Video Rendering on Frontend and Backend

Lightricks

Lightricks is the creator of numerous award-winning photo and video editing apps. Our goal is to build fun and powerful tools that reinvent the way content is created all over the world.

Established 2013

HQ in Jerusalem, branches in Haifa & London

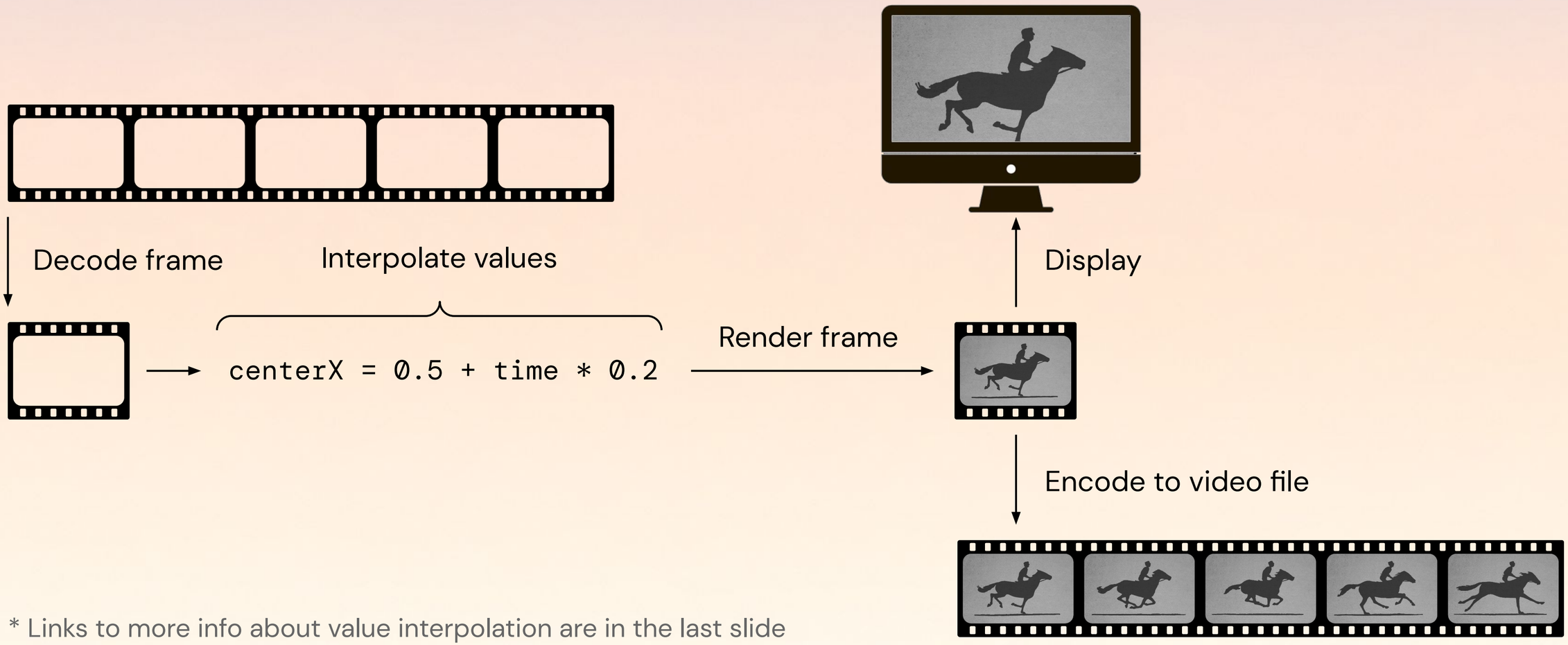
~400 Employees

12 Apps

We’re a Unicorn!

Boosted Web

The Playloop



* Links to more info about value interpolation are in the last slide

Can we do that in the browser?

Decode:

- HTMLVideoElement

Interpolate:

- pure logic

Render:

- WebGL

Encode:

- Software codec

But...

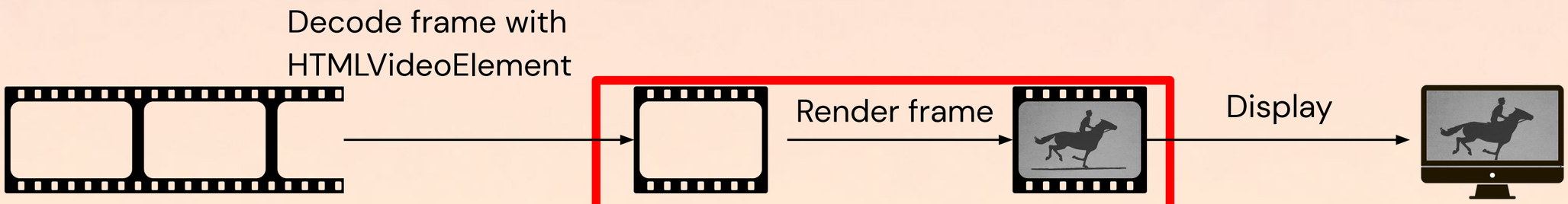
- HTMLVideoElement
  - Can’t give source frame rate
  - Can’t seek to frame
  - Is geared for real-time playing
    - will skip frames during heavy workload
- We can code around it
  - Working against the intended usage
  - Will work on some browsers

Alternative

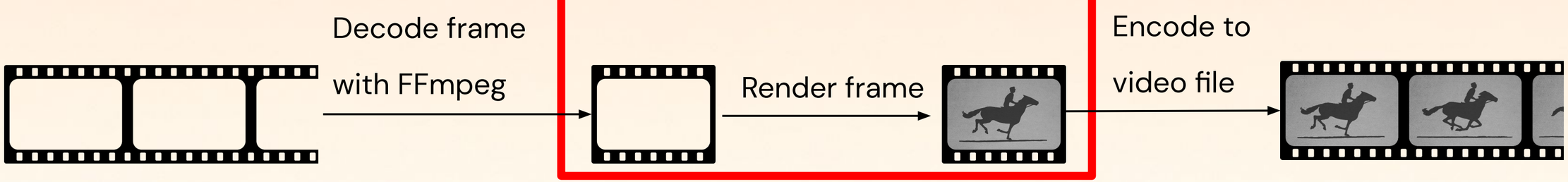
- Software emulation
- FFmpeg library
  - either back-and-forth in backend
  - or large import in frontend
  - Both are slow

Let’s split!

Browser:



Server:



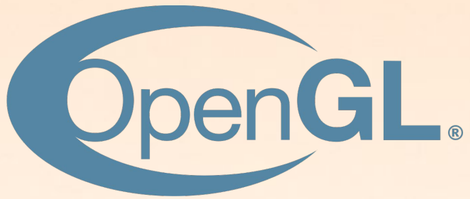
Stacks

	Browser	Server
Language	Javascript	C++
Decoding	HTMLVideoElement	FFmpeg

Rendering

OpenGL / WebGL as API

- GL - Graphics Library



Same functionality, different structure

- OpenGL - global state machine
- WebGL - object oriented

Stacks

	Browser	Server
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Stacks

	Browser	Server
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Text Shaping	...	...

Stacks

	Browser	Server
Language	Javascript	C++
Decoding	HTMLVideoElement	FFmpeg
Rendering	WebGL	OpenGL
Text Shaping	...	...
And more	...	...

WebAssembly

WASM in short

Standard for secure, performant, cross- platform computing

Compiled from any language

Available in browsers

* Links to more info about WebAssembly are in the last slide

Emscripten – compiler toolchain

Compile code to WASM

Create JavaScript bindings

Abstract interfaces to use JavaScript objects

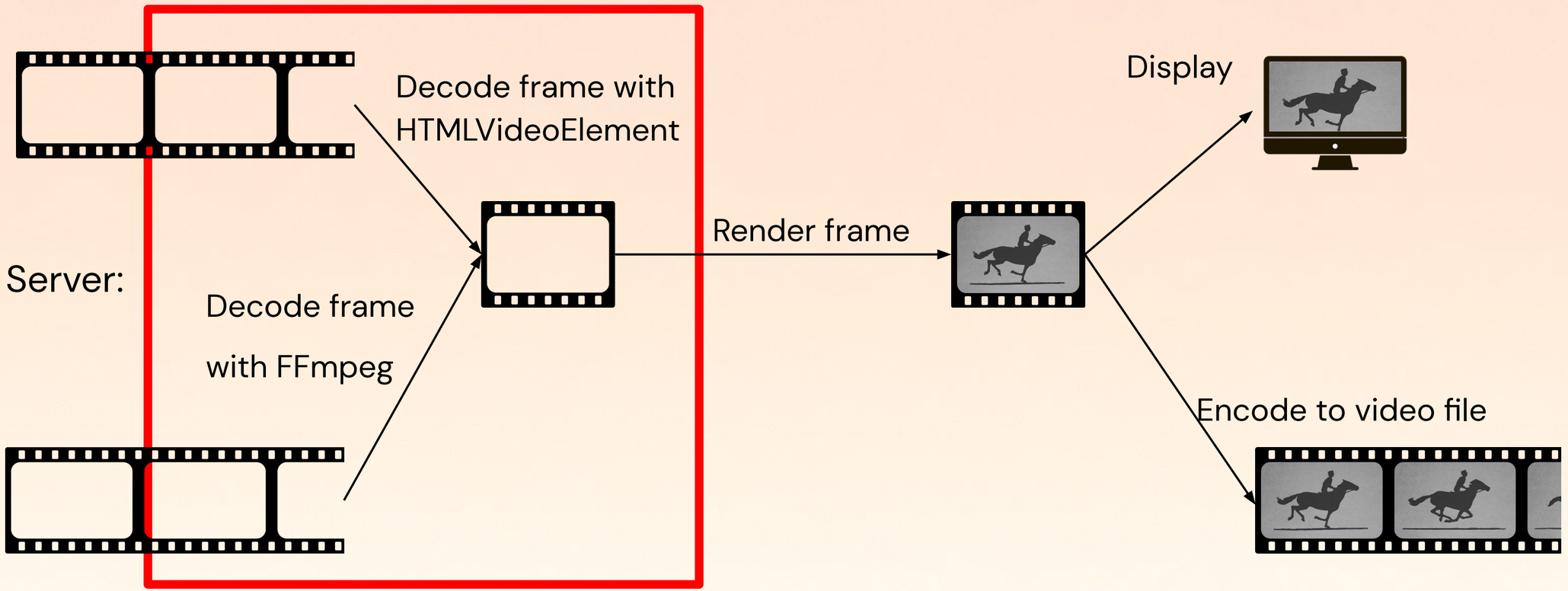
OpenGL + Cpp = WASM + JavaScript + WebGL

Stacks

	Browser	Server
Language	Javascript & C++	C++
Decoding	HTMLVideoElement	FFmpeg
Rendering	OpenGL	
Text Shaping	...	
And more	...	

Let’s combine code!

Browser:



Story Time!

WebAssembly — What does security mean?

WASM has separate memory

Can’t access runtime memory

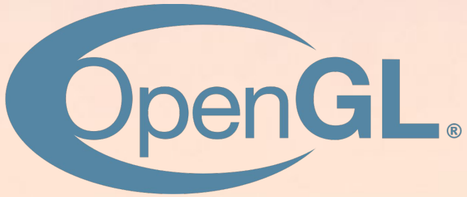
This means that everything must be copied

WASI — WebAssembly System Interface

Loading frames to textures

Has API for fast loading of textures from HTMLVideoElement

Textures represented by opaque JS objects



What's a HTMLVideoElement?

Textures represented by IDs

The Problem

renderer code uses OpenGL, frontend code uses WebGL

How to efficiently pass the frame data to WASM

Frame data — copy to WASM's memory

Copy to WebGL texture — not available in C++

Restating the Problem

Data in JavaScript, needs to be consumed in WASM

Data copy is expensive

Abstraction layer separates between WASM and JavaScript

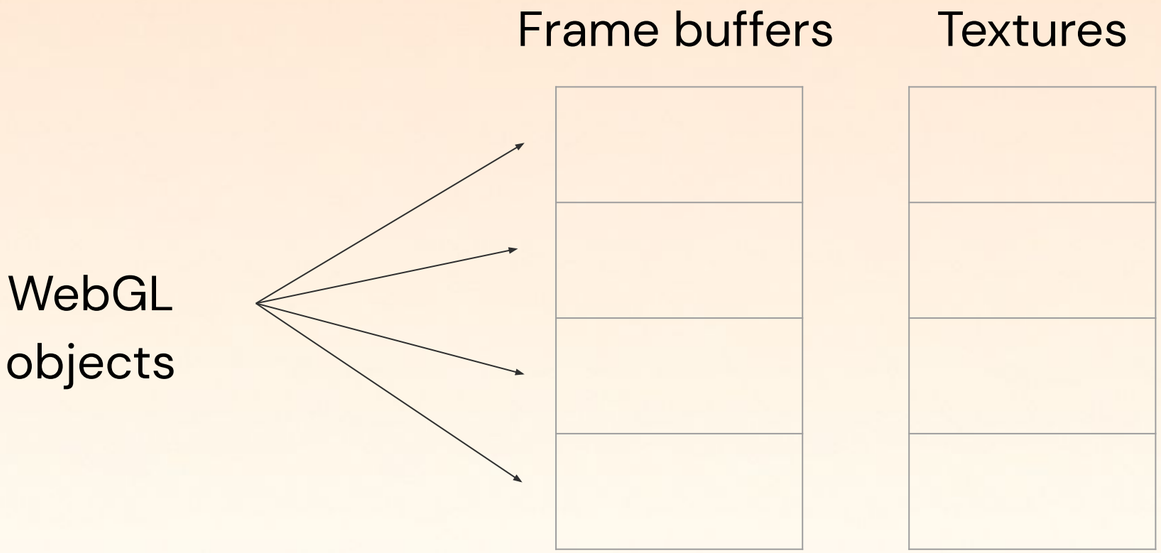
- Can’t use the same objects on both sides

Misusing Emscripten for fun & profit

Emscripten calls WebGL with OpenGL code

Emscripten gives OpenGL texture identifiers to WebGL textures

getNewId — a function that inserts to array, and returns index as identifier



Solution

Create textures → Create texture identifier using Emscripten's getNewId → Load frame data → Explicitly remove texture identifier

Use texture identifier

All’s well that ends well

We’ve reached 60 FPS

We wrote the engine once, used it twice

The bridging code is minimal

Is This Smart?

Relying on internal API which might change — Bad

Bridging abstraction gap — Necessary

Manually Managing texture lifetime isn’t great

Final score: 🤷🤷🤷🤷

Bottom line

We can write C++ code and run it everywhere

Emscripten bridges a lot of platform differences

Some hacking might still be required

Everything is more complicated when rendering :(

Links!

- Check out the app
- My talk about value interpolation
- Lin Clark's excellent intro to WebAssembly
- My talk about the history of efficient computinting on the web
- Contact me

Lightricks

We are hiring!

Lightricks.com/careers