Names

March 21, 2018

Outline

- The Problem
- Naming Concepts
- Name Spaces
- Name Resolution
- Addional Reading

Server/Object Location

Problem: How does a client know where is the server?

Solution: Not one, but several alternatives:

- *hard coded*, seldom;
- via program arguments: more flexible, but ...;
- via configuration file;
- via *broadcast*/*multicast*;
- via a location/name service:
  - local, e.g. *rmiregistry*.
  - *global*.

Addresses

- In the labs, we have used IP addresses (and ports)
- Addresses are **names** of **access points**
- Addresses have some limitations:
  - Addresses often are location dependent and change frequently
    - E.g. when a service is moved from one computer to another
  - Addresses are bound to access points, making it difficult, e.g., to balance the load among several servers.

Names

- Names are ... sequences of symbols (bits/characters/...) that refer to entities/objects. Or better (Schoch):

  *The **name** of a resource indicates **what** we seek,*
  *an **address** indicates **where** it is,*
  *(and a **route** tells us **how** to get there.)*

- Names have some advantages over addresses:
  - They can be human-friendly.
  - They can hide both complexity and dynamics
    - E.g. they can hide access point changes
- Naming is a layer of indirection
  - Ultimately you need an address to access/operate on an object
  - But, as someone said:

    "All problems in CS can be solved by another layer of indirection"

Pure Names

- Are names that contain no informatin whatsoever about what they refer to:
  - Not only about location, but about anything else
  - They do not commit the system to anything
  - They are useful only for comparison

Problems/challenges of pure names

- where to look them up to find out information about them?
- how do you know that an object does not exist? How can a global search be avoided?
- how to engineer uniqueness reliably in a distributed system?

Problems/challenges of impure names

- what if the information yielded by the name, e.g. location, is not valid anymore?
  - This is specially relevant for mobile systems, and requires appropriate solutions

- Examples?
  - From the "real" world?
  - From the "virtual" world?

Identifiers

- An **identifier** is a name with 3 properties:
  1. an identifier refers to an entity at most;
  2. an entity has at most one identifier;
  3. an identifier refers always to the same entity (it is never reused).
- Identifiers provide a mean to refer to an entity in a precise way, independently of its access points.
- Examples?
  - From the "real" world?
  - From the "virtual" world?

Name Spaces

Name Space

- Names are organized into name spaces.
- A name space is composed of a set of bindings of a name to an object/entity (or to one of its attributes, e.g. addresses)
- A name space defines:
  - the syntax and structure (flat vs. hierarchical) of a name in that space;
  - the rules to find a binding of a name (name resolution)

Naming Domain/Context

- Is the scope of a name
  - Names in a domain/context must be unique
- Allows to partition a name space
  - Often, a naming domain has an administrative authority for assigning names within it
  - An administrative authority may delegate name assignments for sub-domains (e.g. in DNS)

Name Space Structure

- Most name spaces have a hierarchical structure:
  - OS filesystem
  - Domain Name System (DNS)
  - Postal addresses
  - Car license plates are resolved in another context – per country, region etc.
- A hierarchical structure simplifies:
  - the assignment;
  - the resolution

  of names
- Up to recently (about the year 2000) nobody knew how to implement efficiently name resolution in a flat name space.

Name Resolution - binding

- **Name resolution/binding** is the procedure to find the value for an attribute, usually an address, of a named entity that allows that entity to be used/accessed
- A name is always resolved in the context of its name space:

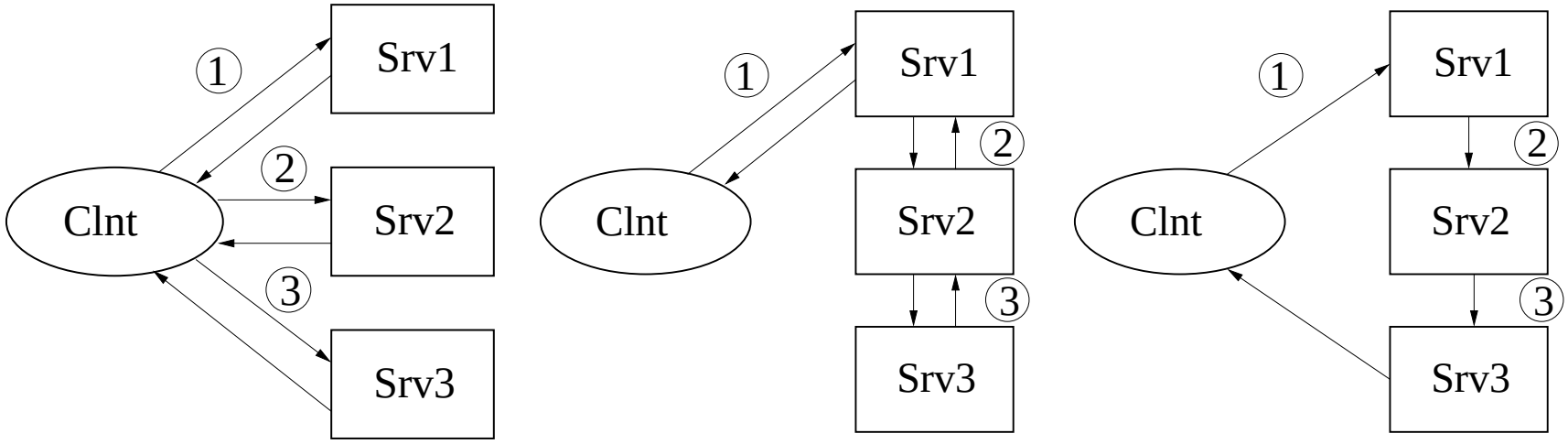
file name	->	OS filesystem
Java program variable	->	JVM executing the program
ISBN of a publication	->	ISBN (Intern.Standard Book Number)
Car license plates	->	national/regional license plate regist

- Late binding is considered good practice
  - Programs should use names rather than addresses
  - Name resolution is performed by a naming service (e.g. `rmiregistry`)

Name Resolution in a Distributed System

- In small scale distributed systems, name resolution requires only one server:
  - E.g., the `rmiregistry` or the `portmap`.
- In distributed systems of larger scale, name resolution may require more than one server. In this case, name resolution can use one of 3 strategies:
  1. Iterative
  2. Recursive.
  3. Transitive.

Name Resolution: Strategies



Iterative **Recursive** **Transitive**

- Recursive name resolution:
  - Allows for caching at servers
    - This may make resolution more efficient (with lower communication costs)
  - But, it:
    - requires servers to keep state
    - makes it harder to set the values of timeouts (unless there is immediate acknowledgment)
- Transitive name resolution is seldom used

Name Resolution and *Closure Mechanism*

Names are resolved always in a context

Problem

- How do you get an initial "context" from which you can start resolving a names?
  - How do you get a "remote reference to the `rmiregistry`"?
  - How to start the name resolution of a name of a file system: i.e. where is the root directory?
  - How to find the IP address of a DNS server to resolve a DNS name?

Response

Use a **closure mechanism**

- Typically this is an *ad-hoc* and simple solution.

Additional Reading

- Chapter 5 of Tanenbaum e van Steen, *Distributed Systems, 2nd Ed.*
  - Section 5.1: *Names, Identifiers and Addresses*
  - Section 5.3: *Structured Naming*