GPU TECHNOLOGY CONFERENCE

TEGRA X1 DEVELOPER TOOLS

SEBASTIEN DOMINE, SR. DIRECTOR SW ENGINEERING

NVIDIA DEVELOPER TOOLS

BUILD. DEBUG. PROFILE.

Microsoft DirectX
OpenGL
NVIDIA CUDA
OpenGL ES
ANDROID NDK
GNU C/C++

IDE INTEGRATION

Visual Studio
eclipse

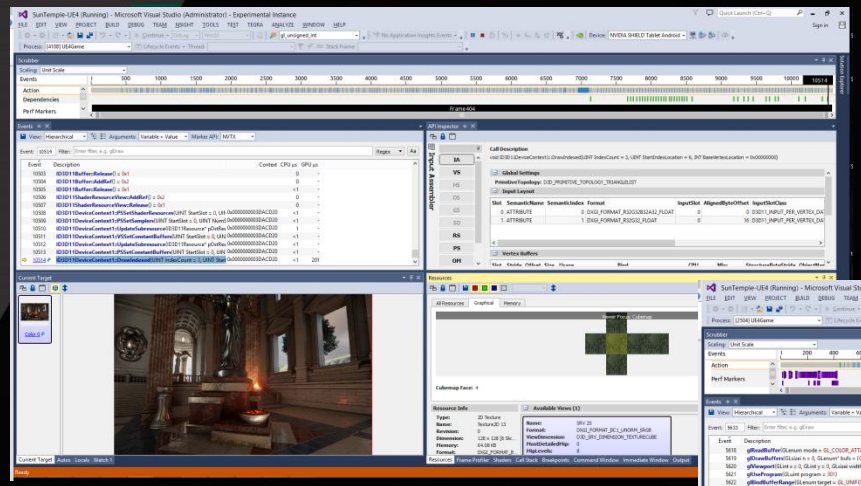
STANDALONE TOOLS

HARDWARE SUPPORT
CPU AND GPU DEBUGGING & PROFILING

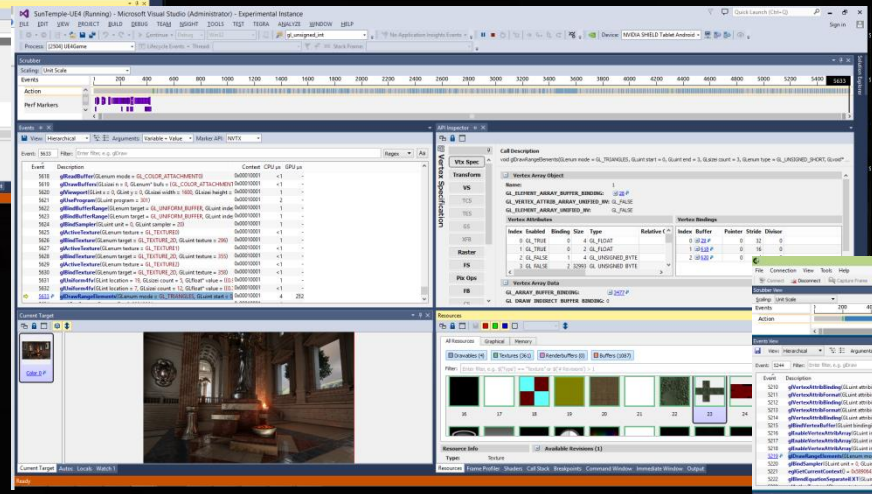
NVIDIA GAMEWORKS™

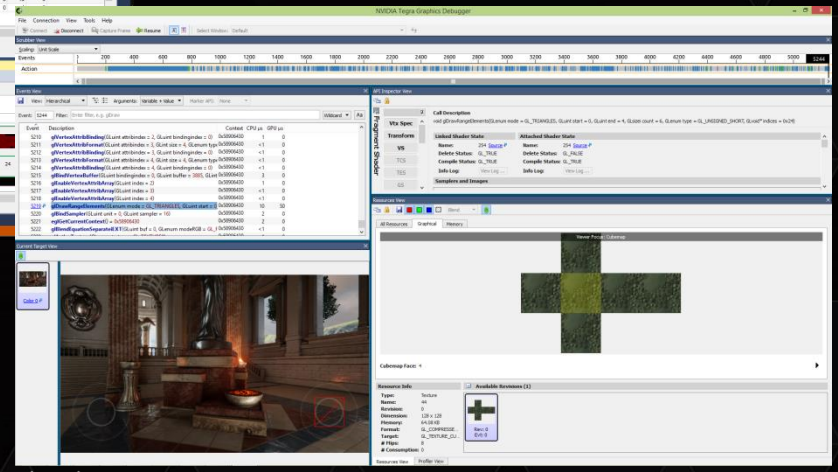
GPU TECHNOLOGY CONFERENCE

PICK A PLATFORM/API



Microsoft® DirectX®

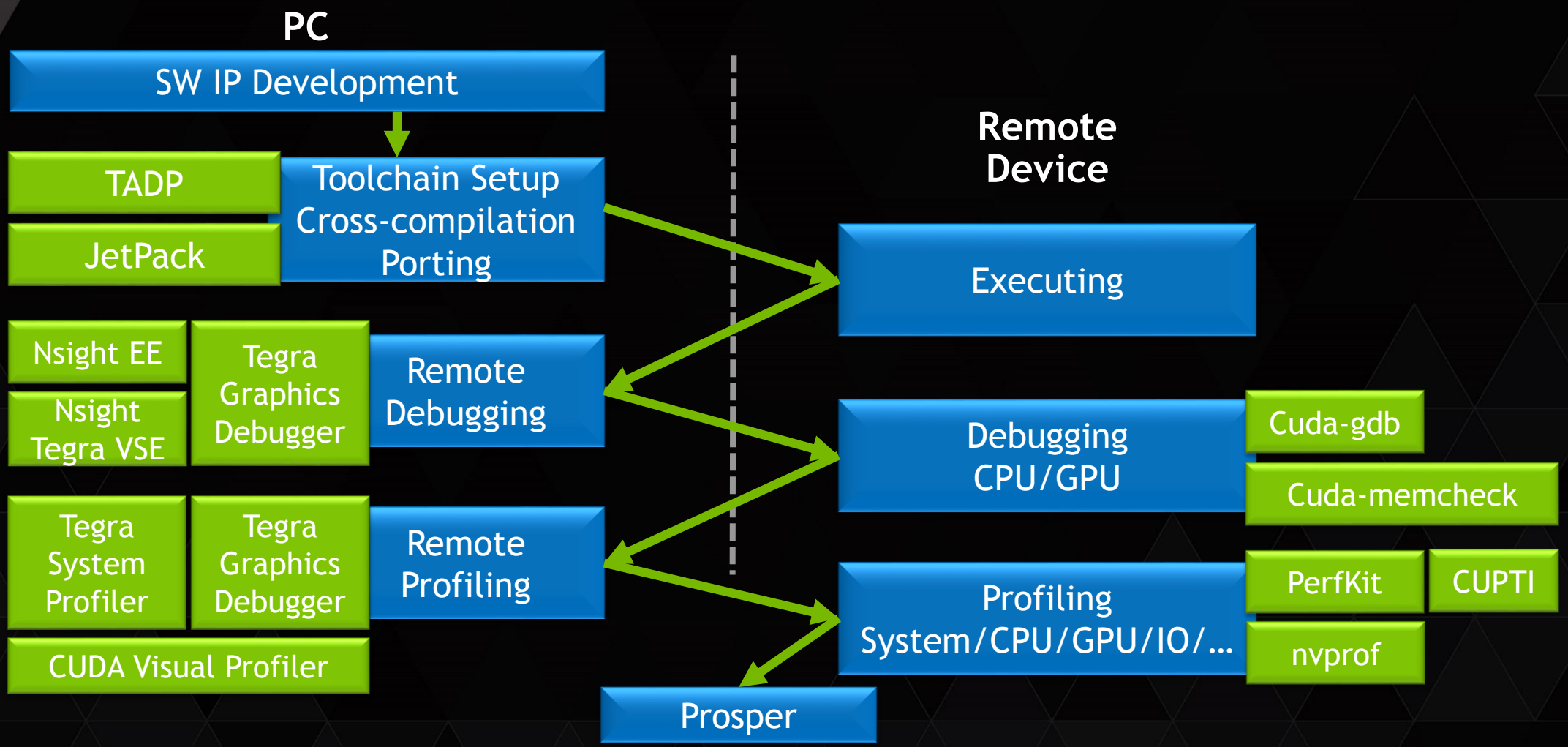




OpenGL

OpenGL OpenGL|ES

DEVELOPMENT FLOW



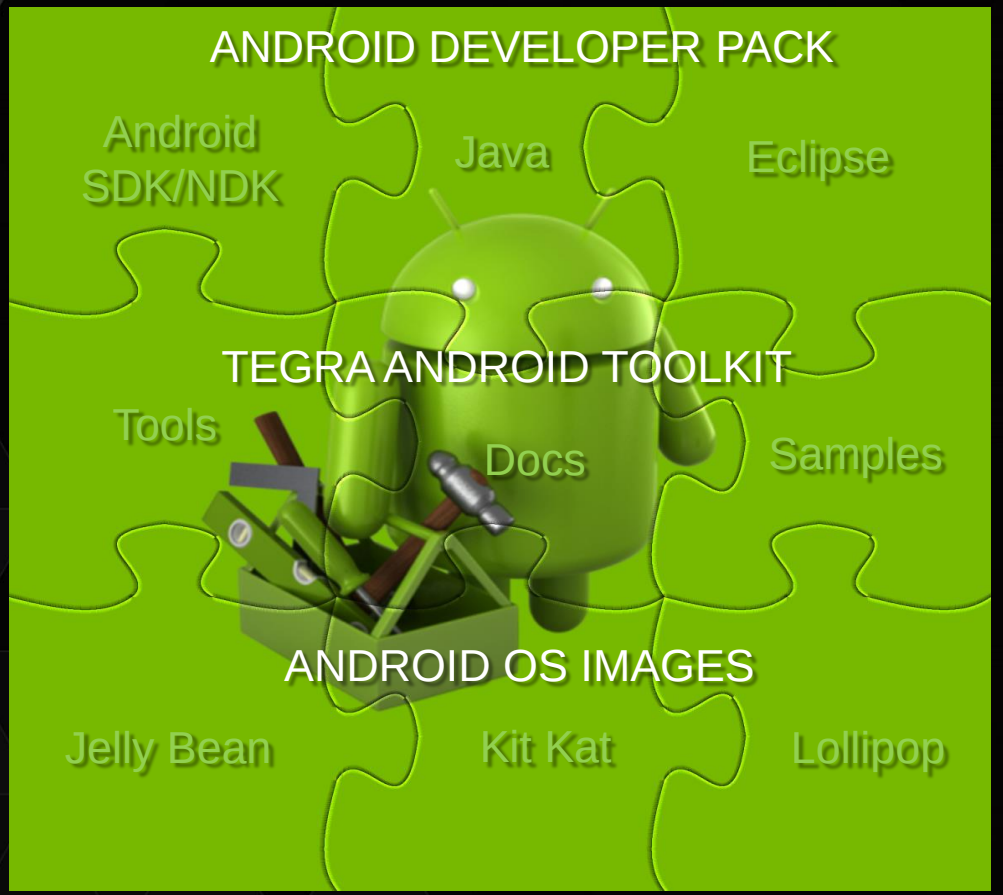
JETSON DEVELOPMENT PACK

JetPack

For Linux Ubuntu 14.04

JUMP STARTS developing for Jetson platform
INSTALLS Linux ARM cross-compilation tool chain
INSTALLS Developer tools, CUDA, OpenCV, Libraries
FLASHES Jetson OS Image
REFERENCE documentation and samples
COMPILES code samples, pushes them to devkit
And RUNS one sample…

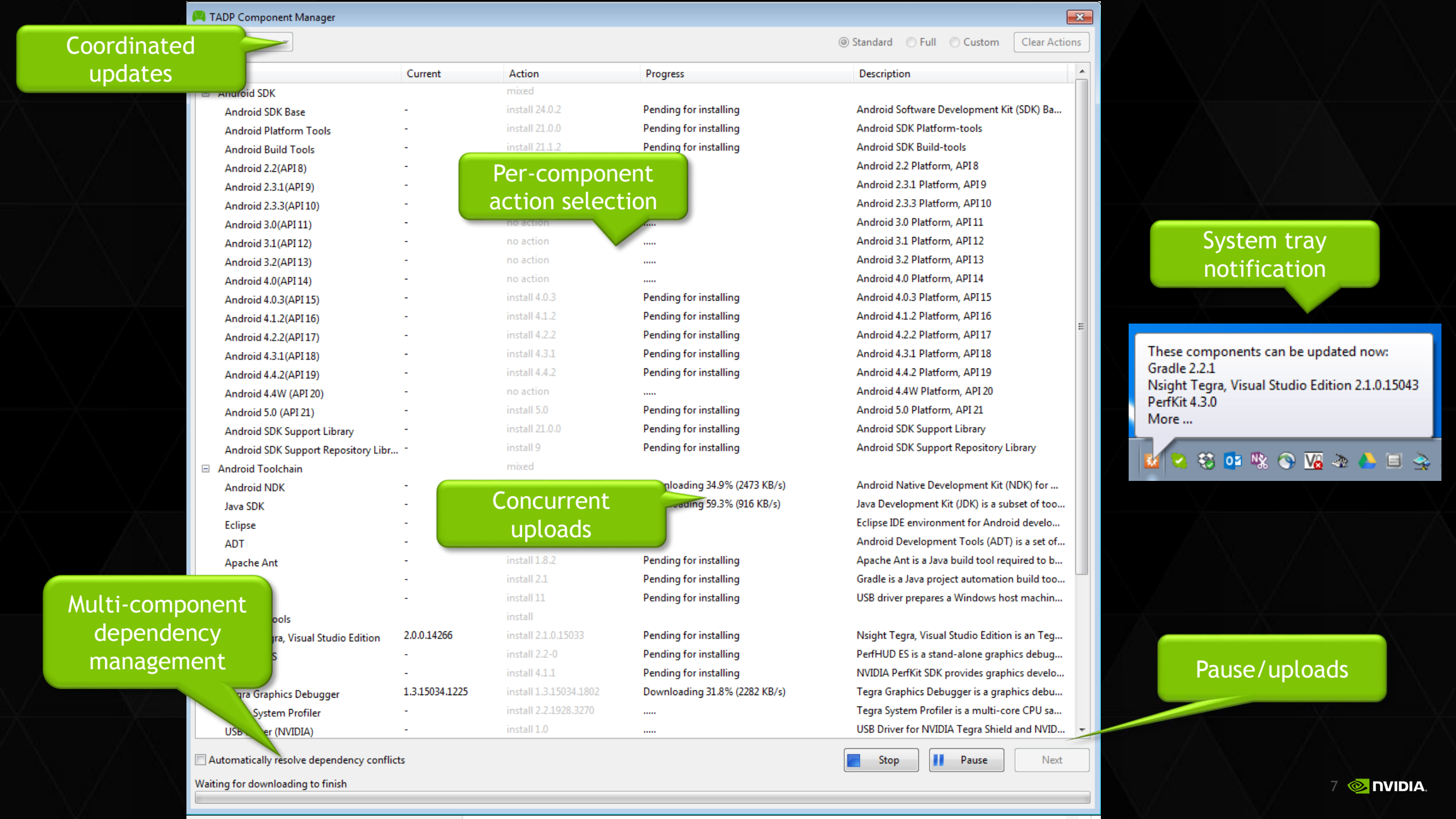
TEGRA ANDROID DEVELOPMENT PACK



TADP

For Windows, OSX, Linux

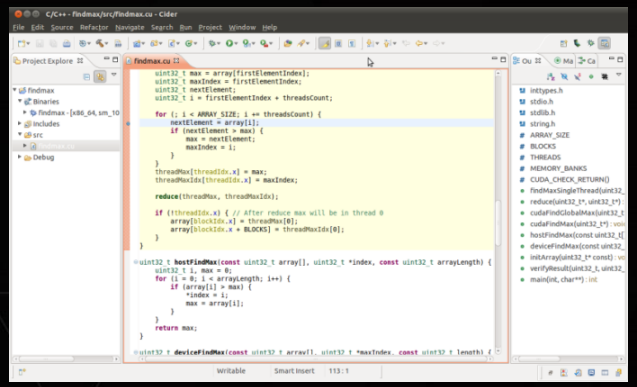
JUMP STARTS developing for Tegra on Android
INSTALLS all tools, SDKs, NDKs, Java,…
REFERENCE docs, samples & tutorials
FLASHES Tegra DevKit with OS Image
COMPILES code samples, pushes them to devkit
And RUNS one sample…


Coordinated updates
TADP Component Manager
Standard
Full
Custom
Clear Actions
Current
Action
Progress
Description
Android SDK
mixed
Android SDK Base
install 24.0.2
Pending for installing
Android Software Development Kit (SDK) Ba...
Android Platform Tools
install 21.0.0
Pending for installing
Android SDK Platform-tools
Android Build Tools
install 21.1.2
Pending for installing
Android SDK Build-tools
Android 2.2(API 8)
Android 2.2 Platform, API 8
Android 2.3.1(API 9)
Android 2.3.1 Platform, API 9
Android 2.3.3(API 10)
Android 2.3.3 Platform, API 10
Android 3.0(API 11)
Android 3.0 Platform, API 11
Android 3.1(API 12)
no action
Android 3.1 Platform, API 12
Android 3.2(API 13)
no action
Android 3.2 Platform, API 13
Android 4.0(API 14)
no action
Android 4.0 Platform, API 14
Android 4.0.3(API 15)
install 4.0.3
Pending for installing
Android 4.0.3 Platform, API 15
Android 4.1.2(API 16)
install 4.1.2
Pending for installing
Android 4.1.2 Platform, API 16
Android 4.2.2(API 17)
install 4.2.2
Pending for installing
Android 4.2.2 Platform, API 17
Android 4.3.1(API 18)
install 4.3.1
Pending for installing
Android 4.3.1 Platform, API 18
Android 4.4.2(API 19)
install 4.4.2
Pending for installing
Android 4.4.2 Platform, API 19
Android 4.4W (API 20)
no action
Android 4.4W Platform, API 20
Android 5.0 (API 21)
install 5.0
Pending for installing
Android 5.0 Platform, API 21
Android SDK Support Library
install 21.0.0
Pending for installing
Android SDK Support Library
Android SDK Support Repository Libr...
install 9
Pending for installing
Android SDK Support Repository Library
Android Toolchain
mixed
Android NDK
Android Native Development Kit (NDK) for ...
Java SDK
Java Development Kit (JDK) is a subset of too...
Eclipse
Eclipse IDE environment for Android develo...
ADT
Android Development Tools (ADT) is a set of...
Apache Ant
install 1.8.2
Pending for installing
Apache Ant is a Java build tool required to b...
install 2.1
Pending for installing
Gradle is a Java project automation build too...
install 11
Pending for installing
USB driver prepares a Windows host machin...
install
2.0.0.14266
install 2.1.0.15033
Pending for installing
Nsight Tegra, Visual Studio Edition is an Teg...
install 2.2-0
Pending for installing
PerfHUD ES is a stand-alone graphics debug...
install 4.1.1
Pending for installing
NVIDIA PerfKit SDK provides graphics develo...
1.3.15034.1225
install 1.3.15034.1802
Downloading 31.8% (2282 KB/s)
Tegra Graphics Debugger is a graphics debu...
install 2.2.1928.3270
Tegra System Profiler is a multi-core CPU sa...
install 1.0
USB Driver for NVIDIA Tegra Shield and NVID...
Per-component action selection
Concurrent uploads
Multi-component dependency management
Automatically resolve dependency conflicts
Waiting for downloading to finish
Stop
Pause
Next
System tray notification
These components can be updated now:
Gradle 2.2.1
Nsight Tegra, Visual Studio Edition 2.1.0.15043
PerfKit 4.3.0
More ...
Pause/uploads

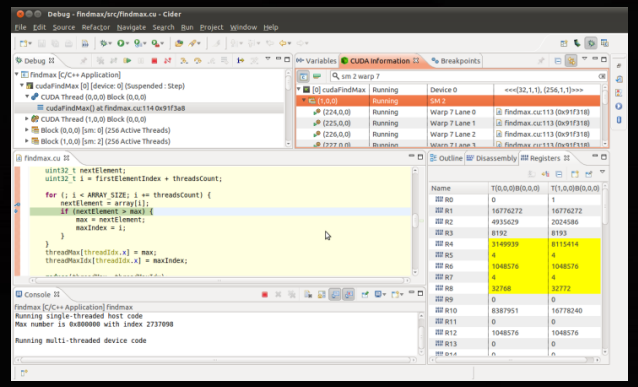
GPU TECHNOLOGY CONFERENCE

NVIDIA® NSIGHT™ ECLIPSE EDITION

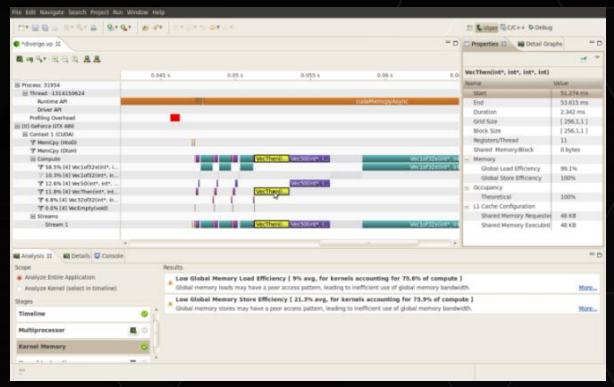
Homogeneous application development for CPU+GPU compute platforms



CUDA-Aware Editor



CUDA Debugger



CUDA Profiler

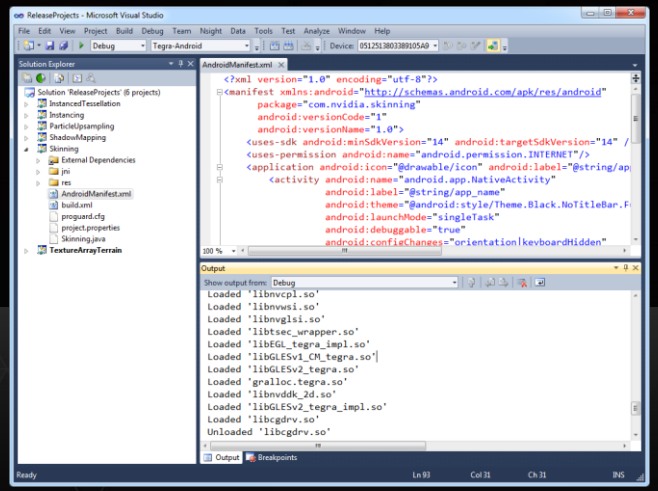
CPU+GPU

GPU TECHNOLOGY CONFERENCE

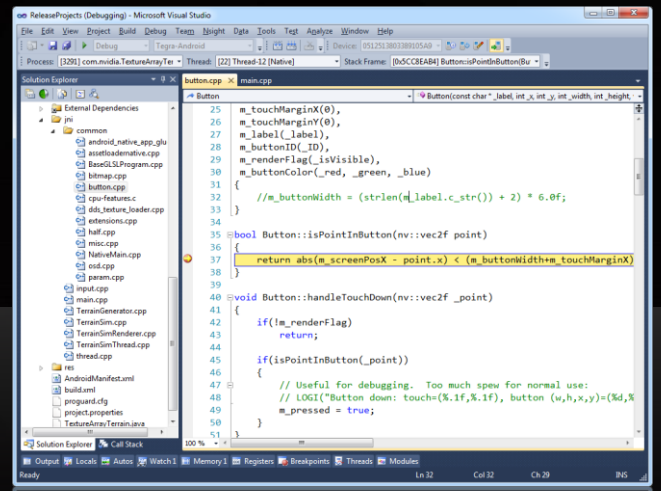
NVIDIA® NSIGHT™ TEGRA

Visual Studio

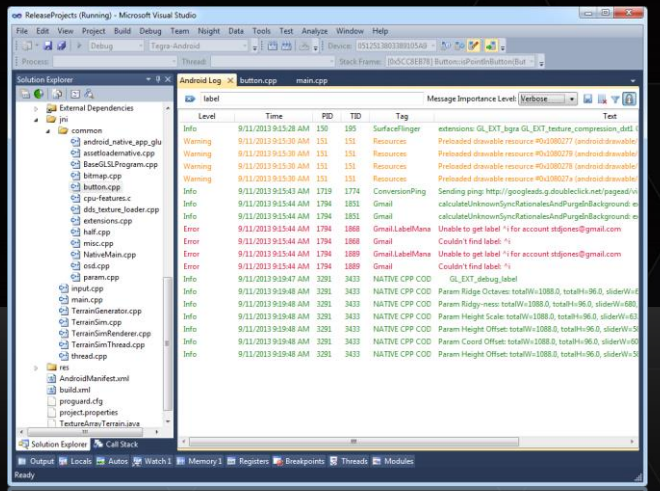
Android NDK/JDK application development



Project Management



Android Debugging
GDB+JDB



Logcat Filtering

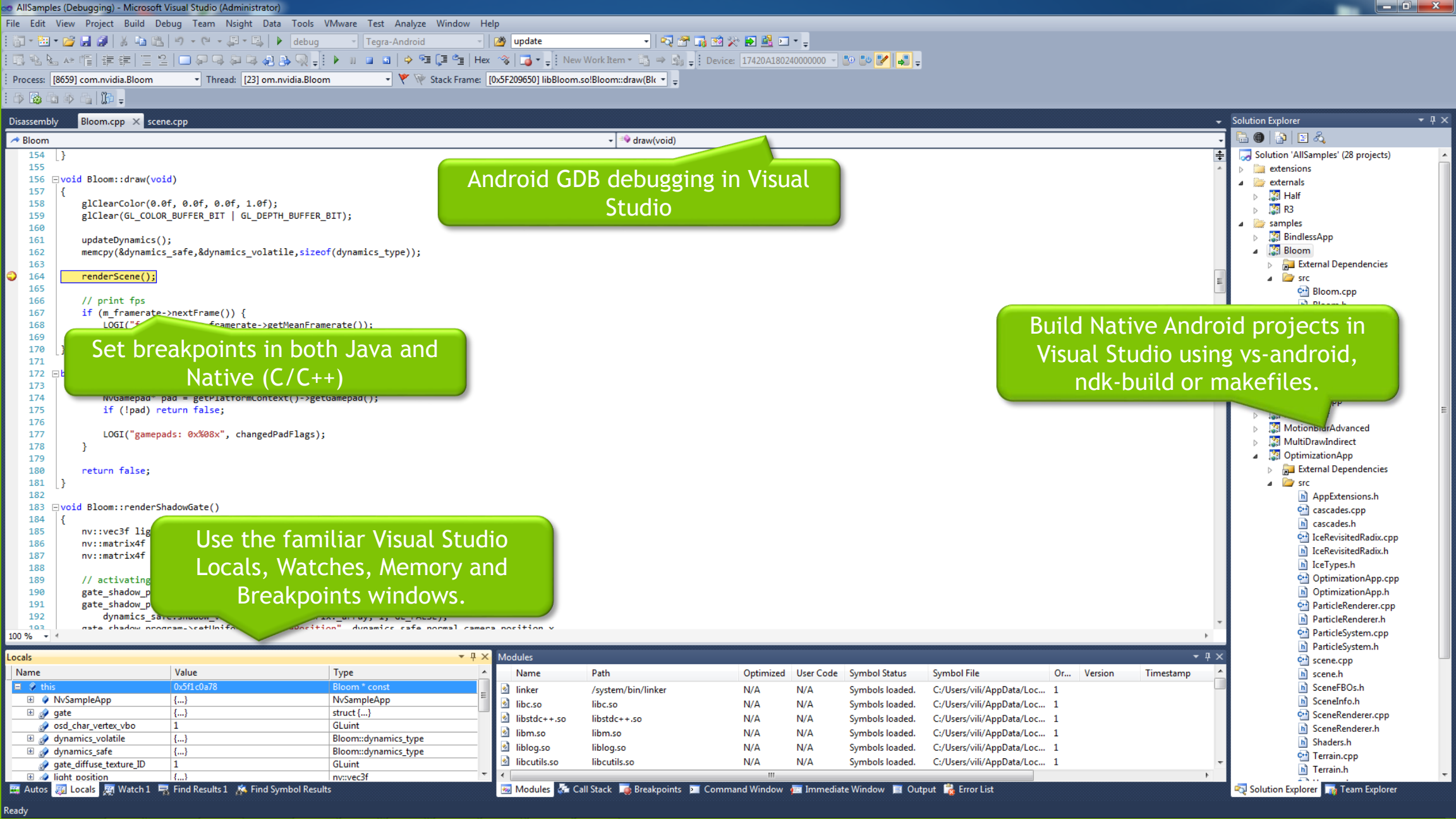
NSIGHT TEGRA Visual Studio 2.1

Android Application Development in Visual Studio

- Microsoft® Visual Studio™ 2010, 2012 and 2013
- NDK r10d / Android SDK 24.0.2
- Support for external build systems (makefile)
- ***IncrediBuild 5.5*** support to allow for distributed builds
- ***CMAKE 3.1*** support
- Multi-architecture APK support
- Faster wireless debugging support

IncrediBuild
BEYOND ACCELERATION

CMake

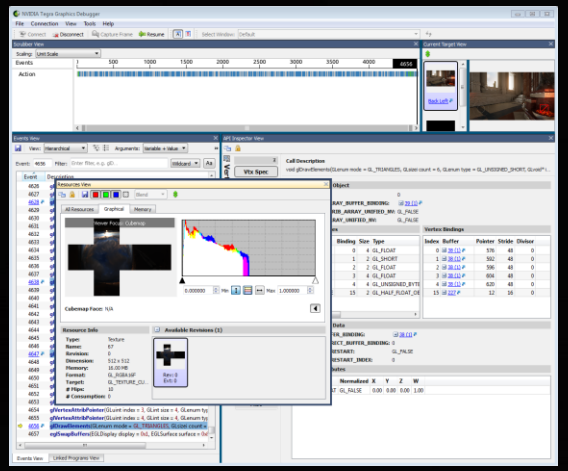

AllSamples (Debugging) - Microsoft Visual Studio (Administrator)
File Edit View Project Build Debug Team Nsight Data Tools VMware Test Analyze Window Help
Android GDB debugging in Visual Studio
Set breakpoints in both Java and Native (C/C++)
Build Native Android projects in Visual Studio using vs-android, ndk-build or makefiles.
Use the familiar Visual Studio Locals, Watches, Memory and Breakpoints windows.
Solution Explorer
Solution 'AllSamples' (28 projects)
Locals
Modules
Ready

GPU TECHNOLOGY CONFERENCE

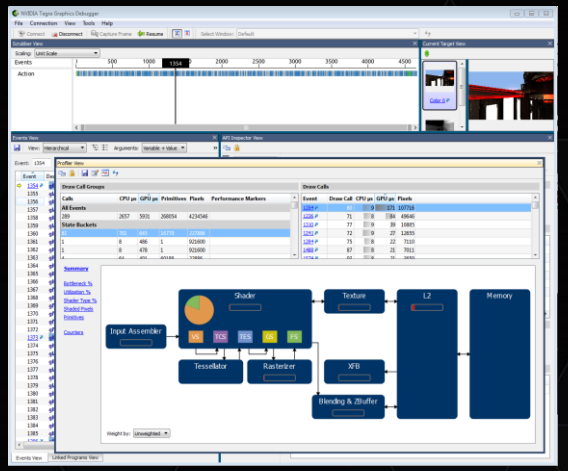
TEGRA GRAPHICS DEBUGGER

Next-gen graphics development tools for TEGRA K1 and beyond…

▶ Monitor performance



▶ Debug a frame



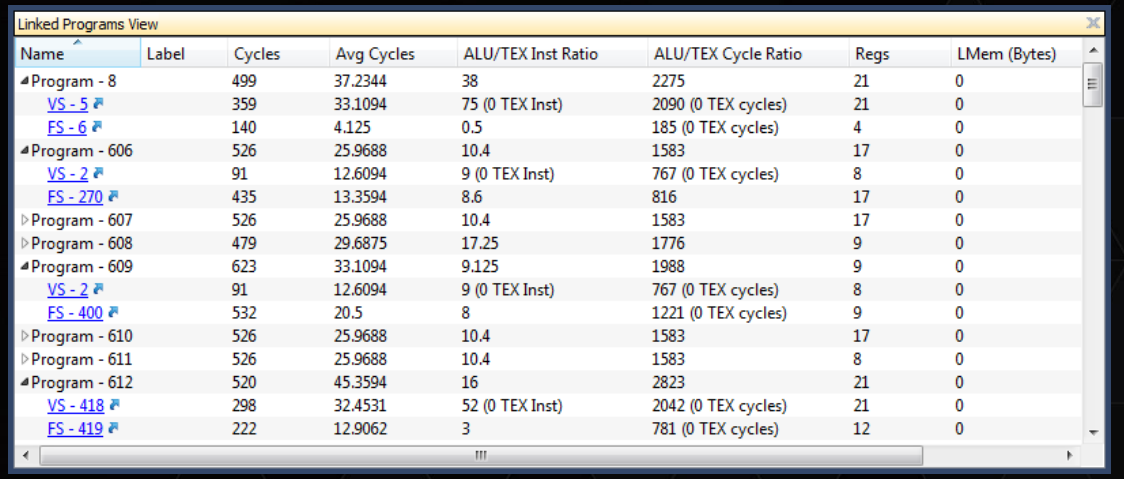
▶ Profile a frame

Supports OpenGL 4.x, OpenGL ES 2.0/3.0/3.1 + numerous extensions

NEW WITH TEGRA GRAPHICS DEBUGGER 2.0

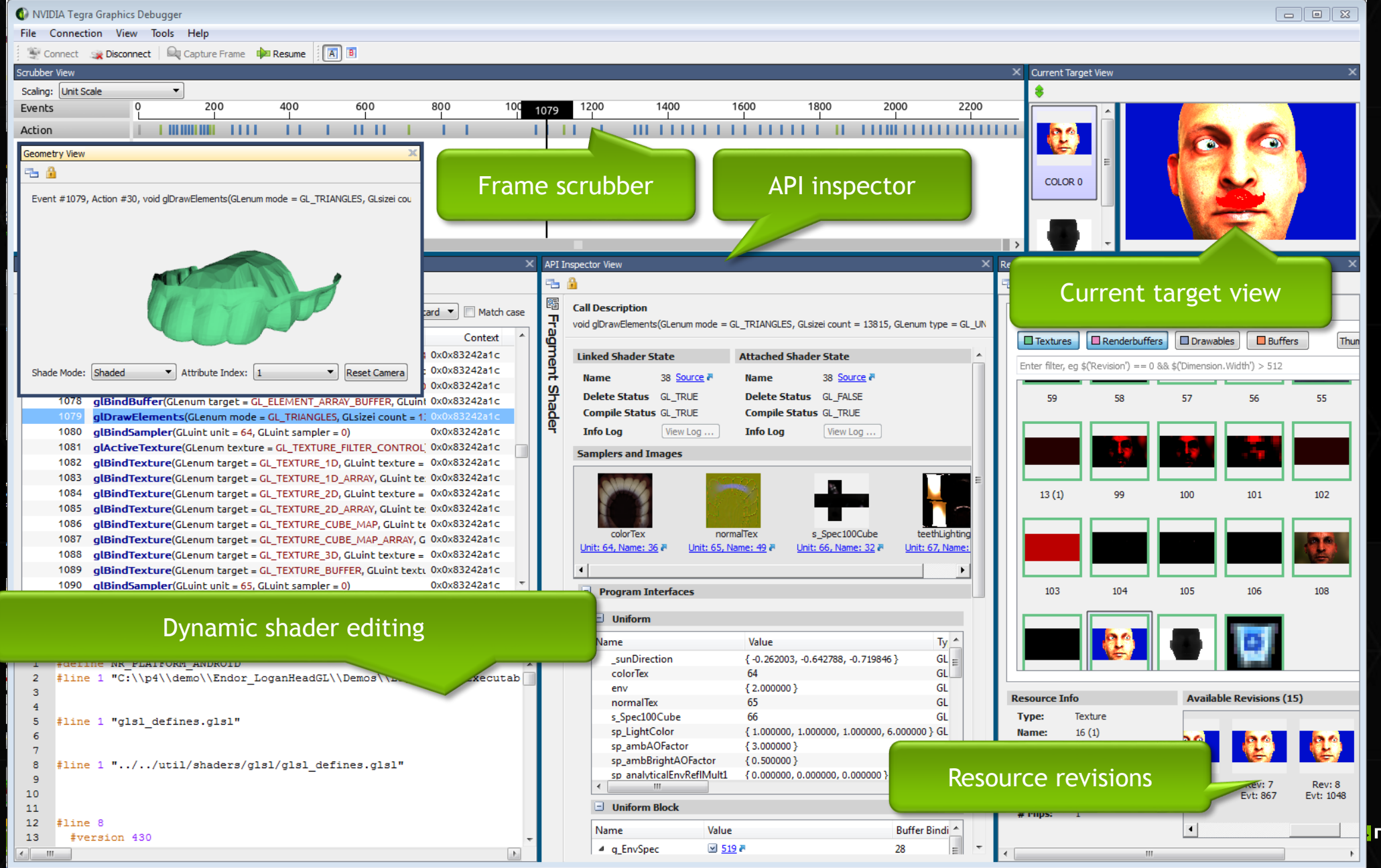
Tegra X1 support

- OpenGL 4.5
- Shader Performance Analysis for Tegra X1
- Capture with source code and Nsight Tegra project generation

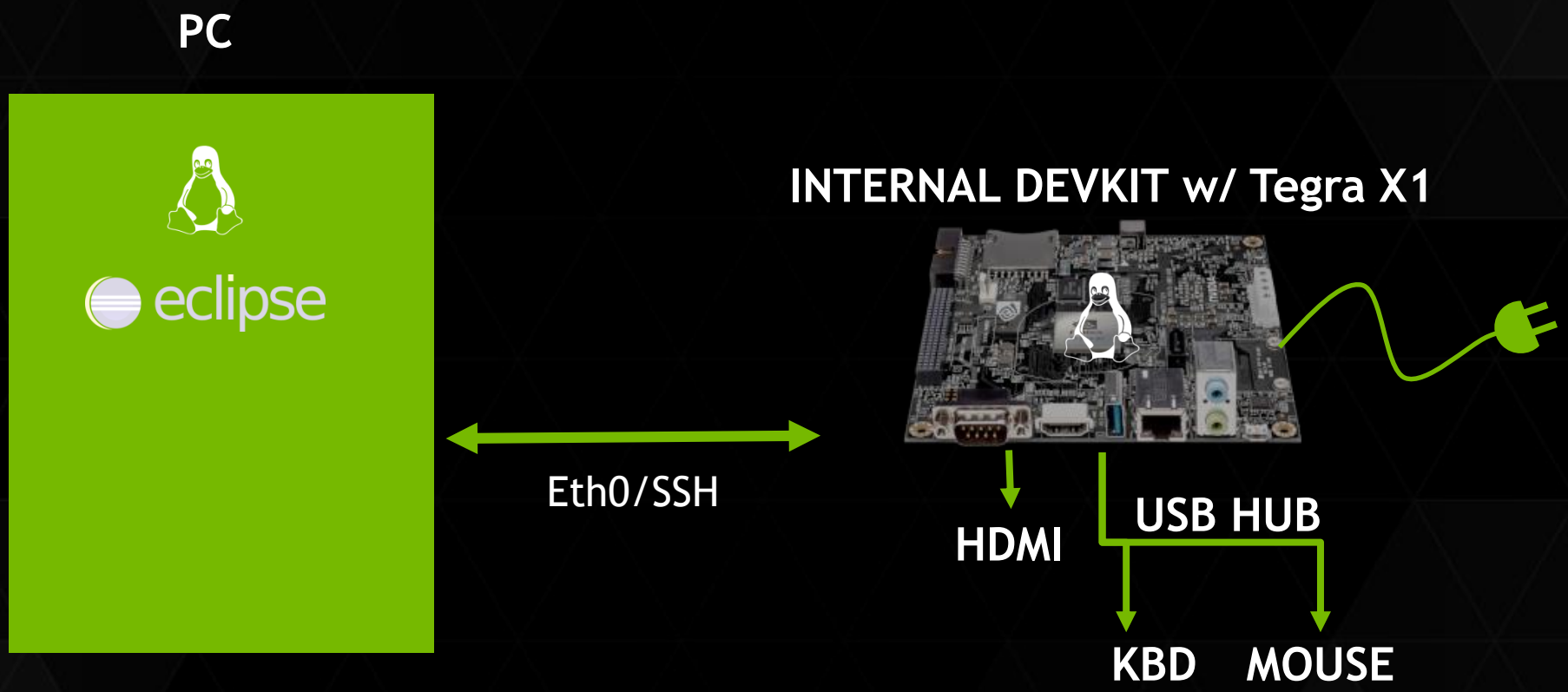


Linked Programs View

Name	Label	Cycles	Avg Cycles	ALU/TEX Inst Ratio	ALU/TEX Cycle Ratio	Regs	LMem (Bytes)
Program - 8		499	37.2344	38	2275	21	0
VS - 5		359	33.1094	75 (0 TEX Inst)	2090 (0 TEX cycles)	21	0
FS - 6		140	4.125	0.5	185 (0 TEX cycles)	4	0
Program - 606		526	25.9688	10.4	1583	17	0
VS - 2		91	12.6094	9 (0 TEX Inst)	767 (0 TEX cycles)	8	0
FS - 270		435	13.3594	8.6	816	17	0
Program - 607		526	25.9688	10.4	1583	17	0
Program - 608		479	29.6875	17.25	1776	9	0
Program - 609		623	33.1094	9.125	1988	9	0
VS - 2		91	12.6094	9 (0 TEX Inst)	767 (0 TEX cycles)	8	0
FS - 400		532	20.5	8	1221 (0 TEX cycles)	9	0
Program - 610		526	25.9688	10.4	1583	17	0
Program - 611		526	25.9688	10.4	1583	8	0
Program - 612		520	45.3594	16	2823	21	0
VS - 418		298	32.4531	52 (0 TEX Inst)	2042 (0 TEX cycles)	21	0
FS - 419		222	12.9062	3	781 (0 TEX cycles)	12	0


NVIDIA Tegra Graphics Debugger
File Connection View Tools Help
Connect Disconnect Capture Frame Resume
Scrubber View
Scaling: Unit Scale
Events
Action
1079
Geometry View
Event #1079, Action #30, void glDrawElements(GLenum mode = GL_TRIANGLES, GLsizei cou
Shade Mode: Shaded
Attribute Index: 1
Reset Camera
Frame scrubber
API inspector
Current target view
Dynamic shader editing
Resource revisions
Current Target View
COLOR 0
API Inspector View
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 ...
Delete Status GL_FALSE
Compile Status GL_TRUE
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 }
sp_analyticalEnvReflMult1 { 0.000000, 0.000000, 0.000000 }
Uniform Block
Name Value Buffer Bindi
q_EnvSpec 519 28
Fragment Shader
Match case
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
#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
NVIDIA

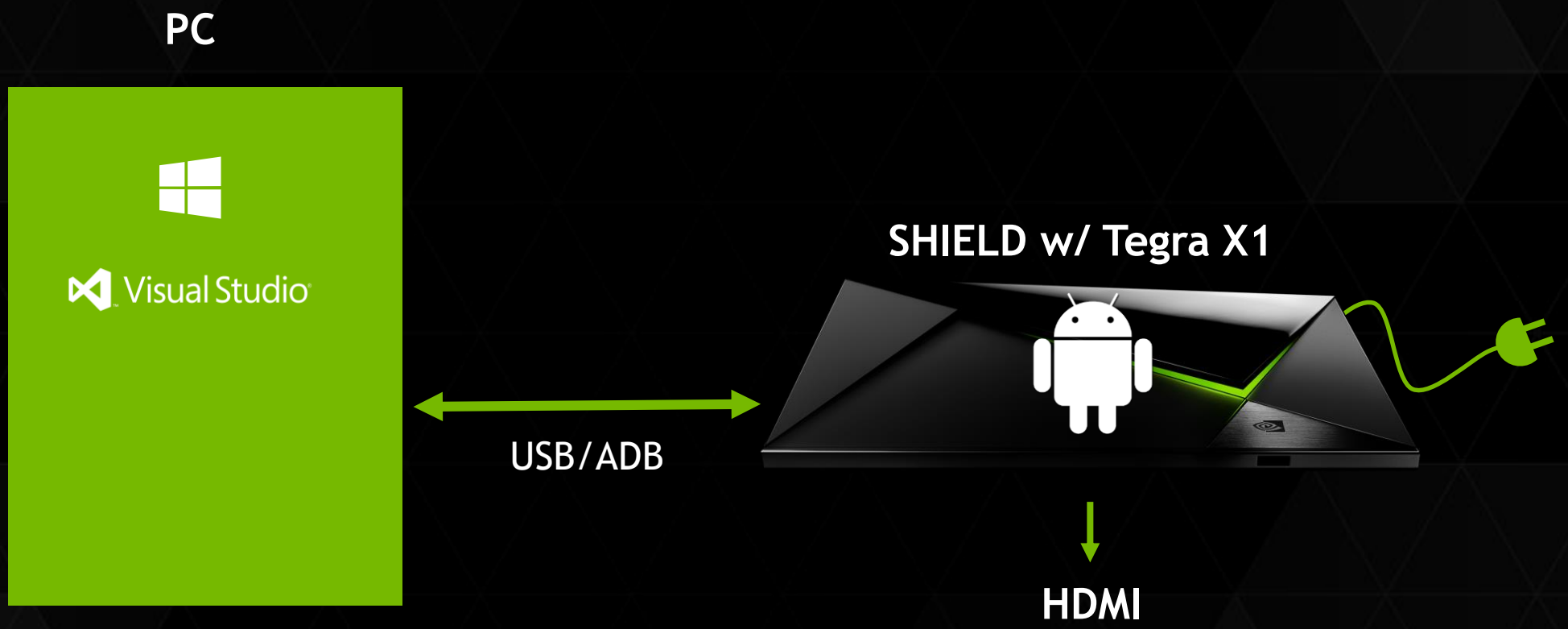
DEMO LINUX EMBEDDED DEVELOPMENT



DEMO TIME

- Drive CX / T210 / L4T
  - Run the Driver CX app
  - Attach Debugger – scrub with it…

DEMO SHIELD DEVELOPMENT



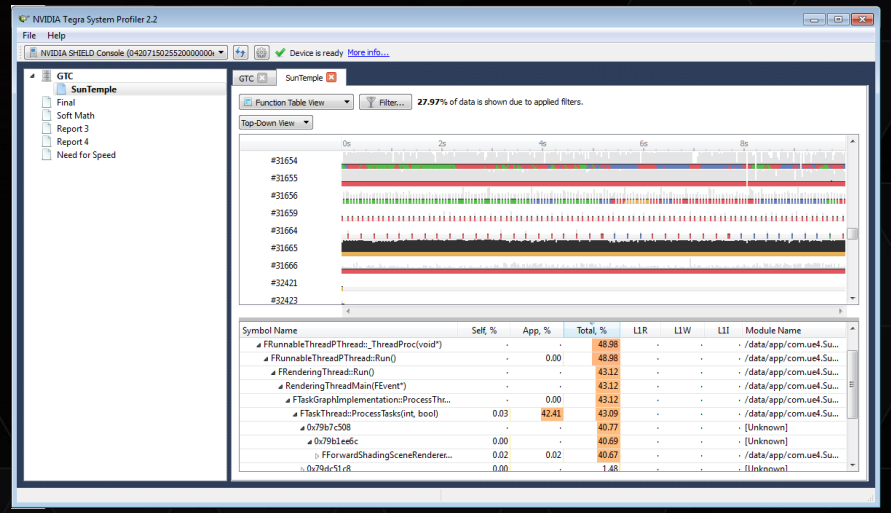
DEMO TIME

- SHIELD Console / Tegra X1 / Android
  - Sun Temple Demo
  - Load the captured frame in Nsight Tegra, run and have TGD attach to it

TEGRA SYSTEM PROFILER

Multi-core CPU profiler for all Tegra platforms

- Windows, Linux and OSX host application
- Easily prepare a device and deploy application for profiling
- Maximize multi-core A15/A9/Denver CPU utilization
- Quickly identify CPU “hot spots”, “hot paths” and L1/L2 cache issues
- Visualize multi-core CPU activities with a new timeline view
- Time range filtering



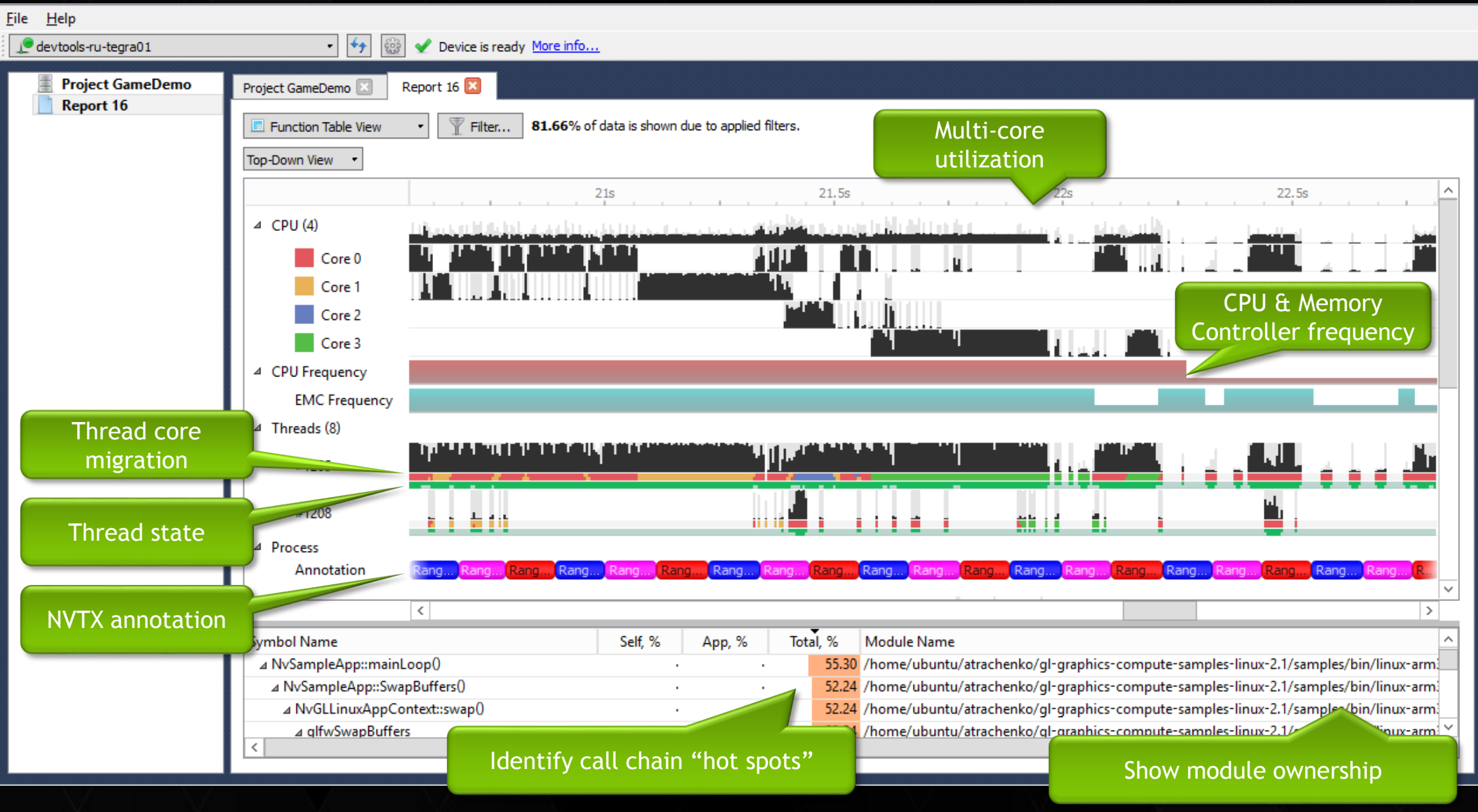
DEMO TIME

- Show Profile of the Sun Temple Demo
- Show some reports of findings from other apps

NEW WITH TEGRA SYSTEM PROFILER 2.3

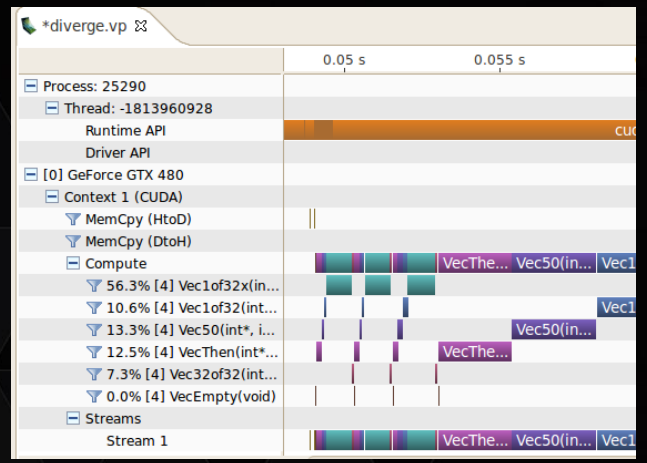
Tegra X1 support and Expanded system trace

- Tegra X1 A57/A53 support
- NVIDIA Tools Extension Support (NVTX)
- Visualize CPU, GPU and EMC frequencies
- Visualize thread state: running/ready/blocked
- Backtrace Quality Improvements

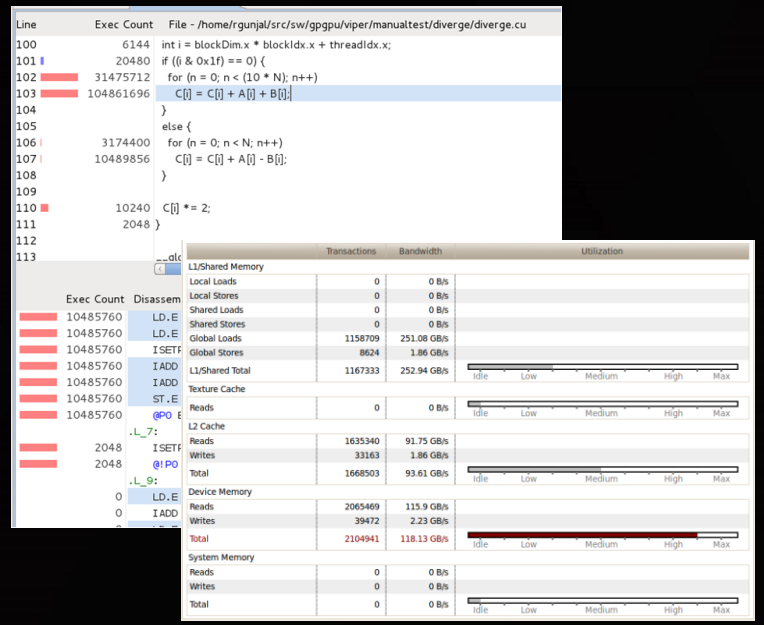

File Help
devtools-ru-tegra01
Device is ready More info...
Project GameDemo
Report 16
Project GameDemo
Report 16
Function Table View
Filter...
81.66% of data is shown due to applied filters.
Top-Down View
Multi-core utilization
21s
21.5s
22s
22.5s
CPU (4)
Core 0
Core 1
Core 2
Core 3
CPU Frequency
EMC Frequency
Threads (8)
Process
Annotation
CPU & Memory Controller frequency
Thread core migration
Thread state
NVTX annotation
Symbol Name
Self, %
App, %
Total, %
Module Name
NvSampleApp::mainLoop()
55.30
/home/ubuntu/atrachenko/gl-graphics-compute-samples-linux-2.1/samples/bin/linux-arm
NvSampleApp::SwapBuffers()
52.24
/home/ubuntu/atrachenko/gl-graphics-compute-samples-linux-2.1/samples/bin/linux-arm
NvGLLinuxAppContext::swap()
52.24
/home/ubuntu/atrachenko/gl-graphics-compute-samples-linux-2.1/samples/bin/linux-arm
glfwSwapBuffers
Identify call chain “hot spots”
Show module ownership

CUDA VISUAL PROFILER

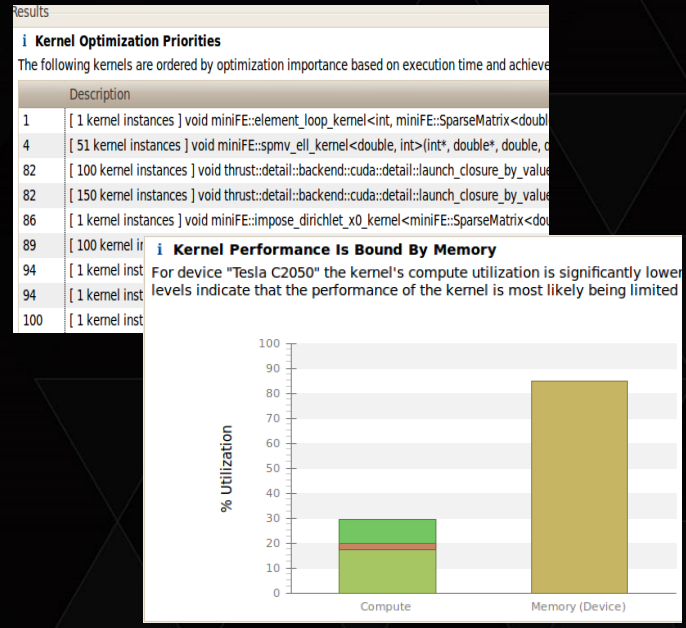
The Complete CUDA Application Performance Analysis



Trace Activities



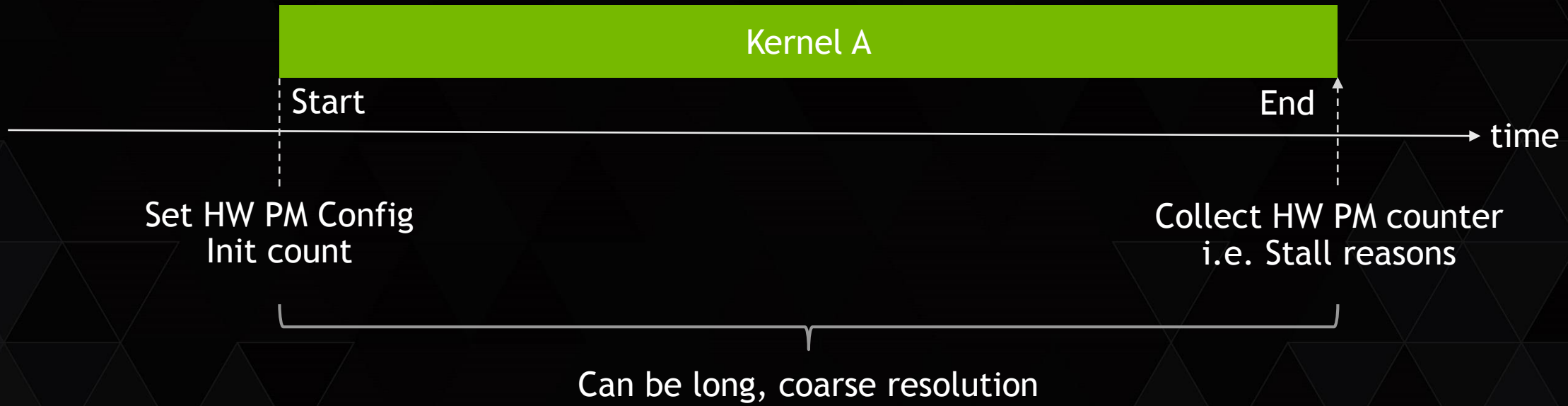
Kernel Profiler



Guided Analysis

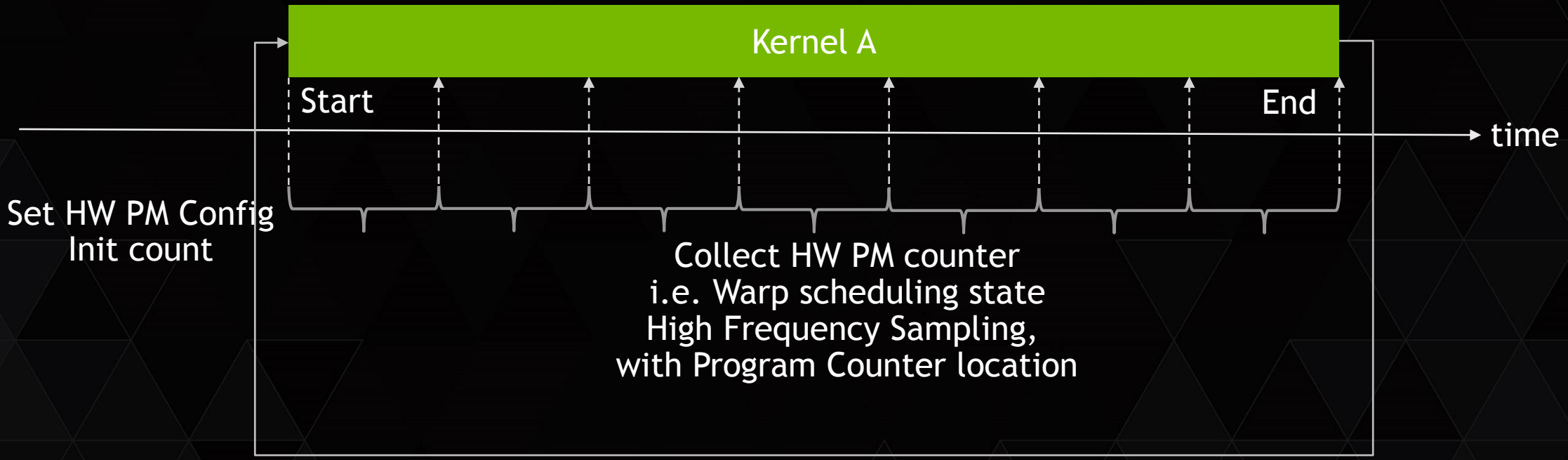
CUDA PROFILING

- Before Maxwell



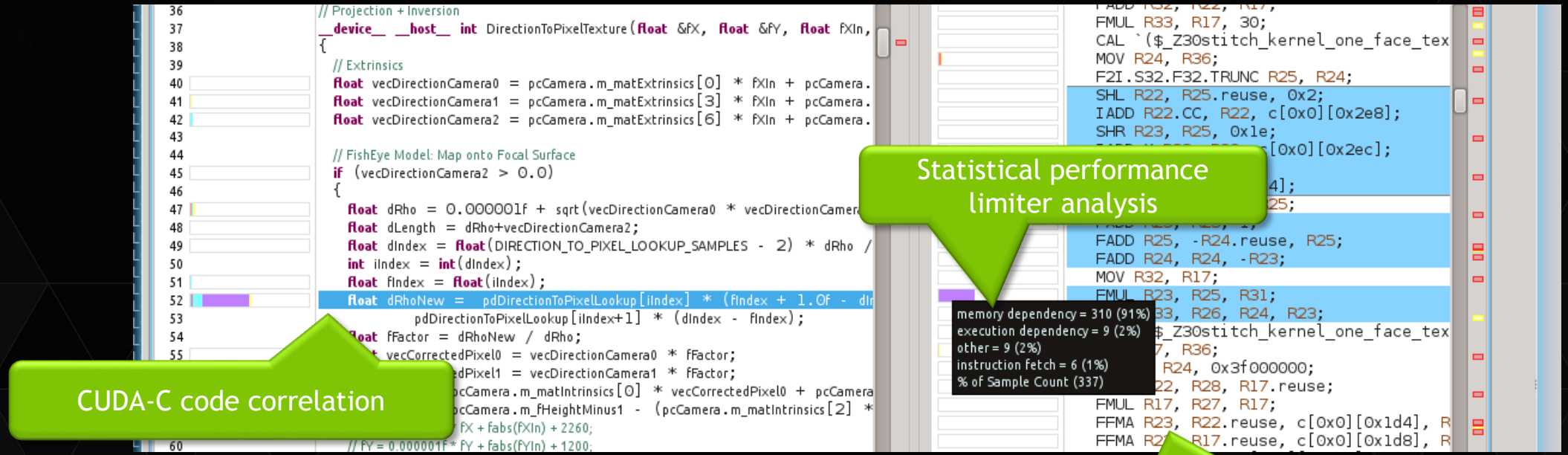
CUDA PROFILING

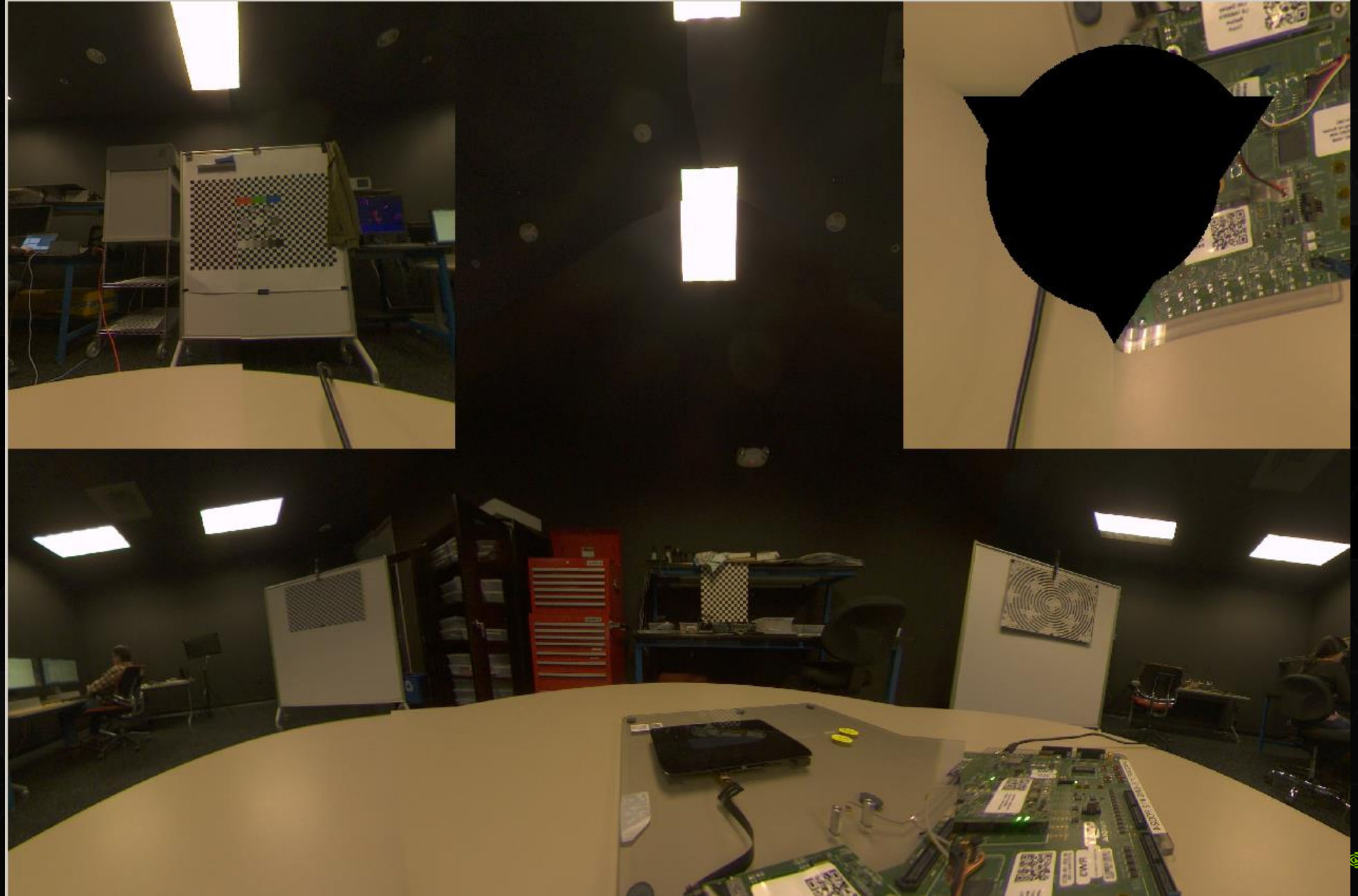
- With Maxwell and Tegra X1



CUDA 7.5

Hardware-based Performance Analysis with Source Code Correlation





CUDA COMMAND LINE TOOLS

CUDA-GDB

- Debug CUDA kernels with CLI
- Debug CPU and GPU code
- Core dump

CUDA-MEMCHECK

- Detect out-of-bounds memory accesses
- Detect race condition in memory accesses
- Init check
- Sync check

NVPROF

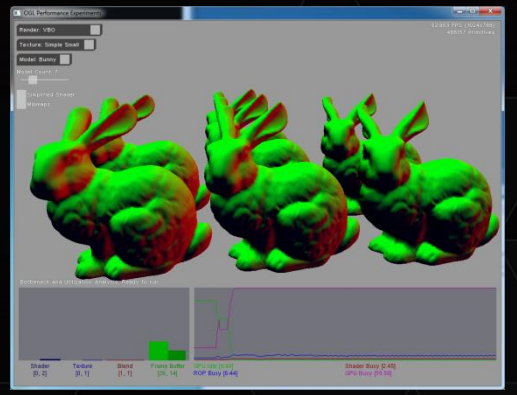
- Collect Performance events and metrics

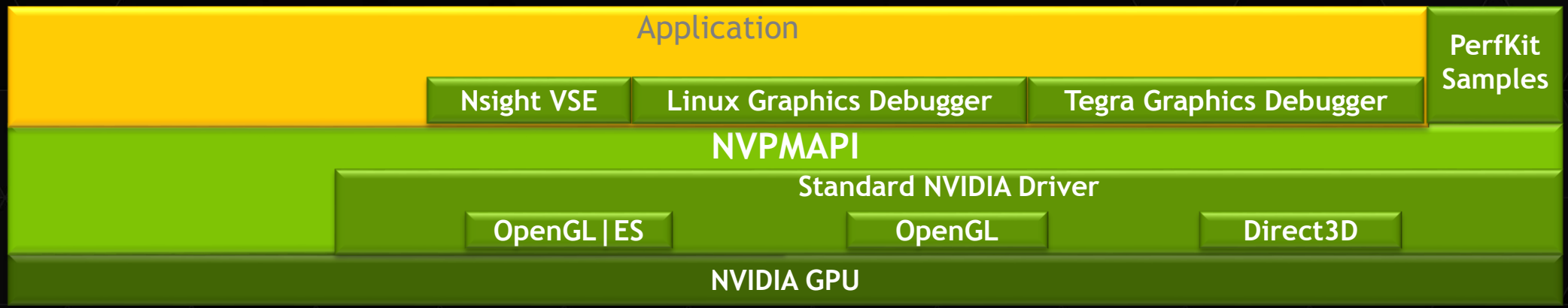
```
$ nvprof dct8x8

======== Profiling result:
 Time(%)      Time   Calls       Avg       Min       Max  Name
   49.52    9.36ms     101   92.68us   92.31us   94.31us  CUDAkernel2DCT(float*, float*, int)
   37.47    7.08ms      10  708.31us  707.99us  708.50us  CUDAkernel1DCT(float*,int, int,int)
    3.75  708.42us       1  708.42us  708.42us  708.42us  CUDAkernel1IDCT(float*,int,int,int)
    1.84  347.99us       2  173.99us  173.59us  174.40us  CUDAkernelQuantizationFloat()
    1.75  331.37us       2  165.69us  165.67us  165.70us  [CUDA memcpy DtoH]
    1.41  266.70us       2  133.35us   89.70us  177.00us  [CUDA memcpy HtoD]
    1.00  189.64us       1  189.64us  189.64us  189.64us  CUDAkernelShortDCT(short*, int)
    0.94  176.87us       1  176.87us  176.87us  176.87us  [CUDA memcpy HtoA]
    0.92  174.16us       1  174.16us  174.16us  174.16us  CUDAkernelShortIDCT(short*, int)
    0.76  143.31us       1  143.31us  143.31us  143.31us  CUDAkernelQuantizationShort(short*)
    0.52   97.75us       1   97.75us   97.75us   97.75us  CUDAkernel2IDCT(float*, float*)
    0.12   22.59us       1   22.59us   22.59us   22.59us  [CUDA memcpy DtoA]
```

PERFKIT 4.2.3

Hardware and Software Performance Counters

- GPU and software performance counter API
- Performance monitoring
- Automated bottleneck analysis
- Graphics and Compute





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

NVIDIA PERFWORKS 1.0

HW and SW performance counters for modern GPUs

- *New* Performance Counters collection engine
  - New user-friendly API
  - Performance Monitoring
  - GPU workload bottleneck analysis
  - User-definable collection ranges with concurrent execution within the range
  - Improved accuracy
- Support for Kepler, Maxwell and higher
- Support DX11, DX12 and OpenGL, Windows and Linux

DEVELOPER TOOLS @ GTC

- Wed 9:30am - S5656 - Hands-on Lab: Debugging and Automated Error Checking Tools and Techniques for GPU Programming
- Wed 2pm - S5657 - Hands-on Lab: Optimizing CUDA Application Performance with NVIDIA's Visual Profiler
- Wed 2pm - S5173 - CUDA Optimization with NVIDIA Nsight Eclipse Edition: A Case Study
- Wed 3:30pm - S5174 - CUDA Optimization with NVIDIA Nsight Visual Studio Edition: A Case Study
- Thu 1pm - S5655 - Hands-on Lab: CUDA Application Development Life Cycle with NVIDIA® Nsight™ Eclipse Edition
- Thu 6pm - S5451 - The Graphics Debugger for Linux

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