REPORT OF THE IAU COMMISSION 4 WORKING GROUP ON STANDARDIZING ACCESS TO EPHEMERIDES AND FILE FORMAT SPECIFICATION

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ABSTRACT. The IAU Commission 4 Working Group on Standardizing Access to Ephemerides recommends the use of the Spacecraft and Planet Kernel (SPK) file format to provide a uniform format for the position ephemerides of planets and other natural solar system bodies, and the use of the binary Planetary Constants Kernel (PCK) format for the orientation of a body. It further recommends supporting data be stored in a text PCK. These formats are used by the SPICE system developed by the Jet Propulsion Laboratory. A new data type, Type 20: Chebyshev (Velocity Only) has been added. Other changes to the specification are new object identification numbers for coordinate time ephemerides, and a set of three new data types that uses the TCB rather than the TDB timescale.

1. RECOMMENDATIONS

To provide a uniform format for the position ephemerides of planets and other natural solar system bodies, the International Astronomical Union (IAU) Commission 4: Ephemerides Working Group on Standardizing Access to Ephemerides recommends:

1. The use of the Spacecraft and Planet Kernel (SPK) file format.
2. The use of the binary Planetary Constants Kernel (PCK) format ephemeris file for the orientation of a body.
3. Supporting data on the ephemerides, such as values of parameters, whether they are fixed or adjusted, and their uncertainties, are stored in a text PCK kernel.

2. INTRODUCTION

These file formats were developed for and are used by the SPICE system, developed by the Navigation and Ancillary Information Facility (NAIF) of NASA's Jet Propulsion Laboratory (JPL).

Most users will want to use either the SPICE libraries or CALCEPH, developed by the Institut de mécanique céleste de calcul des éphémérides (IMCCE), to access ephemerides stored in these formats.

SPICE is an information system to assist scientists in planning and interpreting scientific observations from space-based instruments. SPICE data and software may be used within many different computing environments. The software is available in FORTRAN 77, C, IDL and MATLAB from the NAIF web site.

CALCEPH is an ephemeris file reader developed by the IMCCE primarily to read its Intégrateur Numérique Planétaire de l'Observatoire de Paris (INPOP) planetary ephemerides. Starting with version 2.0, CALCEPH has the ability to read text PCK, binary PCK, and SPK kernels. It may be linked to programs written in C, FORTRAN 77, and Fortran 90/95/2003. It is available at the INPOP web site and will be made available at the IAU Commission 4: Ephemerides web site (http://iaucom4.org/index.html).

3. CHANGES MADE TO THE BINARY SPK AND PCK FORMATS

To meet the requirements of the wider community, NAIF has agreed to make some additions to the SPK format and adjustments to SPICE and its documentation.

1. A new data type, named Type 20: Chebyshev (Velocity Only).
2. The data types beginning with 101 have been reserved for ephemerides where the time argument is TCB rather than TDB.
3. Data types 901 through 910 have been reserved for the development of new ephemeris types by other groups.
4. Each solar system object is assigned a unique identification number. Ephemeris object numbers have also been reserved for coordinate time ephemerides. The value:
   - 1 000 000 001 indicates that $TT - TDB$ is stored in the X-coordinate.
   - 1 000 000 002 indicates that $TCG - TCB$ is stored in the Y-coordinate.
   - 1 000 000 003 indicates that $TT - TDB$ is stored in the X-coordinate and $TCG - TCB$ is stored in the Y-coordinate.

4. THE FULL SPECIFICATIONS OF THE SPK AND PCK FORMATS

Some users, such as ephemeris developers, may want to access the ephemeris files directly or construct ephemeris files in these formats using their own software. For those readers that require a detailed specification of the file formats, they will be made available in the full version of this report online at the IAU Commission 4: Ephemerides web site.

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