Importing a Vehicle Motion Profile

Scope

The Tapestry system is a software suite developed by Navigation Laboratories Inc. that provides a modeling and control gateway for the LabPro SCS3500/3510 Global Positioning System

The SCS3500/3510 when controlled with the Tapestry system, is capable of outputting 24 channels of L_1 (C/A, P, Y, M), L_2 (C/A, P, Y, M) , L_2C, L_5, and WAAS with deterministic Doppler and Doppler derivatives derived directly from Host-Vehicle Dynamic Motion. Tapestry includes a high integrity 6-DOF Motion Generator that will allow you to develop a ***Motion Script*** based upon selection of maneuver primitives from a list.

Should this type of interface prove inadequate, or should you have another mode of construction of vehicle motion, you may input your own motion data in several formats.

This document provides a description of the formats.

Importing a Vehicle Motion Profile

At the heart of the Tapestry Scenario process is the Vehicle Motion and Attitude *Profile*. The *Profile* is used to construct GPS line-of-sight data, auxiliary sensor truth data, and numerous special effects and error models.

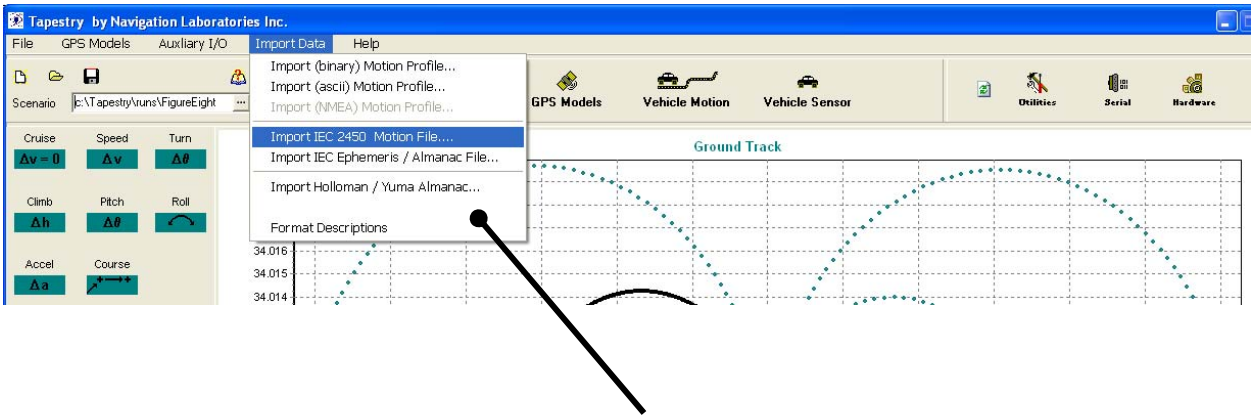
The Tapestry system includes a very accurate Six-Degree-Of-Freedom (6-DOF) trajectory generator as part of the software suite. However, in many end-user applications, there is a desire to import a Vehicle Motion and Attitude *Profile* created externally outside of the Tapestry system. This document describes the various formats supported for importation.

There is no error checking of your data!

Importing Vehicle Trajectory Files into Tapestry

To import your vehicle motion profile you must use the **Build Scenario** application. You may import a Profile into a pre-existing scenario or into a new scenario created for that purpose. You can also import a Profile repeatedly into the same scenario.

From the **Build Scenario** main menu select the **Import Data** pulldown.



Select the Format desired – (descriptions given below)

Selecting the appropriate input format requires the user to enter the name of the file to be imported. Tapestry copies the input file you provide into the scenario folder allowing you to remove your file from the computer upon completion. The original data file is not altered.

When the main ground-track display is updated, importation is complete.

Import (Binary) Motion Profile . . .

This format implements that used internally by the Tapestry system.

Convention/Restrictions

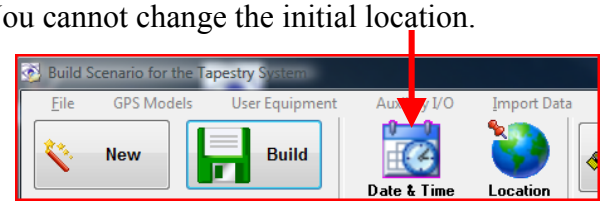
- The data is Binary (Intel).
- The data must start at least 1 second into the simulated week.
- The data must be differentiable.
- The data must have no time gaps.
- The data must be at 10Hz throughout.

- Use the following "C" structure to write successive **10 Hz** record into your file.

```
#pragma pack(push,1)

typedef struct {
        long int Week;          // GPS week number
        double  Time;           // seconds into GPS week
        double  EcefPos[3];     // meters (x, y, z )
        double  EcefVel[3];     // m/s
        double  EcefAcc[3];     // m/s/s
        double  EcefJerk[3];    // m/s/s/s
        double  Attitude[3];    // radians
        double  AngRate[3];     // r/s
        double  AngAccel[3];    // r/s/s
        double  AngJerk[3];     // r/s/s/s

} NAVTRUTHRECORD;               // Tapestry format

#pragma pack(pop)
```

- The pragma directive assures BYTE alignment of the data within the file. This is not the default for most compilers (e.g. Microsoft, Borland).

- The first record in the file is used as the initial state for the Scenario. After you have imported the Trajectory. You may use the Data/Time Icon to move the Start Time from that entered. You cannot change the initial location.



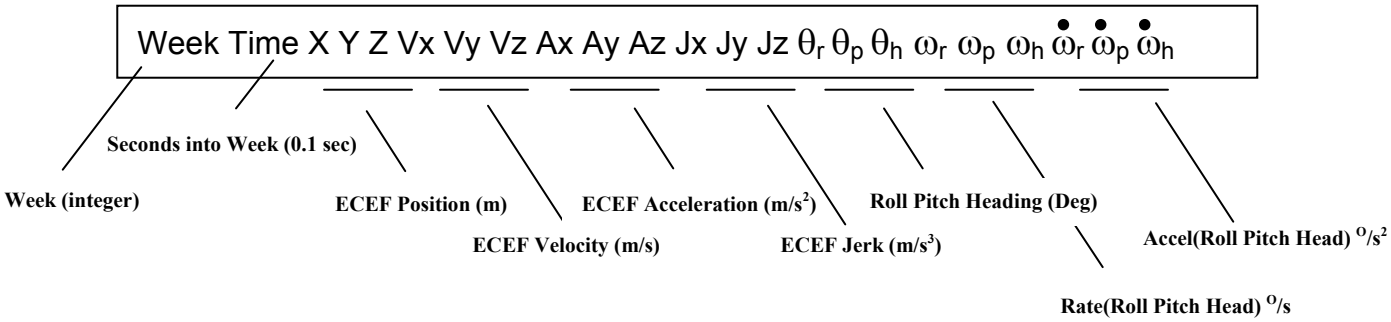
- If you translate the Time or Location, Reset the [SatPowerPro] using the Utilities Icon.

Import (ASCII) Motion Profile . . .

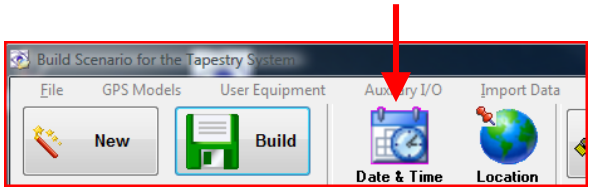
This format implements a generic ASCII representation of the profile data as follows.

Convention/Restrictions

- The data file you import must start at least 1 second into the simulated week.
- The file must be a 10 Hz with no data gaps.
- The file contains time sequential *space delimited* records comprised of,



- The Time tag has a resolution of 0.1 seconds. To avoid truncation errors, provide 5 digits passed the decimal point for all other values.
  If you do not have Attitude data (θ_r …) then omit these items and the program will use the velocity vector to compute attitude.
- If the data is not based upon a continuous and differentiable model, Import this data as a Route File.
- The first record in the file is used as the initial state replacing the value programmed into the scenario. If you want to change the time or Location of the imported data, do so after you've imported the file using the Time Icons located on the main Build Scenario menu.



Import (NMEA) Motion Profile . . .

This format allows the user to LOG actual field data in NMEA format and "play it back" using the simulator. Since this data typically is obtained from an actual (noisy) GPS receiver, the position data is not smooth. The Tapestry system must condition the data by using a cubic spline for smoothing. The spline is differentiated to obtain velocity, and acceleration. Jerk is constructed by first-differencing. Heading is aligned with the vehicle velocity vector.

Convention/Restrictions

- The data file you import must start at least 1 second into the simulated week. If there are data gaps, Build Scenario will interpolate using a Cubic Spline.
- NMEA Message Format.
  - Continuous GGA and at least one GPRMC are required. Time comes from GPRMC. If there is NO GGA data. Ellipsoid Altitude will be set to 0 (the Earths Surface).

An example of each type:

RMC,225446,A,4916.45,N,12311.12,W,000.5,054.7,191194,020.3,E*68

225446	Time of fix 22:54:46 UTC
A	Navigation receiver warning A = OK, V = warning
4916.45,N	Latitude 49 deg. 16.45 min North
12311.12,W	Longitude 123 deg. 11.12 min West
000.5	Speed over ground, Knots
054.7	Course Made Good, True
191194	Date of fix 19 November 1994
020.3,E	Magnetic variation 20.3 deg East
*68	mandatory checksum

GGA - Global Positioning System Fix Data

GGA,123519,4807.038,N,01131.324,E,1,08,0.9,545.4,M,46.9,M, , *42

123519	Fix taken at 12:35:19 UTC
4807.038,N	Latitude 48 deg 07.038' N
01131.324,E	Longitude 11 deg 31.324' E
1	Fix quality: 0 = invalid , 1 = GPS fix ,2 = DGPS
08	Number of satellites being tracked (ignored)
0.9	Horizontal dilution of position (ignored)
545.4,M	Altitude, Metres, above mean sea level
46.9,M	Height of geoid (mean sea level) above WGS84 ellipsoid
(empty field)	time in seconds since last DGPS update
(empty field)	DGPS station ID number

- Tapestry requires at least ONE RMC message with an “A” setting to construct the initial date and time.

- The GGA message is used for navigation as it contains the required ellipsoid altitude. If not present, Tapestry will constrain the vehicle to the earth’s surface.

- The NMEA time string supplies UTC time, while Tapestry requires GPS time. Tapestry equates the two times when imported using the NMEA time as if it was GPS time.

Import SCS2450 Motion Profile . . .

This format provides compatibility with the Interstate Electronics Corp. SCS 2450 GPS Constellation Simulators.

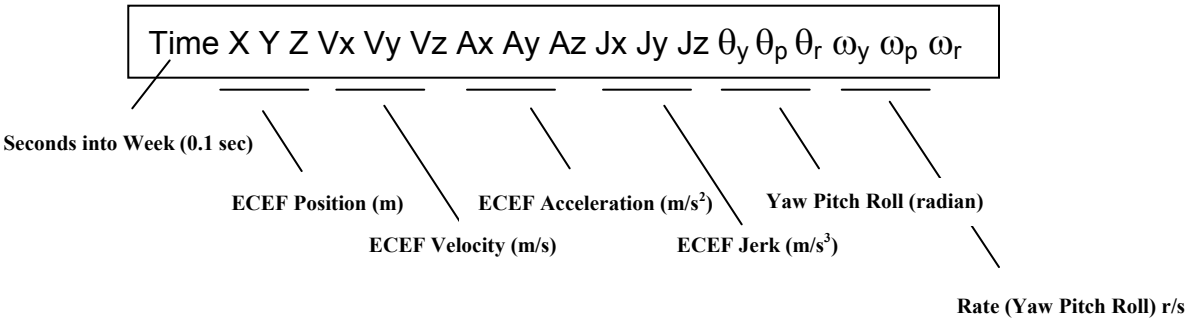
The correctly formatted Input file must be constructed using the SCS 2450 Post Processor capability and selecting the geocentric output log-file format.

Convention/Restrictions

- The data file you import must start at least 1 second into the simulated week.
- Log File Format.

  All items are space delimited on the same line in MKS units. Successive records are on subsequent lines. The file has 10 lines of header data that are skipped over during the import – do not delete these lines from your file nor add additional lines or an error will result.

  Note: The 2450 uses the notation Center-of-Gravity (CG) E-F-G equivalent to ECEF X-Y-Z used by Tapestry.



- The log file contains 8 digits passed the decimal point for all values.
- The Log file header is 10 lines long. An example is;

  Line 1: Blank
  Line 2: Log File: c:\scs454\scenarios\navlabs\data\motcg10.log
  Line 3: Recorded: 02:50:48 PM Oct-04-2005
  Line 4: MOTION DATA (CENTER OF GRAVITY) BLO
  Line 5: Processed: 03:20:43 PM Oct-04-2005
  Line 6: Blank
  Line 7: Blank
  Line 8: Label characters
  Line 9: Label characters
  Line 10: Label characters

Line 11: Data to Import
Line 11 – EOFData to Import

Do Not modify this header by deleting or inserting lines. The import function skips over the first 10 lines of the file unconditionally.