COSC 301
Network Management and Security

Lecture 17: Network Security

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Security of Networks

- Security is something that is not necessary in a trusted world!

FIGURE 10-2 Number of incidents reported to CERT (Computer Emergency Response Team). SOURCE: CERT Statistics, www.cert.org/stats/cert_stats.html.

Cyber Crime Statics and Trends (1)

http://www.go-gulf.com/blog/cyber-crime/

Cyber Crime Statics and Trends (2)

By 2017, the global Cyber Security market is expected to skyrocket to $120.1 billion from $63.7 billion in 2011.

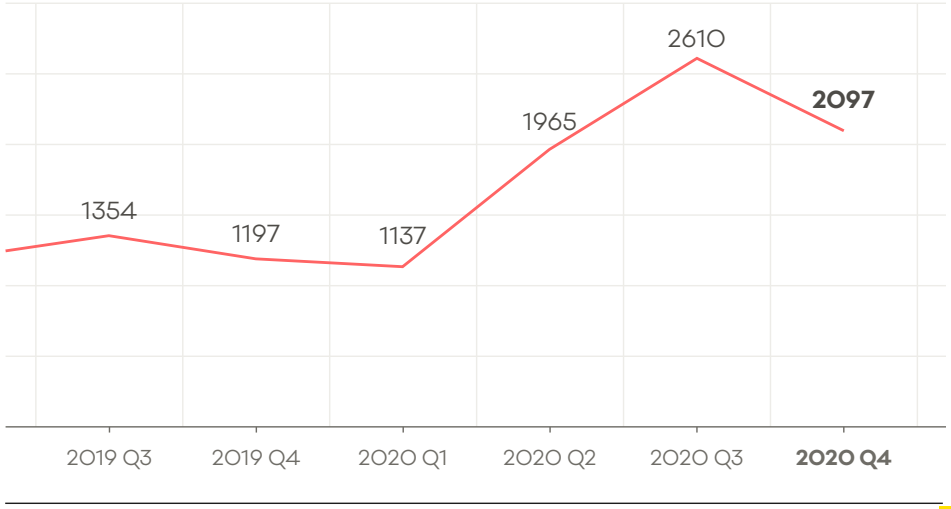
Common Types of Cyber Attacks

Attack types	%
Viruses, malware, worms, trojans	50%
Criminal insider	30%
Theft of data-bearing devices	28%
SQL injection	28%
Phishing	22%
Web-based attacks	17%
Social engineering	17%
others	11%

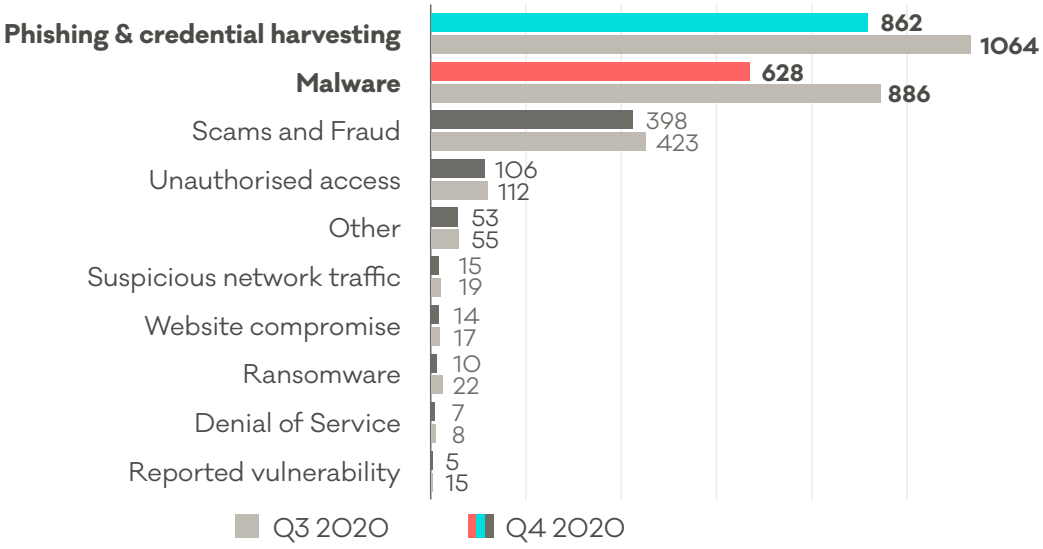
Incidents reported to CERT NZ

2,097
incidents were reported to CERT NZ in Q4 2020.

▼ **20% decrease**
from Q3 2020.



Breakdown by incident category



https://www.cert.govt.nz/about/quarterly-report/quarter-four-report-2020/

Security

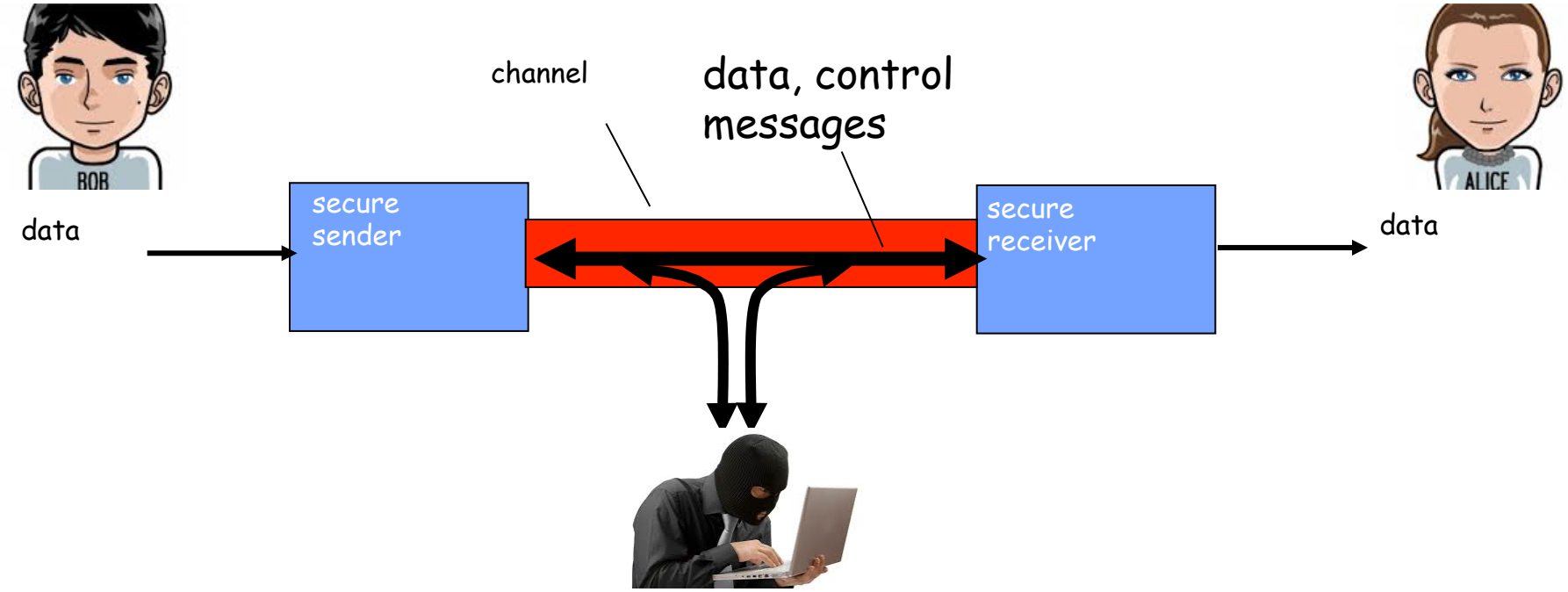
- A system can be compromised by
  - Malicious attacks
  - Accidental erasure of data
  - Disk crashes
  - User ignorance
- Physical security
  - Locked in a secret cabinet
- Trust relationships
  - Trust relationships have be clear before making security policies.
- Security policy
  - Define how secure we want to be, what threats we care about, what controls we implement
  - Balance between risk, convenience and cost

Network Security

- Secures the network, as well as protecting and overseeing operations being done.
  - Confidentiality: only sender, intended receiver should "understand" message contents
  - Authentication: sender, receiver want to confirm identity of each other
  - Message Integrity: sender, receiver want to ensure message not altered (in transit, or afterwards) without detection
  - Access and Availability: which service or device should be accessible to which user, secure access to data

Confidentiality

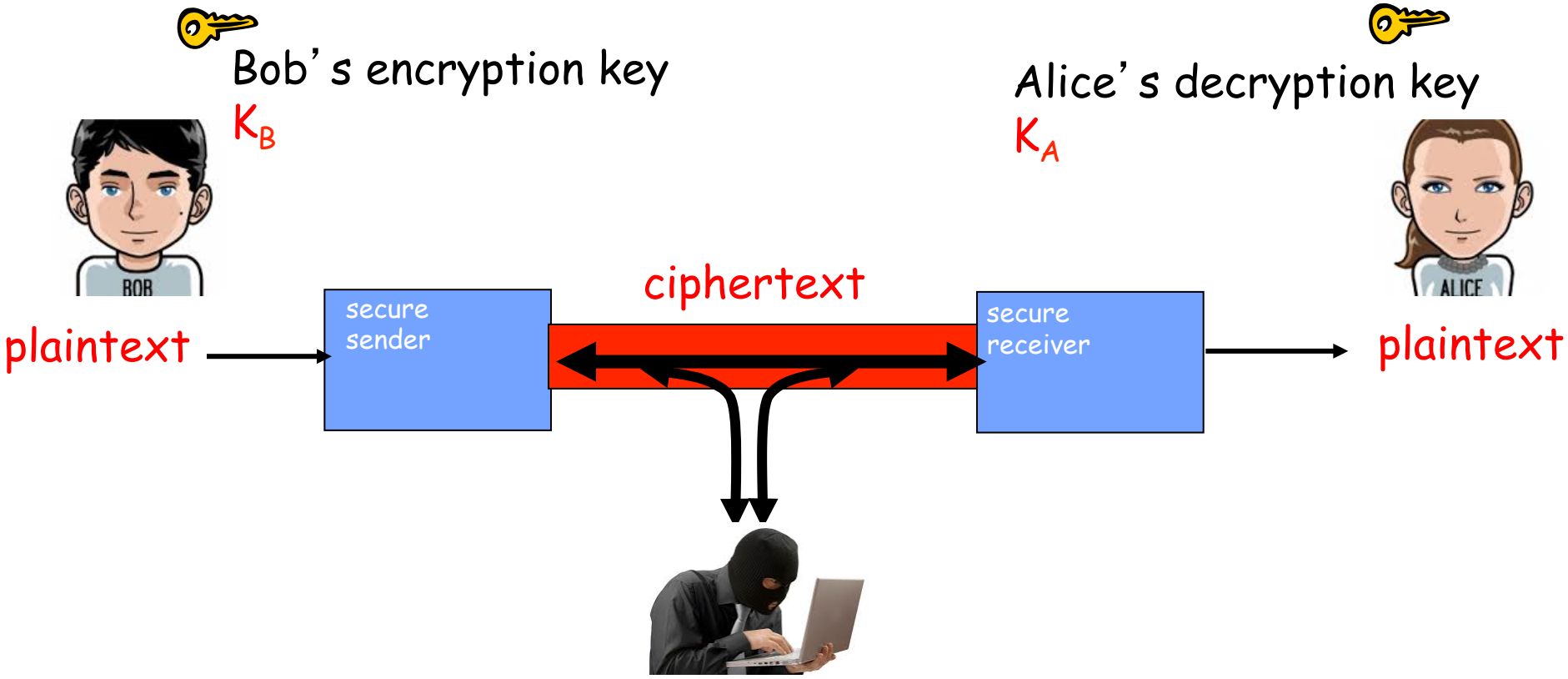
- Friends and enemies: Alice, Bob, and Trudy
  - Bob, Alice (lovers) want to communicate “securely”
  - Trudy (intruder) may intercept, delete, and add messages



What can Trudy do?

- A lot
  - *eavesdrop:* intercept messages
  - actively *insert* messages into connection
  - *impersonation:* can fake (spoof) source address in packet (or any field in packet)
  - *hijacking:* "take over" ongoing connection by removing sender or receiver, inserting himself in place
  - *denial of service*: prevent service from being used by others (e.g., by overloading resources)
  - …

Principle of Cryptography



symmetric key crypto: identical sender and receiver keys
public-key crypto: encryption key *public*, decryption key *private*

Authentication Protocols (1)

- Scenario
  - Alice, the sender, wants to communicate with Bob, the receiver
  - Bob wants Alice to "prove" her identity to him
  - Trudy tries to pretend to be Alice
- AP1.0
  - Alice sends a message to Bob saying she is Alice

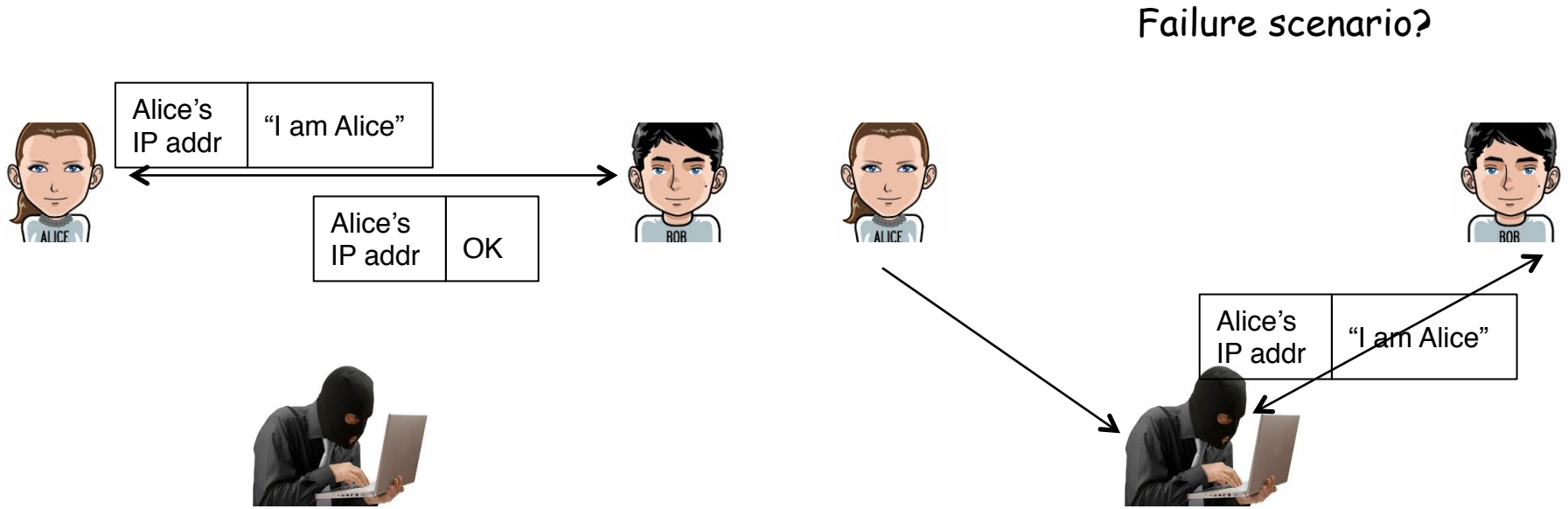
"I am Alice."

Failure scenario?

"I am Alice."

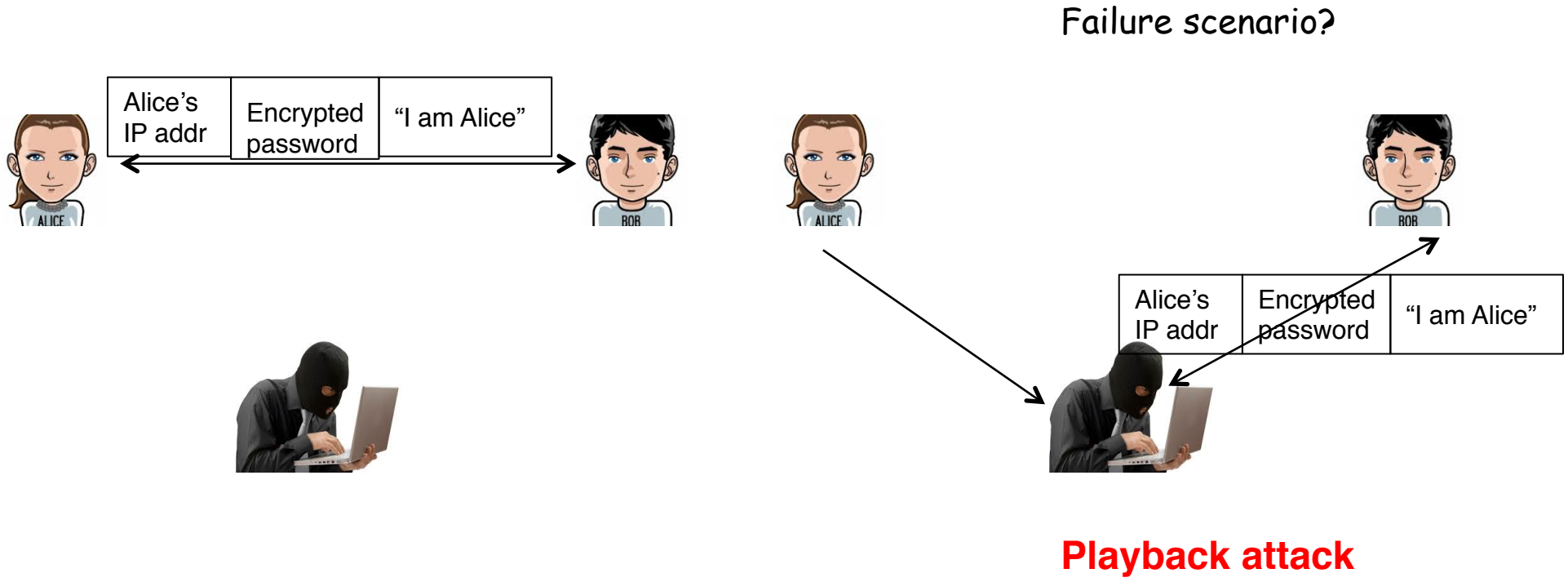
Authentication Protocols (2)

- AP2.0
  - Use the source IP address to authenticate
  - Fails if IP spoofing is used



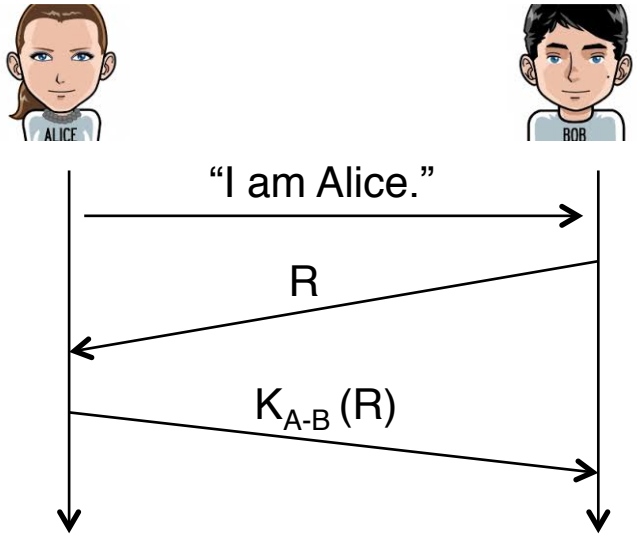
Authentication Protocols (2)

- AP3.0
  - Use secret password
  - Password can be eavesdropped
  - Encrypted password can be played back



Authentication Protocols (3)

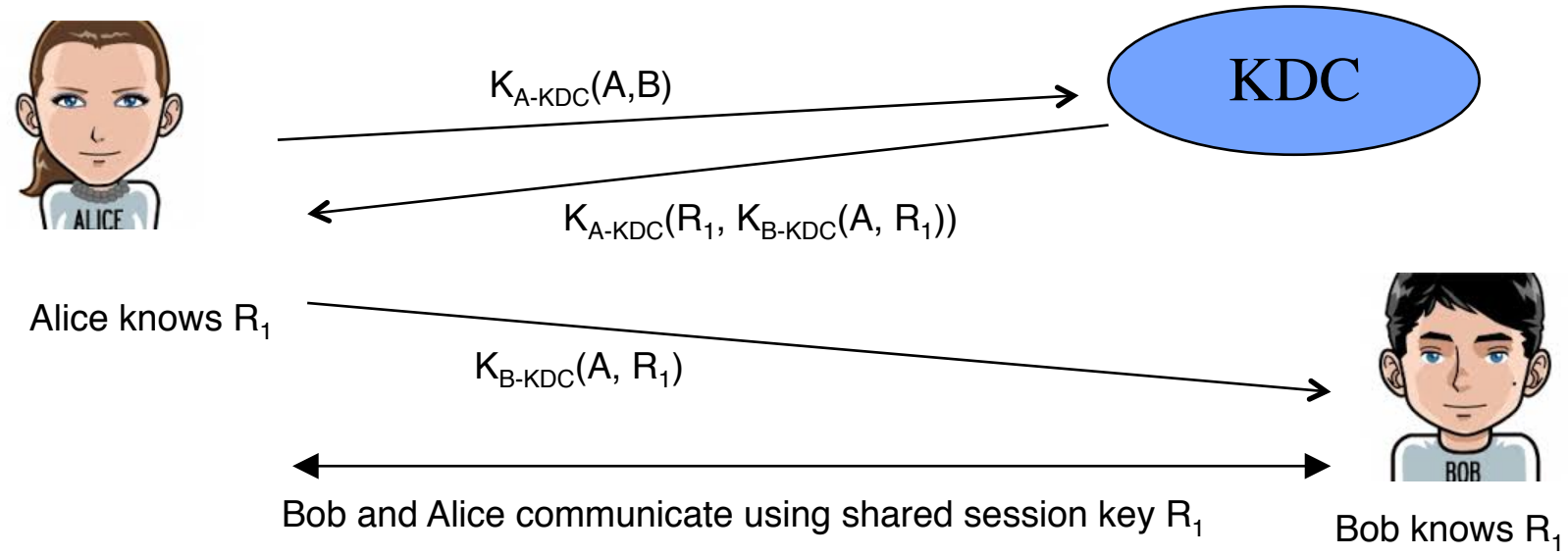
- AP4.0
  - Use a number, called a nonce, that will be used only once in a lifetime
  - The protocol has the following procedures
    - Alice sends "I am Alice", to Bob
    - Bob sends a nonce, R, to Alice
    - Alice encrypts the nonce using Alice and Bob's symmetric secret key, K_{A-B}, and sends it back to Bob
    - Bob decrypts the received message. If the decrypted nonce equals the nonce he sent Alice, then Alice is authenticated.



  - Key distribution can be a logistic problem.

Key Distribution

- Key Distribution Centre (KDC)
  - Everyone has his/her individual key manually installed at KDC (a server) when he/she registers



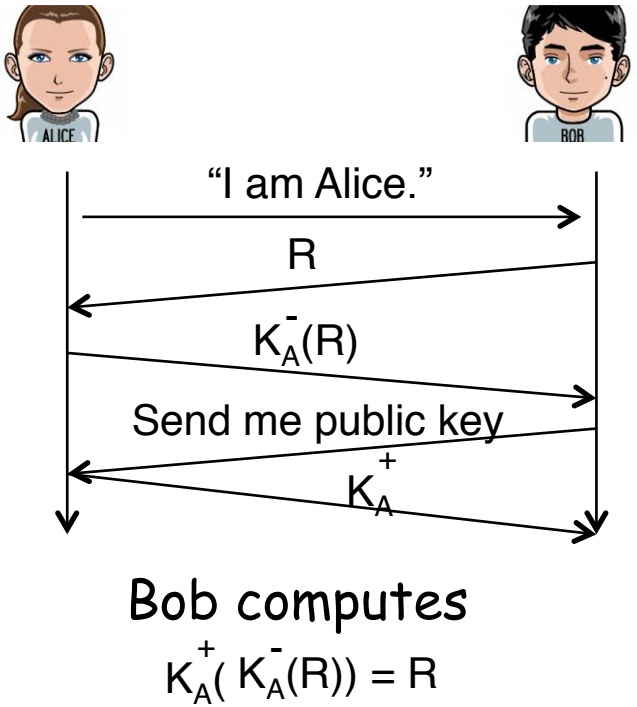
Setting up a one-time session key using a key distribution center

Key Distribution

- Using $K_{A\text{-}KDC}$ to encrypt her communication with the KDC, Alice sends a message to the KDC saying she (A) wants to communicate with Bob(B). The message is denoted as $K_{A\text{-}KDC}$ (A,B)
- The KDC, knowing $K_{A\text{-}KDC}$, decrypts $K_{A\text{-}KDC}$ (A,B). The KDC then generates a random number, R1. This is the shared key value that Alice and Bob will use to perform symmetric encryption when they communicate with each other. R1 is the one-time session key. In addition KDC will send Alice a pair of values A and R1 encrypted by the KDC using Bob's key $K_{B\text{-}KDC}$
- When Alice receives the message from the KDC, extracts R1 from the message and save it, then forwards $K_{B\text{-}KDC}$ (A, R1) to Bob
- Bob decrypts the message and knows the shared key with Alice. He takes care to authenticate Alice using R1 before proceeding further

Authentication Protocols (3)

- AP5.0
  - Use the public key encryption in AP4.0
  - The protocol has the following procedures
    - Alice sends "I am Alice", to Bob
    - Bob sends a nonce, R, to Alice
    - Alice encrypts the nonce using Alice's private key A and sends the encrypted nonce back to Bob
    - Bob decrypts the received message using Alice public key. If the decrypted nonce equals the nonce he sent Alice, then Alice is authenticated.



  - The retrieval of the public key could be a security hole

Access & Availability (1)

- Securing physical access to the network
  - Physical security to servers
  - Physical security to networking devices
- A common guideline

If there is physical access to the equipment, there is no security!

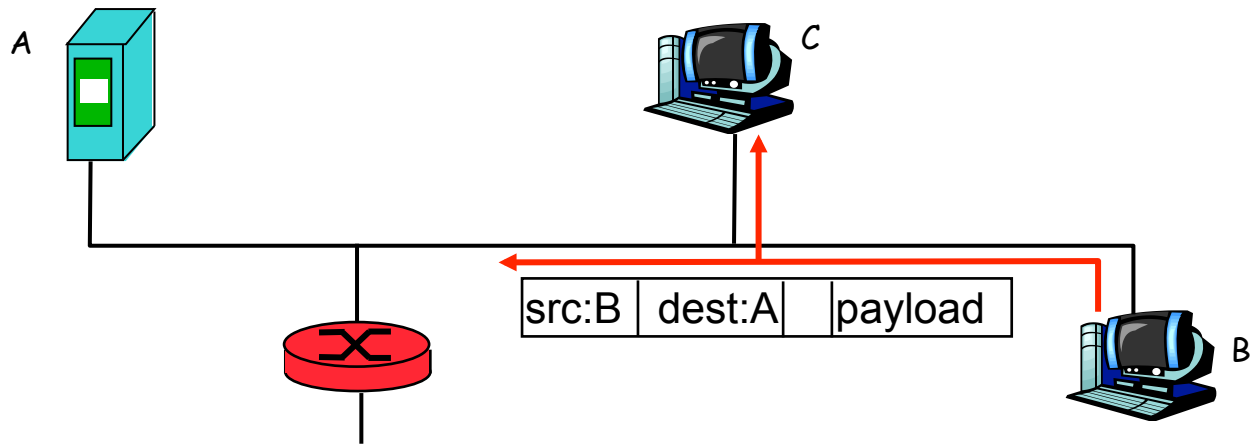
Access & Availability (2)

- Securing access to data
  - *Authentication and authorization:* who is permitted to access which network resources
  - *Encryption/decryption:* data unusable to anyone except the authorized users
  - *Virtual private networks (VPNs):* allow authorized remote access to a private network via the public Internet
  - *Firewalls:* protect a computer from unauthorized access and attacks
  - *Virus and worm protection:* secure data from software designed to destroy data or slow down the computer
  - *Spyware protection:* securing from downloading and running programs that gather personal information
  - *Wireless security*

Internet security threats

Packet sniffing:

- broadcast media
- promiscuous NIC reads all packets passing by
- can read all unencrypted data (e.g. passwords)
- e.g.: C sniffs B's packets



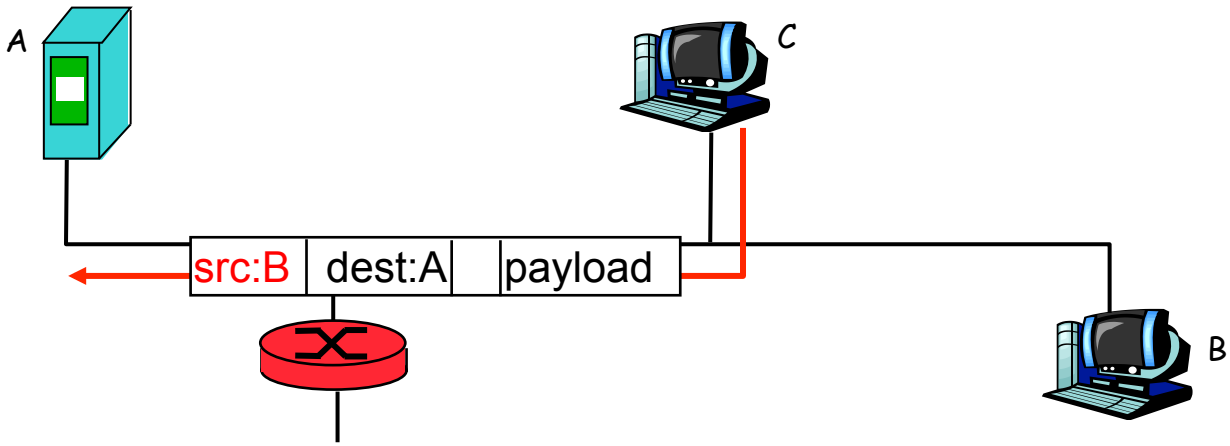
Countermeasures:

- all hosts in organization run software that checks periodically if host interface in promiscuous mode.

Internet security threats

IP Spoofing:

- can generate "raw" IP packets directly from application, putting any value into IP source address field
- receiver can't tell if source is spoofed



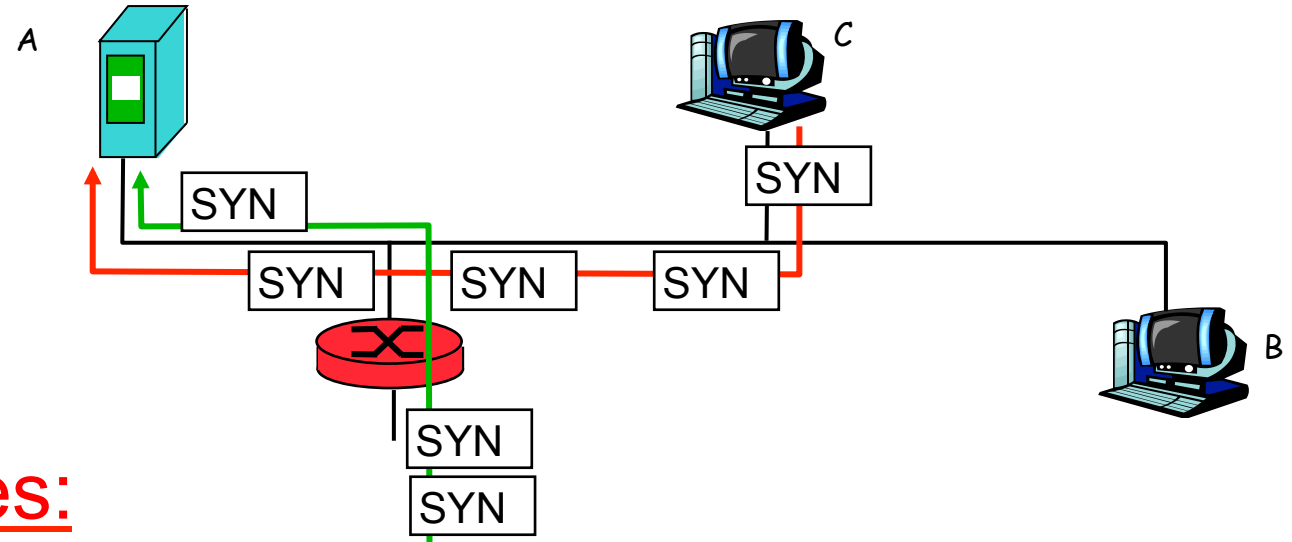
Countermeasures:

- routers shouldn't forward outgoing packets with invalid source addresses (e.g., source address not in router's network)
- but ingress filtering can not be mandated for all networks

Internet security threats

Denial of service (DOS):

- flood of maliciously generated packets to swamp a receiver
- Distributed DOS (DDOS): multiple coordinated sources swamp a receiver
- e.g., C and remote host SYN-attack A



Countermeasures:

- filter out flooded packets (e.g., SYN) before reaching host
- traceback to source of floods

Security Policy

- Security policy
  - A formal statement of the rules by which people who are given access to an organisation's technology and information assets must abide
  - RFC 2196: Site Security Handbook. It is a guide to developing security policies for sites that are connected to the Internet

- Purposes of security policies
  - Policy is the first layer of protection for your resources and information
  - To inform users, staff and managers of their obligations for protecting technology and information assets
    - Should specify the mechanism through which these requirements can be met

Security Policy

- Policies have to be written explicitly
  - Implied policies do not help
- Who should be involved in writing of a policy?
  - Site security manager
  - IT technical staff
  - User representatives
  - Security incident response team
  - Responsible management
  - Legal counsel

Security Policy

- Aspects of a security policy
  - From outside the organisation
  - From inside the organisation
  - Against the interruption of services
  - From user error
  - User convenience
  - What resources are we trying to protect?
  - Whom are we trying to protect the resources from?
  - What will happen if the system is compromised?
  - How much work will we need to put into protecting the system? What risk is acceptable?
  - Protect from loss: backup should be stored at a different physical location to the original.

Security Policy

- Criteria for a good policy
  - Viable implementation through system administration procedures,
  - Acceptable by the users
  - Can be forced with security tools and sanctions
  - Clearly defines the areas of responsibility for the users, administrators and management
- Otago IT policies
  - http://www.otago.ac.nz/its/policies/otago018522.html

Summary

- Cyber security statistics and trends
- Authentication protocols
- Key distribution
- Internet security threats and countermeasures
  - Packet sniffing
  - IP spoofing
  - Denial of service attack
- Security policy