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
(COMPUSE 61232 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 ~1mm² 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 mm²
- 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

Mobile Computing theme intro

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!
• 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
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)

• 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.
  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

**Recommended Text Books:**

- Mobile Communications, Jochen Schiller, Addison-Wesley, 2nd ed., 2003
  (may replace with directed readings)
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)
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%