Reporter

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https://github.com/Rebiss/Presentation

Content

- Whot is Node.js
- Libuv. Event Loop. Threads
- Core Modules. C++ Bindings
- C-ares. ZLib. HTTP Parser. OpenSSL
- V8 Engin. WebAssembly
- Microtask and Macrotask

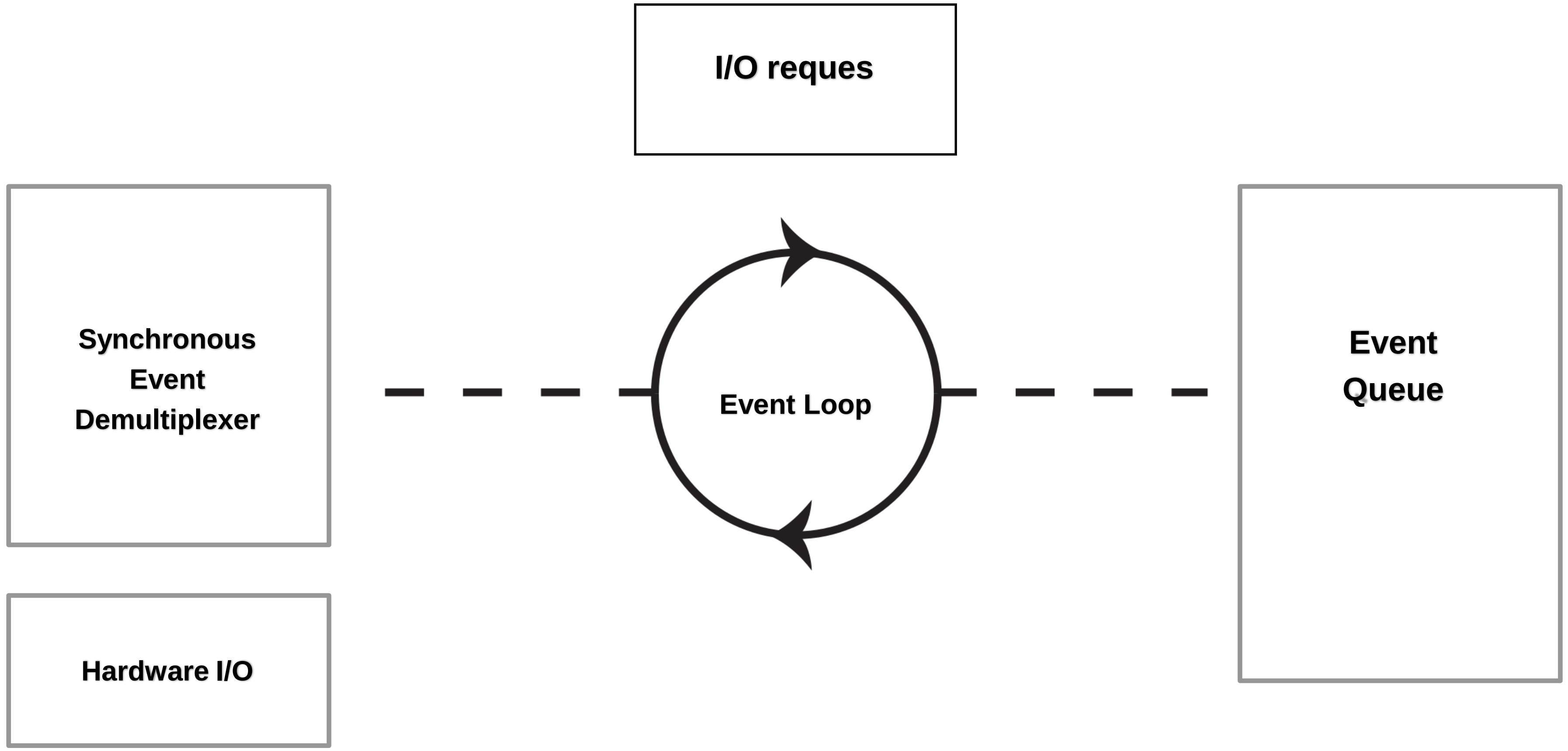
Whot is Node.js

Node.js® is a JavaScript runtime built on Chrome's V8 JavaScript engine.

Node.js uses an event-driven(Reactor Pattern), non-blocking I/O model that mastes is lightweight and efficient.

Node.js use of v8 and libuv

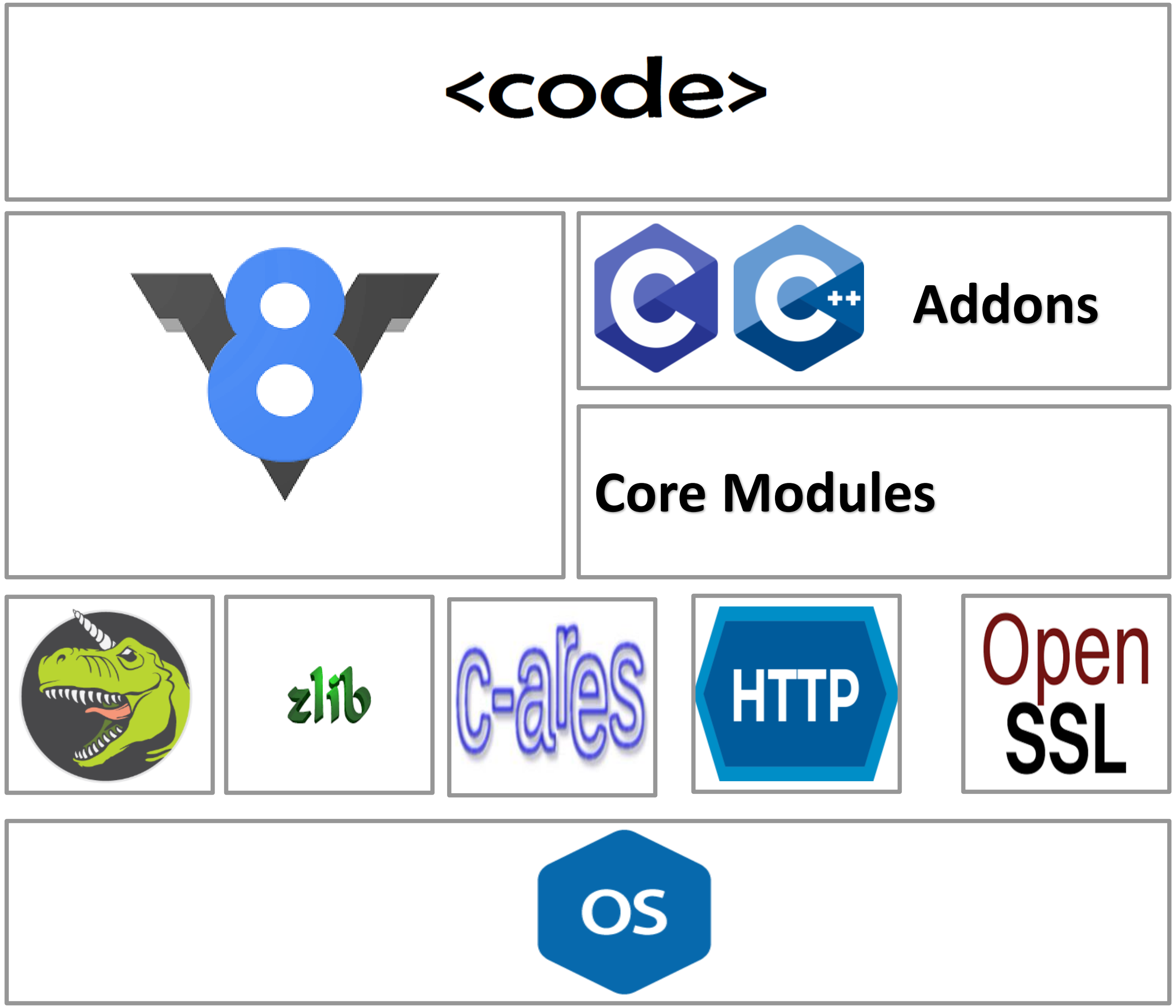
Reactor Pattern



The **reactor design pattern** is an event handling pattern for handling service requests delivered concurrently to a service handler by one or more inputs. The service handler then demultiplexes the incoming requests and dispatches them synchronously to the associated request handlers

Structure: Synchronous Event Demultiplexer, Dispatcher, Request Handler

Node.js Architecture



Libuv

Written in

C++

Event Loop

Node.js

Operating system

Cross-platform

Type

I/O abstraction library

Libuv (Unicorn Velociraptor Library) is a multi-platform C library that provides support for asynchronous I/O based on event loops.

Features

Full-featured event loop backed by epoll, kqueue, IOCP, event ports.

Asynchronous TCP and UDP sockets. DNS resolution.

Asynchronous file and file system operations. File system events.

ANSI escape code controlled TTY. Child processes.

IPC with socket sharing, using Unix domain sockets or named pipes.

Thread pool. Signal handling. High resolution clock.

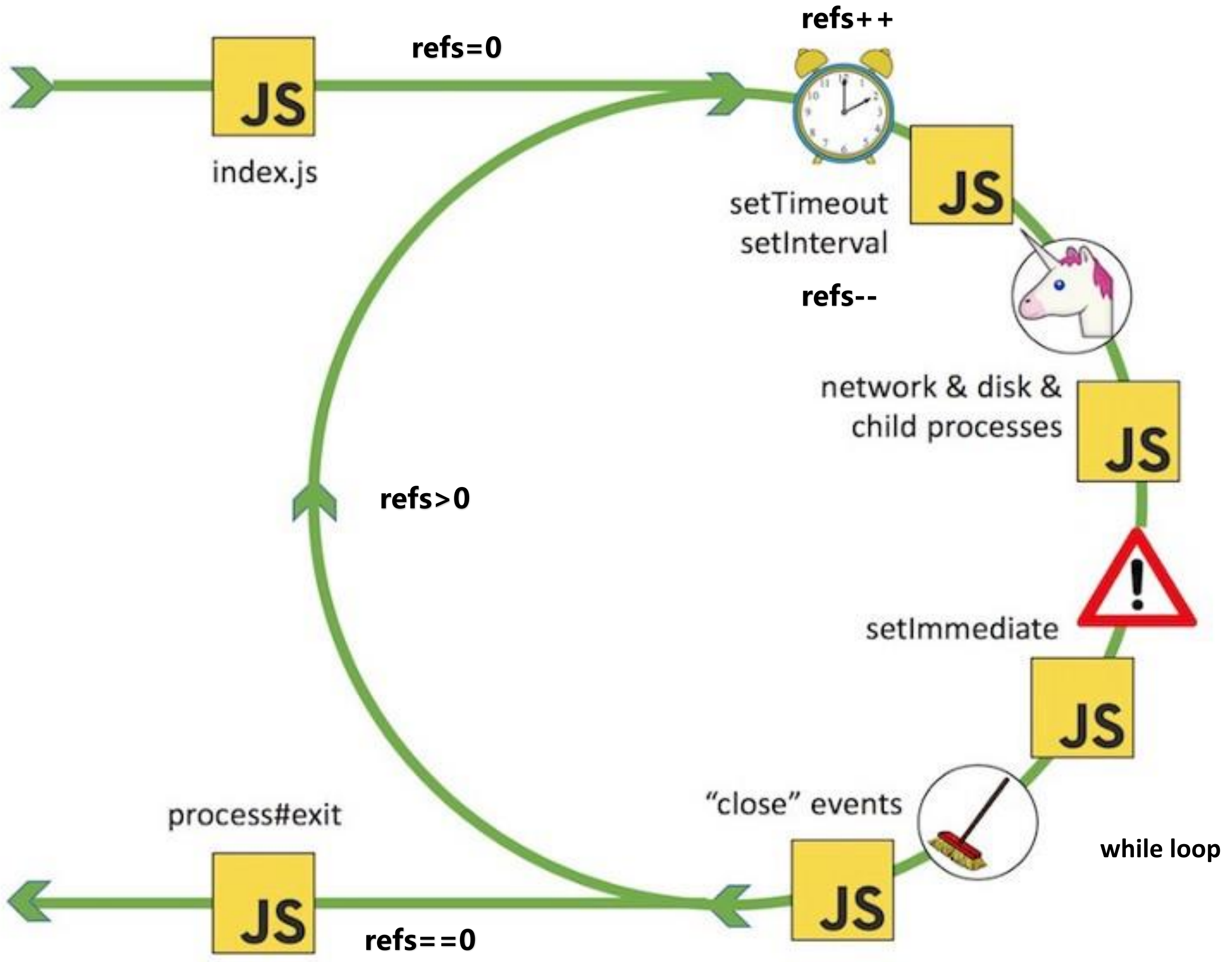
Event Loop or Semi-infinite Loop

Timer. setTimeout,setInterval

I/O.
Collback,network...

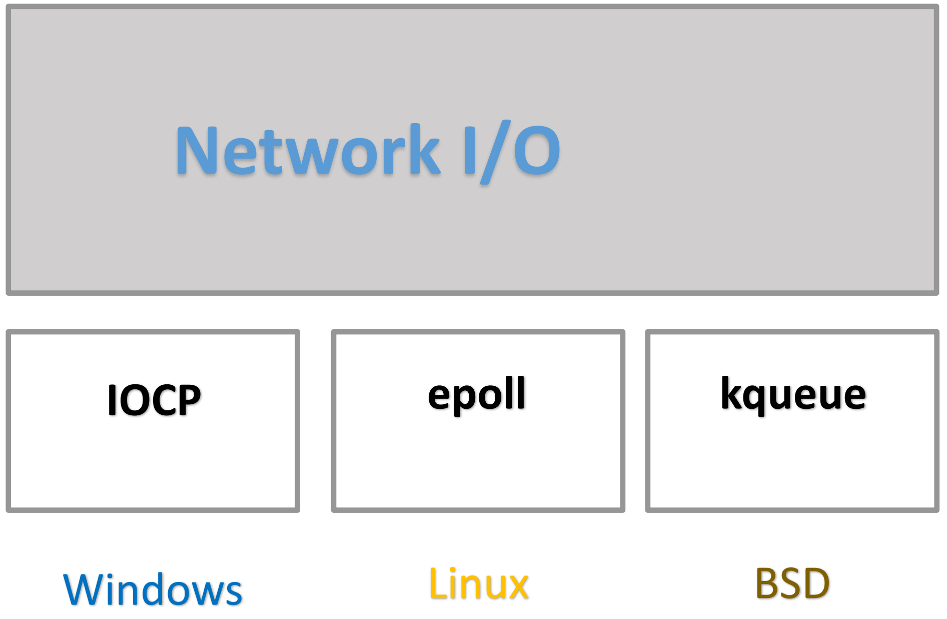
Immediate.
setImmediate

Closed events.
DB close conection

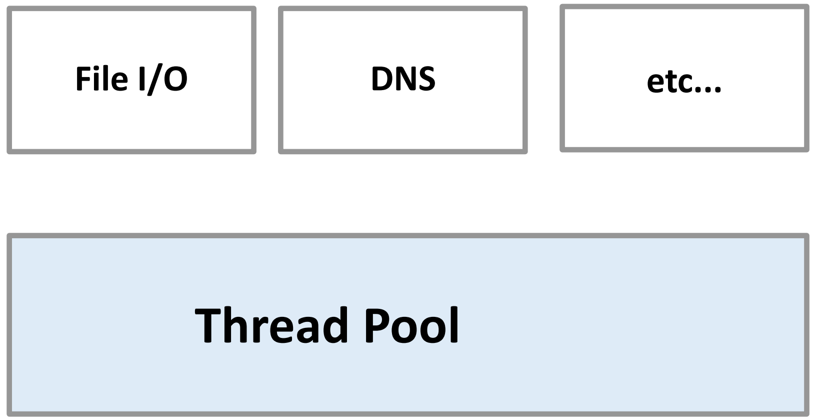


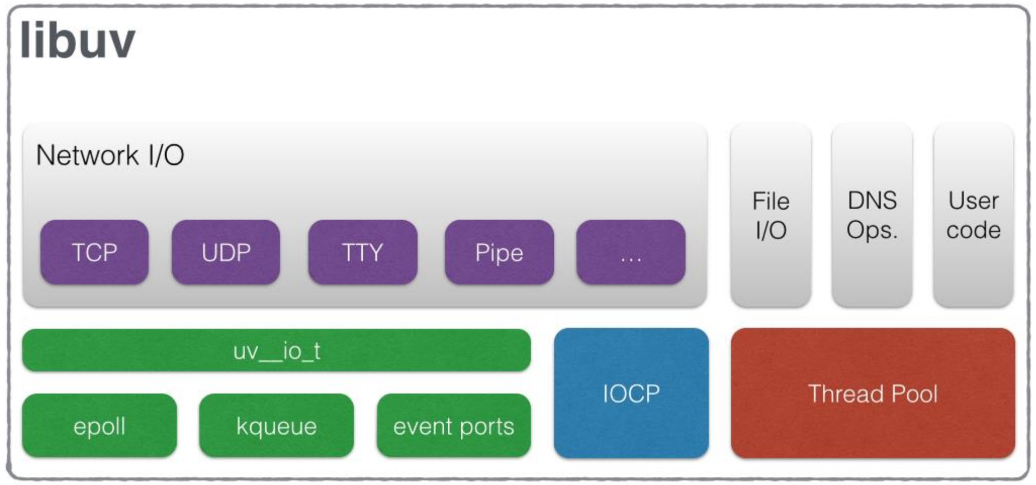
Libuv

Non-Blocking I/O



Blocking I/O

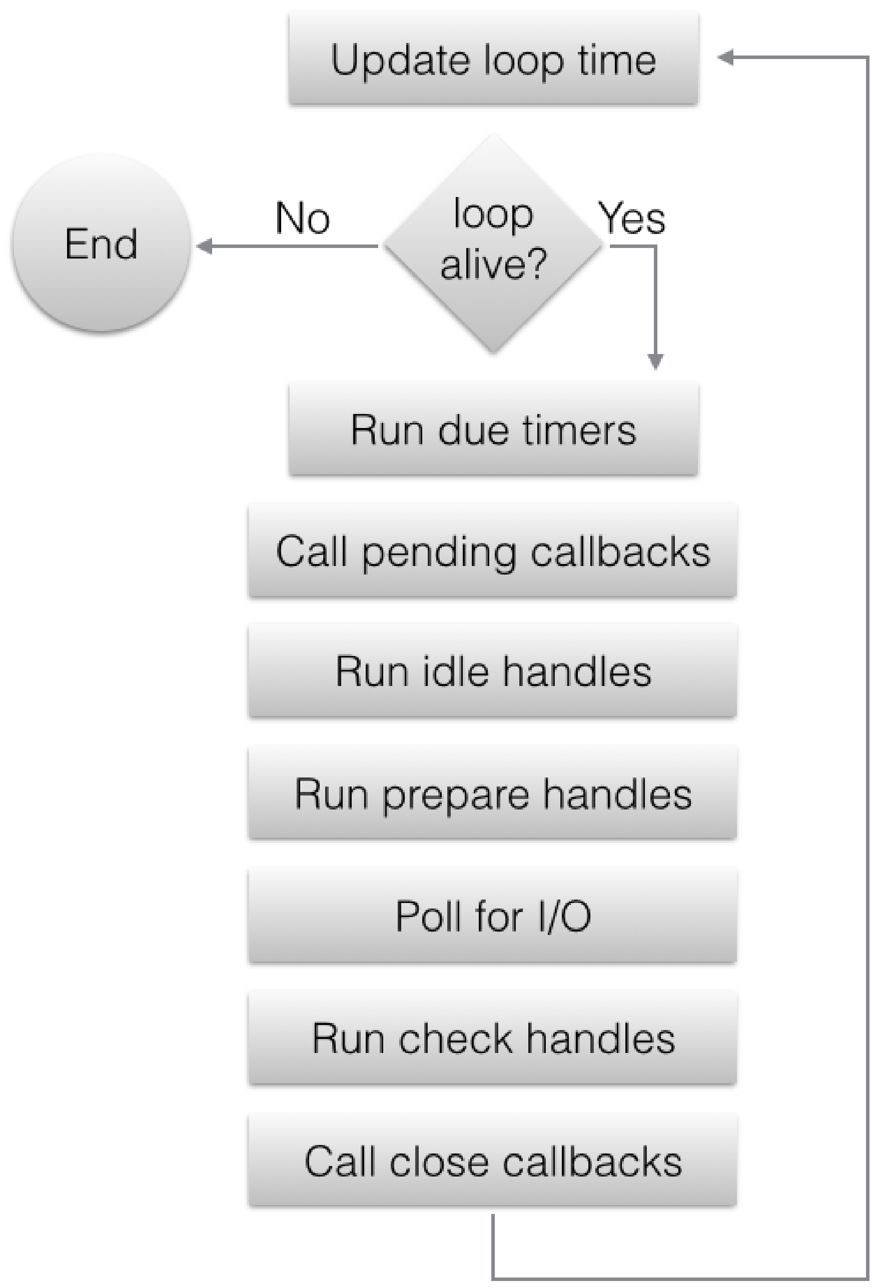




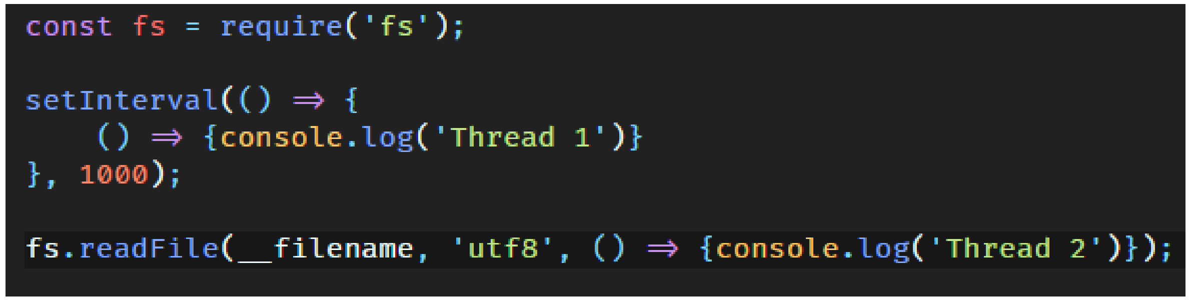
I/O loop

Code

https://github.com/libuv/libuv



Threads

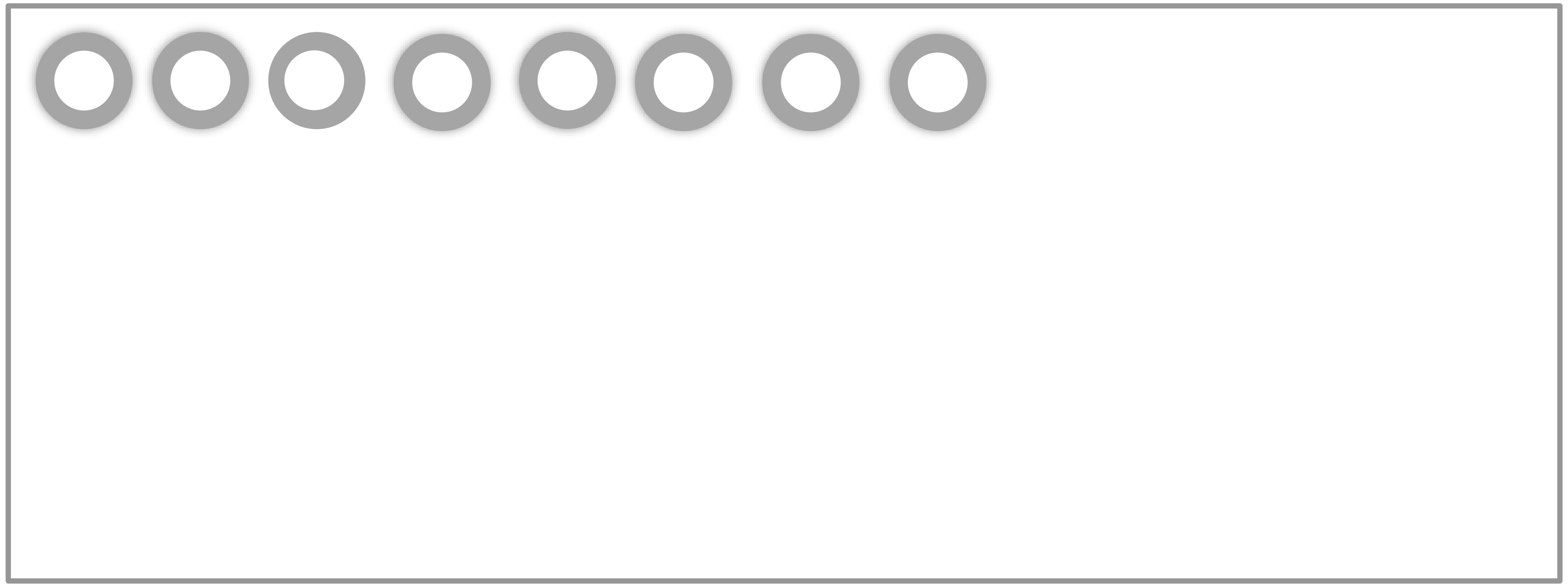


```
const fs = require('fs');

setInterval(() => {
    () => {console.log('Thread 1')}
}, 1000);

fs.readFile(__filename, 'utf8', () => {console.log('Thread 2')});
```

Blocking I/O ***CPU intensive***

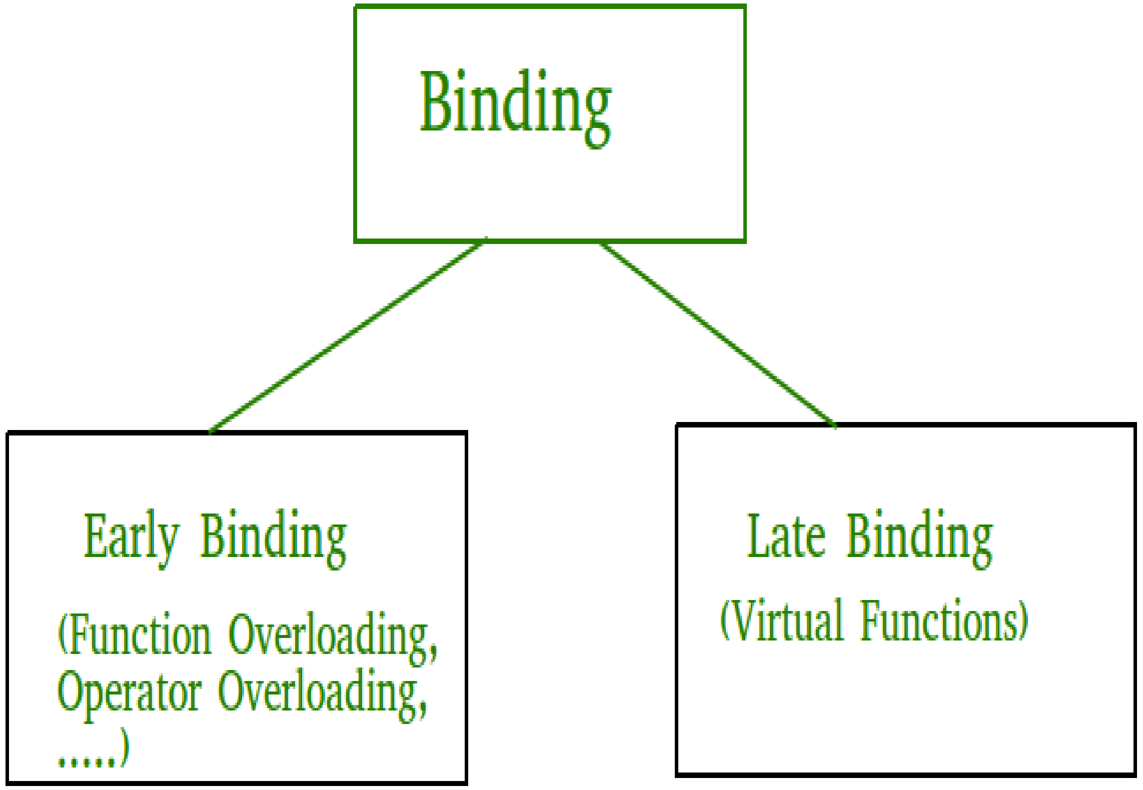


UV_THREADPOOL_SIZE = 8 SIZE <= 128

Thread Pool

Web Workers

C++ Bindings



Binding refers to the process of converting identifiers (such as variable and performance names) into addresses. Binding is done for each variable and functions. For functions, it means that matching the call with the right function definition by the compiler. It takes place either at compile time or at runtime.

E arly Binding (compile-time time polymorphism)

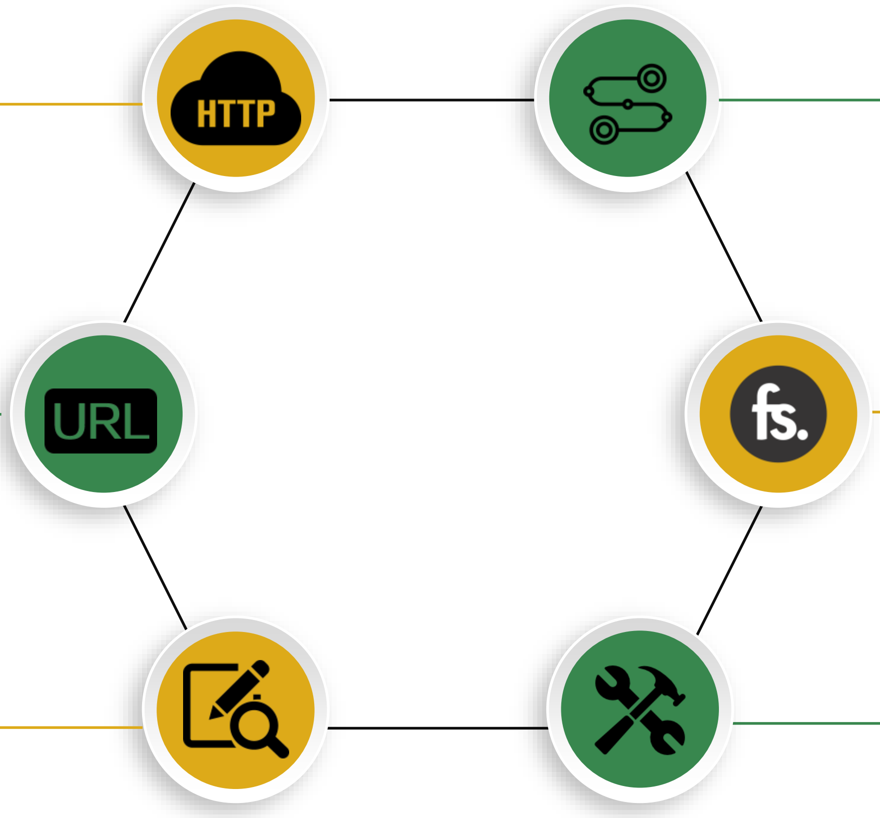
As the name indicates, compiler (or linker) directly associate an address to the function call. It replaces the call with a machine language instruction that tells the mainframe to leap to the address of the function.

L ate Binding

In this, the compiler adds code that identifies the kind of object at runtime then matches the call with the right function definition (Refer this for details). This can be achieved by declaring a virtual function.

Core Modules

Module in Node.js is a simple or complex functionality organized in single or multiple JavaScript files which can be reused throughout the Node.js application.
Each module in Node.js has its own context, so it cannot interfere with other modules or pollute global scope.



Http

Http module includes classes, methods and events to create Node.js http server

Url

url module includes methods for URL resolution and parsing.

Querystring

Querystring module includes methods to deal with query string.

Path

Path module includes methods to deal with file paths.

Fs

Path module includes methods to deal with file paths.

Util

Util module includes utility functions useful for programmers.

Also, each module can be placed in a separate .js file under a separate folder.
Node.js implements CommonJS modules standard. CommonJS is a group of volunteers who define JavaScript standards for web server, desktop, and console application.

C-ares
ZLib

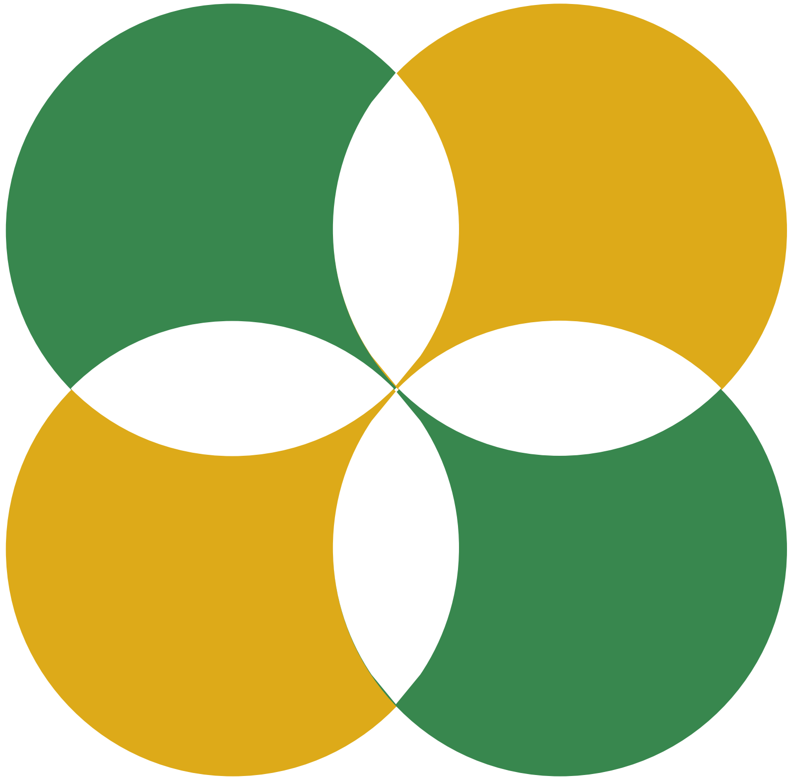
HTTP Parser. OpenSSL

C-ares

is a C library for asynchronous DNS requests (including name resolves).
C89 compatibility, MIT licensed, builds for and runs on POSIX, Windows, Netware, Android and many more operating systems

ZLib

zlib is a software library used for data copression. zlib was written by Jean-loup Gailly and Mark Adler and is an abstraction of the DEFLATE compression algorithm used in their gzip file compression program. zlib is also a crucial component of many software platforms, including Linux, OSX, and iOS.



HTTP Parser

This is a parser for HTTP messages written in C. It parses both requests and responses. The parser is designed to be used in performance HTTP applications. It does not make any syscalls nor allocations, it does not buffer data, it can be interrupted at anytime. Depending on your architecture, it only requires about 40 bytes of data per message stream (in a web server that is per connection).

OpenSSL

OpenSSL is an open-source command line tool that is commonly used to generate private keys, create CSRs, install your SSL/TLS certificate, and identify certificate information. We designed this quick reference guide to help you understand the most common OpenSSL commands and how to use them.

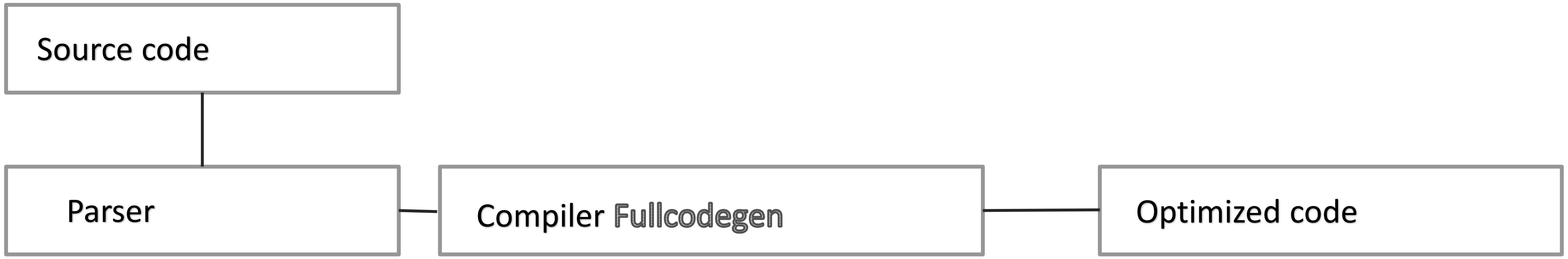
Javascript V8 engin

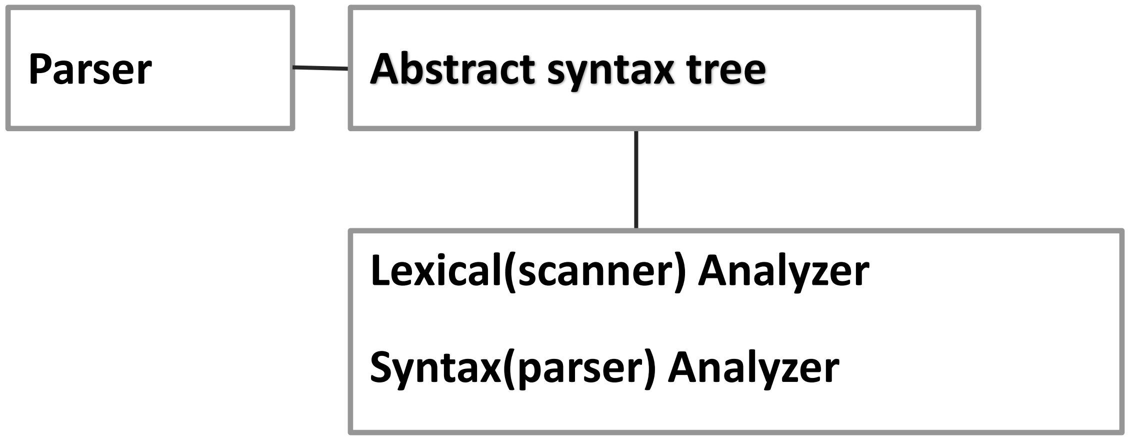
What is javascript engin ?

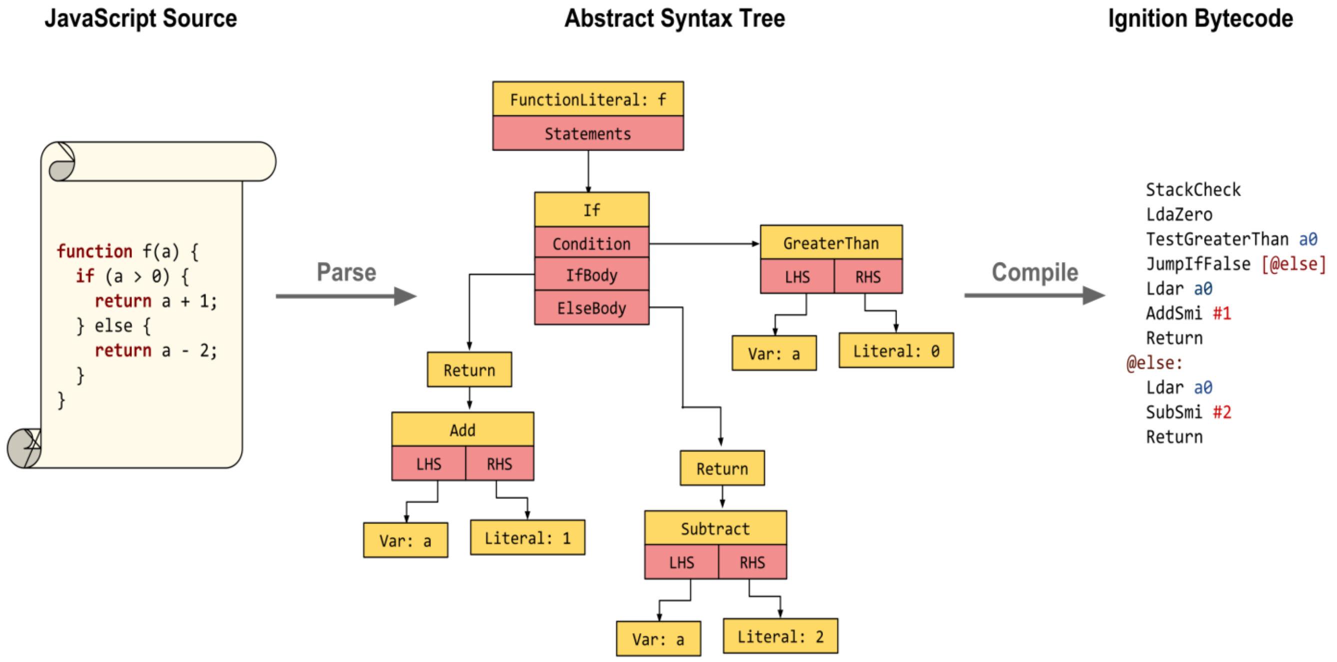
V8 is Google’s open source high-performance JavaScript and WebAssembly engine, written in C++. It is used in Chrome and in Node.js, among others.
This documentation is aimed at C++ developers who want to use V8 in their applications, as well as anyone interested in V8’s design and performance. This document introduces you to V8, while the remaining documentation shows you how to use V8 in your code and describes some of its design details, as well as providing a set of JavaScript benchmarks for measuring V8’s performance.
V8 implements ECMAScript and WebAssembly, and runs on Windows 7 or later, macOS 10.12+, and Linux systems that use x64, IA-32, ARM, or MIPS processors.
V8 can run standalone, or can be embedded into any C++ application.
V8 compiles and executes JavaScript source code, handles memory allocation for objects, and garbage collects objects it no longer needs.

Javascript engin

2008





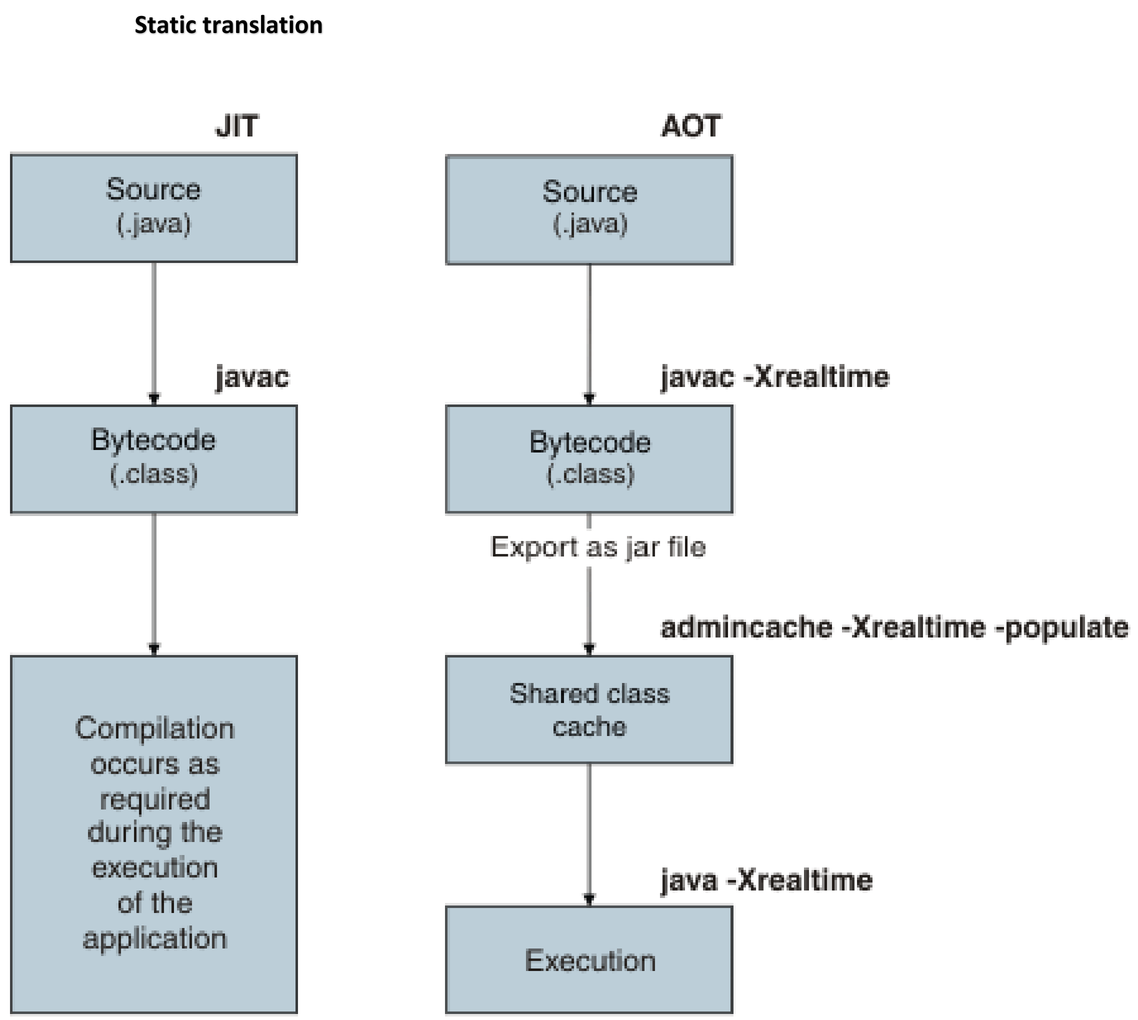


```javascript
function f(a) {
  if (a > 0) {
    return a + 1;
  } else {
    return a - 2;
  }
}
```

```
  StackCheck
  LdaZero
  TestGreaterThan a0
  JumpIfFalse [@else]
  Ldar a0
  AddSmi #1
  Return
@else:
  Ldar a0
  SubSmi #2
  Return
```

Compilation

Ahead of Time



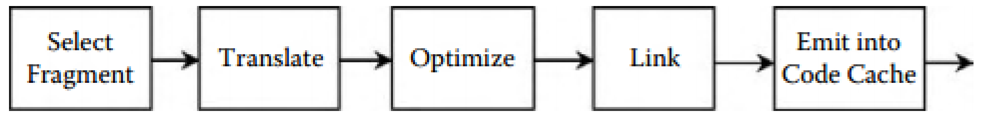
AOT is the act of compiling a higher-level programming language such as C or C++, or an intermediate representation such as Java bytecode or .NET Framework Common Intermediate Language (CIL) code, into a native (system-dependent) machine code so that the resulting binary file can execute natively.

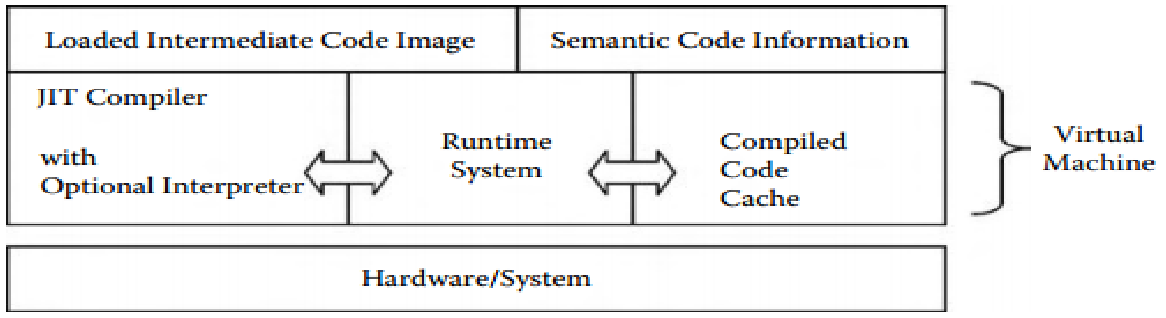
AOT produces machine optimized code, just like a standard native compiler. The difference is that AOT transforms the bytecode of an extant virtual machine (VM) into machine code.

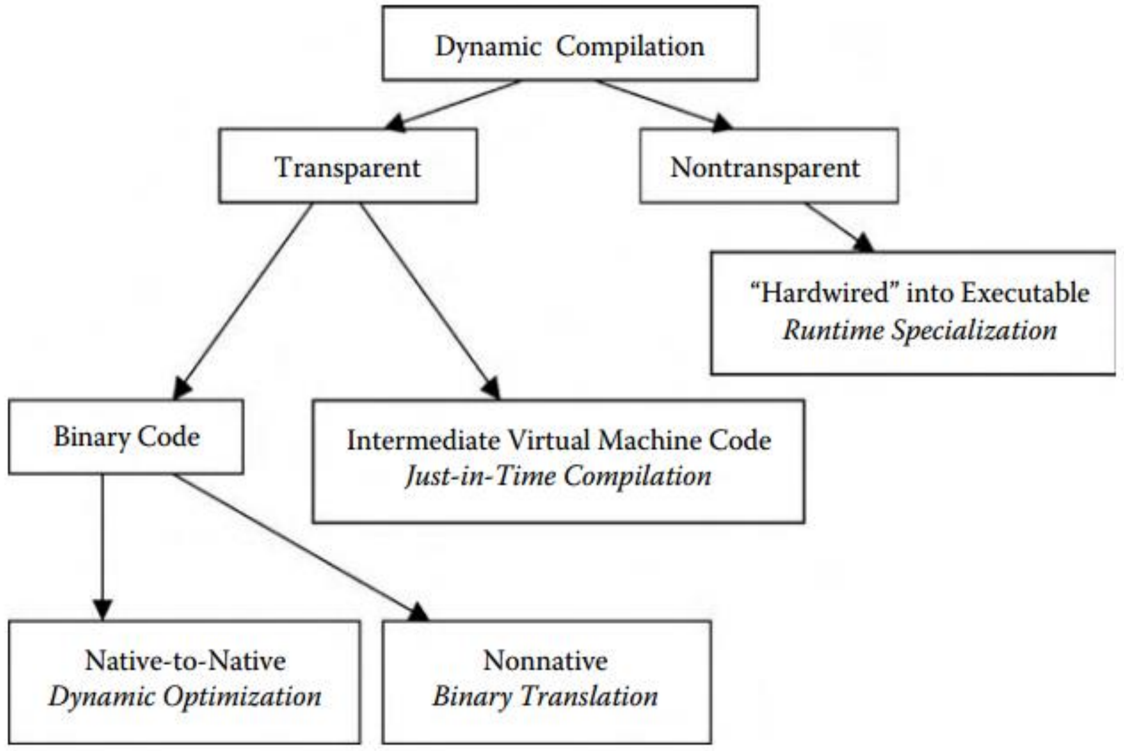
Compilation

Just in Time

Dynamic translation or Run-time compilations

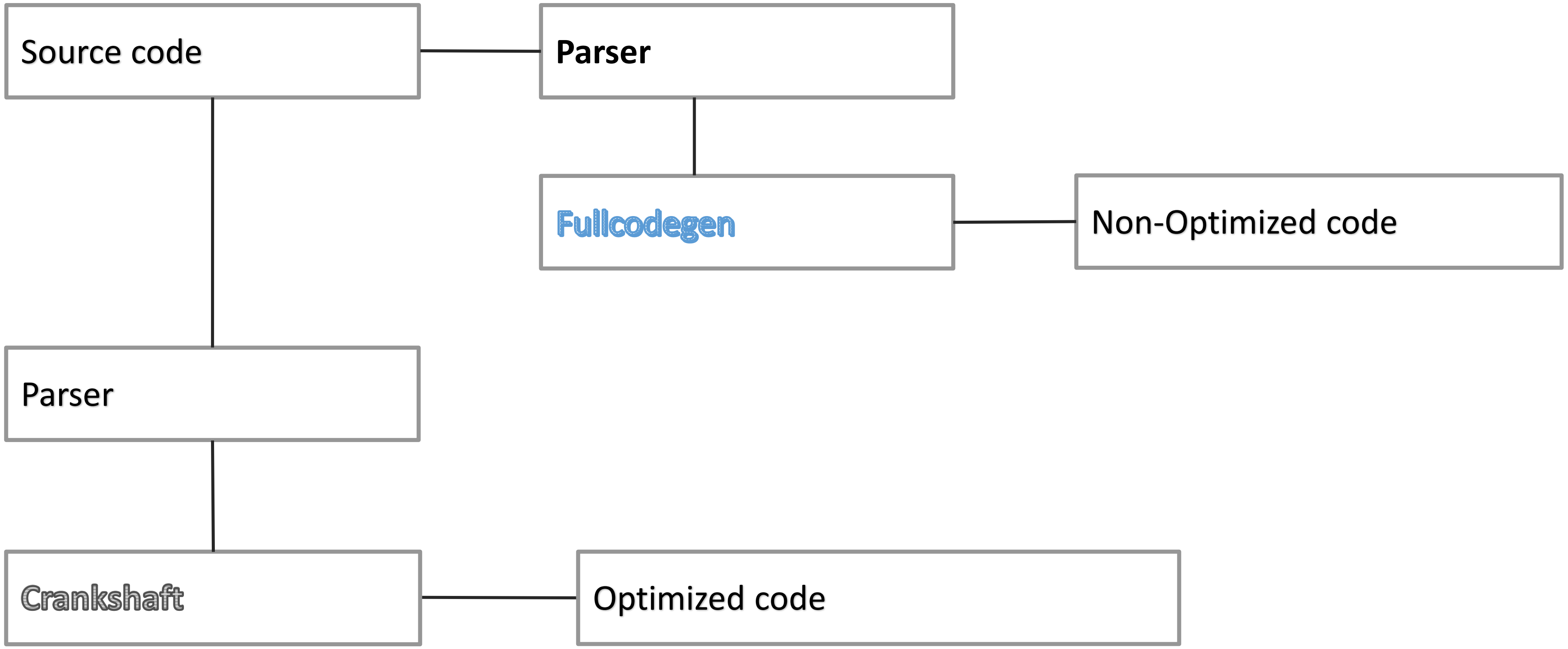



Loaded Intermediate Code Image
Semantic Code Information
JIT Compiler with Optional Interpreter
Runtime System
Compiled Code Cache
Virtual Machine
Hardware/System

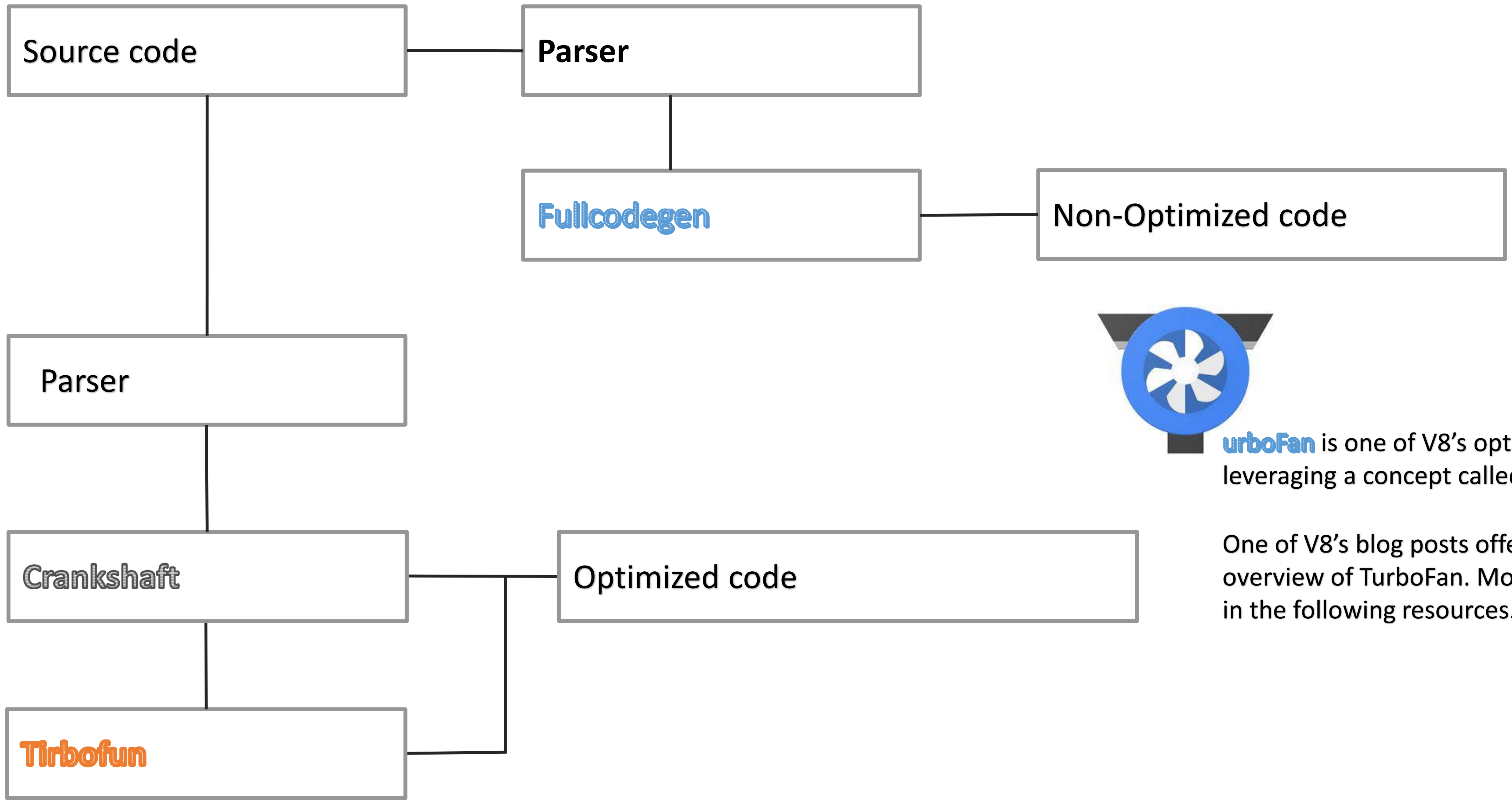


JIT is a way of executing computer code that involves compilation during execution of a program – at run time – rather than prior to execution. Most often, this consists of source code or more commonly bytecode translation to machine code, which is then executed directly. A system implementing a JIT compiler typically continuously analyses the code being executed and identifies parts of the code where the speedup gained from compilation or recompilation would outweigh the overhead of compiling that code.

2010


Source code
Parser
Fullcodegen
Non-Optimized code
Parser
Crankshaft
Optimized code

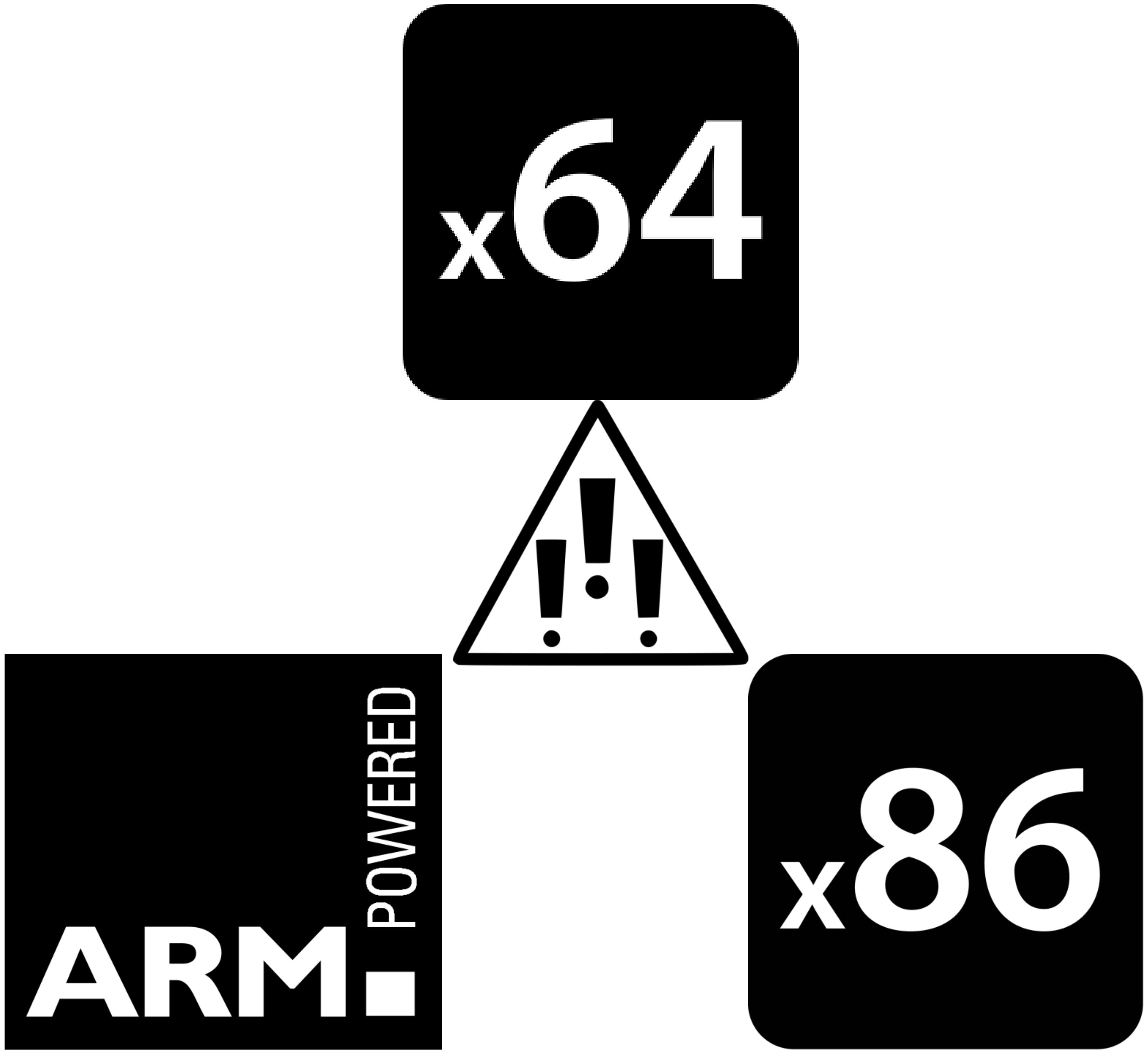
2015



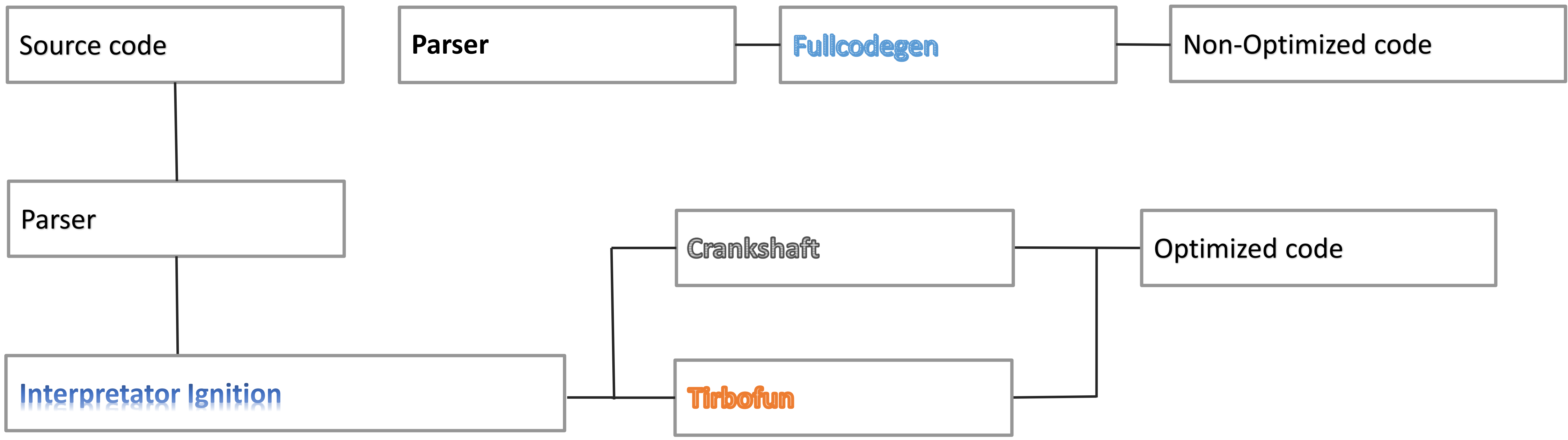
urboFan is one of V8's optimizing compilers leveraging a concept called "Sea of Nodes".

One of V8's blog posts offers a high-level overview of TurboFan. More details can be found in the following resources.

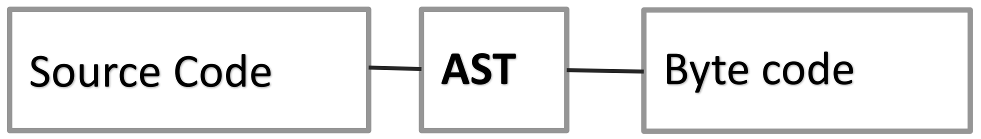
2015



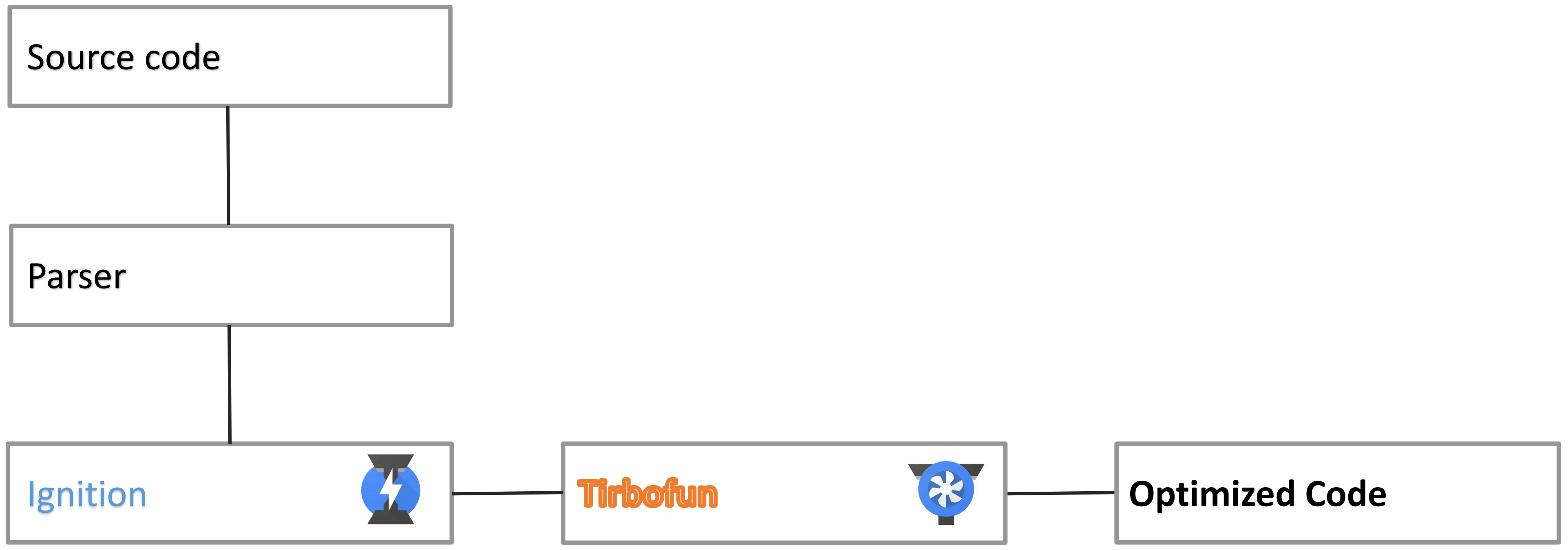
2016



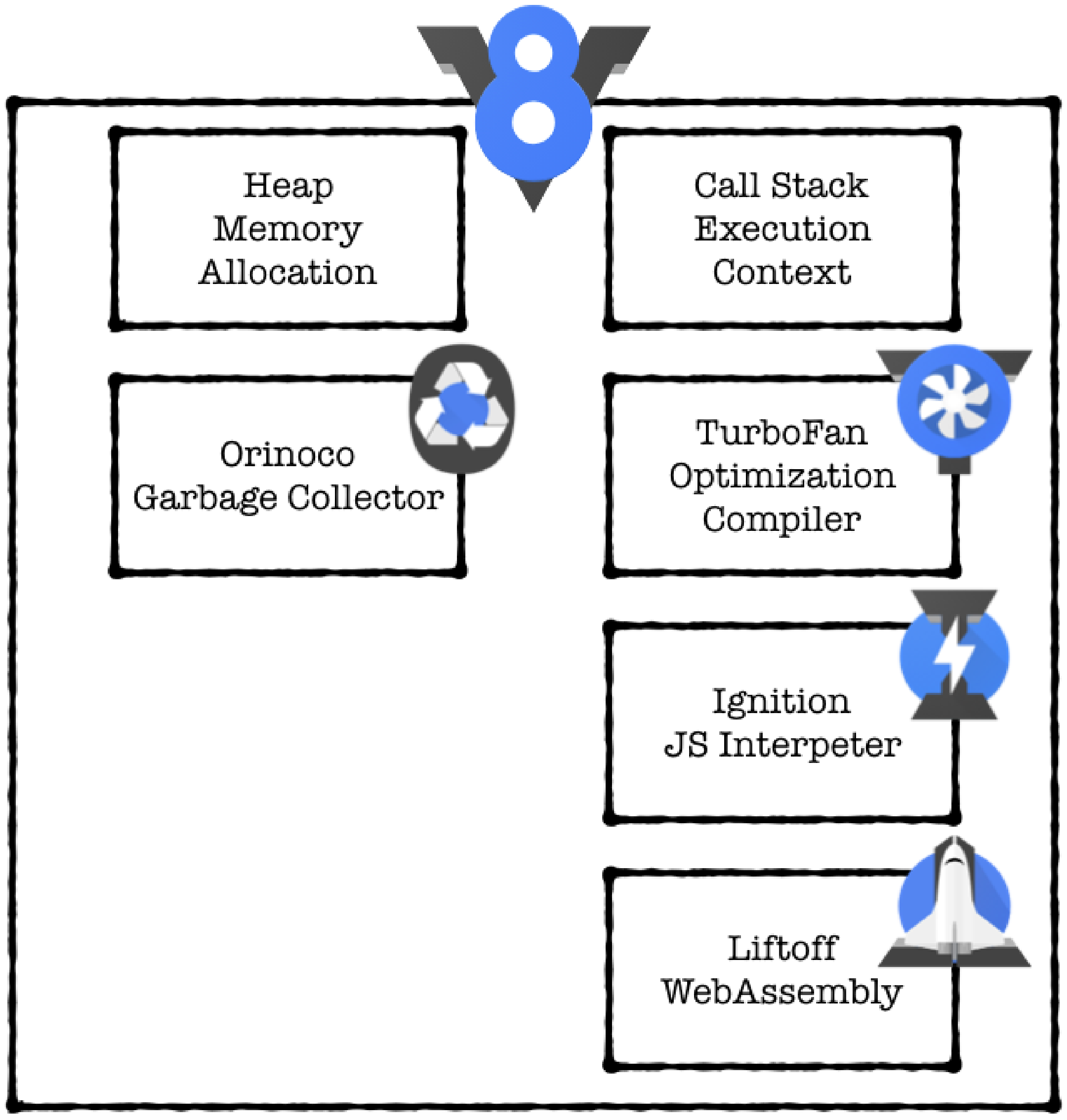
V8 features an interpreter called Ignition. Ignition is a fast low-level register-based interpreter written using the backend of TurboFan. The V8 blog post presents a high-level overview of the Ignition interpreter. More details can be found in the following resources

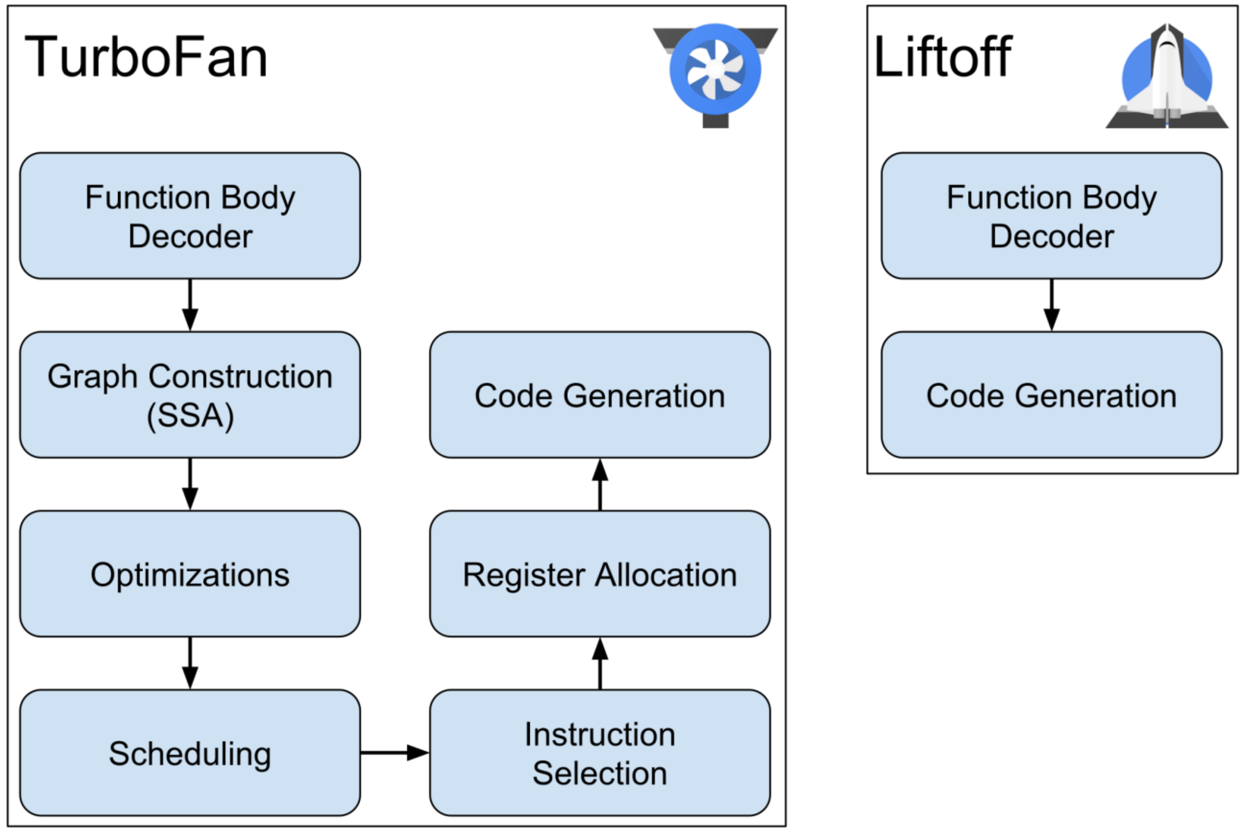


2017



2018


Heap
Memory
Allocation
Call Stack
Execution
Context
Orinoco
Garbage Collector
TurboFan
Optimization
Compiler
Ignition
JS Interpeter
Liftoff
WebAssembly


TurboFan
Function Body Decoder
Graph Construction (SSA)
Optimizations
Scheduling
Instruction Selection
Register Allocation
Code Generation
Liftoff
Function Body Decoder
Code Generation

Liftoff

V8 v6.9 includes Liftoff, a new baseline compiler for WebAssembly. Liftoff is now enabled by default on desktop systems. This article details the motivation to add another compilation tier and describes the implementation and performance of Liftoff. But why does it take this long to start up a WebAssembly app, if similar JS apps start up much faster? The reason is that WebAssembly promises to deliver predictable performance, so once the app is running, you can be sure to consistently meet your performance goals (e.g. rendering 60 frames per second, no audio lag or artifacts…). In order to achieve this, WebAssembly code is compiled ahead of time in V8, to avoid any compilation pause introduced by a just-in-time compiler that could result in visible jank in the app.

Orinoco

Running over the memory heap, looking for disconnected memory allocations is the Orinoco. Implementing a generational garbage collector, moving objects within the young generation, from the young to the old generation, and within the old generation. These moves leave holes, and Orinoco performs both evacuation and compaction to free space for more objects. Another optimization performed by Orinoco is in the way it searches through the heap to find all pointers that contain the old location of the objects moved and update them with the new location. This is made using a data structure called remembered set.

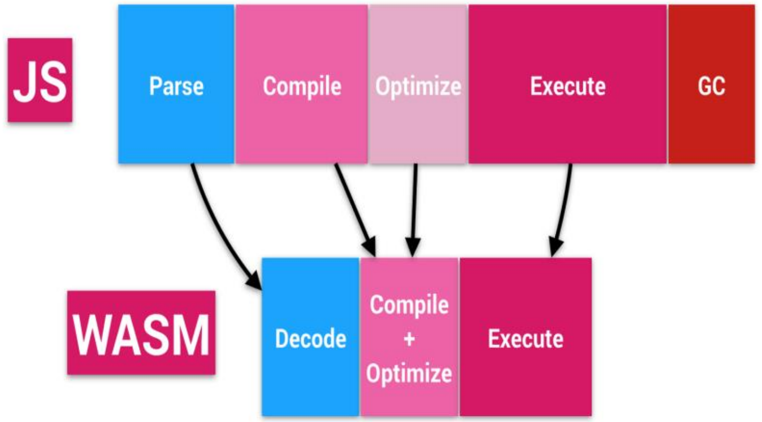
On top of these, black allocation is added, which basically means the garbage collection process automatically marks living objects in black in order to speed up the iterative marking process.

https://v8.dev/blog/liftoff
https://v8.dev/blog/trash-talk

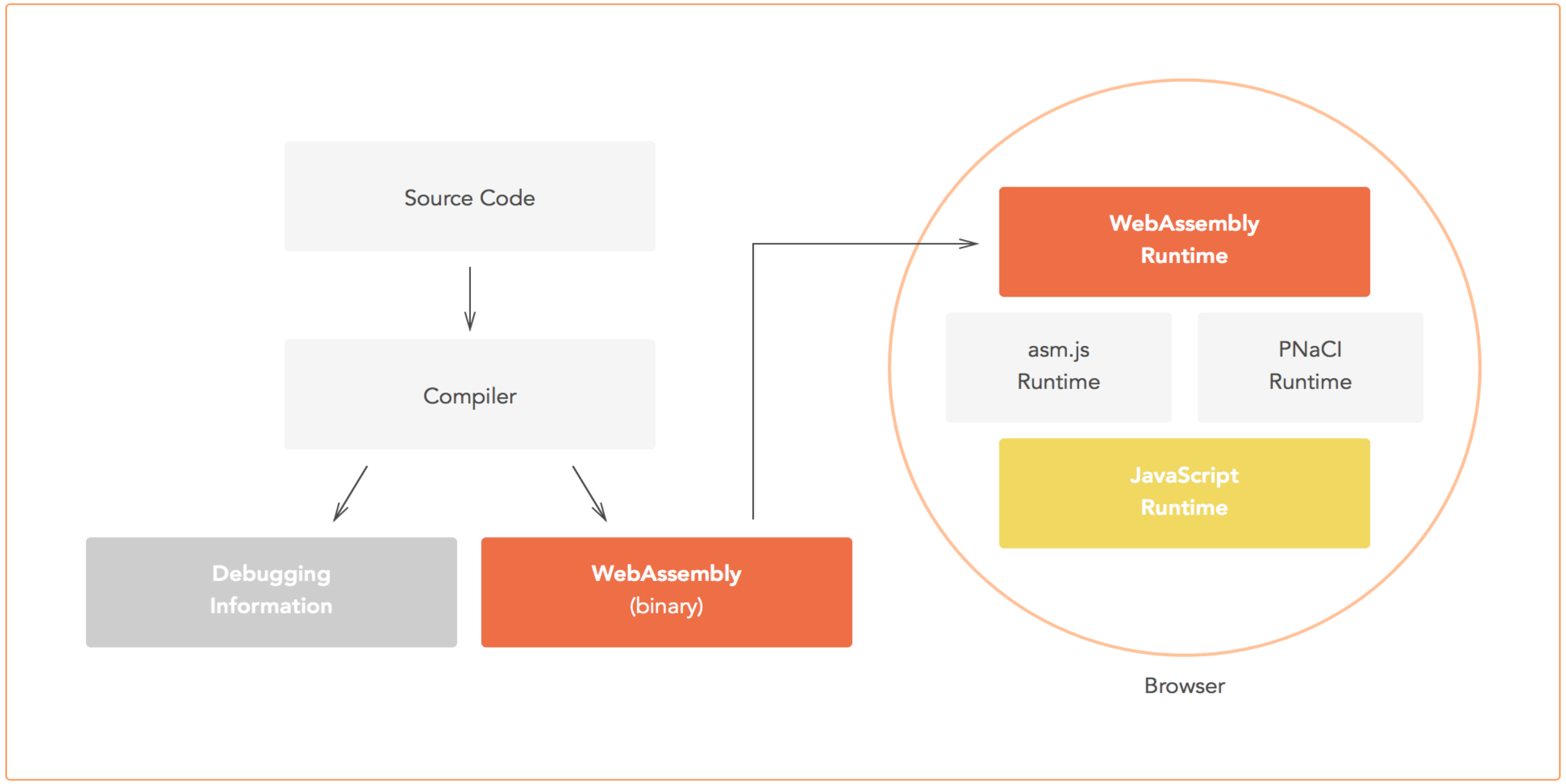
WebAssembly (WASM)

WEBASSEMBLY

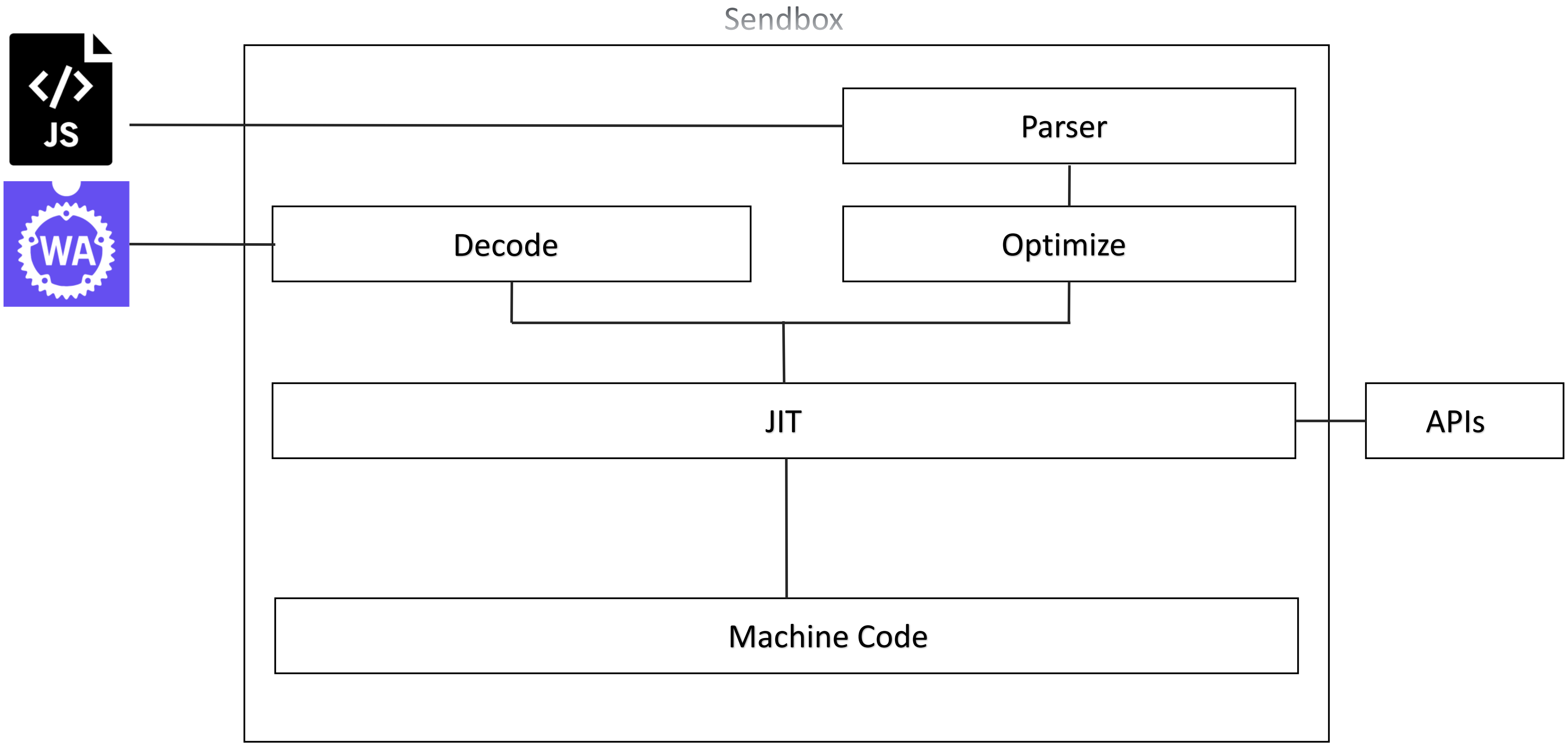
https://webassembly.org



WebAssembly (abbreviated Wasm) is a binary instruction format for a stack-based virtual machine. Wasm is designed as a portable target for compilation of high-level languages like C/C++/Rust, enabling deployment on the web for client and server applications.



Microsoft mozilla Google


Sendbox
JS
WA
Parser
Decode
Optimize
JIT
APIs
Machine Code

Microtask and Macrotask

Example

Thank you ！