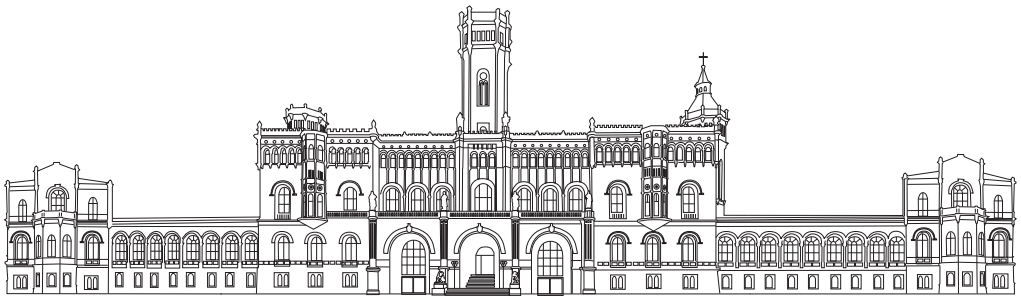
Rechnernetze – Computer Networks

Exercise 1: Scope & Wireshark

Markus Fidler, Mark Akselrod, Lukas Prause



Institute of Communications Technology
Leibniz Universität Hannover

April 8, 2024

Schedule

Exercise

- Instructor: Mark Akselrod, Lukas Prause
- Monday 8:30-10:00
- Lecture hall LFI, Schneiderberg 32
- Start April 8, 2024

Consultation hours

- Monday 10:15-11:15
- Room 1432, IKT

Assignments

General

- weekly assignments
- from Friday (9:30) to Monday (8:00)
- around three tasks
- in Ilias

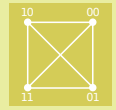
Bonus

- 80% of all points are needed for the bonus
- a 0.3 bonus for grades equal or better than 4.0
  (passing the exam is a prerequisite for getting the bonus)

Outline

Structures and Components of Communications Networks
- Communication links
- Network topologies
- Switching

Wireshark
- Intended purposes
- Don't's for wireshark



What is the difference between simplex, half-duplex and full-duplex transmission modes?

Simplex

- information flows in one direction only
- Example: TV broadcast

Half duplex

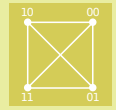
- In half-duplex mode, each station can both transmit and receive, but not at the same time.
- When one device is sending, the other can only receive, and vice versa
- used in cases where there is no need for communication in both directions at the same time;
- the entire capacity of the channel can be utilized for each direction.
- Example: Walkie-talkies

Full duplex (Duplex)

- The full-duplex mode is used when communication in both directions is required all the time.
- The capacity of the channel, however, must be divided between the two directions.
- This sharing can occur in two ways:
  1. Either the link must contain two physically separate transmission paths, one for sending and the other for receiving;
  2. or the capacity of the channel is divided between signals traveling in both directions.

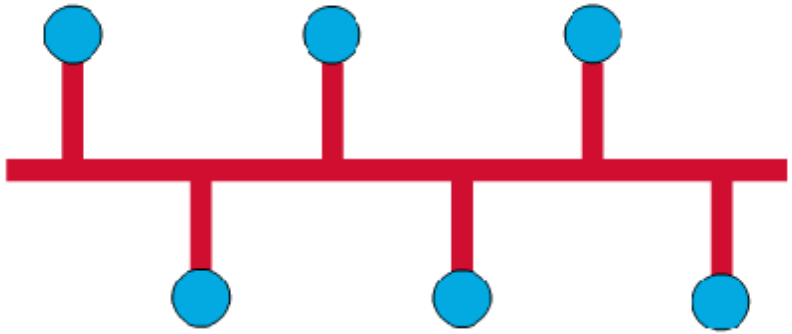
Full duplex (Duplex)

- Example: telephone network. When two people are communicating by a telephone line, both can talk and listen at the same time.



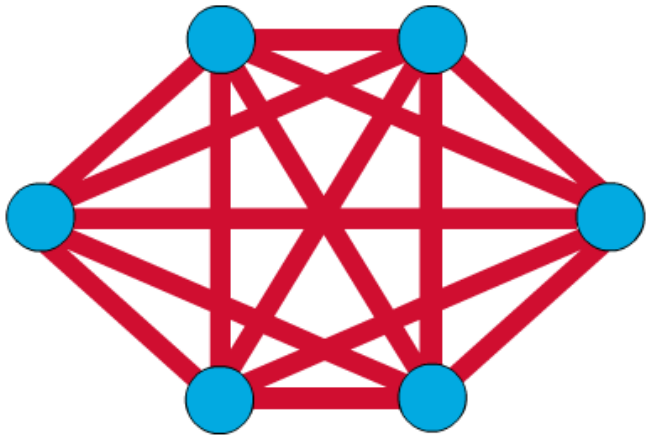
What is a network topology? Name different types of network topologies.

- A Network Topology is the arrangement with which computer systems or network devices are connected to each other.
- Topologies may define both physical and logical aspect of the network.
- Devices may be arranged in a mesh, star, bus, or ring topology.



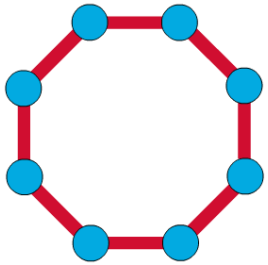
Bus Topology:

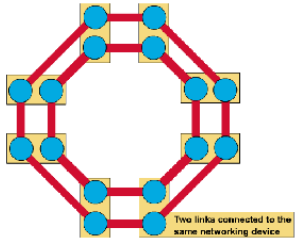
- In case of Bus topology, all devices share single communication line or cable.
- Bus topology may have problem while multiple hosts sending data at the same time. Therefore, Bus topology either uses CSMA/CD technology or recognizes one host as Bus Master to solve the issue.



Mesh Topology:

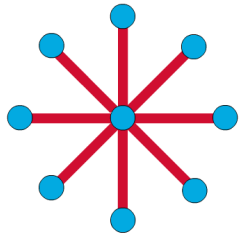
- The mesh topology connects all devices (nodes) to each other for redundancy and fault tolerance.
- It is used in WANs to interconnect LANs and for mission critical networks like those used by banks and financial institutions.
- Implementing the mesh topology is expensive and difficult.





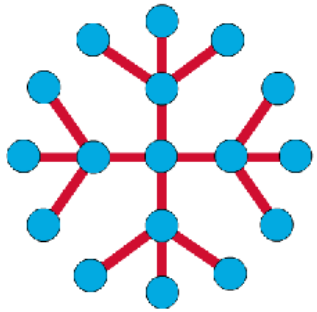
Ring Topology:

- A frame travels around the ring, stopping at each node.
- If a node wants to transmit data, it adds the data as well as the destination address to the frame.
- The frame then continues around the ring until it finds the destination node, which takes the data out of the frame.
  1. Single ring – All the devices on the network share a single cable
  2. Dual ring – The dual ring topology allows data to be sent in both directions.



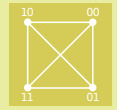
Star Topology:

- the star topology is the most commonly used architecture in Ethernet LANs.
- All hosts in Star topology are connected to a central device, known as hub device, using a point-to-point connection.
- There exists a point to point connection between hosts and hub.
- The hub device can be any of the following:
  - Layer-1 device such as hub or repeater
  - Layer-2 device such as switch or bridge
  - Layer-3 device such as router or gateway



Tree Topology/Hierarchical Topology:

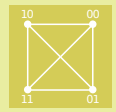
- Larger networks use the extended star topology also called tree topology.
- When used with network devices that filter frames or packets, like bridges, switches, and routers, this topology significantly reduces the traffic on the wires by sending packets only to the wires of the destination host.



What are the consequences of a connection failure in different topologies?

For each of the following four networks, discuss the consequences if a connection or a node fails.

- Mesh topology: If one connection fails, the other connections will still be working.
- Star/Tree: If a connection from one device to the hub fails the other connections will still be working. If the hub fails no communication will be possible.
- Bus: All transmission stops if the failure is in the bus. If the drop-line fails, only the corresponding device cannot operate.
- Ring: The failed connection may disable the whole network unless it is a dual ring or there is a by-pass mechanism.

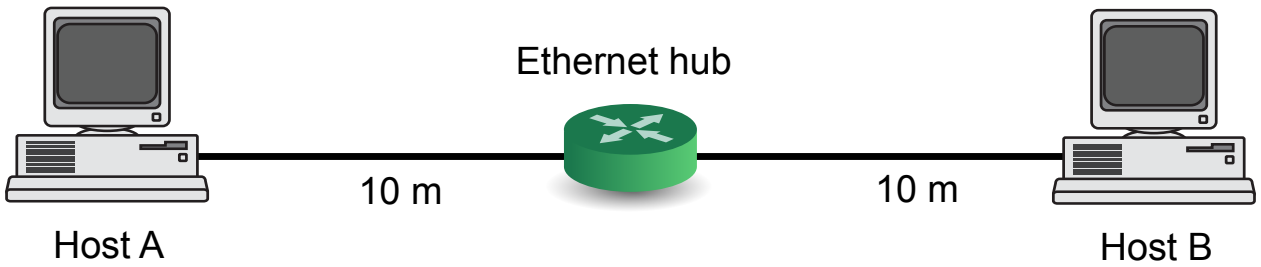


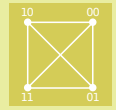
What is the difference between LAN, MAN and WAN?

3.1 Spatial dimension

- LAN: Local area network
  - small spatial dimension, 10-1000 meter
  - typically managed by a single switch
  - medium data rates (1Gb/s), small delays ($<$ 1 ms)
  - typically company or privately owned network
- MAN: metropolitan area network
  - campus, city, regional network, several kilometer
  - medium data rates, small delays
  - owned by a network provider, used by several organizations
- WAN: wide area network
  - country wide, worldwide interconnection of networks
  - substantial infrastructure, numerous routers
  - owned by a single or several network providers
  - high data rates (10 Gb/s and more), some delay ($<$ 100 ms)

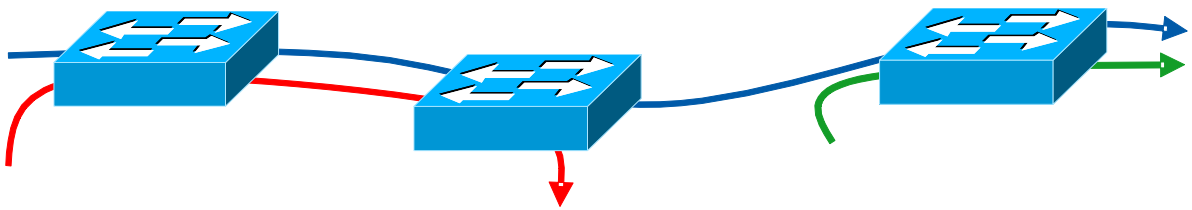
Consider a network in which two hosts are connected with an Ethernet hub. Ist this a LAN, MAN or a WAN?





Two computers connected by an Ethernet hub at home are an example of a LAN.

How are resources allocated along a network path?



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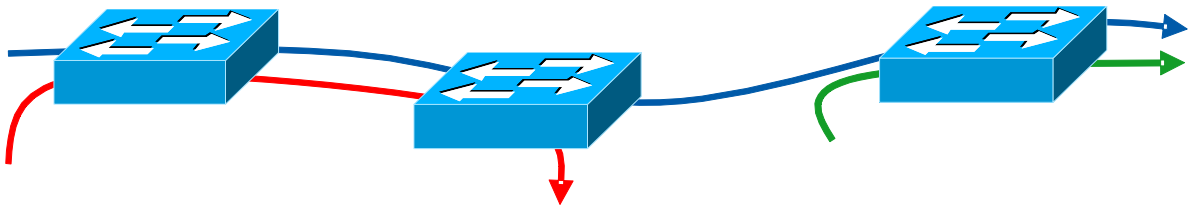
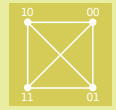


Fundamental design issue

- circuit-switching
  - dedicated circuit
  - e.g. established for each call in telephony networks
- packet-switching
  - data are sent through the network in discrete units, i.e. packets
  - no dedicated resources but first-come first-serve principle



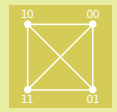
What is the difference between circuit switching and packet switching?

Circuit-switching:

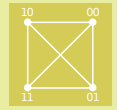
- Guaranteed capacity
- Capacity is wasted if traffic is bursty
- Establishes a path before sending data
- Same path is used for all data
- Packets arrive in correct order, constant delay, no packet drops

Packet-switching:

- No guarantees
- Capacity is used efficiently
- Sends data immediately
- Different packets might follow different paths
- Packets may be reordered, delayed, dropped



What are the three phases involved in data transmission via circuit switching?



Circuit-switching: Three phases involved are:

- Connection establishment
- Data transmission (exclusive access to the connection)
- Connection termination

There is a link with capacity $C = 150\text{Mbit/s}$. It is shared by users requiring a bandwidth of $C = 10\text{Mbit/s}$ each.

- When circuit switching is used, what is the maximum number of circuit-switched users that can be supported? Explain your answer.

- When circuit switching is used, at most 15 circuit-switched users that can be supported. This is because each circuit-switched user must be allocated its 10 Mbps bandwidth, and there is 150 Mbps of link capacity that can be allocated.

Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time.

- Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?

A **circuit-switched** network would be well suited to the application described, because the application involves long sessions with predictable smooth bandwidth requirements. Since the transmission rate is known and not bursty, bandwidth can be reserved for each application session circuit with no significant waste. In addition, we need not worry greatly about the overhead costs of setting up and tearing down a circuit connection, which are amortised over the lengthy duration of a typical application session.

For bursty traffic, is packet-switching more efficient than circuit-switching? Why?

Packet-switching is more efficient than circuit-switching, because: The bursty behaviour leads to peaks and dips in bandwidth demand. The prediction of this demand is much more difficult than for applications with constant data rates. Since in packet-switched networks bandwidth is not exclusively reserved for one link, unused bandwidth is availabe for other connections. Due to this no bandwidth is wasted during dips in demand.

Outline

What is Wireshark?

- Open source network packet analyzer
- UNIX and Windows
- Capture live packet data from a network interface
- Analyse PCAP (Packet Capture) files

Intended purposes

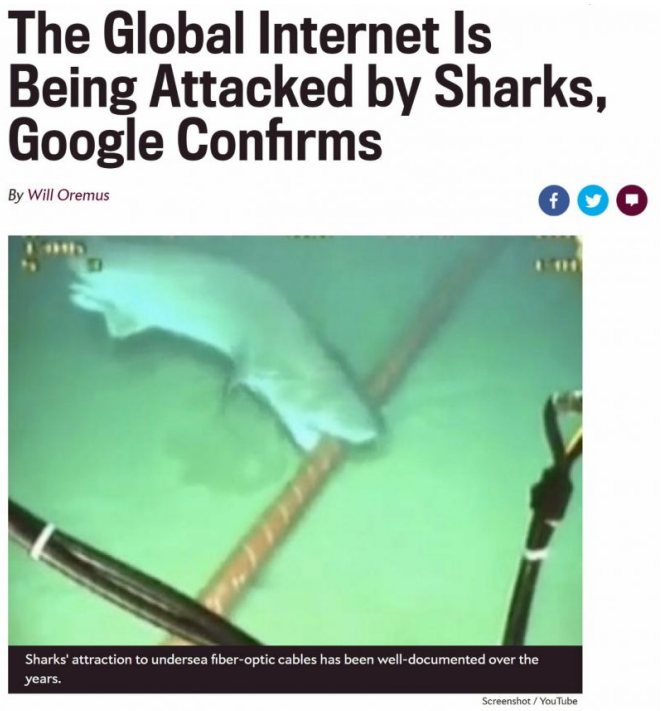
- Network administrators use it to troubleshoot network problems
- Network security engineers use it to examine security problems
- QA engineers use it to verify network applications
- Developers use it to debug protocol implementations
- People use it to **learn** network protocol internals

You can try it at home

- For many mechanisms from the lecture there are sample captures for Wireshark
- `https://www.wireshark.org/download.html`
- `https://wiki.wireshark.org/SampleCaptures`

Don’ts for wireshark

- Don’t sniff other peoples network traffic
- In Germany, it is illegal to use Wireshark (or other tools) to prepare a criminal offense



The Global Internet Is Being Attacked by Sharks, Google Confirms

By Will Oremus

Sharks' attraction to undersea fiber-optic cables has been well-documented over the years.

Screenshot / YouTube