Access Control and Privacy Policies (8)

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Slides: KEATS (also homework is there)

Last Week

Andrew Secure RPC Protocol: A and B share a key K_{AB} and want to identify each other

- A sends B : A, N_A
- B sends A : $\{N_A, K'_{AB}\}_{K_{AB}}$
- A sends B : $\{N_A\}_{K'_{AB}}$

Protocols

A sends B : ...

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$$\vdots$$

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- indicates one "protocol run", or session, which specifies some order in the communication
- there can be several sessions in parallel (think of wifi routers)

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Defeating Challenge-Response

A reflection attack: an intruder I impersonates B.

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Sounds stupid: "...answering a question with a counter question"

was originally developed at CMU for terminals to connect to workstations (e.g. file servers)

Identify Friend or Foe

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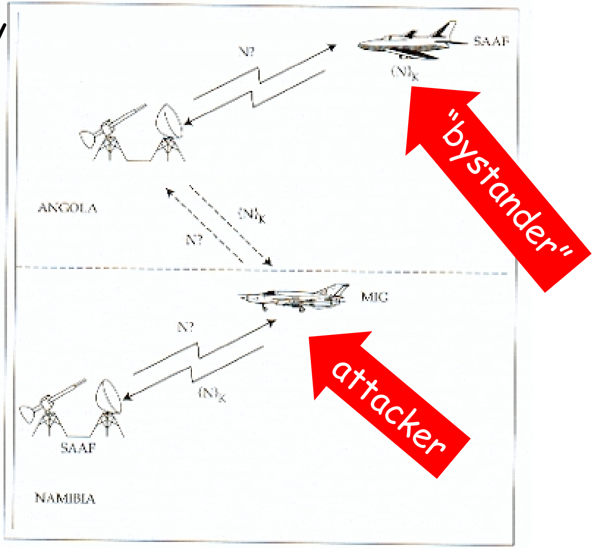

Figure 2.2 The MIG-in-the middle attack.

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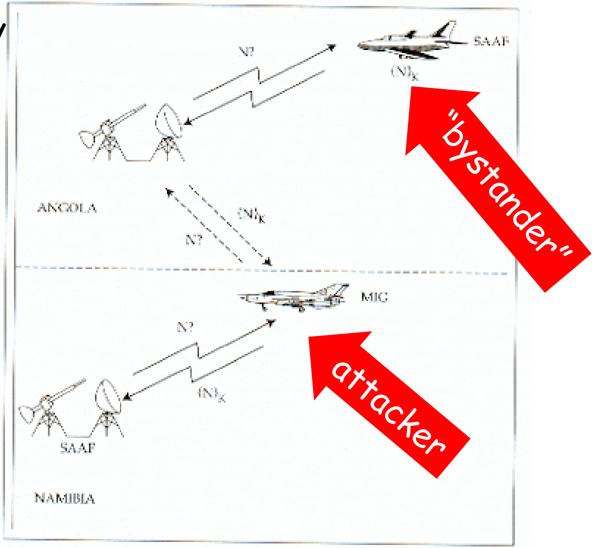

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IFF opened up a nice side-channel attack

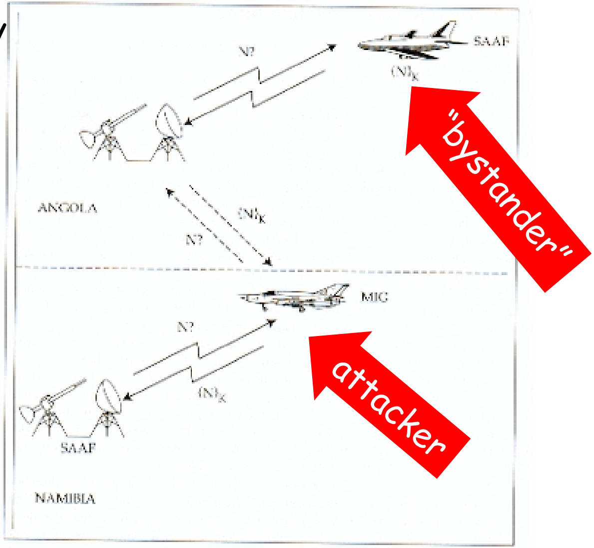

Figure 2.2 The MIG-in-the middle attack.

Encryption to the Rescue?

- A sends B : $\{A, N_A\}_{K_{AB}}$ encrypted
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means you need to send a separate "Hello" signal (bad), or worse share a single key between many entities

Protocol Attacks

- replay attacks
- reflection attacks
- man-in-the-middle attacks
- timing attacks
- parallel session attacks
- binding attacks (public key protocols)
- changing environment / changing assumptions

Replay Attacks

Schroeder-Needham protocol: exchange of a symmetric key with a trusted 3rd-party S:

$$
\begin{array}{l}
A \rightarrow S : A, B, N_A \\
S \rightarrow A : \{N_A, B, K_{AB}, \{K_{AB}, A\}_{K_{BS}}\}_{K_{AS}} \\
A \rightarrow B : \{K_{AB}, A\}_{K_{BS}} \\
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at the end both A and B should be in the possession of the secret key K_{AB} and know that the other principal has the key

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compromise K_{AB}

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B believes it is following the correct protocol, intruder I can form the correct response because it knows K_{AB} and talk to B masquerading as A

Replay Attacks

Andrew Secure RPC protocol: exchanging a new key between A and B

$$
\begin{aligned}
A \rightarrow B &: A, \{N_A\}_{K_{AB}}\\
B \rightarrow A &: \{N_A + 1, N_B\}_{K_{AB}}\\
A \rightarrow B &: \{N_B + 1\}_{K_{AB}}\\
B \rightarrow A &: \{K_{AB}^{new}, N_B^{new}\}_{K_{AB}}
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Assume nonces are represented as bit-sequences of the same length

$$
\begin{array}{ll}
A \rightarrow B : A, \{N_A\}_{K_{AB}} & \\
B \rightarrow A : \{N_A + 1, N_B\}_{K_{AB}} & \\
A \rightarrow I(B) : \{N_B + 1\}_{K_{AB}} & \text{intercepts} \\
I(B) \rightarrow A : \{N_A + 1, N_B\}_{K_{AB}} & \text{resend 2nd msg}
\end{array}
$$

Time-Stamps

The Schroeder-Needham protocol can be fixed by including a time-stamp (e.g., in Kerberos):

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but nothing is for free: then you need to synchronise time and possibly become victim to timing attacks

It can also be fixed by including another nonce:

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Binding Attacks

with public-private keys it is important that the public key is bound to the right owner (verified by a certification authority CA)

$$A \rightarrow CA : A, B, N_A$$
$$CA \rightarrow A : CA, \{CA, A, N_A, K_B^{pub}\}_{K_A^{pub}}$$

A knows K_A^{prig} and can verify the message came from CA in response to A's message and trusts K_B^{pub} is B's public key

Binding Attacks

$$A \to I(CA) : A, B, N_A$$
$$I(A) \to CA : A, I, N_A$$
$$CA \to I(A) : CA, \{CA, A, N_A, K_I^{pub}\}_{K_A^{pub}}$$
$$I(CA) \to A : CA, \{CA, A, N_A, K_I^{pub}\}_{K_A^{pub}}$$

Binding Attacks

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A now encrypts messages for B with the public key of I (which happily decrypts them with its private key)

There are plenty of other protocols and attacks.
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attacks because of changing environment

Changing Environment Attacks

- all protocols rely on some assumptions about the environment (e.g., cryptographic keys cannot be broken)

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- in the "good olden days" (1960/70) rail transport was cheap, so fraud was not worthwhile

Changing Environment Attacks

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- when it got expensive, some people bought cheaper monthly tickets for a suburban station and a nearby one, and one for the destination and a nearby one
- a large investment later all barriers were automatic and tickets could record state

Changing Environment Attacks

- all protocols rely on some assumptions about the environment (e.g., cryptographic keys cannot be broken)

- But suddenly the environment changed: rail transport got privatised creating many companies cheating each other
- revenue from monthly tickets was distributed according to a formula where the ticket was bought

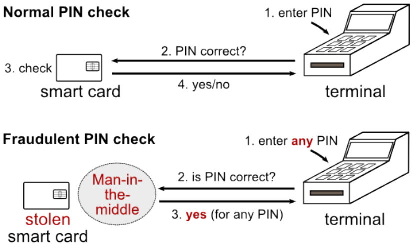
Changing Environment Attacks

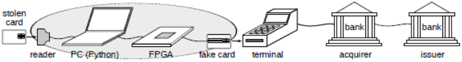
- all protocols rely on some assumptions about the environment (e.g., cryptographic keys cannot be broken)

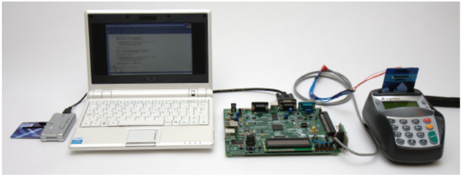
- apart from bad outsiders (passengers) you also had bad insiders (rail companies)
- chaos and litigation ensued

A Man-in-the-middle attack in real life:

- the card only says yes or no to the terminal if the PIN is correct
- trick the card in thinking transaction is verified by signature
- trick the terminal in thinking the transaction was verified by PIN







Problems with EMV

- it is a wrapper for many protocols
- specification by consensus (resulted unmanageable complexity)
- its specification is 700 pages in English plus 2000+ pages for testing, additionally some further parts are secret
- other attacks have been found
- one solution might be to require always online verification of the PIN with the bank

Good Practices

- explicit principles (you authenticate all data you might rely on)
- the one who can fix a system should also be liable for the losses

Privacy et al

Some terminology:

- secrecy is the mechanism used to limit the number of principals with access to information (eg, cryptography or access controls)
- confidentiality is the obligation to protect the secrets of other people or organizations (secrecy for the benefit of an organisation)
- anonymity is the ability to leave no evidence of an activity (eg, sharing a secret)
- privacy is the ability or right to protect your personal secrets (secrecy for the benefit of an individual)