



How It Works: 101: Naming, Addressing, Routing

ALAIN DURAND | ICANN54 | 2015-10-18

Agenda

- ⦿ Networking by Numbers
- ⦿ Naming
- ⦿ Addressing
- ⦿ Routing

Networking by Numbers

Layer 1 to layer 9 examples

Layer 0: Physical Realm

Wired

Copper
Fiber



VS

Wireless

Antenas



Layer 1 Example: Lambda on a fiber

- ⦿ Wave length on a fiber pair
- ⦿ Point-to-point



Layer 2 Example: WAN Fiber Path

- How to get fiber connectivity from A to B?
 - Can't always use a single, dedicated fiber
 - Interconnect multiple Layer 1 to create a fiber path from A to B
- Speed:
 - GE, 10GE, 25GE, 40GE, 100GE,...
 - Multiples of the above

Layer 3: Networking

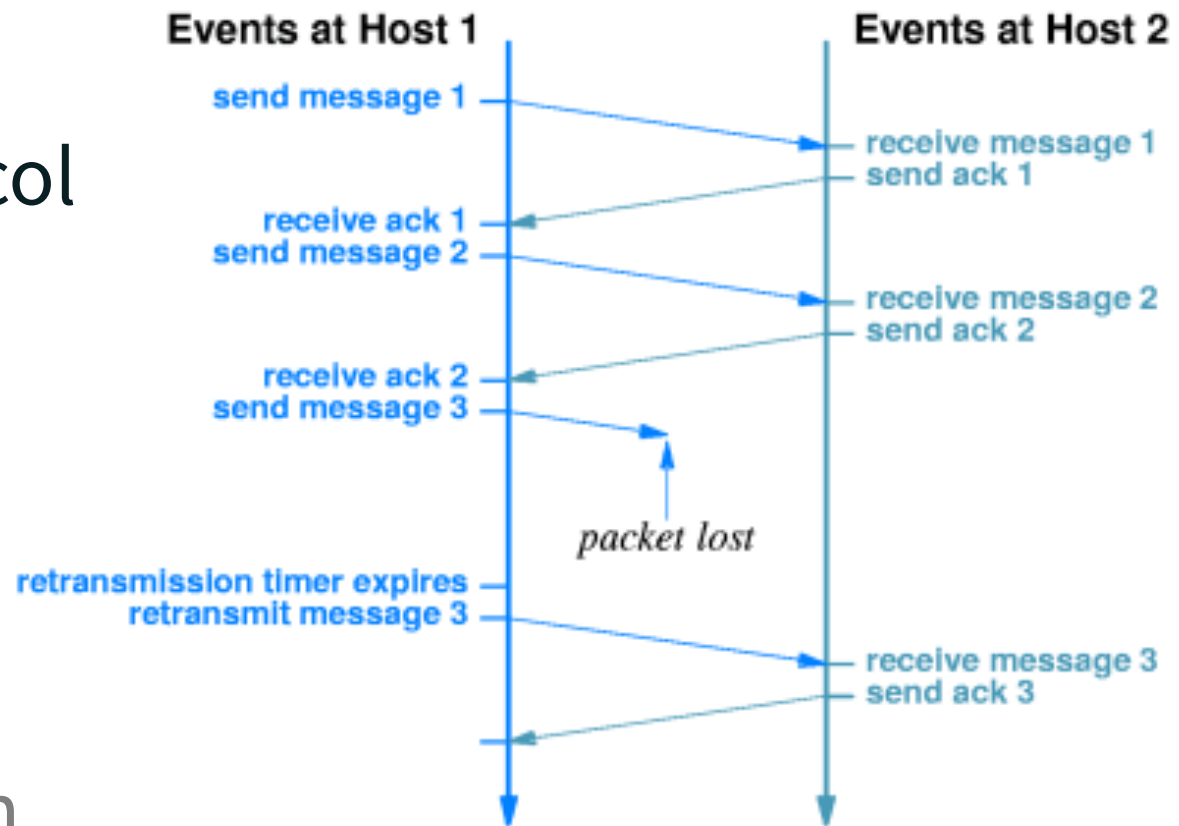
- The world is **NOT** flat
- L2 domain == broadcast domain
- Need for topology isolation
- L3 interconnects L2 domains

Layer 3 == IP

**IP:
Internet
Protocol**

Layer 4: Transport

- Transmission Control Protocol (TCP)



- User Datagram Protocol (UDP)

Layer 5: Session

- Real Time Streaming Protocol (RTSP)



Layer 6: Presentation

- In reverse chronological order:
 - JSON
 - XML
 - ASN.1
 - "fixed width"
 - "anything goes"

```
{"menu": {  
  "id": "file",  
  "value": "File",  
  "popup": { "menuitem": [  
    {"value": "New", "onclick":  
      "CreateNewDoc()"},  
    {"value": "Open", "onclick":  
      "OpenDoc()"},  
    {"value": "Close", "onclick":  
      "CloseDoc()"} ] } } }
```


L7: Applications

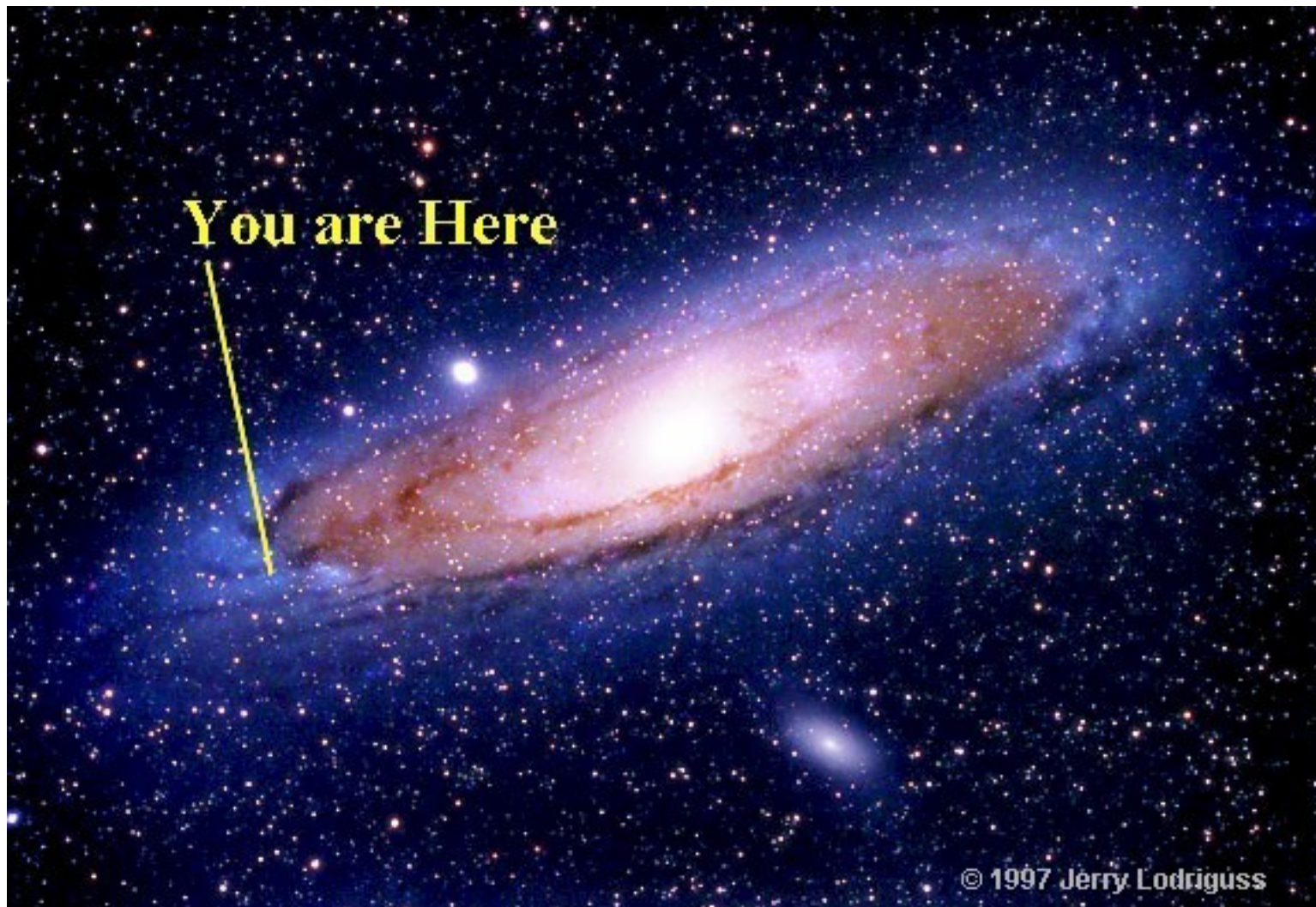


- Hypertext Transfer Protocol (HTTP)
- HTTP Secure (HTTPS)

Layer 8: Financial



Layer 9: Political





Naming “Who is your dentist?”

What is a Name?

- Name |nām|
 - Noun
 - 1: A word or set of words by which a person, animal, place, or thing is known, addressed, or referred to:
my name is Parsons, John Parsons | Köln is the German name for Cologne.
 - 2: A famous person: as usual, the big race will lure the top names.
[in sing.] a reputation, especially a good one: he set up a school that gained a name for excellence.

**→ If I know your name,
I know 'who' you are**

Name as a Handle

- “A word or set of words by which a person, animal, place, or thing is known...”
 - Having a name is only meaningful when other people know about it.
 - Knowing a name enables us to relate to it
 - We can talk –to– someone, or we can talk –about– someone.
 - Names can be passed from one party to another as a referral.



Here is the name of my dentist:

Names have Scopes

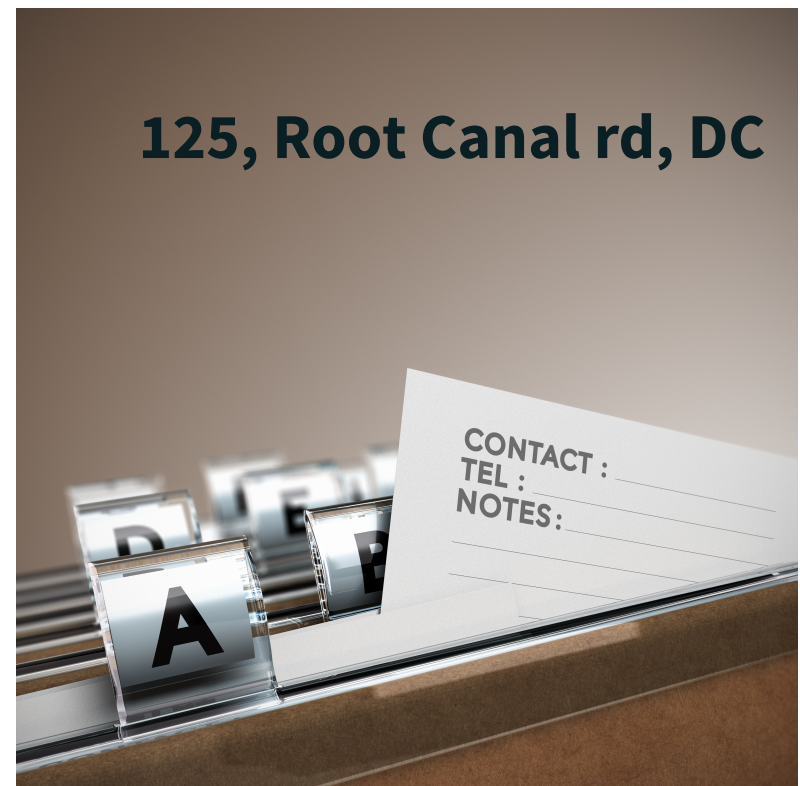
- Names need to be unique within a scope to avoid ambiguity
 - I'm the only Alain in my family
 - There were several Alains in my elementary classes, so teachers had to use a combination of first name/last name.

A name is Not Enough to Communicate

- **Ok, I have your dentist name, but what is his address?**

➔ Names must be mapped to a lower level identifier that will enable communication.

This process is called name resolution.



More Recent Issues

- **Internationalization**

- Refers to basing the writing of a name on Unicode, as opposed to ASCII. First there is the problem of simply rendering. Second there is the problem of uniqueness, confusability, etc., that comes from some names having one "look" but multiple renderings in Unicode. Hence, what looks the same to humans is different to computers

- **Domain Name System (DNS) Authentication**

- DNS, unlike HTTP, is a protocol which sends information via intermediate elements. This means the modern, obvious, ways of testing the accuracy of received data do not work. Domain Name System Security Extensions (DNSSEC) is an application of digital signatures with a hierarchy of keys to allow receiving relying parties verify the information received is what it should be

- **Expansion of the root zone**

- Recent changes to the root zone (new TLDs) upends the assumption in many automated systems that the root does not change. The recent changes have also impacted the nature of the names, they are no longer restricted to ASCII nor even left-to-right writing (rendering)



ADDRESSING

“Where is your dentist?”

What is an Address?

- Address |ə'dres, 'a,dres|
 - Noun
 - The particulars of the place where someone lives or an organization is situated: *they exchanged addresses and agreed to keep in touch*

→ **If I know your address,
I know 'where' you are.**

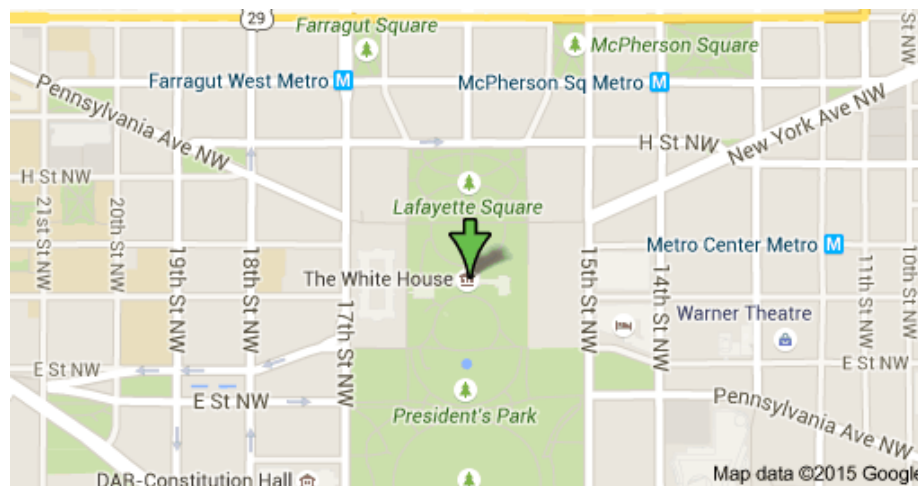
Address Structures

- A little detour: **most famous address in DC:**
1600 Pennsylvania Avenue NW, Washington, D.C.
20500-0003, USA
- Hierarchical structure:
 - USA
 - DC
 - NW
 - » Pennsylvania Avenue
 - 1600
- Not always geographically organized
 - 1-800 (toll free) telephone numbers
 - Cell phone numbers
 - **IP addresses**



Addresses Have Scopes

- If you live in DC, all I need to tell you is:
 - 1600 Pennsylvania Avenue NW



- If you live in Europe, you know that Paris is most probably in France. If you live in the US, you have 29 cities to choose from...

Address as a Handle

- Similar to names:
 - Addresses can be used directly
 - E.g., to send a postcard
 - Passed on to someone else as a reference

Here is the address of my dentist:
125, Root Canal rd, DC



An Address is Not Enough to Communicate

- You can send a postcard to 1600 Pennsylvania Avenue NW, Washington D.C. 20500 USA from anywhere in the world
- It would only arrive there because there is a postal system that will “route” the postcards through a number of mail hubs
- **Now, How do I go to 125, Root Canal rd, DC?**



Internet Addresses

- 2 protocols co-exist on the Internet
 - IPv4 1981 – now
 - IPv6 (1994) 1998 - now
- Those two protocols differ mostly by the format of the IP address
 - IPv4: 32 bits, about **3.2 billion useable addresses**
 - IPv6: 128 bits:
340,282,366,920,938,463,463,374,607,431,768,211,456

IPv4 Exhaustion?

- IPv4 addresses do not get tired...
- However, all of them but a few are allocated
- The Internet is still growing, so what is next?

IPv4 & IPv6 are NOT Compatible

- An IPv4 host and an IPv6 host cannot directly communicate.
- **This is a technical limitation.**



IPv6 is NOT a Direct Replacement for IPv4

- Not all equipment on the Internet support both IPv4 and IPv6
- Not all services are enabled for both for IPv4 and IPv6
- As such IPv6-only products & services are generally not a commercially viable option

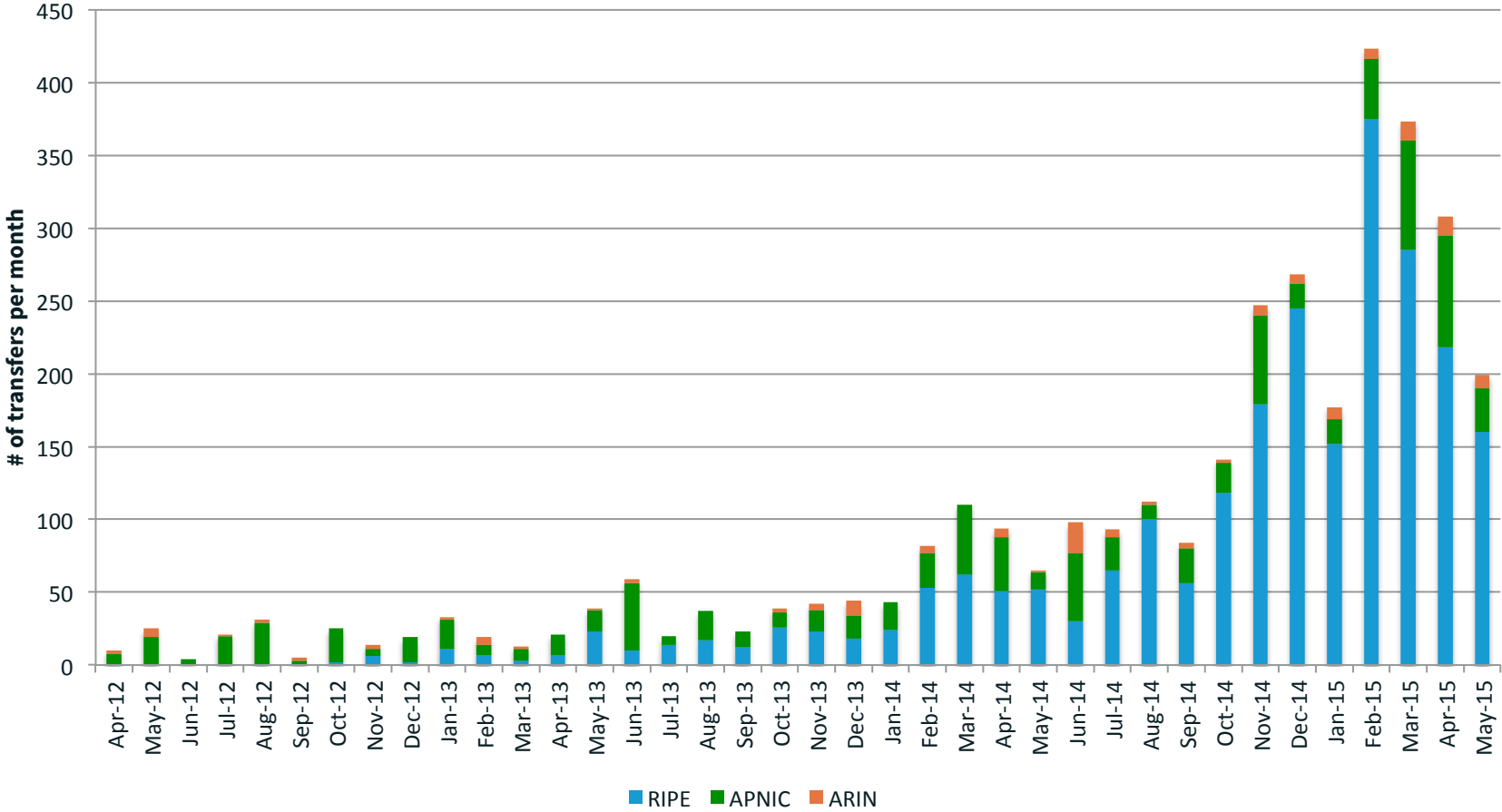
→ **The Internet will have to support both IPv4 & IPv6 for a very long time...**
(ISP, Content Provider, Consumer Electronics,...)

Where to get IPv4 Addresses?

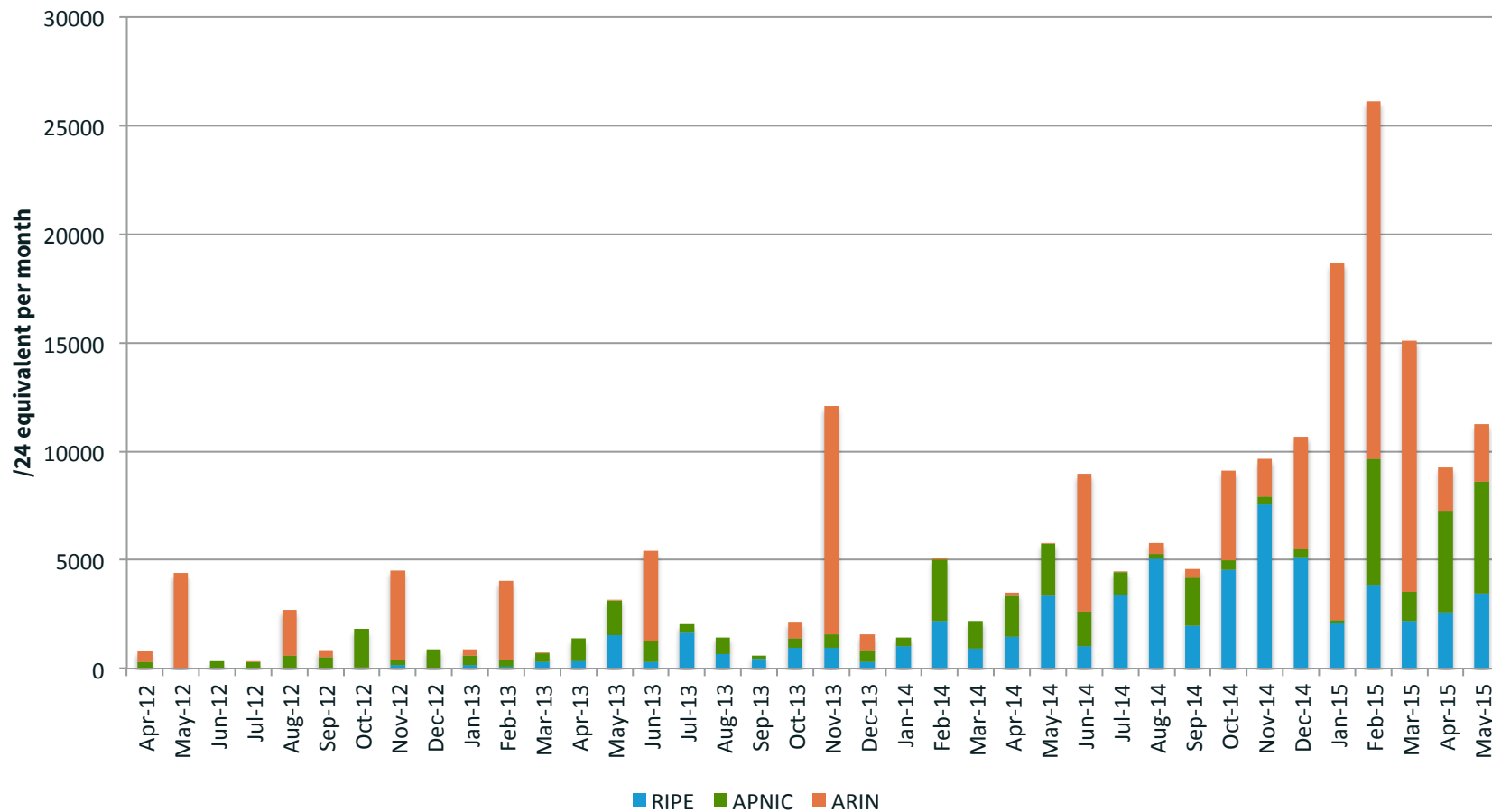
- All 5 RIRs have now enacted IPv4 resource transfer policies
- Terms and conditions vary
 - E.g.,: Need base or not
- **Address sharing (NAT) can help leverage address space.**

IPv4 Transfer Statistics

Number of Transfers per Month



Transfer Volume in /24 Equivalent per Month





Routing

“How do I go to your dentist?”

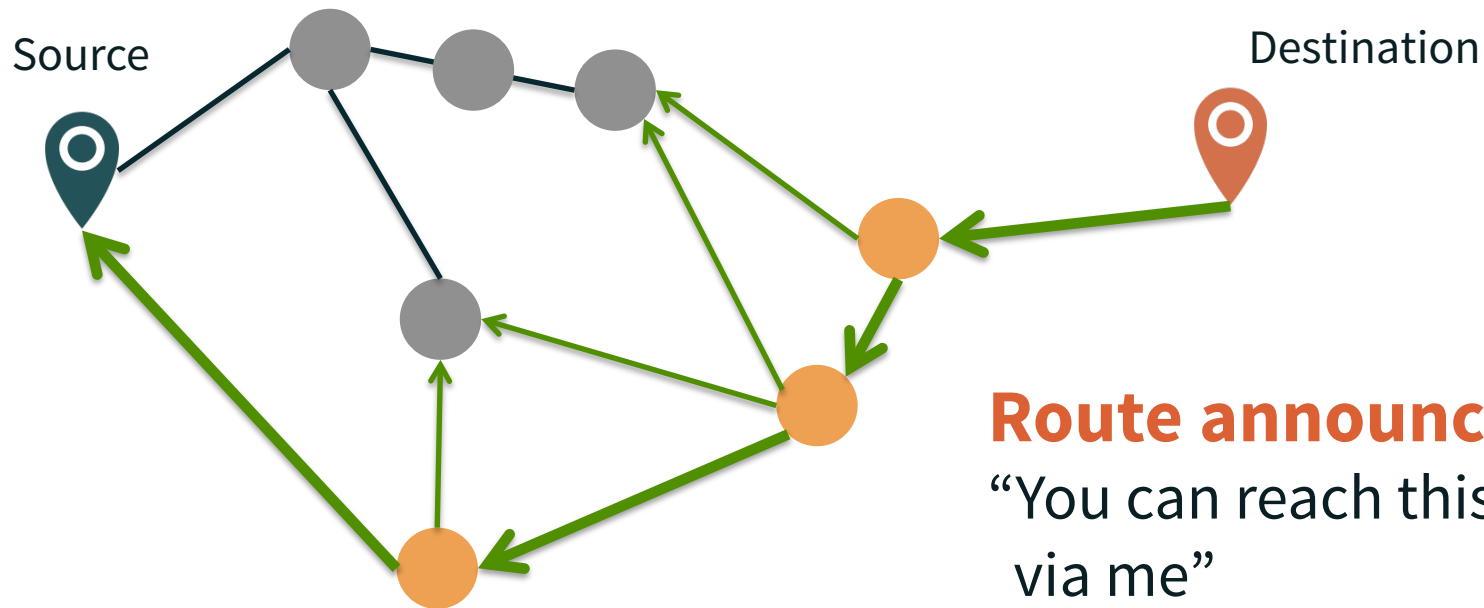
What is a Route?

- route |rōot, rout|
 - Noun
 - A way or course taken in getting from a starting point to a destination: *the most direct route is via Los Angeles*

**→ If I have a route for you,
I know where to go.**

Building Routes Before the Traffic Flows

Route announcements flow in the reverse direction from the future traffic:



Route announcement:
“You can reach this destination via me”

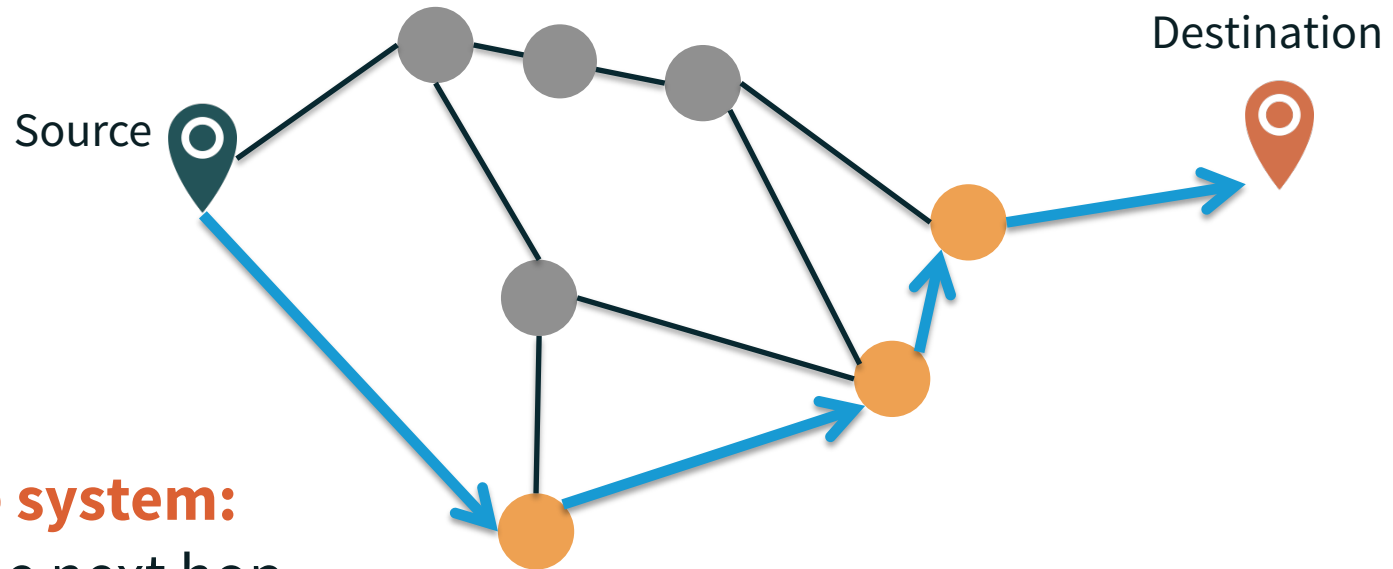
Cooperative system:

Previous hops re-announce routes

Sending Traffic Hop-by-Hop

Forwarding traffic happens hop-by-hop

→ If I have a route for your destination, I know the “next hop” to which I can deliver the packet.



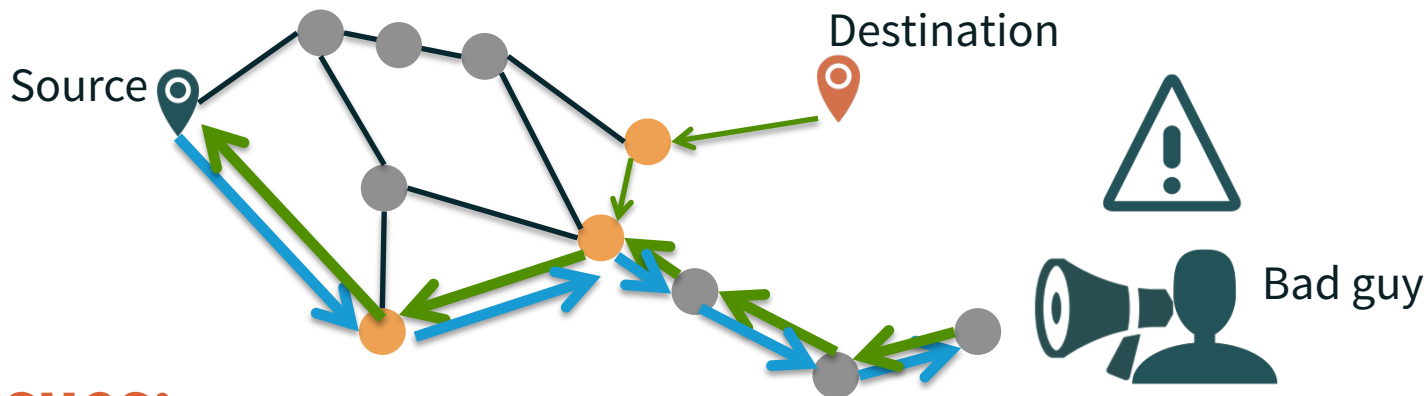
Cooperative system:

We rely on the next hop to do the “right thing”

Resource Public Key Infrastructure: RPKI

- **Origin validation:**

- Validate that whoever is announcing a route for a particular network has the right to do so.
- Avoid rogue injection of networks



Issues:

- Centralized vs de-centralized system
- Provide only origin validation, not path validation
i.e. does not prevent man-in-the-middle attacks

Conclusion

“You have arrived...”

You Have Arrived!

