GPU TECHNOLOGY CONFERENCE

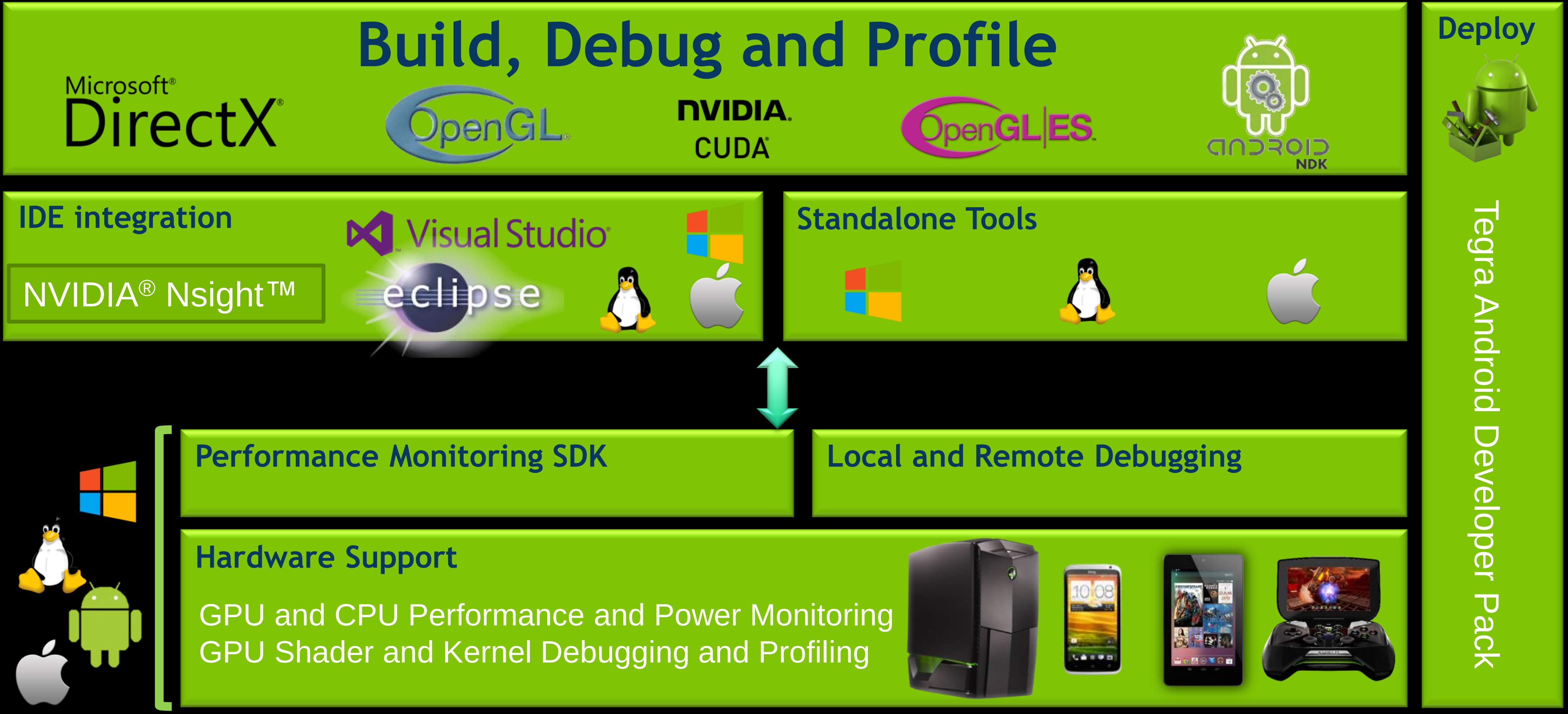
ANDROID DEVELOPER TOOLS TRAINING GTC 2014

Sébastien Dominé, NVIDIA

AGENDA

- NVIDIA Developer Tools Introduction
- Multi-core CPU tools
- Graphics Developer Tools
- Compute Developer Tools

NVIDIA Developer Tools



Build, Debug and Profile

Deploy

Tegra Android Developer Pack

IDE integration

NVIDIA® Nsight™

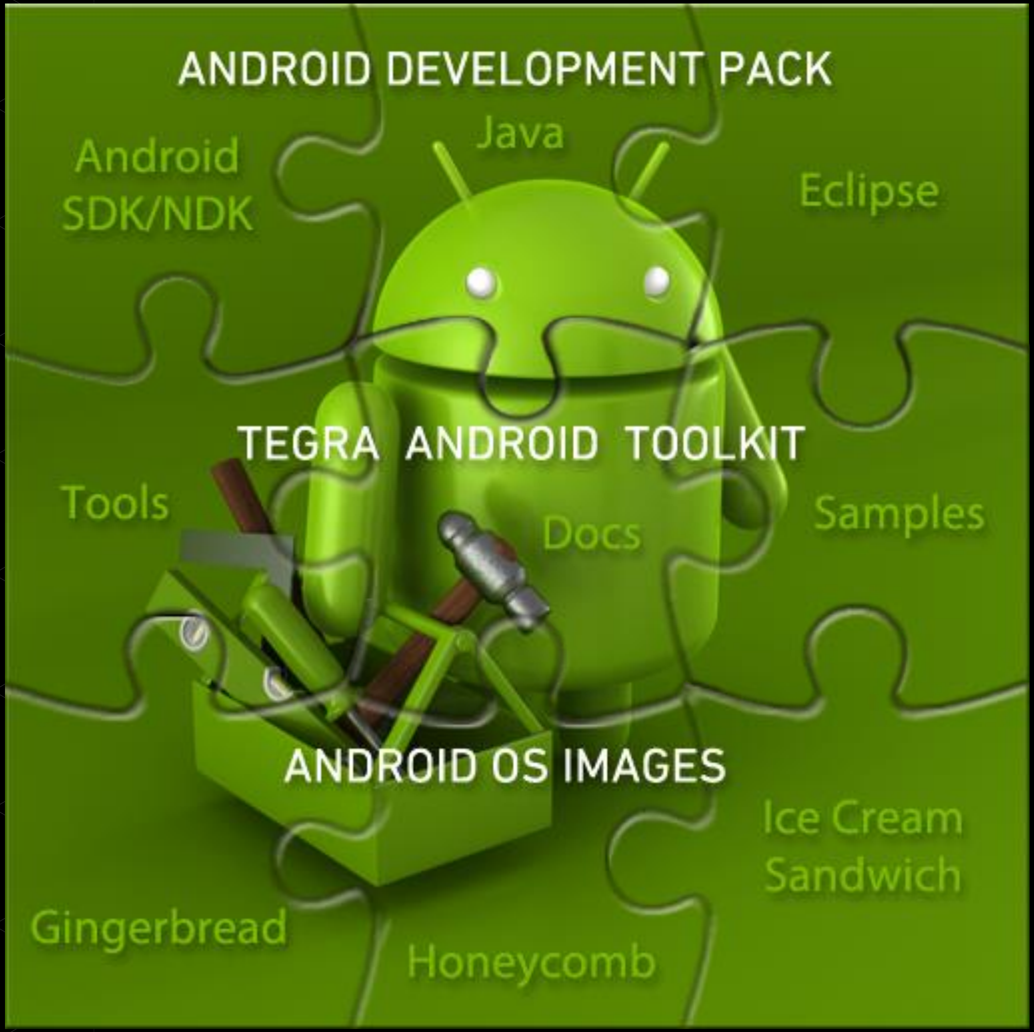
Standalone Tools

Performance Monitoring SDK

Local and Remote Debugging

Hardware Support

GPU and CPU Performance and Power Monitoring
GPU Shader and Kernel Debugging and Profiling



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 PerfHUD ES/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 Kernel symbols and DS-5 support

TEGRA CPU DEVELOPER TOOLS

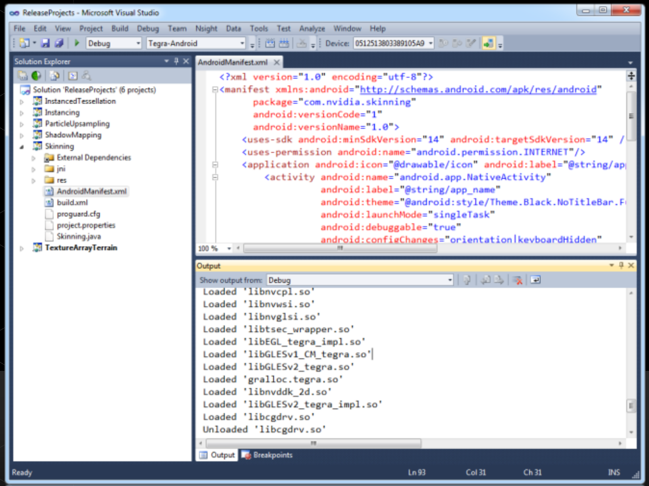
CPU DEBUGGING

- 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

NVIDIA® NSIGHT™ TEGRA Visual Studio

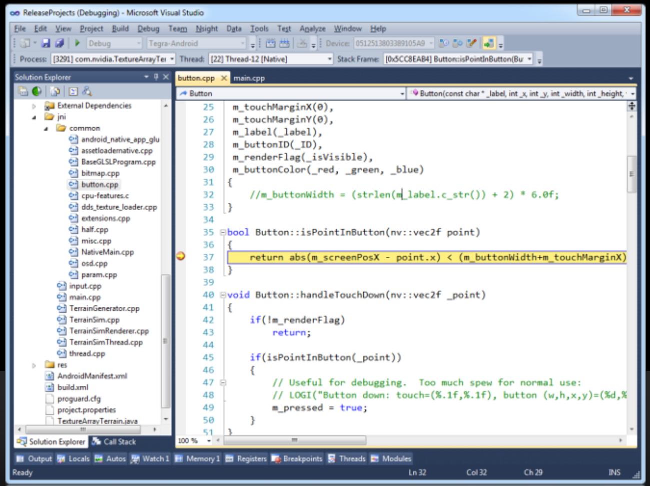
Android NDK/JDK application development



```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
      package="com.nvidia.skinning"
      android:versionCode="1"
      android:versionName="1.0">
    <uses-sdk android:minSdkVersion="14" android:targetSdkVersion="14" /
    <uses-permission android:name="android.permission.INTERNET"/>
    <application android:icon="@drawable/icon" android:label="@string/ap
        <activity android:name="android.app.NativeActivity"
                  android:label="@string/app_name"
                  android:theme="@android:style/Theme.Black.NoTitleBar.F
                  android:launchMode="singleTask"
                  android:debuggable="true"
                  android:configChanges="orientation|keyboardHidden"
```

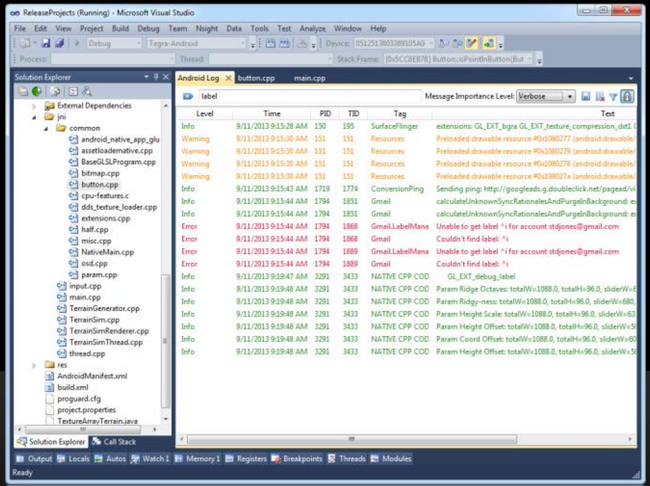
```
Loaded 'libnvcpl.so'
Loaded 'libnvwsi.so'
Loaded 'libnvglsi.so'
Loaded 'libtsec_wrapper.so'
Loaded 'libEGL_tegra_impl.so'
Loaded 'libGLESv1_CM_tegra.so'
Loaded 'libGLESv2_tegra.so'
Loaded 'gralloc.tegra.so'
Loaded 'libnvddk_2d.so'
Loaded 'libGLESv2_tegra_impl.so'
Loaded 'libcgdrv.so'
Unloaded 'libcgdrv.so'
```

Project Management



```
 m_touchMarginX(0),
 m_touchMarginY(0),
 m_label(_label),
 m_buttonID(_ID),
 m_renderFlag(_isVisible),
 m_buttonColor(_red, _green, _blue)
{
    //m_buttonWidth = (strlen(m_label.c_str()) + 2) * 6.0f;
}

bool Button::isPointInButton(nv::vec2f point)
{
    return abs(m_screenPosX - point.x) < (m_buttonWidth+m_touchMarginX)
}

void Button::handleTouchDown(nv::vec2f _point)
{
    if(!m_renderFlag)
        return;

    if(isPointInButton(_point))
    {
        // Useful for debugging.  Too much spew for normal use:
        // LOGI("Button down: touch=(%.1f,%.1f), button (w,h,x,y)=(%d,%
        m_pressed = true;
    }
}
```

Android Debugging



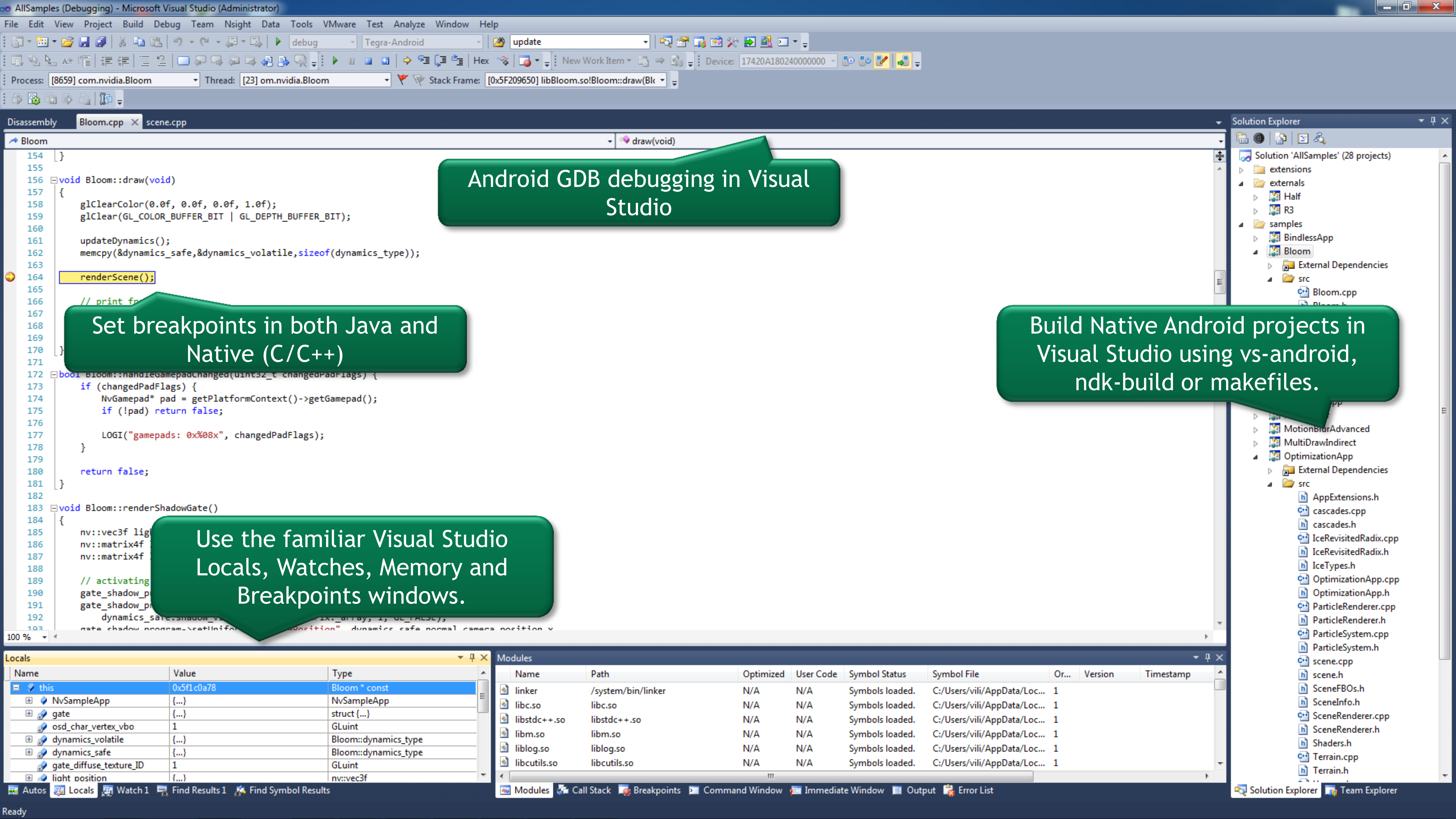
label   Message Importance Level: Verbose

```
Level    Time                  PID   TID   Tag               Text
Info     9/11/2013 9:15:28 AM  150   195   SurfaceFlinger    extensions: GL_EXT_bgra GL_EXT_texture_compression_dxt1
Warning  9/11/2013 9:15:30 AM  151   151   Resources         Preloaded drawable resource #0x1080277 (android:drawable/
Warning  9/11/2013 9:15:30 AM  151   151   Resources         Preloaded drawable resource #0x1080279 (android:drawable/
Warning  9/11/2013 9:15:30 AM  151   151   Resources         Preloaded drawable resource #0x1080278 (android:drawable/
Warning  9/11/2013 9:15:30 AM  151   151   Resources         Preloaded drawable resource #0x108027a (android:drawable/
Info     9/11/2013 9:15:43 AM  1719  1774  ConversionPing    Sending ping: http://googleads.g.doubleclick.net/pagead/vi
Info     9/11/2013 9:15:44 AM  1794  1851  Gmail             calculateUnknownSyncRationalesAndPurgeInBackground: e
Info     9/11/2013 9:15:44 AM  1794  1851  Gmail             calculateUnknownSyncRationalesAndPurgeInBackground: e
Error    9/11/2013 9:15:44 AM  1794  1868  Gmail.LabelMana   Unable to get label ^i for account stdjones@gmail.com
Error    9/11/2013 9:15:44 AM  1794  1868  Gmail             Couldn't find label: ^i
Error    9/11/2013 9:15:44 AM  1794  1889  Gmail.LabelMana   Unable to get label ^i for account stdjones@gmail.com
Error    9/11/2013 9:15:44 AM  1794  1889  Gmail             Couldn't find label: ^i
Info     9/11/2013 9:19:47 AM  3291  3433  NATIVE CPP COD        GL_EXT_debug_label
Info     9/11/2013 9:19:48 AM  3291  3433  NATIVE CPP COD    Param Ridge Octaves: totalW=1088.0, totalH=96.0, sliderW=6
Info     9/11/2013 9:19:48 AM  3291  3433  NATIVE CPP COD    Param Ridgy-ness: totalW=1088.0, totalH=96.0, sliderW=680,
Info     9/11/2013 9:19:48 AM  3291  3433  NATIVE CPP COD    Param Height Scale: totalW=1088.0, totalH=96.0, sliderW=63
Info     9/11/2013 9:19:48 AM  3291  3433  NATIVE CPP COD    Param Height Offset: totalW=1088.0, totalH=96.0, sliderW=5
Info     9/11/2013 9:19:48 AM  3291  3433  NATIVE CPP COD    Param Coord Offset: totalW=1088.0, totalH=96.0, sliderW=60
Info     9/11/2013 9:19:48 AM  3291  3433  NATIVE CPP COD    Param Height Offset: totalW=1088.0, totalH=96.0, sliderW=5
```

Logcat Filtering

NSIGHT TEGRA Visual Studio 1.5

- Microsoft® Visual Studio™ 2013
- NDK r9c / Android SDK 22.3
- Support for external build systems (makefile)
- Improved MSBUILD compatibility with NDK
- Improved project/solution loading performance



Android GDB debugging in Visual Studio

Set breakpoints in both Java and Native (C/C++)

Build Native Android projects in Visual Studio using vs-android, ndk-build or makefiles.

Use the familiar Visual Studio Locals, Watches, Memory and Breakpoints windows.

```
}

void Bloom::draw(void)
{
    glClearColor(0.0f, 0.0f, 0.0f, 1.0f);
    glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);

    updateDynamics();
    memcpy(&dynamics_safe,&dynamics_volatile,sizeof(dynamics_type));

    renderScene();

    // print fr

}

bool Bloom::handleGamepadChanged(uint32_t changedPadFlags) {
    if (changedPadFlags) {
        NvGamepad* pad = getPlatformContext()->getGamepad();
        if (!pad) return false;

        LOGI("gamepads: 0x%08x", changedPadFlags);
    }

    return false;
}

void Bloom::renderShadowGate()
{
    nv::vec3f lig
    nv::matrix4f
    nv::matrix4f

    // activating
    gate_shadow_p
    gate_shadow_p
        dynamics_safe.shadow_v                ix._array, 1, GL_FALSE);
    gate_shadow_program->setUnifo         Position", dynamics_safe.normal_camera_position.x
```

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

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		

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**

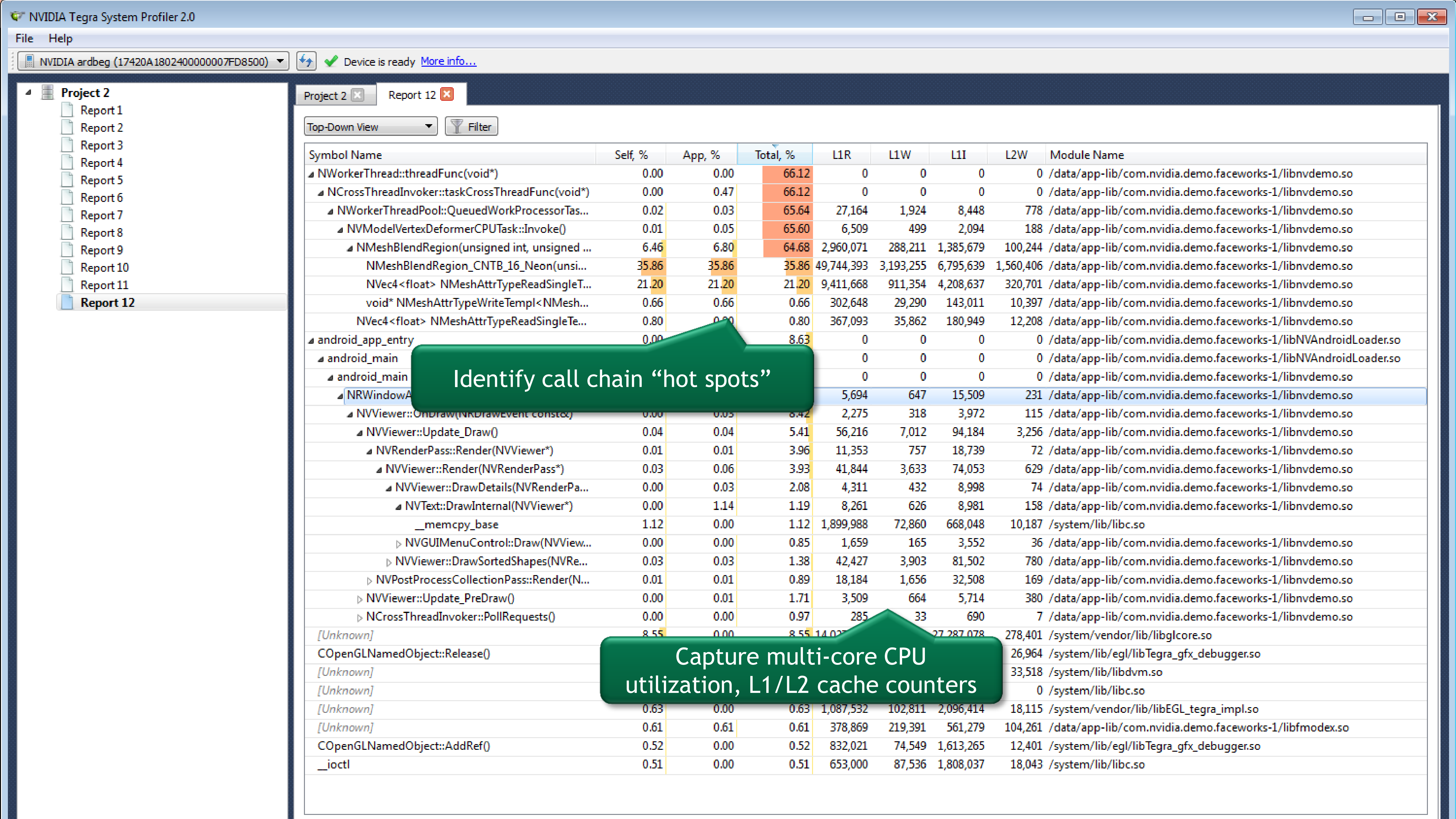
TEGRA SYSTEM PROFILER

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

WHAT'S NEW WITH TEGRA SYSTEM PROFILER 2.0

- Supports Tegra K1 and Tegra Note 7
- CPU usage broken down by module
- New backtrace options simplify call stack collection
- Improved performance and filtering options
- Supports Linux and OSX in addition to Windows



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]	8.55	0.00	8.55	14,02		27,287,078	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

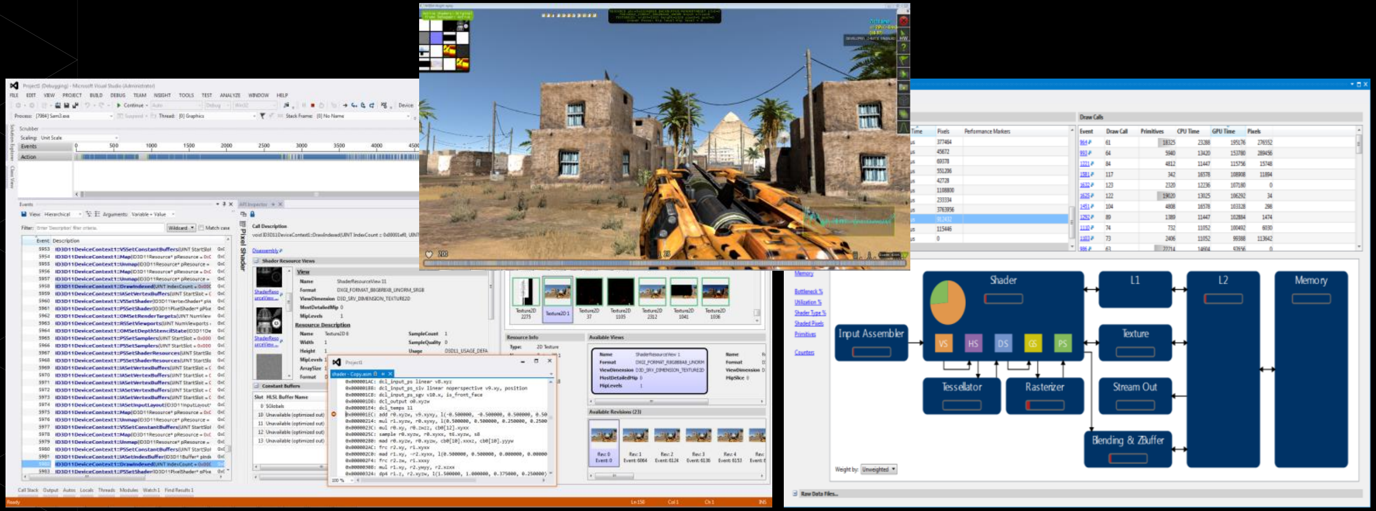
- **Nsight Visual Studio Edition**
  - **Frame Debugging and Profiling**
  - **Shader Debugging and Pixel History**
  - **System trace**

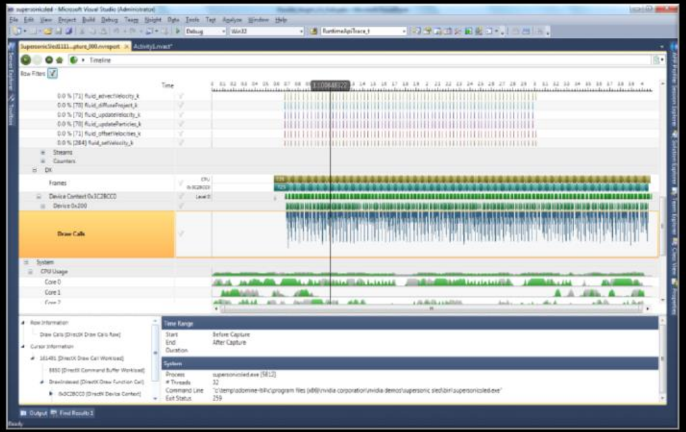
- **Tegra Graphics Debugger**
  - **Frame Debugging and Profiling**
  - **Shader Debugging and Pixel History (v2.0)**

- **PerfKit**
  - **API to sample performance SW and HW counters**

NVIDIA® NSIGHT™ Visual Studio

HOMOGENEOUS APPLICATION DEVELOPMENT FOR CPU+GPU,
GRAPHICS AND COMPUTE



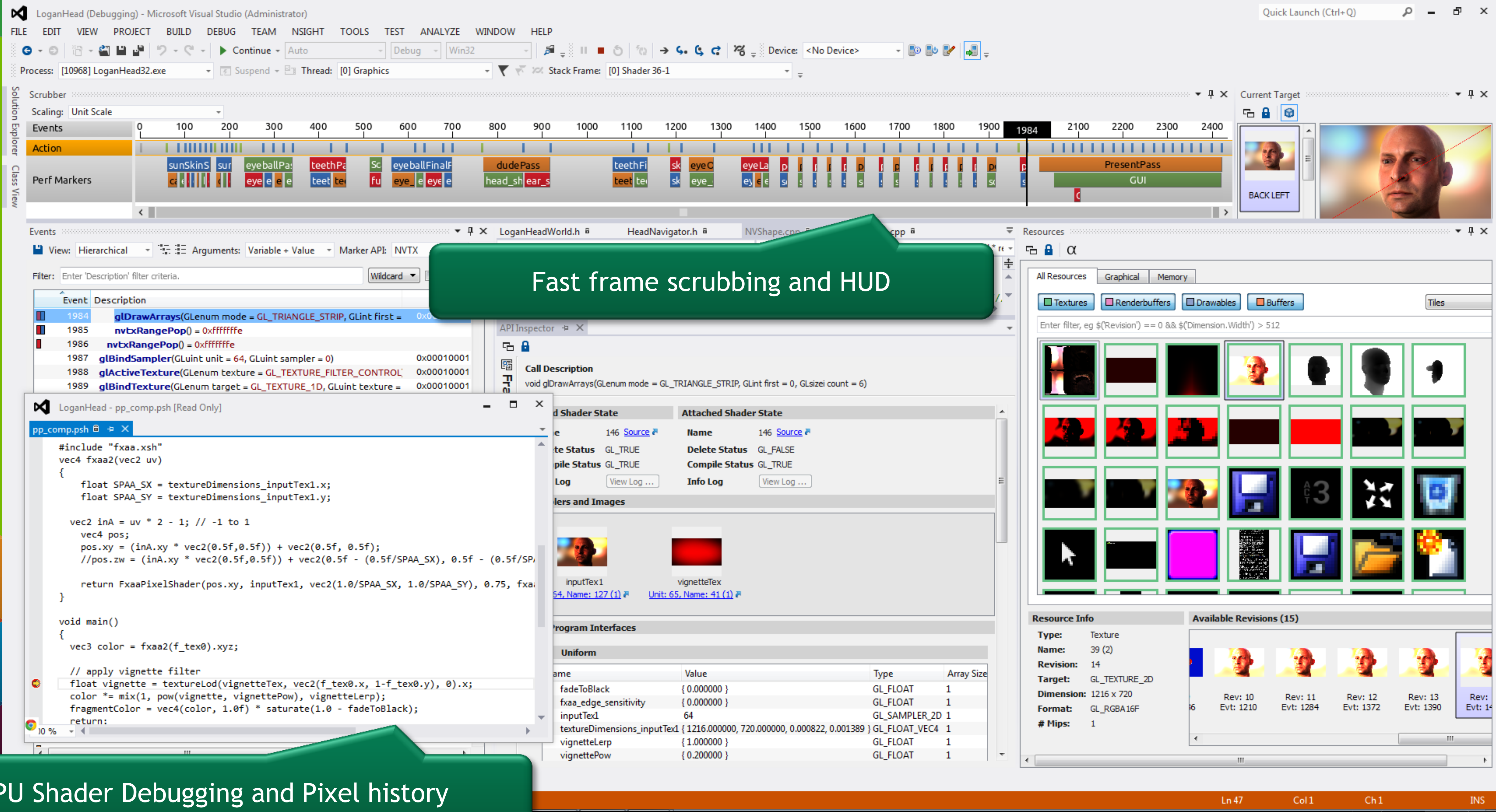


GPU Shader Debugger
Pixel History

Graphics Inspector
and Profiler

System Analysis

GPU TECHNOLOGY CONFERENCE



Process: [10968] LoganHead32.exe Thread: [0] Graphics Stack Frame: [0] Shader 36-1

Scaling: Unit Scale

View: Hierarchical Arguments: Variable + Value Marker API: NVTX

Filter: Enter 'Description' filter criteria.

Event	Description	
1984	glDrawArrays(GLenum mode = GL_TRIANGLE_STRIP, GLint first =	0x0
1985	nvtxRangePop() = 0xffffffff	
1986	nvtxRangePop() = 0xffffffff	
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

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 ...	

LoganHead - pp_comp.psh [Read Only]

```
#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);
    //pos.zw = (inA.xy * vec2(0.5f,0.5f)) + vec2(0.5f - (0.5f/SPAA_SX), 0.5f - (0.5f/SPA

    return FxaaPixelShader(pos.xy, inputTex1, vec2(1.0/SPAA_SX, 1.0/SPAA_SY), 0.75, fxaa
}

void main()
{
  vec3 color = fxaa2(f_tex0).xyz;

  // apply vignette filter
  float vignette = textureLod(vignetteTex, vec2(f_tex0.x, 1-f_tex0.y), 0).x;
  color *= mix(1, pow(vignette, vignettePow), vignetteLerp);
  fragmentColor = vec4(color, 1.0f) * saturate(1.0 - fadeToBlack);
  return;
```

Uniform

ame	Value	Type	Array Size
fadeToBlack	{ 0.000000 }	GL_FLOAT	1
fxaa_edge_sensitivity	{ 0.000000 }	GL_FLOAT	1
inputTex1	64	GL_SAMPLER_2D	1
textureDimensions_inputTex1	{ 1216.000000, 720.000000, 0.000822, 0.001389 }	GL_FLOAT_VEC4	1
vignetteLerp	{ 1.000000 }	GL_FLOAT	1
vignettePow	{ 0.200000 }	GL_FLOAT	1

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

Ln 47 Col 1 Ch 1 INS

Fast frame scrubbing and HUD

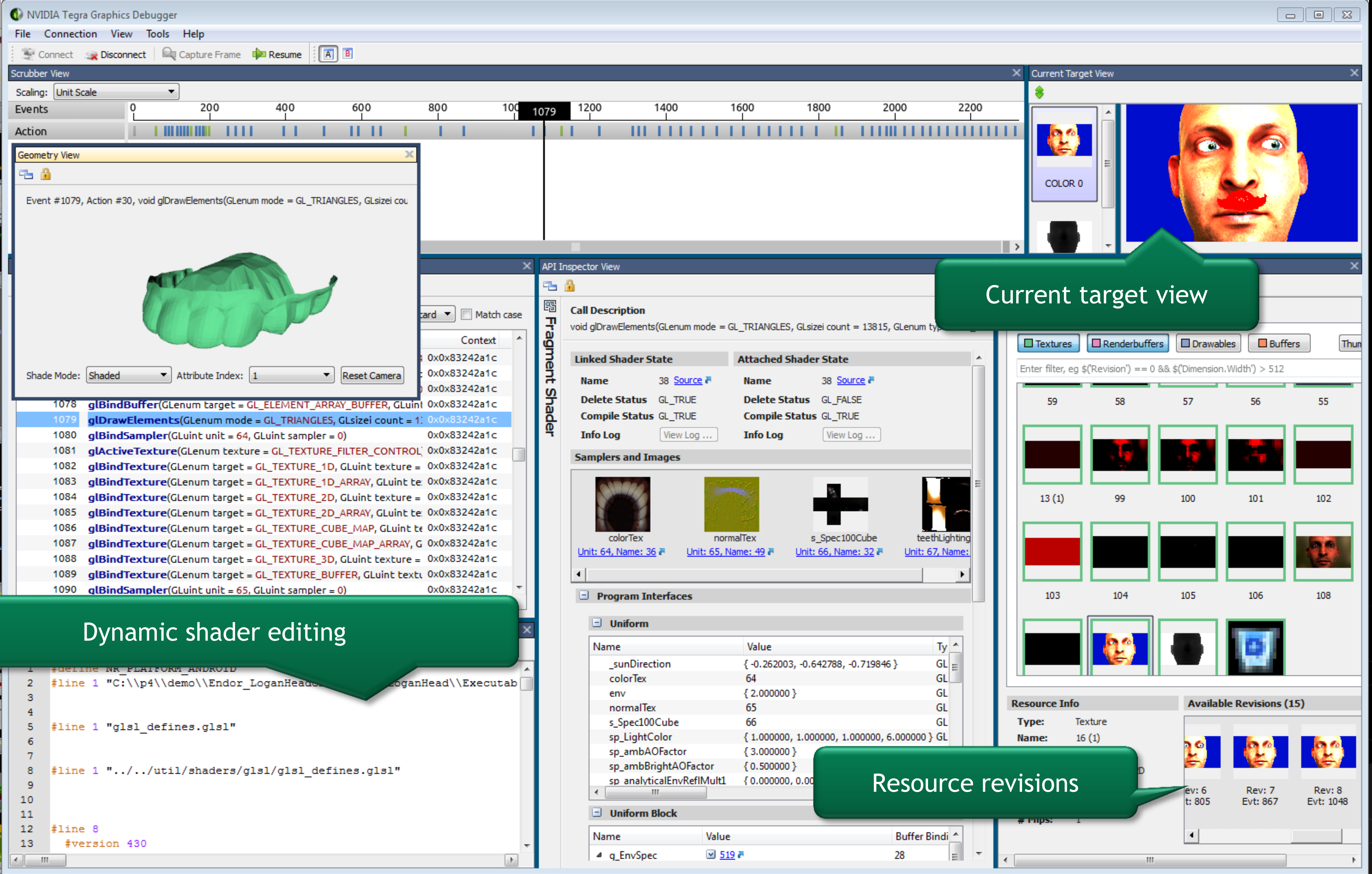
GPU Shader Debugging and Pixel history

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 and 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

GPU TECHNOLOGY CONFERENCE



Event #1079, Action #30, void glDrawElements(GLenum mode = GL_TRIANGLES, GLsizei cou

```
1078  glBindBuffer(GLenum target = GL_ELEMENT_ARRAY_BUFFER, GLuint   0x0x83242a1c
1079  glDrawElements(GLenum mode = GL_TRIANGLES, GLsizei count = 1:  0x0x83242a1c
1080  glBindSampler(GLuint unit = 64, GLuint sampler = 0)             0x0x83242a1c
1081  glActiveTexture(GLenum texture = GL_TEXTURE_FILTER_CONTROL     0x0x83242a1c
1082  glBindTexture(GLenum target = GL_TEXTURE_1D, GLuint texture =   0x0x83242a1c
1083  glBindTexture(GLenum target = GL_TEXTURE_1D_ARRAY, GLuint te    0x0x83242a1c
1084  glBindTexture(GLenum target = GL_TEXTURE_2D, GLuint texture =   0x0x83242a1c
1085  glBindTexture(GLenum target = GL_TEXTURE_2D_ARRAY, GLuint te    0x0x83242a1c
1086  glBindTexture(GLenum target = GL_TEXTURE_CUBE_MAP, GLuint te    0x0x83242a1c
1087  glBindTexture(GLenum target = GL_TEXTURE_CUBE_MAP_ARRAY, G      0x0x83242a1c
1088  glBindTexture(GLenum target = GL_TEXTURE_3D, GLuint texture =   0x0x83242a1c
1089  glBindTexture(GLenum target = GL_TEXTURE_BUFFER, GLuint textu   0x0x83242a1c
1090  glBindSampler(GLuint unit = 65, GLuint sampler = 0)             0x0x83242a1c
```

```
#define NR_PLATFORM_ANDROID
#line 1 "C:\\p4\\demo\\Endor_LoganHead          oganHead\\Executab


#line 1 "glsl_defines.glsl"


#line 1 "../../util/shaders/glsl/glsl_defines.glsl"



#line 8
  #version 430
```

Call Description

void glDrawElements(GLenum mode = GL_TRIANGLES, GLsizei count = 13815, GLenum ty

Linked Shader State		Attached Shader State	
Name	38 Source	Name	38 Source
Delete Status	GL_TRUE	Delete Status	GL_FALSE
Compile Status	GL_TRUE	Compile Status	GL_TRUE
Info Log	View Log ...	Info Log	View Log ...

Samplers and Images

colorTex	normalTex	s_Spec100Cube	teethLighting
Unit: 64, Name: 36	Unit: 65, Name: 49	Unit: 66, Name: 32	Unit: 67, Name:

Program Interfaces

Uniform

Name	Value	Ty
_sunDirection	{ -0.262003, -0.642788, -0.719846 }	GL
colorTex	64	GL
env	{ 2.000000 }	GL
normalTex	65	GL
s_Spec100Cube	66	GL
sp_LightColor	{ 1.000000, 1.000000, 1.000000, 6.000000 }	GL
sp_ambAOFactor	{ 3.000000 }	
sp_ambBrightAOFactor	{ 0.500000 }	
sp_analyticalEnvReflMult1	{ 0.000000, 0.00	

Uniform Block

Name	Value	Buffer Bindi
g_EnvSpec	519	28

Enter filter, eg $('Revision') == 0 && $('Dimension.Width') > 512

Resource Info

Type: Texture

Name: 16 (1)

mips: 1

Current target view

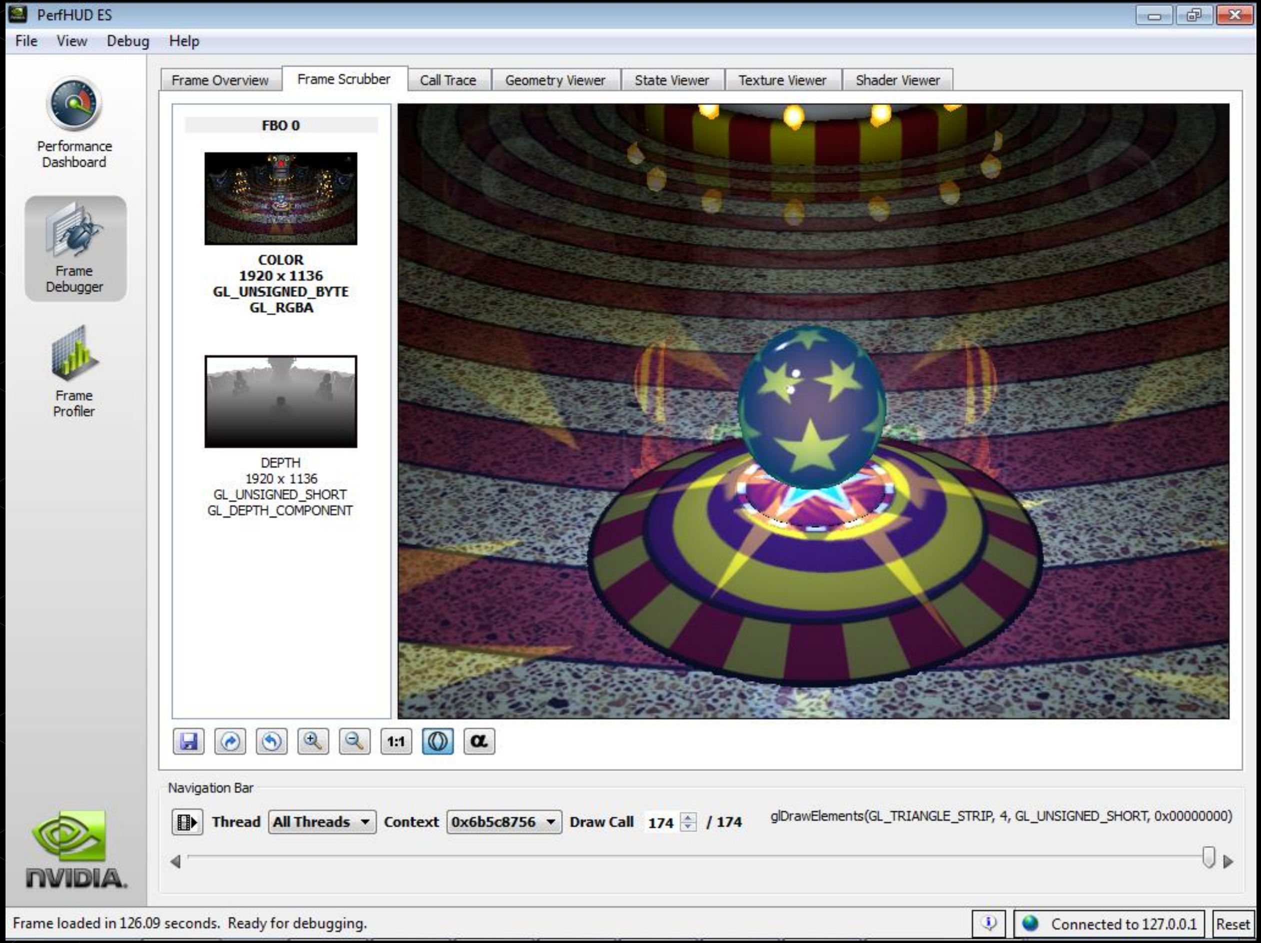
Dynamic shader editing

Resource revisions

PERFHUD ES 2.2

GRAPHICS DEVELOPMENT TOOLS FOR TEGRA 4 AND PRIOR

- Supports OpenGL ES 1.0 and 2.0
- Monitor key software and hardware performance metrics
- Examine frames to reveal rendering problems
- Debug API calls, parameters, return values and errors
- Execute directed tests to identify bottlenecks
- Edit and apply shaders dynamically at runtime
- Monitor CPU and GPU utilization



FBO 0

COLOR
1920 x 1136
GL_UNSIGNED_BYTE
GL_RGBA

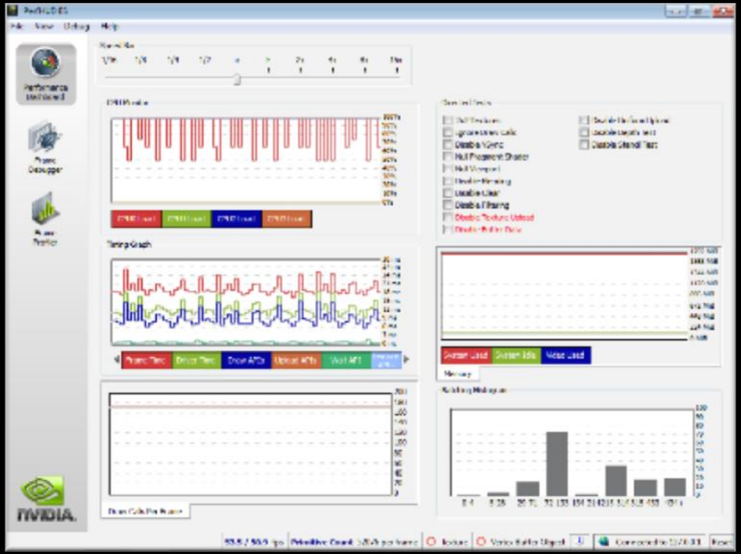
DEPTH
1920 x 1136
GL_UNSIGNED_SHORT
GL_DEPTH_COMPONENT

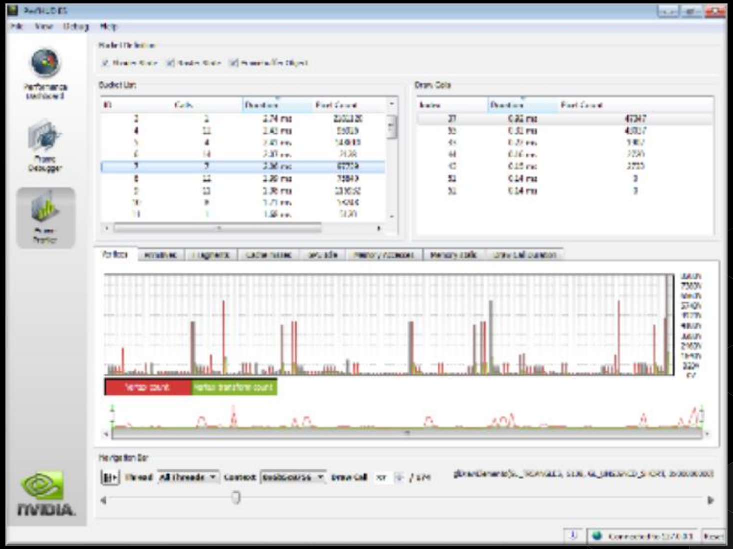
Thread: All Threads
Context: 0x6b5c8756
Draw Call: 174 / 174

glDrawElements(GL_TRIANGLE_STRIP, 4, GL_UNSIGNED_SHORT, 0x00000000)

Frame loaded in 126.09 seconds. Ready for debugging.

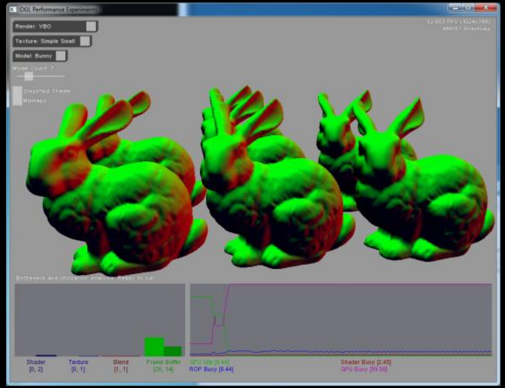
Connected to 127.0.0.1





PERFKIT 3.1

- GPU and Software Performance Counter API
  - Performance Monitoring
  - Automated bottleneck analysis
  - Graphics and Compute
- Supports Kepler Architecture and higher on Android



OGL Performance Experiments

Render: VBO

Texture: Simple Small

Model: Bunny

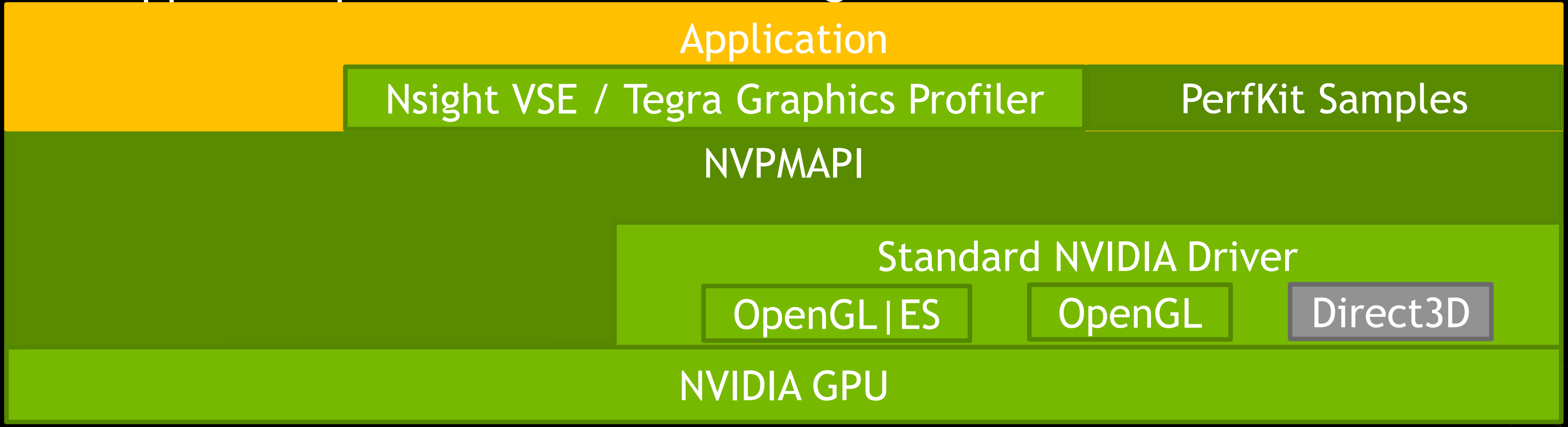
Model Count: 7

Simplified Shader

Mipmaps

52.953 FPS (1024x768)
485157 Primitives

Bottleneck and Utilization Analysis: Ready to run



Application

Nsight VSE / Tegra Graphics Profiler

PerfKit Samples

NVPMAPI

Standard NVIDIA Driver

OpenGL|ES

OpenGL

Direct3D

NVIDIA GPU

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

COMPUTE DEVELOPER TOOLS

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

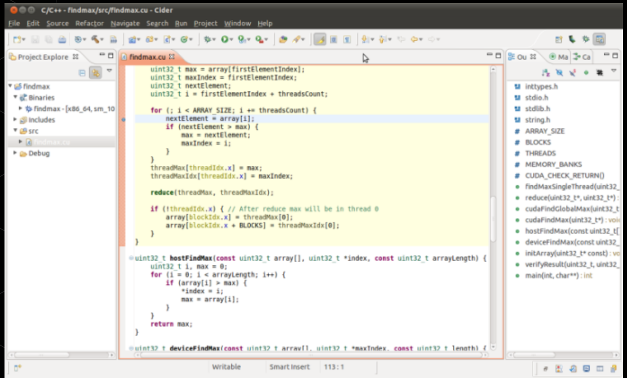
- CUDA 6.0 Toolkit command line tools for Android

- RenderScript Tegra K1 acceleration / No developer tools

NVIDIA® NSIGHT™ eclipse

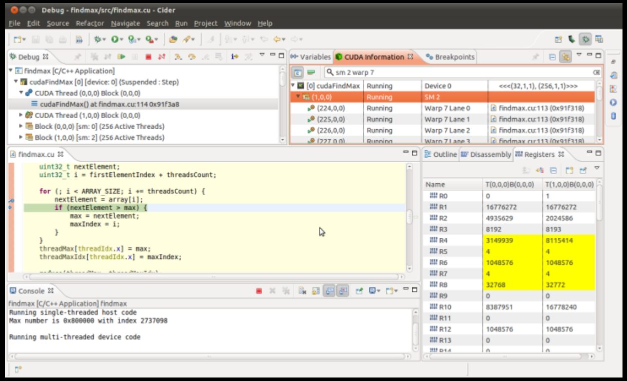
HOMOGENEOUS APPLICATION DEVELOPMENT FOR CPU+GPU COMPUTE PLATFORMS

BUILD, DEBUG AND PROFILE ON REMOTE TARGETS WITH CUDA 6.0


C/C++ - findmax/src/findmax.cu - Cider
File Edit Source Refactor Navigate Search Run Project Window Help
Project Explore
findmax
Binaries
findmax - [x86_64, sm_10
Includes
src
findmax.cu
Debug
findmax.cu
Ou
Ma
Ca
inttypes.h
stdio.h
stdlib.h
string.h
ARRAY_SIZE
BLOCKS
THREADS
MEMORY_BANKS
CUDA_CHECK_RETURN()
findMaxSingleThread(uint32_
reduce(uint32_t*, uint32_t*)
cudaFindGlobalMax(uint32_t
cudaFindMax(uint32_t*) : voi
hostFindMax(const uint32_t[
deviceFindMax(const uint32_
initArray(uint32_t* const) : vo
verifyResult(uint32_t, uint32_
main(int, char**) : int
Writable
Smart Insert
113 : 1

```
    uint32_t max = array[firstElementIndex];
    uint32_t maxIndex = firstElementIndex;
    uint32_t nextElement;
    uint32_t i = firstElementIndex + threadsCount;

    for (; i < ARRAY_SIZE; i += threadsCount) {
        nextElement = array[i];
        if (nextElement > max) {
            max = nextElement;
            maxIndex = i;
        }
    }
    threadMax[threadIdx.x] = max;
    threadMaxIdx[threadIdx.x] = maxIndex;

    reduce(threadMax, threadMaxIdx);

    if (!threadIdx.x) { // After reduce max will be in thread 0
        array[blockIdx.x] = threadMax[0];
        array[blockIdx.x + BLOCKS] = threadMaxIdx[0];
    }
}

uint32_t hostFindMax(const uint32_t array[], uint32_t *index, const uint32_t arrayLength) {
    uint32_t i, max = 0;
    for (i = 0; i < arrayLength; i++) {
        if (array[i] > max) {
            *index = i;
            max = array[i];
        }
    }
    return max;
}

uint32_t deviceFindMax(const uint32_t array[], uint32_t *maxIndex, const uint32_t length) {
```

CUDA-Aware Editor


Debug - findmax/src/findmax.cu - Cider
File Edit Source Refactor Navigate Search Run Project Window Help
Debug
Variables
CUDA Information
Breakpoints
sm 2 warp 7
findmax.cu
Outline
Disassembly
Registers
Console

findmax [C/C++ Application]
- cudaFindMax [0] [device: 0] (Suspended : Step)
  - CUDA Thread (0,0,0) Block (0,0,0)
    - cudaFindMax() at findmax.cu:114 0x91f3a8
  - CUDA Thread (1,0,0) Block (0,0,0)
  - Block (0,0,0) [sm: 0] (256 Active Threads)
  - Block (1,0,0) [sm: 2] (256 Active Threads)

[0] cudaFindMax	Running	Device 0	<<<(32,1,1), (256,1,1)>>>
(1,0,0)	Running	SM 2	
(224,0,0)	Running	Warp 7 Lane 0	findmax.cu:113 (0x91f318)
(225,0,0)	Running	Warp 7 Lane 1	findmax.cu:113 (0x91f318)
(226,0,0)	Running	Warp 7 Lane 2	findmax.cu:113 (0x91f318)
(227,0,0)	Running	Warp 7 Lane 3	findmax.cu:113 (0x91f318)

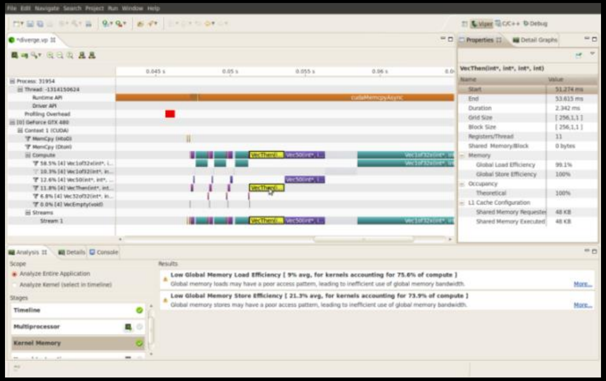
```
    uint32_t nextElement;
    uint32_t i = firstElementIndex + threadsCount;

    for (; i < ARRAY_SIZE; i += threadsCount) {
        nextElement = array[i];
        if (nextElement > max) {
            max = nextElement;
            maxIndex = i;
        }
    }
    threadMax[threadIdx.x] = max;
    threadMaxIdx[threadIdx.x] = maxIndex;
```

```
findmax [C/C++ Application] findmax
Running single-threaded host code
Max number is 0x800000 with index 2737098

Running multi-threaded device code
```

Name	T(0,0,0)B(0,0,0)	T(1,0,0)B(0,0,0)
R0	0	1
R1	16776272	16776272
R2	4935629	2024586
R3	8192	8193
R4	3149939	8115414
R5	4	4
R6	1048576	1048576
R7	4	4
R8	32768	32772
R9	0	0
R10	8387951	16778240
R11	0	0
R12	1048576	1048576
R13	0	0
R14	0	0

CUDA Debugger

CPU+GPU



VecThen(int*, int*, int*, int)

Name	Value
Start	51.274 ms
End	53.615 ms
Duration	2.342 ms
Grid Size	[256,1,1]
Block Size	[256,1,1]
Registers/Thread	11
Shared Memory/Block	0 bytes
Memory	
Global Load Efficiency	99.1%
Global Store Efficiency	100%
Occupancy	
Theoretical	100%
L1 Cache Configuration	
Shared Memory Requested	48 KB
Shared Memory Executed	48 KB

Scope
● Analyze Entire Application
○ Analyze Kernel (select in timeline)

Stages

Results

Low Global Memory Load Efficiency [9% avg, for kernels accounting for 75.6% of compute]
Global memory loads may have a poor access pattern, leading to inefficient use of global memory bandwidth.

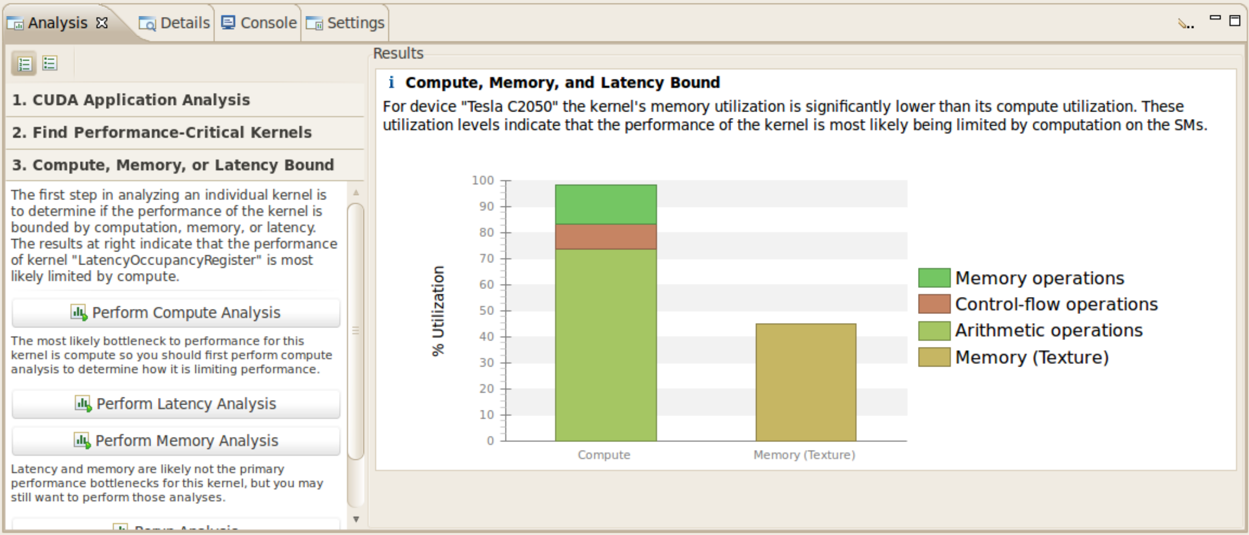
Low Global Memory Store Efficiency [21.3% avg, for kernels accounting for 73.9% of compute]
Global memory stores may have a poor access pattern, leading to inefficient use of global memory bandwidth.

CUDA Profiler

CUDA 6.0 STANDALONE TOOLS

VISUAL PROFILER

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



The first step in analyzing an individual kernel is to determine if the performance of the kernel is bounded by computation, memory, or latency. The results at right indicate that the performance of kernel "LatencyOccupancyRegister" is most likely limited by compute.

The most likely bottleneck to performance for this kernel is compute so you should first perform compute analysis to determine how it is limiting performance.

Latency and memory are likely not the primary performance bottlenecks for this kernel, but you may still want to perform those analyses.

Compute, Memory, and Latency Bound

For device "Tesla C2050" the kernel's memory utilization is significantly lower than its compute utilization. These utilization levels indicate that the performance of the kernel is most likely being limited by computation on the SMs.

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

CONCLUSION

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

Many years of discreet PC GPU developer tools experience leverage to provide a smooth user experience!

FINDING MORE INFORMATION…

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

- https://devtalk.nvidia.com/

NVIDIA

GAMEWORKS™

Developer Tools