Client Side: Embedding Interactive Content

Java Applets, ActiveX, .NET controls, Flash

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Java Applets

- Precompiled Java programs which can run independently within a browser
  - Main applet class inherits from `java.applet.Applet`
- Sandboxed by a variety of security measures and functional limitations
  - Cannot load libraries or native methods
  - Cannot read/write most files on host
  - Most network connections are blocked
  - Cannot start external programs
  - Limited access to system properties
  - Different window style

Java Applets

- Applet API facilitates browser-related tasks
  - Obtain parameters from the <APPLET> tag
  - Load files relative to the applet or page URL
  - Setting status messages on the browser
  - Interact with other applets on the page
  - Make the browser display a document.
  - Play sounds.

ActiveX Controls

- Enhanced OLE controls
  - OLE controls are part of the Microsoft COM framework
  - Support base COM interfaces, as well as interfaces for automation, persistence and UI.
- ActiveX adds web-related features
  - Security
  - Reduced footprint
  - Digital signatures and licensing
  - Simplified distribution as a cabinet file
- Many limitations
  - Works only in Microsoft browsers
  - Numerous security holes
  - Very difficult to develop in C++
  - Simple in visual basic, but not as powerful
- More component and UI oriented than Java applets

.NET Controls

- The equivalents of ActiveX controls in the Microsoft .NET Framework
- Different in internal structure
  - Created from a hierarchy of control classes
  - Represented in Microsoft Intermediate Language
    - Supposedly multiplatform
    - Can be developed in variety of languages

FLASH

- Proprietary MacroMedia Format
  - Provides free browser plugins
  - Deployed as a single SWF file
- Intended to create interactive "movies for the web
  - Initially used mostly for animation
  - Later for interactive menus and navigation
  - Then used for interactive games
    - e.g., Warcraft I in Flash
- Uses vector graphics
- Does not require programming skills
  - Except for highly interactive tasks which use scripting language

Flash

- User uses interactive Flash editor
  - Draws and makes changes to “stage”
  - Uses “timeline” to direct animation
- ActiveScript language has interactive IDE
  - User drags-and-drops elements
    - e.g., drag conditional and then variables
- Users need to learn a new language and type code for sophisticated events
  - Still faster ramp-up than Java applets or .NET

Server side: Scripting and low-level languages

CGI, Perl, PHP, Python, ColdFusion

Common Gateway Interface (CGI)

- Standard interface allowing web server to delegate page creation to external programs
- Any programming language can be used
  - Compile into executable binary
  - Run scripts (e.g., perl) with executable intepreter
- Arguments passed via environment variables
  - `QUERY_STRING`
    - Everything after the first `?` Symbol in the URL
  - `PATH_INFO`, `PATH_TRANSLATED`
    - Additional information in addition to the page URL
- Document returned via standard output
  - Should return `content-type` header
  - Can refer to other document with `Location`

CGI Limitations

- Not appropriate for busy servers
  - Each program instance is a separate process
- Security risks
  - Only web-master has install privileges
  - Bad code can cause serious trouble

PERL BASED CGI SCRIPTS

- Practical Extraction and Report Language [1987]
  - Popular interpreted language among system administrators
  - Aimed at string processing
- Messy yet powerful language
  - Scripted, Procedural, Object Oriented
    - OO support very sketchy
  - Mixed notions from UNIX, C, Basic, SED/AWK
  - Weak typing system
  - Rapid built-in data structures
  - Relies heavily on regular expressions
- Variety of extensions and libraries
  - CGI module facilitates web programming
    - e.g., easy access to arguments from URL

PHP

- Personal Home Page tools
  - Open-source language for server-side scripting
    - Commercial 3rd party optimizers available
  - Adopted in popular large-scale web-applications
    - PhPBB bulletin board system
    - Software behind Wikis and WikiPedia
  - Some standalone rich-client applications
- Built-in facilities for popular protocols and services
- Shifts towards OOP
- Requires special server support
  - Web master must allow php scripts

PYTHON

- A popular multi-paradigm language ['90]
  - Considers itself a "dynamic programming language" rather than a scripting language
  - Used to build some large scale applications
  - Inherent object oriented programming
- Variety of built-in data types
- Extensible
- Some support for functional programming
  - Interactive mode a-la LISP
- Indentation is used to indicate blocks
  - No semicolons or curly braces
  - Whitespace can destroy a program

ColdFusion

- Macromedia’s server-side scripting language
  - Based on Allaire’s software early prototype
    - Tag-based access to databases
- Tag based
  - Easier to learn than other languages
  - Extensible
- Targeted for the enterprise market
  - Security and scalability features
  - Interacts with variety of protocols and services
  - Visual tools for rapid development
- Recent versions can run on J2EE application servers

Server side: High-level languages

Java servlets and JSPs

ASP and ASP.NET

Java Servlets

- Java analogue of a CGI script
  - Servlet-enabled server activates servlet
- A servlet can service multiple requests in its lifetime
  - More efficient than creating separate processes
- User servlet implements `Servlet` interface
  - `init(ServletConfig config)`
  - `Service(ServletRequest req, ServletResponse res)`
  - `destroy()`
- Preferable to inherit from `HttpServlet`
- Filter infrastructure allows transformation of response

Java Servlets

- Servlets can interact and share information with other components
  - They can also invoke other HTTP requests and include their results in their response
- Servlets have access to session information
  - Sessions encoded either as cookies or in URL
    - API hides details from the servlet programmer
- Servlets are good for intermediate service-oriented documents
  - e.g., XML data from a web service
- Servlets are not natural for presentation-oriented documents
  - Usually small portions of the page are dynamic

JAVA SERVER PAGES

- A more natural way to dynamically create web pages
  - Dynamic sections embedded within the static document
  - JSP translator / compiler creates servlet
- Directives
  - e.g., `<%@ page import="java.util.*" %>`
- Scriplets containing Java code
  - e.g., `<% int localStackBasedVariable = 1; %>`
- JSP action tags
  - Invoke built-in servlet functionality

```
<jsp:forward page="subpage.jsp">
    <jsp:param name="forwardedFrom"
value="this.jsp"/>
   </jsp:forward>
```

  - Include plug-ins such as JavaBeans
  - Custom tags

JSP TAG LIBRARIES

- JSP language can be extended with custom tags deployed as tag libraries
  - Reduces amount of Java code that JSP users have to do.
    - e.g., unique iterators to faciliate coding
    - e.g., routines such as clearing a shopping cart

Apache Struts

- A framework for building web applications using a Model-View-Client architecture
  - Model - Database interfaces such as JDBC or EJB
  - View – Presentation interfaces such as JSP or XSLT
  - Struts provides the controller

Classic ASP

- Microsoft’s server-side technology
- Code intermixed with static HTML
  - Classic ASP used VBScript
  - e.g., `<html>`

```
    <body bgcolor="yellow">
       <center>
         <h2>The time is:

<%Response.Write(now())%>
        </h2>
    </center></body>
   </html>
```

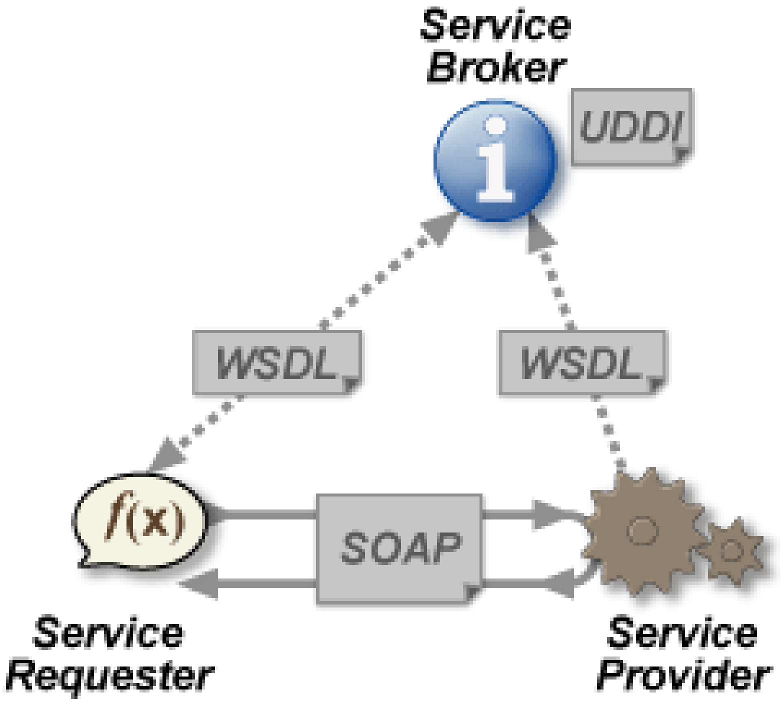
ASP.NET

- New generation of .NET
  - Now supports all .NET languages
- Supports visual editing similar to VB programming
- Allows code to be decoupled from HTML
  - Server controls are tags similar to JSP tags
- Supports a view state for forms
  - In case of problems in form validation, values are restored

Architectures for Web Services

Overall Architecture

- UDDI
  - Information on available web service
- WSDL
  - A description of how to communicate using the web service
- SOAP
  - Protocol for exchanging messages



Universal Description, Discovery, and Integration (UDDI)

- Platform-independent XML registry
- Allows businesses to list services they provide
- Registration consists of:
- While pages info – real address and contact information
- Yellow pages info – industrial categorization
- Green pages info – technical information on exposed services

Web Services Description Language (WSDL)

- XML format for describing public interface of web services
  - Services are collection of abstract endpoints called "ports"
  - Each port has a protocol ("binding") and address
  - Each port has a type that defines valid "operations"
  - An operation consists of messages and data formats

WSDL document describes:

  - Data formats
  - Valid messages
  - Ports types with their supported operations
  - Binding of ports to types and addresses
  - Services in terms of ports they provide and documentation

Simple Object Access Protocol (SOAP)

- Lightweight protocol for message exchange
    - Enable “access” to objects, including RPCs
    - Defines formats for requests, responses, errors
- XML based, runs on top of HTTP
- Optional header with information on
    - Security requirements
    - Routing
    - Transactions
- Body contains actual data

Simple SOAP example

- Request:

  -
    ```
    <soap:Envelope
      xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
       <soap:Body>
         <getProdDetails
    xmlns="http://warehouse.example.com/ws">
           <productId>827635</productId>
         </getProdDetails>
       </soap:Body>
    </soap:Envelope>
    ```
- Response:

  -
    ```
    <soap:Envelope
     xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
    <soap:Body>
    <getProdDetailsResponse
    xmlns="http://warehouse.example.com/ws">
       <getProductDetailsResult>
            <productName>Toptimate 3-Piece Set</productName>
            <productId>827635</productId>
            <description>3-Piece luggage set
    Polyester</description>
            <price>96.50</price>
            <inStock>true</inStock>
        </getProductDetailsResult>
    </getProductDetailsResponse>
    </soap:Body>
    </soap:Envelope>
    ```