# Nouveau

## Recap, on-going and future work

Martin Peres, Lucas Stach & the Nouveau community

Ph.D. student at LaBRI, B.Eng. student at HfTL

February 4, 2012

# Summary

## Your hosts for the next hour

- Martin Peres (mupuf)
- Maarten Lankhorst (mlankhorst)
- Lucas Stach (lynxeye)

## Also attending

- Emil Velikov (xexaxo)
- Francisco Jerez (curro)
- Roy Spliet (rspliet)

# Summary

## History: NVIDIA – a new hope

- 1998(?): NVIDIA releases a Linux open-source 2D-only driver(nv)
- 1998: Obfuscation commit (release only pre-processed source)

After we already finalized XFree86-3.3.3 NVIDIA forced the XFree86 Project to replace the sources we had with sources that were partly run through the C preprocessor in order to remove some of the names that NVIDIA thought might give away IP from NVIDIA. This resulted in unreadable and unmaintainable code.

The XFree86 Project is strongly opposed to such obfuscated code. We do not regard this as free software according to our standards. Due to the extremely late date of this decision from NVIDIA we decided to include the code as offered by NVIDIA. We are considering to remove support for the later NVIDIA chips in a future release, though.

Xfree86, commit message from 11/18/98

## History: The open-source strikes back

- 2005: Stephane Marchesin improves nv and works on 3D
  - Project named Nouveau after an unfortunate automatic spelling correction
  - Back-port nv updates to Nouveau
- 2008: Open Arena runs on nv40
- 2009: KMS driver based on TTM for memory management
- 2010: Merged in Linux 2.6.33
- 2010: Nv is deprecated by NVIDIA, “use VESA”.

## History: The return of the Jedi

"It's so hard to write a graphics driver that open-sourcing it would not help [...] In addition, customers aren't asking for opensource drivers."
Andrew Fear, NVIDIA software product manager, April 2006

# Summary

## Chipset families

- NV03: RIVA 128
- NV04: RIVA TNT/TNT2
- NV10: Geforce2/4 MX
- NV20: Geforce 3, Geforce 4 Ti
- NV30: Geforce FX
- NV40: Geforce 6/7 (the first real family)
- NV50: Geforce 8/9/100/200/300 (the biggest family)
- NVC0: Geforce 400/500, AKA Fermi
- NVD9: Strange Fermi

## Hardware Introduction

- NVIDIA GPUs are controlled by "objects"
- command submission uses DMA buffers
- the GPU can access the host's memory through the aperture
- NV50 features a full-blown virtual memory system for its channels (GPU process)

## important engines

- PFIFO: main command fetching engine
- PCRTC/PDISPLAY: display scanout engines
- PGRAPH: main graphics object AKA OpenGL cast into silicon
- PMPEG: video acceleration found on older cards (MPEG1/2)
- PBSP/PVP/PPPP: modern video decoding engines

## The 4 parts of Nouveau

- Linux kernel module
- libdrm-nouveau
- DDX: xf86-video-nouveau
- Mesa3D drivers:
  - nouveau-vieux
  - nvfx
  - nv50
  - nvc0

## Linux kernel module: Nouveau

- Resources management
  - GPU Channels
  - Memory Management
- Command-submission
- Kernel Mode Setting
- Power Management

## Power management

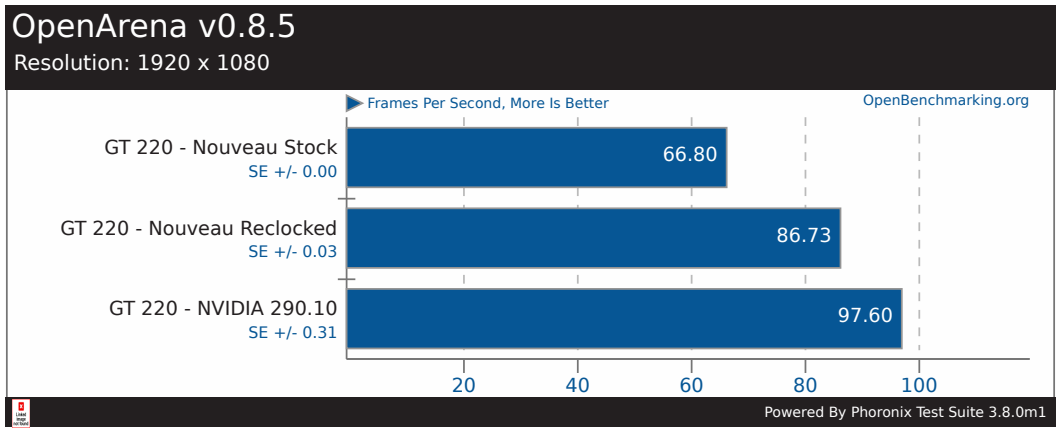
- Parsing power-management-related vbios table
- Temperature management: calibration + fan
- Setting the clocks: changes the performance level
- Other: clock gating, PCIE downclocking, DAC reclocking

## current state

- nvc0: setting engines clocks (mostly)
- nv30-c0: some kind of support to reclock (unreliable)
- nv50-a3: reliable clock changes (almost)
- nv40-d9: memory timings (almost ready)
- fan management: toggle (todo), pwm (done), i2c (WIP)
- performance counters (initial work on nv40-c0)

## WIP

- nva3-d9: setting memory clocks (using PDAEMON)
- nv50-a3: ironing stability bugs
- AGP/PCIE, clock gating: reverse engineering
- Fan: temperature-based management (toggle, pwm and i2c)
- perfmon infrastructure, dynamic reclocking




http://www.phoronix.com/scan.php?page=article&item=nouveau_reclocking_one&num=5

## libdrm-nouveau

- buffer management
  - everything is a buffer!
- wraps around the IOCTL interface

## work in progress

- a new implementation is being written
- designed with nv40 class hardware in mind
- pushbuffer replay

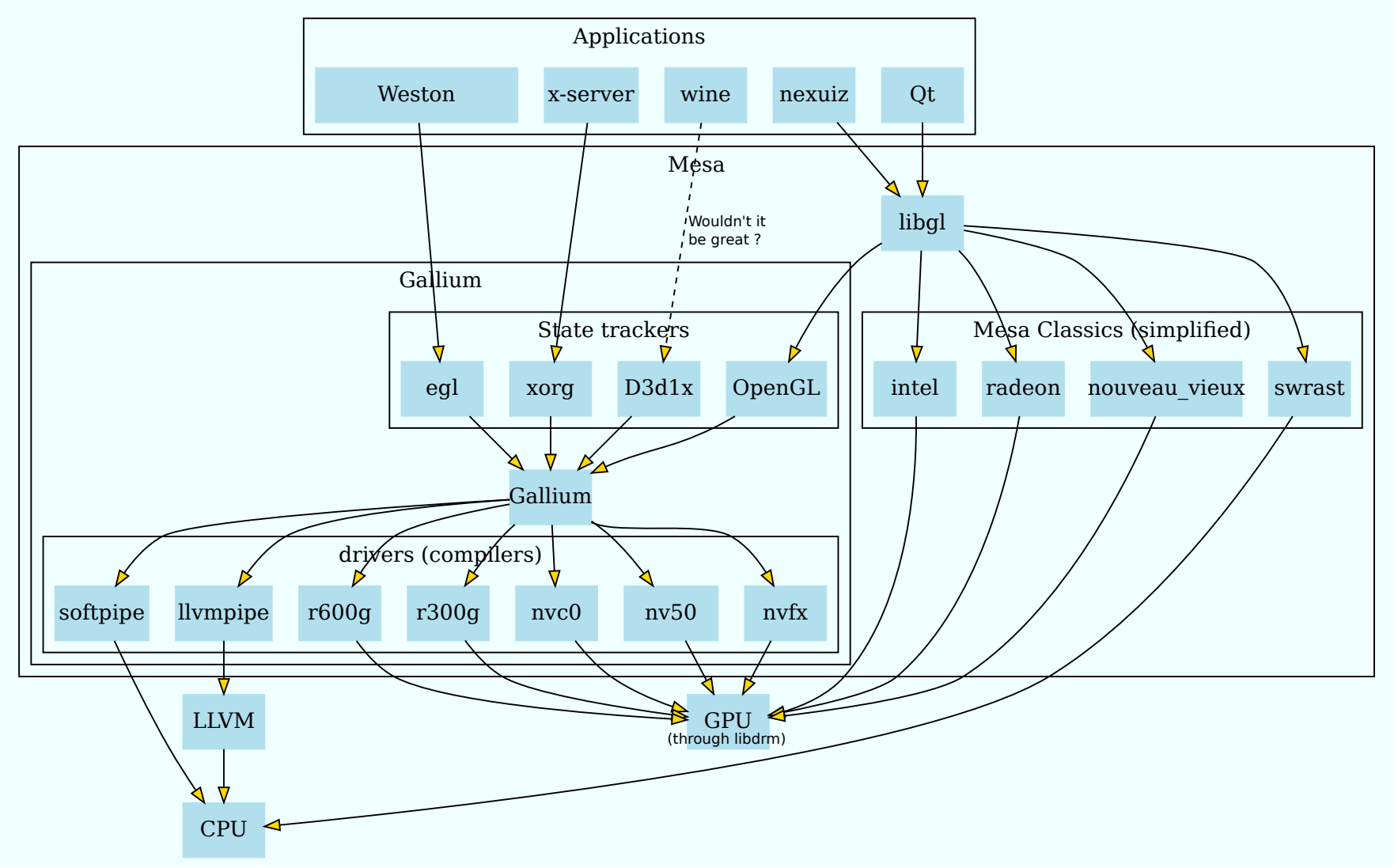
## DDX – xf86-video-nouveau

- EXA (2D acceleration)
- X-Video
- supports full range of GPUs (NV04 - NVD9)
- makes use of all engines for acceleration (including 3D engine)

## Mesa3D: drivers for 3D and more

- two different approaches here: Classic and Gallium3D
- nouveau-vieux: classic Mesa3D driver for NV04,NV1x,NV2x
  - only supports fixed function OpenGL
- Gallium pipe-driver
  - nvfx
  - nv50
  - nvc0

## Components


Applications
Weston
x-server
wine
nexuiz
Qt
Mesa
Wouldn't it be great ?
libgl
Gallium
State trackers
egl
xorg
D3d1x
OpenGL
Mesa Classics (simplified)
intel
radeon
nouveau_vieux
swrast
Gallium
drivers (compilers)
softpipe
llvmpipe
r600g
r300g
nvc0
nv50
nvfx
LLVM
GPU
(through libdrm)
CPU

## nvfx

- Gallium driver for NV3x,4x class GPUs
- one of the first gallium drivers
- created by merging separate nv30 and nv40 drivers
- accumulated much old cruft
- no maintainer for over one year

## work in progress

- will hopefully be soon replaced by rewritten driver

## nv50

- Gallium driver for the NV50 family
- current codebase was formed by adapting nvc0
- first open driver to run OpenCL on the hardware?

## work in progress

- merge the reworked shader compiler
- implement remaining OpenGL 3.x features
- merge the OpenCL work

## nvc0

- Gallium driver for the NVC0 family
- one of the first drivers to support OpenGL 3

## work in progress

- DX11
- OpenGL 3.1+

```
    GLX_SGIX_fbconfig, GLX_SGIX_pbuffer, GLX_SGIX_visual_select_group,
    GLX_EXT_texture_from_pixmap
OpenGL vendor string: nouveau
OpenGL renderer string: Gallium 0.4 on NVC4
OpenGL version string: 3.0 Mesa 8.0-devel (git-8cbe699)
OpenGL shading language version string: 1.30
OpenGL extensions:
    GL_ARB_multisample, GL_EXT_abgr, GL_EXT_bgra, GL_EXT_blend_color,
    GL_EXT_blend_minmax, GL_EXT_blend_subtract, GL_EXT_copy_texture,
    GL_EXT_polygon_offset, GL_EXT_subtexture, GL_EXT_texture_object,
    GL_EXT_vertex_array, GL_EXT_compiled_vertex_array, GL_EXT_texture,
    GL_EXT_texture3D, GL_IBM_rasterpos_clip, GL_ARB_point_parameters,
    GL_EXT_draw_range_elements, GL_EXT_packed_pixels, GL_EXT_point_parameters,
```

## OpenCL

- developed by Francisco Jerez
- sponsored by the X.org EVOC
- very experimental
- in-depth presentation here at 18:00

## d3d1x

- Direct 3D 10/11 on Gallium
- "works" only on nouveau, still a bit hackish
- started by Luca Barbieri
- currently developed by nv50/c0's maintainer: Christoph Bumiller
- Unigine Heaven runs on it when you replace the wine d3d10/11 dlls

## Video decoding

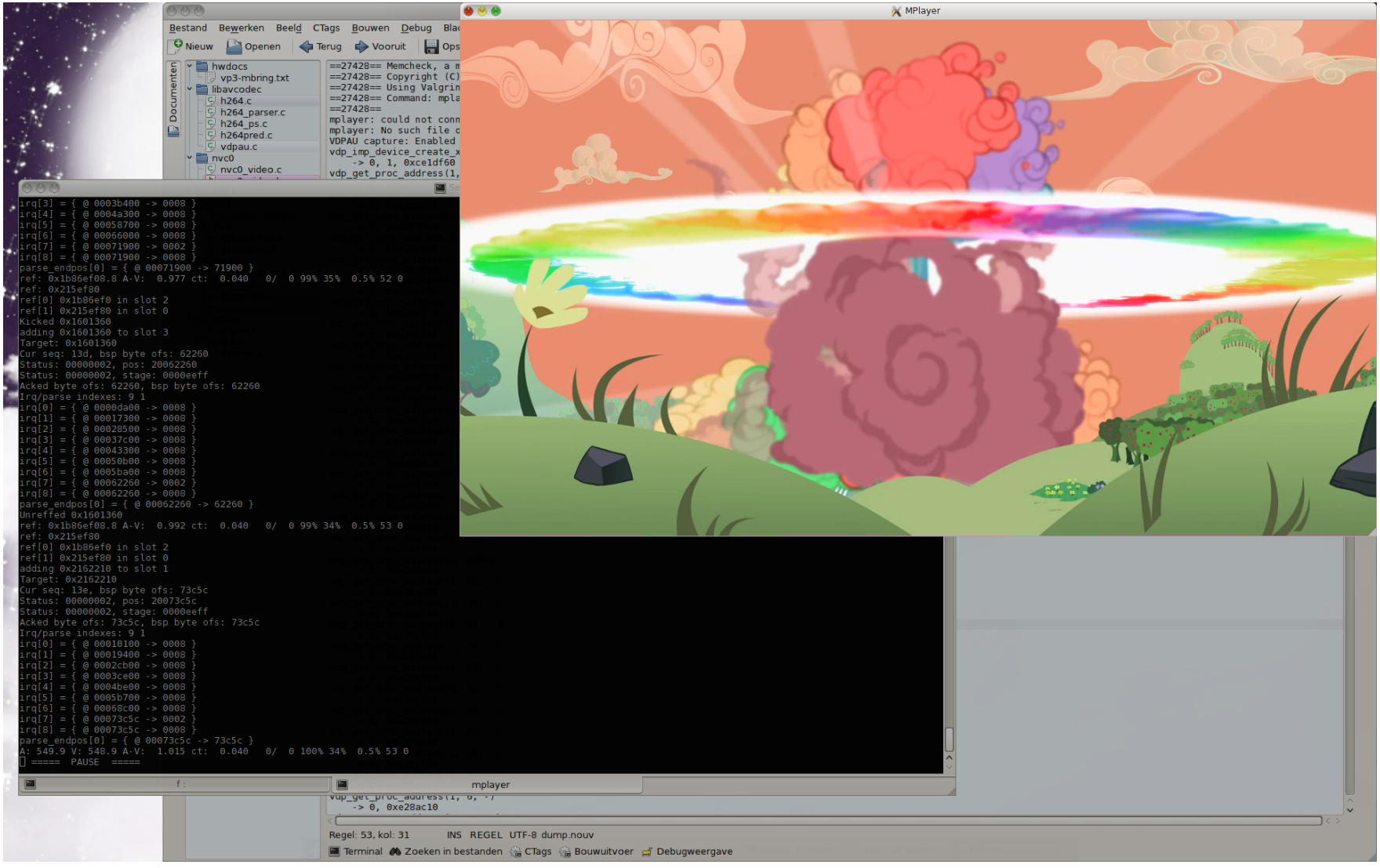
- HD video decoding on atoms
- lower power consumption

## PMPEG

- blob doesn't use this engine
- decodes mpeg1/2

## PBSP/PVP/PPPP

- used by nvidia
- decodes most video streams




VDPAU running on Nouveau with the proprietary microcodes

# Summary

## Why Nouveau?

- support old cards unsupported by the blob ($<$ nv40)
- develop new features (KMS, Xrandr, wayland, d3d1x)
- plug & play support, no need to install and maintain the blob
- for the fun!

# Summary

## MPEG1/2 video decoding

- using MPlayer
- Kernel-side: done
- Mesa: merged in 8.0

## reclocking and opengl

- performance improvements in OpenArena/Nexuiz
- performance improvements in xvmc
- dynamic reclocking (load-based reclocking)!