Network Security

Security in local-area networks

Radboud University, The Netherlands

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A two-slide intro to networking I

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- Command on `arya`:

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- What information (sequence of bits) goes through the cable?

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- `arya` closes the session, `tyrion` closes the session

Sniffing traffic – the good old days

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- For > 2 computers need some joint connection
- A *hub* (active hub) repeats bits received on one port on all other ports
- Simplified view: all connected Ethernet cables "soldered together"
- `joffrey` plugs his computer into the hub:
  - Can listen (sniff, eavesdrop) to all communication between `arya` and `tyrion`
  - Can jam all communication between `arya` and `tyrion` (DOS)
  - Can impersonate `tyrion` or `arya` (more later)

Switched Ethernet

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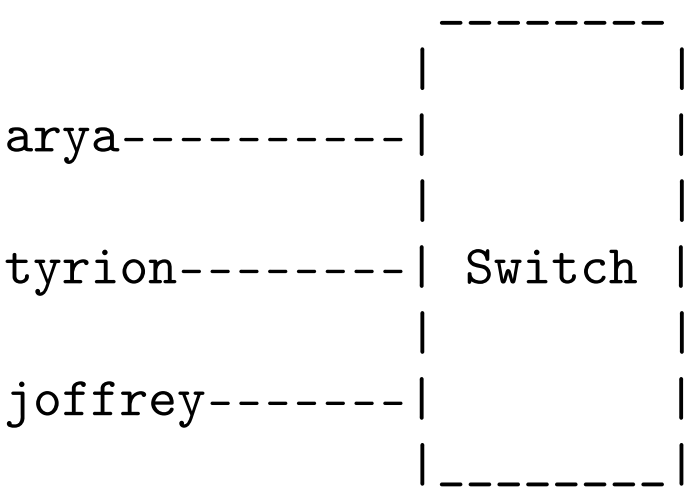
- Switched Ethernet creates separate *collision domains* for each port
- Switched Ethernet also creates separate "sniffing domains" for each port
- How about our nice attacks, do they still work?

Put back the hub

Before the attack



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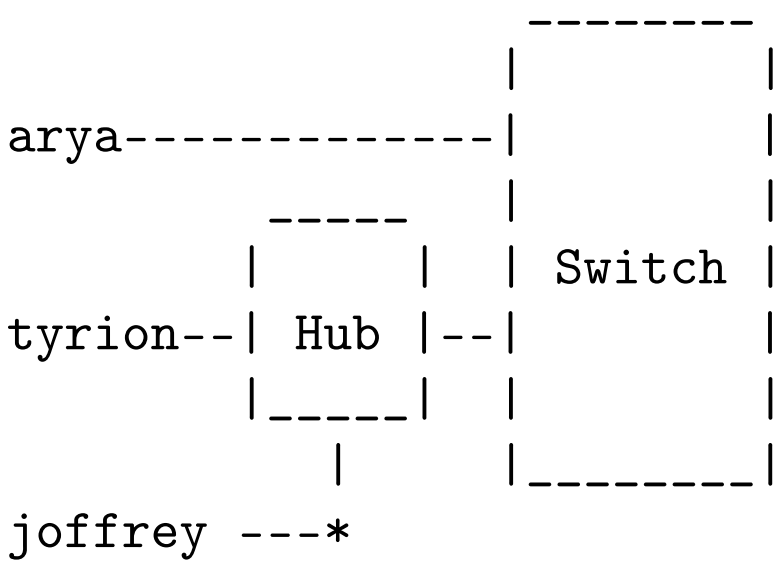

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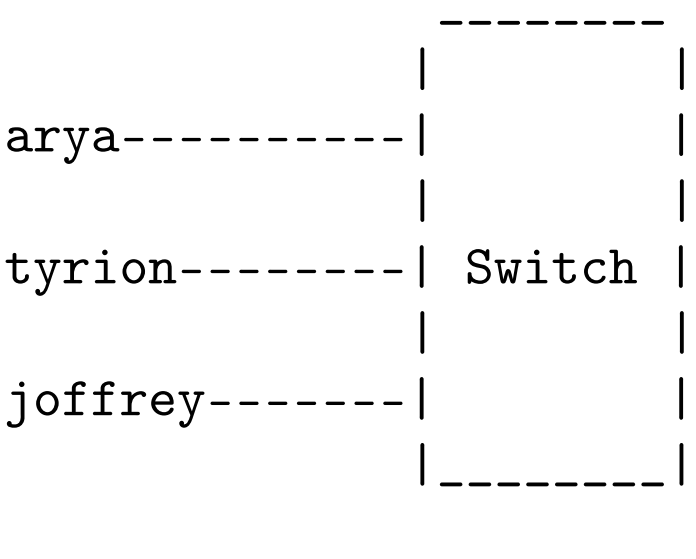

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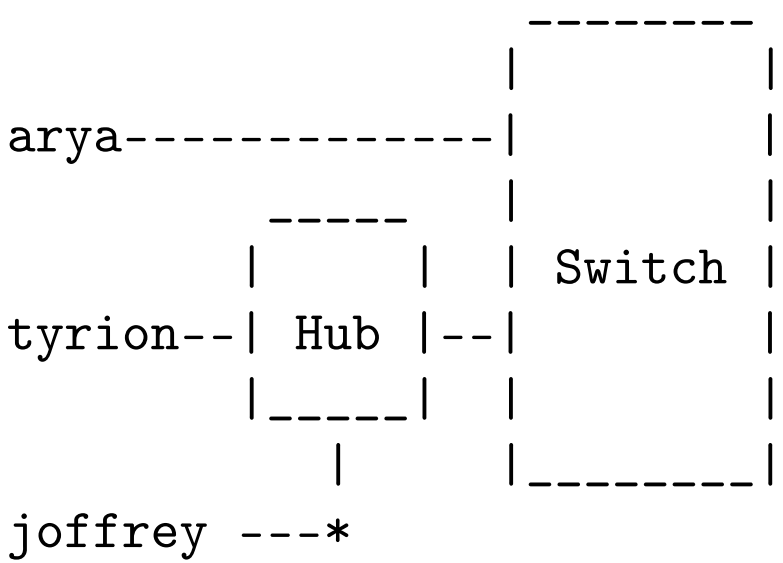

- Can only sniff traffic to and from `tyrion`, but often that's enough
- If you have an old hub, keep it!
- Could also replace the switch by a hub, but that causes all kind of problems (performance, need access to the switch, etc)

ARP Cache poisoning

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- Idea: `joffrey` can simply answer with his MAC address
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- Various good reasons for gratuitous ARP:
  - Announce IP+MAC at boot time
  - Announce changed IP address to other hosts
  - IP-address takeover in high-performance clusters

`arpspoof` – convenient ARP spoofing

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- Now use your favorite sniffer on `tyrion` to see traffic between 192.168.42.2 and 192.168.42.3
- Remark: `arpspoof` is part of the dsniff suite

Ettercap

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- Text mode and different GUIs
- Some features of Ettercap:
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- Very simple (but important) aspect: find all hosts of the network
- Simply send ARP requests for all hosts on the (sub)-network

From RFC 826 – An Ethernet Address Resolution Protocol

```
?Do I have the hardware type in ar$hrd?
Yes: (almost definitely)
  [optionally check the hardware length ar$hln]
  ?Do I speak the protocol in ar$pro?
  Yes:
    [optionally check the protocol length ar$pln]
    Merge_flag := false
    If the pair <protocol type, sender protocol address> is
        already in my translation table, update the sender
        hardware address field of the entry with the new
        information in the packet and set Merge_flag to true.
    ?Am I the target protocol address?
    Yes:
      If Merge_flag is false, add the triplet <protocol type,
          sender protocol address, sender hardware address> to
          the translation table.
      ?Is the opcode ares_op$REQUEST?  (NOW look at the opcode!!)
      Yes:
        Swap hardware and protocol fields, putting the local
            hardware and protocol addresses in the sender fields.
        Set the ar$op field to ares_op$REPLY
        Send the packet to the (new) target hardware address on
            the same hardware on which the request was received.
```

Another kind of ARP spoofing ctd.

- First a clarification of terms:
  - `ar$hrd`: Hardware address space, e.g., Ethernet
  - `ar$pro`: Protocol address space
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- Ettercap supports this: set `arp_poison_request = 1` in `/etc/ettercap/etter.conf`

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- Overflow the table

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- Effects of this depend highly on the switch
- Some (many?) switches will fall back to behave like a hub

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- Disable gratuitous ARP (this may break things)
- Also, it's not so easy (at least on Linux):
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- Generally it's hard to defend against ARP spoofing, because

  ARP does not have any authentication mechanism

VLANs

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- You can think of a VLAN as physically separated LANs (but easier to manage)
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- Example use:
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- This does not prevent ARP-level attacks
- Can limit the damage caused by ARP-level attacks ("students can only attack each other")

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> *"A MAC address is a unique character string, and since it identifies a specific physical device – one individual NIC – the MAC address, by convention, never changes for the life of the NIC. [...] Because your NIC's MAC address is permanent, it's often referred to as the "real," or physical, address of a computer."*

http://www.watchguard.com/infocenter/editorial/135250.asp

MAC spoofing

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(http://netsecurity.about.com/od/quicktip1/qt/qtwifimacfilter.htm)

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> *"It is possible to spoof the MAC address, so an attacker could potentially capture details about a MAC address from your network and pretend to be that device to connect to your network, but no casual hacker or curious snooper will go to those lengths so MAC filtering will still protect you from the majority of users."*

(http://netsecurity.about.com/od/quicktip1/qt/qtwifimacfilter.htm)

- Going to "those lengths" means the following:

```
root@tyrion# ip link set dev eth0 down
root@tyrion# ip link set dev eth0 address 42:42:42:42:42:42
root@tyrion# ip link set dev eth0 up
```

- Obviously, `42:42:42:42:42:42` can be any MAC address

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  - In some public places each MAC address gets free WiFi for a fixed amount of time
- Summary: MAC spoofing is *easy*
- Security based on MAC uniqueness is bad

Wireless Networks

- Most important standard for wireless networks: IEEE 802.11 (released 1997)
- Designed to behave in many ways like a wired network
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- Networks in vicinity are logically separated by their *network names* (service set identification, SSID)
- Communication is physically separated by using different channels (frequencies)
- Two different modes of operation:
  - Ad-hoc mode: peer-to-peer communication between nodes
  - Infrastructure mode: communication through *access point* (AP)
- Typical (and recommended) setup for permanent installations: infrastructure mode (managed mode)

Connecting to a WiFi network

- Connections to a wireless network are handled through management frames
- APs send beacon frames (by default, 10/second) containing:
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- Other important management frames
  - Reassociate request/response frames: change the AP
  - Disassociate frame: leave the network

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- Clearly *security by obscurity*, bad practice
- Not intended by the standard
- Windows XP machines always prefer access points that broadcast their SSID
- Very easy to lure those machines into a fake AP

Nice summary on hidden SSIDs

> *"Do you ever wonder sometimes how it is that some ideas just won't die? Like the thought that not broadcasting your wireless network's SSID will somehow make you more secure? This is a myth that needs to be forcibly dragged out behind the woodshed, strangled until it wheezes its last labored breath, then shot several times for good measure."* —*Steve Riley*

http://blogs.technet.com/b/steriley/archive/2007/10/16/myth-vs-reality-wireless-ssids.aspx

Encrypted WiFi part I

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- WEP was optional; in the early days of WiFi most networks were not encrypted

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- Two parts of the algorithm: key schedule and pseudo-random generation
- Supports keys of length between 1 and 256 bytes
- Very small and simple C code, quickly became popular

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- Consequence: Can break WEP-104 in < 1 minute

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- The aircrack suite has various filters and switches that influence performance
- Generally a very powerful tool to break WiFi encryption (see homework)

Encrypted WiFi part II

- Drop-in replacement for WEP: WiFi Protected Access (WPA)
- Available since 2003 (draft of 802.11i)
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- Reason for WPA/TKIP: No need to update hardware, "only" firmware

Weaknesses in WPA

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Encrypted WiFi part III

- In 2004, IEEE announces 802.11i (WPA2)
- Most important chance compared to WEP and WPA: get rid of RC4
- Use CCMP instead (AES in Counter Mode Cipher Block Chaining Message Authentication Code Protocol)
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- Use CCMP instead (AES in Counter Mode Cipher Block Chaining Message Authentication Code Protocol)
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- Since 2006 all WiFi-certified cards need to support WPA2
- Different ways of handling authentication and keys, easiest one: pre-shared-key (PSK)
- PSK is typically derived from a passphrase through a key-derivation-function (specifically, PBKDF2)

Everything fine with WPA2?

- Essentially three problems with WPA2:
  - Weak passphrases (`aircrack-ng` has support for brute force):

    "A key generated from a pass-phrase of less than about 20 characters is unlikely to deter attacks." —*IEEE 802.11i standard*

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- Two halves of PIN are checked indendently; brute-force takes only $2 \cdot 10^4$
- Last bit of the PIN is a parity bit, hence, only 11000 guesses
- Brute-forcing this PIN takes < 4 hours

The cryptographer's response

- It is very hard to prevent an attacker from sniffing your communication
- It is even harder to prevent an attacker from disrupting your communication
- System administrators can do something, even harder for users
- Most of the network is typically not under your control

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- Solution for confidentiality and integrity: end-to-end encrypt/authenticate everything.