



Introduction to Omniverse

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AGENDA

- **Introduction to Nvidia Omniverse**
Modern Collaboration Workflows & Universal Scene Description (USD)
- **Five Foundational Components (Demo)**
Nucleus, Connect, Kit, Simulation, RTX Renderer
- **Building the Digital Twin (Hands-On)**
Visualizing weather prediction on Omniverse
- **Unified Industrial Digitalization**
Digital twin development & Synthetic data generation
- **Extension & Omni.UI (Hands-On)**
Building an extension to visualize weather prediction using FourCastNet
- **Getting started**
Download & Resources

Hands-On

啟動Omniverse Server

- 打開 Introduction to NVIDIA Omniverse.ipynb。
- 在 Launching NVIDIA Omniverse 區間執行以下Cell以啟動Omniverse Server。

```
[*]: ##### Use the hidden cell above if you are running in a workstation or personal machine
```

```
!cd ../../source_code/omniverse && ./run-kit-on-A100.sh --portable \
--app/livestream/websocket/server_port=$OMNI_P1 \
--exts/omni.services.transport.server.http/port=$OMNI_P2 \
--app/window/dpiScaleOverride=1.5 # <- Change this if needed
```

```
##### Kindly Interrupt this kernel by clicking on Kernel -> Interrupt kernel
##### in the left top bar after completion of the going through the materials.
```

- 開啟<http://userXX.140.110.18.63.nip.io:30030/streaming/client>
並等待Omniverse啟動 (約3-5分鐘)
- 如果視窗文字太大或太小可以調整「--/app/window/dpiScaleOverride=1.5」的數值，
調大可以放大文字， 調小可以縮小文字。修改後須重新執行Cell。

Introduction to Nvidia Omniverse

Modern Collaboration Workflows & Universal Scene Description (USD)



3D協作流程的革新體驗

Omniverse 的環境「就像是 3D 世界的 Google Docs」



皮克斯 (PX AR) & 通用場景描述 (USD)

皮克斯動畫工作室開發並開源的USD 成為一項開放源碼黏合劑，讓電影製作人可以把他們最愛的工具結合起來，如此他們就能跟散居各地的同事合作，並從根本上簡化製作動畫電影的工作。

在 USD 技術誕生之初，即獲得 Autodesk、Foundry 和 SideFX 三個創始重要夥伴的支持。至今已獲得Apple、Adobe到Unity等十多家大型業者支援。



通用場景描述 (Universal Scene Description, USD)

3D世界的HTML標準

USD意義不只是一種通用的3D檔格式，它還包括豐富的資源和技術，包含了幾何結構、相機、燈光和材質等虛擬世界的基礎元素，同時還支援屬性繼承、實例化和專門化等功能，允許3D元素之間建立聯繫。

- 得以使用「非破壞性編輯」使得流水線上的各個環節能最大程度地彼此獨立，避免相互干擾
- 提供開源且可擴展的C++與Python APIs
- 大幅簡化產業與軟體間的資源(assets)交換
- 已經獲得眾多3D建模軟體與製片工作室採用



USD Layers

Multiple Representations

- 一個USD文件通常稱為「層(Layer)」，與其他的圖形檔案非常相似。
- 單個檔案可以包含模型、網格、光線、陰影、以及著色器等...

USD Files

- 最常見的形式是帶有USD副檔名的檔案，這些通常是二進制檔案
- USD的二進制檔案格式稱為crate檔，也具有usdc副檔名
- 它是一種壓縮且容易快速開啟的文件格式

USDA Files

- USDA檔案格式是人類可閱讀的文本格式，任何的USD檔案都可以轉換成USDA
- USDA可在不進行渲染的狀況下，了解USD文件中的內容及進行調適和實驗

USDZ Files

- USDZ檔是一個ZIP壓縮存檔，其中包含USD圖層及其他支援檔案(例如用於渲染的紋理)

其他

- 最後，USD檔案也可以進行擴展以支援其他文件格式，所有的文件格式均由USD中的擴充套件提供
- 例如Google提供了一個擴充套件，讓使用者可在DRC檔案中使用Draco進行壓縮

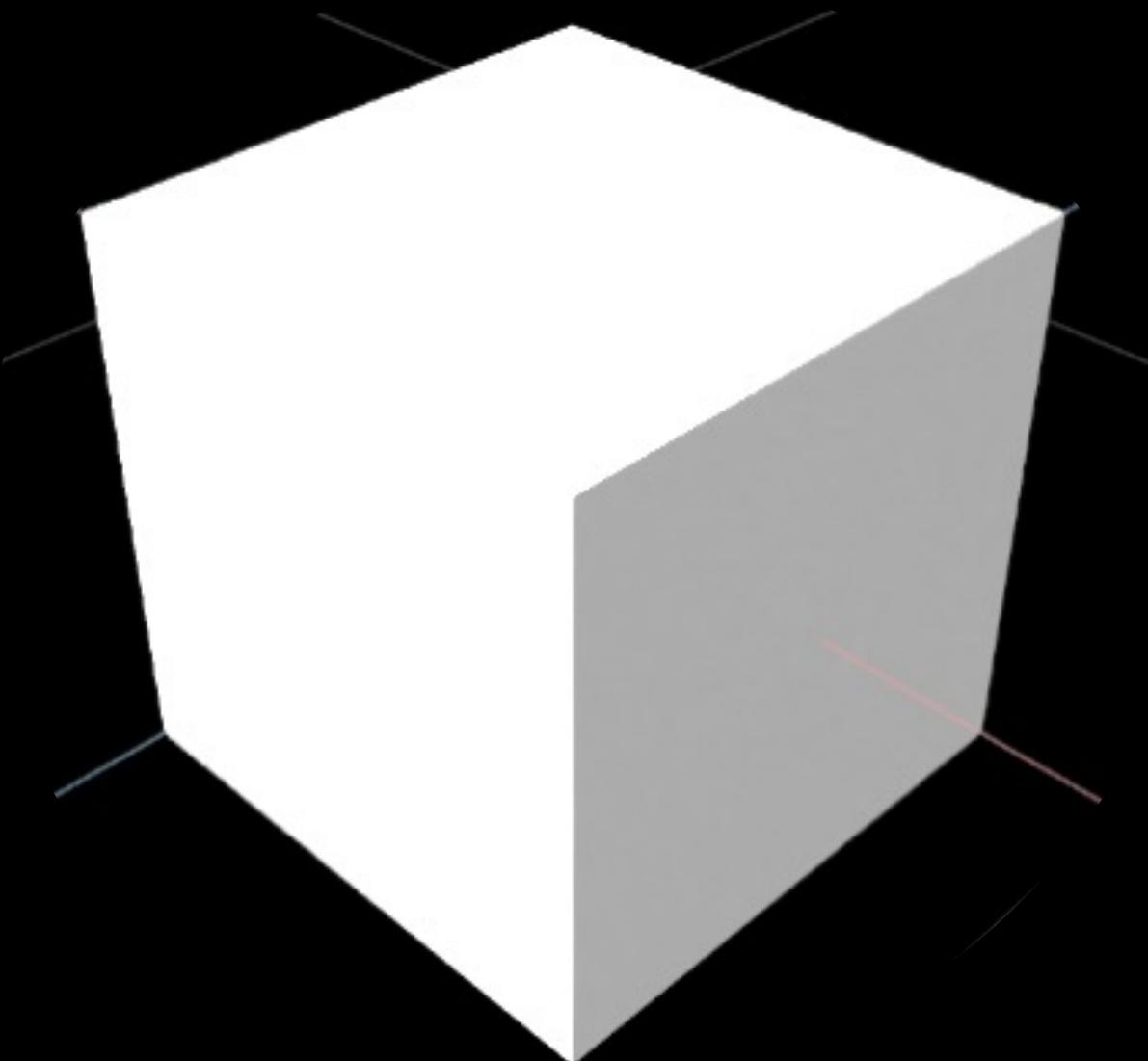
USD Layers

```
def Xform "World"
{
    def DistantLight "defaultLight"
    {
        ... Light Properties ...
    }

    def Mesh "Cube"
    {
        # Cube geometry:
        float3[] extent = [(-0.5, -0.5, -0.5), (0.5, 0.5, 0.5)]
        int[] faceVertexCounts = [4, 4, 4, 4, 4, 4]
        int[] faceVertexIndices = [0, 1, 3, 2, 2, 3, 5, 4, 4, 5, ...]
        point3f[] points = [(-0.5, -0.5, 0.5), (0.5, -0.5, 0.5), ...]

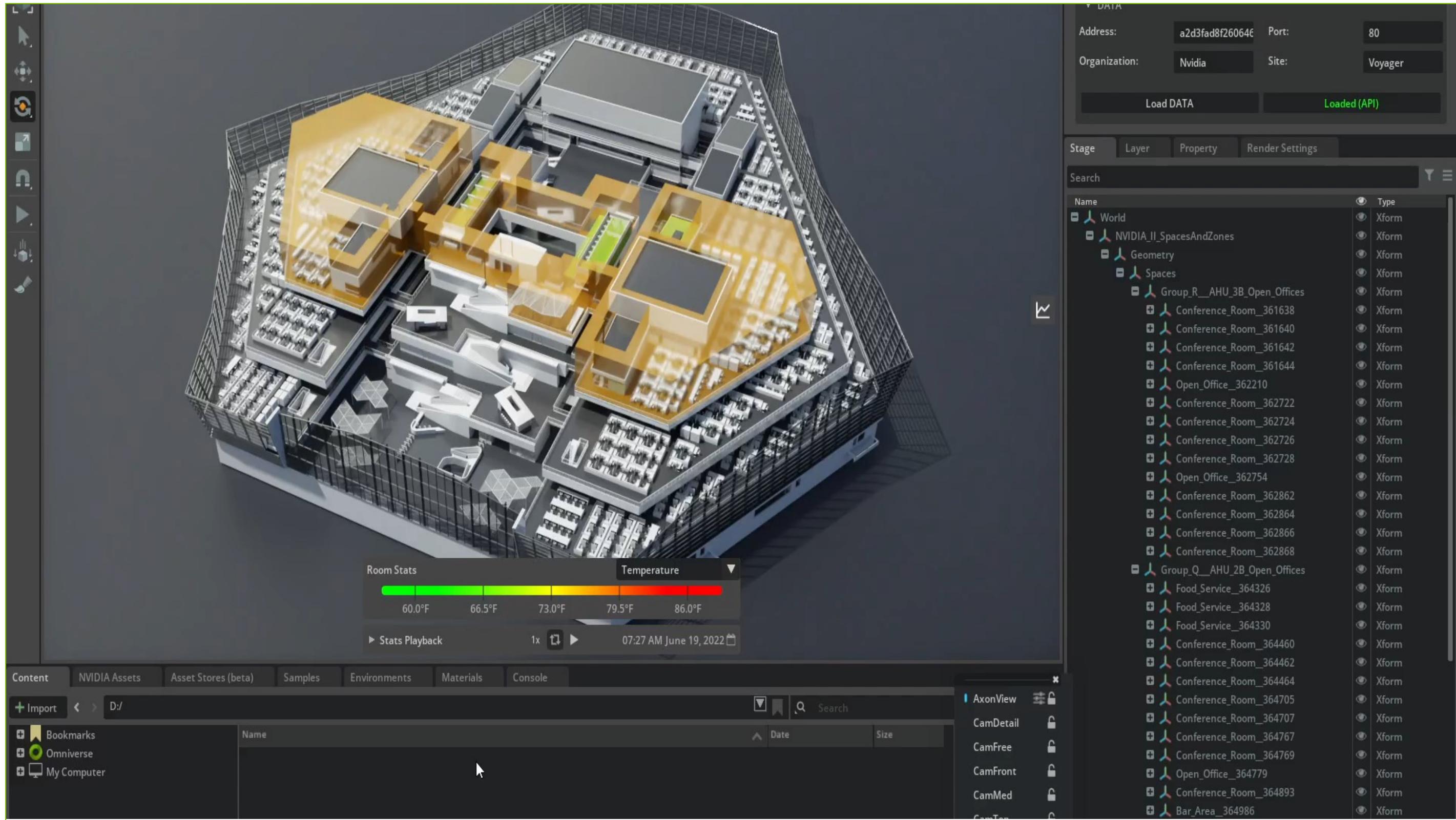
        # Surface color:
        color3f[] primvars:displayColor = [(1.0, 1.0, 1.0)]

        # Coordinates:
        double3 xformOp:translate = (1.0, 0.0, 0.0)
        double3 xformOp:rotateXYZ = (0.0, 45.0, 0.0)
        float3 xformOp:scale = (1.0, 1.0, 1.0)
        uniform token[] xformOpOrder = ["xformOp:translate", ...]
    }
}
```



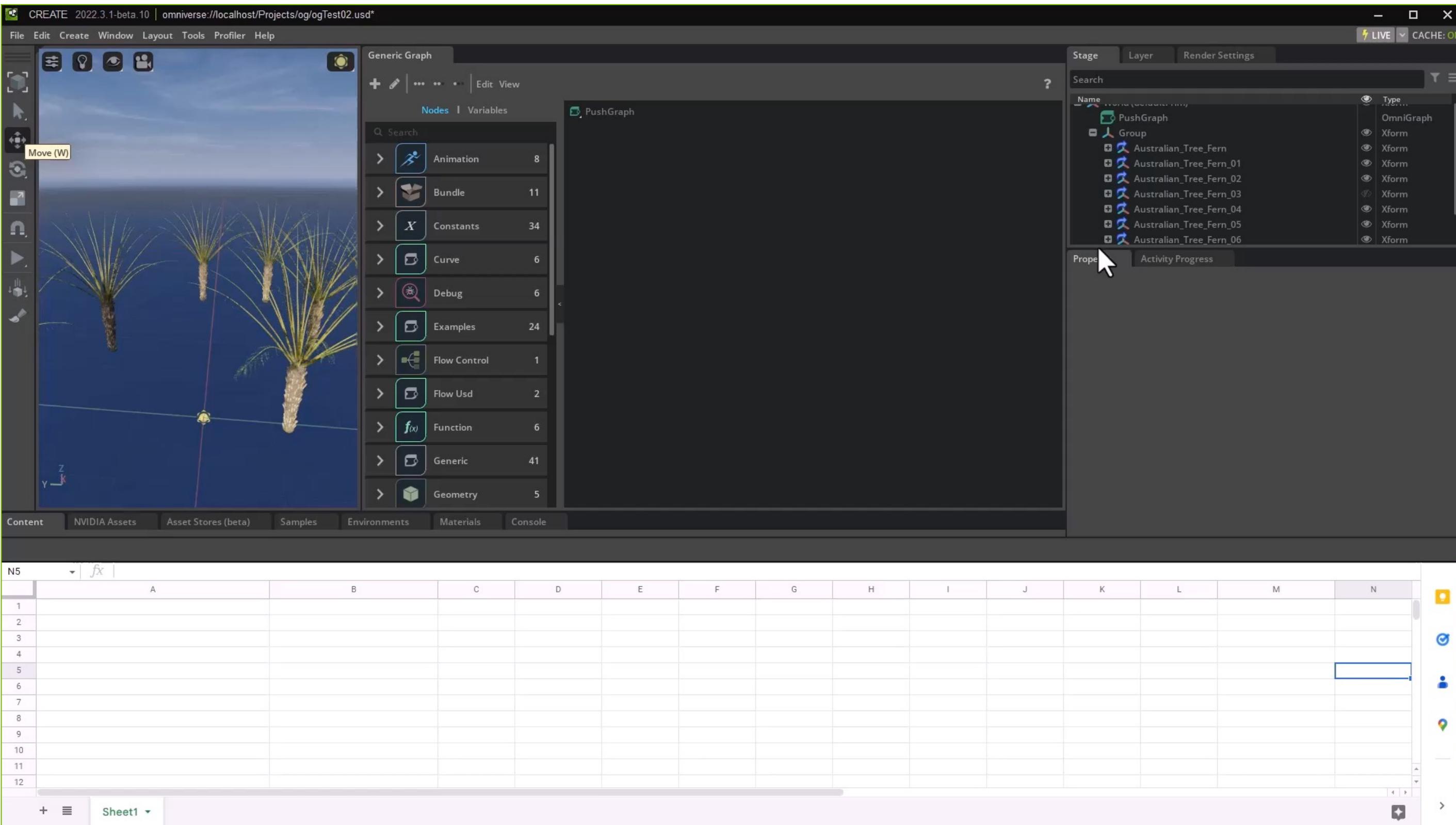
Incorporating Non-Geometric Data into Omniverse

IoT – Cooling Systems



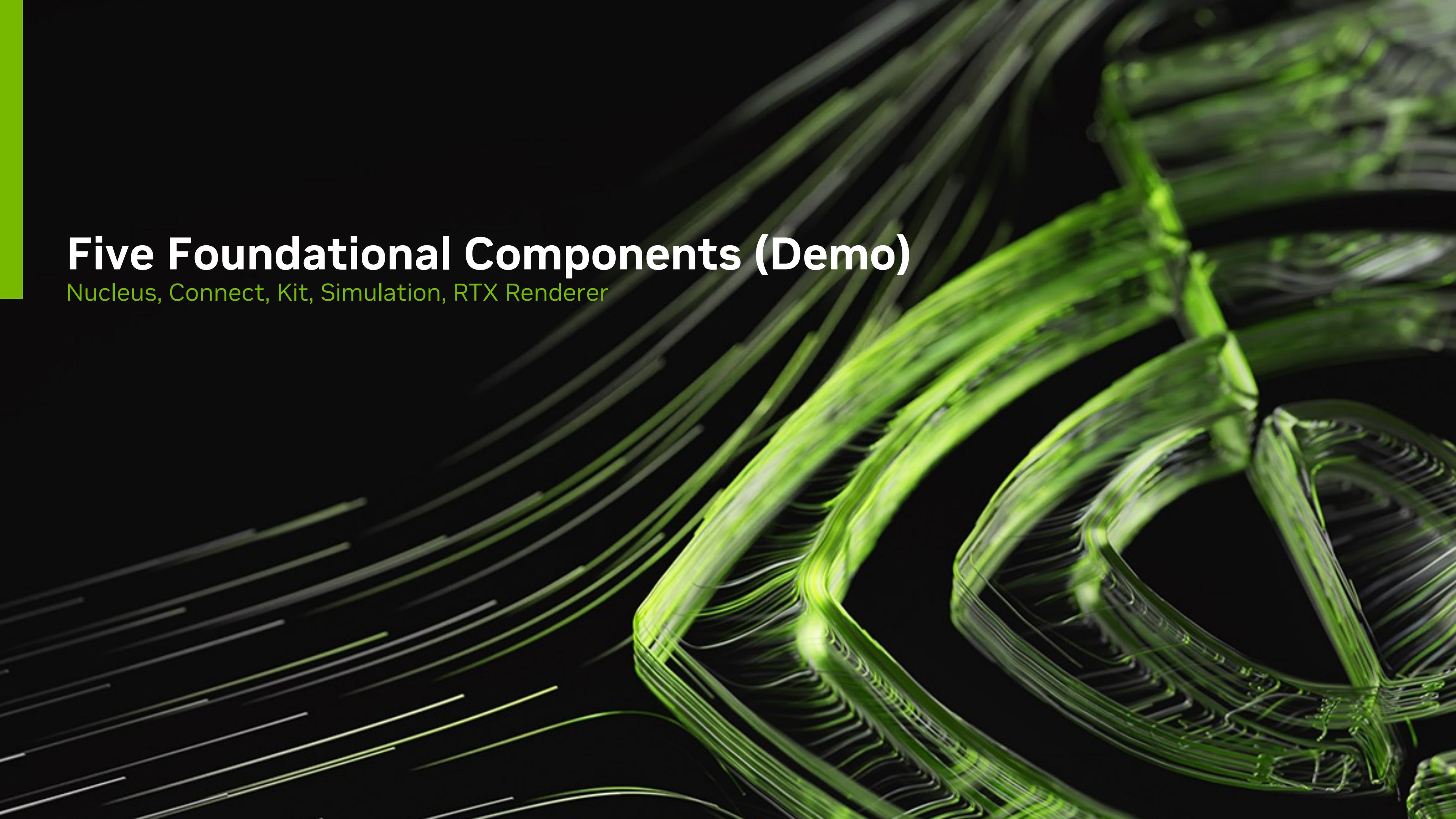
Incorporating Non-Geometric Data into Omniverse

Google Sheets - to OmniGraph



Five Foundational Components (Demo)

Nucleus, Connect, Kit, Simulation, RTX Renderer

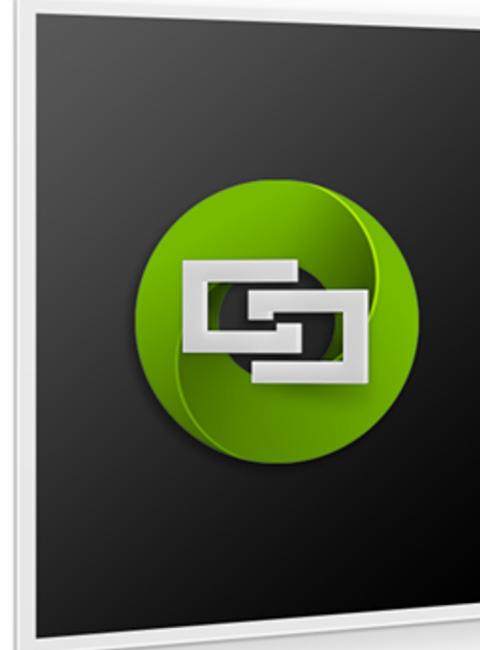


NVIDIA Omniverse 五大核心技術

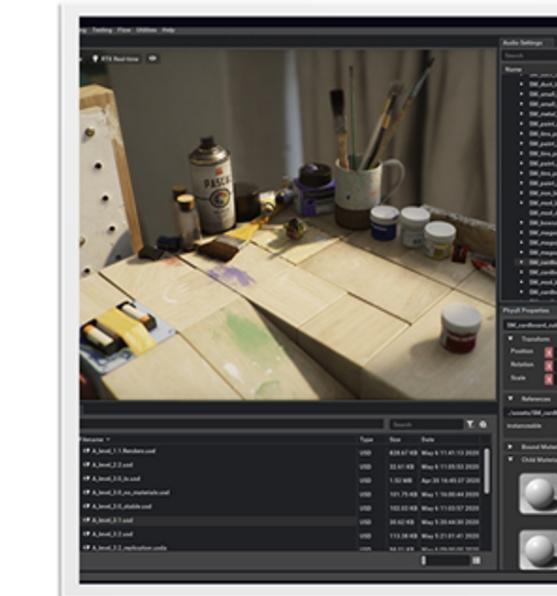
NUCLEUS



CONNECT



KIT



SIMULATION

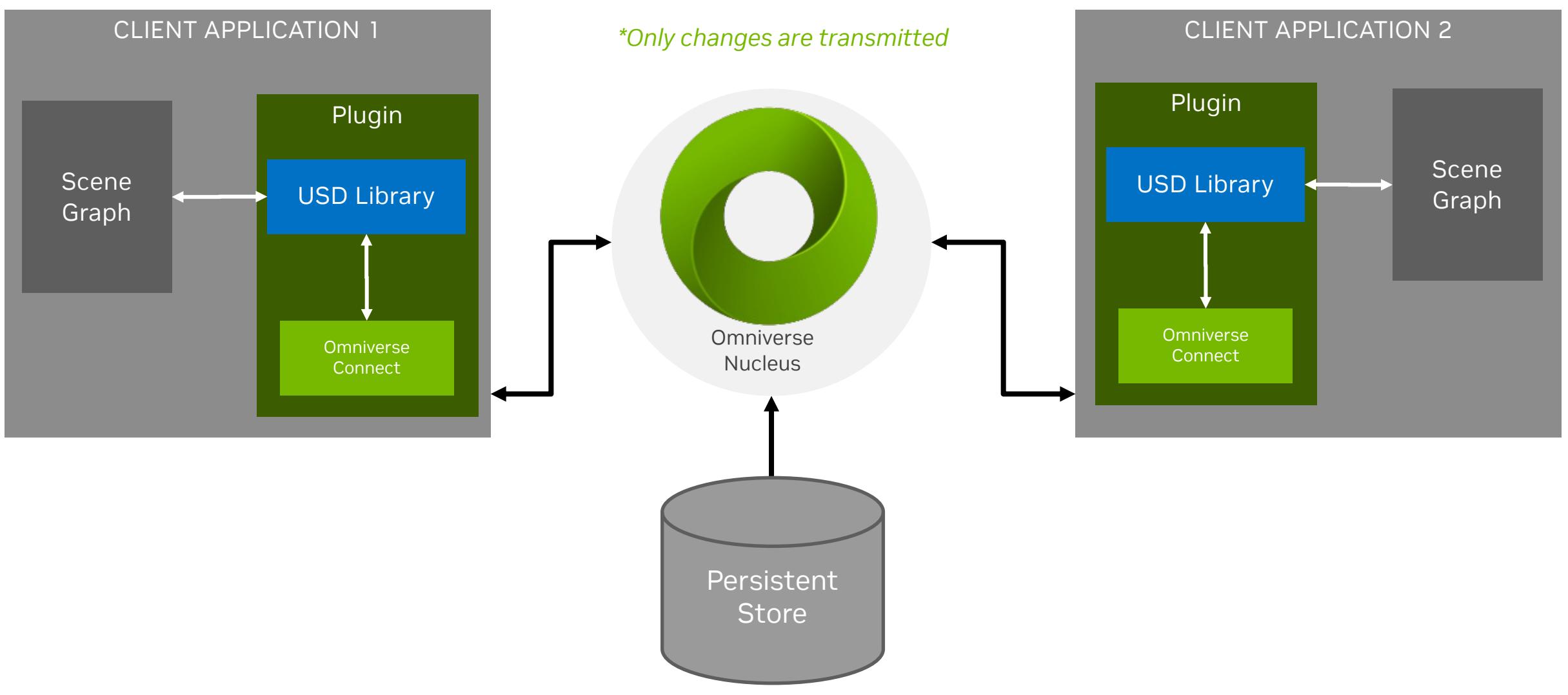


RTX RENDERER



Omniverse Nucleus

Asset Database and Collaboration Engine



CONNECT



KIT



SIMULATION



RTX RENDERER



Connect to Omniverse with USD

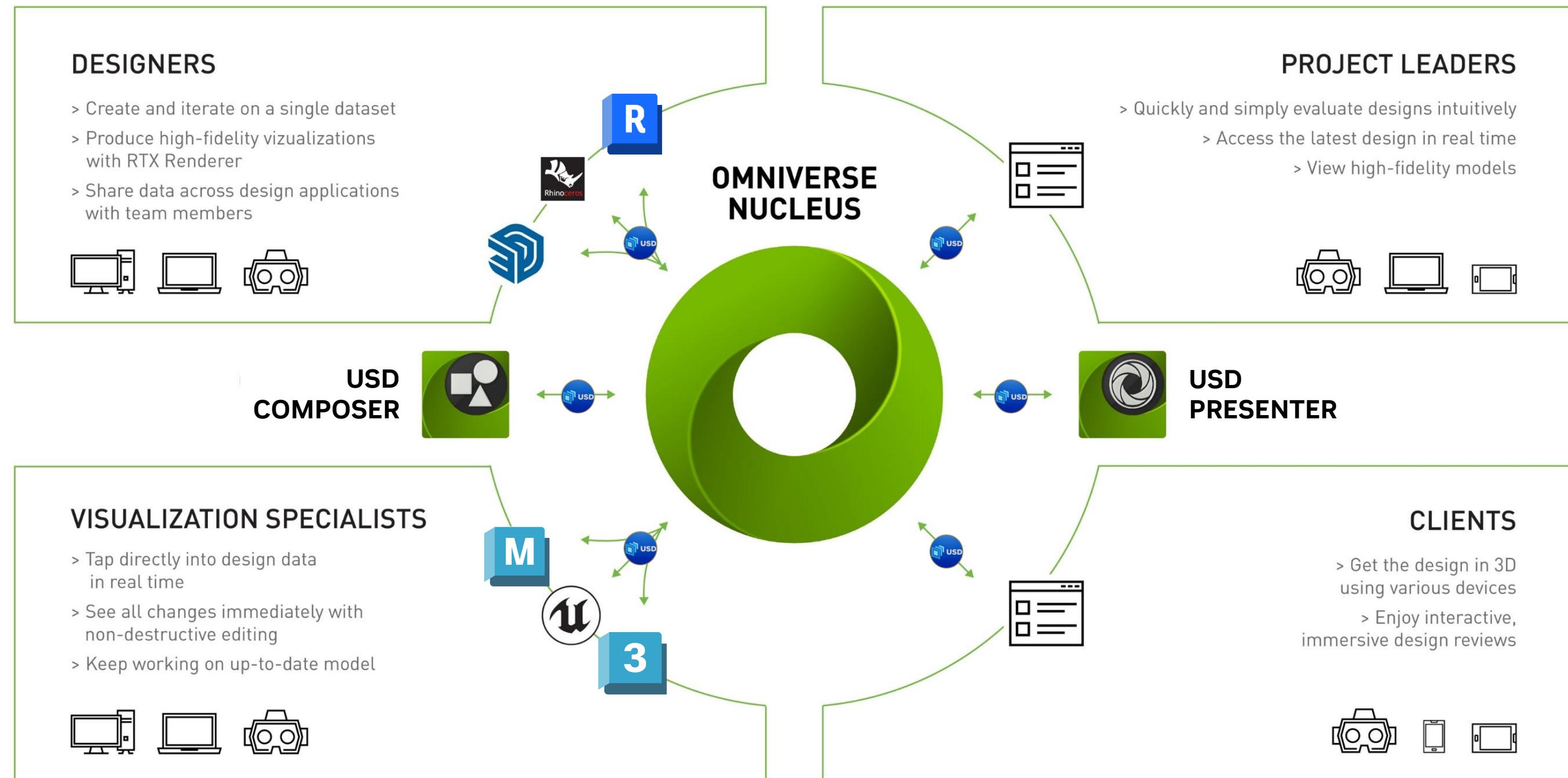
Many Ways to Connect, Baseline is USD Ingest

BI-DIRECTIONAL CONNECTOR	Updates shared between 3rd party tools and Omniverse after a single export/import. Live sync available for some connectors.	
UNI-DIRECTIONAL CONNECTOR	Updates reflected from 3rd party tool to Omniverse but aren't shared back. Material conversion supported. Live sync available for some connectors.	
USD EXCHANGE VIA OMNIVERSE DRIVE	Similar to uni-directional. Allows for USD or texture export.	
EXPORT / IMPORT	Conversion to USD via direct import or third-party app.	



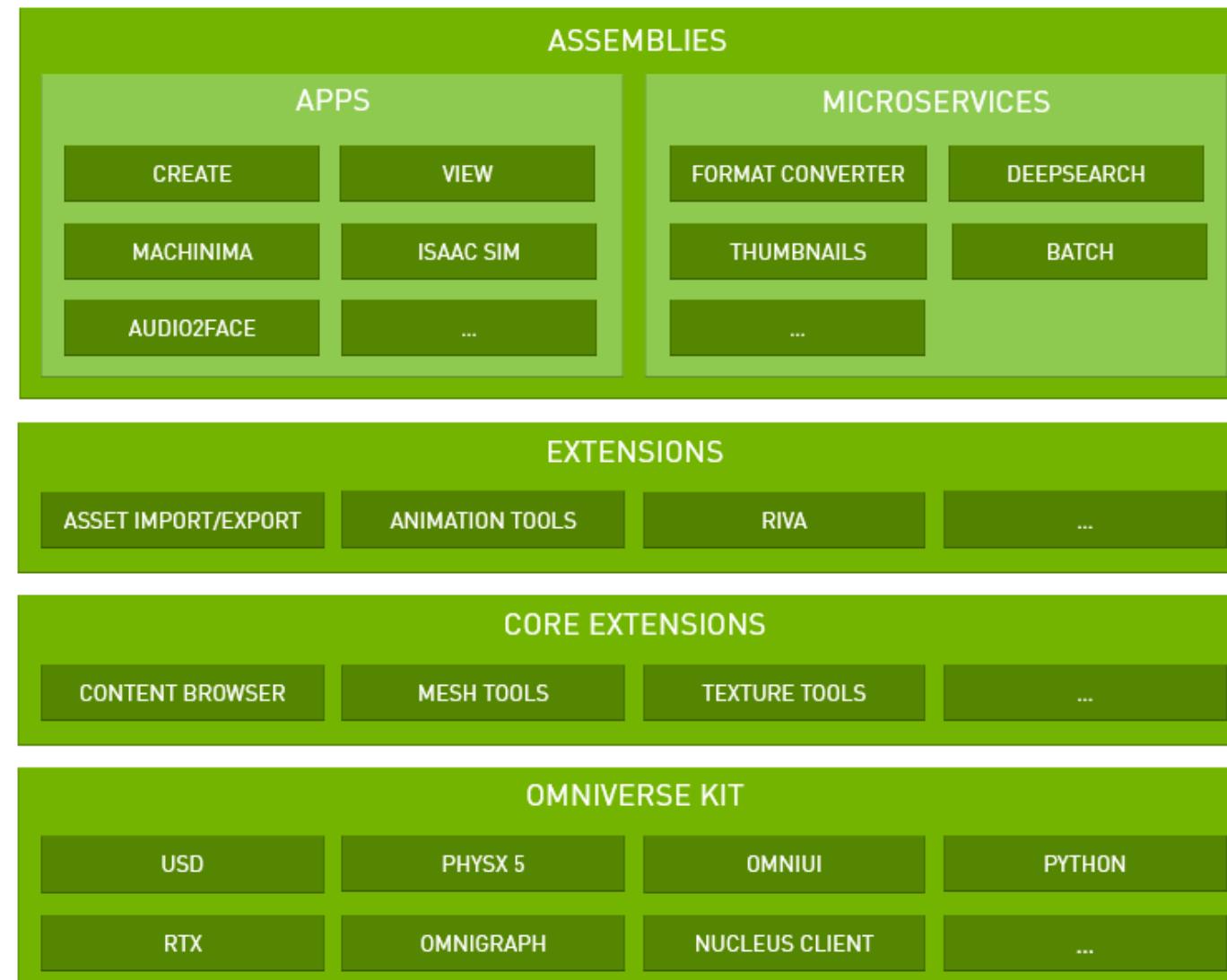
Architecture Concept Design Review in Omniverse

Nucleus & Connector



Omniverse Kit & Kit Extensions

Easily Build Advanced 3D Tools, Services, Applications



- Extensible platform, modular, flexible, open
- **Omniverse Kit** – SDK to build extensions, apps, microservices
- **Omniverse Extensions** - the building blocks of Omniverse Apps
- Provide over 300 extensions as source
- Majority written in Python
- Provide app templates to build-your-own

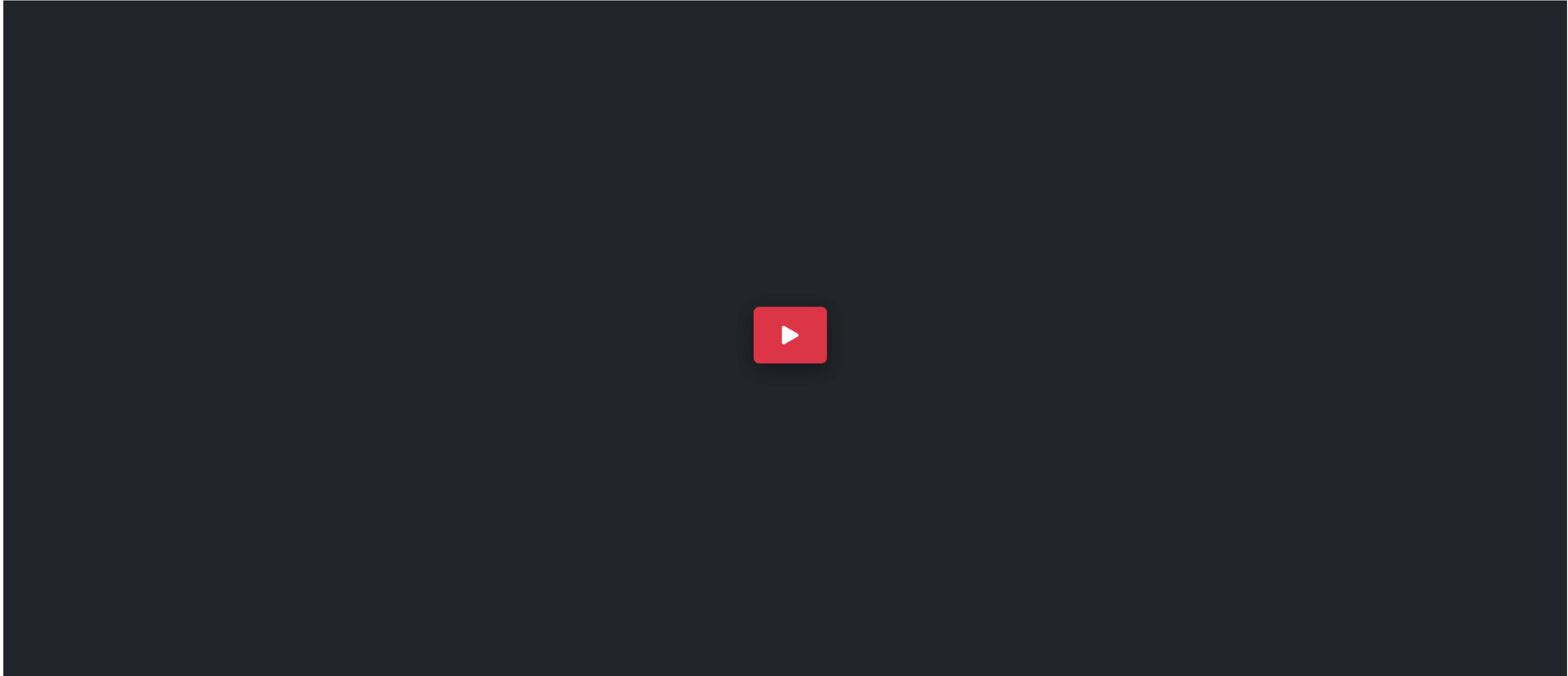
Kit Based Apps

Fully Customizable and Extensible “Template” Applications



<http://userXX.140.110.18.6X.nip.io:30030/streaming/client/>

你的環境開好了嗎？



Physics Simulation in Omniverse

Multiple Ways to Ingest and Simulate Physics in Omniverse



NVIDIA PhysX

Rigid & Soft Body Dynamics,
Destruction, Fluid & Fire



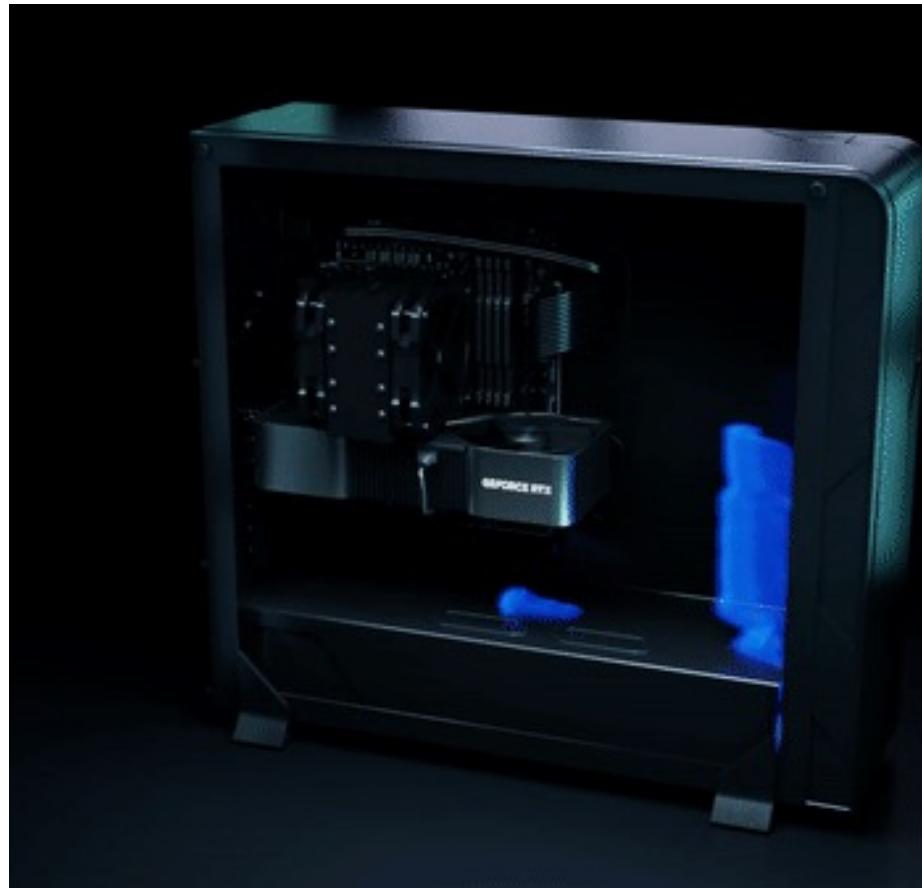
Import Physics Instance

Offline from External 3rd Party
Application



NVIDIA Modulus

Accelerated with Physics-ML Platform



PhysX

Experience Powerful, Flexible Simulation

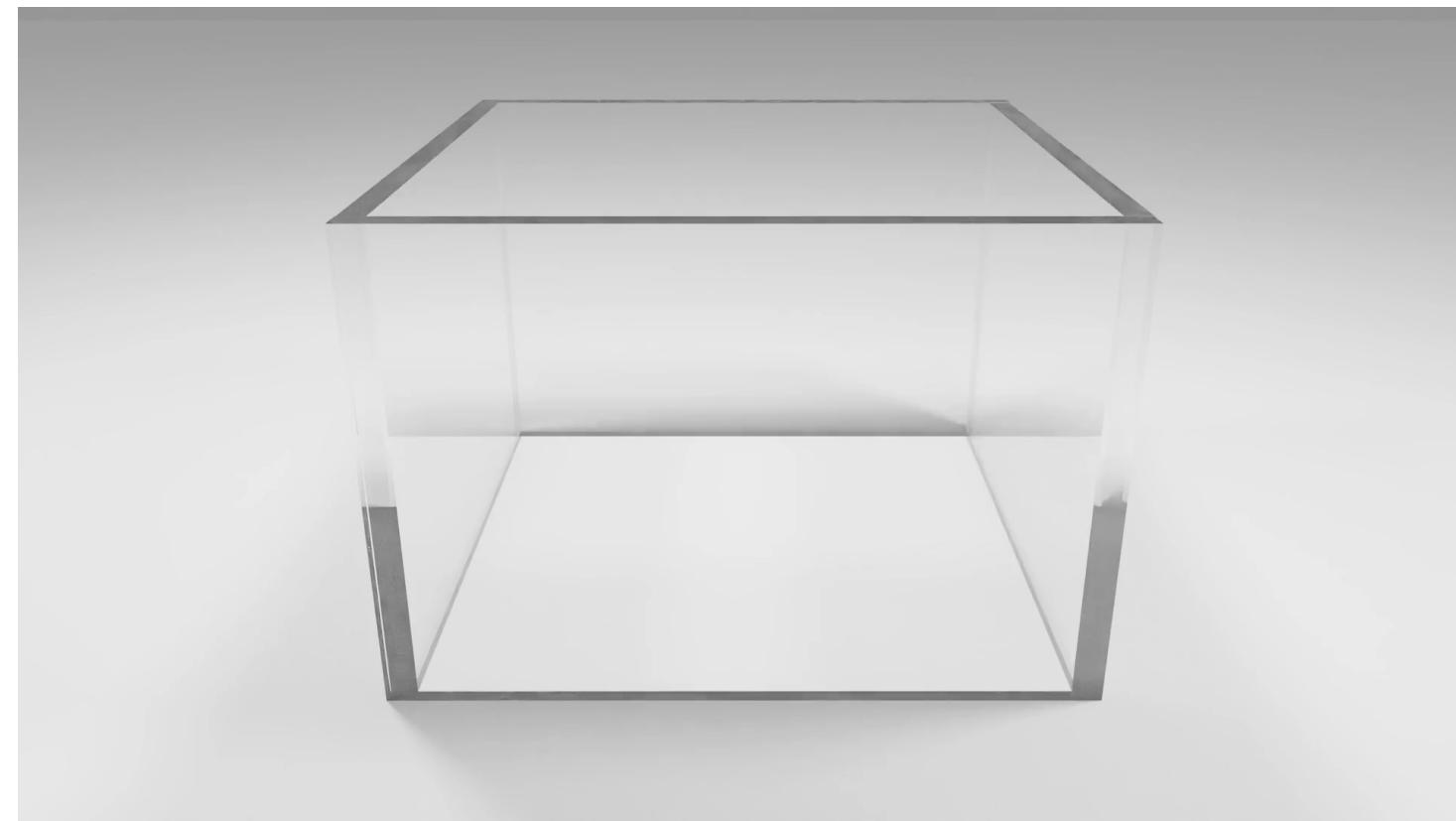
SDF Colliders

A new Signed Distance Field based collision representation allows PhysX to simulate non-convex shapes like gears and cams without convex decomposition.



Position Based Dynamics

Position Based Dynamics provide a flexible framework for simulating a wide range of phenomena including liquids, granular materials, cloth, rigid bodies, deformable bodies, and more. It is used extensively in the VFX industry.



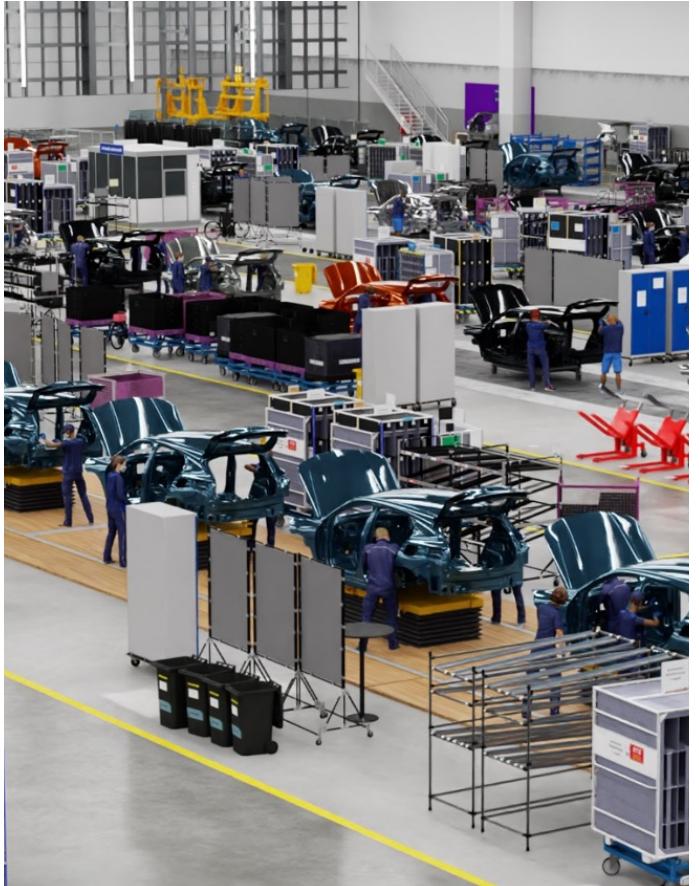
Rendering in Omniverse

Native RTX Renderer, Ability to Connect Hydra-Compliant Renderers



Omniverse RTX Renderer

Real Time Ray Traced & Path Traced Modes



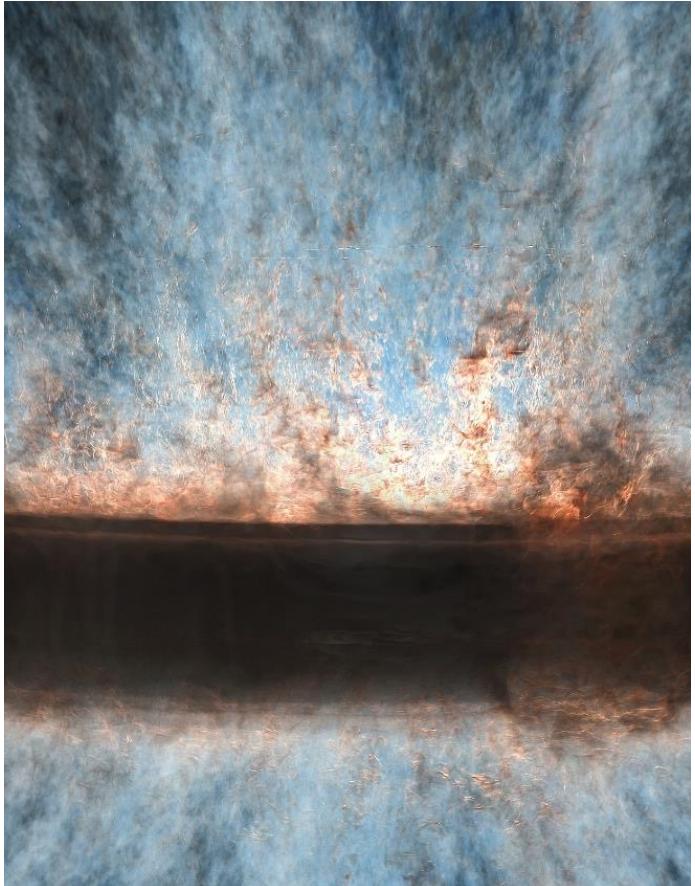
Iray

Accurate Rendering



IndeX in Omniverse

Interactive Volumetric Rendering

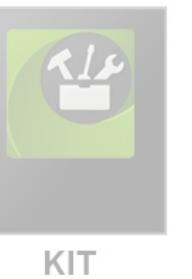
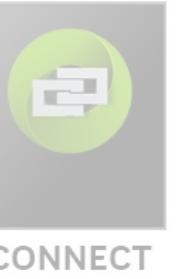
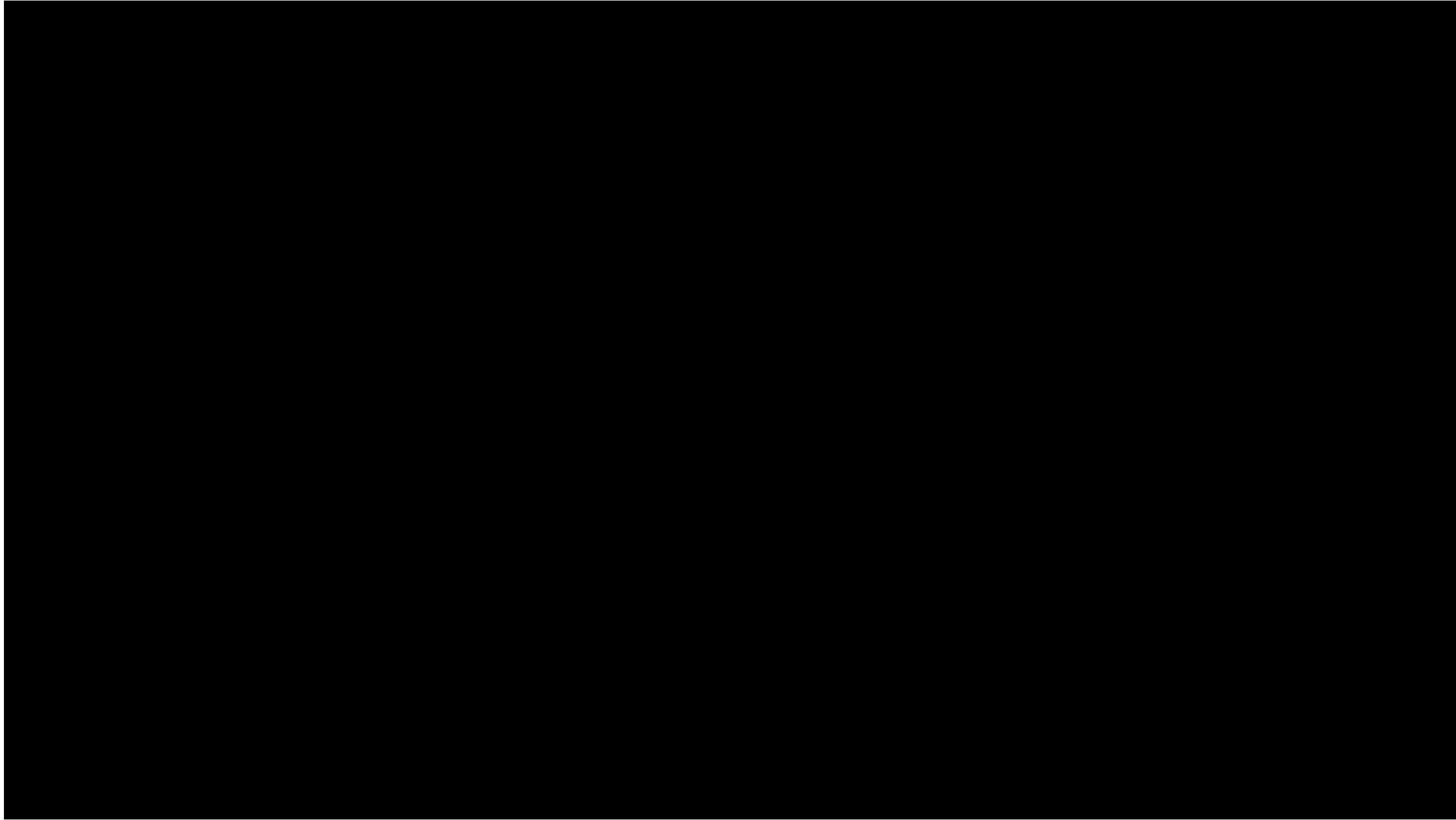


Hydra Render Delegate

Use Your Preferred Hydra Compliant Renderer

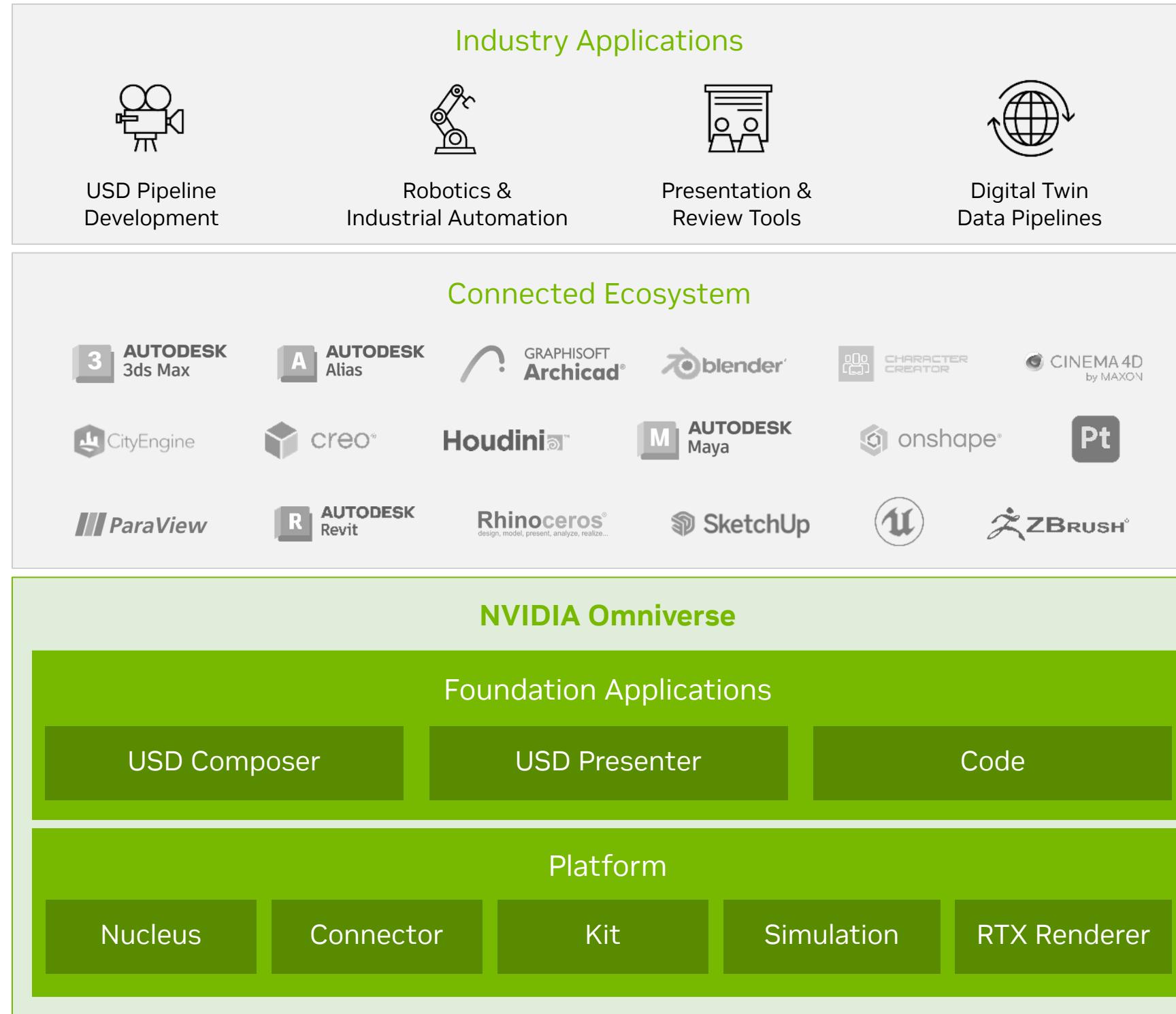


NVIDIA RTX™ 光線追蹤技術

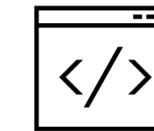


Omniverse is Not a Tool

Omniverse is a development platform for building Tools, Apps, or Services to better connect 3D pipelines



Uplevel performance of existing 3D pipelines without hassle of a monolithic platform



Write Python Script in a fully supported, user-friendly interface



Build advanced tooling and experiences faster than ever with platform reference app templates

Building the Digital Twin (Hands-On)

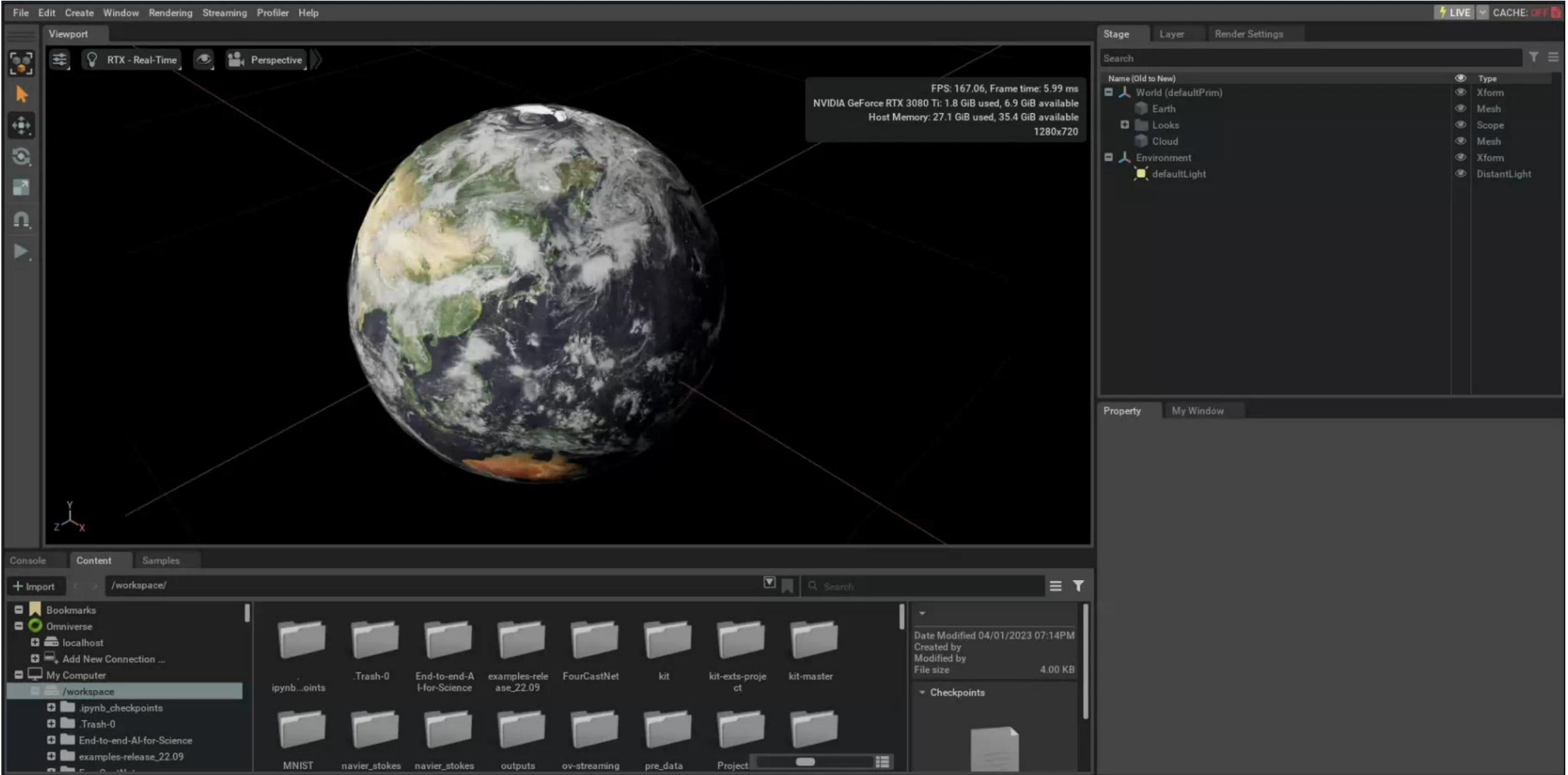
Visualizing weather prediction on Omniverse



學習目標

在Omniverse中視覺化天氣預測的結果

- 了解Omniverse界面與基本使用方式
- 新增Mesh物件與Material物件
- 修改物件屬性(Property)



Mesh & Material



Transform (幾何轉換)

Translate 座標

Scale 大小

...

Geometry (幾何形狀)

Mesh 網格

Face 表面

...

Physics (物理特性)

Mass 質量

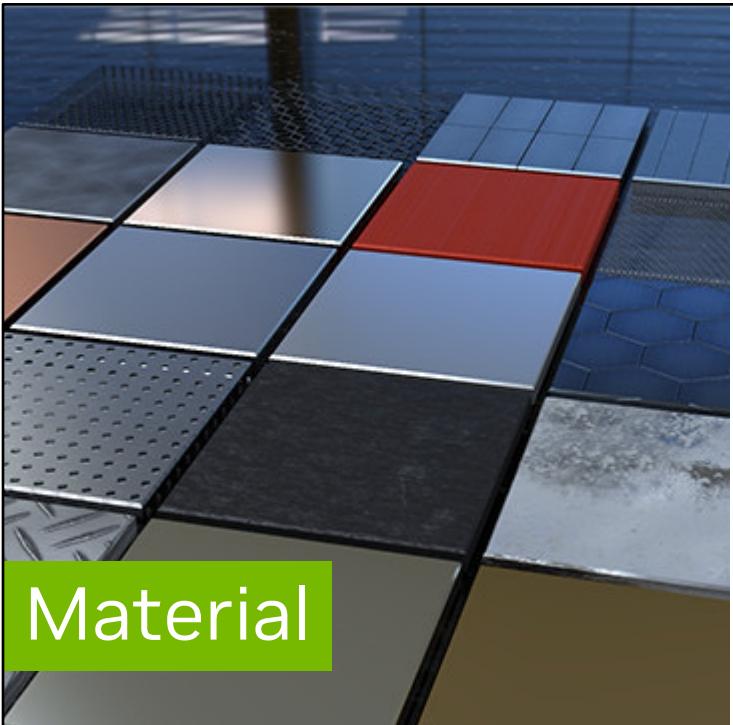
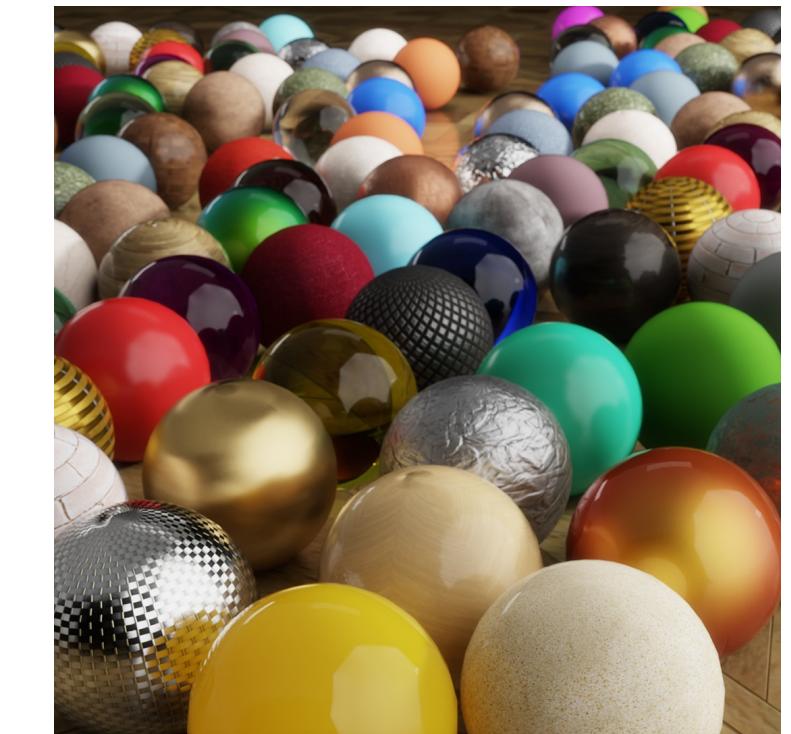
Center of Mass 質心

...

Materials (表現材料)

Materials 材料

(從下面選擇)



Normal (法線貼圖)

Map 圖

...

Albedo (基礎顏色)

Map 圖

color 顏色

...

Reflectivity (反光特性)

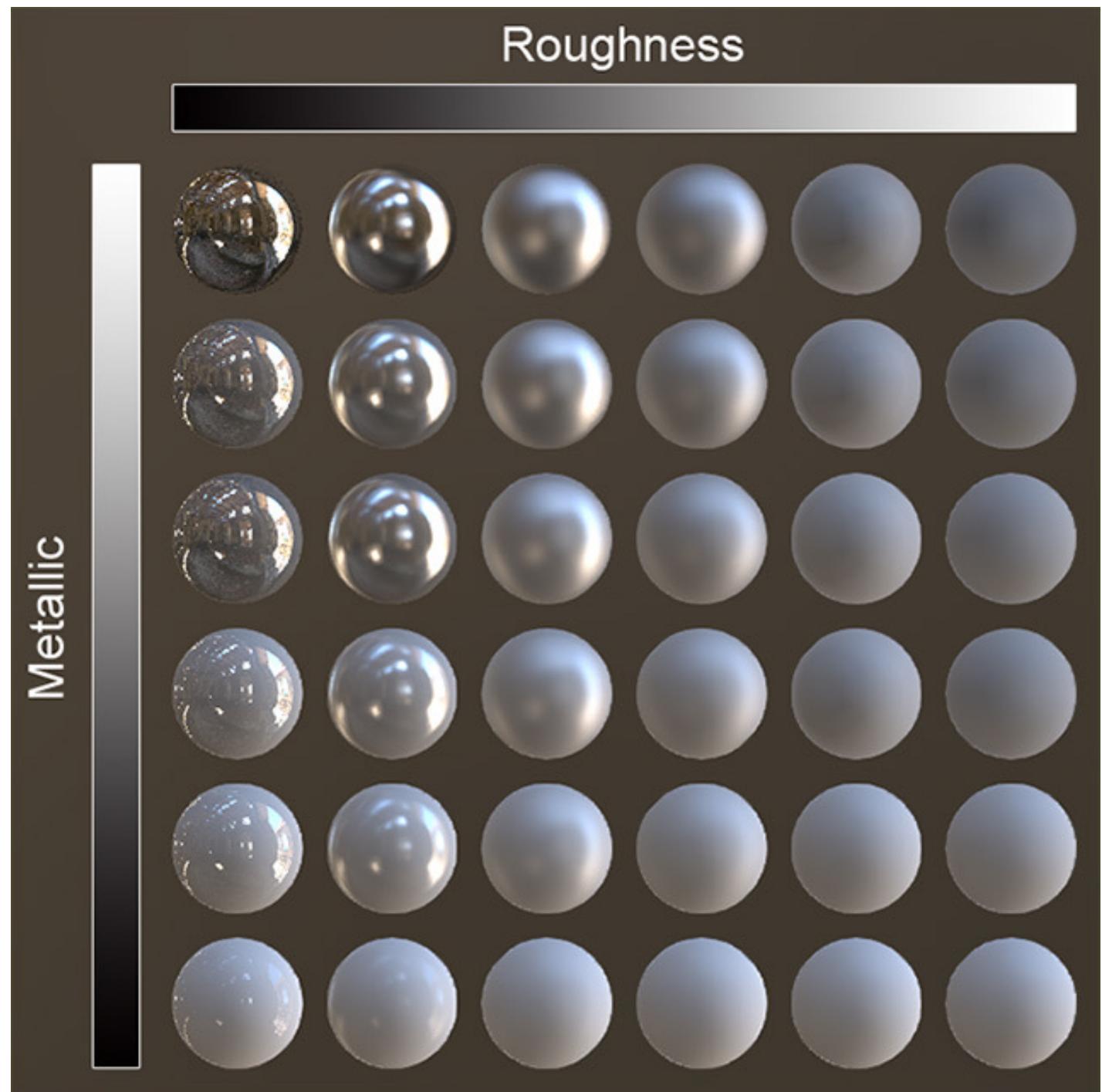
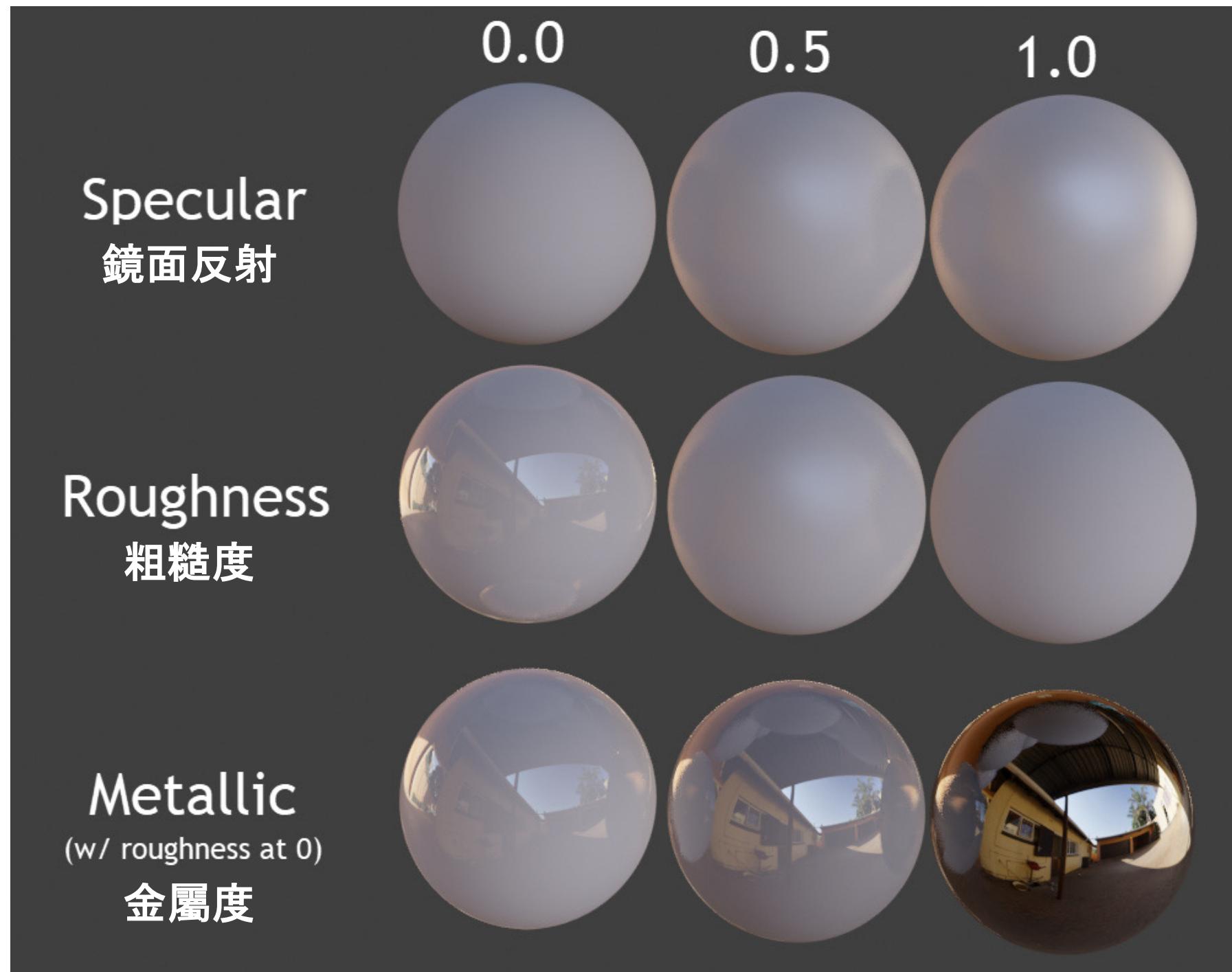
Metallic Amount 金屬度

Roughness Amount 粗糙度

...

PBR材質解析

物理寫實渲染 (Physically Based Rendering)



Hands-On

Visualizing weather prediction on Omniverse

Step 1

Creating a new empty file for us to create a Digital Twin

預設就已經有新檔案，可以不用做

Step 2

Adding a sphere mesh

從上方選單點選Create->Mesh->Sphere，會產生一顆圓球。從右上Stage視窗將Sphere改名為Earth。

注意！若球體不在原點，點擊球體後從右下Property視窗將Transform->Translate調回(0,0,0)。

Step 3

Adding material to the sphere

選中Earth後按右鍵叫出選單，Create->Material->OmniPBR。

注意！若沒有選中Earth就新增Material，需要從Earth的Property->Materials on selected models選單中選擇。

Step 4

Adding the Earth Texture as an Albedo map

從右上Stage選單將OmniPBR改名Surface。

同時將Property->Albedo Map選擇/workspace/python/source_code/extension/assets/earth_colored_august.png

Step 5

Adjusting the roughness value

選中Surface後將其Property->Reflectivity->Roughness Amount調大，以降低反光的感覺。