

G54MDP

Mobile Device Programming

Lecture 2 – Mobile Phone
Architecture

Angry Birds and 'leaky' phone apps targeted by NSA and GCHQ for user data | World news | theguardian.com

www.theguardian.com/world/2014/jan/27/nsa-gchq-smartphone-app-angry-birds-personal-data

g Angry Birds and 'leaky' phone a... +

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Angry Birds and 'leaky' phone apps targeted by NSA and GCHQ for user data

• US and UK spy agencies piggyback on commercial data
• Details can include age, location and sexual orientation
• Documents also reveal targeted tools against individual phones

James Ball
theguardian.com, Tuesday 28 January 2014 07.51 GMT

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Today's best video



Six Nations 2014: what are Wales's chances?
Robert Kitson looks at Wales's chances of becoming the first team to take home the trophy for three consecutive seasons

18 comments



Swimming in the Lake District
Swimmers describe braving 5C water in nothing but a swimsuit

2 comments



What happens if you get too close to a black hole?
Professor Robert Winston answers questions

Israeli army's camera

Learning Outcomes

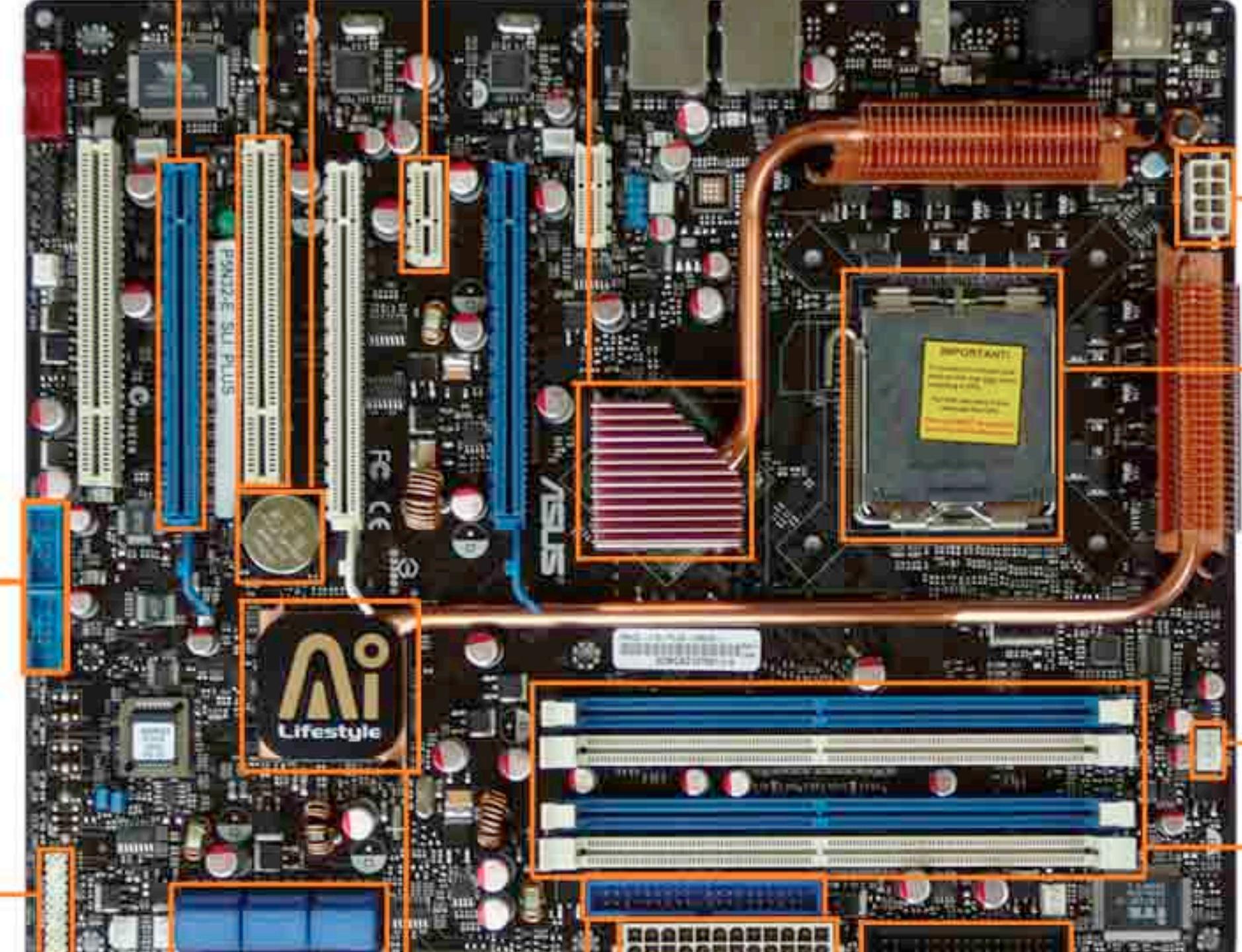
- By the end of this lecture you should...
- Understand the architectural differences between a PC and a mobile phone
- Have an overview of the main components of a mobile phone
- Understand some of the differences between ARM and x86 as relevant to mobile phones

Mobile Device Characteristics

- CPU ~1Gz
- GPU
- Memory
 - RAM 128MB-1GB
 - Flash Storage 16-64GB, internal / external via SD card
- Communications
 - Telephony
 - WiFi
 - Bluetooth
 - NFC
- Screen
- Audio
- User input
- Battery

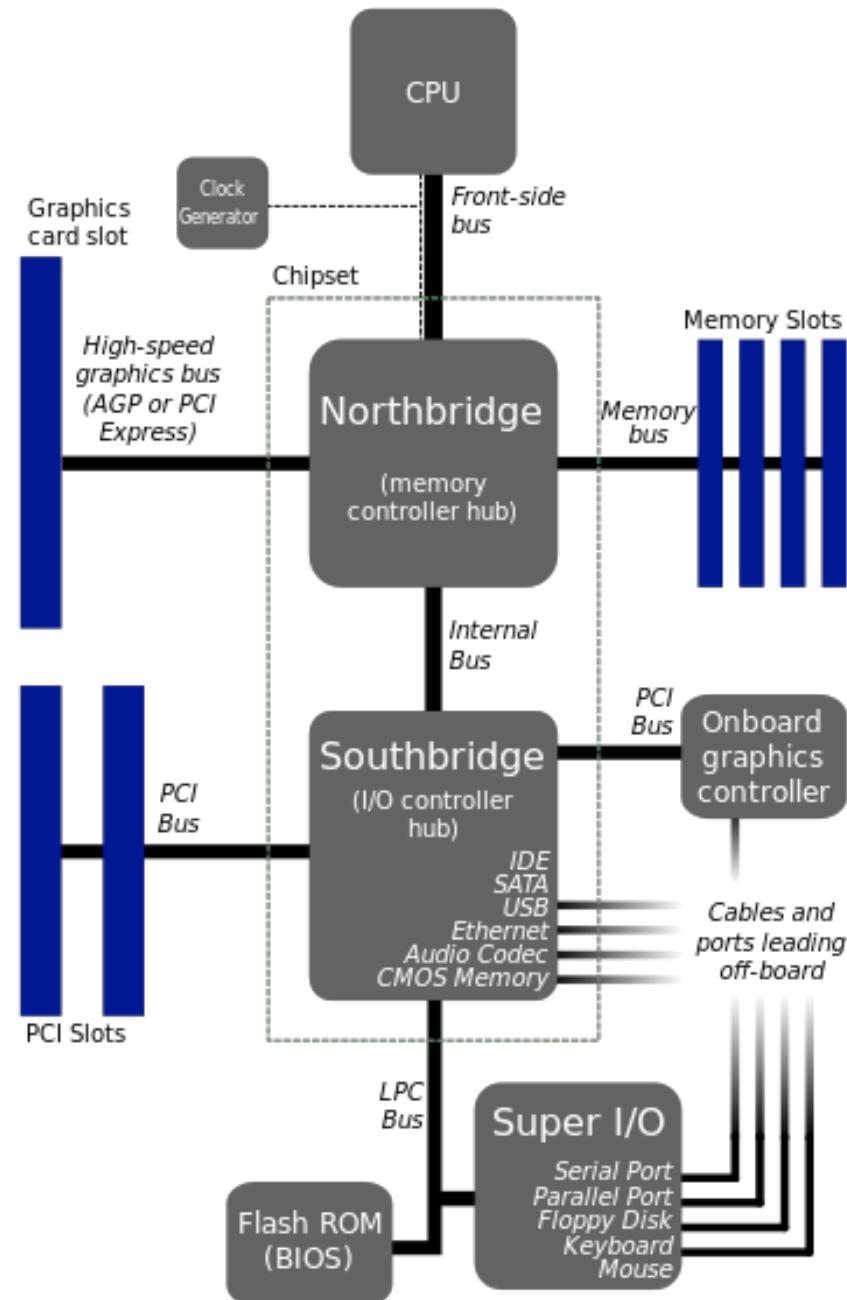
Sound familiar?

- In many ways, the technology inside a modern smart phone is conceptually very similar to that within a desktop PC
- It is the way that it is put together that is different



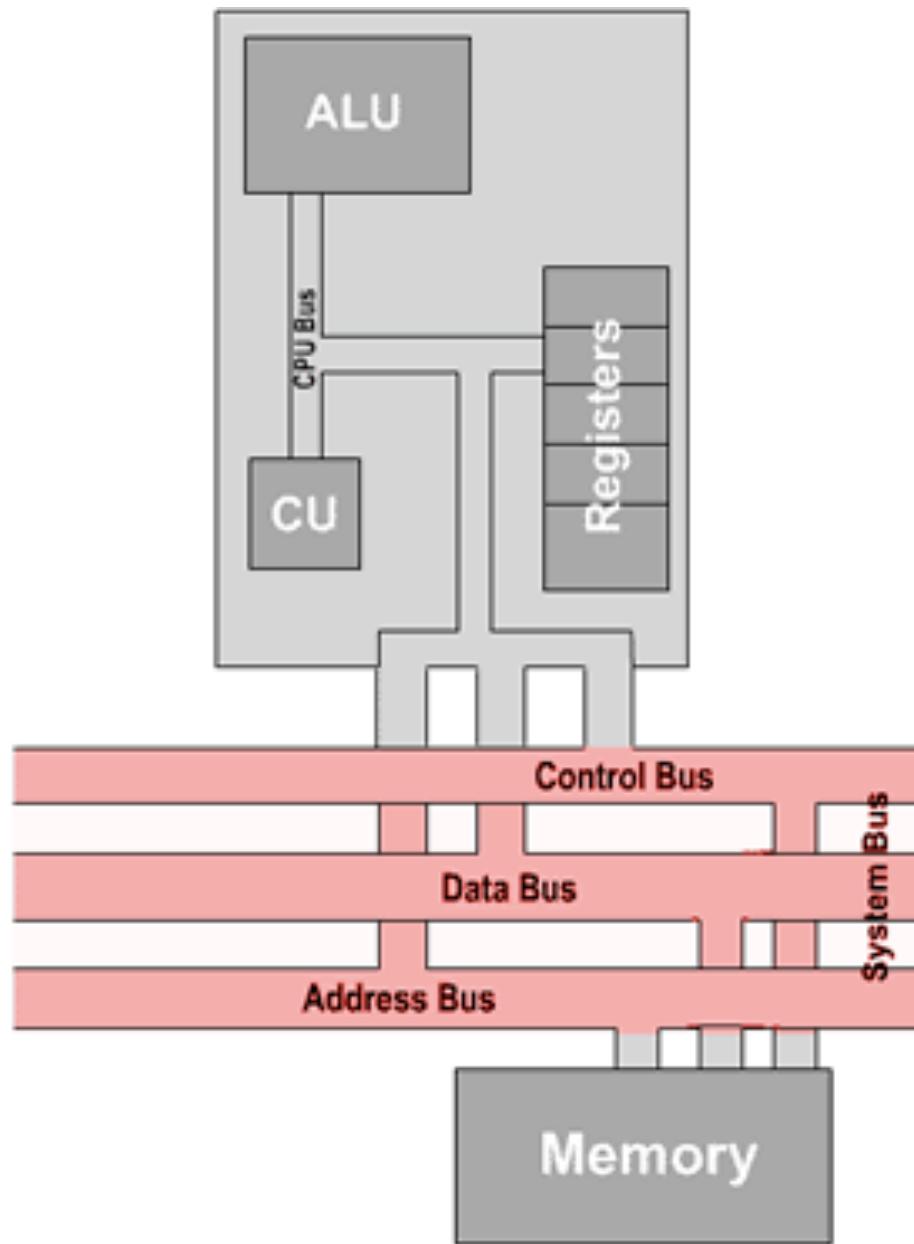
Inside a PC

- Several chips
- CPU
- Northbridge
- Southbridge
- RAM
- Several cards with extra bits
 - NIC, GPU, Audio
- Disks
 - HDD / SSD



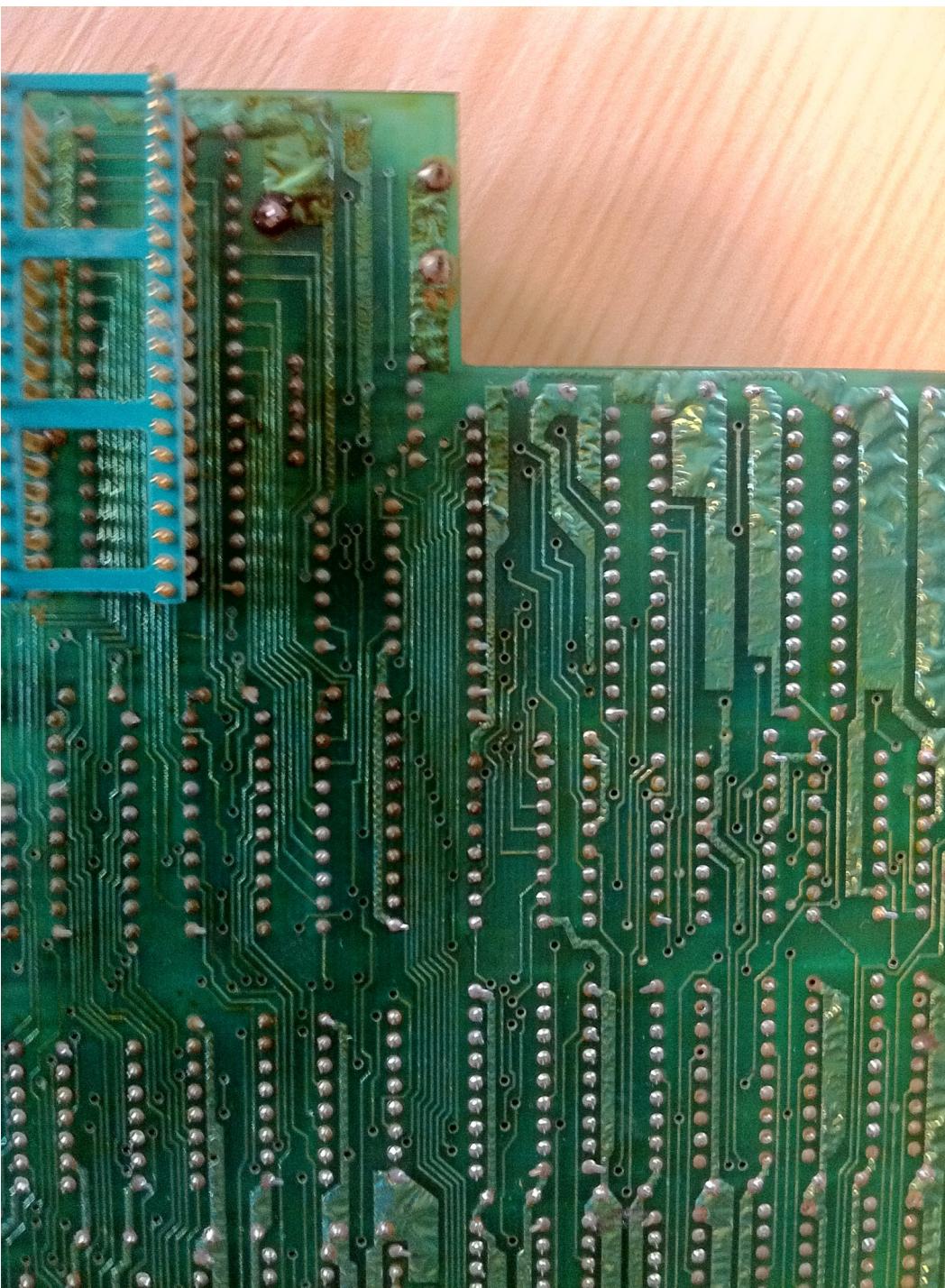
Connections

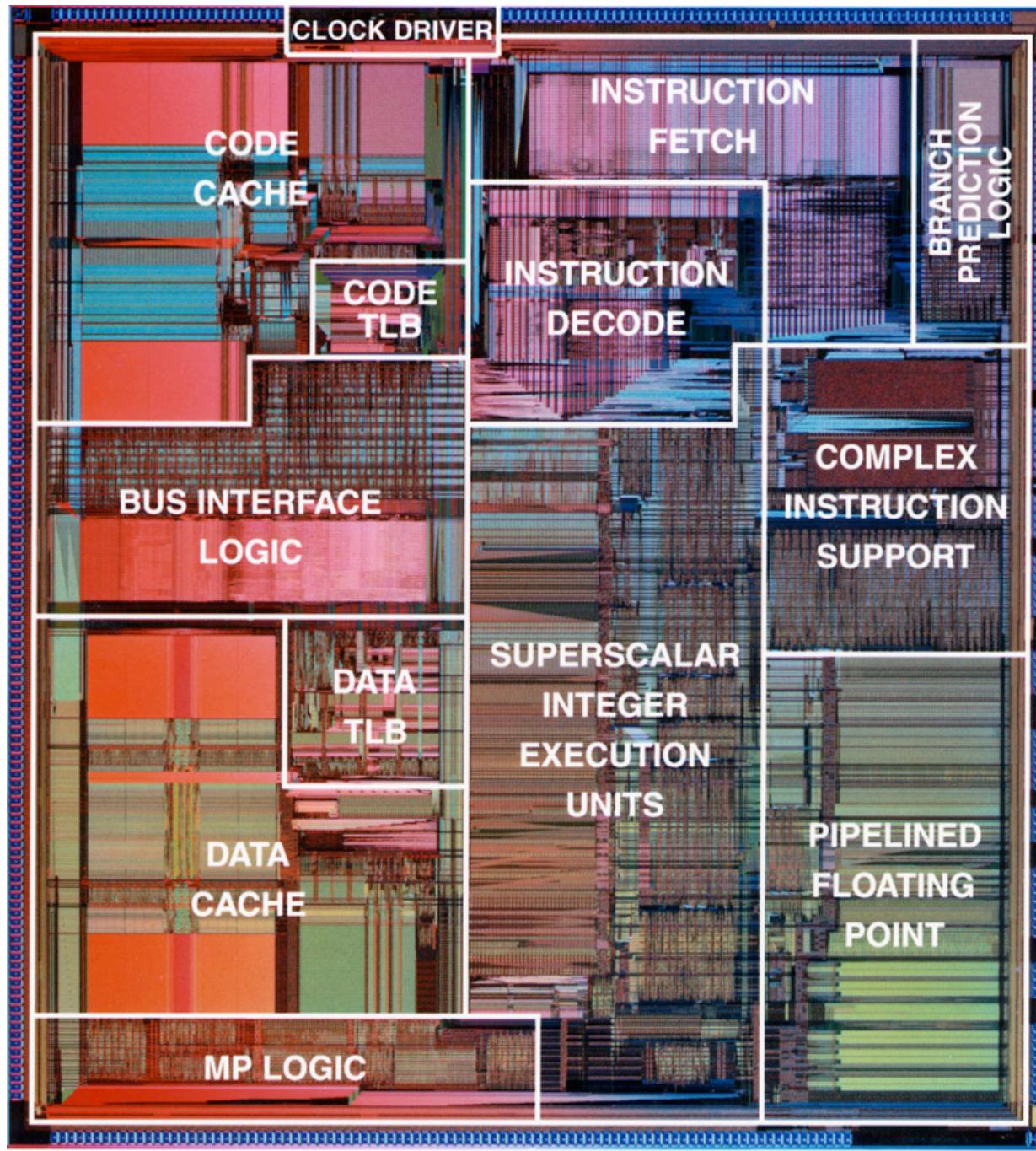
- CPU has a bus that connects it to the other devices / chips
- Originally, this would have been an address bus and a data bus, alongside some control buses
- RAM chips etc have similar connections
- Connect CPU to RAM / ROM
- Add some control logic and you have a PC



Connections

- Nowadays more advanced buses are used
 - E.g. HyperBus
- Bus width
 - The more lines (wires) the more data can be transferred
≈ faster bus
 - However, the number of pins used for the bus defines chip size
- Multiple chips and connections
 - Communications overhead / voltage drop = power
 - Clean architectural principle
 - Difficult to fit into a mobile device
 - Requires a different approach





Transistors

- A CPU is a collection of transistors
- All digital logic devices are built out of transistors
- 4 transistors will build a NAND gate
- Any logic circuit can be built using multiple NAND gates
- Getting better at getting lots of transistors on a chip
 - Moores law

System on a Chip

- Only use some of the transistors on a chip to form the CPU
- Use the rest to build the other required components of the system
- External pins connect directly to peripheral hardware, not core chips
- Called System on a Chip (SoC)
 - The whole system is literally on a single chip
 - Integrates several heterogeneous components on a chip
 - Aims to reduce communications overhead

System on a Chip

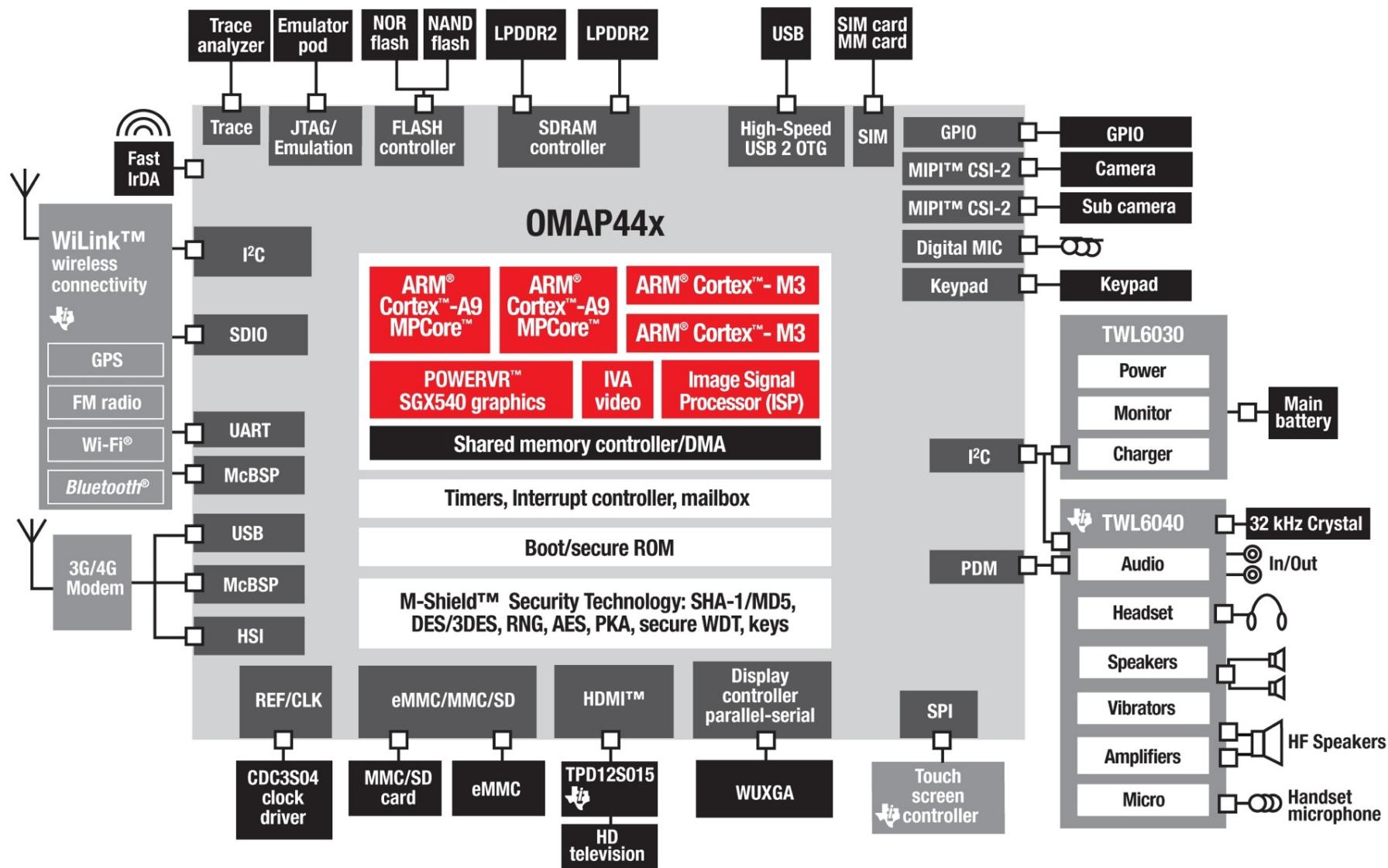
- Transistors provide computation, storage
 - Divide the chip into multiple communicating regions
- Built block by block from descriptions of separate parts
 - IP (intellectual property) cores
 - CPU core
 - GPU core
 - RAM core

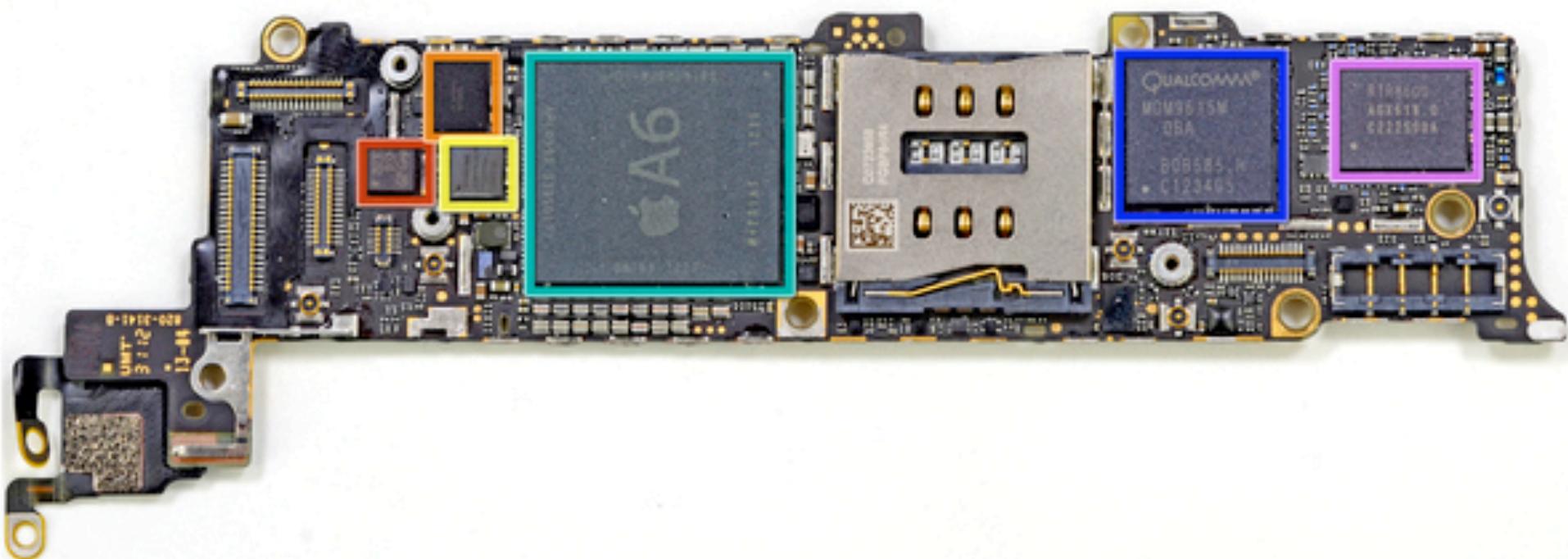
System on a Chip

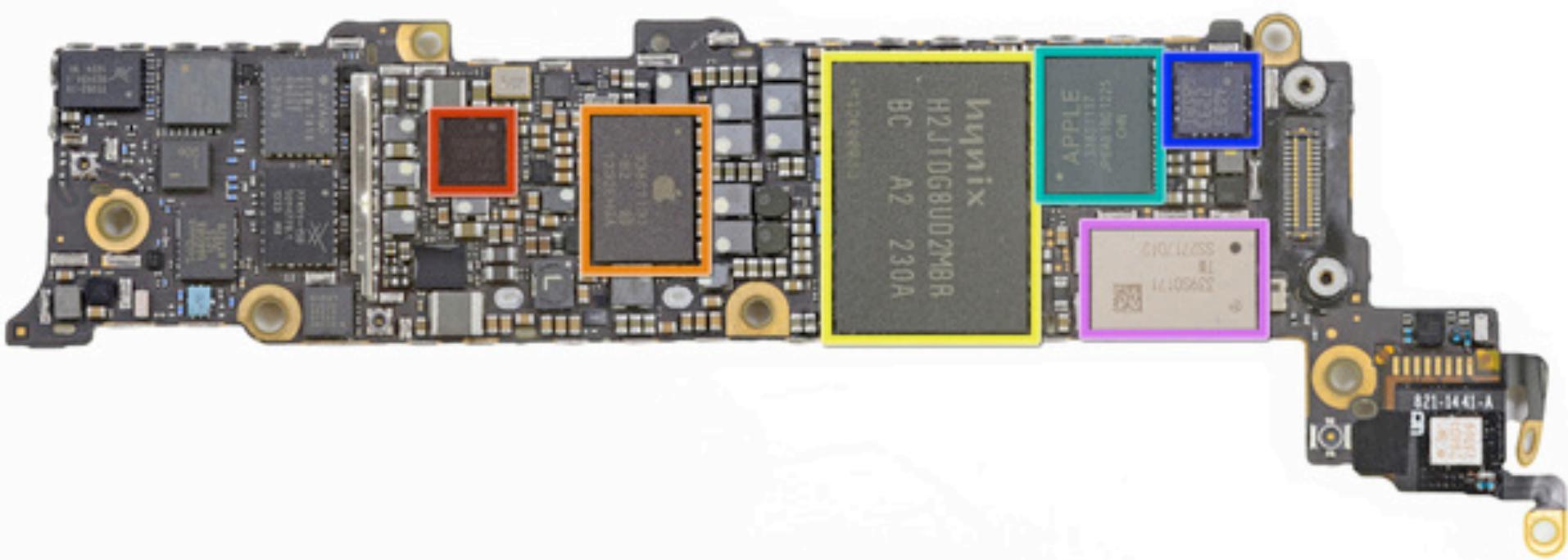
- Qualcomm Snapdragon
 - Nexus 4, Droid Razr, HTC Evo
- Apple A4/A5/A6/A7
 - iPhones
- Texas Instruments OMAP
 - Kindle Fire, Nook
- All share the same CPU block
 - ARM Cortex A8
- But may have different companion blocks

OMAP 44x0

- A typical SoC chip used in mobile phones
- Motorola Droid Bionic, Samsung Galaxy Nexus
- Contains two ARM Cortex-A9 CPU
- 3D GPU (PowerVR SGX)
- IVA Accelerator
- Image Signal Processor
- Some analogue components have a limited minimum size
 - Analogue vs digital – why?

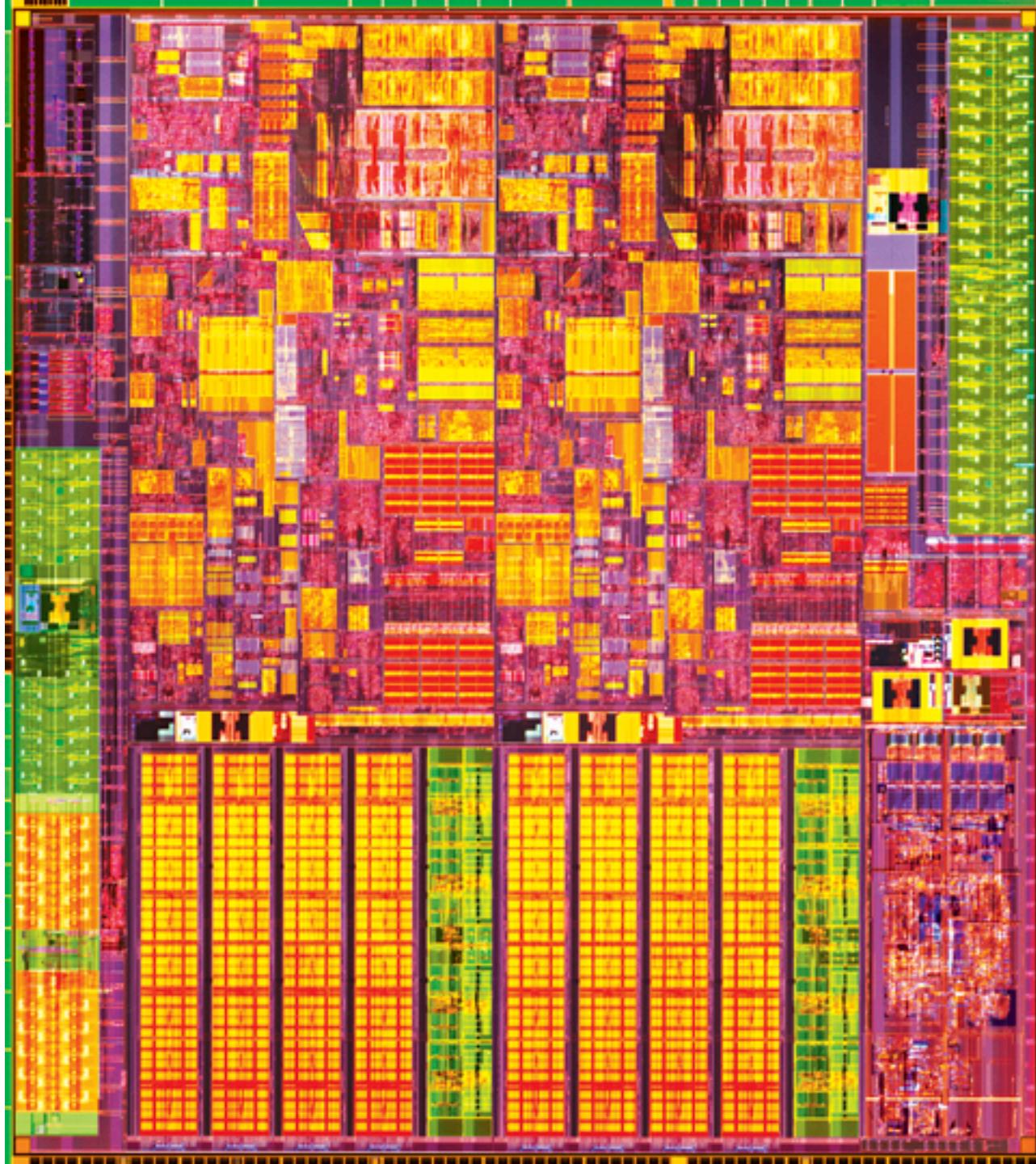


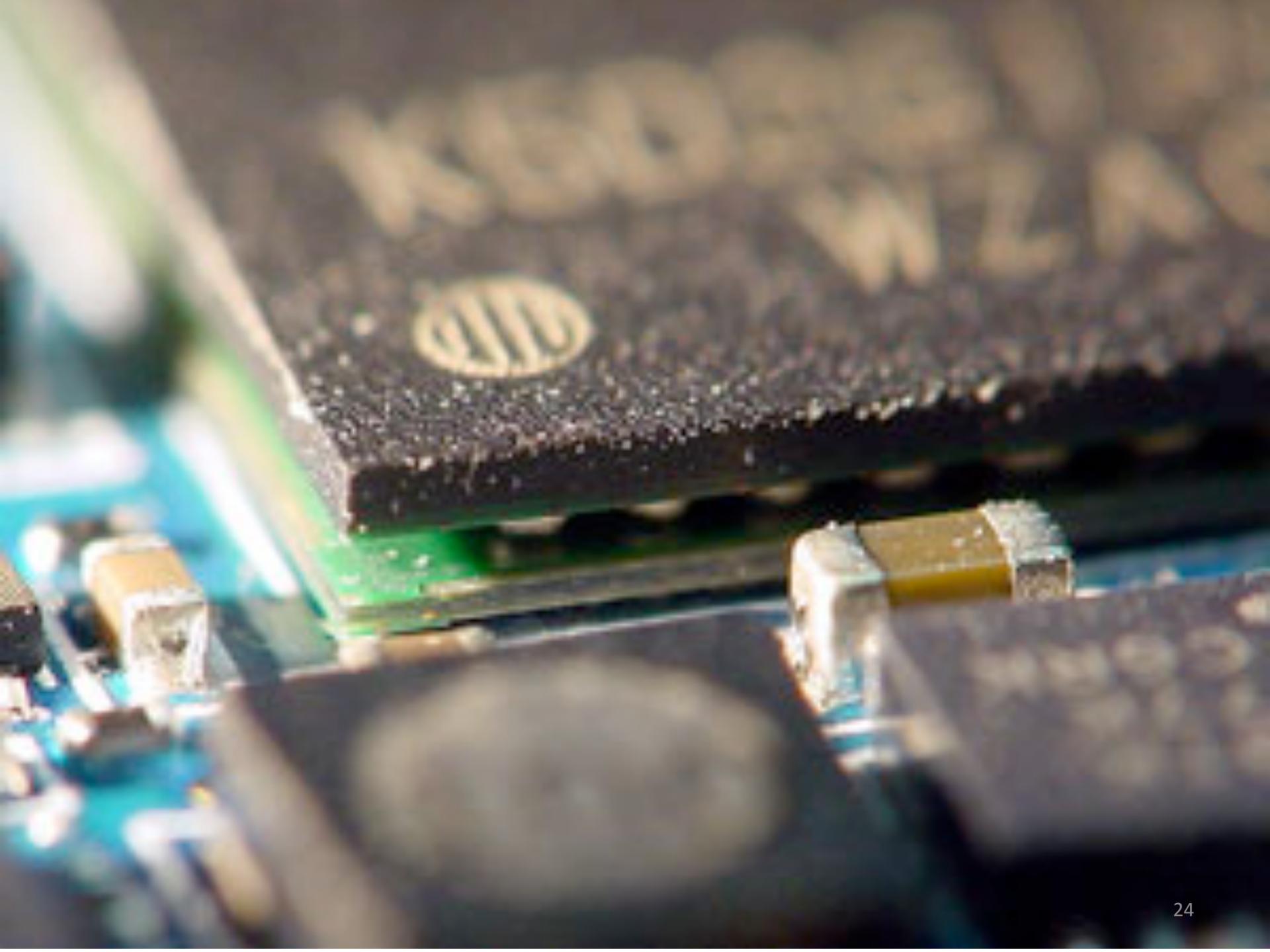


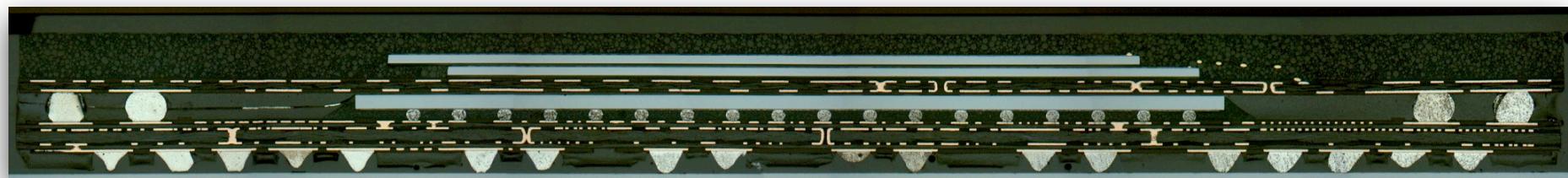


Package-on-Package

- What about RAM?
- Could add it to the SoC...
- But RAM uses a lot of space...
- Space we want to use for ‘useful’ stuff
- Separate package on top of the SoC
- Package-on-Package (or PoP)
 - Separate memory and logic production
 - “Stack” packages to minimise space

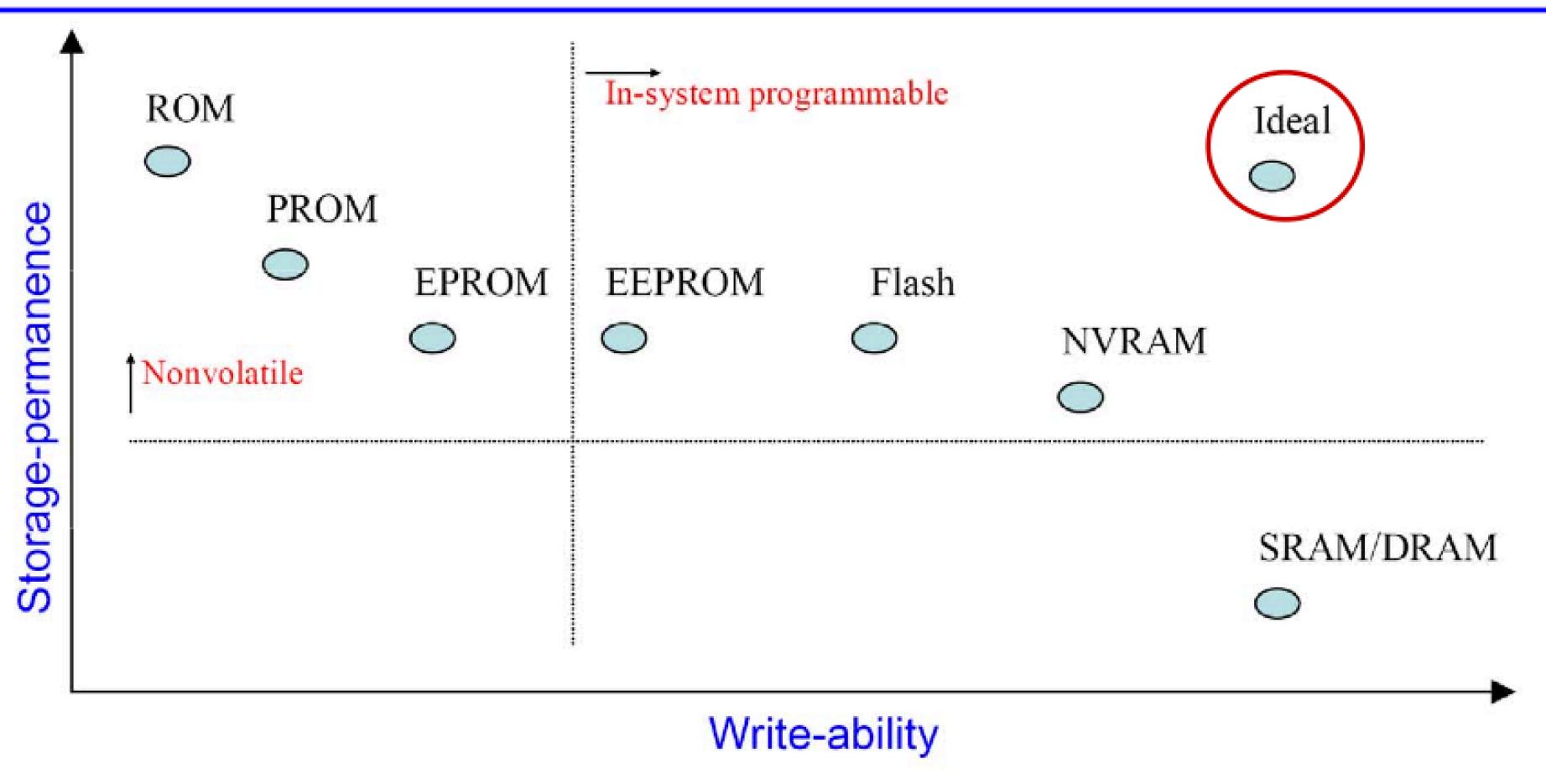






RAM

- RAM in a mobile device tends to be shared between multiple components on the main chip
 - C.f. laptop onboard GPU
 - Unlike separate motherboard RAM / GPU RAM
- Not all the RAM is available to the OS as “CPU RAM”
- No swap partition / page file
 - Why not?
 - What happens when you allocate all of the memory?
- Code assuming you don’t have very much



Next week

- Introduction to Android development tools
- Android as an operating system
 - What is it?