Announcements

- Google gets caught! Twice!!
- Google "caves" on "do not track" for Chrome
- Tyler Clementi trial begins

Relating the “logical” with the “physical”

Domain Name System

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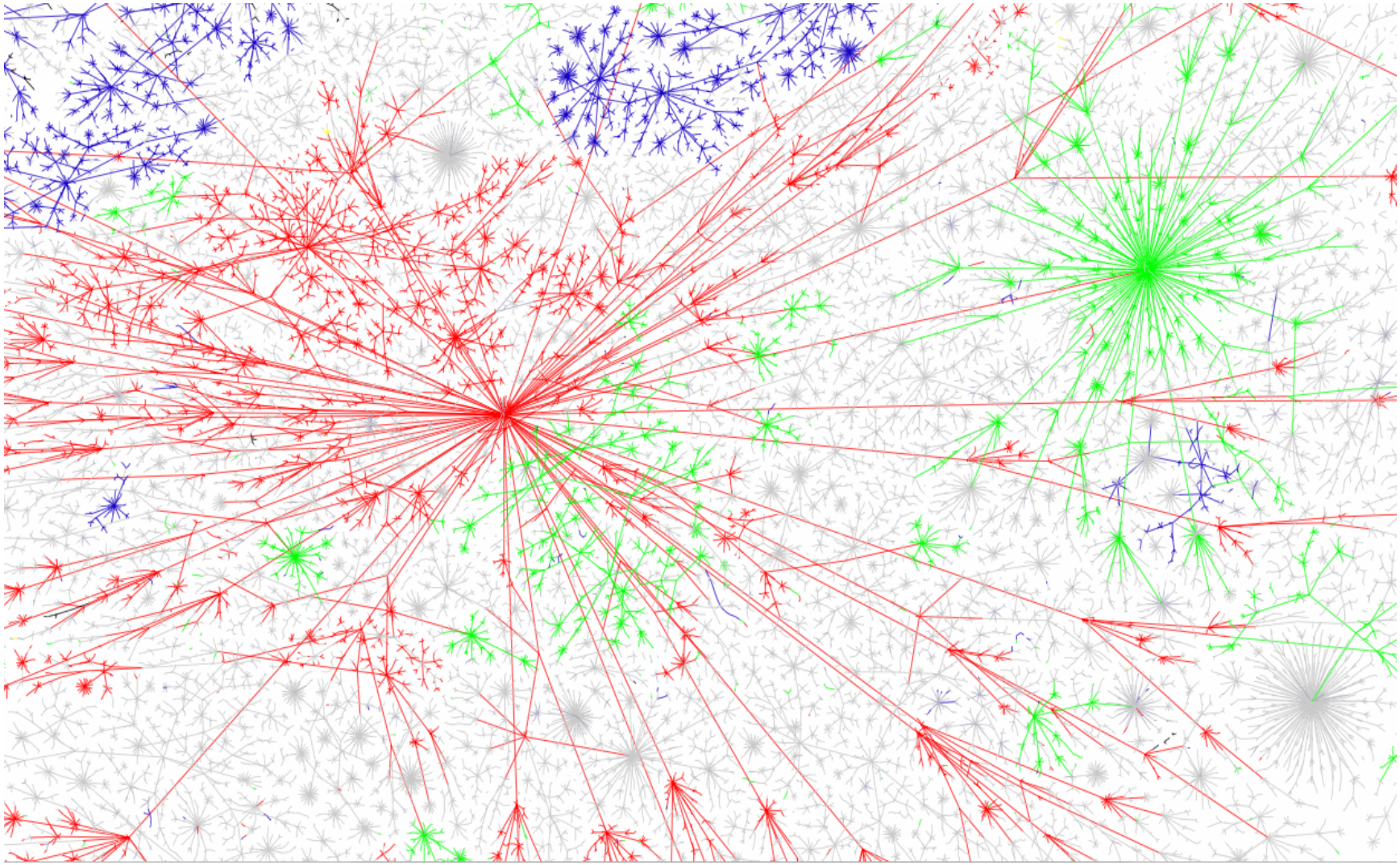
Recall 2 Ways To Name Computers

- **Logical**: Humans use domain names
  - spiff.cs.washington.edu
- **Physical**: Computers use number-quads
  - 128.208.3.136
- This is different than the phone system:
  - The people use numbers: 1 800 555 1212
  - The equipment uses the same numbers
- A key property of computers: they can separate the logical form (preferred by people) from the physical form they must use

Today …

- Today, we explain how the logical/physical separation is implemented for domain names
- But, this is also a chance to illustrate the structure of LARGE systems
  - Study the basic components
  - Study design ideas that make the system work well
  - This matters to you because you'll probably have "big ideas" about using computers

Portion of Physical I'net



What's the Problem?

- The Internet is completely decentralized
  - No one is in charge – ICANN
  - A few companies get permission to give users or organizations IP-addresses – not much logic to it
  - When a person or organization gets an IP-address, it picks a domain name – few rules except to tell the company that gave it out, what the domain is
- Once connected to I'net, users start using domain name … but when someone refers to it, how does their computer get its number??

Internet Corporation for Assigned Names and Numbers

Recall mail to "friend@cise.ufl.edu"

68.87.205.1	-	Mt Laurel, usa
68.85.240.101	be-70-ar01.burien.wa.seattle.comcast.net	Mt Laurel, usa
68.85.240.69	be-30-ar01.seattle.wa.seattle.comcast.net	Seattle, WA, USA
68.86.90.213	pos-0-5-0-0-cr01.seattle.wa.ibone.comcast.net	Seattle, WA, USA
68.86.85.206	pos-0-8-0-0-cr01.portland.or.ibone.comcast.net	Portland, OR, USA
68.86.85.197	pos-1-15-0-0-cr01.sacramento.ca.ibone.comcast	Sacramento, CA, USA
68.86.85.181	pos-0-9-0-0-cr01.sanjose.ca.ibone.comcast.net	San Jose, CA, USA
154.54.11.105	te3-3.mpd01.sjc04.atlas.cogentco.com	San Jose, CA, USA
154.54.0.177	te9-1.ccr02.sfo01.atlas.cogentco.com	San Francisco, CA, USA
154.54.3.137	te3-8.ccr01.lax01.atlas.cogentco.com	Los Angeles, CA, USA
154.54.0.226	te3-8.ccr01.iah01.atlas.cogentco.com	Houston, TX, USA
154.54.24.194	te3-2.ccr01.mia01.atlas.cogentco.com	Miami, FL, USA
154.54.1.186	te3-3.ccr01.mia03.atlas.cogentco.com	Miami, FL, USA
38.112.31.66	florida_lambdarail_llc.demarc.cogentco.com	Washington, DC, USA
198.32.155.10	tpa-flrcore-7609-1-te21-1.net.flrnet.org	Marina del Rey, usa
198.32.173.161	tlh-flrcore-7609-1-te41-1907.net.flrnet.org	Marina del Rey, usa
198.32.173.162	ctx36-ewan-msfc-1-v1907-1.ns.ufl.edu	Marina del Rey, usa
128.227.236.85	ctx36-nexus-msfc-1-v50-1.ns.ufl.edu	Gainesville, FL, USA
128.227.236.14	csev1-core-msfc-1-v41-1.ns.ufl.edu	Gainesville, FL, USA
128.227.254.74	-	Gainesville, FL, USA
128.227.205.2	cise.ufl.edu	Gainesville, FL, USA

- A packet sent to 128.227.205.2 finds its way

But, how do we get 128.227.205.2?

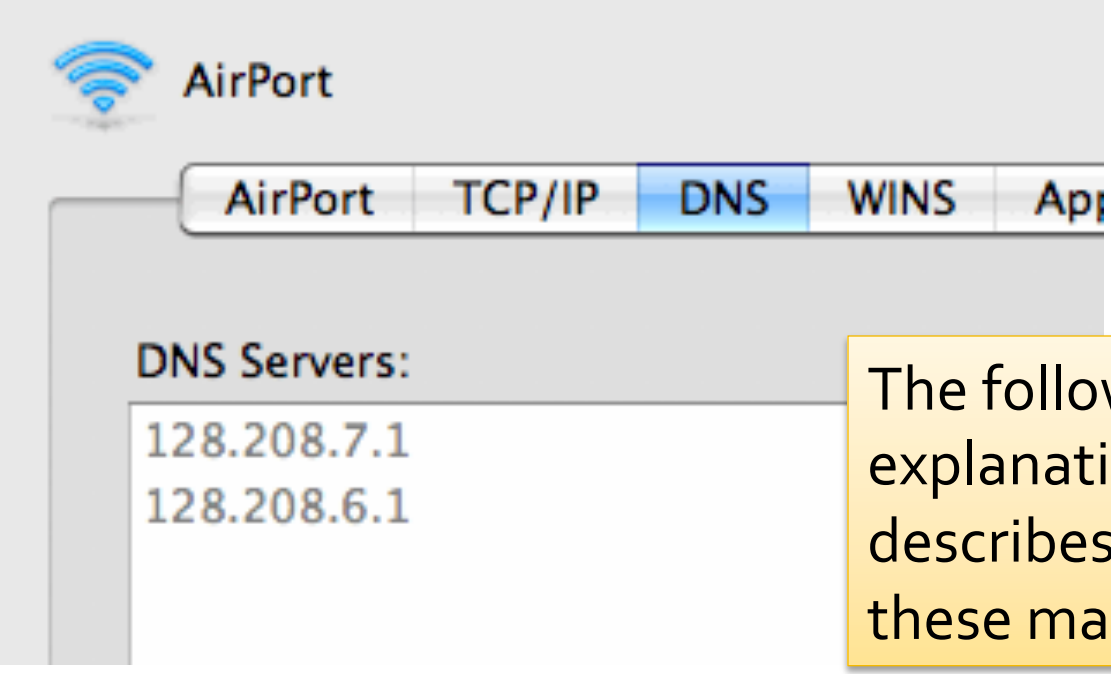
- When we send mail to a friend at the U of FL, we type friend@cise.ufl.edu and the computer that sends mail for us on campus needs to find out this fact:

cise.ufl.edu == 128.227.205.2

- We said it asks the Domain Name System, or DNS … so what happens

But Wait!

- How does it know the address of the DNS?
- You (or someone or something who set up your computer) told it when connecting it to the network … look in net control panel



The following explanation describes what these machines do

First Step

- The DNS server answers the question "what number is cise.ufl.edu?" by this method
- First Step: Look it up in its "address book"
  - The DNS server does that
  - It keeps its own address book, a list of all of the domain names like cise.ufl.edu that it has been asked about and found
  - We say it *caches* the addresses it's found
    - *caching – keeping a copy around in case its needed again*
  - It checks the cache first

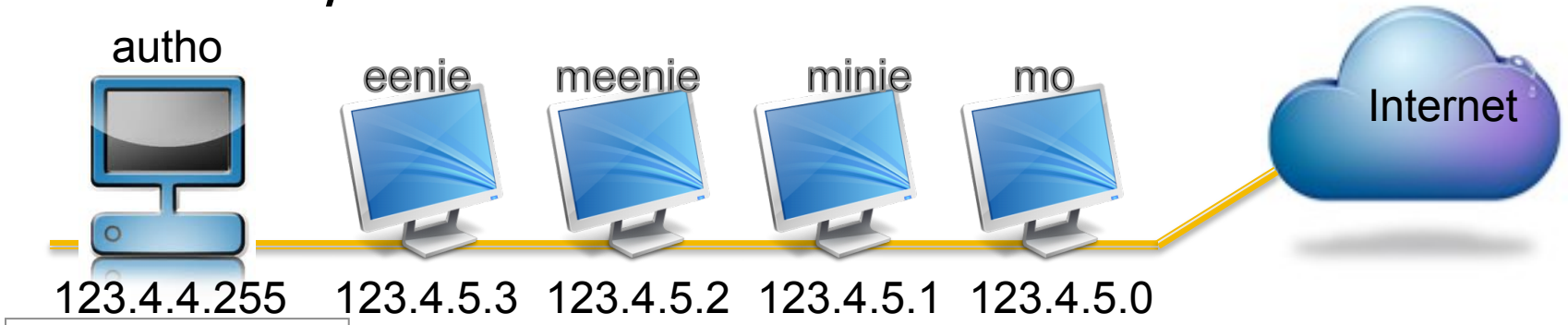
If It Has Never Been Asked …

- The address will not be in the cache if this is the first request
- Second Step: The DNS server begins a process of finding the address on behalf of your computer …

  That process uses 2 Facts of I'net

The DNS Design: Fact 1

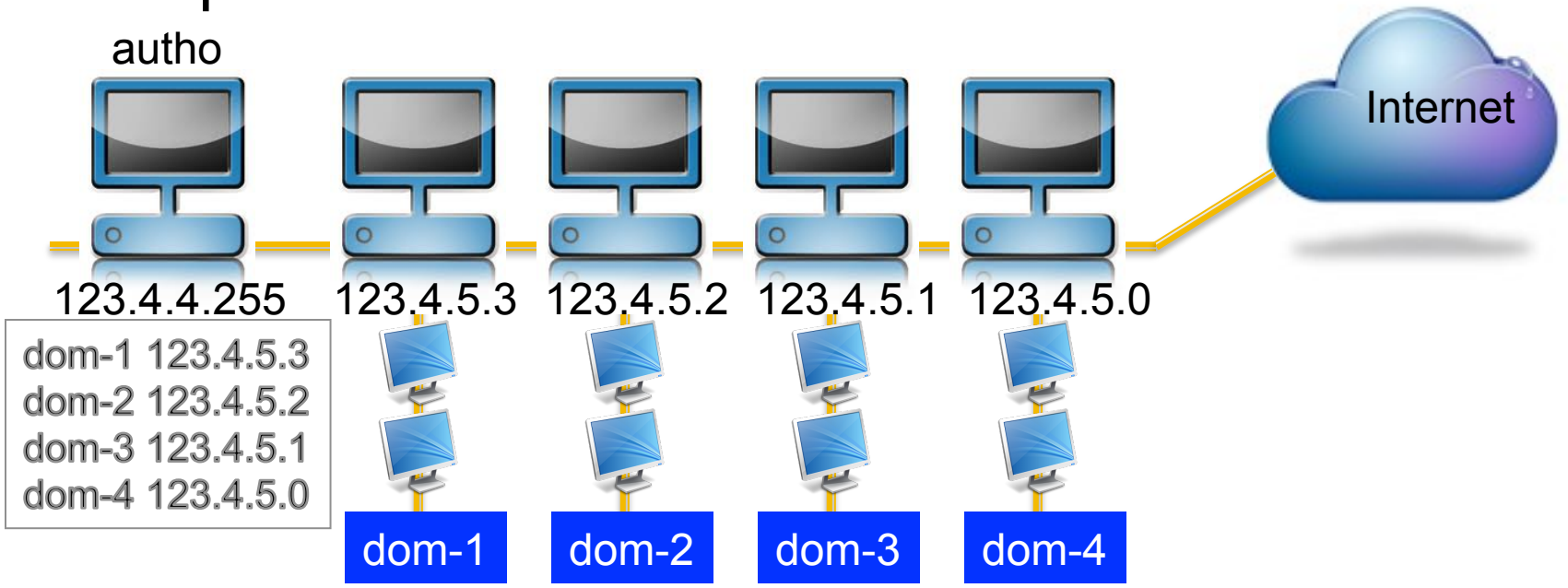
- Every domain has an authoritative name server, which I'll call autho



- Two Cases: Autho knows the number of every computer in its domain

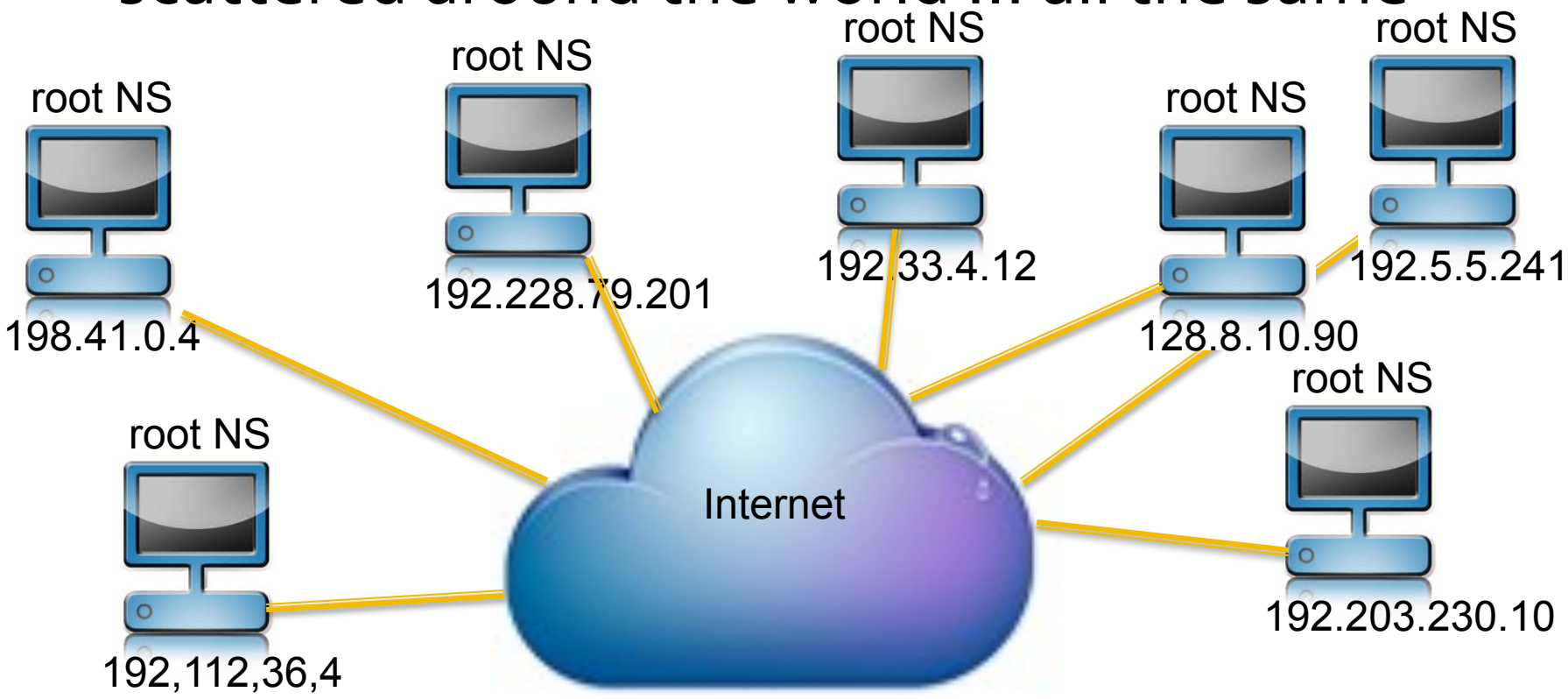
The DNS Design: Fact 1 (Continued)

- OR Autho knows the number of every autho computer in its domain



The DNS Design: Fact 2

- There are 13 Internet "root name servers" scattered around the world … all the same



- All DNS servers have their numbers

www.root-servers.org

"J" Root Name Server

J	VeriSign, Inc.	**Sites: 70** Global: 63 Local: 5 **Dulles, VA, US (2 sites)**; Dulles, VA, US (1 sites); **Ashburn, VA, US ***; **Miami, FL, US**; **Atlanta, GA, US**; Seattle, WA, US; Chicago, IL, US; **New York, NY, US ***; **Honolulu, HI, US**; **Mountain View, CA, US (1 sites)**; Mountain View, CA, US (1 sites); **San Francisco, CA, US (2 sites) ***; **Dallas, TX, US**; **Amsterdam, NL**; **London, UK**; **Stockholm, SE (2 sites)**; **Tokyo, JP**; **Seoul, KR**; Beijing, CN; **Singapore, SG**; **Dublin, IE**; **Kaunas, LT**; Nairobi, KE; **Montreal, CA**; **Perth, AU**; **Sydney, AU**; **Cairo, EG**; Cairo, EG; **Warsaw, PL (2 sites)**; **Brasilia, BR**; **Sao Paulo, BR**; **Sofia, BG**; **Prague, CZ**; **Johannesburg, ZA**; **Toronto, CA**; **Buenos Aires, AR**; **Madrid, ES**; **Fribourg, CH**; **Hong Kong, HK (2 sites)**; **Turin, IT**; **Mumbai, IN**; **Oslo, NO**; **Brussels, BE**; **Paris, FR (2 sites)**; **Helsinki, FI**; **Frankfurt, DE ***; **Riga, LV**; **Milan, IT**; **Rome, IT**; **Lisbon, PT**; **San Juan, PR**; **Edinburgh, UK**; **Tallin, EE**; **Taipei, TW**; **New York, NY, US ***; **Palo Alto, CA, US ***; **Anchorage, US**; **Moscow, RU**; **Manila, PH**; **Kuala Lumpur, MY**; **Luxembourg City, LU**; **Guam, GU, US**; **Vancouver, CA**; **Wellington, NZ**	IPv4: 192.58.128.30 IPv6: 2001:503:C27::2:30

So, Here's How It Goes …

- Your computer's DNS server never heard of cise.ufl.edu.root … so it pulls the domain name apart:
  - cise, a computer in the .ufl domain
  - ufl, a domain in the .edu domain
  - edu, a domain in the .root domain
- So, the DNS begins at the end and starts asking for the numbers of the autho computers … who's the autho for the .root domain?

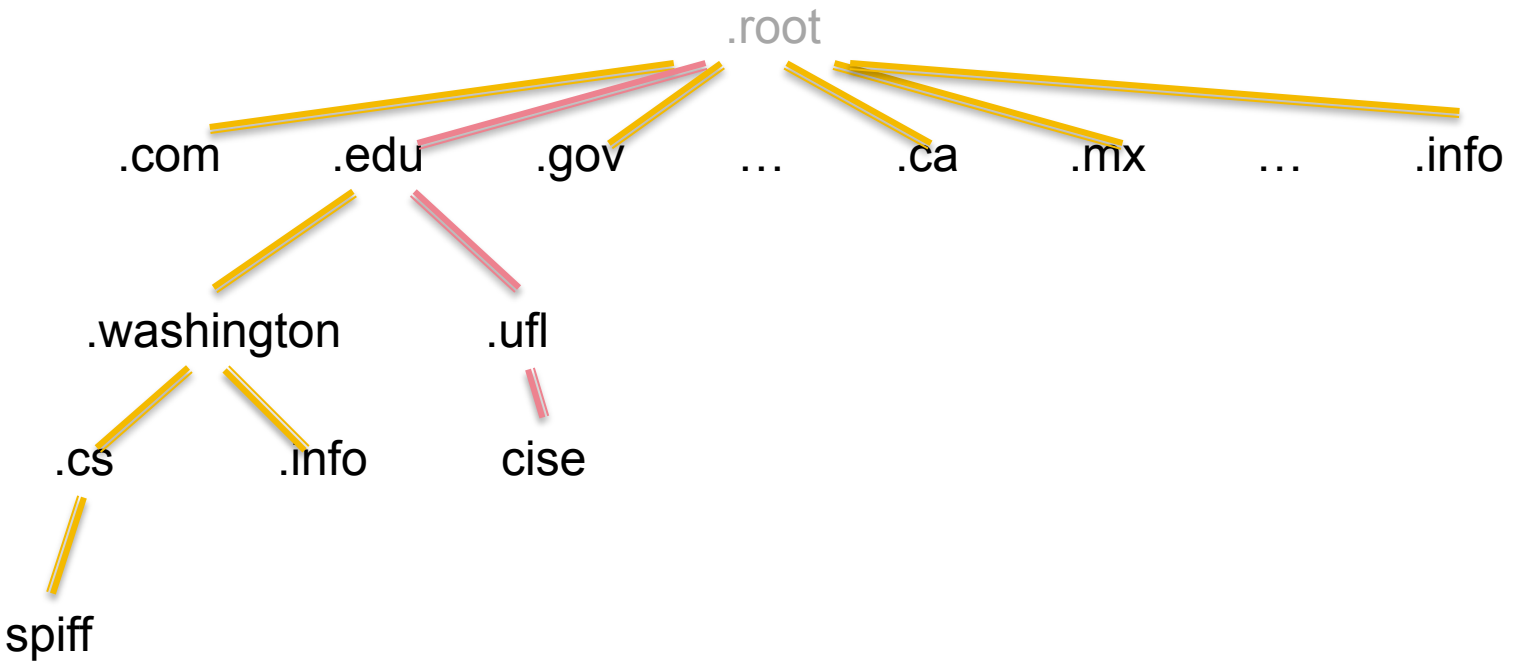
Implied – on all addresses, so don't bother with it

Your DNS Asks the .root NS

- Please give me the number of .edu autho
  - Getting that it asks it, …
- Please give me the number of .ufl autho
  - Getting that it asks it, …
- Please give me the number of the cise machine
  - Getting 128.227.205.2, it addresses your email and sends it on
- Simplification: it might have cached .edu autho and .ufl autho, which saves those requests

Logical Names Form Hierarchy

- As a hierarchy, it can be shown as a tree:

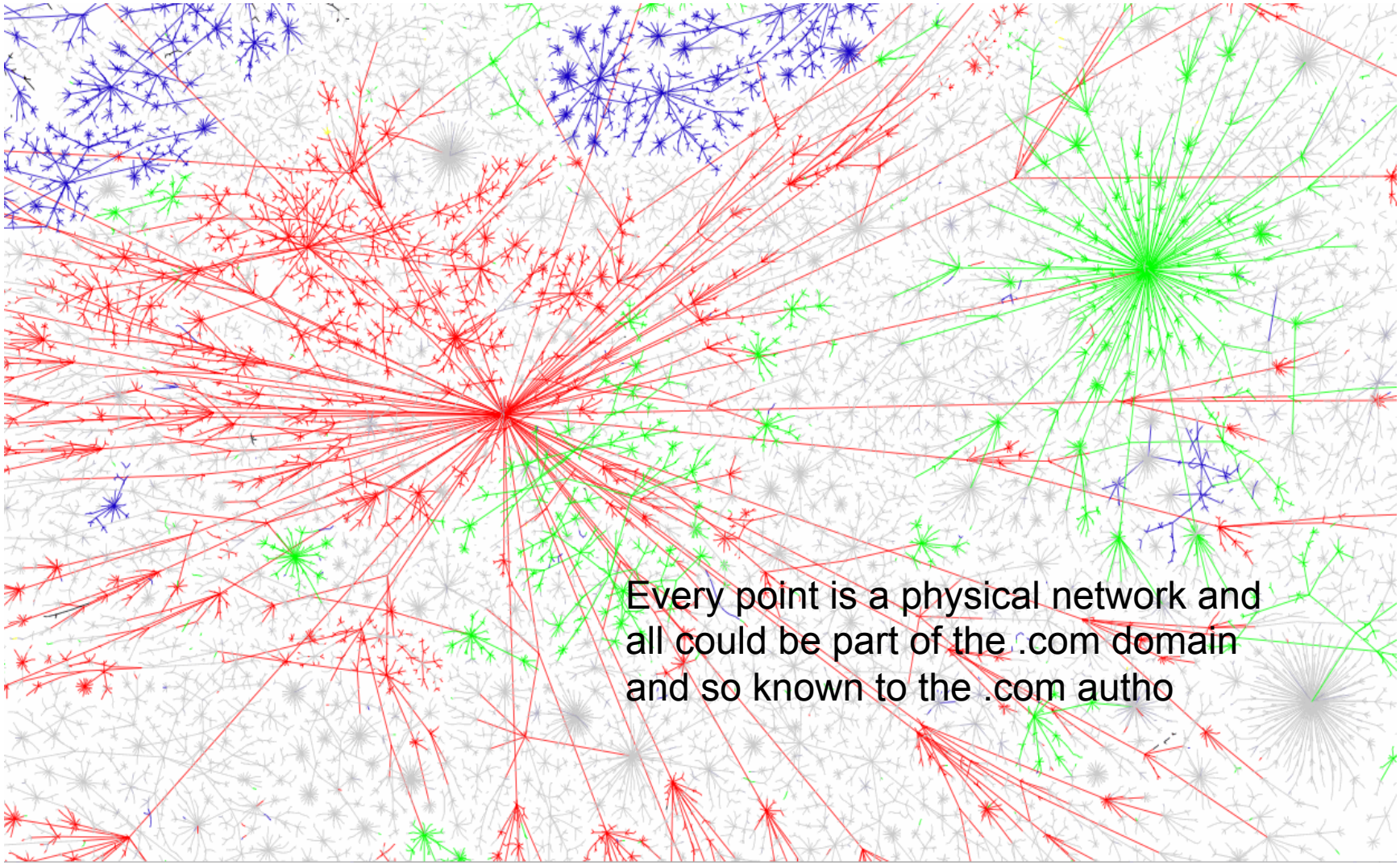


- The DNS is simply "walking" down the tree asking each autho for the number of next item

Exercise:

- I was in NYC last week working at a hotel and went to log into my computer at UW
  - spiff.cs.washington.edu
- How did the hotel's ISP find 128.208.3.136?

Think About This Scheme: Huge



Suppose A Domain Adds Computer

- When a domain, say .ufl, adds a new computer it gets a name and an IP-address
- They add its name and number to the list in ufl autho's memory and its up and running, "known to the world"

- This is a completely decentralized solution – no one needs to be in charge except to make sure that the domain autho is up & correct

Properties …

- Fault tolerant: when a hurricane takes out Miami's power, only the domains without power are affected …
- Robust: when a fire burns down the building of a .root name server, 12 others can carry the load
- Enormous capacity: most lookups are independent and do not collide (b/c higher level domain authos are cached), but more capacity is possible by replicating authos

Compare DNS Structure To ..

- Master List Solution …
  - Suppose the design was for the root NS computers to have a master list of all

    domain_name: IP-address

    pairs connected to the Internet
- How would it be different, better or worse?