Web & Web applications

DBW

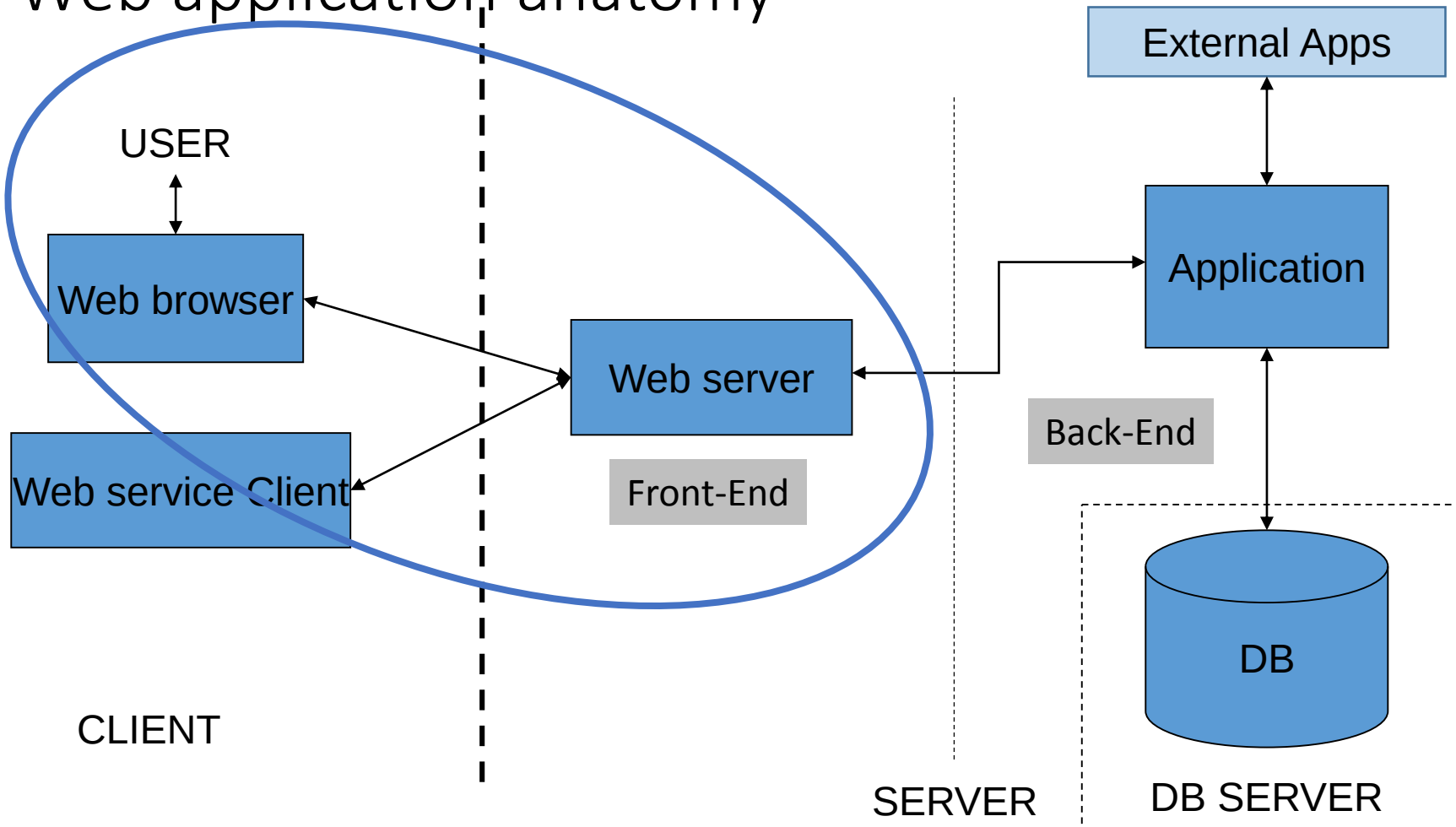
Outline

- Web basics
  - HTTP servers and browsers
  - Languages
  - Software
- Concept and types of Web applications. Web services
- Languages involved
- CGI Protocol.
- Time issues
- Personalization. Cookies & session persistence
- Hints

Reminder: Why Web-based?

- User interface is provided by standard Web servers and browsers (no need to develop friendly interfaces)
- No need to install client software (almost)
- Communications use standard protocols (HTTP, SMTP, SOAP) and languages (HTML, CSS, XML, JSON)
- Several programming languages available

Web application anatomy



Web (HTTP) Servers

- Computer applications that listen to a TCP port (80 typically), and understand HTTP requests.
- Information served are text or binary files (*resources*) stored locally in the server.
- HTTP servers that implements the appropriate protocol, can run **server-side applications** according to the request.
- Example SimpleHTTPServer (Perl, Python)

Web (HTTP) clients (browsers, …)

- Applications making requests to a server at a given TCP port (typically 80) using HTTP protocol
- Simple browsers requests for files (using HTTP) in a similar way to FTP. Resources are identified by URL (wget, curl for example)
- Normal browsers “understand” the contents of the obtained files and combine in graphical output, information from one or more servers according to a given language (usually HTML/CSS)
- Most **browsers can execute applications** (client-side) obtained from the information server

Languages involved

- HTML: Contents management language
  - Defines contents and structure of the page, includes the necessary links to all elements
  - Tag formatted language (… Some text …)
- CSS: Formatting language
  - Defines how the contents is represented in the user browsers
  - `P {font-family:Times; font-family: 10pt; display:block; background-color:black}`
- Data interchange formats
  - XML: Most traditionally used by web applications
    - Same structure as HTML, but with no fixed tags
    - Requires XML-schema to specify tags and check coherence

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<Course id="DBW">
        <Acronym>DBW</Acronym>
        <Title>Databases and Web applications</Title>
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  - JSON: Data interchange format replacing XML
    - Natively understood by Javascript, and of increasing popularity

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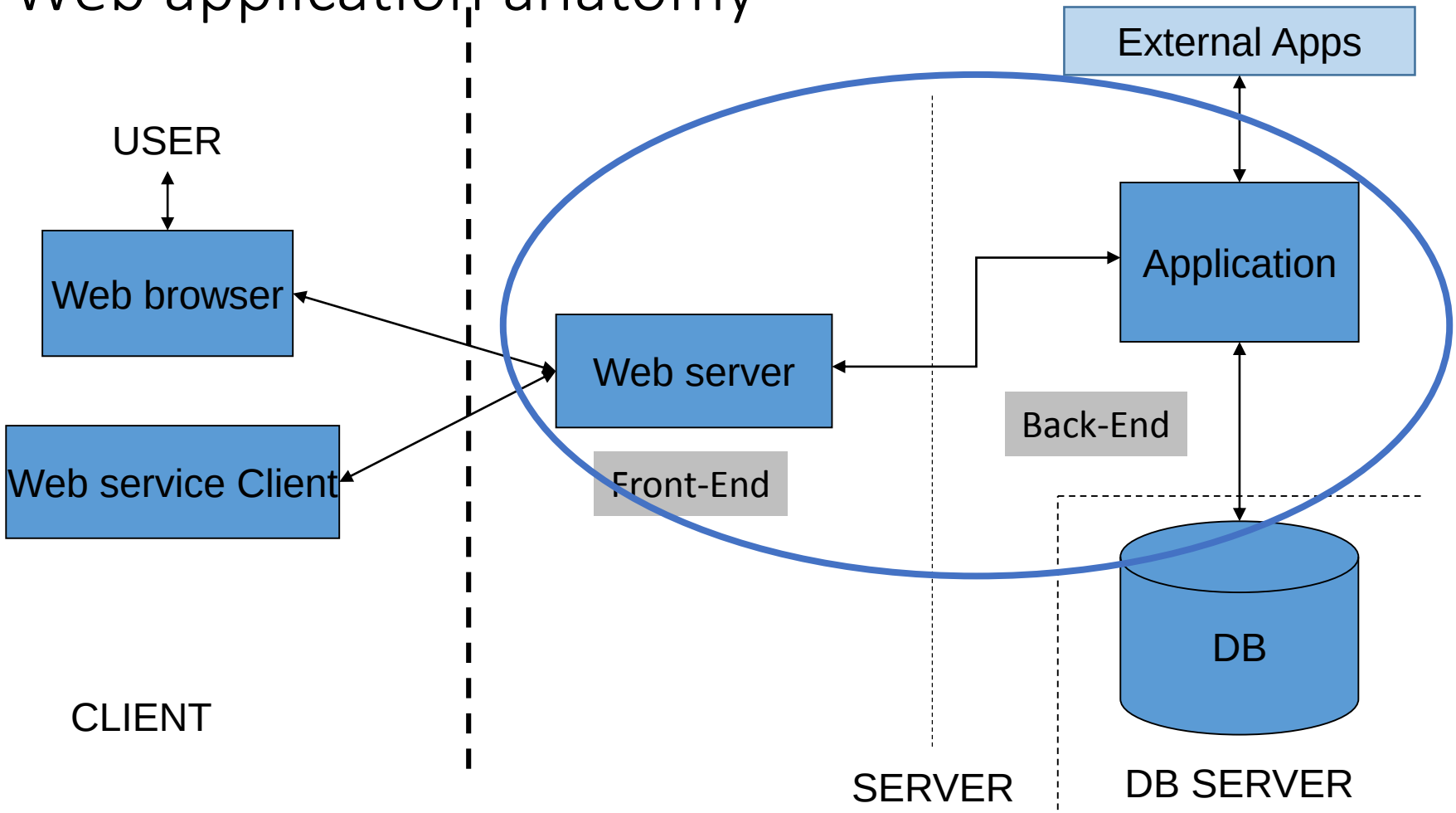
Software to build Web pages

- A simple text editor is enough (Notepad, vi, nano, ...)
- Syntax checking editors are more useful (gedit, NetBeans, ...)
- WYSWYG editors are common (Dreamweaver, Openoffice...). However, they MUST allow to check HTML manually!
- Content Manager Systems (CMSs)
  - Integrated environments to build web sites, general or specialized
  - Can include some useful functionality (user management, email, …)
  - Very useful to build static sites, but difficult to include applications
    - However, web structure and layout made by the CMS can be used
  - Drupal, Joomla, Wordpress, Bookstrap, …

Web application anatomy



Definition & types

- A Web application is a dynamic extension of a Web server.
  - Adapts to user input
  - Can serve non-static information (generated in real-time)
  - Uses standard protocols (HTTP, SMTP)
  - Users interact with the application mainly using Web browsers

- Presentation-oriented
  - Generates dynamic Web pages (HTML/HTTP) responding to user queries
  - Usual way to provide bioinformatics results

- Service-oriented
  - Interacts with other applications (XML/SOAP, REST)
  - Allows to build automatic workflows for complex analyses

Client side

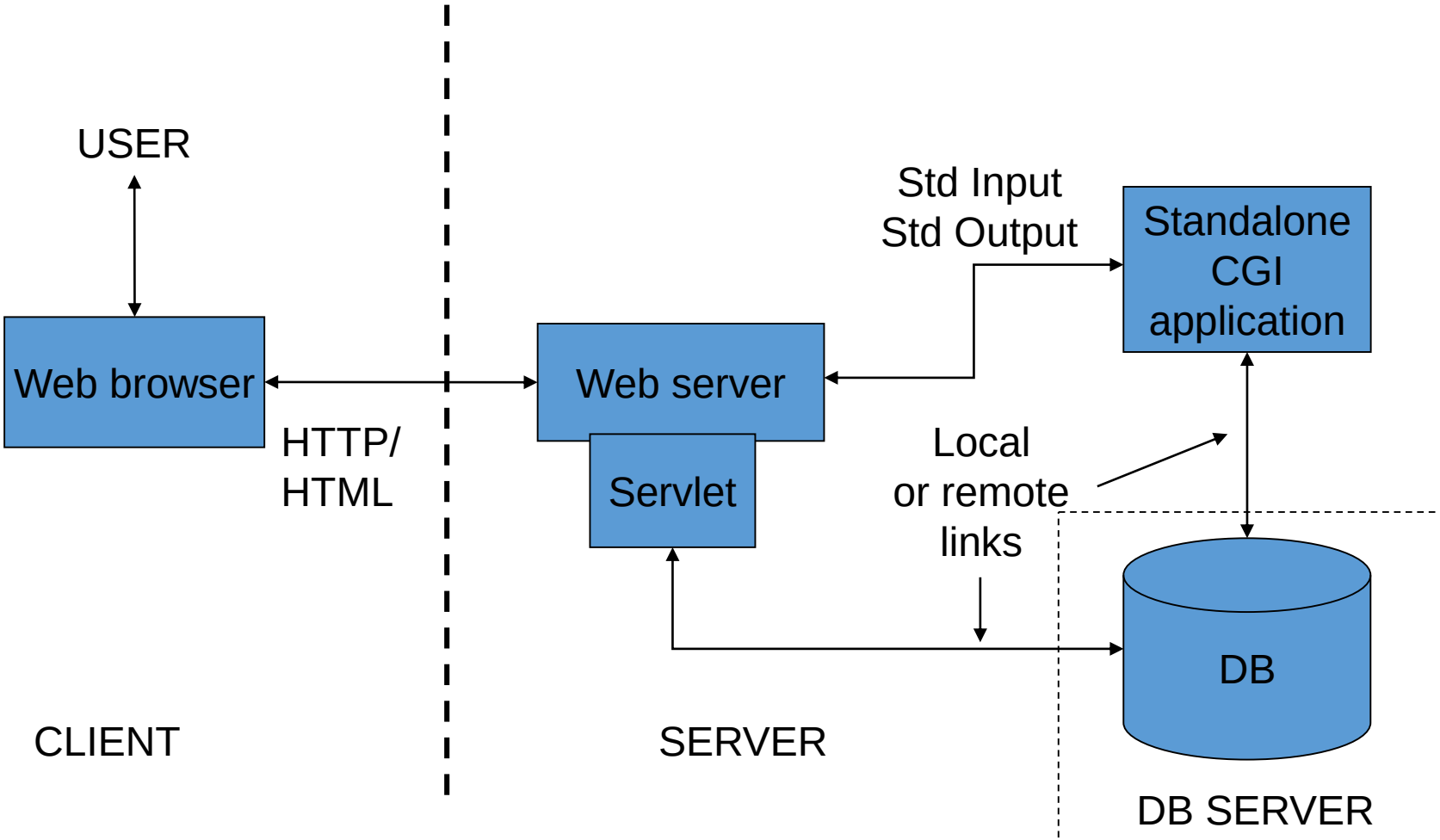
- Application must be compatible with standard web browsers
  - HTTP protocol: GET, POST, (PUT)
- User input comes from URL's or HTML forms
- Output must be standard HTML (XML, JSON), CSS, Javascript
- Output may invoke other programs (plug-ins) though MIME
  - Almost obsolete, except Flash

Client side

- HTML v5 include a variety of native functionalities
  - Audio/video, SVG graphics, MathML, Geolocalization, parallel process, …
- Modern browsers are able to run Java applets, and Javascript
  - Java applets/Javascript are fully qualified applications, served as static files, and run in the browser
  - Javascript is behind most dynamic behaviour of modern web sites (responsiveness).
    - Asynchronous interaction with server (new request do not require reload)
    - JsMol, Jquery, Angular.js,…

Server side

- Application is invoked by web server
  - External application (CGI)
    - Executable running in the server machine.
      Can be written in any language.
    - Get input from standard input and writes in the standard output. Web server redirects both.
  - Server embedded (Servlet).
    - Web server is able to execute the application as a child process
    - Special languages: Scripting: PHP, Python, ASP, JSP, .NET, Servlets (Java, Javascript)
    - Java applications require special servers


USER
Web browser
HTTP/
HTML
Web server
Servlet
Std Input
Std Output
Standalone
CGI
application
Local
or remote
links
DB
CLIENT
SERVER
DB SERVER

CGI Protocol & strategies

- **Common Gateway Interface (CGI)**
  - Formal interface between Web server and external applications
  - CGI interface provides
    - Environment variables including all relevant information from the browser-server conversation
      - Includes GET queries
    - POST input data, as standard input
    - Redirection of application standard output & error to Web stream.
- **External applications**
  - Read Input information from Environment variables, and standard input
  - Provides results and error as standard output
  - Are executed by the operative system as usual command lines executables
    - For security reasons they must be in a special directory (cgi-bin) unless the server in configured otherwise (MIME type cgi).
- **Servlets**
  - Are executed as web server's subprocesses
  - Still use input and output standard and CGI variables, but data is processed

Some CGI variables

- SERVER_SOFTWARE
- SERVER_NAME
- GATEWAY_INTERFACE
- SERVER_PROTOCOL
- SERVER_PORT
- REQUEST_METHOD ("GET", "HEAD", "POST“)
- PATH_INFO
- PATH_TRANSLATED
- SCRIPT_NAME
- QUERY_STRING
- REMOTE_HOST
- REMOTE_ADDR
- CONTENT_TYPE
- CONTENT_LENGTH (with POST)
- HTTP_ACCEPT
- HTTP_USER_AGENT
- HTTP_ HTTP headers

Basic Input and Output

- Input from HTTP “GET” appears as QUERY_STRING
- Input from POST appears on standard input

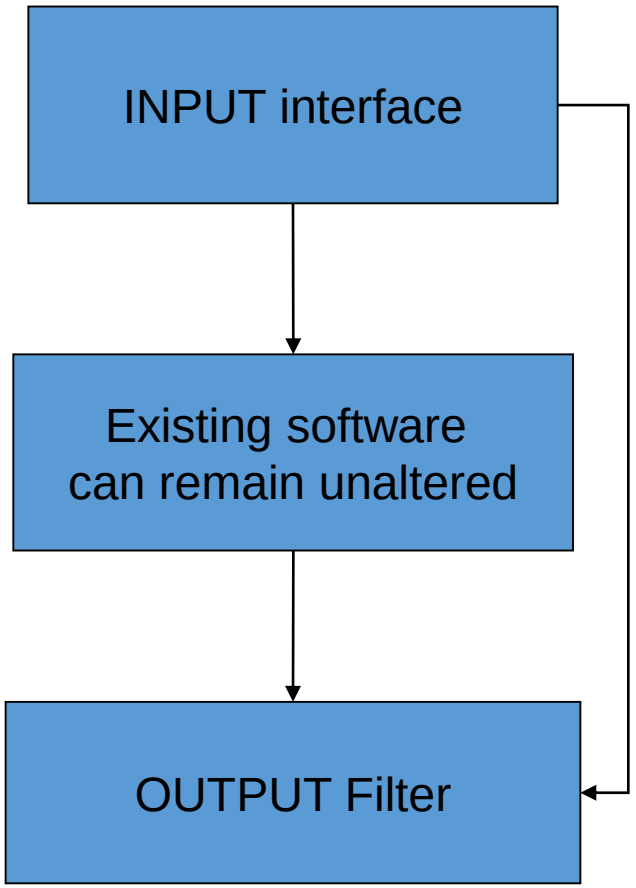
- Output is a document with a MIME Type header

```
Content-type: text/html
<blank>
<html><body>
…
</body></html>
```

- Or a redirection

```
Location: new URL
<blank>
```

The simplest application



HTML Forms
Data validation
Error handling

Output to HTML. EMail

Servlet languages

- Depends on the server software used
  - Java application servers (Tomcat, Jboss, …): JSP, Java
  - Microsoft servers: ASP (old), Aspx, .NET
  - Standard servers (Apache): PHP, node.js
  - With the appropriate extensions: Perl, Python
- Most popular:
  - PHP/Apache, Java/Tomcat
- Growing popularity
  - Python, Javascript (Node.js)

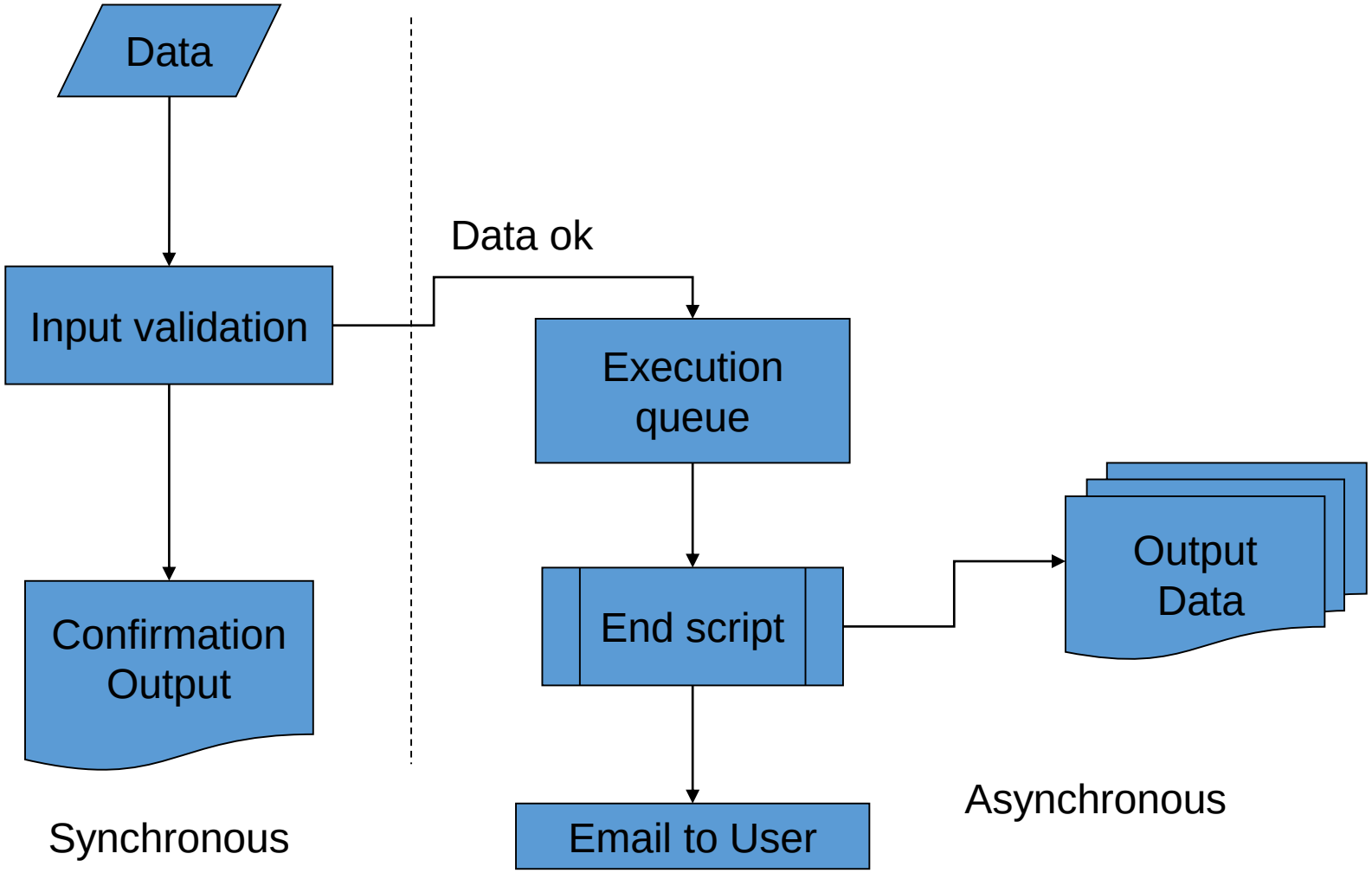
Known issues

- Time issues
  - Web users require “instant” responses
  - Most web browsers have short “timeout”
  - Application that last more that 1-2 mins must be asynchronous

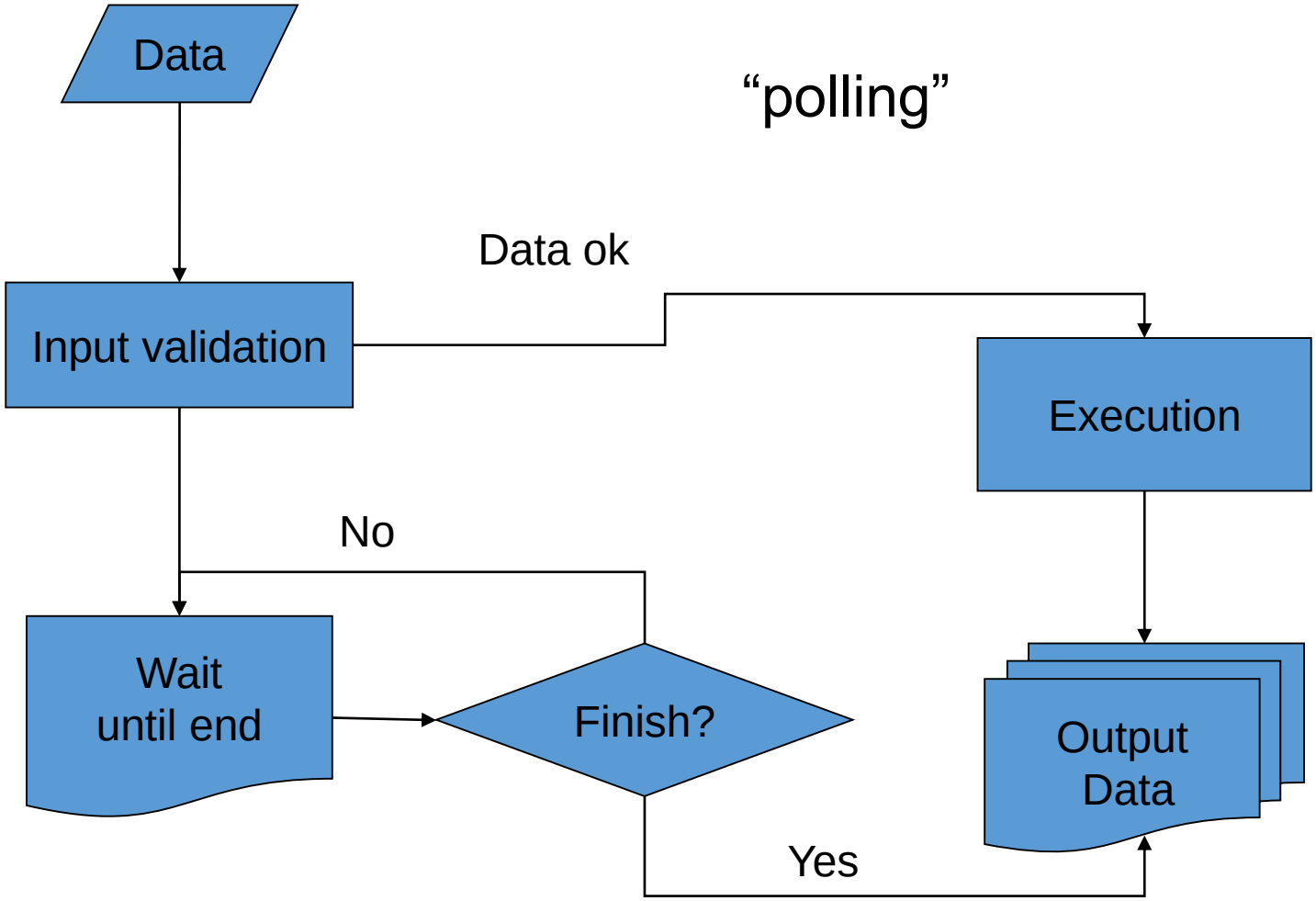
- Persistence, and User recognition
  - HTTP protocol is not persistent: Connection closes short time after the server answers

  - Application need to recognize returning users
    - Authentication (user only must write the login/password once)
    - Keep personal preferences, and private data
    - Grant access to given resources according to previous requests
    - Avoid to request known data more than once
    - Avoid “reloads”

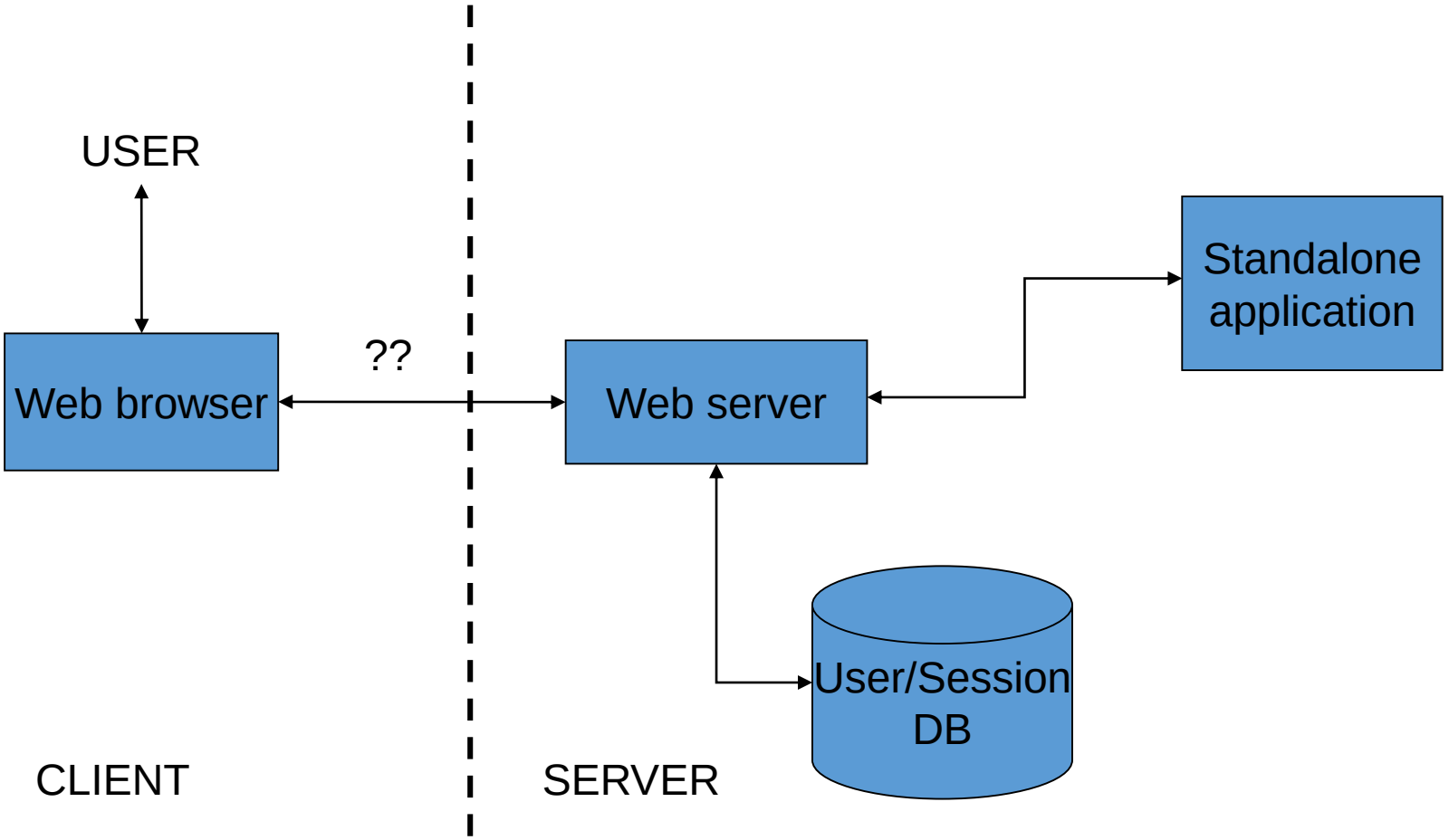
Time issues. Usual strategies



Time issues. Usual strategies



Personalization



A DB stores history of user connections and activities

Authentication schemes

- Server based
  - Based on unix-like passwd files (login / passwd)
  - Protects folders and sub-folders (.htaccess files)
  - Identity via CGI variable (REMOTE_USER)
  - May require access to server configuration
  - Persistence via HTTP
  - Environment managed by local DB
- Application based
  - Do not require access to server configuration
  - Authentication and environment managed by a local DB
  - Full control from the application (login / passwd, SSL Keys, …)
  - Persistence via Cookies or language specific constructs (PHPSessionID / Session)
- Third party authentication and single sign-on
  - Authentication is done by identity servers (Google, openID, ….), or other apps (eGroupWare, Drupal, …) / Session, LDAP

User identification: cookies

- Small amount of text information stored by the server in the users' web browser.
- Do not require user/password (user do not need to be aware of)
- Limited to 4Kb
- Cookies can last for a single session or till a specified date
- Cookies can be used to avoid password request
- Cookies do not identify persons but browsers!!

Cookies: details

- Cookies are key / value pairs
- The normal identification cookie is a unique ID generated by the server
- Origin: server URL. Browsers send back cookies to the servers that created them (no other servers can get the data)
- Expiration date

Web application layout hints

- Static contents (text, images, etc.) stored as normal web resources
  - For optimization some servers separate them from scripts
- Dynamic pages managed by servlet scripts
  - No general rule, depends on language, and programming style
  - The easy way: Each different screen is managed by a specific script.
- Global variables
  - Each script acts in a separated HTTP transaction!
  - All scripts should load the same global environment, usually included from a single file
- Protected/public data
  - Protected data should be stored outside of the web directory tree, and be accessed only programmatically

Web application layout hints

- Temporary data
  - Can be stored anywhere
  - Most languages provide automatic temporary directories and file names.
  - Should be deleted after use!!
- Beware of multiple concurrent users
  - Use request-specific file names for temporary data and results
  - Use user-based directories
  - Think in a queueing system for lengthy operations
- Collect statistics of use!!