Welcome to the World of Tomorrow

A practical Approach to Mixed Reality

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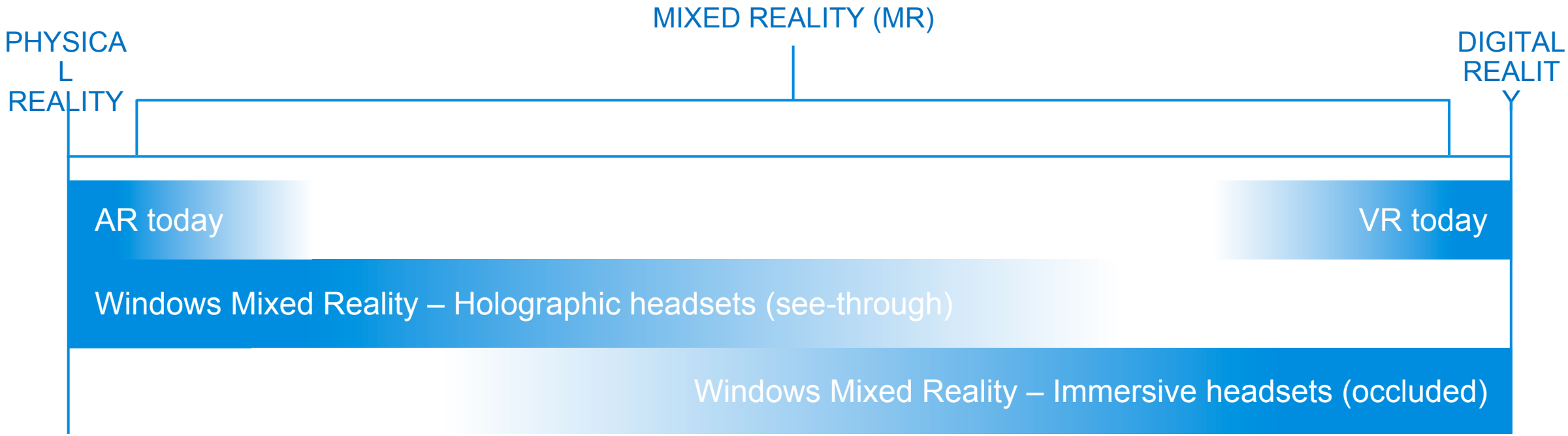
Agenda

1. What is Mixed Reality?
2. Demo
3. Hardware
4. Development
5. Tips & Tricks

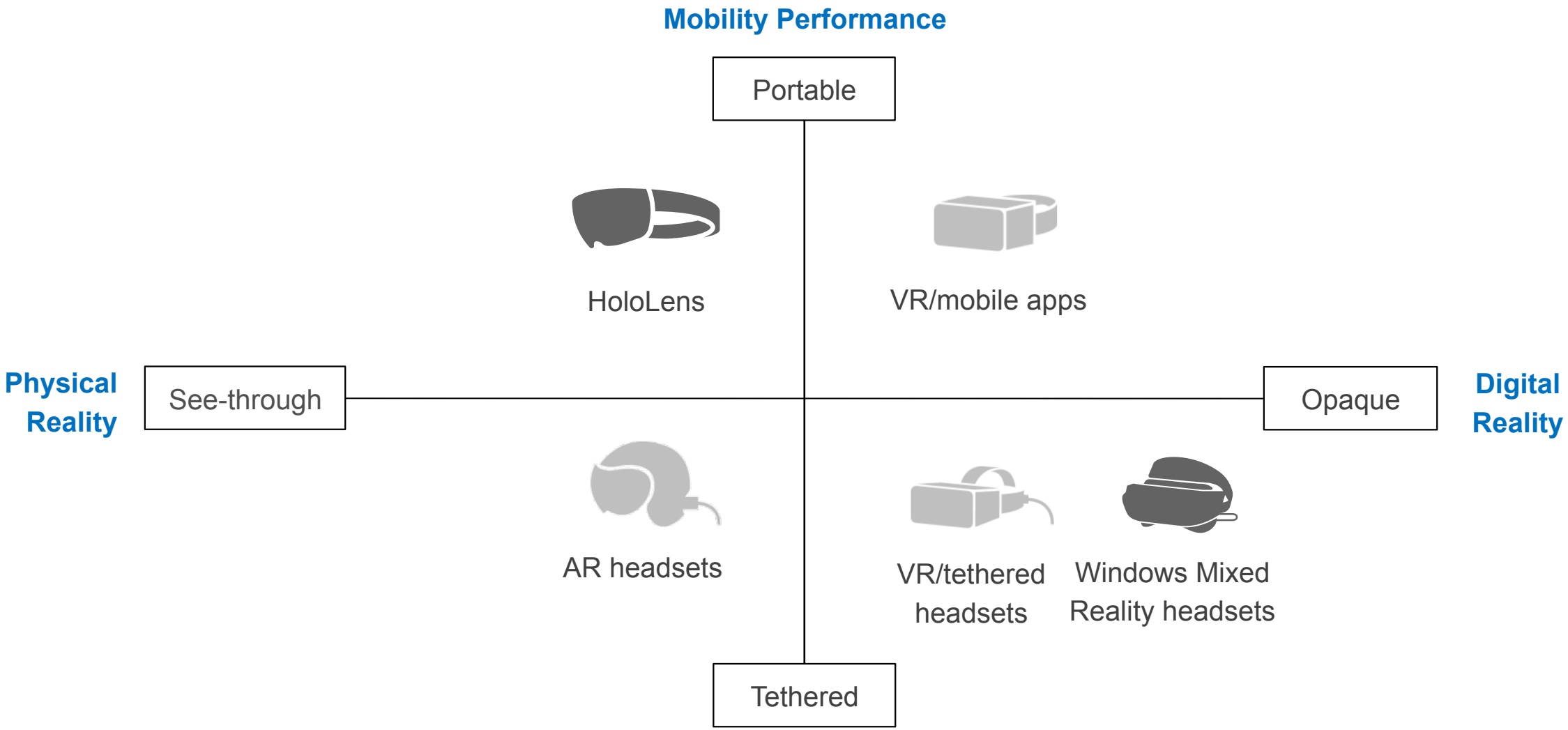
What is Mixed Reality?

Windows 10

Mixed Reality Spectrum



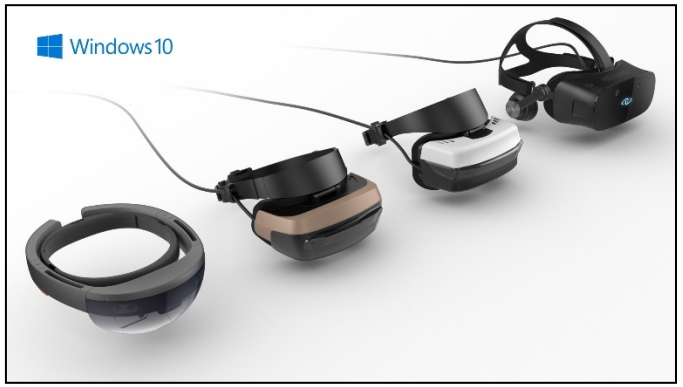
Device Categories



What makes us different?

Freedom of movement

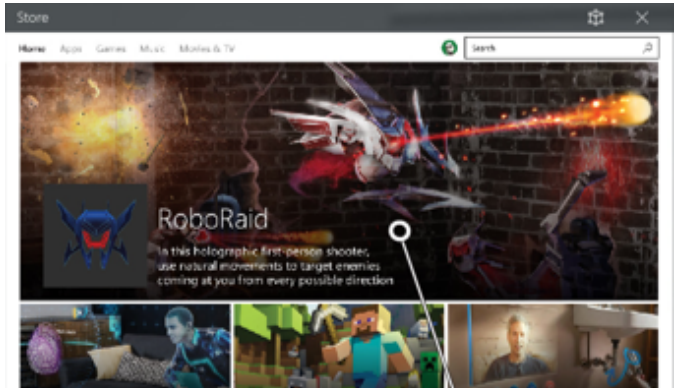
Single, consistent user interface



More choice, more customers

Effortless setup

One SDK for many devices



Windows Store for mixed reality apps

Demo

Windows

Transforming industries

Creation & Design

Assembly & Manufacturing

Training & Development

Communication & Understanding

Entertainment & Engagement

Hardware

Windows

End-User PC Guidelines

	Minimum	Recommended
Processor	**Notebook:** Intel Mobile Core i5 7th generation CPU, Dual-Core with Hyper Threading **Desktop:** Intel Desktop i5 6th generation CPU, Dual-Core with Hyper Threading **OR** AMD FX4350 4.2Ghz Quad-Core equivalent	**Desktop:** Intel Desktop i7 6th generation (6 Core) **OR** AMD Ryzen 5 1600 (6 Core, 12 threads)
GPU	**Notebook:** NVIDIA GTX 965M, AMD RX 460M (2GB) equivalent or greater DX12 capable GPU **Desktop:** NVIDIA GTX 960/1050, AMD Radeon RX 460 (2GB) equivalent or greater DX12 capable GPU	**Desktop:** NVIDIA GTX 980/1060, AMD Radeon RX 480 (2GB) equivalent or greater DX12 capable GPU
GPU driver WDDM version	WDDM 2.2 driver	
Thermal Design Power	15W or greater	
Graphics display ports	1x available graphics display port for headset (HDMI 1.4 or DisplayPort 1.2 for 60Hz headsets, HDMI 2.0 or DisplayPort 1.2 for 90Hz headsets)	
Display resolution	Resolution: SVGA (800x600) or greater Bit depth: 32 bits of color per pixel	
Memory	8 GB of RAM or greater	16 GB of RAM or greater
Storage	>10 GB additional free space	
USB Ports	1x available USB port for headset (USB 3.0 Type-A) **Note: USB must supply a minimum of 900mA**	
Bluetooth	Bluetooth 4.0 (for accessory connectivity)	

Windows 10 Mixed Reality PC Requirements

	Min Laptop PC Requirements*	Min Desktop PC Requirements*
CPU	Intel Mobile Core i5 (7.Gen) Dual-Core with Hyper Threading or AMD Mobile CPU (TBD)	Intel Desktop Core i5 (e.g. 6100) Dual-Core with Hyperthreading or AMD FX4350 Quad-Core equivalent
GPU	NVIDIA GTX 965M / AMD RX 460 (2GB) equivalent or greater DX12 Capable GPU	NVIDIA GTX 960/1050 / AMD Radeon RX 460 (2GB) equivalent or greater
Connectivity	HDMI 1.4 for 60 Hz HMDs, HDMI 2.0/DP for 90 Hz HMDs	
RAM	8GB	
HDD	>10 GB additional free space	
USB	USB 3.0 Type-A or USB 3.1 Type-C Port with DisplayPort Alternate Mode	
BT	Bluetooth 4.0 - for accessories	

The display resolution and refresh rate of the HMD will drive the minimum PC compute (CPU, GPU and display connectivity) requirements

Headsets

Windows

Mixed Reality Headsets

Holographic Headsets

- Untethered computer
- Holographic Processing Unit
- Advanced sensors

Immersive Headsets

- Tethered, computer required
- Freedom to place the system where you want

Development Edition HoloLens

Holographic resolution: 2.3M light points

Holographic density: >2.5k light points per radian

Automatic pupillary distance calibration

1 custom-built 32-bit HPU (Holographic Processing Unit)

2GB RAM / 64GB storage

4 environment cameras, 1 depth camera, 1 2MP video camera

4 microphones

1 IMU (Inertial Measurement Unit)

Wifi 802.11ac / Bluetooth 4.1 LE / USB 2.0

Audio 3.5mm jack

Development Edition Immersive Headsets: Acer and HP

Two high-resolution LCD at 1440 x 1440

2.89” diagonal display size (x2)

Front hinged display

95° horizontal field of view

Display refresh rate up to 90 Hz (native)

Built-in audio out and microphone support through 3.5mm jack

Single cable with HDMI 2.0 (display) & USB 3.0 (data) 4.00m/ 0.60m removable cable

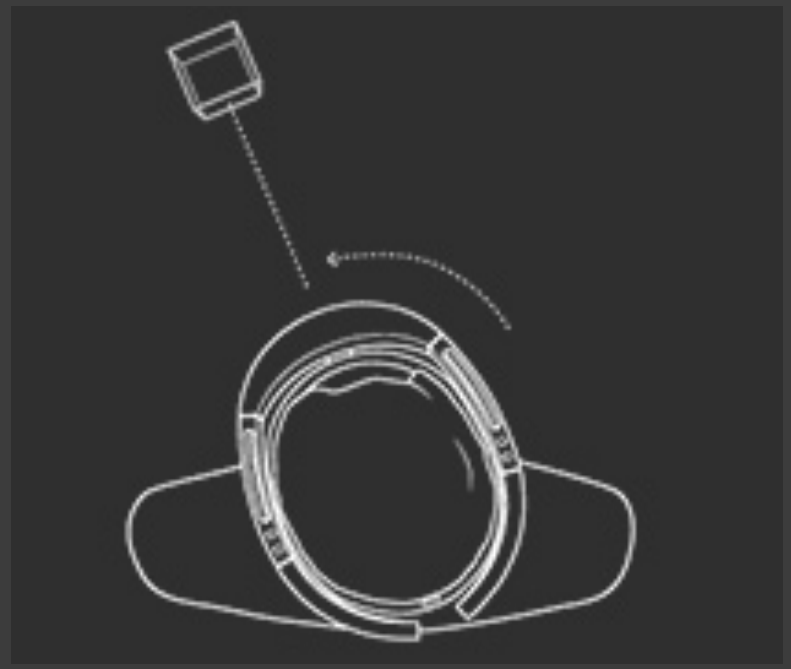
Inside-out tracking

Input

Windows

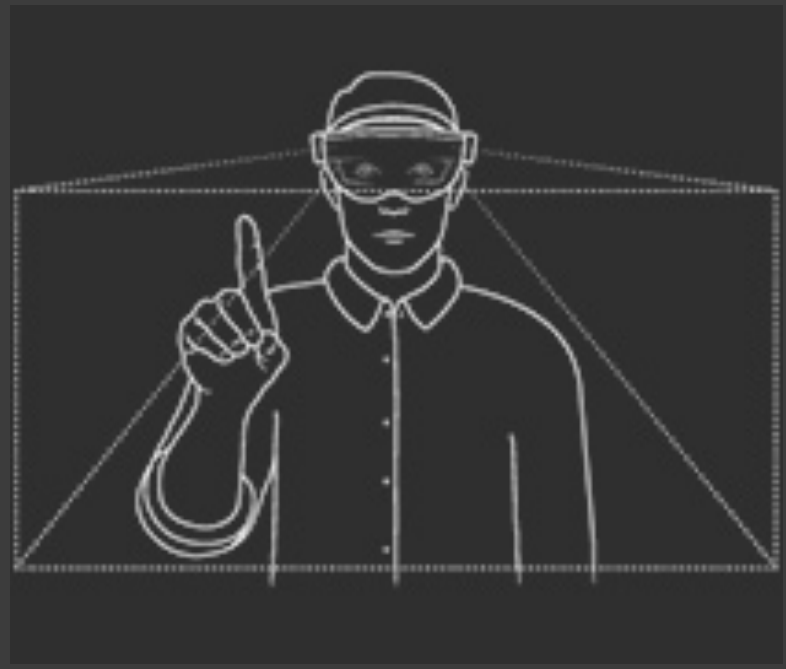
Gaze

Gaze tells you where the user is looking in the world and lets you determine their intent



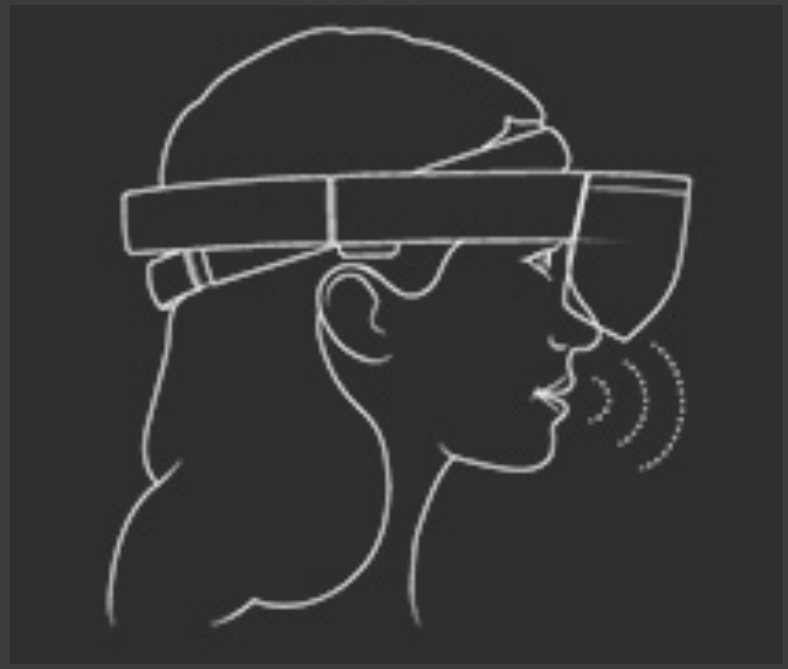
Gesture

Gesture input lets you interact with your holograms naturally using your hands or, optionally, with a clicker

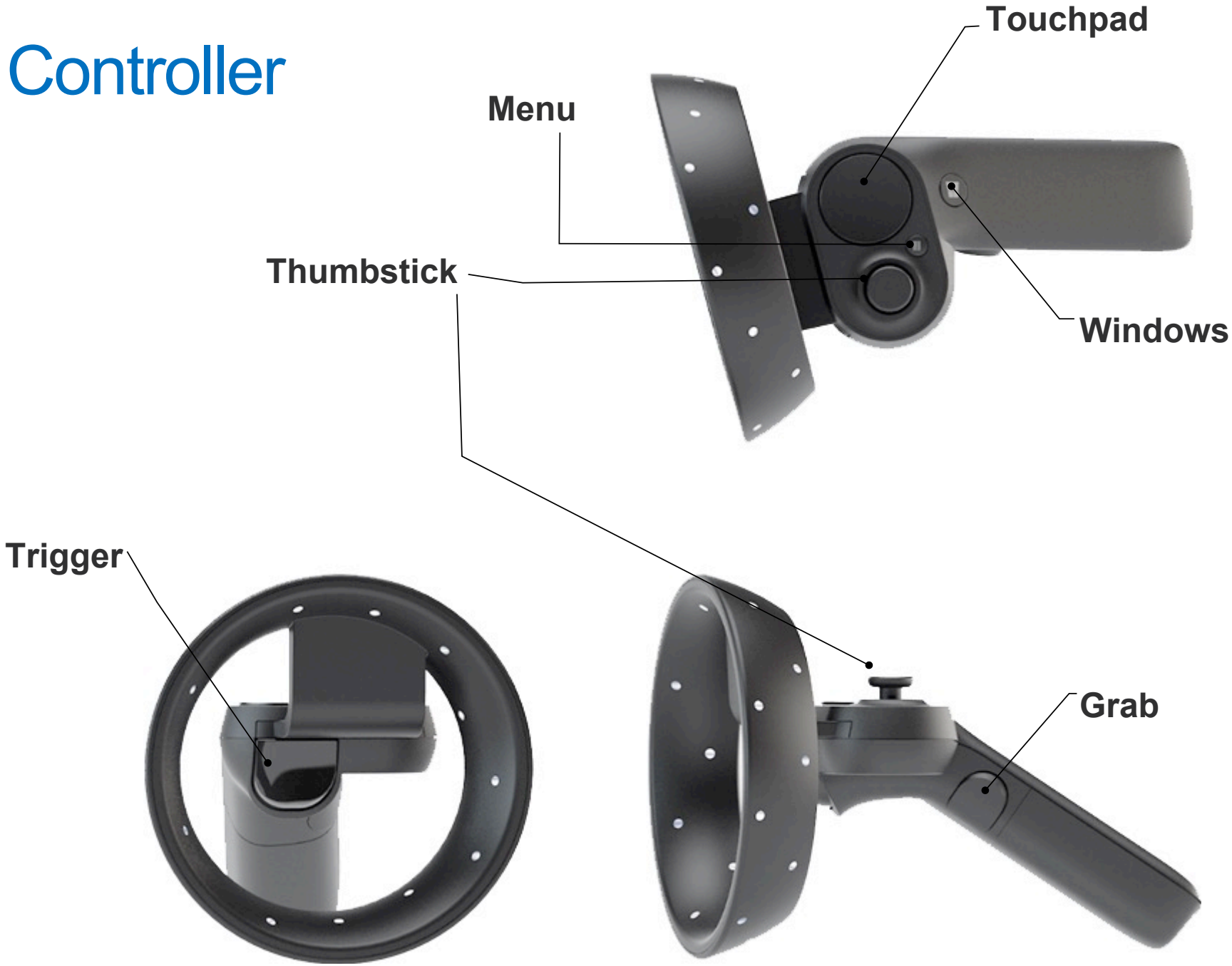


Voice Commands

Voice allows you to directly command a hologram without having to use gestures. You simply gaze at a hologram and speak your command.



Motion Controller



Input Diversity

Support for variety of inputs

Seamless input switching

Feature	HoloLens	Immersive headsets
Gaze	✔	✔
Gestures	✔	
Voice	✔	✔
Gamepad	✔	✔
Motion controllers		✔

Development

Windows

Development Tools

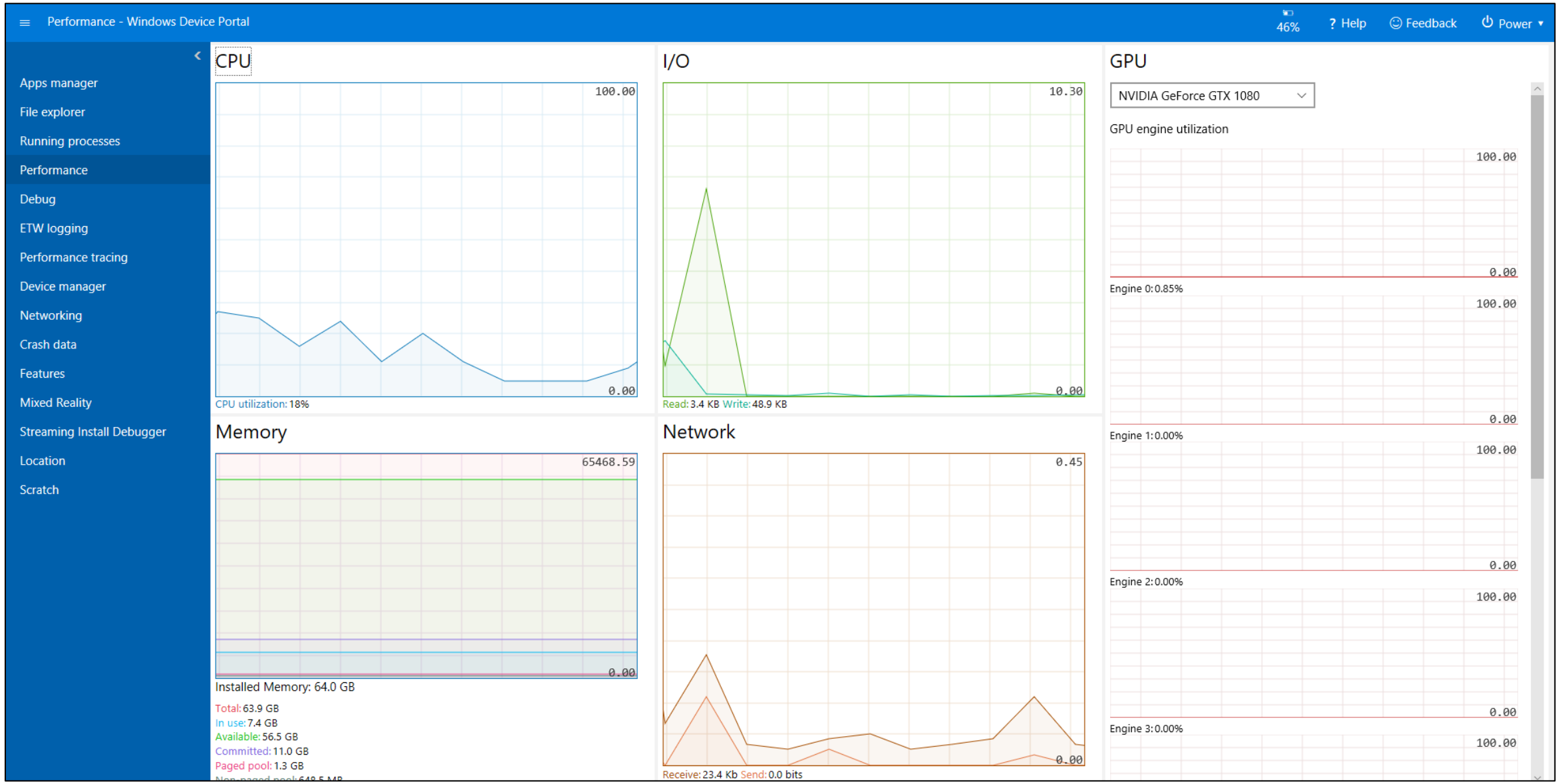
Built-In Tools: Mixed Reality Portal

Available at Microsoft Store

Used for MixedReality capture

Provides emulator for IHMD and input

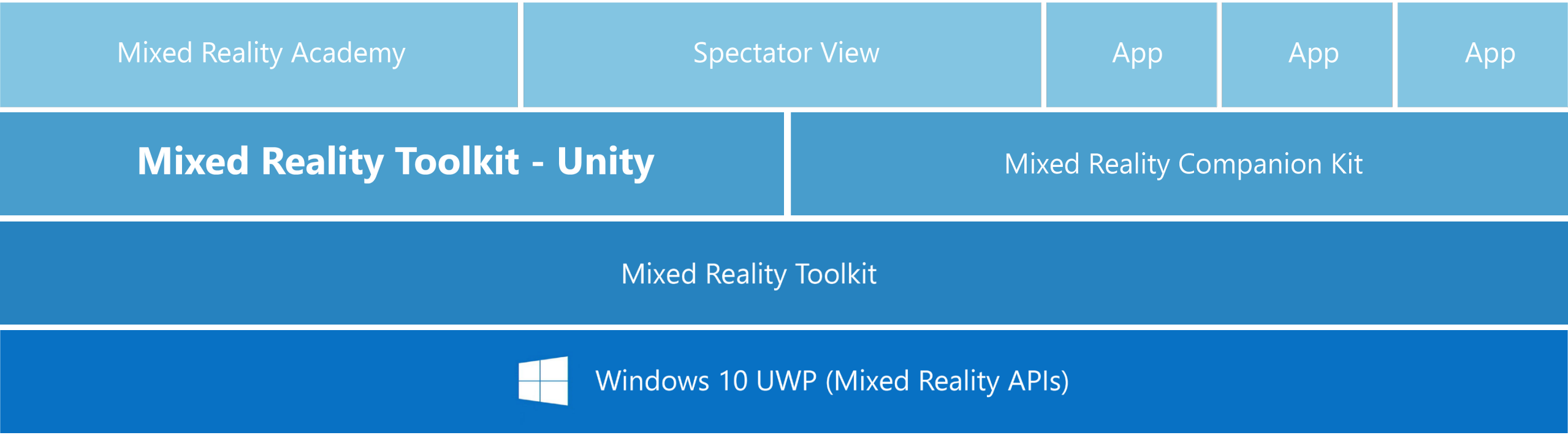
Build-In Tools: Device Portal



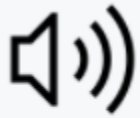
GPU Performance Analysis: Obtaining the Logs

```
C:\Program Files (x86)\Windows Kits\10\Windows Performance Toolkit\gpuview>log
Xperf -on LOADER+PROC_THREAD+CSWITCH+DISPATCHER+POWER+DISK_IO+HARD_FAULTS+PROFILE+MEMINFO+DPC+INTERRUPT -stackwalk @"C:\
Program Files (x86)\Windows Kits\10\Windows Performance Toolkit\gpuview\\EventsForStackTrace.txt" -BufferSize 1024 -MinB
uffers 120 -MaxBuffers 480 -f Kernel.etl

Xperf -start CaptureState -on 802ec45a-1e99-4b83-9920-87c98277ba9d:0x100236:5+a688ee40-d8d9-4736-b6f9-6b74935ba3b1:0xfff
f:5+CA11C036-0102-4A2D-A6AD-F03CFED5D3C9:0xf:6:'stack'+5d8087dd-3a9b-4f56-90df-49196cdc4f11:0xffffffffffffffff:6:'stack'
+db6f6ddb-ac77-4e88-8253-819df9bbf140:0xffffffffffffffff:6:'stack'+7E7D3382-023C-43cb-95D2-6F0CA6D70381:0x1 -BufferSize
1024 -MinBuffers 120 -MaxBuffers 480 -f CaptureState.etl

Xperf -capturestate CaptureState 802ec45a-1e99-4b83-9920-87c98277ba9d:0x10FFFF:5:'stack'+a688ee40-d8d9-4736-b6f9-6b74935
ba3b1:0xffff:5+CA11C036-0102-4A2D-A6AD-F03CFED5D3C9:0xf:6:'stack'+5d8087dd-3a9b-4f56-90df-49196cdc4f11:0xffffffffffffffff
f:6:'stack'+db6f6ddb-ac77-4e88-8253-819df9bbf140:0xffffffffffffffff:6:'stack'+7E7D3382-023C-43cb-95D2-6F0CA6D70381:0x1

Xperf -start NoCaptureState -on DX:0x2F+531A35AB-63CE-4BCF-AA98-F88C7A89E455:0xffff:4+ee685ec4-8270-4b08-9e4e-8b356f48f9
2f:0:1+802ec45a-1e99-4b83-9920-87c98277ba9d:0x208041:5:'stack'+f404b94e-27e0-4384-bfe8-1d8d390b0aa3+362007f7-6e50-4044-9
082-dfa078c63a73:0x000000000000ffff:0x5+8f2048e0-f260-4f57-a8d1-932376291682+8cc44e31-7f28-4f45-9938-4810ff517464:0xffff
:6+30336ed4-e327-447c-9de0-51b652c86108+8c416c79-d49b-4f01-a467-e56d3aa8234c:0xffff+a42c77db-874f-422e-9b44-6d89fe2bd3e5
:0x000000007fffffff:0x5+8c9dd1ad-e6e5-4b07-b455-684a9d879900:0xFFFF:6+9e9bba3c-2e38-40cb-99f4-9e8281425164:0xFFFF:6+3129
3f4f-f7bb-487d-8b3b-f537b827352f+42C4E0C1-0D92-46f0-842C-1E791FA78D52+28cf047a-2437-4b24-b653-b9446a419a69+a6a00efd-21f2
-4a99-807e-9b3bf1d90285:0x000000000000ffff:0x5+a0386e75-f70c-464c-a9ce-33c44e091623:0xffff:5 -BufferSize 1024 -MinBuffer
s 120 -MaxBuffers 480 -f NoCaptureState.etl

C:\Program Files (x86)\Windows Kits\10\Windows Performance Toolkit\gpuview>
```

Mixed Reality Toolkit



Mixed Reality Toolkit Features



HoloLens
IHMD

Spatial Sound

HoloLens
IHMD

UX Controls

HoloLens
IHMD

Utilities

HoloLens
IHMD

Spatial Mapping

HoloLens
IHMD

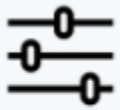
Sharing

HoloLens
IHMD

Input

HoloLens
IHMD

Spatial Understanding



HoloLens
IHMD

Build

HoloLens
IHMD

Boundary

Other helpful Tools

1. MixedReality Design Labs
2. Intel Graphics Performance Analyzer
3. Windows Performance Analyzer
4. DXCap

Tips & Tricks

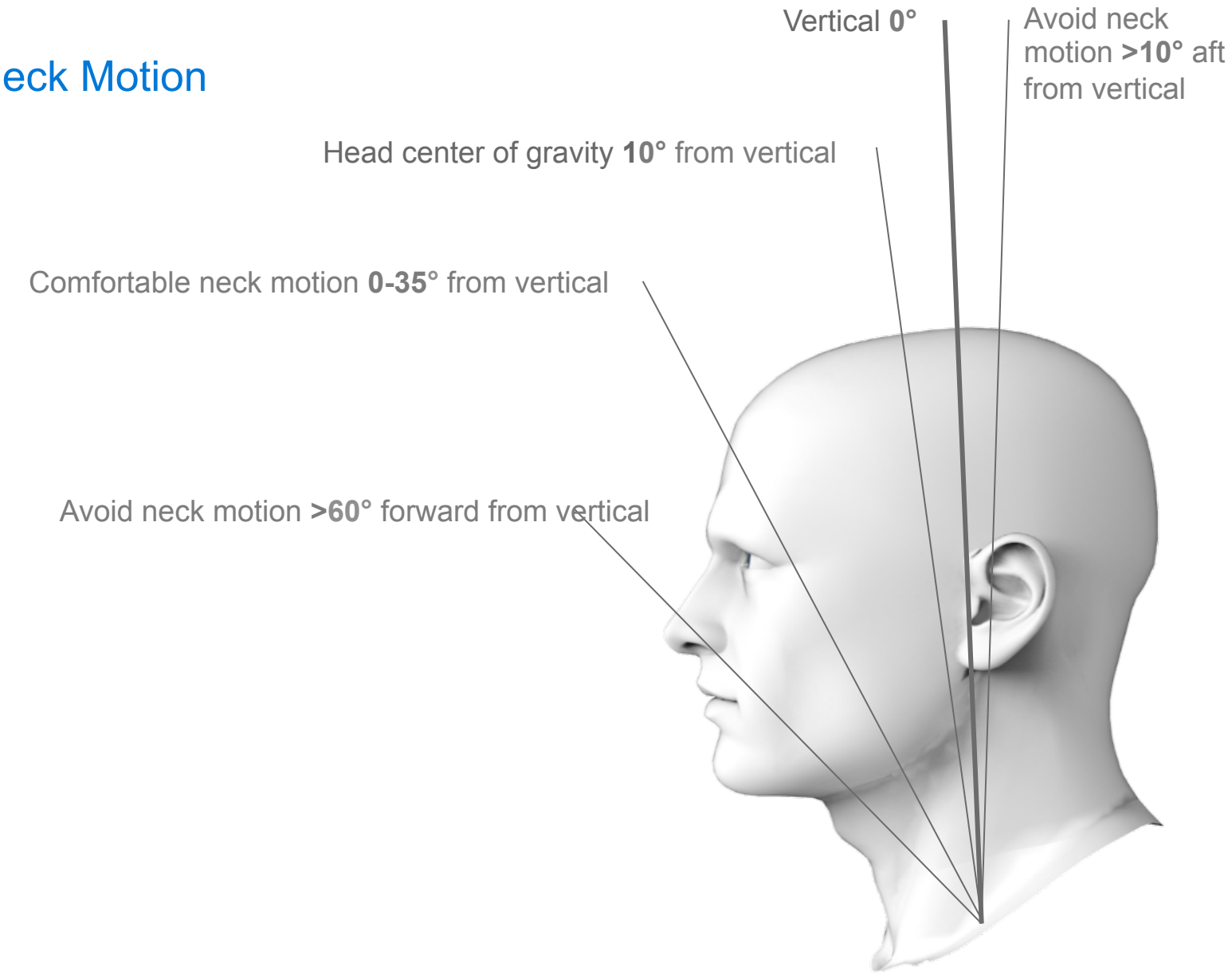
Windows

Placing Content Comfortably

Windows

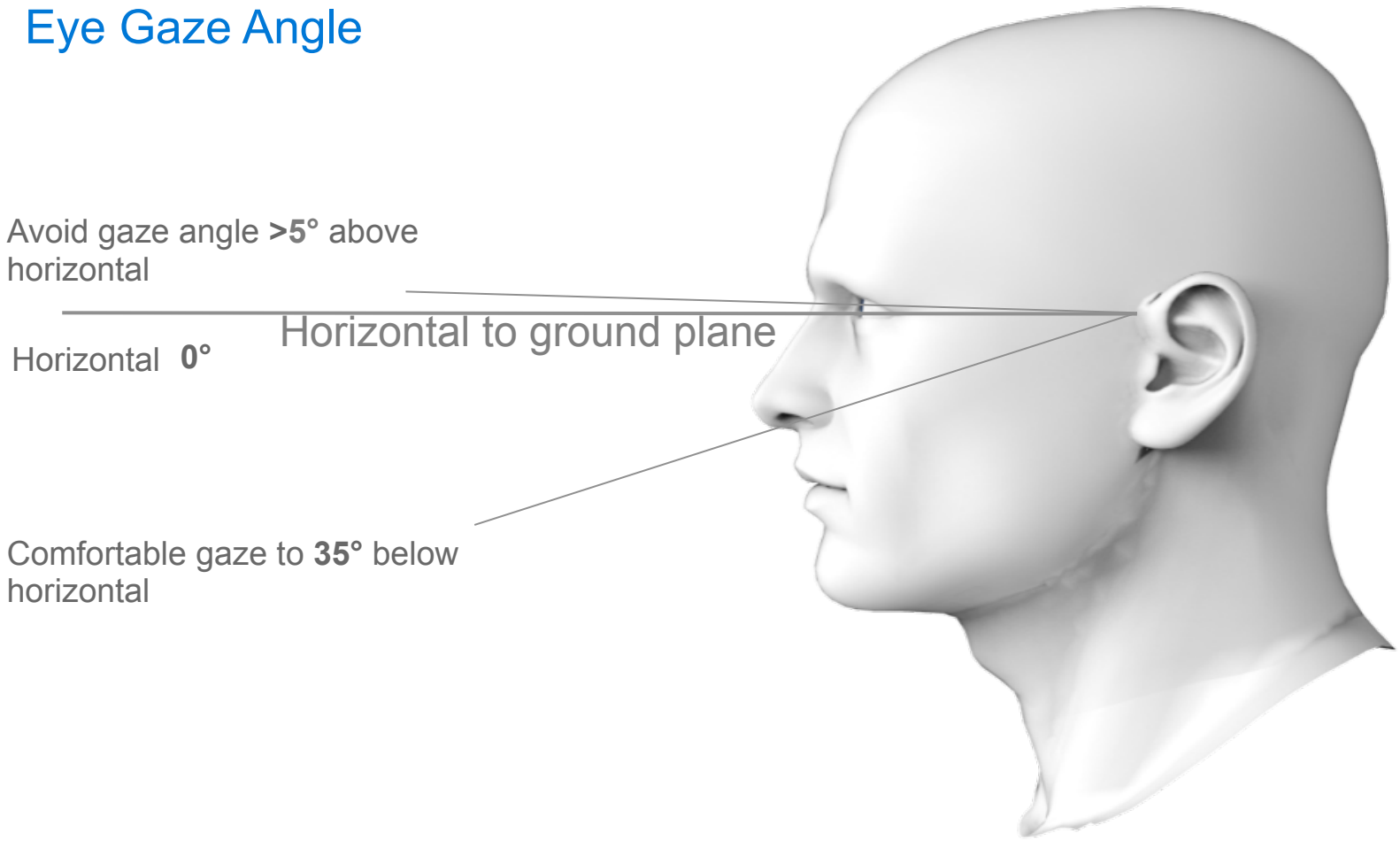
Placing Content Comfortably

Vertical Neck Motion



Placing Content Comfortably

Eye Gaze Angle



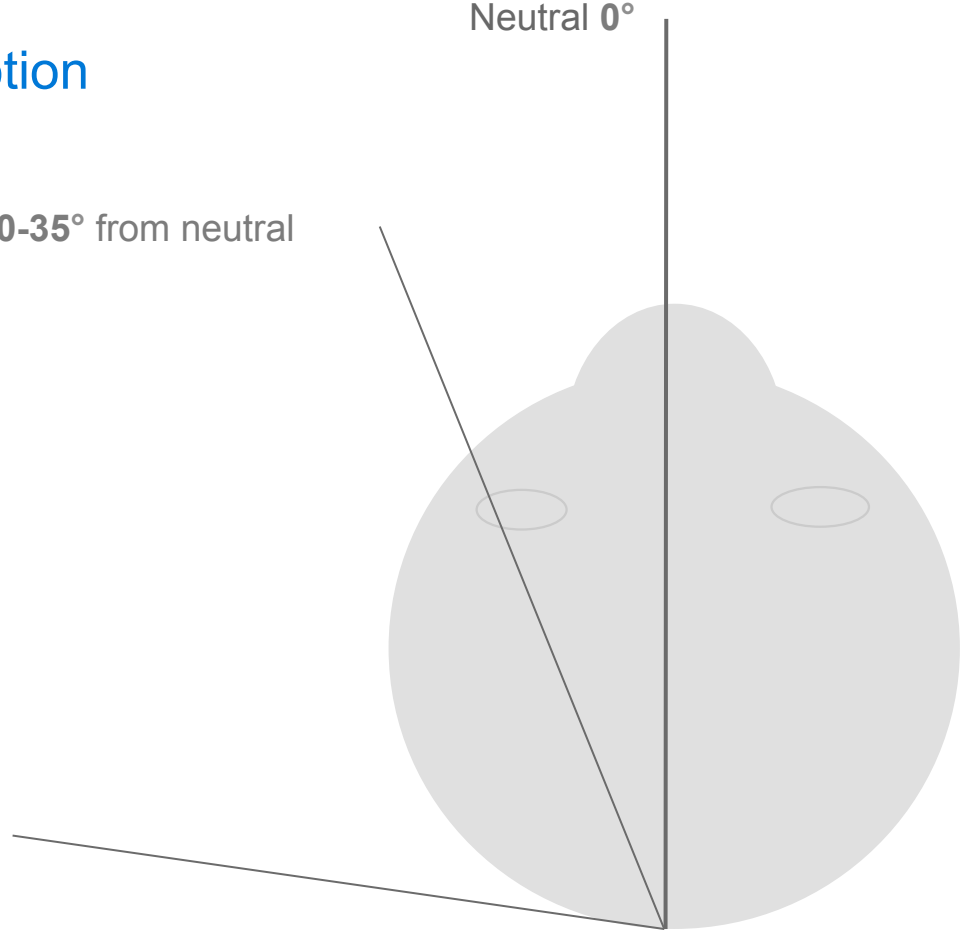
Placing Content Comfortably

Horizontal/Rotational Neck Motion

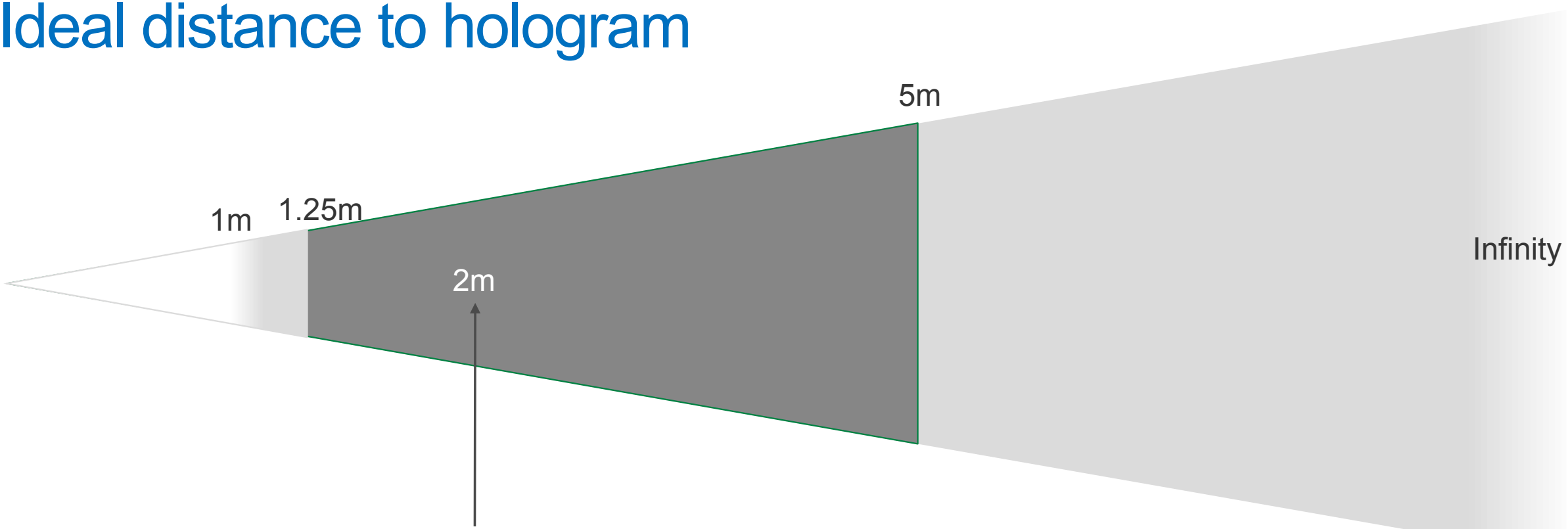
Neutral **0°**

Comfortable neck motion **0-35°** from neutral

Avoid neck rotation left or right **>80°** from neutral



Ideal distance to hologram



Highlighting Content

Windows

First Person Applications in Unity

http://www.naffblog.de/wp-content/uploads/2013/05/tumblr_m089f35TyA1qhy77fo1_500.jpg

https://upload.wikimedia.org/wikipedia/commons/0/0a/Cameraman_John_Fry_Wiltshire_UK.jpg

Transformation

Lerp Position at low latency

-> otherwise targeting actions feel sluggish

Lerp Rotation at a ratio

-> so the cursor respects surface without getting unusable

Lerp scale with added latency

->to give the user an understanding of depth

Selection

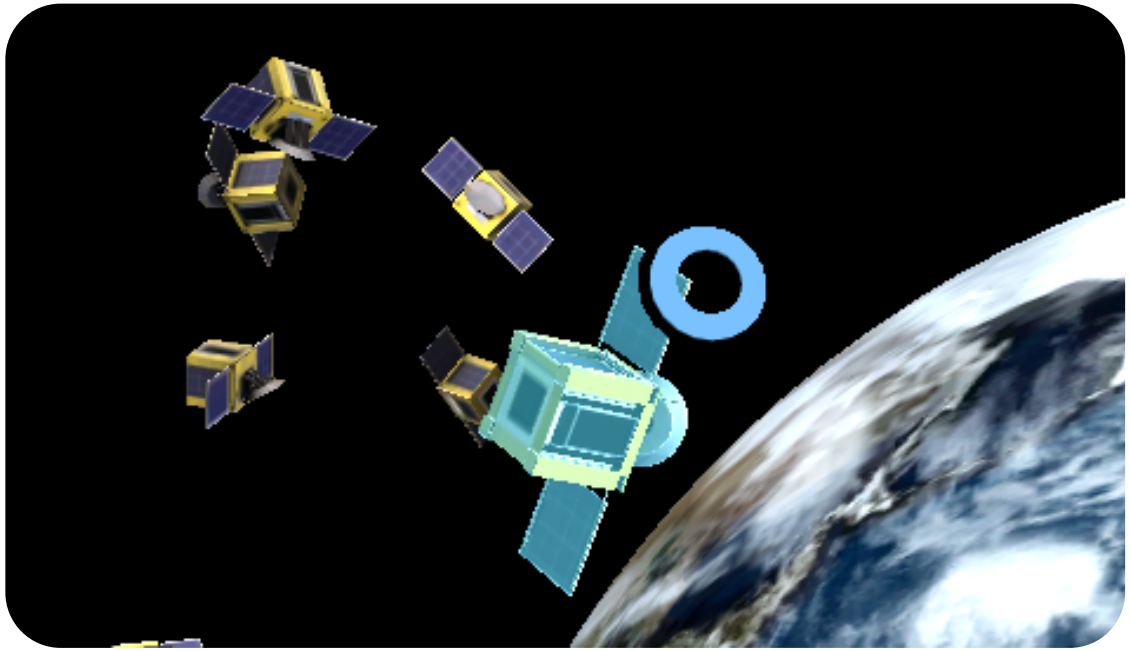
Use Magnetism or Gravity Well

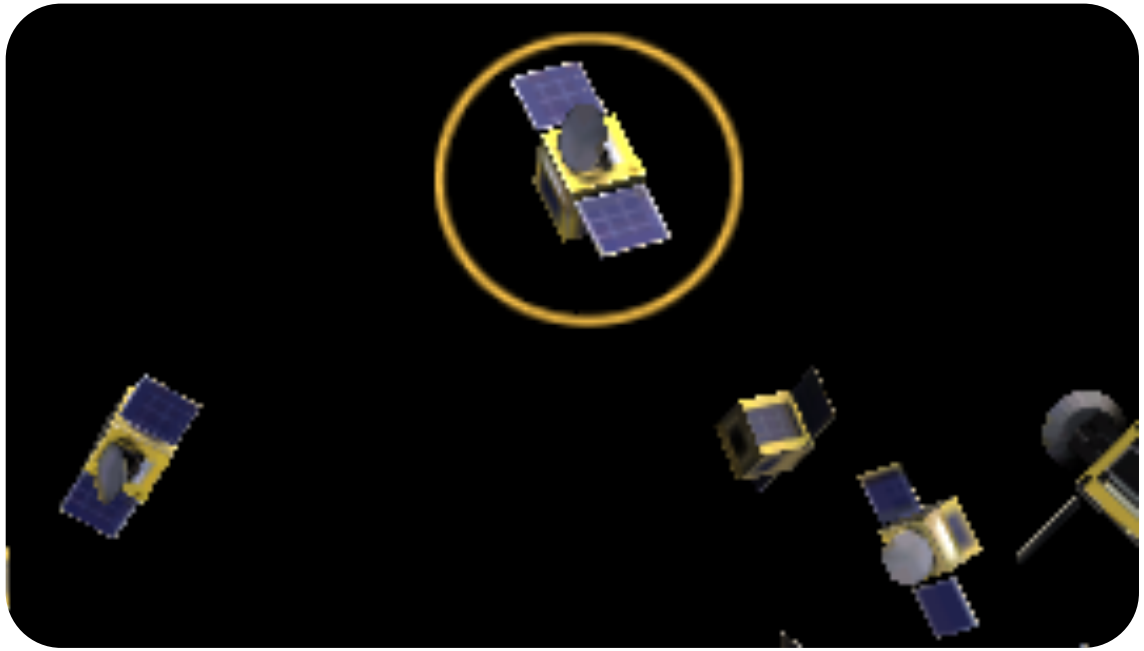
Soft lock the selection

Highlighting

Highlight targeted objects

Indicate actions the user can take whenever possible





Performance Matters

Framerate is King

Windows

Remember the Different Framerates

Immersive HMD target 90 FPS

HoloLens target 60 FPS

Preliminary Performance Testing

Do your Performance Test with each Update

Track the Frame Rate, GPU & CPU Usage and the Memory Usage

Apply Monitoring for your Performance Data

Device Portal is your best Friend

Identify potential issues and bugs, save money

http://www.gratismailer.com/wp-content/uploads/Geldesel-1.jpg

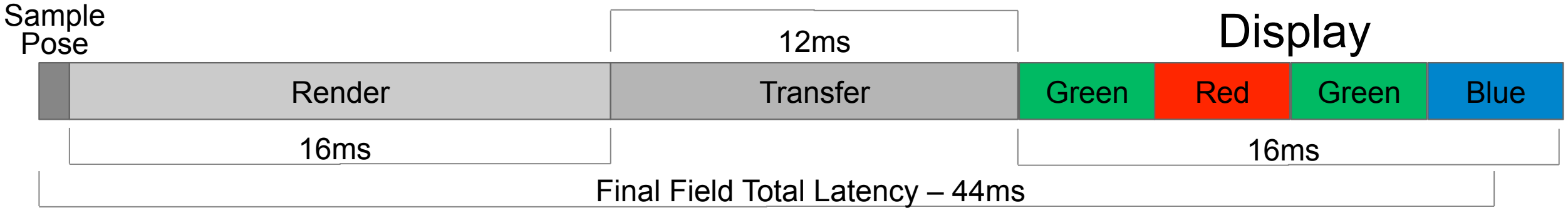
Preliminary Performance Testing

Why is it important to verify performance often

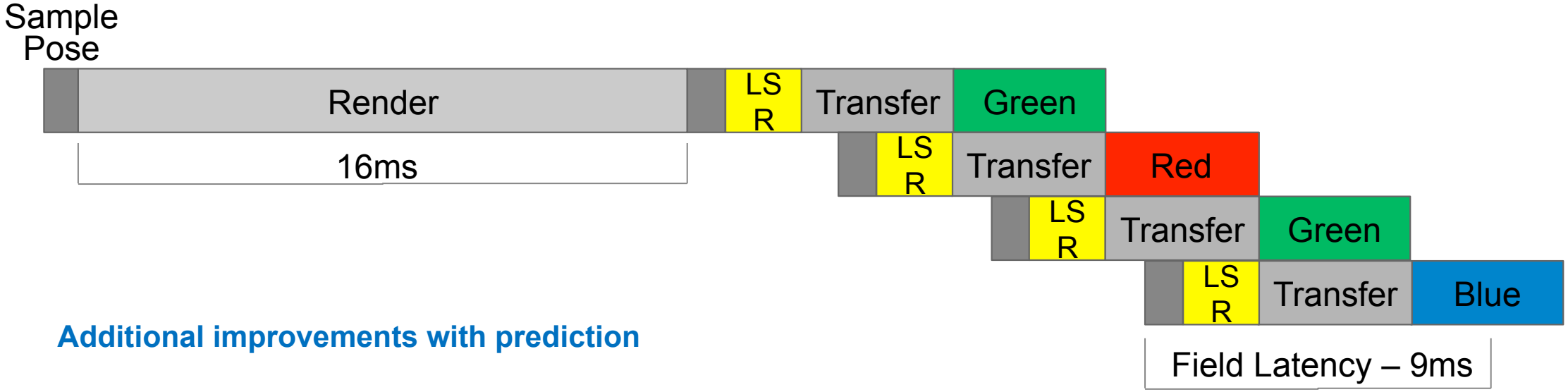
- The integrated Visual Studio Performance Profiler works for Mixed Reality (Exception: GPU)
- Testing graphics performance in Mixed Reality is different than normal flat apps due to the rendering pipeline
- VS Graphics Diagnostic Tools cannot properly capture frames in MR (as of writing).
- VS Graphics Diagnostic Tools is still a very good way of analyzing you graphics pipeline. For critical components or issues, you still may use this toolset on a flat/non-MR version of your app, specifically targeting performance testing. If you are using Unity, make a build without MR support, and profile using this build.
- Intel Graphics Performance Analyzer works for MR apps

Hologram Latency

Total latency to render a Hologram



Late Stage Re-projection (LSR) compensates for computational latency



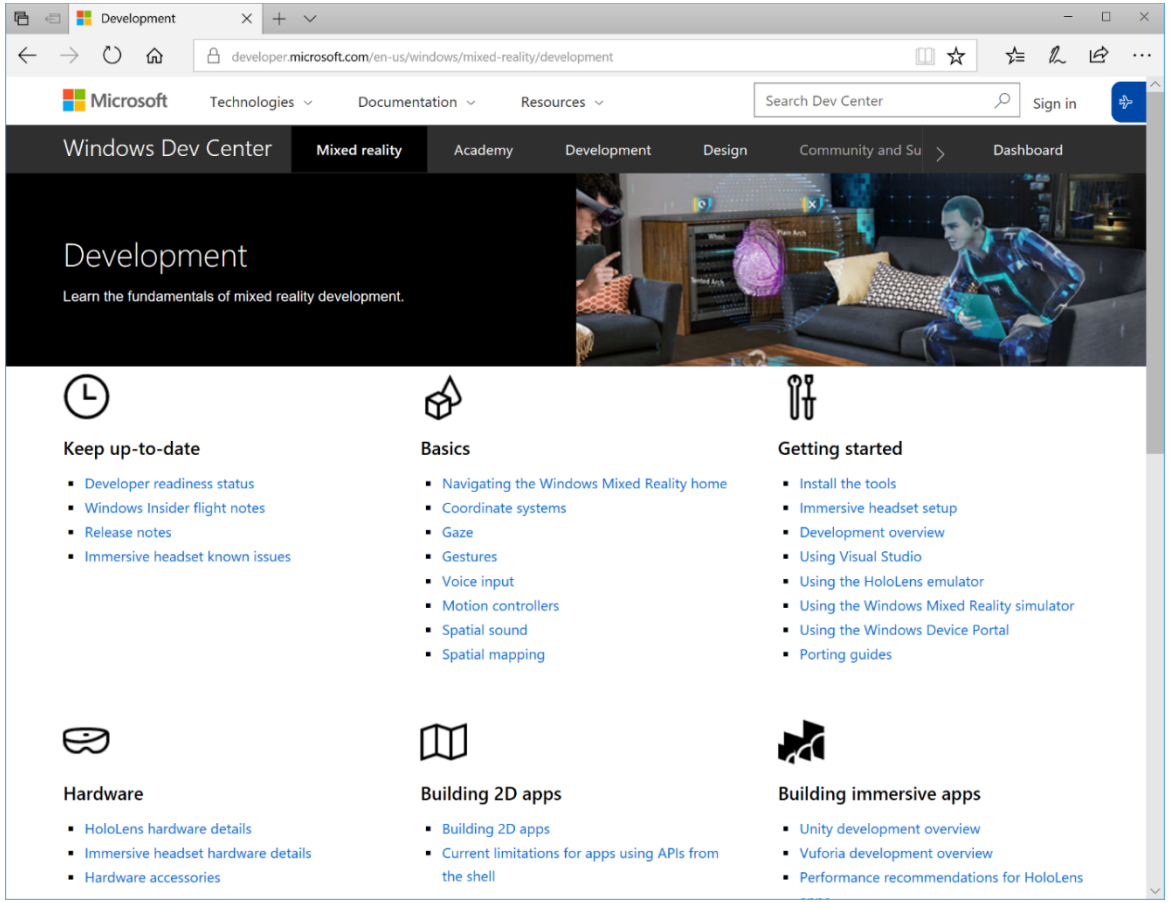
Additional improvements with prediction

Resources

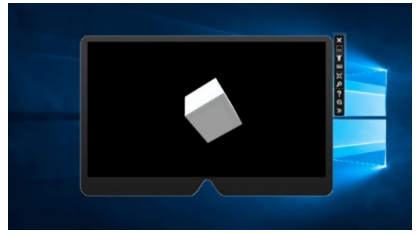
Windows

Developer Resources

Documentation (http://aka.ms/mr)



Tutorials



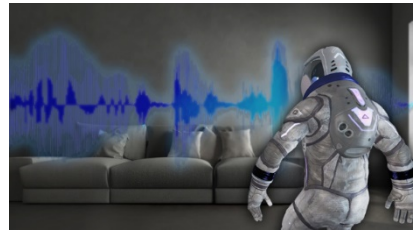
“Hello World”

Introduction

Gaze Input

Gesture Input

Voice Input



Spatial Sound

Spatial Mapping

Shared Experiences

Open Source Projects

Galaxy Explorer

Open source application available in the store. The idea was voted by the community and originally built for HoloLens. It now supports all mixed reality devices, and is a useful end-to-end demonstration of how to build a Unity app for Windows Mixed Reality.

Toolkit

Library with many component that make it easier to build mixed reality apps, including plug-ins for Unity. Some of the more popular components are the sharing services for multiplayer mixed reality apps and spectator view.

Academy Tutorial Apps

The tutorials are great starting points for your app, and they improve with community contributions too.

Questions?

Apply for a dev kit!
https://aka.ms/iwantmr

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Microsoft

Porting an existing VR app to Windows Mixed Reality

Windows

Porting an Existing VR Apps to Windows Mixed Reality

Code Changes

1. Port to UWP
2. Chaperone Implementation
3. Leverage expanding Input Options
4. Windows Process Lifecycle Management
5. Switcher for Desktop and VR View

Design Adjustments

1. Assets for the Holographic Shell
2. Text and Graphics

Test & Publish

1. Test on Multiple HMDs & Low-End/High-End PCs
2. Publish to the Windows Store

- Spatial Stage
  - Spatial stage encapsulates the capabilities of the device as well as the floor and area of use as defined by the user. This info can help devs decide the scale of their application:
    - **Seated-scale VR apps** just need to know where the user's head is relative to a zero position the app snapped – these apps are enabled by today's SpatialStationaryFrameOfReference.
    - **Standing-scale VR apps** will need to know the **floor origin**, so they can place floor-relative content on a plane that will be comfortable for standing users. Note that some devices are only capable of **forward standing-scale** if they cannot reliably track headset position when the user turns around.
    - **Room-scale VR apps** also need to know the **movement bounds** within which the user can safely walk, so they don't place content behind a physical wall that the user must directly grab.
    - **World-scale VR apps** rely on spatial mapping to determine the shape of the world around the user automatically as they walk around. These are the HoloLens apps developers write today and are enabled by today's SpatialSurfaceObserver.

6DOF tracking	Floor defined	360 tracking	Bounds defined	Spatial Mapping	Maximum experience
No	-	-	-	-	Orientation-only
Yes	No	-	-	-	Seated
Yes	Yes	No	-	-	Forward standing
Yes	Yes	Yes	No	-	360 standing
Yes	Yes	Yes	Yes	No	Room
Yes	Yes	Yes	Yes	Yes	World