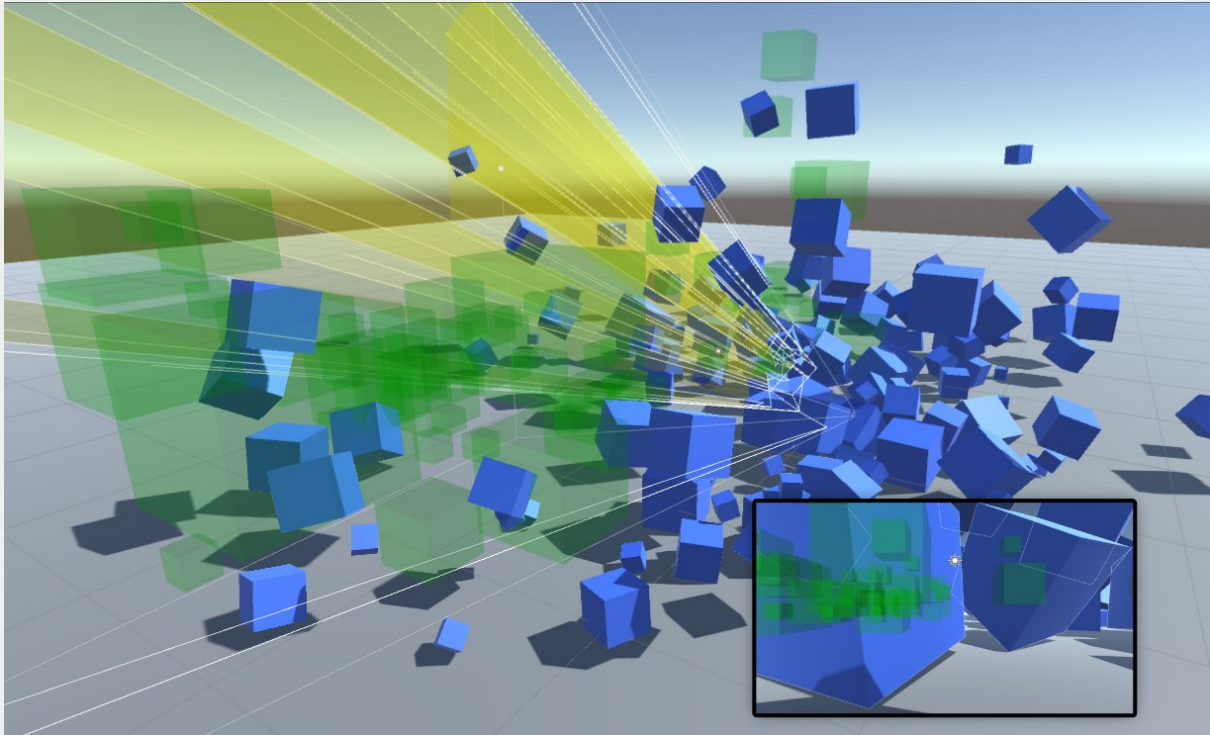


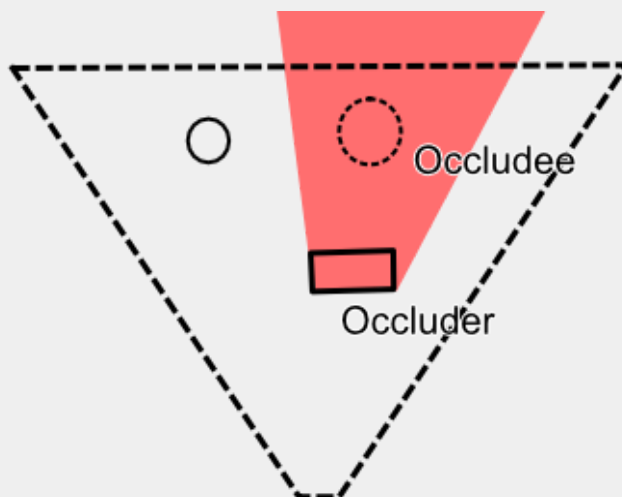
RT Occlusion Culling

for Unity3D

VisualWorks



Objects (aka Occludee) that are entirely behind other opaque objects (aka Occluders) can be culled.



RT Occlusion Culling is a geometric approach to implement dynamic occlusion culling.

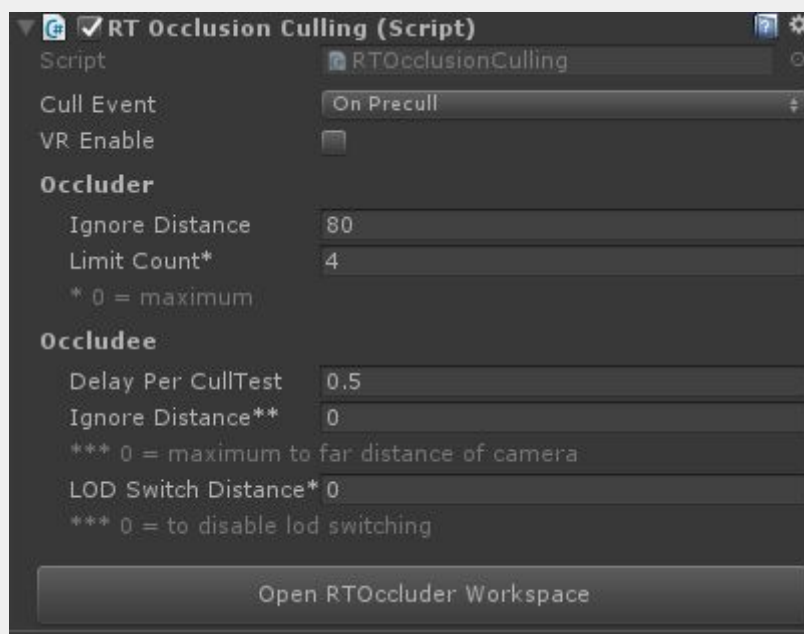


PVS (Unity native Occlusion Culling) vs Dynamic Occlusion Culling

	Potentially Visible Set	Dynamic Occlusion Culling
Memory	Large	Small
Dynamic Object	Bad	Good
Dynamic Environment	Bad	Good
Runtime Performance	Fast	Depend on the situation
Shape Complexity	Complex	Simple
Pre-Computing Time	Long	None

HOW TO USE

1. Attach a RTOcclusionCulling component to the MainCamera.



CullEvent : Set the event timing of the function call. **OnPrecull** is the default, **OnPrecullAndRestoreOnPostRender** restores the settings it disabled mesh renderers after rendering the camera every frame.

If you use the scriptable render pipeline like LWRP, you must set the **LateUpdate** because it will be not triggered a camera event like **OnPrecull**.

VR Enable : Enable occlusion culling for stereoscopic rendering. (Multi-pass, single-pass the same.)

Ignore Distance, Max Occluder Count : Reduces computation quantity by limiting the number of occluder in camera. (MaxOccluderCount, 0 is set to a maximum.)

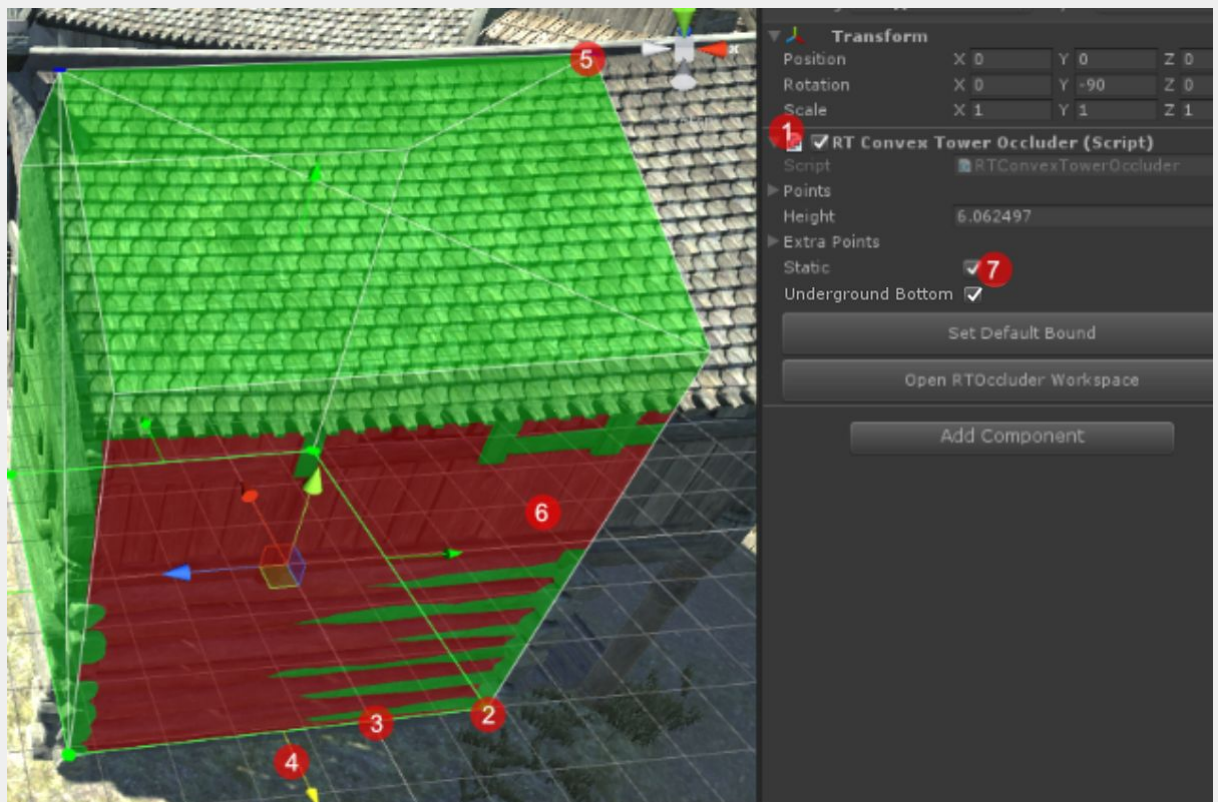


Delay per Cull-testing : Reduces computation quantity by delaying test the occludee that is not occluded.

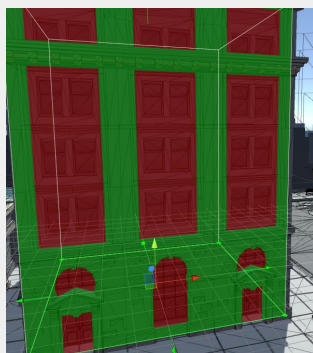
Ignore Distance (Occludee) : Ignoring to test occluding outside the range. The default is 0. (The range is a far distance of the camera.)

LOD Switch Distance : Switch to LOD-model if it is out of range. 0 is to disable to switch.

2. Add Occluders

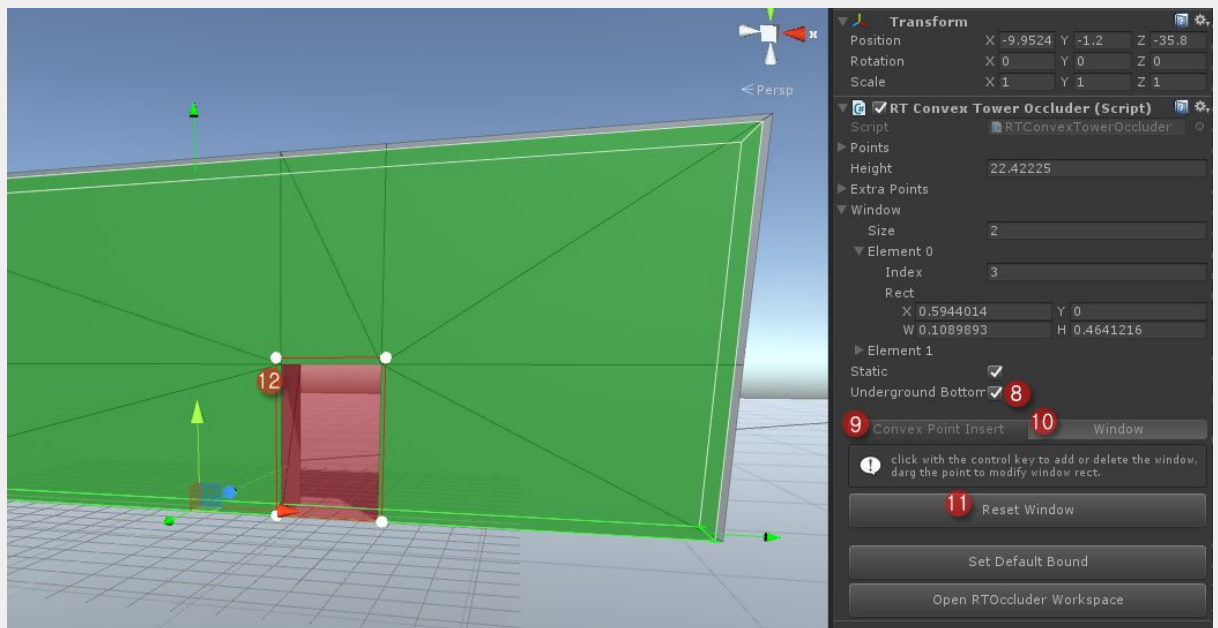


1. Attach an RT Convex Tower Occluder Component to gameObject.
(You can select mesh renderers and add by selecting a create occluder pop-up menu in RT Occluder Workspace.)
2. Drag the point on the bottom to translate it. Click on the control key if you want to delete the point.
3. Drag the point on the line with the control key if you want to add a new point
4. You can also edit the volume with the handler.
5. Clicking on the surface with the control key adds an extra point, and you can translate it. Also, you can delete points by clicking on the control key. Extra points complicate the volume and increase computation. **Don't forget that simpler perform better.**
6. Green means that is inside, red means that outward than the surface. Edit the volume to consider for camera movement.



It seems best not to have a red area, but it might be okay, depending on where the camera can go and an object can be placed inside. It seems more important that the edges are in the area.

7. Check **"Static"** when it is static, it performs better.



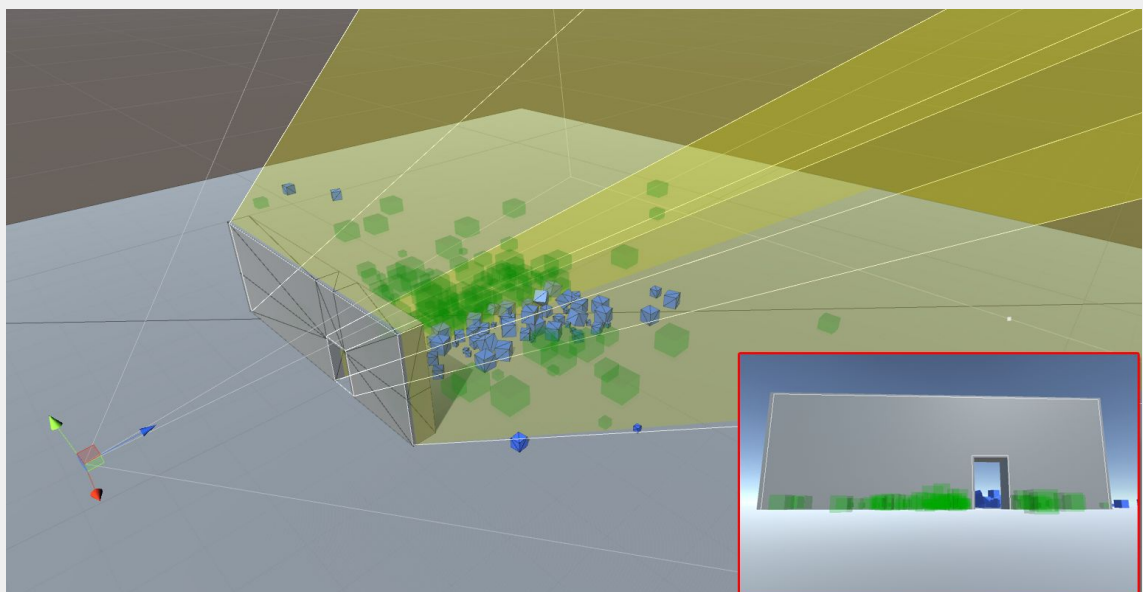
8. Check **"Underground Bottom"** when the bottom is contacted ground and it is a static (or translate only). It is treated as if there are infinite columns, which it culls more effectively.

9, 10. You can select additional vertex types on the tab.

Additional vertices can create various convex shapes in the tower (pic. 5), or add windows (aka portal) to the side.

11. Unable to apply at the same time, the added vertex or window information must be initialized to switch.

You can add a window by clicking the side planes with the Ctrl key. You can remove a window by clicking a point of a window with the Ctrl key. You can then move the point to modify the window area.



You can detect the objects appearing through the window as shown above.

3. Add occludees



1. An occludee includes multiple mesh renderers. (You can select mesh renderers and add by selecting a create occludee pop-up menu in RT Occluder Workspace.)

2. Set the action for culling. **DeactiveType**

- MeshRenderer Disable
- Shadow Cast Only
- Game Obejct Deactive

3. Set static, non-static **VolumeType**

- Static : World space-bound is calculated once
- Static Spatial Partitioning : World space-bound is calculated once in a hierarchy
- Non Static : Local space-bound is calculated once, and transform to world-space bound.
- Update Bounds Always : World-space bound is recalculate the bounds always

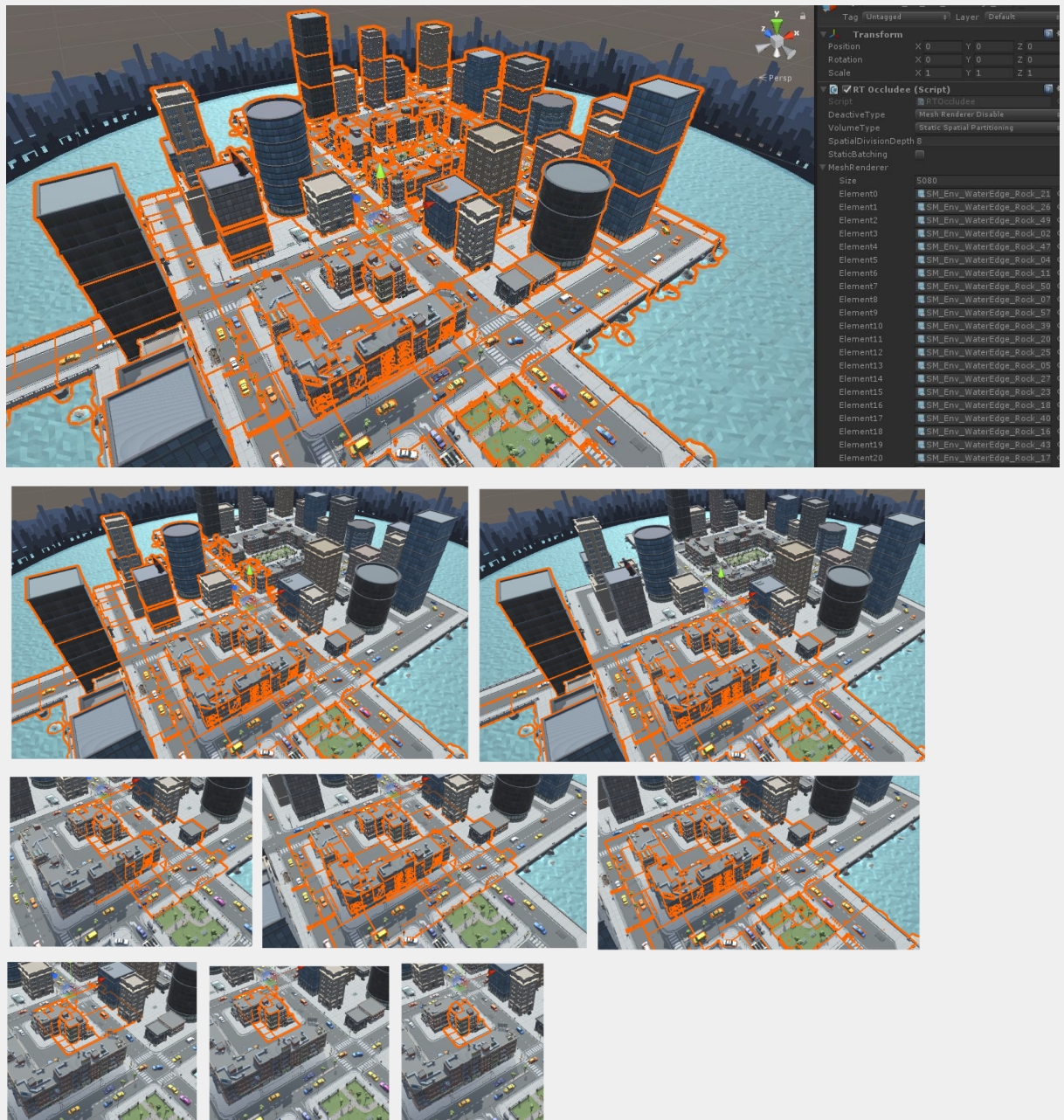
4. It can be combined with each material at runtime for batching optimization.

StaticBatching

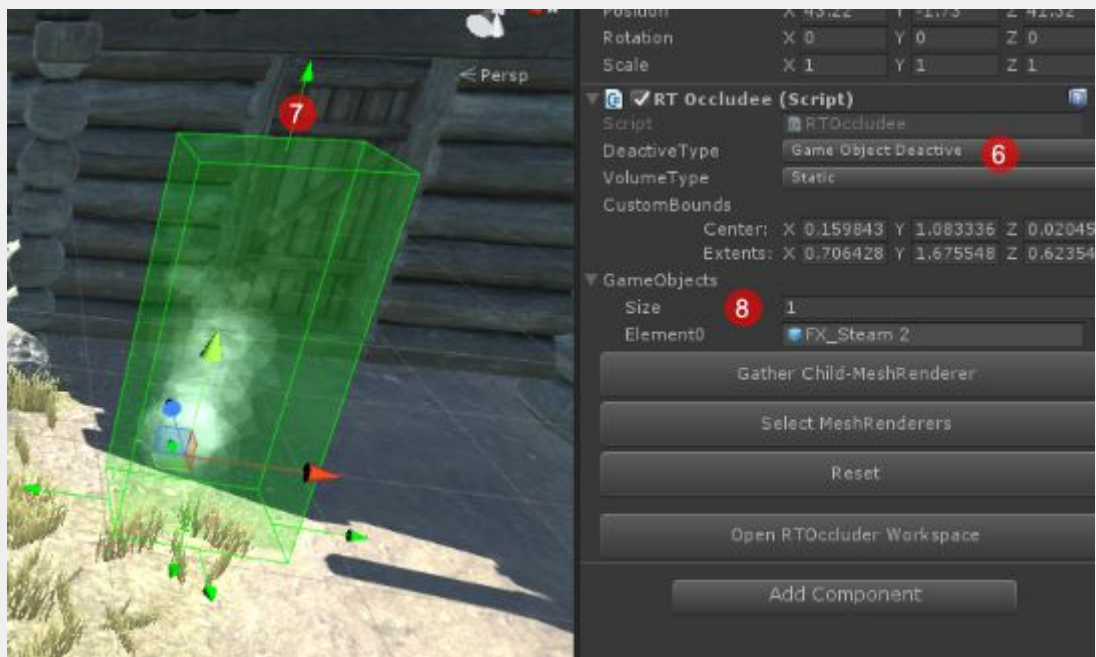


But it needs memory for an extra mesh. And the number of triangles in the camera increases because the bounds combined and have widened. And the animation is ignored. But draw calls will be reduced.

5. Spatial partitioning is used to manage a large number of static objects. **Static Spatial Partitioning**



It is used k-d tree as a spatial-partitioning algorithm. It makes better performance due to hierarchical processing.



6. You can also set custom bounds and deactivate objects on and off. **Game Object Deactive**

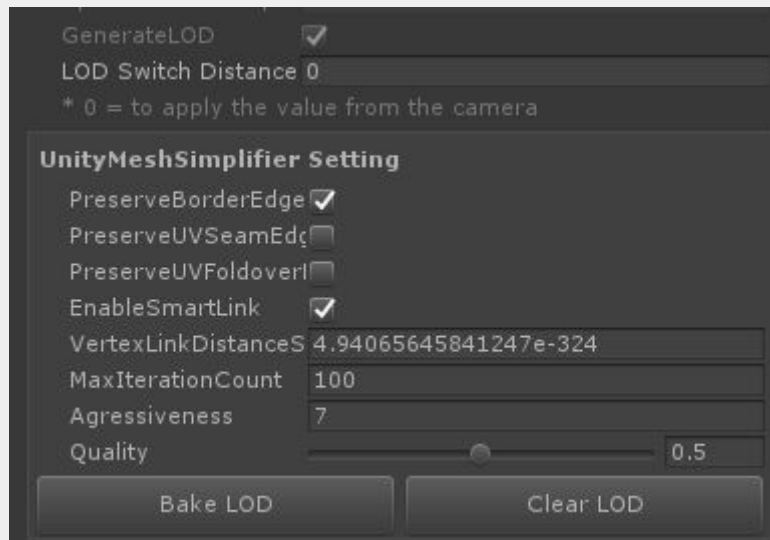
7. Edit custom bound.

8. This type uses GameObjects array. **If it turns off self, it won't work correctly.**

4. Generate LOD (*Experimental)

This feature is optional. It integrated UnityMeshSimplifier for generating LODs.

UnityMeshSimplifier : <https://github.com/Whinarn/UnityMeshSimplifier>



Generate LOD : Turn on LOD-utility. (Disable by Clear LOD button)

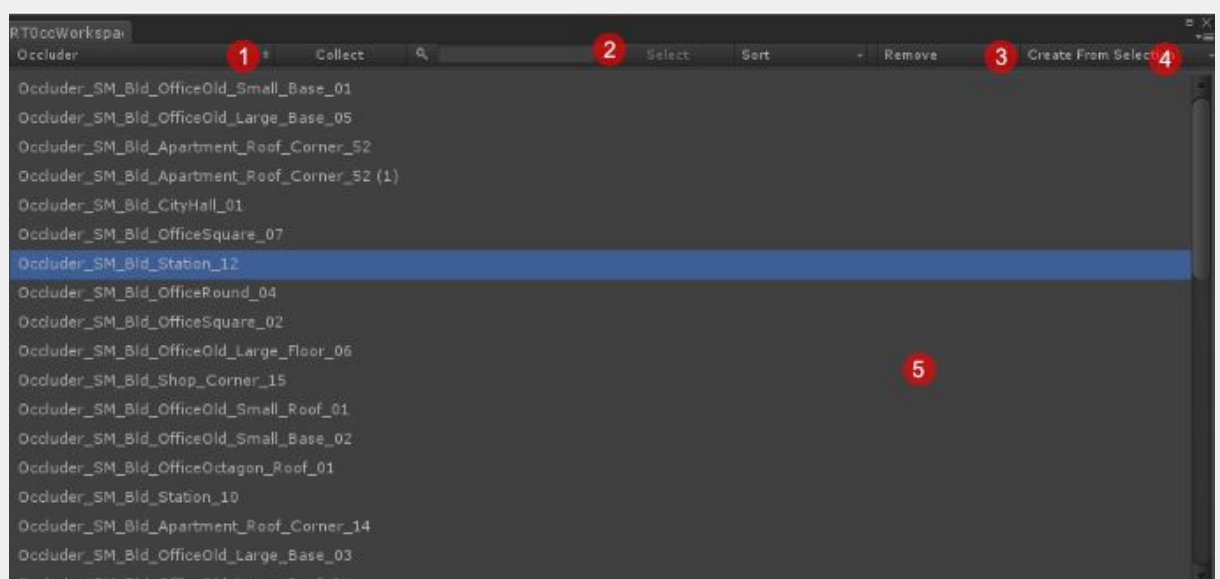
LOD Switch Distance : Modify this value, especially if you want to set the lod transition distance. 0 if default

Bake LOD : Generate a LOD Model. If a spatial partitioning is enabled, it is applied to models on "SpatialPreview" depth each.

Clear LOD : Disable LOD

5. RT Occluder Workspace

It provides an extra workspace window to make it easier to select objects.



1. Select a type, and it filled the the list.

2. Select by multiple keyword, like "Base,Corner" (comma separated)

3. Remove items in this list. (selected, unselected, meshrenderer with occludee,..)
4. Create an occluder / occludee from selection
5. Multiple selectable list items.

SETTING FOR SCRIPT

You can set by RTConvexTowerOccluder, RTOccludee but you can also set them on the script. (And see RTOccludee.cs, RTConvexTowerOccluder.cs)

1. RT.Occludee

```
namespace RT
{
    public class Occludee
    {
        public bool SetMeshRenderer(Renderer[] renderer, Transform transform, bool hideall, int spatialmanage_depth, bool staticbatch, bool statictransform, bool updatebounds);
        public bool SetGameObject(Bounds bounds, Transform transform, GameObject[] o, bool statictransform);

        public bool Enable();
        public bool Disable();
    }
}
```

If the object to be occluded is **MeshRenderer** List, the use SetMeshRenderer. If GameObject is, use **SetGameObject**.

Set the hide method and the static setting.

hide all(*) : true = hide meshrenderer, false = shadow cast only

statictransform : static or dynamic (update method of occludee bounds)

updatebounds(*) : update bounds from meshrenderer every frame

spatialmanage_depth(*) : If it is static and has a lot of objects and need to do hierarchical culling. (greater than 0)

2. RT.Occluder

```
namespace RT
{
    public class Occluder
    {
        public void SetBoxVolume(Bounds bounds, Matrix4x4 localToWorldMatrix, bool undergroundbottom = false);
        public void SetTowerVolume(Vector2[] point, Vector3 offset, float h, Matrix4x4 localToWorldMatrix, bool makeconvex = false, bool undergroundbottom = false);
        public void SetConvexVolume(Vector3[] points, Matrix4x4 localToWorldMatrix, bool undergroundbottom = false, int limitvertex=0);

        public void SetTransform(Transform transform);

        public void Enable();
        public void Disable();
    }
}
```

Set the shape according to the type of occluder.

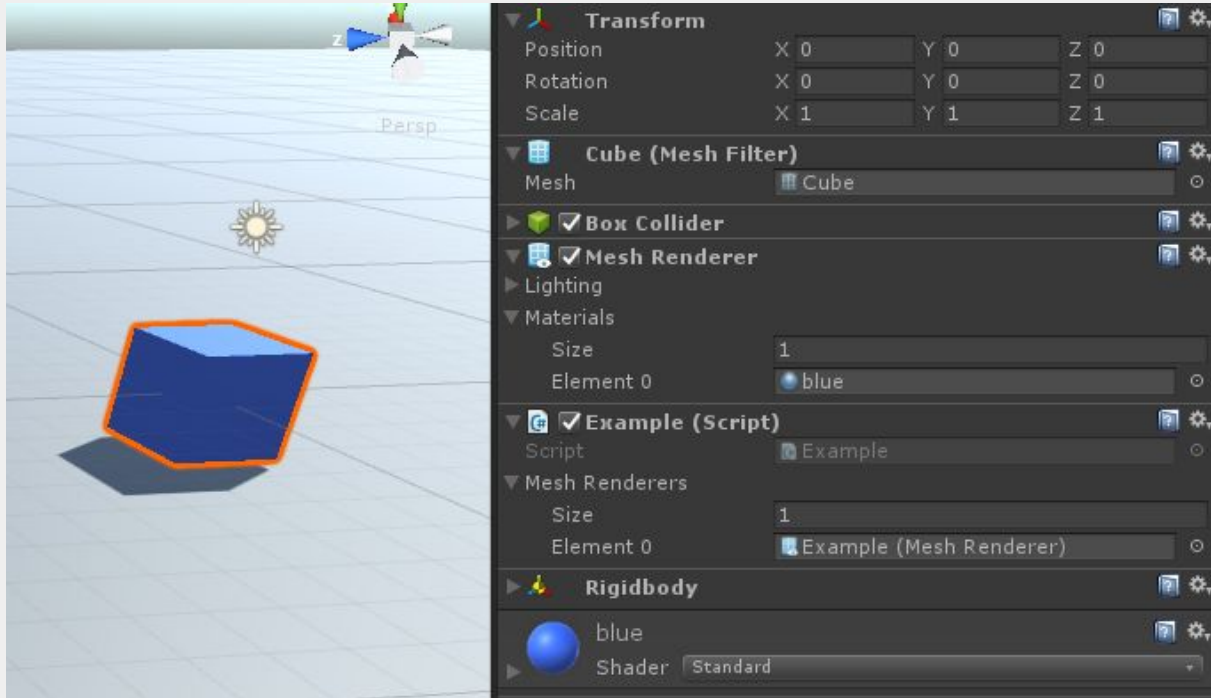
The type is set in the local coordinate system and can be set a dynamic using

SetTransform.

3. Sample Example (example.unity)

This example used a script for occluder setting and implements the following.

- Random size cube
- Apply rigidbody and initialize to random position and direction
- Create and set occludee object
- Create and set occluder objects (omit small objects)
- Activate when the object is turned on, deactivate when the object is turned off.



```
public class Example : MonoBehaviour
{
    public MeshRenderer[] m_MeshRenderers;

    RT.Occludee m_Occludee;
    RT.Occluder m_Occluder;

    private void Awake()
    {
        float scale = UnityEngine.Random.Range(1, 4);
        transform.position = new Vector3(UnityEngine.Random.Range(-20, 20), UnityEngine.Random.Range(1, 4), UnityEngine.Random.Range(-20, 20));
        transform.localScale = Vector3.one * scale;

        m_Occludee = new RT.Occludee();

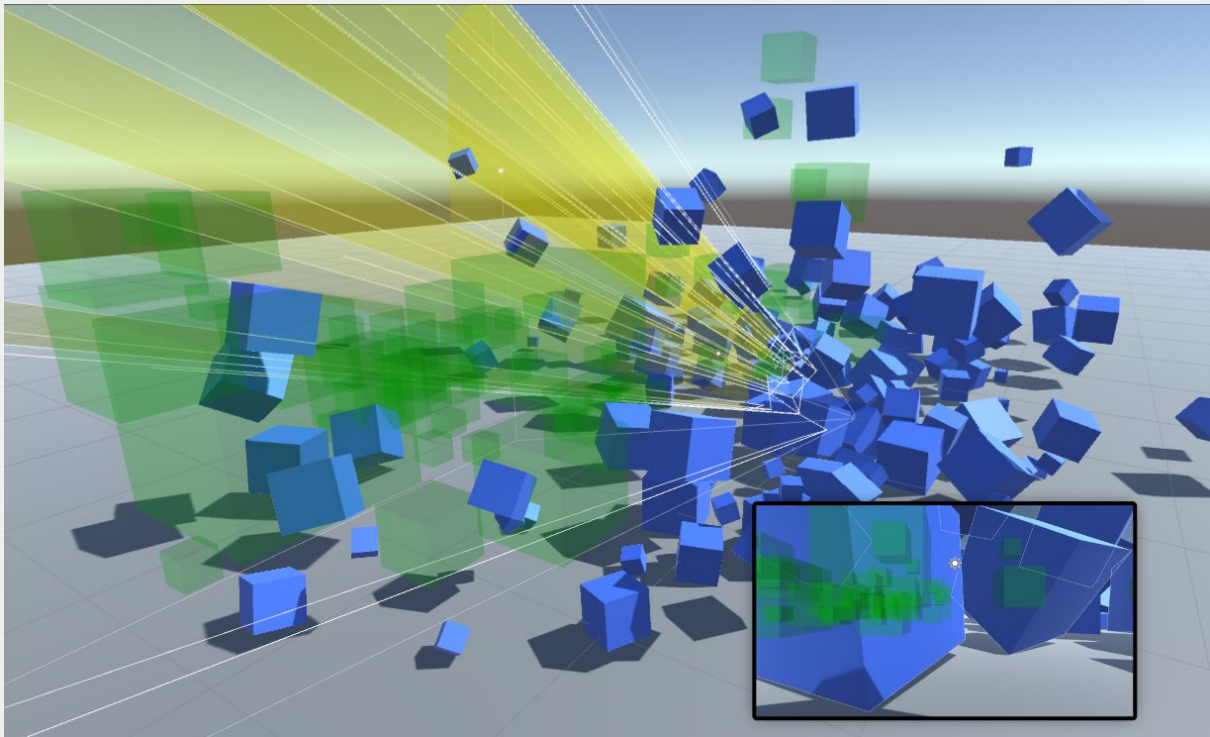
        bool shadowonly = false;
        m_Occludee.SetMeshRenderer(m_MeshRenderers, transform, !shadowonly, 0, false, false, false);

        if (scale >= 2)
        {
            m_Occluder = new RT.Occluder();
            m_Occluder.SetBoxVolume(new Bounds(Vector3.zero, Vector3.one), transform.localToWorldMatrix);
            m_Occluder.SetTransform(transform);
        }
    }

    void OnEnable()
    {
        Rigidbody rigidbody = GetComponent<Rigidbody>();
    }
}
```



```
rigidbody.velocity = Quaternion.Euler(UnityEngine.Random.Range(-10, 10),  
UnityEngine.Random.Range(0, 360), 0) * (Vector3.up * UnityEngine.Random.Range(2, 3));  
  
m_Occludee.Enable();  
if (m_Occluder != null)  
    m_Occluder.Enable();  
}  
  
private void OnDisable()  
{  
    m_Occludee.Disable();  
    if (m_Occluder != null)  
        m_Occluder.Disable();  
}  
}
```



Example

1. Demo.unity



<https://www.youtube.com/watch?v=SzCmsyyA-L0>

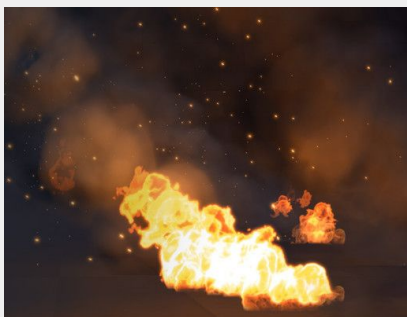
RESOURCES



<https://assetstore.unity.com/packages/essentials/tutorial-projects/lighting-optimisation-tutorial-73563>



<https://assetstore.unity.com/packages/essentials/tutorial-projects/survival-shooter-tutorial-legacy-40756>



<https://assetstore.unity.com/packages/essentials/asset-packs/unity-particle-pack-5-x-73777>

2. PolygonCityDemo.unity



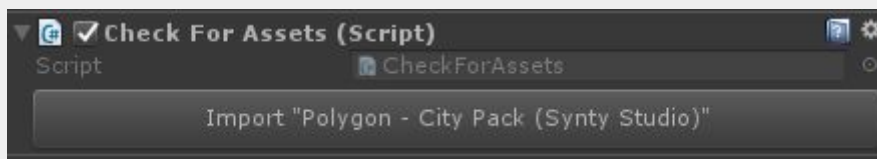
https://www.youtube.com/watch?v=UXw_BWWTm_c

RESOURCES



<https://assetstore.unity.com/packages/3d/environments/urban/polygon-city-pack-95214>

*"Polygon - City Pack" is not included in the package.
If you have a "Polygon - City Pack", import and reopen the scene.*



Thanks for purchasing RT Occlusion Culling.

If you have any questions, suggestions or feedback, please feel free to contact me at ksi@softnette.com