

Winter Semester / Summer Semester .....

Matriculation number: .....(Please also record this on each answer sheet in the top right corner!)

Subject: Mobile Business 1 (MOB1)

Held by: Prof. Dr. Kai Rannenber

**Important: with your signature on the signature list you confirm to observe the following examination requirements**

- You have read the follow text and agree to all points.
- You feel healthy and able to participate in the examination.
- You have informed yourself in the examination regulations regarding the participation of exams.
- You have taken notice that you are responsible to hand in your examination orderly before you leave the examination room. This includes that you remain quietly seated until all examinations have been counted and it is determined that all examinations have been submitted.
- Only the resources and aids listed on the examination paper are allowed.
- Carrying mobile phones or other electronic communication devices during the exam is forbidden. Violating this rule will be counted as an attempt to cheat.
- Please leave sufficient space in the margin for marking, please do **not** write with a **pencil** or **red ink**.

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1. Please record this in writing including your signature on your examination documents and inform an invigilator immediately.
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Please leave free for marking purposes!

Question:	1	2	3	4	5	6	7	8	Sum
Points:									

Points ..... Grade: .....

Examiner Signature: .....

**Question 1: Market structure and value creation (18 points)****1 A) English:**

There are several players in the mobile business market. Describe the functions of each of the following: Service Provider, Content Provider, Device Manufacturer and Network Operator. **(4 points)**

**Deutsch:**

*Es gibt mehrere Akteure im Mobile Business-Markt. Beschreiben Sie jeweils die Funktionen der folgenden: Dienstanbieter, Inhaltsanbieter, Gerätehersteller und Netzbetreiber. (4 Punkte)*

- Device manufacturers: manufacture and distribute mobile terminals and/or network equipment.
- Network operators: operate mobile networks and provide access.
- Service providers: provide different kinds of services, e.g. billing and customer management, acquisition of customers, advertising campaigns...
- Content providers: provide information to customers: banks, shops, media-companies, "game-stations"...

**(1 point each, max. 4 points)**

**1 B) English:**

There are different types of Mobile Virtual Network Operators. Name and explain three types! You can use examples for your explanations. **(6 points)**

**Deutsch:**

*Es gibt verschiedene Arten von virtuellen Mobilnetzbetreibern. Nennen und erläutern Sie drei Arten! Sie können Beispiele für Ihre Erläuterungen verwenden. **(6 Punkte)***

- Subsidiary company – established by a known mobile phone operator (e.g. Simyo, BASE, Ay Yildiz).
- OEM/Branding-products – use the name and the marketing channels of already established brands to address their client base (e.g. Tchibo Mobil, Aldi Talk,...).
- Resellers – offer contracts without owning a network infrastructure but for a large scope they provide the services of the value chain on their own (e.g. the integration of services, the billing, order processing and customer care services) (e.g. mobilcom debitel).
- Full-MVNOs – they operate parts of the network infrastructure (e.g. Callax, vistream, Turkcell).

**(1point per naming, 1point per explanation, max. 6 points)**

**1 C) English:**

Mobile Network Operators in the German market often have similar pricing structures. Also, Mobile Virtual Network Operators have similar pricing structures within their discount market segment.

- (i) What is the reason for this market situation? **(1 point)**
- (ii) Which concept of economics describes this market situation? **(1 point)**
- (iii) Explain the concept and apply it on the market situation described above with regard to the operators' pricing structure. **(6 points)**

**Deutsch:**

Mobilnetzbetreiber im deutschen Markt haben oft ähnliche Preisstrukturen. Auch virtuelle Mobilnetzbetreiber haben ähnliche Preisstrukturen innerhalb ihres Discount-Marktsegments.

- (i) Was ist der Grund für diese Marktsituation? **(1 Punkt)**
- (ii) Welches ökonomische Konzept beschreibt diese Marktsituation? **(1 Punkt)**
- (iii) Erklären Sie das Konzept und wenden Sie es auf die oben beschriebene Marktsituation im Hinblick auf die Preisstruktur der Betreiber an. **(6 Punkte)**

Market structures can be described with regard to the roles of MNOs and/or MVNOs. Whether these aspects are mentioned in (i), (ii) or (iii) and structured accordingly is not relevant. (max. 8 points in total)

- (i) Few MNOs, many customers. **(1 point)**

By the market entry of MVNOs, the mobile market has changed: few middle-sized providers (MNOs) and many small providers (MVNOs). **(1 point)**

- (ii) Heterogeneous oligopoly of MNOs. **(1 point)**

Competitive market of MNOs and MVNOs. **(1 point)**

- (iii) A heterogeneous oligopoly is a market form, in which a market or industry is dominated by a small number of middle-sized sellers with heterogeneous products and many (small-sized) customers. **(1 point)**

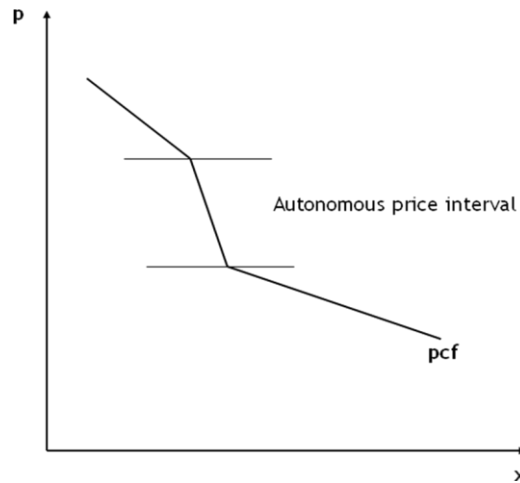
A competitive market is a market form in which a market or industry is dominated by many small-sized sellers with homogeneous products and many small-sized customers. **(1 point)**

There is an autonomous price interval, in which the respective MNOs can operate: **(1 point)**

- Without losing customers or *Mobile Virtual Network Operators* to the business competition due to rise in price. **(1 point)**
- Without acquiring customers from business competition due to cut in price. **(1 point)**
- **OR:** Within this price interval only latent increase and loss of demand, e.g. because of switching costs. **(2 points)**
- Prices above price barrier lead to latent and fluctuating loss in demand. **(1 point)**
- Reduction in price below the barrier lead to latent increase in demand. **(1 point)**

- **OR:** Leaving the price interval leads to migration of customers as long as competition do not change prices (partial independency). (2 points)

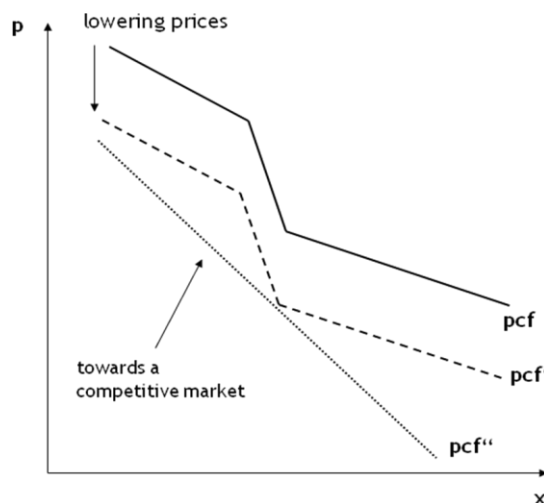
Depiction of the price-consumption function in a heterogeneous oligopoly: (max. 5 points)



Increasing number of sellers (MNOs and MVNOs) in an oligopolistic market causes tendency towards competitive market: (2 points)

- The price converges to the marginal costs. (1 point)
- The output converges to the economically efficient level. (1 point)
- Lower MVNO prices due to lower service costs of MVNOs. (1 point)

Depiction of the MVNO driven change of the price-consumption function: (max. 5 points)



## Question 2: Business models (14 points)

### 2 A) English:

A business model is an abstract description of a business. It contains the value proposition, the value creation architecture and the revenue model. Explain and distinguish the value proposition from the value creation architecture and provide an example related to the mobile communications market. (8 points)

### Deutsch:

Ein Geschäftsmodell ist eine abstrakte Beschreibung einer Unternehmung. Es enthält das Wertangebot, die Wertschöpfungsarchitektur und das Erlösmodell. Erklären und unterscheiden Sie das Wertangebot von der Wertschöpfungsarchitektur und geben Sie ein Beispiel im Zusammenhang mit dem Mobilkommunikationsmarkt. (8 Punkte)

### Value Proposition:

A business model contains a description of what the benefit can be for customers or other partners by association with the respective business. This part of the business model is called value proposition. (2 points)

It deals with the question:

What is the benefit of the business for the partner/customer? (1 point)

### Value creation architecture:

At the same time a business model is a value creation architecture, visualizing how the benefit can be generated for the customers. This architecture contains a description of the different stages of value creation. (2 points)

It deals with the question:

How is the output generated in which configuration? (1 point)

### Example: Classical Business Models for Mobile Network Operators

#### Value proposition:

Offering and marketing of mobile data, communication and/or mobile services.

#### Value creation architecture:

- Provision of mobile data communication
- Provision of content
- Production of content
- Purchase and adaption of content

➔ Combination of service offers (2 points)

**2 B) English:**

Explain the concept of differential pricing and provide an example that shows the influence of different customers' willingness to pay. Point out the preconditions for differential pricing. Name one of the dimensions usually used to differentiate prices within mobile business? **(6 points)**

**Deutsch:**

Erklären Sie das Konzept der differenzierten Preisgestaltung und geben Sie ein Beispiel, das den Einfluss von unterschiedlichen Zahlungsbereitschaften von Kunden darstellt. Nennen Sie die Bedingungen für differenzierte Preisgestaltung. Nennen Sie eine der Dimensionen, die üblicherweise verwendet wird, um Preise im Mobile Business zu differenzieren? **(6 Punkte)**

Differential Pricing (Definition): offering the same product (or products with small variations) to different consumer segments at different prices. **(1 point)**

Example:

▪ Example	
Consumer	WTP
A	8 €
B	5 €

Uniform Price: 5 €  
Profit: 10 €

Differentiated Prices:  
8 € for A and  
5 € for B  
Profit: 13 €

**(2 points)**

Preconditions:

- Segmentation / separation must be possible. **(1 point)**
- Different WTP among segments. **(1 point)**

Dimensions:

- Time based
- Location based
- ...

**(1 point for naming one dimension, max. 1 point)**

**Question 3: Diffusion of technology (13 points)****3 A) English:**

The Diffusion of Innovations theory describes the process by which an innovation is adopted by a social system, e.g. a market, and different stages of the adoption process. Name and explain the stages. **(5 points)**

**Deutsch:**

Die Theorie der Diffusion von Innovationen beschreibt den Prozess, mit dem eine Innovation von einem sozialen System, z.B. einem Markt, adoptiert wird und die verschiedenen Phasen des Adoptionsprozesses. Nennen und erläutern Sie die Phasen. **(5 Punkte)**

The adoption of an innovation includes the following stages:

- Knowledge: learning about the existence and function of the innovation.
- Persuasion: becoming convinced of the value of the innovation.
- Decision: committing to the adoption of the innovation.
- Implementation: putting it to use.
- Confirmation: the ultimate acceptance (or rejection) of the innovation.

**(1 point each, max. 5 points)**



**3 B) English:**

The Theory of Reasoned Action posits that individual behavior is driven by behavioral intentions. Explain the Theory of Reasoned Action and its limitations. Draw the schematic description of the Theory of Reasoned Action. (8 points)

**Deutsch:**

Die Theorie der begründeten Handlung postuliert, dass das individuelle Verhalten durch Verhaltensabsichten getrieben wird. Erklären Sie die Theorie der begründeten Handlung und ihre Einschränkungen. Zeichnen Sie die schematische Darstellung der Theorie der begründeten Handlung. (8 Punkte)

Explanation:

- **Behavioural intentions** are a function of an individual's attitude towards the behaviour and the subjective norm surrounding the performance of the behaviour.
- **Attitude towards the behaviour** are the individual's positive or negative feelings about performing a behaviour, determined through an assessment of one's beliefs.
- **Subjective norm** is defined as an individual's perception of whether people important to the individual think the behaviours should be performed.
- **Behaviour is the actual behaviour of the user.**

Limitations:

- Significant risk of confounding between attitudes and norms since attitudes can often be reframed as norms and vice versa.
- Assumption that when someone forms an intention to act, they will be free to act without limitation, is often unfounded.
- In practice, constraints such as limited ability, time, environmental or organisational limits, and unconscious habits will limit the freedom to act.

(1 point for each bullet point, but max. 6 points)

Schematic:



(2 points for schematics)

**Question 4: Mobile network technologies (12 points)****4 A) English:**

Several technologies for the use of mobile data in GSM and 3G mobile networks have evolved over time. In order to increase general speed and available bandwidth, new LTE (Long Term Evolution) networks, which are currently being rolled out (=built up) in Germany and other countries, play an important role. As a subscriber of an LTE service, would you expect to always have the maximum downlink transmission rate available for your connection? If not, what reasons can you think of with respect to the characteristics of cell-based communication? **(4 points)**

**Deutsch:**

*Im Laufe der Zeit wurden verschiedene Technologien zur Übertragung mobiler Daten über GSM- und 3G-Netze entwickelt. Neue LTE (Long Term Evolution)-Netze spielen eine wichtige Rolle bei der Absicht, Übertragungsgeschwindigkeit und verfügbare Bandbreite allgemein zu erhöhen. Diese Netze werden derzeit in Deutschland und anderswo ausgerollt (=aufgebaut). Würden Sie erwarten, dass Sie als Nutzer eines LTE-Mobilfunknetzes immer mit der maximal möglichen Datenrate Daten herunterladen zu können? Falls nicht, aus welchen Gründen? Berücksichtigen Sie bei Ihren Überlegungen die Eigenschaften zellbasierter Mobilkommunikation. **(4 Punkte)***

Effective transmission rate depends on several factors:

- signal quality varies depending on users' location
- number of other users in the same cell: like other radio-based networks, LTE is also a "shared medium" meaning that all users in an LTE cell share the available bandwidth
- number of cells within reach
- ...

As a result:

- bandwidth can be seen as a limited resource.
- data throughput can vary.
- ...

**(1 point each, max. 4 points)**

**4 B) English:**

Targets for LTE coverage in rural areas (in the countryside) are an important element of the license requirements by the German regulation authority BNetzA (Bundesnetzagentur) to improve coverage in rural areas where fast ADSL, fiber and cable Internet connections are hard to get or unavailable. Explain your position on the following point: Will radio-based networks be able to meet demand for broadband Internet in these areas? Can they deliver a service comparable with fixed-line connections such as ADSL, fiber and cable Internet regarding stability, service availability, bandwidth and data throughput? **(8 points)**

**Deutsch:**

*Die Vorgaben der Bundesnetzagentur(BNetzA) zur Abdeckung ländlicher Gebiete mit LTE-Netzversorgung sind ein wichtiger Bestandteil der Lizenzauflagen an die Netzbetreiber, um die Abdeckung gerade in den Gebieten zu verbessern, in denen*

*kaum oder keine ADSL-, Glaserfaser- oder Kabelinternetanschlüsse verfügbar sind. Erklären Sie Ihren Standpunkt zu der folgenden Frage: Werden Mobilfunknetze dazu in der Lage sein, die Nachfrage nach breitbandigen Internet-Anschlüssen in diesen Gebieten zu befriedigen? Können Mobilfunknetze eine mit dem Festnetz (ADSL-, Glaserfaser- und Kabelinternet) vergleichbare Servicequalität zur Verfügung stellen hinsichtlich Stabilität, Verfügbarkeit, Bandbreite und Datendurchsatz? (8 Punkte)*

Is is a great challenge for radio-based networks to deliver a service comparable with fixed-line connections.

- Fixed lines, esp. fiber connections, are capable of offering a higher data rate and throughput than radio-based networks.
- Fixed lines have a higher availability and stability than radio-based (weather conditions etc.)
- Setup of necessary radio-based infrastructure is expensive, especially in rural areas with no previous infrastructure.
- Providing a very high data rate and availability all-over with no or few interruptions requires a very high number of base stations and high investment
- In some cases though, radio-based networks may offer a higher data rate, e.g. if fiber is unavailable and ADSL does not work very well because of a long copper phone line to the subscriber (local loop).
- Radio-based networks such as LTE are a shared medium, not all users can enjoy maximum capacity at all times, number of users therefor plays an important role
- Demand for and usage of radio-based networks in places without fixed-line alternatives can be high
- User's distance to base station has impact on achievable data rate
- ...

(1 point each, max. 8 points)

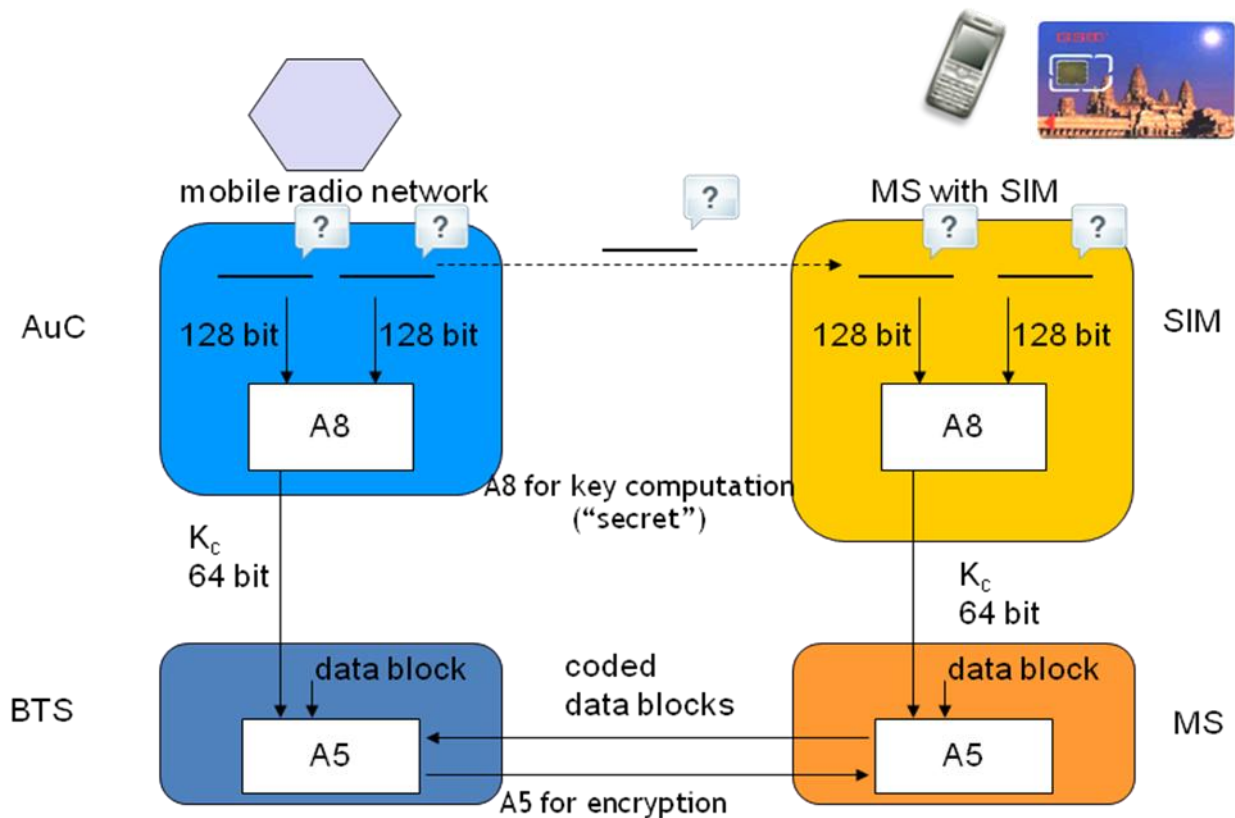
## Question 5: GSM security (11 points)

### 5 A) English:

GSM provides encryption of voice and data transferred via the air interface. The following illustration shows how this is done. However, important information is missing. Five question marks indicate lines with missing information – please add the missing information to the figure on these five lines and give a detailed step-by-step description of how the encryption of voice and data transferred is achieved (five steps). (10 points)

### Deutsch:

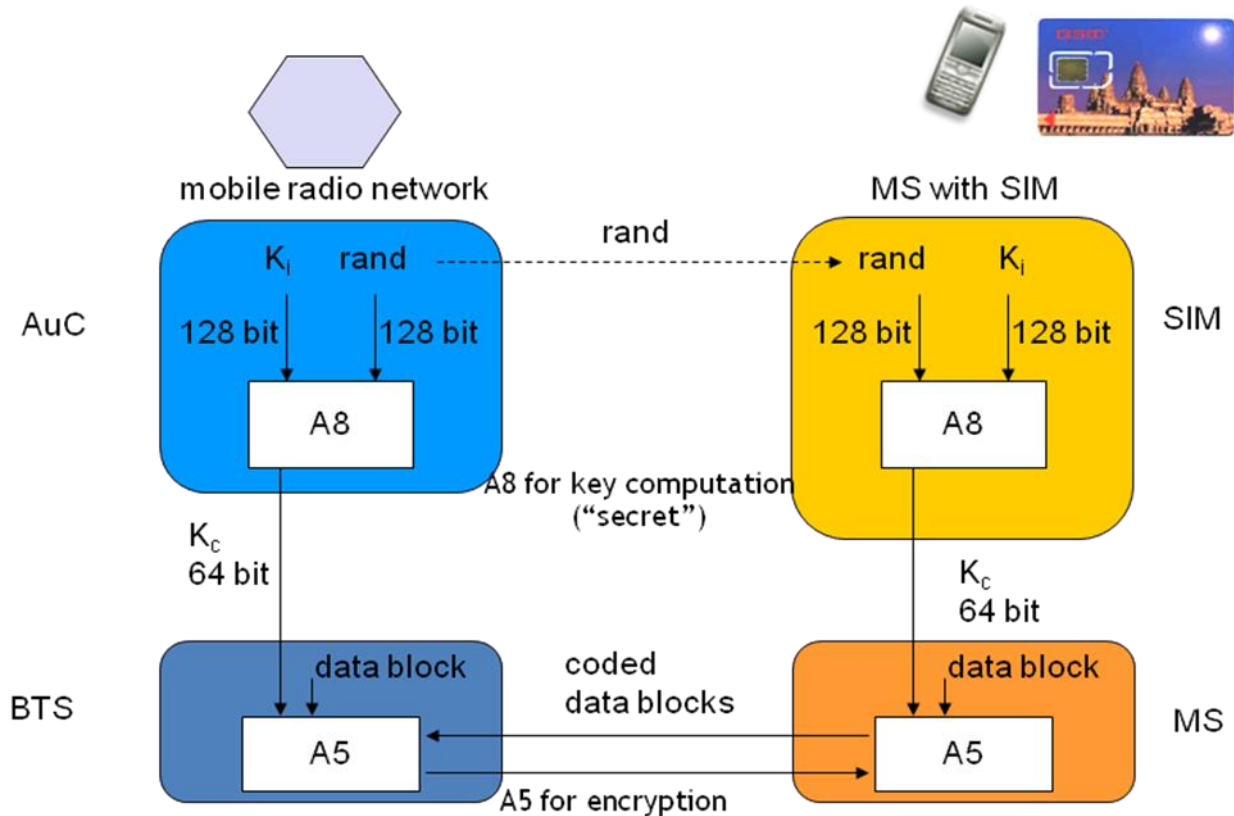
GSM ermöglicht die Verschlüsselung von Sprache und Daten, die über die Luftschnittstelle übertragen werden. Das folgende Schaubild zeigt wie das geschieht, allerdings fehlen wichtige Informationen. Die insgesamt fünf Auslassungen sind mit Fragezeichen markiert. Bitte vervollständigen Sie das Schaubild an den fünf Auslassungen und erklären Sie anschließend ausführlich und schrittweise den genauen Ablauf (fünf Einzelschritte). (10 Punkte)



1. AuC creates random number rand.
2. AuC generates the key  $K_c$  for the encryption of the transferred data via rand,  $K_i$  and A8.
3. From the two pieces of information VLR transfers only the rand to the SIM.

4. SIM computes the key  $K_c$  using A8, the rand received, and the local  $K_i$
5. Mobile station and mobile radio network use generated  $K_c$  and algorithm A5 for encryption and decryption of sent and received data.

(1 point per question mark (max. 5 points), 1 point per correct step (max. 5 points))



**5 B) English:**

Are the following statements true or false? (0,5 points per correct answer, 1 point added up)

**Deutsch:**

Sind die folgenden Aussagen wahr oder falsch? (0,5 Punkte für jede korrekte Antwort, insgesamt 1 Punkt)

**English:**

Subscriber localization in GSM networks can be avoided by end-to-end encryption.

**Deutsch:**

Teilnehmerlokalisierung in GSM-Netzen lässt sich durch den Einsatz von Ende-zu-Ende-Verschlüsselung verhindern.

☐ true / wahr

☐ false / falsch

**English:**

In GSM networks, in order to protect the anonymity of the users against third-parties, temporary user identification is used.

**Deutsch:**

*Um gegenüber Dritten die Anonymität der Nutzer zu schützen wird in GSM-Netzen temporäre Nutzeridentifikation verwendet.*

☐ true / wahr      ☐ false / falsch

(0,5 points per correct answer, max. 1 point)

## Question 6: Mobile operating systems (13 points)

**6 A) English:**

Name three Mobile Operating Systems that are device manufacturer-independent. (3 points)

**Deutsch:**

*Nennen Sie drei geräteherstellerunabhängige mobile Betriebssysteme. (3 Punkte)*

**Lösung:**

- Symbian platform (by Symbian Foundation)
- Embedded Linux
- Android (by Open Handset Alliance)
- Microsoft Windows CE, Pocket PC, Pocket PC Phone Edition, Mobile
- Microsoft Windows Phone 7

(1 point per correct Mobile OS, max. 3 points)

**6 B) English:**

Are the following statements true or false? (1 point each, 3 points added up)

**Deutsch:**

*Sind die folgenden Aussagen wahr oder falsch? (1 Punkt für jede korrekte Antwort, insgesamt 3 Punkte)*

**English:**

Apple iOS is derived from Mac OS X, a Unix-based operating system.

**Deutsch:**

*Apple iOS ist ein Derivat von Mac OS X, einem Unix-basierten Betriebssystem.*

☐ true / wahr      ☐ false / falsch

**English:**

Android was originally based on a modified version of a Linux kernel and was then completely rewritten by Google because Linux is not in every respect „open source“.

**Deutsch:**

*Android basierte ursprünglich auf einem modifizierten Linuxkernel und wurde dann von Google komplett umgeschrieben, weil Linux nicht in allen Teilen „open source“ ist.*

☐ true / wahr      ☐ false / falsch

**English:**

Microsoft Windows Phone 7 features a new user-interface, but allows users to reuse applications written for Windows Mobile.

**Deutsch:**

*Microsoft Windows Phone 7 hat eine neue Benutzeroberfläche, ermöglicht aber die Weiterverwendung von Applikationen, die für Windows Mobile geschrieben wurden.*

☐ true / wahr      ☐ false / falsch

(1 point per correct answer, max. 3 points)

**6 C) English:**

Today, some mobile operating systems allow the execution of 3rd-party software. As a result, malware can also be executed on mobile operating systems. What are the possible threats for the user resulting from this? Name three issues. **(3 points)**

**Deutsch:**

*Heutzutage ermöglichen einige mobile Betriebssysteme das Ausführen von Software, die durch Dritte programmiert und verteilt wird. Auf diese Weise kann ebenso Schadsoftware vom mobilen Betriebssystem ausgeführt werden. Nennen Sie bitte drei hieraus resultierende mögliche Risiken für den Anwender. (3 Punkte)*

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)

(1 point for each threat, max. 3 points)

**6 D) English:**

Additional Security Software, e.g. virus scanners or firewalls, is often installed on computer systems as a security precaution. Name four countermeasures which should be implemented inside the mobile OS in the first place. **(4 points)**

**Deutsch:**

*Zusätzliche Sicherheitssoftware, etwa Virens Scanner oder Firewall, wird auf Computersystemen häufig als Schutzmaßnahme (nach)installiert. Nennen Sie vier Gegenmaßnahmen, die bereits im mobilen Betriebssystem implementiert sein sollten. (4 Punkte)*

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 they are started by e.g.

- Checking certificates
- Proof Carrying Code

(1 point for each countermeasure, max. 3 points)

## Question 7: Push Email Services (3 points)

**7 A) English:**

Name two of the necessary components of a Push Email Service. **(2 points)**

**Deutsch:**

*Nennen Sie zwei der notwendigen Bestandteile eines Push-E-Mail-Services. (2 Punkte)*

- Compatible software on the mobile device
- “Always-on” technology for transmitting new emails by “pushing” them to a mobile device once they arrive
- Needs a special server software to get emails from a standard email server (using POP3, IMAP, etc.) and push them to the recipients device

(1 point for each component, max. 2 points)



**7 B) English:**

Name two benefits to the user of such a service. **(1 point)**

**Deutsch:**

Nennen Sie zwei Vorteile (=Nutzen) für den Anwender durch einen solchen Service.  
**(1 Punkt)**

- No need for the user to check for new incoming e-mails on a server as they are pushed automatically
- E-mails usually arrive instantaneously without delay (e-mails become “instant messages”)
- ...

**(0,5 point for each benefit, max. 1 point)**

**Question 8: Wireless LAN technologies (6 points)**

**English:**

In Wireless LAN („Wi-Fi“) networks different kinds of problems may reduce data throughput. One of these problems is „packet collision“. Please explain

- what happens in case of „packet collision“ **(2 points)**,
- how the RTS-CTS mechanism solves this problem **(4 points)**.

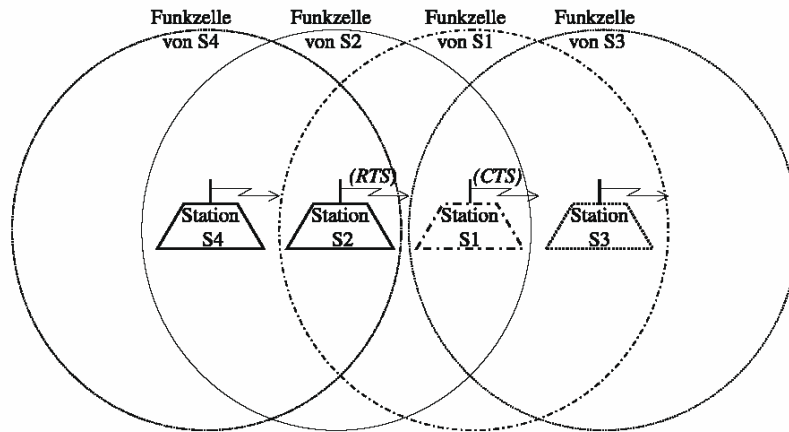
**Deutsch:**

In Wireless-LAN- bzw. „Wi-Fi“-Netzwerken können verschiedene Probleme den Datendurchsatz reduzieren. Eines dieser Probleme sind Kollisionen („packet collisions“). Bitte erklären Sie

- was bei einer „packet collision“ passiert **(2 Punkte)** und
- wie der RTS-CTS-Mechanismus das Problem löst **(4 Punkte)**.

Description of problem and solution for Packet Collision:

- RTS-CTS (Request to send – Clear to send)
- Wireless LAN uses “Air” as medium, but no CSMA/CD (Carrier Sense Multiple Access / Collision Detection) available for Wireless LAN.
- CSMA/CA (Carrier Sense Multiple Access / Collision Avoidance) is possible.
- The following figure shows typical problems in air transmission systems.



- Hidden station problem (S2 and S3)
  - S2 can't hear S3 and the other way round.
  - Starting a communication by both of them leads to a collision at S1
- (packet collision explanation: max. 2 points)

(RTS-CTS mechanism: max. 4 points)

Solution: before communication, S2 sends an RTS-frame to S1

- If there is no other communication a CTS-frame is the response and the communication starts.
- If there is a communication, no CTS-frame is sent, S2 follows a back-up strategy.
- After some time, based on the back-up strategy, S2 starts again sending a new RTS-frame.
- Without a CTS-frame there is no beginning of a communication.

Back-up strategy

- Communication attempt failed
- After a time-interval based on a special algorithm the sender tries again to send an RTS-frame.