Distributed Multi-Tier Web Applications

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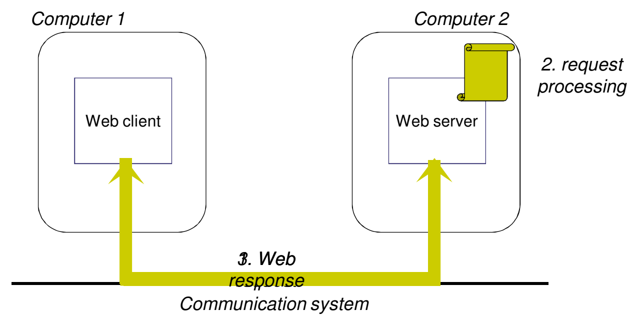
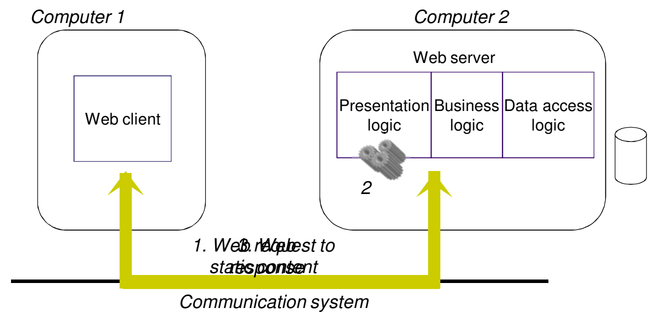
Introduction – Web applications



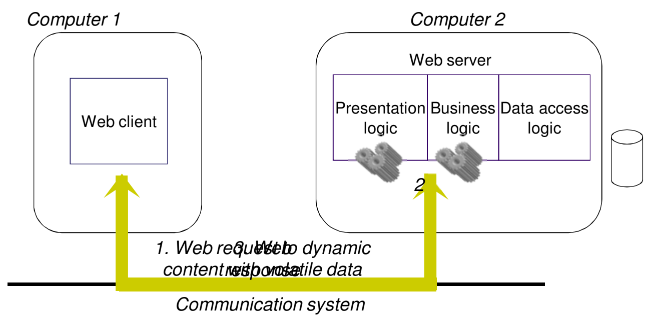
Motivations

- Processing a request on the server may successively involve several types of logic:
  - Data access logic
    - Example: read data from a persistent storage (e.g. a database)
  - Business logic
    - Example: use the read data to perform any application-specific processing
  - Presentation logic
    - Example: use the obtained result to build a user-friendly response to the client

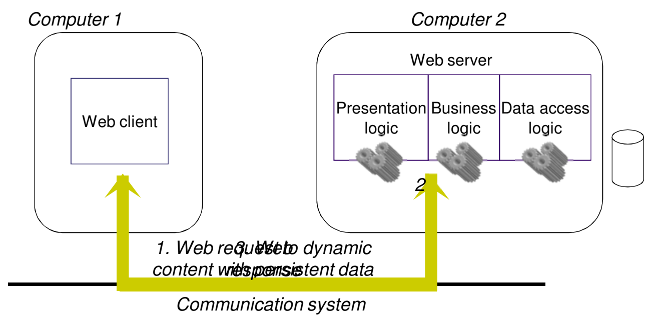
Example 1



Example 2



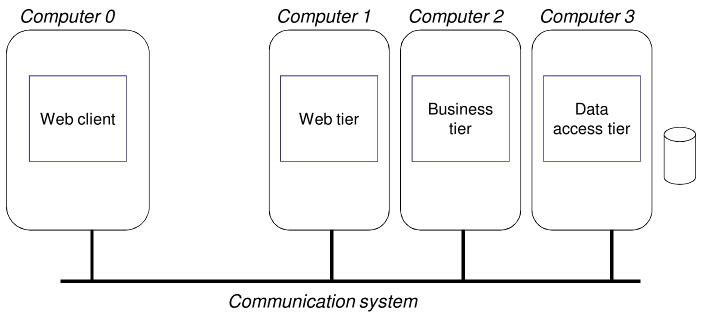
Example 3



Motivations

- These types of logic may be more or less heavy in terms of processing time
- A unique server that hosts multiple types of logic may suffer from scalability issues in case of heavy workload (#concurrent web clients)
- Solution:
  - Separate the different types of logic in different servers
  - Multi-tier architecture

Overview of the multi-tier architecture



Multi-tier architecture

- Java 2 Enterprise Edition
- Web tier
  - Run a web server
  - Receive requests from web clients
  - Run web components
  - May forward requests to the business tier
  - Return web documents as responses (e.g. static HTML pages or dynamically generated web pages)
- Business tier
  - Run an application server
  - Receive requests from the web tier
  - Run business components
  - May forward requests to the data access tier (via JDBC)
- Data access tier
  - Run a database server
  - Receive requests from the business tier

J2EE multi-tier systems

- Web components
  - J2EE web components are either servlets or pages created using JSP technology (JSP pages)
  - *Servlets* are Java programming language classes that dynamically process requests and construct responses
  - *JSP pages* are text-based documents that execute as servlets but allow a more natural approach to creating static content
  - Static HTML pages and applets are bundled with web components during application assembly

J2EE multi-tier systems (2)

- Business components
  - Business code, i.e. the logic that solves or meets the needs of a particular business domain such as banking, retail, or finance, is handled by enterprise beans running in the business tier
  - There are three kinds of enterprise beans: session beans, entity beans, and message-driven beans
  - A *session bean* represents a transient conversation with a client. When the client finishes executing, the session bean and its data are gone
  - An *entity bean* represents persistent data stored in one row of a database table. If the client terminates or if the server shuts down, the underlying services ensure that the entity bean data is saved
  - A *message-driven bean* combines features of a session bean and a Java Message Service (JMS) message listener, allowing a business component to receive JMS messages asynchronously

A simple example

```java
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class MyServlet extends HttpServlet {
   public void doGet(HttpServletRequest req, HttpServletResponse res)
         throws ServletException, IOException {

         // Use "request" to read incoming HTTP headers  and HTML form data
         // (e.g. data the user entered and submitted)
         ...

         // Perform any internal processing for generating dynamic results
         ...

         // Use "response" to specify the HTTP response line and headers
         // (e.g. specifying the content type).
         PrintWriter out = response.getWriter();
         // Use "out" to send content to browser
         ...
   }
...
```

A simple example (2)

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class MyServlet extends HttpServlet {
    public void doGet(HttpServletRequest req, HttpServletResponse res)
          throws ServletException, IOException {
          // Use "request" to read incoming HTTP headers  and HTML form data
          // (e.g. data the user entered and submitted)

          String accountIdStr = req.getParameter("accountId");
          int accountId = Integer.parseInt(accountIdStr);

          if (accountId != null) {

                    ...
          }

          ...

    }
```

A simple example (3)

```
import java.sql.*;

public class MyServlet extends HttpServlet {
    public void doGet(HttpServletRequest req, HttpServletResponse res)
          throws ServletException, IOException {
          ...
          // Perform any internal processing for generating dynamic results
          float balance = 0;
          Connection conn = DriverManager.getConnection(url, user, password);
          Statement stmt = conn.createStatement();
          ResultSet rs =stmt.executeQuery("SELECT balance FROM accounts WHERE id="
                   + accountId);
          try {
             if (rs.next())
                balance = rs.getFloat("balance");
             rs.close(); stmt.close();
           } catch (Exception e) {
             e.printStackTrace();
           }
          ...
    }
```

A simple example (4)

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class MyServlet extends HttpServlet {

    public void doGet(HttpServletRequest req, HttpServletResponse res)
          throws ServletException, IOException {
          ...

          res.setContentType(“text/html”);
          PrintWriter out = res.getWriter();

          out.println(“<HTML>”);
          out.println(“<HEAD> <TITLE> Account ” + accountId + “</TITLE></HEAD>”);
          out.println(“<BODY>”);
          out.println(“Current balance is ” + balance);
          out.println(“</BODY>”);
          out.println(“</HTML>”);
          out.close();
    }

}
```

J2EE features

- Java Servlet technology
- JavaServer Pages technology
- Enterprise JavaBeans technology
- Java Message Service
- Java Transaction
- JavaMail
- Java API for XML processing
- Java API for XML-based RPC
- Java DataBase Connectivity (JDBC)
- Java Naming and Discovery Interface (JNDI)
- Java authentication and authorization service

Other features of distributed Web applications

- Caching
- Prefetching
- Partitioning
- Replication
- Load balancing
- Cloud computing: toward on-demand remote and elastic applications

References

- Sun Microsystems. The J2EE Tutorial http://java.sun.com/j2ee/1.4/docs/tutorial/

Agenda

Lecture, Tuesday, 09:45 – 12:45	**Lab, Tuesday, 09:45 – 12:45**
Introduction to distributed systems	
	Distributed applications with RMI (Part I)
Distributed Web applications	
	Distributed applications with RMI (Part II)
Interruption week	
Event-based systems & MapReduce systems	
	Distributed Web applications with Servlets (Part I)
Cloud computing	
	Distributed Web applications with Servlets (Part II)
Advanced techniques for efficient distributed systems	
	Caching with Memcached
Event-based systems & MapReduce systems	
Interruption week	
Advanced techniques for dependable distributed systems	
	Evaluation