

Emulating a Multiple Hop Network

Goal: Use virtual routers to emulate a multi-hop network.

In this example, LANforge is used to emulate a live routed network by using multiple virtual routers to form a working multi-hop network. Each virtual router has its own routing table and can be configured to use one of many different routing protocols. OSPF will be used in this example and traceroute will be used to demonstrate the traversal of each hop.

- 1. Use Netsmith to create five OSPF virtual routers.
 - A. From the Status tab, select the Netsmith button.

	LANforge Manager Vers	sion(5.3.7)		\odot \times \times
<u>Control Reporting Tear-Off</u> Info Pl	ugins			
	Stop	All Resta	art Manager	Refresh HELP
Layer-4 Generic Test Mgr Tes	t Group Resource Mgr Event Log	Alerts Port Mgr	VAP Stations Messag	es
Status Layer-3 L3 Endps	VoIP/RTP VoIP/RTP Endps	Armageddor	i WanLinks Atte	enuators File-IO
License Info	Current Users		Test Configuration Datab	ase
	* Admin from:192.168.100.239 anuserver from:127.0.0.1	List:	BLANK	Load
Licenses expire in: 702 days.		Name:		Delete
Current suring in 702 days		Load Behavior:	Overwrite	Save
Support expires in: 702 days.			Download DB	Show Progress
				I
	Virtual Shelf	1		
	Resource	L ,		
	•• 🔳 ••			
	••		3	
	Notomith	_		
	NetSmith			
Logged in to: 192.168.100.103:4002	as: Admin			

B. Right-click in the Netsmith window and select New Router.

0	Netsmith configuration for Resource: jw2(1.1) Version: 5.3.7	\odot \otimes \otimes
Mgt-eth0 eth1 eth2	New Router New Connection New Bridge New Bridge	
eth4 eth4 eth5 eth5	yend ☑ Fire	▼ Close
WanLink Names Port Nam Peer WanLinks Parents WanLink Config	les ⊯ Fire Names _ ∠ero-IrV4S Apply Progress: <u>100% Complete</u> ✓ Col. Domains _ IPV6s Netsmith Status: OK	Cancel Apply

C. Select the Use OSPF checkbox.

			CI	reate/Modify	Virtual Rou	ıter			
ame: <auto cre<="" th=""><th>ate New Name></th><th></th><th></th><th>Width:</th><th>100</th><th></th><th>Height:</th><th>100</th><th></th></auto>	ate New Name>			Width:	100		Height:	100	
Use OSPF	Multicast Routine	g 🗌 Us	e OLSR	RIPv2 RI	P Dflt Route	Xorp SHA	IPv6 Rou	iter 🗌 IPv6	RADV
Use Existing Cf	BGP Route	er 🗌 BC	SP 4B AS	BGP Reflect	or BGP C	Confederation	BGP Dar	mping	
			IN IN	otes about thi	s virtual Rout	er			
			E	GP Configurat	ion Informatio	n			
	Router ID		Local	AS		Cluster ID			
	Confederation II	0	Damp	oing Half Life		Damping Ma	KSuppress 3		
	Damping Reuse		Damp	oing Suppress					
3GP Peer Flags			Peer AS	Peer ID	Local Iface	Nexthop	Nexthop6	Hold Time	Delay Oper
Active Clie	nt Confed	Ucast							
Active Clie	nt 🗌 Confed 🛛	✓ Ucast							
Active Clie	nt 🗌 Confed [Ucast							
Active Clie	nt 🗌 Confed [Ucast							
Active Clie	nt 🗌 Confed 🛛	Ucast							
Active Clie	nt 🗌 Confed [Ucast							
Active Clie	nt 🗌 Confed [Ucast							
Active Clie	nt 🗌 Confed [Ucast							
			L	ak	Cancel				
					Cancel				

D. Select OK, then create four more OSPF virtual routers.



E. After creating five OSPF virtual routers, select Apply.



- 2. Create four Netsmith connections to link all of the OSPF virtual routers.
 - A. Right-click in the Netsmith window and select New Connection.



B. Leave all the default settings and select OK.

		6			
ſ		Create/Mor		<u></u>	
		create/mot	Interface-Cost:		
	Port 1-A:	<auto create="" new="" port=""> 💌</auto>	RIP-Metric:	1	
	Port 1-B: 🔲 Skip	<auto create="" new="" port=""></auto>	VRRP IP		
	WanLink: Skip	<auto create="" new="" wanlink=""></auto>	VRRP ID:	1	
		-Auto Croato New Parts	VRRP Priority:	100	
	Ропт 2-В: 🔲 Sкip	Adto create New Ports	VRRP Interval:	1	
	Port 2-A: Skip	<auto create="" new="" port=""></auto>	Next-Hop:		
	DHCP Lease Time:		Subnets (a.b.c.d/xx):		
	DHCP DNS:				
	DHCP Range Min:				
	DHCP Range Max:				
Mgt-eth0	DHCP Domain:		Novt Hop IPv6		
eth2	DHCPv6 DNS:		IPv6 Subnets (aaa::0/xx):		
etl	DHCPv6 Range Min:				
	DHCPv6 Range Max:				
	DHCPd Config File:				
	NAT DHCP	DHCPv6 Custom DHCF	P VRRP Cand-RP		
L					
anLinks	Show Legend	Fire IPv4s	Info Print	Sync Apply Clos	se
ant ink Nor	mes Port Names	Fire Names Zero-IPv4s Ap	nhy Prograssi 10	0% Complete	

C. Create three more Netsmith connections.



D. After creating four Netsmith connections, select Apply.



- 3. Assign IP addresses to either end of each of the four Netsmith connections.
 - \bigcirc \land \times Netsmith configuration for Resource: jw2(1.1) Version: 5.3.7 Virtual Routers and Connections 0 0 rddVR1 R1(NA) Q rddVR5 OUS rdd+R& 0 us, 1 544 Mbps rddt 841.544 92 R0(NA) Display WanLink & WanPaths Connect VRWL-1, 1.003 rddVR7 14 Mbps 0 us, 1.544 Mbps -> Modify Toggle WanLink Modify WanLink VRW1-1. J. 001 0 us, 1.544 Mbps -> Modify Port 2 Create Ports Mgt-eth0 eth1 Sniff Port rddVR3 3(NA) R4(NA) Reset Port Delete Port eth5 Delete WanLink Delete 4 • IPv4s Show Legend 🗹 Fire ✓ WanLinks Info Print Sync Apply Close 🗷 WanLink Names 🖉 Port Names 🖉 Fire Names 🗌 Zero-IPv4s Apply Progress: 100% Complete Cancel Apply Peer WanLinks Parents 🖌 Col. Domains 📃 IPv6s Netsmith Status: ✓ WanLink Config
 - A. Right-click on rddVR0 and select Modify Port.

B. Set rddVR0 to 10.0.0.1/30 and select OK.

•		rddVR) (jw2) Configu	re Settings		\odot
		Current: I Driver Info: I	Port Status Info LINK-UP PROBE-ERF Port Type: Redirect	ormation OR TSO UFO GSO GRO -Device Peer: rddVR0b	\$	
			Port Configu	ables		
Enable Set IF Down Set MAC	Down	General In	terface Settings		Port Rates 0 10bt-HD 0 10bt-FD 0 100bt-HD	Advert Rates 10bt-HD 10bt-FD
Set TX Q Len Set MTU Set Offload	DHCP-IPv6	DHCP Release	DHCP Vendor ID: DHCP Client ID:	None 🗸	 ○ 100bt-FD ○ 1000-FD ● 10G-FD ○ 40G-FD ○ Autonegotiate 	100bt-HD 100bt-FD 1000-FD
Set PROMISC Set Rx-All/FCS	DNS Servers: IP Address: IP Mask:	BLANK 10.0.0.1/30 0.0.0.0	Peer IP: Global IPv6: Link IPv6:	NA AUTO AUTO	Renegotiate	10G-FD 40G-FD Flow-Control
Services	Gateway IP: Alias: MAC Addr: Br Cost: Rpt Timer:	0.0.0.0 9e:ad:d8:40:15:d2 Ignore	J IPV6 GW: MTU: TX Q Len Priority: WiFi Bridge:	1500 1000 Ignore V NONE V	RX-ALL RX-FCS Bypass NOW! Bypass Power-UP Bypass Power-UP	Offload TSO Enabled UFO Enabled GSO Enabled LRO Enabled
,	Print V	ew Details	Probe Sync		Bypass Disconnect	GRO Enabled

C. Right-click on rddVR1 and select Modify Port.



D. Set rddVR1 to 10.0.0.2/30 and select OK.

		rddVR	L (jw2) Configu	re Settings		\odot
			Port Status Info	ormation		
		Current: I	INK-UP PROBE-ERF	OR TSO UFO GSO GRO		
		Driver Info: F	Port Type: Redirect	-Device Peer: rddVR1	b	
			Port Configu	rables		
Enable —		General In	terface Settings		Port Rates	Advert Rates
Set IF Down					O 10bt-HD O 10bt-FD	10bt-HD
Set MAC	Down	Aux-Mgt			O 100bt-HD	10bt-FD
Set TX Q Len				None	0 100bt-FD	100bt-HD
Set MTU	DHCF4FV0	DHCF Release	DHCF Veridor iD:	None	0 10G-FD	100bt-FD
Set Offload	DHCP-IPv4	Secondary-IPs	DHCP Client ID:	None	O Autonegotiate	1000-FD
Set PROMISC	DNS Servers:	BLANK	Peer IP:	NA		10G-FD
Set Rx-All/FCS	IP Address:	10.0.0.2/30	Global IPv6:	AUTO	Renegotiate	40G-FD
Set Bridge Info	IP Mask:	0.0.0.0	Link IPv6:	AUTO	Restart Xcvr	Flow-Contro
	Gateway IP:	0.0.0.0	IPv6 GW:	AUTO		1-
120010000	Alias:		MTU:	1500	RX-ALL	Offload -
- Services	MAC Addr:	7a:84:2b:07:a5:32	TX Q Len	1000	RX-FCS	TSO Enable
	Br Cost:	lanore	Priority	lanore	Bypass NOW!	UFO Enable
FTP	51 0030]		Bypass Power-UP	GS0 Enable
RADIUS	Rpt Timer:	medium (8 s)	WiFi Bridge:	NONE	Bypass Power-DOWN	LRO Enable
					Bypass Disconnect	GRO Enable
	-					1
		Distalla	Dauba Cara		OK Consul	
	Print	ew Details	Probe Sync	Арріу	<u>Cancel</u>	

E. Repeat the steps above to complete the following:



- A. rddVR2 is 11.0.0.1/30 and rddVR3 is 11.0.0.2/30
- B. rddVR4 is 12.0.0.1/30 and rddVR5 is 12.0.0.2/30
- C. rddVR6 is 13.0.0.1/30 and rddVR7 is 13.0.0.2/30

- 4. Drag each end of a Netsmith connection into a virtual router to setup the network.
 - A. A: Setup the following by dragging the interfaces into the specified virtual routers:



- A. rddVR0 in R0 and rddVR1 in R1 $\,$
- B. rddVR2 in R1 and rddVR3 in R2
- C. rddVR4 in R2 and rddVR5 in R3 $\,$
- D. rddVR6 in R3 and rddVR7 in R4

B. B: Right-click on each Wanlink (red bar) and select Toggle Wanlink (change to green bar).



- A. **Note:** If you wanted to emulate an /impaired/ multi-hop network, you could modify each Wanlink to have any LANforge impairment such as latency, jitter, dropped packets, etc...
- C. After all interfaces are moved and Wanlinks started, select Apply in the Netsmith window.



- 5. Assign IP addresses and Default Gateways to each of four physical interfaces.
 - A. Right-click on each interface and select Modify Port.



B. Setup the following IP addresses and Default Gateways:



- A. eth1 IP address is 172.16.0.101/24 and Default GW is 172.16.0.1
- B. eth2 IP address is 172.16.0.1/24 and Default GW is 172.16.0.1
- C. eth3 IP address is 192.168.0.1/24 and Default GW is 192.168.0.1
- D. eth4 IP address is 192.168.0.104/24 and Default GW is 192.168.0.1

C. Drag eth2 into R0 and eth3 into R4, then Apply changes.



A. **Note:** In this example, four physical interfaces are used. eth1 and eth2 are physically connected with a cable, as are eth3 and eth4. This allows us to use eth1 and eth4 to generate traffic to each other through the network interfaced by eth2 and eth3.

- 6. Apply all changes in Netsmith, allow OSPF time to converge, and observe routing tables.
 - A. After applying all Netsmith changes, right-click on a virtual router and select Show Routing Table. (Before OSPF converges, only the directly connected networks are shown.)

	LANforge Dialog 📀 🔿
(i)	09/13 14:08:41.47 Routing table for Virtual Router: Router-0 (5) unreachable default proto xorp scope link metric 1 notify 10.0.0.0/30 dev rddVR0 scope link 172.16.0.0/24 dev eth2 scope link
<u>.</u>	

B. After OSPF converges, each virtual router has a complete routing table for the entire network.

LANforge Dia	alog 📀 🔿	0
	09/13 14:09:29.28	86
Routing table for Virtual Route	er: Router-O (5)	
unreachable default proto xorp 10.0.0.0/30 dev rddVR0 scope li 11.0.0.0/30 via 10.0.0.2 dev ro 172.16.0.0/24 dev eth2 scope li	scope link metric l notify ink ddVR0 proto xorp metric 2 notify ink	y
	\$	
4		Þ
OK		

A. Note: If you select Netsmith Apply again, this will restart all virtual routers and OSPF will need time to converge again.

- 7. Alternative method to observe routing tables of each virtual router.
 - A. With OSPF virtual routers, you can right-click on a virtual router and select Virtual Router Console to bring up the underlying xorp shell for the virtual router.



B. Once at the xorp shell prompt, type the following to display the routing table information:



A. show route table ipv4 unicast final

8. Use traceroute to traverse all five hops.

A. Open a terminal window in the LANforge system.



B. Type the following command at the prompt:

					root	@fwa7	LO-bl	ue:~			6 X
<u>F</u> ile	<u>E</u> dit	<u>V</u> iew	<u>T</u> ermi	nal	<u>H</u> elp						
[roo ⁻	t@fwa7	10-blu	e ~]#	trad	ceroute	-i etł	1 13	.0.0.2			<u>^</u>
											+ + + +
											++
											~

A. traceroute -i eth1 13.0.0.2

B. Note: -i eth1 forces the traceroute program to use eth1 as its outgoing interface.

C. Observe the results of each hop in the network.

	root@fwa710-blue:~	- + X
<u>File Edit View Terminal</u>	<u>H</u> elp	
<pre>[root@fwa710-blue ~]# tra traceroute to 13.0.0.2 (1 1 172.16.0.1 (172.16.0. 2 10.0.0.2 (10.0.0.2) 3 11.0.0.2 (11.0.0.2) 4 12.0.0.2 (12.0.0.2) 5 13.0.0.2 (13.0.0.2) [root@fwa710-blue ~]# ■</pre>	aceroute -i ethl 13.0.0.2 13.0.0.2), 30 hops max, 60 byte packets .1) 0.129 ms 0.098 ms 0.081 ms 0.332 ms 0.299 ms 0.243 ms 0.572 ms 0.549 ms 0.449 ms 2.917 ms 2.902 ms 2.813 ms 4.808 ms 4.712 ms 4.695 ms	

D. Traceroute from eth4.

	root@fwa710-blue:~	×
<u>F</u> ile	e <u>E</u> dit <u>V</u> iew <u>T</u> erminal <u>H</u> elp	
[roo	ot@fwa710-blue ~]# traceroute -i eth1 13.0.0.2	
trad	ceroute to 13.0.0.2 (13.0.0.2), 30 hops max, 60 byte packets	
1	172.16.0.1 (172.16.0.1) 0.111 ms 0.081 ms 0.105 ms	
2	10.0.0.2 (10.0.0.2) 0.226 ms 0.338 ms 0.321 ms	
3	11.0.0.2 (11.0.0.2) 0.640 ms 0.559 ms 0.539 ms	
4	12.0.0.2 (12.0.0.2) 2.937 ms 2.924 ms 3.551 ms	
C	13.0.0.2 (13.0.0.2) 4.778 ms 4.087 ms 0.003 ms	
	oterwa/10-blue ~]#	
[roo	otefwa710-blue ~]#	
trad	cercuite to $10.0.0.1$ ($10.0.0.1$) 30 hors may 60 hyte packets	
1	192 168 0 1 (192 168 0 1) 0 109 ms 0 081 ms 0 100 ms	
2	13.0.0.1 (13.0.0.1) 0.243 ms 0.159 ms 0.489 ms	
3	12.0.0.1 (12.0.0.1) 2.210 ms 2.177 ms 2.142 ms	
4	11.0.0.1 (11.0.0.1) 3.166 ms 3.148 ms 3.177 ms	
5	10.0.0.1 (10.0.0.1) 6.731 ms 6.719 ms 6.699 ms	
[roo	ot@fwa710-blue ~]#	
	_	
		U

A. traceroute -i eth4 10.0.0.1

E. Generate LANforge traffic through the multi-hop network.

A. Go to the Layer-3 tab and select Create.

LANforge Manager Version(5.3.7)
Control Reporting Tear-Off Info Plugins
Stop All Restart Manager Refresh HELP
Generic Test Mgr Test Group Resource Mgr Event Log Alerts Port Mgr vAP Stations Messages Status Layer-3 L3 Endps VolP/RTP VolP/RTP Endps Armageddon WanLinks Attenuators File-10 Layer-4
Rpt Timer: fast (1 s) 🔻 Go Test Manager all 💌 Select All Start Stop Quiesce Clear
View 0 - 500 Go Display Create Modify Delete
Cross Connects for Selected Test Manager
Name Type State Pkt Rx A Pkt Rx B Bps Rx A Bps Rx B Rx Drop % A Rx Drop % B Drop Pkts A
Logged in to: 192.168.100.103:4002 as: Admin

B. Set Endpoint-A to use eth1 and Endpoint-B to use eth4.

0	test-1 - Creat	e/N	lodify Cross Connect				\odot \otimes \times
+ - All	Display	Syn	c Batch-Create	Ар	ply	OK	Cancel
CX Name: CX Type:	Cross-Connect test-1 LANforge / UDP			•		\$	
Resource:	Endpoint A 1 (jw2)	-	Endpoint B 1 (jw2)	-			
Port:	1 (eth1)	-	4 (eth4)	-			
Min Tx Rate:	Mid DSL (768 Kbps)	-	Mid DSL (768 Kbps)	-			
Max Tx Rate:	Same	•	Same	-			
Min PDU Size:	lk (1,024 B)	-	1k (1,024 B)	-			
Max PDU Size:	Same	-	Same	-			
IP ToS:	Best Effort (0)	-	Best Effort (0)	-			
Pkts To Send:	Infinite	-	Infinite	-			
				_			

C. Start the Layer-3 connection.

LANforge Manager Version(5.1.2)								
<u>C</u> ontrol <u>R</u> eporting <u>T</u> ear-Off Help								
Stop All Restart Manager Refresh HELP								
HIE-IO Layer-4 Generic Lest Mgr Resource Mgr Serial Spans PPP-Links Port Mgr Messages								
Status Layer-3 Es Endps von Arti von Arti Endps Annageduoni Waiteness Conston-Domains								
Rpt Timer (ms): 3000 🔻 Go Test Manager all 💌 Select All Start Stop Quiesce Clear								
View 0 - 200 🔽 Go Display Create Modify Delete								
Cross Connects for Selected Test Manager								
Name Type State Pkt Tx A->B Pkt Tx A<-B Rate A->B Rate A->B Rate A->B Rx Drop A Rx Drop B Rpt Timer EID Endpoints (A <-> B)								
test-1 LF/UDP Run 1,554 1,573 767,583 767,710 0 0 1000 1.6 test-1-A <=> test-1-B								
Logged in to: 192.168.100.226:4002 as: Admin								

D. Traffic flowing through the multi-hop network.



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