- eLinux.org
- BeagleBoard.org
- Google Group
- IRC

BeagleBoard.org

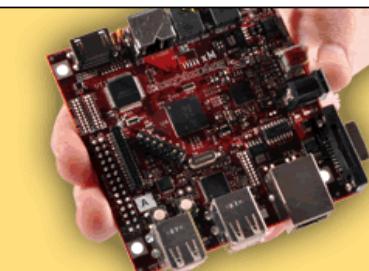


beagleboard.org

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BeagleBoard-xM
\$149*

Popular BeagleBoard.org open development boards

- Based on TI ARM® Cortex™-A8 processors
- Flexible USB and low-level expansion
- Develop anywhere with low-power operation
- Active community with thousands of developers

[Start Developing Today!](#)



BeagleBone
\$89*

* suggested sales price

Getting Started

- ▶ Official documentation
 - BeagleBone README
 - BeagleBoard-xM SRM
 - BeagleBoard SRM
- ▶ eLinux Wiki
 - For Beginning Users
 - For Advanced Users
- ▶ Getting Help
 - Mailing list and IRC
 - Read the FAQ
 - Support Resources
- ▶ Design Source Materials

Top Projects

Take a look at what others have done with the Beagle Board.

Latest News

[Add this feed to your page](#)

BeagleBoard.org



[Connecting Arduino to BeagleBone as first project](#)

Connecting Arduino to BeagleBone as first project X-firm Systems » Blog Archive » First little project with the Beaglebone - My small projects...

[Blogger building motion capture camera to monitor use of wildlife tunnels by amphibians installs ...](#)

Blogger building motion capture camera to monitor use of wildlife tunnels by amphibians installs Ubuntu on BeagleBone BeagleBone - ubuntu precise 12.04 armhf

[OpenROV releases cape for BeagleBone on](#)

Events

[Summer Workshops at Stanford](#)

July 16-20 and July 23-27

[BeagleBoard.org at DESIGN West](#)



[Playlist BeagleBoard.org home page \(4 videos\)](#)

[Today](#) [◀](#) [▶](#) [Wednesday, July 25](#) ▾

[Tuesday, July 31](#)

Google Group

- <https://groups.google.com/forum/#!forum/beagleboard>

Google Groups

Search for topics

Mark Yoder 0 + Share

Groups

NEW TOPIC

Mark all as read

C

!

Filters

Tags

Settings

My groups

Home

Starred

Announcements

Google Groups Announce...

Recently viewed

BeagleBoard ECE497

BeagleBoard Workshop

BeagleBoard

Socket.IO

nodejs

Recent searches

Recently posted to

Favorites

ITS-SPFIRST

BeagleBoard

BeagleBoard

BeagleBone: Maintaining Sub-repository to ease upstream effort

By Hiremath, Vaibhav - 3 posts - 917 views - updated Feb 6

BeagleBone announcement

By Jason Kridner - 54 posts - 1488 views - updated 12/19/11

Need information regarding beagle speech scrambler

By vinod - 7 posts - 316 views - updated 8/24/11

SD card questions...

By johnny zed - 1 post - 1 view - updated 2:48 PM (12 minutes ago)

Cross-compiling a sample OpenCV cpp for BeagleBone

By zero - 7 posts - 39 views - updated 2:27 PM (33 minutes ago)

How to solder on the beagleboard

By Lioric - 6 posts - 15 views - updated 1:54 PM (1 hour ago)

Adding CAN Bus (can0) device to BeagleBone

By Brent - 26 posts - 253 views - updated 1:21 PM (1 hour ago)

Trainer xm Board - I2C

By Vasilis - 3 posts - 13 views - updated 12:20 PM (2 hours ago)

What is the resistance of GPIO pins on the beaglebone

By Conqueror - 3 posts - 5 views - updated 9:53 AM (5 hours ago)

low cpu clock on ubuntu armhf

By gerald - 2 posts - 4 views - updated 9:30 AM (5 hours ago)

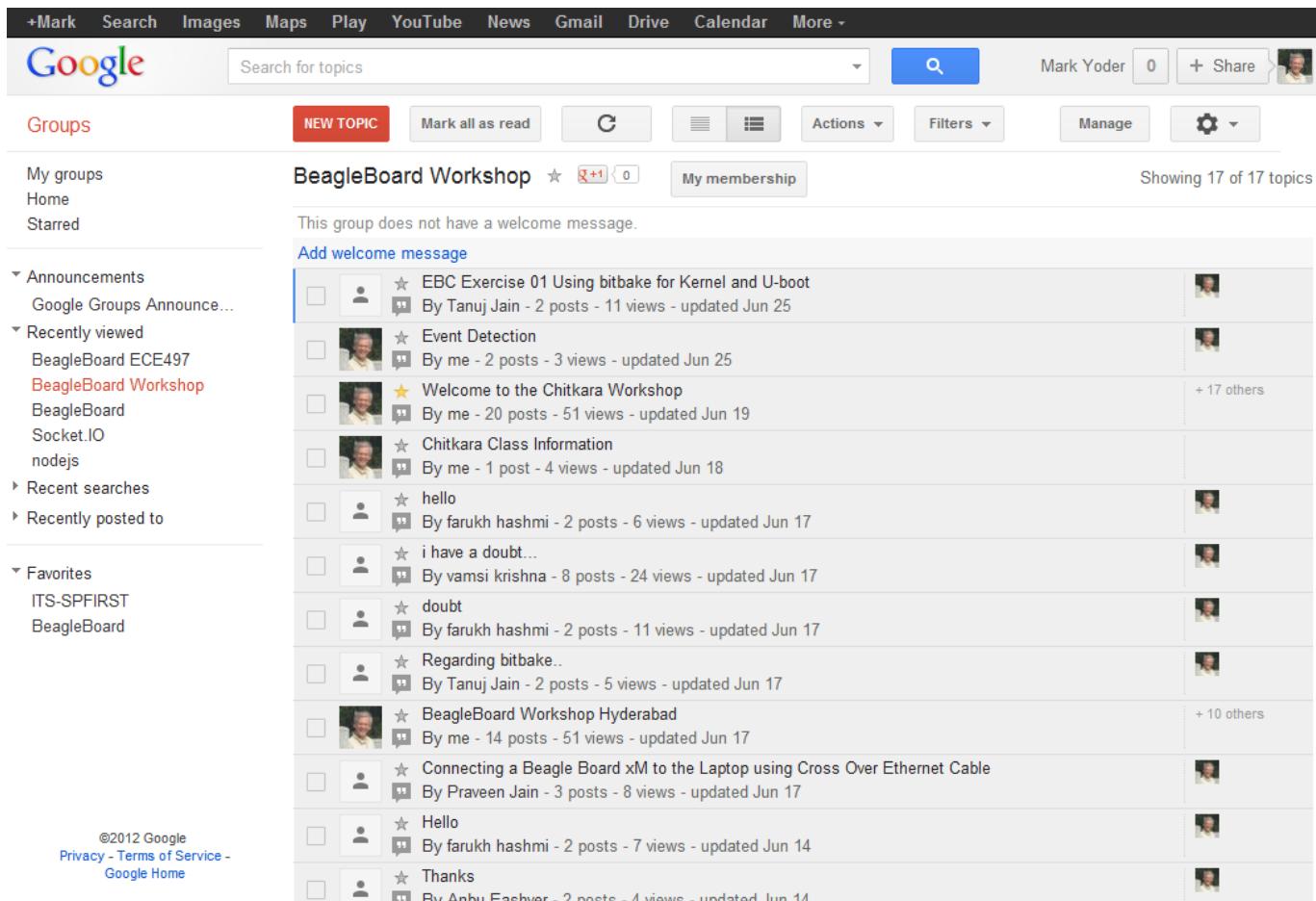
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Google Home

Google Group for Workshop

- <https://groups.google.com/forum/#!forum/beagleboard-workshop>
- Go a post a note...



The screenshot shows the Google Groups interface for the "BeagleBoard Workshop" group. The left sidebar shows navigation links for Groups, My groups, Home, Starred, Announcements, Recently viewed, Recent searches, Recently posted to, and Favorites. The main content area displays the "BeagleBoard Workshop" group with 17 topics. The topics listed are:

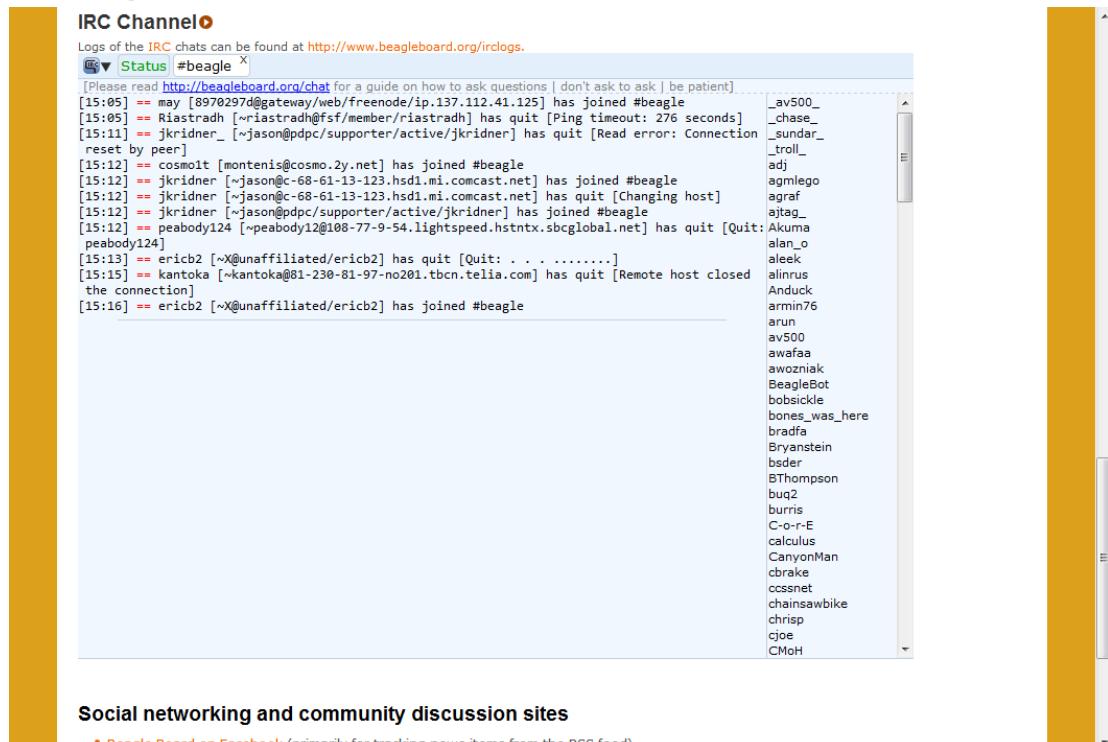
- EBC Exercise 01 Using bitbake for Kernel and U-boot
- Event Detection
- Welcome to the Chitkara Workshop
- Chitkara Class Information
- hello
- i have a doubt...
- doubt
- Regarding bitbake..
- BeagleBoard Workshop Hyderabad
- Connecting a Beagle Board xM to the Laptop using Cross Over Ethernet Cable
- Hello
- Thanks

Each topic includes a small profile picture, a star icon, a message icon, the number of posts and views, and the last update date.

At the bottom left, there is a copyright notice: ©2012 Google, Privacy - Terms of Service - Google Home.

IRC

- Go to: <http://beagleboard.org/discuss>
- Scroll to bottom
- Post something

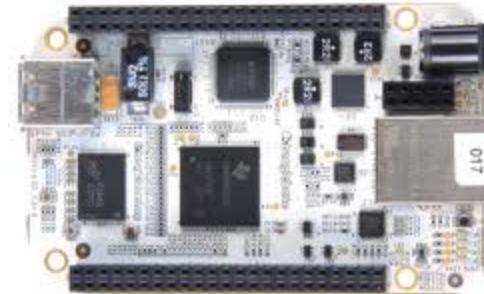


Social networking and community discussion sites

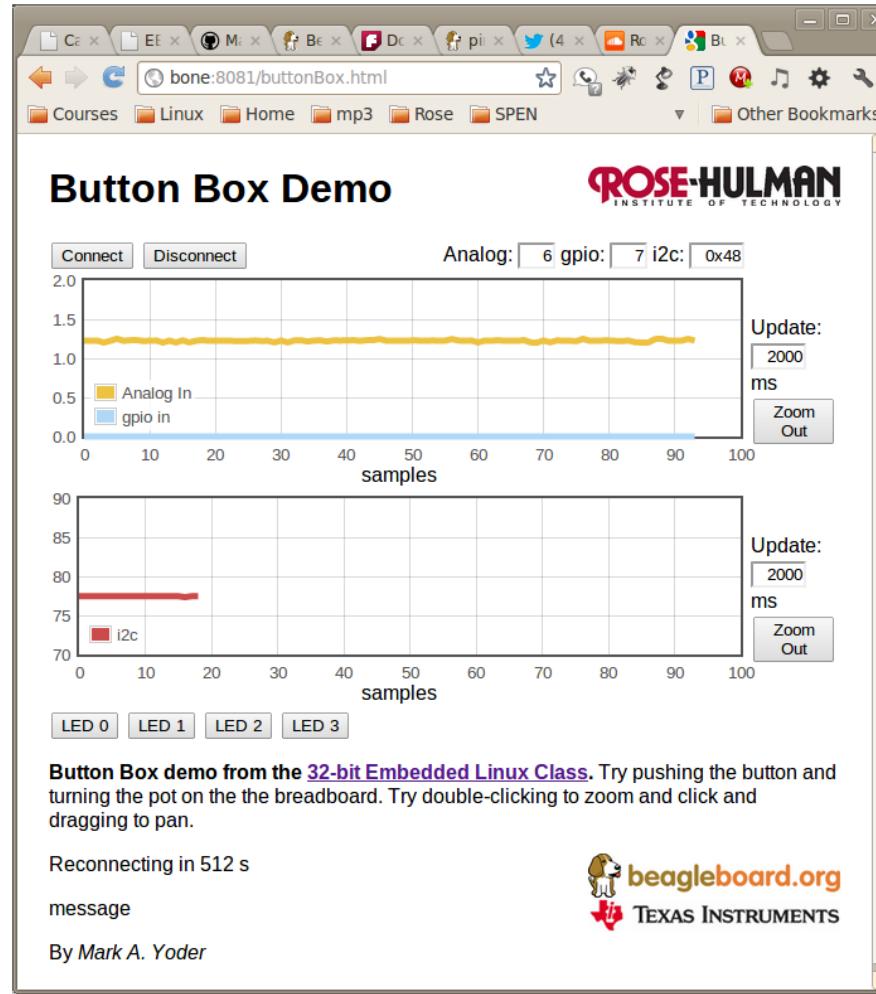
- Beagle Board on Facebook (primarily for tracking news items from the RSS feed)

Outline

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- Flash built-in LEDs
- Wiring other devices
- Beagle Community
- **Button Box Demo**
- **Wrap Up**

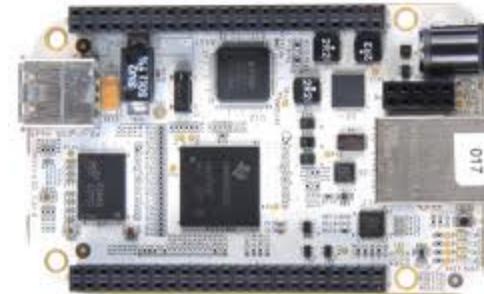


Button Box Demo



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Wrap Up

- Where do you go from here?