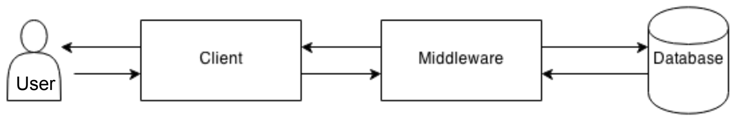
Messaging

Web Application Development 2

System Architecture



- We have not yet specified:
  - how messages are going to be sent, and
  - in what format these messages are going to be
- Different interactions will require using different message formats and protocols

At the Application Layer

- We shall be focusing on a protocol for communication and the payload formats:

1. **Hypertext Transfer Protocol (HTTP)**
   - The application protocol used to send messages
   - This is a specific URL scheme
   - Follows a Request-Response pattern
   - Provides a number of ways to make a request (GET, POST)
2. **User Agent Specific Protocols (UASP)**
   - These package/wrap the information that will be sent when providing a response
   - Such as XML, XHTML, JSON

MESSAGES

Request – Response Pattern

- Or **Request-Reply** pattern is way to exchange messages
- A requester sends a request message and the receiver of that message provides a message in response
- Typically, this is performed in a synchronous fashion (as in HTTP)
- However, maybe asynchronously (e.g. HTTP/2)

Responses and Requests

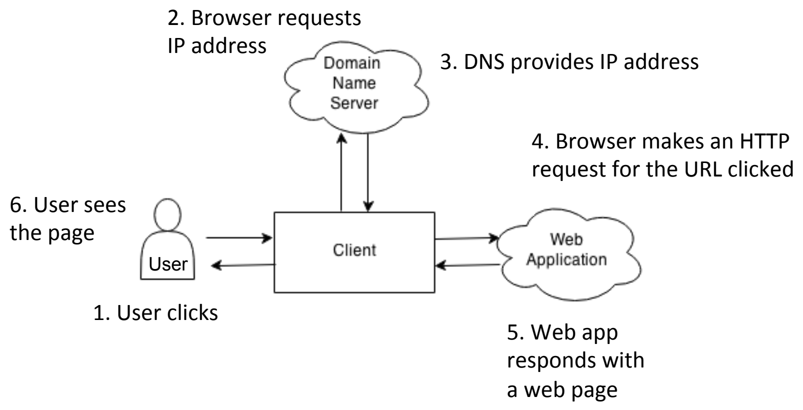
- The following happens when the **user agent**
  - i.e., the web browser/client
- is asked to **send** a **message**,
  - i.e., when the user clicks a link,
- First, the URL is turned into an **IP address**
  - **Request:** ask Domain Name System for IP
  - **Response:** returns the IP for the URL
    - i.e., www.gla.ac.uk maps to 130.209.34.12

Responses and Requests

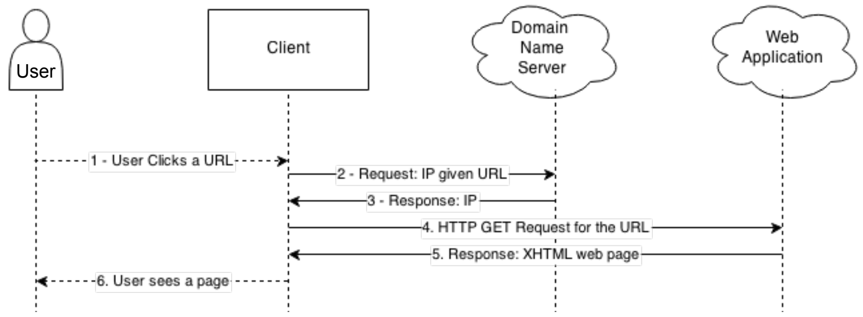
- Second, a **TCP connection** is opened on a particular port on the node at that IP address
  - port 80 for HTTP (standard)
  - port 443 for HTTPS (encrypted through TLS)
- Next, a request is made using a specific URL Scheme (e.g., HTTP) and sent using that TCP connection
  - **Request:** Get the home page of the specified URL
  - **Response:** Returns the XHTML for the home page

For a full ports list see http://www.webopedia.com/quick_ref/portnumbers.asp

Flow of Messages

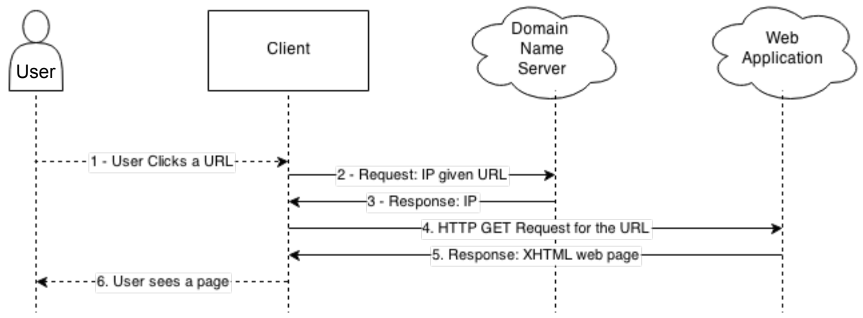

2. Browser requests IP address
Domain Name Server
3. DNS provides IP address
4. Browser makes an HTTP request for the URL clicked
6. User sees the page
User
Client
Web Application
1. User clicks
5. Web app responds with a web page

Sequence Diagrams



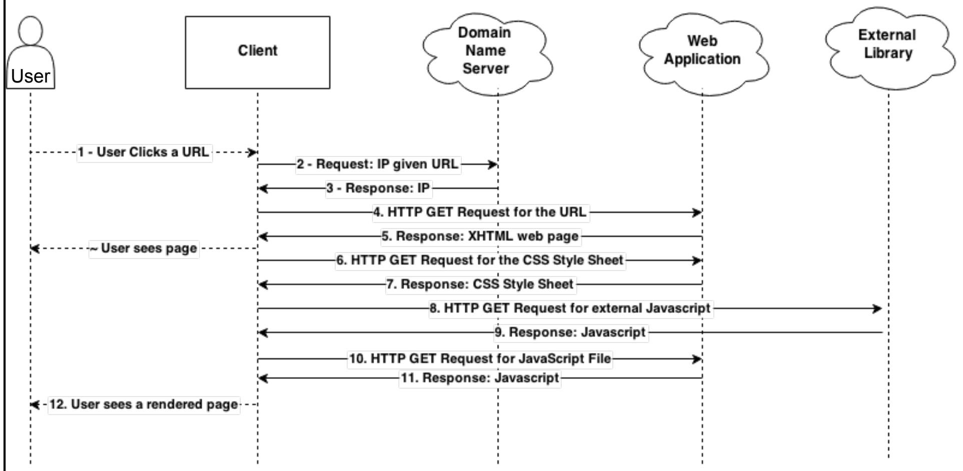
- Sys. Arch. Diagram aggregates over all messages, only showing the flow, but hides a lot of detail
- Sequence Diagrams provide a better way to show the flow of messages
- Label all messages – the more precise the better

Question



What other messages would be sent and received when loading up a web page?

Example


User
Client
Domain Name Server
Web Application
External Library
1 - User Clicks a URL
2 - Request: IP given URL
3 - Response: IP
4. HTTP GET Request for the URL
5. Response: XHTML web page
User sees page
6. HTTP GET Request for the CSS Style Sheet
7. Response: CSS Style Sheet
8. HTTP GET Request for external Javascript
9. Response: Javascript
10. HTTP GET Request for JavaScript File
11. Response: Javascript
12. User sees a rendered page

- Further requests for Style Sheets and JavaScript

Communicating with the Database

- Web Apps typically make requests to a Database
- Since we are using Django, requests are made indirectly, through the Object Relational Mapping (ORM)
- The actual request maybe via HTTP or some other protocol
- But we can specify it as a ORM Request and ORM Response

Protocols

- **Requests can be made using various protocols**
  - **http**: this common protocol indicates a file that a web browser can format and display - an HTML file, image file, sound file, etc.
  - **https**: utilises Transport Layer Security for secure communication and always sends data in encrypted form
  - **file**: this indicates a file which is not in a recognised web format and will be displayed as text

Protocols

- **Other protocols include:**
  - **ftp**: file transfer protocol is used to refer to web sites from which files can be extracted and downloaded to the client machines
  - **mailto**: if selected, such a link generates a form in which an e-mail message can be constructed and sent to a designated user
  - **news**: the resource is a news group or article
  - **telnet**: generates a telnet session to this server
- For a full list, see http://www.iana.org/assignments/uri-schemes/uri-schemes.xhtml

HTTP

- **HTTP** or **Hyper Text Transfer Protocol** is used to deliver virtually all files and other data using **8 bit characters**
  - Usually, HTTP takes place through TCP/IP sockets
- HTTP is used to transmit **resources**, not just files
  - A resource is some chunk of information that can be identified by a URI
- HTTP functions as a **request-response pattern** in the **client-server** computing model

Request and Response Messages

- Under HTTP, communication is as follows:
  - An HTTP client opens a connection and sends a **request message** to an HTTP server
    - Typically the request is either a GET or POST
  - The server then returns a **response message**, usually containing the resource that was requested
    - Typically, in XHTML, XML, but also in other formats like JSON
  - After delivering the response, the server **closes the connection**, making HTTP a stateless protocol
    - i.e., not maintaining any connection information between transactions

http GET

- GET appends the data to the URL as key-value pairs as follows:
  - URL ? key1 = value1 & key2 = value2
- Special characters within the values are replaced, e.g. %20 for space
  - this is called **url-encoding**
- The user can see, copy and bookmark a URL, thus it is easy for them to ‘resubmit’ the page
- Therefore GET should be used for pages which don’t change anything on the server
- e.g. it’s fine for information requests
  - GET pro.pl?name=John%20Smith&address=5%20Queen%20Street HTTP/1.1
  - GET /base/query/?query=big+java HTTP/1.1

http POST

- **POST sends data packaged as part of the message**
  - must be used for multipart/form-data, e.g., file uploading
  - should be used for programs with side effects
    - e.g., database update, purchase requested, sending email
  - or if there are non-ASCII characters in the data (e.g., accented letters)
  - if the data set is large (GET can have problems with >1kb)
  - you want to hide data from users – although they can always view the source
- POST uses the message body to achieve this and so has the following header lines:

```
Content-Type: application/x-www-form-urlencoded
Content-Length: 26    // number of characters
```

  and then the body, e.g.:

```
name=John%20Smith&address=5%20Queen%20Street
```

  - NB. that structure (key1 = value1 & key2 = value2 &....) is what *x-www-form-urlencoded* refers to

GET vs. POST

- What is the difference between these methods?
- When would you use one over another?
  - Use GET for safe and idempotent requests
  - Use POST for requests that are not safe or not idempotent
    - A safe operation is an operation which does not change the data requested
    - An idempotent operation is one in which the result will be the same no matter how many times you request it

Other HTTP Methods

- **The http protocol has numerous other methods too:**
  - **HEAD** is just like GET, except it asks the server to return the response headers only
    - useful to check characteristics of a resource without actually downloading it
  - **PUT** for storing data on the server
  - **DELETE** for deleting a resource on the server
  - **OPTIONS** for finding out what the server can do - e.g., switch to secure connections
  - **TRACE** for debugging connections
  - **CONNECT** for establishing a link through a proxy

Stateless Communication

- "HTTP is a stateless protocol"
- HTTP does not require the server to retain any information about the client/user
  - All requests are independent
- This is a problem if we want to maintain a session

Dealing with Statelessness

- **Common Solutions to overcome statelessness**
  - **Client Side**: use HTTP Cookies
    - Cookies are tokens stored on the client and can be included in the request
    - Best to store a session-id in the cookie that the server can use to retrieve information about the user
    - Rather than actual data about the user, etc on their client
  - **Server Side**: with hidden variables when the page is a form
    - i.e., through POSTs
  - **URL encoding:** store a session-id within the URL
    - `http://.../doing_task?session_id=unique_session_code`