Naming

Content taken from the following:

"Distributed Systems: Principles and Paradigms" by Andrew S. Tanenbaum and Maarten Van Steen (Chapter 4)
Various online sources (including openclipart.org)
Naming

- "What's in a name?"
  - "That which we call a .com by any other TLD would load just as quickly."

“There are only two hard things in Computer Science: cache invalidation and naming things.”

- Phil Karlton (Netscape)
Trivia

- What is *Netscape*?
  - A. A threading technology
  - B. An internet service provider
  - C. A web browser
  - D. A maps/navigation service
  - E. A socket library
Addressing

- Concept of an **entity** and its **name vs. its address**
- Some names are true **identifiers**
  - Each identifier refers to at most one entity
  - Each entity is referred to by at most one identifier
  - Identifiers are never re-used at another time
- Name-to-address **binding**
  - **Name space**: domain of all possible names
  - **Static vs. dynamic**
  - **Central vs. decentralized**
    - **Name server**: central host responsible for maintaining bindings
Addressing

- Which of the following is the most decentralized name binding?
  - A. Mailing addresses
  - B. Socrative participant names
  - C. Subreddits
  - D. Human nicknames
  - E. Xbox gamertags
Naming schemes

eb40af8e
\bin/
bash
c6c1904c
\etc/
passwd
0eced3ae
\usr/
nano
28dec8ba
vim
4b6683e7
lib/
88c9618b

456, Weikle
3566223f
458, Heydari
38b22b10
470, Lam

Flat          Structured          Attribute-based

(444, Molloy)
(446, Bernstein)
(456, Weikle)
(458, Heydari)
(470, Lam)
Flat naming

- Identifiers contain no location information
- Various lookup approaches
  - Broadcast / multicast
  - Forwarding pointers
  - Proximity routing
- Examples: ARP, Chord
Distributed hash tables

- **Chord** uses an m-bit identifier space and modulo arithmetic
  - Key k is stored at succ(k), the node with the smallest id ≥ k
- Each node maintains a **finger table** of forward shortcuts
- To look up k, repeatedly follow lookups in finger table
  - Goal: halve distance to destination every hop
Which of the following is the maximum size of the finger table for a 256-node Chord network?

- A. 0
- B. 1
- C. 8
- D. 32
- E. 128
Structured naming

- Root vs. leaf nodes
- Absolute vs. relative names
  - Global vs. local names
- Iterative vs. recursive resolution
- Linking and aliasing
  - Hard vs. soft (symbolic) links
- Mounting and mount points
- Examples: file systems, DNS, NFS

<table>
<thead>
<tr>
<th>Filesystem</th>
<th>Size</th>
<th>Used</th>
<th>Avail</th>
<th>Use%</th>
<th>Mounted on</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev/mapper/rhel_login01-root</td>
<td>50G</td>
<td>23G</td>
<td>28G</td>
<td>46%</td>
<td>/</td>
</tr>
<tr>
<td>/dev/sda6</td>
<td>497M</td>
<td>206M</td>
<td>292M</td>
<td>42%</td>
<td>/boot</td>
</tr>
<tr>
<td>nfs.cluster.cs.jmu.edu:/nfs/home</td>
<td>100G</td>
<td>4.6G</td>
<td>96G</td>
<td>5%</td>
<td>/nfs/home</td>
</tr>
<tr>
<td>nfs.cluster.cs.jmu.edu:/nfs/scratch</td>
<td>2.0T</td>
<td>862G</td>
<td>1.2T</td>
<td>43%</td>
<td>/scratch</td>
</tr>
</tbody>
</table>
Which of the following is an example of a **structured** (as opposed to **flat**) name binding?

- A. Mailing addresses
- B. Socrative participant names
- C. Subreddits
- D. Human nicknames
- E. Xbox gamertags
IPv4

- IPv4: 32 bits - four octets w/ CIDR notation (/8, /16, etc.)
  - Classful addressing: Class A, Class B, Class C
  - IETF and IANA allocate addresses (32 bits - 4 billion total addresses)
  - Published in 1981; now nearly exhausted

- Notable networks
  - Private (10.0.0.0/8)
  - Loopback (127.0.0.0/8)
  - JMU (134.126.0.0/16)
  - Private (192.168.0.0/16)

An IPv4 address (dotted-decimal notation)

172.16.254.1

10101100 .00010000 .11111110 .00000001

One byte = Eight bits

Thirty-two bits (4 x 8), or 4 bytes

https://xkcd.com/195/
IPv4 map

from https://ant.isi.edu/address/browse/index.html
IPv4

• What is the total number of addresses in IPv4?
  – A. $2^8$
  – B. $2^{16}$
  – C. $2^{32}$
  – D. $2^{64}$
  – E. $2^{128}$
IPv6

- IPv6 published in 1998
  - 128 bits - $3.4 \times 10^{38}$ total addresses
  - Eight groups of 16 bits (4 hex chars)
  - 64-bit routing prefix, 64-bit host/interface identifier
  - Slow uptake due to migration complications

![IPv6 address diagram](https://en.wikipedia.org/wiki/IPv6)
IPv6

• What is the total number of addresses in IPv6?
  - A. $2^8$
  - B. $2^{16}$
  - C. $2^{32}$
  - D. $2^{64}$
  - E. $2^{128}$
The IPv6 name space is far larger than you think!

- In fact, there is NO WAY to draw the two address spaces to scale. If IPv4 were a 1.6-inch square, IPv6 would be a square the size of the solar system!

- \(2^{128} \approx 10^{38}\) \(\gg\) the number of drops of water in all the world’s oceans \((10^{25})\) or the number of stars in the observable universe \((10^{23})\)

- “If we had been assigning IPv6 addresses at a rate of 1 billion per second since the earth was formed, we would have by now used up less than one trillionth of the address space.”

- “We could assign an IPv6 address to every atom on the surface of the earth – and have enough addresses left over for another hundred earths.”

Sources:
Attribute-based naming

- Human-friendly resource identifiers
- Storage of (key, value) pairs
- Often implemented with distributed hash tables
  - Centralized vs. decentralized lookups
  - You will implement this in P4!
- Semantic overlay networks
  - Nodes maintain links to "semantically proximate" nodes
  - Most useful in distributed peer-to-peer networks
  - Exploit small-world effect
• Which of the following is the best example of a semantic overlay network?
  - A. Mailing addresses
  - B. Socrative participant names
  - C. Subreddits
  - D. Human nicknames
  - E. Xbox gamertags