

Introduction to the Performance Analyzer

NEW!

Improved!

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**Developer Support Engineers
SCEA Developer Support**

PLAYSTATION 2
Developers Conference 2003

Agenda

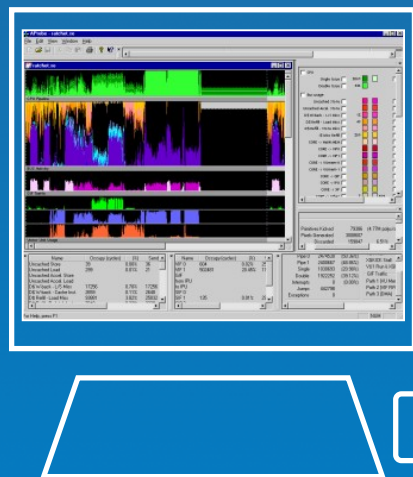
- Overview
- What's new
- GIF packet viewers
- Lessons learned
- Quick Look: Burnout 2
- PA Survey

PA Overview

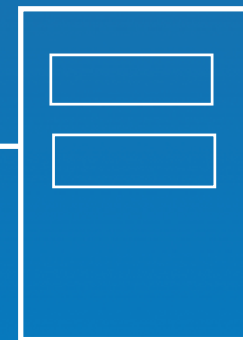
- Hardware: captures a snapshot of EE, GS, GIF, IOP, DMA, main bus activity
 - Samples at main bus clock- 150mhz
- Software: captures & displays the data
 - Graphs, statistics, GIF packet viewer
- Indispensable tool for optimization
 - Non-intrusive
 - Visualize and quantify efficiency

PA Overview (cont.)

- PS2 hardware
- Capture hardware
- Single board Linux PC
- Host PC

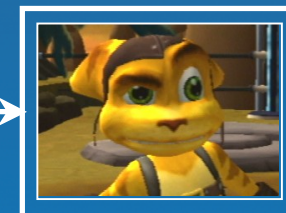
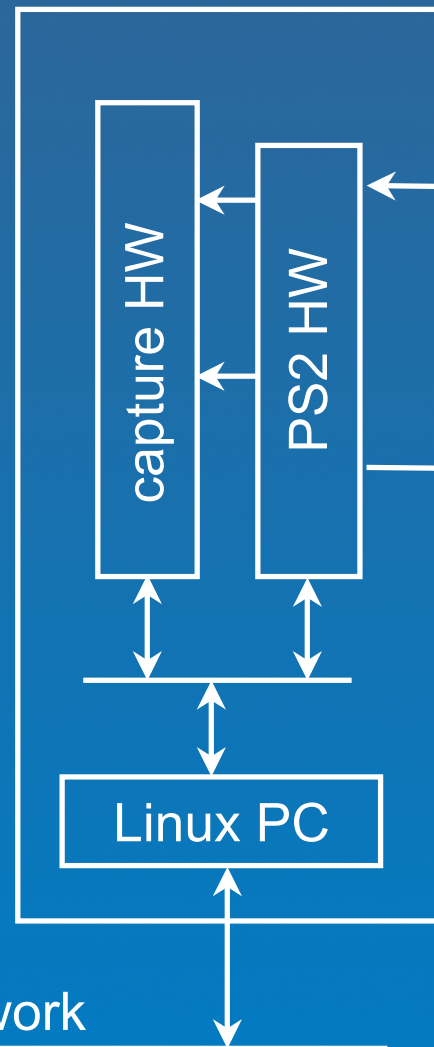


Host PC



network

Performance Analyzer



What's New

- Production Model
 - Tool + integrated capture hardware
 - 3 ring buffers, 256MB ea.=11 frames @60fps
- GIF capture
 - All packets + textures sent to GIF
- IOP capture
 - Main bus, sub-bus, SPU2, CD, HDD, net.
- New windows & Linux software

Hardware

- Model # DEX-T15000
- Dark blue case
- Internal 40GB HDD
- Internal network adaptor
- Foot switch for trigger
- Can't use DVD emulator
- No PCMCIA slot



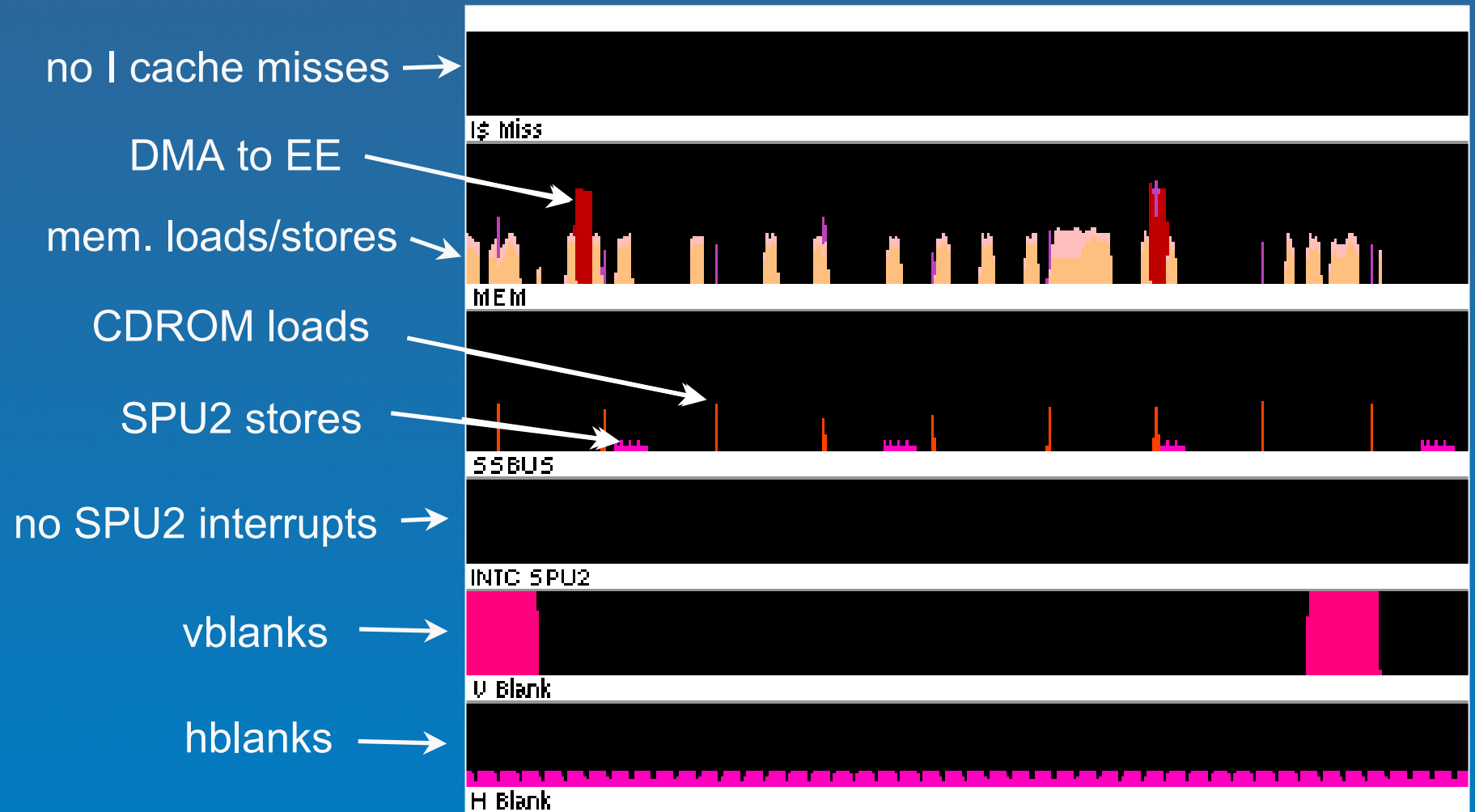
Signals Captured

- EE core: dual/single issue
- Main bus: cache misses, DMA 0-9
- VU0, VU1 run, VU1 XGKICK block
- GS DDA: pixels, primitives, scissoring
- GS Memory: reads, writes, buffer misses
- GIF: path 1,2,3
- GIF packets, textures (new)
- IOP (new)

IOP Capture

- I Cache Misses
- Main bus
 - IOP memory loads/stores
 - DMA to/from EE
- SSBUS: sub-bus transfers
 - ROM, SPU2 , CDRROM, DEV9 (HDD, net)
- SPU2 Interrupts
- HBlank
- VBlank

IOP Example (mpeg Player)



New Software

- WinPACon
 - Set trigger and capture
- A-probe
 - Displays capture in graphs & statistics
- pacons, pmon-2
 - Linux capture & analysis
- GIF Packet viewers
 - Windows: using OpenGL
 - PS2: sent directly to GIF via DECI2

WinPACon

- Capture: set trigger type, offset, and start
- Many triggers to choose from
 - Manual (mouse click / keypress)
 - GS register read/write
 - Vblank
 - Breakpoint
 - Foot switch
 - Code

WinPACon (cont.)

WinPACon

A B C D

Scanning in progress
Scanning stopped
Saved EE/GS Data
Saved GIF Data
Saved EE/GS Data
Saved GIF Data
Saved EE/GS Data
Saved EE/GS Data
Saved GIF Data
Saved EE/GS Data
Saved GIF Data

PPA IP

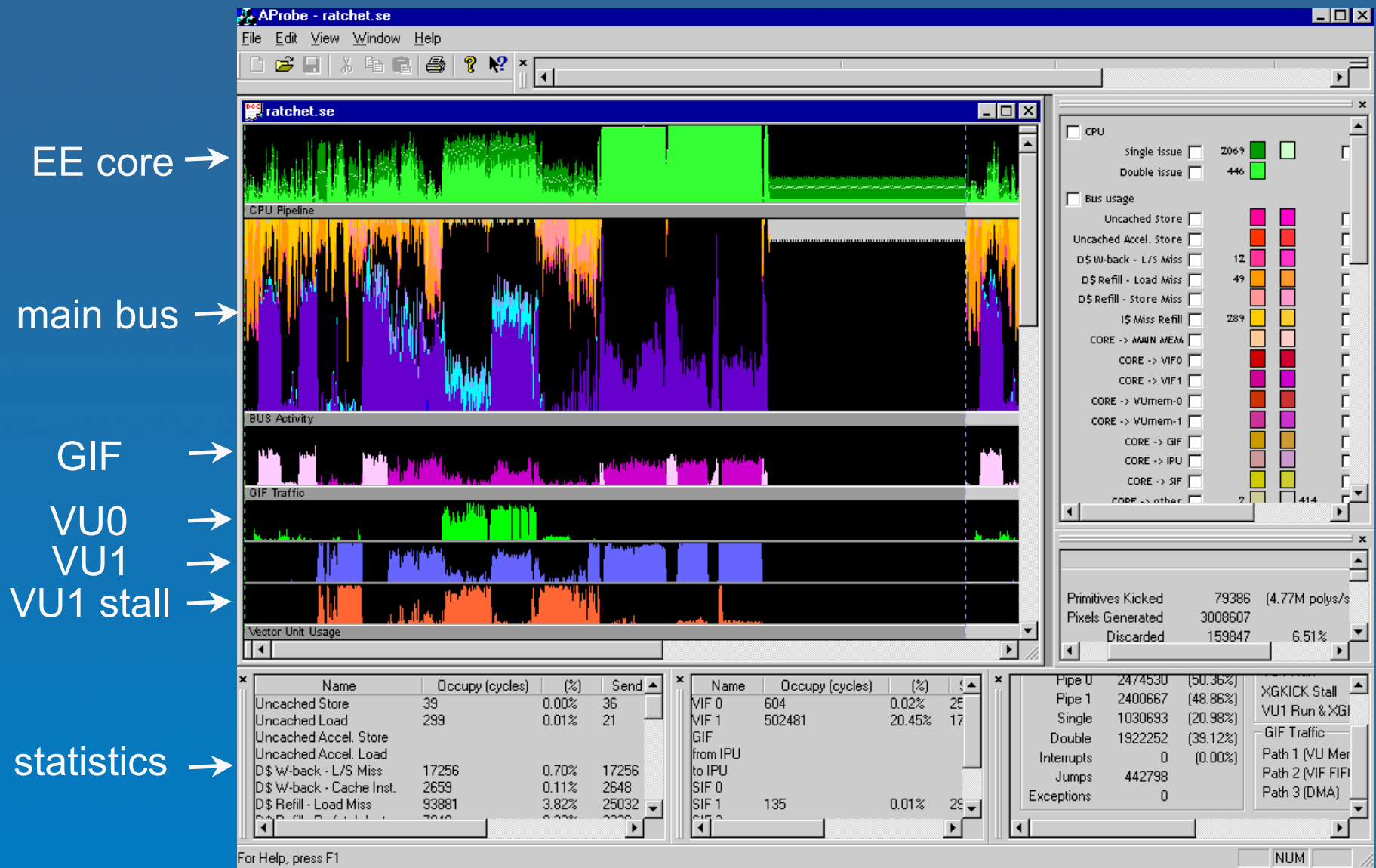
	Gif Trigger Type	Address	Address Mask	Data	Data Mask	VBlank
GIF-A	GPR Write	22 - SCANMSK	0	0	0	Positive Edge (Start)
GIF-A	Priv Write	3f - TEXFLUSH	0	0	0	Negative Edge (End)

Trigger Position Save Start Save End

A-Probe

- Windows or Linux under WINE
- Can change graph colors!
- Dockable windows
- Plug-ins: packet viewer, exporters, etc.
 - Plug-in API & data format to be released
- IOP analysis

A-Probe (cont.)



Demonstration

A-Probe Plug-in API

- For custom needs
- Allows for access to and exchange of PA-captured data
- Have access to ALL data A-Probe has
- What you do with the data is up to you!
- Plug-ins are DLLs
- A basic sample will be included

GIF Packet Viewers

- We know exactly what went through the GIF (GS register settings)
- We're able to rebuild a scene drawn or any part of it, closely simulating the GS
- The cool part: We're able to get more out of it than simply redrawing the scene as-is!

OpenGL GIF Packet Viewer

- Simulates the GS as close as possible
- But not a pixel-to-pixel perfect simulation
- Currently doesn't support textures (will in the near future)
- Mostly used to see things the PS2 itself can't show you
 - Out-of-view geometry
 - Rendering to textures

OpenGL GIF Packet Viewer (cont.)

- Zooming and navigation in the scene
- Various drawing modes
 - Normal mode (geometry + lighting)
 - Wire-frame mode
 - Overdraw mode
 - Primitives color-coded by various things...
- Isolation of context1 and context2
- The code will be made available to licensees
- Demo!

PS2 GIF Packet Viewer

- Captured data is sent back to the tool, and reprocessed by the GS
- Result is as close as it can get to what was displayed at capture time
- Primitives using static textures will look incorrect since static textures aren't captured (will be in the near future)
- Supports every single effect achievable on PS2

PS2 GIF Packet Viewer (cont.)

- Allows to double bracket captured data
 - Outer bracket is what's being drawn
 - Inside bracket is what's highlighted
- Drawing may be done in slow motion
- Allows the visualization of any portion of VRAM
- Communicates via DECI2, so no need to run anything special on the T10k/T15k
- Demo!

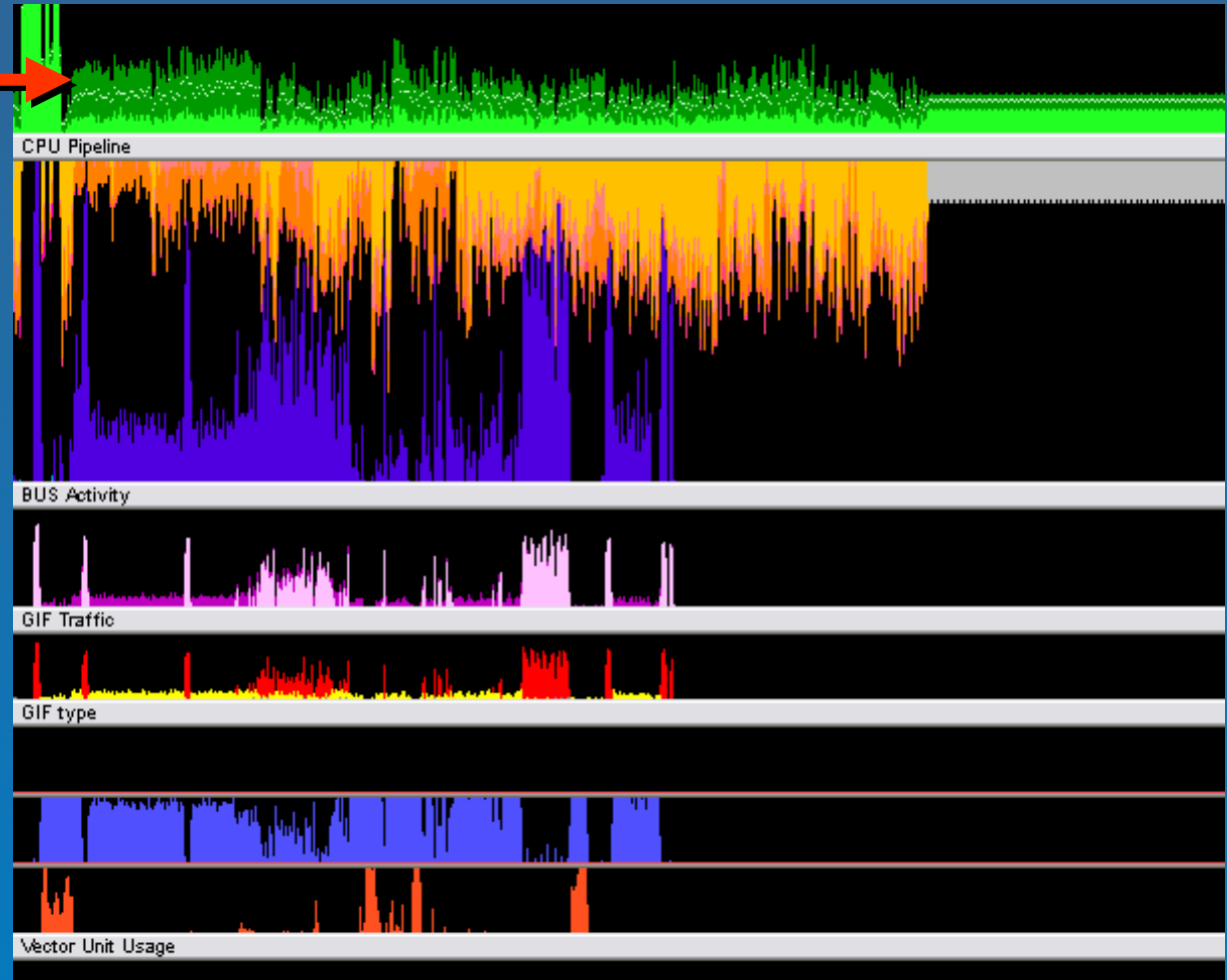
Lessons Learned

- EE-bound
- VU0 micro-mode utilization
- GS-bound
- MFIFO usage
- Scratchpad

Lessons Learned: EE-Bound

EE-Bound! →

Don't waste
your time
optimizing
VU or GS at
this point.
Concentrate
your efforts
on getting
rid of cache
misses!

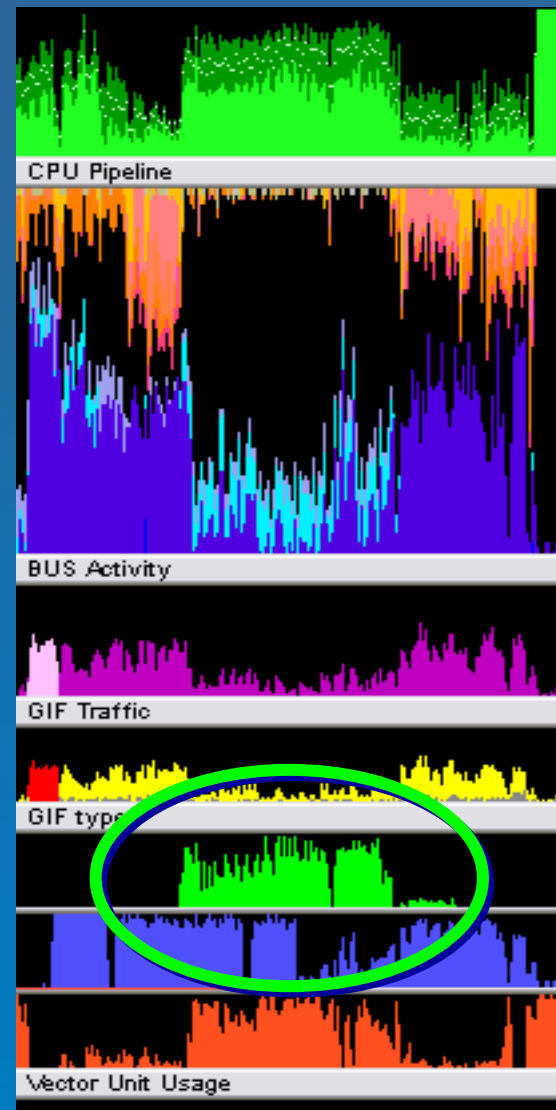


...A profiler will probably be your best friend here

Lessons Learned: VU0 micro-mode

VU0 running in micro-mode
may turn out to be a major
gain over macro-mode, and
in the process will help EE-
bound titles

Most games aren't using it
this way, presumably
because macro-mode fits
better within a traditional
game engine...

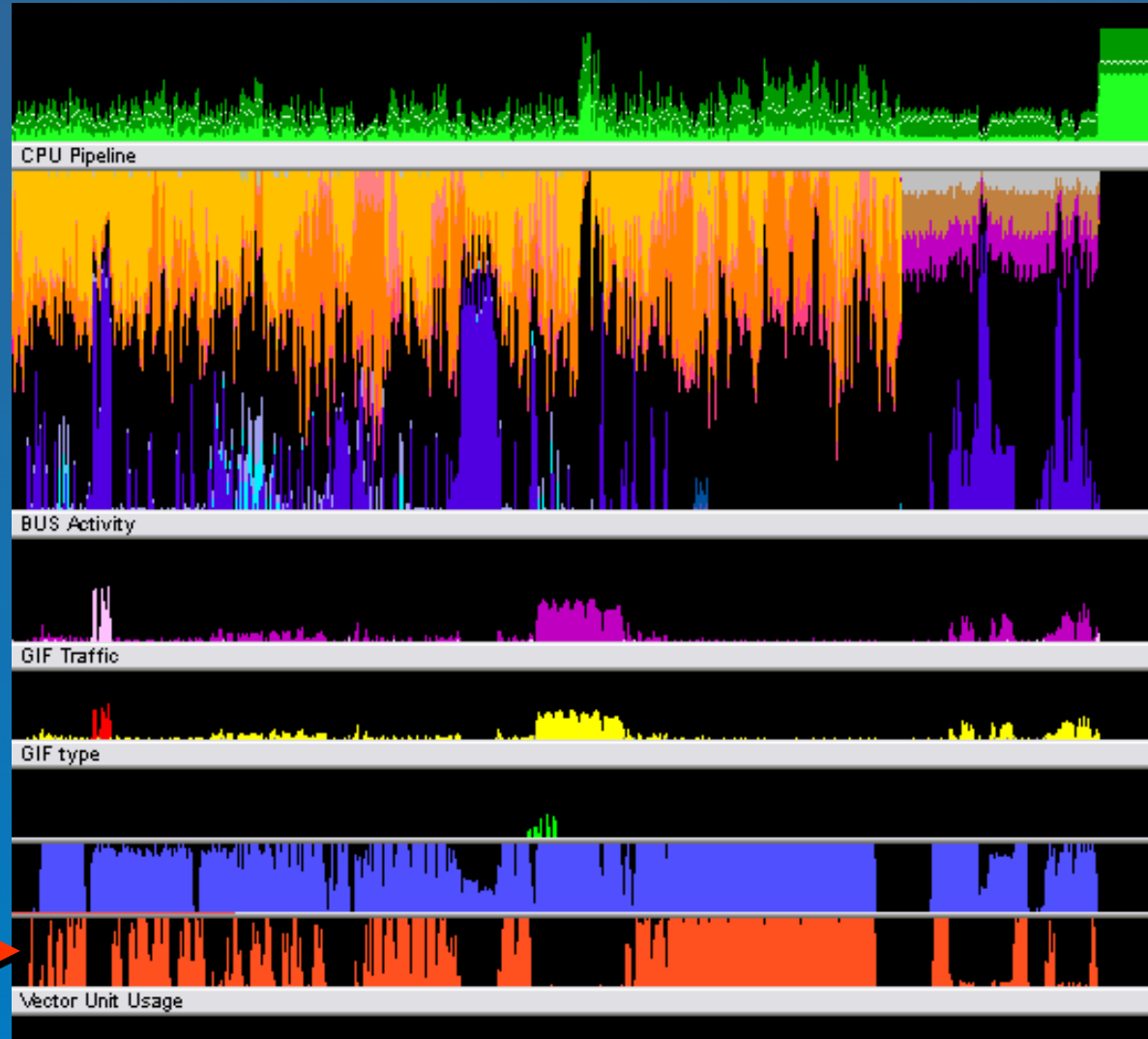


Lessons Learned: GS-Bound???

Although possible,
being GS-bound is
often indicative of a
different problem
with the engine or
with the data

Avoid big polygons
with big textures!

**Yikes! 90%
blocking!** →

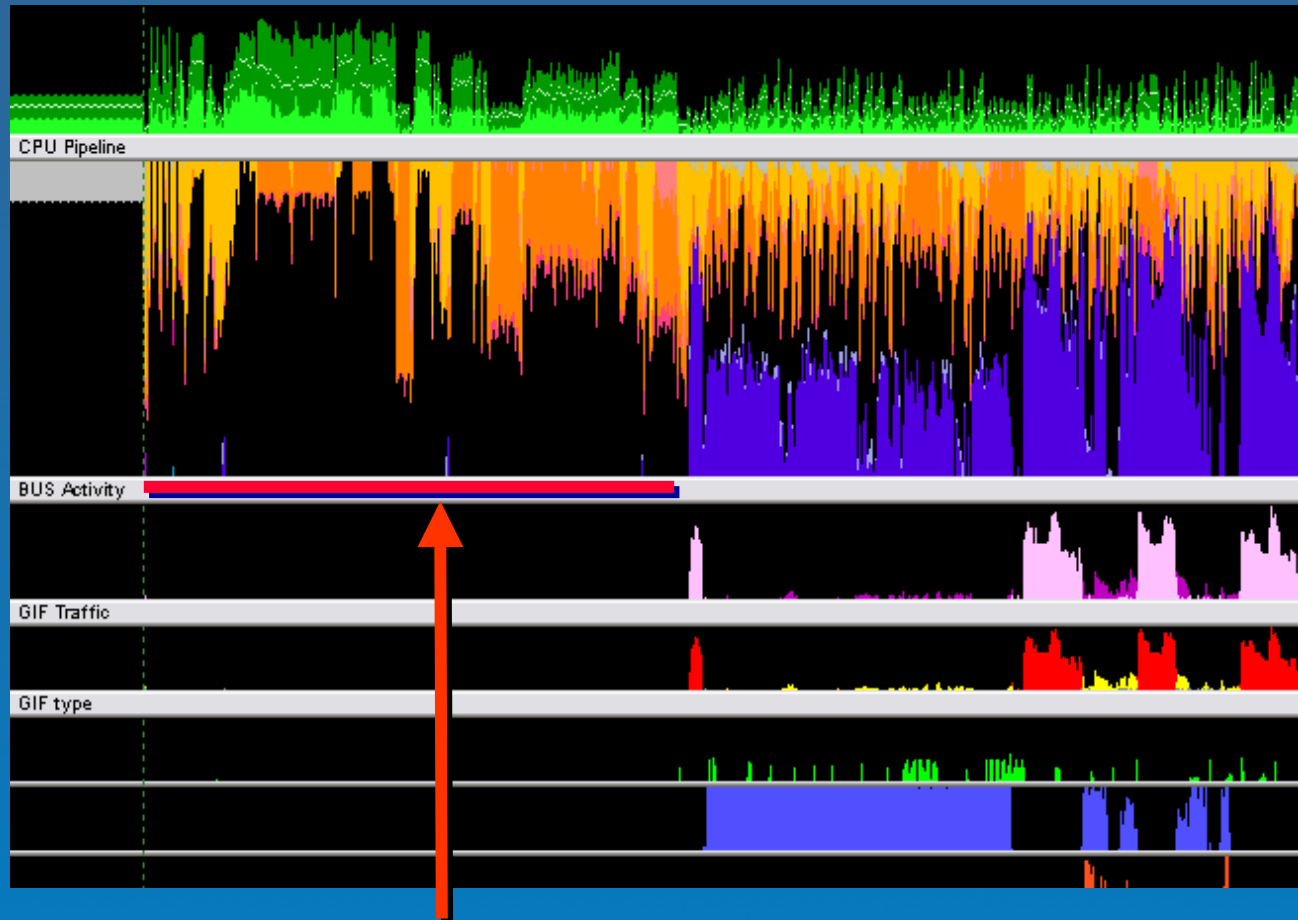


Lessons Learned: MFIFO Usage

- More and more people are using MFIFO over simple deferred rendering
 - Smaller memory footprint
- If buffer too small
 - Can potentially lock the CPU to the rendering
- If buffer too big
 - May lose bus bandwidth before the first kick
 - But you can kick it before it's full!

Lessons Learned: MFIFO Usage

(cont.)



5.7% delay before anything serious starts...

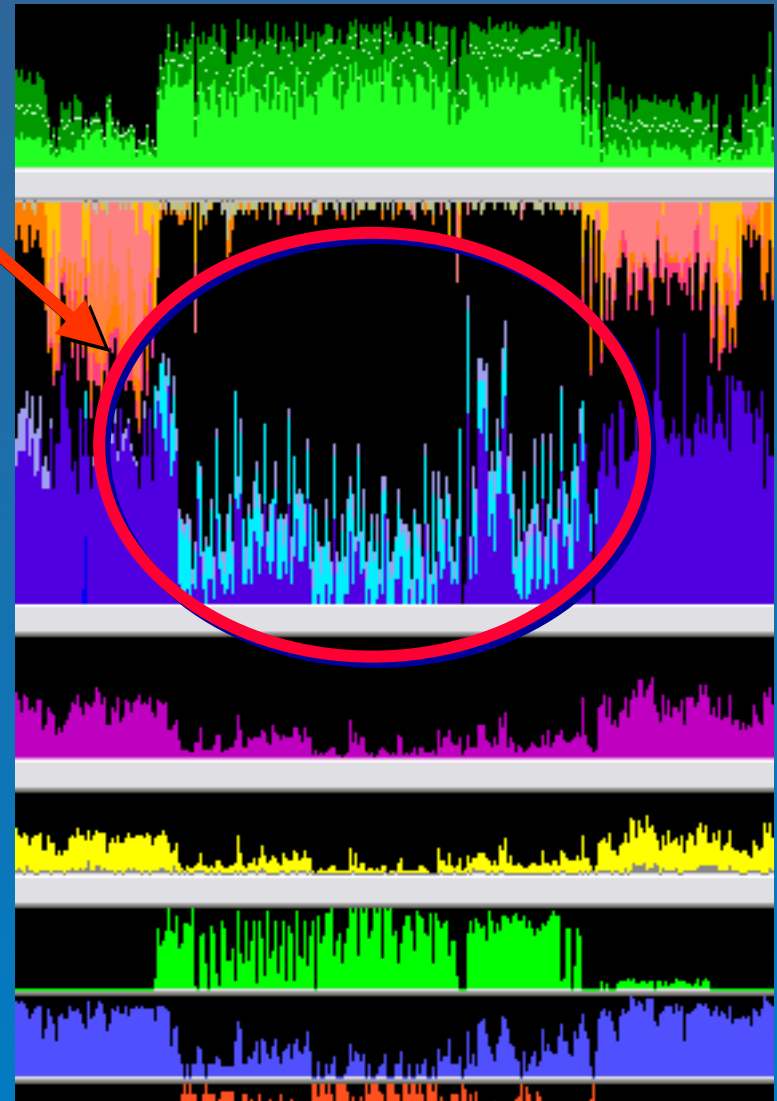
Lessons Learned: Scratchpad

- The PA doesn't show scratchpad accesses by the CPU, but shows DMA transfers to and from it
- Often used in conjunction with an MFIFO scheme and/or alongside VU0 running in micro-mode

Lessons Learned: Scratchpad (cont.)

**toSPR/fromSPR
DMA transfers
in action!**

Scratchpad memory accesses are much faster than main memory ones, so transferring data to and from the scratchpad, then process things in there is faster than processing from main memory!



Lessons Learned: Summary

- Many are “non-traditional”, PS2-specific things:
 - EE-bound = No L2 cache
 - VU0
 - Scratchpad
- Pays off to look at those things at engine-design time

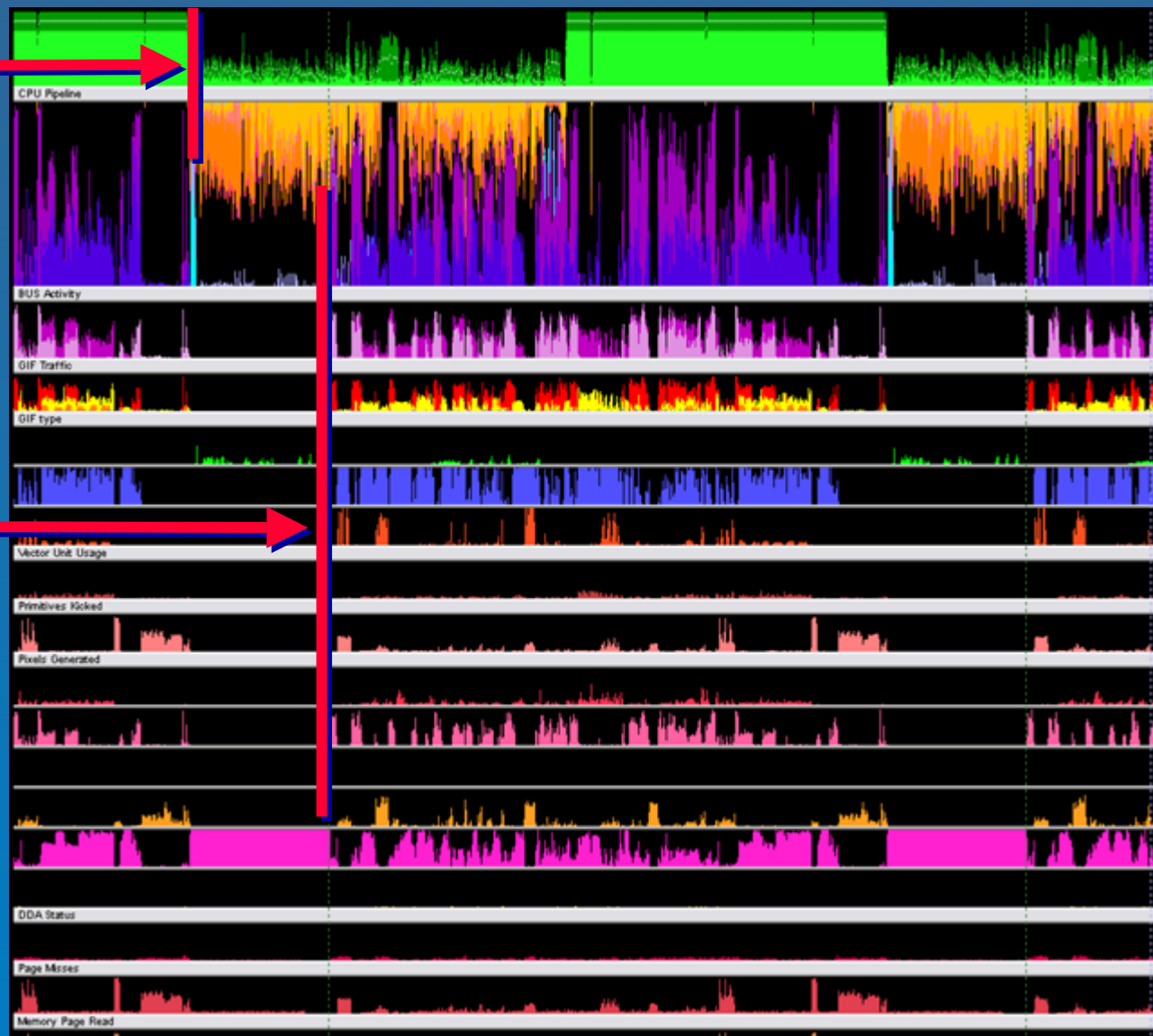
A Quick Look: Burnout 2

- From Criterion Games
- **Disclaimer!**
 - Only one capture in the whole game, the game performance varies greatly depending on where you are
 - Tried to get a good spot

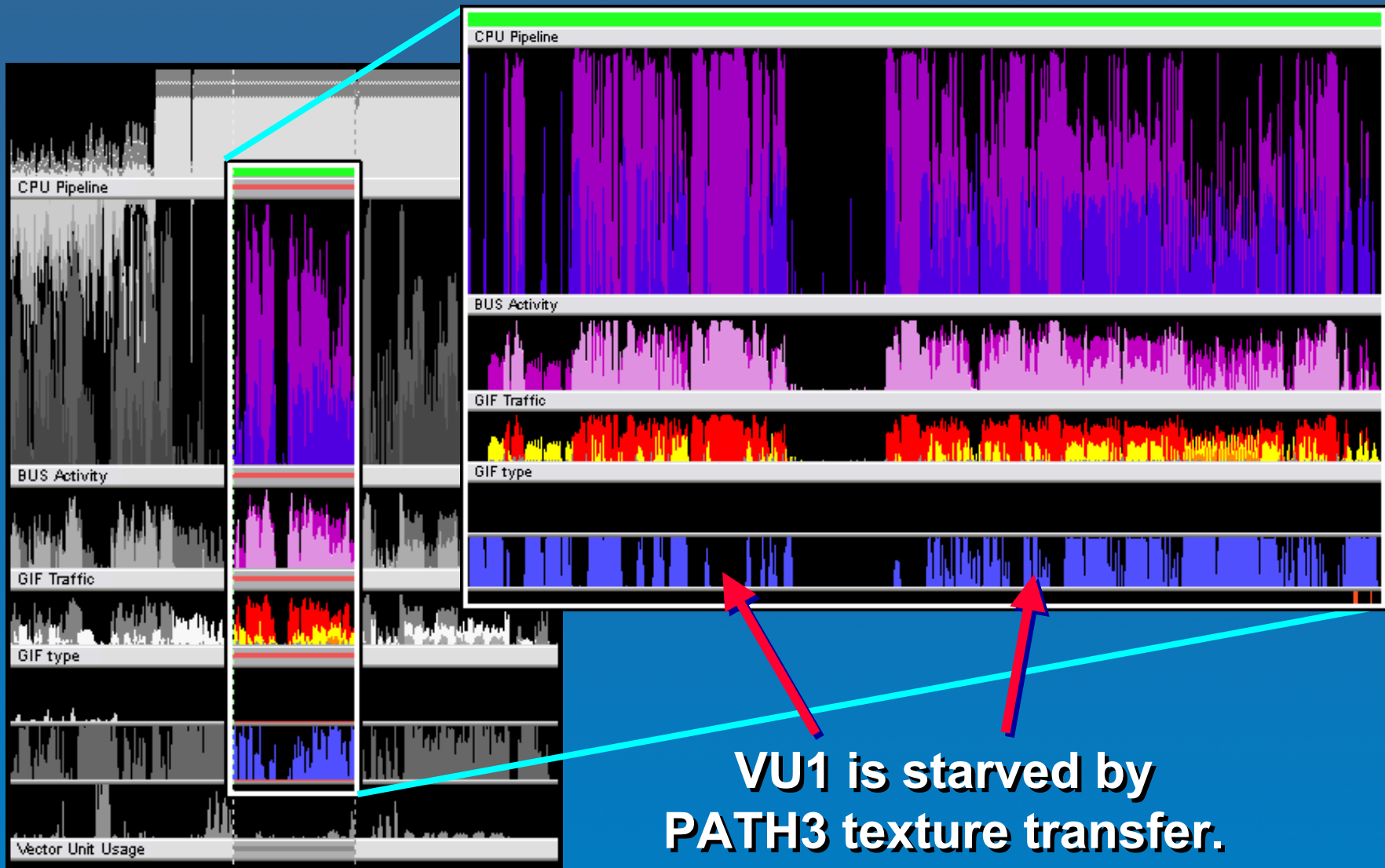
Burnout 2: A Full Frame

CPU processing starts when the previous frame is drawn

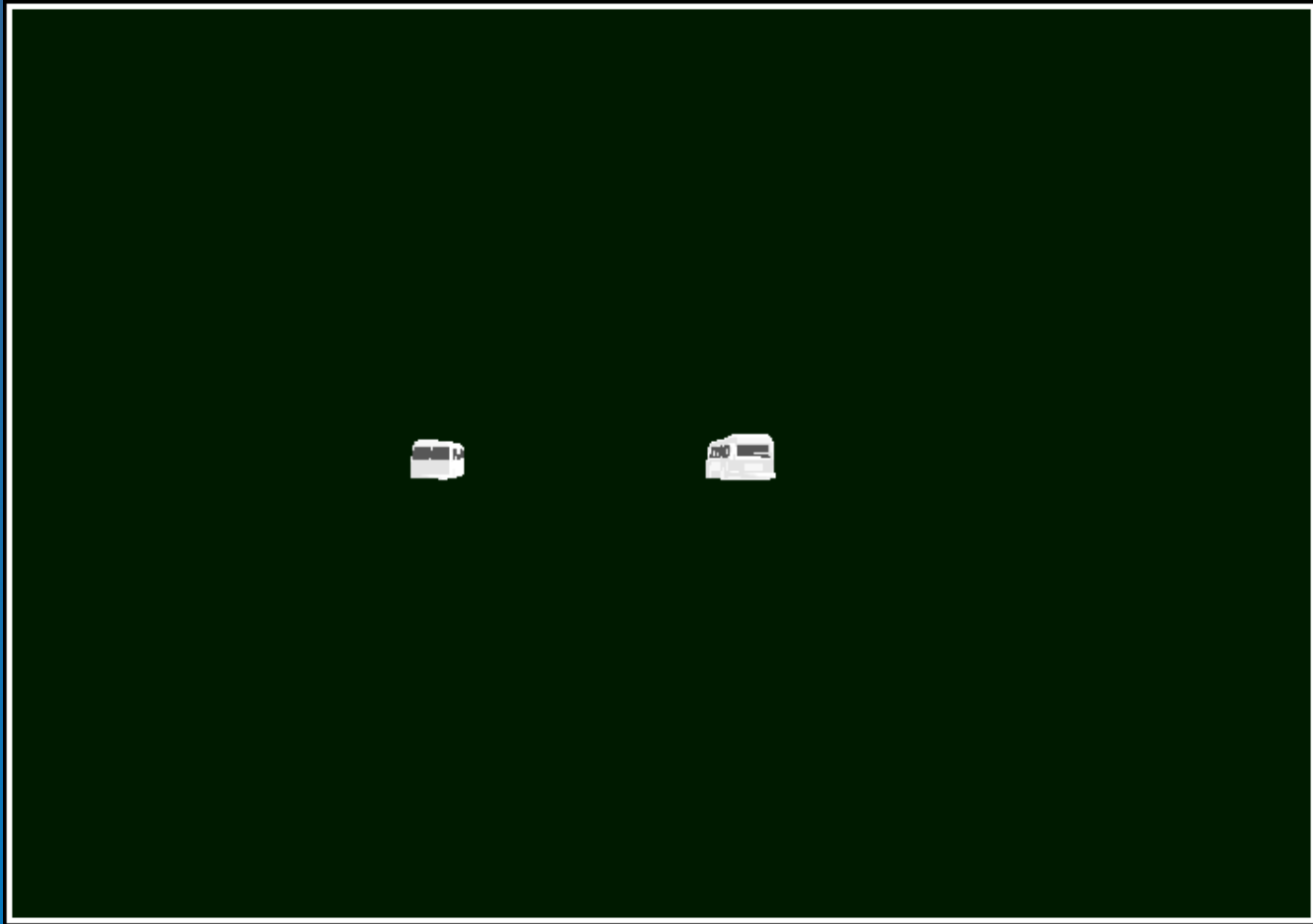
Drawing starts with the VSync



Burnout 2: VU1 Starvation

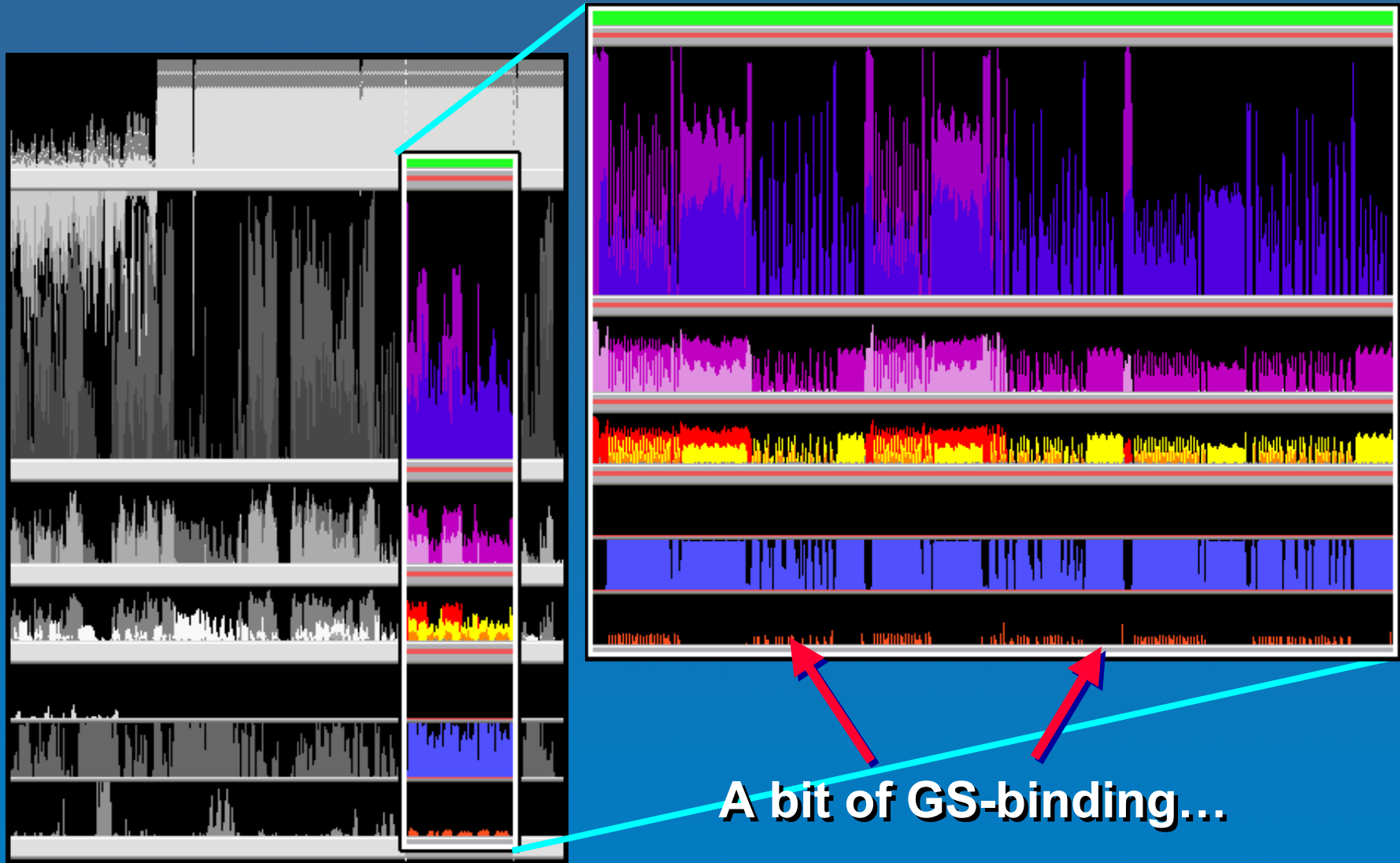


Burnout 2: VU1 Starvation (cont.)

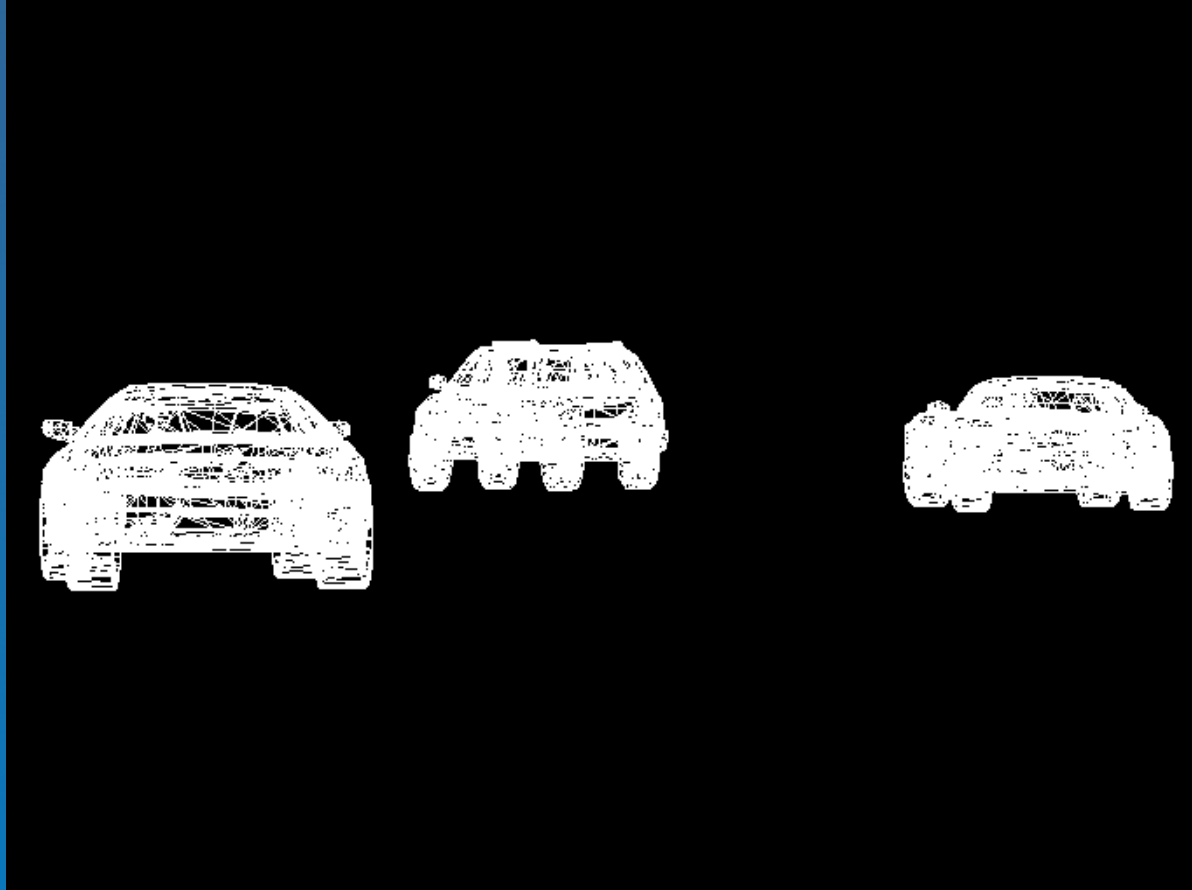


Not in this case. Textures could be reduced in size and, in the process, reduce VU1 starvation!

Burnout 2: GS-Bound

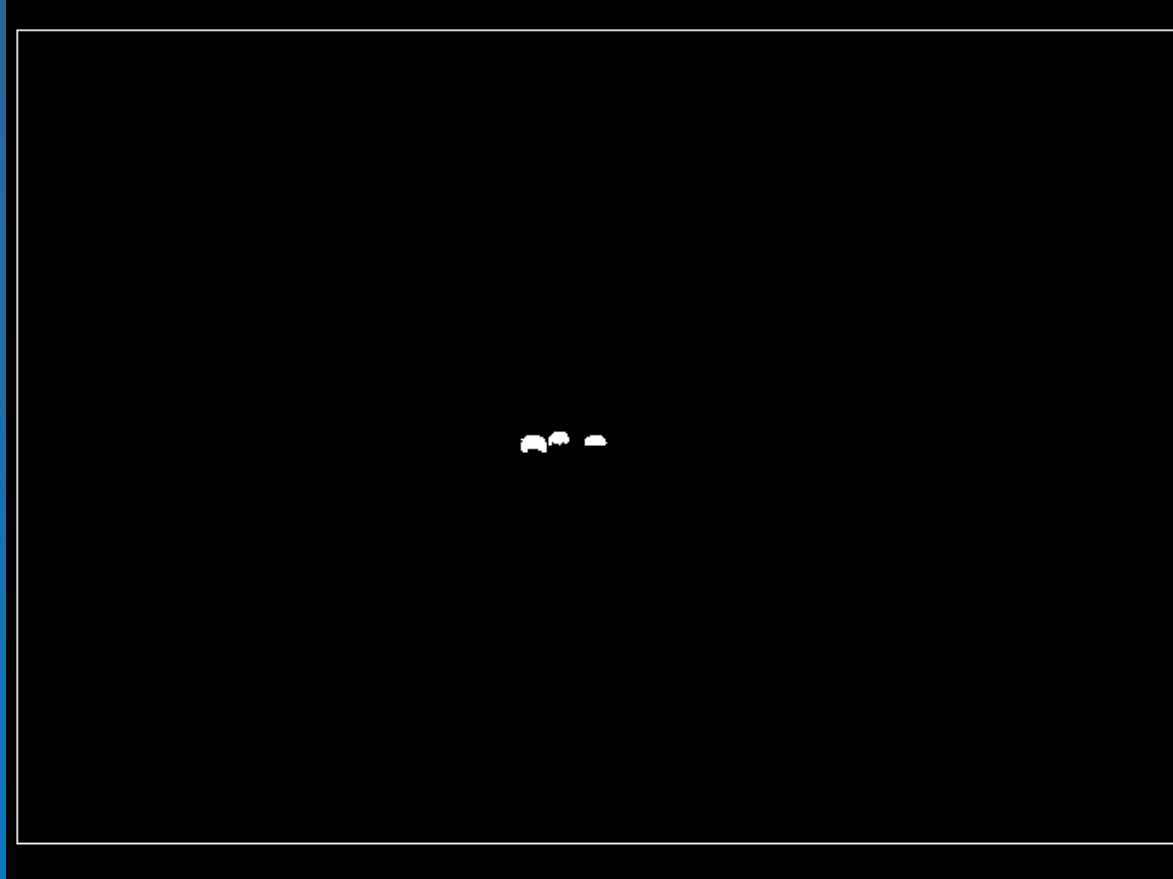


Burnout 2: GS-Bound (cont.)



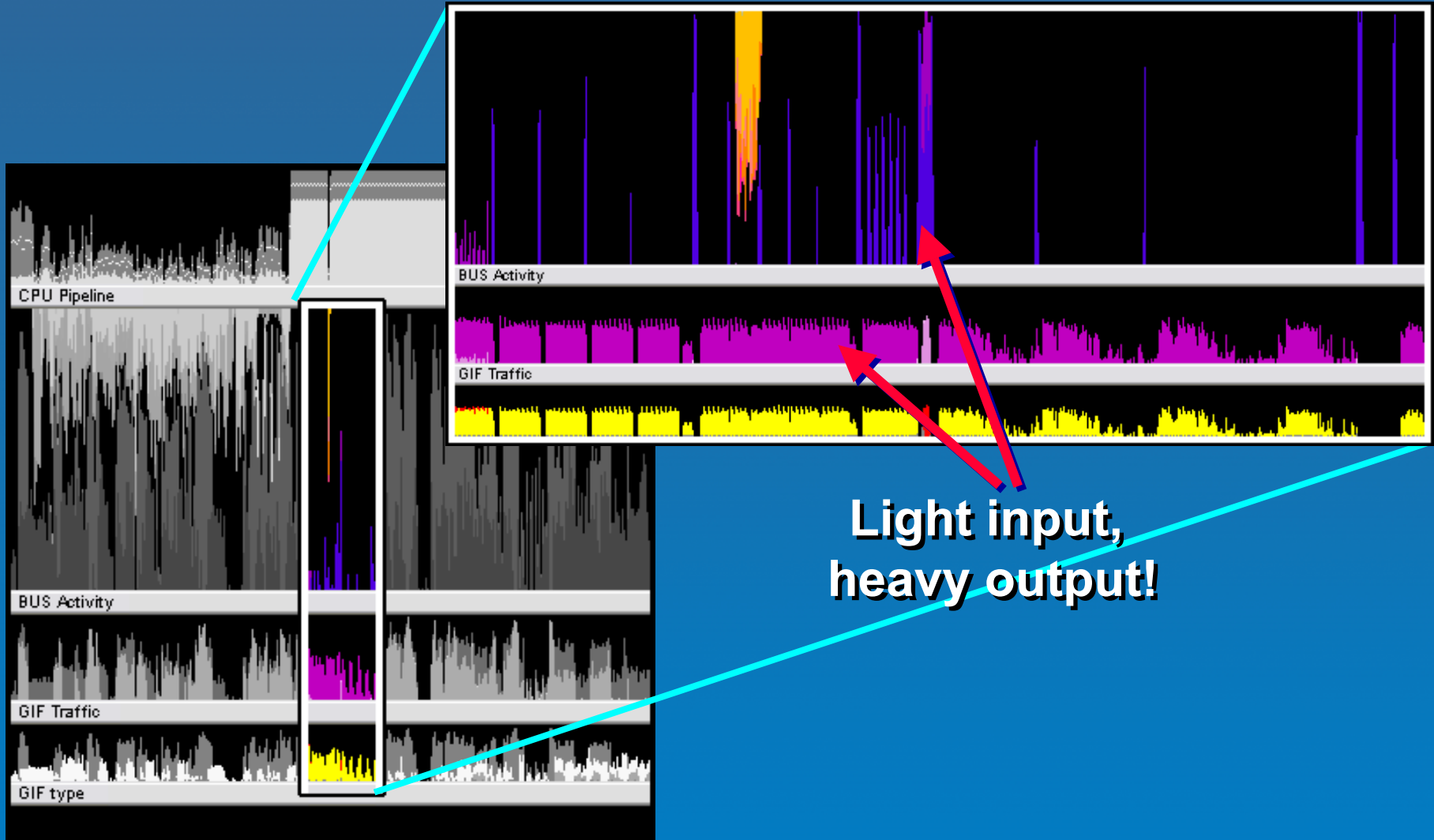
The 3 cars I'm racing against! All high poly-count models, ~17500 polygons total. Nice!...

Burnout 2: GS-Bound (cont.)

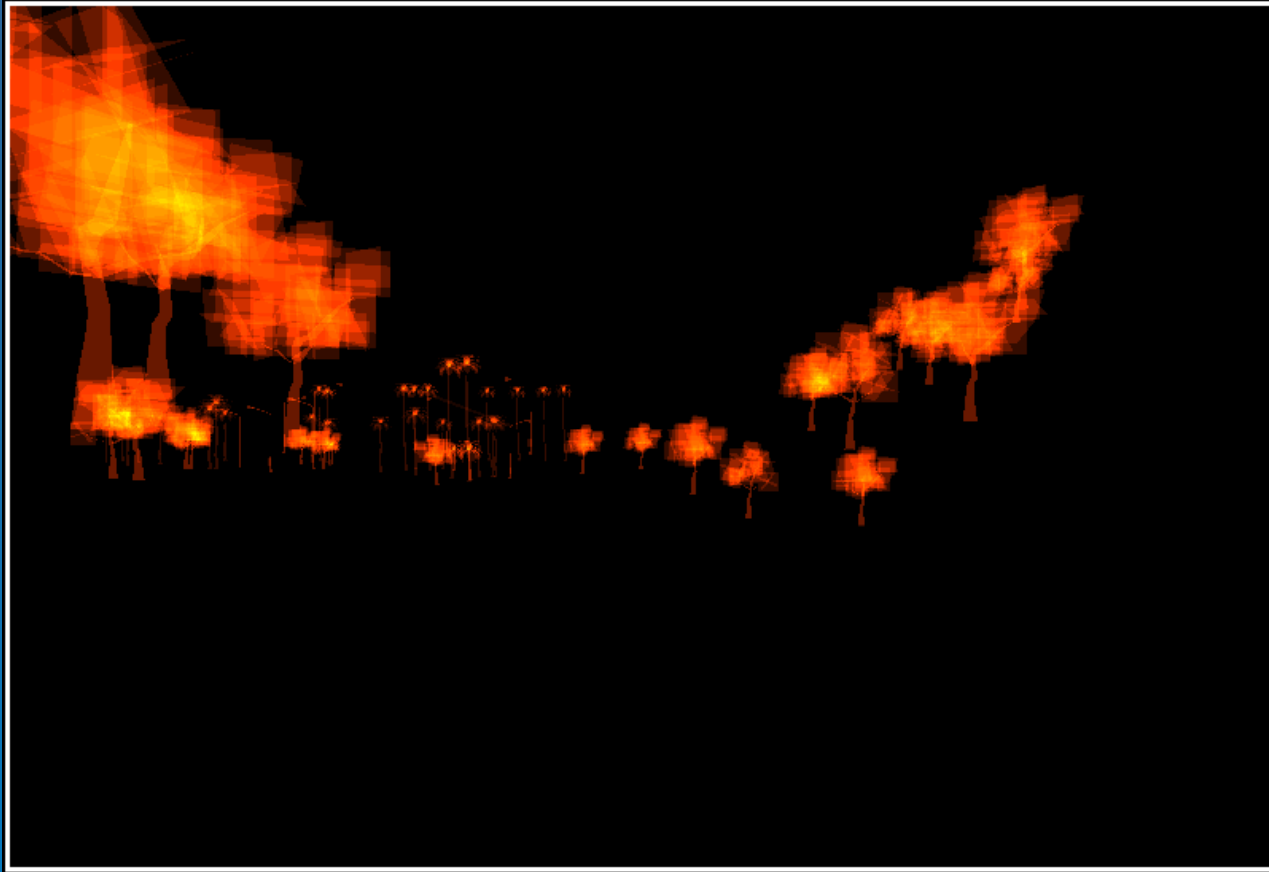


OH WAIT. Only 1287 pixels generated!

Burnout 2: Trees Rendering



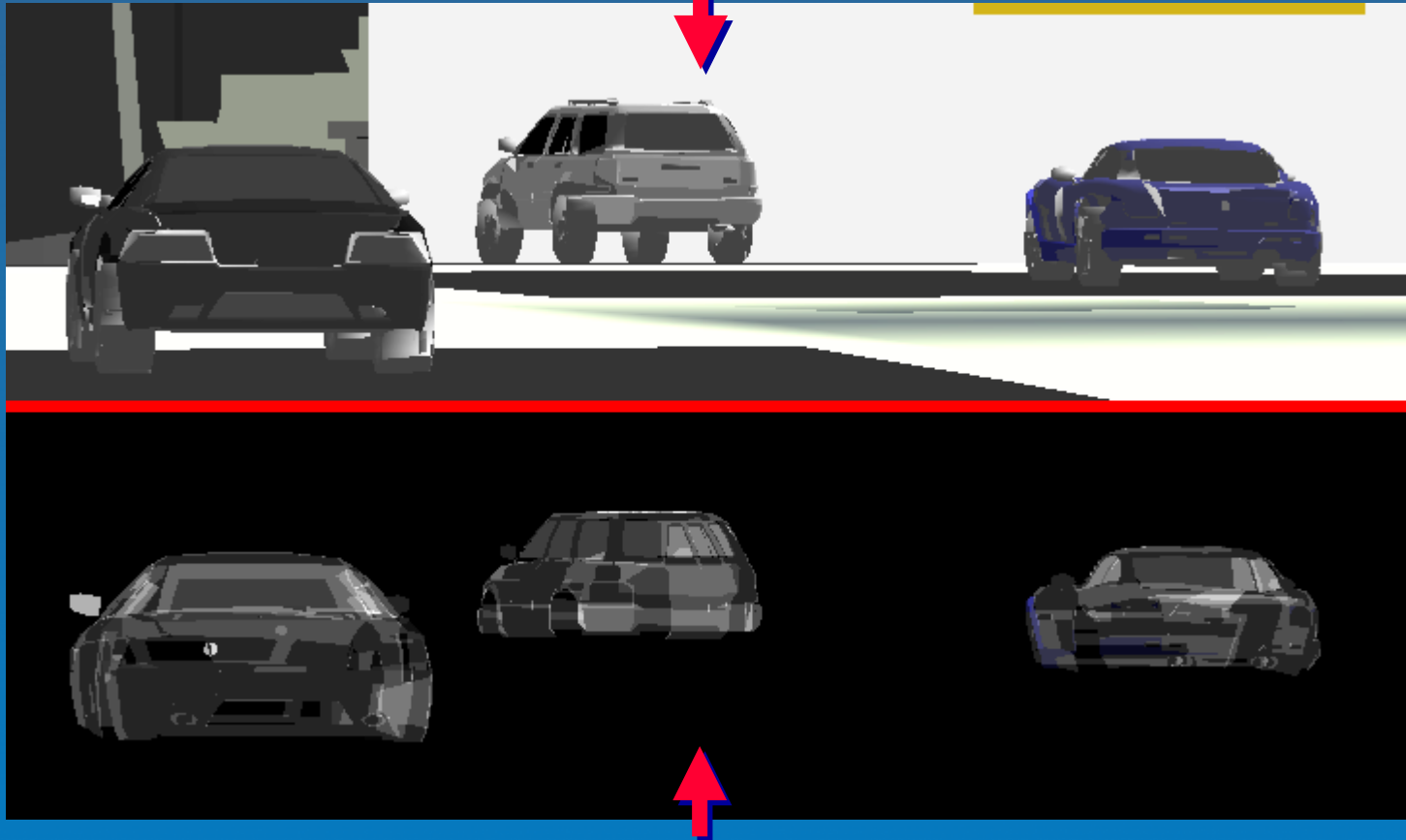
Burnout 2: Trees Rendering (cont.)



Overdraw display of the trees rendering

Burnout 2: Context 2 Use

Both context 1 and 2



Context 2 only (environment mapping)

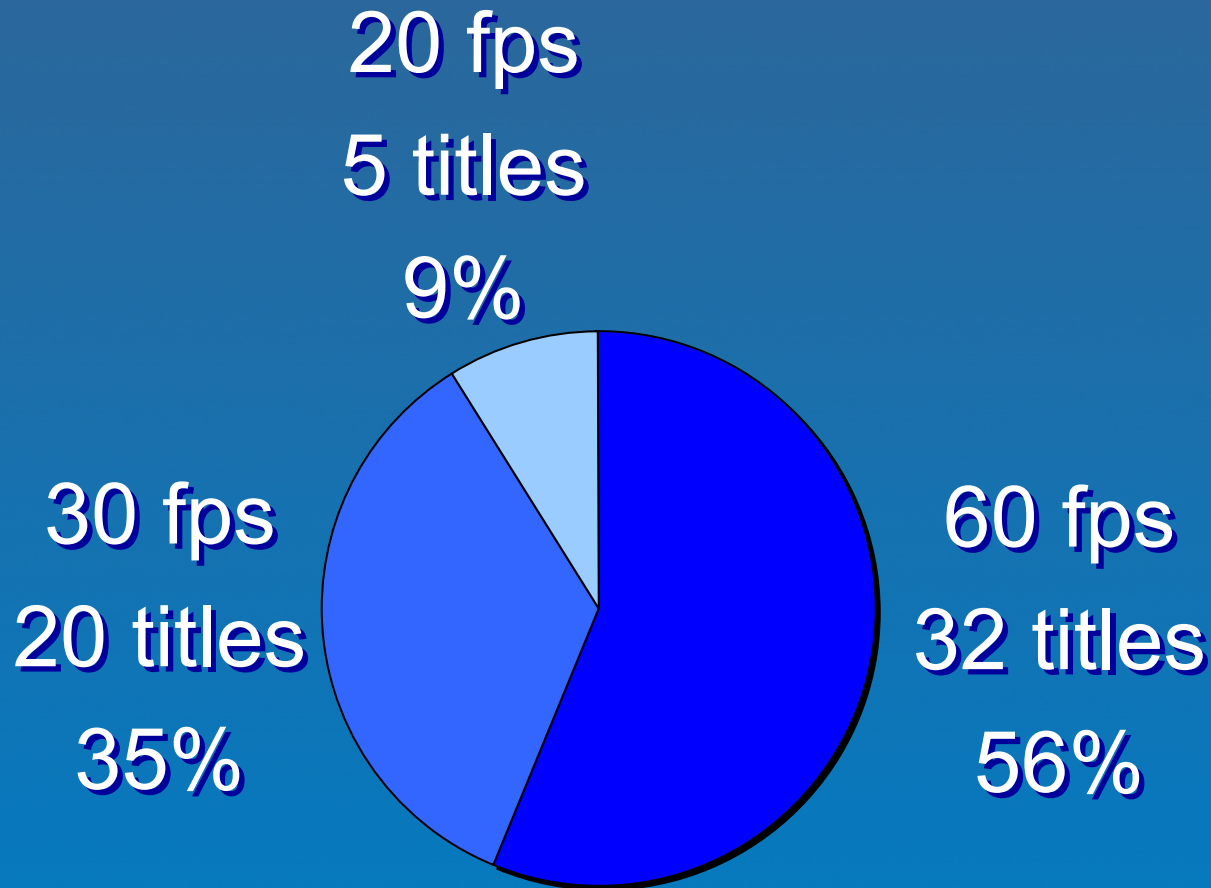
Burnout 2: Conclusion

- Any title can benefit from using the Performance Analyzer
- Yours can benefit as well!

PA Survey

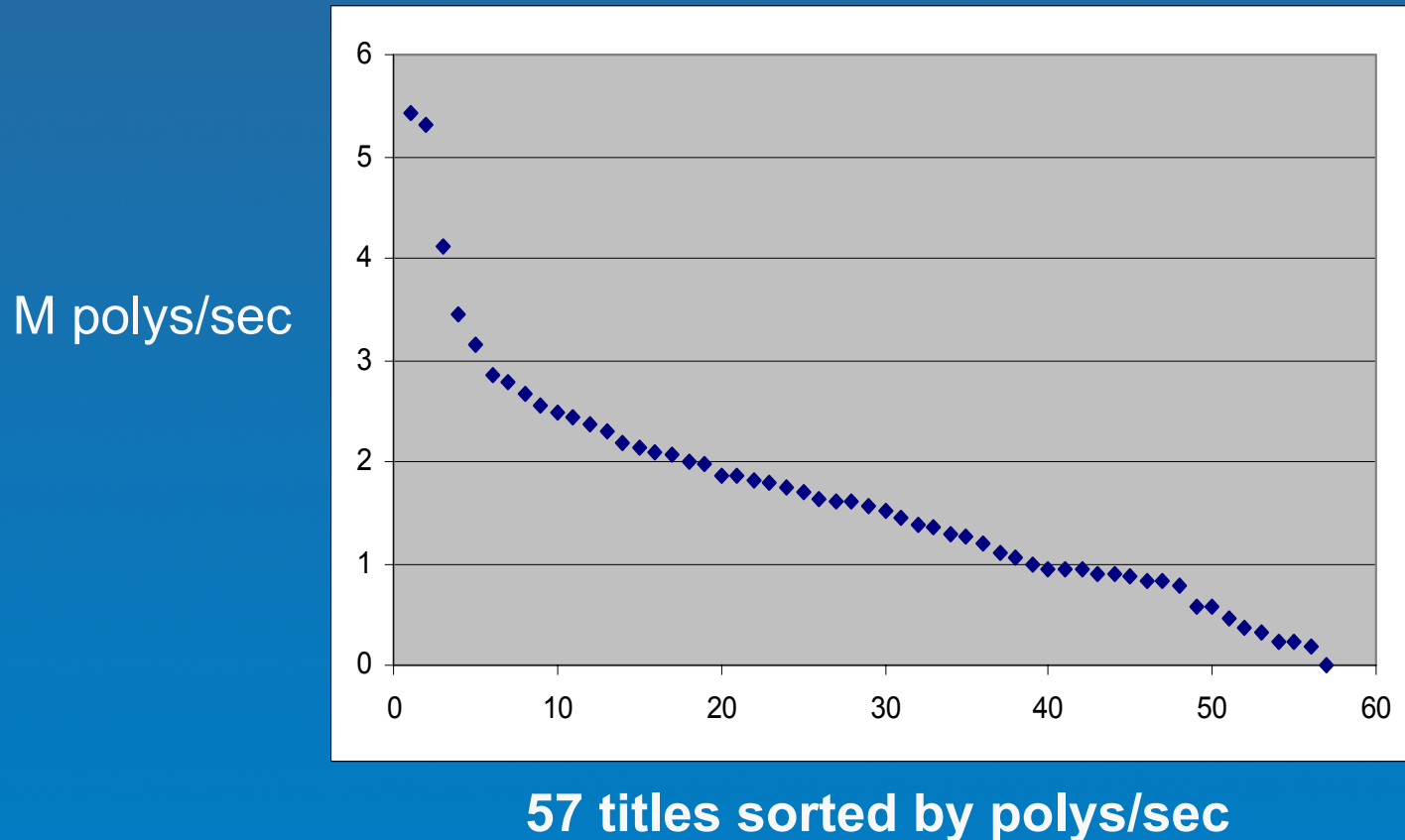
- Captured PA Statistics on 57 titles
- All titles released Nov.-Dec. 2002
- Unscientific!
 - All genres
 - Captured “typical” frame
 - Frame rate of a title may vary
 - “Ballpark” numbers

PA Survey: Frame Rate



PA Survey: Polygon Rate

- Polygons/sec (SRV)
 - Max 5.4 Million, Average 1.7 Million



PA Survey: Misc.

- Polygons/frame:
 - Max 180K
 - Average 40K
- VU0 micro-mode:
 - Max 12% of frame
 - Average 0.9%
 - 58% of titles did not use VU0 micro-mode
- Scratchpad:
 - 54% did not use DMA to/from SPR (ch. 8,9)

Conclusion

- With the latest hardware and software, the Performance Analyzer really gives you a good picture of what's happening on the PlayStation®2 architecture
- No excuse anymore!!!

Questions?

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