
Build the C link
Nikhil Marathe

Introduction

- V8 is a powerful, **fast** JavaScript engine
- It is self contained and easy to embed

  JS is the new Lua?
- node.js is a thin wrapper around V8 and evented I/O (*libuv*)

Follow along

Slides and code

```
git clone git://github.com/nikhilm/jsfoo-pune-2012.git
```

We want to

Use C/C++ libraries in node.js

Exchange data between C++ ⇔ JS

Do asynchronous I/O

Getting started

```
#include <v8.h>
#include <node.h>

using namespace v8;

extern "C" {
    static void Init(Handle<Object> target) {
    }
    NODE_MODULE(firststep, Init)
}
```

Build

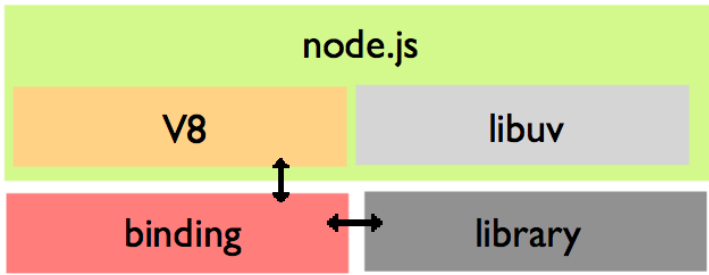
```
# firststep/wscript
import Options

def set_options(opt):
    opt.tool_options("compiler_cxx")

def configure(conf):
    conf.check_tool("compiler_cxx")
    conf.check_tool("node_addon")

def build(bld):
    obj = bld.new_task_gen("cxx", "shlib", "node_addon")
    obj.target = "firststep"
    obj.source = "firststep.cc"
```

Run

```
$ node-waf configure build
...
'build' finished successfully (0.327s)

$ node
```

```
> require('./build/Release/firststep')
{}
```

Architecture



you **will** need http://bespin.cz/~ondras/html/index.html

Handles

- Think of them as **smart pointers**, GCed by V8
- Also encode scope (Use *HandleScope* to manage handles)
- Local - GCed as they go out of scope:

```
Local<String> name; // also Handle<...>
```

- Persistent - Must be manually disposed:

```
Persistent<String> globalVariable;
```

Injecting primitives

```
#include <math.h>
#include <v8.h>
#include <node.h>
#include <node_version.h>
using namespace v8;

extern "C" {
    static void Init(Handle<Object> target) {
        target->Set(String::NewSymbol("pi"),
                    Number::New(M_PI));

        NODE_DEFINE_CONSTANT(target, NODE_MINOR_VERSION);

        target->Set(String::New("name"), String::New("Nikhil"));
    }
    NODE_MODULE(primitives, Init)
}
```

Simple functions

```
exports.square = function(n) {
    return n * n;
}
```

We want to do this in C++

Simple functions

Registering with V8:

```
Handle<Value> Square(const Arguments &args)
```

```
static void Init(Handle<Object> target) {
        HandleScope scope;

        Handle<FunctionTemplate> squareTpl =
            FunctionTemplate::New(Square);

        target->Set(String::New("square"),
                    squareTpl->GetFunction());
    }
```

Simple functions

Implementation:

```
Handle<Value> Square(const Arguments &args) {
    HandleScope scope;

    int a = args[0]->Int32Value();
    int sq = a * a;

    return scope.Close(Integer::New(sq));
}
```

explain scope.Close

Templates

```
FunctionTemplate                          ???

FunctionTemplate::GetFunction             square [Function]

FunctionTemplate::InstanceTemplate()      What `this` would be in 'new square()'

FunctionTemplate::PrototypeTemplate()     square.prototype
```

Simple objects

```
exports.Inventory = function() {
    this.items = 257;
}

// later
var iv = new Inventory();
console.log(iv.items);
```

This is the classic object oriented JS style

Simple objects

```
static void Init(Handle<Object> target) {
        HandleScope scope;

        Handle<FunctionTemplate> inventoryTpl =
            FunctionTemplate::New(Inventory);

        Handle<ObjectTemplate> instance =
            inventoryTpl->InstanceTemplate();

        instance->Set(String::New("items"), Integer::New(257));

        target->Set(String::NewSymbol("Inventory"),
                    inventoryTpl->GetFunction());
    }
```

```
Handle<Value> Inventory(const Arguments &args) {
    return args.This();
```

```
}
```

Methods

```
Inventory.prototype.addStock = function(newStock) {
    this.items += newStock;
}

Inventory.prototype.ship = function(orders) {
    if (this.items < orders)
        throw Exception("Not enough items");

    this.items -= orders
}
```

Methods

Registering prototype methods

```
// operating on inventoryTpl->PrototypeTemplate()
        NODE_SET_PROTOTYPE_METHOD(inventoryTpl,
                                  "addStock",
                                  AddStock);
        NODE_SET_PROTOTYPE_METHOD(inventoryTpl,
                                  "ship",
                                  Ship);

        target->Set(String::NewSymbol("Inventory"),
                    inventoryTpl->GetFunction());
```

Methods

Accessing object properties

```
Handle<Value> AddStock(const Arguments &args) {
    HandleScope scope;

    Handle<Object> This = args.This();

    int items = This->Get(String::New("items"))->Uint32Value();

    items += args[0]->Uint32Value();

    This->Set(String::New("items"), Integer::New(items));

    return Undefined();
}
```

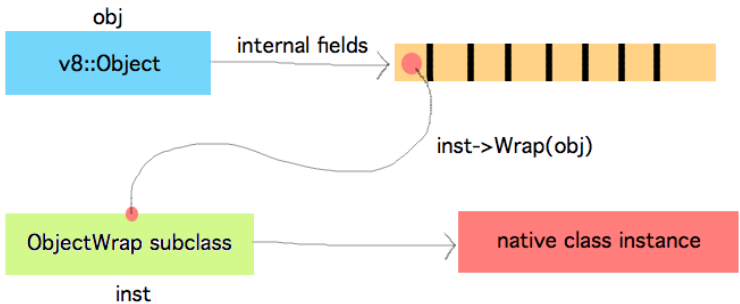
Methods

Throwing an exception

```
Handle<Value> Ship(const Arguments &args) {
    HandleScope scope;

    Handle<Object> This = args.This();
    int items = This->Get(String::New("items"))->Uint32Value();

    int orders = args[0]->Uint32Value();

    if (items < orders)
        return ThrowException(String::New("Not enough items"));

    This->Set(String::New("items"), Integer::New(items - orders));

    return Undefined();
}
```

ObjectWrap

- Associate native C++ objects with JS objects
- Node specific class which manages garbage collection
- Stored internally in fields



ObjectWrap

```
// native C++ class
namespace Library {
class Inventory {
    Inventory();
    void addStock(int);
    int ship(int);
    int getItems();

    int items; // private
};
}
```

ObjectWrap

Setting internal field count

```
Handle<ObjectTemplate> instance =
            inventoryTpl->InstanceTemplate();

        instance->SetInternalFieldCount(1);
```

ObjectWrap

Wrapping

```
namespace binding {
class Inventory : public ObjectWrap {
public:
    static Handle<Value> New(const Arguments &args) {
        Inventory *wrapper = new Inventory();
        wrapper->Wrap(args.Holder());
        return args.Holder();
    }
```

ObjectWrap

Unwrapping

```
static Handle<Value> Ship(const Arguments &args) {
        // extract
        Inventory *wrapper = Unwrap<Inventory>(args.Holder());

        int orders = args[0]->Uint32Value();
        int result = wrapper->inv->ship(orders);

        if (result == -1)
            return ThrowException(String::New("Not enough items"));

        return Undefined();
    }
```

Going Async

- The easiest way is to use *uv_queue_work()*
- **Every async call requires a set of 3 functions**
    1. Set up and invoke *uv_queue_work()*
    2. Do blocking task (run in separate thread)
    3. Clean up (run in main thread)
- **Use a 'baton' to pass around data**
    - *uv_request_t* is used by *libuv*
    - But it's *data* field is important to store the baton itself
- Slightly cumbersome :(

Going Async

```
var inv = new (require('./build/Release/async')).Inventory()

inv.reshelve(function() {
    console.log("Reshelving done");
})
console.log("After reshelve in source");
for (var i = 1; i < 5; i++)
    setTimeout(function() {
        console.log("Tick");
    }, i*1000);
```

Going Async

The native blocking code (method of class *Library::Inventory*)

```
void reshelve() {
        sleep(5);
    }
```

Going Async

The baton

```
struct ReshelveBaton {
    uv_work_t request;
    Persistent<Function> callback;
    Inventory *wrapper;
    // any other data that has to be sent to the callback
    // or for async processing.
}
```

Going Async

JS callback

```
static Handle<Value> Reshelve(const Arguments &args) {
        Inventory *wrapper = Unwrap<Inventory>(args.Holder());

        Handle<Function> cb = Handle<Function>::Cast(args[0]);

        ReshelveBaton *baton = new ReshelveBaton();
        baton->request.data = baton;
        baton->callback = Persistent<Function>::New(cb);
        baton->wrapper = wrapper;

        uv_queue_work(Loop(), &baton->request,
                      ReshelveAsync, ReshelveAsyncAfter);

        return Undefined();
    }
```

Going Async

Thread pool function

```
static void ReshelveAsync(uv_work_t *req) {
        // This runs in a separate thread
        // NO V8 interaction should be done
        ReshelveBaton *baton =
            static_cast<ReshelveBaton*>(req->data);
        // if you want to modify baton values
        // do synchronous work here
        baton->wrapper->inv->reshelve();
    }
```

Going Async

Clean up

```
static void ReshelveAsyncAfter(uv_work_t *req) {
        ReshelveBaton *baton =
            static_cast<ReshelveBaton*>(req->data);

        Handle<Value> argv[] = { Null() }; // no error
        baton->callback->Call(Context::GetCurrent()->Global(),
                              1, argv);

        baton->callback.Dispose();
        delete baton;
    }
```

Going Async

Output

```
After reshelve in source
Tick
Tick
Tick
Tick
Reshelving done
```

Linking your library

Linking external libs in Waf:

```
def configure(conf):
  # ...
  # uses pkg-config
  conf.check_cfg(package='<pkg-config name>', args='--cflags --libs',
  uselib_store='ALIAS')

def build(bld):
  # ...
  obj.uselib = 'ALIAS'
```

Holder vs This

- *args.This()* is always the this object passed in to the function
- *args.Holder()* runs up the prototype chain to the 'right' object
- Signatures decide the 'right' object, automatically handled by *NODE_PROTOTYPE_SET_METHOD*
- **Always** use *Holder()* to be on the safe side

Things I haven't covered

- **Accessors**
    - Per property accessors
    - Indexed accessors (*object[5]*)
    - Named property accessors (*object.property*)
- Function Signatures and HasInstance for type safety
- Emitting events using new JS only EventEmitter
- Details of libuv
- Using V8 on its own

You might want to look at

- https://github.com/weaver/uuidjs
- https://github.com/nikhilm/node-taglib
- https://github.com/pietern/hiredis-node

End notes

Contact:

- @nikhilcutshort
- nsm.nikhil@gmail.com

Cover image by Munjal Savla (*by-nc-sa*)

Extra material below

Calling JS functions

```
var calljs = require("./build/Release/calljs")

var f = function() {
    console.log("This", this);
    console.log(arguments);
}

calljs.apply(f, { cool: "dude" }, "one", 2, 3.14);
```

Calling JS functions

```
Handle<Value> Apply(const Arguments &args) {
    HandleScope scope;

    Handle<Function> func = Handle<Function>::Cast(args[0]);
    Handle<Object> receiver = args[1]->ToObject();

    Handle<Value> *argv = new Handle<Value>[args.Length() - 2];
    for (int i = 2; i < args.Length(); i++)
        argv[i-2] = args[i];

    func->Call(receiver, args.Length()-2, argv);

    delete argv;
    return Undefined();
}
```

Strings to-and-fro

v8::String -> C string

```
Handle<Value> Print(const Arguments &args) {
    HandleScope scope;

    for (int i = 0; i < args.Length(); i++) {
        if (!args[i]->IsString())
            continue;

        // also String::AsciiValue
        String::Utf8Value val(args[i]);
        printf("%s ", *val); // <<<<<<
    }
    return Undefined();
}
```

Strings to-and-fro

C string -> v8::String

```
Handle<Value> Read(const Arguments &args) {
    HandleScope scope;

    char str[1024];
    fgets(str, 1023, stdin);

    Local<String> v8String = String::New(str, strlen(str));
    return scope.Close(v8String);
}
```