Alexander Wood is a Senior Software Engineer at Analytical Graphics Inc (AGI). At AGI, he is a contributor to Cesium and Technical Lead on the STK Terrain Server, a streaming terrain solution that transforms raw terrain data into a format that is efficient for both data transmission and visual presentation.
Agenda

- A Gentle Introduction to Cesium
- Anatomy of a Cesium App
  - Data Sources and CZML
  - Core Features for Visualizing GIS
- Cesium 1.0
- Resources & Getting Started
Cesium is a 3D Web Virtual Globe that runs entirely inside a web browser, and it doesn’t use any sort of plugin to do so.

Active development, active community

We release a new version every month.
D3-Cesium demo started a year ago as a hackathon.

Here’s a good example of the power of the web. This app uses Cesium for 3D visualization, but then overlays a d3 visualization of the same dataset and other HTML elements to create a rich and interactive experience.

Explanation of d3 visualization. Original concept courtesy Hans Rosling, then brought into d3 as an example by Mike Bostocks.
200 countries over 200 years, each bubble represents a country through time Bottom axis is average income; further to the right the wealthier the nation
Left axis is average life expectancy; further up the chart, the healthier the nation.
Size of the bubble is relative to the population of the country.
Witness catastrophic events and industrial revolutions by the movement/growth of these bubbles over time.

Integration with Cesium takes this visualization one step further, by adding context to each bubble. We can more easily identify where in the world these events are occurring. We can interact, pan around the world, and become more engaged with the dataset, which ultimately promotes a better understanding.
Core - number crunching like linear algebra, intersection tests, and interpolation. Map Projections, Sun-Moon Positions,
Renderer - a thin abstraction over WebGL.
Scene - globe and map constructs like streaming terrain and imagery layers, polylines, labels, and cameras.
DataSource- Time-dynamic visualization constructs including CZML rendering.

Most apps will not use Renderer directly; instead, they will use higher-level constructs in Scene or DataSource Layer that are closer to their problem domain. However, Renderer is fully exposed to apps, allowing them to include custom rendering code.
Using D3-Cesium demo as an example, lets break down on one common technique for getting custom data into a Cesium app.

CesiumViewer configured for your application
Datasource to define your data
Modern HTML5, CSS to style your application
Javascript libraries for additional customization (d3, jquery, etc)
Combination of all of above to define an immersive user experience
**DataSource** abstraction embodies your data (e.g., HealthAndWealthDataSource, GeoJsonDataSource)

**Property** represents values that can optionally vary over time (e.g. Wealth SampledProperty)

**Entity** stores processed data and composes visualization (e.g., nationEntity)

**Graphics & Visualizers** render data associated with a DataSource (e.g., PolylineGraphics)
Cesium is tuned for time dynamic visualization; we had a need to create an open standard data format to define this type of data with web applications in mind.

Geospatial description of graphical primitives and how they change with time

JSON schema
CzmlDataSource

The linked example is nothing more than the CesiumViewer widget and a CzmlDataSource.
Geospatial Visualization
Rendering World Terrain

- Requires visually accurate elevation for the entire globe
- Must render well on all target platforms (including mobile)
- Lots of raw terrain data out there, typically height map elevation data
Cesium supports multiple streaming terrain providers out of the box:

- **EllipsoidTerrainProvider**
- **VRTheWorldTerrainProvider**
- **ArcGisImageServerTerrain**
- **CesiumTerrainProvider**

EllipsoidTerrain – Simple geometry that represents the world by tesselating WGS84 ellipsoid
VRTheWorldTerrain – Produces geometry by tesselating heightmaps from VT Mak
VR-TheWorld Server
ArcGisImageServerTerrain – Tesselates heightmaps from ArcGIS Image Server
CesiumTerrainProvider – Terrain formats for streaming meshes: Heightmap-1.0 or Quantized-mesh-1.0
Simple example using the //cesiumjs.org/tilesets/terrain/smallterrain
Derived from SRTM,
Same scene using //cesiumjs.org/stk-terrain/tilesets/world/tiles
Streaming terrain demo of the agi-terrain-showcase

STK World Terrain dataset, maintained by Analytical Graphics, Inc. Constantly updating with higher resolution data.

Lets take a deeper dive into streaming terrain and the quantized-mesh format. Hierarchical LOD $\rightarrow$ quad tree of tiles where the level to render such that our screenspace error is less than a pixel
Triangulated Irregular Mesh $\rightarrow$ only send vertices where it matters

Create compelling visualizations for your application
Quantized-Mesh

- Triangulated Irregular Network
- Multi-resolution pyramid of tiles
- Multiple datasources, layered together
- Efficient transmission and visualization
- Open format

Goto next slide after TIN
Quantized-Mesh

- Triangulated Irregular Network
- Multi-resolution pyramid of tiles
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Cesium 1.0 introduced Quantized-Mesh extensions
Oct-Encoded Vertex Normals
More to come: Water Mask, Normal Maps, Ambient Occlusion

http://jcgt.org/published/0003/02/01/paper.pdf
glTF Models

- Runtime asset format for models (web, mobile, desktop)
- Loaders for Three.js, Cesium, and more!
- [Online model converter](#)

Learn more at Cesium BOF on Tuesday (11am) or glTF BOF on Wednesday (2pm)
Deprecation policy to avoid breaking API changes wherever possible

“Just another release”

Three years in the making
Resources and Getting Started

- Sandcastle
- Tutorials
- Reference Documentation
- Cesium Forum
- @cesiumjs
Cesium is open source, join us!
http://cesiumjs.org

Thanks for listening!

Cesium @ SIGGRAPH
Virtual Globes Using WebGL and Cesium BOF: Tues 11am-12am, East Building, Room 9
COLLADA and glTF BOF: Wed 2pm - 2:30pm, Marriott Pinnacle Hotel