From research to your dome: Data2Dome, an open-data dissemination system for planetarium content

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BIOGRAPHIES

Max R. Rößner is a PhD electrical engineer and has been working in the planetarium field since 1996. At the European Southern Observatory (ESO), he was responsible for the design, integration and commissioning of the projection and multimedia system of ESO's planetarium, and now is for its technical operation and maintenance.
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Mathias André obtained an MSc in Computer Science in England and worked for several years as a Unix system administrator and IT Operations Manager before joining the ESO outreach group to tackle new challenges as Web and Advanced Projects Coordinator.

ABSTRACT

Astronomy is a dynamic discipline, with new scientific findings and data being published every day. Audiences expect planetariums to address such news and discoveries in their daily planetarium programming. The Data2Dome (D2D) project implements a technical standard with which to stream newly released content and metadata from astronomy research organizations and space agencies directly into fulldome planetarium systems – without any need for time-consuming manual data shuffling and processing. In this way, the technical boundary between astronomy research and planetarium programming is bridged, enabling planetarium operators to swiftly offer up-to-date content to planetarium audiences. In this paper, the system's architecture and the interface standard are introduced and the possibilities the interface offers are demonstrated.

INTRODUCTION

The European Southern Observatory (ESO) opened its Visitor Centre, located at its Headquarters in Garching bei München, in April 2018. The centre's planetarium features a 14 m, inclined dome, seating 109 visitors. As a research organization, ESO is particularly interested in featuring latest scientific results in the day-to-day planetarium programming. Ideally, a planetarium show would be updated on a daily basis, as new scientific findings are published. Planetarium system vendor Evans & Sutherland, the International Planetarium Society, and ESO collaborated on the development of a data standard to implement such functionality: Data2Dome. It is an open standard – other planetarium system vendors and data providers are invited to implement this standard in their planetarium software packages and data distribution systems, respectively. This article summarizes the basic concepts of the data interface. The complete specification document [1] is available on www.data2dome.org.

I. DATA SOURCE: THE SERVER SIDE

Data2Dome describes a data-driven content distribution system. It defines a standardized way for data providers to publish their outreach and informal science education offerings. By implementing the Data2Dome publishing standard, organizations can provide content directly to planetarium operators around the world. This content is published and provided in a way that is directly compatible with digital planetarium software.
Data providers are recommended to use a free and open licensing scheme for data distributed through D2D. The presenter in a planetarium should not have to bother with the exact terms and conditions for any individual asset. For example, ESO employs

the Creative Commons Attribution license, which basically states that users can do anything they wish with the data, as long as ESO is mentioned.
On a technical level, Data2Dome is implemented as JSON data feeds. These are URLs that respond with text data formatted using the Javascript Object Notation standard [2].

I.1 Meta Feed

An organization willing to provide material through the D2D scheme first implements a Meta-Feed. A Meta-Feed provides general information about the data provider along with a list of all the various payload feeds that the provider offers. Thus, the URL of the Meta-Feed is the only piece of information a planetarium software package needs to be provided with to access this data supplier's resources. As an example, ESO's D2D Meta-Feed is accessible on http://www.eso.org/public/d2d/. It provides ESO's contact information, the logo used to visually identify a provider in the target software packages, and a list of the URLs of the payload feeds ESO offers, along with a brief description. One of the payload feeds in this example is the "Portal to the Universe" news feed. The Meta-Feed specifies the URL https://www.portaltotheuniverse.org/d2d/news/featured/ for this resource:

Figure 1 – ESO's D2D Meta-Feed, as delivered through http://www.eso.org/public/d2d/

Other D2D feeds ESO offers (hidden above for clarity) are an astro-calendar event feed, image, video and 3D model feeds, and a planetarium music feed.

I.2 Payload Feeds

When accessing one of the payload URLs provided is the Meta-Feed, a JSON file that holds the actual information is sent back. To limit the file size and, hence, realize quick response times even when used through low bandwidth connections, long lists can be split into multiple pages. In the example below, 11721 items are provided in the D2D feed, spread over multiple pages. The "Next" tag provides the URL for the subsequent page.
The assets of one particular feed item are bundled in a collection. A collection is a group of related assets. One can consider collections representing a "Press Release", an "Event" or just a single media item such as a historical or astronomical photo. A collection might, for example, include one or more images, a diagram, a video, and possibly even an audio file containing spoken narration. The video might be provided in both flat and fulldome form. There may be multiple image resolutions, or there may even be flat and fulldome versions of an image. Along with all these assets, there is a written description of the event or release.
Note that image, video and other files are not bundled in the collection. Rather, a link is provided that points to this resource, stored somewhere else on the internet. In this way, it is not necessary for the planetarium system to load and store all items, resulting in massive storage needs. Rather, the assets can be loaded onto the planetarium system only when requested by the planetarium lecturer.
In the example below, taken from ESO's "Portal to the Universe" D2D feed, one can see this concept visualized in a structured way. A collection has, among others, tags for the data creator, a reference URL pointing to a human-readable web page, the publication date, the title and the description. The description can be formatted as an HTML markup page. In the case of this example, resource #0 is an image specified by its URL and the preferred projection onto the dome. In this case, the projection is "Tan", meaning a flat, rectangular image intended for viewing as a billboard in 3D space (equivalent to a slide projector projecting onto the dome). Obviously, other common projections, like fisheye or equirectangular, are specified in the standard as well.

Figure 2 – Portal to the Universe Feed (page 1), as delivered through https://www.portaltotheuniverse.org/d2d/news/featured/, cropped after collection #3 for clarity.

In ESO's implementation, the JSON feeds of the D2D offerings are generated by the content management system also feeding ESO's websites, media kiosks in the exhibition area of ESO Supernova Visitor Centre, and the planetarium ticketing system. With all these systems hosted under a common umbrella, the D2D feeds are created and disseminated automatically, without the need for much user interaction.

II. DATA SINK: PLANETARIUM SOFTWARE INTEGRATION

The amount of assets delivered through a D2D feed can be massive. As an example, ESO's "Portal to the Universe" feed illustrated above has 11721 items (as of June 2018). Therefore, system designers implementing support for Data2Dome feeds are encouraged to implement easy-to-use systems for searching, browsing, sorting, and accessing the data collections and their assets. Wherever possible, previews and thumbnails should be used to help planetarium presenters quickly select appropriate media. Every effort should be made to reduce the effort of selecting, downloading, and displaying Data2Dome resources.
Provider branding should be respected. Use provider logos and contact information where appropriate.
Respect credit and licensing information – and make it easy for the planetarium presenter to find this information. All ESO-produced material is published under the terms of the Creative Commons Attribution license, but D2D is not restricted to this scheme, so other data providers might wish to apply a more restrictive license.

D2D is compatible with the Astronomy Visualization Metadata Standard (AVM), described elsewhere [3]. AVM specifies tags in the file header of image files, such as the wavelength the image was taken in, and its position, orientation and size on the sky.

Figure 3 shows the implementation of D2D in the Digistar 6 software package by Evans & Sutherland. Data 2Dome content is displayed alongside other data sources, such as Digistar's native astronomical database, user-created content, and content provided through the Digistar Cloud Library. It can be sorted in a table similar to a file list view. It is also integrated into the system-wide search functionalities. By selecting an asset, the presenter is provided with a descriptive summary of what the asset illustrates. Once downloaded (by clicking on the "cloud" icon), an asset is automatically delivered to the graphic processor PCs and can be brought to the dome by a simple drag-and-drop procedure. In this way, a planetarium presenter can quickly inform himself about the news that were published during the previous night, and include such content into the planetarium presentations of that day by a few clicks: The show is kept up top date on a daily basis.

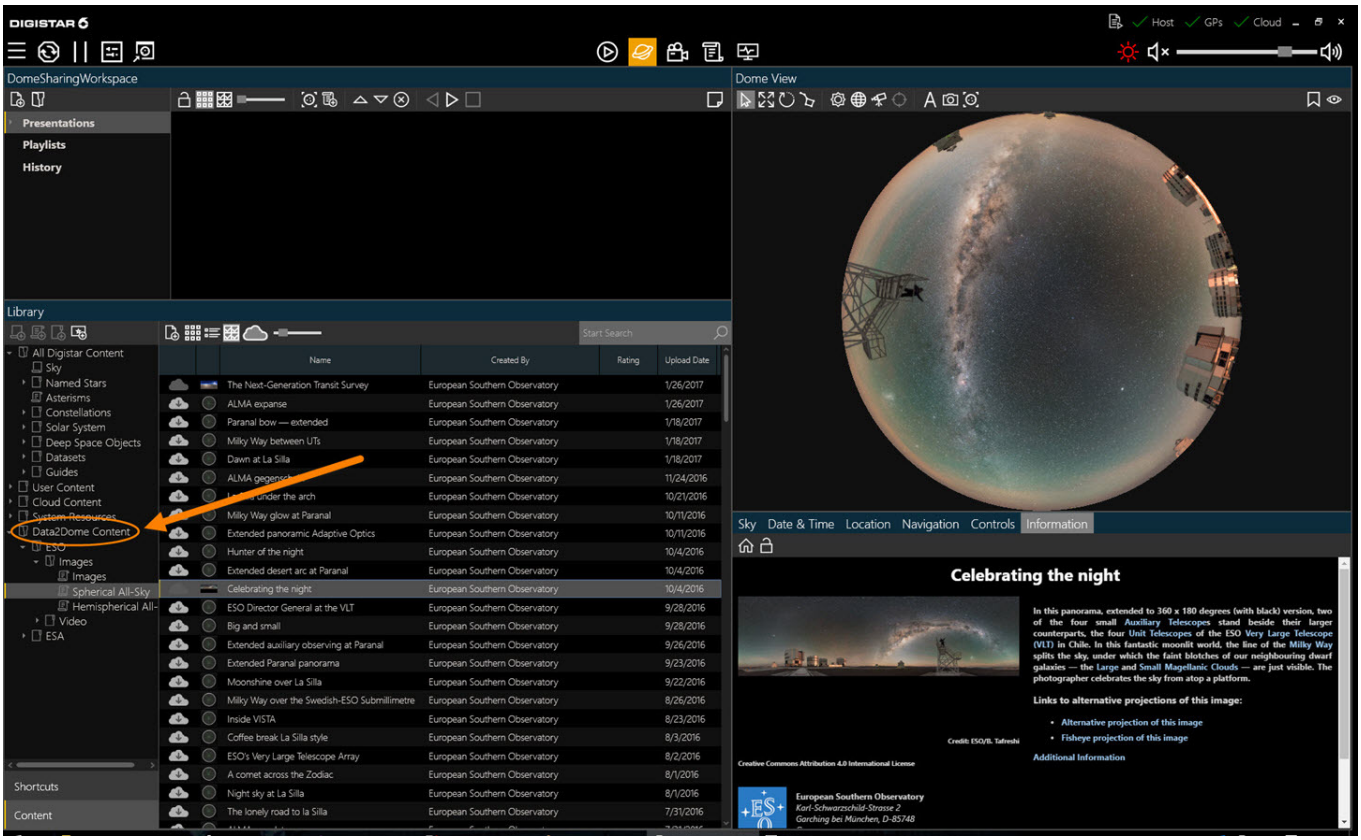

Figure 3 – Data2Dome implementation in Evans & Sutherland's Digistar 6

As of June 2018, the authors are aware of further Data2Dome implementations in DigitalSky Dark Matter by Sky-Skan, and Shira Universe by SureyyaSoft. Other planetarium vendors are invited to join this community effort.

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