

**NVIDIA Parallel Nsight™**  
**Accelerating GPU Development**  
**in BioWare's Dragon Age II**

**March 2011**



# Introductions

**Jeff Kiel**

**Manager of Graphics Tools**

**NVIDIA Corporation**

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**Lead Graphics Programmer**

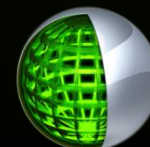
**BioWare**



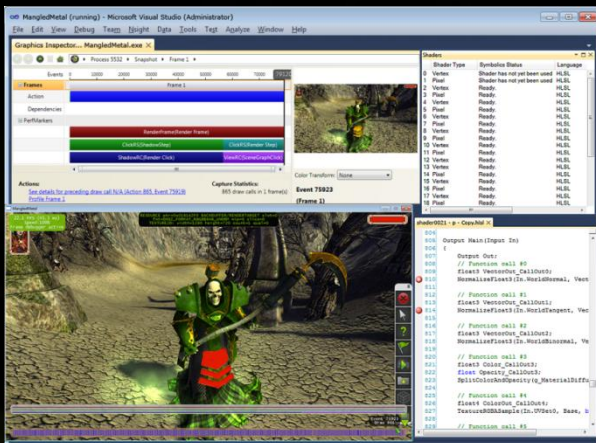
# Agenda



- **NVIDIA Parallel Nsight and DragonAge II**
  - **Graphics Inspector**
  - **Pixel History**
  - **Graphics Debugger**
  - **System Analysis**
  - **Frame Profiler**
- **PerfHUD Update**

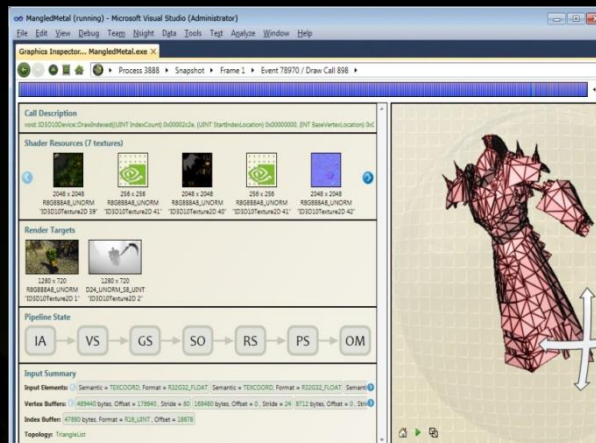


# NVIDIA Parallel Nsight



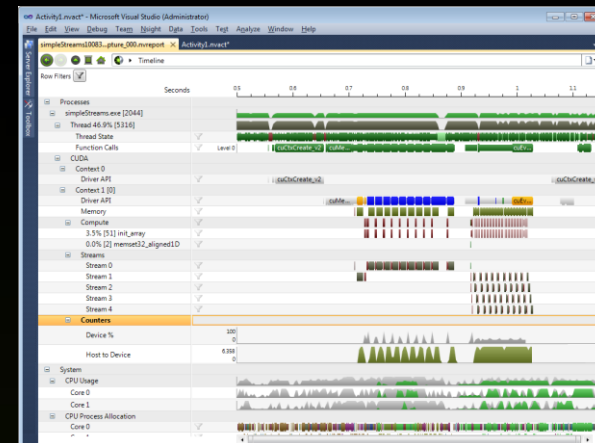
## Graphics Debugger

GPU Accelerated HLSL shader debugging  
Examine shaders executing in parallel  
Identify issues with conditional breakpoints



## Graphics Inspector

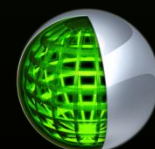
Real-time inspection of DirectX API calls  
Investigate GPU pipeline state  
See contributing fragments with Pixel History  
Profile frames to find GPU bottlenecks



## System Analysis

View CPU & GPU events on a single timeline  
Examine workload dependencies  
Direct3D and OpenGL API Trace

Integrated into Visual Studio 2008 and 2010

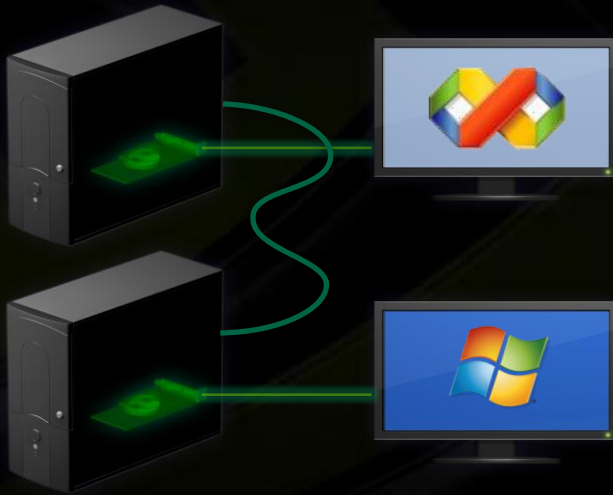


# Parallel Nsight Environment

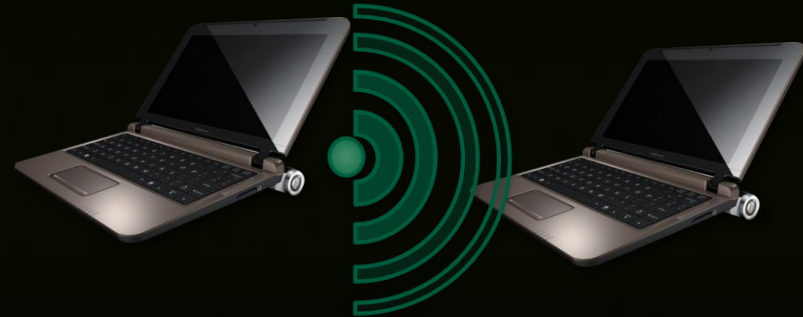


## Remote Debugging

Desktop



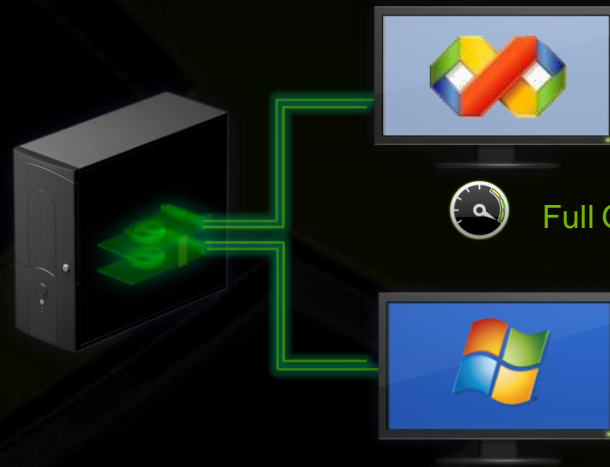
Mobile



# Parallel Nsight Environment



## Local Debugging: SLI Multi-OS



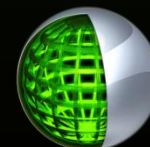
Full GPU acceleration



# Dragon Age II Graphics Engine Overview



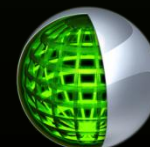
- **Traditional forward renderer**
  - Depth pass for visibility determination and early pixel rejection
  - Directional lightmaps with radiosity for static geometry
  - Precomputed light lookup for dynamic objects
  - Limited number of dynamic lights on DX9 version (2 per object)



# Dragon Age II Graphics Engine Overview



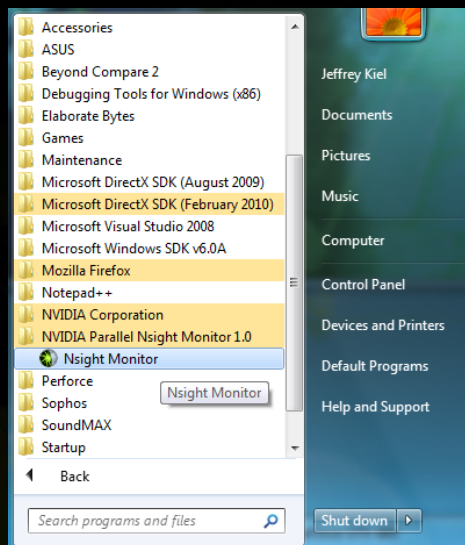
- **DX11 code path uses deferred lighting (light prepass)**
  - Supports hundreds of small dynamic lights efficiently
- **Post-process framework**
  - Bloom (compute shader accelerated on DX11)
  - SSAO
  - Depth of field
  - Distortion



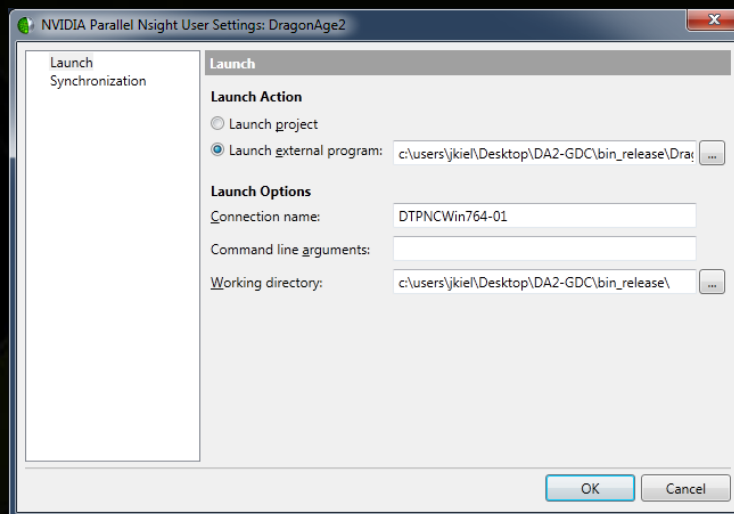
# Demo: Launching...



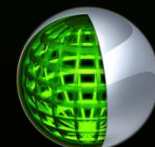
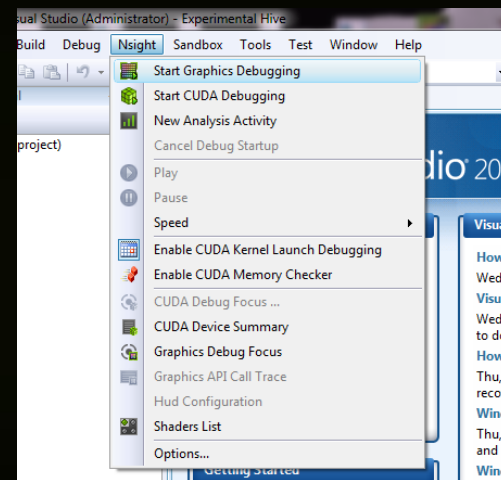
Start Nsight Monitor



Configure Parallel Nsight Project Settings



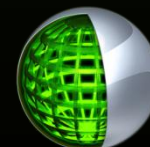
Launch Your Application



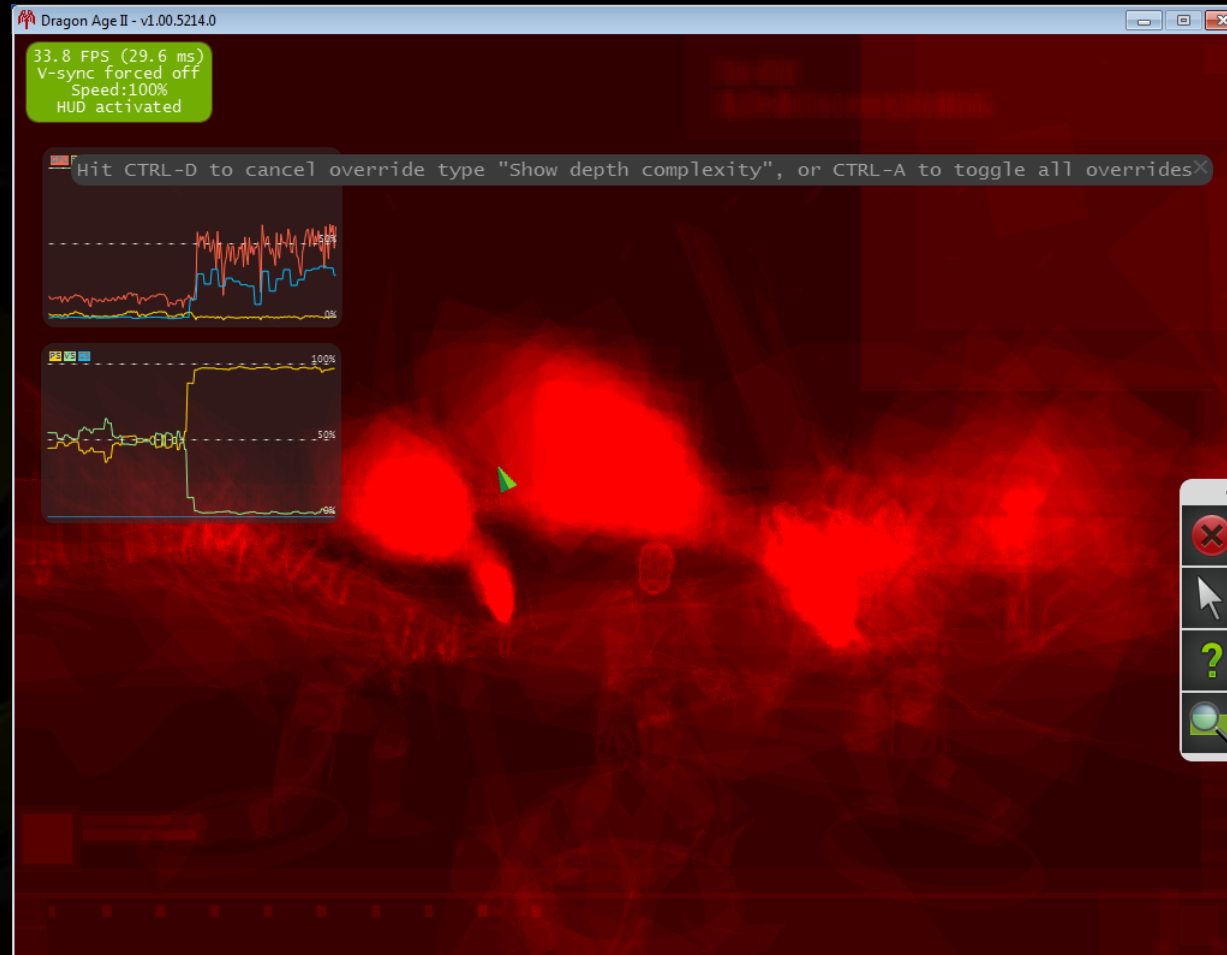
# Demo: HUD on Running Application



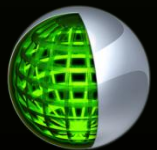
Configurable  
Performance  
Graphs



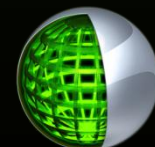
# Demo: HUD Showing Depth Complexity



HUD Toolbar



# Demo: HUD in Graphics Inspector



# Demo: HUD Render Target, Depth & Stencil



# Demo: Host Frames Page

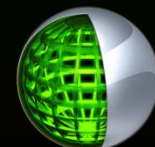
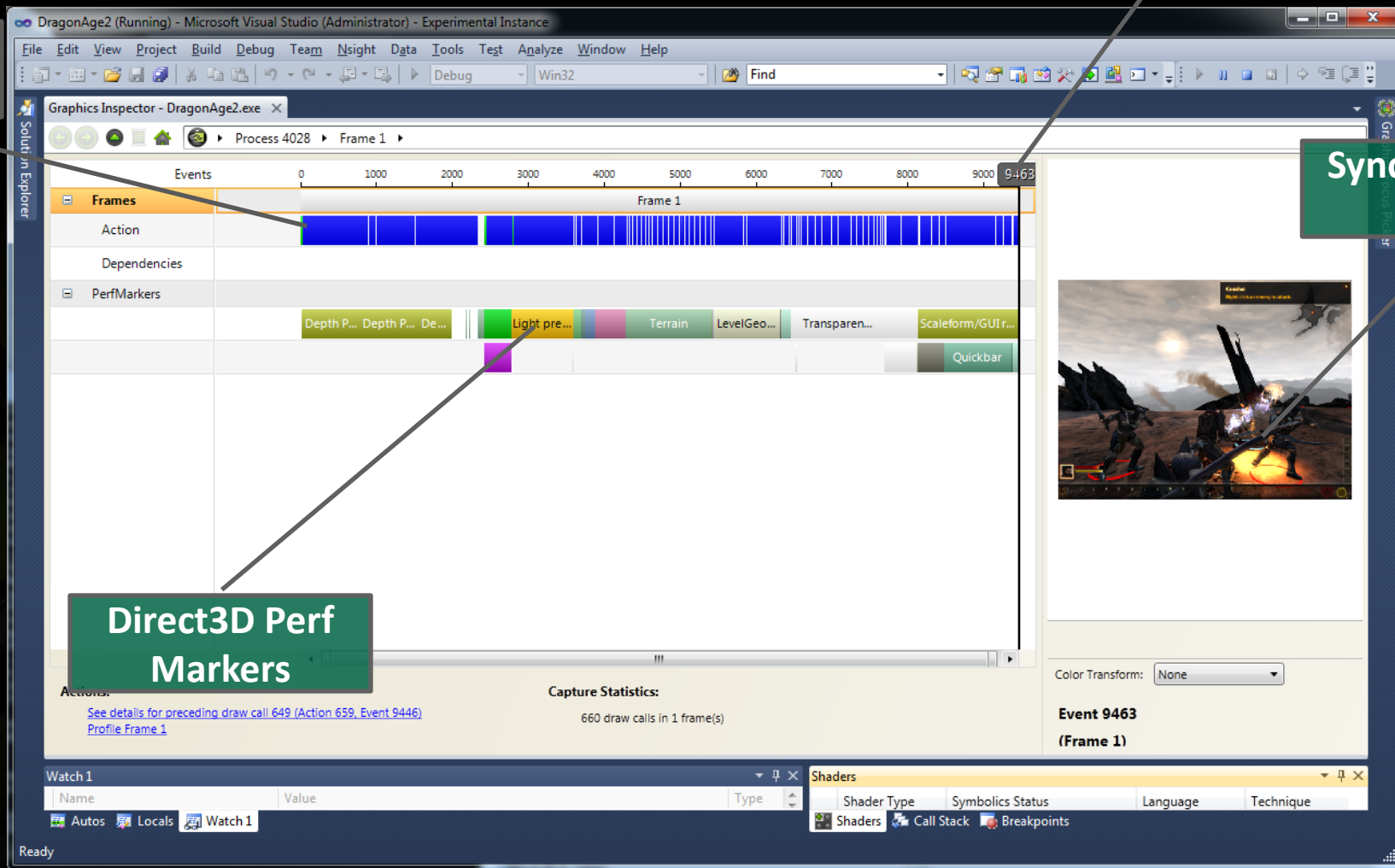


Draw Calls

Scrub Bar

Synced Render  
Target

Direct3D Perf  
Markers



# Demo: Draw Call Page



DragonAge2 (Running) - Microsoft Visual Studio (Administrator) - Experimental Instance

File Edit View Project Build Debug Team Nsight Data Tools Test Analyze Window Help

Graphics Inspector - DragonAge2.exe

Process 4028 ▶ Frame 1 ▶ Event 6307 / Action 459 ▶

**Call Description**  
void: ID3D11DeviceContext::DrawIndexed((UINT IndexCount) 0x00002280, (UINT StartIndexLocation) 0x00000000, (INT BaseVertexLo

**Shader Resources (23 textures)**

PS:0 512 x 512 BC1\_UNORM  
"art\levels\races\natural\blightlands\vista\\_textures\bridge\_d.dds"

PS:1 16 x 16 BC3\_UNORM  
"default\_specularmask.dds"

PS:2 4 x 4 R8G8B8A8\_UNORM  
"default\_black.dds"

**Render Targets**

RT:0 1024 x 768 R8G8B8A8\_UNORM  
DS 1024 x 768 D24\_UNORM\_S8\_UINT  
"ID3D11Texture2D 1" "ID3D11Texture2D 2"

**Pipeline State**

IA → VS → HS → DS → GS → SO → RS → PS → OM

**Input Summary**

Input Elements: Semantic = POSITION, Format = R32G32B32\_FLOAT Semantic = NORMAL, Format = R8G8B8A8\_UNORM

Vertex Buffers: 80064 bytes, Offset = 0, Stride = 28 34284 bytes, Offset = 0, Stride = 12

Index Buffer: 17664 bytes, Format = R16\_UINT, Offset = 0

Topology: TriangleList

**Geometry Preview**

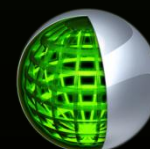
**Render Targets**

**Links to Pipeline Inspectors**

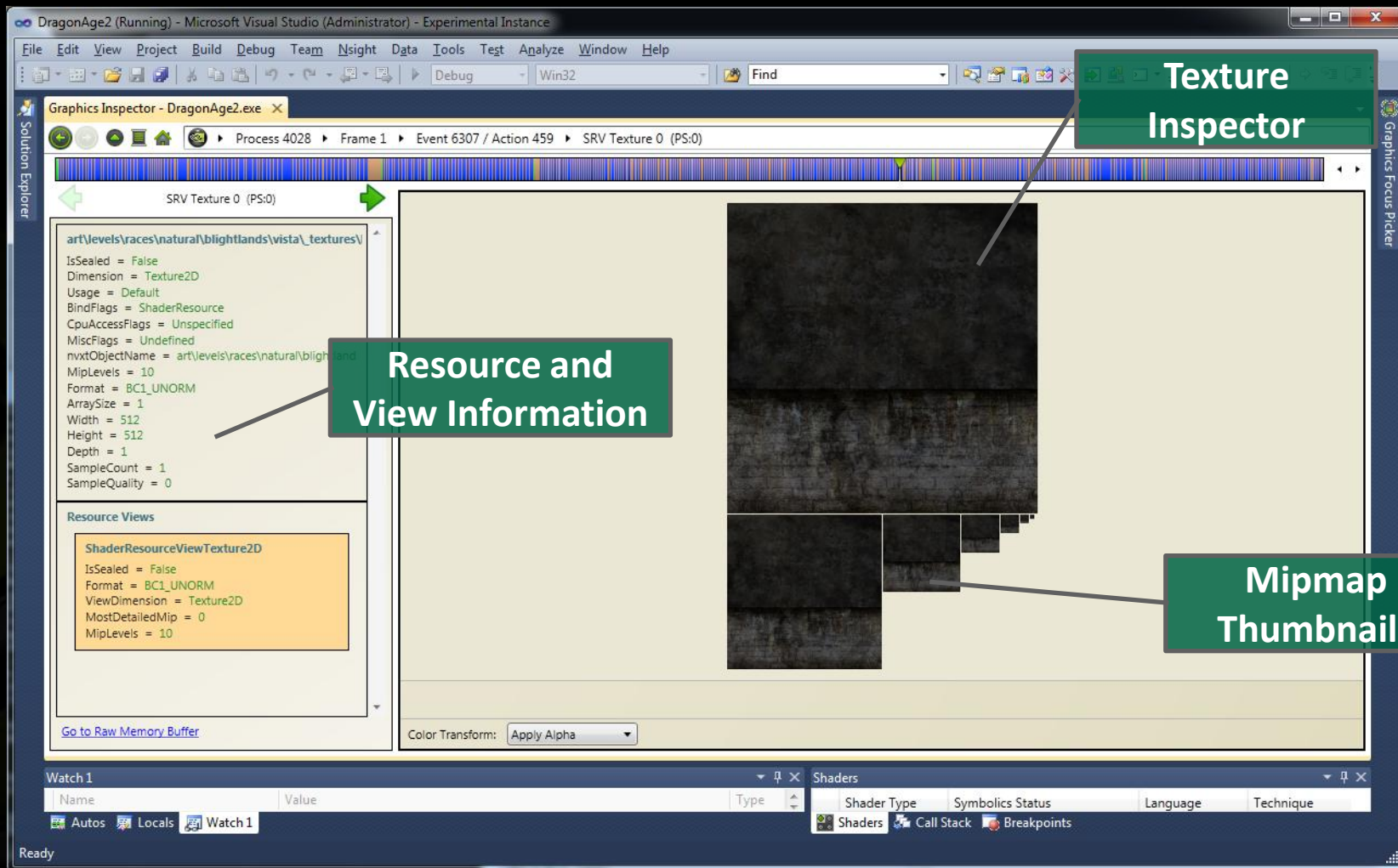
Shaders

Shader Type Symbolics Status Language Technique

Shaders Call Stack Breakpoints



# Demo: Texture Viewer



# Demo: Pixel Shader State Inspector



Scrubber

Link to Shader Source

View Any Stage  
in the Direct3D  
Pipeline

Direct3D State

The screenshot shows the Pixel Shader State Inspector tool. The left sidebar contains a vertical stack of buttons for Direct3D pipeline stages: IA, VS, HS, DS, GS, SO, RS, PS (highlighted), and OM. The main window displays the 'Pixel Shader' details for the selected stage. It includes a call signature, file path, and function name. Below this, the 'Instance and Bind Information' section shows a table of constant buffers. The 'Shader Resource Views' section shows a table of texture and buffer resources. The bottom of the window features a 'Watch' pane and a 'Shaders' pane.

**Pixel Shader**

Call: void: ID3D11DeviceContext::DrawIndexed((UINT IndexCount) 0x00000000, (UINT StartIndexLocation) 0x00000000, (INT BaseVertexLocation) 0x00000000)

File:

Function: Main Profile: Flags1: 0 Flags2: 0

**Instance and Bind Information**

Usage	BindFlags	CpuAccessFlags	MiscFlags	ByteWidth	StructureByteStride	ObjectName
0 Dynamic ConstantBuffer Write		Undefined	80	0	ID3D11Buffer 30	
1 Dynamic ConstantBuffer Write		Undefined	240	0	ID3D11Buffer 31	
2 Dynamic ConstantBuffer Write		Undefined	752	0	ID3D11Buffer 4	
3 Dynamic ConstantBuffer Write		Undefined	752	0	ID3D11Buffer 4	

**Shader Resource Views**

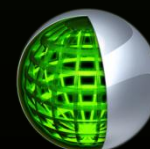
View	Dimension	Format	Dimension	Usage	Bind	CPU	Misc	Width	Height	ObjectName
0 Texture2D	BC1_UNORM	Texture2D	Default ShaderResource	Unspecified	Undefined	512	512	art\levels\races\natural\blightlands\vista\		
1 Texture2D	BC3_UNORM	Texture2D	Default ShaderResource	Unspecified	Undefined	16	16	default_specularmask.dds		
2 Texture2D	R8G8B8A8_UNORM	Texture2D	Default ShaderResource	Unspecified	Undefined	4	4	default_black.dds		
3 Texture2D	R16G16B16A16_FLOAT	Texture2D	Default ShaderResource, RenderTarget	Unspecified	Undefined	1024	768	ID3D11Texture2D 93		
4 Texture2DArray	R24_UNORM_X8_TYPELESS	Texture2D	Default ShaderResource, DepthStencil	Unspecified	Undefined	512	512	ID3D11Texture2D 4		
5 Texture2D	R32_FLOAT	Texture2D	Default ShaderResource, RenderTarget	Unspecified	Undefined	4096	4096	ID3D11Texture2D 70		
6 Texture2D	R16G16B16A16_FLOAT	Texture2D	Default ShaderResource, RenderTarget	Unspecified	Undefined	1024	768	ID3D11Texture2D 93		
7 Texture2DArray	R24_UNORM_X8_TYPELESS	Texture2D	Default ShaderResource, DepthStencil	Unspecified	Undefined	512	512	ID3D11Texture2D 4		
8 Texture2D	BC3_UNORM	Texture2D	Default ShaderResource	Unspecified	Undefined	1024	1024	art\levels\races\natural\blightlands\terrai		
9 Texture2D	BC1_UNORM	Texture2D	Default ShaderResource	Unspecified	Undefined	512	512			
10 Texture2D	BC1_UNORM	Texture2D	Default ShaderResource	Unspecified	Undefined	512	512			
11 Texture2D	BC1_UNORM	Texture2D	Default ShaderResource	Unspecified	Undefined	512	512			
12 Texture2D	R32_FLOAT	Texture2D	Default ShaderResource, RenderTarget	Unspecified	Undefined	4096	4096	ID3D11Texture2D 70		
13 Texture2D	R16G16B16A16_FLOAT	Texture2D	Default ShaderResource, RenderTarget	Unspecified	Undefined	1024	768	ID3D11Texture2D 93		
14 Texture2DArray	R24_UNORM_X8_TYPELESS	Texture2D	Default ShaderResource, DepthStencil	Unspecified	Undefined	512	512	ID3D11Texture2D 4		
15 Texture2D	R16G16B16A16_FLOAT	Texture2D	Default ShaderResource, RenderTarget	Unspecified	Undefined	1024	768	ID3D11Texture2D 93		

**Watch 1**

Name	Value	Type
Autos		
Locals		
Watch 1		

**Shaders**

Shader Type	Symbolics Status	Language	Technique
Shaders	Call Stack	Breakpoints	



# Demo: Buffer Inspector



Cast to value

DragonAge2 (Running) - Microsoft Visual Studio (Administrator) - Experimental Instance

File Edit View Project Build Debug Team Nsight Data Tools Test Analyze Window Help

Graphics Inspector - DragonAge2.exe

Process 912 Frame 1 Event 7936 / Action 560 Buffer 28

Nvda.Platform.Windows.DirectX.DxBuffer

Offset: 0

☒ Hexadecimal Address

Number of Columns: 4

☐ One-Byte Integer

☐ Two-Byte Integer

☐ Four-Byte Integer

☐ Eight-Byte Integer

☐ 16-Bit Float

☒ 32-Bit Float

☐ 64-Bit Float

☒ Default

☐ Scientific with Maximum Significant Figures

☐ Scientific with Two Significant Figures

☐ Decimal with Two Significant Figures

[Go to Resource View](#)

Address	Data
00000000	0.01092579 0.01092579 0.01092579 1
00000010	0.02249624 0.02249624 0.02249624 1
00000020	0.04144881 0.04144881 0.04144881 1
00000030	0.06833753 0.06833753 0.06833753 1
00000040	0.1008211 0.1008211 0.1008211 1
00000050	0.1331033 0.1331033 0.1331033 1
00000060	0.157243 0.157243 0.157243 1
00000070	0.1329808 0.1329808 0.1329808 1
00000080	0.157243 0.157243 0.157243 1
00000090	0.1331033 0.1331033 0.1331033 1
000000A0	0.1008211 0.1008211 0.1008211 1
000000B0	0.06833753 0.06833753 0.06833753 1
000000C0	0.04144881 0.04144881 0.04144881 1
000000D0	0.02249624 0.02249624 0.02249624 1
000000E0	0.01092579 0.01092579 0.01092579 1
000000F0	0 0 0 1
00000100	0 0 0 1
00000110	0 0 0 1
00000120	0 0 0 1
00000130	0 0 0 1
00000140	1.201733 1.201733 1.201733 0
00000150	7.174648E-43 5.380986E-43 7.174648E-43 5.380986E-43

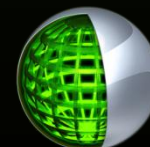
Watch 1

Name	Value	Type
Autos		
Locals		
Watch 1		

Shaders

Shader Type	Symbolics Status	Language	Technique
Shaders			
Call Stack			
Breakpoints			

Ready



# Demo: Pixel History



DragonAge2 (Running) - Microsoft Visual Studio (Administrator) - Experimental Instance

File Edit View Project Build Debug Team Nsight Data Tools Test Analyze Window Help

Graphics Inspector - DragonAge2.exe

Process 2980 Frame 1 Pixel History

Event	RT Before	Source	RT After	Z
void: ID3D11DeviceContext... Event 4894 <a href="#">Event in 4894 / Action 377</a>	R: 0 G: 0	R: 0.30 G: 0.24	R: 78 G: 60	0.9840221
void: ID3D11DeviceContext... Event 4916 <a href="#">Event in 4916 / Action 378</a>	R: 78 G: 60	R: 0.06 G: 0.06	R: 78 G: 60	0.9973061
void: ID3D11DeviceContext... Event 4960 <a href="#">Event in 4960 / Action 380</a>	R: 78 G: 60	R: 0.07 G: 0.07	R: 78 G: 60	0.997546
void: ID3D11DeviceContext... Event 5199 <a href="#">Event in 5199 / Action 393</a> <a href="#">Debug Pixel</a>	R: 78 G: 60 B: 53 A: 255	R: 0.43 G: 0.35 B: 0.32 A: 1.00	R: 78 G: 60 B: 53 A: 255	0.9989913
void: ID3D11DeviceContext... Event 7076 <a href="#">Event in 7076 / Action 508</a> <a href="#">Debug Pixel</a>	R: 78 G: 60 B: 53 A: 255	R: 0.31 G: 0.24 B: 0.21 A: 1.00	R: 78 G: 60 B: 53 A: 255	0
void: ID3D11DeviceContext... Event 7385 <a href="#">Event in 7385 / Action 527</a> <a href="#">Debug Pixel</a>	R: 78 G: 60 B: 53 A: 255	R: 0.31 G: 0.24 B: 0.21 A: 1.00	R: 78 G: 60 B: 53 A: 255	0
void: ID3D11DeviceContext...				

Watch 1

Name	Value
Autos	
Locals	
Watch 1	

Ready

Shaders

Shader Type	Symbolics Status	Language	Technique
Shaders	Call Stack	Breakpoints	

1. Choose Pixel of Interest

2. See All Fragments

3. Goto Draw Call Info or Debug Actual Fragment

# Demo: Shader Debugger Breakpoint



DragonAge2 (Debugging) - Microsoft Visual Studio (Administrator) - Experimental Instance

File Edit View Project Build Debug Team Nsight Data Tools Test Analyze Window Help

gaussblur.csh - Copy.hlsl Static.psh - Copy.hlsl Graphics Inspector - DragonAge2.exe

(Unknown Scope)

```
return 0;
}
```

// Compute shader implementing the horizontal pass of a Gaussian blur

```
[numthreads(RUN_SIZE / PIXELS_PER_THREAD, RUN_LINES, 1)]
void SHorizontalGaussianBlur( uint3 Gid, uint3 GTid )
{
    // Load texels from input texture for RUN_LINES
    // Line group, and iPixelOffset from group thread ID
    int i2GroupCoord = int2( Gid.x * RUN_SIZE - KERNEL_RADIUS, Gid.y * RUN_LINES );
    int i2Coord = int2( i2GroupCoord.x + iPixelOffset, i2GroupCoord.y );
    int i2ClampCoord = clamp( i2Coord, 0, g_i2InputSize - PIXELS_PER_THREAD );

    // Load PIXELS_PER_THREAD texels from input texture for RUN_LINES
    [unroll]
    for( i = 0; i < PIXELS_PER_THREAD; ++i )
    {
        #ifdef USE_LDS_PACKING

```

**Stopped At Breakpoint  
In Specified Fragment**

**Stepping, Run To  
Cursor**

**Visual Studio's Watch  
Window Populated**

**Full Speed, GPU  
Evaluated Conditionals,  
Including Local Variables**

Locals

Name	Value	Type
Gid	{x = 6, y = 0, z = ???}	uint3
GTid	{x = 0, y = 1, z = ???}	uint3
i	-1040563321	int
j	???	unknown
iPixelOffset	0	int

Shaders

Shader Type	Symbolics Status	Language	Technique	Pass	N
218 Compute	Ready.	HLSL	No Technique	No Pass	M
219 Compute	Ready.	HLSL	No Technique	No Pass	M
252 Domain	No symbols have been loaded for HLSL	HLSL	No Technique	No Pass	N
242 Domain	No symbols have been loaded for HLSL	HLSL	No Technique	No Pass	N

Autos Locals Watch 1

Ready

Ln 156 Col 1 Ch 1 INS

# Demo: Focus Picker



DragonAge2 (Debugging) - Microsoft Visual Studio (Administrator) - Experimental Instance

File Edit View Project Build Debug Team Nsight Data Tools Test Analyze Window Help

Static.psh - Copy.hlsl Graphics Inspector - DragonAge2.exe

### Pixels in Flight Select Focus Pixel

```
#ifndef MAT_WARN_MISSING_MATERIAL
return half4((cos(3 * g_ApplicationTime) + 1.0) / 2, 0, 0, 1.0);
#endif

#ifdef MAT_OUTPUT_PITCH_BLACK
return half4(0, 0, 0, 1.0);
#endif

#ifdef MAT_REFLECTION_PASS
clip (mml_fClipHeight - In.WorldPos.z);
#endif

half2 TextureCoordinates = In.TextCoords.xy;
half2 LightmapTexCoords = In.TextCoords.zw;

half4 hDiffuseOpacityMask = GetDiffuseOpacityMask( TextureCoordinates.xy);

#ifdef MAT_PUNCHTHROUGH
// Kill this fragment if the alpha is less than 0.3, for punchthrough sha
// alpha is usually a 1 or zero thing.
clip( hDiffuseOpacityMask.a - 0.75 );
#endif

// If we're in wireframe mode, don't calculate anything, just return the
if (DEBUG_CONTROL_WIREFRAME > 0)
```

Summary  
Show the summary of the current status

Vertices (3D View)  
Show the paused vertices in a 3D view

Vertices (Table View)  
Show the paused vertices in a table view

Geometry (Table View)  
Show the paused geometry shader threads

**Pixels**  
Show the paused pixels on the current render target

Compute  
Show the paused compute threads

RT0 - 640x360 - (R8G8B8A8\_UNORM)  
188 Paused Pixels  
640x360

Set Pixel Rectangle

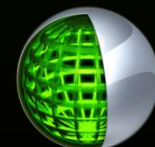
### Change Focus, Locals Update

Locals

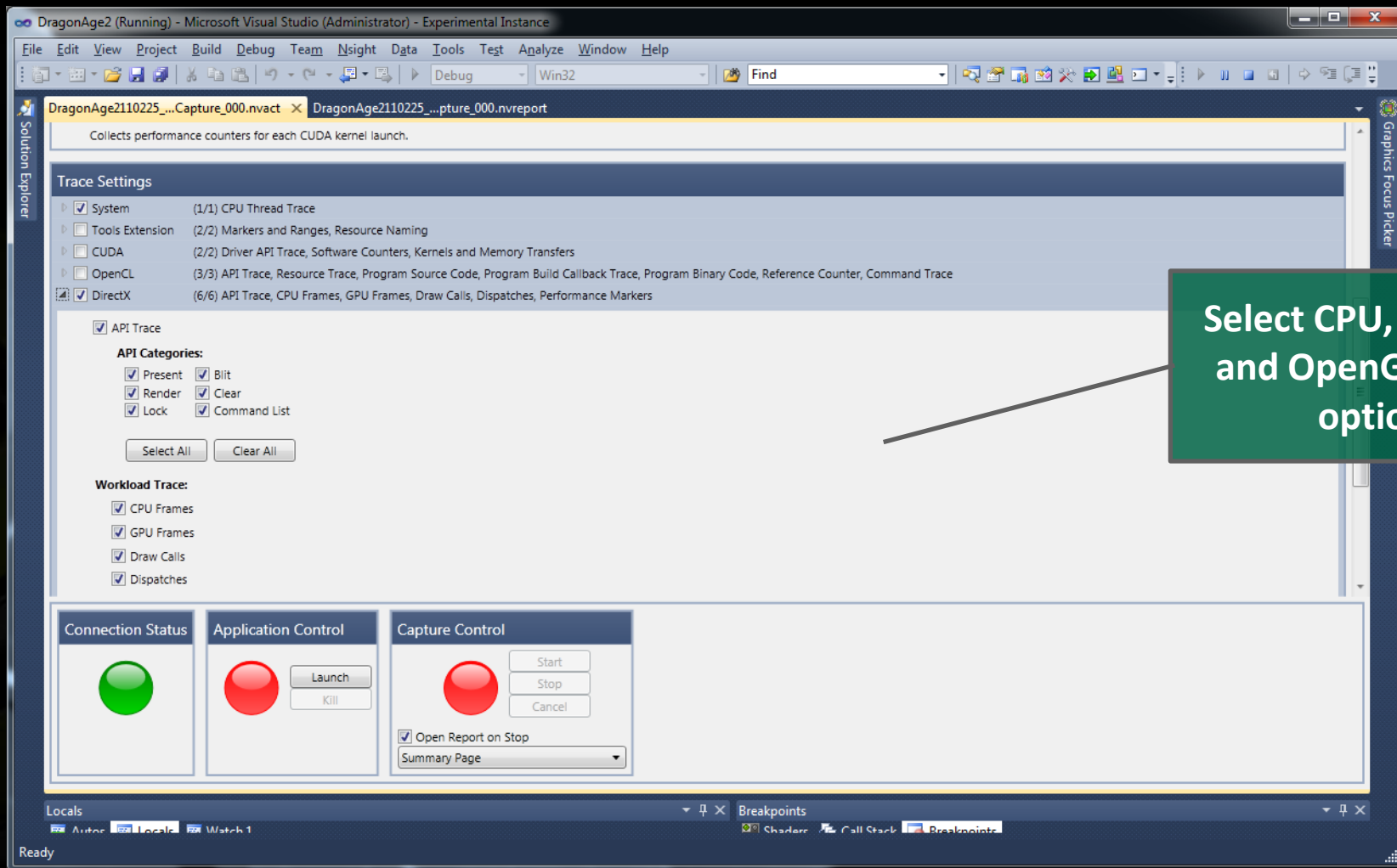
Name	Value
In	{Pos = {...}, TexCoords = {...}, Normal = {...}, EyeVec = {...}, ...}
TextureCoordinates	{x = ???, y = ???}
LightmapTexCoords	{x = ???, y = ???}
@pixel	{x=220.5, y=206.5}

Shaders Call Stack Breakpoints

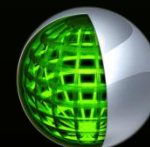
Ln 134 Col 1 Ch 1 INS

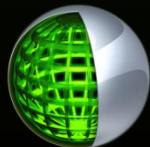


# Demo: Analysis

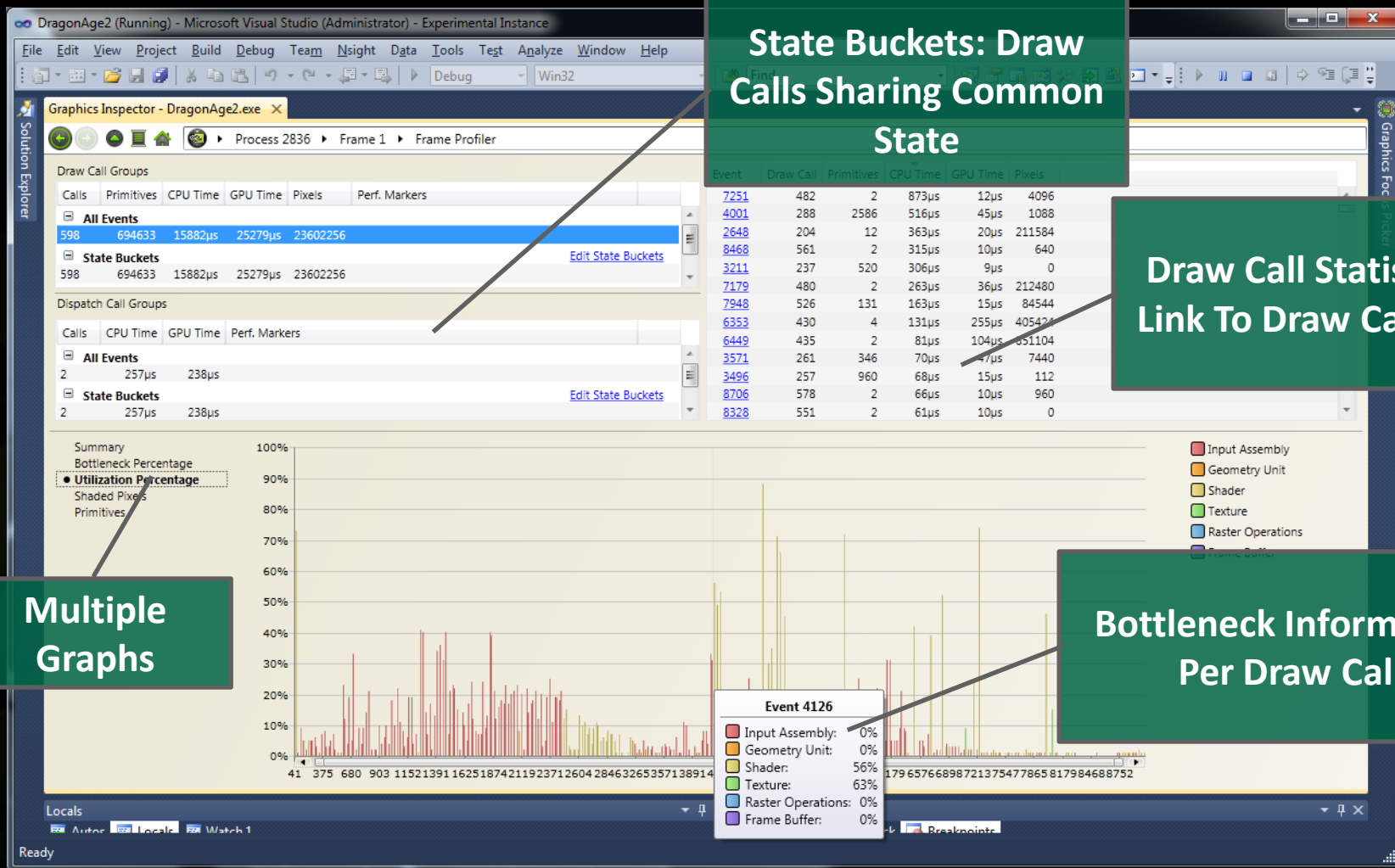


Select CPU, Direct3D,  
and OpenGL tracing  
options





# Demo: Frame Profiler



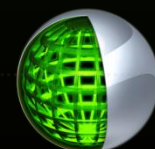
# NVIDIA Parallel Nsight: Roadmap



**Version 1.51**

**2.0**

- Released January 2011
- All Professional Features now FREE!
- Licensing restrictions removed
- Microsoft Visual Studio 2010
- Support for the r265 driver
- Support for GeForce GT 420/30/40, GS 450, GTX 570 and GTX 580 GPUs



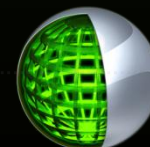
# NVIDIA Parallel Nsight: Roadmap



1.51

Version 2.0

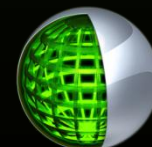
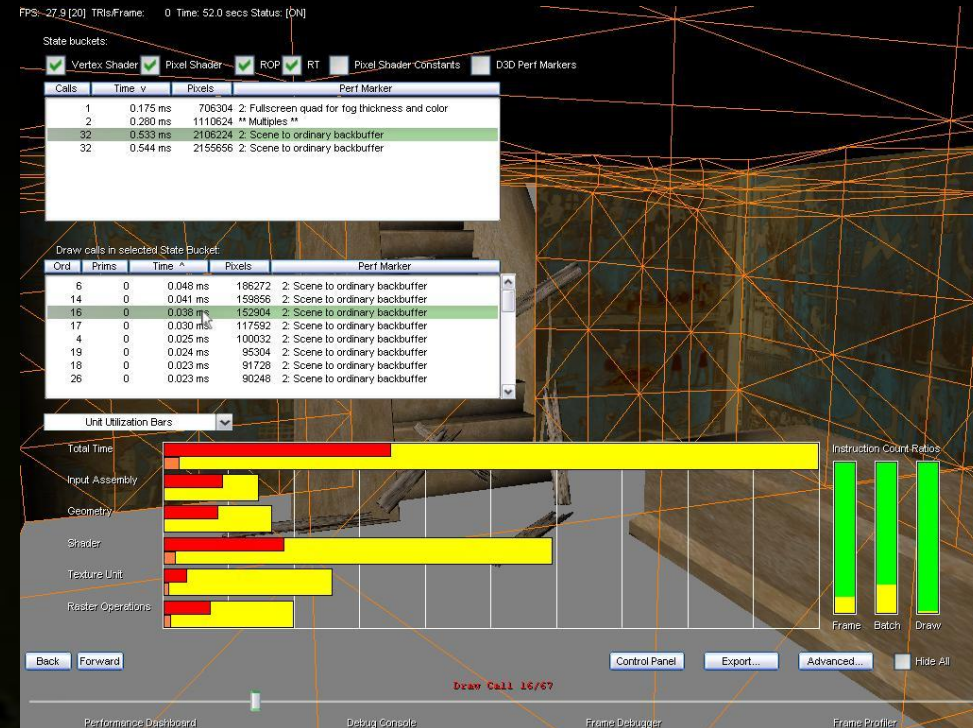
- Available Q2 2011
- View all graphics resources at a glance
- Numerous usability and workflow improvements
- Graphics profiler performance and accuracy
- Driver independence
- Stability improvements
- Support for r270 driver and latest hardware



# DirectX 9 Development? PerfHUD!



- Version 6.70 Shipped 1/2011
  - Support for Fermi GPUs
  - Small bug fixes
- Continue to update for new GPUs
- New PerfKit supporting Fermi Q2

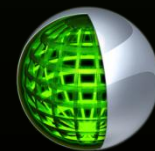


# Wrap Up...Thank You!



- Thanks Andreas and the team at BioWare!
- Call to action!
  - Download Parallel Nsight and try it out
  - Use Direct3D Performance Markers in your game
  - Send us feedback on what features you find important
- Contact us on the NVIDIA Developer Forums

<http://forums.nvidia.com/index.php?showforum=191>



# NVIDIA @ GDC 2011



## CAN'T GET ENOUGH? MORE WAYS TO LEARN:

### NVIDIA GAME TECHNOLOGY THEATER

**Fri, March 4<sup>th</sup> @ NVIDIA Booth**

*Open to all attendees. Featuring talks and demos from leading developers at game studios and more, covering a wide range of topics on the latest in GPU game technology.*

### MORE DEVELOPER TOOLS & RESOURCES

*Available online 24/7 @ [developer.nvidia.com](http://developer.nvidia.com)*

**NVIDIA Booth**

**South Hall #1802**

***Details on schedule and to  
download copies of presentations  
visit***

***[www.nvidia.com/gdc2011](http://www.nvidia.com/gdc2011)***