Architecture of the **BeagleBone BLACK**

CMPE-570 2141

Brent Dimmig, Paul Repka

Agenda

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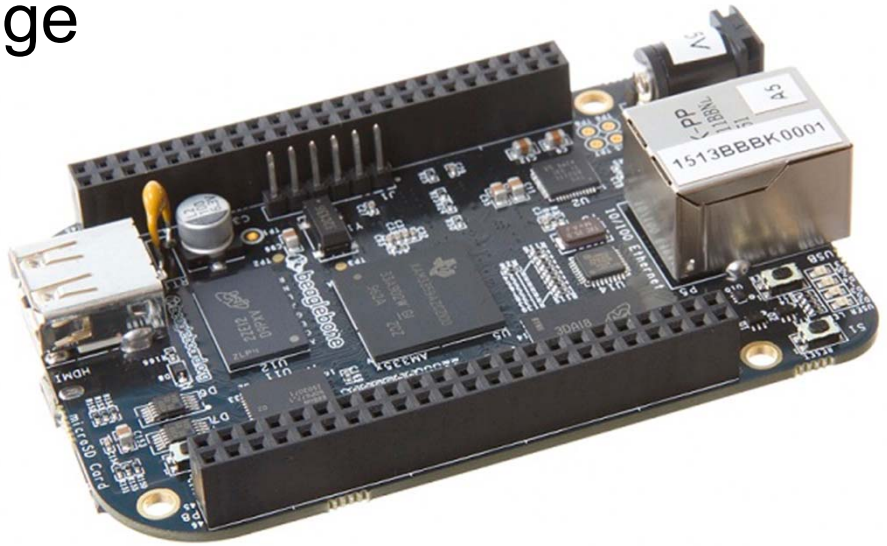
Introduction

- Credit card sized single-board computer
- AM3358 1GHz ARM Cortex-A8
- 4GB eMMC flash storage
- 512MB DDR3 RAM
- Dual PRU 32-bit microcontrollers
- Open hardware



Source: http://elinux.org/BeagleBoneBlack

Processor Overview

- TI AM3358 Sitara™ Processor
- Based on ARM Cortex-A8 processor
- Implements ARMv7-A 32-bit ISA
- < 300 mW overall power consumption
- 65nm technology

Source: http://www.ti.com/product/am3358

Cortex A8 - Pipeline

- Statically scheduled
- Dual-issue in-order
- Dual pipelined ALU
  - Multiplier and load-store pipelines
- 13 stage integer pipeline
  - Additional 10-stage NEON pipeline
- Implements ARM's VFPv3

Source: http://www.design-reuse.com/articles/11580/architecture-and-implementation-of-the-arm-cortex-a8-microprocessor.html

Cortex A8 - Program Flow Control

- Advanced branch prediction
  - > 95% accuracy
- 512-entry branch target buffer
  - 2-way set associative
- Global history buffer
  - 4096 2-bit saturating counters
- 10-bit history for last ten branches
- 4-bit history for Program Counter

Source: http://infocenter.arm.com/

Cortex A8 - Cache

- Two levels of cache
- Level 1 (L1) cache split for instructions and data
  - 32KB, 4-way set associative
  - Write-back replacement policy
  - 1 cycle penalty
- Level 2 (L2) unified cache
  - Configurable: 64KB to 2MB, 8-way set associative
  - Configurable replacement policy per page
  - 8 cycle penalty
- Global miss incurs at least a 20 cycle penalty

Source: http://www.design-reuse.com/articles/11580/architecture-and-implementation-of-the-arm-cortex-a8-microprocessor.html

Cortex A8 - Extra Features

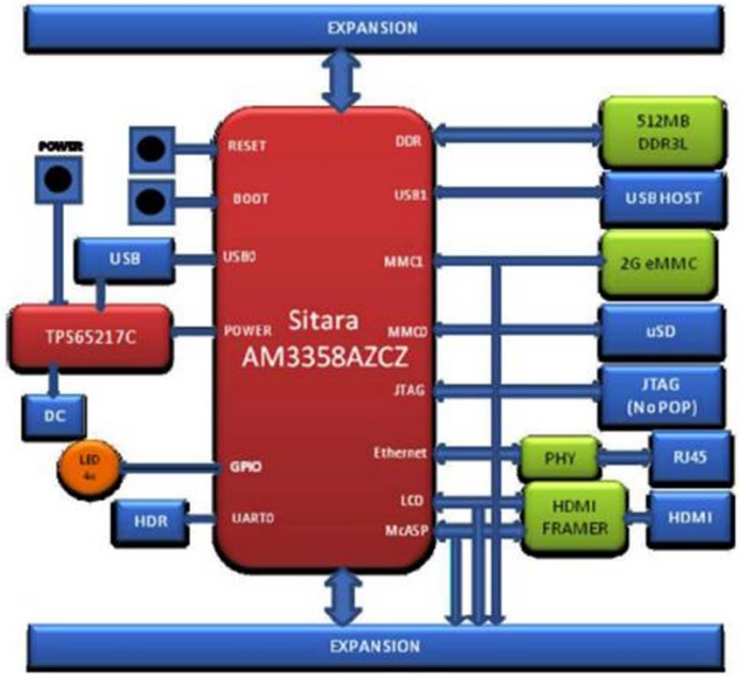
- Thumb-2
  - Allows 16-bit and 32-bit instructions to run side by side.
- ARM VFPv3, IEEE 754 compliant
  - Hardware floating point operations
- NEON media and signal coprocessor
  - SIMD architecture (vector operations)
  - 10 stage pipeline

NEON™

Source: http://www.arm.com/products/processors/technologies/

System Architecture

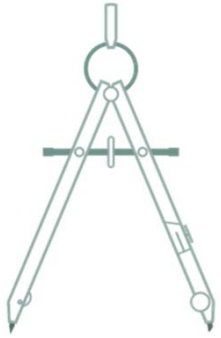
- Powered by TPS65217C
  - 5V from adapter or host USB
- HDMI capabilities
- Boot from µSD card or eMMC
- Two 42-pin expansion ports
  - Common for hardware projects



Source: http://www.adafruit.com/datasheets/BBB_SRM.pdf

Operating Systems

- Supports ARM compatible Linux 3.8 kernel
- Distros: Debian, Android, Ubuntu, Angstrom



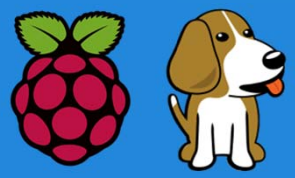
Source: http://www.beagleboard.org/BLACK

Design and production

- BeagleBoard.org's newest board
- Non-profit corporation run by Texas Inst. employees
- Manufactured by CircuitCo
- All designs are fully open source
  - Supported by development community
- Cost: $55
- Targeted towards developers and hobbyists
  - Allows rapid prototyping at low-cost

Source: http://www.beagleboard.org/BLACK

Comparison with the Raspberry PI



BeagleBone Black

- Better interfaces with external sensors
- Faster, newer, better supported processor
- Includes an OS out of the box
- Runs Angstrom, Ubuntu and other OS's

Raspberry PI

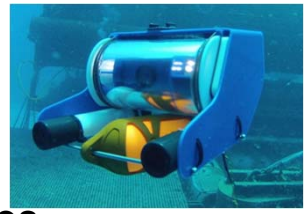
- Better graphics capabilities
- Better audio capabilities
- Better community support
- Mainly runs Raspbian
- You can play Minecraft

Which would you choose?

Source: http://www.raspberrypi.org/

Applications

- Robotics
  - Autonomous Vehicle Xplorer
  - OpenROV Underwater Robot
  - Dancing SpiderBot
- Media
  - LED displays
  - Plotters
  - Mini arcade machines
- Manufacturing
  - 3D printing
  - CNC and milling machines



- Internet of Things
  - Tweeting intrusion detection
- Home automation
  - Ninja Cloud
- Wearables
  - Wearable Dog Gear
- Sensor platforms
  - High-altitude camera
  - Descriptive camera
  - The Sense of Things

Source: http://www.eetimes.com/document.asp?doc_id=1319094

Conclusion

The BeagleBone Black is an affordable single-board credit card sized computer. It has a powerful ARM Cortex A8 CPU, a full Linux OS, and allows for easy access to external sensors.

It is an open platform targeting students and hobbyists who want a hardware focussed alternative to the Raspberry PI.

Questions?