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2.15.1 Problems 2.15.2 Sender- and receiver-based schemes; 2.16 Incentive issues; 2.16.1 Tragedy of the commons; 2.16.2 Game theory; 2.16.3 Congestion pricing; 2.17 Fairness; 2.17.1 Max-min fairness; 2.17.2 Utility functions; 2.17.3 Proportional fairness; 2.17.4 TCP friendliness; 2.18 Conclusion; 3 Present technology; 3.1 Introducing TCP; 3.1.1 Basic functions; 3.1.2 Connection handling; 3.1.3 Flow control: the sliding window; 3.1.4 Reliability: timeouts and retransmission; 3.2 TCP window management; 3.2.1 Silly window syndrome; 3.2.2 SWS avoidance; 3.2.3 Delayed ACKs 3.2.4 The Nagle algorithm 3.3 TCP RTO calculation; 3.3.1 Ignoring ACKs from retransmissions; 3.3.2 Not ignoring ACKs from retransmissions; 3.3.3 Updating RTO calculation; 3.4 TCP congestion control and reliability; 3.4.1 Slow start and congestion avoidance; 3.4.2 Combining the algorithms; 3.4.3 Design rationales and deployment considerations; 3.4.4 Interactions with other window-management algorithms; 3.4.5 Fast retransmit and fast recovery; 3.4.6 Multiple losses from a single window; 3.4.7 NewReno; 3.4.8 Selective Acknowledgements (SACK); 3.4.9 Explicit Congestion Notification (ECN) 3.5 Concluding remarks about TCP 3.6 The Stream Control Transmission Protocol (SCTP); 3.7 Random Early Detection (RED); 3.8 The ATM 'Available Bit Rate' service; 3.8.1 Explicit rate calculation; 3.8.2 TCP over ATM; 4 Experimental enhancements; 4.1 Ensuring appropriate TCP behaviour; 4.1.1 Appropriate byte counting; 4.1.2 Limited slow start; 4.1.3 Congestion window validation; 4.1.4 Robust ECN signalling; 4.1.5 Spurious timeouts; 4.1.6 Reordering; 4.1.7 Corruption; 4.2 Maintaining congestion state; 4.2.1 TCP Control Block Interdependence; 4.2.2 The Congestion Manager; 4.2.3 MulTCP 4.3 Transparent TCP improvements

## Sommario/riassunto

As the Internet becomes increasingly heterogeneous, the issue of congestion control becomes ever more important. In order to maintain good network performance, mechanisms must be provided to prevent the network from being congested for any significant period of time. Michael Welzl describes the background and concepts of Internet congestion control, in an accessible and easily comprehensible format. Throughout the book, not just the how, but the why of complex technologies including the Transmission Control Protocol (TCP) and Active Queue Management are explained. The text also gives