Porting DRM/KMS drivers to DragonFly BSD

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About myself

- Consultant, software developer, Sysadmin

- X11 and *BSD user

- Former ccTLD System Engineer

- Introduced FreeBSD in the .fr registry

- DragonFly developer since 2011

About DragonFly

- Unix-like Operating System
- Forked from FreeBSD 4.8 in 2003 by Matthew Dillon
- Aims to be high-performance and scalable
- Uses per-core replicated resources
- Many operations are naturally lockless

About DragonFly (2)

- Innovative features very useful for some workloads

- HAMMER filesystem

    – History retention

    – Deduplication

    – Real-time replication

- Swapcache: second-level file cache

    – Uses existing swap infrastructure

    – Optimized for SSDs

About DragonFly (3)

PostgreSQL 9.3 performance
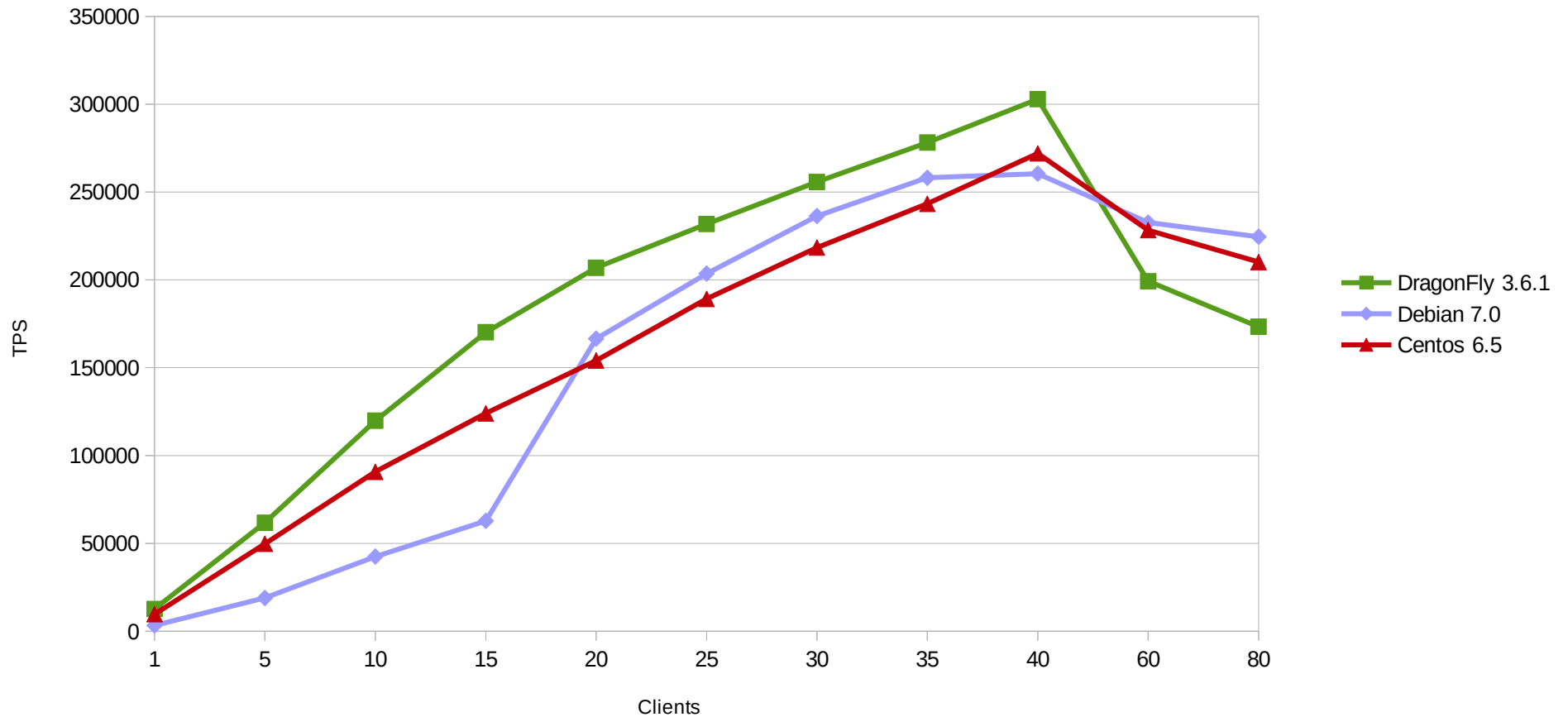
First tentative

- David Shao, Google Summer Of Code 2010
- Based on Linux + a compatibility layer
- Dropped early but continued in his spare time later
- Apparently got something to work
- Sadly probably specific to his machine
- Only got crashes with my hardware

Starting again with FreeBSD

- Many common kernel APIs with DragonFly, seemed like a good idea at the time

- **June 2012**: Start implementing newly required APIs

- **December 2012**: drm/i915 mostly ported

- **June 2013**: i915 starts working after adding PAT support to the kernel

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

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

FreeBSD dropped the ball

- No significant updates to drm/i915 after 2012

- Latest supported hardware: Ivy-Bridge

- I switched to Linux as the new i915 upstream in September 2013

- Most important goal: Haswell support

Rebasing on Linux

- Target: Linux 3.8.13
  - Linux 3.8 first version with known working Haswell support
  - drm/radeon port based on Linux 3.8
  - OpenBSD also targeting Linux 3.8.x
  - OpenBSD has the best *BSD drm implementation so far (2014-10)
- Not an easy ride, many issues with the FreeBSD i915 code

FreeBSD issues

- Drm/i915 code vastly different from Linux
- Some very old parts
- Most modern features ~= Linux 3.4
- Two different versions of drm + drm drivers
    - Old drm/ directory
    - New drm2/ directory
- Most code the same, pointlessly duplicated!

FreeBSD issues (2)

- The FreeBSD developer rewrote the entire driver to change its coding style

  - if (ret) => if (ret != NULL)

  - return blah; => return (blah);

- Different file names

- Functions implemented in different order or present in different files

- June 2014: moved most functions to the same place they were in Linux 3.8.13

- Reduced differences from ~= 50K to 22K loc

Update process

- 1. Diff Linux and DragonFly code
- 2. Reduce pointless noise
- 3. Identify important functional differences
- 4. Implement them piecemeal
- 6. Replay Linux git history if required
- 5. Try to keep commits small

Implement Linux APIs

- Same old idea as David Shao's who used a Linux compatibility layer

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

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

- Other Linux functions taken from OpenBSD

Implement Linux APIs (2)

- Graphic drivers very complex

- Fast moving targets

- It makes more sense to change the DragonFly kernel to behave like Linux than trying to constantly keep up and change the drivers to use *BSD-specific APIs

- In a way I'm porting DragonFly to the drm drivers and not the drivers to DragonFly

Implement Linux APIs (3)

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

`atomic.h`	`export.h`	`jiffies.h`	`timer.h`
`bitops.h`	`hash.h`	`kernel.h`	`types.h`
`compiler.h`	`highmem.h`	`kref.h`	`wait.h`
`completion.h`	`i2c.h`	`list.h`	`workqueue.h`
`delay.h`	`idr.h`	`mutex.h`	
`err.h`	`io.h`	`time.h`	

- Most common Linux APIs used in i915 ttm and radeon implemented by wrappers

- Reduce differences as much as possible in the drm/* directories

- Major exception: locking directives

Difficult spots

- GEM VM code

  - FreeBSD used custom do-everything routines different from the Linux GEM implementation

  - i915_gem_obj_io() in FreeBSD

  - Various functions like i915_gem_shmem_pwrite() in Linux

- I2c API in Linux, iic API in FreeBSD+DragonFly

- Hard to make these parts of the drivers work like they do in Linux

The road to Haswell support

- 1. Reduce noise
- 2. Replace FreeBSD APIs by Linux ones
- 3. Update the interrupt code
- 4. Update the ringbuffer code
- 5. Update the output management code
- 6. Haswell-specific cache attributes in page tables
- Finally working reliably in August 2014

A few words about Userland

- Pkgsrc packages used until 2013
    - Xorg-server 1.6
    - Required an update
- Switched to Dports
    - FreeBSD ports + adaptation layer + automatic tests and validation
    - Much better
    - Gave us xorg-server 1.12 and contemporary software

A few words about Userland (3)

- Sadly, FreeBSD ports are beginning to lag

- Updating Cairo from 1.10 to 1.12 took years

- Still using xf86-video-intel 2.21.15

- Had to create a locally managed port of xf86-video-intel 2.99.x

- Hope it won't become necessary for other parts

Current state

- drm/i915 mostly in sync with Linux 3.8.13

  – Not the GEM code

- drm/radeon mostly in sync with Linux 3.8

- drm/ttm in sync with Linux 3.9

- Generic drm code a mess

  – A few parts up to Linux 3.8.13

  – Others much much older (< Linux 2.6.26)

Future directions

- Synchronize the drm code itself to Linux 3.8.x

  - Required for key features like DRM Prime, DRM-master, etc...

- Then start upgrading drm+drivers to more recent versions

- Porting drm/nouveau also a good idea

  - Should be easier now that ttm is working properly

Future directions (2)

- Restore 80x25 VGA text mode after Xorg exit

- Currently black screen or frozen image

- Alternatively implement a graphical TTY layer

- Patches are floating around

FreeBSD credits

- ## Konstantin Belousov

  - Updated drm and drm/i915 to support gem+kms
  - Ported most parts of drm/ttm to FreeBSD

- ## Alexander Kabaev

  - Started to port the radeon driver

- ## Jean-Sébastien Pédron

  - Finished the port of drm/radeon from Linux 3.8
  - Critical fixes to drm/ttm

DragonFly Credits

- François Tigeot: bulk of drm, drm/i915, drm/ttm and drm/radeon porting

- 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

Questions ?