ФАКУЛТЕТ ЗА ИНФОРМАТИЧКИ НАУКИ И КОМПЈУТЕРСКО ИНЖЕНЕРСТВО

Internet services

Internet programing

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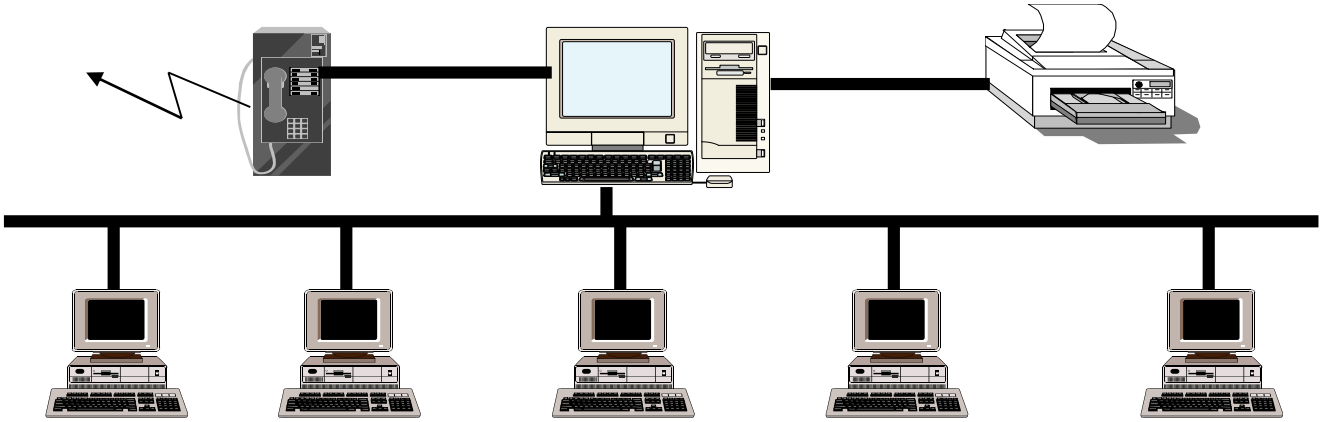
Internet

- What is the internet?
- A global computer network providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocols (IP).

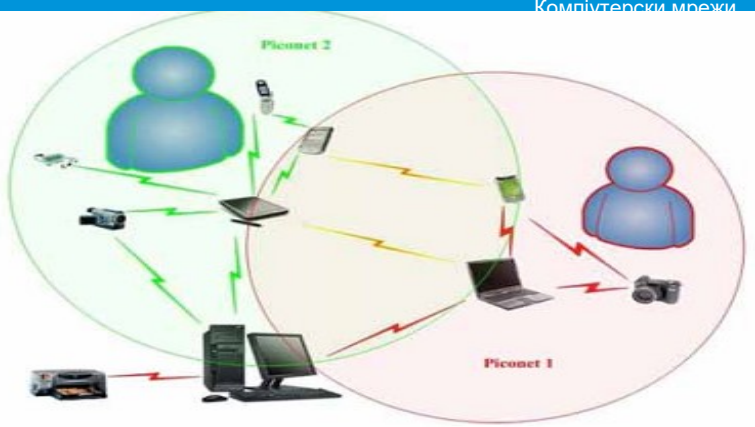
Computer networks

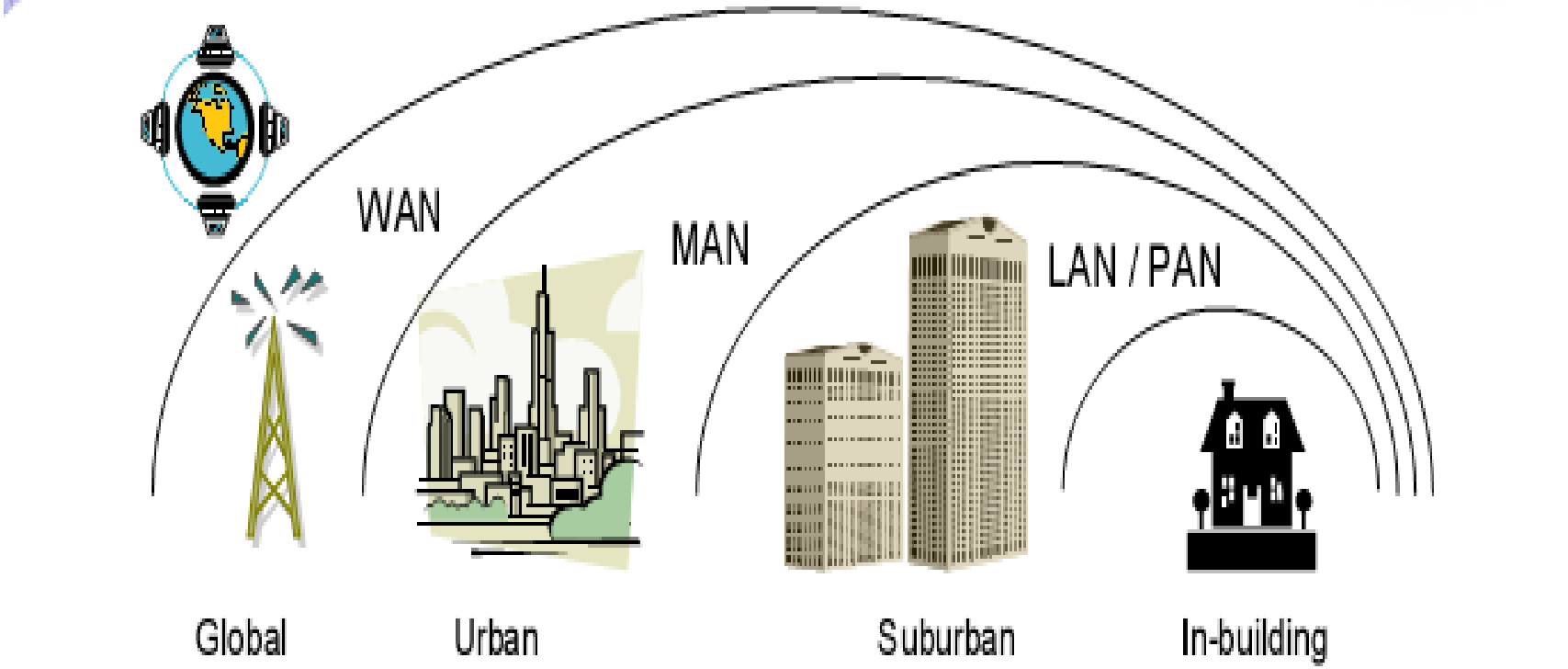
- Most computers communicate over wired or wireless medium to exchange data and other resources
- Connected in an appropriate way to allow the users to share resources



Classification of computer networks

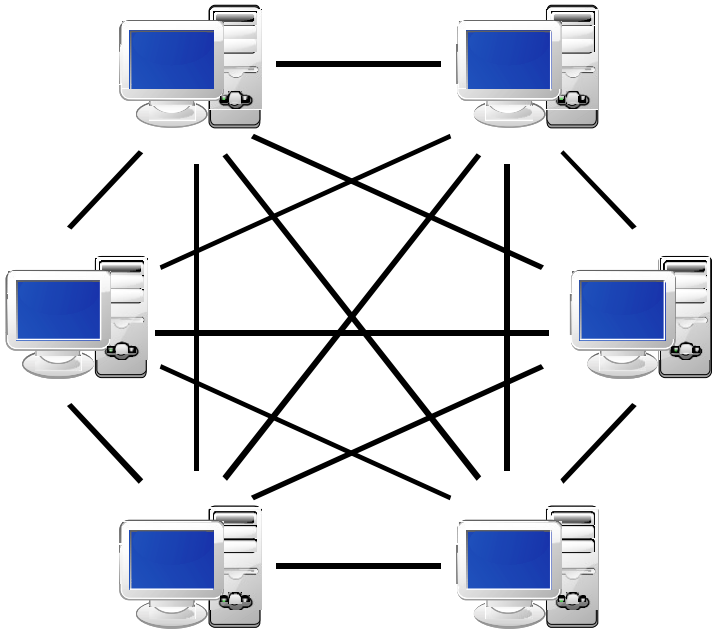
- Networks can be classified:
  - By network layer (ISO-OSI model)
  - By scale
    - PAN, LAN, CAN, WAN, MAN, GAN
  - By connection method
    - Ethernet, Wireless LAN, Fiber optic, Power line communication
  - By functional relationship
    - Active Networking, Client-server, Peer-to-peer (workgroup)
  - By network topolgy
    - Bus network, Star network, Ring network, Mesh network, Star-bus network, Tree or Hierarchical topology network, etc.
  - By protocol


Piconet 2
Piconet 1

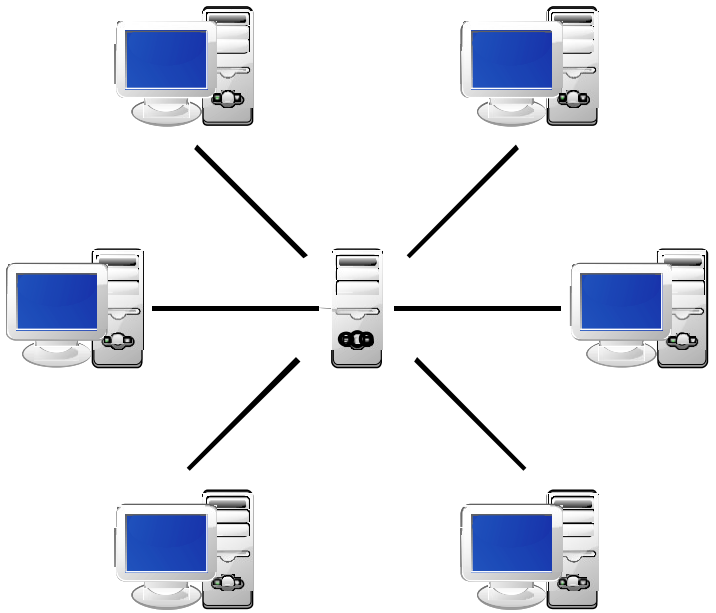

WAN
MAN
LAN / PAN
Global
Urban
Suburban
In-building
Satellite
Macro Cell (20-50 km)
Micro Cell (≈1 km)
Pico Cell (1-10 m)

Model for network communication

- Peer-to-peer (P2P)
- Client-server

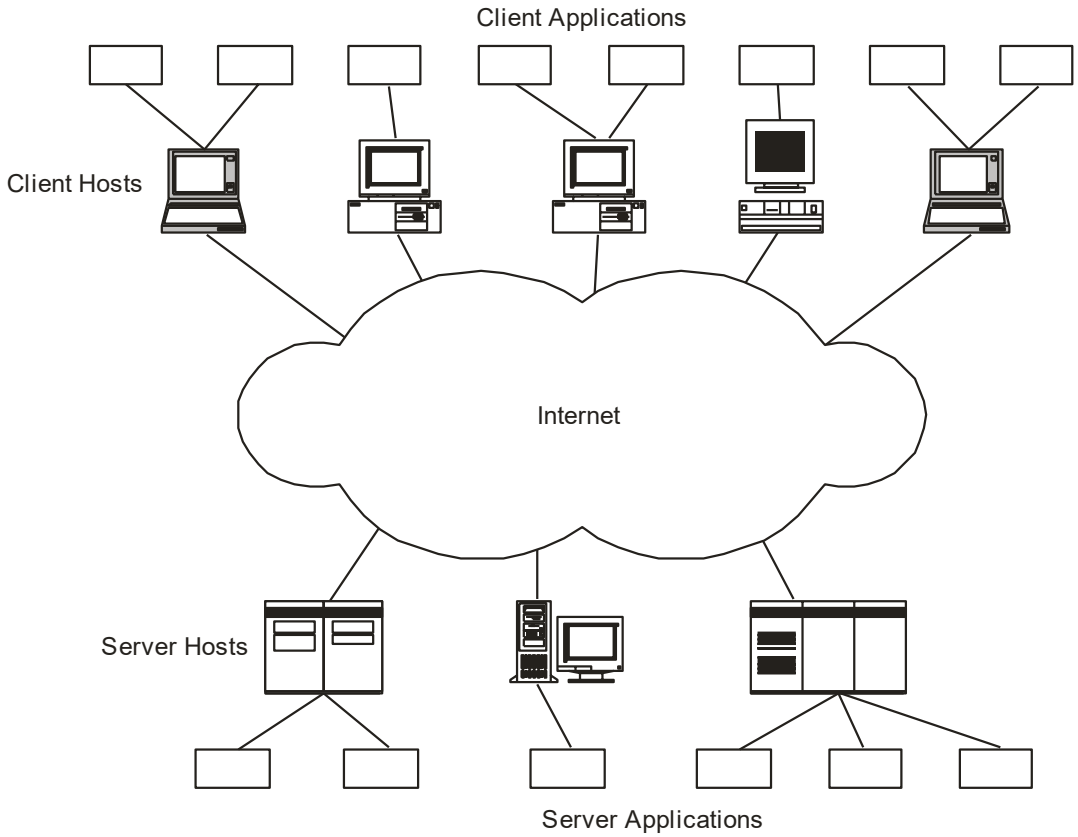


peer-to-peer



client/server

Client – server model



e-mail

telnet

FTP

HTTP

Client computers access information from server computers which store and distribute information. A given program becomes a *client* when it sends a request to a server and waits for an answer. The client executes on the user computer and allows the user to search, download (retrieval) and use (display) the information provided by the server. A *server* is a program which offers a service that can be provided over the network.

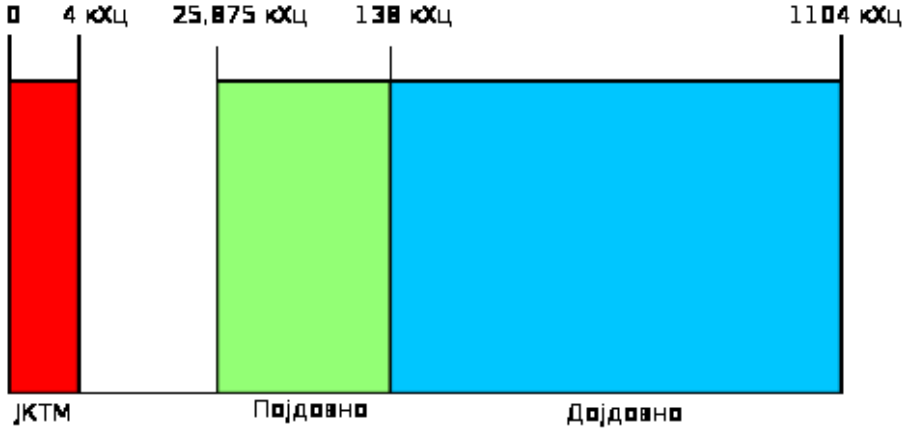
Connecting to the internet

- Small bandwidth
  - Analog telephone line– modem up to 56Kbps (POTS – plain old telephone system)
  - Digital telephone line– ISDN “modem” 128Kbs (POTS)
- Large bandwidth (fast connection)
  - DSL (ADSL) – telephone line
  - Cable Modem – cable TV
  - Wi-Fi, WiMax, WADSL – wireless
  - Fiber Optics

Connecting to the internet

D.S.L. (Digital Subscriber Lines)

- Works over existing telephone lines
- It needs an ADSL model (3 channels: up, down, voice)
- Always on
- Up to 10 Mbps

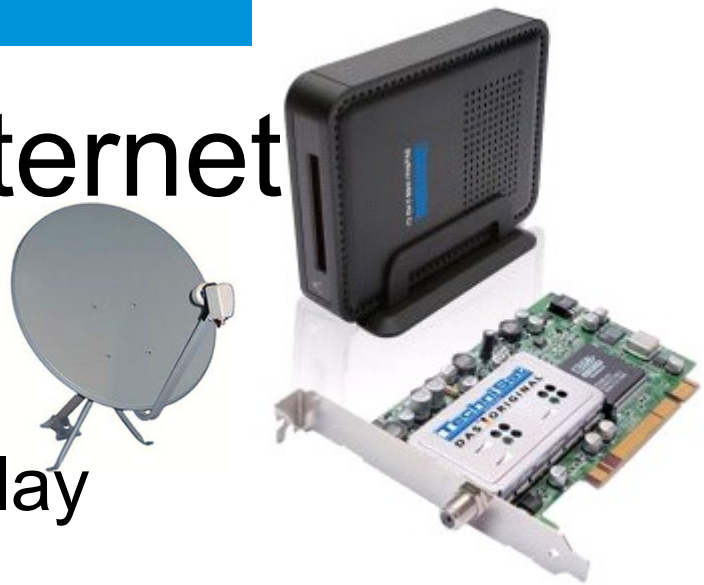


- Asymmetric (slower upload than download)
- Usually provided by telecom operators

Connecting to the internet

- Cable internet
- Cable model
- Easy to install, fast connection, shared bandwidth
- Up to 30 Mbps (usually 0.5 – 10 Mbps)
- Asymmetric (slower upload than download)
- Usually offered by cable TV operators
- Available in most urban areas

Connecting to the internet



- Satellite internet
- до 16 Gbps download
- High latency - 0.7 seconds delay
- Shared bandwidth
- One way Satellite Internet
  - one-way multicast, (standard digital SAT TV antenna)
  - one-way with terrestrial return, (standard digital SAT TV antenna + other traditional equipment)
- very small aperture terminal (VSAT) - two-way satellite access (special equipment)

Connecting to the internet

- Wi-Fi – the “third pipe” to the home
  - *What’s a hot spot?*
- In the beginning, used for local networks
- Today, it’s used as a commercial option in some urban and rural area
  - Similar technology to that of the mobile phones
  - Antenna, directed at the nearest micro-station
  - Делен опсег
  - Speeds up to 54 Mbps for 802.11g (up to 300 Mbps for 802.11n) depends on signal strength (distance to station) typical 1-4 Mbps download
  - Needs a “line of sight”, performance can depend on weather

Connecting to the interne

- WiMAX : WiFi on steroids
  - Works on large distances (covers a larger area than WiFi with a single antenna) over 40 km
  - Speeds up to 70 Mbps (10 Mbps @ 10km)
  - Possibility for adapters for mobile computers PDAs and mobile phones

Connecting to the internet

- Wireless over the mobile network infrastructure
- Offered by mobile operators
- Internet access everywhere where there is a signal for the mobile phone
- GPRS (~56Kbps)
- EDGE (236Kbps)
- UMTS (3G) (384Kbps)
- HSDPA
  - (до 14.4Mbit/s downlink, до 5.8Mbit/s uplink)
- Usually used for mobile devices

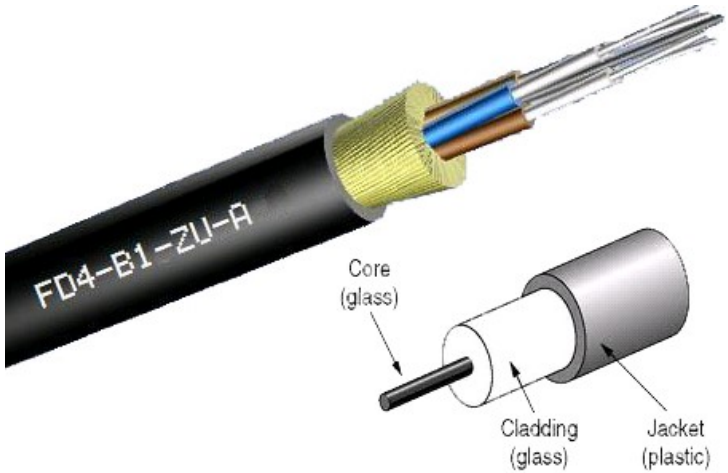
Connecting to the internet

- Leased line
  - Companies that have their own networks
- T1: guarantied speed of 1.5 Mbps
  - Usually has a 24/7 service and a guarantied minimal speed
  - Huge differences in prices…
  - Ability to create private networks
- T2 : 6.3 Mbps
- T3: 44.7 Mbps
- Fiber-to-the-Home: speeds up to 40 Gbps and more

Cable techonlogies

- Twisted pair
  - Telephony, speeds 2-100 Mbps

- Coaxial cable
  - Cable TV, speeds 200-500 Mbps



- Optical fiber cable
  - 40 Mbps - 1Tbps

Wireless technologies

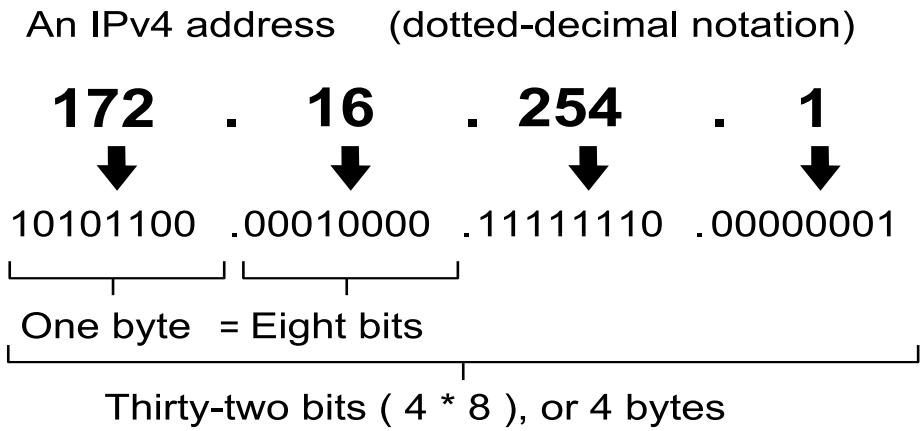
- Microwaves – sender / receiver, similar to satellite antennas, directed ~40 km
- Satellite (36.000 km)
- Cellular systems– up to 10s of km
- Wireless LAN – up to a few km (typically a few hundred meters)
- Infrared light communcation – 10m

IP address

- An Internet Protocol address (IP address) is a numerical label assigned to each device connected to a computer network that uses the Internet Protocol for communication.
- An IP address serves two principal functions:
  - host or network interface identification
  - location addressing.

IP address

- The name states what are looking for
- The address specifies where it is located
- The route (the path) specifies how to reach it
- IP address today use 32-bit numbers which are represented as 4 decimal numbers – octets (dotted-decimal notation), so it is easier for people to work with them



Address classes

- Historically, addresses were separates in to 2 parts:
  - Network number
  - Host number
- Address classes
  - The first 3 bits of the highest octet define the class

Class	First octet in binary	Range of first octet	Network ID	Host ID	Number of networks	Number of addresses
A	0XXXXXXX	0 - 127	a	b.c.d	$2^7 = 128$	$2^{24} = 16777216$
B	10XXXXXX	128 - 191	a.b	c.d	$2^{14} = 16384$	$2^{16} = 65536$
C	110XXXXX	192 - 223	a.b.c	d	$2^{21} = 2097152$	$2^8 = 256$

Internet services

- Internet service – provide some sort of service to the highest (application) layer
- Protocols
  - DHCP
  - DNS
  - FTP
  - Gopher
  - HTTP
  - IMAP4
  - IRC
  - NNTP
  - XMPP (Jabber)
  - POP3
  - SIP
  - SMTP
  - SNMP
  - SSH
  - TELNET
  - TLS/SSL

Internet services

- e-mail – sending and receiving messages
- telnet – directly connecting and working on remote computers
- FTP (File Transfer Protocol) – connecting to a remote computer with the *only* goal to download or upload a file
- WWW (World Wide Web) – combining all services through an intuitive user interface and much more…
  - Access to all kinds of data (text, graphics, audio, video,…) through hypertextual organization. Special programs are needed – browser to access the content.

Internet services

- Listserv (e-mail list server) – дискусија околу заеднички интереси преку e-mail
- News groups (USENET) - дискусија околу заеднички интереси преку специјализиран медиум (протокол)
- Archie – пребарување на FTP сервери
- WAIS (Wide Area Information Server) – Популарен начин за пребарување на големи количини на дисперзирани електронски информации. Пребарување по клучни зборови, предвесник на WWW.
- Gopher / Veronica – Првиот љубезен, кориснички ориентиран интерфејс за интернет. Исто така предвесник на WWW.

Archie, WAIS, gopher се денес излишни, Web форумите се попопуларни од USENET и Listserv.

DHCP - Dynamic Host Configuration Protocol

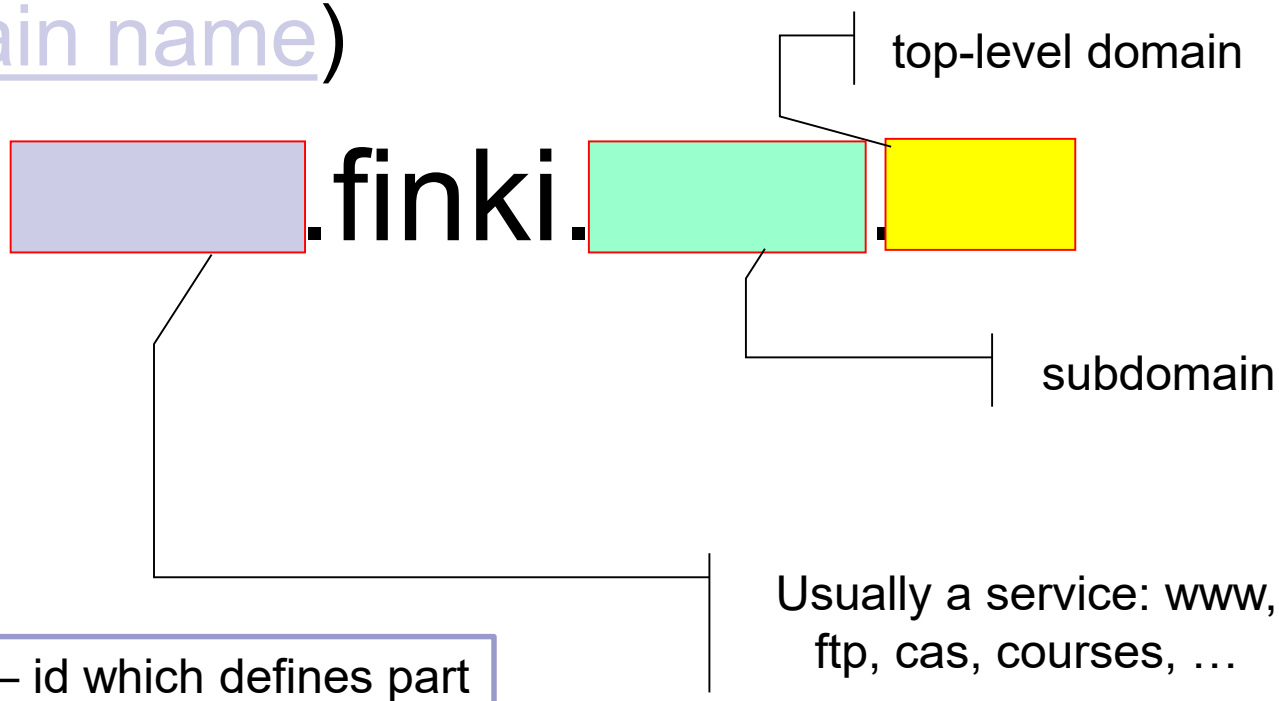
- Network protocol for automatic configuration fo the devices connected on the IP networks
- Every device needs to have a unique IP address. Who assigns this address (in the local network)?
- It can be setup manually and be permanent, or
- There can be a device in the local network, which is responsible for all devices connected to on that network

DHCP

- Additional values need to be configured on the devices connected on the IP network
  - IP address
  - Subnet mask
  - Default gateway
  - Preffered DNS server

Naming in the internet

- Name of the internet host(resource) (domain name)



Domain name – id which defines part of the internet managing and/or administrative autonomy

250,000,000

DNS (Domain Name System)

- Main purpose – translating a host name to an IP address
  - (from en.wikipedia.org to *66.230.200.100*)
- System of aliases of numeric IP addresses
- Convention for naming hosts and way to resolve (associate) names to IP addresses.
- Naming
  - top-level internet domains
  - case insensitive
  - multiple aliases

increasing granularity →

www.elsevier.com
ftp.elsevier.com
karyn.editorial.elsevier.com
www.shef.ac.uk
www.finki.ukim.mk

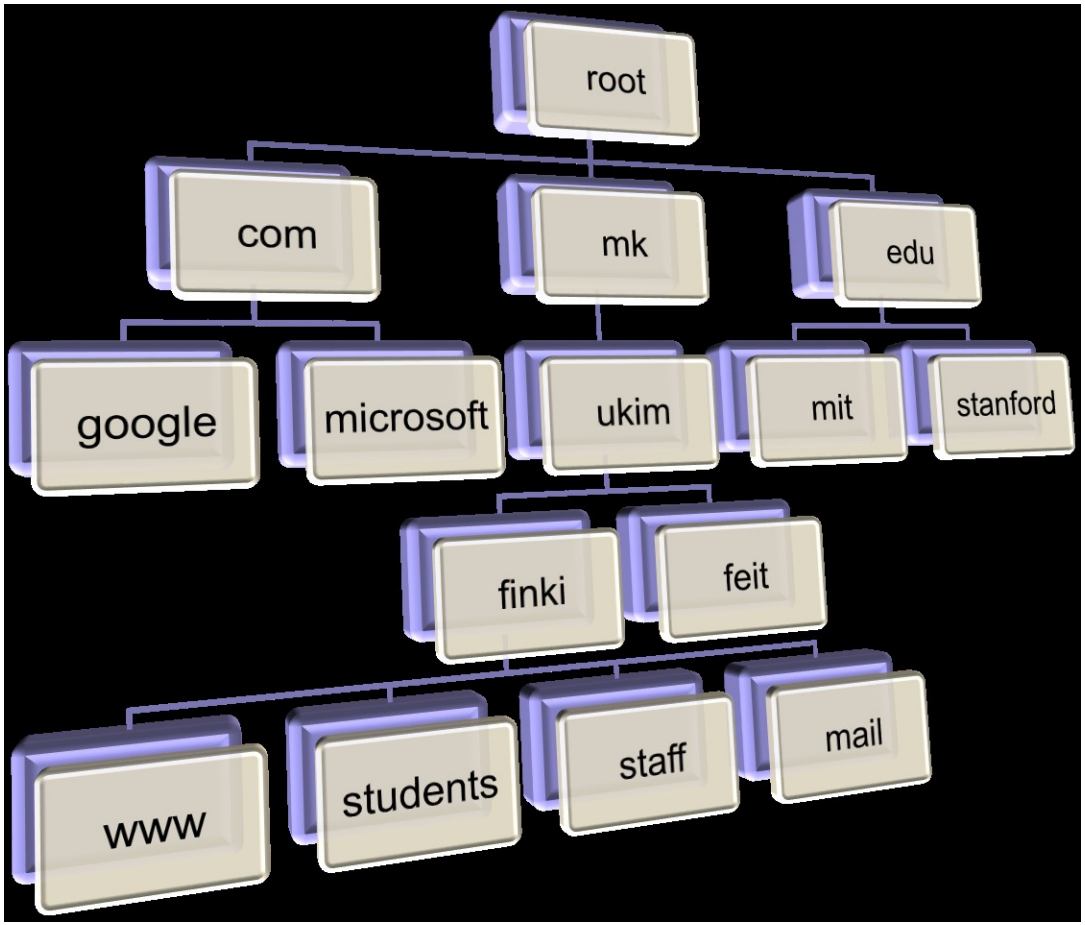
Domain structure

- The internet keeps two regulated spaces of names
  - Hierarchy of domain names
  - IP address spaces
- The DNS system keeps the hierarchy of domain names and provides services to map between these two spaces

DNS server

- DNS server is a server which keeps DNS entries for given domain, such as:
  - Addresses
  - Names of domain servers
  - Email servers
- Responds to requests to it’s database

Structure


root
com
mk
edu
google
microsoft
ukim
mit
stanford
finki
feit
www
students
staff
mail

Domain name syntax

- The domain name is consisted of the parts called labels, which are appended and connected with a doc (primer.com)
- The (right-most) last label is called a top-level domain. E.g. www.primer.com belongs to the com top-level domain
- The domain hierarchy goes from right to left and every label is a subdomain of the label on the right.
- There can be 127 levels of subdomains and each label can have 63 characters and the full path (labels and dots included) can be up to 253 characters longs. Labels can contain letters, numbers and “-” (which can’t be the first or last sign of the label) and there no distinction being made between capital and small letters.
- Hostname is a name of a domain which is assigned to, at least, one IP address

Internet top-level domains

- Divided by intented usage – domain
  - edu – for education
  - com – for industry
  - gov – for government
  - mil – for military
  - org – for non-profit organizations
  - net – for computer networks
  - int – for international organizations

Internet top-level domains

- By country
  - mk – Macedonia
  - gr – Greece
  - bg – Bulgaria
  - uk – United Kingdom
  - fr – France
  - de – Germany
  - se – Sweden
  - ru – Russia
  - . . . 250+

Internet top-level domains

- Regional domains
  - eu – European Union
  - asia – Asian-Pacific region
  - cat – Catalonia

Generic top-level domains

Name	Entity
.aero	air-transport industry
.asia	Asia-Pacific region
.biz	business
.cat	Catalan
.com	commercial
.coop	cooperatives
.edu	educational
.gov	governmental
.info	information
.int	international organizations
.jobs	companies
.mil	U.S. military
.mobi	mobile devices
.museum	museums
.name	individuals, by name
.net	network
.org	organization
.pro	professions
.tel	Internet communication services
.travel	travel and tourism industry related sites
.xxx	adult entertainment

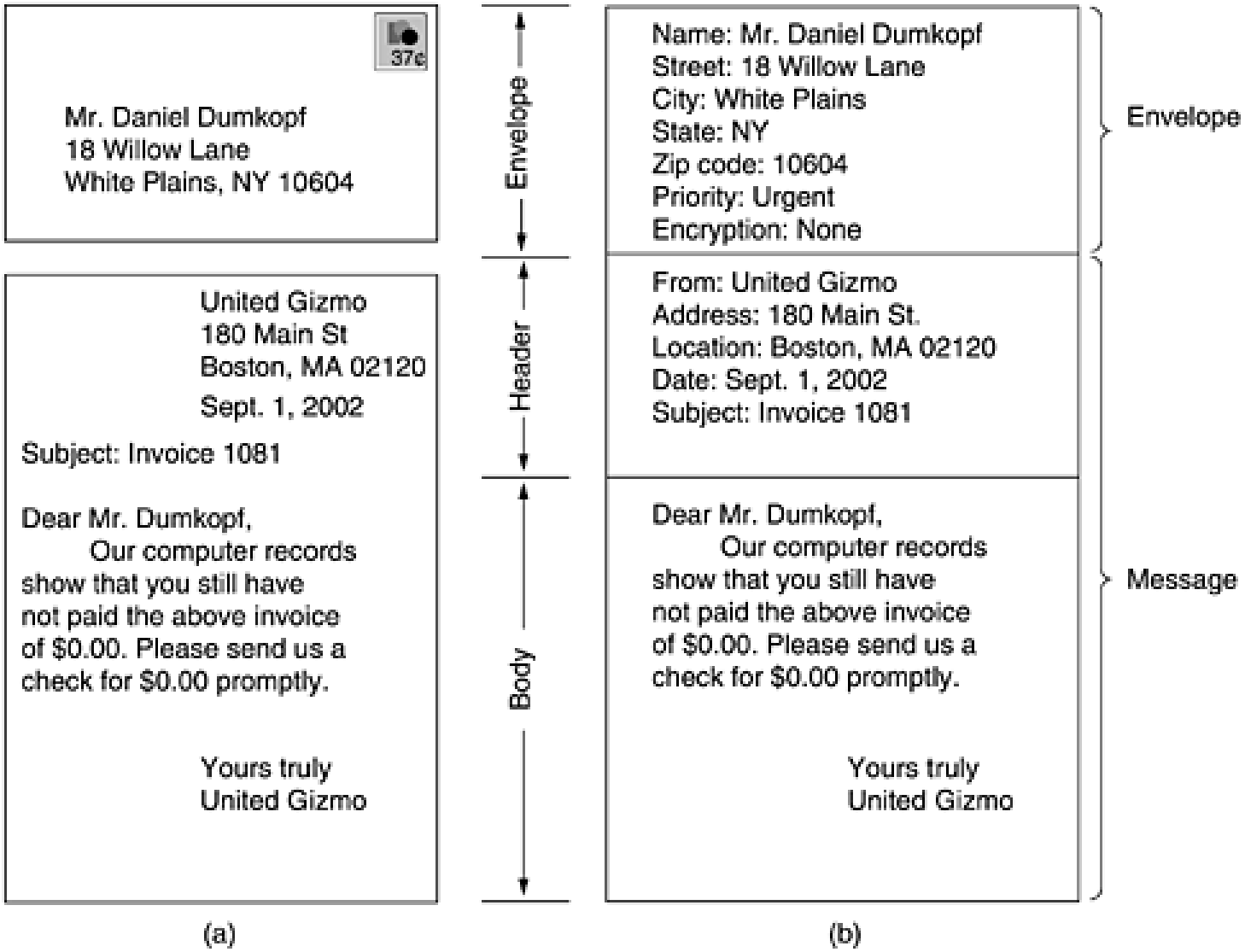
E-mail -SKIP

- Electronic mail or email is a simple method to exchange digital messages from on user to another
- Organized as a “Store and forward” method of creating, sending, storing and sending messages over electronic communication systems
- The users are not required to be constantly on-line
- Most internet users use this service, because it is fast, simple, cheap and very practical
- Before email there were: BBS, CompuServe, MCI Mail, Fidonet, …
- Basically, it is just a simple text file which is being sent from one system to another
- This file can contain other non-text (binary) data (MIME - Multipurpose Internet Mail Extensions, base64, UUENCODE)

Email

- Needs special app to receive/send/read/store email messages
- Public email services (yahoo, hotmail, gmail,…)
- Address: someone@somewher.edu
- Mailing listi (moderated, unmoderated, digest)
- Email protocols: SMTP, POP3, IMAP, MIME
- viruses, SPAM, filtering ...

Constructing an e-mail



Fields of an email

- From: *email_address* (AUTO)
- Date: -
- Message-ID: (AUTO)
- In-Reply-To:... (AUTO)
- To: *email_address(es)*
- Subject:
  - кратко резиме на темата на пораката ("RE:" и "FW:".)
- Cc: Carbon copy
- Bcc: Blind Carbon
- Content-Type:
- Precedence:
- References:
- Reply-To:
- Sender:
- Archived-At:

- *X-Priority:*
- *Importance:*
- Return-Receipt-To:
- Disposition-Notification-To:
- . . .
- *Received*:
- *Return-Path*:
- *Authentication-Results*:
- *Received-SPF*:
- *Auto-Submitted*:
- *VBR-Info*:

Sample header from an e-mail

```
Delivered-To: name@gmail.com
Received: by 10.27.91.9 with SMTP id p9csp74213wlb;
        Thu, 2 Oct 2014 10:31:18 -0700 (PDT)
X-Received: by 10.224.165.1 with SMTP id g1mr119972qay.97.1412271077657;
        Thu, 02 Oct 2014 10:31:17 -0700 (PDT)
Return-Path: <jBzsDMysnLSsrEyc7IxMTLRGtEwsnAxMDMyM@smtp-coi-11.aweber.com>
Received: (qmail 22044 invoked by uid 0); 2 Oct 2014 17:31:14 -0000
Message-ID: <78.17.31236.2EB8D245@momentum1-mta2>
Content-type: text/plain; charset=utf-8
Content-Transfer-Encoding: 8bit
To: “Name" <name@gmail.com>
From: "FreeVideoLectures" <ak@freevideolectures.com>
Sender: video_lectures@aweber.com
X-Mailer: AWeber 4.1
Feedback-ID: A556494:L1870359:M10-01-2014-16-59-45:AWeber
Date: Thu, 2 Oct 2014 13:31:14 -0400
Subject: 7 Most Interesting Courses For Learning "Ocean Engineering Courses"

Hey Dejan,
7 Most Interesting Courses For Learning "Ocean Engineering Courses"
…
```

Apps for email

- **email client**, **email reader**, or **mail user agent** (MUA)
- provides:
  - create
  - send
  - receive
  - view/read
  - manage/search
- scripting
- Popular e-mail clients: Outlook (Microsoft), Mail (Apple), Lotus Notes (IBM), Thunderbird, Kmail, …
- **Webmail**: Gmail, Outlook.com, Yahoo, …

e-mail protocols

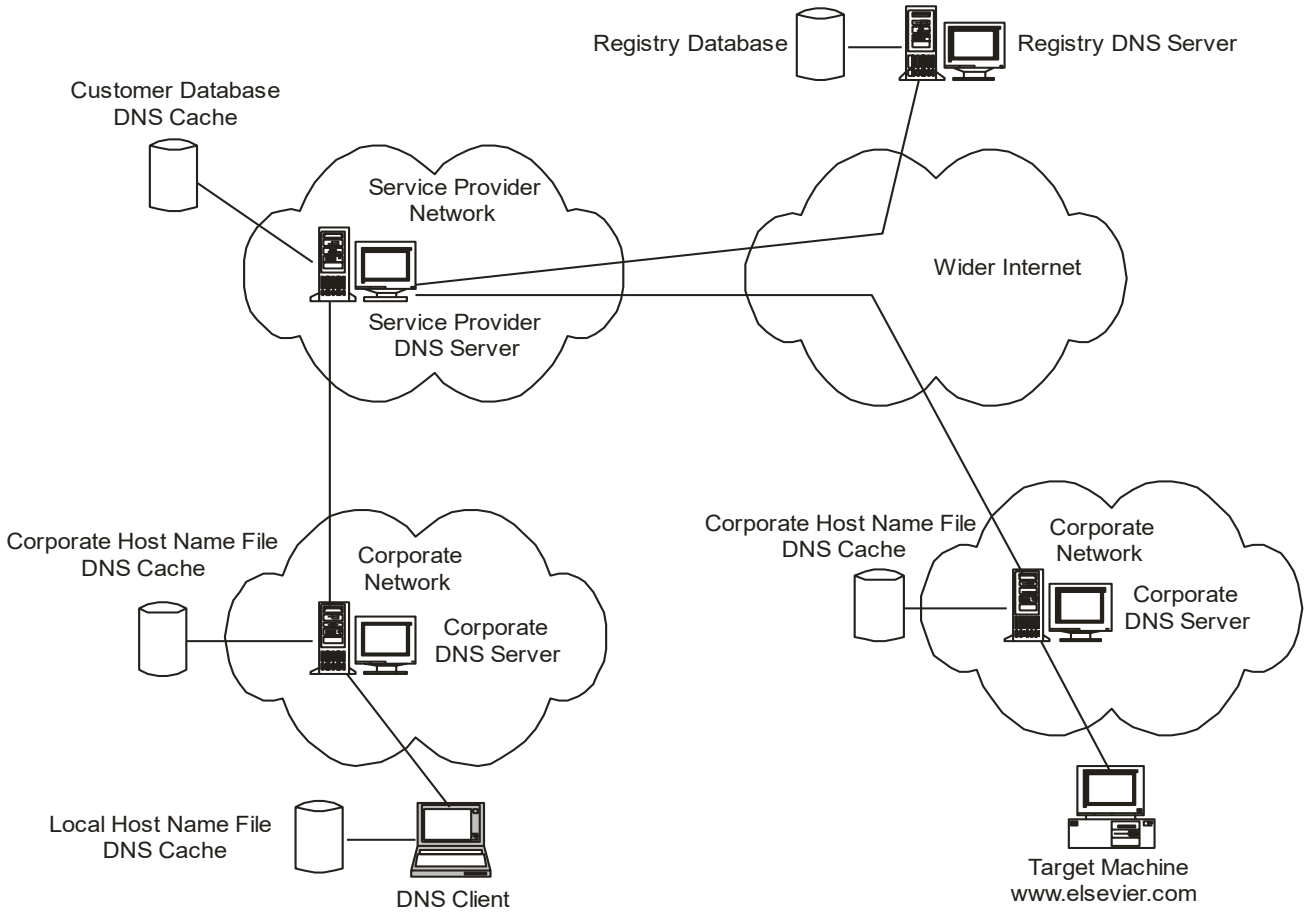
- SMTP
  - Simple Mail Transfer Protocol –TCP connection on port 25
- POP3
  - Post Office Protocol version 3
  - Good for dial-up
- IMAP
  - Internet Message Access Protocol –

Problems with e-mail

- E-mail spoofing
- Computer virus
- Computer worm
- Hoax
- Chain e-mail
- Netiquette - "network etiquette
- E-mail spam, bulk e-mail or junk e-mail
- Information overload

DNS protocol

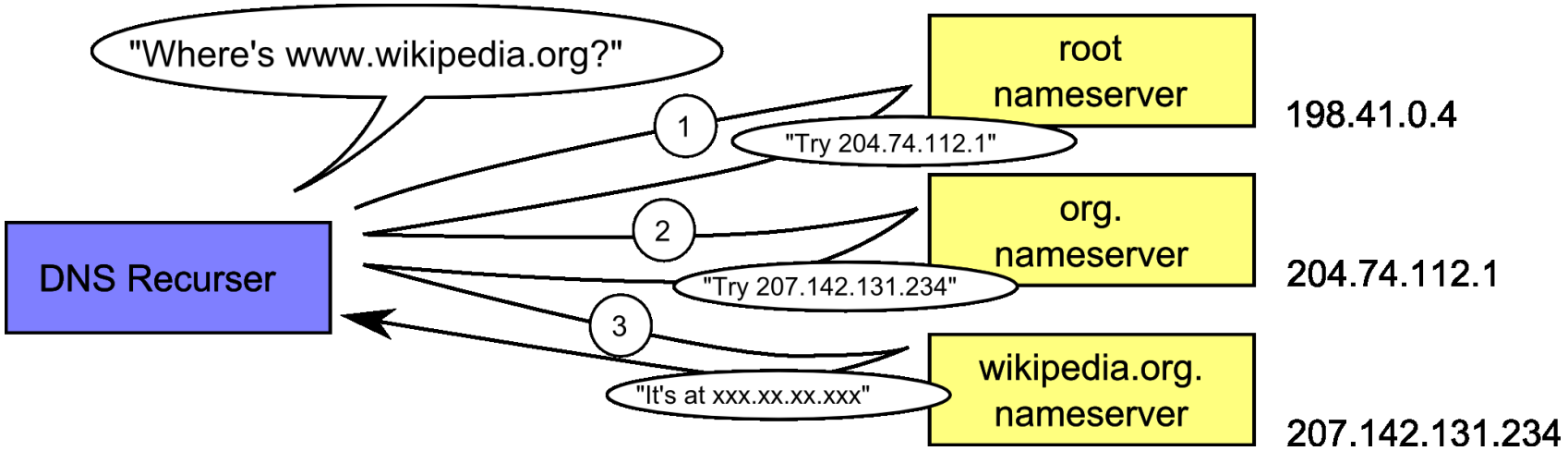
How to get the IP address for a given host name?
Distributed database of hostname – IP mapping

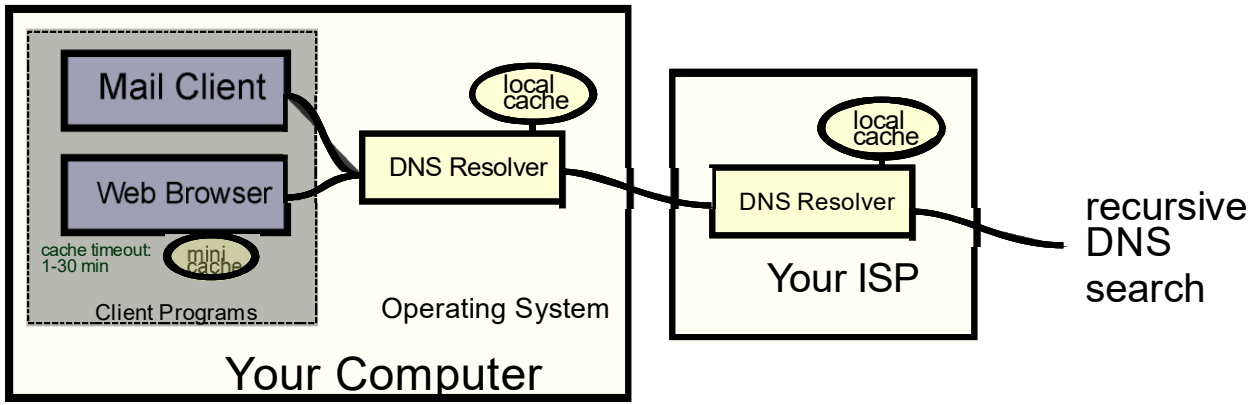


DNS request

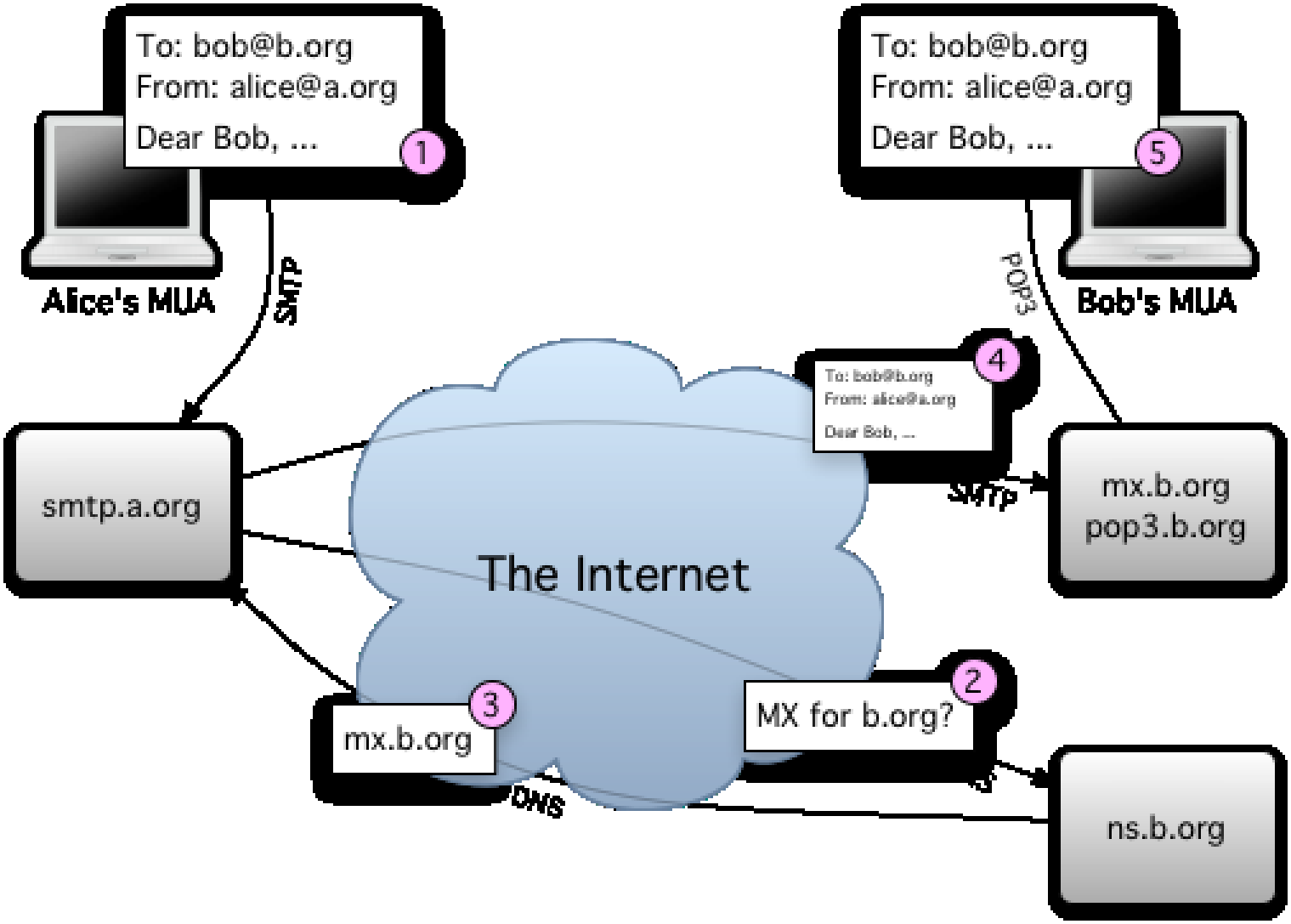
- To access a given hostname, the system needs to know it's IP address
  1. Does it have it in it's own local database?
  2. If it does not have it, it sends a request to the local DNS (which has a bigger database)
  3. If that one does not have it, then it forwards the request it's superior DNS server
  4. If it does not have it, it sends an answer with the server which should have it (don't ask me, ask him)
  5. Finally, the request is sent to it
- Caching, expiration time

Resolving and DNS request





The process of sending an e-mail



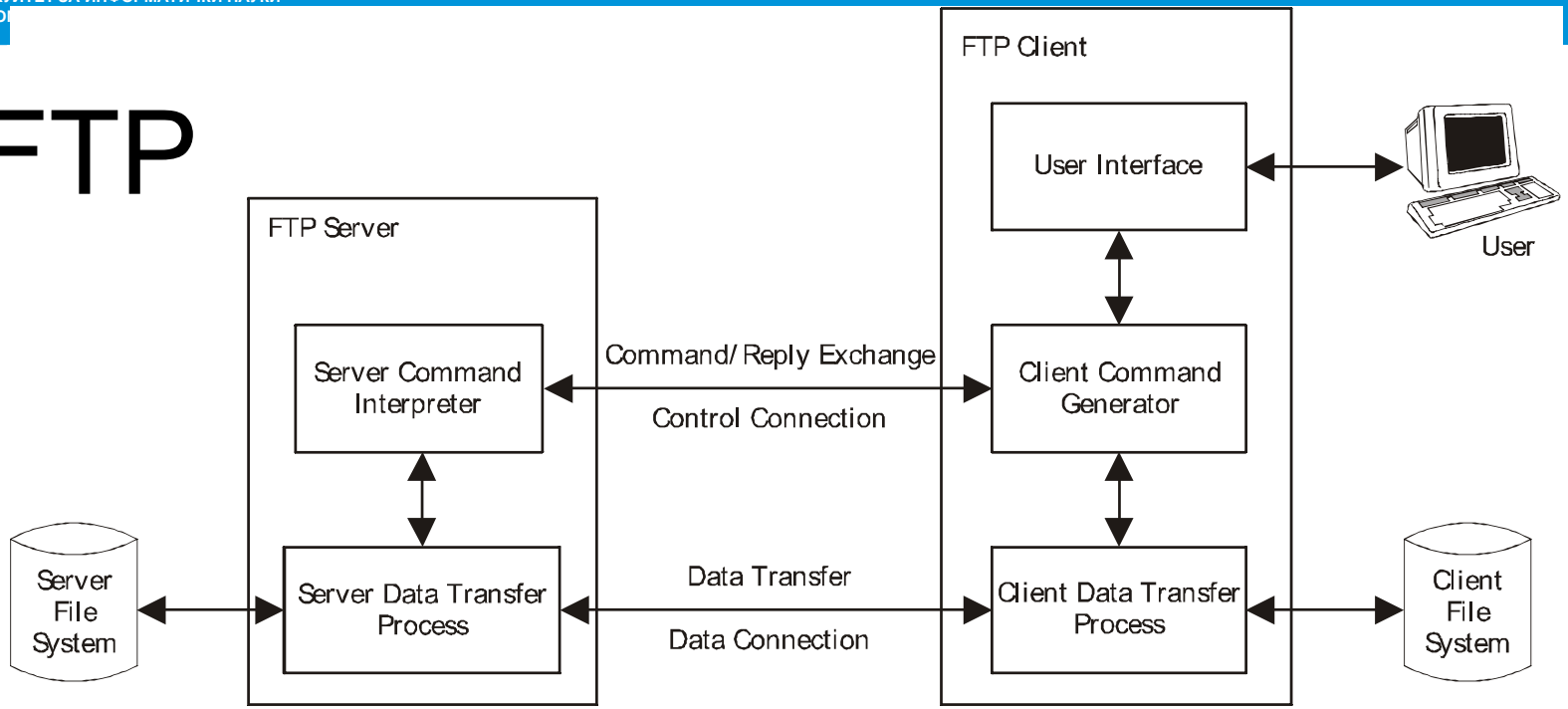
FTP (1)

- FTP (File Transfer Protocol) is a software standard for transferring files between systems with drastically different operating systems
- Client-server transaction protocol based on TCP/IP, capable to work with any kind of file without additional processing
- Has a high latency
- It has a relatively long login procedure
- Not safe
  - The login process is not protected (the password is sent as plan text)
  - Files are transferred non-encrypted
  - Uses multiple TCP/IP connections, one for the control connection and one for the data connection
  - Lots of vulnerabilities

FTP (2)

- Works with 2 connections on port 20 and 21. Data is transferred on port 20, whereas the control is handled on port 21. During the data transfer, there is no traffic on port 21.
- anonymous ftp
- Modern browsers and file manager support connecting to FTP servers
- URL of the type ftp://<ftpserveraddress> (e.g. ftp://ftp.gimp.org/) or ftp://<*login*>:<*password*>@<*ftpserveraddress*> (пр. ftp://user123:secret@ftp.somehost.com)
- There is a secure *SSH file transfer protocol* (*sftp or* FTPS) – not to be confused with SFTP
- TFTP (Trivial FTP) – offers minimal subset of FTP commands (functionality) over UDP

FTP



Command Operation

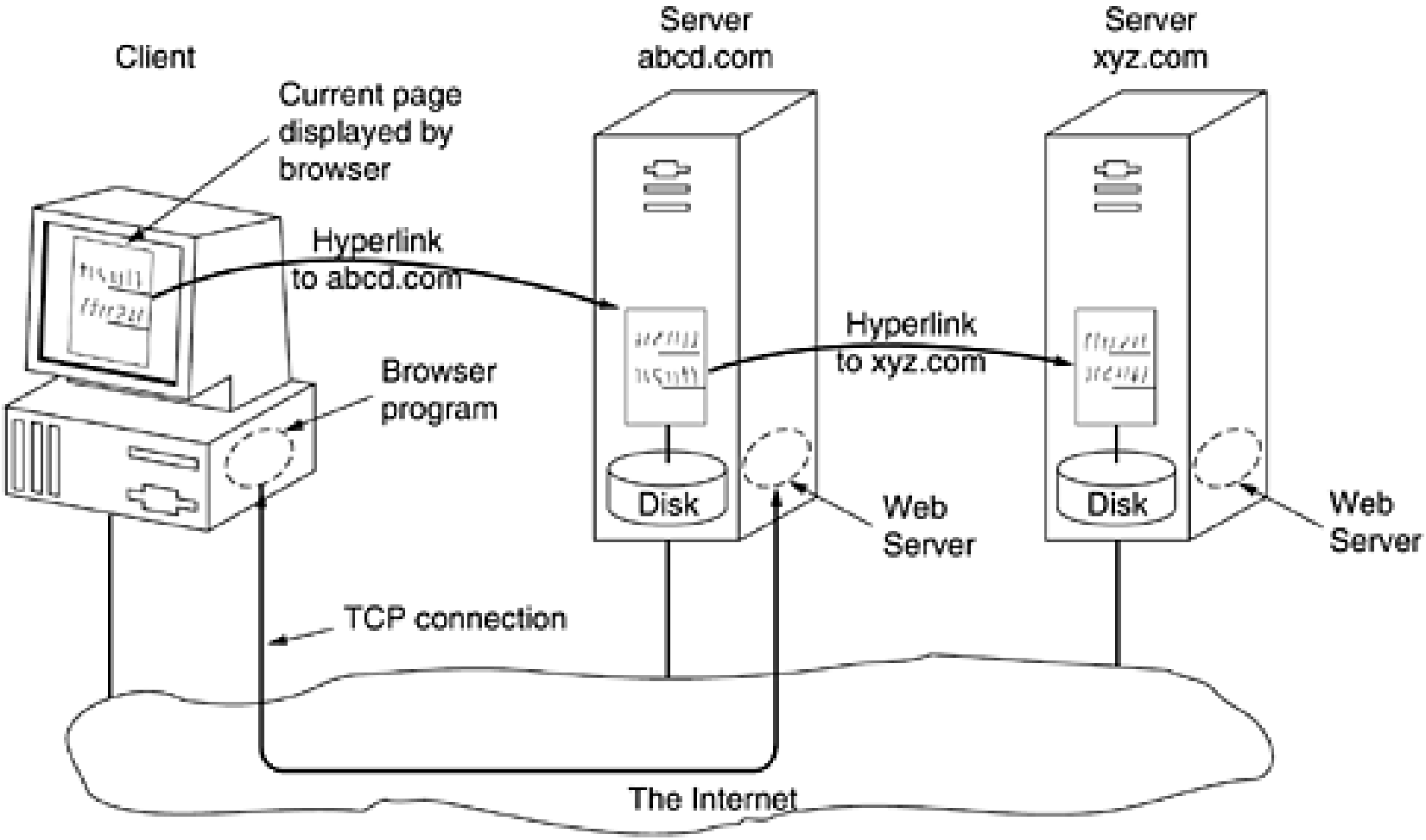
open Connect to the FTP server on a remote host
user Log in as a specific user on a remote host
close/disconnect Disconnect from the remote FTP server
quit/bye Disconnect from the remote FTP server and exit the client application
pwd Display the current directory on the remote host
cd Change the current directory on the remote host
lcd Change the current directory on the local host
ls/dir List the files in the current directory on the remote host
mkdir Make a new directory on the remote host
rmdir Remove a directory on the remote host
get/recv Retrieve a file from the remote host
put/send Copy a file to the remote host

delete Delete a file on the remote host
rename Rename a file on the remote host
append Append the contents of a local file to a file on the remote host
mget Retrieve multiple files for the remote host
mput Copy multiple files to the remote host
mdelete Delete multiple files on the remote host
ascii Set the file transfer mode to ASCII (text) and convert text formatting characters between the local and remote host formats
binary Set the file transfer mode to binary and do not attempt to examine or modify the contents of the files
prompt Prompt the user between each of a set of operations
literal/quote Send a specific command direct to the protocol

Other internet services

- Chat (Microsoft chat, IRC, …)
- Instant messaging (ICQ, yahoo, microsoft)
- Internet telephony (Skype, Voice-over-IP)
- Teleconferencing/videoconferencing over internet
- Webcast, Internet radio, Internet TV
- Gopher, Archie, Veronica, WAIS и останати старудии...
- P2P мрежи (gnutella, Kazaa, edonkey, Bittorrent)

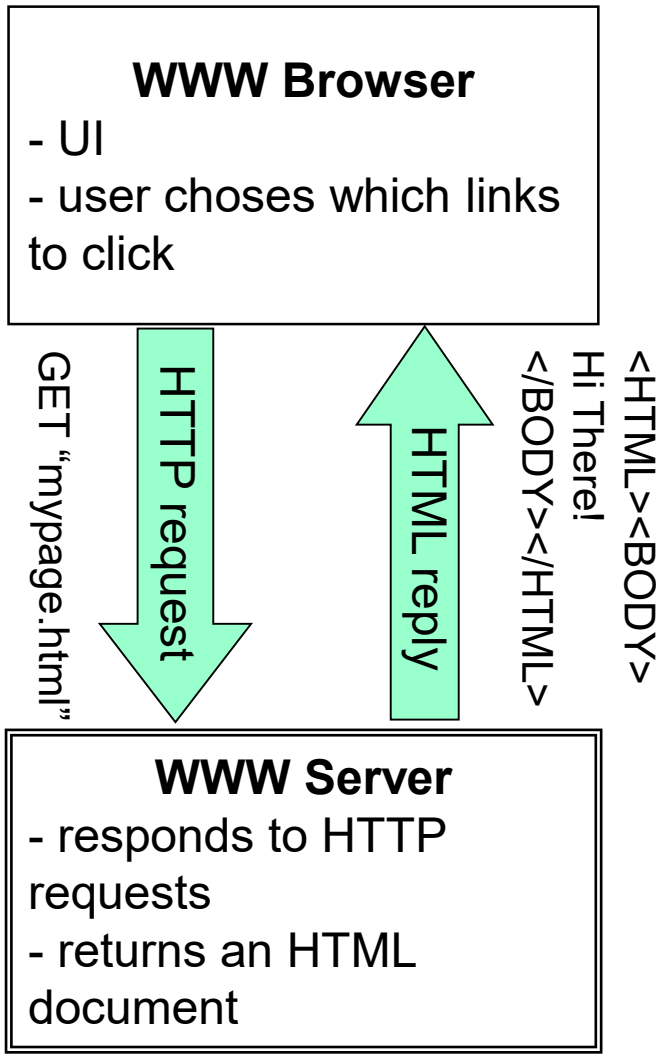
Web model


Client
Server
abcd.com
Server
xyz.com
Current page
displayed by
browser
Hyperlink
to abcd.com
Hyperlink
to xyz.com
Browser
program
Disk
Disk
Web
Server
Web
Server
TCP connection
The Internet

Client (browser) – server interaction

When the browser asks for web page:

- The browser opens a connection with the HTTP protocol and sends a request for the required page
- The server:
  - Accepts the request
  - Send the content of the page (file) back to the browser
  - Closes the connection
- The browser formats and shows the downloaded (HTML) data



URL

- URL (Uniform Resource Locator)
- Contains information for:

1. The name of the web page
2. The location
3. How it can be accessed

http://www.finki.ukim.mk/kursevi/prva-godina.html

file://[<*host_name_or_address*>**/**]<*path_and_file_name*>
http://<*host_name_or_address*>[:<*port*>]**/**<*path_and_file_name*>
[<*additional_tags*>]
mailto:<*user_name*>**@**<*host_name_or_address*>
gopher://<*host_name_or_address*>[:<*port*>]**/**<*path_and_file_name*>
telnet://<*user_name*>[:<*password*>]**@**<*host_name_or_address*>[:<*port*>]
ftp://[<*login*>**:**<*password*>]**@**<*ftpserveraddress*>[:<port>]/<*path_and_file_name*>

http://dejan.gjorgjevikj.com

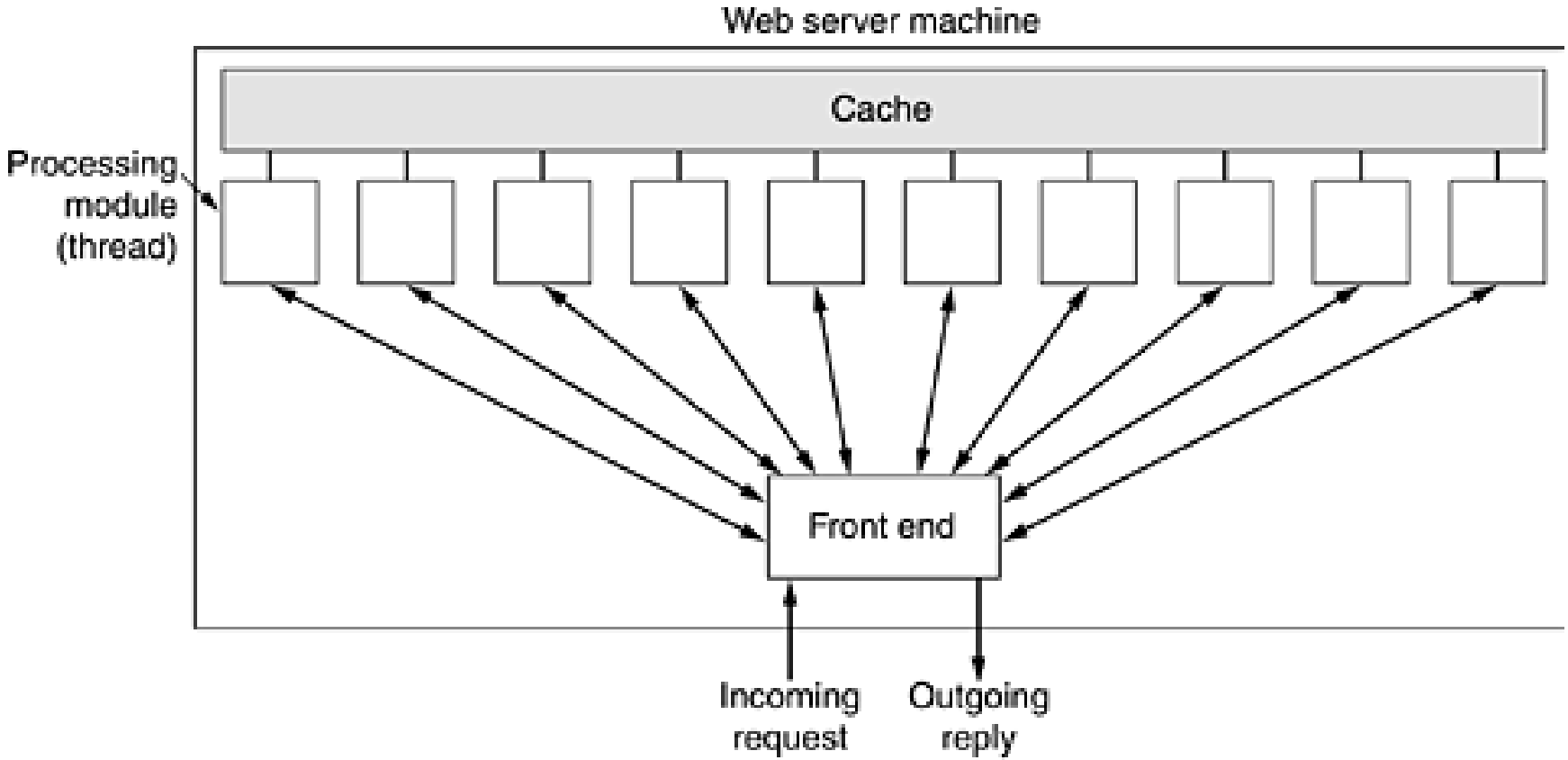
Cookies

- The web browser send a request to the server for a given page, the server returns the page, closes the connection and forgets what the client saw.
- Netscape developed (highly coitized) technique of so called cookies.
- When the client asks for a page, the server can send additional data along with the page. These data can contain a cookie, which is a small (<4kb) file or a string. Browsers keep the cookies in a specific folder in the client computer. Any kind of text data can be kept in the cookie and later, when the user visits the same page again, it can be read

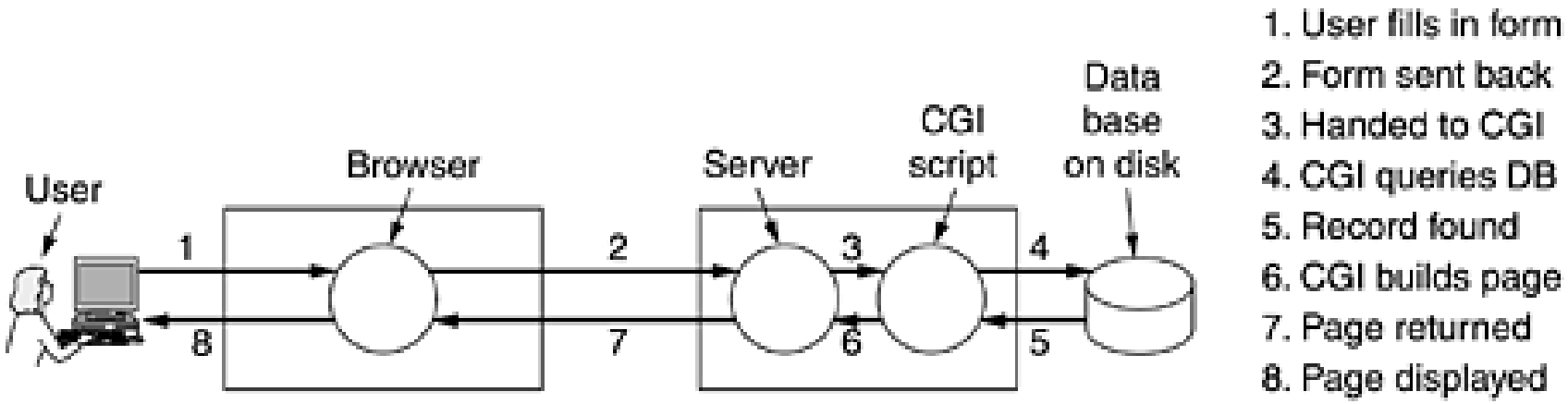
Cookies

- Contains 5 fields:
  1. Domain
  2. Path
  3. Content (*name*=*value*)
  4. Expiry date (non/persistent cookie)
  5. Secure (do you only need to use https сервер)
- Can be used to track users and for marketing research

Working with advances web servers

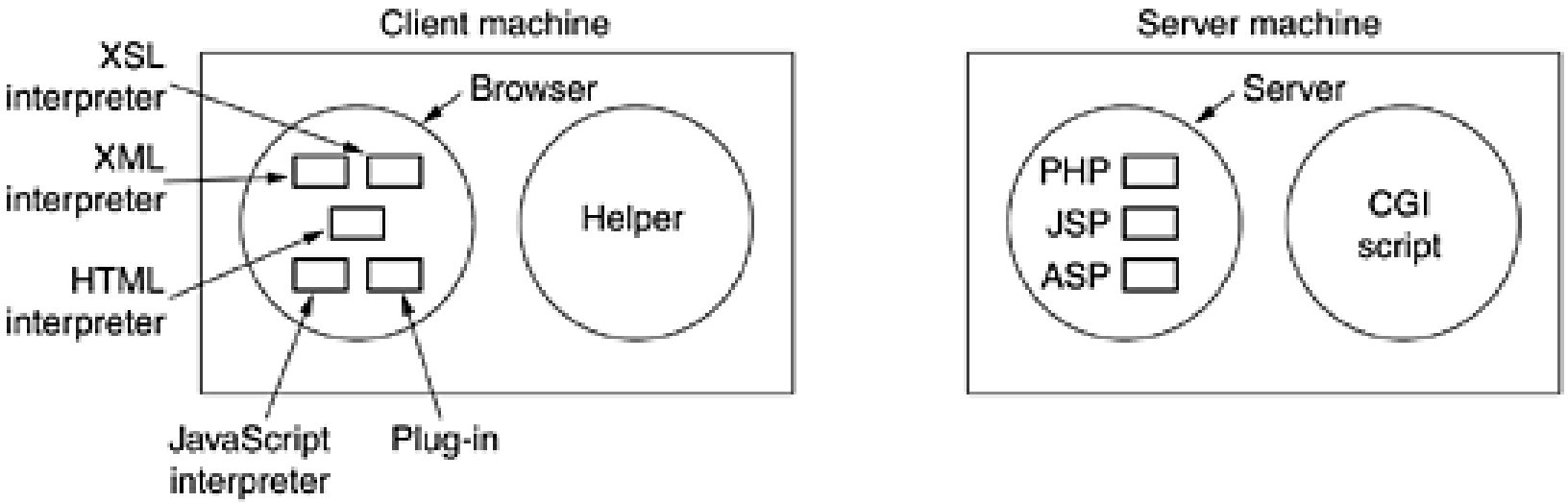


Web forms

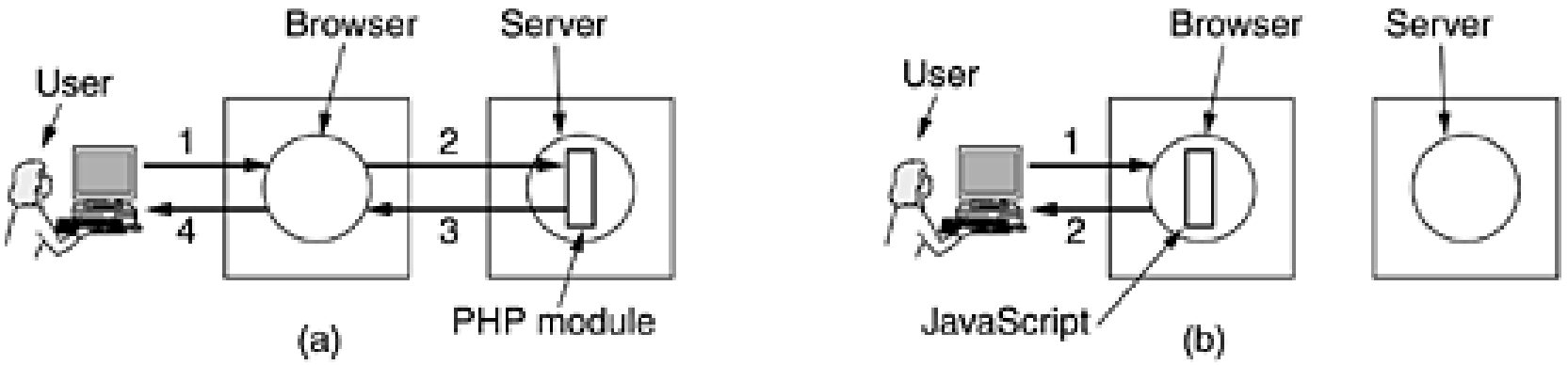


- CGI – Common Gateway Interface

Dynamic HTML – server side



Dynamic HTML – client side



Questions / discussion