

# **TEGRA X1 DEVELOPER TOOLS**

SEBASTIEN DOMINE, SR. DIRECTOR SW ENGINEERING



## **NVIDIA DEVELOPER TOOLS**





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Global Setting Presidive Topology: D3D\_PRIPETOVE\_TOPOLOGY\_TRANSLED Input Levingt

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### **PICK A PLATFORM/API**



0-010-0405

# Microsoft<sup>®</sup> DirectX<sup>®</sup>





# **DEVELOPMENT FLOW**

PC



### 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... 🞮 TADP Component Manager

Coordinated

Standard Full Custom Clear Actions

Description

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Automatically resolve dependency conflicts

Waiting for downloading to finish



## NVIDIA® NSIGHT<sup>TM</sup> ECLIPSE EDITION

Homogeneous application development for CPU+GPU compute platforms

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### **CUDA** Debugger

CPU+GPU

### **CUDA** Profiler



### NVIDIA® NSIGHT<sup>™</sup> TEGRA Visual Studio

### Android NDK/JDK application development



Project Management

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#### GPU TECHNOLOGY CONFERENCE

# 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









### **TEGRA GRAPHICS DEBUGGER**

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

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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

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## DEMO LINUX EMBEDDED DEVELOPMENT

PC



### DEMO TIME

### Drive CX / T210 / L4T

Run the Driver CX app

> Attach Debugger - scrub with it...



## DEMO SHIELD DEVELOPMENT

PC



## 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

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VIDIA Tegra System Profiler 2.2												
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## DEMO TIME

Show Profile of the Sun Temple Demo

Show some reports of findings from other apps

#### GPU TECHNOLOGY CONFERENCE

## **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





## **CUDA VISUAL PROFILER**

100

### The Complete CUDA Application Performance Analysis

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T MemCpy (HtoD)				
WemCpy (DtoH)				
<ul> <li>Compute</li> </ul>		VecThe	Vec50(in	Vec1
T 56.3% [4] Vec1of32x(in				
T10.6% [4] Vec1of32(int				Vec1
🍸 13.3% [4] Vec50(int*, i			Vec50(in	
T 12.5% [4] VecThen(int*	- I I	VecThe		
7.3% [4] Vec32of32(int	l l			
T 0.0% [4] VecEmpty(void)				
<ul> <li>Streams</li> </ul>				
Stream 1		VecThe	Vec50(in	Vec1

		_									
	Exec (	Count	File	e - /home/rgunjal/src/sw/g	pgpu/viper/ma	nualtest/diver	ge/diver	ge.cu			
	6	5144	int i	= blockDim.x * blockIdx.x							
	20	0480	if ((i	(0, 1f) == 0)							
	31479	5712	for	(n = 0; n < (10 * N); n++)							
	104861	1696	C	(1 - 0) + (1 - 0) + B(1)							
	104803	10 90		[i] = C[i] + A[i] + D[i],]							
			·	(							
			else								
	3174	+400	ror	(n = 0; n < N; n++)							
	10489	9856	, C	[i] = C[i] + A[i] - B[i];							
			}								
	10	0240	C[i]	*= 2;							
	2	2048	}								
					Transactions	Bandwidth			Utilization		_
		(		L1/Shared Memory							
		,		Local Loads	0	0 B/s					
	Exec Count	Disa	ssem	Local Stores	0	0 B/s					
	10495760		DE	Shared Loads	0	0 B/s					
-	10485760		D.E	Shared Stores	0	0 B/s					
	10485760		D.E	Global Loads	1158709	251.08 GB/s					
	10485760		SEIF	Global Stores	8624	1.86 GB/s					
	10485760	1	ADD	L1/Shared Total	1167333	252.94 GB/s	Idle	Low	Medium	High	Max
	10485700		ADD	Texture Cache							
	10485760			Reads	0	0 B/s	Idle	Low	Medium	High	Max
	10405700	1 7		L2 Cache							
_	204.9	·	CET	Reads	1635340	91.75 GB/s					
	2048		SEIF	Writes	33163	1.86 GB/s					
	2040	1.0	91 PO	Total	1668503	93.61 GB/s	Idle	Low	Medium	High	Max
	0			Device Memory							
	ő			Reads	2065469	115.9 GB/s					
	0		ADD	Writes	39472	2.23 GB/s					
				Total	2104941	118.13 GB/s	Idle	Low	Medium	High	Max
				System Memory							
				Reads	0	0 B/s					
				Writes	0	0 B/s					
				Total	0	0 B/s	Idle	Low	Medium	High	Мах

20	oculto				
W.	courto				
	i Kern	el Optimizati	on Priorities		
	The follo	wing kernels ar	e ordered by optimi	zation importance based on execution time an	nd achieve
		Description			
	1	[ 1 kernel inst	ances ] void miniFE:	element_loop_kernel <int, minife::sparsemate<="" th=""><th>rix<doubl< th=""></doubl<></th></int,>	rix <doubl< th=""></doubl<>
	4	[ 51 kernel ins	tances ] void miniFE	::spmv_ell_kernel <double, int="">(int*, double*,</double,>	, double, d
	82	[ 100 kernel in	stances ] void thrus	t::detail::backend::cuda::detail::launch_closure	e_by_value
	82	[ 150 kernel in	stances ] void thrus	t::detail::backend::cuda::detail::launch_closure	e_by_value
	86	[ 1 kernel inst	ances ] void miniFE:	:impose_dirichlet_x0_kernel <minife::sparsem< th=""><th>latrix<dou< th=""></dou<></th></minife::sparsem<>	latrix <dou< th=""></dou<>
	89	[ 100 kernel ir	i Kernel Per	rformance Is Bound By Memory	
	94	[ 1 kernel inst	For device "Tes	la C2050" the kernel's compute utili	zation is significantly lowe
	94	[ 1 kernel inst	levels indicate	that the performance of the kernel is	s most likely being limited
	100	[ 1 kernel inst			
		:		100 -	
				90 -	
				80	
			-	70	
			tion	60 -	_
			liza	50 -	
		$- \setminus /$	CEI	40	_
		$\sim$	%	30	
				20	
				10	
				o =	

**Guided Analysis** 



### Kernel Profiler



## **CUDA PROFILING**

### Before Maxwell





## **CUDA PROFILING**

With Maxwell and Tegra X1



Combined with Kernel replay and offset of PC sampling start time



### CUDA 7.5 Hardware-based Performance Analysis with Source Code Correlation



SASS microcode correlation



## **CUDA COMMAND LINE TOOLS**

### **CUDA-GDB**

GPU TECHNOLOGY

- 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:

ime(%)	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



Application											
	Nsight VSE	Linux Graphics Debugger	Tegra Graphics Debugger		Samples						
NVPMAPI											
	Standard NVIDIA Driver										
	OpenGL E	S OpenGL		Direct3D							
NVIDIA GPU											
	http://www.nvidi	a.com/object/nvperfkit_h	ome.html								

#### GPU TECHNOLOGY CONFERENCE

# **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<sup>™</sup> Eclipse Edition

Thu 6pm - S5451 - The Graphics Debugger for Linux



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# Q&A THANK YOU

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