



Tunneling IPv6

Antonius Duty Susilo
Indonesia

**MUM Myanmar
2019**

Profile

- Antonius Duty Susilo
- Email : dutymlg@gmail.com
- Mikrotik Trainer And Consultant
- Instructor Cisco Academy, Oracle Academy
- Ph.D Candidate In UTEM Malaysia (Universiti Teknikal Malaysia Melaka)
- Guest Lecturer in BINUS University Malang, POLINEMA (Politeknik Negeri Malang), Universitas Ma Chung, STIMATA (STMIK PPKIA Pradnya Paramita Malang, STIKI Malang (Sekolah Tinggi Informatika dan Komputer Indonesia Malang)



Shwe Dagon Pagoda

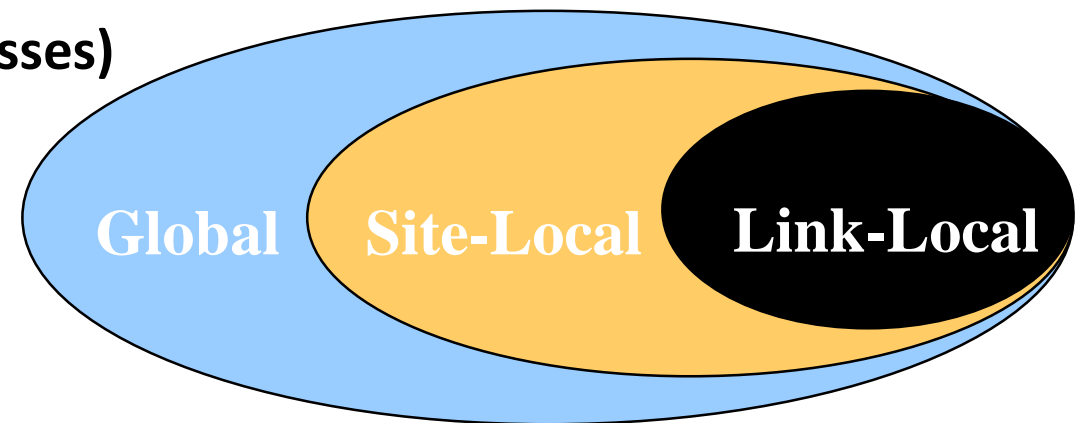
Theory of IPv6

- **IPv6 is designed to be the successor to IPv4.**
- **Projections show that all five RIRs will run out of IPv4 addresses between 2015 and 2020.**
- **With an increasing Internet population, a limited IPv4 address space, issues with NAT and an Internet of things, the time has come to begin the transition to IPv6!**
- **IPv4 has a theoretical maximum of 4.3 billion addresses, plus private addresses in combination with NAT.**
- **IPv6 larger 128-bit address space provides for 340 undecillion addresses.**
- **IPv6 fixes the limitations of IPv4 and includes additional enhancements, such as ICMPv6.**

Scope IPv6

Addresses have scope

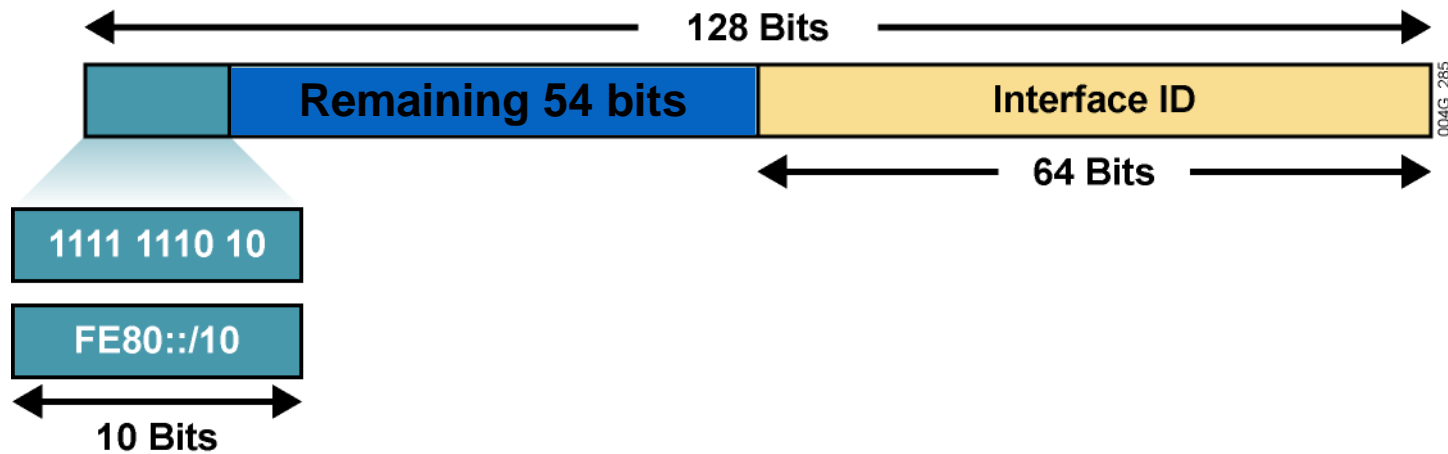
- **Link-local:** The scope is the local link (nodes on the same subnet)
 - **Unique-local:** The scope is the organization (private site addressing)
 - **Global:** The scope is global (IPv6 Internet addresses)
- **Addresses have lifetime**
Valid and Preferred lifetime



Types of IPv6 Addresses

- **Unicast**
 - **Address of a single interface**
 - **Delivery to single interface**
- **Multicast**
 - **Address of a set of interfaces**
 - **Delivery to all interfaces in the set**
- **Anycast**
 - **Address of a set of interfaces**
 - **Delivery to a single interface in the set**
- **No more broadcast addresses**

IPv6 Address Representation: Link Local



Mandatory address for communication between two IPv6 devices
Automatically assigned by router as soon as IPv6 is enabled

Link-Local & Site-Local Unicast Addresses

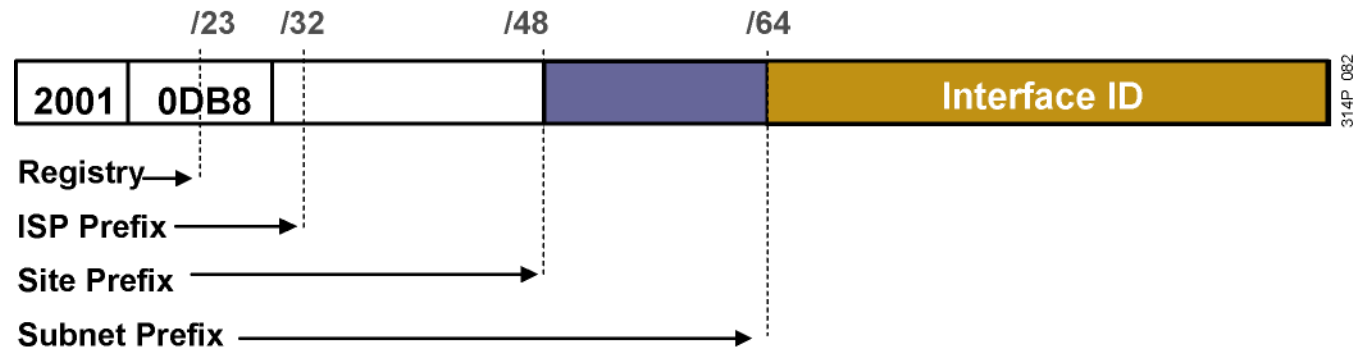
Link-local addresses for use during auto-configuration and when no routers are present:



Site-local addresses for independence from changes of TLA / NLA*:

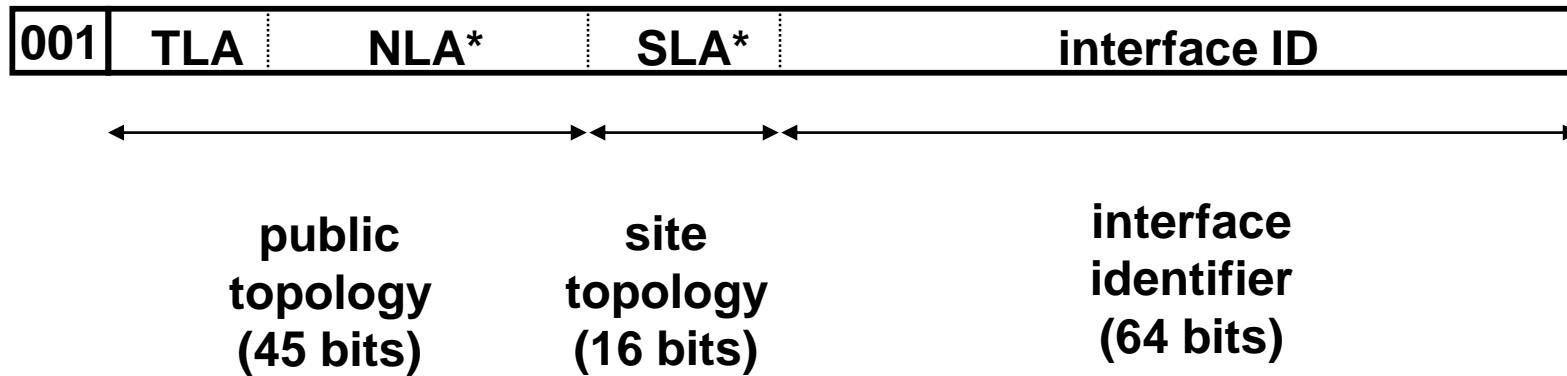


IPv6 Address Representation: Global Unicast



Global unicast and anycast addresses are defined by a global routing prefix, a subnet ID, and an interface ID.

Global Unicast Addresses **public topology(45 bits)**



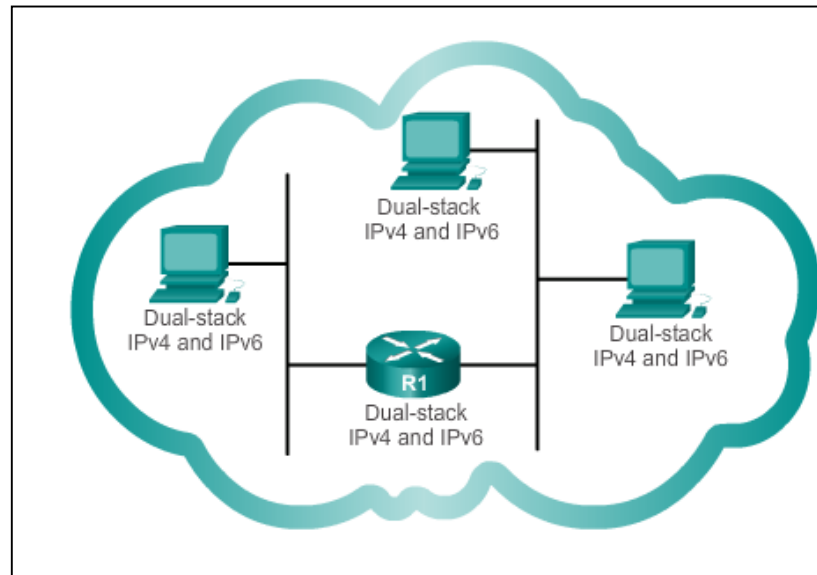
TLA = Top-Level Aggregator

NLA* = Next-Level Aggregator(s)

SLA* = Site-Level Aggregator(s)

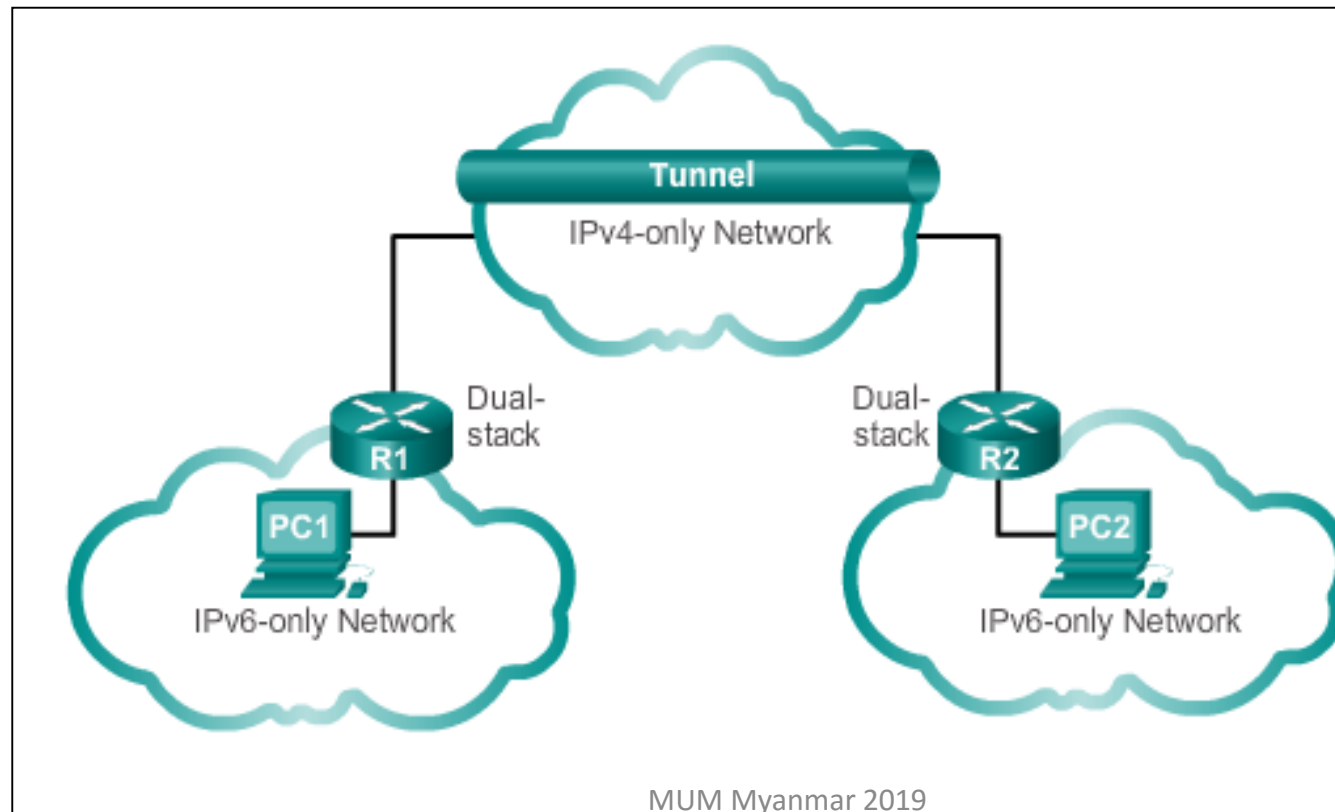
IPv4 and IPv6 Coexistence

- The migration techniques can be divided into three categories:
- Dual-stack, Tunnelling, and Translation.
- **Dual-stack: Allows IPv4 and IPv6 to coexist on the same network. Devices run both IPv4 and IPv6 protocol stacks simultaneously.**



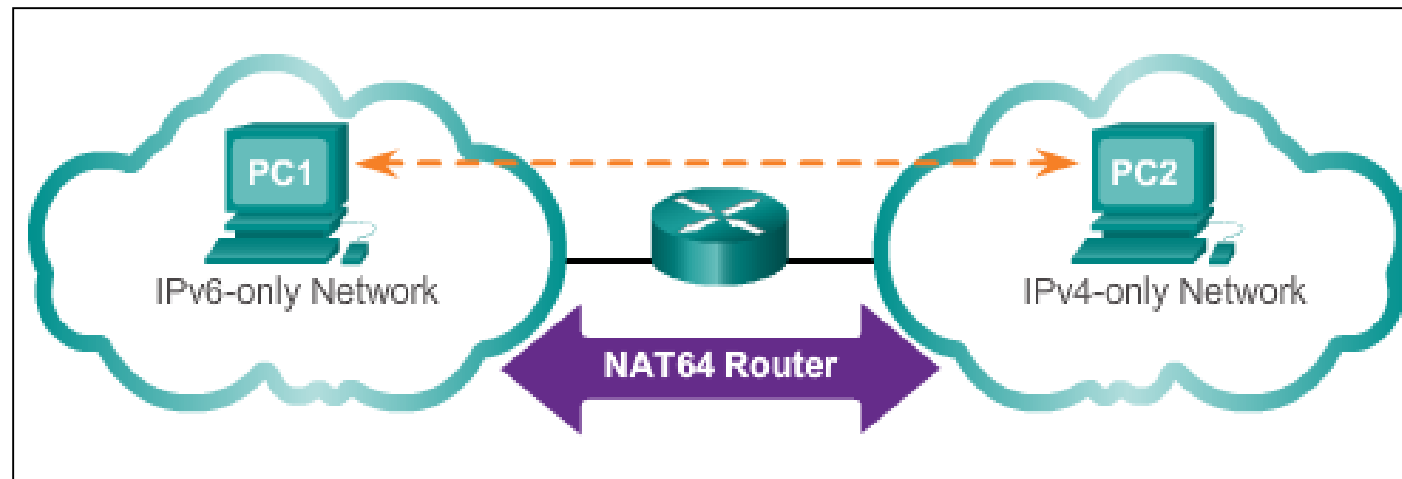
Tunneling

- **Tunnelling:** A method of transporting an IPv6 packet over an IPv4 network. The IPv6 packet is encapsulated inside an IPv4 packet.



Translation

- **Translation: The Network Address Translation 64 (NAT64) allows IPv6-enabled devices to communicate with IPv4-enabled devices using a translation technique similar to NAT for IPv4. An IPv6 packet is translated to an IPv4 packet, and vice versa.**

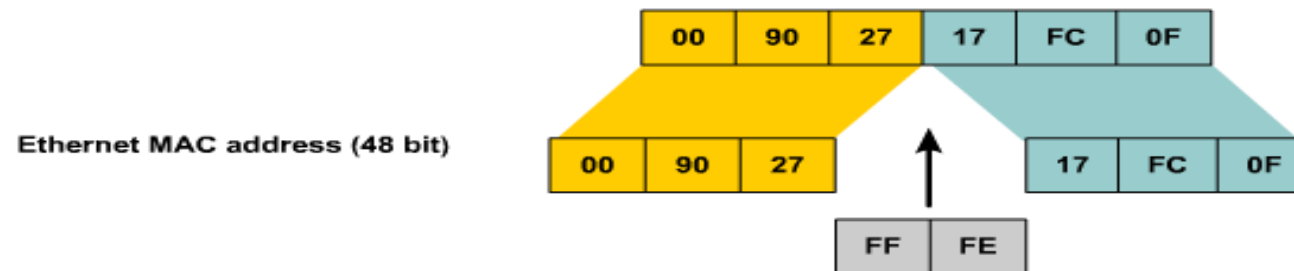


IPv6 Address Representation EUI 64

IPv6 uses the extended universal identifier (EUI)-64 format to do stateless autoconfiguration.

This format expands the 48-bit MAC address to 64 bits by inserting “FFFE” into the middle 16 bits.

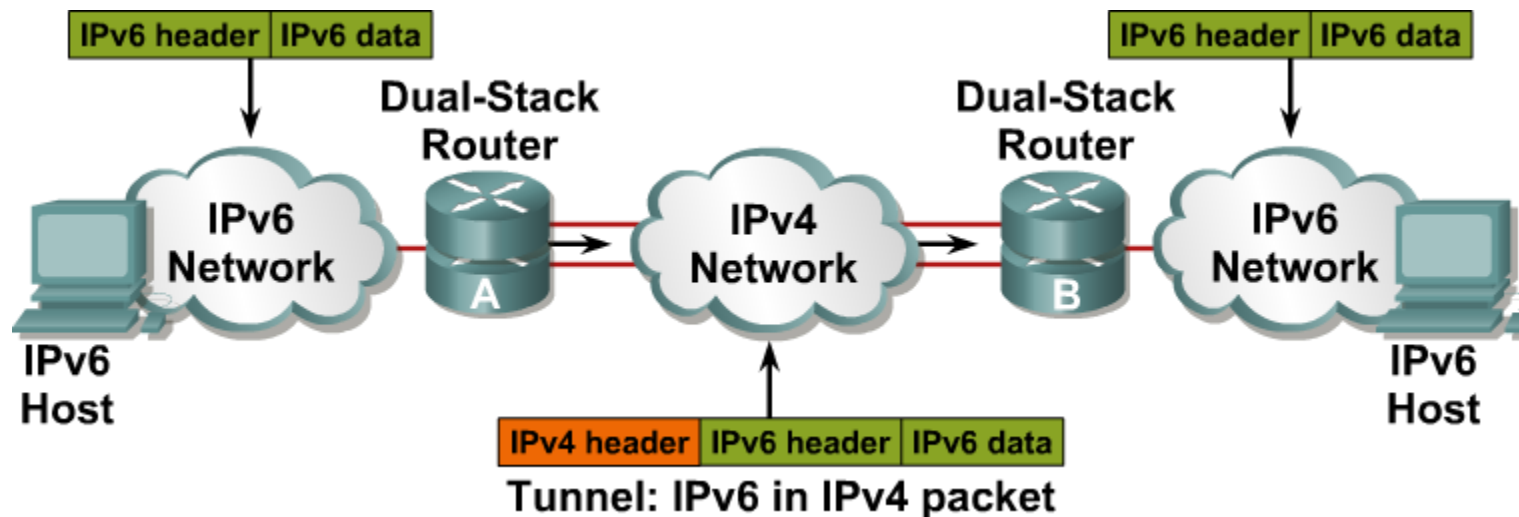
To make sure that the chosen address is from a unique Ethernet MAC address, the universal/local (U/L bit) is set to 1 for global scope (0 for local scope).



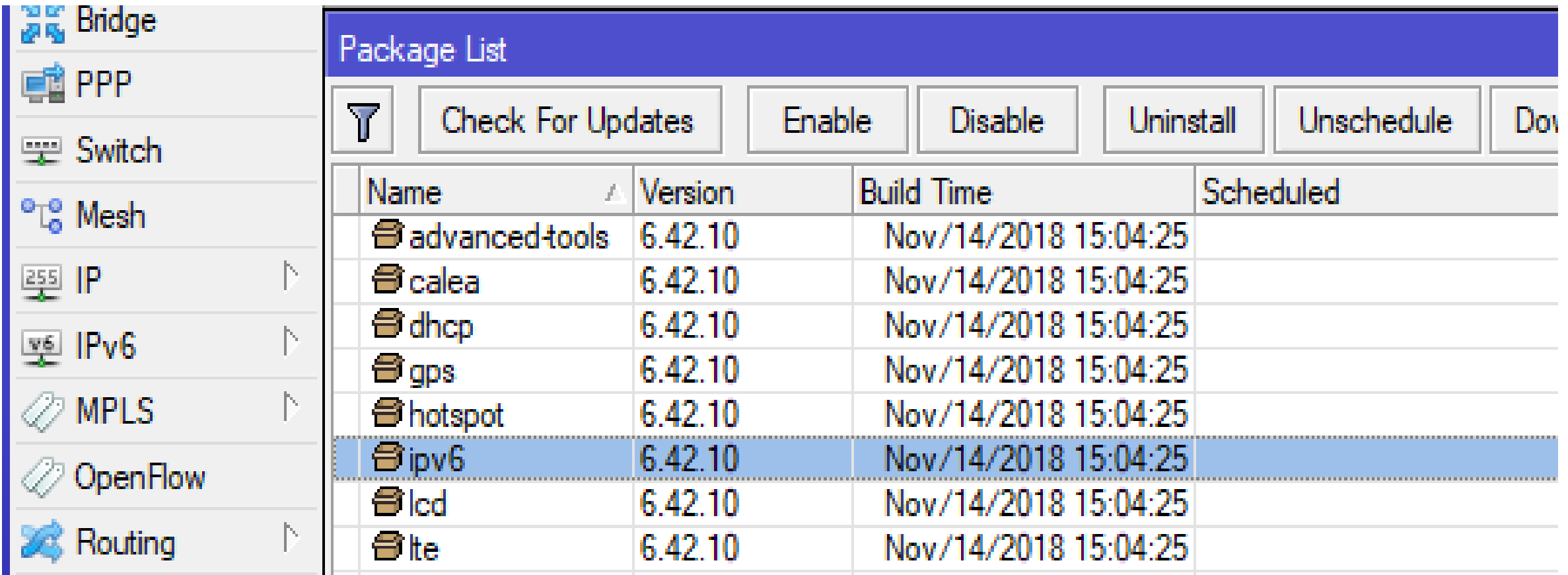
Tunneling IPv6 via IPv4

This allows encapsulating IPv6 packets in IPv4 packets for transport over IPv4 only network.

This will allow IPv6 only end stations to communicate over IPv4 only networks.



IPv6 Package in Mikrotik

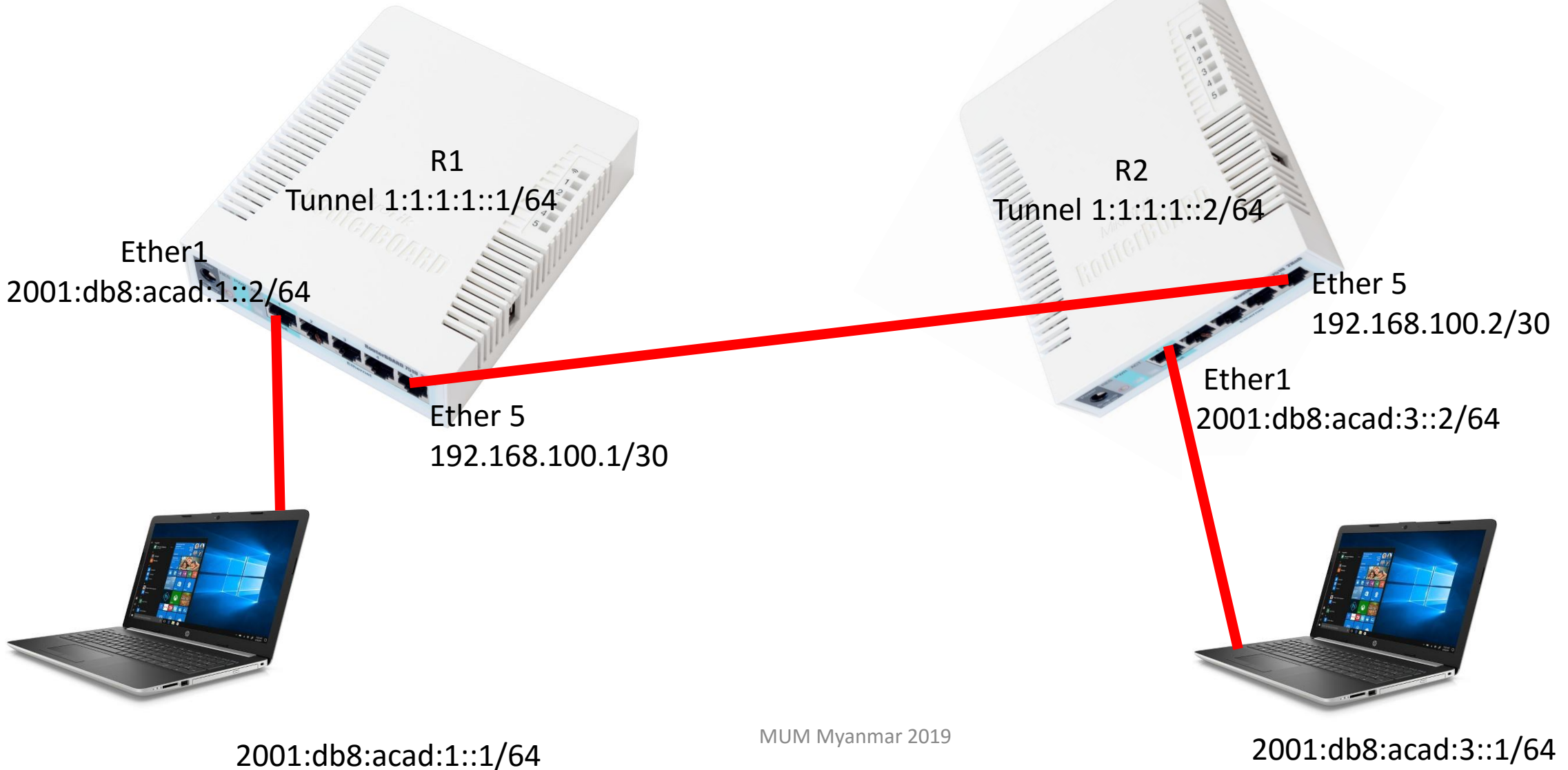


The screenshot displays the Mikrotik WinBox interface, specifically the Package List window. On the left sidebar, the 'IPv6' package is selected under the 'IP' category. The main window shows a table of installed packages, with the 'ipv6' package highlighted in blue. Above the table are several action buttons: 'Check For Updates', 'Enable', 'Disable', 'Uninstall', 'Unschedule', and 'Download'.

Name	Version	Build Time	Scheduled
advanced-tools	6.42.10	Nov/14/2018 15:04:25	
calea	6.42.10	Nov/14/2018 15:04:25	
dhcp	6.42.10	Nov/14/2018 15:04:25	
gps	6.42.10	Nov/14/2018 15:04:25	
hotspot	6.42.10	Nov/14/2018 15:04:25	
ipv6	6.42.10	Nov/14/2018 15:04:25	
lcd	6.42.10	Nov/14/2018 15:04:25	
lte	6.42.10	Nov/14/2018 15:04:25	

LAB

Topology



IPv4 in R1

Address	Network	Interface
+ 192.168.100.1/30	192.168.100.0	ether5

Tunnel Interface in R1

Interface <6to4-tunnel1>

General	Status	Traffic
Name:	6to4-tunnel1	
Type:	6to4 Tunnel	
MTU:	<input type="text"/> ▼	
Actual MTU:	1430	
L2 MTU:	65535	
Local Address:	<input type="text"/> ▲	
Remote Address:	<input type="text"/> ▲	
IPsec Secret:	<input type="text"/> ▲	

IPv6 Configuration in R1 and PC1

IPv6 Address <1:1:1:1::1/64>

Address:

From Pool: ▼

Interface: ▼

IPv6 Address <2001:db8:acad:1::2/64>

Address:

From Pool: ▼

Interface: ▼

IPv6 Address List

+ - ✓ ✗ [] []

	Address	From Pool	Interface
G	1:1:1:1::1/64		Gto4-tunnel1
G	2001:db8:acad:1::2/64		ether1
DL	fe80::3:c0a8:6401/64		Gto4-tunnel1
DL	fe80::d6ca:6dff:feef:ad58...		ether1
DL	fe80::d6ca:6dff:feef:ad5c...		ether5

Internet Protocol Version 6 (TCP/IPv6) Properties

General

You can get IPv6 settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IPv6 settings.

Obtain an IPv6 address automatically

Use the following IPv6 address:

IPv6 address:

Subnet prefix length:

Default gateway:

IPv6 route in R1 (Default Route)







IPv6 Route <::/0>




General | Attributes

Dst. Address:

Gateway:

IPv6 Route List

	Dst. Address	Gateway
AS	 ::/0	1:1:1:1::2 reachable 6to4-tunnel1
DAC	 1:1:1:1::/64	6to4-tunnel1 reachable
DAC	 2001:db8:acad:1::/64	ether1 reachable

::/0 is Default Route in IPv6

IPv4 in R2

Address <192.168.100.2/30>

Address: 192.168.100.2/30

Network: 192.168.100.0 ▲

Interface: ether5 ▼

OK

Cancel

Apply

Address List

+ - ✓ ✗ 📄 🔍 Find

Address	Network	Interface
+ 192.168.100.2/30	192.168.100.0	ether5

Tunnel Interface in R2

Interface <Gto4-tunnel1>

General	Status	Traffic
Name:	<input type="text" value="Gto4-tunnel1"/>	
Type:	<input type="text" value="Gto4 Tunnel"/>	
MTU:	<input type="text" value=""/> ▼	
Actual MTU:	<input type="text" value="1430"/>	
L2 MTU:	<input type="text" value="65535"/>	
Local Address:	<input type="text" value="192.168.100.2"/> ▲	
Remote Address:	<input type="text" value="192.168.100.1"/> ▲	
IPsec Secret:	<input type="text" value="1111"/> ▲	

IPv6 in R2 and Host

IPv6 Address <2001:db8:acad:3::2/64>

Address:

From Pool:

Interface:

OK

Cancel

Apply

IPv6 Address <1:1:1:1::2/64>

Address:

From Pool:

Interface:

IPv6 Address List

	Address	From Pool	Interface
G	1:1:1:1::2/64		6to4-tunnel1
G	2001:db8:acad:3::2/64		ether1
DL	fe80::3:c0a8:6402/64		6to4-tunnel1
DL	fe80::d6ca:6dff:fe2:110c...		ether1
DL	fe80::d6ca:6dff:fe2:1110...		ether5

Internet Protocol Version 6 (TCP/IPv6) Properties

General

You can get IPv6 settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IPv6 settings.

Obtain an IPv6 address automatically

Use the following IPv6 address:

IPv6 address:

Subnet prefix length:

Default gateway:

IPv6 Route in R2 (Default Route)

IPv6 Route <::/0>

General | Attributes

Dst. Address:

Gateway:

IPv6 Route List

	Dst. Address	Gateway
AS	▶ ::/0	1:1:1:1::1 reachable 6to4-tunnel1
DAC	▶ 1:1:1:1::/64	6to4-tunnel1 reachable
DAC	▶ 2001:db8:acad:3::/64	ether1 reachable

Result

Ping Tunnel from PC1

Command Prompt

```
C:\Users\Duty>ping 1:1:1:1::1

Pinging 1:1:1:1::1 with 32 bytes of data:
Reply from 1:1:1:1::1: time<1ms
Reply from 1:1:1:1::1: time=1ms
Reply from 1:1:1:1::1: time=1ms
Reply from 1:1:1:1::1: time=1ms

Ping statistics for 1:1:1:1::1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Command Prompt

```
C:\Users\Duty>ping 1:1:1:1::2

Pinging 1:1:1:1::2 with 32 bytes of data:
Reply from 1:1:1:1::2: time=1ms
Reply from 1:1:1:1::2: time=1ms
Reply from 1:1:1:1::2: time=1ms
Reply from 1:1:1:1::2: time=1ms

Ping statistics for 1:1:1:1::2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

Ping R1 and PC1 from PC1

Command Prompt

```
C:\Users\Duty>ping 2001:db8:acad:1::1
```

```
Pinging 2001:db8:acad:1::1 with 32 bytes of data:
```

```
Reply from 2001:db8:acad:1::1: time<1ms
```

```
Reply from 2001:db8:acad:1::1: time<1ms
```

```
Reply from 2001:db8:acad:1::1: time<1ms
```

```
Reply from 2001:db8:acad:1::1: time<1ms
```

```
Ping statistics for 2001:db8:acad:1::1:
```

```
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

```
Approximate round trip times in milli-seconds:
```

```
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Command Prompt

```
C:\Users\Duty>ping 2001:db8:acad:1::2
```

```
Pinging 2001:db8:acad:1::2 with 32 bytes of data:
```

```
Reply from 2001:db8:acad:1::2: time<1ms
```

```
Reply from 2001:db8:acad:1::2: time=1ms
```

```
Reply from 2001:db8:acad:1::2: time=1ms
```

```
Reply from 2001:db8:acad:1::2: time=1ms
```

```
Ping statistics for 2001:db8:acad:1::2:
```

```
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

```
Approximate round trip times in milli-seconds:
```

```
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Ping R2 and PC 2 from PC1

Command Prompt

```
C:\Users\Duty>ping 2001:db8:acad:3::2
```

```
Pinging 2001:db8:acad:3::2 with 32 bytes of data:
```

```
Reply from 2001:db8:acad:3::2: time=1ms
```

```
Reply from 2001:db8:acad:3::2: time=1ms
```

```
Reply from 2001:db8:acad:3::2: time=1ms
```

```
Reply from 2001:db8:acad:3::2: time=1ms
```

```
Ping statistics for 2001:db8:acad:3::2:
```

```
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

```
Approximate round trip times in milli-seconds:
```

```
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

Command Prompt

```
C:\Users\Duty>ping 2001:db8:acad:3::1
```

```
Pinging 2001:db8:acad:3::1 with 32 bytes of data:
```

```
Reply from 2001:db8:acad:3::1: time=4ms
```

```
Reply from 2001:db8:acad:3::1: time=2ms
```

```
Reply from 2001:db8:acad:3::1: time=2ms
```

```
Reply from 2001:db8:acad:3::1: time=2ms
```

```
Ping statistics for 2001:db8:acad:3::1:
```

```
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

```
Approximate round trip times in milli-seconds:
```

```
    Minimum = 2ms, Maximum = 4ms, Average = 2ms
```

Ping Tunnel from PC2

```
Command Prompt
C:\Users\Duty>ping 1:1:1:1::2

Pinging 1:1:1:1::2 with 32 bytes of data:
Reply from 1:1:1:1::2: time<1ms
Reply from 1:1:1:1::2: time<1ms
Reply from 1:1:1:1::2: time<1ms
Reply from 1:1:1:1::2: time<1ms

Ping statistics for 1:1:1:1::2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
Command Prompt
C:\Users\Duty>ping 1:1:1:1::1

Pinging 1:1:1:1::1 with 32 bytes of data:
Reply from 1:1:1:1::1: time=1ms
Reply from 1:1:1:1::1: time=1ms
Reply from 1:1:1:1::1: time=1ms
Reply from 1:1:1:1::1: time=1ms

Ping statistics for 1:1:1:1::1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

Ping R2 and host from PC2

C:\ Command Prompt

```
C:\Users\Duty>ping 2001:db8:acad:3::1

Pinging 2001:db8:acad:3::1 with 32 bytes of data:
Reply from 2001:db8:acad:3::1: time<1ms
Reply from 2001:db8:acad:3::1: time<1ms
Reply from 2001:db8:acad:3::1: time<1ms
Reply from 2001:db8:acad:3::1: time<1ms

Ping statistics for 2001:db8:acad:3::1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

C:\ Command Prompt

```
C:\Users\Duty>ping 2001:db8:acad:3::2

Pinging 2001:db8:acad:3::2 with 32 bytes of data:
Reply from 2001:db8:acad:3::2: time<1ms
Reply from 2001:db8:acad:3::2: time<1ms
Reply from 2001:db8:acad:3::2: time<1ms
Reply from 2001:db8:acad:3::2: time<1ms

Ping statistics for 2001:db8:acad:3::2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Ping R1 from PC2

Command Prompt

```
C:\Users\Duty>ping 2001:db8:acad:1::2

Pinging 2001:db8:acad:1::2 with 32 bytes of data:
Reply from 2001:db8:acad:1::2: time=1ms
Reply from 2001:db8:acad:1::2: time=1ms
Reply from 2001:db8:acad:1::2: time=1ms
Reply from 2001:db8:acad:1::2: time=1ms

Ping statistics for 2001:db8:acad:1::2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

Command Prompt

```
C:\Users\Duty>ping 2001:db8:acad:1::1

Pinging 2001:db8:acad:1::1 with 32 bytes of data:
Reply from 2001:db8:acad:1::1: time=3ms
Reply from 2001:db8:acad:1::1: time=2ms
Reply from 2001:db8:acad:1::1: time=2ms
Reply from 2001:db8:acad:1::1: time=2ms

Ping statistics for 2001:db8:acad:1::1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 3ms, Average = 2ms
```


Demo

Thank You Myanmar

dutymlg@gmail.com

+62 816559940

