



EPN2020-RI

EUROPLANET2020 Research Infrastructure

H2020-INFRAIA-2014-2015

Grant agreement no: 654208

Deliverable D11.4

Spice kernels in 3Dview

Due date of deliverable: 31/01/2016

Actual submission date: 29/01/2016

Start date of project: 01 September
2015

Duration: 48 months

Responsible WP Leader: ObsParis, Stéphane Erard

| Project funded by the European Union's Horizon 2020 research and innovation programme | | |
|---|---|---|
| Dissemination level | | |
| PU | Public | X |
| PP | Restricted to other programme participants (including the Commission Service) | |
| RE | Restricted to a group specified by the consortium (including the Commission Services) | |
| CO | Confidential, only for members of the consortium (excluding the Commission Services) | |

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|-------------------------|---|
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| Project Title | EPN2020 - RI |
| Project Duration | 48 months: 01 September 2015 – 30 August 2019 |

| | |
|--------------------------------------|-------------------------|
| Deliverable Number | D11.4 |
| Contractual Delivery date | 31.01.2016 |
| Actual delivery date | 29.01.2016 |
| Title of Deliverable | Spice kernels in 3Dview |
| Contributing Work package (s) | WP11 |
| Dissemination level | PU |
| Author (s) | Laurent BEIGBEDER |

Abstract: In order to enhance 3DView capabilities in terms of mission planning, data contextualization and comparison with models, the need for a better description of instrument Field Of Views (FOV) and spacecraft attitude has emerged. Scientists and planning teams alike should be able to access these parameters directly in the tool or ingest them.

GFI searched for available spice kernels to provide orientation for a wider set of missions and modified the 3DView tool to read these new data types. Some mission orientation/FOV data have been added but some others need manual processing and deeper investigations so they will be added during following months. All available data will be added for PM12 at the latest. GFI also created new GUI to allow user to import custom orientation data.

This is a JRA work (WP11) that has been delivered for VA use.

The software associated with the deliverable is developed by Laurent Beigbeder and it is available on the GFI server (<http://78.209.63.63/3DVH2020/>) until March 31 2016, and on IRAP server (<http://3dview.cdpp.eu/3DVH2020/> from April 01 2016).

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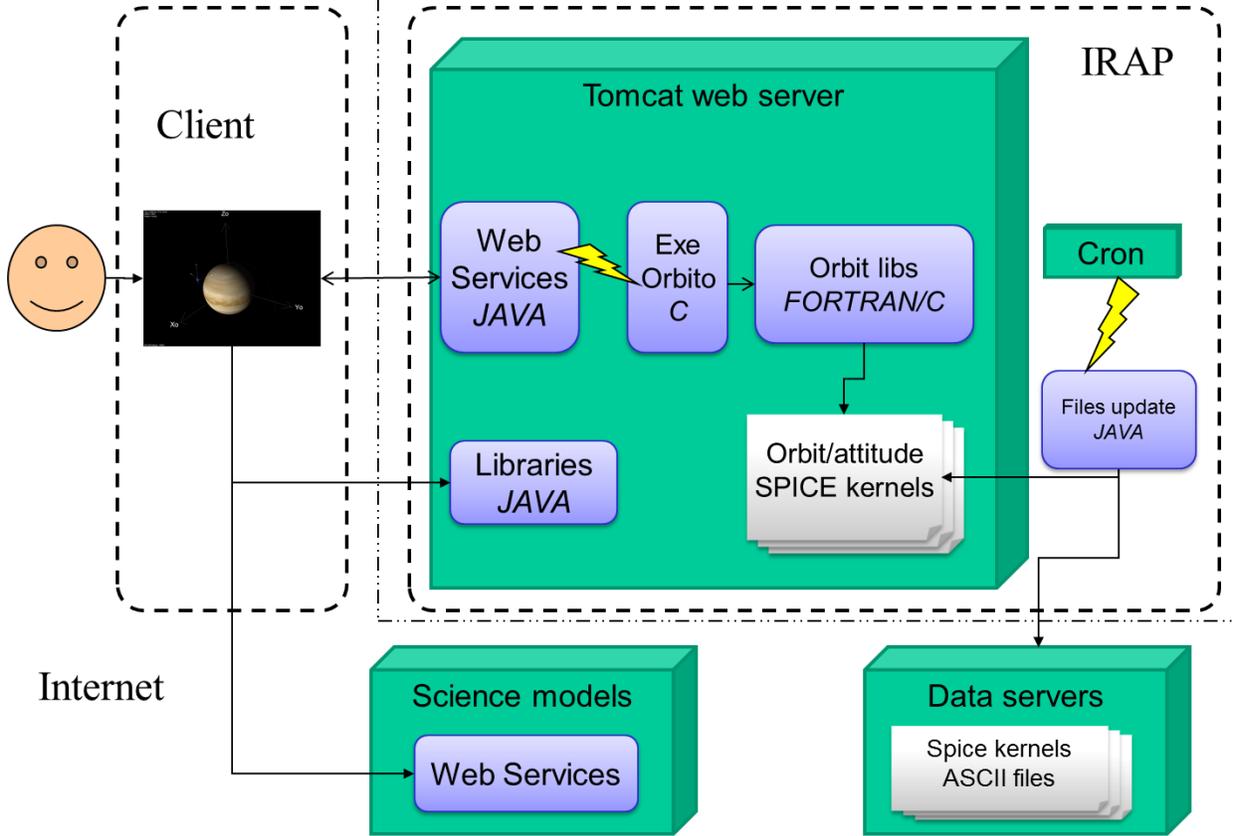
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1 Introduction and goals

The 3DView Tool was part of a CNES project and GFI has developed expertise on this tool over many years. Dedicated to a single mission at first, it has been extended to create a generic multi mission tool. Europlanet support is used to extend 3DView capabilities in term of mission planning, data contextualization and comparison to models.

3DView is an interactive software for 3D animated view of satellites trajectory and altitude in the solar system. It is a tool for the scientific community to be used during operational phases of mission and for exploitation of mission results, offering immediate knowledge of parameters, position and orientation and allowing scientific data interpretation.

3DView tool is composed of a server for data and all the mechanisms needed for science computing, and a client for lightweight computing and 3DDisplay.



1. 3DView tool architecture

In this task 2 Tools and interfaces, some improvements have been identified:

- Access to Spice Kernels for instrument FOV (IK, FK) and Attitude Kernels (CK) for all missions available at NAIF(<http://naif.jpl.nasa.gov/naif/data.html>) via text file configurations on the server side will be implemented.
- User upload for attitude will be implemented, including those of spacecraft uploaded by the user. Supported format for attitude: quaternion and 3D rotation matrices (with documentation on input specifications provided to the user).
- User upload for instrument FOV will be implemented, including those of spacecraft uploaded by the user. Supported format for FOV: cone (direction + angle). Visualisation of FOV in dedicated window.

2 Implementation

2.1 New instruments spice kernels

Adding FOV from SPICE kernels in 3DView requires two prerequisites: the spacecraft attitude and kernels describing instruments on spacecraft.

This is done by three files:

- Spacecraft attitude (CK)
- Text frame kernels(FK)
- Instrument kernels (IK)

Those files are added by a server team so the user will only have to select newly available instruments.

We never used the instruments kernels before but we already had attitude for Rosetta, Mars-Express, Venus-Express, COROT, SVOM, Jason 2, PICARD and MSL.

Only missions that have convenient spacecraft attitude are eligible. For example, MRO total attitude files size is 121GB and server does not have enough free storage space.

All data is coming from NAIF official web

site:http://naif.jpl.nasa.gov/naif/data_operational.html

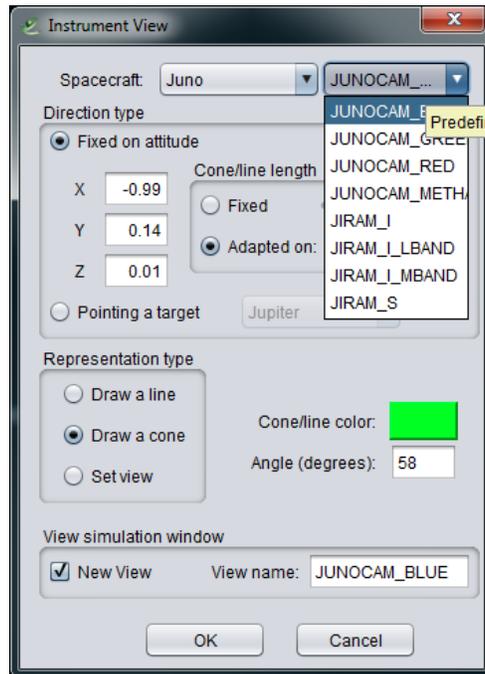
This table describes which kernels were available:

| Spacecraft | ORBIT | CK | FK | IK | Comment |
|-------------|-----------|----|----|----|---|
| Ulysses | X | | | | No data |
| Messenger | X | X | X | X | Files size to big: 26GB |
| PVO | X | | X | | No data |
| VEX | X | X | X | X | OK |
| MAVEN | X | X | X | X | 3859 attitude files with no comments. Maybe 500 files with overlapping data for 4,5GB. TBD* |
| MEX | X | X | X | X | OK |
| MGS | X | X | X | X | 4GB for files, needs files and segments merge, TBD* |
| MRO | X | X | X | X | Files size to big: 121GB |
| MSL | X(cruise) | X | X | X | Not interesting during cruise |
| CASSINI | X | X | X | X | 1120 files, 6GB, needs files and segment merge, TBD* |
| GALILEO | X | X | | X | Missing FK |
| JUNO | X | X | X | X | OK |
| Voyager 1-2 | X | X | X | X | Instruments are moving w.r.t spacecraft. This is not managed by 3DView |
| GIOTTO | X | | | | No data |
| ROSETTA | X | X | X | X | OK |

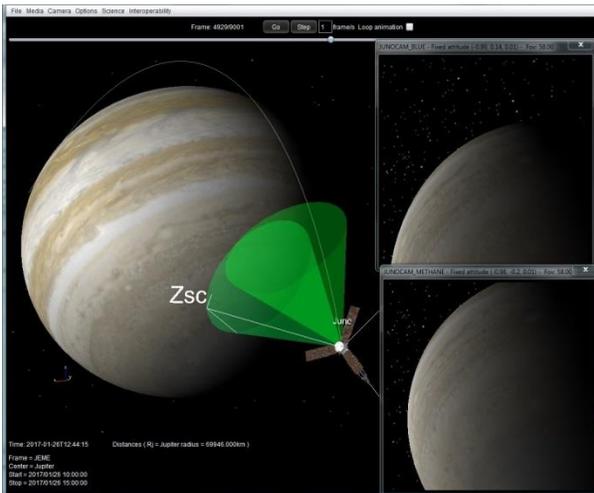
*Files need some manual processing and deeper study. That will be done for PM12.

As we already had an instrument description file on server, we just had to replace it with new values with only minor changes on the 3DClient (up vector for instrument added). The drawback of this method is that some instruments that were described before do not have spice kernels. For that, the reader on the server, depending on the description format, has now two ways of fetching boresight and FOV.

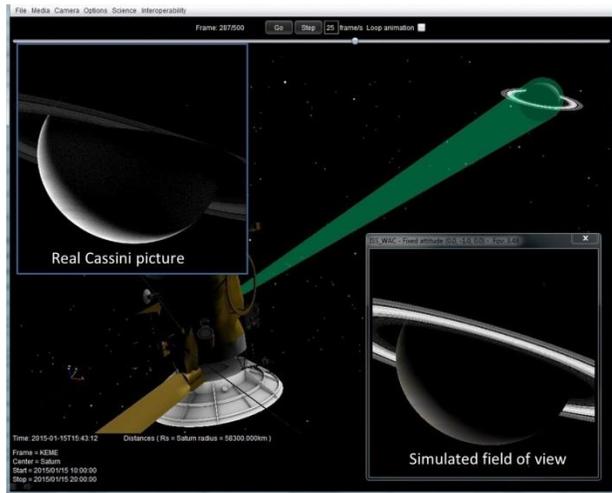
Once all data and instrument description is added on server, the user just has to add predefined instruments:



2. Add instrument to scene dialog



Two Juno instruments FOV added from kernel
juni_junocam_v00.ti

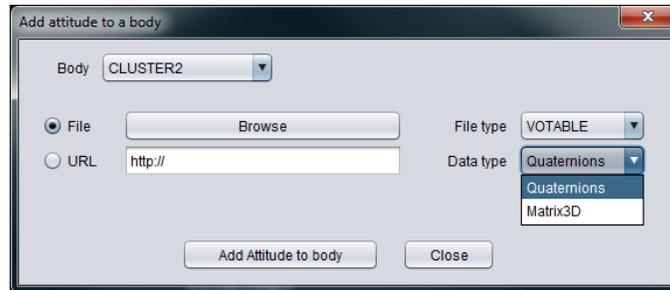


Cassini simulated FOV compared to real picture

3. Sample scenes with newly added attitude and instrument kernels

2.2 User custom attitude file upload

For spacecraft that do not have attitude, user can upload a customised one. A new menu "Add attitude to object from file" opens an input GUI to do this:



4. Custom attitude user upload dialog

The user only has to select an object available in 3DScene, and set a file with attitude data. Data do not need to have the same timestep than the scene. File can be located on local disk or distant if an URL can reach it.

Input file is a timeseries text file with blank separator or a VOTable. It can contain quaternions (Time,x,y,z,w) or rotation matrix (Time,xx,xy,xz,yx,yy,yz,zx,zy,zz).

2.2.1 VOTable format

Time is in ISO format YYYY-MM-DD'T'HH:MI:SS.SSSS'Z'.

Data type, ucd, utype is not important but names must be Time,xx,,xz,yx,yy,yz,zx,zy,zz.

File sample with matrices content:

```
<RESOURCE name="Attitude file">
<TABLE name="Attitude matrix of body -94000">
<DESCRIPTION>TBC</DESCRIPTION>
<FIELD name="Time" ID="col1" ucd="time.epoch" xtype="dateTime" utype="" datatype="char" />
<FIELD name="xx" ID="col2" ucd="" utype="" datatype="float" width="10" unit="" />
<FIELD name="xy" ID="col3" ucd="" utype="" datatype="float" width="10" unit="" />
<FIELD name="xz" ID="col4" ucd="" utype="" datatype="float" width="10" unit="" />
<FIELD name="yx" ID="col2" ucd="" utype="" datatype="float" width="10" unit="" />
<FIELD name="yy" ID="col3" ucd="" utype="" datatype="float" width="10" unit="" />
<FIELD name="yz" ID="col4" ucd="" utype="" datatype="float" width="10" unit="" />
<FIELD name="zx" ID="col2" ucd="" utype="" datatype="float" width="10" unit="" />
<FIELD name="zy" ID="col3" ucd="" utype="" datatype="float" width="10" unit="" />
<FIELD name="zz" ID="col4" ucd="" utype="" datatype="float" width="10" unit="" />
<DATA><TABLEDATA>
<TR><TD>2001-01-01T14:00:00.000Z</TD><TD>-0.19</TD><TD>0.51</TD><TD>0.83</TD><TD>-
0.56</TD><TD>-0.75</TD><TD>0.32</TD><TD>0.80</TD><TD>-0.40</TD><TD>0.43</TD></TR>
...
```

2.2.2 Ascii format

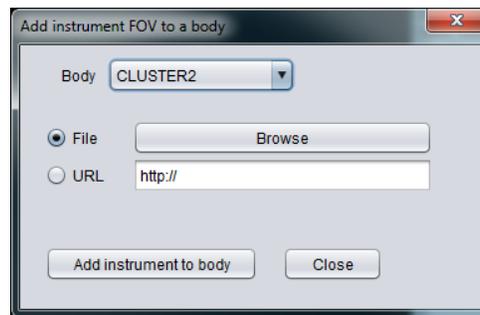
Time is in ISO format YYYY-MM-DD'T'HH:MI:SS.SSSS'Z', and values must be split with one or more blank characters. Do not use tab.

File sample with quaternions:

```
2014-01-01T00:00:00.000Z 0.0 0.0 0.0 1.0
2014-01-01T00:05:15.000Z 0.0 0.01745240643728351 0.0 0.9998476951563913
2014-01-01T00:10:30.000Z 0.0 0.03489949670250097 0.0 0.9993908270190958
2014-01-01T00:15:46.000Z 0.0 0.05233595624294382 0.0 0.9986295347545738
2014-01-01T00:21:01.000Z 0.0 0.06975647374412529 0.0 0.9975640502598243
```

2.3 User custom instrument FOV file upload

Finally, for those who do not want to use the existing GUI to add an instrument Field of view, they now can do it faster with a simple text file:



5. Custom instrument description user input dialog

Each instrument line is made of values separated by a semi-colon with: boresight vector (x,y,z), full angle FOV in degrees and description(will be in FOV view window title).

Each line in file will create an instrument and an independent view:

```
1;0;0;90;X axis 90°
0;1;0;45;Y axis 45°
0;0;1;45;Z axis 45°
```