

Fundamental of Internet Programming (ITec2211)

Chapter 1 Fundamentals of IP

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Chapter Outline

Fundamentals of IP

Introduction – Internet programming, The Internet and Web,

Architecture of Internet, WWW

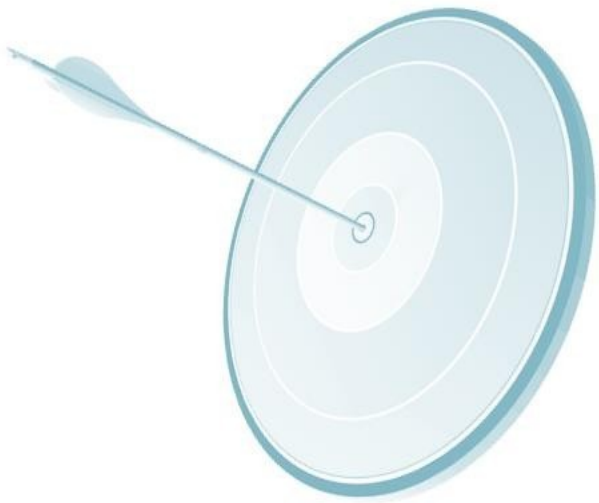
Client Vs Server side web programm

Terminologies

Protocol Suite -TCP/IP

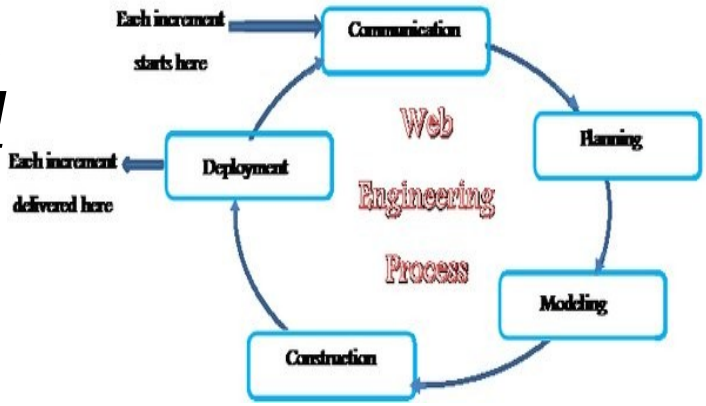
HTTP Overview

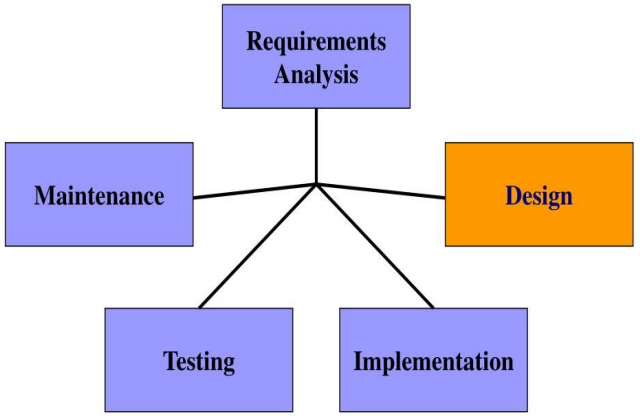
Web Design & Development issues



Introduction -Web Engineering

- ***Web Engineering*** *is concerned with the establishment and use of sound scientific, engineering, and management principles and disciplined and systematic approaches to the successful development, deployment, and maintenance of high quality Web-based systems and applications.*
- *An* *ed fra* *buil* *ity Web*





Introduction -Internet Programming

- **Internet Programming(IP)** : Used to design and develop an/a Internet-based (Internet applications) and web-based applications, systems and services.
- Generally IP Aims:
  - To keep up with emerging web technologies and languages
  - To mine knowledge from internet and WWW(Web)
  - To design and develop static and dynamic internet and web based applications (web sites)
  - To improve interaction of the user experience

Introduction (cont'd)

- **Internet applications** is a kind of applications that implement a distributed system architecture using the Internet as a medium of communication between its components

- **Internet-based Applications**
  - Using the protocol-existing application or define their own protocols
  - Application on the server side to communicate directly with the client
  - Application on the client side can be either stand-alone application or embedded in other

Introduction (cont'd)

- **Web-based Applications**
  - Using the HTTP protocol
  - Application on the server side to communicate with clients via a web server
  - Application on the client side is generally in the form of a web browser

- Internet Programming includes diverse areas such as:
  - Protocols for communication networks
  - Programming of GUIs or structuring information and
  - Interfacing to DBs, and applications

Introduction (cont'd)

Attribute of Web and Internet Based Application

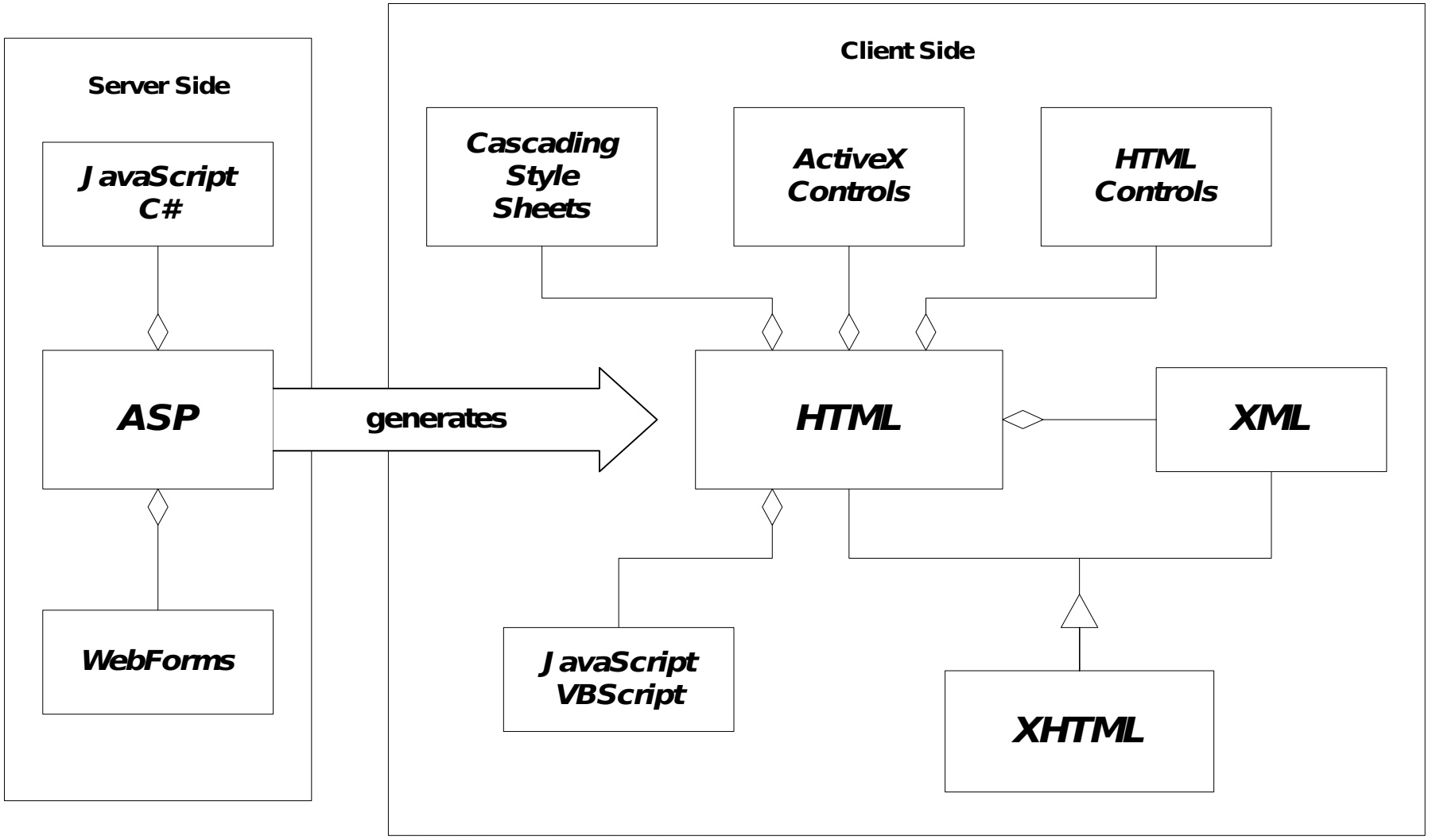
- *Network intensive*
- *Content driven*
- *Continuous evolution*
- *Immediacy*
- *Security*
- *Aesthetics*
- *Customizable*
- *Efficient and Effective*

Introduction (cont'd)

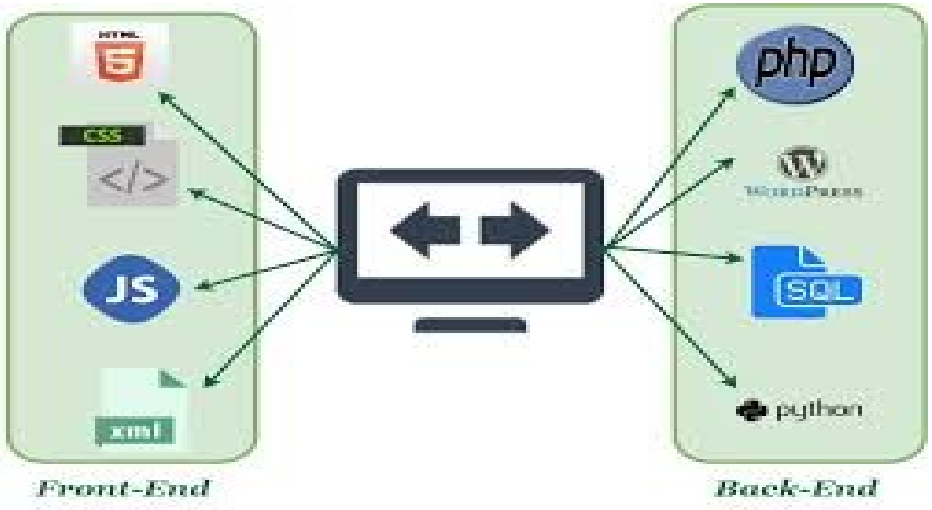
Internet/Web programming Advantages

- Points to be discussed are :
  - Ease of development
  - Performance (responsiveness, reliability, …)
  - Scalability
  - Security (Desktop, Server, DB, and Network)
  - Functionality (Simplicity, breadth of user options, …)

Introduction (cont'd)- Web Programming Model



Introduction (cont'd)- Web Programming



Client-side Programming

Skills that are often required:

- **HTML**
- XHTML
- DHTML
- **Javascript**
- VBScript
- XML
- **CSS , …**

Server-side Programming

Skills that are often required:

- CGI
- PHP
- ASP
- Perl
- JSP/F
- Python
- Java Servlet, …

Client-Side VS Server-Side Programming



Frontend Runs on the user computer		Backend Runs on the server
Interfacing Collection of user input, interfacing with the server	FACING	**Processing** Process es data, doing transactions, and complex computetion
Fully Visible Scripts can beviewed by the user	PURPOSE CODE TRANSPARENCY	**Invisible** Scripts are not open to users.
Less Secure Generally less secure as users can see and mess with the scripts	SECURITY	**More Secure** Alot more secure as users don't see the source code, and they usually can not interrupt the process.
HTML, CSS, JavaScript, VBScript	EXAMPLES	**PHP, ASP, Phyton, Ruby, C#, Java**

How website looks rathe

How website works.

Client-side Programming

- Defined components on the page with HTML
- Make them look pleasing with CSS
- Enable interactivity with JavaScript
- Enhance productivity with use of frameworks





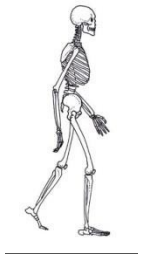


Client-side Programming …

- The structure, design, behavior, and content of everything seen on browser screen when websites, web applications, or mobile apps are opened up, is implemented by front end developers.
- ***Responsiveness*** and ***performance*** are two main objectives of the front end.
- The developer must ensure that the site is responsive i.e. it appears correctly on devices of all sizes no part of the website should behave abnormally irrespective of the size of the screen.

HTML, CSS, and JavaScript – An Overview

- HTML
  - Hypertext Markup Language
  - Structure of Page



- JavaScript
  - Interactivity with User
  - Dynamic Updates in a Web Page





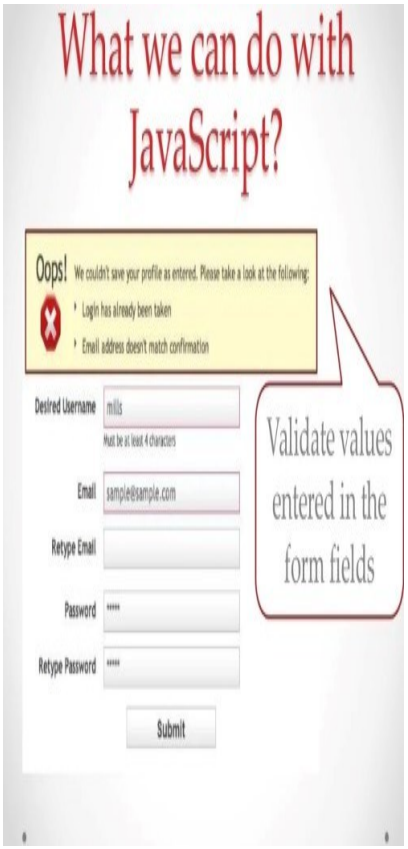
- CSS
  - Cascading Style Sheets
  - Presentation/Styling

HTML, CSS, and JavaScript – Overview ...





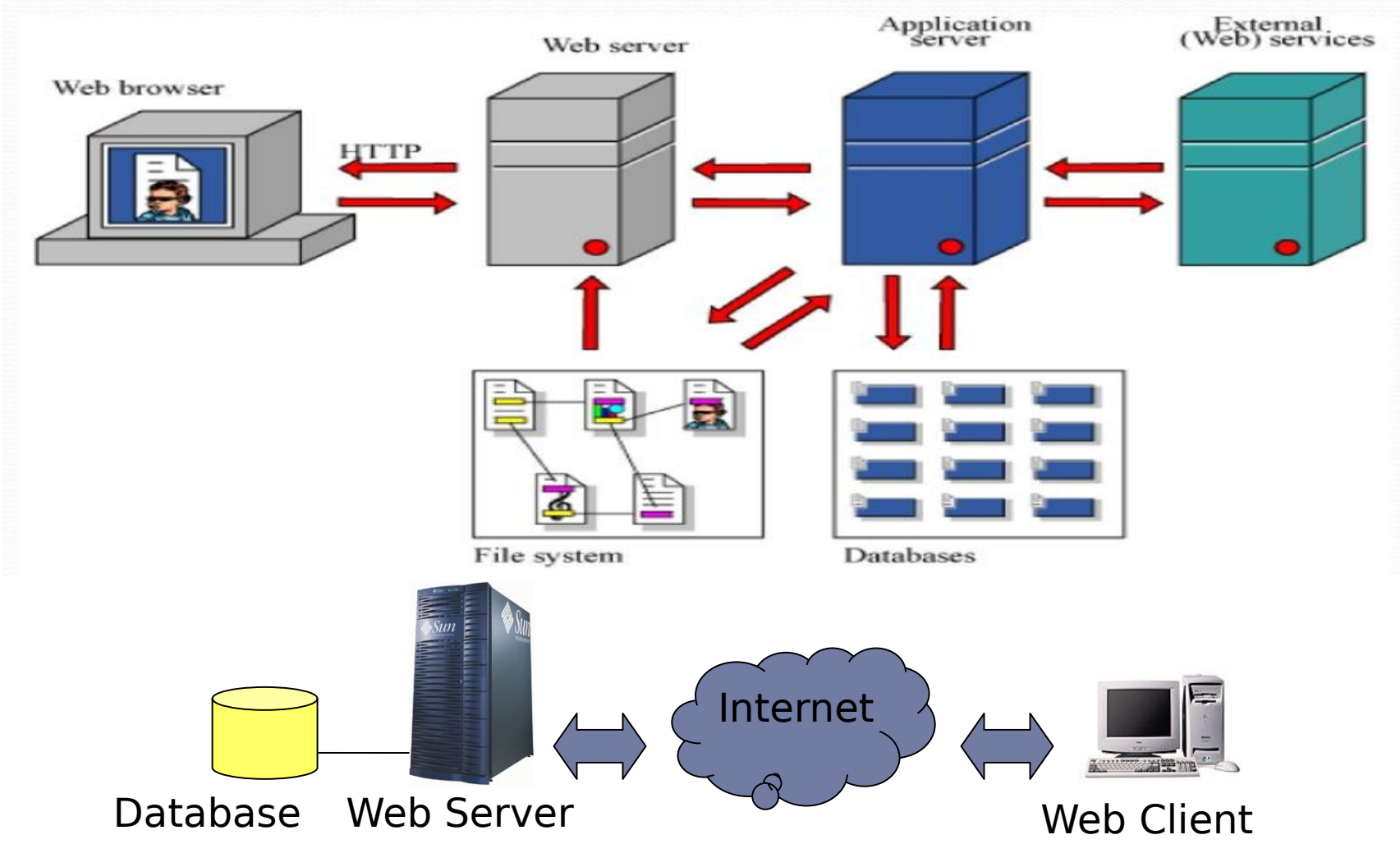




is what a page looks like without HTML

After using HTML and CSS JS add interactivity to the pag

Architecture of the Web, Internet



Introduction (cont'd) -Internet

- The Internet – a network of networks
  - An infrastructure (connectivity among a large number of machines world wide)
- The Federal Networking Council (FNC) agrees and define of the term "Internet" as: It refers to the global information system that -
  - (i) is logically linked together by a globally unique address space based on the Internet Protocol (IP) or its subsequent extensions/follow-ons ;

Introduction (cont'd) - Internet

- (ii) is able to support communications using the Transmission Control Protocol/ Internet Protocol (TCP/IP) suite or its subsequent extensions/follow-ons , and/or other IP-compatible protocols; and
- (iii) provides, uses or makes accessible, either publicly or privately, high level services layered on the communications and related infrastructure described herein.

Introduction (cont'd) -Internet

- Internet Evolution:
  - **Beginning of 70's-** the DARPA researchers had established the first experimental WAN which use packet switching involving ***Network Control Protocol (NCP),*** called ***ARPANET.***
  - ***Mid of 70's –TCP/IP protocol*** specified in details
  - In 80's – the ARPANET switched from NCP to TCP/IP by the ***National Science Foundation(NSF) ,*** and then establish ***NSFNET.***
  - ***By 90's ,*** **internet** connected virtually to all colleges and universities as internet community for testing and comments
  - ***Early 90' s*** the internet was transferred to **non-profit org** and become **WWW** or simple **Web**

Exercise:

- **Explain the Evolution of Web briefly.**

Introduction (cont'd) -Internet

Internet Services and Tools

- Several applications:
  - E-mal
  - www
  - File transfer (FTP)
  - Remote login
  - E-commerce
  - Instant messaging (chat)
  - Mailing lists etc
- Tools:
  - Browsers- used to view docs on WWW
  - Web Servers- to response requests from clients for web resources
  - Filters – to convert legacy docs to HTML format
  - Authoring tools-to edit HTML docs

Introduction (cont'd) –Terminologies

- The www or Web is a collection of documents that are interconnected by hyper-links (websites).
  - These documents are accessed by web browsers and provided by web servers.
- A website
  - A collection of resources:
    - Web pages (static / dynamic)
    - Media files (images, animations, sound, …)
    - Style files (CSS)
    - Documents (pdf, doc, txt, rtf, …)
  - Has a globally unique **name**
    - E.g. www.hu.edu.et
  - Stored on machines called **web servers**

Introduction (cont'd) –Terminologies

- A web page
  - A document with a mark-up language called HTML
  - The basic unit of information storage on the www
  - Any page that is hosted on the Internet.

- How does the www work
  - Websites (with unique names) are stored on web servers
  - Users access these websites via the Internet using software called a web browser.
  - A user sends requests for resources from a server with the help of the a user agent (browser)
  - The server sends the requested resource to the user agent
  - The user agent renders the resource for the user

How WWW Works?



- The web works on a **"client-server model".**
- **Client-server architecture** is an architecture of a computer network in which many clients (remote processors) request and receive service from a centralized server (host computer)
- **Clients** are the typical web user's internet-connected devices and web-accessing software available on those devices. Client is capable of receiving information or using a particular service from the service providers (Servers).
- **Server** is a remote computer which provides information (data) or access to particular services. It stores webpages, sites, or apps. When a client device wants to access a webpage, a copy of the webpage is

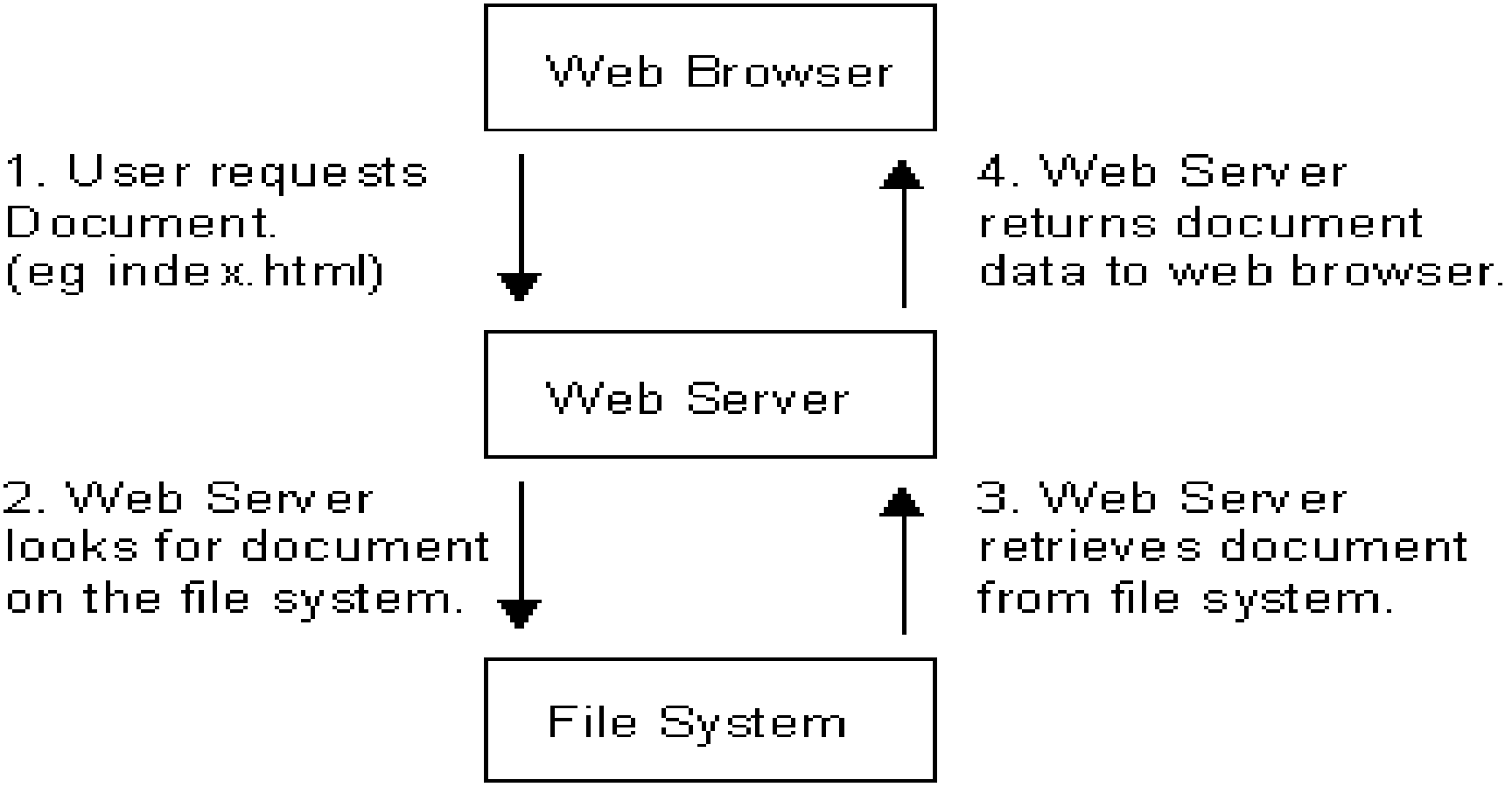


How WWW Works?

Following steps explains how the web works:

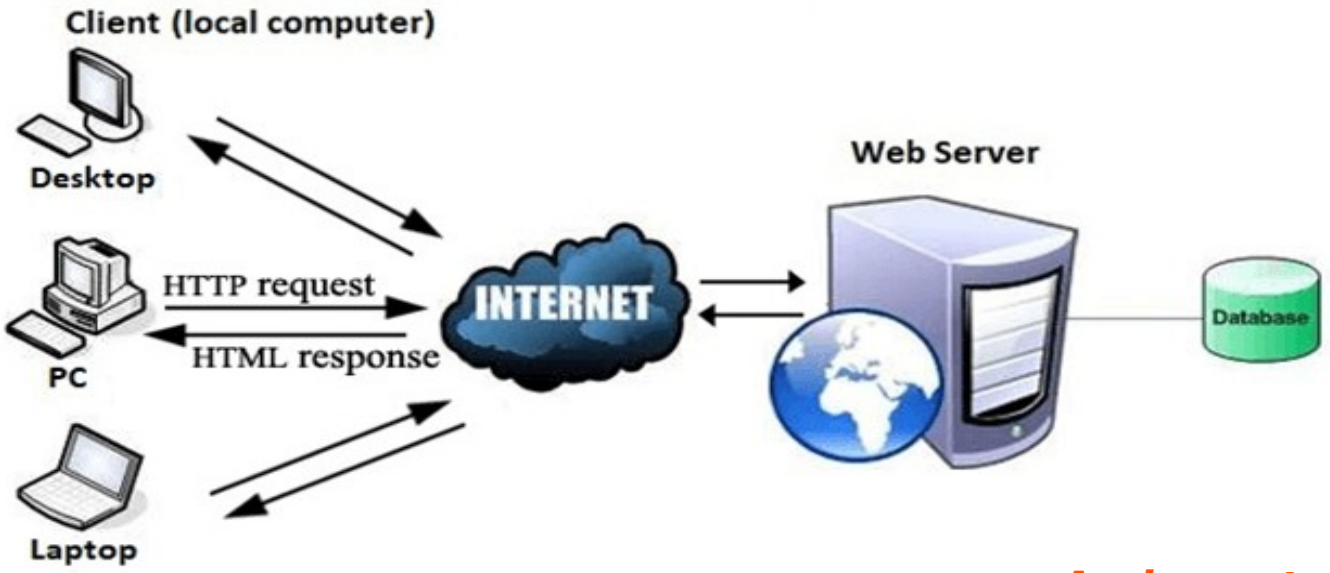
- User enters the URL of the web page in the address bar of web browser.
- The **client**, which is your computer, more specifically the browser you are using, sends a request to the Domain Name Server for the corresponding IP address.
- After receiving IP address, browser sends the request for web page to the web server using HTTP protocol which specifies the way the browser and web server communicates.
- Then **web server** receives request using HTTP protocol and checks if the page exists, if it exists the server will send the HTML page in response
- Now the **web browser** receives the web page. It interprets it and display the contents of web page in web browser's window.
- If the requested page doesn't exists then the server sends a 404 Error code which means the web page doesn't exist on the

How it Works ....? WWW



How it Works ….? WWW …





- ***An important advantage of the client-server model is that its centralized architecture helps make it easier to protect data with access controls that are enforced by security policies.***

- ***An important disadvantage of the client-server model is that if too many clients simultaneously request data from the server, it may get overloaded. In addition to causing network congestion, too many requests may result in a denial of service.***

Introduction (cont'd) –Terminologies

- Software involved:
  - At the server:
    - **Web server software** : listens for incoming requests for resources from clients and serves the requests
      - **Apache** - open source
      - IIS (Internet Information Services) – Microsoft
      - Tomcat
      - Squid
      - ---
  - At the client:
    - **Web browser** : sends/receives requests/responses to/from web servers on behalf of the client and renders content as necessary
      - Microsoft Internet Explorer
      - Mozilla
      - Firefox
      - Opera
      - Safari

Introduction (cont'd) –Terminologies

- **Communication protocol**
  - **HTTP (HyperText Transfer Protocol)**
    - Client (web browser) and Server (web server) communicate via the HTTP

    to exchange request/response messages

- The web is governed by the **w3c** (world wide web consortium) (www.w3.org)

Introduction (cont'd) –Terminologies

- How are websites uniquely named?
  - **DNS (Domain Name System)**
    - Resolves a human friendly name (e.g. www.hu.edu.et) to a machine friendly IP address (e.g. 164.233.187.99)
    - "Phone book" of the Internet
    - For this purpose, DNS servers store a table containing name-IP (among other things) pairs and do a look-up when requested
    - A DNS server may communicate with other server to resolve a given name
  - There are about 13 root DNS servers (http://www.root-servers.org/)

Introduction (cont'd) –Terminologies

- DNS name structure
  - Hierarchical in nature (e.g.. cs.hu.edu.et)
    - cs is under hu (a subdomain of hu), hu is under edu, edu is under et.
  - The highest level is the last component of the DNS address
  - Labels separated by . (dot)
  - Labels can be up to 63 characters long and are case insensitive
  - A maximum of 255 characters is allowed in total

- The last (highest) labels of a DNS name can be:
  - Three letter code top level domains (TLDs): indicating the type of organization
    - com, edu, gov, net, org, biz, …
  - Two letter country codes (GCTLDs): indicating the country
    - et, us, za, uk, ty

Introduction (cont'd) –Terminologies

- **URL (Uniform Resource Locator)**
  - The exact address of a resource on the web and has such format:
    - <**protocol**>://<**host**>[:<p**ort**>][<**path**>][?<**query**>]
      - E.g. 1. http://www.somedomain.com/search.php?q=dns&lang=en
      - **Protocol** – identifies the type of protocol to be used for communication
        - http, ftp, mailto, …
      - **Host** – identifies the machine on which the requested resource is stored
        - Domain names (e.g.. www.hu.edu.et)
        - IP address
      - **Port** – identifies the port number of the web server software on the web server machine
        - Default port for http: 80
      - **Path** – identifies the name and path of the resource on the server

Introduction (cont'd) –Terminologies

- Read about **URI** and **URN**

- **Questions:**
  - How the internet and web works(and why we care)?
  - Why do people want to be 'on the internet'?
  - Is there any difference between OSI and TCP/IP model?

TCP/IP Protocols Suite

- Protocol is a collection of rules and procedures for two computers to exchange digital information(docs)
- Consists of 4 layers

Application	Telnet, FTP, HTTP, SMTP, DNS, ...
Transport	TCP, UDP
Internet	IP, ARP, ICMP, IGMP
Host to network	Ethernet, Token Ring

TCP- provides error detection and correction, automatic repeat requests, reliable end-to-end communications

TCP/IP layers

- **Application**– used to implement specific internet applications such as file/mail transfer, remote login, …
- **Transport**- used for sequencing transmitting, and recovering of pkts ; error checking and flow control
- **Internet**- helps for packaging, managing, addressing and routing
- **Network (host to network) interface-** responsible for sending and receiving of TCP/IP pkts on the network medium

Advantage of TCP/IP protocols

- It is the most complete and accepted enterprise networking protocol
- Offers all modern operating systems- platform indep't
- Able to connect dissimilar network systems
- Provide standard protocol for the internet
- Provide efficient network traffic management

- Some core TCP/IP related protocols are:
  - HTTP
  - SMTP
  - FTP
  - Telnet
  - …

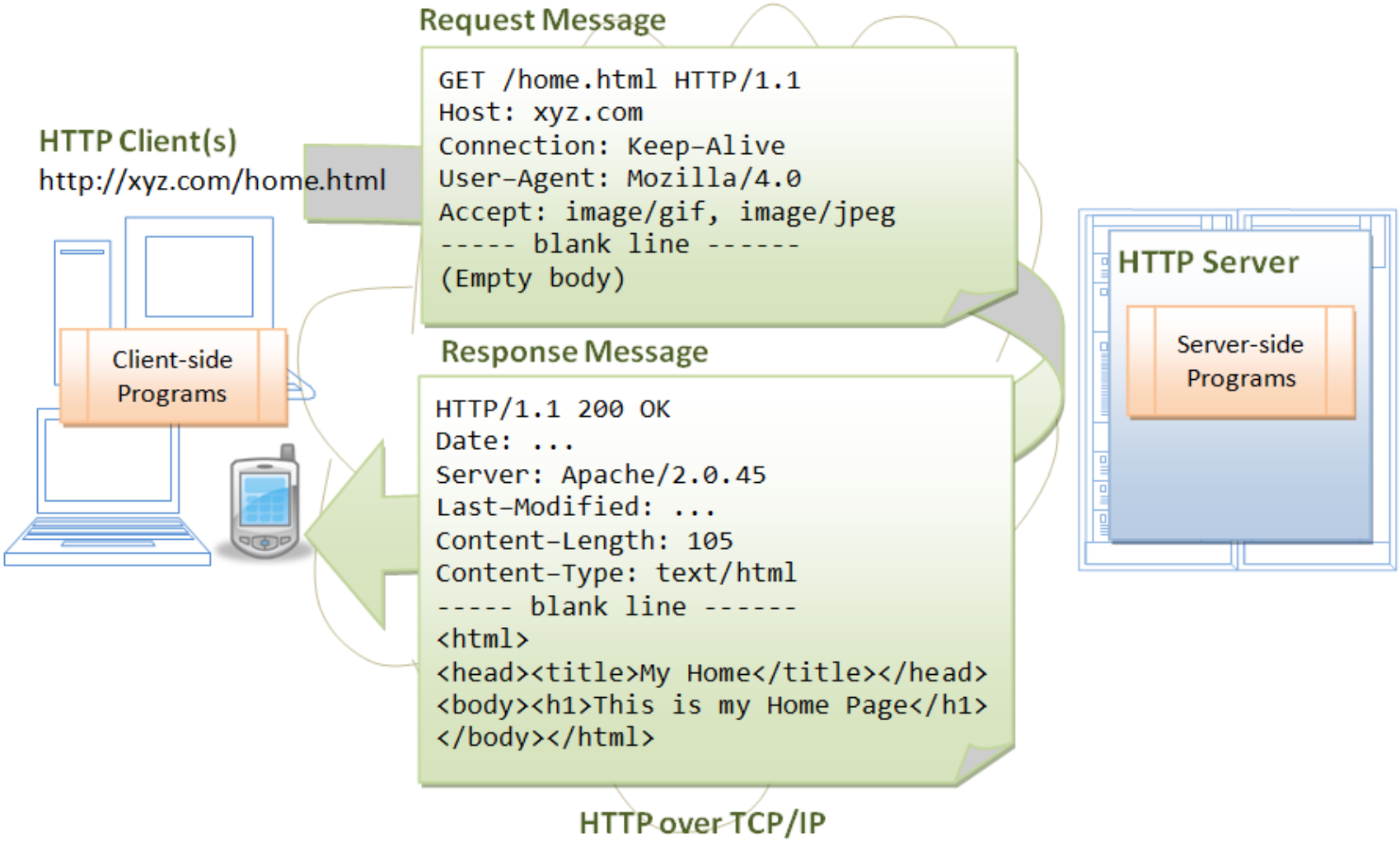
Hyper**T**ext **T**ransfer **P**rotocol (**HTTP**)

- A protocol that enables communication b/n browser and web server
- The rules governing the conversation between a Web client and a Web server by providing universal access to web docs by defining methods and ways of communications
- A ***stateless*** protocol
- Each request a browser sends to a web server is independent of any other request or there is no built-in state management between successive requests.
- HTTP 1.1(RFC 2616) is the current version of HTTP
- HTTP conversation involves the exchange of ***HTTP messages***.

HTTP Protocol

- **Client/Server, Request/Response Architecture**
  - You request a Web page
    - e.g. `http://www.hu.edu.et/default.asp`
    - HTTP request
  - The Web server responds with data in the form of a Web page
    - HTTP response
    - Web page is expressed as HTML form and identified by Uniform Resource Locator (URL), so
      - Protocol: `http`
      - Web server: `www.hu.edu.et`
      - Web page: `default.asp`
      - Can also provide parameters: `?name=Leon`

The HTTP Request/Response-Retrieving a File



HTTP Request

- The request line contains three parts:
  - Request method
  - Request URI
  - HTTP Version

- Request method
  - GET (or retrieve) information from the server
  - POST (information) back to the server
  - HEAD – like GET but only returns meta-information
  - PUT (information) at the server
  - DELETE (information) from the server

HTTP Response

- The response line contains:
  - **HTTP version**
  - **Status code**
  - **Status code description**

  E. g. HTTP/1.1 200 ok

- Status code
  - Has 5 categories (from 1,2,3,4, and 5)

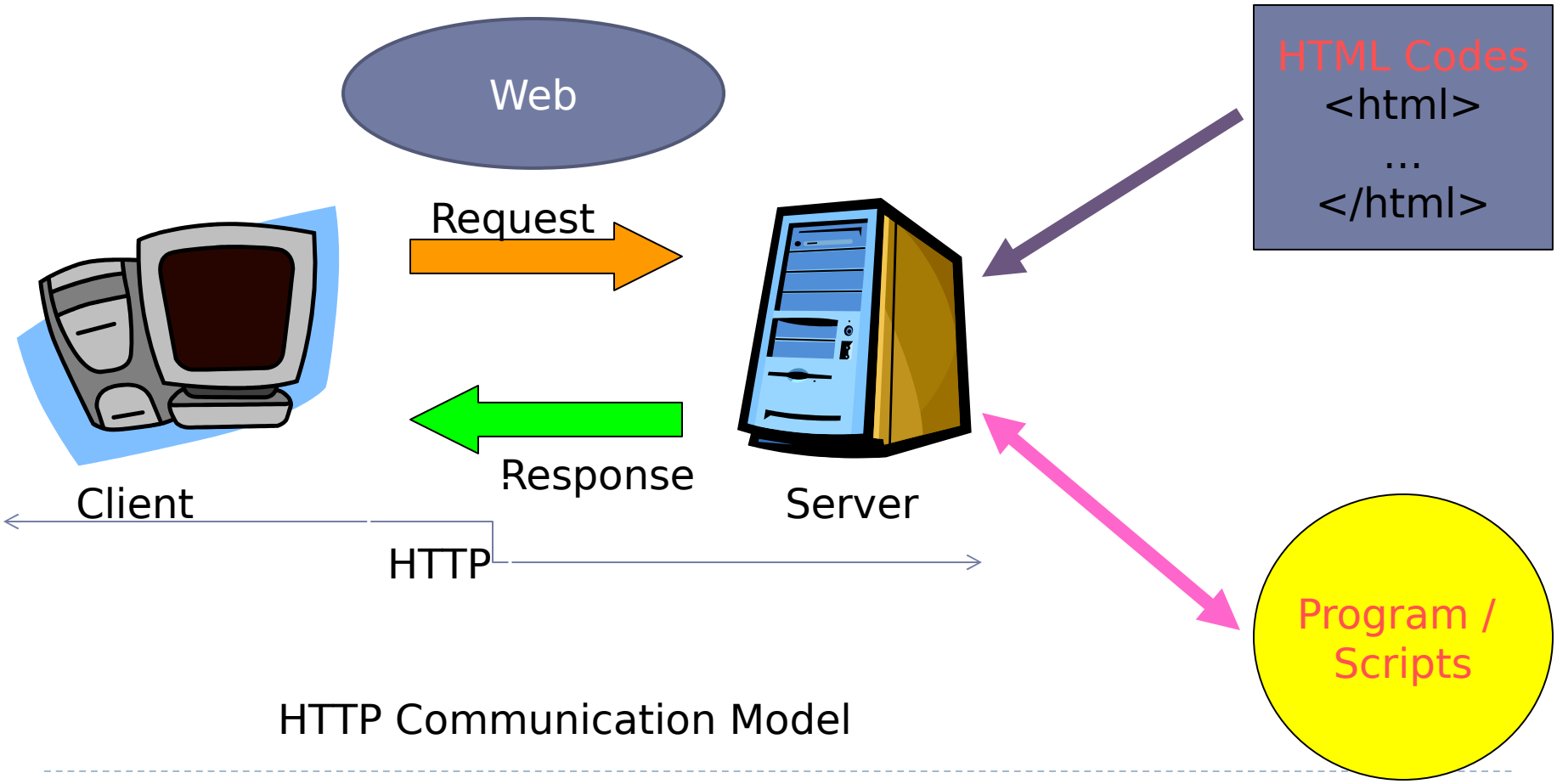
HTTP Response (cont'd)

- 1xx – request received, processing continues
  - E.g.
    - 100 Continue – tells client to continue with a request
- 2xx – success, action was successfully received, understood and accepted
  - E.g.
    - 200 Ok – request has succeeded
    - 202 Accepted – request accepted but not processed
- 3xx – further action must be taken to complete the request
  - E.g.
    - 302 Found – resource found but temporarily moved

HTTP Response (cont'd)

- 4xx – client error or invalid request
  - E.g.
    - 400 Bad Request – couldn't understand request
    - 401 Unauthorized – request requires authorization
    - 403 Forbidden – client may not have access to the resource
- 5xx – server error occurred
  - E.g.
    - 500 Internal Server Error – server encountered an unexpected error (error/bug with a server side script)
    - 505 HTTP Version Not Supported – server

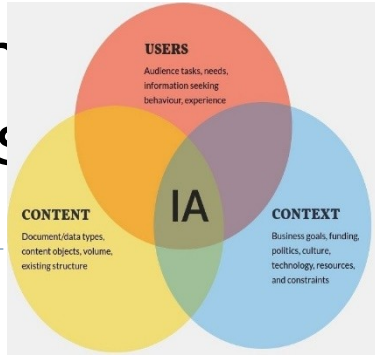
The HTTP Request/Response Model



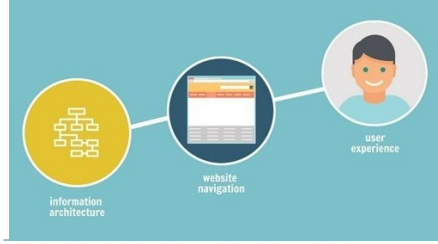
HTTP Communication Model

Web Design and Development Issues

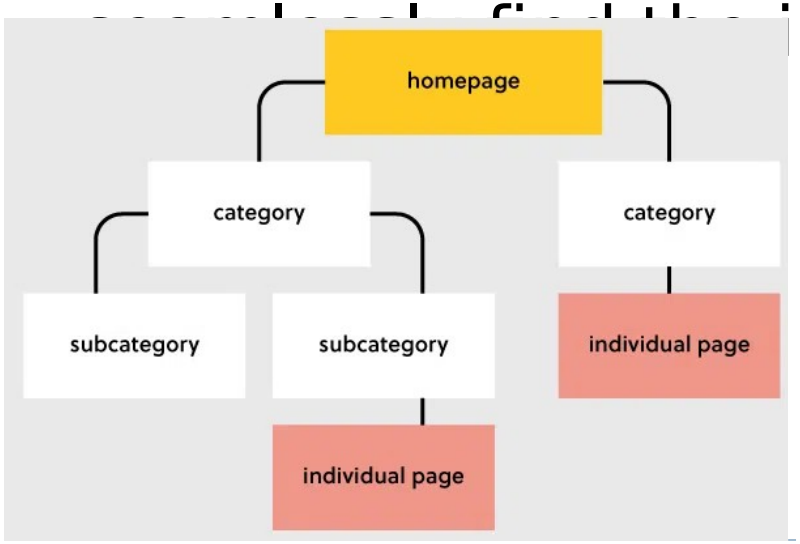
- **Information architecture (IA)** is the science of structuring content as it is applied to news websites or blogs, online stores, booking apps, downloadable software, etc. The goal of information architecture is to classify the content in a clear and understandable way and arrange it according to relations between the content pieces, allowing users to find what they need with less effort.
- It refers to organizing and labeling content to make the product usable and understar while enhancing user experience. IA des foundation of UX, and UI.

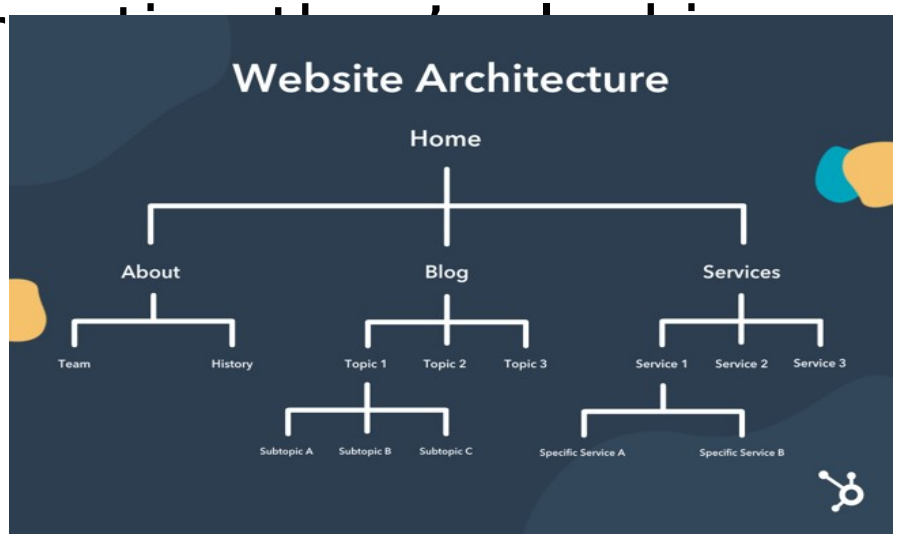


Website Architecture



- **Website architecture** is the hierarchical structure of your website pages through internal linking.
- A sound website architecture strengthens your website's user experience. When you structure your website in an intuitive way, users can





Types of Web Structures

- There are different types of web structure that you may use in UX design.

1. **Hierarchical structure:** It's the most common website structure is a hierarchical structure that is based on one parent page (main page) and child pages (categories and sub-categories) that flow from the main page.
2. **Sequential structure:** It's used when you want your users to go through steps or any other sequence.
3. **Matrix structure:** This is site structure that's common for online newspapers, such as New York Times.
4. **Database model:** This is the model prevalent

Web Design and Development Issues …

- We understand that a well-designed website is crucial to the success of any business.
- A successful website is one that helps you meet your business goals!. Generally the web Design and development considers the points:-
  - Plan the site and its structure
    - Determine the site's purpose
    - Identify the site contents and target audience
    - Plan the structure of site
  - Design the look and feel
    - Sketching, Prototyping, and Testing the Design
  - Arrange strategy of recovery and maintenance

Principles of Good Web Design

- An effective website design should fulfil its intended function by conveying its particular message whilst simultaneously engaging the visitor. Several factors such as consistency, colours, typography, imagery, simplicity, and functionality contribute to good website design.
- When designing a website there are many key factors that will contribute to how it is perceived. A well-designed website can help build trust and guide visitors to take action. Creating a great user experience involves making sure your website design is optimised for usability (form and aesthetics) and how easy is it to use (functionality).

Principles of Good Web Design …

1. **Website purpose-** Your website needs to accommodate the needs of the user. Having a simple clear intention on all pages will help the user interact with what you have to offer.
2. **Simplicity-** is the best way to go when considering the user experience and the usability of your website. Below are ways to achieve simplicity through design. Includes color, type(Typography) and imagery(visual aspect).
3. **Navigation-** is the wayfinding system used on websites where visitors interact and find what they are looking for. Website navigation is key to retaining visitors. Keeping navigation simple,

Principles of Good Web Design …

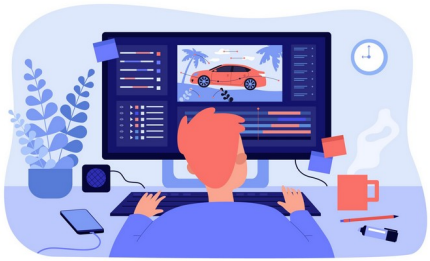
4. **Content-** An effective website has both great design and great content. Using compelling language great content can attract and influence visitors by converting them into customers.
5. **User friendly-** more people are using their phones or other devices to browse the web. It is important to consider building your website with a responsive layout where your website can adjust to different screens.

Importance of Web Development

- The Internet is ubiquitous
  - Accessible through mobile and desktop
  - Customers/users need to find you/your business
  - Builds trust in your organization and improves your reputation
  - Your website is your first round-the-clock sales person!
- The Website
  - Creates first impression of your business
  - Create it to suit the needs of your target audience
  - Reflects your expertise and reputation
  - Can bring business from any part of the world!
  - Call to Action – Encourage the users to give you business
- You need Web Development skills to create a Website!

Web Designer Vs. Web Developer --- Web Master

- A Web Designer
  - Designs the look and feel of a website (creative side of website)
  - Decides the layout, fonts, color, images and
  - Creates the visual mock-up of the website
  - Rarely does the development of a website!
  - A Right-brained (Creative) Person



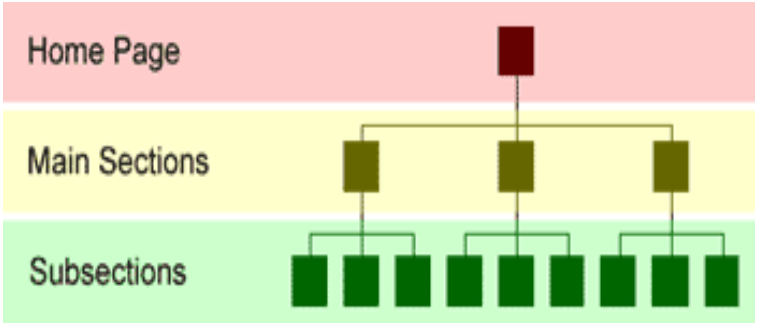
- A Web Developer
  - Brings the website mock-up to life on the Internet (development side of website)
  - Develops the website and hosts on a web server
  - Has Web Development Skills: HTML, CSS, JavaScript, Node.js
  - A Left-brained (Logical) Person



- Gain Web Development skills to become a Web Developer!

Step for effective website design

1. **Analyse**
   - Info / content
   - Target Audience
   - Top Checklist
2. **Organise**
   - Navigation(L,DB, Hi)
   - Content
   - Page layout
   - Page design
3. **Develop**
   - Web page layout
   - Site layout
   - Web page construction
   - Graphics techniques
4. **Implement**
   - User Interaction
   - Final Checklist
   - FTP
   - Fine Tune
5. **Test and Evaluate**
6. **Maintain**
   - Marketing
   - Optimisation
   - Traffic analysis



Web development : Front End Development

- Front end developers create the content you see when interacting with a website. This includes visual elements such as menus, buttons and animations that can execute on a client's machine. Front end developers use three primary languages: **Markup language(HTML)** to create a website's structure, **Style Sheet language(CSS)** to change how a website looks and **Scripting language(JavaScript)** to create interactive elements.

Challenges In Web Application Development



Top 10 website design tips - checklist

- **Know your audience**
- **Keep web pages short**
- **Limit the amount of text**
- **Avoid large images**
- **Use web safe colors**
- **Clearly identify all links**
- **Check spelling**
- **Use a site map or directory page**
- **Update and check all links**
- **Include contact information**

Requirements:

1. **Get a domain name** - This is your personal/private address on the Web. E.g. xyz@ip.com
2. **Find a web hosting service**- Here is where your website will reside.

   Free vs. Private Web Hosting , e.g.. Ethio Telecom (ETC)
3. **Technology -**web techs (e.g.. PHP, MySQL, etc…)
4. **Design, build and upload your website** - The process of website creation.

Web Sites May be:-

E-business	E-business solutions consultation to small and home-based businesses at an affordable cost.
Development	Website development, ranging from one to several pages depending on your needs.
Searches	Make your website work better so that others can find you on the World Wide Web.
Shopping	Add shopping carts to existing websites to have the capability of selling products and services online.
Static Site	Website pages are not automatically updated and with limited interactivity features.
Dynamic Site	Website pages are automatically updated using database-driven code modifiable by the user.

Exercise

- **Explain the Evolution of Web briefly.**
- **Differentiate internet and web.**
- **What is information architecture and web architecture.**

THANK YOU!!

