



Technology Training that Works

Practical Fundamentals of Voice over IP (VoIP) for Engineers and Technicians

Contents

1	Introduction	1
	1.1 Overview	1
	1.2 Introduction	1
2	Telecommunications Fundamentals	5
	2.1 Introduction	5
	2.2 Local Loops	5
	2.3 Trunks	5
	2.4 Switching	6
3	Overview of TCP/IP	7
	3.1 Overview	7
	3.2 The OSI Reference Model	7
	3.3 TCP/IP Protocol Suite	9
	3.4 LANs (Local Area Networks)	9
	3.5 Internet Protocol	14
	3.6 IP Addressing	16
	3.7 Transport Layer	18
	3.8 Transmission Control Protocol (TCP)	19
	3.9 User Datagram Protocol	22
	3.10 Router and Routing Protocols	23
	3.11 Autonomous System	24
	3.12 Wide Area Network	27
	3.13 ISDN – Integrated Services Digital Network	28
	3.14 Digital Subscriber Lines (DSL)	29
	3.15 SDH/SONET	30
	3.16 Frame Relay	30
	3.17 IP Over ATM Networks	32
	3.18 WAN Encapsulation Protocols	35
	3.19 Real Time Transport Protocol	37
	3.20 Real Time Transport Control Protocol (RTCP)	40



Technology Training that Works

4	H.323	45
4.1	The H.323 Architecture	45
4.2	H.323 Protocol Format	48
4.3	H.323 Addressing	49
4.4	RAS Messages	51
4.5	Discovery of a Gatekeeper	53
4.6	Registration and Deregistration of an Endpoint	53
4.7	H.245 Control Signaling	56
4.8	H.245 Operations	56
4.9	Different Call Scenarios	58
5	Session Initiation Protocol	73
5.1	Introduction	73
5.2	SIP Components	74
5.3	Message Headers	80
5.4	The Session Description Protocol (SDP)	81
5.5	Description and Format of Important Field Type Values	85
5.6	SIP Protocols	85
5.7	Comparison between SIP and H.323	91
6	Media Gateway Control Protocol (MGCP) and MEGACO/H.248 Protocol	93
6.1	Introduction	93
6.2	Media Gateway Control Protocol	93
6.3	MEGACO/H.248	95
7	SIGTRAN	101
7.1	Introduction	101
7.2	SS7 Signaling Network Architecture	101
7.3	SS7 Protocol Suite	103
7.4	SIGTRAN Protocol Stack	105
7.5	SCTP	108
8	Introduction to Voice Ports and Dial Peers	113
8.1	Voice Ports	113
8.2	Configuring FXO or FXS Voice Ports	116
8.3	Fine Tuning FXS/FXO Ports	118
8.4	Optional Configuration for FXS/FXO Ports	119
8.5	Configuring E&M Voice Ports	119
8.6	Digital Interfaces	121
8.7	Dial Peers and Call Legs	122



Technology Training that Works

9	Quality of Service in VoIP	131
9.1	Introductions	131
9.2	Compressed Real-Time Transfer Protocol (CRTP)	131
9.3	Three Levels of QOS	133
9.4	Quality of Service Solutions	134
9.5	VOIP over MPLS	145
10	Speech Coding Techniques	147
10.1	Introduction	147
10.2	Sampling of Voice	147
10.3	Types of Speech Coders	147
10.4	Overview of Source Coding Standards	153
11	Traffic Theory Basics	155
11.1	Introduction	155
11.2	Traffic Load Measurement	155
11.3	Network Capacity Measurements	156
11.4	Grade of Service	157
11.5	Traffic Model Selection Criteria	158
11.6	Traffic Models	160
11.7	Applying Traffic Analysis to VOIP Networks	162
11.8	Point-to-Point versus Point-to-Multipoint	164
11.9	End-to-End Traffic Analysis Example	165
12	Developing a Dial Plan for a VoIP Network	169
12.1	Introduction	169
12.2	Dial Plan Organization	169
12.3	Dial Plan Overview	172
12.4	Principles for Designing Large-Scale Dial Plans	173
12.5	Number Normalization for an International Dial Plan Example	175
12.6	Call Topologies for VOIP Network	177
12.7	Fault Tolerance in Dial Plans	178
13	VoIP Implementation over SIP	179
13.1	Introduction	179
13.2	Components for Implementation of VOIP Infrastructure Solution over SIP	179
13.3	Implementation of VOIP for SIP in a Phased Manner	180
13.4	Processing of Calls between SIP IP Telephony Networks	184
13.5	Call Processing between a SIP IP Telephone and a PSTN Phone	185



Technology Training that Works

14	Fax over IP (FoIP)	187
14.1	Introduction	187
14.2	Standards	187
14.3	Gateway	189
14.4	Transmission of Fax Messages over IP	189
14.5	H.323 and Fax	189
14.6	Email-based Fax	190
15	Video conferencing over VoIP	193
15.1	Introduction	193
15.2	Video Conferencing using H.323	193
15.3	H.323 Video Conferencing Components	194
15.4	Multipoint Conference Unit (MCU)	197
15.5	Objectives of Videoconferencing Solution over IP	198
15.6	Deployment Models	198
15.7	Network Infrastructure	205
15.8	Quality of Service Tools for Wide Area Networks	205
15.9	Call Admission Control (CAC)	207
15.10	H.323 Video over IP Dial Plan Architecture	208
15.11	Single Zone Dial Plan	210
15.12	Zone Prefix Design	213
15.13	Multi Zone Dial Plan	214
15.14	Call Routing Scenarios	215
16	Tests, Measurements and Troubleshooting VoIP Networks	219
16.1	Introduction	219
16.2	Factors Affecting Voice Quality	219
16.3	Tunable and Adjustable Parameters in VOIP Equipment	221
16.4	Troubleshooting in H.323 VOIP Network	224
16.5	Testing SIP	227
17	VoIP Bandwidth Calculation	229
17.1	Overview	229
17.2	The Codec	229
Appendices		233
	Appendix A – Case Studies	233
	Appendix B – Practical Exercise	239
	Appendix C – Practical Session	261
	Appendix D – Questions	265
	Appendix E – Solutions	267