Network Security (NetSec)

IN2101 – WS 16/17

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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

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Threats Technically Defined

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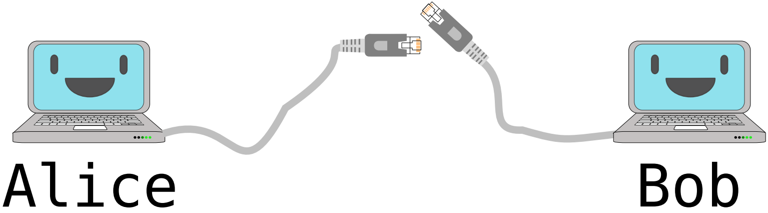
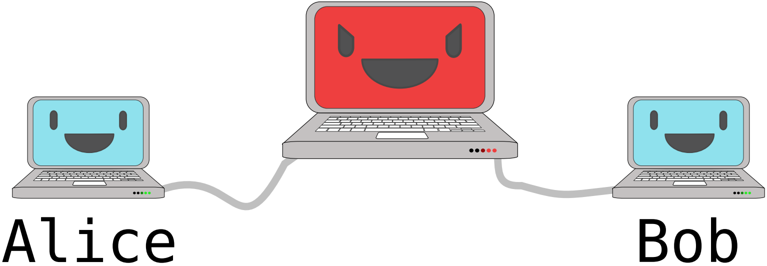
- By example: An Ethernet cable
- How secure is it?

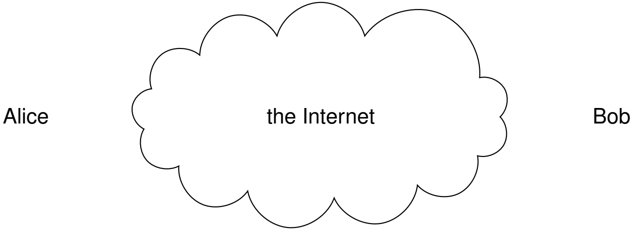
- Step 1: Obtain a knife
- Step 2: Add RJ45 adapters



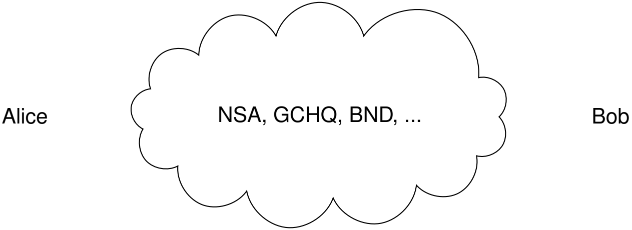
- Step 3: Configure transparent ethernet bridging
- You are now in full control of the traffic
  - read
  - modify
- Technical term: Man in the Middle (MitM)



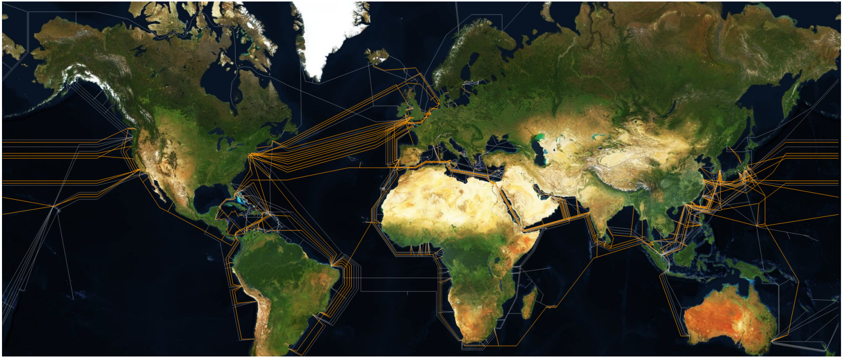
Network InSecurity



Network InSecurity



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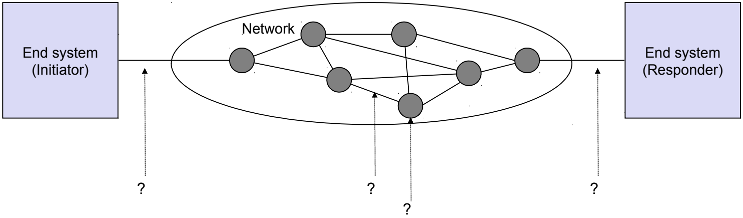
- Attacking communications on the message level
- Passive attacks:
  - Eavesdropping of messages
- Active attacks
  - all passive attacks
  - Delay
  - Replay
  - Deletion
  - Modification
  - Insertion

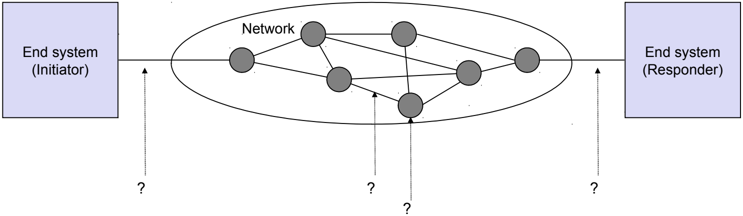
General Attacker Model

- 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

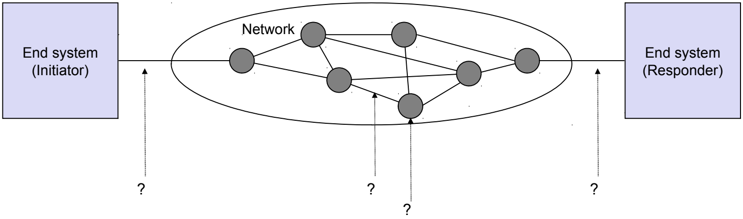


Attackers Limited by their Position in the Network



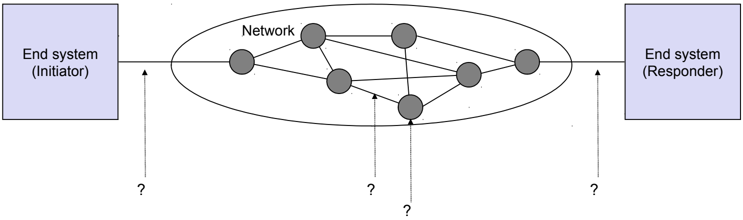
- Assume the Attacker is close to you
- Example: You sit in a cyber cafe and accidentally connected to the attacker’s hotspot
  - The attacker can perform any active attacks on you
  - But you can bypass this attacker: Establish a secure tunnel to a server in the Internet
  - Route all your packets over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

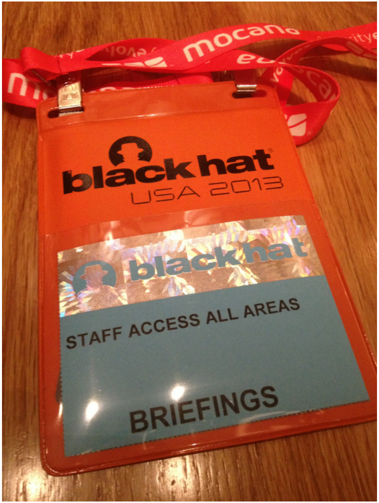
Quiz

- 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



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

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

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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

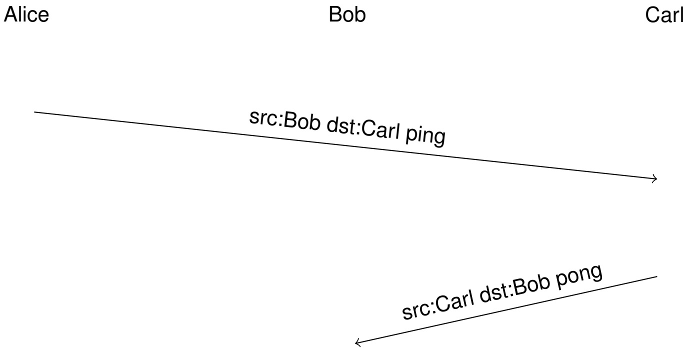
- Eavesdropping + Authorization Violation
- Example

  -
    ```
    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

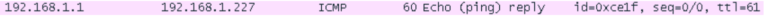
- Masquerade + Forgery of Information
- Example
  - Alice pretends to be Bob
  - `Alice@Box$ hping3 --count 1 --spoof $BOB --icmp --icmptype 8 $CARL`
  - Bob gets an ICMP Echo Reply which he never requested
- Alice is an active attacker

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

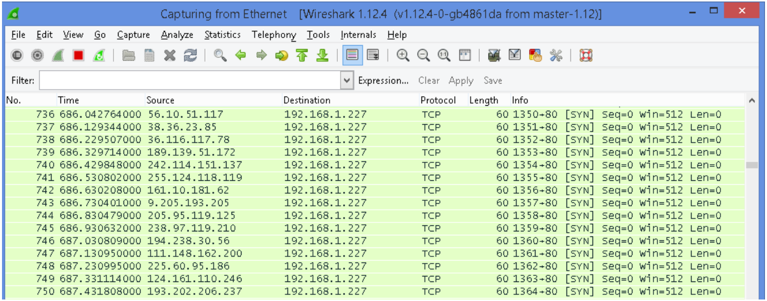


```
192.168.1.1          192.168.1.227          ICMP          60 Echo (ping) reply    id=0xce1f, seq=0/0, ttl=61
```

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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