Computer Networks

Message Authentication

(§8.2-8.3, §8.4.2-8.4.3)

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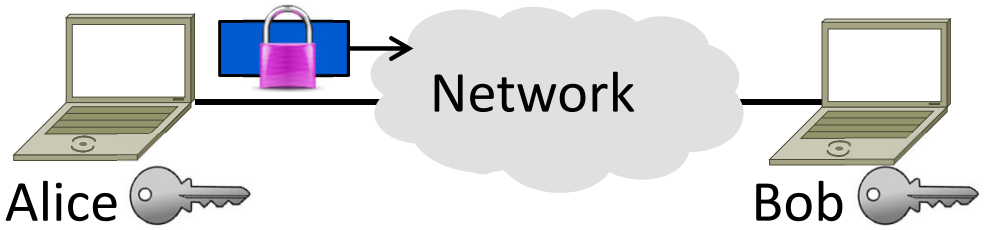
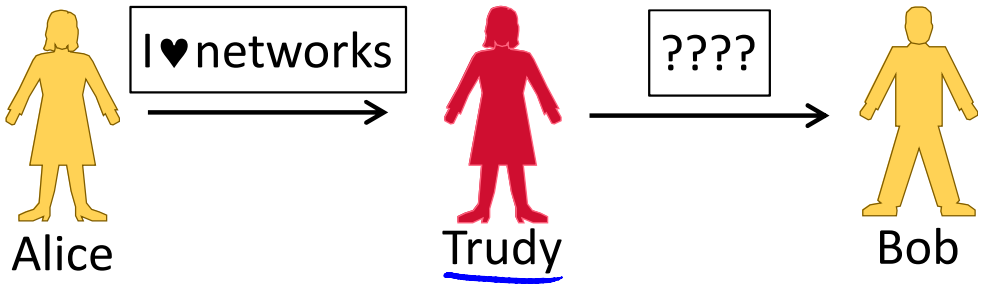
Topic

- Encrypting information to provide authenticity (=correct sender) and integrity (=unaltered)
  - Confidentiality isn't enough



Goal and Threat Model

- Goal is to let Bob verify the message came from Alice and is unchanged
  - This is called integrity/authenticity
- Threat is Trudy will tamper with messages
  - Trudy is an active adversary (interferes)



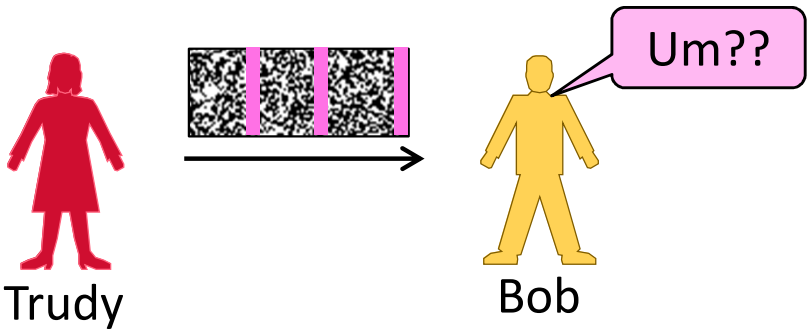
Wait a Minute!

- We're already encrypting messages to provide confidentiality
- Why isn't this enough?

Encryption Issues

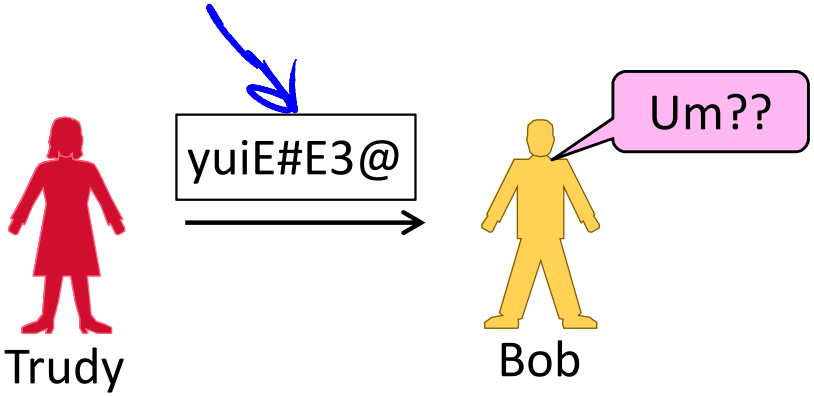
- What will happen if Trudy flips some of Alice's message bits?

→ Bob will decrypt it, and …



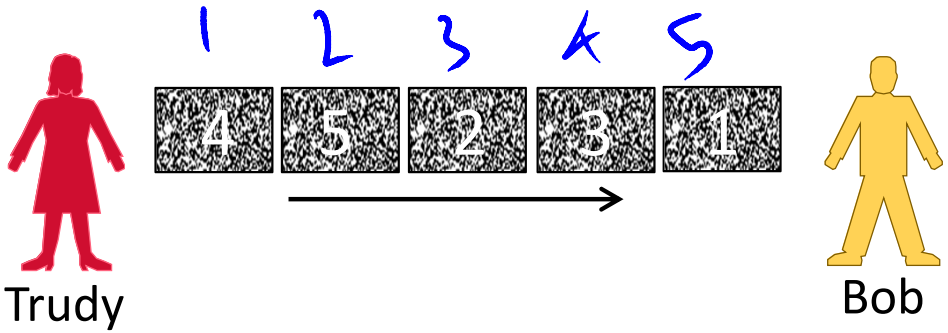
Encryption Issues (2)

- What will happen if Trudy flips some of Alice's message bits?
  - Bob will receive an altered message



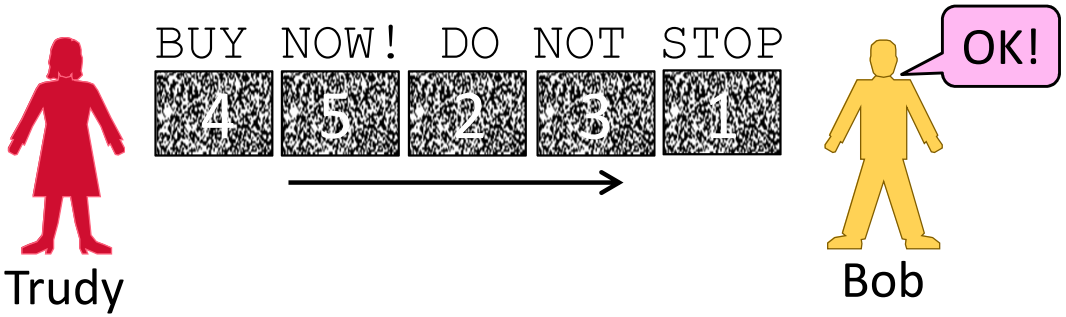
Encryption Issues (3)

- Typically encrypt blocks of data
- What if Trudy reorders message?
  - Bob will decrypt, and …



Encryption Issues (4)

- What if Trudy reorders message?
  - Bob will receive altered message

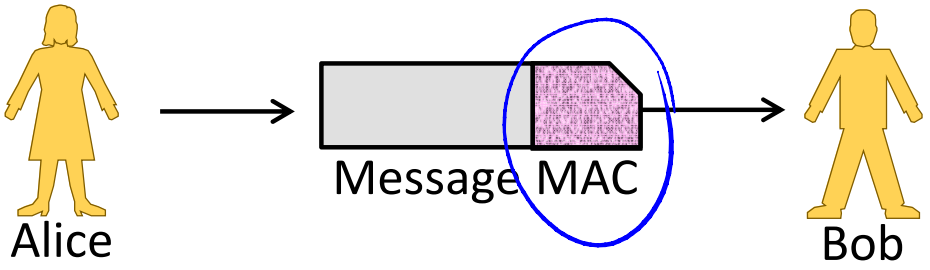


  - Should have been (Woops)

STOP DO NOT BUY NOW!

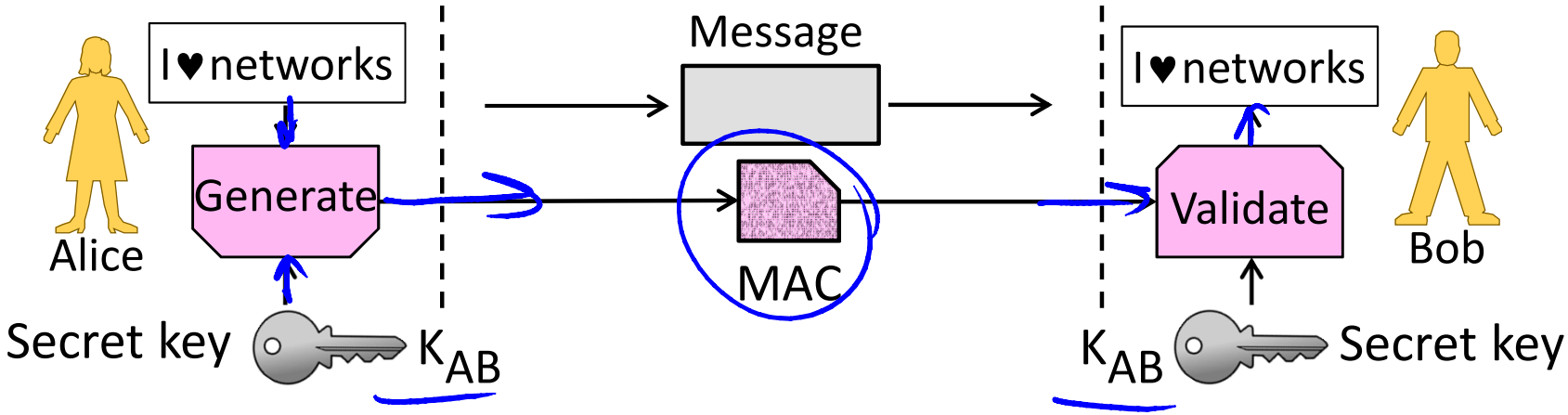
MAC (Message Authentication Code)

- MAC is a small token to validate the integrity/authenticity of a message
  - Send the MAC along with message
  - Validate MAC, process the message
    - Example: HMAC scheme



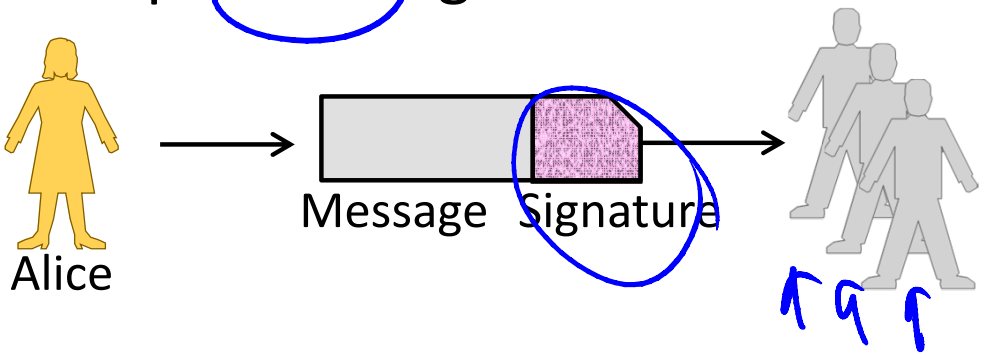
MAC (2)

- Kind of symmetric encryption operation – key is shared
  - Lets Bob validate unaltered message came from Alice
  - Doesn't let Bob convince Charlie that Alice sent the message



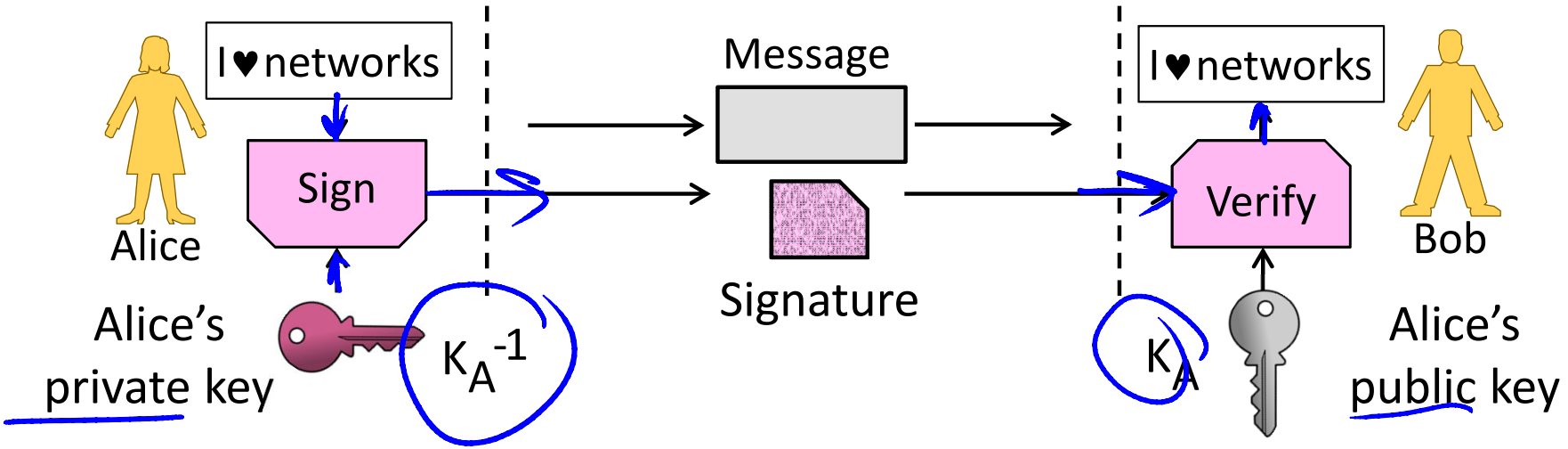
Digital Signature

- Signature validates the integrity/ authenticity of a message
  - Send it along with the message
  - Lets all parties validate
    - Example: RSA signatures



Digital Signature (2)

- Kind of public key operation – public/private key parts
  - Alice signs with private key, K_A^{-1}, Bob verifies with public key, K_A
  - Does let Bob convince Charlie that Alice sent the message

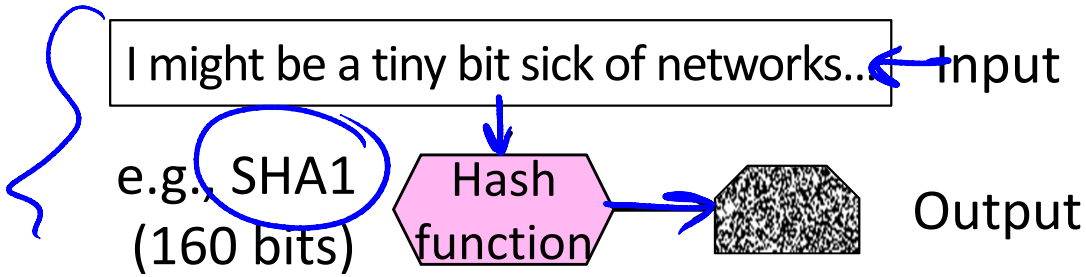


Speeding up Signatures

- Same tension as for confidentiality:
  - Public key has keying advantages
  - But it has slow performance!
- Use a technique to speed it up
  - Message digest stands for message
    - Sign the digest instead of full message

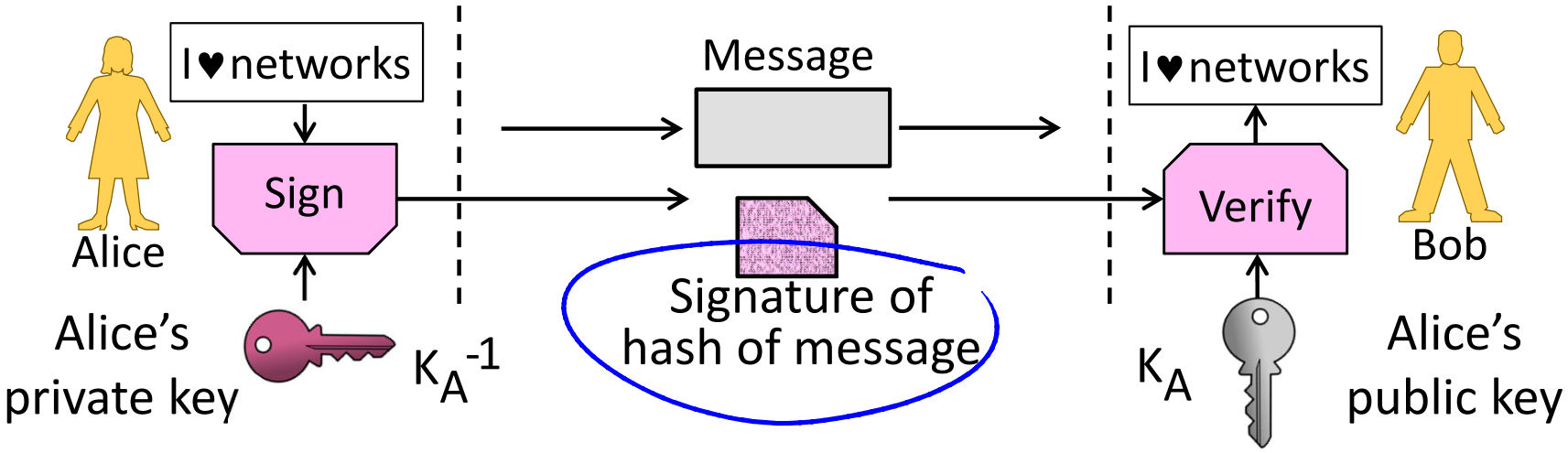
Message Digest or Cryptographic Hash

- Digest/Hash is a secure checksum
  - Deterministically mangles bits to pseudo-random output (like CRC)
  - Can't find messages with same hash
  - Acts as a fixed-length descriptor of message – very useful!



Speeding up Signatures (2)

- Conceptually as before except sign the hash of message
  - Hash is fast to compute, so it speeds up overall operation
  - Hash stands for message as can't find another with same hash

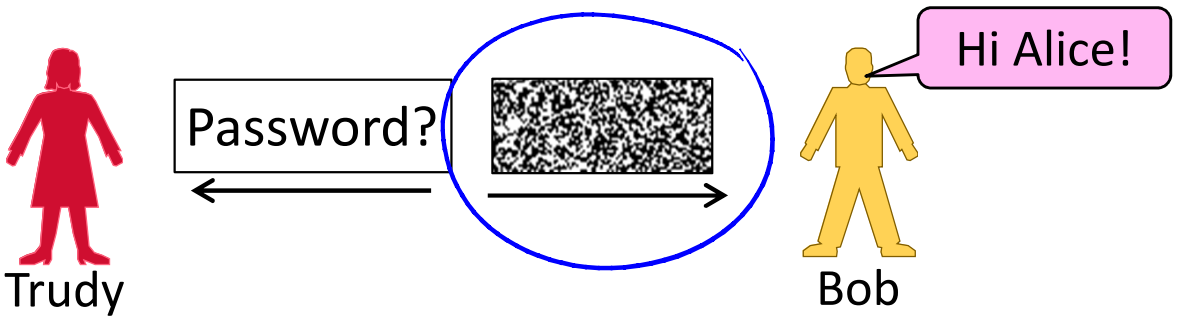


Preventing Replays

- We normally want more than confidentiality, integrity, and authenticity for secure messages!
  - Want to be sure message is fresh
- Don't want to mistake old message for a new one – a replay
  - Acting on it again may cause trouble

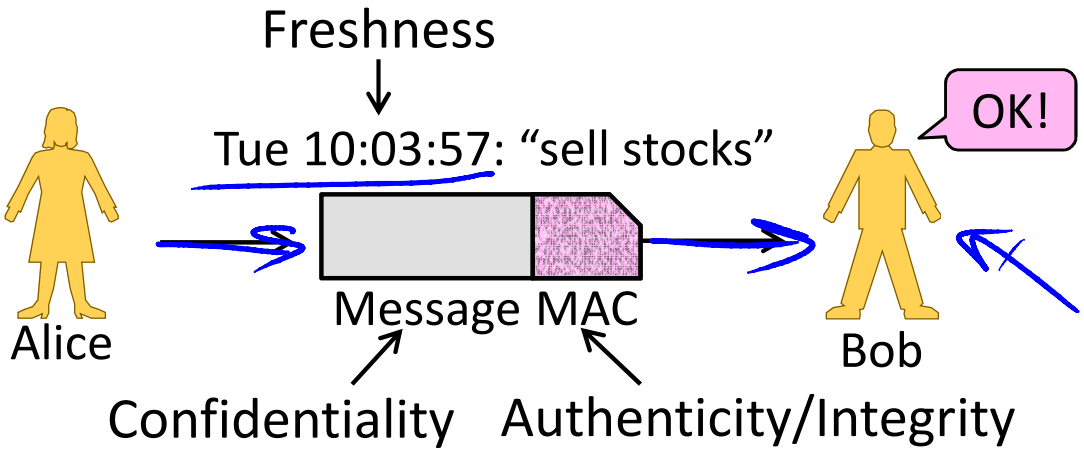
Preventing Replays (2)

- Replay attack:
  - Trudy records Alice's messages to Bob
  - Trudy later replays them (unread) to Bob; she pretends to be Alice



Preventing Replays (3)

- To prevent replays, include proof of freshness in messages
  - Use a timestamp, or nonce



Takeaway

- Cryptographic designs can give us integrity, authenticity and freshness as well as confidentiality. Yay!
- Real protocol designs combine the properties in different ways
  - We'll see some examples
  - Note many pitfalls in how to combine, as well as in the primitives themselves

END