CHANGE NOTICE

Affected Document:	IRN/SCN Number	Date:
IS-GPS-800 Rev F	IRN-IS-800F-002	25-SEP-2019
Authority:	**Proposed Change Notice**	**Date:**
RFC-00395	PCN-IS-800F_RFC395	12-APR-2019

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

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

RFC Title: 2019 Public Document Proposed Changes

Reason For Change (Driver):

1. IS-GPS-705 identifies dual frequency users as "L1/L2" and "L1/L5 (recommended)". Users may interpret frequency pair (L2/L5) as a viable dual frequency; that is not recommended.
2. The user implementation community has identified equations in the Elements of Coordinates Systems tables in documents ICD-GPS-700 (non-public), IS-GPS-200, IS-GPS-705, and IS-GPS-800 that can benefit from an improvement.
3. ~~Documents IS-GPS-200, IS-GPS-705, IS-GPS 800, and ICD-GPS-700 (non-public) are not consistent in their definition of when to broadcast CNAV UTC data. These documents need to be made consistent.~~
4. ICD-GPS-870 Appendices 1-6 currently define an ASCII format for public release GPS products, the legacy format. The ICD states that modernized formats in XML will be defined. The ICD does not specifically call the current format legacy nor does it have placeholders for the modernized formats. Stakeholders could incorrectly assume that the ASCII format is the modernized format.
5. ICD-GPS-870 Appendices OCX provides a utility to convert modernized GPS products to the legacy, AEP-formatted GPS products. The legacy formats are characterized with default filenames, which are important for the public user community to interpret and process the GPS products. However, these default filenames are not described in ICD-GPS-870.
6. Public documents need clarification and clean-up, as identified in past Public ICWGs and as newly-identified changes of administrative nature.
7. Currently the Operational Advisories (OAs) that are published and archived contain plane/slot descriptions that are not in the constellation definition provided to the public in the SPS Performance Standard as well as the data provided by the National Geospatial-Intelligence Agency (NGA) (refer to http://earth-info.nga.mil/GandG/sathtml/satinfo.html). The OA does not have the capability to correctly publish information regarding fore/aft position since moving to the 24+3 constellation with three expanded slots. (Moved from RFC-374)

Description of Change:

1. In IS-GPS-705, state operational use of the group of signals (L2/L5) is at the users own risk.
2. Recommend a different, less complicated kinematic formulation that improves the equations in the Elements of Coordinate Systems tables in the Signal in Space (SiS) documents.
3. No change was needed.
4. Deferred for future RFC.
5. ICD-GPS-870 stakeholders are relying on the default filenames used by AEP for their equivalent files. ICD-GPS-870 does not capture the default filenames. Need to document the default filenames to support stakeholders.
6. Provide clarity and clean up identified administrative changes in all public documents.
7. This topic was originally addressed in RFC-374 but needs to be re-addressed in order to update ICD-GPS-870 such that OCX produces an OA with section one set to the original data or set to "RESERVED."

Authored By: RE: Anthony Flores **Checked By: RE: Edgar Valenzuela**

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

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	CODE IDENT 66RP1

IS800-15 :

Section Number :
2.1.0-4

WAS :
Other Publications

IS-GPS-200 (current issue)	Navstar GPS Space Segment/Navigation User Interfaces
GP-03-001A (20 April 2006)	GPS Interface Control Working Group Charter

Redlines :
Other Publications

IS-GPS-200 (current issue)	Navstar GPS Space Segment/Navigation User Interfaces
GP-03-001A (~~20 April 2006~~Current Issue)	~~GPS Interface Control Working Group Charter~~ GPS Adjudication Working Group (AWG) and Rough Order of Magnitude (ROM)/ Impact Assessment (IA) Charter

IS :
Other Publications

IS-GPS-200 (current issue)	Navstar GPS Space Segment/Navigation User Interfaces
GP-03-001A (Current Issue)	GPS Adjudication Working Group (AWG) and Rough Order of Magnitude (ROM)/ Impact Assessment (IA) Charter

IS800-1020 :

Insertion after object IS800-179

The user shall compute the ECEF coordinates of position for the SV's antenna phase center (APC) utilizing a variation of the equations shown in Table 3.5-2. The ephemeris parameters are Keplerian in appearance; however, the values of these parameters are produced by the SV via a least squares curve fit of the propagated ephemeris of the SV APC (time-position quadruples: t, x, y, z expressed in ECEF coordinates). Particulars concerning the applicable coordinate system are given in Sections 20.3.3.4.3.3 and 20.3.3.4.3.4 of IS-GPS-200.

Section Number :

3.5.3.6.1.1

WAS :

N/A

Redlines :

<INSERTED OBJECT>

IS :

The user can compute velocity and acceleration for the SV utilizing a variation of the equations, as required, shown in Table 3.5- 2 Part 3 and 4.

IS800-948 :

Section Number :

3.5.3.6.1.1-2

WAS :

Table 3.5-2. Elements of Coordinate System (part 1 of 2)

Redlines :

Table 3.5-2.~~ Elements of~~Broadcast ~~Coordinate~~Navigation ~~System~~User Equations (~~part~~sheet 1 of ~~2~~4)

IS :

Table 3.5-2. Broadcast Navigation User Equations (sheet 1 of 4)

IS800-181 :

Section Number :
3.5.3.6.1.1-3

WAS :
Table 3.5-2

Element/Equation	Description
$\mu = 3.986005 \times 10^{14}$ meters^3/sec^2	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e = 7.2921151467 \times 10^{-5}$ rad/sec	WGS 84 value of the earth's rotation rate
$A_0 = A_{REF} + \Delta A$ *	Semi-Major Axis at reference time
$A_k = A_0 + (\dot{A})\, t_k$	Semi-Major Axis
$n_0 = \sqrt{\frac{\mu}{A_0^3}}$	Computed Mean Motion (rad/sec)
$t_k = t - t_{oe}$ **	Time from ephemeris reference time
$\Delta n_A = \Delta n_0 + ½ \Delta \dot{n}_0\, t_k$	Mean motion difference from computed value
$n_A = n_0 + \Delta n_A$	Corrected Mean Motion
$M_k = M_0 + n_A\, t_k$	Mean Anomaly
$M_k = E_k - e_n \sin E_k$	Kepler's equation for Eccentric Anomaly (radians) (may be solved by iteration)
$\nu_k = \tan^{-1}\left\{\frac{\sin \nu_k}{\cos \nu_k}\right\}$	True Anomaly
$= \tan^{-1}\left\{\frac{\sqrt{1-e_n^2}\,\sin E_k \,/\, (1-e_n \cos E_k)}{(\cos E_k - e_n)/(1-e_n \cos E_k)}\right\}$	
$E_k = \cos^{-1}\left\{\frac{e_n + \cos \nu_k}{1+e_n \cos \nu_k}\right\}$	Eccentric Anomaly

* A_{REF} = 26,559,710 meters

** **t** is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total difference between the time **t** and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.

Redlines :

Table 3.5-2

Element/Equation	Description
μ = 3.986005 x 10^{14} meters^3/sec^2	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e$ = 7.2921151467 x 10^{-5} rad/sec	WGS 84 value of the earth's rotation rate
$A_0 = A_{REF} + \Delta A$ *	Semi-Major Axis at reference time
$A_k = A_0 + (\dot{A})\, t_k$	Semi-Major Axis
$n_0 = \sqrt{\frac{\mu}{A_0^3}}$	Computed Mean Motion (rad/sec)
$t_k = t - t_{oe}$ **	Time from ephemeris reference time
$\Delta n_A = \Delta n_0 + ½\, \Delta\dot{n}_0\, t_k$	Mean motion difference from computed value
$n_A = n_0 + \Delta n_A$	Corrected Mean Motion
$M_k = M_0 + n_A\, t_k$	Mean Anomaly
~~$M_k = E_k - e_n \sin E_k$~~	~~Kepler's equation for Eccentric Anomaly (radians) (may be solved by iteration)~~
	Kepler's equation ($M_k = E_k - e \sin E_k$) solved for Eccentric anomaly (E_k) by iteration:
$E_0 = M_k$	– Initial Value (radians)
$E_j = E_{j-1} + \frac{M_k - E_{j-1} + e \sin E_{j-1}}{1 - e \cos E_{j-1}}$	– Refined Value, three iterations, (j=1,2,3)
$E_k = E_3$	– Final Value (radians)
~~$\nu_k = \tan^{-1}\left\{\frac{\sin \nu_k}{\cos \nu_k}\right\}$~~	~~True Anomaly~~
~~$= \tan^{-1}\left\{\frac{\sqrt{1-e_n^2}\sin E_k/(1-e_n \cos E_k)}{(\cos E_k - e_n)/(1-e_n \cos E_k)}\right\}$~~	
$\nu_k = 2\tan^{-1}\left(\sqrt{\frac{1+e}{1-e}}\tan\frac{E_k}{2}\right)$	True Anomaly (unambiguous quadrant)
~~$E_k = \cos^{-1}\left\{\frac{e_n + \cos \nu_k}{1 + e_n \cos \nu_k}\right\}$~~	~~Eccentric Anomaly~~

* A_{REF} = 26,559,710 meters ** **t** is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total difference between the time **t** and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.

IS :

Table 3.5-2

Element/Equation	Description
μ = 3.986005 x 10^{14} meters^3/sec^2	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e$ = 7.2921151467 x 10^{-5} rad/sec	WGS 84 value of the earth's rotation rate
$A_0 = A_{REF} + \Delta A$ *	Semi-Major Axis at reference time
$A_k = A_0 + (\dot{A})\, t_k$	Semi-Major Axis
$n_0 = \sqrt{\dfrac{\mu}{A_0^3}}$	Computed Mean Motion (rad/sec)
$t_k = t - t_{oe}$ **	Time from ephemeris reference time
$\Delta n_A = \Delta n_0 + ½ \Delta\dot{n}_0\, t_k$	Mean motion difference from computed value
$n_A = n_0 + \Delta n_A$	Corrected Mean Motion
$M_k = M_0 + n_A\, t_k$	Mean Anomaly
	Kepler's equation ($M_k = E_k - e \sin E_k$) solved for Eccentric anomaly (E_k) by iteration:
$E_0 = M_k$	– Initial Value (radians)
$E_j = E_{j-1} + \dfrac{M_k - E_{j-1} + e \sin E_{j-1}}{1 - e \cos E_{j-1}}$	– Refined Value, three iterations, (j=1,2,3)
$E_k = E_3$	– Final Value (radians)
$\nu_k = 2 \tan^{-1}\left(\sqrt{\dfrac{1+e}{1-e}} \tan \dfrac{E_k}{2}\right)$	True Anomaly (unambiguous quadrant)

* A_{REF} = 26,559,710 meters ** **t** is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total difference between the time **t** and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.

IS800-949 :

Section Number :
3.5.3.6.1.1-4

WAS :
Table 3.5-2. Elements of Coordinate System (part 2 of 2)

Redlines :
Table 3.5-2. ~~Elements of~~Broadcast ~~Coordinate~~Navigation ~~System~~User Equations (~~part~~sheet 2 of ~~2~~4)

IS :
Table 3.5-2. Broadcast Navigation User Equations (sheet 2 of 4)

IS800-1009 :
Insertion after object IS800-182

Table 3.5-2. Part 2

Element/Equation	Description
$\Phi_k = \nu_k + \omega_n$	Argument of Latitude
$\delta u_k = C_{us-n}\sin 2\Phi_k + C_{uc-n}\cos 2\Phi_k$	Argument of Latitude Correction (Second Harmonic Perturbations)
$\delta r_k = C_{rs-n}\sin 2\Phi_k + C_{rc-n}\cos 2\Phi_k$	Radial Correction (Second Harmonic Perturbations)
$\delta i_k = C_{is-n}\sin 2\Phi_k + C_{ic-n}\cos 2\Phi_k$	Inclination Correction (Second Harmonic Perturbations)
$u_k = \Phi_k + \delta u_k$	Corrected Argument of Latitude
$r_k = A_k(1 - e_n \cos E_k) + \delta r_k$	Corrected Radius
$i_k = i_{o-n} + (i_{o-n}\text{-DOT})t_k + \delta i_k$	Corrected Inclination
$x_k' = r_k \cos u_k$ $y_k' = r_k \sin u_k$	Positions in orbital plane
$\dot{\Omega} = \dot{\Omega}_{REF} + ?\dot{\Omega}$ ***	Rate of Right Ascension
$\Omega_k = \Omega_{0-n} + (\dot{\Omega} - \dot{\Omega}_e)\, t_k - \dot{\Omega}_e t_{oe}$	Corrected Longitude of Ascending Node
$x_k = x_k' \cos \Omega_k - y_k' \cos i_k \sin \Omega_k$ $y_k = x_k' \sin \Omega_k + y_k' \cos i_k \cos \Omega_k$ $z_k = y_k' \sin i_k$	Earth-fixed coordinates of SV antenna phase center
*** $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ semi-circles/second.	

Section Number :
3.5.3.6.1.1-6

WAS :
N/A

Redlines :
<INSERTED OBJECT>

IS :
Broadcast Navigation User Equations (sheet 3 of 4)

IS800-1011 :
Insertion after object IS800-1009 (See Previous)

Section Number :
3.5.3.6.1.1-7

WAS :
N/A

Redlines :
<INSERTED OBJECT>

IS :
Table 3.5-2. 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)

IS800-1008 :
Insertion after object IS800-1011 (See Previous)

Section Number :
3.5.3.6.1.1-8

WAS :
N/A

Redlines :
<INSERTED OBJECT>

IS :
Table 3.5-2. Broadcast Navigation User Equations (sheet 4 of 4)

IS800-1010 :
Insertion after object IS800-1008 (See Previous)

Section Number :
3.5.3.6.1.1-9

WAS :
N/A

Redlines :
<INSERTED OBJECT>

IS :
Table 3.5-2. Part 4

Element/Equation	Description
SV Acceleration	
R_E = 6378137.0 meters	WGS 84 Earth Equatorial Radius
J_2 = 0.0010826262	Oblate Earth Gravity Coefficient
$F = -(3/2)\, J_2\, (\mu / r_k^2)\, (R_E / r_k)^2$	Oblate Earth acceleration Factor
$\ddot{x}_k = -\mu\, (x_k / r_k^3) + F\, [(1 - 5\, (z_k / r_k)^2)(x_k / r_k)] + 2\dot{y}_k\dot{\Omega}_e + x_k\dot{\Omega}_e^2$	Earth- Fixed *x* acceleration (m/s^2)
$\ddot{y}_k = -\mu\, (y_k / r_k^3) + F\, [(1 - 5\, (z_k / r_k)^2)(y_k / r_k)] - 2\dot{x}_k\dot{\Omega}_e + y_k\dot{\Omega}_e^2$	Earth- Fixed *y* Acceleration (m/s^2)
$\ddot{z}_k = -\mu\, (z_k / r_k^3) + F\, [(3 - 5\, (z_k / r_k)^2)(z_k / r_k)]$	Earth- Fixed *z* Acceleration (m/s^2)

IS800-902 :

Section Number :
6.3.3.0-1

WAS :
As an aid to user equipment receiver designers, a plot is provided (Figure 6-1) of a typical GPS III phase noise spectral density for the un-modulated L1C carrier.

Redlines :
As an aid to user equipment receiver designers, a plot is provided (Figure 6-1) of a typical GPS III and GPS IIIF phase noise spectral density for the un-modulated L1C carrier.

IS :
As an aid to user equipment receiver designers, a plot is provided (Figure 6-1) of a typical GPS III and GPS IIIF phase noise spectral density for the un-modulated L1C carrier.

IS800-1007 :

Section Number :
6.3.3.0-1.0-2

WAS :
Figure 6-1 Typical GPS III L1C Carrier Phase Noise Spectral Density

Redlines :
Figure 6-1 Typical GPS III and GPS IIIF L1C Carrier Phase Noise Spectral Density

IS :
Figure 6-1 Typical GPS III and GPS IIIF L1C Carrier Phase Noise Spectral Density

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