Addendum to the **Voyager WindowsNT GPS Constellation Simulation Software**

Propagation of Almanac and Ephemeris Data

Date: March 1 1999

This Addendum presents the operational description for the propagation and date determination of the GPS subframe 1,2,3 (Ephemeris) and subframe 4,5 (Almanac) data.

The model described herein is contained in BldScn version 2.91+ beginning with software build 1103. This model and operational description supersedes that described in the Voyager WindowsNT Graphical User Interface Users manual (revision data March 1998 and earlier) page 44-46.

Overview of the GPS Data Set Propagation

A change - relative to the description in the manual - has been made to how the Voyager propagates the GPS data frames 1-5 in relation to the simulation start time. This addendum presents an overview of the processing involved with maintenance of subframe data and then explains the modification.

By default the simulator contains a base file set containing subframes 1-3 and subframes 4-5. These files reside in the default directory:

\voyager\runs\default\sub123.dat (base ephemeris data set)
\voyager\runs\default\sub45.dat (base almanac data set)

When a new simulation is created these subframe files become the basis for the new simulation. Changing the initial simulation time - by clicking on the ***Earth*** icon and entering a new simulation start epoch - causes the Voyager to propagate the base subframe data (in the current scenario only) to time associated with the new simulation start time. If a new Almanac is imported into the simulation - by using the ***tools*** pull down menu and selecting *import Holloman Almanac data…*the Holloman data file is also propagated to the current simulation start time. In either case, the propagation proceeds as follows:

1. If a Holloman data set is imported, Ephemeris data is constructed based upon the input Almanac data. At this point the Almanac and Ephemeris agree. For all values not contained in the Almanac, eg. the various harmonic corrections, the values are set to zero. The contents of the Almanac data are written to sub45.dat and the Ephemeris data written to sub123.dat

2. If a current subframe set is in place, and the simulation start time is changed, the ephemeris data is propagated to the current new simulation epoch such that the Time-of-Ephemeris (TOE) is 1 hour ahead of the current simulation start time rounded to the nearest hour. In no case however, will the TOE be more than 2 hours ahead of the current simulation time. For example, if the current simulation time is 603000 seconds into the week 1023 (23 hours 30 minutes into August 21 1999), the Ephemeris data will be propagated from the previous simulation (TOE) time to the new TOE computed as:

   New TOW = 603000 Seconds (week 1023) + 3600 Seconds = 3600 + 800 Seconds into week 1024.
   = 3600 seconds week 1024 (the 800 sec are rounded down to nearest hour)

   All dynamic parameters, such as the mean anomaly, are propagated to coincide with the TOE computed above. This ephemeris data with the TOE determined as described is valid for 3

hours past the simulation start time. This is because - according to ICD-GPS-200 - when a four hour ephemeris curve fit is active (the default Voyager configuration) the TOE shall be in the center of the curve fit interval. The ephemeris is considered valid for four complete hours - 2 hours on each side of the TOE. *To create additional Ephemeris data past the 3 hours of applicability, the "more" function should be used - See the manual for a description of the creation of more ephemeris data.*

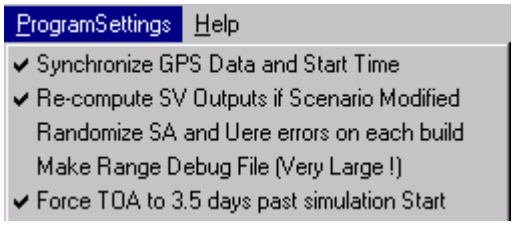
3. The Almanac is propagated when the time is changed as follows. The Time-of-Almanac (TOA) is computed to lie as closely as possible to the current simulation time modulo 4096 seconds. That is, for the example time of Week 1023 603000 seconds, the TOA would be given as:

   New TOA = mod(603000,4096)*4096 = 602112 seconds into Week 1023

   This implies a time of transmission of 3 ½ days previous to this TOA. The time dependent parameters in the Almanac are propagated to be consistent with this TOA.

4. The method of determination of the Almanac TOA described above is in *strict* compliance with ICD-GPS-200 but does not correspond necessarily to the method of determination of the TOA for the current (actual) GPS system. The current GPS system uploads a new Almanac on Thursday of each week (this is not required but corresponds to current standard operating procedure). Based upon this condition, just prior to any week rollover, the Almanac TOA will be in the next week. Thus, in the real world and if the current operational procedures are maintained, on Saturday of week 1023 prior to the week rollover, the Almanac will already have rolled over to week 1024 (or any other week). This will not be the case for the Voyager based upon the current model. The current Voyager model will have a TOA in week 1023 when the week rolls from week 1023 to 1024. It has been pointed out that certain receivers fail to rollover correctly when this condition occurs. In our opinion this would technically be an incorrect implementation of ICD-GPS-200 for any receiver that depends upon the TOA to be ahead of the current week prior to the rollover.

5. Never the less, with the last sentence of item 4 not withstanding, we have modified the Voyager software by mechanization of a new program setting in the *ProgramSettings* menu pull down and in the Satellite database editor. The ProgramSettings item has been changed to look as follows:



The item **Force TOA to 3.5 days past simulation Start** when checked will cause the TOA to be computed by adding 3.5 days to the current simulation time and propagating the various parameters accordingly. This allows the Almanac week to always be in the next week prior to a simulated week rollover. If this item is checked in the default scenario, then this will be the normal operation of the simulator when new scenario's are created.