REPORT OF THE IAU COMMISSION 4 WORKING GROUP ON STANDARDIZING ACCESS TO EPHEMERIDES AND FILE FORMAT SPECIFICATION: UPDATE SEPTEMBER 2014

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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. The Working Group also recommends the use of the binary Planetary Constants Kernel (PCK) format ephemeris file for the orientation of a body. It further recommends supporting data be stored in a text PCK. Since the previous report:

- Some minor changes have been made to the formats for:

  - the coordinate time ephemeris
  - data types 20: Chebyshev Polynomials (Velocity Only) and 120: Chebyshev Polynomials (TCB:Velocity Only)

- the working group's final report is currently undergoing review by the Navigation and Ancillary Information Facility (NAIF) of NASA's Jet Propulsion Laboratory (JPL) to assure it correctly describes these file formats.

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 toolkit or CALCEPH, developed by the Institut de mécanique céleste de calcul des éphémérides (IMCCE), to access ephemerides stored in these formats. The SPICE toolkit is available at

    http://naif.jpl.nasa.gov/naif/toolkit.html,

and CALCEPH is available at

    http://www.imcce.fr/inpop/calceph/index.php.

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, it is available in the full version of this report online at the IAU Commission 4: Ephemerides (or its successor) web site.

3. TEXT PCK KERNELS

Most of the supporting data consist of a limited number of single values or small vectors and matrices that are easily stored as text. Text PCK kernels are ASCII files so they may be modified by text editors and can also be ported between computer systems, even when the systems have different file systems and file formats.

Parameter values are associated with name strings using a "keyword = value" format. These name strings, together with their associated values, are called "kernel variables". Kernel variables may consist of arrays of values such as

```
NAME = ( VALUE1, VALUE2, ... )
```

where `NAME` is a case sensitive string, no longer than 32 characters. The values on the right hand side may be integer or floating point numeric values or strings.

4. RECENT CHANGES MADE TO THE SPK AND BINARY PCK FORMATS

Coordinate time scales are now designated by three NAIF identification numbers.

- 1 000 000 001: TT – TDB data are stored in the X-coordinate,

- 1 000 000 002: TCG – TCB data are stored in the Y-coordinate,

- 1 000 000 003: TT – TDB data are stored in the X-coordinate and TCG – TCB data are stored in the Y-coordinate.

5. CURRENT STATUS

The IAU Commission 4 Working Group on Standardizing Access to Ephemerides and File Format Specification recommends the use of the SPICE Toolkit's SPK kernel format for the positional ephemerides of solar system bodies, the SPICE Toolkit's binary PCK for the orientation ephemeris of the Moon, and the text PCK format for the storage of other data useful for the application of these ephemerides.

To assure that the specification of the portions of these kernels of interest to users comply with the SPICE Toolkit, the detailed final report is currently being reviewed by NAIF. Once the detailed report is approved, it will be made available at the IAU Commission 4 or comparable web site and a summary report will be submitted for publication.