WebAssembly: Status & Web IDL Bindings

W3C Games Workshop - June, 2019

Luke Wagner

Based on joint Mozilla/Google presentation to WebAssembly CG last week (link)

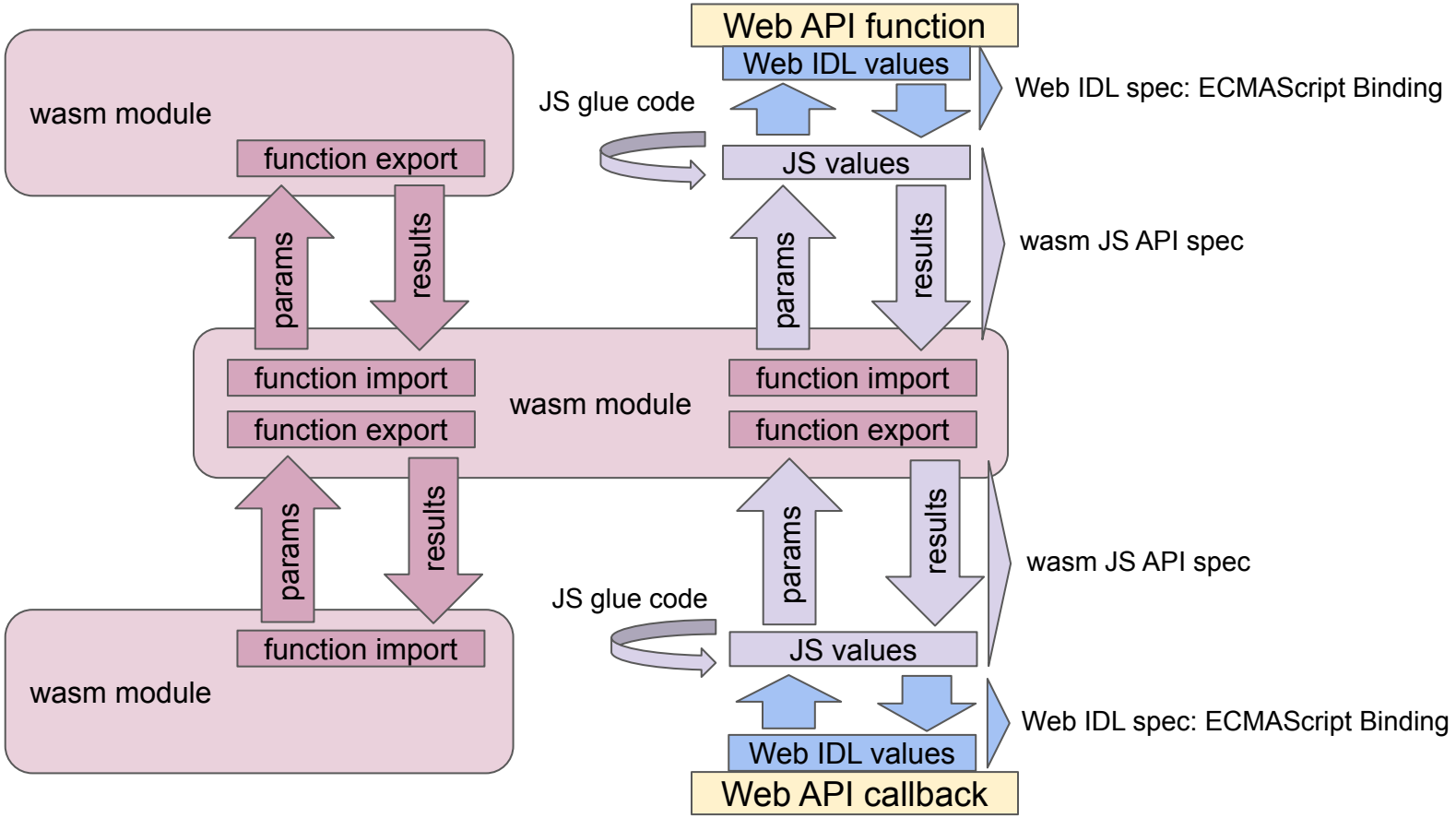
WebAssembly Status

- 2017: "MVP" ships in 4 browsers \o/
- Immediately continued work on a pipeline of proposed additions
- Based on TC39 stages process
- Post-MVP Roadmap
- https://github.com/webassembly/proposals

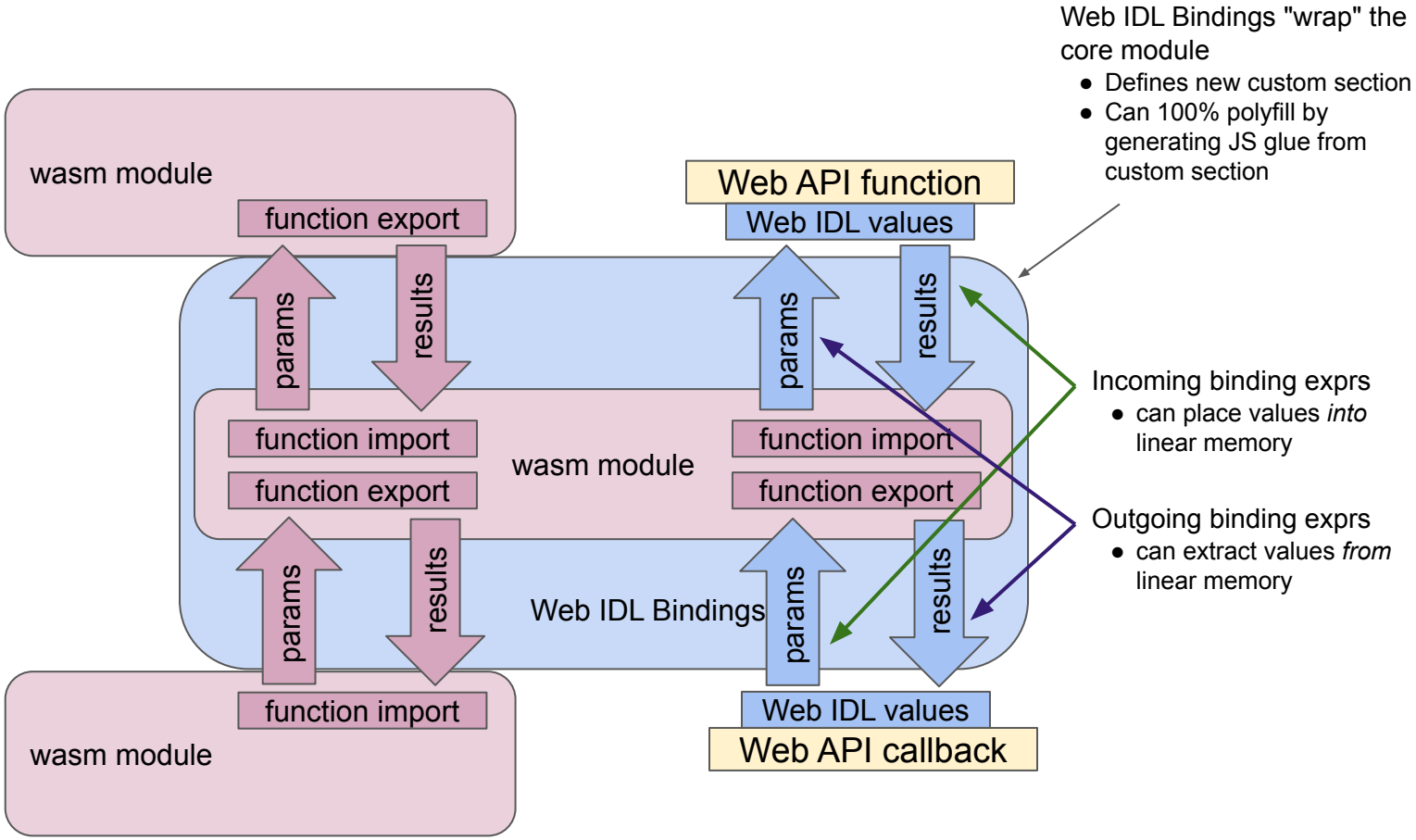
* Bindings Proposal History

- 2017 - Ship the WebAssembly "MVP"
  - Only 4 value types: i32, i64, f32, f64
  - *How can WebAssembly call Web APIs?*
- 2017 - Take 1: "Host Bindings" (CG pres, TPAC pres)
  - All host values go in wasm tables (wasm linear memory requires exposing raw bits)
  - Automatically convert between table indices and host values at the interface
  - Increasingly awkward as we worked through use cases; also not efficient
- 2018 - Reference Types (CG pres, explainer)
  - Subtype hierarchy: anyref, funcref, ref T (where T = func(X→Y), struct{x:A,y:B}, array(T), ...)
  - Gives wasm first-class host values
- 2019 - Take 2: "Web IDL Bindings" (CG pres, explainer)
  - Let's focus just on *efficiently* binding to *Web IDL*, building on reference types
  - "Efficiently" means eliminating copies, garbage, auxiliary calls ("Host Bindings" didn't)
  - "Web IDL" allows us to focus on Web IDL's types, avoid Hard(TM) problems

In the MVP, ... when calling wasm ... when calling a Web API



With the proposal... ... when calling wasm ... when calling a Web API



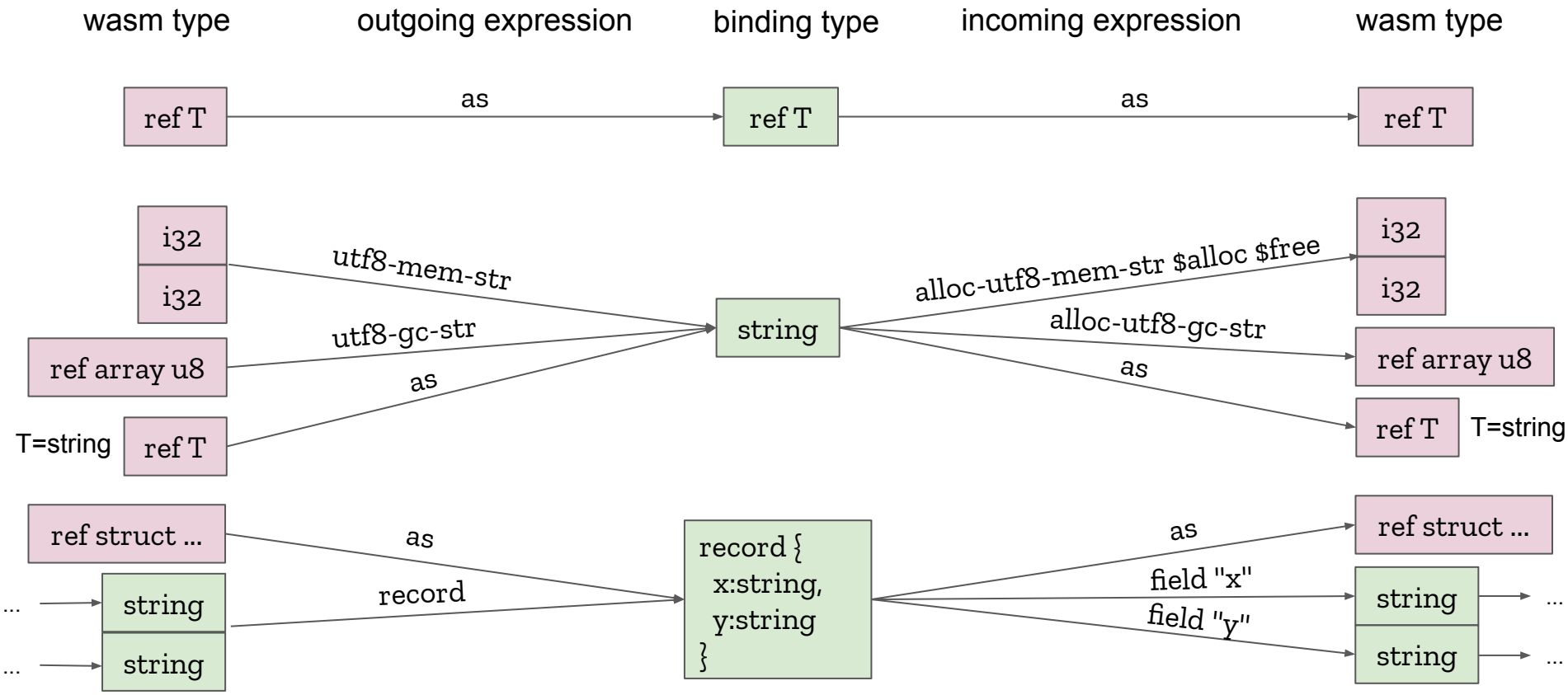
Binding Types/Values sketch

reftype ::= ... all the core wasm reference types

numtype ::= s8 | u8 | s16 | u16 | s32 | u32 | s64 | u64 | f32 | f64 // signedness matters

```
bindingtype ::=                                  // Web IDL type
        reftype |                                // ↔ any, Interface, Promise, ...
        numtype |                                // ↔ byte, octet, short, ...
        string |                                 // ↔ DOMString
        bytes |                                  // ↔ ArrayBuffer
        numtype view |                           // ↔ Int8Array, Uint8Array, ...
        bindingtype list |                       // ↔ Sequence
        record{ (lbl: bindingtype)* } |          // ↔ Dictionary
        variant{ (lbl: bindingtype)* } |         // ↔ Union, Enumeration
        func(bindingtype* → bindingtype*)        // ↔ Callback function
```

Binding Expressions sampler



Two facets of "direct" Web IDL access from wasm

Importing

```
// JS loader glue code:

const importObj = {
  Document: {
    createElement:
      Document.prototype.createElement
  }
};

WebAssembly.instantiate(module, importObj)
.then(...)
```

This JS glue will be removed by a combination of:

- WebAssembly ESM-integration
- Built-in modules + import-maps
- get-originals

Calling

```
// JS runtime glue code

var memory = ...
var td = new TextDecoder();

function createElement_glue(doc,tagOff,tagLen) {
  var buf = memory.buffer;
  var bytes = new Uint8Array(buf,tagOff,tagLen);
  return doc.createElement(td.decode(bytes));
}

// wasm caller

(import "Document" "createElement"
   (func (param anyref i32 i32) (result anyref)))
```

Removing *this* type of JS glue is the focus of Web IDL Bindings

C++ Prototype

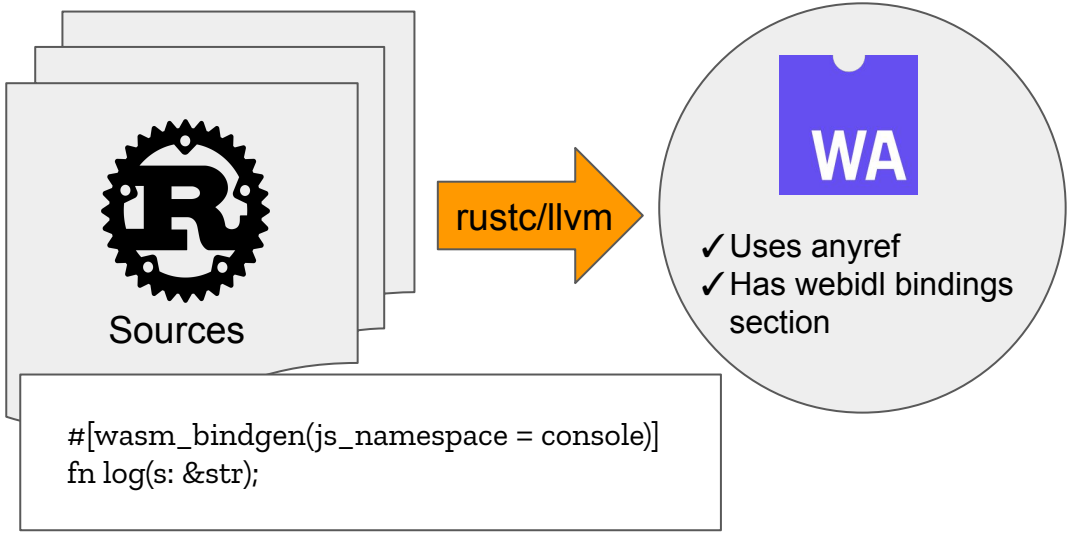
https://github.com/jgravelle-google/wasm-webidl-polyfill

Building a webIDL.js module, reads a custom section and fixes up import + export dicts at runtime

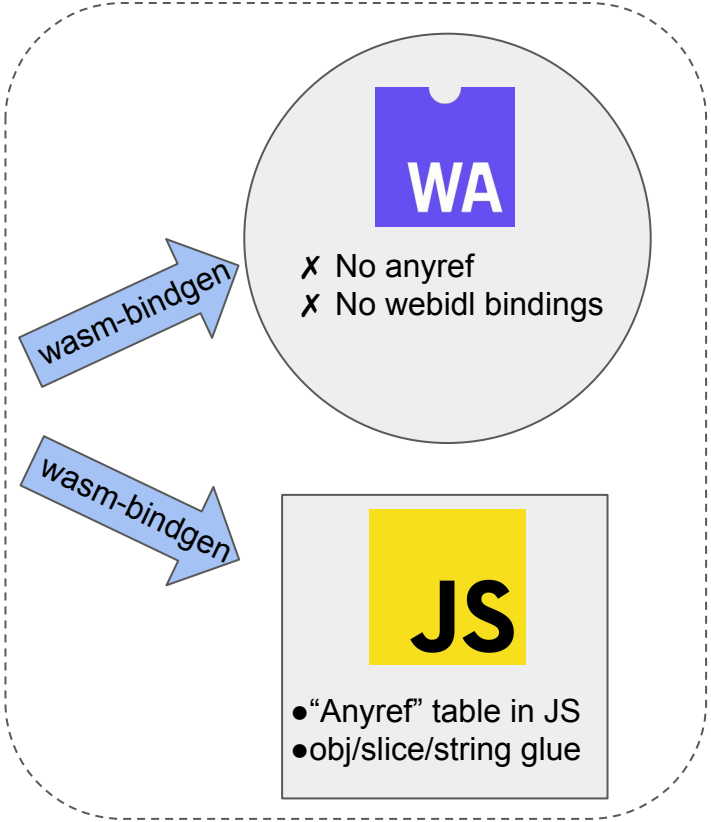
Goals:

- Prototype the design, prove feasibility of polyfilling
- Polyfillability in general is a useful property because developers can ship the real bytes early, and the browser can support that natively at a later time
- Having a prepackaged chunk of JS makes this easier to include in arbitrary toolchains

Rust: wasm-bindgen



wasm-bindgen as optional AOT polyfill



WebGL Prototype

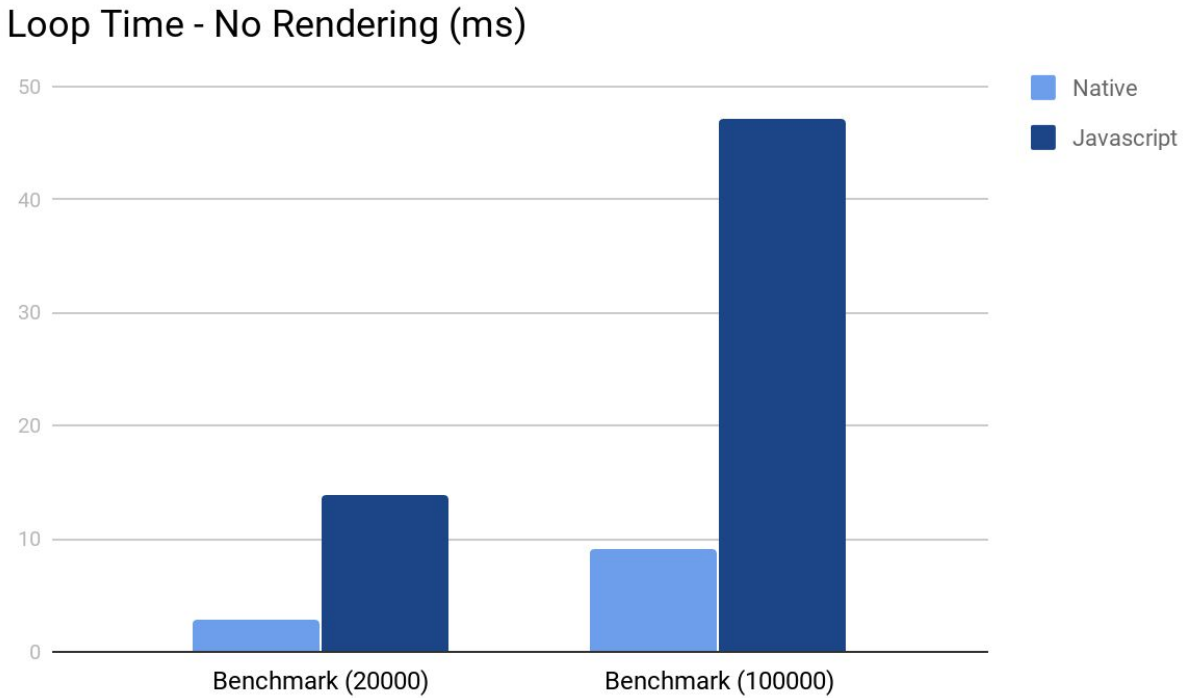
- Animometer Benchmark uses ~20 OpenGL functions.
- 7 function calls in a hot loop.

```
// repeated for 20,000 primitives

 glUniform1f(uScale, uniformData[i].scale);
 glUniform1f(uTime, uniformData[i].time);
 glUniform1f(uOffsetX, uniformData[i].offsetX);
 glUniform1f(uOffsetY, uniformData[i].offsetY);
 glUniform1f(uScalar, uniformData[i].scalar);
 glUniform1f(uScalarOffset, uniformData[i].scalarOffset);

 glDrawArrays(GL_TRIANGLES, 0, 3);
```

WebGL Prototype Experimental Results



Debugging

- Discussion at CG meeting last week (minutes)
- Converging on new debugging interfaces allowing portable debuggers
  - Goal: don't require building DWARF into all browsers
- Expect renewed activity in WebAssembly debugging subgroup (link)
  - Join!

Discussion