Android Architecture

Alexandra Harrison & Jake Saxton

Overview

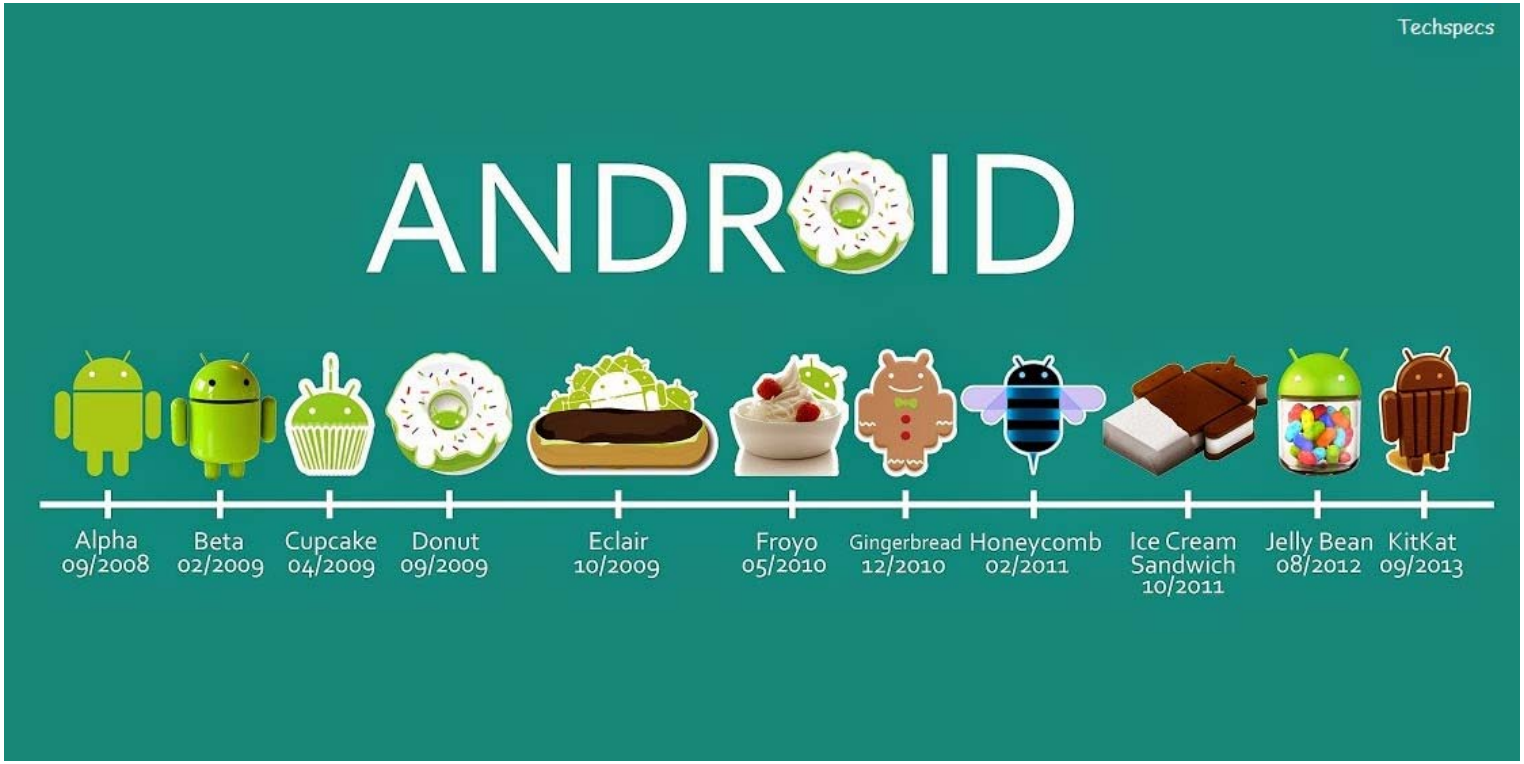
- History of Android Architecture
- Five Layers
  - Linux Kernel
  - Android Runtime
  - Libraries
  - Application Framework
  - Applications
- Summary

History

- 2003 –Founded
  - No product for two years, funded by Andy Rubin
    - Planned the next generation of smartphones
    - **Open source** evolution of “Danger”
- 2005 – Purchased by Google
  - Sooner or G1?
- 2007 – Publically announced
- 2008 – Sold first phone

G1

Previous Versions



Lollipop
09/2014

Marshmallow
09/2014

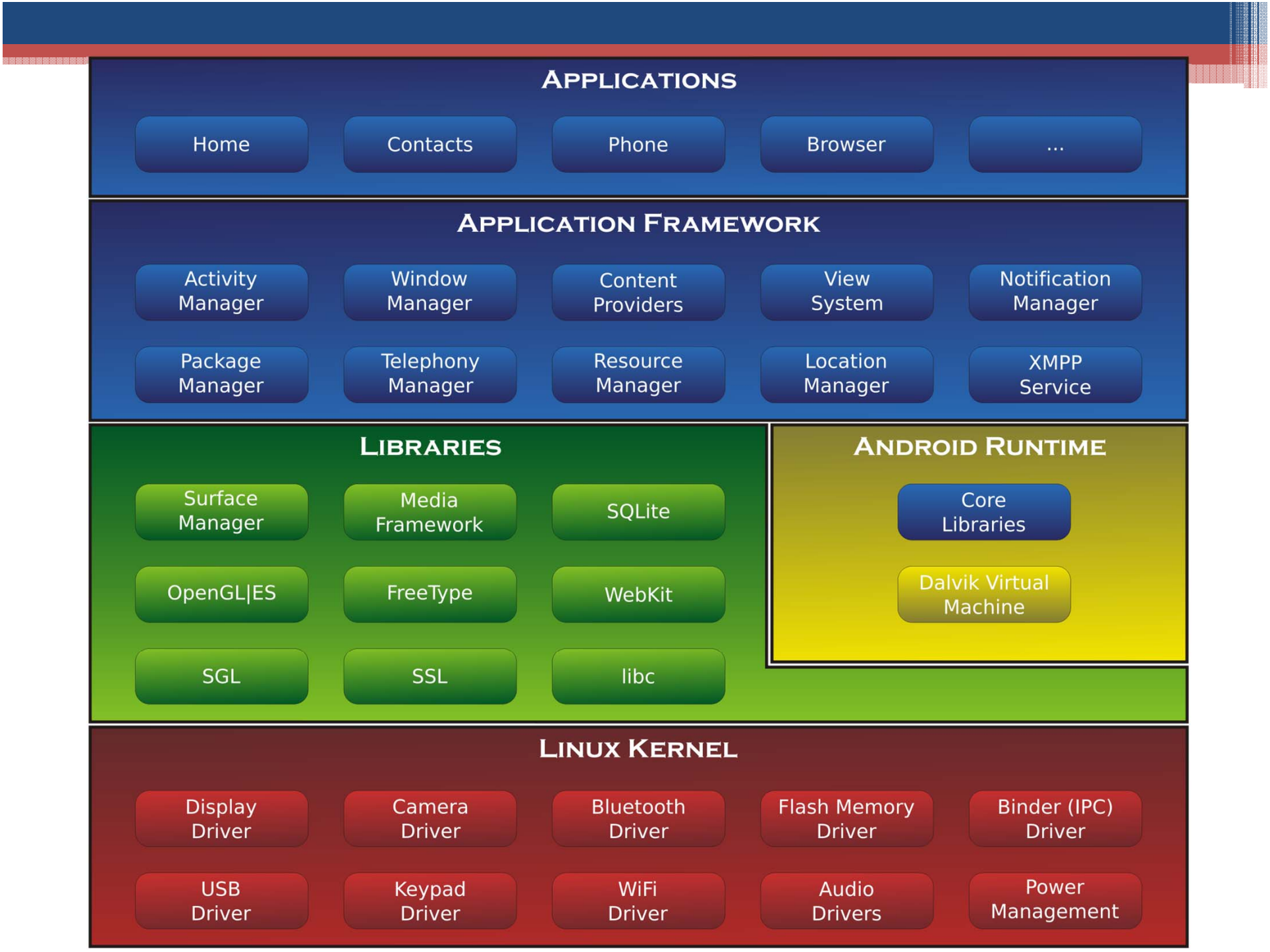
Previous Versions

Cupcake

Ice Cream Sandwich

Lollipop

- Unnamed (1.0 + 1.1)
- **C**upcake (1.5)
- **D**onut (1.6) – Quick Search Box
- **É**clair (2.1) – High Density Displays, Traffic + Navigation
- **F**royo (2.2) – Voice Control, Hotspot, Speed
- **G**ingerbread (2.3) – Simpler, Battery Life, More apps
- **H**oneycomb (3.0) – Flexible interface, tablets
- **I**ce Cream Sandwich (4.0) - Customization
- **J**elly Bean (4.1) – Google Now, actionable notifications
- **K**itKat (4.4) – “Ok Google”, voice control variety
- **L**ollipop (5.0) – fluid tactile screens
- **M**arshmallow (6.0) – battery life, app permissions, UI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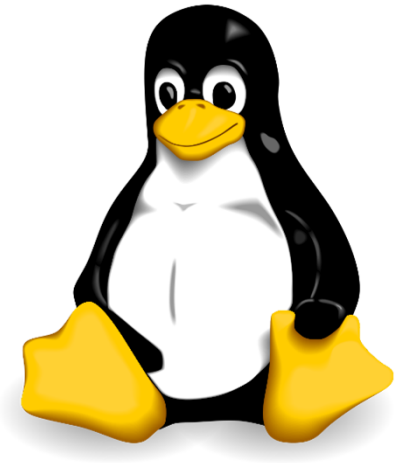
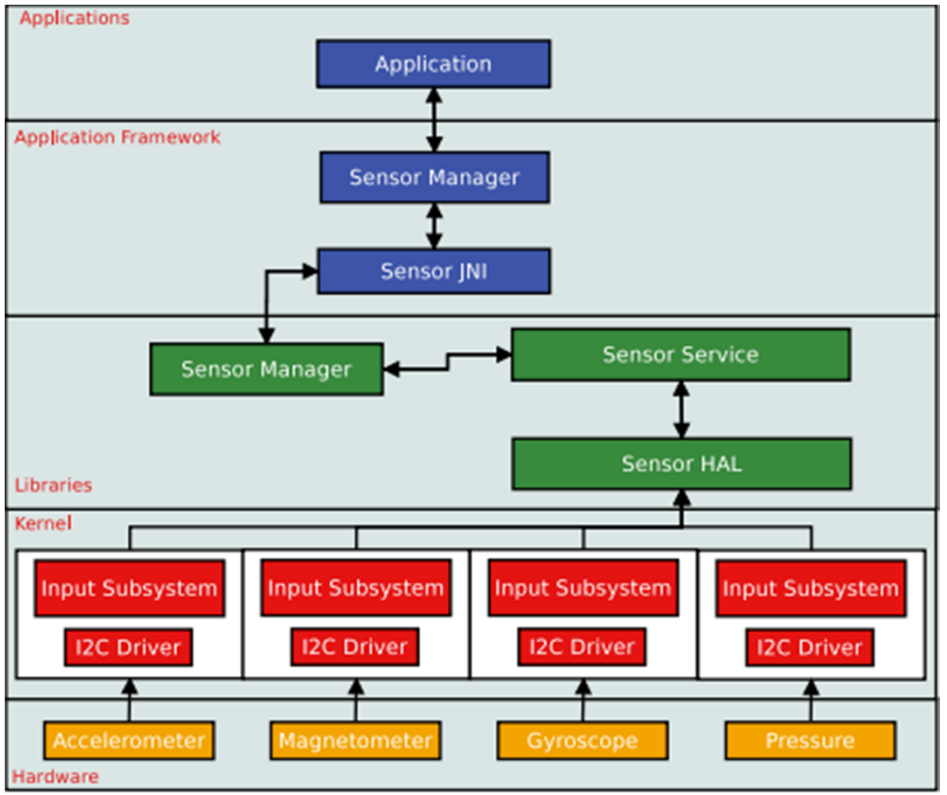
Linux Kernel



- 3.6 with ~115 patches
- Generic System Services
  - Permissions
  - Memory and Process management
  - File & Network I/O
  - Device Drivers
- Preemptive Multitasking
- Lean, efficient, and secure
- Open Source

Hardware Abstraction Layer (HAL)

- Software hooks between stack and hardware
- Hardware Specific
  - Allows Applications to be hardware ignorant

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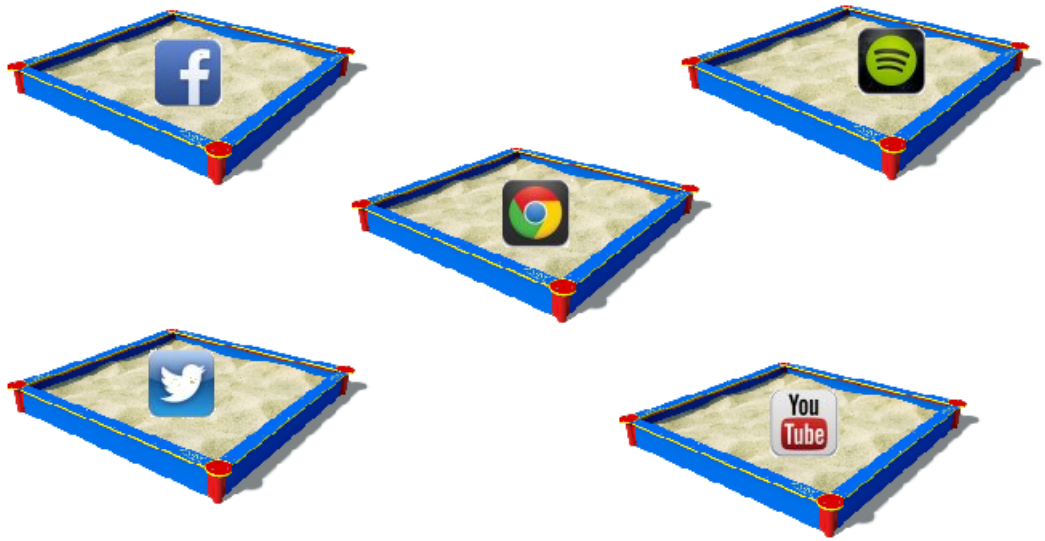
Android Runtime

- Dalvik Virtual Machine
- Core Java libraries
  - Specific to Android development
    - Apple: Swift (Objective C)
    - Windows: Visual C++ (C++), Changes with OS
  - Wrappers around C/C++ libraries
- ART (Android Runtime VM)
  - Replaced Dalvik in Lollipop (Android 5.0)
  - Advantages over Dalvik
    - AOT (Ahead of Time) Compilation
    - Improved Garbage Collection

Dalvik Virtual Machine

- Executes Android Applications
  - Each Application runs within its own VM
    - Each app is “sandboxed”
- Memory Management
- Multi-threading

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Libraries

- C/C++
- Play and record audio and video
- Internet Security
- User interface building
- Graphics
- Database access

Library Examples

- WebKit
  - Web Browser Engine
- OpenGL
  - High Performance Graphics
  - Render 2D or 3D Graphic Content
- libc
  - Generic C library
- SQLite
  - Storage and sharing of application data

Library Examples Cont.

- Surface Manager
  - Off-screen buffering
    - Apps can't directly draw into screen
    - Drawings go to off-screen buffer
    - Combined with other drawings
    - Reason behind window transparency
- Media Framework
  - Provides media codecs allowing recording and playback of different types of media


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Application Framework

- Higher Level Services to Applications
- Environment in which applications are run and managed
- Package Manager
  - Keeps track of installed Applications
  - Apps can communicate with other Apps on device
- Window Manager
  - Manages main window that comprises Application

Application Framework Cont.

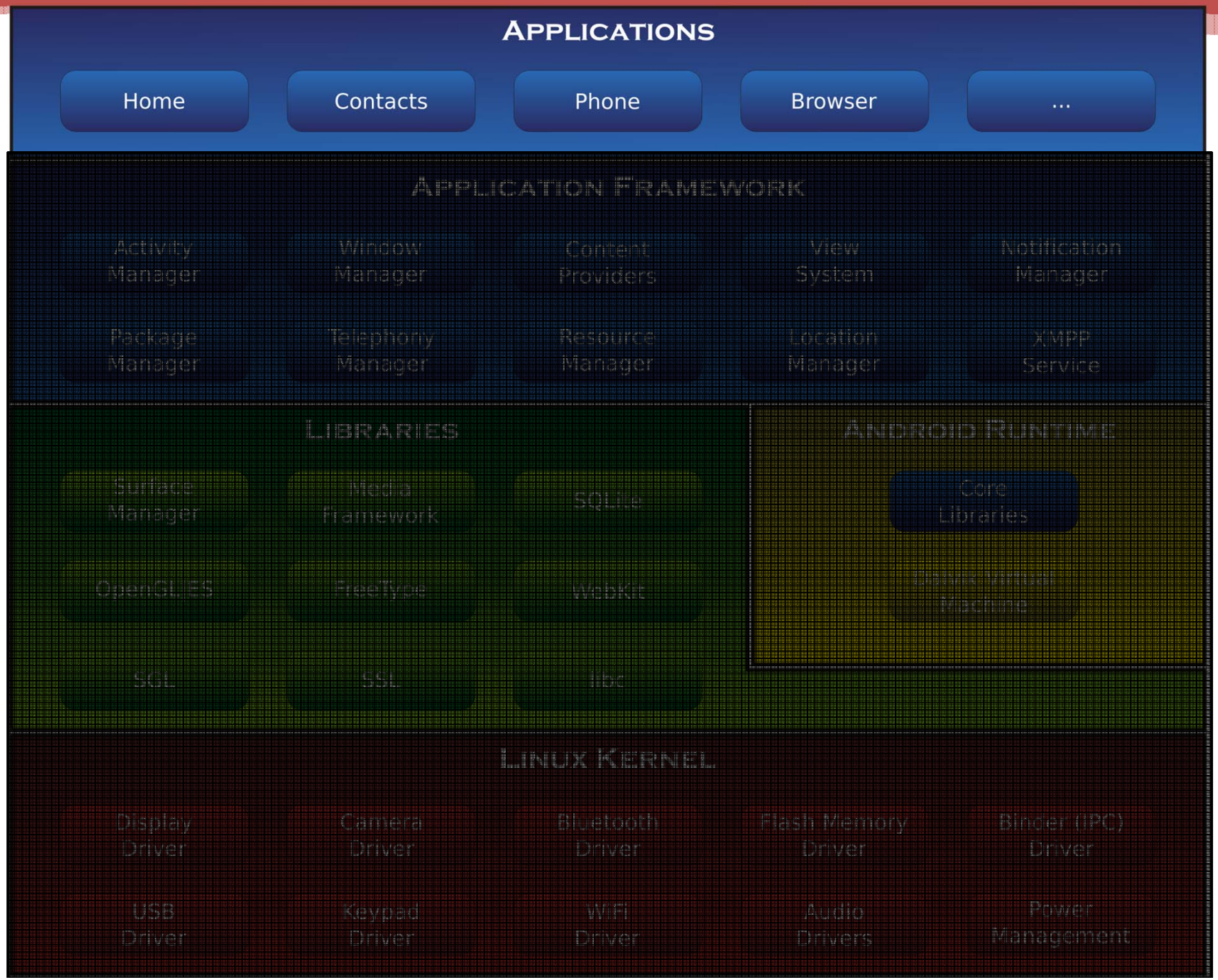
- View System
  - Provide Common User Interface Elements
    - Icons
    - Buttons
    - Text Entry
    - Etc.
- Content Providers
  - Databases that allow application to store and share structured info

Application Framework Cont.

- Location Manager
  - Allows application to receive location and movement info generated by GPS
- Activity Manager
  - Manages activity life cycle of applications
- Telephony Manager
  - Manages all voice calls

Application Framework Cont.

- Resource Manager
  - Manage various types of resources used in applications
  - Allows access to non-code embedded resources
    - Strings
    - Color settings
    - UI Layout
- Notifications Manager
  - Allows applications to display alerts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Applications

- Hosts Android Applications
- Written in Java
  - Access to all Android APIs
- Executed in the VM (Dalvik or ART)
- Examples
  - SMS client app
  - Dialer
  - Web Browser
  - Contact manager

Conclusion

- **Designed** for mobile and flexibility
  - Both in software and hardware
- 5 Layers
- Application Development
  - Simple
    - Java
  - Access to all aspects of the Kernel
    - Open Source
    - APIs

Arduino Architecture

By: Joshua Rosas and Olohirere J. Aruya

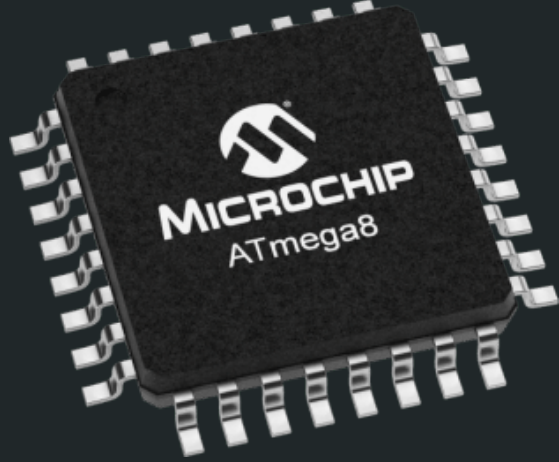
Overview

- Arduino (What is it?)
- History
- Arduino Uno
- ATmega328P
- Arduino Due
- AT91SAM3X8E (Cortex-M3)
- Summary
- Sample Projects

What is Arduino?

- Microcontroller development board originally aimed towards students
- Contains open-source hardware and software.
- Various boards and revisions for project needs
- Requires no prior programming experience and is cross platform
- Heavily influencing IoT and DIY solutions

History of Arduino



- Started in 2003 by Massimo Banzi aimed towards his students
- Provide an affordable platform to understand microcontrollers
- First board along with IDE released in 2005
- Originally based off the ATmega8 chip but has adopted several revisions and different microprocessors

ARDUINO UNO V3

* Price at the arduino store as of 12/03/17

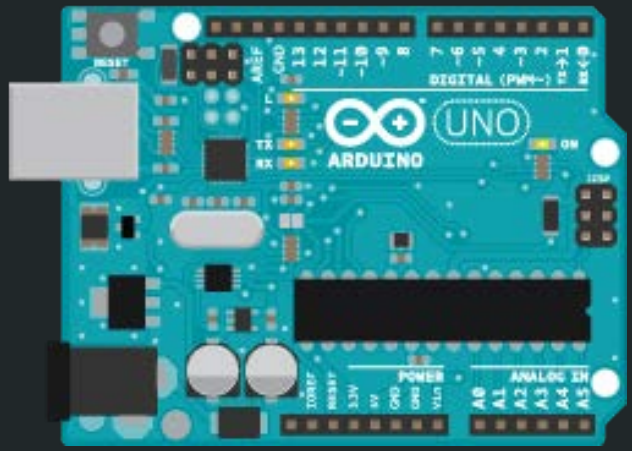
µController: ATmega328P

Frequency: 16MHz

I/O Pins: 14 (6 PWM)

*Price: $22 US

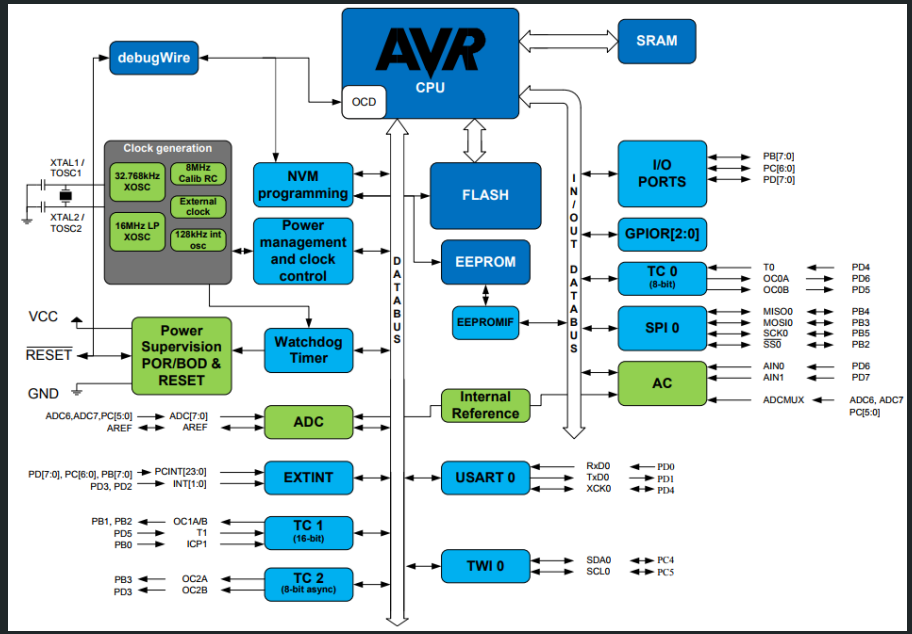
Power: USB 5V or DC Barrel Jack



Common Usage: Robots, DIY home projects, machine controller, rapid development, data logger

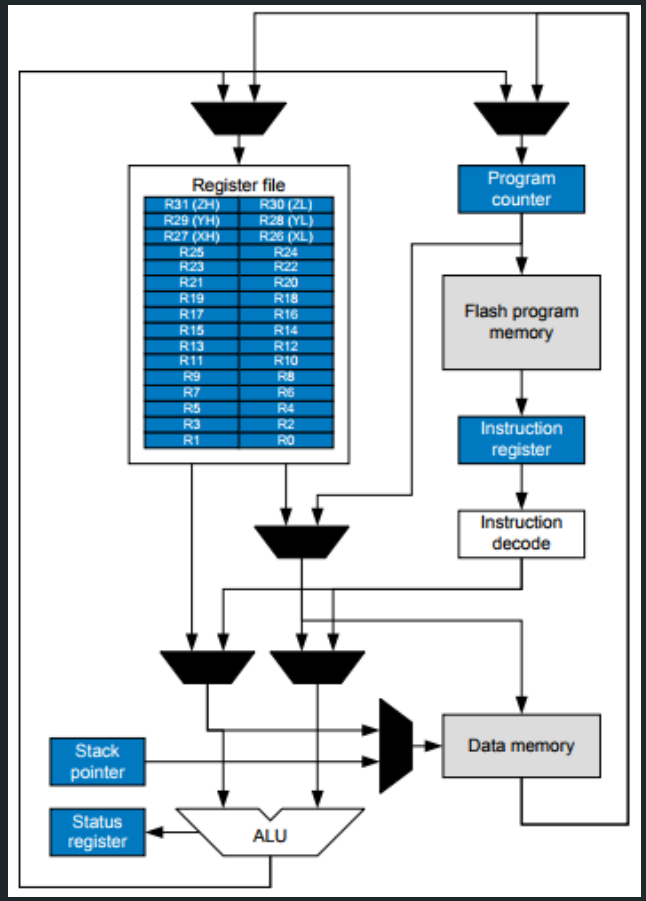
ATmega328

- High Performance, Low Power Atmel 8-bit Processor
  - Advanced RISC Architecture
    - 32 x 8 GPW Registers
    - 32Kb Programmable Flash
    - 8-bit Timer (x2)
    - 16-bit Timer (x1)
- Can theoretically achieve 20 MIPS



ATmega328 Continued

- AVR CPU Core Architecture
  - Uses Harvard Architecture
    - Two Main Memory Spaces
      - Data Memory
      - Program Memory
  - Instructions are executed in a single level pipelining
  - Prefetching is enabled
  - AVR Instructions have a single 16-bit word format
  - Memory Addresses contain a 16 or 32-bit instruction



* Price as of 12/03/17

Arduino Due

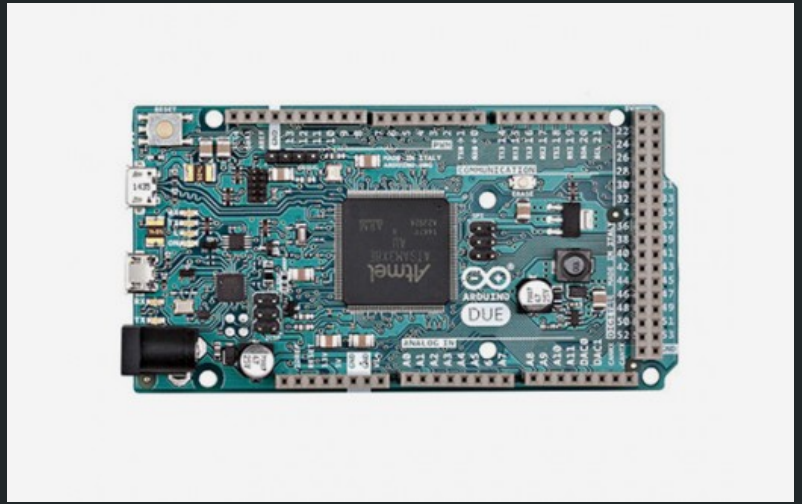
µController: AT91SAM3X8E

Frequency: 84MHz

I/O Pins: 54 (12 PWM)

*Price: $37.40 US

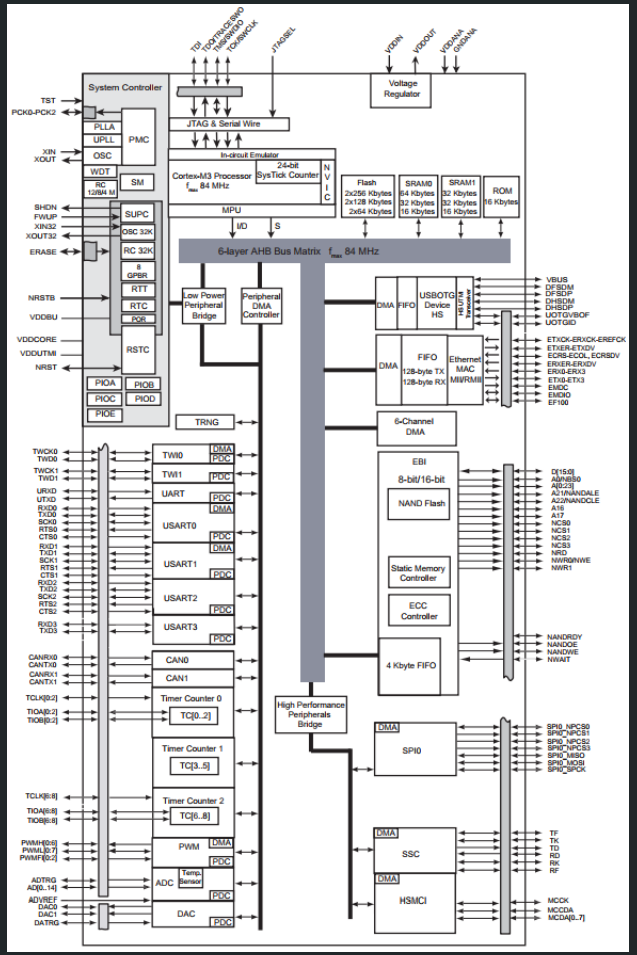
Power: USB 3.3V or DC Barrel Jack



Common Usage: Includes everything from Uno with the addition of connecting more analog devices, 3D-Printers, CNC machines

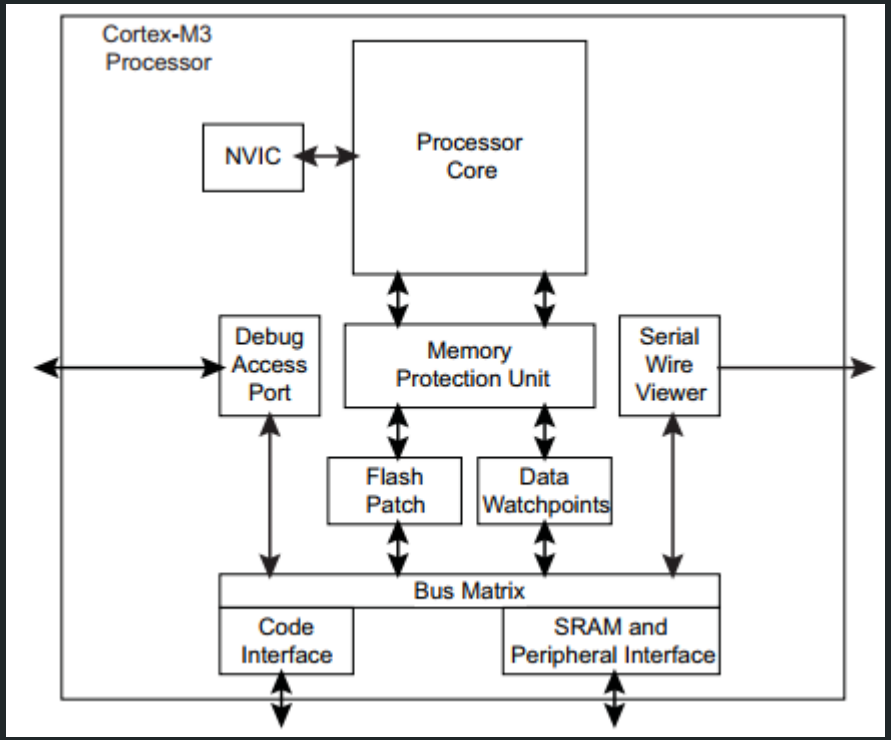
AT91SAM3X8E (Cortex-M3)

- High Performance, Low Power 32-bit ARM Cortex-M3
  - Different family compared to UNO
  - Advanced RISC Architecture
    - 13 x 32 GPW Registers
    - 512Kb Programmable Flash
    - 32-bit timer (x3)
    - 3 USART and 2 UART
    - 12-bit ADC and DAC



AT91SAM3X8E (Cortex-M3) Continued

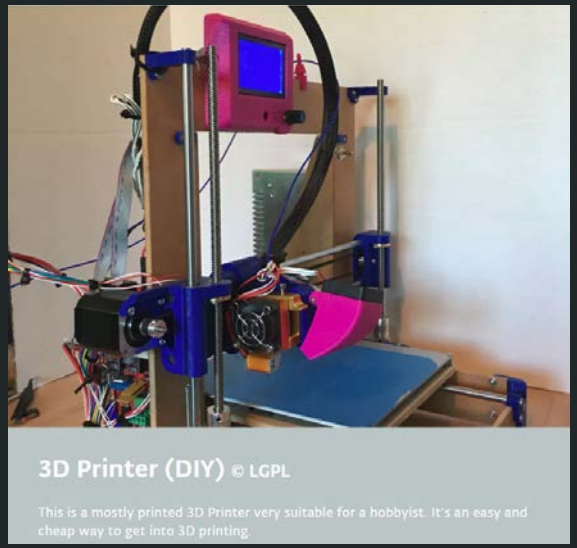
- Uses Harvard Architecture
  - 3-Stage Pipelining
  - NAND Flash Controller
  - 24-bit SysTick Counter
- Thumb-2 (ISA) both 16-bit and 32-bit
- Contains Nested Interrupt Controller (NVIC)
  - Can provide up to 16 interrupts



Arduino Projects

Barbot: Cocktail Mixing Robot © GPL3+

Barbot is an open source Arduino cocktail mixing robot controlled with the hybrid mobile app via Bluetooth.

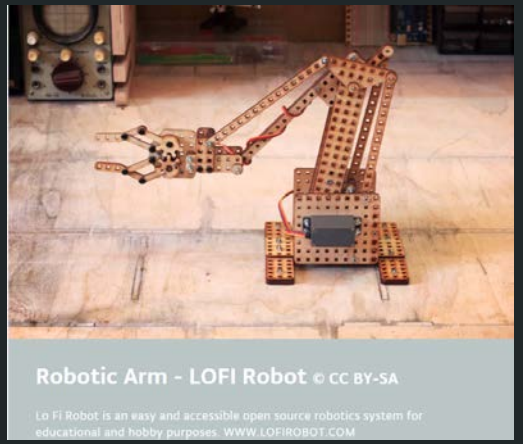


3D Printer (DIY) © LGPL

This is a mostly printed 3D Printer very suitable for a hobbyist. It's an easy and cheap way to get into 3D printing.

Critter: Crawling Arduino Robot © CC BY

The Critter is a simple Arduino walking robot that is fully 3D printed.

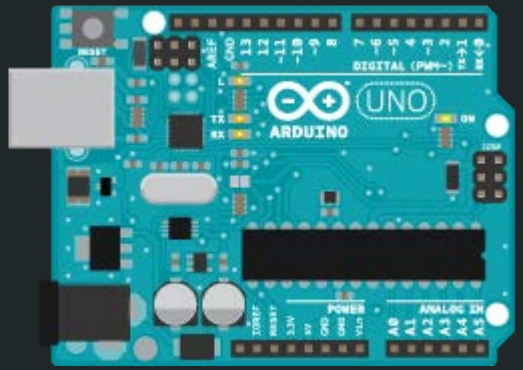


Robotic Arm - LOFI Robot © CC BY-SA

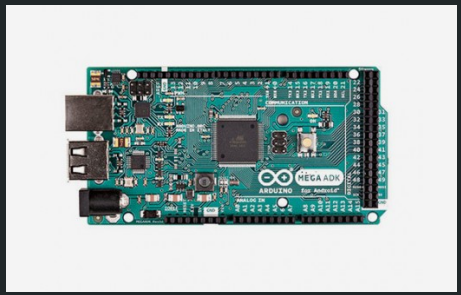
Lo Fi Robot is an easy and accessible open source robotics system for educational and hobby purposes. WWW.LOFIROBOT.COM

Summary

- Low cost for rapid prototyping
- Compatibility amongst different platform (Windows, Linux, Unix)
- Power Consumption is low
- Open Source means 3rd party libraries!
- Can be customized to your needs.

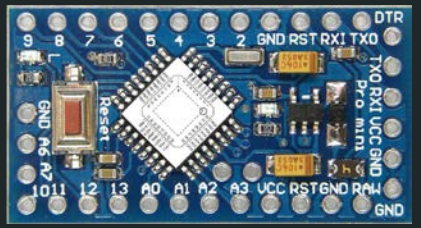


Arduino Uno



Arduino Mega

Arduino Mini



Arduino Nano Pro

QUESTIONS?

Resources

https://core-electronics.com.au/videos/history-and-evolution-of-arduino

http://www.atmel.com/Images/Atmel-42735-8-bit-AVR-Microcontroller-ATmega328-328P_Datasheet.pdf

http://www.atmel.com/Images/Atmel-11057-32-bit-Cortex-M3-Microcontroller-SAM3X-SAM3A_Datasheet.pdf

https://www.arduino.cc/en/Main/Products