CS120: Computer Networks

Lecture 22. DNS

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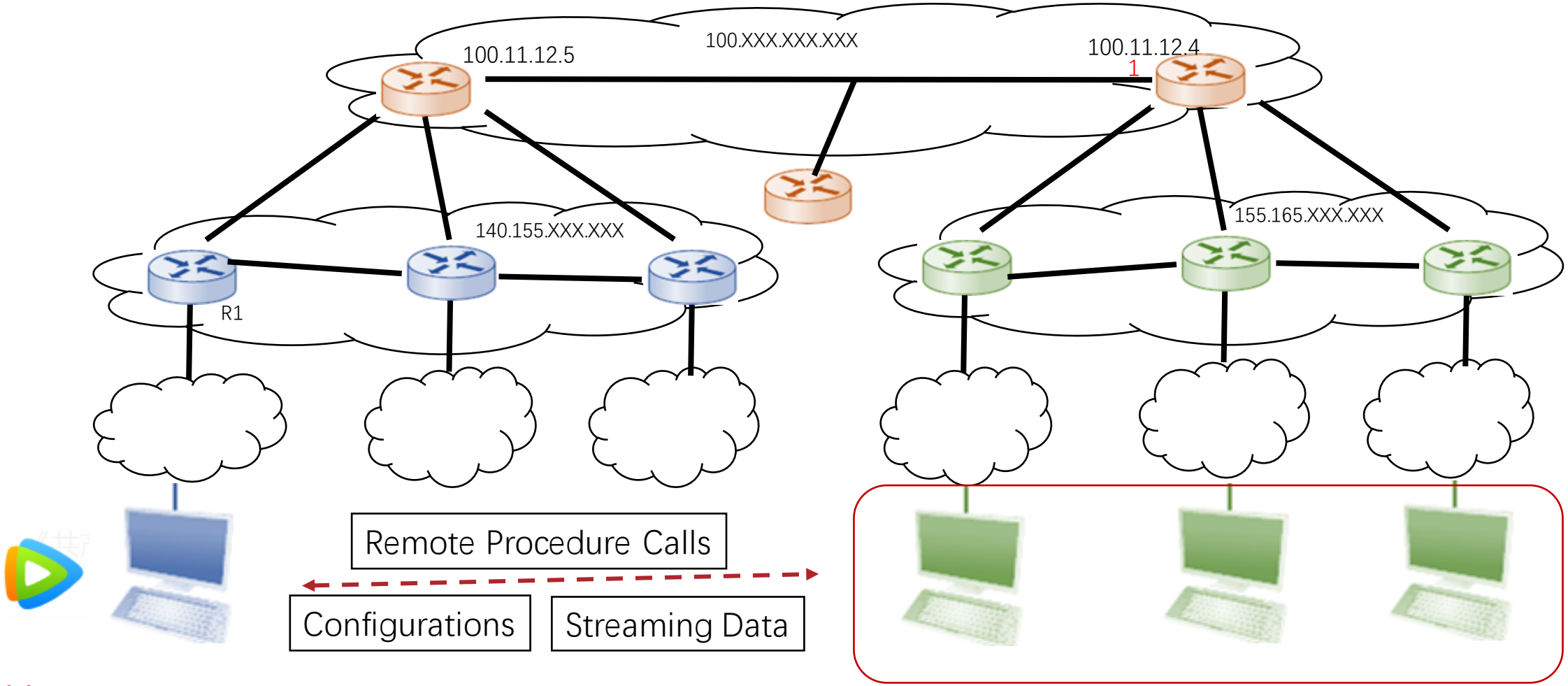
Slides adopted from: Zhice Yang

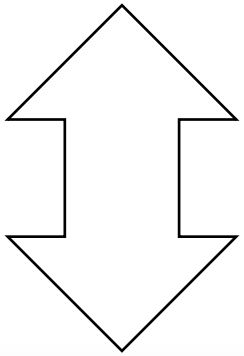
How to Name a Network Host ?



How to Name a Network Host ?

- For Machine
  - IP address
    - Easy to process
- For Human
  - Literal Content
    - Easy to remember
    - eg:

IP Addresses



Name to IP Mapping

Domain Name System (DNS)

- DNS Services
  - Hostname to IP address translation
  - Host aliasing
  - Mail server aliasing
  - Load distribution
    - Replicated Web servers: many IP addresses correspond to one name
- DNS Implementation ?
  - Centralize DNS server v.s. Distributed DNS server
    - scalability
      - Akamai DNS servers alone: 2.2T DNS queries/day
    - single point of failure
    - traffic volume
    - distant centralized database
    - maintenance

Name in the ID Card

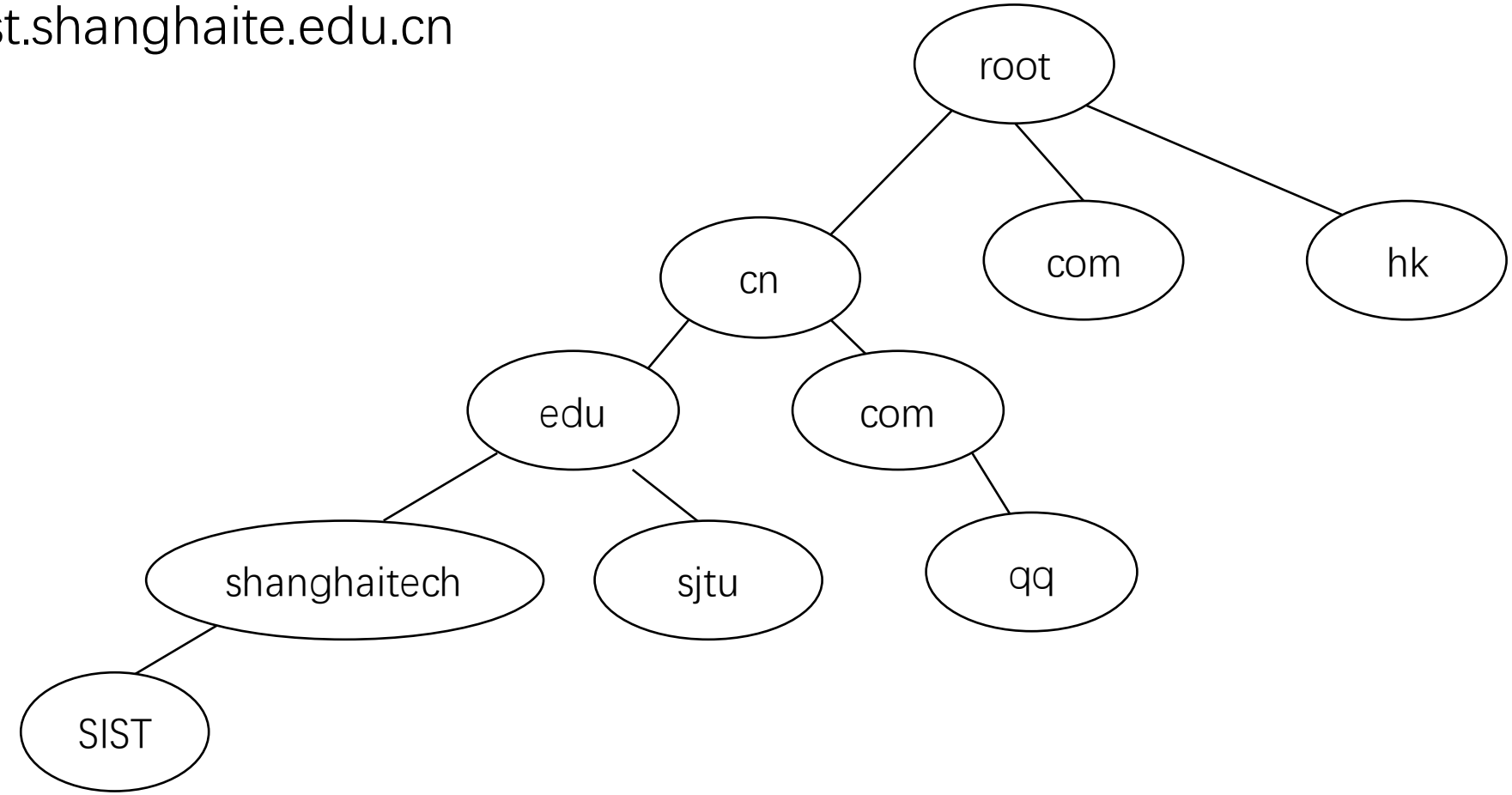
- Should be a unique name
  - China
  - Shanghai
  - Pudong
  - ShanghaiTech
  - Haoxian Chen

Domain Name

- Domain names are used to address remote servers
  - Web: http://sist.shanghaitech.edu.cn
  - Email: hxchen@shanghaite.edu.cn
  - FTP: ftp://sist.shanghaiteh.edu.cn

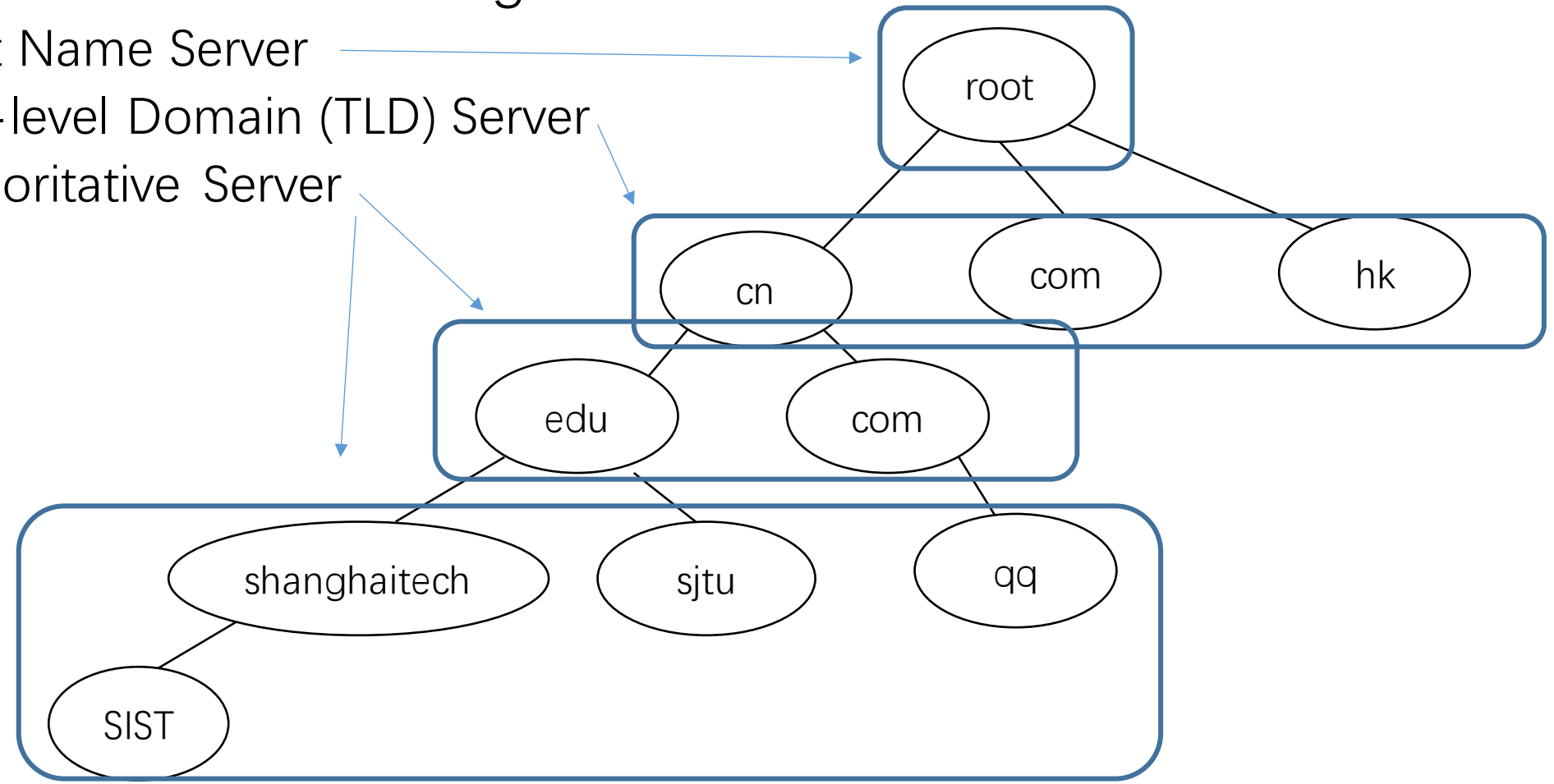
Domain Name Hierarchy

- Domain names are designed with hierarchy
  - eg: sist.shanghaite.edu.cn



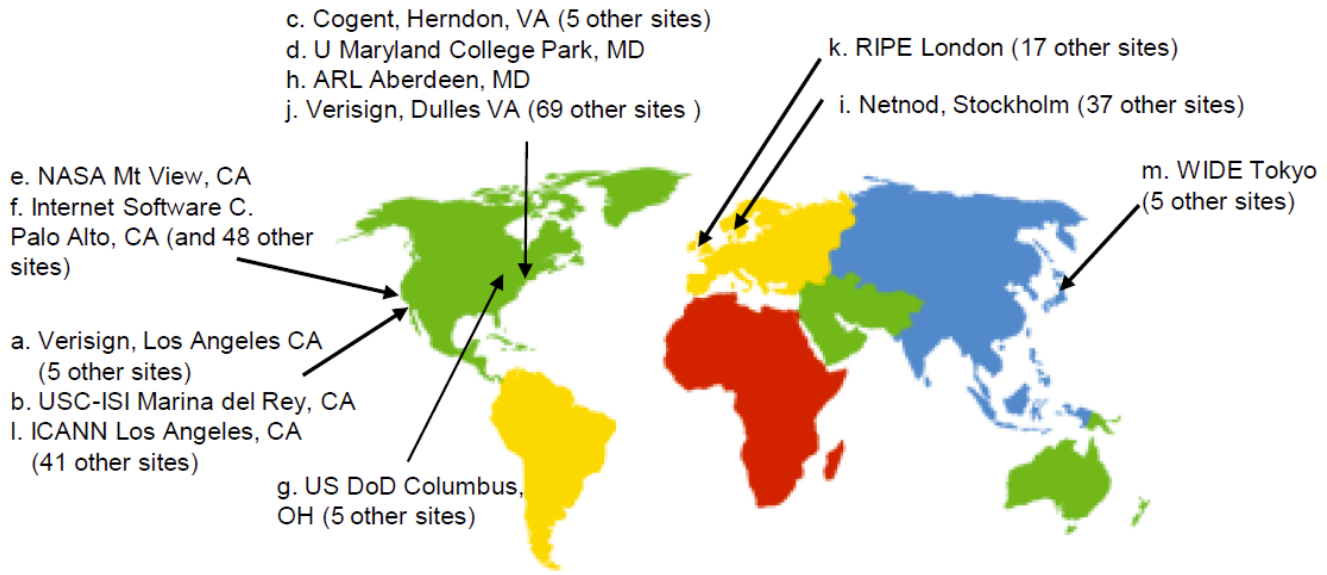
Name Server Hierarchy

- Domain Names are Managed in Servers
  - Root Name Server
  - Top-level Domain (TLD) Server
  - Authoritative Server



Root Name Server

- 13 Logical Root DNS Servers
  - official, contact-of-last-resort by name servers that can not resolve name
  - Multiple Mirrors
  - Managed by ICANN (Internet Corporation for Assigned Names and Numbers)

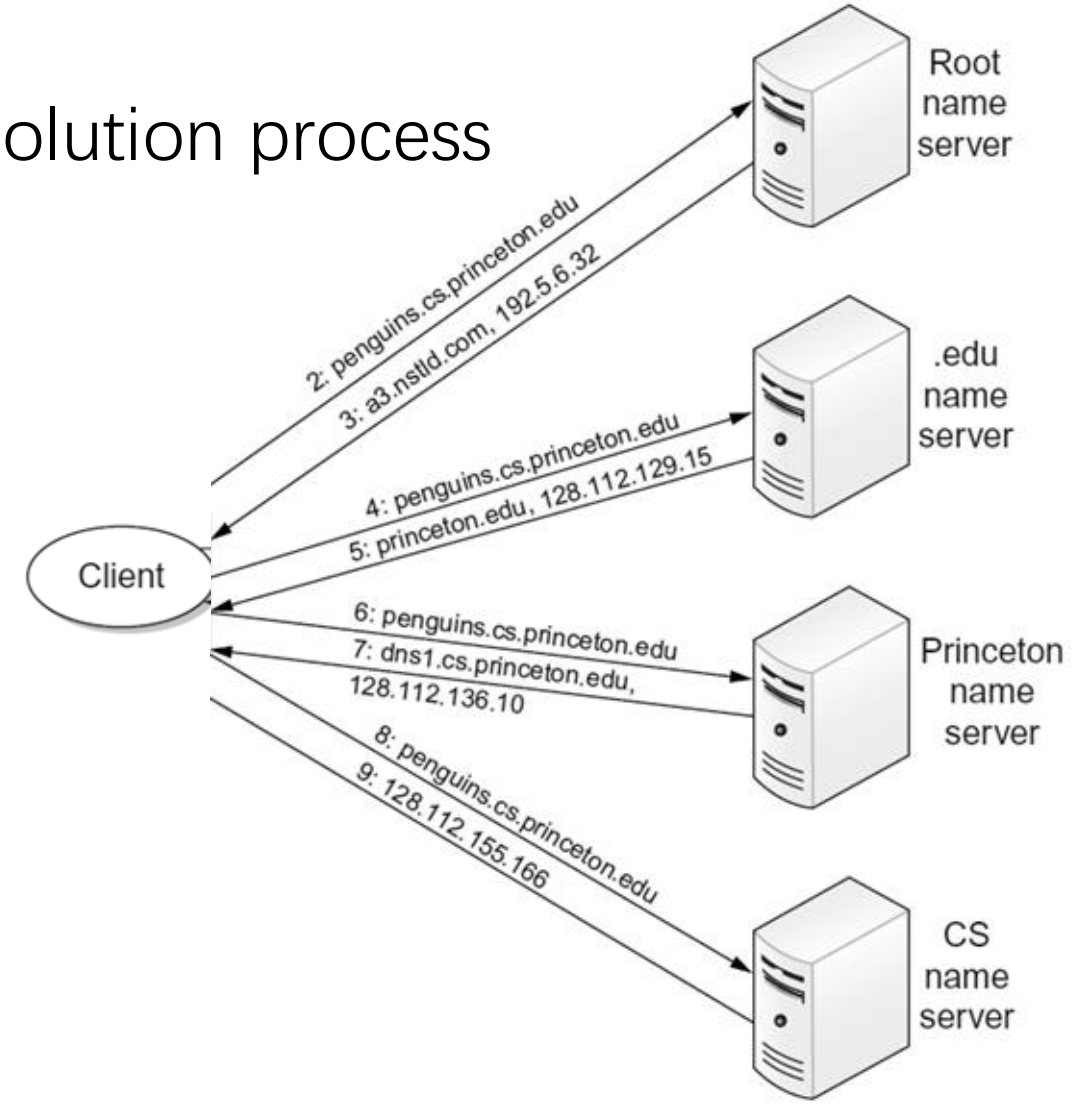


TLD and Authoritative Servers

- Top-level Domain (TLD) Servers
  - Responsible for com, org, net, edu, aero, jobs, museums, and all top-level country domains, e.g.: uk, fr, ca, jp
  - “Big Six” Domains
    - .edu, .com, .gov, .mil, .org and .net
    - Based in the U.S.
    - Managed by Internet Corporation for Assigned Names and Numbers (ICANN)
- Authoritative Servers
  - Maintained by organization or service provider
  - Provide authoritative hostname to IP mappings for organization’s named hosts
    - eg., dns.baidu.com

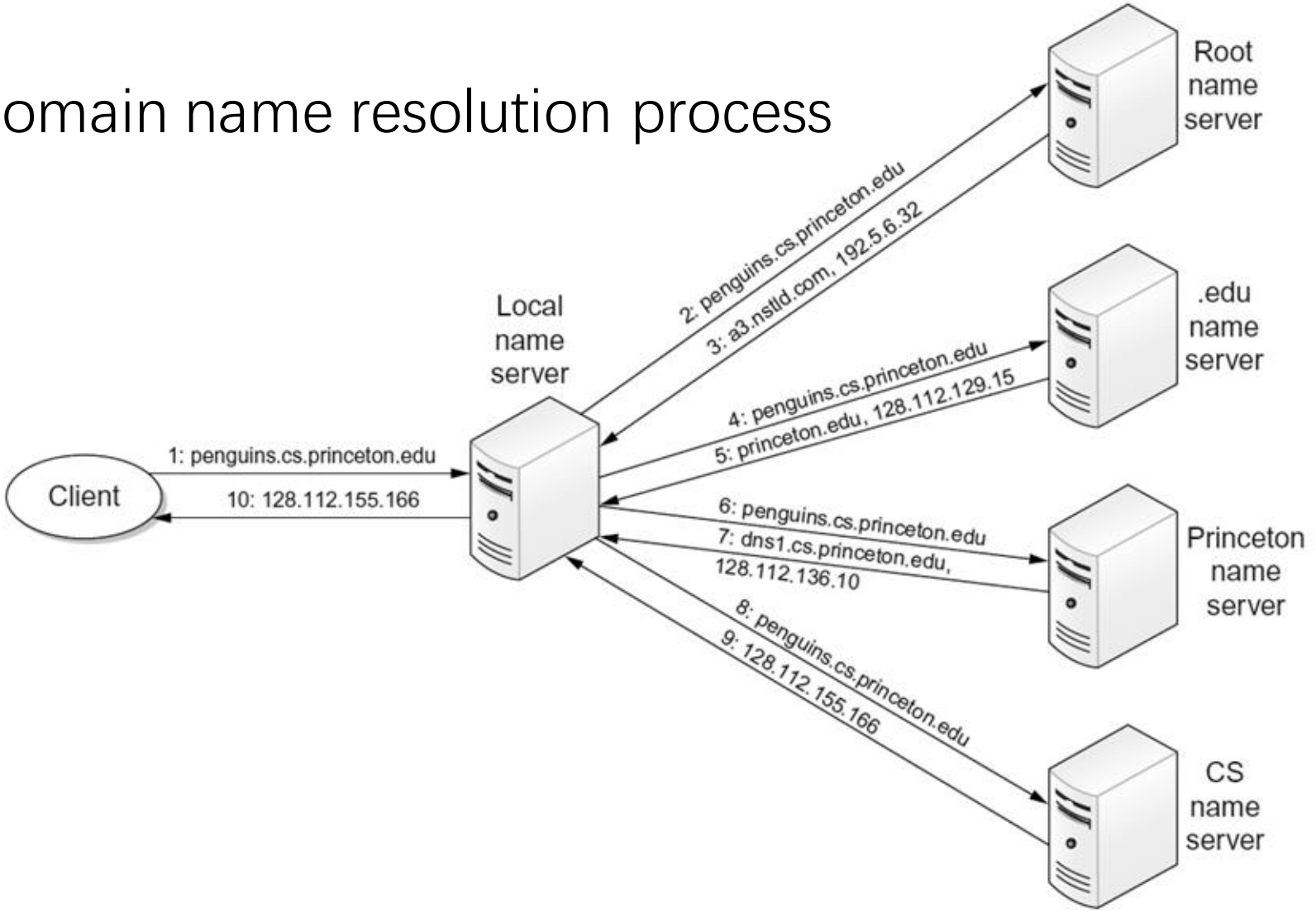
Domain Name Resolution

- Iterative domain name resolution process



Domain Name Resolution

- Iterative domain name resolution process



Local Name Server

- Each ISP (residential ISP, company, university) has one
  - It could be provided by DHCP
  - It could be configured to “big” public DNS servers
    - Examples:
      - Google: 8.8.8.8
      - Cloudflare: 1.1.1.1
      - Baidu: 180.76.76.76
    - For reliability, security, etc.

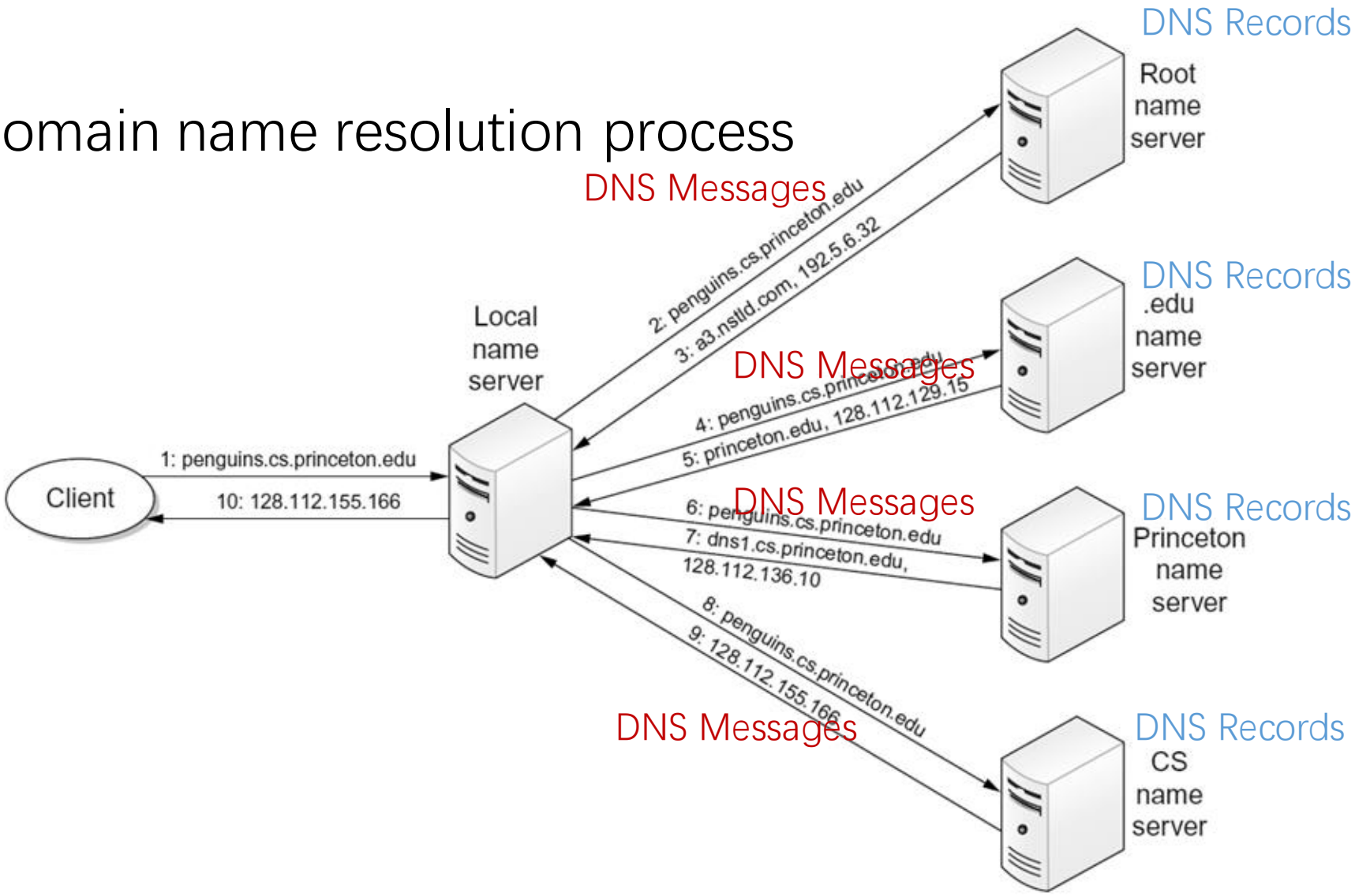
- When host makes DNS query, query is sent to its local DNS server
  - If hit cache, return IP address
  - else, forward the query to DNS hierarchy, i.e., the root name server

Demo: Default Name Server

- Window: ipconfig /all
- Linux: dig

Domain Name Resolution

- Iterative domain name resolution process

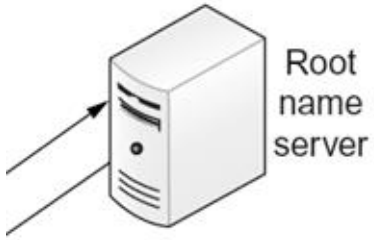


DNS Record

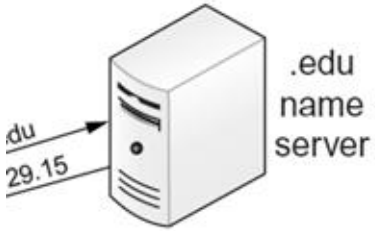
- Format
  - <name, value, type, class, ttl>
- Name
  - The name for this record
  - Determined by type
- Value
  - Could be IP address or other values
  - the value of Name
- ➢Type
  - Four Types
- Class
  - Only one value: IN (internet)
- TTL
  - Time to live

- Type=A (address)
  - Name: hostname
    - eg.: shanghaitech.edu.cn
  - Value: IP address
- Type=NS (name server)
  - Name: domain
    - e.g.: .com
  - Value: hostname
- Type=CNAME (canonical name)
  - Name: alias name for some “canonical” (the real) name
  - Value: canonical name
- Type=MX
  - Name: mail server name
    - eg.: mail.google.com, shanghaitech.edu.cn
  - Value: IP address

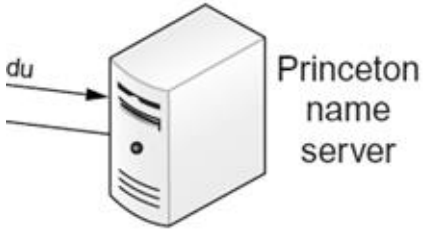
DNS Record




```
<edu,a3.nstld.com,NS,IN>
<a3.nstld.com,192.5.6.32,A,IN>
<com,a.gtld-servers.net,NS,IN>
<a.gtld-servers.net, 192.5.6.30,A,IN>
```




```
<princeton.edu,dns.princeton.edu,NS,IN>
<dns.princeton.edu,128.112.129.15,A,IN>
```

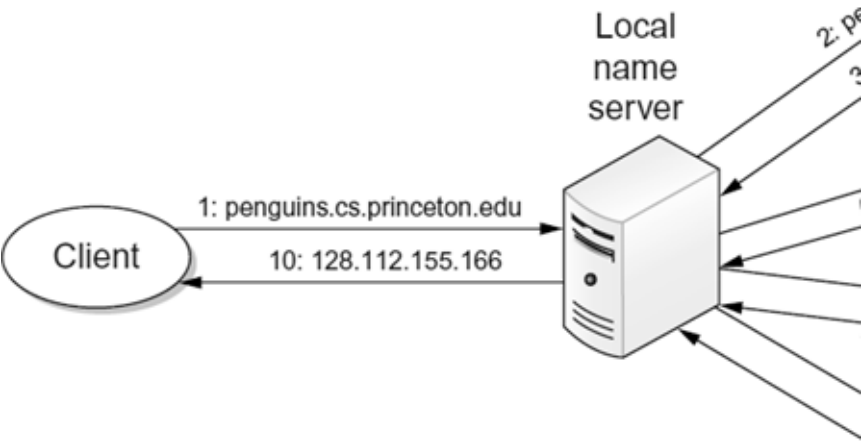



```
<email.princeton.edu,128.112.198.35,A,IN>
<penguins.cs.princeton.edu,dns1.cs.princeton.edu,NS,IN>
<dns1.cs.princeton.edu,128.112.136.10,A,IN>
```


```
<penguins.cs.princeton.edu,128.112.155.166,A,IN>
<www.cs.princeton.edu,coreweb.cs.princeton.edu,CNAME,IN>
<coreweb.cs.princeton.edu,128.112.136.35,A,IN>
<cs.princeton.edu,mail.cs.princeton.edu,MX,IN>
<mail.cs.princeton.edu,128.112.136.72,A,IN>
```

- Type=A
  - Name: hostname
    - eg.: shanghaitech.edu.cn
  - Value: IP address
- Type=NS
  - Name: domain
    - e.g.: .com
  - Value: hostname
- Type=CNAME
  - Name: alias name for some "canonical" (the real) name
  - Value: canonical name
- Type=MX
  - Name: mail server
    - eg.: gmail.com, shanghaitech.edu.cn
  - Value: mail server name
    - eg,: mail.shanghaitech.edu.cn

DNS Record




```
<'root', a.root-servers.net,NS,IN>
<a.root-servers.net, 198.41.0.4,A,IN>
```

- Type=A
  - Name: hostname
    - eg.: shanghaitech.edu.cn
  - Value: IP address
- Type=NS
  - Name: domain
    - e.g.: .com
  - Value: hostname
- Type=CNAME
  - Name: alias name for some "canonical" (the real) name
  - Value: canonical name
- Type=MX
  - Name: mail server
    - eg.: gmail.com, shanghaitech.edu.cn
  - Value: mail server name
    - eg,: mail.shanghaitech.edu.cn

Demo: DNS Query

- Linux & windows: dig
- Online:
  - https://www.diggui.com

DNS Caching

- Once (any) name server learns mapping, it caches mapping
  - Cache entries timeout (disappear) after some time (TTL)
- DNS Caching Exists in Every Place of the Hierarchy
  - Local DNS servers cache names of high-frequency
  - OS and browser of PC caches names of high-frequency
  - etc.

Demo: Local Host Caching

- Windows
  - ipconfig /displaydns
- Linux
  - Has no OS DNS caching
- Network Browser
  - chrome://net-internals/#dns

How to Reach shanghaitech.edu.cn?

- Check local cache (assume DNS miss) to find IP of shanghaitech.edu.cn
- Check local DNS server to find IP of shanghaitech.edu.cn
  - Same subnet: use ARP to find DNS server's MAC
  - Different subnet: use ARP to find gateway's MAC, then route the DNS query to the local DNS server
- Local DNS server resolves IP of shanghaitech.edu.cn
  - Reply to host
- Connect to the IP of shanghaitech.edu.cn
  - Same subnet: ARP
  - Different subnet: Routing

Reference

- Textbook 9.3