Web

Master 1 IFI

Andrea G. B. Tettamanzi

Université de Nice Sophia Antipolis

Département Informatique

andrea.tettamanzi@unice.fr

Unit 5

Persistence, AJAX, and REST

Persistence

- General mechanism to save and restore
  - Data
  - State of computation
- Allows a program to terminate without its data and execution state being lost
- A central subject in Web programming
  - Server-side and client-side
  - Web protocols are stateless!
- Saving
  - Locally on disk
  - Remotely on a server
    - E.g., a relational DB server

Client-Side Persistence (JavaScript)

- Client-side persistence requires serialization
- Serialization = translating data structures or object state into a format that can be stored or transmitted and reconstructed later
- Possible choices for serialization
  - Binary
  - XML
  - JSON
- Three persistence mechanisms for client-side persistence
  - HTTP Cookies (traditional solution, predates JavaScript)
  - Web Storage API (convenient for small amounts of data)
  - IndexDB API (suitable for large, structured data)

XML

- XML : e**X**tensible **M**arkup **L**angage
- W3C standard since 1998
- Version 1.0 (February 1998); Version 1.1 (February 2004)
- A description language for a class of data objects called “XML documents”
- The standard partially describes the behavior of programs that process them
- XML is a restricted form of SGML (1986)

XML Document Example

```
<!DOCTYPE glossary PUBLIC "-//OASIS//DTD DocBook V3.1//EN">
<glossary><title>example glossary</title>
 <GlossDiv><title>S</title>
  <GlossList><GlossEntry ID="SGML" SortAs="SGML">
    <GlossTerm>Standard Generalized Markup Language</GlossTerm>
    <Acronym>SGML</Acronym>
    <Abbrev>ISO 8879:1986</Abbrev>
    <GlossDef>
     <para>A meta-markup language, used to create markup
           languages such as DocBook.</para>
     <GlossSeeAlso OtherTerm="GML">
     <GlossSeeAlso OtherTerm="XML">
    </GlossDef>
    <GlossSee OtherTerm="markup">
 </GlossEntry></GlossList>
 </GlossDiv>
</glossary>
```

XML Documents

- Consist of storage units called entities, containing data, which may be parsed or not
- Data are characters representing either simple values or tagged content
- The markup (tags) describes the logical/storage structure of the document
- An XML document is **well-formed** if it respects XML syntax
- XML provides a mechanism to constrain this syntax, namely the DTD (Document Type Definition)
- An XML document may be **valid** w/ respect to one or more DTDs

DTD

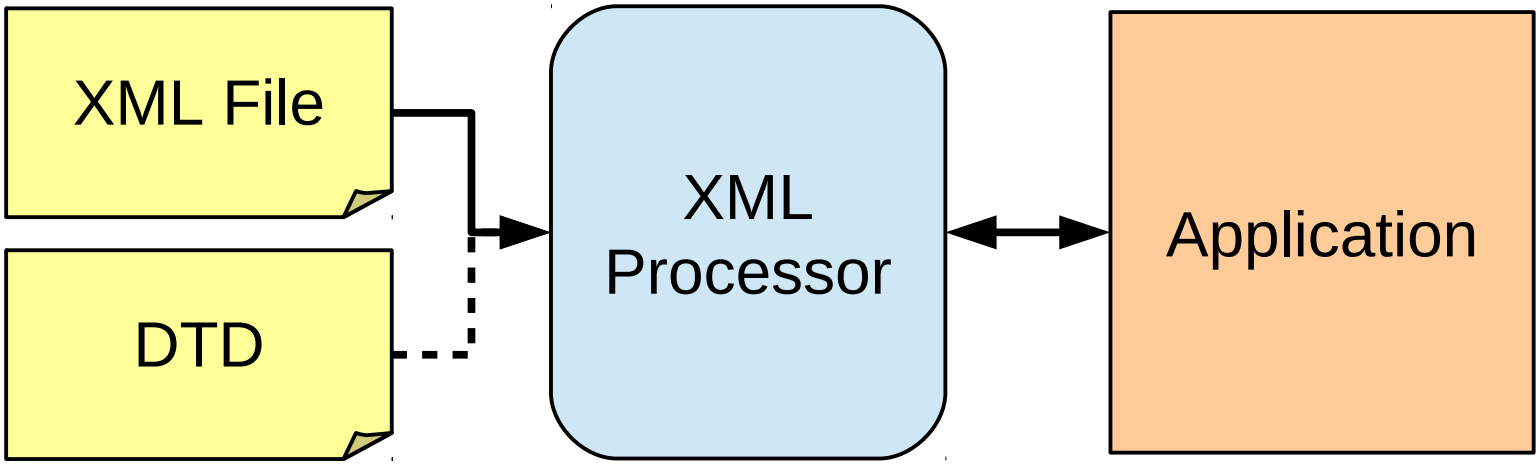
- Element Definition: <! ELEMENT Name Content >
- Content:
  - ANY: The element may contain data of any type
  - EMPTY: The element contains no data
  - #PCDATA: The element must contains a character string (parsed character data)
  - Operators:
    - + at least one
    - ? optional
    - , concatenation
    - * zero or more
    - | alternative
    - ( ) grouping

DTD Example

```
<!ELEMENT    contact (address, url?, tel*)>
<!ELEMENT    address (addrline, zip, city)>
<!ELEMENT    addrline (line+)>
<!ELEMENT    line (#PCDATA)>
<!ELEMENT    zip (#PCDATA)>
<!ELEMENT    city (#PCDATA)>
<!ELEMENT    url (#PCDATA)>
<!ELEMENT    tel (#PCDATA)>
<!ATTLIST    tel t (fixed|fax|mobile) “fixed”>
```

XML Processor

- A software module used to read XML documents and access their content (with or without validation)
- An XML processor does the work on behalf of another module, an application



XML in JavaScript

- The XML processor in JavaScript is the DOM API
- The XML DOM defines the properties and methods for accessing and editing XML
- Before an XML document can be accessed, it must be loaded into an XML DOM object
- DOMParser

```
parser = new DOMParser();
xmlDoc = parser.parseFromString(xml,"text/xml");
title = xmlDoc.getElementsByTagName("title")[0];
…
```

JSON

- JSON = JavaScript Object Notation
  - Lighter than XML
  - Native to JavaScript
  - Platform- and Programming-language-independent

object ::= '{}' | '{' members '}'
members ::= pair | pair ',' members
pair ::= string ':' value
array ::= '[]' | '[' elements ']'
elements ::= value | value ',' elements
value ::= string | number | object | array | 'true' | 'false' | 'null'

JSON Example

```
{ "glossary":
  { "title": "example glossary",
    "GlossDiv": {
      "title": "S",
      "GlossList": {
        "GlossEntry": {
          "ID": "SGML",
          "SortAs": "SGML",
          "GlossTerm": "Standard Generalized Markup Language",
          "Acronym": "SGML",
          "Abbrev": "ISO 8879:1986",
          "GlossDef": {
            "para": "A meta-markup language, used to create
                     markup languages such as DocBook.",
           "GlossSeeAlso": ["GML", "XML"] },
          "GlossSee": "markup" } } }
  }
}
```

The JSON Object

- JSON.**stringify**(*value*[, *replacer*[, *space*]])
  - Returns a JSON representation of *value* as a string
  - Throws a TypeError exception if *value* is cyclic
  - *space* is a Number (0, 1, …) or String (like “”, “ ”, “\t”, “\n”)
  - *replacer* is a function(*key*, *value*) → JSON string

- JSON.**parse**(*json_string*[, *reviver*])
  - Throws a SyntaxError exception if *json_string* is not valid
  - *reviver* is a function(*key*, *json_string*) → value

Cookies

- An HTTP cookie is a small piece of data that a server sends to the user's browser
- The browser may store it and send it back with the next request to the same server
- Cookies are used for
  - Session management
  - Personalization (preferences, themes, settings)
  - Tracking (bad, bad, …)
  - General client-side persistence (but that’s old-fashioned)
- In JavaScript:
  - document.cookie is a pseudo-variable to access cookies

Web Storage API

- Two storage object are available in an HTML5 client:
  - **sessionStorage** maintains a separate storage area for each given origin that's available for the duration of the page session (as long as the browser is open, including page reloads and restores)
  - **localStorage** does the same thing, but persists even when the browser is closed and reopened
- They expose the same interface:
  - length: the number of data items stored in the area
  - setItem(key, serializedValue), getItem(key), removeItem(key)
  - Clear() – clear the whole area, key(n) – returns the *n*th key
  - The “storage” event is fired when the a storage area changes

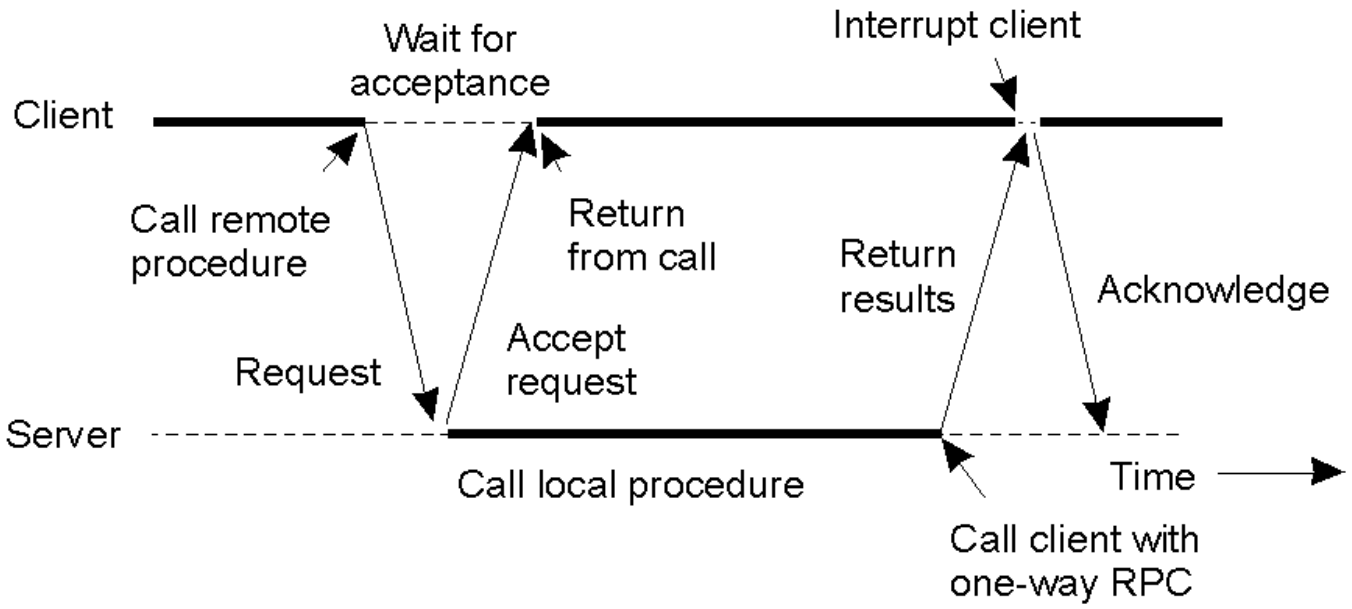
Event-Driven Programming

- A programming style based on events
- Contrasts with traditional sequential programming
- The program is mainly defined by its reactions to the various events that can occur
  - Variable state changes
  - User actions
  - Message reception
  - End of a long task delegated to another process/thread
- Much used in graphical user interfaces (GUIs)
- Typical of distributed systems
  - Parallelism and asynchronous execution
- Node.js is a JavaScript-based event-driven software platform

Callback Functions

- Web programming promotes an event-driven style for two main reasons
  - Web clients often implement reactive GUIs
  - Web applications are distributed (client-server)
- In this style, so-called *callback* functions are first-class citizens
  - HTML event handlers are one remarkable example
  - Interrupt handlers in system programming are another
- A callback function is a function
  - Passed as an argument to another function/method
  - This latter calls it (asynchronously) at the end of its execution, to pass back some results, for instance
  - Other uses/schemes are possible and popular

Asynchronous Remote Procedure Call



AJAX

- Acronym of “Asynchronous JavaScript and XML”
- Principle: to make an asynchronous request to a server/service
  - To verify/validate
  - Po get/retrieve information
- Asynchronous HTTP request (to a CGI script or similar)
- The HTTP response will consist of XML (or JSON, or other…)
  - Such content will then be exploited to change the Web page (e.g., getElementById + innerHTML)
- The whole process does not require to reload the current page or to download a new page!

AJAX: XMLHttpRequest

- A JavaScript constructor providing an API to exchange data between an HTTP client and an HTTP server:
  - http://www.w3.org/TR/XMLHttpRequest/
- The name has historical reasons, however
  - Any textual format can be used, not just XML
  - It allows to use HTTP as well as SHTTP (or other protocols)
  - Request, here, is in a very broad sense (any HTTP method)
- Working principle:
  - Create an object with this constructor
  - Assign a reference to a handler (i.e., a callback function) to the “onreadystatechange” property/event
  - Call the open() et send() methods to submit the request

Handler Example

```
function my_handler( ) {
  // test the processing state of the request
  if ((this.readyState==4) && (this.status==200))
  {
    // retrieve the response in XML or text format
    var myXML = this.responseXML; // a DOM object
    var myText = this.responseText; // a string
  // … do something with the response
  }
}
```

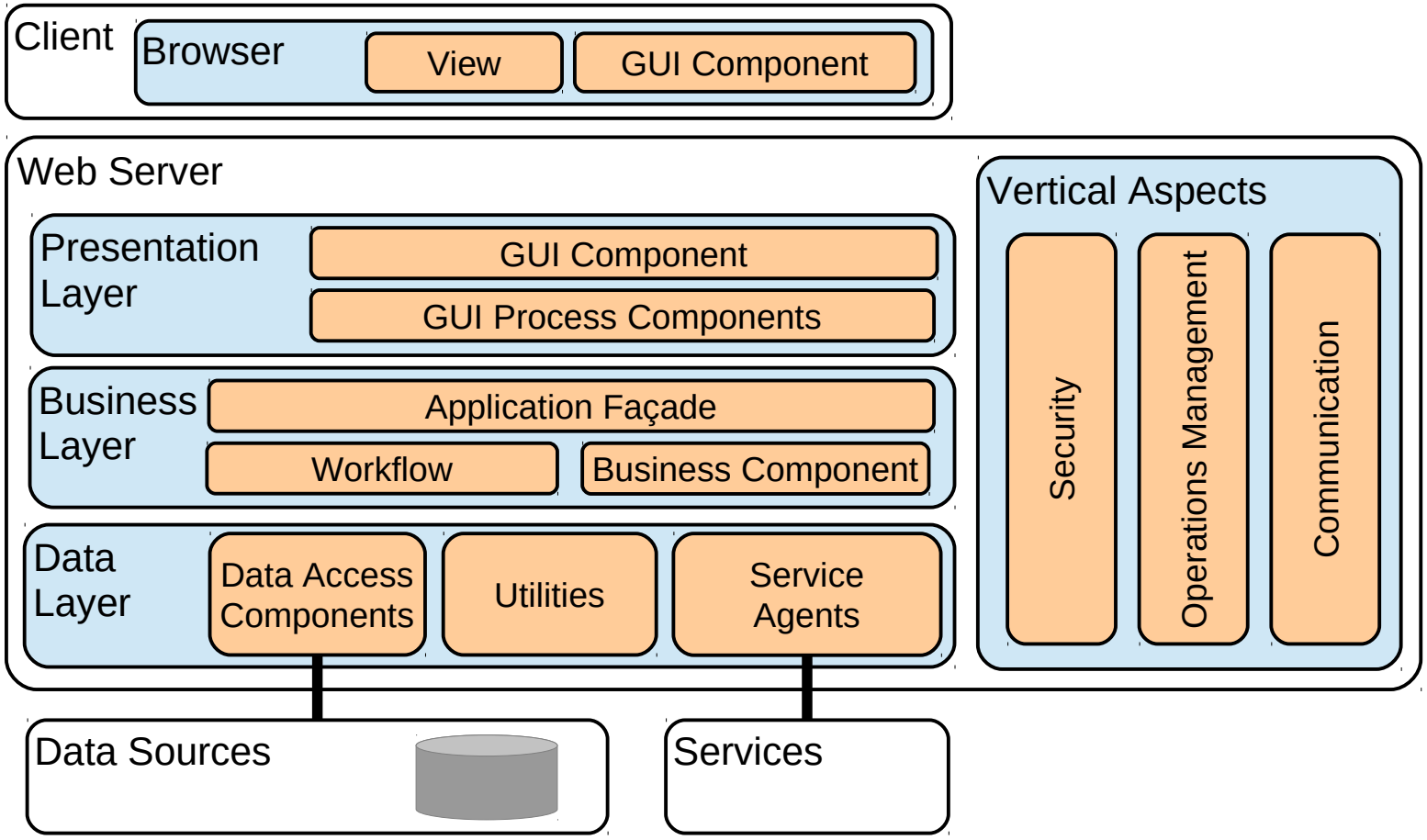
Using XMLHttpRequest

```
var client = new XMLHttpRequest();
client.onreadystatechange = my_handler;

client.open("GET", url);
client.send();

// alternatively:
client.open("POST", url);
client.setRequestHeader("Content-Type",
  "text/plain;charset=UTF-8");
client.send("var1=va1&var2=val2&…");
```

Architecture of a Web Application



Request Handling

- Two approaches to request handling:
  - "Post-Back" Approach (we know that already, cf. CGIs)
    - Form-based development
    - Server-centric
    - Rapid prototyping
  - "RESTful" Approach, based on the notion of Web service
    - More client-centric
    - Finer control of the GUI and more flexibility
- The choice between these two approaches must take into account the desired degree of control on GUI, the development process and scalability

Representational State Transfer (REST)

- Architectural style for distributed hypermedia systems
- Proposed in 2000 by Roy Fielding
- Defined by six architectural constraints:
  1) Client-server architecture: clear separation of concerns
  2) Statelessness: each requests must also contain its context
  3) Cacheabilty: responses must define if they are cacheable
  4) Uniform Interface: (a) resource identification in requests;
     (b) resource manipulation through representations;
     (c)self-descriptive messages;
     (d) Hypermedia as the engine of application state (HATEOAS)
  5) Layered System
  6) Code on Demand (→ client-side scripting)