

Alternative Prototype Platforms

Embedded Interface Design

with **Bruce Montgomery**



Learning Objectives

Students will be able to...

- Consider various platforms for building IoT and device prototypes



Alternative Prototyping Platforms

- Raspberry Pi family of SBCs
 - Alternative OSes for RPi
 - Yocto Linux for RPi
- Other SBCs
 - Beaglebone family
- Micropython and related devices
 - PyBoard
 - BBC micro:bit
- Other Microcontrollers
 - Arduino – Mega, Uno, Photon, Trinket
- Development Kits
 - Ex: Silicon Labs Blue Gecko
- Amazon FreeRTOS for AWS
- Other Embedded UI Tools
 - emWin, TouchGFX, PEGPlus/Pro
- Sources
 - Adafruit, SparkFun, Maker Shed
- Specialized devices
 - AT&T LTE-M Button, AWS IoT Button, SDRs



Raspberry Pi Family

- Biggest: Pi4 (up to 4GB RAM, dual HDMI, Gigabit Ethernet, etc.)
- Standard: Pi3B+ (1GB RAM, WiFi, Ethernet, HDMI, etc.)
- Alternate: Pi3A+ (no ethernet/USB hub chip, 512 MB RAM, single USB port, smaller than a 3B+)
- Zero W: Smaller form factor, 512 MB RAM, BLE & WiFi, HDMI & USB
- Compute Module 3: 1GB RAM, 4 GB onboard eMMC Flash, DDR2 SODIMM Connector
- Various HATs: PoE, Sense, ADC/DAC, etc. (HAT = Hardware attached on top)



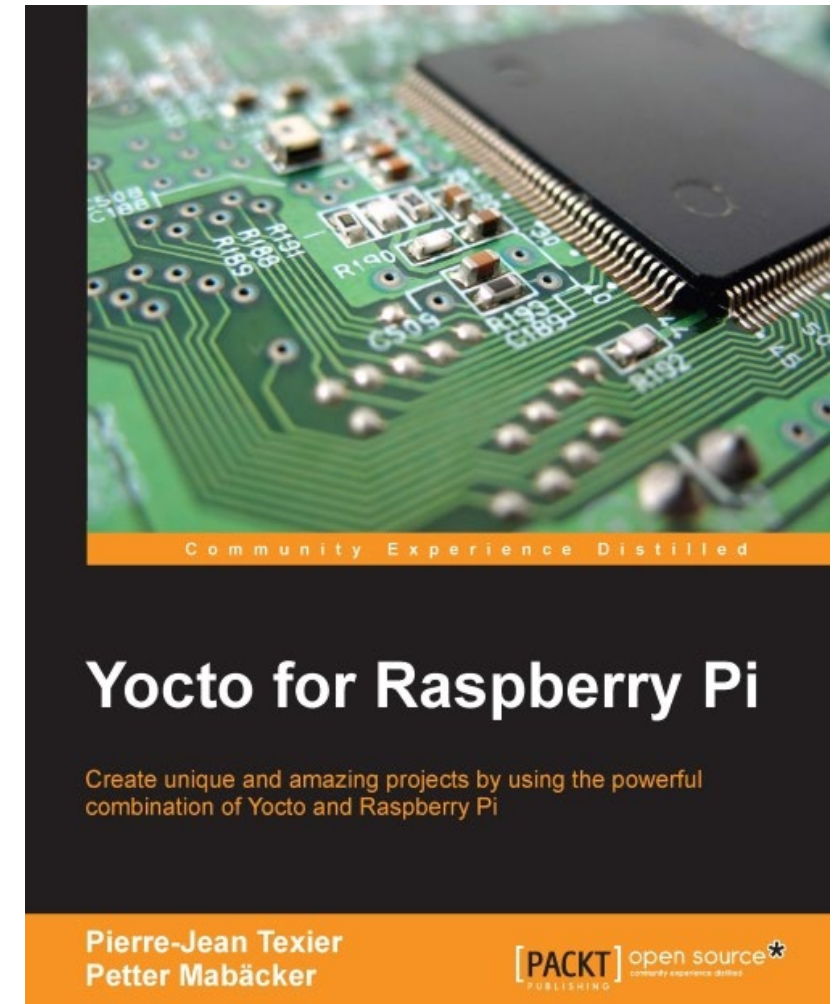
Alternative OS choices for Raspberry Pi

- Linux derivatives
 - Raspbian – Debian-based (vs. Slackware, S.u.S.E. Red Hat), what we use for class
 - Fedberry – Red Hat-derived Fedora remix – <http://fedberry.org/>
 - Kali Linux – Debian-based, tools for penetration testing/ethical hacking – <https://www.offensive-security.com/kali-linux-arm-images/>
 - Nard SDK – Targets long running embedded designs – <http://www.arbetsmyra.dyndns.org/nard/>
 - OpenELEC – small Linux OS for media applications – <http://openelec.tv/news/23-development/44-openelec-meets-raspberry-pi-part-1>
 - OSMC – Debian-based media center focused OS – <https://osmc.tv/download/>
 - Ubuntu MATE – Debian-based small/stable desktop Linux – <https://ubuntu-mate.org/raspberry-pi/>
- Windows 10 IoT Core – Windows 10 version for RPi
 - <https://developer.microsoft.com/en-us/windows/iot/Downloads.htm>
- RISC OS – originally developed by Acorn in 1987 targeting ARM systems
 - <https://www.riscosopen.org/content/downloads/raspberry-pi>
- There are others many others...
 - <https://raspberrypi.stackexchange.com/questions/534/definitive-list-of-operating-systems>



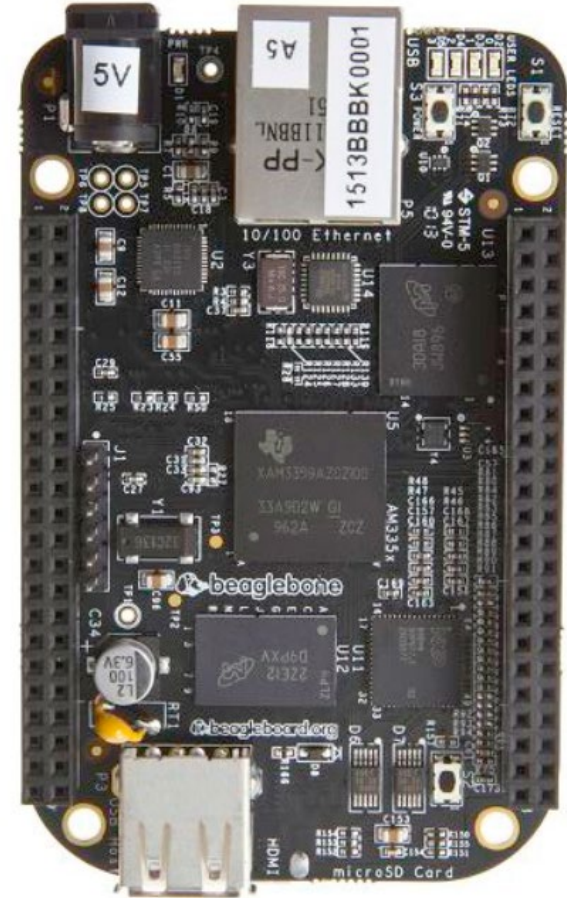
Yocto Linux for Raspberry Pi

- Yocto is a popular customizable set of templates, tools, and methods to create custom Linux-based embedded systems
- Key elements:
 - Poky – the build system (and reference distribution)
 - BitBake – build engine and task scheduler
 - Recipes
 - Metadata to collect source to build OS elements for specific target deployments and installable images
- Typical build process at:
<https://www.instructables.com/id/Building-GNULinux-Distribution-for-Raspberry-Pi-Us/>



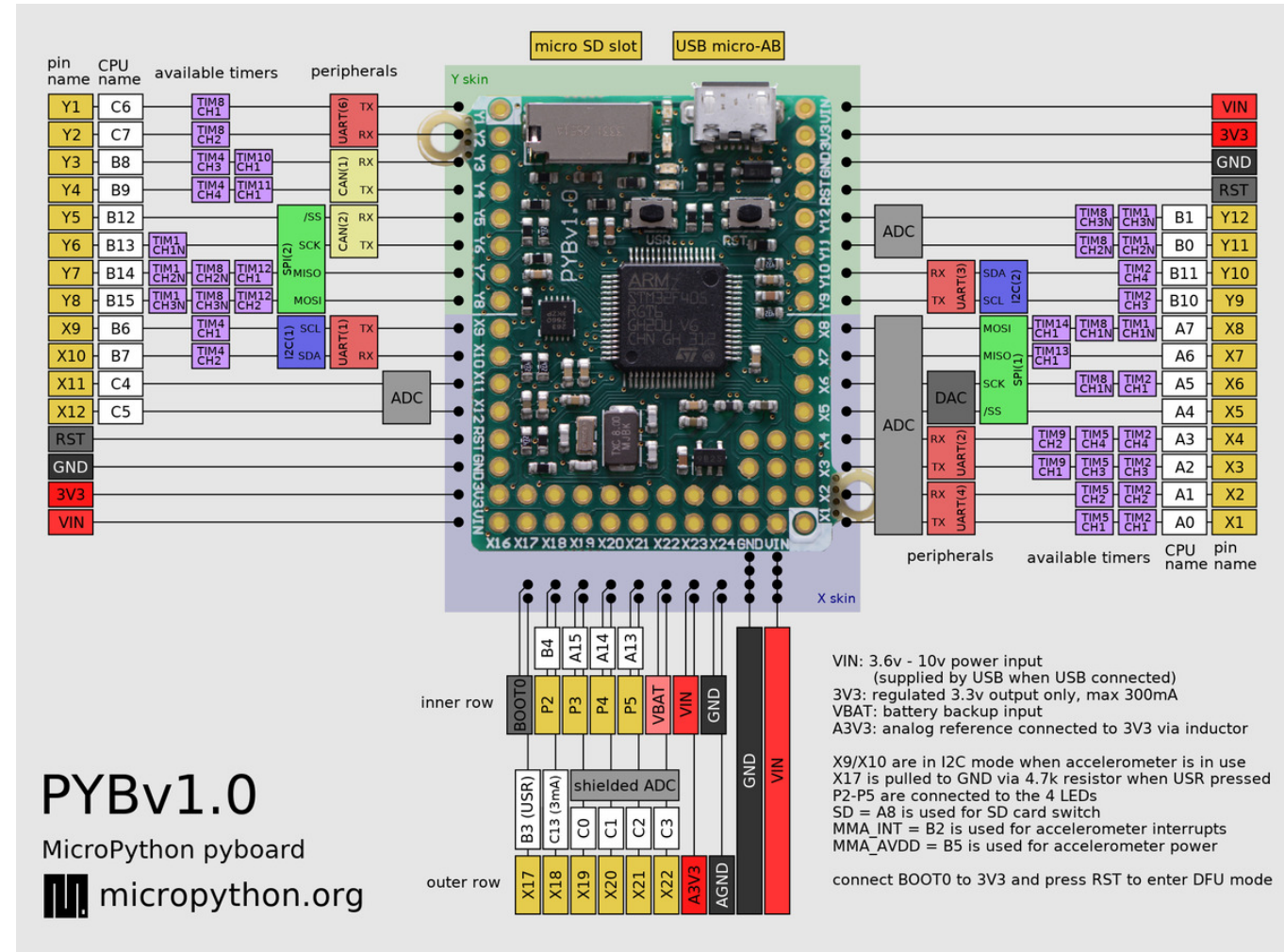
Other SBCs: BeagleBone family

- BeagleBone Black – 1 GHz Arm A8, 4GB Flash, 3D Graphics Accelerator, NEON Floating-point accelerator, USB, HDMI, UARTs, A/D, I2C, SPI, etc.
- Great alternative to the RPi family
- Runs Ubuntu, Android, Yocto, etc.
- <https://beagleboard.org/bone>



MicroPython and Compatible Devices

- MicroPython is a version of Python 3 built to run directly on select microcontrollers (a “bare metal” implementation – no OS)
- Compatible devices
 - PyBoard
 - BBC Micro:Bit
 - ESP32 Thing
 - Others
- <https://micropython.org/>



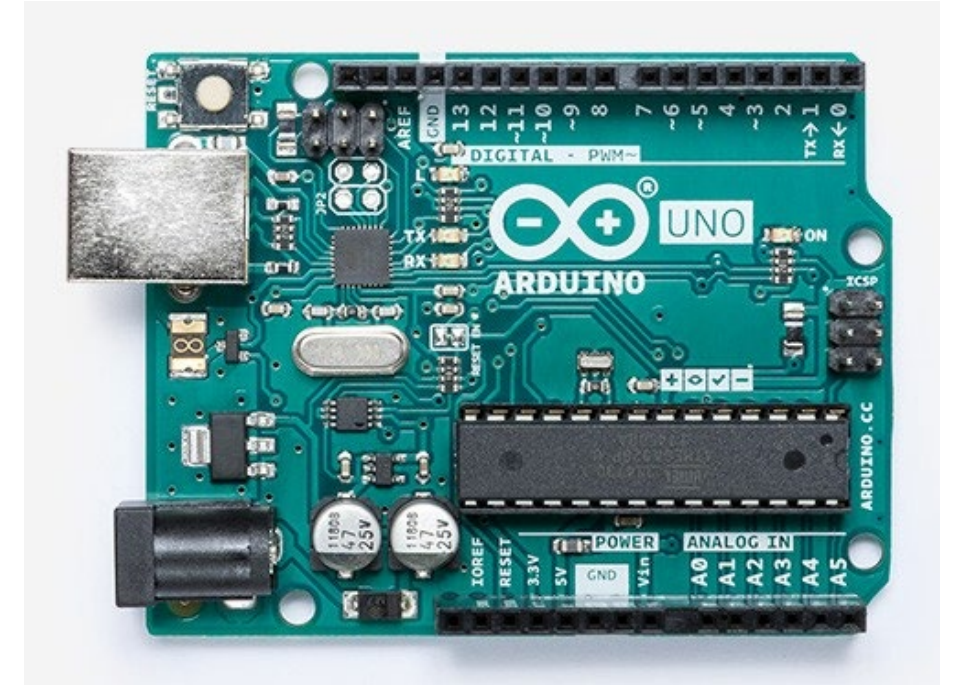
PYBv1.0

MicroPython pyboard

 micropython.org

Typical Arduino Microcontrollers

- Uno – 32 KB Flash, 2 KB SRAM, 14 DI/DO, 6 Analog IN, USB, 16 MHz Clock
- Mega 2560 – 256K Flash, 8 KB SRAM, 54 DI/DO, 16 Analog IN, USB
- Many versions, many vendors, many compatible and specialized devices
- C/C++
- <https://www.arduino.cc/en/Main/Products>



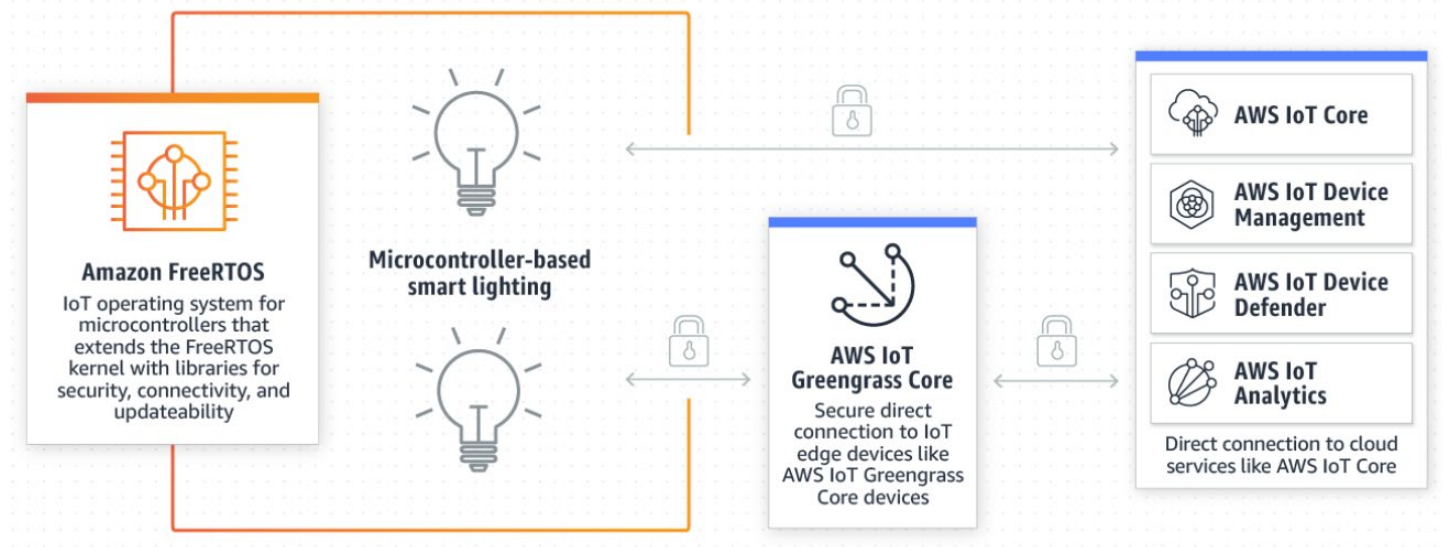
Development Kits

- Typical Dev Kit – Silicon Labs Blue Gecko SoC
- Allows development of Bluetooth LE, 5, Mesh systems using SDK and special application support
- <https://www.silabs.com/products/development-tools/wireless/bluetooth/blue-gecko-bluetooth-low-energy-soc-starter-kit>



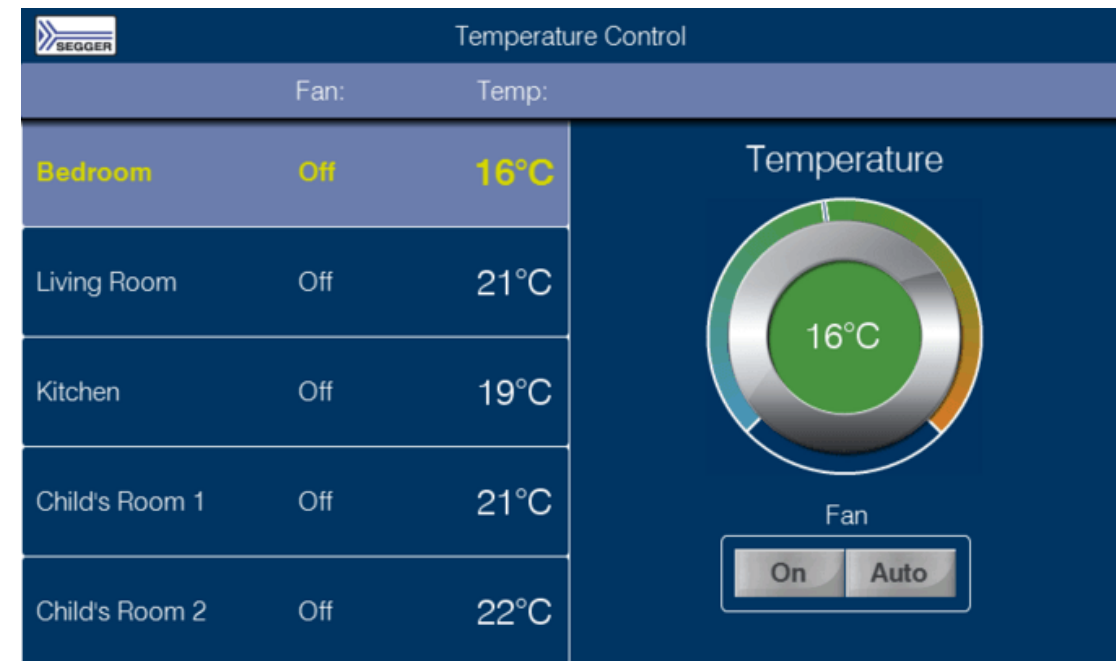
Amazon FreeRTOS for AWS

- Amazon has extended the FreeRTOS kernel to support IoT connectivity, including MQTT, TCP/IP, WiFi, and BLE with standard TLS security
- Devices use Amazon IoT Framework with standard thing and policy definitions for AWS connectivity
- Supports many microprocessor architectures, including Arduino Uno
- <https://aws.amazon.com/freertos/faqs/>



Other Embedded UI Tools (besides QT)

- There are many UI development environments for direct embedded C/C++ development – examples include:
- emWin by Segger
(<https://www.segger.com/products/user-interface/emwin/>)
- TouchGFX (<https://www.touchgfx.com/>)
- PEG Plus/Pro/Lite from NXP
(<https://www.nxp.com/support/developer-resources/run-time-software/peg-graphics-software/peg-pro-runtime:PEGPR>)
- Wide support for RTOSes and Microprocessors
- Generally licensed for industrial use



Maker Community and Vendors

- Many embedded device “Maker” oriented sites with tutorials
- Examples:
 - SparkFun (next door in Niwot)
 - <https://www.sparkfun.com/>
 - <https://learn.sparkfun.com/tutorials/introduction-to-mqtt>
 - Adafruit
 - <https://www.adafruit.com/>
 - Maker Shed
 - <https://www.makershed.com/>



Next Steps

- Quiz Extra Credit - Article Review assignment is posted...
- Project 5 demos today (due 11/20 for demos)
- Project 6 active today (due 12/11)
- 2nd Annual EID Mini-hackathon in class 12/4
- New Quiz is up – another next weekend
- Class staff available to help
 - Shubham - Tues 12-2 PM, Fri 3-5 PM in ECEE 1B24
 - Sharanjeet - Tues 2-3 PM, Thur 2-3 PM in ECEE 1B24
 - Bruce - Tue 9:30-10:30 AM, Thur 1-2 PM in ECOT 242
- Final Exam is set
 - Tuesday Dec 17 7:30 PM - 10 PM ECCR 1B51
 - Final will be open notes and Canvas based, you'll need a PC

