

Scenario-1 MLTG-360 (DN) to MLTG-360 (DN)

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1. Test Environment



One MLTG-360 (DN) setup links with 2 MLTG-360 (DN) on 2 different radio cards.

2. Prerequisites

- i. QR code scanner Scan the QR code sticker to obtain the device's Serial number and MAC address.
- ii. PoP (Point-of-Presence) Node A DN that serves as the demarcation between the Terragraph network and the provider's backbone network. The PoP node is part of the Terragraph network.
- iii. An **IPv6-compatible** router which can be configured for routing traffic to and from the Terragraph network prefix.

3. Hardware Setup

Quantity	Device	Description				
		DN serves as the demarcation between the Terragraph network and				
C	DN	the provider's backbone network. While Terragraph is a wireless				
3	DN	technology, there must be at least one wired Terragraph PoP node				
		that connects to an upstream IPv6-enabled network.				
1	SFP+10Gbps	The SFP+ port is utilized to connect the Terragraph network into a				
T	Ethernet module	provider's IP network and to the Client.				
1 PC(Client) Clients use PC to connect to DN's LAN port to use network		Clients use PC to connect to DN's LAN port to use network				

4. Use ports

Device	Port name	Description		
		The interface that the PoP node uses to communicate with		
	SFP+	the upstream router and the interface that the client uses		
IVILIG-360		to communicate with the upstream.		
	IN	For management and PoE power in		

5. Indication of radio card

DN

4x 60GHz Radio, supporting 360° (90° x 4)



6. Setup procedure

6.1. In order to configures and control the DN network, we have to enable the E2E(End-to-End) Controller on the PoP node (**DN1 in this setup**).

The E2E controller is a software application that communicates with and manages Terragraph nodes in the network. It also provides service that bring-up wireless links.

a. To access the PoP Node's web management interface, follow the steps below: Enter the "management IP address" on the address bar of a web browser. The management port is set to operate by default in DHCP mode. If no DHCP server is available for management port, the device has a fall-back management IP address of 192.168.1.20 with a subnet mask of 255.255.255.0. You must set your PC's IP address to be on the same subnet with the PoP Node.

🗧 🔶 C 🟠 本安全 10.131.5.2000/rdsshboard 🏠 🗸 🌖 💿 🖏 🕭 👔					
dge-corg					
🙆 DASHBOARD	DASHBOARD				
Hanagement Port	Status				
풉 Topology 🗸 🗸					
O E2E controller	Uptime		Version		
Site Setting	15:29:19 up 5 min		RELEASE_M55-0-g9bf956c28		
O Link Setting	Serial Number		мас		
Route V	AK23058500		04:f8:f8:e7:5a:b2		
O E2E Network					
O Routing Table	Interface IP				
Firmware					
	Management Interface				
	IPv4	10.131.5.208			
	IPv6 Link	fe80::6f8:f8ff:fee7:5ab2/64			
	IPv6 Global	2001:b030:200b:5a1:6f8:f8ff:fee7:5ab2/64			
	Uplink Interface				
	IPv6 Link	fe80::e4ac:c6ff:fe8b:c7b3/64			
	IPv6 Global	2001:b030:200b:5a1::c/64,2001:b030:200b:5a1:e4ac:c6ff:fe	8b:c7b3/64		
	Loopback Interface				
	IPv6	2001:b030:200b:5cf::1/128			

6.1.1. On the left-hand panel, Navigate to Topology and click on E2E controller

- b. Enable E2E Controller *(*No need to enable E2E controller for other DN*).
- c. Click 'Save' button

← → C ① ▲ 不安全 10	.131.5.208/#e2econtroller	\$	· 🗸 🥞 🤤 🗞 🔅 🤅
	=		ტ
🔁 dashboard	E2E Controller		
Management Port			
윰 Topology ~	Enable E2E Controller	● <mark>✓</mark>	
O E2E controller			
O Site Setting			
O Node Setting			2 Save
O Link Setting			
器 Route 🗸			
O E2E Network			
O Routing Table			
Firmware			

6.2. After enabling the E2E controller, you have to setup the site by entering site information for each of the Nodes deployed.

In this scenario, there will be 3 sites for each of the 3 DN nodes used in this deployment.

- 6.2.1. Under Topology, click on Site Setting and follow the below examples:
 - a. Click 'Add' button

b.

c.

i.	Site name:	POPSite
ii.	Longitude:	121.544616
iii.	Latitude:	25.06156
iv.	Altitude:	2
٧.	Accuracy:	5
Clic	k 'Add' button	
i.	Site name:	DN2Site
ii.	Longitude:	121.544606
iii.	Latitude:	25.06155
iv.	Altitude:	2
٧.	Accuracy:	5
Clic	k 'Add' button	
i.	Site name:	DN3Site
ii.	Longitude:	121.544612
iii.	Latitude:	25.06154
iv.	Altitude:	2

- iv. Altitude: 2 v. Accuracy: 5
- v. Accuracy: d. Click 'Save' button

← → C ① ▲ 不安全 10	0.131.5.208/#site_setting				☆ ✓	🤊 🔕 🐁 💼 E
🔁 DASHBOARD						
뭅 Management Port						
뮵 Topology 🗸 🗸	Name	Longitude	Latitude	Altitude	Accuracy	
O E2E controller			6			
O Site Setting	PoPSite	121.544616	25.06156	2	5	Delete
O Node Setting						
O Link Setting	DN2Site	121.544606	25.06155	2	5	Delete
器 Route ~	DN3Site	121.544595	25.06153	2	5	Delete
O E2E Network				-	-	
O Routing Table						
Firmware						3 Save

6.3. Next, proceed to Note settings to set up Node MAC and Radios MACs of each particular Nodes.

6.3.1. Under Topology, click on Node Setting

a. On each Node, take note of the Node MAC and the Radio MAC of 4 radio cards and the NODE MAC address on the dashboard page. You will be entering this information in the following step:

	≡						
🔁 DASHBOARD	La	Loopback Interface					
뮴 Management Port	IP	Pv6 2	2001:b030:200b:5cf::1/128				
품 Topology							
뭅 Route	Rac	dio MAC					
	R	tadio A	04:ce:14:fe:a4:41		fe80::6ce:14ff:fefe:a441		
	R	tadio B	04:ce:14:fe:a8:4b		fe80::6ce:14ff:fefe:a84b		
	R	tadio C	04:ce:14:fe:a3:d0		fe80::6ce:14ff:fefe:a3d0		
	R	tadio D	04:ce:14:fe:a7:ad		fe80::6ce:14ff:fefe:a7ad		

Here is an example setting:

- i. Click 'Add' button
- ii. Name: POP
- iii. Node MAC: 04:f8:f8:e7:5a:b2
- iv. Radio MAC: *Must be entered in order (RadioA,RadioB,RadioC,RadioD) and to be separated by a comma 04:ce:14:fe:a4:41,04:ce:14:fe:a8:4b,04:ce:14:fe:a3:d0,04:ce:14:fe:a7:ad
- v. Site: POPSite
- b. Add DN node according to Radio mac of 4 radio cards and node mac address on the dashboard page.

	=		
dashboard			
륨 Management Port 뮴 Topology <	Radio MAC		
뭅 Route <	Radio A	04:ce:14:fe:a4:2e	fe80::6ce:14ff:fefe:a42e
Firmware	Radio B	04:ce:14:fe:a4:2a	fe80::6ce:14ff:fefe:a42a
	Radio C	04:ce:14:fe:a4:58	fe80::6ce:14ff:fefe:a458
	Radio D	04:ce:14:fe:a4:22	fe80::6ce:14ff:fefe:a422

Here is an example setting:

- i. Click 'Add' button
- ii. Name: DN2
- iii. Node MAC: {DN2's node mac}
- iv. Radio MAC: {DN2's

radio_cardA_mac,radio_cardB_mac,radio_cardC_mac,radio_cardD_mac}

- v. Site: DN2Site
- vi. Click 'Add' button
- vii. Name: DN3

- viii. Node MAC: {DN3's node mac}
- ix. Radio MAC: {DN3's
 - radio_cardA_mac,radio_cardB_mac,radio_cardC_mac,radio_cardD_mac}
- x. Site: DN3Site
- c. Assign DN1 as PoP node and Click 'Save' button

Here is an example setting:

← → C 凸 ▲ 不安全 1	10.131.5.208/#node_setting					* ~ 🤜	G 😼 🏞 🗉
Edge core Networks	≡						ტ
🙆 DASHBOARD	Nodes						
Hanagement Port			0				
Topology V	Name	Node Mac	Radio MACs	POP Node	Site		
O E2E controller							
O Site Setting	POP	04:f8:f8:e7:5a:b2	04:ce:14:fe:a4:41,04:ce:14:fe:a8:4b,04:ce:14:fe	3	PoPSite	\$	Delete
O Node Setting							
O Link Setting	DN2	34:ef:b6:45:f6:0c	04:ce:14:te:a4:7t,04:ce:14:te:a4:33,04:ce:14:te:		DN2Site	÷	Delete
Route V	DN3	34:ef:b6:45:fe:2e	04:ce:14:fe:a4:2e,04:ce:14:fe:a4:2a,04:ce:14:fe		DN3Site	¢	Delete
O E2E Network							
O Routing Table							
Firmware							4 Save

- 6.4. Proceed to Link Setting to configure the wireless connection between the different Nodes.
 - 6.4.1. Under Topology, click on Link Settings:
 - a. Add links between 3 DN nodes.

In this scenario, use different radio card to add 2 links between 3 DN nodes.

- Adding 1 link between the DN2 node and the PoP node.
 DN2(Radio card C: 04:ce:14:fe:a4:49)----60GHz----PoP(Radio_card A: 04:ce:14:fe:a4:41)
 Here is an example setting:
 - 1. Select "DN2" in Peer field, and select "04:ce:14:fe:a4:49" in Peer Radio MAC field
 - 2. Select "**PoP**" in **Initiator** field, and select "**04:ce:14:fe:a4:41**" in **Initiator Radio MAC** field. (* Must select PoP node in Initiator Radio MAC)
- ii. Adding 1 link between the DN3 node and the PoP node.
 DN3(Radio card A: 04:ce:14:fe:a4:2e)----60GHz----PoP(Radio_card C: 04:ce:14:fe:a3:d0)
 Here is an example setting:
 - 1. Select "DN3" in Peer field, and select "04:ce:14:fe:a4:2e" in Peer Radio MAC field.

2. Select "**PoP**" in **Initiator** field, and select "**04:ce:14:fe:a3:d0**" in **Initiator Radio MAC** field. (* Must select PoP node in Initiator Radio MAC)

C 台 ム 不安全 10.131.5.208/#link_setting								
	≡							ወ
🖚 DASHBOARD								Add
품 Management Port								
뮵 Topology ~	Name	Peer	Peer Radio MAC	Initiator	Initiator Radio MAC	Status	Туре	
 E2E controller Site Setting 	link-DN2-POP	DN2 🗢	04:ce:14:fe:a4:49	POP \$	04:ce:14:fe:a4:41 \$	Down	Wireless	Delete
 Node Setting Link Setting 	link-DN3-POP	DN3 ÷	04:ce:14:fe:a4:2e \$	POP \$	04:ce:14:fe:a3:d0 \$	Down	Wireless	Delete
Route V								
O E2E Network								Save
O Routing Table								
Firmware								

6.5. To route traffic to external network outside of the Terragraph network we need to setup the PoP node routing to configure the default routing either static routing.

In this scenario, this can be configured from using the following section on the PoP node:

Field	Description
	The network prefix in Terragraph is usually a /56 allocation, which is further
	divided into /64 prefixes to be assigned to individual nodes. The network prefix
	bounds the maximum possible number of radios in the deployment.
	Each Terragraph node is assigned an IPv6 /64 prefix as the loopback interface.
E2E Network Prefix	This loopback interface address is used by the E2E controller to address the
	node. Prefix allocation to the nodes can be done randomly or centrally through
	the E2E controller.
	In this scenario, fixed /64 prefix as the loopback interface, so the network
	prefix space should be larger than /64.

- 6.5.1. Take our IPv6 network environment as an example:
 - 1. Our gateway IPv6 address is 2001:B030:200B:05A1::1/64
 - 2. We configure specific IPv6 routes in the gateway to achieving the network prefix space larger than /64
 - 3. The rule for specific routing is "2001:B030:200B:05C0::/60 via 2001:B030:200B:05A1::C"
- 6.5.2. On the PoP node(DN1), go to [Route] > [E2E Network] Here is an example setting:
 - a. E2E Network Prefix: 2001:B030:200B:05C0::/60
- 6.5.3. Set the interface on which you want to configure the default route. Usually, it's on the 10G interface (SFP+ port). Give the gateway address, static address being assigned to the 10G interface is given as "POP Uplink Address" and static address assigned to uplink interface on the PoP node. Here is an example setting:

a. Gateway Address:

b.

2001:B030:200B:05A1::1

- POP Uplink Address: 2001:B030:200B:05A1::C
- c. Click "Save" button and Reboot

← → C 凸 ▲ 不安全 10	0.131.5.208/#kvstore_setting		☆ 💩 無痕模式 (2) 🕴
dge-core Networks	=	10.131.5.208 顯示	<u>ں</u>
🔁 DASHBOARD	E2E Network	Please reboot to apply!	•
움 Management Port	KVstore	3 强定	
품 Topology <			
뭅 Route V	E2E Network Prefix	2001-0020-2000-5-00	
O E2E Network		2001.0050.2000.500/60	
O Routing Table	· · · · · · · · · · · · · · · · · · ·		
Firmware	POP Parameters		
		0	
	Gateway Address	2001:B030:200B:05A1::1	
	PoP Uplink Address	2001:B030:200B:05A1::C	
			2 Save

6.6. Once this config is configured and node is rebooted. You should see static IP address configured on the uplink interface on Dashboard

← → C 合 ▲ 不安全	10.131	.5.208/#dashboard		x 🗸 4 6 6 7 8 8 8					
		=		e					
한 DASHBOARD 중 ManageWAN 중 Topology < 중 Route <		DASHBOARD Status							
	L	Uptime		Version					
Firmware	L	07:33:02 up 1 dəy		RELEASE_MS5-0-g9bf956c28					
		Serial Number		мас					
	L	AK23058500		04;f6;f8;e7:5a;b2					
		Interface IP Management Interface							
	L	IPv4	10.131.5.208						
	L	IPv6 Link	fe80::6f8:f8ff:fee7:5ab2/64						
	L	IPv6 Global 2001:b030:200b:5a1:6f8:f8ff-fee7:		ab2/64					
	L	Uplink Interface							
		IPv6 Link	fe80::a410:a2ff:fe65:2371/64						
		IPv6 Global	2001:b030:200b:5a1::c/64						
		Loopback Interface							
		IPv6	2001:b030:200b:5c7::1/128						

6.6.1. Go to [Dashboard]

6.7. You will see default route being configured over gateway address on Routing Table:

6.7.1. Go to [Route] > [Routing Table]

← → C 企 ▲ 不勢	建 10.13	1.5.208/#route_setting		🖈 🗸 🥞 🔕 🏞 🕒
🕰 DASHBOARD		Route via terra		
Hanagement Port				
뀸 Topology	۲.	Destination	via	Interface
Route	~	::/0	2001:b030:200b:5a1::1	loop1
O E2E Network		2001:b030:200b:5c7::/64	fe80::6ce:14ff:fefe:a42e	vpp-terra32
O Routing Table		2001:b030:200b:5c7::1/128	fe80::6ce:14ff:fefe:a42e	vpp-terra32
L Firmware		2001:b030:200b:5cb::/64	fe80::6ce:14ff:fefe:a449	vpp-terra0
		2001:b030:200b:5cb::1/128	fe80::6ce:14ff:fefe:a449	vpp-terra0

- 6.8. Then the PoP node start igniting the links, you can check the status of link and node.
 - 6.8.1. Go to [Topology] > [Link setting]
 - a. Check if all links status becomes "Up"

	1								ს
🕰 DASHBOARD									Add
岩 Management Port									
뭅 Topology ~	Name	Peer		Peer Radio MAC	Initiator	Initiator Radio MAC	Status	Туре	
O E2E controller	link-DN2-POP						Up	Wireless	
O Site Setting		DN2	÷	04:ce:14:fe:a4:49 \$	POP 🗢	04:ce:14:fe:a4:41 ÷			Delete
O Node Setting	link-DN3-POP	DN3	÷	04:ce:14:fe:a4:2e \$	POP ÷	04:ce:14:fe:a3:d0 \$	Up	Wireless	Delete
O Link Setting									

6.9. Make sure that each DN node has got the loopback IPv6 address

6.9.1. On DN2 and DN3, go to [Dashboard]

← → G ♥ ▼	← → C 合 ▲ 不安全 10.131.5.151/#dashboard										
		≡									
🗥 DASHBOARD		Uplink Interface									
뀸 Management Port											
뭄 Topology	<	IPv6 Link									
Route	<	IPv6 Global									
Firmware		Loopback Interface									
		IPv6	2001:b030:200b:5cb::1/128								

6.10. After checking that all link status have become "Up", set the route between DN3 and Client. For example, DN3's OUT1 port is ethernet linked PC(Client).

DN3(SFP+ port)————PC(Ethernet port)

So we need to set up 1 route for the link between DN3 and PC.

- 6.10.1. **On DN3**, go to [Route] > [Routing Table] Add link-DN3-PC route:
 - a. Action: Add
 - b. Destination Radio MAC: {PC's ethernet interface mac}
 - c. Destination Global IP: {PC's global IPv6/128}
 - d. Destination Link IP: {PC's link-local IPv6}
 - e. Interface: TenGigabitEthernet0



You can check the mac, link-local address and global IPv6 address of PC's ethernet interface on PC.

Here is an example setting:

	≡				ტ
🔁 DASHBOARD	Route				
몹 Management Port 몸 Topology <	Create Route				Add
뭄 Route 🗸					
O E2E Network	Destination Radio MAC	Destination Global IP	Destination Lnik IP	Interface	
O Routing Table	00:90:9E:9D:0A:F0	2001:b030:200b:5c7::9/128	fe80::114a:fd73:3401:32c4	TenGigabitEthernet0	Delete
Firmware					
	Route via terra				

6.10.2. On PC(Linux)

a. Set static IPv6 address which is in the same subnet (prefix) as IPv6 address of DN3's loopback interface.

ip -6 addr add {the same subnet (prefix) as IPv6 IP address}/128 dev interface} Here is an example setting:

ip -6 addr add 2001:b030:200b:5c7::9/128 dev enx00909e9d0af0

b. Set default gateway to link local-address of SFP+ interface of DN3.

You can find the local-address of SFP+ interface on the DN3's dashboard.

ROADD								
BUARD	Loopback Interface							
gement Port	IPv6			2001:b030:200b:5c7::1/128				
ogy <								
ř R	adio MAC							
Network								
ting Table	Radio A		04:ce:14:fe:	a4:2e			fe80::6ce:14ff:fefe:a42e	
rare	Radio B			04:ce:14:fe:a4:2a				
	Radio C			04:ce:14:fe:a4:58				
	Radio D		04:ce:14:fe:a4:22				fe80::6ce:14ff:fefe:a422	
PL	hysical Interface Information				SFP+			
P	hysical Interface Information IN 34:EF:B6:45:FE:2E	fe80::36ef:b6ff:f	fe45:fe2e		SFP+ 34:EF:B6:45:FE:2F	fe80::36ef:b6ff:fi	245:fe2f	
Pi	Nysical Interface Information IN 34:EF:B6:45:FE:2E OUT 2	fe80::36ef:b6ff:f	fe45:fe2e		5FP+ 34:EF:B6:45:FE:2F OUT 3	fe80::36ef;b6ff;f	s45:fe2f	

ip -6 ro add default via {SFP+ link-address} dev {ethernet interface}

ip -6 ro add default via fe80::36ef:b6ff:fe45:fe2f dev enx00909e9d0af0

c. Setup DNS server.

vi /etc/resolv.conf

Modify nameserver to the gateway IPv6 address

nameserver 2001:b030:200b:5a1::1

- 6.11. Verification results on Client
 - 6.11.1. We need to verify that this topology can be used by customers to connect to external network.
 - a. PC access website(<u>www.google.com</u>)

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