

REVIEW OF DIGITAL GLOBES 2015

JESSICA KEYSERS
MARCH 2015

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Author: Ms Jessica Keyzers

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1 PURPOSE OF THIS PAPER

This paper presents a preliminary summary of 16 digital globe platforms and associated visualisation applications.

2 EXECUTIVE SUMMARY

In 1998 Al Gore described his vision for a digital/virtual earth/globe as being a 3D virtual representation of the Earth which would provide access to vast amounts of scientific and cultural information to help people understand the Earth and its natural and human phenomena. The International Society for Digital Earth was established in 2006 to further this vision. The vision has been partly realised, with a number of different digital globes existing today. However, this remains an emerging area and the Open Digital Earth Foundation (OEDF) was recently established to contribute to the global effort to help fully realise the original vision.

The OEDF plans to prepare a discussion paper comparing existing digital globe platforms with a view to creating a foundation globe or 'global globe' using the most suitable platform. The Institute of Remote Sensing and Digital Earth (RADI) of the Chinese Academy of Sciences (CAS) also plan to publish a manual on the topic of digital earth. This paper provides a preliminary summary of 16 existing unique digital globe platforms and 21 associated visualisation applications, including 2 digital globe visualisation applications that do not qualify as platforms as do not allow users to add any data or make any customisations. The intention of this paper is to assist with the development of the OEDF discussion paper and to contribute to the manual. Information is mostly drawn from the website of each globe, with limited software testing performed. The paper classifies digital globes as; platforms and/or visualisation applications, open source or closed source, and public access or restricted access.

One preliminary finding is that if there is a preference to use a completed application targeted at end users that only requires the creation of a data package to produce the globe, then Google Earth may provide the best option. If there is a preference to use an open-source platform on which to build and customise a globe via the source code then either Cesium or World Wind may provide the best option. Note, this finding may change when more information becomes available on the Chinese globes and when further more detailed investigations are undertaken.

This document is only intended to provide a preliminary summary of digital globes. It is not possible at this stage to draw firm conclusions until the capabilities of each existing globe are more fully evaluated.

3 INTRODUCTION

A digital/virtual earth/globe is a 3D virtual representation of the Earth that can display many different views of the planet and its natural and human phenomena. Digital globes can be categorised as platforms or visualisation applications, open source or closed source, and public access or restricted access.

Platforms provide the base globe (software or source code) onto which data and/or customisations can be added to create visualisation applications for specific regions or themes. Many of the existing digital globe platforms are also classified as visualisation applications as they come with data (the amount and type of which varies). There are a few digital globes that are only classified as visualisation applications and do not qualify as platforms, as do not allow users to add any data or make any customisations.

Closed source platforms are complete software packages targeted at end users who simply need to add data to create visualisation applications for particular areas or themes. Users often have to pay for closed source systems, although free versions with limited functionality are sometimes available. For closed source systems, the ownership of the software stays with the producer of the product which means the user cannot sell, distribute, copy and/or change the content of the software. As the owner has complete control, it puts the user at risk if for instance the owner decides to suddenly decommission the product. Open source platforms are often not as straight forward to use, so tend to be targeted at experienced users/developers who can support customisation (via coding). Open source platforms can be updated more quickly than closed source platforms when the user community gets enthusiastic. They may be more reliable for long term projects due to the broader base of developers which reduces the likelihood that they will disappear if the original creator stops working on them.

Public access globes are visualisation applications for which the data they contain is publicly available, while the data in restricted access globes may be restricted to, for example, a specific company or section of government.

The Open Digital Earth Foundation plans to prepare a discussion paper comparing existing digital globe platforms with a view to creating a foundation globe or 'global globe' using the most suitable platform. The Institute of Remote Sensing and Digital Earth (RADI) of the Chinese Academy of Sciences (CAS) also plan to publish a manual on the topic of digital earth. This document is a preliminary summary of existing globes to assist the discussion paper and to contribute to the manual.

4 EXISTING DIGITAL GLOBES

Table 1 summarises 16 existing unique digital globe platforms and 21 associated visualisation applications, including 2 digital globe visualisation applications that do not qualify as platforms as do not allow users to add any data or make any customisations. It is likely that many other visualisation applications exist which are not discussed in this paper. The globes in the table are categorising as platform and/or visualisation application, closed source or open source, and public or restricted access (based on available information and limited testing). Some of the major globes (those numbered 1-6) are then described in further detail in sections 4.1 and 4.2 with the remainder very briefly described in section 4.3.

TABLE 1: CATEGORISATION OF 16 EXISTING UNIQUE DIGITAL GLOBE PLATFORMS AND 21 ASSOCIATED VISUALISATION APPLICATIONS, INCLUDING 2 DIGITAL GLOBE VISUALISATION APPLICATIONS

UNIQUE PLATFORM	VISUALISATION APPLICATION	CLOSED / OPEN SOURCE	PUBLIC / RESTRICTED ACCESS
1 Google Earth	Google Earth (provides imagery, elevation, vector data, 3D buildings, map gallery)	Closed	Public (free and paid versions)
	QLD Globe	Closed	Public
	QLD G20 Globe		Public
2 Bing Maps 3D	Bing Maps 3D (provides imagery, roads basemap, vector data)	Closed	Public (free)
3 Cesium	Cesium (provides imagery, elevation, roads basemaps, demo gallery)	Open	Public (free)
	Bhuvan-3D	Open	Public
	QLD Cube Globe	Open	Public
4 World Wind	World Wind (provides imagery, elevation applications gallery)	Open	Public (free)
5 WebGL Earth 2	WebGL Earth 2 (uses Cesium but is its own platform and provides imagery, roads basemaps)	Open	Public (free)
6 Marble	Marble (provides imagery, roads basemaps, vector data, weather, satellites, historical maps, moon & planets etc)	Open	Public (free)

	UNIQUE PLATFORM	VISUALISATION APPLICATION	CLOSED / OPEN SOURCE	PUBLIC / RESTRICTED ACCESS
7	SkylineGlobe	SkylineGlobe (provides imagery, vector data)	Open	Public (free)
		Army Geospatial Enterprise (AGE) GeoGlobe	Closed (can be customised via an API)	Restricted (paid enterprise solution)
8	ArcGlobe	ArcGlobe (provides imagery, elevation)	Closed	Public (paid)
9	EV-Globe	<i>Not sure as in Chinese</i>	<i>Not sure as in Chinese</i>	<i>Not sure as in Chinese</i>
10	SuperMap GIS	<i>Not sure as in Chinese</i>	<i>Not sure as in Chinese</i>	<i>Not sure as in Chinese</i>
11	Digital Earth Science Platform/ Chinese Academy of Sciences (DESP/CAS)	DESP/CAS <i>Not sure as little information available</i>	Closed <i>Not sure as little information available</i>	Restricted (Chinese Government) <i>Not sure as little information available</i>
12	osgEarth	-	Open	n/a as platform only
12	CitySurf Globe	- <i>Not sure as can't access product</i>	Closed	n/a as platform only
13	Earth 3D	Earth 3D	Closed	Public

4.1 MAJOR CLOSED-SOURCE PLATFORMS & ASSOCIATED VISUALISATION APPLICATIONS

PLATFORM 1:

Google Earth (Google – US)

Google Earth is the most well-known digital globe platform. It is a closed-source, complete application targeted at end users and has free and paid versions (i.e. Google Earth Pro). It is also a visualisation application as provides a range of data to the user. After the download and installation of software, it can be used on desktop, web or mobile. It does not provide the ability for users to customise the interface.

The following capabilities are noted;

- + User-friendly
- + A lot of functionality including; navigation, search, drawing and measuring, place marks and tours, 3D terrain and buildings, support for kml/kmz and gps data containing placemarks, vector data, raster overlays and 3D models, views of ocean, sky and planets, ability to adjust sunlight, print, share, overview map, fly throughs, historical aerial photography, street view, sketchup, lots of vector data available
- + Extra features include dynamic imagery source and date, dynamic coordinates and elevation at cursor, dynamic eye altitude
- + Ability to link to all other Google applications and accounts
- + Google Earth Pro has advanced measuring and drawing tools and the ability to create movies
- + Imagery loads seamlessly

The following limitations are noted;

- No bar scale
- Cannot turn off imagery i.e. no other basemaps (but it does have all the additional vector data)
- Zooming can be a bit jumpy
- Custom tile sets and custom terrain data are difficult to add



FIGURE 1: THE GOOGLE EARTH GLOBE

QLD Globe / QLD G20 Globe (DNRM QLD)

QLD Globe and QLD G20 Globe are visualisation applications implemented within the Google Earth platform, using Google Earth Enterprise at the back end. They are free public access interactive tools allowing users to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data. The data is packaged as KML that can be opened in Google Earth and easily used on desktop, web or mobile. Download and installation of the Google Earth software is required.

The following capabilities are noted;

- + All the features of the free Google Earth application are available (or Pro if the user has Pro)
- + The custom data available within the QLD Globe KML includes;
 - + places (e.g. population centre, suburb)
 - + boundaries (e.g. coastline, local government, electorate, postcode)
 - + roads (e.g. arterial road, minor road)
 - + rail (e.g. railway line, railway station)
 - + transport (e.g. ferry, mall, busway, path, track)
 - + addresses
 - + land parcel (e.g. property boundary, property label)
 - + land parcel tenures (e.g. freehold, national park, state forest, state land)
- + The data available within the QLD G20 Globe KML relates to 6 sectors;
 - + agriculture
 - + construction
 - + resources
 - + tourism
 - + science and innovation
 - + education and training
- + Releases and updates of the QLD Globe are regularly made

The following limitations are noted;

- Same limitations as Google Earth

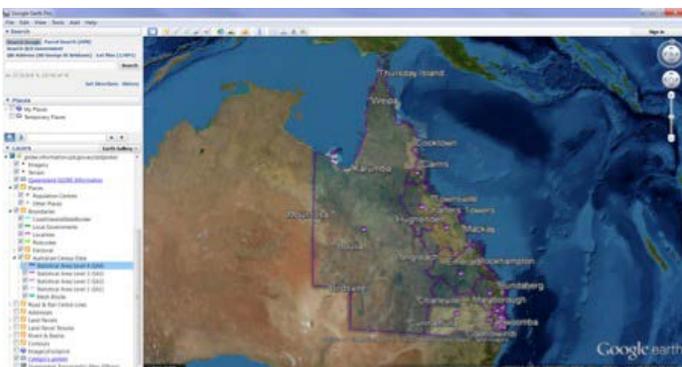


FIGURE 2: THE QLD GLOBE



FIGURE 3: THE QLD G20 GLOBE

PLATFORM 2:

Bing Maps 3D (Microsoft - US)

Bing Maps 3D is another closed-source digital globe platform similar to Google Earth. It is also a visualisation application as provides some data to users. It is free, but download and installation of software is required. It runs inside Internet Explorer and Firefox, and uses NASA Blue Marble: Next Generation (imagery).

The following capabilities are noted;

- + Aerial imagery has a normal aerial view and a bird's eye view optimised for the tilt angle
- + Road and Aerial basemaps are available
- + Functionality includes; directions, search, print, share, add points paths areas etc and save to places, traffic, bar scale
- + Zooming is fast

The following limitations are noted;

- Reduced “3D” capability – there is only a single tilt view and when fully zoomed out the view is 2D not a 3D globe
- Limited navigation – the user can only pan and zoom (not rotate or continuously tilt like in Google Earth)
- No additional vector data available
- Adding photos, importing kml etc requires a Microsoft account
- Labelling does not scale well (some labels are too big when zoomed in)
- No terrain data available
- The loading speed of imagery does not keep up with zooming speed

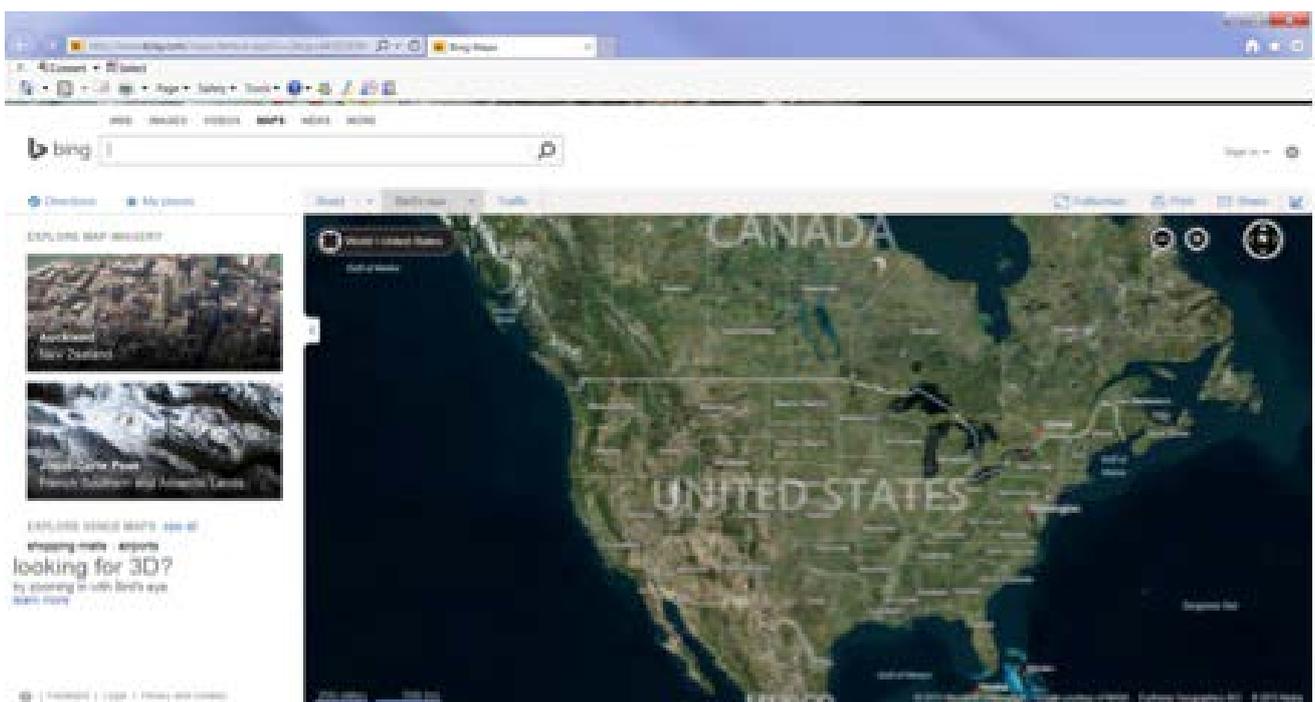


FIGURE 4: THE BING MAPS 3D GLOBE



FIGURE 5: A CESIUM GLOBE DEMO

4.2 MAJOR OPEN-SOURCE PLATFORMS & ASSOCIATED VISUALISATION APPLICATIONS

PLATFORM 3:

Cesium (AGI - US)

Cesium is a JavaScript library for creating 3D globes and 2D maps in a web browser without a plugin. It uses WebGL (web graphics library) for hardware-accelerated graphics, and is cross-platform, cross-browser, and aimed at dynamic-data visualisation. Cesium is open-source under the Apache 2.0 license so is free for commercial and non-commercial use. It is different from a 3D globe like Google Earth because it is not a complete application targeted at end users. It requires programming to use and has a lot of potential for customisation and user added content. As it provides some base data to users, it is also classified as a visualisation application.

The following capabilities of Cesium are noted (as per the Cesium website);

- + API has 3 views; 3D, 2D & 2.5D
- + Create data-driven time-dynamic scenes using CZML (Cesium language based on JSON)
- + Visualize high-resolution worldwide Terrain and add custom terrain data
- + Layer imagery from multiple sources, including WMS, TMS, WMTS, OpenStreetMap, Bing Maps, ArcGIS MapServer, Google Earth Enterprise, and standard image files
- + Draw GeoJSON and TopoJSON, draw 3D models using COLLADA and glTF with animations and skins, draw and style a wide range of geometries: polylines, billboards, labels
- + Draw and extrude polygons, polygons with holes, rectangles, circles, and ellipses, boxes, spheres, ellipsoids, and cylinders, corridors, polyline volumes, and walls
- + Draw the atmosphere, sun, sun lighting, moon, stars, and water
- + Camera navigation with mouse and touch handlers for rotate, zoom, pan with inertia, flights, free look, and terrain collision detection
- + Batching, culling, and JavaScript and GPU optimizations for performance
- + Precision handling for large view distances (avoiding z-fighting) and large world coordinates (avoiding jitter)

- + High-precision math and time for reference frames, projections and conversions Widgets available for a range of functions (<http://cesiumjs.org/features.html>)
- + Plugins for extra functionality (<http://cesiumjs.org/plugins/index.html>)

The following limitations are noted;

- Currently no 3D buildings layer (although there may be soon)
- Lack of tutorials (although there are more to come)
- Coding in JavaScript and CZML required to use Cesium so it is more difficult to implement than if using a compete globe e.g. Google Earth

NICTA (National Information Communications Technology Australia) use Cesium in their National Map software which provides map-based access to Australian government agency spatial data. Data is not stored in the National Map; it is all accessed directly from each custodian government agency using OGC (Open Geospatial Consortium) standards. This provides centralised access to multi-jurisdictional, multi-custodian authoritative datasets, with users also able to obtain information on how to download the data and use it within other applications. The map is open source software developed by NICTA working with the Commonwealth Department of Communications, Geoscience Australia and other government agencies. NICTA is adding useful code back into the Cesium database as a result of this project. The map is still currently a beta service but is available to government, business and the public to facilitate the open data initiative and support commercial and community innovation.

Bhuvan-3D (India)

Bhuvan-3D is a digital globe visualisation application for India built using the Cesium API digital globe platform. It is free and there is no installation required, access is via a web browser.

The following capabilities are noted;

- + Good quality navigation, similar to Google Earth
- + The few 3D building models available are good quality
- + Authoritative Indian satellite imagery and roads basemaps are provided

The following limitations are noted;

- Indian imagery is not colour corrected/balanced
- There is little data available
- Layer labels cannot be turned off
- Features cannot be clicked for more information
- There are no road labels
- Layers draw in the order they are turned on, hence roads appear on top of administrative boundary labels if roads are turned on second
- The “Panchayat boundaries” layer doesn’t seem to work
- The loading bar does not seem to disappear
- The help displays underneath the navigation panel and cannot be seen
- Some of the 3D Model bookmark zoom locations are not quite right
- Loading response as you zoom is a little slow
- Not a lot of functionality built in i.e. no directions, mark-up, kml support etc



FIGURE 6: THE BHUVAN GLOBE

QLD Cube Globe (QUT & DNRM QLD)

The Cube Globe was developed in a partnership between the Australian State Government Department of Natural Resources and Mines, and Queensland University of Technology's Institute for Future Environments. The Cube is one of the world's largest digital interactive learning and display spaces, consisting of 48 multi-touch screens two storeys high. The Cube Globe is a state-of-the-art visualisation application built on the Cesium platform using the same data as the G20 Globe.

The following capabilities are noted;

- + World-first spatial platform using state-of-the-art immersive visualisation, interactive maps, animation and multi-media design
- + Tells compelling stories about QLD using the same data as the G20 Globe
- + Touch screen

The following limitations are noted;

- Same limitations as Cesium



FIGURE 7: THE QLD CUBE GLOBE



FIGURE 8: THE WORLD WIND GLOBE

PLATFORM 4:

World Wind (NASA – US)

Similar to Cesium but developed by NASA, World Wind is a JavaScript software development kit (SDK) for creating 3D virtual globes in a web browser or on a mobile device. It is free, open source, cross-platform, and cross-browser. World Wind allows developers to quickly and easily create interactive visualisations of 3D globe, map and geographical information. Again, it requires programming to use but has a lot of potential for customisation and user added content. Its capabilities seem very similar to Cesium and the advantages/disadvantages of each are difficult to compare without actually using the packages. As with Cesium, because it provides some base data as standard, it is also classified as a visualisation application.

The following capabilities are noted (as per the World Wind website);

- + Adds 3D geographic visualization to any application
- + Runs on Windows, Mac OS X, Linux, iOS (partial) and Android (partial)
- + Runs in web pages in Java applets
- + Free run-time and development license
- + Huge collection of high-resolution imagery and terrain from NASA servers, plus displays high-resolution imagery, terrain and geographic information from any open-standard public or private source
- + Open-standard interfaces to GIS services and databases
- + Large collection of geometric and geographic shapes
- + Simple to extend and modify, designed to be extensible
- + Uses Java and OpenGL
- + Point, Path, Polygon, Curtain, Extruded Polygon, Ellipsoid, Sphere, Cylinder, Cone, Pyramid, Box, Airspaces, Path, Polygons, Ellipse, Circle, Quadrilateral, Rectangle, Square, Text, Image
- + Annotation: Text, Text Balloon, HTML5 web-browser Balloon, Image, Icons, all with geo-



FIGURE 9: THE WEBGL EARTH2 GLOBE

- located and screen versions
- + Placenames, Political boundaries
- + 2.5D “Flat Globe” with terrain
- + Navigation and Viewing: Orbit View, First Person, Stereo, application-defined
- + Multiple World Wind windows
- + Many imagery and vector formats
- + Coordinate Systems: Lat/Lon, UTM, MGRS. Datums: WGS84, NAD27 and many others

The following limitations are noted;

- Image download speeds will vary, depending on internet connection
- A blank screen can be caused by out of date graphics drivers
- Coding in JavaScript is required to use the API so more difficult to build than if using a complete globe e.g. Google Earth

PLATFORM 5:

WebGL Earth 2 (Klokantek Technologies - Swiss)

WebGL Earth 2 is an open source, Leaflet compatible API (Leaflet is a modern open-source JavaScript library for mobile-friendly interactive maps). It allows easy embedding of a 3D globe in websites, with out-of-the-box user friendly features and support for mobile devices. WebGL Earth uses the CesiumJS project for the rendering of core globe data and the WebGL developers contribute code back into the Cesium project. It is free and there is no installation required, access is via a web browser. It can be easily used with little customisation or users can choose to customise it to their own needs. The out-of-the-box features and a focus on rendering custom map tiles with the Klokantek MapTiler targets a slightly different audience to Cesium. It is a separate platform to Cesium despite using and contributing to Cesium, and it is also a visualisation application, providing some base data.

The following capabilities are noted;

- + Runs automatically on all modern browsers on all computers with recent graphic cards
- + Makes embedding a globe in a website very easy
- + OpenStreetMap, Bing, MapBox and other tile layers can be easily used with the globe
- + Custom geodata (GeoTIFF, ECW, MrSID etc) can be easily pre-processed with MapTiler

The following limitations are noted;

- Only supports Apple devices from iOS 8+
- Coding required to use the API so more difficult to build than if using a complete globe e.g. Google Earth

PLATFORM 6:

Marble (KDE - International)

Marble is another free, open-source (LGPL) virtual globe and world atlas for desktop and mobile that is written in C++ and provides bindings for Qt Quick (QML) and Python. It is part of the KDE (international free software community) education project and allows users to learn more about the Earth and other planets. Data is provided by OpenStreetMap, as well as NASA Blue Marble: Next Generation and others. The user can view clouds and sun shadow, follow satellites and space stations and display their orbits, which are all updated in real-time. They can also travel back in time and learn about historic views of the planet using maps from past centuries as well as maps of the moon and other planets. As it provides a vast array of data and information to users it is also classified as a visualisation application.

The following capabilities are noted;

- + A lot of maps are provided including; imagery, roads basemaps, weather, real-time clouds, real-time satellites, post codes, earthquakes, real-time traffic, historical maps, moon and planets, photos
- + Functionality includes; address searching, positioning and tracking, routing and navigation for vehicles bikes and pedestrians, measurement and bookmarks.
- + Links to Wikipedia articles
- + Uses little disk space and memory
- + Great educational tool

The following limitations are noted;

- The user cannot add many types of custom datasets
- Existing maps are low resolution
- No elevation data
- Not 'real' 3D only uses 2D graphics so no camera rotation available



FIGURE 10: THE MARBLE GLOBE

4.3 OTHER PLATFORMS & VISUALISATION APPLICATIONS

PLATFORM 7: SkylineGlobe

-  A US enterprise globe provided as an API that allows users to customise the interface to their needs and create, view, analyse, edit, and share 3D environments.
-  Army Geospatial Enterprise (AGE) GeoGlobe
-  A US Army enterprise approach to raster and vector data sharing and visualisation in a 3D worldwide environment. It is based on Skyline and use is restricted to the US Army.

PLATFORM 8: ESRI ArcGlobe / ArcGIS Pro / ArcGIS Online 3D Scene Viewer

-  ArcGlobe is part of the ArcGIS 3D Analyst extension allowing seamless 3D visualization of raster and feature data. ArcGIS Pro is the new 3D aspect of ArcGIS desktop. 3D scene viewer allows users to view and share 3D scenes created with ArcGIS Pro via ArcGIS Online.

PLATFORM 9: EV-Globe

-  A Chinese globe with limited information available in English.

PLATFORM 10: SuperMap GIS

-  A Chinese GIS product with limited information available in English.

PLATFORM 11: Digital Earth Science Platform/Chinese Academy of Sciences (DESP/CAS)

-  A Chinese digital globe with limited information available in English.

PLATFORM 12: osgEarth

-  By Pelican Mapping in the US, it is another open-source (LGPL) C++ software library that enables run-time terrain model generation in an OpenSceneGraph application (open source high performance 3D graphics toolkit). It can pull data from web services (WMS, WCS, TMS) as well as many GDAL supported formats.

PLATFORM 13: CitySurf Globe

-  A commercial Turkish product by CitySurf that displays and analyses the whole earth in 3D.

PLATFORM 14: Earth3D

-  Developed as part of a student's diploma thesis at Braunschweig University of Technology, Germany before Google bought Keyhole Inc and created Google Earth. It visualises

the Earth in a real-time 3D view using data from NASA, USGS, the CIA and the city of Osnabrück. Earth3D is free software (GPL).

PLATFORM 15: **EarthBrowser**

- 🌐 A cheap (US\$20) product developed by Lunar software which is an Adobe Flash/AIR-based virtual globe with real-time weather forecasts, earthquakes, volcanoes, and webcams.

PLATFORM 16: **OpenWebGlobe**

- 🌐 The bachelor's thesis of a student at University of Applied Sciences North western Switzerland. It is a virtual globe SDK written in JavaScript using WebGL and is free and open-source software.

APPLICATION VISUALISATION 17: **Worldwide Telescope**

- 🌐 Created by Microsoft, it displays the astronomical sky as maps, the 3D Universe, and earth science data. It functions primarily as a virtual telescope, with imagery from ground and space based telescopes to enable exploration of the universe, but also has an Earth mode.

APPLICATION VISUALISATION 18: **NASA Jet Propulsion Laboratory (JPL) Eyes on the Earth**

- 🌐 A 3D visualization of Earth's vital signs, including recent data for air temperature, carbon dioxide, carbon monoxide, sea level, ice and water.

5 CONCLUDING REMARKS

This paper is only intended to provide a preliminary summary of digital globes. Fuller testing of the capabilities of each existing globe will help form a view about how best to improve the Open Digital Earth Foundation Globe.

However, if there is a preference to use a platform that is a completed application targeted at end users and hence would only require the creation of a data package to produce the globe, then Google Earth may provide the best option because it has the:

- 🌐 Best navigation and range of functionality
- 🌐 Fastest data loading
- 🌐 Best 3D buildings
- 🌐 Most familiar platform to users

If there is a preference to use an open-source platform on which to build and customise a globe via the source code (or application programming interface (API) or software development kit (SDK)) then either Cesium or World Wind may provide the best option. The two seem to have very similar functionality and are briefly compared to other open-source globes and each other below;

- 🌐 Both have the ability to add many formats of custom data (which is limited in e.g. Marble)
- 🌐 Cesium has 3 views; 3D, 2.5D, 2D (World Wind only has 3D and 2.5D)
- 🌐 World Wind is compatible with mobile (for Cesium this is planned capability)
- 🌐 Some users have stated there are a lack of tutorials for Cesium, however the website indicates there are more tutorials to come

This paper provides the basic foundation from which the OEDF discussion paper comparing existing digital globe platforms and the CAS RADI manual on the topic of digital earth can build and elaborate. It is suggested that further software testing be undertaken for these publications.

6 GLOSSARY OF TERMS

2D	Two Dimensional
3D	Three Dimensional
AGI	Analytical Graphics Inc. The US Company who provides commercial software for designing, developing and operating missions within the space and national defence communities. They are the founders of Cesium.
Apache 2.0	Apache 2.0 software license (http://www.apache.org/licenses/LICENSE-2.0)
API	Application Programming Interface. In computer programming, an API is a set of routines, protocols, and tools for building software applications. An API expresses a software component in terms of its operations, inputs, outputs, and underlying types.
C++	A general-purpose programming language.
CAS	Chinese Academy of Sciences. CAS comprises a comprehensive research and development network, a merit-based learned society and a system of higher education. CAS brings together scientists and engineers from China and around the world to address both theoretical and applied problems using world-class scientific and management approaches.
CIA	Central Intelligence Agency. The CIA is one of the principal intelligence-gathering agencies of the United States federal government.
COLLADA	An interchange file format for interactive 3D applications.
CZML	Cesium code language based on JSON for describing a time-dynamic graphical scene, primarily for display in a web browser running Cesium. It describes lines, points, billboards (markers), models, and other graphical primitives, and specifies how they change with time.
DNRM	Department of Natural Resources and Mines. State Government of Queensland, Australia.
GDAL	Geospatial Data Abstraction Library. GDAL is a library for reading and writing raster geospatial data formats.
GeoJSON	Is an open standard format for encoding collections of simple geographical features along with their non-spatial attributes using JavaScript Object Notation.
gTIF	A file format.
GPL	General Public License. The most widely used free software license, which guarantees end users (individuals, organizations, companies) the freedoms to use, study, share (copy), and modify the software.

OEDF	Open Digital Earth Foundation. The ODEF has been established through initial collaboration between the State Government of Queensland, Australia, the Australia and New Zealand Cooperative Research Centre for Spatial Information, and the International Society for Digital Earth. It is a non-profit organisation supporting the application and use of open Digital Earth data and technologies for shared societal benefits.
OGC	Open Geospatial Consortium. The OGC are an international voluntary consensus standards organization, originated in 1994. In the OGC, more than 400 commercial, governmental, non-profit and research organizations worldwide collaborate in a consensus process encouraging development and implementation of open standards for geospatial content and services, GIS data processing and data sharing.
OpenGL	Open Graphics Library. OpenGL is a cross-language, multi-platform application programming interface for rendering 2D and 3D vector graphics.
HTML5	Is a core technology markup language of the Internet used for structuring and presenting content for the World Wide Web.
JavaScript	A dynamic computer programming language.
Leaflet	Leaflet is a modern open-source JavaScript library for mobile-friendly interactive maps.
LGPL	Lesser General Public License. LGPL is a free software license published by the Free Software Foundation. The license allows developers and companies to use and integrate LGPL software into their own (even proprietary) software without being required by the terms of a strong copyleft license to release the source code of their own software-parts.
NASA	National Aeronautics and Space Administration. NASA is the United States government agency responsible for the civilian space program as well as aeronautics and aerospace research.
NICTA	National Information Communications Technology Australia. NICTA is Australia's Information Communications Technology (ICT) Research Centre of Excellence and the nation's largest organisation dedicated to ICT research. NICTA's primary goal is to pursue high-impact research excellence and, through application of this research, to create national benefit and wealth for Australia.
Python	Is a widely used general-purpose, high-level programming language.
Qt Quick	Is a free software application framework that provides a way of building custom, highly dynamic user interfaces with fluid transitions and effects, which are becoming more common especially in mobile devices.
QLD	State of Queensland, Australia.
QUT	Queensland University of Technology, Australia.
RADI	Chinese Institute of Remote Sensing and Digital Earth. RADI sits under the Chinese Academy of Sciences (CAS) and was founded in 2012. The largest research institute in the field, RADI was established through consolidating two CAS institutes: the Institute of Remote Sensing Applications (IRSA) and the Center for Earth Observation and Digital Earth (CEODE).

SDK	Software Development Kit. An SDK is typically a set of software development tools that allows the creation of applications for a certain software package, software framework, hardware platform, computer system, video game console, operating system, or similar development platform.
TMS	Tile Map Service. TMS, is a specification for storing and retrieving cartographic data, developed by the Open Source Geospatial Foundation.
TopoJSON	Is an extension of GeoJSON that encodes topology.
USGS	United States Geological Survey. The USGS is a scientific agency of the United States Government.
WebGL	Web Graphics Library. WebGL is a JavaScript API for rendering interactive 3D computer graphics and 2D graphics within any compatible web browser without the use of plug-ins
WCS	Web Coverage Service. WCS defines Web-based retrieval of coverages – that is, digital geospatial information representing space/time-varying phenomena.
WMS	Web Map Service. WMS is a standard protocol for serving georeferenced map images over the Internet that are generated by a map server using data from a GIS database.
WMTS	Web Map Tile Service. WMTS is a standard protocol for serving pre-rendered georeferenced map tiles over the Internet.

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