Network Security (NetSec)

IN2101 – WS 17/18

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Chapter 1: Introduction

Network InSecurity

Network “Security” offered by our Secret Services

Attacker Models

General Attacker Model

Attackers Limited by their Position in the Network

Security Goals

Security Goals Technically Defined

Threats

Threats Technically Defined

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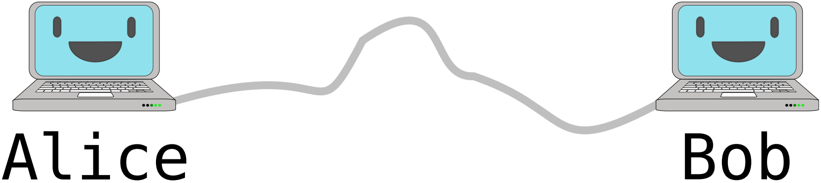
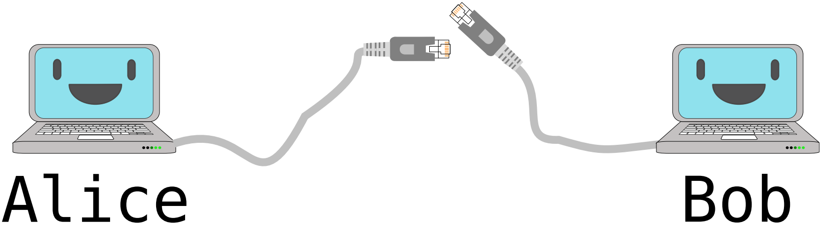
- By example: An Ethernet cable
- How secure is it?



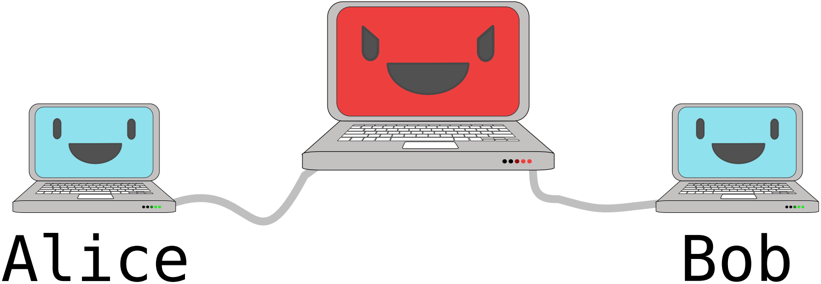
Network InSecurity

- Step 1: Obtain a knife
- Step 2: Add RJ45 adapters



Network InSecurity

- Step 3: Configure transparent ethernet bridging
- You are now in full control of the traffic
  - read
  - modify
- Technical term: Man in the Middle (MitM)



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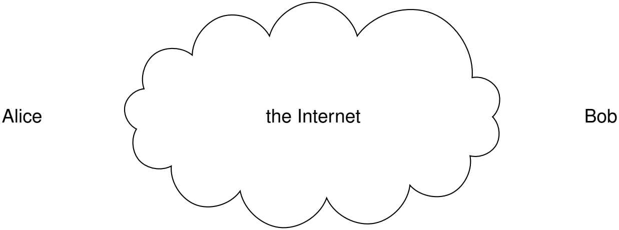
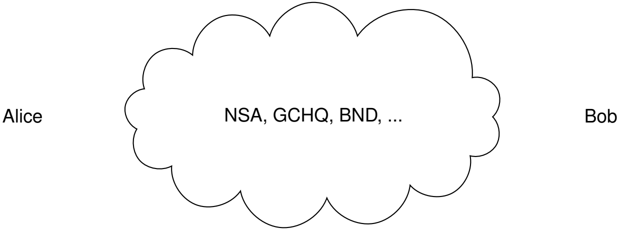


Alice

the Internet

Bob

Network InSecurity

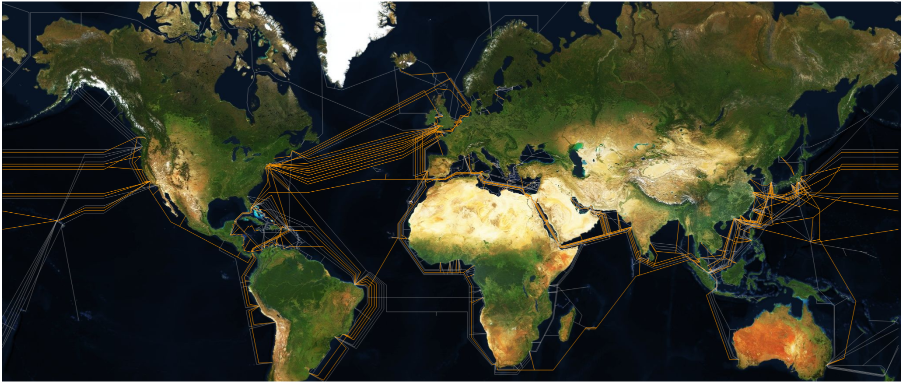


Alice

NSA, GCHQ, BND, ...

Bob

Network “Security” offered by our Secret Services



http://lifewinning.com/submarine-cable-taps/

- Passive attacks: wiretapping, . . .
- Active attacks: Quantum Insert, . . .
- Combined: economic espionage, . . .

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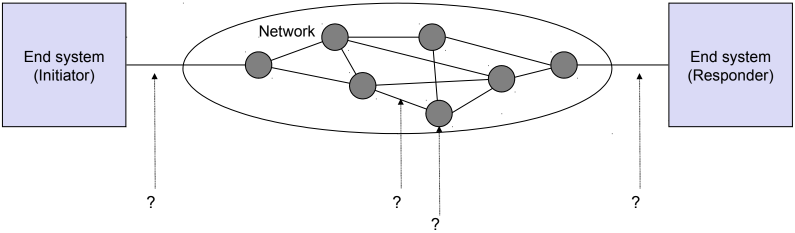
- Attacking communications on the message level
- Passive attacks:
  - Eavesdropping of messages
- Active attacks
  - all passive attacks
  - Delay
  - Replay
  - Deletion
  - Modification
  - Insertion

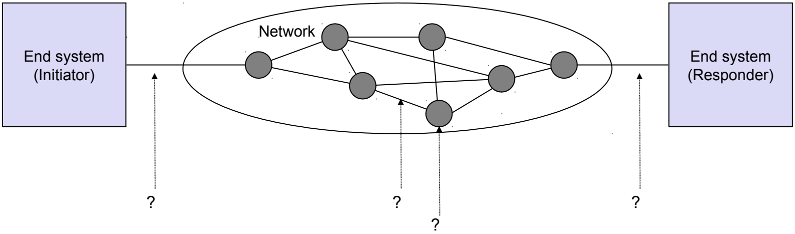
General Attacker Model

- The attacker is the network
- And can perform any active attack
- But cannot break cryptographic primitives
- This is called the Dolev-Yao attacker model
- If not stated otherwise, we will always assume this attacker model.

Attackers Limited by their Position in the Network

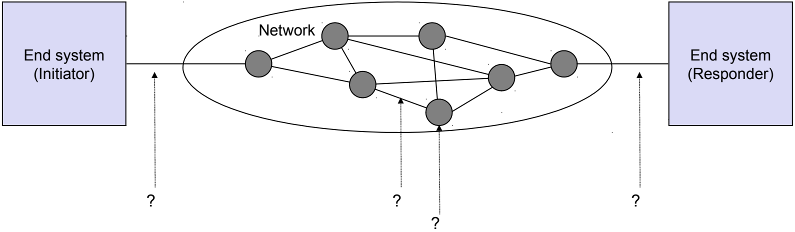


Attackers Limited by their Position in the Network



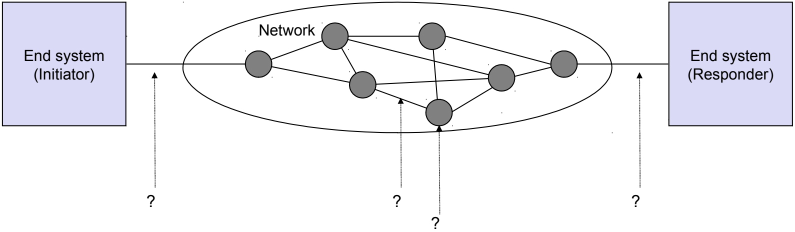
- Assume the Attacker is close to you
- Example: You sit in a cyber cafe and accidentally connected to the attacker’s hotspot
  - The attacker can perform any active attacks on you
  - But you can bypass this attacker: Establish a secure tunnel to a server in the Internet
  - Route all your packets over the secure tunnel
  - The attacker can now perform only DOS (Denial Of Service) attacks against you

Attackers Limited by their Position in the Network



- Assume the Attacker is close to your servers
- Example: She rented a VM on the same host machine where your virtual server is running
  - The attacker could try to perform timing attacks against you
  - By measuring how long certain operations take at your server, the attacker might be able to break a security service
  - (only if the service is vulnerable to side channel attacks)
  - Such measurement is usually not possible over the Internet

Attackers Limited by their Position in the Network



- Assume the Attacker is somewhere in the Internet
- Internet: Best effort packet switching
- End-user has no control how packets are routed
- Are all AS/ISP trustworthy?
- Does you ISP alter your packets?
  - “value added service” i.e. your ISP places advertisement on the websites you are visiting
- NSA/GCHQ/BND/... black boxes are basically everywhere

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- Data Integrity
  - No improper or unauthorized change of data
- Confidentiality
  - Concealment of information
- Availability
  - Services should be available and function correctly
- Authenticity
  - Entity is who she claims to be
- Accountability german: „*Zurechenbarkeit*“
  - Identify the entity responsible for any communication event
- Controlled Access
  - Only authorized entities can access certain services or information

Quiz

- What is needed to support non-repudiation? („*Nicht-Abstreitbarkeit*“)

Quiz

- What is needed to support non-repudiation? („*Nicht-Abstreitbarkeit*“)
  - Accountability

Quiz

- What is necessary to support accountability?

Quiz

- What is necessary to support accountability?
    - Authenticity

Quiz

- What do you want to support deterrence („*Abschreckung*“)

Quiz

- What do you want to support deterrence („*Abschreckung*“)
    - Accountability

Quiz

- What is data origin integrity?

Quiz

- What is data origin integrity?
    - Authenticity

Quiz

- What it the difference?
- Authentication
- Authorization

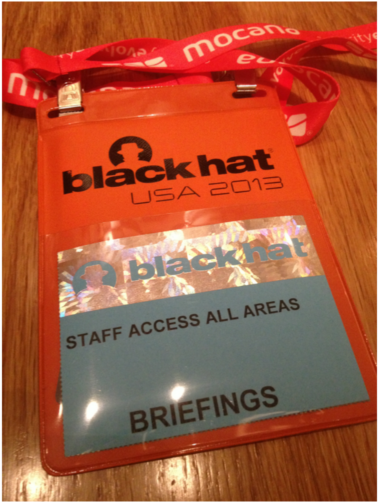
Quiz

- What it the difference?
- Authentication
  - Proves who you are
  - Associated security goal: Authenticity
- Authorization
  - Defines what you are allowed to do
  - Associated security goal: Controlled Access

Quiz

- What it the difference?
- Authentication
    - Proves who you are
    - Associated security goal: Authenticity
    - E.g. your passport
- Authorization
    - Defines what you are allowed to do
    - Associated security goal: Controlled Access
    - E.g. "*are you on the VIP list?*"

Mixing Authentication and Authorization



https://twitter.com/mikko/status/587973545797492738

My best attempt was registering to Black Hat with first name: "Staff" and last name: "Access All Areas"

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Threats

- Abstract Definition
  - A threat in a communication network is any possible event or sequence of actions that might lead to a violation of one or more security goals
  - The actual realization of a threat is called an attack

Threats Technically Defined

- Masquerade
  - An entity claims to be another entity (also called “impersonation”)
- Eavesdropping
  - An entity reads information it is not intended to read
- Loss or Modification of (transmitted) Information
  - Data is being altered or destroyed
- Denial of Communication Acts (Repudiation)
  - An entity falsely denies its participation in a communication act
- Forgery of Information
  - An entity creates new information in the name of another entity
- Sabotage/Denial of Service
  - Any action that aims to reduce the availability and / or correct functioning of services or systems
- Authorization Violation:
  - An entity uses a service or resources it is not intended to use

Example 1

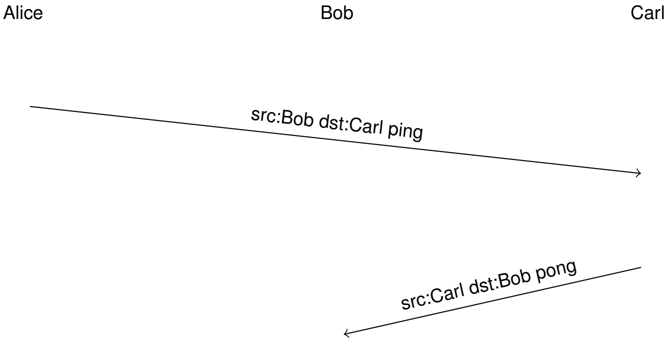
- Eavesdropping + Authorization Violation
- Example

  -
    ```
    Alice@Box$ ./rootremoteshell $ROUTER
    root@router# tcpdump | grep password
    ```
- If Alice does not start modifying the traffic, she is a passive attacker
- Note: If not stated otherwise, we assume that attackers don’t have remote code execution on our boxes

Example 2

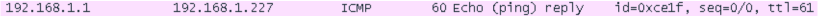
- Masquerade + Forgery of Information
- Example
  - Alice pretends to be Bob
  - `Alice@Box$ hping3 --count 1 --spoof $BOB --icmp --icmptype 8 $CARL`
  - Bob gets an ICMP Echo Reply which he never requested
- Alice is an active attacker

Example 2: IP Spoofing cont.



Example 2: IP Spoofing cont.

- Alice: 192.168.1.170
- Bob 192.168.1.227
- Carl: 192.168.1.1
- Alice sends the spoofed packet
  - Internet Protocol Version 4, Src: 192.168.1.227, Dst: 192.168.1.1; ICMP Echo Request
- Carl replies to the source address specified
- Bob receives a lonely echo reply
  - Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.1.227; ICMP Echo Reply

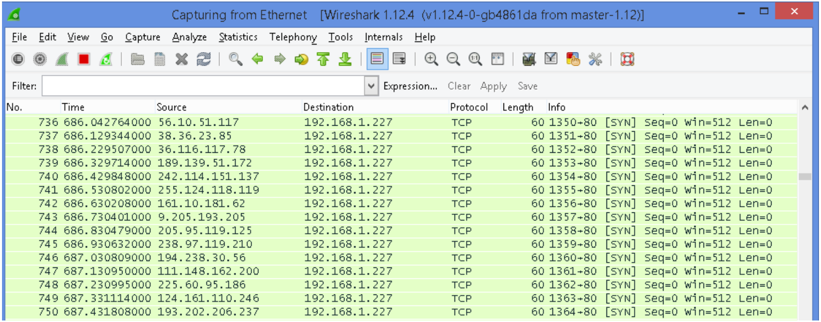


```
192.168.1.1          192.168.1.227        ICMP        60 Echo (ping) reply    id=0xce1f, seq=0/0, ttl=61
```

Example 3

- Denial of Service
- Example
  - Bob runs a webserver (http, tcp port 80) with very few memory
  - Alice floods Bob with TCP SYN packets
  - `Alice@Box$ hping3 --fast --count 42 --syn --destport 80 $BOB`
  - Bob allocates memory to store the 42 connections in the SYN-RECEIVED state
- Now Alice starts to deny that she is responsible for the attack
- Denial of Service + Forgery of Information + Denial of Communication Acts
- Example
  - `Alice@Box$ hping3 --fast --count 42 --rand-source --syn --destport 80 $BOB`
  - `--rand-source`: random spoofed source IP address

Example 3



Capturing from Ethernet [Wireshark 1.12.4 (v1.12.4-0-gb4861da from master-1.12)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter:
Expression... Clear Apply Save

```
No.    Time            Source            Destination      Protocol  Length Info
   736 686.042764000 56.10.51.117      192.168.1.227    TCP           60 1350→80 [SYN] Seq=0 Win=512 Len=0
   737 686.129344000 38.36.23.85       192.168.1.227    TCP           60 1351→80 [SYN] Seq=0 Win=512 Len=0
   738 686.229507000 36.116.117.78     192.168.1.227    TCP           60 1352→80 [SYN] Seq=0 Win=512 Len=0
   739 686.329714000 189.139.51.172    192.168.1.227    TCP           60 1353→80 [SYN] Seq=0 Win=512 Len=0
   740 686.429848000 242.114.151.137   192.168.1.227    TCP           60 1354→80 [SYN] Seq=0 Win=512 Len=0
   741 686.530802000 255.124.118.119   192.168.1.227    TCP           60 1355→80 [SYN] Seq=0 Win=512 Len=0
   742 686.630208000 161.10.181.62     192.168.1.227    TCP           60 1356→80 [SYN] Seq=0 Win=512 Len=0
   743 686.730401000 9.205.193.205     192.168.1.227    TCP           60 1357→80 [SYN] Seq=0 Win=512 Len=0
   744 686.830479000 205.95.119.125    192.168.1.227    TCP           60 1358→80 [SYN] Seq=0 Win=512 Len=0
   745 686.930632000 238.97.119.210    192.168.1.227    TCP           60 1359→80 [SYN] Seq=0 Win=512 Len=0
   746 687.030809000 194.238.30.56     192.168.1.227    TCP           60 1360→80 [SYN] Seq=0 Win=512 Len=0
   747 687.130950000 111.148.162.200   192.168.1.227    TCP           60 1361→80 [SYN] Seq=0 Win=512 Len=0
   748 687.230995000 225.60.95.186     192.168.1.227    TCP           60 1362→80 [SYN] Seq=0 Win=512 Len=0
   749 687.331114000 124.161.110.246   192.168.1.227    TCP           60 1363→80 [SYN] Seq=0 Win=512 Len=0
   750 687.431808000 193.202.206.237   192.168.1.227    TCP           60 1364→80 [SYN] Seq=0 Win=512 Len=0
```

- Why does the attack succeed?
- This is a good opportunity to refresh your knowledge about the TCP 3-way handshake

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