CESIUM

Geo-Scale Data Visualization in a Web Browser

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agi

About Me

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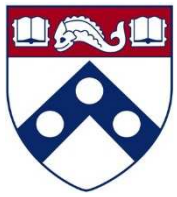
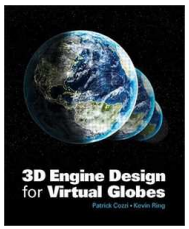
Developer



Lecturer



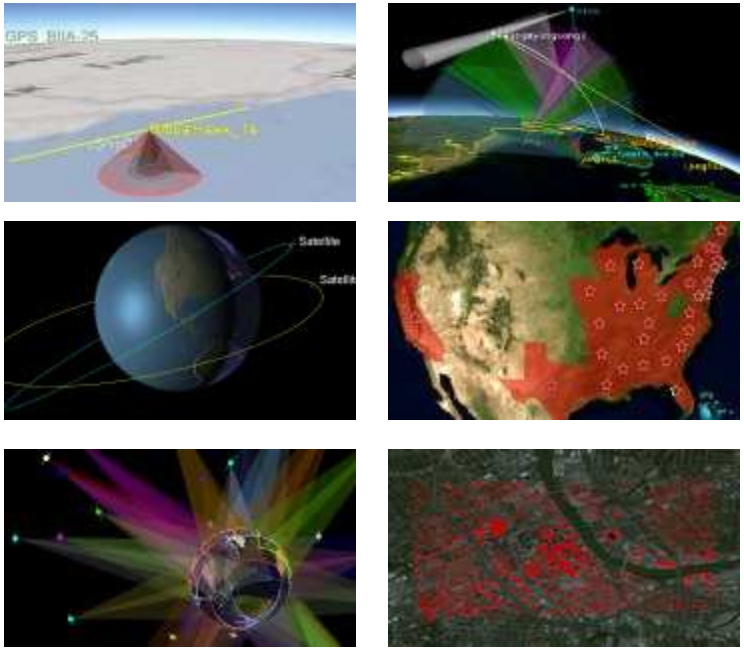
Author

Editor

http://www.seas.upenn.edu/~pcozzi/

About Cesium

- A WebGL virtual globe and map engine
- Open source - Apache 2.0 license



Quick Demo

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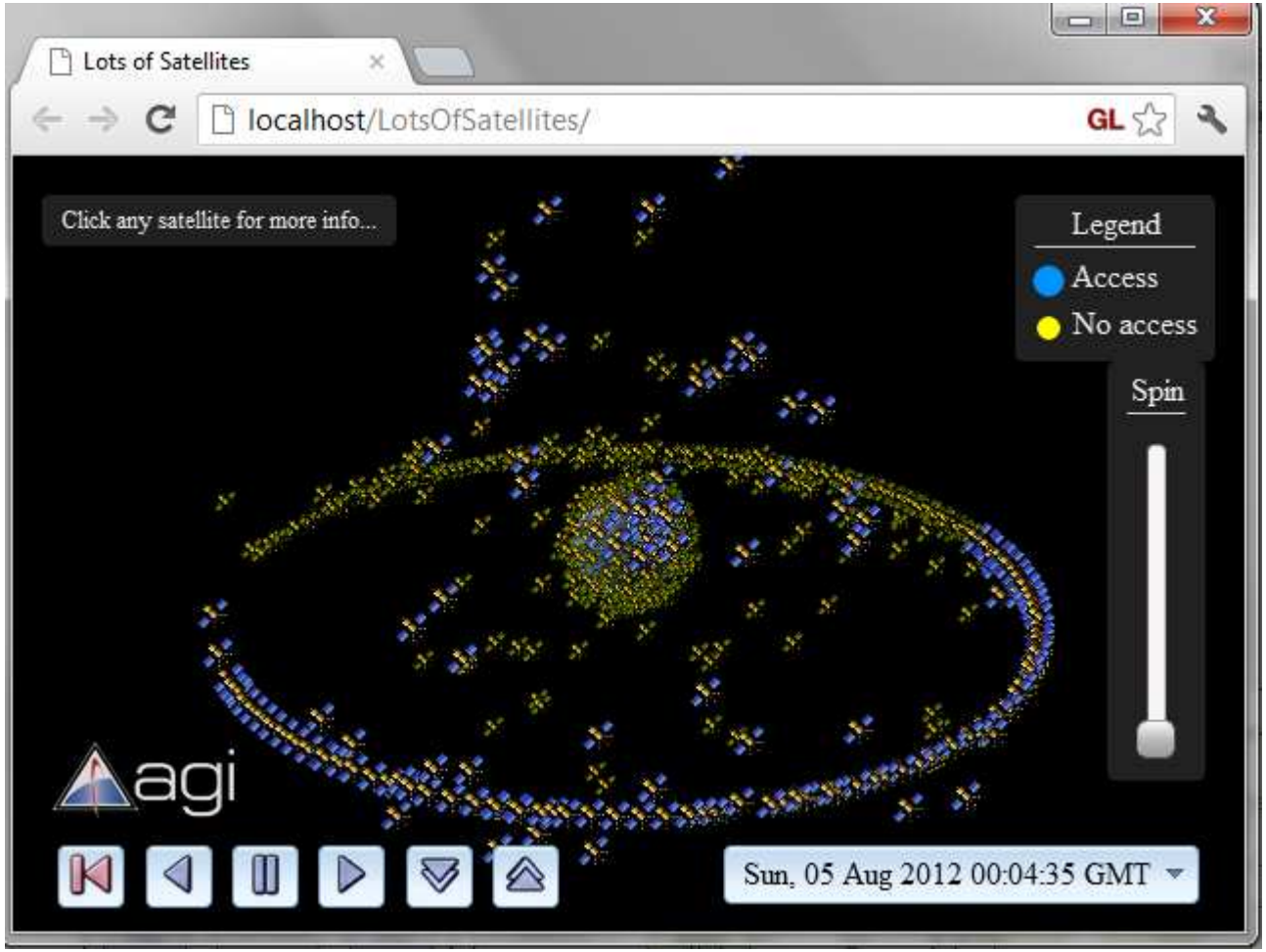

Demo

Today

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- WebGL in general
- Cesium in particular
  - Architecture and applications

WebGL for Web Developers

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- The web has
  - Text
  - Images
  - Video
- What is the next media-type?

WebGL for Desktop Developers

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- We want to support
  - Windows, Linux, Mac
  - Desktop and mobile
- How?

Bring 3D to the Masses

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- Put it in on a webpage
  - Does not require a plugin or install
  - Does not require administrator rights
- Make it run on most GPUs

WebGL

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- OpenGL ES 2.0 for JavaScript
  - Seriously, JavaScript

Image from http://www.khronos.org/assets/uploads/developers/library/2011-siggraph-mobile/Khronos-and-the-Mobile-Ecosystem_Aug-11.pdf

WebGL Performance

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- Performance can be very good
  - The GPU is still doing the rendering
  - Push work onto
    - The GPU
    - Servers
    - Web workers

See http://www.youtube.com/watch?v=rfQ8rKGTVlg

WebGL Performance

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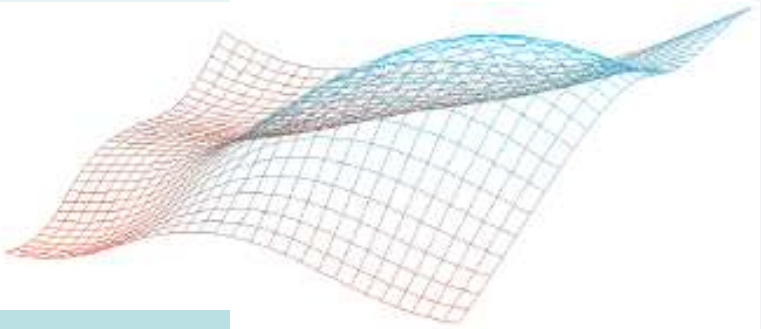
	32x32	64x64	128x128
C++	1.9 ms	6.25 ms	58.82 ms
Chrome 18	27.77 ms	111.11 ms	454.54 ms
x slowdown	14.62	17.78	7.73

CPU-intensive



	32x32	64x64	128x128
C++	3.33 ms	9.43 ms	37.03 ms
Chrome 18	12.82 ms	22.72 ms	41.66 ms
x slowdown	3.85	2.41	1.13

GPU-intensive (256 draws per frame)

Image from http://openglinsights.com/

WebGL Stats

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- In October, 2012

http://webglstats.com/

Desktop WebGL Support

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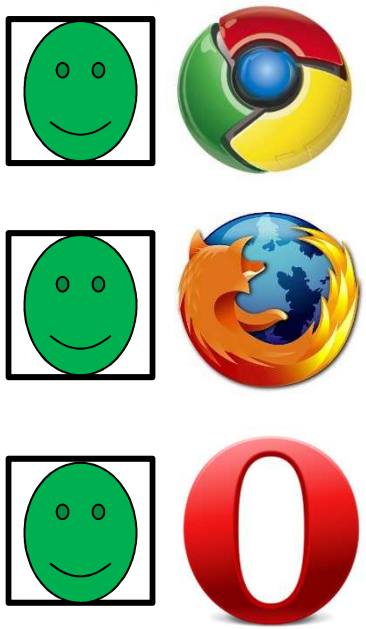
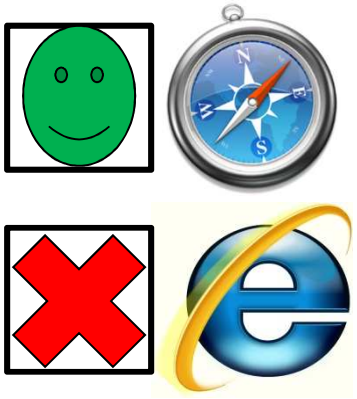
- In October, 2012



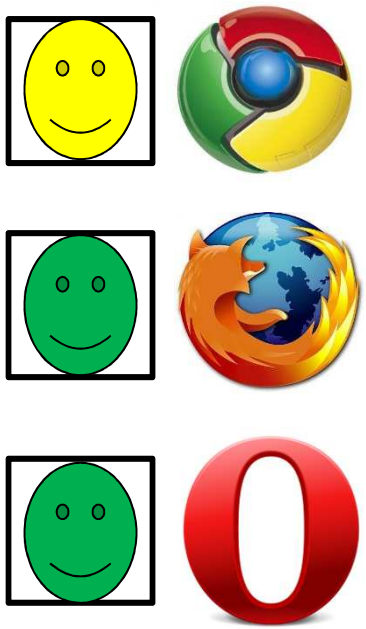


- 3rd Party Plugins available

See http://www.khronos.org/webgl/wiki/Getting_a_WebGL_Implementation

Android WebGL Support

- In October, 2012



Stock Browser
- Demo at SIGGRAPH 2011

For Cesium, see our mobile page

Mobile WebGL Support

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- In October, 2012

In iOS 5 for iAd developers

Windows Mobile

See http://news.cnet.com/8301-30685_3-20071902-264/apple-signs-up-for-webgl-graphics-in-iads/

HTML5 on Mobile

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- Touch events
  - Test with http://www.snappymaria.com/misc/TouchEventTest_v2.html
- Geolocation
- Device orientation and motion

- The future of HTML5 and WebGL on mobile is *very promising*

WebGL on Your System

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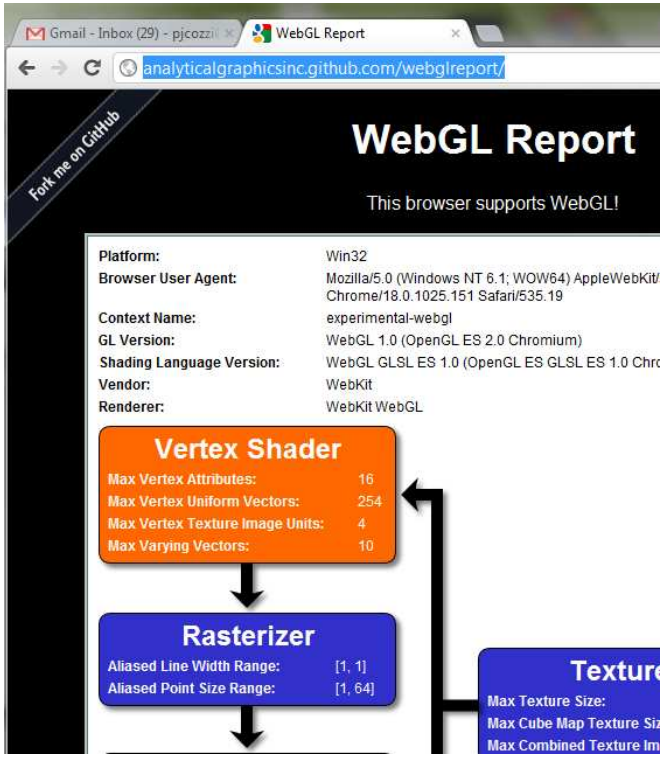
- http://www.webglreport.com



WebCL

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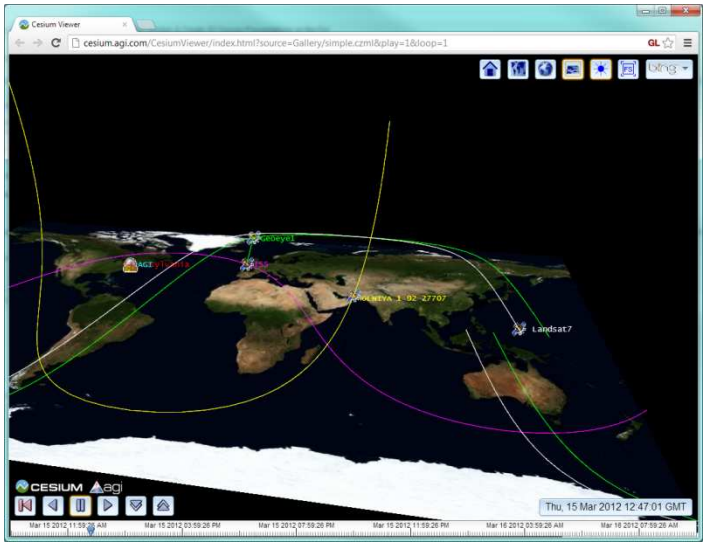
- OpenCL bindings for JavaScript are coming.

N-Body Simulation
http://www.youtube.com/watch?v=F7YSQxz3j7o

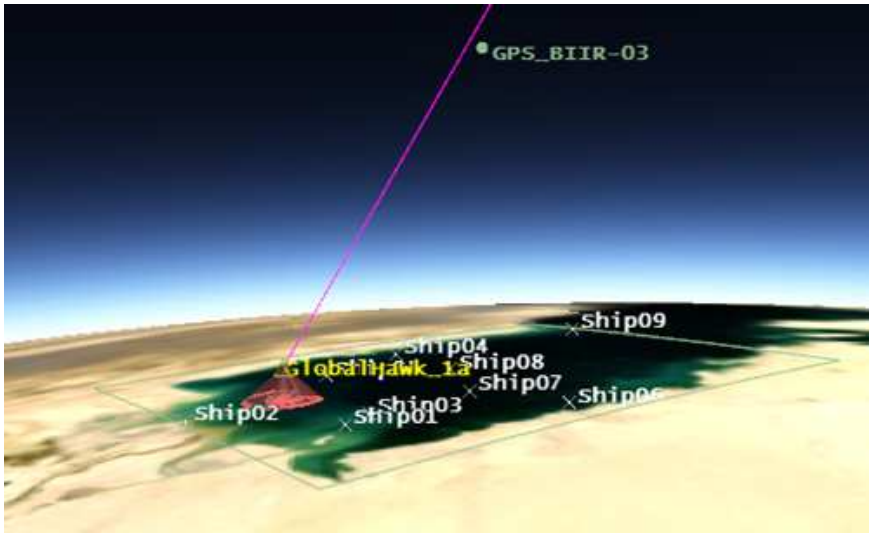
http://www.khronos.org/webcl/
Prototypes for Firefox and WebKit are available

Cesium

- Builds on WebGL to provide a JavaScript virtual globe and map for the web



Demo



Demo

CZML

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- Data-Driven visualization
- A streamable JSON scene description
- Describes the value of properties over time
- Intend to propose as an OGC standard
- Static, real-time, or streaming

- CZML Guide - http://git.io/czml

CZML

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```
[
  {
    "id":"any unique identifier",

    // Static properties, value is constant across time
    "label":{
      "text":"Cesium",
      "verticalOrigin":"CENTER"

      // Interval properties, value is constant within intervals
      "show":[
        {
          "interval":"2012-03-15T22:32:58.828Z/2012-03-15T22:35:59.807Z",
          "boolean":true
        },
        {
          "interval":"2012-03-15T22:35:59.807Z/2012-03-15T23:17:33.032Z",
          "boolean":false
        },
    },

    // ...next slide
```

CZML

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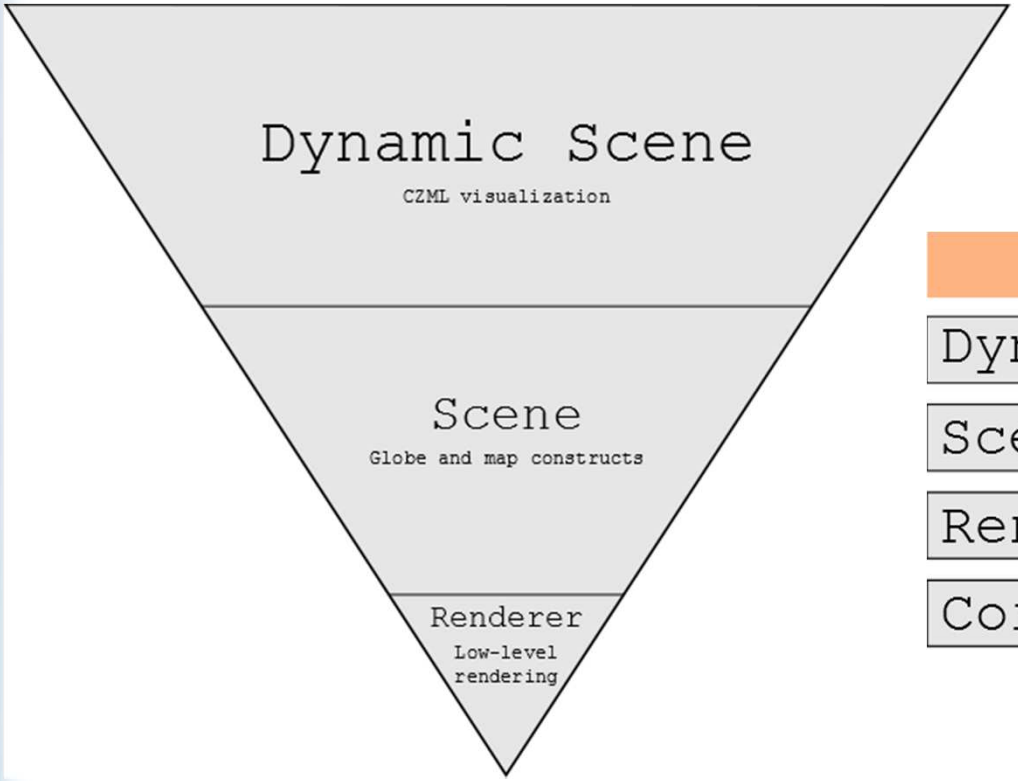
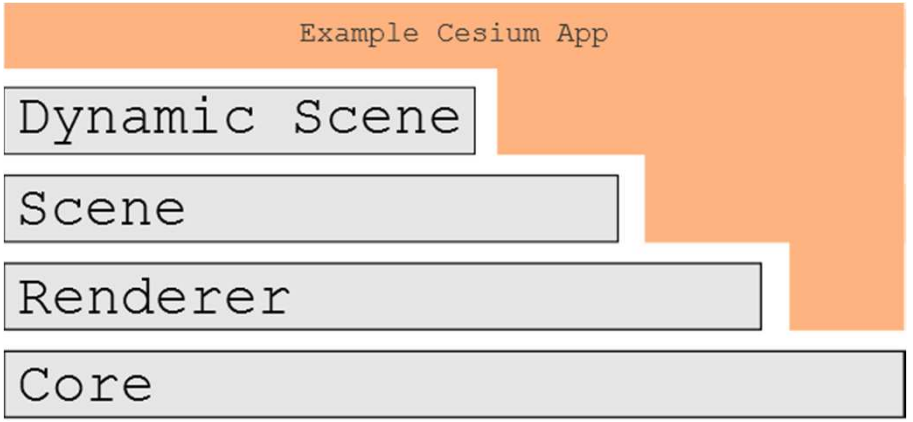
```
    // ...previous slide

    // Sampled properties, value is interpolated across time
    "position":{
      "interpolationAlgorithm":"LAGRANGE",
      "interpolationDegree":5,
      "epoch":"2012-03-15T10:00:00Z",
      "cartesian":[
        0.0,5758814.86335812,68448.0918072779,-4082012.64698081,
        60.0,5491825.89961442,-36646.1482569654,-4436012.6589284,
        120.0,5201672.72301352,-139154.225693654,-4771903.02821491
      ]
    }
]
```

Cesium Architecture

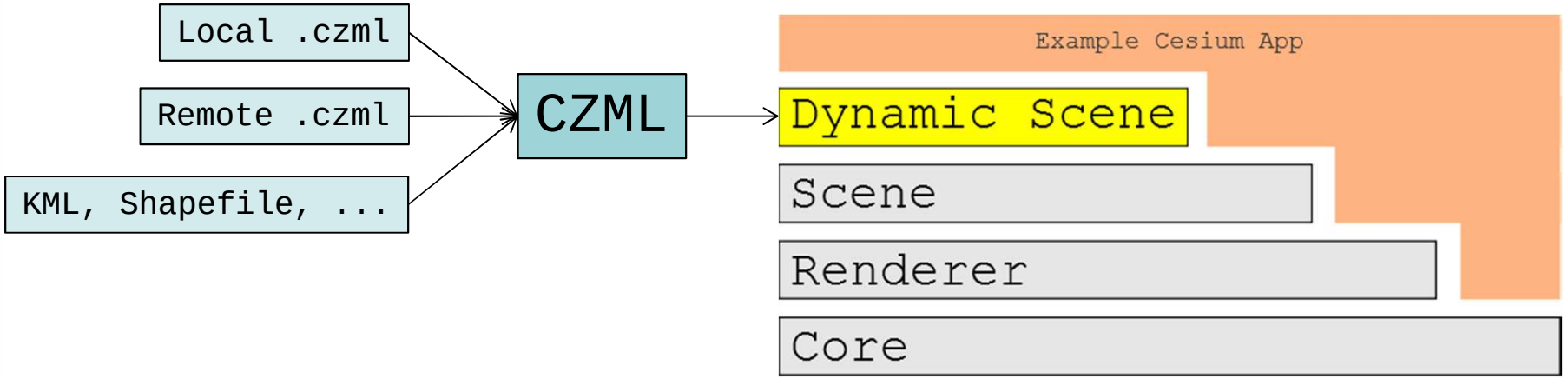




https://github.com/AnalyticalGraphicsInc/cesium/wiki/Architecture

CZML Architecture

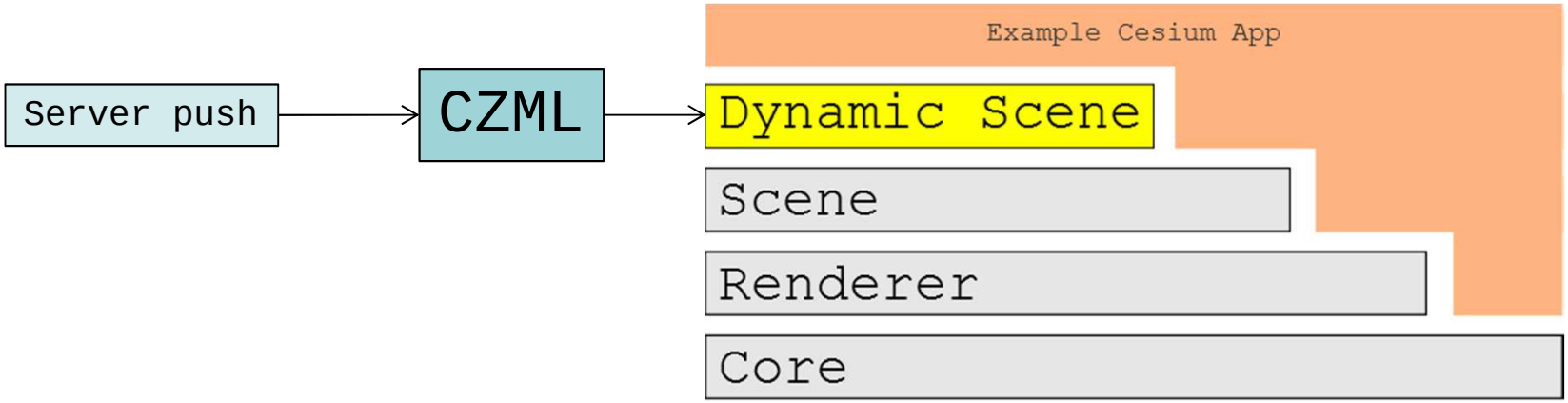
- Static CZML



Open source CZML writer: https://github.com/AnalyticalGraphicsInc/czml-writer

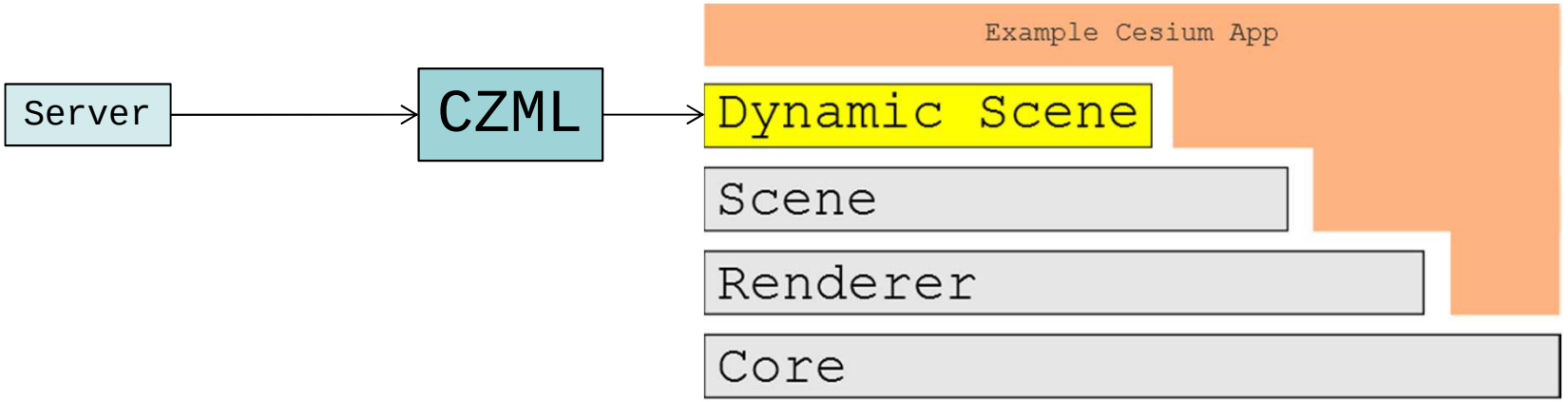
CZML Architecture

- Real-Time CZML



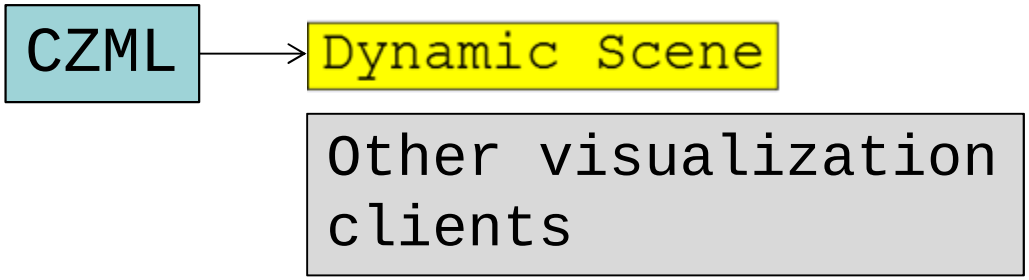
CZML Architecture

- Streaming CZML



Client-side buffering and prefetching

CZML Architecture



Demo

Terrain and Imagery

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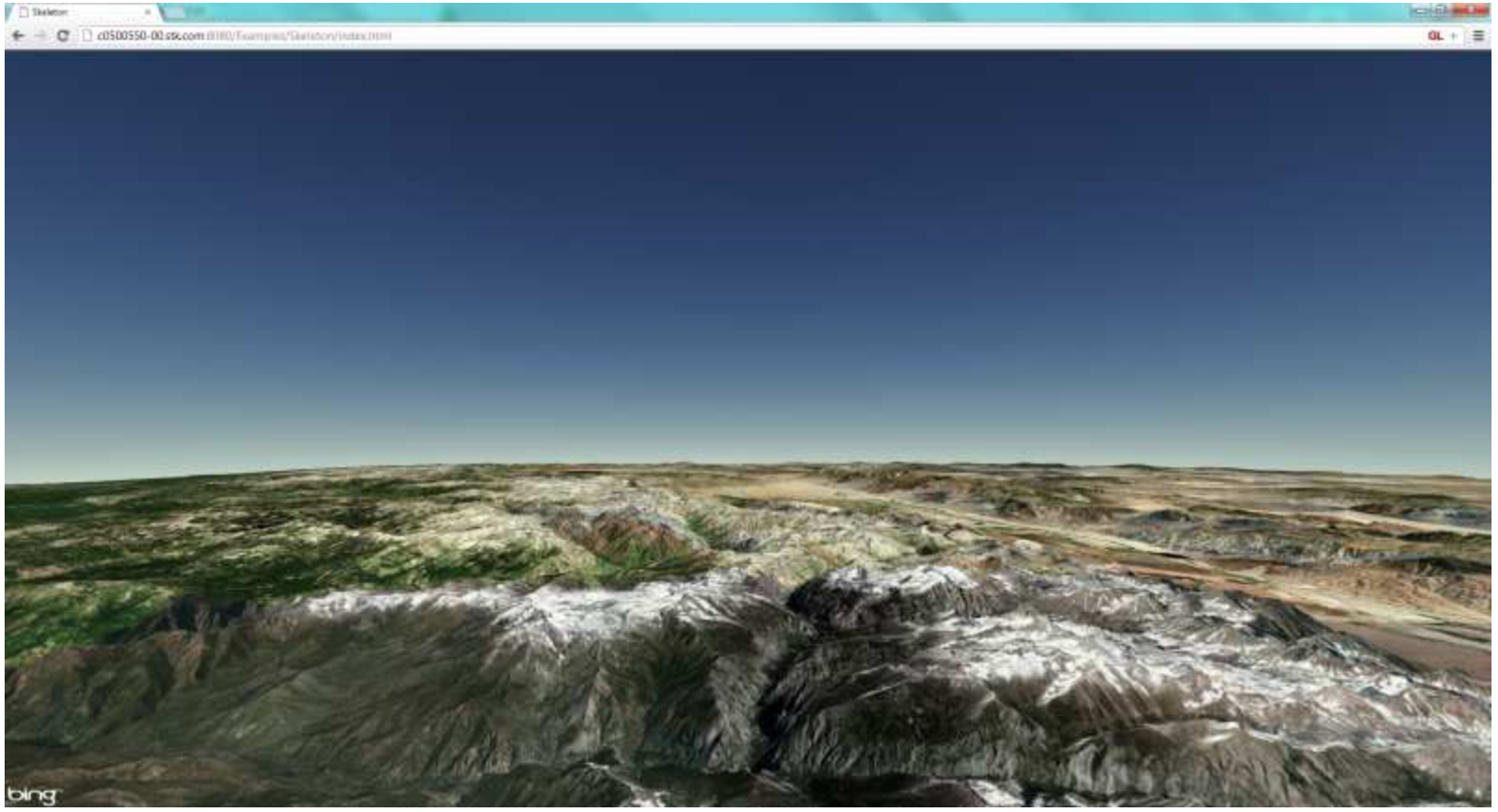
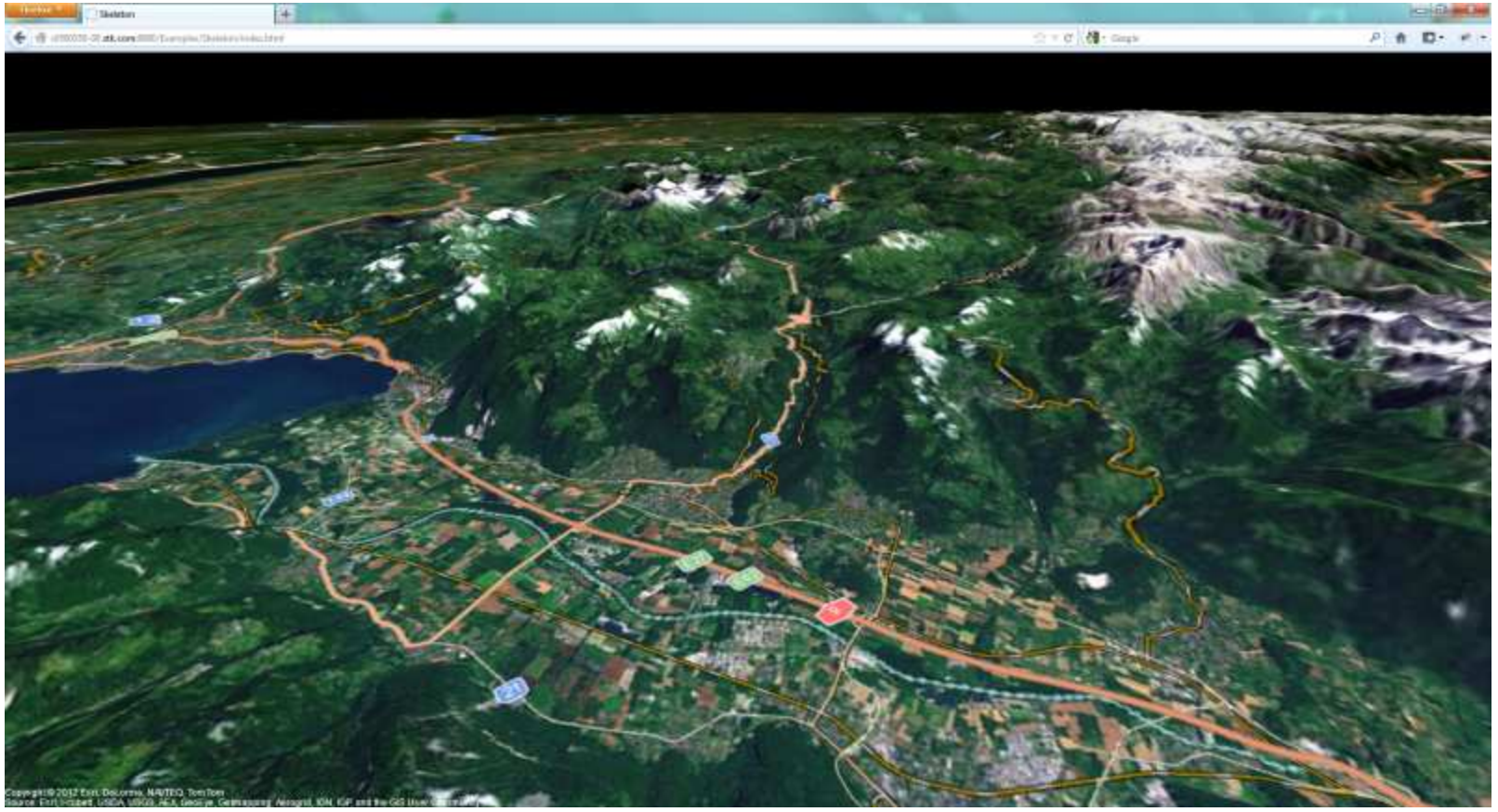


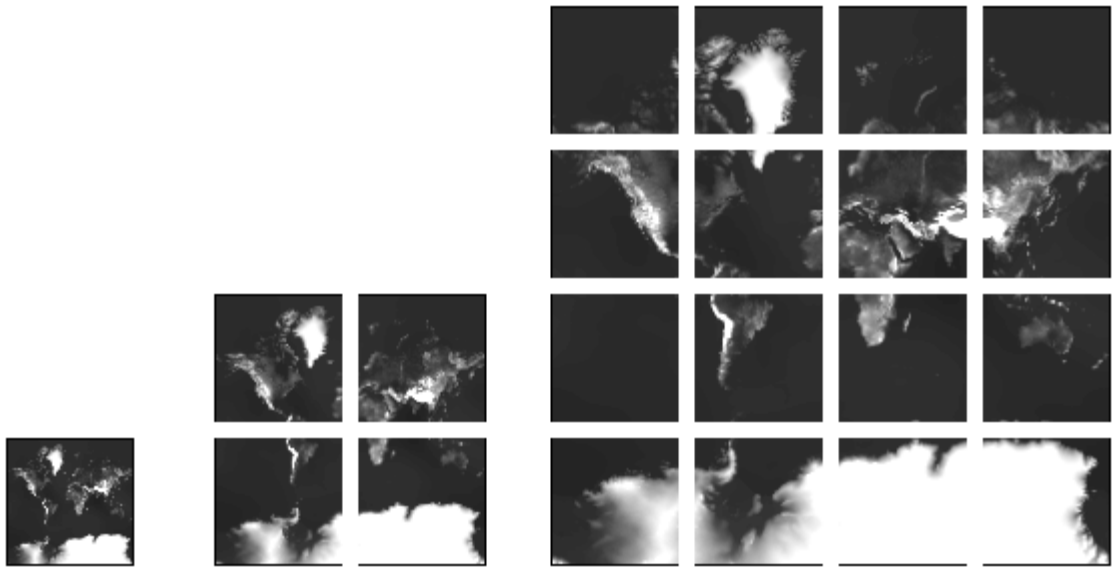
Terrain and Imagery

CESIUM



Terrain and Imagery

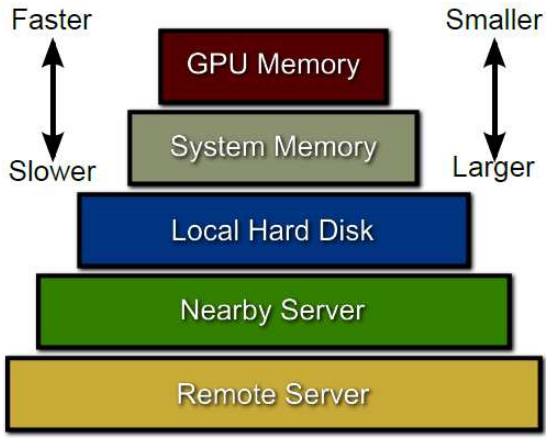
CESIUM

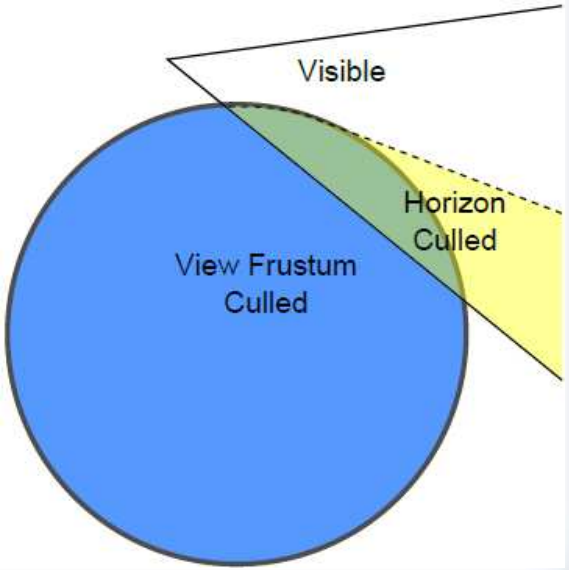


- Heightmap terrain subdivided into a quadtree
- Hierarchical level of detail (HLOD)

Terrain and Imagery

- Out-of-Core
- HLOD
- Backface culling
- View frustum culling
- Occlusion culling
- Asynchronous requests
- Web worker transforms





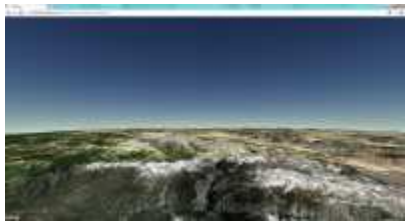
Images from http://www.virtualglobebook.com/

Terrain and Imagery

CESIUM

- Performance
  - Intel Core i7-860, NVIDIA GeForce GTS 250, 1920x1200

	Max Level	Tiles	Triangles	Textures	FPS
Whole-earth view	4	30	253,500	68	210
Top-down view	14	38	321,100	86	166
Horizon view	13	113	954,850	254	146



Roadmap

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- Improved mobile support
- COLLADA models
- …
- Full list:

  https://github.com/AnalyticalGraphicsInc/cesium/wiki/Roadmap

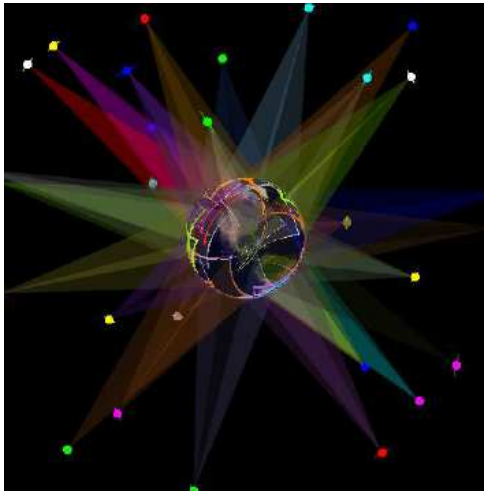
Cesium

Demos

- cesium.agi.com

Code

- github.com/AnalyticalGraphicsInc/cesium



Contributors

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- Tom Fili
- Matt Ford
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- Ian Lilley
- Ed Mackey @emackey
- Kevin Ring
- Frank Stoner

Closing Thoughts

CESIUM

- JavaScript and WebGL are the platform for thin-client visualization
  - No install, no plugin, no admin rights
  - Cross-platform, cross-device
- Cesium is one example

- Contact
  - Patrick Cozzi
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