Thomas Watson

@wa7son

github.com/watson

Who is this guy anyway?

- Thomas Watson
- Open Source developer at github.com/watson

- Node.js Lead at Opbeat
- Member of the Diagnostics Working Group under the Node.js Foundation
- Tweets as @wa7son

Instrumentation and Tracing in Node.js

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Incoming Request

Response

Transaction

HTTP Request lifetime

Traces

Incoming Request

Response

Transaction

HTTP Request lifetime

BOOM!

Traces

The Event Loop

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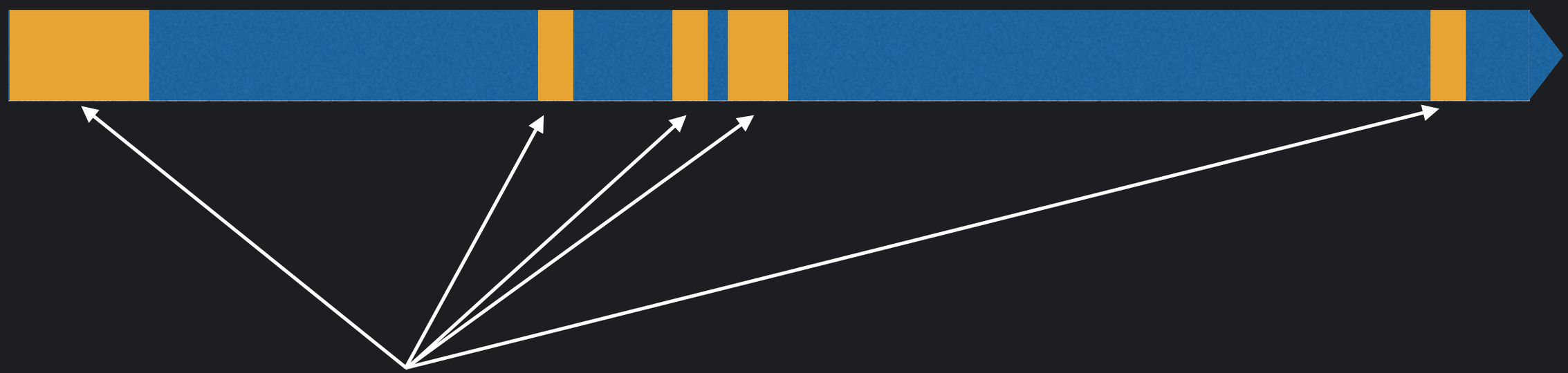
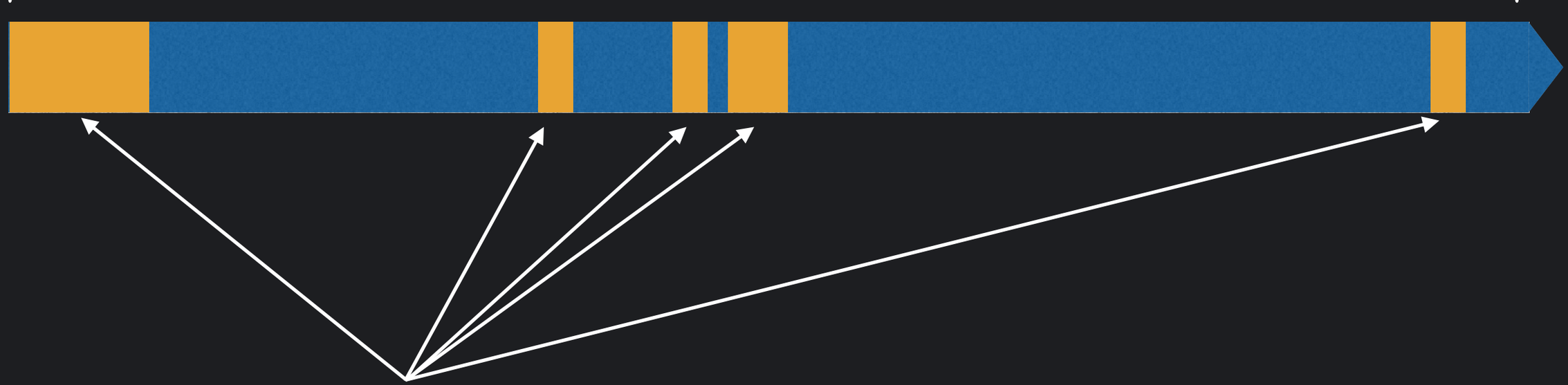
nodejsreactions.tumblr.com

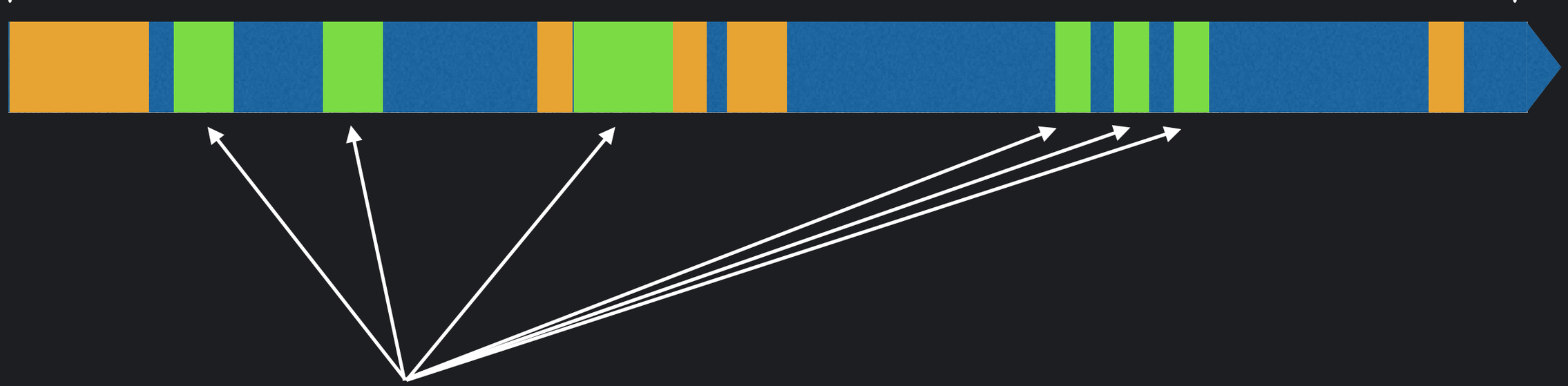
The Event Loop



The Event Loop



The Event Loop



```
http.createServer(function (req, res) {
  global.currentRequest = req
  // ... continue as normal
})
```

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Request Lifecycle

global.currentRequest == Req #1

Request Lifecycle

global.currentRequest == Req #2

global.currentRequest == Req #1

Request Lifecycle

global.currentRequest == Req #2

global.currentRequest == Req #1

Request Lifecycle

global.currentRequest == Req #2

global.currentRequest == Req #1

Request Lifecycle

global.currentRequest == Req #2

global.currentRequest == Req #1

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```
var origSetTimeout = global.setTimeout

global.setTimeout = function (callback) {
  var origReq = global.currentRequest
  return origSetTimeout(function () {
    var prevReq = global.currentRequest
    global.currentRequest = origReq
    callback.apply(this, arguments)
    global.currentRequest = prevReq
  })
}
```

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Patch the world

- Patch **every** async operation in core
  - timers
  - Promise (native)
  - (process.nextTick)
  - libuv
- Patch certain 3rd party modules

AsyncHooks

https://github.com/nodejs/diagnostics

ϕrevor ηorris
@trevnorris

Follow

async_wrap is dead. now called async_hooks, and will come with an embedder API so modules can trigger async hook callbacks.

12:20 AM - 8 Sep 2016

11 17

https://github.com/nodejs/diagnostics

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```
var asyncWrap = process.binding('async_wrap')

asyncWrap.setupHooks({init, pre, post, destroy})
asyncWrap.enable()

function init (uid, provider, parentUid, parentHandle) {
  log('async_wrap: init')
}
function pre (uid) {
  log('async_wrap: pre')
}
function post (uid) {
  log('async_wrap: post')
}
function destroy (uid) {
  log('async_wrap: destroy')
}

var fs = require('fs')

log('user: before')
fs.open(__filename, 'r', function (err, fd) {
  log('user: done')
})
log('user: after')
```

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```
var asyncWrap = process.binding('async_wrap')

asyncWrap.setupHooks({init, pre, post, destroy})
asyncWrap.enable()

function init (uid, provider, parentUid, parentHandle) {
  log('async_wrap: init')
}
function pre (uid) {
  log('async_wrap: pre')
}
function post (uid) {
  log('async_wrap: post')
}
function destroy (uid) {
  log('async_wrap: destroy')
}

var fs = require('fs')

log('user: before')
fs.open(__filename, 'r', function (err, fd) {
  log('user: done')
})
log('user: after')
```

```
user: before
async_wrap: init
user: after
async_wrap: pre
user: done
async_wrap: post
async_wrap: destroy
```

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```
var asyncWrap = process.binding('async_wrap')

asyncWrap.setupHooks({init, pre, post, destroy})
asyncWrap.enable()

function init (uid, provider, parentUid, parentHandle) {
  console.log('async_wrap: init')
}
function pre (uid) {
  console.log('async_wrap: pre')
}
function post (uid) {
  console.log('async_wrap: post')
}
function destroy (uid) {
  console.log('async_wrap: destroy')
}

var fs = require('fs')

console.log('user: before')
fs.open(__filename, 'r', function (err, fd) {
  console.log('user: done')
})
console.log('user: after')
```

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```
var asyncWrap = process.binding('async_wrap')

asyncWrap.setupHooks({init, pre, post, destroy})
asyncWrap.enable()

function init (uid, provider, parentUid, parentHandle) {
  console.log('async_wrap: init')
}
function pre (uid) {
  console.log('async_wrap: pre')
}
function po
  console.l
}
function destroy (uid) {
  console.log('async_wrap: destroy')
}

var fs = require('fs')

console.log('user: before')
fs.open(__filename, 'r', function (err, fd) {
  console.log('user: done')
})
console.log('user: after')
```

```
TypeError: console.log is not a function
```

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```
fs.writeSync(1, util.format('%s\n', msg))
```

```
fs.writeSync(1, util.format('%s\n', msg))
process._rawDebug(msg)
```

```
var asyncWrap = process.binding('async_wrap')

asyncWrap.setupHooks({init, pre, post, destroy})
asyncWrap.enable()

function init (uid, provider, parentUid, parentHandle) {
  process._rawDebug('async_wrap: init')
}
function pre (uid) {
  process._rawDebug('async_wrap: pre')
}
function post (uid) {
  process._rawDebug('async_wrap: post')
}
function destroy (uid) {
  process._rawDebug('async_wrap: destroy')
}

var fs = require('fs')

process._rawDebug('user: before')
fs.open(__filename, 'r', function (err, fd) {
  process._rawDebug('user: done')
})
process._rawDebug('user: after')
```

```
user: before
async_wrap: init
user: after
async_wrap: pre
user: done
async_wrap: post
async_wrap: destroy
```

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```
function init (uid, provider, parentUid, parentHandle) {
  // this         => current handle
  // uid          => 1, 2, 3...
  // provider     => 0 - 23 (asyncWrap.Providers)
  // parentUid    => 1, 2, 3...
  // parentHandle => parent `this`
}
```

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```
> var asyncWrap = process.binding('async_wrap')
undefined
> asyncWrap.Providers
{ NONE: 0,
  CRYPTO: 1,
  FSEVENTWRAP: 2,
  FSREQWRAP: 3,
  GETADDRINFOREQWRAP: 4,
  GETNAMEINFOREQWRAP: 5,
  HTTPPARSER: 6,
  JSSTREAM: 7,
  PIPEWRAP: 8,
  PIPECONNECTWRAP: 9,
  PROCESSWRAP: 10,
  QUERYWRAP: 11,
  SHUTDOWNWRAP: 12,
  SIGNALWRAP: 13,
  STATWATCHER: 14,
  TCPWRAP: 15,
  TCPCONNECTWRAP: 16,
  TIMERWRAP: 17,
  TLSWRAP: 18,
  TTYWRAP: 19,
  UDPWRAP: 20,
  UDPSENDWRAP: 21,
  WRITEWRAP: 22,
  ZLIB: 23 }
```

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```
function init (uid, provider, parentUid, parentHandle) {
  // this         => current handle
  // uid          => 1, 2, 3...
  // provider     => 0 - 23 (asyncWrap.Providers)
  // parentUid    => 1, 2, 3...
  // parentHandle => parent `this`
}
```

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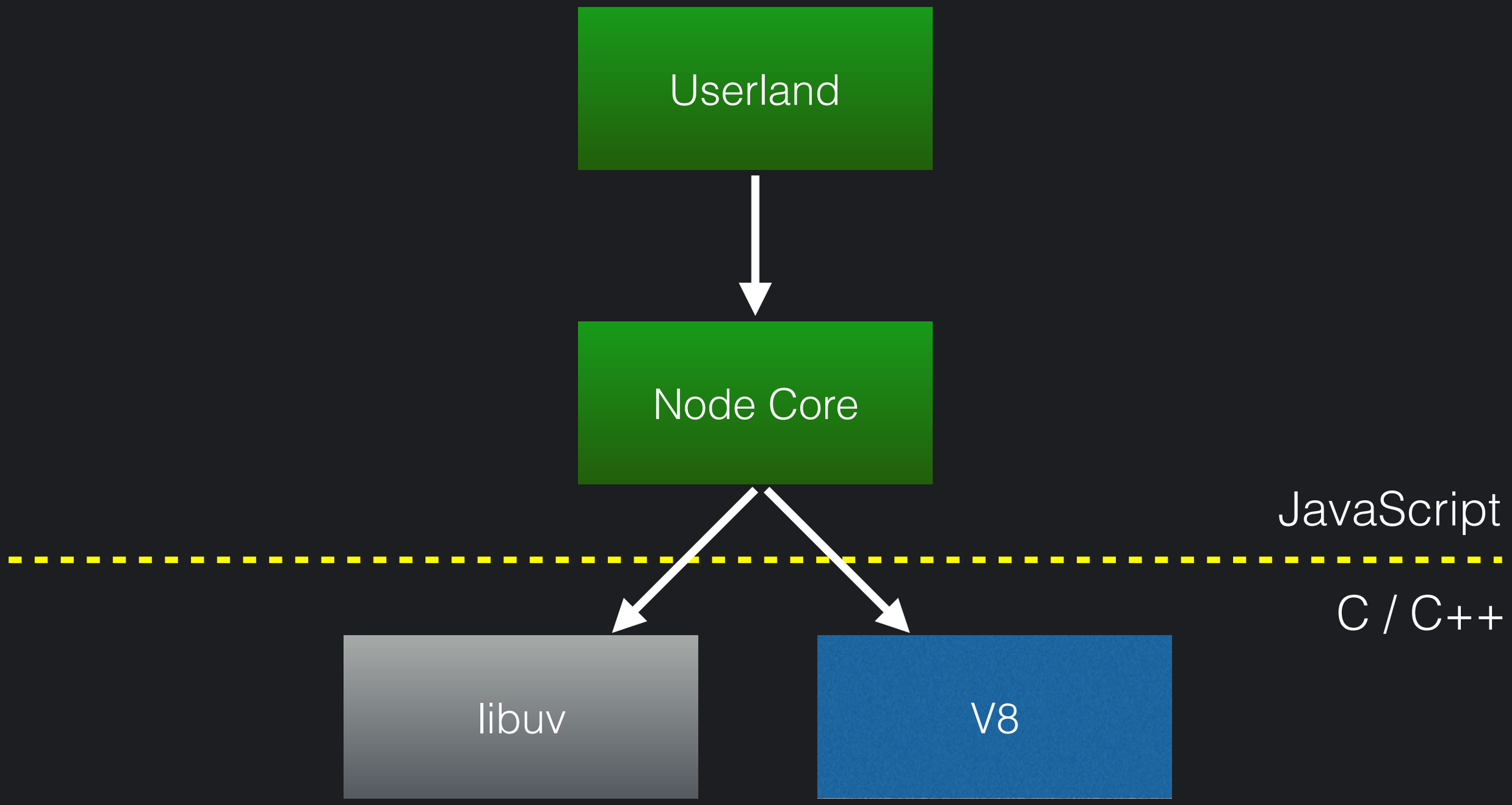
Handle Objects



Handle Objects

```
const TCPConnectWrap = process.binding('tcp_wrap').TCPConnectWrap;
const TCP = process.binding('tcp_wrap').TCP;

const req = new TCPConnectWrap();
req.oncomplete = oncomplete;
req.address = address;
req.port = port;

const socket = new TCP();
socket.onread = onread;
socket.connect(req, address, port);

// later
socket.destroy();
```

Handle Objects

```
const TCPConnectWrap = process.binding('tcp_wrap').TCPConnectWrap;
const TCP = process.binding('tcp_wrap').TCP;

const req = new TCPConnectWrap();
req.oncomplete = oncomplete;
req.address = address;
req.port = port;

const socket = new TCP();
socket.onread = onread;
socket.connect(req, address, port);

// later
socket.destroy();
```

Handle objects

Handle Objects

```
const TCPConnectWrap = process.binding('tcp_wrap').TCPConnectWrap;
const TCP = process.binding('tcp_wrap').TCP;

const req = new TCPConnectWrap();
req.oncomplete = oncomplete;
req.address = address;
req.port = port;

const socket = new TCP();
socket.onread = onread;
socket.connect(req, address, port);

// later
socket.destroy();
```

req === this

socket === this

Timers

```
log('user: before #1')
setTimeout(function () {
  log('user: done #1')
}, 2000)
log('user: after #1')

log('user: before #2')
setTimeout(function () {
  log('user: done #2')
}, 2000)
log('user: after #2')
```

Timers

```
log('user: before #1')
setTimeout(function () {
  log('user: done #1')
}, 2000)
log('user: after #1')

log('user: before #2')
setTimeout(function () {
  log('user: done #2')
}, 2000)
log('user: after #2')
```

```
user: before #1
async_wrap: init
user: after #1
user: before #2
user: after #2
```

Timers

```
log('user: before #1')
setTimeout(function () {
  log('user: done #1')
}, 2000)
log('user: after #1')

log('user: before #2')
setTimeout(function () {
  log('user: done #2')
}, 2000)
log('user: after #2')
```

```
user: before #1
async_wrap: init
user: after #1
user: before #2
user: after #2

async_wrap: pre
user: done #1
user: done #2
async_wrap: post
async_wrap: destroy
```

Real World Example

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```
const asyncWrap = process.binding('async_wrap')
```

```
const asyncWrap = process.binding('async_wrap')
const TIMER = asyncWrap.Providers.TIMERWRAP
```

```
const asyncWrap = process.binding('async_wrap')
const TIMER = asyncWrap.Providers.TIMERWRAP

asyncWrap.setupWrap({init, before, after, destroy})
```

```
const asyncWrap = process.binding('async_wrap')
const TIMER = asyncWrap.Providers.TIMERWRAP

asyncWrap.setupWrap({init, before, after, destroy})
asyncWrap.enable()
```

```
const asyncWrap = process.binding('async_wrap')
const TIMER = asyncWrap.Providers.TIMERWRAP

asyncWrap.setupWrap({init, before, after, destroy})
asyncWrap.enable()

const initState = new Map()
const prevState = new Map()
```

```
const asyncWrap = process.binding('async_wrap')
const TIMER = asyncWrap.Providers.TIMERWRAP

asyncWrap.setupWrap({init, before, after, destroy})
asyncWrap.enable()

const initState = new Map()
const prevState = new Map()

function init (uid, provider, parentUid, parentHandle) {
  if (provider === TIMER) return // timers share handles, manage manually
  initState.set(uid, global.currentRequest)
}
```

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```
const asyncWrap = process.binding('async_wrap')
const TIMER = asyncWrap.Providers.TIMERWRAP

asyncWrap.setupWrap({init, before, after, destroy})
asyncWrap.enable()

const initState = new Map()
const prevState = new Map()

function init (uid, provider, parentUid, parentHandle) {
  if (provider === TIMER) return // timers share handles, manage manually
  initState.set(uid, global.currentRequest)
}

function before (uid) {
  if (!initState.has(uid)) return // in case provider === TIMER
  prevState.set(uid, global.currentRequest)
  global.currentRequest = initState.get(uid)
}
```

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```
asyncWrap.setupWrap({init, before, after, destroy})
asyncWrap.enable()

const initState = new Map()
const prevState = new Map()

function init (uid, provider, parentUid, parentHandle) {
  if (provider === TIMER) return // timers share handles, manage manually
  initState.set(uid, global.currentRequest)
}

function before (uid) {
  if (!initState.has(uid)) return // in case provider === TIMER
  prevState.set(uid, global.currentRequest)
  global.currentRequest = initState.get(uid)
}

function after (uid) {
  if (!initState.has(uid)) return // in case provider === TIMER
  global.currentRequest = prevState.get(uid)
}
```

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```
function init (uid, provider, parentUid, parentHandle) {
  if (provider === TIMER) return // timers share handles, manage manually
  initState.set(uid, global.currentRequest)
}

function before (uid) {
  if (!initState.has(uid)) return // in case provider === TIMER
  prevState.set(uid, global.currentRequest)
  global.currentRequest = initState.get(uid)
}

function after (uid) {
  if (!initState.has(uid)) return // in case provider === TIMER
  global.currentRequest = prevState.get(uid)
}

function destroy (uid) {
  if (!initState.has(uid)) return // in case provider === TIMER
  initState.delete(uid)
  prevState.delete(uid)
}
```

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AsyncHooks Gotchas

- Handle creation time
- console.log
- (process.nextTick)
- Timers
- Promises
- Multiple AsyncHooks

New AsyncHooks API

https://github.com/nodejs/node-eps/pull/18

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I/O in user-land

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Embedder API

- Native API - for native modules
- JavaScript API - for JavaScript modules

JavaScript Embedder API

```
async_hooks.newUid()

async_hooks.emitInit(id, handle, type[, triggerId])

async_hooks.emitBefore(id)

async_hooks.emitAfter(id)

async_hooks.emitDestroy(id)
```

ES Modules

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GitHub, Inc. github.com/nodejs/node-eps/pull/18/files

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AsyncWrap public API proposal #18

Open **trevnorris** wants to merge 12 commits into `master` from `async-wrap-ep`

Conversation 293 Commits 12 Files changed 1

Changes from all commits 1 file +554 −0 Unified Split Review changes

554 XXX-asyncwrap-api.md Show notes View

```
@@ -0,0 +1,554 @@
+| Title   | AsyncHook API |
+|---------|---------------|
+| Author  | @trevnorris   |
+| Status  | DRAFT         |
+| Date    | 2016-09-14    |
+
+## Description
+
+Since its initial introduction along side the `AsyncListener` API, the internal
+class `AsyncWrap` has slowly evolved to ensure a generalized API that would
+serve as a solid base for module authors who wished to add listeners to the
+event loop's life cycle. Some of the use cases `AsyncWrap` has covered are long
+stack traces, continuation local storage, profiling of asynchronous requests
+and resource tracking. The public API is now exposed as `'async_hooks'`.
+
```

Display a menu

@wa7son https://github.com/nodejs/node-eps/pull/18

GitHub, Inc. github.com/nodejs/tracing-wg

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Tracing Working Group

47 commits 1 branch 0 releases 12 contributors

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watson committed with AndreasMadsen Update asyncWrap.Providers list (#55) ... Latest commit d3a41e9 a day ago

docs	Update asyncWrap.Providers list (#55)	a day ago
wg-meetings	updated YouTube link to video owned by node.js	2 days ago
README.md	joflo request to join	6 months ago

README.md

tracing-wg

Tracing Working Group

Members

GitHub, Inc. github.com/nodejs/tracing-wg/tree/master/

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Branch: master tracing-wg / docs / AsyncWrap / Create new file Upload files Find file History

watson committed with AndreasMadsen Update asyncWrap.Providers list (#55) ... Latest commit d3a41e9 a day ago

..

example-trace docs: update after nodejs/node#5756 a month ago

README.md Update asyncWrap.Providers list (#55) a day ago

README.md

Node.js tracing - AsyncWrap

AsyncWrap is two things. One is a class abstraction that provides an internal mechanism for handling asynchronous tasks, such as calling a callback. The other part is an API for setting up hooks and allows one to get structural tracing information about the life of handle objects. In the context of tracing the latter is usually what is meant.

The reasoning for the current naming confusion is that the API part implements the hooks through the AsyncWrap class, but this is not inherently necessary. For example if v8 provided those facilities the AsyncWrap class would not need be involved in the AsyncWrap API.

For the remaining description the API part is what is meant by AsyncWrap.

@wa7son https://github.com/nodejs/diagnostics/tree/master/tracing/AsyncWrap

GitHub, Inc. github.com/nodejs/tracing-wg/issues/29

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AsyncWrap issues - overview #29

Edit New issue

Open **AndreasMadsen** opened this issue on Oct 7, 2015 · 8 comments

AndreasMadsen commented on Oct 7, 2015 • edited — Node.js Foundation member

Missing Handle context

- [x] TCPwrap created from server (issue: nodejs/node#2986) - solved by nodejs/node#3216
- [x] HTTP sockets `parserOnBody`
  - issues: nodejs/node#3241, nodejs/node#4416
  - PR: nodejs/node#5419 and nodejs/node#5591, ~~depends on: nodejs/node#4597~~
- [ ] Promises or Microtask in general
  - node issue: nodejs/promises#9
  - v8 issue: https://bugs.chromium.org/p/v8/issues/detail?id=4643
- [ ] nextTick (issue: nodejs/node#636) - should get a new issue
- [ ] setTimeout, setInterval, setImmediate (issue: nodejs/node#666) - should get a new issue
- [ ] addon modules integration with AsyncWrap (~~PR: nodejs/node#3594~~) - needs further discussion.

More events

- [ ] onready (issue: #11) - unlikely to be solved
- [ ] onerror (issue: nodejs/node#669, #7) - awaiting use cases
- [x] ondestructor (PR: nodejs/node#3461)

Labels — None yet

Milestone — No milestone

Assignees — No one—assign yourself

Notifications — Unsubscribe

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4 participants

Lock conversation

@wa7son

https://github.com/nodejs/diagnostics/issues/29

Thank you

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github.com/watson

opbeat