Inside libplacebo

From mpv renderer to portable GPU video pipeline

Intro

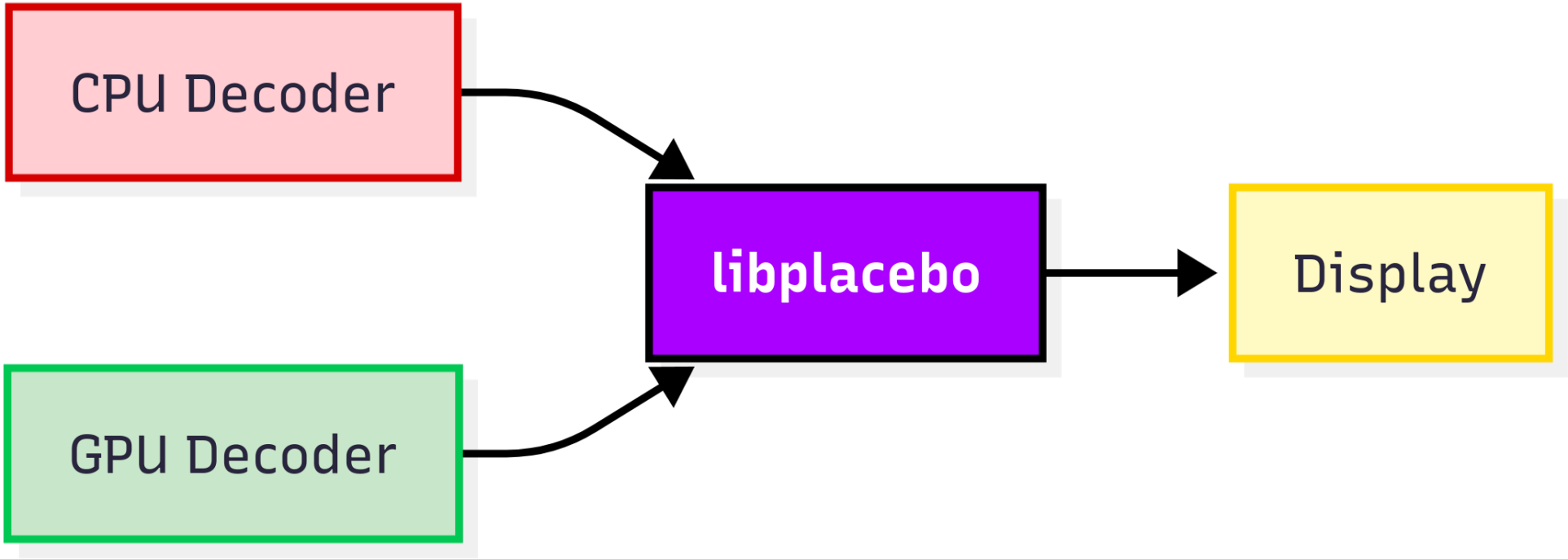
Who am I?

- Niklas Haas <contact@niklashaas.de>
- Multimedia Consultant (https://niklashaas.de)
- Main author

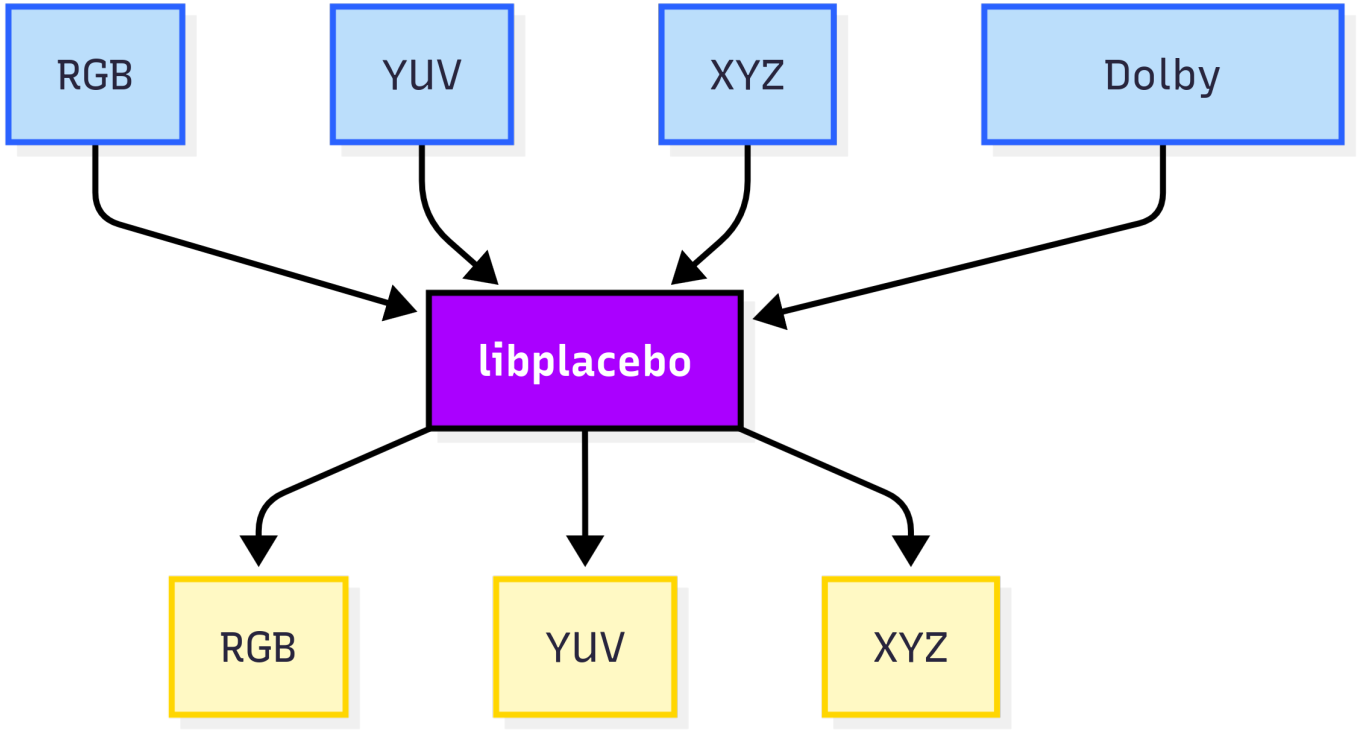
What is libplacebo?

- GPU-based image processing

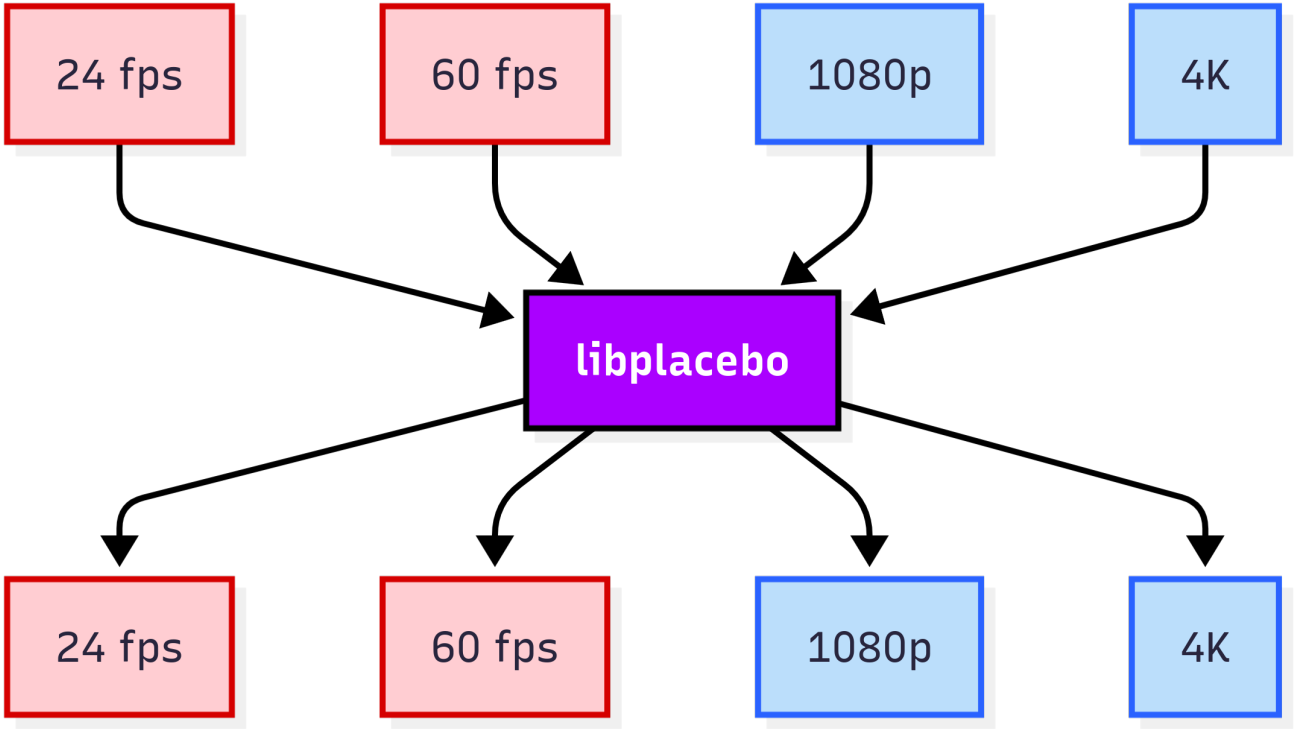
What is libplacebo?



What is libplacebo?



What is libplacebo?

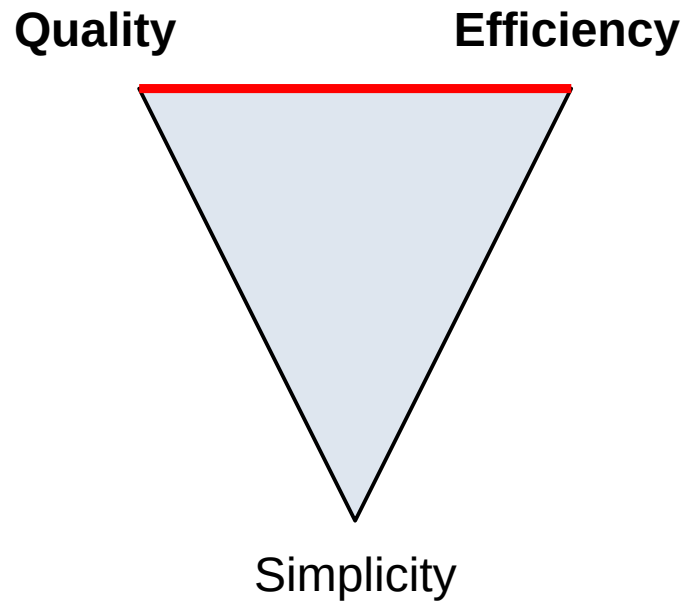


Core Features

- **Scaling**
- **Color management**
- **HDR tone-mapping**
- Debanding, Deinterlacing, Dithering
- Film grain synthesis
- Framerate compensation
- Custom shaders

Design Philosophy

- **Maximum quality**
- Standards adherence
- GPU accelerated
- Fully dynamic
- Cross-platform

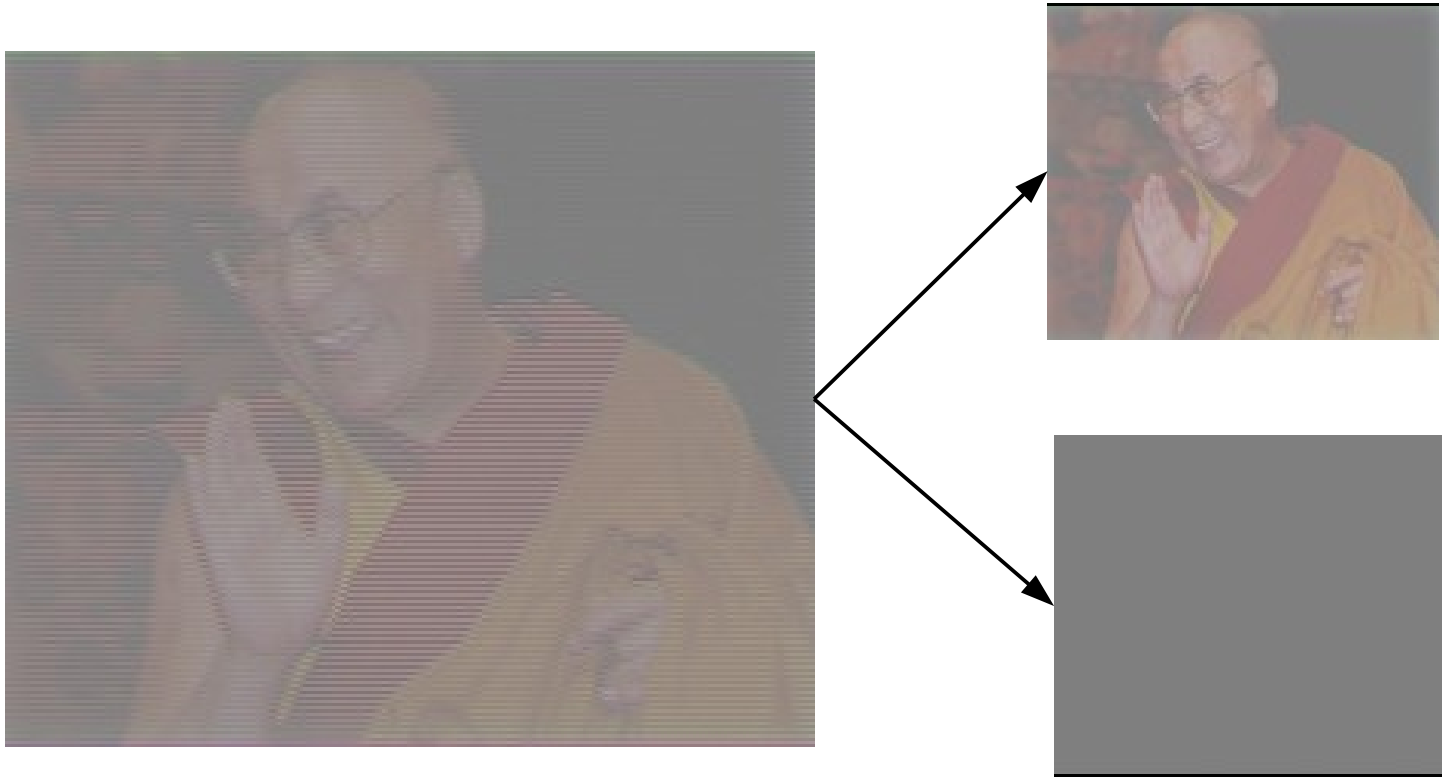


Demos

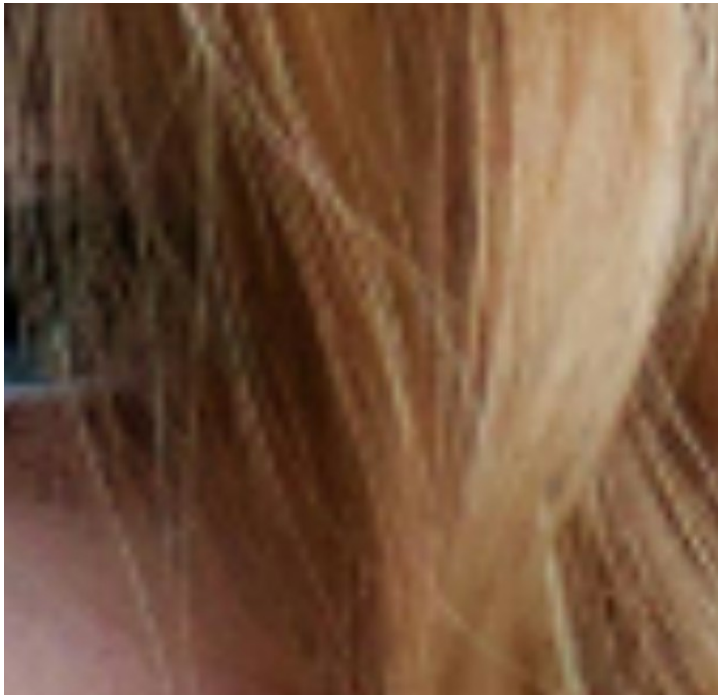
Upscaling

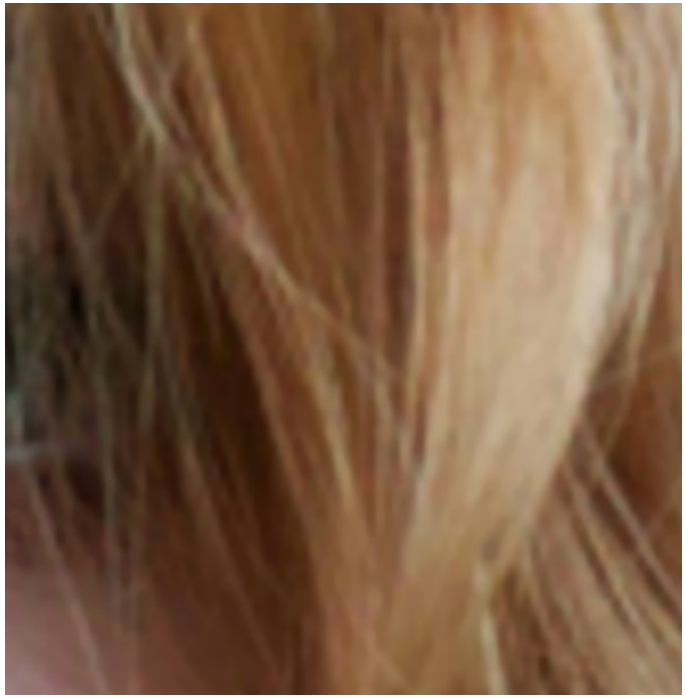
Downscaling

Downscaling



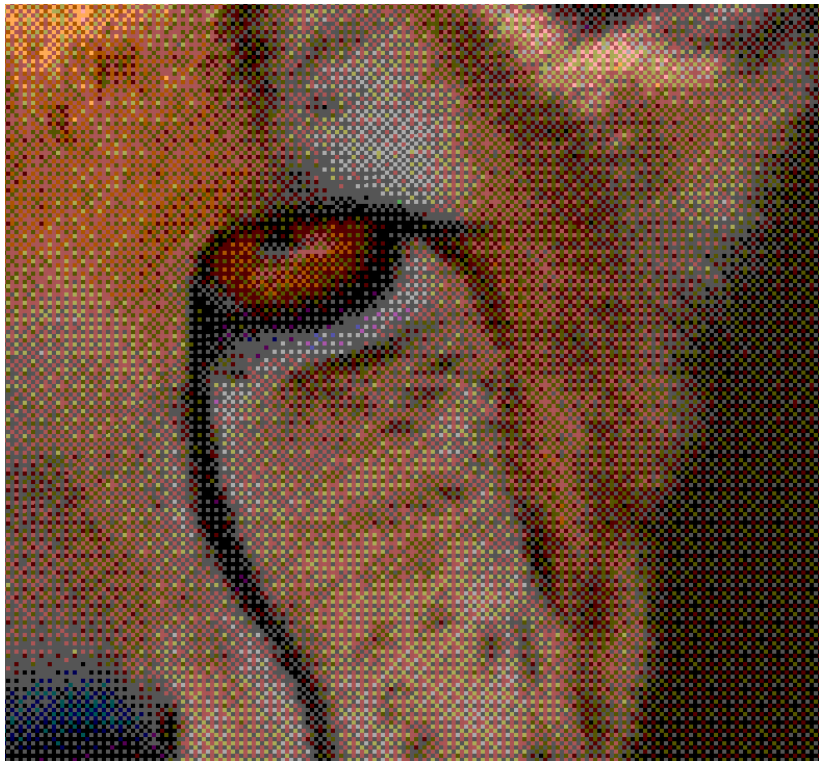
Downscaling

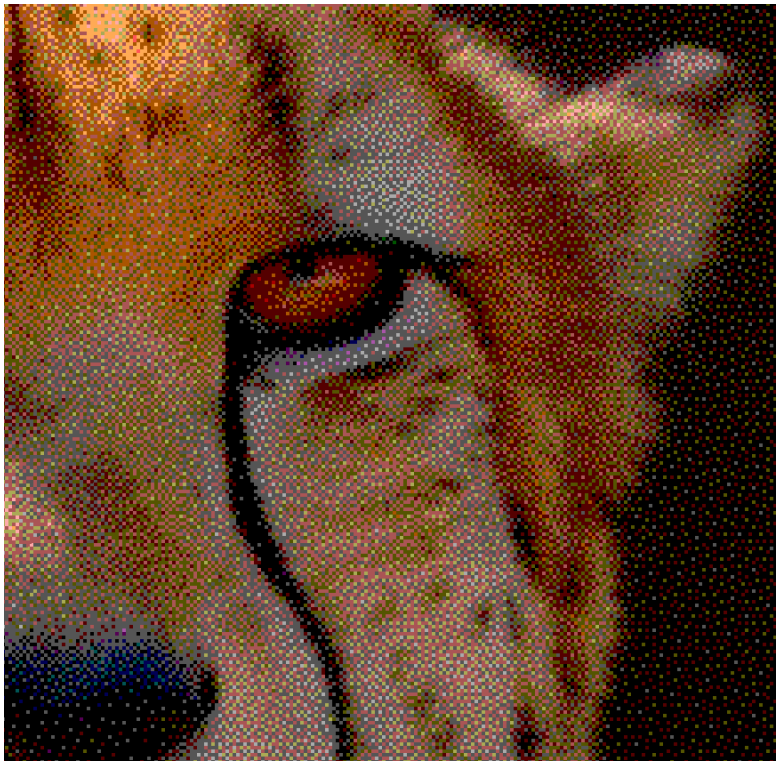




Debanding

Dithering





Tone-mapping

Design

Project History

2001 – 2022 **MPlayer**

2010 – 2014 └ **mplayer2**

2012 – present └ **mpv**

2012 – 2021 └ OpenGL 3.x (vo_gl3)

2016 – 2018 └ Vulkan backend (ra_vulkan)

2017 – present └ **libplacebo**

2017 – present ├ VLC OpenGL integration

2018 – present ├ VLC Video Output (vout_libplacebo)

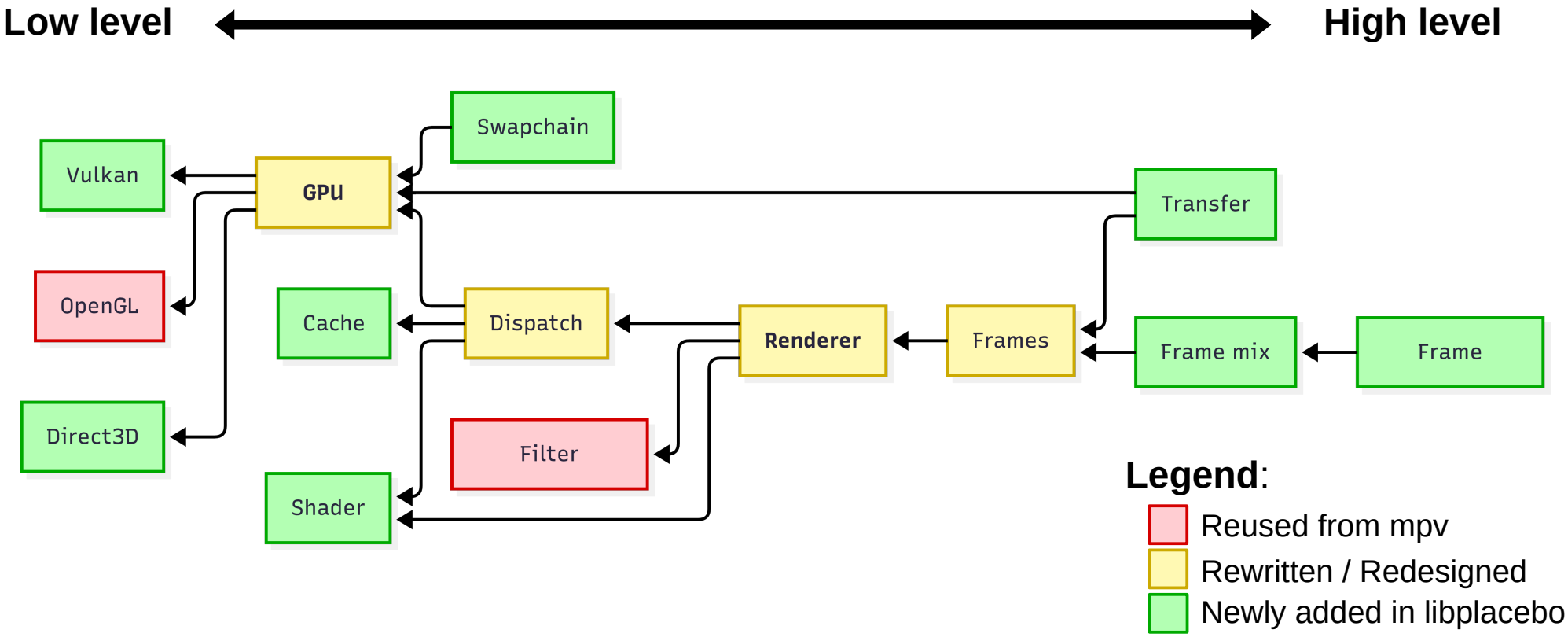
2018 – present └ mpv Vulkan replacement (ra_pl)

2021 – present ├ mpv (vo_gpu_next)

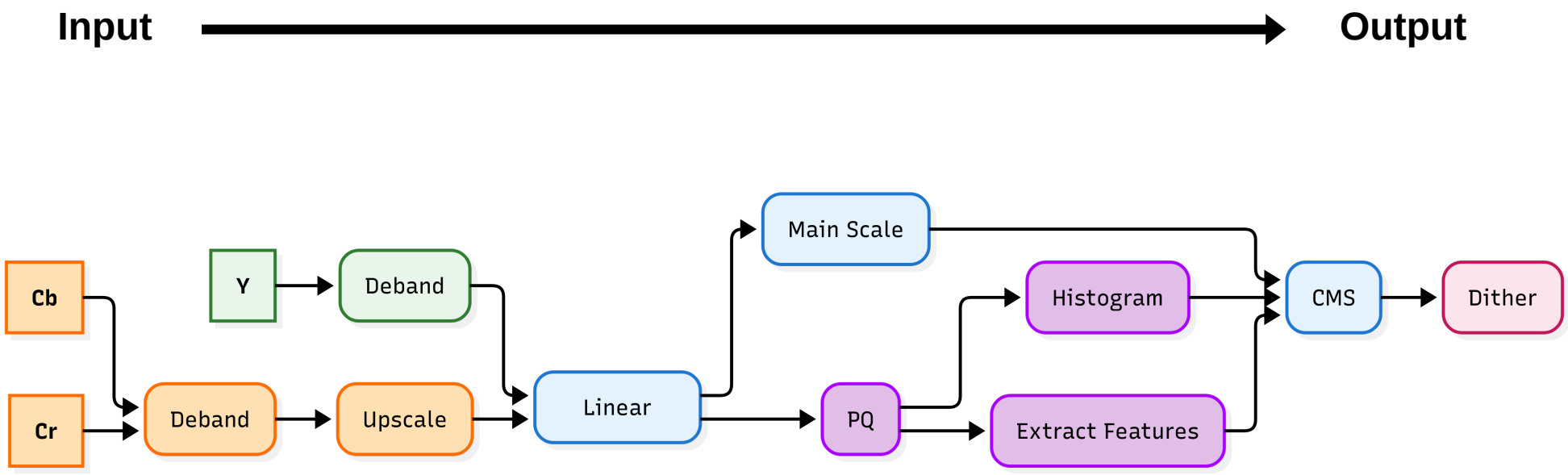
2021 – present ├ **FFmpeg** (vf_libplacebo)

2023 – present └ JRiver Media Center

Internal Architecture

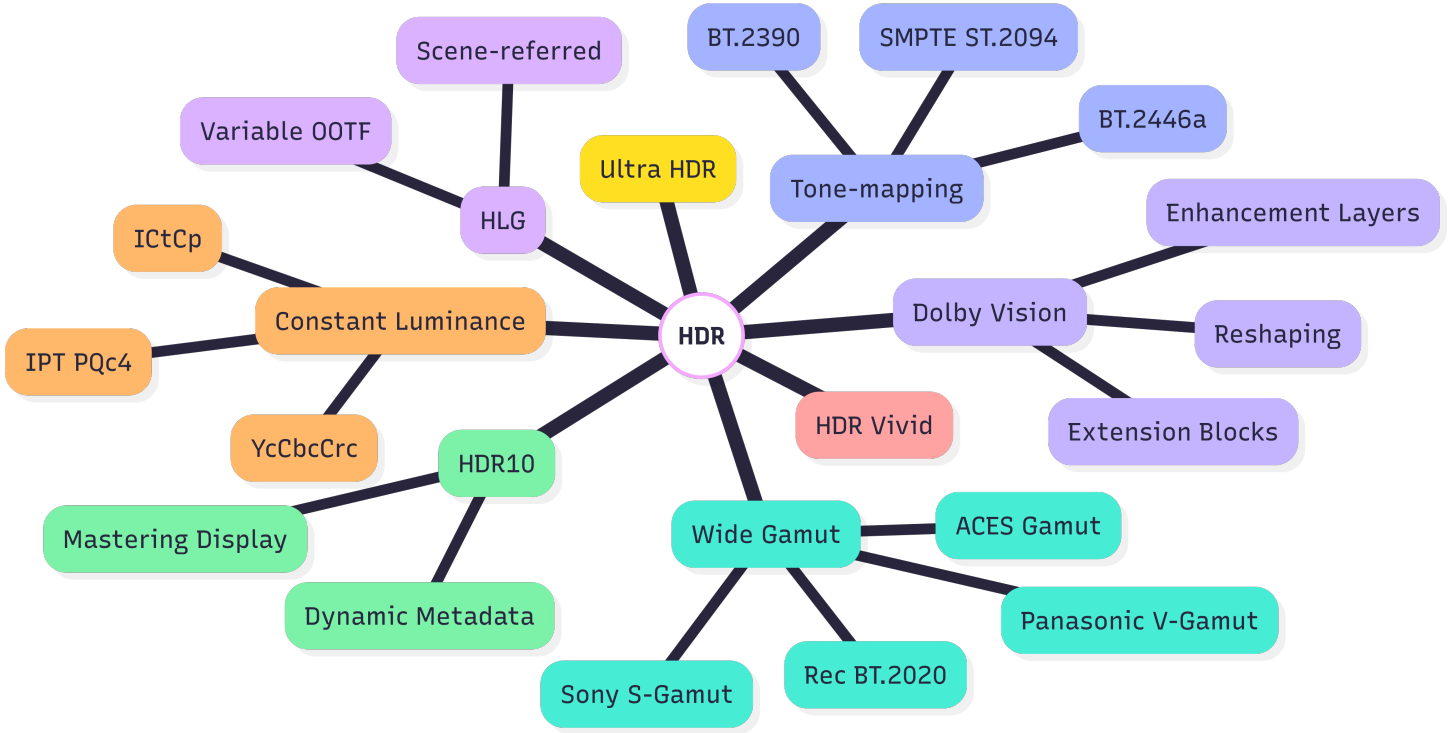


Renderer


Input
Output
Cb
Cr
Y
Deband
Deband
Upscale
Linear
Main Scale
PQ
Histogram
Extract Features
CMS
Dither

HDR

HDR Mess


HDR
Scene-referred
Variable OOTF
HLG
ICtCp
Constant Luminance
IPT PQc4
YcCbcCrc
HDR10
Mastering Display
Dynamic Metadata
Ultra HDR
BT.2390
SMPTE ST.2094
BT.2446a
Tone-mapping
Enhancement Layers
Dolby Vision
Reshaping
Extension Blocks
HDR Vivid
Wide Gamut
ACES Gamut
Panasonic V-Gamut
Rec BT.2020
Sony S-Gamut

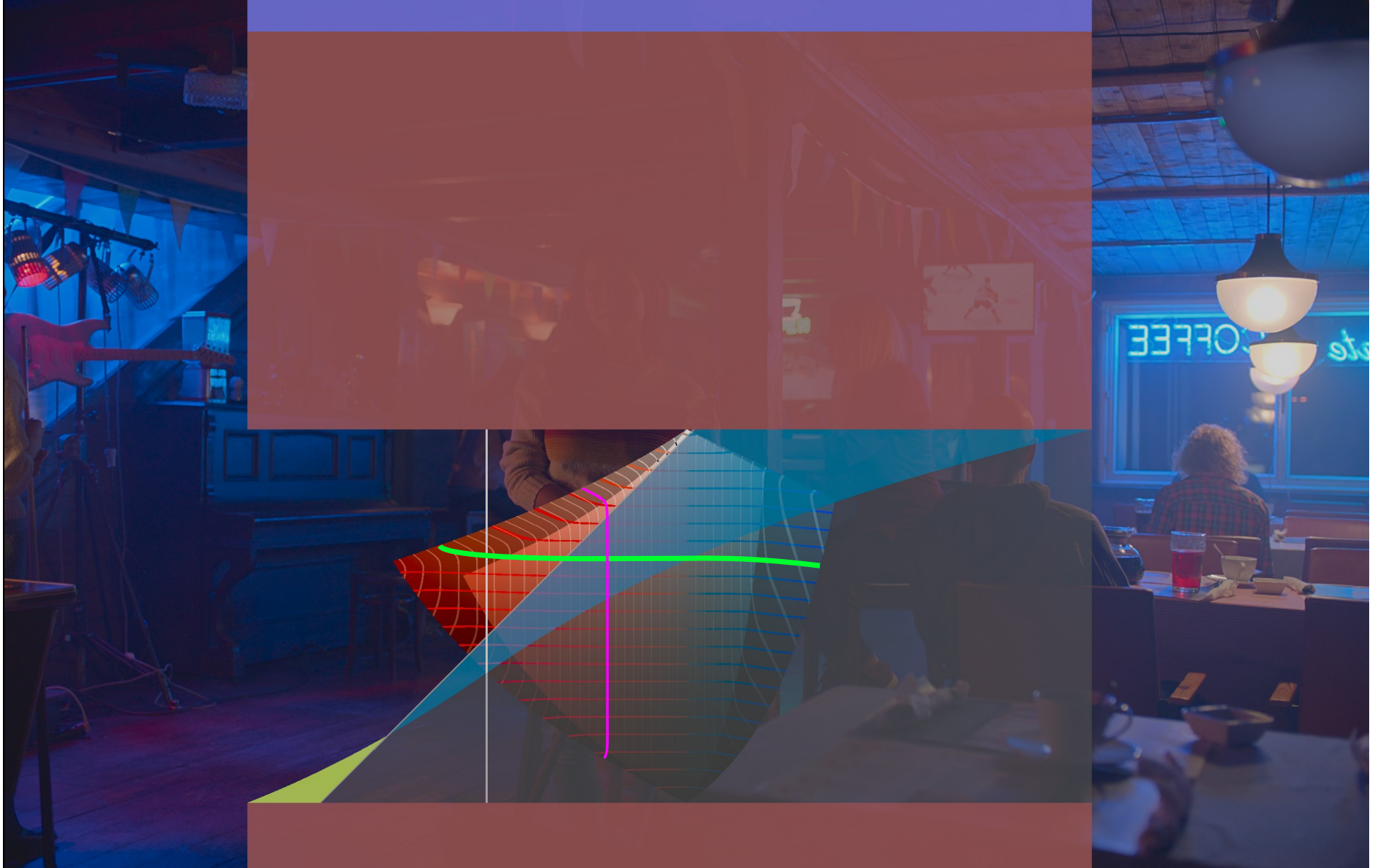
HDR Mess

Metadata

Common real-world issues:

- Missing primaries
- Unreliable HDR metadata
- Inconsistent metadata

→ **Solution:** Heuristics, Automatic detection



Summary

“The Good”

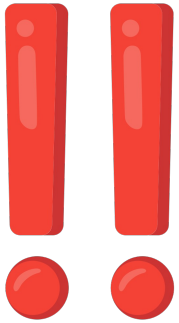
- **API abstraction**
- **Vulkan / OpenGL / Direct3D**
- Shader preprocessor
- Backward-compatible API
- Adoption
  - nxtedition
  - **BBC India!**

“The Bad”

- **GLSL Compilation**
- **OpenGL 2.1 / GLES compatibility**
- Scene change detection
- Diverse HDR conventions
- Real-time gamut mapping

“The Ugly”

- **Floating point**
- **RGB Internals** (e.g. 420 → 420)
- Monolithic renderer
- Swapchain API



What’s next?

Wishlist:

- **Enhancement Layers**
- **Optical Flow**
- Presentation feedback
- WebAssembly
- **CasparCG**

Thank you!

Questions? contact@niklashaas.de

Links:

- https://libplacebo.org
- https://code.videolan.org/videolan/libplacebo

Support: GitHub sponsors