

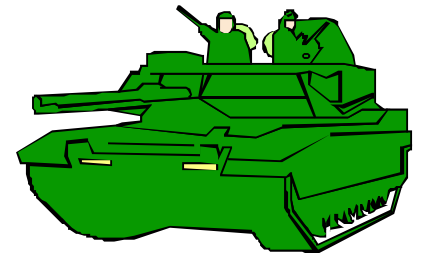
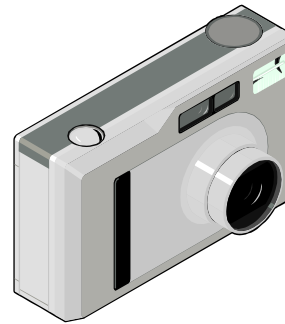
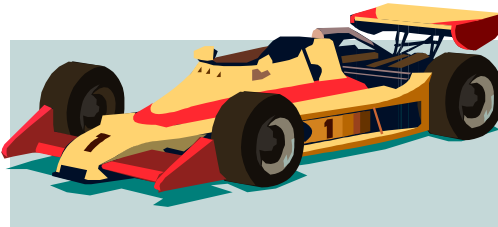
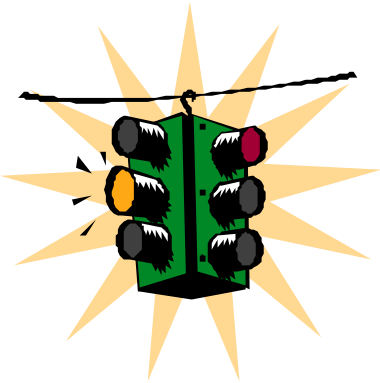
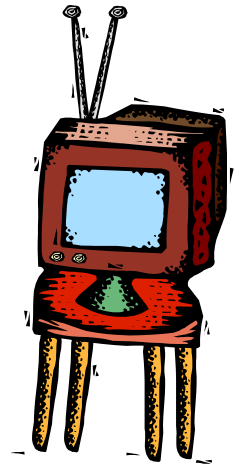


Embedded systems

Mobile phones
and forensics

Embedded system definition:

A computer that is not perceived as such



Real-time system - definitions

A definition: Real-time systems (RT-Systems)

are those computational systems that

- offer an assurance of timeliness of service provision

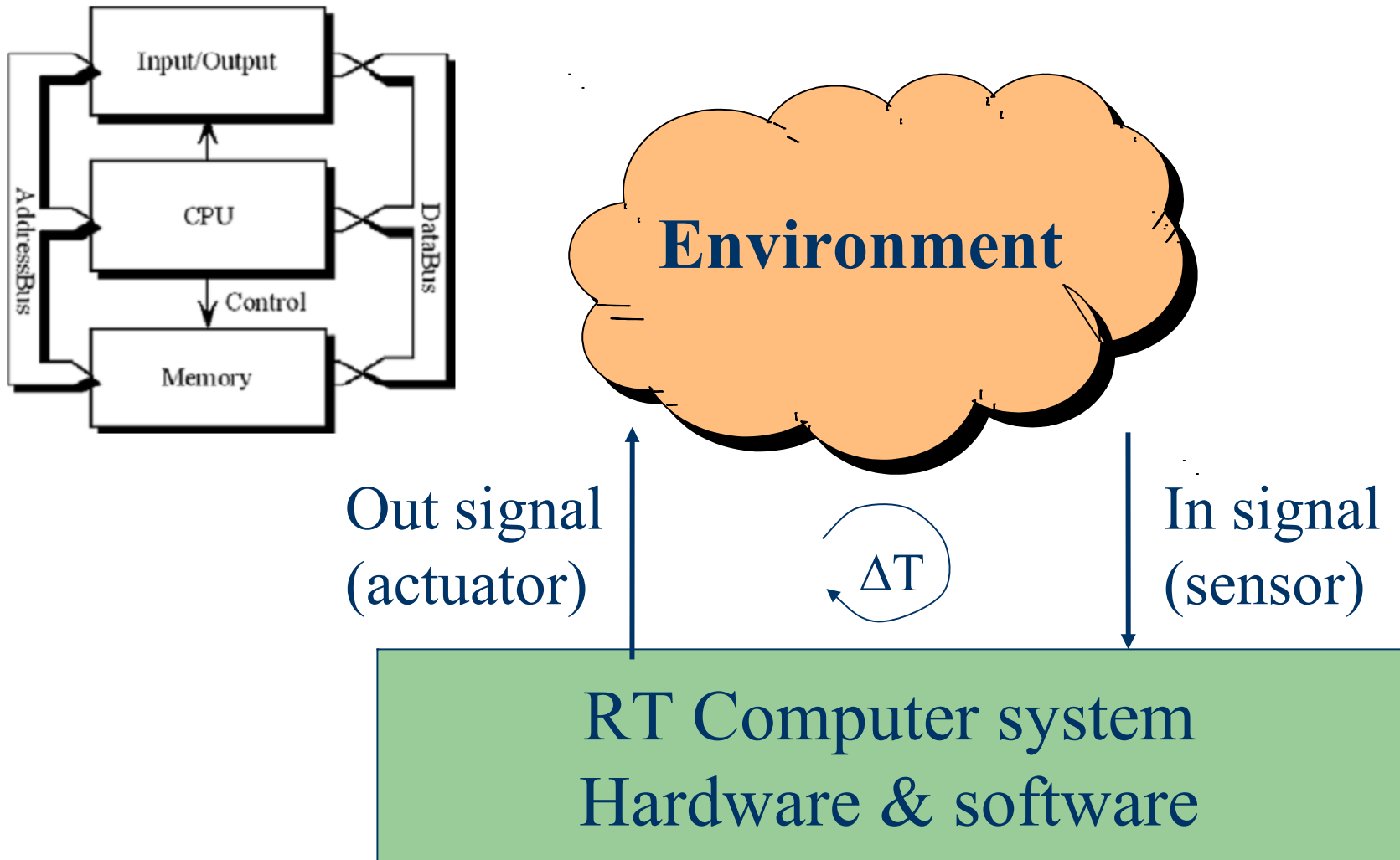
Another definition: RT-systems are those where the correctness of the system behaviour depends

- on the logical results of the computations, ***and also***
- on the physical time when these results are produced

Yet another definition: RT-systems are those that

- have to be designed according to the dynamics of a physical process

A simple real-time system



Further RT System Classifications

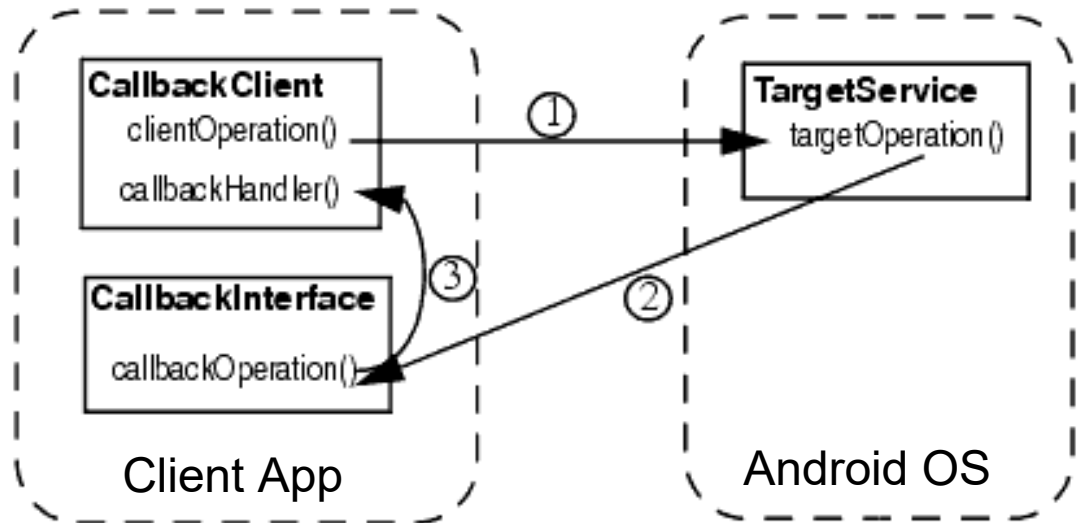
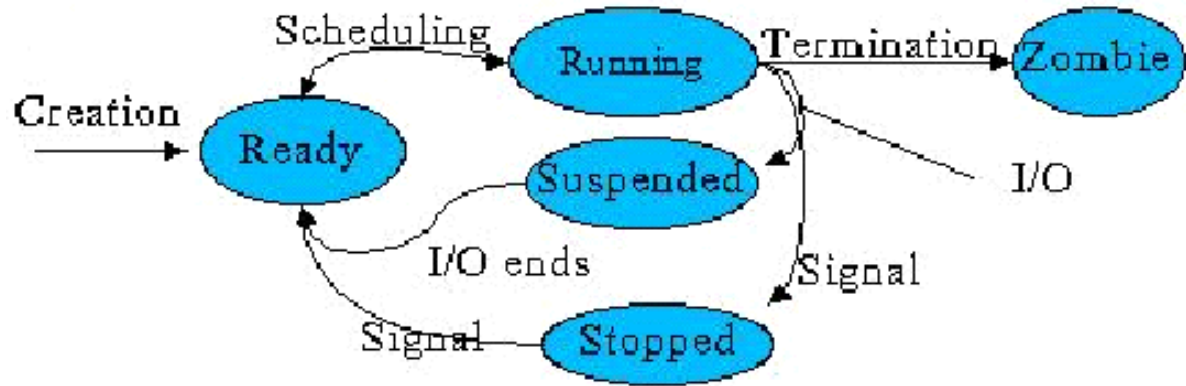
- ***Fail-Safe vs. Fail-Operational***
 - Error detection coverage critical
 - Often use watch dog, heart-beat signal
- ***Resource-Adequate vs. Resource-Inadequate***
- ***Event-Triggered vs. Time-Triggered***
 - Dynamic vs. static scheduling
 - Presence of global time base

Summary

- ***Real-Time Systems:***
 - Focus is predictability – not performance per sec.
 - Correct behaviour = correctness + timeliness of results
 - Must consider dynamics of physical process
- ***Real-Time Systems is usually used in Safety-critical systems***
 - Humans, environment or property can be damaged
 - Safety vs. Security
 - Two types
 - Safe state exists – if everything goes wrong, the system can transition to a safe state
 - Safe state is the working state – high availability
 - Safety critical software – **Dependable** (reliable and safe)

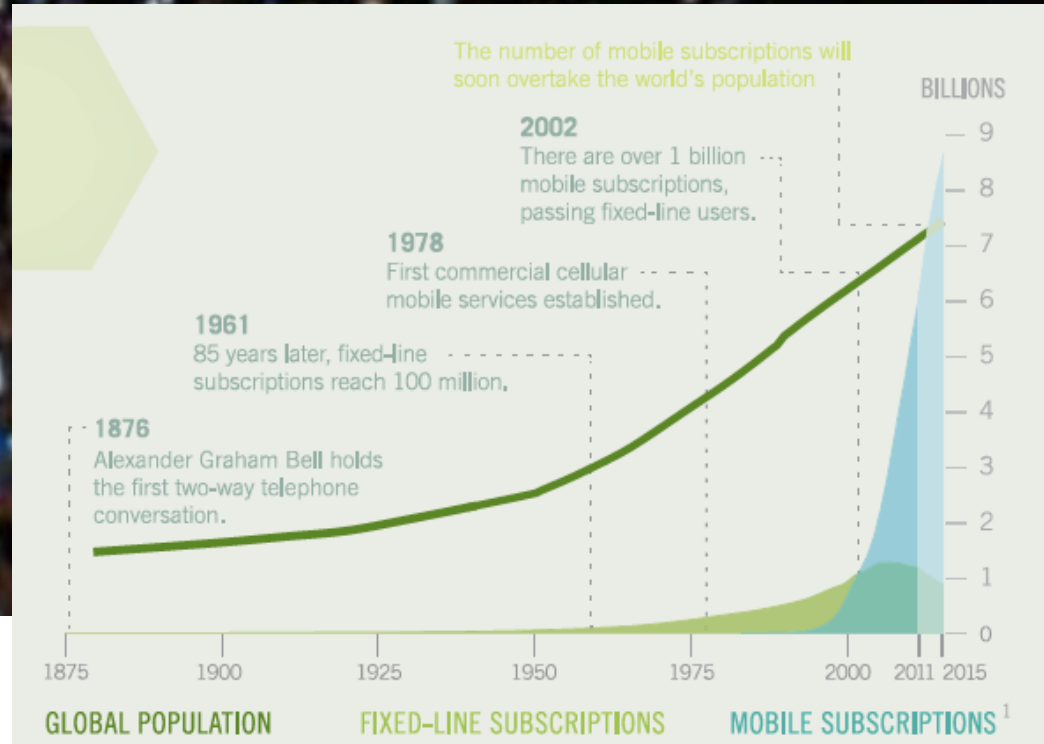
OS concepts

- Threads/tasks
- Priorities
- Scheduling
- IPC and signals
- Locks
 - Semaphores
 - Mutexes
- Callbacks
- Asynchronos
- Synchronos

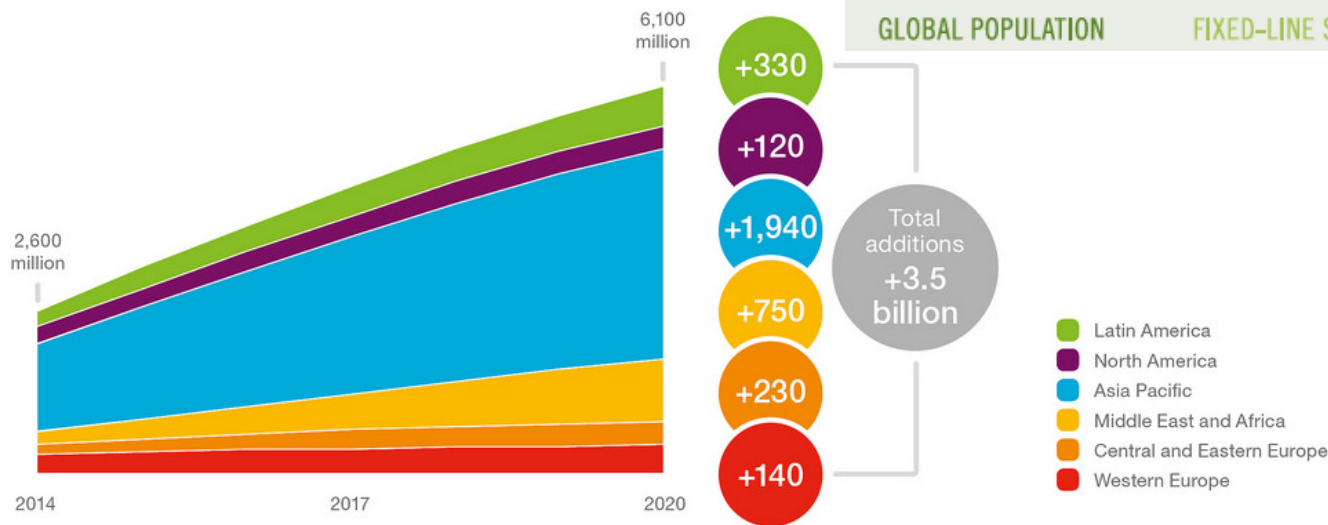


Globally by the end of 2010 there will be 5.1 billion mobile subscriptions

That represents about 2 mobile subscriptions for every 3 people in the world



Smartphone subscriptions per region 2014–2020



Globally by the end of 2010 there will be 5.1 billion mobile subscriptions

That represents about 2 mobile subscriptions for every 3 people in the world

Company	2Q16 Units	2Q16 Market Share (%)	2Q15 Units	2Q15 Market Share (%)
Samsung	76,743.5	22.3	72,072.5	21.8
Apple	44,395.0	12.9	48,085.5	14.6
Huawei	30,670.7	8.9	26,454.4	8.0
Oppo	18,489.6	5.4	8,073.8	2.4
Xiaomi	15,530.7	4.5	15,464.5	4.7
Others	158,530.3	46.0	160,162.1	48.5
Total	344,359.7	100.0	330,312.9	100.0

**Worldwide
Smartphone Sales to
End Users by
Vendor in 2Q16
(Thousands of Units)**

Source: www.gartner.com

**Worldwide
Smartphone Sales to
End Users by
Operating System in
2Q16 (Thousands of
Units)**

Operating System	2Q16 Units	2Q16 Market Share (%)	2Q15 Units	2Q15 Market Share (%)
Android	296,912.8	86.2	271,647.0	82.2
iOS	44,395.0	12.9	48,085.5	14.6
Windows	1,971.0	0.6	8,198.2	2.5
Blackberry	400.4	0.1	1,153.2	0.3
Others	680.6	0.2	1,229.0	0.4
Total	344,359.7	100.0	330,312.9	100.0

Sales by mobile computer type

Worldwide mobile device shipments

Category	2012 shipments (millions)	2016 shipments (millions)	CAGR
Total	1,936.2	2,614.2	7.8%
Basic phone	122.0	58.0	-17.0%
Feature phone	770.8	660.9	-3.8%
Smart phone	694.8	1,342.5	17.9%
Tablet	114.6	383.5	35.3%
Notebook	215.7	169.1	-5.9%
Netbook	18.3	0.3	-65.4%

Source: Canalys estimates and forecast, © Canalys 2013

CAGR = Compound annual growth rate

Why do we do forensic examinations?

- Ask yourself who do you know who doesn't have a mobile?
- Most crimes are committed by one person against another
- Most criminals don't commit crime at home
- Serious Road Accidents now require mobiles to be seized
- Mobile phones are a goldmine of information
- However they present a unique challenge due to rapid changes in technology...



COMPUTER FORENSICS

– Operating Systems



Windows

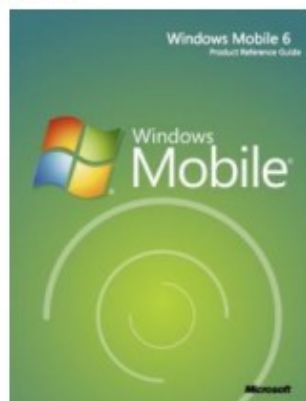
Linux



Apple



MOBILE – Operating Systems



6 runner ups



Linux for Human Beings
ubuntu Phone

Install thousands of Apps and Games from the **Ubuntu Software Centre**.

Featuring the beautiful **Unity** interface.

Sync between your phone and desktop with **Ubuntu One**.

Swipe up or down to switch between homescreens

Regain **control** of your devices

The Power of **Open Source** within your hand

www.must1m.tumblr.com

The image shows a smartphone displaying the Ubuntu Phone interface. The screen is filled with various app icons like Firefox, Messages, Phone, Mail, Contacts, Music, Software Centre, Clock, Calendar, Camera, Calculator, Facebook, Videos, Spotify, YouTube, Gallery, Themes, Weather, To-do List, Dropbox, Voice Control, and Settings. The phone is shown from a slightly angled perspective.

2005

2007

2009 2010

2012



The history of Meego & Tizen

Mobile Phone Evidence

1. Billing History – network time stamped call history

+ Reliable and Accurate

- Takes long time to get from providers

2. Cell Site Analysis – real time tracking

+ Known suspects tracking

- Only most serious offences, takes time to initiate

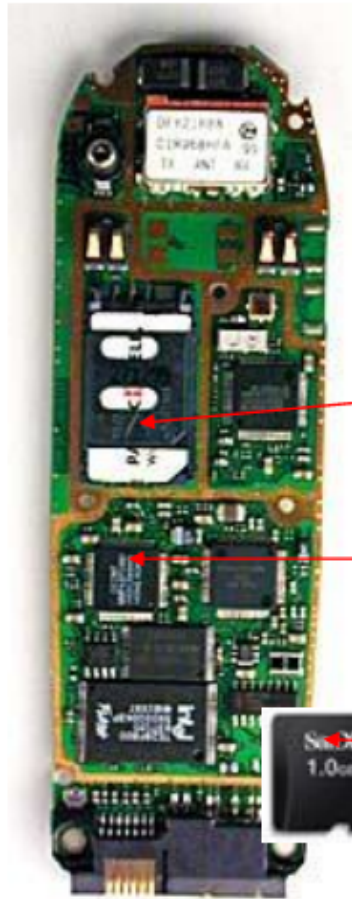
3. Handset – evidence of preliminary activity, drafts,

+ Immediate recovery, draft activity on handset

- Time & Dates can be altered and inaccurate

What's on a mobile device?

➤ Data can be stored in 4 primary locations



- SIM

- Handset

- Memory card

- Cloud



What information can we expect in a mobile phone handset?

- **Contacts**
- **Calls** (dialled, missed, received)
- **Text Messages**
- **Multimedia Messages**
- **Drafts...**
- **Pictures, Audio and Video Images**
- **E-mail, Browser History,**
- **Tasks / Notes / Calendars**
- **Application Files**
- **Maps, GPS Locations visited**
- **Time & Dates**



Forensic Examination Techniques

- Logical acquisition may be sufficient
 - Items from AT(tention) or proprietary commands
 - User backup utilities as iTunes, PC companion tools etc.
- Software agent using device API
- Physical acquisition
 - Hex dump to recover lock code and deleted data etc.
- Whatever can be acquired...
 - Should be complete and accurate
- The complexity and cost rise when moving up in the pyramid

