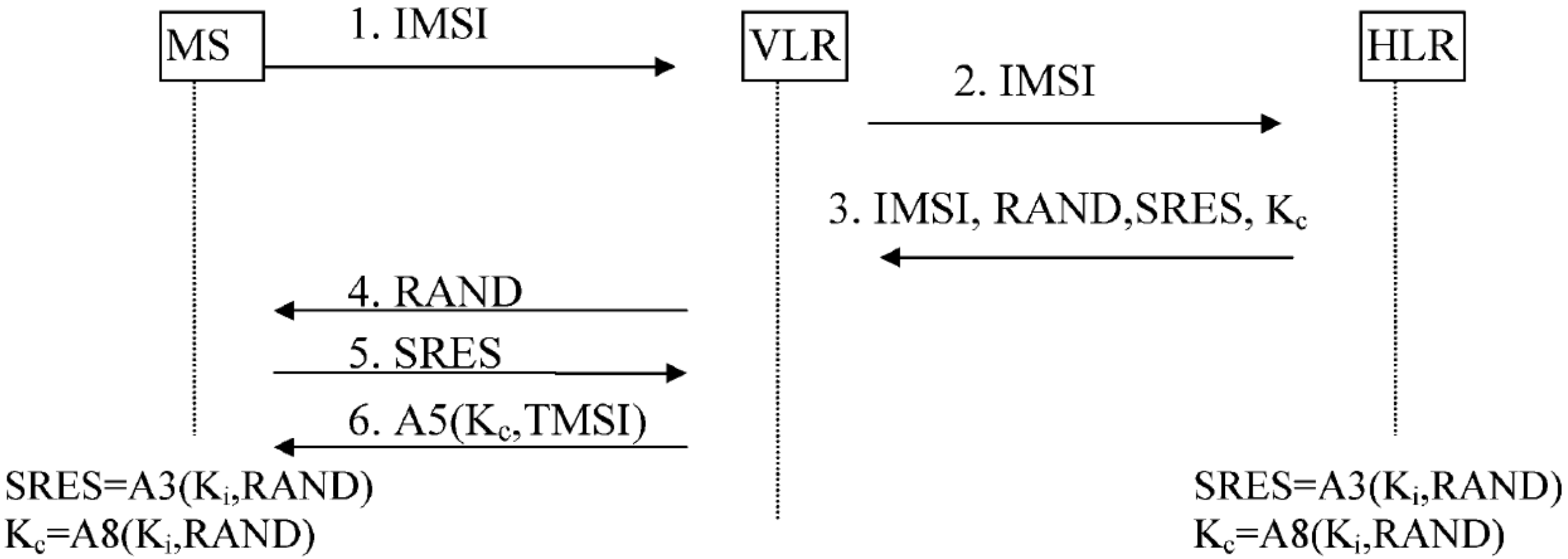
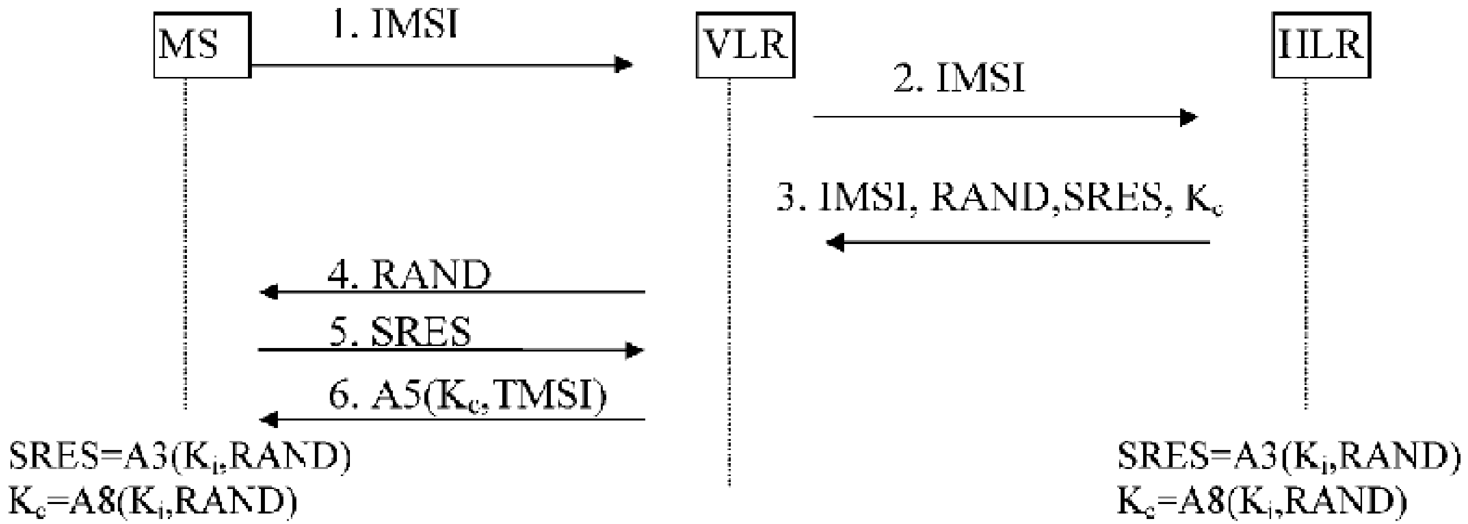
Tutorial 8

GSM AKA


MS
1. IMSI
VLR
2. IMSI
HLR
3. IMSI, RAND,SRES, K_c
4. RAND
5. SRES
6. A5(K_c,TMSI)
SRES=A3(K_i,RAND)
K_c=A8(K_i,RAND)
SRES=A3(K_i,RAND)
K_c=A8(K_i,RAND)

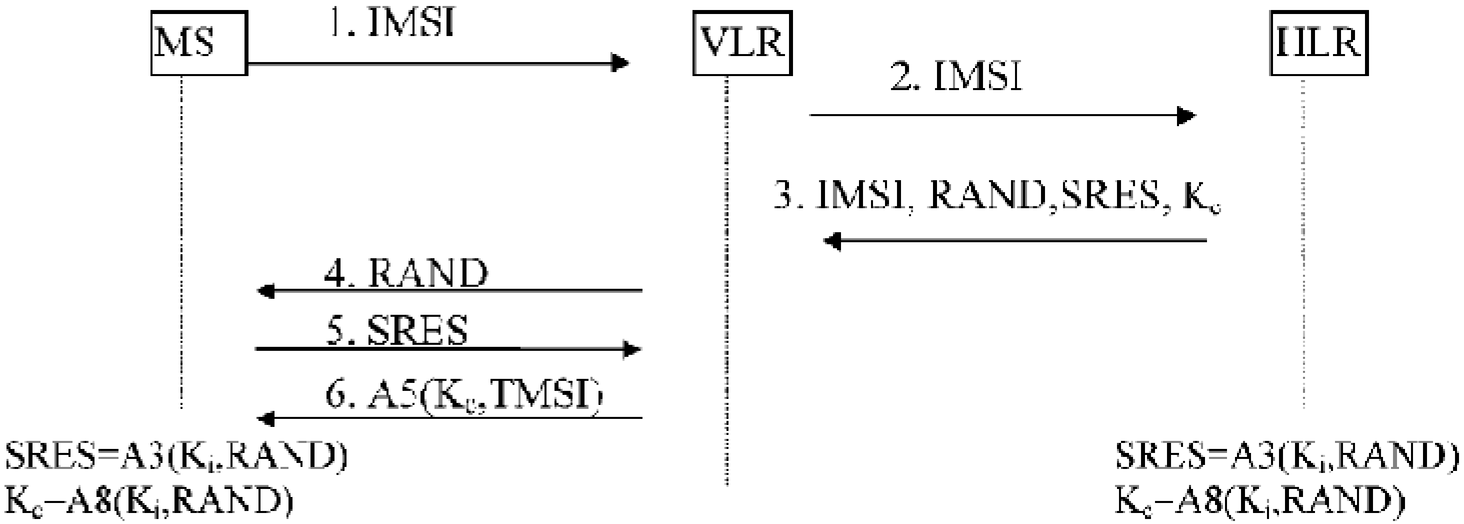


- Is a replay attack against the protocol possible?

- Yes. Similar to the replay attack against the Needham-Schroeder protocol, if a past session key Kc is known by the attacker, then the attacker can perform a replay attack by sending the same RAND in step 4

- Is the 3GPP AKA protocol vulnerable to the replay attack?

- Is the 3GPP AKA protocol vulnerable to the replay attack?
  - No.
  - The counter (or sequence-number) based authentication mechanism is employed in the 3GPP AKA.
  - An authentication token computed based on a sequence number is included in Steps 3 & 4
  - The MS can check the authentication token using it’s local sequence number to ensure the message in step 4 is not a replayed message



- In order to enhance the anonymity of the mobile station, suppose the following modified protocol is used
  - The MS and the VLR perform a Diffie-Hellman key exchange on-the-fly
  - The MS uses the agreed Diffie-Hellman key to encrypt its identity (i.e., IMSI) and sends the encrypted identity to VLR
  - VLR decrypts the data to obtain IMSI and continues the rest of the protocol
- Does the above approach work?

- If the attacker is passive
  - Yes. The IMSI is protected by the Diffie-Hellman key
- If the attacker is active
  - No. The active attacker (a rogue access point) can impersonate the VLR and engage in the Diffie-Hellman key exchange. The attacker can then obtain the IMSI by decrypting the data.
  - Alternatively, the active attacker can perform an MITM attack to obtain the IMSI.

Mobile Authentication Protocol based on PKC

- GSM and 3GPP are based on symmetric key cryptography
- Limitations:
  - Weak anonymity
  - No forward secrecy
- Protocols with stronger security can be obtained by using PKC
- Below is an example

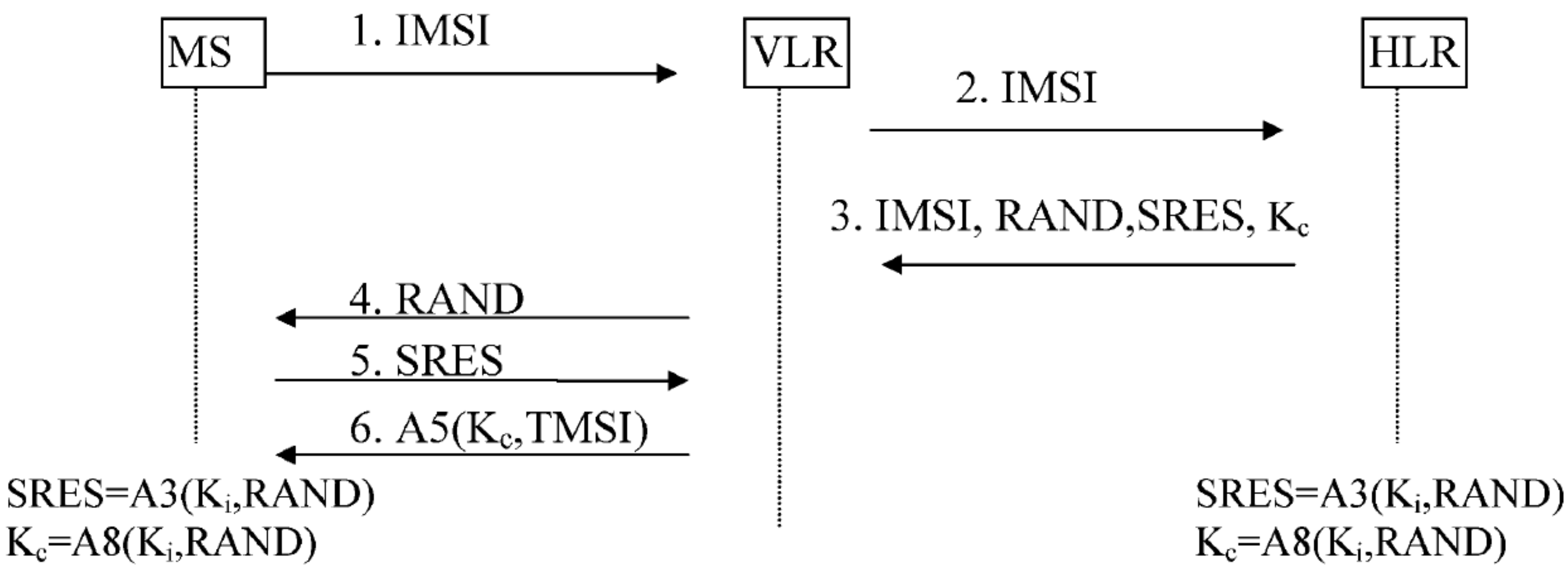
$$
\begin{array}{lll}
(1) & M \rightarrow V & g^{r_M}, TID_M, H \\
(2) & V \rightarrow H & g^{r_V}, g^{r_M}, TID_M, \\
 & & \{h(g^{r_V}, g^{r_M}, TID_M, V)\}_{SK_V}, T_V, cert_V \\
(3) & V \leftarrow H & g^{r_H}, [\{h(g^{r_H}, g^{r_V}, h(M) \oplus g^{r_M}, H)\}_{SK_H}, \\
 & & h(M) \oplus g^{r_M}]_{K_{VH}}, T_H, cert_H \\
(4) & M \leftarrow V & g^{r_V}, \{h(g^{r_V}, g^{r_M}, TID'_M, V), T_H\}_{K_{MV}}, \\
 & & T'_V, cert_V \\
(5) & M \rightarrow V & [\{h(g^{r_M}, g^{r_V}, T_H, V)\}_{SK_M}, T'_V, cert_M]_{K_{MV}}
\end{array}
$$

- $K_{MH} = g^{SK_H \cdot r_M}$, is used to encrypt the information about real identity of a user M and generate his initial temporary identity $TID_M = \{h(M) \oplus g^{r_M}\}_{K_{MH}}$. It can be computed with the random number selected by M and the public key of the home network H, $PK_H = g^{SK_H}$, already known to the user.
- $K_{VH} = h1(g^{r_V \cdot r_H}, g^{r_H \cdot SK_V})$, which is used for message encryption between V and H. It can be computed with the random numbers chosen by both parties and the public key of V.
- $K_{MV} = h1(g^{r_M \cdot r_V}, g^{SK_V \cdot r_M})$, is used for the message encryption and authentication between M and V. It can be computed with the random numbers chosen by both parties and the public key of V

$$TID_M = \{h(M) \oplus g^{r_M}\}_{K_{MH}}$$

$$TID'_M = h(g^{r_M \cdot r_V}, h(M))$$

GSM Authentication and Key Agreement



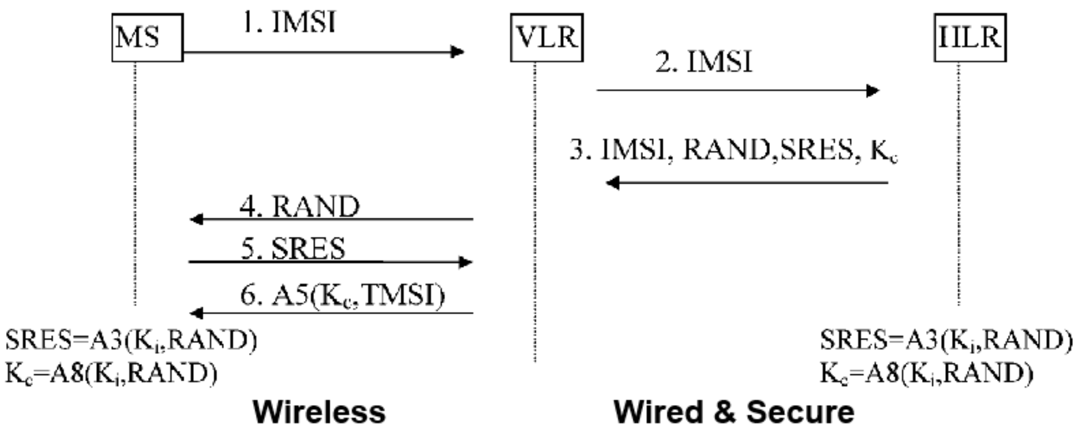
Wireless **Wired & Secure**

IMSI: International mobile subscriber identity
TMSI: Temporary Mobile Subscriber Identity
Ki: the long-term symmetric-key shared between MS & HLR
RAND: a freshly generated random number
A3/5/8: cryptographic algorithms

VLR: visitor location register
HLR: Home location register

How to provide anonymity such that IMSI is unknown to VLR?

GSM Authentication and Key Agreement



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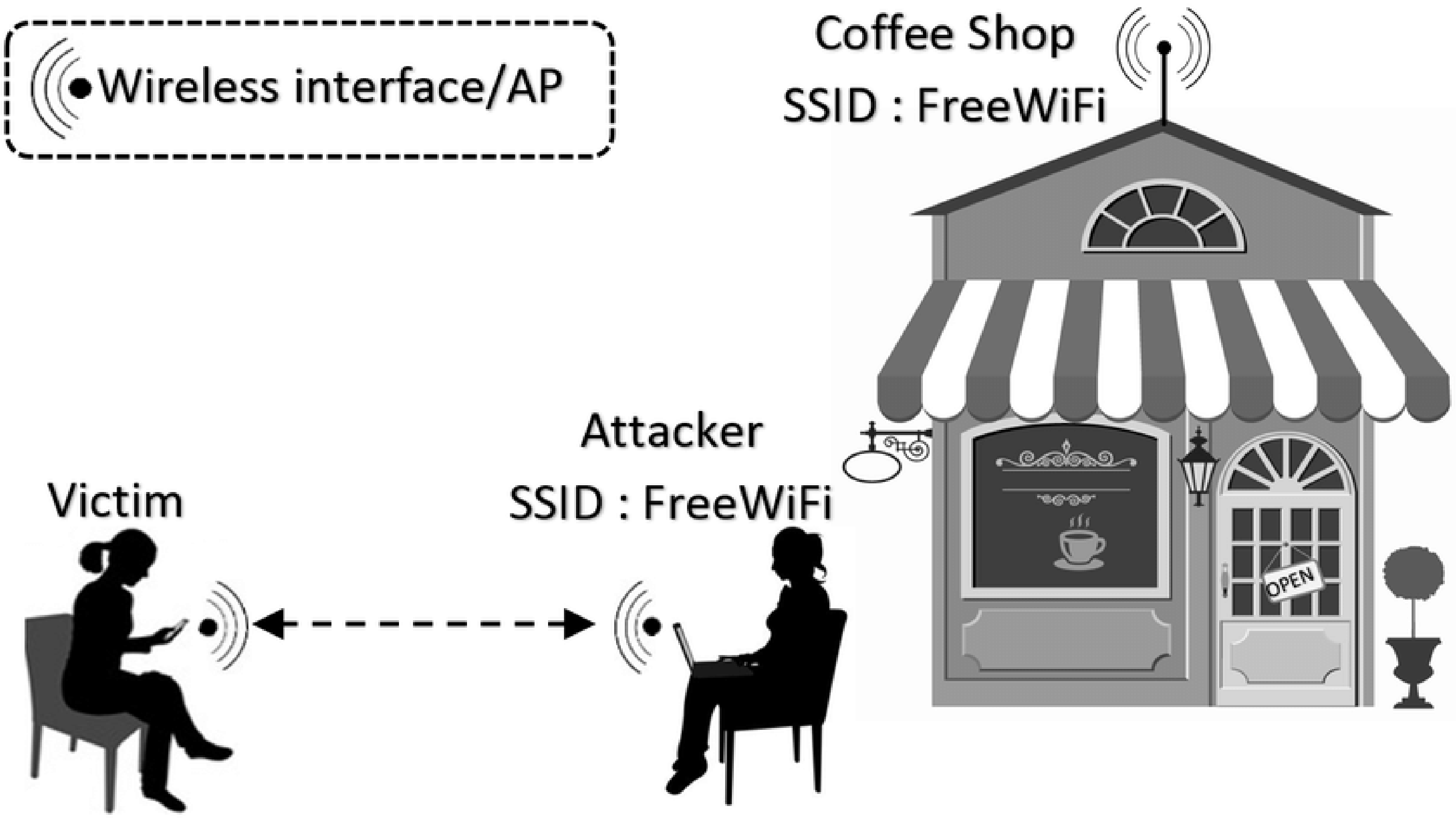
How to provide anonymity such that IMSI is unknown to VLR?

- MS uses the pk of HLR to encrypt IMSI and obtain CT=Epk(Fake-IMSI,IMSI)
- MS sends (Fake-IMSI, HLR, CT) to VLR.
- The IMSI in step 3 should be replaced with fake-IMSI.

Note: Fake-IMSI here is used by VLR to distinguish one MS from others.

Discussions(Different Cases, Different Answers)



A coffee shop provides free wifi but an attacker is trying to cheat as the hotspot. When the victim is connecting to this hotspot, what could happen?

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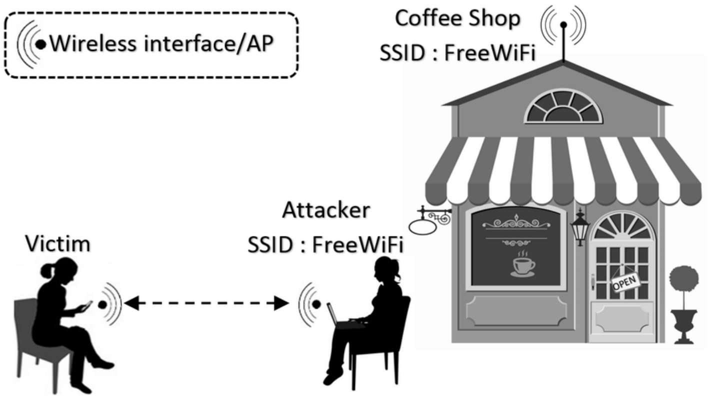

A coffee shop provides free wifi but an attacker is trying to cheat as the hotspot. When the victim is connecting to this hotspot, what could happen?

- All data sent from the victim and received by the victim will be copied and seen by the attacker. For example, if the victim tries to access a host at port number 80, then the content of request (which website and address such as uow.edu.au) will be seen by the attacker (including password).

- However, security protocols can be provided to secure the connection. For example, https can secure the browsing connection. For example, using IPSec for tunnel model (VPN), then the attack can only know that the victim is communicating with the VPN provider.