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Nota di contenuto	Front Cover; Internet Congestion Control; Copyright Page; Dedication; Contents; Preface; About the Author; Acknowledgments; List of Abbreviations; 1 Introduction; 1.1 Introduction; 1.2 Basics of Congestion Control; 1.2.1 The Congestion Control Problem Definition; 1.2.2 Optimization Criteria for Congestion Control; 1.2.3 Optimality of Additive Increase Multiplicative Decrease Congestion Control; 1.2.4 Window-Based Congestion Control; 1.2.5 Rate-Based Congestion Control; 1.2.6 End-to-End versus Hop-by-Hop Congestion Control; 1.2.7 Implicit versus Explicit Indication of Network Congestion 1.3 Description of TCP Reno1.3.1 Basic TCP Windowing Operations; 1.3.2 Window Size Decrements, Part 1: Timer Operation and Timeouts; 1.3.3 Window Size Increments: Slow Start and Congestion Avoidance; 1.3.3.1 Slow Start; 1.3.3.2 Congestion Avoidance; 1.3.4 Window Size Decrements, Part 2: Fast Retransmit and Fast Recovery; 1.3.5 TCP New Reno; 1.3.6 TCP Reno and AIMD; 1.4 Network Feedback Techniques; 1.4.1 Passive Queue Management; 1.4.2 Active Queue Management (AQM); 1.5 Delay-Based Congestion Control: TCP Vegas; 1.6 Outline of the Rest of the Book; 1.7 Further Reading; References; 1 Theory 2 Analytic Modeling of Congestion Control2.1 Introduction; 2.2 TCP Throughput Analysis; 2.2.1 Throughput as a Function of Window Size; 2.2.2 Throughput as a Function of Buffer Size; 2.2.3 Throughput as a Function of Link Error Rate; 2.2.3.1 Link Errors Recovered by Duplicate ACKs; 2.2.3.2 Link Errors Recovered by Duplicate ACKs and Timeouts;

2.3 A Fluid Flow Model for Congestion Control; A General Procedure for Computing the Average Throughput; 2.3.1 Throughput for General Additive Increase/Multiplicative Decrease (AIMD) Congestion Control 2.3.2 Differentiating Buffer Overflows from Link Errors 2.4 A Stochastic Model for Congestion Control; 2.5 Why Does the Square-Root Formula Work Well?; 2.6 The Case of Multiple Parallel TCP Connections; 2.6.1 Homogeneous Case; 2.6.2 Heterogeneous Case; 2.7 Further Reading; Appendix 2.A: Derivation of  $Q = \min(1, 3/E(W))$ ; References; Suggested Reading; 3 Optimization and Control Theoretic Analysis of Congestion Control; 3.1 Introduction; 3.2 Congestion Control Using Optimization Theory; 3.2.1 Utility Function for TCP Reno; 3.3 Generalized TCP-Friendly Algorithms 3.4 Stability Analysis of TCP with Active Queue Management 3.4.1 The Addition of Controllers to the Mix; 3.4.1.1 Random Early Detection (RED) Controllers; 3.4.1.2 Proportional Controllers; 3.4.1.3 Proportional-Integral (PI) Controllers; 3.5 The Averaging Principle (AP); 3.6 Implications for Congestion Control Algorithms; 3.7 Further Reading; Appendix 3.A: Linearization of the Fluid Flow Model; Appendix 3.B: The Nyquist Stability Criterion; Appendix 3.C: Transfer Function for the RED Controller; Appendix 3.D: Convex Optimization Theory; Appendix 3.E: A General Class of Utility Functions References

## Sommario/riassunto

Internet Congestion Control provides a description of some of the most important topics in the area of congestion control in computer networks, with special emphasis on the analytical modeling of congestion control algorithms. The field of congestion control has seen many notable advances in recent years and the purpose of this book, which is targeted towards the advanced and intermediate reader, is to inform about the most important developments in this area. The book should enable the reader to gain a good understanding of the application of congestion control theory to a number of applic

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