

IPv6 Technical Introduction



Rayed Alrashed
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IPv6 Address: Overview

- IPv4 address:
 - 32 Bits (4 Bytes)
 - Presented as 4 decimal numbers separated by a dot
 - 192.168.1.240
- IPv6 address:
 - 128 Bits (16 Bytes)
 - Presented as:
 - 8 Groups separated by colons (:)
 - Each group represent 4 Hexadecimal digits (i.e. 16 bits)
- IPv6 = IPv4 × 4 ?!!!
 - IPv4 addresses = $2^{32} = 4.294967296 \times 10^9$
 - IPv6 addresses = $2^{128} = 3.40282367 \times 10^{38}$

2001:0db8:85a3:0000:0000:8a2e:0370:7334

IPv6 Address: Simplified

- Remove leading zeros:

2001:0db8:85a3:0000:0000:8a2e:0370:7334

2001:0db8:85a3:0000:0000:8a2e:0370:7334

2001:db8:85a3:0:0:8a2e:370:7334

- 2+ consecutive groups of 0 replaced with two consecutive colons (::)

2001:db8:85a3:0:0:8a2e:370:7334

2001:db8:85a3::8a2e:370:7334

IPv6 Address: Examples

- Loopback:
0000:0000:0000:0000:0000:0000:0000:0001
0:0:0:0:0:0:0:1
::1
- Unspecified address
0000:0000:0000:0000:0000:0000:0000:0000
0:0:0:0:0:0:0:0
::
- rayed.com
2001:0470:1f08:1160:0000:0000:0000:0002
2001:470:1f08:1160:0:0:0:2
2001:470:1f08:1160::2

IPv6 Address: Scope

- Every IPv6 address has a scope
- Link-Local
 - Used for directly attached network (link)
 - Not routable
 - Connect to IPs on same link (LAN)
 - e.g.
 - Loopback (::1)
 - Link-Local addresses (start with fe80)
- Global
 - Global/Universal address
 - Routable
 - Connect to any global scope address anywhere (almost)

IPv6 Address: ifconfig

```
$ ifconfig -a
```

```
lo          Link encap:Local Loopback
            inet addr:127.0.0.1  Mask:255.0.0.0
            inet6 addr:  ::1/128 Scope:Host

eth0       Link encap:Ethernet  HWaddr 00:1e:0b:d6:7b:b8
            inet addr:88.85.245.43  Bcast:88.85.245.47  Mask:255.255.255.248
            inet6 addr: fe80::21e:bff:fed6:7bb8/64 Scope:Link

he-ipv6    Link encap:IPv6-in-IPv4
            inet6 addr: 2001:470:1f08:1160::2/64 Scope:Global
            inet6 addr: fe80::5855:f52b/64 Scope:Link
```

IPv6 Ping: Loopback Address

- Loopback = localhost = same machine
- Command:
 - ping6 ::1
- Must enable IPv6, most OS enabled by default
- IPv4 version:
 - ping 127.0.0.1

IPv6 Ping: Link Local Address

- Link Local Address = Machine in the same “Link” = Same LAN
- Each interface has an IPv6 Link Local address:
 - fe80:: + MAC address
- Command:
 - ping6 fe80::216:cbff:fe8a:1bb (**Will not work!**)
 - ping6 fe80::216:cbff:fe8a:1bb%en0
 - ping6 -I en0 fe80::216:cbff:fe8a:1bb
- IPv4:
 - Link Local is optional
 - Random address from the block: 169.254.0.0/16

IPv6 Ping: Global Address

- Global Address = Routable
- Unique Local Address (ULAs):
 - Private address space
 - fc00::/7
 - IPv4: 10.0.0.0/8 or 172.16.0.0/12 or 192.168.0.0/16
 - Not routed through public Internet
- Global Unicast
 - Routed through the public Internet
- Command:
 - ping6 2001:470:1f08:1160::2

IPv6 and DNS: Overview

- DNS = Domain Name System
- Map: hostname \Leftrightarrow IP
- IPv4:
 - rayed.com \Rightarrow 88.85.245.43
 - IPv4 address stored in “A” record
- IPv6:
 - rayed.com \Rightarrow 2001:470:1f08:1160::2
 - IPv6 stored in “AAAA” record (Quad-A)

IPv6 and DNS: Using “dig”

- IPv4:

```
$ dig rayed.com // OR
$ dig rayed.com A
;; ANSWER SECTION:
rayed.com. 3600 IN A 88.85.245.43
```

- IPv6:

```
$ dig rayed.com AAAA
;; ANSWER SECTION:
rayed.com. 3600 IN AAAA 2001:470:1f08:1160::2
```

IPv6 and DNS: Using “nslookup”

- IPv4:

```
$ nslookup rayed.com // OR  
$ nslookup -type=a rayed.com  
Name: rayed.com  
Address: 88.85.245.43
```

- IPv6:

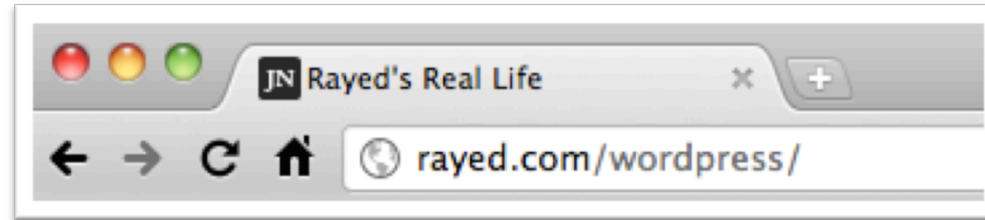
```
$ nslookup -type=aaaa rayed.com  
rayed.com has AAAA address 2001:470:1f08:1160::2
```

IPv6 and DNS: Reverse lookup

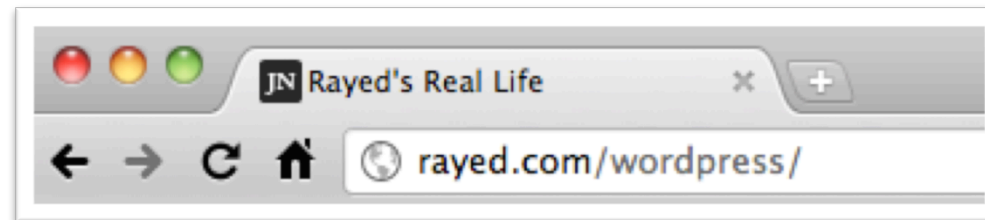
- IPv4:
 - rayed.com => 88.85.245.43
 - 88.85.245.43 => rayed.com
 - `$ dig 43.245.85.88.in-addr.arpa`
- IPv6:
 - rayed.com => 2001:470:1f08:1160::2
 - 2001:470:1f08:1160::2 => rayed.com
 - `$ dig`
`2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.6.1.1.8.0.f.`
`1.0.7.4.0.1.0.0.2.ipv6.arpa`

IPv6 and the Web

- IPv6



- IPv4



- It is the same!

IPv6 and the Web

- Web Server Dual Stack (IPv4 + IPv6)
- <http://rayed.com/>
 - A record (88.85.245.43)
 - AAAA record (2001:470:1f08:1160::2)
- <http://ipv6.rayed.com/>
 - Only AAAA record (2001:470:1f08:1160::2)
- <http://test.rayed.com/>
 - Only A record (88.85.245.43)

IPv6 and the Web

- What about IP address in URL?
- IPv4:
 - `http://88.85.245.43/`
- IPv6:
 - `http://2001:470:1f08:1160::2/` **WRONG**
 - `http://2001:470:1f08:1160::2:88/` (88 port or part of the address)
 - `http://[2001:470:1f08:1160::2]/` **CORRECT**
 - `http://[2001:470:1f08:1160::2]:88/` **CORRECT**

Thank You

