Enlightenment Foundation Libraries

New Vector Graphics API For Designing User Interfaces

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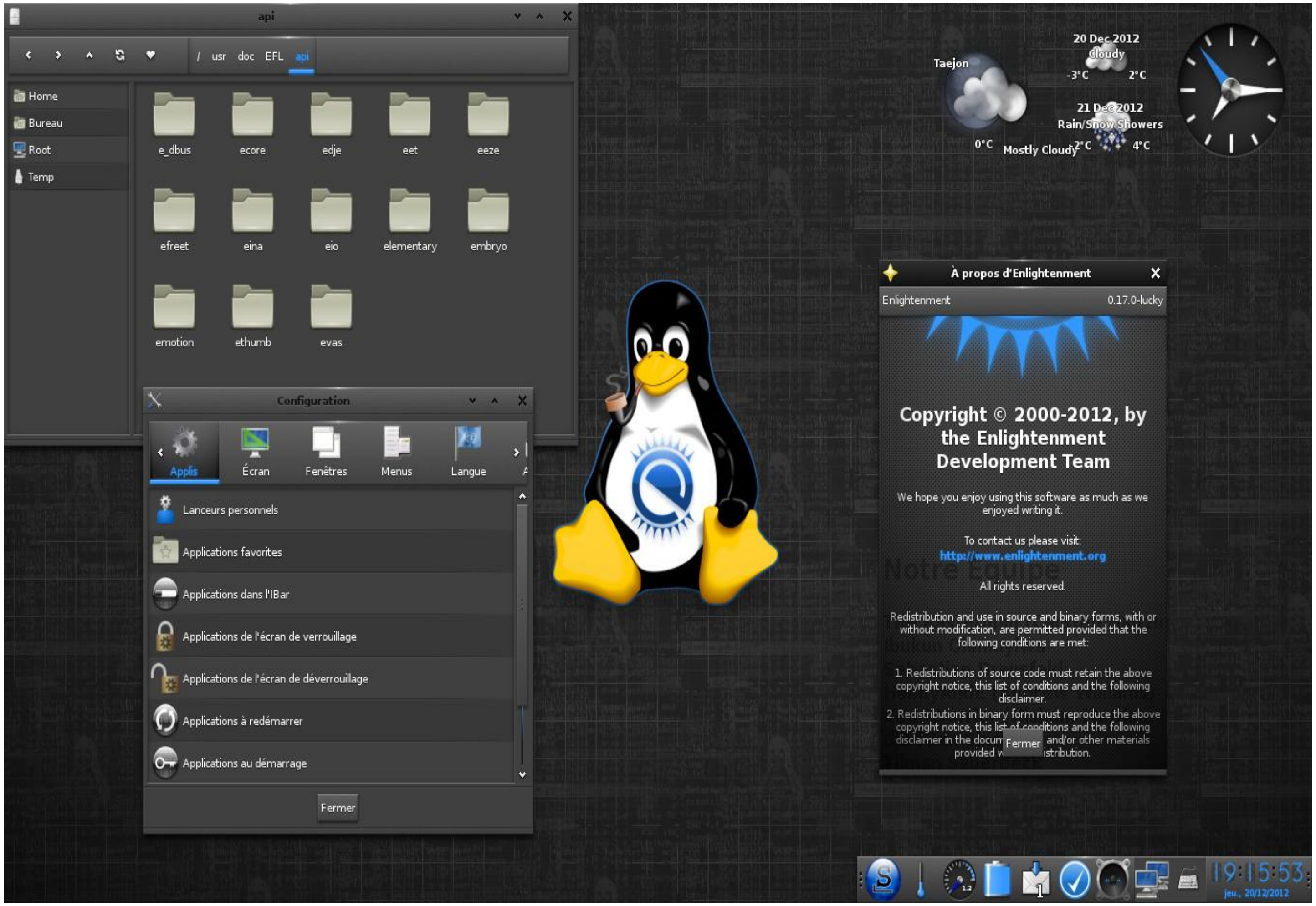
- EFL, in short !
- Vector graphics for user interface
- Designing a modern rendering pipeline for vector graphics
- Questions?

EFL, in short !

EFL: A Toolkit Created for Enlightenment 17



À propos d'Enlightenment

Enlightenment 0.17.0-lucky

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Enlightenment Foundation Libraries (*EFL*)

- Spent a decade writing a modern graphic toolkit
- Licensed under a mix of LGPL and BSD license
- Focus on embedded devices, but scale from the low end to the high end.
- First release on January 2011
- Stable, long term API/ABI
- In the process of releasing version 1.16
- 3 month release cycle

Enlightenment Community

- The Enlightenment community
  - 60 uniq contributors per release (10 cores)
  - 1000 users that build from source
  - 2 distributions based on Enlightenment (Bodhi and Elive)
- The Enlightenment community expected Linux to takeoff in the embedded world, not on the desktop
- The values shared by this community:
  - Fast
  - Light
  - Feature Rich
  - Customizable
  - Scalable

State of EFL

- Designed for creating a Windows Manager (WM), now used for any type of application
- Has its own scene graph and rendering library
- Optimized to reduce CPU, GPU, memory and battery usage
- Supports international language requirements (LTR/RTL, UTF8)
- Supports all variations of screens and input devices (scale factor)
- Fully Themable (layout of the application included)
- Supports profiles
- Can take up as little as 8MB of space with a minimal set of dependencies
- Has a modular design

Why We Care About Optimization

- Moore's law doesn't apply to battery and memory bandwidth
- Most rendering operations are limited directly by memory bandwidth
- Many embedded devices have less available memory than a low end phone
  - Refrigerator, oven, dish washer, washing machine, home automation…
- Even a low end phone doesn't have much memory to spare once you run a browser!
- GL context at best consumes 10MB, usually more around 40MB; this is bad

for multitasking!

Current State of Optimization

- Application runtime memory use is mostly driven by screen size
- EFL can fit in 8MB on disk (static compilation with minimal dependencies, OS included)
- No hard requirement on the GPU
- Enlightenment + Arch Linux combined :
  - 48 MB RAM
  - 300 Mhz (1024 x 768)
  - Yes, for a desktop profile!

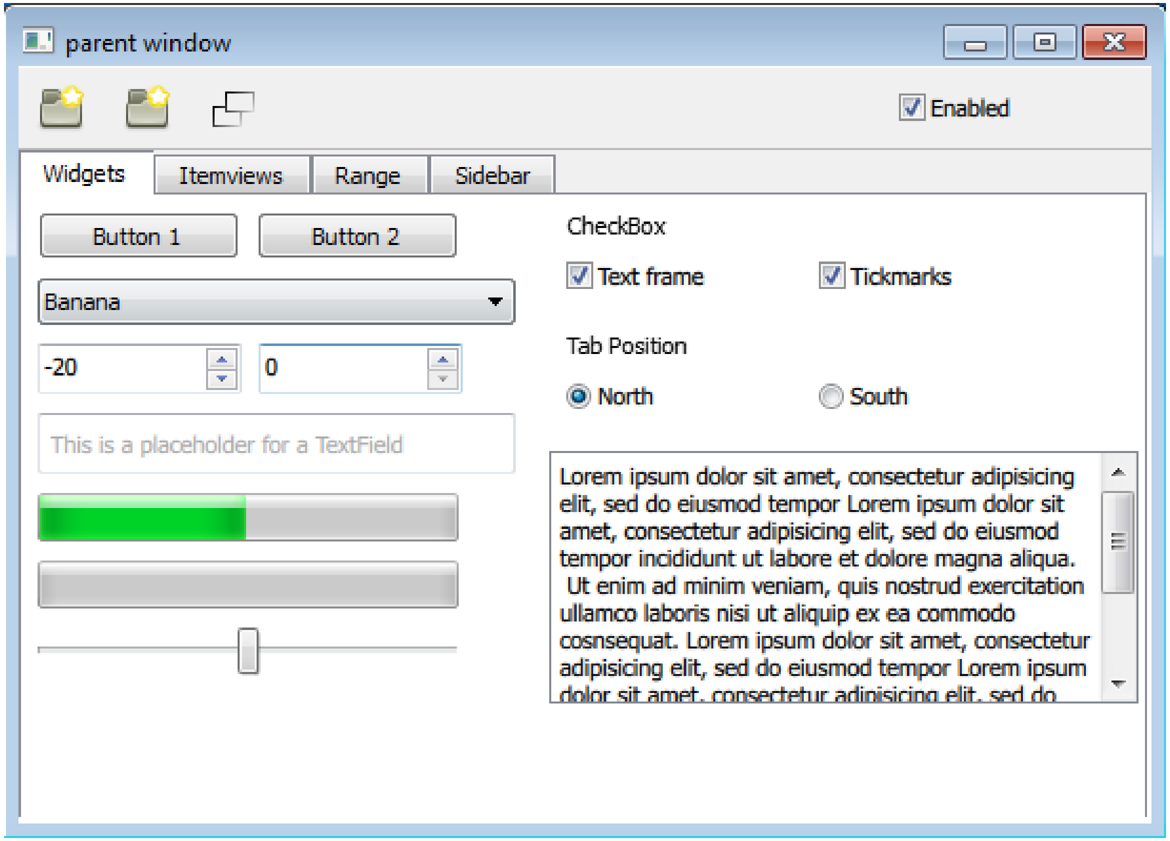
Vector graphics for user interface

Vector graphics quick definition

Wikipedia :

> “*Vector graphics are based on vectors (also called* ***paths****), which lead through locations called* ***control points*** *or* ***nodes****. Each of these points has a definite position on the x and y axes of the work plane and determines the direction of the path; further, each path may be assigned a* ***stroke color****,* ***shape****,* ***thinkness****, and* ***fill****.*”

Let's look at some application and toolkit



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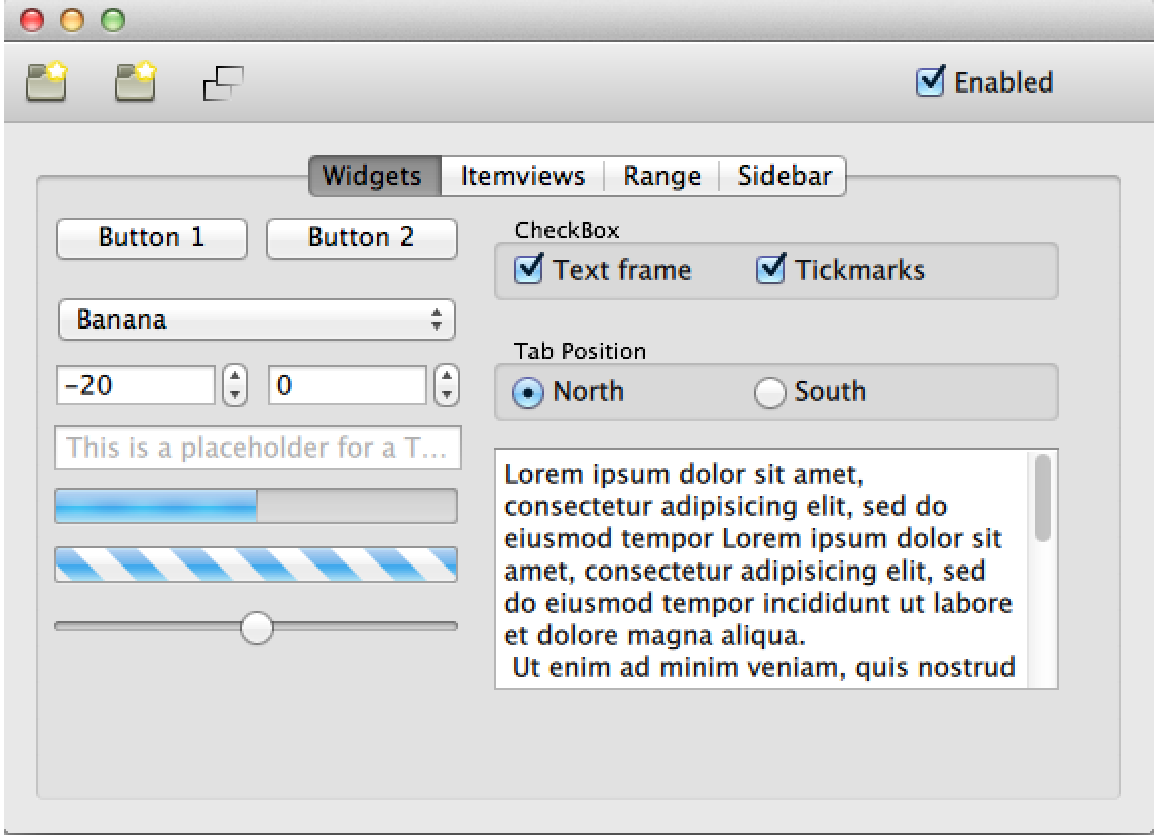

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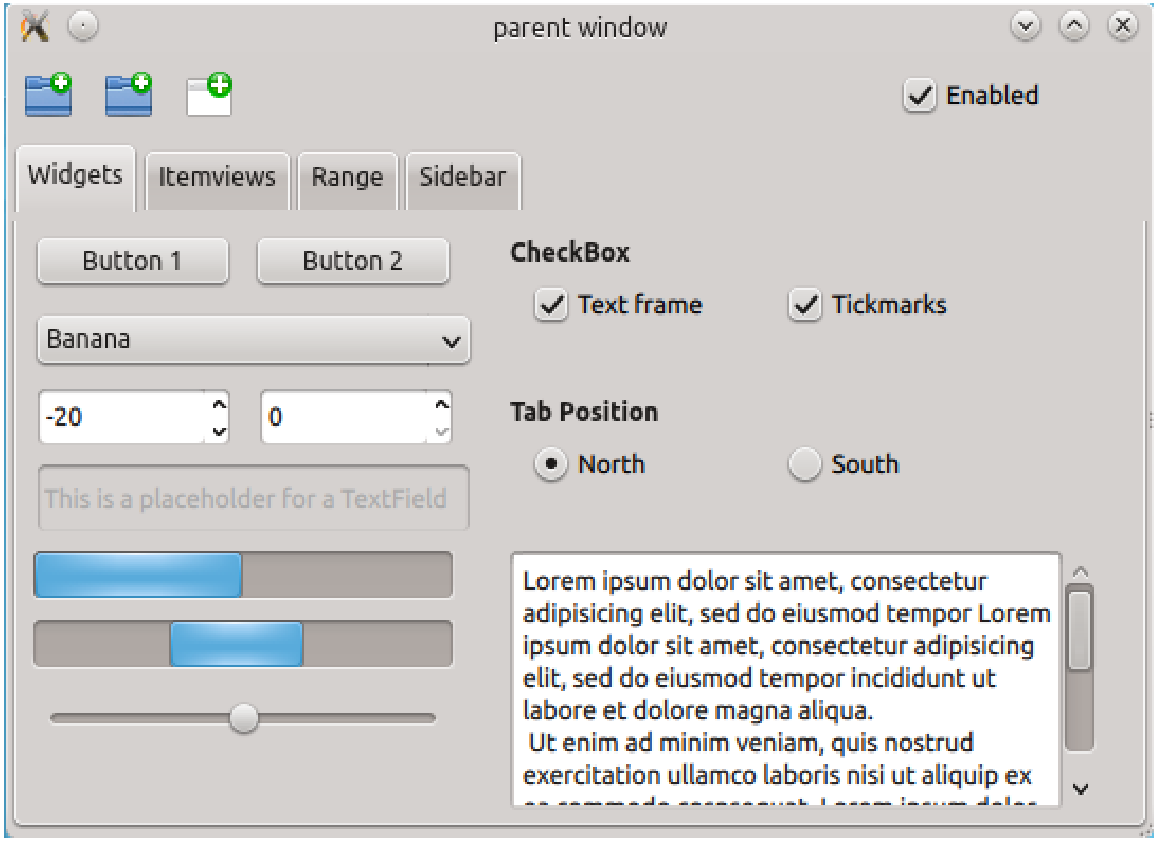

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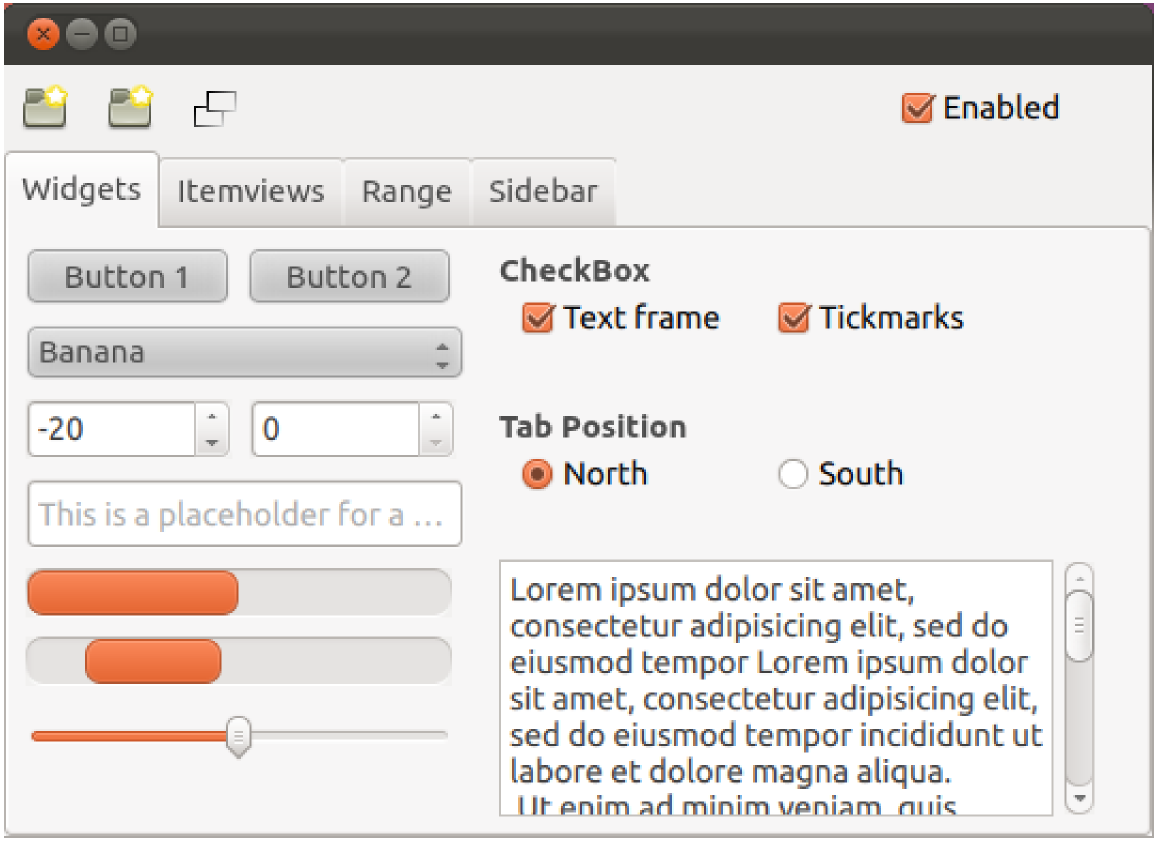

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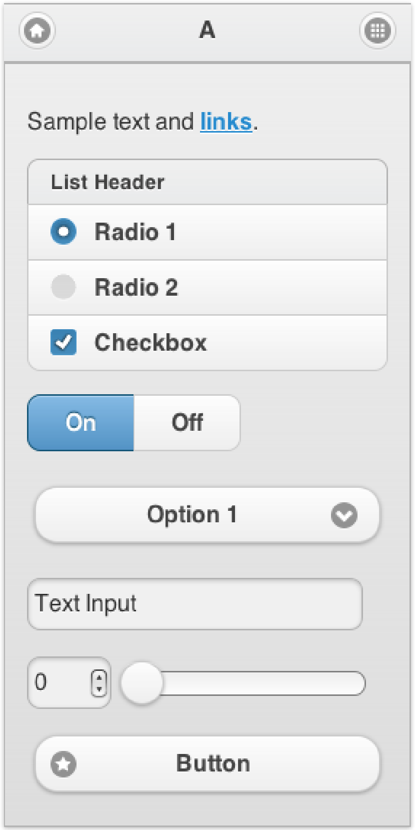

Sample text and links.

List Header

● Radio 1

○ Radio 2

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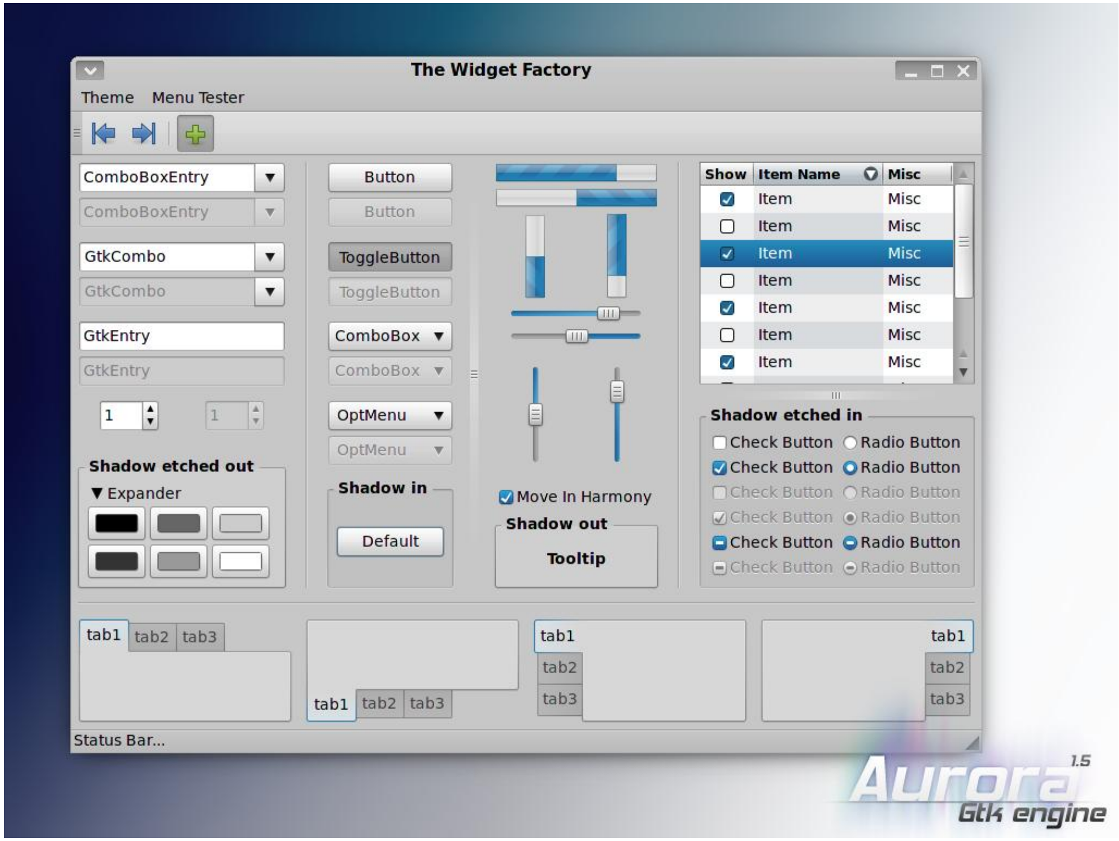
Let's look at some application and toolkit



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Observation

- Common pattern
  - Same shape
  - Same gradient
  - Same color
- Interface are consistent !
- When we raster image, we reuse the same image everywhere
  → Let's do the same with vector graphics !

Designing a modern rendering pipeline for vector graphics

What should we cache ?

- Caching CPU intensive information
- Minimize amount of memory needed to keep that information
- Minimize memory bandwidth needed to replay that information
- Vector graphics are done in 3 stages :
  - Computing the spans lines (CPU intensive)
  - Filling that spans lines (Depend on operation, but mostly cache bound)
  - Compositing the spans lines (Memory bound operation)
- Cache the spans lines and math, not the generated texture
  → Cache the CPU intensive information without increasing the memory use
- Caching texture result in higher cost during animation

Let's talk a little bit about modern device

- Multi core with different characteristic (big/little)
- Some kind of GPU
- Constrained by memory, because of multi tasking
- Constrained by memory bandwidth
- Constrained by battery
- Everyone expect great and reactive user experience whatever the device
- Everyone want weeks of battery life !

Evas - Scene Graph

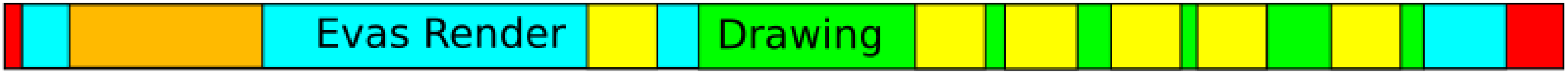
- A basic scene graph rendering ascends from the bottom to the top of the tree
- Possible optimizations
  - Reorder GL operations to limit Texture and Shader changes
  - Partial updates
  - Cutout opaque areas
  - Complete drawing operations in another thread
  - Efficiently cache costly CPU operations between frames
  - Deduplicate objects

Now what can we do with vector graphics in a scenegraph ?

- Possible optimizations :
  - Reorder GL operations to limit Texture and Shader changes
  - Partial updates
  - Cutout opaque areas
  - Complete drawing operations in another thread
  - Efficiently cache costly CPU operations between frames
  - Deduplicate objects

- Vector graphics will always be less efficient than just image rasterizing

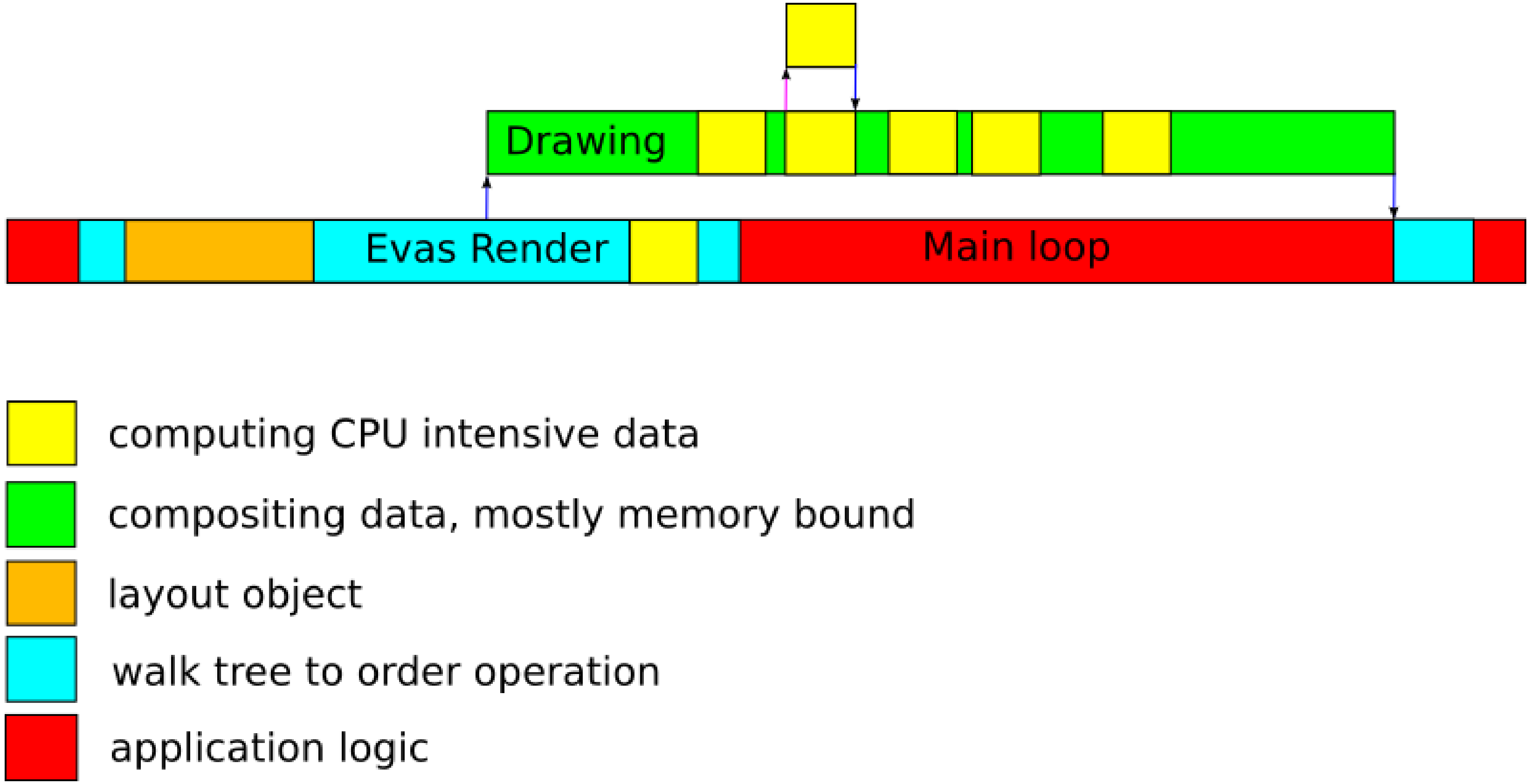
Rendering Pipeline – Where we started



- 🟨 computing CPU intensive data
- 🟩 compositing data, mostly memory bound
- 🟧 layout object
- 🟦 walk tree to order operation
- 🟥 application logic

Historical rendering pipeline for Evas

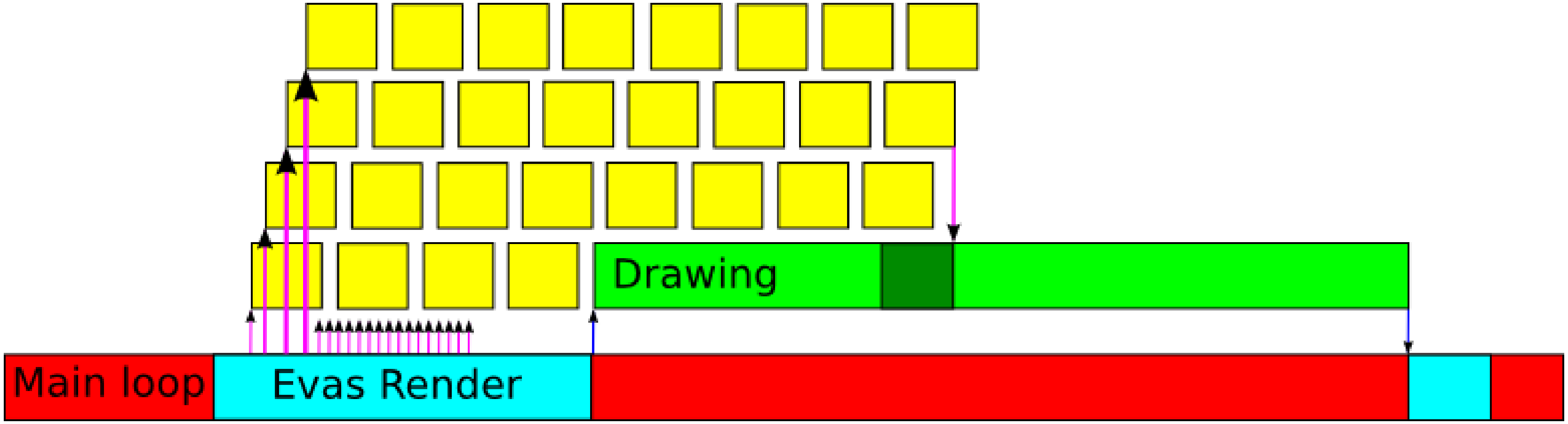
Rendering Pipeline – Where we are



- 🟨 computing CPU intensive data
- 🟩 compositing data, mostly memory bound
- 🟧 layout object
- 🟦 walk tree to order operation
- 🟥 application logic

Current rendering pipeline for Evas

Rendering Pipeline – Where we are going



Future rendering pipeline for Evas

Ector – Retained rendering library

- The idea of retained rendering come from Enesim (http://www.enesim.org)
- Didn't want to reinvent everything, so we have multiple backend :
  - Freetype
  - Cairo
- Ector is used by Evas for the drawing

Ector – Freetype backend

- Freetype provide an API to get spans lines easily
- Freetype provide in fact a source code you can include in your project
- It's fast, tested and support all the primitive we need to generate all shape
- Also we can make it match our retained API well
- We do already have better performance than we expected
- Still missing
  - Deduplicating shape
  - Asynchronous computation of shape and gradient information
  - GL backend

Ector – API

- Surface object per backend with a renderer factory
- Renderer just draw one primitive into the surface that created them
- Renderer can be moved at no cost (Ease reuse)
- Renderer have 3 functions :
  - Prepare
  - Render
  - Fill
- Renderer :
  - Shape
  - Gradient Linear
  - Gradient Radial

Ector – Where are we going ?

- Improve testing
- Understand why we have so much difference with Cairo
- Experiment with different GL backend design
  - Classic Loop & Blinn Approach
  - Use a texture filled with span information to fill
- Vulkan backend once we have some driver to play with
- Replacement of all Evas immediate rendering code by Ector
  - Filters
  - Text
  - Image
  - GL

Evas – Integration with the scene graph

- Evas work with Evas_Object primitive :
  - Rectangle
  - Image
  - Text
- We just added a Vector graphics object that is handle as a transparent object
- Contain a tree of primitives
- Tree's :
  - Can be disconnected from the canvas
  - Can be duplicated
  - Can be interpolated (following w3c SVG specification)

Evas – What come next ?

- Add SVG file loading/saving support
- Add EET (binary file format for theme) file loading/saving support
- Add more primitive (Likely order) :
  - Filter
  - Text
  - Image

Edje – Theme integration proposal

- SVG animation and interaction definition are “tricky”
- Most tool generate heavy animation instead of simpler one
- Keep it simple :
  - Starting point defined by SVG
  - End point defined by another SVG
  - Interpolate in between them
- Vector graphics part
  - State defined by a SVG
  - Program define rules for interpolation

EFL – Vector graphics cheat sheet

- Vector graphics will always be slower than just image rendering
- Can still be made fast and usable for real time user interface component
- Require to rethink how we do rendering
- Retained rendering is likely to open a lot of possibility in the futur
- EFL introduce 3 new components :
  - *Ector*: Retained rendering library
  - *Evas_Object_VG*: Vector graphics scene graph object
  - *VECTOR*: part in Edje theme

Questions?

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