

ROME - APRIL 13/14 2018

{codemotion}

{ Node.js Native AddOns from zero to hero }

Nicola Del Gobbo



Who is Nicola Del Gobbo?

Developer

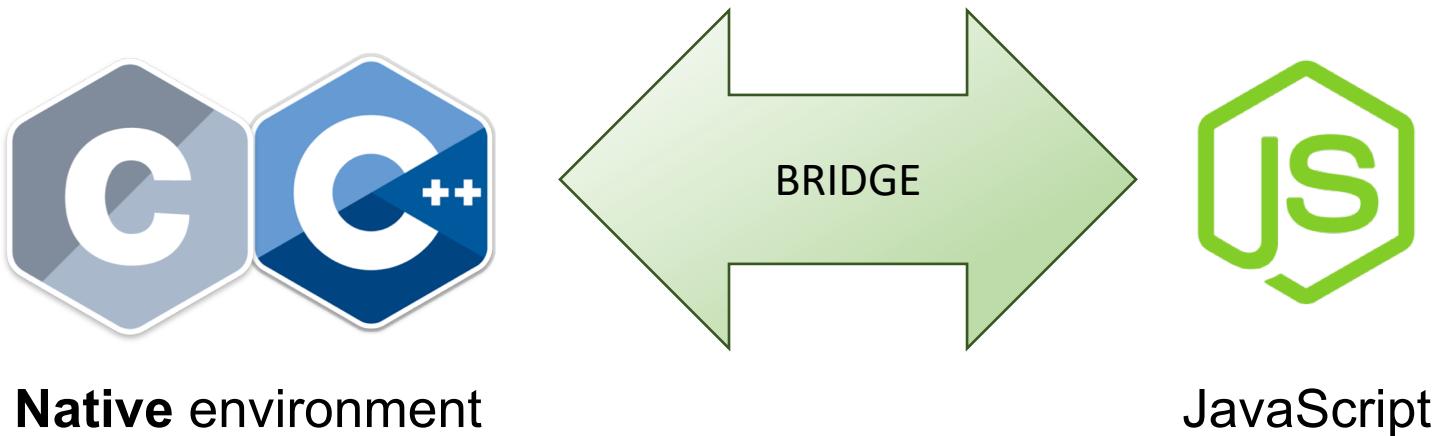


open source

N-API TEAM

What is Node.js Native Addon?

C / C++ code called from **JavaScript**



From Node.js documentation

*Node.js Addons are **dynamically-linked shared objects**, written in **C++**, that can be loaded into Node.js using the **require()** function, and used just as if they were an ordinary Node.js module.*

*They are used primarily to provide an **interface** between **JavaScript** running in Node.js and **C/C++** libraries.*

How is it possible?

All the **magic** is behind the **Node.js** architecture

Node.js API

Node.js Bindings

C / C++ Addons



c-ares

HTTP
parser

Open
SSL

zlib

nghttp2

Why?

Performance

In general **C / C++** code performs better than JavaScript code, but it's not always true.

Image processing (in average 6 times faster)

Video processing

CRC cyclic redundancy check (in average 125 times faster)

Compression

Scientific calculus

Algorithms that execute CPU heavy tasks

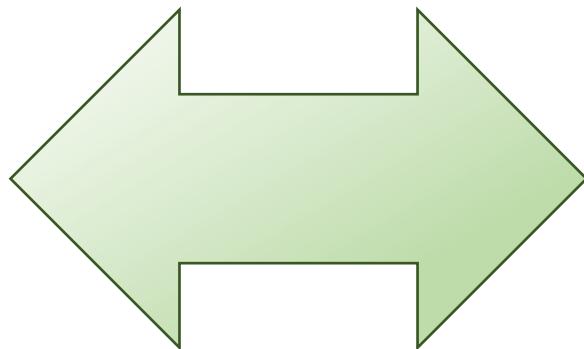
Why?

Integrate legacy application

You have the source code of an **old C / C++** application and want to expose something of its functionalities

```
#include <stdio.h>
int main(void)
{
    printf("Hello World!\n");
    return 0;
}
```

C/C++



Why?

You don't find what fits your specific needs on **npm**

Sometimes completely implementing the module
in **JavaScript** is not the right solution

Think at libraries like:

ImageMagick

Ghostscript

FFmpeg

TensorFlow

...

Why?

Better error handling

Even if you will use **an old C / C++ library** you will get an error code that explains the error that just happened

In **new C / C++ library** you have the **exception**

You don't have to parse some string to identify if there was an error and what kind of it

Problems

Fragmentation API

The API to implement native add-ons have been changed across different version of Node.js

Most of the changes were on **V8 API** and **ObjectWrap API**



0.8 - 0.10.x - 0.12.x - 1.x - 2.x - 3.x - 4.x - 5.x - 6.x - 7.x - 8.x - 9.x

For more info <http://v8docs.nodesource.com/>

Problems

Need an adapter to stay compatible across different version of Node.js

- **NAN** - Native Abstraction for Node.js
 - **API compatibility**
 - Strong bonded with **V8 API**
 - You have to recompile your native add-ons switching to different version of Node.js

Problems

End user

```
| was compiled against a different Node.js version using
| NODE_MODULE_VERSION 51. This version of Node.js requires
| NODE_MODULE_VERSION 57. Please try re-compiling or re-installing
| the module (for instance, using `npm rebuild` or `npm install`).
```

Maintainers



was compiled against a different Node.js version using

#117

was compiled against a different Node.js version using NODE_MODULE_VERSION 59. This version of Node.js requires NODE_MODULE_VERSION 57. Please try re-compiling or re-installing the module (for ...)

JCMais/node-libcurl Opened by gSION on 6 Mar 1 comment

Problems

Write portable C / C++ code

Your native code **must compile and run** on different:

ARCHITECTURE

PLATFORM

COMPILER

Problems

Documentation

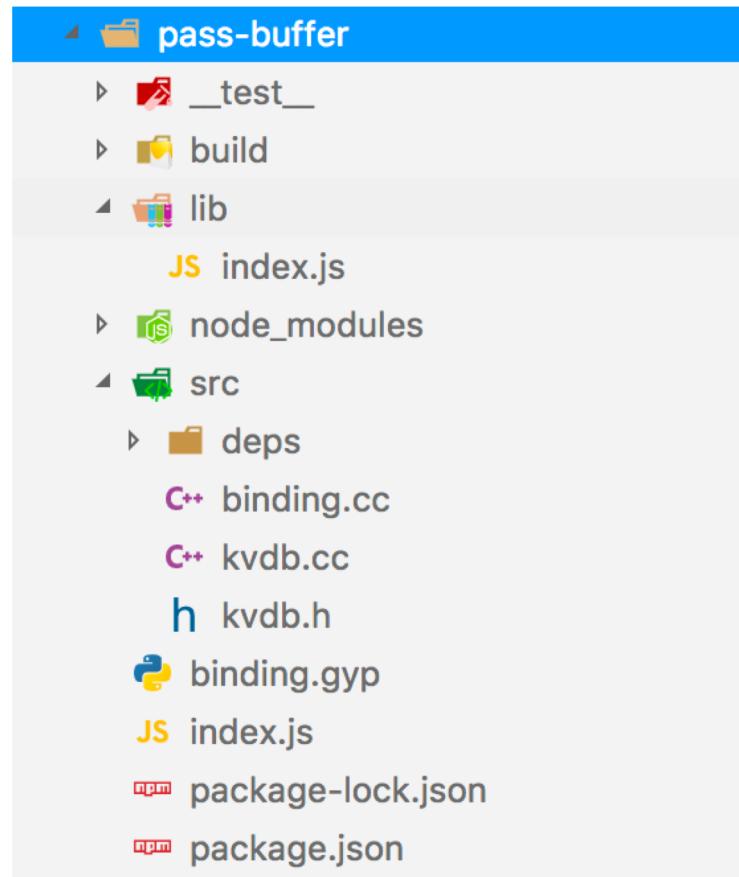
- **C / C++** libraries that you are integrating are not well documented
- There are good **references** but not so much practical guide focusing on complex concepts about native add-ons

N-API

N-API will a game changer on the native add-on development

- **API** and **ABI** compatibility
- **Isolated** from **V8** (VM agnostic)
- New **ES6** types
- C / C++ (only header wrapper)
- **Conversion** tool that helps to migrate from **NAN**
- **Generator** (help with initial scaffolding)
- Pre-builds (**node-pre-gyp** - **prebuildify**)

How to organize your project



Example: the JavaScript part

```
{  
  "name": "echo-example",  
  "version": "0.0.0",  
  "description": "Node.js Addons – echo example",  
  "main": "index.js",  
  "private": true,  
  "gypfile": true,  
  "scripts": {  
    "start": "node index.js"  
  },  
  "dependencies": {  
    "node-addon-api": "*",  
    "bindings": "*"  
  }  
}
```

npm will build the add-on automatically

Example: the JavaScript part

1

Import the add-on

```
const addon = require('bindings')('echo')
```

2

Call the add-on's function

```
let myEcho = addon.echo('Hey coders!')  
console.log(myEcho)
```

Example: the binding.gyp

```
{  
  "targets": [  
    {  
      "target_name": "echo",  
      "sources": [  
        "src/addon.cc"  
      ],  
      "cflags!": [ '-fno-exceptions' ],  
      "cflags_cc!": [ '-fno-exceptions' ],  
      "include_dirs": [ "<!@(node -p \\\"require('node-addon-api').include\\\")" ],  
      "dependencies": [ "<!(node -p \\\"require('node-addon-api').gyp\\\")" ],  
      "conditions": [  
        ['OS=="win"', {  
          "msvs_settings": {  
            "VCCLCompilerTool": {  
              "ExceptionHandling": 1  
            }  
          }  
        }],  
        ['OS=="mac"', {  
          "xcode_settings": {  
            "CLANG_CXX_LIBRARY": "libc++",  
            "GCC_ENABLE_CPP_EXCEPTIONS": 'YES',  
            "MACOSX_DEPLOYMENT_TARGET": '10.7'  
          }  
        }]  
      ]  
    }  
  ]  
}
```

Name used to register the addon

Example: the C / C++ part

```
Napi::Value Echo(const Napi::CallbackInfo& info) {
    Napi::Env env = info.Env();

    3
    Validate your input - Execute operations on them - Return results

    if (info[0].IsString()) {
        std::string in = info[0].As<Napi::String>();
        return Napi::String::New(env, in);
    } else {
        throw Napi::Error::New(env, "The argument must be a string");
    }
}
```

2 Export objects and functions

```
// Init
Napi::Object Init(Napi::Env env, Napi::Object exports) {
    exports.Set(Napi::String::New(env, "echo"), Napi::Function::New(env, Echo));
    return exports;
}
```

1 Registration and Initialization

```
NODE_API_MODULE(NODE_GYP_MODULE_NAME, Init);
```

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package.json — conf-cd-rome-2018

EXPLORER

- OPEN EDITORS
 - package.json 00-echo
- CONF-CD-ROME-2018
 - 00-echo
 - build
 - node_modules
 - src
 - addon.cc
 - .gitignore
 - binding.gyp
 - index.js
 - package-lock.json
 - package.json
- 01-pass-function
- 02-async-worker
- 03-vedis-napi
- 04-addon-event-emitter
- 05-addon-stream
- slides
- .gitignore
- LICENSE
- README.md

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GITLENS

AZURE FUNCTIONS

master 0 0 0 NickNaso, a day ago Ln 1, Col 1 Spaces: 2 UTF-8 LF JSON ESLint Prettier

```
1  [NickNaso, a day ago * Added first example
2  "name": "echo-example",
3  "version": "0.0.0",
4  "description": "Node.js Addons - echo example",
5  "main": "index.js",
6  "private": true,
7  "gypfile": true,
8  "scripts": {
9    "start": "node index.js"
10 },
11 "dependencies": {
12   "node-addon-api": "*",
13   "bindings": "*"
14 }
15 ]
16 ]
```

Asynchronous code

```
const addon = require('bindings')('echo')

function callback(err, data) {
  if (err) {
    console.error(err)
  } else {
    console.log(data)
  }
}
```

```
addon.echo('Hey coders!', callback) 2
```

```
console.log('My next code ...') 1
```

Asynchronous code

```
void Echo(const Napi::CallbackInfo& info) {
    Napi::Env env = info.Env();
    // You need to check the input data here
    Napi::Function cb = info[1].As<Napi::Function>();
    std::string in = info[0].As<Napi::String>();
    // std::this_thread::sleep_for(std::chrono::seconds(1));
    // In case of error
    // Napi::Error::New(env, "Error ...").Value()
}
```

Call a callback and return the result back

```
cb.Call({env.Null(), Napi::String::New(env, in)});
```

```
}
```

index.js — conf-cd-rome-2018

NickNaso, a day ago • Pass function example

```
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12 * See the Apache Version 2.0 License for specific language governing
13 * permissions and limitations under the License.
14 *
15 * Contributors - initial API implementation:
16 * Nicola Del Gobbo <nicoladelgobbo@gmail.com>
17 ****
18
19 'use strict'
20
21 const addon = require('bindings')('echo') 6.2K (gzipped: 2.5K)
22
23 Complexity is 3 Everything is cool
24 function callback(err, data) {
25   if (err) {
26     console.error(err)
27   } else {
28     console.log(data)
29   }
30
31 addon.echo('Hey coders!', callback)
32
33 console.log('My next code ...')
```

EXPLORER

- OPEN EDITORS
- JS index.js 01-pass-function
- CONF-CD-ROME-2018
 - 00-echo
 - 01-pass-function
 - build
 - node_modules
 - src
 - .gitignore
 - binding.gyp
 - JS index.js
- package-lock.json
- package.json
- 02-async-worker
- 03-vedis-napi
- 04-addon-event-emitter
- 05-addon-stream
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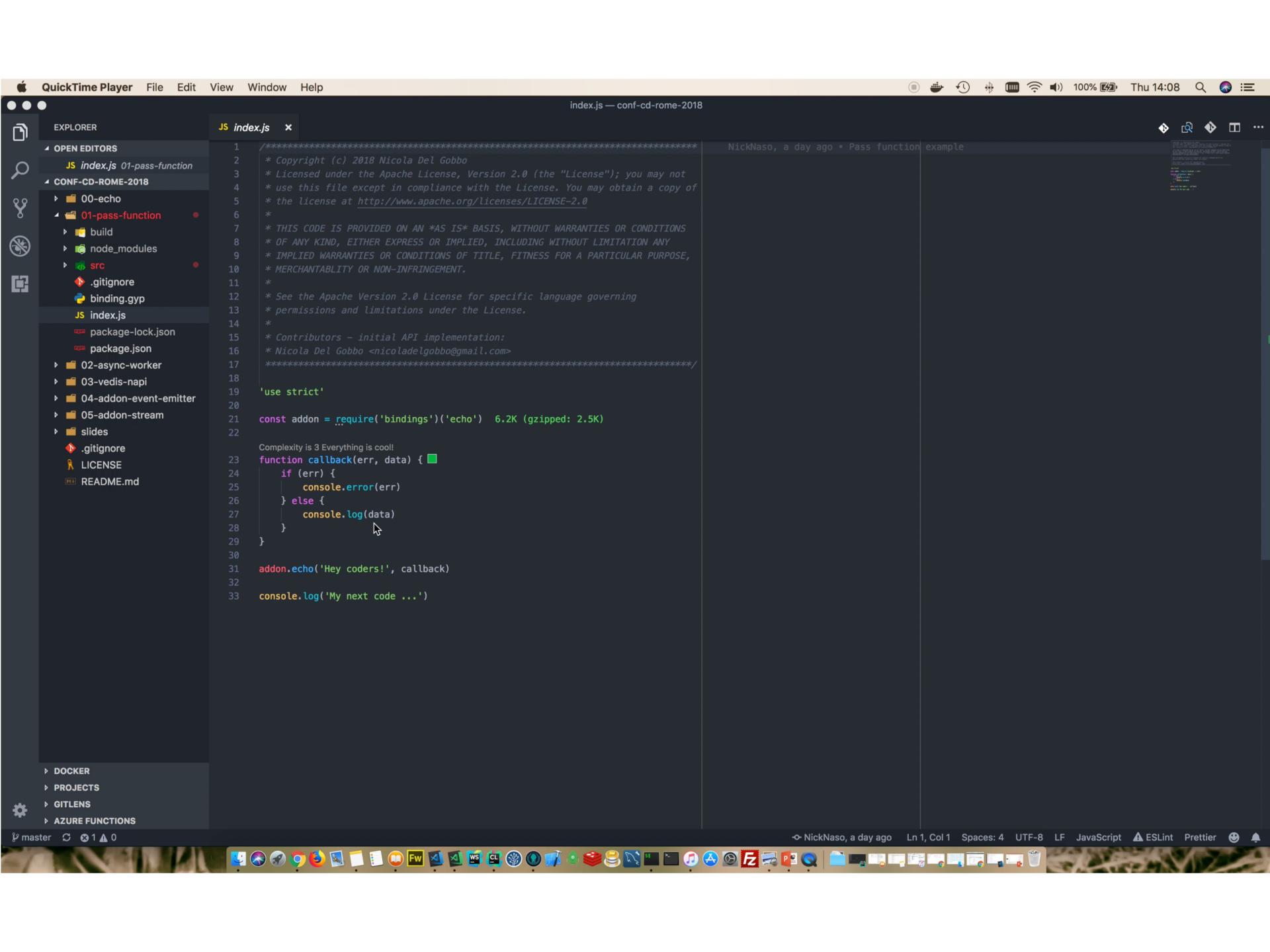
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AZURE FUNCTIONS

master 0 1 0

NickNaso, a day ago Ln 1, Col 1 Spaces: 4 UTF-8 LF JavaScript ▲ ESLint Prettier



Asynchronous code

Preserve reference to function we want call

Create worker threads using libuv

Handle the results

AsyncWorker

```
class EchoWorker : public Napi::AsyncWorker {  
public:  
    EchoWorker(Napi::Function& callback, std::string& echo)  
        : Napi::AsyncWorker(callback), echo(echo) {}  
  
    ~EchoWorker() {}
```

1

This code will be executed on the Worker Thread

```
// This code will be executed on the worker thread  
void Execute() {  
    // Need to simulate cpu heavy task  
    std::this_thread::sleep_for(std::chrono::seconds(1));  
    // std::cout << echo << std::endl;  
}
```

2

When the Execute method ends its computation the results will be reassembled and passed to JS context

```
void OnOK() {  
    Napi::HandleScope scope(Env());  
    Callback().Call({Env().Null(), Napi::String::New(Env(), echo)});  
}  
  
private:  
    std::string echo;  
};
```

AsyncWorker

```
Napi::Value Echo(const Napi::CallbackInfo& info) {  
    // You need to check the input data here  
    Napi::Function cb = info[1].As<Napi::Function>();  
    std::string in = info[0].As<Napi::String>();
```

1

Create an AsyncWorker asynchronously via libuv

```
EchoWorker* wk = new EchoWorker(cb, in);  
wk->Queue();
```

2

Return immediately

```
return info.Env().Undefined();  
}
```

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index.js — conf-cd-rome-2018

EXPLORER

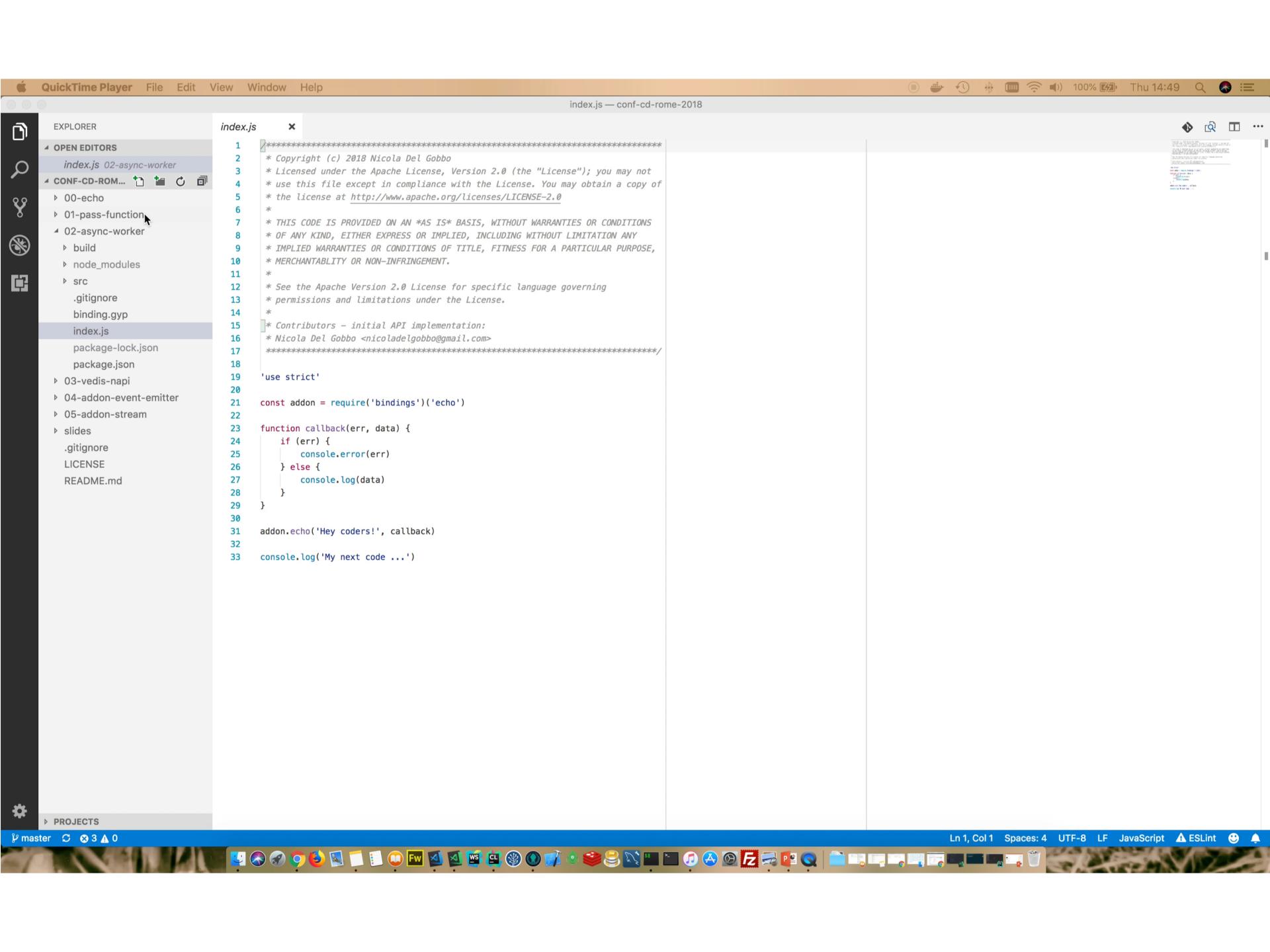
- OPEN EDITORS
- index.js 02-async-worker
- CONF-CD-ROM...
- 00-echo
- 01-pass-function
- 02-async-worker
 - build
 - node_modules
 - src
 - .gitignore
 - binding.gyp
 - index.js
 - package-lock.json
 - package.json
- 03-vedis-napi
- 04-addon-event-emitter
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index.js

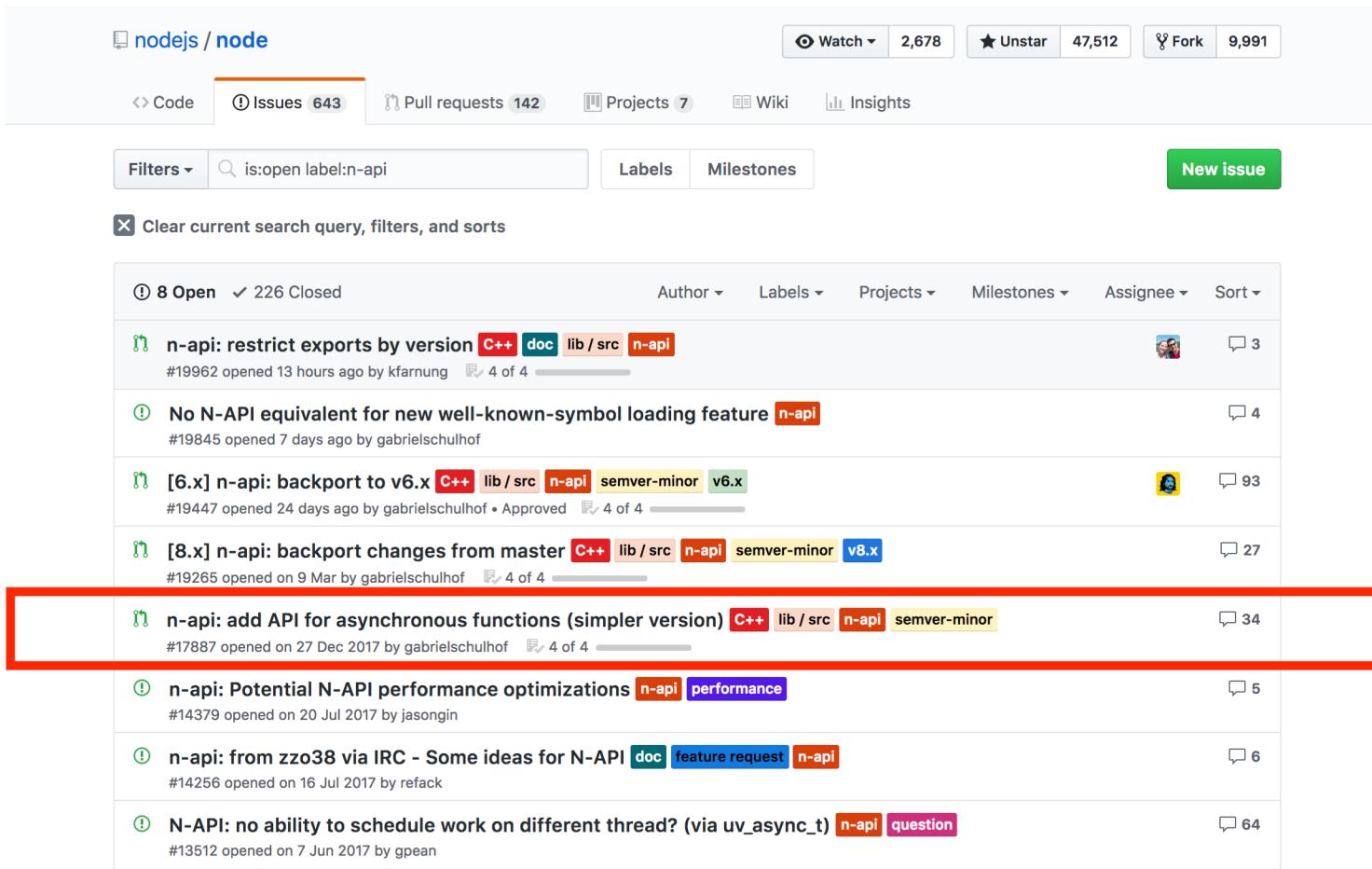
```
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13 * permissions and limitations under the License.
14 *
15 /* Contributors - initial API implementation:
16 * Nicola Del Gobbo <nicoladelgobbo@gmail.com>
17 ****
18
19 'use strict'
20
21 const addon = require('bindings')('echo')
22
23 function callback(err, data) {
24     if (err) {
25         console.error(err)
26     } else {
27         console.log(data)
28     }
29 }
30
31 addon.echo('Hey coders!', callback)
32
33 console.log('My next code ...')
```

Ln 1, Col 1 Spaces: 4 UTF-8 LF JavaScript ESLint



AsyncWorker

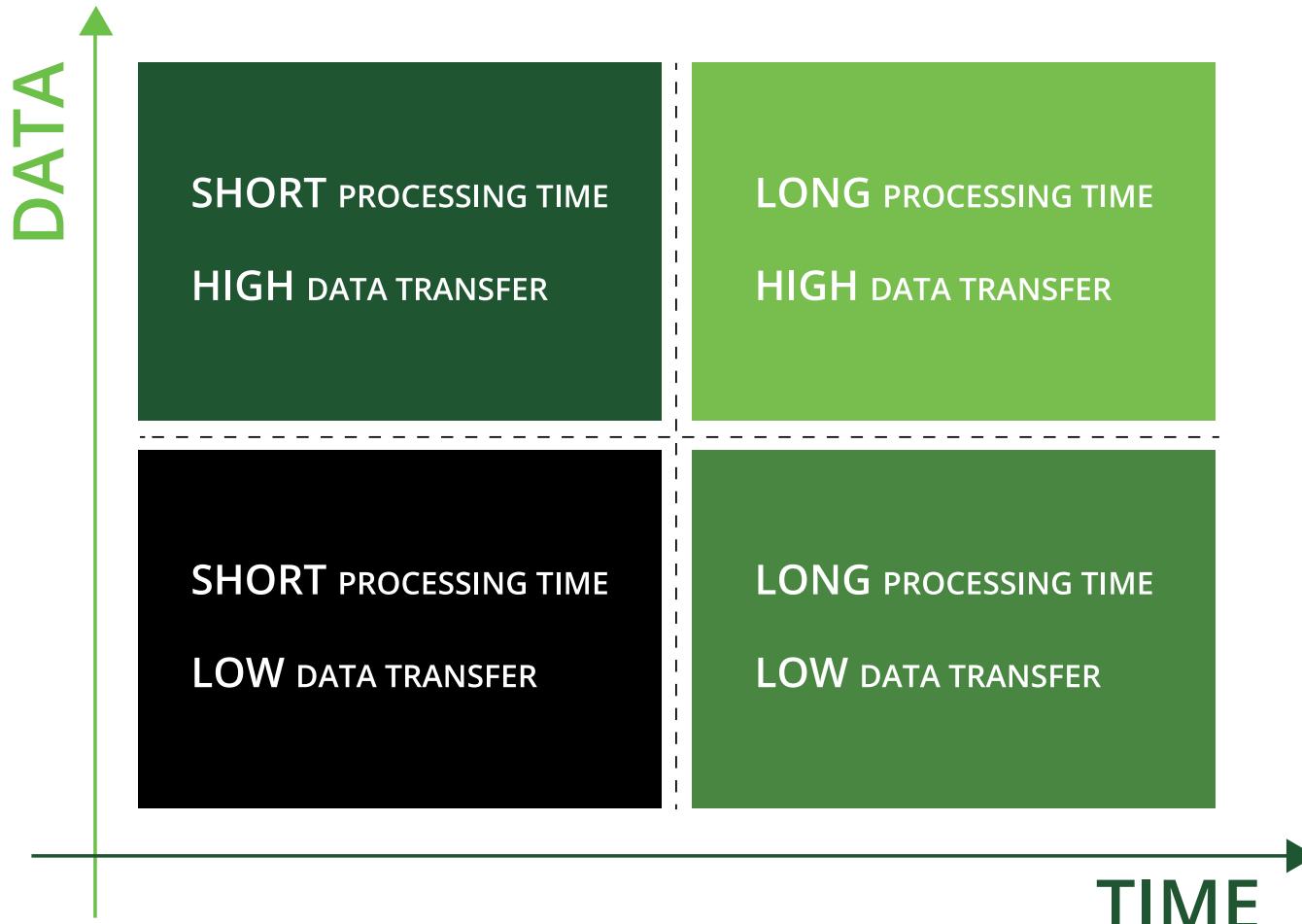
You cannot call JavaScript function from the Worker Thread until this PR will be landed



The screenshot shows the GitHub repository for Node.js. The 'Issues' tab is selected, displaying 643 open issues. A search bar at the top is set to 'is:open label:n-api'. The main list shows several issues related to the 'n-api' module, including backports and performance optimizations. One specific issue, '#17887', is highlighted with a red box. This issue, titled 'n-api: add API for asynchronous functions (simpler version)', was opened on December 27, 2017, by gabrielschulhof. It has 34 comments and is currently at '4 of 4' in the review process. The issue is labeled with C++, lib / src, n-api, and semver-minor.

Issue #	Title	Author	Labels	Comments	Status
#19962	n-api: restrict exports by version	kfarnung	C++, doc, lib / src, n-api	3	Open
#19845	No N-API equivalent for new well-known-symbol loading feature	gabrielschulhof	n-api	4	Open
#19447	[6.x] n-api: backport to v6.x	gabrielschulhof	C++, lib / src, n-api, semver-minor, v6.x	93	Open
#19265	[8.x] n-api: backport changes from master	gabrielschulhof	C++, lib / src, n-api, semver-minor, v8.x	27	Open
#17887	n-api: add API for asynchronous functions (simpler version)	gabrielschulhof	C++, lib / src, n-api, semver-minor	34	Open
#14379	n-api: Potential N-API performance optimizations	jasongin	n-api, performance	5	Open
#14256	n-api: from zzo38 via IRC - Some ideas for N-API	refack	doc, feature request, n-api	6	Open
#13512	N-API: no ability to schedule work on different thread? (via uv_async_t)	gpmean	n-api, question	64	Open

Which kind of add-on should you implement?



TIME: Amount of processing time spent on the **C++** code

DATA: Amount of data flowing between **C++** and **JavaScript**

ObjectWrap API

- **ObjectWrap** is a way to expose your C++ code to JavaScript
- You have to extend **ObjectWrap** class that includes the plumbing to connect JavaScript code to a C++ object
- Classes extending **ObjectWrap** can be instantiated from JavaScript using the **new** operator, and their methods can be **directly invoked from JavaScript**
- Unfortunately, the **wrap** part really refers to a way to group methods and state
- It's **your responsibility write custom code to bridge** each of your C++ class methods.

Implement key value database

Binding to **Vedis** an embeddable datastore **C** library



```
const { Database } = require('bindings')('kvdb')

const mydb = new Database('test', './tmp-sync')
console.log(mydb.db_name)

mydb.putKeySync("username", "NickNaso");
console.log(mydb.getKeySync("username"));
```

```
mydb.putKey('password', 'keeplooking', function (err) {
  if (err) {
    console.error(err)
  } else {
    console.log("Value stored")
  }
})

mydb.getKey('username', function(err, value) {
  if (err) {
    console.error(err)
  } else {
    console.log('Value from my async API')
    console.log(value)
  }
})
```

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binding.cc — conf-cd-rome-2018

EXPLORER

- OPEN EDITORS
- binding.cc 03-vedis-napi/src
- CONF-CD-ROME-2018
- 00-echo
- 01-pass-function
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- 03-vedis-napi
 - build
 - node_modules
 - src
 - binding.cc
 - kvdb.cc
 - kvdb.h
 - deps
 - binding.gyp
 - nodejs.png
 - package-lock.json
 - package.json
 - start-async.js
 - start-buffer.js
 - start.js
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- 05-addon-stream
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binding.cc

```
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10 * MERCHANTABILITY OR NON-INFRINGEMENT.
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12 * See the Apache Version 2.0 License for specific language governing
13 * permissions and limitations under the License.
14 *
15 * Contributors - initial API implementation:
16 * Nicola Del Gobbo <nicoladegobbo@gmail.com>
17 ****
18
19 #include <napi.h>
20 #include "kvdb.h"
21
22
23 Napi::Object Init(Napi::Env env, Napi::Object exports) {
24     KVDB::Database::Init(env, exports); Nicola Del Gobbo, 2 days ago • Added vedis example
25     return exports;
26 }
27
28 NODE_API_MODULE(kvdb, Init)
```

Init(Napi::Env env, Napi::Object exports) Nicola Del Gobbo, 2 days ago Ln 24, Col 25 (4 selected) Spaces: 2 UTF-8 LF C++ Mac ESLint

Event Emitter

Much of the Node.js core API modules are built around an idiomatic asynchronous event-driven architecture in which certain kinds of objects (called **emitter**) periodically emit named events that cause Function objects ("listeners") to be called.

- Emit event from **C++**
- Implement a native add-on object that inherits from Event Emitter

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index.js — conf-cd-rome-2018

EXPLORER

OPEN EDITORS

JS index.js 04-addon-event-emitter/00

CONF-CD-ROME-2018

- 00-echo
- 01-pass-function
- 02-async-worker
- 03-vedis-napi
- 04-addon-event-emitter
 - 00
 - build
 - node_modules
 - src
 - binding.gyp
 - JS index.js
 - package-lock.json
 - package.json
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 - .gitignore
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 - README.md
- 05-addon-stream
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JS index.js

```
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13 * permissions and limitations under the License.
14 *
15 * Contributors - initial API implementation:
16 * Nicola Del Gobbo <nicoladegobbo@gmail.com>
17 ****
18
19 'use strict'
20
21 const EventEmitter = require('events').EventEmitter
22 const addon = require('bindings')('emit_from_cpp') 6.2K (gzipped: 2.5K)
23
24 const emitter = new EventEmitter()
25
26 emitter.on('start', () => {
27   console.log('## START ...')
28 })
29 emitter.on('data', (evt) => {
30   console.log(evt);
31 })
32
33 emitter.on('end', () => {
34   console.log('## END ##')
35 })
36
37 addon.callEmit(emitter.emit.bind(emitter))
```

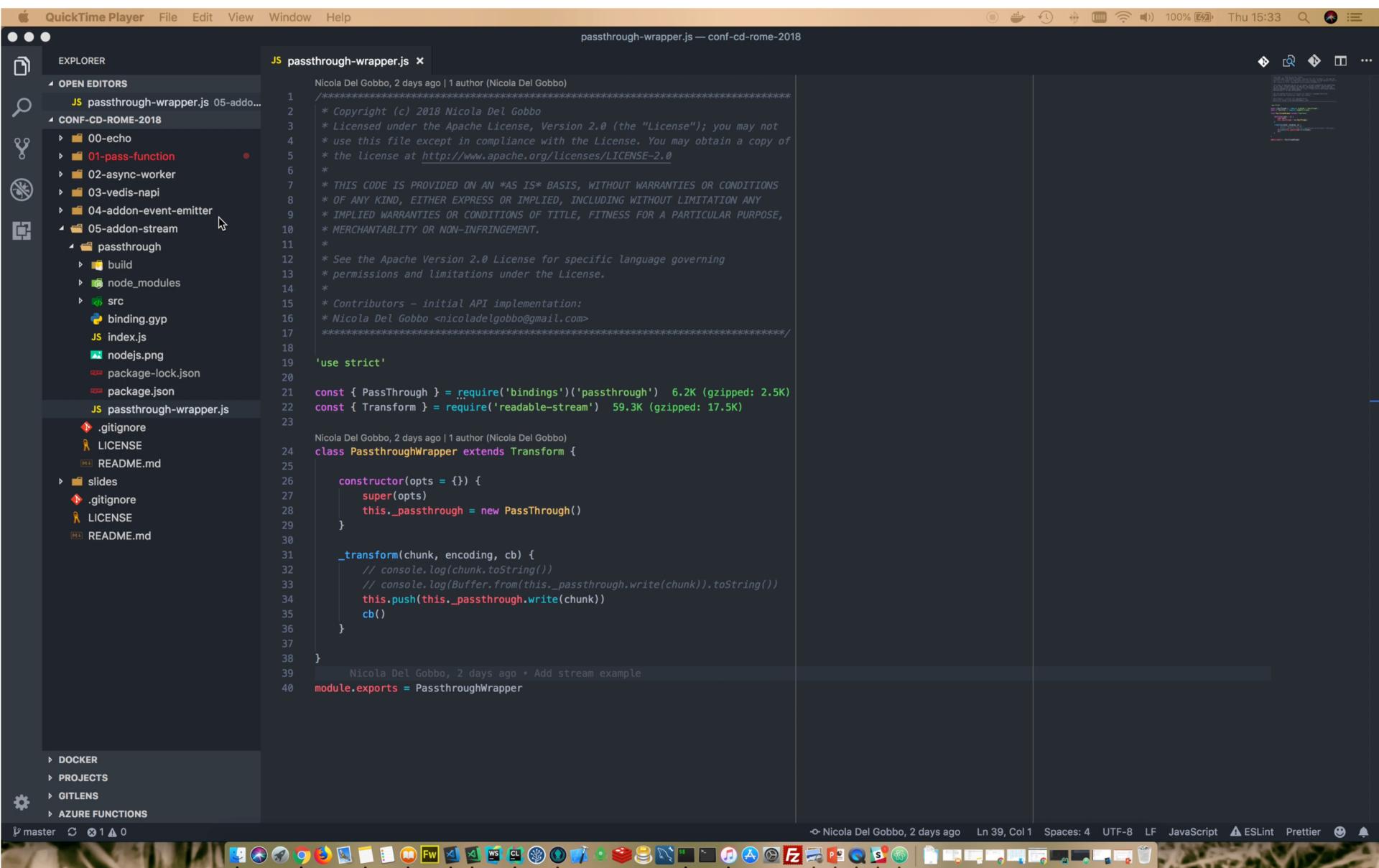
Nicola Del Gobbo, 2 days ago • Added event emitter examples

Nicola Del Gobbo, 2 days ago Ln 37, Col 43 Spaces: 4 UTF-8 LF JavaScript ▲ ESLint Prettier

Stream

A stream is an abstract interface for working with streaming data in Node.js. The stream module provides a base API that makes it easy to build objects that implement the stream interface.

Using **Transform** stream to pass and get back data from a native add-on



Lessons learned

- Create **simple interface** between C / C++ and JavaScript
- Insert **complexity** on the JavaScript side
- Think **carefully** at **JavaScript** interface
- Use **ObjectWrap** API to return C / C++ object to JavaScript
- Validate the **types** on the native side
- Expose **only the functionalities you need**
- **Don't block the event loop**, stay **asynchronous**: this is a must if you will use the add-ons in high performance services
- Use **Buffer** to pass big quantity of data

Present and future

- The largest number of native addons is written using **NAN**
- N-API will be go out of experimental very soon
- Backports for 8.x
- Backports for 6.x
- Documentation for **node-addon-api**
- Porting preexistentes native addon-ons to N-API
- Investigate how to use prebuild with N-API

Thanks!



nicoladelgobbo@gmail.com

[@NickNaso](https://twitter.com/NickNaso) on Twitter

Don't be afraid sometimes it's a good thing dirty your hands
with a little of C++

All examples and materials are here

<https://github.com/NickNaso/conf-cd-rome-2018>