NodeJS

Background

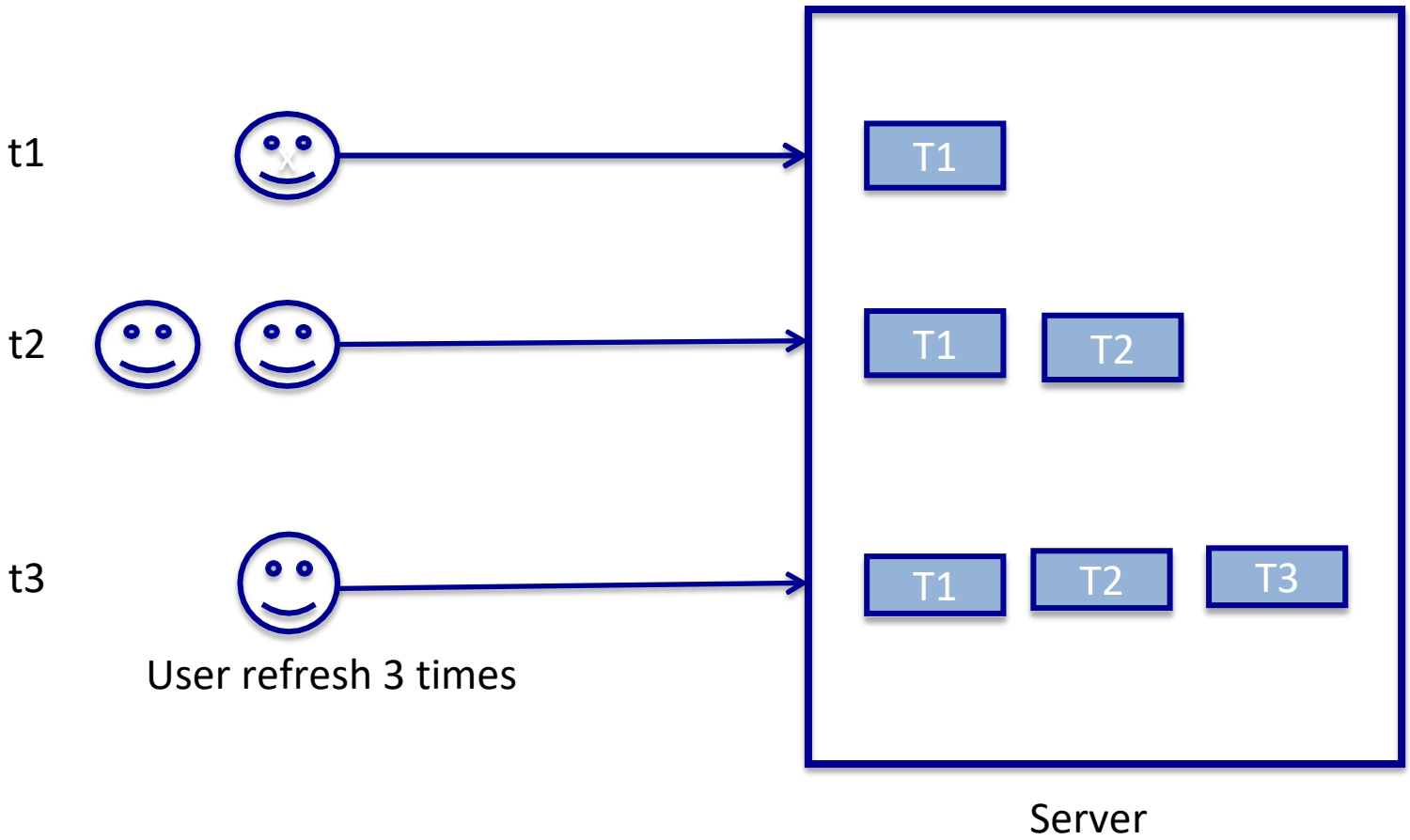
- Node.js runs on V8.
- V8 is an open source JavaScript engine developed by Google. Its written in C++ and is used in Google Chrome Browser.
- It was created by Ryan Dahl in 2009.
- Is Open Source. It runs well on Linux systems, can also run on Windows systems.
- Latest version: v4.0.0

Evolution of web

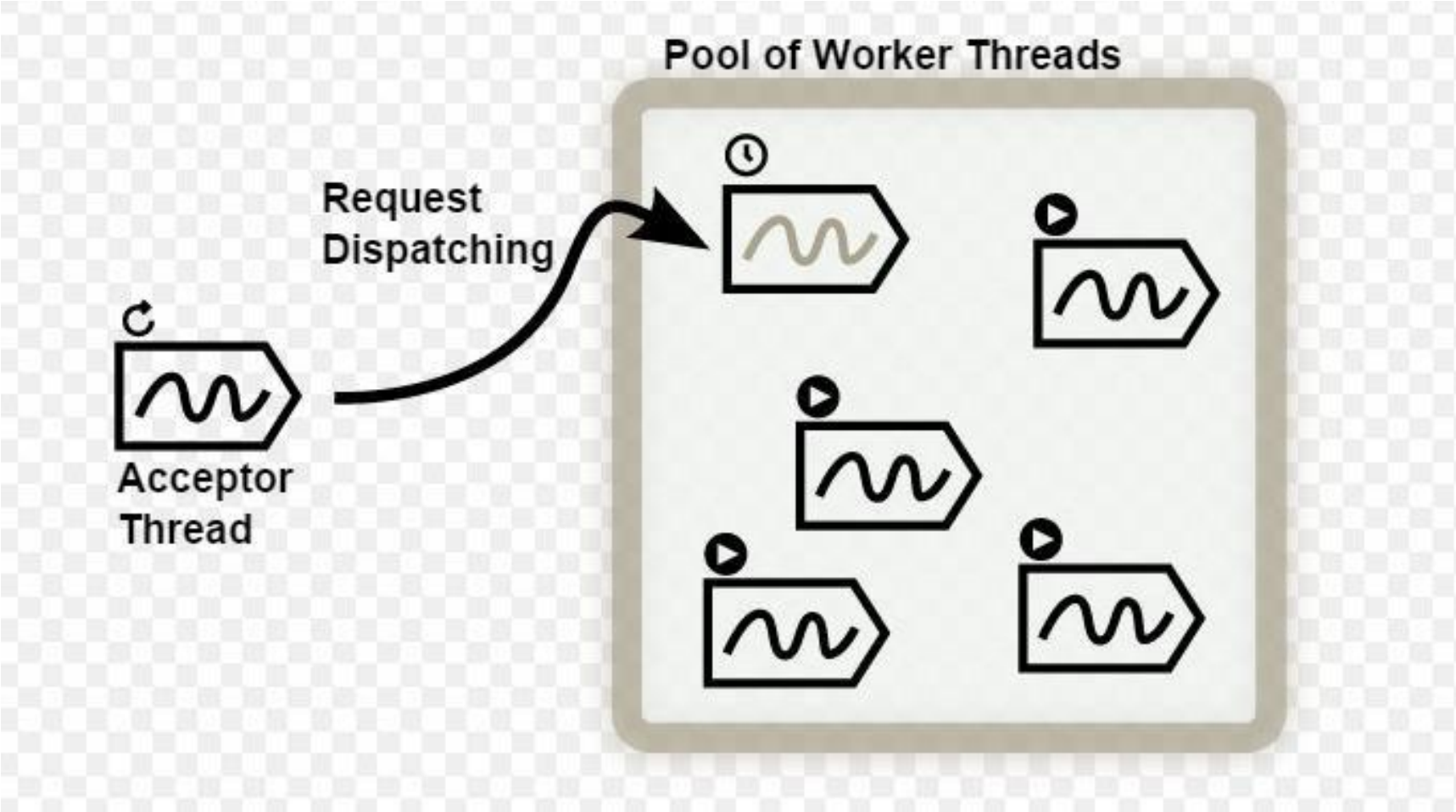
Web has evolved from

- Static websites (90’s)
- Dynamic web applications (AJAX) (early 2000’s)
- Real time web applications (Notifications)

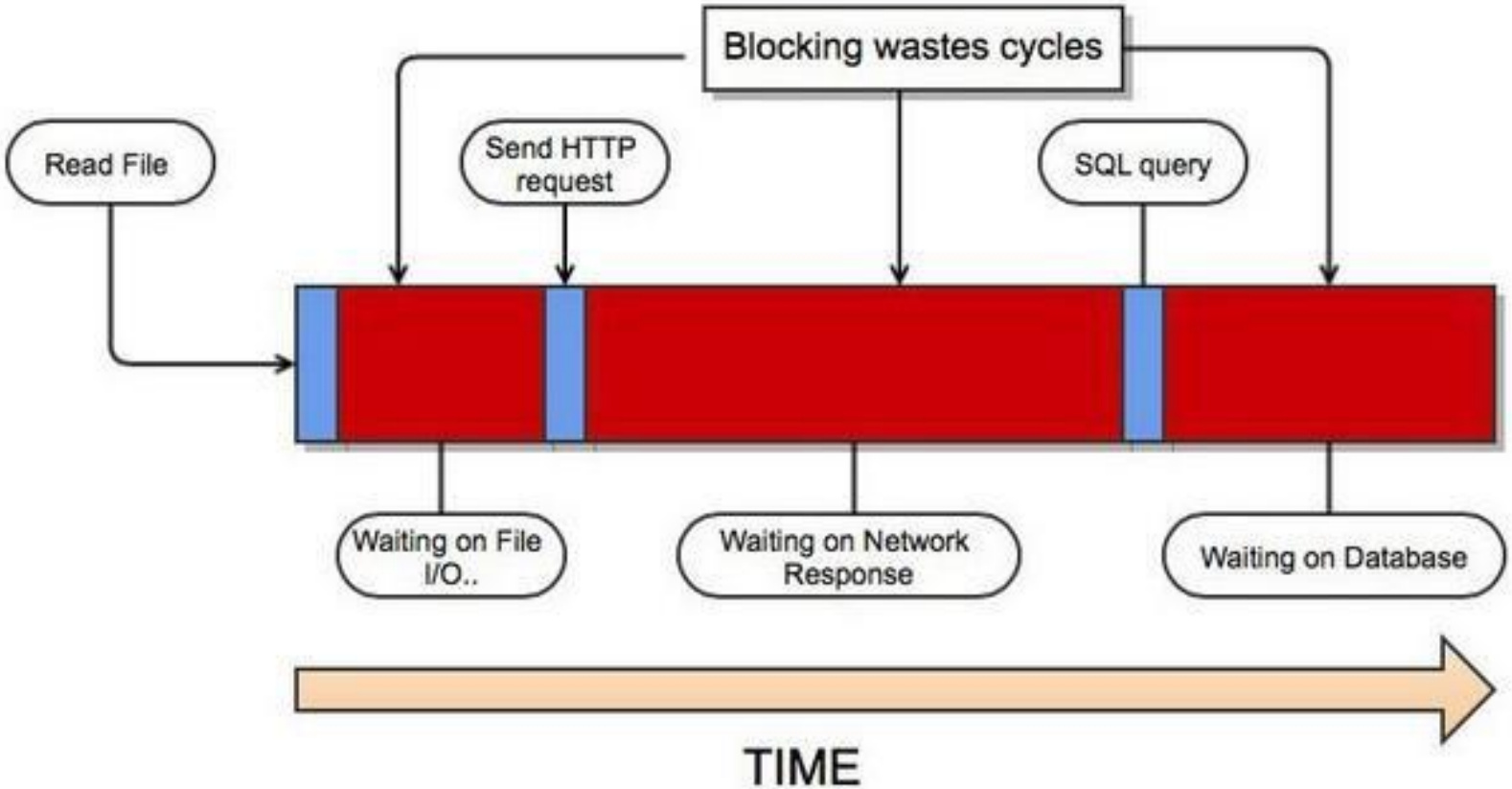
Traditional multi threaded server



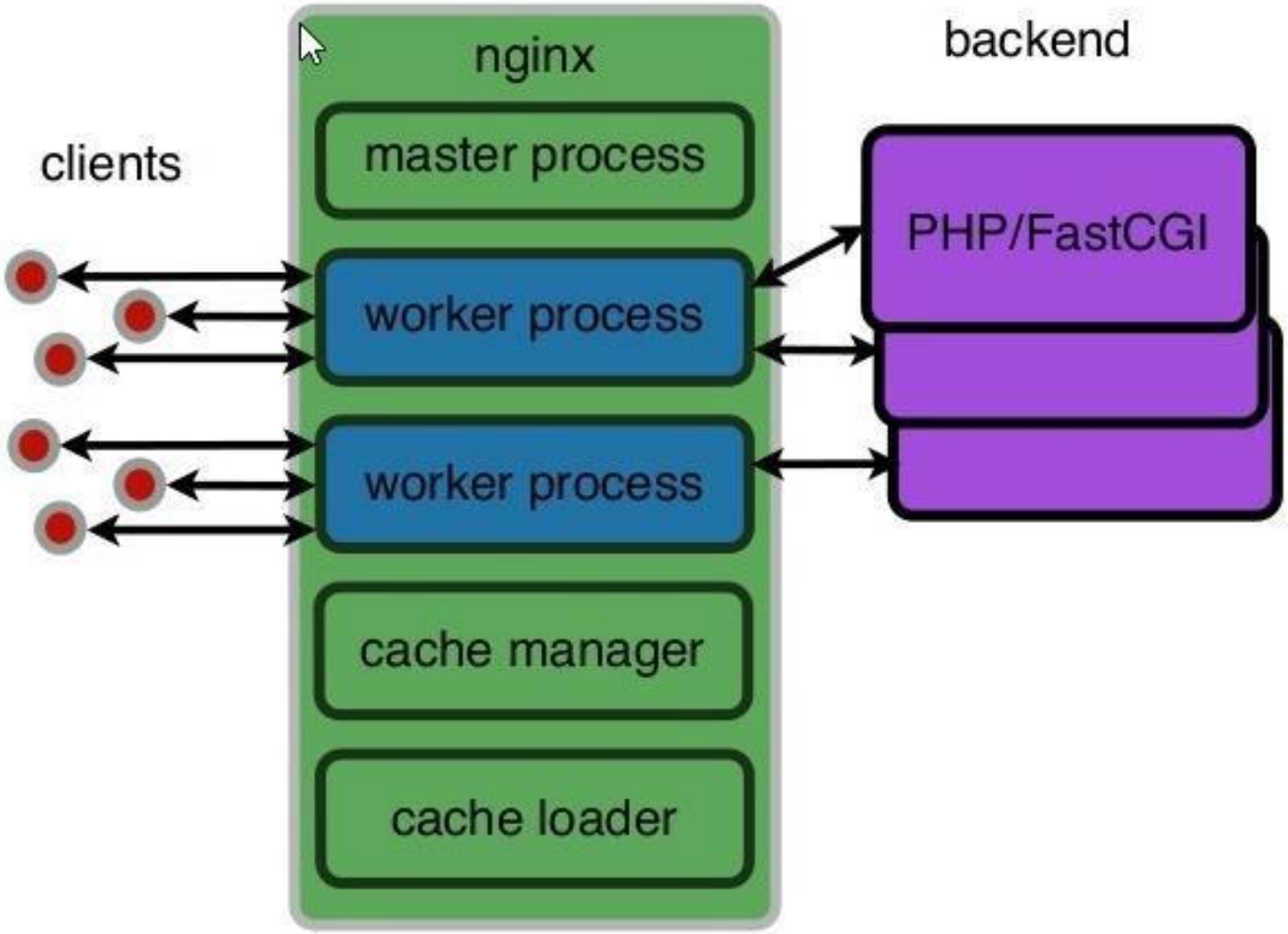
Web Server Architecture



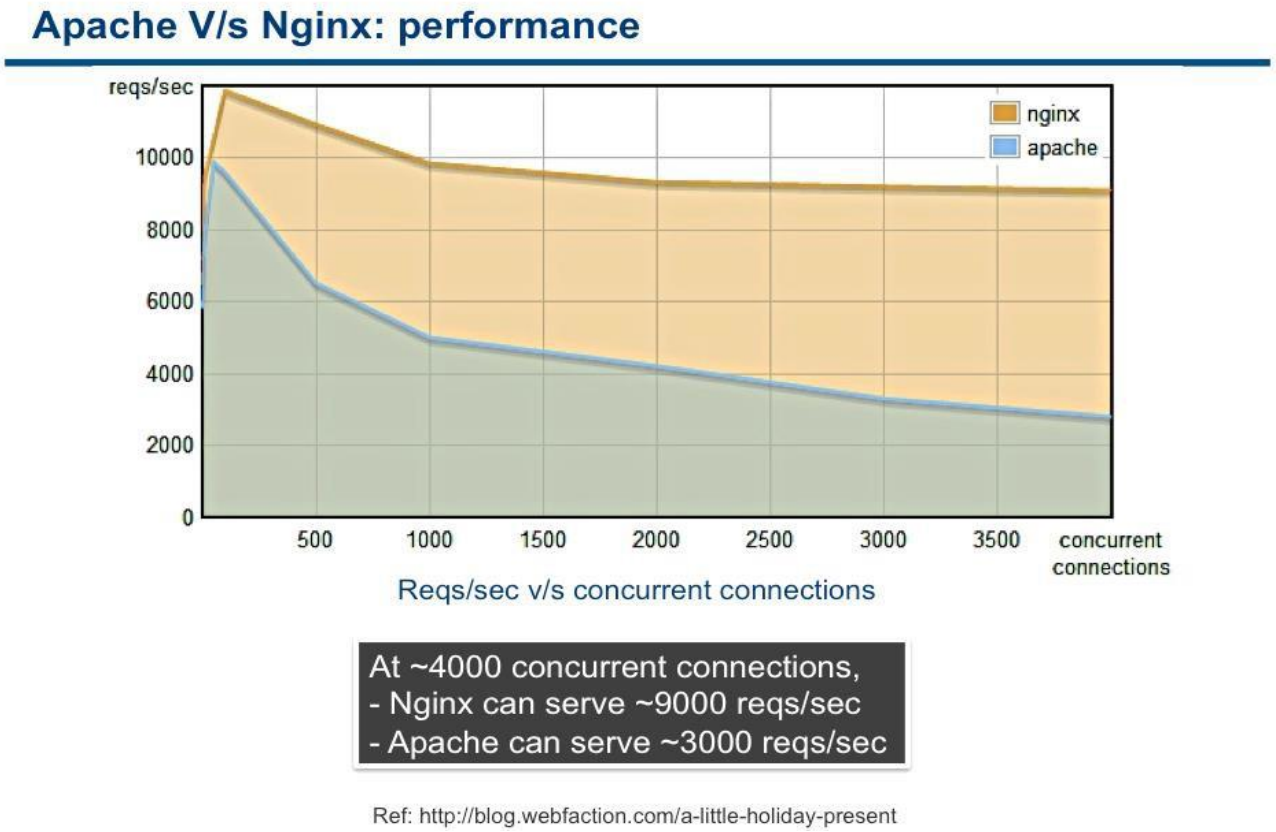
Traditional (Blocking) Thread Model



Nginx


nginx
backend
clients
master process
PHP/FastCGI
worker process
worker process
cache manager
cache loader

Apache vs Nginx



Picture source : cloudfoundry, vmware

Cost of IO

- L1-cache 3 cycles
- L2-cache 14 cycles
- RAM 250 cycles

Non-Blocking IO

- Disk 41 000 000 cycles
- Network 240 000 000 cycles

Blocking IO

Handling IO

- Threads wait for IO to complete at application level.

Example

results = db.getData(‘select * from users’);

Evented asynchronous platform

Javascript in browser

- Single Threaded.
- Asynchronous.
- Functional language. Native callback function support.

Asynchronous IO

Example

```
db.getData('select * from users', function(err, results) {
        console.log(results);
});
```

Non-Blocking I/O

- Traditional I/O

```
var result = db.query("select x from table_x");
doSomethingWith(result); //wait for result!
doSomethingWithOutResult(); //execution is blocked!
```

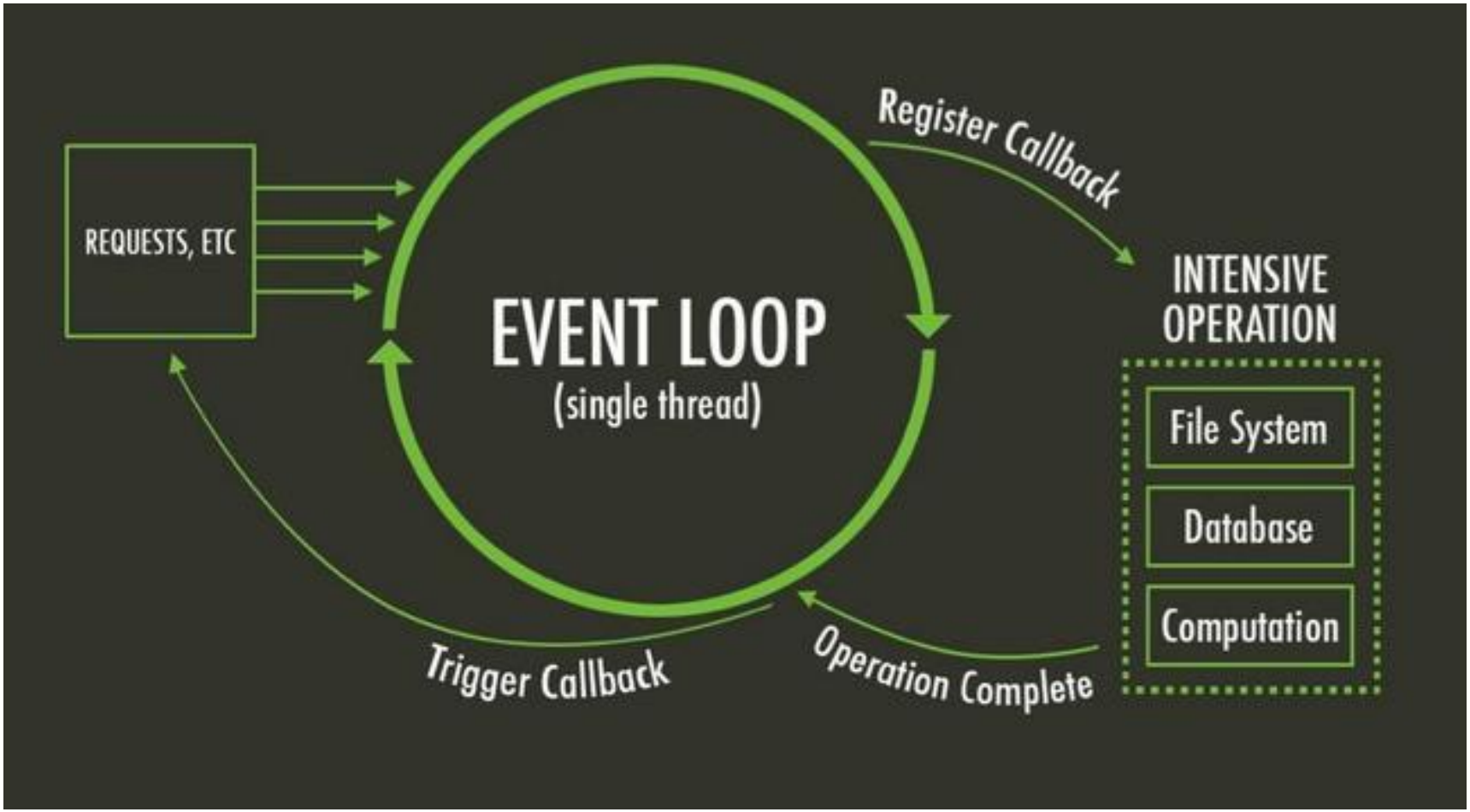
- Non-traditional, Non-blocking I/O

```
db.query("select x from table_x",function (result){
    doSomethingWith(result); //wait for result!
});
doSomethingWithOutResult(); //executes without any delay!
```

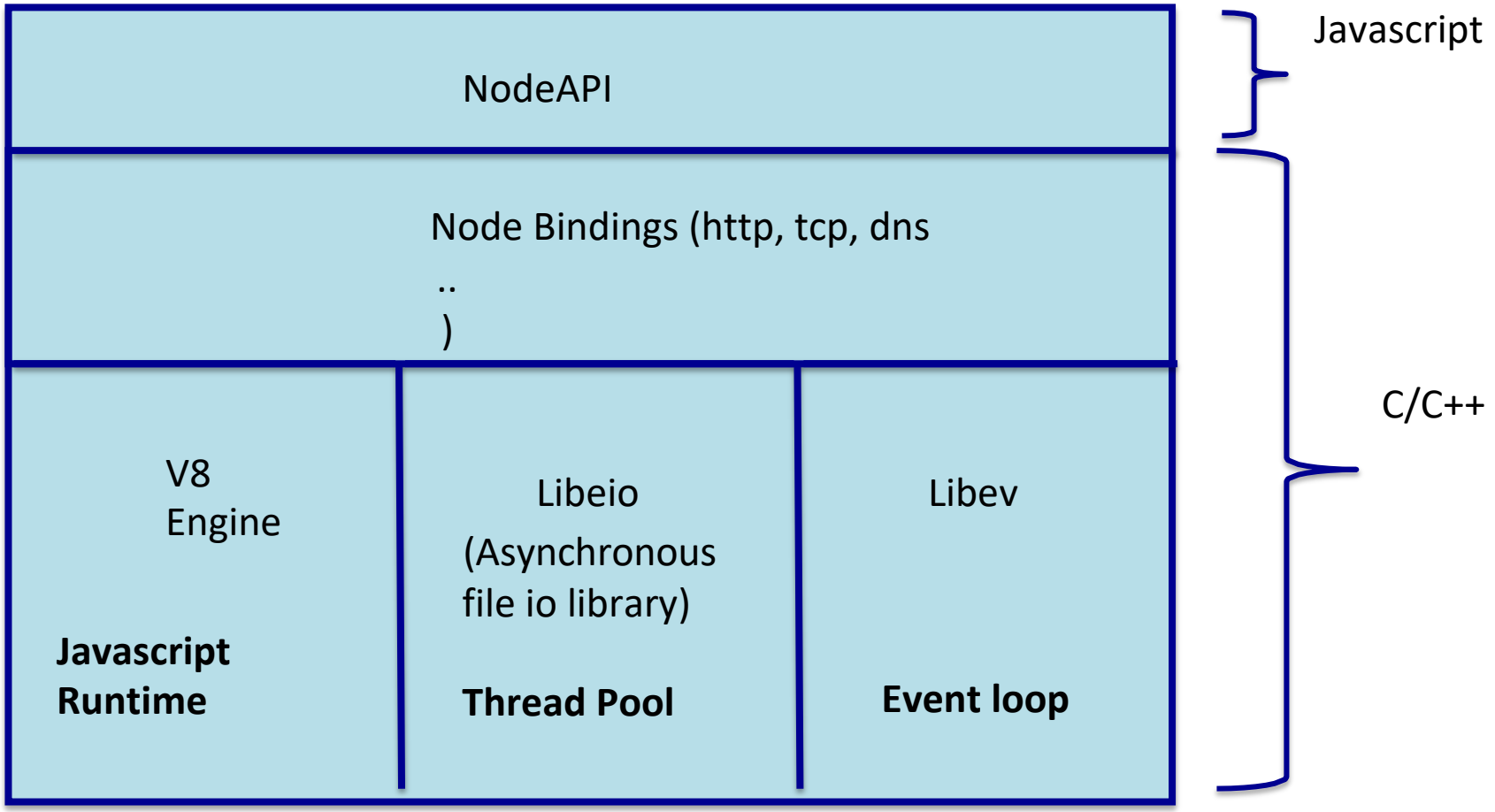
Introduction

- ”Node's goal is to provide an easy way to build scalable network programs” : (from nodejs.org)
- Node.js is a high-performance **network applications framework**, well optimized for high concurrent environments.
- Everything inside Node.js runs in a **single-thread**.
- Node.js uses an **event-driven, non-blocking I/O** model, which makes it lightweight.
- It makes use of **event-loops** via JavaScript’s

Event Loop Example



Node.js under the hood



Non-blocking I/O

- Servers do nothing but I/O
  - Scripts waiting on I/O requests degrades performance
- To avoid blocking, Node makes use of the event driven nature of JS by attaching callbacks to I/O requests
- Scripts waiting on I/O waste no space because they get popped off the stack when their non-I/O related code finishes executing

Cool facts

- Javascript is the most popular language in Github. (132K repositories)
- node.js third most starred repository in Github. (29K)
- One of the most quickly adopted platform (1-2 years)
- Companies who gained from using nodejs (linkedin, paypal, groupon, walmart labs, uber, airbnb and many gaming companies)

When to use Node.js

- Node.js is good for creating streaming based real-time services, web chat applications, static file servers etc.
- If you need high level concurrency and not worried about CPU-cycles.
- If you are great at writing JavaScript code because then you can use the same language at both the places: server-side and client-side.

Resources to Get Started

- Watch this video at Youtube: http://www.youtube.com/watch?v=jo_B4LTHi3I
- Read the free O'reilly Book **'Up and Running with Node.js'**
- Visit www.nodejs.org for Info/News about Node.js
- Watch Node.js tutorials @ http://nodetuts.com/
- For anything else Google!

References

- http://nodejs.org/
- http://nodejs.org/cinco_de_node.pdf
- http://ajaxian.com/archives/google-chrome-chromium-and-v8
- http://blog.chromium.org/2010/12/new-crankshaft-for-v8.html
- http://news.softpedia.com/news/IE9-RC-vs-Chrome-10-9-vs-Opera-11-vs-Firefox-11-Performance-Comparison-183973.shtml

Node.js Codes

What is a MEAN stack?

- MongoDB as the database
- Express as the web framework
- AngularJS as the frontend framework, and
- Node.js as the server platform

- Single language is used in the whole application
- Support for the MVC pattern
- JSON is used for transferring data
- Node.js's huge module library

Node Importing Modules

- Java/ Python use “import” to load other libraries
- PHP/ Ruby use “require” to load libraries
- Node.js similarly uses “require” to load other dependencies

```
//Loading external modules
var http = require('http');
//Loading relative files from the project
var myFile = require('./myFile');
```

- External modules can be installed locally using npm command:

```
- npm install express      //to install express module
```

Modules

- A Module encapsulates related code in a single unit
- **`Authenticate.js`** – Module

```
var sign_in = function(req,res){ //functionality goes here }
var sign_up = function(req,res){ //functionality goes here }
```

- **Exporting** **`Authenticate.js`** module

```
exports.sign_in = function(req,res) { //functionality goes here }
exports.sign_up = function(req,res) { //functionality goes here }
```

- Importing **`Authenticate.js`** module

```
var authenticate = require("./authenticate.js");
authenticate.sign_in(req,res);
```

Callback functions

- Node.js uses JavaScript, which has callback functions
- Normal functions wait for the function block to complete
- Callback function is a function called in another function as a parameter and is called inside the function

```
var customCallback = function(data) {
        console.log('Data is : '+data);
};
var checkTheCallback = function(callback) {
        callback('Hello World!');
};

checkTheCallback(customCallback)
```

- Callback function enables node.js in asynchronous, non-blocking implementation

- Blocking Code

```
var contents = fs.readFileSync('/etc/hosts');
console.log(contents);
console.log('Doing something else');
```

Stop process until complete

- Non-Blocking Code

```
fs.readFile('/etc/hosts', function(err, contents) {
  console.log(contents);
});
console.log('Doing something else');
```

Simple HTTP Server

```
var http = require("http");                //load external
library - http

http.createServer(function (req,res) {   //callback
function
        res.sendHeader(200,
              {"Content-Type": "text/plain"});
        res.sendBody("Hello\r\n");
        res.sendBody("World\r\n");
        res.finish();
}).listen(3000);            //server connected and listening
to the port 3000
```

Simple HTTP Server

- node http_server.js //Running node command with the filename

- curl -i http://localhost:3000 //Running curl command to check output

```
//Expected Output
HTTP/1.1 200 OK
Content-Type: text/plain
Connection: keep-alive
Transfer-Encoding: chunked

Hello
World
```

OR

- http://localhost:3000 //Run the link in your browser

Req and Res in Node.js

- req = { _startTime : Date,
  app : function(req,res){},
  body : {},
  client : Socket,
  complete : Boolean,
  connection : Socket,
  cookies : {},
  files : {},
  headers : {},
  httpVersion : String
  method : String, // e.g. GET POST PUT
  DELETE next : function next(err){}, originalUrl
  : String, /* e.g. /erer?param1=23¶m2=45 */
  params : [],
  query : {},
  readable : Boolean,
  route : Route,
  signedCookies : {},
  socket : Socket,
  url : String /*e.g. /erer?param1=23¶m2=45
  */ }

- res = { app : function(req, res) {},
  chunkedEncoding: Boolean,
  connection : Socket,
  finished : Boolean,
  output : [],
  outputEncodings: [],
  req : IncomingMessage,
  sendDate : Boolean,
  shouldkeepAlive : Boolean,
  socket : Socket,
  useChunkedEncdoingByDefault : Boolean,
  viewCallbacks : [],
  writable : Boolean }

Express Framework, Connect

- **Express.js** is a Node.js web application server framework, designed for building single page, multi-page, and hybrid web applications
- Express is the backend part of the MEAN stack, together with MongoDB database
  and AngularJS frontend framework
- Sinatra-inspired MVC framework for Node.JS
- Built on Connect Middleware
- **Connect** is an extensible HTTP server framework for node using "plugins" known as middleware

What Express Does?

- Parses arguments and headers
- Routing
- Views
  - Partials
  - Layouts
- Configurations
- Sessions

Express 4.0

```
var express = require('express');                // call express
var app = express();                             // define our app
using express
var bodyParser = require('body-parser');

// configure app to use bodyParser()
// this will let us get the data from a POST
app.set('views', __dirname + '/views');          //setting the path for
the views
app.set('view engine', 'ejs');                   //setting the view
engine to ejs
app.use(bodyParser.urlencoded({ extended: true }));
app.use(bodyParser.json());
var port = process.env.PORT || 8080;             // set our port

var router = express.Router();
// respond with "Hello World!" on the homepage
router.get('/', function(req, res)
{
        res.send('Hello World!');
});
app.use('/api', router);
// START THE SERVER
app.listen(port);
console.log('Express server listening on port ' + port);
```

Express Configuration file (app.js)

```
var express = require('express');                // loading modules
var app = express();                             // initializing express
var bodyParser = require('body-parser');         // loading body-parser
// configure app to use bodyParser()
// this will let us get the data from a POST
app.set('views',_dirname + '/views');//setting the path for the views
app.set('view engine', 'ejs');          //setting the view engine to ejs
app.use(sessions({secret: 'adfasdf34efsdfs34sefsdf'}));//setting the
session key
app.use(bodyParser.urlencoded({ extended: true }));
app.use(bodyParser.json());
app.use(express.static(__dirname + '/public'));   //setting path for
static(images, stylesheets)
var port = process.env.PORT || 8080;             // set our port
app.configure('development', function(){         //development-environment
configurations
  app.use(express.errorHandler({ dumpExceptions: true, showStack:
true }));
});
//Start Server
app.listen(port);
console.log('Express server listening on port ' + port);
```

Routing

```
//Catch-all
app.all('/app(/*)?', requiresLogin);          //works for all HTTP
verbs
// Routes
app.get('/', routes.index);   //GET Request, for the homepage
app.get('/about', routes.about);//GET Request, for other routes
app.get('/contact', routes.contact);
app.get('/app/list', routes.listapps);
app.get('/app/new', routes.newapp);
app.post('/app/new', routes.saveapp);         //POST Request
app.get('/app/:app', routes.getapp);
app.get('/app/:app/edit', routes.editapp);
```

Syntax pattern : `App.[verb](path, function(req,res), [function(req,res)]);`

How about /user/12?

Request Object

- **`req.param`**
  - Return the value of param name when present
  - **`req.param`** is an abstraction layer for picking up information about a request – it automatically searches:
    - Query strings
    - Posted form values
    - Route values
- **`req.session`**
  - To store or access session data
- **`req.params`**
  - object containing properties mapped to the named route "parameters"
  - Eg: `/user/:name`, then the "`name`" property is available as `req.params.name`
- **`req.headers`**
  - Returns the specified HTTP request header field (case-insensitive match)

Response Object

- **`res.render`**
  - Renders a view and sends the rendered HTML string to the client

```
// send the rendered view to the client
res.render('index');
//send the rendered view to the client with the parameters
res.render('index',{name:"SJSU"});
```

- **`res.end`**
  - Ends the response process

- **`res.redirect`**
  - Redirects to the URL dervied from the specified path
  - Redirects can be a fully-qualified URL for redirecting to a different site

```
res.redirect('http://google.com');
```

  - Redirects can be relative to the root of the host name

```
res.redirect('/admin');
```

Views

- Support for multiple view engines
  - Jade
  - **Ejs**
  - Jshtml
  - Hogan-js
- Layout supports
- Partials
- Dynamic Helpers

Session Management

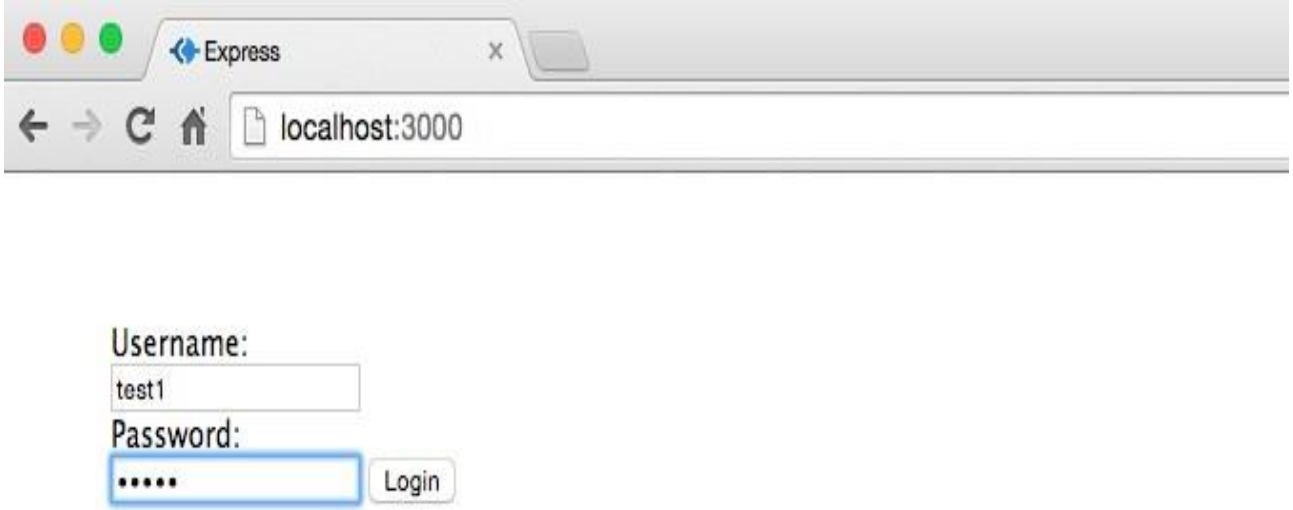
- Session State Providers
  - Cookie + Back-end Session Store
- Session Cookies
  - cookie-sessions NPM package

```
//store the username and email address after
successful login
req.session.username = username;
req.session.email_address = email_address;
```

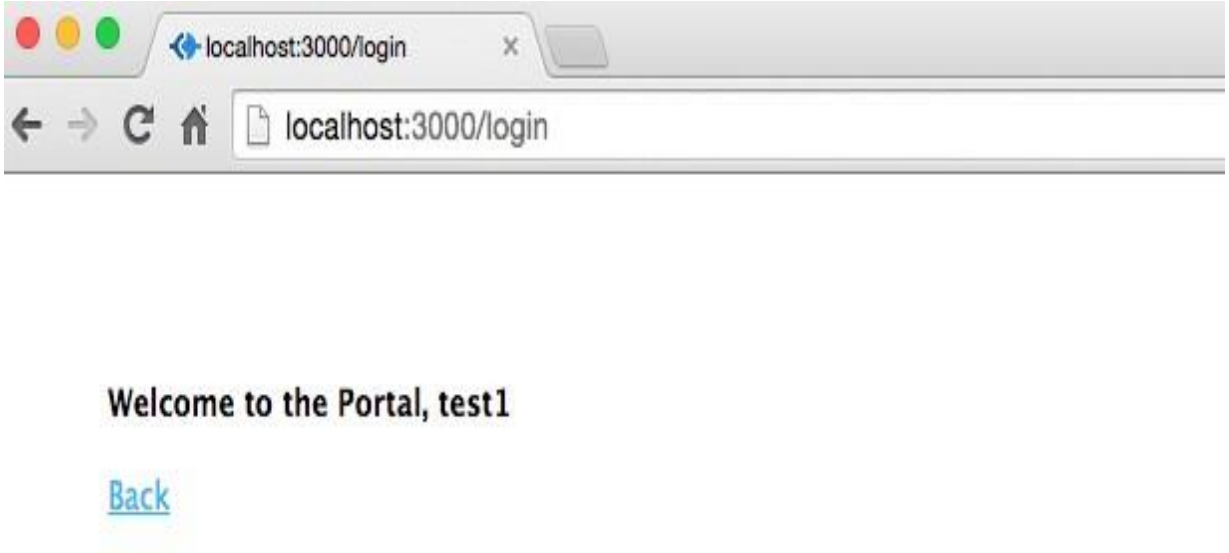
Example 1

- Simple Login Application, to check the username and password.
- The user should be directed to different pages on validating.
- Incorrect username, password entered should be directed to different page and valid login should direct to different page

Example 1 – Login Page



Example 1 – Success Page



Example 1 – Error Page

Example 1 – app.js

```
1
2  /**
3   * Module dependencies.
4   */
5
6  var express = require('express')
7    , routes = require('./routes')
8    , login = require('./routes/login')
9    , http = require('http')
10   , path = require('path');
11
12 var app = express();
13
14 // all environments
15 app.set('port', process.env.PORT || 3000);
16 app.set('views', __dirname + '/views');
17 app.set('view engine', 'ejs');
18 app.use(express.favicon());
19 app.use(express.logger('dev'));
20 app.use(express.bodyParser());
21 app.use(express.methodOverride());
22 app.use(app.router);
23 app.use(express.static(path.join(__dirname, 'public')));
24
25 // development only
26 if ('development' == app.get('env')) {
27   app.use(express.errorHandler());
28 }
29
30 app.get('/', routes.index);
31 app.post('/login', login.login);
32
33 http.createServer(app).listen(app.get('port'), function(){
34   console.log('Express server listening on port ' + app.get('port'));
35 });
36
```

Example 1 – login.js

```
1  /**
2   * New node file
3   */
4  exports.login = function(req,res)
5  {
6      var username, password;
7      username = req.param("username");
8      password = req.param("password");
9
10     console.log(username+" "+password);
11     if(username === "test1" && password ==="test1")
12     {
13         res.render("success",{username:username});
14     }
15     else
16     {
17         res.render("error");
18     }
19 };
```

Example 1 – index.ejs

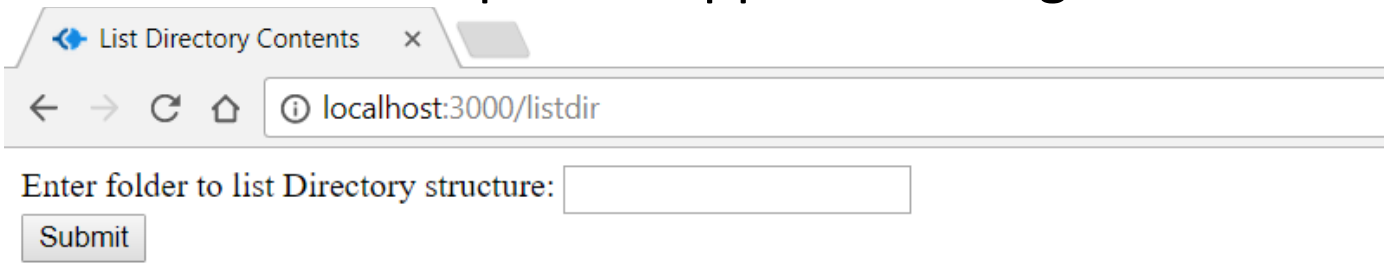
SampleApplication/app.js

```
1  <!DOCTYPE html>
3  <head>
4  <title><%= title %></title>
5  <link rel='stylesheet' href='/stylesheets/style.css' />
6  </head>
7  <body>
8      <form method="post" action="login">
9          Username:<br> <input type="text" name="username"> <br>
10         Password:<br> <input type="password" name="password">
11         <input type="submit" value="Login"/>
12     </form>
13 </body>
14 </html>
```

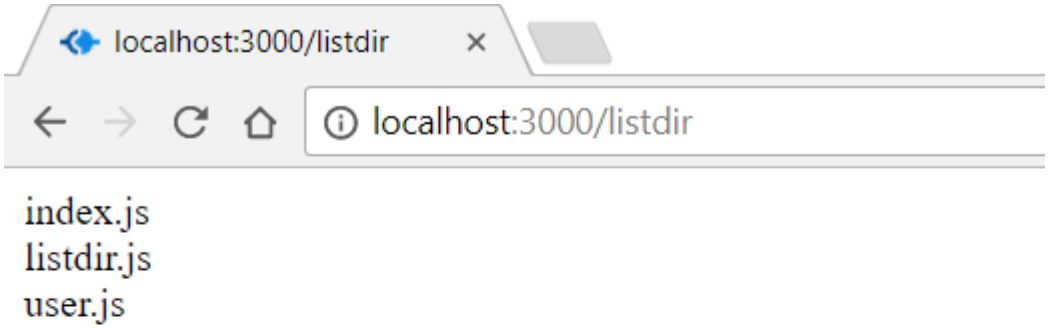
Example 2

- List Directory application
- User gives path of a folder to list all the files and application should display the response as array.

Example 2 – Application Page



Example 2 – List of Files



Example 2 – app.js

app.js listdir.js ListDir.ejs

```
var express = require('express')
  , routes = require('./routes')
  , user = require('./routes/user')
  , http = require('http')
  , path = require('path')
  , listdir = require('./routes/listdir');

var app = express();

// all environments
app.set('port', process.env.PORT || 3000);
app.set('views', __dirname + '/views');
app.set('view engine', 'ejs');
app.use(express.favicon());
app.use(express.logger('dev'));
app.use(express.bodyParser());
app.use(express.methodOverride());
app.use(app.router);
app.use(express.static(path.join(__dirname, 'public')));

// development only
if ('development' == app.get('env')) {
  app.use(express.errorHandler());
}

app.get('/', routes.index);
app.get('/users', user.list);
app.get('/listdir',listdir.loadDirPage);
app.post('/listdir',listdir.listdir);

http.createServer(app).listen(app.get('port'), function(){
```

Example 2 – ListDir.ejs

app.js listdir.js ListDir.ejs

```html
<html>
<head>
<title>List Directory Contents</title>
</head>
<body>
    <form action="listdir" method="post">
        <label>Enter folder to list Directory structure:</label> <input
            type="text" name = "dir"> <br /> <input type="submit" value="Submit">
    </form>
</body>
</html>
```

Example 2 – listdir.js

app.js | listdir.js | *ListDir.ejs

```
1  var fs = require('fs');
2  var ejs = require('ejs');
3  var testFolder = './routes/';
4
5  function listdir(req,res)
6  {
7      var response = "";
8      testFolder = req.param('dir');
9      console.log(testFolder);
10     fs.readdir(testFolder, function (err, files)
11     {
12         console.log(files.length);
13         console.log(files);
14         for(var i=0;i<files.length;i++)
15         {
16             response += files[i]+"<br>";
17         }
18         res.send(response);
19     });
20 }
21
```

```
function loadDirPage(req,res)
{
    ejs.renderFile('./views/ListDir.ejs',function(err, result) {
        if (!err) {
            res.end(result);
        }
        else {
            res.end('An error occurred');
            console.log(err);
        }
    });

    //res.render("ListDir");
}

exports.listdir = listdir;
exports.loadDirPage = loadDirPage;
```

Exercise (show demo next week)

- Build a sign up page with fields username, password, firstname, lastname, date of birth, gender
- Build a login page to login
- Build 2 pages for after successful login and incorrect password/username
- The after successful login page should show all the information of the user(firstname, lastname, date of birth and gender)
- The error page should show the message and take him back to the login page

Future References

- ExpressJS.com – Official Express JS Homepage
- docs.npmjs.com – Documentation for npm
- nodejs.org/api – Node.js API Documentation