A look into 2D performance

Discussion about the current architecture

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Agenda

- Introduction
- Users of X-server’s 2D acceleration framework
- Evaluation of the performance
- Future for toolkits
- Discussion

Introduction

- The X11 protocol provides rendering primitives
- The primitives are rendered on the X-Server
- When GPU appeared, these primitives got accelerated
- The XRender extension extended this set of primitives

Users of the X11 2D primitives

- Toolkits:
  - Xt: Used by Motif and other ancient toolkits
    - All the rendering is done by the X Server
  - Gtk: Base of the Gnome Desktop Environment
    - Uses Cairo for all the rendering (X11 and XRender)
    - Cairo then uses the X Server for rendering
  - Qt: Base of the KDE desktop environment
    - Uses XRender for AA-text and cursor alpha blending
    - Uses the GPU or the CPU for all the other cases

- Applications:
  - Plenty of X demos and other legacy apps (xeyes, ...)
  - Applications should never use the X11 API directly

Performance evaluation

- Performance evaluated on:
  - Intel platform (Haswell GT2) on Arch Linux
  - X-Server and Intel DDX from git (September 15th)
  - Mesa from git (September 14th)
  - Power is read through RAPL (verified with a meter)

- Benchmarks:
  - Cairo demos: various demos, fixed execution time
  - Cairo traces: traces of actual 2D applications (fixed workload)

Performance: Cairo demos

xf86-video-intel:

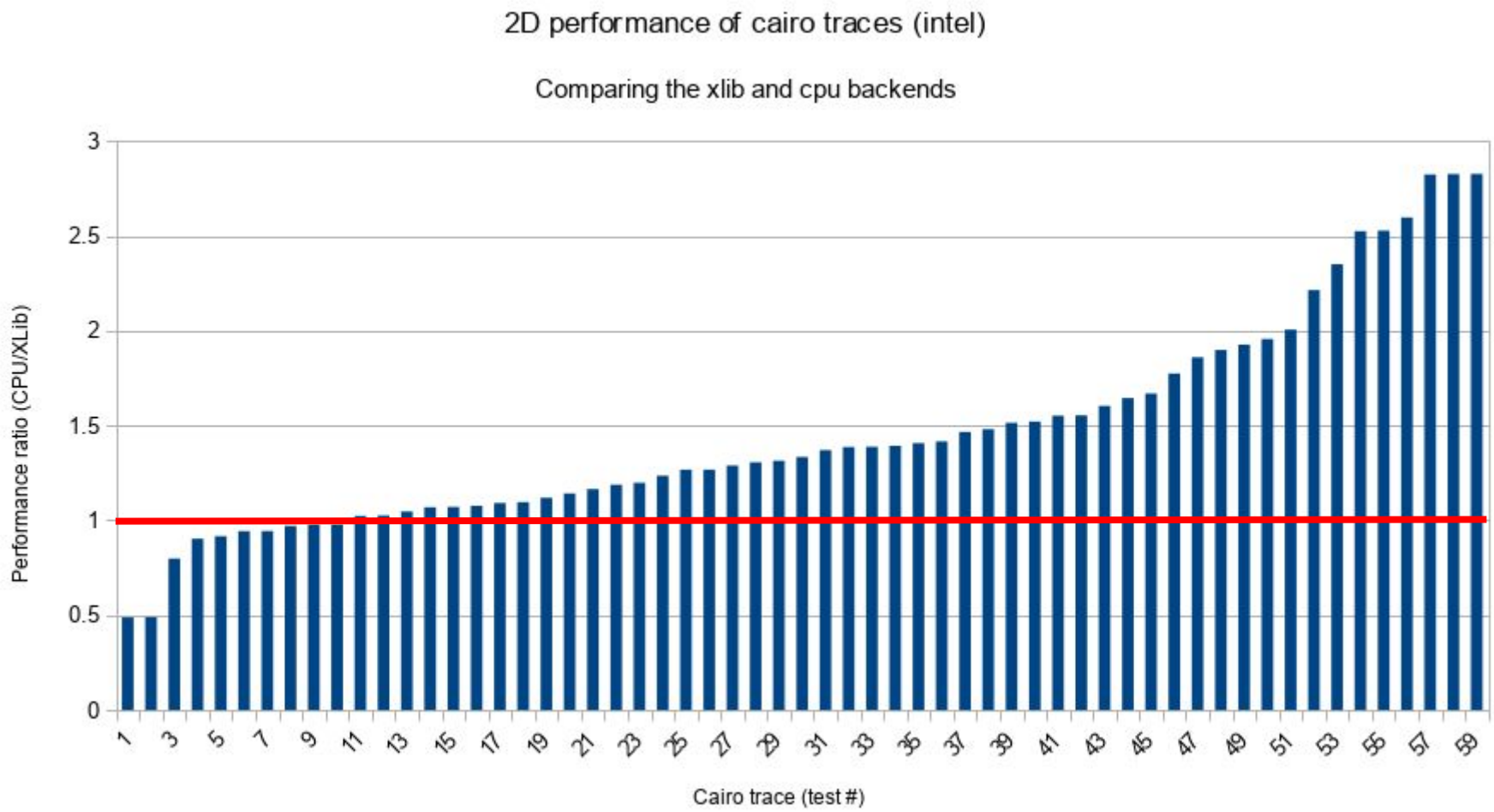
Demo name	Performance ratio (XLib/CPU)	FPS/W ratio (XLib/CPU)
x11:cairo:demo:fish	32.6	15.1
x11:cairo:demo:chart	3.05	1.12
x11:cairo:demo:tiger	1.51	0.73

xf86-video-modesetting:

Demo name	Performance ratio (XLib/CPU)	FPS/W ratio (XLib/CPU)
x11:cairo:demo:fish	31.8	14.9
x11:cairo:demo:chart	1.24	0.69
x11:cairo:demo:tiger	1.16	0.90

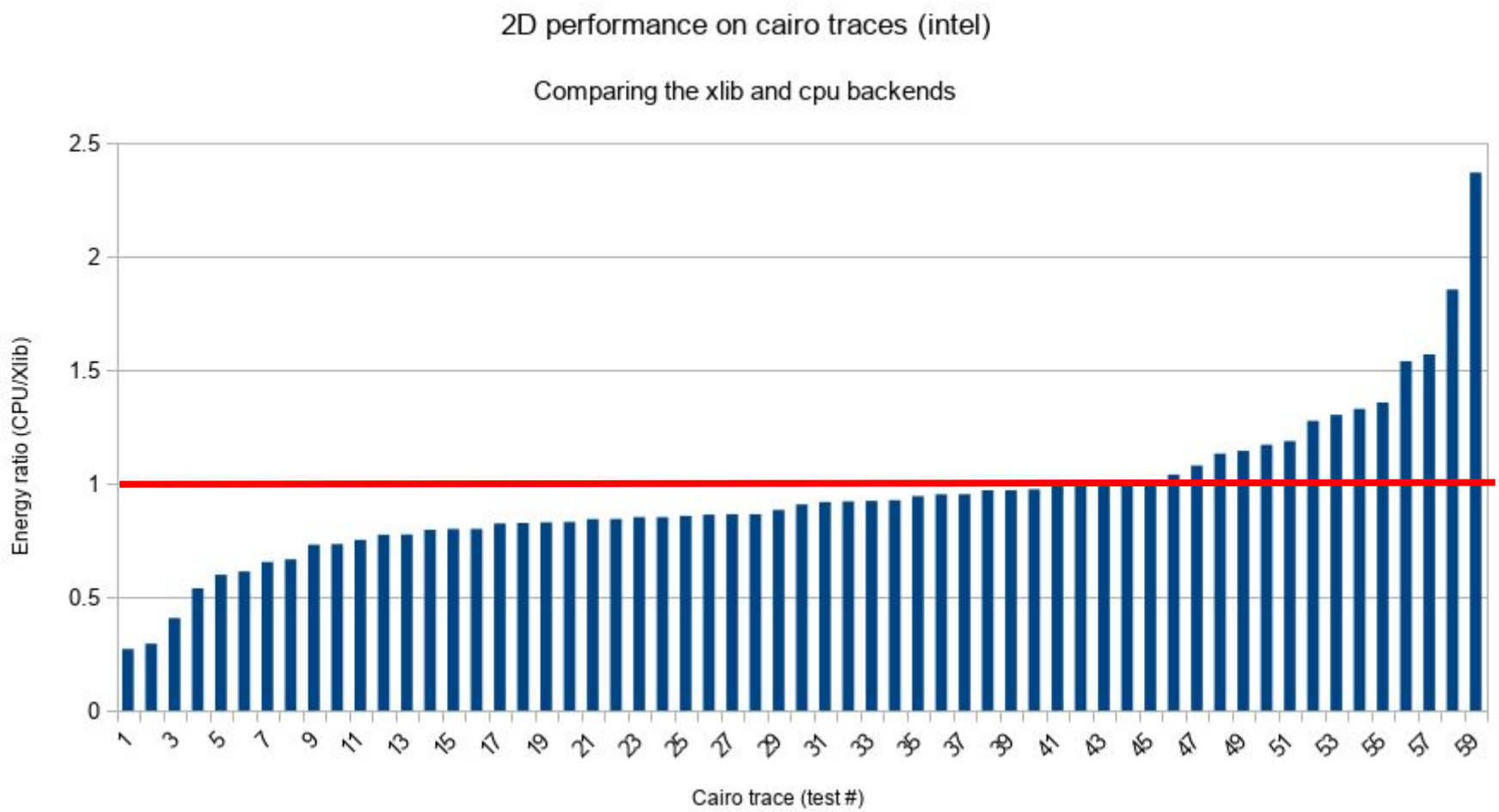
Performance: Cairo traces

xf86-video-intel: Perf Min/Avg/Max: -50/+44/+182%



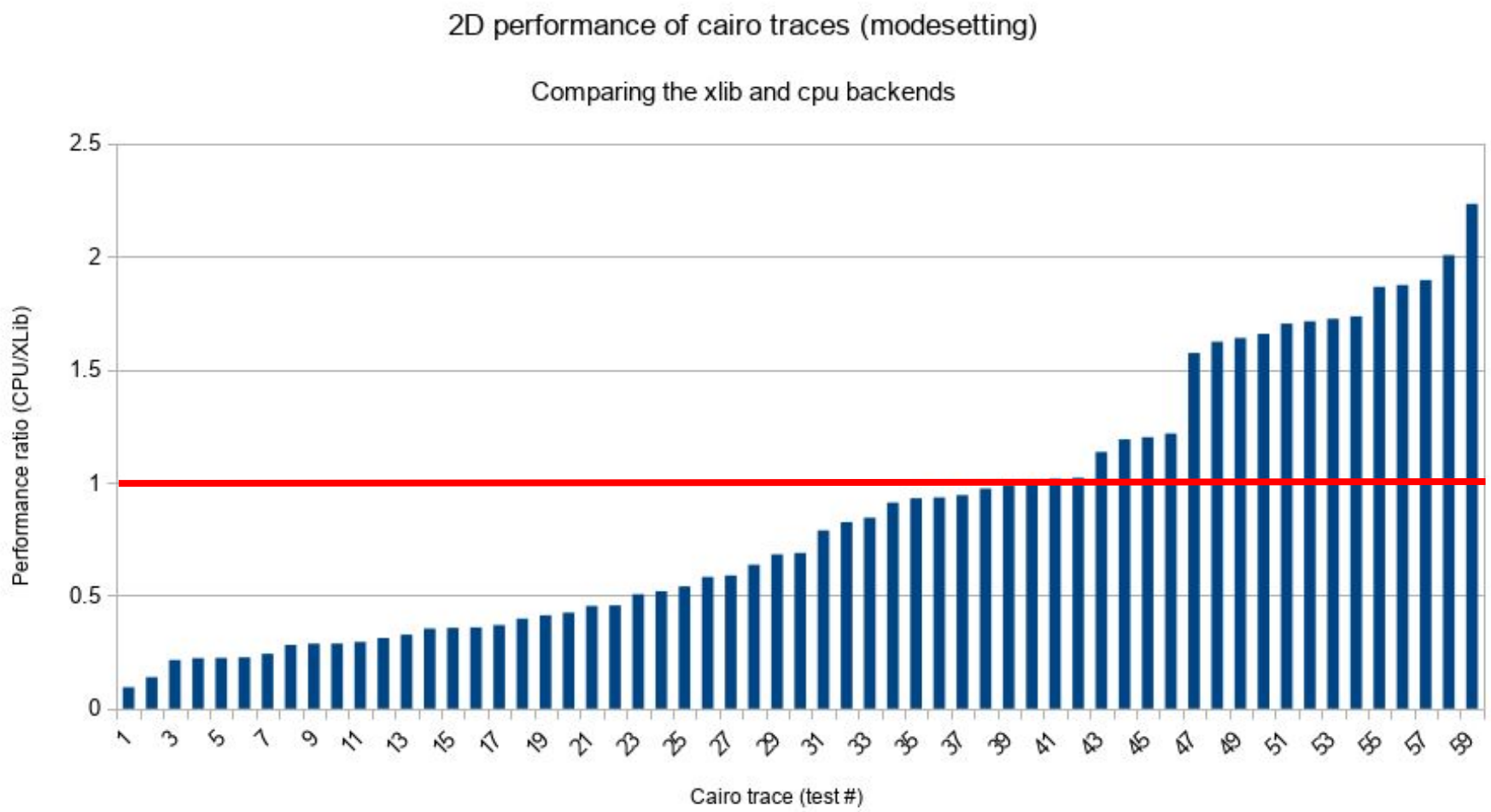
Energy efficiency: Cairo traces

xf86-video-intel: Efficiency Min/Avg/Max: -73/-5/+137%



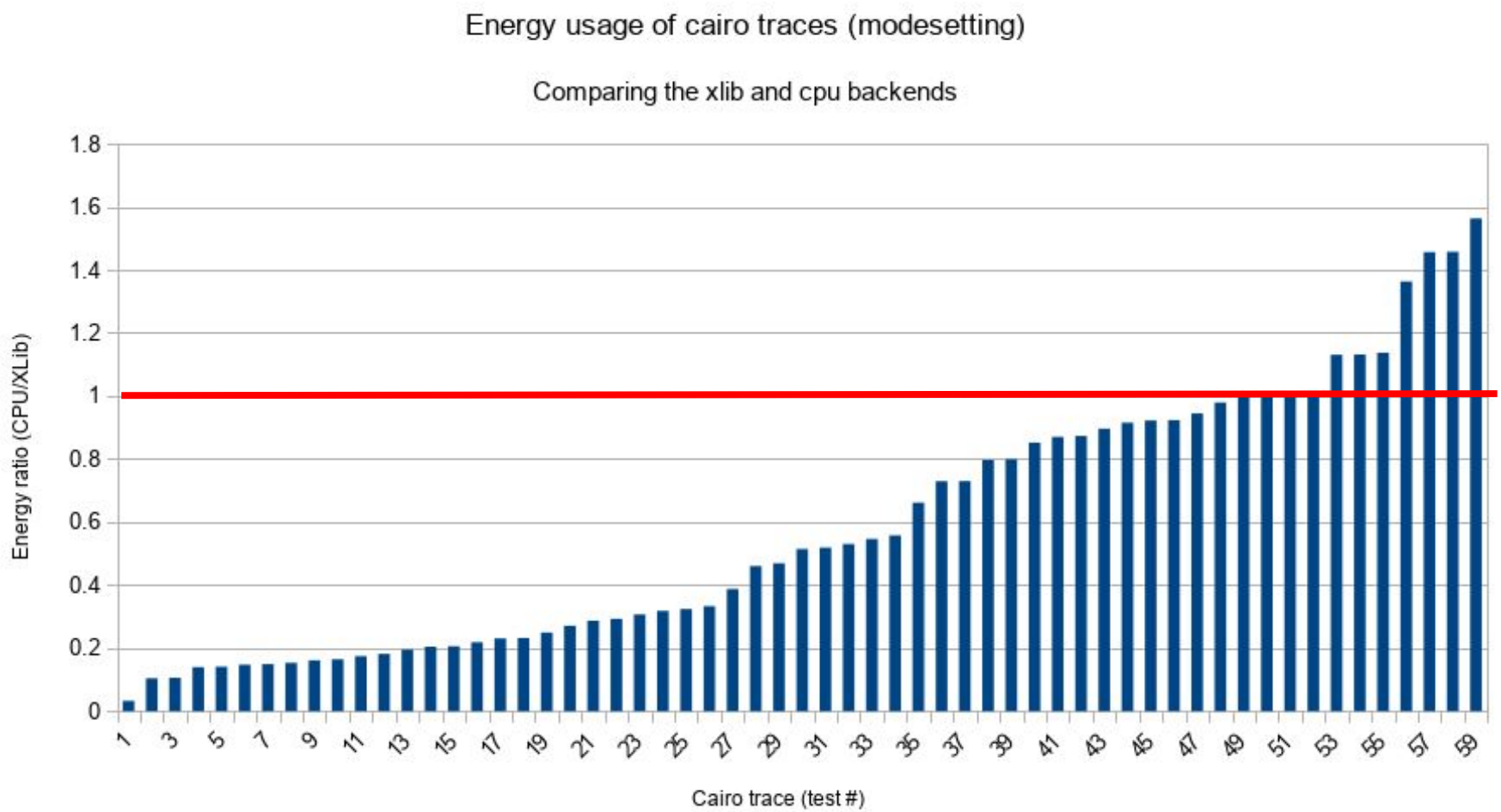
Performance: Cairo traces

Modesetting: Perf Min/Avg/Max: -90/-26/+123%



Energy efficiency: Cairo traces

Modesetting: Energy Min/Avg/Max: -97/-43/+56%



Future for toolkits

- X-server is not always present anymore (Wayland, KMS)
  - Toolkits should not depend on X11 for rendering
- Qt already mostly moved away from 2D accel using X11
  - They invested in their own CPU/GPU renderer
- GTK is replacing Cairo with GTK Scene Kit (GSK)
  - GSK: Scene graph + GPU rendering

Discussion

- Rendering 2D on X is
  - barely faster than CPU rendering, unless compositing
  - using more energy than using the CPU
  - not going to work for Wayland or KMS-only apps
  - not supporting 3D transformations

- Toolkits are moving away from relying on X for rendering
  - Qt has its own CPU renderer and GPU acceleration
  - GTK is moving to GSK

- Should we tell applications to use client-side rendering?
  - CPU: Cairo, Qt
  - GPU: SKIA, Fast-UI-Draw