THE UNIVERSITY OF MELBOURNE

Learning Outcomes

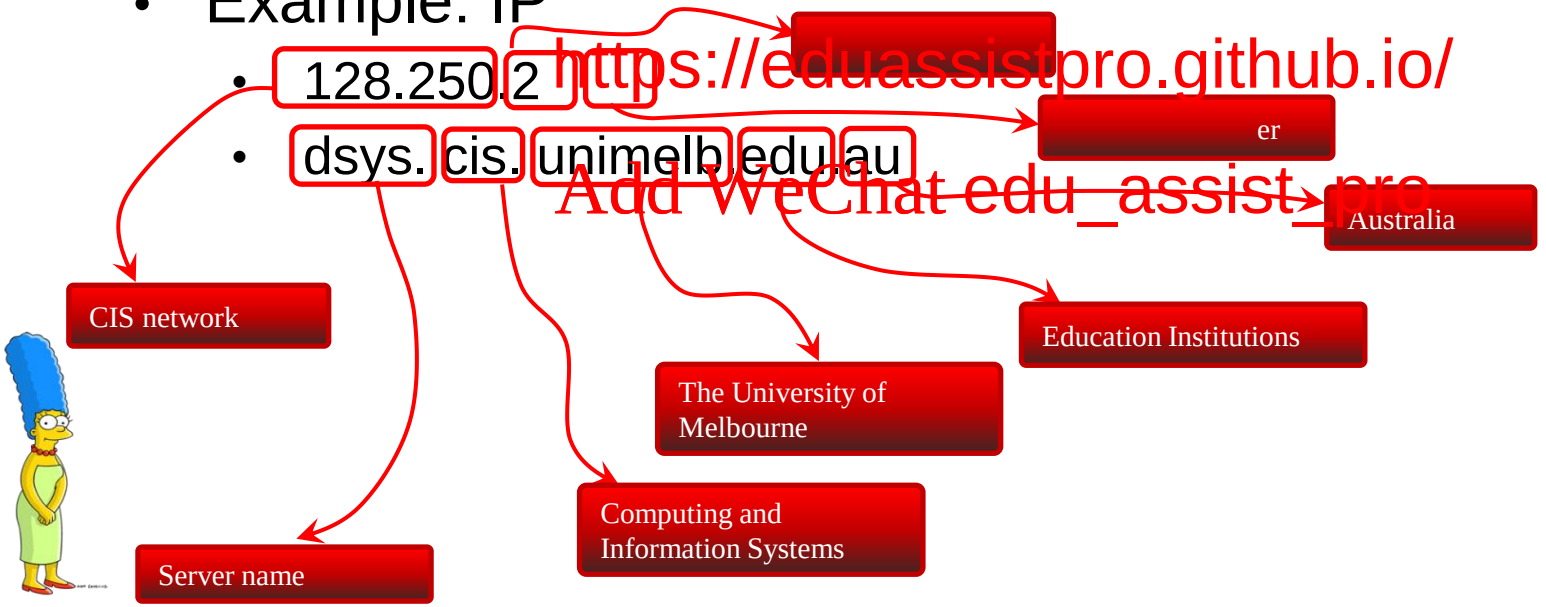
- To understand the need for naming systems in distributed systems
- To be familiar with the design requirements such as structure and management of name spaces, and operations supported by them.
- To understand the operation of the Internet naming service – DNS (Domain Name System)
- To understand str tory services – X.500 Directory Service ry Access Protocol)
- Reading: Distributed Systems: Con sign by George Coulouris (5th edition): Chapter 13: , 13.2, 13.3

Which one is easy for humans and machines? and why?

- 74.125.237.83 or google.com
- 128.250.1.25 or cis.unimelb.edu.au
- Disk 4, Sector 2, block 5 or /usr/home/tawfiq/Hello.java
- tawfiq@128.250.1.25 or tawfiqul.islam@unimelb.edu.au

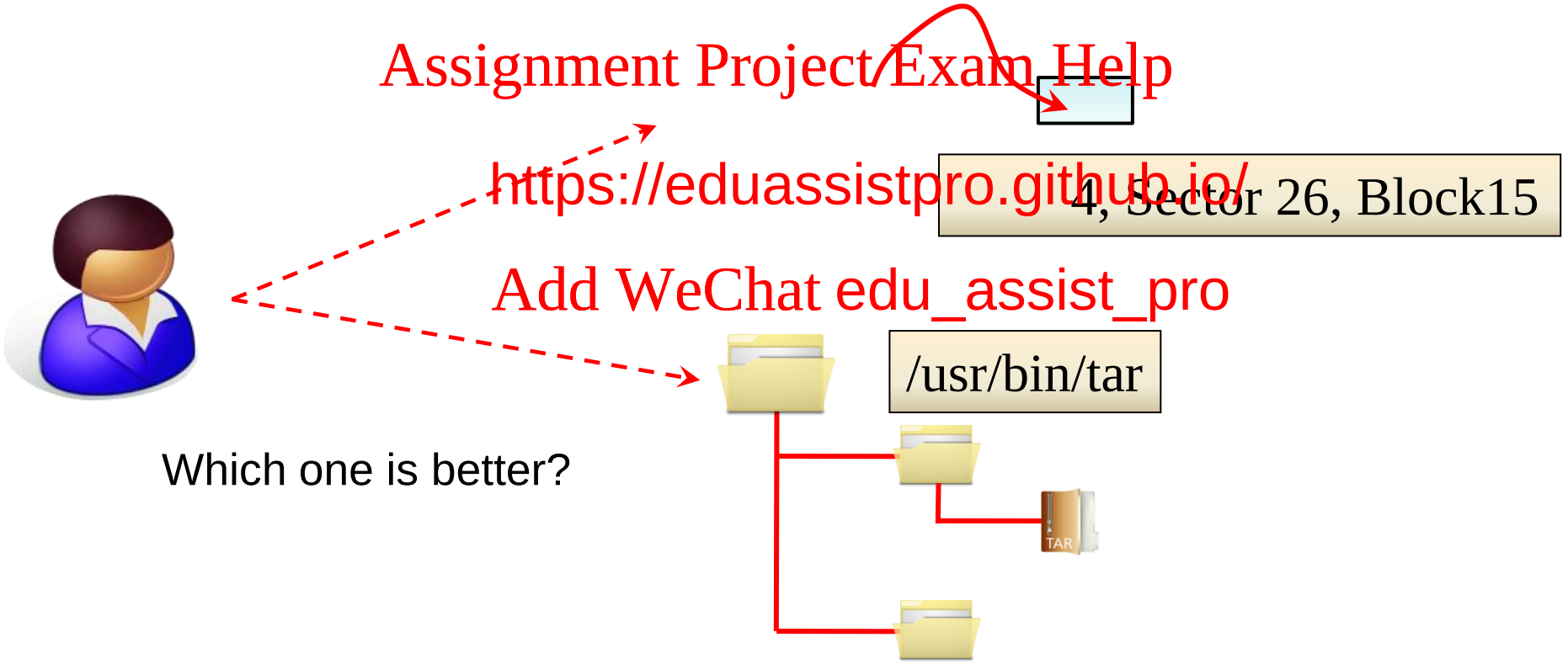
Names or Codes, or Numbers?

- Names (when meaningful) are easier to remember than codes or numbers…
- Number (or sequence codes) are more useful for structuring data and locating resources by a program..
- Example: IP
  - 128.250.2
  - dsys. cis. unimelb. edu. au



Names or Codes, or Numbers?

- As discussed in file system (hierarchical naming of files) and mounting at right location.



Which one is better?

Names in Distributed Systems

- In a distributed system, names are used to refer to a wide variety of resources such as:
  - Computers, services, remote objects, and files, as well as users.
- Naming is a fundamental issue in DS design as it facilitates communicatio
  - A name in th ccess a specific web page.
  - Processes cannot share resou d by a computer system unless they can name them ac
  - Users cannot communicate wit er via a DS unless they can name one another, with email address.

Naming Services

- **Definition**
  - In a Distributed System, a Naming Service is a specific service whose aim is to provide a consistent and uniform naming of resources, thus allowing other programs or services to localize them and obtain the required metadata for interacting with them.
  - A name service r more naming contexts, sets of bindings attributes for objects such as computers,
  - The major operation that a name orts is to resolve names.
- **Key benefits**
  - Resource localization
  - Uniform naming
  - Device independent address (e.g., you can move domain name/web site from one server to another server seamlessly).

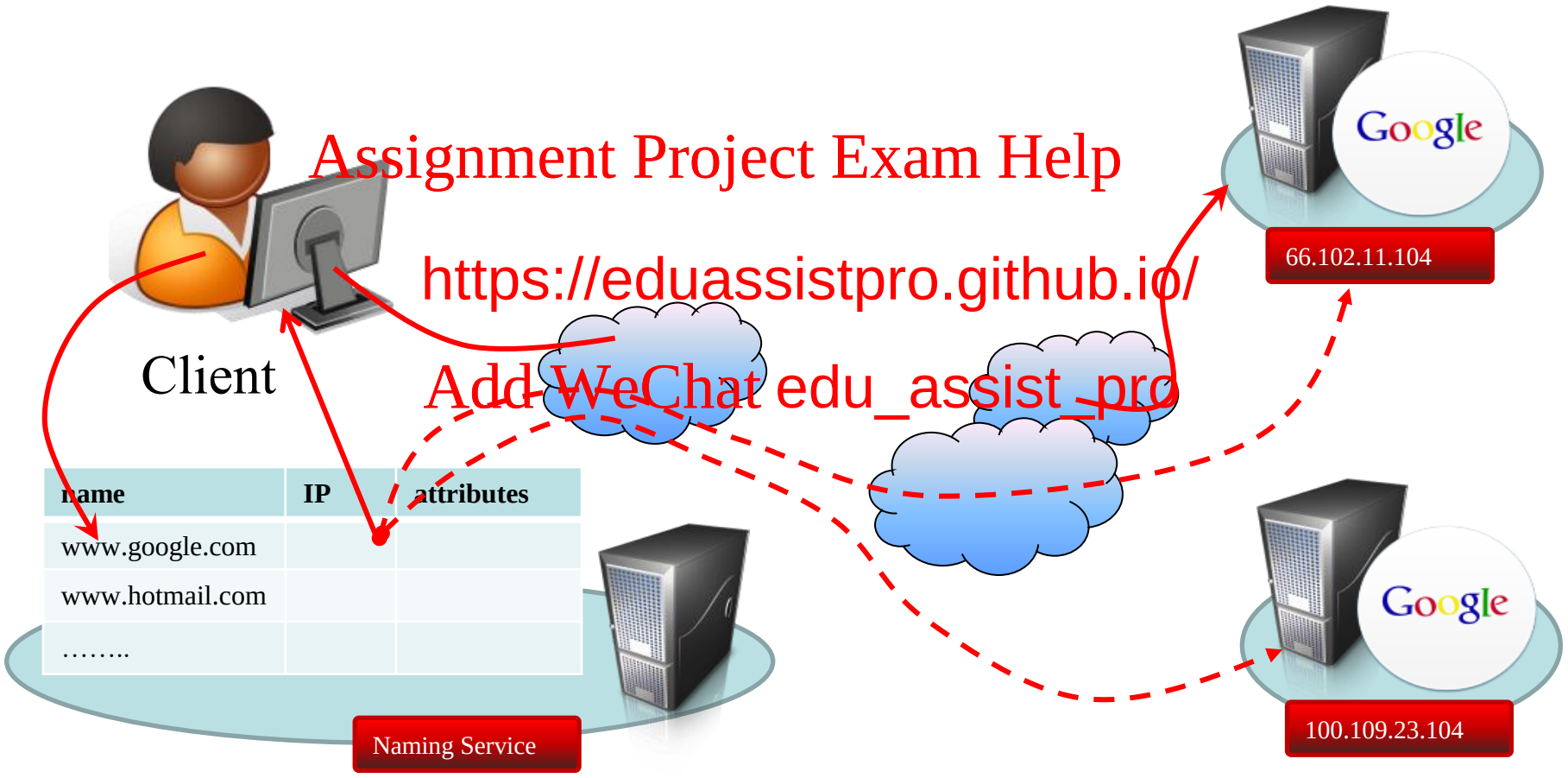
Naming Services

- How do Naming Services facilitate communication and resource sharing?
  - A URL facilitates the localization of a resource exposed on the Web.
    - e.g., abc.net.au means it is likely to be an Australian entity?
  - A consistent system to int ocesses in a distributed rces.
    - e.g., commercials use .com; n izations use .org
    - .edu, ac.uk or edu.au educati
  - Users refers to each other by means of their names (i.e., email) rather than their system ids
  - Naming Services are not only useful to locate resources but also to gather additional information about them such as attributes

The Role of Names and Name Services

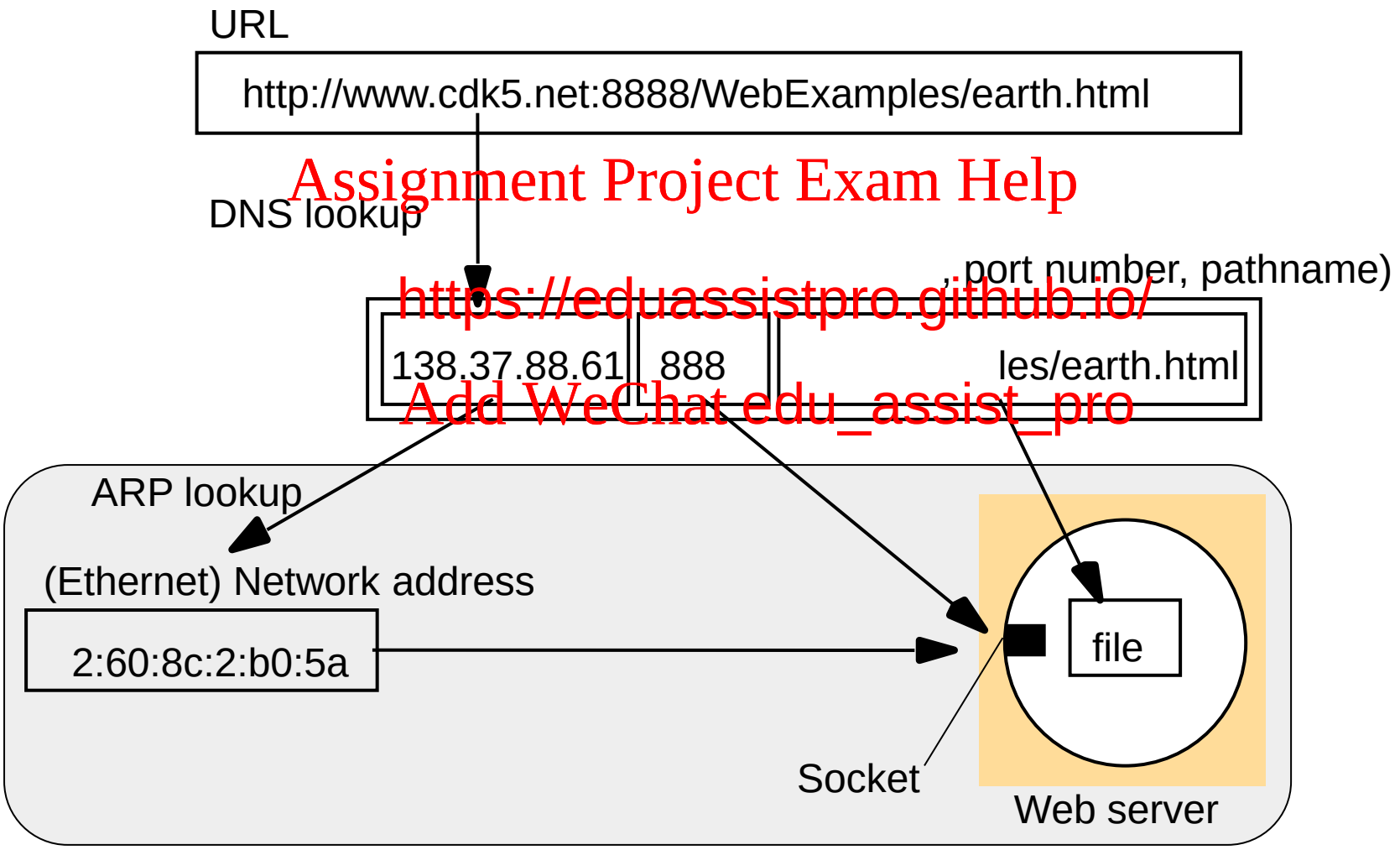
- Resources are accessed using *identifier* or *reference*
  - An identifier can be stored in variables and retrieved from tables quickly
  - Identifier includes or can be transformed to an address for an object
    - E.g. NFS file handle, CORBA remote object reference
  - A *name* is human-readable value (usually a string) that can be *resolved* to an identifier
    - Internet domai ber
    - E.g ./etc/passwd, http://www.cdk5.ne
- For many purposes, names a le to identifiers
  - because the binding of the named resource to a physical location can be changed
  - because they are more meaningful to users
- Resource names are *resolved* by name services
  - to give identifiers and other useful attributes

Name Resolution



name	IP	attributes
www.google.com		
www.hotmail.com		
……..		

Accessing Resources from URL



Names and Resources

- Currently, different name systems are used for each type of resource:

resource	*name*	*identifies*
file	pathname	file within a given file system
process	process Id	process on a given computer
port	po	a given computer

- Uniform Resource eneral any type of resource. There two main

URL Uniform Resource Locator (

- typed by the protocol field (http, ftp, nfs, etc.)
- part of the name is service-specific
- resources cannot be moved between domains

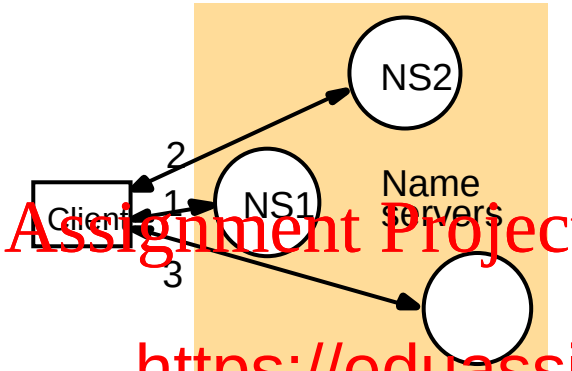
URN Uniform Resource Name (URN)

- requires a universal resource name lookup service - a DNS-like system for all resources

Navigation

- Navigation is the act of chaining multiple Naming Services in order to resolve a single name to the corresponding resource.
- Namespaces allows for structure in names.
- URLs provide a default structure that decompose the location of a resource in
  - protocol used fo
  - Internet end point of the service
  - service specific path
- This decomposition facilitates the resolution of the name into the corresponding resource
- Moreover, structured namespaces allows for iterative navigation…

Iterative Navigation



A client iteratively contacts name serve er to resolve a name

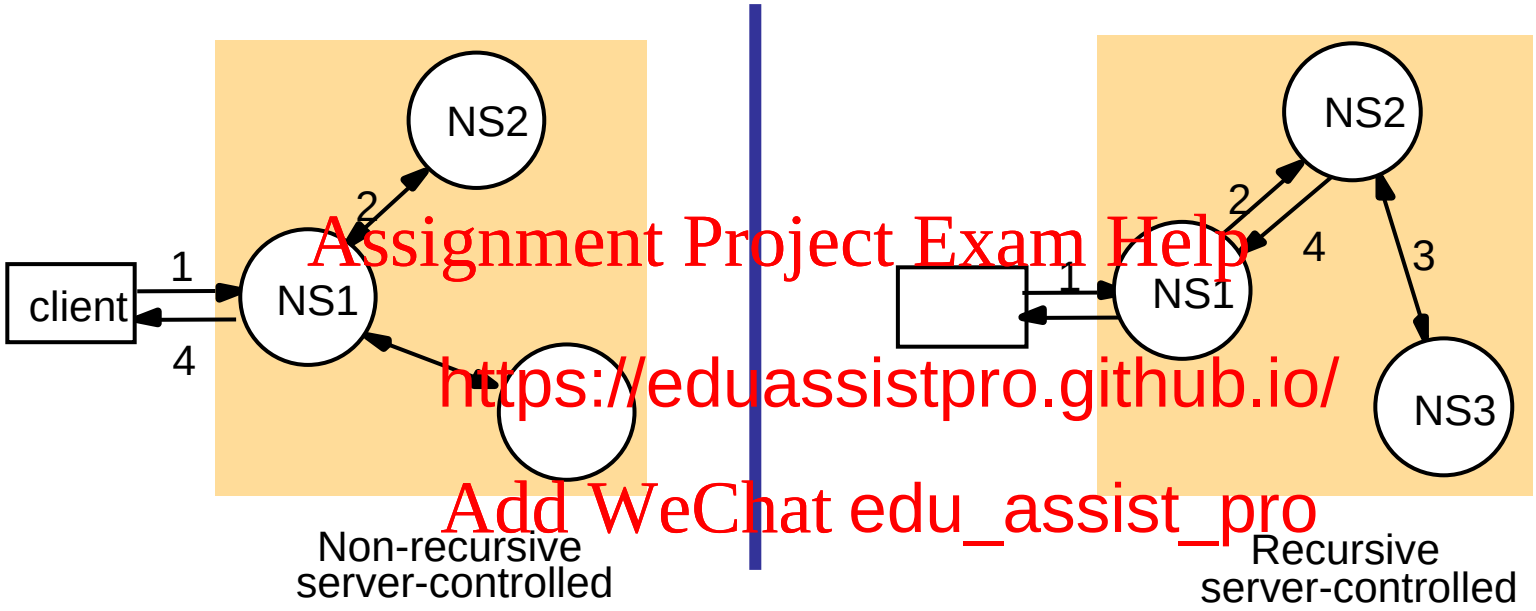
Used in:

- **DNS:** Client presents entire name to s ng at a local server, NS1. If NS1 has the requested name, it is resolved, else NS1 suggests contacting NS2 (a server for a domain that includes the requested name).
- **NFS:** Client segments pathnames (into 'simple names') and presents them one at a time to a server together with the filehandle of the directory that contains the simple name.

Server Controlled Navigation

- In an alternative model, name server coordinates naming resolution and returns the results to the client. It can be:
  - **Recursive:**
    - it is performed by the naming server
    - the server becomes like a client for the next server
    - this is nec tivity constraints
  - **Non recursiv**
    - it is performed by the client or
    - the server bounces back the lient

Non-recursive and Recursive Server Controlled Navigation



A name server NS1 communicates with other name servers on behalf of a client

DNS offers recursive navigation as an option, but iterative is the standard technique. Recursive navigation must be used in domains that limit client access to their DNS information for security reasons.

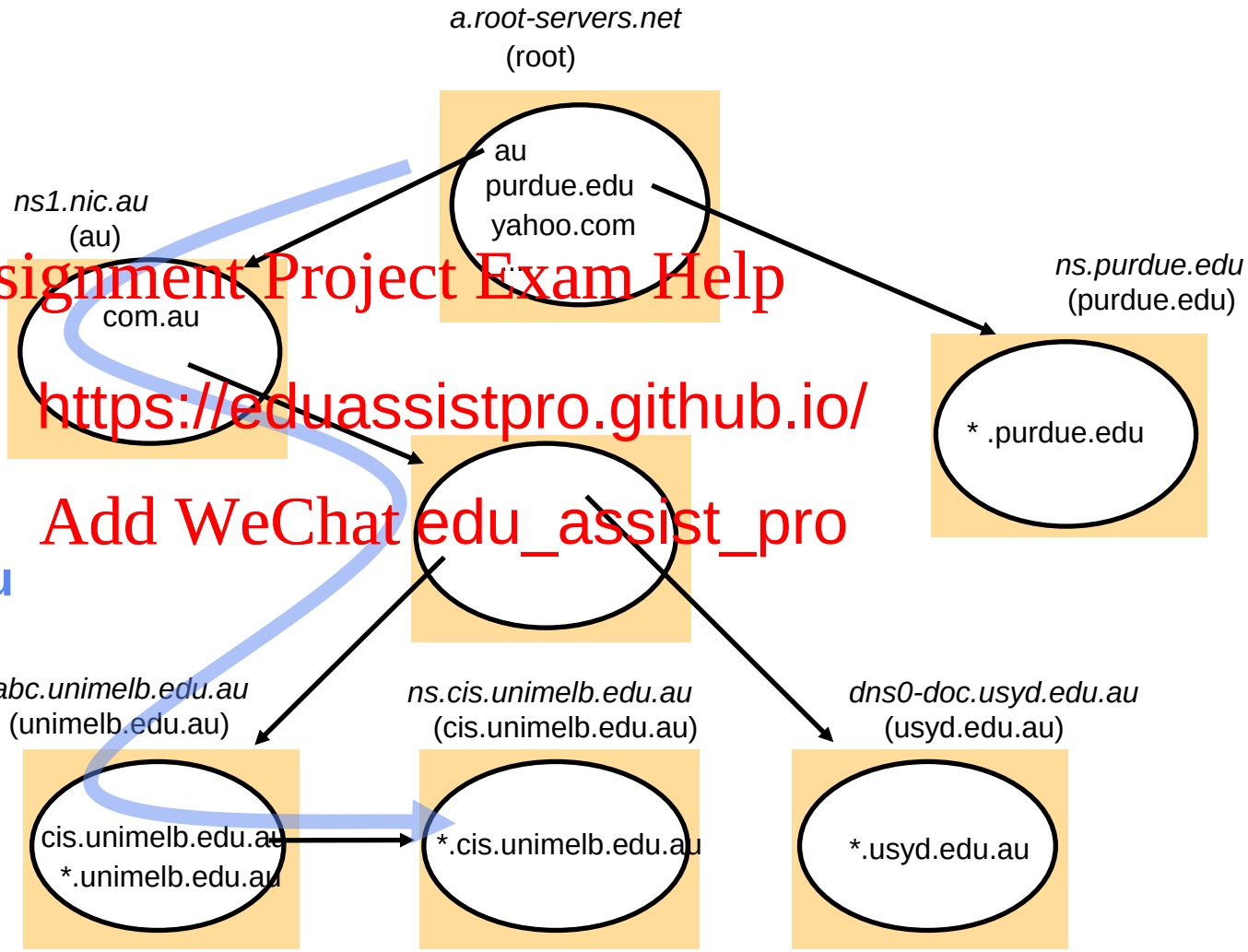
The Domain Name System (DNS)

- A distributed naming database (specified in RFC 1034/1035)
- Name structure reflects administrative structure of the Internet
- Rapidly resolves domain names to IP addresses
  - exploits caching heavily
  - typical query time
- Scales to millions ed database, caching
- Resilient to failure of a server: r
- Basic DNS algorithm for name resolution (domain name -> IP number):
  - Look for the name in the local cache
  - Try a superior DNS server, which responds with:
    - another recommended DNS server
    - the IP address (which may not be entirely up to date)

DNS Name Servers: Hierarchical Organisation

Note: Name server names are in italics, and the corresponding domains are in parentheses. Arrows denote name server entries

authoritative path to lookup:
dsys.cis.unimelb.edu.au



DNS Server Functions

- Main function is to resolve domain names for computers, i.e. to get their IP addresses
  - caches the results of previous searches until they pass their 'time to live'
- Other functions:
  - get *mail host* for
  - reverse resoluti P address
  - Host information - type of hardwa
  - Well-known services - a list of well-known services offered by a host
  - Other attributes can be included (optional)

DNS Resource Records

Record type	*Meaning*	*Main contents*
A	A computer address (IPv4)	IPv4 number
AAA	A computer address (IPv6)	IPv6 number
NS	An authorita	name for server
CNAME	The canonic	name for alias
SOA	Marks the start of data for a zone	governing the zone
PTR	Domain name pointer (reverse lookups)	me
HINFO	Host information	Machine architecture and operating system
MX	Mail exchange	List of *<preference, host>* pairs
TXT	Text string	Arbitrary text

DNS Issues

- Name tables change infrequently, but when they do, caching can result in the delivery of stale data.
  - Clients are responsible for detecting this and recovering
- Its design makes changes to the structure of the name space difficult. For exa
  - merging previous a new root
  - moving subtrees to a different part of e.g. if Scotland became a separate country, its domains should o a new country-level domain.)

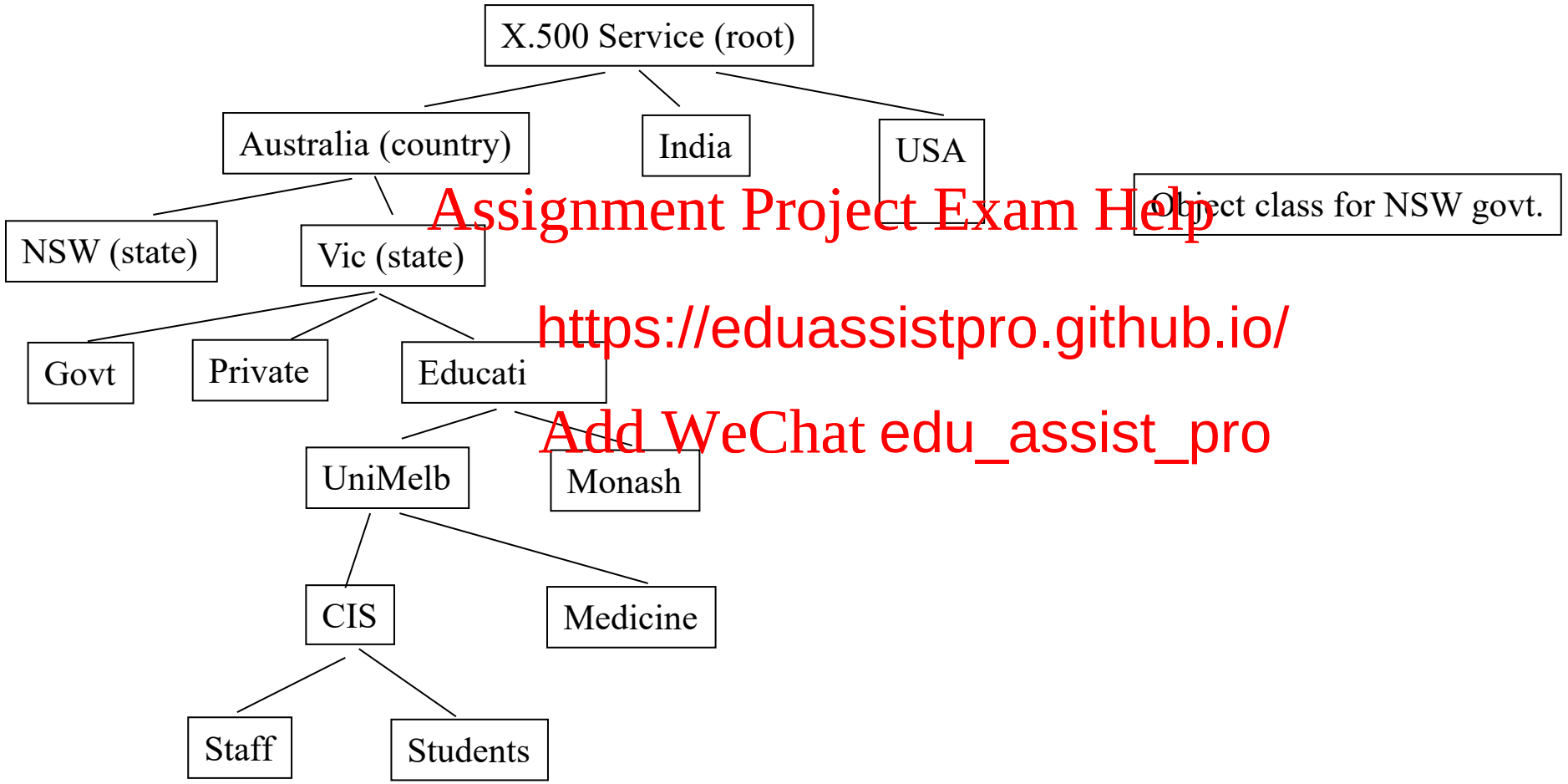
Directory Services

- Sometime users wish to find a particular person or resource, but they don't know its name, only some of its attributes.
  - What is the name of the user with a telephone number 03-83441344?
  - What is the name of an academic researching Cloud computing at UniMelb (e.g., ask Google!)
- Sometime users require a service, but they are not concerned with what system entity provides it.
  - Where can I print hi
- Directory services ca they store collections of bindings and attributes and also looks t match attribute-based specs.
- Directory service: 'yellow pages' for the resources in a network
  - Retrieves the set of names that satisfy a given description
  - e.g. X.500, LDAP, MS Active Directory Services
- Discovery service:- a directory service that also:
  - is automatically updated as the network configuration changes
  - discovers services required by a client (who may be mobile) within the current scope, for example, to find the most suitable printing service for image files after arriving at a hotel.
  - Examples of discovery services: Jini discovery service, the 'service location protocol'

X.500 Directory Service

- X.500 and LDAP (Lightweight Directory Access Protocol)
  - a hierarchically-structured standard directory service designed for world-wide use
  - X.500 is standardised by ITU (International Telecommunication Union) and ISO
  - accommodates resource descriptions in a standard form and their retrieval for any resource (online or offline)
  - never fully deploye sis for LDAP, the Lightweight Directory Access Pr IETF RFC 2251.
  - A secure access to directory through a also supported.

Part of the X.500 Directory Information Tree (DIT)



Summary

- Names services facilitate communication and resource sharing in distributed systems.
- They are playing an important role in Distributed systems such as the Internet, Web, CDNs (Content Delivery Networks), Web Services, Location-aware services – publication and discovery
- Name services:
  - defer the binding of other attributes)
  - Names are resolve tes
  - Goals :
    - Scalability (size of database, access traffi state traffic)
    - Reliability
    - Trust management (authority of servers)
    - exploitation of replication and caching to achieve scalability without compromising the distribution of updates
- Directory and discovery services:
  - 'yellow pages' retrieval by attributes
  - dynamic resource registration and discovery