

Emerging Technologies in Embedded System Design

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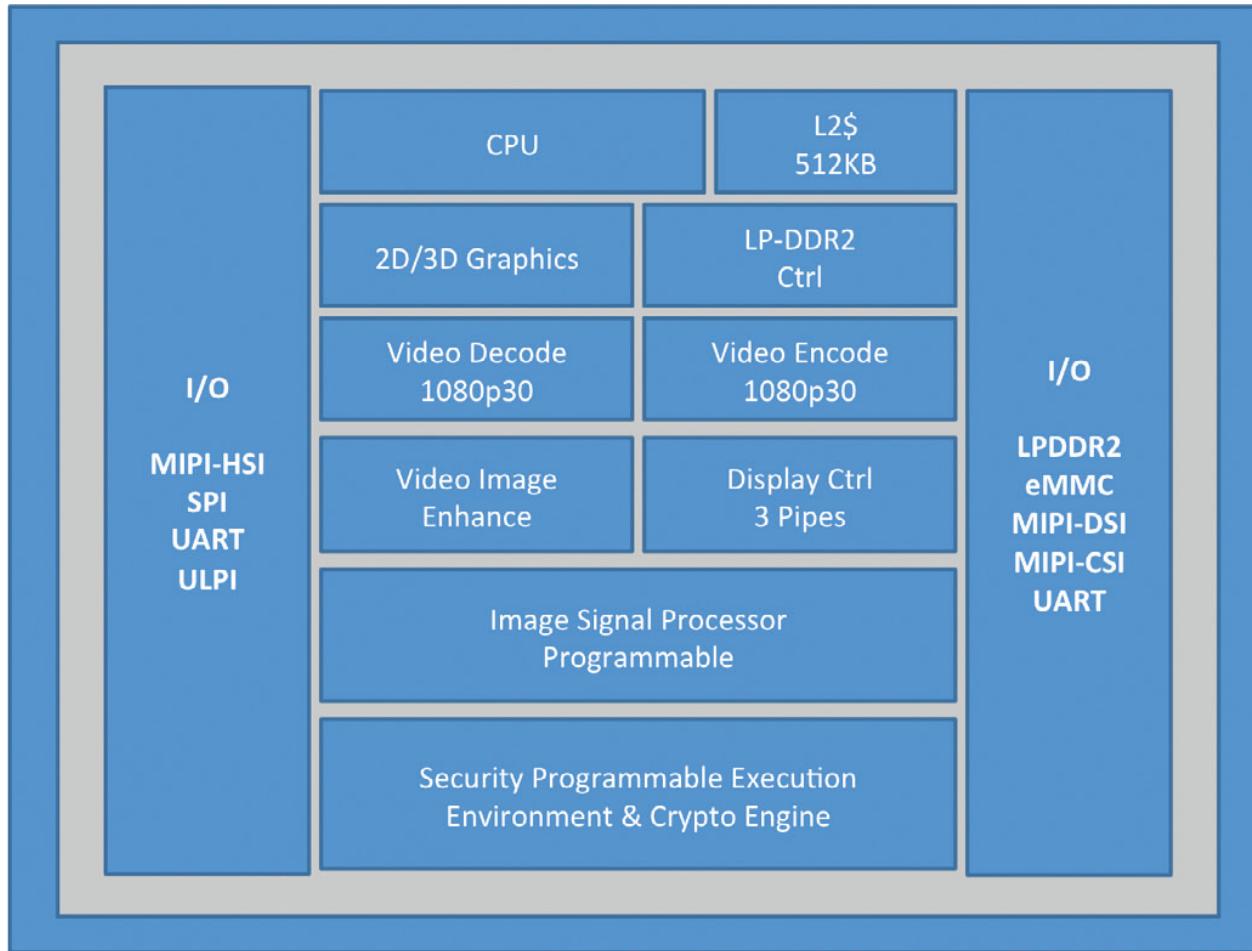
Overview

- **Hardware**
 - System on Chip (SoC)
 - Open Hardware (Beagleboard, Edison, Galileo, etc.)
- **Software**
 - Embedded OS (Android etc.)
 - Applications (health care, e-commerce, etc.)
 - Internet of Things and Intelligent System
 - Open Embedded Projects (Yocto)
- **Design Methodology**
 - Full System Simulation (Simics)

System on a Chip

- Integrate (all) components of a computer into a single chip
 - ARM, MIPS, or x86 cores
 - digital, analog, mixed-signal, RF, DSP
 - much more powerful than conventional simple microcontrollers
- connects to
 - external Flash or RAM
 - USB, Ethernet, SPI, I2C, etc.
- Runs embedded OS and many applications
 - Linux or embedded Windows
 - network stack, database, etc.

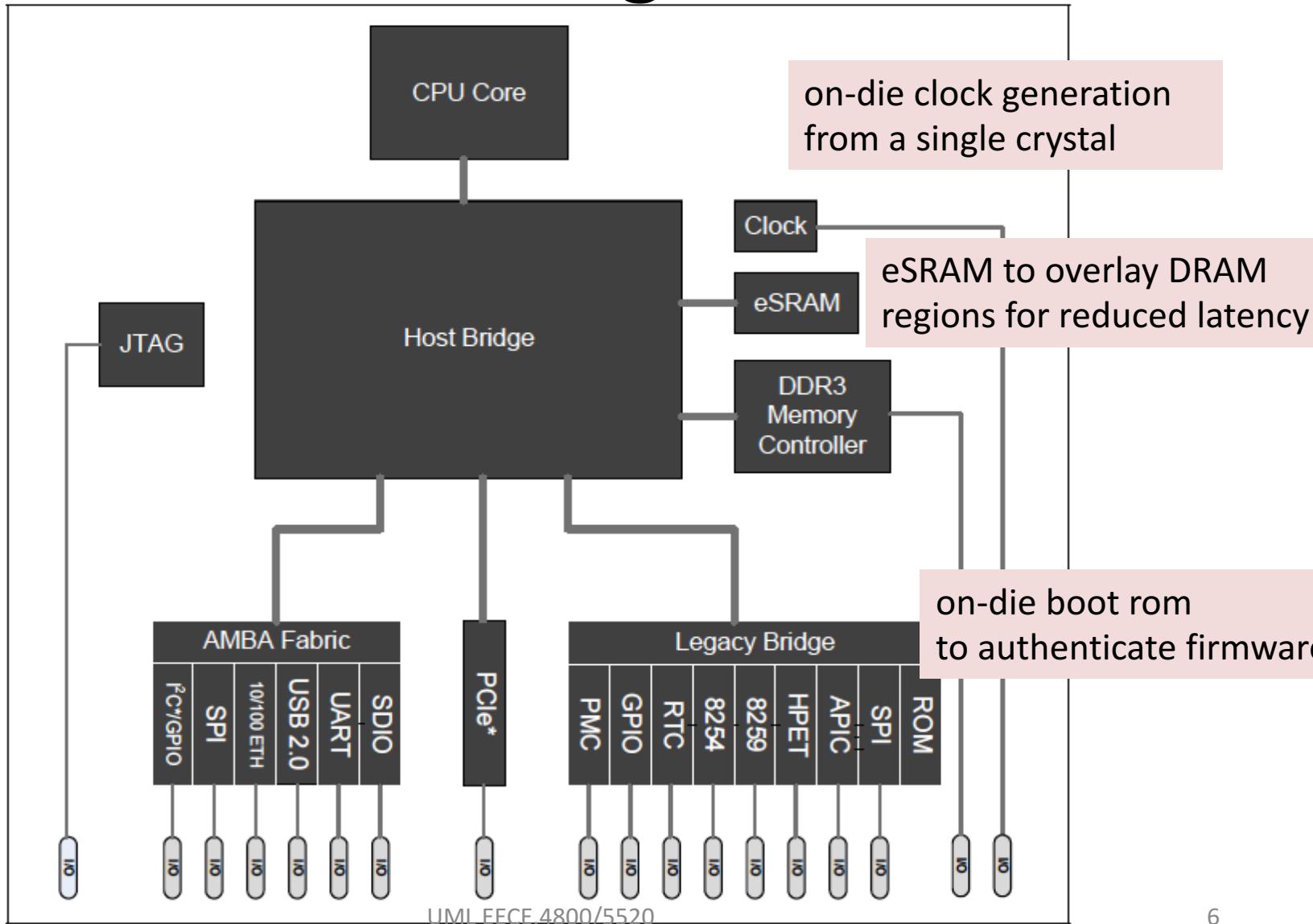
Intel Atom Z2580



Intel Quark

- low power secure System-on-Chip (SoC) designed for bring intelligence to network edge for securely managed Internet of Things (IOT)
- Single 32-bit core, single thread
- Integration of I/O interfaces:
 - on-chip Ethernet* interfaces, PCI Express*, USB 2.0, SD/SDIO/eMMC, SPI, UART, and I2C/GPIO.
- Supports Intel Pentium instruction set

Block Diagram



Apple A8

- 64-bit SoC used in iPhone 6 and iPhone 6 Plus
- 25% more CPU performance and 50% more GPU performance, 50% less power than A7
- ARMv8 instruction set
- 20nm technology with 2 billion transistors
- Dual-core @ 1.38GHz



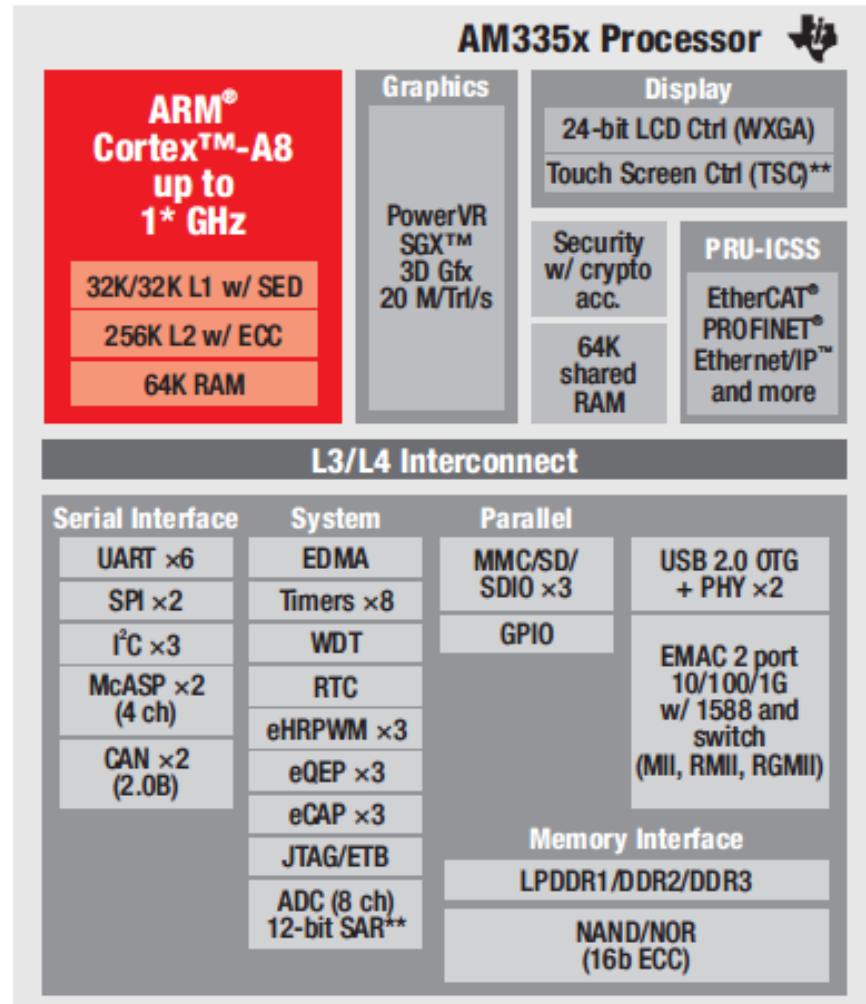
Qualcomm Snapdragon

- SoC (CPU+DSP+GPU)
- Hexagon DSP
 - maximize work per clock cycle (e.g. FFT in one cycle)
 - high performance at lower clock freq, thus low power
 - could be used for “camera/vision/video/sensor” tasks
- Heterogeneous system to share processing intensive tasks among CPU,DSP,GPU



TI Sitara AM335x

- ARM cortex-A9 core
- 3D graphics processing power
- on-chip quad-core PRU for real-time processing
- vector floating-point
- two parallel camera ports, dual-port 1Gb Ethernet



* 1 GHz only available on 15×15 package. 13×13 is planned for 600 MHz.

** Use of TSC will limit available ADC channels.

SED: Single error detection/parity.

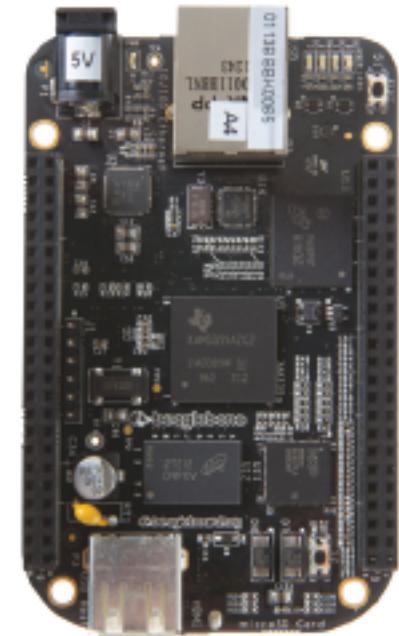
Intel Edison

- Intel Atom (2-core) @ 500MHz + Quark SoC @ 100MHz, 1G memory, 4G flash
- Small form factor (SD size)
- support Arduino sketch, Linux, wifi, bluetooth
- digital/analog I/Os, UART, I2C, SPI, etc.
- Yocto Linux, Arduino IDE



BeagleBone Black

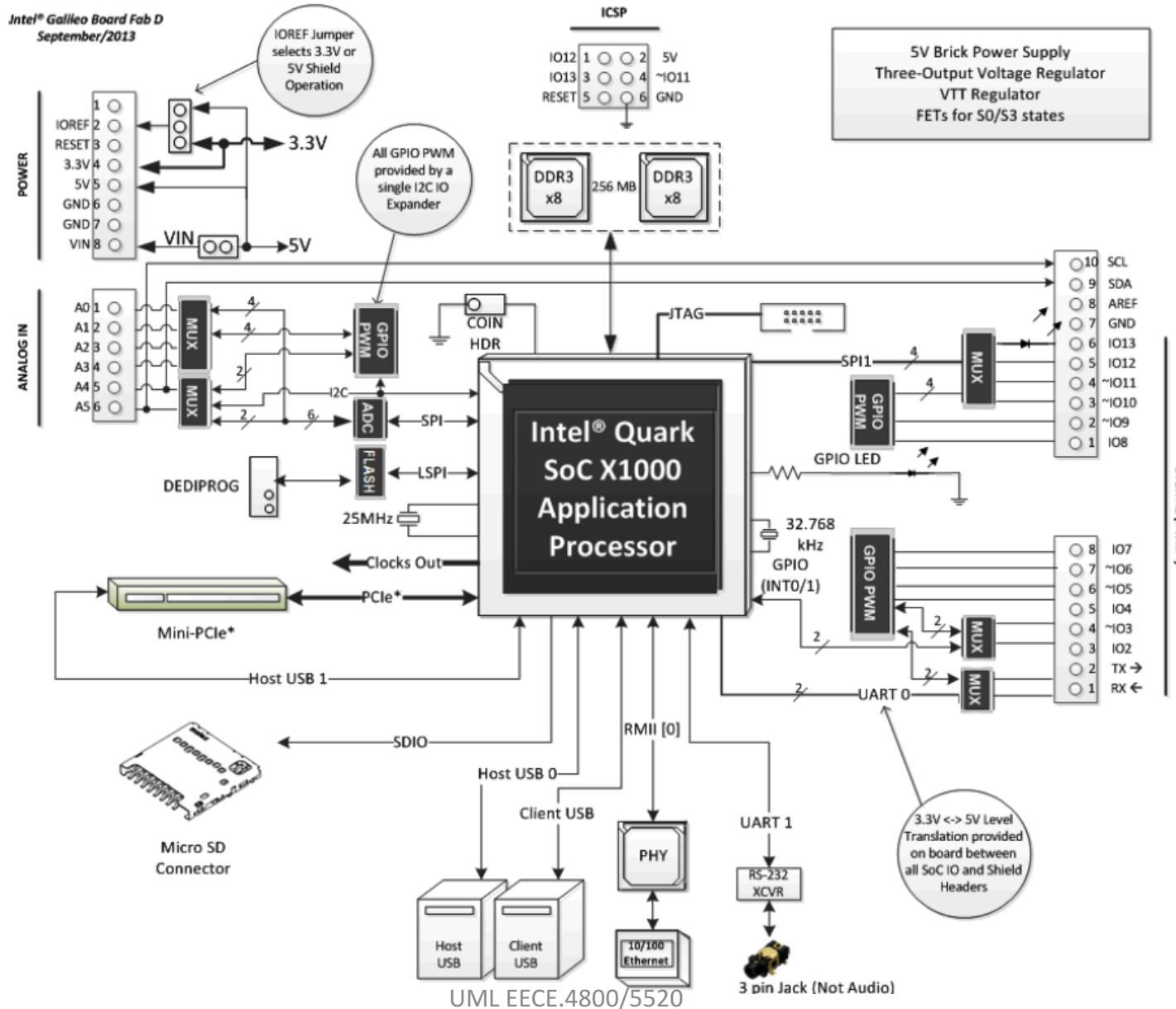
- www.beagleboard.org
- credit-card size, open hardware
- 1GHz CPU, 512MB DDR3, eMMC flash
- HDMI, USB, Ethernet, UART
- Runs Android, Linux, Windows CE, RT OS
- Yocto compatible



Intel Galileo

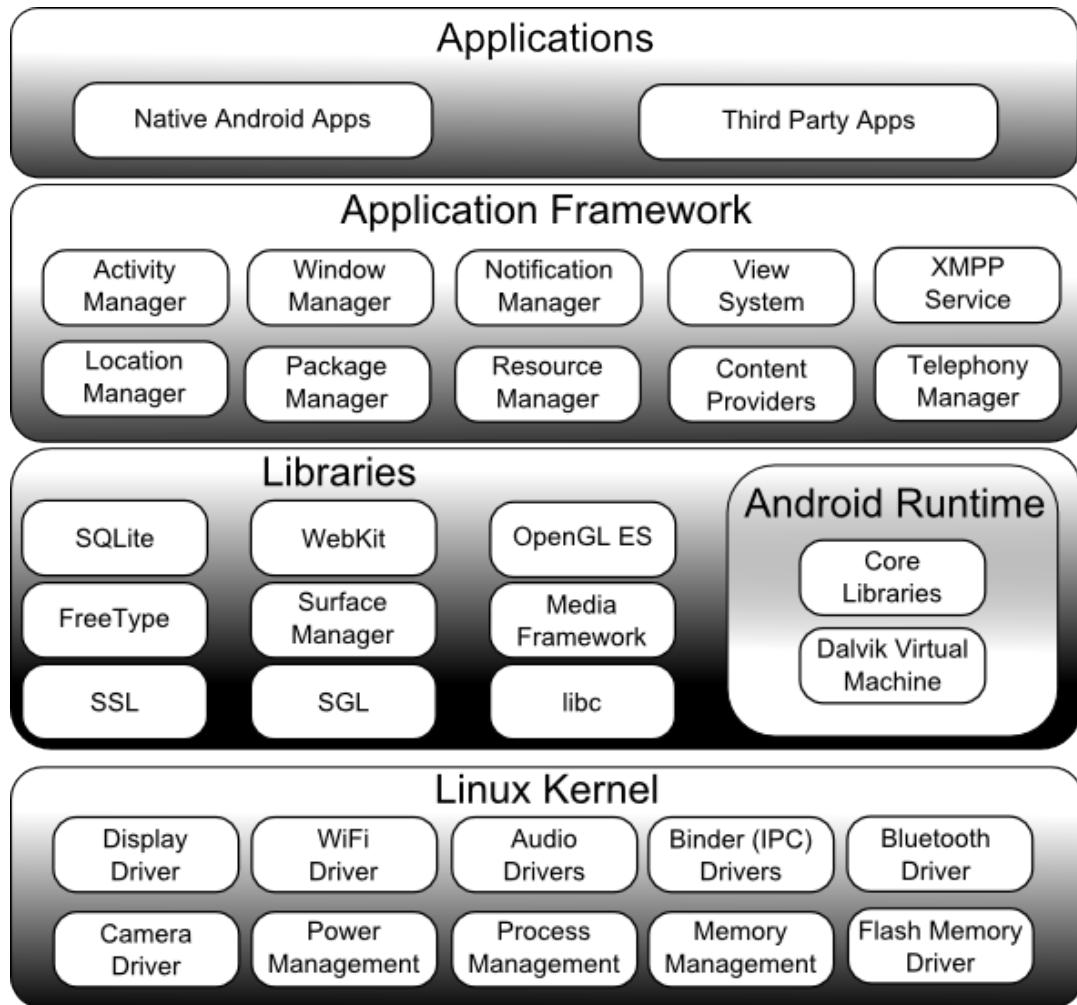
- Intel's Embedded Development Board based on Quark processor
- Open Source Hardware and Software
- Arduino Compatible
- With a variety of ports
 - USB, GPIO, Ethernet, mini PCIe, serial, etc.

Overview of Galileo Hardware



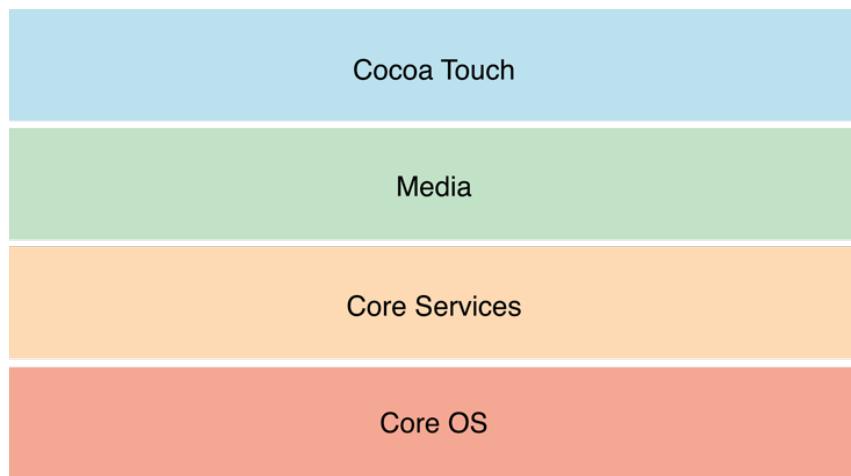
Android

- mobile OS / platform released in 2009
- Google backed, contributed by community and vendors
- Android SDK for App development



iOS

- Mobile OS / Platform
- By Apple and for Apple Only
- iOS SDK /Xcode, App development with Objective-C and/or Swift



- Appearance of the App
- graphics, video, audio
- location, social media, networking
- security, authentication, bluetooth

Other Embedded OSes

- Windows CE
 - Different kernel from desktop Windows
 - Supports x86 and ARM
 - Base of Windows Phone
- Wind River Linux
 - Commercial Linux, good support
 - Supports many processor architectures, and Yocto
- Wind River VxWorks
 - Real-time OS for critical applications (power, teleco, aerospace, etc.) -- Curiosity on Mars!
 - Modular: Microkernel (20KB) + common kernel
 - Broad connectivity: USB, CAN, Bluetooth, etc.

Yocto Project

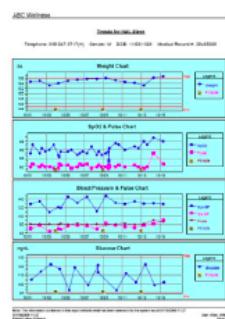
- Yocto is not a new Linux
- Yocto is a collection of tools to
 - Help you build a (Embedded) Linux distribution
 - Help you customize your distribution/package
 - Help you pull sources and compile packages for a specific hardware platform
- Supports many processor ISA
- Backs from a large group of companies

Remote Patient Monitoring

PHILIPS

Remote Patient Monitoring

- Measuring devices at patient's home (or even mobile)
- Network connection to service center
- Web-based clinical software to monitor a large number of patients efficiently



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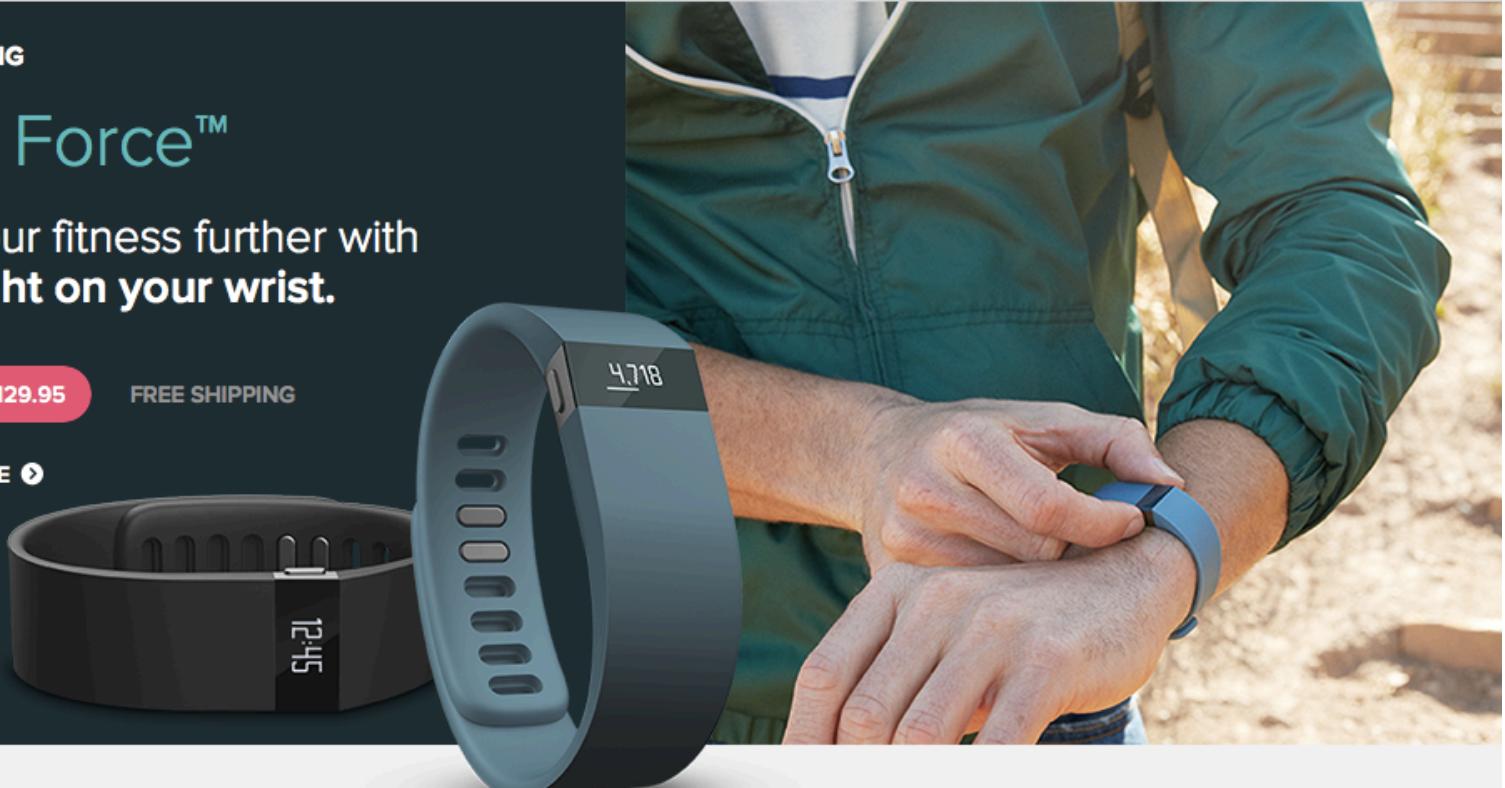
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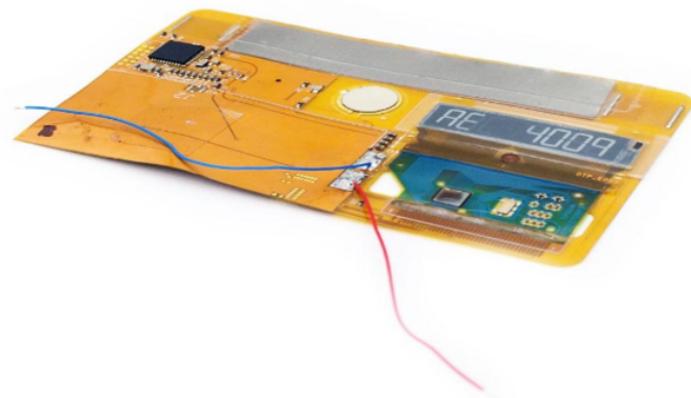


Pebble Smart Watches and Wearables



WE'RE ON
KICKSTARTER

The “Coin” Credit Card(s)



COIN V3

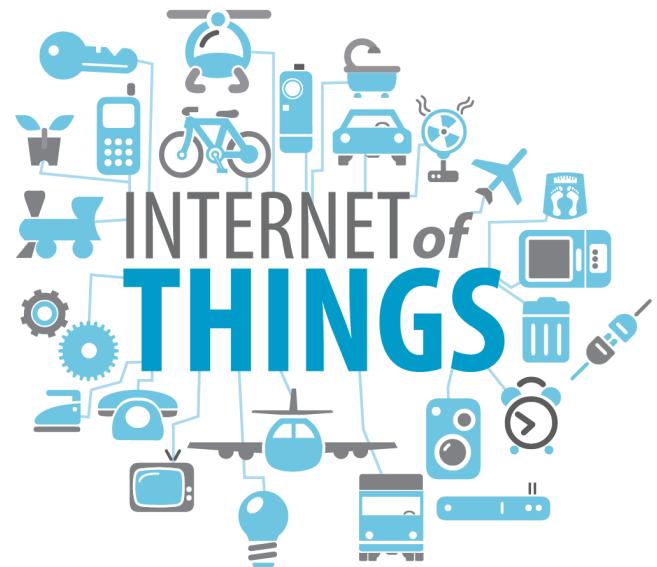
Design metrics:

- Form factor
- Power
- Communication media/range
- Security

<https://onlycoin.com>

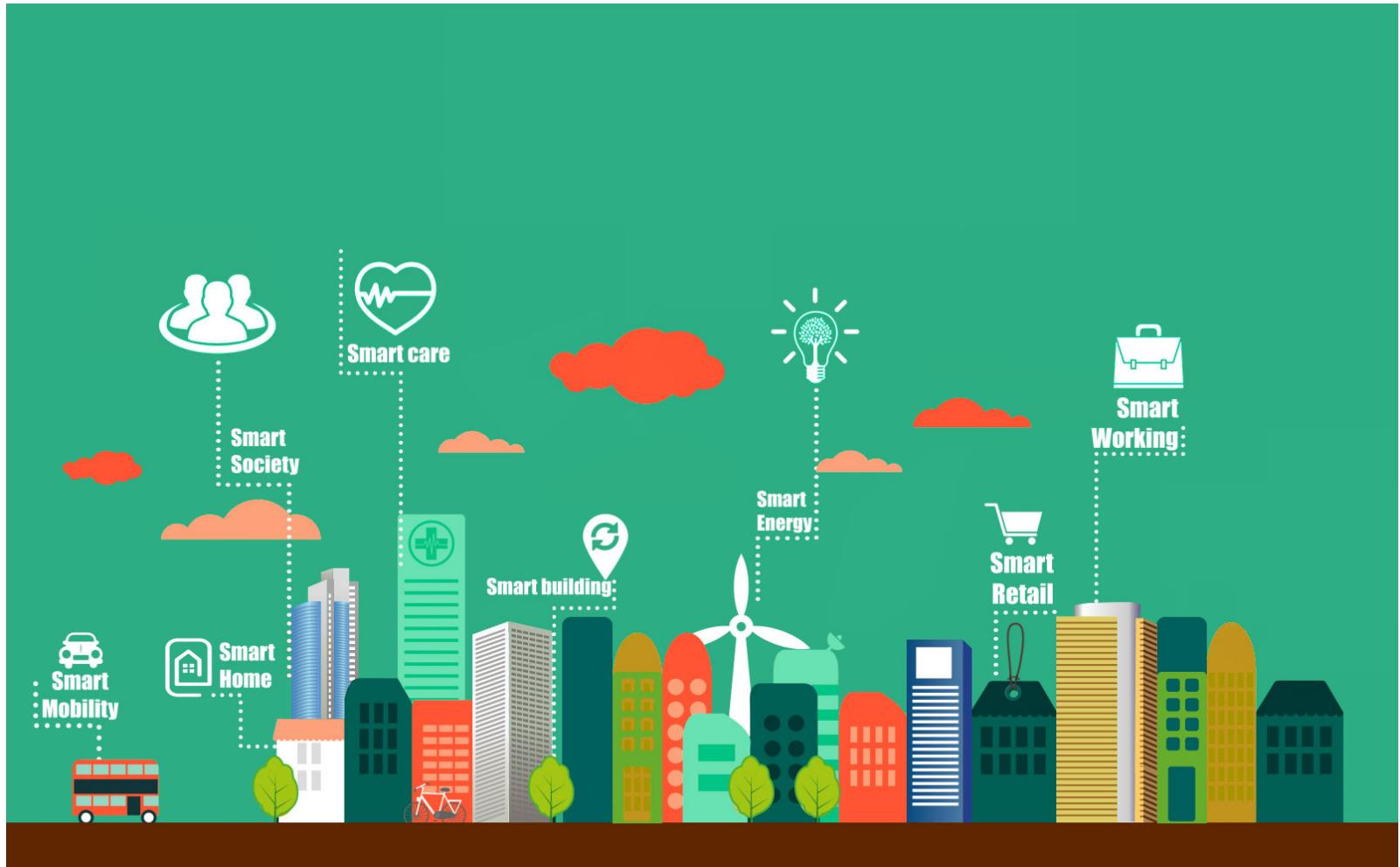
Internet of Things (IoT)

- Ubiquitous interconnection of embedded devices (sensors, actuators, systems, services, ...)
- 26 billions of smart connected objects in 2020
- Example of “Things”
 - Heart monitoring implant
 - Smart grid
 - Cars with sensors
 - Thermostat
 - Toys and diapers
 - ...



Picture source: <http://blog.surveyanalytics.com/2014/09/top-5-infographics-of-week-internet-of.html>

Smart Cities



Embedded Systems in 2020 and beyond

- What are the emerging technologies?
- What kind of problems they are going to address?
- What are the design metrics?
- What could be an interesting application in the future that requires innovations in embedded system designs?