Collabora Productivity

VCL OpenGL backend performance improvements

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Work on VCL OpenGL backend started in 2014 (LibreOffice 4.4)

In LibreOffice 5.1 most annoying render bugs are fixed

First make it work, then make it fast

Usual misconception:
“It is hardware accelerated so it is fast.”

First make it work, then make it fast

However rendering on GPU is different than how 2D rendering is done with typical “canvas” style API.

Rendering with GPU

- Everything is composed of triangles
- No immediate drawing (performance hit)
- Upload objects (vertices, textures) to the GPU memory and reuse
- Programmable rasterization (With fragment shaders)

Performance improvements

Native control cache

- Native controls are rendered to a buffer, then uploaded as a texture
  - Expensive on each draw
- Some controls never change, some change when resizing
  - We can cache them as textures

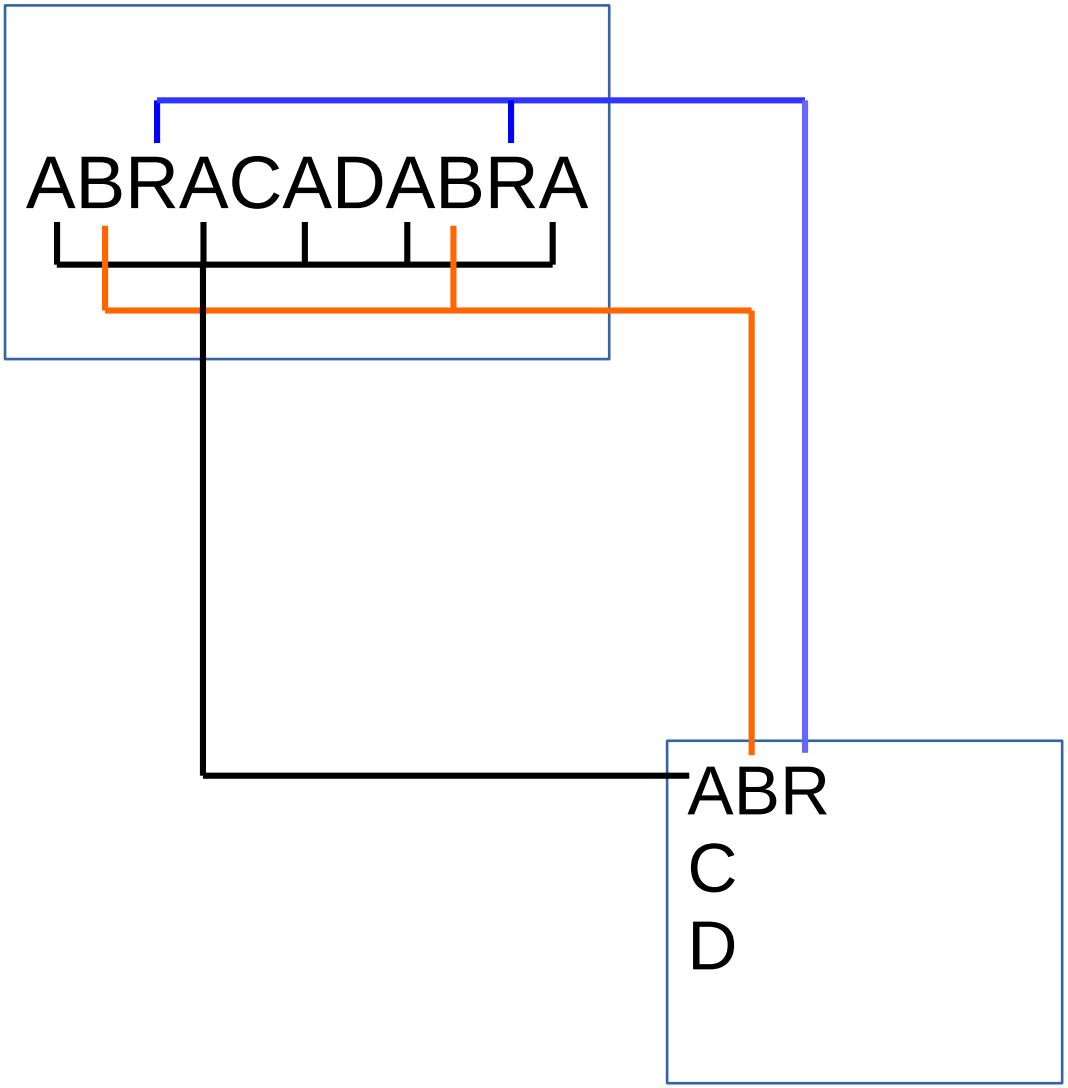
Texture atlas to increase texute drawing performance

- Use one texture for more images
- Packing
  - Use a simple algorithm – divide texture to equally sized regions
  - Highly dynamic but wastes space in texture
  - Useful for icons

Text rendering

- No support to draw text on GPU so we must render text to texture and upload – slow
- Instead render individual glyphs to texture atlas and reuse when drawing
- Draw more glyphs of them with one draw call

Text rendering



Decreasing state changes

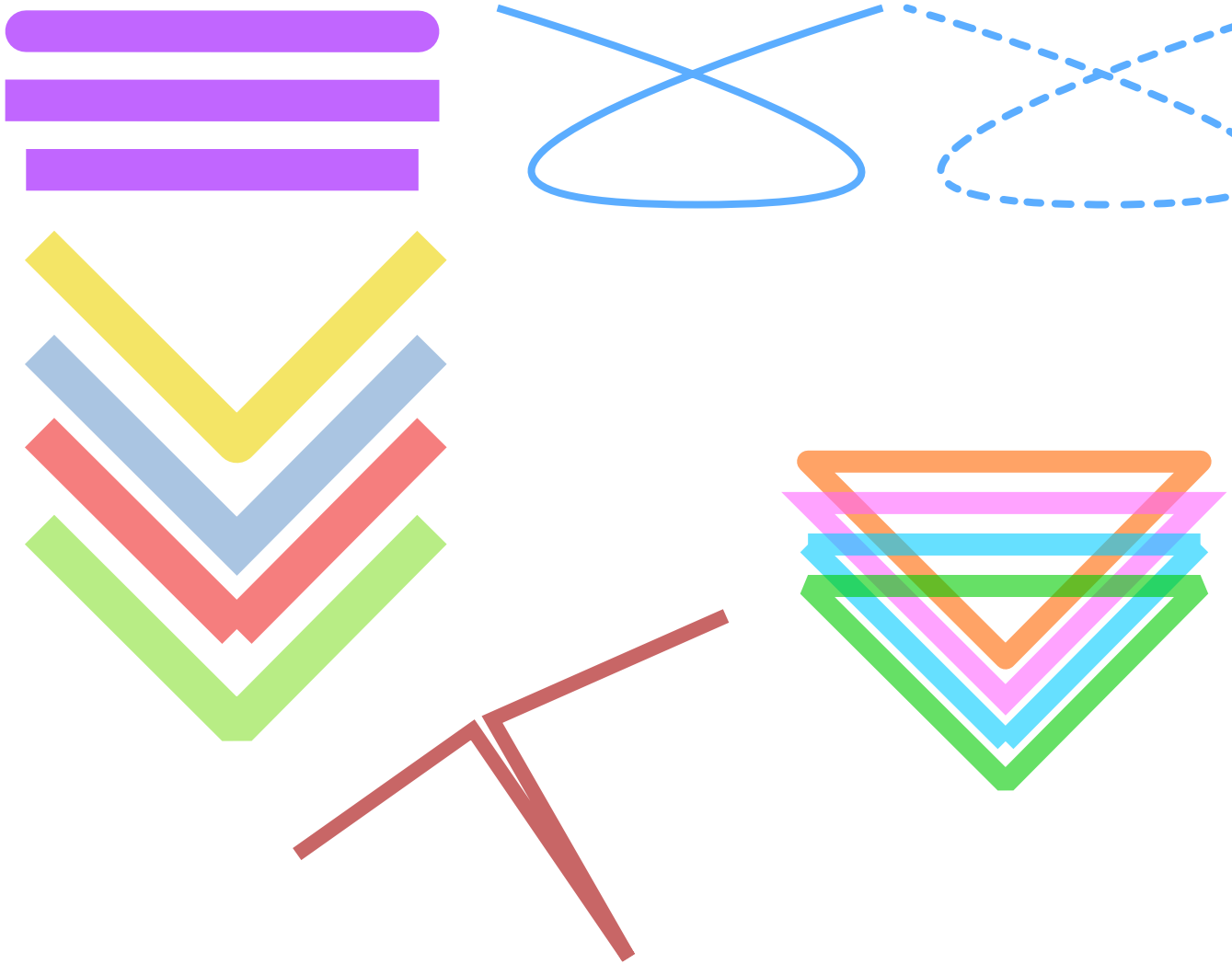
- Track bound textures – don’t unbind if not necessary
- Track state of GL_SCISSOR_TEST, GL_STENCIL_TEST, GL_BLEND_TEST and don’t enable/disable if already enabled/disabled
- Don’t change glViewport and glScissor if it already is set correctly

Combine shaders

- Shader program switching is changing state
- Combine shaders into bigger shaders
  - Non-texture drawing
  - Texture drawing
  - Shaders for scaling, gradient drawing, etc.
- Switch between modes with a shader parameter (and switch or if inside shader)

Polyline drawing with GPU

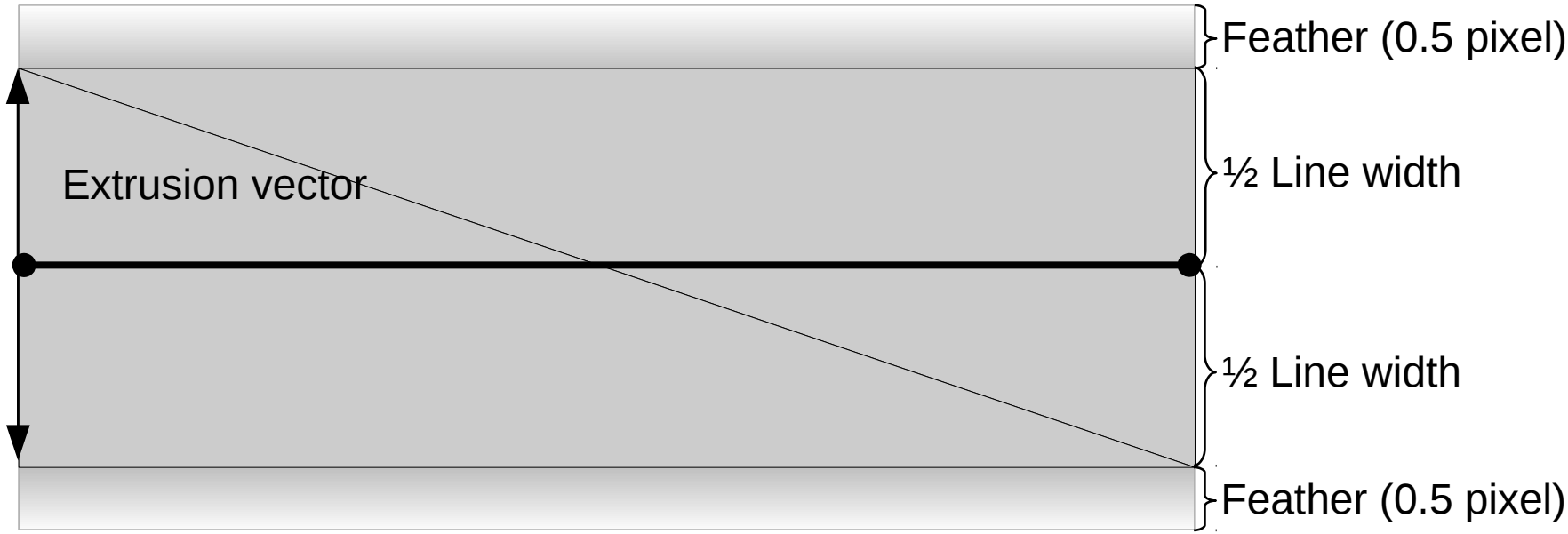
- Bezier curves
- Open / closed
- Line ending
- Line joins



Polyline drawing with GPU

- Trapezoid decomposition for a polyline on the CPU is expensive – we can draw lines on GPU
- Anti-aliasing using shaders
- Also used for line drawing, polypolygon and polygon outline and anti-aliasing

Polyline drawing with GPU

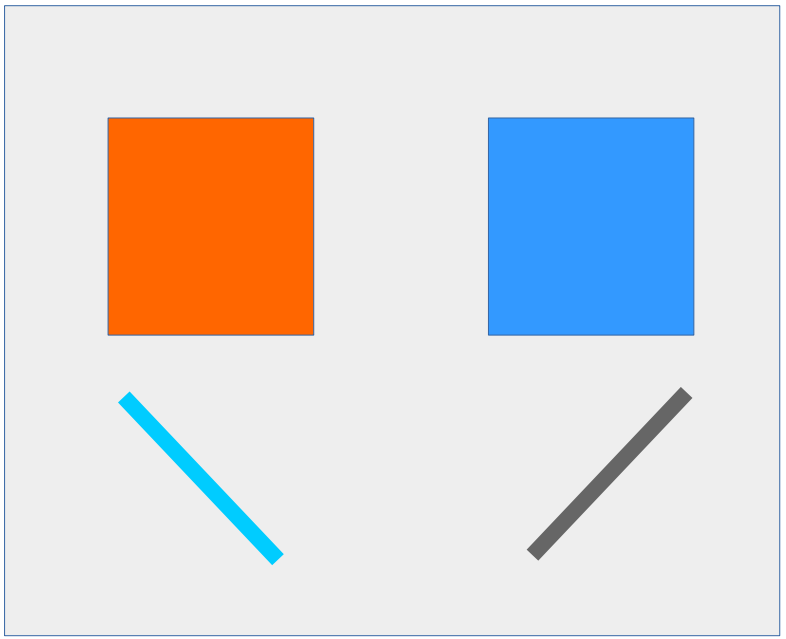


Batching & combining

- Decrease GPU overhead – reduce draw calls
- Batch drawing to be able to reorder and combine same draw actions
- Current state:
  - (Poly)Polygon, Rectangle, (Poly)line and text rendering is batched.
  - Gradient, most texture rendering is not (yet).

Batching & combining

Draw Rect (0, 0, 60, 60)
Draw Rect (10, 10, 20, 20)
Draw Line (10, 20, 20, 30)
Draw Rect (40, 10, 50, 20)
Draw Line (30, 30, 30, 10)



Batching & combining

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Overlap

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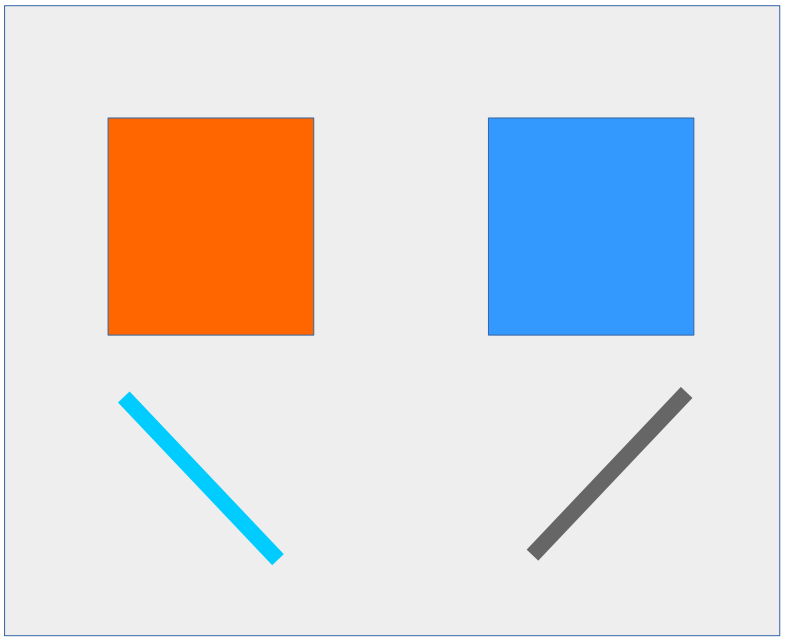

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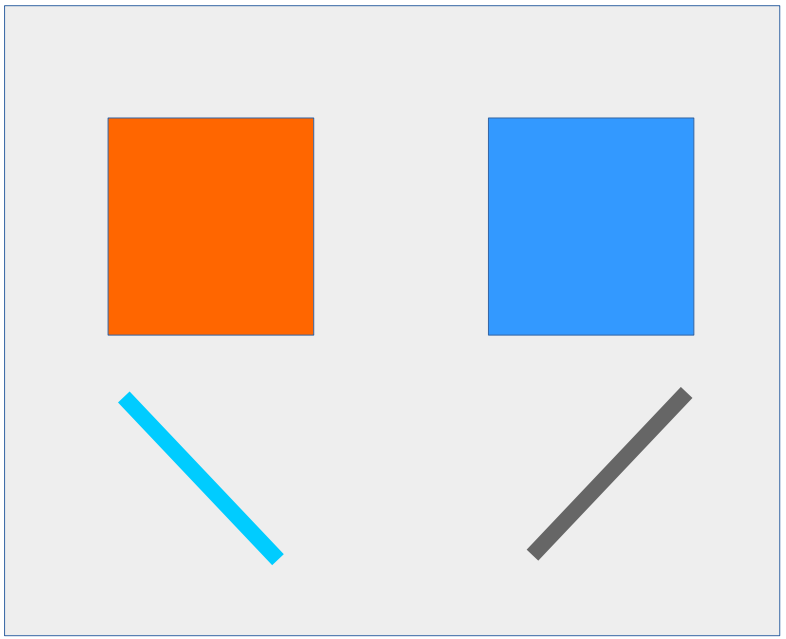

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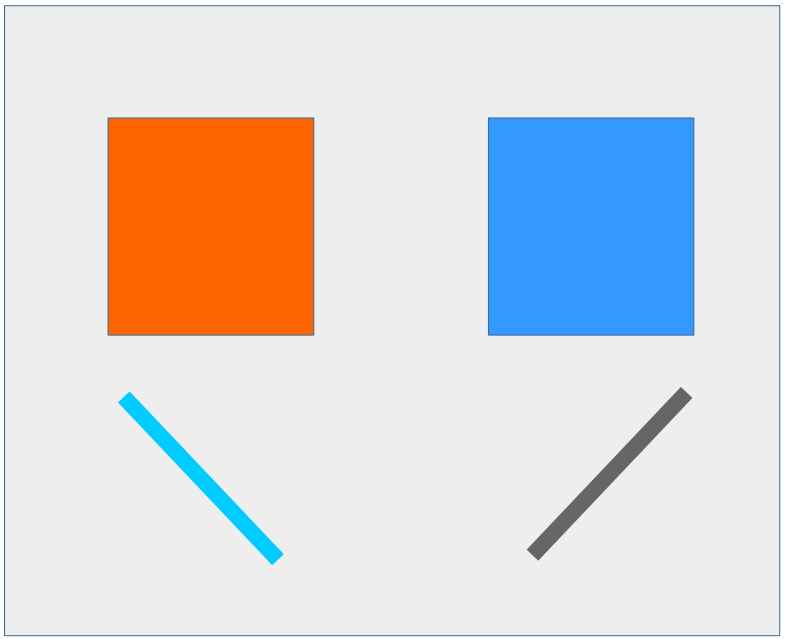

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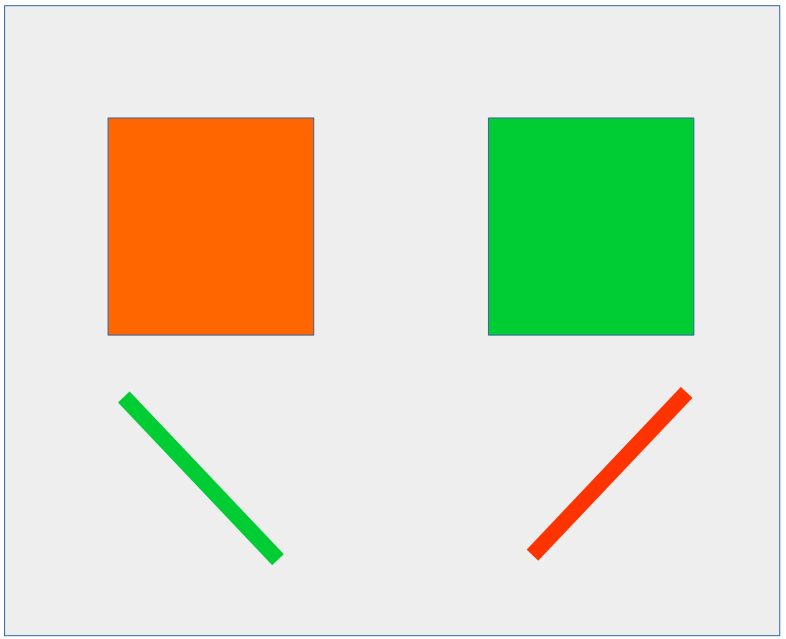

Backend Testing

Visual backend test

- Draw primitives to a virtual device
- Check pixels if they match
- Pass, Fail, Pass with quirks

Visual backend test

- For finding rendering bugs in existing backends
- Helpful to code new backends
- First run test for OpenGL driver (when using OpenGL test)

Future improvements

(Filled) Polygon drawing with GPU

- Draw with help of stencil buffer which covers
- But this is mostly expensive
- Not implemented – generally better to do it on the CPU

Bézier curves

- Curve Rendering using GPU - Loop Blinn algorithm
- Alternative: do decomposition with geometry shader

Make API more GPU frendly

- Scenegraph API for VCL
- Tree of objects, we can optimize for a rendering target
- Matrix transform instead of modifying coordinates
- Rendering thread

Thanks