Security Engineering (5)

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Problems with Key Fobs

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Insurers refuse to cover Range Rovers due to security flaw

Kiran Randhawa

INSURANCE companies are refusing to cover new Range Rovers in London after thieves found a way of bypassing the vehicles' keyless ignition systems.

Criminals use hand-held electronic devices, available on eBay, to get around the feature. Unless owners have secure parking, underwriters are now said to be refusing to insure them.

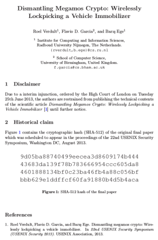
Insurers have asked to meet Jaguar Range Rover to discuss the growing problem. Thatcham Research, the motor insurers' automotive research centre, said that 294 Range Rover Evoque and Sport vehicles were stolen in London between January and July. In the same period, 63 BMW X5s, a rival to the Range Rover, were taken.

James Wasdell, co-founder of Quantum Underwriting, said: "If you are an owner of a street-parked Range Rover, nine out of 10 insurers will now say no. However, we have found a solution by combining the use of physical protection [for the car] and advising clients to insure all assets with one insurer."

Jaguar Land Rover said: "Our line-up continues to meet the insurance industry requirements. Nevertheless we are taking this issue very seriously."

Circumventing the ignition protection:

- either dismantling Megamos crypto,
- or use the diagnostic port to program blank keys



Dismantling Megamos Crypto: Wirelessly Lockpicking a Vehicle Immobilizer

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1 Disclaimer

Due to a interim injunction, ordered by the High Court of London on Tuesday 25th June 2013, the authors are restrained from publishing the technical contents of the scientific article *Dismantling Megamos Crypto: Wirelessly Lockpicking a Vehicle Immobilizer* [1] until further notice.

2 Historical claim

Figure 1 contains the cryptographic hash (SHA-512) of the original final paper which was scheduled to appear in the proceedings of the 22nd USENIX Security Symposium, Washington DC, August 2013.

```
9d05ba88740499eecea3d8609174b444
43683da139f78b783666954ccc605da8
4601888134bf0c23ba46fb4a88c056bf
bbb629e1ddffcf60fa91880b4d5b4aca
```

Figure 1: SHA-512 hash of the final paper

References

1. Roel Verdult, Flavio D. Garcia, and Barış Ege. Dismantling megamos crypto: Wirelessly lockpicking a vehicle immobilizer. In *22nd USENIX Security Symposium (USENIX Security 2013)*. USENIX Association, 2013.

Protocols

- The point is that we have no control over the network
- We want to avoid that a message exchange (a protocol) can be attacked without detection

G20 Summit in 2009

- Snowden documents reveal "that during G20 meetings…GCHQ used 'ground-breaking intelligence capabilities' to intercept the communications of visiting delegations. This included setting up internet cafes where they used an email interception program and key-logging software to spy on delegates' use of computers…"
- "The G20 spying appears to have been organised for the more mundane purpose of securing an advantage in

A Simple PK Protocol

$$
\begin{array}{ll}
1. & A \rightarrow B : K_A^{pub} \\
2. & B \rightarrow A : K_B^{pub} \\
3. & A \rightarrow B : \{A, m\}_{K_B^{pub}} \\
4. & B \rightarrow A : \{B, m'\}_{K_A^{pub}}
\end{array}
$$

A Simple PK Protocol

1. $A \rightarrow B : K_A^{pub}$
2. $B \rightarrow A : K_B^{pub}$
3. $A \rightarrow B : \{A, m\}_{K_B^{pub}}$
4. $B \rightarrow A : \{B, m'\}_{K_A^{pub}}$

unfortunately there is a simple man-in-the-middle-attack

A MITM Attack

1. $A \rightarrow E : K_A^{pub}$
2. $E \rightarrow B : K_E^{pub}$
3. $B \rightarrow E : K_B^{pub}$
4. $E \rightarrow A : K_E^{pub}$
5. $A \rightarrow E : \{A, m\}_{K_E^{pub}}$
6. $E \rightarrow B : \{E, m\}_{K_B^{pub}}$
7. $B \rightarrow E : \{B, m'\}_{K_E^{pub}}$
8. $E \rightarrow A : \{E, m'\}_{K_A^{pub}}$

A MITM Attack

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5. $A \to E : \{A, m\}_{K_E^{pub}}$
6. $E \to B : \{E, m\}_{K_B^{pub}}$
7. $B \to E : \{B, m'\}_{K_E^{pub}}$
8. $E \to A : \{E, m'\}_{K_A^{pub}}$

and A and B have no chance to detect it

Interlock Protocol

The interlock protocol ("best bet" against MITM):

1. $A \to B : K_A^{pub}$
2. $B \to A : K_B^{pub}$
3. $\{A, m\}_{K_B^{pub}} \mapsto H_1, H_2$

   $\{B, m'\}_{K_A^{pub}} \mapsto M_1, M_2$
4. $A \to B : H_1$
5. $B \to A : \{H_1, M_1\}_{K_A^{pub}}$
6. $A \to B : \{H_2, M_1\}_{K_B^{pub}}$
7. $B \to A : M_2$

Splitting Messages

`0X1peUVTGJK+H70mMjAM8p`

$\{A, m\}_{K_B^{pub}}$

`0X1peUVTGJK` — H_1

`+H70mMjAM8p` — H_2

- you can also use the even and odd bytes
- the point is you cannot decrypt the halves

$$A \to C : K_A^{pub}$$
$$C \to B : K_C^{pub}$$
$$B \to C : K_B^{pub}$$
$$C \to A : K_C^{pub}$$
$$\{A, m\}_{K_C^{pub}} \mapsto H_1, H_2$$
$$\{B, m'\}_{K_C^{pub}} \mapsto M_1, M_2$$
$$\{C, a\}_{K_B^{pub}} \mapsto C_1, C_2$$
$$\{C, b\}_{K_A^{pub}} \mapsto D_1, D_2$$

$$A \to C : H_1$$
$$C \to B : C_1$$
$$B \to C : \{C_1, M_1\}_{K_C^{pub}}$$
$$C \to A : \{H_1, D_1\}_{K_A^{pub}}$$
$$A \to C : \{H_2, D_1\}_{K_C^{pub}}$$
$$C \to B : \{C_2, M_1\}_{K_B^{pub}}$$
$$B \to C : M_2$$
$$C \to A : D_2$$

$$A \rightarrow C : K_A^{pub}$$
$$C \rightarrow B : K_C^{pub}$$
$$B \rightarrow C : K_B^{pub}$$
$$C \rightarrow A : K_C^{pub}$$
$$\{A, m\}_{K_C^{pub}} \mapsto H_1, H_2$$
$$\{B, m'\}_{K_C^{pub}} \mapsto M_1, M_2$$
$$\{C, a\}_{K_B^{pub}} \mapsto C_1, C_2$$
$$\{C, b\}_{K_A^{pub}} \mapsto D_1, D_2$$

$$A \rightarrow C : H_1$$
$$C \rightarrow B : C_1$$
$$B \rightarrow C : \{C_1, M_1\}_{K_C^{pub}}$$
$$C \rightarrow A : \{H_1, D_1\}_{K_A^{pub}}$$
$$A \rightarrow C : \{H_2, D_1\}_{K_C^{pub}}$$
$$C \rightarrow B : \{C_2, M_1\}_{K_B^{pub}}$$
$$B \rightarrow C : M_2$$
$$C \rightarrow A : D_2$$

m = How is your grandmother? m' = How is the weather today in London?

- you have to ask something that cannot imitated (requires A and B know each other)
- what happens if m and m' are voice messages?

- you have to ask something that cannot imitated (requires A and B know each other)
- what happens if m and m' are voice messages?

- So C can either leave the communication unchanged (Hellamn-Diffie), or invent a complete new conversation

- the moral: establishing a secure connection from “zero” is almost impossible—you need to rely on some established trust
- that is why we rely on certificates, which however are badly, badly realised

Trusted Third Parties

Simple protocol for establishing a secure connection via a mutually trusted 3rd party (server):

$$
\begin{array}{l}
A \rightarrow S : A, B \\
S \rightarrow A : \{K_{AB}, \{K_{AB}\}_{K_{BS}}\}_{K_{AS}} \\
A \rightarrow B : \{K_{AB}\}_{K_{BS}} \\
A \rightarrow B : \{m\}_{K_{AB}}
\end{array}
$$

PKI: The Main Idea

- the idea is to have a certificate authority (CA)
- you go to the CA to identify yourself
- CA: “I, the CA, have verified that public key P^{pub}_{Bob} belongs to Bob”
- CA must be trusted by everybody
- What happens if CA issues a false certificate? Who pays in case of loss? (VeriSign explicitly limits liability to $100.)

Best Practices

Principle 1: Every message should say what it means: the interpretation of a message should not depend on the context.

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Principle 1: Every message should say what it means: the interpretation of a message should not depend on the context.

Principle 2: If the identity of a principal is essential to the meaning of a message, it is prudent to mention the principal's name explicitly in the message (though difficult).

Best Practices

Principle 3: Be clear about why encryption is being done. Encryption is not wholly cheap, and not asking precisely why it is being done can lead to redundancy. Encryption is not synonymous with security.

Possible Uses of Encryption

- Preservation of confidentiality: $\{X\}_K$ only those that have K may recover X.
- Guarantee authenticity: The partner is indeed some particular principal.
- Guarantee confidentiality and authenticity: binds two parts of a message — $\{X, Y\}_K$ is not the same as $\{X\}_K$ and $\{Y\}_K$.

Best Practices

Principle 4: The protocol designers should know which trust relations their protocol depends on, and why the dependence is necessary. The reasons for particular trust relations being acceptable should be explicit though they will be founded on judgment and policy rather than on logic.

Example Certification Authorities: CAs are trusted to certify a key only after proper steps have been taken to identify the principal that owns it.

Formal Methods

Ross Anderson about the use of Logic:

> *Formal methods can be an excellent way of finding bugs in security protocol designs as they force the designer to make everything explicit and thus confront difficult design choices that might otherwise be fudged.*

Mid-Term

- homework, handouts, programs…

Any Questions?