

AGI Recommended Practices

For incorporating the 31 Dec 2005 leap second

Overview

A new leap second has been added to the Coordinated Universal Time (UTC) time scale as of 31 December 2005. For users of the latest versions of AGI software products, no action is necessary. This document provides the procedures for updating AGI software products and scenarios for older software versions, to account for the new leap second.

[Note: The option exists for the addition of a leap second every six months (at the end of June and at the end of December) to keep the UTC and Universal Time (UT1) time scales within 0.9 second. There has not been a need for the addition of a leap second, however, since 31 December 1998.]

AGI Leap Second Data Files

The new leap second is identified to AGI products through two ASCII files: LeapSecond.dat and EOP.dat. LeapSecond.dat contains the dates of all historical and announced leap seconds. The contents of this file affect the conversion of dates between UTC and other time scales. AGI products operate internally on continuous time scales which are not affected by leap seconds. The LeapSecond.dat file is, however, required for proper transformation between internal time scales and the UTC time scale which is the default time scale for input and output of dates. The EOP.dat file contains Earth Orientation Parameters which describe the motion of the spin axis (pole wander) and the irregular rotation rate of the Earth (UT1 – UTC). These parameters are used in the computation of the transformation between the Earth Centered Fixed (ECF) reference frame and Earth Centered Inertial (ECI) frames. At the time of a leap second, the (UT1 – UTC) time history experiences a discontinuity of 1 second. It is therefore important that the EOP.dat and LeapSecond.dat files be updated together to properly establish the existence of the new leap second. Instructions are provided below for updating these files.

AGI Product Versions Affected

For users of the latest versions of STK, ODTK and NTK, no action is required. These products all were created with updated data files. Specifically, the following versions are unaffected:

- STK version 6.2 and higher (includes 6.2.1 and 7)
- ODTK version 4.0.1 and higher (includes 4.1)
- NTK version 2.1

The remainder of this document only pertains to any earlier versions.

Effect on Existing Scenarios

The addition of a new leap second will have no effect on existing scenarios whose stop time pre-dates the epoch of the leap second – 31 December 2005 at 23:59:60. The meaning of civil times after the epoch of the leap second will change, however, upon the introduction of the leap second. This means that loading of existing scenarios with stop times after the leap second epoch following the update of the LeapSecond.dat and EOP.dat files may result in some unexpected behavior unless certain computations are refreshed. New scenarios, created after the update of the data files reflecting the new leap second, will not have any such computational issues.

The effect of the introduction of the leap second on existing scenarios is minimal if the scenario is basically independent of continuous moving time scales, such as an analysis performed for a notional constellation of satellites in 2010. In cases where the scenario is dependent upon continuously moving time, such as the design of an Earth to Mars trajectory in 2008, times may have to be shifted one second earlier in the UTC time scale to achieve the similar results. The following activities are recommended to ensure accurate results from scenarios with time spans which span or come after the new announced leap seconds:

Updating AGI Leap Second Data

1. Use the following steps to update the LeapSecond.dat and EOP.dat files together. The LeapSecond.dat file resides in the STKData\Astro directory under the product installation directory. The EOP.dat file resides in the DynamicEarthData directory under the product installation directory.

- **STK:**

For STK versions 6.0 - 6.1.3, the EOP and Leap Second data files used by STK may be updated by using the update utility (UpdateDataFiles60.htm) which may be accessed via the Utilities section of the STK Start Page. The Start Page is accessible through the Help menu on the application.

For STK versions prior to 6.0, these two files can be manually updated in the appropriate directories by the user.
- **ODTK:**

The EOP and Leap Second data files used by ODTK may be updated by using the update utility (UpdateDataFiles.htm) which may be accessed via the Utilities section of the ODTK Start Page. The Start Page is accessible through the Help menu on the application.
- **NTK:**

The EOP data file used by NTK may be updated by using the update utility (UpdateDataFiles.htm) which may be accessed via the Utilities section of the NTK Start Page. The LeapSecond.dat file will not be updated by the 2.0.1 version of this utility however. This file will have to be manually updated for 2.0.1 users.

2. Close the application

3. Restart the application

Updating Existing Scenarios

- **STK:**

Upon opening an existing scenario for the first time after performing the file updates described above, use the following steps to update the scenario.

 - 1) Clear access computations for all CoverageDefinition objects. Do not recompute accesses until after the regeneration of all vehicle trajectories (see next step).
 - 2) Force the regeneration of all vehicle trajectories. This can be done for most vehicles by changing the stop time, applying changes and resetting the stop time back to the original time. Trajectories read from external ephemeris files will be read in properly, but the original

source of such data should be examined to determine if the data is still valid.

- 3) Recompute the access information for CoverageDefinition objects.
- 4) Access based targeting times for targeted sensors and targeted attitude profiles should be recomputed by removing target objects from the targeting list, applying those changes and adding the target objects back.
- 5) Review all manually entered times to determine if they are still appropriate.

- ODTK:

- 1) Verify the validity of any externally provided ephemerides.
- 2) Rerun all simulator, filter, smoother and least squares processes.

- NTK:

- 1) If your scenario has a scenario start time later than December 31, 2005 23:59:45, you will need to execute your scenario again to ensure that the data saved in the archive reflects the new leap second.

Known Software Issues

AGI is aware of the following minor issues:

- 1) Issue #19085 – This issue affects STK version 6.1.3 and prior, ODTK version 4.0 and prior and NTK version 2.0.1 and prior.

The computation of the Greenwich hour angle displays a discontinuity over the span of the leap second. As a result of this issue, the transformation between the ECI and ECF reference frames is in error by 1 second of Earth rotation during the leap second. Computations prior to and after the leap second are correct.

This issue has been fixed for:

- STK version 6.2 and higher (includes 6.2.1 and 7)
- ODTK version 4.0.1 and higher (includes 4.1)
- NTK version 2.1

- 2) Issue #19087 – This issue affects STK versions 4.2 - 6.1.3, ODTK version 4.0 and prior and NTK version 2.0.1 and prior.

Date formatting is incorrect at the time of the start of the leap second. Date formatting is correct for times within the leap second and at the end of the leap second. In the case of the current leap second, this issue affects the reporting of the time “31 Dec 2005 23:59:60.00 UTCG”. This issue affects the following date formats: UTCG, UTCJ, UTCJFOUR, YYYY/MM/DD, DD/MM/YYYY.

This issue has been fixed for:

- STK version 6.2 and higher (includes 6.2.1 and 7)
- ODTK version 4.0.1 and higher (includes 4.1)
- NTK version 2.1

- 3) Issue #19122 – This issue affects STK version 6.1.3 and prior, ODTK version 4.0 and prior and NTK version 2.0.1 and prior.

Local time date formatting is incorrect for times between the start of the leap second until the start of the next local day. As a result of this issue, the leap second is not applied in the local time representation until the end of the local day, not at the time of the leap second in UTC. This issue affects the following date formats: UTCG and UTCJ.

This issue has been fixed for:

- STK version 6.2.1 and higher (includes 7)
- ODTK version 4.0.1 and higher (includes 4.1)
- NTK version 2.1

4. Issue #19168–This issue affects NTK version 2.0.1 and prior.

The update data files utility does not provide the option to update the LeapSecond.dat file. This file must therefore be updated manually.

This issue has been fixed for:

- NTK version 2.1

Limitations

Users of AGI software should also be aware of the inherent limitations of particular date formats with respect to representing times across a leap second. Such limitations, which typically involve expressing the time as

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the fraction of a day, affect the following date formats: JDate, JDateOff, ModJDate, YYDDD, and YYYYMMDD. Dates represented in these formats will appear to jump backwards in time as the leap second is crossed.

Summary

The following table provides a summary of the various AGI products.

STK 6.2.1 & STK 7, ODTK 4.0.1& ODTK 4.1, NTK 2.1: No known issues

| | STK | | ODTK | | NTK | |
|--|--------------------------------------|--------------------------------|--------------------|----------------------|---|--------------|
| | 6.1.3 & prior | 6.2 | 4.0 & prior | 4.0.1 and subsequent | 2.0.1 & prior | 2.1 |
| Leap second data files | Not updated (no 31Dec05 leap second) | Updated (with new leap second) | Not updated | Updated | Not updated | Updated |
| Data file update procedure | Use update utility | Not required | Use update utility | Not required | Use update utility and manual update for LeapSecond.dat | Not required |
| s/w Issue 19085 ECI-ECF transformations during the leap second | Open | Fixed | Open | Fixed | Open | Fixed |
| s/w issue 19087 Date formatting during the leap second | Open (since 4.2) | Fixed | Open | Fixed | Open | Fixed |
| s/w issue 19122 Local time date formatting for 1 Jan 2006 | Open | Open - Fixed in 6.2.1 | Open | Fixed | Open | Fixed |
| s/w issue 19168 NTK update files utility | n/a | n/a | n/a | n/a | Open | Fixed |