



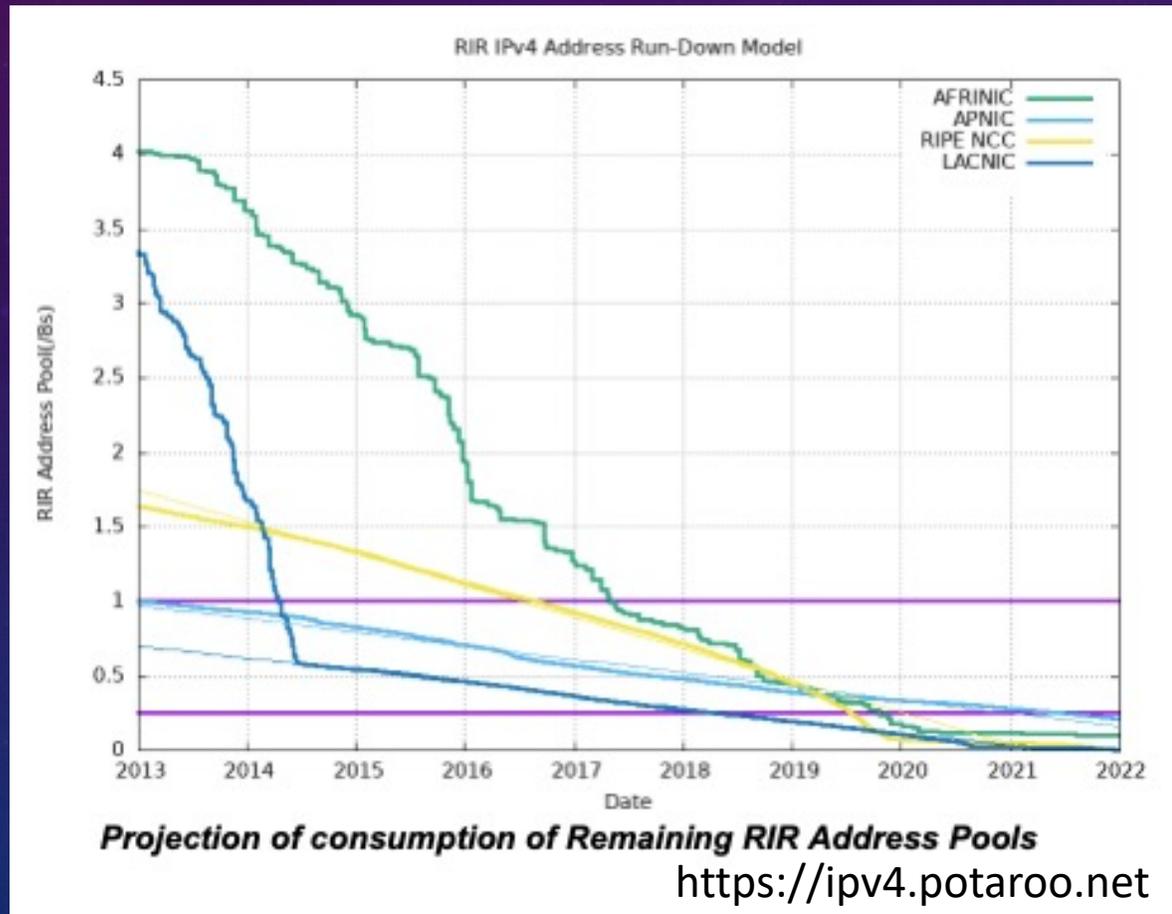
IPV6 AND LINUX

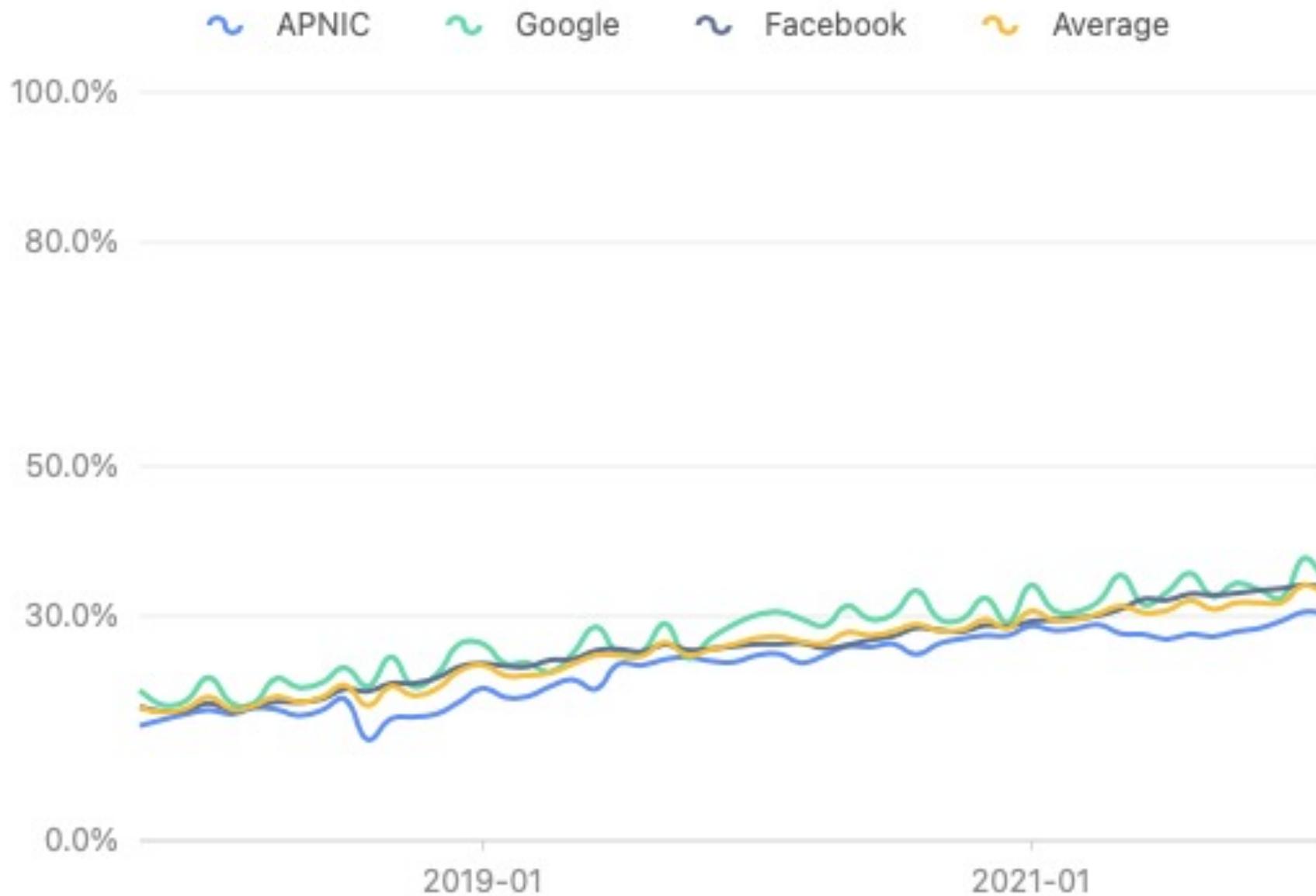
ANDREW DENNER

CENTRAL IOWA LINUX USERS GROUP



WE ARE OUT OF IP V4 ADDRESSES





Global IPv6 deployment (data sources: APNIC, Facebook and Google)

<https://pulse.internetsociety.org/technologies>

A LITTLE BIT ABOUT IPV6

The principles you learned about ipv4 are still the same

For the foreseeable future we will have to deal with both

128 bit address space, 340 undecillion unique addresses

3001:0da8:75a3:0000:0000:8a2e:0370:7334
Aka 3001:0da8:75a3::8a2e:0370:7334

TYPES OF
IPV6
ADDRESSES

Unicast

Multicast

Anycast

ADVANTAGES



Reliability



Faster Speed-Multicast
vs Broadcast



Stronger Security
IPSec



Routing Efficiency



The Future

WHAT IS DIFFERENT

- Larger Address space
- Multicasting
- Stateless address autoconfiguration (Privacy addresses see RFC4941)
- Can also get additional attributes via DHCPv6 or manually
- Neighbor Discovery protocol (think like ARP) *
- IPSec (recommended)
- Easier processing by routers (simpler header)
 - But CPU based processing
 - No checksum
 - No ip fragmentation (must do MTU discovery or no larger than 1280 octets packet size)

WHAT IS DIFFERENT (CONT)

Mobility (no triangle routing)

Extension headers

Flexibility for the future *

Jumbograms

ipv4 is limited to $2^{16}-1$ octets where
ipv6 can be as large as $2^{32}-1$ octets.

DISADVANTAGES



CONVERSION



COMMUNICATION FROM IPV4
TO IPV6 (SEE NEXT SLIDE)

TRANSITION PATH

Dual stack

Public Facing ipv6

Tunneling (6to4, teredo, 6rd)

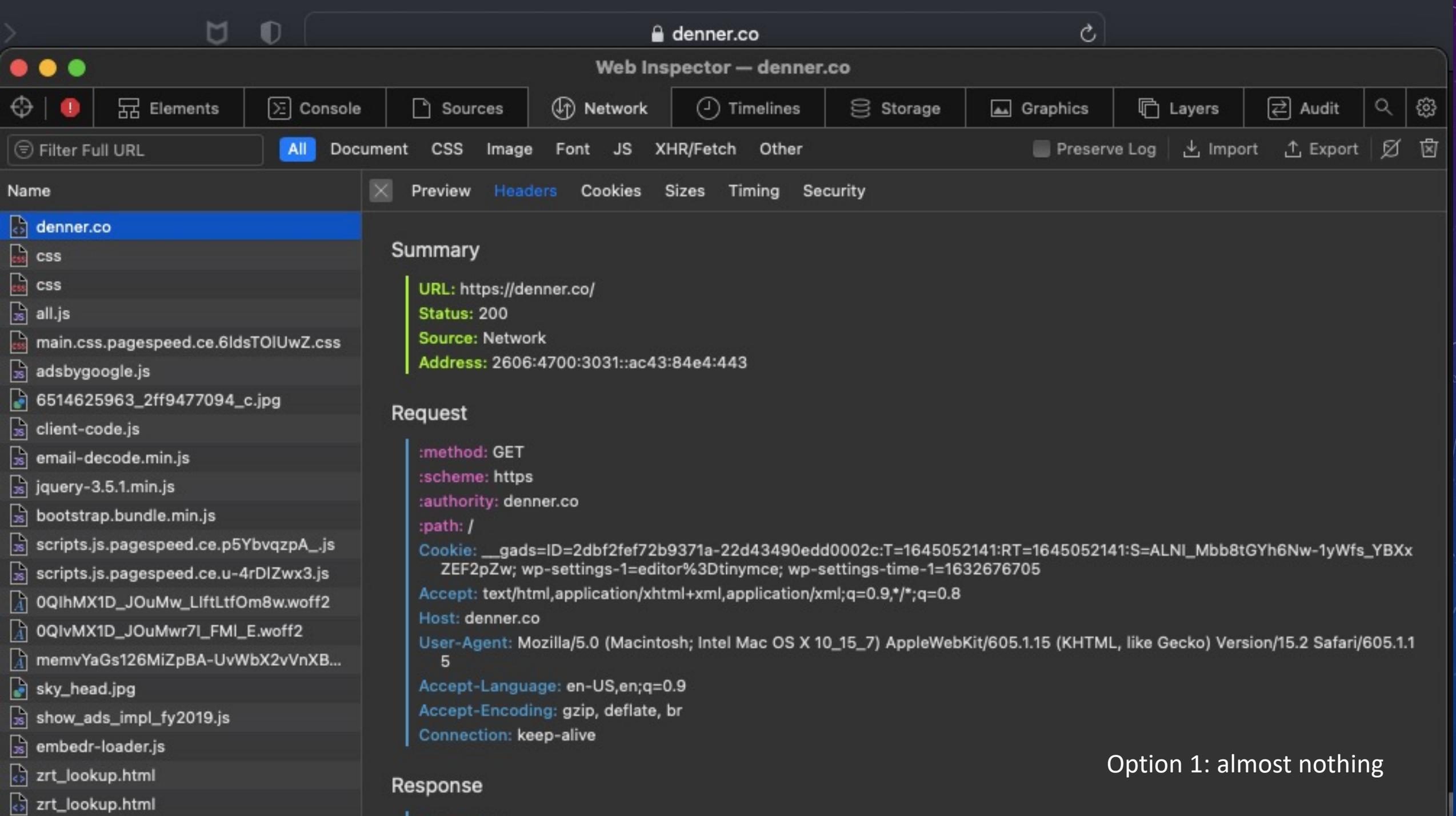
IPv4 mapped ipv6 (sometimes seen as `::fff:192.168.0.1`) can also see NAT64
`64:ff9b::/96` address space

NEIGHBOR DISCOVERY PROTOCOL

- Operates on the link layer
- Icmpv6 packet types
 - Router Solicitation
 - Router Advertisement
 - Neighbor Solicitation
 - Neighbor Advertisement
 - Redirect
- Functionality:
 - Router discovery
 - Prefix discovery
 - Parameter discovery (mtu)
 - Address autoconfigure
 - Address resolution
 - Next hop determination
 - Neighbor unreachability
 - Duplicate address detection
 - Recursive DNS server
 - Packet redirection



SO WHAT DO I NEED TO DO?



Option 1: almost nothing



ip6.google.com



Google



Google Search

I'm Feeling Lucky



Calling all young artists: Submit your artwork for [Doodle for Google](#) today

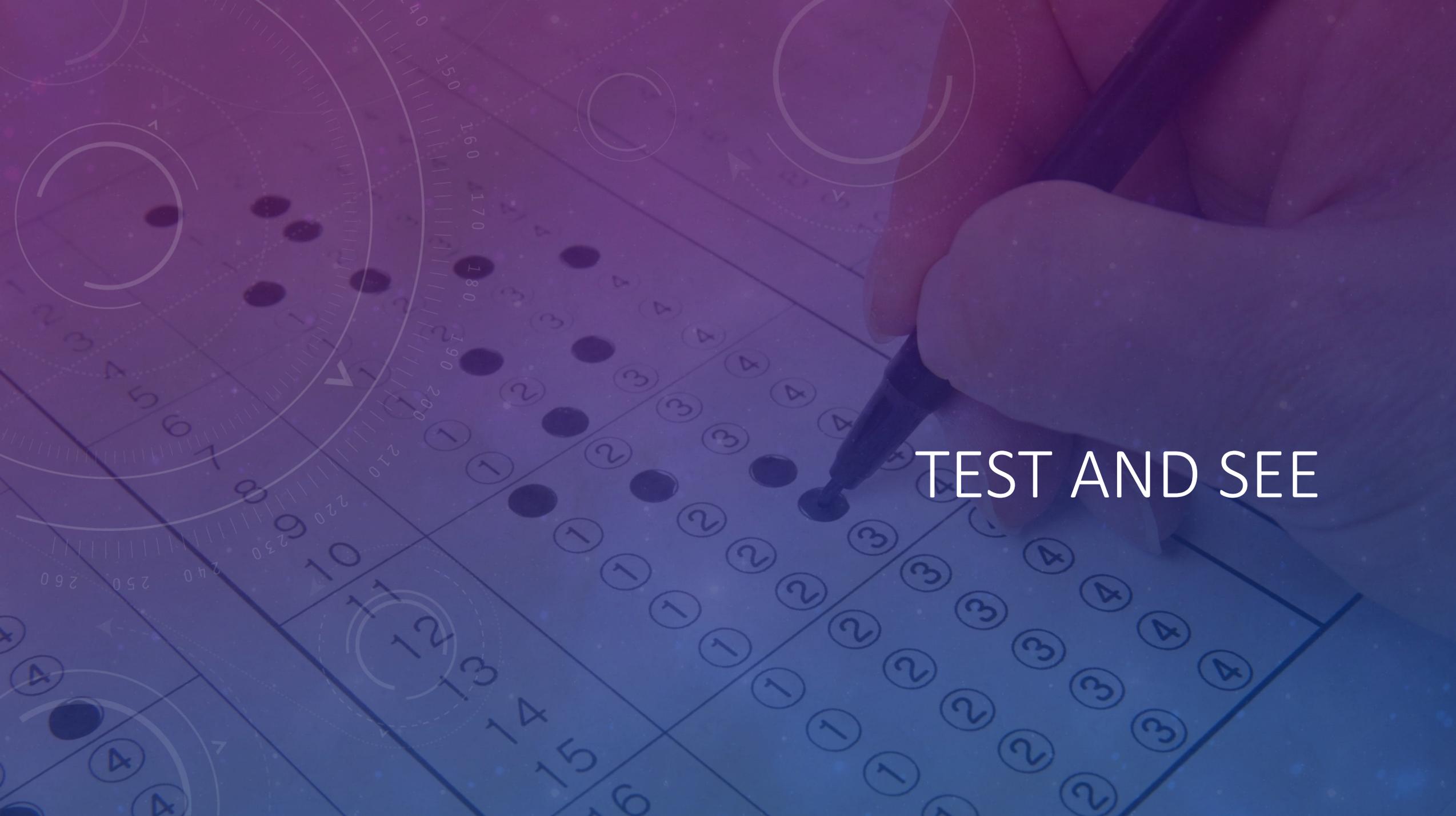
Option 2 Seek it out

BE

THE

CHANGE

Provide ipv6 services if you can



TEST AND SEE



IPv6-test.com is a free service that checks your IPv6 and IPv4 connectivity and speed. Diagnose connection problems, discover which address(es) you are currently using to browse the Internet, and what is your browser's protocol of choice when both v6 and v4 are available.

IPv4 connectivity

IPv4	Supported
Address	50.80.2.57
Hostname	50-80-2-57.client.mchsi.com
ISP	Mediacom Communications Corp

IPv6 connectivity

IPv6	Supported
Address	2604:2d80:4e81:ba00:2076:9690:f50c:57ff
Type	Native IPv6
SLAAC	No
ICMP	Filtered
Hostname	SERVFAIL
ISP	Mediacom Communications Corp

Score

15 / 20

How can you improve your score ?

1. Reconfigure your firewall
2. Fix your DNS configuration
3. Use IPv6 as your default

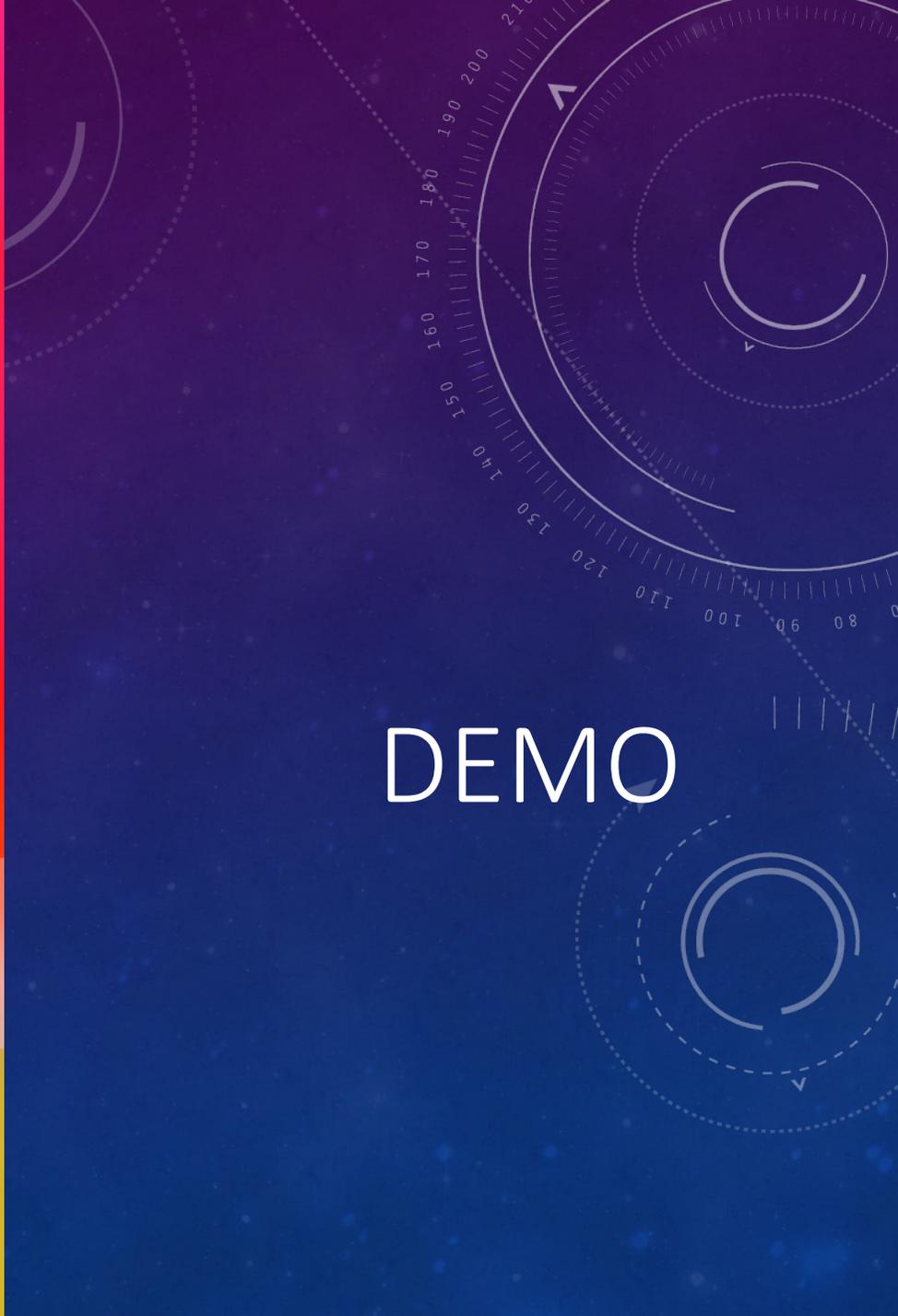
Your router or firewall is filtering ICMPv6 messages sent to your computer. An IPv6 host that cannot receive ICMP messages may encounter problems like some web pages loading partially or not at all.

Browser

Default	IPv4
Fallback	to IPv6 in 1 second

DNS

DNS4 + IP6	Reachable
DNS6 + IP4	Reachable
DNS6 + IP6	Reachable



DEMO

```
MacBook-Air:~ adenner$ ifconfig
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
    options=1203<RXCSUM, TXCSUM, TXSTATUS, SW_TIMESTAMP>
    inet 127.0.0.1 netmask 0xff000000
    inet6 ::1 prefixlen 128
    inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
    nd6 options=201<PERFORMNUD,DAD>
gif0: flags=8010<POINTOPOINT,MULTICAST> mtu 1280
stf0: flags=0<> mtu 1280
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 98:e0:d9:7d:3f:b1
    inet6 fe80::896:8662:f70f:dd42%en0 prefixlen 64 secured scopeid 0x4
    inet 10.0.0.213 netmask 0xfffff000 broadcast 10.0.0.255
    inet6 2604:2d80:4e81:ba00:18b1:69b1:859f:df96 prefixlen 64 autoconf secured
    inet6 2604:2d80:4e81:ba00:2076:9690:f50c:57ff prefixlen 64 autoconf temporary
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect
    status: active
en1: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TSO4,TSO6,CHANNEL_IO>
    ether 82:18:03:ee:ca:80
    media: autoselect <full-duplex>
    status: inactive
bridge0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=63<RXCSUM, TXCSUM, TSO4, TSO6>
    ether 82:18:03:ee:ca:80
    Configuration:
        id 0:0:0:0:0:0 priority 0 hellotime 0 fwddelay 0
        maxage 0 holdcnt 0 proto stp maxaddr 100 timeout 1200
        root id 0:0:0:0:0:0 priority 0 ifcost 0 port 0
        ipfilter disabled flags 0x0
    member: en1 flags=3<LEARNING,DISCOVER>
        ifmaxaddr 0 port 5 priority 0 path cost 0
    nd6 options=201<PERFORMNUD,DAD>
    media: <unknown type>
    status: inactive
p2p0: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 2304
    options=400<CHANNEL_IO>
    ether 0a:e0:d9:7d:3f:b1
    media: autoselect
    status: inactive
```

```
[MacBook-Air:~ adenner$ dig google.com
```

```
; <<>> DiG 9.10.6 <<>> google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 39504
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;google.com.                IN      A

;; ANSWER SECTION:
google.com.                300     IN      A      142.250.190.46

;; Query time: 47 msec
;; SERVER: 2604:2d80:4e81:ba00:3223:3ff:fecd:ca84#53(2604:2d80:4e81:ba00:3223:3ff:fecd:ca84)
;; WHEN: Wed Feb 16 15:46:41 CST 2022
;; MSG SIZE rcvd: 55
```

```
[MacBook-Air:~ adenner$ dig -4 google.com
```

```
; <<>> DiG 9.10.6 <<>> -4 google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 59309
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;google.com.                IN      A

;; ANSWER SECTION:
google.com.                288     IN      A      142.250.190.46

;; Query time: 20 msec
;; SERVER: 10.0.0.1#53(10.0.0.1)
;; WHEN: Wed Feb 16 15:46:52 CST 2022
;; MSG SIZE rcvd: 55
```

```
[MacBook-Air:~ adenner$ dig -6 denner.co
```

```
; <<>> DiG 9.10.6 <<>> -6 denner.co
```

```
;; global options: +cmd
```

```
;; Got answer:
```

```
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 13786
```

```
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1
```

```
;; OPT PSEUDOSECTION:
```

```
; EDNS: version: 0, flags:; udp: 4096
```

```
;; QUESTION SECTION:
```

```
;denner.co.                IN      A
```

```
;; ANSWER SECTION:
```

```
denner.co.                 300     IN      A      172.67.132.228
```

```
denner.co.                 300     IN      A      104.21.13.143
```

```
;; Query time: 43 msec
```

```
;; SERVER: 2604:2d80:4e81:ba00:3223:3ff:fece:ca84#53(2604:2d80:4e81:ba00:3223:3ff:fece:ca84)
```

```
;; WHEN: Wed Feb 16 15:52:35 CST 2022
```

```
;; MSG SIZE rcvd: 70
```

```
[MacBook-Air:~ adenner$ traceroute6 denner.co
traceroute6: Warning: denner.co has multiple addresses; using 2606:4700:3031::ac43:84e4
traceroute6 to denner.co (2606:4700:3031::ac43:84e4) from 2604:2d80:4e81:ba00:2076:9690:f50c:57ff, 64 hops max, 12 byte packets
^C
[MacBook-Air:~ adenner$ traceroute6 www.iastate.edu
traceroute6: nodename nor servname provided, or not known
[MacBook-Air:~ adenner$ traceroute6 iastate.edu
traceroute6 to iastate.edu (2610:130:108:480::81ba:5a54) from 2604:2d80:4e81:ba00:2076:9690:f50c:57ff, 64 hops max, 12 byte packets
 1 2604:2d80:4e81:ba00:3223:3ff:fecd:ca84 4.128 ms 3.655 ms 4.236 ms
 2 2604:2d80:4011::1 10.726 ms 12.059 ms 13.933 ms
 3 2607:fdc8:2000:2::13 12.409 ms 11.886 ms 13.649 ms
 4 2607:fdc8:2000:22::4b 15.022 ms 11.495 ms 12.957 ms
 5 2607:fdc8:2000:22::11 15.087 ms 16.275 ms 13.847 ms
 6 2607:fdc8:d:1::207 10.403 ms 12.347 ms 15.799 ms
 7 2607:fdc8:d:1::165 26.820 ms 22.179 ms 23.264 ms
 8 2607:fdc8:7::b 17.973 ms 28.827 ms 18.828 ms
 9 rtr-border-bsb.net.uiowa.edu 22.584 ms 22.847 ms 22.921 ms
10 uiowa-isu-100g.uiowa.edu 22.608 ms 30.736 ms 28.625 ms
11 rtr-e63be-be154.tele.iastate.edu 25.594 ms
   rtr-b31be-be156.tele.iastate.edu 32.472 ms 25.711 ms
12 m22dc1-vlan254.tele.iastate.edu 28.703 ms
   b06dc1-vlan254.tele.iastate.edu 25.301 ms 29.145 ms
13 redirect.its.iastate.edu 23.544 ms 26.498 ms 24.449 ms
MacBook-Air:~ adenner$ █
```