Build Games in the Cloud: Streamline 3D Content Production With OpenUSD

Calvin Gu, Sr. Technical Artist, Tencent; Haoran Wei, Game Development Engineer, Tencent | GTC / Mar. 19, 2024

Tencent Games

Calvin Gu

Sr. Technical Artist from Tencent Games

Tencent Games

GDC 22

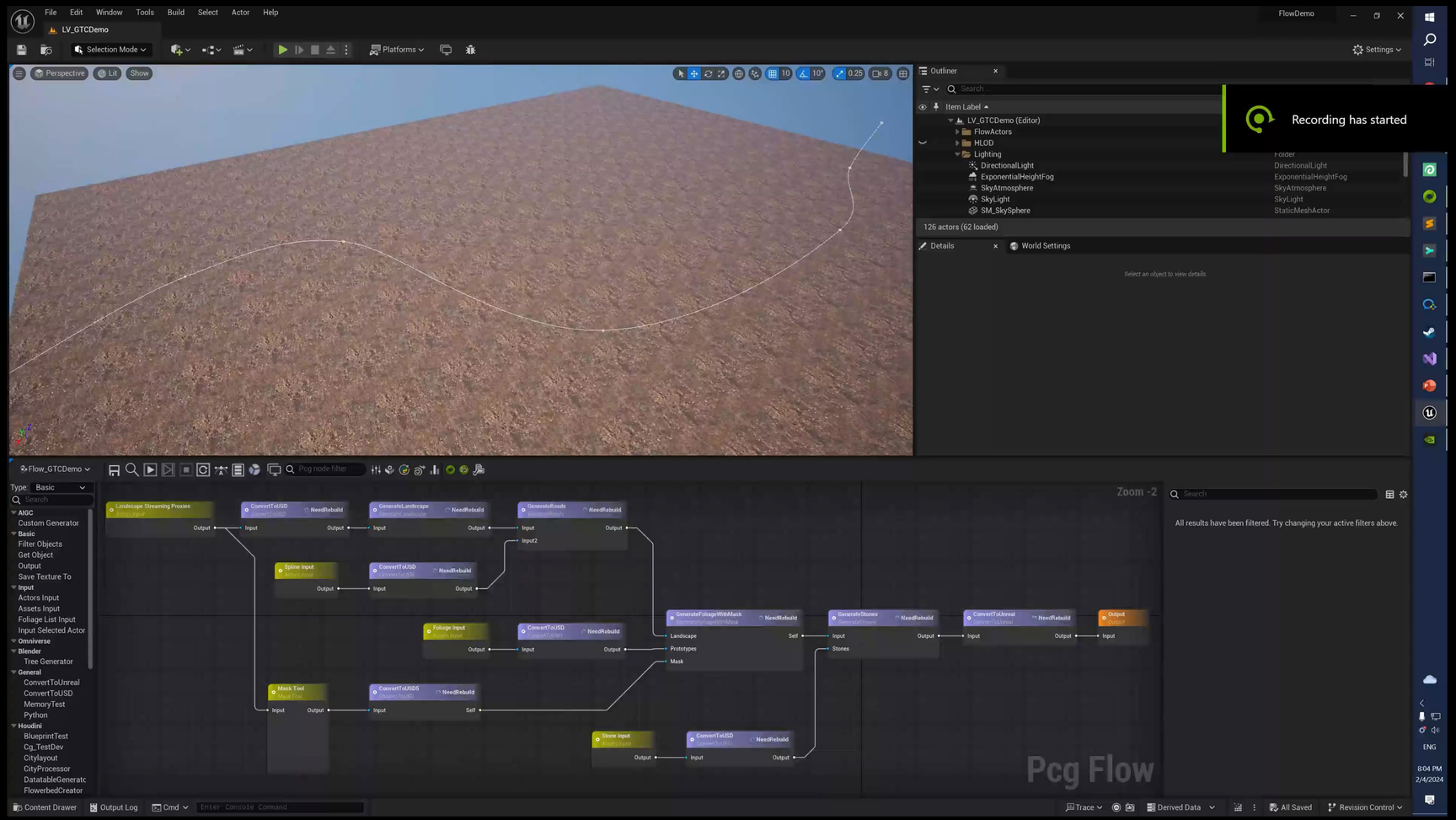
Opportunities for Universal Scene Description in Game Development

GDC 23

Evolving the Game Development Pipeline with Omniverse

Introduction

procedural generate content in the cloud



“

Why would we have to switch our pipeline to OpenUSD?

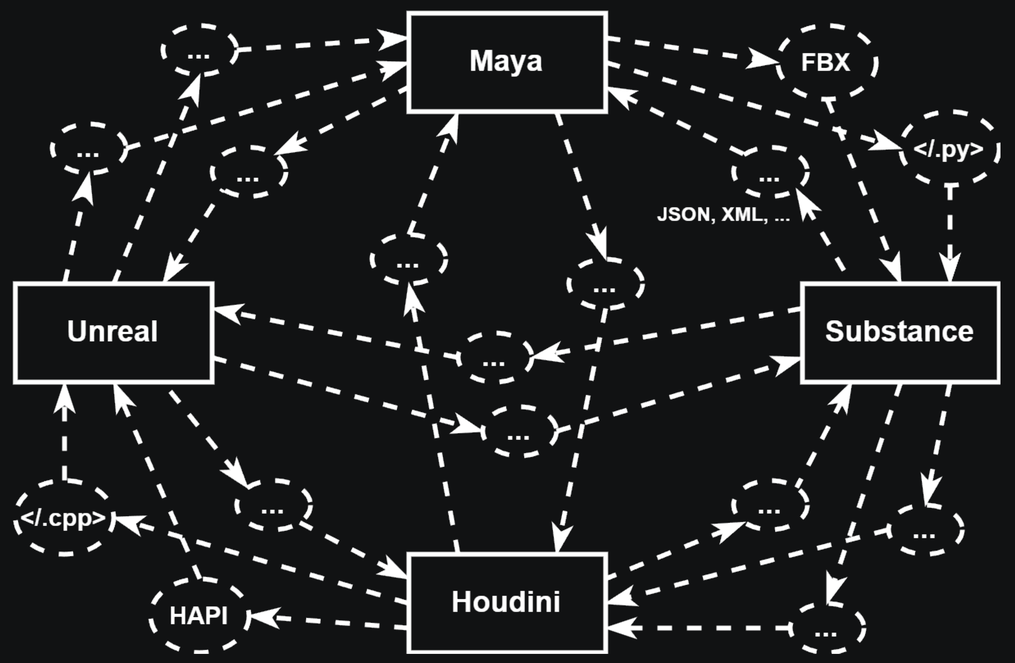
—synchronize multiple DCCs and artists using Omniverse

”

Pipeline of Creating Art Resources

the problems we face

- Inconsistency
- Operational Overhead
- Inability to Scale
- Data Duplication

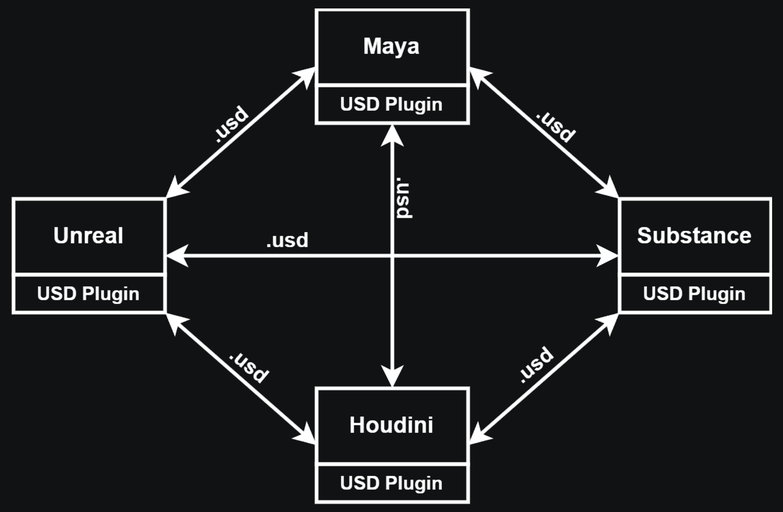


Old-fashioned Pipeline

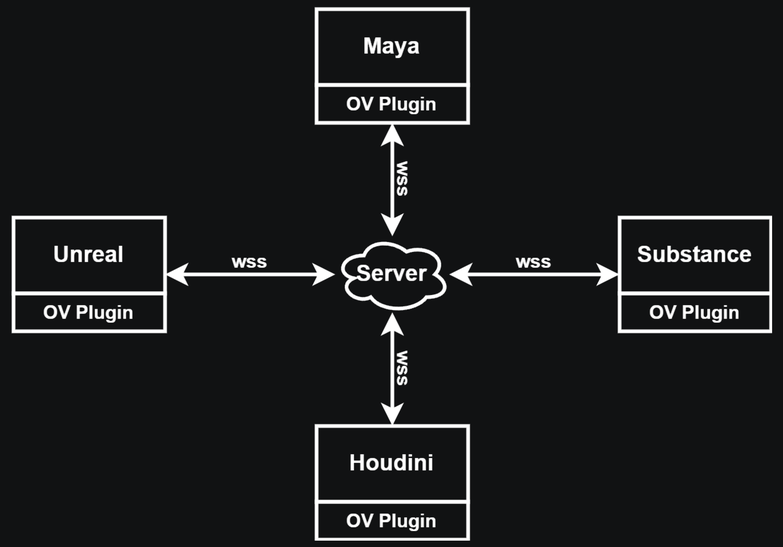
Pipeline of Creating Art Resources

what should the ideal pipeline be like?

- Universality
- Streamlined Experience
- Flexible Scaling
- Incremental Data Update



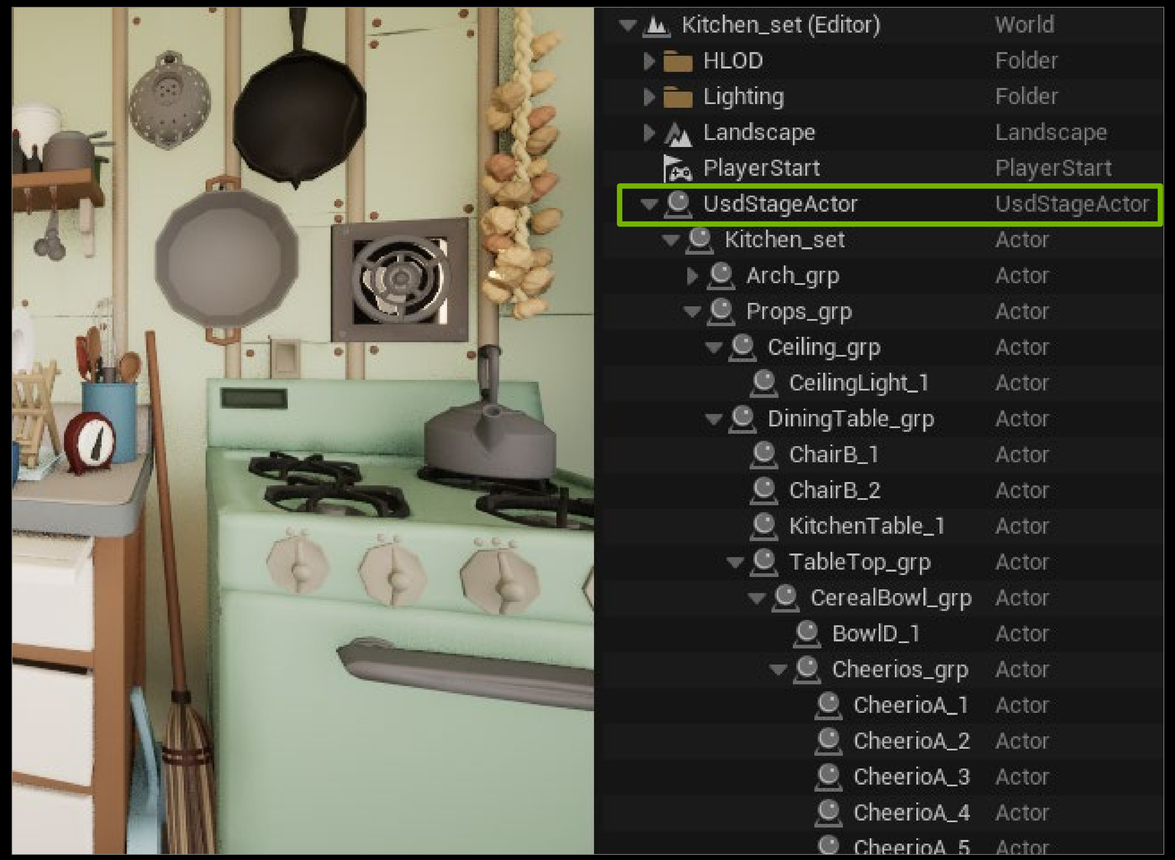
USD Pipeline



Omniverse Pipeline

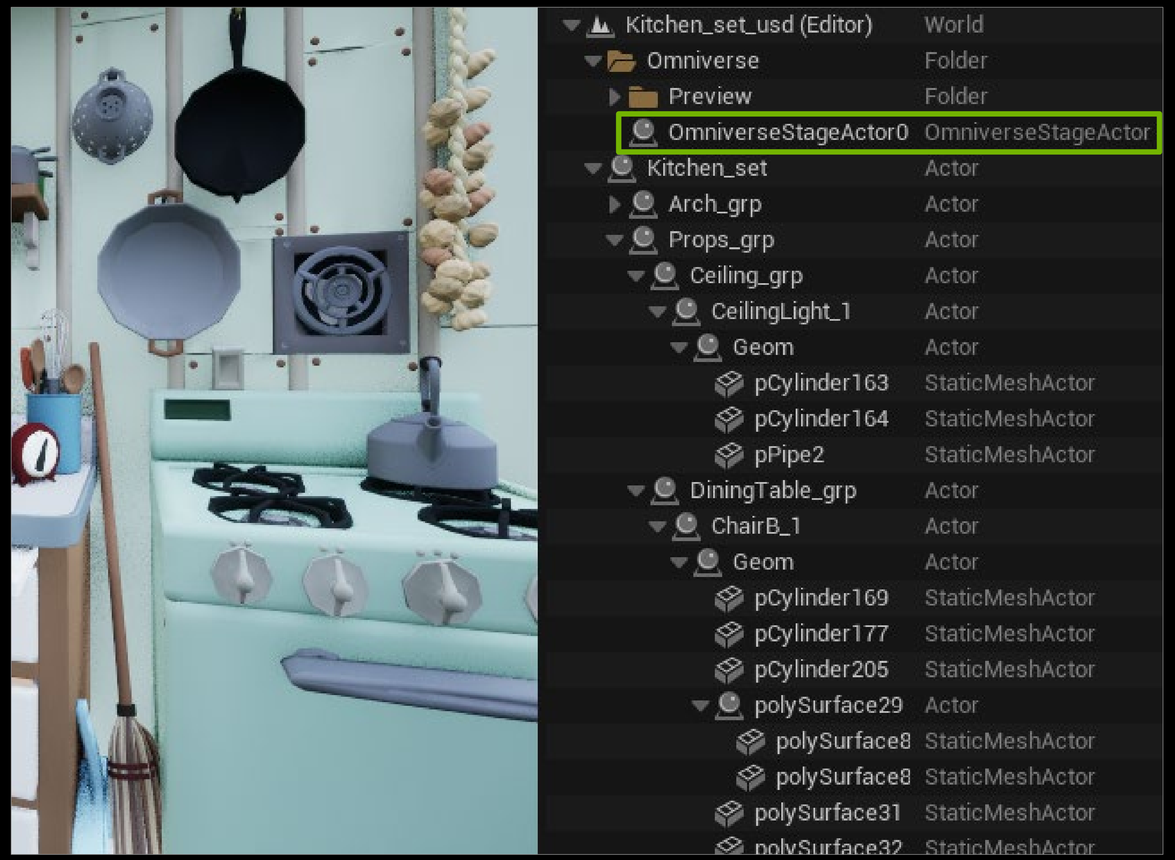
Why not use community solutions?

game pipeline cannot rely on “proxies”



Unreal USD Importer

USD assets must be within the USD Stage Actor

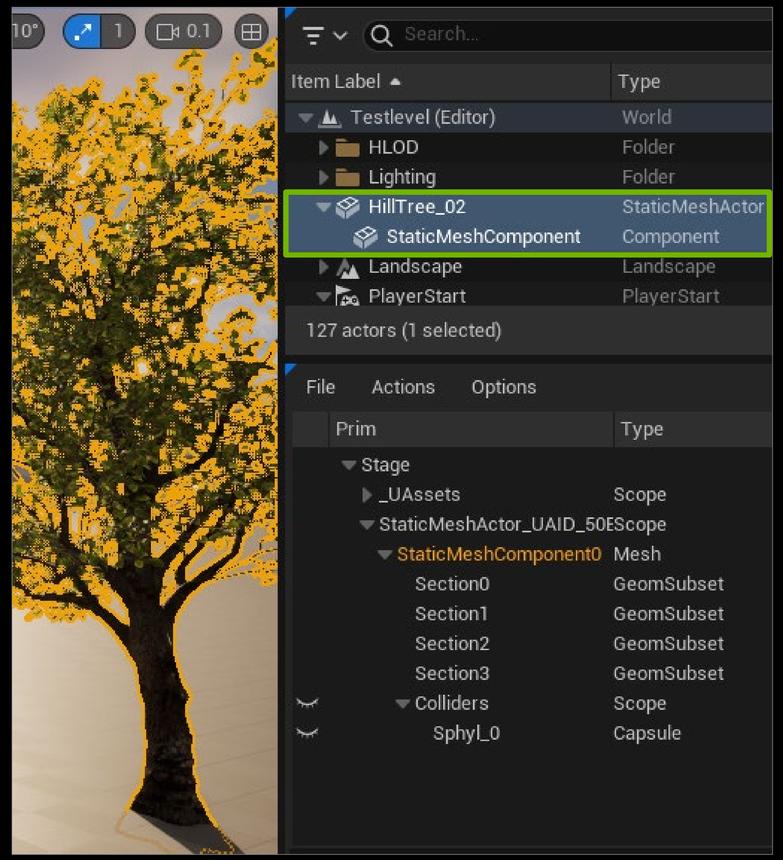


Omniverse Unreal Connector

Level must be exported to Omniverse before using USD

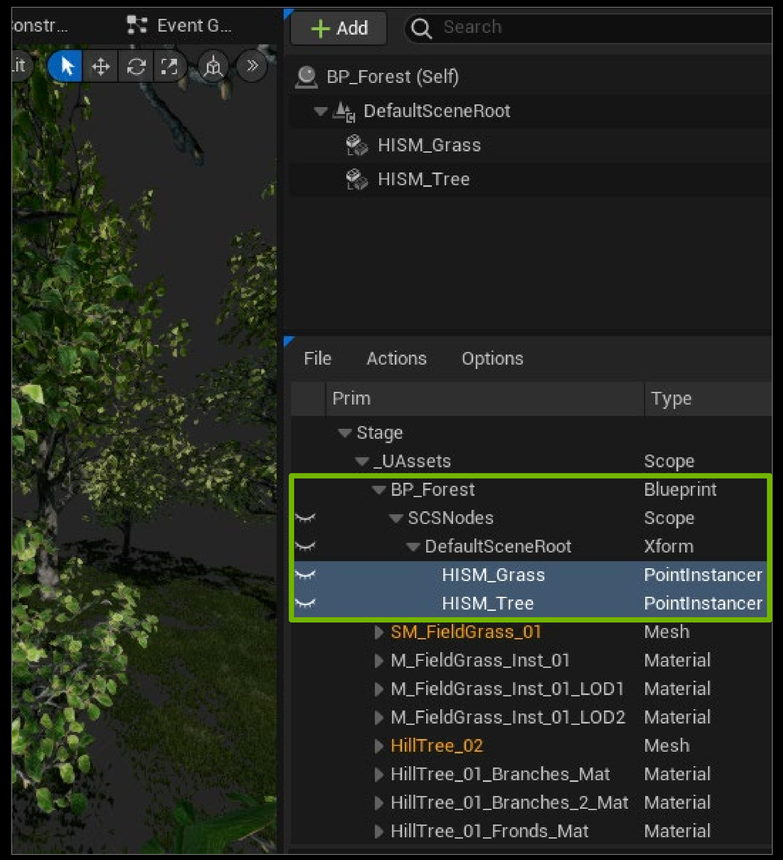
What are the Points of Game Pipeline?

how to convince the game projects?



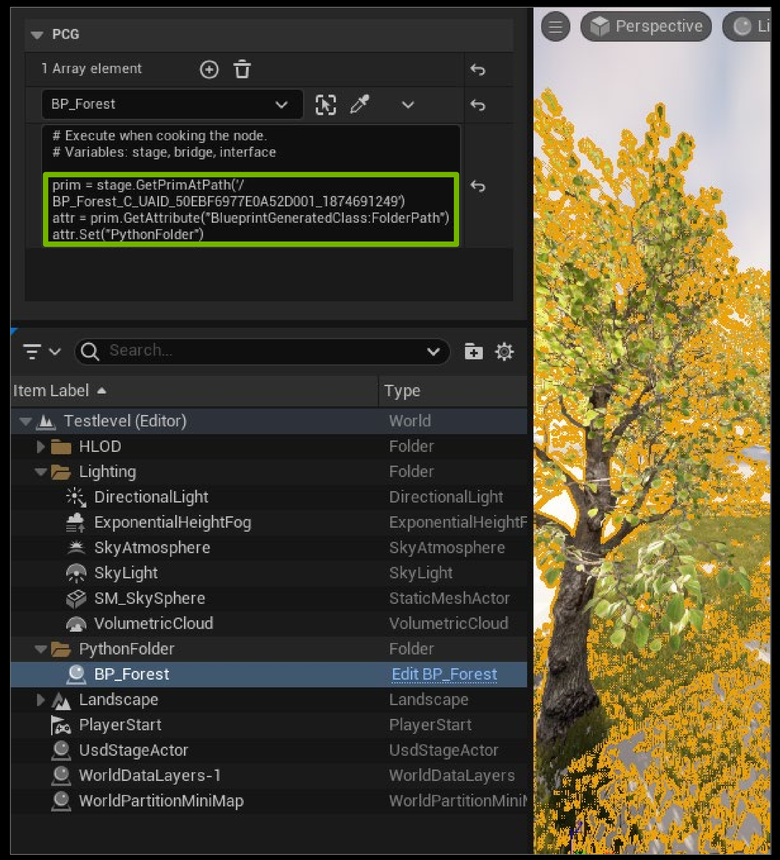
Non-Intrusiveness

USD should not be in the game package



Flexibility

support for USD in the customized game engines



Programmability

allow arbitrary pipelines based on USD

“

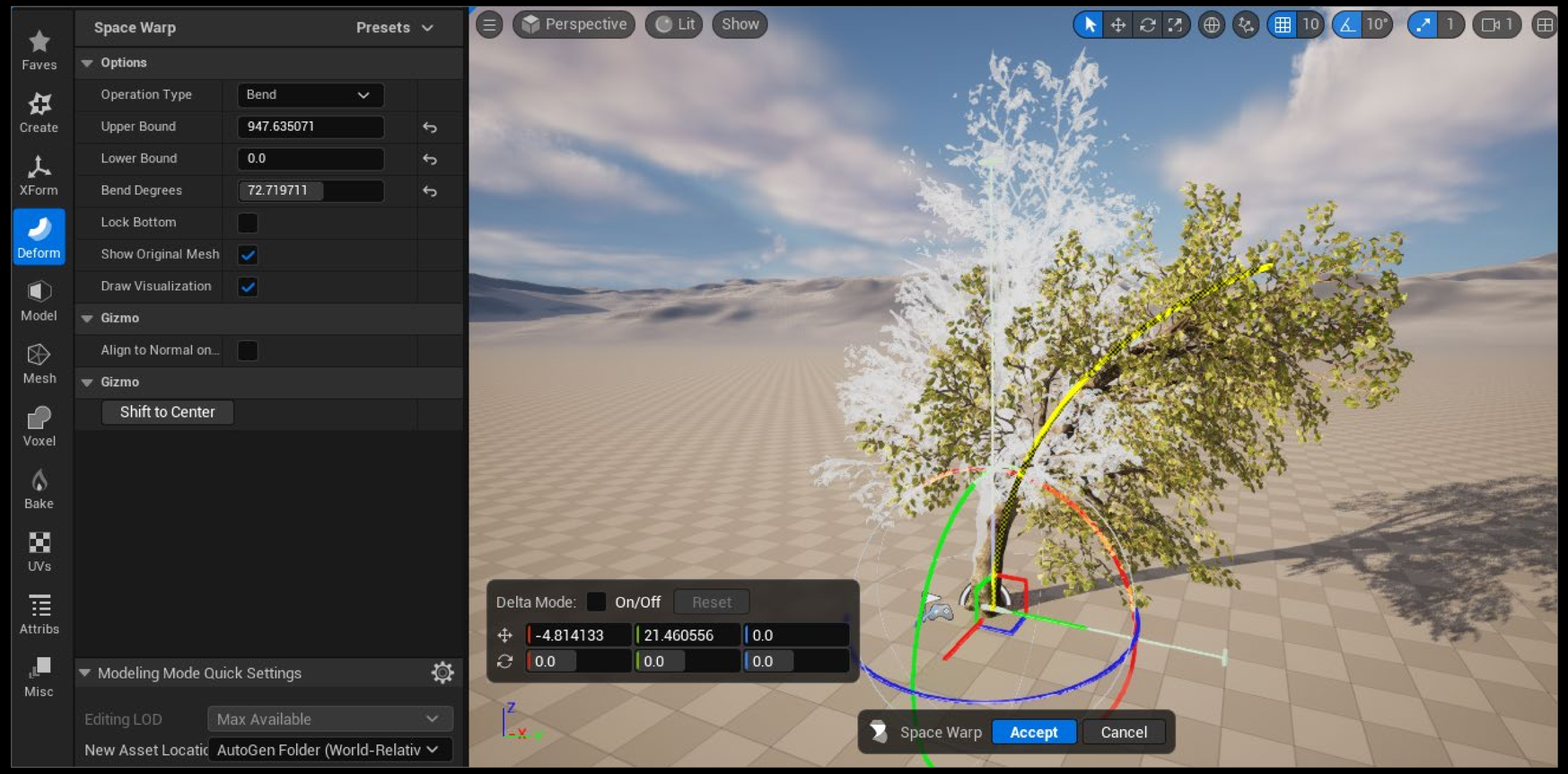
Treat USD as Middleware

—leaving nothing behind in the users' workspace

”

The “Middleware” ?

what does it mean?

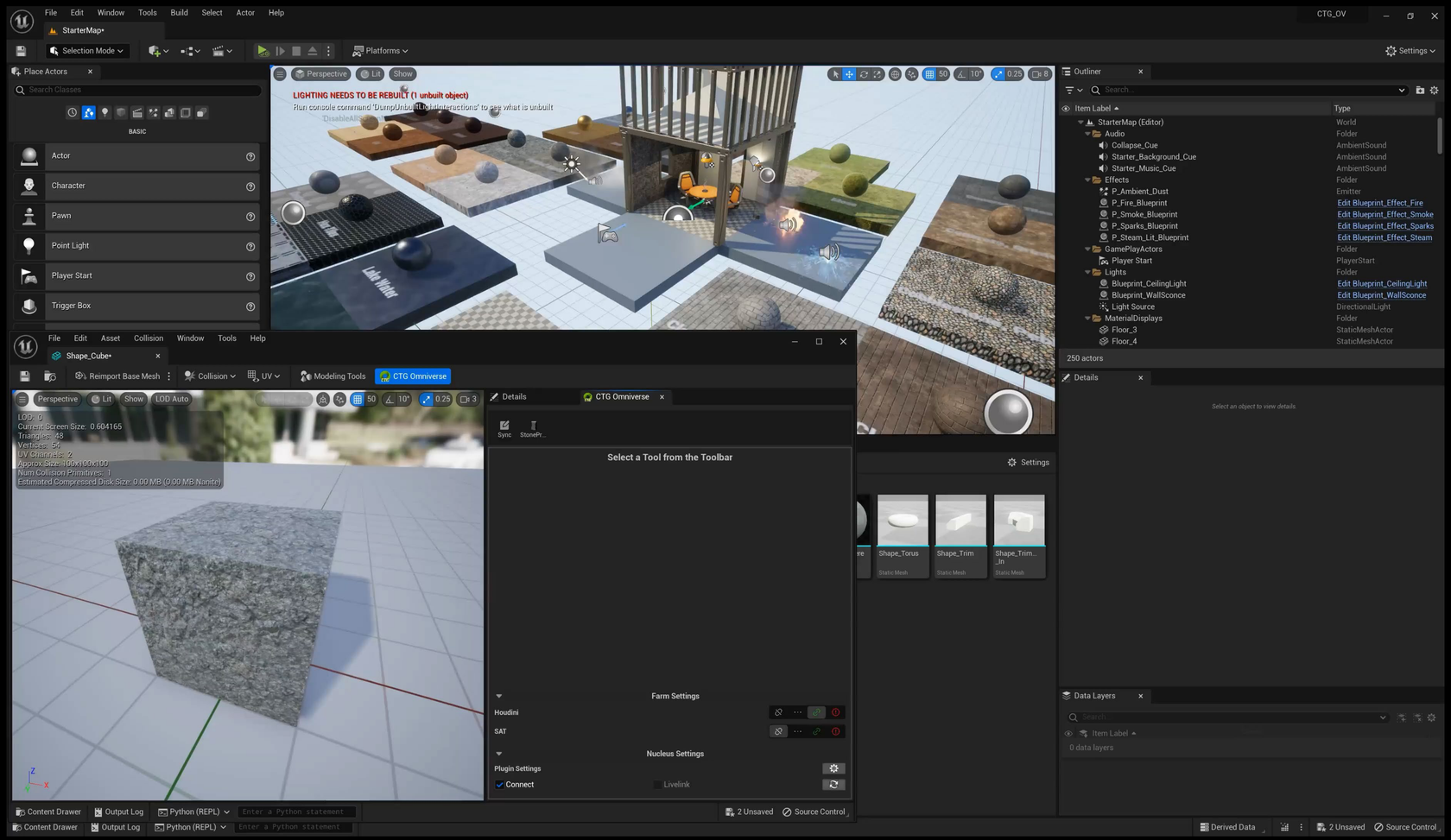


Unreal Modeling Mode

where we started from

The “Middleware” ?

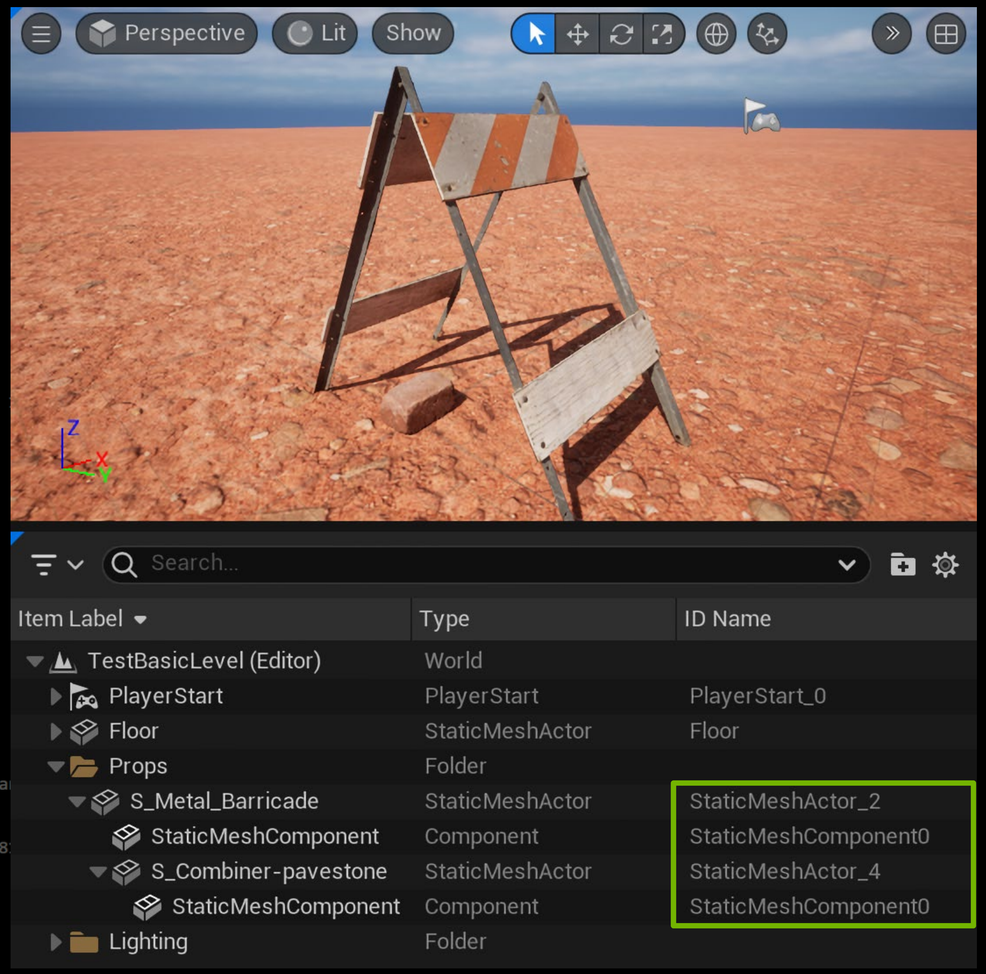
how does it look like?



Object Equivalence

reflect names

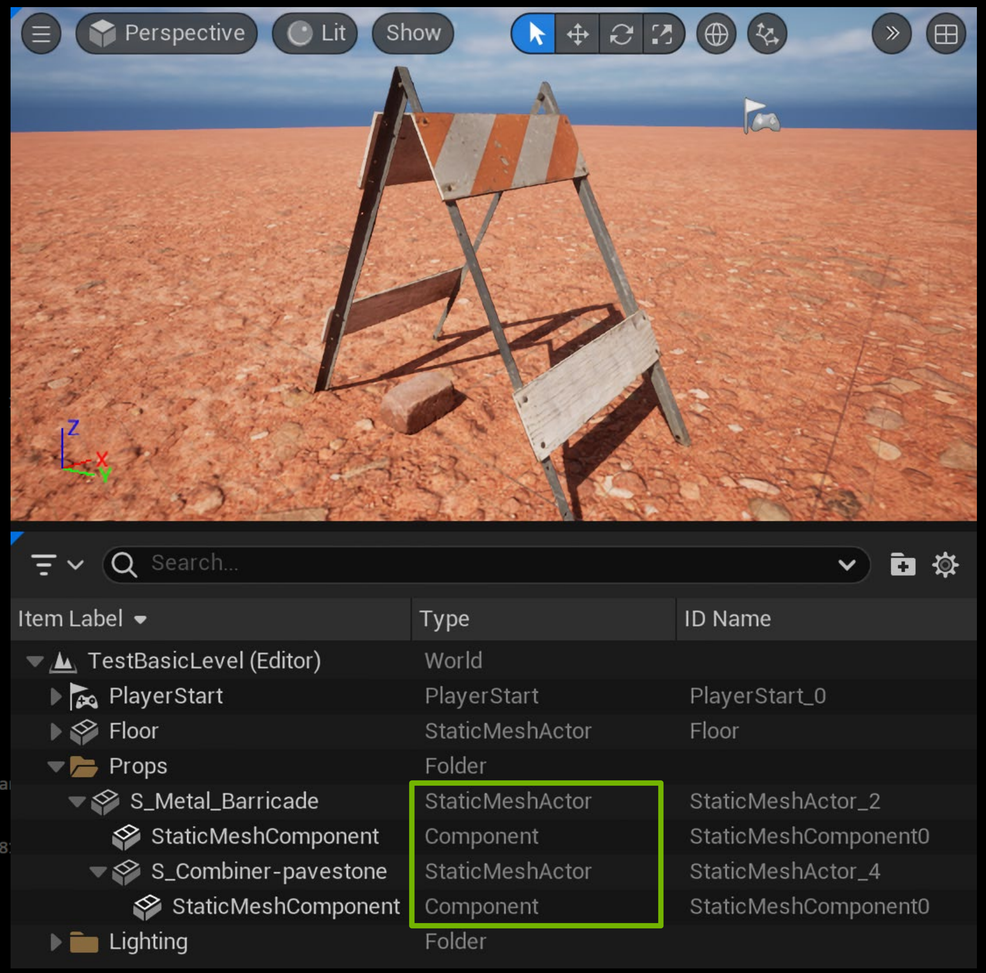
```
def Scope "StaticMeshActor_2" (
    customData = {
        string UClass = "StaticMeshActor"
    }
    kind = "assembly"
)
{
    custom string StaticMeshActor:ActorLabel = "S_Metal_Barricade"
    custom string StaticMeshActor:FolderPath = "Props"

    def "StaticMeshComponent0" (
        customData = {
            string UClass = "StaticMeshComponent"
        }
        kind = "component"
        prepend specializes = </_UAssets/S_Metal_Barricade_vgkxdhk_lod3>
    )
    {
        matrix4d xformOp:transform = ( (1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (-7.825517552048922, -0.005000022249404594,
        uniform token[] xformOpOrder = ["xformOp:transform"]

        def Scope "StaticMeshActor_4" (
            customData = {
                string UClass = "StaticMeshActor"
            }
            kind = "assembly"
        )
        {
            custom string StaticMeshActor:ActorLabel = "S_Combiner-pavestone"
            custom string StaticMeshActor:FolderPath = "Props"

            def "StaticMeshComponent0" (
                customData = {
                    string UClass = "StaticMeshComponent"
                }
                kind = "component"
                prepend specializes = </_UAssets/S_Combiner_char045_pavestone_char045_set_char045_3_char045_red__char045__cha
            )
            {
                matrix4d xformOp:transform = ( (1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (-0.14157702845801054, 3.36840116688
                uniform token[] xformOpOrder = ["xformOp:transform"]
            }
        }
    }
}
```



Object Equivalence

reflect types

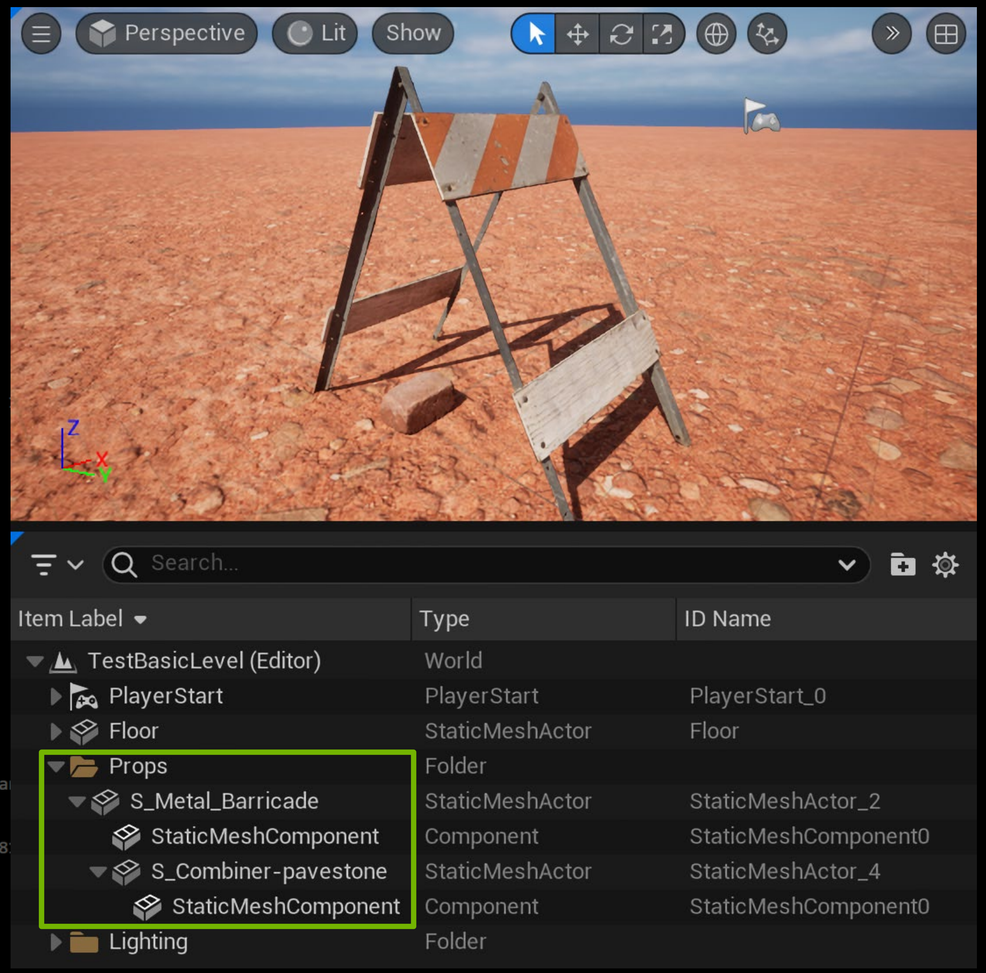
```
def Scope "StaticMeshActor_2" (
    customData = {
        string UClass = "StaticMeshActor"
    }
    kind = "assembly"
)
{
    custom string StaticMeshActor:ActorLabel = "S_Metal_Barricade"
    custom string StaticMeshActor:FolderPath = "Props"

    def "StaticMeshComponent0" (
        customData = {
            string UClass = "StaticMeshComponent"
        }
        kind = "component"
        prepend specializes = </_UAssets/S_Metal_Barricade_vgkxdhk_lod3>
    )
    {
        matrix4d xformOp:transform = ( (1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (-7.825517552048922, -0.005000022249404594,
        uniform token[] xformOpOrder = ["xformOp:transform"]

        def Scope "StaticMeshActor_4" (
            customData = {
                string UClass = "StaticMeshActor"
            }
            kind = "assembly"
        )
        {
            custom string StaticMeshActor:ActorLabel = "S_Combiner-pavestone"
            custom string StaticMeshActor:FolderPath = "Props"

            def "StaticMeshComponent0" (
                customData = {
                    string UClass = "StaticMeshComponent"
                }
                kind = "component"
                prepend specializes = </_UAssets/S_Combiner_char045_pavestone_char045_set_char045_3_char045_red__char045__cha
            )
            {
                matrix4d xformOp:transform = ( (1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (-0.14157702845801054, 3.36840116688
                uniform token[] xformOpOrder = ["xformOp:transform"]
            }
        }
    }
}
```



Object Equivalence

reflect properties

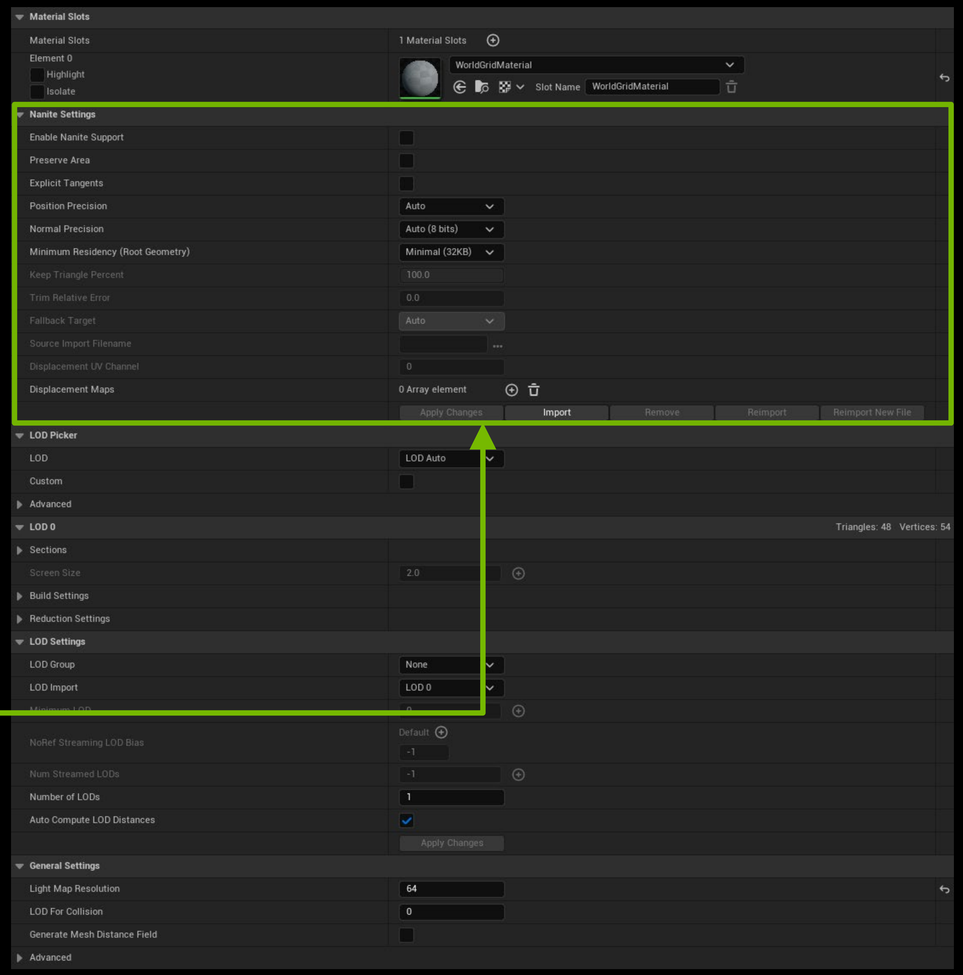
```
def Scope "StaticMeshActor_2" (
    customData = {
        string UClass = "StaticMeshActor"
    }
    kind = "assembly"
)
{
    custom string StaticMeshActor:ActorLabel = "S_Metal_Barricade"
    custom string StaticMeshActor:FolderPath = "Props"

    def "StaticMeshComponent0" (
        customData = {
            string UClass = "StaticMeshComponent"
        }
        kind = "component"
        prepend specializes = </_UAssets/S_Metal_Barricade_vgkxdhk_lod3>
    )
    {
        matrix4d xformOp:transform = ( (1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (-7.825517552048922, -0.005000022249404594,
        uniform token[] xformOpOrder = ["xformOp:transform"]

        def Scope "StaticMeshActor_4" (
            customData = {
                string UClass = "StaticMeshActor"
            }
            kind = "assembly"
        )
        {
            custom string StaticMeshActor:ActorLabel = "S_Combiner-pavestone"
            custom string StaticMeshActor:FolderPath = "Props"

            def "StaticMeshComponent0" (
                customData = {
                    string UClass = "StaticMeshComponent"
                }
                kind = "component"
                prepend specializes = </_UAssets/S_Combiner_char045_pavestone_char045_set_char045_3_char045_red__char045__cha
            )
            {
                matrix4d xformOp:transform = ( (1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (-0.14157702845801054, 3.36840116688
                uniform token[] xformOpOrder = ["xformOp:transform"]
            }
        }
    }
}
```



Property Equivalence

reflect recursively

```
def Mesh "Cube" (
    customData = {
        string PackagePath = "/Engine/BasicShapes/Cube.Cube"
        string UClass = "StaticMesh"
    }
    kind = "model"
    variants = {
        string LOD = "0"
    }
    prepend variantSets = "LOD"
)
{
    custom string StaticMesh:AssetImportData = "FbxStaticMeshImportData'/Engine/BasicShapes/Cube.Cube:FbxStaticMeshImportData_11'"
    custom bool StaticMesh:bAllowCPUAccess = 0
    custom bool StaticMesh:bCustomizedCollision = 1
    custom bool StaticMesh:bGenerateMeshDistanceField = 0
    custom bool StaticMesh:bGlobalForceMipLevelsToBeResident = 0
    custom bool StaticMesh:bHasNavigationData = 1
    custom string StaticMesh:BodySetup = "BodySetup'/Engine/BasicShapes/Cube.Cube:BodySetup_1'"
    custom bool StaticMesh:bSupportGpuUniformlyDistributedSampling = 0
    custom bool StaticMesh:bSupportPhysicalMaterialMasks = 0
    custom bool StaticMesh:bSupportRayTracing = 1
    custom bool StaticMesh:bSupportUniformlyDistributedSampling = 0
    custom float StaticMesh:DistanceFieldSelfShadowBias = 0
    custom int StaticMesh:LightMapCoordinateIndex = 1
    custom int StaticMesh:LightMapResolution = 64
    custom int StaticMesh:LODForCollision = 0
    custom string StaticMesh:LODGroup = "None"
    custom bool StaticMesh:NaniteSettings:bEnabled = 0
    custom bool StaticMesh:NaniteSettings:bExplicitTangents = 0
    custom bool StaticMesh:NaniteSettings:bPreserveArea = 0
    custom int StaticMesh:NaniteSettings:DisplacementUVChannel = 0
    custom float StaticMesh:NaniteSettings:FallbackPercentTriangles = 1
    custom float StaticMesh:NaniteSettings:FallbackRelativeError = 1
    custom string StaticMesh:NaniteSettings:FallbackTarget = "Auto"
    custom float StaticMesh:NaniteSettings:KeepPercentTriangles = 1
    custom int StaticMesh:NaniteSettings:NormalPrecision = -1
    custom int StaticMesh:NaniteSettings:PositionPrecision = -2147483648
    custom int StaticMesh:NaniteSettings:TangentPrecision = -1
    custom uint StaticMesh:NaniteSettings:TargetMinimumResidencyInKB = 0
    custom float StaticMesh:NaniteSettings:TrimRelativeError = 0
    custom string StaticMesh:NavCollision = "NavCollision'/Engine/BasicShapes/Cube.Cube:NavCollision_1'"
    custom vector3d StaticMesh:NegativeBoundsExtension = (0, 0, 0)
    custom bool StaticMesh:NeverStream = 0
    custom int StaticMesh:NumCinematicMipLevels = 0
    custom vector3d StaticMesh:PositiveBoundsExtension = (0, 0, 0)
    custom string StaticMesh:ThumbnailInfo = "SceneThumbnailInfo'/Engine/BasicShapes/Cube.Cube:SceneThumbnailInfo_0'"
```



Object Equivalence

reflect the whole world

/StaticMeshActor_2

←→

/Game/TestBasicLevel.TestBasicLevel:PersistentLevel.StaticMeshActor_2

/StaticMeshActor_2/StaticMeshComponent0

←→

/Game/TestBasicLevel.TestBasicLevel:PersistentLevel.StaticMeshActor_2.StaticMeshComponent0

/StaticMeshActor_2/StaticMeshComponent0/StaticMeshActor_4

←→

/Game/TestBasicLevel.TestBasicLevel:PersistentLevel.StaticMeshActor_4

/StaticMeshActor_2/StaticMeshComponent0/StaticMeshActor_4/StaticMeshComponent0

←→

/Game/TestBasicLevel.TestBasicLevel:PersistentLevel.StaticMeshActor_4.StaticMeshComponent0

USD Statistics

I/O history

Object	Type	USD Root Layer	USD Session Layer	Date Operated	Operation
StaticMeshActor_UAID_7085C2DA46CBE06B01_1889121576	StaticMeshActor	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
StaticMeshActor_UAID_7085C2DA46CBE06B01_1893055577	StaticMeshActor	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
StaticMeshActor_UAID_7085C2DA46CBE06B01_1897325578	StaticMeshActor	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
StaticMeshComponent0	StaticMeshComponent	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
SM_Rock1	StaticMesh	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
MI_Rock1	MaterialInstanceConstant	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
StaticMeshComponent0	StaticMeshComponent	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
SM_Rock2	StaticMesh	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
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StaticMeshComponent0	StaticMeshComponent	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
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MI_Rock3	MaterialInstanceConstant	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E24FA0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.33	Unreal -> USD
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StaticMeshActor_UAID_7085C2DA46CB976B01_2139876729	StaticMeshActor	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
StaticMeshActor_UAID_7085C2DA46CB976B01_2133271727	StaticMeshActor	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
StaticMeshComponent0	StaticMeshComponent	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
HillTree_02	StaticMesh	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
HillTree_01_Branches_Mat	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
HillTree_01_Branches_2_Mat	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
HillTree_01_Fronds_Mat	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
HillTree_01_Leaves_Mat	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
StaticMeshComponent0	StaticMeshComponent	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
HillTree_Tall_02	StaticMesh	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
HillTree_01_Leaves_Mat2	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
StaticMeshComponent0	StaticMeshComponent	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
ScotsPineTall_01	StaticMesh	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
ScotsPine_01_Branches_Mat	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
ScotsPine_01_Branches_2_Mat	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
ScotsPine_01_Leaves_Mat	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
ScotsPine_01_Fronds_Mat	Material	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FEE7E293B0:Flow_GDCDemo_02-session.usda	2024.01.21-06.34.35	Unreal -> USD
FlowSplineActor_UAID_7085C2DA46CBB1B101_1831912225	FlowSplineActor	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
FlowSplineComponent_0	FlowSplineComponent	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_0_0_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_0_1_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_0_2_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
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LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_1_0_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
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LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_1_2_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_1_3_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
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LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_2_2_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_2_3_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_3_0_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal
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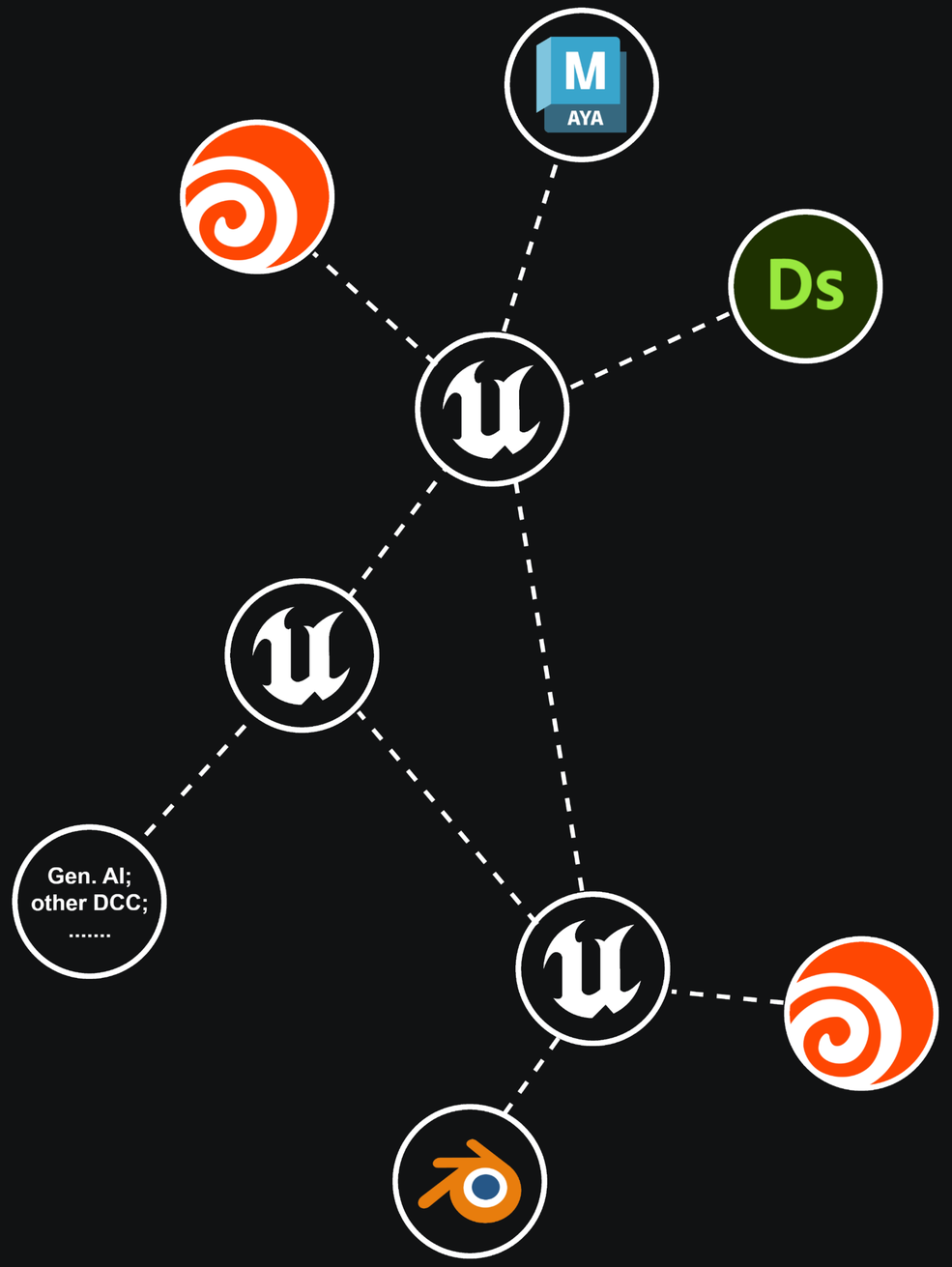
LandscapeStreamingProxy_AUTLO55F1W71HXGJY6NBUFINC_126_3_2_0	LandscapeStreamingProxy	omniverse://ov.woa.com/Projects/%20/Users/calvingu/Flow_GDCDemo_02/Flow_GDCDemo_02.usd	anon:000001FF938739C0:Flow_GDCDemo_02-session.usda	2024.01.21-06.35.23	USD -> Unreal

Goal of our Pipeline

make games as if in the metaverse

- Unreal-centric
- Highly Efficient Procedural Content Generation
- DCC as a Service
- Realtime Collaboration



USD Schemas for Games

—what we have proposed and developed

USD Schemas for Games

what is USD missing

Xform	Distant Lt.	Audio	Shader	Skeleton	Volume	Collision	Foliage
Mesh	Disk Lt.	Preview	Material	Animation	Field 3D	Rigid Body	Landscape
Curves	Sphere Lt.	.....	Node Graph	Binding	OpenVDB	.....	Decal
Points	Cylinder Lt.		.....	Blend Shape	.....		Blueprint
Instancer	Dome Lt.			.....			Data Table
Camera	Portal Lt.						.....
.....	.....						
Geometry	Lighting	Media	Shade	Skeleton	Volume	Physics	Execution

Film | Game

USD

USD Schemas for Games

our implementation

- Foliage Schema:
  - Foliage Instances
  - Foliage Types
- Decal Schema:
  - Decal Transform
  - Decal Material
- Landscape Schema:
  - Edit Layers
  - Weight Maps
  - World Partition
  - .....
- Static Mesh Schema:
  - Level of Details
  - Colliders
- Data Table Schema:
  - Row Struct
  - JSON String
- Blueprint Schema:
  - Blueprint Variables
  - Sub Objects
  - .....

- We are collaborating with Epic to improve support for USD features for games!

Foliage

Landscape

Decal

Blueprint

Data Table

.....

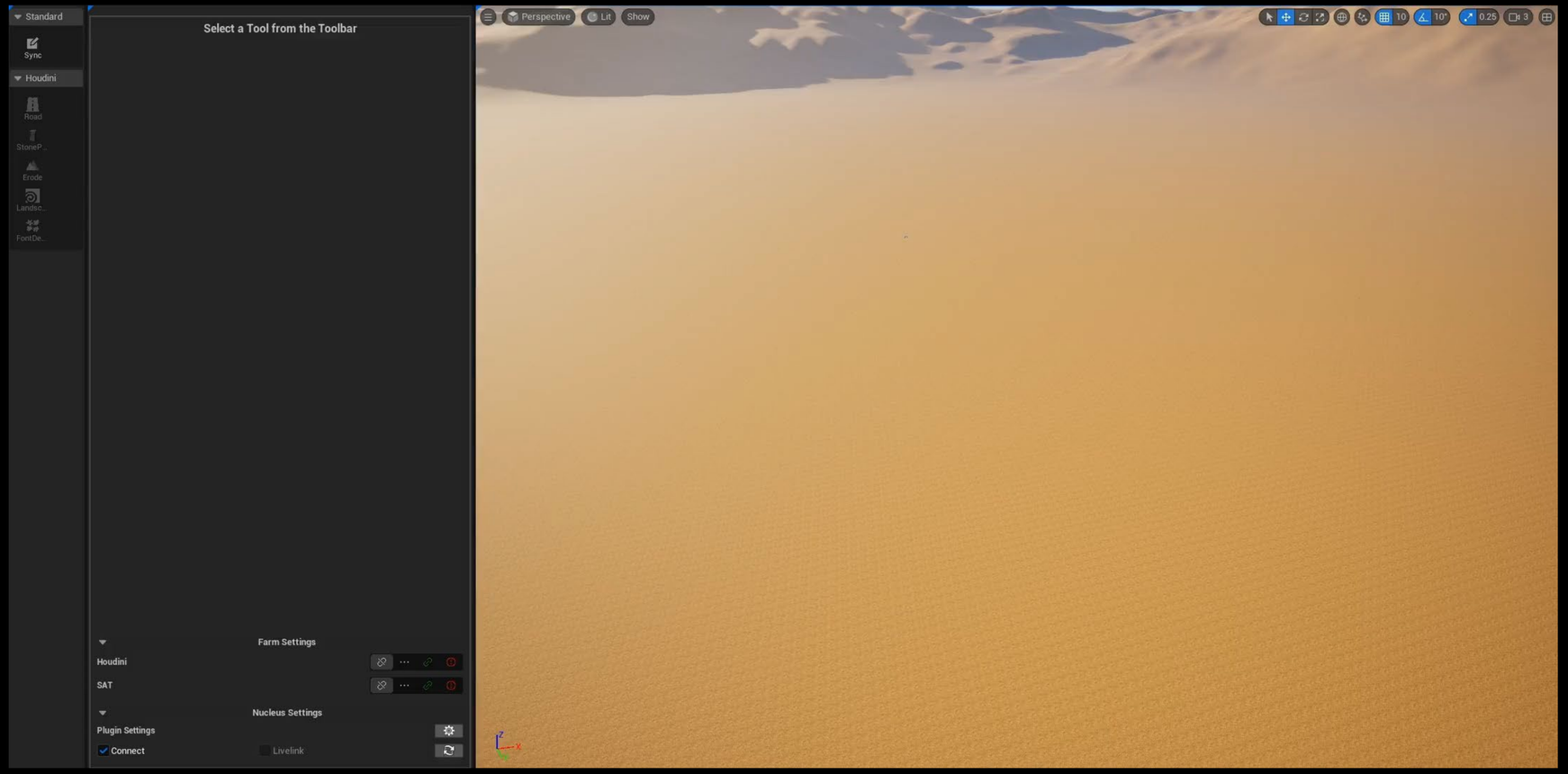
Execution

Game

USD

USD Schemas for Games

sync game assets with USD



Foliage Types from USD

reaction with Foliage EditMode

USD Schemas for Games

sync game assets with USD

Decals from Fonts

generated by Houdini

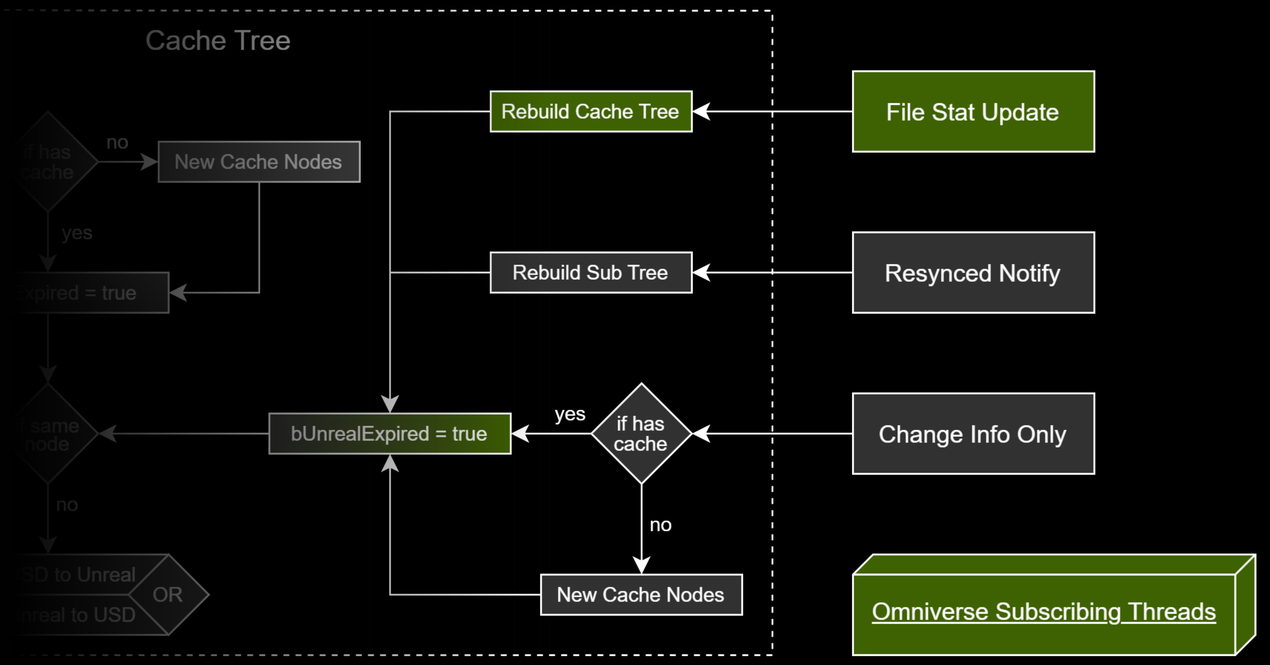
Incremental Computing via Omniverse

—what does Omniverse do on top of USD?

Incremental Computing

import USD files

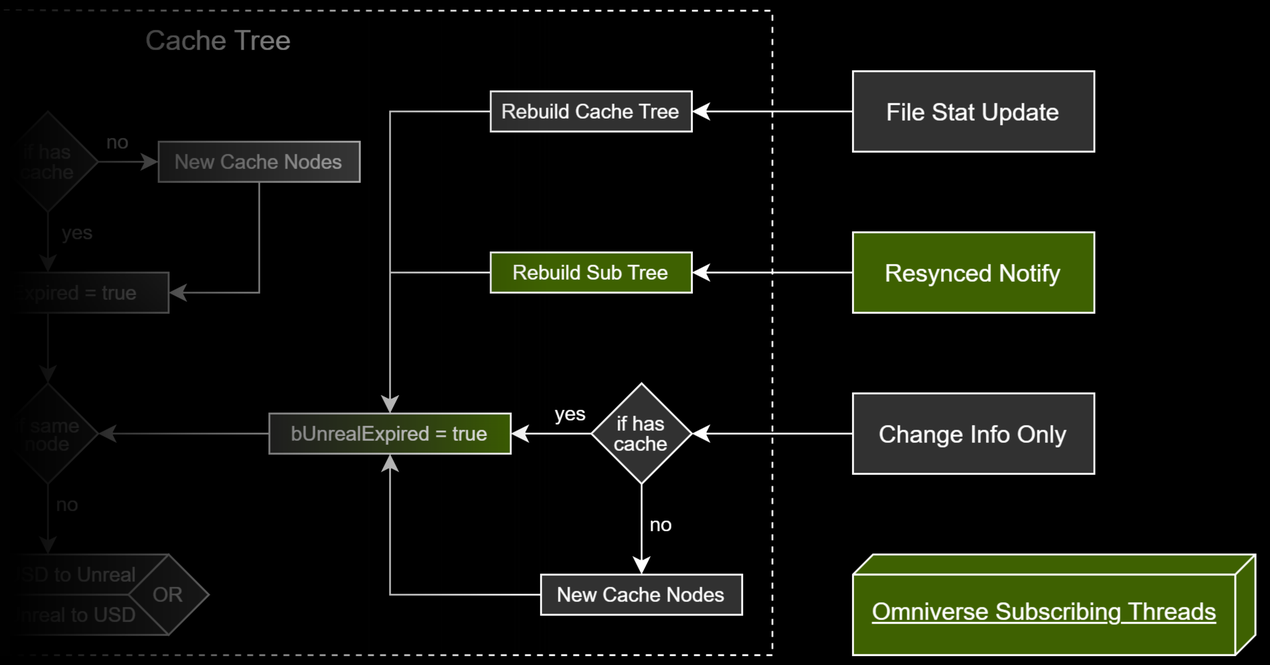
- Rebuild the cache from USD
- Mark all nodes as pending converts to Unreal



Incremental Computing

import USD primitives

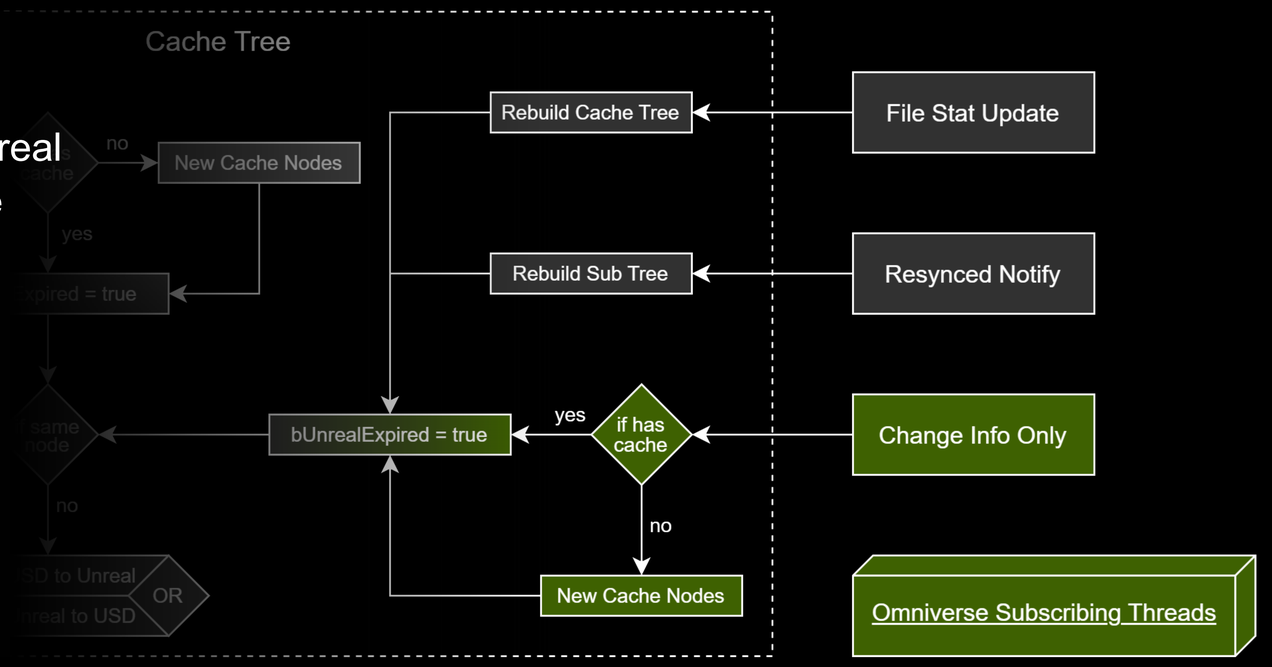
- Rebuild the given nodes and their children
- Mark new nodes as pending converts to Unreal



Incremental Computing

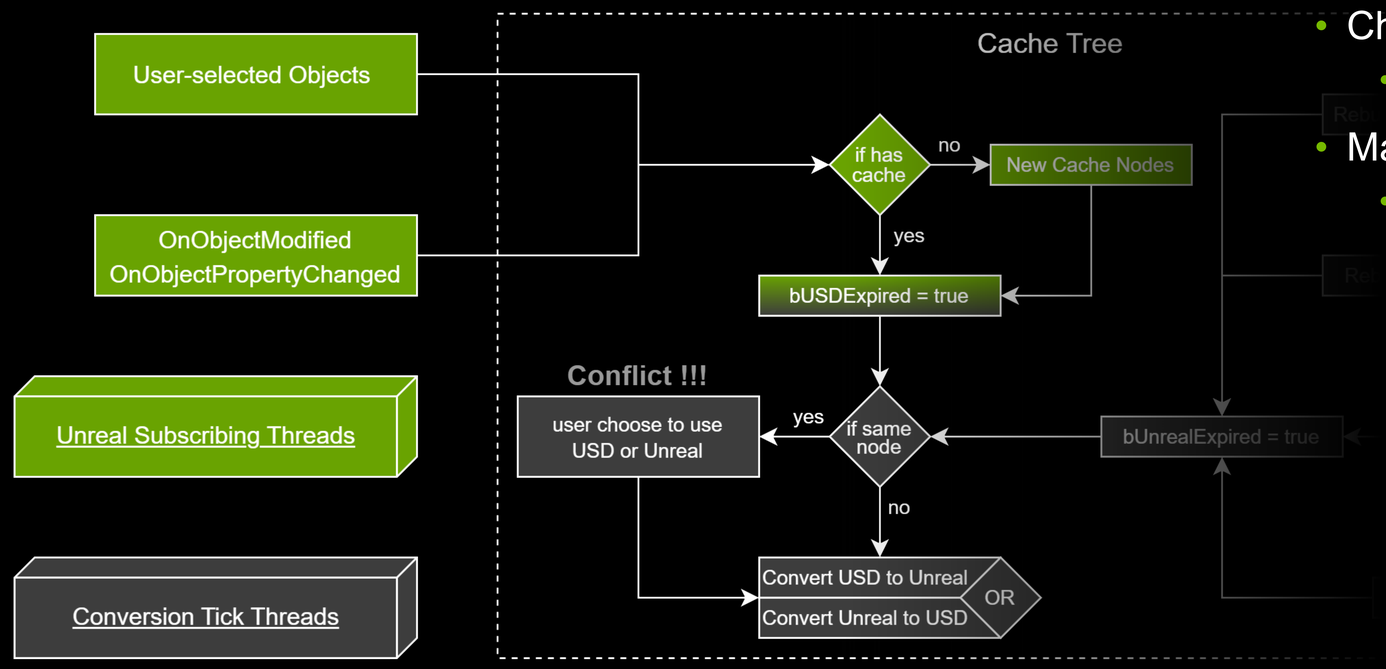
import USD attributes

- Check if the given nodes are already cached
  - Build the nodes' cache if they do not exist
- Mark the given nodes as pending converts to Unreal
  - Record the list of updated attributes for future use



Incremental Computing

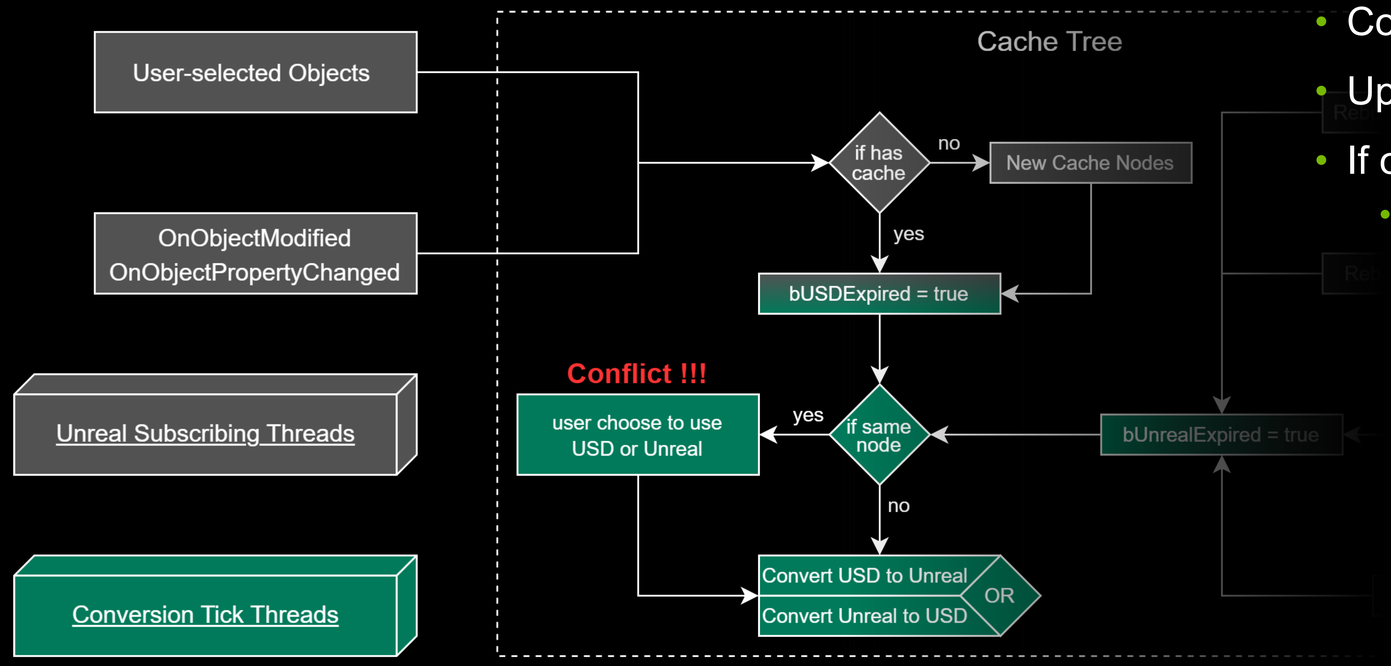
export Unreal objects



- Check if the given nodes are already cached
  - Build the nodes' cache if they do not exist
- Mark the given nodes as pending converts to USD
  - Record the list of updated attributes for future use

Incremental Computing

merge conflicts



- Conversion is handled in the tick threads
- Updates of different nodes can be auto -merged
- If one node has been updated from both sides
  - User will decide which version to use

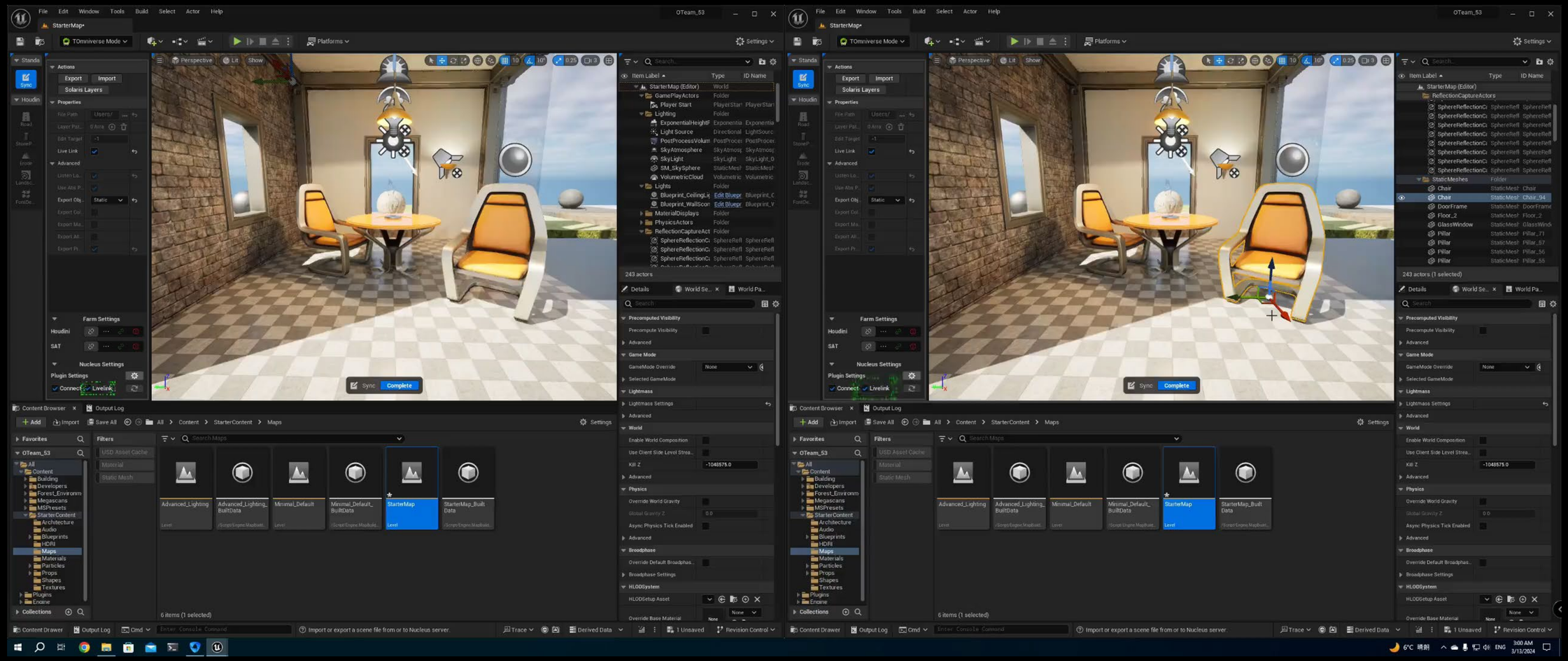
```
// If the input properties are only transform properties, the caller explicitly
// asks to ONLY update transform, which should be processed in pre/post factories.
// So there is nothing to do here.
if (PropNames.IsEmpty()) { bUpdate = true; }
else
{
    for (const FString& PropName : PropNames)
    {
        if (!PropName.StartsWith(TEXT("xformOp")))
        {
            bUpdate = true;
            break;
        }
    }
}
```

NOTE

use the list of updated attributes to convert objects partially

Incremental Computing

multi -user synchronization



Compose USD Layers in the Node Graph

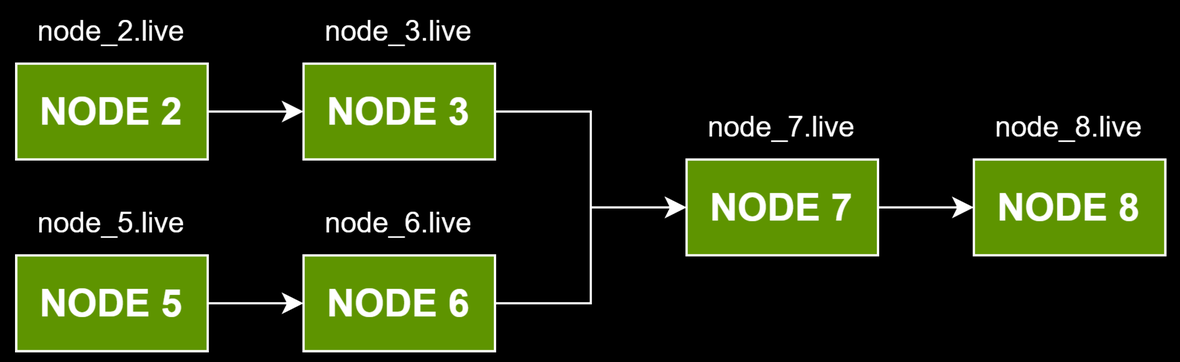
—putting everything together procedurally

USD Node Graph

one layer per node

graph.usd

```
#usda 1.0
(
    metersPerUnit = 1
    upAxis = "Y"
)
```

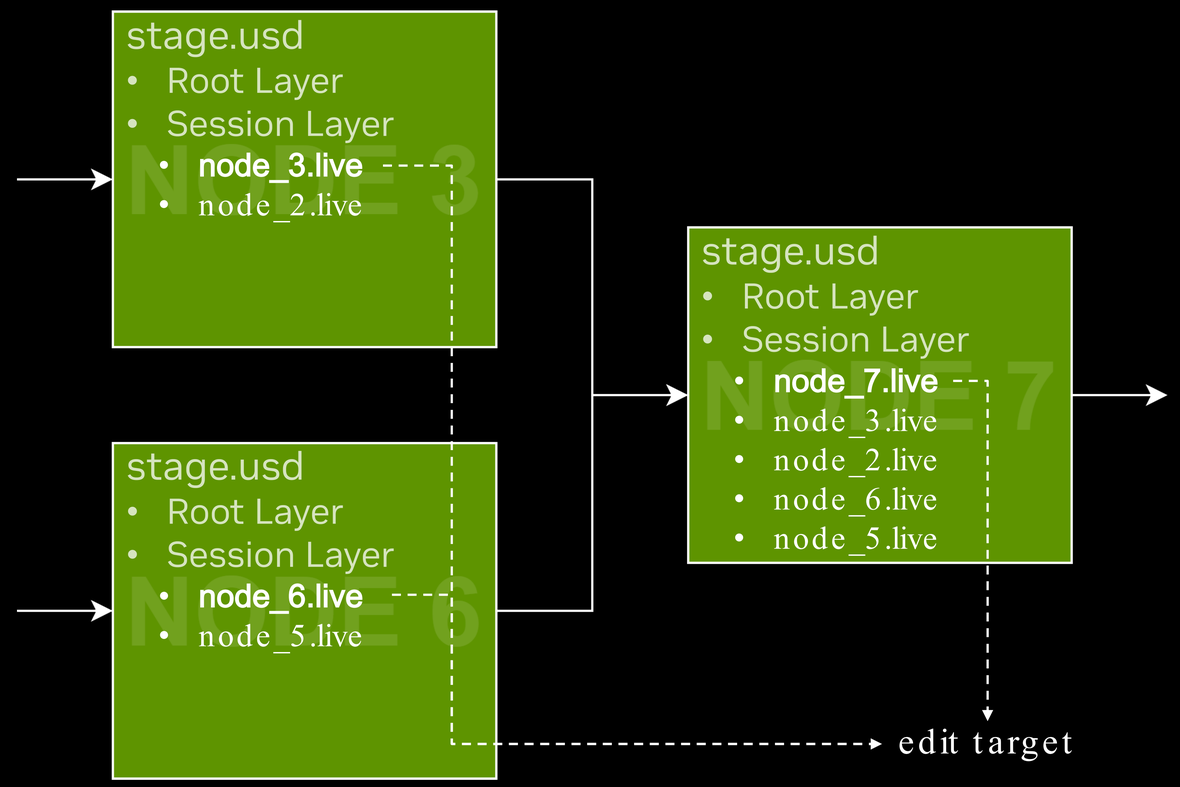


".live" refers to Live Layer Wire Format

- Each graph holds an unique stage
- Metrics are recorded in the stage's root layer
- Each node records the modifications in its target layer

USD Node Graph

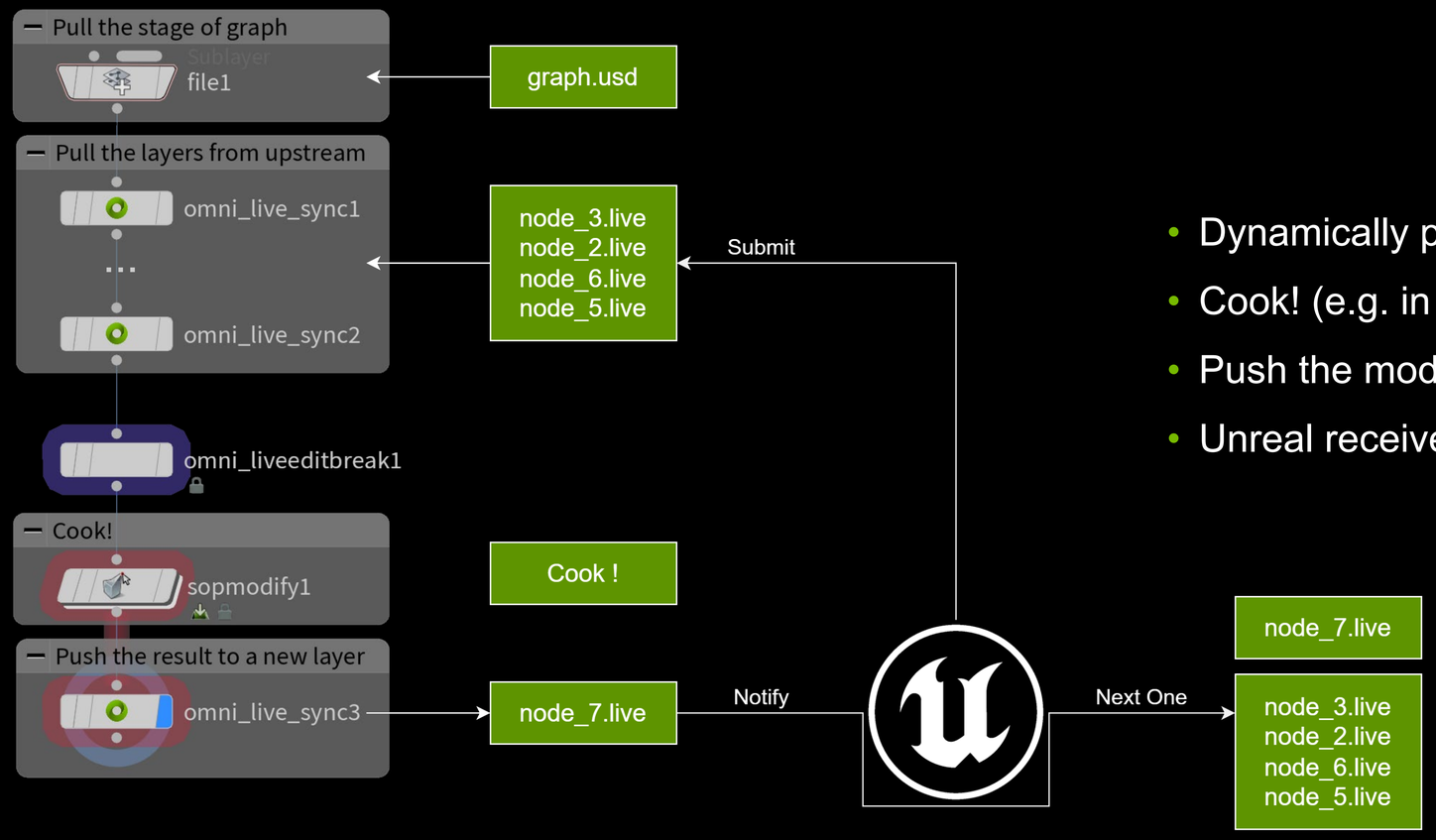
layer composition



- Each session layer maintains a stack of layers of nodes
- The target layer is always on the top of the stack

USD Node Graph

software as a service

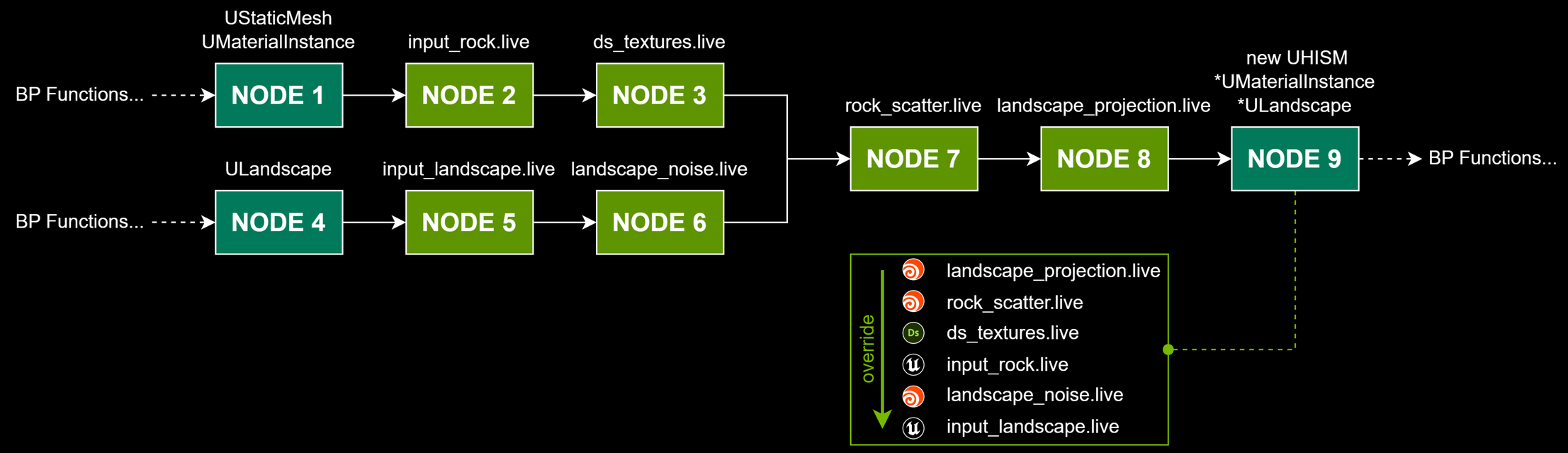


- Dynamically pulls the input layers
- Cook! (e.g. in Houdini running on the server)
- Push the modifications to the target layer
- Unreal receives the notification and cooks the next one

USD Node Graph

interact with Unreal

- Collect all the modifications, our graph imports all at once. Generate new UObjects and modifies the existing ones.
- The stage can be seamlessly converted back and forth with UObjects, meaning users can even use BP in the graph.



Haoran Wei

Game Development Engineer from Tencent

Offline PCG

for massive landscape shaping, 3D contents generation and asset placement

Features

Landscape

- Procedural Noise
- Stamp and Sculpt

Geometry

- Building and Street
- River and Lake

Placement

- Massive Foliage
- Natural and Urban Scenery

Local Section

sculpt landscape manually or procedurally by CUDA kernel

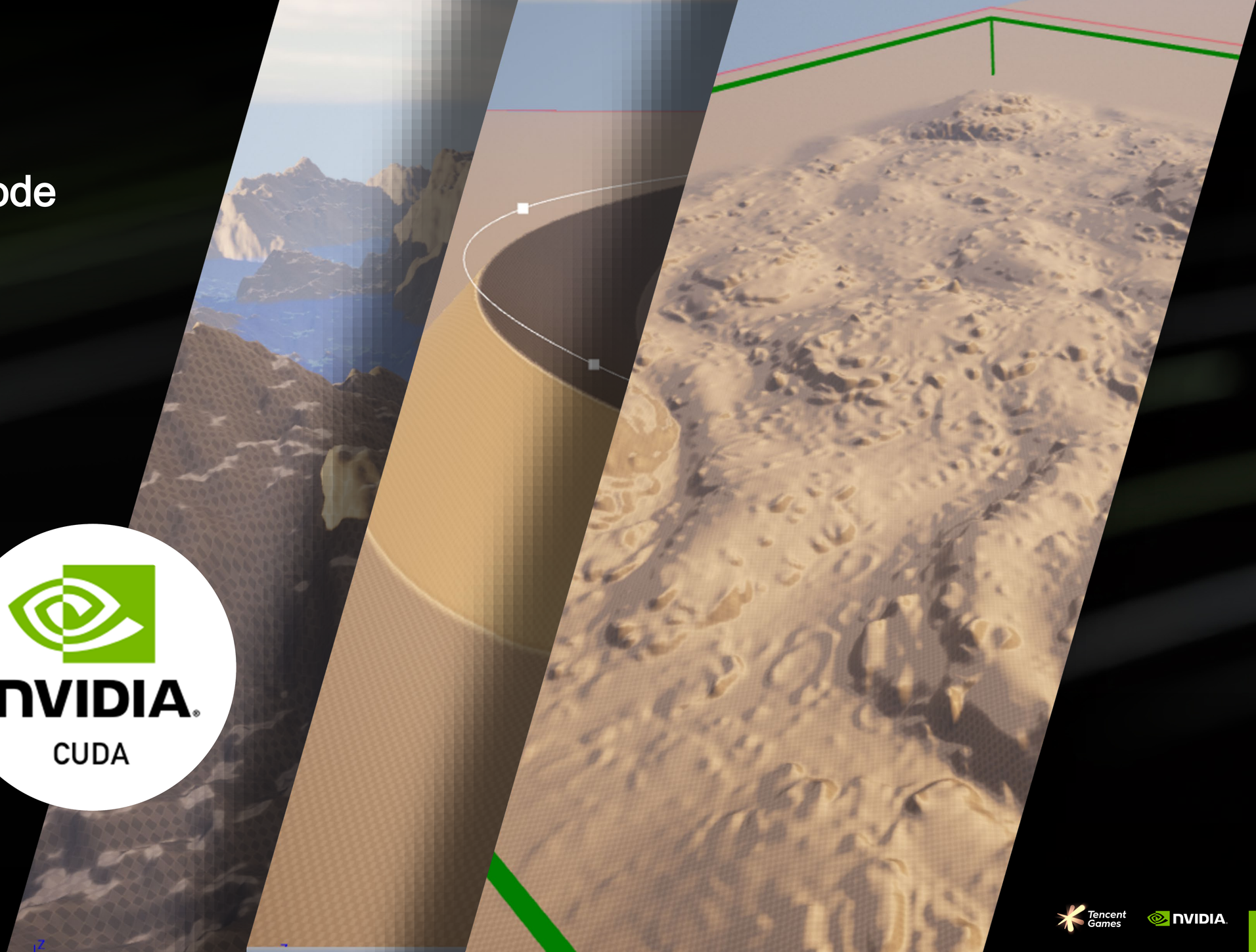
Cloud Section

produce contents in Houdini on the server, Omniverse responses for dispatch and storage

Local Compute Node

- Procedural Noise
- SDF Sculpt
- Terrain Stamp
- Foliage and Biome

…



NVIDIA CUDA

Why adopt
USD Workflow

bridge Unreal and Houdini through Omniverse

- HDA reuse and migration
- Avoid reinventing the wheel
- Lightweight real -time update
- Friendly for sharing

3D Content Generation

asynchronous asset cooking

Unreal Engine

- Node Graph

3D Content Generation

asynchronous asset cooking

Unreal Engine

Omniverse

- Queue & Database

3D Content Generation

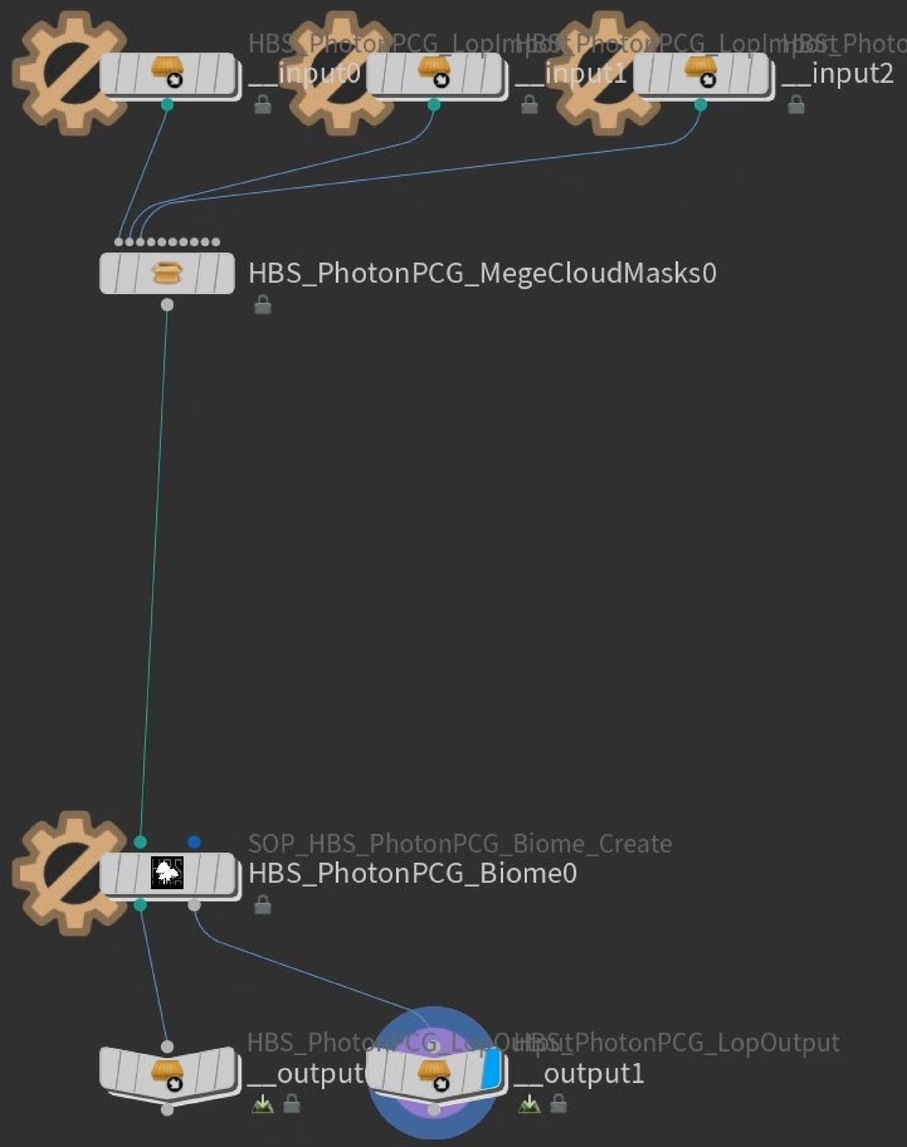
asynchronous asset cooking

Unreal Engine

Omniverse

Houdini

- HDA Node Graph



3D Content Generation

asynchronous asset cooking

Unreal Engine

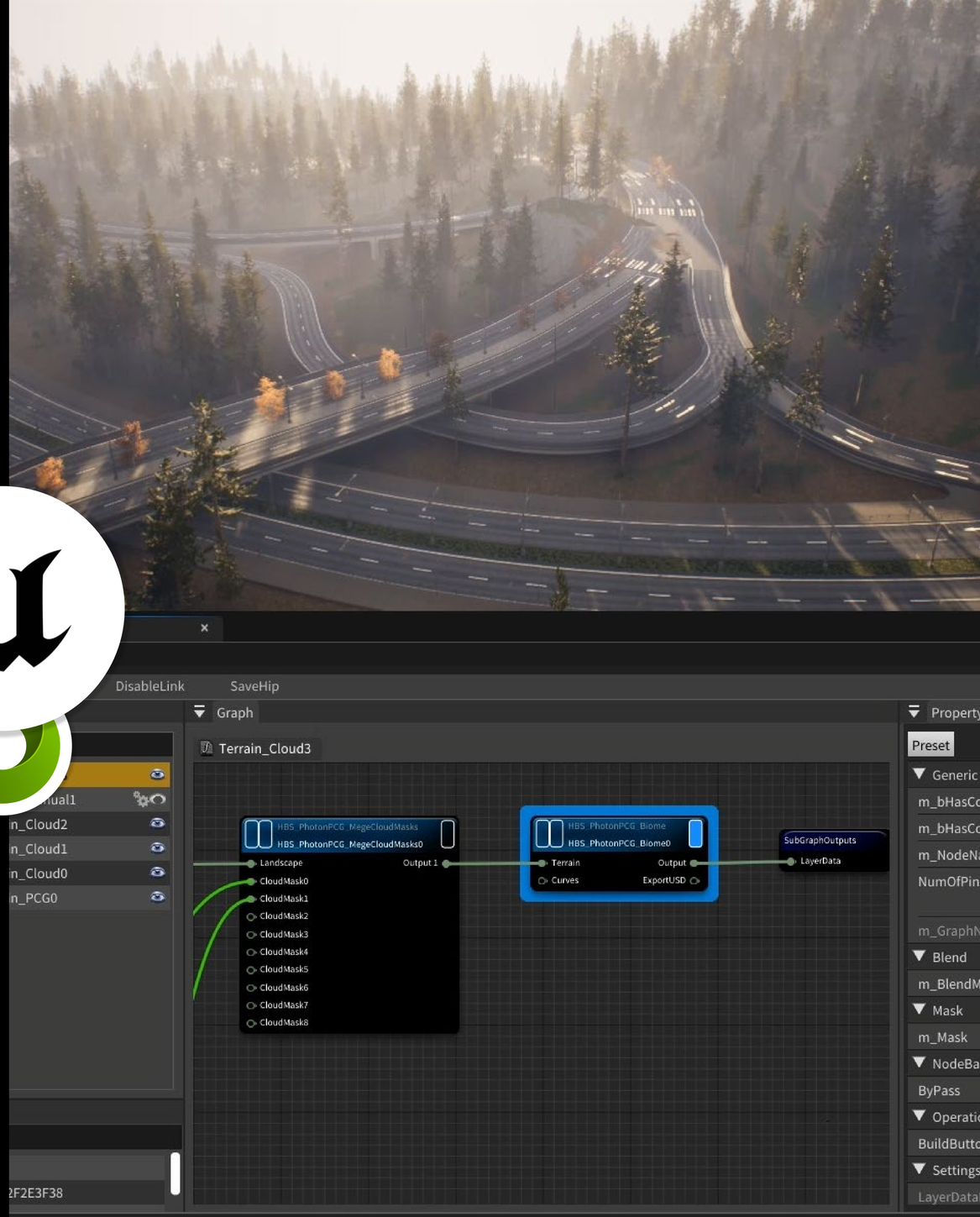
Omniverse

Houdini

Omniverse

Unreal Engine

- Spawn or Update Asset

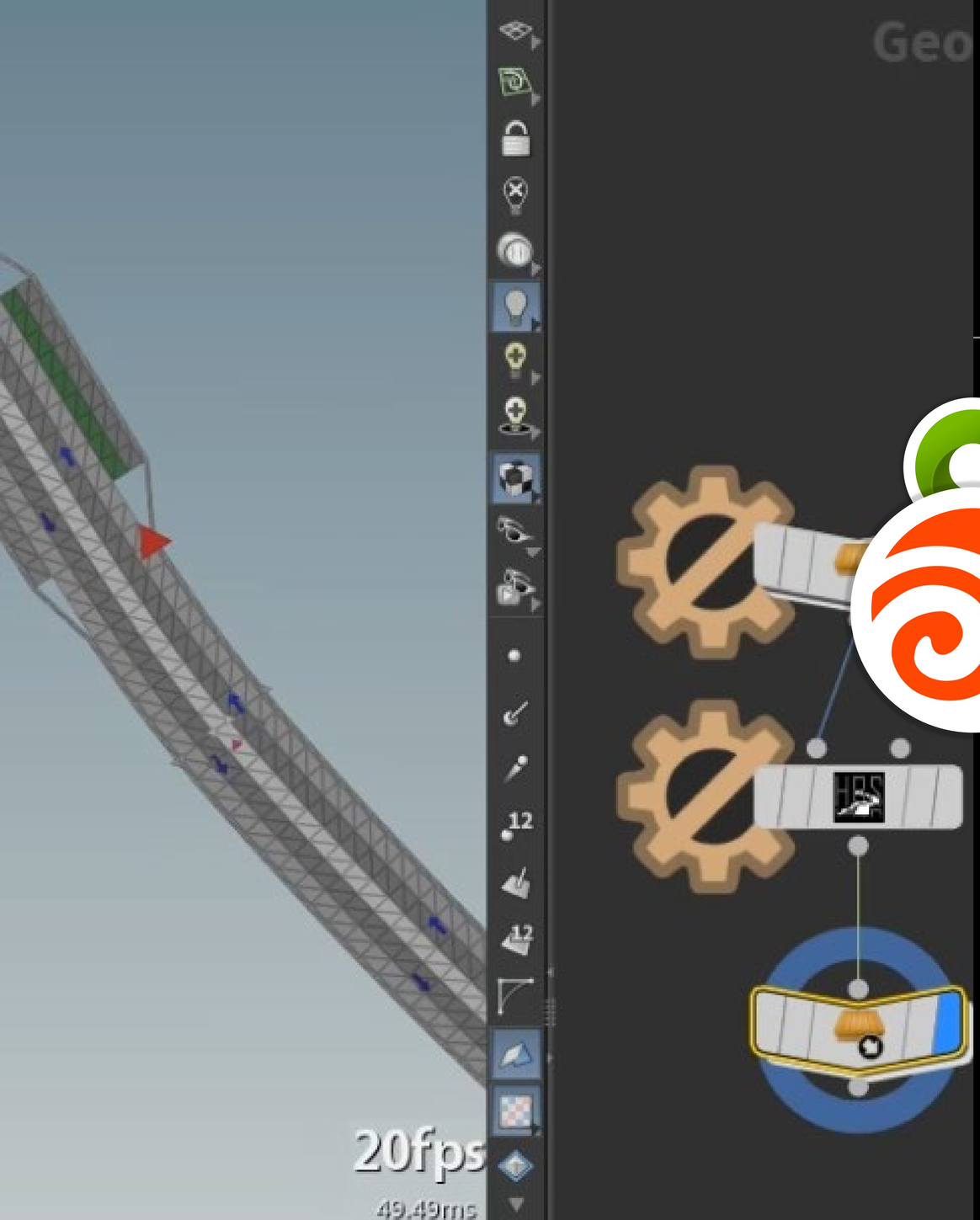


Edit Mesh & Edit Curve

real-time editing and updating

Unreal Engine

- Draw Edit Curve



Edit Mesh & Edit Curve

real-time editing and updating

Unreal Engine

Omniverse

Houdini

- HDA Node

Edit Mesh & Edit Curve

real-time editing and updating

Unreal Engine

Omniverse

Houdini

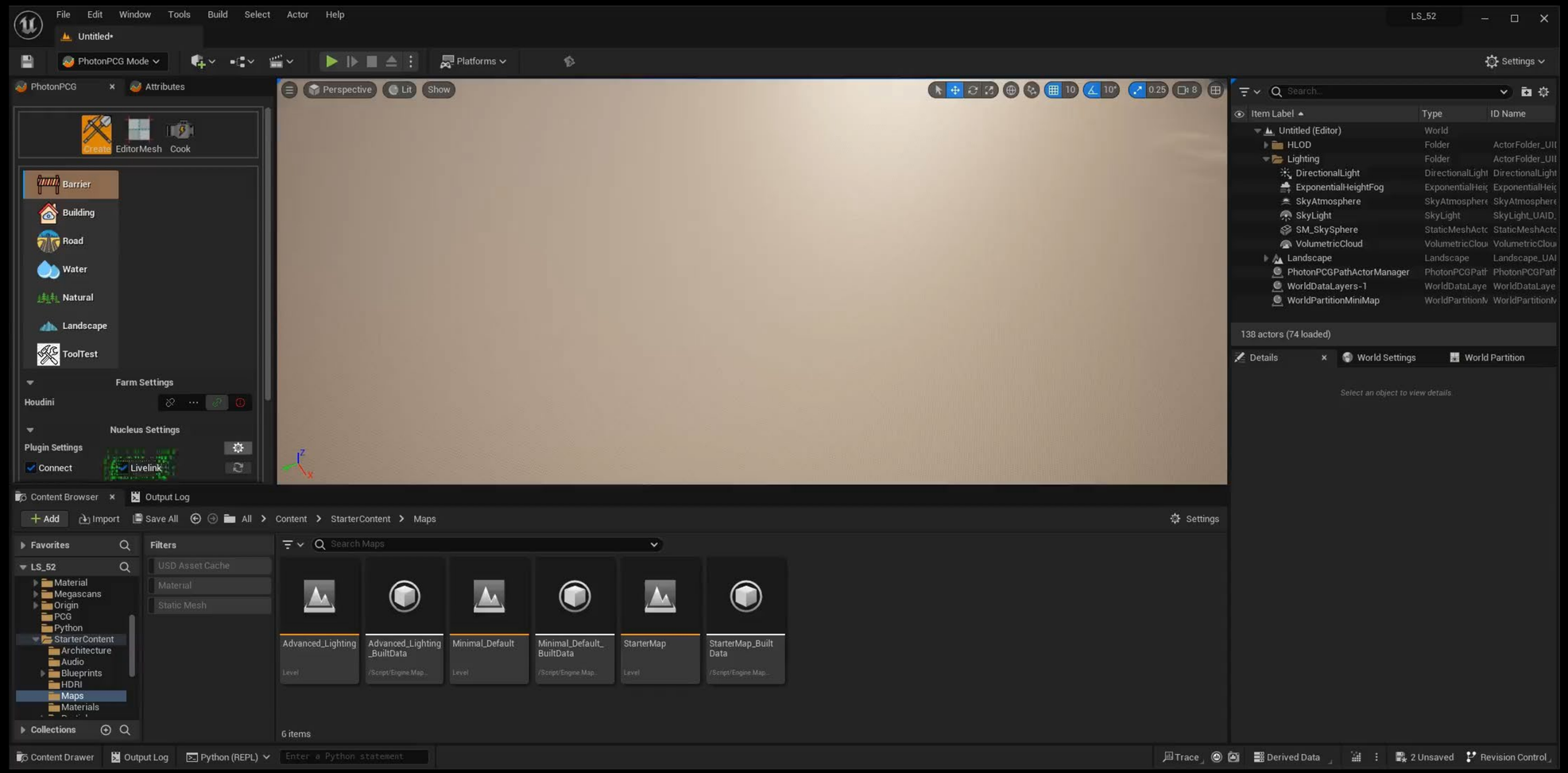
Omniverse

Unreal Engine

- Update Edit Curve

Edit Mesh & Edit Curve

real-time editing and updating



Natural Scenery

City View

How to do
Collaboration

share via Omniverse

- Refresh
- Checkout
- Pull
- Push

Special Thanks

If Yu

Yuyu Zhao

Baishun He

Bernie Wang

Wenyan Li

Michael A Kowalski

Brian Harris

Lou Rohan

And many others,

across all of Tencent and Nvidia!

Questions?

Tencent Games looks forward to collaborating with both internal and external projects.

In case you are interested in our pipeline and USD solution: calvingu@tencent.com , zigarwei@tencent.com