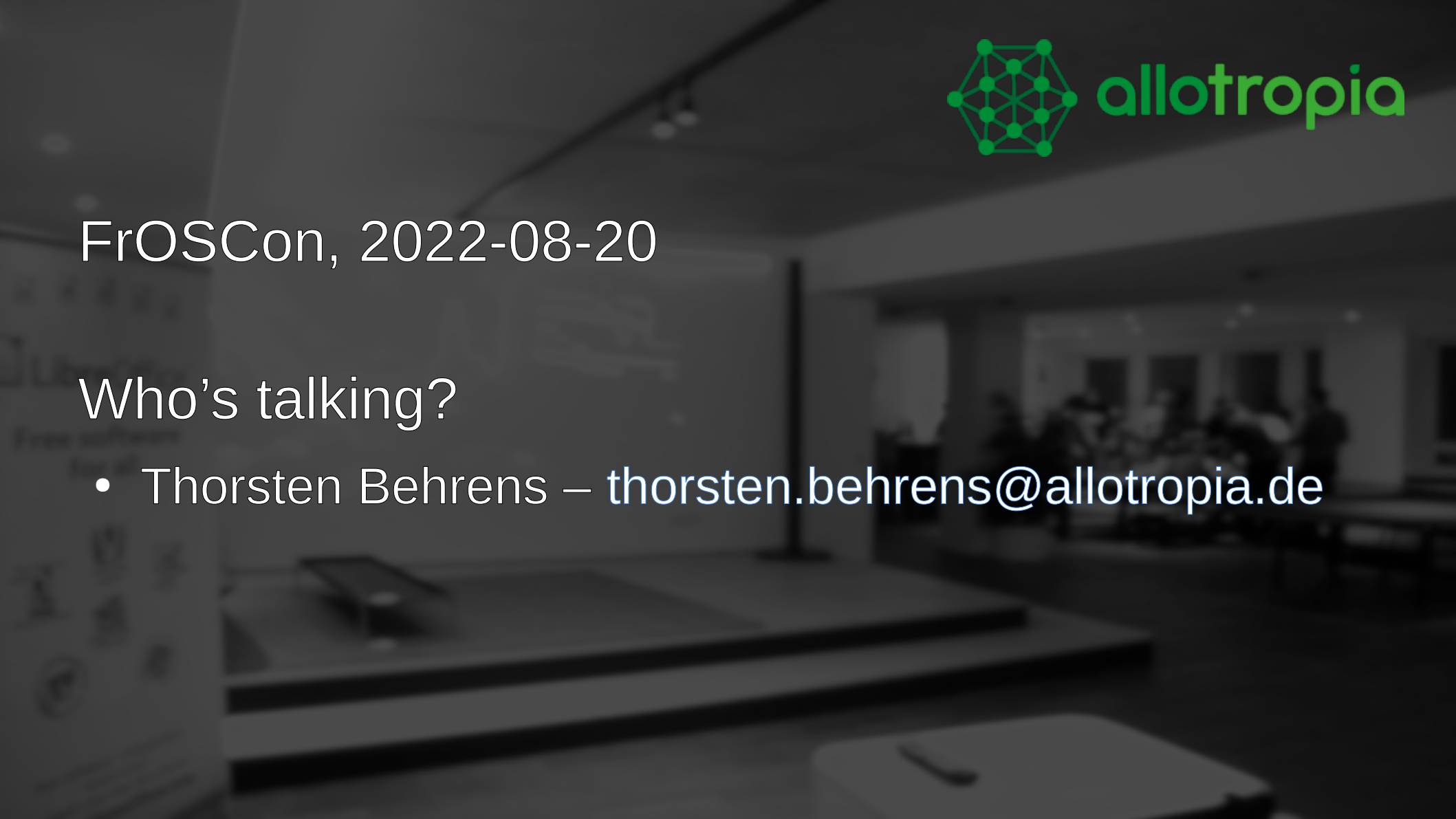
LOWA or how we managed to run LibreOffice in your browser

Stories from the journey to port a massive c++ application to WASM/emscripten



FrOSCon, 2022-08-20

Who’s talking?

- Thorsten Behrens – thorsten.behrens@allotropia.de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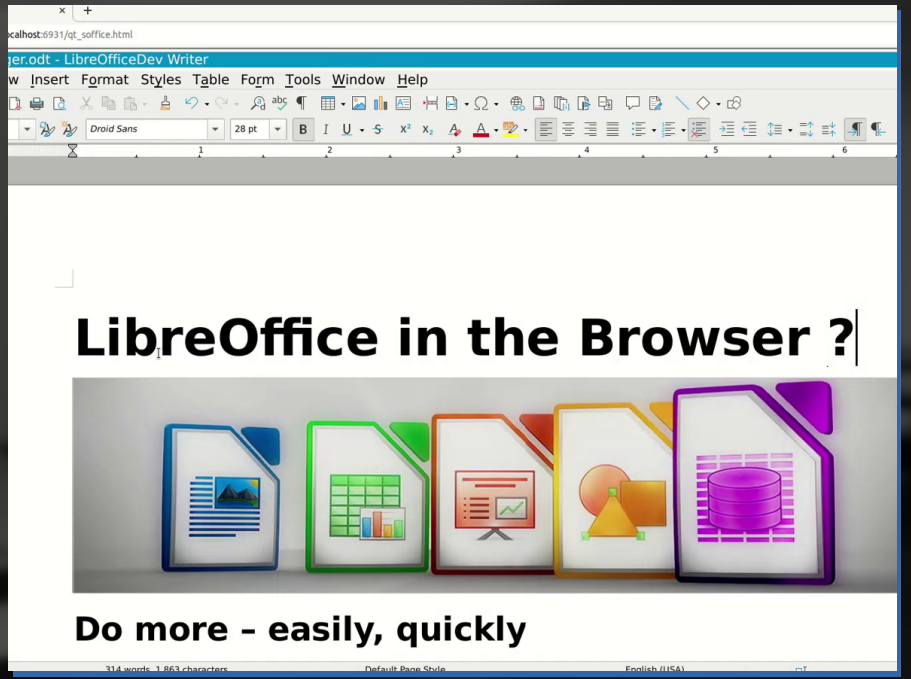
Why?

What?

- LOWA - LibreOffice WebAssembly
- native port of LibreOffice, running client-side in the the browser
  - C++, cross-compiled via emscripten
  - Using WASM / W3C since 2019
- project is funded by NLnet / Horizon 2020, and allotropia software GmbH



Challenges

Challenges

- maturity of platform (emscripten/WASM/browsers) unclear
  - we tried it in 2015 – not even got c++ exceptions to work
- size of the problem
  - >10M LoC
  - >100 3rd party libraries
  - notorious to break tool chains (“..breaking your tools since 1990..”)
  - size of the resulting WASM binary – browsers capsize hard
  - download size (also affecting cache-ability)
- Multi-threading & GUI event handling peculiarities
  - Multi-threaded document loading and UNO IPC are disabled
- Heap size tops out at 4GB, because of WASM32 32bit pointers
- Development / Debugging environment still very “fresh”

Challenges

- Size of the resulting WASM binary

  Currently: packed = 35M, optimised = 150M, debug = 200M + ~1G separate DWARF info

- Size of the filesystem image

  ~ 100M with all LO fonts, can be stored locally and split if needed

  → less downloads on updates

  → can use webfonts

- embeddability & programmability
  - you want to use this from your JS framework
  - massively powerful API (“UNO API”), how to bind that

Current LOWA status

- https://wiki.documentfoundation.org/Development/WASM
  - boils down to: use master, read static/README.wasm.md
- Branch with extra features: https://git.libreoffice.org/core/+/refs/heads/feature/wasm
- Master can now build and run:
  - A WASM soffice.(html|wasm)*
  - A WASM vcldemo.(html|wasm) – works mostly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The journey

Timeline

- Project kickoff:
  - October 2020
- Build env & configury & emscripten setup
  - December 2020 – cross-building of a subset works
  - Docker builders for CI available
- Get the first LibreOffice-rendered pixel on the screen
  - October 2021 – after a death march of one year…
- Get Writer practically working
  - February 2022 – also merged ~all of the changes into master
  - first fully working demo presented at FOSDEM
- Ongoing:
  - get Calc working, get headless PDF conversion & JS framework connectors running

Core ideas

- LibreOffice is an autotools & GNU make project
  - stick to that, avoid other parallel build systems
  - and its already pretty portable, cross-compilation is supported out of the box
- LibreOffice has its own GUI abstraction
  - with plugins for Gtk, Qt/KF5, Win32 and OSX
  - with Qt5 supporting WASM natively, we went with that

Core ideas

- LibreOffice is basically c++ (by and large c++17)
  - we went with emscripten as platform compiler (pinned to 2.0.31 currently)
- We don’t want to use any experimental WASM features
  - no threading
  - no dynamic linking (sadly require a re-tooling of the build system)
  - no native WASM exceptions
- We wanted to focus on Writer initially (and save size by not building/shipping the rest)

Major problems

- emscripten & browser tools
  - several moving targets
  - random setups (`emsdk activate / install` not repeatable)
  - In 2020: no source-level debugging, SharedArrayBuffer limitations, unstable WASM impls
- LibreOffice gbuild make system w/o support for static linking
  - GNU make with a ton of `$(eval.. & $(call ..` self-made, functional build system
  - 88 commits, 4kLOC change to add that
- LibreOffice gbuild make system with dependency loops
  - UNO component system for dependeny inversion
  - once we link statically, we get loops

Major problems

- LibreOffice UNO components
  - no static dependencies, but factory & runtime resolution
  - switched to static dependency per toplevel application
- LibreOffice needs a ton of secondary files (config, fonts, gui descriptions)
  - building a virtual embedded filesystem image
- Linker problems:
  - Link time grew quadratically with symbol amount
  - at some stage took >1h and >64GB to link
  - debug build now links in ~30s; not great but manageable
  - optimized build still needs huge amounts of memory and time, but saves 25% binary size with -O2
  - always separate debug data, downloadable on demand (DWARF)

Diversion: static build

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- turns out developing for WASM was super-hard
  - long link times, huge linking memory usage
  - impossible to get decent turn-around times
- turns out debugging WASM was not efficient
  - Basically reading disassembled WASM code
- So lets use known tools on the native side
  - made a native, static, single-library build work
  - automagically include all build components
  - based on the Android + iOS static build ideas
- And get ***that*** to work first

Achievements unlocked

..aka demo..

Improved WASM dev experience

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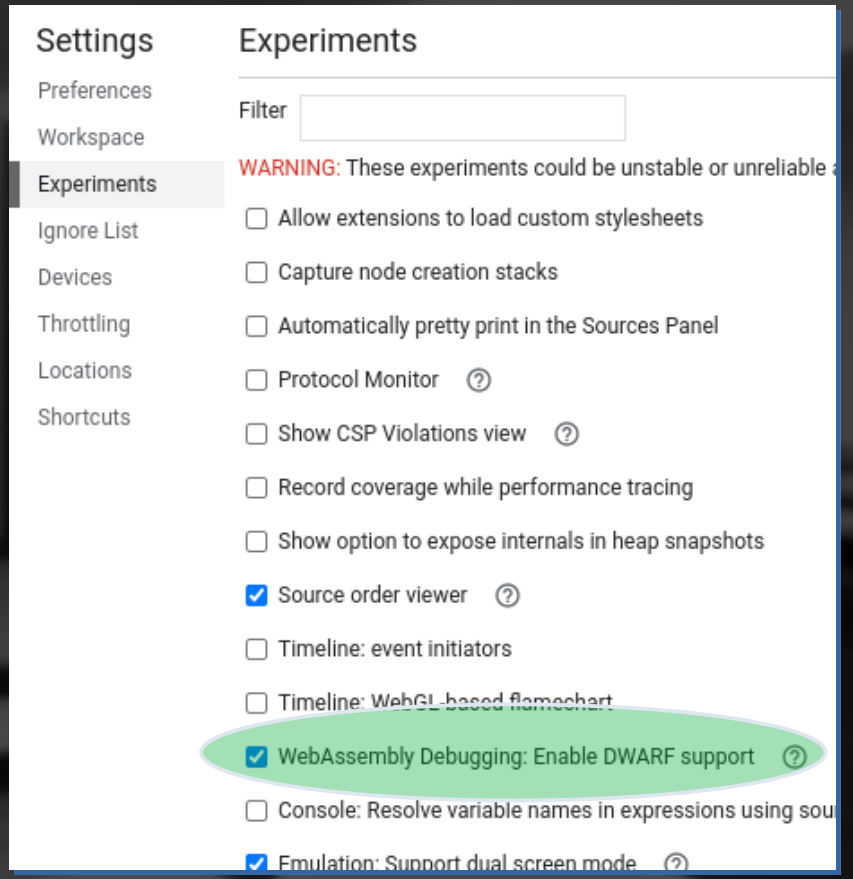
- since late 2021:
- now on Emscripten 2.0.23
  - `./emsdk install 2.0.23`
  - `./emsdk activate --embedded 2.0.23`
  - massively better build & link times
- Chrome debugging support
  - DWARF debug info included into binary
    - Much less linking time then generating huge source-maps
  - Debugging optimized code
  - https://developer.chrome.com/blog/wasm-debugging-2020/

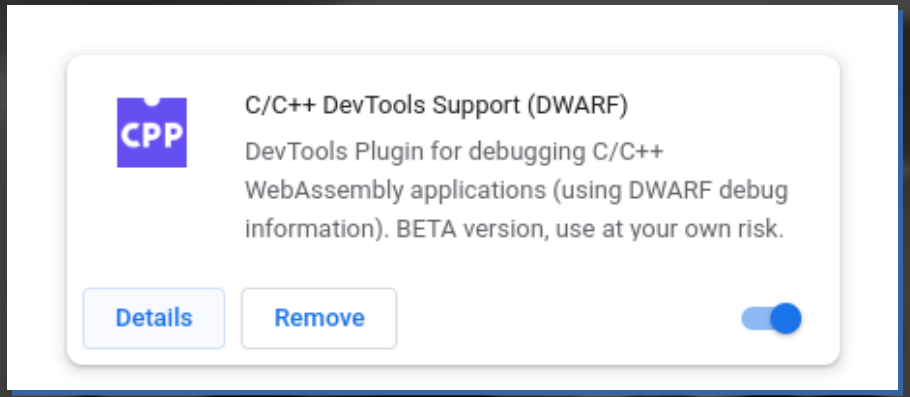
Chrome Debug Setup

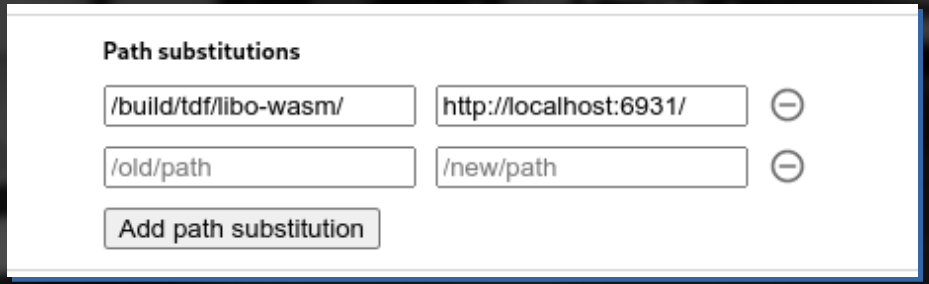
- DWARF debugging howto
- Install C/C++ DevTools Extension
- enable experimental WebAssembly debugging:



Chrome Debug Setup

- If necessary, tweak path mappings:
- Extensions → Details → Extension Options → Path substitutions
- And then serve your full source tree via `emrun` :
- `emrun --serve_root=<path>/<to>/core/instdir/program/qt_soffice.html`





Remaining problems

Problems still to tackle

- No nested main loops / no blocking of the browser
  - You can run the main loop in a web worker, but then need a separate frontend.
  - Convert dialogs to async + no more Reschedule() calls.

→ SAL_USE_SYSTEM_LOOP=1 make debugrun

→ Easy start: grep `Application::CreateMessageDialog`

- Like commit 972aa39fb976e30ce73065b1eba69f4c78c17855

→ Easy hack to reference: tdf#146919

Problems still to tackle

- Fixed the WASM Qt backend:
  - use qtbase branch 5.15.2+wasm from allotropia Github
  - much more bugs than expected for Qt
  - upgrade to Qt6 / WASM (not perfect yet either)
- Alternatives:
  - port Gtk to WASM

    but you need some kind of compositor for multiple windows..
  - use the same frontend as COOL… somehow
  - implement some “WASM-native” VCL plugin / WebGL

More problems to tackle

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- “Upload and Download” of local files
- Use browser APIs where / if possible
  - from spell-checking to ICU
- Implement persistent storage for the FS image and user files / data
- Use / Download translations + dictionaries (and keep in local storage)
- Implement a real UNO bridge, probably using WAT
- p2p document editing (as originally planned…)
- Port to a WASI
- Moonshots:
  - Switch to WASM modules AKA “dynloading”
  - Replace gbuild with Meson

Project plan

- switch focus onto JavaScript side:
  - GUI & embedding
    - sample code for VueJS
    - access to full UNO API (webIDL or embind) – at least cmd & callbacks & state checks need to wok
  - use browser APIs whereever possible
- usable HTML widget for rich text editing by Q4
- headless conversion (PDF & more)
- get Calc into shape

What to expect
(and our vision for LOWA)

- ***not*** a replacement for desktop/mobile LibreOffice, or Collabora Online
- instead serving unmet needs:
  - your platform is the browser? here's your everything-works text widget!
  - require privacy-by-default, or end2end encryption? here's your no-data-ever-goes-to-any-server solution!
  - want planetary-scale for your product, but lack GAFAM's number of data centers? here's something that scales like a static website!
- want to play yourself? have a look, demo setup here:

https://lab.allotropia.de/wasm


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Questions & Answers