WebAssembly - a new technology and its potential for geospatial application

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What is WebAssembly?

- WebAssembly (Wasm) is a simple machine model and binary executable format
- Designed to be portable, compact, and execute at or near native speed
- Memory-safe, sandboxed execution environment
- A Wasm module has access to a single "linear memory", which is essentially a flat array of bytes

WebAssembly Text (wat)

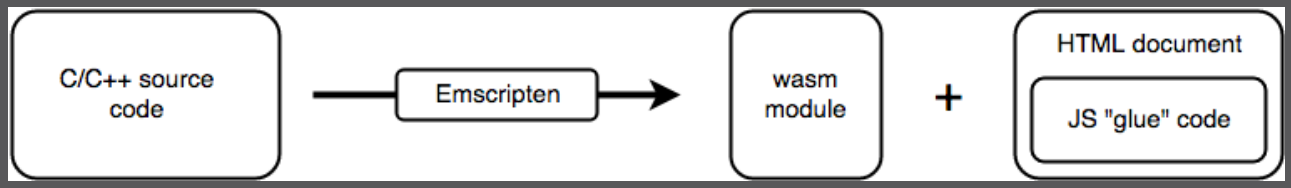
```
(module
  (func $fac (param f64) (result f64)
    get_local 0
    f64.const 1
    f64.lt
    if (result f64)
      f64.const 1
    else
      get_local 0
      get_local 0
      f64.const 1
      f64.sub
      call $fac
      f64.mul
    end)
  (export "fac" (func $fac)))
```

asm.js

- 2013: Firefox 22
- Subset of JavaScript
- Can be generated with Emscripten
- Fallback for Browsers without Wasm support

Generating WebAssembly

- C / C++



- Rust
- With GC: C#, Go, ...
- Assembly Script
- Writing WebAssembly directly (wat)

What can be done in Wasm

- **Supported:**
  - Calculations
  - Calling Javascript (and vice versa)
  - Futures
  - Transferring data via linear memory (e.g. Canvas data)
- **Preview:**
  - Multithreading
- **Can’t be done (yet):**
  - Direct DOM access
  - Direct Web API access (via Javascript calls only)

Browser support

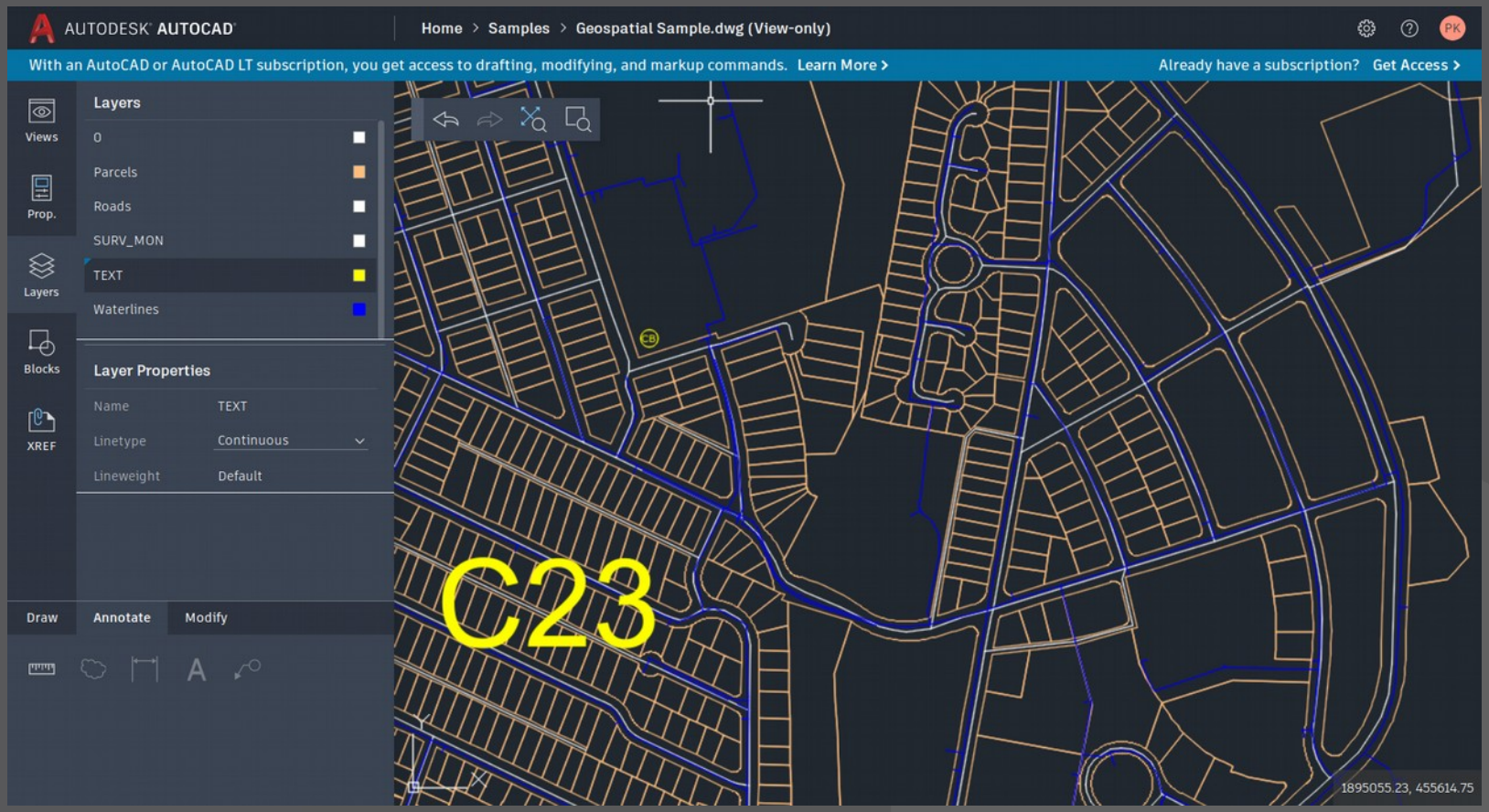
- Firefox 52 (March 2017)
- Chrome 57 (March 2017)
- Safari 11 (Sept. 2017)
- Edge 16 (Oct. 2017)
- Android, iOS
- No support: IE

https://caniuse.com/*feat=wasm

Specifications

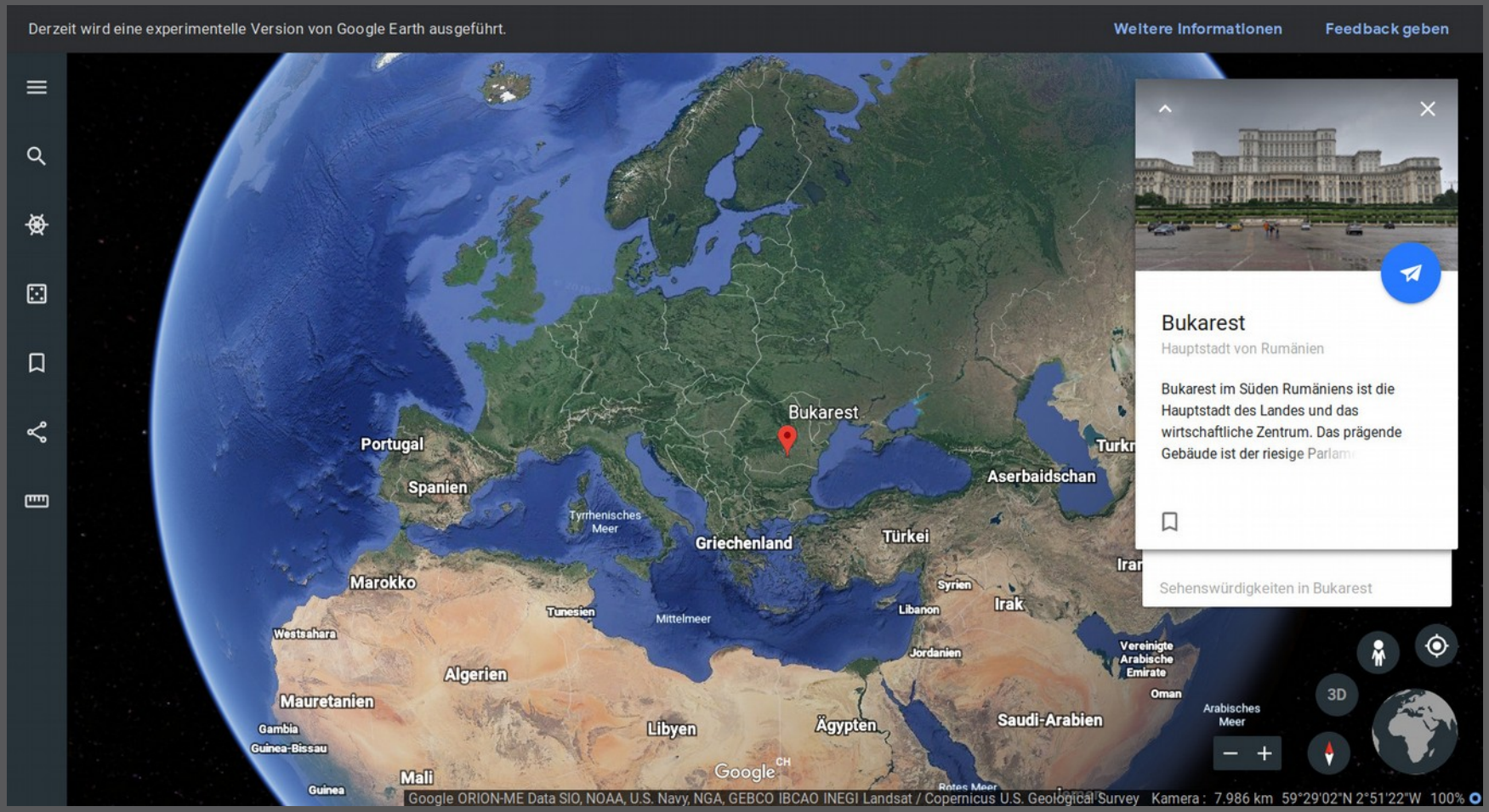
- https://webassembly.org/
- W3C WebAssembly Community Group
- W3C WebAssembly Working Group
  - WebAssembly Specification Release 1.0 (Draft, May 30, 2019)

Applications: Autocad



- https://web.autocad.com/
- Google I/O Keynote

Applications: Google Earth



- https://g.co/earth/beta
- Chromium Blog

Libraries

- Client -side projection engine (ESRI Blog)
- Qt Demos & Examples
- Skia (OSS C++ graphics library)
- PSPDFKit

Demo applications

- Liquid simulation (Demo)
- VR: Julia set on a planar object (Demo)
- Doom 3
- WasmBoy / VaporBoy (GameBoy emulators)
- Vim
- Nginx web server
- Python interpreter, Go Compiler, ...

Chapter 2: WASM Runtimes

- **Browser**
- **Standalone**
  - Wasmer
  - Wasmtime
  - Lucet
  - Intel WebAssembly Micro Runtime (WAMR)
- **Standard: WASI (https://wasi.dev/)**
- **Embedding Wasm in other languages**
  - Wasmer: Rust, C/C++, Python, Ruby, Go, C#, PHP
- **Runtime as a service**
  - Cloudflare workers

What does that mean?

- Portable binary code between different platforms
- Alternative to NodeJS, Electron, …?
- Common runtime format for multilingual Edge/Serverless applications (sandboxed!)
- Common runtime format for application plugins/extensions (sandboxed!)
- Portable runtime format for embedded/IoT devices?

Geospatial applications

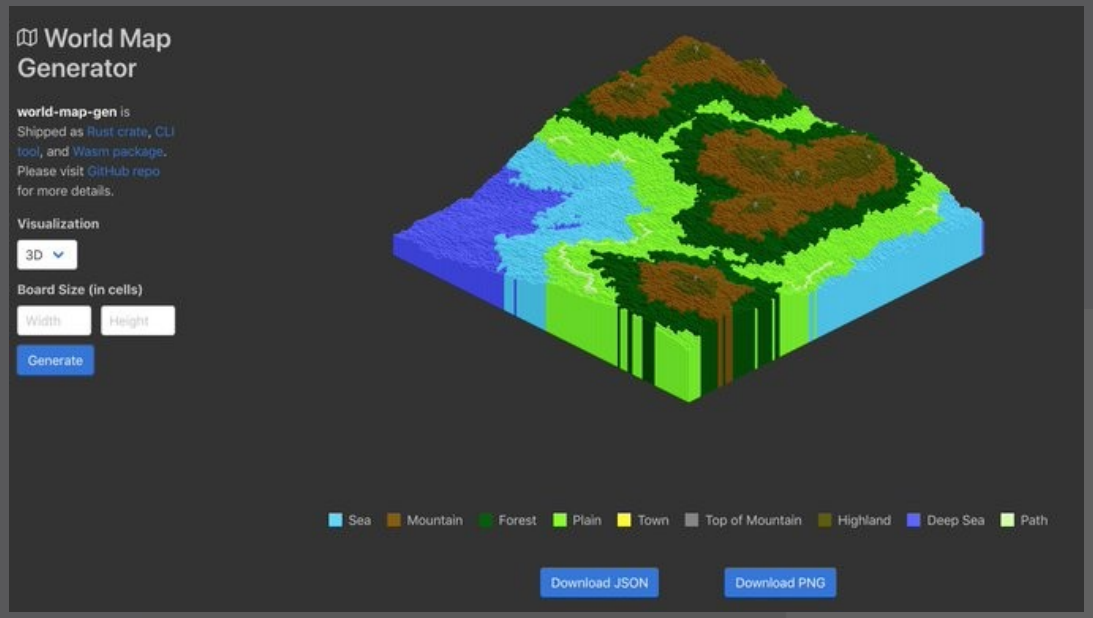
- **Top candidates**
  - Proj
  - GEOS
- **Ideas**
  - Client-side map printing (PDF)
  - Rendering vector tiles (MVT V3)
  - Importing Shapefiles with GDAL
  - Routing
  - Desktop GIS in the browser?
    - Complex GUI → possible, but a lot of work
    - Web optimized data formats: COG, FlatGeobuf

Wasm Speed

- **Expectation:**
  - 20-30% faster than Javascript
- **PSPDFKit benchmark (early 2018)**
  - Slower than Javascript on most browsers, 70% faster on Firefox
- **WasmBoy benchmark**
  - About 30% faster than JS on Chrome. Can be faster at around 60% on mobile and on Firefox it can be faster around 90%. Slower than 30% on Safari.

Comparison WASM / Native

- World Map Generator 1000x1000 cells



- Native: 2.9s
- Wasm (2D) Firefox: 6.4s
  - 45% of native speed

Conclusion / Outlook

- Wasm is here
- FOSS4G will catch up
- Funding needed for core libraries?
- Wasm will get even better

Thank you!

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