Web Visualization of a Trajectory Generated from the General Mission Analysis Tool (Part 2)

By Daniel A. O'Neil

Introduction

A Web-based Mission Visualization System (WMVS) would enable the public to engage in future mission concept development. Presently, NASA offers a free open source General Mission Analysis Tool (GMAT). A WMVS would complement GMAT by providing the public with a capability to create and share interactive animated web visualizations of potential space missions. This tutorial builds upon Part 1 by explaining how to texture map an object, separate data from the code, and animate an object along a trajectory.

Prerequisites and Objectives

This tutorial assumes that the reader has completed the Part 1 tutorial. To accomplish the objectives, of this tutorial, the reader must be familiar with GMAT, understand how to export data and convert the data to a JavaScript object, and how to develop a JavaScript + WebGL visualization. Activities described in the Part 1 tutorial produced an interactive model with a blue sphere and a dashed line that represented an orbital trajectory. In Part 2, the activities will produce an interactive animated visualization of a trajectory that results from a Hohmann transfer maneuver.

Learning objectives for this tutorial include:

1. Texture map an X3D object
2. Separate the trajectory data from the visualization code
3. Develop code to animate an X3D object
4. Display the date and time stamps
5. Add a button to reset the animation

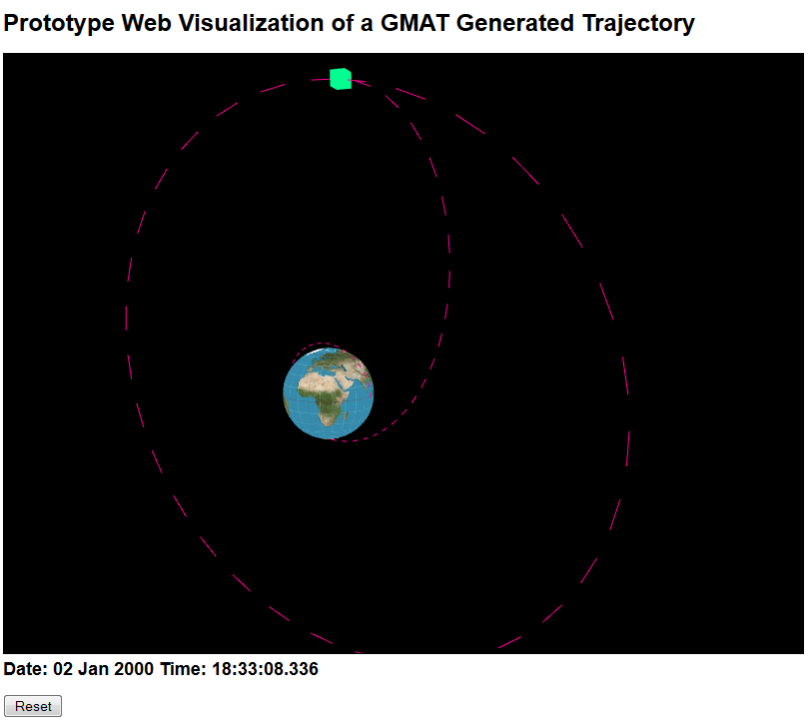


Figure 1Interactive Animated Visualization of a Huhmman Maneuver Trajectory

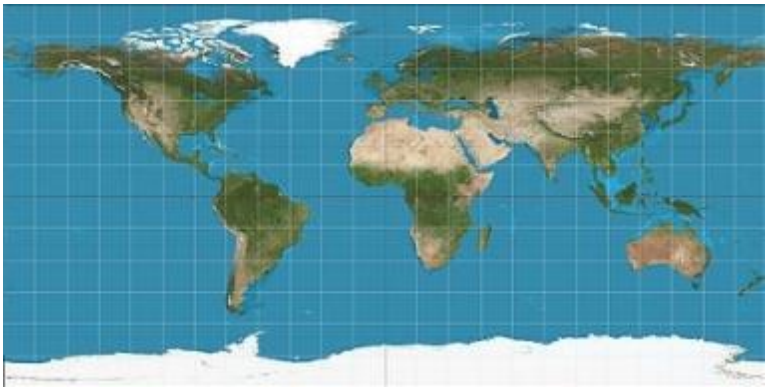
Before starting the first activity, review the Part 1 tutorial, particularly using GMAT to generate a trajectory. When the splash screen appears, select the Homann transfer example script. The Homann transfer maneuver uses two burns to transfer from one orbit to another orbit. Switching the initial velocities for the Y and Z directions will make a polar orbit. The prototype depicted in Figure 1 is available at http://daoneil.github.io/spacemission/X3Dom/AHohmannTrajectory_JSON.html

Texture Map an X3D Object

Assuming that a JavaScript object for the orbital trajectory was generated successfully, this activity involves applying a texture map to an X3D Object. The previous tutorial explained X3D, WebGL, and the WebGL compliant JavaScript code library, X3Dom. A code snippet in the Part 1 tutorial presented the X3D XML tags to produce a blue sphere. In the following code snippet, the Material with the blue diffuse color attribute was replaced with an ImageTexture with a Uniform Resource Locator (URL) attribute.

```
<X3D xmlns="http://www.web3d.org/specifications/x3d-namespace" showStat="false"
showLog="false" x="0px" y="0px" width="800px" height="600px">
   <Scene>
      <background DEF='bgnd' transparency='0' skyColor='0.0 0.0 0.0'>
      </background>
         <Transform id="theEarth" translation="0 0 0">
              <Shape>
                <Appearance>
                    <ImageTexture url='EarthImage.jpg'/>
                </Appearance>
                <Sphere radius='0.65'/>
            </Shape>
              </Transform>
              <Viewpoint fieldOfView="0.785398" position="6 5.5 6.5"
               orientation="1 -1 0 -0.785" description=""/>
          </Scene>
        </X3D>
```

The URL refers to a local file named EarthImage.jpg. This image was downloaded from the Wikipedia commons. https://en.wikipedia.org/wiki/File:Equirectangular_projection_SW.jpg There is a white border that must be removed from the image, otherwise the texture mapped globe with have a white line around one side of it. Use your favorite paint program to crop the image to remove the white border. Rename the file and store it in the same directory as the JavaScript file and ensure the URL refers to the file. Successfully completing this activity will produce a texture mapped globe as depicted in Figure 1.



Separate the Trajectory Data from the Visualization Code

Storing the trajectory data in a separate file will reduce the clutter of the visualization code thus making it easier to maintain. JavaScript can use global variables that are declared in referenced script file. In the following code snippets, the trajectory data, formatted in the JavaScript Object Notation (JSON), is stored in a file named *mission.js*. The web-page, containing the script that reads the trajectory data object, includes the other file by referencing it in the header.

The file named mission.js contains:
var trajectory = '{"coordinates":[' +
'{"Date":"01 Jan 2000","Time":"11:59:28.000","X":7100,"Y":0,"Z":1300},' + … ']}';

The web-page with the visualization code includes a reference to mission.js in the header:

```
<head>
….
<script src="missionfile.js" type="text/javascript"></script>
</head>
```

Develop Code to Animate an X3D Object

Animating an object requires code that creates the object, inserts it into the scene graph, reads the trajectory data, and translates the position of the object. The following code snippet creates a green box to represent a satellite and appends the box to the scene graph.

```
/*----------------------------
*  Create a satellite model
*----------------------------*/
var pos = [mission.coordinates[0].X/10000, mission.coordinates[0].Y/10000,
mission.coordinates[0].Z/10000]
var t = document.createElement('Transform');  // create a transform object
    t.setAttribute("translation", pos[0] + " " + pos[1] + " " + pos[2] );
    t.setAttribute("id", 'satPosition');

var satellite = document.createElement('Shape'); // Shape Node for satellite
            satellite.setAttribute("id", "satellite");

var satapp = document.createElement('Appearance');     // Appearance Node
var satmat = document.createElement('Material');       // Material Node
   satmat.setAttribute("id", "SatMat");
   satmat.setAttribute("diffuseColor", 0 + " " + 1 + " " + 0);
   satmat.setAttribute("emissiveColor", 0 + " " + 1 + " " + 0.3);
   satapp.appendChild(satmat);
   satellite.appendChild(satapp);

var satmodel = document.createElement('Box');
    satmodel.setAttribute("size", 0.2 + " " + 0.2 + " " + 0.2);
    satellite.appendChild(satmodel);
    t.appendChild(satellite) ;

var objsat = document.getElementById('theEarth');
      objsat.appendChild(t);

            setInterval(function () {updatePosition() }, 50);
  };
```

The pos variable specifies a current position for the satellite object. The previous section presented the reference to the mission file, which contained the trajectory coordinates. A mission variable, set to the trajectory JavaScript Object Notation (JSON) object in the missionfile, provides the date and time stamp and associated Cartesian coordinates. In the code snippet, the createElement command adds the Transform, Shape, Appearance, and Material nodes and appends the nodes to the sphere that represents the Earth.

The last line of the previous code snippet is a SetInterval function, which periodically calls another function within a specified time interval. The following code snippet is the updatePosition function that the SetInterval function calls every 50 milliseconds. A step variable, within the updatePosition function, serves as an index to the mission.coordinates array. The pos variable uses the step variable to access the current set of mission coordinates.

```
function updatePosition()   {
     pos = [mission.coordinates[step].X/10000,
mission.coordinates[step].Y/10000, mission.coordinates[step].Z/10000] ;
          var Xpos = pos[0] ;
          var Ypos = pos[1] ;
          var Zpos = pos[2] ;
      document.getElementById('satPosition').setAttribute('translation', Xpos +
" " + Ypos + " " + Zpos);
          console.log("x  " + Xpos + "  y  " + Ypos + "  z  " + Zpos) ;

document.getElementById("demo").innerHTML =
"<p>" + "<H2>" + "Date:  " + mission.coordinates[step].Date + "  Time: " +
mission.coordinates[step].Time + "</H2>" + "<p>"

 //  }
 step = step + 1 ;
 };
```

Display the date and time stamps

The next to last line in the code snippet accesses the data and time stamps from the mission coordinates and uses the innerHTML an header format to display the date and time. A future version of this code could parse the time-stamp and rotate the Earth in accordance with the time-stamp.

Add a button to reset the animation

The following line of HTML displays a reset button and calls a function to reset the position of the satellite.

```
<input type="button" id="reset" value="Reset" onclick="resetPosition();" />
```

The resetPosition function sets the step variable to zero, accesses the coordinates, and sets the translation attribute of the transform node to the current position. The following code snippet presents the resetPosition function. At the end of the resetPosition function, a setInterval function calls the updatePosition function to restart the animation.

```
function resetPosition() {
    step = 0 ;
       pos = [mission.coordinates[step].X/10000,
mission.coordinates[step].Y/10000, mission.coordinates[step].Z/10000] ;
          var Xpos = pos[0] ;
          var Ypos = pos[1] ;
          var Zpos = pos[2] ;
      document.getElementById('satPosition').setAttribute('translation', Xpos +
" " + Ypos + " " + Zpos);

          setInterval(function () {updatePosition() }, 60);
 } ;
```

Conclusions

Activities and code snippets in this tutorial explained how to texture map an X3D shape, how to reference data objects in another file, and how to iteratively call a function using the SetInterval function. These lessons enable the separation of data from the code and animate an X3D object. A potential improvement to the demonstration involves parsing the time-stamp and rotating the sphere. An appendix includes the source code for the prototype.

Appendix A Source Code

```
<!DOCTYPE html>
<head>
        <meta http-equiv="X-UA-Compatible" content="chrome=1" />
                <meta http-equiv="Content-Type" content="text/html;charset=utf-8"
/>
<title>Trajectory from GMAT</title>
                <meta name="author" content="Daniel A. O'Neil">
                <meta name="copyright" content="? Daniel A. O'Neil" />
        <style>
          p.case { clear: both; border-top: 0px; solid: #fff; }
        </style>
        <link rel="stylesheet" type="text/css" href="x3dom.css" />
        <script src="missionfile.js" type="text/javascript"></script>
</head>
<body onload="startUpdate()">

<h1>Prototype Web Visualization of a GMAT Generated Trajectory</h1>

        <p class="case">
                <X3D xmlns="http://www.web3d.org/specifications/x3d-namespace"
showStat="false" showLog="false" x="0px" y="0px" width="800px" height="600px">
          <Scene>
                        <background DEF='bgnd' transparency='0' skyColor='0.0 0.0
0.0' ></background>
           <Transform id="theEarth" translation="0 0 0">
               <Shape>
                 <Appearance>
                     <ImageTexture
url='EarthImage.jpg'/>
                 </Appearance>
                 <Sphere radius='0.65'/>
              </Shape>
                   </Transform>
                   <Viewpoint fieldOfView="0.785398" position="6 5.5 6.5"
orientation="1 -1 0 -0.785"  description=""/>
          </Scene>
        </X3D>
    </p>

        <p class="case" align="center">

        <p id="demo"></p>

<script>

var mission = JSON.parse(trajectory) ;    // Parse the trajectory in the mission
file.
var step = 0 ;

function startUpdate() {
// Generate line segments from points around the trajectory of the orbiting
objects.
           var segIndex = 0 ;   // segment counter
           var orbitCoords = "" ;
        for (var segment in mission.coordinates) {

                var s = document.createElement('Shape');            // Shape Node
                s.setAttribute("id", "segment" + segIndex);
```

```
                var app = document.createElement('Appearance');     // Appearance
Node
                var mat = document.createElement('Material');       // Material
Node
                   mat.setAttribute("id", "Mat" + segIndex);
                   mat.setAttribute("diffuseColor", 1 + " " + 0 + " " + 0);
                   mat.setAttribute("emissiveColor", 1 + " " + 0 + " " + 0.3);
                app.appendChild(mat);
                s.appendChild(app);

                var segCoords = [mission.coordinates[segment].X/10000,
mission.coordinates[segment].Y/10000, mission.coordinates[segment].Z/10000] ;
                // console.log("x  " + segCoords[0] + "  y  " + segCoords[1] + "
z  " + segCoords[2]) ;

                orbitCoords = orbitCoords + segCoords[0]  + " " + segCoords[1]  +
" " + segCoords[2]  + " " ;

                var line = document.createElement('IndexedLineSet');
        line.setAttribute("coordIndex", segIndex);
                var coords = document.createElement('Coordinate');
                coords.setAttribute("point", orbitCoords);

                line.appendChild(coords) ;

                s.appendChild(line);
                var ot = document.getElementById('theEarth');
        ot.appendChild(s);

                segIndex = segIndex + 1 ;
         }

    /*-----------------------------
         *  Create a satellite model
         *----------------------------*/
         var pos = [mission.coordinates[0].X/10000,
mission.coordinates[0].Y/10000, mission.coordinates[0].Z/10000]
          var t = document.createElement('Transform');
        t.setAttribute("translation", pos[0] + " " + pos[1] + " " + pos[2] );
        t.setAttribute("id", 'satPosition');

                var satellite = document.createElement('Shape');        // Shape
Node for satellite
                satellite.setAttribute("id", "satellite");

                var satapp = document.createElement('Appearance');     //
Appearance Node
                var satmat = document.createElement('Material');       //
Material Node
                   satmat.setAttribute("id", "SatMat");
                   satmat.setAttribute("diffuseColor", 0 + " " + 1 + " " + 0);
                   satmat.setAttribute("emissiveColor", 0 + " " + 1 + " " + 0.3);
                satapp.appendChild(satmat);
                satellite.appendChild(satapp);

                var satmodel = document.createElement('Box');
                satmodel.setAttribute("size", 0.2 + " " + 0.2 + " " + 0.2);
                // satellite.setAttribute("id", "sat1");
                satellite.appendChild(satmodel);
                t.appendChild(satellite) ;
```

```
                var objsat = document.getElementById('theEarth');
        objsat.appendChild(t);

                setInterval(function () {updatePosition() }, 50);
   };

   function updatePosition()   {
 // for (segment in mission.coordinates) {
  //    pos = [mission.coordinates[segment].X/10000,
mission.coordinates[segment].Y/10000, mission.coordinates[segment].Z/10000] ;
     pos = [mission.coordinates[step].X/10000,
mission.coordinates[step].Y/10000, mission.coordinates[step].Z/10000] ;
          var Xpos = pos[0] ;
          var Ypos = pos[1] ;
          var Zpos = pos[2] ;
      document.getElementById('satPosition').setAttribute('translation', Xpos +
" " + Ypos + " " + Zpos);
          console.log("x  " + Xpos + "  y  " + Ypos + "  z  " + Zpos) ;

document.getElementById("demo").innerHTML =
"<p>" + "<H2>" + "Date:  " + mission.coordinates[step].Date + "  Time: " +
mission.coordinates[step].Time + "</H2>" + "<p>"

 //  }
 step = step + 1 ;
 };

 function resetPosition() {
    step = 0 ;
       pos = [mission.coordinates[step].X/10000,
mission.coordinates[step].Y/10000, mission.coordinates[step].Z/10000] ;
          var Xpos = pos[0] ;
          var Ypos = pos[1] ;
          var Zpos = pos[2] ;
      document.getElementById('satPosition').setAttribute('translation', Xpos +
" " + Ypos + " " + Zpos);

          setInterval(function () {updatePosition() }, 60);
 } ;
 </script>
<script type="text/javascript" src="x3dom.js"></script>
<input type="button" id="reset" value="Reset" onclick="resetPosition();" />
</body>
</html>
```

Appendix B Mission File

```
var trajectory = '{"coordinates":[{"Date":"01 Jan 2000
","Time":"11:59:28.000","X":7100,"Y":0,"Z":1300},' +
'{"Date":"01 Jan 2000 ","Time":"12:01:09.908","X":7061.06,"Y":747.657,"Z":1394.59},' +
'{"Date":"01 Jan 2000 ","Time":"12:02:50.560","X":6946.93,"Y":1478.13,"Z":1473.08},' +
'{"Date":"01 Jan 2000 ","Time":"12:04:31.410","X":6758.92,"Y":2194.37,"Z":1536.1},' +
'{"Date":"01 Jan 2000 ","Time":"12:06:12.607","X":6498.65,"Y":2889.83,"Z":1583.07},' +
'{"Date":"01 Jan 2000 ","Time":"12:07:54.156","X":6168.61,"Y":3557.07,"Z":1613.42},' +
'{"Date":"01 Jan 2000 ","Time":"12:09:36.037","X":5772.07,"Y":4188.78,"Z":1626.76},' +
'{"Date":"01 Jan 2000 ","Time":"12:11:18.229","X":5313.08,"Y":4777.97,"Z":1622.88},' +
'{"Date":"01 Jan 2000 ","Time":"12:13:00.705","X":4796.41,"Y":5318.08,"Z":1601.76},' +
'{"Date":"01 Jan 2000 ","Time":"12:14:43.436","X":4227.51,"Y":5803.04,"Z":1563.58},' +
'{"Date":"01 Jan 2000 ","Time":"12:16:26.387","X":3612.46,"Y":6227.36,"Z":1508.7},'  +
'{"Date":"01 Jan 2000 ","Time":"12:18:09.524","X":2957.88,"Y":6586.21,"Z":1437.67},' +
'{"Date":"01 Jan 2000 ","Time":"12:19:52.809","X":2270.89,"Y":6875.5,"Z":1351.24},' +
'{"Date":"01 Jan 2000 ","Time":"12:21:36.203","X":1558.98,"Y":7091.87,"Z":1250.33},' +
'{"Date":"01 Jan 2000 ","Time":"12:23:19.665","X":830.002,"Y":7232.83,"Z":1136.03},' +
'{"Date":"01 Jan 2000 ","Time":"12:25:03.154","X":91.9878,"Y":7296.71,"Z":1009.59},' +
'{"Date":"01 Jan 2000 ","Time":"12:26:46.627","X":-646.9,"Y":7282.75,"Z":872.404},' +
'{"Date":"01 Jan 2000 ","Time":"12:28:30.045","X":-1378.48,"Y":7191.07,"Z":725.98},' +
'{"Date":"01 Jan 2000 ","Time":"12:30:13.364","X":-2094.64,"Y":7022.7,"Z":571.943},' +
'{"Date":"01 Jan 2000 ","Time":"12:31:56.545","X":-2787.48,"Y":6779.53,"Z":412.002},' +
'{"Date":"01 Jan 2000 ","Time":"12:33:39.549","X":-3449.33,"Y":6464.32,"Z":247.932},' +
'{"Date":"01 Jan 2000 ","Time":"12:35:22.339","X":-4072.94,"Y":6080.67,"Z":81.5528},' +
'{"Date":"01 Jan 2000 ","Time":"12:37:04.883","X":-4651.48,"Y":5632.91,"Z":-85.2984},' +
'{"Date":"01 Jan 2000 ","Time":"12:38:47.146","X":-5178.7,"Y":5126.12,"Z":-250.782},' +
'{"Date":"01 Jan 2000 ","Time":"12:40:29.104","X":-5648.95,"Y":4566.01,"Z":-413.088},' +
'{"Date":"01 Jan 2000 ","Time":"12:42:10.730","X":-6057.22,"Y":3958.87,"Z":-570.447},' +
'{"Date":"01 Jan 2000 ","Time":"12:43:52.005","X":-6399.28,"Y":3311.48,"Z":-721.158},' +
'{"Date":"01 Jan 2000 ","Time":"12:45:32.910","X":-6671.63,"Y":2631.02,"Z":-863.604},' +
'{"Date":"01 Jan 2000 ","Time":"12:47:13.433","X":-6871.58,"Y":1924.99,"Z":-996.273},' +
'{"Date":"01 Jan 2000 ","Time":"12:48:53.568","X":-6997.26,"Y":1201.1,"Z":-1117.77},' +
'{"Date":"01 Jan 2000 ","Time":"12:50:33.308","X":-7047.62,"Y":467.216,"Z":-1226.84},' +
'{"Date":"01 Jan 2000 ","Time":"12:52:12.656","X":-7022.45,"Y":-268.771,"Z":-1322.37},' +
'{"Date":"01 Jan 2000 ","Time":"12:53:51.614","X":-6922.33,"Y":-999.002,"Z":-1403.39},' +
'{"Date":"01 Jan 2000 ","Time":"12:55:30.191","X":-6748.66,"Y":-1715.75,"Z":-1469.11},' +
'{"Date":"01 Jan 2000 ","Time":"12:57:08.400","X":-6503.59,"Y":-2411.5,"Z":-1518.89},' +
'{"Date":"01 Jan 2000 ","Time":"12:58:46.255","X":-6190,"Y":-3079.02,"Z":-1552.29},' +
'{"Date":"01 Jan 2000 ","Time":"13:00:23.779","X":-5811.46,"Y":-3711.44,"Z":-1569.03},' +
'{"Date":"01 Jan 2000 ","Time":"13:02:00.994","X":-5372.17,"Y":-4302.3,"Z":-1568.98},' +
'{"Date":"01 Jan 2000 ","Time":"13:03:37.927","X":-4876.93,"Y":-4845.61,"Z":-1552.23},' +
'{"Date":"01 Jan 2000 ","Time":"13:05:14.606","X":-4331.07,"Y":-5335.92,"Z":-1518.99},' +
'{"Date":"01 Jan 2000 ","Time":"13:06:51.064","X":-3740.38,"Y":-5768.34,"Z":-1469.67},' +
'{"Date":"01 Jan 2000 ","Time":"13:08:27.333","X":-3111.07,"Y":-6138.58,"Z":-1404.81},' +
'{"Date":"01 Jan 2000 ","Time":"13:10:03.450","X":-2449.71,"Y":-6443.02,"Z":-1325.14},' +
'{"Date":"01 Jan 2000 ","Time":"13:11:39.452","X":-1763.12,"Y":-6678.67,"Z":-1231.49},' +
'{"Date":"01 Jan 2000 ","Time":"13:13:15.375","X":-1058.38,"Y":-6843.25,"Z":-1124.84},' +
'{"Date":"01 Jan 2000 ","Time":"13:13:20.565","X":-1019.86,"Y":-6850.1,"Z":-1118.72},' +
'{"Date":"01 Jan 2000 ","Time":"13:14:53.860","X":-120.114,"Y":-6972.25,"Z":-970.597},' +
'{"Date":"01 Jan 2000 ","Time":"13:16:25.993","X":769.667,"Y":-7025.02,"Z":-814.86},' +
'{"Date":"01 Jan 2000 ","Time":"13:17:59.431","X":1664.69,"Y":-7011.27,"Z":-649.112},' +
'{"Date":"01 Jan 2000 ","Time":"13:19:35.842","X":2572.2,"Y":-6929.73,"Z":-471.853},' +
'{"Date":"01 Jan 2000 ","Time":"13:21:19.786","X":3524.33,"Y":-6771.31,"Z":-275.966},' +
'{"Date":"01 Jan 2000 ","Time":"13:23:07.629","X":4476.32,"Y":-6537.94,"Z":-69.9075},' +
'{"Date":"01 Jan 2000 ","Time":"13:24:51.208","X":5351.61,"Y":-6256.31,"Z":128.673},' +
'{"Date":"01 Jan 2000 ","Time":"13:26:34.085","X":6180.51,"Y":-5929.09,"Z":324.965},' +
'{"Date":"01 Jan 2000 ","Time":"13:28:19.438","X":6986.55,"Y":-5552.8,"Z":523.745},' +
'{"Date":"01 Jan 2000 ","Time":"13:30:09.420","X":7781.93,"Y":-5123.33,"Z":727.809},' +
'{"Date":"01 Jan 2000 ","Time":"13:32:05.854","X":8573.97,"Y":-4635.71,"Z":939.173},' +
'{"Date":"01 Jan 2000 ","Time":"13:34:10.549","X":9367.6,"Y":-4083.97,"Z":1159.55},' +
'{"Date":"01 Jan 2000 ","Time":"13:36:25.431","X":10166.1,"Y":-3461.01,"Z":1390.51},' +
'{"Date":"01 Jan 2000 ","Time":"13:38:52.554","X":10971,"Y":-2759.04,"Z":1633.4},' +
'{"Date":"01 Jan 2000 ","Time":"13:41:33.966","X":11781.4,"Y":-1970.63,"Z":1889.04},' +
'{"Date":"01 Jan 2000 ","Time":"13:44:31.387","X":12592.5,"Y":-1090.72,"Z":2157.26},' +
'{"Date":"01 Jan 2000 ","Time":"13:47:46.025","X":13396.3,"Y":-117.983,"Z":2436.79},' +
```

```
'{"Date":"01 Jan 2000 ","Time":"13:51:18.974","X":14184.1,"Y":947.073,"Z":2725.94},' +
'{"Date":"01 Jan 2000 ","Time":"13:55:11.929","X":14949.3,"Y":2105.75,"Z":3023.7},' +
'{"Date":"01 Jan 2000 ","Time":"13:59:27.559","X":15687.3,"Y":3362.87,"Z":3329.86},' +
'{"Date":"01 Jan 2000 ","Time":"14:04:09.540","X":16393.9,"Y":4726.52,"Z":3644.76},' +
'{"Date":"01 Jan 2000 ","Time":"14:09:22.604","X":17064,"Y":6207.5,"Z":3968.95},' +
'{"Date":"01 Jan 2000 ","Time":"14:15:12.764","X":17690.8,"Y":7819.3,"Z":4303.02},' +
'{"Date":"01 Jan 2000 ","Time":"14:21:47.339","X":18264.4,"Y":9576.79,"Z":4647.16},' +
'{"Date":"01 Jan 2000 ","Time":"14:28:58.492","X":18754.3,"Y":11425.4,"Z":4988.36},' +
'{"Date":"01 Jan 2000 ","Time":"14:36:49.186","X":19150.3,"Y":13359.1,"Z":5323.95},' +
'{"Date":"01 Jan 2000 ","Time":"14:45:23.761","X":19442.5,"Y":15374.9,"Z":5651.72},' +
'{"Date":"01 Jan 2000 ","Time":"14:54:47.021","X":19619.5,"Y":17468.3,"Z":5968.95},' +
'{"Date":"01 Jan 2000 ","Time":"15:05:04.179","X":19667.9,"Y":19632.6,"Z":6272.26},' +
'{"Date":"01 Jan 2000 ","Time":"15:16:20.807","X":19572.8,"Y":21857.4,"Z":6557.55},' +
'{"Date":"01 Jan 2000 ","Time":"15:28:42.791","X":19317.7,"Y":24128.6,"Z":6819.84},' +
'{"Date":"01 Jan 2000 ","Time":"15:42:16.096","X":18884.7,"Y":26426.4,"Z":7053.19},' +
'{"Date":"01 Jan 2000 ","Time":"15:57:06.214","X":18255.7,"Y":28724,"Z":7250.61},' +
'{"Date":"01 Jan 2000 ","Time":"16:13:17.515","X":17413.4,"Y":30985.7,"Z":7404.1},' +
'{"Date":"01 Jan 2000 ","Time":"16:30:52.111","X":16344.1,"Y":33165.7,"Z":7504.93},' +
'{"Date":"01 Jan 2000 ","Time":"16:49:49.282","X":15040.2,"Y":35209.8,"Z":7544.27},' +
'{"Date":"01 Jan 2000 ","Time":"17:10:06.201","X":13500.4,"Y":37058.8,"Z":7513.92},' +
'{"Date":"01 Jan 2000 ","Time":"17:31:39.966","X":11728.5,"Y":38653.9,"Z":7406.51},' +
'{"Date":"01 Jan 2000 ","Time":"17:54:30.249","X":9728.76,"Y":39937.1,"Z":7214.94},' +
'{"Date":"01 Jan 2000 ","Time":"18:18:41.947","X":7501.19,"Y":40847.5,"Z":6930.94},' +
'{"Date":"01 Jan 2000 ","Time":"18:33:08.336","X":6129.74,"Y":41171.7,"Z":6723.94},' +
'{"Date":"01 Jan 2000 ","Time":"18:35:08.336","X":5770.47,"Y":41232.9,"Z":6666.48},' +
'{"Date":"01 Jan 2000 ","Time":"18:40:50.724","X":4743.04,"Y":41390.2,"Z":6499.76},' +
'{"Date":"01 Jan 2000 ","Time":"19:01:53.852","X":932.083,"Y":41746.8,"Z":5850.5},' +
'{"Date":"01 Jan 2000 ","Time":"19:25:10.654","X":-3290.04,"Y":41729,"Z":5075.02},' +
'{"Date":"01 Jan 2000 ","Time":"19:48:43.295","X":-7525.2,"Y":41271.2,"Z":4237.27},' +
'{"Date":"01 Jan 2000 ","Time":"20:12:17.751","X":-11685.8,"Y":40374.3,"Z":3353.45},' +
'{"Date":"01 Jan 2000 ","Time":"20:35:52.413","X":-15722.9,"Y":39048.2,"Z":2433.84},' +
'{"Date":"01 Jan 2000 ","Time":"20:59:27.082","X":-19592.7,"Y":37306.9,"Z":1488.36},' +
'{"Date":"01 Jan 2000 ","Time":"21:23:01.754","X":-23254.3,"Y":35168.9,"Z":527.051},' +
'{"Date":"01 Jan 2000 ","Time":"21:46:36.436","X":-26668.7,"Y":32657,"Z":-439.869},' +
'{"Date":"01 Jan 2000 ","Time":"22:10:11.124","X":-29799.5,"Y":29797.9,"Z":-1402.12},' +
'{"Date":"01 Jan 2000 ","Time":"22:33:45.817","X":-32613.6,"Y":26622,"Z":-2349.46},' +
'{"Date":"01 Jan 2000 ","Time":"22:57:20.506","X":-35080.8,"Y":23163,"Z":-3271.82},' +
'{"Date":"01 Jan 2000 ","Time":"23:20:55.193","X":-37175.1,"Y":19457.8,"Z":-4159.39},' +
'{"Date":"01 Jan 2000 ","Time":"23:44:29.884","X":-38874.1,"Y":15545.6,"Z":-5002.75},' +
'{"Date":"02 Jan 2000 ","Time":"00:08:04.566","X":-40159.9,"Y":11468.3,"Z":-5792.91},' +
'{"Date":"02 Jan 2000 ","Time":"00:31:39.258","X":-41018.6,"Y":7268.94,"Z":-6521.48},' +
'{"Date":"02 Jan 2000 ","Time":"00:55:13.954","X":-41441.3,"Y":2992.31,"Z":-7180.72},' +
'{"Date":"02 Jan 2000 ","Time":"01:18:48.628","X":-41423.3,"Y":-1316.07,"Z":-7763.6},' +
'{"Date":"02 Jan 2000 ","Time":"01:42:23.308","X":-40964.9,"Y":-5610.47,"Z":-8263.95},' +
'{"Date":"02 Jan 2000 ","Time":"02:05:58.004","X":-40071,"Y":-9845.28,"Z":-8676.44},' +
'{"Date":"02 Jan 2000 ","Time":"02:29:32.701","X":-38751,"Y":-13975.4,"Z":-8996.68},' +
'{"Date":"02 Jan 2000 ","Time":"02:53:07.379","X":-37019.1,"Y":-17956.9,"Z":-9221.26},' +
'{"Date":"02 Jan 2000 ","Time":"03:16:42.065","X":-34893.6,"Y":-21747.5,"Z":-9347.8},' +
'{"Date":"02 Jan 2000 ","Time":"03:40:16.747","X":-32397,"Y":-25306.9,"Z":-9374.96},' +
'{"Date":"02 Jan 2000 ","Time":"04:03:51.432","X":-29556.1,"Y":-28597.2,"Z":-9302.45},' +
'{"Date":"02 Jan 2000 ","Time":"04:27:26.120","X":-26400.9,"Y":-31583.4,"Z":-9131.03},' +
'{"Date":"02 Jan 2000 ","Time":"04:51:00.810","X":-22965,"Y":-34233.9,"Z":-8862.53},' +
'{"Date":"02 Jan 2000 ","Time":"05:14:35.506","X":-19284.9,"Y":-36520.4,"Z":-8499.8},' +
'{"Date":"02 Jan 2000 ","Time":"05:38:10.205","X":-15399.7,"Y":-38418.7,"Z":-8046.7},' +
'{"Date":"02 Jan 2000 ","Time":"06:01:44.904","X":-11350.9,"Y":-39908.4,"Z":-7508.05},' +
'{"Date":"02 Jan 2000 ","Time":"06:25:19.600","X":-7181.33,"Y":-40973.9,"Z":-6889.57},' +
'{"Date":"02 Jan 2000 ","Time":"06:48:54.297","X":-2935.43,"Y":-41603.7,"Z":-6197.84},' +
'{"Date":"02 Jan 2000 ","Time":"07:12:28.989","X":1341.66,"Y":-41791.1,"Z":-5440.21},' +
'{"Date":"02 Jan 2000 ","Time":"07:36:03.674","X":5604.47,"Y":-41534.3,"Z":-4624.75},' +
'{"Date":"02 Jan 2000 ","Time":"07:59:38.354","X":9807.68,"Y":-40835.8,"Z":-3760.13},' +
'{"Date":"02 Jan 2000 ","Time":"08:23:13.048","X":13906.7,"Y":-39703.2,"Z":-2855.51},' +
'{"Date":"02 Jan 2000 ","Time":"08:46:47.752","X":17857.8,"Y":-38148.5,"Z":-1920.53},' +
'{"Date":"02 Jan 2000 ","Time":"09:10:22.448","X":21619,"Y":-36188.1,"Z":-965.137},' +
'{"Date":"02 Jan 2000 ","Time":"09:33:57.142","X":25150.4,"Y":-33843,"Z":0.517068},' +
'{"Date":"02 Jan 2000 ","Time":"09:57:31.835","X":28414.4,"Y":-31138.1,"Z":966.165},' +
'{"Date":"02 Jan 2000 ","Time":"10:21:06.528","X":31376.3,"Y":-28102.1,"Z":1921.54},' +
'{"Date":"02 Jan 2000 ","Time":"10:44:41.211","X":34004.6,"Y":-24767.4,"Z":2856.48},' +
'{"Date":"02 Jan 2000 ","Time":"11:08:15.903","X":36271.3,"Y":-21169.3,"Z":3761.06},' +
```

```
'{"Date":"02 Jan 2000 ","Time":"11:31:50.585","X":38152.4,"Y":-17346.1,"Z":4625.64},' +
'{"Date":"02 Jan 2000 ","Time":"11:55:25.278","X":39627.9,"Y":-13338.6,"Z":5441.05},' +
'{"Date":"02 Jan 2000 ","Time":"12:18:59.966","X":40682.1,"Y":-9189.16,"Z":6198.6},'+
'{"Date":"02 Jan 2000 ","Time":"12:42:34.661","X":41303.7,"Y":-4942.05,"Z":6890.26},' +
'{"Date":"02 Jan 2000 ","Time":"13:06:09.359","X":41486.2,"Y":-642.382,"Z":7508.66},' +
'{"Date":"02 Jan 2000 ","Time":"13:29:44.050","X":41227.5,"Y":3664.09,"Z":8047.22},' +
'{"Date":"02 Jan 2000 ","Time":"13:53:18.722","X":40530.6,"Y":7931.56,"Z":8500.22},' +
'{"Date":"02 Jan 2000 ","Time":"14:16:53.409","X":39402.7,"Y":12114.7,"Z":8862.85},' +
'{"Date":"02 Jan 2000 ","Time":"14:40:28.101","X":37855.9,"Y":16169.1,"Z":9131.25},' +
'{"Date":"02 Jan 2000 ","Time":"15:04:02.803","X":35906.6,"Y":20051.6,"Z":9302.57},' +
'{"Date":"02 Jan 2000 ","Time":"15:27:37.488","X":33575.6,"Y":23720.9,"Z":9374.98},' +
'{"Date":"02 Jan 2000 ","Time":"15:51:12.174","X":30887.6,"Y":27138,"Z":9347.71},' +
'{"Date":"02 Jan 2000 ","Time":"16:14:46.866","X":27871.2,"Y":30266.5,"Z":9221.06},' +
'{"Date":"02 Jan 2000 ","Time":"16:38:21.547","X":24558.4,"Y":33073.3,"Z":8996.38},' +
'{"Date":"02 Jan 2000 ","Time":"17:01:56.240","X":20984.6,"Y":35528.4,"Z":8676.04},' +
'{"Date":"02 Jan 2000 ","Time":"17:25:30.928","X":17187.6,"Y":37605.8,"Z":8263.46},' +
'{"Date":"02 Jan 2000 ","Time":"17:49:05.619","X":13207.9,"Y":39283.3,"Z":7763.02},' +
'{"Date":"02 Jan 2000 ","Time":"18:12:40.306","X":9087.79,"Y":40543.2,"Z":7180.04},' +
'{"Date":"02 Jan 2000 ","Time":"18:33:08.336","X":5431.36,"Y":41287.7,"Z":6611.85}' +
']}'
```