Having Fun with IPv6

On MikroTik RouterOS Today

By : TEDDY YULISWAR

MUM MikroTik User Meeting

Indonetworkers.com

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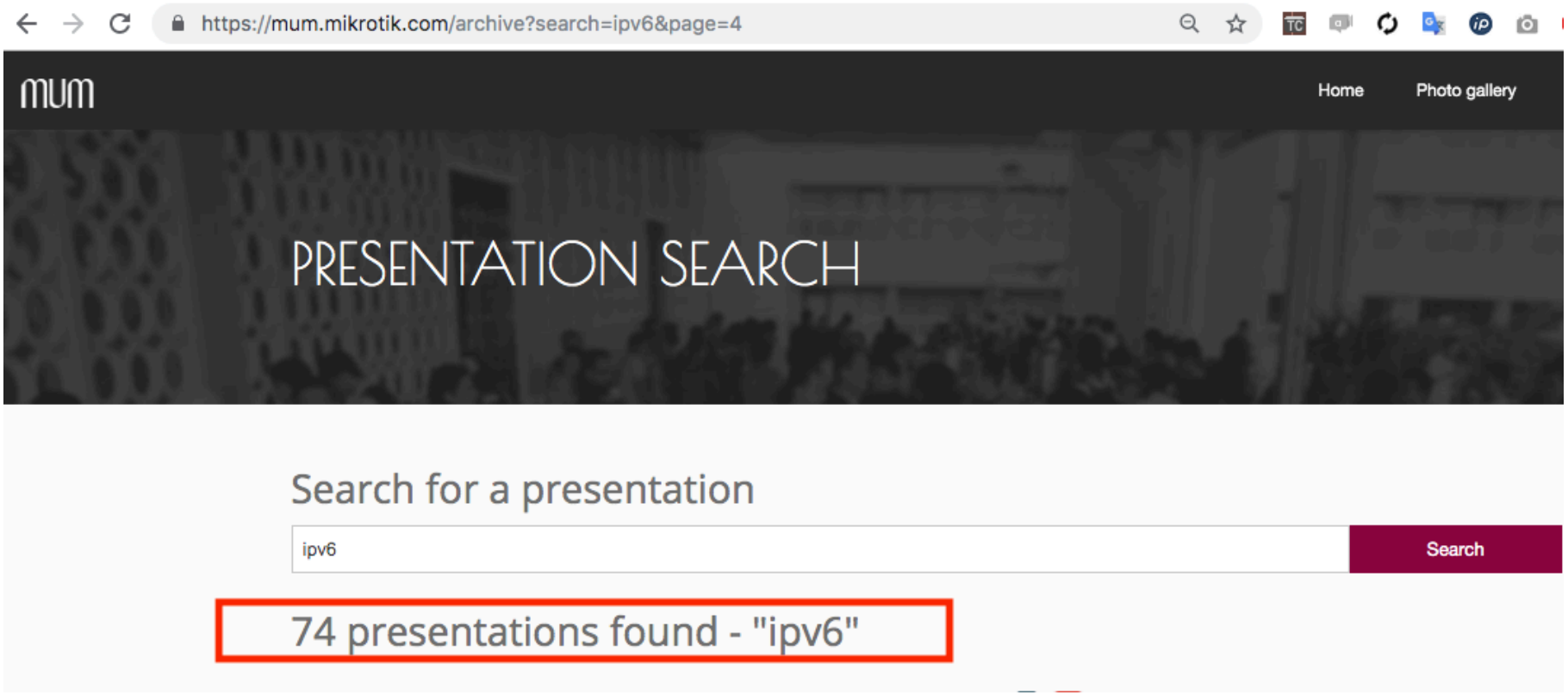
MikroTik Certified Trainer Since 2016
MikroTik MUM Presenter (Indonesia, Cambodia, Laos, Malaysia)

Kenapa saya pilih topik ini?



https://indonetworkers.com/training/

Hotspot Class in Kuala Lumpur with HOTSPOTSYSTEM WWW.HOTSPOTSYSTEM.COM.MY on January, 2019

MikroTik
MTCIPv6E

MTCIPv6E Class in Batam Island, Indonesia at 2017

What is an IP address?

determined by
telecommunications service providers
And Unique Number

+60173916319

International Telecommunication Union (ITU)

INTERNET

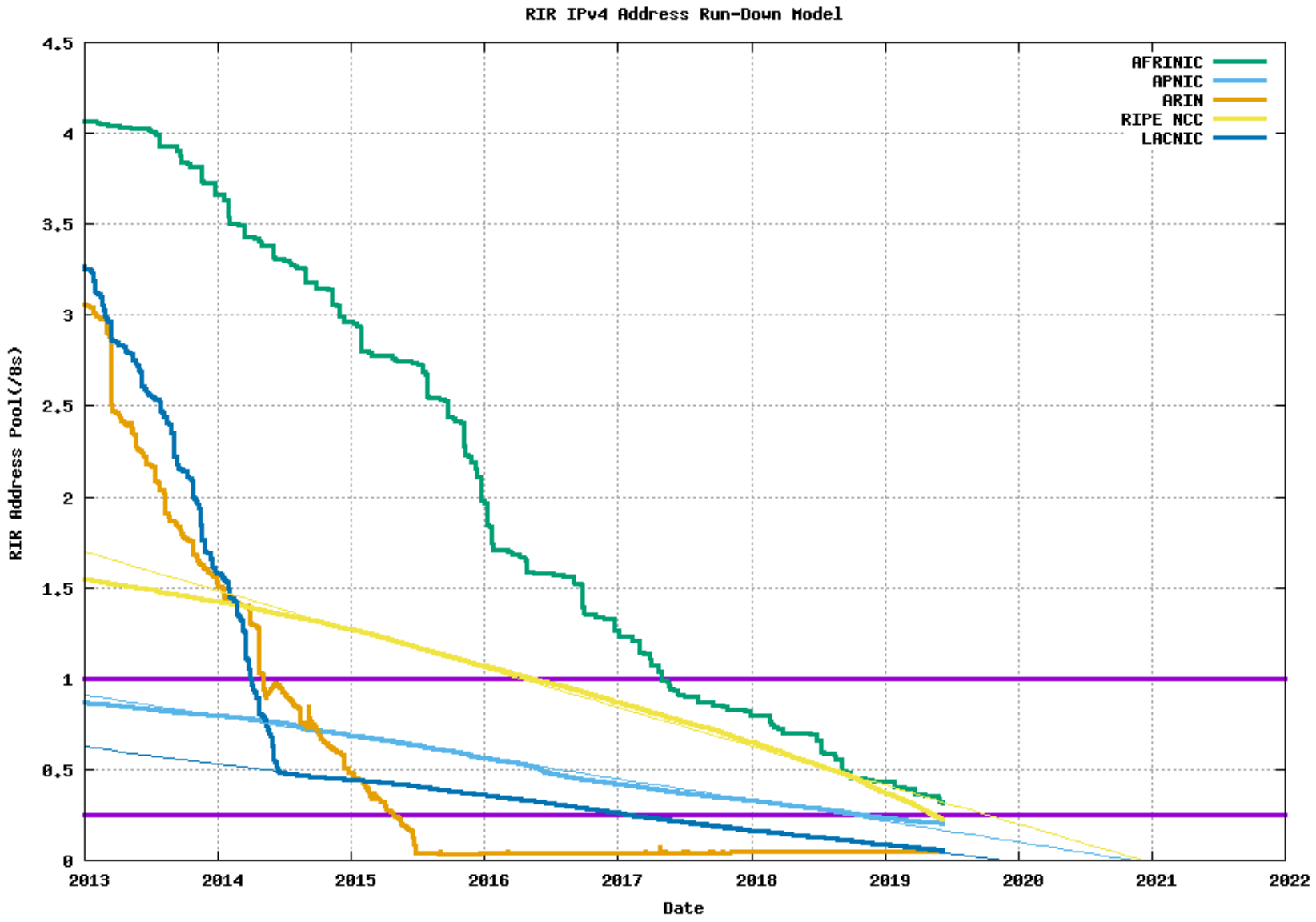
Network-ID Host-ID

103.227.141 254 /24

IP Address

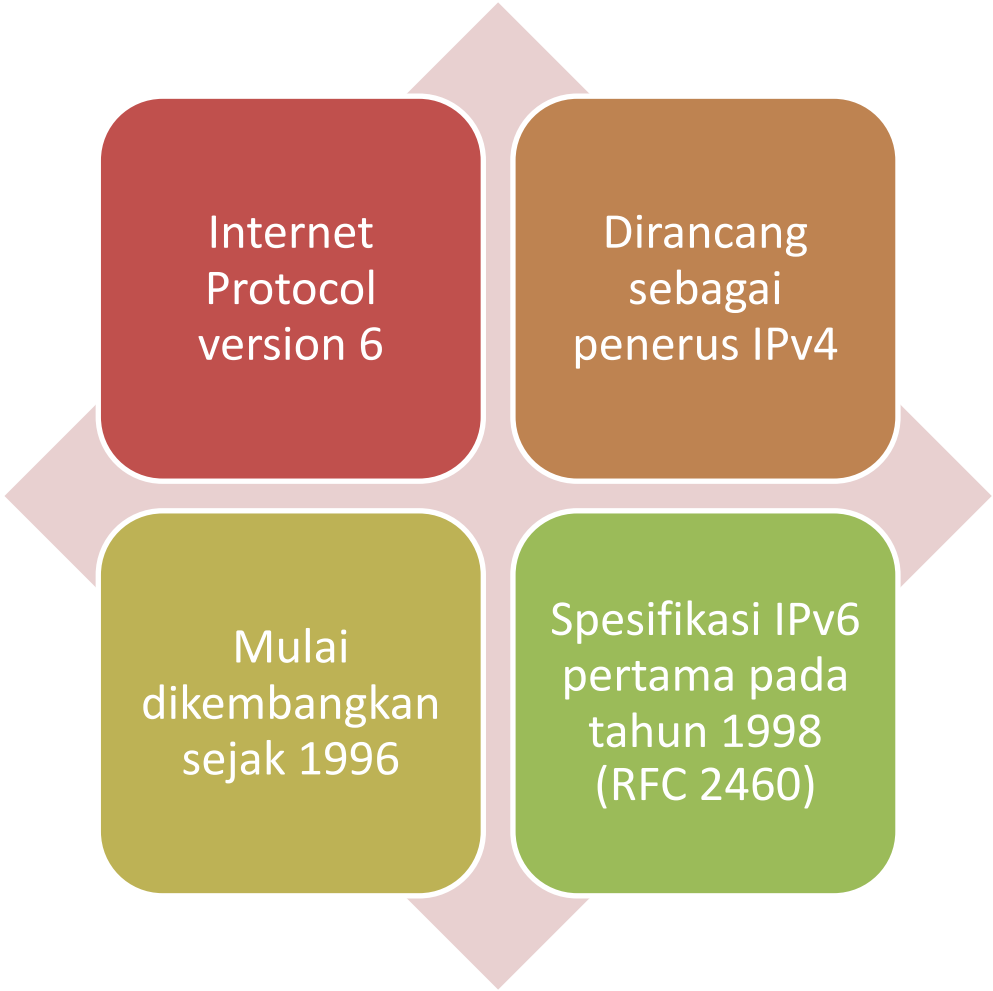
What is the problem?

IPv4 exhaustion

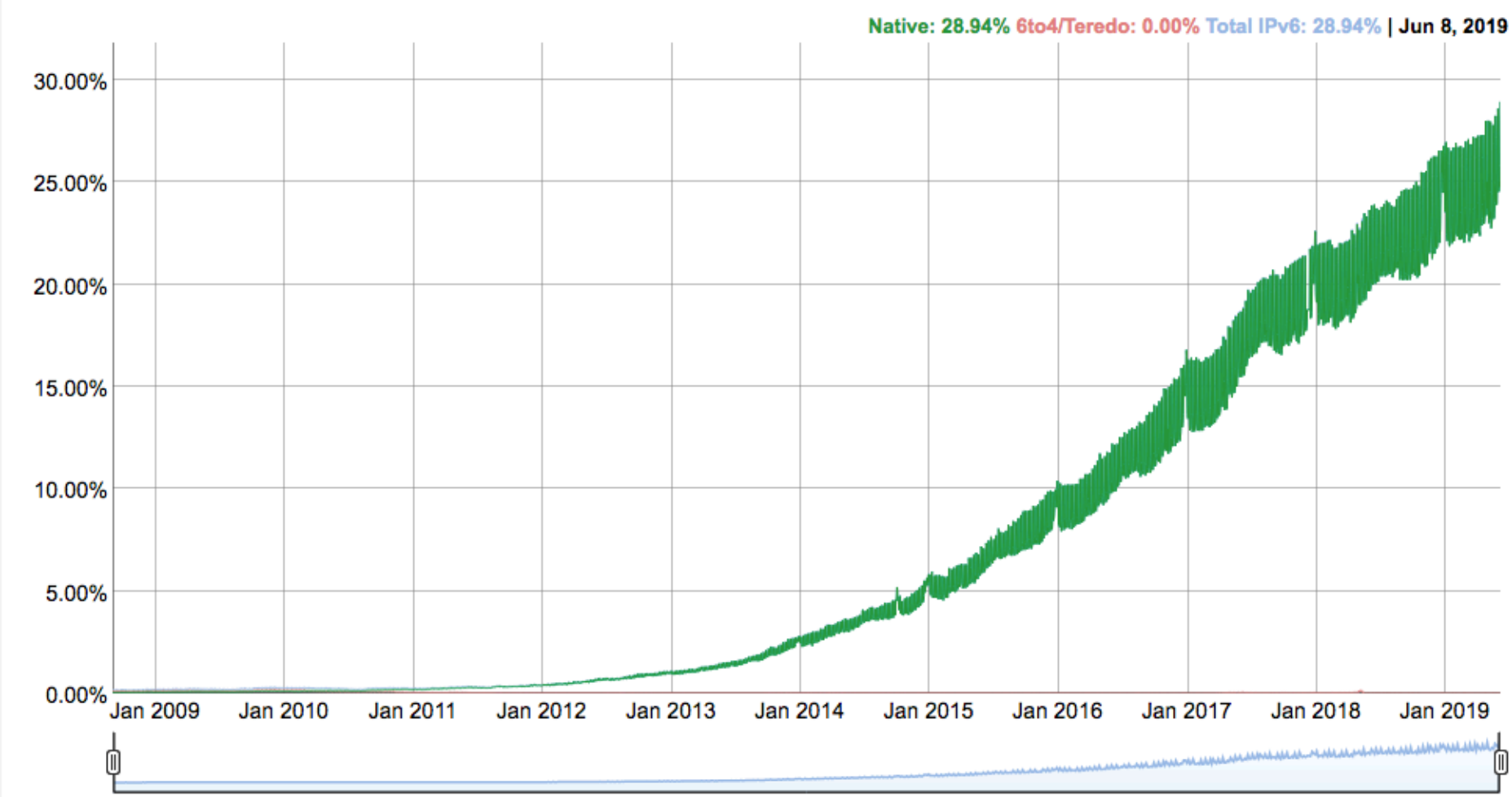

RIR IPv4 Address Run-Down Model
AFRINIC
APNIC
ARIN
RIPE NCC
LACNIC
RIR Address Pool(/8s)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Date

What is the solution?

IPv6

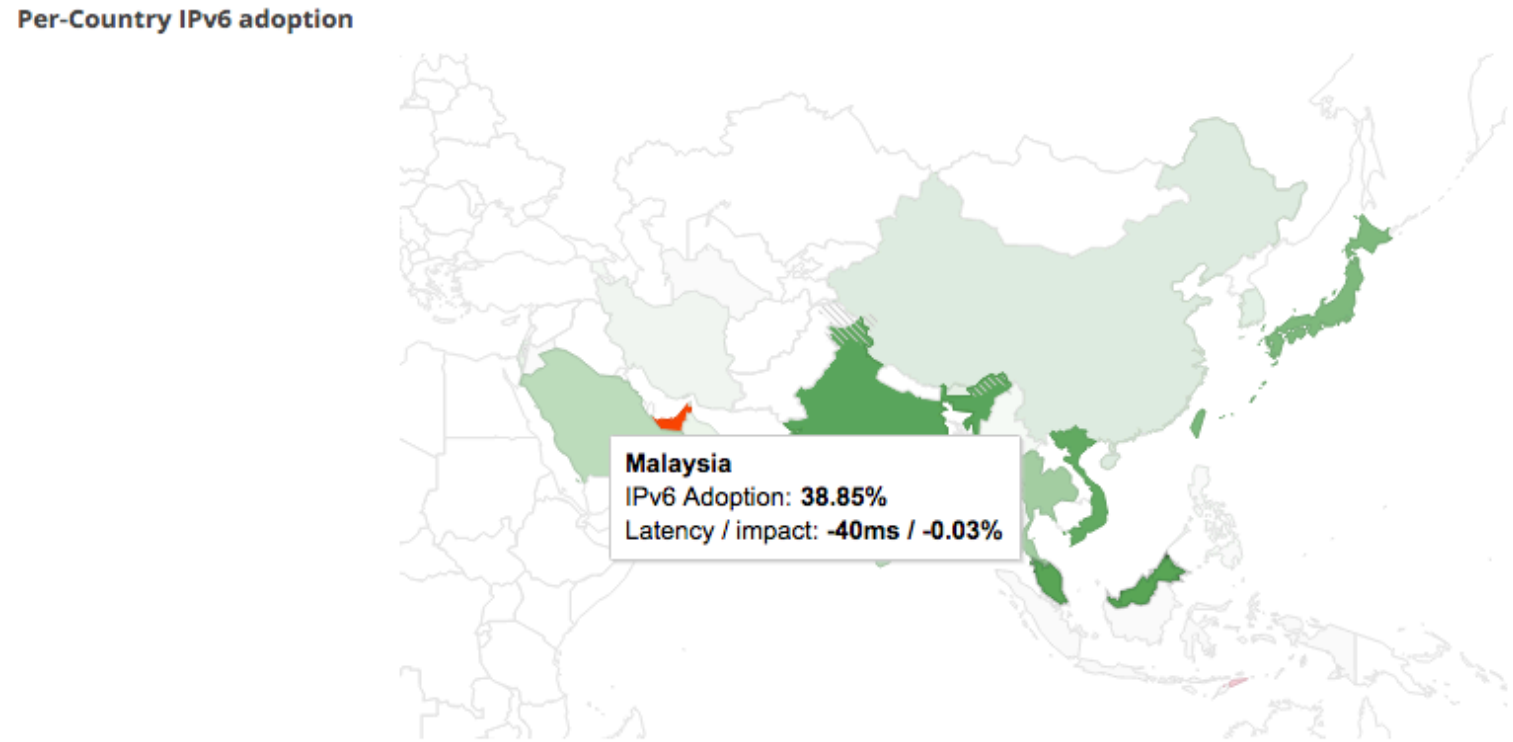

Internet Protocol version 6
Dirancang sebagai penerus IPv4
Mulai dikembangkan sejak 1996
Spesifikasi IPv6 pertama pada tahun 1998 (RFC 2460)

Adopsi IPv6



https://www.google.com/intl/en/ipv6/statistics.html#tab=ipv6-adoption&tab=ipv6-adoption

Adopsi IPv6



https://www.google.com/intl/en/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=ipv6-adoption

Perbandingan IPv4 & IPv6

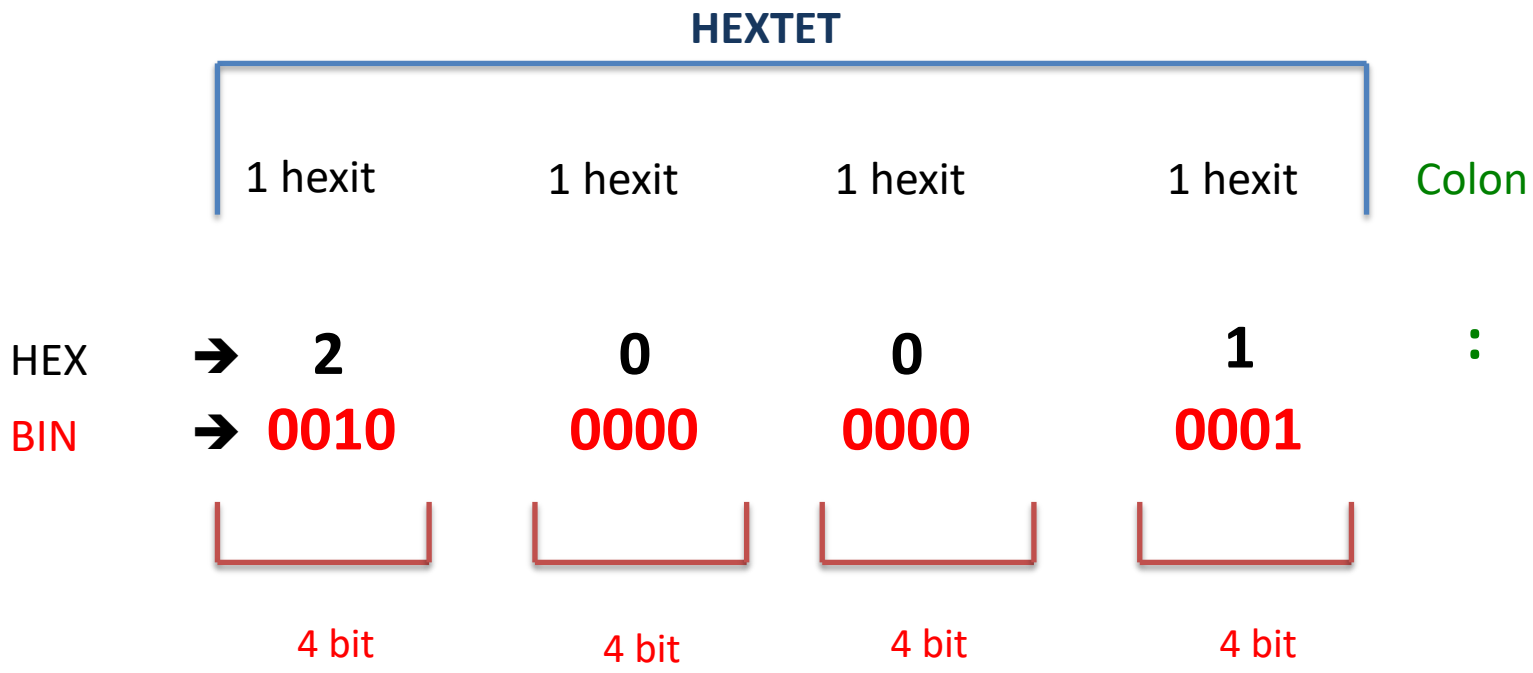
	IPv4	IPv6
Address space	32 bits	128 bits
Possible addresses	2^{32}	2^{128}
Address format	192.0.2.1	2001:db8:3:4:5:6:7:8
Header length	20bytes	40bytes
Header fields	14	8
IPsec	optional	SHOULD*

Notasi Alamat

- IPv6 di tulis dalam bentuk **hexadecimal** (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F)
- IPv6 di bagi menjadi delapan segmen, tiap segmen disebut dengan **Hextet**
- Tiap hextet terdiri dari 4 hexadecimal digit (hexit). Sehingga dalam satu alamat Ipv6 address terdapat 32 Hexit.
- Tiap hexit sama dengan 4 bit (1 Nibble), sehingga tiap hextet berukuran 16 bit, jadi totalnya sama dengan 128 bit.
- Tiap hextet dipisahkan oleh tanda titik dua (colon) :
- Total alamat yang disediakan IPv6 adalah 340.282.366.920.938.463.463.374.607.431.768.211.455 di hitung dari 2^{128}

Contoh Alamat IPv6

2001:0DB8:00A0:0000:0000:BABE:0000:CDF0



Notasi Alamat

Field (16 bits)	Hexadecimal	Binary
1	2001	0010 0000 0000 0001
2	0db8	0000 1101 1011 1000
3	0be0	0000 1011 1110 0000
4	75a1	0111 0101 1010 0001
5	0000	0000 0000 0000 0000
6	0000	0000 0000 0000 0000
7	0000	0000 0000 0000 0000
8	0001	0000 0000 0000 0001

2001:0db8:0be0:75a1:0000:0000:0000:0001

Notasi Alamat

2001:0db8:0be0:75a2:0000:0000:0000:0001

Angka nol yang didepan bisa dihilangkan
4 hexit nol dalam suatu hextet boleh diganti dengan sebuah hexit nol

2001:db8:be0:75a2:0:0:0:1

Beberapa hextet nol boleh diganti dengan sebuah double colon (::)

2001:db8:be0:75a2::1

Notasi Alamat

2001:0db8:0000:0000:0010:0000:0000:0001

Jika terdapat beberapa hextet bernilai nol maka hanya 1 yang bisa diganti dengan ::

2001:db8::10:0:0:1

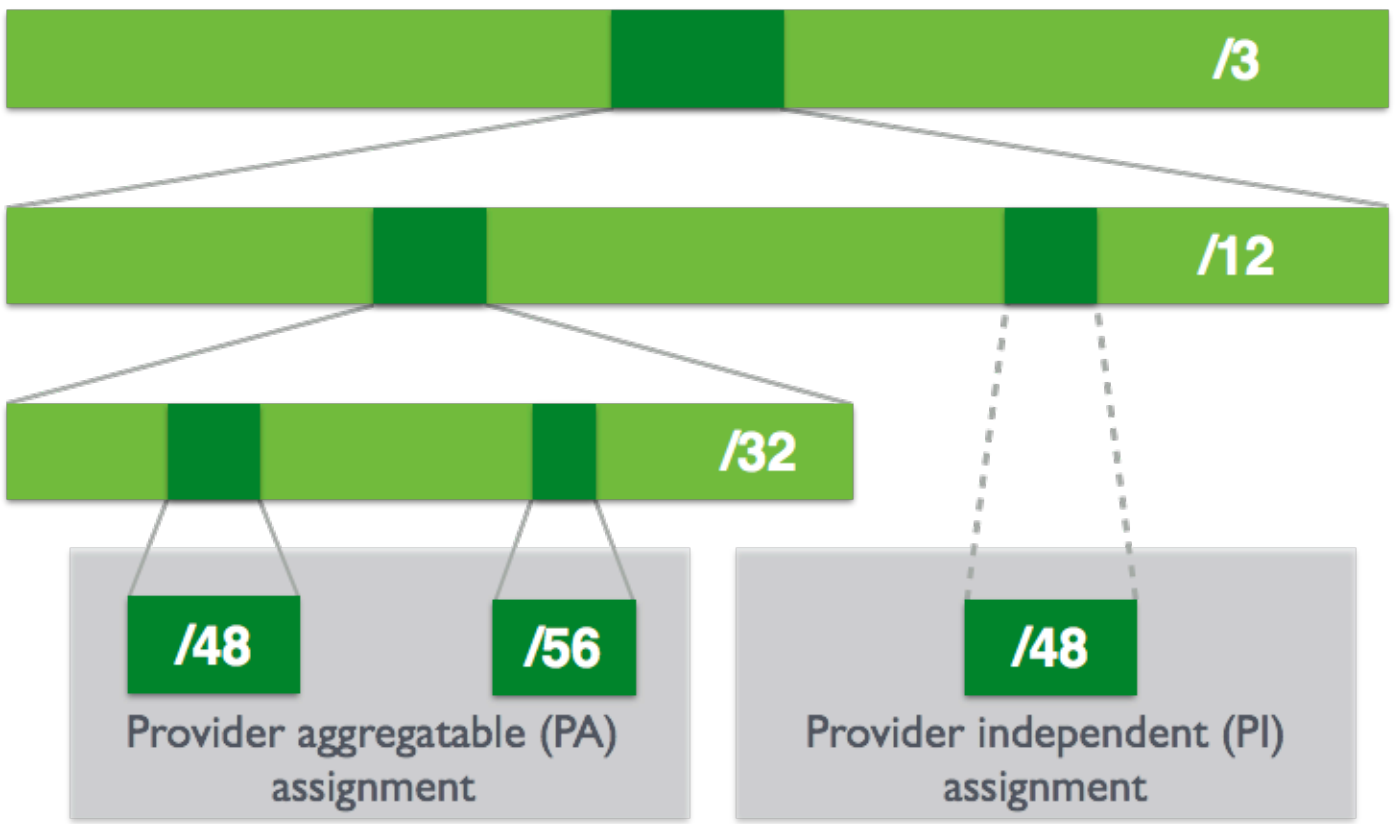
Kita bisa memilih salah satu

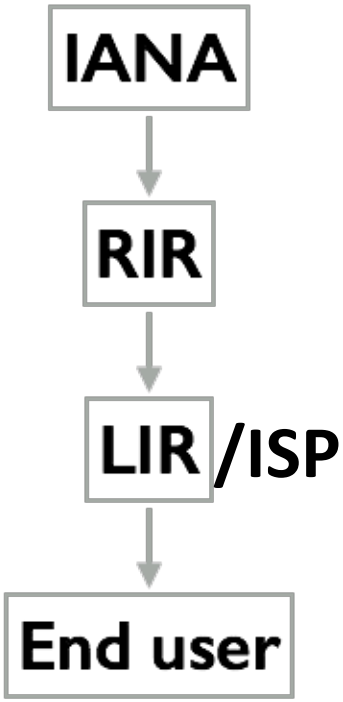
2001:db8:0:0:10::1

IP address yang sama dan keduanya valid namun yang rekomendasi adalah yang pertama

Untuk info lebih lanjut "A Recommendation for IPv6 Address Text Representation (RFC5952)"

Pendistribusian Alamat





Global Unicast Address

Tipe Alamat

Type	Range
Link Local	Fe80::/10
Global Unicast	2000::/3
Multicast	Ff00::/8
Unique local	Fc00::/7

Global Unicast Address

- Sama dengan Public IPv4 Address yang *unik* secara global.
- Dapat dirutekan ke Internet.
- Dapat di konfigurasi secara statis ataupun dinamis.
- Global Unicast Address dialokasikan oleh The Internet Committee for Assigned Name and Number (ICANN). ICANN merupakan operator dari IANA (Internet Assigned Number Authority) yang bertugas mengalokasikan blok-blok IPv6 Address ke seluruh RIR (Regional Internet Registry) yang ada di dunia.

Prefix 2000::/3

Global Unicast Address

5 RIR (Regional Internet Registry) mendapatkan prefix /12 dari /3 dengan masing-masing Regional mendapatkan network prefix sebagai berikut :

1. APNIC (2400:0000::/12)
2. ARIN (2600:0000::/12)
3. AfriNIC (2c00:0000::/12)
4. LacNIC (2800:0000::/12)
5. RipeNIC (2A00:0000::/12)

Link Local Address

- Link Local Address digunakan untuk komunikasi dengan perangkat lainnya yang berada di link local (subnet) yang sama dan hanya pada link tersebut saja
- Setiap host yang diberikan alamat ini akan berada dalam link atau network yang sama
- Link Local Address tidak bisa komunikasi dengan network lainnya (router tidak akan meneruskannya) Berarti tidak bisa dirutekan ke komunikasi publik (Internet).
- Alamat yang diberikan harus *unik* hanya pada link atau network tersebut saja.

Prefix FE80::/10

Multicast Address

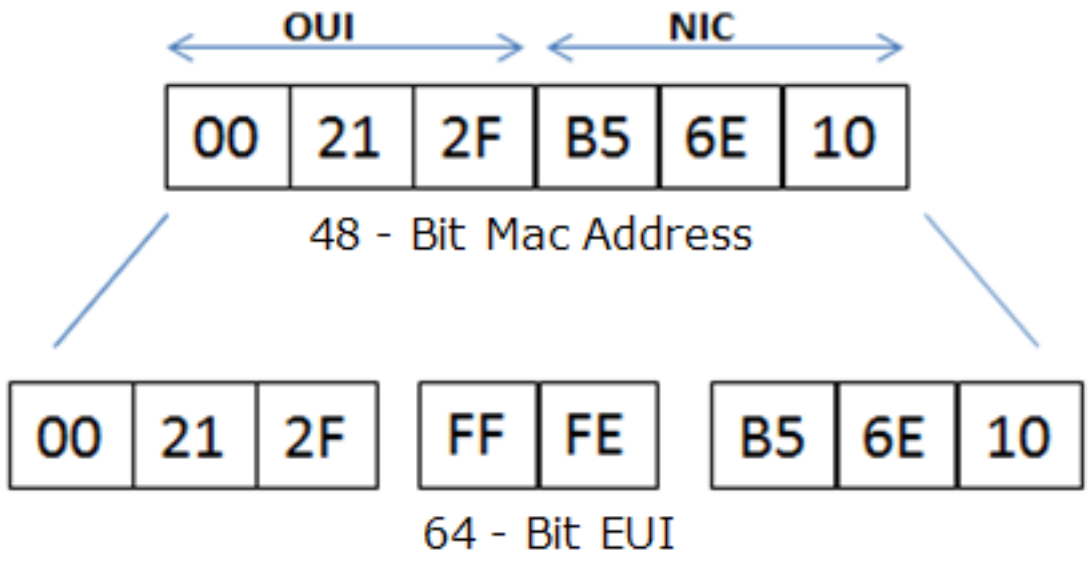
- Digunakan untuk pengiriman sebuah packet dari satu host ke suatu grup atau kumpulan beberapa host baik di dalam network yang sama, maupun di dalam network yang berbeda.

- IPv6 Multicast Address Hanya dapat digunakan sebagai Destination IPv6 Address.

Prefix FF00::/8

EUI-64

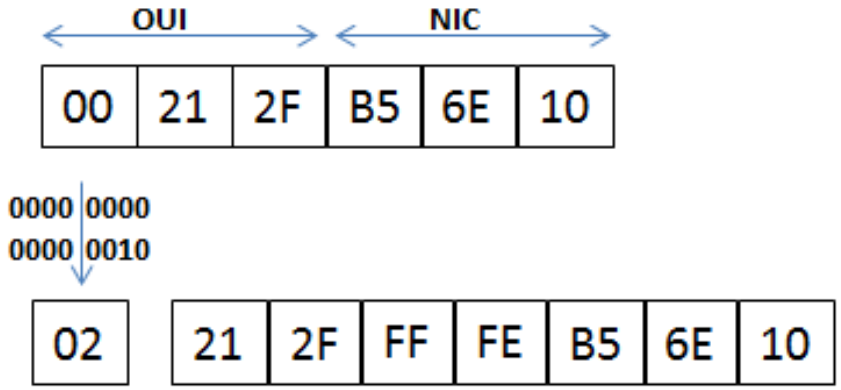
- 64-bit extended unique identifier (EUI)
- Berasal dari 48-bit MAC Address



OUI (Organizationally Unique Identifier) dan yang lain spesifik NIC.

Modifikasi EUI-64

- Digunakan pada Stateless address autoconfiguration (SLAAC)
- Bit ke 7 dari kiri atau bit universal /local (U/L)
- Bit ini mengidentifikasi apakah pengenal interface ini dikelola
- secara universal atau lokal jika 0 maka alamat dikelola secara lokal,
- jika 1 maka adalah alamat unik global



00 (L) → 02 (U)

Modifikasi EUI-64

Prefix Ipv6

```
2001:db8:be0:75a2::/64
```

Dan modifikasi EUI-64 dari Mac Address

```
02:21:2f:ff:fe:b5:6e:10
```

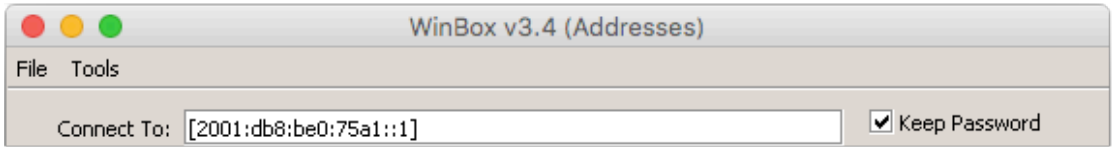
Hasil dari Alamat IPv6 nya

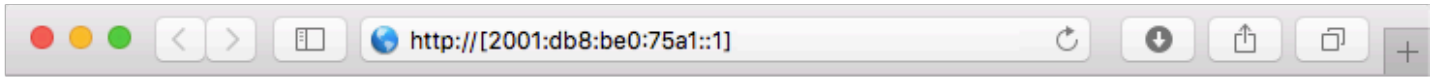
```
2001:db8:be0:75a2:0221:2fff:feb5:6e10
```

Special Address

Type	Range
Loopback	::1/128
Documentation	2001:db8::/32
6to4	2002::/16
Unspecified Address	::/128
Teredo	2001::/32
Anycast	2001:db8:db1b:1e3::/64

Connecting ke Host IPv6 Global






```
scp supout.rif admin@[2001:db8:be0:75a1::1]:
```

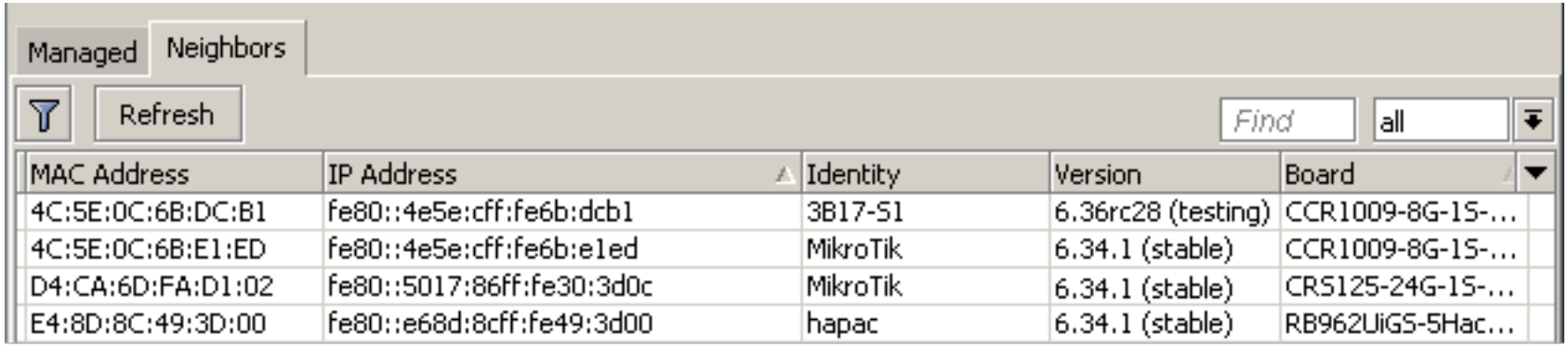
```
[admin@MikroTik] > /ping 2001:db8:be0:75a1::1
```

```
ping6 2001:db8:be0:75a1::1
```

Berdasarkan kontek IPv6 address bisa ditulis dengan atau tanpa kurung siku.

IPv6 Connectivity

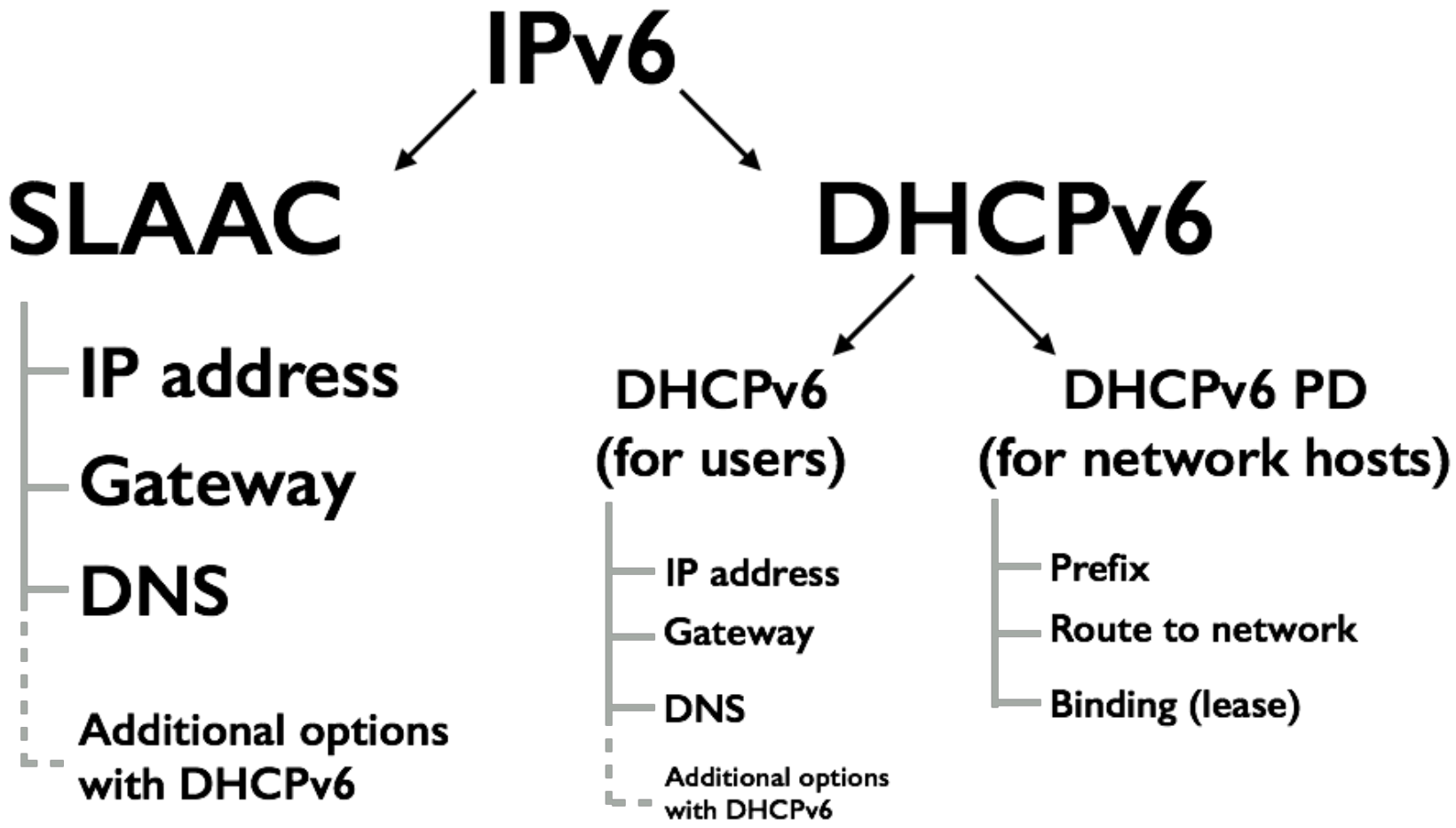
- Link-local address bisa digunakan untuk connect ketika perangkat belum memiliki Global Route Ipv6 Address
- Alternatif ke Mac Winbox



WinBox → Neighbors

Konfigurasi Address

- Auto Configuration dari link local address
- Stateless
  - Stateless address autoconfiguration (SLAAC)
  - Additional options dengan DHCPv6
- Stateful
  - DHCPv6
- Static



SLAAC

- Stateless address autoconfiguration
- Menggunakan pesan router Solicitation dan Pesan
- Router Advertisement.
- Meminta router
- Menerima alamat router dan Konfigurasi IP

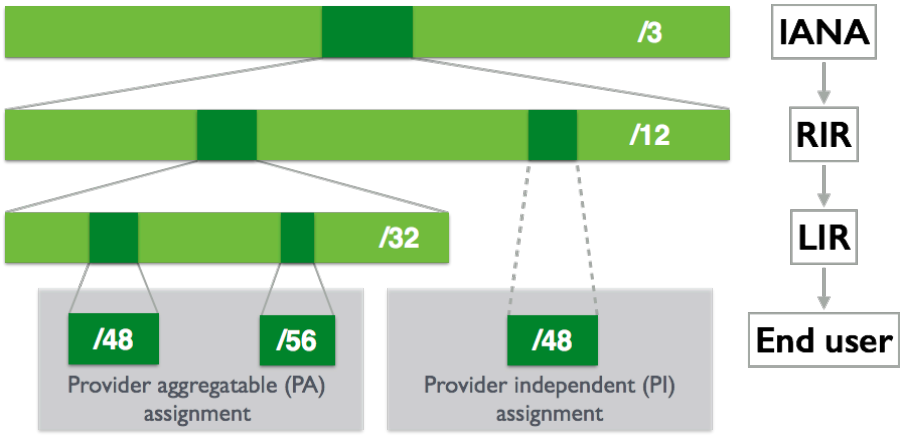
Konstruksi alamat SLAAC

Routing prefix	Subnet	Interface identifier
0-64 bits	0-64 bits	64 bits

- Routing prefix + subnet identifier = 64 bits
- /64 adalah prefix terkecil yang bisa di berikan ke pelanggan
- Umumnya seorang pelanggan diberikan /48 - /64 subnet

IPv6 Relative Network Sizes

/128	1 IPv6 address	A network interface
/64	1 IPv6 subnet	18,446,744,073,709,551,616 IPv6 addresses
/56	256 /64 prefix	Popular prefix size for one subscriber site
/48	65,536 /64 Prefix	Popular prefix size for one subscriber site
/32	65,536 /48 prefix	Minimum IPv6 allocation



Neighbor Discovery Protocol (NDP)

- Mengantikan ARP pada IPv4
- Track dan discover IPv6 Host lainnya.
- Auto-Configures Address
- Menggunakan Protocol ICMPv6

Neighbor Discovery Protocol (NDP)

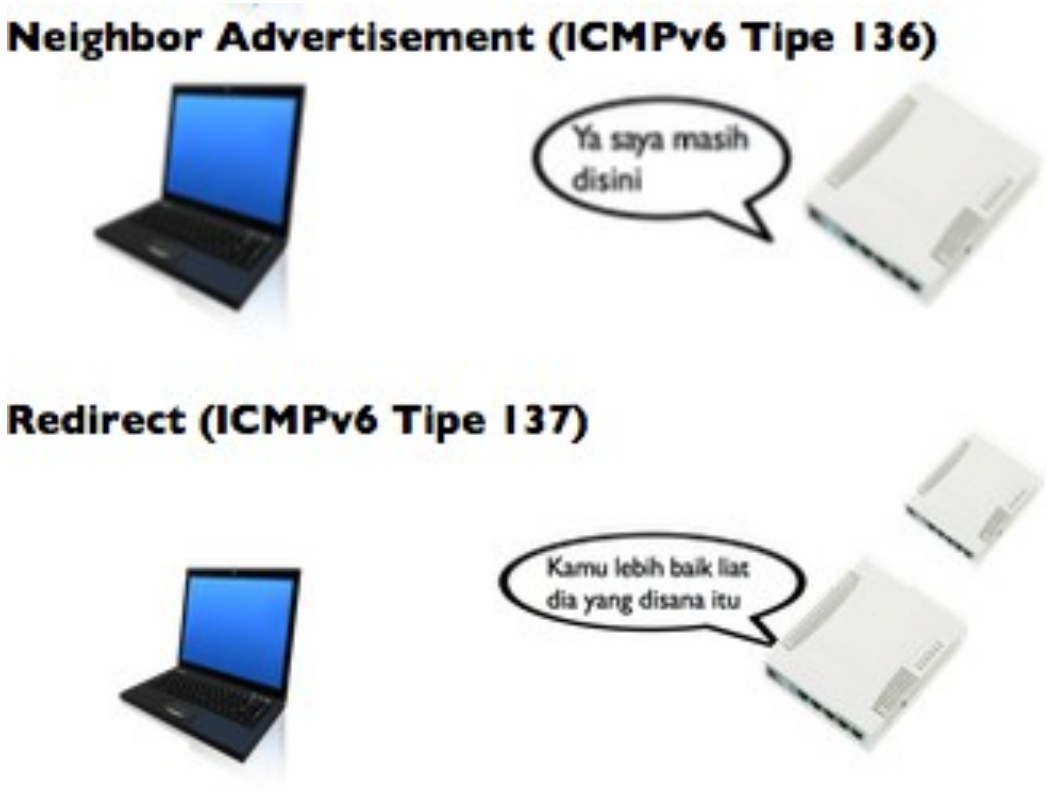
5 Tipe Pesan NDP :

Router Solicitation (ICMPv6 Tipe 133)

Router Advertisement (ICMPv6 Tipe 134)

Neighbor Solicitation (ICMPv6 Tipe 135)

Neighbor Discovery Protocol (NDP)



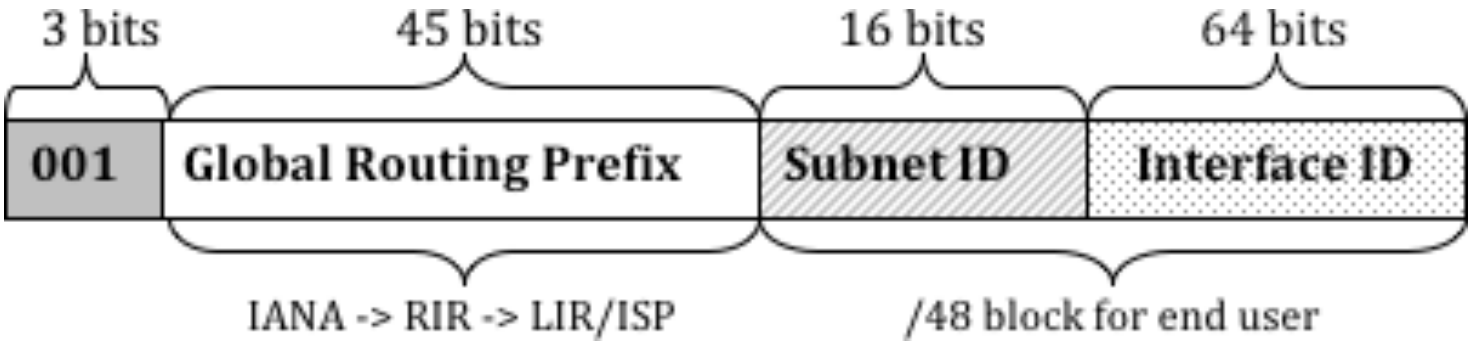
Apa itu Subnetting ?

Subnetting

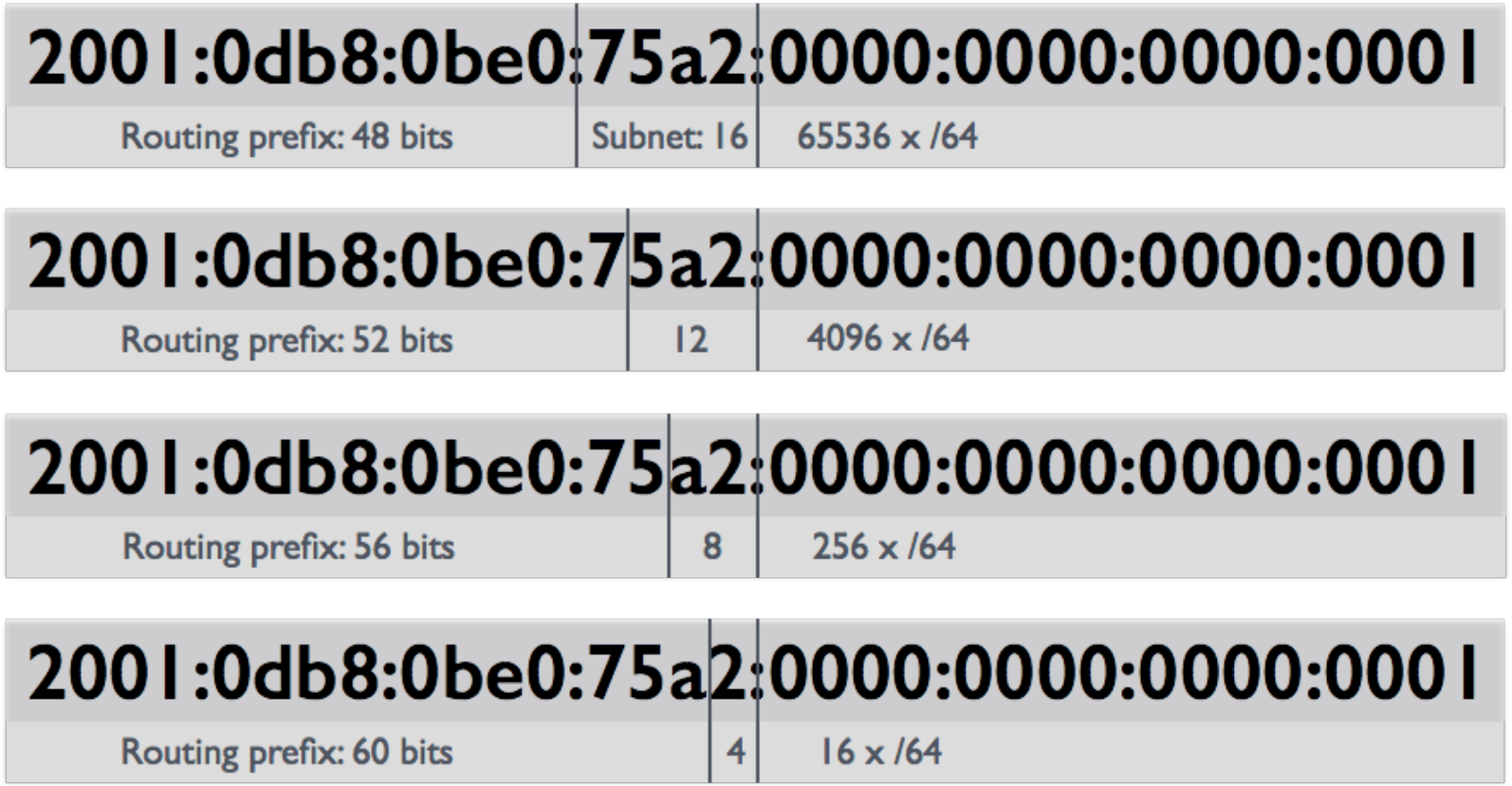
- **Subnetting** adalah teknik memecah suatu jaringan besar menjadi jaringan yang lebih kecil dengan cara mengorbankan bit Host ID pada **subnet** mask untuk dijadikan Network ID baru.

- **Subnetting** merupakan teknik memecah network menjadi beberapa subnetwork yang lebih kecil.

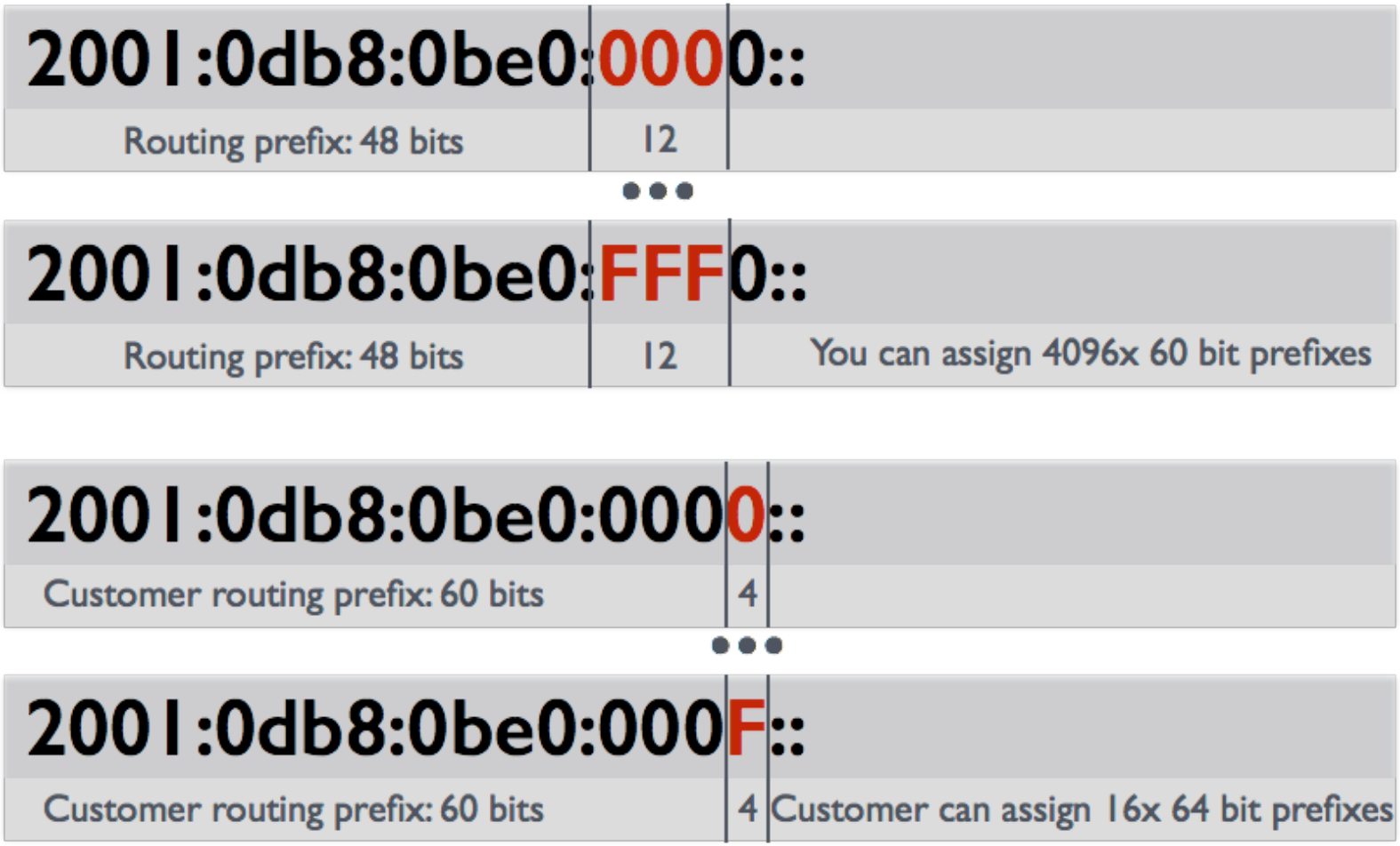
IPv6 Address Format



Subnetting



IPv6 Subnetting

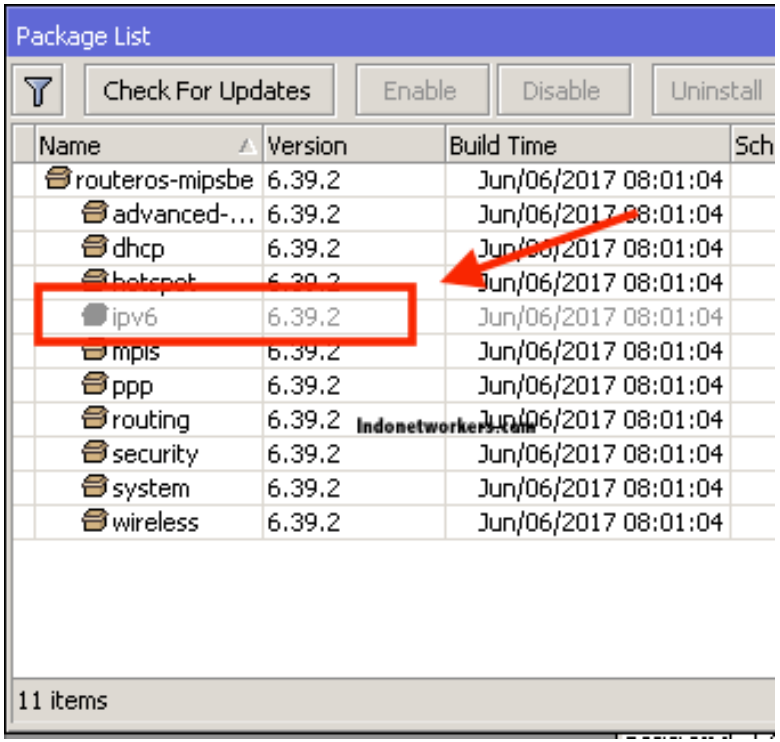


IPv6 Subnetting

- Kita sebagai ISP diberikan /48 Block prefix
- Kita berencana memberikan /60 kepada pelanggan kita
- 60 -48 = 12 maka 2^{12} = 4096 buah /60 subnets
- Sedangkan di pelanggan 64 - 60 = 4 maka 2^{4} = 16 x /64 prefix untuk device mereka.

IPv6 on Mikrotik RouterOS

- Package IPv6 by default nya belum Aktif seperti berikut :



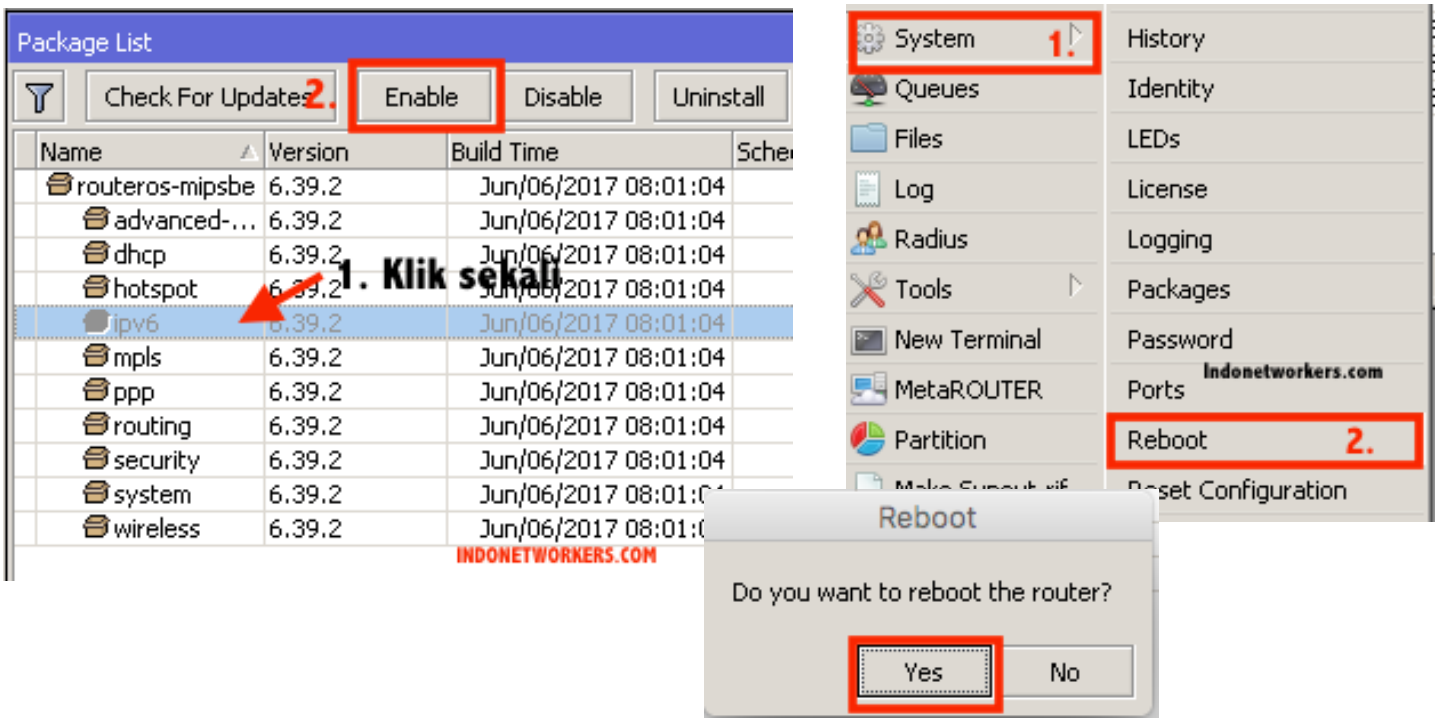
IPv6 on Mikrotik RouterOS

- Silahkan Aktifkan dengan cara :

1. System > Packages

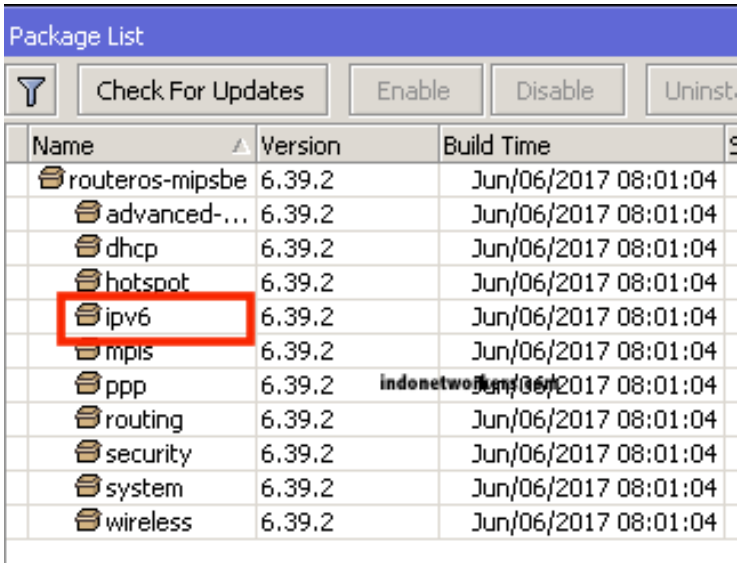
IPv6 on Mikrotik RouterOS

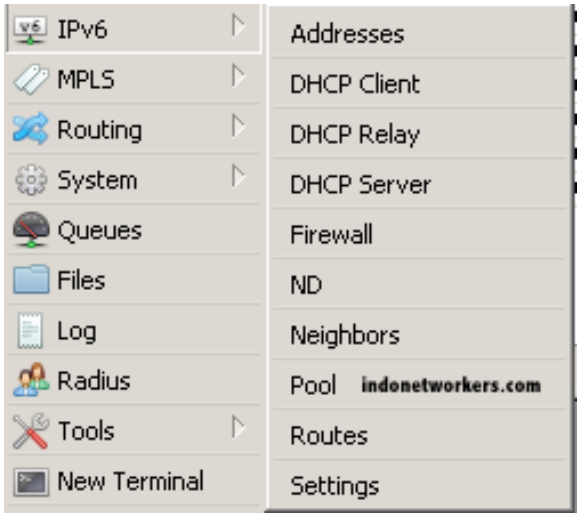
2. Klik Pada Packages ipv6 kemudian enabled , Lalu reboot router nya.



IPv6 on Mikrotik RouterOS

3. Ketika kita check kembali di System > Packages maka packages ipv6 sudah enable, dan menu nya sudah muncul di winbox.





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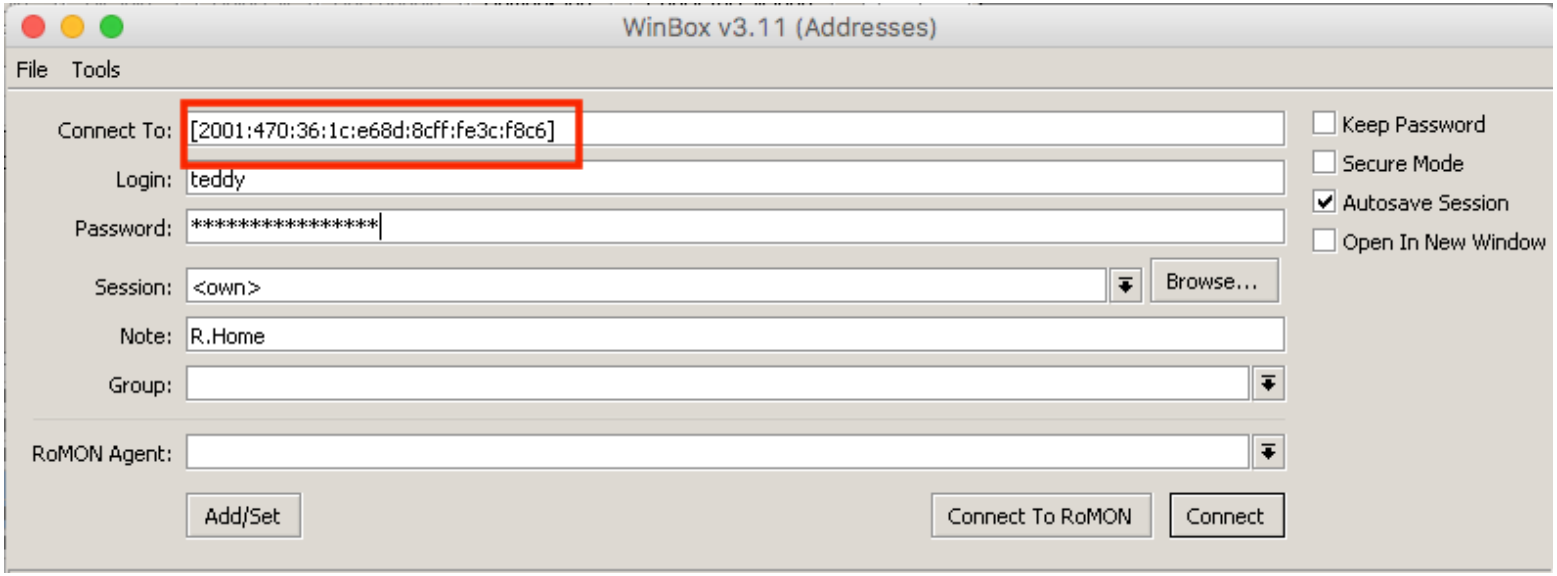
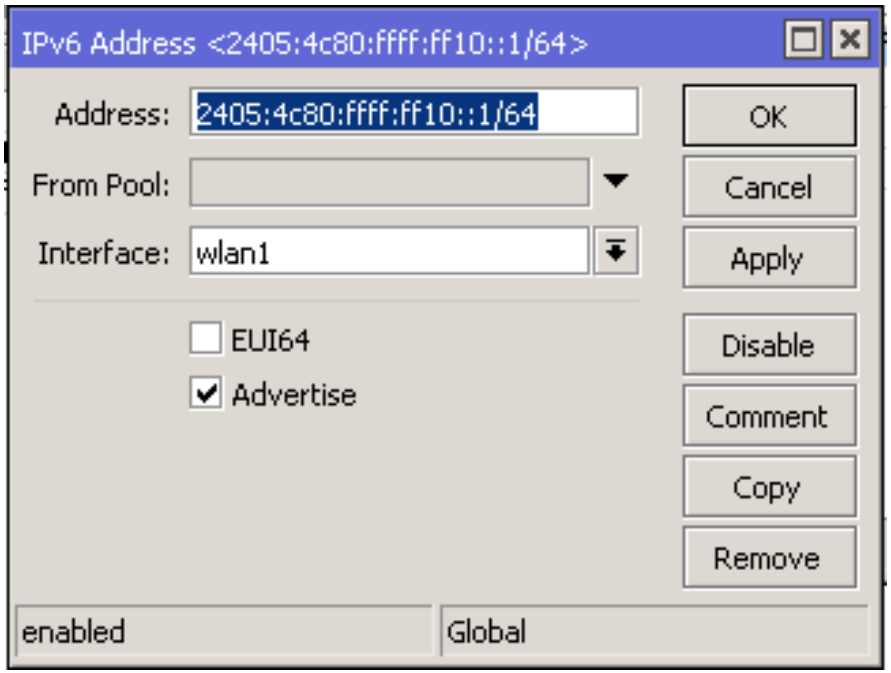
IPv6 on Mikrotik RouterOS

Mengakses Router Mikrotik dengan IPv6 via Winbox dengan format menggunakan tanda [ ] seperti berikut :



IPv6 on Mikrotik RouterOS

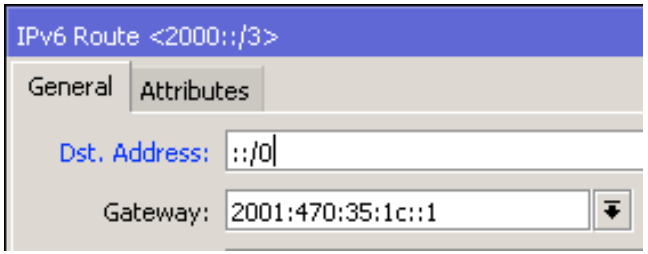
Konfigurasi IP address IPv6 pada IPV6 >Addresses



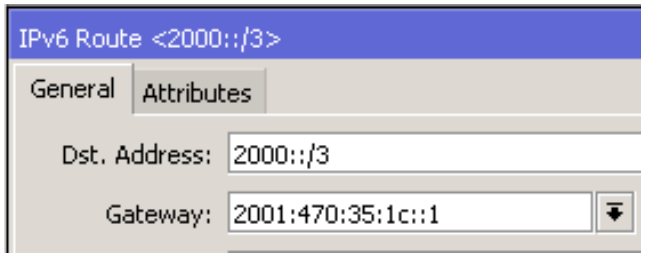
IPv6 on Mikrotik RouterOS

Konfigurasi Gateway IPv6 pada IPV6 > Routes

Destination Address bisa ::/0

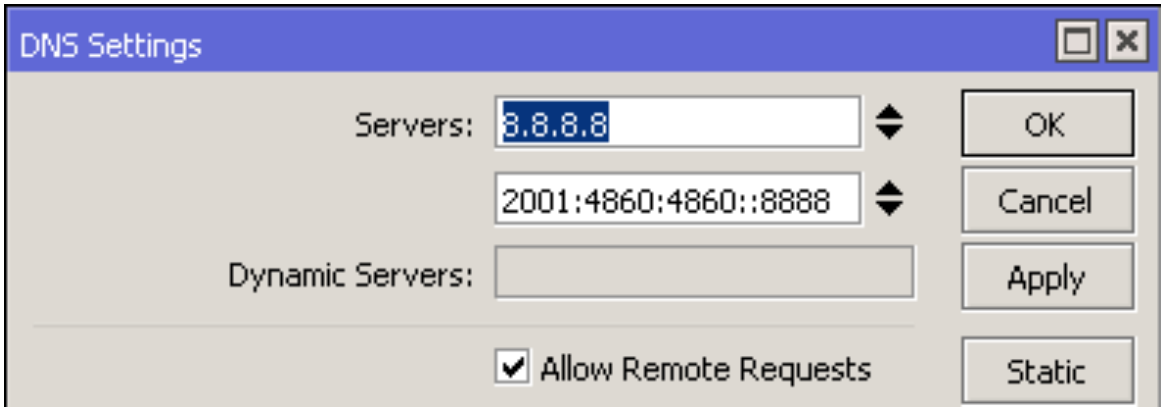


atau 2000::/3



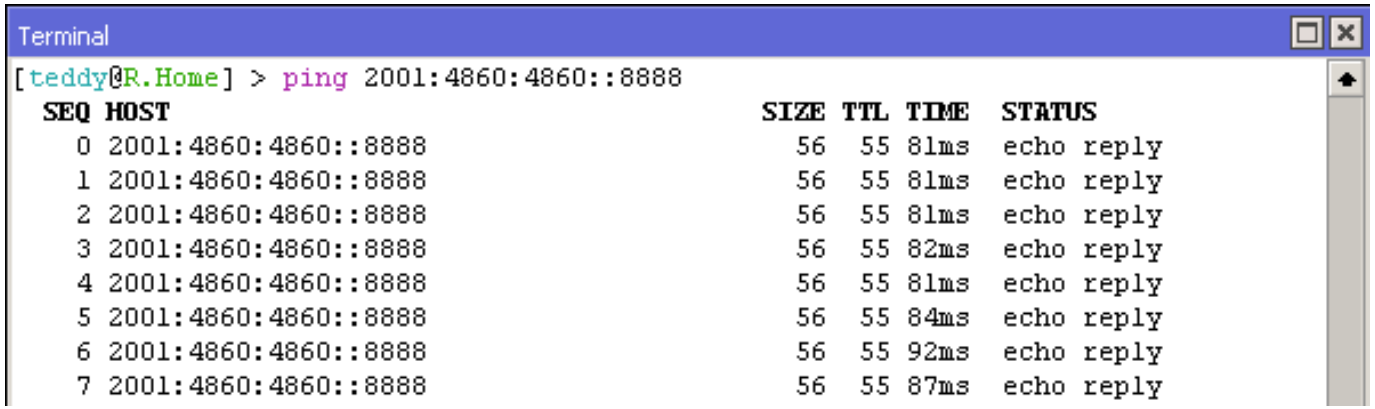
IPv6 on Mikrotik RouterOS

Konfigurasi DNS IPv4 dan IPv6 tetap sama di IP > DNS

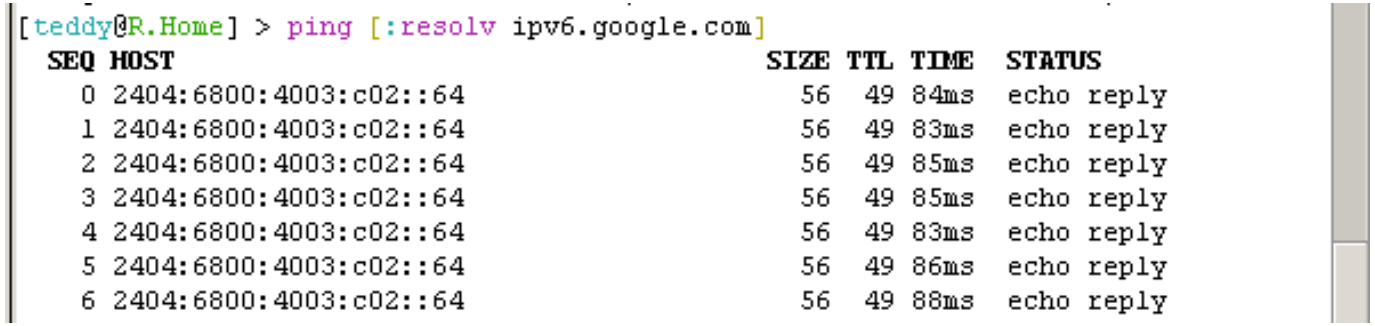


IPv6 on Mikrotik RouterOS

1. Ping



2. Ping domain



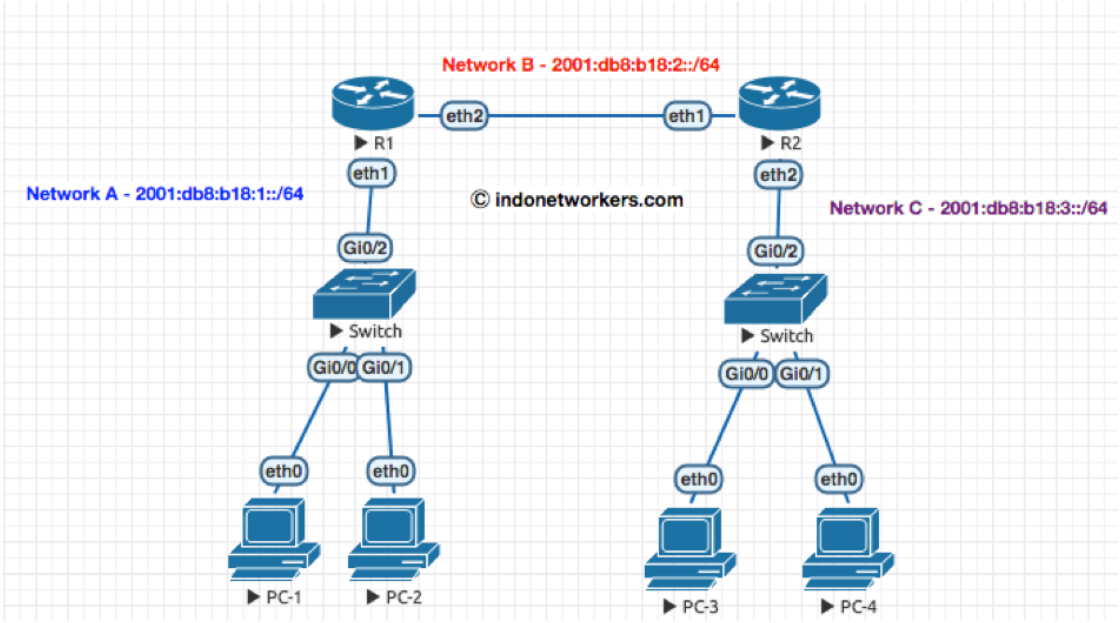
IPv6 on Mikrotik RouterOS

3. Traceroute

```
[teddy@R.Home] > /tool traceroute 2001:4860:4860::8888
 # ADDRESS                          LOSS SENT    LAST     AVG    BEST   WORST
 1 2001:470:35:1c::1                  0%    7   54.4ms    53.5    49.9    55.6
 2 2001:470:0:17c::1                  0%    7   61.3ms    52.2    46.3    61.3
 3 2001:de8:4::1:5169:1               0%    7   46.7ms    47.6      45    49.9
 4 2001:4860:0:f88::1                 0%    6   86.3ms    83.2    80.9    86.3
 5 2001:4860:0:1::dd5                 0%    6   84.5ms    85.3    84.5    85.7
 6 2001:4860:4860::8888               0%    6   84.6ms      84    80.2      87
```

IPv6 Static Route

- LAB



- Silahkan Download Lab lengkap di :http://s.id/IPv6

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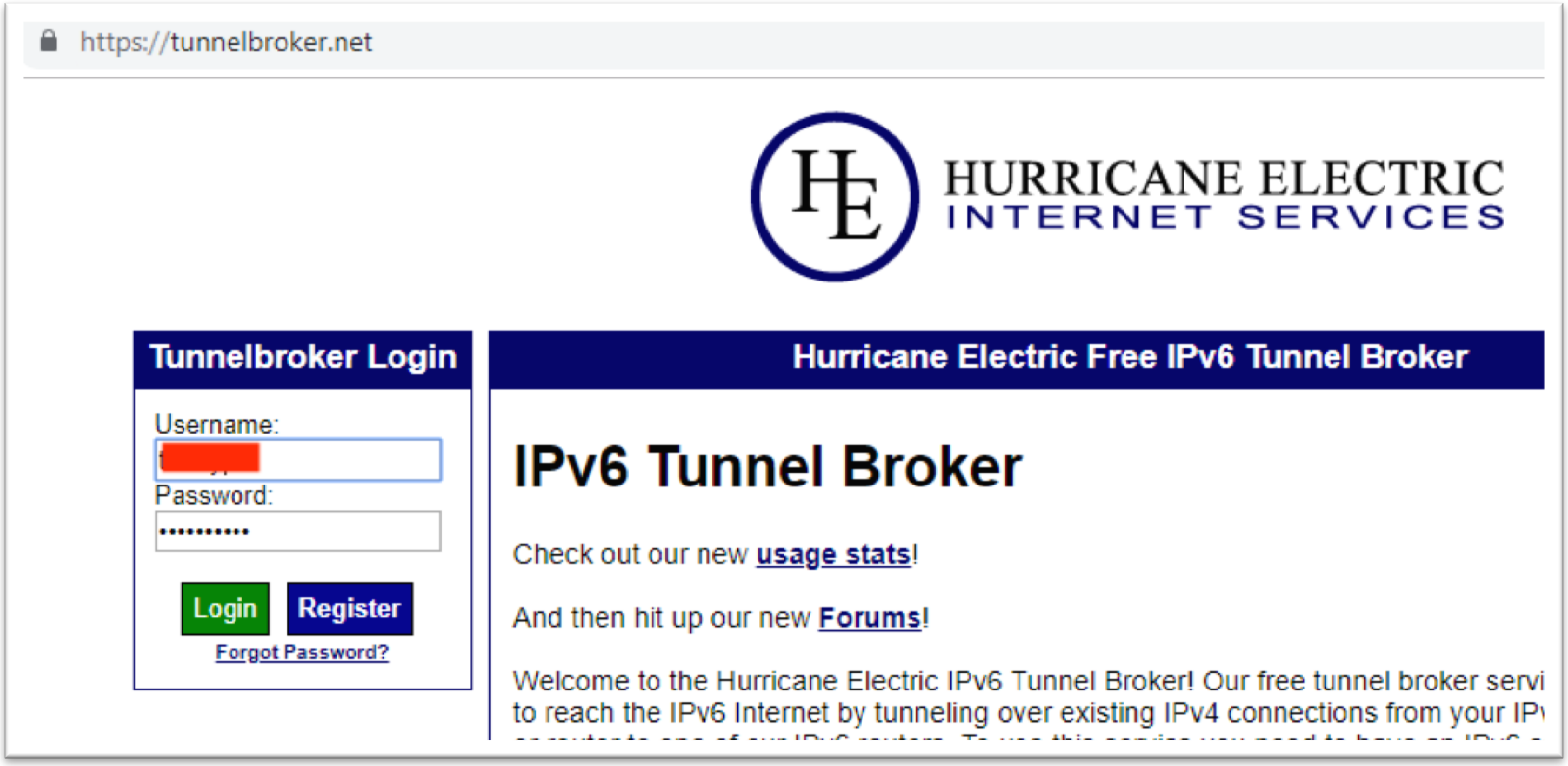
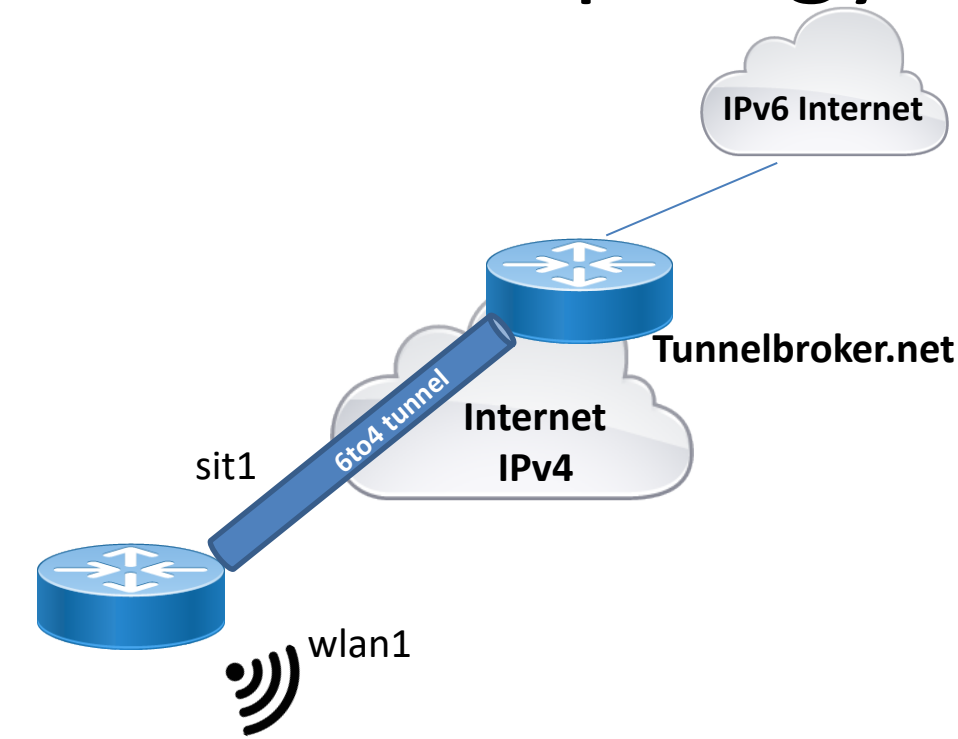
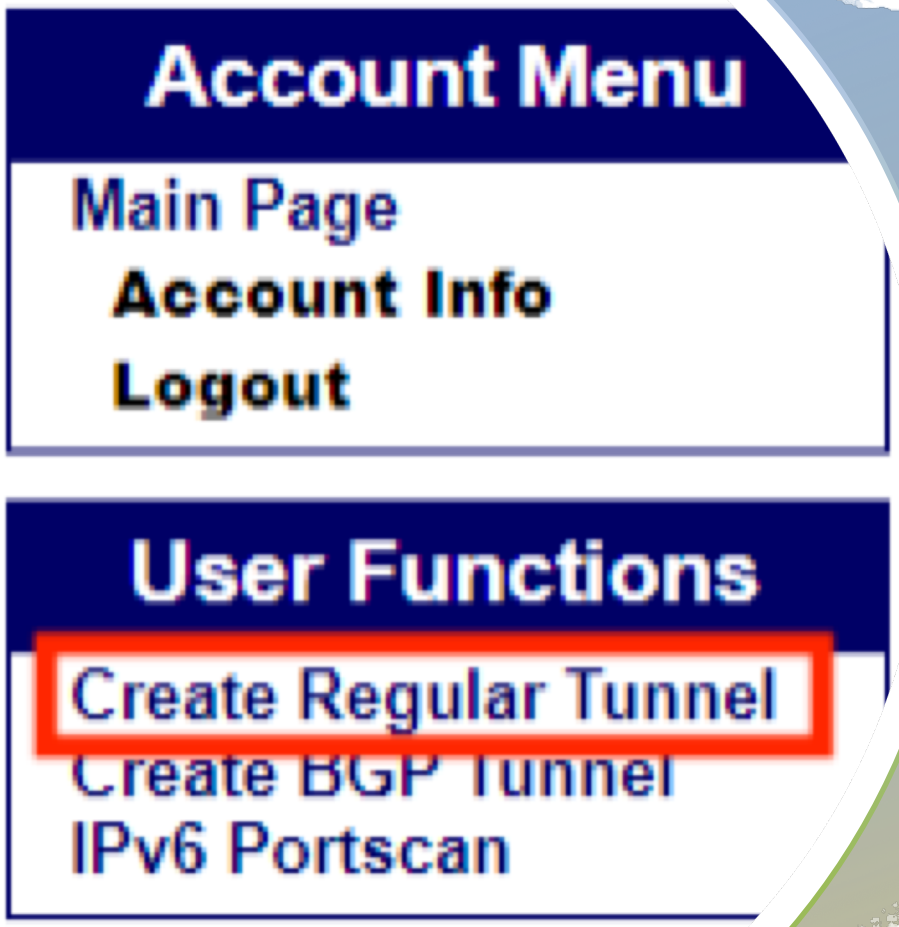
Try Using IPv6 Global Address with Tunnelbroker.net

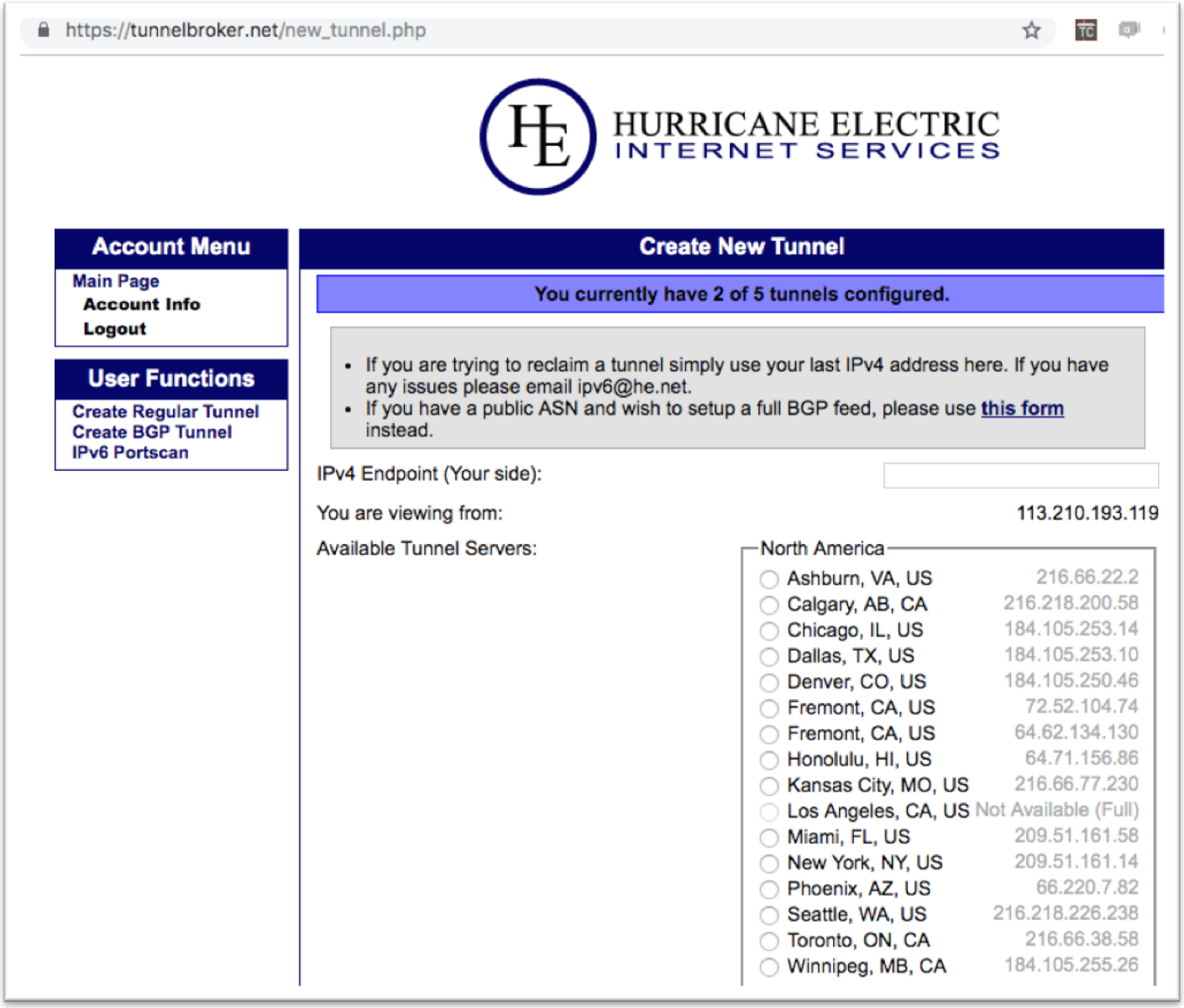


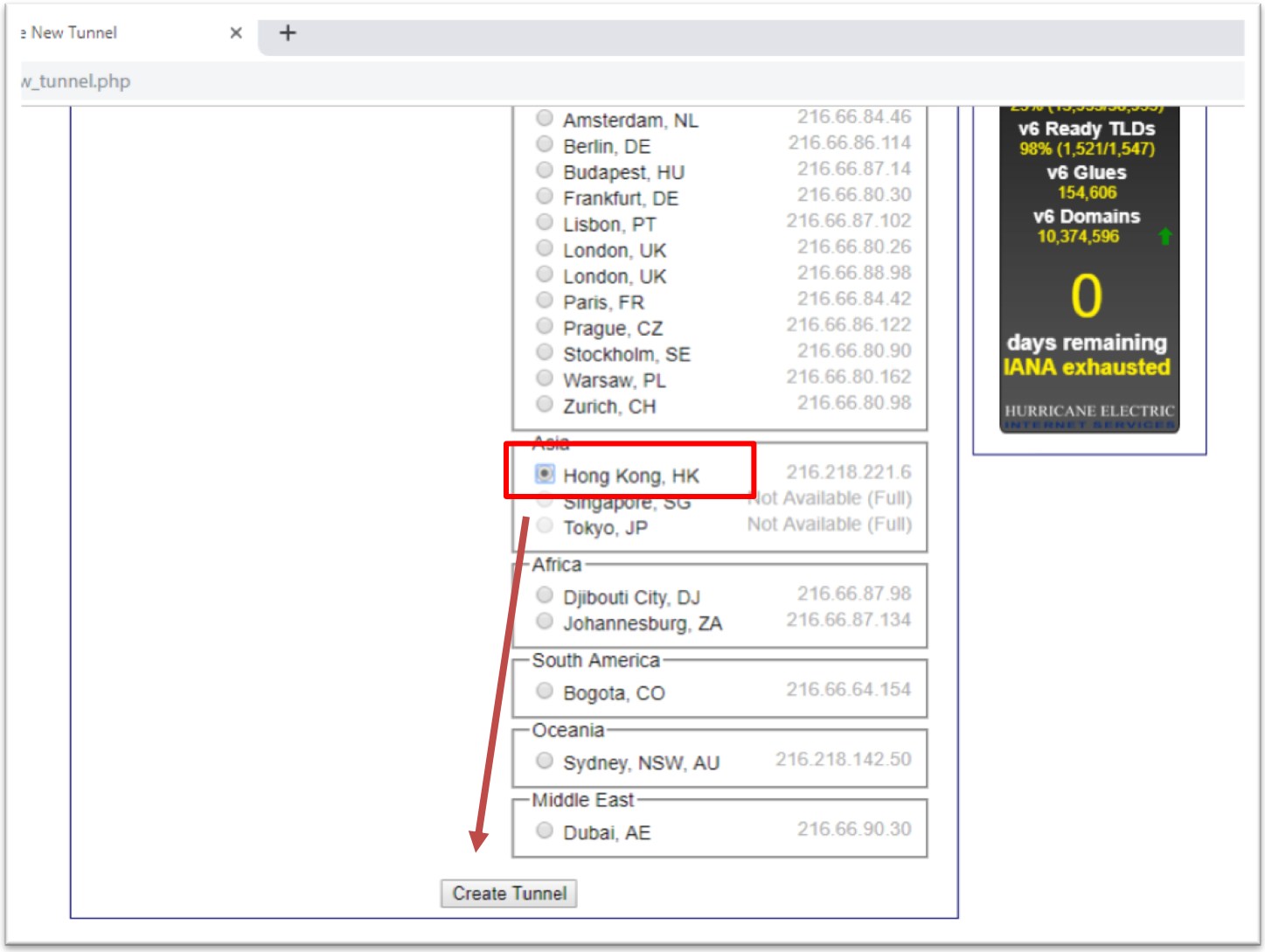
Network Topology

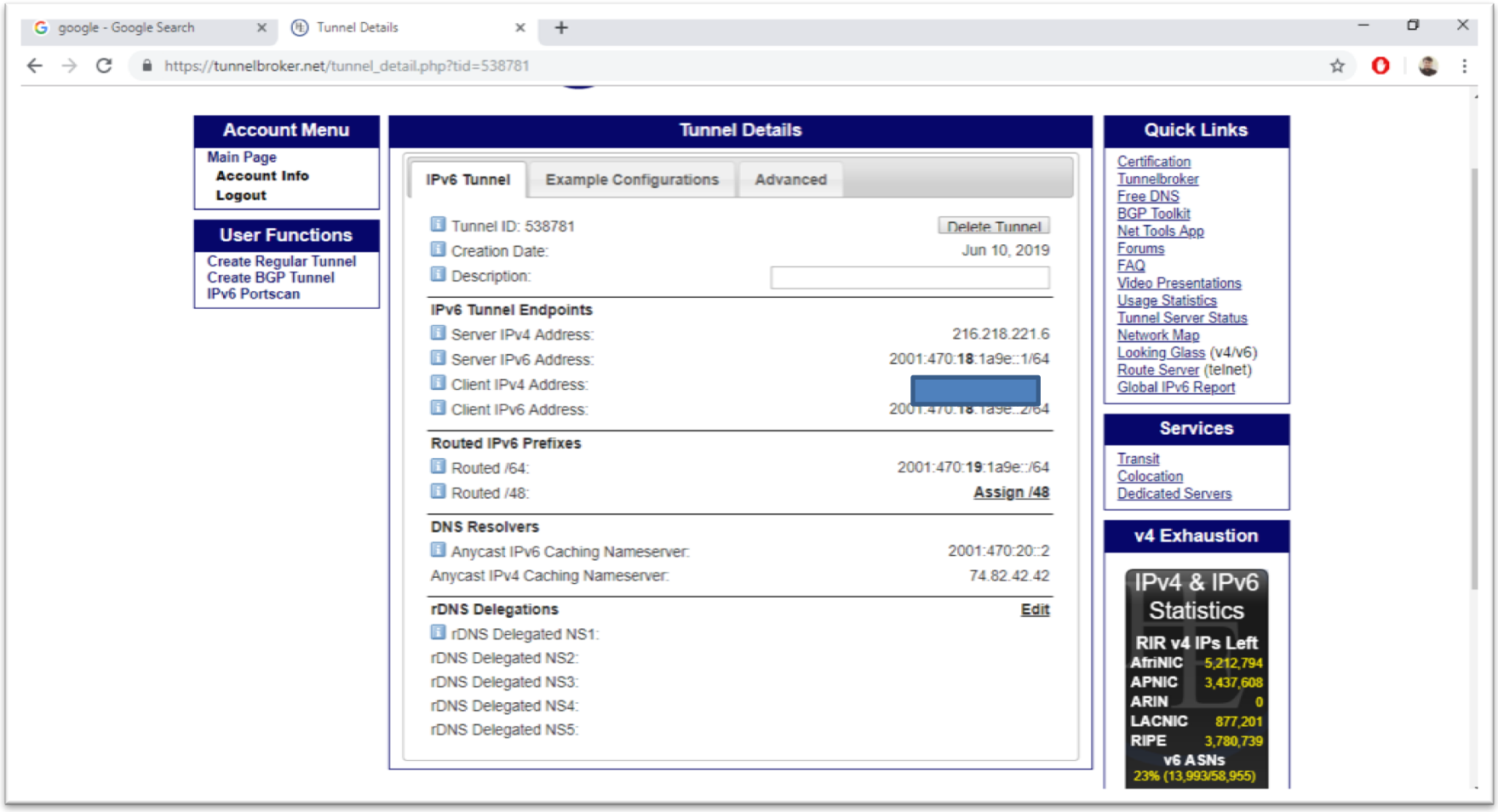


Click “Create Regular Tunnel”

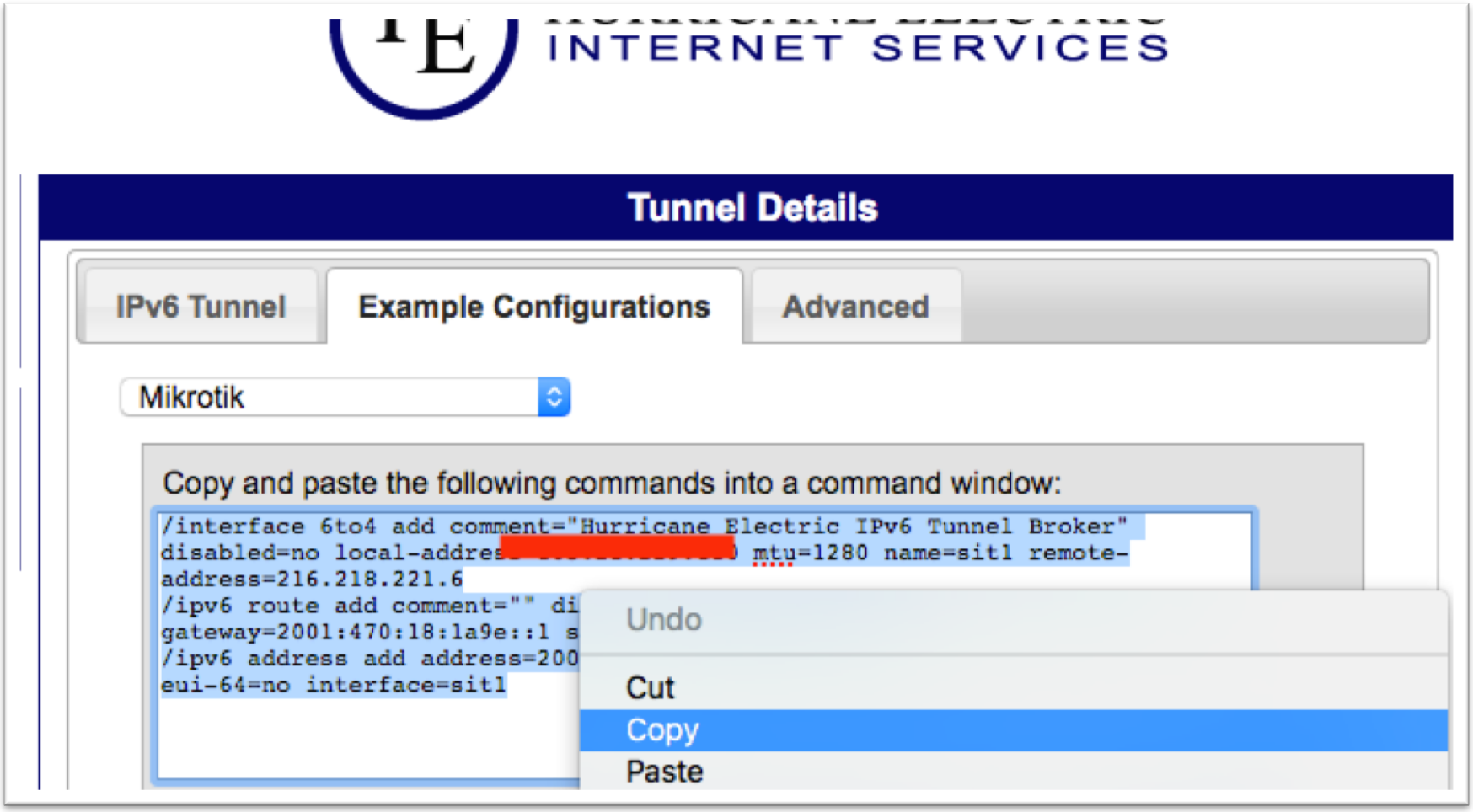


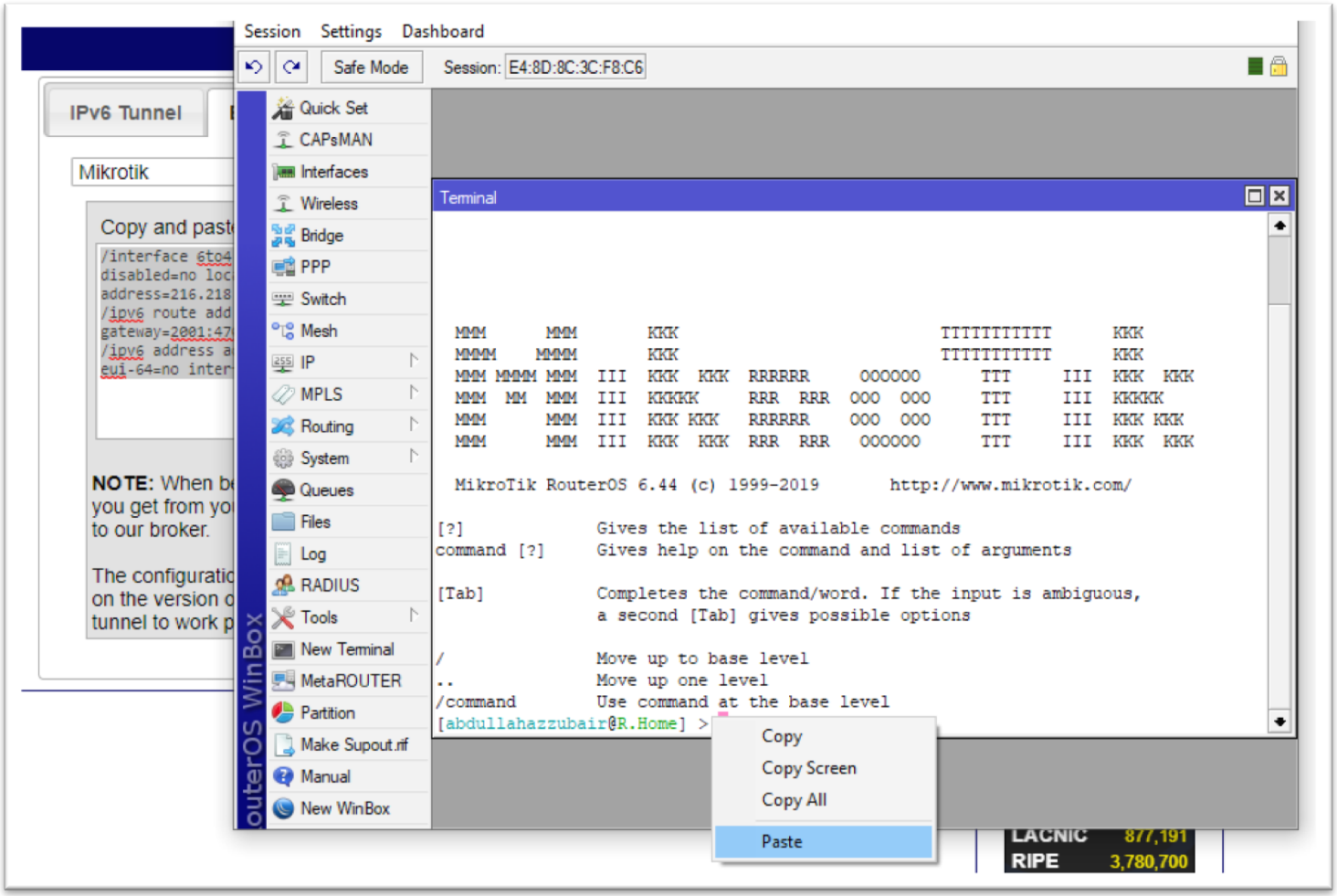

https://tunnelbroker.net/new_tunnel.php
HURRICANE ELECTRIC
INTERNET SERVICES
Account Menu
Main Page
Account Info
Logout
User Functions
Create Regular Tunnel
Create BGP Tunnel
IPv6 Portscan
Create New Tunnel
You currently have 2 of 5 tunnels configured.
If you are trying to reclaim a tunnel simply use your last IPv4 address here. If you have any issues please email ipv6@he.net.
If you have a public ASN and wish to setup a full BGP feed, please use this form instead.
IPv4 Endpoint (Your side):
You are viewing from: 113.210.193.119
Available Tunnel Servers:
North America
Ashburn, VA, US 216.66.22.2
Calgary, AB, CA 216.218.200.58
Chicago, IL, US 184.105.253.14
Dallas, TX, US 184.105.253.10
Denver, CO, US 184.105.250.46
Fremont, CA, US 72.52.104.74
Fremont, CA, US 64.62.134.130
Honolulu, HI, US 64.71.156.86
Kansas City, MO, US 216.66.77.230
Los Angeles, CA, US Not Available (Full)
Miami, FL, US 209.51.161.58
New York, NY, US 209.51.161.14
Phoenix, AZ, US 66.220.7.82
Seattle, WA, US 216.218.226.238
Toronto, ON, CA 216.66.38.58
Winnipeg, MB, CA 184.105.255.26

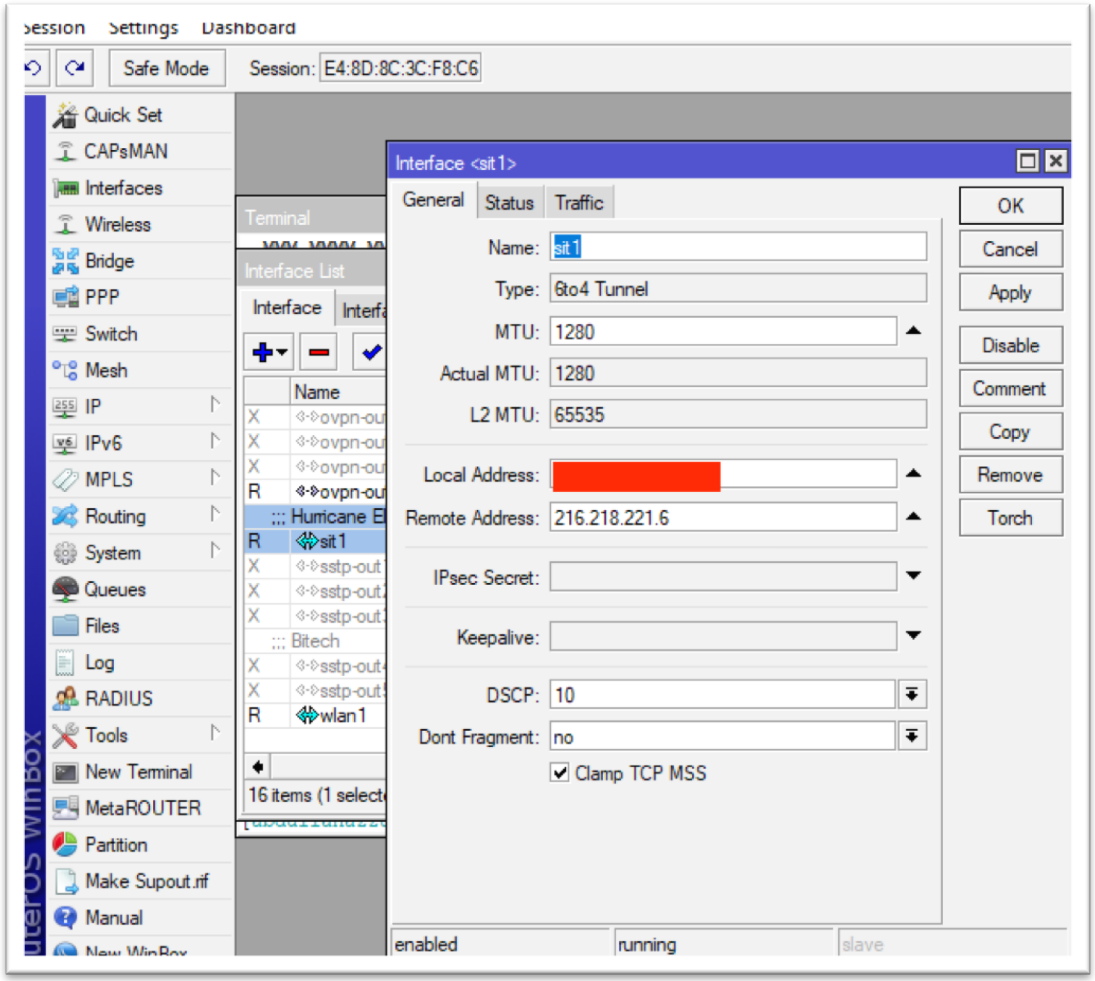

New Tunnel
w_tunnel.php
Amsterdam, NL 216.66.84.46
Berlin, DE 216.66.86.114
Budapest, HU 216.66.87.14
Frankfurt, DE 216.66.80.30
Lisbon, PT 216.66.87.102
London, UK 216.66.80.26
London, UK 216.66.88.98
Paris, FR 216.66.84.42
Prague, CZ 216.66.86.122
Stockholm, SE 216.66.80.90
Warsaw, PL 216.66.80.162
Zurich, CH 216.66.80.98
Asia
Hong Kong, HK 216.218.221.6
Singapore, SG Not Available (Full)
Tokyo, JP Not Available (Full)
Africa
Djibouti City, DJ 216.66.87.98
Johannesburg, ZA 216.66.87.134
South America
Bogota, CO 216.66.64.154
Oceania
Sydney, NSW, AU 216.218.142.50
Middle East
Dubai, AE 216.66.90.30
Create Tunnel
v6 Ready TLDs
98% (1,521/1,547)
v6 Glues
154,606
v6 Domains
10,374,596
0
days remaining
IANA exhausted
HURRICANE ELECTRIC



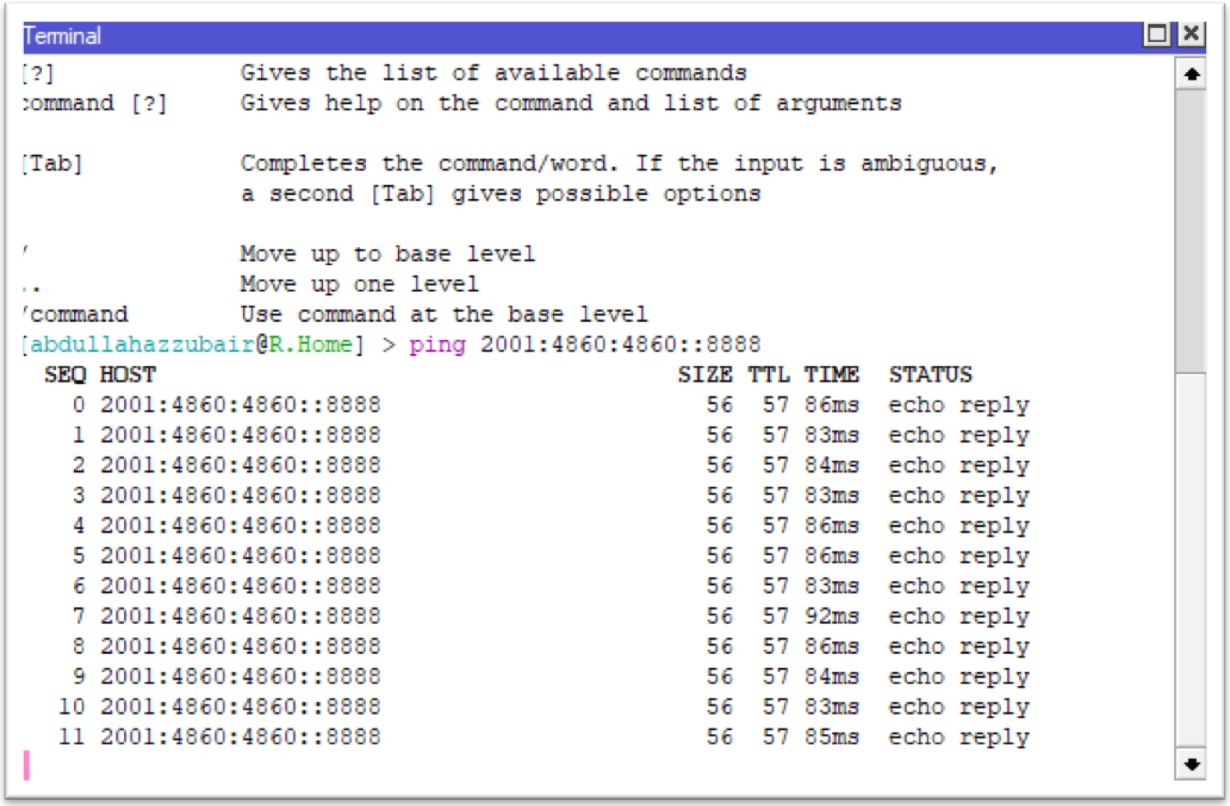
Tunnel Detail

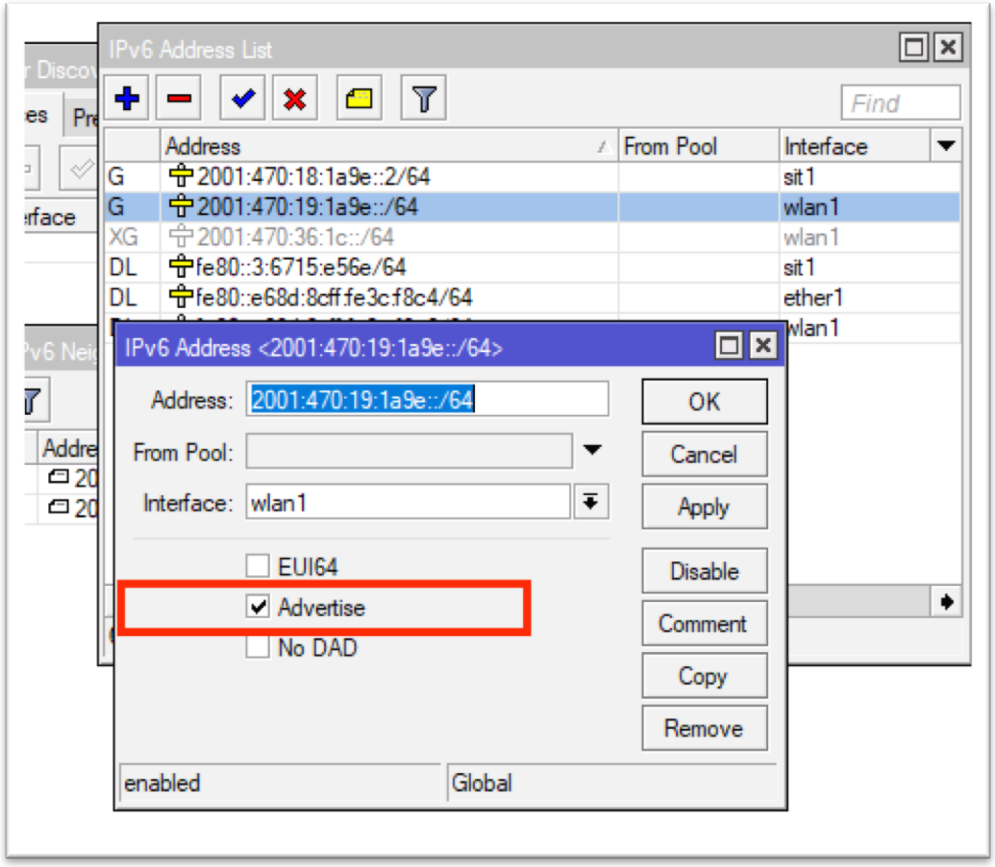

INTERNET SERVICES
Tunnel Details
IPv6 Tunnel
Example Configurations
Advanced
Mikrotik
Copy and paste the following commands into a command window:
/interface 6to4 add comment="Hurricane Electric IPv6 Tunnel Broker"
disabled=no local-addres [redacted] mtu=1280 name=sit1 remote-
address=216.218.221.6
/ipv6 route add comment="" di
gateway=2001:470:18:1a9e::1 s
/ipv6 address add address=200
eui-64=no interface=sit1
Undo
Cut
Copy
Paste


IPv6 Tunnel
Mikrotik
Copy and past
/interface 6to4
disabled=no loc
address=216.218
/ipv6 route add
gateway=2001:47
/ipv6 address a
eui-64=no inter
NOTE: When b
you get from yo
to our broker.
The configuratio
on the version o
tunnel to work p
Session Settings Dashboard
Safe Mode
Session: E4:8D:8C:3C:F8:C6
Quick Set
CAPsMAN
Interfaces
Wireless
Bridge
PPP
Switch
Mesh
IP
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
MetaROUTER
Partition
Make Supout.rif
Manual
New WinBox
outerOS WinBox
Terminal
MMM MMM KKK TTTTTTTTTTT KKK
MMMM MMMM KKK TTTTTTTTTTT KKK
MMM MMMM MMM III KKK KKK RRRRRR 000000 TTT III KKK KKK
MMM MM MMM III KKKKK RRR RRR 000 000 TTT III KKKKK
MMM MMM III KKK KKK RRRRRR 000 000 TTT III KKK KKK
MMM MMM III KKK KKK RRR RRR 000000 TTT III KKK KKK
MikroTik RouterOS 6.44 (c) 1999-2019 http://www.mikrotik.com/
[?] Gives the list of available commands
command [?] Gives help on the command and list of arguments
[Tab] Completes the command/word. If the input is ambiguous,
a second [Tab] gives possible options
/ Move up to base level
.. Move up one level
/command Use command at the base level
[abdullahazzubair@R.Home] >
Copy
Copy Screen
Copy All
Paste
LACNIC 877,191
RIPE 3,780,700

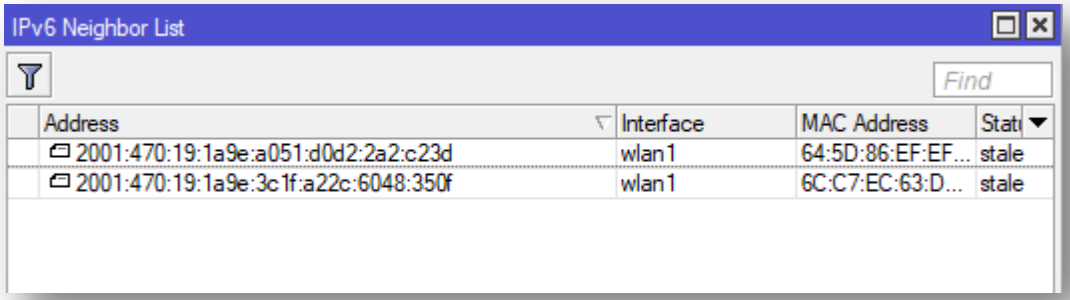

Session Settings Dashboard
Safe Mode
Session: E4:8D:8C:3C:F8:C6
Quick Set
CAPsMAN
Interfaces
Wireless
Bridge
PPP
Switch
Mesh
IP
IPv6
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
MetaROUTER
Partition
Make Supout.rif
Manual
RouterOS WinBox
Terminal
Interface List
Interface
Name
R sit1
R wlan1
16 items (1 select
Interface <sit1>
General
Status
Traffic
Name: sit1
Type: 6to4 Tunnel
MTU: 1280
Actual MTU: 1280
L2 MTU: 65535
Local Address:
Remote Address: 216.218.221.6
IPsec Secret:
Keepalive:
DSCP: 10
Dont Fragment: no
Clamp TCP MSS
OK
Cancel
Apply
Disable
Comment
Copy
Remove
Torch
enabled
running
slave

Test Ping to Google Ipv6 DNS

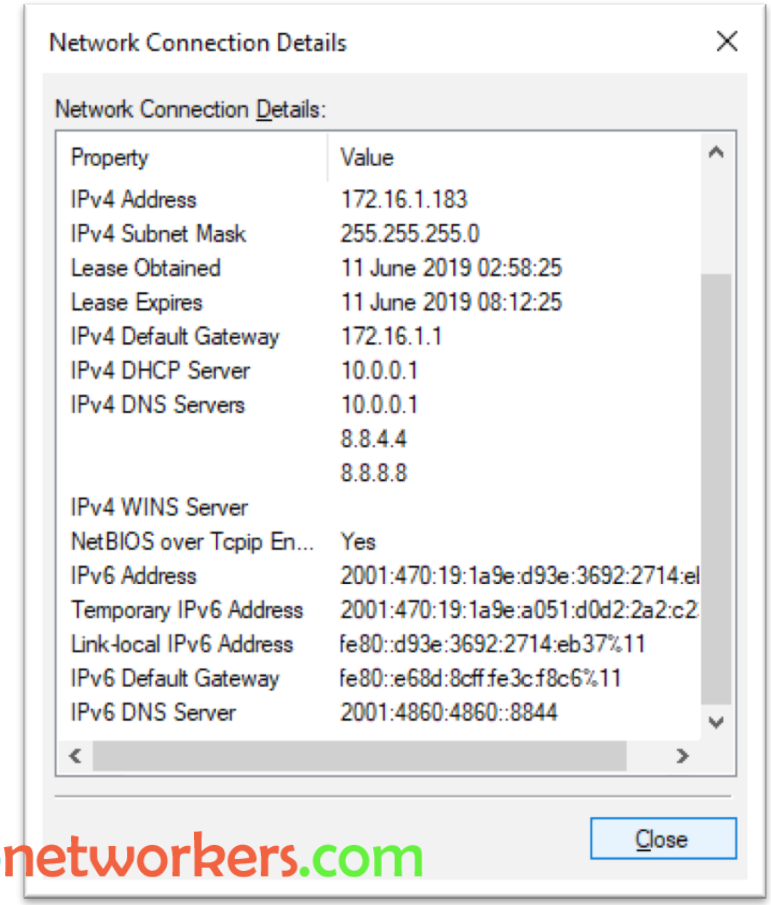


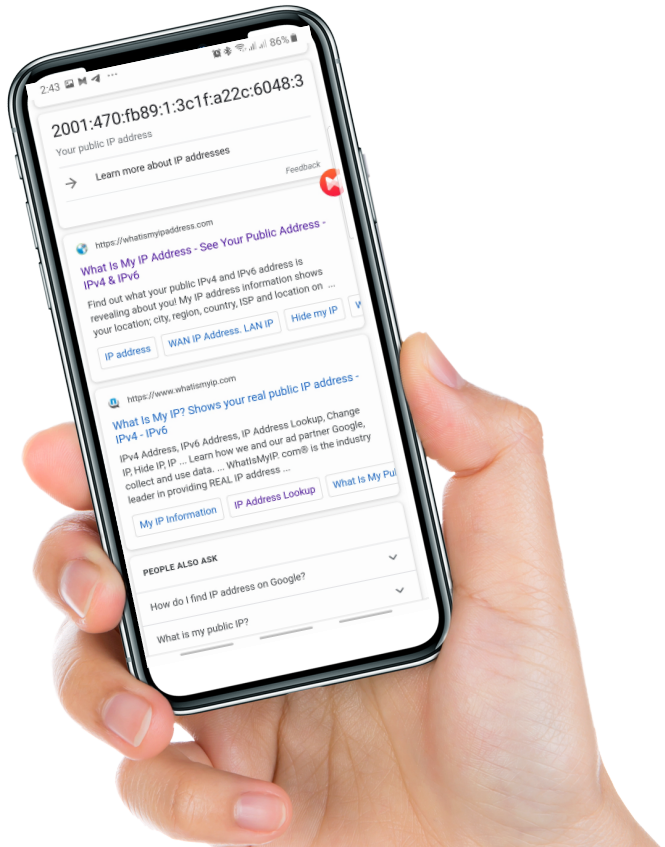


Set IP to Client via Wlan Interface



IPv6 Neighbor





Results

IPv6 Security Issue

- CVE-2018-19298, CVE-2018-19299 IPV6 RESOURCE EXHAUSTION

- Keduanya sudah fix di RouterOS versi RouterOS v6.44.2, RouterOS v6.45beta23 and RouterOS v6.43.14 yang di publish di April 2019

So Please Always Update your RouterOS version

Path MTU

- Path MTU (PMTU) adalah ukuran paket terbesar yang bisa dilalui antara sumber dan tujuan tanpa fragmentasi
- IPv6 membutuhkan MTU 1280 bytes atau lebih besar
- IPv4 membutuhkan MTU 68 bytes

Path MTU Discovery

- PMTU Discovery adalah teknik penentuan Path MTU antara dua host IP. Untuk discovery dan memanfaatkan PMTU lebih besar dari 1280, sangat disarankan untuk menerapkan PMTU Discovery

- Untuk paket yang lebih besar dari fragmen PMTU yang digunakan.

Thank you

Telegram : @teddyyuliswar