

INTERNET ENGINEERING

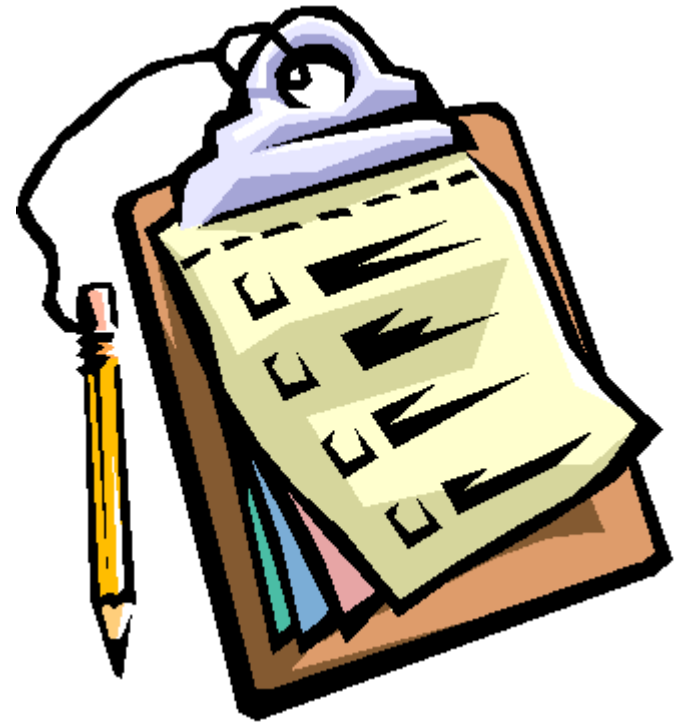


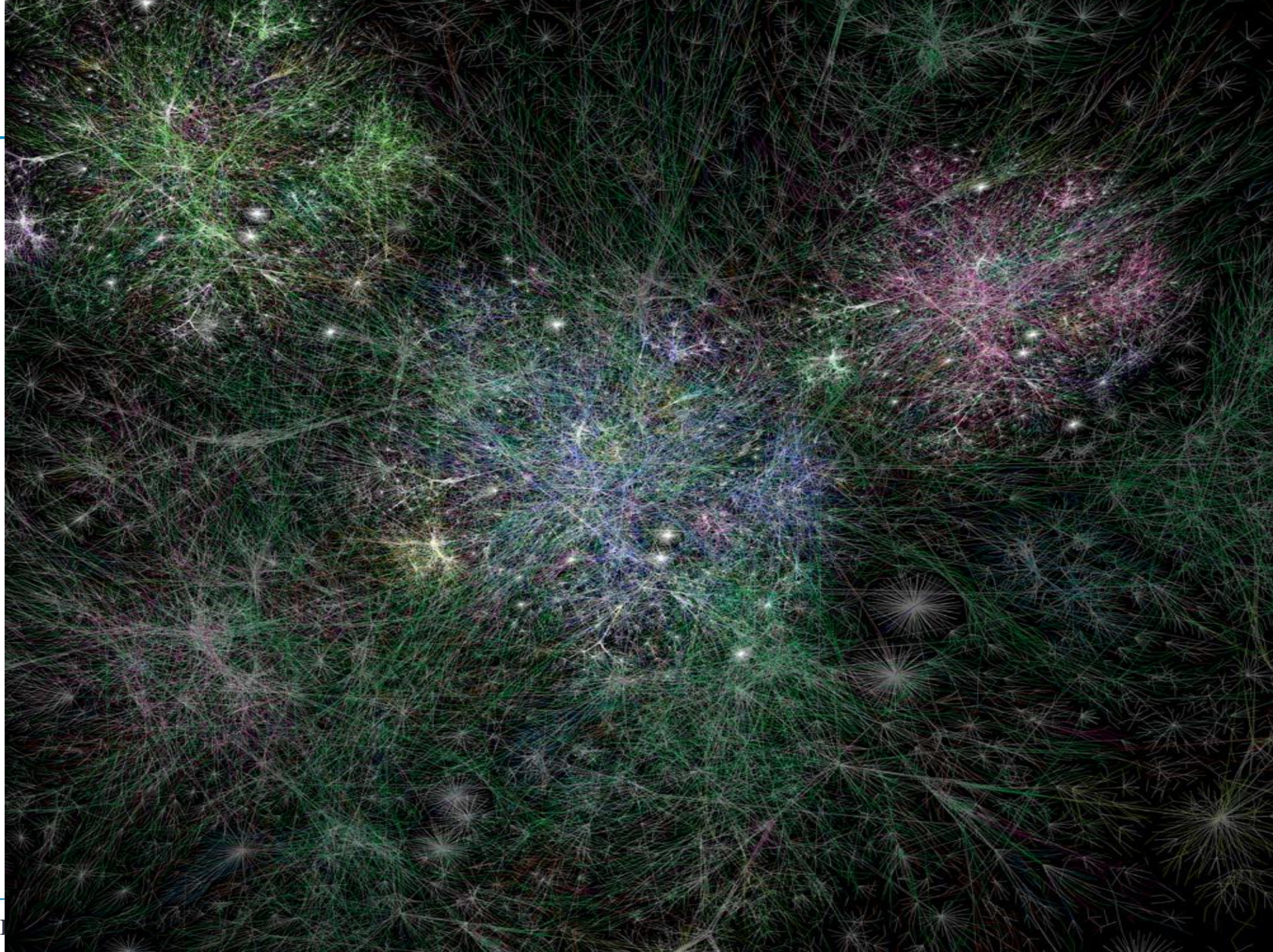
Overview and History

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Agenda

- A Brief History
- Overview of Concepts
 - Internet
 - Web
 - Protocols
 - Services







What is the Internet?

Internet

- It is the **largest network** in the world
 - Connects many individual networks all over the world
 - (Network of networks)
- No one owns it
- Originally developed by the **DoD**
 - US Department of defense
- It has **no central management** organization
- The lack of centralization → **less vulnerable** to attack



The Uses of the Internet

- Surfing the web
- Shopping
- Messaging and Chats (text, voice, video)
- Send e-mail messages
- Social Networks (Facebook, Twitter, etc).
- Send or receive files between computers
- Games
- Voice and Video Streaming
 - IPTV, Youtube, ...
 - Aparat, Beeptunes, ...
- Reading Books
 - Amazon (From book sale to Kindle)



What is the Web?



- The **World Wide Web** or **WWW** or **Web**
- Consists of information organized into **Web pages**
 - containing text, hyperlink, and graphic images
 - The Web also contains other resources: files, web services, ...
- An information space where:
 - documents and **other web resources** are identified by **URLs**, interlinked by hypertext links, and can be accessed via the Internet

A Quote

- **The World Wide Web**
is the only thing I know
of whose **shortened form**
takes three times **longer to say**
than what it's short for!
(Douglas Adams)



World Wide Web

- The Web was central to the development of the **Information Age**
 - the primary tool billions of people use to interact on the Internet
- Invented by English scientist **Tim Berners-Lee** in 1989
 - He wrote the first web browser in 1990



The Invention of the Web

- Tim Berners-Lee developed three essential technologies:
 - **URL:** A system of globally unique identifiers and locators
 - **HTML:** The publishing language Hyper-Text Markup Language
 - **HTTP:** The Hypertext Transfer Protocol

Internet vs Web

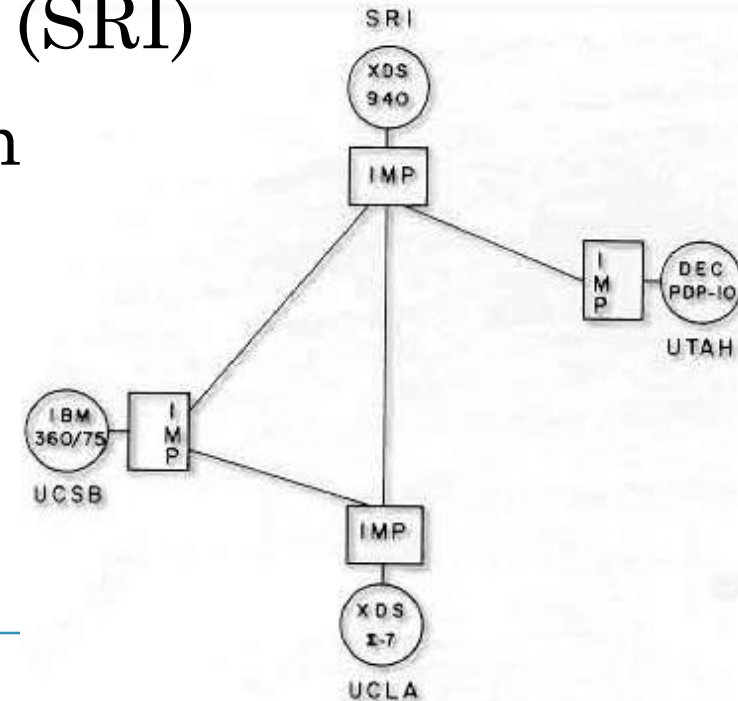
- The **Internet** is a global system of interconnected computer networks
 - a networking infrastructure
 - Information travels over the Internet via a variety of **languages** known as **protocols**
 - http, ftp, smtp, email protocols, ...
- The **World Wide Web** is **one** of the services transferred over these networks
 - The most important one
 - Based on HTTP
 - Mainly on HTML (but is not restricted to HTMLs)



A Brief History

The Start

- **1965**: the first wide area connection via **telephone line**
 - turns out to be inefficient and costly
- **1969**: US Department of Defense started **ARPANET** project
 - The first line: University of California, Los Angeles (UCLA) to Stanford Research Institute (SRI)
 - Then 4 nodes: UCLA, SRI, UCSB, Utah
 - 50kbit backbone
 - Design Goal: robustness (e.g., to survive a nuclear attack)

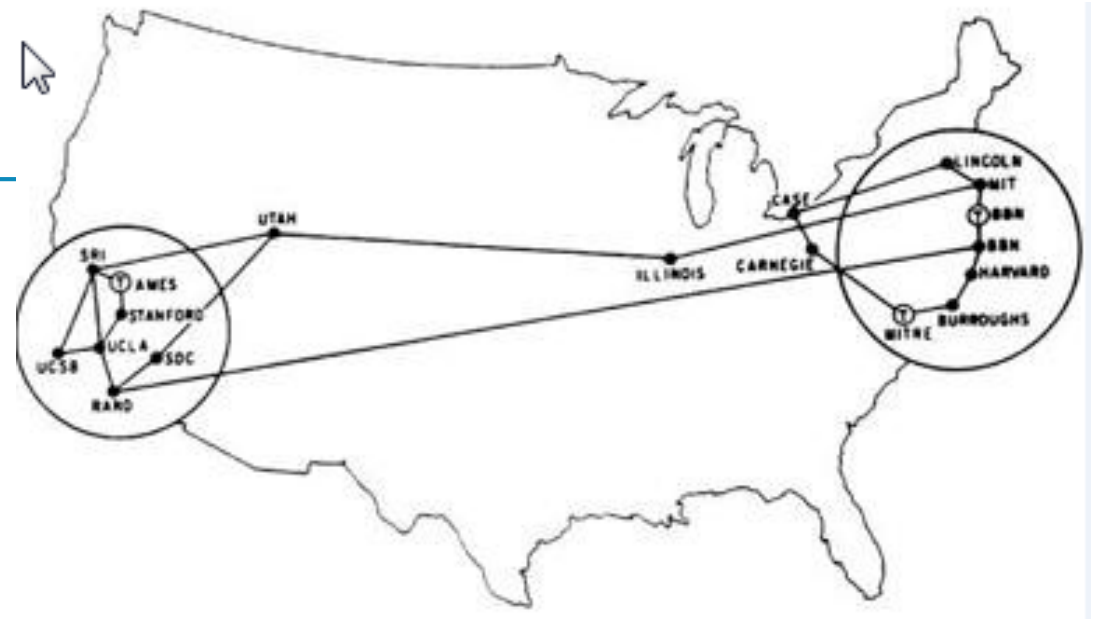


Initial Design Goals

- Built as a collaboration of global proportions
 - **independent** stand on own, **self managed** autonomous systems
 - **decentralized**: no central control/management (cf. phone system)
- Best effort, no guarantees
- Non-proprietary
- Little focus on security
 - if had focused on this it might never have happened
- Simple black boxes (routers connect nets)

Early days

- 1969: started
- 1972: 15 nodes
- 1983: 400 nodes
- 1987: 30,000 nodes
- 2015: 15 billion nodes
- 2020: 50 billion nodes



History

- 1961 – First packet-switching papers
- 1966 – ARPANET planning starts
- 1969 – ARPANET carries its first packets
- 1971 – E-mail is born
- 1972 – Internet Assigned Numbers Authority (IANA) established
 - (IP addresses)
- 1980 – Ethernet standard introduced
- 1982 – TCP/IP protocol suite formalized
- 1982 – Simple Mail Transfer Protocol (SMTP)
- 1983 – Domain Name System (DNS)

History (cont'd)

- 1985 – First .COM domain name registered (symbolics.com)
- 1986 – Internet Engineering Task Force (IETF) (Internet standards)
- 1991 – World Wide Web (WWW)
 - 1993 – Mosaic web browser released
 - 1994 – Netscape web browser released
 - 1995 – Internet Explorer (IE) released
- 1995 – IPv6 proposed
- 2000 – Dot-com bubble (and boom)
- 2001 – New top-level domain names activated
- 2012 – ICANN accepts applications for new top-level domains

Popular Internet Services History

- 1990 – IMDb Internet movie database
- 1995 – Amazon.com online retailer
- 1995 – eBay online auction and shopping
- 1995 – Craigslist classified advertisements
- 1996 – Hotmail free web-based e-mail
- 1998 – Google Search
- 1998 – PayPal Internet payment system
- 1999 – Napster peer-to-peer file sharing
- 2001 – BitTorrent peer-to-peer file sharing

Popular Internet Services History (cont'd)

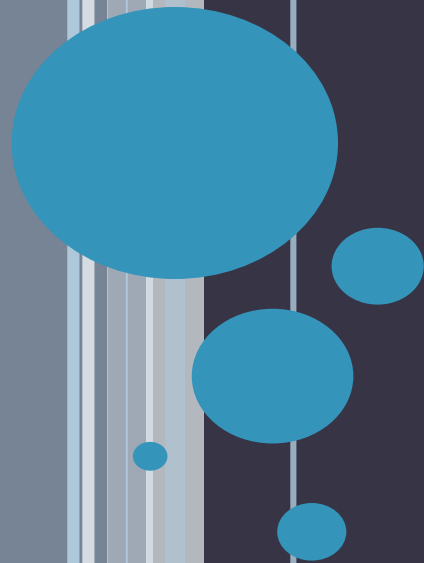
- 2001 – Wikipedia, the free encyclopedia
- 2003 – LinkedIn business networking
- 2003 – Myspace social networking site
- 2003 – Skype Internet voice calls
- 2003 – iTunes Store
- 2004 – Facebook social networking site
- 2004 – Flickr image hosting
- 2005 – YouTube video sharing
- 2005 – Reddit link voting
- 2006 – Twitter microblogging

Popular Internet Services History (cont'd)

- 2007 – Google Street View
- 2007 – Kindle, e-reader and virtual bookshop
- 2008 – Amazon Elastic Compute Cloud (EC2)
- 2008 – Dropbox cloud-based file hosting
- 2009 – Bing search engine
- 2009 – Google Docs (Now: Google Drive)
- 2009 – Bitcoin, a digital currency
- 2010 – Instagram, photo sharing and social networking
- 2010 – Pinterest
- 2011 – Google+, social networking
- 2012 – Coursera, massive open online courses
- 2013 – Telegram

Iranian Sites/Services History

- Tebyan.net (1381)
- Baztab.com (1381)
- Farsnews (1381)
- Blogfa (1383)
- Digikala (1385)
- Zoodfood (1388)
- Café-Bazar (1389)
- Zarinpal (1389)
- Netbarg (1390)
- Alibaba (1390)
- Aparat (1390)
- Sheypoor (1391)
- Divar (1392)
- Snapp (1393)



Top Sites and Services

Sites Ranking (Jan 2018)

1. Google.com	821 B	10. Amazon.com ↑	676B
2. Youtube.com		12. Twitter.com ↑	18B
3. Facebook.com	552 B	16. Live.com ↓	
4. Baidu.com		17. Instagram.com	
(Chinese Search Engine)		28. Netflix.com ↑	Apple 880B
5. Wikipedia.org		31. LinkedIn.com ↓	Oracle 220B
6. Reddit ↑		41. Ebay.com	IBM 155B
7. Yahoo.com ↓		49. imdb.com ↓	Intel 234 B
		77. Pinterest.com ↓	MS 726B

Top Iranian Sites



1. Blogfa.com
2. Varzesh3.com
3. Digikala.com
4. Aparat.com
5. Shaparak.ir
6. Mihanblog.com
7. Bankmellat.ir
8. Yjc.ir
9. Farsnews.com
10. Facenama.com
11. Divar.ir

(Jan 2016)

History

1. Varzesh3.com
2. Digikala.com
3. Aparat.com
4. **Blogfa.com**
5. Shaparak.ir
6. **Divar.ir**
7. **Tebyan.net**
8. **Beytoote.com**
9. Bankmellat.ir
10. Mihanblog.com
11. Yjc.ir
12. Farsnews.com

(Jan 2017)

Sadegh Aliakbary

1. Aparat.com
2. Digikala.com
3. Varzesh3.com
4. Shaparak.ir
5. Namnak.com
6. **Telewebion.com**
7. Divar.ir
8. Beytoote.com
9. **Namasha.com**
10. Blogfa.com
11. Bankmellat.ir
12. **Ninisite.com**
13. Bamilo.com
14. Tebyan.net **(Jan 2018)**

Internet Engineering



The Future of the internet?

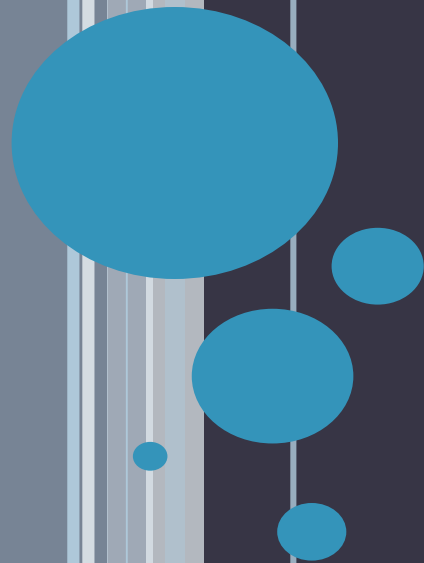


Internet Trends

- Big Data
- Cloud
- IoT
- Digital currency (Bitcoin, etc.)
- Distributed Computing
- Data Mining
- Web 2
- Social Networks
- Semantic Web
- Mobile Apps
- Healthcare
- Games

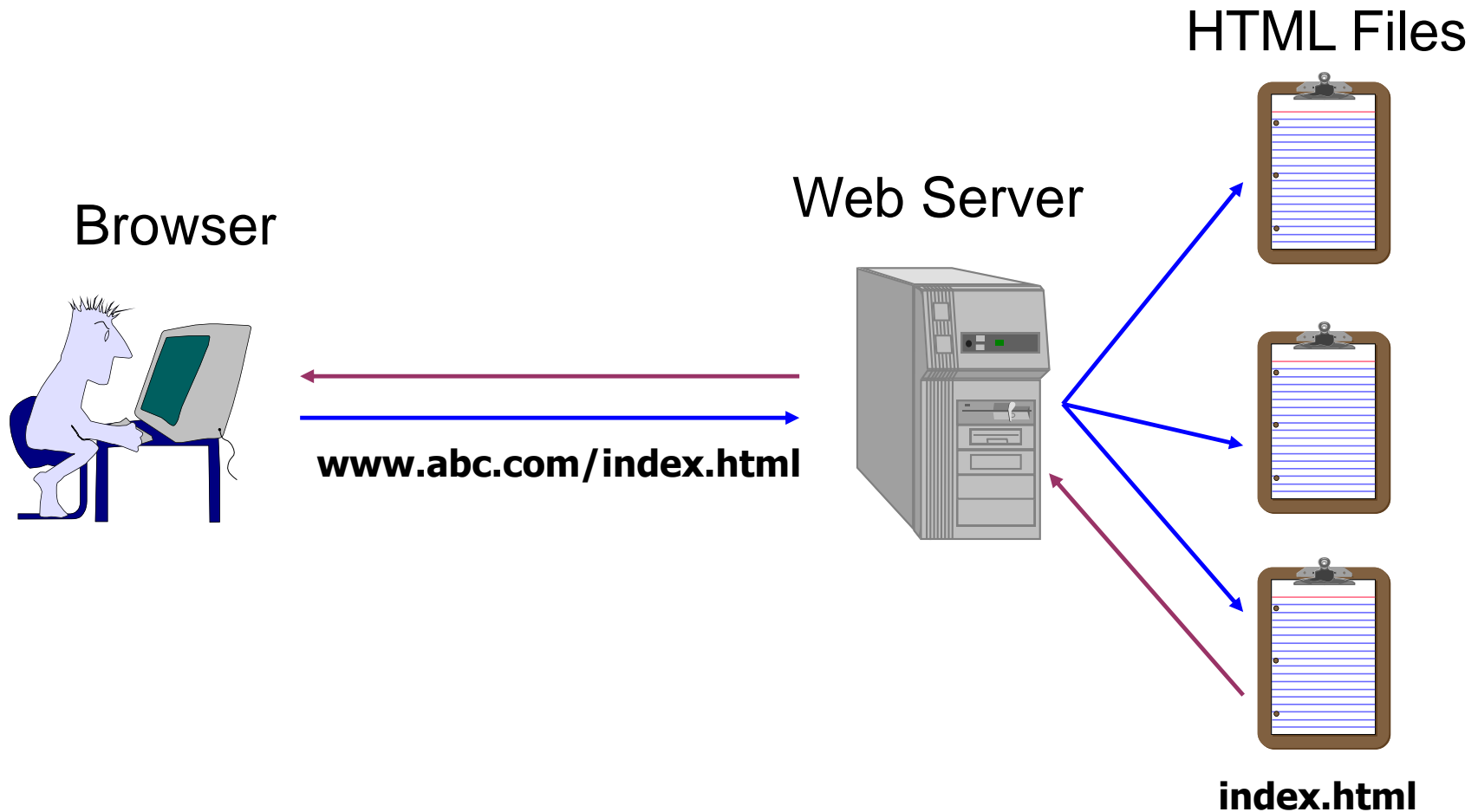
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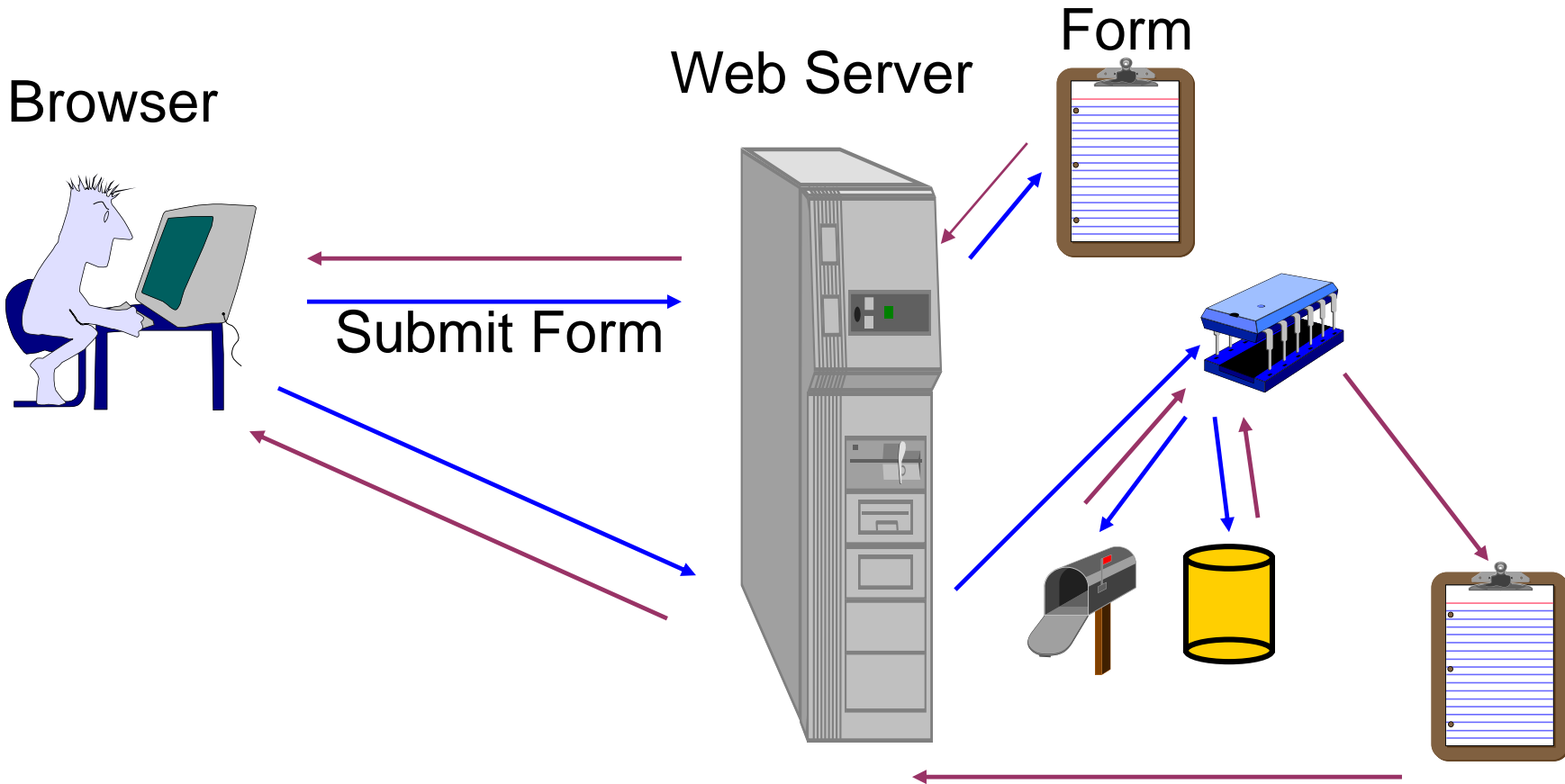


Internet Programming

Static Web Pages



Dynamic Web Pages



Web Application

- *A **web application** is an application delivered to users from a web server over a network such as the Internet*
- Only needs a web browser to use the application
(Thin Client)
 - Software application that is coded in a browser-supported language
- Common web applications, e.g., webmail, Google Docs, Portals, ...

Web Languages

- **Client side:**

- Hypertext Markup Language (HTML): used for writing web pages
- Cascading Style Sheets (CSS): stylistic info for web pages
- JavaScript: interactive and programmable web pages

- **Server Side:**

- dynamically create pages on a web server
- PHP, JSP, ASP.NET, ...



Internet Protocols, Services and Concepts

Key aspects of the internet

- Sub-networks are independent
- Computers can dynamically join and leave the network
- Built on open standards
- Lack of centralized control (mostly)
- Everyone can use it with simple, commonly available software

Internet Organizations

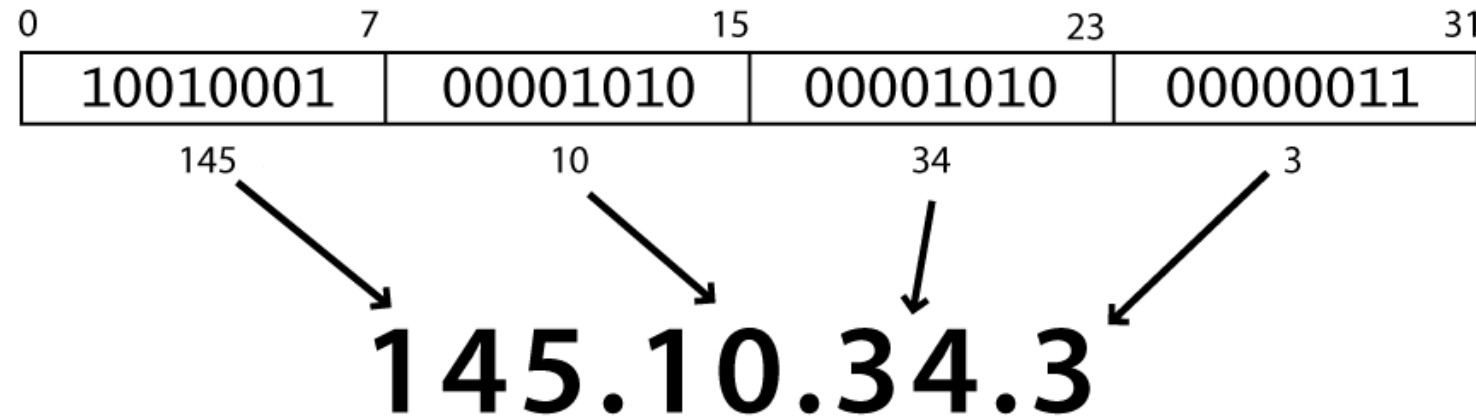


- Internet Engineering Task Force (IETF)
 - internet protocol standards
- Internet Corporation for Assigned Names and Numbers (ICANN)
 - decides top-level domain names
- Internet Assigned Numbers Authority (IANA)
 - IP addressing, ...
- World Wide Web Consortium (W3C)
 - web standards



Internet Protocol (IP)

- Simple protocol for data exchange between computers
- IP Addresses:
 - 32-bit for IPv4
 - 128-bit for IPv6



Transmission Control Protocol (TCP)

- Adds multiplexing, guaranteed message delivery on top of IP
- Multiplexing: multiple programs using the same IP address
- Port: a number given to each program or service
 - port 80: web browser (port 443 for secure browsing)
 - port 25: email
 - port 22: ssh
- Some programs (games, streaming media programs) use simpler UDP protocol instead of TCP

Web Servers

- Web server
 - Hardware and software that listens for web page requests
- Software:
 - Apache
 - Microsoft Internet Information Services (IIS)



Application Server

- Software framework that provides an environment where applications can run
 - JBoss
 - Glassfish
 - WebSphere
 - WebLogic



Web Browser

- Web browser:
fetches/displays documents from web servers
 - Mozilla Firefox
 - Microsoft Internet Explorer (IE)
 - Microsoft Edge (from Windows 10)
 - Apple Safari
 - Google Chrome
 - Opera

Usage Share of Web Browsers

Global Desktop stats from StatCounter (Top 5 browsers)

Date	Chrome	Firefox	Internet Explorer	Safari	Edge	Mobile
December 2017	64.72%	12.21%	7.71%	6.29%	4.18%	54.81%
January 2009	1.38%	27.03%	65.41%			
July 2008		26.14%	68.57%			
April 2002			96.6%			

Domain Name Server (DNS)

- Set of servers that map written names to IP addresses
 - Example: sbu.ac.ir → **194.225.24.120**
- Many systems maintain a local cache called a hosts file
 - Windows: C:\Windows\system32\drivers\etc\hosts
 - Mac: /private/etc/hosts
 - Linux: /etc/hosts

Uniform Resource Locator (URL)

- Identifier for the location of a document on a web site
 - Example: <http://www.sbu.ac.ir/Cols/CSE/Pages/default.aspx>
- Upon entering this URL into the browser, it would:
 - ask the DNS server for the IP address of sbu.ac.ir
 - connect to that IP address at port 80
 - ask the server to GET */Cols/CSE/Pages/default.aspx*
 - display the resulting page on the screen

Hypertext Transport Protocol (HTTP)

- Set of commands understood by a web server and sent from a browser
- Some HTTP commands (your browser sends these internally):
 - GET filename : download
 - POST filename : send a web form response
 - PUT filename : upload
- HTTP is a **stateless protocol**
- Exercise: simulate a browser with a terminal window

HTTP Error Codes

- When something goes wrong, the web server returns a special "error code" number
- Common codes:

Number	Meaning
200	OK
301-303	page has moved (permanently or temporarily)
403	you are forbidden to access this page
404	page not found
500	internal server error



Internet Challenges

Challenges: Address space

- IPv4 address space 32 bits ~ 4 billion addresses
- Fine for initial usage but IANA ran out Feb 2011
- Recognized in 1991
 - By-passes evolved: private addresses (e.g. NATs), etc...
 - Even with that will run out in next couple of years
- Solution: IPv6
 - Not backward compatible
 - not as mature as IPv4 (target for crackers),
 - will run both for many years so added complexity

Challenges: Mobility

- Computers used to be big and did not move
- As move need to change IP addresses
 - This can look like a hi-jack so need trust mechanism
 - Topology can change
- Need persistence across links going up & down
 - Delay & disruption tolerance (e.g. for space flights)
 - No session layer in TCP/IP so left to application or just disconnect and start again
- Sensor nets, self-organizing networks
 - Bad guy may join, e.g. military position overrun, enemy gets device, pretends to be friend



Challenges SPAM

- **2003:**

- an estimated 15 B spam messages were sent over the Internet daily.
- 45% Spam

- **2008:** 164 B spam messages daily, =97% of email.

- **2015: ?**

- 704 B email messages
- Less than 50% spams
- Spams are slowly falling since 2010 (why?!)
- What kinds of spam? Email, message, calls, ...



How Have Things Changed

- In 1998 75% of Internet users were Americans, now < 15%.
- 2014 global IP traffic exceeded 750 Exabytes (10^{18} , $\frac{3}{4}$ zettabyte)
 - annual growth rate 34% 2009-2014
 - 2014 avg monthly traffic = 32M people streaming Avatar movie in 3D continuously for whole month

Changes: Ubiquity/ Mobility

- Smartphones
- WiFi
- 257M mobile broadband subscriber in 2007
 - 85% increase yearly, 2.5B by 2014
 - 2G, 3G, 4G, 5G, ...
- GPS and geolocation. What applications?
 - For language, currency selection, targeted advertising
- Many airplanes [will] have WiFi
- Universities > businesses > homes (broadband DSL, Cable, ...)

Changes: Voice

- VoIP, e.g. Skype, originally to save phone cost
- Skype uses open Internet
- Integration with other apps/services

Changes: Video

- Digital cameras everywhere (hit mass market in 2000), can do video
- GPU's can process video
- Cost of storage dropped rapidly
- Video Streams (IPTV, Netflix, ...)
- Video Calls

Changes: Video (cont'd)

- Video traffic exceeded P2P traffic by end 2010
- Video community exceeded 1B by end 2010
- Internet video now 1/3 of Internet consumer traffic
- The sum of all forms of video (TV, video on demand, Internet, and P2P) exceeded 91 percent of global consumer traffic by 2014.
- Mobile video has the highest growth rate of any application category measured within the mobile sphere

Changes: Others

- Desktops → Laptops → Tablets and Smart Phones
- Need to be greener
 - Energy doubled 2000-2006
- Management needs to be more automated
- Increased services in cloud

Further Reading



- Internet and Web History
- Internet Protocols
- Internet Programming Technologies
- Internet Trends
- Web Programming Challenges
 - Trends in technologies

Quiz

1. Is “web application” without internet possible?
2. Is internet without “web applications” possible?
3. Is there any internet application based on UDP?
 - Which applications are better on UDP (than TCP)?
4. The main elements of world wide web are three standards. List them.

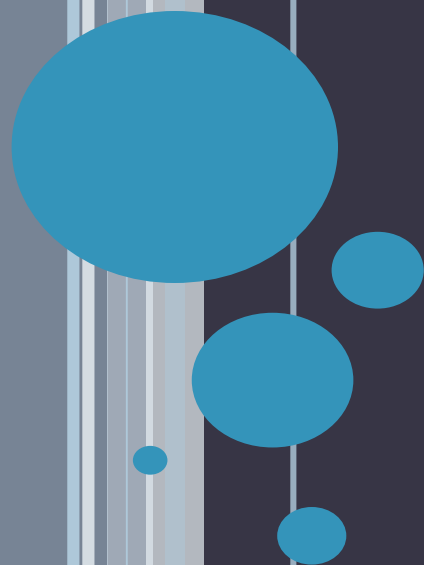
Exercise 0

- Think about it:
 - You have 10, 100, or 1000 Million Tomans
 - What “Internet application” do you create and why?
(Why don’t you start it?!)
- Study these java topics using Javacup slides/videos
(You will implement a web-server soon!)
 - Threads and Concurrency
 - Socket Programming
 - Reflection



Assignment #1

- Write a Web-Server
 - It supports simple web-page transfers
 - You may connect to it via a browser (e.g., Firefox)
 - You need:
 - Socket programming
 - Concurrency control
- Extra bonus:
 - Support dynamic content (e.g., invoking a method by its name)



The End