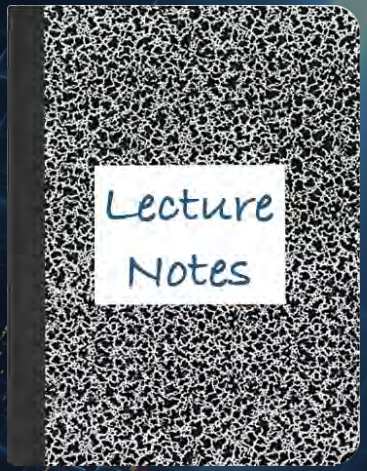
CS 417 – DISTRIBUTED SYSTEMS

Week 3: Part 1

Naming and binding



Paul Krzyzanowski

© 2022 Paul Krzyzanowski. No part of this content, may be reproduced or reposted in whole or in part in any manner without the permission of the copyright owner.

Naming things

Naming: map names to objects

- Helps with using, sharing, and communicating information

Examples

- User names: *used for system login, email, chat*
- Machine names: *used for ssh, email, web*
- Files
- Devices
- Objects, functions, variables in programs
- Network services

© 2014-2022 Paul Krzyzanowski

What's a name?

Name: identifies what you want

Address: identifies where it is

Route: identifies how to get there

Binding: the association of a name with the object

"choose a lower-level-implementation for a higher-level semantic construct"

— RFC 1498: Inter-network Naming, addresses, routing

`ls.cs.rutgers.edu` → `128.6.13.171`

© 2014-2022 Paul Krzyzanowski

Pure & Impure Names

Pure names – *identify*

- The name contains no information aside from the name
- It does not identify *where* the object can be found
- Examples:
  - c8:2a:14:3f:92:d1 — my computer's ethernet MAC address
  - p_k — my Twitter handle
  - 908-555-3836 — phone # (this used to be an impure name)

© 2014-2022 Paul Krzyzanowski

Pure & Impure Names

Impure names – *guide*

- The name contains context information
- Object is generally unmovable
- Examples:
  - pk@pk.org, pxk@cs.rutgers.edu, happyuser@verizon.net
    - User names in different Internet domains: same person or not?
    - Context (domain name) is encoded into the name
  - /home/paul/bin/qsync
    - File pathname changes if we move the object

© 2014-2022 Paul Krzyzanowski

Uniqueness of names

- Easy on a small scale – problematic on a large scale
  - It can be difficult to make globally unique names
- Uniqueness for pure names
  - Designate a bit pattern or naming prefix that does not convey information
    - Ethernet MAC address: 3 bytes: organization, 3 bytes: controller
    - IP address: network & host (variable partition)
- Uniqueness for impure names — use a hierarchy
  - Compound name: iterative list of pure names connected with separators
    - Domain name: www.cs.rutgers.edu
    - URLs: https://pk.org/417/lectures/intro.html
    - File pathnames: /usr/share/dict/words

© 2014-2022 Paul Krzyzanowski

Terms: Naming convention = syntax

Naming convention determines syntax for names

- Ideally, a format that will suit the application and user
  - E.g., human readable names for humans, binary identifiers for machines
- UNIX file names:
  - Parse components from left to right separated by /

    /home/paul/src/gps/gui.c
- Internet domain names:
  - Ordered right to left and delimited by .

    www.cs.rutgers.edu
- LDAP names
  - Attribute/value pairs ordered right to left, delimited by ,

    cn=Paul Krzyzanowski, o=Rutgers, c=US

© 2014-2022 Paul Krzyzanowski

Terms: Context = specific implementation

A particular set of *name* → *object* bindings

- Names are unique within the context
  - E.g., `/etc/postfix/main.cf` on a specific computer
- Each context has an associated naming convention
- A name is always interpreted relative to some context
  - E.g., directory /usr in a Linux file system on crapper.pk.org

© 2014-2022 Paul Krzyzanowski

Name Service

The service that performs name resolution

Allows you to resolve names

- Looking up a *name* gives the corresponding *address* as a response

Can be implemented as

- Search through file
- Database query
- Client-server program (name server) – may be distributed
- …

© 2014-2022 Paul Krzyzanowski

Directory Service ≈ Name Service

Often completely synonymous with Name service

- Extension of name service:
  - Associates names with objects, where objects have attributes
  - Can query for specific attributes
    - Example: LDAP (Lightweight Directory Access Protocol)

- Sometimes refers to searching through a hierarchical namespace

© 2014-2022 Paul Krzyzanowski

Terms: Namespace = entire set of names

A container for a set of names in the naming system

- A namespace has a scope
  - scope = region where the name exists & refers to the object
  - For example,
    - Names of all files in a directory
    - All domain names within rutgers.edu
    - E.g., Java package, local variables
- A namespace may be tree structured (hierarchical)
  - Fully-qualified or hierarchical names may be used to identify names outside the local namespace
  - Global namespace = root of the tree

© 2014-2022 Paul Krzyzanowski

Terms: Resolution

- **Resolution** = name lookup
  - Return the underlying representation of the name
  - Look up the **binding** of the name to its object

- For example,
  - www.rutgers.edu → 128.6.4.5
- Iterative resolution
  - Example: parse a pathname
- Recursive resolution
  - Example: parse a distribution list: each entity may be expanded

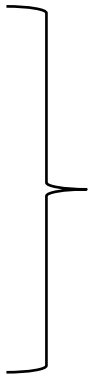
© 2014-2022 Paul Krzyzanowski

When do should you do a resolution?

Static binding
- Hard-coded

Early binding
- Look up binding before use
- Cache previously used binding

Late binding
- Look up just before use



These can cause problems!

© 2014-2022 Paul Krzyzanowski

The End

© 2014-2022 Paul Krzyzanowski

IP Domain Names

Human readable names

e.g., www.cs.rutgers.edu

Hierarchical naming scheme

- Top of hierarchy on the right
- No relation to IP address or network class

© 2014-2022 Paul Krzyzanowski