Bridging the Physical and Digital Worlds
Cesium and 3D Tiles for O3DE

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Cesium is the platform for 3D geospatial

- Visualization and analytics platform for massive 3D geospatial data
- Open Source + Open Standards + Cloud/On-premises
- Commercial and Government use
- Started in 2011 at AGI
- Created a dedicated company in June 2019 - $5M Series A
2 Million+ lifetime downloads and millions of users across markets
CESIUM® is 3D born in Aerospace
CESIUM® is the software platform for making 3D geospatial data valuable to users.
Cesium Platform

Fuse global curated data with your own data using best-in-class content pipelines.

Your 3D Data

Tiling and Hosting

CESIUM Ion

Global Terrain, Imagery and Buildings

Cloud or On-premises

3D Tiles

Open standards and APIs optimized for runtime

CESIUM Ion SDK

Advance Analytics

CESIUMJS

Visualization for the Web

CESIUM for Unreal

Simulation, AEC, XR and more

Other 3D Engines and Custom Apps
**3D Tiles**

- **Efficient** streamable massive heterogeneous 3D geospatial datasets
  - Terrain & imagery, 3D cities, photogrammetry, point clouds, BIM models, interiors, etc.
- **Visualization + analysis**
- Combine:
  - Flexible **spatial index** in JSON
  - “Runtime-ready” binary tile formats
  - Khronos **glTF** open standard for 3D models
  - **Attribution and metadata**
  - Declarative **styling**
- Started by Cesium
- OGC Community Standard
glTF 2.0 Scene Description Structure

- **.gltf (JSON)**
  - Node hierarchy, PBR material textures, cameras

- **.bin**
  - Geometry: vertices and indices
  - Animation: key-frames
  - Skins: inverse-bind matrices

- **.png**
- **.jpg**
- **.ktx2**
  - Textures

### Metallic-Roughness Materials

```
Material = BaseColor + Metallic + Roughness
```

### Optional Specular-Glossiness Materials

```
Material = Specular + Glossiness
```

Geometry

Texture based PBR materials
3D Tiles Streaming Engine

- Frustum and fog cull tiles that are not in the view
- May select low detailed tiles far away from viewer
- Imperceptible tiles are not rendered
- Selected tiles will be processed in the worker thread as much as possible
- Engine receives a list of tiles that need to be displayed at the end
Cesium Native

- Open source engine-agnostic C++ Library for
  - 3D Tiles streaming
  - Lightweight glTF serialization and deserialization, and
  - High-precision 3D geospatial math for global-scale WGS84 ellipsoids

- Cesium Native powers Cesium for Unreal and O3DE

https://github.com/CesiumGS/cesium-native
● Bridging scale and accuracy of Cesium with the high-fidelity rendering and visual realism of O3DE

● Runtime **3D Tiles engine** with LOD selection and caching for streaming massive global 3D geospatial content

● Integrating with O3DE as a **Gem**

● **Integrated with Cesium ion** cloud for access to curated 3D geospatial content

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*Reusing Cesium Native progress & features developed for Cesium for Unreal*

- 3D Tiles in Unreal: 8 months
- 3D Tiles in O3DE: 3 months
Advancing 3D Geospatial and Game Engines

- Global scale and accuracy
- Real-world 3D Content and Geospatial data
- Stream massive content at runtime
- 3D Tiles runtime engine and content pipelines

High-fidelity of Game Engines
- Rendering, visual quality, physics, simulations
- Tools, Marketplace content, Creator ecosystem
- Immersive experiences - AR, VR
Render 3D Tiles in O3DE
Create glTF Meshes

- **StandardPBR** material can support most of glTF material’s properties
- **ModelAsset** and **MaterialAsset** are created in the worker thread
- Use **MeshFeatureProcessor** to create draw packets in the main thread
- Gain performance when all vertices are packed into a single buffer. **2x Times faster!**
Integrate Cesium Native to O3DE

Private Cesium Ion account or Cesium on-premises

Content pipelines for your 3D data

Cloud-based global 3D content
- Photogrammetry
- Terrain
- Imagery
- Buildings

REST API

Request and Receive Tile Content

Display Tile Content

Render Resource Manager

Current View State

Create Render Resources

Traversal Process

3D Tiles Selection
Integrate Cesium Native to O3DE
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Content pipelines for your 3D data

Cloud-based global 3D content
Photogrammetry, terrain, imagery, buildings

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3D Tiles

Cesium for O3DE

Cesium Native
Georeference and Precision

- O3DE coordinate origin cannot be at center of the earth
- Floating point precision is not enough:

<table>
<thead>
<tr>
<th>64-bit coordinate of Cesium office</th>
<th>32-bit coordinate of Cesium office</th>
</tr>
</thead>
<tbody>
<tr>
<td>x: 1254151.3944734565</td>
<td>x: 1254151.375</td>
</tr>
<tr>
<td>y: -4732843.845023793</td>
<td>y: -4732844</td>
</tr>
<tr>
<td>z: 4073794.407620059</td>
<td>z: 4073794.5</td>
</tr>
</tbody>
</table>

- That results in an error of about 0.25m or 10 inches, leading to jitter
Cesium Native uses ECEF coordinate system:

O3DE coordinate system needs to be ENU (East North Up):
The origin of O3DE coordinate system is placed relative to the earth surface.
Georeference and Precision

- Place O3DE origin relative to the earth surface only helps somewhat with precision problem.
- The precision for object's position still lost when being far away from the origin.
- Possible solutions:
  - Shift the origin along with the Camera.
  - Create level streaming with each level storing a different origin and only one level displayed at a time.
Demo
What’s Next

- Cesium ion Integration
- O3DE Editor Component
- KTX2 & Meshopt
- MVP / Go-to-Market

Post MVP:
- 3D Tiles Metadata Support
- Point Clouds
- 3D Tiles Next
Thank you

https://github.com/CesiumGS/o3de
Appendix
Overview (Tentative)

- Set up the Story and why (Shehzan)
- Our philosophy on integrations and growing in the community (Shehzan)
  - Cesium Native
  - 3D Tiles
  - Open-core platform

- Architecture for Cesium Native + ion <-> O3DE (Bao) (10-12 minutes)
  - One overview slide about 3D Tiles
  - How data is streamed from Server to O3DE, Multithreaded, Bridge between Cesium Native and O3DE, Georeferences, Challenges to solve
  - Challenges with large scale worlds and precision
    - 32 bit vs. 64 bit
    - How we can achieve precision given the constraints
    - Flat earth model typical in games to Earth
    - Sub-levels

- What we enable (use-cases / demos) (Bao)
- Live demo? (Bao): photogrammetry SF, go between different cities on other side of globe (prototype)
  - Frustum culling in action
  - Some sort of debug coloring

- [https://docs.google.com/presentation/u/1/d/1sVvV5igTYuPFLRS1OuavLG_Gn3VCTY0hi8kjjvRDiYE/edit?usp=drive_web&ouid=1094053903002222268629](https://docs.google.com/presentation/u/1/d/1sVvV5igTYuPFLRS1OuavLG_Gn3VCTY0hi8kjjvRDiYE/edit?usp=drive_web&ouid=1094053903002222268629)
3D Tiles Metadata
Semantically Rich 3D Tiles Enabling the Next Generation of Geospatial Applications
Precise Rendering and Analysis of High-Resolution Data