# Mobile and Ubiquitous Computing

# Introduction

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# Session Overview

- The mobile computing paradigm
- The ubiquitous computing paradigm
- Elements of mobile and ubiquitous computing
- Enabling technologies
- Computer science challenges
- Applications and their role

# 1940s



NACA High Speed Flight Computer Room

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# 1950s



LEO Computer 30,000 watts, 5,000 square feet

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# 1960s

SABRE

# 1970s



PDP-1, 114kb, 200kHz

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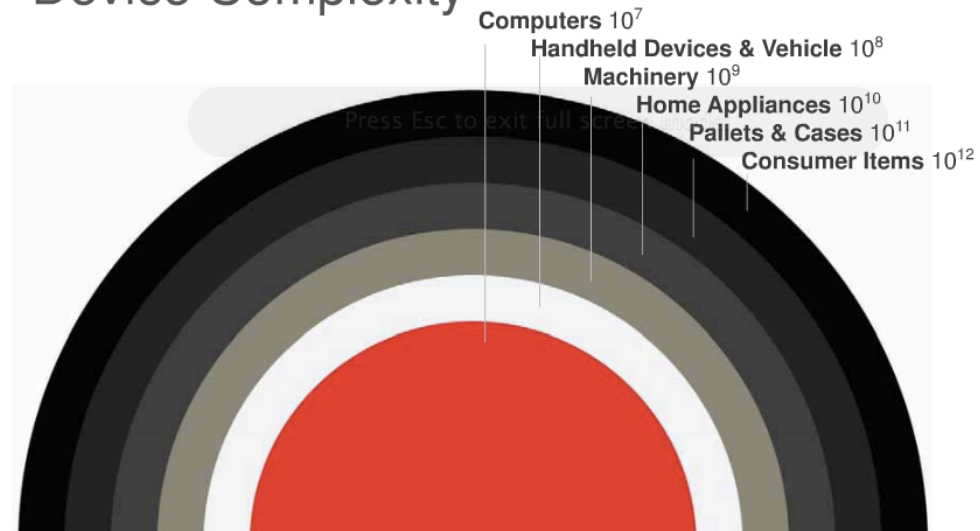# 1980s



Apple II 4K-48K, 1MHz

# 1990s

# 2000

2005

# Main ingredients

- Possible due to minaturisation of computing and communication devices

- Automatic links between physical and digital worlds

- Reality embedded with and embedded in information space aka cyber-physical space

- Dual existence for
  - People
  - Places
  - Things

# Device numbers vs. complexity

Device Complexity

Computers $10^7$
Handheld Devices & Vehicle $10^8$
Machinery $10^9$
Home Appliances $10^{10}$
Pallets & Cases $10^{11}$
Consumer Items $10^{12}$

Press Esc to exit full screen

Get in touch

Close

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# Example

- BMW 745i
- 2,000,000 LOC
- Windows CE
- 53 8-bit processors
- 11 32-bit processors
- 7 16-bit processors
- Multiple networks

What networks does this car have?

What other networks can you think of?



www.familycar.com

# Mobile Computing

- The application of small, portable, and wireless computing and communication devices

- Being able to use a computing device even when being on the move (and thus changing location)

- Portability is one aspect of mobile computing
  - portable vs. mobile

- Mobile telephony in particular allows you to make and receive voice calls on the move

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# Mobile Computing Ingredients

- Device
  - laptop, PDA, mobile phone, tablet, smart phone
- Network
  - cellular telephony, data over cellular, wi-fi, Bluetooth, Zigbee, infra-red, 3G, 4G
- System support
  - routing, billing, voice mail, data routing

- In-depth discussion of the issues raised by mobile systems architectures later today

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# What does ubiquitous mean?

- Dictionary definition:
  - being or seeming to be everywhere at the same time;
  - omnipresent;
  - found in large quantities everywhere;
  - "all over the place."
- Term introduced by Mark Weiser (but others have also described the vision, notably Ken Sakamura)

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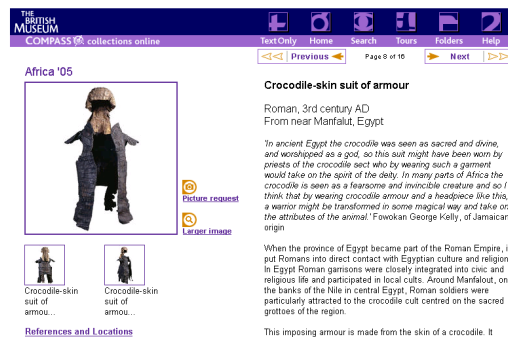
# Cyber-physical Systems

**Physical**



## Physical (material) entities:

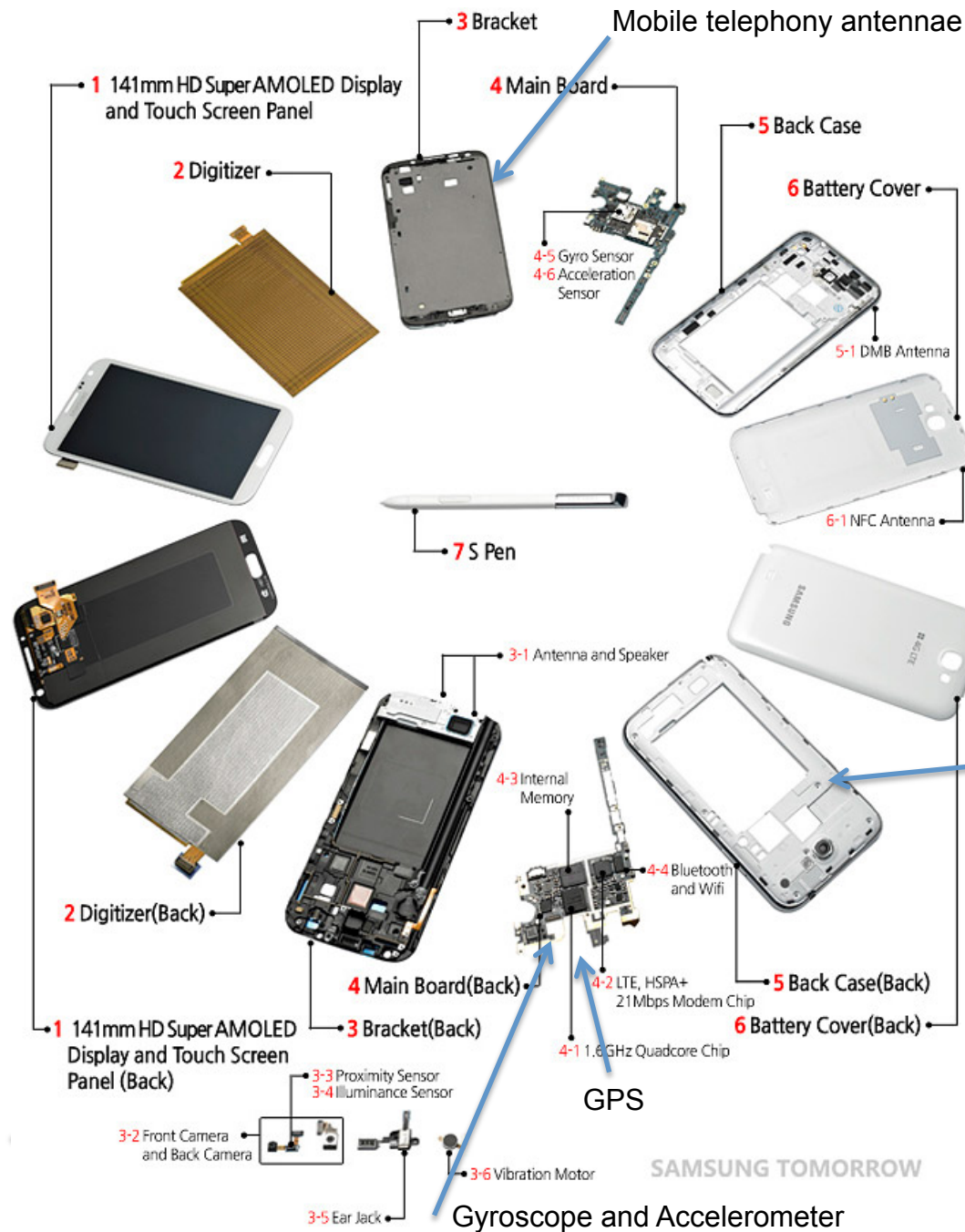- – People
- – Objects
- – Places

**Digital**



## Digital entities:

- – Object info and location
- – Maps
- – Person info
- – Activities

# Ubiquitous Computing

- Ubiquitous computing:
  - activates the world,
  - is invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere,
  - makes a computer so imbedded, so fitting, so natural, that we use it without even thinking about it.
- Also called: pervasive, deeply embedded, 4G mobile or sentient computing, and ambient intelligence.

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Samsung
Galaxy Note II

Image source:
http://blog.gsmarena.com/