mobile business

Lecture 8

Smartcards and Related Application Infrastructures

Mobile Business I (WS 2014/15)

Prof. Dr. Kai Rannenberg

Deutsche Telekom Chair of Mobile Business & Multilateral Security
Johann Wolfgang Goethe University Frankfurt a. M.

Overview

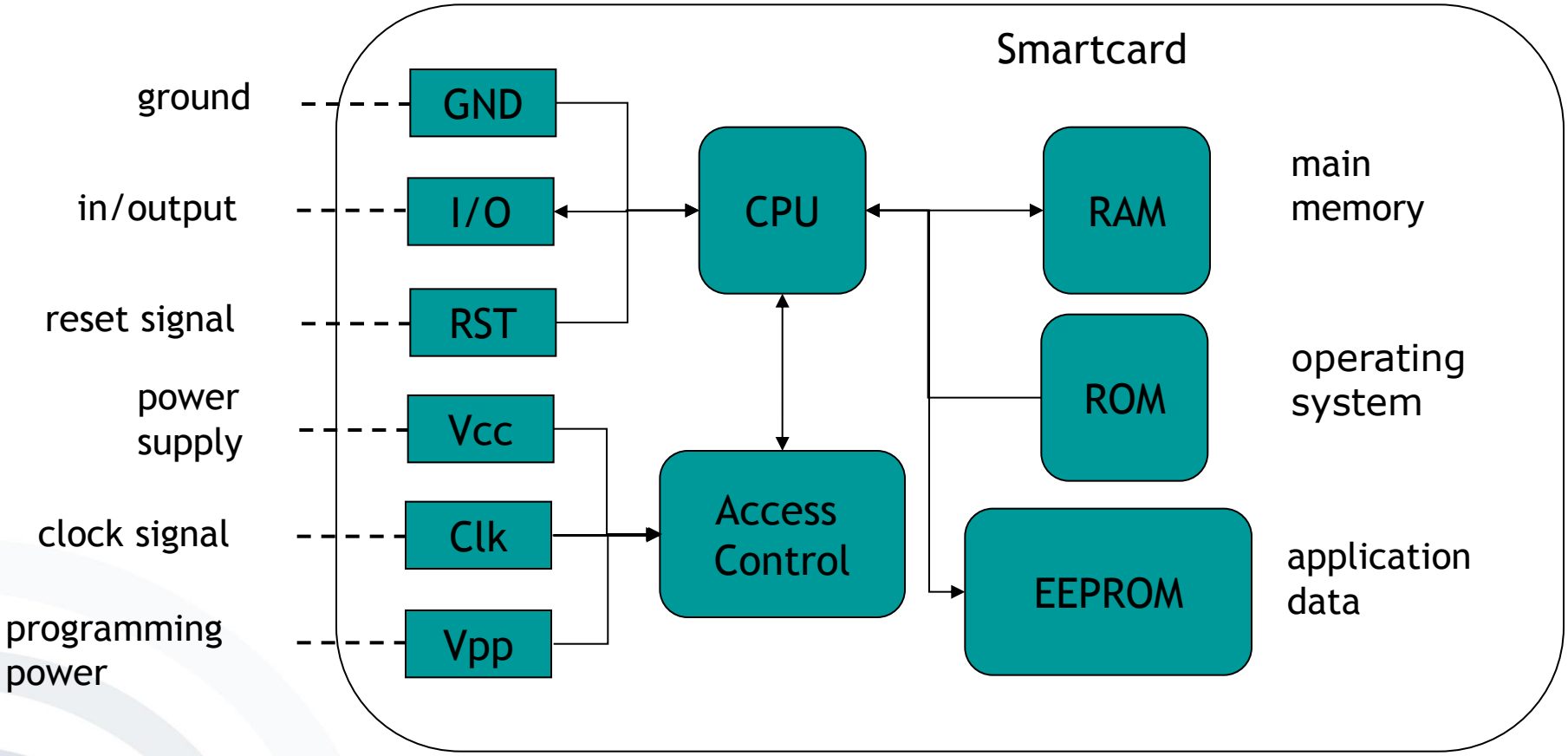
Smartcards and Related Application Infrastructures

- Smartcards – Introduction
- Subscriber Identity Module (SIM)
- WAP Identity Module (WIM)
- Universal SIM (USIM) and UICC
- IP Multimedia Services Identity Module (ISIM)
- New Applications — CamWebSIM

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.

Smartcards



[Source: SecCommerce2013]

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)

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Smartcards – Examples

Why Smartcards?

Protection needed against:

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

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Example for faulty system design (CDMA)

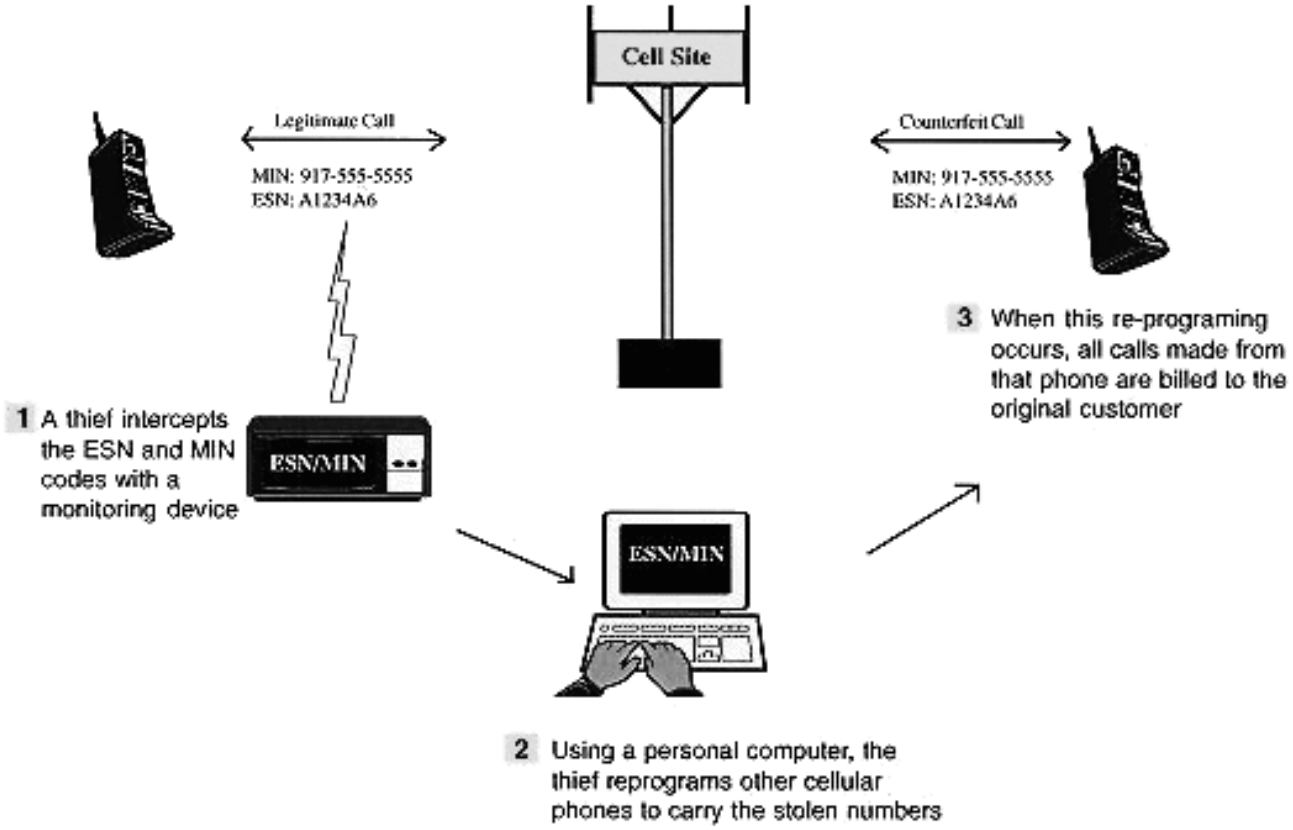
Duplication of intercepted user IDs

CDMA2000 overcame this by introducing the CSIM.

CELLULAR COUNTERFEITING/CLONING FRAUD

Cellular Phone Counterfeiting

With each call made, a cellular phone transmits an Electronic Serial Number (ESN) and a Mobile Identification Number (MIN) identifying the caller. Possession of these numbers is the key to the counterfeiting.



Overview

Smartcards and Related Application Infrastructures

- Smartcards – Introduction
- Subscriber Identity Module (SIM)
  - Functionality
  - Technology
  - SIM Application Toolkit (SAT)
- WAP Identity Module (WIM)
- Universal SIM (USIM) and UICC
- IP Multimedia Services Identity Module (ISIM)
- Applications — CamWebSIM

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**

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

cf. [EffingRankl2008]

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.

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)

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.
- Meanwhile SIMs are available in different **form factors**
  - Same size as 'regular' smart cards (Full-size, FF).
  - Mini-SIM (2FF) introduced circa 1996
  - Micro-SIM (3FF) introduced in 2010
  - Nano-SIM (4FF) introduced in 2012

[Wiki2014]

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“

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

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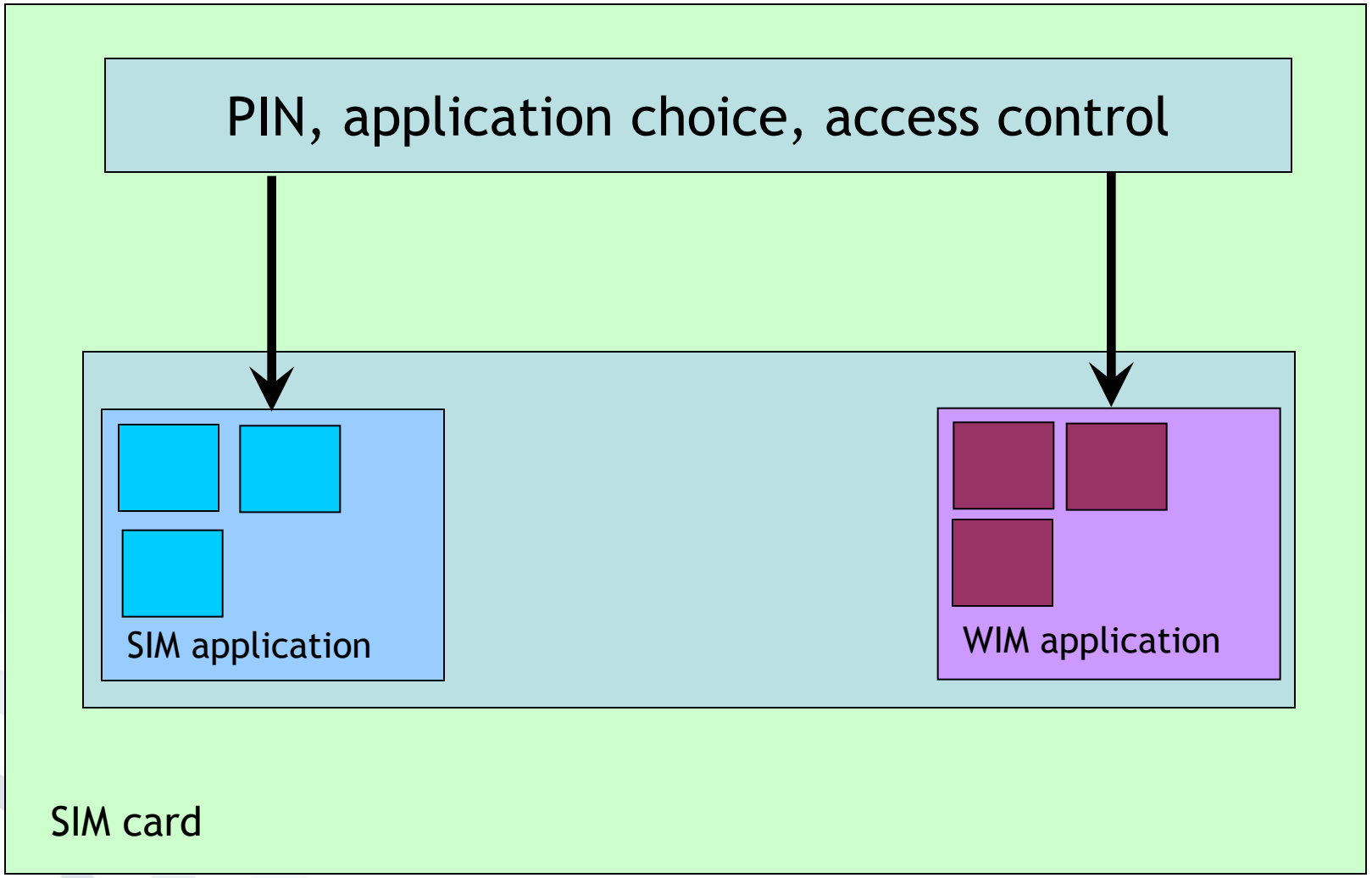
WIM – WAP Identity Module

- **WAP** is a protocol family implementation of Client/Server applications on mobile devices.
- Originally WAP did not provide sufficient **end-to-end security** for applications.
- The **WAP Identity Module (WIM)** should solve security problems raised by WAP.
- **WIM** is implemented as an **additional application** on a SIM.
- More and more called "**Wireless Identification** Module" to reflect progress in the general field of **Identity Management**

SIM / WIM – Structure



WIM – Security Functionality

- **Secure storage** for keys and certificates
- **Tamper resistance** of SIM based crypto algorithms
- **Standardised interface** to security functions (PKCS#15)
- **RSA signatures** are implemented on WIM

WIM in Real Life

- Not in widespread use
- Many demonstrations, including signature applications
- Smartcard manufacturers provide WIM as an option for SIMs (e.g. Gieseke & Devrient's StarSIM®).
- Till now no WIM has been certified as signature creation device as required by German "Signaturgesetz" (SigG).

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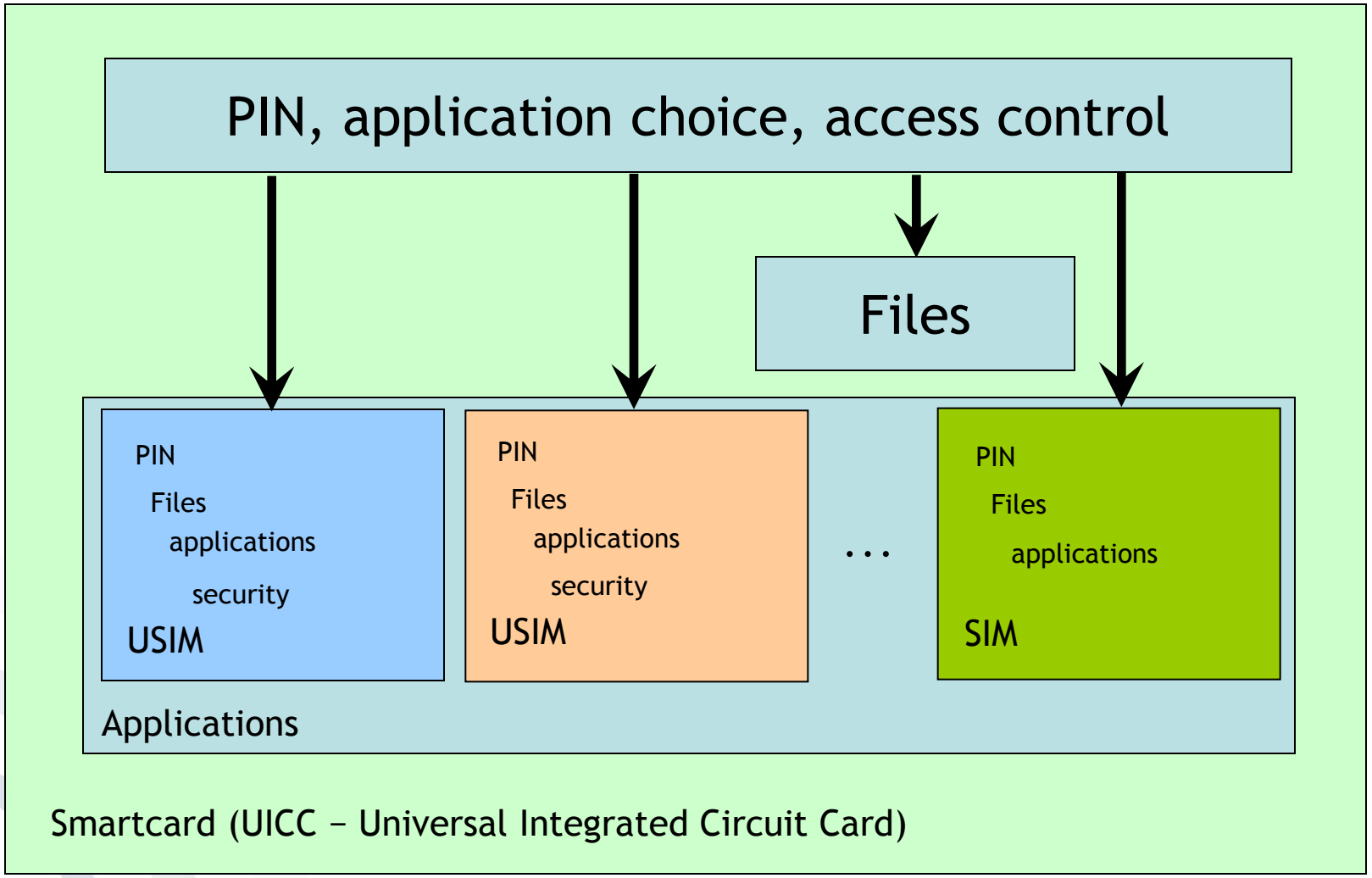
Universal SIM – USIM

- **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 card – i.e. multifunctional smartcard
- Specified as **„UMTS-SIM“**, to support authentication, authorisation and computation of future services

USIM on UICC – Structure



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

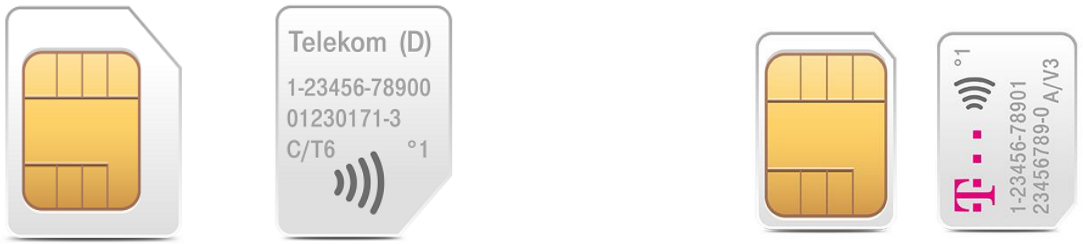
USIM – Visions of new Opportunities

- **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?

UICCs as Secure Elements

- Secure Elements (SE) are hardware tokens, that offer secure services, e.g. tamper-proof storage and cryptographic operations (cf. Lecture 12).
- UICCs are one form factor of a Secure Element (SE), enabling secure mobile applications and services.



[DTAG2014]

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ISIM

IP Multimedia Services Identity Module

- An **IP Multimedia Services Identity Module (ISIM)** is an application running on a UICC smart card in a 3G mobile telephone in the IP Multimedia Subsystem (IMS).
- It contains parameters for identifying and authenticating the user to the IMS.
- The ISIM application can co-exist with SIM and USIM on the same UICC making it possible to use the same smartcard in both GSM networks and earlier releases of UMTS.
- It is specified in 3GPP TS 31.103 [3GPP2013] and described in e.g. [GSM2006].

ISIM

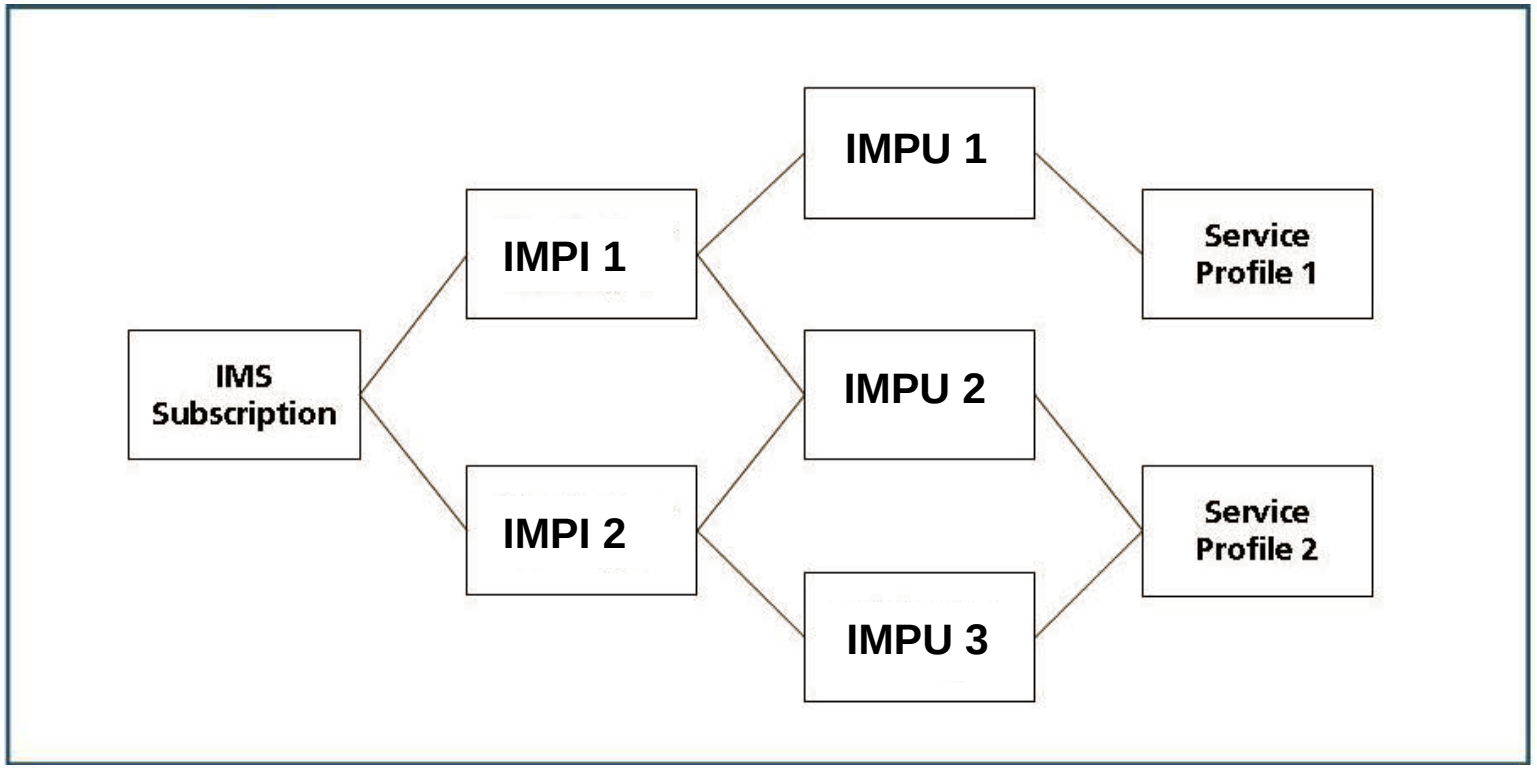
User Identifiers ("Identities") and Secret

- The ISIM contains:
  - One "IM Private Identity"
  - One or more "IM PUblic Identities"
  - A long-term secret used to authenticate and calculate cipher keys
- The IM **Private** Identity (IMPI)
  - Unique global identifier per IMS subscriber: username@operator.com
  - Assigned by the home network operator
  - Used for e.g. registration, authorisation, administration, and billing
  - Not accessible to the user
  - Only visible to control nodes inside the IMS
  - One ISIM application includes only one IMPI – but an IMS user may have several UICC cards carrying an ISIM application or a UICC card with several different ISIM applications.
- IM **PUblic** Identities (IMPUs)
  - Every IMS subscriber has one or more IMPUs, e.g. user@operator.com, or tel:+1-212-555-12345.
  - Used for requesting communications to other users
  - Visible to the outside, e.g. to be shown on a business card

- Service Profile
  - identifies the services a user may currently use such as video telephony, VoIP, Presence
  - defined and maintained in the Home Subscriber Server (HSS) of the subscriber's home network
- Home domain name
  - The ISIM application stores the home domain name of the subscriber securely.
  - This can not be changed or modified.

ISIM

IMPIs, IMPUs, and Service Profiles



- In case of more than one IMS subscription, there may be a many-to-many mapping of IMPIs to IMPUs.
- Each IMPU is assigned exactly one Service Profile, but a Service Profile may be assigned to more than one IMPU.

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A smaller personal security device

HTTP server (!) in the GSM SIM card

- A SIM based on the MS Smart Card can be programmed

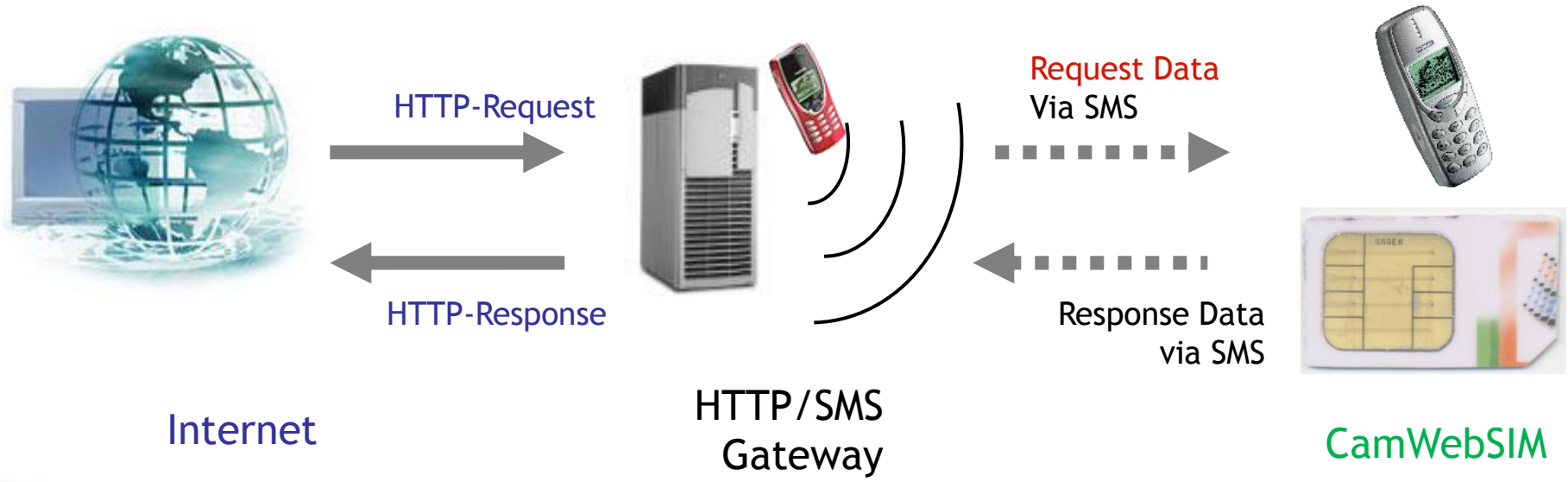
Connection between GSM and Internet

- HTTP Requests via HTTP/SMS Gateway to mobile phone

More than a cool demo …

- Explore the relation between PDAs and Smart Cards
  - What can really be done on the Smart Card?
  - Can Smart Card encrypt info to be stored in the PDA?
- Explore the possibilities of extra interaction channels
  - SMS in parallel to Internet
- Research Authorisation vs. Authentication vs. Identification

CamWebSIM
Combine Infrastructures



http://www.camwebsim.telco.com/+14253334711/dt=(Hello World)

SIM Addressing via HTTP

- Website
  - http://www.camwebsim.telco.com/
- Tel-No.
  - +14253334711/
- Command (SIM AT V 2.0 ++)
  - dt=(Hello World!)
  - LOCATION INFO **`info`**
  - SELECT ITEM **`si=(title,item1,item2,…)`**
  - DISPLAY TEXT **`dt=(text)`**
  - GET INPUT **`gi=(text)`**
  - MAIL NOTIFICATION **`mail=(who,subj,phone)`**
  - SIGN CHEQUE **`cq=(who,amount)`**

Website

Tel.-No.

Command

SIM based Payment Authorisation

.com.

WELCOME ADDRESS ITEMS WRAP SHIP PAY CONFIRM

- More Payment Channels
  - Telephone Bill
  - …

si=(Toys.com 3 Gimmicks, Pay $ 27.80, Cancel, Help)

Payment Authorisation live

HTTP-Request

HTTP-Response

Response Data
via SMS

Internet

HTTP/SMS
Gateway

CamWebSIM

www.camwebsim.telco.com/+14253334711/
si=(Toys.com 3 Gimmicks, Pay 27.80, Cancel, Help)

What have we done in this example?

- Technologywise
  - Connected a smart card to the Internet
    Goal: transparent, uniform access to smart card services
  - Used the mobile phone as a trusted device
    Assumed a secure path between SIM and display/keyboard
    ! This might be (more) dangerous with more complex phones
  - Used the existing GSM infrastructure and security model for payment authorisation
    User authentication key is stored in the SIM
  - …

What have we done in this example?

- Applicationwise
  - …
  - Used the existing GSM infrastructure and security model for payment authorisation
    User authentication key is stored in the SIM
  - *Provided a telecom with a new revenue channel based on an existing process*
    Telecoms as payment servers (the Teletext model)
  - *Enabled cash-like payment for Internet services*
    In countries where one does not need to register a name with a prepaid GSM account

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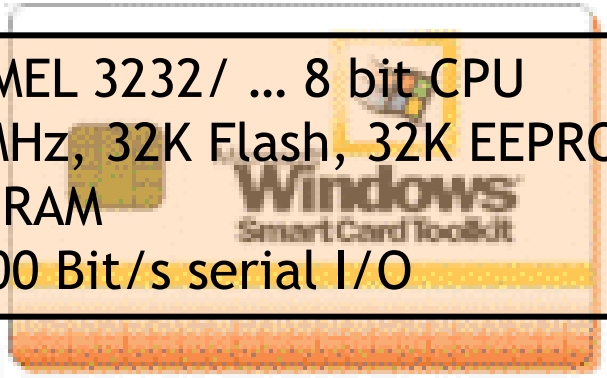
Technical Details and Issues (in 2001)

Microsoft Windows

ATMEL 3232/ … 8 bit CPU
5 MHz, 32K Flash, 32K EEPROM,
1K RAM
9600 Bit/s serial I/O



Sagem Smart Card

SMS limits

- No guaranteed delivery times
- 140 “real” Bytes just cover a 128 Bytes signed message ...
- ... and sometimes not even that
- We look forward to GPRS.

Space limits

- More than 32K in the chip would be helpful.

Phone capability limits

- SIM Application Toolkit Support is being interpreted widely …

SIM Addressing via HTTP indication application areas

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- Tel-No.
  - +14253334711/
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Tel.-No.

Command

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Literature

- [3GPP2013] 3GPP (2013), www.3gpp.org/ftp/Specs/html-info/31103.htm, accessed 2013-10-03
- [DTAG2014] Deutsche Telekom: SIM-Kartenformate, www.t-mobile.de/sim-kartenformate/0,27115,28905-_,00.html, accessed 2014-11-05.
- [EffingRankl2008] Effing, Wolfgang and Rankl, Wolfgang (2008) Handbuch der Chipkarten: Aufbau – Funktionsweise – Einsatz von Smart cards, Hanser-Verlag
- [GSM2006] GSM Specification, www.3gpp.org/ftp/Specs/archive, accessed 2013-10-03
- [GSM2013] GSM Association (2014), GSM Technology, www.gsma.com/aboutus/gsm-technology/gsm, accessed 2014-09-03
- [GSMAI2014] GSMA Intelligence, http://gsmaintelligence.com, accessed 2014-09-03.
- [ITU2014] International Telecommunication Union, www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf, accessed 2014-09-03
- [McDonalds2013] McDonald's Corporation (2013), www.aboutmcdonalds.com/mcd/our_company.html, accessed 2013-10-10

Literature

- [SecCommerce2013] SecCommerce (2013), Überblick über Smartcards, www.seccommerce.de/de/component/content/article/39-root-de/knowledge/technology/122-smartcard-architecture.html, accessed 2013-10-10
- [UN2013] United Nations (2013), www.un.org/en/members/index.shtml, accessed 2013-10-10
- [Wiki2014] Subscriber identity module, en.wikipedia.org/wiki/Subscriber_identity_module#Formats, accessed 2014-11-06