



State of the Beagle

BeaglePlay, BeagleConnect and beyond!

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BeagleBoard.org Foundation is a non-profit organization seeking to improve the state of embedded Linux and Zephyr development.

Learn more about our mission: bbb.io/about



BeagleBoard.org Foundation Leadership



Christine
Long
CEO



Jason Kridner
Board
Member
JK Embedded



Robert Nelson
Board
Member
DigiKey



Mark Yoder
Board Member
Rose-Hulman
Institute of
Technology



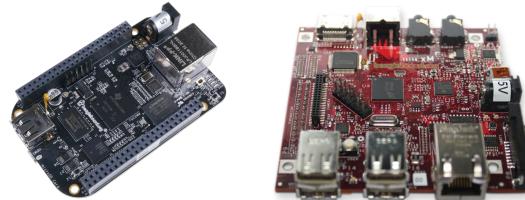
Drew Fustini
Board
Member
BayLibre



Kathy Giori
Board
Member
MicroBlocks



What is BeagleBoard.org?



- Community supported by non-profit BeagleBoard.org Foundation in the United States
- Focus on embedded, reliability, longevity, control and machine learning, not just cheap computers
- Approach is open and collaborative with open hardware, detailed documentation and fully open source software
- Entrepreneurial and open community of domain experts that share our passion and approach

Visit bbb.io/about to learn more

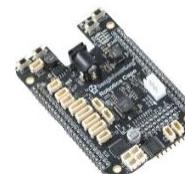


bbb.io/pocketnc

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Embedded Open Source Summit 2023 (Prague)

- [Improving Embedded Linux Development with BeagleBoard.org](#)
- [Simplifying Zephyr Usage Through Linux Host Integration](#)

Join the BeagleBoard.org community

- New website: beagleboard.org
 - beagleboard.org/projects
 - beagleboard.org/blog
 - [Educational Materials](#)
 - [Bootlin course updated for BeaglePlay](#)
- [BeagleBoard.org Forum](#)
- [Discord chat group](#)
 - [#beagle on libera.chat IRC still exists](#)
- [BeagleCast](#)
 - bi-weekly video stream



The screenshot displays the BeagleBoard.org website's forum section and its corresponding Discord channel. The forum page shows various categories like FAQ, General Discussion, and GoogleGroups, with posts from users like "L", "Z", and "F". The BeaglePlay topic in the General Discussion category has 21 messages. The BeagleBoard.org Discord channel shows messages from users like "rcn-ee" and "pchapin" discussing BeaglePlay setup and calibration tools. The right side of the image shows a list of board models and software projects available on the BeagleBoard.org website.

Join the BeagleBoard.org community

- GitLab instance: git.beagleboard.org
- New documentation: docs.beagleboard.org
- Software distribution images
- Google Summer of Code (GSoC)

This screenshot shows the BeagleBoard.org GitLab instance's 'Your work' page. It features a navigation bar with icons for dashboard, projects, groups, issues, merge requests, to-do list, milestones, snippets, and activity. Below the dashboard icon is a note about the new navigation experience. The main area displays a list of projects under the 'Personal' tab, including 'BeagleBoard.org / 18xx-ti-utils', 'BeagleBoard.org / arm-trusted-firmware', 'BeagleBoard.org / armv4l-drm', 'BeagleBoard.org / armv4l-linux', 'BeagleBoard.org / armv4l-mainline-linux', 'BeagleBoard.org / baylibre-android', and 'BeagleBoard.org / baylibre-android-ci-tools'. Each project entry includes a thumbnail, name, maintainer, and last updated date.

This screenshot shows the BeagleBoard.org Software Distribution Images page. At the top, there is a search bar labeled 'Filter Software Distributions' and a dropdown menu for 'Select Filter Option'. A 'Latest Version' button is also present. The main content area lists several software distributions, each with a thumbnail, name, description, and download links. Examples include 'BeaglePlay v1.7 2023-09-09 00:00:00 (latest)', 'BeagleImage v1.7 2023-09-02 06:08:46 (latest)', and 'BB464 v1.7 2023-09-02 06:08:46 (latest)'. Each listing includes a 'Download' button and a timestamp indicating when the image was created.

This screenshot shows the BeagleBoard.org Documentation homepage. It features a sidebar with links to 'INTRODUCTION', 'Blink LED', 'Support', 'Beagle 101', 'Contribution', 'BOARDS', 'BeaglePlay', 'BeagleBone AI-64', 'BeagleBone AI', 'BeagleBone Black', 'BeagleBone Blue', 'BeagleBone (all)', 'BeagleV-Ahead', 'Capes', 'PocketBeagle', 'BeagleConnect Freedom', 'BeagleBoard (all)', 'Terms & Conditions', and 'PROJECTS'. The main content area is titled 'BeagleBoard Project' and includes a 'v. latest' link. A note at the bottom states: 'This is the latest (main) BeagleBoard documentation. If you are looking for stable releases, use the drop-down menu on the bottom-right and select the desired version.'

This screenshot shows three pages from the BeagleBoard.org Documentation:

- BeagleBoard Documentation**: Welcome message and note about the latest documentation.
- BeagleBoard Documentation**: Overview of the documentation and links to 'Introduction', 'Support', 'Beagle 101', 'Contribution', and 'Boards'.
- Boards**: Information about the BeagleBoard.org Foundation and its mission to provide open hardware computing solutions for makers, educators, and professionals.



Google
Summer of Code

This screenshot shows the BeagleBoard.org GSoC 2023 projects page. It features a grid of cards for various projects, each with a thumbnail, title, and a 'View Details' button. Projects include 'Adding Features to simpRPU', 'Building an LLVM Backend for PRU', 'Greybus for Zephyr', and 'Profiling Tools'. Each card also has a small '2023' badge.

BeagleBone® AI-64

Expansion headers compatible with many BeagleBone® cape add-on boards

M.2 E-key connector with PCIe, USB, and SDIO for WiFi/Bluetooth and expansion

5 user LEDs and 1 power LED

Wake-up domain serial port

Main domain serial port

USB super-speed (5Gbps) Type-C port with power input (5V@3A)

Boot button
Power button
Reset button

16-pin microcontroller header

Gigabit Ethernet

Dual USB super-speed (5Gbps) Type-A host ports

Mini-DisplayPort

5V input power

Bottom-side:

- Texas Instruments TDA4VM system-on-chip with dual Arm® Cortex®-A72, C7x DSP, and deeplearning, vision and multimedia accelerators
- 4GB DDR4 RAM
- 16GB on-board eMMC flash storage
- Micro-SD slot
- Dual CSI-2 camera connectors

BeagleBone AI-64

- Open source NPU stack on C7x DSP and MMA
- Program in Python instead of just C
- Bring TF Lite model into AI-64 using open source tool
- [Edge AI tutorial](#)

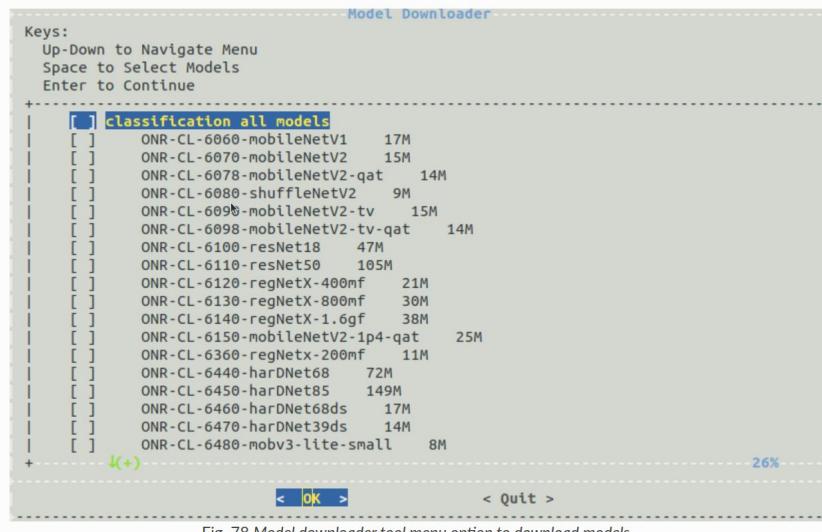


Fig. 78 Model downloader tool menu option to download models

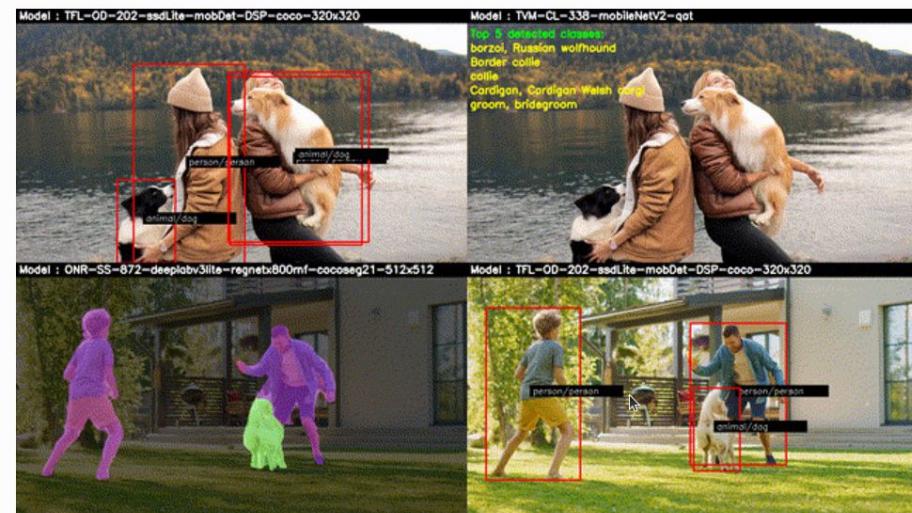
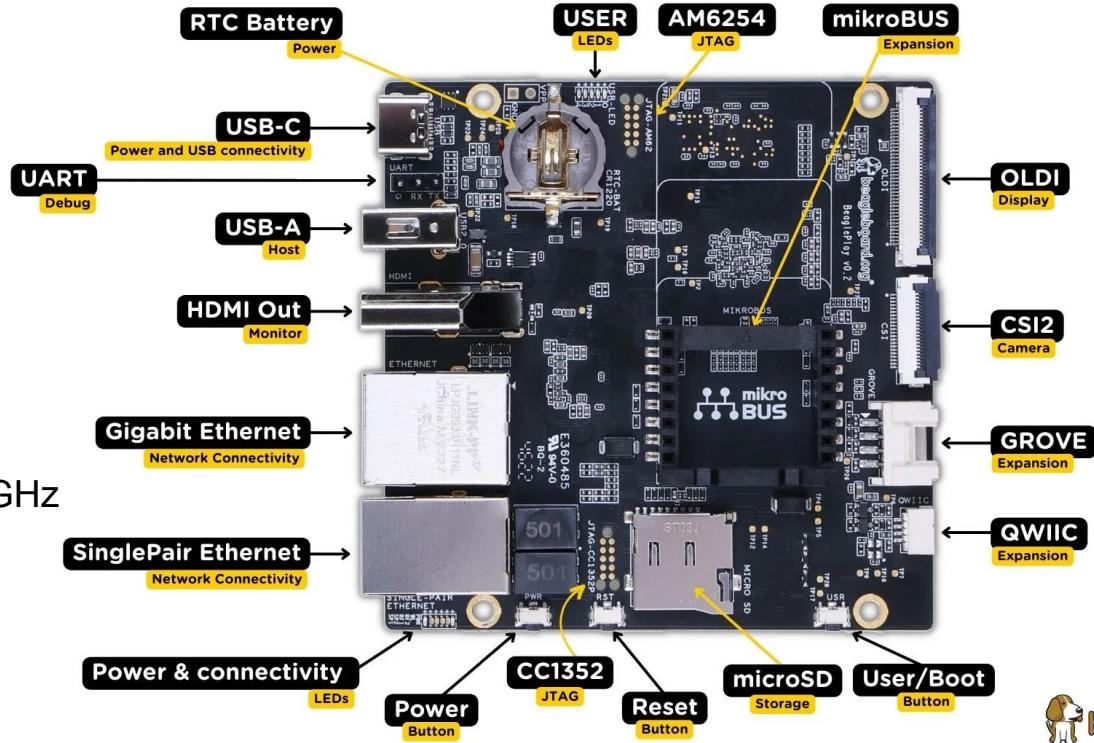


Fig. 80 Sample output showing multi-input, multi-inference output

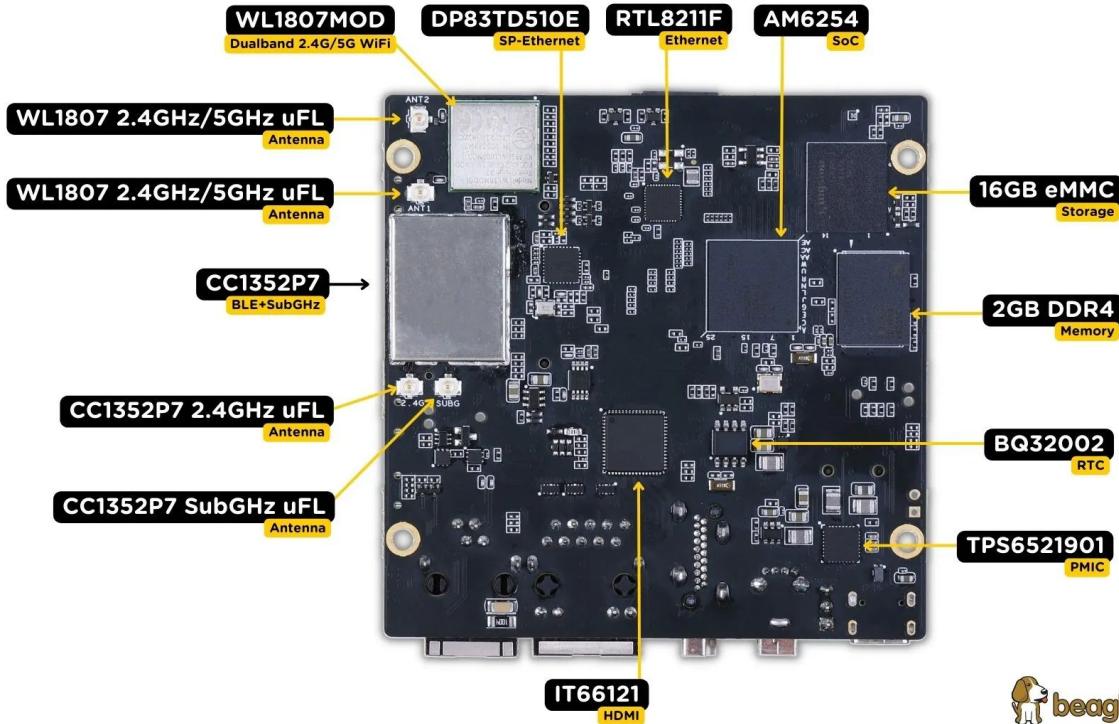
BeaglePlay

- TI Sitara AM625
 - 1.4GHz quad-core Arm Cortex-A53
 - Arm Cortex-M4F
 - PRU Subsystem
 - HDMI, USB 2.0, CSI
 - Gigabit Ethernet
 - 5GHz, 2.4GHz and sub-1GHz wireless
 - Single-pair Ethernet with power-over-data-line
 - PowerVR Rogue AXE-1-16



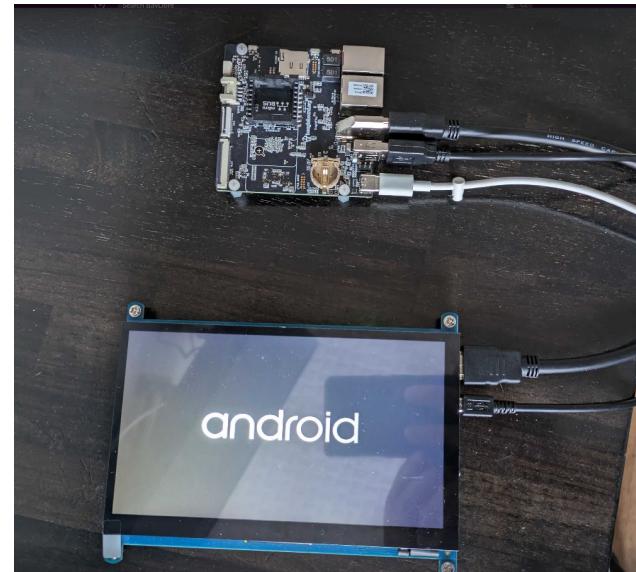
BeaglePlay

- 1,000s of available off-the-shelf sensors, actuators, indicators and connectivity options over mikroBUS, Grove, and QWIIC connections
- Utilize BeagleConnect technology over the sub-1GHz IEEE 802.15.4 wireless network to a BeagleConnect® Freedom up to 1km away.



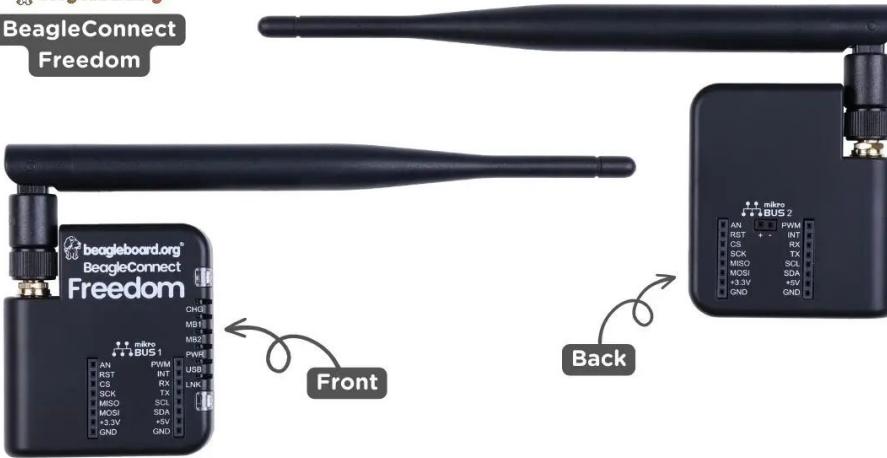
BeaglePlay

- [BeaglePlay: First Experience](#)
- [Documentation and tutorials](#)
- [Android \(AOSP\) on BeaglePlay](#)
 - Mattijs Korpershoek, BayLibre
- U-Boot series for BeaglePlay:
[\[PATCH V6 00/20\] board: ti: Add support for BeaglePlay](#)
- Kernel series for BeaglePlay:
[\[PATCH V2 0/3\] arm64: dts/defconfig/binding: Add support for BeaglePlay](#)

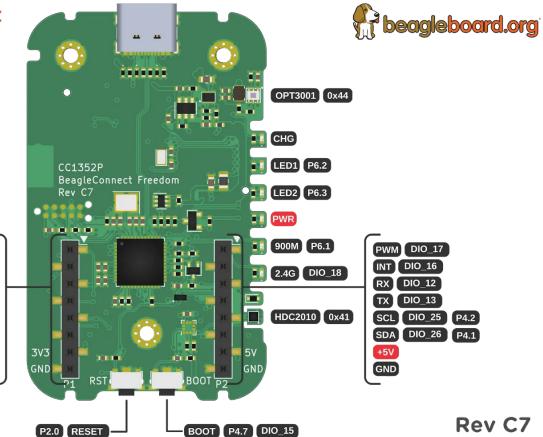




BeagleConnect
Freedom



beagleconnect
freedom



- **BeagleConnect Freedom: TI CC1352** wireless microcontroller running Zephyr
 - Works with BeagleConnect™ enabled sub-GHz wireless gateways,
 - Can be used with over 1,000 mikroBUS-based Click boards from MikroE,
 - Provides Bluetooth Low Energy (BLE)-enabled Linux computers at 2.4GHz and long-range, low-power sub-GHz IEEE 802.15.4 wireless connections at up to 1km with data rates of 1kbps,
 - Includes enclosure and antenna, on-board sensors, a USB-to-UART bridge, battery charger, buzzer and user-programmable LEDs and button.

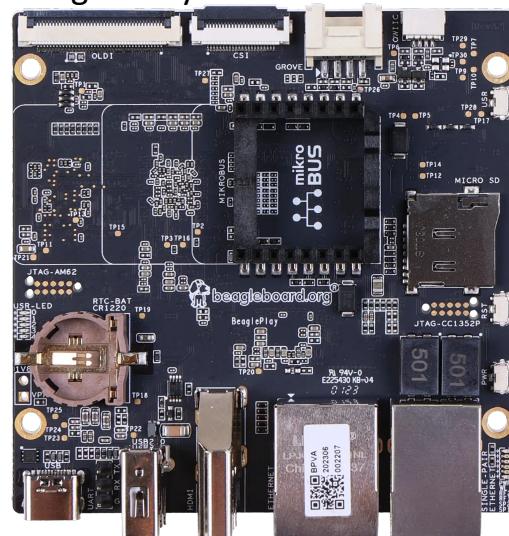
Zephyr sensor + Linux gateway

Simplifying Zephyr Usage Through Linux Host Integration Jason Kridner (EOSS 2023)



Microcontroller
running Zephyr
with sensor
attached

Wireless network connection



Zephyr sensor + Linux gateway

[Simplifying Zephyr Usage Through Linux Host Integration](#) Jason Kridner (EOSS 2023)



- Linux nodes can be more expensive, but offer greater remote access and redundant connectivity options
 - Terminal shell, rotated journals, virtualization, and more...
 - Large storage, high-level database queries, ...
 - Common execution environment as server infrastructure
- Zephyr nodes are growing in capability, but data will touch Linux system eventually for storage, analysis and presentation
 - git.beagle.cc/beagleconnect/zephyr/zephyr

Greybus and Project Ara

- Greybus comes from Project Ara
- Project Ara sought to create a modular mobile phone, so you could update only what you want
- Needed to make embedded busses hot pluggable
- In mainline kernel, using Unipro

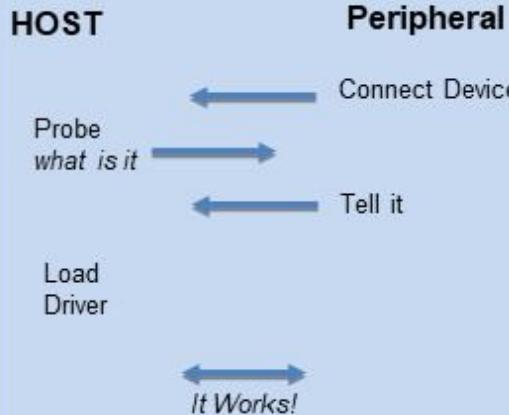


Zephyr sensor + Linux gateway

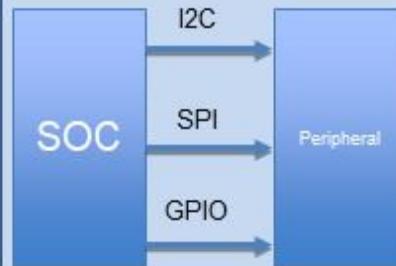
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USB in Linux Today

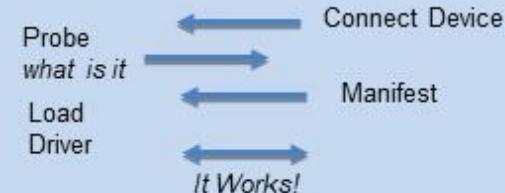
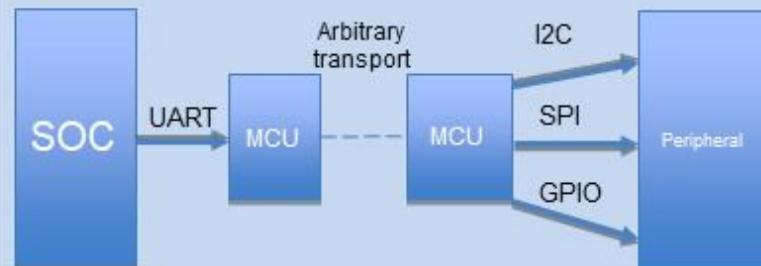


I2C/SPI/GPIO/... Before Greybus



*Specific device tree required
(Frustration ensues)*

I2C/SPI/GPIO/... With Greybus



BeagleConnect and Greybus

[Simplifying Zephyr Usage Through Linux Host Integration](#) Jason Kridner (EOSS 2023)

BeaglePlay

Linux userspace on AM62

gbridge**

Linux kernel on AM62

greybus

gb-netlink**

lowpan0

ieee802154g

bcfserial**

UART

Zephyr on CC1352

wpanusb**

BeagleConnect
Freedom

Zephyr
on CC1352

greybus-for-zephyr**

SubG

QEMU

BeagleConnect and Greybus

Simplifying Zephyr Usage Through Linux Host Integration Jason Kridner (EOSS 2023)

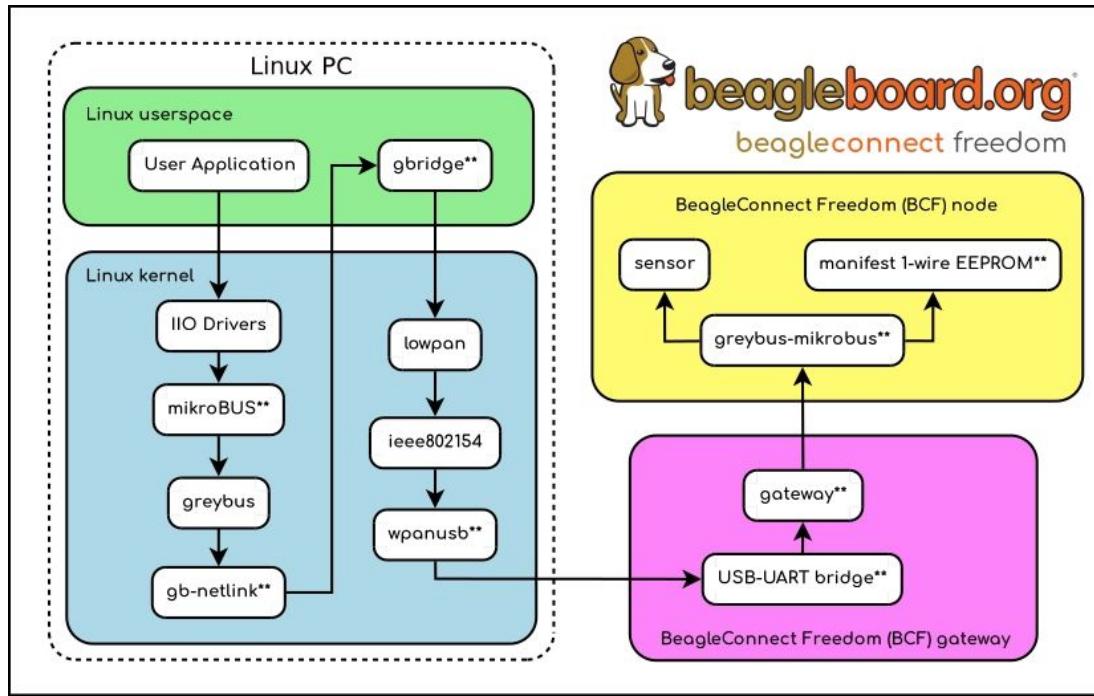
```
debian@BeaglePlay:~$ sudo modprobe opt3001
debian@BeaglePlay:~$ i2cdetect -y -r 6
      0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- --
10:          -- -- -- -- -- -- -- -- -- --
20:          -- -- -- -- -- -- -- -- -- --
30:          -- -- -- -- -- -- -- -- -- --
40:          -- UU -- -- UU -- -- -- -- -- -- --
50:          -- -- -- -- -- -- -- -- -- --
60:          -- -- -- -- -- -- -- -- -- --
70:          -- -- -- -- -- -- -- -- -- --

debian@BeaglePlay:~$ iio_info
Library version: 0.24 (git tag: v0.24)
Compiled with backends: local xml ip usb
IIO context created with local backend.
Backend version: 0.24 (git tag: v0.24)
Backend description string: Linux BeaglePlay 5.10.168-ti-arm64-r104
IIO context has 2 attributes:
    local,kernel: 5.10.168-ti-arm64-r104
    uri: local:
```

Replace GBridge in BeagleConnect

Ayush Singh for Google Summer of Code 2023

Problem: The existing architecture revolves around GBridge. Ran in userspace and interacted with gb-netlink in kernel. Design was brittle and could hang kernel.



Replace GBridge in BeagleConnect

Ayush Singh for Google Summer of Code 2023

Solution

- Eliminate GBridge and merge its functionality into greybus (linux driver) and cc1352 driver.
- Allow Greybus Linux driver to directly communicate with cc1352
- Move SVC and APBridge roles into cc1352

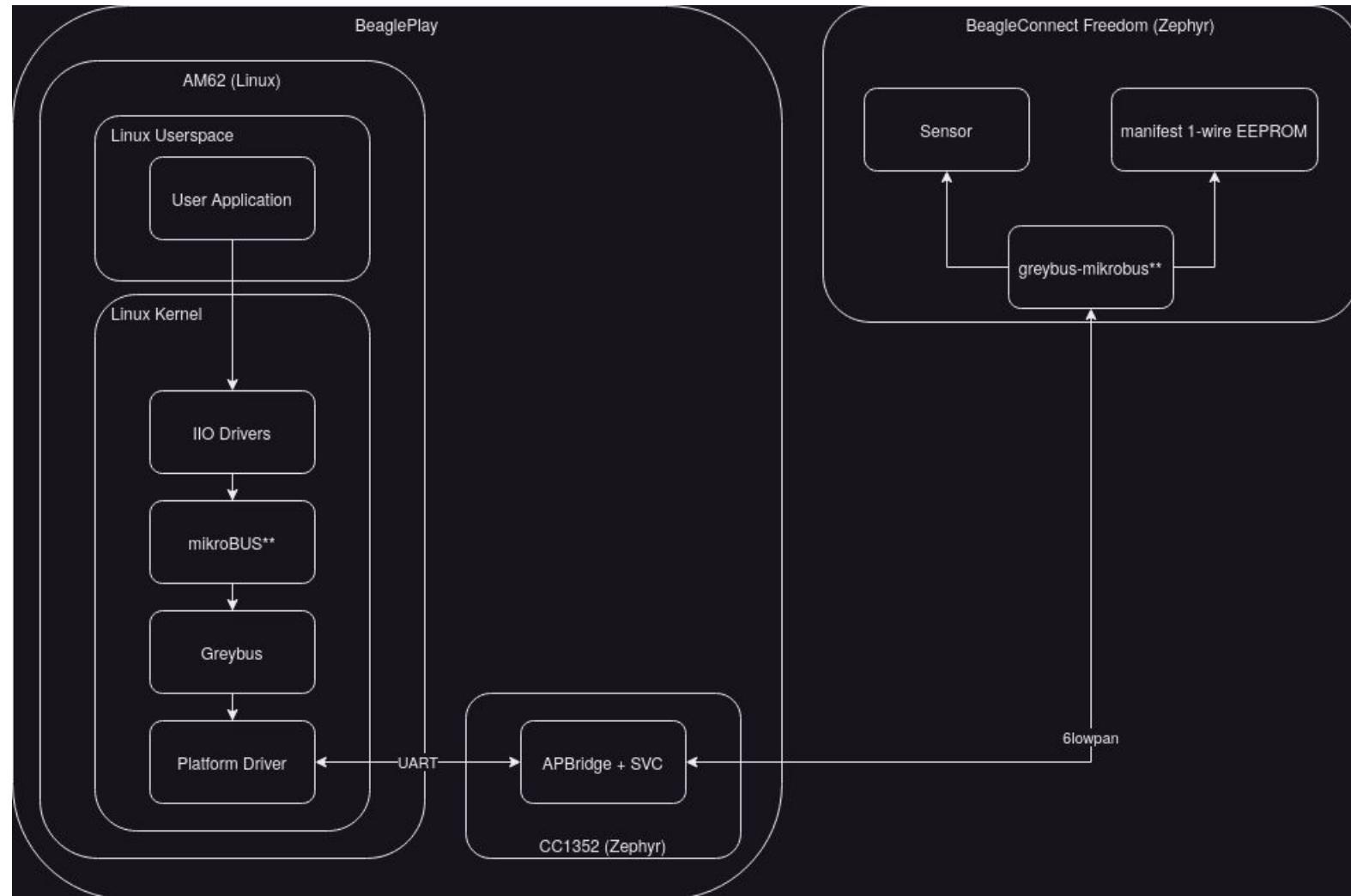
Videos

- GSoc Demo: <https://youtu.be/GVuIB7i5pjk>
- [BeagleCast Episode 5 - Talking Rust.](#)
- [Greybus and Gbridge with Ayush Singh](#)

Software

- Zephyr: [cc1352-firmware](#)
- Linux driver
- [\[PATCH v5 0/3\] greybus: Add BeaglePlay Greybus Driver](#)





BeagleV Ahead

T-Head TH1520 (quad-core Xuantie C910 processor)

4GB LPDDR4



16GB eMMC

WiFi/Bluetooth

Ethernet

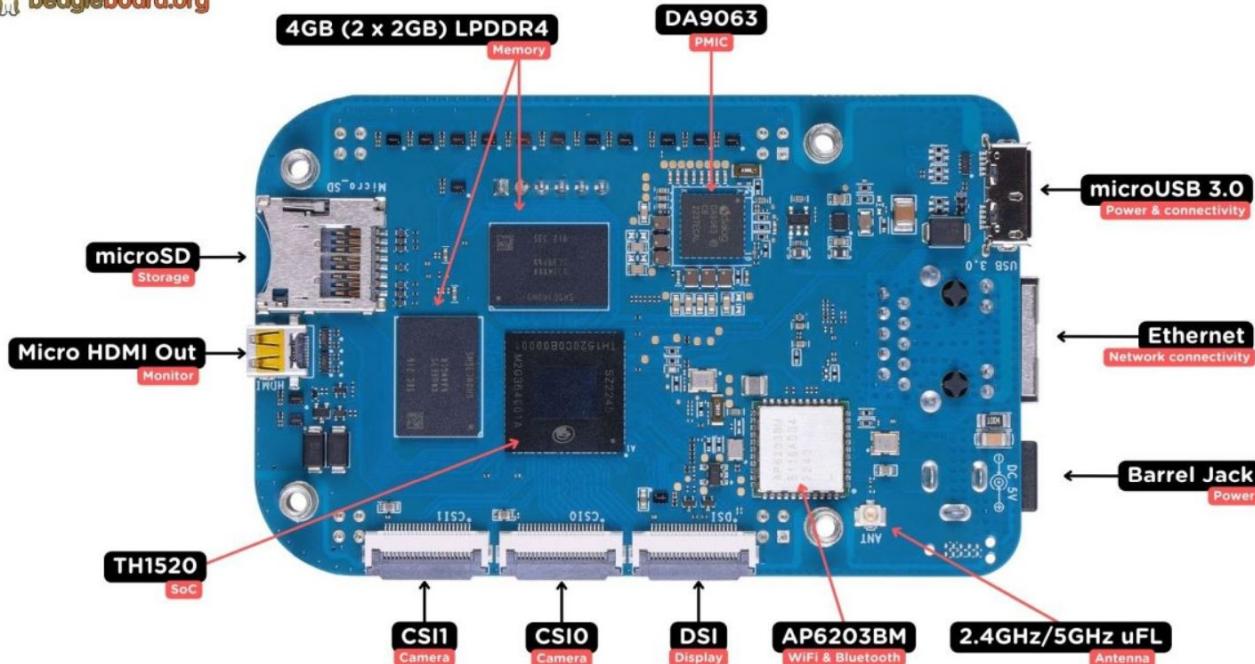
microUSB 3.0

HDMI

mikroBUS

2 x CSI connector

DSI connector



BeagleV Ahead



T-Head TH1520 (quad-core Xuantie C910 processor)

4GB LPDDR4

16GB eMMC

WiFi/Bluetooth

Ethernet

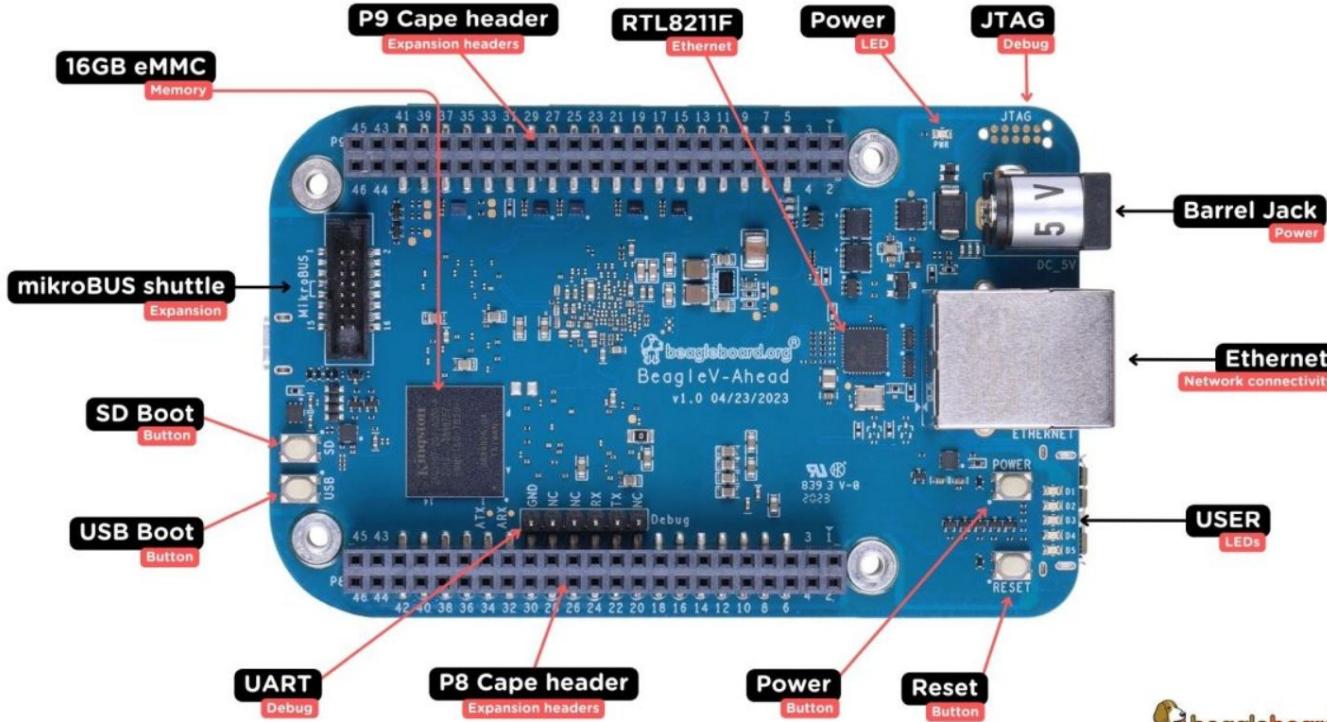
microUSB 3.0

HDMI

mikroBUS

2 x CSI connector

DSI connector



BeagleV Ahead



Upstream Linux TH1520 patch series

Log In



Maintainer Git Repos:

Palmer Dabbelt - (RISCV) - [kernel/git/palmer/linux.git](#) - palmer kernel tree 4 - (v6.7.x-rc)

Conor Dooley - (dt) - [kernel/git/conor/linux.git](#) - conor's fork of linux.git 3 - (v6.6-rc)

RFC for Mainline:

Version	SubSystem	lore
RFC 0	THEAD Clock	[PATCH 0/3] Add T-HEAD th1520 soc clock support - Yangtao Li 4
RFC 2	dwmac driver	[PATCH net-next v2 0/3] add the dwmac driver for T-HEAD TH1520 SoC - Jisheng Zhang 5
RFC 2	riscv: errata: improve T-Head CMO	[PATCH v2 0/2] riscv: errata: improve T-Head CMO - Jisheng Zhang 3
RFC 0	riscv: dts: thead: set dma-noncoherent to soc bus	[PATCH] riscv: dts: thead: set dma-noncoherent to soc bus - Jisheng Zhang 1
RFC 0	riscv: mm: update T-Head memory type definitions	[PATCH] riscv: mm: update T-Head memory type definitions - Jisheng Zhang 2
RFC 0	Reset	[RFC PATCH 0/3] Introduce reset driver for T-HEAD th1520 SoC 2



Maintainer Git Repos:

RFC for Mainline:

Staged for Mainline:

Mainline Status: