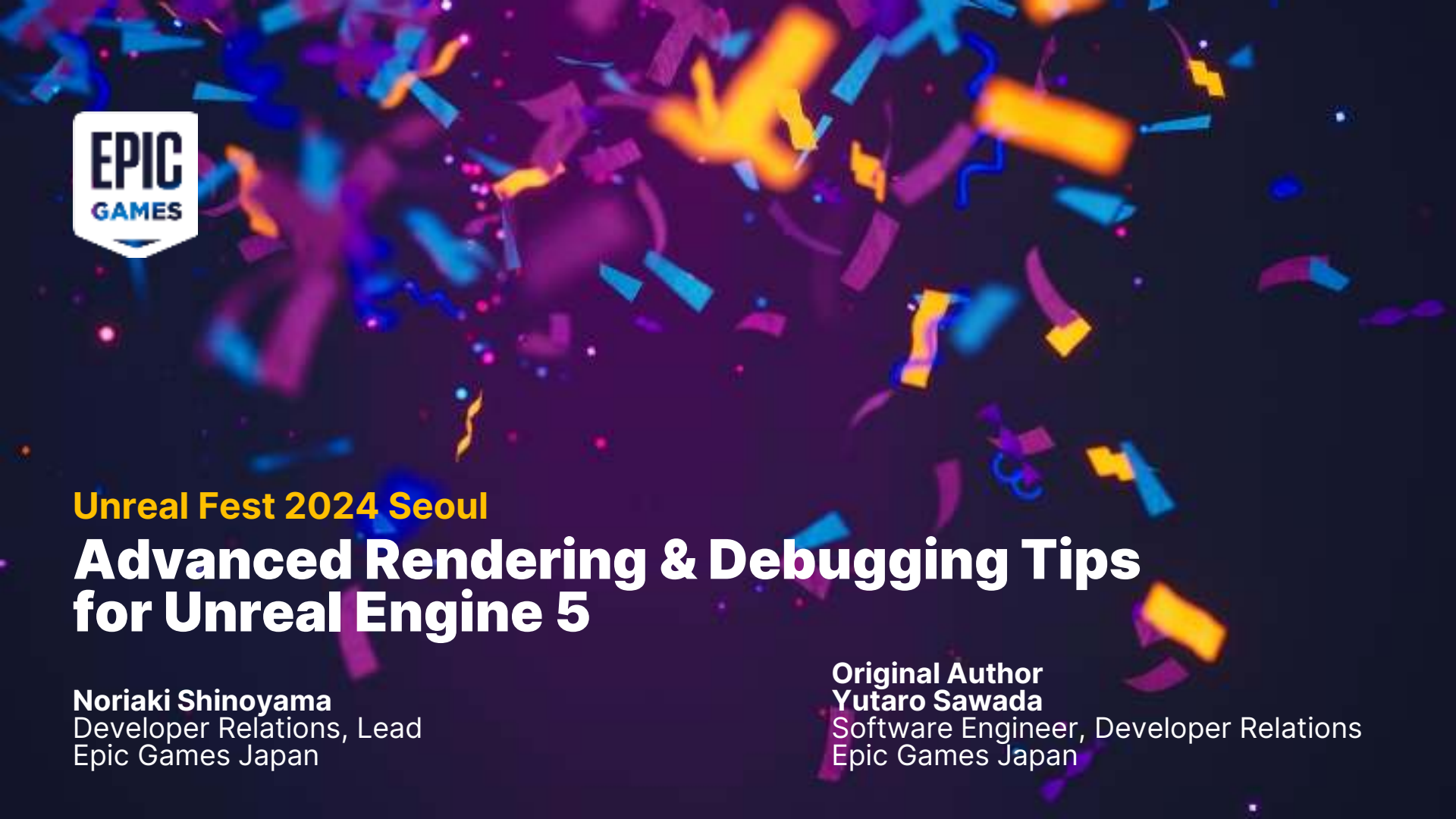

Unreal Fest 2024 Seoul

Advanced Rendering & Debugging Tips for Unreal Engine 5

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Epic Games Japan

Original Author
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Epic Games Japan

Theme

Introduction

Who made this presentation?

Yutaro Sawada

Epic Games Japan,
Developer Relations Engineer

Graphics Specialist

Introduction

Who I am?

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International Sake Sommelier

X(Twitter): @tempkinder

Agneda

Nanite

Lumen

VSM

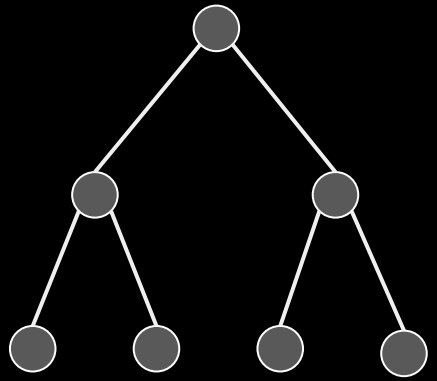
Other Development Tips

Nanite

Nanite: Overview

Virtualized Geometry

- Divide the mesh into **clusters** to build a hierarchical structure
- Switching drawing clusters like LOD on a per-cluster basis
- Streaming only the data that is actually drawn to memory



Nanite：Overview

Point

・Even super high-resolution meshes render down to one triangle of detail per pixel

・Software rasterizer of Nanite enables **multi-view rendering**

Nanite supported a vriety of materials…

But still **opaque rendering is preferred**, especially when aiming for 60 fps.
Masked materials are computationally expensive

Trees in Epic’s game are also drawn opaque with polygonal leaves.
https://www.unrealengine.com/ja/tech-blog/bringing-nanite-to-fortnite-battle-royale-in-chapter-4

※Trees in the Electric Dream environment demo shown at GDC2023 are Masked Material

Not entirely useless, but you should do profiling carefully.

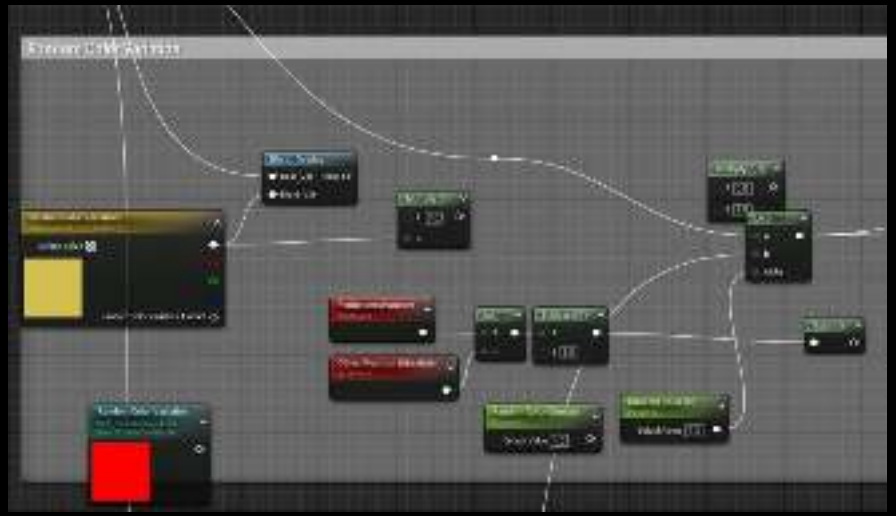
Example: Trees generated by PCG

SM_EuropeanHornbeam_Field_01

Tree assets used in Electric Dream
・Masked Material
・Color changes depending on position
and natural sway (WPO) already set up.

It's **Substrate material.**
Needs to be fixed when used in your projects
(Delete **Legacy Conversion node** in the parent material "M_Foliage")

MF_WorldspaceColorVariation



Nanite performance on the test scene

Environment
- Masked material
- with WPO
- PC Development build
- 1080p

PC Spec
CPU: AMD Ryzen Threadripper PRO 3995WX
GPU: NVIDIA GeForce RTX 3080
Memory: 256GB

Removing WPO and Masked...

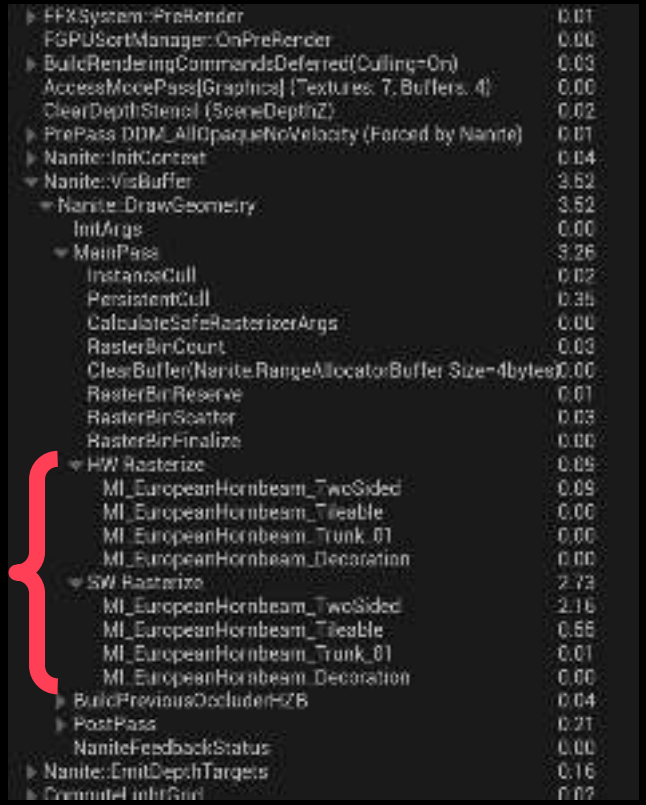
- has very large improvements on performance

Original	Without WPO	Without Opaque/Masked
		

Nanite performance on the test scene

- Where Nanite affects a lot is...
  - VisBuffer
  - Shadow Depth
  - Lumen

Rasterization time per material in Nanite
can be displayed
by activating the following console command
r.Nanite.ShowMeshDrawEvents 1



About Nanite's Rasterizer

・**Software** and **Hardware** Rasterizer
GPU HW rasterization is slow for very tiny polygons,
SW rasterizer was made for such tiny polygons.
(HW and SW are divided according to the following settings)
r.Nanite.MinPixelsPerEdgeHW 32

・Software rasterizer is turned off when the following setting is 0
r.Nanite.ComputeRasterization

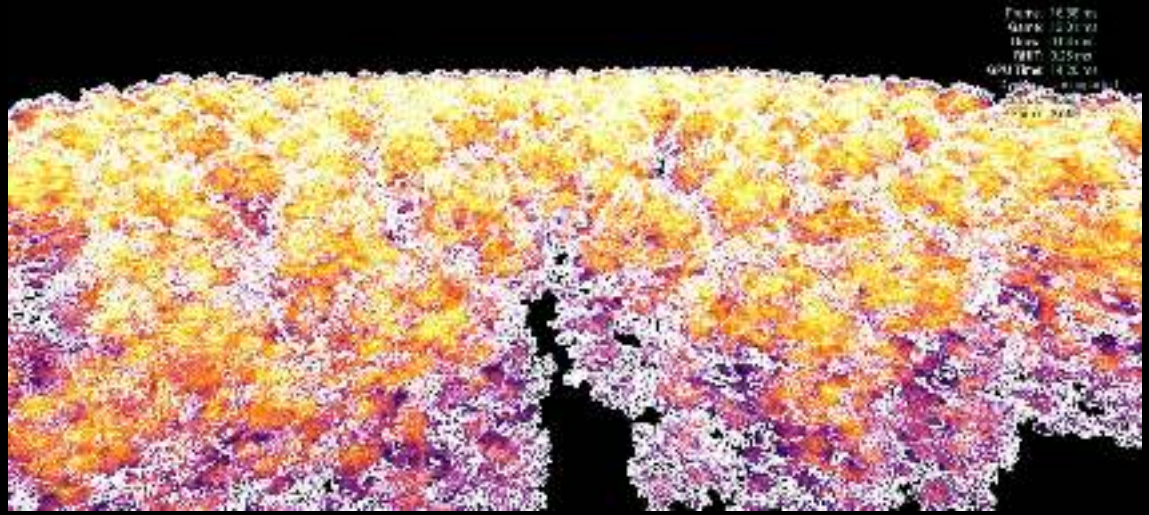
※Nanite uses Async Compute on supported platforms
You can turn off it by the following settings to 0
r.Nanite.AsyncRasterization

Nanite: Optimization General Guidelines

- Reduce overdraw
- Minimize the use of Programmable Rasterizer such as Masked

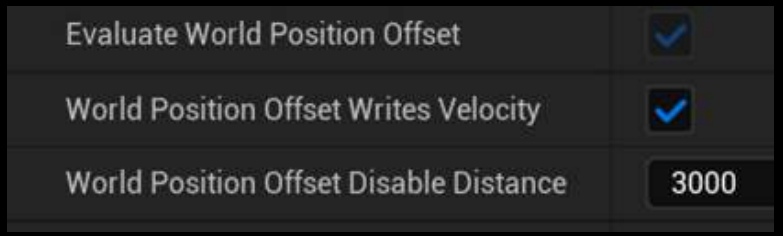
Comparison Opaque and Masked

- Nanite Visualization -> **Overdraw**
  Rasterization of the trees causes overdraw



WPO disabled by distance

You can disable WPO for each distant StaticMeshComponent
Nanite Visualization -> Evaluate WPO
It visualize the meshes whose WPO is evaluated / isn’t evaluated



When Nanite is not rendered correctly…

Tons of Nanite objects might not be rendered correctly.

Adjust not to exceed the following parameters
r.Nanite.MaxNodes
r.Nanite.MaxVisibleClusters

You might need to check Nanite PoolSize
r.Nanite.Streaming.StreamingPoolSize

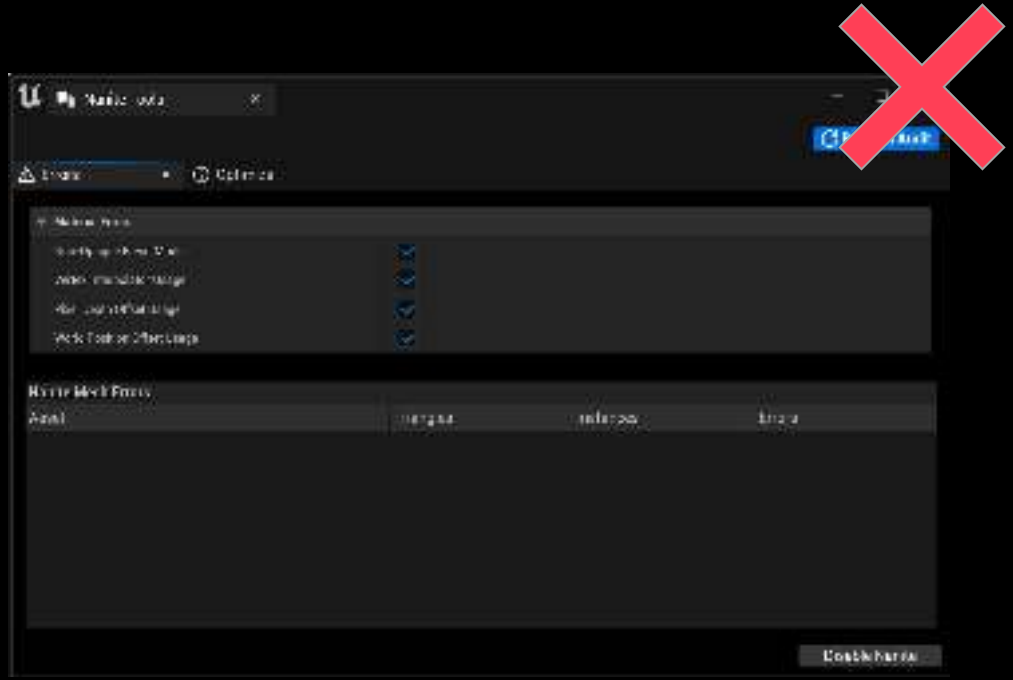
When Nanite is not rendered correctly…

In some cases, the silhouette of the Nanite meshes can be broken.

Try to increase the level of detail per pixel with
r.Nanite.MaxPixelsPerEdge
It specify the size of Nanite triangles in pixels
Smaller values (e.g., 0.1) display higher res clusters

Note: Nanite Tools

Nanite Tools was discontinued because it could be replaced by Content Browser.

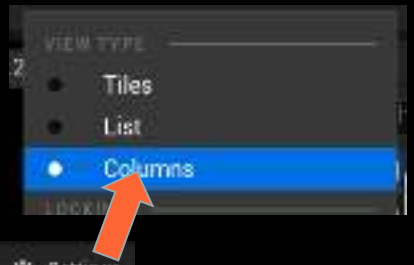


Filter Methods for Non Nanite Meshes

Filtering by property value on the search bar of Content Browser

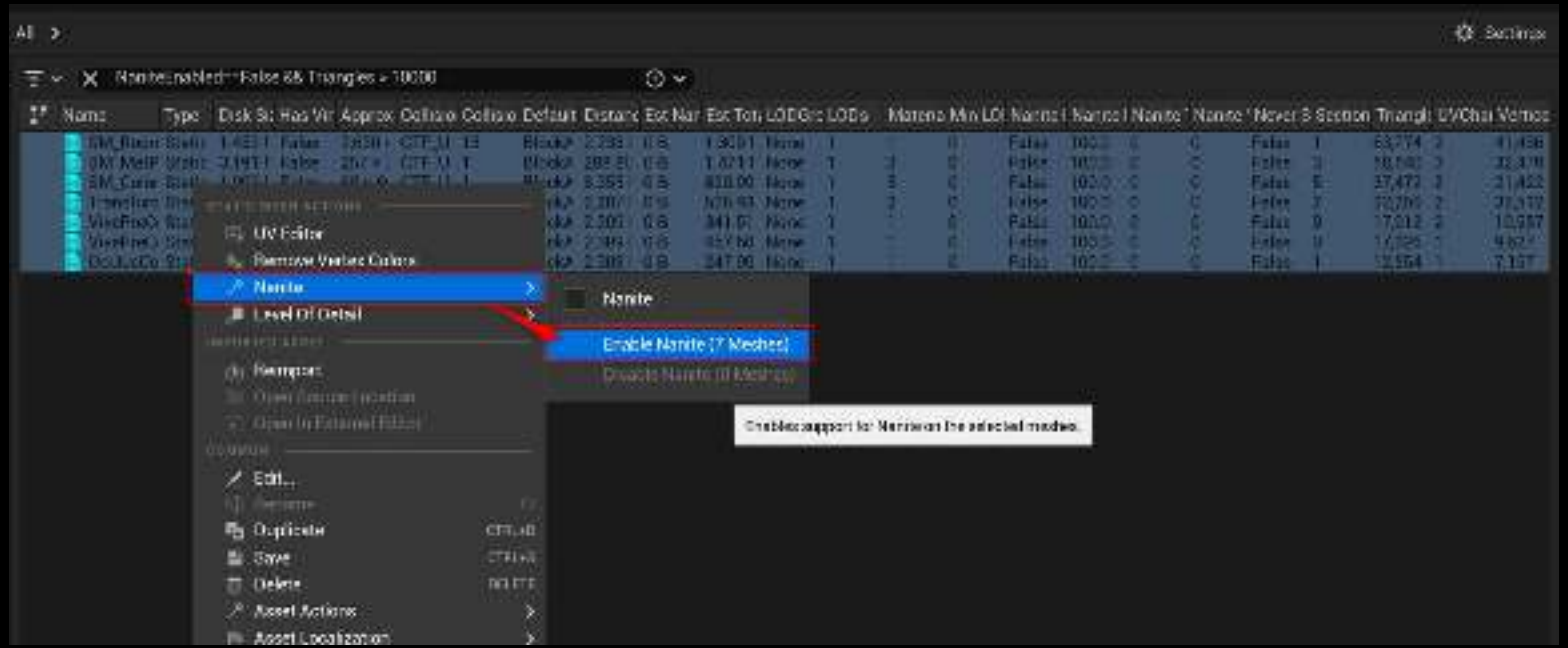
Filter Methods for Non Nanite Meshes

Columns view allows sorting, etc.



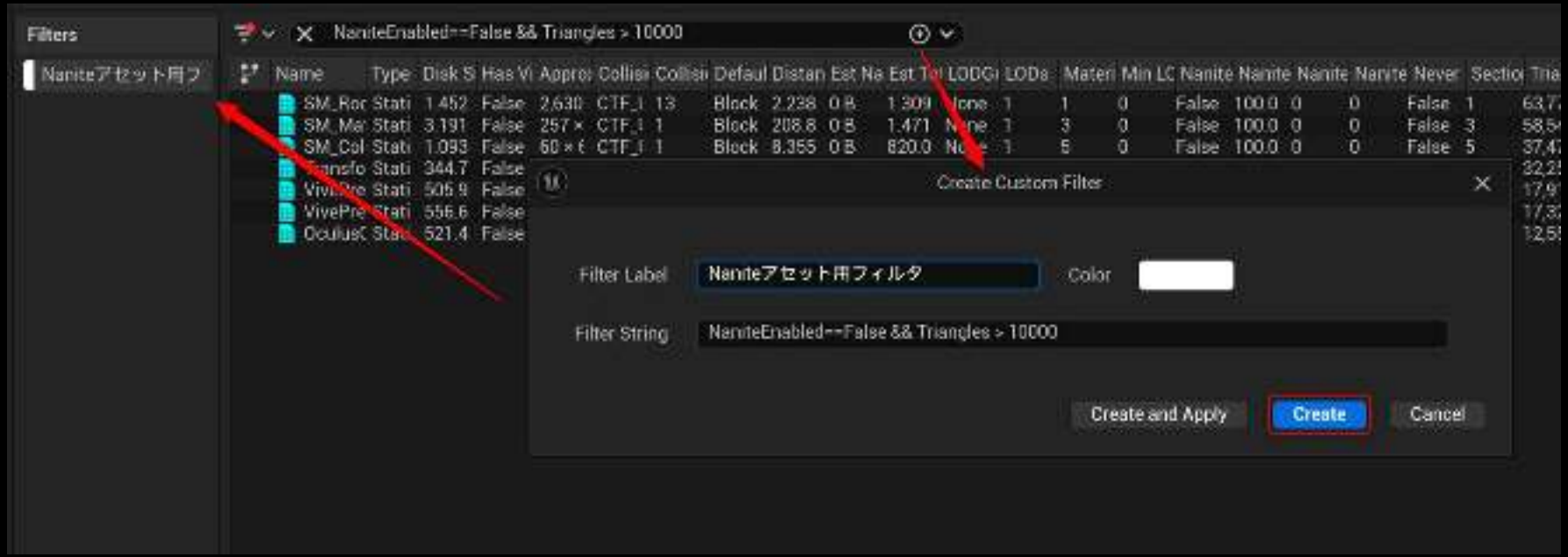
Filter Methods for Non Nanite Meshes

Make multiple assets Nanite from the right-click menu



Saving Filters

Filters can be saved from the + icon to the right of the search window

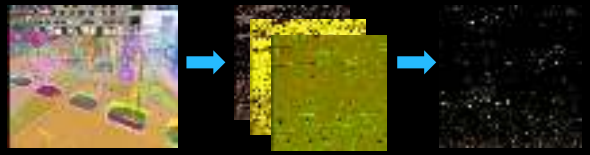


Lumen

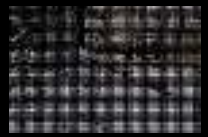
Lumen Algorithm Overview

Lumen Card Generation

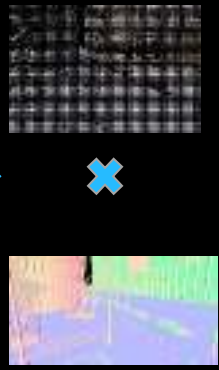
Advance Preparation (Editor)



Construction of Lumen Scene and Lighting on Lumen Scene



On-screen Low resolution GI calculations



Upsampling on Lumen

Runtime

Lumen Cards

In order to calculate GI,
Lumen creates Lumen cards covering each object to calculate GI

You can visualize Lumen cards by *r.Lumen.Visualize.CardPlacement 1*

Lumen card resolution

Mirror material assigned to floor / screen tracing turned off

FLumenSurfaceCacheUpdateMeshCardsTask

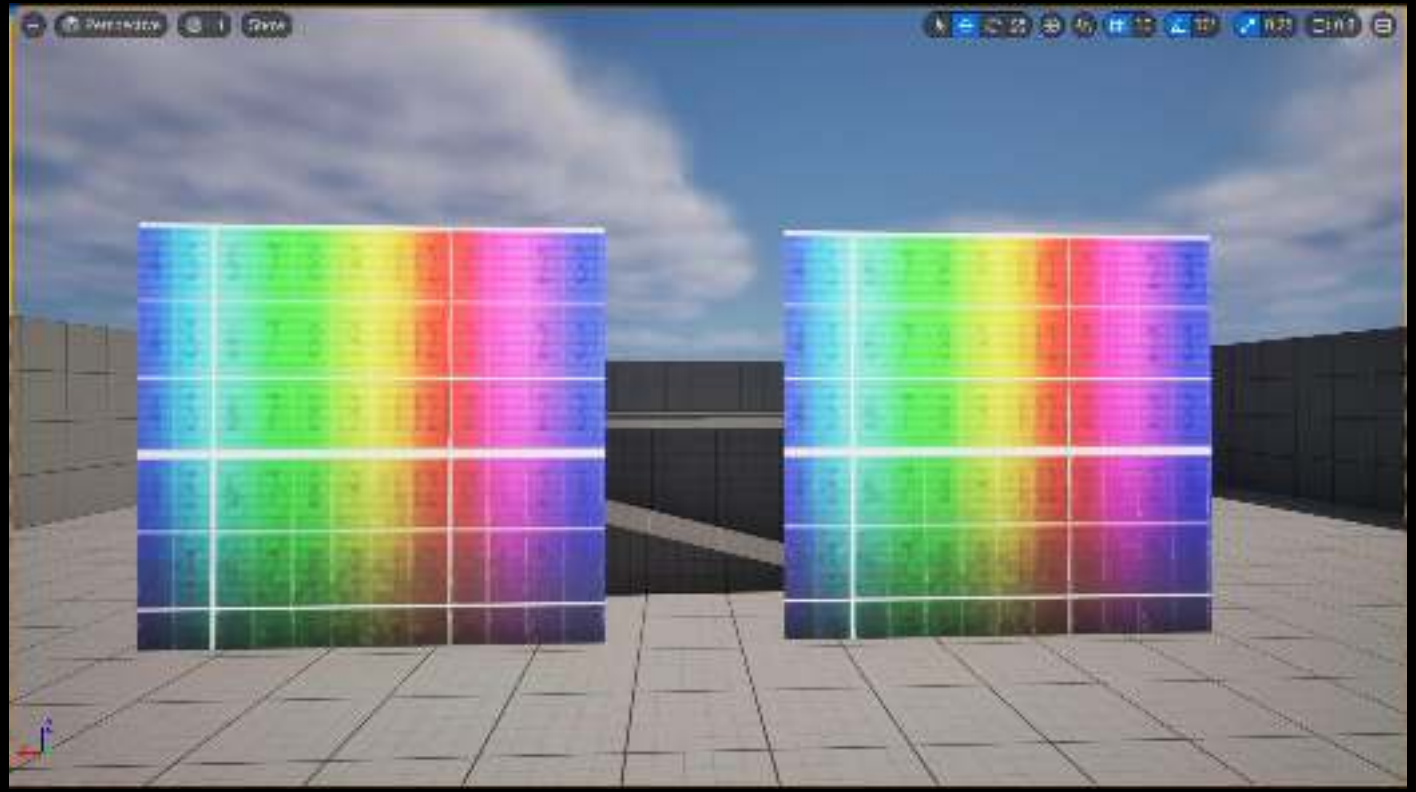
The resolution of a Lumen Card can dynamically change
(max 1024)

- Cvars useful to adjust
  Black if required resolution is less than *CardMinResolution*
  r.LumenScene.SurfaceCache.CardMinResolution

Scale value according to the size of the card's OBB (maximum X or Y) and distance
r.LumenScene.SurfaceCache.CardTexelDensityScale

Coefficient to decide the max value according to the size of the OBB
of the card (maximum X or Y)
r.LumenScene.SurfaceCache.CardMaxTexelDensity

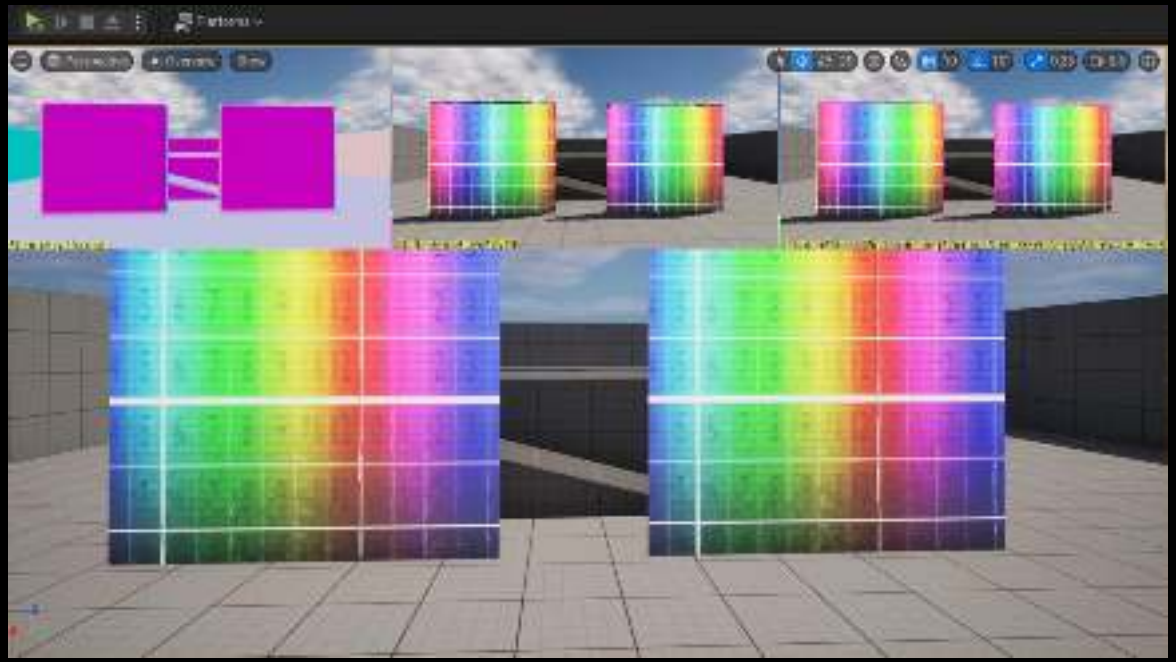
Lumen: LumenScene Update

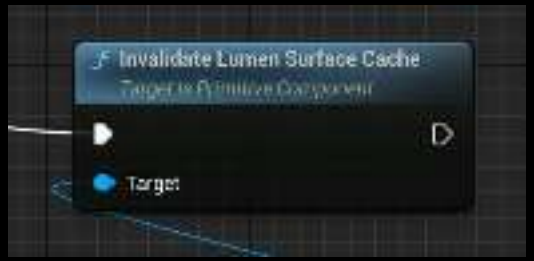


Lumen: LumenScene Update

r.LumenScene.SurfaceCache.CardCaptureRefreshFraction (default: 0.125)

Lumen: LumenScene Update





InvalidateLumenSurfaceCache (C++/BP)

Lumen: Optimization

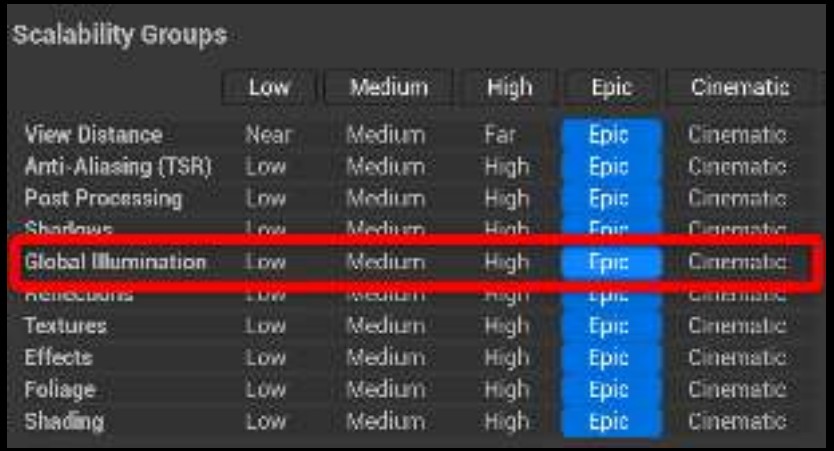
The first move is to set up *scalability*

Possible actions on the asset side ...

・Merge Lumen cards

・Adjustment to lower the resolution of the Lumen card

・ Use Nanite meshes as much as possible



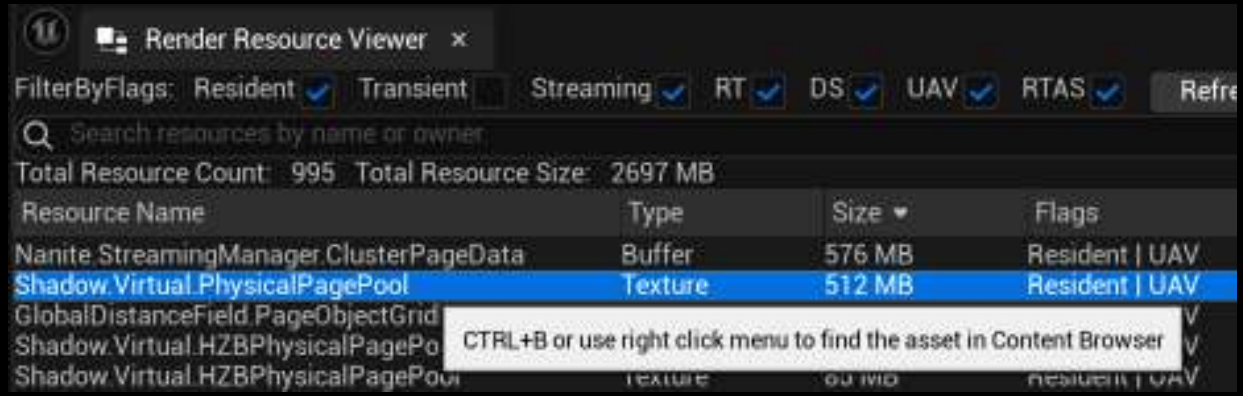
Virtual Shadow Maps

Virtual Shadow Maps

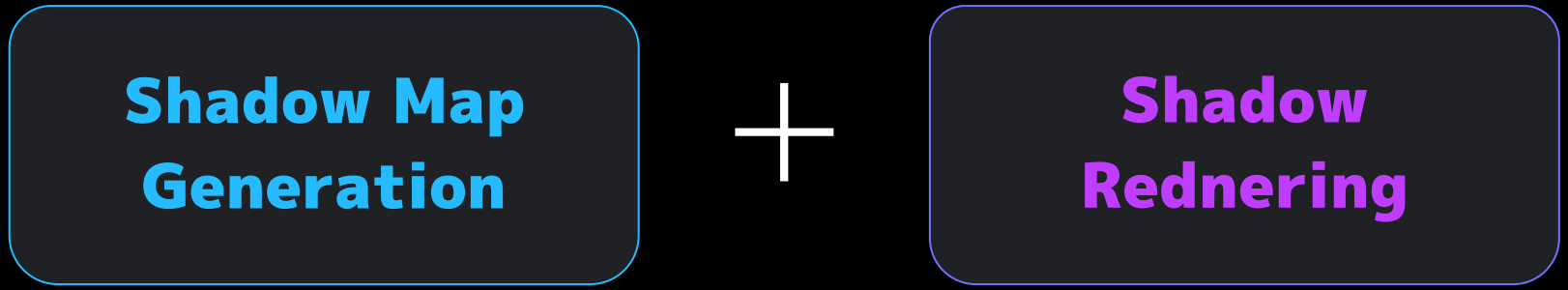
The default setting of VSM has high memory consumption and load,
such as **PoolSize of 512MB**.

Since we've heard from several devs that they have given up on using VSM,

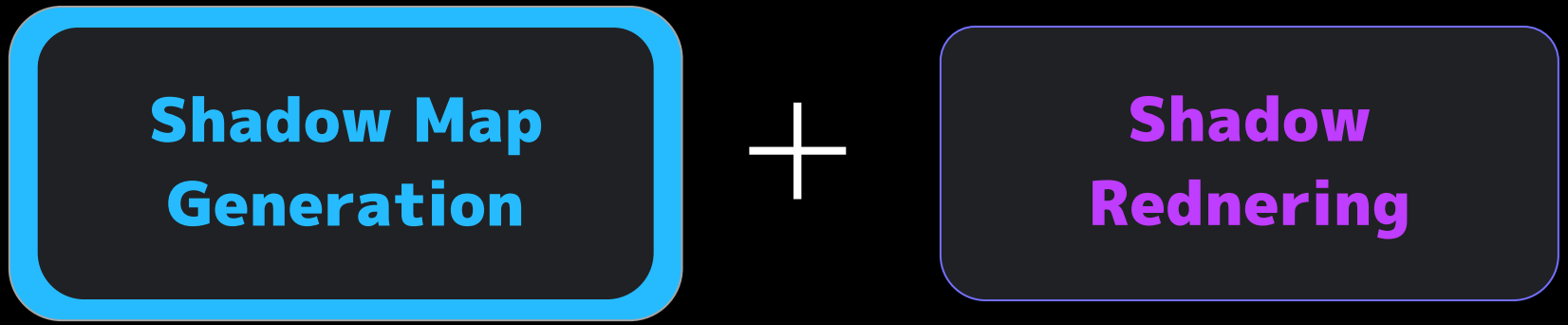
Let me introduce the basic behavior of the VSM to understand how to adjust and set up the VSM



VSM Algorithm

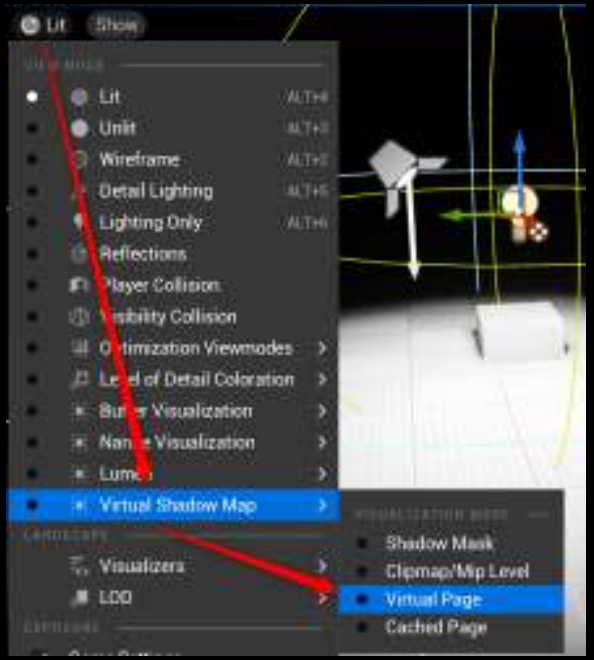


VSM Algorithm



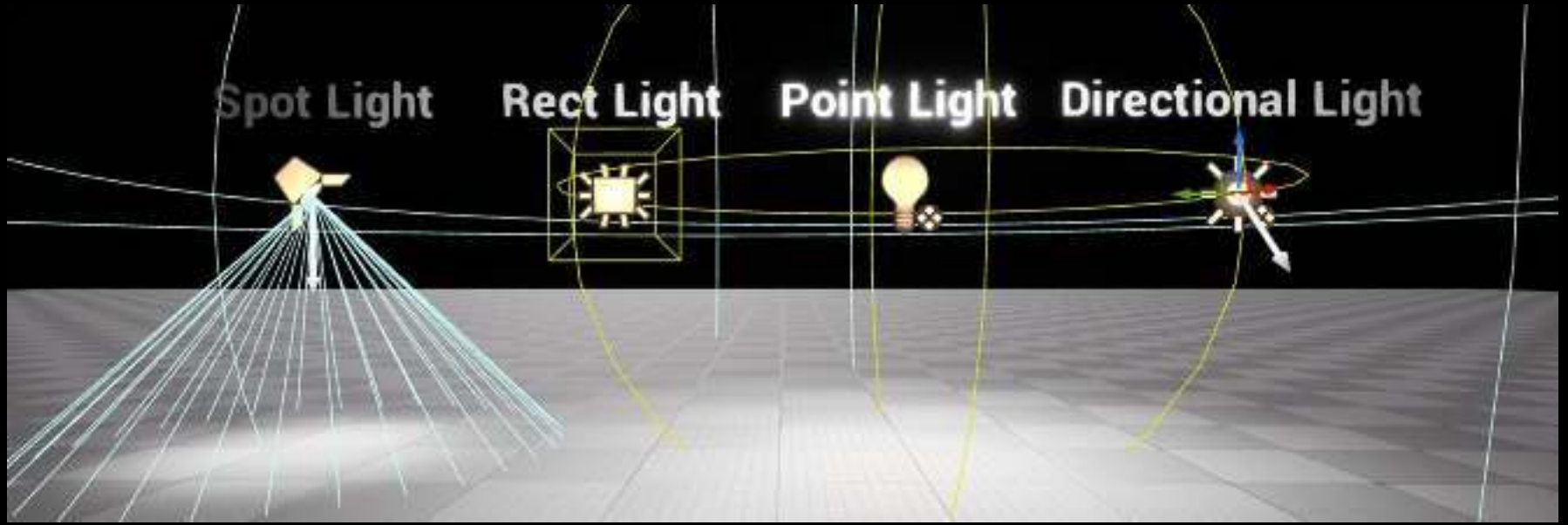
Virtual Shadow Maps: Feature

Decompose a shadow map into tiles and set the required resolution for each tile
It enables high-resolution Shadow Map



Page
128 × 128

Various lights in UE



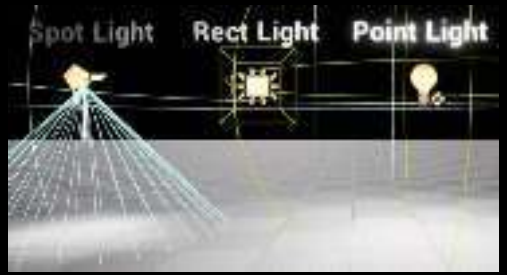
Light Classification by VSM

Local Light

- Point Light
- Spot Light
- Rect Light

Directional Light

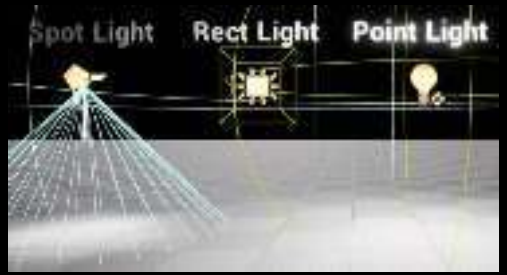
- Directional Light



Light Classification by VSM

Local Light

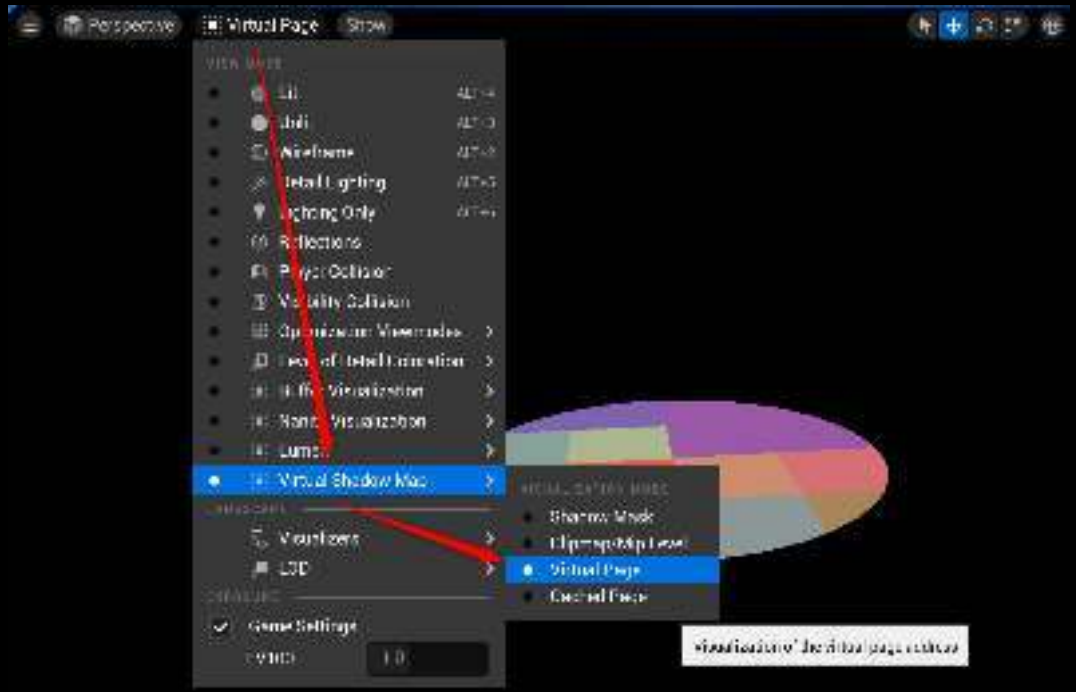
- Point Light
- Spot Light
- Rect Light

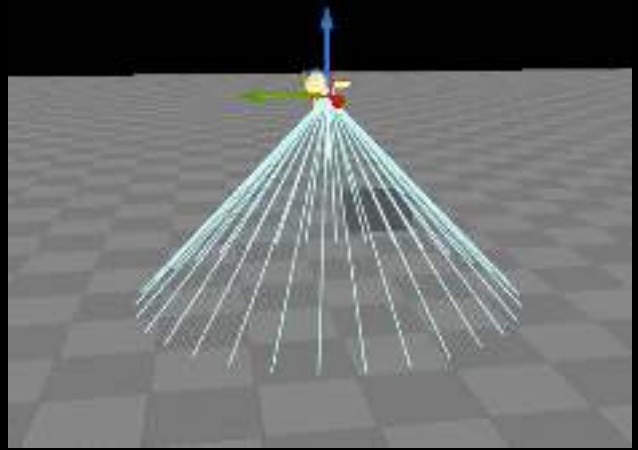


Directional Light

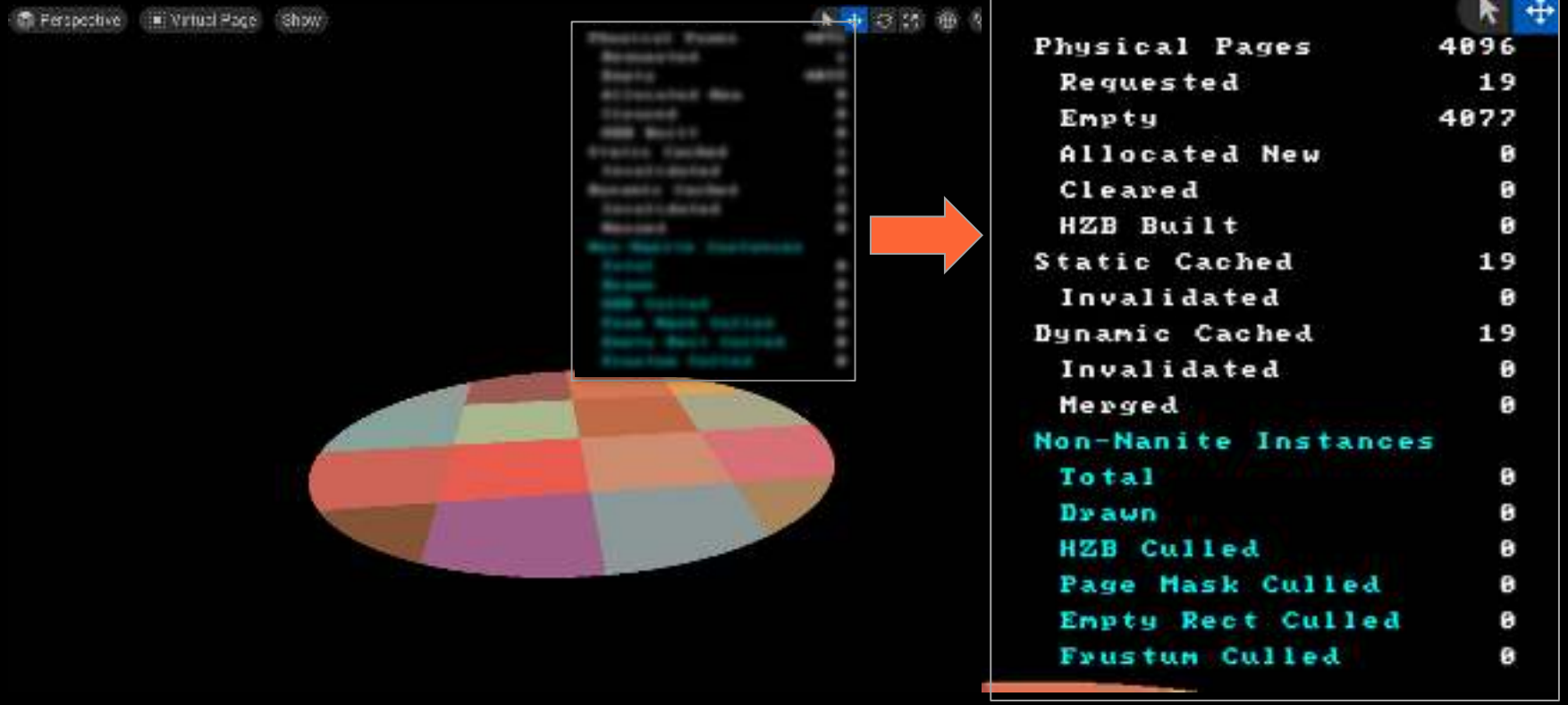
- Directional Light

Spot Light

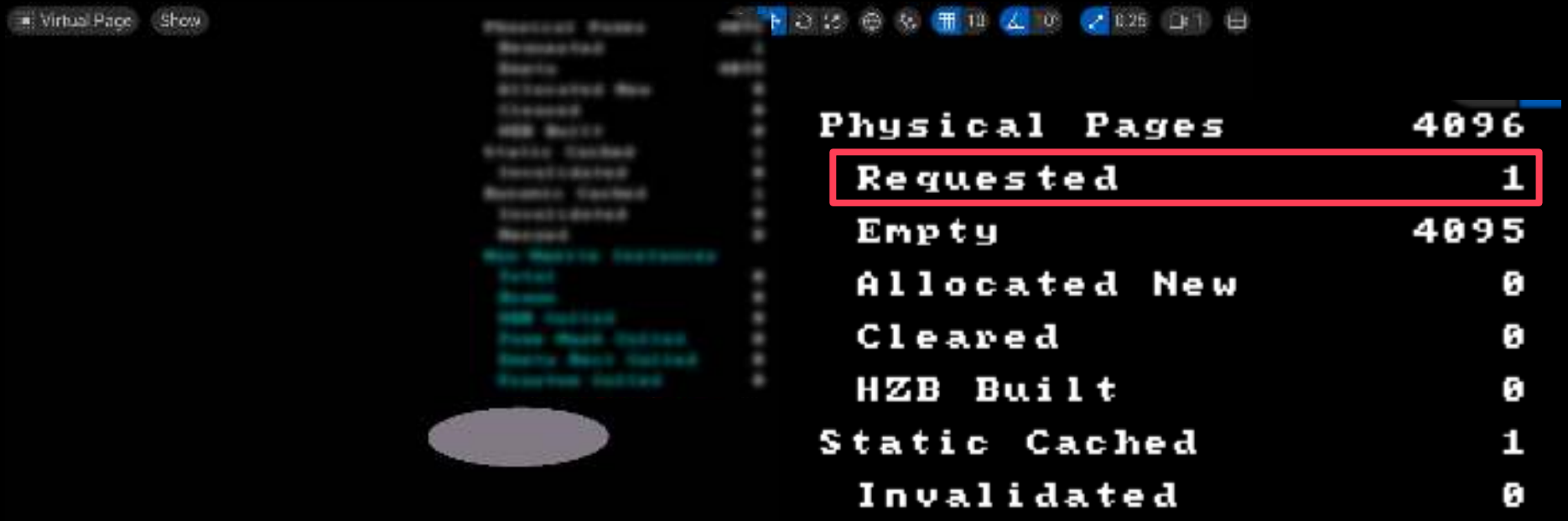

Perspective
Virtual Page
Show
Virtual Shadow Maps
Visualizers
LOD
Game Settings
Virtual Page
Cached Page



r.shadow.virtual.showstats 1



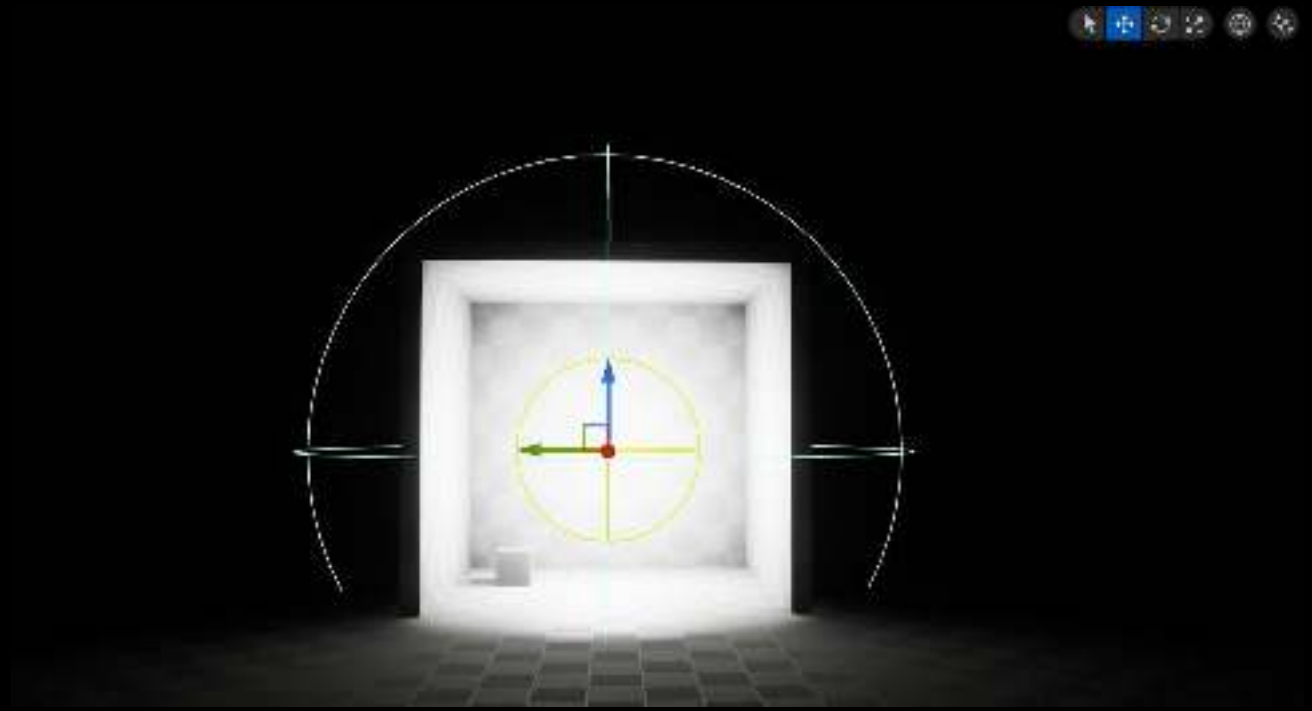
Spot Light - Shadow Depth



Spot Light

Physical Pages	4096
Requested	1
Empty	4095
Allocated New	0
Cleared	0
HZB Built	0
Static Cached	1
Invalidated	0
Dynamic Cached	1
Invalidated	0
Merged	0

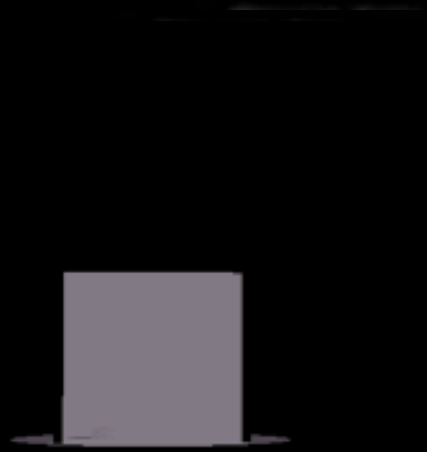
Point Light & Rect Light



Point Light & Rect Light - Cube map

Physical Pages	4096
Requested	6
Empty	4090
Allocated New	0
Cleared	0
HZB Built	0
Static Cached	6
Invalidated	0
Dynamic Cached	6
Invalidated	0
Merged	0

Point Light & Rect Light

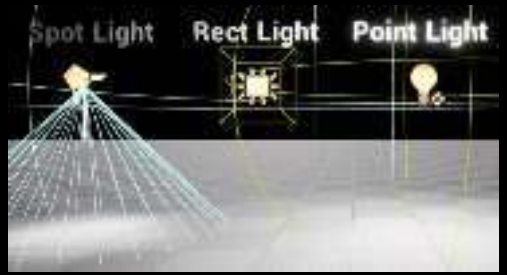


Physical Pages	4096
Requested	6
Empty	4090
Allocated New	0
Cleared	0
HZB Built	0
Static Cached	6
Invalidated	0
Dynamic Cached	6
Invalidated	0
Merged	0

Light Classification by VSM

Local Light

- Point Light
- Spot Light
- Rect Light

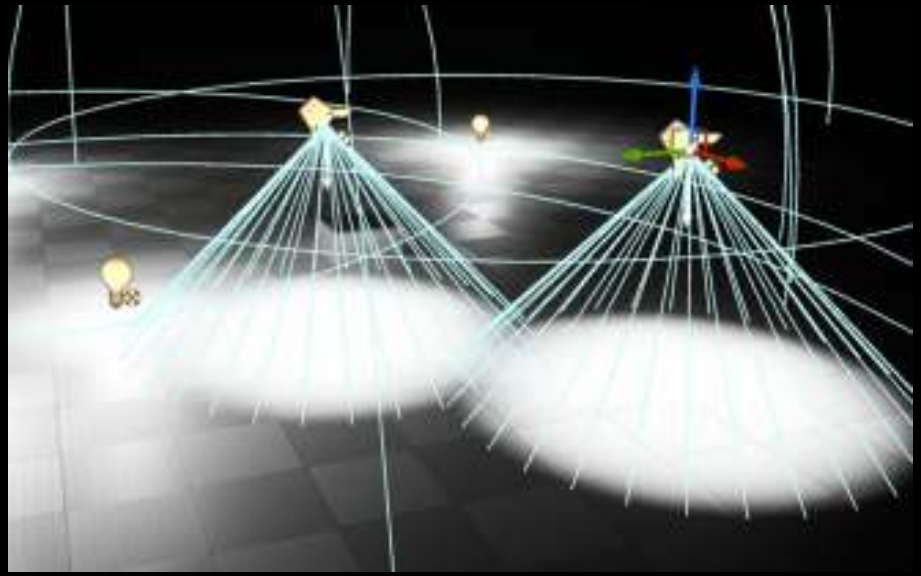


Directional Light

- Directional Light

Multiple lights

All visible pages(shadow map) of the lights are requested
→ The more lights, the more pages and updates required!



Physical Pages	4096
Requested	162
Empty	3940
Allocated New	6
Cleared	14
HZB Built	7
Static Cached	155
Invalidated	1
Dynamic Cached	155
Invalidated	0
Merged	0

Two important functions of the VSM

Cache System

Page Management

Two important functions of the VSM

Cache System

Page Management

Cache System

VSM try to cache pages as much as possible if the pages aren't updated across frames (Default: *r.Shadow.Virtual.Cache 1*)

Physical Pages	4096
Requested	1
Empty	4095
Allocated New	0
Cleared	0
HZB Built	0
Static Cached	1
Invalidated	0
Dynamic Cached	1
Invalidated	0
Merged	0

Separate Cache

r.Shadow.Virtual.Cache.StaticSeparate 1
Enabled by default

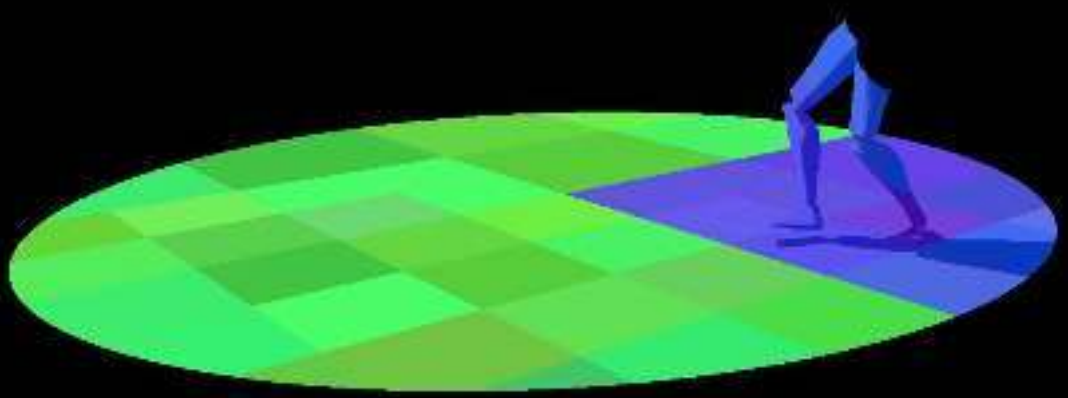
To reduce cache invalidation as much as possible
VSM can have two caches
- for static objects
- for dynamic objects

Physical Pages	4096
Requested	1
Empty	4095
Allocated New	0
Cleared	0
HZB Built	0
Static Cached	1
Invalidated	0
Dynamic Cached	1
Invalidated	0
Merged	0

Cache Visualization

Cache Visualization

The blue area is the updated Pages (Invalidated)



Physical Pages	4096
Requested	40
Empty	4056
Allocated New	0
Cleared	11
HZB Built	0
Static Cached	40
Invalidated	0
Dynamic Cached	29
Invalidated	11
Merged	0

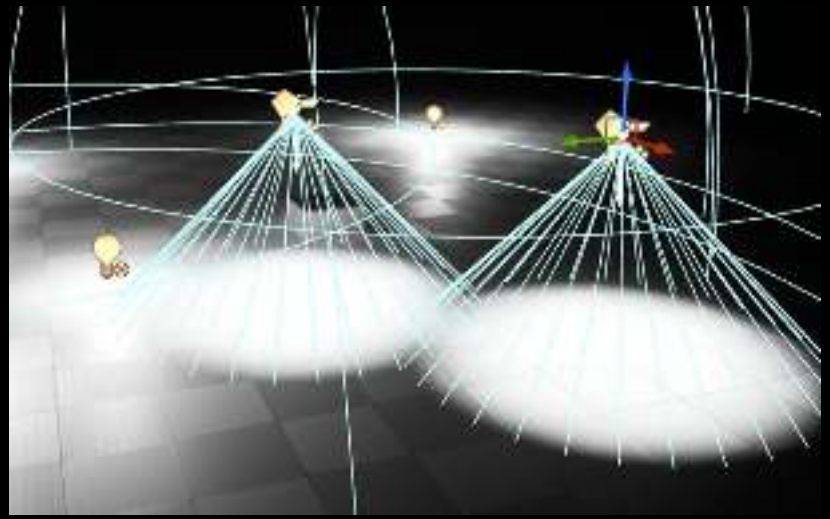
Two important functions of the VSM

Cache System

Page Management

VSM page management

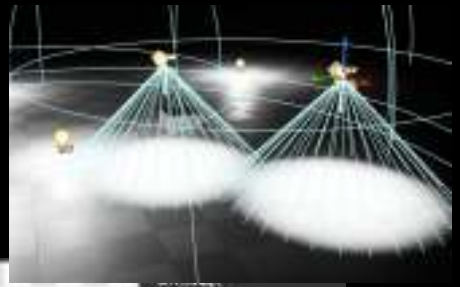
The more lights you place, the more shadow maps in VSM
Max Physical Pages limits the number of shadow maps in the entire VSM
r.Shadow.Virtual.MaxPhysicalPages (Default: 4096)

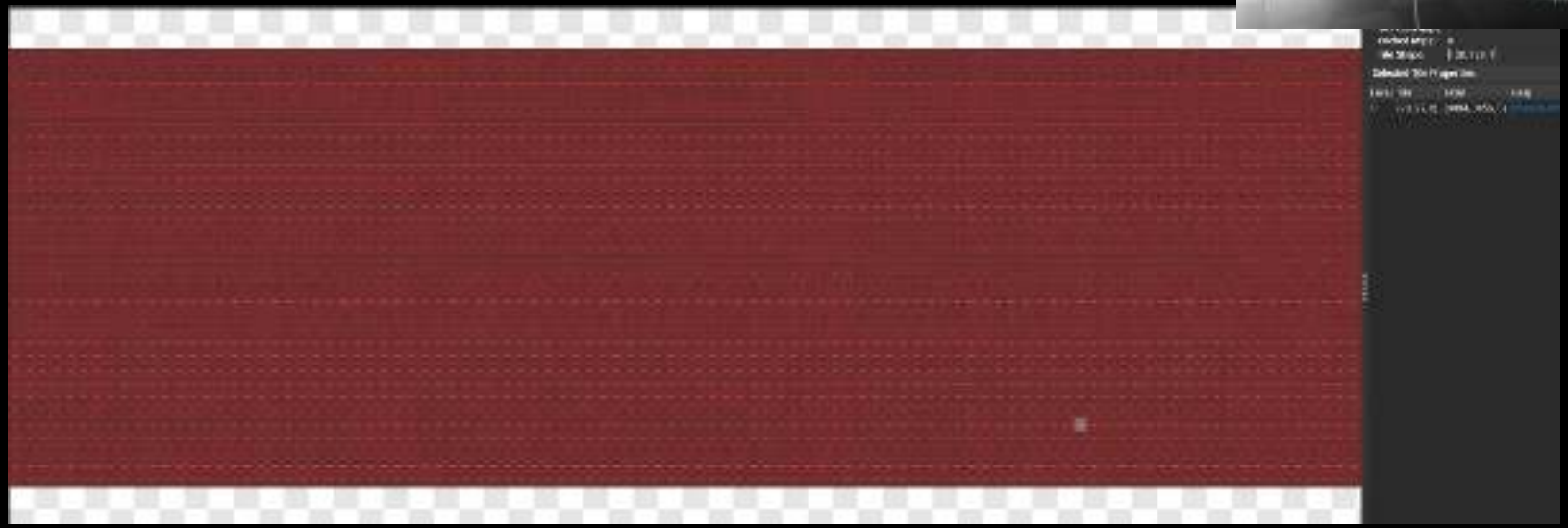


Physical Pages	4096
Requested	162
Empty	3940
Allocated New	6
Cleared	14
HZB Built	7
Static Cached	155
Invalidated	1
Dynamic Cached	155
Invalidated	0
Merged	0

VSM page management

Shadow maps of all lights are managed in one pool
※Separate Static option -> 2 pools

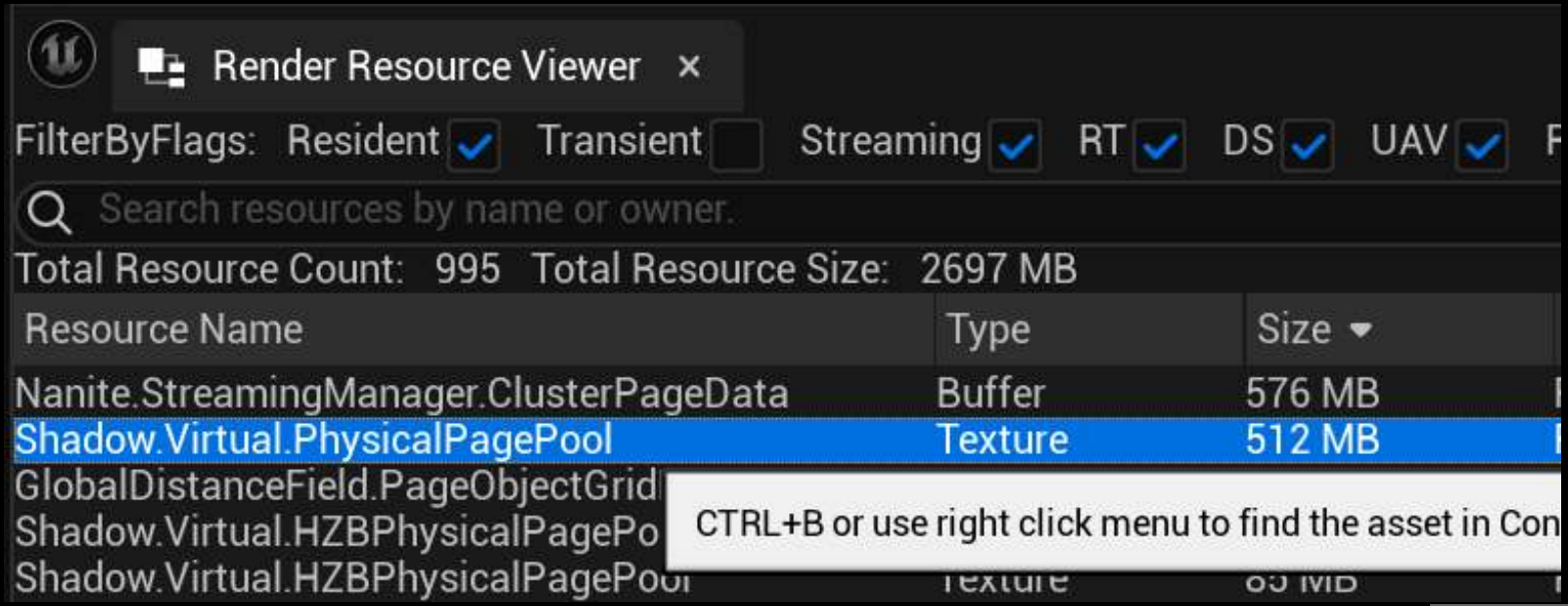




VSM Memory Comsumption

Pool Size = (R32 buffer) * 128 * 128 * (MaxPhysicalPages) * (Separate Pool)

512MB = 4 Bytes * 128 * 128 * 4096 * 2



To Reduce VSM Memory Consumption

1. **Reduce Max Physical Pages**
   ※ But put lots lights that exceed the page number will break shadows

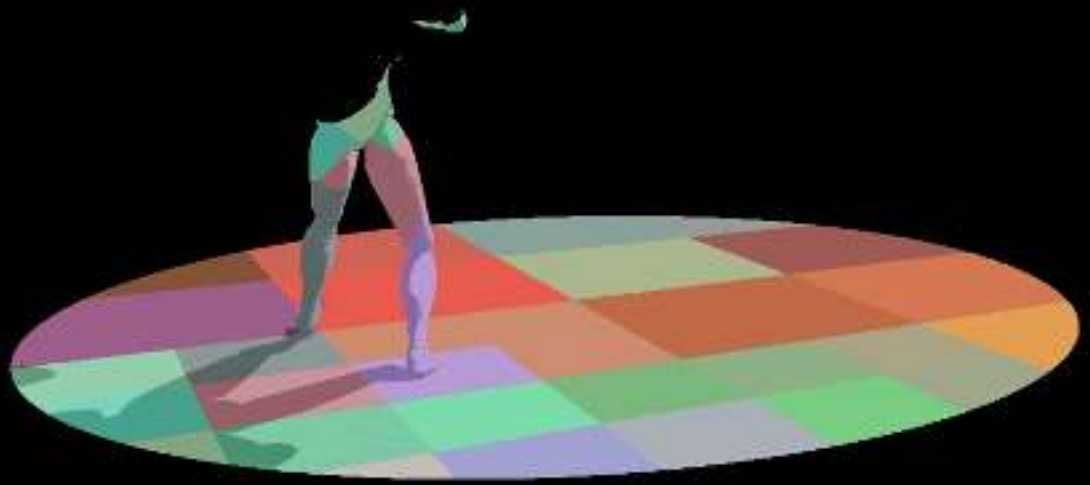
2. If memory size is a priority
   Separate Static option should be turned off
   (Memory usage cut in half)

3. **bias adjustment** by console command

ResolutionLodBiasLocal

r.Shadow.Virtual.ResolutionLodBiasLocal

- Set to 1 or less for finer detail, 1 or more for rougher detail



Physical Pages	4096
Requested	32
Empty	4064
Allocated New	0
Cleared	17
HZB Built	0
Static Cached	32
Invalidated	0
Dynamic Cached	15
Invalidated	17
Merged	0

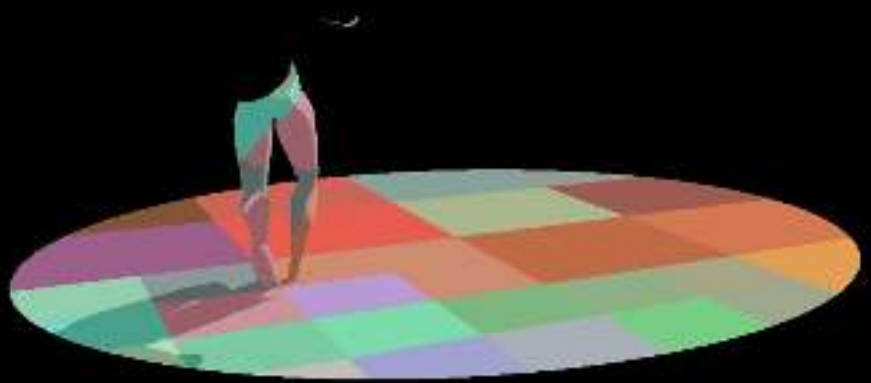
ResolutionLodBiasLocalMoving

r.Shadow.Virtual.ResolutionLodBiasLocalMoving

Apply bias ONLY when lights are moving

This bias can reduce the number of pages updated

Because all cache of the light must be invalidated when the light is moving.

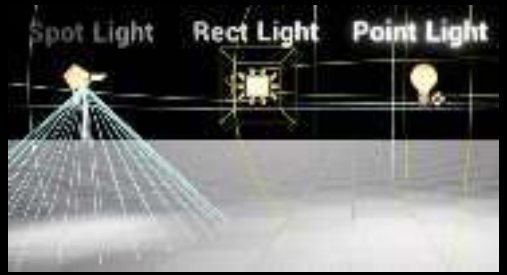


Physical Pages	4096
Requested	32
Empty	4064
Allocated New	0
Cleared	15
HZB Built	0
Static Cached	32
Invalidated	0
Dynamic Cached	17
Invalidated	15
Merged	0

Light Classification by VSM

Local Light

- Point Light
- Spot Light
- Rect Light



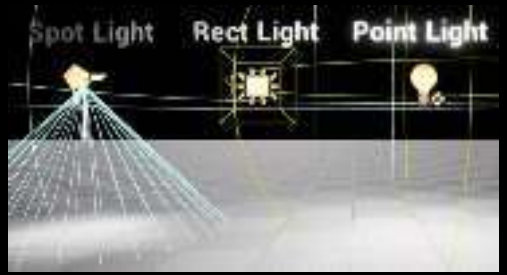
Directional Light

- Directional Light

Light Classification by VSM

Local Light

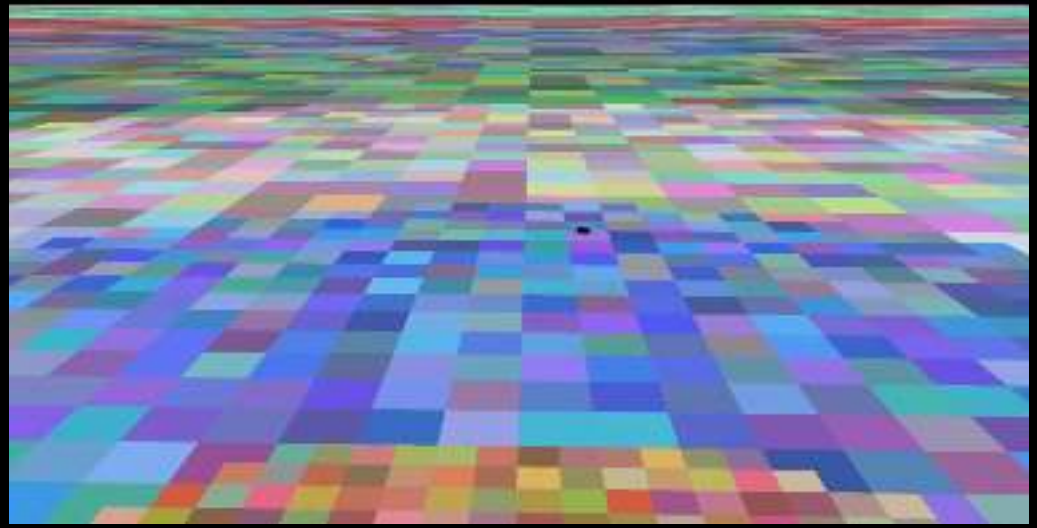
- Point Light
- Spot Light
- Rect Light



Directional Light

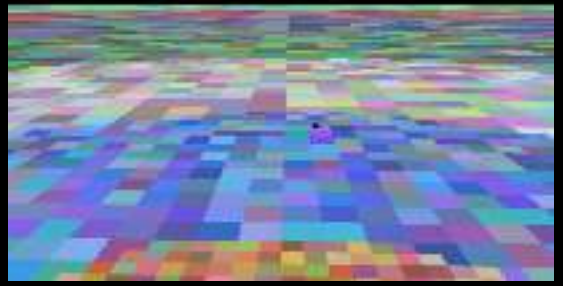
- Directional Light

Directional Light



Physical Pages	4096
Requested	2098
Empty	2187
Allocated New	189
Cleared	378
HZB Built	189
Static Cached	1909
Invalidated	0
Dynamic Cached	1909
Invalidated	0
Merged	0

Directional Light



Lighting the entire screen
-> the closer a page is to the camera,
    it needs to be more detailed

Basically, the same mechanism as Local Light,
As an additional function,
there is a clip map that changes LOD according to the distance from the camera.

CVars
r.Shadow.Virtual.ResolutionLodBiasDirectional
r.Shadow.Virtual.ResolutionLodBiasDirectionalMoving

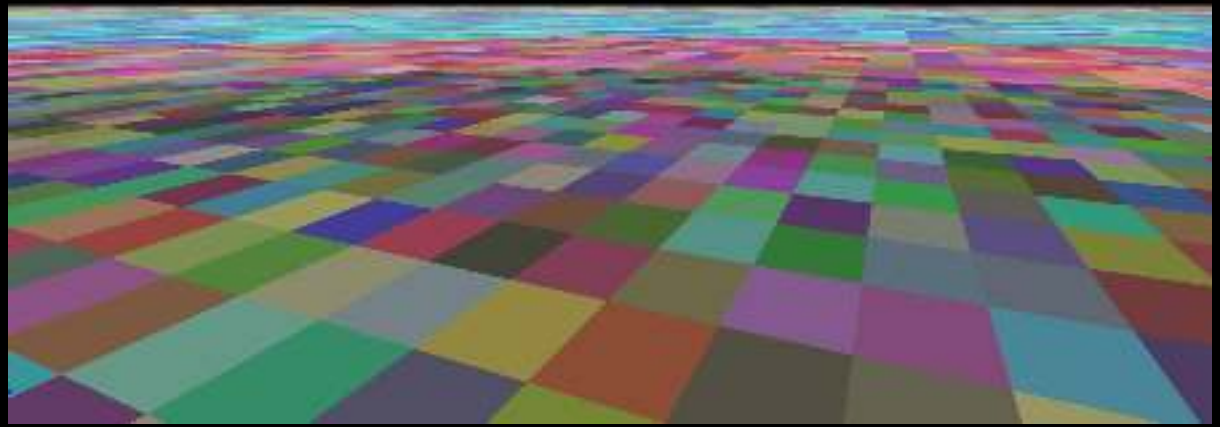
Directional Light – Adjusting Clip Map

r.Shadow.Virtual.Clipmap.FirstLevel

Use the *FirstLevel* page size for levels below the *FirstLevel*
(Default: 6) - 64 cm (2^6 cm)

r.Shadow.Virtual.Clipmap.LastLevel

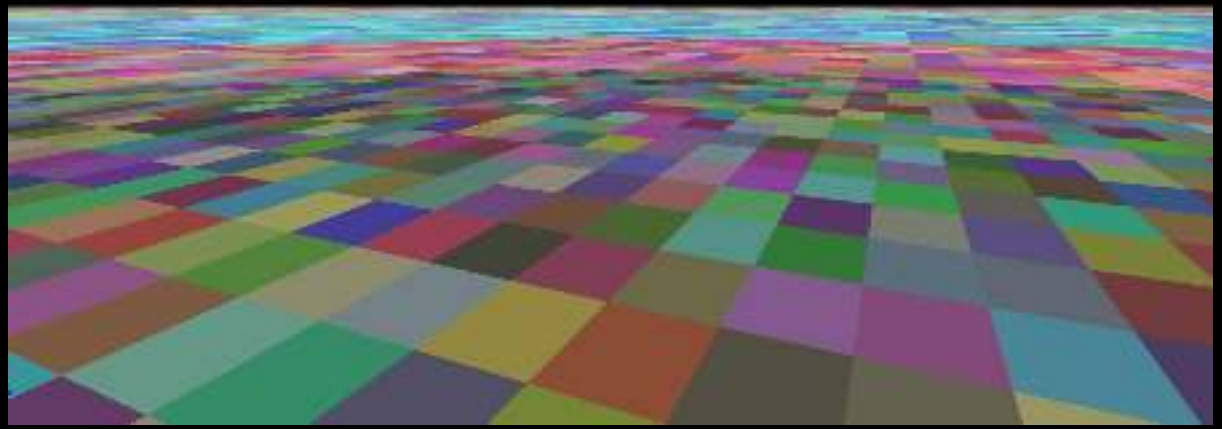
Do not render pages above the *LastLevel* (Default: 22) - about 40 km (2^22 cm)



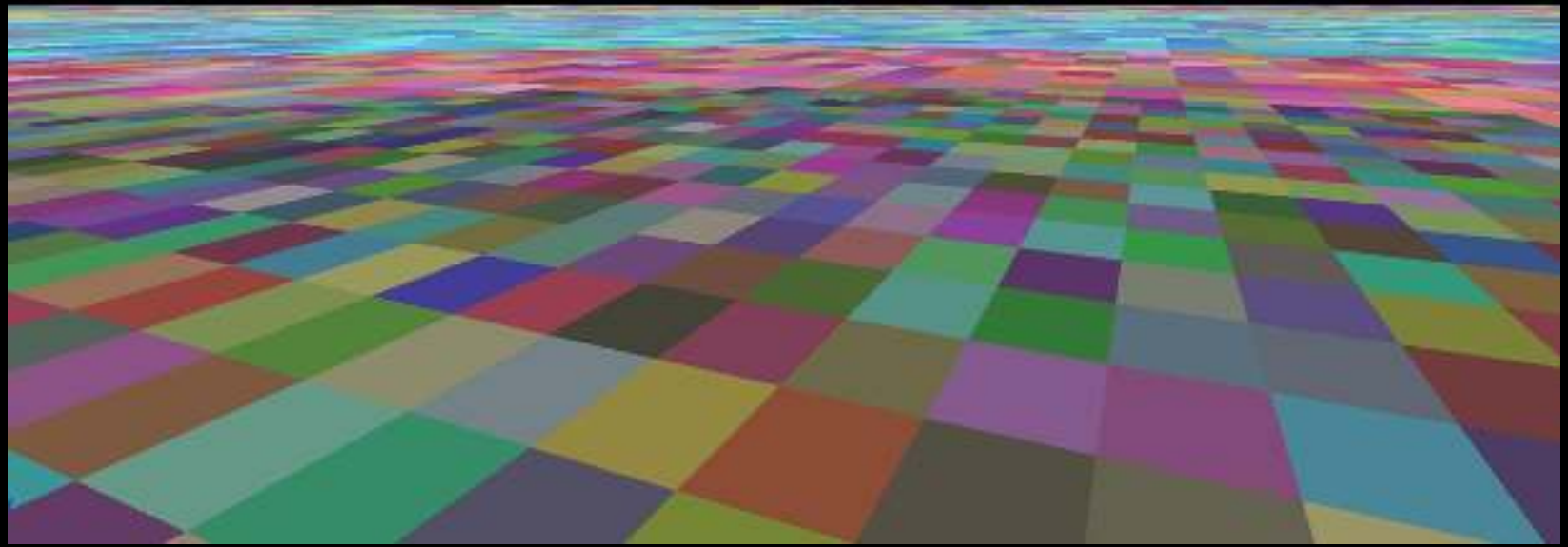
Directional Light – Adjusting Clip Map

r.Shadow.Virtual.Clipmap.FirstLevel
Use the *FirstLevel* page size for levels below the *FirstLevel* (Default: 6) - 64 cm (2^6 cm)

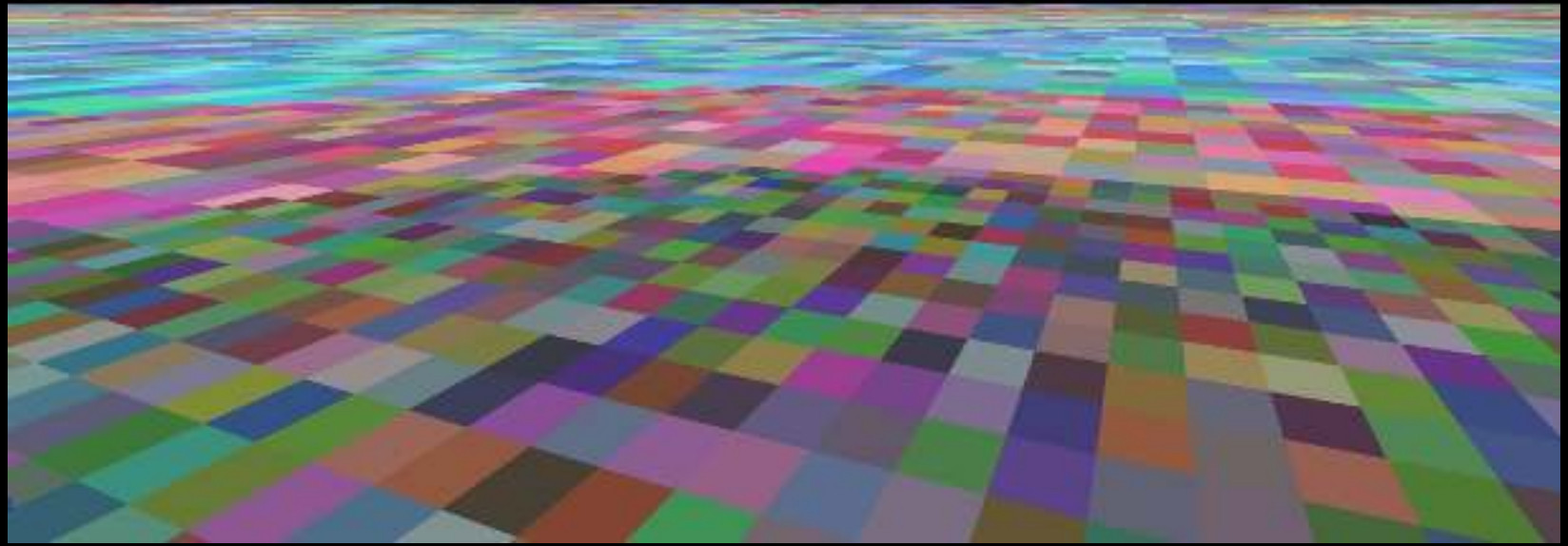
r.Shadow.Virtual.Clipmap.LastLevel
Do not draw pages above the *LastLevel* (Default: 22) - about 40 km (2^22 cm)



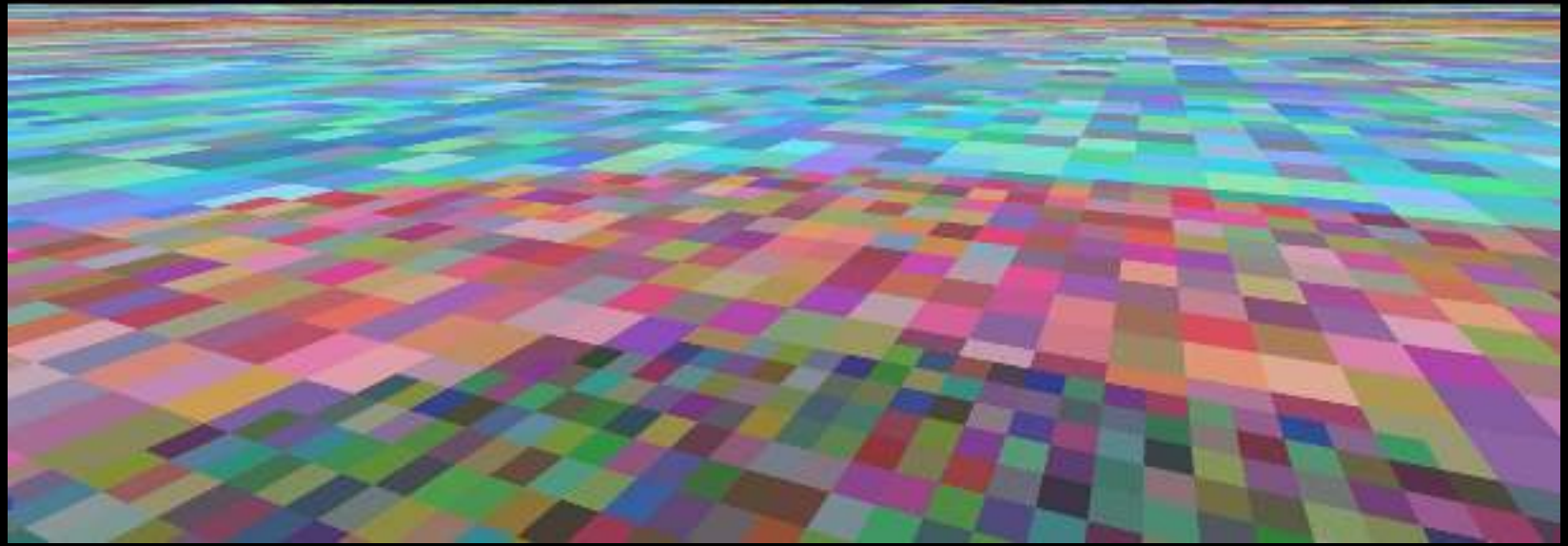
r.Shadow.Virtual.Clipmap.FirstLevel 6



r.Shadow.Virtual.Clipmap.FirstLevel 5



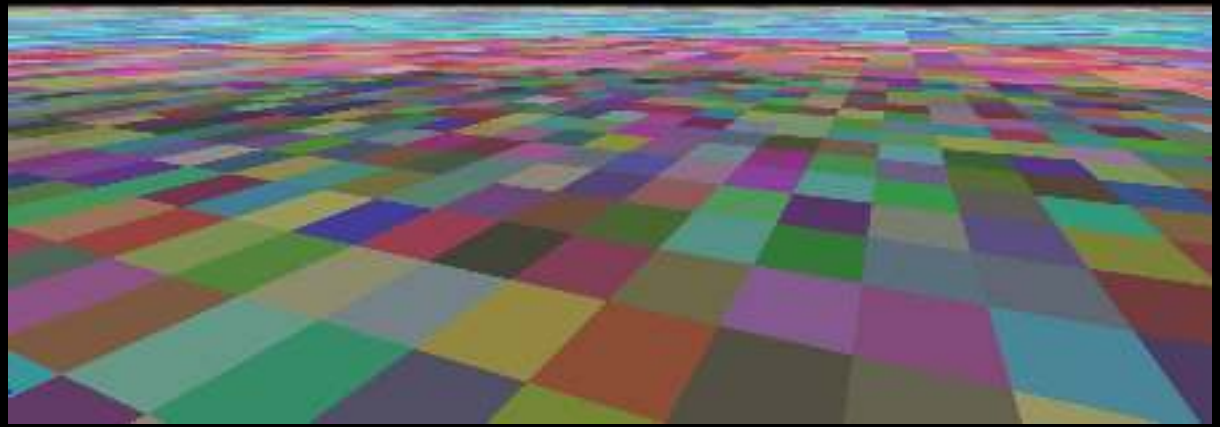
r.Shadow.Virtual.Clipmap.FirstLevel 4



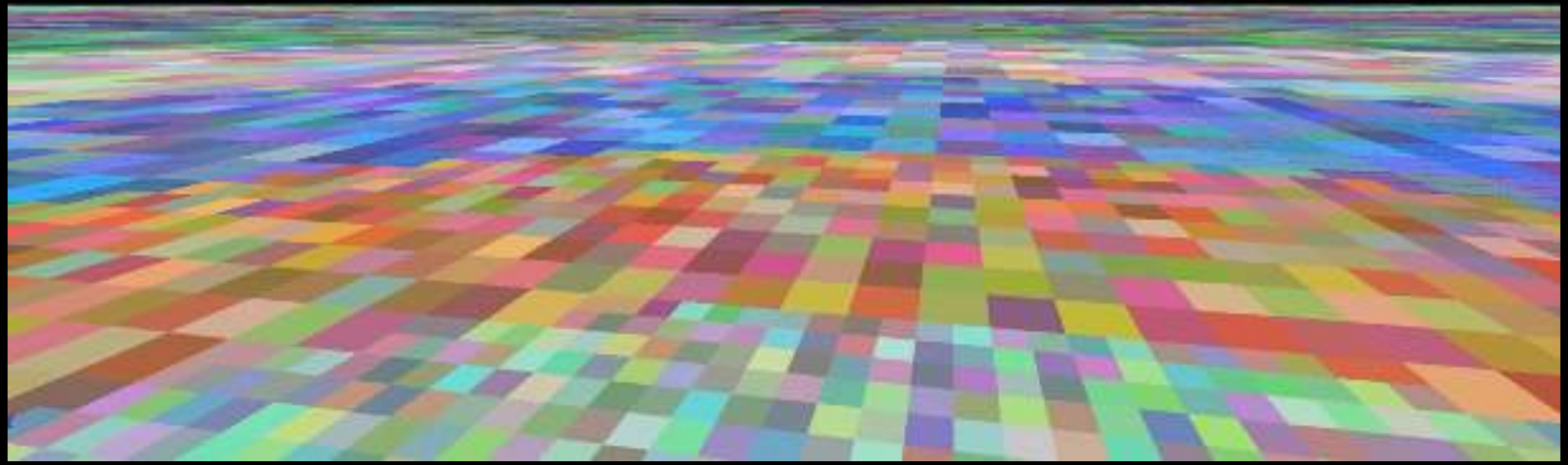
Directional Light – Adjusting Clip Map

r.Shadow.Virtual.Clipmap.FirstLevel
Use the *FirstLevel* page size for levels below the *FirstLevel*
(Default: 6) - 64 cm (2^6 cm)

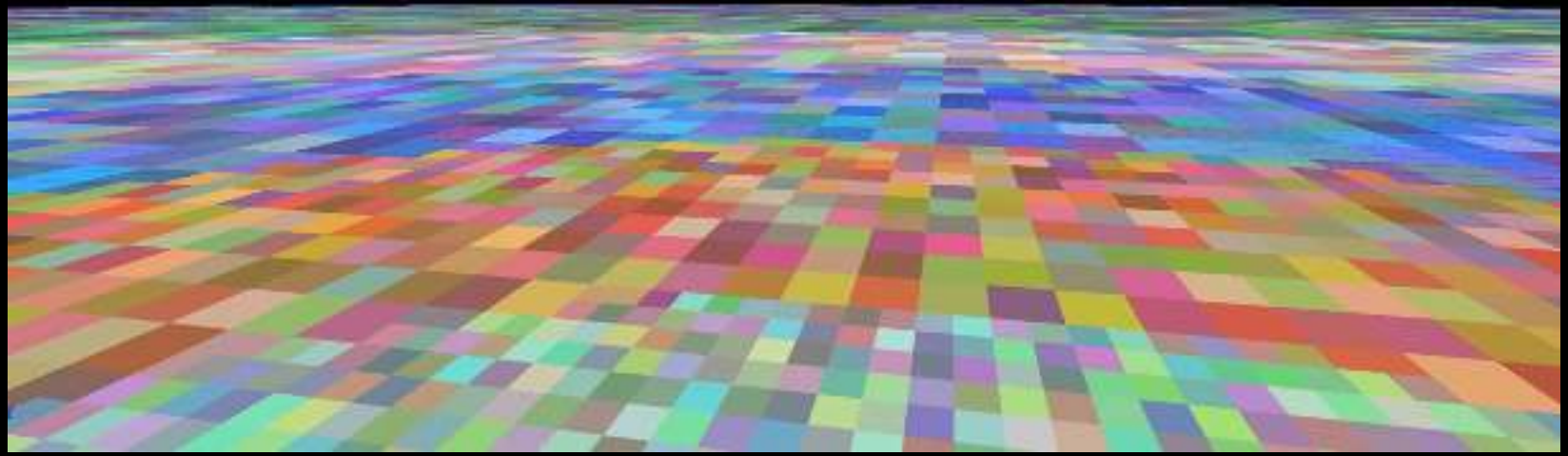
r.Shadow.Virtual.Clipmap.LastLevel
Do not draw pages above the *LastLevel* (Default: 22) - about 40 km (2^22 cm)



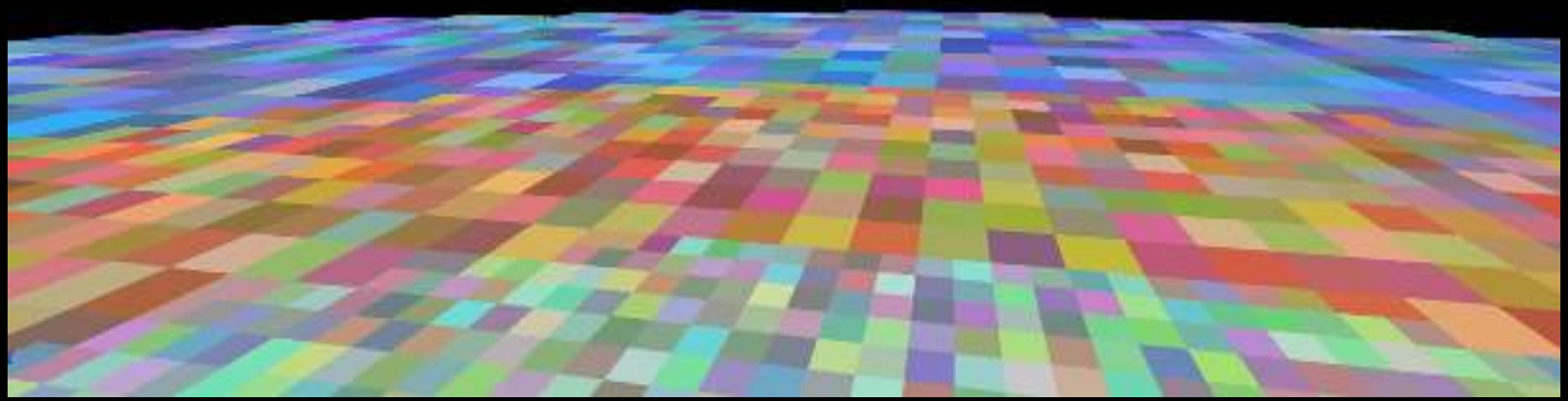
r.Shadow.Virtual.Clipmap.LastLevel 22



r.Shadow.Virtual.Clipmap.LastLevel 13



r.Shadow.Virtual.Clipmap.LastLevel 10



Directional Light setting for VSM

・Adjust LOD with *LodBias*

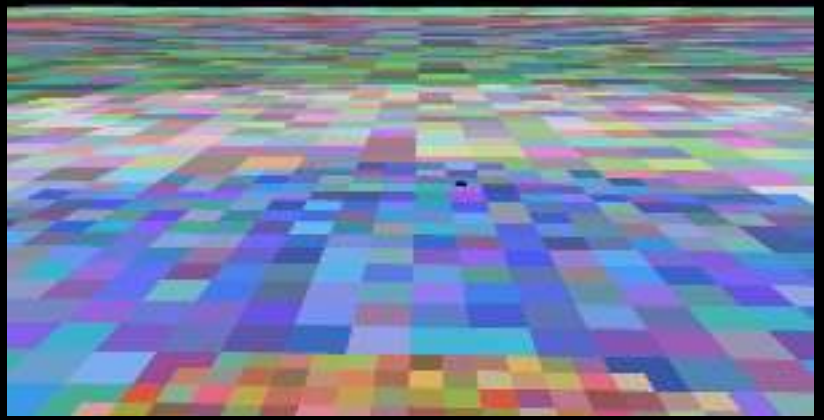
r.Shadow.Virtual.ResolutionLodBiasDirectional

r.Shadow.Virtual.ResolutionLodBiasDirectionalMoving

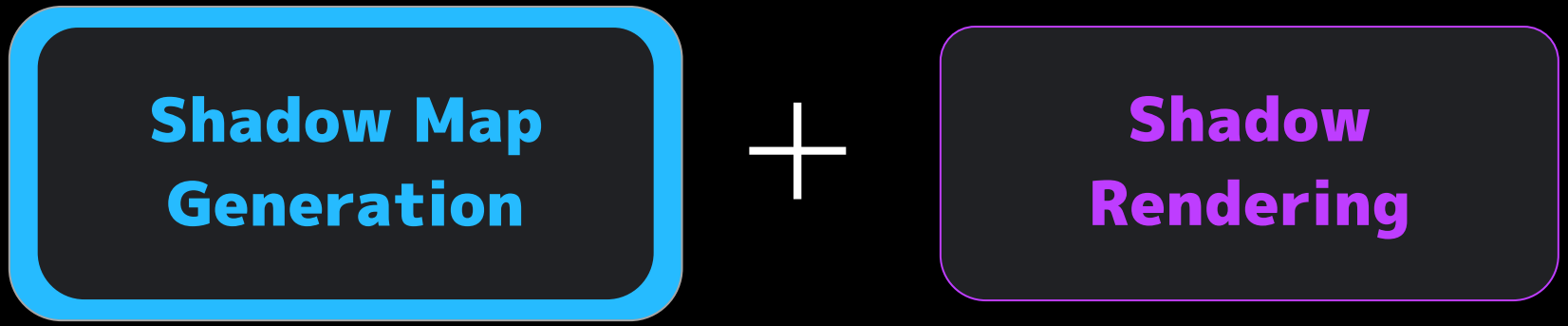
・Adjust range with *ClipmapLevel*

r.Shadow.Virtual.Clipmap.FirstLevel

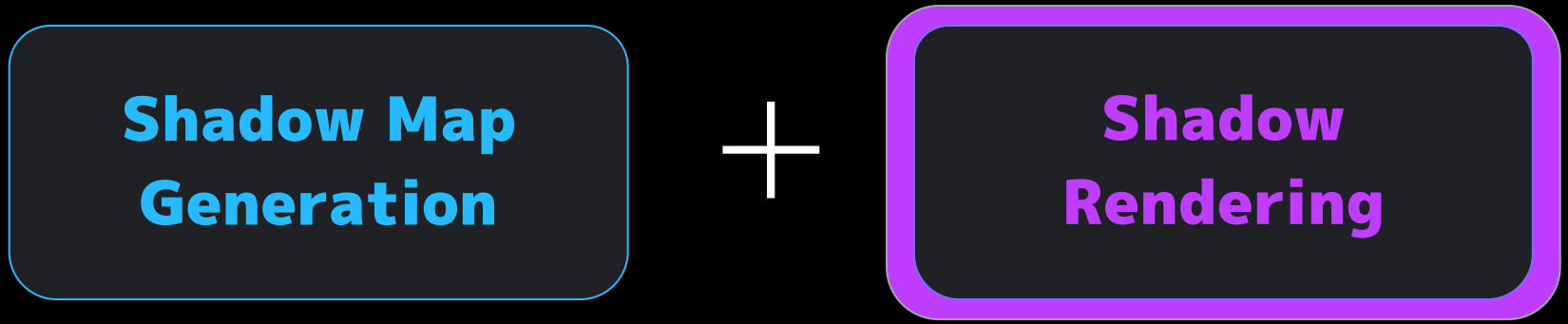
r.Shadow.Virtual.Clipmap.LastLevel



VSM Algorithm



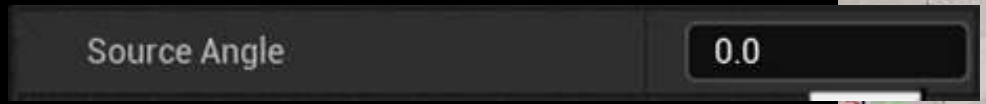
VSM Algorithm



Shadow Map Ray Tracing (SMRT)

VSM does ray tracing on the shadow map for high quality shadow rendering.
Shadow rays are distributed with the following parameters of the light

- Local Light: **Source Radius**
- Directional Light: **Source Angle**



SMRT - RayCount

SMRT.RayCount directly affect shadow quality and performance
※Default:8 (If set to 0, single-sample = hard shadow)
r.Shadow.Virtual.SMRT.RayCountLocal
r.Shadow.Virtual.SMRT.RayCountDirectional

Test scene->
Source Radius is fixed to 1.5
Changing *RayCountDirectional*

SMRT - RayCountLocal

More local lights has a greater impact
r.Shadow.Virtual.SMRT.RayCountLocal

Test scene ->
Meshes and Lights placed with PCG
Source Radius = 100
Adjust *RayCountLocal*

VSM: Optmization

Cache as much as possible → Reduce Objects to invalidate cache

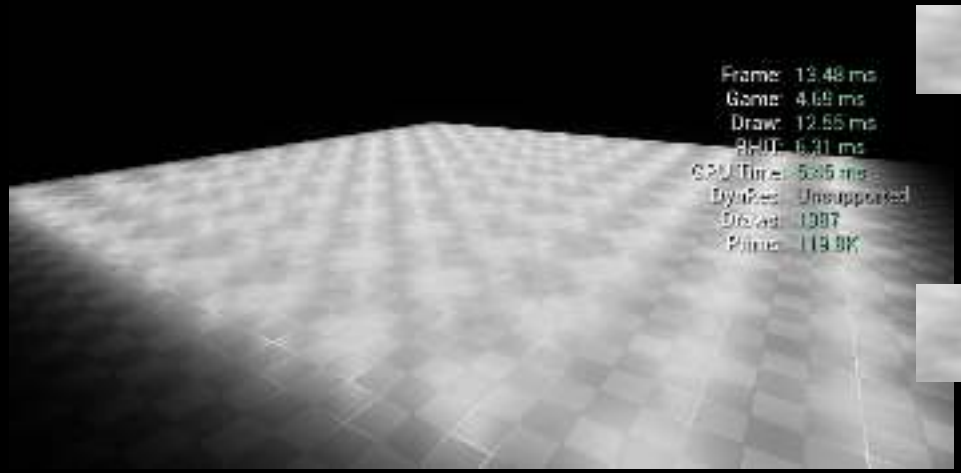
Consider using only Contact Shadow in situations
where the cache cannot be utilized in large areas such as grasslands

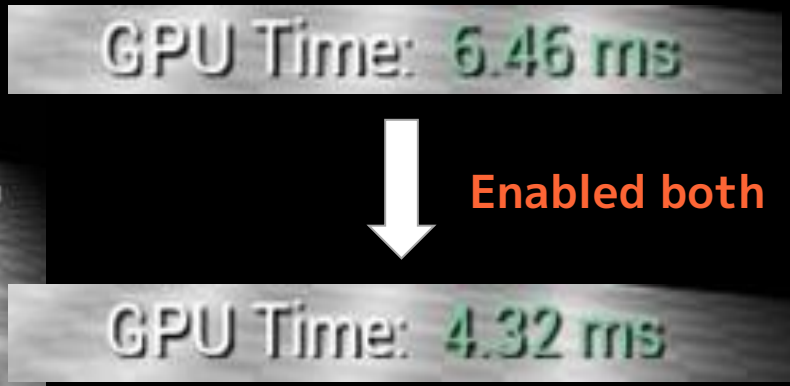
Set Contact Shadow Length
in Directional Light settings

In the Static Mesh settings
Turn off Dynamic Shadow
Enable Contact Shadow only

VSM: Optmization

- Distant Lights and Onepass Projection are enabled by default





# of point lights:100
With RTX4090

Distant Lights and Onepass Projection

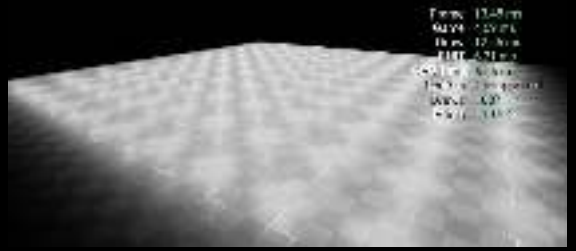
- **Distant Lights**

  the function to reduce the frequency of updating distant lights that have a small area of influence

  r.shadow.virtual.distantlightmode

  Maximum number of distant lights to update each frame

  r.Shadow.Virtual.MaxDistantUpdatePerFrame 1



- **Onepass Projection**

  Projects all local light virtual shadow maps in a single pass

  r.Shadow.Virtual.OnePassProjection 1

※Some restrictions are described in the official VSM document

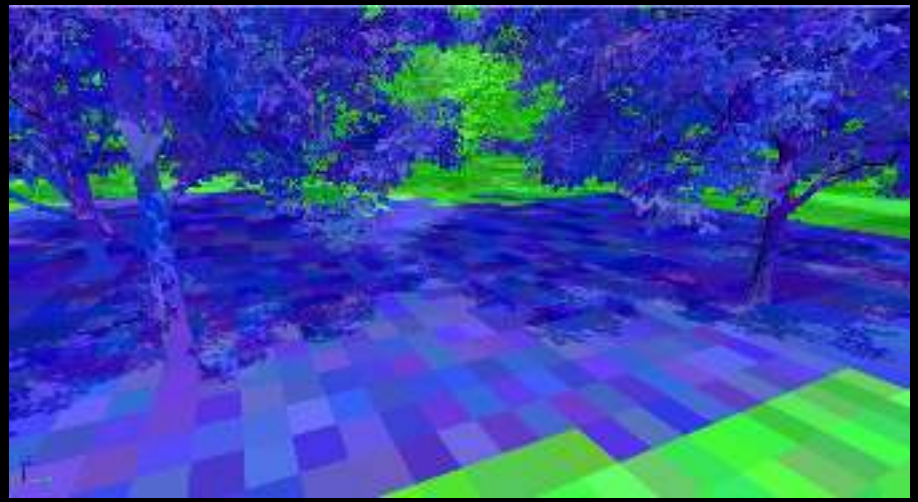
https://dev.epicgames.com/documentation/en-us/unreal-engine/virtual-shadow-maps-in-unreal-engine

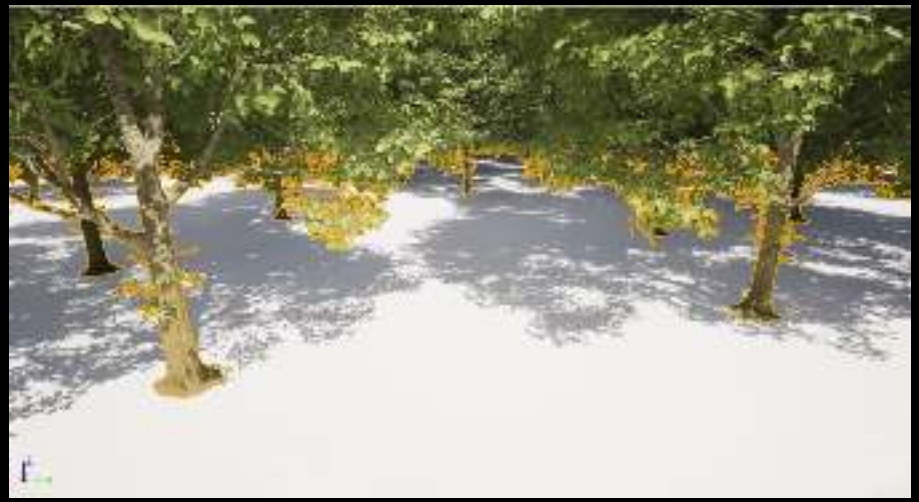
VSM: Optmization - 5.4~

Dynamically change page resolution to match Pool Size

r.Shadow.Virtual.DynamicRes.MaxPagePoolLoadFactor Default: 0.85

Adjust Page's LOD when exceeding 85% of pool size





Example: Limit PagePoolSize to 4096->100 (memory reduced from 512MB to 16MB)

Other Tips

- Some debug commands
- Render Resource View
- RDG Insights

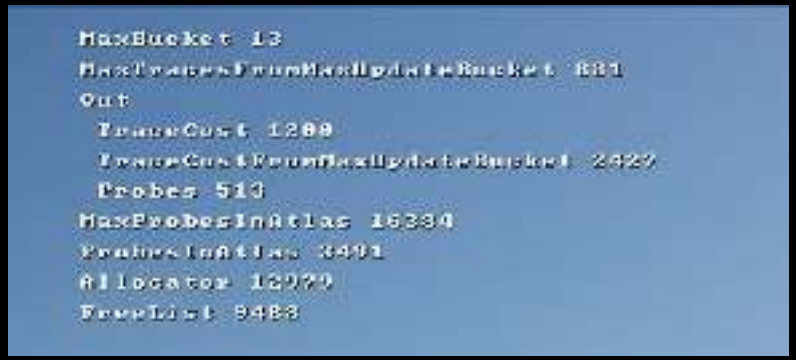
Shader Print

Some Stats/Debug info are drawn by ***ShaderPrint***
(Compute Shader converts various resources into data for display)
r.Nanite.ShowStats
r.Shadow.Virtual.ShowStats
etc.

Some settings to adjust the ShaderPrint view
r.ShaderPrint.FontSize
r.ShaderPrint.FontSpacingX
r.ShaderPrint.FontSpacingY

Shader Print

Need to be implemented on CPP side and CS Shader respectively
RadianceCacheUpdateStats can be a good simple example



r.Lumen.ScreenProbeGather.RadianceCache.Stats

```
Newline(Context);
Print(Context, TEXT("MaxBucket "));
Print(Context, MaxUpdateBucketIndex);

Newline(Context);
Print(Context, TEXT("MaxTracesFromMaxUpdateBucket "));
Print(Context, LocalMaxTracesFromMaxUpdateBucket);

Newline(Context);
Print(Context, TEXT("Out "));

Newline(Context);
Print(Context, TEXT(" TraceCost "));
Print(Context, ProbesToUpdateTraceCost[0]);
```

LumenRadianceCacheDebug.usf

If you want to check other examples in UE,
You can see some implementations by searching “../ShaderPrint.ush”

r.ShaderPrint.Zoom

You can zoom in on the position of the mouse cursor in the viewport.

r.ShaderPrint 1 and
r.ShaderPrint.Zoom 1

- Change the debug view location
  r.ShaderPrint.Zoom.Corner
- Number of pixels to be zoomed
  r.ShaderPrint.Zoom.Pixel
- Zooming magnification
  r.ShaderPrint.Zoom.Factor

VisualizeTexture/Vis

Supports RDG resources and real-time visualization (on Development builds)
VisualizeTexture/Vis <RDGResourceName>[@<Version>] [<Mode>] ~
Executing only *Vis* command shows Help and a list of resource names

```
RDGResourceName (what was rendered this frame, use <RDGResource
    BloomX                                                  Lumen
    BloomY                                                  Lumen
    Cloud.ColorCubeDummy                                    Lumen
    CombineLUTs                                             Lumen
    Dummy                                                   Lumen
    EyeAdaptationTexture                                    Lumen
    Final Luminance                                         Lumen
    GBufferA                                                Lumen
    GBufferB                                                Lumen
    GBufferC                                                Lumen
    GBufferD                                                Lumen
    GBufferE                                                Lumen
    HalfResolutionDepthCheckerboardMinMax                   Lumen
```

Vis - Pool

Vis Pool : Show resource list only
Vis Pool BYNAME : Sort by name
Vis Pool BYSIZE : Sort by size

```
Cmd: Vis pool BYSIZE
LogConsoleResponse:      5 - 524288 KB (2D[2] 16384x4096 PF_R32_UINT UAV) Shadow.Virtual.PhysicalPagePool
LogConsoleResponse:    113 - 524288 KB (2D[2] 16384x4096 PF_R32_UINT UAV) Shadow.Virtual.PhysicalPagePool
LogConsoleResponse:      4 - 87424 KB (2D 8192x2048 PF_R32_FLOAT UAV) Shadow.Virtual.HZBPhysicalPagePool
LogConsoleResponse:    114 - 87424 KB (2D 8192x2048 PF_R32_FLOAT UAV) Shadow.Virtual.HZBPhysicalPagePool
LogConsoleResponse:     33 - 87424 KB (2D 8192x2048 PF_R32_FLOAT UAV) Shadow.Virtual.HZBPhysicalPagePool
LogConsoleResponse:     16 - 87424 KB (2D 8192x2048 PF_R32_FLOAT UAV) Shadow.Virtual.HZBPhysicalPagePool
LogConsoleResponse:    131 - 73984 KB (2D 4352x4352 PF_FloatRGB UAV) Lumen.RadianceCache.FinalRadianceAtlas
LogConsoleResponse:     10 - 73984 KB (2D 4352x4352 PF_FloatRGB UAV) Lumen.RadianceCache.FinalRadianceAtlas
LogConsoleResponse:    145 - 65536 KB (2D 4096x4096 PF_B8G8R8A8 RT) VisualizeTexture
LogConsoleResponse:     69 - 65536 KB (2D 4096x4096 PF_FloatR11G11B10 RT UAV) Lumen.SceneDirectLighting
LogConsoleResponse:    151 - 65536 KB (2D 4096x4096 PF_FloatR11G11B10 RT UAV) Lumen.SceneDirectLighting
LogConsoleResponse:    154 - 65536 KB (2D 4096x4096 PF_FloatR11G11B10 RT UAV) Lumen.SceneFinalLighting
LogConsoleResponse:     57 - 65536 KB (2D 4096x4096 PF_FloatR11G11B10 RT UAV) Lumen.SceneFinalLighting
LogConsoleResponse:     70 - 65536 KB (2D 4096x4096 PF_FloatR11G11B10 RT UAV) Lumen.SceneIndirectLighting
LogConsoleResponse:    152 - 65536 KB (2D 4096x4096 PF_FloatR11G11B10 RT UAV) Lumen.SceneIndirectLighting
LogConsoleResponse:      9 - 65536 KB (2D 4096x4096 PF_FloatRGB UAV) Lumen.RadianceCache.RadianceProbeAtlasTextureSource
LogConsoleResponse:    130 - 65536 KB (2D 4096x4096 PF_FloatRGB UAV) Lumen.RadianceCache.RadianceProbeAtlasTextureSource
LogConsoleResponse:    157 - 65536 KB (2D 4096x4096 PF_FloatRGB UAV) Lumen.Radiosity.TraceRadianceAtlas
LogConsoleResponse:     54 - 65536 KB (2D 4096x4096 PF_FloatRGB UAV) Lumen.Radiosity.TraceRadianceAtlas
LogConsoleResponse:    116 - 57344 KB (3D 1024x1024x56 PF_R8 UAV) GlobalDistanceField.PageAtlas
LogConsoleResponse:     35 - 57344 KB (3D 1024x1024x56 PF_R8 UAV) GlobalDistanceField.PageAtlas
```

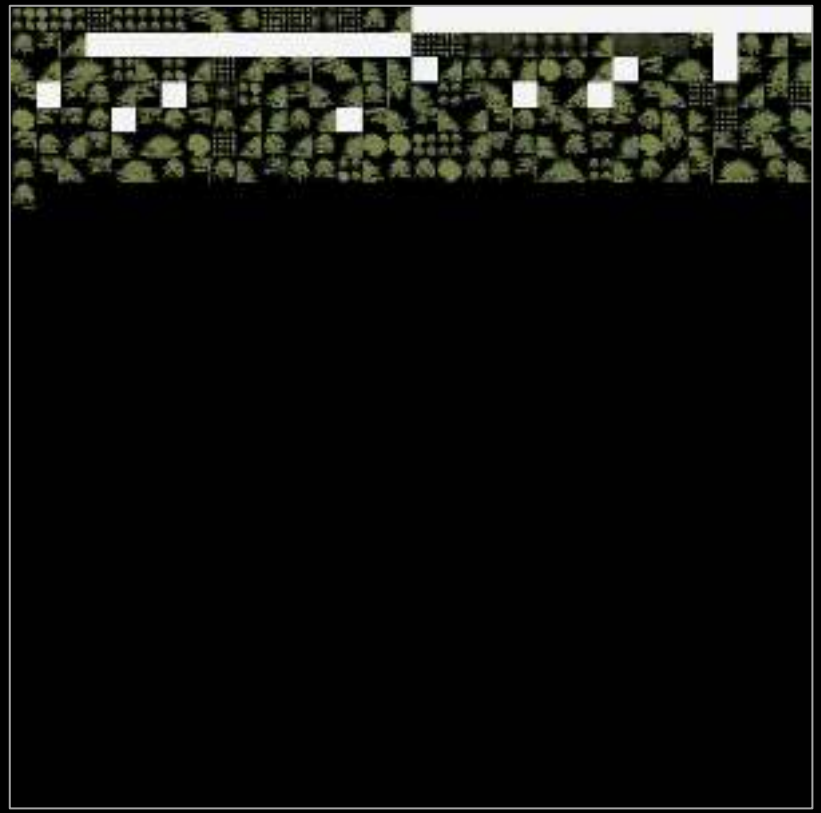
Vis - BMP

・Can output images in original size with BMP command

Vis [ResourceName] BMP

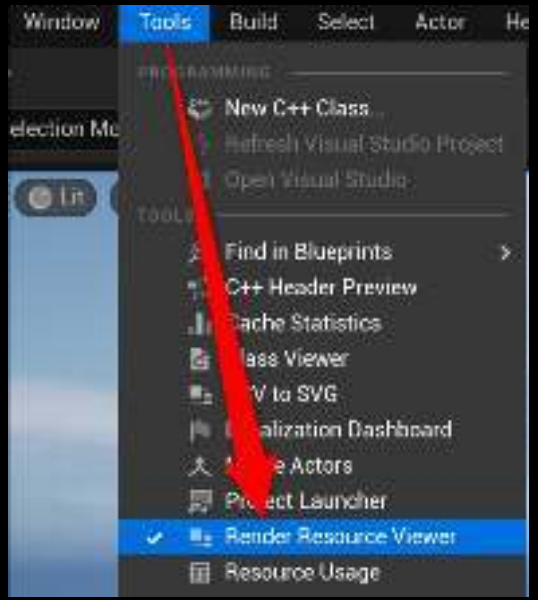
・ Example

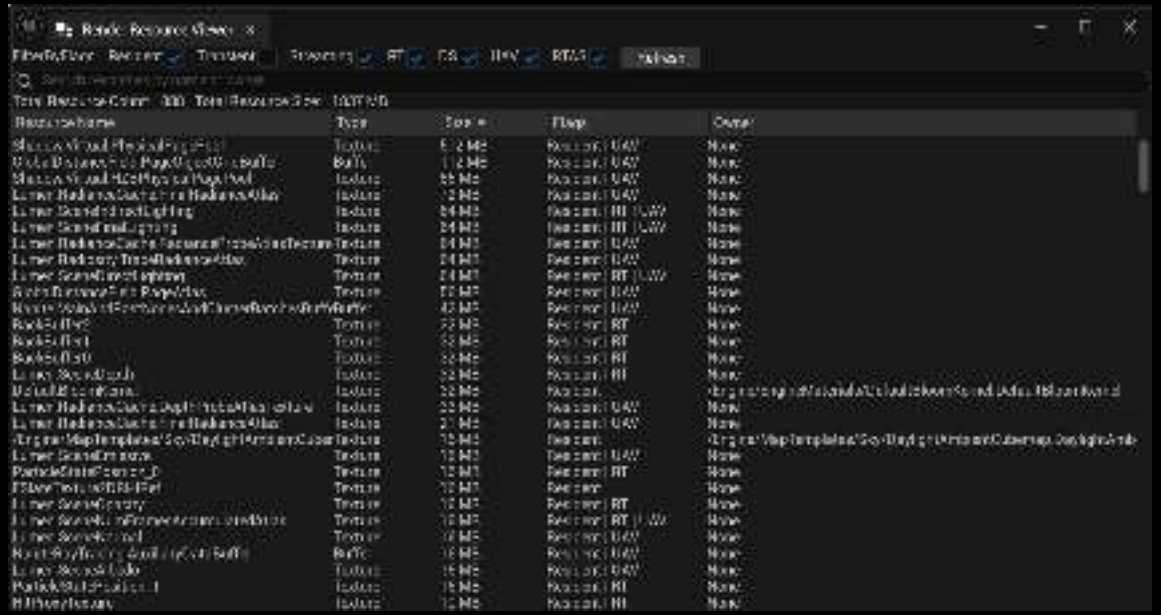
vis Lumen.SceneAlbedo BMP



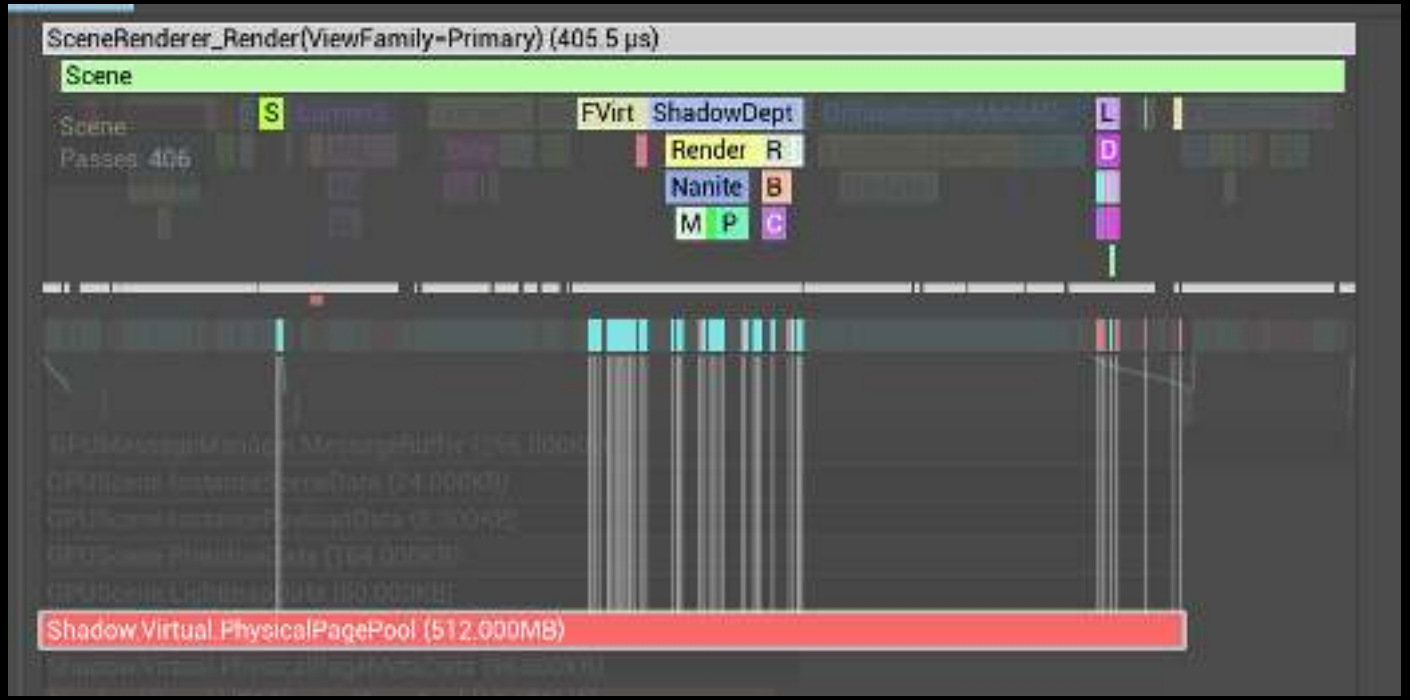
Render Resource View

Sorting by size, etc. is very useful to find large resources easily and early



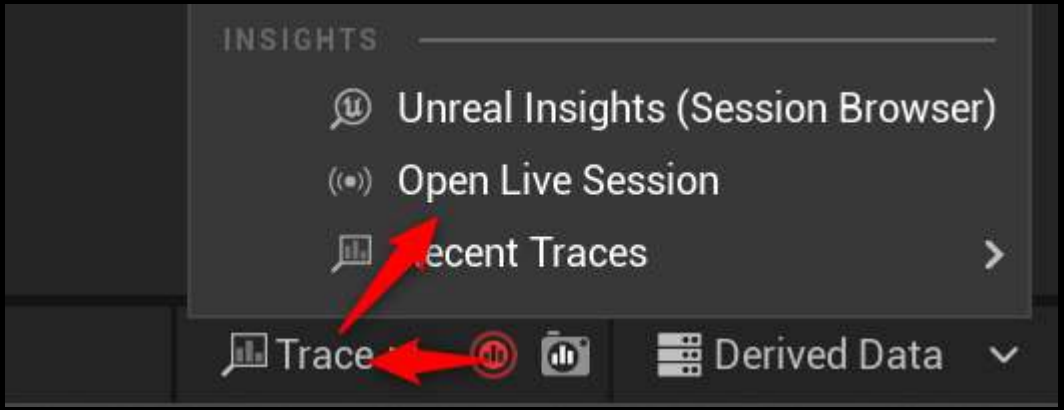


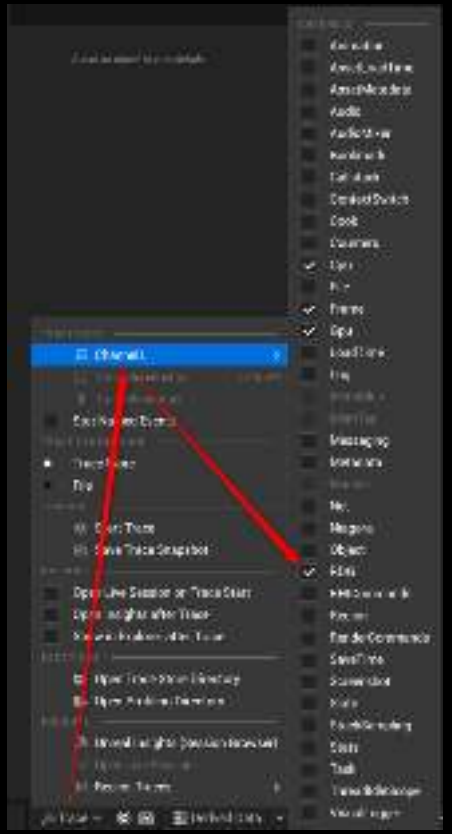
RDG Insights



RDG Insights - how to capture

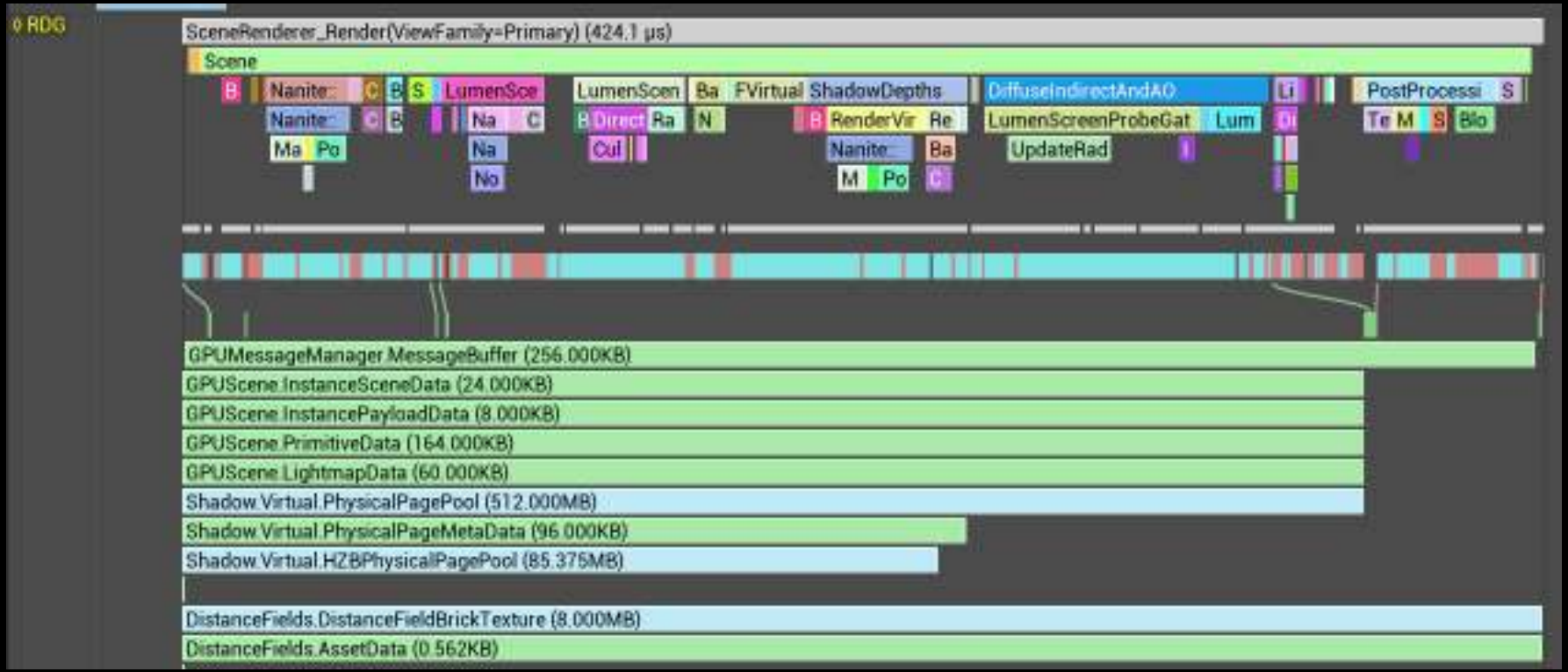
Activate RDG Insights plugin
Run with "*-trace=rdg,default*"
Or set RDG channel from the bottom right menu of the editor
Then start Trace -> Open Live Session





RDG Insights - RDG is at the bottom of the trace

RDG Insights - 3 categories



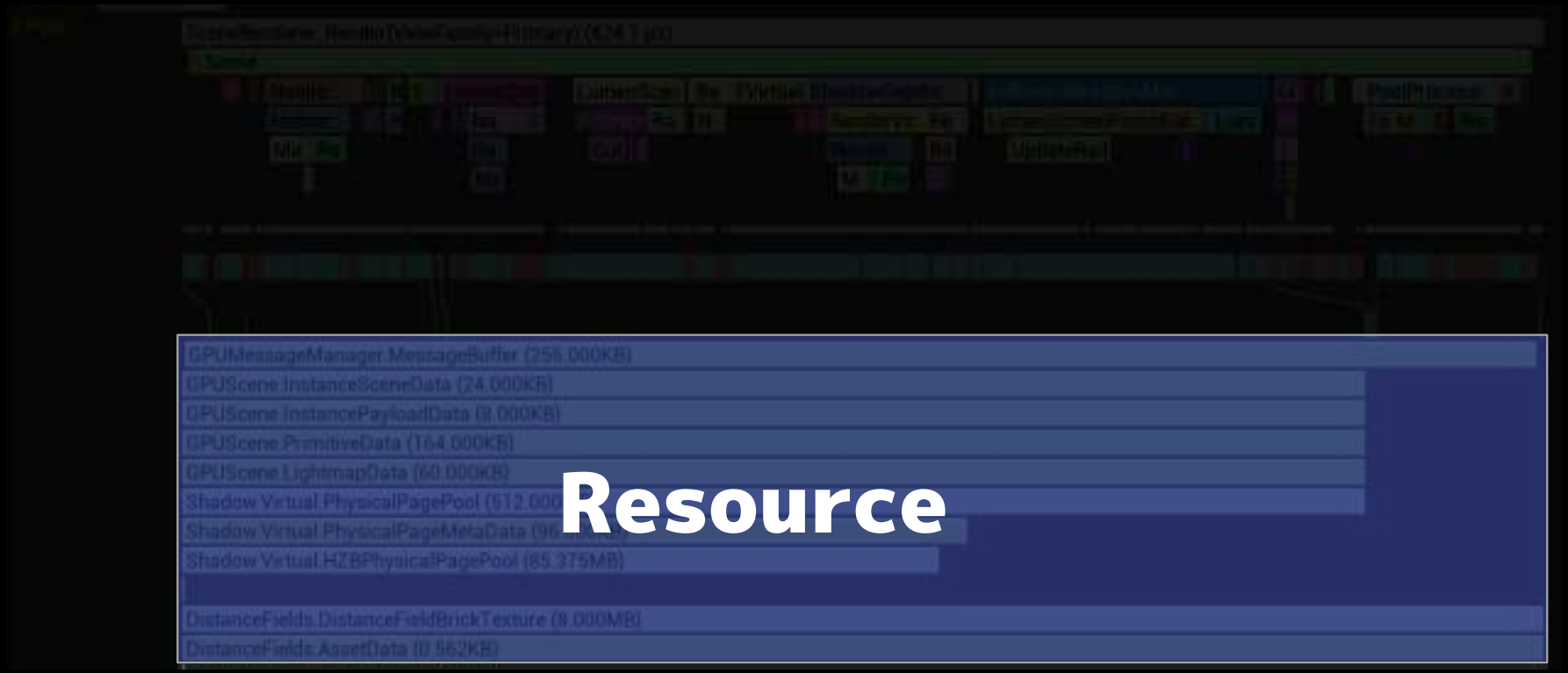
RDG Insights - 3 categories

RDG Insights - 3 categories

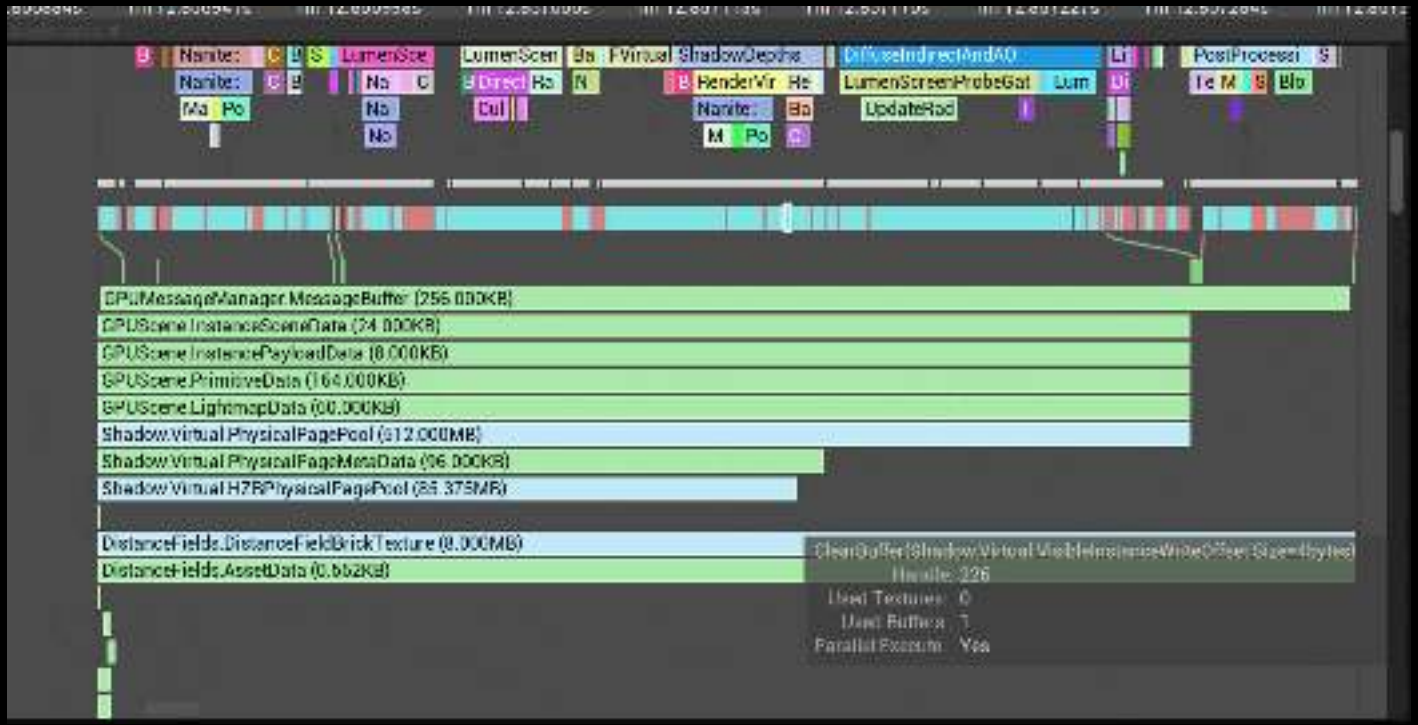
RDG Insights - Pass

Blue is Compute 、Red is Raster、
Green at the bottom of the row is Async Compute

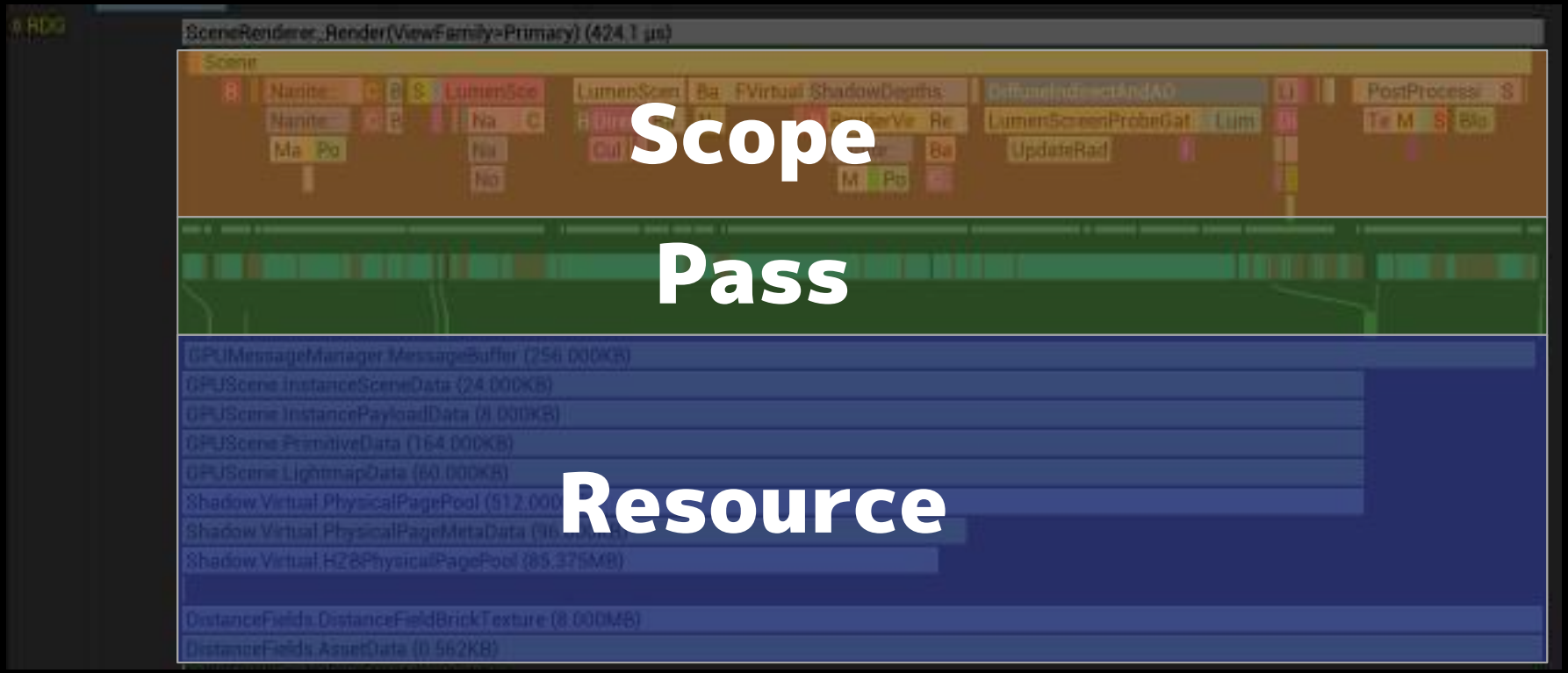
RDG Insights - 3 categories



RDG Insights – Resource

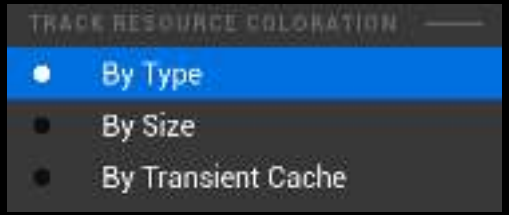


RDG Insights - 3 categories



RDG Insights – Resource color change

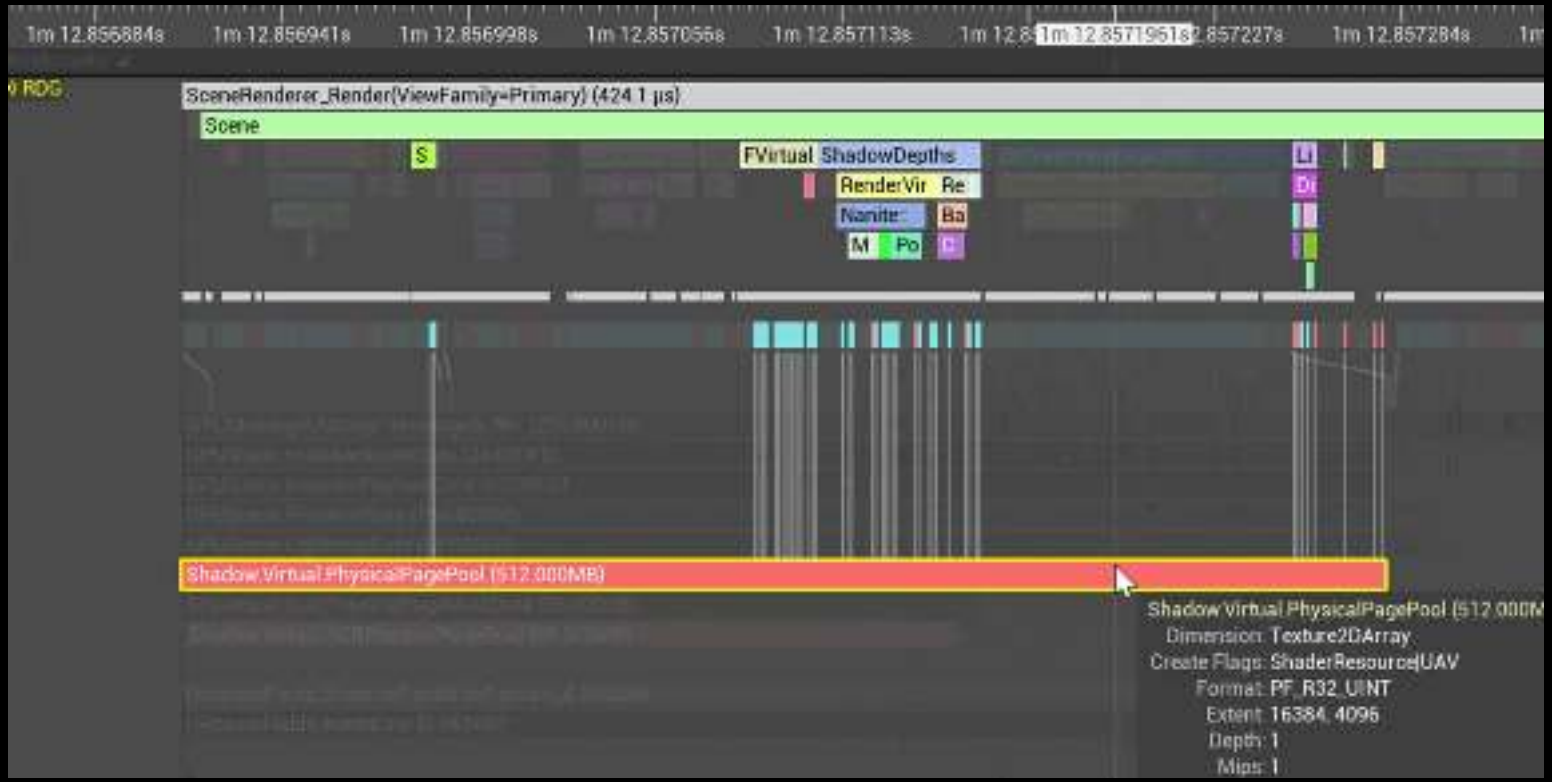
- The default setting is “By Type”
  Green is Buffer、Blus is Texture



RDG Insights – Coloration by Size

- Color can be changed on the right-click menu
- by Size = Larger resources are highlighted in red

RDG Insights



Agneda

Nanite

Lumen

VSM

Other Development Tips


Thank you!


EPIC
GAMES