CHANGE NOTICE

Affected Document:	IRN/SCN Number	Date:
IS-GPS-705 Rev G	XXX-XXX-XXX	DD-MMM-YYYY
Authority:	**Proposed Change Notice**	**Date:**
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DECLASSIFY ON: N/A

Document Title: NAVSTAR GPS Space Segment/User Segment L5 Interfaces

RFC Title: 2020 Public Documents Proposed Changes

Reason For Change (Driver): For the upcoming 2020 Public ICWG, there is an opportunity to clarify the documents for better understanding such as:

1. The public user community has expressed interest in adding a new clock error rate equation that aids in their calculations.
2. User equations involving time calculations need to be clarified.
3. To improve consistency in IS-GPS-200, clarify that a LNAV T_{GD} value of '10000000' means that the group delay value is unavailable, which aligns with the clarification of CNAV T_{GD}.
4. Administrative clarification and clean-up, identified in past Public ICWGs and as newly-identified changes of administrative nature.

Description of Change:

1. Recommend new SV Clock Relativistic Correction rate equation.
2. Clarify equations by recommending examples or clarifying instructions.
3. Add a statement that clarifies whether a LNAV T_{GD} value of '10000000' indicates that the group delay value in unavailable.
4. Provide clarity and clean up identified administrative changes in all public documents.

Authored By: RE: Kevin Cano **Checked By: RE: Dylan Nicholas**

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

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CODE IDENT 66RP1

IS705-313:

Section Number :
20.3.3.6.2

WAS:
UTC and GPS Time. Message type 33 includes: (1) the parameters needed to relate GPS Time to UTC (USNO), and (2) notice to the user regarding the scheduled future or recent past (relative to CNAV message upload) value of the delta time due to leap seconds (Δt_{LSF}), together with the week number (WN_{LSF}) and the day number (DN) at the end of which the leap second becomes effective. Information required to use these parameters to calculate (and define) t_{UTC} is in paragraph 20.3.3.5.2.4 of IS-GPS-200 except the following definition of Δt_{UTC} shall be used.

Redlines:
UTC and GPS Time. Message type 33 includes: (1) the parameters needed to relate GPS Time to UTC (USNO), and (2) notice to the user regarding the scheduled future or recent past (relative to CNAV message upload) value of the delta time due to leap seconds (Δt_{LSF}), together with the GPS week number (WN_{LSF}) and the GPS day number (DN) ~~at~~ near the end of which the leap second becomes effective. Information required to use these parameters to calculate (and define) t_{UTC} is in paragraph 20.3.3.5.2.4 of IS-GPS-200 except the following definition of Δt_{UTC} shall be used.

IS:
UTC and GPS Time. Message type 33 includes: (1) the parameters needed to relate GPS Time to UTC (USNO), and (2) notice to the user regarding the scheduled future or recent past (relative to CNAV message upload) value of the delta time due to leap seconds (Δt_{LSF}), together with the GPS week number (WN_{LSF}) and the GPS day number (DN) near the end of which the leap second becomes effective. Information required to use these parameters to calculate (and define) t_{UTC} is in paragraph 20.3.3.5.2.4 of IS-GPS-200 except the following definition of Δt_{UTC} shall be used.

Rationale:

To clarify the time scale of WN_{LSF} and DN so that user equipment does not misplace the timing of the leap second.

IS705-256 :

Section Number :
20.3.3.2.3.0-1

WAS :

The algorithms defined in paragraph 20.3.3.3.3.1 of IS-GPS-200 allow all users to correct the code phase time received from the SV with respect to both SV code phase offset and relativistic effects. However, since the SV clock corrections of equations in paragraph 20.3.3.3.3.1 of IS-GPS-200 are estimated by the CS using dual frequency L1 and L2 P(Y) code measurements, the single-frequency L5 user and the dual-frequency L1 and L5, and L2 and L5 users must apply additional terms to the SV clock corrections equations. These terms are described in paragraph 20.3.3.3.1.

Redlines :
The algorithms defined in paragraph 20.3.3.3.3.1 of IS-GPS-200 allow all users to correct the code phase time received from the SV with respect to both SV code phase offset and relativistic effects. However, since the SV clock corrections of equations in paragraph 20.3.3.3.3.1 of IS-GPS-200 are estimated by the CS using dual frequency L1 and L2 P(Y) code measurements, the single-frequency L5 user and the dual-frequency L1 and L5, and L2 and L5 users must apply additional terms to the SV clock corrections equations. These terms are described in paragraph 20.3.3.3.1. Refer to IS-GPS-200, Section 20.3.3.3.3.1 for optional first and second derivative of the SV clock correction equation.

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The algorithms defined in paragraph 20.3.3.3.3.1 of IS-GPS-200 allow all users to correct the code phase time received from the SV with respect to both SV code phase offset and relativistic effects. However, since the SV clock corrections of equations in paragraph 20.3.3.3.3.1 of IS-GPS-200 are estimated by the CS using dual frequency L1 and L2 P(Y) code measurements, the single-frequency L5 user and the dual-frequency L1 and L5, and L2 and L5 users must apply additional terms to the SV clock corrections equations. These terms are described in paragraph 20.3.3.3.1. Refer to IS-GPS-200, Section 20.3.3.3.3.1 for optional first and second derivative of the SV clock correction equation.

Rationale :
Adding references to the added SV clock correction equations for user clarifications.

IS705-274 :

Section Number :
20.3.3.3.3.1

WAS :
The group delay differential correction terms, $T_{GD,}$ ISC_{L5I5} and ISC_{L5Q5}, for the benefit of single frequency L5-I5 and L5-Q5 users and dual frequency L1/L5 and L2/L5 users are contained in bits 128 through 140 and 167 through 192 of message type 30 (see Figure 20-3 for complete bit allocation). The bit lengths, scale factors, ranges, and units of these parameters are given in Table 20-IV. The bit string of "1000000000000" shall indicate that the group delay value is not available. The related algorithms are given in paragraphs 20.3.3.3.1.2.1, 20.3.3.3.1.2.2, and 20.3.3.3.1.2.3.

Redlines :
The group delay differential correction terms, $T_{GD,}$ ISC_{L5I5} and ISC_{L5Q5}, for the benefit of single frequency L5-I5 and L5-Q5 users and dual frequency L1/L5 and L2/L5 users are contained in bits 128 through 140 and 167 through 192 of message type 30 (see Figure 20-3 for complete bit allocation). The bit lengths, scale factors, ranges, and units of these parameters are given in Table 20-IV. ~~The bit string of "1000000000000" shall indicate that the group delay value is not available.~~ The related algorithms are given in paragraphs 20.3.3.3.1.2.1, 20.3.3.3.1.2.2, and 20.3.3.3.1.2.3.

IS :
The group delay differential correction terms, $T_{GD,}$ ISC_{L5I5} and ISC_{L5Q5}, for the benefit of single frequency L5-I5 and L5-Q5 users and dual frequency L1/L5 and L2/L5 users are contained in bits 128 through 140 and 167 through 192 of message type 30 (see Figure 20-3 for complete bit allocation). The bit lengths, scale factors, ranges, and units of these parameters are given in Table 20-IV. The related algorithms are given in paragraphs 20.3.3.3.1.2.1, 20.3.3.3.1.2.2, and 20.3.3.3.1.2.3.

Rationale :
20200605: It was determined to delete this statement in order to make the CNAV section consistent with LNAV. As LNAV does not check for unavailable group delay value.

IS705-1594 :

Section Number :
20.3.3.1.3.0-13

WAS :
Table 20-II part 3

Element/Equation	Description
SV Velocity	
$\dot{E}_k = n/(1 - e\cos E_k)$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1-e^2}/(1 - e\cos E_k)$	True Anomaly Rate
$(di_k/dt) = (IDOT) + 2\dot{v}_k(c_{is}\cos 2\phi_k - c_{ic}\sin 2\phi_k)$	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k(c_{us}\cos 2\phi_k - c_{uc}\sin 2\phi_k)$	Corrected Argument of Latitude Rate
$\dot{r}_k = eA\dot{E}_k \sin Ek + 2\dot{v}_k(c_{rs}\cos 2\phi_k - c_{rc}\sin 2\phi_k)$	Corrected Radius Rate
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k \cos u_k - r_k \dot{u}_k \sin u_k$	In- plane *x* velocity
$\dot{y}'_k = \dot{r}_k \sin u_k + r_k \dot{u}_k \cos u_k$	In- plane *y* velocity
$\dot{x}_k = -x'_k \dot{\Omega}_k \sin\Omega_k + \dot{x}'_k \cos\Omega_k - \dot{y}'_k \sin\Omega_k \cos i_k - y'_k(\dot{\Omega}_k \cos\Omega_k \cos i_k - (di_k/dt)\sin\Omega_k \sin i_k)$	Earth- Fixed *x* velocity (m/s)
$\dot{y}_k = x'_k \dot{\Omega}_k \cos\Omega_k + \dot{x}'_k \sin\Omega_k + \dot{y}'_k \cos\Omega_k \cos i_k - y'_k(\dot{\Omega}_k \sin\Omega_k \cos i_k + (di_k/dt)\cos\Omega_k \sin i_k)$	Earth- Fixed *y* velocity (m/s)
$\dot{z}_k = \dot{y}'_k \sin i_k + y'_k (di_k/dt)\cos i_k$	Earth- Fixed *z* velocity (m/s)

Redlines :

Table 20-II part 3

Element/Equation	Description
SV Velocity	
$\dot{E}_k = n/(1 - e\cos E_k)$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1-e^2}/(1 - e\cos E_k)$	True Anomaly Rate
$(di_k/dt) = (IDOT) + 2\dot{v}_k(c_{is}\cos 2\phi_k - c_{ic}\sin 2\phi_k)$	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k(c_{us}\cos 2\phi_k - c_{uc}\sin 2\phi_k)$	Corrected Argument of Latitude Rate
~~$\dot{r}_k = eA\dot{E}_k \sin Ek + 2\dot{v}_k(c_{rs}\cos 2\phi_k - c_{rc}\sin 2\phi_k)$~~	~~Corrected Radius Rate~~
$\dot{r}_k = \dot{A}(1\text{-}e\cos(E_k)) + A\,e\sin(E_k)\,\dot{E}_k + 2(c_{rs}\cos(2\phi_k) - c_{rc}\sin(2\phi_k))\,\dot{v}_k$	Corrected Radius Rate for CNAV
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k\cos u_k - r_k\dot{u}_k\sin u_k$	In- plane *x* velocity
$\dot{y}'_k = \dot{r}_k\sin u_k + r_k\dot{u}_k\cos u_k$	In- plane *y* velocity
$\dot{x}_k = -x'_k\dot{\Omega}_k\sin\Omega_k + \dot{x}'_k\cos\Omega_k - \dot{y}'_k\sin\Omega_k\cos i_k - y'_k(\dot{\Omega}_k\cos\Omega_k\cos i_k - (di_k/dt)\sin\Omega_k\sin i_k)$	Earth- Fixed *x* velocity (m/s)
$\dot{y}_k = x'_k\dot{\Omega}_k\cos\Omega_k + \dot{x}'_k\sin\Omega_k + \dot{y}'_k\cos\Omega_k\cos i_k - y'_k(\dot{\Omega}_k\sin\Omega_k\cos i_k + (di_k/dt)\cos\Omega_k\sin i_k)$	Earth- Fixed *y* velocity (m/s)
$\dot{z}_k = \dot{y}'_k\sin i_k + y'_k(di_k/dt)\cos i_k$	Earth- Fixed *z* velocity (m/s)

IS :

Table 30-II. Part 3

Element/Equation	Description
SV Velocity	
$\dot{E}_k = n/(1 - e\cos E_k)$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1-e^2}/(1 - e\cos E_k)$	True Anomaly Rate
$(di_k / dt) = (\text{IDOT}) + 2\dot{v}_k (c_{is}\cos 2\phi_k - c_{ic}\sin 2\phi_k)$	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k (c_{us}\cos 2\phi_k - c_{uc}\sin 2\phi_k)$	Corrected Argument of Latitude Rat
$\dot{r}_k = \dot{A}(1-e\cos(E_k)) + A\, e \sin(E_k)\dot{E}_k + 2(c_{rs}\cos(2\phi_k) - c_{rc}\sin(2\phi_k))\dot{v}_k$	Corrected Radius Rate for CNAV
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k \cos u_k - r_k \dot{u}_k \sin u_k$	In- plane *x* velocity
$\dot{y}'_k = \dot{r}_k \sin u_k + r_k \dot{u}_k \cos u_k$	In- plane *y* velocity
$\dot{x}_k = -x'_k \dot{\Omega}_k \sin\Omega_k + \dot{x}'_k \cos\Omega_k - \dot{y}'_k \sin\Omega_k \cos i_k - y'_k(\dot{\Omega}_k \cos\Omega_k \cos i_k - (di_k/dt)\sin\Omega_k \sin i_k)$	Earth- Fixed *x* velocity (m/s)
$\dot{y}_k = x'_k \dot{\Omega}_k \cos\Omega_k + \dot{x}'_k \sin\Omega_k + \dot{y}'_k \cos\Omega_k \cos i_k - y'_k(\dot{\Omega}_k \sin\Omega_k \cos i_k + (di_k/dt)\cos\Omega_k \sin i_k)$	Earth- Fixed *y* velocity (m/s)
$\dot{z}_k = \dot{y}'_k \sin i_k + y'_k (di_k/dt)\cos i_k$	Earth- Fixed *z* velocity (m/s)

Rationale :

The Corrected Radius Rate was found to be different between CNAV and LNAV by a stakeholder. Since the semi-major axis is time dependent for CNAV this equation needs to be added to IS200, IS705, and IS800.