

# 7CC003 Distributed And Mobile Computing

## Introduction

Jeffrey Ting

# What is Mobile Computing

- Mobile Computing is simply computing that isn't fixed to any one location.
- In general it is taken to mean portable computers
- However, the range of applicable technologies can be very wide

















# History of Mobile Computing



# 3000 BC Abacus

- Used by merchants and scholars
- Requires no external power
- Lasts generations
- Green



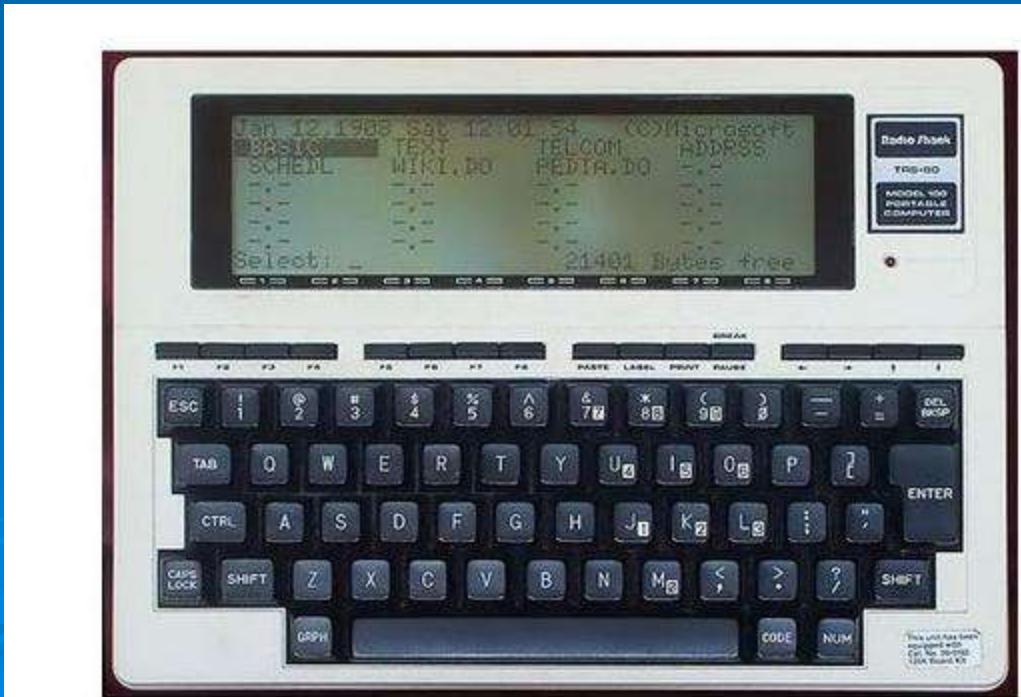
# 1981 Osborne 1

- The first “portable” computer
- Over 10kg
- Mains powered
- \$1,795
- 64kB RAM
- 4 Mhz Z80



# 1983 TRS-80 Model 100

- 5 days battery life(!)
- 3Mhz Intel 8085
- 2 kg
- £500
- 8 kB RAM
- Modem



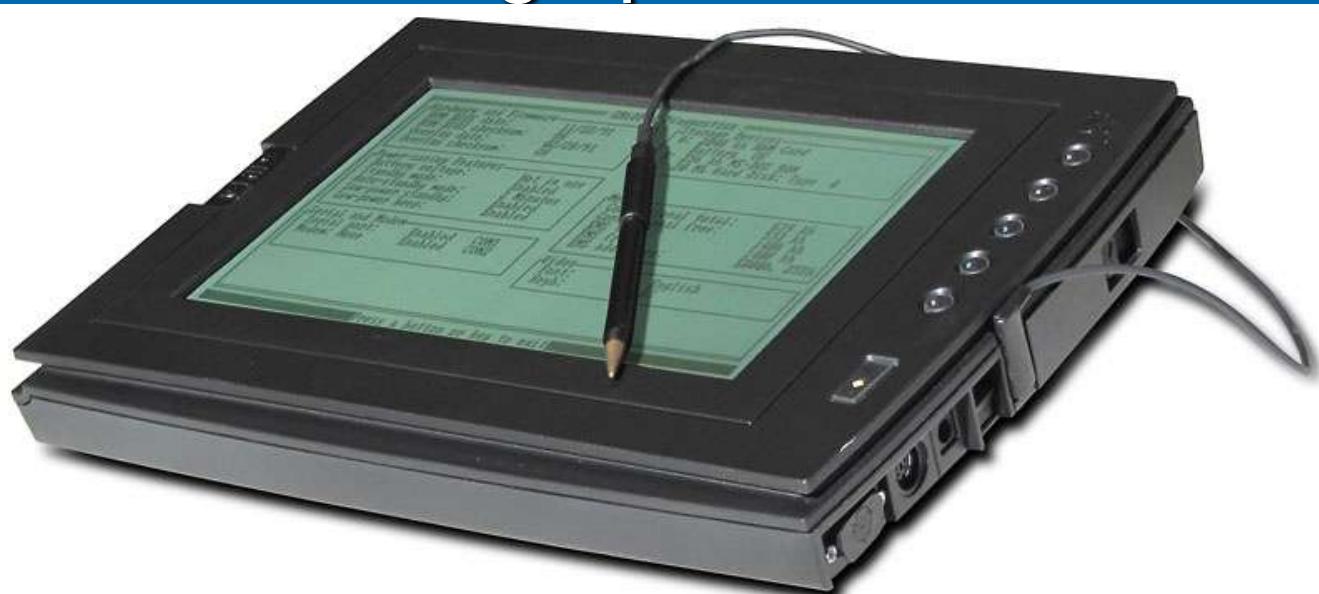
# 1984 Psion Organiser

- The first handheld programmable computer
- BASIC-like programming language OPL
- Operating system became Nokia's Symbian phone operating system
- 0.9 Mhz Hitachi 6301 CPU
- 4kB of ROM, 2kB of RAM



# 1989 GRiDPAD

- \$2,370 2 kg
- Intel 8086 @ 10MHz
- 1 MB RAM
- 10-inch LCD 640 x 400 graphics



# 1991 Hewlett-Packard 95LX

- \$699.99, 11oz / 312g
- 5.37 MHz 8088
- 512K RAM
- 40 x 16 text LCD
- 248 x 128 graphics



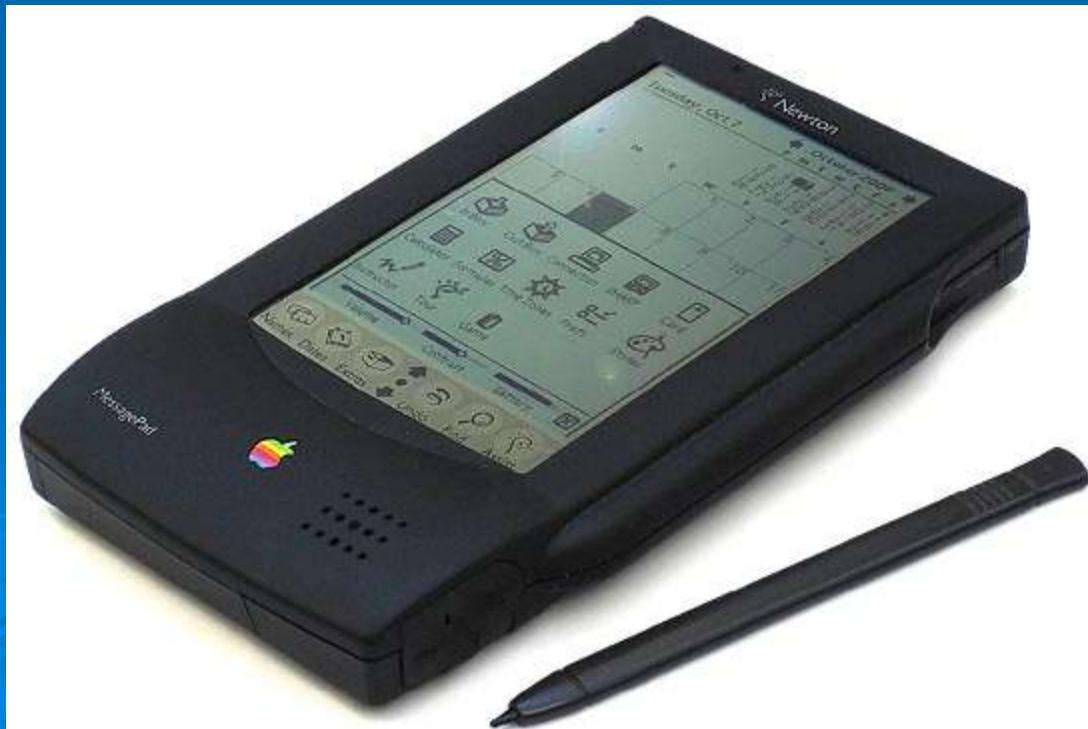
# 1992 Windows for Pen Computing

- Windows 3.1 with Pen extensions
- Touch-screen with passive stylus
- on-screen keyboard
- notepad for writing with stylus
- program for handwriting training



# 1993 Newton MessagePad

- US \$699.99
- 20 MHz ARM 610
- 640K RAM, 4MB PCMCIA
- 336 x 240 LCD
- Handwriting  
recognition
- RS422 serial
- Infrared



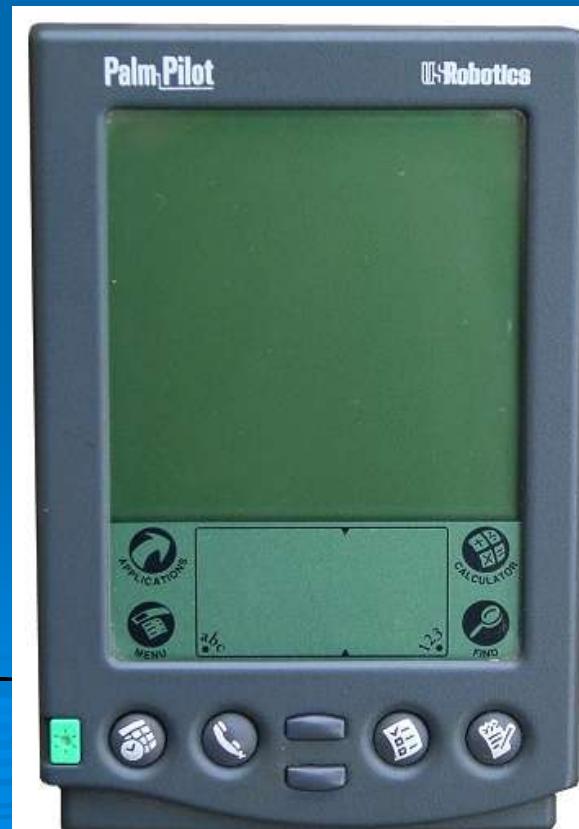
# 1995 Windows CE

- Various manufacturers using Microsoft software
- About £400
- 44Mhz MIPS
- 4 MB RAM
- The beginning of Windows Phone



# 1996 Palm Pilot

- \$130
- 16 MHz Motorola 68328
- 512 kB RAM
- 160x160 pixel LCD
- Touchscreen Input
- Graffiti input zone
- PalmOS



# 2000 iPAQ 3600 Pocket PC

- \$400
- 206MHz StrongArm Processor
- 3.5 inch Color LCD
- CF & PC Card Expansion
- 32MB RAM 16MB ROM
- 6.3oz
- IRDA Data Port
- Evolution of Windows CE



# 2002 RIM BlackBerry 5810 email machine / phone

- \$500
- The first handheld to combine phone with push email
- Secure encrypted instant messaging
- Became very popular with companies



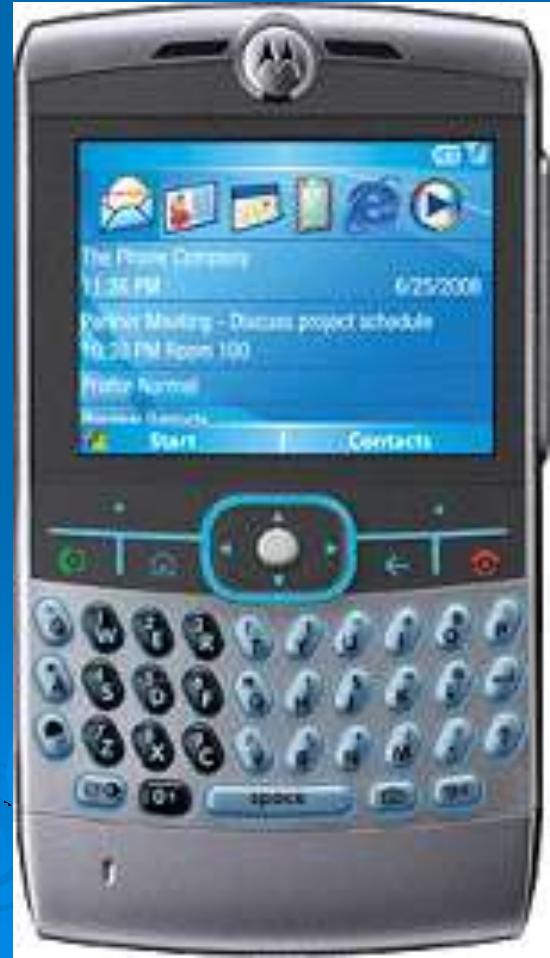
# 2002 Windows Tablet PC

- From £800
- Windows XP Tablet PC Edition
- Stylus-sensitive screen
- With or without keyboard
- 256 MB RAM 20GB HD
- 500 MHz Intel
- Gestures and handwriting



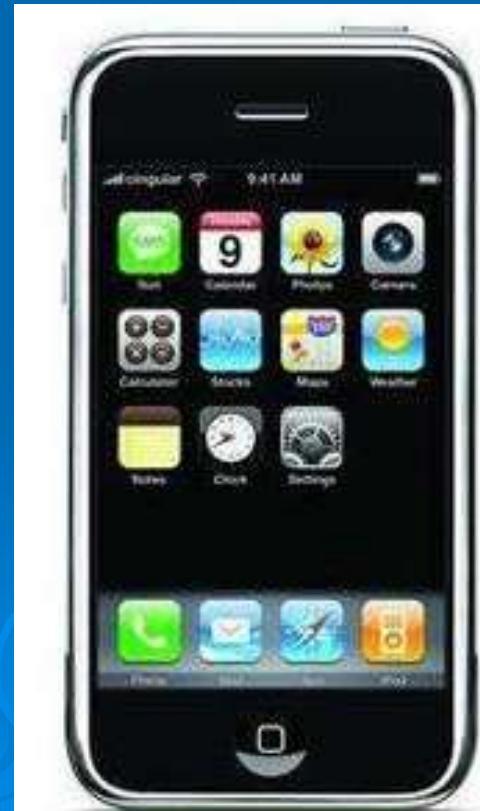
# 2005 Windows Mobile

- Successor to Windows Pocket PC
- Emphasis on phone and connectivity
- Web, email
- Office productivity suite
- Wifi, GSM, 2G, GPRS
- GPS
- Camera



# 2007 Apple iPhone

- £900
- GSM, GPRS
- Finger optimised touch-screen and operation
- Media player
- “Apps” and App-store



# 2008 Android

- HTC Dream/T-Mobile G1 with Android 1.0
- Full Google services: Gmail, Maps, Search, Talk, and YouTube
- Online Google Contacts and Google Calendar
- Android Market Place



# 2010 iPad

- £400
- 256MB RAM, 16 GB to 128 GB Flash
- Wifi, Bluetooth,  
3G
- 1024×768 pixels
- 1 GHz ARM  
Cortex A8
- IOS 5.1.1



# 2010 Windows Phone

- Windows Phone 7 OS
- Based on Windows Mobile, but incompatible
- New touch-optimised "Metro" UI
- Windows App Store
- Xbox Live Games
- Microsoft Office Suite

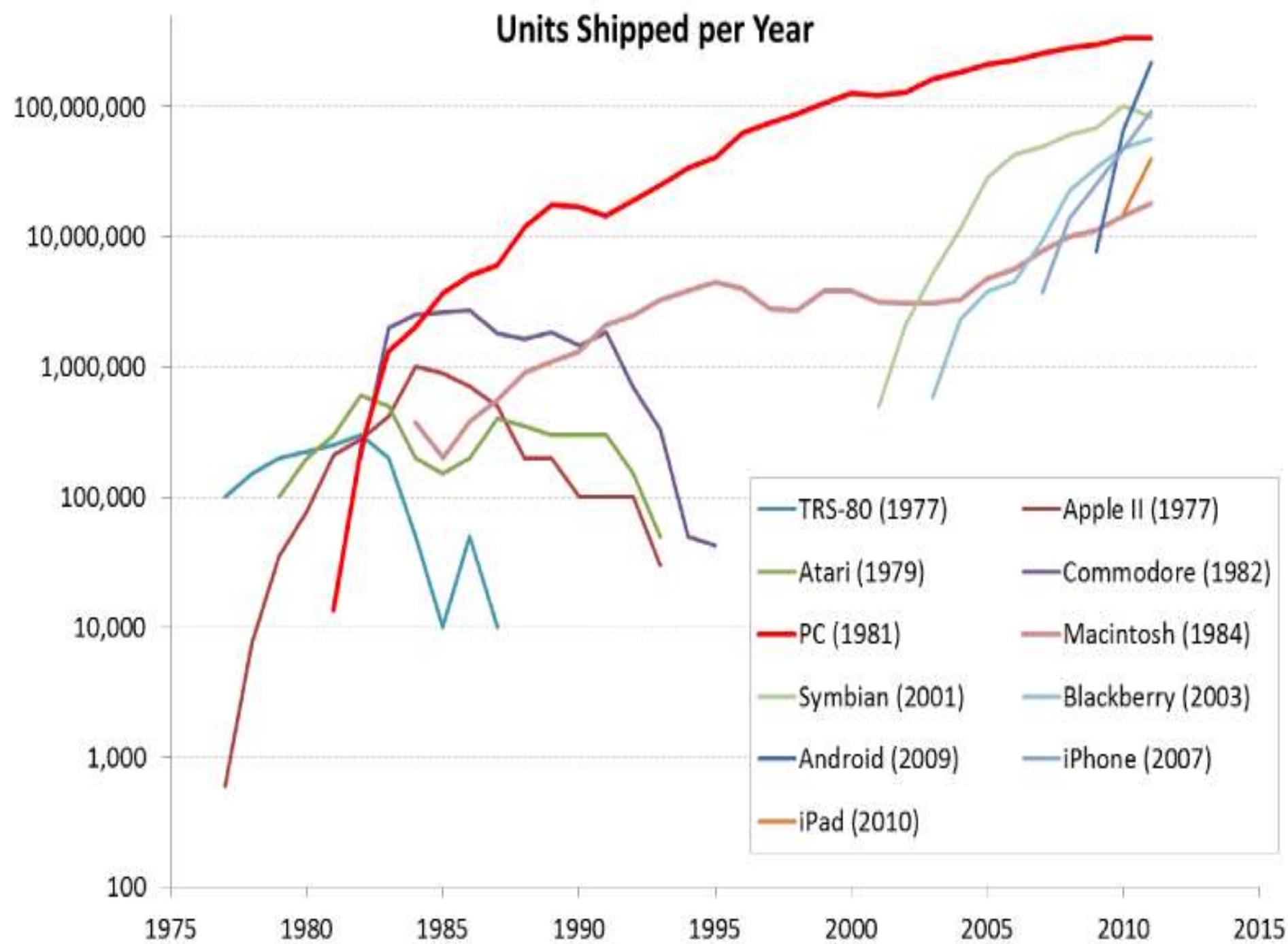


# 2012 Microsoft Surface

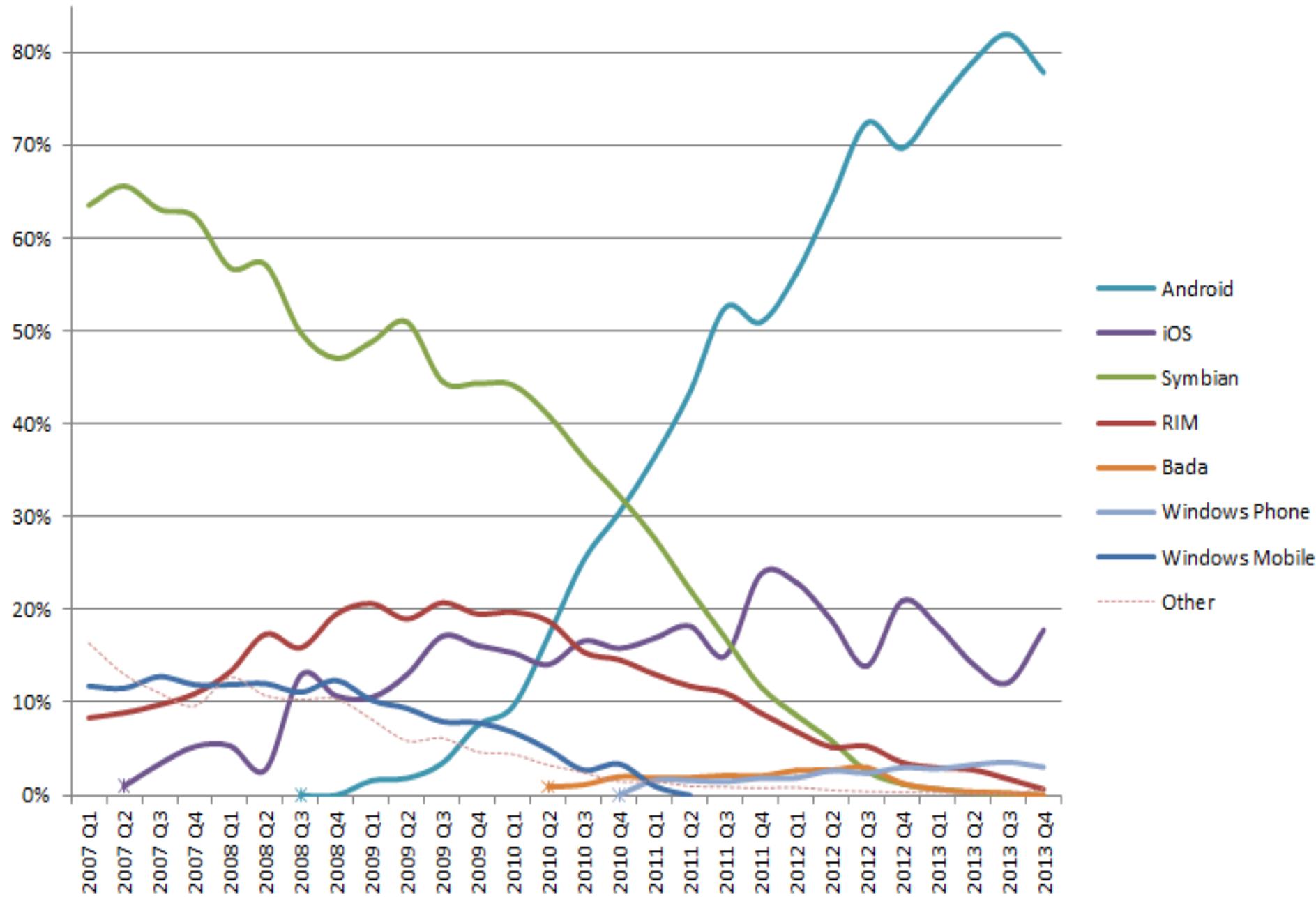
- £400
- 1.3 GHz quad-core ARM Cortex-A9
- 2GB RAM, 32GB Flash
- 10.6 inch 1366 x 768
- Windows RT 7
- Microsoft Office suite
- Windows App Store



## Units Shipped per Year



# World-Wide Smartphone Sales (%)



# Challenges of the Mobile Environment

- Limitations of the Wireless Network
  - heterogeneity of fragmented networks
  - frequent disconnections
  - limited communication bandwidth
- Limitations Imposed by Mobility
- Limitations of the Mobile Computer

# Frequent Disconnections

- Handoff blank out (>1ms for most cellolars)
- Drained battery disconnection
- Battery recharge down time
- Voluntary disconnection (turned off to preserve battery power, also off overnight)
- Theft and damage (hostile environment)
- Roam-off disconnections

# Limited Communication Bandwidth

- Orders of magnitude slower than fixed network
- Higher transmission bit error rates (BER)
- Uncontrolled cell population
  - Difficult to ensure Quality of Service (QoS)
  - Availability issues (admission control)
- Asymmetric duplex bandwidth
- Limited communication bandwidth exacerbates the limitation of battery lifetime.

# Limitations of the Mobile Computer

- Short battery lifetime (max ~ 5 hours)
- Subject to theft and destruction => unreliable
- Highly unavailable (normally powered-off to conserve battery)
- Limited capability (display, memory, input devices, and disk space)
- Lack of *de-facto* general architecture: hand-helds, communicators, laptops, and other devices

# Limitations Imposed by Mobility

- **Lack of mobility-awareness by applications**
  - inherently transparent programming model (object-, components-oriented, but not aspect-oriented)
  - lack of environment test and set API support
- **Lack of mobility-awareness by the system**
  - *network*: existing transport protocols are inefficient to use across heterogeneous mix of fixed/wireless networks
  - *session and presentation*: inappropriate for the wireless environment and for mobility
  - *operating systems*: lack of env. related conditions and signals
  - *client/server*: unless changed, inappropriate and inefficient

# Mobile Operating Systems

- Android
- Apple iOS
- Windows Phone
- Blackberry
- Firefox OS
- Sailfish OS
- Tizen
- Ubuntu Touch OS
- Symbian
- Windows Mobile
- Palm OS
- webOS
- Maemo
- MeeGo

# Android

- Android has the largest installed base at 85%
- Based on Linux OS.
- Open source except for Google's Play Store, Google Search, Google Music, etc.
- Android's releases are named after sweets and desserts like Cupcake, Kit Kat and Lollipop

# Apple iOS

- Apple iOS second largest installed base at 11%
- Closed source and proprietary based on Darwin BSD core OS.
- Close ecosystem - all apps have to come from iTunes unless the devices have been "jail-broken"
- All iOS devices are developed by Apple and manufactured by Foxconn

# Windows Phone

- Windows Phone is closed source and proprietary. Successor to Windows Mobile
- Third largest installed base at 3%
- Includes full integration of OneDrive and Office, Xbox Music, Xbox Video, Xbox Live games and Bing
- Windows Phone devices are made primarily by Nokia, along with HTC, Samsung.

# BlackBerry

- Closed source and proprietary based on QNX
- Mostly used by corporates and governments
- Encrypted messaging
- Previously one of the most dominant smartphone OS. Now less than 1%.

# Firefox OS

- Mozilla Firefox OS is open source, based on Linux.
- HTML5 based Apps
- Designed for lower end smartphones
- Supported by ZTE and Telefonica

# Sailfish OS

- Partly open source.
- Linux based but UI is closed and proprietary.
- Built by ex-Nokia MeeGo employees.
- Application Programming Interface based on the Qt Framework

# Tizen

- Linux based.
- Supported by the Linux Foundation, Fujitsu, Huawei, Intel, NEC, Casio, NTT DoCoMo, Orange, Panasonic, Samsung and Vodafone
- Targeted at consumer devices.

# End of Introduction to Mobile Computing

