

# Node.js

## Embedded web server

# Topics

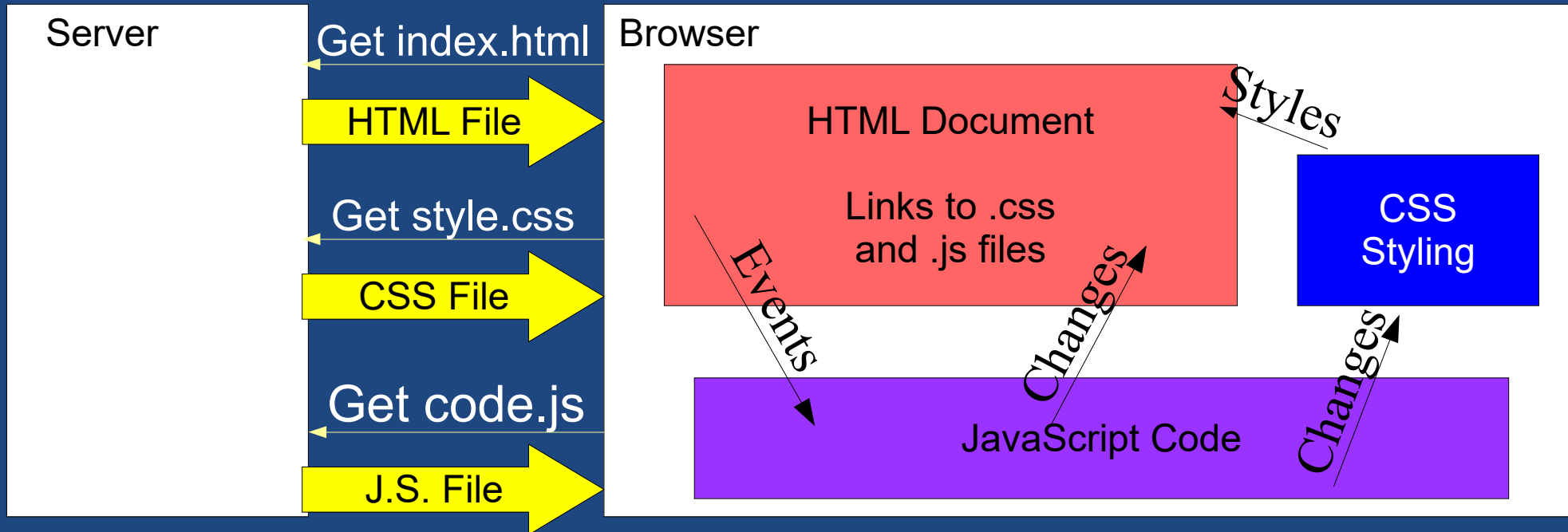
- 1) How to build a static web pages: `.html`, `.css`, `.js`?
- 2) How to `serve` static pages with `Node.js`?
- 3) How to create `dynamic content` via `WebSocket`?
- 4) How to connect `Node.js` to `C` program?

# Static Client Pages

## HTML, CSS, and JavaScript

# Static Client Content

- **Static content** is stored in files on a server and sent to the client on demand.
  - File content does not dynamically change.



Click Me!

### XHTML: index.html

```
<html>
<head>
  <title>DOM Basics</title>
  <link rel="stylesheet" href="style.css"
        type="text/css"/>
</head>

<body>
  <h1>DOM Basics</h1>
  <div id="daBox" onclick="yaClickedBox()">
    Click Me!
  </div>
  <script type="text/javascript" src="code.js">
  </script>
</body>
</html>
```

### CSS: style.css

```
#daBox {
  border: thin black solid;
  background-color: yellow;
  margin: 10px;
  padding: 5px;
  float: left;
  width: 100px;
  text-align: center;
}
```

### JavaScript: code.js

```
function yaClickedBox() {
  // Your Code Here...
}
```

# JavaScript Basics

- **JavaScript:**
  - case sensitive, dynamically typed
  - ; at end of statements optional
- **String:** "Hello World" same as 'Hello World'
- **Variables**
  - `var str = "123";`  
`var x = str.length;`  
`var y = Number(str);` // Convert string to number  
`str = 5;` // Change type
  - Can create a variable without declaration:  
`terribleIdea = 43;` // Why bad?

Make this illegal by placing this at top of file:  
`"use strict";` // quotes included!

# DOM

- Client-side JavaScript runs in the browser
  - i.e., It's runtime environment is the browser.
  - Can interact with HTML and CSS that make up the currently loaded web page (“document”).
  - Called the..
  - `function` `changeBox()` {  
    // Change HTML code “inside” the the div “box”:  
    `$('#daBox').html("Hello World");`  
}



# jQuery

- **jQuery**
  - A client-side JavaScript library to simplify interacting with the browser (DOM).
- **Use in JavaScript:**
  - `$('#myStuff')`: gets the..
    - In HTML: `<div id="myStuff">.....</div>`
    - In JavaScript (change contents):  
`$('#myStuff').html("Hello <em>world</em>!");`
  - `$('<div></div>')`: Create a new DOM `<div>` object.
    - **Example:** Add text to a new div:  
`var block = $('<div></div>').text('Hello world!');`



# Form Example

## DOM Basics

```
<body>
<form action="">
  <h1>DOM Basics</h1>
  <p>Name:
    <input type="text" id="nameId"/>
  </p>
  <p>
    <input type="button" id="changeBtn"
      value="Change Boxes"/>
  </p>
  <div id="box1">Box 1</div>

  <script
    src='http://code.jquery.com/jquery-1.11.1.min.js'
    type='text/javascript'></script>
  <script type="text/javascript"
    src="javascripts/code.js"></script>
</form>
</body>
</html>
```

**<form> wraps all input elements.**

**Text entry box**

**Clickable button.**

**jQuery library**

**Our code**

Name:

"use strict";

Run when page is fully loaded.

```
$(document).ready(function() {
  $('#changeBtn').click(function() {
    changeBoxStyles();
  });
});

function changeBoxStyles() {
  // Change HTML making up the div:
  var name = $('#nameId').val();

  $('#box1').html("Hello <em>"
    + name + "</em>!");
}
```

**Read contents of "name" input box.**

**Write HTML code into the div.**

# JQuery to Change Webpage

```
function changeBoxStyles() {  
  
    console.log("Changing box styles.");  
  
    var name = $('#nameId').val();  
    $('#box1').html("Hello <em>" + name + "</em>!");  
  
    $('#box2').html(  
        '<h3>An Idea!</h3>'+  
        '<p></p>' +  
        '<p>That\'s it!</p>');  
  
    $('#box3').css({"border": "5px yellow",  
                    "color": "red",  
                    "backgroundColor": "green"});  
  
    $('#box4').hide();  
  
}
```

Display browser console message

Read input field's text and use it.

Create complex html code from inside JavaScript code.

Style an element using CSS rules/properties

Hide the div (great for error displays)

# Client-Side Timers

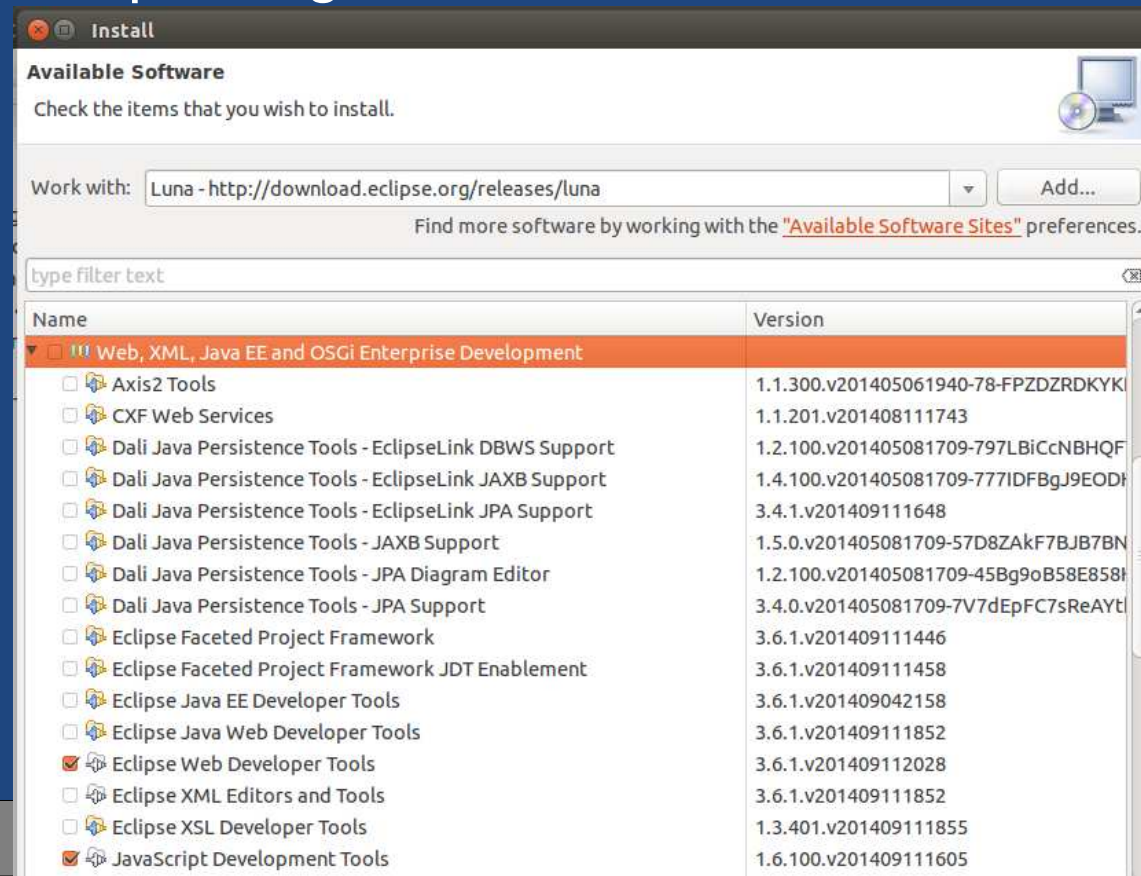
```
$(document).ready(function() {  
    window.setInterval(function() {updateTime()}, 1000);  
});
```

```
function updateTime() {  
    var now = new Date();  
    var timeStr = now.getHours() + ':'  
                 + now.getMinutes() + ':'  
                 + now.getSeconds();  
    $('#box3').html("Its now<br/>" + timeStr);  
}
```

Call updateTime()  
every 1000ms (1sec)

# Eclipse Setup

- Setup Eclipse to better handle .html, .css, .js files
  - Help --> Install New Software
  - Select update site for your version from drop-down, such as: “Mars – <http://download.eclipse.org/releases/mars>”
  - Under “Web, XML, Java EE...”
    - Eclipse Web Developer Tools
    - JavaScript Development Tools



# Debugging Tools

- **Browsers try to always make things work.**
  - They usually quietly do their best to hide errors.
  - View error messages with the console (Firefox & Chrome F12)
  - Do this whenever your page is doing “funny” things.
- **Validate your HTML to ensure it's correct.**
  - Incorrect HTML can be rendered in unexpected ways.
  - <https://validator.w3.org/>

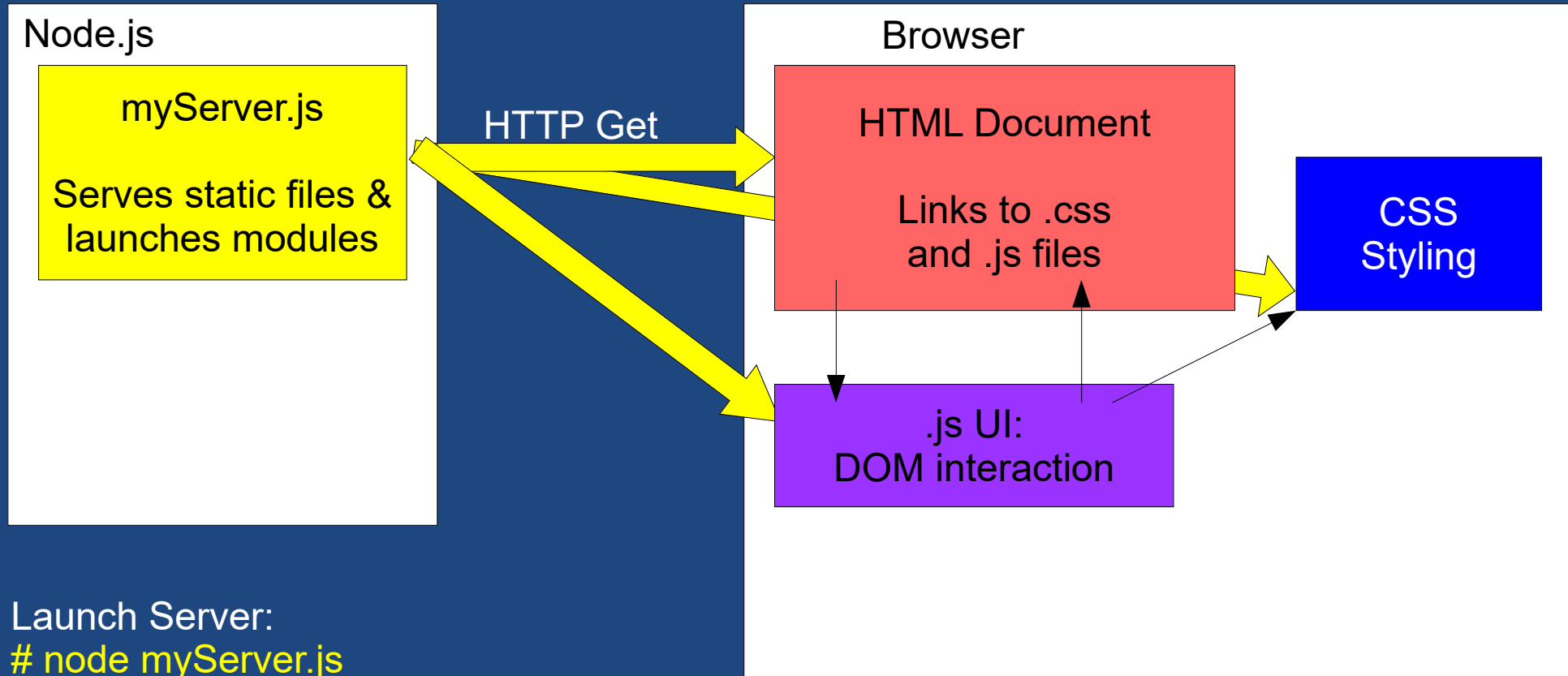
# Serving Static Content with Node.js

Node.js is a **platform** built on Chrome's **JavaScript** runtime for building network applications.

Node.js uses an **event-driven, non-blocking I/O model** that makes it lightweight and efficient.

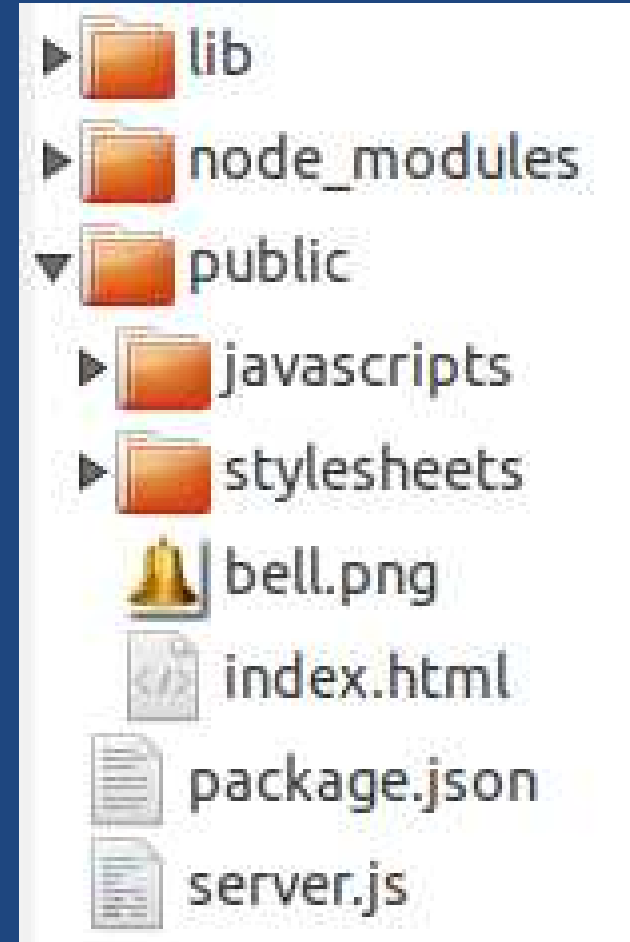
# Serving Static Files to Client

- Your Node.js server reads files from disk to send to client.



# Suggested Server File Structure

- **lib/**  
Server side J.S. (more later...)
- **node\_modules/**  
Modules installed by npm
- **public/**  
All client side static files
- **/**
  - **package.json**  
Configures server
  - **server.js**  
Server side starting logic.





# Node.js Server

- Setup a Node.js application with a **package.json** file:

```
{
  "name": "demo-static-server",
  "version": "0.0.1",
  "description": "Demo Node.js server.",
  "dependencies": {
    "mime": "~1.2.7"
  }
}
```

- **Install dependencies**  
# npm install
- **Run server**  
# node myServer.js

Both work on host and target.

No need to cross-compile /  
recompile because..

# myServer.js (1/3)

```
var http = require('http');
var server = http.createServer(function(request, response) {
  var filePath = false;
  if (request.url == '/') {
    filePath = 'public/index.html';
  } else {
    filePath = 'public' + request.url;
  }
  var absPath = './' + filePath;
  serveStatic(response, absPath);
});

var PORT = 3042;
server.listen(PORT, function() {
  console.log("Server listening on port " + PORT);
});
```

..

Callback function  
created at startup, but..

Think of the event that  
triggers the function vs where  
the function is in the code.

Prints message to  
the server's terminal.

# myServer.js (2/3)

```
var fs = require('fs');
function serveStatic(response, absPath) {
  fs.exists(absPath, function(exists) {
    if (exists) {
      fs.readFile(absPath, function(err, data) {
        if (err) {
          send404(response);
        } else {
          sendFile(response, absPath, data);
        }
      });
    } else {
      send404(response);
    }
  });
}
```

Node.js is an asynchronous  
(non-blocking i/o) webserver:

All calls that could block..

# myServer.js (3/3)

```
function send404(response) {  
  response.writeHead(404, {'Content-Type': 'text/plain'});  
  response.write('Error 404: resource not found.');
```

Setup HTTP return packet:  
Code (404)  
Type (text/plain)  
Content

```
  response.end();  
}
```

```
var mime = require('mime');
```

```
var path = require('path');
```

```
function sendFile(response, filePath, fileContents) {
```

```
  response.writeHead(  
    200,  
    {"content-type": mime.lookup(path.basename(filePath))}
```

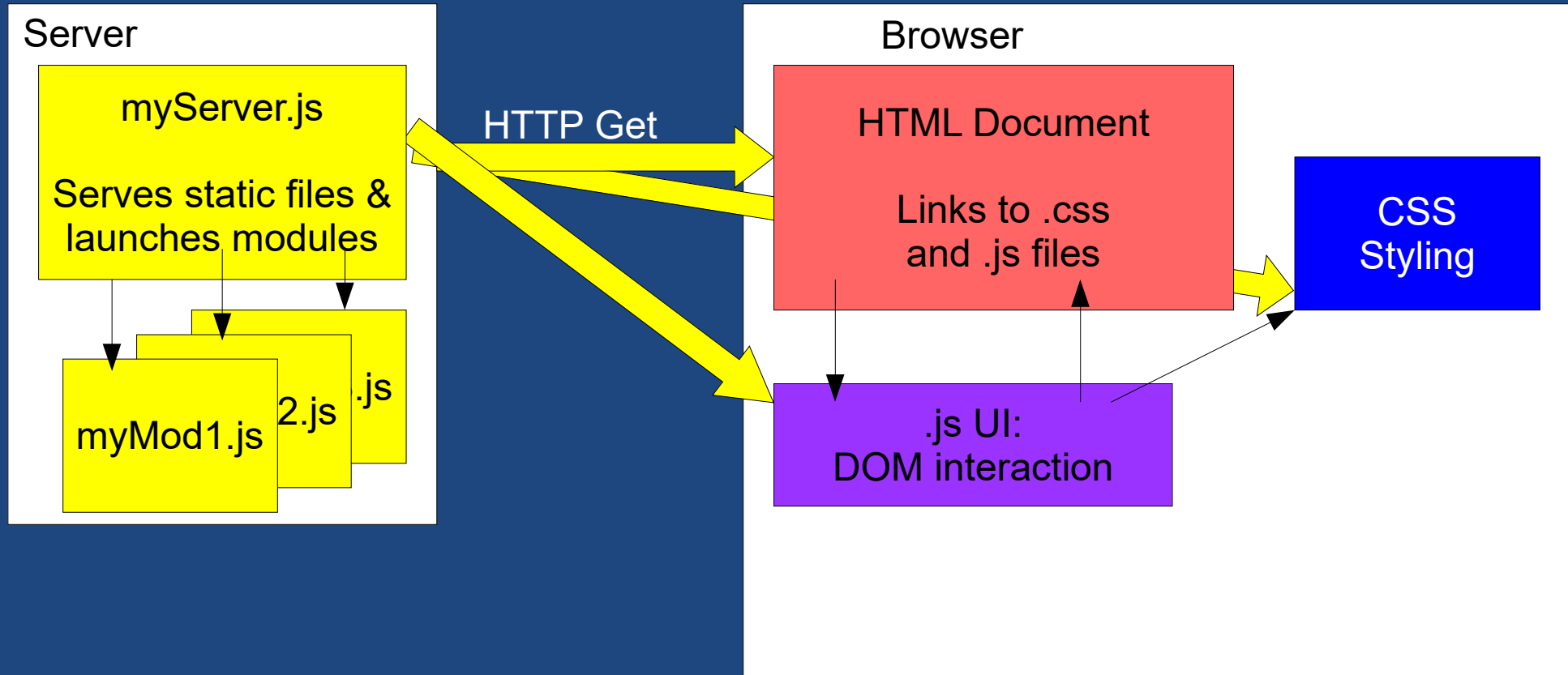
```
  );  
  response.end(fileContents);
```

mime module figures out  
content type from file name.

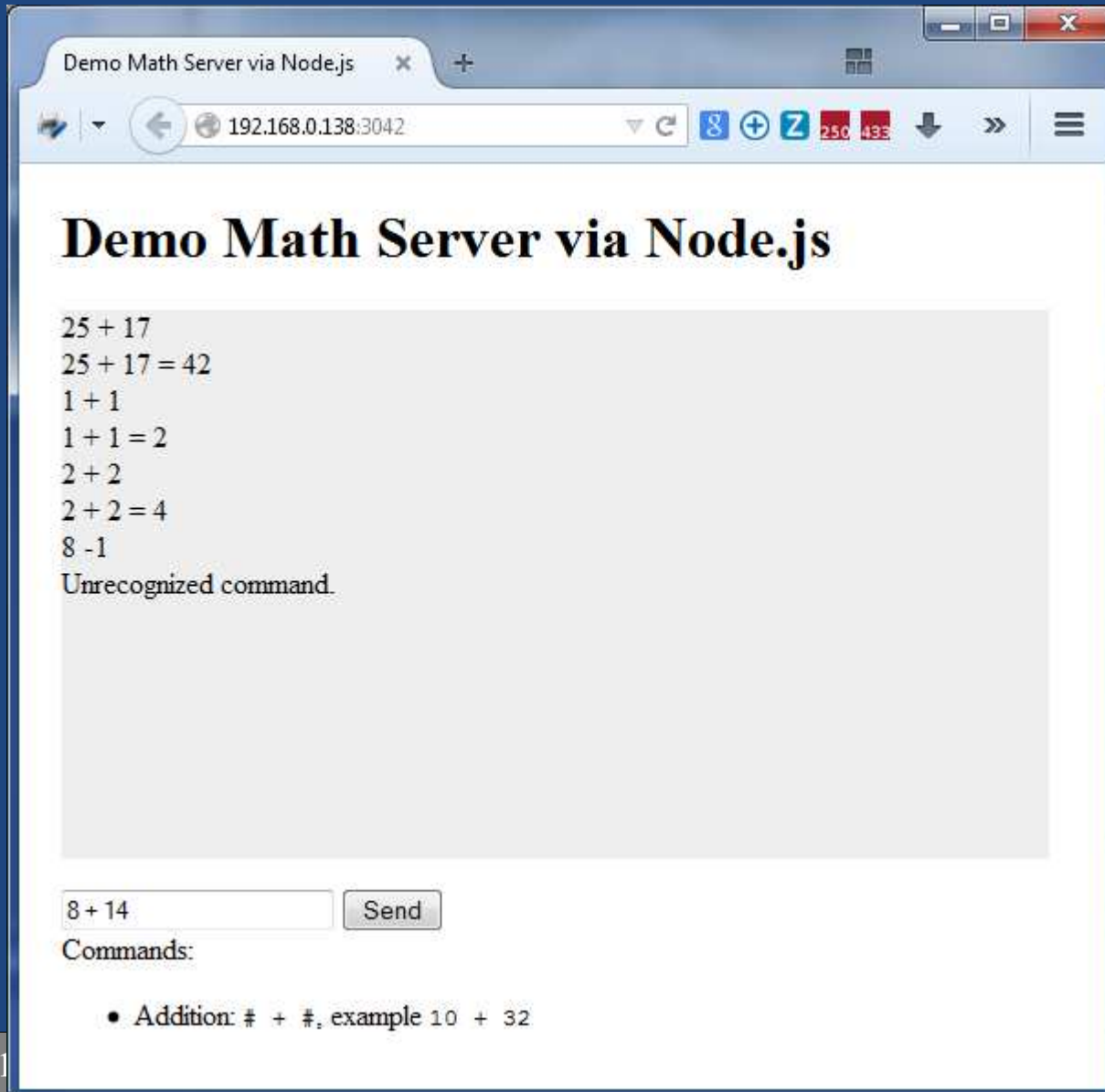
# Dynamic Server Example with Node.js

# Dynamic Client Content

- **WebSocket** used to dynamically exchange messages.

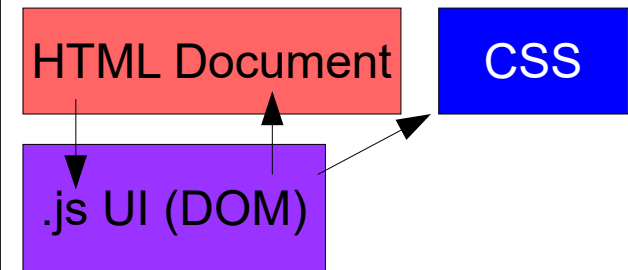


# Client: Webpage



The screenshot shows a web browser window titled "Demo Math Server via Node.js". The address bar displays the URL "192.168.0.138:3042". The main content area features the heading "Demo Math Server via Node.js" and a list of mathematical operations:  $25 + 17$ ,  $25 + 17 = 42$ ,  $1 + 1$ ,  $1 + 1 = 2$ ,  $2 + 2$ ,  $2 + 2 = 4$ , and  $8 - 1$ . Below these is the text "Unrecognized command." At the bottom, there is an input field containing "8 + 14" and a "Send" button. Underneath the input field, the text "Commands:" is followed by a bullet point: "• Addition: # + #, example 10 + 32".

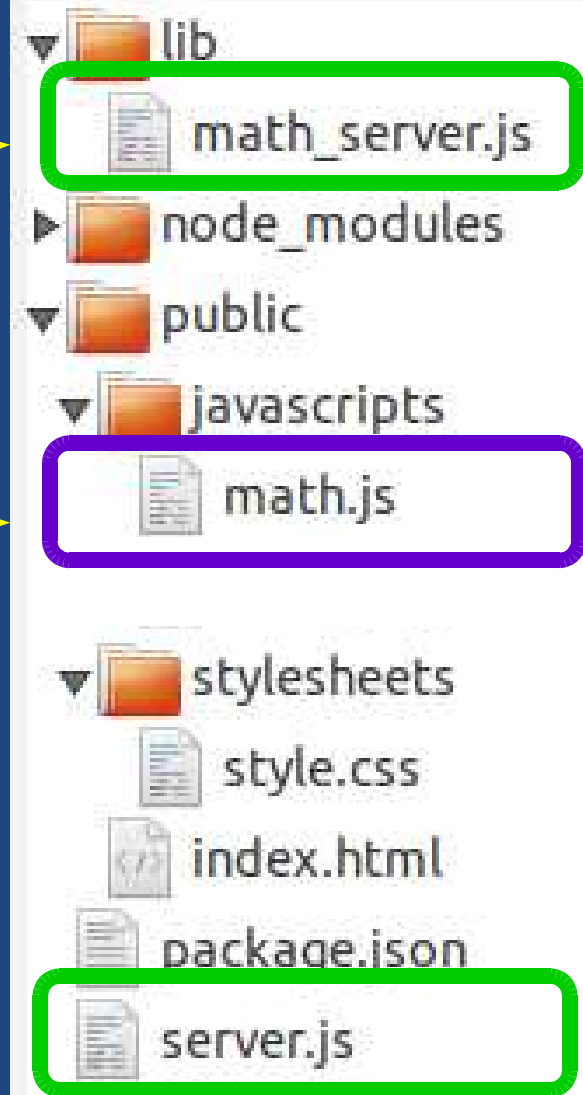
## Browser



# Suggested Server File Structure

Server Side  
Scripts

Client Side  
Script(s)





# Dynamic Server: Sequence of calls

Server

Client

Serve static files

Create WebSocket

`math_ui.js`:

1. HTML form's button pressed.
2. js UI: get's text & calls server

Async

`math_server.js`:

3. Rx data, does work.
4. Emits answer

"daAdd"

`.addend1 = ..`

`.addend2 = ..`

Async

"daAnswer"  
(String)

`math_ui.js`:

5. js UI: Rx answer and display in browser.

# Dynamic Server Example

## Server

server.js

```
// Create the Math server to listen for the websocket  
var mathServer = require('./lib/math_server');  
mathServer.listen(server);
```

Add to end of [server.js](#)  
File holds the static-content server, plus kicks-off our module

math\_server.js

```
var socketio = require('socket.io');  
var io;  
exports.listen = function(server) {  
  io = socketio.listen(server);  
  io.sockets.on('connection', function(socket) {  
    handleCommand(socket);  
  });  
};  
  
function handleCommand(socket) {  
  // ... more on next slide.  
};
```

Create custom module:  
[./lib/math\\_server.js](#)

# Dynamic Server cont. (math\_server.js)

```
function handleCommand(socket) {  
  socket.on('daAdd', function(data) {  
    var val1 = Number(data.addend1);  
    var val2 = Number(data.addend2);  
    console.log('Adding ' + val1 + ' + ' + val2);  
  
    var answer = doDaAddition(val1, val2);  
    var message = val1 + ' + ' + val2 + ' = ' + answer;  
  
    // Build and send reply.  
    socket.emit('daAnswer', message);  
  });  
};  
  
function doDaAddition(x, y) {  
  return x + y;  
}
```

Callback function for daAdd call.

Extract field from struct.

Send data over WebSocket

Server

server.js

math\_server.js

# Server Timers

- Server-side timers are great for error timeouts.
  - Create a new timer and set what to run if it expires.
  - Elsewhere, clear timer when no longer needed.

```
function handleCommand(socket) {
    var errorTimer = setTimeout(function() {
        socket.emit("daError",
                    "Oops: Too slow!");
    }, 5000);

    socket.on('daAdd', function(data) {
        // ... code omitted...

        // Stop the timer:
        clearTimeout(errorTimer);
    });
};
```

# Client: Webpage ID's

The screenshot shows a web browser window titled "Demo Math Server via Node.js" with the address bar displaying "192.168.0.138:3042". The page content includes a list of math problems and their solutions, followed by an input field and a "Send" button. Three yellow callouts point to specific elements: "#messages" points to the list of math problems, "#send-command" points to the input field, and "#send-button" points to the "Send" button.

**Demo Math Server via Node.js**

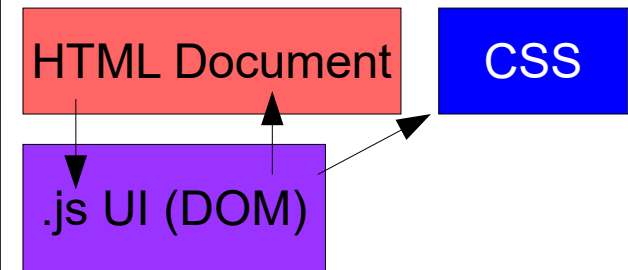
25 + 17  
25 + 17 = 42  
1 + 1  
1 + 1 = 2  
2 + 2  
2 + 2 = 4  
8 - 1  
Unrecognized command.

Send

Commands:

- Addition: # + #, example 10 + 32

## Browser



# Client UI: Integrate with DOM (1/2)

./public/javascripts/math\_ui.js

Execute function  
when page loaded

Callback for  
form's submit.

Create callback  
listening for  
"daAnswer" calls.

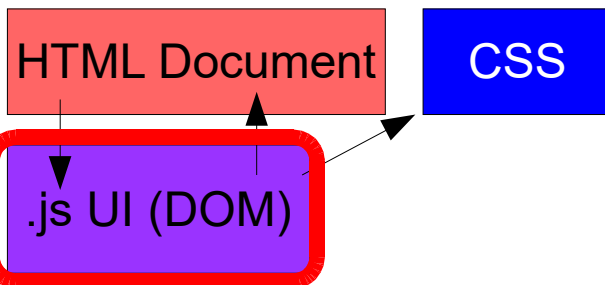
```
var socket = io.connect();
$(document).ready(function() {
    // Make the text-entry box have focus
    $('#send-command').focus();

    // Allow sending the form
    $('#send-form').submit(function() {
        readUserInput();

        // Return false to show we have handled it
        return false;
    });

    // Handle data coming in from the server
    socket.on('daAnswer', function(result) {
        $('#messages').append(divMessage(result));
    });
});
```

Browser

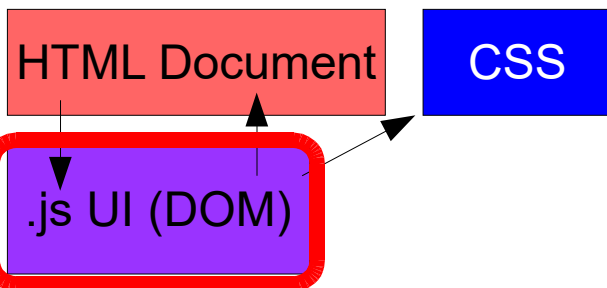


# Client UI: Integrate with DOM (2/2)

```
function readUserInput() {  
    // Get the user's input from the browser.  
    var message = $('#send-command').val();  
    // Display the command in the message list.  
    $('#messages').append(divMessage(message));  
    // Process the command  
    var errMsg = processCommand(message);  
    if (errMsg) {  
        $('#messages').append(divMessage(errMsg));  
    }  
    // Clear the user's command (ready for next command).  
    $('#send-command').val("");  
}
```

```
// Wrap a string in a new <div> tag  
function divMessage(inString) {  
    return $('<div></div>').text(inString);  
}
```

Browser



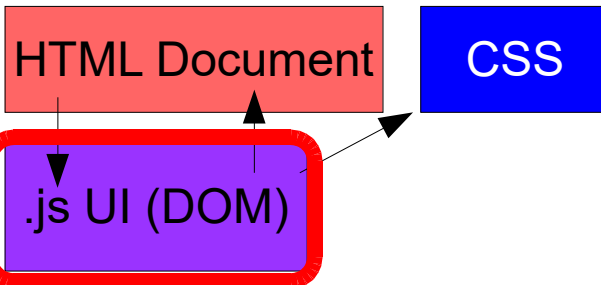
# Client UI: Interact with Server

```
function processCommand(command) {  
  var words = command.split(' ');  
  var operation = words[1];  
  var message = false;  
  
  switch(operation) {  
    case '+':  
      var request = {  
        addend1: Number(words[0]),  
        addend2: Number(words[2]);  
      };  
      socket.emit('daAdd', request);  
      break;  
    default:  
      message = 'Unrecognized command.'  
  }  
  return message;  
};
```

Dynamically create a structure type.

“Emit” the message to the server.  
Give it a “message” name of 'daAdd'

Browser





# Node.js to C App (UDP)

# Text in Webpage

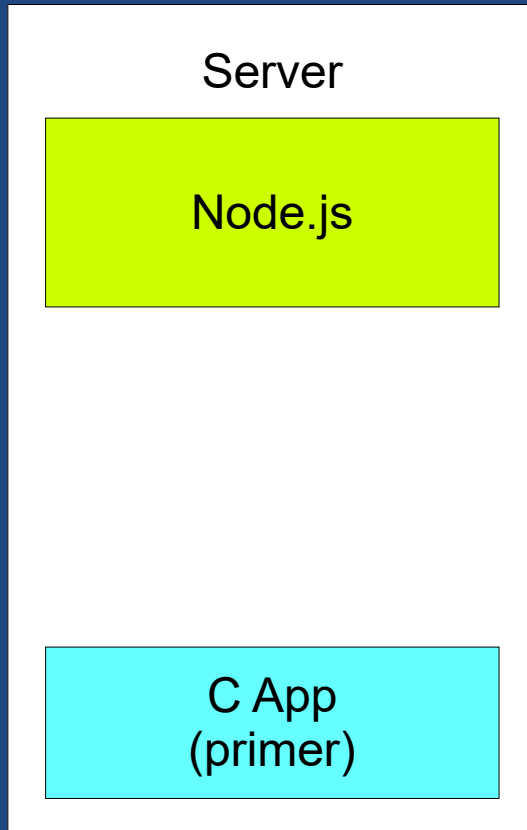
- JavaScript can insert text/content into the web page.
- **HTML**: Use `<div>` and `<span>`
  - For dynamic content..  
`<div id="daName"></div>`
  - For dynamic content..  
`<span id="daName"></span>`
- **JavaScript**
  - `$('#daName').html('My dynamic content');`

# Reading Files

- Node.js on the server reads files using “fs” module
  - Used in our “static” page server.
  - Can also be used for reading /proc files
- Details
  - File data comes back as a character array.  
Convert to a string:  
`var str = daFileContents.toString('utf8');`
  - Possible security problem:  
Allowing client to request a file: may have ../ in path.

# Node.js and C Sockets

- Use UDP socket for Node.js server to communicate with a local C/C++ application.



- **Sequence:**
  - 1) Browser sends request to server via websocket
  - 2) Node.js relays to C-app via UDP
  - 3) C-app replies with content to node.js via UDP
  - 4) Node.js relays content to browser via websocket

# FYI: HTTPS

- Use HTTPS for secure, non-sniffable communication
  1. Generate private key in base folder of project  
`$ openssl genrsa 1024 > key.pem`
  2. Generate public certificate (unsigned)  
`$ openssl req -x509 -new -key key.pem > key-cert.pem`
  3. Code changes from non-HTTPS:
    - a) `require('https')`
    - b) options struct for `private/public key`
    - c) pass options to `http.createServer`
  4. HTML: Use `https://` (vs `http://`) to link to jQuery:  
`<script src='https://code.jquery.com/jquery-1.8.0.min.js'  
type='text/javascript'></script>`

# Summary

- **Client Side:**
  - .html for **static page content**
  - .css for **look**
  - UI .js for **DOM interaction & WebSocket**
- **Server Side:**
  - Serve static pages
  - Module(s) for dynamic content via WebSocket
- **Node.js:** JavaScript based web-server platform.
  - `<div>` and `<span>` to insert text into web page.
  - “fs” module to read from **/proc/** files (or others).
  - **UDP socket** to access C/C++ application.

## Node.js Troubleshooting:

Error: No such file or directory  
at Function.resolveArgv0 (node.js:289:23)  
at startup (node.js:43:13)  
at node.js:448:3

Run the following on your BeagleBone in  
the server's folder:

```
sudo npm cache clean -f  
sudo npm install -g n
```