TEGRA K1 DEVELOPER TOOLS FOR ANDROID

Sébastien Dominé, Sr. Director SW Engineering | SIGGRAPH 2014

AGENDA

- NVIDIA Developer Tools Introduction
- Multi-core CPU tools
- Graphics Developer Tools
- Compute Developer Tools
- Q&A

https://developer.nvidia.com/gameworks

NVIDIA BEST OF GTC

NVIDIA DEVELOPER TOOLS

BUILD. DEBUG. PROFILE.

Microsoft DirectX | OpenGL | NVIDIA CUDA | OpenGL ES | Android NDK

IDE INTEGRATION

Visual Studio

eclipse

STANDALONE TOOLS

HARDWARE SUPPORT
CPU AND GPU DEBUGGING/PROFILING

https://developer.nvidia.com/gameworks

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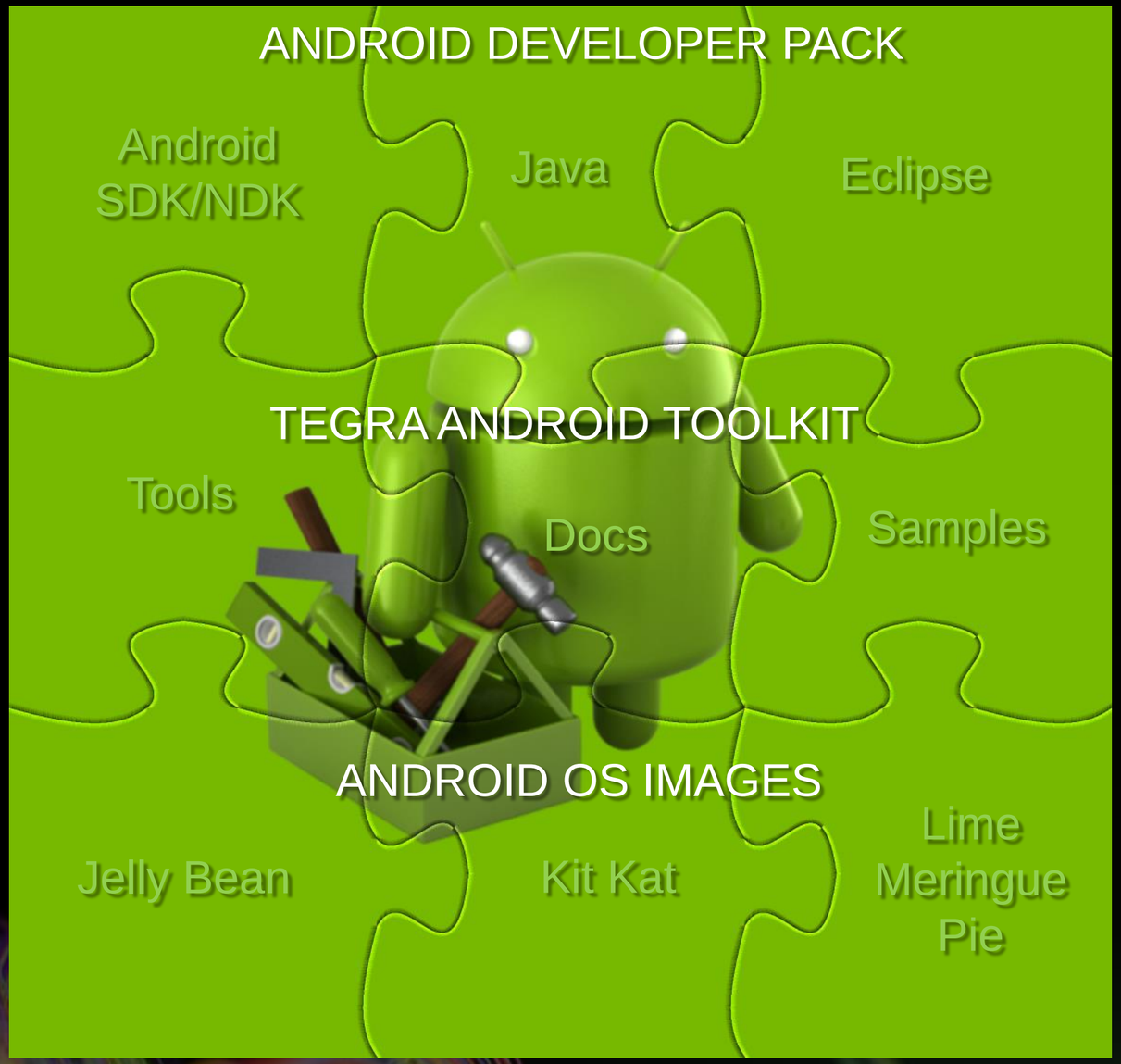

Tegra Android Development Pack

For Windows, OSX, Linux

GET STARTED in minutes NOT hours or days
INSTALLS all tools required for Tegra Android

CPU DEBUGGING with Nsight Tegra
GPU DEBUGGING with Tegra Graphics Debugger
OPTIMIZE applications with Tegra System Profiler
REFERENCE docs, samples & tutorials

OPTIMIZED for Tegra Android development
FLASHES Tegra DevKit with OS Image
CONFIGURED for debugging and profiling
INCLUDES some Driver symbols and DS-5 support

https://developer.nvidia.com/gameworks

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TEGRA CPU DEVELOPER TOOLS

CPU Debugging

- Supports Android/Linux standard tools
  - Eclipse/NDK/JDK
  - Android Studio
  - Gdb/gdbserver 7.3.x (Android)

- Nsight® Tegra™ Visual Studio Edition
  - Gdb/Jdb within Visual Studio

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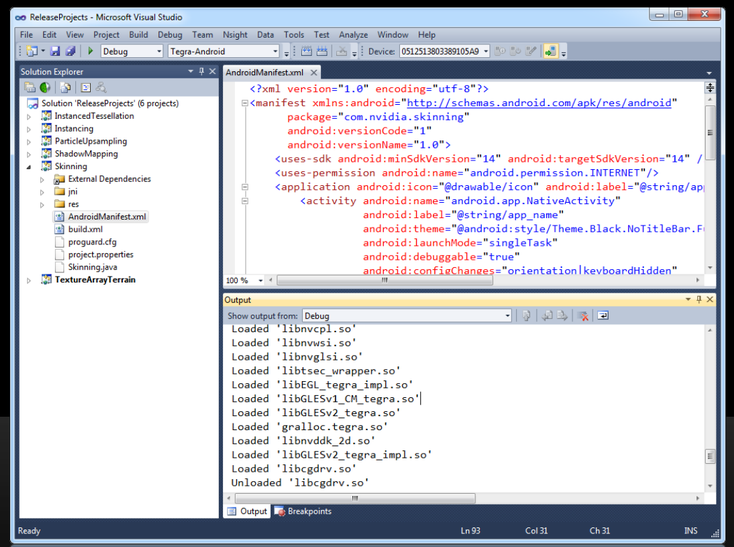
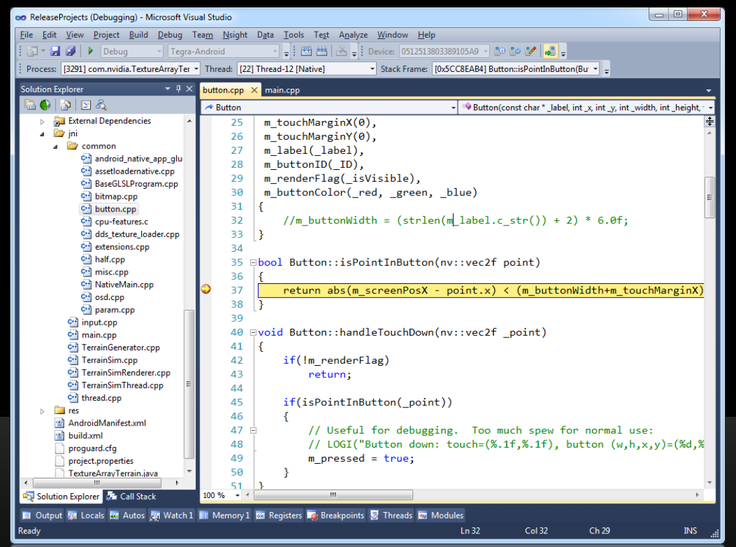
NVIDIA® NSIGHT™ TEGRA

Android NDK/JDK application development

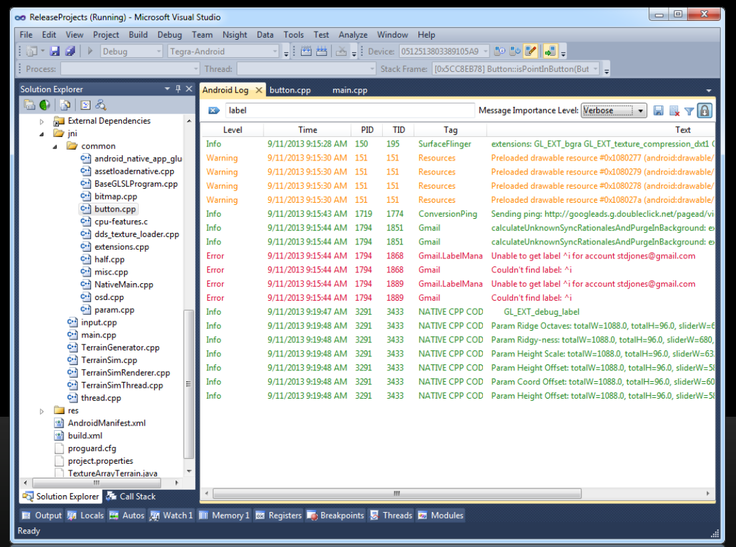
Visual Studio



Project Management



Android Debugging



Logcat Filtering

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NSIGHT TEGRA Visual Studio 1.6

- Microsoft® Visual Studio™ 2013
- NDK r9d / Android SDK 22.3
- Support for external build systems (makefile)
- ***IncrediBuild 5.5*** support to allow for distributed builds
- Faster wireless debugging support
- Breakpoints in NEON code
- HardFP support

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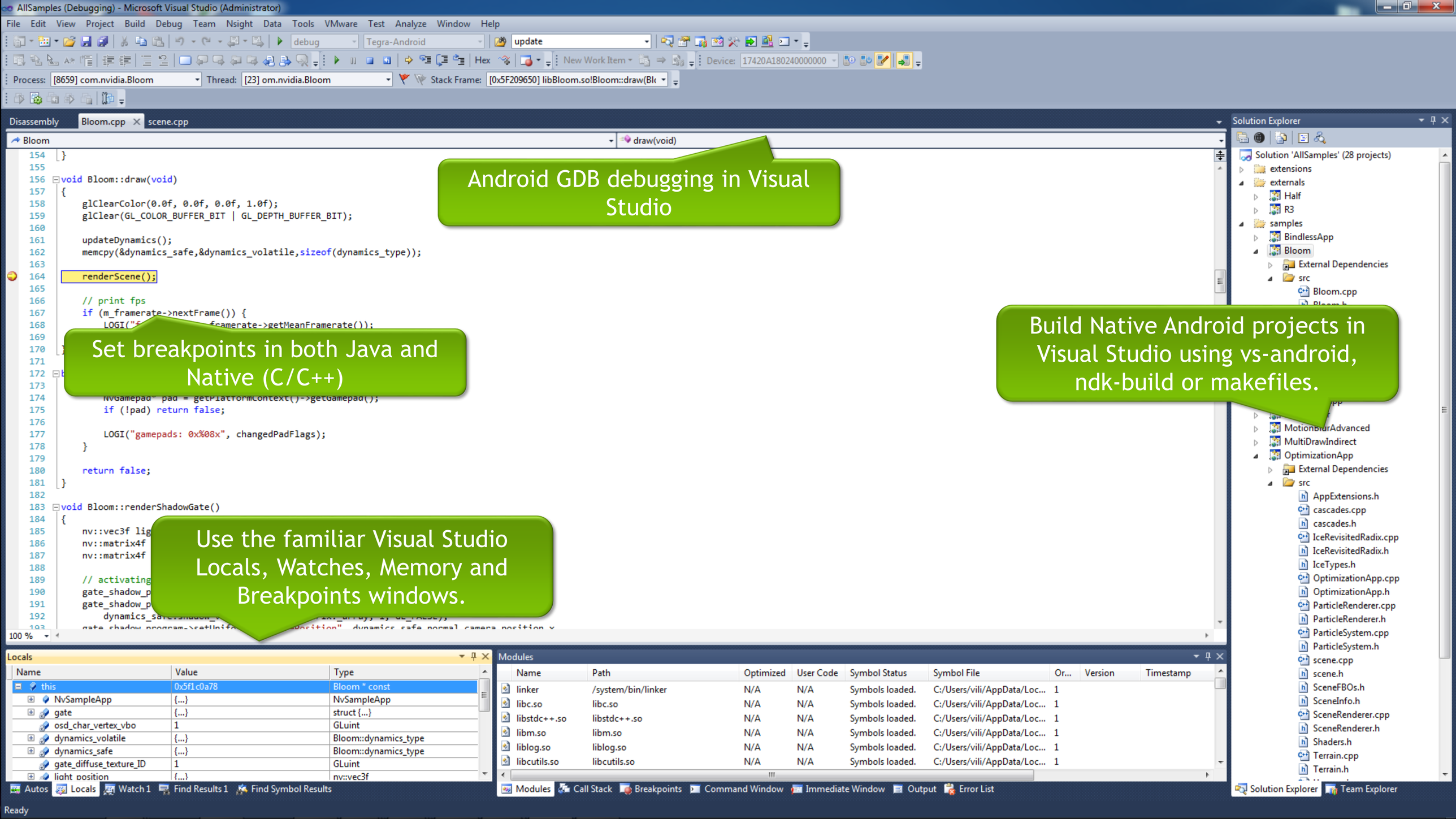
AllSamples (Debugging) - Microsoft Visual Studio (Administrator)
File Edit View Project Build Debug Team Nsight Data Tools VMware Test Analyze Window Help
Process: [8659] com.nvidia.Bloom
Thread: [23] om.nvidia.Bloom
Stack Frame: [0x5F209650] libBloom.so!Bloom::draw(Bl
Disassembly
Bloom.cpp
scene.cpp
Bloom
draw(void)
154 }
155
156 void Bloom::draw(void)
157 {
158 glClearColor(0.0f, 0.0f, 0.0f, 1.0f);
159 glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
160
161 updateDynamics();
162 memcpy(&dynamics_safe,&dynamics_volatile,sizeof(dynamics_type));
163
164 renderScene();
165
166 // print fps
167 if (m_framerate->nextFrame()) {
168 LOGI("
framerate->getMeanFramerate());
169
170 }
171
172 b
173
174 NvGamepad* pad = getPlatformContext()->getGamepad();
175 if (!pad) return false;
176
177 LOGI("gamepads: 0x%08x", changedPadFlags);
178 }
179
180 return false;
181 }
182
183 void Bloom::renderShadowGate()
184 {
185 nv::vec3f lig
186 nv::matrix4f
187 nv::matrix4f
188
189 // activating
190 gate_shadow_p
191 gate_shadow_p
192 dynamics_sa
193 gate_shadow_program->setUnif
Position", dynamics_safe.normal_camera_position.x
100 %
Android GDB debugging in Visual Studio
Set breakpoints in both Java and Native (C/C++)
Use the familiar Visual Studio Locals, Watches, Memory and Breakpoints windows.
Build Native Android projects in Visual Studio using vs-android, ndk-build or makefiles.
Solution Explorer
Solution 'AllSamples' (28 projects)
extensions
externals
Half
R3
samples
BindlessApp
Bloom
External Dependencies
src
Bloom.cpp
MotionBlurAdvanced
MultiDrawIndirect
OptimizationApp
External Dependencies
src
AppExtensions.h
cascades.cpp
cascades.h
IceRevisitedRadix.cpp
IceRevisitedRadix.h
IceTypes.h
OptimizationApp.cpp
OptimizationApp.h
ParticleRenderer.cpp
ParticleRenderer.h
ParticleSystem.cpp
ParticleSystem.h
scene.cpp
scene.h
SceneFBOs.h
SceneInfo.h
SceneRenderer.cpp
SceneRenderer.h
Shaders.h
Terrain.cpp
Terrain.h
Solution Explorer
Team Explorer
Locals
Name Value Type
this 0x5f1c0a78 Bloom * const
NvSampleApp {...} NvSampleApp
gate {...} struct {...}
osd_char_vertex_vbo 1 GLuint
dynamics_volatile {...} Bloom::dynamics_type
dynamics_safe {...} Bloom::dynamics_type
gate_diffuse_texture_ID 1 GLuint
light_position {...} nv::vec3f
Autos
Locals
Watch 1
Find Results 1
Find Symbol Results
Modules
Name Path Optimized User Code Symbol Status Symbol File Or... Version Timestamp
linker /system/bin/linker N/A N/A Symbols loaded. C:/Users/vili/AppData/Loc... 1
libc.so libc.so N/A N/A Symbols loaded. C:/Users/vili/AppData/Loc... 1
libstdc++.so libstdc++.so N/A N/A Symbols loaded. C:/Users/vili/AppData/Loc... 1
libm.so libm.so N/A N/A Symbols loaded. C:/Users/vili/AppData/Loc... 1
liblog.so liblog.so N/A N/A Symbols loaded. C:/Users/vili/AppData/Loc... 1
libcutils.so libcutils.so N/A N/A Symbols loaded. C:/Users/vili/AppData/Loc... 1
Modules
Call Stack
Breakpoints
Command Window
Immediate Window
Output
Error List
Ready

TEGRA CPU DEVELOPER TOOLS

CPU Profiling

- Supports Android/Linux standard tools
  - Systrace/atrace/ftrace
  - Perf
    - L1-dcache|icache-load|store|prefetch{-misses}
    - l2cache-dr/dw/instr-misses
  - Oprofile
- ARM DS-5 Gator
- Tegra System Profiler

https://developer.nvidia.com/gameworks

NVIDIA BEST OF GTC

TEGRA SYSTEM PROFILER

Multi-core CPU profiler for all Tegra platforms

- Windows, Linux and OSX host application
- Maximize multi-core A15/A9 CPU utilization
- Quickly identify CPU “hot spots” and “hot paths”
- Quickly identify L1/L2 cache issues
- Easily prepare a device for profiling
- Easily deploy applications for profiling

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WHAT'S NEW WITH TEGRA SYSTEM PROFILER 2.1

- Visualize multi-core CPU activities with a new timeline view
- Processor, core, thread utilization
- New backtrace options simplify call stack collection
- CPU usage broken down by module
- New Stack% mode to isolate cycles spent on high-level algorithms
- Visualize thread core migration
- Time range filtering

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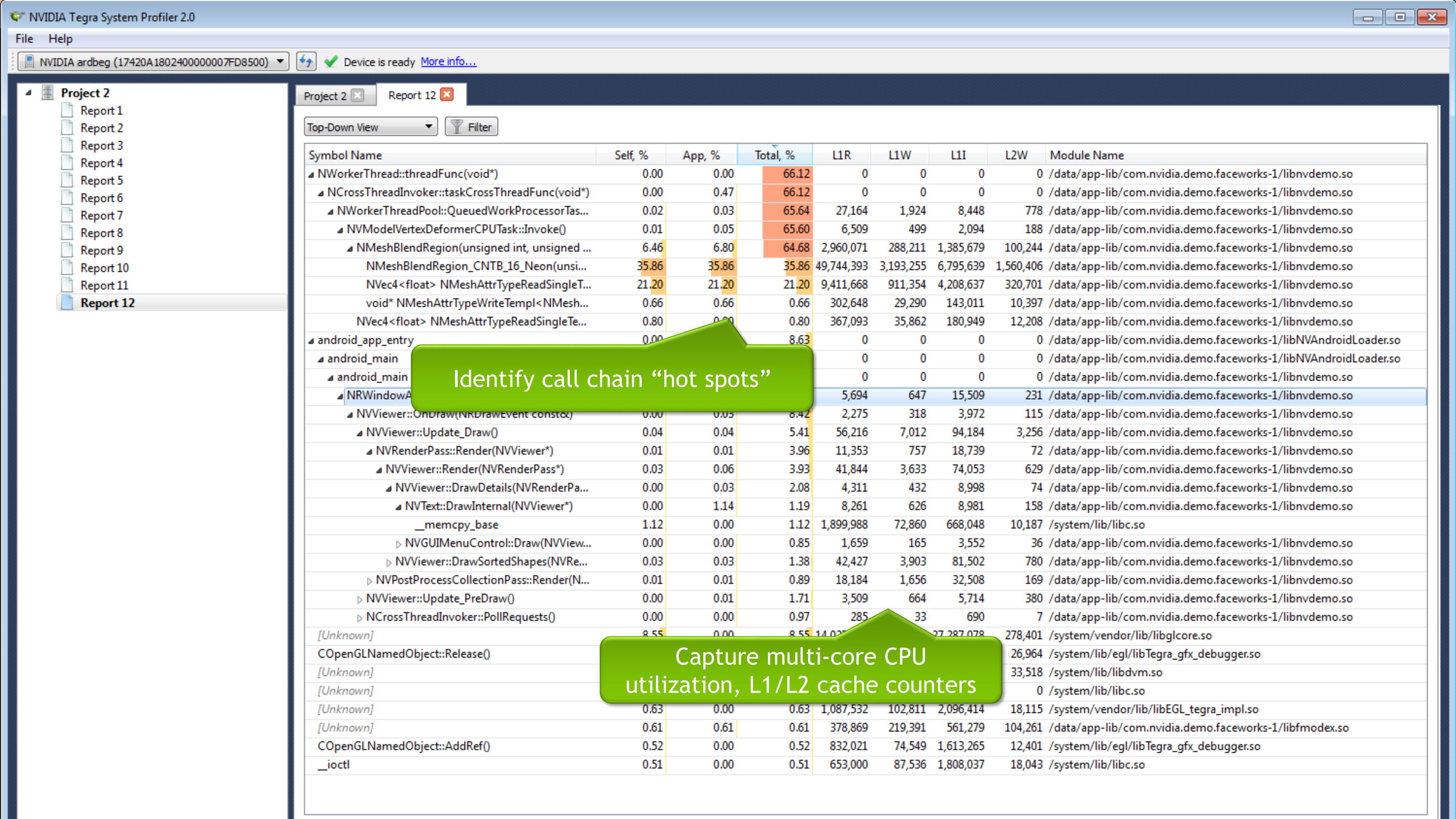
NVIDIA Tegra System Profiler 2.0
File
Help
NVIDIA ardbeg (17420A1802400000007FD8500)
Device is ready
More info...
Project 2
Report 1
Report 2
Report 3
Report 4
Report 5
Report 6
Report 7
Report 8
Report 9
Report 10
Report 11
Report 12
Project 2
Report 12
Top-Down View
Filter
Symbol Name
Self, %
App, %
Total, %
L1R
L1W
L1I
L2W
Module Name
NWorkerThread::threadFunc(void*) 0.00 0.00 66.12 0 0 0 0 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NCrossThreadInvoker::taskCrossThreadFunc(void*) 0.00 0.47 66.12 0 0 0 0 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NWorkerThreadPool::QueuedWorkProcessorTas... 0.02 0.03 65.64 27,164 1,924 8,448 778 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVModelVertexDeformerCPUTask::Invoke() 0.01 0.05 65.60 6,509 499 2,094 188 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NMeshBlendRegion(unsigned int, unsigned ... 6.46 6.80 64.68 2,960,071 288,211 1,385,679 100,244 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NMeshBlendRegion_CNTB_16_Neon(unsi... 35.86 35.86 35.86 49,744,393 3,193,255 6,795,639 1,560,406 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVec4<float> NMeshAttrTypeReadSingleT... 21.20 21.20 21.20 9,411,668 911,354 4,208,637 320,701 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
void* NMeshAttrTypeWriteTempl<NMesh... 0.66 0.66 0.66 302,648 29,290 143,011 10,397 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVec4<float> NMeshAttrTypeReadSingleTe... 0.80 0.80 0.80 367,093 35,862 180,949 12,208 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
android_app_entry 0.00 8.63 0 0 0 0 /data/app-lib/com.nvidia.demo.faceworks-1/libNVAndroidLoader.so
android_main 0 0 0 0 /data/app-lib/com.nvidia.demo.faceworks-1/libNVAndroidLoader.so
android_main 0 0 0 0 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NRWindowA 5,694 647 15,509 231 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVViewer::OnDraw(NRDrawEvent const&) 0.00 0.03 8.42 2,275 318 3,972 115 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVViewer::Update_Draw() 0.04 0.04 5.41 56,216 7,012 94,184 3,256 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVRenderPass::Render(NVViewer*) 0.01 0.01 3.96 11,353 757 18,739 72 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVViewer::Render(NVRenderPass*) 0.03 0.06 3.93 41,844 3,633 74,053 629 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVViewer::DrawDetails(NVRenderPa... 0.00 0.03 2.08 4,311 432 8,998 74 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVText::DrawInternal(NVViewer*) 0.00 1.14 1.19 8,261 626 8,981 158 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
__memcpy_base 1.12 0.00 1.12 1,899,988 72,860 668,048 10,187 /system/lib/libc.so
NVGUIMenuControl::Draw(NVView... 0.00 0.00 0.85 1,659 165 3,552 36 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVViewer::DrawSortedShapes(NVRe... 0.03 0.03 1.38 42,427 3,903 81,502 780 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVPostProcessCollectionPass::Render(N... 0.01 0.01 0.89 18,184 1,656 32,508 169 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NVViewer::Update_PreDraw() 0.00 0.01 1.71 3,509 664 5,714 380 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
NCrossThreadInvoker::PollRequests() 0.00 0.00 0.97 285 33 690 7 /data/app-lib/com.nvidia.demo.faceworks-1/libnvdemo.so
[Unknown] 278,401 /system/vendor/lib/libglcore.so
COpenGLNamedObject::Release() 26,964 /system/lib/egl/libTegra_gfx_debugger.so
[Unknown] 33,518 /system/lib/libdvm.so
[Unknown] 0 /system/lib/libc.so
[Unknown] 0.63 0.00 0.63 1,087,532 102,811 2,096,414 18,115 /system/vendor/lib/libEGL_tegra_impl.so
[Unknown] 0.61 0.61 0.61 378,869 219,391 561,279 104,261 /data/app-lib/com.nvidia.demo.faceworks-1/libfmodex.so
COpenGLNamedObject::AddRef() 0.52 0.00 0.52 832,021 74,549 1,613,265 12,401 /system/lib/egl/libTegra_gfx_debugger.so
__ioctl 0.51 0.00 0.51 653,000 87,536 1,808,037 18,043 /system/lib/libc.so
Identify call chain “hot spots”
Capture multi-core CPU utilization, L1/L2 cache counters

GRAPHICS DEVELOPER TOOLS

- Tegra Graphics Debugger
  - Frame Debugging and Profiling
  - Shader Debugging and Pixel History (v2.0)
- Nsight Visual Studio Edition
  - Frame Debugging and Profiling
  - Shader Debugging and Pixel History
  - System trace
- PerfKit
  - API to sample performance SW and HW counters

https://developer.nvidia.com/gameworks

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TEGRA GRAPHICS DEBUGGER

Next-gen graphics development tools for TEGRA K1

- Supports OpenGL 4.x, OpenGL ES 2.0/3.0/3.1 + numerous extensions
- Monitor key software and hardware performance metrics
- Debug draw calls, related states and resources
- Live capture of a single rendering frame
- Edit and recompile shaders live
- Automatic GPU bottleneck analysis
- Advanced timings for draw calls and kernel dispatches

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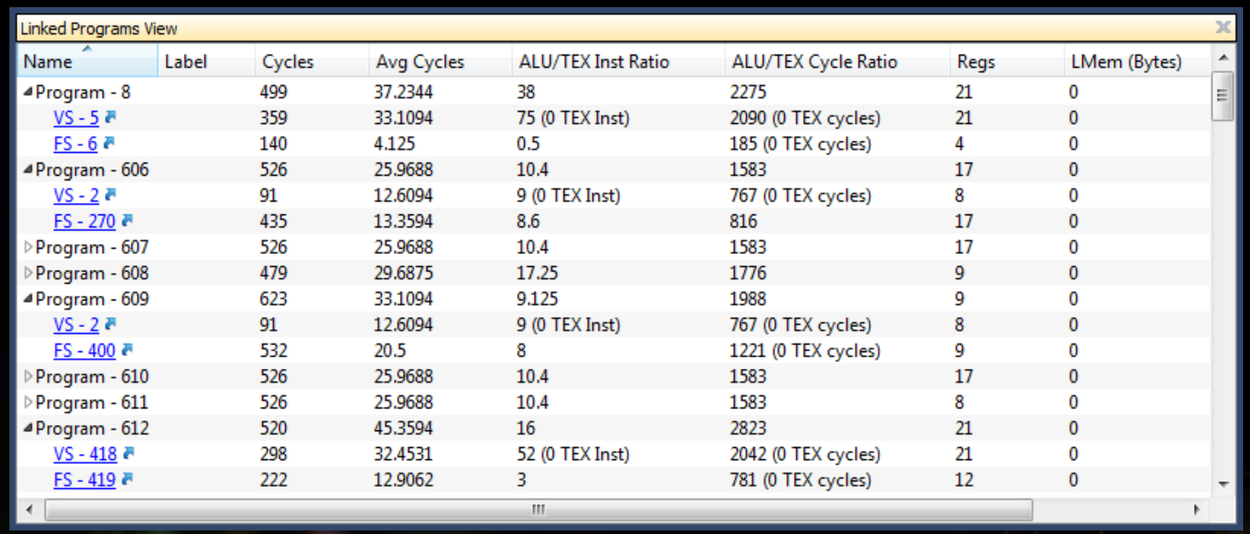
WHAT'S NEW WITH TEGRA GRAPHICS DEBUGGER 1.1

- Offline Shader Performance Analysis for Tegra K1
- ASTC Texture compression
- Google OpenGL ES 3.1 extensions (KHR_Debug, …)
- Android Extension Pack
  - ARB_tessellation_shader
  - ARB_Geometry_shader4
  - ARB_texture_cube_map_array
  - ARB_texture_buffer_object
  - ARB_texture_view
  - ARB_gpu_shader5
- Launch process to debug



https://developer.nvidia.com/gameworks

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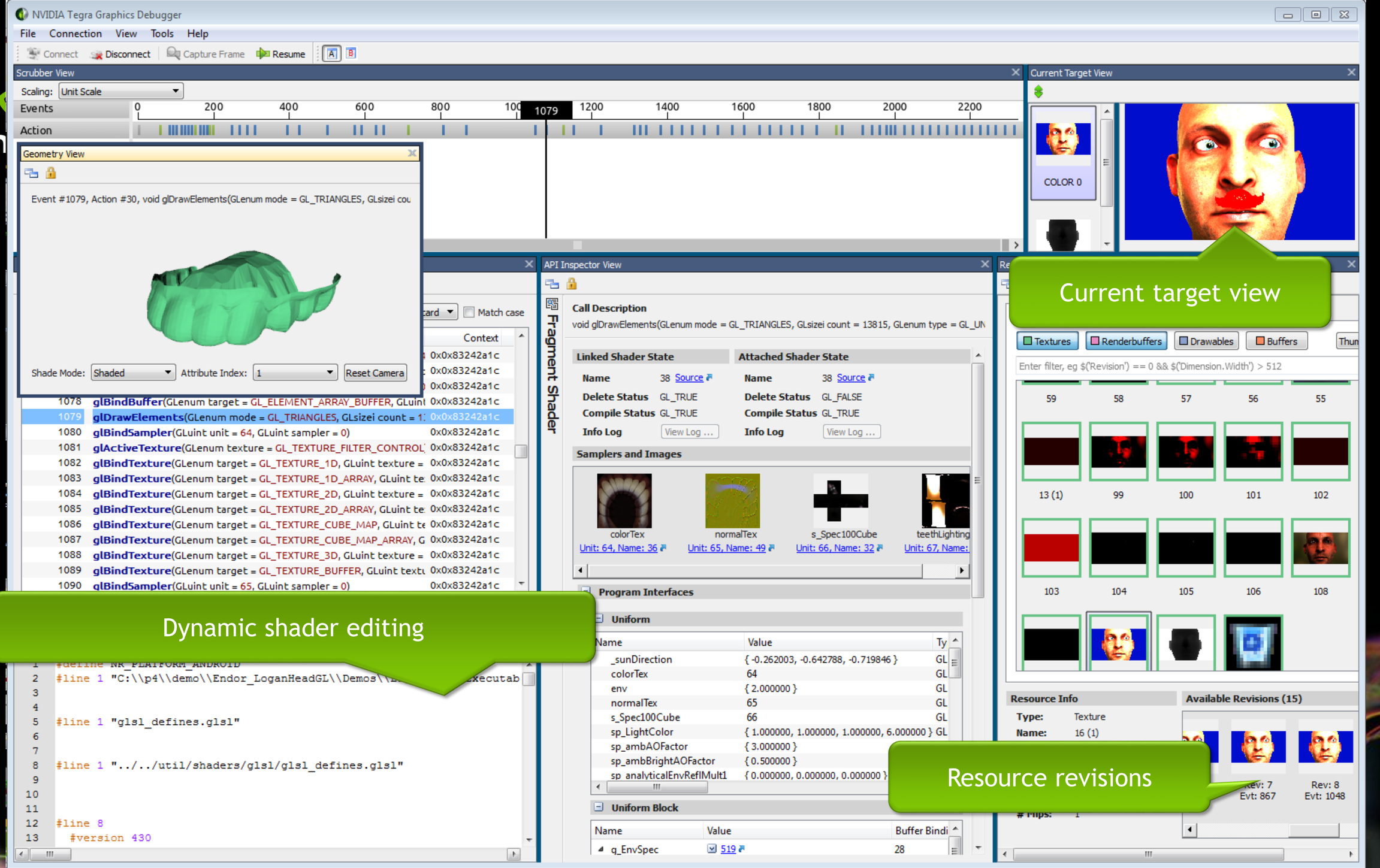
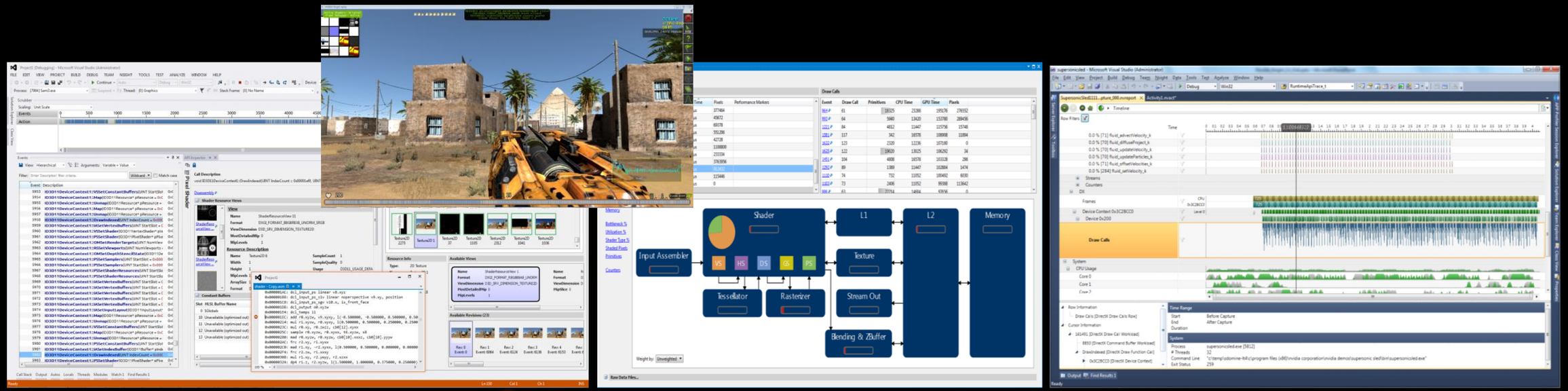

NVIDIA Tegra Graphics Debugger
File Connection View Tools Help
Connect Disconnect Capture Frame Resume
Scrubber View
Scaling: Unit Scale
Events
Action
0 200 400 600 800 1000 1079 1200 1400 1600 1800 2000 2200
Geometry View
Event #1079, Action #30, void glDrawElements(GLenum mode = GL_TRIANGLES, GLsizei cou
Shade Mode: Shaded
Attribute Index: 1
Reset Camera
Current Target View
COLOR 0
Current target view
API Inspector View
Fragment Shader
Call Description
void glDrawElements(GLenum mode = GL_TRIANGLES, GLsizei count = 13815, GLenum type = GL_UN
Linked Shader State
Attached Shader State
Name 38 Source
Delete Status GL_TRUE
Compile Status GL_TRUE
Info Log View Log ...
Name 38 Source
Delete Status GL_FALSE
Compile Status GL_TRUE
Info Log View Log ...
Samplers and Images
colorTex Unit: 64, Name: 36
normalTex Unit: 65, Name: 49
s_Spec100Cube Unit: 66, Name: 32
teethLighting Unit: 67, Name:
Program Interfaces
Uniform
Name Value
_sunDirection { -0.262003, -0.642788, -0.719846 }
colorTex 64
env { 2.000000 }
normalTex 65
s_Spec100Cube 66
sp_LightColor { 1.000000, 1.000000, 1.000000, 6.000000 }
sp_ambAOFactor { 3.000000 }
sp_ambBrightAOFactor { 0.500000 }
Uniform Block
Name Value Buffer Bindi
q_EnvSpec 519 28
Context
1078 glBindBuffer(GLenum target = GL_ELEMENT_ARRAY_BUFFER, GLuint
1079 glDrawElements(GLenum mode = GL_TRIANGLES, GLsizei count = 1
1080 glBindSampler(GLuint unit = 64, GLuint sampler = 0)
1081 glActiveTexture(GLenum texture = GL_TEXTURE_FILTER_CONTROL
1082 glBindTexture(GLenum target = GL_TEXTURE_1D, GLuint texture =
1083 glBindTexture(GLenum target = GL_TEXTURE_1D_ARRAY, GLuint te
1084 glBindTexture(GLenum target = GL_TEXTURE_2D, GLuint texture =
1085 glBindTexture(GLenum target = GL_TEXTURE_2D_ARRAY, GLuint te
1086 glBindTexture(GLenum target = GL_TEXTURE_CUBE_MAP, GLuint te
1087 glBindTexture(GLenum target = GL_TEXTURE_CUBE_MAP_ARRAY, G
1088 glBindTexture(GLenum target = GL_TEXTURE_3D, GLuint texture =
1089 glBindTexture(GLenum target = GL_TEXTURE_BUFFER, GLuint textu
1090 glBindSampler(GLuint unit = 65, GLuint sampler = 0)
0x0x83242a1c
Dynamic shader editing
#line 1 "C:\\p4\\demo\\Endor_LoganHeadGL\\Demos\\
#line 1 "glsl_defines.glsl"
#line 1 "../../util/shaders/glsl/glsl_defines.glsl"
#line 8
#version 430
Textures Renderbuffers Drawables Buffers
Enter filter, eg $('Revision') == 0 && $('Dimension.Width') > 512
59 58 57 56 55
13 (1) 99 100 101 102
103 104 105 106 108
Resource Info
Type: Texture
Name: 16 (1)
Available Revisions (15)
Rev: 7 Evt: 867
Rev: 8 Evt: 1048
Resource revisions

NVIDIA® NSIGHT™ Visual Studio

Homogeneous application development for CPU+GPU, graphics and compute



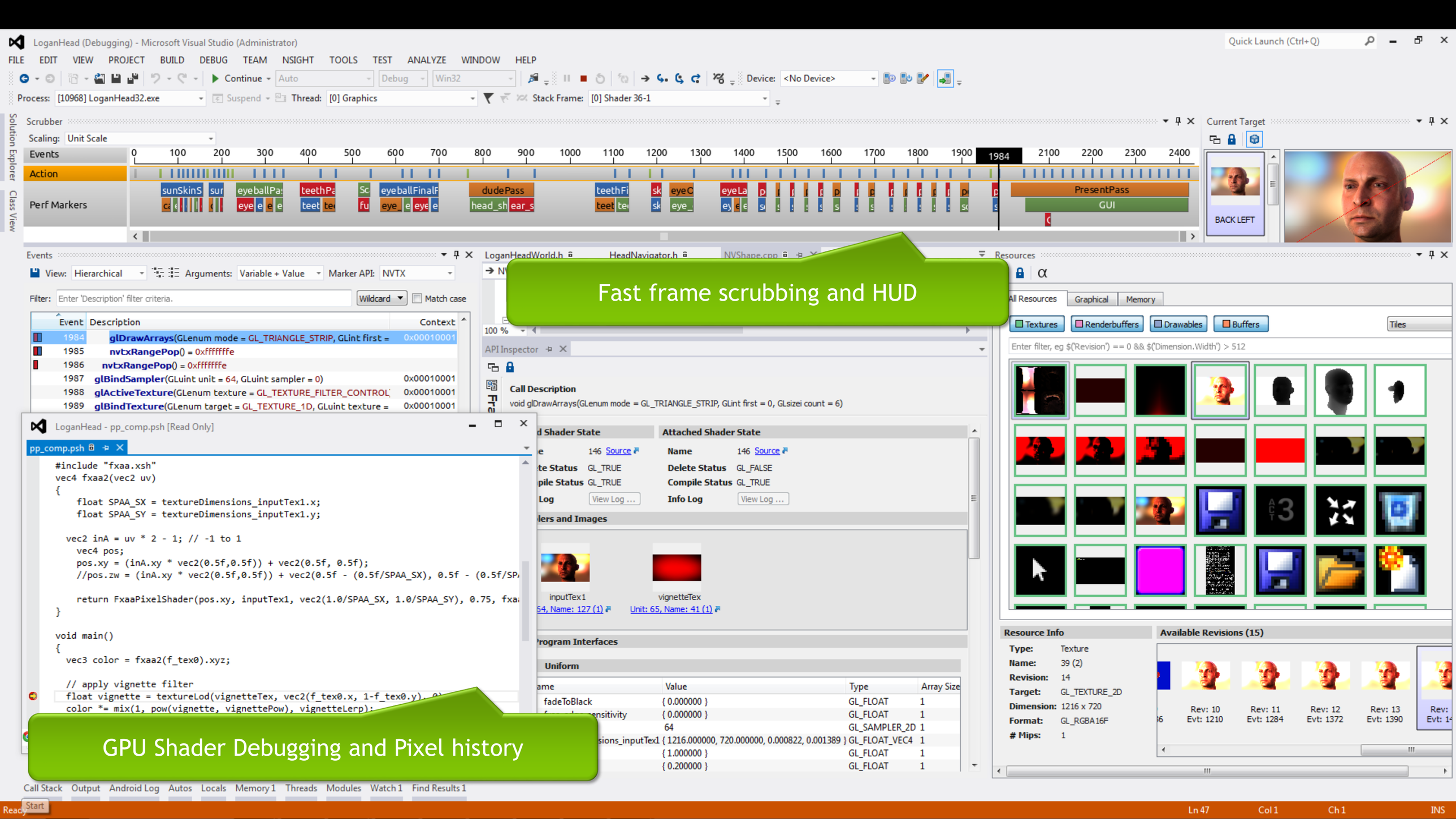
GPU Shader Debugger
Pixel History

Graphics Inspector
and Profiler

System Analysis

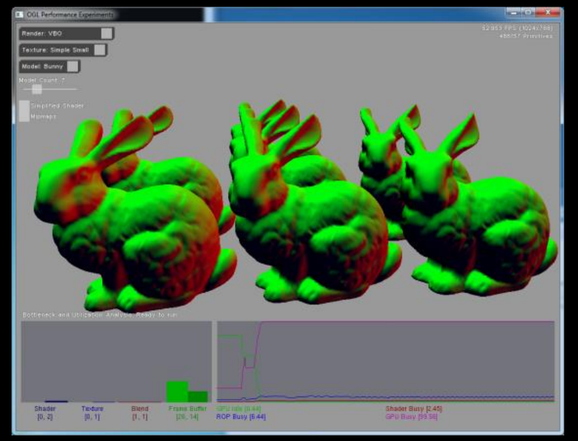
https://developer.nvidia.com/gameworks

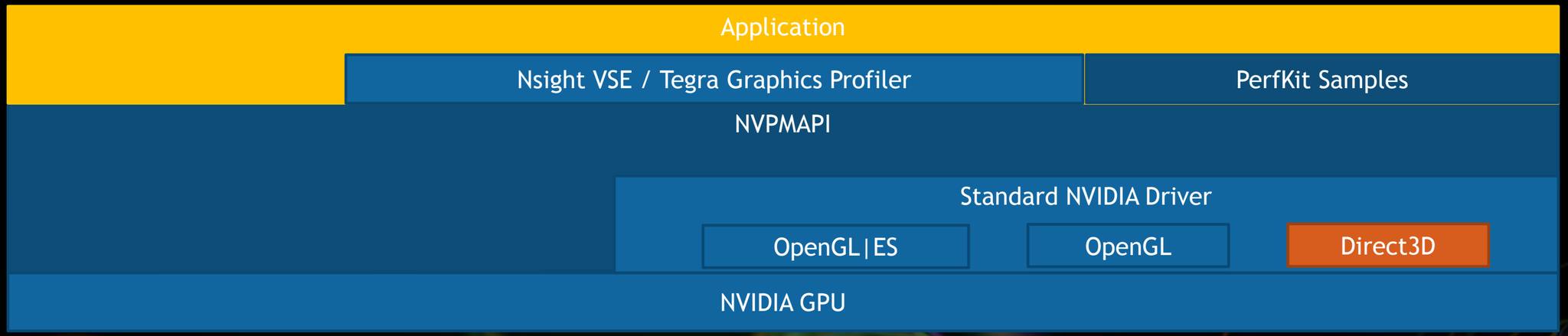
NVIDIA BEST OF GTC


LoganHead (Debugging) - Microsoft Visual Studio (Administrator)
Quick Launch (Ctrl+Q)
FILE EDIT VIEW PROJECT BUILD DEBUG TEAM NSIGHT TOOLS TEST ANALYZE WINDOW HELP
Continue
Device: <No Device>
Process: [10968] LoganHead32.exe
Thread: [0] Graphics
Stack Frame: [0] Shader 36-1
Scrubber
Scaling: Unit Scale
Events
Action
Perf Markers
PresentPass
GUI
Current Target
BACK LEFT
Fast frame scrubbing and HUD
Events
View: Hierarchical
Arguments: Variable + Value
Marker API: NVTX
Filter: Enter 'Description' filter criteria.
Wildcard
Match case
Event Description Context
1984 glDrawArrays(GLenum mode = GL_TRIANGLE_STRIP, GLint first = 0x00010001
1985 nvtxRangePop() = 0xffffffffe
1986 nvtxRangePop() = 0xffffffffe
1987 glBindSampler(GLuint unit = 64, GLuint sampler = 0) 0x00010001
1988 glActiveTexture(GLenum texture = GL_TEXTURE_FILTER_CONTROL 0x00010001
1989 glBindTexture(GLenum target = GL_TEXTURE_1D, GLuint texture = 0x00010001
LoganHead - pp_comp.psh [Read Only]
pp_comp.psh
#include "fxaa.xsh"
vec4 fxaa2(vec2 uv)
{
float SPAA_SX = textureDimensions_inputTex1.x;
float SPAA_SY = textureDimensions_inputTex1.y;
vec2 inA = uv * 2 - 1; // -1 to 1
vec4 pos;
pos.xy = (inA.xy * vec2(0.5f,0.5f)) + vec2(0.5f, 0.5f);
return FxaaPixelShader(pos.xy, inputTex1, vec2(1.0/SPAA_SX, 1.0/SPAA_SY), 0.75, fxa
}
void main()
{
vec3 color = fxaa2(f_tex0).xyz;
// apply vignette filter
float vignette = textureLod(vignetteTex, vec2(f_tex0.x, 1-f_tex0.y),
color *= mix(1, pow(vignette, vignettePow), vignetteLerp);
GPU Shader Debugging and Pixel history
API Inspector
Call Description
void glDrawArrays(GLenum mode = GL_TRIANGLE_STRIP, GLint first = 0, GLsizei count = 6)
Attached Shader State
Name 146 Source
Delete Status GL_FALSE
Compile Status GL_TRUE
Info Log View Log ...
Uniform
fadeToBlack { 0.000000 } GL_FLOAT 1
{ 0.000000 } GL_FLOAT 1
64 GL_SAMPLER_2D 1
{ 1216.000000, 720.000000, 0.000822, 0.001389 } GL_FLOAT_VEC4 1
{ 1.000000 } GL_FLOAT 1
{ 0.200000 } GL_FLOAT 1
inputTex1
vignetteTex
Unit: 65, Name: 41 (1)
Resources
All Resources
Graphical
Memory
Textures
Renderbuffers
Drawables
Buffers
Tiles
Enter filter, eg $('Revision') == 0 && $('Dimension.Width') > 512
Resource Info
Type: Texture
Name: 39 (2)
Revision: 14
Target: GL_TEXTURE_2D
Dimension: 1216 x 720
Format: GL_RGBA16F
Mips: 1
Available Revisions (15)
Rev: 10 Evt: 1210
Rev: 11 Evt: 1284
Rev: 12 Evt: 1372
Rev: 13 Evt: 1390
Call Stack Output Android Log Autos Locals Memory 1 Threads Modules Watch 1 Find Results 1
Ready
Ln 47 Col 1 Ch 1 INS

PERFKIT 3.1

- GPU and Software Performance Counter API
  - Performance Monitoring
  - Automated bottleneck analysis
  - Graphics and Compute
- Supports Kepler Architecture and higher on Android
- Available on Windows (upcoming Linux)





http://www.nvidia.com/object/nvperfkit_home.html

https://developer.nvidia.com/gameworks

NVIDIA BEST OF GTC

COMPUTE DEVELOPER TOOLS

- Nsight Eclipse Edition
  - Integrated CUDA development environment for Linux and MAC
- Nsight Visual Studio Edition
  - Integrated CUDA development environment for Windows

- CUDA 6.0 Toolkit command line tools for Android

- RenderScript Tegra K1 acceleration / No developer tools

https://developer.nvidia.com/gameworks

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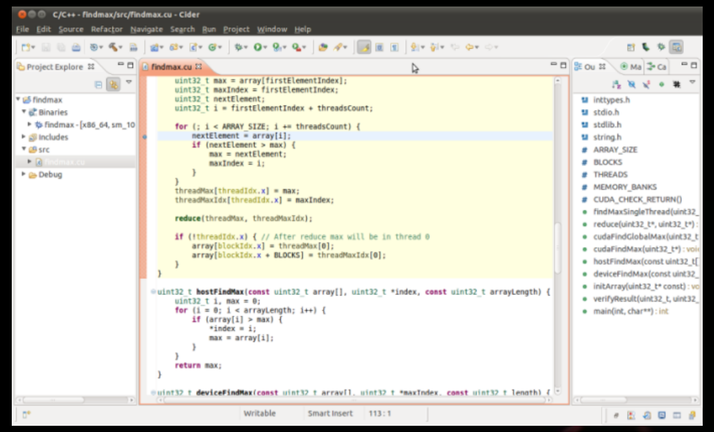
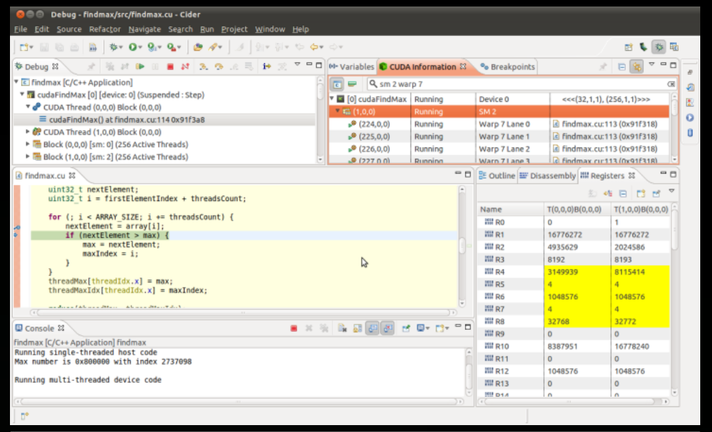
NVIDIA® NSIGHT™ eclipse

Homogeneous application development for CPU+GPU compute platforms

Build, Debug and Profile on remote targets with CUDA 6.0

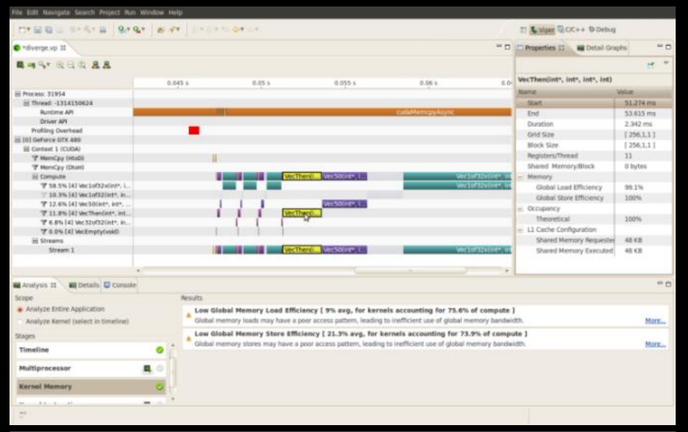


CUDA-Aware Editor



CUDA Debugger

CPU+GPU



CUDA Profiler

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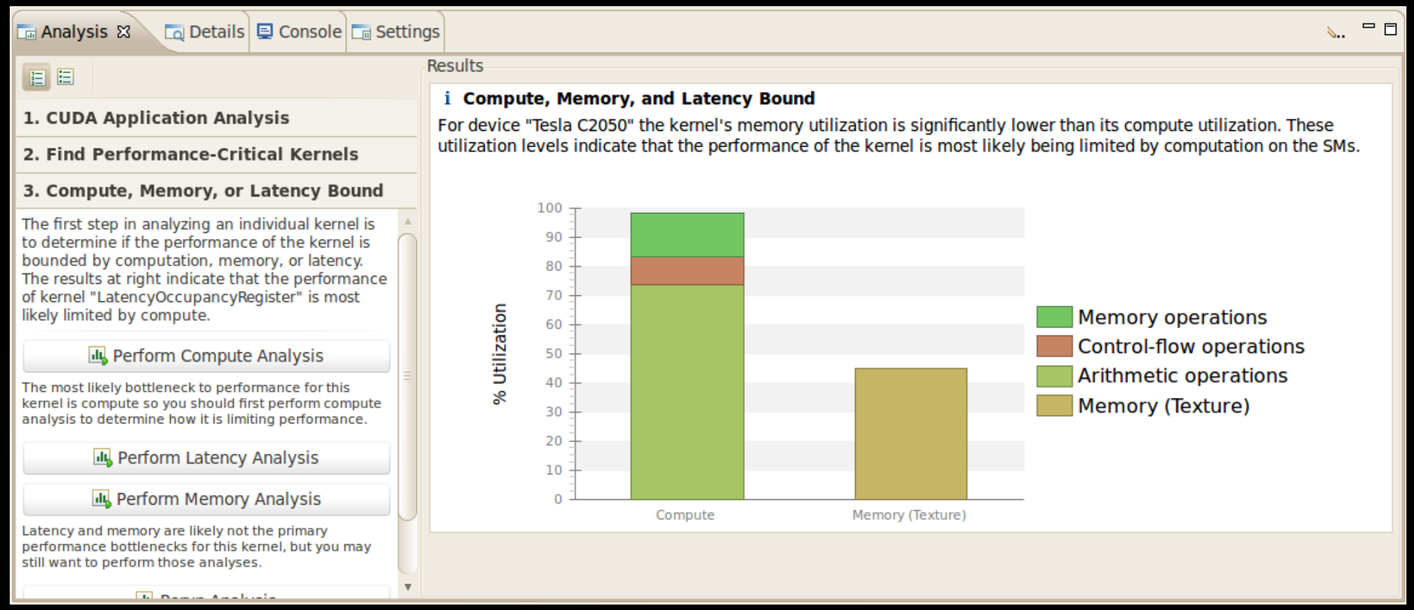
CUDA 6.0 Standalone Tools

VISUAL PROFILER

- Trace CUDA activities
- Kernel Profiler
- Performance instrumentation with source code correlation
- Guided Expert Analysis



NVPROF

- Generates execution summary
- Gather Performance events and metrics

CUDA-MEMCHECK

- Out of bounds memory access detection
- Detects Race Condition

CUDA-GDB

- Command line CUDA debugging
- Debug CPU and GPU code

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CONCLUSION

- Full TEGRA K1 support
- Full OpenGL 4.x and ES 2.0/3.0/3.1/AEP
- Advanced Visual Studio integration
- Advanced CPU profiling
- Full support for Renderscript and CUDA 6.0
- Consistent developer experience from Desktop to Tegra Android devices

https://developer.nvidia.com/gameworks

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FINDING MORE INFORMATION…

- https://developer.nvidia.com/tegra-development
- https://devtalk.nvidia.com/

Developer Tools

https://developer.nvidia.com/gameworks