SHARKFEST '13

Wireshark Developer and User Conference

IPv6 Address Planning

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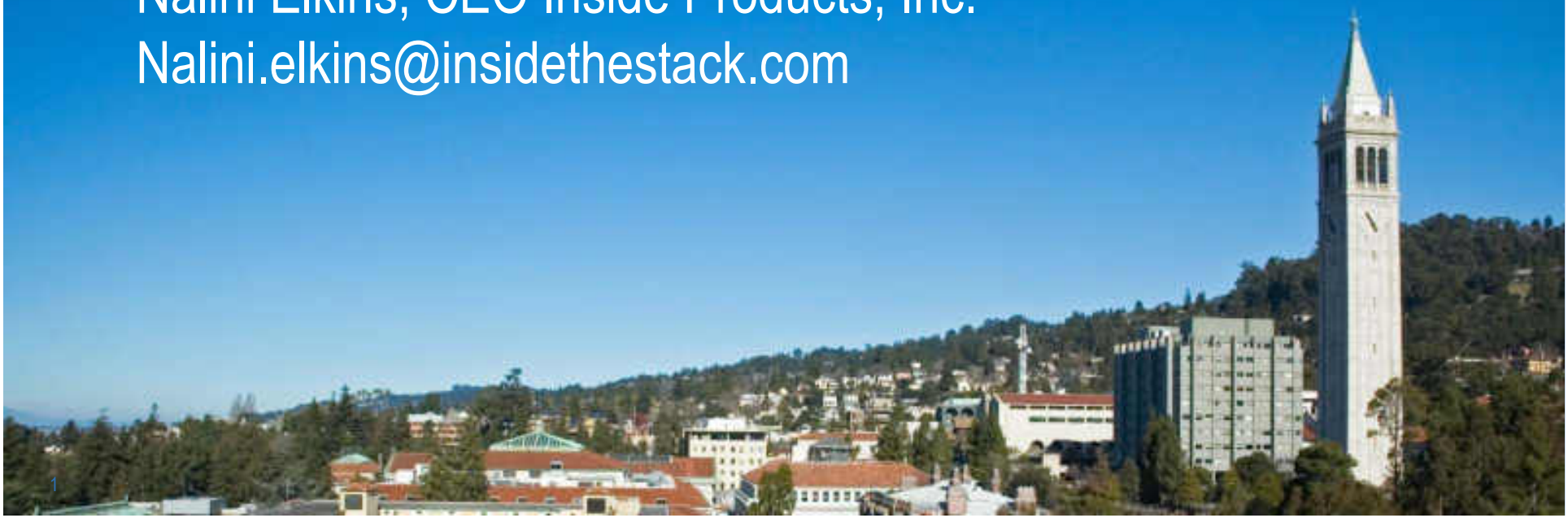


Agenda

- IPv4 address planning (review)
- IPv6 address planning guidelines
- How to do a simple addressing plan
- Security issues
- Migration strategies

IPv4 Address Planning

- How did we do this in IPv4?
- We got an address assignment from ARIN.
- In 1993, IETF introduced classless interdomain routing (CIDR) (RFC 1517). CIDR allowed the following:
  - More efficient use of IPv4 address space
  - Prefix aggregation (reduce size of routing tables)
- Network portion of the address determined by network subnet mask (***network prefix)*** /8, /19, etc.
- VLSM for subnets

Common Masks

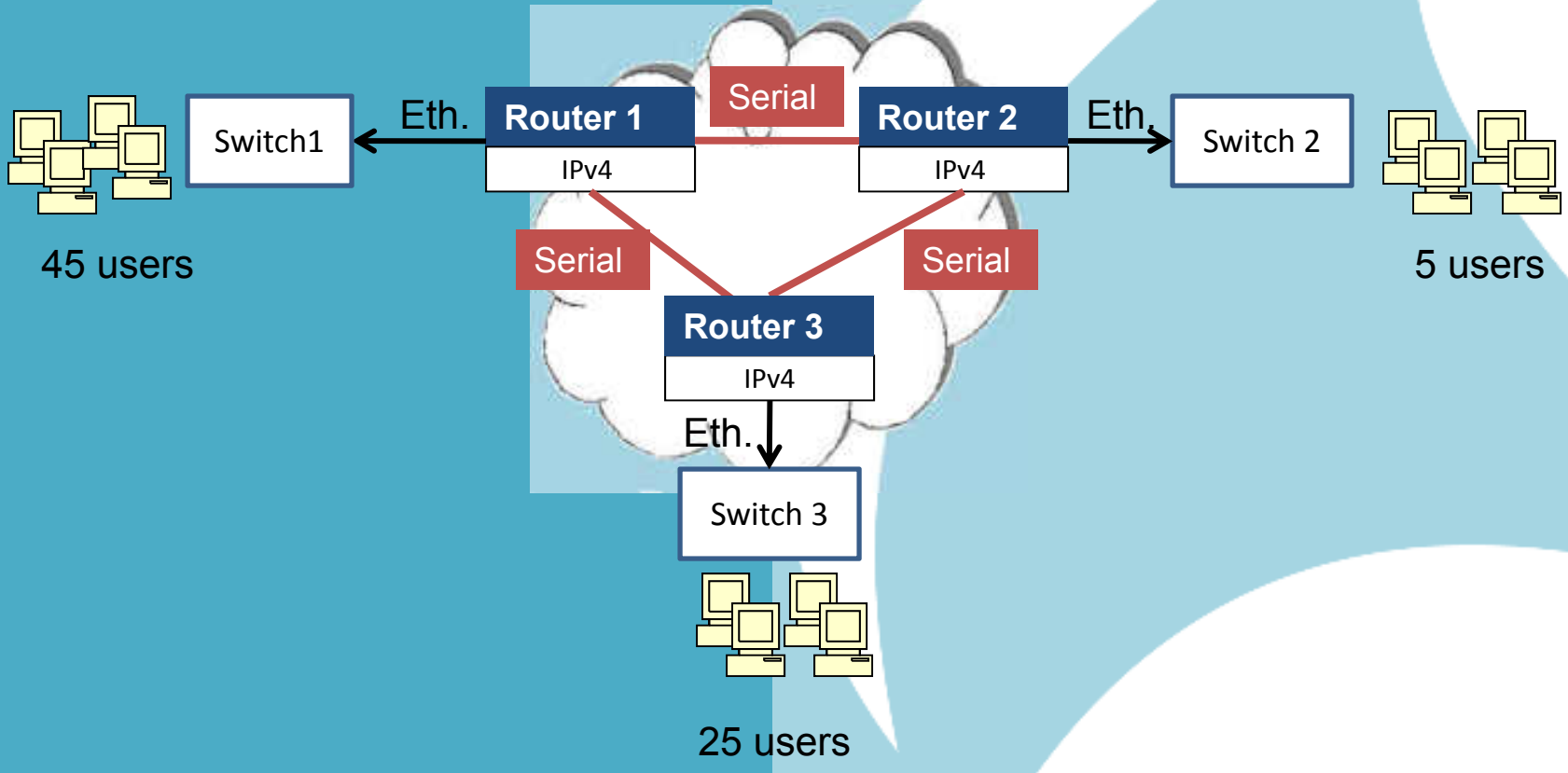
```
/30 (255.255.255.252) 4 hosts
/24 (255.255.255.0) 256 hosts
/16 (255.255.0.0) 65,536 hosts
/8  (255.0.0.0) 16,777,216 hosts
```

11111111.00000000.00000000.00000000	/8	(255.0.0.0)	16,777,216 host addresses
11111111.10000000.00000000.00000000	/9	(255.128.0.0)	8,388,608 host addresses
11111111.11000000.00000000.00000000	/10	(255.192.0.0)	4,194,304 host addresses
11111111.11100000.00000000.00000000	/11	(255.224.0.0)	2,097,152 host addresses
11111111.11110000.00000000.00000000	/12	(255.240.0.0)	1,048,576 host addresses
11111111.11111000.00000000.00000000	/13	(255.248.0.0)	524,288 host addresses
11111111.11111100.00000000.00000000	/14	(255.252.0.0)	262,144 host addresses
11111111.11111110.00000000.00000000	/15	(255.254.0.0)	131,072 host addresses
11111111.11111111.00000000.00000000	/16	(255.255.0.0)	65,536 host addresses
11111111.11111111.10000000.00000000	/17	(255.255.128.0)	32,768 host addresses
11111111.11111111.11000000.00000000	/18	(255.255.192.0)	16,384 host addresses
11111111.11111111.11100000.00000000	/19	(255.255.224.0)	8,192 host addresses
11111111.11111111.11110000.00000000	/20	(255.255.240.0)	4,096 host addresses
11111111.11111111.11111000.00000000	/21	(255.255.248.0)	2,048 host addresses
11111111.11111111.11111100.00000000	/22	(255.255.252.0)	1,024 host addresses
11111111.11111111.11111110.00000000	/23	(255.255.254.0)	512 host addresses
11111111.11111111.11111111.00000000	/24	(255.255.255.0)	256 host addresses
11111111.11111111.11111111.10000000	/25	(255.255.255.128)	128 host addresses
11111111.11111111.11111111.11000000	/26	(255.255.255.192)	64 host addresses
11111111.11111111.11111111.11100000	/27	(255.255.255.224)	32 host addresses
11111111.11111111.11111111.11110000	/28	(255.255.255.240)	16 host addresses
11111111.11111111.11111111.11111000	/29	(255.255.255.248)	8 host addresses
11111111.11111111.11111111.11111100	/30	(255.255.255.252)	4 host addresses
11111111.11111111.11111111.11111110	/31	(255.255.255.254)	2 host addresses
11111111.11111111.11111111.11111111	/32	(255.255.255.255)	“Host Route”

IPv4 Allocation

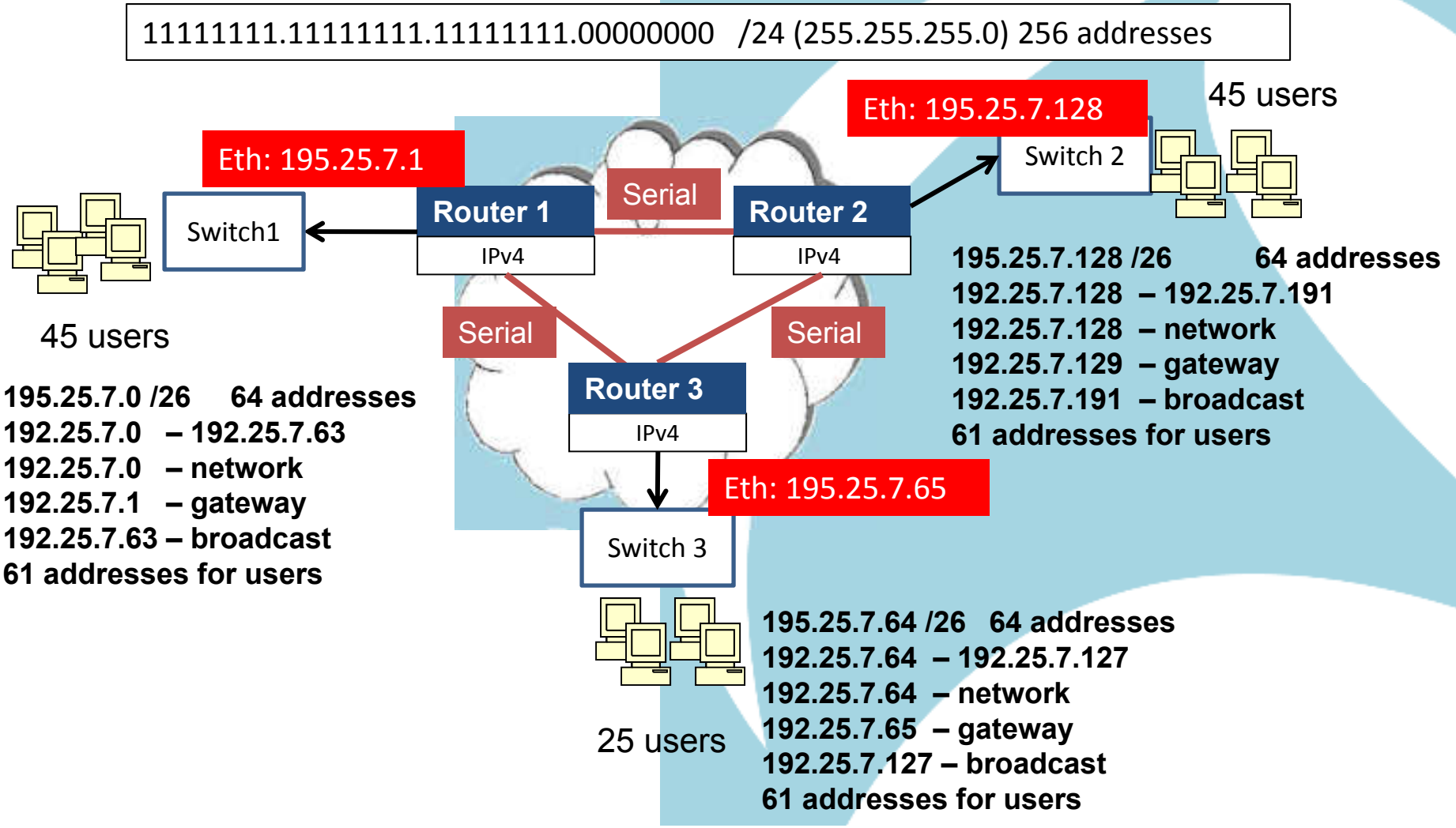
IP Space available: 195.25.7.0 /24

11111111.11111111.11111111.00000000 /24 (255.255.255.0) 256 addresses



Let's Assign Some Addresses

IP Space available: 195.25.7.0 /24



195.25.7.0 /26 64 addresses
192.25.7.0 – 192.25.7.63
192.25.7.0 – network
192.25.7.1 – gateway
192.25.7.63 – broadcast
61 addresses for users

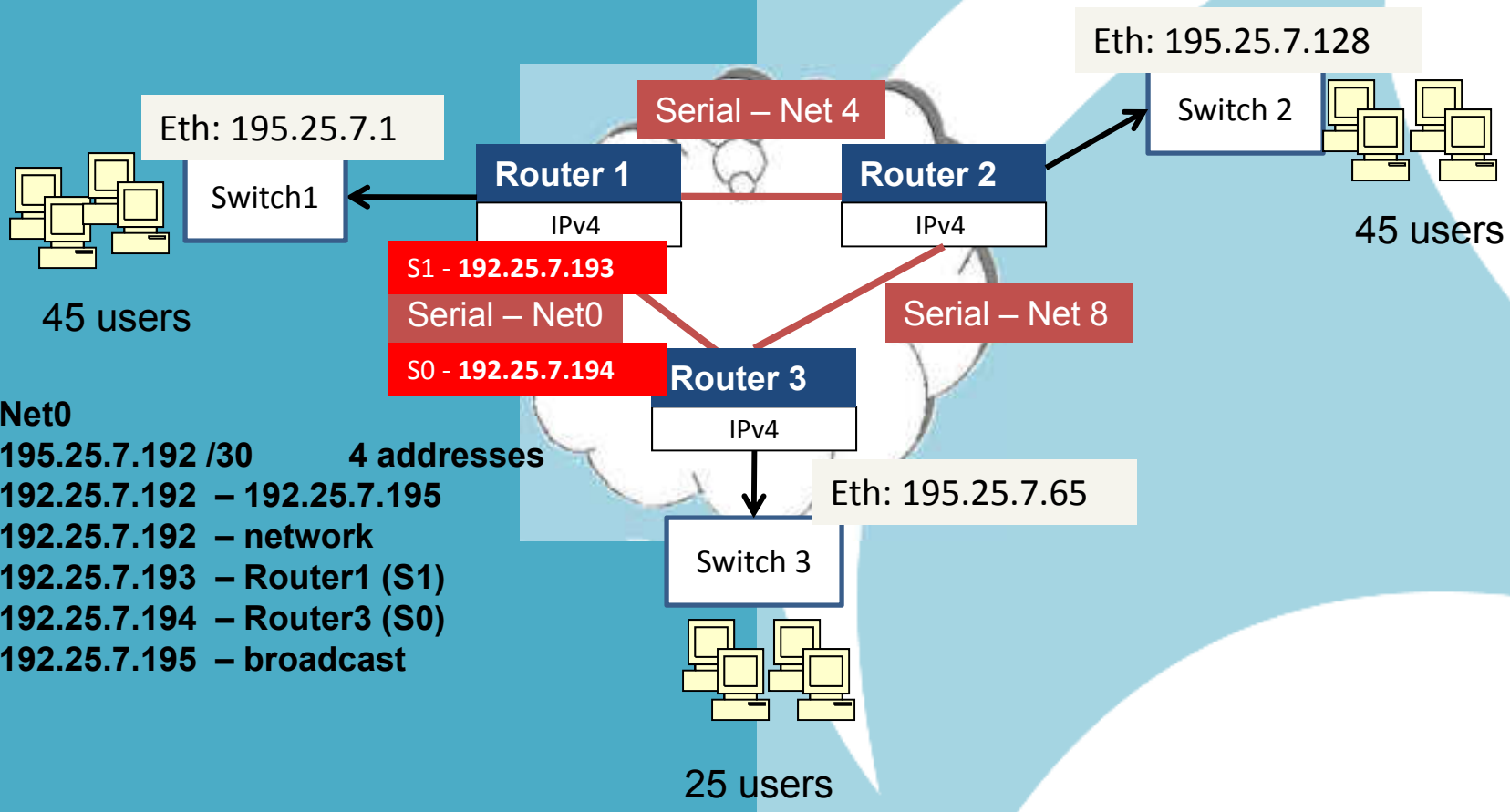
195.25.7.128 /26 64 addresses
192.25.7.128 – 192.25.7.191
192.25.7.128 – network
192.25.7.129 – gateway
192.25.7.191 – broadcast
61 addresses for users

195.25.7.64 /26 64 addresses
192.25.7.64 – 192.25.7.127
192.25.7.64 – network
192.25.7.65 – gateway
192.25.7.127 – broadcast
61 addresses for users

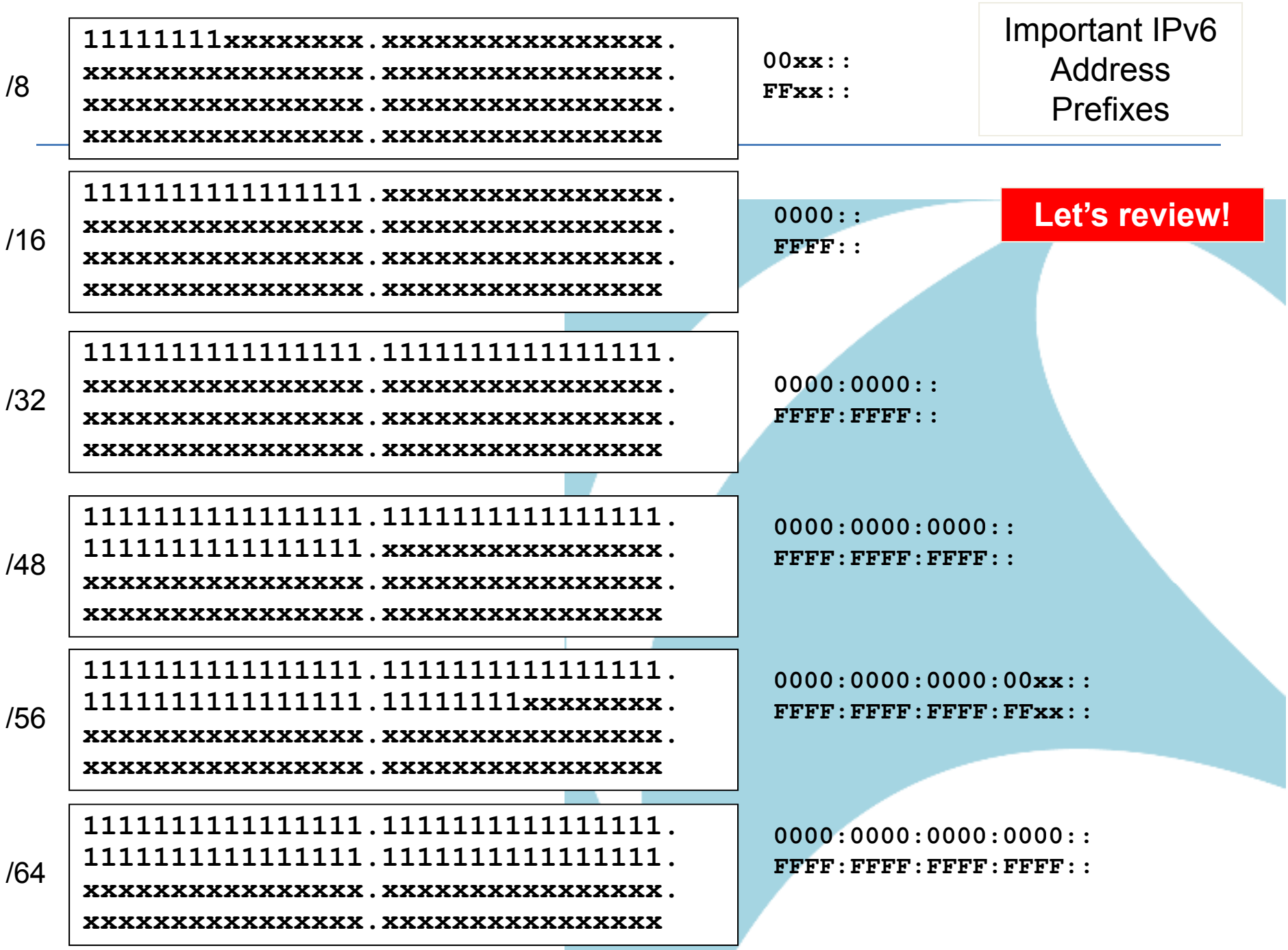
Let's Do the Serial Links

IP Space available: 195.25.7.0 /24

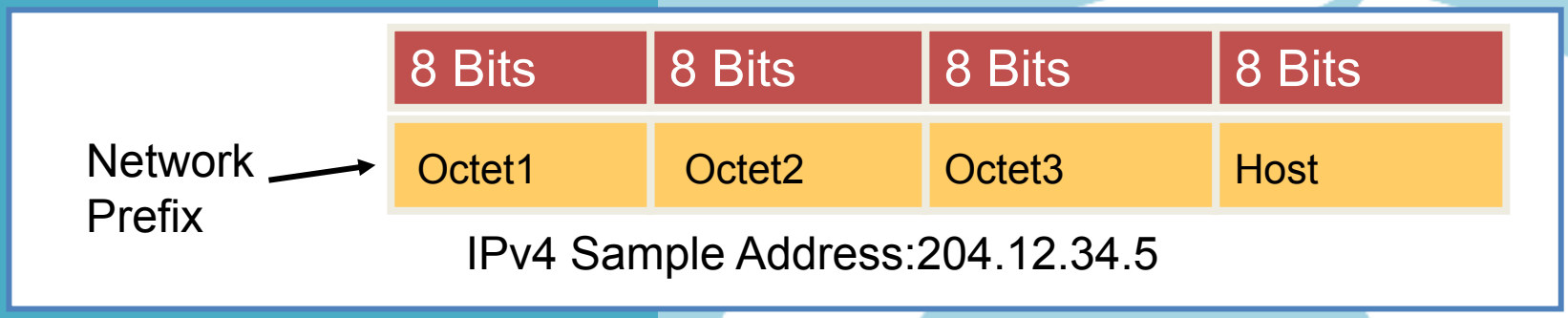
11111111.11111111.11111111.00000000 /24 (255.255.255.0) 256 addresses

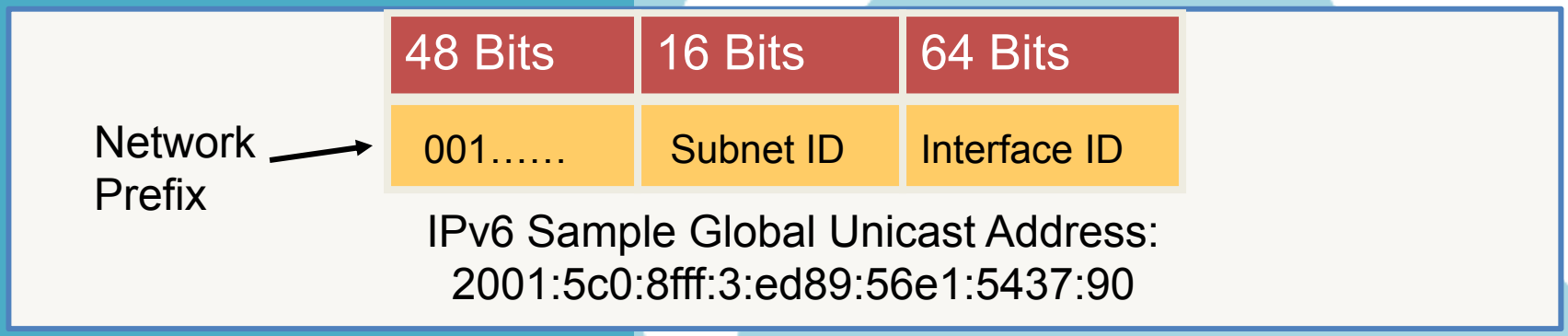


Net0
195.25.7.192 /30 4 addresses
192.25.7.192 – 192.25.7.195
192.25.7.192 – network
192.25.7.193 – Router1 (S1)
192.25.7.194 – Router3 (S0)
192.25.7.195 – broadcast

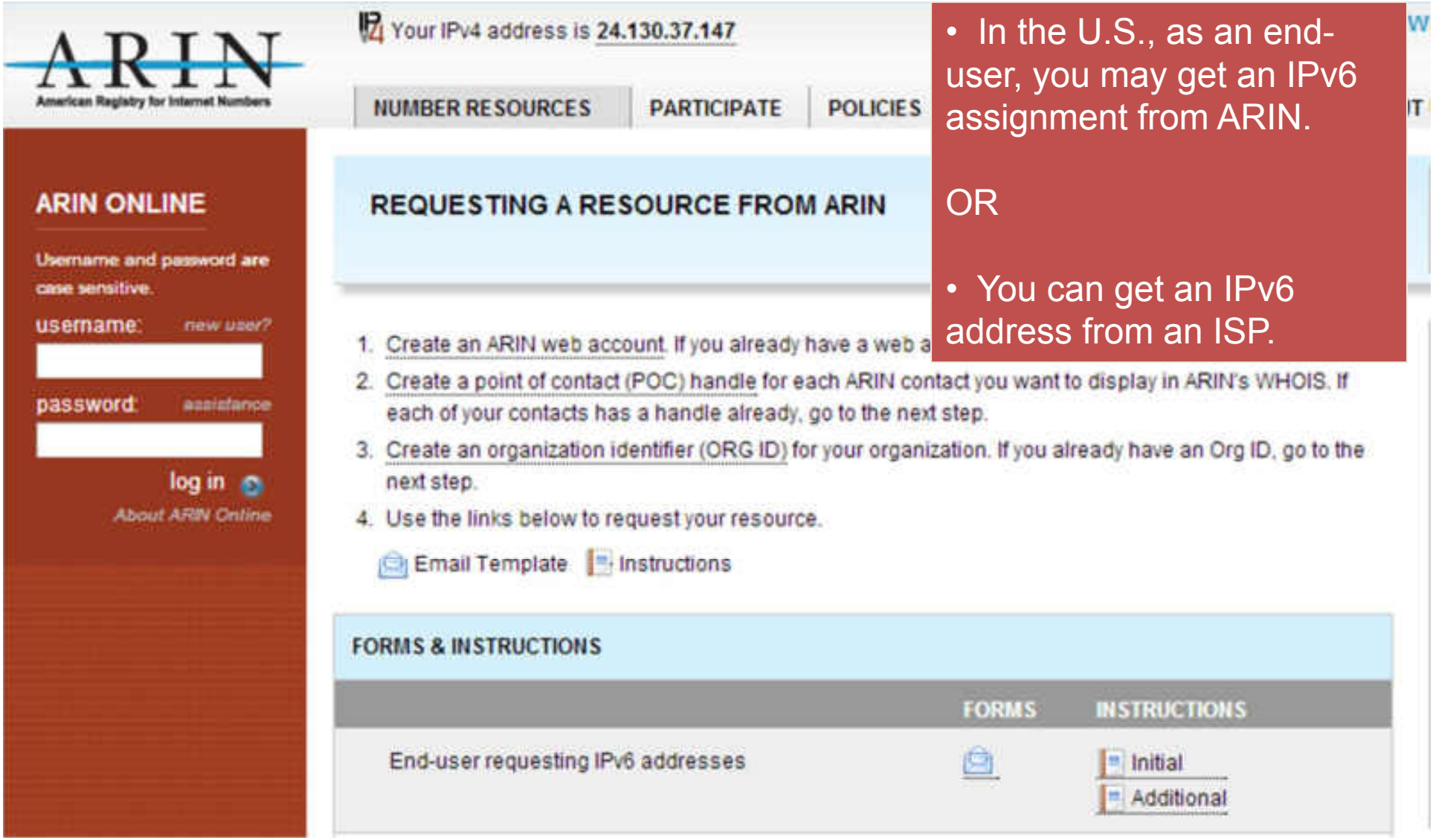

Important IPv6 Address Prefixes
Let's review!
/8
11111111xxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
00xx::
FFxx::
/16
1111111111111111.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
0000::
FFFF::
/32
1111111111111111.1111111111111111.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
0000:0000::
FFFF:FFFF::
/48
1111111111111111.1111111111111111.
1111111111111111.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
0000:0000:0000::
FFFF:FFFF:FFFF::
/56
1111111111111111.1111111111111111.
1111111111111111.11111111xxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
0000:0000:0000:00xx::
FFFF:FFFF:FFFF:FFxx::
/64
1111111111111111.1111111111111111.
1111111111111111.1111111111111111.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
0000:0000:0000:0000::
FFFF:FFFF:FFFF:FFFF::

What Is An Address Range?





Where Do You Get An IPv6 Range?



- In the U.S., as an end-user, you may get an IPv6 assignment from ARIN.

OR

- You can get an IPv6 address from an ISP.

IPv6 Assignments

Prefix	Who	Date
2001:0000::/23	IANA	01 Jul 99
2001:0200::/23	APNIC	01 Jul 99
2001:0400::/23	ARIN	01 Jul 99
2001:0600::/23	RIPE NCC	01 Jul 99
2001:0800::/23	RIPE NCC	01 May 02
2001:0A00::/23	RIPE NCC	02 Nov 02
2001:0C00::/23	APNIC	01 May 02
2001:0E00::/23	APNIC	01 Jan 03
2001:1200::/23	LACNIC	01 Nov 02
2001:1400::/23	RIPE NCC	01 Feb 03
2001:1600::/23	RIPE NCC	01 Jul 03
2001:1800::/23	ARIN	01 Apr 03
2001:1A00::/23	RIPE NCC	01 Jan 04
2001:1C00::/22	RIPE NCC	01 May 04
2001:2000::/20	RIPE NCC	01 May 04
2001:3000::/21	RIPE NCC	01 May 04
2001:3800::/22	RIPE NCC	01 May 04
2001:3C00::/22	RESERVED	11 Jun 04
2001:4000::/23	RIPE NCC	11 Jun 04
2001:4200::/23	AfriNIC	01 Jun 04
2001:4400::/23	APNIC	11 Jun 04
2001:4600::/23	RIPE NCC	17 Aug 04

Prefix	Who	Date
2001:4800::/23	ARIN	24 Aug 04
2001:4A00::/23	RIPE NCC	15 Oct 04
2001:4C00::/23	RIPE NCC	17 Dec 04
2001:5000::/20	RIPE NCC	10 Sep 04
2001:8000::/19	APNIC	30 Nov 04
2001:A000::/20	APNIC	30 Nov 04
2001:B000::/20	APNIC	08 Mar 06
2002:0000::/16	6to4	01 Feb 01
2003:0000::/18	RIPE NCC	12 Jan 05
2400:0000::/12	APNIC	03 Oct 06
2600:0000::/12	ARIN	03 Oct 06
2610:0000::/23	ARIN	17 Nov 05
2620:0000::/23	ARIN	12 Sep 06
2800:0000::/12	LACNIC	03 Oct 06
2A00:0000::/12	RIPE NCC	03 Oct 06
2C00:0000::/12	AfriNIC	03 Oct 06
2D00:0000::/8	IANA	01 Jul 99
2E00:0000::/7	IANA	01 Jul 99
3000:0000::/4	IANA	01 Jul 99
3ffe::/16	IANA	01 Apr 08
5f00::/8	IANA	01 Apr 08

What Do You Get?

- Normal site assignment: /48
  - 2**16 or 65,536 subnets
  - 2**64 hosts per subnet

/48

```
1111111111111111.1111111111111111.
1111111111111111.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
```

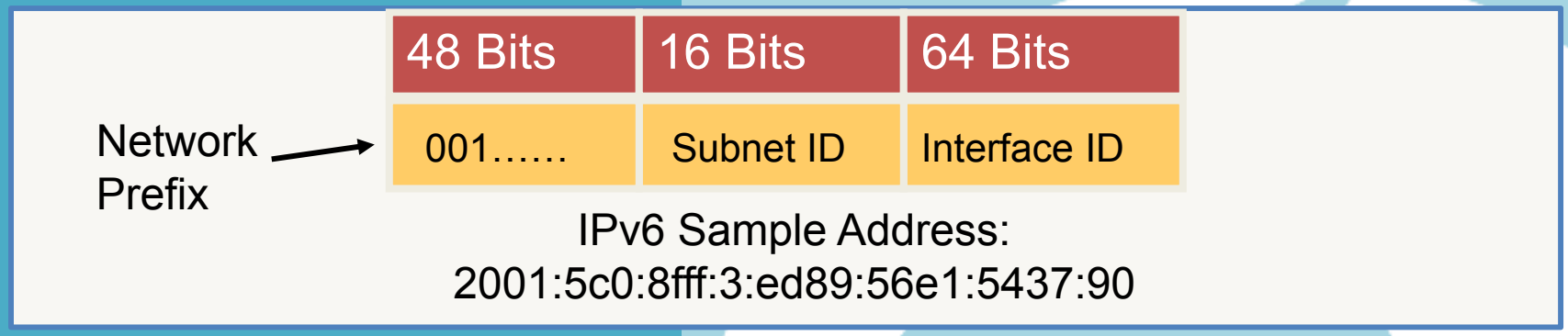
```
0000:0000:0000::
FFFF:FFFF:FFFF::
```

- From ARIN, may get:

  2620:1234:5678::/48

- Remember, ARIN has IPv6 address block: 2620:0000::/23

Is This Enough?



- Network Prefix from ARIN (48 bits)
- Subnet : 16 bits (65,535)
- Host : 64 bits (2^64)

International Electrotechnical Commission (IEC) Units of measurement.

kibibyte (KiB) - 2^10
mebibyte (MiB) - 2^20
gibibyte (GiB) - 2^30
tebibyte (TiB) - 2^40
pebibyte (PiB) - 2^50
exbibyte (EiB) - 2^60
zebibyte (ZiB) - 2^70
yobibyte (YiB) - 2^80

Exponential Growth (Powers of 2)

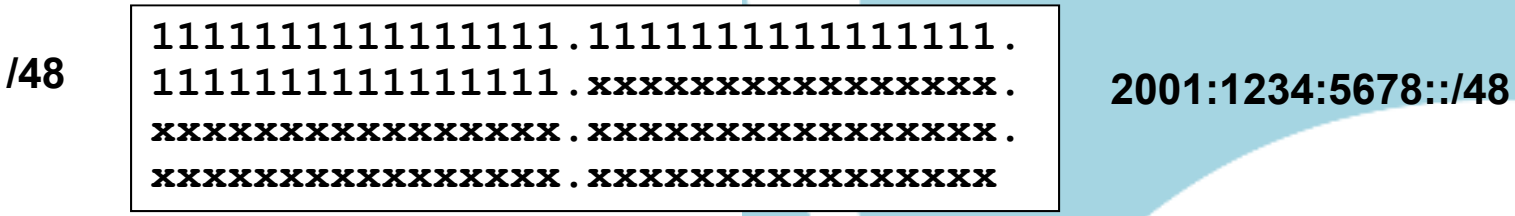
20	1048576	104.9 x 10**-3	quarter of the Sears tower (440m)
25	33554432	3.4 x 10**0	past the Matterhorn
30	1073741824	107.4 x 10**0	outer limits of the atmosphere
35	34359738368	3.4 x 10**3	
40	1099511627776	109.9 x 10**3	
45	35184372088832	3.5 x 10**6	
50	1125899906842624	112.5 x 10**6	~ distance to sun (95 million miles)
55	36028797018963968	3.6 x 10**9	
60	1152921504606846976	115.3 x 10**9	size of the solar system?
65	36893488147419103232	3.7 x 10**12	one-third of a light year
70	1180591620717411303424	118.1 x 10**12	11 light years
75	37778931862957161709568	3.8 x 10**15	377 light years
80	1208925819614629174706176	120.9 x 10**15	12,000 light years
85	38685626227668133590597632	3.9 x 10**18	4x the diameter of our galaxy
90	1237940039285380274899124224	123.8 x 10**18	12 million light years
95	39614081257132168796771975168	4.0 x 10**21	
100	1267650600228229401496703205376	126.8 x 10**21	(12 billion light years) approx. radius of the known universe?

What to Do Once You Have It

- Address planning
  - Break out your address range by ‘subnets’ or regions
  - Assign addresses to devices (servers, clients, routers, etc.)
- Changes
  - In IPv4, Variable Length Subnet Mask (VLSM) used.
  - No VLSM in IPv6
  - No network and broadcast addresses per subnet
  - Many more hosts per subnet
  - No NAT
- Best practices are still being defined
- Security must be considered

Simple IPv6 Address Plan

- Given: 2001:1234:5678::/48
- Nationwide company:
  - 50 regions,
  - 100 offices per region,
  - 100 departments per office
- Initial allocation:



Define Regions

- Make regions /56
- Range: 2001:1234:5678:**00**xx:: to 2001:1234:5678:**FF**xx::
- 256 possible regions
- Only need 50

/56

```
1111111111111111.1111111111111111.
1111111111111111.11111111xxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
```

- For example:
  - Alabama: 2001:1234:5678:**00**xx::/56
  - Alaska: 2001:1234:5678:**01**xx::/56
  - Arizona: 2001:1234:5678:**02**xx::/56
  - California: 2001:1234:5678:**03**xx::/56

Define Offices

- Make offices each /64
- The range is: 2001:1234:5678:nn**00**::/64 to 2001:1234:5678:nn**FF**::/64
- 256 offices per region
- Need only 100 per region

/64

```
1111111111111111.1111111111111111.
1111111111111111.1111111111111111.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
```

```
0000:0000:0000:0000::
FFFF:FFFF:FFFF:FFFF::
```

- For example, in California:
  - Oakland: 2001:1234:5678:03**01**::/64
  - Carmel Valley: 2001:1234:5678:03**02**::/64
  - Moraga: 2001:1234:5678:03**03**::/64
  - San Diego: 2001:1234:5678:03**04**::/64

Define Departments

- Make departments each /72
- Range: 2001:1234:5678:0000:**00**xx:: to 2001:1234:5678:FFFF:**FF**xx::
- 256 possible departments per office
- Need only 100

/72

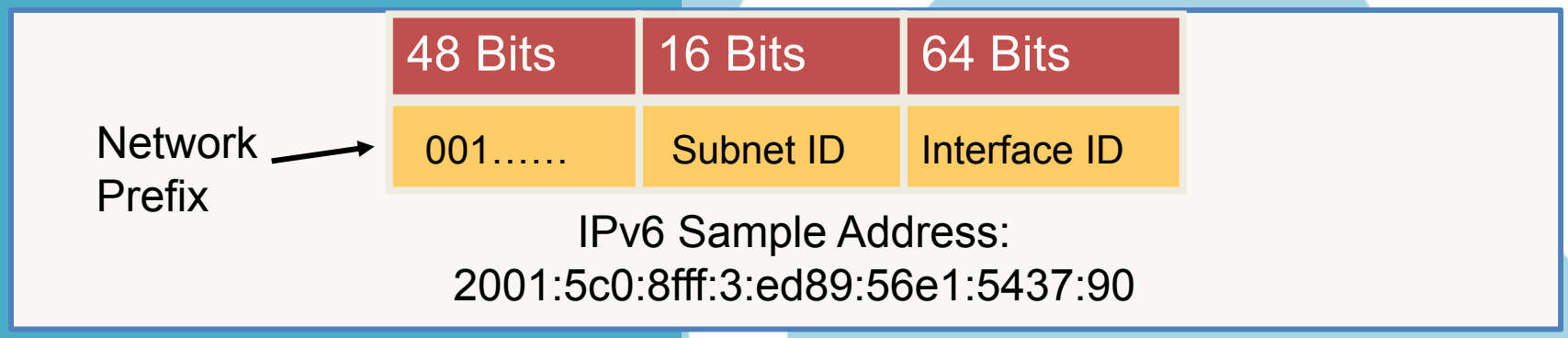
```
1111111111111111.1111111111111111.
1111111111111111.1111111111111111.
11111111xxxxxxxx.xxxxxxxxxxxxxxxx.
xxxxxxxxxxxxxxxx.xxxxxxxxxxxxxxxx
```

```
0000:0000:0000:0000:00xx::
FFFF:FFFF:FFFF:FFFF:FFxx::
```

- For example, the Carmel Valley office:
  - Payroll: 2001:1234:5678:0302:**00**xx::/72
  - Engineering: 2001:1234:5678:0302:**01**xx::/72
  - Shipping: 2001:1234:5678:0302:**02**xx::/72
  - Sales: 2001:1234:5678:0302:**03**xx::/72

But Wait! 64-bit Interface ID

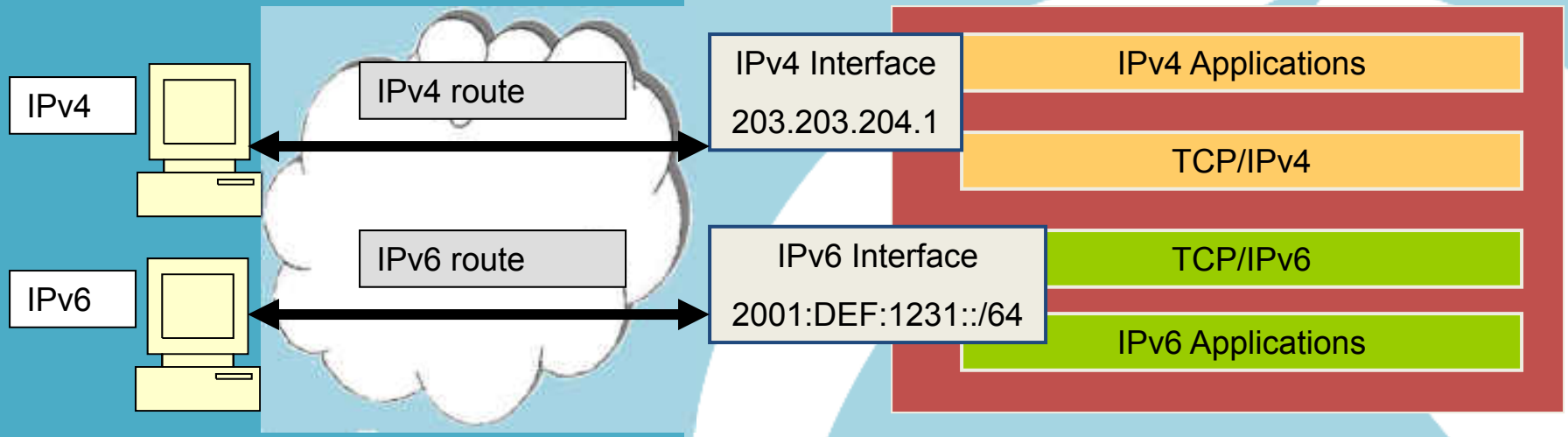
- Format of a Global Unicast Address!
- Save 64 bits for the Interface ID.



Let's Make Some Rules

1. Use /48 for a site.
2. Use /49 - /63 for subnets.
3. Leave /65 – /128 for IID.

Dual Stack Mode



- Need IPv4 and IPv6 addresses per device
- Dual stack = IPv4 and IPv6 TCP/IP stack
- Router or host = dual stack
- Both IPv4 and IPv6 packets

Embed VLAN ID

- VLAN ID **201**
- IPv4: 129.150.**201**.x
- IPv6: 2001:1234:5678:**201**::/64

Reuse IPv4 Host ID

- Host ID **123**
- IPv4: 129.150.201.**123**
- IPv6: 2001:1234:5678:201::**123**

Other Conventions

- Use first 48 bits of IPv6 host ID
- 2001:1234:5678:201:**xxxx**:**xxxx**:**xxxx**::
- Examples
  - DHCP assigned:
    2001:1234:5678:201:**xxxx**:**xxxx**:**Dxxx**::
  - IP Printers
    2001:1234:5678:201:**xxxx**:**xxxx**:**Bxxx**::

Other Ways to Assign

- Geographical Boundaries
- Organizational Boundaries
- Service Type
  - VoIP,
  - Wireless,
  - Internet Access,
  - Security zones

Breaking on Nibble Boundary

- Nibble is half of a byte. (A byte is 8 bits. So, a nibble is 4 bits)
- Take address:

2001:1234:5678:1201:DF89:783C:2590:67ED

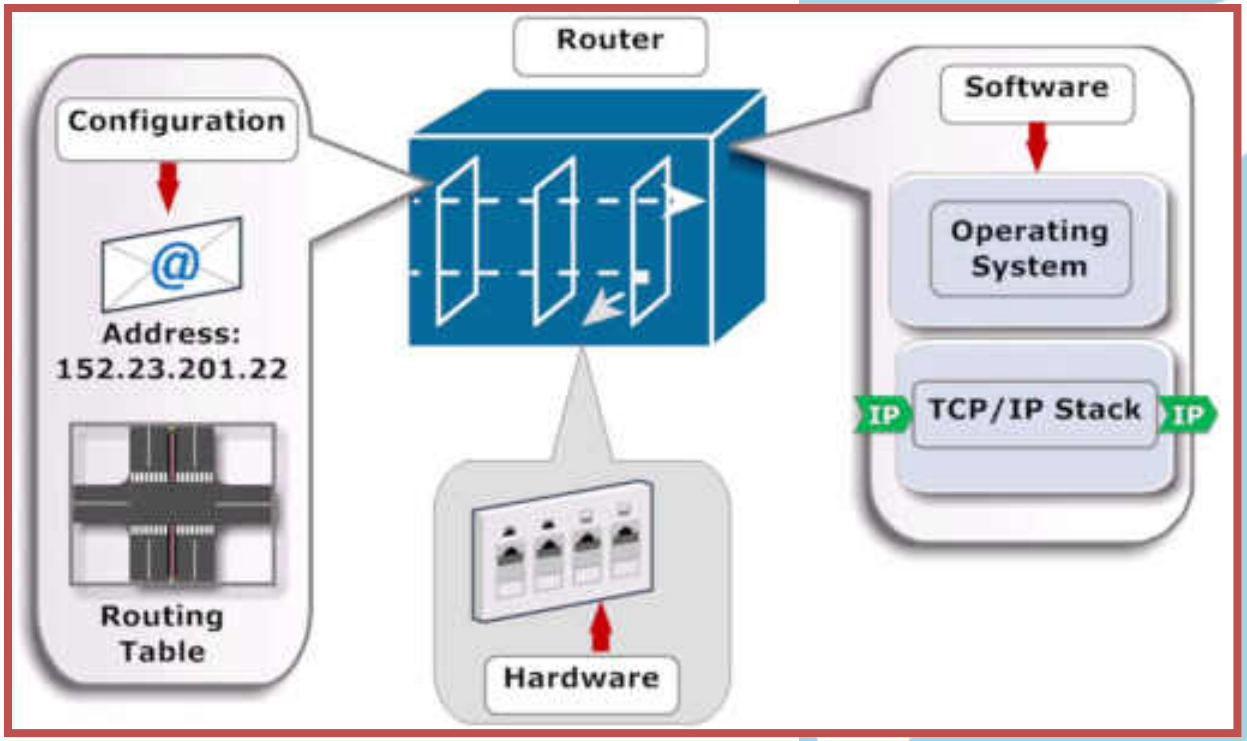
XXXX:XXXX:XXXX:XXXX:XXXX:XXXX:XXXX:XXXX

- X marks nibble boundary
- Break at bit 4, 8, 12, 16, etc. (All the multiples of 4)

New Rule

1. Use /48 for a site.
2. Use /49 - /63 for subnets.
3. Leave /65 – /128 for IID.
4. Break on nibble boundary.

Route Summarization



- IP – routes packets
- IPv6 routing table size
- Mirror geography

IPv6 Routes on Windows

Publish	Type	Met	Prefix	Idx	Gateway/Interface Name
Yes	Manual	9000	::/0	23	2620:9b::1900:1
No	Manual	256	::1/128	1	Loopback Pseudo 1
No	Manual	8	2001::/32	12	Teredo Tunneling
No	Manual	256	2620:9b::/96	23	Hamachi
No	Manual	256	2620:9b::1991:e216/128	23	Hamachi
No	Manual	256	fe80::/64	23	Hamachi
No	Manual	256	fe80::/64	12	Teredo Tunneling
No	Manual	256	ff00::/8	1	Loopback Pseudo
No	Manual	256	ff00::/8	12	Teredo Tunneling
No	Manual	256	ff00::/8	23	Hamachi

Route Table Growth

- Large routing table → poor performance
- IPv6 address prefixes are larger
- Poor planning can mean too many routes

Routing Issues on 6bone

Prefix aggregation problems / Alain Durand

Alain Durand spoke on route anomalies that he has observed in the running 6bone.

--Inconsistency in method of aggregation. Too many routes.

-- Backdoor routes...leads to looping, requires additional routes to suppress.

-- Unaggregated advertisements (might have been one-time blip)

-- “Weird" prefixes...typos, incorrect scope. Alain noted that site-local prefix could use a tighter definition. His conclusion...160 routes today, could easily be cut to 95 through better aggregation.

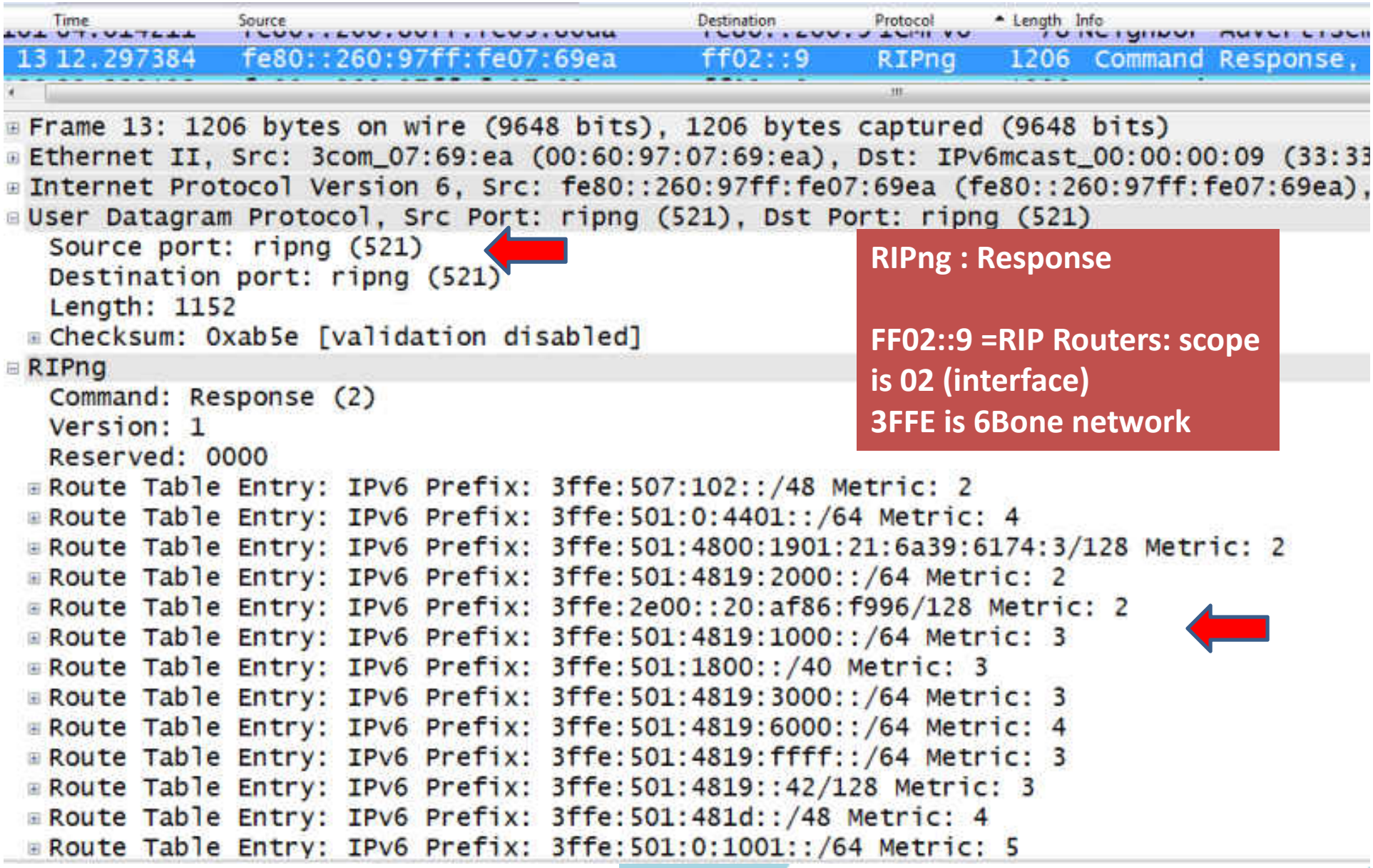
6bone Address Problems:

--No organized hierarchical addressing structure.

-- No correlation between DNS structure and addressing structure.

-- No correlation between 6Bbone topology and addressing structure.

RIPng Response



RIPng : Response

FF02::9 =RIP Routers: scope is 02 (interface)
3FFE is 6Bone network

Good Aggregation

Prefixes : **2001:1234:5678:9**xxx::/52
2001:1234:5678:Axxx::/52

Locations

- Chicago, IL : **2001:1234:5678:9**aaa::/64
- Bloomington, IL : **2001:1234:5678:9**bbb::/64
- Normal, IL : **2001:1234:5678:9**ccc::/64
- Fairbanks, AK : **2001:1234:5678:A**111::/64
- Anchorage, AK : **2001:1234:5678:A**333::/64

Routes : **2001:1234:5678:9**xxx::/52
2001:1234:5678:Axxx::/52

Bad Aggregation

Prefix : **2001:1234:5678:9**xxx::/52

2001:1234:5678:Axxx::/52

Locations

- Chicago, IL : **2001:1234:5678:9**aaa::/64
- New York, NY : **2001:1234:5678:A**bbb::/64
- San Jose, CA : **2001:1234:5678:9**ccc::/64
- Fairbanks, AK : **2001:1234:5678:9**111::/64
- Anchorage, AK : **2001:1234:5678:A**333::/64

Routes : **2001:1234:5678:9aaa**::/64, **2001:1234:5678:9111**::/64

2001:1234:5678:Abbb::/64, **2001:1234:5678:A333**::/64

2001:1234:5678:9ccc::/64

Address by Department

Prefix : **2001:1234:5678:9**xxx::

Locations

- **Payroll**: Chicago, IL: **2001:1234:5678:9**aaa::/64
- **Payroll**: New York, NY: **2001:1234:5678:9**bbb::/64
- **Payroll**: San Jose, CA: **2001:1234:5678:9**ccc::/64

Routes : 2001:1234:5678:9aaa::,
2001:1234:5678:9bbb::,
2001:1234:5678:9ccc::

Let's Add To Our Rules

1. Use /48 for a site.
2. Use /49 - /63 for subnets.
3. Leave /65 – /128 for IID.
4. Break on nibble boundary.
5. Aggregate routes.

Sparse Allocation

- Do this:
- Chicago, IL : 2001:1234:5678:9**aaa**::/64
- Bloomington, IL : 2001:1234:5678:9**bbb**::/64
- Normal, IL : 2001:1234:5678:9**ccc**::/64

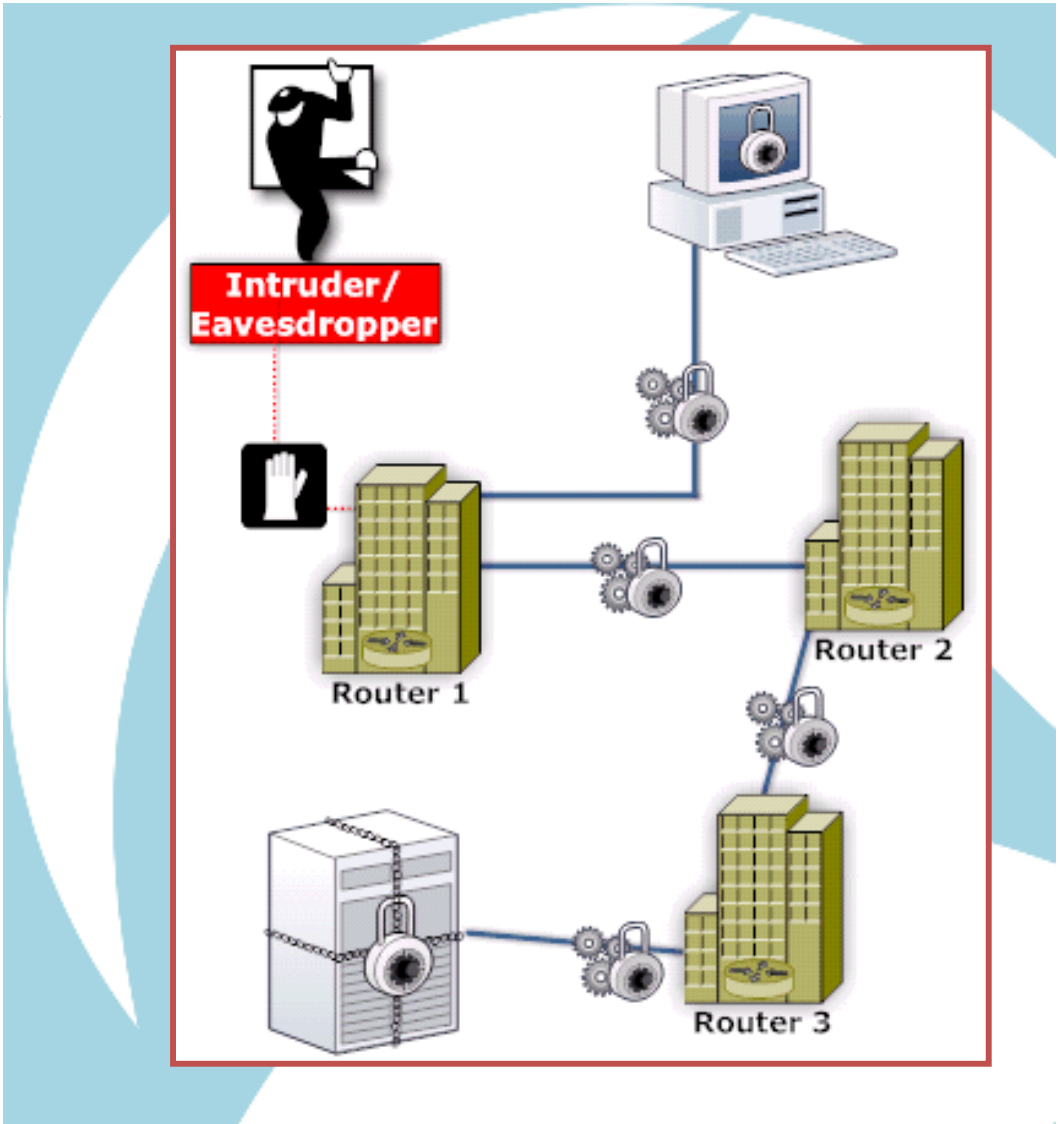
- NOT:
- Chicago, IL : 2001:1234:5678:9**aaa**::/64
- Bloomington, IL : 2001:1234:5678:9**aab**::/64
- Normal, IL : 2001:1234:5678:9**aac**::/64

One More Rule

1. Use /48 for a site.
2. Use /49 - /63 for subnets.
3. Leave /65 – /128 for IID.
4. Break on nibble boundary.
5. Aggregate routes.
6. Use sparse allocation.

Privacy / Security

- Divulge topology
- DoS attacks
- Privacy addressing
- Internet access



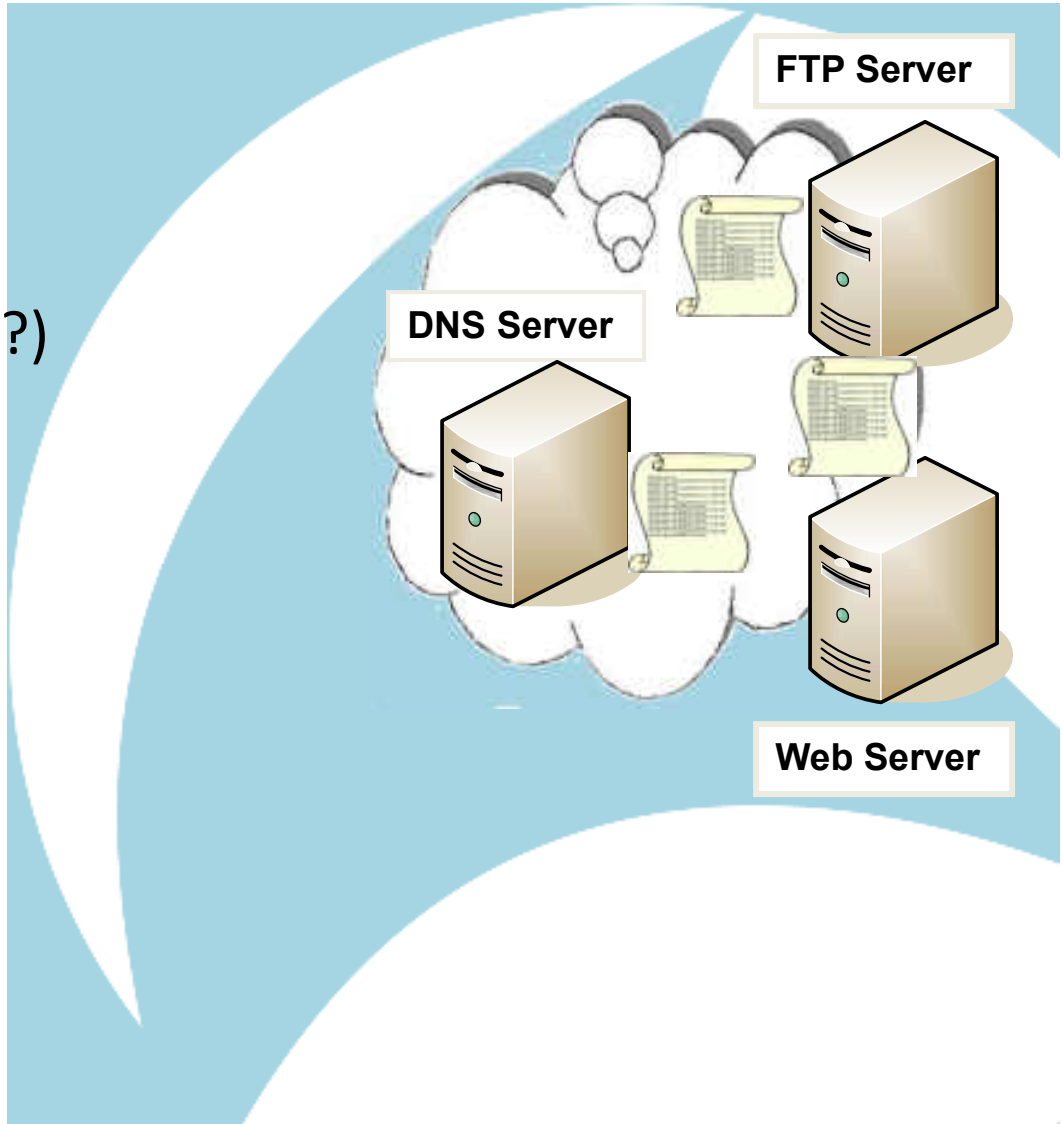
Divulge Topology

```
FTP Server 1: 2001:1234:5678:03df::
FTP Server 2: 2001:1234:5678:04df::
DNS Server 1: 2001:1234:5678:03aa::
DNS Server 2: 2001:1234:5678:04aa::
Web Server 1: 2001:1234:5678:0322::
Web Server 2: 2001:1234:5678:0422::
```

- Security vs. aggregation
- Allocate in a pattern?

Methods To Harvest Addresses

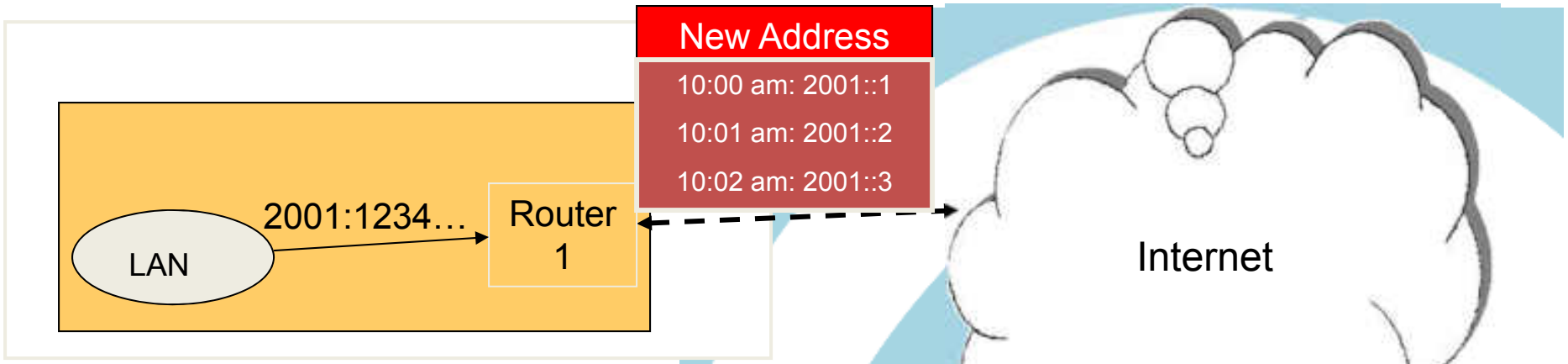
- Find new methods!
- No NAT (translation ~= NAT?)
- Web or FTP server logs.
- Email headers



Facebook Packet

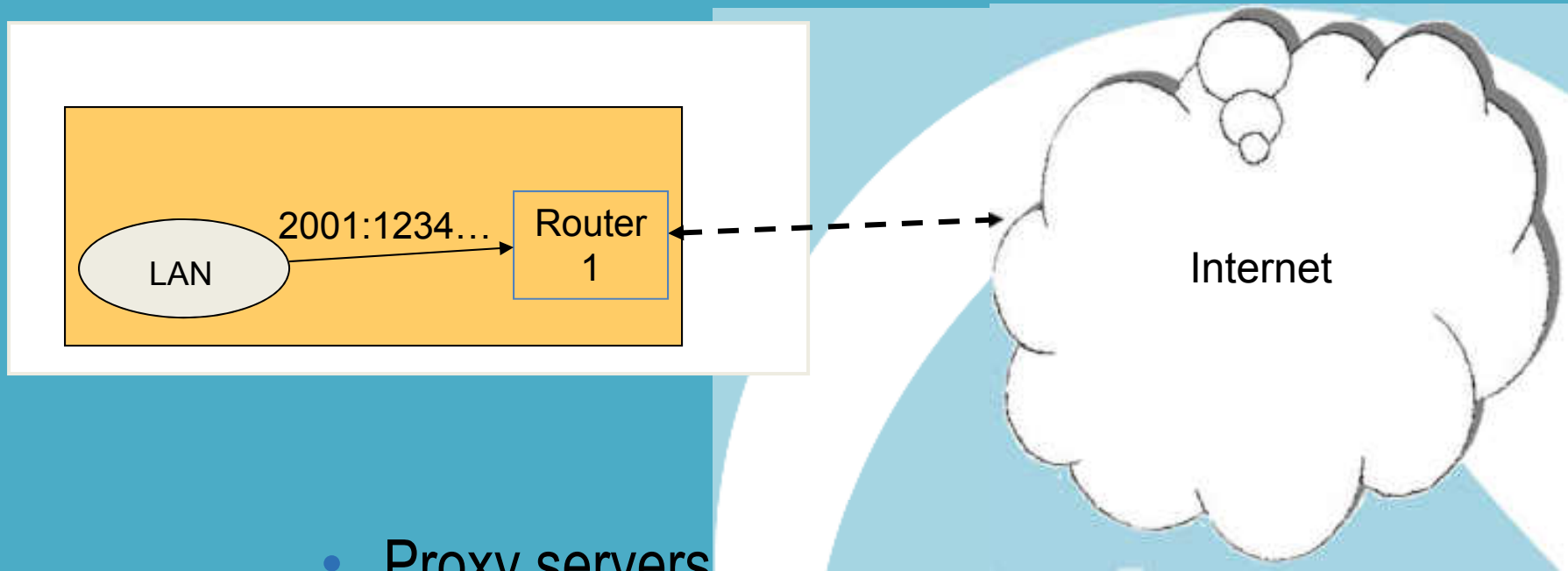
```
Domain Name System (Response)
        Transaction ID : 0x2c4b
        DNSflags: 0x8180(Standard Query)
        Q/R flag : 1
        Opcode : 0x0
        Authoritative Answer Flag : 0
        Truncation Flag : 0
        Recursion Desired Flag : 1
        Recursion Available Flag : 1
        Answer Authenticated Flag : 0
        Reply code : 0 (No Error)
Questions : 1
Answer RRS : 1
Authority RRS : 0
Additional RRS : 0
        Queries :
        Name : www.facebook.com
        Type : AAAA (IPv6 Address)
        Class : 0x1 IN
        -------------------------
        Answers :
        Name : www.facebook.com
        Type : AAAA (IPv6 Address)
        Class : 0x1 IN
        Time to live : 0 Hours 0 Minutes, 9 Seconds.
        Data Length : 16
        IPv6 Addr : 2620:0000:1c00:0000:face:b00c:0000:0002
        zCompressed IPv6 Address: 2620::1c00:0:face:b00c:0:2
        -------------------------
```

IPv6 Privacy Addresses



- RFC4941
- Anonymous addressing
- Change address frequently
- How to diagnose problems?
- Implementation differences

Internet Access



- Proxy servers
- Different network prefix

Another Rule

1. Use /48 for a site.
2. Use /49 - /63 for subnets.
3. Leave /65 – /128 for IID.
4. Break on nibble boundary.
5. Aggregate routes.
6. Use sparse allocation.
7. Remember security!

Subnet Router Anycast Address

- RFC4291 provides a definition for the required Subnet Router Anycast Address as follows:

- This is an address such as: 2001:1234:5678:0000:0000:0000:0000:0000 (2001:1234:5678::)

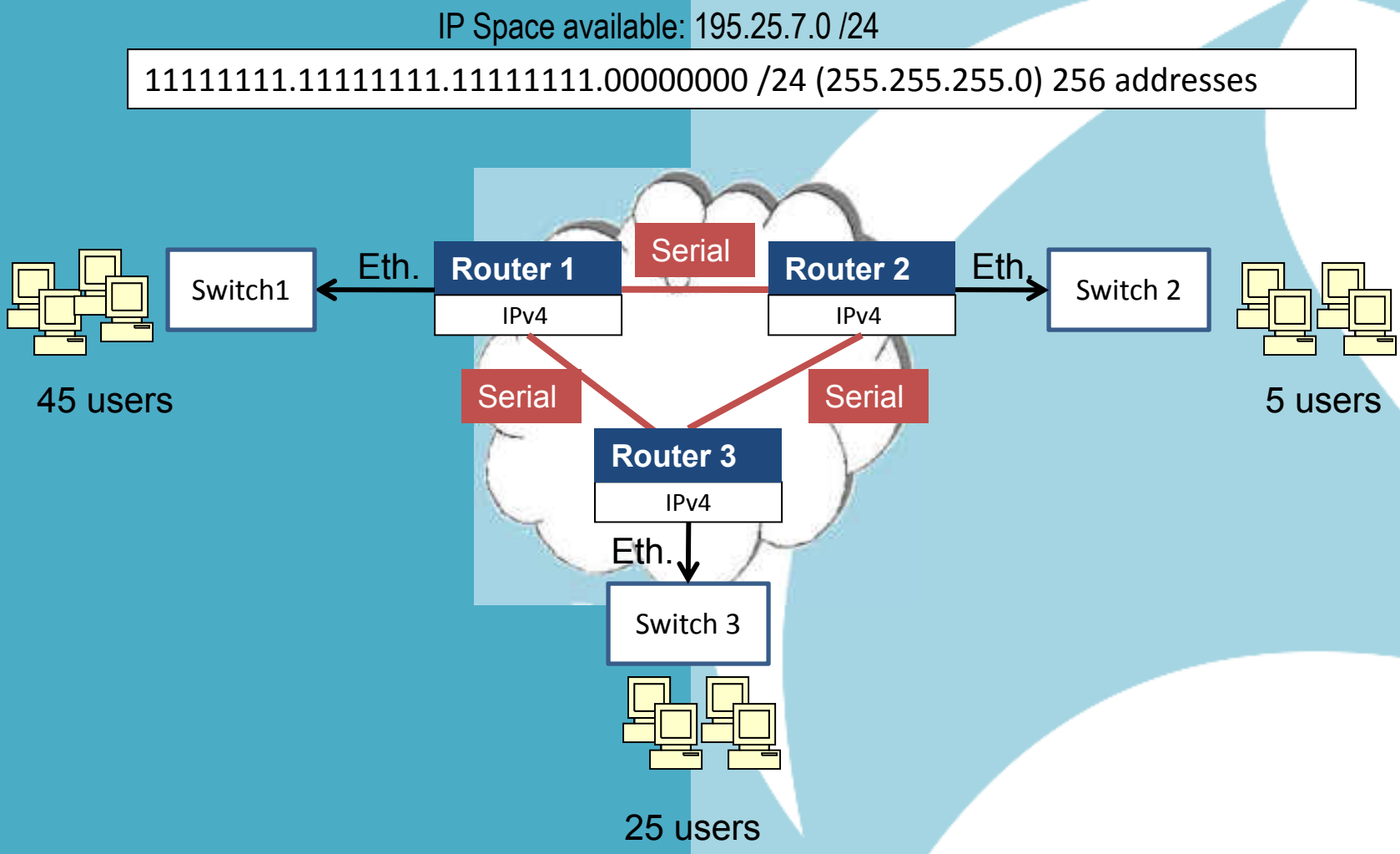
Other IPv6 Reserved Ranges

Subnet Router Anycast	[RFC4291]
Reserved Subnet Anycast	[RFC2526]
Reserved Subnet Anycast	[RFC2526]
MobileIPv6 Home Agents Anycast	[RFC2526]

Still Another Rule…

1. Use /48 for a site.
2. Use /49 - /63 for subnets.
3. Leave /65 – /128 for IID.
4. Break on nibble boundary.
5. Aggregate routes.
6. Use sparse allocation.
7. Remember security!
8. Avoid reserved addresses.

IPv4 /30 Allocation



IPv6 /126 Prefix

- So, what does a /126 look like?

/126

```
1111111111111111.1111111111111111.
1111111111111111.1111111111111111.
1111111111111111.1111111111111111.
1111111111111111.111111111111111xx
```

How many addresses are we talking about?

4 addresses – none used for network or broadcast.

```
0000:0000:0000:0000:0000:0000:0000:000x
FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FF0x
```

- Let's look at an example

2001:1234:5678:1234:5678:90AB:CDEF:0000 –
2001:1234:5678:1234:5678:90AB:CDEF:0003

IPv6 /127 Prefix

The usage of the /127 addresses is discouraged as documented in RFC3627 (Use of /127 Prefix Length Between Routers Considered Harmful).

/127

```
1111111111111111.1111111111111111.
1111111111111111.1111111111111111.
1111111111111111.1111111111111111.
1111111111111111.111111111111111x
```

```
0000:0000:0000:0000:0000:0000:0000:000x
FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFx
```

How many addresses are we talking about?

2 addresses – none used for network or broadcast.

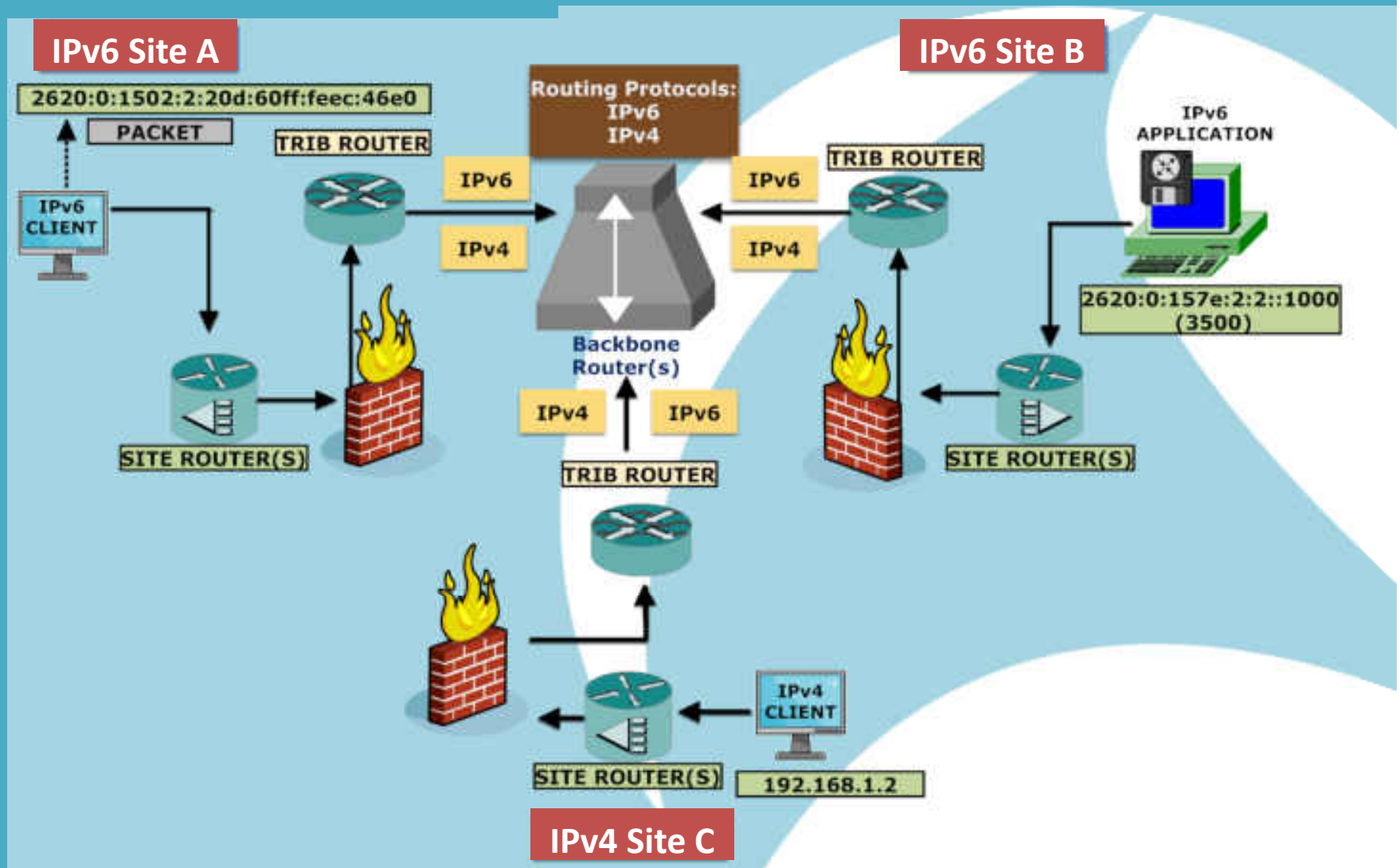
- Let's look at an example

2001:1234:5678:1234:5678:90AB:CDEF:0000 –
2001:1234:5678:1234:5678:90AB:CDEF:0001

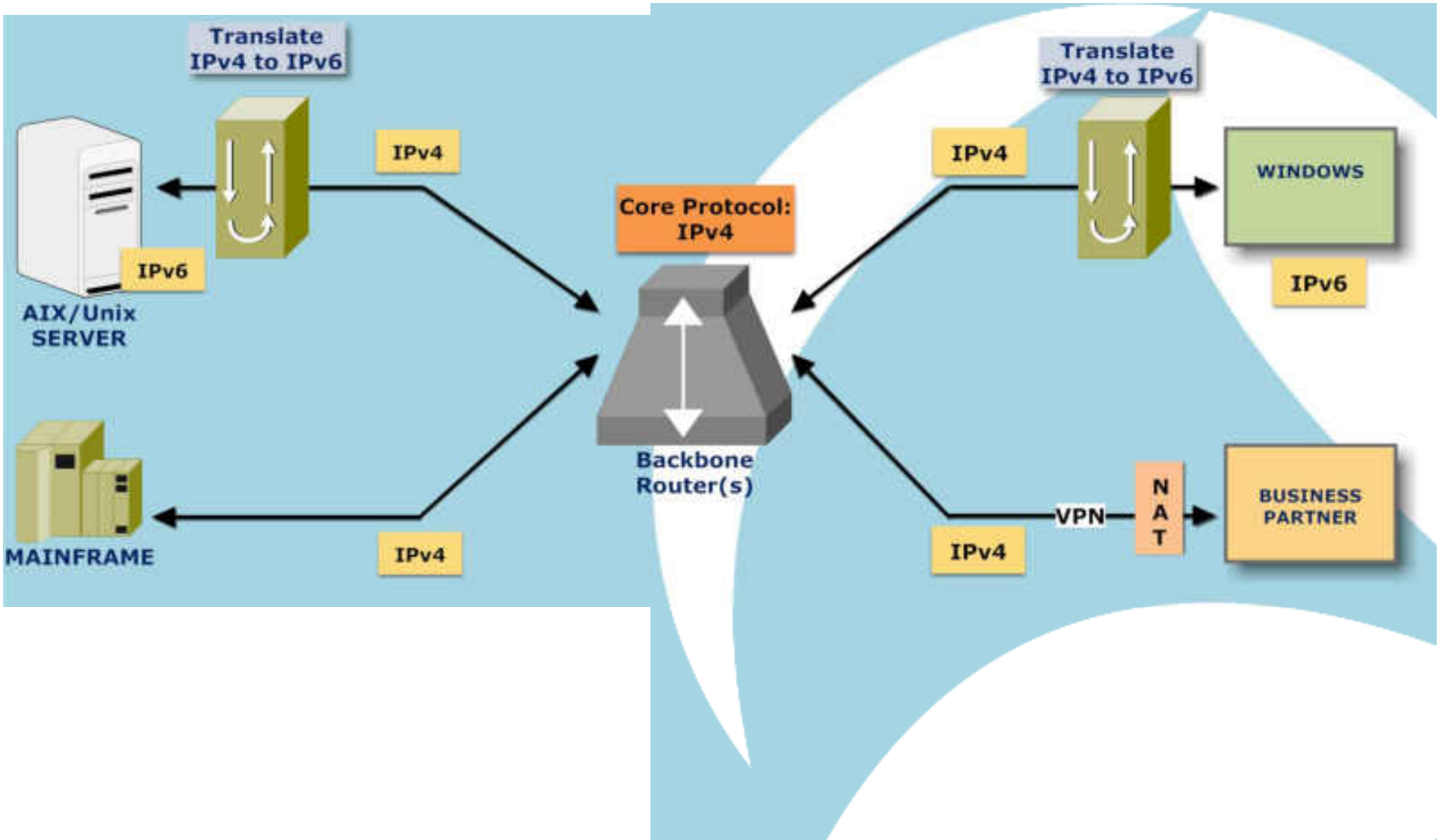
Last Rule…

1. Use /48 for a site.
2. Use /49 - /63 for subnets.
3. Leave /65 – /128 for IID.
4. Break on nibble boundary.
5. Aggregate routes.
6. Remember security!
7. Use sparse allocation.
8. Avoid reserved addresses.
9. Decide policy for point-to-point links.

Option 1: Dual Stack Backbone



Option 2: Boundary Converts to IPv6



Summary

- You can get an IPv6 address range directly from ARIN, or from an ISP.
- What to do once you have it is the biggest issue.
- IPv6 address planning is different from IPv4 address planning.

Other IPv6 Sessions

- Sunday: 3:00 - Intro to IPv6 Addressing
- Tuesday: 4:45 - IPv6 Trace Analysis Using Wireshark
- Wednesday: 10:15 - IPv6 Security