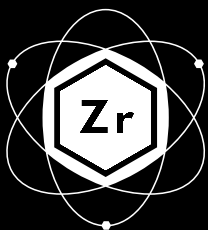


Data Dome Unity Toolkit

Prepared by At-Bristol and Zubr VR Ltd

First Production release - October 2016

Seamus Foley and Jack Norris



Zubr vr



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Introduction

What is the Data Dome?

The Data Dome is a 360 x 180 ultra high resolution, high frame rate, 3D cinema environment. It is one of only 25 stereoscopic dome screens worldwide and the only one in the UK. During the day the screen is used as digital planetarium showing astronomy shows to visitors to At-Bristol science centre. During the evening however the Data Dome's unique projection environment can be used to stage other experiences. What those experiences are is entirely up to you as a content producer. You can use the dome screen by itself, or you can use it hooked up to the cutting edge Bristol is Open smart city network. <http://www.bristolisopen.com>.

Digital planetaria have been around for a while, but what's new about the Data Dome is its flexibility. Unlike other 4k domes you don't need to use dedicated hardware and software to produce interactive data-driven visualisations. You can use familiar software, like Unity, to produce or adapt experiences for the dome that you can interact with with extremely low latency.

Currently the data dome is a beta stage, the technology works well and we are working on making it easier to use - ease of use is what this Unity toolkit is all about. We want to see compelling interactive and data driven experiences in the dome, and for that to happen we need you - talented producers with good content to experiment. If you have Unity content that you think may be interesting in the dome then give this toolkit a go. If you can make it to Bristol, please get in touch to arrange a preview in the dome. (Contact details are at the end of the document)

Note that this toolkit is licensed under the BSD 3 clause license, which allows you to use this toolkit in any project, including commercial projects, in any dome. That said, if you are trying this in another dome we would love to hear about your project and your experiences.

The Data Dome project is supported by the Bristol City Council, At-Bristol Science Centre, The University of Bristol and Bristol is Open.

Been there, dome that

A number of developers have already produced content for the Data Dome. However, part of that development process is almost always a complex configuration of the fisheye dome distortion format. We've created this open source Unity asset package in order to make it as easy as possible for anyone to make content for the Data Dome. This helps to remove a potentially large stumbling block in the development pipeline.

Quick Start Guide

- 1) Import the asset package into your Unity project.
- 2) Replace your main camera with the Dome Projector prefab and orientate it correctly.
- 3) Build your project for the Windows platform.
- 4) Run your application.

If all went well, you'll see your scene rendered in the circular fulldome format. Wondomeful!

Best Practices

Setting up your scene

Operator UI and black screen

It is a good idea to use the dead space around the fulldome circle to display developer/operator information, instructions and controls, as the audience will not see this area. With this in mind, it is also very useful for your build to feature black intro and outro scenes for the operators to smoothly transition your experience with the previous/next project that might be scheduled for the event.

Watch out for incompatible camera and image effects

Especially important if you're converting a complex, pre-existing Unity project, is being aware of certain camera tricks and effects that do not play well in the dome format. This is likely to include camera-aligned particle systems and billboards, certain types of anti-aliasing and depth-reliant effects such as depth-of-field. There are of course many 3rd party effects that we have not tested for compatibility, so careful testing is the best approach.

Crafting your content

Make the most of your realtime experience

Modern game engines such as Unity can create such visually impressive experiences that they can almost be mistaken for pre-rendered CGI videos - which is great, but at the same time you want your audience to know they are experiencing something more than a film. Consider having a live presenter narrate and control your show, utilise live data streams to form some of the visuals, or find a way to hand over some of the interaction to the audience itself!

Smooth out those camera moves

Remember that the Data Dome screen covers a very large portion of your audience members' field of view - as such, it can be easy to provoke motion sickness and other forms of discomfort with jerky animations. Keyframe curves are your friends.

Watch out for over-interaction

Similarly to the previous point, you are advised to be careful when enabling the use of major movement controls. For example, it may not be a great idea to allow someone to control the Unity camera with the use of an unfiltered, sensitive input device such as a mouse. Consider using pre-configured interactive paths that can be triggered.

Indulge in the details...

The Data Dome is great at showing off incredible details in your models - you'll be surprised how you can create a compelling experience out of simply a great spectacle. Give your audience a good amount of time to be amazed.

...But be careful with your composition!

It can be very misleading to view dome content on an ordinary monitor, as you don't get a sense for the scale or immersiveness of your scene. One thing to bear in mind is that you don't need to fill the screen with a single subject - you'll be surprised how big something appears, even if it seems like it's only taking up a small proportion of the screen. Getting too close, or zooming into subjects over-enthusiastically can break the effect of the dome's immersive ultra-wide field of view.

Getting ready for showtime

Testing and optimisation

As we've mentioned a few times in this guide, you're likely to experience a drop in performance when you swap out the main camera in your scene for our Dome camera. We'd advise you to keep an eye on your framerate, and try to optimise your scene as best you can. It's a great idea to get an early version of your project running in the Data Dome itself so you can effectively judge what amendments need to be made.

Delivery to the Data Dome team

The Data Dome machines are not currently running an instance of Unity itself, so ready-prepared executable builds are essential for testing and deployment. Please make your Unity build include an option for running in a resizable-window. Simply copy your builds onto a USB memory stick and bring them along to your testing session.

Troubleshooting/FAQ

How can I test my content in the dome format?

We would suggest that in the short term, you familiarise yourself with the Domemaster format - this will help you get a feel for the audience's focus point, the field of view and what sort of content works well.

When you are ready to start testing your content in the Data Dome itself, you can book drop-in development sessions with At-Bristol.

How do I make my Data Dome project work in stereoscopic 3D?

We are still developing an accessible solution that can enable most Unity Data Dome content to be displayed in stereo 3D - please keep an eye out for this feature in a future update of the asset package.

What are the performance considerations?

Rendering a cubemap camera every frame is not cheap - you are likely to experience a drop in performance when you implement this plugin into your existing scene. However, the Data Dome's machines are very powerful - please see the specifications of the Data Dome's machines in the section below.

It is of course good practice to optimise your project - please try your project in the Data Dome as soon as you can to get a feel for what level of ambition you can get away with. If you don't get a chance to test your project in the Dome itself before you are planning to exhibit it to an audience, we advise you to target a reasonably fast performance, high optimisation level.

I'm having a technical problem implementing the plugin. Can you help?

We'll be on standby to help as much as we can. Please check out our Github page to track issues, or see the contact details at the end of this document to get in touch with us directly.

Specifications

Meet the Domemaster

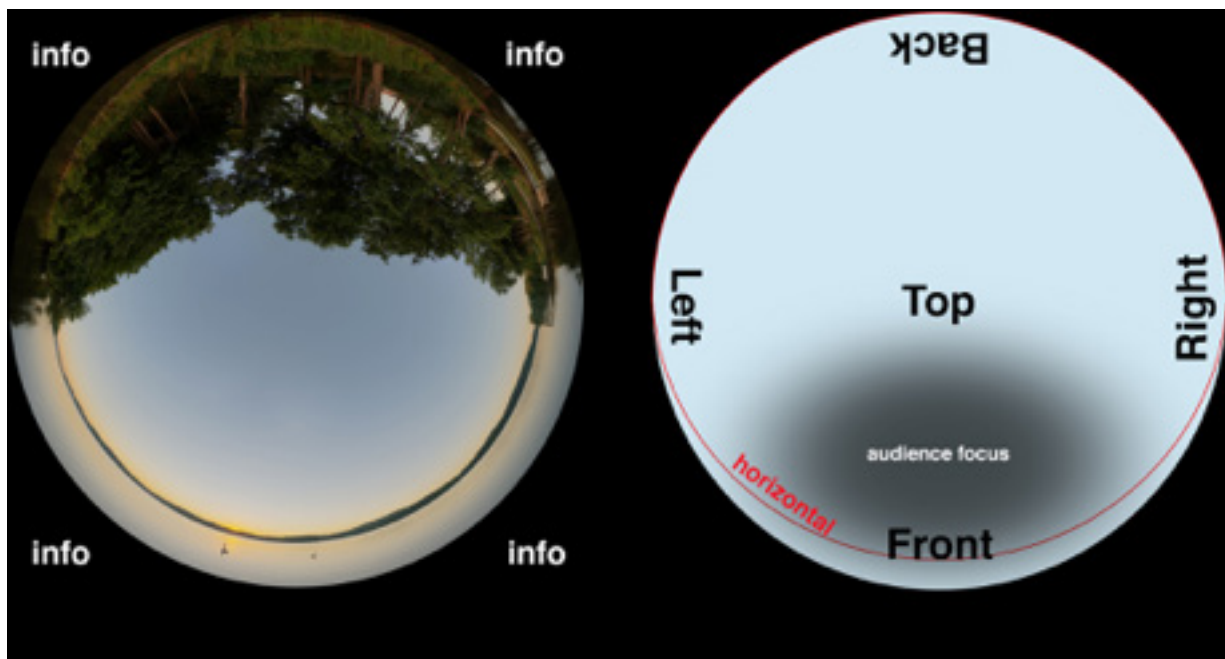
There are many dome screen theaters around the world, but all are slightly different. To simplify the process of creating and redistributing content, a standard has been devised: The Domemaster format. Almost all dome playback systems are designed to blend, warp and align domemaster images correctly.

The format

The domemaster format specifies a circular image that fits perfectly inside a square frame. The bottom of the image is the front of the dome, and so the area where the audience's attention will be focused.

Resolution of the image is described by the resolution of the bounding frame. For example, a circle inside a 4096 x 4096 frame is a 4k domemaster, even though only the pixels inside the circle will actually appear when projected. As only the circle is projected, the corners of the frame are often used for information such as timecodes, copyright information, and logos.

The image inside the circle needs to be of a specific projection (or distortion). For those familiar with mapping, it is an azimuthal equidistant projection. For those more familiar with photography, it is an equidistant fisheye. The easiest way to imagine this projection is to think of a camera with a circular fisheye lens pointing 80 degrees up from the horizon toward the subject (to match the 10 degree forward tilt of the Dome). Though the domemaster format is universal, the degree of tilt on each dome theatre is not. At-Bristol's Data Dome has a 10 degree tilt, but other domes can have more or less. Almost all are tilted forward to some degree as this makes for a more comfortable viewing experience for the audience.



Domemaster image

Domemaster orientation

Headline specs of the Data Dome

- 12-metre hemispherical screen with 10 degree forward tilt
- 2 x 4k Christie Boxer projectors projecting 2 x 4k (4096 x 4096) frame
- 30,000 lumens from each projector
- 120Hz active stereo 3D
- 7.1 surround audio
- 98 forward-facing seats

Media Servers

The recommended platform for content development are two powerful domemaster media servers from the company Vioso, <http://www.vioso.com/>. These have been installed in At-Bristol as part of the Data Dome hardware.

These servers provide hardware blending and warping of domemaster images; auto alignment facilities; 4k video playback and mixing; and capture cards for video input. They output to the 16 DVI connections on our projectors to produce the final 4k fulldome stereo image.

If you wish to use your own blending/warping/alignment solution then the Vioso system can be bypassed. You can also use these servers as a two channel per-eye cluster with your own solution.

Vioso media server specifications, for each server:

- 2x nVidia Quadro M6000s 12GB DDR5
- 900GB Raided SSD
- 1x DP 1.2 capture card VisionSC-DP2 Capture Card : 616 MPixel/second capture bandwidth per channel. Captures up to 4096 x 2160p @ 60Hz. per input
<http://www.datapath.co.uk/products/video-capture-cards/visionsc-range/new-visionsc-dp2>
- 8x DVI single link outputs
- DMX interface
- DVI over fibre to the projectors
- RME Fireface 802x audio interface, 8x balanced I/O, 2xADAT I/O, MIDI IO
http://www.rme-audio.de/en/products/fireface_802.php

Vioso media server routing diagram:

Additional hardware

Two workstations have also been installed that you can use as you wish. We are happy for you to temporarily install different operating systems or new cards.

Each workstation features:

- Intel i7 5820K 3.3GHz 6 Core (12 logical cores)
- 16GB DDR4 RAM
- PNY Quadro K4200 4GB
- 750W PSU
- MSI X99S SLI PLUS Motherboard
- Gigabit network

Other

- 3x wireless Sennheiser G3 headset microphones
- 3x wireless Sennheiser G3 handheld microphones
- 1x wired microphone from stage lectern
- Full HD conference projector with HDMI input from stage lectern
- Audio mixer connected to 4200w 7.1 surround sound system
- KVM connection back to the Vioso servers and workstations
- USB over Cat5 connection to the Vioso servers
- 10 Gbit network connection to the Vioso servers
- Three wireless channels are available in total

Toolkit Notes

Here we have provided some guidelines for developers using the asset package. Please find further annotations and guidance within the individual scripts themselves. We will continue to add information to this section for the next release.

Standard models and materials will work as-is.

Camera-aligned effects (such as particles and billboards) may cause some slight rendering problems. As such, it is advised that you use them sparingly and wisely.

Following on from this, image effects that require depth information (such as Depth-of-Field or SSAO) will not work on the fisheye image. You may be able to use some of these effect types on the camera which captures the cubemap - although the success of this technique is likely to vary depending on what your needs are. We are hoping to support some features in this area in the future.

Similarly, image effects that make assumptions about the camera (such as most post-filter AA solutions) will not work on the fisheye camera, but may be effective on the cubemap camera.

A UI, and 2D images effects - such a colour correction, vignette etc, may also then be rendered on top of the fisheye effect.

It is worth noting that rendering a cubemap every frame is of course computationally expensive. Generally you are likely to find that performance of your existing Unity project will decrease after implementing this plugin on your own development machine - however, the powerful machines in the Data Dome should be able to mitigate this impact.

If you wish to add an FPS counter to your scene for checking the frame rate, follow these steps:

- Create a Canvas
- Put a Text object in the centre of the canvas
- Drag that Text into the "FPS Text" slot

Operation Controls

For the latest version of the toolkit, we have implemented a system which enables both content developers and Dome operators to maintain control over some of the main camera, graphics and optimisation functions.

Default and Product Settings files

As a Developer, you can create your own perfect calibration of these settings and save them to an external file. This file will be created as '[product_name]_settings.txt' in the current users' 'My Documents' folder. You should deliver this file as part of your project.

The Operators of the Dome will have their own Default version of these settings, which is identified as 'dome_default_settings.txt' which is tuned to the optimal settings of the Dome. The version of this file stored on the Data Dome's machine can be re-calibrated at any time.

Between your custom project settings and the Dome's default settings, the perfect calibration will be easy to figure out! Not only that, but all settings can also be changed at runtime, using the key bindings below.

Modifier	Key	Function
SHIFT	F1	Decrease FOV
	F2	Increase FOV
	F3	World camera pitch down
	F4	World camera pitch up
	F5	World camera roll left
	F6	World camera roll right
	F7	Decrease cubemap size
	F8	Increase cubemap size
	F9	Cycle AA modes: Off, SSAA 2x, SSAA 4x
	F10	Toggle V-sync on or off
	F11	Save current settings as new 'dome default settings' These settings are saved as 'dome_default_settings.txt' in the current user's "My Documents" folder
	F12	Load settings from the 'dome default settings' file. On the first run, if no 'dome default settings' file exist yet on the current computer, a settings file with the following defaults will be created: <ul style="list-style-type: none"> • FOV at 270 degrees • World camera pitch at -80 degrees (where -90 is straight up) • World camera roll at 0 degrees (level) • Cubemap size at 1024x1024x1024 • AA mode at SSAA 2x • V-sync on • Back fade intensity at 10% • Crescent fade intensity at 50% • Crescent fade (start) radius at 80% • Crescent fade offset at -0.2 (where -1 is front and +1 is back of dome) (delete the 'dome_default_settings.txt' file in the current user's "My Documents" folder to restore these defaults)

Modifier	Key	Function
CTRL	F1	Decrease back fade intensity
	F2	Increase back fade intensity
	F3	Decrease crescent fade intensity
	F4	Increase crescent fade intensity
	F5	Decrease crescent fade (start) radius
	F6	Increase crescent fade (start) radius
	F7	Decrease crescent fade offset (toward bottom of frame / front of dome)
	F8	Increase crescent fade offset (toward top of frame / back of dome)
	F9	Enable FPS display (requires FPS Text to be setup properly)
	F10	
	F11	Save current settings as the new 'product settings' These settings are saved as '[product_name]_settings.txt' in the current user's "My Documents" folder.
	F12	Load settings from the 'product settings' file.



Image Credit: ESO/B.Tafreshi (twanight.org)

References and contact information

At-Bristol Data Dome team

seamus.foley@at-bristol.org.uk

E-mail this address to organise access to the dome.

Bristol is Open

<http://www.bristolisopen.com/>

Zubr VR Ltd.
9 Marsh Street
Bristol
BS1 4AA

A specialist digital studio with a focus on virtual and augmented reality projects.

<http://www.zubrvr.com/>

jack@zubrvr.com

+447534933475

Development history

14/10/16 – Production release

13/05/16 - Beta release

18/03/16 - Development started

License

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