Relating the Dynamical Frame and the Ephemerides to the ICRF

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The dynamical reference frame no longer serves its original purpose: that of establishing an inertial reference frame; that function is now fulfilled by the ICRF. Planetary and lunar ephemerides continue to be vitally important, however, in a number of different roles.

JPL will continue its 30-year tradition of providing such ephemerides to the astronomical community, and the ephemerides will continue to be based upon the PPN formulism of relativity, with equations of motion correct and complete through order of 1/c**2. The independent variable of the equations of motion will continue to be "Teph", a relativistic coordinate time, rigorously equivalent to the IAU's newly-defined quantity, TCB, but having the added benefit that |Teph-TT| < 2 milliseconds of time. The JPL ephemerides have been oriented onto the ICRF (formerly, the "IERS reference frame") since 1995. The accuracy of the orientation is now about 1 mas, accomplished by the inclusion of VLBI observations of Magellan, Phobos, MGS, and Odyssey spacecraft approaching or in orbit around Venus and Mars.

The ephemerides provide accurate coordinates of the earth about the sun, from which the location of a "mean ecliptic" may be determined for use with other studies, such as precession, etc.

The major uncertainty in the ephemerides of earth and Mars comes from the perturbations of many asteroids whose masses are not well-known. These cause the computed motion of Mars to be not fully self-consistent over a period of years. As a result, the ephemeris is contorted in other dimensions in order to absorb the unmodeled signatures in the accurate ranging observations. One must then make choices regarding the proper weighting of the different data sets and time intervals, according to the eventual purposes of the ephemerides.