Authenticating with Block Ciphers

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Internet Security Protocols

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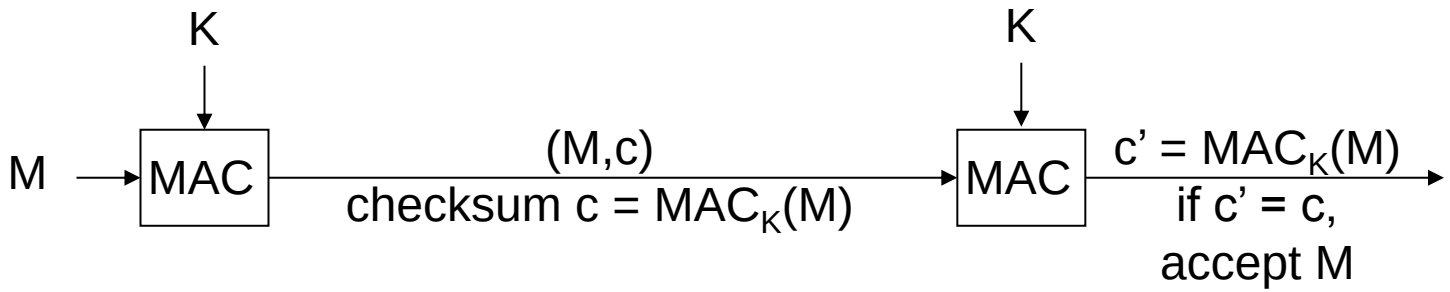
Message Authentication

- MAC: “message authentication code”



- A checksum (MAC) is computed over the message using the secret key & is transmitted.
- Message is accepted as authentic if the receiver also obtains the same checksum value.

Message Authentication Codes (MAC)

- A keyed checksum of the message.
- Sender of a message M computes $c = MAC_K(M)$ and sends (M,c) to the receiver.
- Receiver also computes $c' = MAC_K(M)$. If $c' = c$ the message is accepted.
- Example applications:
  - protecting files on an OS against modification
  - authentication of routing messages

MACs (cont'd)

- A MACed message is not necessarily encrypted.
- MAC function doesn't need to be invertible.
- MAC keys are symmetric. Hence, doesn't provide non-repudiation. (unlike digital signatures)
- Security of a MAC: An attacker shouldn't be able to generate a valid (M', c') pair, even after seeing many valid message-MAC pairs possibly of his choice (i.e. by a chosen message attack).

MAC from a Block Cipher

How to obtain a MAC from a block cipher?

Suggestion:

- divide message into blocks
- compute a checksum by adding (or xoring) them
- encrypt the checksum with the block cipher

Is this construction secure?

- If the message is not encrypted?
- If the message is encrypted?

CBC-MAC

- Simple CBC-MAC:
  - Compute the CBC over the message with IV = 0. (Q: Why not a random IV?)
  - The last output block is the MAC

Other alternatives:

- ECB?
- OFB/CTR?
- CFB?

CBC-MAC in Practice

Simple CBC-MAC is not exactly secure as a MAC. It has two popular flavors:

- CMAC (authentication only)
  - CBC-MAC with some extra processing at the end
  - Recommended by NIST SP 800-38B
- CCM (both encryption & authentication)
  - Counter mode encryption with CBC-MAC
  - Recommended by NIST SP 800-38C
  - Used in WPA2