mobile business

Practical Exercise 3

Technology II

Mobile Business I (WS 2014/15)

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Literature

- This set of slides is based upon the following lectures:
  - ***Lecture 8:*** Smartcards and Related Application Infrastructures
  - ***Lecture 9:*** Mobile Devices
  - ***Lecture 10:*** Concepts of Mobile Operating Systems
  - ***Lecture 11:*** Market Overview of Mobile Operating Systems and Security Aspects

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Exercise 1: Smartcards

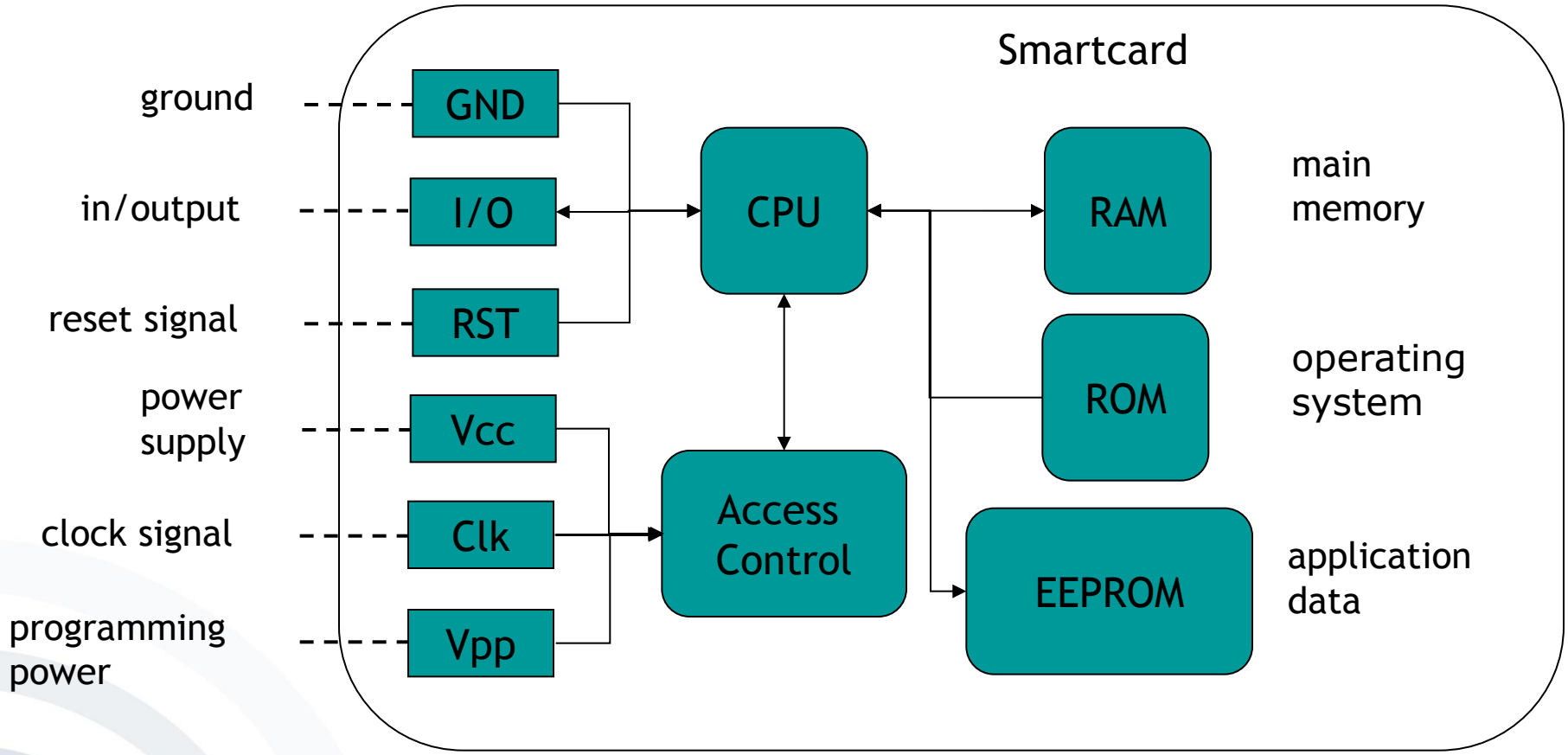
a) What are smartcards and what components do they consist of (=what do they contain)?

Smartcards

- Small computers with **memory**, **operating system**, **software**, **processor**, **I/O** and **access control**
- Chip **protected against manipulation**
- After being **initialised** with **keys** and other data smartcards are distributed to their users.

1a

Smartcards



1a

[Source: SecCommerce2002]

Exercise 1: Smartcards

b) Why are they used and what role do smartcards play with respect to
(i) security
(ii) applications?

Smartcards

- Used when **security** of data (e.g. for keys, signatures, physical access control, payment) is needed **in insecure environments**

- Examples:
  - Phone cards of Deutsche Telekom
  - Signature cards according to German Signature Law
  - Smartcard applications for PC
  - Smartcards for mobile communication (SIMs)

1b

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Smartcards – Examples

1b

Why Smartcards?

Protection needed against:

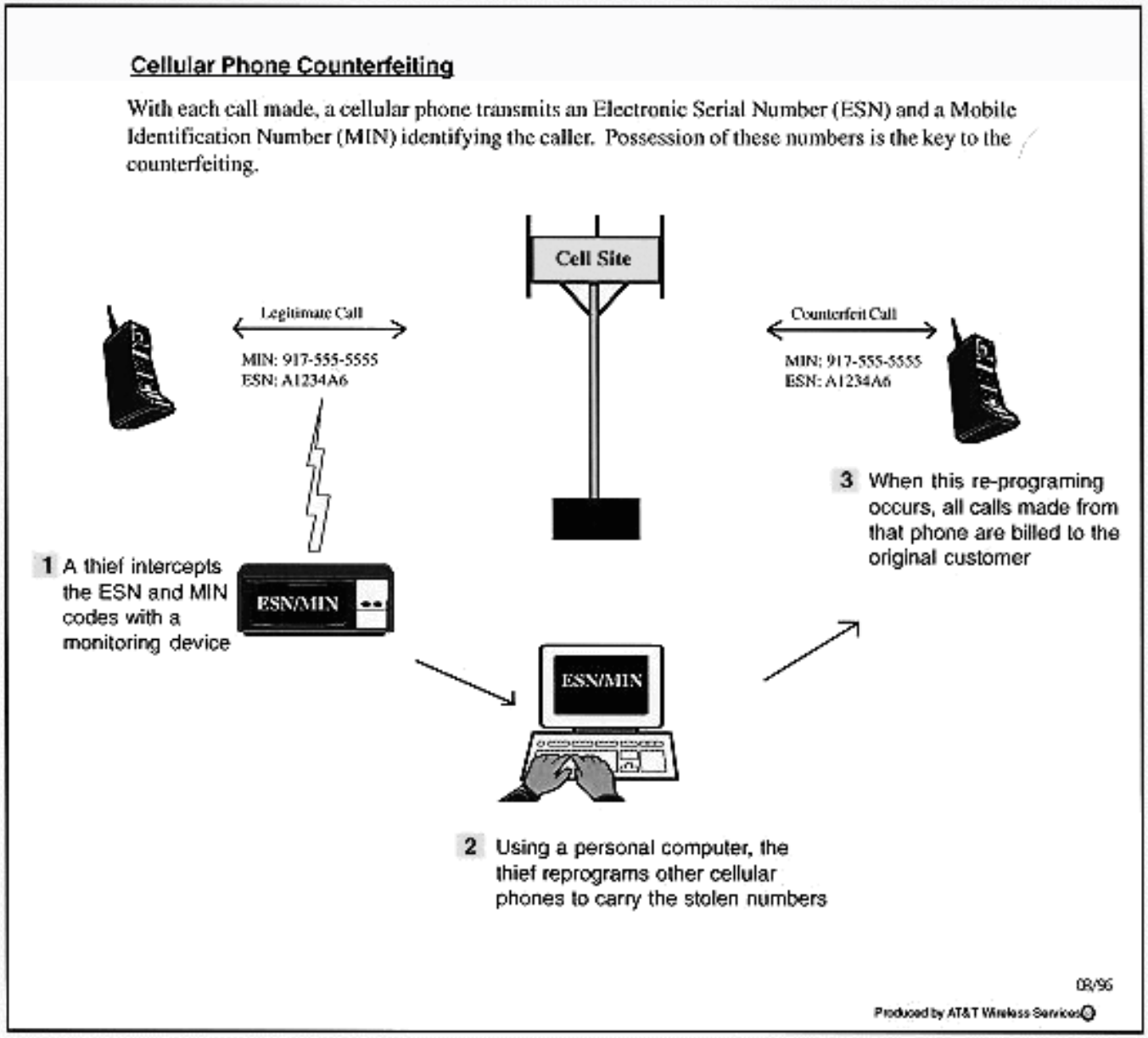
- Unauthorised usage of services through forged user data
- Duplication of a user's credentials
- „Cracking" of credentials
- Billing fraud

1b

CELLULAR COUNTERFEITING/CLONING FRAUD

Example for faulty system design (CDMA)

Duplication of intercepted user IDs



1b

Exercise 2: Subscriber Identity Module (SIM)

a) Name the most important function of the Subscriber Identity Module (SIM) in GSM and UMTS networks.

The Subscriber Identity Module (SIM)

- In GSM and UMTS since 1991, upcoming for WLAN
- **Represents** contract **between subscriber & network operator**
- Authorises **a "phone"** to **use** the network by linking it to a **subscription**
- By November 2014 more than **7.2 billion** mobile-cellular subscriptions [ITU2014, GSMAI2014]
- **More** countries with **SIM** infrastructure (219, 2013-Q3) **than** with **McDonald's** (118, 2013-Q3) and **more than UN** member states (193, 2013-Q3) [GSM2013, McDonalds2013, UN2013]
- More and more called "Subscriber **Identification** Module" to reflect progress in the general field of **Identity Management**

2a

Exercise 4: Subscriber Identity Module (SIM)

b) What does the Subscriber Identity Module contain? Which of these contents are protected, which are not and why?

SIM Card Content (Extract)

- Protected data:
  - IMSI, PIN, PUK
  - A3, A8 crypto algorithms
  - List of subscribed services
  - Language used by the subscriber
- Dynamic data:
  - Cell information
  - Frequency information
  - Dynamically generated (session) keys
  - Attributes of GSM login
  - User data (address book, telephone list, SMS memory)

2b

Exercise 2: Subscriber Identity Module (SIM)

c) Name other functionalities of the Subscriber Identity Module.

SIM: Functionality

- SIM serves as **„identity card“** for GSM cellular phone subscribers.
- SIM identifies the **issuer of the card** – important for the **billing of roaming subscribers** by roaming partner.
- SIM allows for **secure billing of roaming subscribers** through SIM-cryptography – important for card issuer.
- SIM contains additional **configuration data** of the GSM system.

2c

Smartcards for Mobile Communication

- **SIM**s are **Smartcards:**
  - **SIM cards** serve as security medium.
  - Tamper-resistance prevents counterfeiting.
  - robust design
- Contain **International Mobile Subscriber Identity (IMSI)** for subscriber identification and the key $\mathbf{K_i}$ provided by the mobile operator
- Reliably execute computational functions for the mobile device

2c

cf. [EffingRankl2002]

Exercise 2: Subscriber Identity Module (SIM)

d) What is SIM Application Toolkit?
   (i) What does it do?
   (ii) Name application examples for SIM Application Toolkit.

SIM: Integration into Mobile Phones

- **ETSI GSM 11.11** [GSM2006] specifies electrical as well as software interfaces between SIM and device.
- A **serial interface is** used for accessing the card.
- Communication through **SIM commands**
- Device can access **files** or execute **actions** through SIM commands.
- „SIM Application Toolkit“ allows for implementing of **additional applications** on a SIM.

2d

SIM Application Toolkit – SAT

- Provides an interface for **Value Added Services** implemented on **programmable SIMs** for interacting with mobile devices
- **Standardised** 1996 as ETSI GSM 11.14, extended 1999 [GSM2006]
- **Controls** I/O, Telephony, Download
- Allows for **security functionality**
- „Living standard“

2d

SAT – Application Examples

- **Mobile Banking** and **Brokerage**
  - T-Mobile and T-Online SMS banking
- **Secure payment** via cellular phone
- **Authentication** of users trying to access servers
- **Location-based services**
  - ATM search, navigation
- **Security applications in general**
  - Mobile signatures

2d

Exercise 3: Universal SIM/USIM

a) What is a USIM?

Universal SIM – USIM

- **Standardised** in 3GPP TS 21.111 and 3GPP TS 31.102 [GSM2006]
- **Successor** of SIM in 3G networks (but 3G networks are downward compatible to many SIMs)
- Supports different **„virtual“ USIMs** and **SIMs** on one cards – i.e. multifunctional smartcard
- Specified as **„UMTS-SIM“**, to support authentication, authorisation and computation of future services

3a

Exercise 3: Universal SIM/USIM

b) Name the innovations introduced with the USIM.

USIM – Visions of new Opportunities

- **Market entry** of USIM „disguised“ **as SIM**
  ➲ UMTS activated by operator
- **Multiple USIMs** – possibly **from competing providers** – can technically coexist on one card. Selection via menu on mobile device
  ➲ Reduction of operator switching cost

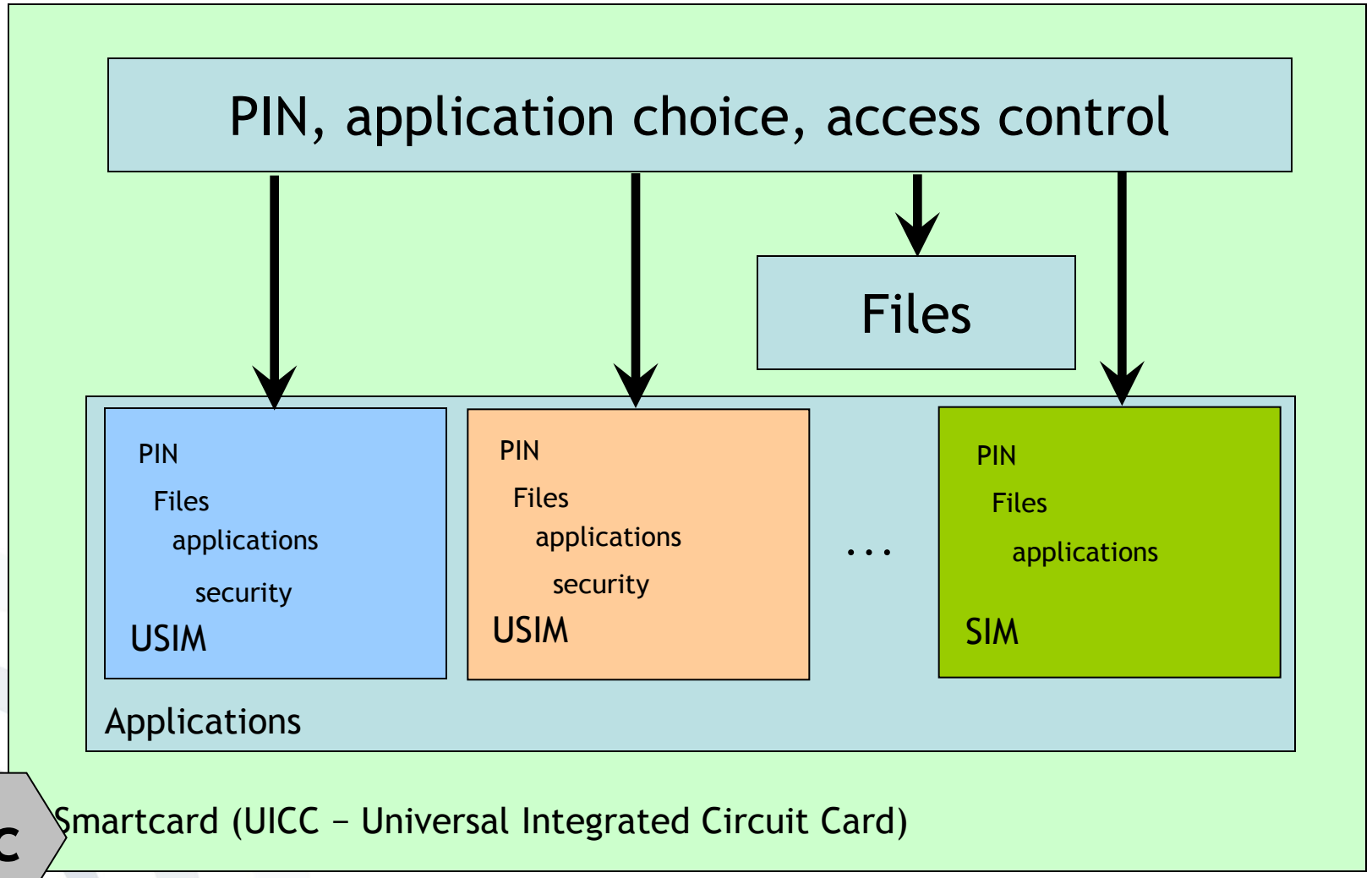
- Switching to anonymous prepaid USIM as a privacy option when using privacy sensitive services?

3b

Exercise 3: Universal SIM/USIM

c) What is a UICC and how do USIMs relate to a UICC?

USIM on UICC – Structure



3c

Exercise 3: Universal SIM/USIM

d) Describe market opportunities and effects of competing USIMs.

USIM – Innovations

- **Support for multiple applications**
- **End-to-end security** from the USIM to the application
- **Authentication of the network** towards the USIM via cryptography
  ➲ **Multilateral Security** is possible!
- **Downward compatible** to SIM
- **Extended phone book** on card:
  - Email addresses
  - Multiple names & numbers for each entry
  - More memory
  - Standardised entries

3d

Exercise 4: Mobile Devices

a) How can mobile devices be categorized?
   (i) Technical characteristics
   (ii) Application Aspects

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

4a

Categorisation of Mobile Devices

Technical Characteristics

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

4a

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

4a

Categorisation of Mobile Devices

Application Aspects 2

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

4a

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]

4a

Exercise 4: Mobile Devices

b) Name four components of mobile devices. Which two of these components do considerably determine the size of a mobile terminal?

Size of a mobile Device

- The size of a mobile terminal 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)

Exercise 4: Mobile Devices

c) Describe the functional architecture of a mobile device.

4

OS – Functional Architecture

Radio Link

Mobile Device

Radio Interface

User Interface

Application

Browser / Interpreter

Security

Operating System

NFC

Application

Browser / Interpreter

Keys, Certificates

Operating System

Smart Card

Global Positioning System (GPS)

PAN: Bluetooth, Infrared, …

Bluetooth

Infrared Data Association

Near Field Communication (NFC)

4c

Based on [Posegga2001]

Exercise 5: Personal Area Networks (PAN)

a) Personal Area Networks (PAN) – what are they good for, what do they do?

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)

5a

Exercise 5: Personal Area Networks (PAN)

b) Please do briefly describe the related technologies IRDA and Bluetooth. Name the advantages and disadvantages of both IRDA and Bluetooth.

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

5b

Personal Area Network (PAN)

Infrared-Transmission

- 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.

5b

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
  - …

5b

Bluetooth™

Personal Area Network (PAN)

Popular Bluetooth Applications

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

Wireless communications between devices
(Bluetooth-Headset)

5b

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

5b

a) What are the advantages and disadvantages of mobile operating systems unavailable to other device manufacturers?

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Mobile OS unavailable to other device manufacturers

- Originally, most mobile phone manufacturers used their own “closed” operating systems for their mobile devices.
- Later, more and more platforms switched to more open and interoperable operating systems (e.g. Windows CE, Symbian OS, Android).
- Some manufacturers (still) rely on own OS, e.g. RIM Blackberry OS, Apple iOS.
- ***Advantage:*** Tend to be not as much affected by malware than “open” operating systems
- ***Disadvantage***: Less flexible, as 3rd-party software cannot be easily installed and executed

6a

b) Name two mobile operating systems unavailable to other device manufacturers and two manufacturer-independent mobile operating systems.

Mobile OS unavailable to other device manufacturers

- Palm OS (Garnet OS)
  - Latest release: Most devices equipped with Palm OS 5.4
- Apple iOS (Unix-based)
  - Latest release: iOS 8
- BlackBerry OS
  - Latest release: BlackBerry OS 10.3
- Nokia Series 40, Asha
  - Latest release: Asha 1.4
- Samsung bada
  - Latest release: 2.0

6b

Manufacturer-independent mobile OS

- Linux: LiMo (Linux Mobile), Openmoko Linux, Qt Extended (Qtopia) 
- Symbian platform
  - Latest release: “Nokia Belle Feature Pack 2“ for Symbian^3 devices
- Android (by Open Handset Alliance) 
  - Latest release: 5.0 (Lollipop)
- Windows Mobile
  - Latest release: Windows Mobile 6.5.5
- Windows Phone
  - Latest release: Windows Phone 8.1
- Maemo (by Nokia) → MeeGo (by Nokia, Intel) → Sailfish OS (by Jolla) 
  - Latest release: Sailfish OS v1.1.0.39 (October 2014)
- Tizen (by Samsung, Intel, Linux Foundation) 
  - Latest release: 2.3 (November 2014)
- Firefox OS (by non-profit organisation Mozilla) 
  - Latest release: 1.4 (August 2014)
- China-Focused Mobile OS
  - Currently under development by Taiwan-based HTC [WSJ2013]

 = Linux-based

c) When mobile operating systems allow the execution of 3rd-party software, what are the threats resulting from this for the user?

Current Threats from Malware on Mobile OS

- Many mobile operating systems allow the execution of 3rd-party software:
  - Malware can be executed on mobile operating systems, either intentionally or by security leaks inside the mobile operating system (exploits).
- Possible threats for the user are:
  - Device malfunction
  - Loss of data (malware erasing data)
  - Loss of money (e.g. malware sending SMS to premium services)
  - Shorter battery runtime (more processing/resource usage)

6c

Beginnings of Mobile Malware

- *09/2000*: Liberty Horse Trojan
- *12/2000*: Telefonica SMS Mailer
- *08/2001*: Flooder sends unwanted SMS
- *09/2001*: Phage erases data on Palm devices
- *02/2003*: Nokia V-Card exploit
- *09/2004*: First Symbian OS malware
- …

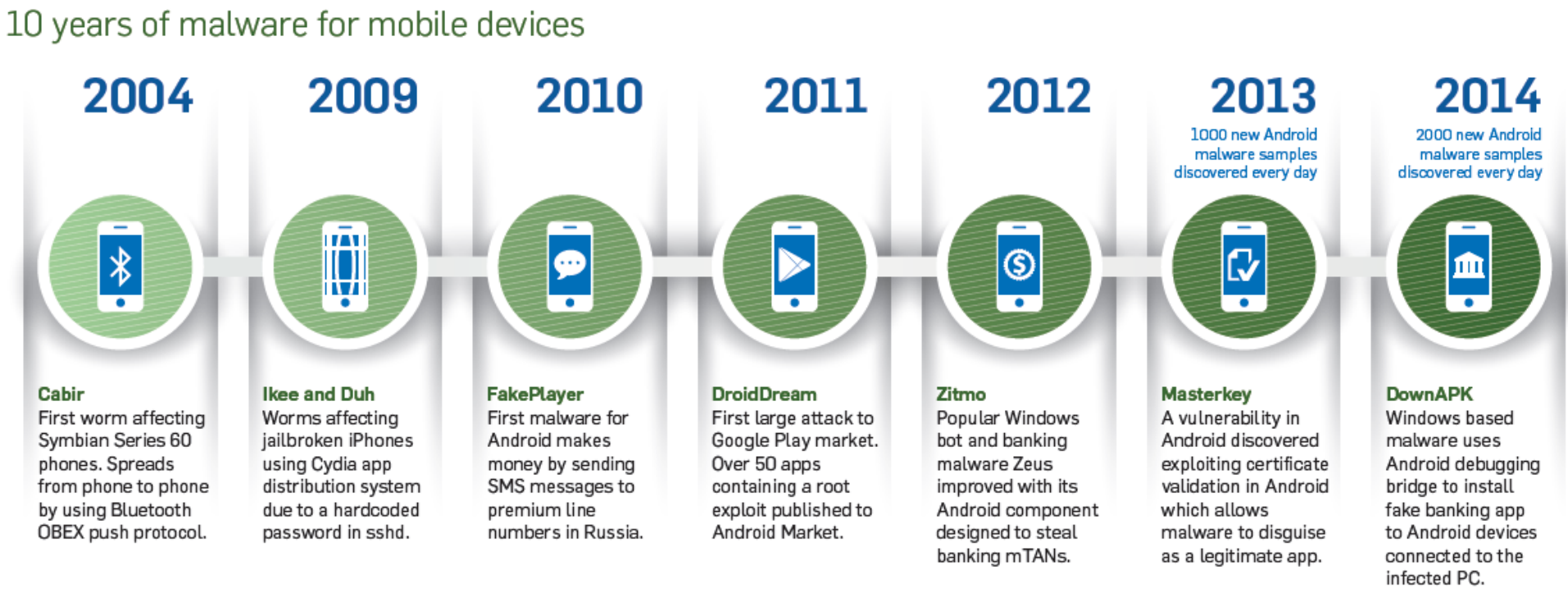
Strong growth of Mobile Malware

- The number of malware programs masquerading as legitimate mobile apps grew by more than 600 percent in 2012
- Most popular target: Android

[ATD2013]

6c

Timeline PDA/Mobile Threats



[Sophos2014]

6c

d) What are the security precautions and countermeasures available in mobile operating systems?

Security Precautions and Countermeasures

- Memory protection
  - Processes are not able to access the memory of other processes.
- File protection
  - Encryption
  - Access control
- Access controls
  - Definition of access rights and monitoring of their enforcement.
- Support for security modules
- Secure I/O
- Code integrity management: Integrity of programs is checked before the are started by e.g.
  - Checking certificates
  - Proof Carrying Code
- Additional Security Software may be needed, e.g.
  - Virus scanners
  - Firewalls

6d

Exercise 7: Concepts of Mobile Operating Systems

a) What is the primary goal and what is the secondary goal of an OS?

What is an operating system (OS)?

- An OS is a program that serves as a mediator between the user and the hardware.
- It enables the users to execute programs
- *Other properties:* Multi-user, multi-thread, high availability, real-time, …

- ***Primary goal of an OS***: Easy usage of the actual hardware
- ***Secondary goal of an OS***: Efficient usage of the hardware

7a

[SilberGalvin1999]

b) Name three functions of the operating system and state two examples (exemplifications) for each of these functions.

OS Functions

- Controlling and sharing of resources
  - Computation time, real-time processing
    “Who is computing how much? How long does it take?”
  - Memory (RAM, Disk)
    “Who gets which part of the memory?”

- Security functions
  - Protection of the data (memory, hard disk):
    “Who is allowed to access resources?”
  - Process protection (computation time, code, isolation):
    “Who is allowed to compute?”
  - Security module support

- Communication
  - Allocation of I/O-Resources
  - Processing of the communication
  - User interface (UI)

c) What is a process? What does it do, what does it use and how is the mobile operating system involved?

Process

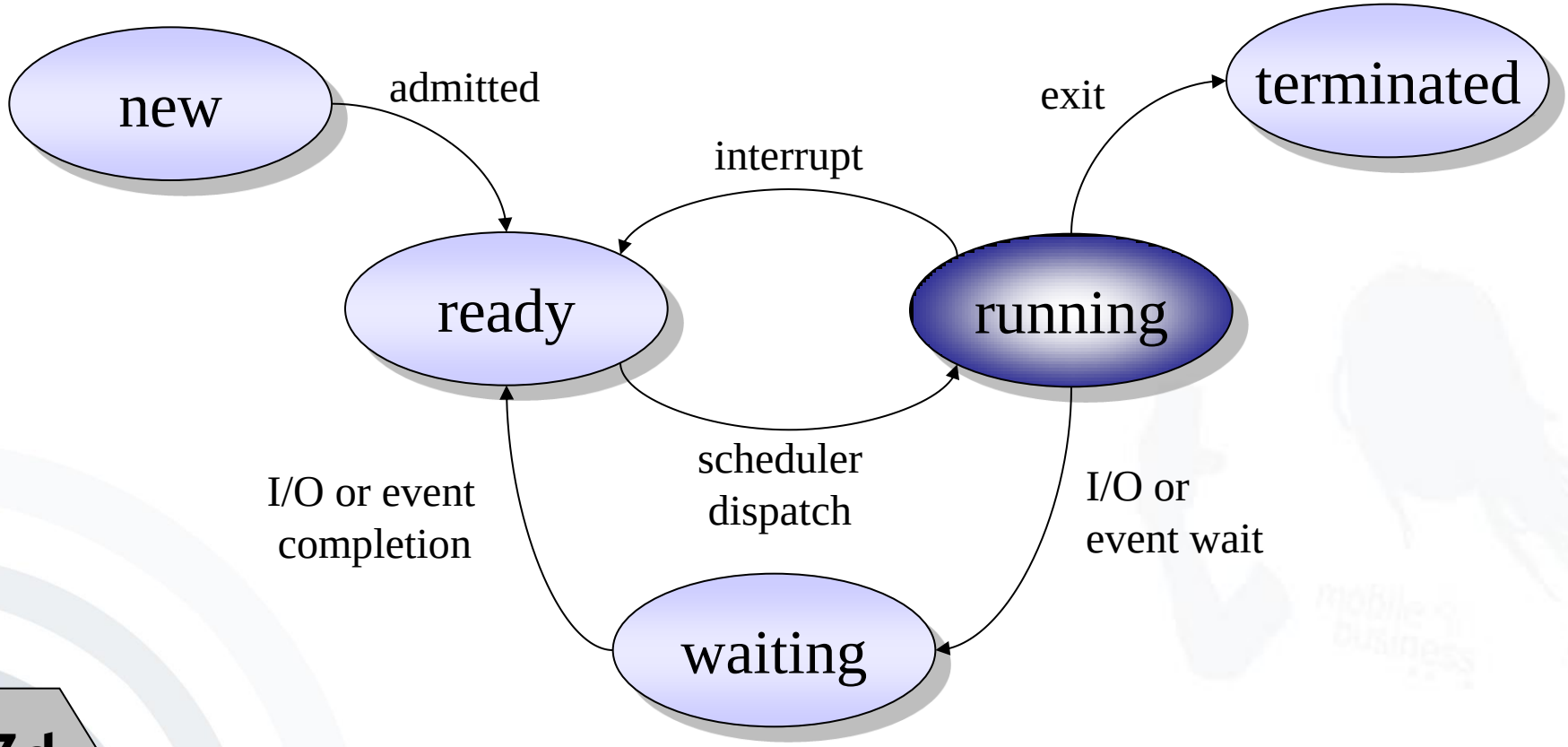
- A process is a program “in operation”.
- A process uses resources, such as CPU time, memory, files, and I/O devices.
- The resources of a process are allocated while it is created or when it is running.
- The operating system has to manage the process (creation, resource distribution, etc.).

Components of a Process

- More than simple code!
- Program counter: Indicates on which point in the code the process resides.
- Contents of the process registers:
  - ***Stack:*** Contains temporary data, such as subroutine parameters or return addresses, etc.
  - ***Data section:*** Contains the global variables
  - ***Heap:*** Dynamically allocated memory

d) Which are the states of a process?

States of a Process



7d

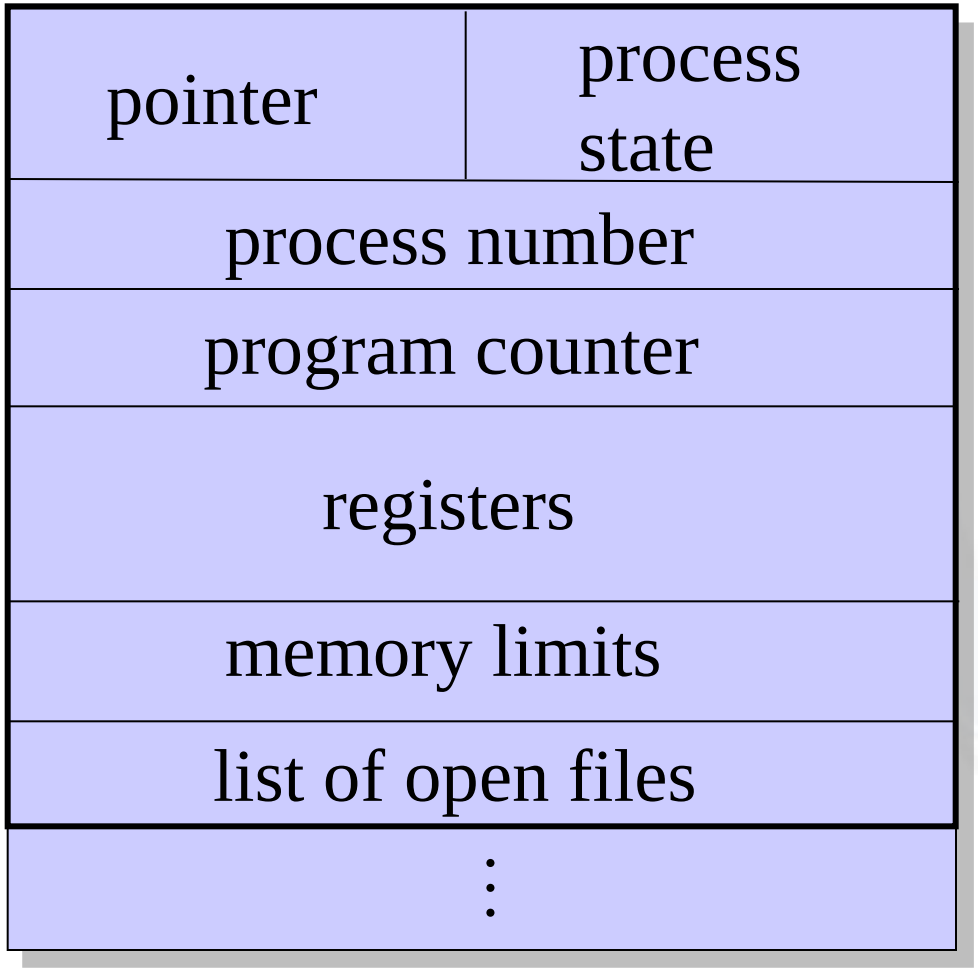
[SilberGalvin1999]

States of a Process

- **New:** Process is created.
- **Ready:** Process is waiting for being executed.
- **Running:** Process is running.
- **Waiting:** Process is waiting for results:
  - Completion of an I/O-operation
  - An event
- **Terminated:** Process is terminated.

Abstracted View on a Process: Process Control Block (PCB)

- Abstracted representation of the contents of a process control block (PCB), needed by an operating system.



[SilberGalvin1999]

7d

Abstracted View on a Process: Process Control Block (PCB)

- **Process State**: *new*, *ready*, *running*, *waiting*, …
- **Program Counter**: Address of the next command to be executed
- **CPU Registers:** Accumulator, Index Register, Stack Pointer and general registers
- **Information for:**
  - CPU-Scheduling
  - Memory-Management
  - Accounting
  - I/O Status

7d

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