# USING NODE WITH FORK(2)

*Node.js And ShadowNode*

# WHY WE WANT THEM

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1. Runtime 冷启动通常需要约 50~100ms
2. 嵌入式设备性能相当紧凑
3. 函数运行时请求响应时间敏感

# 嵌入式环境

1. 多进程适应多使用场景切换
2. 紧凑的设备性能、能耗限制

# 函数运行时

1. 需要良好的运行环境隔离
2. 需要控制每次执行资源使用

# 函数运行时

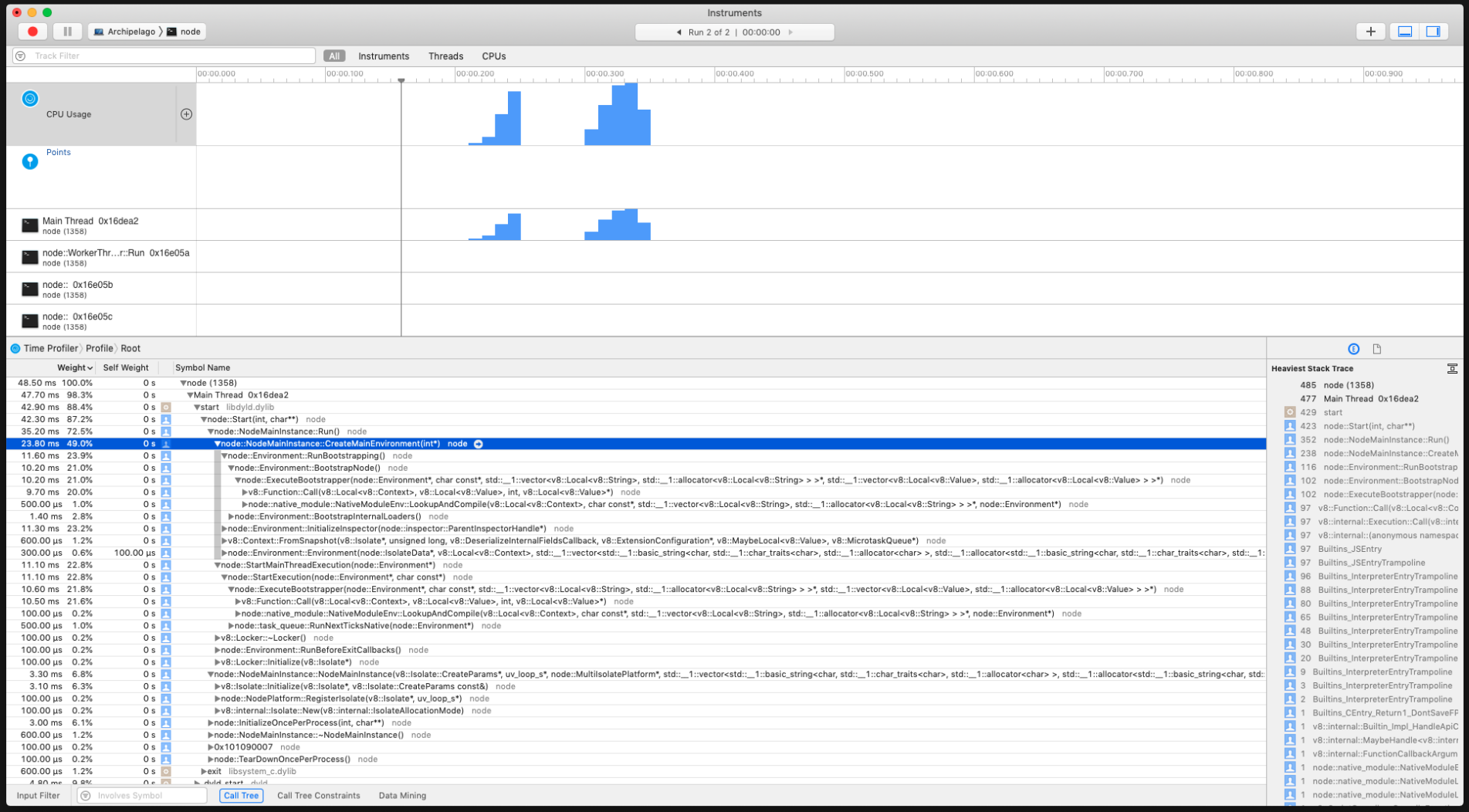
1. 单进程服务无法隔离运行环境
2. VM Contexts 无法隔离运行时操作
3. WorkerThreads 无法细分单次资源使用

# WHAT WE WANT

1. 更低的 CPU 时间使用
2. 更快到达进程可使用状态
3. 能够良好地隔离运行环境
4. 能够良好地控制运行资源

# WHAT HAPPENS ON LAUNCH

1. 初始化 uv/vm/platform
2. (code-cache/snapshot)
3. bootstrap loader/node/env
4. main/pre_execution
5. user scripts
6. libraries


Instruments
Archipelago 〉 node
Run 2 of 2 | 00:00:00
Track Filter
All
Instruments
Threads
CPUs
00:00.000
00:00.100
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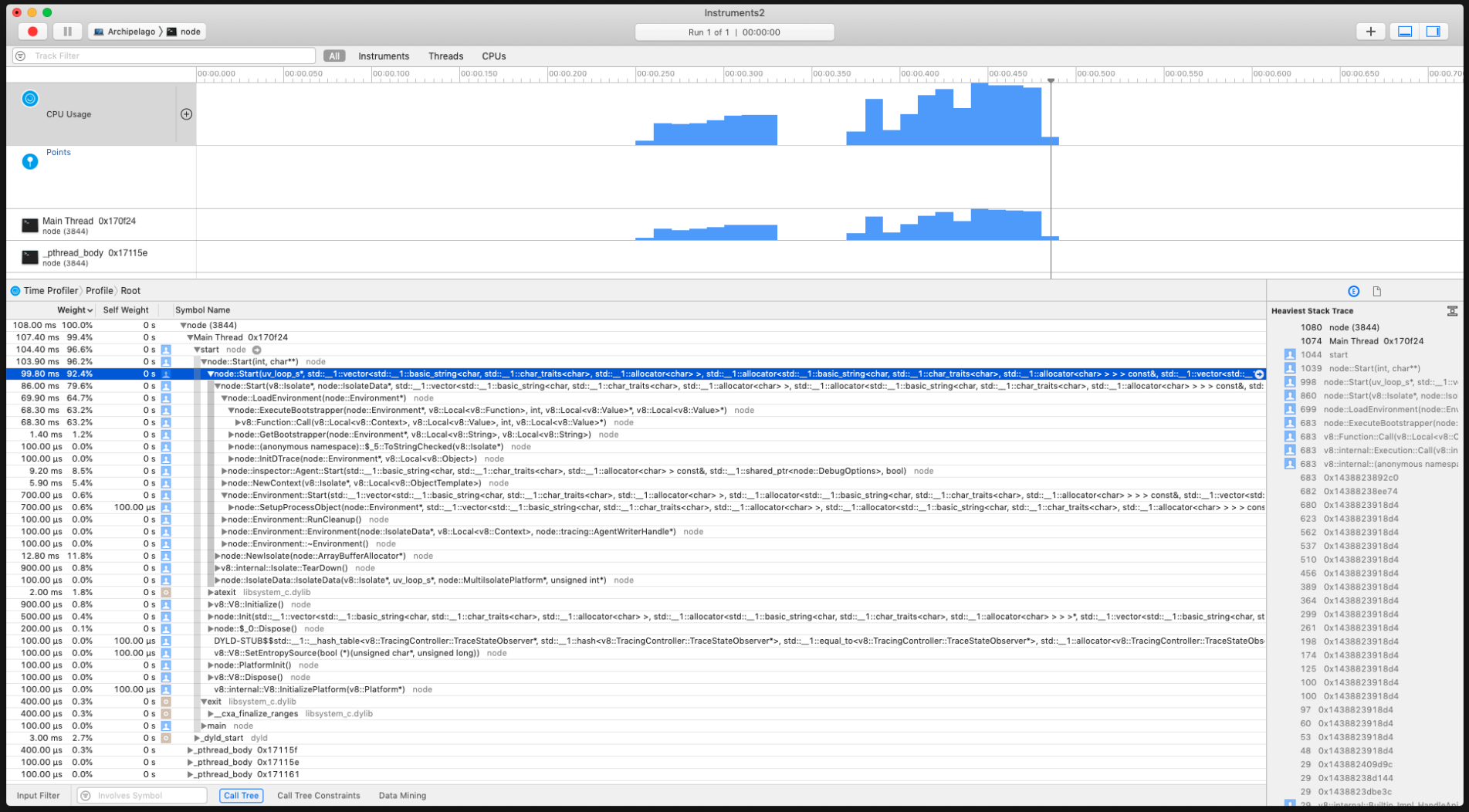
00:00.800
00:00.900
CPU Usage
Points
Main Thread 0x16dea2
node (1358)
node::WorkerThr…r::Run 0x16e05a
node (1358)
node:: 0x16e05b
node (1358)
node:: 0x16e05c
node (1358)
Time Profiler 〉 Profile 〉 Root
Weight
Self Weight
Symbol Name
48.50 ms 100.0% 0 s ▼node (1358)
47.70 ms 98.3% 0 s ▼Main Thread 0x16dea2
42.90 ms 88.4% 0 s ▼start libdyld.dylib
42.30 ms 87.2% 0 s ▼node::Start(int, char**) node
35.20 ms 72.5% 0 s ▼node::NodeMainInstance::Run() node
23.80 ms 49.0% 0 s ▼node::NodeMainInstance::CreateMainEnvironment(int*) node
11.60 ms 23.9% 0 s ▼node::Environment::RunBootstrapping() node
10.20 ms 21.0% 0 s ▼node::Environment::BootstrapNode() node
10.20 ms 21.0% 0 s ▼node::ExecuteBootstrapper(node::Environment*, char const*, std::__1::vector<v8::Local<v8::String>, std::__1::allocator<v8::Local<v8::String> > >*, std::__1::vector<v8::Local<v8::Value>, std::__1::allocator<v8::Local<v8::Value> > >*) node
9.70 ms 20.0% 0 s ▶v8::Function::Call(v8::Local<v8::Context>, v8::Local<v8::Value>, int, v8::Local<v8::Value>*) node
500.00 µs 1.0% 0 s ▶node::native_module::NativeModuleEnv::LookupAndCompile(v8::Local<v8::Context>, char const*, std::__1::vector<v8::Local<v8::String>, std::__1::allocator<v8::Local<v8::String> > >*, node::Environment*) node
1.40 ms 2.8% 0 s ▶node::Environment::BootstrapInternalLoaders() node
11.30 ms 23.2% 0 s ▶node::Environment::InitializeInspector(node::inspector::ParentInspectorHandle*) node
600.00 µs 1.2% 0 s ▶v8::Context::FromSnapshot(v8::Isolate*, unsigned long, v8::DeserializeInternalFieldsCallback, v8::ExtensionConfiguration*, v8::MaybeLocal<v8::Value>, v8::MicrotaskQueue*) node
300.00 µs 0.6% 100.00 µs ▶node::Environment::Environment(node::IsolateData*, v8::Local<v8::Context>, std::__1::vector<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> >, std::__1::allocator<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1:
11.10 ms 22.8% 0 s ▼node::StartMainThreadExecution(node::Environment*) node
11.10 ms 22.8% 0 s ▼node::StartExecution(node::Environment*, char const*) node
10.60 ms 21.8% 0 s ▼node::ExecuteBootstrapper(node::Environment*, char const*, std::__1::vector<v8::Local<v8::String>, std::__1::allocator<v8::Local<v8::String> > >*, std::__1::vector<v8::Local<v8::Value>, std::__1::allocator<v8::Local<v8::Value> > >*) node
10.50 ms 21.6% 0 s ▶v8::Function::Call(v8::Local<v8::Context>, v8::Local<v8::Value>, int, v8::Local<v8::Value>*) node
100.00 µs 0.2% 0 s ▶node::native_module::NativeModuleEnv::LookupAndCompile(v8::Local<v8::Context>, char const*, std::__1::vector<v8::Local<v8::String>, std::__1::allocator<v8::Local<v8::String> > >*, node::Environment*) node
500.00 µs 1.0% 0 s ▶node::task_queue::RunNextTicksNative(node::Environment*) node
100.00 µs 0.2% 0 s ▶v8::Locker::~Locker() node
100.00 µs 0.2% 0 s ▶node::Environment::RunBeforeExitCallbacks() node
100.00 µs 0.2% 0 s ▶v8::Locker::Initialize(v8::Isolate*) node
3.30 ms 6.8% 0 s ▼node::NodeMainInstance::NodeMainInstance(v8::Isolate::CreateParams*, uv_loop_s*, node::MultiIsolatePlatform*, std::__1::vector<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> >, std::__1::allocator<std::__1::basic_string<char, std::
3.10 ms 6.3% 0 s ▶v8::Isolate::Initialize(v8::Isolate*, v8::Isolate::CreateParams const&) node
100.00 µs 0.2% 0 s ▶node::NodePlatform::RegisterIsolate(v8::Isolate*, uv_loop_s*) node
100.00 µs 0.2% 0 s ▶v8::internal::Isolate::New(v8::internal::IsolateAllocationMode) node
3.00 ms 6.1% 0 s ▶node::InitializeOncePerProcess(int, char**) node
600.00 µs 1.2% 0 s ▶node::NodeMainInstance::~NodeMainInstance() node
100.00 µs 0.2% 0 s ▶0x101090007 node
100.00 µs 0.2% 0 s ▶node::TearDownOncePerProcess() node
600.00 µs 1.2% 0 s ▶exit libsystem_c.dylib
Input Filter
Involves Symbol
Call Tree
Call Tree Constraints
Data Mining
Heaviest Stack Trace
485 node (1358)
477 Main Thread 0x16dea2
429 start
423 node::Start(int, char**)
352 node::NodeMainInstance::Run()
238 node::NodeMainInstance::CreateM
116 node::Environment::RunBootstrap
102 node::Environment::BootstrapNod
102 node::ExecuteBootstrapper(node:
97 v8::Function::Call(v8::Local<v8::Co
97 v8::internal::Execution::Call(v8::int
97 v8::internal::(anonymous namespac
97 Builtins_JSEntry
97 Builtins_JSEntryTrampoline
96 Builtins_InterpreterEntryTrampoline
88 Builtins_InterpreterEntryTrampoline
80 Builtins_InterpreterEntryTrampoline
65 Builtins_InterpreterEntryTrampoline
48 Builtins_InterpreterEntryTrampoline
30 Builtins_InterpreterEntryTrampoline
20 Builtins_InterpreterEntryTrampoline
9 Builtins_InterpreterEntryTrampoline
3 Builtins_InterpreterEntryTrampoline
2 Builtins_InterpreterEntryTrampoline
1 Builtins_CEntry_Return1_DontSaveFP
1 v8::internal::Builtin_Impl_HandleApiC
1 v8::internal::MaybeHandle<v8::inter
1 v8::internal::FunctionCallbackArgum
1 node::native_module::NativeModuleE
1 node::native_module::NativeModuleL
1 node::native_module::NativeModuleL


Instruments2
Archipelago 〉 node
Run 1 of 1 | 00:00:00
Track Filter
All
Instruments
Threads
CPUs
CPU Usage
Points
Main Thread 0x170f24
node (3844)
_pthread_body 0x17115e
node (3844)
Time Profiler 〉 Profile 〉 Root
Weight
Self Weight
Symbol Name
108.00 ms 100.0% 0 s node (3844)
107.40 ms 99.4% 0 s Main Thread 0x170f24
104.40 ms 96.6% 0 s start node
103.90 ms 96.2% 0 s node::Start(int, char**) node
99.80 ms 92.4% 0 s node::Start(uv_loop_s*, std::__1::vector<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> >, std::__1::allocator<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> > > > const&, std::__1::vector<std::
86.00 ms 79.6% 0 s node::Start(v8::Isolate*, node::IsolateData*, std::__1::vector<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> >, std::__1::allocator<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> > > > const&, std:
69.90 ms 64.7% 0 s node::LoadEnvironment(node::Environment*) node
68.30 ms 63.2% 0 s node::ExecuteBootstrapper(node::Environment*, v8::Local<v8::Function>, int, v8::Local<v8::Value>*, v8::Local<v8::Value>*) node
68.30 ms 63.2% 0 s v8::Function::Call(v8::Local<v8::Context>, v8::Local<v8::Value>, int, v8::Local<v8::Value>*) node
1.40 ms 1.2% 0 s node::GetBootstrapper(node::Environment*, v8::Local<v8::String>, v8::Local<v8::String>) node
100.00 µs 0.0% 0 s node::(anonymous namespace)::$_5::ToStringChecked(v8::Isolate*) node
100.00 µs 0.0% 0 s node::InitDTrace(node::Environment*, v8::Local<v8::Object>) node
9.20 ms 8.5% 0 s node::inspector::Agent::Start(std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> > const&, std::__1::shared_ptr<node::DebugOptions>, bool) node
5.90 ms 5.4% 0 s node::NewContext(v8::Isolate*, v8::Local<v8::ObjectTemplate>) node
700.00 µs 0.6% 0 s node::Environment::Start(std::__1::vector<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> >, std::__1::allocator<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> > > > const&, std::__1::vector<std:
700.00 µs 0.6% 100.00 µs node::SetupProcessObject(node::Environment*, std::__1::vector<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> >, std::__1::allocator<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> > > > cons
100.00 µs 0.0% 0 s node::Environment::RunCleanup() node
100.00 µs 0.0% 0 s node::Environment::Environment(node::IsolateData*, v8::Local<v8::Context>, node::tracing::AgentWriterHandle*) node
100.00 µs 0.0% 0 s node::Environment::~Environment() node
12.80 ms 11.8% 0 s node::NewIsolate(node::ArrayBufferAllocator*) node
900.00 µs 0.8% 0 s v8::internal::Isolate::TearDown() node
100.00 µs 0.0% 0 s node::IsolateData::IsolateData(v8::Isolate*, uv_loop_s*, node::MultiIsolatePlatform*, unsigned int*) node
2.00 ms 1.8% 0 s atexit libsystem_c.dylib
900.00 µs 0.8% 0 s v8::V8::Initialize() node
500.00 µs 0.4% 0 s node::Init(std::__1::vector<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> >, std::__1::allocator<std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> > > >*, std::__1::vector<std::__1::basic_string<char, st
200.00 µs 0.1% 0 s node::$_0::Dispose() node
100.00 µs 0.0% 100.00 µs DYLD-STUB$$std::__1::__hash_table<v8::TracingController::TraceStateObserver*, std::__1::hash<v8::TracingController::TraceStateObserver*>, std::__1::equal_to<v8::TracingController::TraceStateObserver*>, std::__1::allocator<v8::TracingController::TraceStateObs
100.00 µs 0.0% 100.00 µs v8::V8::SetEntropySource(bool (*)(unsigned char*, unsigned long)) node
100.00 µs 0.0% 0 s node::PlatformInit() node
100.00 µs 0.0% 0 s v8::V8::Dispose() node
100.00 µs 0.0% 100.00 µs v8::internal::V8::InitializePlatform(v8::Platform*) node
400.00 µs 0.3% 0 s exit libsystem_c.dylib
400.00 µs 0.3% 0 s __cxa_finalize_ranges libsystem_c.dylib
100.00 µs 0.0% 0 s main node
3.00 ms 2.7% 0 s _dyld_start dyld
400.00 µs 0.3% 0 s _pthread_body 0x17115f
100.00 µs 0.0% 0 s _pthread_body 0x17115e
100.00 µs 0.0% 0 s _pthread_body 0x171161
Input Filter
Involves Symbol
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1080 node (3844)
1074 Main Thread 0x170f24
1044 start
1039 node::Start(int, char**)
998 node::Start(uv_loop_s*, std::__1::v
860 node::Start(v8::Isolate*, node::Iso
699 node::LoadEnvironment(node::Env
683 node::ExecuteBootstrapper(node:
683 v8::Function::Call(v8::Local<v8::C
683 v8::internal::Execution::Call(v8::in
683 v8::internal::(anonymous namespa
683 0x1438823892c0
682 0x14388238ee74
680 0x1438823918d4
623 0x1438823918d4
562 0x1438823918d4
537 0x1438823918d4
510 0x1438823918d4
456 0x1438823918d4
389 0x1438823918d4
364 0x1438823918d4
299 0x1438823918d4
261 0x1438823918d4
198 0x1438823918d4
174 0x1438823918d4
125 0x1438823918d4
100 0x1438823918d4
100 0x1438823918d4
97 0x1438823918d4
60 0x1438823918d4
53 0x1438823918d4
48 0x1438823918d4
29 0x143882409d9c
29 0x14388238d144
29 0x1438823dbe3c

# 启动时间都消耗在哪儿了

1. Parsing/Compiling
2. Interpreting
3. Repeat

# ALTERNATIVES

1. code-cache
2. Ahead of Time
3. fork(2)

## Preloaded Modules List

- 嵌入式系统库
- 函数运行时库

# PRIOR ARTS

1. Zygote

# RECOVERING FROM FORK(2)

1. 需要重新创建工作线程
2. 需要保护同步原语不被污染
3. 重新初始化 IPC 句柄

# FORK(2) WITH NODE.JS

1. 事件驱动范式
2. 单线程模型不代表单线程实现
3. Native Addon 访问系统 API

# RECOVER: UV_LOOP_FORK

1. epoll backend fd
2. async backend fd
3. signals

# RECOVER: NODE PLATFORM

1. Threaded tasks from VM
2. Threaded tasks from JS land
3. Threaded tracing
4. 暂不支持 worker_threads

# RECOVER: NODE ADDONS

1. 没有成标准 API 提供 addon 恢复线程工作
2. 同样 builtin 模块线程工作也无法恢复

# LIMITATIONS

1. 需要持续运行 seed 进程
2. seed 进程特性使用有较大限制
3. 需要有对系统的权限控制权限

# YODAOS-PROJECT/HIVE

```
using 'node' as runtime... (node v12.8.1)
fork/hive-fork-child-process.js n=100: 5.954ms
fork/node-fork-child-process.js n=100: 27.218ms
fork/node-spawn-child-process.js n=100: 24.239ms
```

```
using 'node' as runtime... (node v12.8.1)
require-lodash/hive-fork-child-process.js n=100: 5.872ms
require-lodash/node-fork-child-process.js n=100: 37.843ms
require-lodash/node-spawn-child-process.js n=100: 34.628ms
```

```
using 'iotjs' as runtime... (iotjs v0.11.7)
fork-child-process.js n=100: 2.863ms
node-fork-child-process.js n=100: 36.566ms
node-spawn-child-process.js n=100: 25.797ms
```

# WHAT'S NEXT

1. Collect Usage Case
2. Standardize Fork API

Thanks

*@legendecas*