

CS 417 – DISTRIBUTED SYSTEMS

Week 3: Part 1
Naming and binding

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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

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`

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)

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

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](#)

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`

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`

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
- ...

Directory Service \approx 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

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

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

When do should you do a resolution?

Static binding

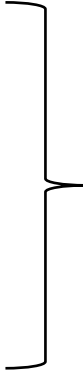
- Hard-coded

Early binding

- Look up binding before use
- Cache previously used binding

Late binding

- Look up just before use



These can cause problems!

The End

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