
An Introduction to Computer Networks

Release 1.9.15

Peter L Dordal

Oct 18, 2018

CONTENTS

0 Preface	3
0.1 Licensing	3
0.2 Classroom Use	4
0.3 Progress Notes	6
0.4 Technical considerations	6
0.5 A Note On the Cover	8
0.6 Recent Changes	9
1 An Overview of Networks	13
1.1 Layers	13
1.2 Data Rate, Throughput and Bandwidth	14
1.3 Packets	14
1.4 Datagram Forwarding	15
1.5 Topology	18
1.6 Routing Loops	19
1.7 Congestion	20
1.8 Packets Again	21
1.9 LANs and Ethernet	22
1.10 IP - Internet Protocol	24
1.11 DNS	30
1.12 Transport	30
1.13 Firewalls	34
1.14 Some Useful Utilities	35
1.15 IETF and OSI	37
1.16 Berkeley Unix	39
1.17 Epilog	39
1.18 Exercises	40
2 Ethernet	45
2.1 10-Mbps Classic Ethernet	45
2.2 100 Mbps (Fast) Ethernet	56
2.3 Gigabit Ethernet	58
2.4 Ethernet Switches	59
2.5 Spanning Tree Algorithm and Redundancy	61
2.6 Virtual LAN (VLAN)	66

2.7	TRILL and SPB	67
2.8	Software-Defined Networking	69
2.9	Epilog	76
2.10	Exercises	76
3	Other LANs	83
3.1	Virtual Private Networks	83
3.2	Carrier Ethernet	84
3.3	Token Ring	85
3.4	Virtual Circuits	86
3.5	Asynchronous Transfer Mode: ATM	90
3.6	Adventures in Radioland	92
3.7	Wi-Fi	96
3.8	WiMAX and LTE	123
3.9	Fixed Wireless	126
3.10	Epilog	129
3.11	Exercises	129
4	Links	135
4.1	Encoding and Framing	135
4.2	Time-Division Multiplexing	140
4.3	Epilog	145
4.4	Exercises	145
5	Packets	147
5.1	Packet Delay	147
5.2	Packet Delay Variability	150
5.3	Packet Size	151
5.4	Error Detection	153
5.5	Epilog	158
5.6	Exercises	159
6	Abstract Sliding Windows	163
6.1	Building Reliable Transport: Stop-and-Wait	163
6.2	Sliding Windows	168
6.3	Linear Bottlenecks	171
6.4	Epilog	179
6.5	Exercises	179
7	IP version 4	183
7.1	The IPv4 Header	184
7.2	Interfaces	186
7.3	Special Addresses	188
7.4	Fragmentation	189
7.5	The Classless IP Delivery Algorithm	191
7.6	IPv4 Subnets	192
7.7	Network Address Translation	198
7.8	DNS	202

7.9	Address Resolution Protocol: ARP	208
7.10	Dynamic Host Configuration Protocol (DHCP)	211
7.11	Internet Control Message Protocol	213
7.12	Unnumbered Interfaces	217
7.13	Mobile IP	218
7.14	Epilog	219
7.15	Exercises	220
8	IP version 6	223
8.1	The IPv6 Header	224
8.2	IPv6 Addresses	225
8.3	Network Prefixes	227
8.4	IPv6 Multicast	228
8.5	IPv6 Extension Headers	229
8.6	Neighbor Discovery	232
8.7	IPv6 Host Address Assignment	236
8.8	Globally Exposed Addresses	240
8.9	ICMPv6	241
8.10	IPv6 Subnets	242
8.11	Using IPv6 and IPv4 Together	244
8.12	IPv6 Examples Without a Router	248
8.13	IPv6 Connectivity via Tunneling	250
8.14	IPv6-to-IPv4 Connectivity	253
8.15	Epilog	255
8.16	Exercises	255
9	Routing-Update Algorithms	257
9.1	Distance-Vector Routing-Update Algorithm	258
9.2	Distance-Vector Slow-Convergence Problem	262
9.3	Observations on Minimizing Route Cost	264
9.4	Loop-Free Distance Vector Algorithms	266
9.5	Link-State Routing-Update Algorithm	272
9.6	Routing on Other Attributes	276
9.7	ECMP	277
9.8	Epilog	278
9.9	Exercises	278
10	Large-Scale IP Routing	285
10.1	Classless Internet Domain Routing: CIDR	285
10.2	Hierarchical Routing	287
10.3	Legacy Routing	288
10.4	Provider-Based Routing	288
10.5	Geographical Routing	293
10.6	Border Gateway Protocol, BGP	294
10.7	Epilog	312
10.8	Exercises	312
11	UDP Transport	319

[Click here to download full PDF material](#)