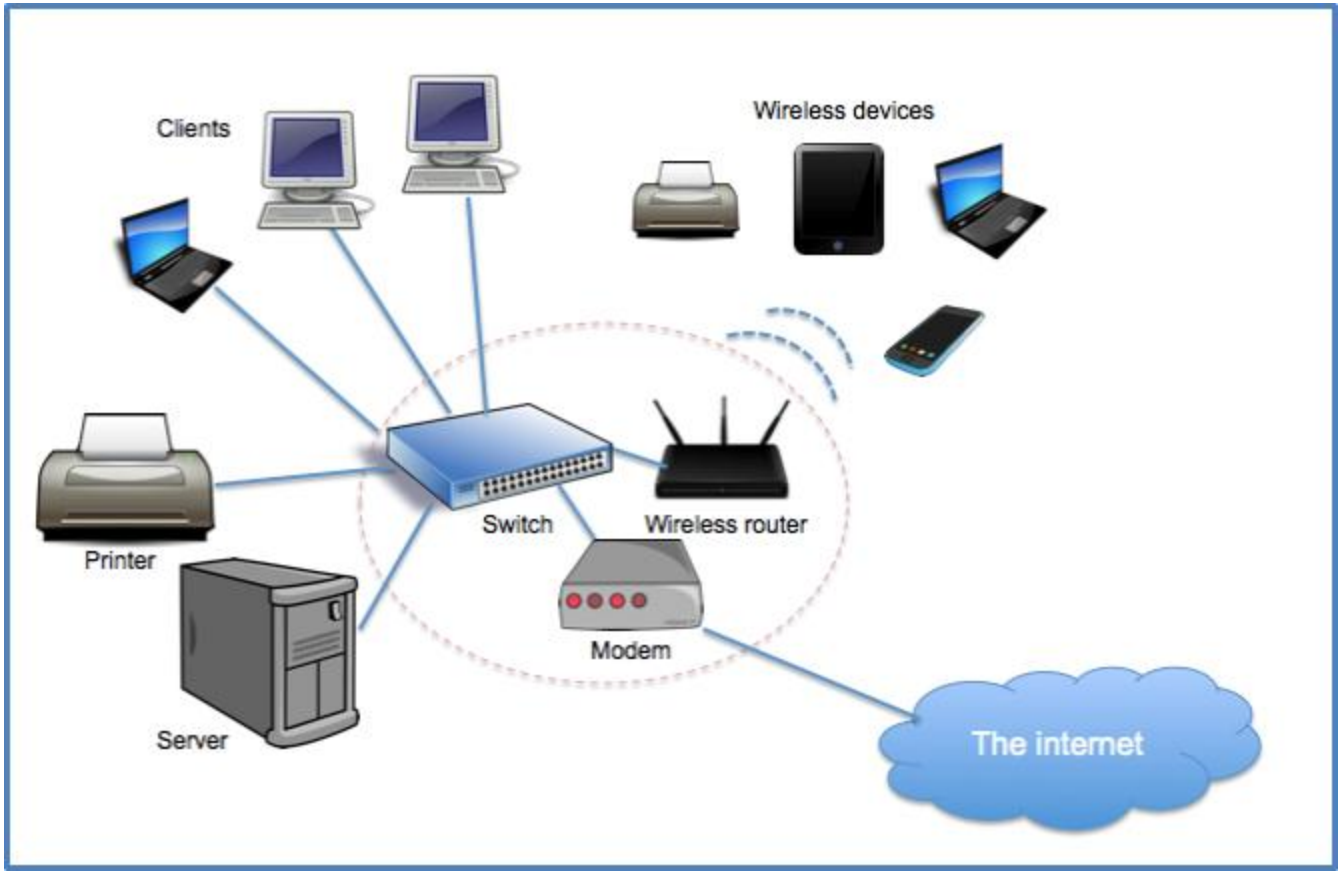
COMPUTER NETWORKS



Instructor: Mr. B. V. Sathish Kumar, Assistant Professor

Department of Electronics and Communication Engineering

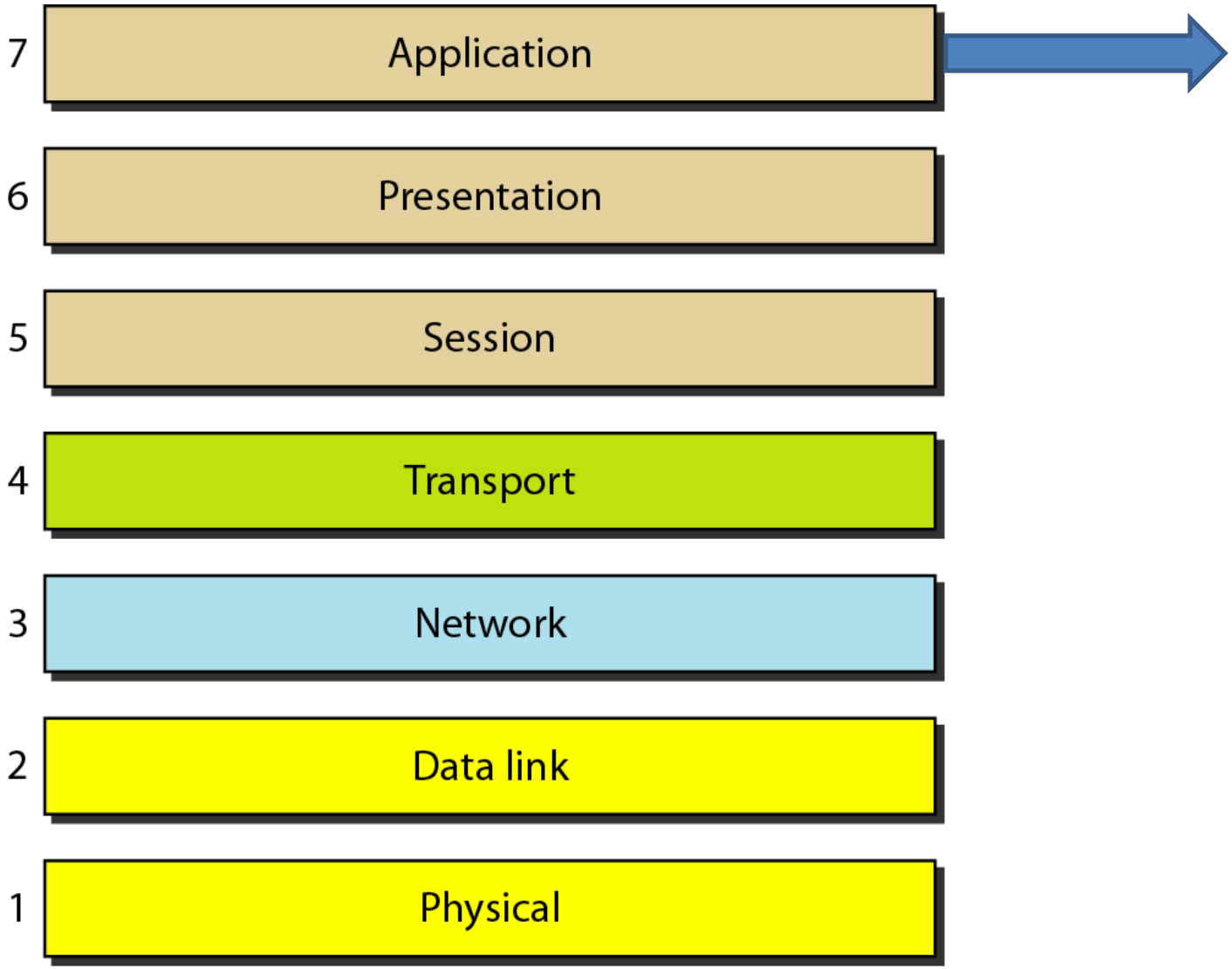
UNIT – V

Syllabus

- Transport Layer – Design Issues, Connection Establishment, Connection Termination, Transport and User Datagram Protocols

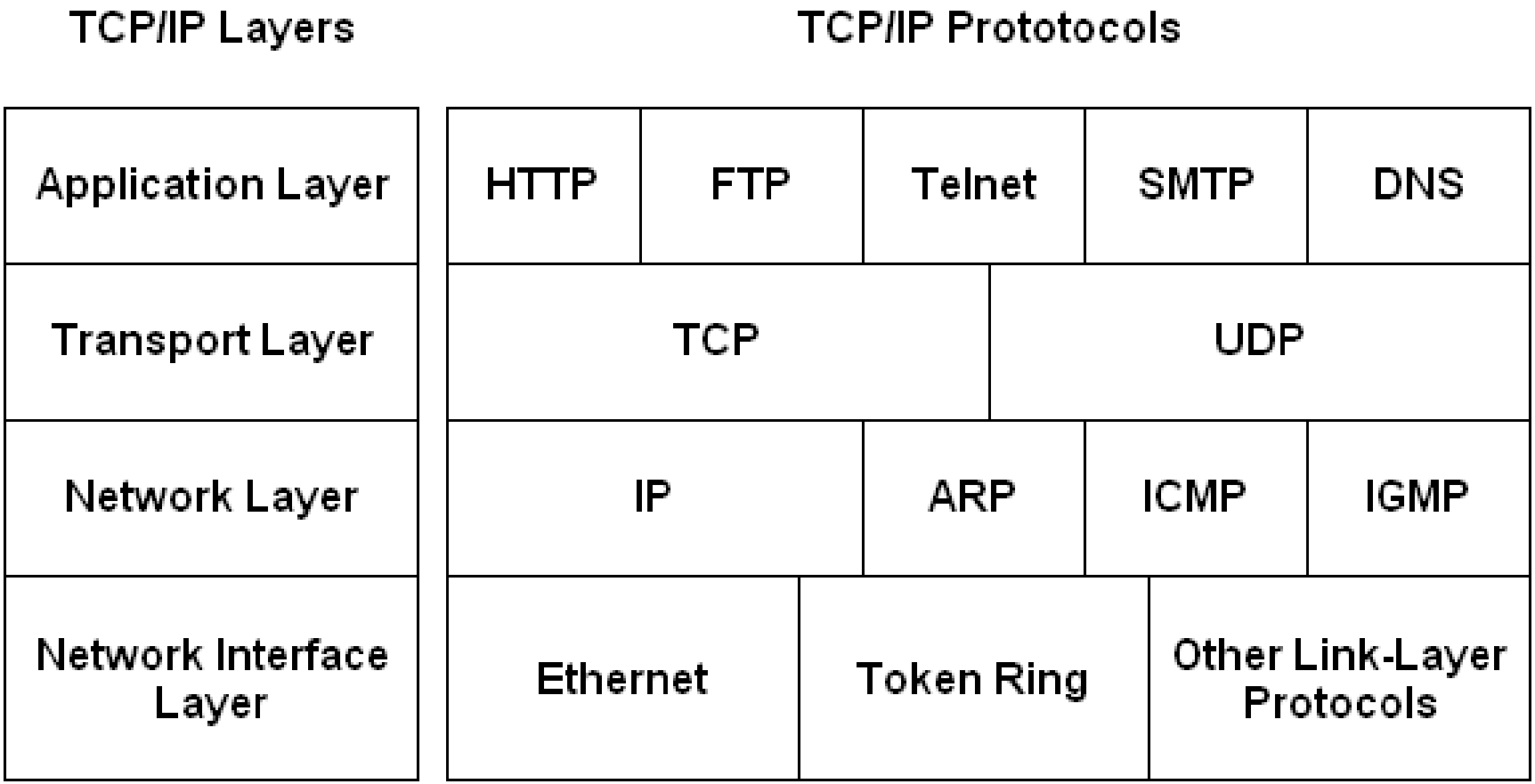
- Application Layer –Design Issues, DNS, WWW, HTTP/HTTPS, E-mail

Figure: Seven layers of OSI Model



Application Layer

Figure: TCP/IP Model



FTP–File Transfer Protocol

Transferring files from one computer to another is one of the most common tasks expected from a networking or internetworking environment. As a matter of fact, the greatest volume of data exchange in the Internet today is due to file transfer.

Note

FTP uses the services of TCP. It needs two TCP connections.

The well-known port 21 is used for the control connection and the well-known port 20 for the data connection.

Figure: FTP

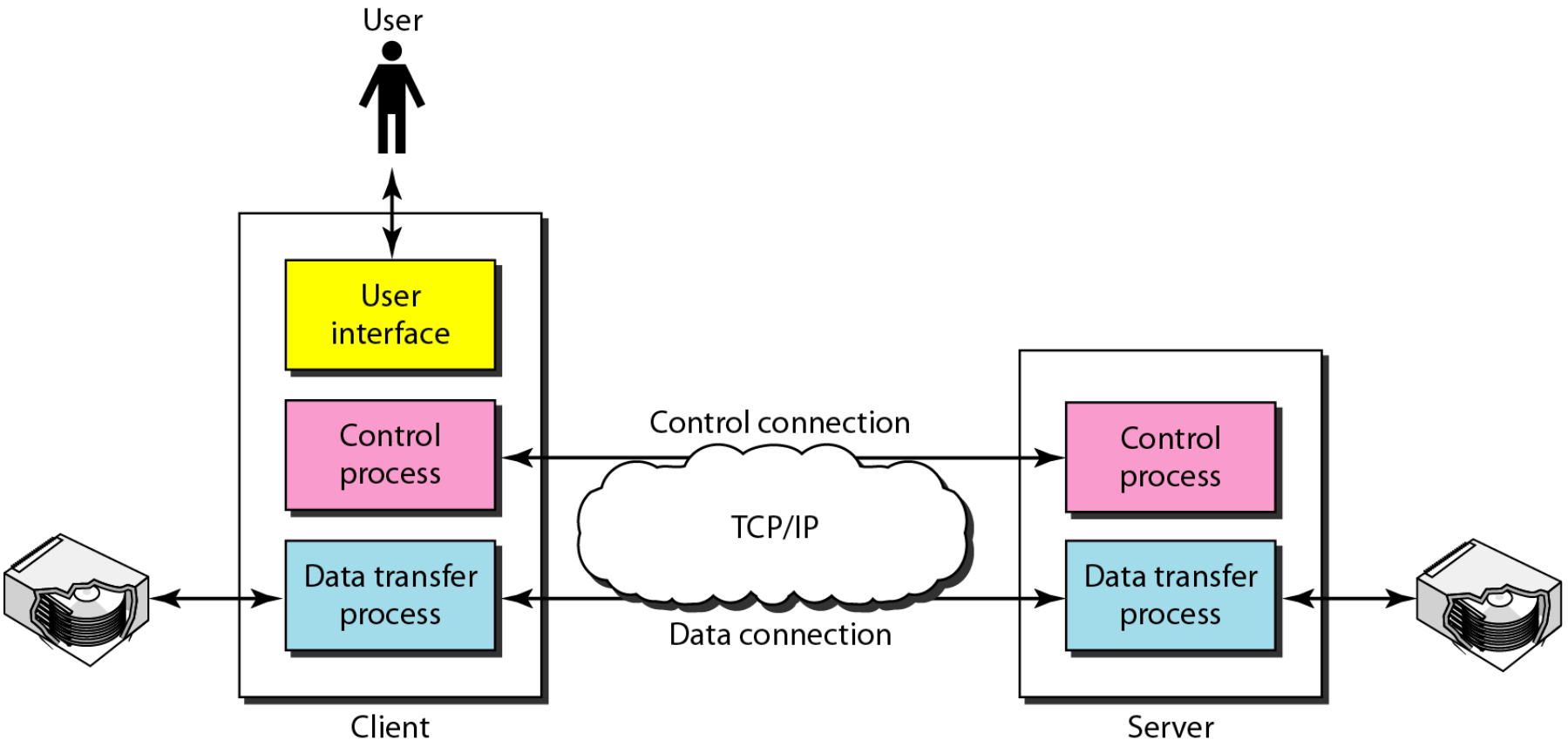

User
User interface
Control process
Data transfer process
Client
Control connection
TCP/IP
Data connection
Control process
Data transfer process
Server

Figure: Using the control connection

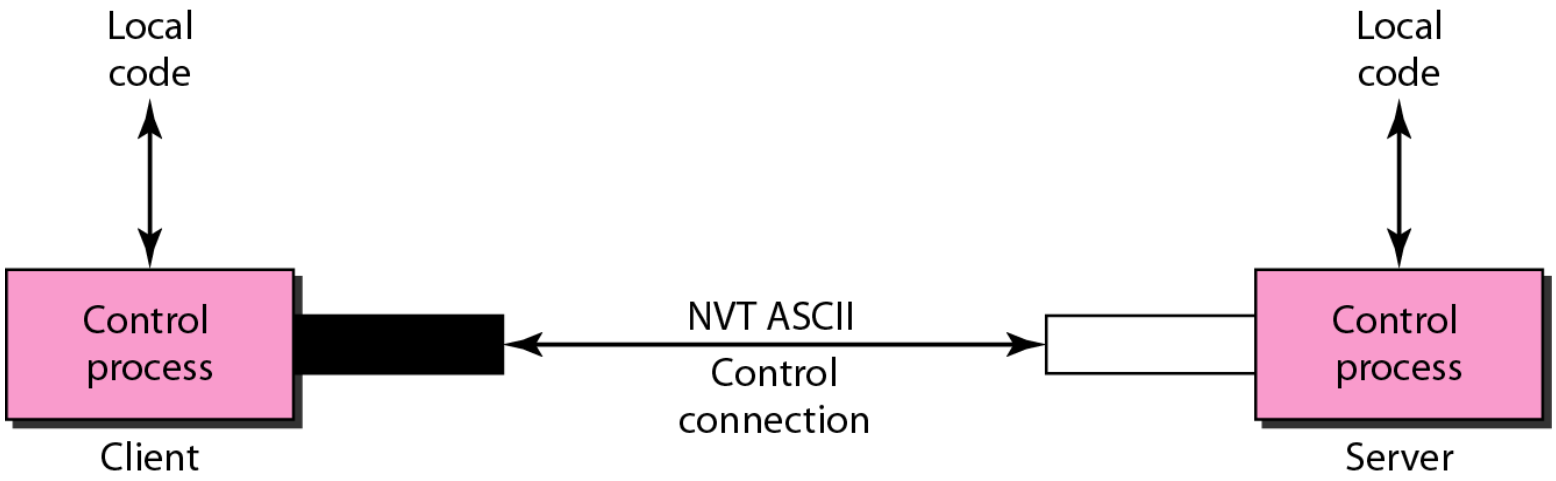
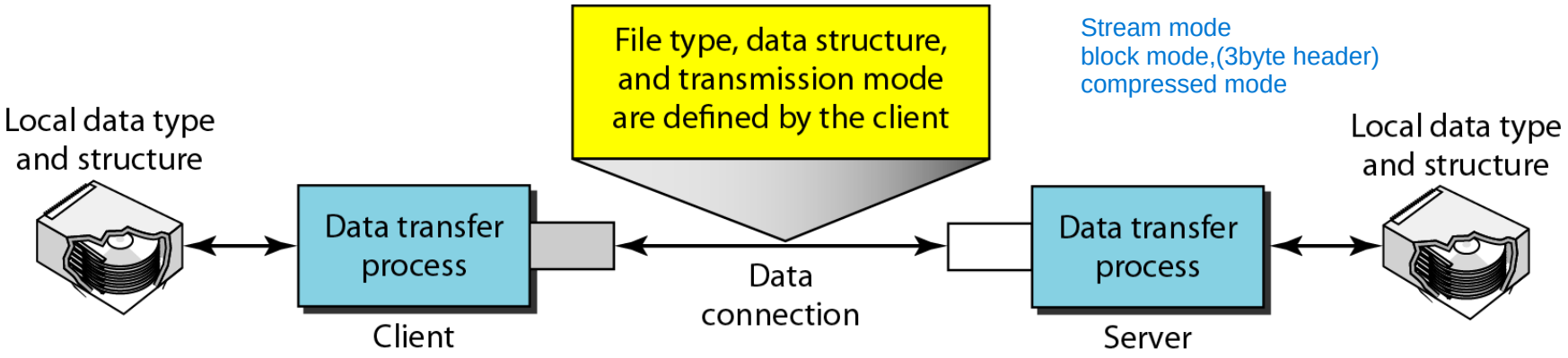


Figure: Using the data connection



DNS–Domain Name System

- Although programs theoretically could refer to Web pages, mailboxes, and other resources by using the network (e.g., IP) addresses of the computers on which they are stored, these addresses are hard for people to remember.

- Also, browsing a company's Web pages from 128.111.24.41 means that if the company moves the Web server to a different machine with a different IP address, everyone needs to be told the new IP address.

- Consequently, high-level, readable names were introduced in order to decouple machine names from machine addresses.

Cntd...

- In this way, the company's Web server might be known as www.cs.washington.edu regardless of its IP address.
- Nevertheless, since the network itself understands only numerical addresses, some mechanism is required to convert the names to network addresses.
- The essence of DNS is the invention of a hierarchical, domain-based naming scheme and a distributed database system for implementing this naming scheme.
- It is primarily used for mapping host names to IP addresses but can also be used for other purposes.
- To map a name onto an IP address, an application program calls a library procedure called the resolver, passing it the name as a parameter.

Cntd…

For the Internet, the top of the naming hierarchy is managed by an organization called ICANN (Internet Corporation for Assigned Names and Numbers). ICANN was created for this purpose in 1998.

Topics discussed in this section:

- The DNS name space
- Domain Resource records
- Name servers

Figure: Example of using the DNS service

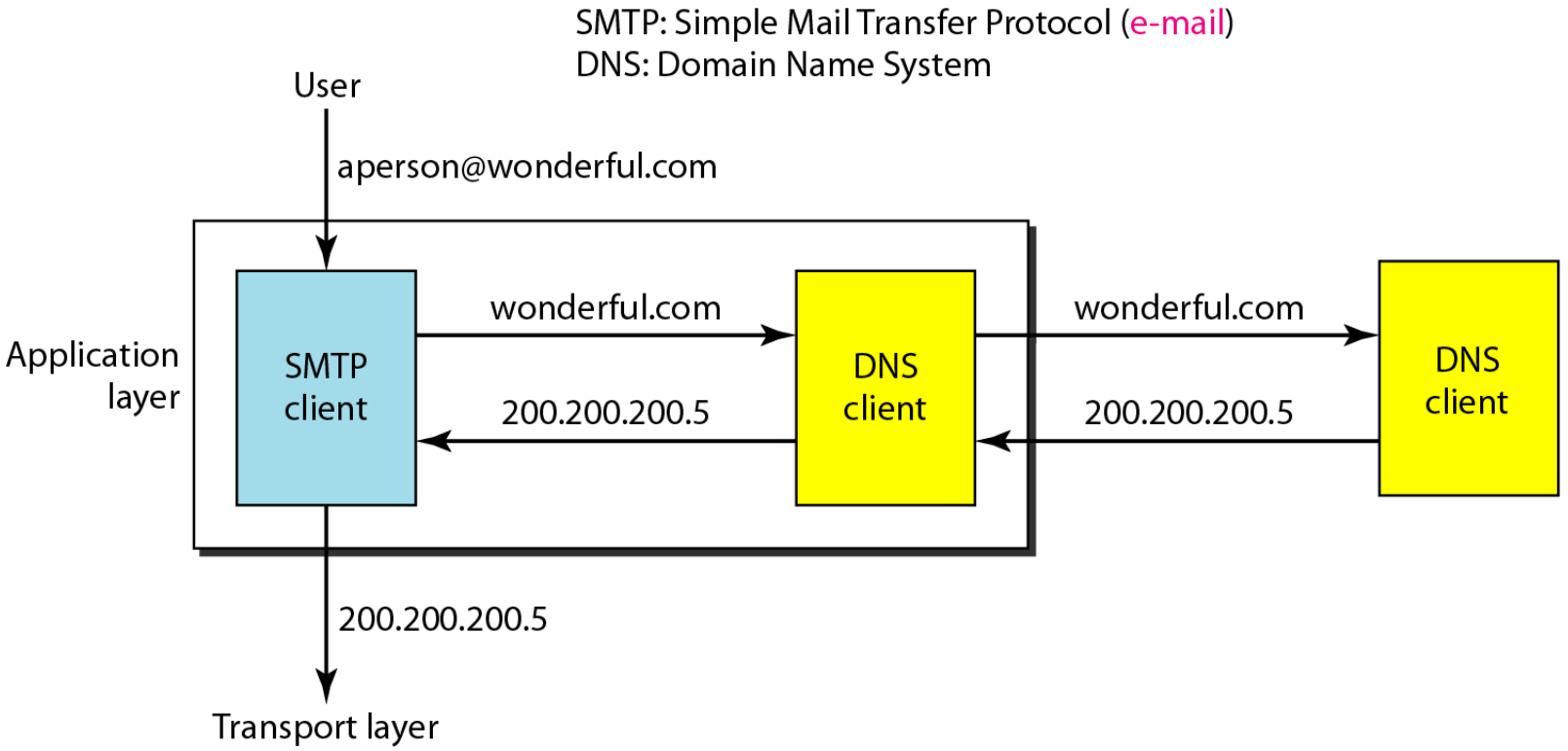
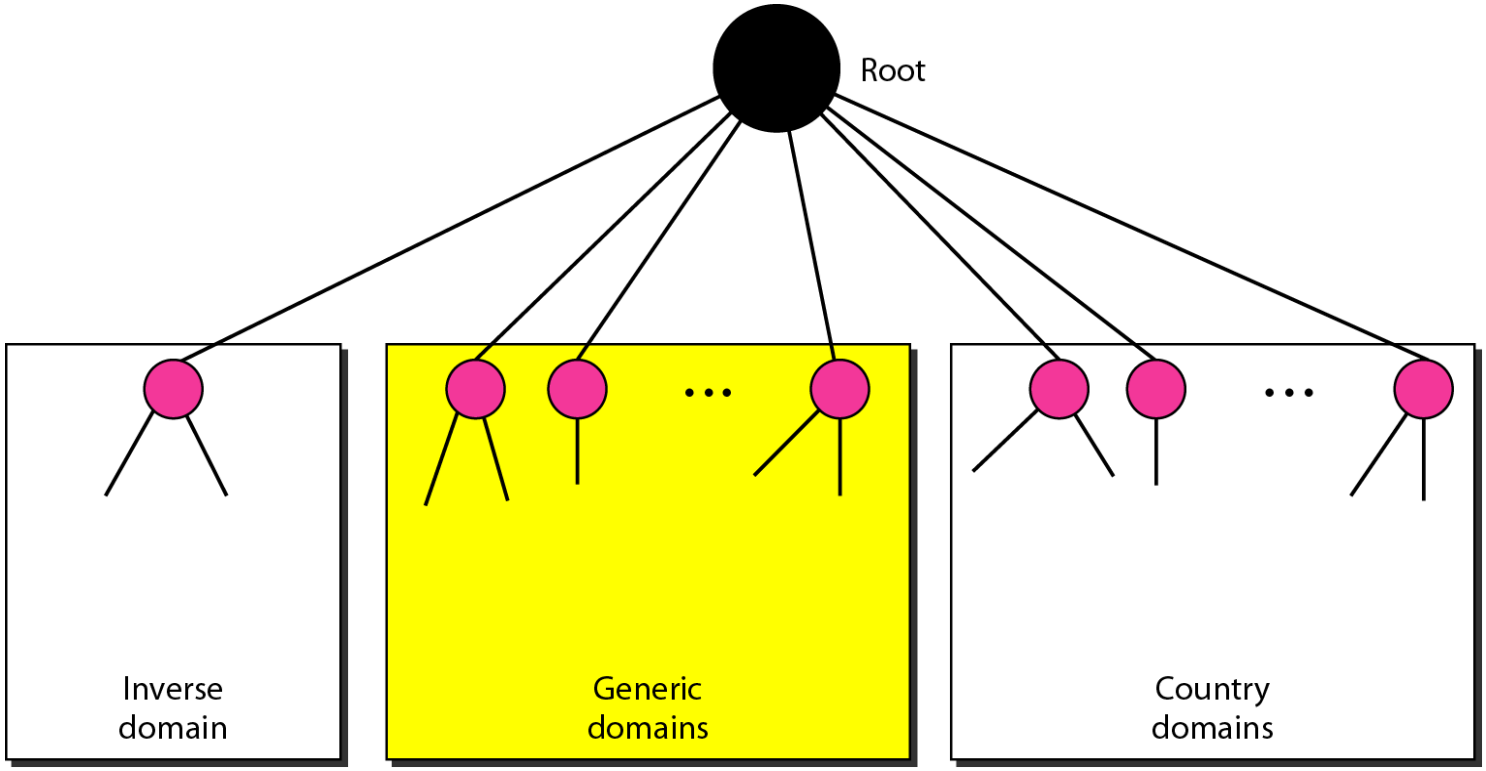
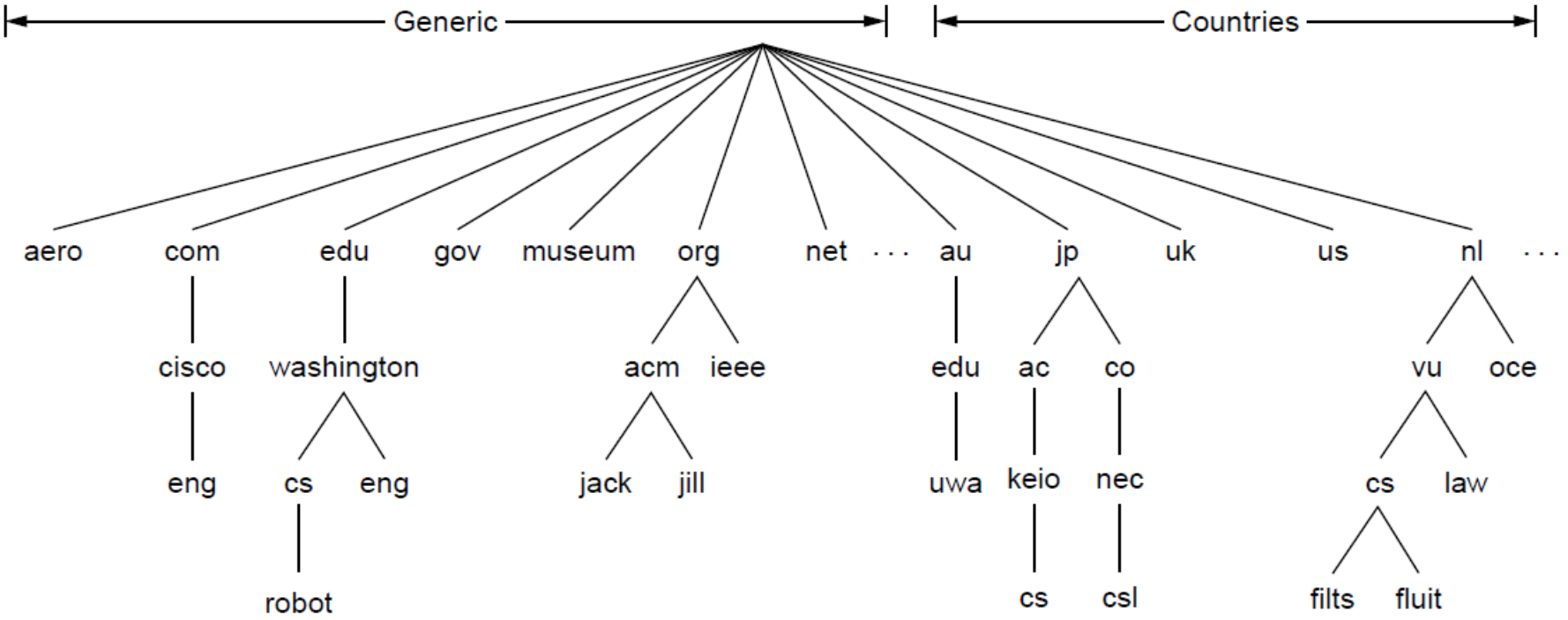


Figure: DNS IN THE INTERNET

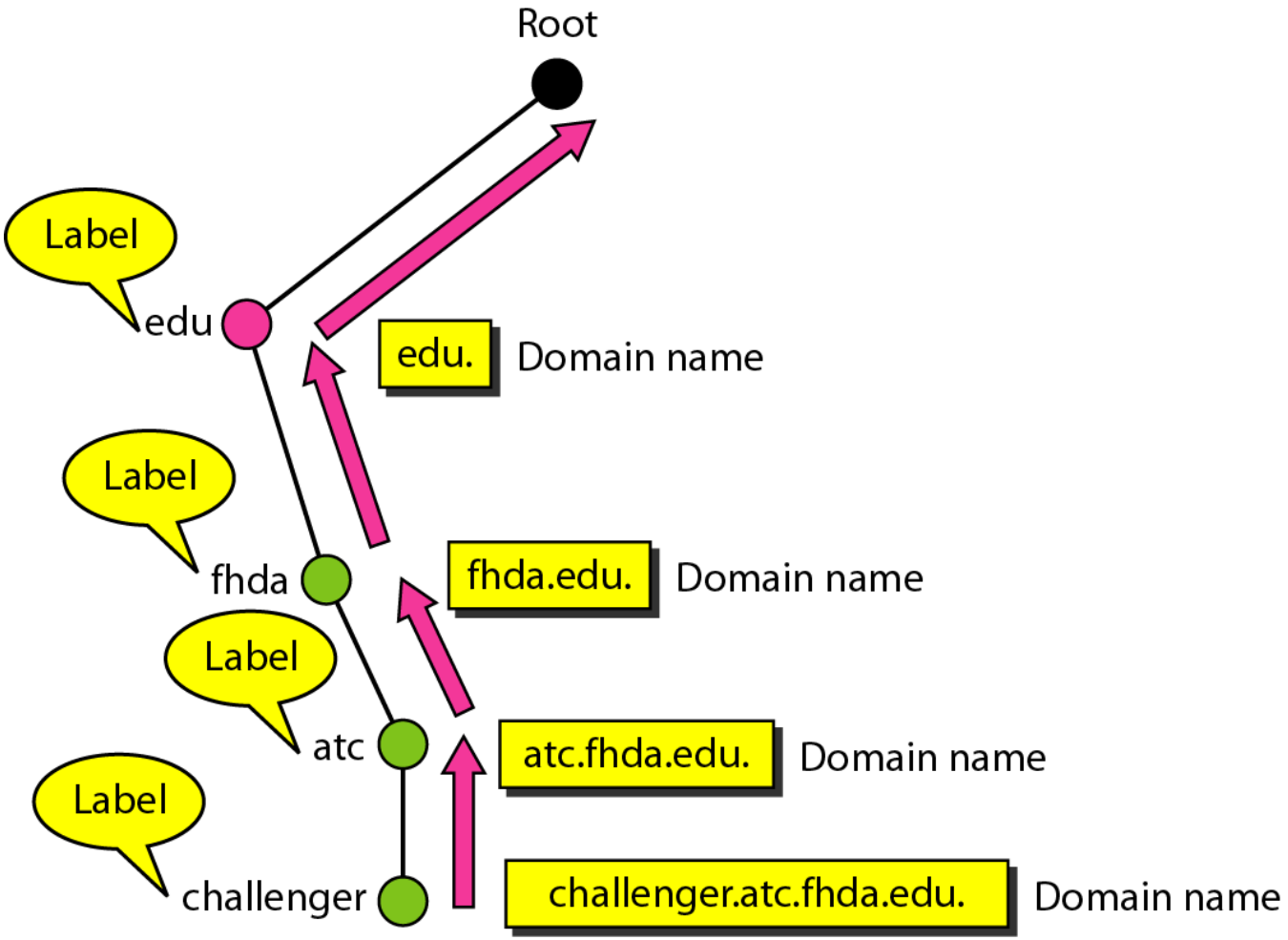


The DNS Name Space



A portion of the Internet domain name space.

Figure: Domain names and labels



Cntd...

Domain	Intended use	Start date	Restricted?
com	Commercial	1985	No
edu	Educational institutions	1985	Yes
gov	Government	1985	Yes
int	International organizations	1988	Yes
mil	Military	1985	Yes
net	Network providers	1985	No
org	Non-profit organizations	1985	No
aero	Air transport	2001	Yes
biz	Businesses	2001	No
coop	Cooperatives	2001	Yes
info	Informational	2002	No
museum	Museums	2002	Yes
name	People	2002	No
pro	Professionals	2002	Yes
cat	Catalan	2005	Yes
jobs	Employment	2005	Yes
mobi	Mobile devices	2005	Yes
tel	Contact details	2005	Yes
travel	Travel industry	2005	Yes
xxx	Sex industry	2010	No

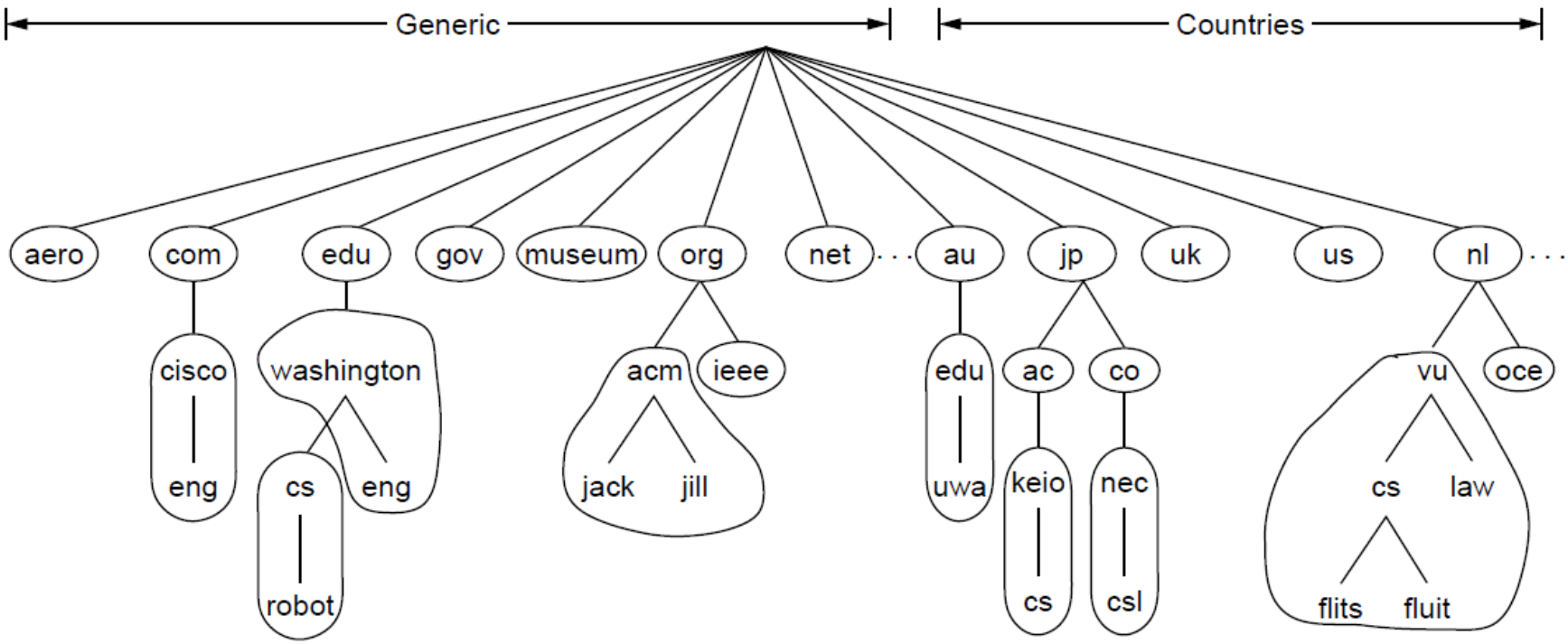
Generic top-level domains

Domain Resource Records

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

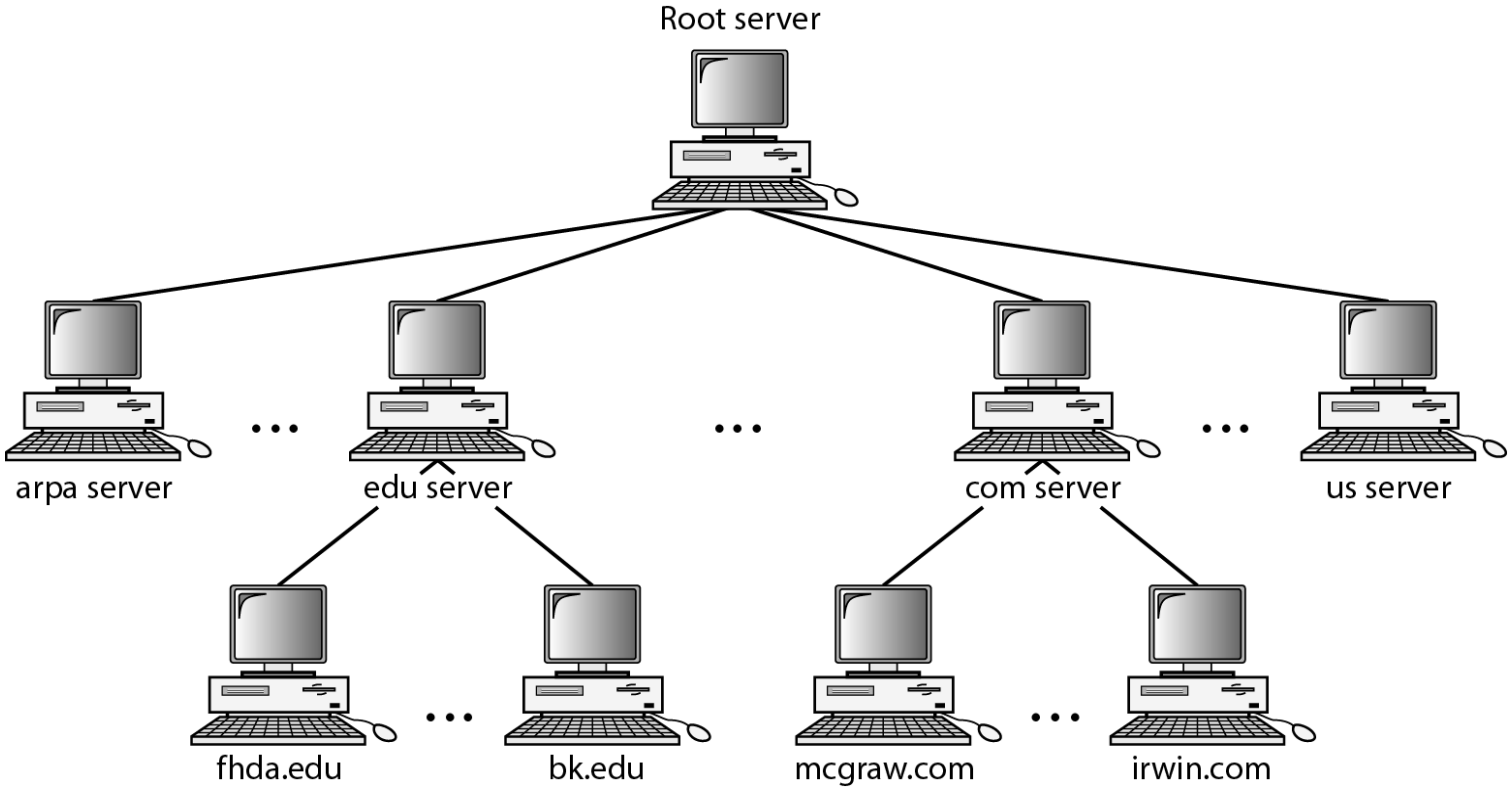
The principal DNS resource record types

Name Servers

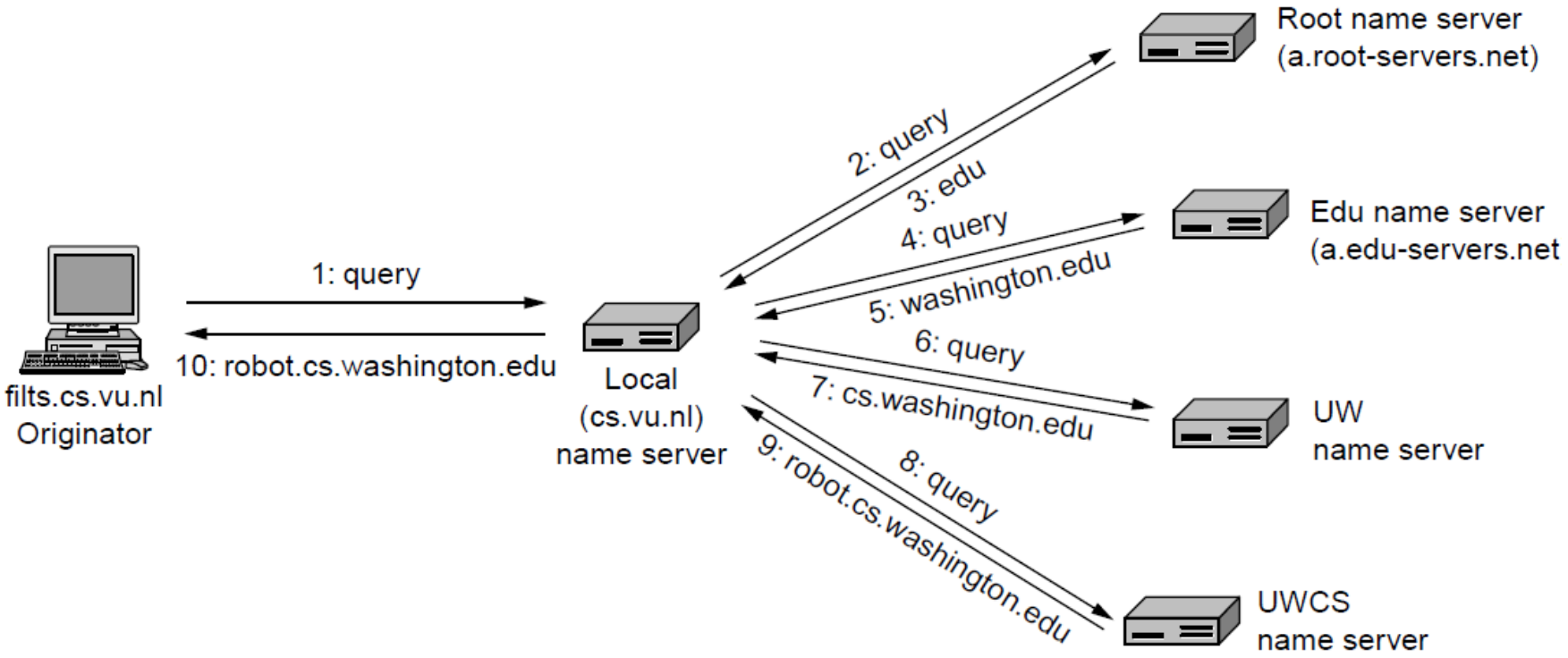


Part of the DNS name space divided into zones (which are circled).

Figure: Hierarchy of name servers



Cntd...



Example of a resolver looking up a remote name in 10 steps.

Note

A primary server loads all information from the disk file; the secondary server loads all information from the primary server.

When the secondary downloads information from the primary, it is called zone transfer.

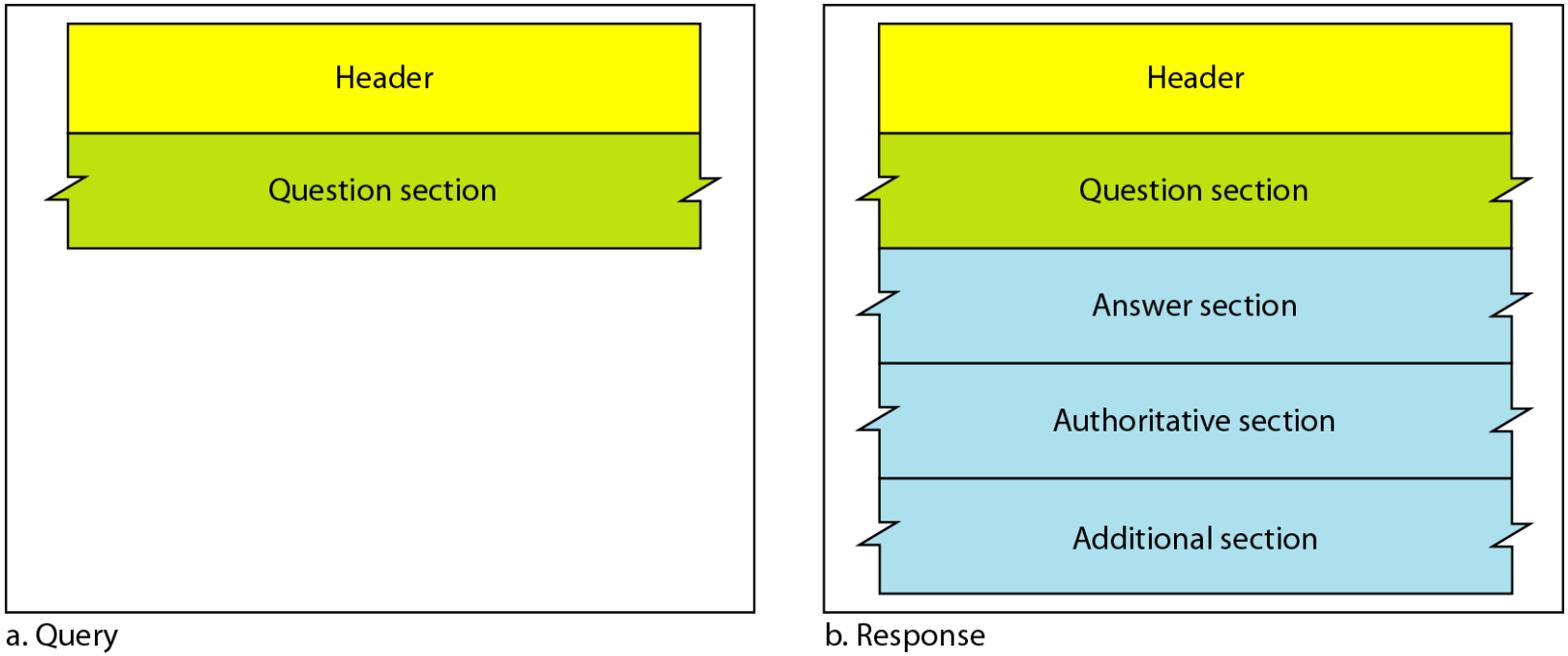
DNS Message

DNS has two types of messages: query and response. Both types have the same format.

The query message consists of a header and question records.

The response message consists of a header, question records, answer records, authoritative records, and additional records.

Figure: Query and response messages



a. Query

b. Response

Figure: Header format

Identification	Flags
Number of question records	Number of answer records (all 0s in query message)
Number of authoritative records (all 0s in query message)	Number of additional records (all 0s in query message)

Note

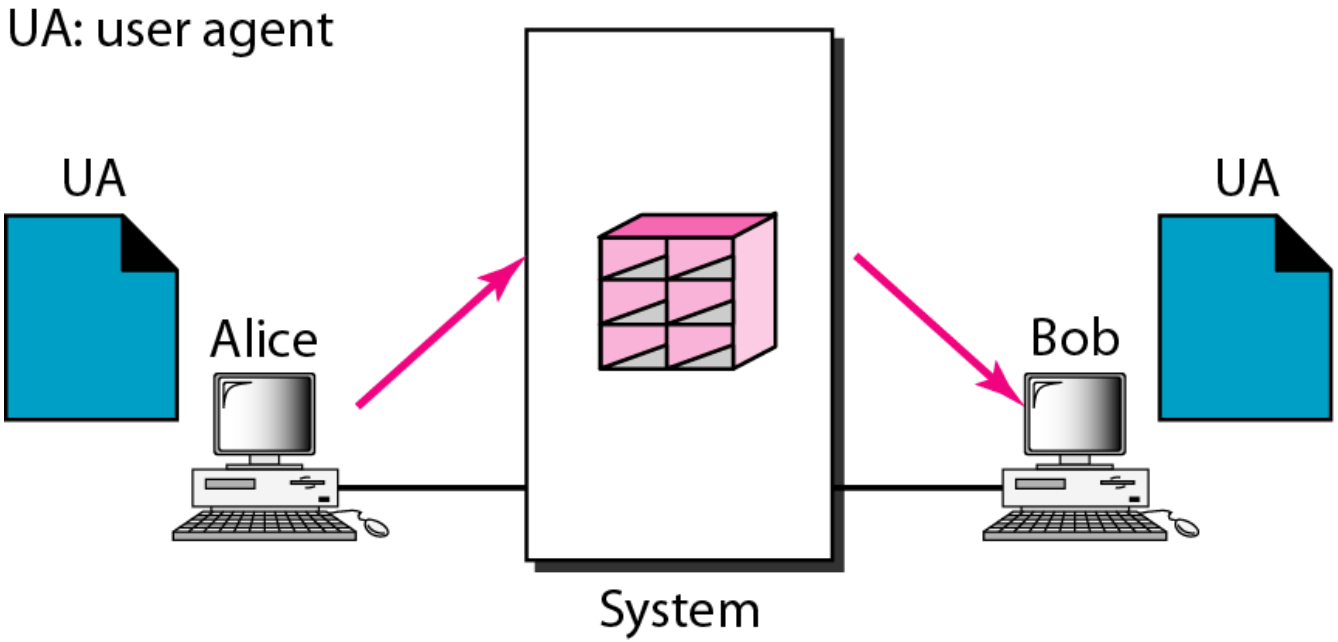
DNS can use the services of UDP or TCP using the well-known port 53.

Electronic Mail (E-mail)

Topics discussed in this section:

- Architecture and services
- The user agent
- Message formats
- Message transfer
- Final delivery

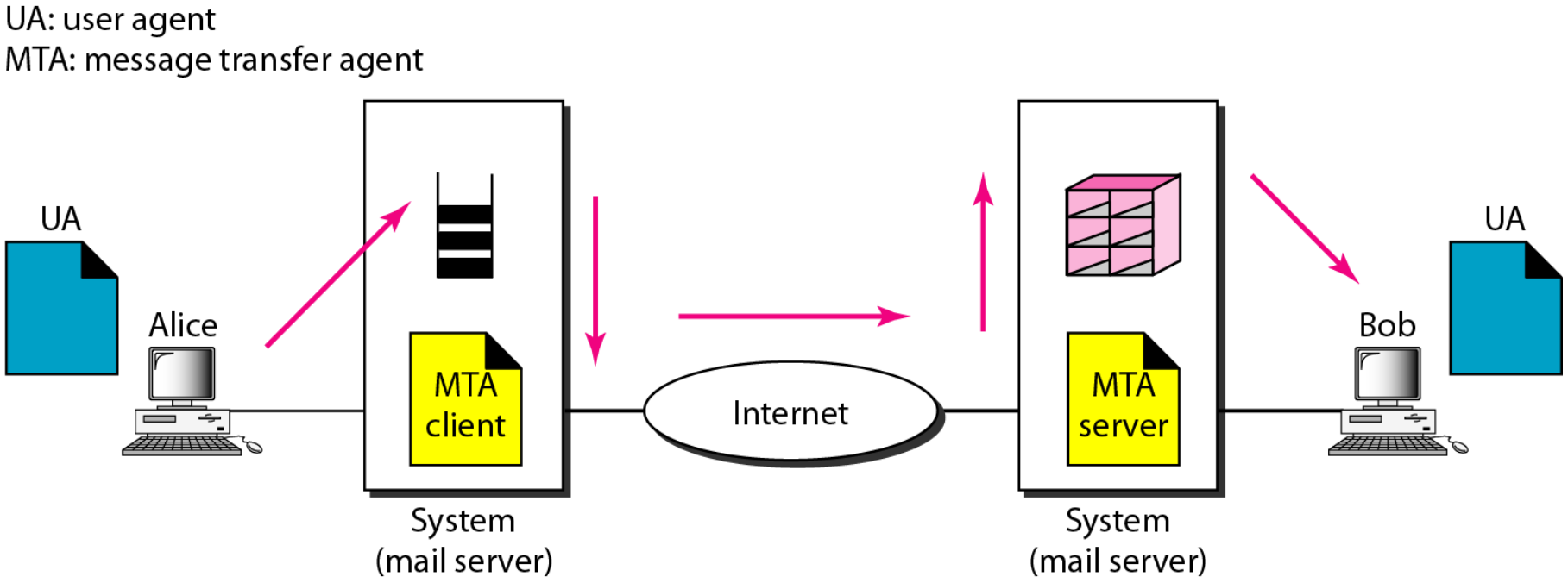
Figure: First scenario in electronic mail



Note

When the sender and the receiver of an e-mail are on the same system, we need only two user agents.

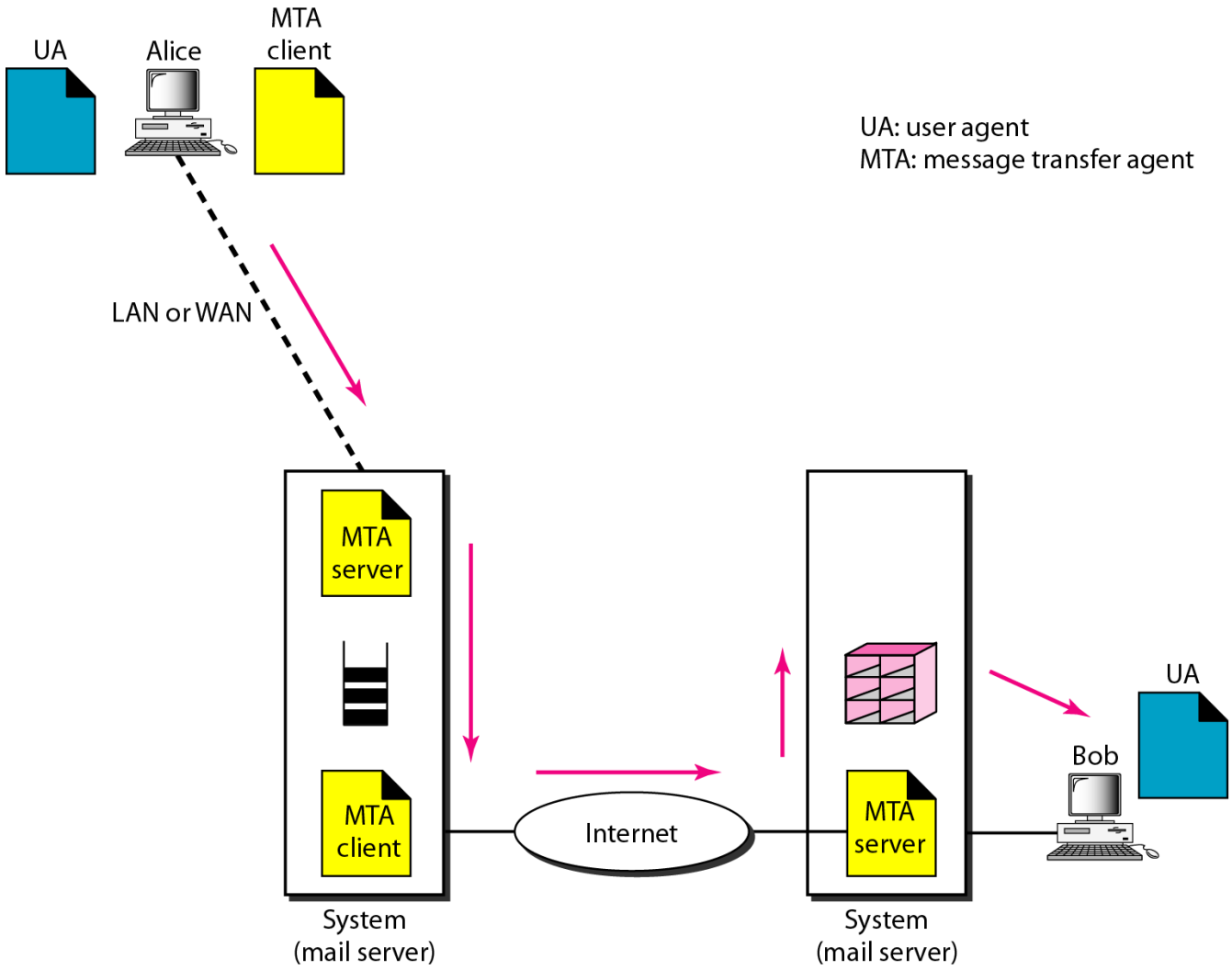
Figure: Second scenario in electronic mail



Note

When the sender and the receiver of an e-mail are on different systems, we need two UAs and a pair of MTAs (client and server).

Figure: Third scenario in electronic mail



Note

When the sender is connected to the mail server via a LAN or a WAN, we need two UAs and two pairs of MTAs (client and server).

Figure: Fourth scenario in electronic mail

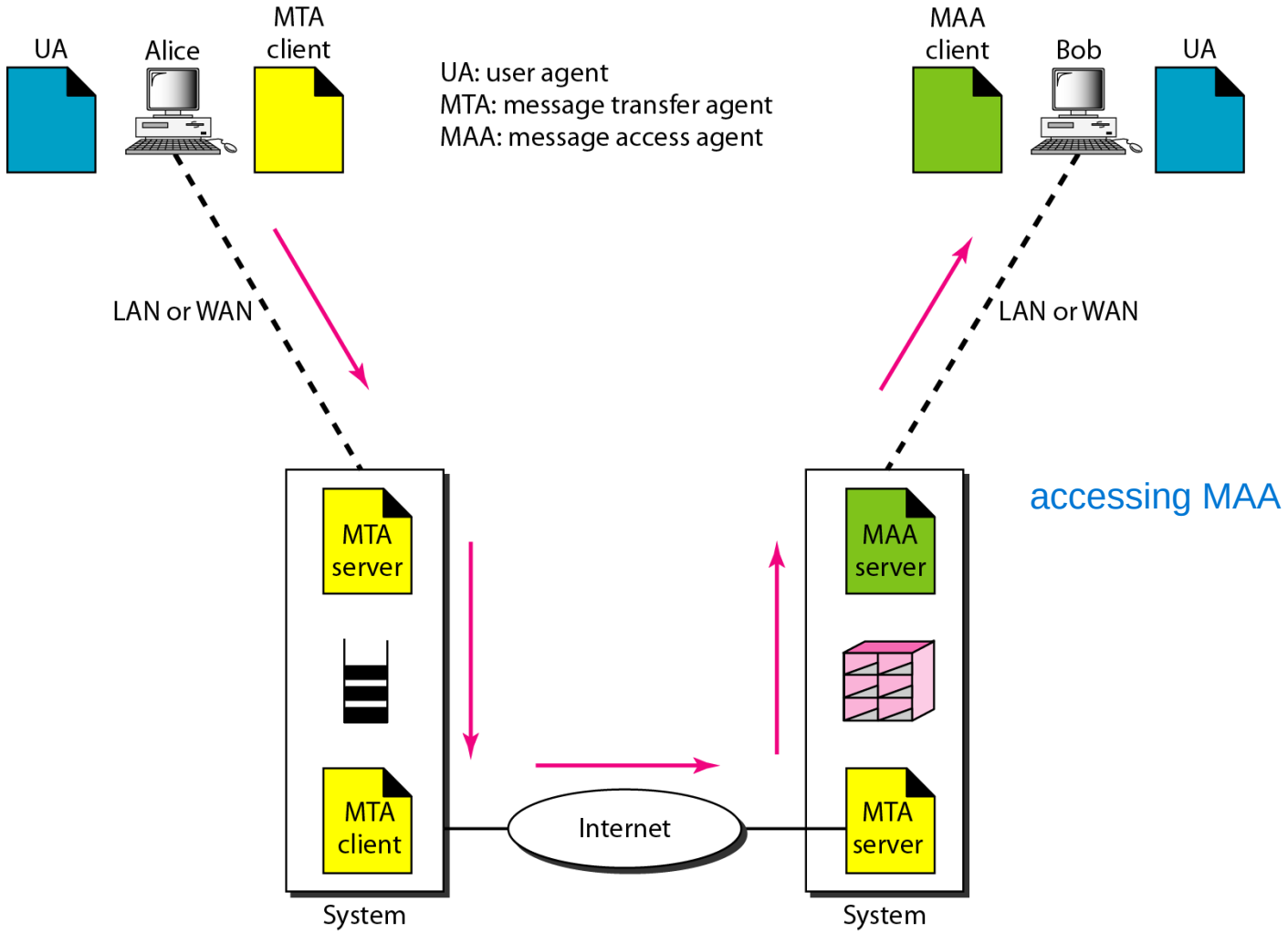
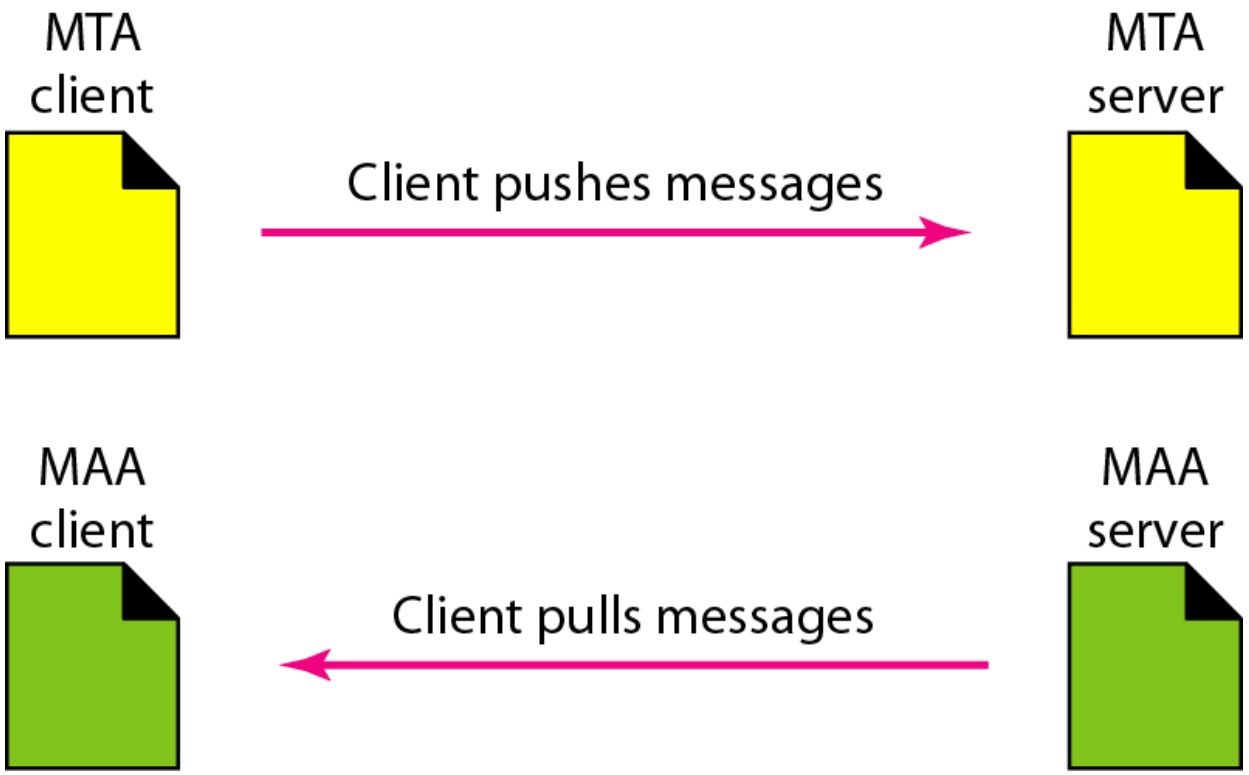


Figure: Push versus pull in electronic email



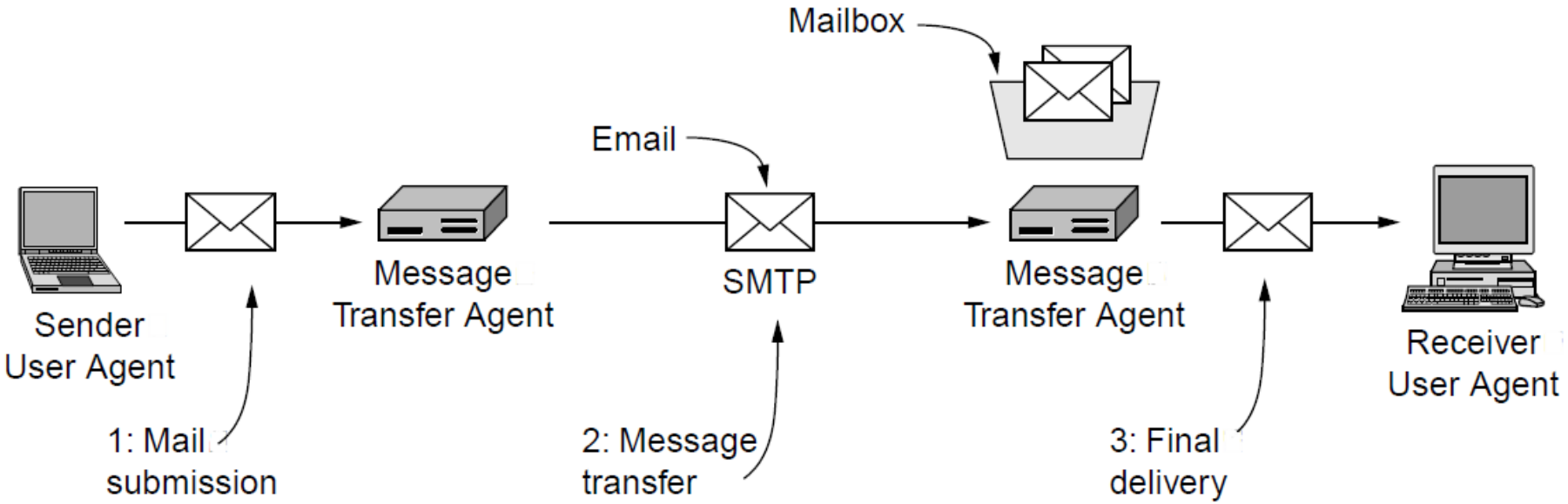
Note

When both sender and receiver are connected to the mail server via a LAN or a WAN, we need two UAs, two pairs of MTAs and a pair of MAAs.

This is the most common situation today.

Figure: E-mail address

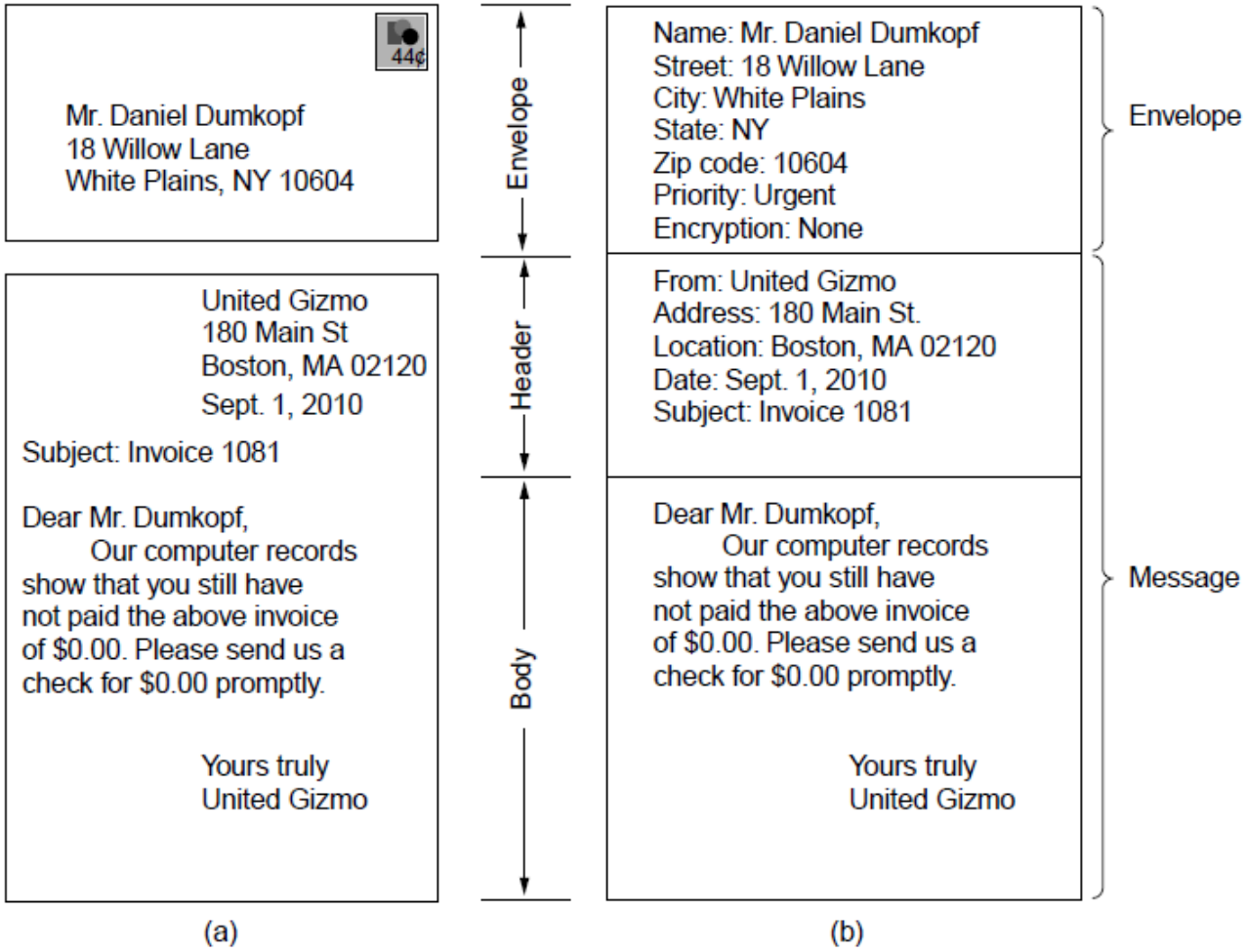
Architecture and Services



Architecture of the email system

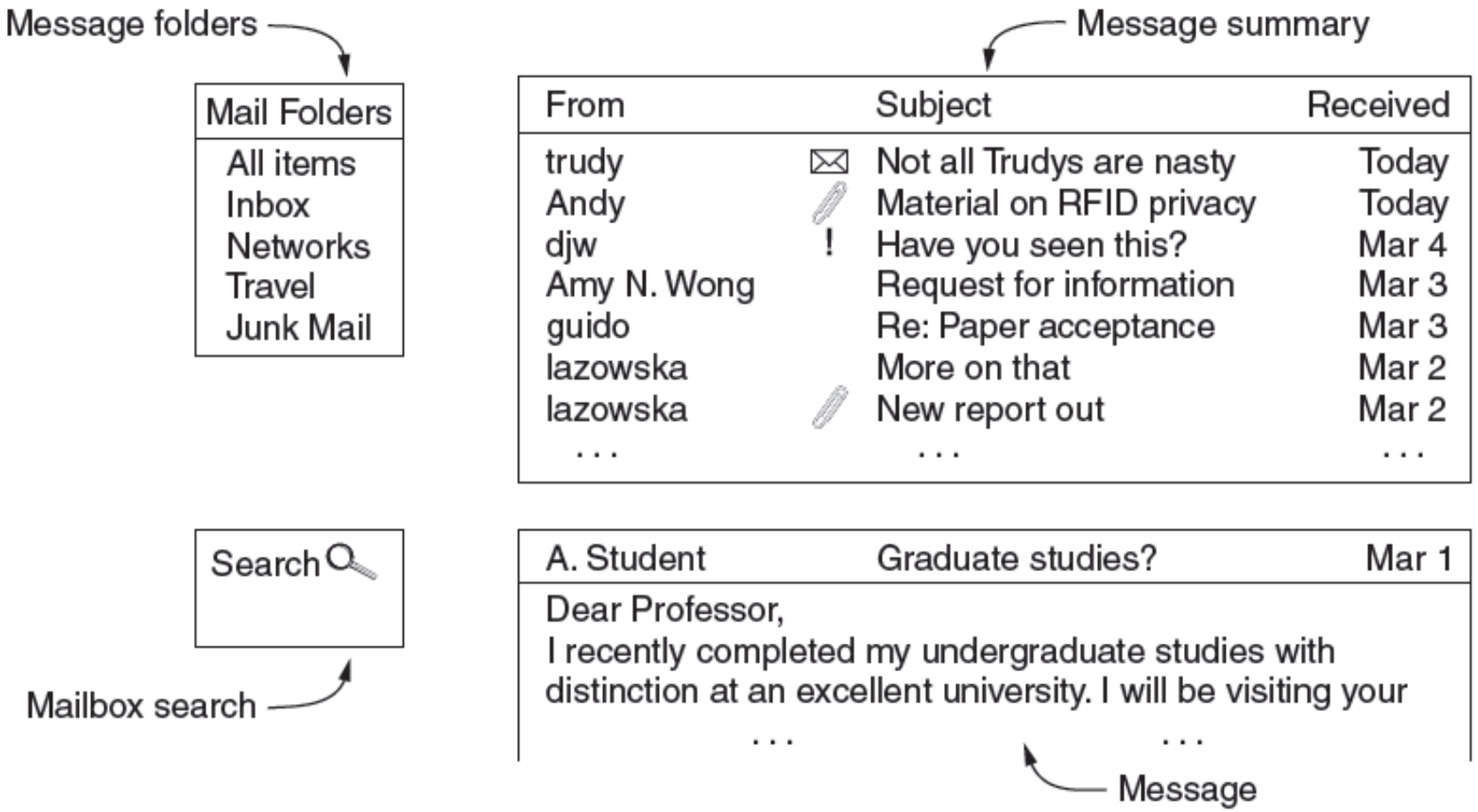
POP-post offfice protocol
MIME-multiport internet Mail extension

Cntd...



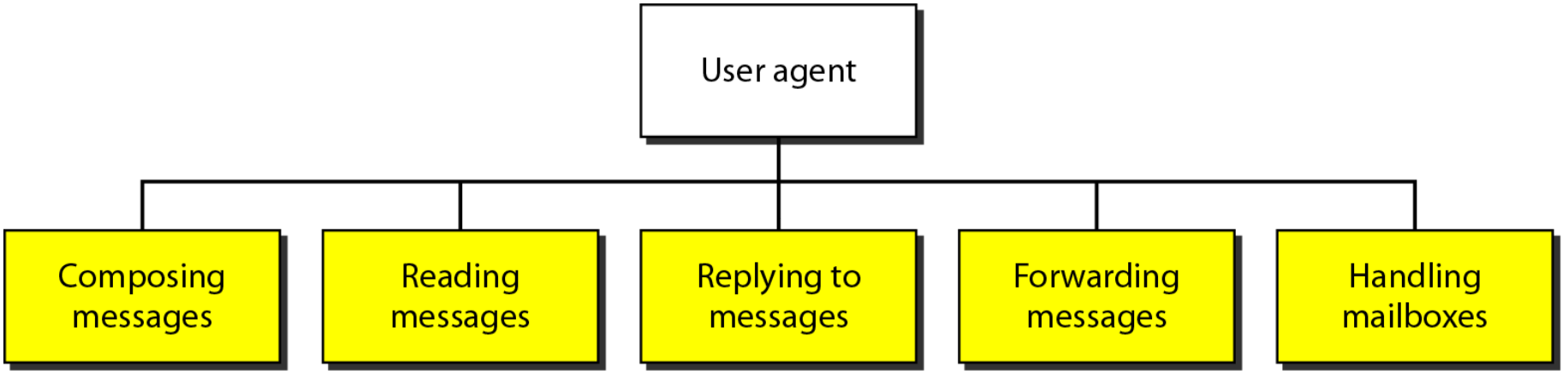
Envelopes and messages. (a) Paper mail. (b) Electronic mail.

The User Agent



Typical elements of the user agent interface

Figure: Services of user agent



Message Formats

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

RFC 5322 header fields related to message transport.

Cntd...

Header	Meaning
Date:	The date and time the message was sent
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

Some fields used in the RFC 5322 message header.

Cntd...

Header	Meaning
MIME-Version:	Identifies the MIME version
Content-Description:	Human-readable string telling what is in the message
Content-Id:	Unique identifier
Content-Transfer-Encoding:	How the body is wrapped for transmission
Content-Type:	Type and format of the content

Message headers added by MIME.

Cntd...

Type	Example subtypes	Description
text	plain, html, xml, css	Text in various formats
image	gif, jpeg, tiff	Pictures
audio	basic, mpeg, mp4	Sounds
video	mpeg, mp4, quicktime	Movies
model	vrml	3D model
application	octet-stream, pdf, javascript, zip	Data produced by applications
message	http, rfc822	Encapsulated message
multipart	mixed, alternative, parallel, digest	Combination of multiple types

MIME content types and example subtypes.

Cntd...

Keyword	Description
AUTH	Client authentication
BINARYMIME	Server accepts binary messages
CHUNKING	Server accepts large messages in chunks
SIZE	Check message size before trying to send
STARTTLS	Switch to secure transport (TLS; see Chap. 8)
UTF8SMTP	Internationalized addresses

Some SMTP extensions.

Final Delivery

Command	Description
CAPABILITY	List server capabilities
STARTTLS	Start secure transport (TLS; see Chap. 8)
LOGIN	Log on to server
AUTHENTICATE	Log on with other method
SELECT	Select a folder
EXAMINE	Select a read-only folder
CREATE	Create a folder
DELETE	Delete a folder
RENAME	Rename a folder
SUBSCRIBE	Add folder to active set
UNSUBSCRIBE	Remove folder from active set

IMAP (version 4) commands.

Cntd...

LIST	List the available folders
LSUB	List the active folders
STATUS	Get the status of a folder
APPEND	Add a message to a folder
CHECK	Get a checkpoint of a folder
FETCH	Get messages from a folder
SEARCH	Find messages in a folder
STORE	Alter message flags
COPY	Make a copy of a message in a folder
EXPUNGE	Remove messages flagged for deletion
UID	Issue commands using unique identifiers
NOOP	Do nothing
CLOSE	Remove flagged messages and close folder
LOGOUT	Log out and close connection

IMAP (version 4) commands.

World Wide Web

The WWW today is a distributed client/server service, in which a client using a browser can access a service using a server. However, the service provided is distributed over many locations called sites.

Figure: Architecture of WWW

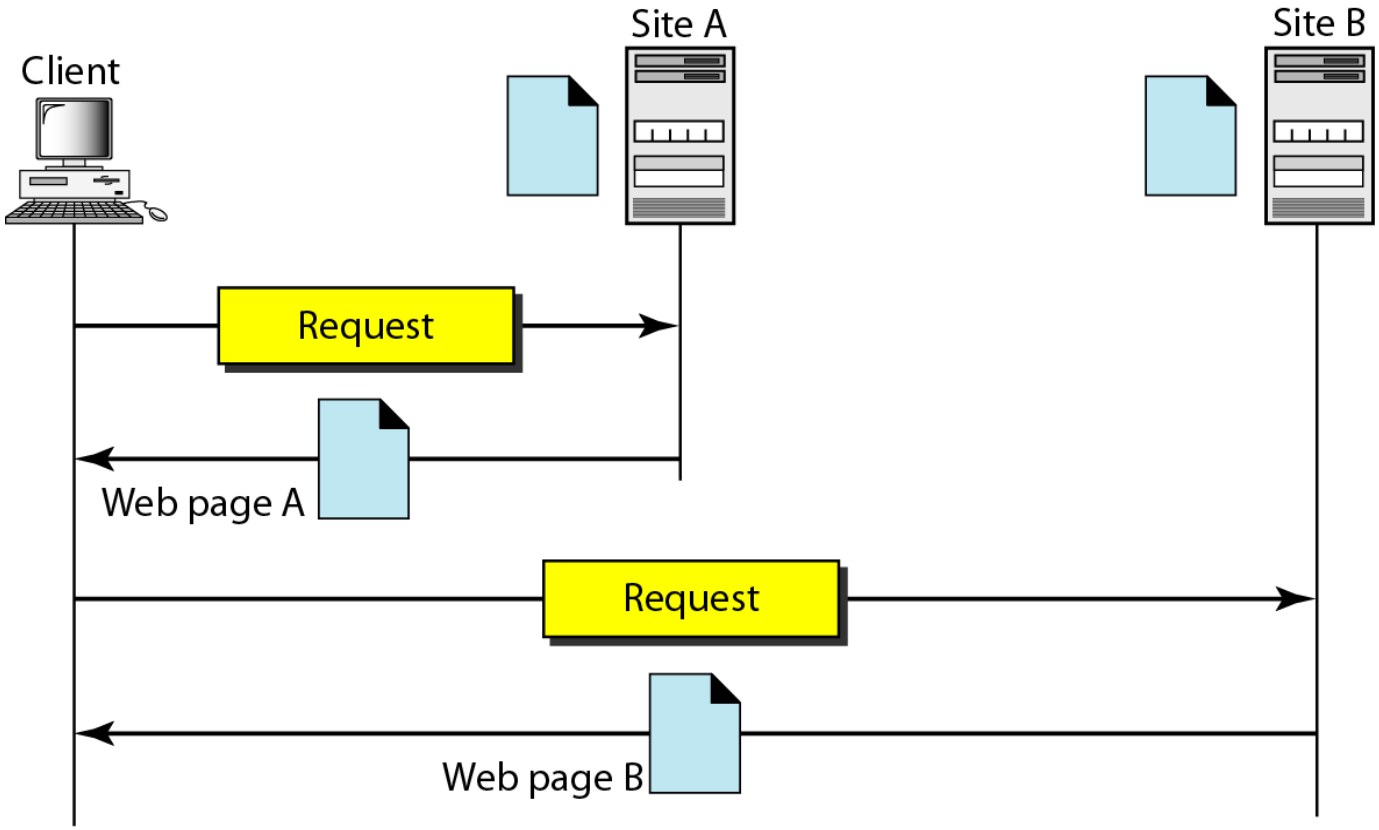


Figure: Browser

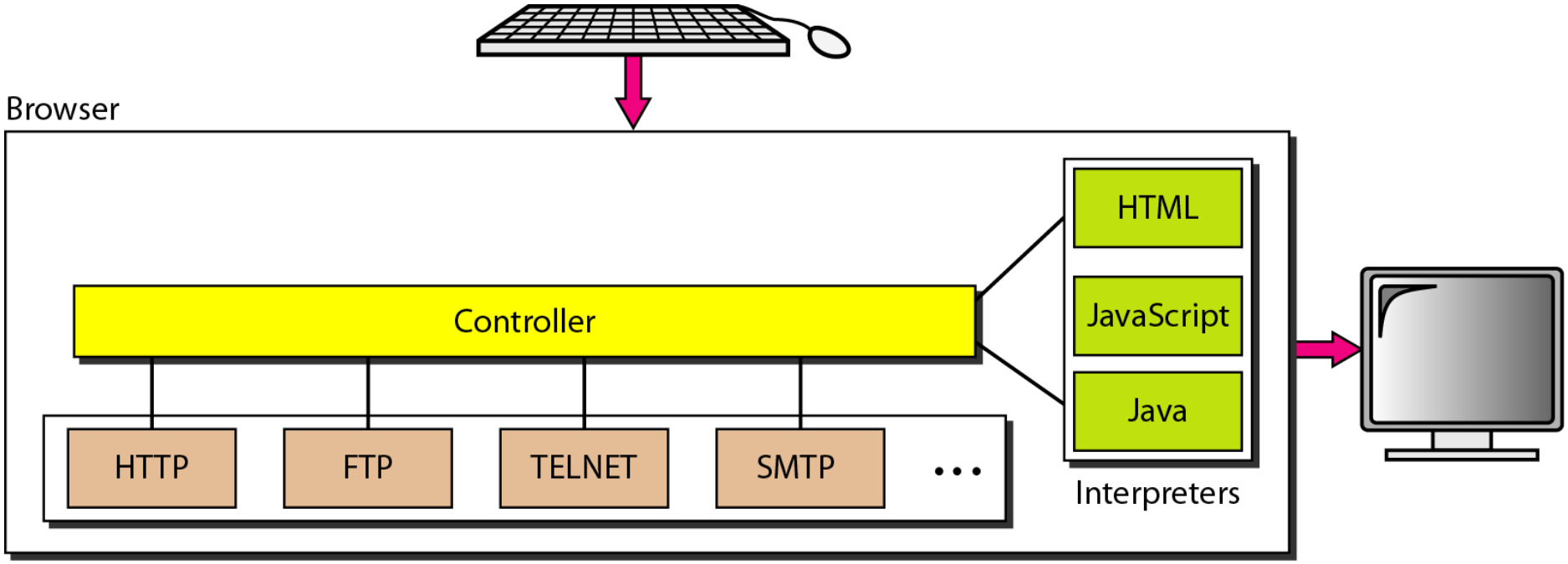
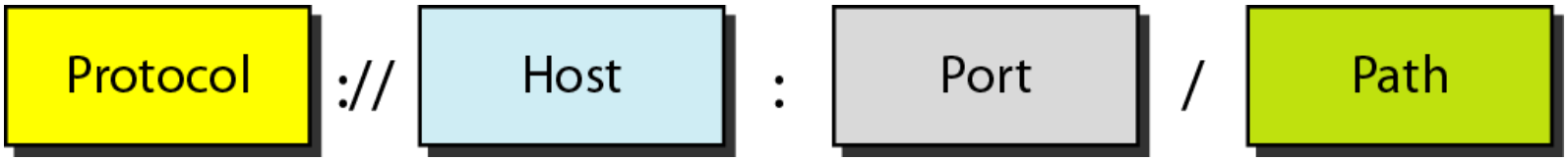


Figure: URL



HTTP

The Hypertext Transfer Protocol (HTTP) is a protocol used mainly to access data on the World Wide Web.

HTTP functions as a combination of FTP and SMTP.

Note

HTTP uses the services of TCP on well-known port 80.

Figure: HTTP transaction

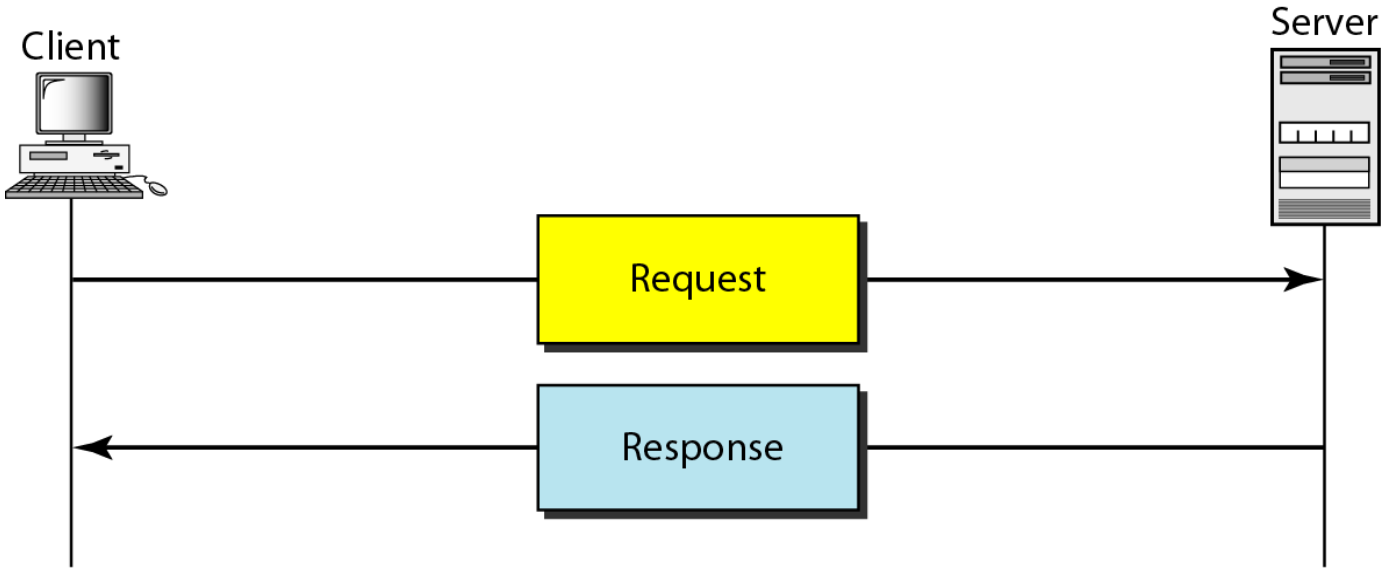
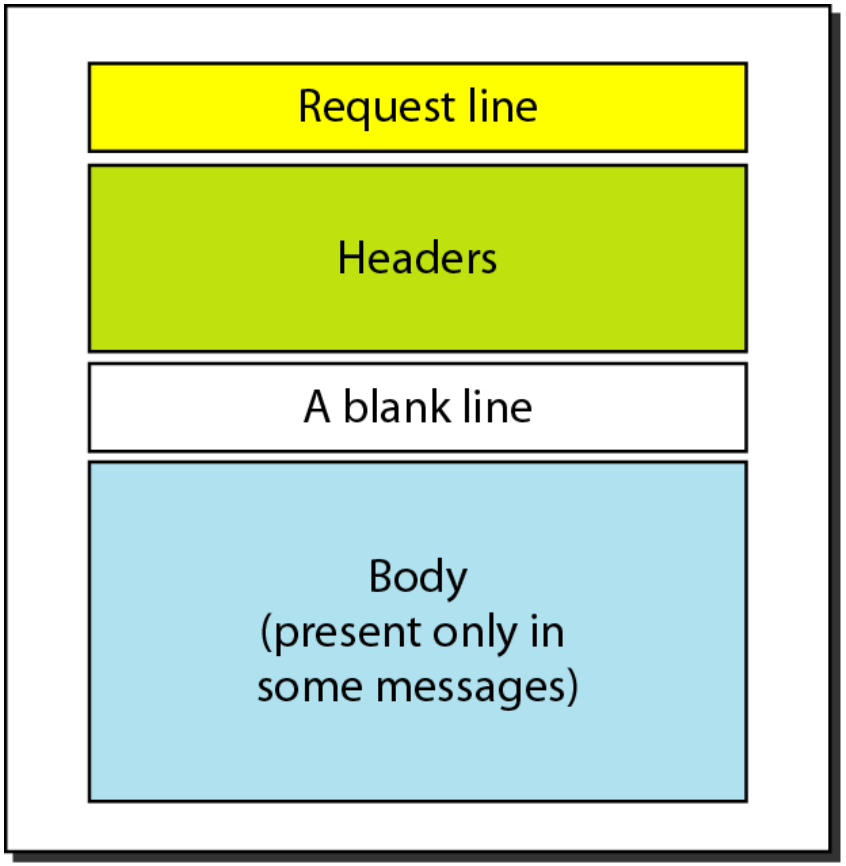
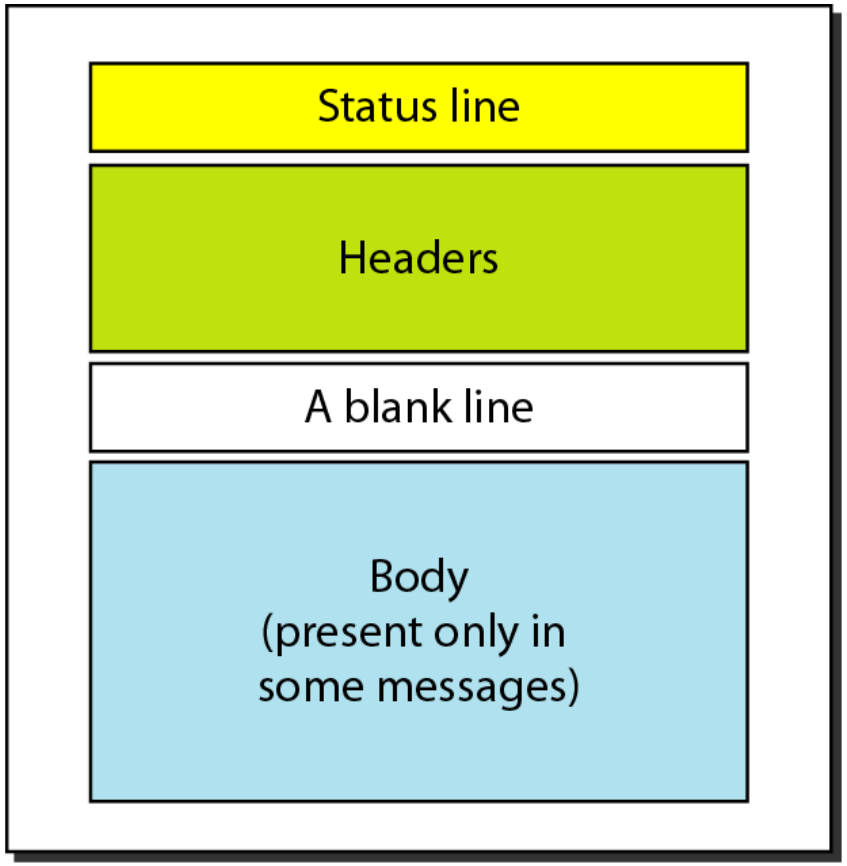


Figure: Request and response messages



Request message



Response message

Figure: Request and status lines

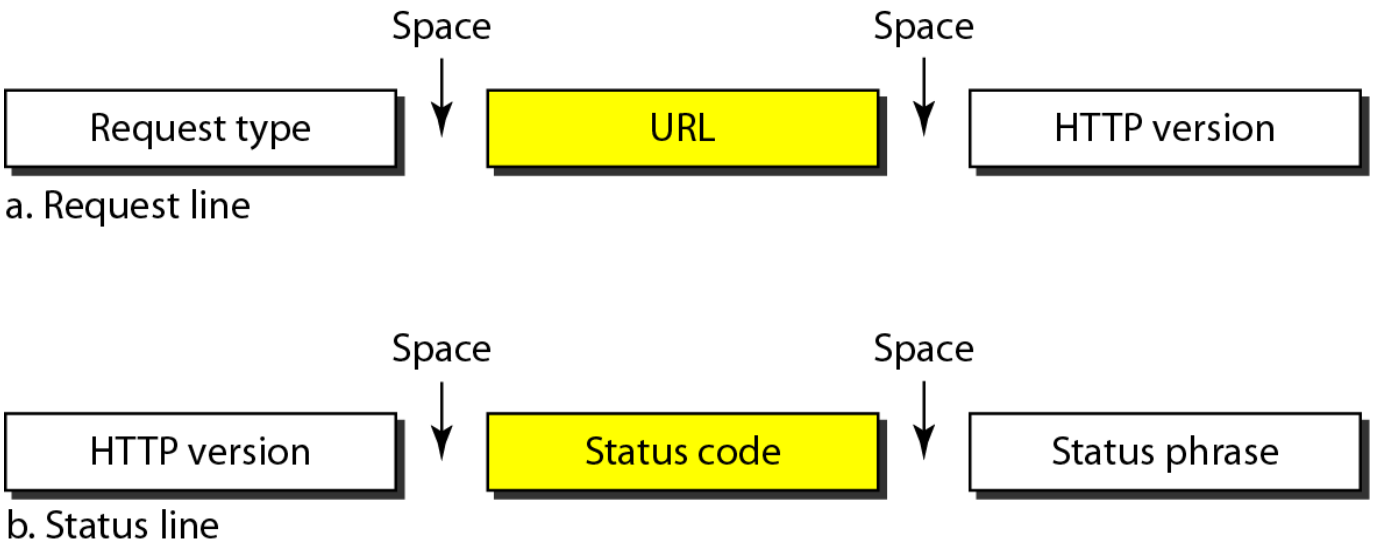


Table: Methods

Method	*Action*
GET	Requests a document from the server
HEAD	Requests information about a document but not the document itself
POST	Sends some information from the client to the server
PUT	Sends a document from the server to the client
TRACE	Echoes the incoming request
CONNECT	Reserved
OPTION	Inquires about available options

Table: Status codes

Code	*Phrase*	*Description*
	Informational	
100	Continue	The initial part of the request has been received, and the client may continue with its request.
101	Switching	The server is complying with a client request to switch protocols defined in the upgrade header.
	Success	
200	OK	The request is successful.
201	Created	A new URL is created.
202	Accepted	The request is accepted, but it is not immediately acted upon.
204	No content	There is no content in the body.

Table: Status codes (continued)

Code	*Phrase*	*Description*
	Redirection	
301	Moved permanently	The requested URL is no longer used by the server.
302	Moved temporarily	The requested URL has moved temporarily.
304	Not modified	The document has not been modified.
	Client Error	
400	Bad request	There is a syntax error in the request.
401	Unauthorized	The request lacks proper authorization.
403	Forbidden	Service is denied.
404	Not found	The document is not found.
405	Method not allowed	The method is not supported in this URL.
406	Not acceptable	The format requested is not acceptable.
	Server Error	
500	Internal server error	There is an error, such as a crash, at the server site.
501	Not implemented	The action requested cannot be performed.
503	Service unavailable	The service is temporarily unavailable, but may be requested in the future.

Figure: Header format