Classical Protocols
Needham-Schroeder Protocol Family

Design and Verification of Security Protocols and Security Ceremonies

Programa de Pós-Graduacão em Ciências da Computacão
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- Kerberos authentication protocol suite is one of the main used protocols and is derived from NSSKP;
- NSSKP is a shared-key authentication protocol designed to generate and propagate a session key which is used for subsequent symmetrically encrypted communication;
- There is no public key infrastructure in place.

NSSKP Goals

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- The adversary can intercept messages, delay messages, read and copy messages and generate messages;
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- It is assumed that the attacker can not be a legitimate party within the protocol.

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- A sends the certificate to B;
- B decrypts the certificates and sends his own nonce encrypted by the session key to A; (nonce handshake);
- A decrypts the last message and sends modified nonce back to B.

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Goal

By the end of the message exchange both A and B share the secret key and both are assured in the presence of each other.

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$\{X\}_{K_{AS}}$	Encrypted message using K_{AS}

NSSKP Message Exchange

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   Bob there is a ticket for you!

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   I want to challenge Alice to see if she has the key on the ticket.
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   Challenge accepted. Take it back!

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  - What tools can an attacker deploy?
  - If any key is compromised, what are the consequences?

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- There is no way for B to know if the K_{AB} it receives is current;
- Lack of freshness on message 3 means an intruder has unlimited time to crack an old session key and reuse it.

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- Usually the lost of control on long term secrets affects deeply how a protocol operate;
- It is important to have mechanisms that could revoke keys or at least render them unusable after sometime.

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- Ask what happens if a key is broken is a fair question?
- How can you address these design faults pointed out by Denning and Sacco and Bauer et al.?

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- There is no public key infrastructure in place, but the identities related top public keys are an assumption.

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Needham-Schroeder Public Key Protocol Objectives

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2. B $\rightarrow$ A: $\{|N_a, N_b|\}_{K_a}$
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- The protocols authenticates Alice to Bob;
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- By the usage of fresh Nonces, we obtain the aliveness property in the protocols;
- But, Is it secure?

Almighty Attack - Rules of the Game

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  - Guess random numbers.

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- Bob believes to be talking to Alice , while he is talking to Charlie;
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- Charlie can use Nb to prove to Bob he is Alice.

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- Gavin Lowe was a random Computer Theoretician at Oxford;
- The attack looks easy, but it took 15 years to be found;
- The attack works because of a change on the threat model;
- But his attack is important because it was only discovered with the help of a formal verification tool.

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- The idea is to explore all the reachable states of the model;
- This verification is considered bound to the amount of peers and parallel runs tested.

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What we learned from this example?

- Some tests are too hard to be executed by hand;
- Theoretical tool are a good breakthrough for any area;
- Event very simple and well studied protocols may contain hidden failures;
- We learned to be diligent and somewhat paranoid on protocols and how they achieve their goals.

Discussion

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Discussion

- Which other protocols do you believe there are failures that were not detected yet?
- How do we correct Lowe's attack on NSPKP?
- Is formally prove a protocol enough to claim it is secure?
- What if a user drop an assumption of the protocol? Is it still secure?
- How secure is formally secure?

Questions????

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