

Packet Switching (1/9)

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Considering first traditionally telecommunication networks:

Circuit-switched networks or switching networks, look like follows:

- Communication partners are provided with a standing connection that cannot be shared or interrupted by other participants
- A connection is established via many different switching stations
- During connection establishment waiting time occurs
- Transmission itself is carried out with minimal constant delay
- Communication participants are offered fixed data transmission rates
- Communication costs are proportional to connection duration
- A failure of just one switching station is enough to disrupt the connection

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Considering computer networks:

- Strong fluctuations in the amount of data traffic can be observed in computer communication – “**bursts**” – of maximum activity occur at time intervals
- To ensure fail-safe and fair access to all communication participants in a shared network infrastructure, computer networks are not organized according to the principle of circuit switching but the principle of **packet switching**
- Packet switching is also the basic communication principle in the Internet

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- In **packet switching** messages are broken down into small data packets → "**fragmentation**"
- Packets are transmitted individually and independent of each other. They are reassembled into the original message at the receiver again → "**defragmentation**"
- The route of individual packets is not fixed at the onset. The sender only knows the first path segment to the next switching station
- Optimal paths are determined by special
→ **routing algorithms**

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Advantages of packet switching:

- High network utilization – individual packets are quite small therefore waiting time for all participants is minimal
- Fair allocation of resources – participants are provided with equal use of the network, packets are sent alternately by each participant based on the time division multiplexing procedure
- Fast error detection – due to the small packet size, transmission errors can be detected and resolved quickly; only erroneous packets need be retransmitted
- High level of reliability – if any switching station fails, traffic is simply redirected through other switching stations

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In order for packet switching to function, data packets must be provided with additional management information: “**packet header**”

- Address information – Information about the sender and receiver
- Packet number – for reconstruction of the message itself packets must be numbered consecutively
- Padding data – required if necessary to fill a packet to meet the required size
- Error detection mechanisms – Additional data for detecting transmission errors, e.g. parity bits, checksums, ...

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Disadvantages of packet switching:

- Overload (congestion) – because transmission routes are not fixed congestion can occur at individual switching stations – the buffer overflows and packets are lost
- Complex communication protocol – whereas data transmission in circuit-switching is completely transparent and participants can communicate as they choose, in packet switching all participants must follow the same network protocol.
- No service guarantee – no guarantee of a constant bandwidth for the whole transmission – delay can become relatively high

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Packet-switched networks provide both connectionless and connection-oriented network services

- **Connectionless service** – individual packets are transported on their own paths through the network independent of each other
- **Connection-oriented service** – sender and receiver have the impression of a standing connection. Before transmission of the message packets, a virtual connection is established, thus sender and the receiver already “know” each other and communication can be uniquely identified
 - **Advantages:** packet mix-up is impossible / security mechanisms can be implemented as communication is uniquely identified
 - **Disadvantages:** transmission overhead is too complex for simple services

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For reliable data transmission via interference-prone transmission media, mechanisms for **automatic error detection** and **error correction** must be implemented

Basic idea:

To provide packets with additional information and help detect errors and, when necessary, to reconstruct correct contents of the packet, e.g.

- Checksum – the sum of all data bits in a packet:
 - Sender calculates the checksum of a packet, which is appended to the packet
 - Receiver calculates the checksum of received packet and compares this with the transmitted checksum
 - In case of a discrepancy the receiver re-requests the packet

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The **bit error rate** is a measure of transmission error

- Over a fixed period of time it measures the ratio between:
erroneous bits transmitted / total number of bits transmitted

Two approaches for dealing with errors:

- **Error-detecting codes** to initiate a retransmission
- **Error-correcting codes** to enable automatic reconstruction in case of an error

Adding redundancy to the packets to be transmitted

Important methods:

- Parity bits, Hamming code, parity check matrix, checksum methods, block codes, convolutional codes, ...