

# Poor mans journey to the future

Story of my dual stacked home network

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# Bio #AboutMe

Security Devops Engineer

15 year Linux guy

3D printer owner

Drone pilot

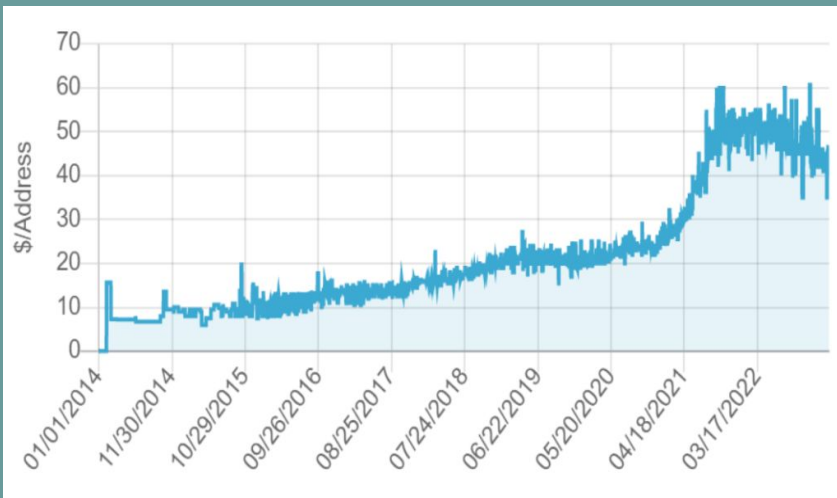
# Why are we here? #Motivation

- using (Proxmox) VE
- host stuff at home
- get some address space
- profit



## Why not ipv4?

- buy: avg 40usd per ip address
- lease: avg 100usd per /24 block annually



# Why ipv6?

- why not? #trendsetter
- almost free\* IP space



tenor.com

# Ipv6 quickstart

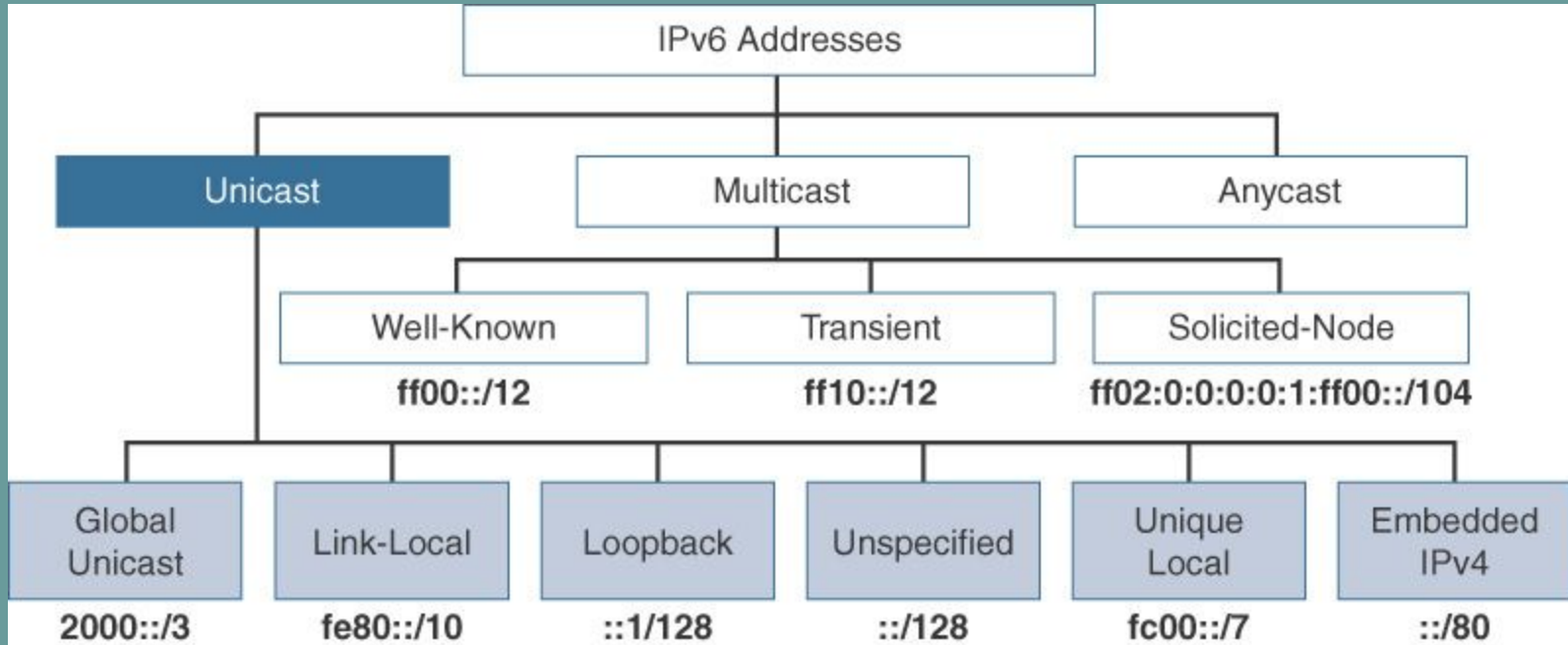
Your IPv6 address on the public Internet appears to be  
2a02:e220:7:0:e14b:e8cb:741a:c2a9

- 64 bit network prefix / 64 bit host part
- whole ipv4 fits in one block #mindblown
- arp -> ndp
- no checksum
- no fragmentation



tenor.com

# ipv6 quick introduction



# Ipv6 brief history

- 1995 first introduction
- 1998 first draft
- 8th of June 2011. - world ipv6 day
- 6th of June 2012. - world ipv6 launch day
- 16th of June 2023. - still around 40% ipv6 adoption





# Ipv6 adoption

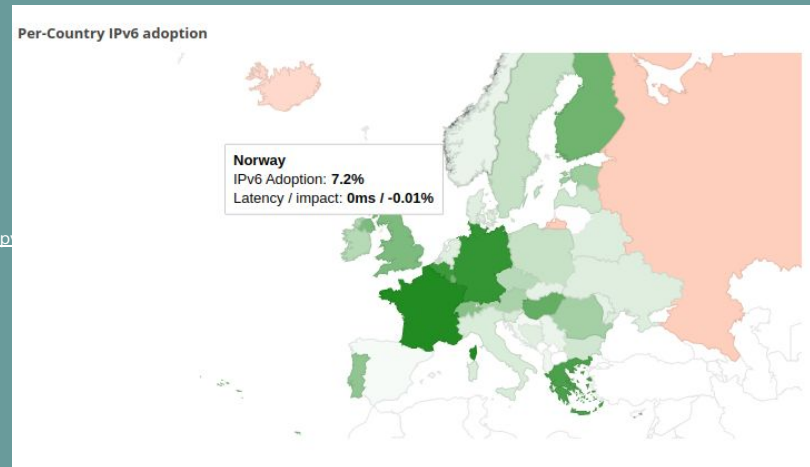
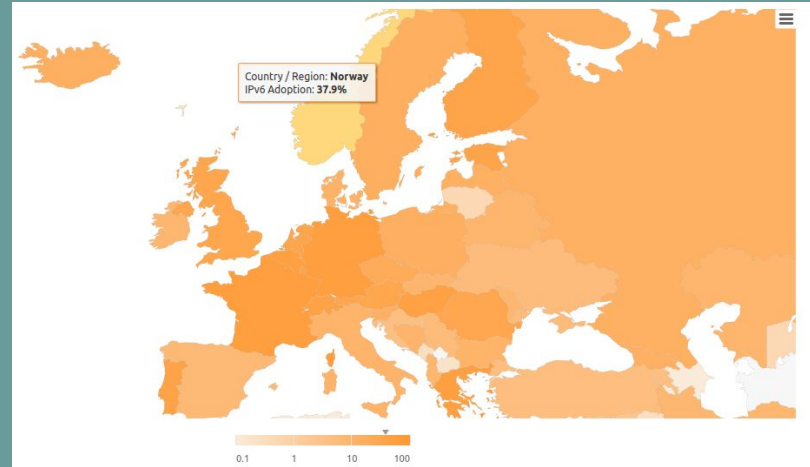
Show stoppers:

- we have “plenty” of ipv4 space
- we don't need it
- it is expensive
- nobody uses it

Stats:

- Akamai - <https://www.akamai.com/internet-station/cyber-attacks/state-of-the-internet-report/ip>

- Google - <https://www.google.com/intl/en/ipv6/statistics.html>



# How to start journey to the future

- scope - local or global
- hardware
- tunnel
- level of difficulty

dn42 



 route64.org

# Easy way

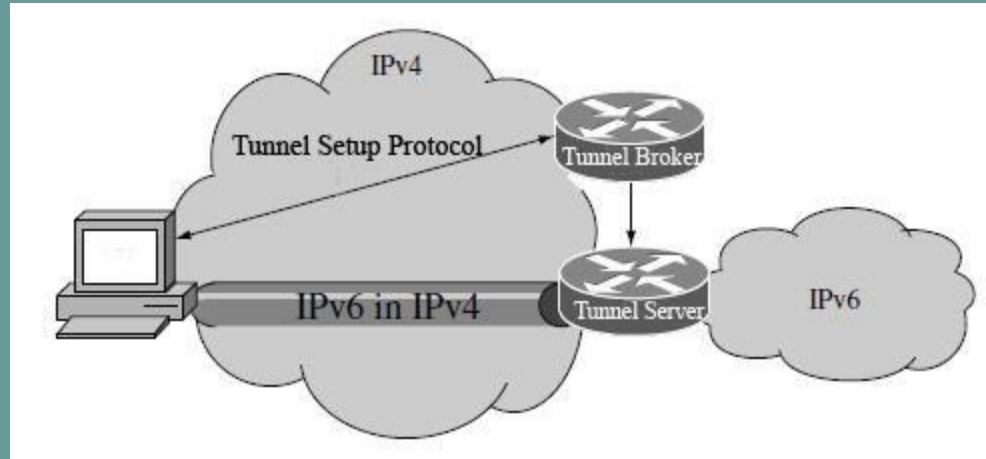
- choose tunnel broker
- setup your tunnel endpoint

- pros:

- free
- fast deployment

- cons:

- sponsored/free shared ipv6 transit
- geoblocking
- abuse



[https://www.researchgate.net/figure/Esquema-de-Tunnel-Broker\\_fig6\\_282644148](https://www.researchgate.net/figure/Esquema-de-Tunnel-Broker_fig6_282644148)



# Hard way

- learn BGP
- choose ipv6 transit upstream -> bgp.services
- get AS number -> LIR
- get ipv6 blocks -> LIR
- tunnel
- use BGP

# Pick your poison

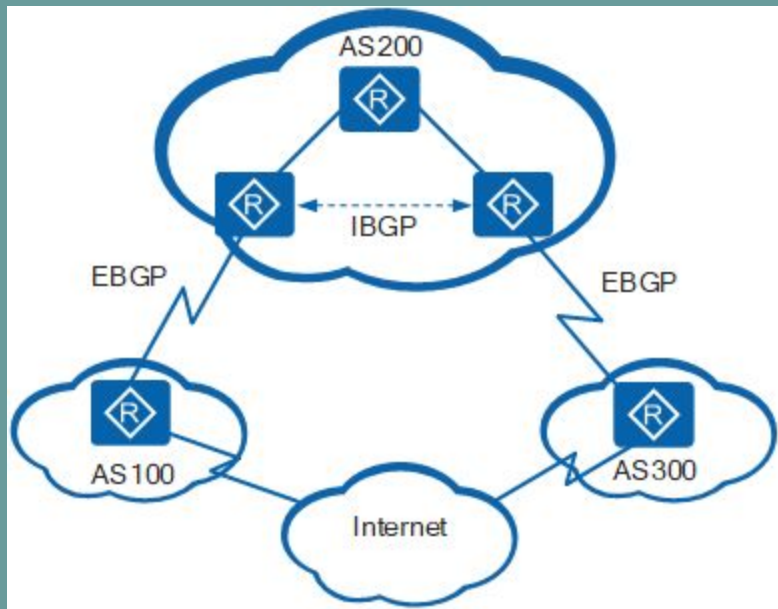


# Short intro to BGP

- exchange routing information
- path vector
- flexible
- scalable
- bgp sites:

[bgp.he.net](http://bgp.he.net)

[bgp.tools](http://bgp.tools)

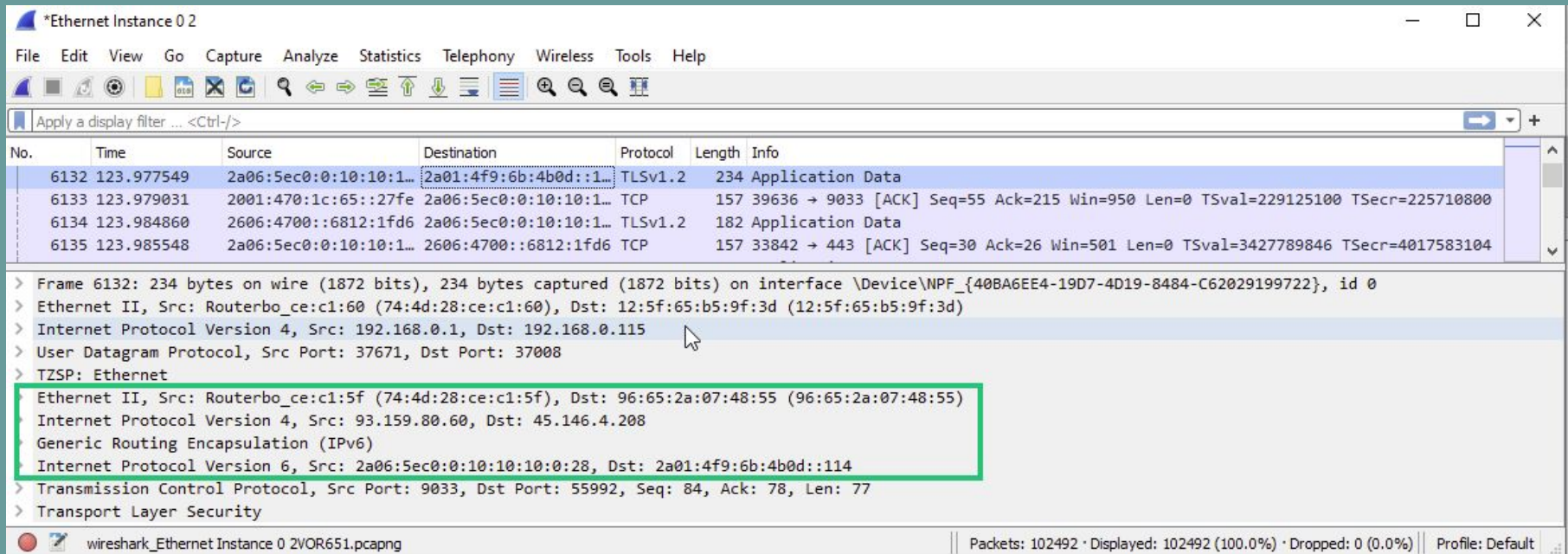




# My ipv6 setup

- home:
  - gre to vps
- vps (native ipv6)
  - bgp session

# Gre tunnel - ipv6 over ipv4



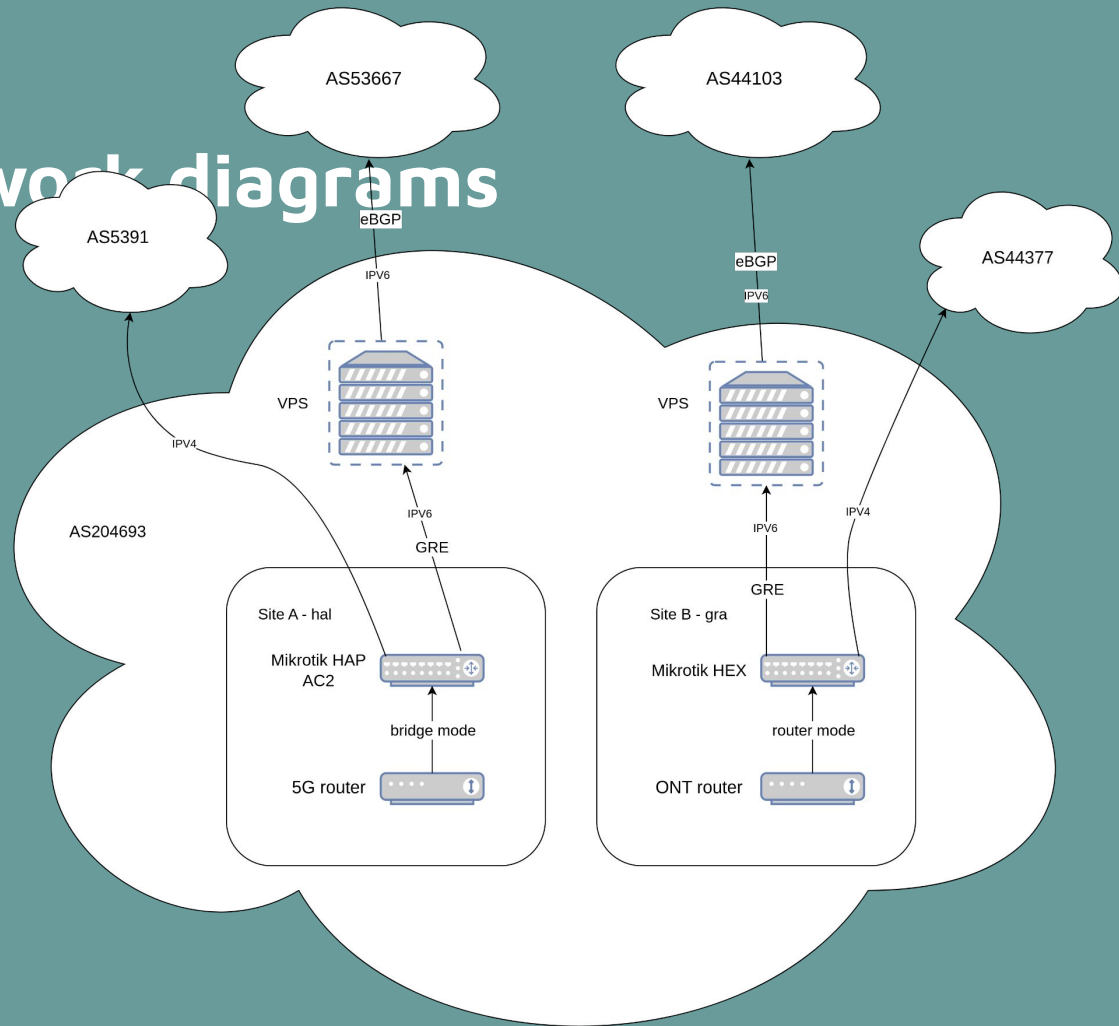
The image shows a Wireshark capture of a GRE tunnel packet. The packet list pane shows four packets, with packet 6132 selected. The packet details pane shows the following layers:

- Frame 6132: 234 bytes on wire (1872 bits), 234 bytes captured (1872 bits) on interface \Device\NPF\_{40BA6EE4-19D7-4D19-8484-C62029199722}, id 0
- Ethernet II, Src: Routerbo\_ce:c1:60 (74:4d:28:ce:c1:60), Dst: 12:5f:65:b5:9f:3d (12:5f:65:b5:9f:3d)
- Internet Protocol Version 4, Src: 192.168.0.1, Dst: 192.168.0.115
- User Datagram Protocol, Src Port: 37671, Dst Port: 37008
- TZSP: Ethernet
- Ethernet II, Src: Routerbo\_ce:c1:5f (74:4d:28:ce:c1:5f), Dst: 96:65:2a:07:48:55 (96:65:2a:07:48:55)
- Internet Protocol Version 4, Src: 93.159.80.60, Dst: 45.146.4.208
- Generic Routing Encapsulation (IPv6)
- Internet Protocol Version 6, Src: 2a06:5ec0:0:10:10:10:0:28, Dst: 2a01:4f9:6b:4b0d::114
- Transmission Control Protocol, Src Port: 9033, Dst Port: 55992, Seq: 84, Ack: 78, Len: 77
- Transport Layer Security

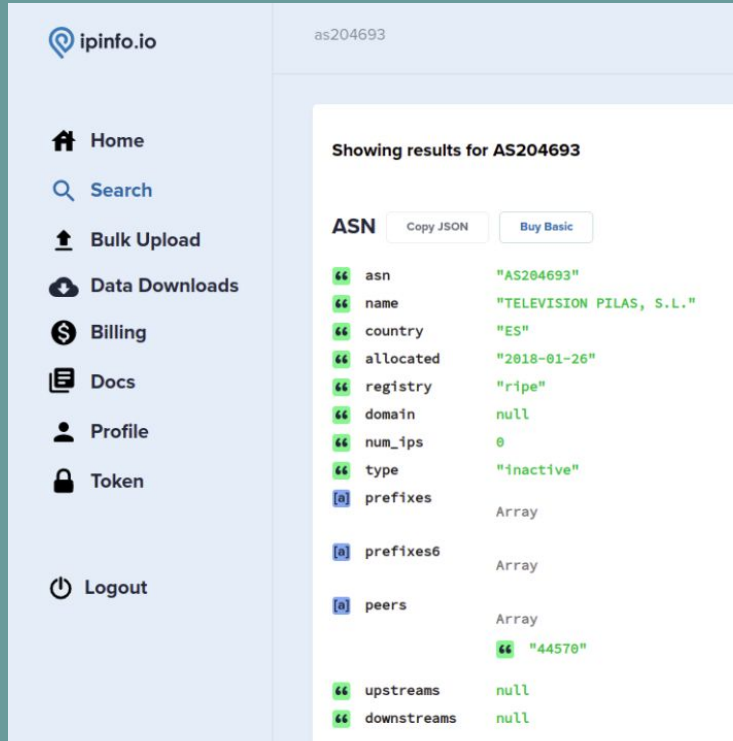
The status bar at the bottom shows: wireshark\_Ethernet Instance 0 2VOR651.pcapng | Packets: 102492 · Displayed: 102492 (100.0%) · Dropped: 0 (0.0%) | Profile: Default



# My network diagrams



# ASN allocation #WeRecycle



The screenshot displays the ipinfo.io website interface. On the left is a navigation sidebar with icons and labels for Home, Search, Bulk Upload, Data Downloads, Billing, Docs, Profile, Token, and Logout. The main content area shows the search results for the ASN 'as204693'. It includes a title 'Showing results for AS204693', a 'Copy JSON' button, and a 'Buy Basic' button. Below these are the details for the ASN, presented as a list of key-value pairs.

Showing results for AS204693	
ASN	<a href="#">Copy JSON</a> <a href="#">Buy Basic</a>
asn	"AS204693"
name	"TELEVISION PILAS, S.L."
country	"ES"
allocated	"2018-01-26"
registry	"ripe"
domain	null
num_ips	0
type	"inactive"
prefixes	Array
prefixes6	Array
peers	Array
	["44570"]
upstreams	null
downstreams	null

# Ipv6 with Mikrotik

-	D	R	gre-tunnel1	GRE Tunnel	1400	65535	83.4
---	---	---	-------------	------------	------	-------	------

		▲ Address	From Pool	Interface	
-	LD	➕ fe80::a55:31ff:fe64:c718/64		bridge	
-	D	➕ 2a02:e220:7::2/64		bridge	yes
-	LD	➕ fe80::2:6bbd:1e8c/64		gre-tunnel1	no
-	D	➕ 2605:6400:c807:1::3/127		gre-tunnel1	no

Disable IPv6

IPv6 Forward

Accept Redirects

Accept Router Advertisements

Max Neighbor Entries

▲ Interface	RA Interval (s)	RA Delay (s)	MTU	Reachable Time (s)	Retransmit Interval (s)	RA Lifetime (s)	Hop Limit	DNS Servers	Advertise MAC Address	Advertise DNS
bridge	200-600	3				1800		2001:4860:4860::8888, 2001:4860:4860::8844	yes	yes

Dst. Address

Gateway

Immediate Gateway ▼  ▲

Check Gateway ▼

# BGP quick start - bird2 conf

```
log syslog all;
```

```
router id 107.189.30.140;
```

```
protocol device {  
    scan time 5;  
}
```

```
protocol direct {  
    interface "dummy*";  
    ipv6;  
}
```

```
protocol static {  
    ipv6;  
    route 2a0e:b107:1ad0::/44 reject;  
    route 2a06:a005:ce0::/44 reject;  
    route 2a06:1287:1100::/43 reject;  
    route 2a02:e220:7::/48 reject;  
}
```

```
filter AS204693 all {  
    if (net ~ [  
        2a06:1287:1100::/43,  
        2a06:a005:ce0::/44,  
        2a0e:b107:1ad0::/44,  
        2a02:e220:7::/48  
    ]) then accept;  
    else reject;  
}
```

```
protocol bgp frantech {  
    description "Frantech/BuyVM";  
    local 2605:6400:0030:f4f5:d79b:2a70:92bd:6a69 as 204693;  
    neighbor 2605:6400:ffff::2 as 53667;  
    multihop 2;  
    password "xxx";  
    ipv6 {  
        import all;  
        export filter AS204693 all;  
    };  
}
```

Dont forget to add route for prefix via tunnel :)

# BGP quick start - bird2 stats

```
frantech BGP --- up 2023-05-17 Established
Description: Frantech/BuyVM
BGP state: Established
Neighbor address: 2605:6400:ffff::2
Neighbor AS: 53667
Local AS: 204693
Neighbor ID: 169.254.169.179
...
...
Channel ipv6
State: UP
Table: master6
Preference: 100
Input filter: ACCEPT
Output filter: AS204693 all
Routes: 179604 imported, 4 exported, 179604 preferred
```

# Traceroute4 - google.com

```
$ traceroute google.com
traceroute to google.com (216.58.214.142), 30 hops max, 60 byte packets
 1 * * *
 2 * 10.200.10.10 (10.200.10.10) 178.073 ms 178.029 ms
 3 10.10.0.13 (10.10.0.13) 87.892 ms 87.887 ms 87.882 ms
 4 10.10.0.29 (10.10.0.29) 87.877 ms 87.871 ms 87.865 ms
 5 185.151.134.25 (185.151.134.25) 87.859 ms 87.850 ms 185.151.132.64 (185.151.132.64) 87.909 ms
 6 185.151.132.64 (185.151.132.64) 87.903 ms 185.151.132.67 (185.151.132.67) 13.492 ms 185.151.132.64 (185.151.132.64)
13.442 ms
 7 185.151.132.67 (185.151.132.67) 13.433 ms 213.186.23.18 (213.186.23.18) 17.885 ms 185.151.132.67 (185.151.132.67)
13.407 ms
 8 108.170.250.177 (108.170.250.177) 21.024 ms 108.170.250.161 (108.170.250.161) 89.747 ms 108.170.250.177
(108.170.250.177) 18.364 ms
 9 142.250.235.225 (142.250.235.225) 23.267 ms 142.250.235.223 (142.250.235.223) 17.979 ms 108.170.250.177
(108.170.250.177) 17.354 ms
10 142.250.235.225 (142.250.235.225) 16.881 ms sof02s42-in-f14.1e100.net (216.58.214.142) 16.563 ms 142.250.235.223
(142.250.235.223) 16.861 ms
```

# Traceroute6 - google.com

```
$ traceroute6 google.com
traceroute to google.com (2a00:1450:4017:803::200e), 30 hops max, 80 byte packets
 1 2a02:e220:7::2 (2a02:e220:7::2) 10.914 ms 11.216 ms 11.581 ms
 2 2605:6400:c807:1::2 (2605:6400:c807:1::2) 36.628 ms 36.614 ms 37.500 ms
 3 2605:6400:3:fed5::1 (2605:6400:3:fed5::1) 37.484 ms 38.024 ms 38.007 ms
 4 e0-25.core2.lux1.he.net (2001:470:1:594::1) 37.986 ms 40.286 ms 37.954 ms
 5 * * *
 6 ipv6.de-cix.fra.de.as15169.google.com (2001:7f8::3b41:0:1) 44.329 ms ipv6.de-cix.fra.de.as15169.google.com (2001:7f8::3b41:0:2)
 30.793 ms 30.961 ms
 7 2001:4860:0:11e0::10 (2001:4860:0:11e0::10) 32.315 ms 2001:4860:0:11df::10 (2001:4860:0:11df::10) 45.995 ms 2001:4860:0:11e1::e
 (2001:4860:0:11e1::e) 55.305 ms
 8 2001:4860::c:4000:f873 (2001:4860::c:4000:f873) 66.546 ms 2001:4860::c:4002:365d (2001:4860::c:4002:365d) 66.517 ms 66.506 ms
 9 2001:4860::9:4002:1b54 (2001:4860::9:4002:1b54) 66.494 ms 65.107 ms 2001:4860::9:4002:1b53 (2001:4860::9:4002:1b53) 64.753 ms
10 2001:4860:0:1::dad (2001:4860:0:1::dad) 66.449 ms 2001:4860:0:1::4a6b (2001:4860:0:1::4a6b) 66.402 ms 2001:4860:0:1::dad
 (2001:4860:0:1::dad) 66.381 ms
11 2001:4860:0:1::dad (2001:4860:0:1::dad) 66.254 ms sof02s42-in-x0e.1e100.net (2a00:1450:4017:803::200e) 64.628 ms 58.868 ms
```



# Ipv6 firewall

- common sense:
  - allow related/established
  - allow icmpv6/rate limit?
  - put prefixes to allowed list
  - drop invalid packets
- good starting point:  
[https://wiki.mikrotik.com/wiki/Manual:Securing\\_Your\\_Router#IPv6](https://wiki.mikrotik.com/wiki/Manual:Securing_Your_Router#IPv6)



# My future plans

- migrate to x86
- migrate to OpnSense
- migrate to Wireguard
- get second isp
- utilize multihoming



# Conclusion

- great learning experience
- among “chosen few” - country asn list
- dual stack





# Takeaways

- ipv4 will remain
- ipv6 is the new cool
- you can do it
- native ipv6 works too



# Useful resources

- discord: <https://discord.gg/ipv6>
- upstreams: bgp.services
- bgp:
  - bgp.tools
- <https://academy.ripe.net/>

**Thank you! Any questions?**

