

# Foundations of Computer Security

## Lecture 57: Cryptographic Protocols II

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Almost everything that occurs on the Internet occurs via a protocol.

**Definition:** A *protocol* is a structured dialogue among two or more parties in a distributed context controlling the syntax, semantics, and synchronization of communication, and designed to accomplish a communication-related function.

**Definition:** A *cryptographic protocol* is a protocol using cryptographic mechanisms to accomplish some security-related function.

## Possible Goals

Among the goals of cryptographic protocols are the following:

- *Unicity*: secret shared by exactly two parties
- *Integrity*: message arrived unmodified
- *Authenticity*: message claim of origin is true
- *Confidentiality*: message contents are inaccessible to an eavesdropper
- *Non-repudiation of origin*: sender can't deny sending
- *Non-repudiation of receipt*: receiver can't deny receiving

## Cryptographic Protocols Fundamentals

All cryptographic protocols share the following characteristics:

- several *principals* are exchanging messages;
- they are attempting to accomplish some security-related function;
- they are operating in a hostile and insecure environment.

The protocol must be robust and reliable in the face of a determined attacker.

A protocol involves a sequence of message exchanges of the form:

$$A \rightarrow B : M$$

meaning that principal  $A$  sends to principal  $B$  the message  $M$ .

Because of the distributed nature of the system and the possibility of malicious actors, there is typically no guarantee that  $B$  receives the message, or is even expecting the message.

Consider the following simple protocol:

1.  $A \rightarrow B : \{\{K\}_{K_a^{-1}}\}_{K_b}$
2.  $B \rightarrow A : \{\{K\}_{K_b^{-1}}\}_{K_a}$

**Informal goal:**  $A$  shares with  $B$  a secret key  $K$ , and each party is authenticated to the other.

*What are the assumptions? Precisely what are the goals? Are they satisfied? How can you be sure?*

However, this protocol is fatally flawed. *Can you see how?*

## Lessons

- Protocols are structured exchanges of messages at the very heart of distributed communication.
- Cryptographic protocols use cryptography to accomplish security-related functions.
- Protocols operate in a hostile environment, so cannot assume that messages are delivered.

**Next lecture:** Cryptographic Protocols: Abstract View