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COMP2009J
Networks & Internet

Network Applications
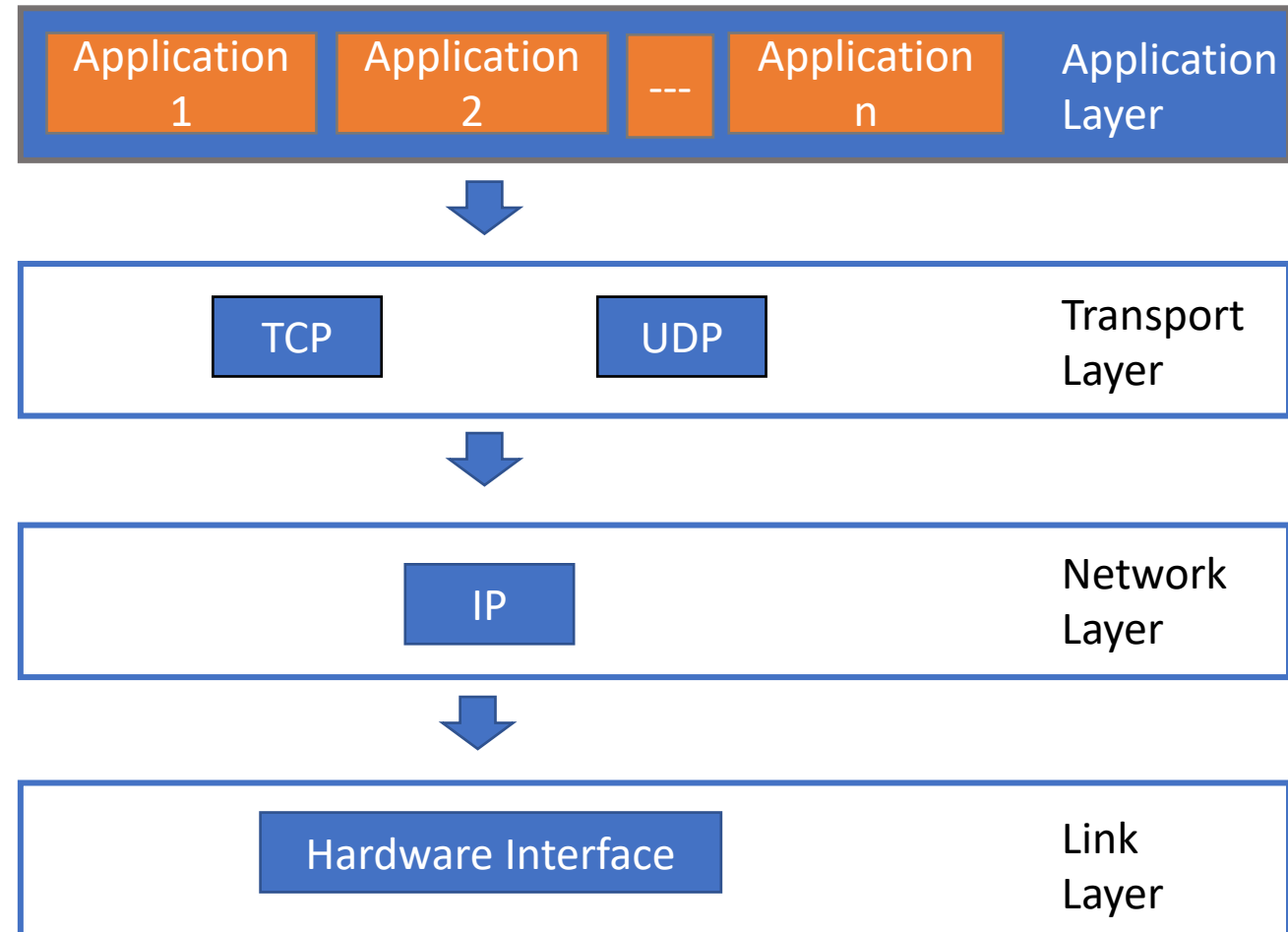
Previously

- Addressing is done using a tuple <IP Address, Port Address>
- Applications use one of two transport protocols:
  - UDP: unreliable, end-to-end, connectionless datagrams
  - TCP: reliable, end-to-end, connection-oriented byte stream

Today

- ## Network applications
  - ### Client-Server network model
  - ### Some well-known applications
    - DNS: Domain Name
    - HTTP: Browsing the Web
    - SMTP: Sending Emails

Application 1	Application 2	---	Application n	Application Layer

↓

		Transport Layer
TCP	UDP	

↓

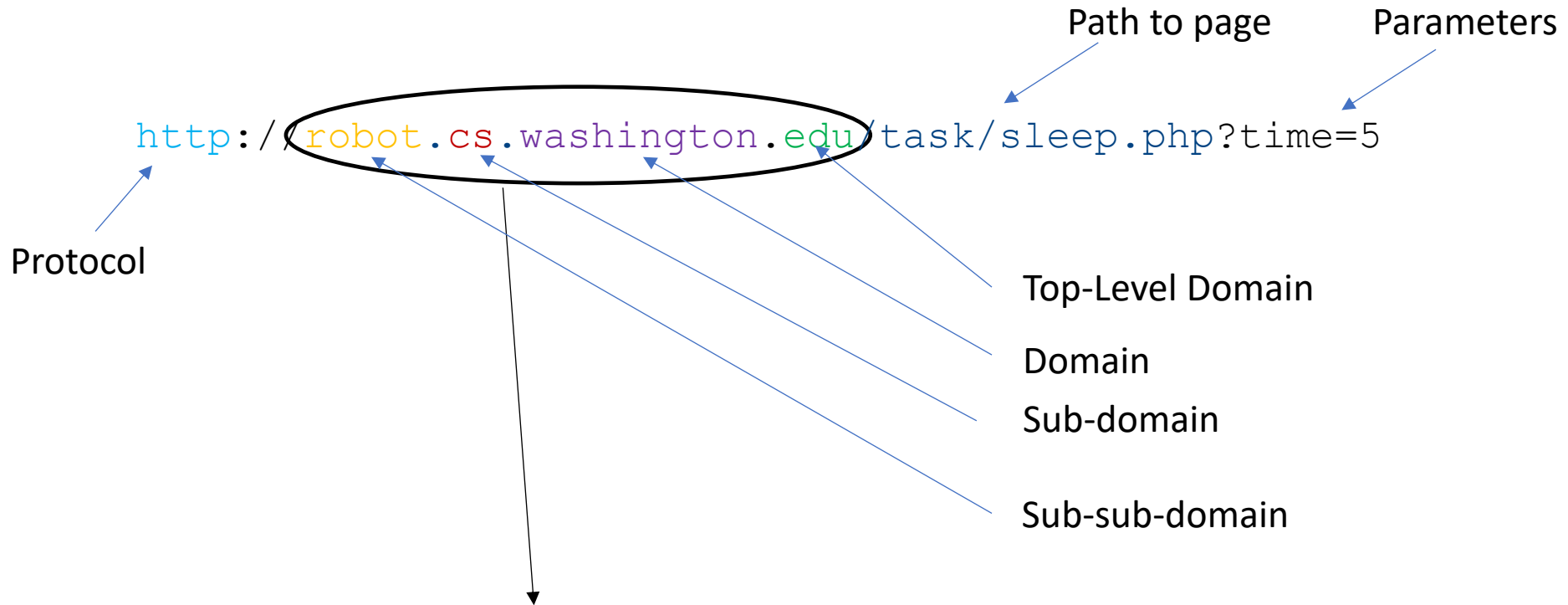| IP	Network Layer

↓

Hardware Interface	Link Layer

DNS: Domain Name System

- People are bad at remembering series of numbers
- It is easier to remember www.dcu.ie instead of 99.80.221.0
- Organizations want to manage their own namespace
  - www.dcu.ie
  - www.dcu.ie/iss
  - www.dcu.ie/…

- DNS objective is to resolve high-level human readable names for computers to low-level IP addresses
- It uses a distributed, hierarchical database system, to cache server names for better performance
- Runs on UDP port 53, retransmits lost messages

Example

- We need a way to find the IP address of the server that hosts a website

Path to page   Parameters

http://robot.cs.washington.edu/task/sleep.php?time=5

Protocol

Top-Level Domain

Domain

Sub-domain

Sub-sub-domain

We need to find the IP address of the
Server that manages this domain name

Hierarchical Domain Name System

The server robot.cs.washington.edu
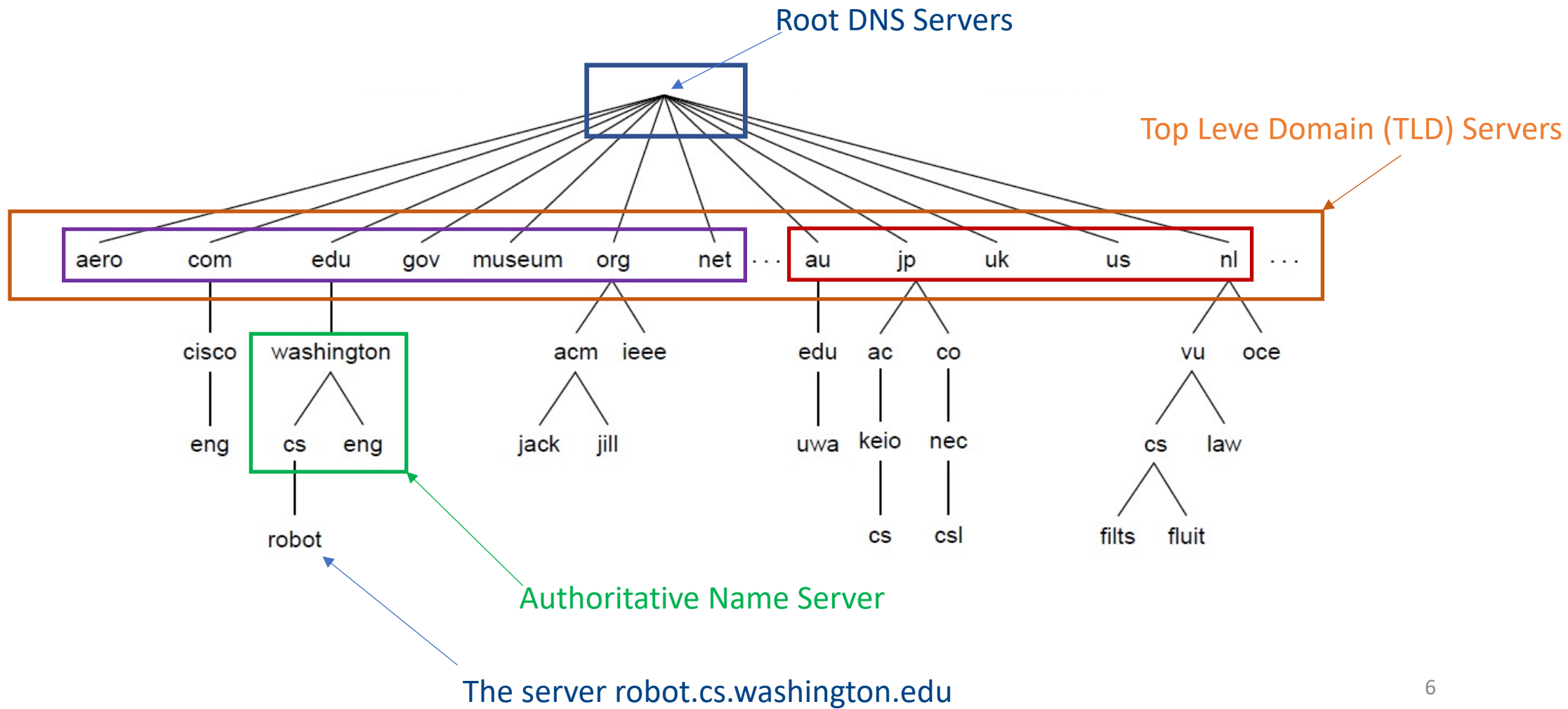
Root and Top Level Domain Servers

- Root DNS:
  - There are only 13 Root DNS servers in the world

- Top-Level Domains are controlled by ICANN
  - ICANN appoints registrars to run them

- Root and TLD servers do not contain hostname and IP address mappings
  - They contain mappings for locating authoritative servers

Domain Resource Records

- Authoritative servers are responsible for maintaining the their domain resource record
  - They can delegate parts of the domain to sub-domain authoritative servers

Domain Resource Record

Type	Meaning	Value
SOA	Start of authority	Parameters for this zone
A	IPv4 address of a host	32-Bit integer
AAAA	IPv6 address of a host	128-Bit integer
MX	Mail exchange	Priority, domain willing to accept email
NS	Name server	Name of a server for this domain
CNAME	Canonical name	Domain name
PTR	Pointer	Alias for an IP address
SPF	Sender policy framework	Text encoding of mail sending policy
SRV	Service	Host that provides it
TXT	Text	Descriptive ASCII text

Finding Records Through Recursive Servers

- Recursive servers are a point of contact for the host

- They perform the recursive calling
  - ask the domain name servers until a final the result is found
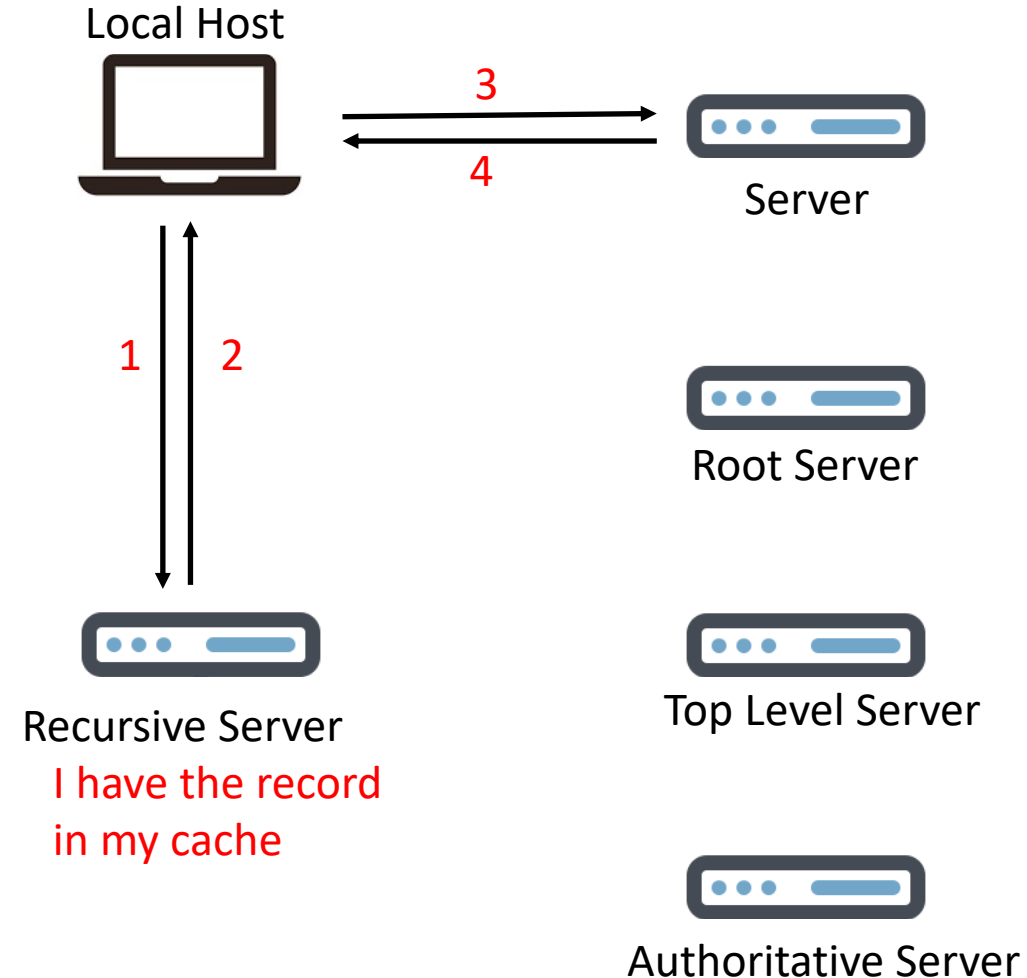
- Then sent the result back to the host
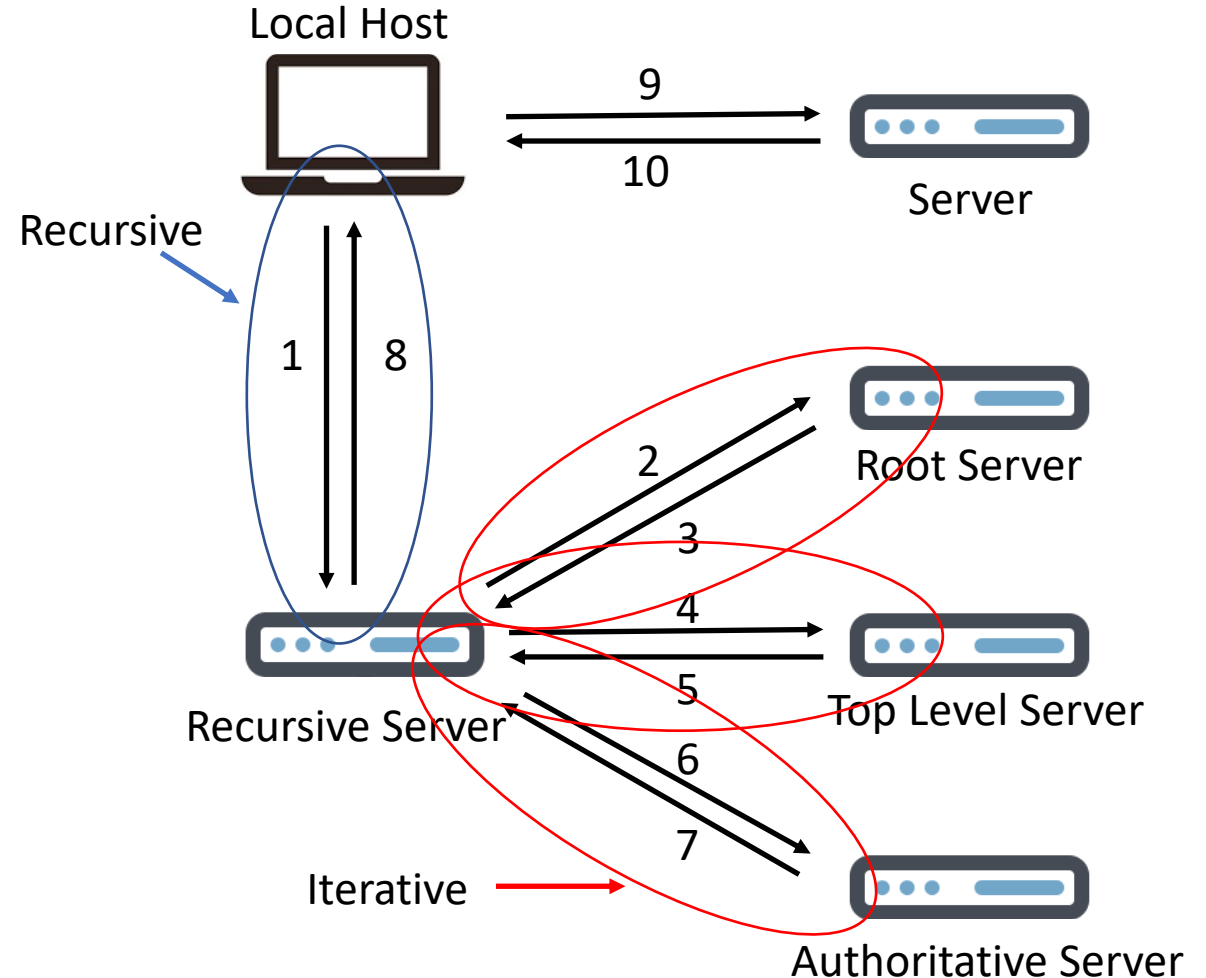
Excess Workload in the Network

- This process creates a lot of work in the network
- Many messages must be sent through the Internet in order to **resolve** the correct address
- Which nodes in the network are most overloaded?
- The **Root name servers** see the bulk of the traffic

- There is a process to reduce the workload on higher level name servers
  - Record Caching

Records Caching

- Caching is the holding of learned data/records for a period of time

- Caching nameserver is used to reduce traffic

- Both the hosts and nameservers have the capability to cache records that they receive

- This is usually carried out by the recursive nameserver

Local Host

3

4

Server

1   2

Root Server

Top Level Server

Recursive Server

I have the record in my cache

Authoritative Server

11

URLs: Uniform Resource Locators

- Pages are named with Uniform Resource Locators (URLs)

Path to page   Parameters

`http://robot.cs.washington.edu/task/sleep.php?time=5`

Protocol

Server Name

- There are many common URL protocols (e.g., http, https, ftp, …)
- However, we will focus on http

Hypertext Transfer Protocol

- Hypertext Transfer Protocol (HTTP) transfers pages from servers to browsers

HTTP Request

HTTP Response

wikipedia.org
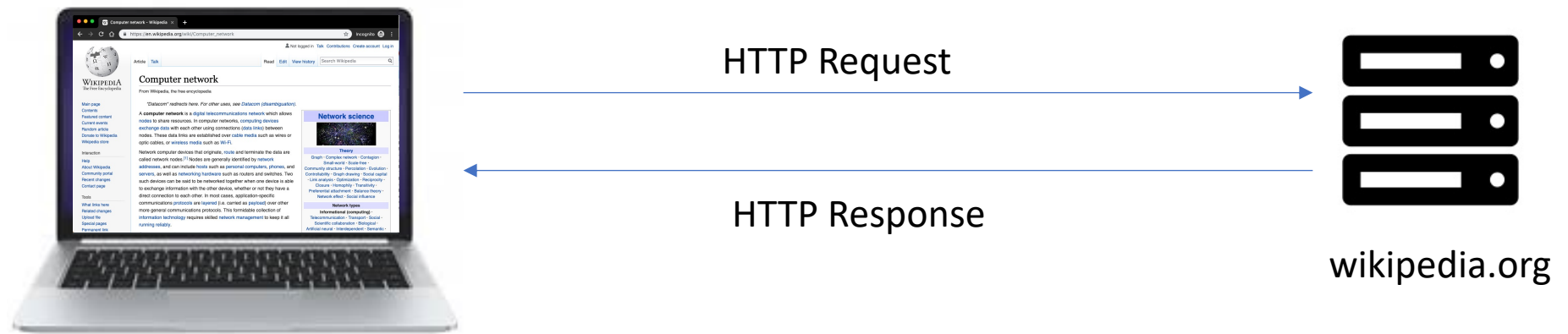
Hypertext Transfer Protocol

- HTTP (HyperText Transfer Protocol) is a Request-Response protocol that runs on top of TCP
  - Server usually runs on port 80
- Data
  - Headers are given in readable ASCII
  - Content is described with MIME types

Request Methods

- Http uses various methods to enable mode than basic page retrieval, e.g.,
    - GET: read a Web page
    - HEAD: read the header of a Web page
    - POST: send data to the server
    - PUT: replace all current representations of the target resource with the uploaded content
    - DELETE: remove the Web page
    - CONNECT: reserve for future use
    - TRACE: test the path to the target
   - OPTIONS: query the communication options for the target resource

Response Codes

- HTTP response codes tell the client how the request was handled

| Code	Meaning	Examples
1xx	Information	100 = server agrees to handle client's request
2xx	Success	200 = request succeeded; 204 = no content present
3xx	Redirection	301 = page moved; 304 = cached page still valid
4xx	Client error	403 = forbidden page; 404 = page not found
5xx	Server error	500 = internal server error; 503 = try again later

HTTP Caching

- HTTP caching checks if the browser has a known fresh copy
  - if not if the server has updated the page
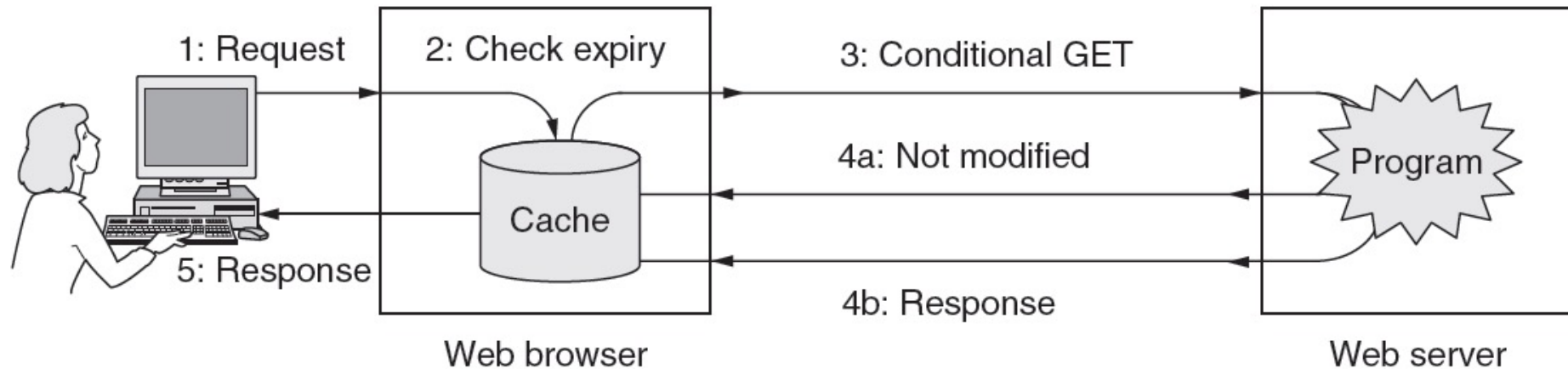
Electronic Mail (eMail)

- These are the key components and steps to send an email
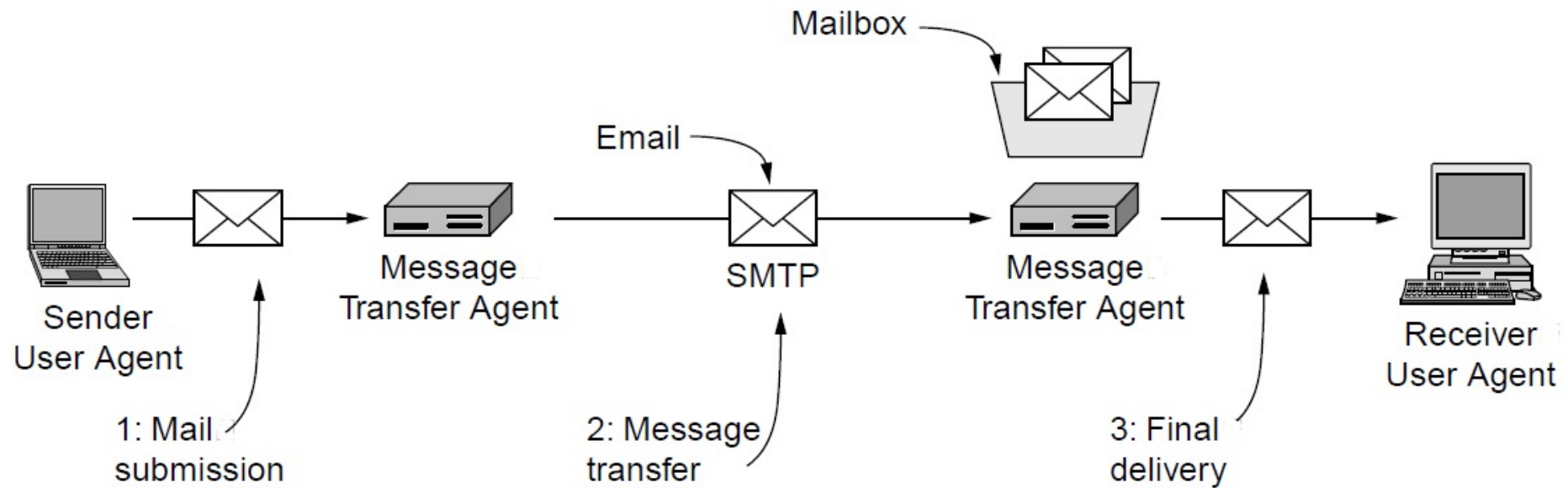
Message Transfer

- Messages are transferred with SMTP (Simple Mail Transfer Protocol)
- Submission from a User Agent (UA) to a Message Transfer Agent (MTA)
  - on port 587
- Submission from an MTA to the next MTA
  - on port 25

Message Header

Header	Meaning
To:	Email address(es) of primary recipient(s)
Cc:	Email address(es) of secondary recipient(s)
Bcc:	Email address(es) for blind carbon copies
From:	Person or people who created the message
Sender:	Email address of the actual sender
Received:	Line added by each transfer agent along the route
Return-Path:	Can be used to identify a path back to the sender
Reply-To:	Email address to which replies should be sent
Message-Id:	Unique number for referencing this message later
In-Reply-To:	Message-Id of the message to which this is a reply
References:	Other relevant Message-Ids
Keywords:	User-chosen keywords
Subject:	Short summary of the message for the one-line display

Fields related to Message Transport

Fields useful for the User Agent

Many Other Applications

- There exists several other applications …
- Some of them are not used much anymore, while others are being created.