
TABLE OF CONTENTS

1	INTRODUCTION.....	13
2	DYNAMIC ROUTING PROTOCOLS.....	17
2.1	BROADCAST DOMAINS, AN INTRODUCTION TO THE ROUTING.....	17
2.2	BASIC CONCEPTS OF ROUTING	20
2.2.1	<i>Neighbor Routers</i>	<i>20</i>
2.2.2	<i>Directly Connected Network.....</i>	<i>20</i>
2.2.3	<i>The Code of Source of the Routing Information</i>	<i>21</i>
2.2.4	<i>Administrative Distance</i>	<i>22</i>
2.2.5	<i>Routing Metric.....</i>	<i>23</i>
2.2.6	<i>Routing Table</i>	<i>24</i>
2.2.7	<i>Routing Updates.....</i>	<i>25</i>
2.2.8	<i>Routes Summarization</i>	<i>25</i>
2.2.9	<i>Split Horizon</i>	<i>26</i>
2.3	RIPV1 PROTOCOL	29
2.3.1	<i>Basic Features of the RIPv1 Protocol.....</i>	<i>29</i>
2.3.2	<i>Configuring IP Addresses for Interfaces</i>	<i>30</i>
2.3.3	<i>RIP Protocol Configuration via Config Tab</i>	<i>30</i>
2.3.4	<i>RIP Protocol Configuration via IOS Commands</i>	<i>32</i>
2.3.5	<i>Automatic Network Summarization.....</i>	<i>33</i>
2.3.6	<i>RIP Protocol Configuration Check.....</i>	<i>33</i>
2.3.7	<i>Display of Existing Routes in the Routing Table</i>	<i>34</i>
2.3.8	<i>Display of Current RIP Protocol Settings.....</i>	<i>34</i>
2.3.9	<i>Configuring the Timers for the RIP Protocol.....</i>	<i>35</i>
2.4	RIPV2 PROTOCOL	37
2.4.1	<i>Common Features of RIP Protocol Version 1 and 2.....</i>	<i>37</i>
2.4.2	<i>Differences between Protocols RIP v1 and RIP v2</i>	<i>38</i>
2.5	EIGRP PROTOCOL	38
2.5.1	<i>Introduction to EIGRP.....</i>	<i>38</i>
2.5.2	<i>Basic Concepts on EIGRP</i>	<i>38</i>
2.5.3	<i>Basic Configuration and Verification Commands.....</i>	<i>39</i>
2.5.4	<i>Example of Configuring and Checking the EIGRP Protocol</i>	<i>40</i>
2.5.5	<i>Selecting the Best Route in the EIGRP Protocol.....</i>	<i>45</i>
2.5.6	<i>Configuration of Parameters for Interfaces in the EIGRP Protocol.....</i>	<i>49</i>
2.6	OSPFV2 PROTOCOL.....	50
2.6.1	<i>Introduction to OSPFv2.....</i>	<i>50</i>
2.6.2	<i>Basic Concepts of OSPFv2.....</i>	<i>51</i>
2.6.3	<i>SPF Algorithm.....</i>	<i>52</i>

Table of Contents

2.6.4	<i>Selection of Routers DR and BDR in OSPFV2</i>	57
2.6.5	<i>Configuring Protocol OSPFV2</i>	57
2.6.6	<i>Display Existing OSPF Routes in the Routing Table</i>	60
2.6.7	<i>Route Distributions between Different Protocols</i>	60
2.6.8	<i>Route Distributions between RIPv2 and OSPF Protocols</i>	61
2.6.9	<i>Route Distributions between OSPF protocols with different process ID..</i>	62
2.7	BGPV4 PROTOCOL	63
2.7.1	<i>Introduction to BGPv4</i>	63
2.7.2	<i>Basic IOS Commands Configuring eBGPv4</i>	64
2.7.3	<i>Configuring protocol eBGPv4</i>	65
3	STATIC ROUTING	73
3.1	INTRODUCTION TO STATIC ROUTING	73
3.2	BASIC CONCEPTS OF STATIC ROUTING	73
3.3	STATIC ROUTES CONFIGURATION TYPES	74
3.4	CONFIGURING ROUTES USING NEXT HOP ADDRESS	75
3.5	CONFIGURING ROUTES USING THE OUTPUT INTERFACE	78
3.6	CONFIGURING MULTIPLE STATIC ROUTES	81
3.7	CONFIGURING BACKUP ROUTES	85
3.8	CONFIGURING THE DEFAULT ROUTE.....	87
4	ACCESS CONTROL LISTS	93
4.1	INTRODUCTION	93
4.2	TYPES OF ACL	94
4.2.1	<i>Standard ACL</i>	94
4.2.2	<i>Extended ACL</i>	94
4.2.3	<i>Named ACL</i>	95
4.3	RULES FOR CREATING ACCESS CONTROL LISTS	95
4.4	PLANNING ACCESS CONTROL LISTS	96
4.5	MOST COMMON MISTAKES	97
4.5.1	<i>Wrong Sequence of Introduced Rules</i>	97
4.5.2	<i>Incomplete Rules</i>	99
4.5.3	<i>Wrong Choice of Interface or Direction of the Introduced ACL</i>	100
4.6	ACCESS CONTROL LIST NUMBERING.....	101
4.7	STANDARD ACL	102
4.7.1	<i>Syntax of a Standard ACL</i>	102
4.7.2	<i>Using Standard ACLs</i>	102
4.8	EXTENDED ACL.....	106
4.8.1	<i>Syntax of the Extended ACLs</i>	106
4.8.2	<i>Use of Extended ACLs</i>	108

4.8.2.1	Blocking Subnets	108
4.8.2.2	Blocking the WWW Service	111
4.8.2.3	Blocking the FTP Service	113
4.8.2.4	Blocking the Ping Command	116
4.8.2.5	Use of Extended Named ACLs	119
5	THE VOIP TECHNOLOGY	125
5.1	INTRODUCTION TO THE VOIP TECHNOLOGY.....	125
5.2	IP PHONE END DEVICE	125
5.3	PREPARING THE IP TELEPHONE FOR OPERATION.....	126
5.4	CALL MANAGER EXPRESS.....	129
5.5	CONFIGURING A SIMPLE VOIP NETWORK	130
5.6	COMMUNICATION BETWEEN TWO VOIP EXCHANGES.....	136
6	STP PROTOCOL.....	147
6.1	INTRODUCTION TO STP PROTOCOL.....	147
6.2	BASIC STP CONCEPTS.....	147
6.3	MAIN PRINCIPLES OF THE STA.....	149
6.3.1	<i>Determining the BID and Root BID Sent by the Switches</i>	<i>149</i>
6.3.2	<i>Root Bridge Switch Election.....</i>	<i>150</i>
6.3.3	<i>Establishing the Role of the Root</i>	<i>151</i>
6.3.4	<i>Determining the Role of a Designated Port.....</i>	<i>151</i>
6.4	OBSERVATION OF THE STP PROTOCOL OPERATION.....	152
6.4.1	<i>First Case of Link Failure.....</i>	<i>153</i>
6.4.2	<i>Second Case of Link Failure</i>	<i>155</i>
6.5	DESCRIPTION OF THE RSTP	156
6.6	COMPARISON OF RSTP AND STP PERFORMANCE.....	156
6.6.1	<i>Enabling the RSTP Protocol</i>	<i>157</i>
6.6.2	<i>Disabling the RSTP Protocol</i>	<i>157</i>
7	VTP PROTOCOL	161
7.1	INTRODUCTION TO VTP PROTOCOL	161
7.2	CONFIGURING OF VTP AND RSTP PROTOCOL.....	162
7.2.1	<i>Configuring the RSTP Protocol without Using VTP.....</i>	<i>162</i>
7.2.2	<i>Configuring RSTP without Using VTP</i>	<i>168</i>
8	FRAME RELAY TECHNOLOGY	175
8.1	BRIEF DESCRIPTION OF FRAME RELAY TECHNOLOGY	175
8.2	FRAME RELAY OPERATING PRINCIPLE	176
8.2.1	<i>Frame Relay Operating Principle.....</i>	<i>176</i>

Table of Contents

8.2.2	<i>Frame Relay Frame Format</i>	178
8.2.3	<i>Network Congestion and the Role of CIR, CBIR Parameters in the FR...</i>	178
8.3	FRAME RELAY ADDRESS MAPPING.....	179
8.3.1	<i>Inverse ARP Protocol</i>	179
8.3.2	<i>Frame Relay Connection Status</i>	180
8.3.3	<i>DLCI Reserved Numbers</i>	180
8.4	CONFIGURING FRAME RELAY NETWORKS.....	181
9	PPP PROTOCOL	189
9.1	INTRODUCTION TO PPP PROTOCOL	189
9.1.1	<i>PPP Protocol Characteristics</i>	189
9.1.2	<i>NCP Sublayer (NCP Protocol)</i>	189
9.1.3	<i>LCP Sublayer (LCP Protocol)</i>	189
9.2	AUTHENTICATION TYPES IN THE PPP PROTOCOL	190
9.2.1	<i>Configuring PPP with PAP Authentication</i>	190
9.2.2	<i>Configuring PPP with CHAP Authentication</i>	192
10	RADIUS PROTOCOL	199
10.1	SHORT INTRODUCTION TO RADIUS PROTOCOL	199
10.2	CONFIGURING RADIUS PROTOCOL	199
11	NETFLOW TECHNOLOGY	205
11.1	INTRODUCTION TO NETFLOW TECHNOLOGY.....	205
11.2	NETFLOW OPERATION.....	205
11.3	CONFIGURING NETFLOW.....	206
12	ADDRESS TRANSLATION USING NAT	213
12.1	INTRODUCTION TO NAT	213
12.1.1	<i>Reasons for Using the NAT Technique</i>	213
12.1.2	<i>NAT Technique Terminology</i>	213
12.2	NAT OPERATING DIAGRAM	214
12.3	NAT TRANSLATION TYPES	215
12.3.1	<i>Static Translation (Static NAT)</i>	215
12.3.2	<i>Dynamic NAT Translation</i>	215
13	ADDRESS TRANSLATION USING L2NAT	221
13.1	INTRODUCTION TO L2NAT	221
13.2	L2NAT OPERATING DIAGRAM	222
13.2.1	<i>Example of the Simple L2NAT Configuration</i>	224
13.2.2	<i>Handling repeating IP addresses in L2NAT</i>	225

14	VIRTUAL PRIVATE NETWORKS.....	231
14.1	BASIC CONCEPTS.....	231
14.2	BASIC PROTOCOLS, ENCRYPTION AND AUTHENTICATION METHODS.....	232
14.3	CONFIGURING REMOTE ACCESS VPN.....	233
14.4	CONFIGURING A SITE-TO-SITE VPN TUNNEL USING IPSEC	243
15	MULTILAYER SWITCHES.....	251
15.1	INTRODUCTION TO NETWORK LAYER SWITCHING.....	251
15.2	MULTILAYER SWITCH MODELS IN PACKET TRACER.....	251
15.3	RESETTING THE SWITCH.....	253
15.4	CONFIGURATION OF THE 3560 24PS MULTILAYER SWITCH	253
15.4.1	<i>Example of the Router-Switch Topology</i>	<i>254</i>
15.4.2	<i>Example of L3 Switch - L2 Switch topology.</i>	<i>257</i>
15.5	CONFIGURATION OF THE 3650-24PS MULTILAYER SWITCH.....	261
15.5.1	<i>Introductory Note for the 3650-24PS Switch.....</i>	<i>261</i>
15.5.2	<i>Example of L3 Switch - L2 Switches Topology</i>	<i>263</i>
15.5.3	<i>Example of Topology with Fiber-based L3 Switches.....</i>	<i>267</i>
16	EXERCISES.....	281
16.1	RIP PROTOCOL.....	281
16.1.1	<i>Exercise (No. 1) – Configuring RIP v2.....</i>	<i>281</i>
16.1.2	<i>Exercise (No. 2) – Configuring RIP v2.....</i>	<i>282</i>
16.1.3	<i>Exercise (No. 3) – Configuring RIP v2 with Static Routing</i>	<i>283</i>
16.1.4	<i>Exercise (No. 4) – Exporting the RIP v2 Protocol Configuration</i>	<i>284</i>
16.1.5	<i>Exercise (No. 5) – Incorrect Local Subnet Addressing.....</i>	<i>284</i>
16.1.6	<i>Exercise (No. 6) – Incorrect Protocol Configuration</i>	<i>285</i>
16.1.7	<i>Exercise (No. 7) – Incorrect Configuration of Interfaces and RIP Vers... 286</i>	
16.2	EIGRP PROTOCOL	288
16.2.1	<i>Exercise (No. 8) – Configuring EIGRP.....</i>	<i>288</i>
16.2.2	<i>Exercise (No. 9) – EIGRP Configuring and Testing</i>	<i>289</i>
16.2.3	<i>Exercise (No. 10) – Configuring and Verifying Secure EIGRP.....</i>	<i>290</i>
16.2.4	<i>Exercise (No. 11) – Configuring Packet Metrics and Path in EIGRP.....</i>	<i>291</i>
16.2.5	<i>Exercise (No. 12) – Incorrect Configuration of Adjacent Networks</i>	<i>292</i>
16.2.6	<i>Exercise (No. 13) – Wrong Wildcard Mask</i>	<i>293</i>
16.2.7	<i>Exercise (No. 14) – Incorrect EIGRP Process Number</i>	<i>294</i>
16.3	OSPF PROTOCOL.....	295
16.3.1	<i>Exercise (No. 15) – Basic Configuration of OSPF</i>	<i>295</i>
16.3.2	<i>Exercise (No. 17) – OSPF Configuration with Change of Link Costs.....</i>	<i>296</i>
16.3.3	<i>Exercise (No. 18) – Configuring OSPF Based on the Loopback Address. 297</i>	

Table of Contents

16.3.4	<i>Exercise (No. 19) – Configuring OSPF Based on Priority</i>	299
16.3.5	<i>Exercise (No. 20) – Wrong Area Number</i>	300
16.3.6	<i>Exercise (No. 21) – Wrong Wildcard Mask</i>	301
16.3.7	<i>Exercise (No. 22) – Incorrect Interface Configuration</i>	302
16.4	E BGP PROTOCOL	303
16.4.1	<i>Exercise (No. 23) – Configuring eBGP with the Loopback Address</i>	303
16.4.2	<i>Exercise (No. 24) – Configuring eBGP with the Router ID</i>	304
16.4.3	<i>Exercise (No. 25) – No Entries for BGP Neighbors</i>	305
16.4.4	<i>Exercise (No. 26) – No Entry for Local Network</i>	306
16.5	STATIC ROUTING	308
16.5.1	<i>Exercise (No. 27) – Static Routing Using the Next Hop</i>	308
16.5.2	<i>Exercise (No. 28) – Static Routing Using the Output Interface</i>	309
16.5.3	<i>Exercise (No. 29) – Packet Routing (Static Routing)</i>	310
16.5.4	<i>Exercise (No. 30) – Creating Routing Using the Next Hop</i>	311
16.5.5	<i>Exercise (No. 31) – Incorrect Subnet Mask</i>	313
16.5.6	<i>Exercise (No. 32) – Incorrect IP Address of Next Hop</i>	314
16.6	ACCESS CONTROL LISTS	315
16.6.1	<i>Exercise (No. 33) – Configuring the Basic ACL</i>	315
16.6.2	<i>Exercise (No. 34) – Configuring the Extended ACLs</i>	316
16.6.3	<i>Exercise (No. 35) - Configuring the Extended ACLs and EIGRP</i>	317
16.6.4	<i>Exercise (No. 36) - Named ACLs and OSPF Routing Protocol</i>	319
16.7	VOIP TECHNOLOGY	320
16.7.1	<i>Exercise (No. 37) – Configuring VoIP Phones and Routers as a PBX</i>	320
16.7.2	<i>Exercise (No. 38) - Configuring VoIP Phones in Two Networks</i>	322
16.8	STP PROTOCOL	323
16.8.1	<i>Exercise (No. 39) – Configuring Rapid-PVST and VLANs</i>	323
16.8.2	<i>Exercise (No. 40) – Rapid-PVST, VLANs and Port Fast Functions</i>	324
16.8.3	<i>Exercise (No. 41) – STP Switch Server</i>	326
16.8.4	<i>Exercise (No. 42) – PVST, VTP and Routing between VLANs</i>	328
16.9	VTP PROTOCOL	329
16.9.1	<i>Exercise (No. 43) – Configuring VTP without Routing between VLANs</i> .	329
16.9.2	<i>Exercise (No. 44) – Configuring VTP and Routing between VLANs</i>	338
16.10	FRAME RELAY PROTOCOL	346
16.10.1	<i>Exercise (No. 45) – Configuring the Frame Relay Protocol</i>	346
16.10.2	<i>Exercise (No. 46) – Configuring the Frame Relay Protocol</i>	357
16.10.3	<i>Exercise (No. 47) – Configuring Frame Relay Using Subinterfaces</i>	364
16.11	PPP PROTOCOL	369
16.11.1	<i>Exercise (No. 48) – Configuring PPP with PAP Authentication</i>	369
16.11.2	<i>Exercise (No. 49) – Configuring PPP with CHAP Authentication</i>	372

Table of Contents

16.12	RADIUS PROTOCOL	376
16.12.1	<i>Exercise (No. 50) – Configuring RADIUS Protocol.....</i>	<i>376</i>
16.13	NETFLOW TECHNOLOGY	380
16.13.1	<i>Exercise (No. 51) – Testing Traffic Using Traditional NETFLOW.....</i>	<i>380</i>
16.13.2	<i>Exercise (No. 52) - Testing Traffic Using Flexible NETFLOW.....</i>	<i>383</i>
16.14	ADDRESS TRANSLATION USING NAT AND L2NAT	389
16.14.1	<i>Exercise (No. 53) – Configuring Static NAT Translation.....</i>	<i>389</i>
16.14.2	<i>Exercise (No. 54) - Configuring Dynamic and Static NAT Translation. ..</i>	<i>391</i>
16.14.3	<i>Exercise (No. 55) – Configuring L2NAT Translation.....</i>	<i>394</i>
16.15	VIRTUAL PRIVATE NETWORKS.....	399
16.15.1	<i>Exercise (No. 56) – Configuring a Simple VPN (Remote Access).....</i>	<i>399</i>
16.16	MULTILAYER SWITCHES 3560 AND 3650	402
16.16.1	<i>Exercise (No. 57) - Configuring Network with 3560 Switches.....</i>	<i>403</i>
16.16.2	<i>Exercise (No. 58) – Configuring Network with a Single 3560 Switch.....</i>	<i>412</i>
16.16.3	<i>Exercise (No. 59) - Configuring Network with 3650 Switches.....</i>	<i>417</i>
17	APPENDICES.....	427
17.1	GLOSSARY OF THE KEY TERMS	427
17.2	SHORTENED IOS COMMANDS	430
17.2.1	<i>Introduction to IOS shortcut commands</i>	<i>430</i>
17.2.2	<i>Table of commonly used commands.....</i>	<i>430</i>
18	FILE LIST.....	437
18.1	EXAMPLES	437
18.2	EXERCISES.....	439