V8

The `v8` module exposes APIs that are specific to the version of V8 built into the Node.js binary. It can be accessed using:

```js
const v8 = require('v8');
```

`v8.cachedDataVersionTag()`

- Returns: {integer}

Returns an integer representing a version tag derived from the V8 version, command-line flags, and detected CPU features. This is useful for determining whether a `vm.Script` `cachedData` buffer is compatible with this instance of V8.

```js
console.log(v8.cachedDataVersionTag()); // 3947234607
// The value returned by v8.cachedDataVersionTag() is derived from the V8
// version, command-line flags, and detected CPU features. Test that the value
// does indeed update when flags are toggled.
v8.setFlagsFromString('--allow_natives_syntax');
console.log(v8.cachedDataVersionTag()); // 183726201
```

`v8.getHeapCodeStatistics()`

- Returns: {Object}

Returns an object with the following properties:

- `code_and_metadata_size` {number}
- `bytecode_and_metadata_size` {number}
- `external_script_source_size` {number}

```js
{
  code_and_metadata_size: 212208,
  bytecode_and_metadata_size: 161368,
  external_script_source_size: 1410794
}
```

`v8.getHeapSnapshot()`

- Returns: {stream.Readable} A Readable Stream containing the V8 heap snapshot

Generates a snapshot of the current V8 heap and returns a Readable Stream that may be used to read the JSON serialized representation. This JSON stream format is intended to be used with tools such as Chrome DevTools. The JSON schema is undocumented and specific to the V8 engine. Therefore, the schema may change from one version of V8 to the next.

Creating a heap snapshot requires memory about twice the size of the heap at the time the snapshot is created. This results in the risk of OOM killers terminating the process.

Generating a snapshot is a synchronous operation which blocks the event loop for a duration depending on the heap size.

```js
// Print heap snapshot to the console
const v8 = require('v8');
const stream = v8.getHeapSnapshot();
stream.pipe(process.stdout);
```

`v8.getHeapSpaceStatistics()`

- Returns: {Object[]}

Returns statistics about the V8 heap spaces, i.e. the segments which make up the V8 heap. Neither the ordering of heap spaces, nor the availability of a heap space can be guaranteed as the statistics are provided via the V8 `GetHeapSpaceStatistics` function and may change from one V8 version to the next.

The value returned is an array of objects containing the following properties:

- `space_name` {string}
- `space_size` {number}
- `space_used_size` {number}
- `space_available_size` {number}
- `physical_space_size` {number}

```json
[
  {
    "space_name": "new_space",
    "space_size": 2063872,
    "space_used_size": 951112,
    "space_available_size": 80824,
    "physical_space_size": 2063872
  },
  {
    "space_name": "old_space",
    "space_size": 3090560,
    "space_used_size": 2493792,
    "space_available_size": 0,
    "physical_space_size": 3090560
  },
  {
    "space_name": "code_space",
    "space_size": 1260160,
    "space_used_size": 644256,
```

```json
    "space_available_size": 960,
    "physical_space_size": 1260160
  },
  {
    "space_name": "map_space",
    "space_size": 1094160,
    "space_used_size": 201608,
    "space_available_size": 0,
    "physical_space_size": 1094160
  },
  {
    "space_name": "large_object_space",
    "space_size": 0,
    "space_used_size": 0,
    "space_available_size": 1490980608,
    "physical_space_size": 0
  }
]
```

`v8.getHeapStatistics()`

- Returns: {Object}

Returns an object with the following properties:

- `total_heap_size` {number}
- `total_heap_size_executable` {number}
- `total_physical_size` {number}
- `total_available_size` {number}
- `used_heap_size` {number}
- `heap_size_limit` {number}
- `malloced_memory` {number}
- `peak_malloced_memory` {number}
- `does_zap_garbage` {number}
- `number_of_native_contexts` {number}
- `number_of_detached_contexts` {number}

`does_zap_garbage` is a 0/1 boolean, which signifies whether the `--zap_code_space` option is enabled or not. This makes V8 overwrite heap garbage with a bit pattern. The RSS footprint (resident set size) gets bigger because it continuously touches all heap pages and that makes them less likely to get swapped out by the operating system.

`number_of_native_contexts` The value of native_context is the number of the top-level contexts currently active. Increase of this number over time indicates a memory leak.

`number_of_detached_contexts` The value of detached_context is the number of contexts that were detached and not yet garbage collected. This number being non-zero indicates a potential memory leak.

```
{
  total_heap_size: 7326976,
  total_heap_size_executable: 4194304,
  total_physical_size: 7326976,
  total_available_size: 1152656,
  used_heap_size: 3476208,
  heap_size_limit: 1535115264,
  malloced_memory: 16384,
  peak_malloced_memory: 1127496,
  does_zap_garbage: 0,
  number_of_native_contexts: 1,
  number_of_detached_contexts: 0
}
```

`v8.setFlagsFromString(flags)`

- `flags` {string}

The `v8.setFlagsFromString()` method can be used to programmatically set V8 command-line flags. This method should be used with care. Changing settings after the VM has started may result in unpredictable behavior, including crashes and data loss; or it may simply do nothing.

The V8 options available for a version of Node.js may be determined by running `node --v8-options`.

Usage:

```js
// Print GC events to stdout for one minute.
const v8 = require('v8');
v8.setFlagsFromString('--trace_gc');
setTimeout(() => { v8.setFlagsFromString('--notrace_gc'); }, 60e3);
```

`v8.stopCoverage()`

The `v8.stopCoverage()` method allows the user to stop the coverage collection started by `NODE_V8_COVERAGE`, so that V8 can release the execution count records and optimize code. This can be used in conjunction with `v8.takeCoverage()` if the user wants to collect the coverage on demand.

`v8.takeCoverage()`

The `v8.takeCoverage()` method allows the user to write the coverage started by `NODE_V8_COVERAGE` to disk on demand. This method can be invoked multiple times during the lifetime of the process. Each time the execution counter will be reset and a new coverage report will be written to the directory specified by `NODE_V8_COVERAGE`.

When the process is about to exit, one last coverage will still be written to disk unless `v8.stopCoverage()` is invoked before the process exits.

`v8.writeHeapSnapshot([filename])`

- `filename` {string} The file path where the V8 heap snapshot is to be saved. If not specified, a file name with the pattern `'Heap-${yyyymmdd}-${hhmmss}-${pid}-${thread_id}.heapsnapshot'` will be generated, where `{pid}` will be the PID of the Node.js process, `{thread_id}` will be `0` when `writeHeapSnapshot()` is called from the main Node.js thread or the id of a worker thread.
- Returns: {string} The filename where the snapshot was saved.

Generates a snapshot of the current V8 heap and writes it to a JSON file. This file is intended to be used with tools such as Chrome DevTools. The JSON schema is undocumented and specific to the V8 engine, and may change from one version of V8 to the next.

A heap snapshot is specific to a single V8 isolate. When using worker threads, a heap snapshot generated from the main thread will not contain any information about the workers, and vice versa.

Creating a heap snapshot requires memory about twice the size of the heap at the time the snapshot is created. This results in the risk of OOM killers terminating the process.

Generating a snapshot is a synchronous operation which blocks the event loop for a duration depending on the heap size.

```
const { writeHeapSnapshot } = require('v8');
const {
  Worker,
  isMainThread,
  parentPort
} = require('worker_threads');

if (isMainThread) {
  const worker = new Worker(__filename);

  worker.once('message', (filename) => {
    console.log(`worker heapdump: ${filename}`);
    // Now get a heapdump for the main thread.
    console.log(`main thread heapdump: ${writeHeapSnapshot()}`);
  });

  // Tell the worker to create a heapdump.
```

```js
  worker.postMessage('heapdump');
} else {
  parentPort.once('message', (message) => {
    if (message === 'heapdump') {
      // Generate a heapdump for the worker
      // and return the filename to the parent.
      parentPort.postMessage(writeHeapSnapshot());
    }
  });
}
```

Serialization API

The serialization API provides means of serializing JavaScript values in a way that is compatible with the HTML structured clone algorithm.

The format is backward-compatible (i.e. safe to store to disk). Equal JavaScript values may result in different serialized output.

`v8.serialize(value)`

- `value` {any}
- Returns: {Buffer}

Uses a `DefaultSerializer` to serialize `value` into a buffer.

`ERR_BUFFER_TOO_LARGE` will be thrown when trying to serialize a huge object which requires buffer larger than `buffer.constants.MAX_LENGTH`.

`v8.deserialize(buffer)`

- `buffer` {Buffer|TypedArray|DataView} A buffer returned by `serialize()`.

Uses a `DefaultDeserializer` with default options to read a JS value from a buffer.

Class: `v8.Serializer`

`new Serializer()` Creates a new `Serializer` object.

`serializer.writeHeader()` Writes out a header, which includes the serialization format version.

`serializer.writeValue(value)`

- `value` {any}

Serializes a JavaScript value and adds the serialized representation to the internal buffer.

This throws an error if `value` cannot be serialized.

`serializer.releaseBuffer()`

- Returns: {Buffer}

Returns the stored internal buffer. This serializer should not be used once the buffer is released. Calling this method results in undefined behavior if a previous write has failed.

`serializer.transferArrayBuffer(id, arrayBuffer)`

- `id` {integer} A 32-bit unsigned integer.
- `arrayBuffer` {ArrayBuffer} An `ArrayBuffer` instance.

Marks an `ArrayBuffer` as having its contents transferred out of band. Pass the corresponding `ArrayBuffer` in the deserializing context to `deserializer.transferArrayBuffer()`.

`serializer.writeUint32(value)`

- `value` {integer}

Write a raw 32-bit unsigned integer. For use inside of a custom `serializer._writeHostObject()`.

`serializer.writeUint64(hi, lo)`

- `hi` {integer}
- `lo` {integer}

Write a raw 64-bit unsigned integer, split into high and low 32-bit parts. For use inside of a custom `serializer._writeHostObject()`.

`serializer.writeDouble(value)`

- `value` {number}

Write a JS `number` value. For use inside of a custom `serializer._writeHostObject()`.

`serializer.writeRawBytes(buffer)`

- `buffer` {Buffer|TypedArray|DataView}

Write raw bytes into the serializer's internal buffer. The deserializer will require a way to compute the length of the buffer. For use inside of a custom `serializer._writeHostObject()`.

`serializer._writeHostObject(object)`

- `object` {Object}

This method is called to write some kind of host object, i.e. an object created by native C++ bindings. If it is not possible to serialize `object`, a suitable exception should be thrown.

This method is not present on the `Serializer` class itself but can be provided by subclasses.

`serializer._getDataCloneError(message)`

- `message` {string}

This method is called to generate error objects that will be thrown when an object can not be cloned.

This method defaults to the `Error` constructor and can be overridden on subclasses.

`serializer._getSharedArrayBufferId(sharedArrayBuffer)`

- `sharedArrayBuffer` {SharedArrayBuffer}

This method is called when the serializer is going to serialize a `SharedArrayBuffer` object. It must return an unsigned 32-bit integer ID for the object, using the same ID if this `SharedArrayBuffer` has already been serialized. When deserializing, this ID will be passed to `deserializer.transferArrayBuffer()`.

If the object cannot be serialized, an exception should be thrown.

This method is not present on the `Serializer` class itself but can be provided by subclasses.

`serializer._setTreatArrayBufferViewsAsHostObjects(flag)`

- `flag` {boolean} **Default:** `false`

Indicate whether to treat `TypedArray` and `DataView` objects as host objects, i.e. pass them to `serializer._writeHostObject()`.

Class: `v8.Deserializer`

`new Deserializer(buffer)`

- `buffer` {Buffer|TypedArray|DataView} A buffer returned by `serializer.releaseBuffer()`.

Creates a new `Deserializer` object.

`deserializer.readHeader()` Reads and validates a header (including the format version). May, for example, reject an invalid or unsupported wire format. In that case, an `Error` is thrown.

`deserializer.readValue()` Deserializes a JavaScript value from the buffer and returns it.

`deserializer.transferArrayBuffer(id, arrayBuffer)`

- `id` {integer} A 32-bit unsigned integer.
- `arrayBuffer` {ArrayBuffer|SharedArrayBuffer} An `ArrayBuffer` instance.

Marks an `ArrayBuffer` as having its contents transferred out of band. Pass the corresponding `ArrayBuffer` in the serializing context to `serializer.transferArrayBuffer()` (or return the `id` from `serializer._getSharedArrayBufferId()` in the case of `SharedArrayBuffers`).

`deserializer.getWireFormatVersion()`

- Returns: {integer}

Reads the underlying wire format version. Likely mostly to be useful to legacy code reading old wire format versions. May not be called before `.readHeader()`.

`deserializer.readUint32()`

- Returns: {integer}

Read a raw 32-bit unsigned integer and return it. For use inside of a custom `deserializer._readHostObject()`.

`deserializer.readUint64()`

- Returns: {integer[]}

Read a raw 64-bit unsigned integer and return it as an array `[hi, lo]` with two 32-bit unsigned integer entries. For use inside of a custom `deserializer._readHostObject()`.

`deserializer.readDouble()`

- Returns: {number}

Read a JS `number` value. For use inside of a custom `deserializer._readHostObject()`.

`deserializer.readRawBytes(length)`

- `length` {integer}
- Returns: {Buffer}

Read raw bytes from the deserializer's internal buffer. The `length` parameter must correspond to the length of the buffer that was passed to `serializer.writeRawBytes()`. For use inside of a custom `deserializer._readHostObject()`.

`deserializer._readHostObject()` This method is called to read some kind of host object, i.e. an object that is created by native C++ bindings. If it is not possible to deserialize the data, a suitable exception should be thrown.

This method is not present on the `Deserializer` class itself but can be provided by subclasses.

Class: `v8.DefaultSerializer`

A subclass of `Serializer` that serializes `TypedArray` (in particular `Buffer`) and `DataView` objects as host objects, and only stores the part of their underlying `ArrayBuffer`s that they are referring to.

Class: `v8.DefaultDeserializer`

A subclass of `Deserializer` corresponding to the format written by `DefaultSerializer`.

Promise hooks

The `promiseHooks` interface can be used to track promise lifecycle events. To track *all* async activity, see `async_hooks` which internally uses this module to produce promise lifecycle events in addition to events for other async resources. For request context management, see `AsyncLocalStorage`.

```
import { promiseHooks } from 'v8';

// There are four lifecycle events produced by promises:

// The `init` event represents the creation of a promise. This could be a
// direct creation such as with `new Promise(...)` or a continuation such
// as `then()` or `catch()`. It also happens whenever an async function is
// called or does an `await`. If a continuation promise is created, the
// `parent` will be the promise it is a continuation from.
function init(promise, parent) {
  console.log('a promise was created', { promise, parent });
}

// The `settled` event happens when a promise receives a resolution or
// rejection value. This may happen synchronously such as when using
// `Promise.resolve()` on non-promise input.
function settled(promise) {
  console.log('a promise resolved or rejected', { promise });
```

```
}

// The `before` event runs immediately before a `then()` or `catch()` handler
// runs or an `await` resumes execution.
function before(promise) {
  console.log('a promise is about to call a then handler', { promise });
}

// The `after` event runs immediately after a `then()` handler runs or when
// an `await` begins after resuming from another.
function after(promise) {
  console.log('a promise is done calling a then handler', { promise });
}

// Lifecycle hooks may be started and stopped individually
const stopWatchingInits = promiseHooks.onInit(init);
const stopWatchingSettleds = promiseHooks.onSettled(settled);
const stopWatchingBefores = promiseHooks.onBefore(before);
const stopWatchingAfters = promiseHooks.onAfter(after);

// Or they may be started and stopped in groups
const stopHookSet = promiseHooks.createHook({
  init,
  settled,
  before,
  after
});

// To stop a hook, call the function returned at its creation.
stopWatchingInits();
stopWatchingSettleds();
stopWatchingBefores();
stopWatchingAfters();
stopHookSet();
```

`promiseHooks.onInit(init)`

- `init` {Function} The `init` callback to call when a promise is created.
- Returns: {Function} Call to stop the hook.

The `init` hook must be a plain function. Providing an async function will throw as it would produce an infinite microtask loop.

```
import { promiseHooks } from 'v8';

const stop = promiseHooks.onInit((promise, parent) => {});
```

```
const { promiseHooks } = require('v8');

const stop = promiseHooks.onInit((promise, parent) => {});
```

`promiseHooks.onSettled(settled)`

- `settled` {Function} The `settled` callback to call when a promise is resolved or rejected.
- Returns: {Function} Call to stop the hook.

The `settled` hook must be a plain function. Providing an async function will throw as it would produce an infinite microtask loop.

```
import { promiseHooks } from 'v8';

const stop = promiseHooks.onSettled((promise) => {});
```

```
const { promiseHooks } = require('v8');

const stop = promiseHooks.onSettled((promise) => {});
```

`promiseHooks.onBefore(before)`

- `before` {Function} The `before` callback to call before a promise continuation executes.
- Returns: {Function} Call to stop the hook.

The `before` hook must be a plain function. Providing an async function will throw as it would produce an infinite microtask loop.

```
import { promiseHooks } from 'v8';

const stop = promiseHooks.onBefore((promise) => {});
```

```
const { promiseHooks } = require('v8');

const stop = promiseHooks.onBefore((promise) => {});
```

`promiseHooks.onAfter(after)`

- `after` {Function} The `after` callback to call after a promise continuation executes.
- Returns: {Function} Call to stop the hook.

The `after` hook must be a plain function. Providing an async function will throw as it would produce an infinite microtask loop.

```
import { promiseHooks } from 'v8';

const stop = promiseHooks.onAfter((promise) => {});
```

```
const { promiseHooks } = require('v8');

const stop = promiseHooks.onAfter((promise) => {});
```

`promiseHooks.createHook(callbacks)`

- `callbacks` {Object} The Hook Callbacks to register
  - `init` {Function} The `init` callback.
  - `before` {Function} The `before` callback.
  - `after` {Function} The `after` callback.
  - `settled` {Function} The `settled` callback.
- Returns: {Function} Used for disabling hooks

The hook callbacks must be plain functions. Providing async functions will throw as it would produce an infinite microtask loop.

Registers functions to be called for different lifetime events of each promise.

The callbacks `init()`/`before()`/`after()`/`settled()` are called for the respective events during a promise's lifetime.

All callbacks are optional. For example, if only promise creation needs to be tracked, then only the `init` callback needs to be passed. The specifics of all functions that can be passed to `callbacks` is in the Hook Callbacks section.

```
import { promiseHooks } from 'v8';

const stopAll = promiseHooks.createHook({
  init(promise, parent) {}
});
```

```
const { promiseHooks } = require('v8');

const stopAll = promiseHooks.createHook({
  init(promise, parent) {}
});
```

Hook callbacks

Key events in the lifetime of a promise have been categorized into four areas: creation of a promise, before/after a continuation handler is called or around an await, and when the promise resolves or rejects.

While these hooks are similar to those of `async_hooks` they lack a `destroy` hook. Other types of async resources typically represent sockets or file descriptors which have a distinct "closed" state to express the `destroy` lifecycle event while promises remain usable for as long as code can still reach them. Garbage collection tracking is used to make promises fit into the `async_hooks` event model, however this tracking is very expensive and they may not necessarily ever even be garbage collected.

Because promises are asynchronous resources whose lifecycle is tracked via the promise hooks mechanism, the `init()`, `before()`, `after()`, and `settled()` callbacks *must not* be async functions as they create more promises which would produce an infinite loop.

While this API is used to feed promise events into `async_hooks`, the ordering between the two is undefined. Both APIs are multi-tenant and therefore could produce events in any order relative to each other.

`init(promise, parent)`

- `promise` {Promise} The promise being created.
- `parent` {Promise} The promise continued from, if applicable.

Called when a promise is constructed. This *does not* mean that corresponding `before`/`after` events will occur, only that the possibility exists. This will happen if a promise is created without ever getting a continuation.

`before(promise)`

- `promise` {Promise}

Called before a promise continuation executes. This can be in the form of `then()`, `catch()`, or `finally()` handlers or an `await` resuming.

The `before` callback will be called 0 to N times. The `before` callback will typically be called 0 times if no continuation was ever made for the promise. The `before` callback may be called many times in the case where many continuations have been made from the same promise.

`after(promise)`

- `promise` {Promise}

Called immediately after a promise continuation executes. This may be after a `then()`, `catch()`, or `finally()` handler or before an `await` after another `await`.

`settled(promise)`

- `promise` {Promise}

Called when the promise receives a resolution or rejection value. This may occur synchronously in the case of `Promise.resolve()` or `Promise.reject()`.