PROPOSED CHANGE NOTICE

Affected Document:	IRN/SCN Number	Date:
IS-GPS-800E	PCN-IS-800E_RFC400	07-MAY-2019
Authority:	**Proposed Change Notice**	**Date:**
RFC-00400	IS800E_RFC400	20-DEC-2018

CLASSIFIED BY: N/A
DECLASSIFY ON: N/A

Document Title: NAVSTAR GPS Space Segment / User Segment L1C Interfaces

RFC Title: Leap Second and Earth Orientation Parameters

Reason For Change (Driver):

As currently documented in the technical baseline for Earth Orientation Parameters (EOP) data and applications, CNAV and CNAV-2 users will calculate the wrong UT1 time immediately following a leap second change, as the linkage between Coordinated Universal Time (UTC) and UT1 time is not properly captured. This issue affects user applications that require high precision pointing, which may include optical telescopes, spacecraft, or any system with this requirement. Documents affected: IS-GPS-200, IS-GPS-705, IS-GPS-800. The topic was originally a part of RFC-354 & RFC-374.

Description of Change:

Resolve the leap second problem such that the user knows how to calculate the correct UT1 time following a leap second change given the current definition and implementation of EOP and UTC parameters.

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AUTHORIZED SIGNATURES	REPRESENTING	DATE
	GPS Directorate Space & Missile Systems Center (SMC) – LAAFB	

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El Segundo, CA 90245

CODE IDENT 66RP1

IS800-875 :

Section Number :
3.5.2.0-7

WAS :

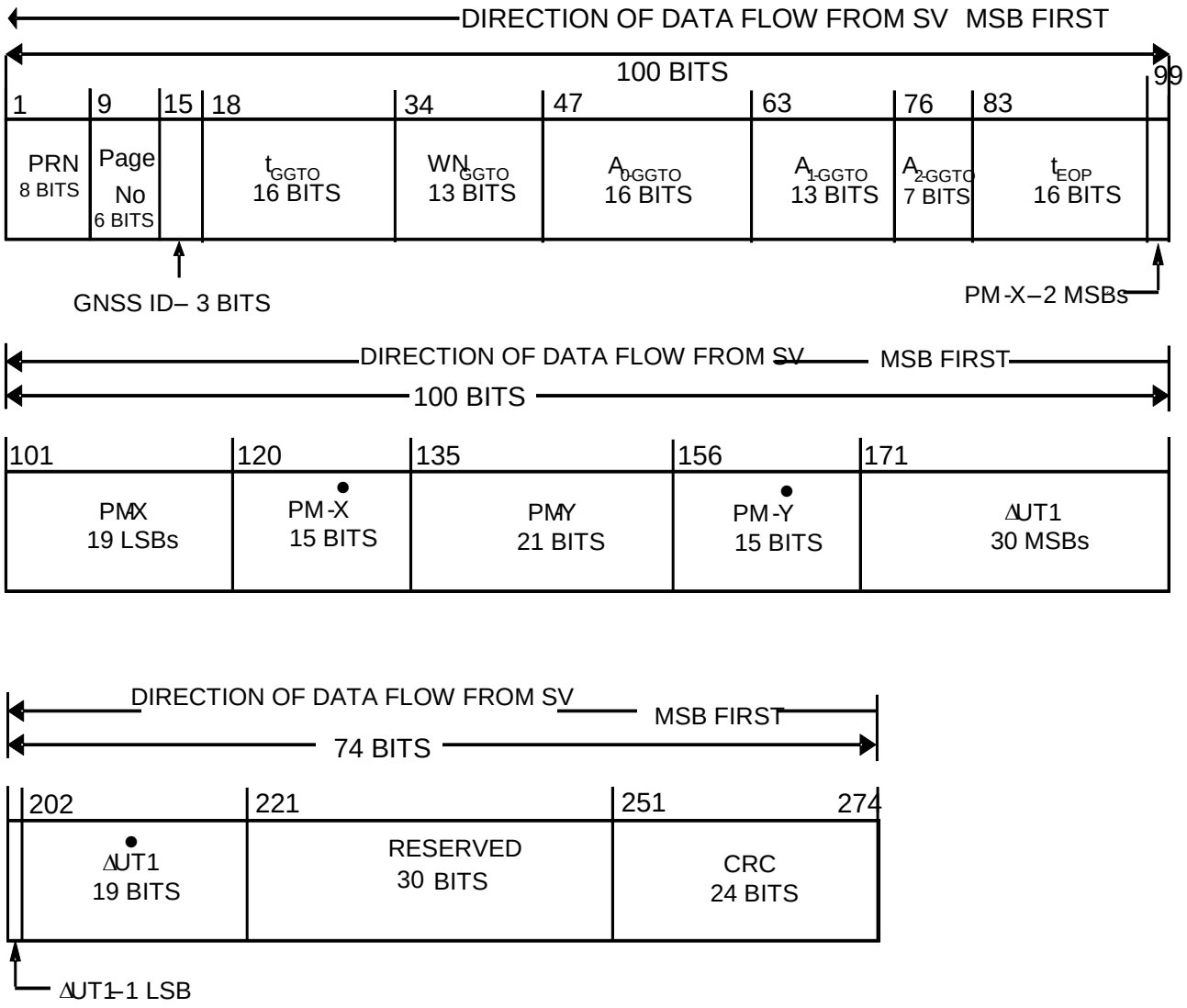

Figure 3.5-3 Subframe 3, Page 2

Redlines :

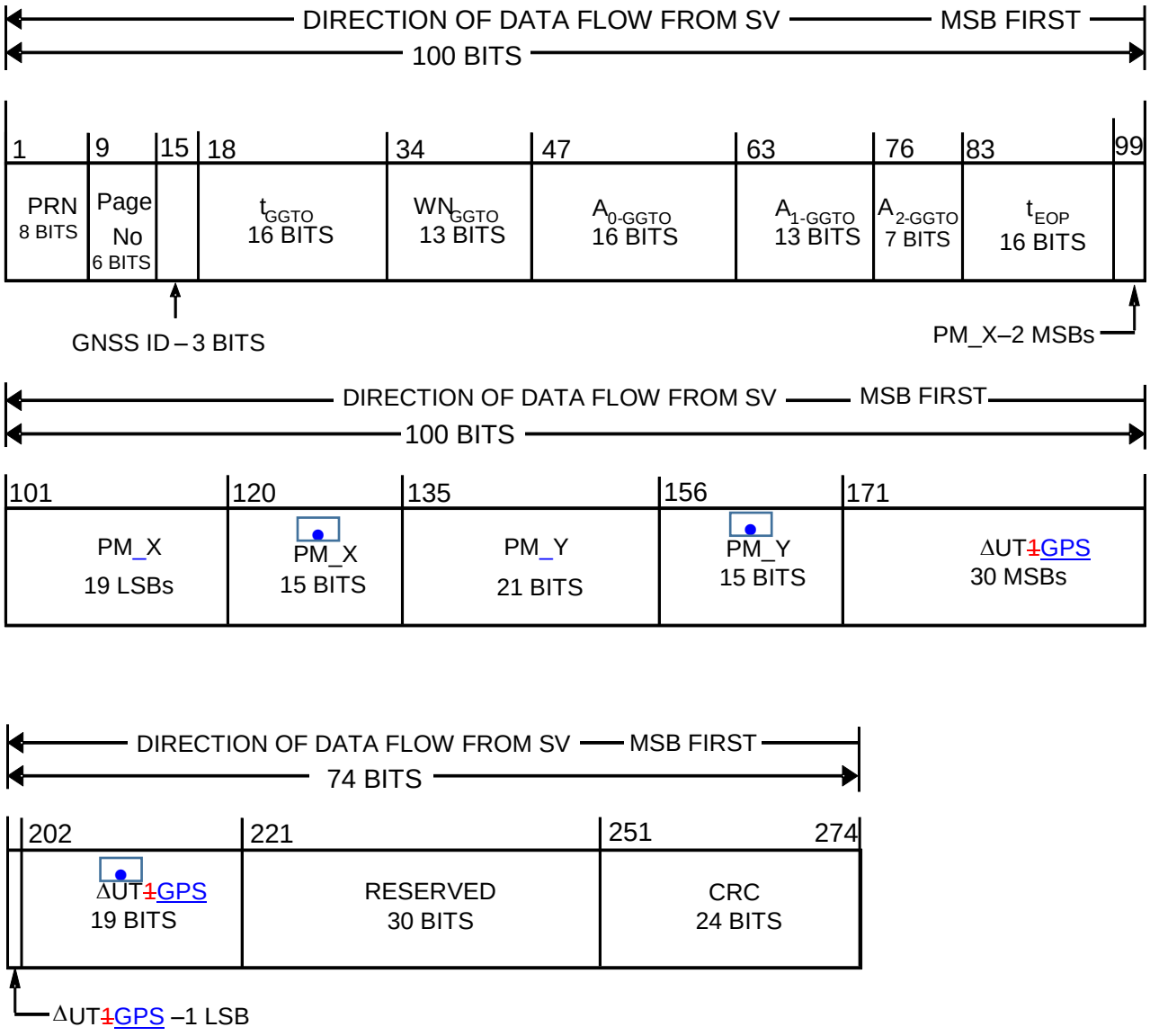

Figure 3.5-3 Subframe 3, Page 2

IS :

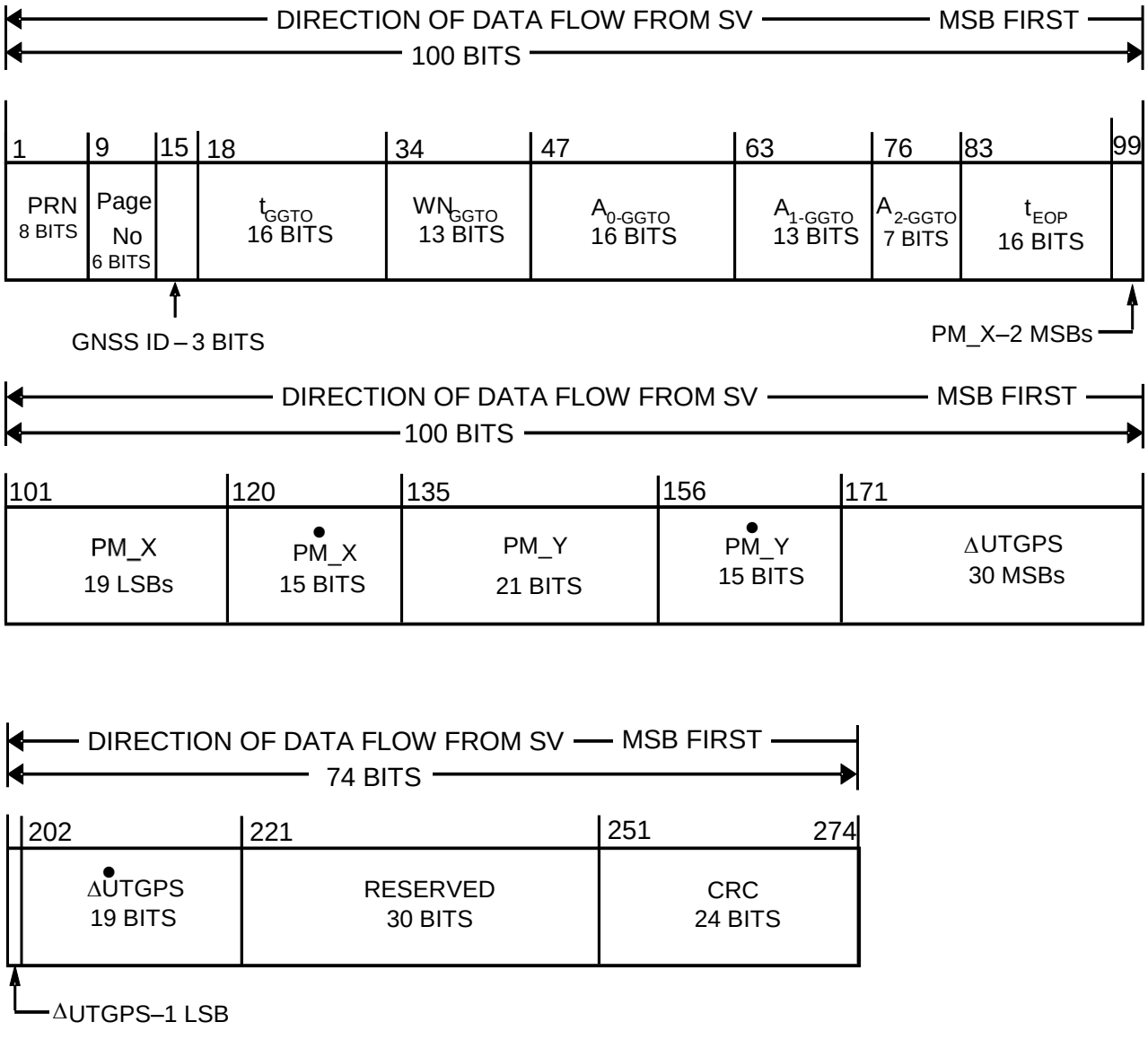

Figure 3.5-3 Subframe 3, Page 2

Rationale :
Change UT1-UTC difference and rate of UT1-UTC difference to use GPS time to simplify UT1 calculations. Update the EOPs to be consistent (in the variable's appearance) with usages in this document and other documents.

IS800-237 :

Section Number :
3.5.4.2.2

WAS :
EOP Parameter Content

Redlines :
EOP ~~Parameter~~ Content

IS :
EOP Content

Rationale :
Administrative: remove redundancy with "EOP Parameters."

IS800-240 :

Section Number :
3.5.4.2.3.0-1

WAS :
The EOP fields in subframe 3, page 2 contain the EOP needed to construct the ECEF-to-ECI coordinate transformation. The user computes the ECEF position of the SV antenna phase center using the equations shown in Table 3.5-2. The coordinate transformation, for translating to the corresponding ECI SV antenna phase center position, is derived using the equations shown in IERS Technical Note 36 and Table 30-VIII of IS-GPS-200. The coordinate systems are defined in Section 20.3.3.4.3.3 of IS-GPS-200.

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EOPs that are not updated by the CS will degrade in accuracy over time.

IS :
The EOP fields in subframe 3, page 2 contain the EOP needed to construct the ECEF-to-ECI coordinate transformation. The user computes the ECEF position of the SV antenna phase center using the equations shown in Table 3.5-2. The coordinate transformation, for translating to the corresponding ECI SV antenna phase center position, is derived using the equations shown in IERS Technical Note 36 and Table 30-VIII of IS-GPS-200 in accordance with Section 30.3.3.5.1.1 of IS-GPS-200. The coordinate systems are defined in Section 20.3.3.4.3.3 of IS-GPS-200.

EOPs that are not updated by the CS will degrade in accuracy over time.

Rationale :
Originally discussed in RFC-374: add language to point to Section 30.3.3.5.1.1 of IS-GPS-200 so that the users follow the guidelines covered there in addition to IERS Technical Note 36 and Table 30-VIII of IS-GPS-200. Add information to tell the user the data will degrade over time if the CS is unable to update the EOPs.

IS800-922 :

Section Number :
3.5.4.2.3.0-2 (after IS800-240)

> The EOP fields in subframe 3, page 2 contain the EOP needed to construct the ECEF-to-ECI coordinate transformation. The user computes the ECEF position of the SV antenna phase center using the equations shown in Table 3.5-2. The coordinate transformation, for translating to the corresponding ECI SV antenna phase center position, is derived using the equations shown in IERS Technical Note 36 and Table 30-VIII of IS-GPS-200. The coordinate systems are defined in Section 20.3.3.4.3.3 of IS-GPS-200.

WAS :
N/A

Redlines :
<INSERTED OBJECT>

IS :
When calculating UT1, x_p, and y_p in Table 30-VIII of IS-GPS-200, the week number for t_{EOP} is equal to the WN_{ot} value in subframe 3 page 2 when both criteria are met:

- t_{EOP} in subframe 3 page 1 is equal to t_{ot} in subframe 3 page 2
- Subframe 3 page 1 and subframe 3 page 2 were transmitted within a continuous 4-hour period

If both criteria are not met, the data between the two pages may be inconsistent with each other and should not be used for the calculations in Table 30-VIII of IS-GPS-200.

Rationale :
Originally inserted in RFC-354 and further modifications provided in RFC-400. Provide detailed instructions to the user on how to use corresponding EOP and UTC messages given the current implementation of linking the EOP and UTC messages. In this specific case, the t_{op} values are not present in both subframe 3 pages as in L2 and L5 CNAV, so replacement criterion would be that the subframe 3 pages would need to be transmitted within 4 hours of each other.

IS800-241 :

Section Number :
3.5.4.2.3.0-5

WAS :

Table 3.5-5. Earth Orientation Parameters

Parameter		No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
t_{EOP}	EOP Data Reference Time	16	2^{4}	0 to 604,784	seconds
PM_X †	X-Axis Polar Motion Value at Reference Time.	21*	2^{-20}		arc-seconds
$\dot{PM}$_X	X-Axis Polar Motion Drift at Reference Time.	15*	2^{-21}		arc-seconds/day
PM_Y ††	Y-Axis Polar Motion Value at Reference Time.	21*	2^{-20}		arc-seconds
$\dot{PM}$_Y	Y-Axis Polar Motion Drift at Reference Time.	15*	2^{-21}		arc-seconds/day
ΔUT1 †††	UT1-UTC Difference at Reference Time.	31*	2^{-24}		seconds
$\dot{\Delta UT1}$ †††	Rate of UT1-UTC Difference at Reference Time	19*	2^{-25}		seconds/day

* Parameters so indicated are in two's complement notation;

** See Figure 3.5-3 for complete bit allocation in subframe 3, page 2;

*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.

† Represents the predicted angular displacement of instantaneous Celestial Ephemeris Pole with respect to semi-minor axis of the reference ellipsoid along Greenwich meridian.

†† Represents the predicted angular displacement of instantaneous Celestial Ephemeris Pole with respect to semi-minor axis of the reference ellipsoid on a line directed 90° west of Greenwich meridian.

††† With zonal tides restored.

Redlines :

Table 3.5-5. Earth Orientation Parameters

Parameter		No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
t_{EOP}	EOP Data Reference Time	16	2^{4}	0 to 604,784	seconds
PM_X †, ††††	X-Axis Polar Motion Value at Reference Time.	21*	2^{-20}		arc-seconds
$\dot{PM}$_X ††††	X-Axis Polar Motion Drift at Reference Time.	15*	2^{-21}		arc-seconds/day
PM_Y ††, ††††	Y-Axis Polar Motion Value at Reference Time.	21*	2^{-20}		arc-seconds
$\dot{PM}$_Y ††††	Y-Axis Polar Motion Drift at Reference Time.	15*	2^{-21}		arc-seconds/day
ΔUT~~1~~GPS †††	~~UT1-UTC~~UT1-GPS Difference at Reference Time.	31*	2^{-24}~~^{23}~~		seconds
$\dot{\Delta UT}$~~1~~GPS †††	Rate of ~~UT1-UTC~~UT1-GPS Difference at Reference Time.	19*	2^{-25}		seconds/day

* Parameters so indicated are in two's complement notation;

** See Figure 3.5-3 for complete bit allocation in subframe 3, page 2;

*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.

† Represents the predicted angular displacement of instantaneous Celestial ~~Ephemeris~~Intermediate Pole with respect to semi-minor axis of the reference ellipsoid along Greenwich meridian.

†† Represents the predicted angular displacement of instantaneous Celestial ~~Ephemeris~~Intermediate Pole with respect to semi-minor axis of the reference ellipsoid on a line directed 90° west of Greenwich meridian.

††† ~~With zonal tides restored.~~Already account for zonal, diurnal, and semi-diurnal tides and should not be further applied by the user.

†††† Already account for diurnal and semi-diurnal tides and should not be further applied by the user.

IS :

Table 3.5-5. Earth Orientation Parameters

Parameter		No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
t_{EOP}	EOP Data Reference Time	16	2^{4}	0 to 604,784	seconds
PM_X †, ††††	X-Axis Polar Motion Value at Reference Time.	21*	2^{-20}		arc-seconds
$\dot{PM}$_X ††††	X-Axis Polar Motion Drift at Reference Time.	15*	2^{-21}		arc-seconds/day
PM_Y ††, ††††	Y-Axis Polar Motion Value at Reference Time.	21*	2^{-20}		arc-seconds
$\dot{PM}$_Y ††††	Y-Axis Polar Motion Drift at Reference Time.	15*	2^{-21}		arc-seconds/day
ΔUTGPS †††	UT1-GPS Difference at Reference Time.	31*	2^{-23}		seconds
$\dot{\Delta UTGPS}$ †††	Rate of UT1-GPS Difference at Reference Time.	19*	2^{-25}		seconds/day

* Parameters so indicated are in two's complement notation;

** See Figure 3.5-3 for complete bit allocation in subframe 3, page 2;

*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.

† Represents the predicted angular displacement of instantaneous Celestial Intermediate Pole with respect to semi-minor axis of the reference ellipsoid along Greenwich meridian.

†† Represents the predicted angular displacement of instantaneous Celestial Intermediate Pole with respect to semi-minor axis of the reference ellipsoid on a line directed 90° west of Greenwich meridian.

††† Already account for zonal, diurnal, and semi-diurnal tides and should not be further applied by the user.

†††† Already account for diurnal and semi-diurnal tides and should not be further applied by the user.

Rationale :

Update EOPs to calculate UT1 with respect to GPS time in order to resolve the leap second problem in calculating UT1. In addition, update the scale factor for the new ΔUTGPS to align with the current valid range of UTC-GPS time offset; otherwise, the range would be half that as currently inferred from the UTC parameters. Update the notes at the bottom of the table to make clear that the tides are already accounted for in the parameters.

In addition, based on the IERS Tech Note 36, the IAU resolutions on reference systems include recommending that "the terminology "Celestial Intermediate Origin" (CIO) and "Terrestrial Intermediate Origin" (Terrestrial Intermediate Origin)

be used in place of the previously introduced "Celestial Ephemeris Origin" (Celestial Ephemeris Origin) and "Terrestrial Ephemeris Origin" (Terrestrial Ephemeris Origin)"