Mobile Computing
theme introduction

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Mobile computing

- Human interaction with battery powered portable devices.
- Convergence of telephony & computing.
- Advances in hardware, software & communications
  - Mobile devices using low-power components; e.g. ARM CPU
  - Software platforms for applications, some with DSP requirements
  - Infrastructure (WI-FI) & ad-hoc network technology with protocols, data formats & technologies.

Mobile Computing

- Mobile Systems
  (COMP 61232)
- Mobile Communications
  (COMP 61242)

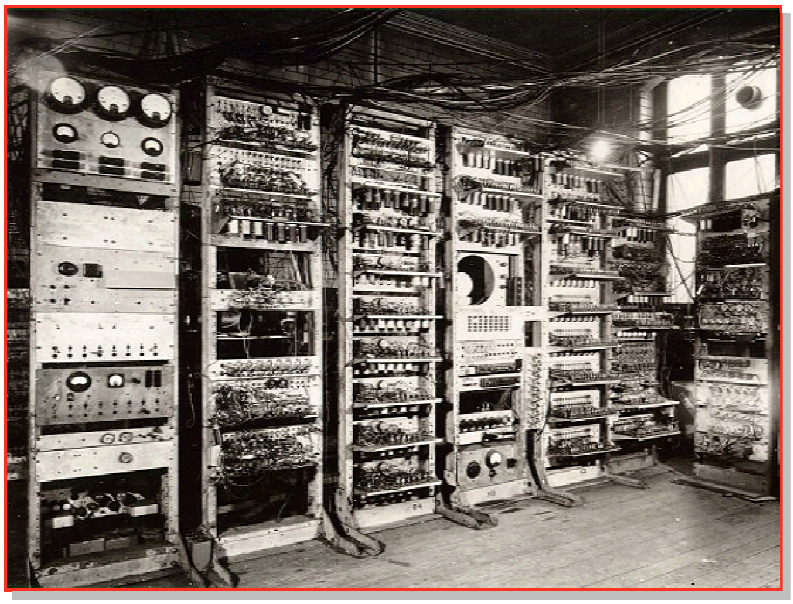
Mobile Systems
(COMP61232 previously 61221)

- Schedule
  - Wed 30 Jan to Fri 8 Mar 2013
- Aim
  - to introduce practical aspects of high-performance low-power system design
- Focus
  - practical use of the ARM 32-bit RISC processor core
    (a world-leading processor for power-sensitive applications)

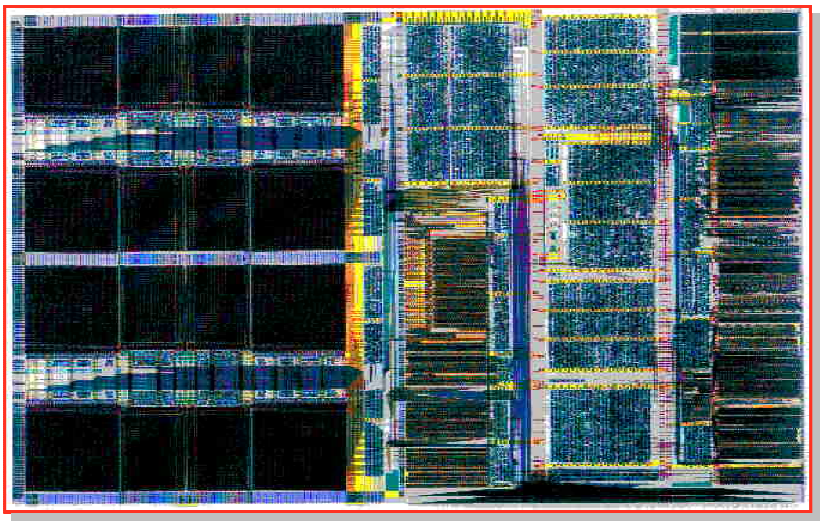
Mobile Systems
(COMP61232)

- Objectives: students will understand
  - low-power RISC processor design
    - including the ARM and Thumb instruction sets
  - memory hierarchy
    - and its influence on power-efficiency
  - system issues

Baby (1948)

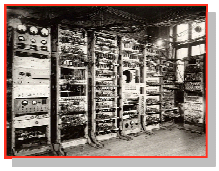


ARM9 (2008)

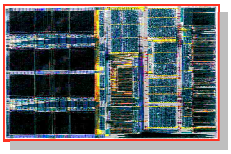


50 years of progress

- ***Baby:***
  - filled a medium-sized room
  - used 3.5 kW of electrical power
  - executed 700 instructions per second



- ***ARM968:***
  - fills ~1mm^2 of silicon
  - uses 20 mW of electrical power
  - executes 200,000,000 instructions per second



Energy efficiency

- Baby:
  - 5 Joules per instruction
- ARM968:
  - 0.000 000 000 1 Joules per instruction

50,000,000,000

times better than Baby!

(James Prescott Joule born Salford, 1818)

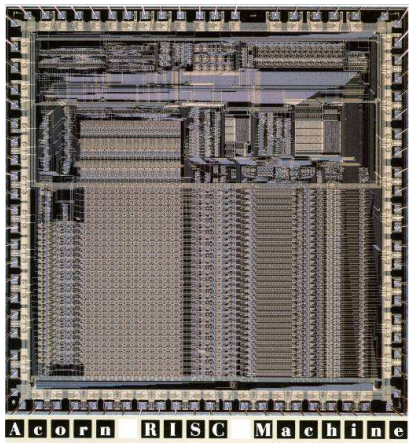
AAA battery can store up to abt 5000 Joules (Watt-secs)

Power

- Power is already a vital parameter
  - in mobile systems, for battery life
  - in tethered systems, for performance
  - in ecology, for human survival
- Despite x50 billion progress
  - electronics consumes more resources
  - low power expands the market *faster* than the power goes down!
- "Batteries not Included"
  - a Grand Challenge for future microelectronic design
  - leakage power is a big problem
  - variability will demand locally higher supply voltages
  - delivering "Moore for Less"

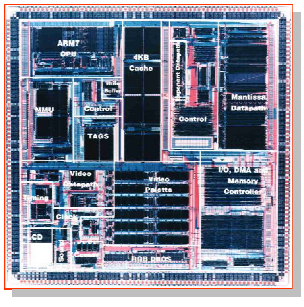
First ARM chip:
26th April 1985

- Full custom
- 6MHz, 120mW
- 3.0µm CMOS
- 2-layer metal
- 25,000 transistors
- 50 mm^2
- 84 pins
- 32-bit data
- 26-bit address

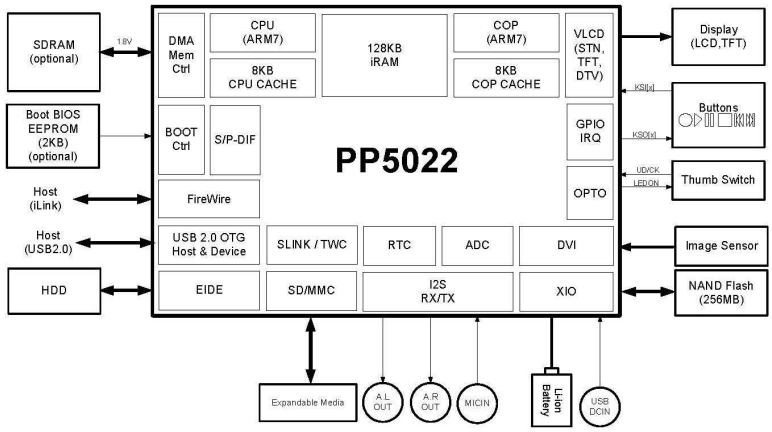


ARM Limited

- Systems-on-Chip
  - SoCs took off in the early 1990s
  - ARM's simplicity
    - led to low power…
    - …and small size
      - leaving room for other components
    - both important features in early SoCs
      - where chip area and power were at a premium

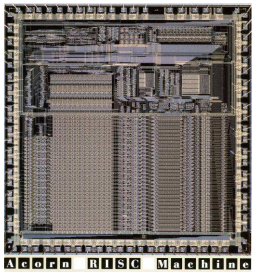


iPod hardware

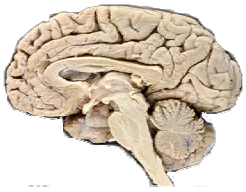


ARM milestone

- 2013 – ARM processors
  - over 40 billion shipped
  - ~100,000 transistors
    - ignoring memory
  - total: 10^{15} transistors



= number of synapses in one human brain!



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Mobile Systems
(COMP61232)

- Syllabus
  - Basics of processor design
  - Processor design trade-offs
  - The ARM and Thumb instruction sets in outline
  - The ARM instruction set in detail
  - Exceptions and special instructions
  - The Thumb instruction set in detail

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Mobile Systems
(COMP61232)

- Syllabus
  - ARM integer cores
  - Memory hierarchy
  - The ARM memory management and memory protection units
  - ARM CPUs
  - System development
  - On-chip buses & on-chip debug

Mobile Systems
(COMP61232)

- Course history
  - Course has been presented about 50 times as an industry training course
  - Now on-line as part of the UK CEESI Masters programme

Course Delivery
(COMP 61232)

- On-line course
  - no lectures
  - material and exercises on-line (Moodle)
    - course text:
      - "ARM System-on-Chip Architecture"
    - some exercises assessed
    - two post-course 'projects'
  - weekly face-to-face 'workshop'
  - exam at end (worth 33%)

Mobile Communications
(COMP61242 previously 61232)

- Timetable & personnel
  - Wednesdays 13 Mar - 8 May 2013
  - Lecturers:
    - Nick Filer (nfiler@cs.man.ac.uk)
    - Possibly Barry Cheetham (barry@man.ac.uk)

Mobile Communications
(COMP61242)

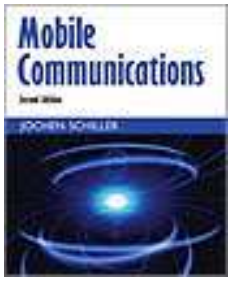
- Introduction
  - Networked computing hardware & software designed to be used in locations that are not necessarily fixed"
  - Definition encompasses mobile computing & telephony.
  - Wireless (radio) links to networked 'base stations' or 'access points' with provision for 'handover' from one to another.
  - Wireless networks supporting mobility may be termed either:
  - Cellular (evolved from trad mobile phone networks) or
  - Nomadic (wireless LANs, PANs, cordless & maybe WANs)
  - Include satellite communication links as cellular (with large cells).

Mobile Communications (COMP61242)

- Syllabus
  1. Intro to mobile computing & comms ("towards 4G").
  2. Protocols supporting mobility.
  3. Security in mobile comms.
  4. Application layer issues – including voice & multimedia
  5. Network & transport layer issues: incl. DHCP, mob-TCP & WAP
  6. 'Data link layer' issues 1 - Medium access control (MAC)
  7. 'Data link layer' issues 2 - Error control
  8. Physical layer issues - Digital modulation & transmission.

Mobile Communications (COMP61242)

Recommended Text Books:



- Mobile Communications, Jochen Schiller, Addison-Wesley, 2nd ed., 2003

(may replace with directed readings)

- A. Tanenbaum, Computer Networks, Prentice-Hall, 4th edition, 2003
- Wireless Communications, 2nd Edition, T. S. Rappaport, Prentice Hall, 2002

Mobile Communications (COMP61242)

- **Generations of mobile telecoms standards**
  - 0G Radio telephones
  - 1G (1983) Cellular analogue for voice – e.g. AMPS
  - 2G (1991) Cellular digital for voice & slow data – e.g. GSM, IS95
  - 2.5G(≈1998) Introduce GPRS (56-114 kb/s)
  - 2.75G(≈2003) Add EDGE (E-GPRS) (up to 384 kb/s)
  - 3G (≈2001) IMT2000 for speech & faster data - UMTS etc
  - 3.5G (≈2007) HSPDA (1.8-7.2 Mb/s downlink); UL: 384 kb/s
  - 3.75G (≈2010) HSPA+ (DL: 56, UL: 22 Mb/s) etc.
  - 3.95G (?) 3GPP-LTE, mobile WIMAX, etc.
  - 4G (?) ITU-'IMT Advanced'

Mobile Communications (COMP61242)

- **4G – IMT Advanced (ITU-R defn)**
  - Proposed by ITU-R for 4th generation of cellular wireless standards. Goals are:
    - + To fuse cellular mobile & nomadic access into a seamless layered architecture that is transparent to user
    - + By ≈2010, to achieve 100 Mb/s for mobile access & 1000 Mb/s (1GB/s) for nomadic access.
    - + To pursue world-wide common spectrum & open global standardisation.
  - Only 2 technologies had been proposed by Sept 2009:
    - + 3GPP-LTE-Advanced (due 2010)
    - + IEEE 802.16m (enhanced mobile WiMAX)

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Mobile Communications (COMP61242)

Delivery:

- Weeks 1-5 Lectures & laboratories
- Laboratory work has 2 assignments:
  - Network simulation using OPNET
  - Error control in mobile comms
- Week 6 Complete lab work/assignments
- Assessment:
  - OPNET assignment: 20%
  - Error control assignment: 30%
  - Exam (2 hours): 50%