

Congestion Control (1/5)

1

Congestion control is one of the most difficult problems for TCP, because TCP cannot detect the overload situation directly

- Data packets are transported via IP on different paths through the Internet so that direct conclusions cannot be drawn about overload at specific intermediate systems
- Different TCP instances cannot co-operate with each other

Idea:

- TCP interprets the number of lost (i.e. not acknowledged) segments as a measure for overload and parameter for determining the congestion window to control overload

Congestion Control (2/5)

2

Slow-start algorithm – for fast adjustment of the congestion window:

- Connections are started with a small window size that is raised exponentially until packets are lost ...

Congestion-avoidance algorithm – to reduce the congestion situation:

- If segment loss accumulates – i.e. acknowledgements do not reach the sender within the set period of time – TCP lowers the sending data rate so as to not further increase network overload with the continuous repetition of transmissions

Congestion Control (3/5)

3

Nagle algorithm – limits the overhead when transmitting:

- If TCP segments are just a short length, the command and control information in the header makes up the majority of the transmitted data
- Acknowledgement of the segment is therefore delayed as long as possible to e.g. enrich it with its own payload or other outstanding acknowledgements
- Transmission of own payload is delayed as long as possible in order to send it together with outstanding acknowledgements
- The Nagle algorithm collects all payload until the next due acknowledgement and then transfers both together

Congestion Control (4/5)

4

Determining the Round Trip Time (RTT) (1/2):

■ Original implementation:

- RTT is determined for every transmitted segment and a weighted average is calculated

■ Karn/Partridge algorithm:

- In the original implementation, the actual value might be underestimated because time between the retransmission of a packet believed to be lost and the delayed incoming acknowledgement of the segment can be wrongly measured
- Karn/Partridge algorithm for RTT calculation is based only on measurements of segments that were actually acknowledged by the receiver
- In addition, the time limit is raised after each successful delivery

Congestion Control (5/5)

5

Determining the Round Trip Time (RTT) (2/2):

■ **Karel/Jacobsen algorithm**

- Refinement of the Karn/Partridge algorithm by weighting the fluctuations in the measured network roundtrip time
- In addition, calculation of timeouts is adjusted