

# Foundations of Computer Security

## Lecture 51: Key Exchange

Dr. Bill Young  
Department of Computer Sciences  
University of Texas at Austin

# The Key Exchange Problem

Suppose you want to establish a secure communication channel with someone you don't know. We call this a situation of *mutual suspicion*. This is extremely common.

- You submit your income tax on-line.
- You send your credit card information to a shopping website.
- You wish to exchange encrypted email with another party.

Once you agree on a shared secret (key) the communication can proceed. But how do you exchange the key? This is the *key exchange problem*.

# Key Exchange: Attempt 1

Suppose both parties  $S$  and  $R$  have a public / private RSA key pair for asymmetric communication. Say  $S$  chooses a new symmetric key  $K$  and sends to  $R$  the following message:

$$\{K\}_{K_S^{-1}}.$$

$R$  can decrypt the message using  $S$ 's public key to retrieve  $K$ .  
*What is wrong with this scheme?*

**Answer:** Any eavesdropper can intercept the message and decrypt it using  $S$ 's public key to retrieve  $K$ .

# Key Exchange: Attempt 2

Instead, suppose  $S$  sends to  $R$  the following message:

$$\{K\}_{K_R}.$$

Since only  $R$  can decrypt this message, confidentiality is assured.  
*What's wrong this time?*

Now  $R$  doesn't have any assurance that the message actually came from  $S$ . An intruder may be "spoofing" (pretending to be  $S$ ) to obtain information that  $R$  intends only for  $S$ .

*Can we preserve both confidentiality and authentication with one transaction?*

# Key Exchange (Cont.)

A third attempt is for  $S$  to send  $R$  the following:

$$\{\{K\}_{K_S^{-1}}\}_{K_R}.$$

*How does  $R$  extract  $K$ ? What assurances does this provide?*

- 1 Since, no one but  $R$  can decrypt the message, confidentiality is assured.
- 2 No one but  $S$  could have performed the inner encryption, so authentication is accomplished.

This notion of nested encryptions is very useful in a variety of cryptographic protocols. *Could you have done the encryptions in the other order?*

- Public key cryptosystems can be used for key exchange, but you have to do it carefully.
- Key exchange requires both confidentiality and authentication.

**Next lecture:** Diffie-Hellman Key Exchange