mobile business

Lecture 9

Mobile Devices

[Source: Nokia]

Mobile Business I (WS 2014/15)

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- Introduction
- Categorisation of Mobile Devices
- Components of Mobile Devices
  - Accumulators
  - Processors, Memory, and Storage
  - Display
  - Means for I/O

Mobile Terminal vs. Mobile Device

- A *Mobile Device* is a small, handheld computing device.

- *Mobile Terminal* emphasises the fact that the mobile device represents the end of a communications link or the edge node of a communications network.

Device Manufacturers and Brands

(including some historic ones)

- Alcatel
- Apple
- Audiovox
- Benefon
- BenQ Mobile
- Blackberry
- Bosch
- Ericsson
- Google
- HTC
- Huawei
- LG Electronics
- Motorola
- NEC
- Nokia
- Panasonic

- Philips
- Sagem
- Samsung
- Sendo
- Siemens
- Sony
- TCL Communication
- Telepong
- Telit
- Telme
- Toshiba
- Trium
- Windhorst
- Xelibri
- Yulong
- ZTE

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Worldwide Mobile Phone Sales to End Users by Vendor Q1-2014 vs. Q1-2005

In 1.000 Units

Company	1Q14 Units	1Q14 Market Share (%)	1Q05 Units	1Q05 Market Share (%)
Samsung	109,099.8	***24.3***	24,479.8	***13.5***
Nokia	50,691.8	***11.3***	54,960.1	***30.4***
Apple	43,514.2	***9,7***	-	
LG	16,149.6	***3,6***	11,464.2	***6.3***
Huawei	14,355.2	***3,2***	➲ others	
ZTE	➲ Others		➲ others	
Sony Mobile Com.			9,905.8	***5.5***
Motorola			30,143.3	***16.7***
BenQ Mobile			10,209.5	***5.7***
Others incl. Blackberry, HTC	214,879.4	***47,9***	39,829.5	***21.9***
TOTAL	**448,600**	**100.0**	**180,992.2**	**100.0**

Based on [Gartner2006], [Statista2014a], [Statista2014b]

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Worldwide Mobile Phone Sales to End Users by Vendor Q1-2014 vs. Q1-2013

In 1.000 Units

Company	1Q14 Units	1Q14 Market Share (%)	1Q13 Units	1Q13 Market Share (%)
Samsung	109,099.8	***24.3***	109,245.4	***25.3***
Nokia	50,691.8	***11.3***	61,747.4	***14.3***
Apple	43,514.2	***9,7***	37,566.6	***8.7***
LG Electronics	16,149.6	***3,6***	16,408.4	***3.8***
Huawei	14,355.2	***3.2***	10,795.0	***2.5***
ZTE	214,879.4	***47.9***	13,817.6	***3.2***
Others			182,219.6	***42.2***
TOTAL	**448,600**	**100.0**	**435,158.4**	**100.0**

Based on [Statista2014a], [Statista2014b]

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Worldwide Mobile Phone Sales to End Users by Vendor 2012 vs. 2011 – A Decline?

In 1.000 Units

Company	2012 Units	2012 Market Share (%)	2011 Units	2011 Market Share (%)
Samsung	384,631.2	***22.0***	315,052.2	***17.7***
Nokia	333,938.0	***19.1***	422,478.3	***23.8***
Apple	130,133.2	***7.5***	89,263.2	***5.0***
ZTE	67,344.4	***3.9***	56,881.8	***3.2***
LG Electronics	58,015.9	***3.3***	86,370.9	***4.9***
Huawei Technologies	47,288.3	***2.7***	40,663.4	***2.3***
TCL Communication	37,176.6	***2.1***	34,037.5	***1.9***
Research In Motion	34,210.3	***2.0***	51,541.9	***2.9***
Motorola	33,916.3	***1.9***	40,269.1	***2.3***
HTC	32,121.8	***1.8***	43,266.9	***2.4***
Others	587399.6	***33.6***	595886.9	***33.6***
TOTAL	**1,746,175.6**	**100.0**	**1,775,712.0**	**100.0**

Cf. TOTAL Units sold in 2013: 1,820,200.0

[Statista2014b]

[Gartner2013a]

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Worldwide Smartphone Sales to End Users by Vendor Q3-2014 vs. Q2-2014

Company	3Q14 Units	3Q14 Market Share (%)	2Q14 Units	2Q14 Market Share (%)
Samsung	78,100	***23.8***	74,415.6	***25.2***
Apple	39,300	***12.0***	35,140.7	***11.9***
Xiaomi	17,300	***5.3***	13,800.0	***4.7***
Lenovo	16,900	***5.2***	15,946.2	***5.4***
LG Electronics	16,800	***5.1***	14,469.7	***4.9***
Huawei			20,375.7	***6.9***
Others	159,200	***48.6***	121,447.4	***41,1***
TOTAL	**327,600**	**100.0**	**295,300**	**100.0**

In 1.000 Units

Based on [Statista2014c], [Statista2014d]

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Worldwide Smartphone Sales to End Users by Vendor Q2-2014 vs. Q2-2013

Company	2Q14 Units	2Q14 Market Share (%)	2Q13 Units	2Q13 Market Share (%)
Samsung	74,415.6	***25.2***	71,380.9	***31.7***
Apple	35,140.7	***11.9***	31,899.7	***14.2***
LG Electronics	14,469.7	***4.9***	11,473.0	***5.1***
Lenovo	15,946.2	***5.4***	10,671.4	***4.7***
Huawei	20,375.7	***6.9***		
Others	135,247.4	***45,8***	99,901.2	***44.3***
TOTAL	**295,300**	**100.0**	**225,326.2**	**100.0**

In 1.000 Units

Based on [Gartner2013b], [Statista2014c], [Statista2014d]

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Worldwide Smartphone Sales to End Users by Vendor Q2-2013 vs. Q2-2012

Company	2Q13 Units	2Q13 Market Share (%)	2Q12 Units	2Q12 Market Share (%)
Samsung	71,380.9	***31.7***	45,603.8	***29.7***
Apple	31,899.7	***14.2***	28,935.0	***18.8***
LG Electronics	11,473.0	***5.1***	5,827.8	***3.8***
Lenovo	10,671.4	***4.7***	4,370.9	***2.8***
ZTE	9,687.6	***4.3***	6,331.4	***4.1***
Others	90,213.6	***40.0***	62,704.0	***40.8***
TOTAL	**225,326.2**	**100.0**	**153,772.9**	**100.0**

In 1.000 Units

[Gartner2013b]

Worldwide Smartphone Sales in Q2-2013

- “Smartphones accounted for 51.8 percent of mobile phone sales in the second quarter of 2013, resulting in smartphone sales surpassing feature phone sales for the first time.”

[Gartner2013b]

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Evolution of Mobile Devices

- **Development of device capabilities**
  - Multimedia applications (MP3, radio, video, TV, etc.)
  - Possibility to execute 3rd party software
  - Sensors (microphone, camera, GPS, …)
  - Data Services (Internet connectivity)
  - Short Message Service (SMS)
  - Interactive Voice Response (IVR)
  - General telephony capabilities

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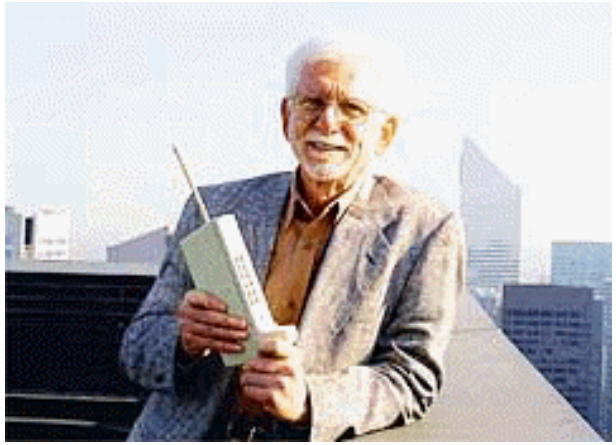
Evolution of Mobile Devices Examples



© New York Times

1973

2001

© Microoptical

2005

© IBM

2006

2007

2010

© Google

2013

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Mobile Devices Size

- Everybody wants smaller devices.
- Everybody ? …

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Worldwide Device Shipments by Segment

- Worldwide device shipments and projections by segment show a shift in consumer preferences:

In 1.000 Units

Device Type	2012	2013	2014	2015
PC (Desk-based and Notebook)	341,273	296,131	276,221	261,657
Ultramobile (Thin, light, slate or hybrid, e.g. Chromebooks)	9,787	21,517	32,251	55,032
Tablet	120,203	206,807	256,308	320,964
Mobile Phone	1,746,177	1,806,964	1,862,766	1,946,456
Other Ultramobiles (Hybrid and Clamshell)	-	2,981	5,381	7,645
TOTAL	**2,217,440**	**2,334,400**	**2,432,927**	**2,591,753**

- The reason may be an increasing focus on energy efficiency and weight.

[Gartner2013c, 2013d, 2014]

“Fair” and ecologically friendly Mobile Devices

- Grounded in the idea to develop and market smartphone hardware and software designed and produced with minimal harm to people and planet.
- Strict observation of:
  - Type of raw materials (ecological aspects)
  - Origin of raw materials (political aspects)
  - Lifespan of components and easy repair (durability aspects)

FAIRPHONE

- **25,000** first edition Fairphones sold in 2013.
- **35,000** second batch Fairphones on sale in 2014.

[www.fairphone.com/about/]

It is *“not possible to produce a 100% fair phone yet, but by aiming toward this end seeks to raise awareness among consumers and in the mobile industry.”* [Wiki2013]

[Source: news.phonebloks.com]

Based on [Tage2013]

- Introduction
- Categorisation of Mobile Devices
- Components of Mobile Devices
  - Accumulators
  - Processors, Memory, and Storage
  - Display
  - Means for I/O

- Categorisation is possible by:
  - Technical characteristics
  - Application aspects
    - Functional completeness (Is the functionality comparable to a desktop PC/Laptop?)
    - Size of the device
    - Security features

Categorisation of Mobile Devices

Technical Characteristics

- Hardware independence
  - Independent devices
  - Devices with external communication
  - Devices with external security modules
  - Devices with external memory
- Operating system – Characteristics
  - Memory security, file security, access control
  - Security module support, secure I/O, program and system integrity

Categorisation of Mobile Devices

Application Aspects 1

- Lifespan of an application
  - Battery consumption, amount of data, and size of memory
  - Data integrity, amount of communication, and costs
- Completeness of the functionality for the end-user
  - Information / Reaction
  - Limitations due to device size
  - Feature Sets

Categorisation of Mobile Devices

Application Aspects 2

- Device size
  - Small / integrated devices
  - „Pocket-sized“
  - „Tablet-sized”
  - „Laptop-sized“
- Access to the security module
  - Data integrity, encryption
  - Digital signatures
  - Access control, authentication

Use Cases

- Different requirements for different kinds of devices:

	Mobile Phone	Tablet	Laptop
Number of „Switch-ons“ per day	low	low	variable
Frequency of use cases	very high	rather low	low
Duration of usage per task	?	short/ medium	high

Based on [Burckhardt2001]

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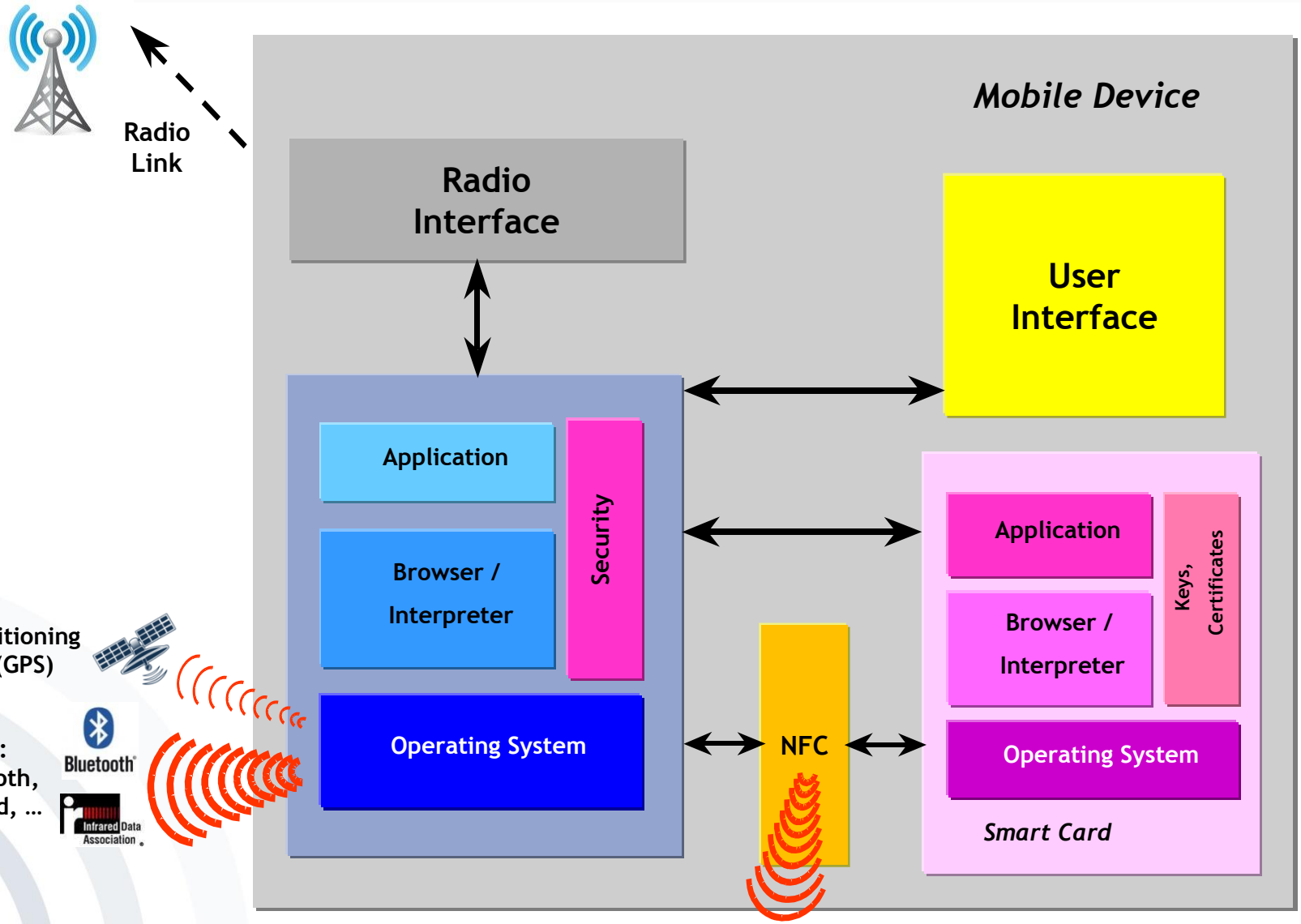
OS – Functional Architecture



Based on [Posegga2001]

Size of a mobile Device

- The size of a mobile device is considerably determined by its:
  - Input Facilities (e.g. keyboard)
  - Output Facilities (e.g. display)

➲ Separation of components (e.g. display in the watch, head-mounted-displays)

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Accumulators

Mobile phone	Standby time (in h)	Talk time (in min)	Capacity (in mAh)	Display
Nokia 6310 (2001) 	408	360	Li-Polymer; 1.100 mAh	Graphic 96 x 65
Nokia N-Gage (2004) 	240	120	Li-Ion; 850 mAh	Color 176 x 208 4.096 colours
MDA pro (2005) 	260	480	Li-Polymer; 1.620 mAh	Touch TFT 640 x 480 65.536 colours
MDA Vario II (2006) 	200	300	Li-Polymer; 1.350 mAh	Touch TFT 320 x 240 65.536 colours
T-Mobile Ameo (2007) 	300	240	Li-Ion; 2200 mAh	Touch TFT 640 x 480 65.536 colours
Apple iPhone 4 (2010) 	300	420 (3G) - 840 (2G)	Li-Polymer; 1420 mAh	Touch TFT 960 x 640 16.7m colours
Apple iPad Air (2013) 	*Up to 9 hours of surfing the web using 3G data network (10 hours with WiFi)*		Li-Polymer; 8,600 mAh	Touch TFT 2048 x 1536 16.7m colours

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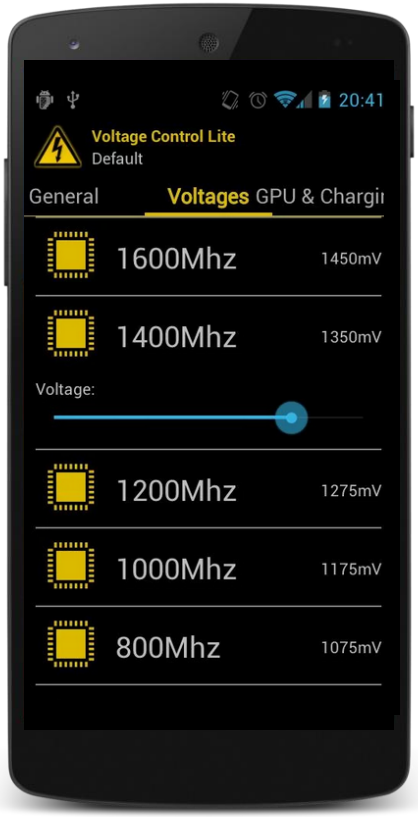
Processors

- Performance increase
  - Higher clock frequency (but frequency scaling typically comes at the price of higher voltage!)
  - Larger on-die-caches (cache memory) built into the CPU (“on die”) to reduce memory access time
- Power consumption decrease
  - Processor's core voltage (1995: 3.5 V; 2000: 1.35 V; 2013: 1.0 V)
    - Lower bound is the voltage needed to switch a transistor
    - Quadratic relationship between voltage and power consumption
  - ➲ Less heat loss
- Power Management
  - triggered by changes of the energy supply



Picture source: “Voltage Control” Application (Google Play Store) by darek.xan

Processors

Overview of Mobile Devices

Logo	Device	Processor	Mhz	MIPS
	Nokia N-Gage (2004)	ARM7	104	??
	HTC/T-Mobile MDA (2002)	Intel StrongARM	206	274
	Apple iPhone 4, iPad (2010)	Apple A4	800 (iPad: 1000)	2.000
	Notebook (2006)	Intel CoreDuo Processor	2.000	< 14.000
	Notebook (2010)	Intel Core i7 Quad-Core	3.600	> 20.000
	Apple iPad Air 2 (2014)	Apple A8X	1.500 (Triple-core)	??

Memory

- General trade-off between storage on the server vs. storage on the client
- Storage on the client
  - Subscriber Identity Module (SIM)
  - Random Access Memory (RAM)
  - Memory cards
  - Microdrives

- Introduction
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    - Liquid-Crystal-Displays (LCD)
    - Organic Light Emitting Diodes (OLED)
  - Means for I/O

Display
Liquid-Crystal-Displays (LCD)

- The LCD technology is widespread in the market.
- “Consists of an array of tiny segments (called pixels) that can be manipulated to present information“
- Examples:
  - Dual Scan Twisted Nematic (DSTN)
  - Thin-film Transistor (TFT)

Example: Dynasheet (Toshiba)
1cm, 200g, 2005

Display
Liquid-Crystal-Displays (LCD)

- DSTN-Display (Dual Scan Twisted Nematic)
  - Passive matrix
  - LCD displays with passive control have a relatively high latency (generally more than 100 ms). This implies a blurred image with frequently changing picture elements.
- TFT-Displays (Thin Film Transistor)
  - Active (transistor for each pixel)

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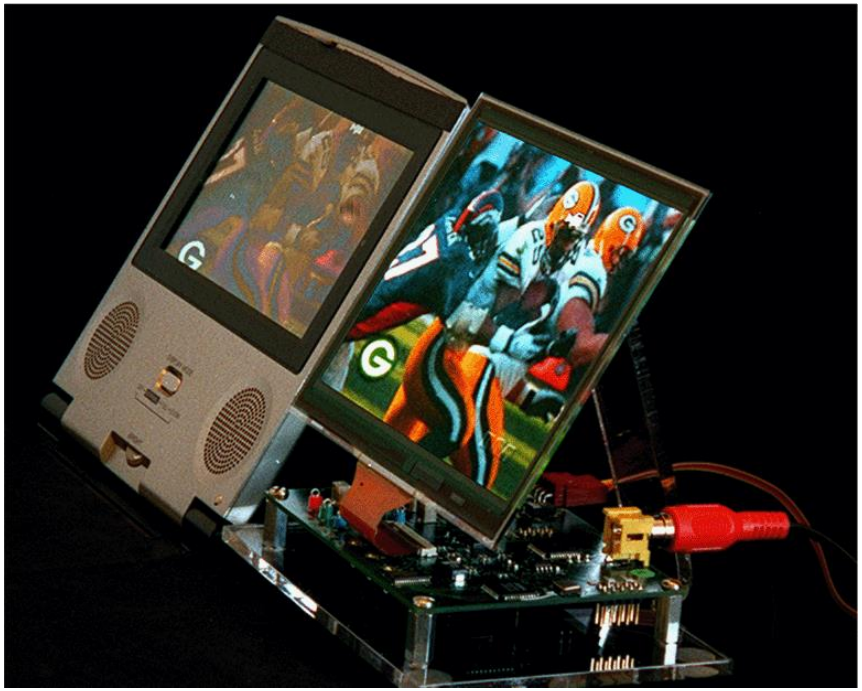
Display
Resolution

Logo	Mobile phone	Display	Resolution	Colors
	Nokia 6310 (2001)	Graphic	96 x 65	none
	Siemens S55 (2002)	Color	101 x 80	256
	Nokia N-Gage (2004)	Color	176 x 208	4.096
	Samsung E700 (2003)	TFT-Color	160 x 128	65.536
	MDA III (2004)	Touch TFT	320 x 240	65.536
	MDA pro (2005)	Touch TFT	640 x 480	65.536
	T-Mobile Ameo (2007)	Touch TFT	640 x 480	65.536
	Apple iPhone 4 (2010)	Touch TFT	960 x 640	16.7m
	Apple iPad 2 (2010)	Touch TFT	1024 x 768	16.7m
	Apple iPad 3 (2012)	Touch TFT	2048 x 1536	16.7m

Display

Organic Light Emitting Diodes (OLED)

- Polymers can convert electric energy to light.
- Complete layer is thinner than 500 nm (0.5 thousandth part of one mm), luminosity approx. 100W electric bulb.
- 180° viewing angle

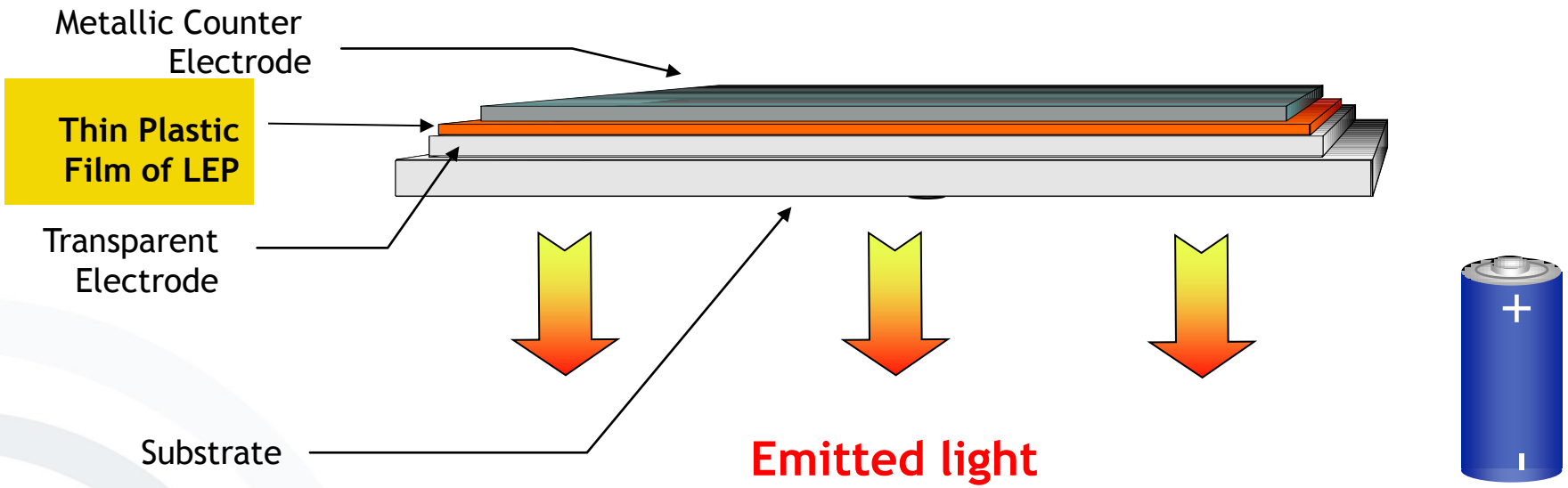


www.opto.com.tw

Display
Advantages of OLED

- OLED consist of self lighting polymer molecules:
  - No background lighting is necessary
  - Electric power consumption decreases and longer usage times become possible.
  - Space for extra components
  - Devices can be thinner and lighter.

Light Emitting Polymer Device



[Covion2006]

Display

Organic Light Emitting Diodes (OLED)

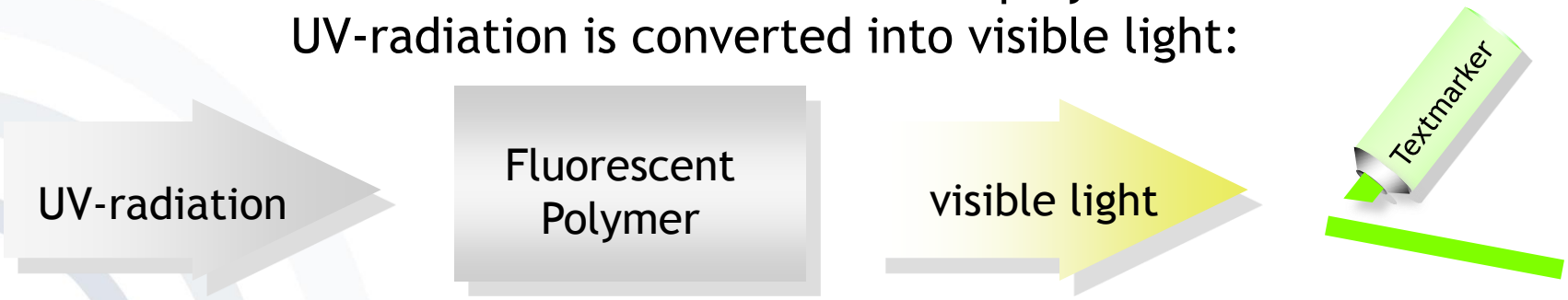
- Polymers are large molecules widely known as plastics.
- *Light Emitting Polymers (LEPs)* are special plastic materials that convert electrical power into visible light.
- A thin film of *Light Emitting Polymer* put between two electrodes will glow ...

Display

Organic Light Emitting Diodes (OLED)

Light Emitting Polymers convert electrical power into visible light:

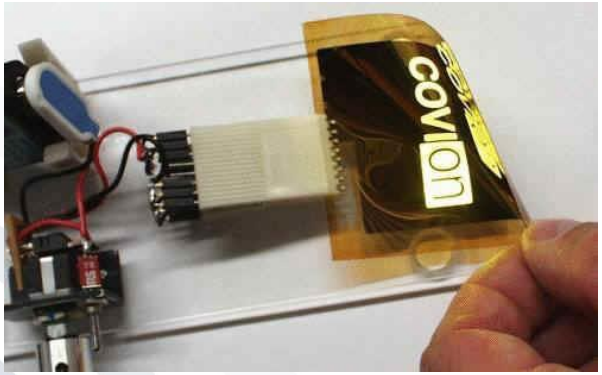
This is related to the fluorescence of polymers where UV-radiation is converted into visible light:

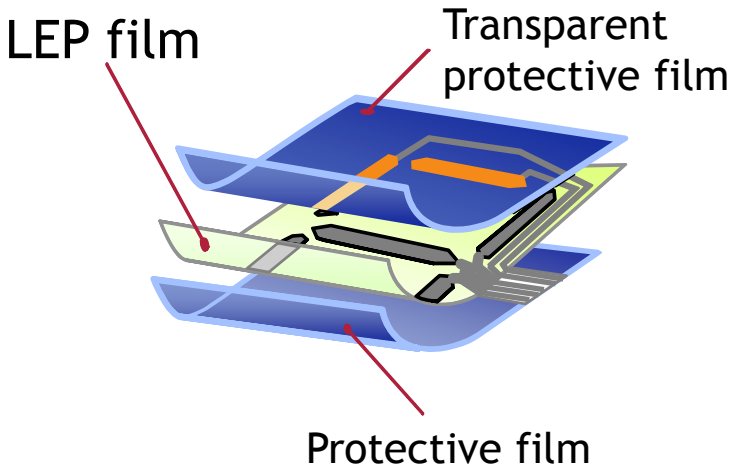


[Covion2006]

Display
Organic Light Emitting Diodes (OLED)

- Because plastic materials are flexible and robust even non-planar displays can be manufactured ...





[Covion2006]

- Introduction
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  - Means for I/O
    - Device Input
    - Personal Area Networks (PAN)

Input
"Standardization Battles"

- Excursion "standardization battles": ***QWERTY vs. Dvorak's DSK***
- ***1868*** Christopher Latham Sholes Copyright (goal: minimum key conflicts)
- ***1873*** sale of QWERTY to E. Remington & Sons
- "Jamming" was a problem until 1979. As a consequence, the ball-shaped head technique was invented.

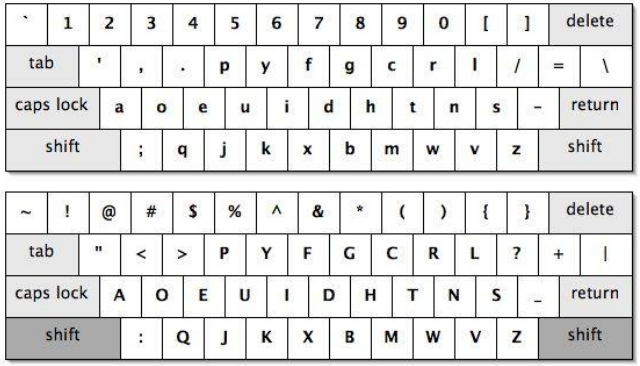
Input

"Standardization Battles"

- De-facto standard, high competition
- 1936 Dvorak's Simplified Keyboard (DSK)
- Goals:
  - Keys which are used most frequently are close to each other
  - Change of hands well balanced
  - Frequent keys preferably with strong fingers

- Fact = We all use QWERTY.

➲ ***What did go wrong?***



Input
"Standardization Battles"

- QWERTY is an example for market failure in the presence of network effects.
- *"Worse standard dominates a better standard".*
  ➲ *What is the better standard?*
- ***Further problems:*** Lock-in, switching costs

➲ Unfortunately, the case is not as easy!

Input

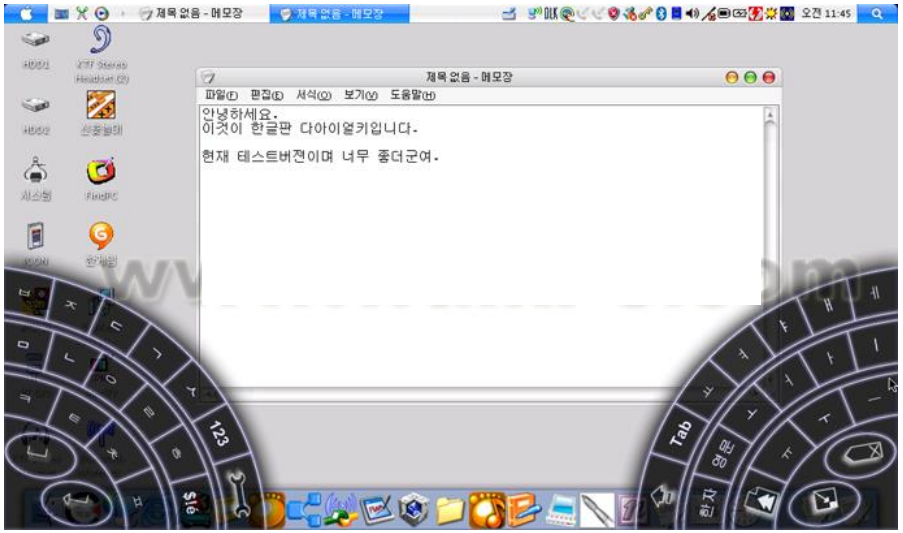
"Standardization Battles"

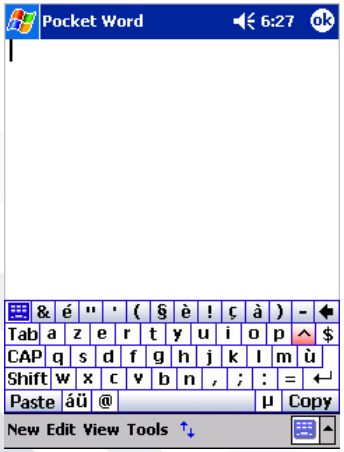
- Often cited US Navy Research Report of 1944 ➲ DSK is more efficient than QWERTY.
  - No official report but a falsely cited internal paper from an officer = Lieutenant Commander August Dvorak!
  - ***Critics:*** Methodological biases: Two test persons of different age and abilities
  - Chaos between 108 and 180 hits per minute - Many contrasting findings
  - *… the QWERTY keyboard appears to be fast enough for almost all users. If you are just driving about in town you do not need a 500 horse-power V8.*" (Poole 1997)
- Things are not as easy as they seem to be!
- For more details see: [LiebowMargol1996].

Currently, the following input solutions for mobile devices exist:

- QWERTY-Keyboard
- Palm-Graffiti
- Tegic T9
- Octave
- SWYPE
- Recognition of handwriting
- Speech recognition

Input
QWERTY-Keyboards





Input
PALM Graffiti

- Handwriting recognition software
- Artificial script, based on upper-case characters
- Can be drawn blindly with a stylus on a touch-sensitive panel

Input

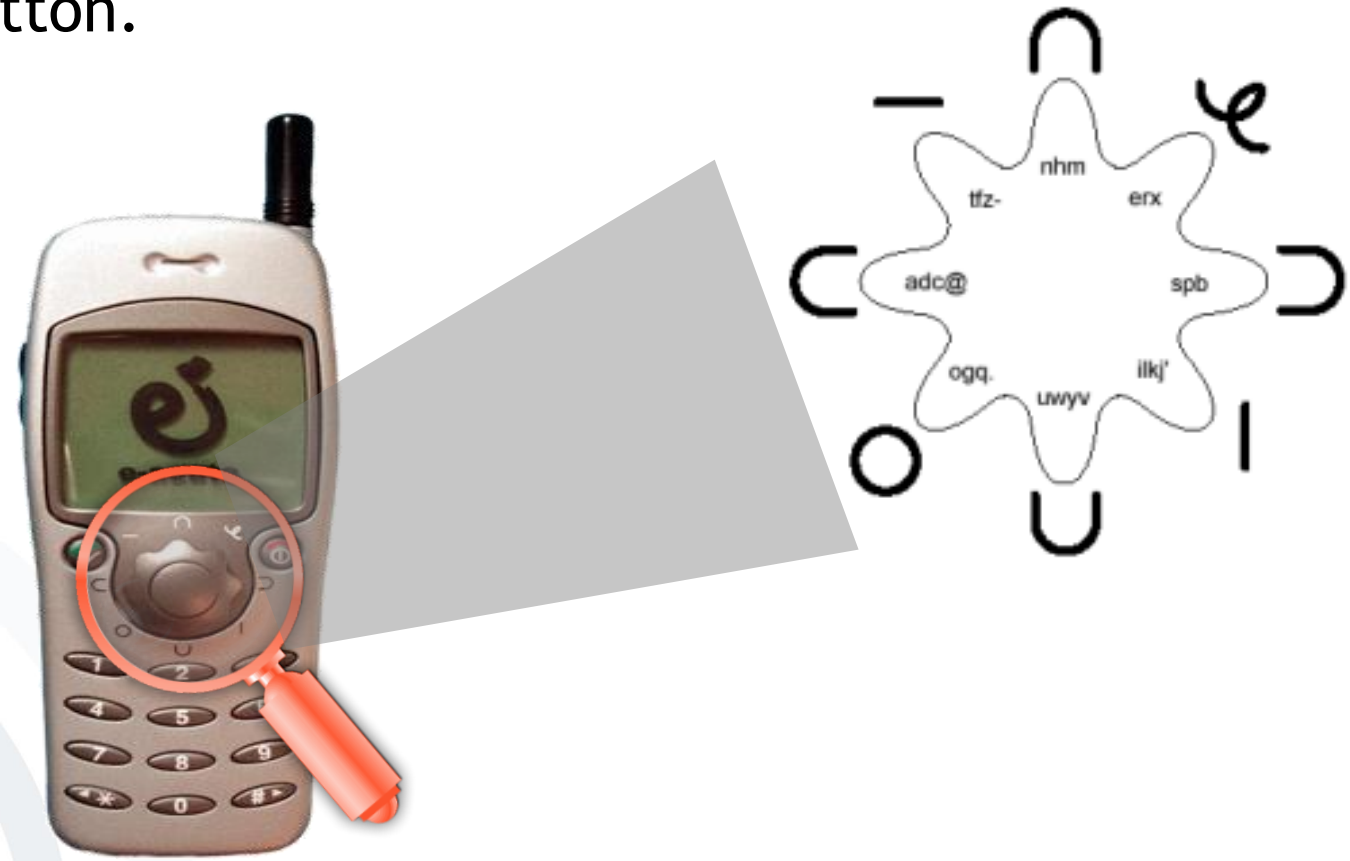
Tegic Communications T9

- T9 (*Text on **9** keys)* is a predictive text technology developed by Tegic Communications.
- Widely used by: LG, Samsung, Nokia, Siemens, Sony Ericsson, Sanyo
- Uses a dictionary of words, which is used to look up all the possible words, corresponding to the sequence of keypresses.
- Available in 27 languages

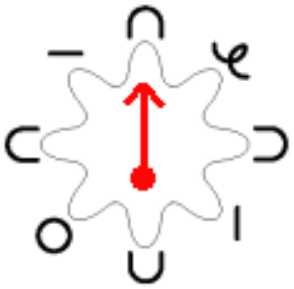
[T92006]

Input
Octave

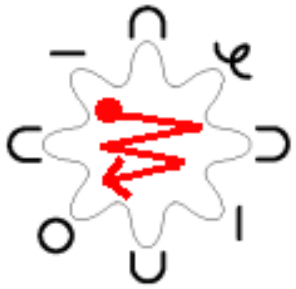
- Characters can be input by either pen or button.



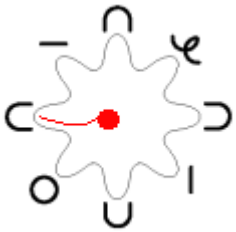
Input
Octave



“capital letters”



“reset”



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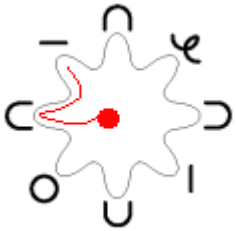

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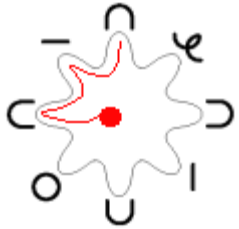

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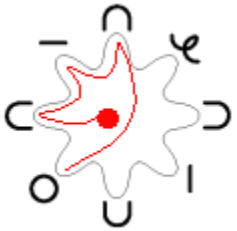


atmo·sphere

Input
SWYPE

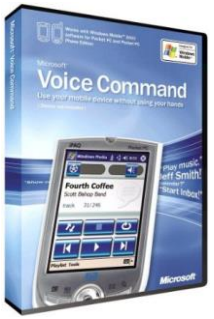
[http://swypeinc.com/product.html]

- Input by sliding a finger or stylus from letter to letter, lifting only between words
- Word is guessed using error-correcting algorithms and language model
- Developed by Swype Inc.
- First commercially available on Samsung Omnia II (on Windows Mobile 6.5), also available for Android

Input
Speech Recognition

- Translation of spoken words into text
- Supports various applications, e.g. for
  - initiation of phone calls
  - message composition
  - …
- Originally performed directly on PDAs/smartphones
- Nowadays usually provided as a cloud service
  - Voice is recorded and compressed
  - Sound file is sent to a server where the actual recognition process is performed
  - Text is sent back to smartphone
- Examples
  - Apple Siri
  - Google Now
  - Samsung S-Voice
  - Windows Phone Voice Control
  - Blackberry 10 Voice control
  - …
- May become important feature for smart watches
- In contrast, term *voice recognition* refers to *identity* of the speaker, not *what* is said.

[Source: Wikipedia]



[Source: Samsung]

- Introduction
- Categorisation of Mobile Devices
- Components of Mobile Devices
  - Accumulators
  - Processors, Memory, and Storage
  - Display
  - Means for I/O
    - Device Input
    - Personal Area Networks (PAN)

Personal Area Network (PAN)

- Personal environment, short range
- ***Purpose***: Connection of devices in short range, for example mobile device and printer.
- Replaces cable-connections:
  - **I**nfra**r**ed **D**ata **A**ssociation (IrDA)
  - Bluetooth
  - Near Field Communication (NFC)

Personal Area Network (PAN)
Infrared

- IrDA: Infrared Data Association (1993):
- Standardized infrared-protocols
- Asynchronous, serial connections up to 115 kbit/s (Serial Infrared) or 4 Mbit/s (Fast Infrared)
- Point-to-Point
- Protocol-family for various purposes

- Exemplary applications:
  - Transmission of mobile business cards
  - Sales data extraction from cigarette vending machines
  - Connection between mobile and laptop
  - Wireless printing
  - Remote control for consumer electronics, e.g. TVs

Personal Area Network (PAN)

Infrared

- Attributes:
  - Wireless
  - Range of up to 10 meters
  - Illumination-angle 15° - 30°
- Disadvantages:
  - **Sounding:** If the infrared-ray misses the target
  - Optical connection required
  - Short interruptions of the optical connection, e.g. between laptop and mobile phone in trains, lead to complete network-interruption.

Personal Area Network (PAN)

Bluetooth

- Frequency range of 2.4 GHz
- Simple and cheap possibility to set up ad-hoc networks of limited range (up to 10 meters)
- No official standard, but de-facto-standard
- Consortium: Ericsson, Intel, IBM, Nokia, Toshiba, etc.
- Broadly supported by related industries:
  - Computer hardware
  - Software
  - Consumer electronics
  - …

Personal Area Network (PAN)

Popular Bluetooth Applications

Sound transmission
(to earphones, headphones
or Hi-Fi equipment)

Wireless communications between devices
(Bluetooth-Headset)

Personal Area Network (PAN)

Bluetooth Applications

- Connection of periphery-devices (headsets, keyboards, mice, etc.)
- Setting up of ad-hoc networks for spontaneous data exchange
- Ad-hoc connection of different networks (e.g. laptop ⇔ mobile or phone ⇔ GSM ⇔ net)
- Applications similar to applications based on infrared technology
- Weaknesses of infrared technology were overcome
  - Increased bandwidth (up to 865.2KBit/s)
  - No optical connection between devices necessary
  - Expanded range (up to 10m)
  - Allows setting up of ad-hoc networks instead of point-to-point connections

Personal Area Network (PAN)

Near Field Communication (NFC)

- Enables radio communication between
  - two NFC devices,
  - an NFC device and an (unpowered) tag.
- NFC based on existing radio-frequency identification (RFID) standards
- Range: 10 cm or less
- Transfer rates between 106 kbit/s and 424 kbit/s
- Three major modes of NFC
  - Reader/Writer Mode
  - Card Emulation Mode (referred to as "Digital Wallet")
  - Peer-to-Peer Mode

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