Digital Signatures

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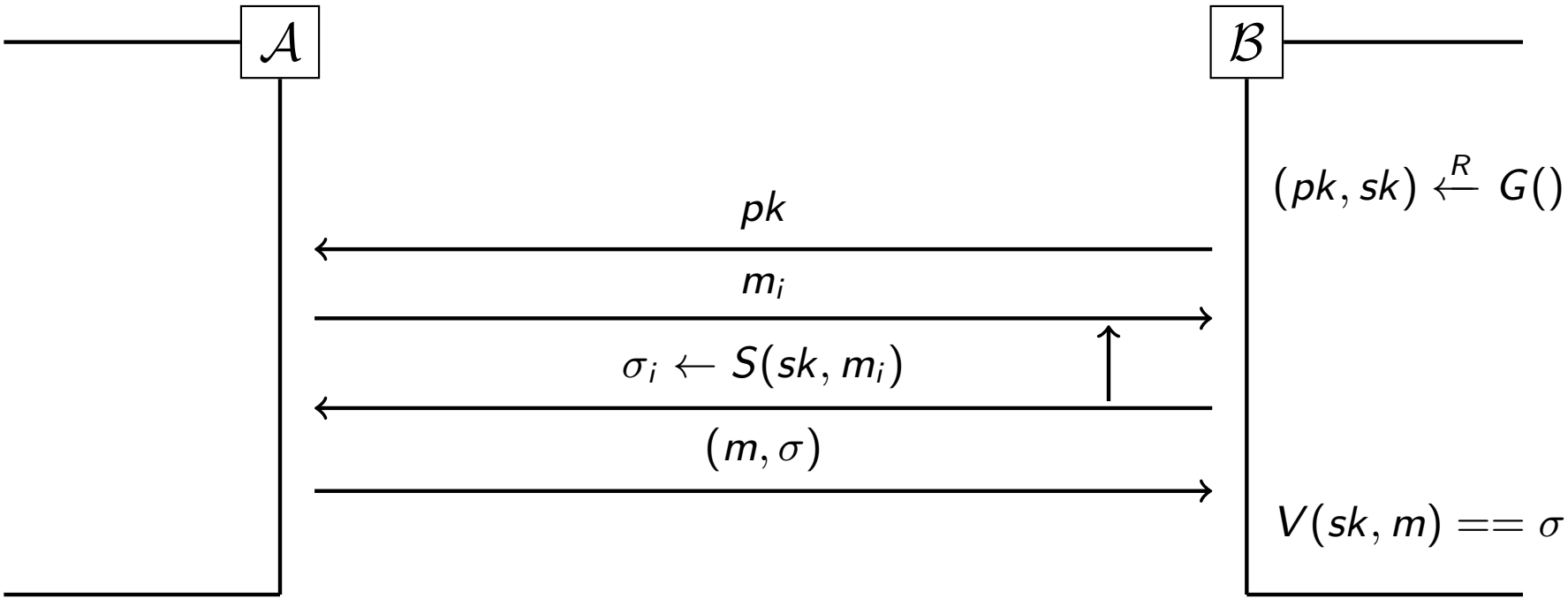
Example Use Case

- Let's pretend you are a software company
- Occasionally, you will distribute updates to your software
- Customers will need a way to verify that the software is really from the company without sharing a secret key with every single customer
- Enter digital signatures!

Digital Signatures Attack Game



Non-Repudiation

1. Non-Repudiation: there is no way to deny that the signature was not produced by someone with access to the secret key
2. This sounds legally useful right? Unfortunately not, it is very easy for someone to claim the public key isn't theirs or their secret key was exposed/leaked/stolen by a hacker.
3. Even more maliciously, Alice could have leaked her key right after or before sending a signatunre

Limits

1. Binding Signatures: Easy for a signer to issue multiple yet contradicting signed messages
2. Duplicate Keys: Given a signature σ for a public key pk, could I generate a pk', sk', m that produces $\sigma' == \sigma$
3. Future HW Queston: Is there an easy way to get around duplicate keys attacks???

2 Trapdoor Construction of Digital Signatures

Construction

$$S(sk, m) = y \leftarrow H(m), \sigma \leftarrow I(sk, y)$$

$$V(pk, m\sigma) = y \leftarrow F(pk, sigma), y == H(m)$$

Security

- In order to prove security we most model the hash function as a random oracle
- This means that y is essentially a random point in the space, and there is no way for an attacker to forge its signature
- Without this hashing, an attacker could trivially generate secure signatures! Future HW question: How???

3 Legality of Digital Signatures

US

- In 2000, Congress passed a law known as E-signatures
- The goal was to facilitate the use of digital signatures over interstate commerce
- all sales of goods over $500 require a signatures
- a US digital signature must contain three elements
  1. a symbol or sound
  2. attached or logically associated digital record
  3. made with the intent to sign the record
- did they succeed? qualifying signature examples: name typed, digitized picture of signature, pin to identify the recipient, mouse click, a sound, a cryptographic digital signature

UN

- UN adopted digital signature requirements in a 2005 convention
- additional requirements including identify the signer and is reliable (basically a mouse click still qualifies if you can prove who clicked and establish a clear intention behind the click)