

# From mutilating zombies to managing kingdoms

Looking back at the VR development of Arizona Sunshine and Skyworld



Trevor Blom  
Lead Developer  
Vertigo Games



# Outline



Arizona Sunshine features



Skyworld features



Performance & Profiling



Common Tools



# VR History



2012 – Oculus kickstarter campaign



2014 – World of Diving



2015 – Prototypes Skyworld & Arizona Sunshine



2016 – Arizona Sunshine



2017 – Skyworld



2018 – More VR!



Intel collaboration

Zombie Mutilation

Destruction

Side effects

Physics

PlaystationVR

# Working together with Intel



# What were the requirements?

Oculus Rift & Vive

90 fps

2160x1200 resolution

Specs

Recommended: i5-4590 + GTX 970

High end: i7-6700 (~20%) + GTX 980

# Environment & settings

Unity (5.4.2p4)

Single pass rendering

No asynchronous timewarp

Deferred rendering

# Effects

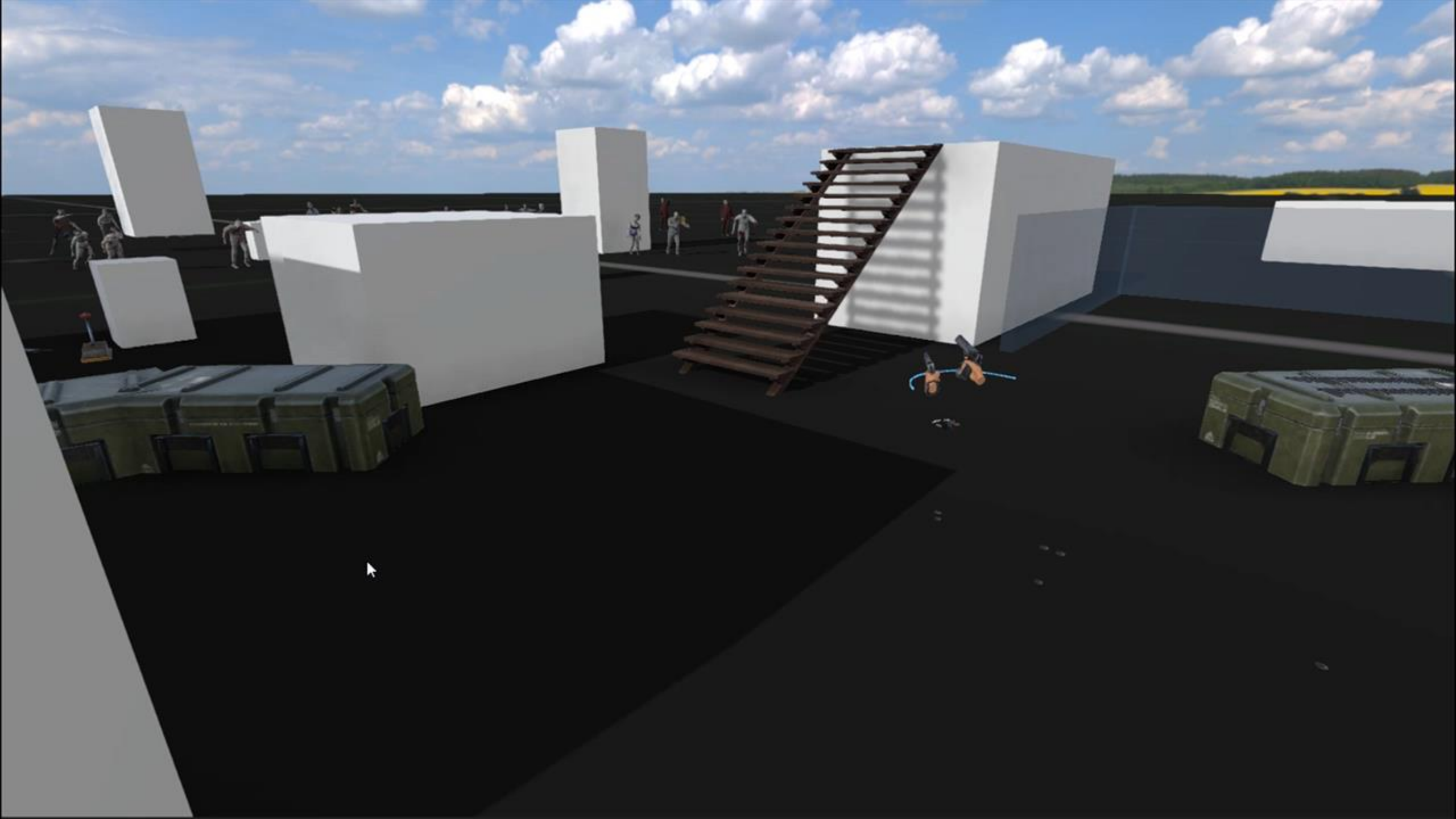
Zombie mutilation

Object destruction

Wind simulation

World deformation

# Zombie mutilation



# Zombie mutilation

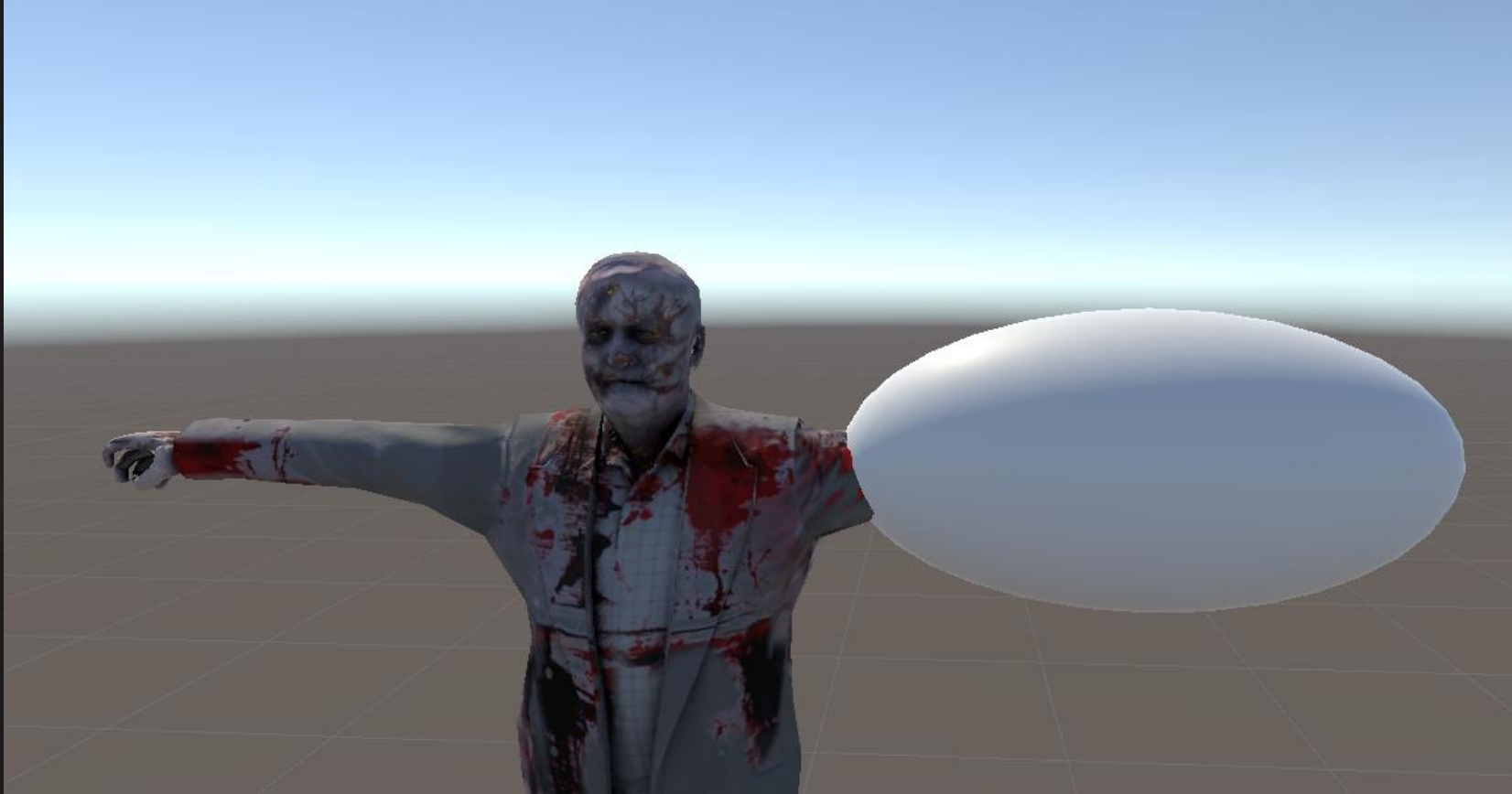
Based on "Rendering Wounds in Left 4 Dead 2" by Alex Vlachos, Valve



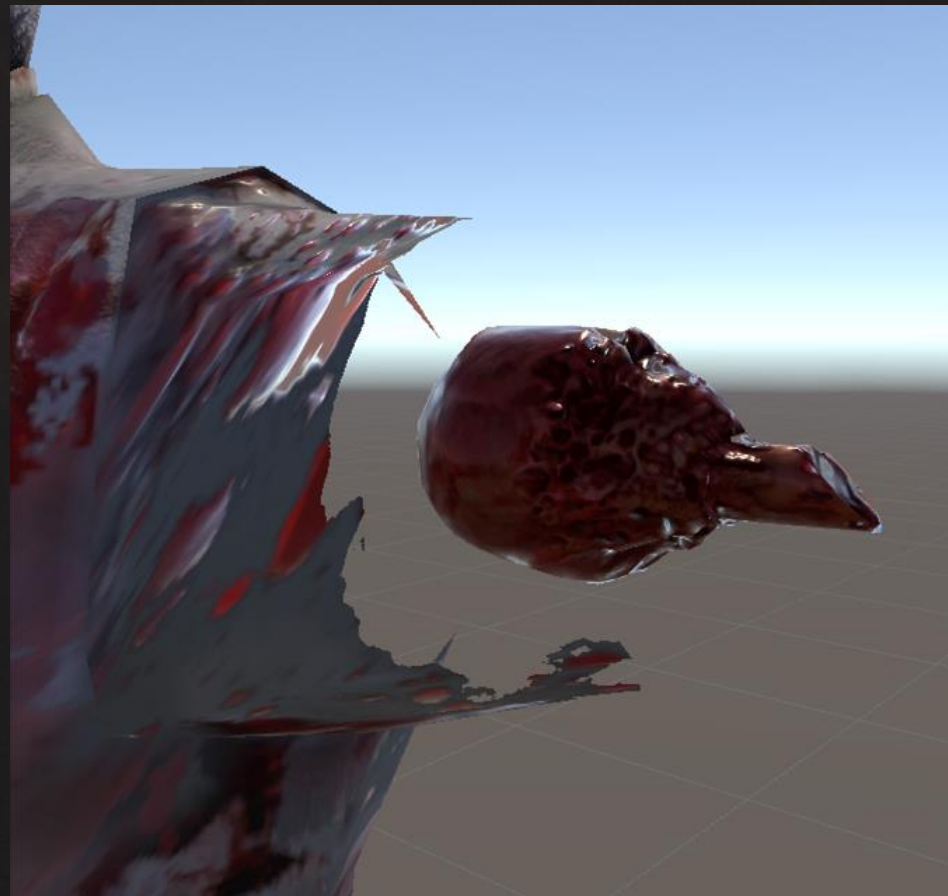
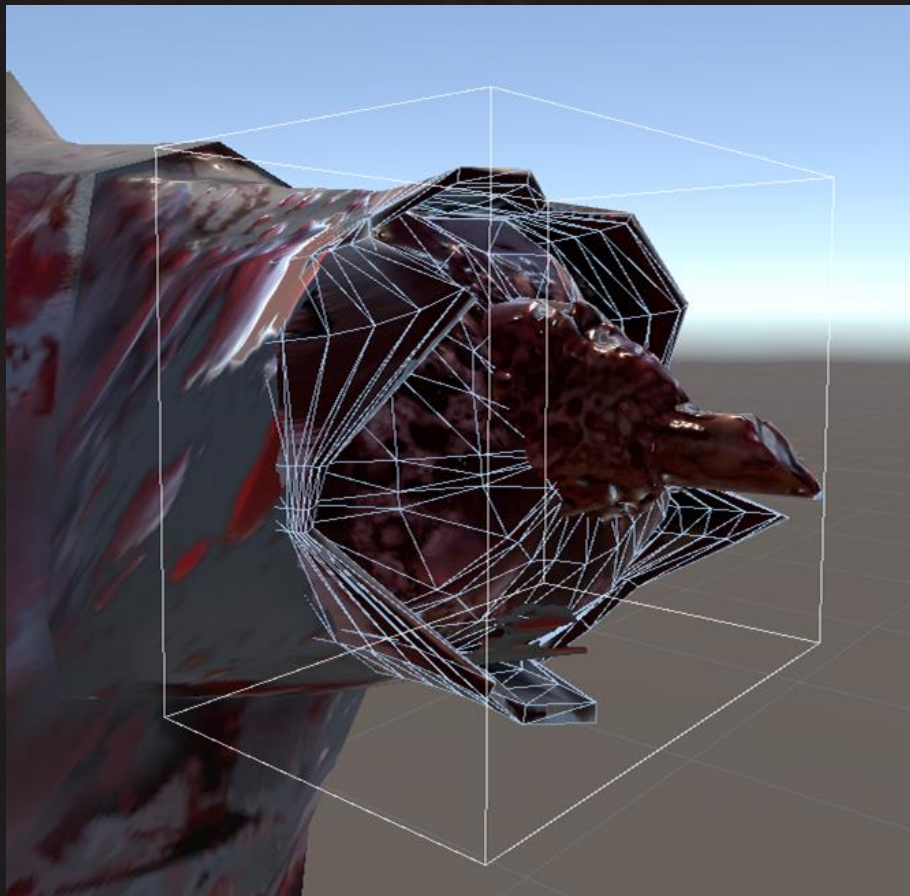
# Zombie mutilation



# Zombie mutilation



# Zombie mutilation



# Object destruction

Preprocessing cutting technique

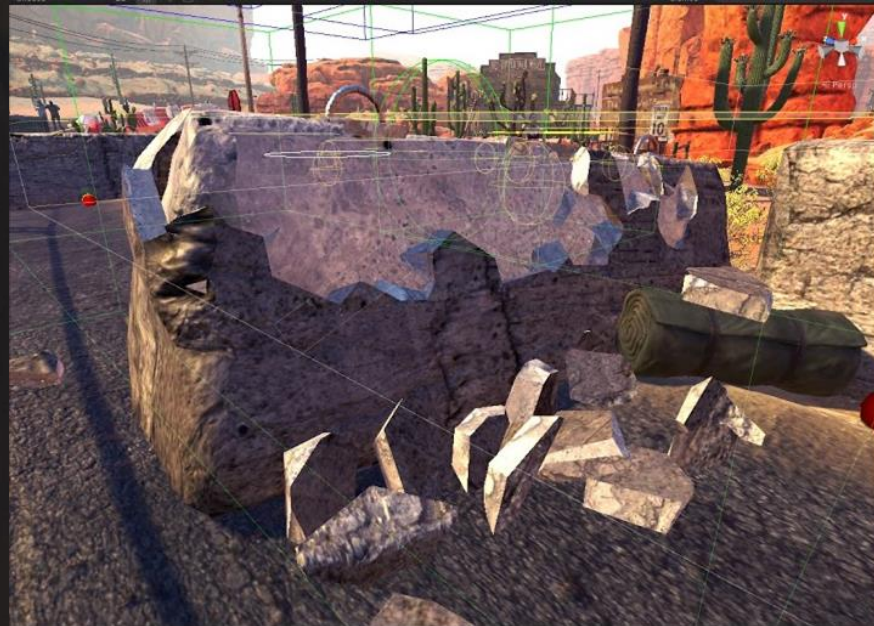
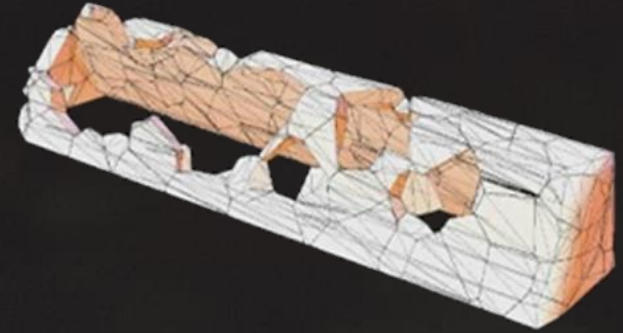
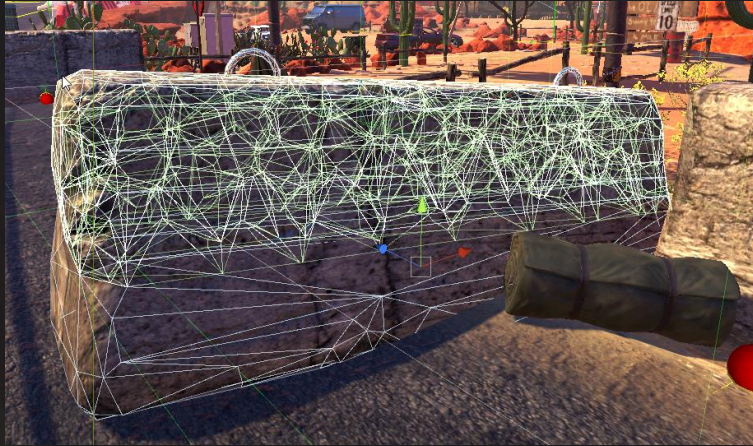
Voronoi

Cell management

Gunshots, explosions



# Object destruction



# Side effects

Too much data

Long load/unload times

Physics...

# Physics

Colliders waking up when shooting

Watch your layers

Enabling and disabling problematic

# Locomotion

From teleporting to walking

Delayed calls

LOD's and culling

# Playstation port

Simplified scenes and data

Ragdoll animations

Baked lighting

Experimental features



Table flip

Skinned instancing

Table flip



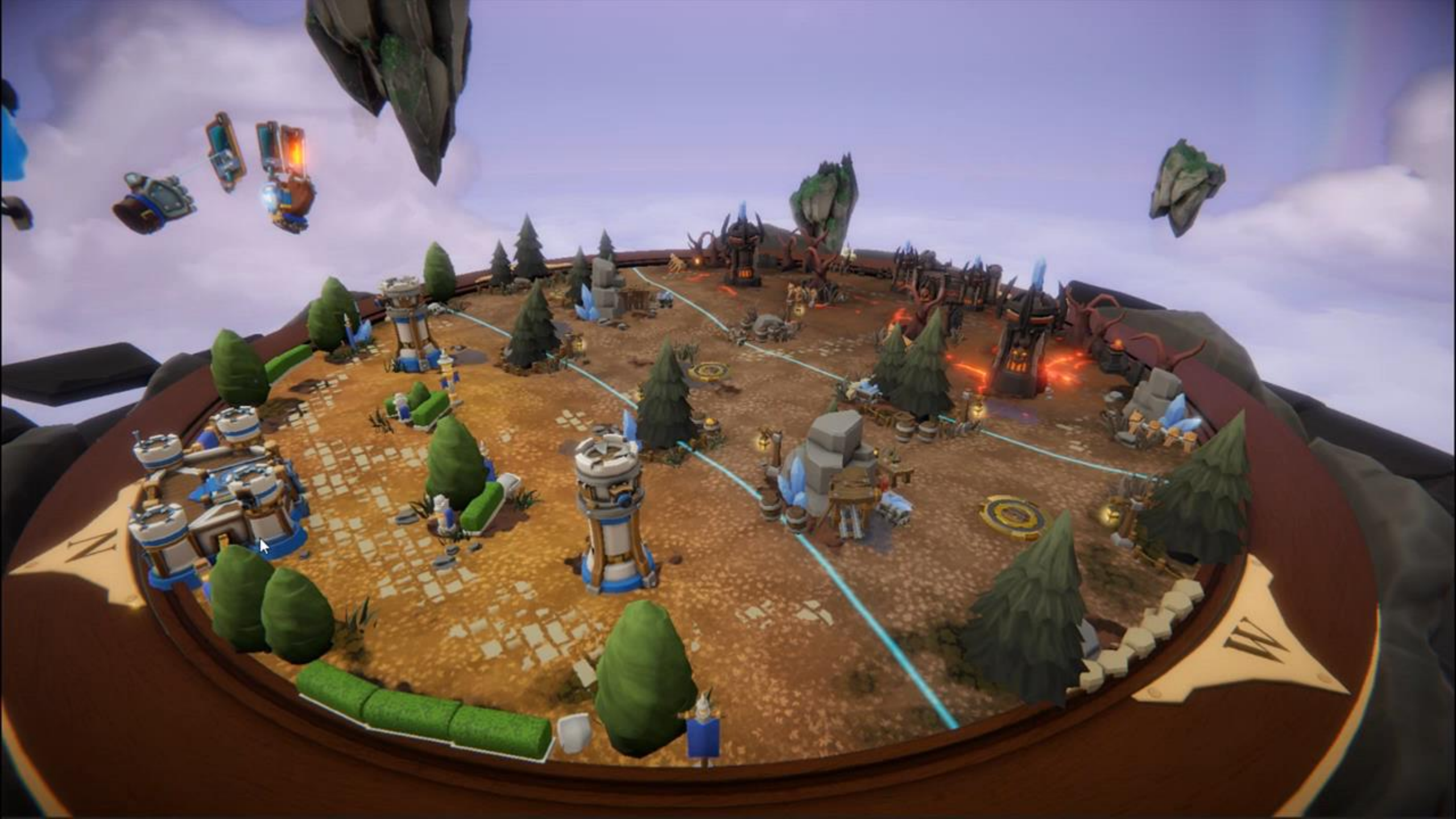




PlayerSpawn

# Skinned instancing





# Skinned instancing

No skinned mesh renderer

No animator

Bake animations to texture

4 pixels per bone matrix

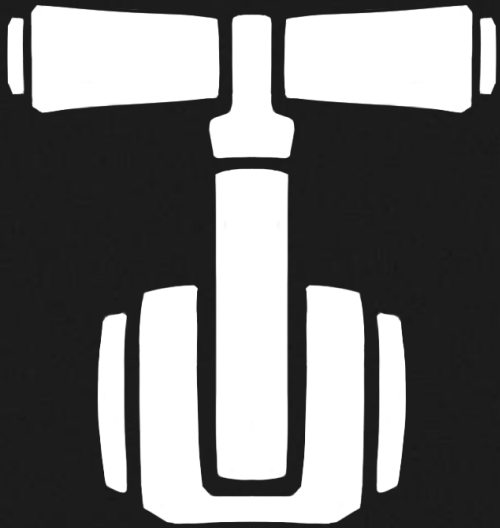
2 bones

Blend between samples for higher fps

Blend between animations



# Performance & Profiling



CPU costs

GPU costs

GPU frame capture

# Costs CPU

Draw calls

Culling

Transform updating

Physics

Animators

Scripts

Audio



# Costs GPU

Draw calls

Culling

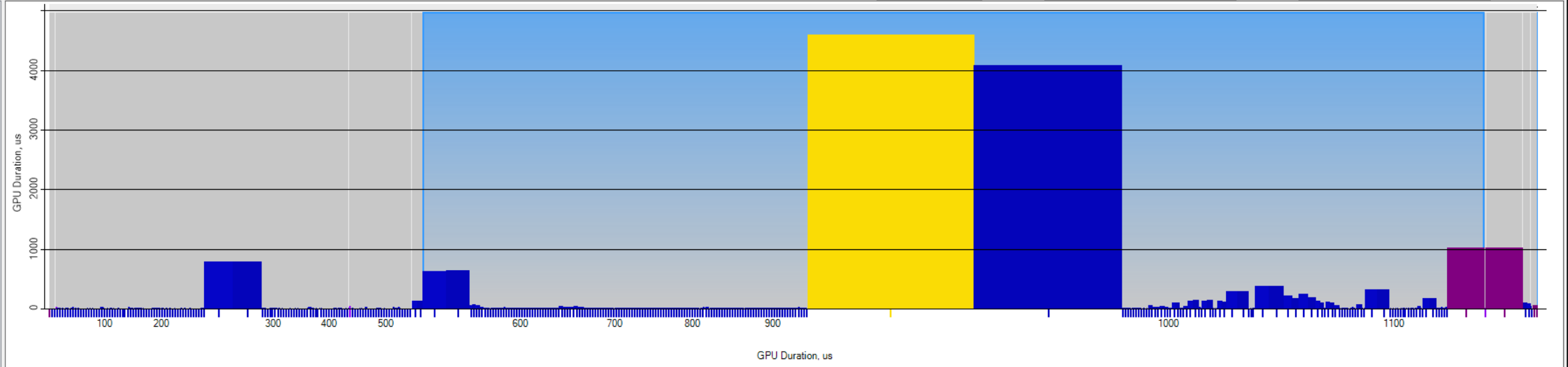
Pixel fillrate

Overdraw

Heavy shaders



- RT 0  
(Ergs 0 to 16)
- Z  
No Color Buffer  
RT 1  
(Ergs 17 to 433)
- Z  
No Color Buffer  
RT 2  
(Ergs 434 to 546)
- RT 3  
(Ergs 547 to 549)
- RT 4  
(Ergs 550 to 1164)
- RT 5  
(Erg 1165)
- RT 6  
(Erg 1166)
- RT 7  
(Ergs 1167 to 1168)
- RT 8  
(Ergs 1169 to 1174)



Full Tree GPU Duration

Selected: 1 / 1175 ergs, 4,598.5 / 23,671.0  $\mu$ s (19.4%) of scene.

Selected Highlighted Other Normal

☐ Clear before drawing ☒ Flip RT  
☒ Draw only to last selected

Color Depth

Stencil Pixel Overdraw

R16G16B16A16\_ 2816x1600 Go

Frame Overview Details Texture State Shaders Shader Constants Experiments Pixel History Geometry API Log

☐ Show Data Viewer

Erg 946

Cull: None Coordinates: Left-handed Mode: Wireframe Reset

Draw call type: DrawIndexed Topology: PatchList\_3\_ControlPoints Input primitive count: 11534 Generated primitive count: 11534 Vertex position format: R32G32B32\_FLOAT Index buffer offset: 0 Index buffer size: 34602 Number of vertices referenced: 5881

VS 0.0 $\mu$ s (0.0%) HS/DS 0.0 $\mu$ s (0.0%) GS

# Tools



Common code

Execution order callback

Staggered scene loader

Database editor

Hand poser

# Common code

Reusable code for all projects

Separate repository

Build DLL's



# Spatializer

Threaded triggers!

Less load on Physics

No layer limit!



# Database editor





Vertigo.Skyworld.SkyworldDatabaseEditorWindow

1	SwordsmenUnit
2	PikemanUnit
3	KnightUnit
4	ArcherUnit
5	FirecrossbowUnit
6	SniperUnit
7	BattleblimpUnit
8	BattleballoonUnit
9	SiegeTankUnit
10	FlyingFortressUnit
11	HealBalloonUnit
12	BeserkerUnit
13	BomblingUnit
14	DragonUnit
15	SummonerUnit
16	OperatorUnit
17	ThiefUnit
18	BattleRamUnit
19	ParatroopersUnit
20	CatapultUnit
21	HeliUnit
22	PaladinUnit
23	War pigeonsUnit
24	Ice throwerUnit
25	CreepUnit
26	FirewalkerUnit

# Staggered scene loader

Avoid scene load hiccup

Stagger awakes

First awake -> Disable all gameobjects

Budget per frame



# Execution order callback

```
public class ExampleBehaviour : MonoBehaviour
{
    // Update is called once per frame
    void Update () {

    }
}
```

Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms	▲
WaitForTargetFPS	68.0%	68.0%	1	0 B	10.21	10.21	▲
▼ BehaviourUpdate	29.9%	0.0%	1	0 B	4.49	0.00	▲
▼ BehaviourUpdate	29.9%	13.3%	1	0 B	4.49	2.00	▲
ExampleBehaviour.Update()	16.5%	16.5%	10000	0 B	2.48	2.48	▲



# Execution order callback

```
public class ExampleBehaviour : MonoBehaviour
{
    // Update is called once per frame
    public void OnUpdate() {

    }
}
```

Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms	▲
WaitForTargetFPS	96.5%	96.5%	1	0 B	14.30	14.30	
▼ BehaviourUpdate	1.7%	0.0%	1	0 B	0.25	0.00	
▼ BehaviourUpdate	1.7%	0.0%	1	0 B	0.25	0.00	
▼ main.Update()	1.6%	0.0%	1	0 B	0.24	0.00	
Update 10000 calls	1.6%	1.6%	1	0 B	0.24	0.24	



# Execution order callback

```
private void Awake() {  
    PostExecutionOrderCallback.AddCallback(ECallbackEvent.UPDATE, OnUpdate);  
}
```

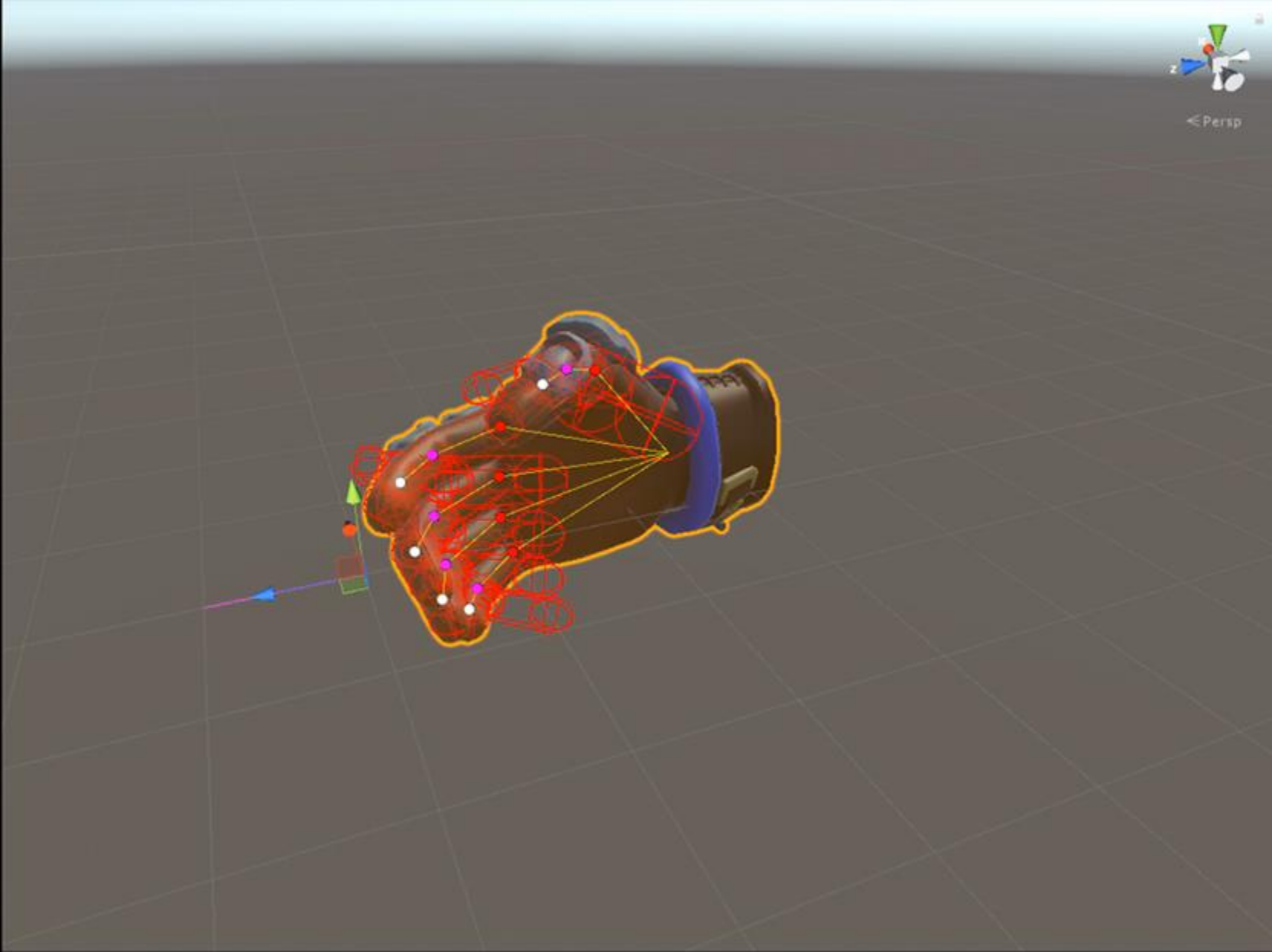
```
private bool OnUpdate() {  
    // Do something  
  
    return false;  
}
```

```
PreExecutionOrderCallback.AddCallback(ECallbackEvent.LATE_UPDATE, () => {  
    // Do something  
  
    if(doneUpdating) {  
        return false;  
    } else {  
        return true;  
    }  
});
```



# Hand poser





HandPosing\*

Main Camera

Directional Light

HandPoser

Tag

Untagged

Select

Revert

Transform

Position

X 0

Y 0

Rotation

X 0

Y 0

Scale

X 16.66666

Y 16.66666

Hand Poser (Script)

General settings

Right hand

Left hand

Display left hand

Transform to pose for

Right Hand (Posable)

Left Hand (Posable)

None (Transform)

Pose selector

Filter

Neutral\_OpenVR

Neutral\_Oculus

Card

Point

Neutral\_NoVR

CastSpell

Gesture\_Point

Gesture\_Thumb

Gesture\_Grip

CardSmall

Index\_Finger

Middle\_Finger

Ring\_Finger

Pinky\_Finger

Pose settings

Pose name

Neutral\_NoVR

Transform masking

Paste pose

Save to selected pose

Save as new

Add Component

Project

Create

Assets

HandPoser

HandPoser

HandPoser

HandPoser

HandPoser

HandPoserEditor

HandPoserEditor

SceneHopper

Launcher

MainMenu

Skyworld

Mountain

Island

Jungle

Laboratory

ThroneRoom

mockup

Jungle open

Mountain open

Mountain open

ation

Play Error Pause E

dated in 16/01/0254ms. Total resources: 396. Runtime memory: 2.2 MiB:

to Vertigoresources: bree serif bold

ted by runtime memory size:

evillieutenant

Thank you!



@TrevorBlom

