Node Program

Node Basics

Node.js version: 7
Last updated: Nov 2016

Node.js

Introduction

Why Server-Side JavaScript?

Node was originally born out of this problem — how can you handle two things at the same time
— Ryan Dahl, The Creator of Node.js

Why Server-Side JavaScript?

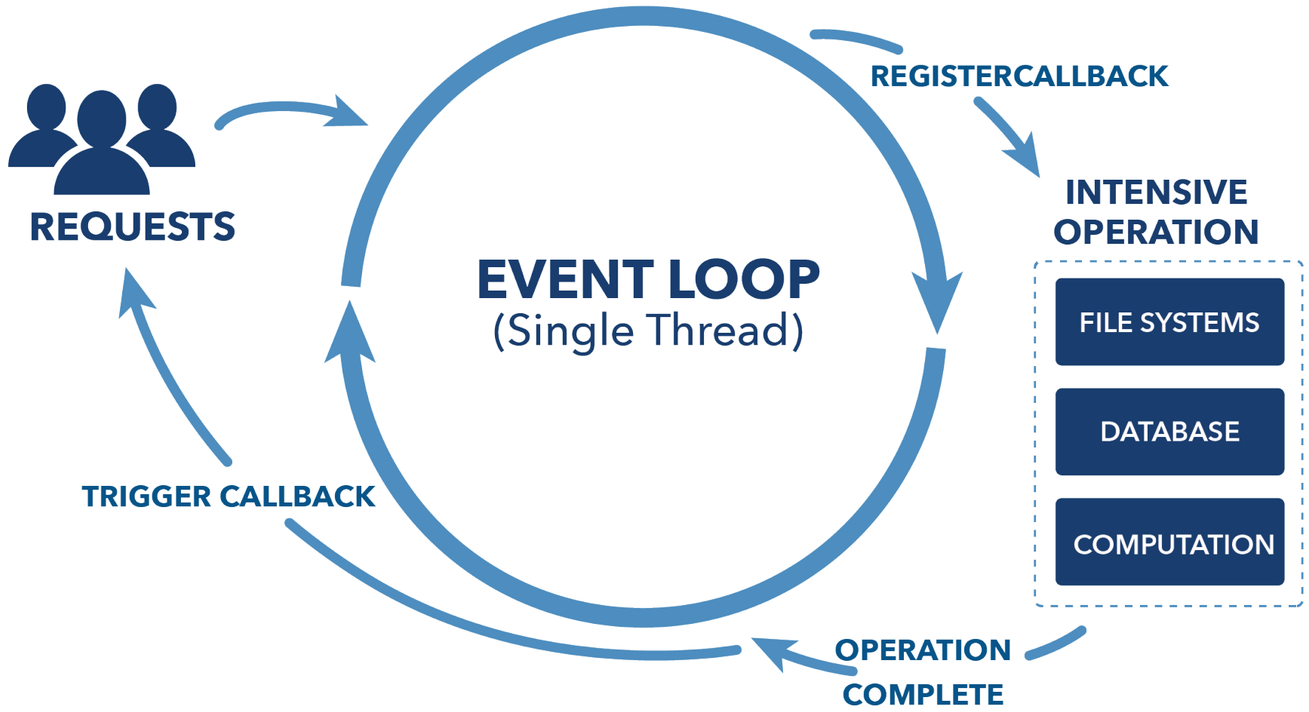
- Non-blocking I/O: performant
- Fast: browser arms race (V8)
- **One language across the stack**
- Expressive: don't waste time on setup
- Solid standard (ECMA)

Advantages of Node.js

- Non-blocking I/O
- Super fast (V8)
- Vibrant ecosystem (npm)
- Ability to re-use code on browser and server
- Ability to use front-end devs for back-end and vice versa

Non-blocking I/O

It's kind of a big deal



Disadvantages of Node.js

- Devs have to think in async and functional+prototypal
- Frameworks and tools are not as mature as in Ruby, Java, Python (yet)
- JavaScript "quirks" (mostly fixed in ES6!)

Node Gotcha

Don't use Node.js for CPU-intensive tasks. Hand them over to other workers.

Downsides of JavaScript (Not only Node)

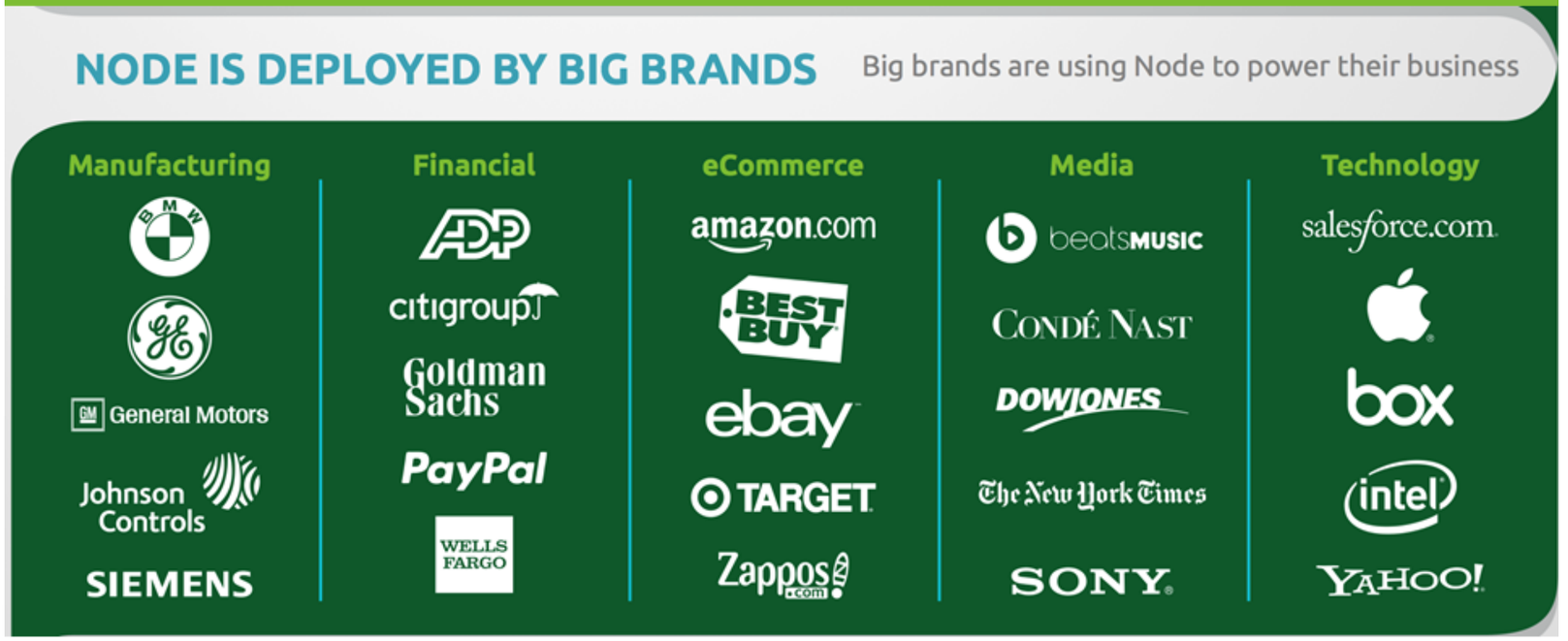
» Callback Hell

» Prototypal inheritance

JavaScript is Optional in Node.js

It's **possible** to use other languages for Node.js that compile into JavaScript, e.g., CoffeeScript, TypeScript, and ClosureScript.

Nodies are not just Silicon Valley hipsters !



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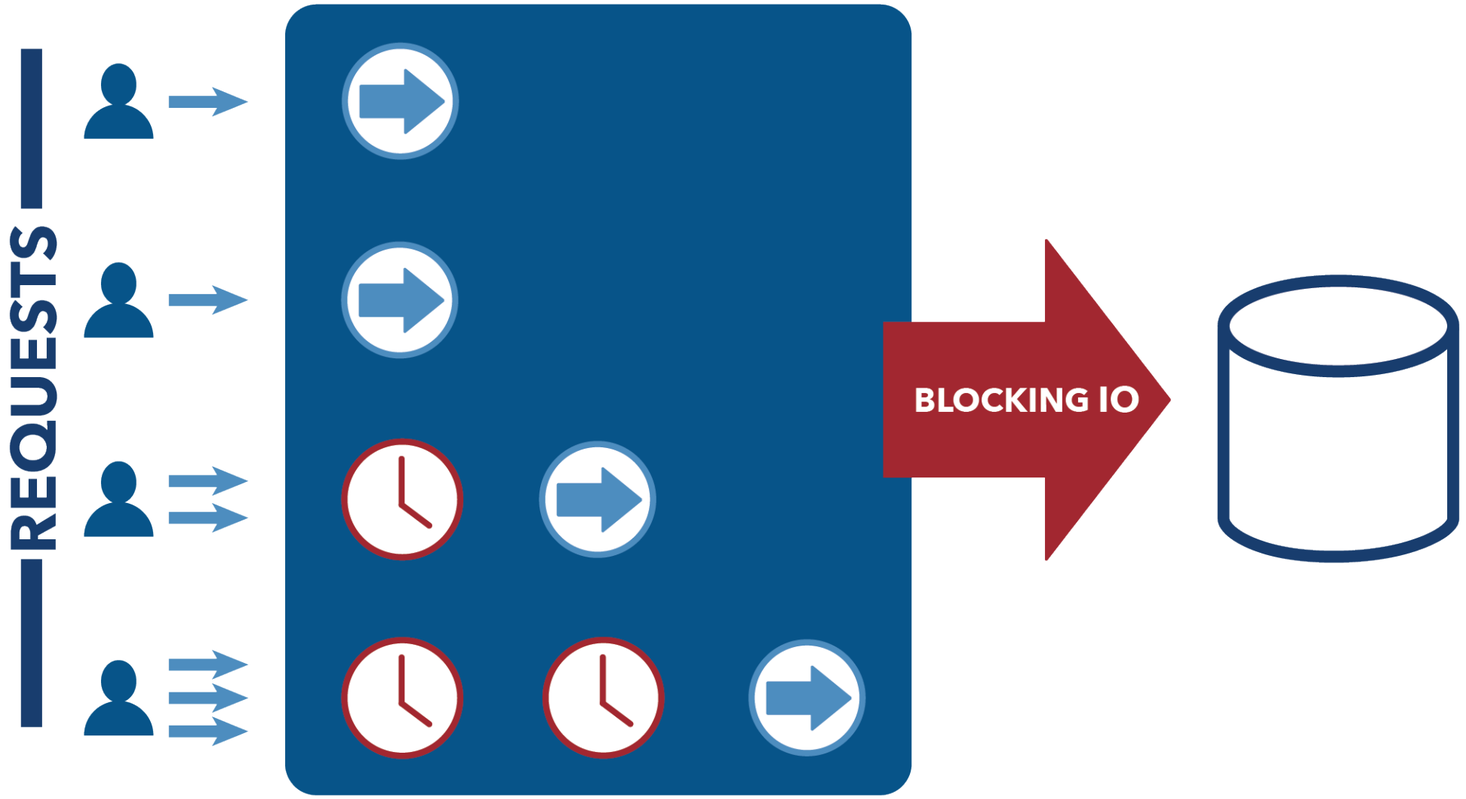
StrongLoop

Node is Single-Threaded

Node.js is single-threaded by design to make asynchronous processing simpler. Multi-threading can be very complex: racing condition, deadlocks, priority inversions…

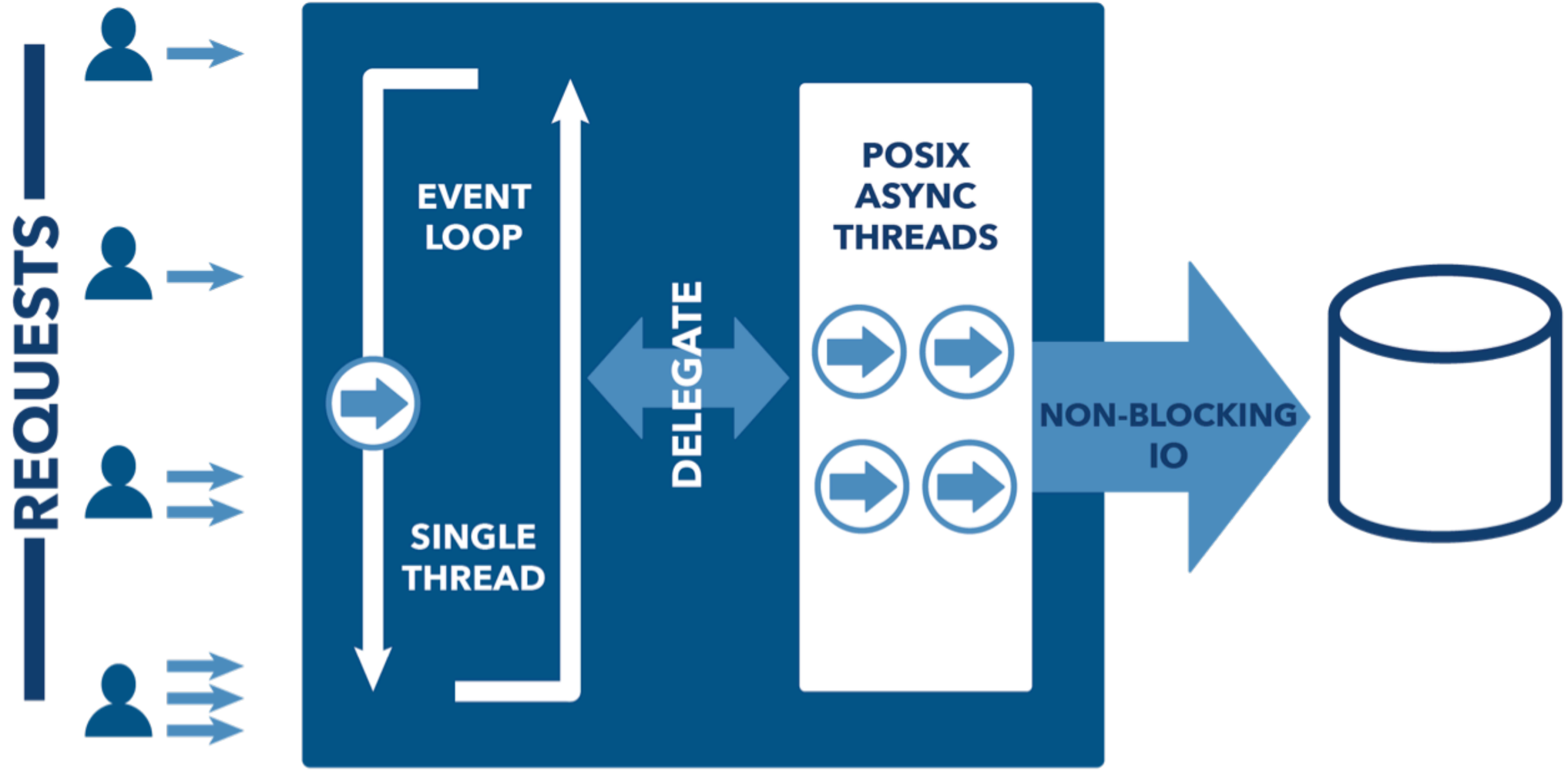
It turned out for web-based application, single-threaded asynchronous event-loop based non-blocking I/O is very performant!

MULTI THREADED SERVER



THREAD PROCESSING

THREAD WAITING



Scaling Node Vertically

To scale Node vertically, you can take advantage of multiple CPUs cores or compute units (multi-threading) with clustering (e.g., StrongLoop's PM).

The idea is to have multiple processes from the same code base to listen on the same port for requests.

Integration

- noSQL
- SQL
- OAuth 1.0/2.0
- REST
- SOAP

Databases

- mySQL
- PostgreSQL
- Oracle
- MS SQL
- MongoDB
- Cassandra

Node + Client MVC Architecture

Single-Page Applications a.k.a. BYOC: REST API in Node + SPA

» Backbone

» Angular (e.g., M.E.A.N)

» Ember

» React

» MV*

Server-side Rendering

» Jade

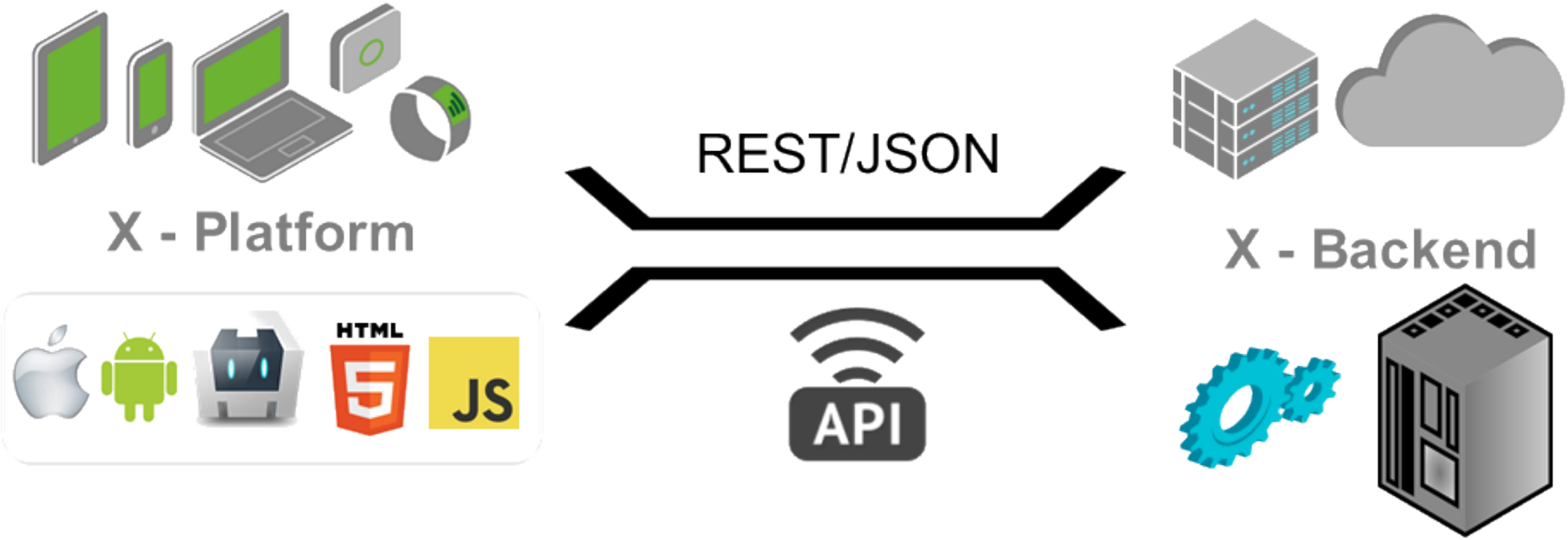
» Handlebars

» EJS

» Hogan

Many more: http://garann.github.io/template-chooser

Node for SOA / REST



So what is ECMAScript?

ES as a Language Specification

» Browser implementations (like Chrome's V8)

» Node builds on V8 with C++

Disclaimer: This is NOT a course on JavaScript. Please invest a few days in learning its fundamentals:

» Eloquent JavaScript

» JavaScript The Good Parts

» ES6

» JavaScript Ninja

» Functional JavaScript

ES6 Sidenote

» Destructuring

» Const and let

» Functions

» Interpolations

More: Top 10 ES6 Features Every Busy JavaScript Developer Must Know

Demo

`code/node/lang`

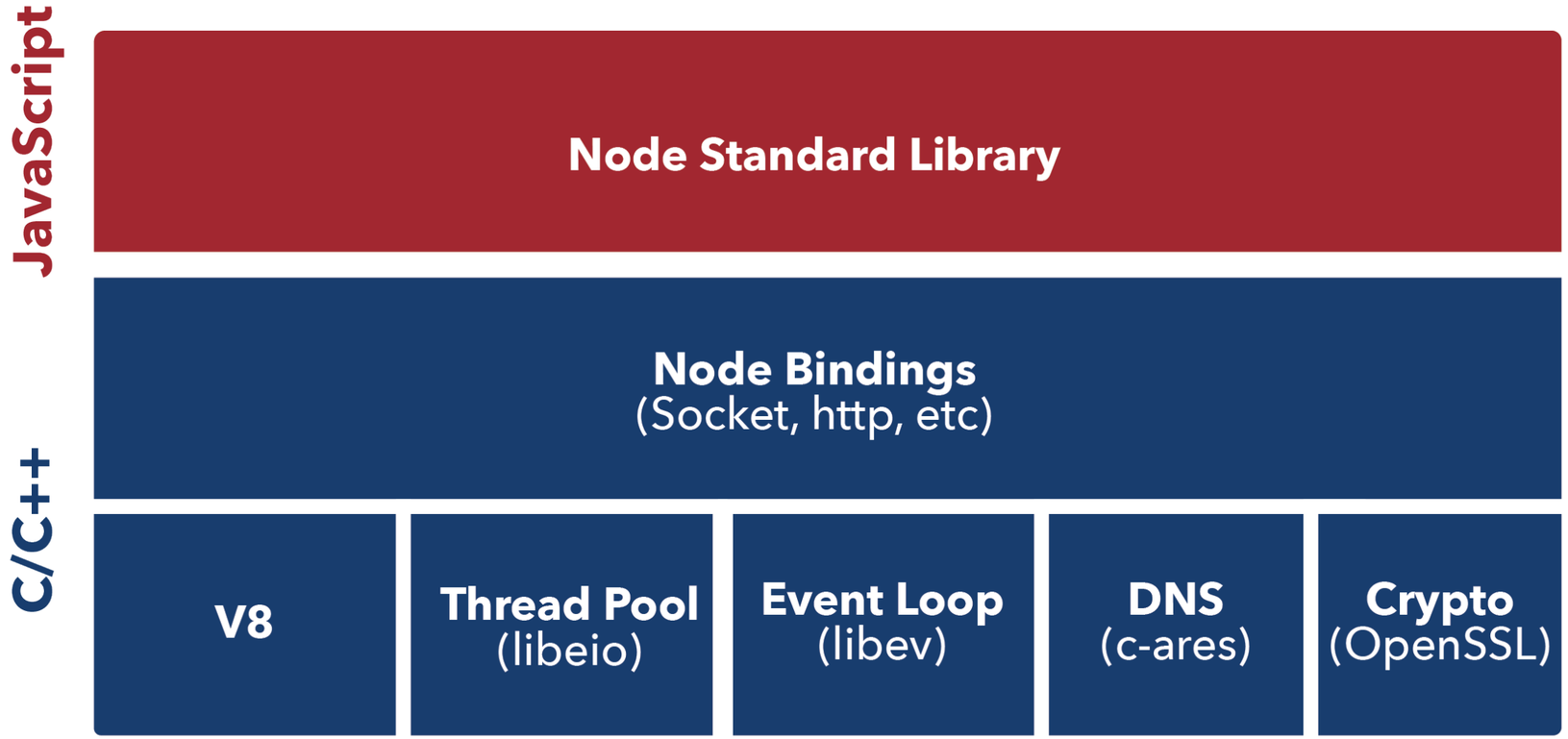
Browser JS != Node

- Modules
- Scopes
- window vs. global and process
- `fs` and other modules

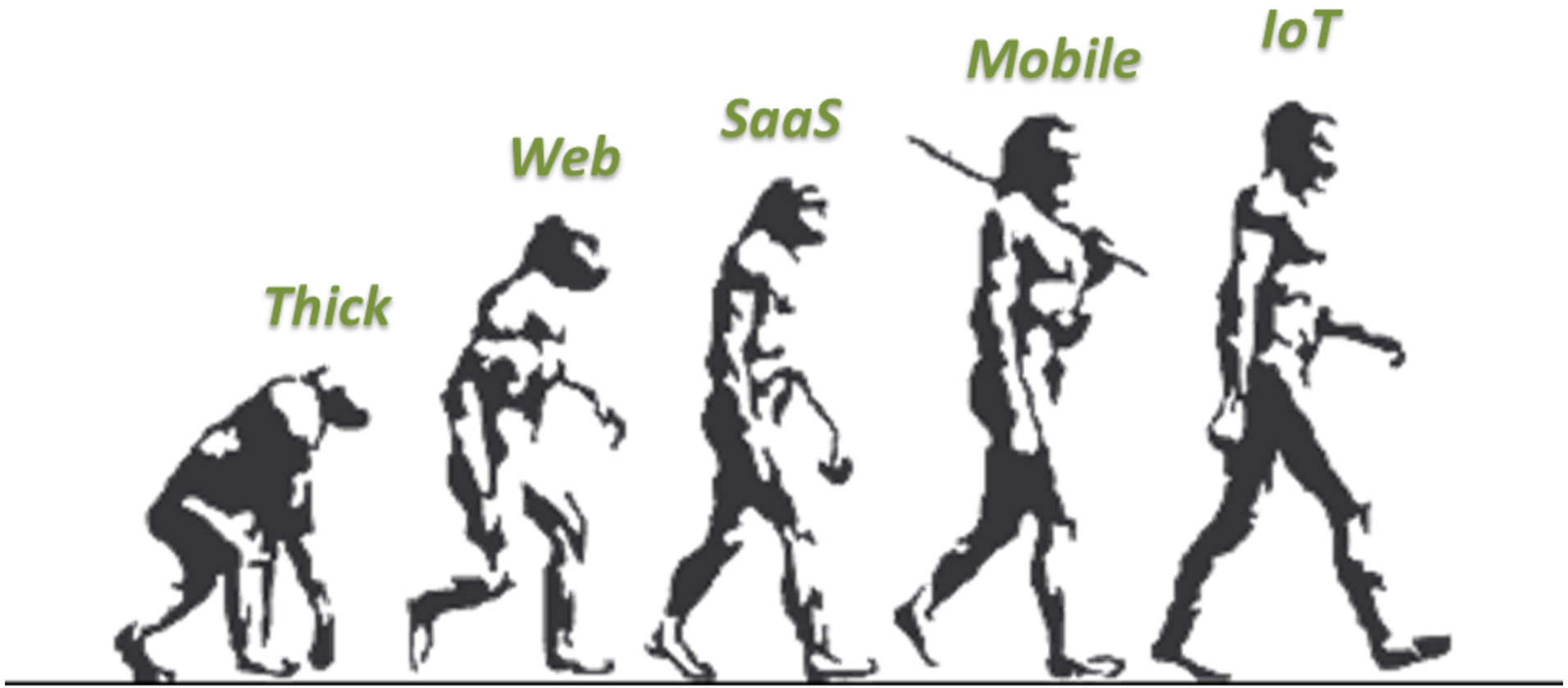
Node Core: V8, libev, and libeio

- Libev: The event loop
- LibEio: Async I/O
- LibUv: Abstraction on libEio, libev, c-ares (for DNS) & iocp (for Windows)

Node Core Architecture



Patterns evolve to serve market needs



Framework Categories

» KISS Servers: small core, small modules

» Convention: follow the leader, steep learning curve

» Configuration: open path, manual effort for advanced

» ORM & Isomorphic: model-driven, shared code, steep learning

Framework Examples

» KISS Servers: Node core

» Convention: Restify, Total.js

» Configuration: Hapi, Kraken, Express

» ORM & Isomorphic: LoopBack, Sails, Meteor*

Everything is a callback... in Node everything is non-blocking and so it doesn't allow you to just sit there and then return the response. "

— Ryan Dahl http://

Node Language

Node is not JavaScript, but both JavaScript and Node are ECMAScript.

Demo

Ways to run Node:

1. Node REPL
2. Node Eval (`node -e`)
3. Node Command
4. Other tools and scripts, e.g., bash script, Makefile, nodemon, node-dev, superviser, pm2, etc.

`global` Object

The global object is similar to window object in the browser JavaScript.

```
global.process === process
global.console === console
global.require === require
global.module.export === module.exports
```

`process` Object

In Node, interaction with the current Node process takes place via the `process` object.

As the `process` object is a global, it is accessible from anywhere in the application source code.

Note: it is an instance of EventEmitter – logic can therefore be applied
to the process object via callbacks assigned to specific events.

Environment Variables

Environment variables can be accessed via the `env` attribute:

```
console.log(process.env)
```

```
{ SHELL: '/bin/bash',
  USER: 'jordan',
  HOME: '/home/jordan',
  ...
}
```

Command-Line Arguments

Shell commands accept arguments to alter their behaviour:

```
$ echo "Hello World!" // "Hello World" is the argument here
```

Node makes these arguments accessible via `process.argv`

Command-Line Options

The `argv` property is an array.

The first two elements are 'node' and the application's name:

```
$ node app.js arg1 arg2 arg3=val3

/*
process.argv => [
  'node', 'app.js', 'arg1',
  'arg2', 'arg3=val3'
]
*/
```

Exiting a Process

To exit a process, use the `exit` function

```
process.exit()
```

Exiting with Errors

Exit codes can also be specified

```
// this process exits successfully
process.exit(0)

// this process failed
process.exit(1)

// this process failed with a different code
process.exit(129)
```

Exiting with Errors

Note:

» Different failure codes can be used to differentiate types of failure

» Knowing how an application failed allows the developers the means
to program an appropriate response

Child Processes

A child process is a process created by another process.

To have Node applications run other processes, use the `child_process` module.

Execute a Process

The `exec` function runs a shell command, and invokes a callback with references to the child process' standard output and error

```
var cp = require('child_process')
var ps = cp.exec('ps aux', function (err, stdout, stderr) {
    console.log('STDOUT: ', stdout) // data written to stdout
    console.log('STDERR: ', stderr) // data written to stderr
})
```

Exec Callback

The `exec` callback also provides an error object as its first argument,
which can be analyzed in the event process execution fails.

```
var ps = cp.exec('nonexistant-command', function (err, stdout, stderr) {
  if (err) {
    // stack trace
    console.log(err.stack)
    // exit code
    console.log(err.code)
  }
})
```

Modules

Modules in Browser

Don't exist natively until ES6, i.e., no built-in module support!

Modules in Browser Workarounds

- `<script>`
- CommonJS
- AMD (requirejs)
- ES6

Module Loaders in Browser

» SystemJS

» RequireJS

» Browserify

» es6-module-loader

More info: http://mzl.la/1Ieu8zM and http://mzl.la/1Ieu7vz

Modules in Node

Built-in modules with `require` a CommonJS notatioin! 💝

Node Require Example:

```
var express = require('express')
var app = express()
```

Requiring Modules

Modules can live different places with JavaScript. They can be on local machines, virtual machines, servers, remote URI locations, or anywhere really.

Loading Node Modules

These modules can be loaded with module loaders like require or via inversion of control patterns.

```
var filesystem = require('fs'),
  databaseConfigs = require('./configs/database.json'),
  routes = require('../routes'),
  server = require('./boot/server.js')
```

Creating a Module with a "Class" Example:

```
function UserController() {
  var username, password
  function doLogin(user, pw) {
    username = user;
    password = pw
    // do the rest of the login work
  }
  var publicAPI = {
    login: doLogin
  }
  return publicAPI
}
// create a `UserController` instance
var ctrl = UserController()
ctrl.login( "fred", "12Battery34!" )
```

Node Patterns for Module Exports

```
>> module.exports = function(ops) {...}

>> module.exports = {...}

>> exports.methodA = function(ops) {...}

>> exports.obj = {...}
```

Function Pattern

module.js:

```
module.exports = function(options) {
  var limit = 100
  if (options.type === 'foobar') {
    limit = 200;
  }
  return {
    name: 'request',
    limit: limit,
    type: options.type,
    method: function(data) { return data; }
  }
}
```

Functional Pattern

main.js:

```
var mod = require('./module.js')
var request = mod({
  type:'foobar'
})
request.method({
  x: 10,
  y: 20
})
```

Demo

» `code/node/module-basic`

» `code/node/module-greetings` v2 and v3

Observer Pattern

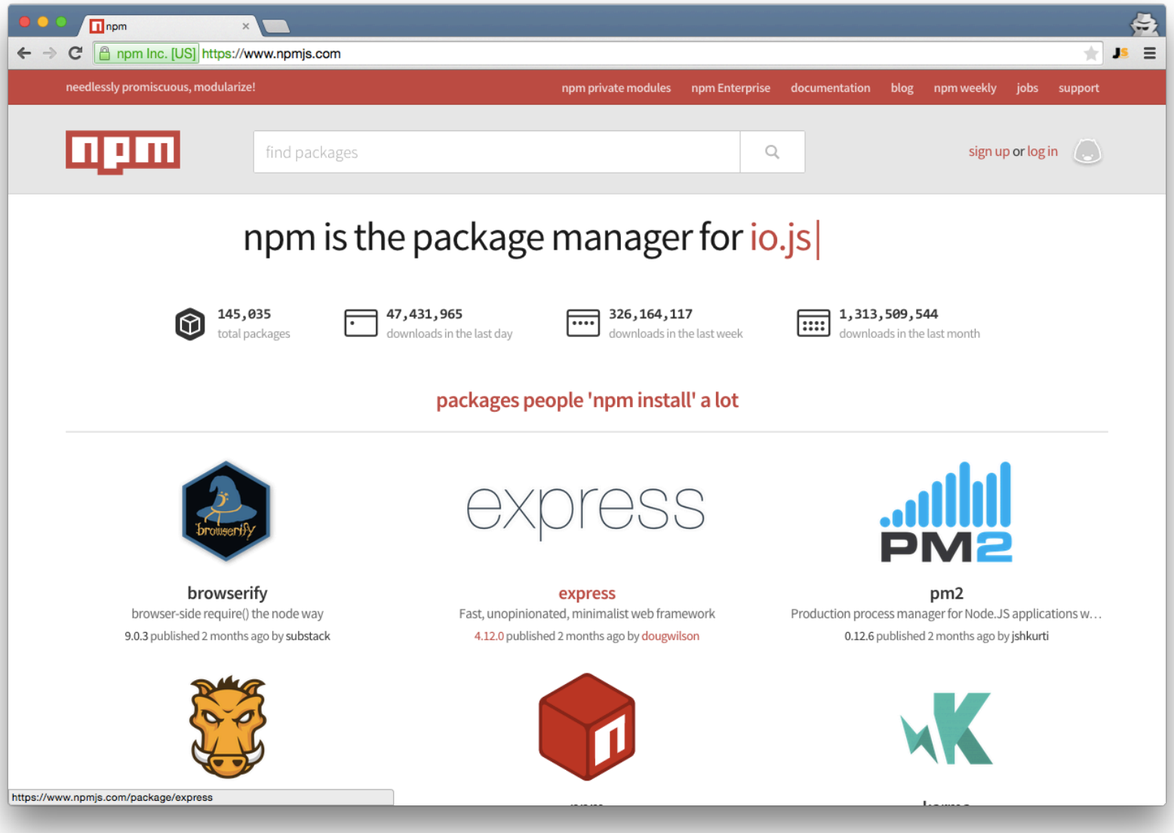
```
var Job = function() {}
require('util').inherits(Job, require('events').EventEmitter)
job = new Job()

job.on('done', function(timeDone){
  console.log('Job was pronounced done at', timeDone)
})

job.emit('done', new Date())
job.removeAllListeners()
```

npm

Meet the beast!



What is npm?

A package manager for Node.

» Website: https://www.npmjs.com/

» Command-line tool: `npm`

» Registries: public and private

Introduction to NPM

Two ways to install a module:

» Locally: most of your projects' dependencies, e.g., `express`, `request`, `hapi`

```
npm install module-name
```

» Globally: command-line tools only (mostly), e.g., `mocha`, `grunt`, `slc`

```
npm install -g module-name
```

Installing packages

```
$ npm install express
$ npm install express@4.2.0
$ npm install express@latest
$ npm install express --save
$ npm install mocha --save-dev
$ npm install grunt -g
$ sudo npm install grunt -g
```

Package.json

Creating package.json: Run init action to interactively create a package.json

```
$ npm init

This utility will walk you through creating a package.json
file.  It only covers the most common items, and tries to
guess sane defaults.

See `npm help json` for definitive documentation on these
fields and exactly what they do.

Use `npm install <pkg> --save` afterwards to install a package
and save it as a dependency in the package.json file

Press ^C at any time to quit
name: (my-package-name)
```

Package.json

```
{
  "name": "my-cool-app",
  "version": "0.1.0",
  "description": "A gret new application",
  "main": "server.js",
  "dependencies": {
    "express": "~4.2.0",
    "ws": "~0.4.25"
  },
  "devDependencies": {
    "grunt": "~0.4.0"
  }
}
```

npm

When running `npm install NAME` in a folder:

» nmp looks for node_modules or package.json

» if nothing is found it goes up the tree

Therefore, in an empty folder, create package.json or node_modules dir first.

Demo 🖥️

Sample Code:

`code/node/11-npm-cli.txt`

Public Modules & Registries

Set config values…

```
$ npm set init.author.name "Your Name"
$ npm set init.author.email "you@example.com"
$ npm set init.author.url "http://yourblog.com"
```

Sign up on the npm website and add yourself:

```
$ npm adduser
```

Publishing your module

Add `package.json` (maybe try `npm init`)

Then Publish!

```
$ cd my-cool-app
$ npm publish
```

Private Registries

» Hosted by npmjs

» Hosted by you

Advantages of private:

Code is not exposed to outside and no external dependencies (if self-hosted)

(There are strategies for deployment, e.g., tar file)

To list curently installed npm modules, use the ls action
ls lists out modules local to the current Node project

```
$ npm ls
/home/johndoe/node-app
|__ q@1.0.1
```

To list globally installed modules, add the -g flag

```
$ npm ls -g
/usr/lib
|__ bower@1.3.11
  |__ abbrev@1.0.5
  |__ archy@0.0.2
|__ semver@4.0.0
```

Search

Search for npm modules via the search action

```
$ npm search [keyword]
```

This action carries out several tasks

1. Queries the npm Registry
2. Retrieves search results
3. Prints it out to standard output

Update

To update an npm module, use the update command

```
$ npm update mysql
```

Updating only works if the module has already been installed

Remove a module

To remove an npm module

```
$ npm rm mysql
```

To remove a global module

```
$ npm rm mysql -g
```

Packaging

Module packaging in Node is done using a `package.json` file
There are many options that can be configured:

» name

» version number

» dependencies

» etc

Private Modules

The private attribute prevents accidental publishing

```
{
    "name" : "my-private-module",
    "version": "0.0.1",
    ...
    "private": true,
    ...
}
```

npm Enterprise

When to use `-g`?

A: Only for command-line tools. They usually have `bin` in package.json:

```
{
  "name": "stream-adventure",
  "version": "4.0.4",
  "description": "an educational stream adventure",
  "bin": {
    "stream-adventure": "bin/cmd.js"
  },
  "dependencies": {
    ...
```

Hello World

Web Content

Types of web content

» Static

» Dynamic

Static content

Static content is inclusive of things like image files, static html files that are already put together, and other related content that is stored on some style of drive storage and available for immediate return to a requestor via general response.

Dynamic content

Dynamic content, which is the content that is put together – or generated – by code pulling together data from data sources or other means, and then provided to the requestor.

I/O

Node.js is excellent at dynamic generation and returning content that is pure I/O in the sense of built or dynamic content.

For static content like image files and related content it is actually a great benefit to hand that off to server software that can handle the specific OS level request.

The server, request, response objects

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

http.createServer(function (req, res) {
  res.writeHead(200, {'Content-Type': 'text/plain'})
  res.end('Hello World\n')
}).listen(1337, '127.0.0.1')

console.log('Server running at http://127.0.0.1:1337/')
```

Running the App

Run with:

```
$ node server.js
```

Send requests:

```
$ curl http://localhost:1337
```

Or

http://localhost:1337

HTTP Object

Http object:

https://nodejs.org/api/http.html
https://nodejs.org/api/http.html#http_class_http_server

```
var server = http.createServer([requestListener])
server.listen(port[, hostname][, backlog][, callback])
```

HTTP Response

```
response.writeHead(200, {
  'Content-Length': body.length,
  'Content-Type': 'text/plain' })
```

Demo

Sample Code (`code/node`):

1. `code/node/08-nodejs-app.js`
2. `code/node/09-nodejs-app2.js`
3. `code/node/static-app-project`

Testing

assert:

```
const asesrt = require ('assert')
```

Chai Should

```
const should = require('chai').should()
```

code/node/escape.test.js

Starting learnyounode

Install:

```
$ sudo npm install learnyounode -g
```

Start:

```
$ learnyounode
```

Verifying `learnyounode`

Verify solution with:

```
$ learnyounode verify program.js
```

`learnyounode` Workshop

1. Pick the first problem
2. Read instructions
3. Solve the problem (e.g., create `program.js`)
4. Verify
5. Pick the next problem