

# Week 9: Application Layer

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Intern <https://eduassistpro.github.io/> P90007

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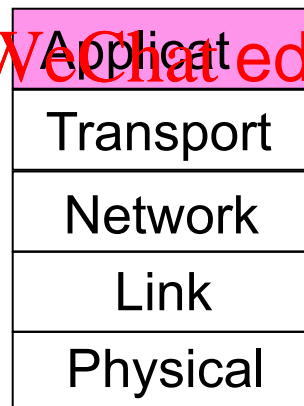
# The Last Layer in Hybrid Stack

- Application Layer
- We will look at key implementations to study this system first

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# DNS (Domain Name System)

## ■ Problem?

- IP address (32 bit), e.g., 121.7.106.83 – used for addressing datagrams
- www.yahoo.com – used by humans

## ■ Question: how do you map between IP address and name, and vice

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## ■ Domain Name

- *distributed database* implemented by many *name servers*
- *application-layer protocol* that allows a host to query the database in order to *resolve* names (address/name translation)
- used by other application-layer protocols (http, ftp, smtp)

# Conceptual Divisions of DNS Namespace

- A hierarchical naming convention; the top of the hierarchy is managed by ICANN (*The Internet Corporation for Assigned Names and Numbers*).

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The computer *robot.cs.washington.edu*

# Name Space

- Internet  
historically divided  
into over 250 top-  
level domains  
(TLD).

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# Why not centralize DNS?

- Single point of failure
- Traffic volume
- Distant centralized database
- Maintenance
- Does not scale well

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# DNS Services

- hostname to IP **address translation**
- host **aliasing** – alias names for canonical names
  - e.g., canonical `relay1.westcoast.enterprise.com` aliased to `www.enterprise.com`

- mail server aliasing

`mail.com`, `Bob@re` aliased to `Bob@hotmail.com`

- **load distribution**

- *busy sites are replicated over multiple servers*
- *a set of IP addresses is associated with one canonical name*
- *DNS server rotates the order of the addresses to distribute the load*

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# Domain Name Characteristics

- Domain names:
  - ❑ Are case insensitive
  - ❑ Can have up to 63 characters per constituent
  - ❑ Can have up to 255 chars per path
  - ❑ Can be internationalised (since 1999)
- Naming conventions for geographical or organisational or physical location
  - ❑ au.ibm.com / uk.ibm.com (for e)
  - ❑ ibm.com.au / ibm.co.uk (for web)
- Absolute domain names ends in a “.”
- Relative domain names partially specify the location and can be used only within the context of an absolute domain name



# Zone Name Servers

- DNS namespace divided into **non-overlapping zones**
- Each zone contains a part of the DNS tree and also name servers for that zone -
  - usually 2 name servers: the primary and secondary name server
  - sometimes secondary is authoritative for the zone (for reliability)
- Name servers are arranged in a hierarchical manner extending from a set of root servers

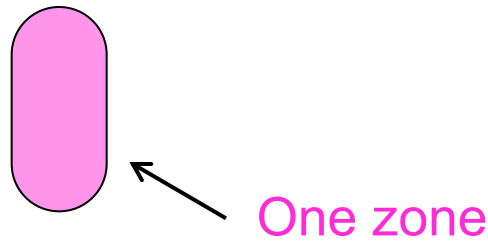
# Name Servers

- The DNS name space is divided into nonoverlapping zones; each circled contains some part of the tree.

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# Root Name Servers

- The root servers form the authoritative cluster for enquiry in the event of locally-unresolvable name queries
- There are 13 root servers
  - In some cases, a cluster of servers may be used to provide redundancy

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# Resource Records

- The **Resource Records** (RR) are the key objects in the Domain Name System
- A RR consists of a domain name, TTL, class, type, value
  - Domain Name: which domain this record applies to
  - TTL: indicates stability or temporal extent of the record
  - Class: IN for internet (ed)
  - Type: a closed vocabulary
    - A : The Internet address of the host
    - CNAME : The canonical name for an
    - MX : The mail exchanger
    - NS : The name server
    - PTR : The host name if the query is in the form of an Internet address; otherwise the pointer to other information
    - SOA : The domain's start-of-authority information
  - Value: data (semantics depend on record type)

# Asking for Domain Name: Example

User requests the URL

`www.someschool.edu/index.html`

1. User machine runs the client side of the DNS software
2. Browser extracts the domain name from the URL, and passes it to the application
3. DNS client sends a query for the domain name to a DNS server
4. DNS client eventually receives a reply containing the IP address for the hostname
5. Browser initiates a TCP connection to the process located at port 80 at the IP address

# A Typical DNS Query: dig

```
dig www.unimelb.edu.au
```

```
; <<>> DiG 9.3.0s20021217 <<>> www.unimelb.edu.au
```

```
;; global options: printcmd
```

```
;; Got answer:
```

```
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 19905
```

```
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 2, ADDITIONAL: 2
```

```
;; QUESTION SECTION:
```

```
www.unimelb.edu.au. IN A
```

```
;; ANSWER SECTION:
```

```
www.unimelb.edu.au. 1 https://eduassistpro.github.io/
```

```
;; AUTHORITY SECTION:
```

```
unimelb.edu.au. 1217 IN NS ns2.unimel
```

```
unimelb.edu.au. 1217 IN NS ns1.unimel
```

```
;; ADDITIONAL SECTION:
```

```
ns1.unimelb.edu.au. 491 IN A 128.250.20.2
```

```
ns2.unimelb.edu.au. 494 IN A 128.250.144.180
```

```
;; Query time: 393 msec
```

```
;; SERVER: 128.250.66.5#53(128.250.66.5)
```

```
;; WHEN: Fri Apr 18 05:46:56 2014
```

```
;; MSG SIZE rcvd: 120
```

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# Domain Resource Records

← Name  
server

← IP addresses of  
computers

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← Mail  
gateways

- A portion of a possible DNS database for cs.vu.nl.

# DNS In Action

- Finding the IP address for a given hostname is called **name resolution** and is done with the DNS protocol.
- Resolution
  - ❑ Computer requests IP address to solve
  - ❑ Local name server checks for <https://eduassistpro.github.io/>
  - ❑ Root returns the name server for the domain
  - ❑ Continue down zones until name server is found
- DNS protocol:
  - ❑ Runs on UDP port 53, retransmits when lost messages
  - ❑ Caches name server answers for better performance



# Example

- Example of a computer looking up the IP for a name

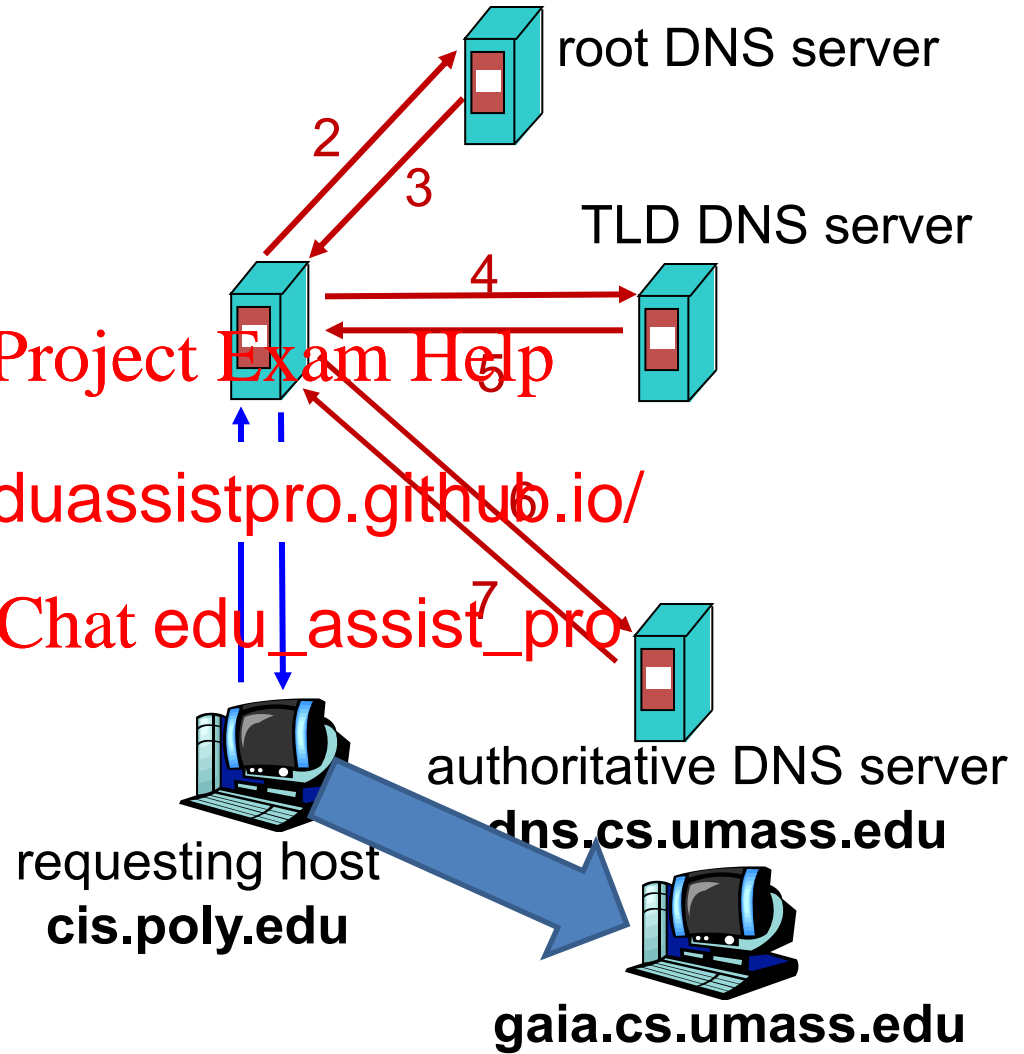
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# DNS Name Resolution Contd

- host at cis.poly.edu wants IP address for gaia.cs.umass.edu
- iterated query:
  - contacted server replies with name of server to contact
    - “I don’t know this name, but ask this server”
- recursive query:
  - server obtains mapping on client’s behalf



# DNS: Caching & Updating Records

- Once (any) name server learns a mapping, it *caches* the mapping
  - IP addresses cached in local name servers <https://eduassistpro.github.io/>
  - ➔ root name servers not often
  - Cache entries timeout (disa some time