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Mobile Systems

Lecture 1– Course Introduction

COMP28512

Steve Furber & Barry Cheetham

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Syllabus

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Smartphone

- Mobile phone running a mobile operating system, with advanced computing capability & connectivity.
- More advanced than a ‘feature phone’ (retronym).
- First ones combined functions of PDAs & mobile phones.
- Now: cameras, multimedia, GPS, high-res touchscreens, nice web browsers etc.
- Speech by accessing cellular networks (2G, 3G, 4G).
- Data from same networks: GPRS, EDGE for 2G
  HSPA, LTE for 3G
- Also Wi-Fi, Bluetooth, GPS & Near Field Comms (NFC).
- Access to rapidly developing mobile apps.

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Mobile operating system: Android

- Founded in Oct 2003 by Andy Rubin & backed by Google & others in 'Open Handset Alliance'.
- Mostly free & open-source:
  - 'Cupcake', 'Donut', 'Eclair; 'Froyo', 'Gingerbread', 'Honeycomb', 'IcecreamSandwich', 'JellyBean', 'KitKat', Lollypop, M…?
- First phone to use Android was HTC Dream in Oct 2008.
- Full HTML web browser & apps available via Google Play,
- In Jan 2010, Google launched Nexus 1.
- In 2010, Android became best selling platform.
- In 2012, Samsung Galaxy sales hit 18 million.
- In 2014 Google released Nexus 6 Smartp (with Motorola) & Nexus 9 tablet (with HTC).
  Galaxy 5,

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Mobile operating system: iOS

- Platform for Apple iPhone, introduced in ‘07,
- Closed source & proprietary
- Noted for its first use of fingered touchscreen
- Initially no native 3rd party apps were allowed
- In 2008, Apple introduced a new iPhone & ‘App Store’,
- Allowed any iPhone to install third party

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Mobile operating sys: Windows Phone

- **Version 7** mobile OS was released in 2010 by Microsoft.
- **Version 8** was released in Oct ’12 to replaced its Windows CE-based architecture with one based on Windows NT allowing developers to easily port apps between the two platforms.
- **Version 8.1** released in 2014
- (**Version 10** expected soon)
- Closed source & proprietary.

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Mobile operating sys: Blackberry

- Released in 1999 by RIM, making secure email comms possible on wireless devices.
- Services such as BlackBerry Messenger widely used
- More recently, RIM has undergone a platform transition to "BlackBerry 10”
- Closed source and proprietary.

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Other mobile operating systems

- **Bada** was announced by Samsung in Nov 2009.
- First Bada-based phone was Samsung Wave S8500, released in June 2010.
- **Symbian** (obsolete in 2011)
- **Palm OS** (discontinued in ’11)
- **Windows mobile** (became Windows Phone).
- Yet others exit

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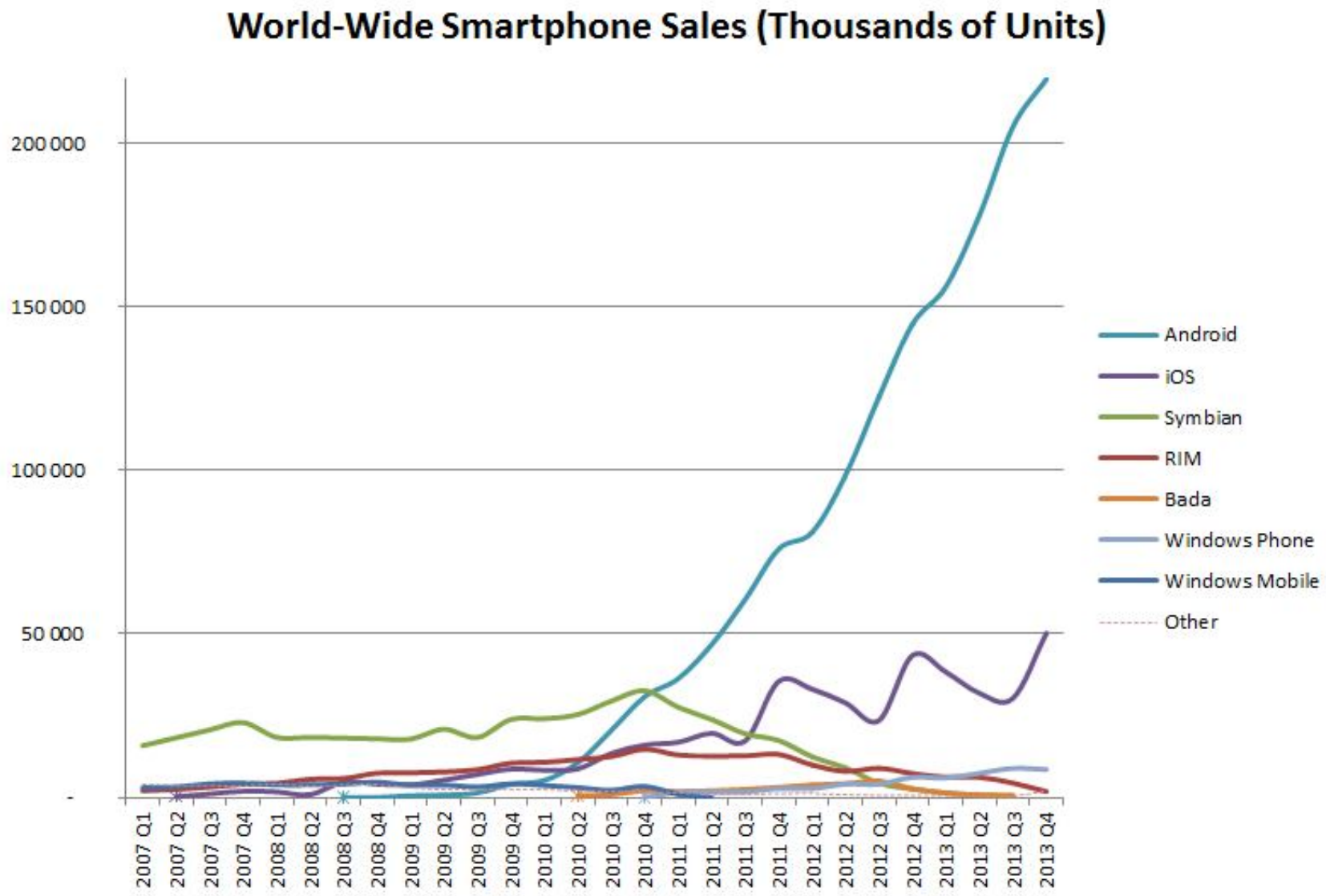
Ref: wikipedia/mobile operating systems (Jan;15)



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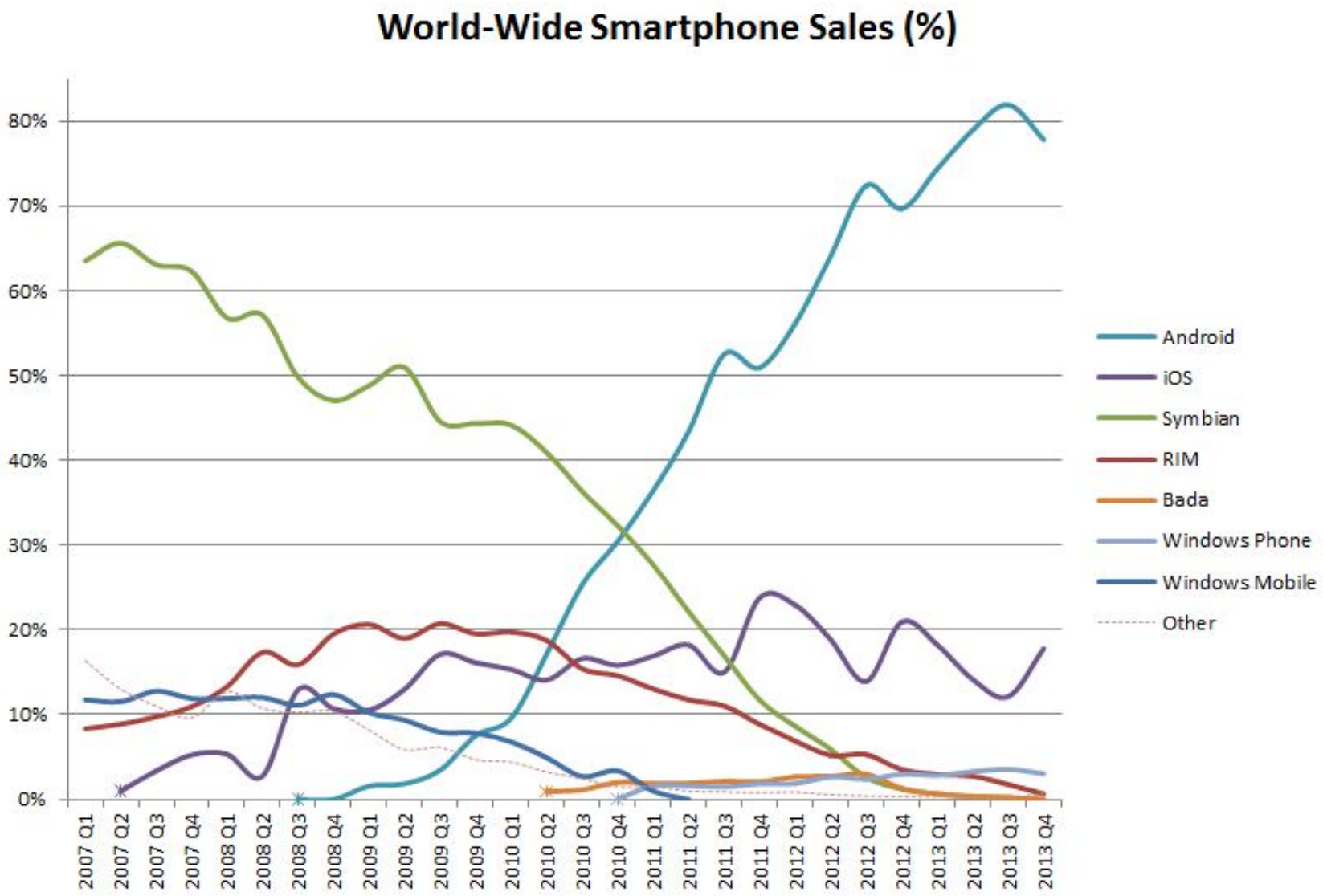

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Current market share

- According to 'The Financial Express', Sept 2014:
  Global market share:
  - Android: 85 %
  - IOS: 11 %
  - Windows phone: 3 %
  - Blackberry: <1 %
- In USA number of mobiles >> 3 x number of landlines.

- Ref: wikipedia/mobile operating systems (Jan'15)

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Two aspects of OS

1. User-facing software platform
   - Interface with display & any keys/buttons
   - Uses RISC type instructions
2. Real-time operating system
   - Operates sound I/O,
   - radio comms,
   - error control,
   - other time-critical hardware specific features.
   - Uses DSP type instructions

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Smartphone anatomy

- Memory
- Touch screen display, buttons, microphone/speaker etc.
- radio communications interface
- antenna
- Battery
- Techniques implemented in or essential to support the operation of a mobile phone or tablet:
  - ✓ Speech I/O
  - ✓ Speech & music storage
  - ✓ Image capture & storage
  - ✓ Data network & internet access
  - ✓ Comms by cellular network, wi-fi, bluetooth, NFC
  - ✓ Comms for navigation satellites (GPS)

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The future ?

- ‘Fairphone’ – socially ethical smartphone.
  ‘Quasar iV’ – “cipherphone” : smartphone with enhanced security.
- Curved-organic LED technology with bends & folds in the screens
- Foldable OLED smartphone screens – hard to produce.
- Solar powered screens to increase battery life.
- Li-Fi (wi-fi by light) via smartphone screen & camera.
- Energy ‘harvesting’ from radio, television, light, Wi-Fi etc.
- Higher res (Quad-HD) smartphone screens (2560x1440 pixels)
- Battle between mobile network & cable operators (MNOs & MSOs)

  Look at www.cablewifi,com &
  www.wired.com/2014/01/collision-course-wi-fi-ifirst...
- Money exchange !!!!! (Also water & dust – proofing)
- Better & laser focused cameras with better 'bokeh’ effects.
- Open source uncompressed (RAW) images.
- Modular smartphones - users can remove & replace parts

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Syllabus

- Insights into issues of mobile systems covering:
  - mobile communications,
  - data storage
  - application development
  - maximising battery life.
- Issues that differentiate mobile from “tethered” (wired) systems
- Working knowledge of speech, music & video codecs.
- Understanding of basics of wireless comms
- Holistic nature of power efficient systems design

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Breakdown

- **Mobile Systems**
  - Features of mobile systems including smartphones.
- **Representing signals in smartphones**
  - An & digital signals, time & freq domain representations, sampling, aliasing, quantisation, compression, real time computation.
- **Coding, decoding & compression**
  - GSM, MP3, JPEG & MPEG coding & decoding, error correcting codes, comms coding schemes,
- **Android applications**
  - Principles, tools & some techniques
- **Mobile Comms**
  - Transmitting real time info over wireless networks; cellular & ad-hoc coding of multimedia to increase capacity of radio channels & to minimise effect of transmission errors
- **Maximising battery life**
  - Addressed at many levels: chip design, signal coding & processing, medium access control, power control & error control.

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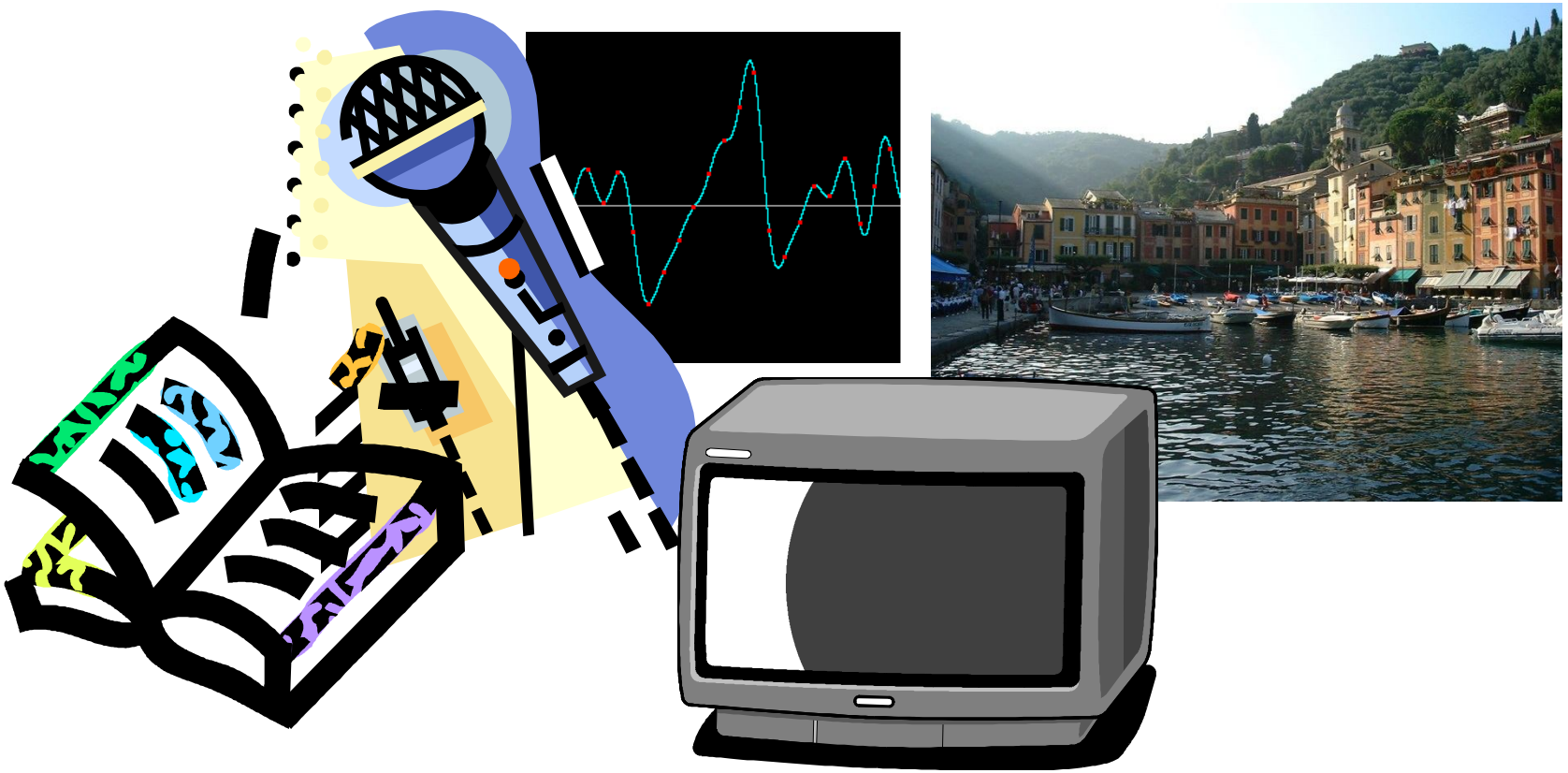
Everything is numbers…



…1001011011100101101110101100011101011010100…

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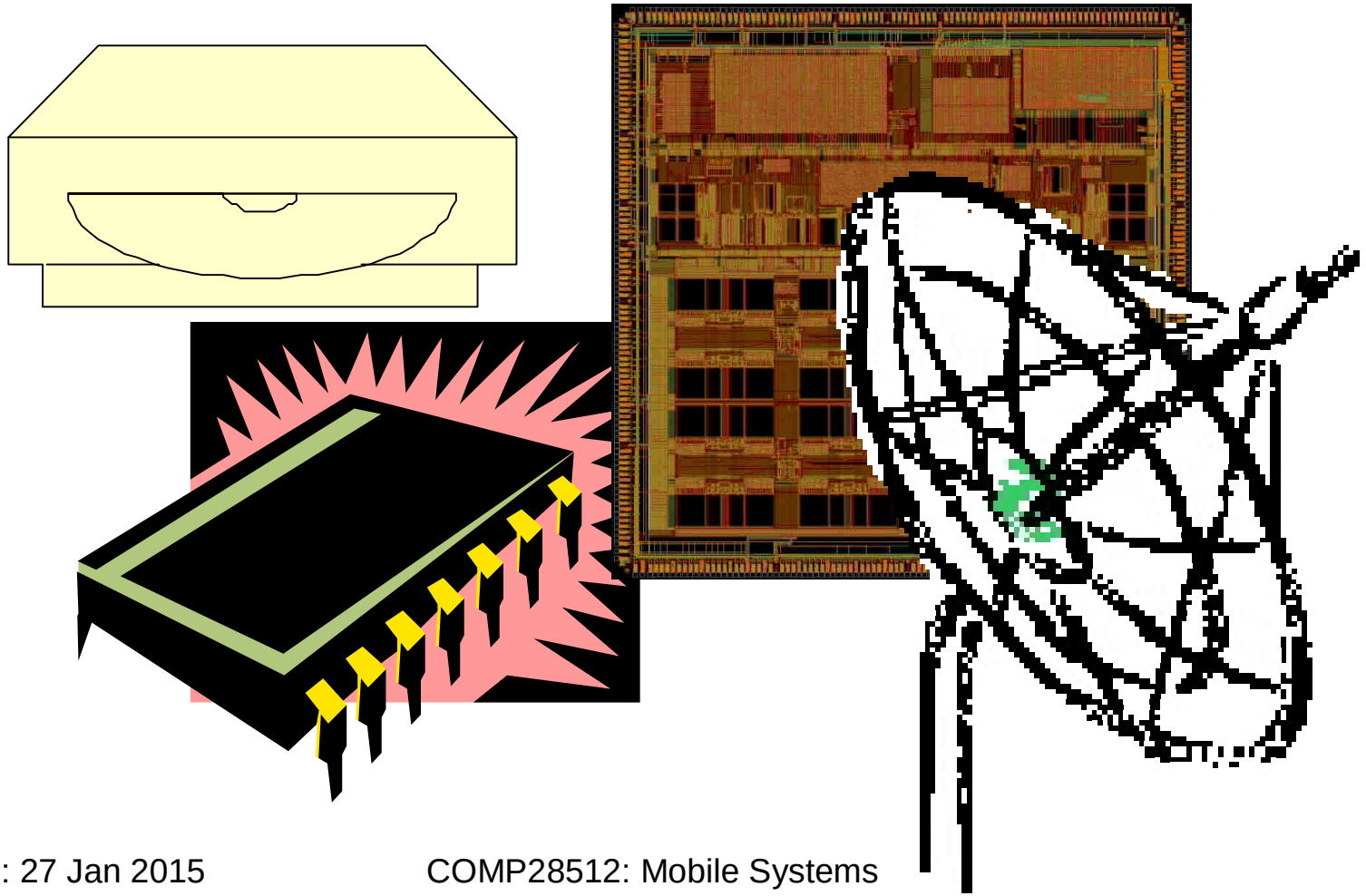
Store, Process, Communicate…



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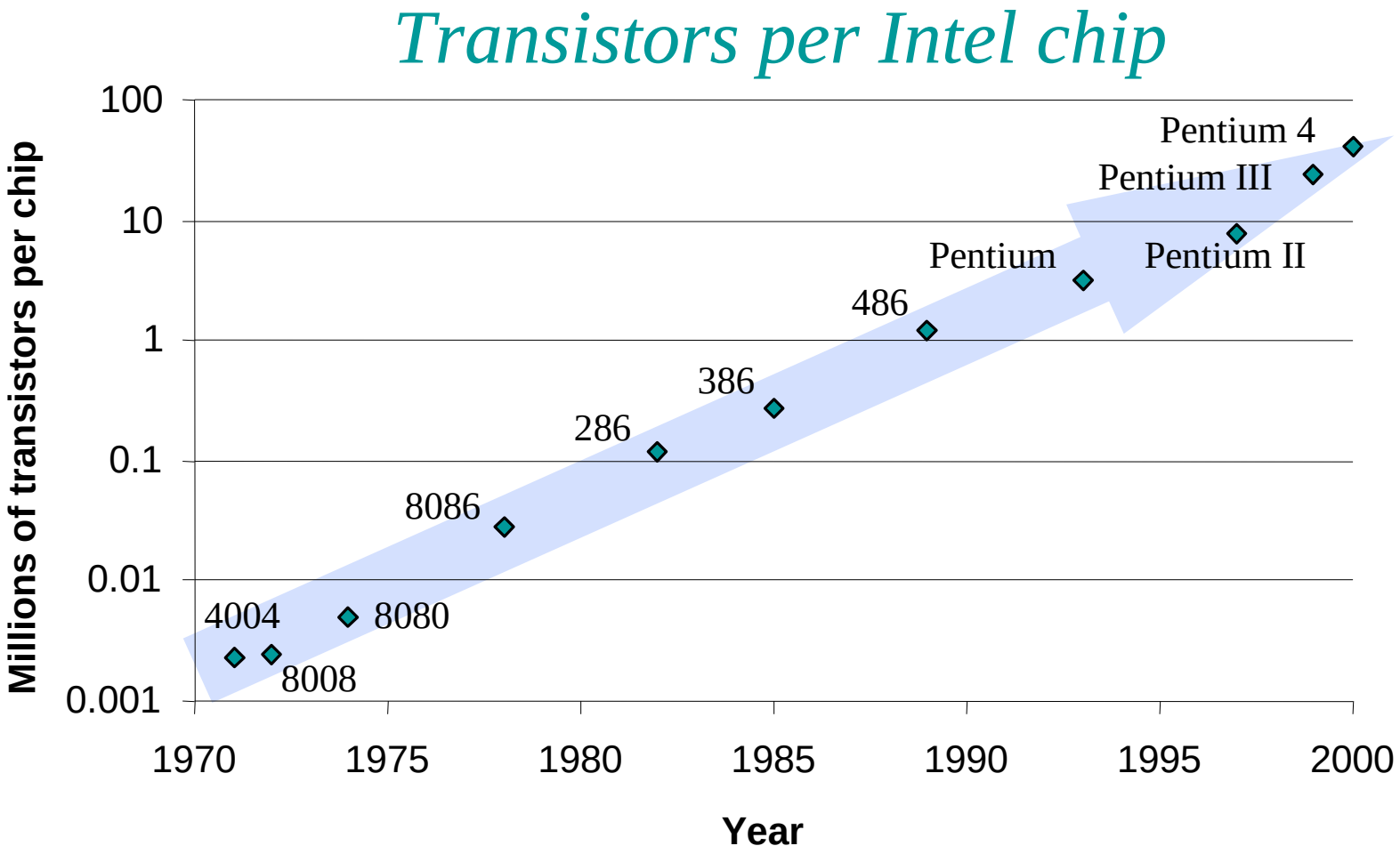
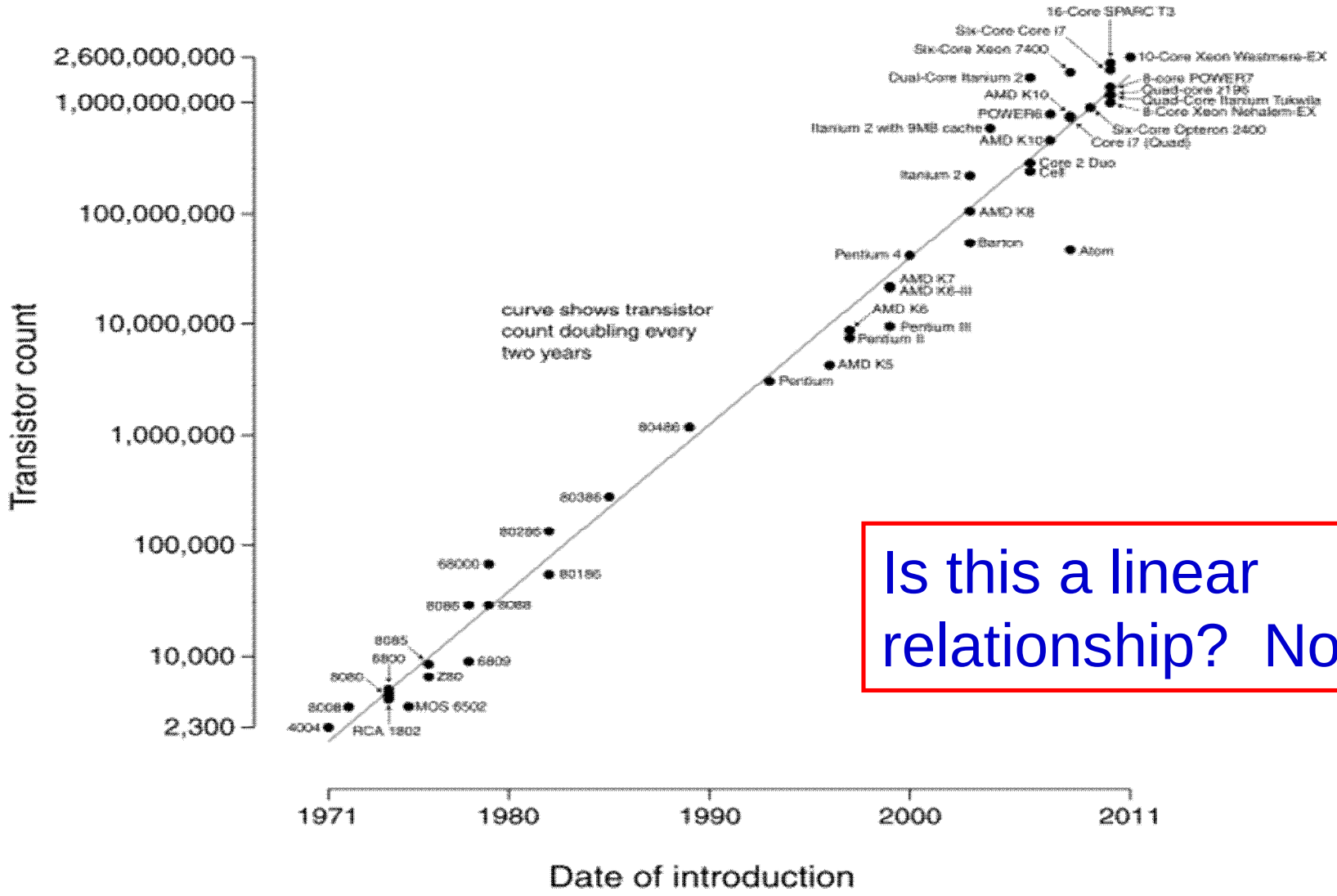
Moore's Law

Number of transistors per square cm in state-of-art I/Cs doubles every 2 years

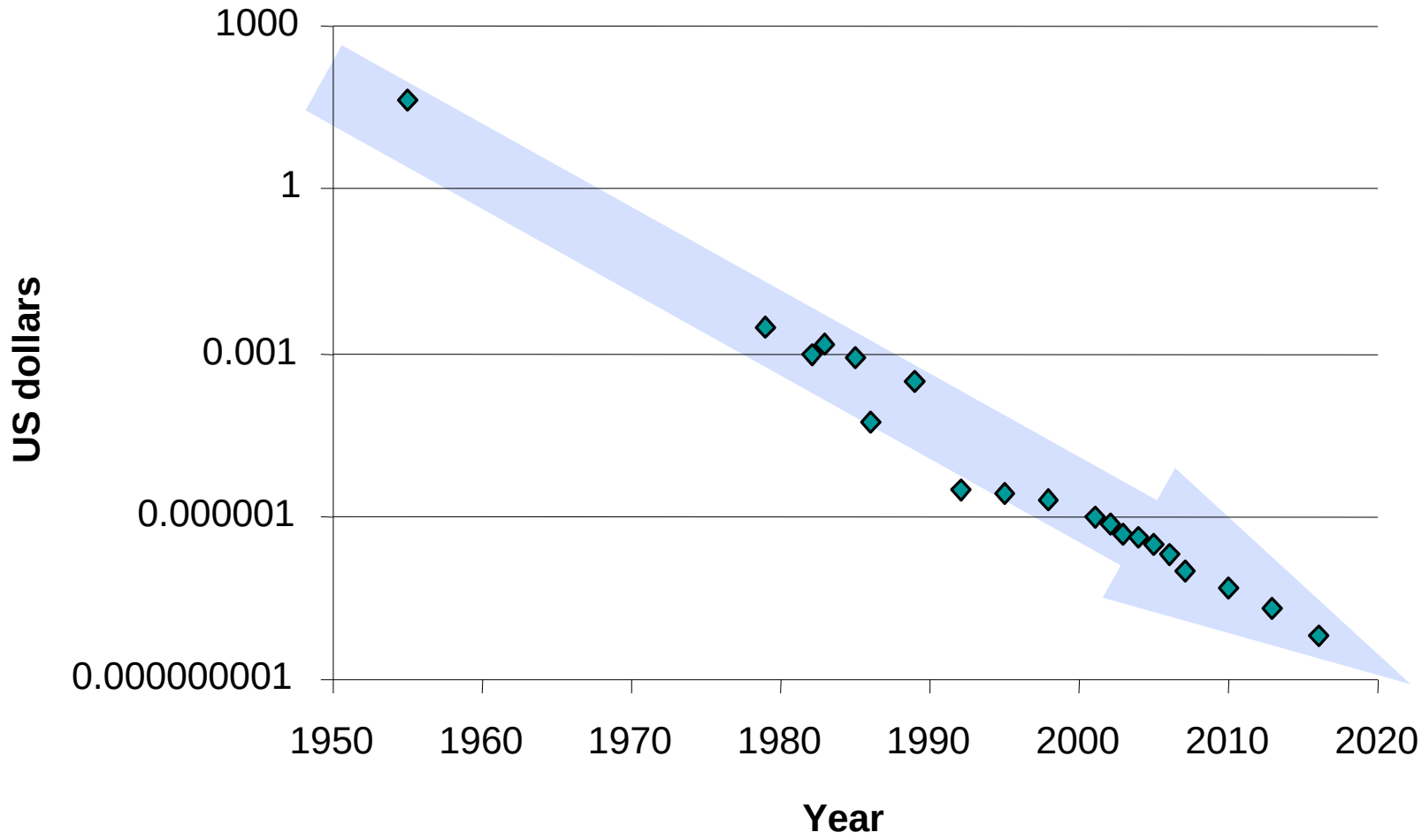


Microprocessor Transistor Counts 1971-2011 & Moore's Law



Is this a linear relationship? No!

Cost of a Transistor



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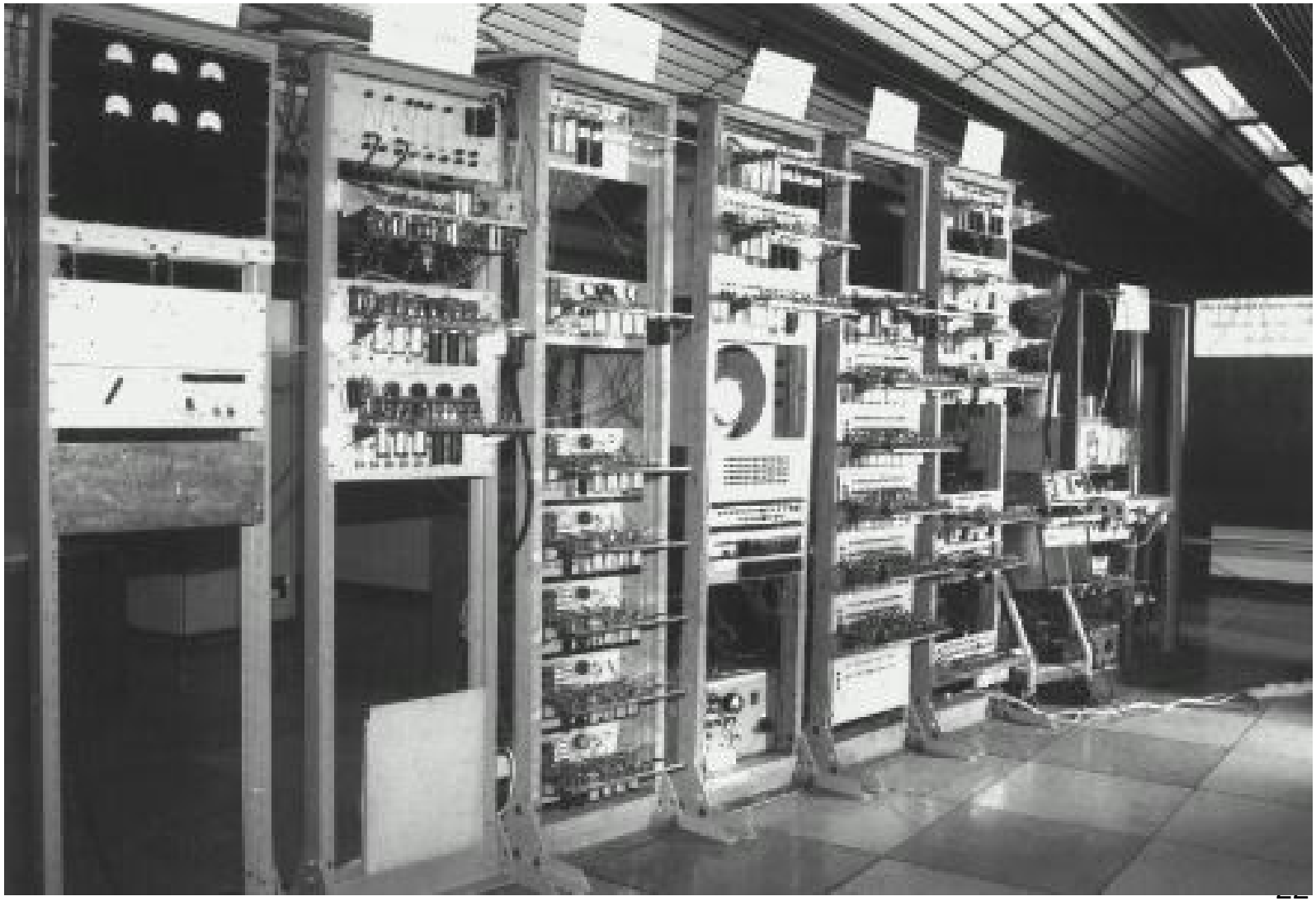
Baby (1948)



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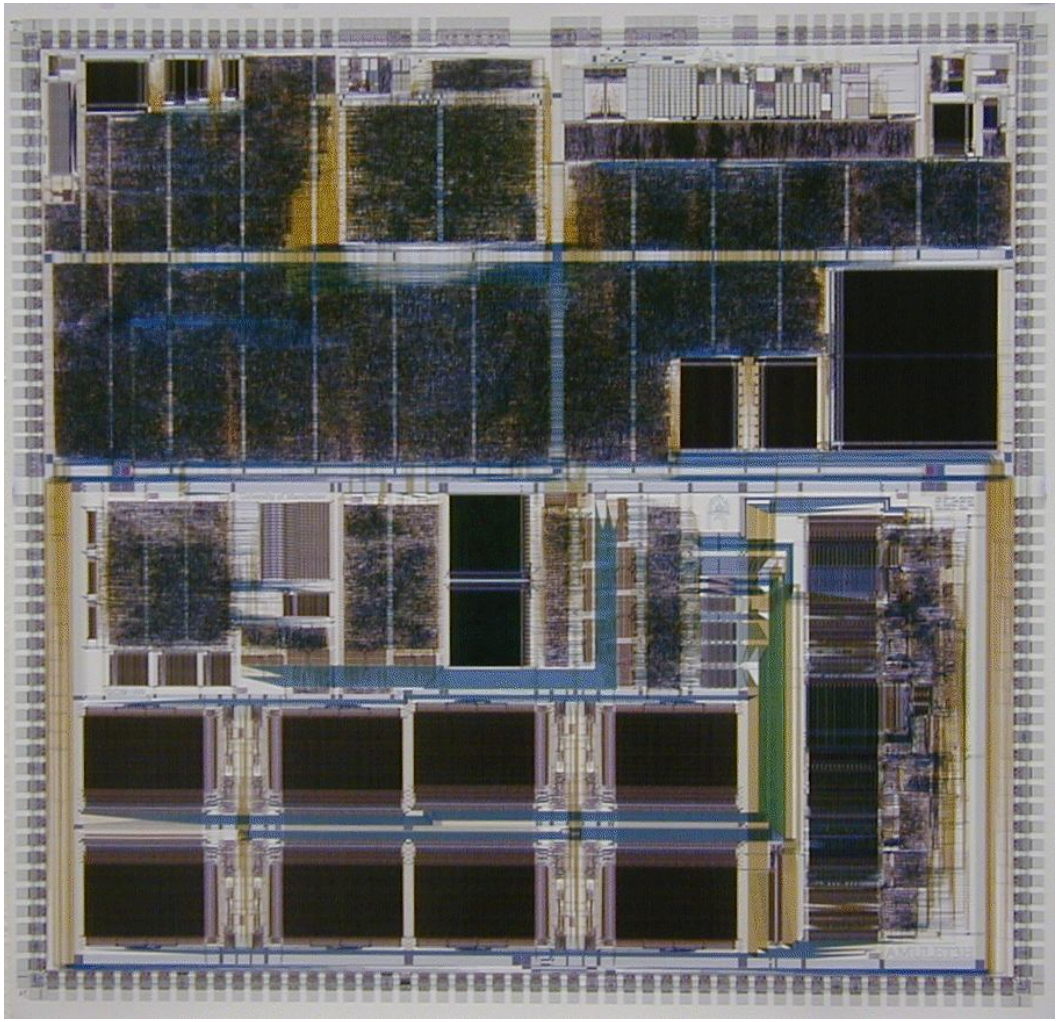
DRACO (2000)



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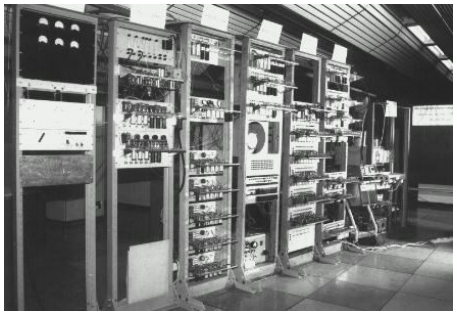
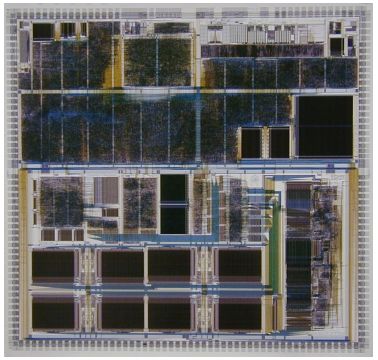
50 years of progress

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



- ***DRACO:***
  - fills 7mm x 7mm of silicon
  - uses 215 mW of electrical power
  - executes 100,000,000 instructions per second



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Energy efficiency

(James Prescott Joule born Salford, 1818)

Joule: unit of energy (=1 Newton-meter)
Watt: unit of power (Joule per second)

- Baby : 3.5k / 700 = 5 Joules per instruction
- DRACO: 0.215 / 10^8 ≈ 2×10^{-9} Joules per instruction
  - over ***2,000,000,000*** times better than Baby!
- If we got 5 miles per litre of petrol in 1948
  & achieved a similar reduction in energy efficiency,
  would now get 1 million miles for a spoonful of petrol.

(NB Smartphone battery holds ≈ 5 Watt-hours = 18,000 Joules)

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Memorable quotes

- "…computers of the future may have only 1,000 vacuum tubes and perhaps weigh 1.5 tons." - Popular Mechanics, Mar 1949
- "But what is .. (the microchip) ... good for?"- IBM engineer, 1968
- "There is no reason anyone would want a computer in their home"
  - Ken Olson, president/founder of DEC, 1977
- "640K [of RAM] ought to be enough for anybody"- Bill Gates, 1981
- "Speech bit-rate compression will never have applications in commercial telephony" – Anon, 1975
- "phone is not just a communication tool but a way of life" Steve Jobs, '07.
- "A smartphone is a mobile games console that you can also make phone calls on" Andrew Leeming, 2014

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Lectures

1. Introduction (this lecture)
2. Analogue and digital signals
3. Frequency-domain processing
4. Image & video processing (JPEG, MPEG etc)
5. Forward error correction (FEC) coding
6. GSM & 4G telephony & narrow-band speech coding
7. Wireless communications
8. Real time computation & SpiNNaker
9. Multi-media communication & power trade-offs
10. Mobile System-on-Chip design

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Laboratory Support Lectures
Workshops & Examples classes

1 Intro to Task 1 : Software platform & sound digitisation

2. Workshop1: Time-domain speech coding for mobile phones (LPC etc.)

3. Intro to Task 2: Frequency-domain coding & mp3 for music & wide-band speech

4. Workshop2: Image processing demonstrations

5. Intro to Task 3 (Bit-error control)

6. Workshop3: MP3 compression

7. Intro to Task 4: Android application development.

8. Examples class, revision & lab issues

9. Intro to Task 5: Android comms

10. Examples class, revision & lab issues

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Laboratory sessions

- Thurs/Fri 9:00 – 11:00 am Toothill Lab
- Five units covering:
  - Speech / music digitisation for mobile telephony
  - Frequency-domain processing (MP3 etc.)
  - Forward error correction
  - Development of Android Apps for messaging
  - Communications over a simulated channel using Android
- Each unit takes 2 weeks
- Assessed by interview in lab: demo, code & questions.
- Each unit is worth 20% of coursework mark.
- Coursework mark combined with exam mark 50-50.

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Workshops (new)

Demonstrations of software issues with discussion & exercises.

1. LPC speech coding (week 2)
2. Image & video coding (week 8)
3. MP3 compression (week 6)

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Deliverables

Week	Deliverable	Date	Marks
2	Task 1	5 Feb'15	20% of CW
4	Task 2	19 Feb	20%
6	Task 3	5 Mar	20%
8	Task 4	19 Mar	20%
10	Task 5	23 Apr	20%
?	Exam	May/June	Total= 50%+50%

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Summary

- Smartphones have evolved because of:
  - Moore's Law allowing low cost, low power, low weight
  - mobile operating systems & apps
  - digital media processing & compression
    - for speech, music, image & video
  - digital communications, error correction, etc.
  - improvements in batteries (slow) & their usage
- Syllabus covers key aspects of mobile phone technology
- Lab work based on Python, Matlab? & Android