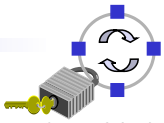
# Network Security

## Chapter 14

# Security Aspects of Mobile Communications



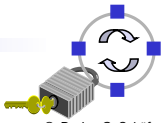




## Security Aspects of Mobile Communication

- Mobile communication faces all threats that does its' fixed counterpart:
  - Masquerade, eavesdropping, authorization violation, loss or modification of transmitted information, repudiation of communication acts, forgery of information, sabotage
  - Thus, similar measures like in fixed networks have to be taken
- However, there are some specific issues arising out of mobility of users and / or devices:
  - Some already existing threats get more dangerous:
    - Wireless communications is more accessible for eavesdropping
    - The lack of a physical connection makes it easier to access services
  - Some new difficulties for realizing security services:
    - Authentication has to be re-established when the mobile device moves
    - Key management gets harder as peer identities can not be pre-determined
  - One completely new threat:
    - The location of a device / user becomes a more important information that is worthwhile to eavesdrop on and thus to protect

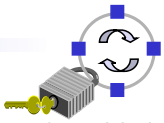




# Location Privacy in Mobile Networks (1)

- There is no appropriate location privacy in today's mobile networks:
  - GSM / UMTS / LTE:
    - Active attackers can collect IMSIs on the air interface
    - Visited network's operators can partially track the location of users
    - Home network operators can fully track the location of users
    - However, at least communicating end systems can not learn about the location of a mobile device
  - Wireless LAN:
    - No location privacy, as the (world-wide unique) MAC address is always included in the clear in every MAC frame



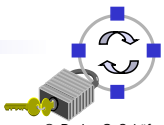




# Location Privacy in Mobile Networks (2)

- The basic location privacy design problem:
  - A mobile device should be reachable
  - No (single) entity in the network should be able to track the location of a mobile device
- Some fundamental approaches to this problem [Müller99a]:
  - *Broadcast of messages:*
    - Every message is sent to every possible receiver
    - If confidentiality is needed, the message is encrypted asymmetrically
    - This approach does not scale well for large networks / high load
  - *Temporary pseudonyms:*
    - Mobile devices use pseudonyms which are changed regularly
    - However, to be able to reach the mobile device this needs a mapping entity which can track the mobile's history of pseudonyms
  - *Mix networks:*
    - Messages are routed via various entities (mixes) and every entity can only learn a part of the message route (see below)

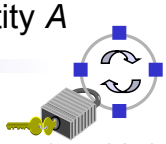




# Location Privacy in Mobile Networks (3)

- Addressing schemes for location privacy with broadcast:
  - *Explicit addresses:*
    - Every entity that "sees" an explicit address is able to determine the addressed entity
  - *Implicit addresses:*
    - An implicit address does not identify a specific device or location, it just names an entity without any further meaning attached to the name
    - *Visible implicit addresses:*
      - Entities that see multiple occurrences of an address can check for equality
    - *Invisible implicit addresses:*
      - Only the addressed entity can check for equality of the address
      - This requires public key operations: $ImplAddr_A = \{r_B, r_A\}_{+K_A}$ where $r_A$ is chosen by the addressed entity and $r_B$ is a random value created by an entity *B* which wants to invisibly make reference to entity *A*





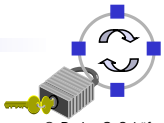




# Location Privacy in Mobile Networks (4)

- *Temporary Pseudonyms:*
  - The location of a device A is no longer stored with its' identification $ID_A$ but with a changing pseudonym $P_A(t)$
    - Example: VLRs in GSM might just know and store the TMSI (which is kind of a temporary pseudonym)
  - The mapping of an $ID_A$ to the current pseudonym $P_A(t)$ is stored in a trustworthy device
    - Example: GSM HLRs might be realized as trustworthy devices
  - When an incoming call has to be routed to the current location of device A:
    - The network provider of device A asks the trustworthy device for the current pseudonym $P_A(t)$
    - The network then routes the call to the current location of A by looking up the temporary pseudonym in a location database
    - It is important, that the entities that route a call can not learn about the original address of the call setup message (→ implicit addresses)
    - The use of mixes (see below) can provide additional protection against attacks from colluding network entities

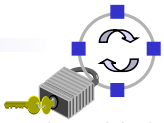




# Location Privacy in Mobile Networks (5)

- *Communication mixes:*
  - The concept was invented in 1981 by D. Chaum for untraceable email communication
  - A *mix* hides the communication relations between senders and receivers:
    - It buffers incoming messages which are asymmetrically encrypted so that only the mix can decrypt them
    - It changes the "appearance" of messages by decrypting them
    - It changes the order of messages and relays them in batches
    - However, if the mix is compromised an attacker can learn "everything"
  - Security can be increased by cascading mixes
  - Example: A sends a message m to B via two mixes M1 and M2
    - A $\rightarrow$ M1: $\{r_1,\{r_2, \{r_3, m\}_{+K_B}\}_{+K_{M2}}\}_{+K_{M1}}$
    - M1 $\rightarrow$ M2: $\{r_2, \{r_3, m\}_{+K_B}\}_{+K_{M2}}$
    - M2 $\rightarrow$ B: $\{r_3, m\}_{+K_B}$
    - It is important, that the mixes process "enough" messages
  - This concept can be applied to mobile communications [Müller99a]









# Additional References

[Müller99a] G. Müller, K. Rannenberg (Ed.). *Multilateral Security in Communications.* Addison-Wesley-Longman, 1999.