State of the DragonFly graphics stack

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About myself

- System engineer at Synthesio
  - Social media business intelligence
  - Monitoring dashboards
- X11 and *BSD user
- DragonFly developer since 2011
- Ported drm/i915 and drm/radeon
- Have been updating drm/i915 since then

About DragonFly

- Unix-like Operating System

- Forked from FreeBSD 4.8 in 2003 by Matthew Dillon

- High-performance and scalable

- Uses per-core replicated resources

- Many operations are naturally lockless

About DragonFly (2)

- Innovative HAMMER filesystem

- Disaster recovery on desktop and WAN scale

  - History retention

  - Real-time master-slave replication

- Non resource-intensive deduplication

  - Great with DNA/protein and other repeating pattern data

- SSD-optimized second-level file cache

  - Killer feature for fileservers and database workloads not fitting in RAM

Kernel drivers based on Linux

- Many people are writing Linux drm drivers

- Very complex, fast-moving targets

- Nobody is writing DragonFly drm drivers

- I'm a sysadmin and I'm lazy

- It's easier to change the DragonFly kernel to behave like Linux and use the Linux drivers as unmodified as possible than trying to constantly keep up and change the drivers to use DragonFly-specific APIs

Linux compatibility layer

- From the point of view of the graphics drivers, the DragonFly kernel can be considered a BSD-licensed implementation of Linux

- Many linux/xxx.h wrappers taken from FreeBSD (OFED project, Infiniband drivers)

- Some APIs implemented locally: idr(9), various linux/yyy.h headers, etc...

- Other Linux functions taken from OpenBSD

- A few from NetBSD

Linux compatibility layer (2)

- ls /usr/src/sys/dev/drm/include/linux

`atomic.h`	`gcd.h`	`list.h`	`sched.h`
`backlight.h`	`gfp.h`	`log2.h`	`seq_file.h`
`bug.h`	`hashtable.h`	`mm.h`	`slab.h`
`capability.h`	`hdmi.h`	`module.h`	`spinlock.h`
`compiler.h`	`highmem.h`	`mutex.h`	`time.h`
`device.h`	`kernel.h`	`pci.h`	`etc...`

- Most common Linux APIs used in the drm subsystem implemented by wrappers

- 78 files in drm/include/asm and drm/include/linux

- 8379 lines in headers and drm/linux_*.c files

- BSD 2-clause license

drm/i915 kernel driver

- Mostly in sync with Linux 3.17

    - Not the MST Display-Port code

- Some critical fixes from Linux 3.18 and 3.19

- Supports ~= Core 2 to Broadwell GPUs

- Skylake will require an update to Linux 3.19+

- Involved people: François Tigeot, Johannes Hofmann, Matthew Dillon, Imre Vadasz, Rimvydas Jasinskas

drm/i915 history

- **Summer 2010**: GSoC, never went anywhere
- **June 2012**: Start new i915 port from FreeBSD
- **June 2013**: i915 working after adding PAT support to the kernel
- **September 2013:** i915 work based on Linux
- **August 2014**: Haswell support (Linux 3.8.13)
- **May 2015**: Broadwell support (Linux 3.14)

drm/radeon kernel driver

- drm/radeon mostly in sync with Linux 3.17

- drm/ttm mostly in sync with Linux 3.11

- People most involved lately:

  - Rimvydas Jasinskas (updates up to Linux 3.17)

  - Michael Neumann (updates up to Linux 3.11)

  - Imre Vadasz (temperature sensors support, various critical fixes)

  - Matthew Dillon (critical ttm fixes)

drm/radeon history

- **August 2013:** Start porting drm/ttm and drm/radeon from FreeBSD (~= Linux 3.8)

- **October 2013**: ttm + radeon mostly ported

- **July 2014**: ttm + radeon working reliably

- **February 2015**: updated to Linux 3.9

- **May 2015**: updated to Linux 3.11

- **August 2015**: updated to Linux 3.17

drm/amdgpu kernel driver

- Only appeared in Linux 4.2

- We're not there yet

- Will be required for Topaz, Tonga and Carrizo GPU families support

drm/nouveau kernel driver

- Nvidia hardware was never really well supported,
- Support has actually regressed
  - xf86-video-nv: 2D-only accelerated driver, stopped being updated years ago
- Almost nobody in the DragonFly community has any investment to protect
- Still played a bit with the driver
- Some files with the same name exist in different subdirectories, cannot be built with the traditional *BSD build systems
- Very low priority

Vesa driver

- Basic framebuffer display

- Purely userland

- Neither 3D nor 2D acceleration

- Only way to use Nvidia hardware

- Not too painful to display xterms and web browser windows

- Don't try to play full-screen videos

Generic drm code

- Still in bad shape

- A few parts up to Linux 3.17 (crtc, edid, hdmi, irq)

- Others much much older (< Linux 2.6.26)

- No drm master support

- No dma-buf support

Userland software

Dports packages

- – FreeBSD ports + adaptation layer + automatic tests and validation
- – *Ports* = repository of package building instructions
- – Created and maintained by John Marino
- – 20,000+ packages
- – Not enough manpower to maintain a complete ports tree from scratch

Userland in September 2015

- Xorg-server 1.14.7
  - Version 1.17.2 works fine but not packaged
- xf86-video-vesa 2.3.3
- xf86-video-ati 7.5.0
- xf86-video-ati-ums 6.14.6
- xf86-video-intel 2.99.917
  - Git master works fine but not used by default

Userland in September 2015 (2)

- Cairo 1.14.2
- Mesa 10.4.6
  - Mesa 11 is better, not packaged yet
- FreeBSD ports are a bit stale
  - Still using xf86-video-intel 2.21.15
  - Had to create a locally managed port of xf86-video-intel 2.99.917
  - Hope it won't become necessary for other parts

Userland in September 2015 (3)

- Basic 2D operations work fine
- OpenGL also works fine
- Accelerated Videos
- Mate / kde / mpv / etc ...
  - "KDE works beautifully […] better under [DragonFly] 4.2.4 than under 4.0.6"
- Openarena: up to ~= 200fps on HD4000 / 1920x1200

Userland in September 2015 (4)

- Beignet
  - OpenCL library for i915 hardware
  - Mostly works fine, >90% pass rate on Haswell + test suite
  - Currently requires "export OCL_IGNORE_SELF_TEST=1" on Haswell

- Wayland
  - Sort of future Xorg-server replacement
  - Doesn't speak X11, applications have to be ported
  - Working with the drm/i915 driver
  - Currently requires superuser rights

Other changes since 2014

- New graphical TTY layer in DragonFly 4.3
  - By Imre Vadasz and Sascha Wildner
- In-kernel, dumb framebuffer
  - Uses big, non-anti-aliased characters by default
  - Easy to read, even on small screens
  - Only supports ASCII characters
- Previously black screen or frozen image after Xorg exit

Difficult spots

- GEM and TTM code
  - DragonFly's VM subsystem works differently than Linux
  - Hard to handle things properly without introducing very nasty bugs
- iic(4) API
  - Difficult to use, the Linux i2c one is much better
  - Devices are created top-down vs bottom-up in Linux

Known problems

- Youtube videos

  - Tearing when the mouse is moving

  - Bug in xf86-video-intel 2.99.917

  - Fixed in git master; have started to package my own releases

- Slight display corruption in some rare cases

- LLC has to be disabled in xf86-video-intel

  - Probably a memory cache attribute not correctly changed in the drm/i915 kernel driver

  - Intel-gpu-tools also says we're leaking internal kernel return values in some IOCTLs (ERESTARTSYS)

Known problems (2)

- Some radeon models only support Glamor acceleration

    - Xorg-server 1.17.2 works fine with it

    - But the packaged 1.14.7 version doesn't support Glamor at all

- At some point we'll probably have to package new xorg-server versions ourselves

Future directions

- Synchronize the drm code itself to recent Linux versions

  – The lack of drmDropMaster() support is starting to become a problem

- Continue upgrading drm+drivers to more recent Linux versions

  – Skylake support could become important soon

- Use formal test-suites to find and fix kernel driver bugs

- Run some benchmarks, check if performance is OK

- Userland utf8 terminal emulator

  – https://github.com/ivadasz/fbteken

DragonFly Credits

- François Tigeot: drm, drm/i915, drm/ttm and drm/radeon ports, i915 updates
- Johannes Hofmann: made i915 work
- Matt Dillon: made i915 and ttm work reliably
    - Added PAT support to the kernel
    - fixed critical VM bugs
- Joris Giovanelli and Markus Pfeiffer: critical bug investigations and fixes
- Michael Neumann: drm/radeon updates, critical drm improvements
- Rimvydas Jasinskas: drm/radeon updates, OpenCL, critical improvements
- Imre Vadasz: vtty kms support, drm bugfixes and improvements, Wayland
- Yellow Rabbit: testing, drm bugfixes and improvements
- Sascha Wildner: drm bugfixes and improvements, vtty support

Questions ?