

# Lecture 8

## Communication Fundamentals in Computer Networks

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# Topics

## **Performance Ratios of Computer Networks**

- User-Related Parameters
- Qualitative Performance Criteria
- Quality of Service

# Performance Ratios of Computer Networks

*The average user is likely to judge a network according to its speed – it is either a **fast** or a **slow** network.*

- So that an objective comparison of different network technologies is possible, hard quantitative metrics must be used to describe network performance rather than vague classifications.
- These measured values called *performance indicators* deliver a quantitative, qualified description of the concrete properties of communication networks.

# Performance Ratios of Computer Networks

A distinction is made between

- *user-related* services, which are referred to as technology-independent, and
- *technology-related* performance indicators.

At the same time, this distinction is not always consistent and cannot always be categorized. Therefore, technical performance indicators are normally grouped together and combined with those that are user-related.

# User-Related Parameters

A compilation of user-related performance parameters is published by the ANSI (American National Standards Institute) as ANSI X3.102, based on the following simple model.

**Table 3.4** User-related performance parameters according to ANSI X3.102

|                                 | <b>Speed</b>                         | <b>Correctness</b>  | <b>Reliability</b>   |
|---------------------------------|--------------------------------------|---|--|
| <b>Connection establishment</b> | Duration of connection establishment | Probability of incorrect connection establishment<br>Probability of total failure               | Probability of denied connection                               |
| <b>Data transmission</b>        | Transmission duration                | Probability of error<br>Probability of incorrect delivery<br>Probability of denied transmission | Probability of data loss<br>Probability of denied transmission |
| <b>Connection establishment</b> | Duration of connection establishment | Probability of denied transmission  | Probability of denied connection setup                         |

*The ANSI model assumes a connection-oriented service and provides a rating for each of its three phases.*

# User-Related Parameters

An assessment is made of the following connection-oriented network service criteria evidenced in each phase:

- **Speed**
- **Correctness** – What are the chances that a (repairable) error will occur?
- **Reliability** – What are the chances that a (irreparable) error will occur that results in termination?

# Qualitative Performance Criteria

## Availability

- Specifies how much of the operation time of the communication network is actually available to users (expressed in percent) with the performance required by the service provider. The operation time is often given in 24 hours a day and 365 days a year.

## Usability

- An elusive parameter, whereby user satisfaction is measured by the network available from the service provider. Both ease of use and compliance with acceptable performance specifications are criteria in this group.

## Compatibility

- Indicates the extent to which the end devices of the user are compatible with the network interface from the service provider and can be operated without a great adaptation effort.

# Qualitative Performance Criteria

## Security

- Combination of multiple criteria defining the reliability of data transmission in a communication network, as well as in terms of intervention by unauthorized third parties.

## Scalability

- Expresses the extent to which a communication network can be operated, when actual use far exceeds what was laid down as the original operational parameters.

## Manageability

- This criterion indicates the extent of which the communication network is monitored, adapted to changing circumstances and regulated in the sense of control engineering. A network can only function satisfactorily if monitoring occurs on a continuous basis and if the necessary adjustments are made quickly.

# Quality of Service (QoS)

*QoS describes the **properties** of a communication network in terms of the services rendered by a specific network service.*

## Performance:

- **Throughput:** The throughput is understood as a guaranteed amount of data that can be transmitted error-free per unit of time. The throughput is often given in bits per second – **bps**.
- **Delay:** Delay refers to the maximum guaranteed length of time between the start of a data transfer and its conclusion. The delay is measured in seconds or in fractions of seconds.

# Quality of Service (QoS)

## Performance fluctuation:

- **Jitter:** Jitter is a term used to express the fluctuation that takes place during delay. As a parameter for a communication network, jitter describes the maximum allowable fluctuation.
  - **Asynchronous behavior:** The residence time of the packets at the sender and at the receiver in the network is completely uncertain.
  - **Synchronous behavior:** Although the length of the residence time of data packets in the communication network is still indeterminate and variable its upper limit is capped.
  - **Isochronous behavior:** Here, the length of residence is the same for all data packets in the network.
- **Error rate:** The term error rate expresses the probability of data loss during transmission and data corruption along the transmission path. An essential element of this definition is the bit error rate.

# Quality of Service (QoS)

## Reliability

- **Completeness:** The service parameter completeness ensures that all data packets sent reach their designated target at least once.
- **Uniqueness:** If uniqueness is guaranteed for a data transmission then the user can be certain that the sent data reaches its designated goal one time.
- **Order-preserving:** The user is assured that all sent data packets sent reach their destination in the same sequence in which they were transmitted by the sender.

# Quality of Service (QoS)

## Security

- **Confidentiality:** With a guarantee of the confidentiality of data transmission no unauthorized third party is able to understand the contents of the communication between the sender and the receiver.
- **Integrity:** This means, in particular, that no unauthorized third party can distort the data along the transmission path.
- **Authenticity:** With this QoS parameter the user is assured that the received message is actually from the user indicated and not from an unauthorized third party who claims to be the sender of the message.