Agoric

Dear Google, Let's Harden JavaScript

Kris Kowal and Mark S. Miller

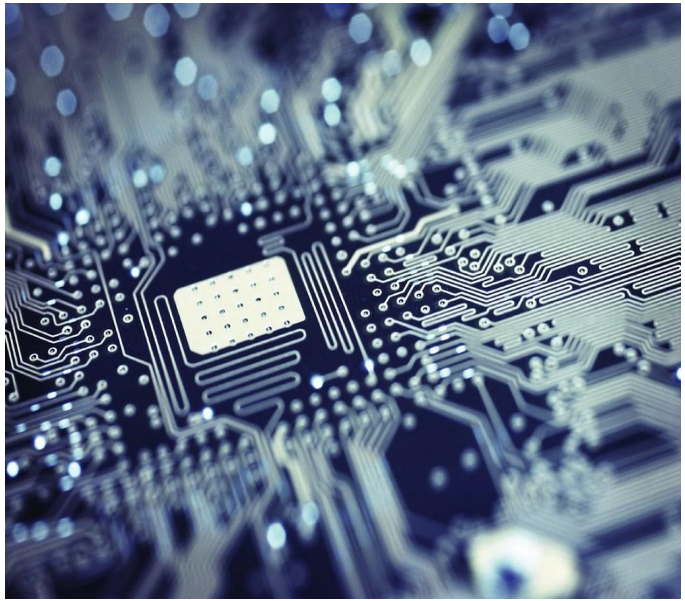
2024-02-12

How JavaScript can evolve to better support Hardened JavaScript

Agoric

Dear Google,

- What is **Hardened JavaScript**?
- Why do we need it?
- How do we emulate it?
- Limits to faithful emulation
- How can JavaScript evolve to better support Hardened JavaScript?



Hardened JavaScript

It's just JavaScript, plus:

- Lockdown
- Harden
- Compartment

Does:

- Integrity
- Multi-tenant
- API defensibility

Doesn't (alone):

- Availability (Denial of Service)
- Side-channel (Spectre/Meltdown) resistance

Agoric

Example

```
lockdown();

const compartment = new Compartment();
harden(compartment.globalThis);

const SafeFunction = compartment.globalThis.Function;

const search = harden(query => {
  const match = new SafeFunction('item', query);
  const matches = [];
  for (const item of database.items()) {
    if (match(harden(item))) {
      matches.push(item);
    };
  }
  return harden(matches);
});
```

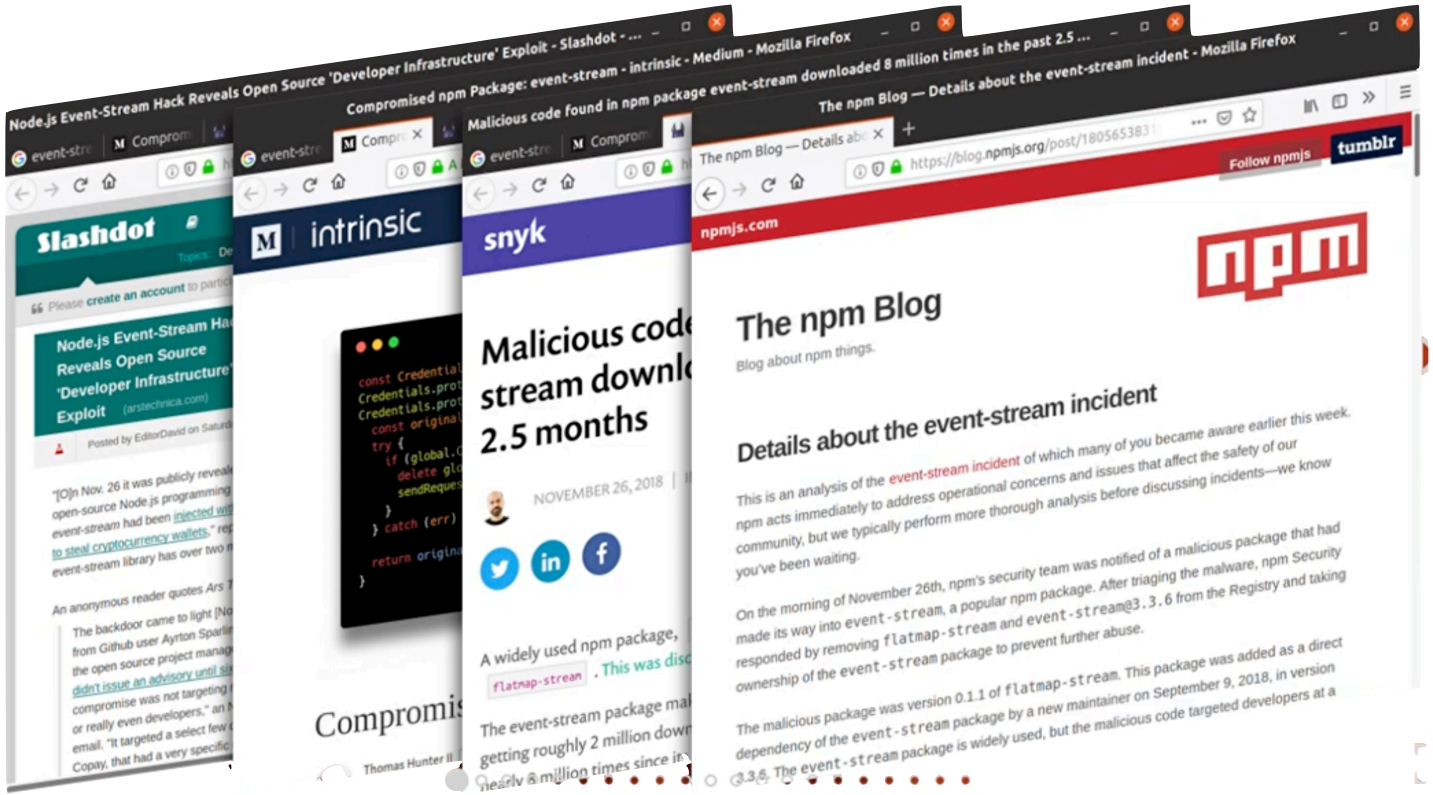
Why do we need Hardened JavaScript

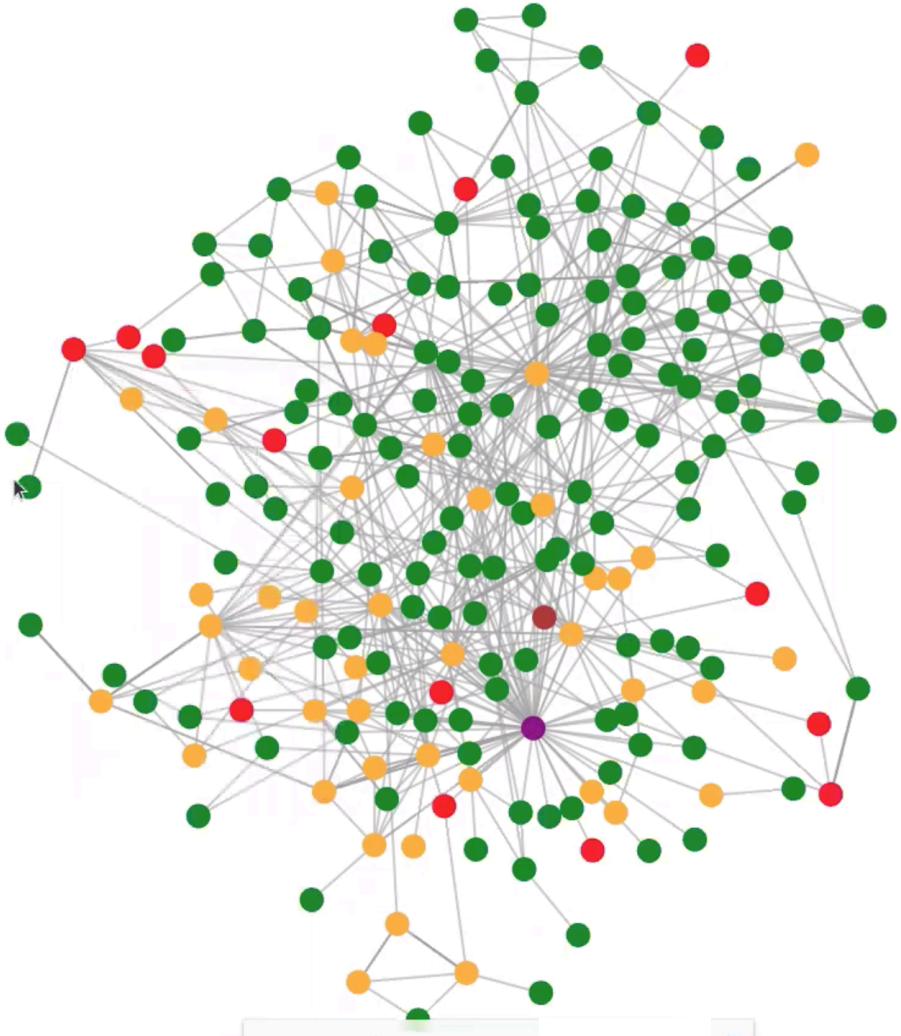
That *any* JavaScript program consists of code that represents the interests of any single party is a rapidly deteriorating fiction.

Agoric

Why do we need HardenedJS

- Supply Chain Defense
- Decentralization / Mashups
- Smart Contracts
- Host Emulation


Node.js Event-Stream Hack Reveals Open Source 'Developer Infrastructure' Exploit - Slashdot - ... - Mozilla Firefox
Slashdot
Node.js Event-Stream Hack Reveals Open Source 'Developer Infrastructure' Exploit
Compromised npm Package: event-stream - intrinsic - Medium - Mozilla Firefox
intrinsic
Malicious code found in npm package event-stream downloaded 8 million times in the past 2.5 ... - Mozilla Firefox
snyk
Malicious code found in npm package event-stream downloaded 8 million times in the past 2.5 months
NOVEMBER 26, 2018
A widely used npm package, flatmap-stream, This was discovered
The event-stream package ma
getting roughly 2 million down
The npm Blog — Details about the event-stream incident - Mozilla Firefox
https://blog.npmjs.org/post/180565383
Follow npmjs
tumblr
npmjs.com
The npm Blog
Blog about npm things.
Details about the event-stream incident
This is an analysis of the event-stream incident of which many of you became aware earlier this week. npm acts immediately to address operational concerns and issues that affect the safety of our community, but we typically perform more thorough analysis before discussing incidents—we know you've been waiting.
On the morning of November 26th, npm's security team was notified of a malicious package that had made its way into event-stream, a popular npm package. After triaging the malware, npm Security responded by removing flatmap-stream and event-stream@3.3.6 from the Registry and taking ownership of the event-stream package to prevent further abuse.
The malicious package was version 0.1.1 of flatmap-stream. This package was added as a direct dependency of the event-stream package by a new maintainer on September 9, 2018, in version 3.3.6. The event-stream package is widely used, but the malicious code targeted developers at a



Emulating Hardened JavaScript Today

- `with`
- `eval`
- `Proxy`
- Sloppy mode

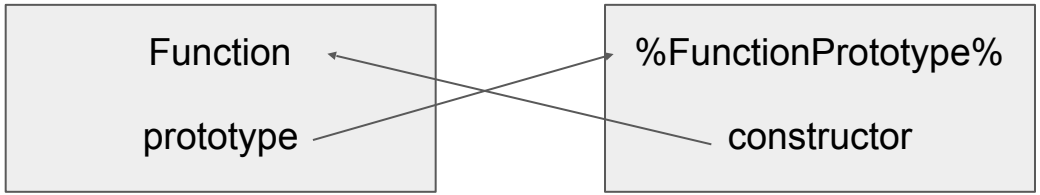
Agoric

The Device

```
const makeEval = Function(`
  with (this.scopeTerminator) {
    with (this.globalObject) {
      with (this.moduleLexicals) {
        with (this.evalScope) {
          ${globalObjectOptimizer} // const {a,b,c} = this.globalObject;
          ${moduleLexicalOptimizer} // const {d,e,f} = this.moduleLexicals;
          return function(/* source */) {
            'use strict';
            return eval(arguments[0]); // censored: eval, import, HTML comments
          };
        }
      }
    }
  }
`);
```

Agoric

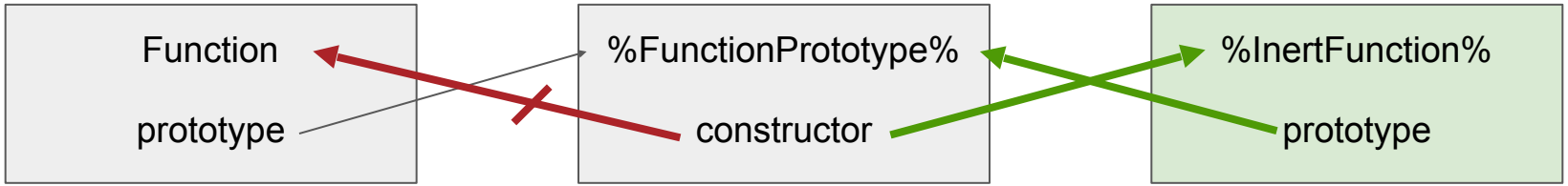
Shared Intrinsics



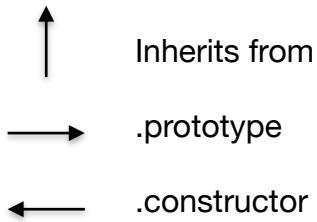

```
new Function("return 42") instanceof Function
    new Function.constructor("return 42")
```

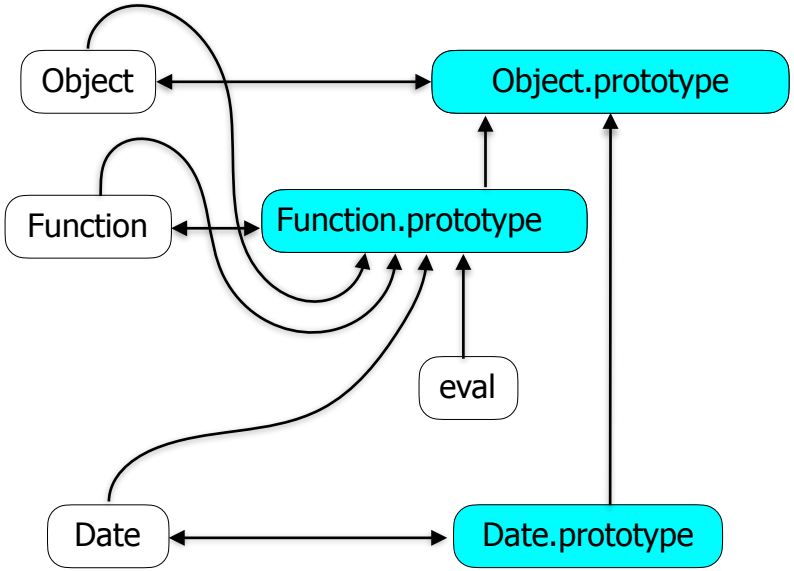
Agoric

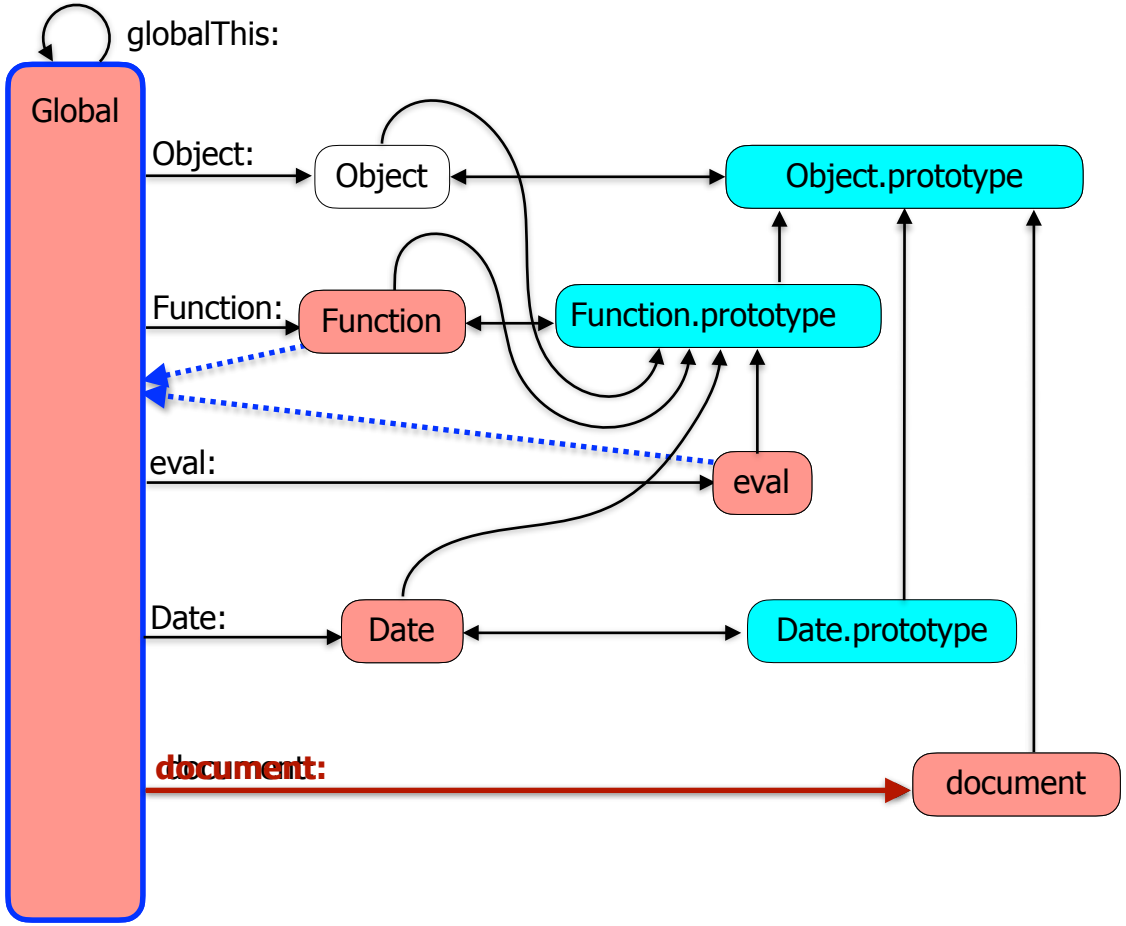
Lockdown Shared Intrinsics

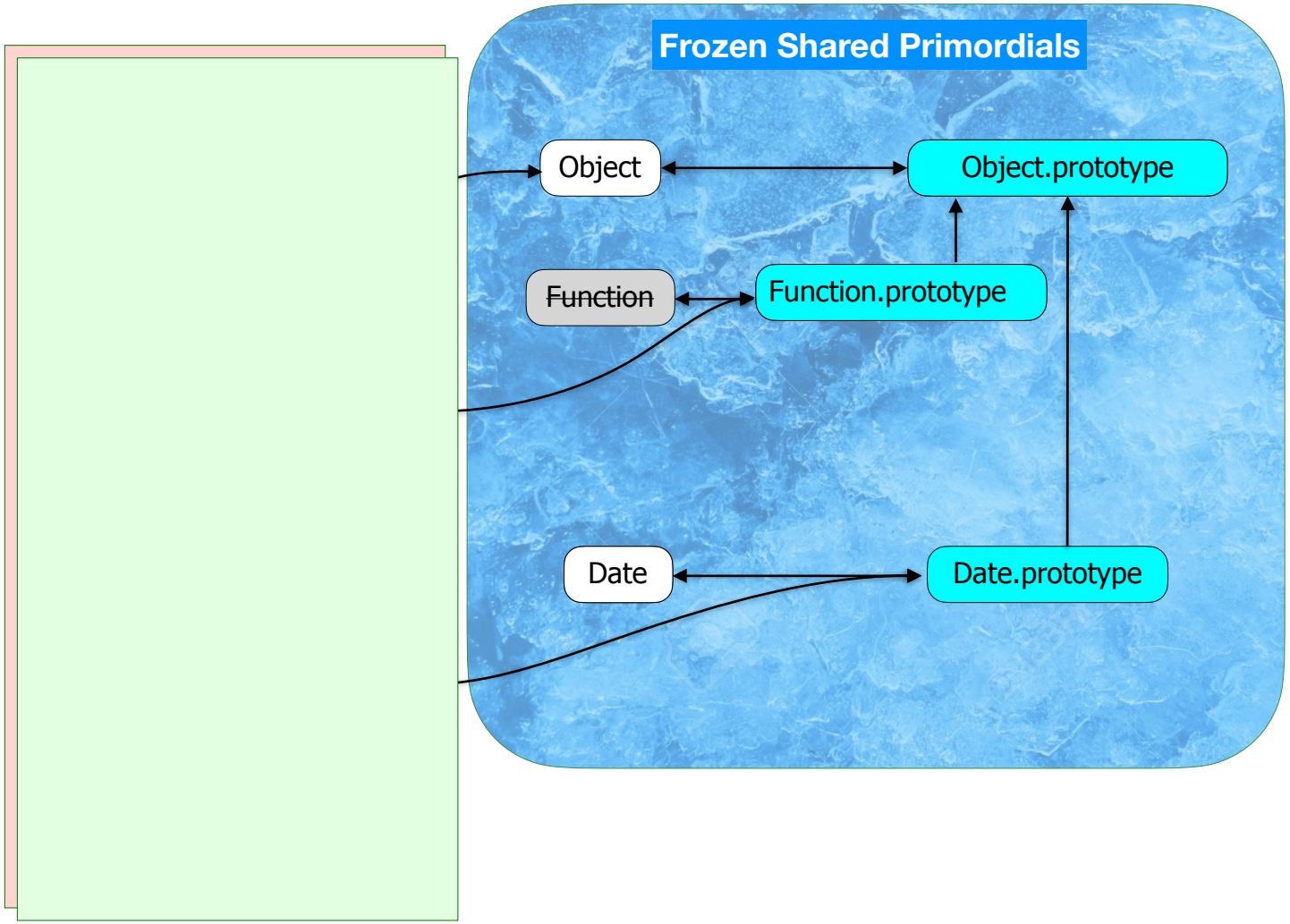


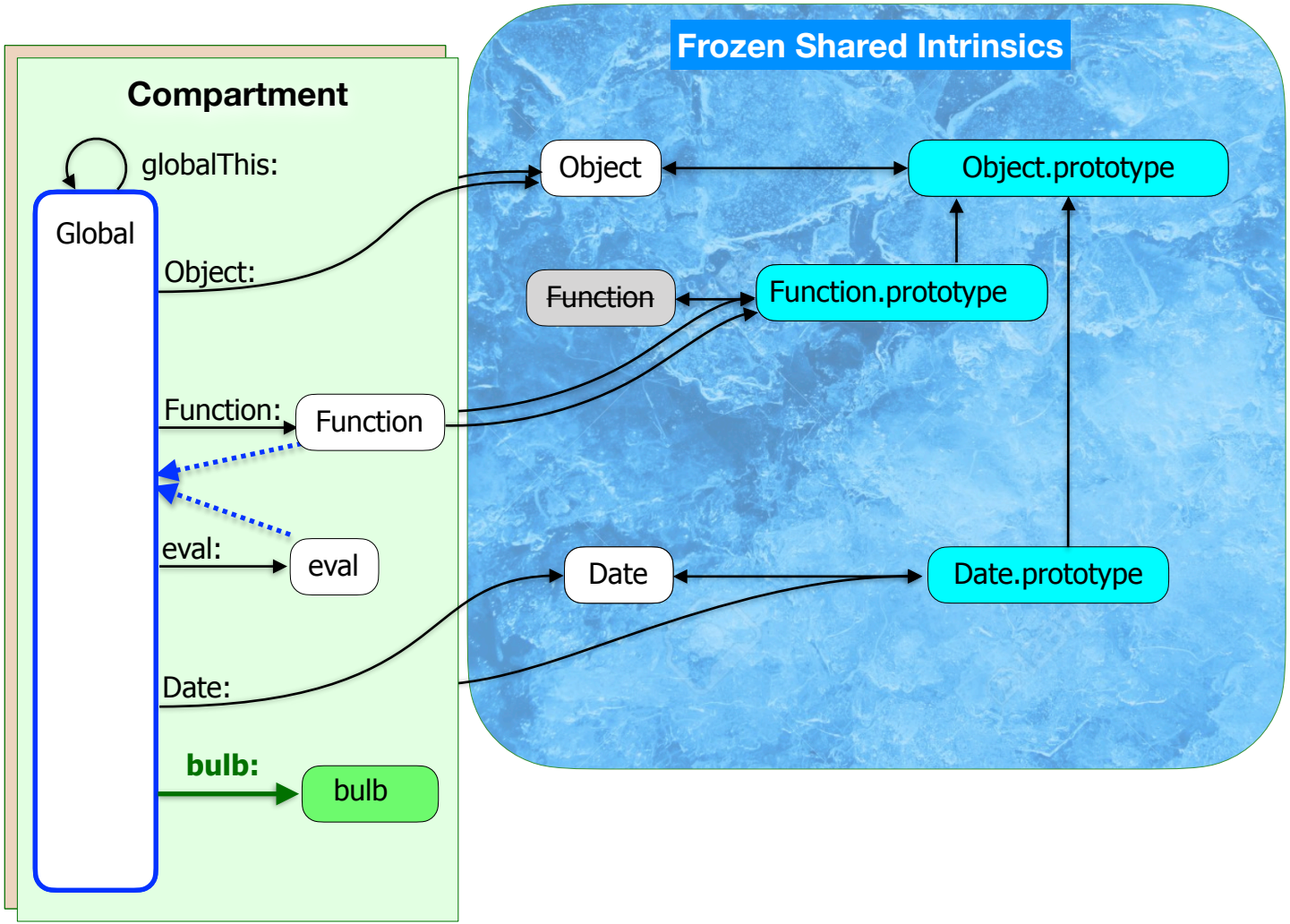

```
new Function("return 42") instanceof Function
    new Function.constructor("return 42")
```

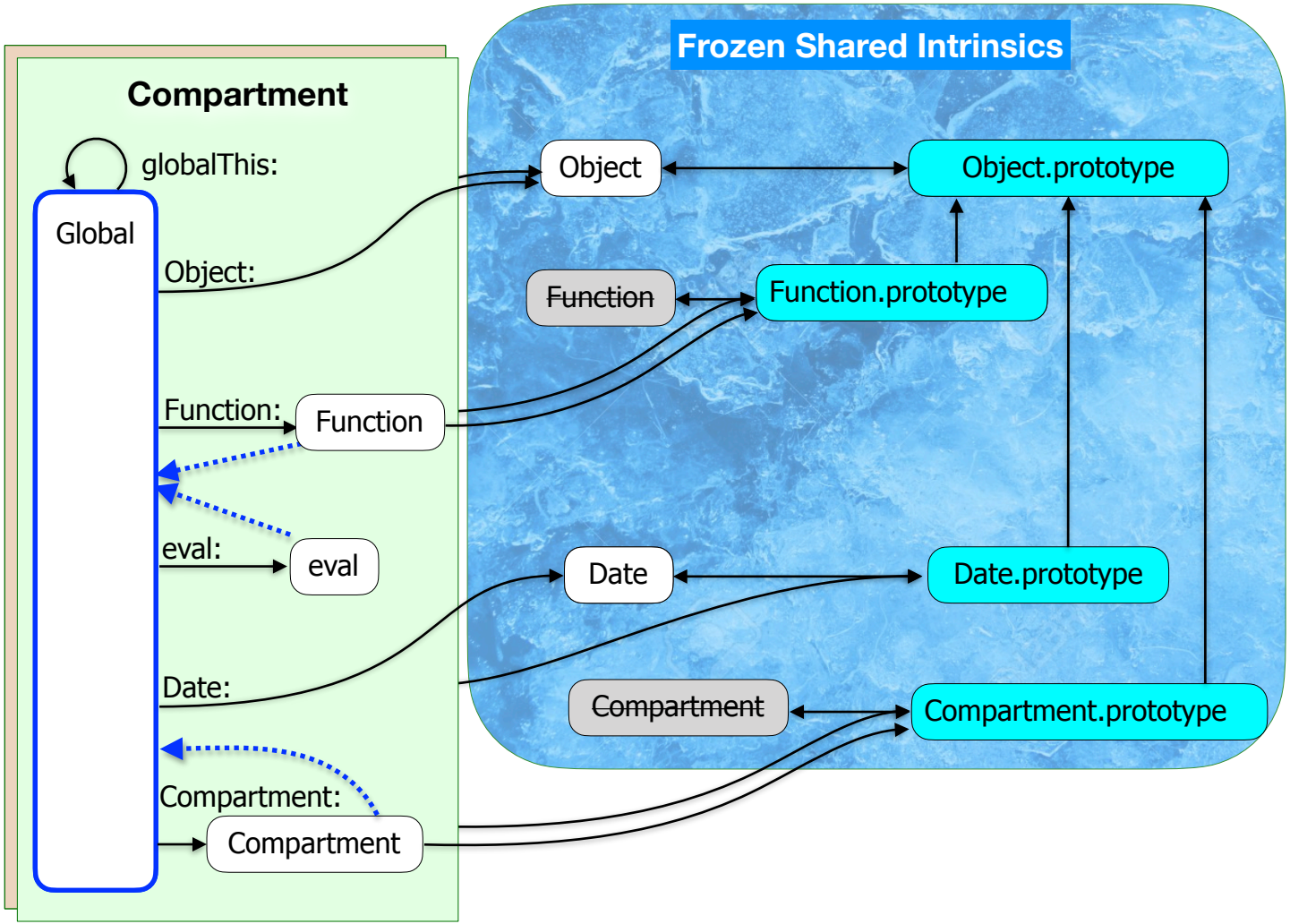

Inherits from
.prototype
.constructor


Object
Object.prototype
Function
Function.prototype
eval
Date
Date.prototype


globalThis:
Global
Object:
Object
Object.prototype
Function:
Function
Function.prototype
eval:
eval
Date:
Date
Date.prototype
document:
document


Frozen Shared Primordials
Object
Object.prototype
Function
Function.prototype
Date
Date.prototype


Compartment
globalThis:
Global
Object:
Function:
Function
eval:
eval
Date:
bulb:
bulb
Frozen Shared Intrinsics
Object
Object.prototype
Function
Function.prototype
Date
Date.prototype


Compartment
globalThis:
Global
Object:
Function:
Function
eval:
eval
Date:
Compartment:
Compartment
Frozen Shared Intrinsics
Object
Object.prototype
Function
Function.prototype
Date
Date.prototype
Compartment
Compartment.prototype

Taming of the Realm

- Tame RegExp constructor
- Tame Function constructors
- Disable Math.random
- Disable Date.now
- %SharedSymbol% snapshot
- &c

Caveats, Provisos, and Quid Pro Quos

A Hardened JavaScript shim admits an astonishing body of existing JavaScript, but a native implementation can admit even more.

Agoric

Limitations of the emulation

- **Property override mistake**
- Censorship of eval, import, import.meta, and HTML comment **syntax**
- Revelation of module lexicals scope object
- Limitations to typeof

Property Override Mistake

```
lockdown();

const x = {};
x.constructor = function () {};
x.toString = function () { return 'x'; };
```

```
Cannot assign to read only property 'constructor' of
object '[object Object]'
```

How can JavaScript Improve HardenedJS

Native implementations of Hardened JavaScript can confine nearly any JavaScript program.

Agoric

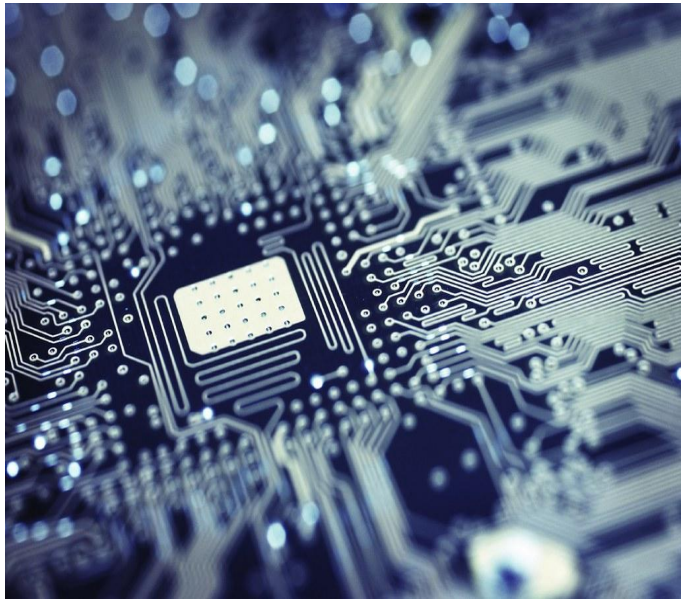
How JavaScript can grow to help

- Override integrity level
- Evaluators
- Module Harmony
- Please, move the stack back to Error prototype.

Agoric

Dear Google,

- What is **Hardened JavaScript**?
- Why do we need it?
- How do we emulate it?
- Limits to faithful emulation
- How can JavaScript evolve to better support Hardened JavaScript?



Agoric

References

- SES (Hardened JavaScript shim)
- TC39 Compartments Proposal


Agoric