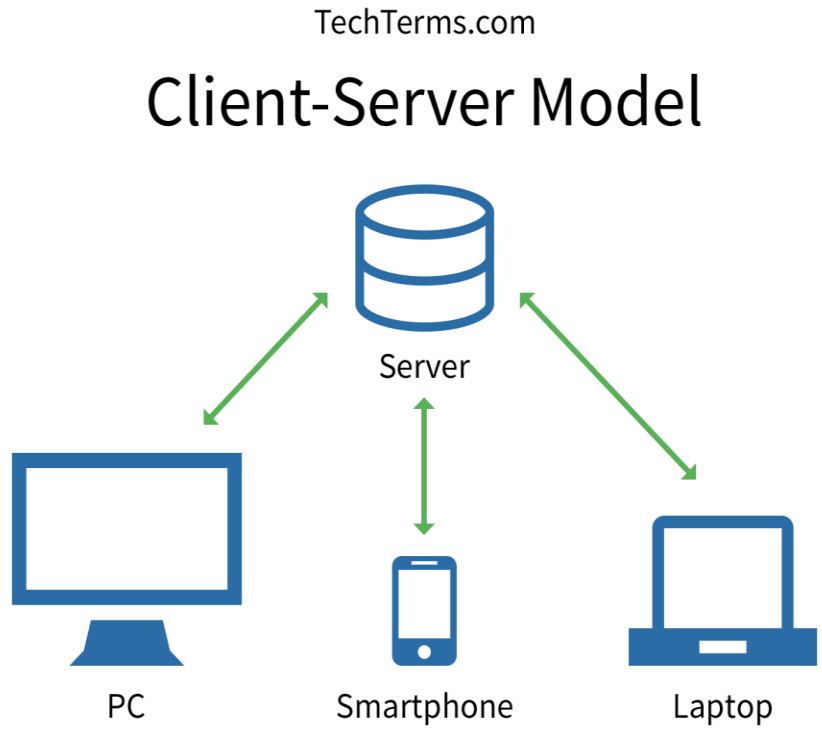
Objects in Client-Server applications

CSCI 2300

Client-Server applications



- Server accepts connections from client (socket)
- Client creates a connection to server (socket)
- Client sends data to the server via the socket
- Server receives data from client via the socket
- Can send “objects” as data

Sockets in Java

- `java.net.Socket` – socket class in Java
- Create a socket connection to server:
  - `Socket socket = new Socket(HostIP, HostPort);`
  - Server must be running on the “HostIP”
  - Server must be listening for connections on HostPort
- Write to a socket:
  - Use OutputStream object of the socket `socket.getOutputStream()`

So what do we “write” to the socket

- Custom message format
- Serializable object
- Object stored in commonly accepted format:
  - XML
  - JSON

Example: Pass a “TextMessage” object from Client to Server: client_server/proprietary/

- Client and Server have an identical serializable “`TextMessage`” class
- Client
  - instantiates a `TextMessage` object and fills it with details
  - Client connects to the server via a Socket
    - `Socket socketToServer = new Socket(hostIP, hostPort);`
  - Client sends the TextMessage object to the server
    - `ObjectOutputStream streamToServer;`
      `// initialize streamToServer`
      `streamToServer.writeObject(textMessage);`

What allows us to pass textMessage to the writeObject() method:

```
streamToServer.writeObject(textMessage);
```

A. `toString()` method of `TextMessage`
B. `Serializable` interface that `TextMessage` implements
C. The constructor of `TextMessage`
D. The `getMessage()` method of `TextMessage`
E. `textMessage` cannot be passed to `writeObject()`

Server can be running on the same machine as Client

- If Server is on the same machine as client, connect to ‘localhost’ network interface: 127.0.0.1
- Useful for testing
- Create a server socket:
  - `ServerSocket serverSocket = new ServerSocket(port);`
  - Creates a server socket that can listen on all network interfaces of the server, using the given port number
- Server has to listen on a given interface and port
  - `Socket incoming = serverSocket.accept();`
  - Waits for client connections on `serverSocket`

Example: client_server/proprietary

- `TextMessage` implements `Serializable`
- Client
  - instantiates a `TextMessage` object
  - Sets the message
  - Sends the message to the server
- Server
  - Creates a server socket
  - Listens for client connections on the server socket
  - Reads the `TextMessage` object from the client

What if Client and Server ran on different machines. What would happen if the TextMessage class changed on the client machine and not on the server machine?

A. This example would continue to work fine
B. Client would not be able to send TextMessage
C. Server would not be able to interpret received TextMessage
D. Code on the client machine would not compile

Let’s try it

- Added ‘`String timeStamp`‘ to client
- Kept old version of `TextMessage` on server

Run the example

- But what if we have to make a change and we have several servers and clients?
- In practice, you can’t upgrade all clients and servers simultaneously
- We don’t want to break compatibility
- Proprietary format is not the best option in this case

JSON – Commonly used format

- JavaScript Object Notation
- Used to format data
- Commonly used in Web as a vehicle to describe data being sent between systems

JSON example

- “JSON” stands for “JavaScript Object Notation”
  - Despite the name, JSON is a (mostly) language-independent way of specifying objects as name-value pairs
- Example
  - ```
    {“TextMessage”: {
        “name”: “Kate”,
        “message”: “Hello”
    }}
    ```
    ```

JSON syntax

- An *object* is an unordered set of name/value pairs
  - The pairs are enclosed within braces, { }
  - There is a colon between the name and the value
  - Pairs are separated by commas
  - Example: { "name": “Kate", “message": “Hello” }
- An *array* is an ordered collection of values
  - The values are enclosed within brackets, [ ]
  - Values are separated by commas
  - Example: ["html", ”xml", "css"]

JSON syntax

- A *value* can be: A string, a number, true, false, null, an object, or an array
  - Values can be nested
- *Strings* are enclosed in double quotes, and can contain the usual assortment of escaped characters
- *Numbers* have the usual C/C++/Java syntax, including exponential (E) notation
  - All numbers are decimal--no octal or hexadecimal
- *Whitespace* can be used between any pair of tokens

Mapping between JSON and Java entities

JSON	Java
string	java.lang.String
number	java.lang.Number
true|false	java.lang.Boolean
null	null
array	java.util.List
object	java.util.Map

JSON reading in Java example

- http://www.tutorialspoint.com/json/json_java_example.htm

Client Server example using JSON format: client_server/json/

- Additional classes from javax.json package
  - JsonObject
  - JsonObjectBuilder
  - JsonWriter
  - JsonReader
- Convert TextMessage to JsonObject:
  - TextMessage: `toJson()`
- Send JsonObject from client to server:
  - Client: `sendTextMessage()`
- Re-build TextMessage from JsonObject:
  - Server: `readTextMessage()`
  - TextMessage: constructor with `JsonObject` parameter

Uses javax.json-1.1.4.jar

- Modify CLASSPATH from client_server directoryy
  source configure.sh
- cd json
- javac –cp $CLASSPATH *.java
- java –cp $CLASSPATH Server
- java –cp $CLASSPATH Client

Image Client and Server ran on different machines. What would happen if we added a class variable to the TextMessage class on the client machine and not on the server machine?

A. This example would still work, the Server would read TextMessage in the old format.
B. Client would not be able to send TextMessage
C. Server would not be able to interpret received TextMessage
D. Code on the client machine would not compile

Let’s try it

- Added ‘String timeStamp‘ to client
- Kept old version of TextMessage on server

Run the example

- As long as we didn’t remove any fields from TextMessage, we can upgrade all client machines and then upgrade the server
- Can we upgrade the server first?

A. Yes B. No