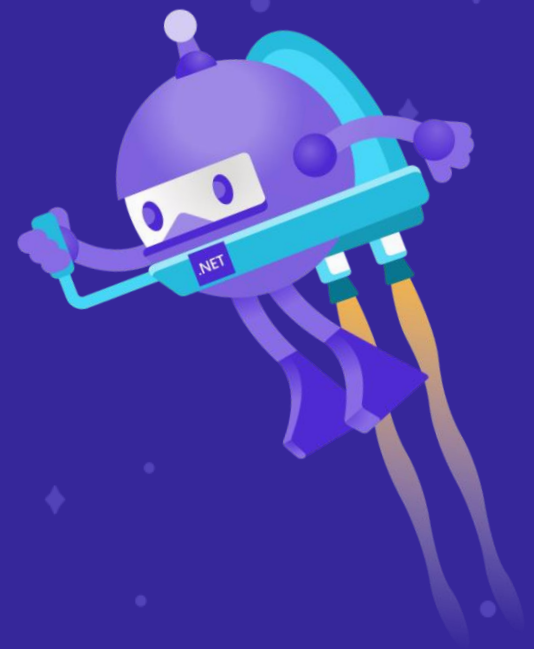
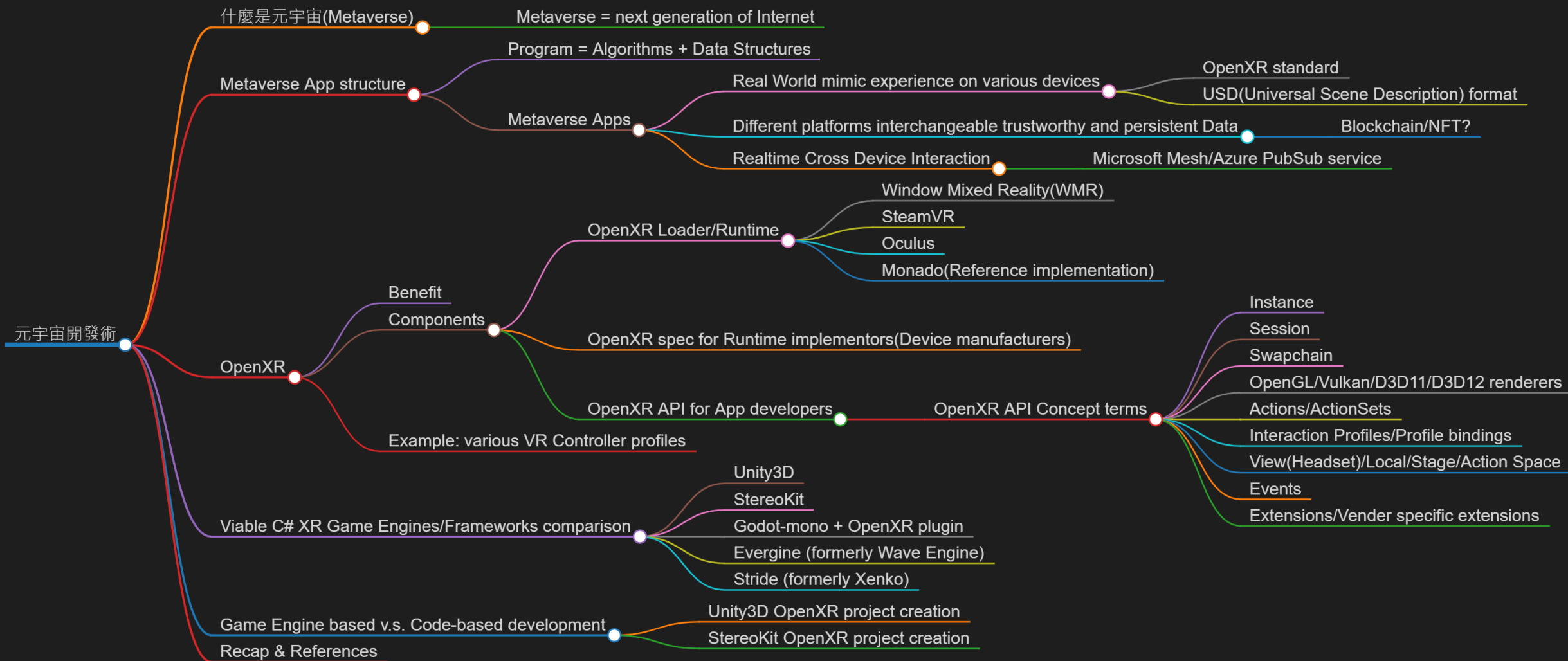


元宇宙開發術

鮑承佑



Agenda



什麼是元宇宙 (Metaverse)

- 我只知道 #元宇宙概念股 炒很凶 😏
- 然後大家都會說開Netflix看以下的影片：







A video frame featuring Satya Nadella on the left, speaking with his hands clasped. On the right, a dark overlay titled "Metaverse solutions" lists various Microsoft services categorized by application area. The categories and their associated services are:

- Applications**: Microsoft Teams, Dynamics 365 Connected Spaces
- Mixed reality**: Microsoft HoloLens, Microsoft Mesh
- Logic**: Power Platform
- Intelligence**: Azure AI, Autonomous Systems
- Data**: Azure Synapse Analytics
- Location**: Azure Maps
- Modeling**: Azure Digital Twins
- Connectivity**: Azure IoT
- Physical world**: Sensors — Devices/equipment — Edge

什麼是元宇宙 (Metaverse)

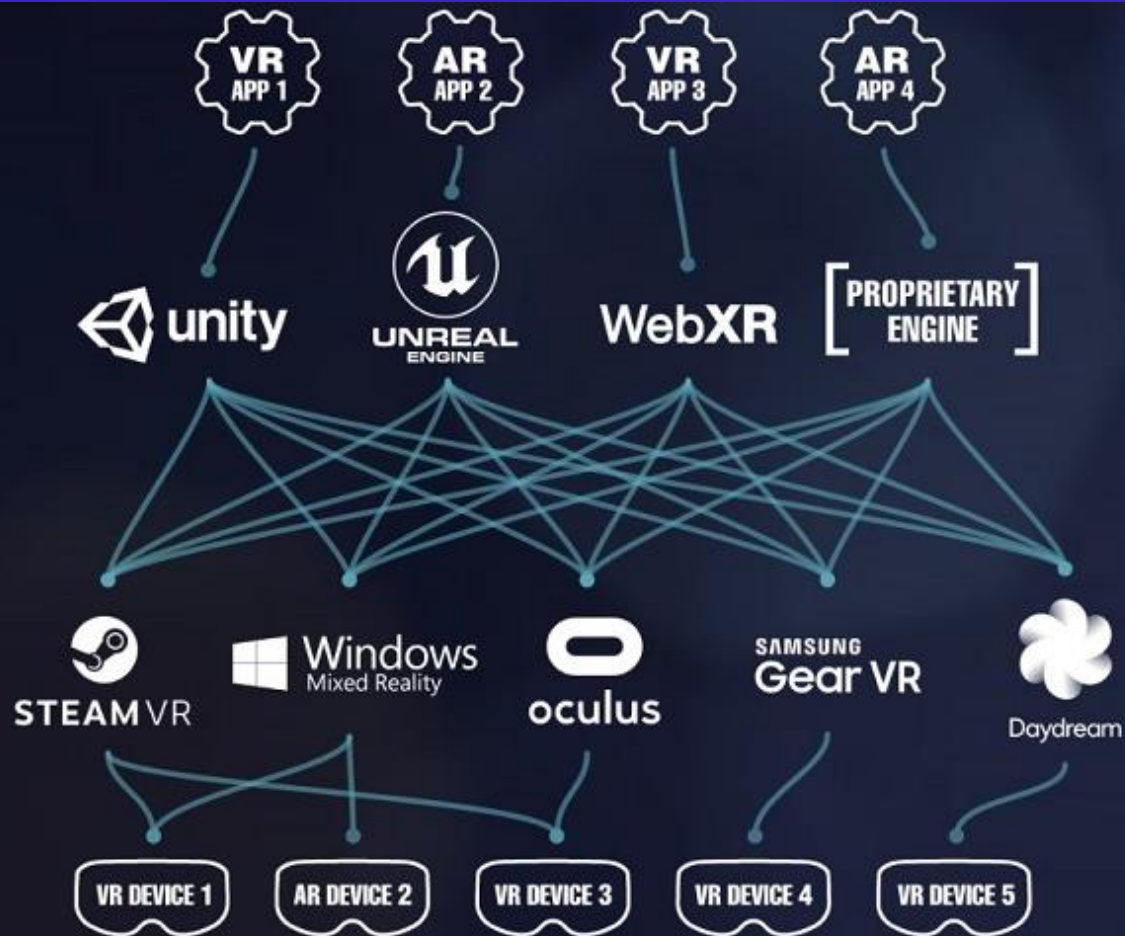
- Next Generation of Internet
- 使用各種最新人機互動技術來達到與世界各地人與人之間的即時互動

Metaverse App structure

- Program = Algorithms + Data Structures
- Metaverse Program:
 - Real World mimic experience on various devices:
 - **OpenXR** standard
 - **USD**(Universal Scene Description) format
 - Different platforms interchangeable trustworthy & persistent Data:
 - **Blockchain/NFT?**
 - Realtime Cross Device Interaction
 - Microsoft Mesh/Azure PubSub service

OpenXR

- What is:
 - An Industry Standard for various AR/VR/MR/XR devices & SDKs
- Purpose:
 - Try to solve the software/hardware incompatibilities of XR industry products



Before OpenXR
XR Market Fragmentation



After OpenXR
Wide interoperability of XR apps and devices

* OpenXR 1.0 is focused on enabling cross-platform applications. Optional device plugin interface will be supported post V1.0

OpenXR benefits

- Composition of multiple already established Industry standards(OpenGL/Vulkan/D3D11/D3D12)
- Currently official version 1.0
- Mostly vendors adopting OpenXR except Apple (currently), so the compatibility of those device application development can be easier



OpenXR Widespread Industry Adoption



Conformant Implementations



Microsoft HoloLens 2
Windows Mixed Reality Headsets



Oculus Rift S
Quest and Quest 2



HTC Vive Cosmos

Developer Preview Implementations



Now
Conformant!
Version 1.16

Valve SteamVR
Transitioning from OpenVR to OpenXR



ALL Varjo
Headsets
Conformant!
April 13th, 2021

Varjo
Preliminary support shipping now



Now
Conformant!
Version 21.0.0

Collabora
Monado open-source Implementation

Engine Support



Unreal Engine
Support in 4.24. Optimizations in 4.25



Just
Announced!

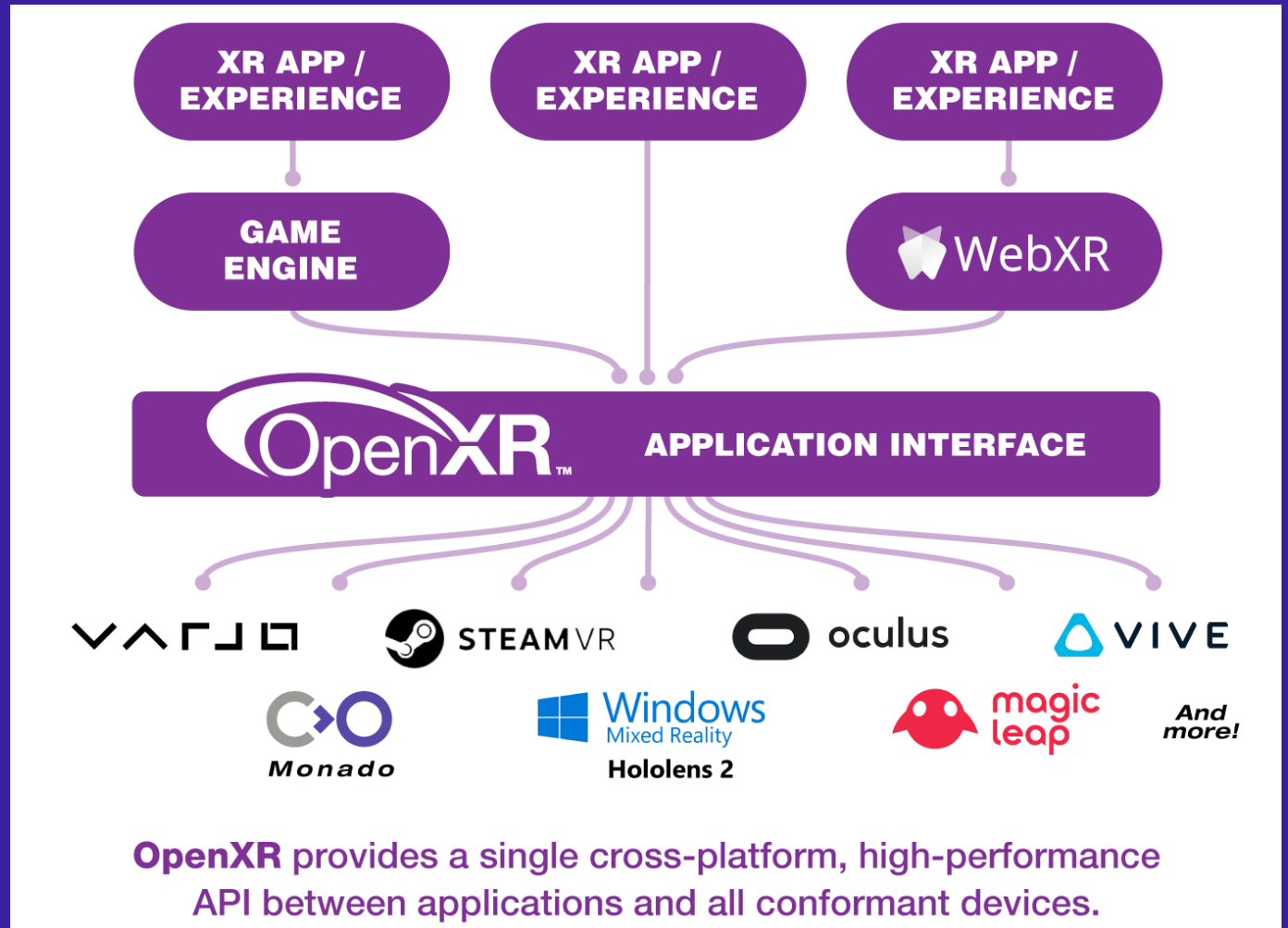
Unity Engine
OpenXR Plugin Preview in 2020.2+



Chromium 81 for Chrome and Edge Browsers
OpenXR default backend for WebXR

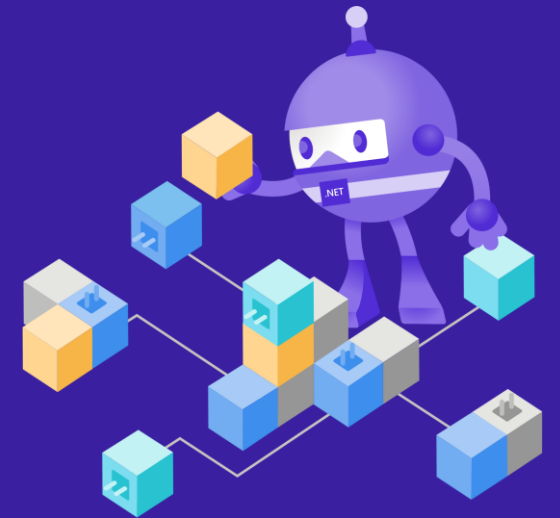
OpenXR Components

- OpenXR Loader/Runtime:
 - Window Mixed Reality(WMR)
=> Windows
 - SteamVR
=> Windows/Linux
 - Oculus
=> Android
 - Monado (Spec Reference implementation) => Linux
- OpenXR spec for Runtime implementors (Device manufacturers)
- OpenXR API for App developers



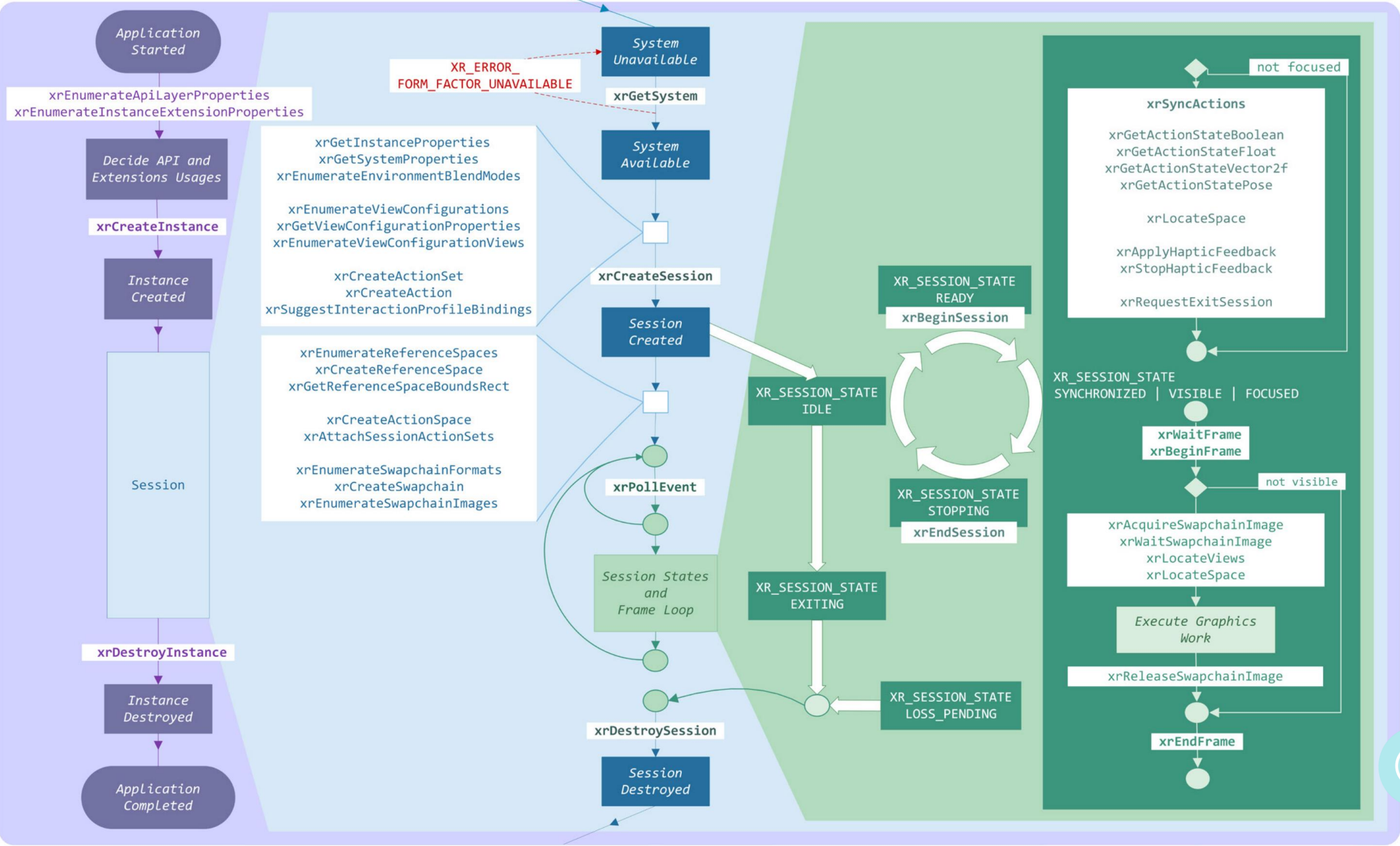
OpenXR API Concept & Terminology

- Instance
- Session
- Swapchain
- OpenGL/Vulkan/D3D11/D3D12 renderers
- Actions/ActionSets
- Interaction Profiles/Profile bindings
- View(Headset)/Local/Stage/Action Space
- Events
- Extensions/Vender specific extensions



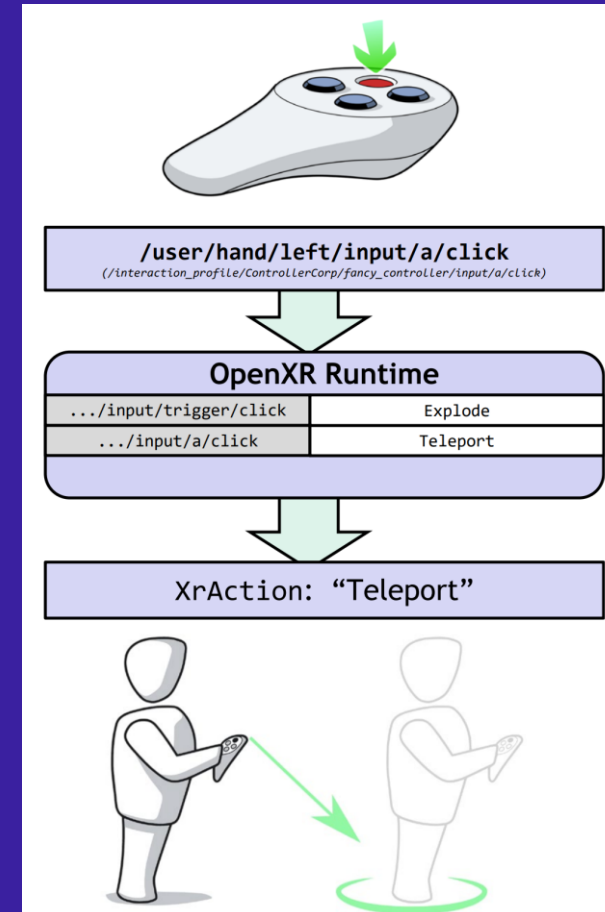
OpenXR API Overview

A high level overview of a typical OpenXR application including the order of function calls, creation of objects, session state changes, and the rendering loop.



Example: various VR Controller profiles

- App Developer needs to initiates the OpenXR "Instance", to do so, developer must Claire app's support "Profiles".
- During the frame loop session, when User invokes an input event, it is handled by OpenXR runtime.
- OpenXR runtime will dispatch correct "Action"



xrSuggestInteractionProfileBindings 1

- Standard defines “khr/simple_controller” as a minimal subset profile
- Note here that grab_object is float, but suggested to bind to “select/click” (boolean)
 - Runtime will automatically convert boolean to a 1 or 0.

actionName	actionType	subaction path	/interaction_profiles/khr/simple_controller
grab_object	Float Input	/user/hand/left	/user/hand/left/input/select/click
		/user/hand/right	/user/hand/right/input/select/click
hand_pose	Pose Input	/user/hand/left	/user/hand/left/input/grip/pose
		/user/hand/right	/user/hand/right/input/grip/pose
quit_session	Boolean Input	/user/hand/left	/user/hand/left/input/menu/click
		/user/hand/right	/user/hand/right/input/menu/click
vibrate_hand	Vibration Output	/user/hand/left	/user/hand/left/output/haptic
		/user/hand/right	/user/hand/right/output/haptic

xrSuggestInteractionProfileBindings 2

- HTC Vive controller
- The grab_object action is here suggested for the “squeeze/click” input
 - still boolean like simple controller, but squeeze instead of select

actionName	actionType	subaction path	/interaction_profiles/htc/vive_controller
grab_object	Float Input	/user/hand/left	/user/hand/left/input/squeeze/click
		/user/hand/right	/user/hand/right/input/squeeze/click
hand_pose	Pose Input	/user/hand/left	/user/hand/left/input/grip/pose
		/user/hand/right	/user/hand/right/input/grip/pose
quit_session	Boolean Input	/user/hand/left	/user/hand/left/input/menu/click
		/user/hand/right	/user/hand/right/input/menu/click
vibrate_hand	Vibration Output	/user/hand/left	/user/hand/left/output/haptic
		/user/hand/right	/user/hand/right/output/haptic

xrSuggestInteractionProfileBindings 3

- Oculus Touch controller
- Has a float input suitable for grab_object action - called “squeeze/value”
- Only left controller has a menu button, so not suggesting a binding for quit_session on the right hand.

actionName	actionType	subaction path	/interaction_profiles/oculus/touch_controller
grab_object	Float Input	/user/hand/left	/user/hand/left/input/squeeze/value
		/user/hand/right	/user/hand/right/input/squeeze/value
hand_pose	Pose Input	/user/hand/left	/user/hand/left/input/grip/pose
		/user/hand/right	/user/hand/right/input/grip/pose
quit_session	Boolean Input	/user/hand/left	/user/hand/left/input/menu/click
		/user/hand/right	
vibrate_hand	Vibration Output	/user/hand/left	/user/hand/left/output/haptic
		/user/hand/right	/user/hand/right/output/haptic

Viabale C# XR Game Engines/Frameworks comparison

In foreseeable future, the following Game Engines/Frameworks should be able to support developing OpenXR app using C#:

- **Unity3D**(<https://unity.com>)
- **StereoKit**(<https://stereokit.net>)
- **Godot-mono**(<https://godotengine.org/article/introducing-csharp-godot>) with
OpenXR plugin(https://github.com/GodotVR/godot_openxr)
- **Evergine MRTK**(formerly Wave Engine)
(<https://github.com/EvergineTeam/MixedRealityToolkit>)
- **Stride** Game Engine(formerly Xenko)

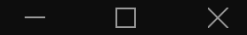
Game Engine based v.s. Code-based development

- Unity3D
- Powerful WYSIWYG Editor
- Easier to produce beautiful 3D content
- Less control of app developers
- Harder to SCM & co-work with others
- StereoKit
- Do almost everything via developer's code
- Hard to produce astonished 3D content
- Much easier to co-work with others

Unity3D OpenXR project creation

- 流程跟去年分享的HoloLens 2 使用Unity + MRTK開發差不多
- 微軟官方提供一個新工具(Mixed Reality Feature Tool)讓專案套件安裝便利快速不少：
<https://www.microsoft.com/en-us/download/details.aspx?id=102778>

Unity Hub 3.0.0-beta.7



New project

Editor Version: **2020.3.25f1** LTS ↕

☰ All templates

▣ Core

▣ Sample

🎓 Learning

🔍 Search all templates



2D

Core



3D

Core



3D Sample Scene (HDRP)

Sample



3D Sample Scene (URP)

Sample



VR

Core



3D

This is an empty 3D project that uses Unity's built-in renderer.

📖 [Read more](#)

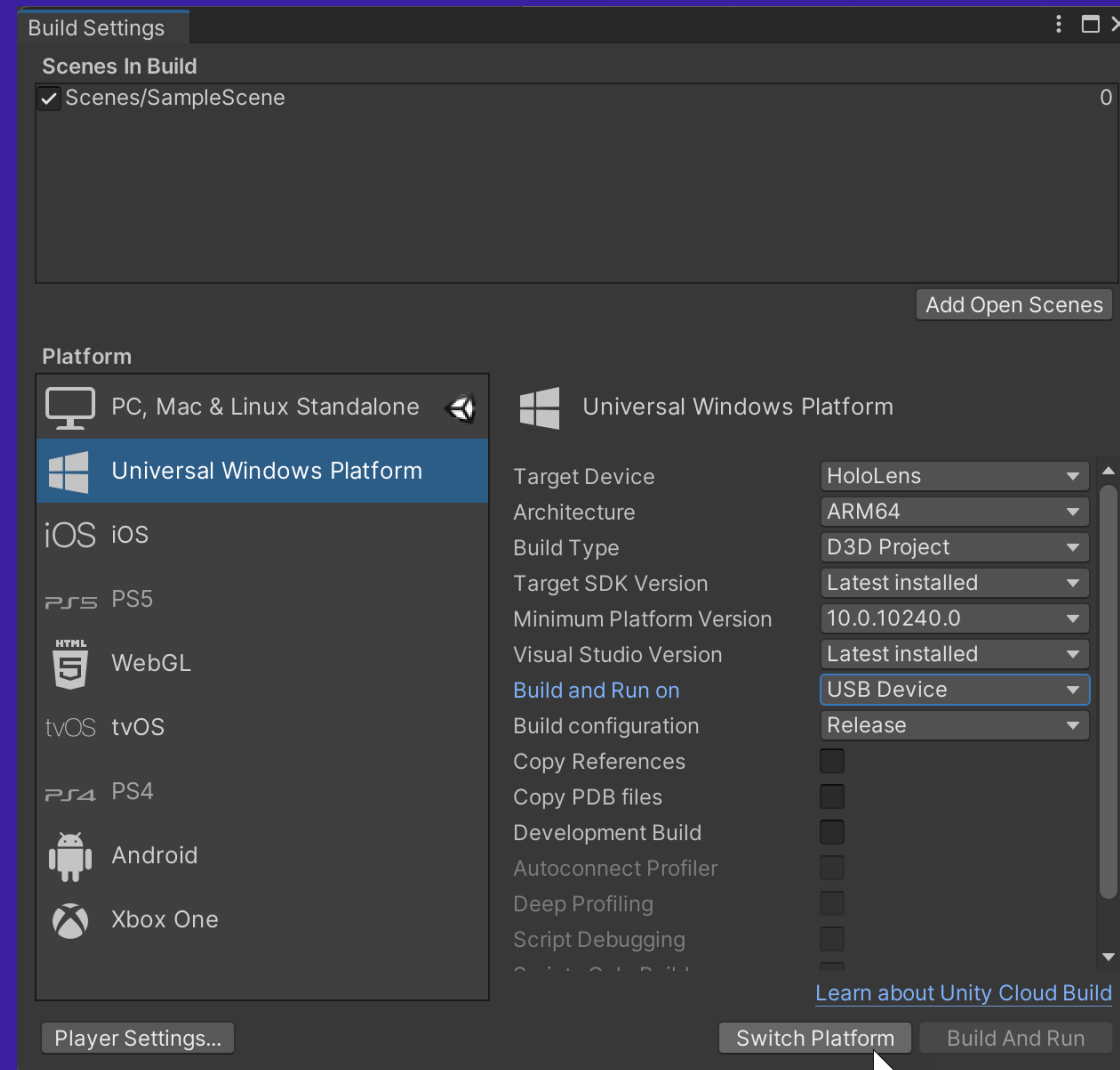
PROJECT SETTINGS

Project name

MRTK27OpenXrTutorial

Cancel

Create project





Select project

The Mixed Reality Feature Tool needs to know the location of your Unity project.

Project Path:



Project Unity version: 2020.3.25f1

NOTE: To be recognized as a Unity project, the selected folder must contain Assets, Packages and ProjectSettings folders.



Go Back

Discover Features

Discover Features

☒	Mixed Reality Toolkit Foundation	2.7.3	(Details)
☒	Mixed Reality Toolkit GPU Stats	1.0.3	(Details)
☐	Mixed Reality Toolkit Microphone Stream Selector	1.0.0	(Details)
☐	Mixed Reality Toolkit Plane Finding	1.0.0	(Details)
☐	Mixed Reality Toolkit Standard Assets	2.7.3	(Details)
☐	Mixed Reality Toolkit Test Utilities	2.7.3	(Details)
☐	Mixed Reality Toolkit Tools	2.7.3	(Details)

Platform Support (1 of 4)

Select None

☒	Mixed Reality OpenXR Plugin	1.2.1	(Details)
-------------------------------------	-----------------------------	-------	---------------------------

Last updated 12/18/2021 2:17:17 AM



Go Back

Get Features

Import Features

The Mixed Reality Feature Tool has identified the packages that are required to import your chosen features.

Features

- ☒ **Mixed Reality Toolkit Foundation** 2.7.3 [\(Details\)](#)
- ☒ **Mixed Reality Toolkit GPU Stats** 1.0.3 [\(Details\)](#)
- ☒ **Mixed Reality OpenXR Plugin** 1.2.1 [\(Details\)](#)

Required dependencies

- ☒ **Mixed Reality Toolkit Standard Assets** 2.7.3 [\(Details\)](#)

Mixed Reality Feature Tool

No validation issues were detected.

OK **2**



Go back

Validate **1**

Import **3**

Review and Approve

Manifest

```
{  
  "dependencies": {  
    "com.unity.collab-proxy": "1.15.4",  
    "com.unity.ide.rider": "2.0.7",  
    "com.unity.ide.visualstudio": "2.0.12",  
    "com.unity.ide.vscode": "1.2.4",  
    "com.unity.test-framework": "1.1.29",  
    "com.unity.textmeshpro": "3.0.6",  
    "com.unity.timeline": "1.4.8",  
    "com.unity.ugui": "1.0.0",  
    "com.unity.modules.ai": "1.0.0",  
    "com.unity.modules.androidjni": "1.0.0",  
    "com.unity.modules.animation": "1.0.0",  
    "com.unity.modules.assetbundle": "1.0.0",  
    "com.unity.modules.audio": "1.0.0",  
    "com.unity.modules.cloth": "1.0.0",  
    "com.unity.modules.director": "1.0.0",
```

Files to be copied into the project

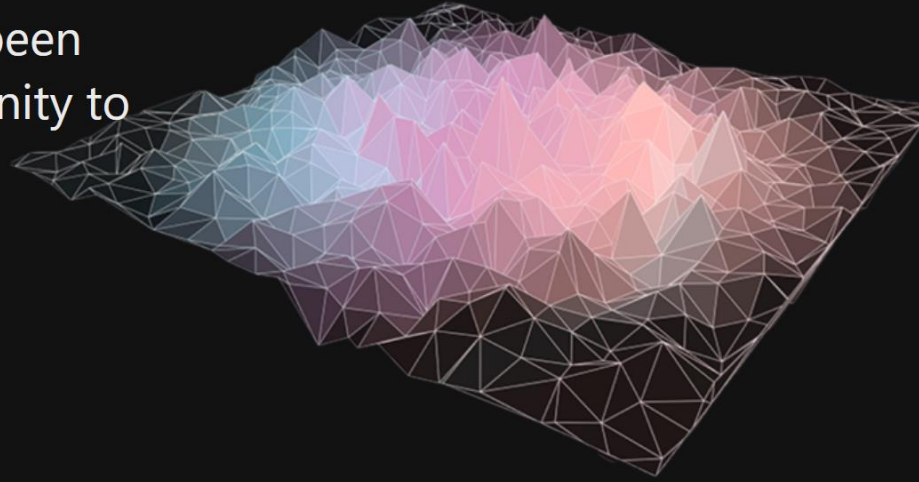
```
com.microsoft.mixedreality.toolkit.foundation-2.7.3.tgz  
com.microsoft.mixedreality.toolkit.gpustats-1.0.3.tgz  
com.microsoft.mixedreality.openxr-1.2.1.tgz  
com.microsoft.mixedreality.toolkit.standardassets-2.7.3.tgz
```

[Compare](#)[?](#)[Go Back](#)[Approve](#)



Unity Project Updated

Demo_MRTK_OpenXR has been updated. Please return to Unity to load the imported features.



Start Over

Exit

StereoKit OpenXR project creation

- 基本上就是 .NET 5 Visual Studio專案加上StereoKit的nuget套件
- 作者有提供Visual Studio專案的範本：
<https://marketplace.visualstudio.com/items?itemName=NickKlingensmith.StereoKitTemplates>

Visual Studio interface showing the StereoKitLink.csproj file in the Server Explorer. The code is an XML project file for a .NET SDK project. The `<TargetFramework>netcoreapp5.0</TargetFramework>` line is highlighted with a red box.

```
<?xml version='1.0' encoding='utf-8'>
<Project Sdk="Microsoft.NET.Sdk">
  <PropertyGroup>
    <OutputType>Exe</OutputType>
    <TargetFramework>netcoreapp5.0</TargetFramework>
    <ApplicationIcon>StereoKitInk.ico</ApplicationIcon>
  </PropertyGroup>
  <ItemGroup>
    <Compile Remove="StereoKitInk_UWP\**" />
    <EmbeddedResource Remove="StereoKitInk_UWP\**" />
    <None Remove="StereoKitInk_UWP\**" />
  </ItemGroup>
  <ItemGroup>
    <PackageReference Include="StereoKit" Version="0.3.4" />
  </ItemGroup>
  <ItemGroup>
    <None Update="Assets\InkBottle.glb">
      <CopyToOutputDirectory>PreserveNewest</CopyToOutputDirectory>
    </None>
    <None Update="Assets\InkSplat.glb">
      <CopyToOutputDirectory>PreserveNewest</CopyToOutputDirectory>
    </None>
    <None Update="Assets\StereoKitInkLight.png">
      <CopyToOutputDirectory>PreserveNewest</CopyToOutputDirectory>
    </None>
  </ItemGroup>
</Project>
```

The Solution Explorer on the right shows the project structure for StereoKitLink, including Dependencies, Properties, Assets, Docs, .gitignore, LICENSE, Painting.cs, PaletteMenu.cs, Program.cs, README.md, StereoKitInk.ico, StereoKitInk.svg, and StereoKitInk_UWP (unloaded).

The Properties window at the bottom right shows the XML Document properties, including Encoding (Unicode (UTF-8)) and Output path (C:\Program Files\Microsoft Visual Studio).

Source code: <https://github.com/maluoi/StereoKit-PaintTutorial>

Demo

順便秀一下怎樣在Windows 11上跑WMR的電腦模擬器

Recap & References

- Metaverse is an on-going concept, like Internet.
- With OpenXR, the compatibility problem of various XR devices should be ease.
- References:
 - Khronos OpenXR Registry: <https://www.khronos.org/registry/OpenXR/>
 - OpenXR API history: <https://www.eet-china.com/news/202104290855.html>
 - Khronos GDC2019 presentation: <https://youtu.be/ITl-hAw3HY8>
 - MS Learn MRTK tutorial: <https://docs.microsoft.com/en-us/learn/modules/learn-mrtk-tutorials/>
 - StereoKit tutorial: <https://aka.ms/stereokit>
 - **MR/XR Developers Community** => 蒐集各類XR開發資訊的臉書社團
<https://www.facebook.com/groups/mrxrdevelopers>

Thanks for joining!



特別感謝



以及各位參與活動的你們



啟用Windows Mixed Reality模擬器

- 需要滿足最低硬體需求：
<https://docs.microsoft.com/en-us/windows/mixed-reality/enthusiast-guide/windows-mixed-reality-minimum-pc-hardware-compatibility-guidelines#minimum-pc-hardware-guidelines>
- 安裝**Mixed Reality Portal** (<https://www.microsoft.com/en-us/p/mixed-reality-portal/9ng1h8b3zc7m>)後，第一次執行時會檢查。
- 檢查通過的畫面先別急著按Next，改點左下角的"Setup simulation(for developers)"以便啟用模擬器功能。
- 啟用模擬器時仍須Internet連線下載額外部件，需要一些時間。



Mixed Reality Portal

Microsoft Corporation • [Entertainment](#)

Discover Windows Mixed Reality and dive into more than 3,000 games and VR experiences from Steam® VR and Microsoft Store. Get extraordinary access to live sports and entertainment and connect with others in the ultimate high-octane VR gaming experience.* Download this app to set up [More](#)

Free

Get

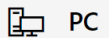
[⚠ See System Requirements](#)

Overview

System Requirements

Related

Available on



PC

Description

Discover Windows Mixed Reality and dive into more than 3,000 games and VR experiences from Steam® VR and Microsoft Store. Get extraordinary access to live sports and entertainment and connect with others in the ultimate high-octane VR gaming experience.* Download this app to set up and manage



Good to go

Your PC is ready to run mixed reality games and experiences.

Graphics card	NVIDIA GeForce RTX 2070	✓
Graphics driver	30.0.15.1006 (WDDM 3.0)	✓
CPU	11th Gen Intel(R) Core(TM) i7-1165G7 @ 2.80GHz	✓
RAM	32 GB	✓
Disk space	473 GB	✓
USB	3.0+	✓
Bluetooth (for controllers)	4.0	✓

Your PC looks good, but keep in mind that performance may vary depending on your exact setup. You'll also need to make sure your PC has the right ports for the headset you choose. [Learn more](#)

Set up simulation (for developers)



Next



Good to go

Your PC is ready to run mixed reality games and experiences.

Graphics card NVIDIA GeForce RTX 2070



Graphics driver 30.0.15.1006 (WDDM 3.0)



Set up simulation?

Set this up if you want to run Windows Mixed Reality as a desktop simulation. You can also set up a headset now, and add simulation later. (If you don't know what this is, you probably don't want to do it.)

Set up

Cancel



(for controllers) 4.0

Your PC looks good, but keep in mind that performance may vary depending on your exact setup. You'll also need to make sure your PC has the right ports for the headset you choose. [Learn more](#)

Set up simulation (for developers)

Next

啟用Windows Mixed Reality模擬器

- 模擬器功能啟用完成後，Mixed Reality Portal UI主畫面的左邊漢堡選單會多一個“For Developers”的選項，點進去之後有控制啟用軟體模擬及虛擬控制器相關設定的工具列。
- 相關操作的官方說明：<https://docs.microsoft.com/en-us/windows/mixed-reality/develop/advanced-concepts/using-the-windows-mixed-reality-simulator>
- 也可以藉由串接在PC上的Xbox搖桿來替代鍵盤滑鼠操作：<https://www.windowscentral.com/how-use-xbox-one-controller-windows-mixed-reality>

Mixed Reality Portal



 Headset
Disconnected

 Room boundary visuals



Set up room boundary

 New for you

 For developers

 See mixed reality photos

... See more



Welcome to Windows Mixed Reality

Connect your headset.

Don't have a VR headset? [Learn more about the latest devices](#)

Simulation

Headset

☒ On

Body

x: 0 yaw: 0
y: 0
z: 0

Head

Default tracking

yaw: 0
pitch: 0
roll: 0

Left controller

☒ On

Idle

x: -0.24 yaw: -0.27
y: 1.4 pitch: 0.1
z: -0.49 roll: 0



Touchpad



Thumbstick



Battery

Right controller

☐ Off

Input settings

☒ Use keyboard for simulation☒ Use mouse for simulation☒ Use gamepad for simulation

Turn ON/OFF software simulation

3D Viewer

