3-Tier Web Architectures

Ramakrishnan & Gehrke, Chapter 7

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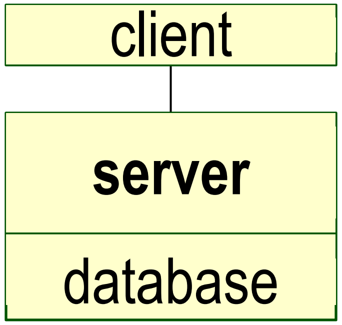
…

Components of Data-Intensive Systems

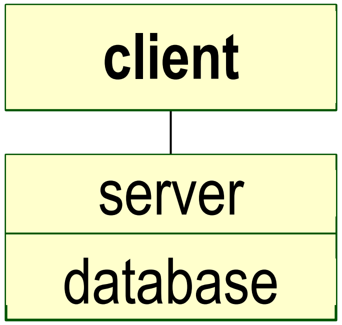
- Presentation
  - Primary interface to the user
  - Needs to adapt to different display devices (PC, PDA, cell phone, voice access, …)
- Application (“business”) logic
  - Implements business logic (implements complex actions, maintains state between different steps of a workflow)
  - Accesses different data management systems
- Data management
  - One or more standard database management systems
- system architecture determines whether these three components reside on a single system (“tier) or are distributed across several tiers

Client-Server Work Division

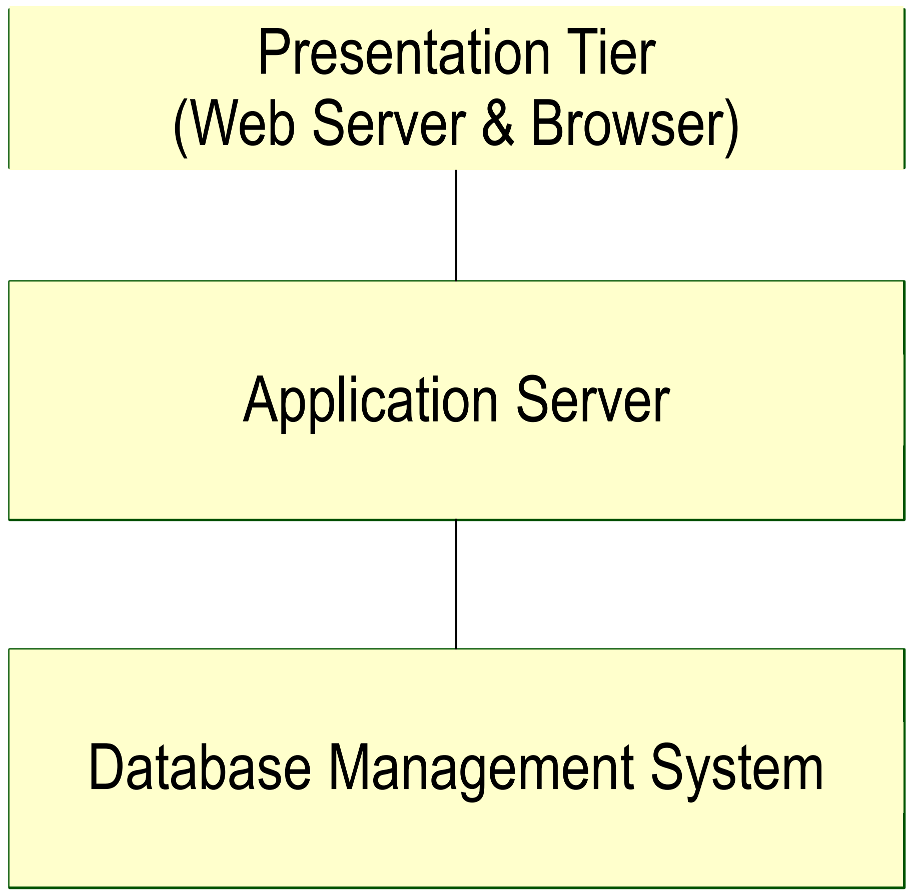
- Thin client
  - Client implements only GUI
  - Server implements business logic and data management



- Thick client
  - Client implements GUI & business logic
  - Server implements data management



Technologies



HTML, CSS, Javascript
Ajax
Cookies

JSP, Servlets, CGI, …

Tables, XML, JSON, …
Stored Procedures

The Presentation Tier

- Recall: Functionality of the presentation tier
  - Primary interface to the user
  - Needs to adapt to different display devices (PC, PDA, cell phone, voice access?)
  - For efficiency, simple functionality (ex: input validity checking)
- Mechanisms:
  - HTML Forms
  - Dynamic HTML / JavaScript
  - CSS

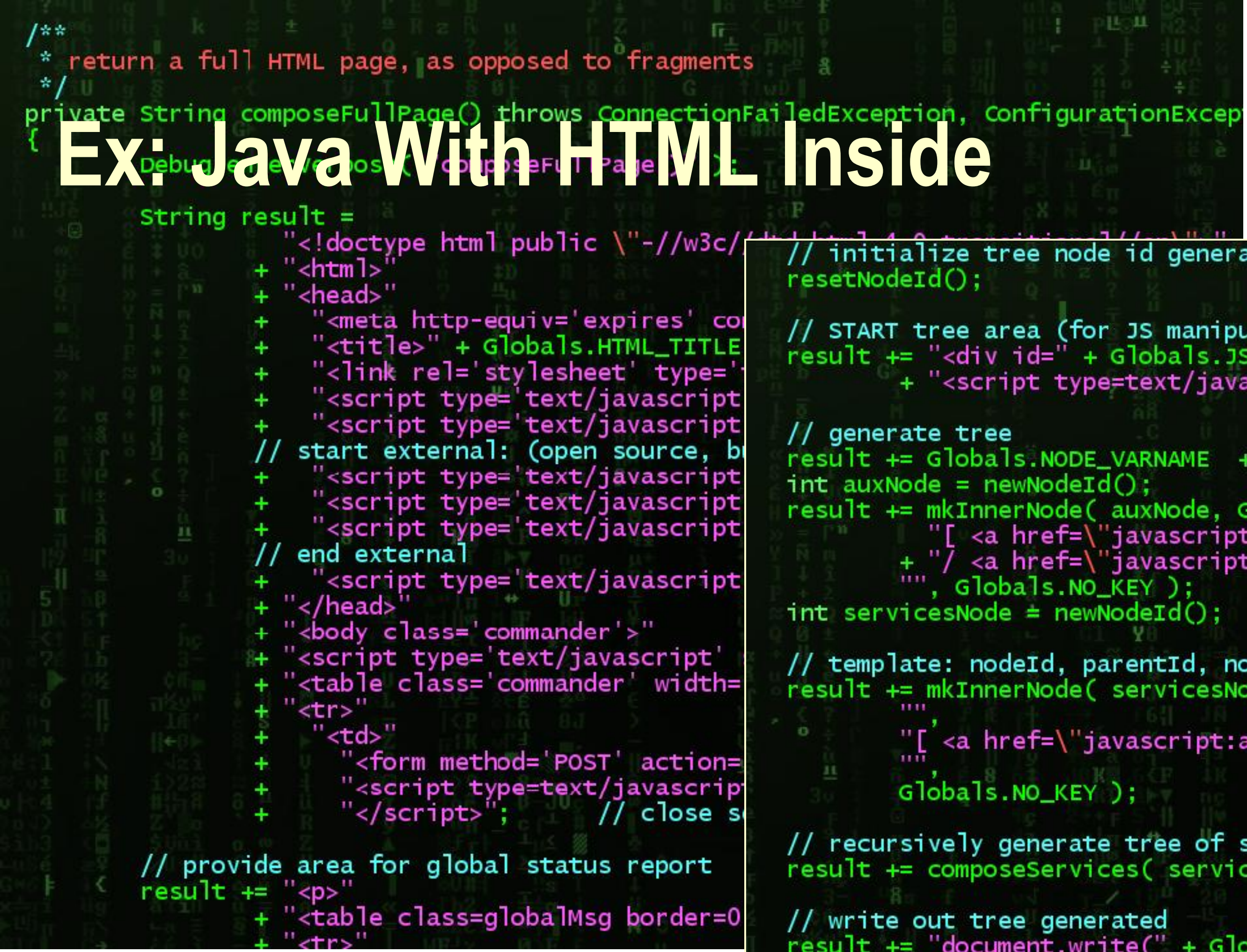
JavaScript

- Goal: Add functionality to the presentation tier
- Sample applications:
  - Detect browser type and load browser-specific page
  - Browser control: Open new windows, close existing windows (example: pop-ups)
  - Client-side interaction (conditional forms elements, validation, …)
- JavaScript optimal for Web browser because:
  - Built-in engine – always available, fast
  - Operates directly on “browser brain” = DOM

The Middle (Application) Tier

- Recall: Functionality of the middle tier
  - Encodes business logic
  - Connects to database system(s)
  - Accepts form input from the presentation tier
  - Generates output for the presentation tier
- Mechanisms:
  - CGI: Protocol for passing arguments to programs running at the middle tier
  - Application servers: Runtime environment at the middle tier
  - Servlets: Java programs at the middle tier
  - PHP: Program parts in schematic documents (see earlier)
  - How to maintain state at the middle tier

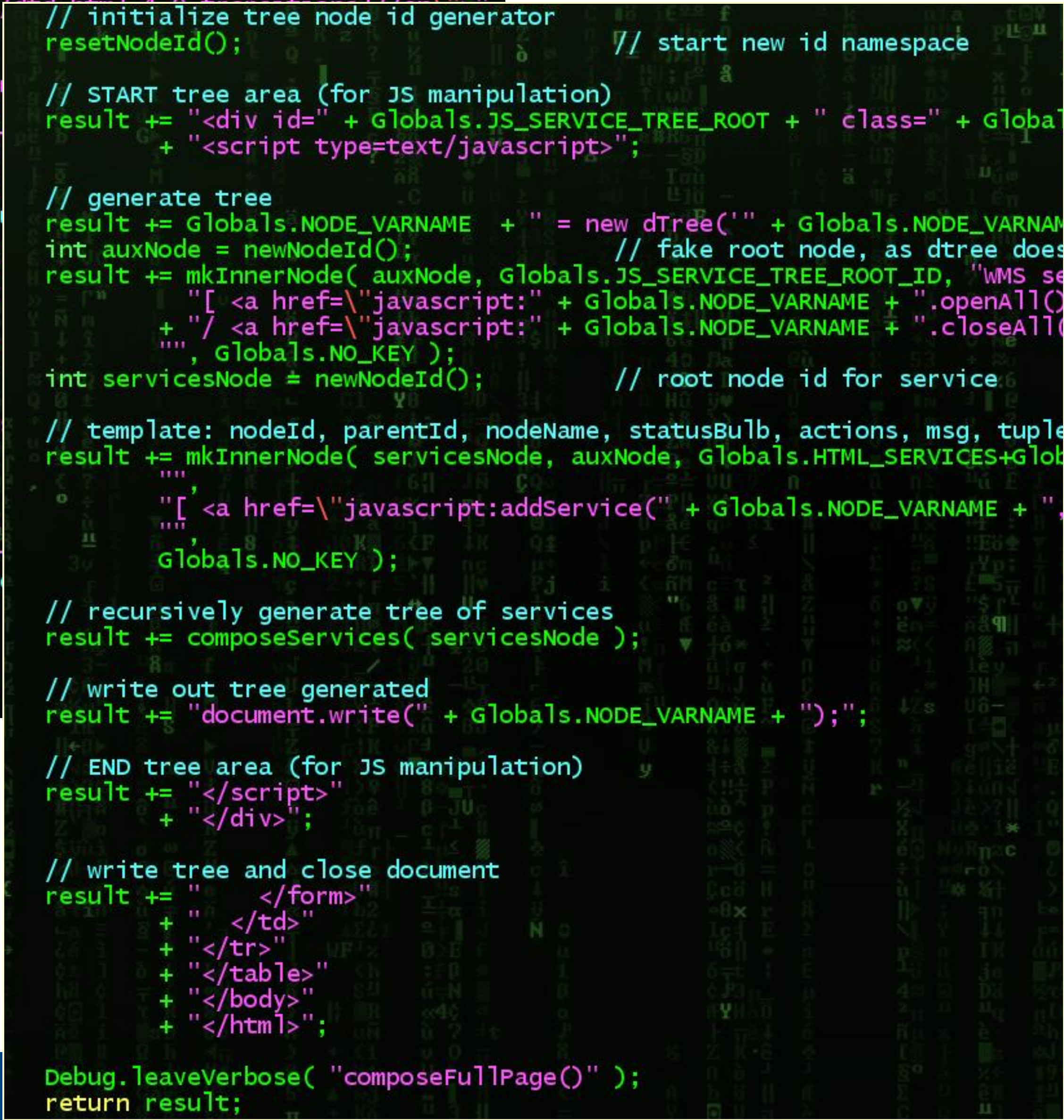
Ex: Java With HTML Inside



```
/**
 * return a full HTML page, as opposed to fragments
 */
private String composeFullPage() throws ConnectionFailedException, ConfigurationExcep
{
    Debug.enterVerbose( "composeFullPage()" );

    String result =
                "<!doctype html public \"-//w3c//dtd html 4.0 transitional//en\" "
              + "<html>"
              + "<head>"
              +   "<meta http-equiv='expires' co
              +   "<title>" + Globals.HTML_TITLE
              +   "<link rel='stylesheet' type='
              +   "<script type='text/javascript
              +   "<script type='text/javascript
              // start external: (open source, bu
              +   "<script type='text/javascript
              +   "<script type='text/javascript
              +   "<script type='text/javascript
              // end external
              +   "<script type='text/javascript
              + "</head>"
              + "<body class='commander'>"
              + "<script type='text/javascript'
              + "<table class='commander' width=
              + "<tr>"
              +   "<td>"
              +     "<form method='POST' action=
              +     "<script type=text/javascrip
              +     "</script>";       // close s

    // provide area for global status report
    result += "<p>"
              + "<table class=globalMsg border=0
              + "<tr>"
```



```
// initialize tree node id generator
resetNodeId();                               // start new id namespace

// START tree area (for JS manipulation)
result += "<div id=" + Globals.JS_SERVICE_TREE_ROOT + " class=" + Global
        + "<script type=text/javascript>";

// generate tree
result += Globals.NODE_VARNAME  + " = new dTree('" + Globals.NODE_VARNAM
int auxNode = newNodeId();                   // fake root node, as dtree does
result += mkInnerNode( auxNode, Globals.JS_SERVICE_TREE_ROOT_ID, "WMS se
          "[ <a href=\"javascript:" + Globals.NODE_VARNAME + ".openAll()
        + "/ <a href=\"javascript:" + Globals.NODE_VARNAME + ".closeAll(
        "", Globals.NO_KEY );
int servicesNode = newNodeId();              // root node id for service

// template: nodeId, parentId, nodeName, statusBulb, actions, msg, tuple
result += mkInnerNode( servicesNode, auxNode, Globals.HTML_SERVICES+Glob
        "",
        "[ <a href=\"javascript:addService(" + Globals.NODE_VARNAME + ",
        "",
        Globals.NO_KEY );

// recursively generate tree of services
result += composeServices( servicesNode );

// write out tree generated
result += "document.write(" + Globals.NODE_VARNAME + ");";

// END tree area (for JS manipulation)
result += "</script>"
        + "</div>";

// write tree and close document
result += "     </form>"
        + "   </td>"
        + "</tr>"
        + "</table>"
        + "</body>"
        + "</html>";

Debug.leaveVerbose( "composeFullPage()" );
return result;
```

Where to Keep Application State?

- Client-side state
  - Information is stored on the client’s computer in the form of a cookie
- Hidden state
  - Information is hidden within dynamically created web pages
- Server-side state
  - Information is stored in a database, or in the application layer’s local memory

Server-Side State

- Various types of server-side state, such as:
- 1. Store information in a database
  - Data will be safe in the database
  - BUT: requires a database access to query or update the information
- 2. Use application layer's local memory
  - Can map the user's IP address to some state
  - BUT: this information is volatile and takes up lots of server main memory

Client-side State: Cookies

- Cookie = (Name, Value) pair
- Text stored on client, passed to the application with every HTTP request
  - Lifetime can be preset (eg, 1 hour)
  - Can be disabled by client
  - wrongfully perceived as "dangerous", therefore will scare away potential site visitors if asked to enable cookies
- Advantages
  - Easy to use in Java Servlets / PHP
  - simple way to persist non-essential data on client even when browser has closed
- Disadvantages
  - Limit of 4 kilobytes
  - Users can (and often will) disable them
- Usage: store interactive state
  - current user’s login information
  - current shopping basket
  - Any non-permanent choices user has made

Hidden State

- overcome cookie disabling
- Can “hide” data in two places:
  - Hidden fields within a form
  - path information
- Requires no client or server “storage” of information
  - state information passed inside of each web page – “on the wire”

Hidden State: Hidden Fields

- Declare hidden fields within a form:

```
<form method='GET' action='http://.../input.php'>
   <input type='hidden' name='basketid' value='PJyACJt4eYmWrcp'/>
   <input name='wordKey' type='text'>
   <input type='submit' value='Go'>
</form>
```

- Advantages
  - Users will not see information (unless they view HTML source!)
- Disadvantages
  - If used prolifically, it's a performance killer
  - Works only in presence of forms

Hidden State: KVP Information

- Information stored in URL GET request:
  - http://server.com/index.htm?user=jeffd
  - http://server.com/index.htm?user=jeffd&preference=pepsi
- Parsing field in Java:
  - javax.servlet.http.HttpUtils.parserQueryString()
- Advantages
  - Independent from forms
- Disadvantages
  - Limited to URL size (some kB)

Multiple state methods

- Typically all methods of state maintenance are used:
  - User logs in and this information is stored in a cookie
  - User issues a query which is stored in the URL information
  - User places an item in a shopping basket cookie
  - User purchases items and credit-card information is stored/retrieved from a database
  - User leaves a click-stream which is kept in a log on the web server (which can later be analyzed)

Some Web Service Security Hints

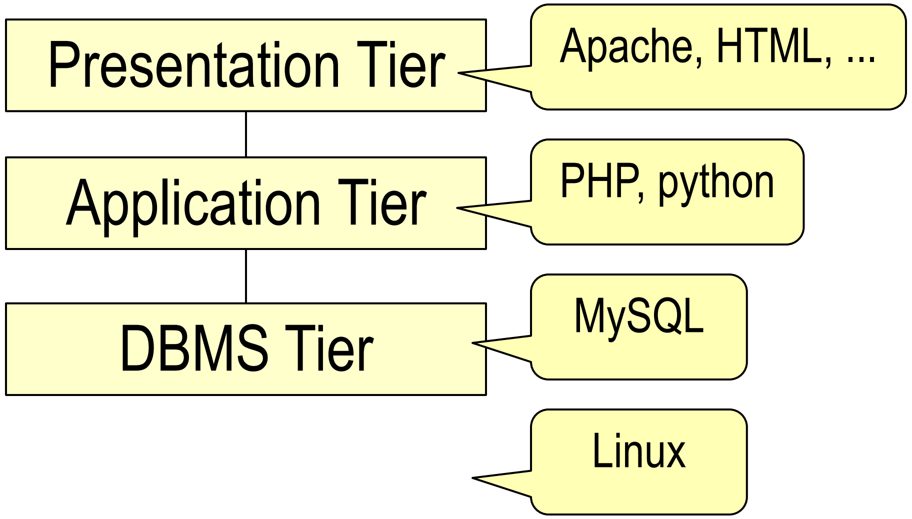
- Never use anything blindly that comes from client side
  - don't assume that JavaScript code has been executed
  - double check cookies on server
  - don't trust hidden fields contents
- never assume anything!
  - set defaults (define in a central place!)
- Clear state after request response
- as with any API: clean, defensive programming
  - perform standard plausi checks:
    admissible number ranges, empty strings, max string lengths!
- *Be paranoid !!!*

Summary: 3-Tier Architectures

- Web services commonly architected as having 3 components
  - Presentation / application / data management tier
- Application tier needs most implementation flexibility
  - Rich choice of platforms (Java servlets, PHP, ...), each with tool support
- To maintain state, use:
  - Hidden form fields, hidden paths, cookies, server store, …
- *For every aspect & component, security is an issue!*

DBWS Relevance

- In the project: LAMP stack
  - Linux, Apache, MySQL, PHP/Python



- Alternatives:
  - MERN stack:
    - *MongoDB: A document database*
    - *Express: web framework for Node.js*
    - *React: JavaScript front-end library*
    - *Node.js: JavaScript runtime bringing JavaScript to the server*
  - MEAN stack
    - *MongoDB, Express.js, AngularJS, Node.js*