JavaScript in IoT

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自我介绍

- Creator of ShadowNode & tensorflow-nodejs
- Node.js Collaborator
- Rokid Engineer

目录

- What’ s the **IoT**?
- Why **JavaScript** ?
- **Node.js** on Edge Device
- Make an **OS** for JavaScript Developer

What's the IoT

- Service-oriented user interface
- Resource restricted device
- Efficient is greater than elegance

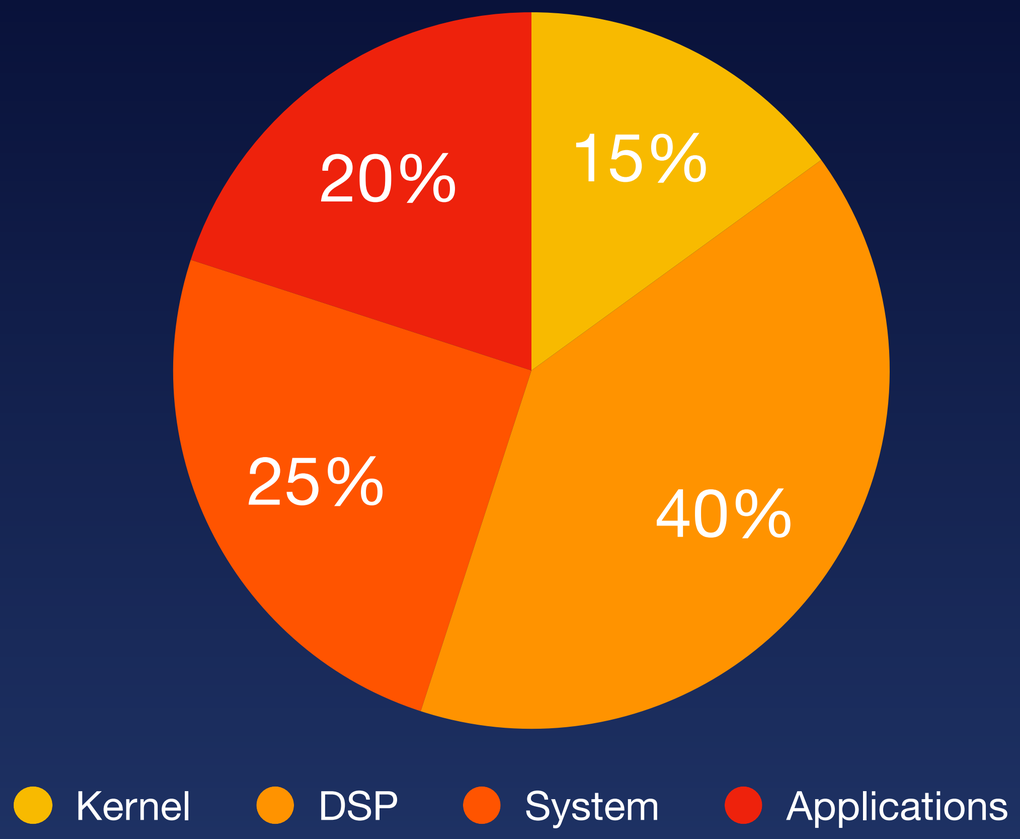
Service-oriented User Interface

- user interface is expanding to every IoT device.
- user interface is adaptive, also known as AUI.
- screen is optional.
- collaboration everywhere.
- in-parallel runtimes.

Resource Restricted Device

	low-end	medium-end	smart phone
RAM / ROM	4MB / 4MB	128MB / 128MB	2GB / 16GB
Processors	1 Core	1 - 4 Core	4 Core+
OS	RTOS	Linux	Android / iOS

Resource Restricted Device



20% * 128MB = 25.6MB

Efficient is greater than Elegance

- trade off everyday.
- efficient workflows on the hand.
- efficiency is elegant at real world.

Why JavaScript

- IoT fragmentation
- JavaScript ecosystems (including Web and Node.js)

IoT Fragmentation

The unified Web — WOT

Popular Programming language — JavaScript

Popular Programming language — JavaScript

**“Any application that can be written in JavaScript,
will eventually be written in JavaScript ?”**

Node.js on Edge Device — ShadowNode

- Brief introduction and history of ShadowNode
- Use **N-API**
- Optimizations on device

ShadowNode: brief introduction

- bio: use Node.js in your end device
  - support Linux and macOS
  - support x86, arm and aarch64
  - core APIs: *assert / buffer / N-API Add-ons / child process / crypto / dns / events / file system / http / https / module / net / os / process / timers / TLS / UDP*
  - extended APIs: *WebSocket / D-Bus / MQTT / Profiler*
  - heap & cpu profiler
- a fork of another awesome project: IoT.js
  - panda-project/jerryscript: memory optimized ECMAScript JITless VM
  - panda-project/libtuv: memory optimized libuv fork

ShadowNode: project tree

- src/
  - src/modues.json, modules configure.
  - src/iotjs.c, bootstrap and entry file.
  - modules/, the C implementation of core modules.
  - js/, the JavaScript part of core modules.
  - napi/, the N-API related files.
- deps/, the dependencies just like Node.js
- cmake/, the build scripts in CMake.
- test/, the test directory
  - testsets.json, defines the run set for unit tests.
  - napi-testsets.json, defines run set for N-API tests.
- tools/
  - tools/build.py, the build starter

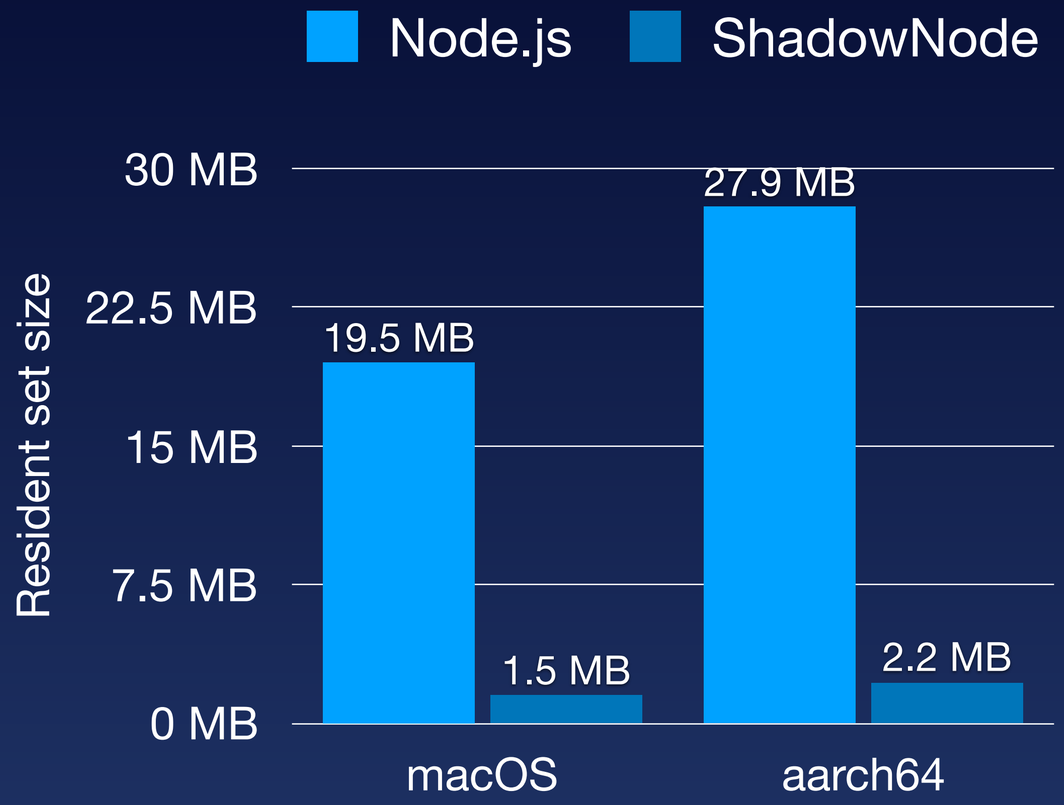
ShadowNode: history

- ***2017.09*** Migrate a Node.js application from android to linux which only owns 256MB RAM at **Rokid**.
- ***2017.10*** Try to do reduction on this existed application includes: tree-shaking, unnecessary dependencies and refactors, but failed always.
- ***2017.11*** The IoT.js project was found, but no TLS, MQTTs, D-Bus and child process, start hacking ShadowNode and supporting the above modules and some of NPM modules.
- ***2018.06*** **N-API** implementation has been released.
- ***2018.08*** Start building a new project which is based on ShadowNode.

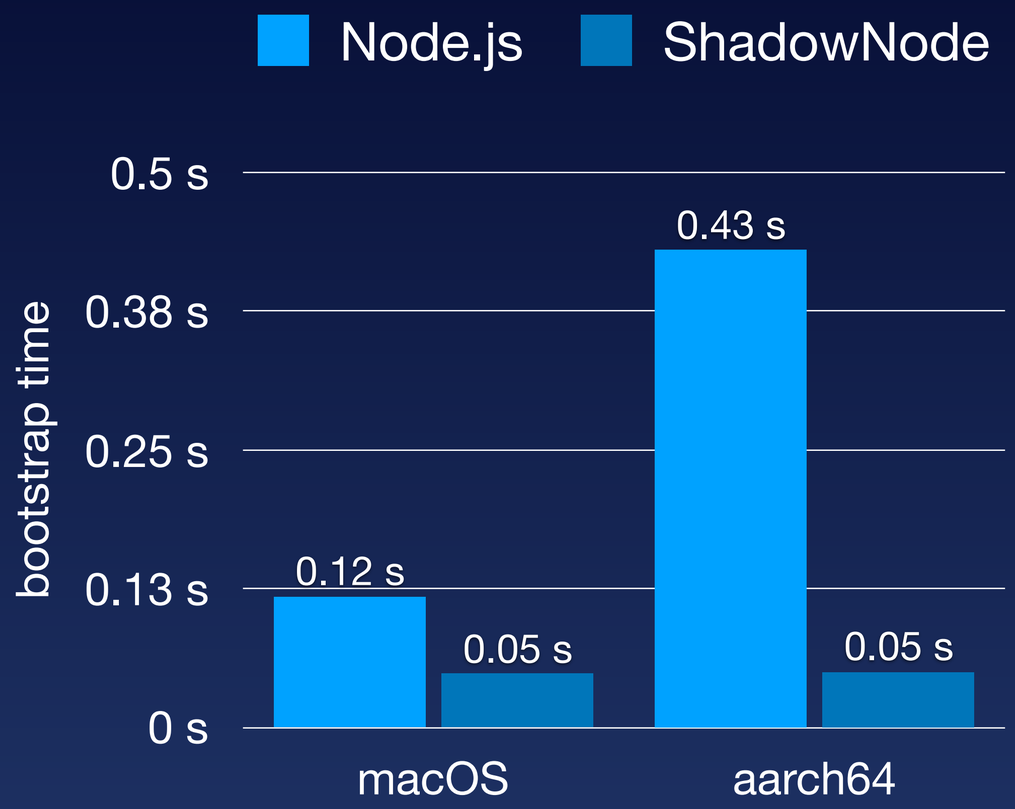
Compare to Node.js

NPM	
Node.js Official	**ShadowNode**
V8	**JerryScript**
libuv	**libtuv**
OpenSSL	**mbedTLS**

Compare to Node.js



Compare to Node.js



Compare to Node.js

- ShadowNode is not going to replace the official Node.js
- ShadowNode shall be the subset of Node.js ecosystem on embedded system
- ShadowNode embraces Node.js community

Use N-API

- how it works seamlessly on Node.js & ShadowNode
- implement `HandleScope` on JerryScript
- try **N-API**
- test **N-API** implementation

N-API ABI Stability

- no re-compiling on different Node.js versions.
- no re-compiling on different JavaScript engine like node-chakracore.
- no re-compiling on the runtime outside of Node.js like ShadowNode.

Comments from Node.js Team

Node.js Collection

Community-curated content for the millions of Node.js users.

Following

340

Since N-API provides a JavaScript engine-independent interface to the language features, its availability makes it possible to drop other JavaScript engines into Node.js. The node-chakracore project is an example of a Node.js version with a different JavaScript engine “under the hood”.

N-API can also serve as an interface to the JavaScript engine outside of Node.js. The ShadowNode project is in the process of implementing N-API using the JerryScript JavaScript engine as its back end. Such efforts make it possible to provide native add-ons for a variety of environments such as constrained IoT devices using a single code base.

HandleScope on V8

```
void Init(Handle<Object> target) {
  HandleScope scope;
  target->Set(String::New(“gc"), FunctionTemplate::New(GC)->GetFunction());
  target->Set(String::New(“pause”),
              FunctionTemplate::New(Pause)->GetFunction());
  target->Set(String::New("resume"),
              FunctionTemplate::New(Resume)->GetFunction());
}

// copy from https://github.com/bnoordhuis/node-profiler
```

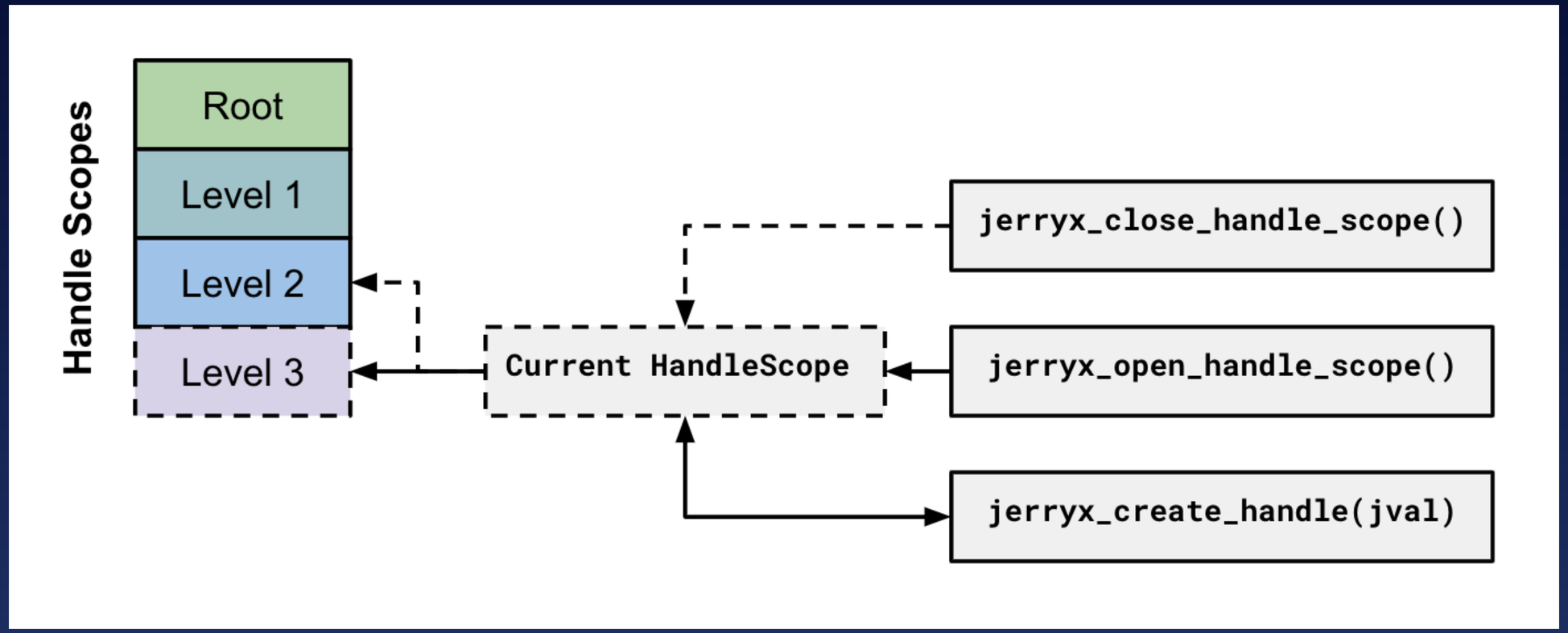
HandleScope on JerryScript

```
JS_FUNCTION(Test) {
  jerry_value_t name = JS_GET_ARG(0, string);
  // ... do something
  jerry_release_value(name);
}
```

HandleScope on JerryScript

```
JS_FUNCTION(Test) {
  jerry_value_t name = JS_GET_ARG(0, string);
  // ... do something
  jerry_release_value(name);
}

JS_FUNCTION(TestWithHandleScope) {
  jerryx_handle_scope scope;
  jerryx_open_handle_scope(&scope);

  jerry_value_t name = jerryx_create_handle(JS_GET_ARG(0, string));
  jerryx_close_handle_scope(scope);
  // name has been released
}
```

HandleScope on JerryScript



Usage threshold of HandleScope

- `HandleScope` is nested, but it commonly is up to a threshold value.
- introduce a pool to pre-allocated handle scopes could avoid most `malloc()` in real world.
- the pool is configurable by **`JERRYX_SCOPE_PRELIST_SIZE(20)`**, it stands for the maximum depth at call stack without `malloc()` at N-API add-on.

Try **N-API**

Test **N-API** implementation

- pull **N-API** tests from nodejs/node repository.
- build add-ons with node-gyp.
- run tests on ShadowNode.
- NAPI Test Suite reuses tests for different **N-API** implementations, but still work in progress.

Optimizations on Device

- re-implement the NPM package in C is always working.
- otherwise
  - introduce **NODE_PRIORITIZED_PATH** to decrease the module path searching on device case.
  - linux ***Copy-On-Write***.

C/C++ advanced NPM package

- JavaScript must be the application-level language at embedded device.
- JavaScript object heap is always expensive than system allocators.
- keep the API to be consistent at JavaScript.
- some packages are optimized in this way: MQTT / WebSocket.

NODE_PRIORITIZED_PATH

- `NODE_PRIORITIZED_PATH=/usr/lib/node_modules node app.js`
- A workaround to improve performance of the Node.js module searching algorithm.
  - most `require` are from the global path, which differs from server-side use cases.
  - no effect on previous algorithm by introducing the new env variable.
- optimized 30% on booting the main service.

Copy On Write

- principle of laziness, do action when it’s really required.
- do copy when the data is really changed.
- linux `fork()` implements COW.

Copy On Write - uv_spawn

```
function spawn (file, args) {
  var pid = fork()
  if (pid === 0) {
    execvp(file, args) // this disables COW
    // starting VM and load script
  }
}

spawn(‘test.js’, [])
```

Copy On Write - fork

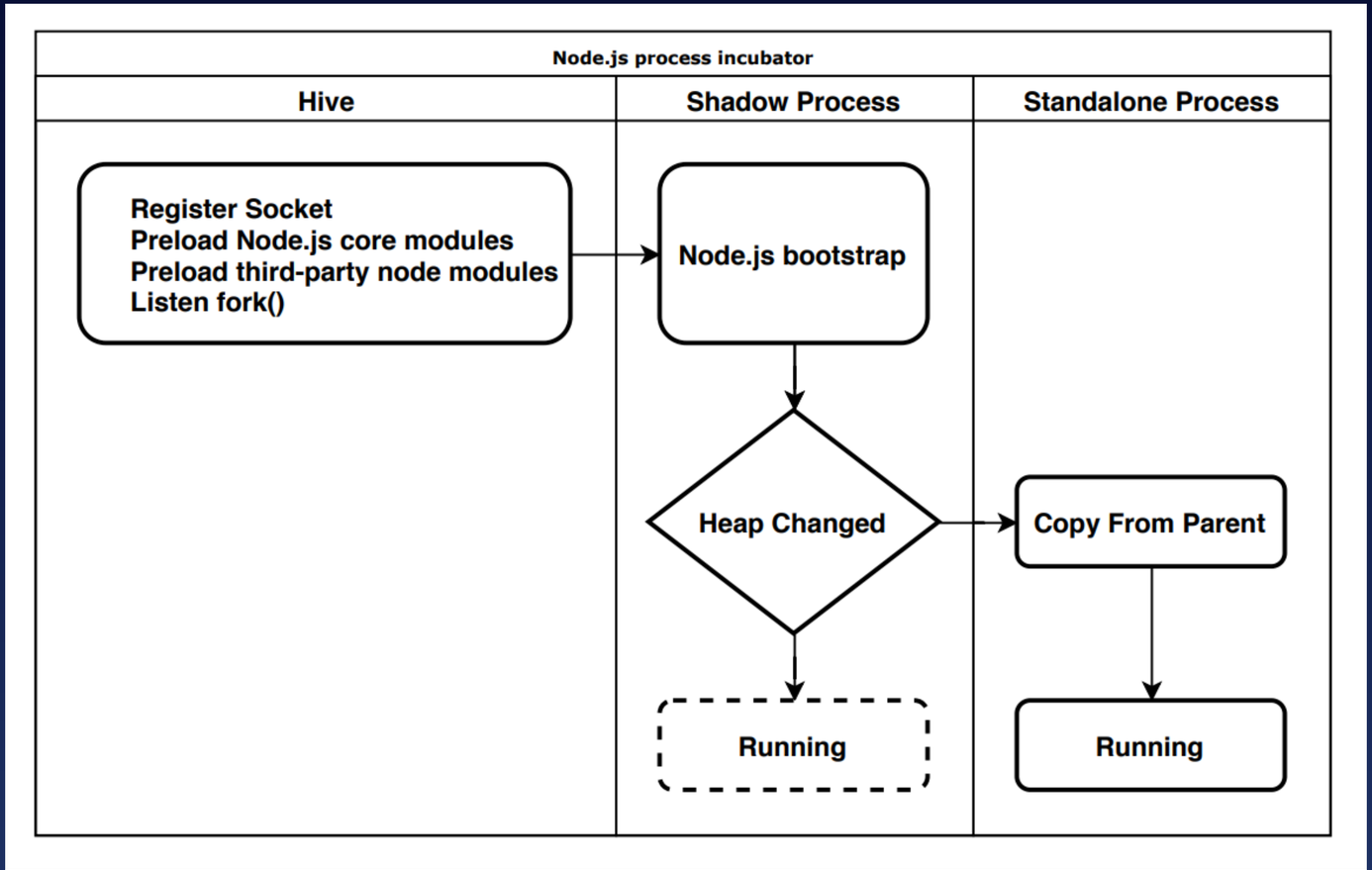
```
var fork = require('linux-sys').fork

// load common modules for children
var player = require('player')
var http = require('http')
var foobar = require('foobar')

// start forking
var pid = fork()
if (pid == 0) {
  // here is the child process
  // use player / http / foobar
}
```

4ms

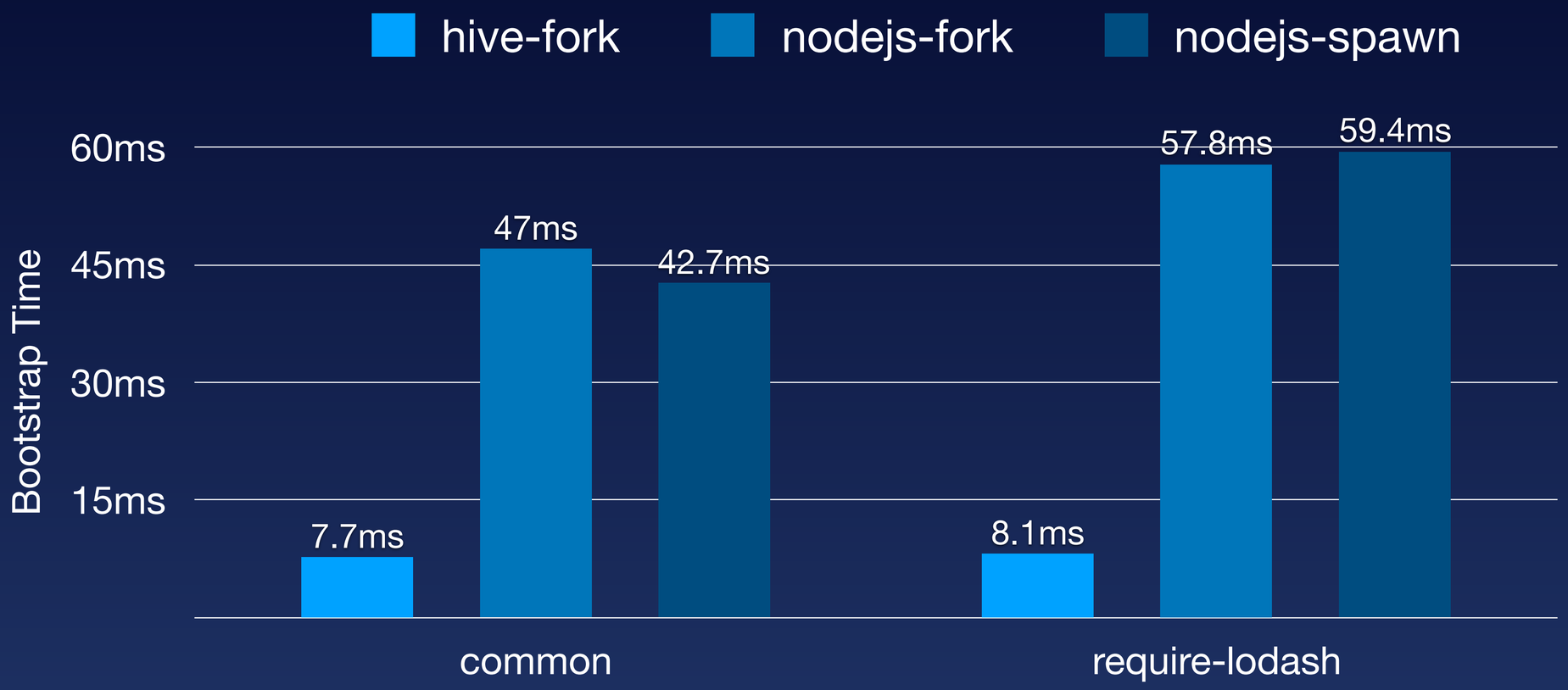
Hive — Node.js process incubator

Zygote	**Hive**
Register socket	**Register socket**
Preload all Java class	**Preload all Node.js core modules**
Preload resource	**Preload third-party node modules**
Listen for `fork()` connection	**Listen for `fork()` connection**

Hive — Node.js process incubator



Hive — Node.js process incubator



Make an OS for JavaScript Developer

- Guide to make an operating system
- Principles of design API
- Boundaries between JavaScript and others

Guide to make an operating system

Source code	**Google Repo**
Kernel	**Linux**
Build Framework	**OpenWRT**
Configuration	**defconfig**

Google Repo

```
repo init
  -u https://github.com/yodaos-project/yodaos
  -m default.xml
  -b master

repo sync
```

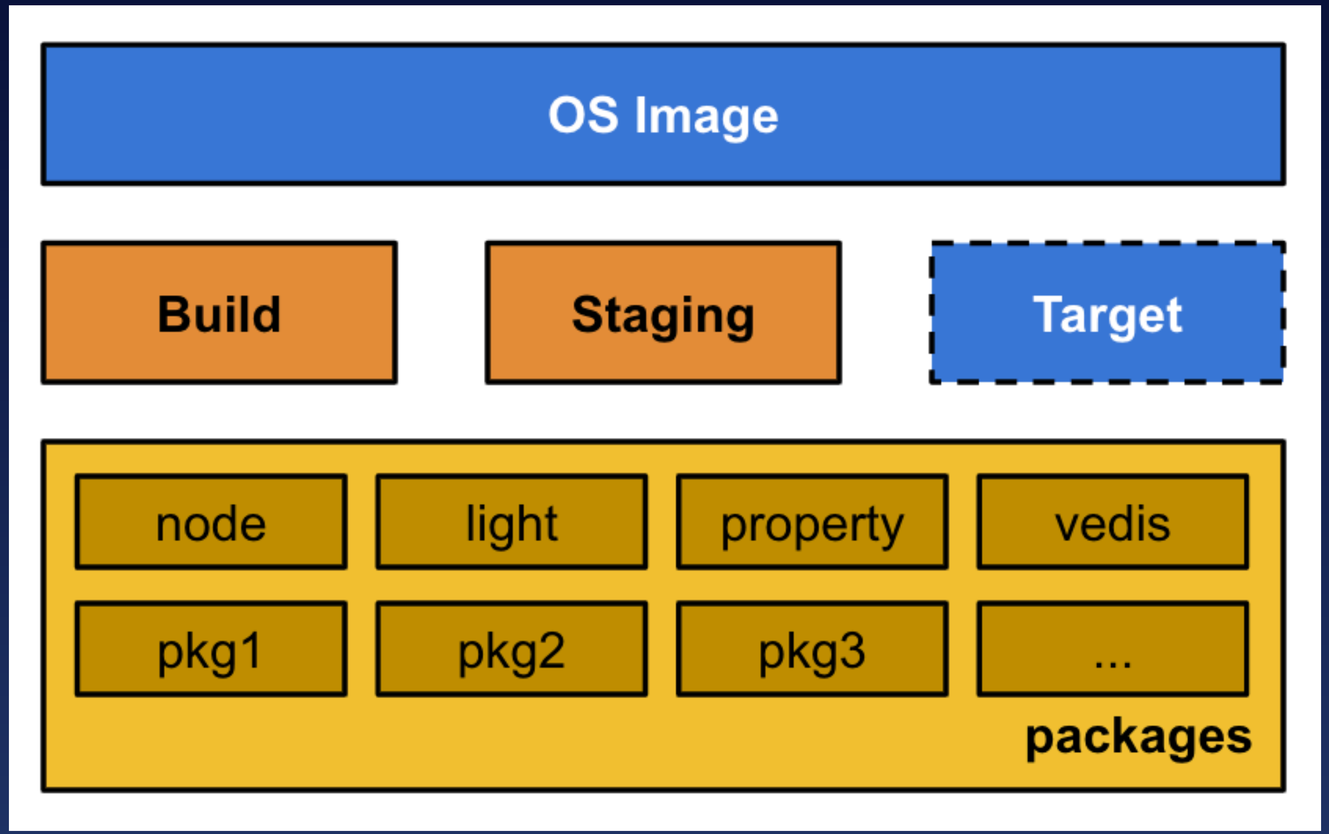
Google Repo

```
<?xml version="1.0" encoding="UTF-8"?>
<manifest>
  <remote name="github" fetch="https://github.com" review="https://github.com" />
  <default revision="master" remote="github" sync-c="true" sync-j="2" />
  <include name="manifests/base.xml" />

  <project path="libs/nodejs" name="yodaos-project/ShadowNode" remote="github"
revision=“master" />
  <project path="products/yodaos/rbpi-3b-plus"
    name="yodaos-project/product-raspberry" remote="github" revision=“refs/tags/v1.0" />
</manifest>
```

Kernel — Why Linux?

- provide the Posix-compatible APIs for system programming.
- provide the richness drivers ecosystem for different hardwares.
  - microphone
  - speaker
  - input event
  - motion control
  - light & display
  - ...

OpenWRT - build system for linux distribution



Makefile and defconfig

```
# config target
CONFIG_TARGET_leo=y
CONFIG_TARGET_leo_k18_universal=y
CONFIG_TARGET_leo_k18_universal_LEO_K18_UNIVERSAL=y

# config product
CONFIG_PRODUCT_OS_NAME="yodaos"
CONFIG_PRODUCT_NAME="Rokid-Devkit"
CONFIG_PRODUCT_PATHNAME="rokid/universal"

# config kernel
CONFIG_EXTERNAL_KERNEL_CONFIG=y
CONFIG_EXTERNAL_KERNEL_TREE="$(TOPDIR)/../kernel/k18/4.4"

# config packages
CONFIG_PACKAGE_nodejs=y
CONFIG_PACKAGE_wget=y
CONFIG_PACKAGE_wpa-cli=y
CONFIG_PACKAGE_wpa-supplicant=y
CONFIG_PACKAGE_light=y
```

Makefile and defconfig

```
$ cd ./openwrt
$ cp ./path/to/your/defconfig .config
$ make defconfig
$ make -j32
```

There is an OS for Web community

YODAOS

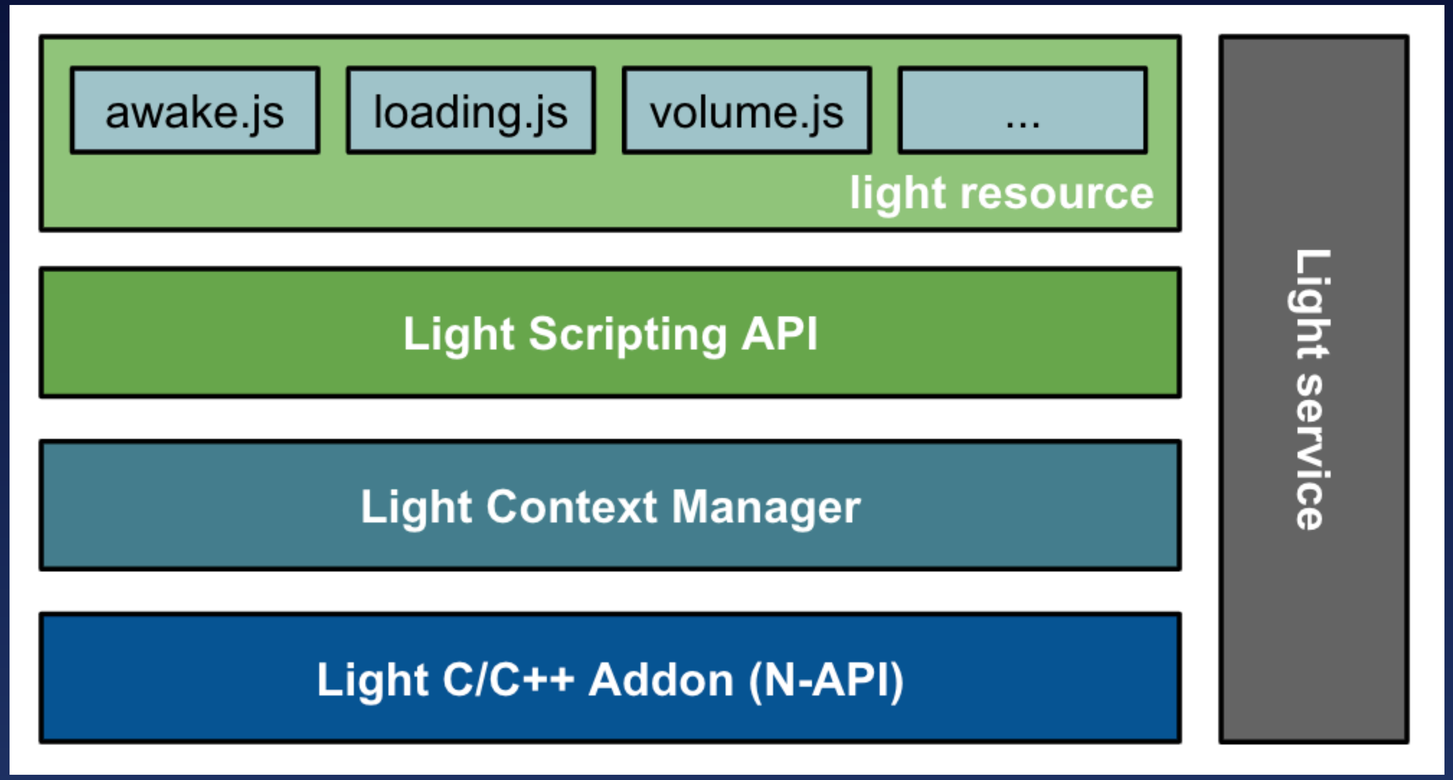
Principles of design API

- consider the messaging ways firstly
- the shape of applications on your OS
- design your “system calls”
- design your application API

Boundaries between JavaScript and others

- JavaScript is application-level
- outside of Node.js

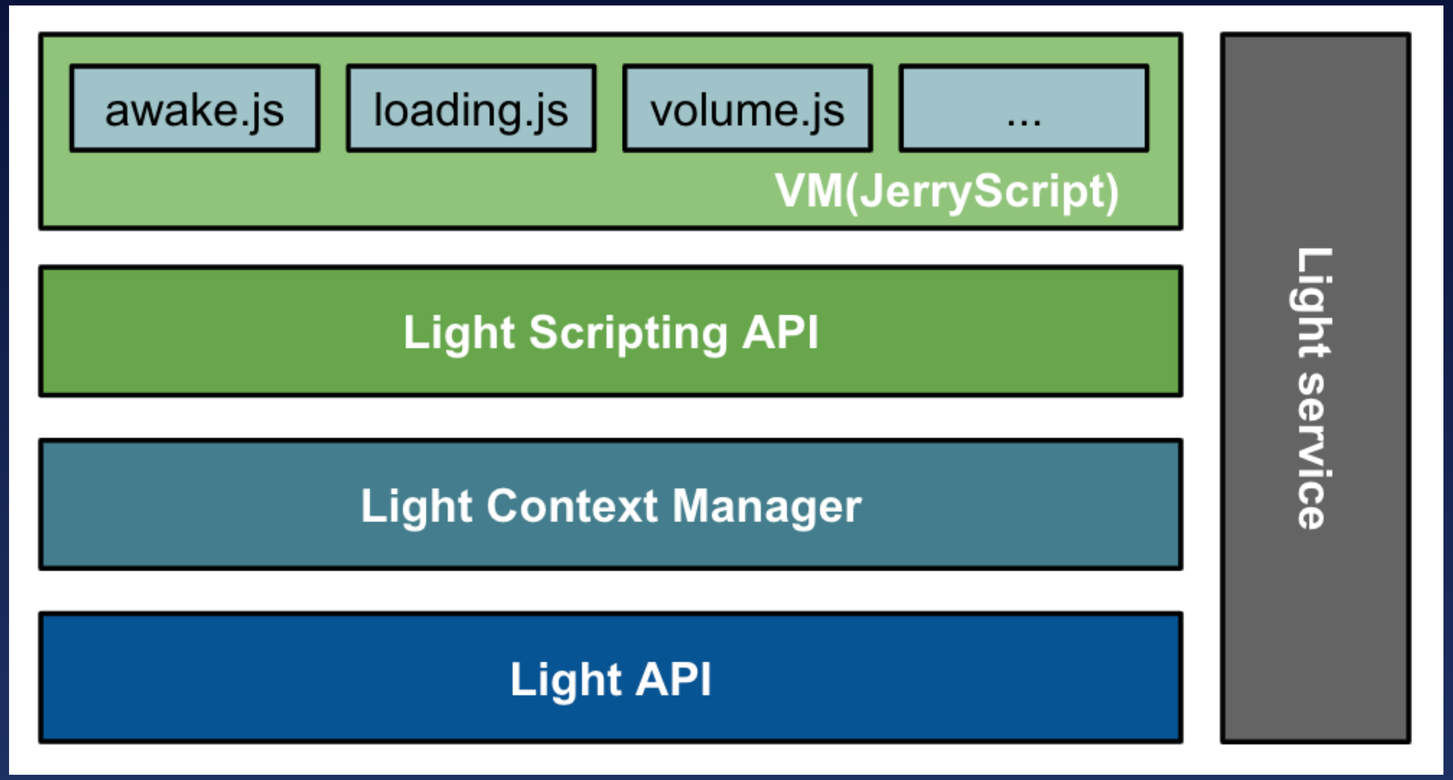
Example: LED Architecture(0)



Example: LED Architecture

```
module.exports = function render (light, args, done) {
  var muted = !!(args && args.muted)
  light.clear()

  if (!muted) {
    light.sound('system://mic_enable.ogg')
    light.render()
    done()
  } else {
    light.sound('system://mic_close_tts.ogg')
    light.fill(255, 0, 0)
    light.render()
  }
}
```

Example: LED Architecture(1)



THANKS

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