Global Positioning Systems (GPS) Public Interface Control Working Group and Public Forum

9-10 December 2015
0830 – 1630 hrs PST

United States Air Force GPS Directorate
Telecon: (877) 249 – 2489 Conference Code: 8069960874
DCS Website: https://conference.apps.mil/webconf/2015PICWG

Agenda – Day 1 (Public ICWG)

0830	Opening Remarks
0845	Roll Call
0900	Meeting Logistics
0910	Meeting Purpose
0930	Coordinated Universal Time Offset Error Disconnects (RFC 266)
1000	Break
1015	Incorrect CNAV-2 Message Structure Reference for $IAURA_{NED}$ Parameters (RFC 268)
1045	Incorrect P-Code Phase Assignments (RFC 269)
1130	Lunch
1300	Data Message Validation Parameters and Clarifications (RFC 288)
1500	Break
1515	L5 & L1C Phase Noise Plot (RFC 267)
1600	Action Item Review
1630	Adjourn

Agenda – Day 2 (Public Forum)

0830	Reconvene
0835	Roll Call
0845	Review of 2014 Public Forum Topics
0915	Time of Clock Clarification
1000	Break
1015	Probability of Satellite & Constellation Fault
1045	GPS **Off**line Integrity Support Message (ISM)
1115	GPS **On**line Integrity Support Message (ISM)
1145	Lunch
1330	GPS Satellite Outage File in Control Segment Output Products
1400	Open Discussion
1545	Break
1600	Action Item Review
1630	Adjourn

Opening Remarks

James Horejsi

Chief Engineer, Global Positioning Systems (GPS) Directorate Space and Missile Systems Center

Roll Call

GPS Requirements Team

Air Force

James Horejsi, GPS Chief Engineer

Daniel Godwin, GPS Requirements Section Chief

Capt Robyn Anderson, User/Ground Requirements Engineer

Capt Jenny Ji, Space/Enterprise Requirements Engineer

Bruce Charest, Section Support Engineer

Aerospace

Karl Kovach

Rhonda Slattery

SE&I

Pauline Bennett

Omar Menjivar

Huey Nguyenhuu

Barbara Hemmerich

Randy Grossman

Meeting Logistics

- Parking
- Restrooms
- Emergency Exits
- Refreshments
- Lunch
- Wi-Fi
- Additional Meeting Space
- Forms

Rules of Engagement

UNCLASSIFIED

ABSOLUTELY NO PROPRIETARY, CLASSIFIED, OR COMPETITION SENSITIVE INFORMATION IS TO BE DISCUSSED DURING THIS MEETING.

Rules of Engagement

- Please place your phones on mute when not speaking to minimize background noise
- Comments against the topics listed on the official agenda will get priority during discussion
- Topics that warrant additional discussion may be side-barred
- Ad-hoc topics may be discussed during the open discussion on 10 Dec 15
- Meeting minutes and final IRNs will be generated and distributed as a product of this meeting
- Please announce your name and organization before addressing the group

Meeting Purpose

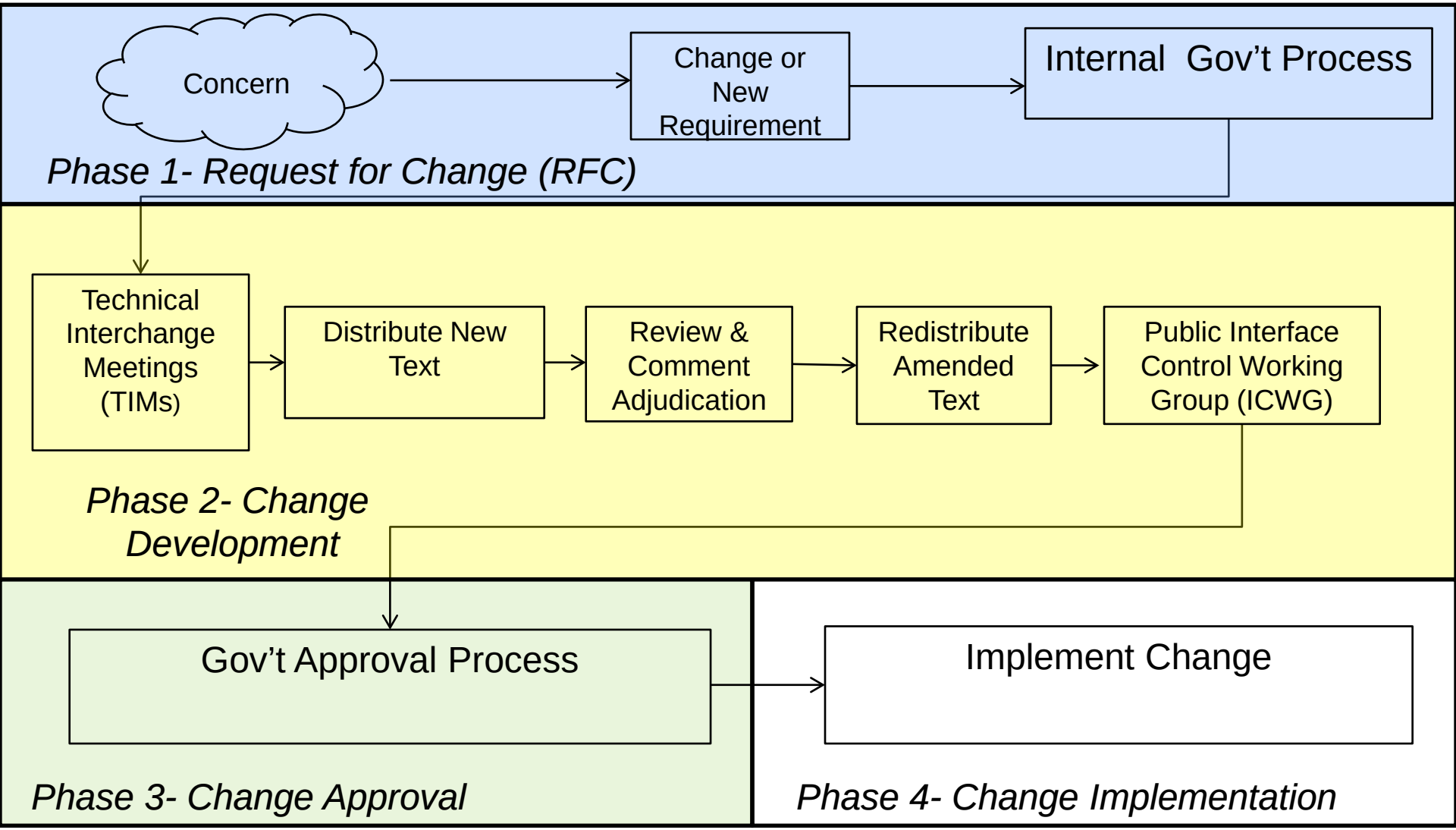
- The purpose of the meeting is to:

1) Obtain ICWG approval on the proposed language generated for the enterprise RFCs that may impact the public documents

2) Discuss any new open forum items against the Public Signals in Space documents

Comments received will be vetted per the standard change management process

Change Management High Level Process Flow



2015 PUBLIC INTERFACE CONTROL WORKING GROUP

COORDINATED UNIVERSAL TIME OFFSET ERROR (UTCOE) DISCONNECTS

B. Charest
O. Menjivar

UTCOE Disconnects

Problem Statement:
The current Signal-in-Space Coordinated Universal Time Offset Error (UTCOE) values are inconsistent across the Signal-in-Space documents and have not been updated to reflect either GPS III specifications or current as-built capabilities. The 90ns (1 sigma) UTCOE in IS-GPS-200 falls well below actual system performance and contradicts current technical documents such as system performance standards and current legacy and modernized military user equipment specifications. The current UTCOE spec may cause receivers to operate outside of their current requirements.
Proposed Solution:
Revise UTCOE in IS-GPS-200 to be consistent with current technical documents.
Impacted Documents:
IS-GPS-200

CRM Status

CRM – COMBINED STAKEHOLDER/DIRECTORATE REVIEW STATUS						
Disposition/Type	**Critical**	**Substantial**	**Administrative**	**Totals**	**Concurrence**	**Notes**
Accept	**00**	**00**	**01**	**01**	**00**	
Accept with Change	**00**	**00**	**00**	**00**	**00**	
Reject	**00**	**00**	**00**	**00**	**00**	
Grand Totals:	**00**	**00**	**01**	**01**	**00**	

Comments

Comment Originator(s)	Raytheon
Resolution	Discuss
Impacted Docs	IS-GPS-705; IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
Split the object in 3.3.4 into two different objects (i.e., requirements and information-only) in SE&I DOORS	The NAV data contains the requisite data for relating GPS time to UTC. The accuracy of this data during the transmission interval shall be such that it relates GPS time (maintained by the MCS of the CS) to UTC (USNO) within 20 nanoseconds (one sigma). This data is generated by the CS; therefore, the accuracy of this relationship may degrade if for some reason the CS is unable to upload data to a SV. At this point, it is assumed that alternate sources of UTC are no longer available, and the relative accuracy of the GPS/UTC relationship will be sufficient for users. Range error components (e.g. SV clock and position) contribute to the GPS time transfer error, and under normal operating circumstances (two frequency time transfers from SV(s) whose navigation message indicates a URA of eight meters or less), this corresponds to a 28 nanosecond (one sigma) apparent uncertainty at the SV. Propagation delay errors and receiver equipment biases unique to the user add to this time transfer uncertainty.	OBJECT 1: The NAV data contains the requisite data for relating GPS time to UTC. The accuracy of this data during the transmission interval shall be such that it relates GPS time (maintained by the MCS of the CS) to UTC (USNO) within 20 nanoseconds (one sigma). OBJECT 2: This data is generated by the CS; therefore, the accuracy of this relationship may degrade if for some reason the CS is unable to upload data to a SV. At this point, it is assumed that alternate sources of UTC are no longer available, and the relative accuracy of the GPS/UTC relationship will be sufficient for users. Range error components (e.g. SV clock and position) contribute to the GPS time transfer error, and under normal operating circumstances (two frequency time transfers from SV(s) whose navigation message indicates a URA of eight meters or less), this corresponds to a 28 nanosecond (one sigma) apparent uncertainty at the SV. Propagation delay errors and receiver equipment biases unique to the user add to this time transfer uncertainty.	Discuss

BREAK

INCORRECT CNAV-2 MESSAGE STRUCTURE REFERENCE FOR IAURA$_{NED}$ PARAMETERS

B. Charest
H. Nguyenhuu

Incorrect CNAV-2 Message Structure Reference for $IAURA_{NED}$ Parameters

Problem Statement:
The parameters used to calculate $IAURA_{NED}$ from the CNAV-2 message incorrectly reference "Message Type 10" in IS-GPS-800. CNAV-2 utilizes the Frame/Subframe architecture, and the parameters needed to calculate $IAURA_{NED}$ are located in "Subframe 2", not "Message Type 10".
Proposed Solution:
Replace "Message Type 10" with "Subframe 2" (one instance) in affected sentence in paragraph 3.5.3.8 of IS-GPS-800.
Impacted Documents:
IS-GPS-800D, NAVSTAR GPS Space Segment/User Segment L1C Interface

NED - Non Elevation Dependent
URA - User Range Accuracy

CRM Status

CRM – COMBINED STAKEHOLDER/DIRECTORATE REVIEW STATUS						
Disposition/Type	**Critical**	**Substantial**	**Administrative**	**Totals**	**Concurrence**	**Notes**
Accept	**00**	**02**	**00**	**02**	**01**	
Accept with Change	**00**	**00**	**00**	**00**	**00**	
Reject	**00**	**00**	**00**	**00**	**00**	
Grand Totals:	**00**	**02**	**00**	**02**	**01**	

Comments

Comment Originator(s)	Lockheed Martin
Resolution	Discuss
Impacted Docs	IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
Ensure all deleted headings and figures are “reserved” so as not to mess up order	N/A	N/A	Not applicable to this document

Comments

Comment Originator(s)	Lockheed Martin
Resolution	Discuss
Impacted Docs	IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
Correct who is deriving the URA for L1C CNAV2	The CS shall derive URANED0, URANED1, and URANED2 indexes which, when used together in the above equations, results in the minimum IAURANED that is greater than the predicted IAURANED during the clock/ephemeris fit interval.	The ~~CS~~ SV shall derive URANED0, URANED1, and URANED2 indexes which, when used together in the above equations, results in the minimum IAURANED that is greater than the predicted IAURANED during the clock/ephemeris fit interval.	Concur

INCORRECT P-CODE PHASE ASSIGNMENTS

B. Charest
B. Hemmerich

Incorrect P-Code Phase Assignments

Problem Statement:
The P-Code algorithm, as described in IS-GPS-200H, does not produce the same First 12 Octal Chips for some PRNs (IDs 64+) listed in Table 6-I.
Proposed Solution:
Correct First 12 Octal Chips for P-code in Table 6-I
Impacted Documents:
IS-GPS-200H

CRM Status

CRM – COMBINED STAKEHOLDER/DIRECTORATE REVIEW STATUS						
Disposition/Type	**Critical**	**Substantial**	**Administrative**	**Totals**	**Concurrence**	**Notes**
Accept	**00**	**00**	**01**	**01**	**00**	
Accept with Change	**00**	**00**	**00**	**00**	**00**	
Reject	**00**	**00**	**00**	**00**	**00**	
Grand Totals:	**00**	**00**	**01**	**01**	**00**	

Comments

Comment Originator(s)	Lockheed Martin
Resolution	Discuss
Impacted Docs	IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
Ensure all deleted headings and figures are “reserved” so as not to mess up order	N/A	N/A	Not applicable to this document

LUNCH

DATA MESSAGE VALIDATION PARAMETERS AND CLARIFICATIONS

R. Anderson
R. Grossman

Data Message Validation and Clarification

Problem Statement:
Some data items within IS-200 do not have either a valid range or their entire bit allocation defined.
Proposed Solution:
Define valid ranges and bit allocations for several data items within IS-200.
Impacted Documents:
IS-GPS-200

CRM Status

CRM – COMBINED STAKEHOLDER/DIRECTORATE REVIEW STATUS						
Disposition/Type	**Critical**	**Substantial**	**Administrative**	**Totals**	**Concurrence**	**Notes**
Accept	**01**	**14**	**00**	**15**	**15**	
Accept with Change	**00**	**00**	**00**	**00**	**00**	
Reject	**00**	**00**	**00**	**00**	**00**	
Grand Totals:	**01**	**14**	**00**	**15**	**15**	

Comments

Comment Originator(s)	Aerospace; Rockwell Collins; GPN
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
With the introduction of a range of values that is less than the maximum attainable from the bit allocation and scale factor, it would be beneficial to indicate both the minimum and maximum value.	See next chart	See next chart	A complete range of values is more clear and will be added to every parameter within LNAV and CNAV that does not define its range of values as the maximum attainable from the bit allocation and scale factor.

Comments

Table 20-I. Subframe 1 Parameters				
Parameter	No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
Code on L2	2	1		discretes
Week No.	10	1		week
L2 P data flag	1	1		discrete
SV accuracy	4			(see text)
SV health	6	1		discretes
T_{GD}	8*	2^{-31}		seconds
IODC	10			(see text)
t_{oc}	16	2^{4}	0 to 604,784	seconds
a_{f2}	8*	2^{-55}		sec/sec^2
a_{f1}	16*	2^{-43}		sec/sec
a_{f0}	22*	2^{-31}		seconds

* Parameters so indicated shall be two's complement, with the sign bit (+ or -) occupying the MSB;

** See Figure 20-1 for complete bit allocation in subframe;

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

Comments

Comment Originator(s)	Rockwell Collins
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
Notes 3 in Tables 20-V and 40-V are not identical. It seems that they should be, as it implies that GPS III SVs may vary SV ID for some subframe 4 pages transmitted by the lower set of PRN numbers (LNAV-L data), but may not vary the SV ID for those same subframe 4 pages transmitted by the upper set of PRN numbers (LNAV-U data).	Table 20-V Note 3: SV ID may vary (except for IIR/IIR-M/IIF) Table 40-V Note 3: SV ID may vary (except for IIR/IIR-M/IIF)	Table 20-V Note 3: SV ID may vary (except for IIR/IIR-M/IIF / and GPS III SVs) Table 40-V Note 3: SV ID may vary (except for IIR/IIR-M/IIF / and GPS III SVs)	These notes should be the same for GPSIII SVs.

Comments

Comment Originator(s)	Rockwell Collins
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
Table 30-III is missing top, Data Predict time of week parameter.	See next chart	See next chart	It is appropriate to add this parameter to Table 30-III because it is relevant to Clock Correction and Accuracy.

Comments

Table 30-III. Clock Correction and Accuracy Parameters					
Parameter		No. of Bits**	Scale Factor (LSB)	~~Effective~~ Valid Range***	Units
t_{op}	Data Predict Time of Week	11	300	0 to 604,500	seconds
t_{oc}	Clock Data Reference Time of Week	11	300	0 to 604,500	seconds
URA_{NED0} Index	NED Accuracy Index	5*			(see text)
URA_{NED1} Index	NED Accuracy Change Index	3			(see text)
URA_{NED2} Index	NED Accuracy Change Rate Index	3			(see text)
a_{f2-n}	SV Clock Drift Rate Correction Coefficient	10*	2^{-60}		sec/sec^2
a_{f1-n}	SV Clock Drift Correction Coefficient	20*	2^{-48}		sec/sec
a_{f0-n}	SV Clock Bias Correction Coefficient	26*	2^{-35}		seconds

* Parameters so indicated are two's complement, with the sign bit (+ or -) occupying the MSB;

** See Figure 30-3 through 30-10 for complete bit allocation in Message types 30 to 37;

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

Comments

Comment Originator(s)	Rockwell Collins
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
In Table 30-VII, the polar motion and UT1 parameters are all 2's complement values, with valid range being maximum range attainable with bit allocation and scale factor. Explicit valid ranges do not need to be provided.	See next chart	See next chart	Removing these values will make the table consistent with the other parameter tables within the document.

Comments

Table 30-VII. Earth Orientation Parameters					
Parameter		No. of Bits**	Scale Factor (LSB)	~~Effective~~ Valid Range***	Units
t_{EOP}	EOP Data Reference Time	16	2^{4}	~~604,784~~	seconds
PM_X †	X-Axis Polar Motion Value at Reference Time.	21*	2^{-20}	~~1~~	arc-seconds
$\dot{PM}$_X	X-Axis Polar Motion Drift at Reference Time.	15*	2^{-21}	~~7.8125 x 10-3~~	arc-seconds/day
PM_Y ††	Y-Axis Polar Motion Value at Reference Time.	21*	2^{-20}	~~1~~	arc-seconds
$\dot{PM}$_Y	Y-Axis Polar Motion Drift at Reference Time.	15*	2^{-21}	~~7.8125 x 10-3~~	arc-seconds/day
ΔUT1 †††	UT1-UTC Difference at Reference Time.	31*	2^{-24}	~~64~~	seconds
$\dot{\Delta UT1}$ †††	Rate of UT1-UTC Difference at Reference Time	19*	2^{-25}	~~7.8125 x 10-3~~	seconds/day

* Parameters so indicated are two's complement, with the sign bit (+ or -) occupying the MSB;

** See Figure 30-5 for complete bit allocation in Message type 32;

*** Unless otherwise indicated in this column, ~~effective~~ 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.

Comments

Comment Originator(s)	Aerospace; GPA
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
Define the term “Invalid”. You have used it in these changes and have defined “Valid Range” and “Reserved”.	N/A	6.2.8 Invalid Invalid refers to a value that is within a data field’s bit allocation and scale factor, but is outside the valid range and which GPS has no intention of functionally defining.	The term invalid is used in this change package to refer to values that are not intended for use by GPS.

Comments

Comment Originator(s)	Aerospace
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
The Table 30-VI still uses “Effective Range”. Update this to “Valid Range” as was done for the other tables.	See next chart	See next chart	The term “Valid” has replaced “Effective” when describing a range of values and should be done so consistently.

Comments

Table 30-VI. Reduced Almanac Parameters *****				
Parameter	No. of Bits	Scale Factor (LSB)	~~Effective~~ Valid Range **	Units
δ_A ****	8 *	2^{+9}	**	meters
Ω_0	7 *	2^{-6}	**	semi-circles
Φ_0 ****	7 *	2^{-6}	**	semi-circles

* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;

** ~~Effective~~ Valid range is the maximum range attainable with indicated bit allocation and scale factor;

*** Relative to A_{ref} = 26,559,710 meters;

**** Φ_0 = Argument of Latitude at Reference Time = $M_0 + \omega$;

***** Relative to following reference values:

e = 0

δ_i = +0.0056 semi-circles (i = 55 degrees)

Ω = -2.6 x 10^{-9} semi-circles/second.

Comments

Comment Originator(s)	Aerospace
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
In section 20.3.3.5.1.9 and 40.3.3.5.1.9 change “Effective Range” to “Valid Range”.	20.3.3.5.1.9 NMCT Each ERD value contained in an NMCT ERD slot shall be represented as a six-bit two’s complement field with the sign bit occupying the MSB and an LSB of 0.3 meters for an effective range of ±9.3 m. 40.3.3.5.1.9 NMCT Each ERD value contained in an NMCT ERD slot shall be represented as a six-bit two’s complement field with the sign bit occupying the MSB and an LSB of 0.3 meters for an effective range of ±9.3 m	20.3.3.5.1.9 NMCT Each ERD value contained in an NMCT ERD slot shall be represented as a six-bit two’s complement field with the sign bit occupying the MSB and an LSB of 0.3 meters for an ~~effective~~ valid range of ±9.3 m. 40.3.3.5.1.9 NMCT Each ERD value contained in an NMCT ERD slot shall be represented as a six-bit two’s complement field with the sign bit occupying the MSB and an LSB of 0.3 meters for an ~~effective~~ valid range of ±9.3 m.	The term “Valid” has replaced “Effective” when describing a range of values and should be done so consistently.

Comments

Comment Originator(s)	GPSIII, Rockwell Collins, Aerospace
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
When limiting orbital parameters such as in Table 20-III, 20-VI, 30-I (2 of 2), and 30-V, if this is only intended for PRN IDs 1-63, please update the text to reflect that.	N/A	6.2.7 Valid Range Valid Range identifies the range of values used by GPS. The Valid Range is only for PRNs 1-63.	These valid value ranges are only relevant for PRNs 1-63. The definition of “Valid Range” will be updated to indicate such.

Comments

Comment Originator(s)	GPA
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
A reserved value (1 value of a defined bit) should also be added to the definition of Reserved.	N/A	6.2.6 Reserved Data Reserved bits (or a single reserved value within a defined bit) are intended for future or other use and their values may change throughout the life of the system. In order to preserve future use of a reserved value within a defined bit, the user segment should handle those values as described for each applicable field.	Both reserved bits and reserved values within defined bits should be uniquely indicated.

Comments

Comment Originator(s)	GPA
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
The values for AS Flags and SV Config should be updated to reflect what to do with reserved values within an unreserved bit.	Code SV Configuration 000 Reserved 001 A-S capability, plus flags for A-S and "alert" in HOW; memory capacity as described in paragraph 20.3.2 (e.g. Block II/Block IIA/IIR SV). 010 A-S capability, plus flags for A-S and "alert" in HOW; memory capacity as described in paragraph 20.3.2, M-Code signal capability, L2C signal capability (e.g., Block IIR-M SV). 011 A-S capability, plus flags for A-S and "alert" in HOW; memory capacity as described in paragraph 20.3.2, M-Code capability, L2C signal capability, L5 signal capability (e.g., Block IIF SV). 100 A-S capability, plus flags for A-S and "alert" in HOW; memory capacity as described in paragraph 20.3.2, M-Code capability, L1C signal capability, L2C signal capability, L5 signal capability, no SA capability (e.g., GPS III SVs). Additional codes will be assigned in the future, should the need arise.	Code SV Configuration 000 Reserved in order to preserve future use of these values in a future revision of this IS. Until such a revision, the user segment developing to this version of this IS should interpret these values as indicating that no information in this data field is presently usable as a means to identify the actual SV configuration. 001 A-S capability, plus flags for A-S and "alert" in HOW; memory capacity as described in paragraph 20.3.2 (e.g. Block II/Block IIA/IIR SV). 010 A-S capability, plus flags for A-S and "alert" in HOW; memory capacity as described in paragraph 20.3.2, M-Code signal capability, L2C signal capability (e.g., Block IIR-M SV). 011 A-S capability, plus flags for A-S and "alert" in HOW; memory capacity as described in paragraph 20.3.2, M-Code capability, L2C signal capability, L5 signal capability (e.g., Block IIF SV). 100 A-S capability, plus flags for A-S and "alert" in HOW; memory capacity as described in paragraph 20.3.2, M-Code capability, L1C signal capability, L2C signal capability, L5 signal capability, no SA capability (e.g., GPS III SVs). 101, 110, 111 Reserved in order to preserve future use of these values in a future revision of this IS. Until such a revision, the user segment developing to this version of this IS should interpret these values as indicating that no information in this data field is presently usable as a means to identify the actual SV configuration.	Reserved bits and reserved values within unreserved bits should be defined.

Comments

Comment Originator(s)	GPA
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
The values for the NMCT Table in 20.3.3.5.1.1 should be updated to reflect what to do with reserved values within a defined bit.	See next chart	See next chart	Both reserved bits and reserved values within defined bits should be uniquely indicated.

Comments

AI	Navigation Message Correction Table Availability
00	The correction table is unencrypted and is available to both precise positioning service users and standard positioning service users.
01	The correction table is encrypted and is available only to authorized users (normal mode).
10	No correction table available for either precise positioning service users or standard positioning service users.
11	~~Reserved.~~ Reserved in order to preserve future use of these values in a future revision of this IS. Until such a revision, the user segment developing to this version of this IS should interpret this value as indicating that no correction table is available for either precise positioning service users or standard positioning service users, i.e. until such a revision, the user segment developing to this version of this IS should interpret this value as functionally equivalent to an AI setting of 10.

Comments

Comment Originator(s)	GPA
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
The values for GPS/GNSS Time Offset Parameter in 30.3.3.8.1 should be updated to reflect what to do with reserved values within a defined bit.	**30.3.3.8.1 GPS/GNSS Offset Parameter Content** Message Type 35 provides SV clock correction parameters (ref. Section 30.3.3.2) and also, shall contain the parameters related to correlating GPS time with other GNSS time. Bits 157 through 159 of message type 35 shall identify the other GPS like navigation system to which the offset data applies. The three bits are defined as follows; 000 = no data available, 001 = Galileo, 010 = GLONASS, 011 through 111 = reserved for other systems.	**30.3.3.8.1 GPS/GNSS Offset Parameter Content** Message Type 35 provides SV clock correction parameters (ref. Section 30.3.3.2) and also, shall contain the parameters related to correlating GPS time with other GNSS time. Bits 157 through 159 of message type 35 shall identify the other GPS like navigation system to which the offset data applies. The three bits are defined as follows; 000 = no data available, 001 = Galileo, 010 = GLONASS, 011 through 111 = Reserved in order to preserve use of these values in a future revision of this IS. Until such a revision, the user segment developing to this version of this IS should interpret these values as indicating that the GPS/GNSS Time Offset Parameter data, to which the GNSS Type ID applies, is presently unusable.	Both reserved bits and reserved values within defined bits should be uniquely indicated.

Comments

Comment Originator(s)	Rockwell Collins
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	(PIRN) WAS	IS	GPS Directorate Response
As defined, the "Code(s) on L2 Channel" field in section 20.3.3.3.1.2 only clearly denotes the code modulated on the in-phase component of L2. IIR-M, IIF, and GPS III SVs also have either L2C or C/A in quadrature with P(Y) on L2. It is not clear how this field is set for these SVs. Please clarify.	**20.3.3.3.1.2 Code(s) on L2 Channel.** Bits 11 and 12 of word three shall indicate which code(s) is (are) commanded ON for the L2 channel, as follows: 00 = Invalid, 01 = P code ON, 10 = C/A code ON. 11= Invalid	**20.3.3.3.1.2 Code(s) on L2 Channel.** Bits 11 and 12 of word three shall indicate which code(s) is (are) commanded ON for the in-phase component of the L2 channel, as follows: 00 = Invalid, 01 = P code ON, 10 = C/A code ON. 11= Invalid These bits provide no indication of which code(s), if any, may be commanded ON for the quadrature component of the L2 channel.	Further defining the in-phase vs quadrature phase component of this field will add clarity.

Comments

Comment Originator(s)	Rockwell Collins
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
For IIR-M, IIF, and GPS III SVs, C/A may be modulated in quadrature on L2, with or without data. As this field is defined, it only applies to the presence of data on P(Y) modulated in-phase on L2. It is not clear how the user can determine if data is present on C/A, if C/A is modulated in quadrature on L2.	**20.3.3.3.1.6 Data Flag for L2 P-Code.** When bit 1 of word four is a "1", it shall indicate that the NAV data stream was commanded OFF on the P-code of the L2 channel.	**20.3.3.3.1.6 Data Flag for L2 P-Code.** When bit 1 of word four is a "1", it shall indicate that the NAV data stream was commanded OFF on the P-code of the in-phase component of the L2 channel. This bit provides no indication of whether NAV data is or is not present on any code modulated on the quadrature component of the L2 channel.	Further defining the in-phase vs quadrature phase component of this field will add clarity.

Comments

Comment Originator(s)	Lockheed Martin
Resolution	Accept
Impacted Docs	IS-GPS-200

Comment	WAS	IS	GPS Directorate Response
Constraining the "valid" range for orbital parameters beyond what is physically possible can greatly limit GPS.	See next chart	See next chart	The orbital parameters for Square root of the Semi-Major Axis, Rate of Right Ascension, Rate of Right Ascension Difference, and Inclination Angle at Reference Time defined in the PIRN will be redefined based on physical limits.

Comments

From PIRN-IS-200H-003

Table 20-III. Ephemeris Parameters

Parameter	No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
IODE	8			(see text)
C_{rs}	16*	2^{-5}		meters
Δn	16*	2^{-43}		semi-circles/sec
M_0	32*	2^{-31}		semi-circles
C_{uc}	16*	2^{-29}		radians
e	32	2^{-33}	0.0 to 0.03	dimensionless
C_{us}	16*	2^{-29}		radians
$\sqrt{A}$	32	2^{-19}	~~4906 to 5390~~ 2530 to 8192	$\sqrt{\text{meters}}$
t_{oe}	16	2^{4}	0 to 604,784	seconds
C_{ic}	16*	2^{-29}		radians
Ω_0	32*	2^{-31}		semi-circles
C_{is}	16*	2^{-29}		radians
i_0	32*	2^{-31}	~~0.237 to 0.363~~	semi-circles
C_{rc}	16*	2^{-5}		meters
ω	32*	2^{-31}		semi-circles
$\dot{\Omega}$	24*	2^{-43}	~~-5.20E-09 to 0.0~~ -6.33E-07 to 0.0	semi-circles/sec
IDOT	14*	2^{-43}		semi-circles/sec

* Parameters so indicated shall be two's complement, with the sign bit (+ or -) occupying the MSB;
** See Figure 20-1 for complete bit allocation in subframe;
*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.

Comments

From PIRN-IS-200H-003

Table 30-I. Message Types 10 and 11 Parameters (2 of 2)

Parameter		No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
t_{oe}	Ephemeris data reference time of week	11	300	0 to 604,500	seconds
$\Omega_{0\text{-}n}$	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	33*	2^{-32}		semi-circles
$\dot{\Delta\Omega}$****	Rate of right ascension difference	17*	2^{-44}	~~-2.60E-09 to 2.6E-09~~	semi-circles/sec
$i_{0\text{-}n}$	Inclination angle at reference time	33*	2^{-32}	~~0.237 to 0.363~~	semi-circles
$i_{0\text{-}n}$ –DOT	Rate of inclination angle	15*	2^{-44}		semi-circles/sec
$C_{is\text{-}n}$	Amplitude of the sine harmonic correction term to the angle of inclination	16*	2^{-30}		radians
$C_{ic\text{-}n}$	Amplitude of the cosine harmonic correction term to the angle of inclination	16*	2^{-30}		radians
$C_{rs\text{-}n}$	Amplitude of the sine correction term to the orbit radius	24*	2^{-8}		meters
$C_{rc\text{-}n}$	Amplitude of the cosine correction term to the orbit radius	24*	2^{-8}		meters
$C_{us\text{-}n}$	Amplitude of the sine harmonic correction term to the argument of latitude	21*	2^{-30}		radians
$C_{uc\text{-}n}$	Amplitude of the cosine harmonic correction term to the argument of latitude	21*	2^{-30}		radians

* Parameters so indicated are two's complement, with the sign bit (+ or -) occupying the MSB;

** See Figure 30-1 and Figure 30-2 for complete bit allocation in Message Types 10 and 11;

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

**** Relative to $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ semi-circles/second.

BREAK

L5 AND L1C PHASE NOISE PLOT

B. Charest
O. Menjivar

L5 And L1C Phase Noise Plot

Problem Statement:
A plot of typical GPS III phase noise spectral density is currently TBD in IS-GPS-705 and IS-GPS-800. A plot of L5 IIF data is provided in IS-GPS-705. Since these are provided for user reference and do not drive design, they do not belong in interface specifications.
Proposed Solution:
Remove section 6.3.2 from IS-GPS-705 and associated reference in 3.3.1.3. Remove section 6.3.3 from IS-GPS-800. Move data to an application note TBD. This does not affect the phase noise spectral density requirement.
Impacted Documents:
IS-GPS-705 and IS-GPS-800

TBD - To Be Determined

CRM Status

CRM – COMBINED STAKEHOLDER/DIRECTORATE REVIEW STATUS						
Disposition/Type	**Critical**	**Substantial**	**Administrative**	**Totals**	**Concurrence**	**Notes**
Accept	**00**	**02**	**00**	**02**	**02**	
Accept with Change	**00**	**00**	**00**	**00**	**00**	
Reject	**00**	**00**	**00**	**00**	**00**	
Grand Totals:	**00**	**02**	**00**	**02**	**02**	

Comments

Comment Originator(s)	GPC
Resolution	Discuss
Impacted Docs	IS-GPS-705, IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
GPC non-concur. There are civil applications where some knowledge of SV phase noise is important.	IS705-47 : The phase noise spectral density of the un-modulated carrier shall be such that a phase locked loop of 10 Hz one-sided noise bandwidth shall be able to track the carrier to an accuracy of 0.1 radians root mean square (RMS). See additional supporting material for phase noise characteristics in section 6.3.2.	IS705-47 : The phase noise spectral density of the un-modulated carrier shall be such that a phase locked loop of 10 Hz one-sided noise bandwidth shall be able to track the carrier to an accuracy of 0.1 radians root mean square (RMS). ~~See additional supporting material for phase noise characteristics in section 6.3.2.~~	Discuss

Comments

Comment Originator(s)	GPC
Resolution	Discuss
Impacted Docs	IS-GPS-705, IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
GPC non-concur. There are civil applications where some knowledge of SV phase noise is important.	IS705-137 : Integrated Phase Noise Characteristics. CS Effectivity: N/A SS Effectivity: N/A	IS705-137 : <DELETED OBJECT>	Discuss

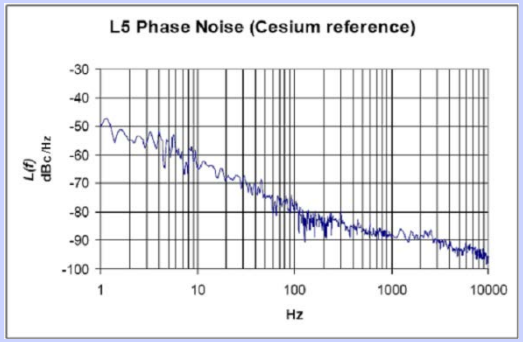
Comments

Comment Originator(s)	GPC
Resolution	Discuss
Impacted Docs	IS-GPS-705, IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
GPC non-concur. There are civil applications where some knowledge of SV phase noise is important.	IS705-138 : As an aid to user equipment receiver designers, a plot is provided (Figure 6-1) of a typical GPS Block IIF phase noise spectral density for the un-modulated L5 carrier. A plot of a typical GPS III phase noise spectral density will be added TBD. CS Effectivity: N/A SS Effectivity: N/A	IS705-138 : <DELETED OBJECT>	Discuss

Comments

Comment Originator(s)	GPC
Resolution	Discuss
Impacted Docs	IS-GPS-705, IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
GPC non-concur. There are civil applications where some knowledge of SV phase noise is important.	IS705-139 :  Figure 6-1. Carrier Phase Noise Spectral Density CS Effectivity: N/A SS Effectivity: N/A	IS705-139 : <DELETED OBJECT>	Discuss

Comments

Comment Originator(s)	GPC
Resolution	Discuss
Impacted Docs	IS-GPS-705, IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
GPC non-concur. There are civil applications where some knowledge of SV phase noise is important.	IS800-901 : Integrated Phase Noise Characteristics. CS Effectivity: N/A SS Effectivity: N/A	IS800-901 : <DELETED OBJECT>	Discuss

Comments

Comment Originator(s)	GPC
Resolution	Discuss
Impacted Docs	IS-GPS-705, IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
GPC non-concur. There are civil applications where some knowledge of SV phase noise is important.	IS800-902 : 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. CS Effectivity: N/A SS Effectivity: N/A	IS800-902 : <DELETED OBJECT>	Discuss

Comments

Comment Originator(s)	GPC
Resolution	Discuss
Impacted Docs	IS-GPS-705, IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
GPC non-concur. There are civil applications where some knowledge of SV phase noise is important.	IS800-903 : Reserved for L1C Phase Noise Plot Figure 6-1 Carrier Phase Noise Spectral Density CS Effectivity: N/A SS Effectivity: N/A	IS800-903 : <DELETED OBJECT>	Discuss

Comments

Comment Originator(s)	Lockheed Martin
Resolution	Discuss
Impacted Docs	IS-GPS-705, IS-GPS-800

Comment	WAS	IS	GPS Directorate Response
Ensure all deleted headings and figures are “reserved” so as not to mess up order	N/A	N/A	Concur

Action Item Review

Closing Comments

Thank You

The meeting will reconvene tomorrow at 0830 hrs PST.

Global Positioning Systems (GPS) Public Interface Control Working Group and Public Forum

9-10 December 2015
0830 – 1630 hrs PST

United States Air Force GPS Directorate
Telecon: (877) 249 – 2489 Conference Code: 8069960874
DCS Website: https://conference.apps.mil/webconf/2015PICWG

Rules of Engagement

UNCLASSIFIED

ABSOLUTELY NO PROPRIETARY, CLASSIFIED, OR COMPETITION SENSITIVE INFORMATION IS TO BE DISCUSSED DURING THIS MEETING.

Rules of Engagement

- Please place your phones on mute when not speaking to minimize background noise
- Comments against the topics listed on the official agenda will get priority during discussion, all others will be addressed during the open discussion
- Topics that warrant additional discussion may be side-barred
- Meeting minutes and final IRNs will be generated and distributed as a product of this meeting
- Please announce your name and organization before addressing the group

Meeting Purpose

- The purpose of the meeting is to:

1) Obtain ICWG approval on the proposed language generated for the enterprise RFCs that may impact the public documents

2) Discuss any new open forum items against the Public Signals in Space documents

Comments received will be vetted per the standard change management process

Agenda – Day 2 (Public Forum)

0830	Reconvene
0835	Roll Call
0845	Review of 2014 Public Forum Topics
0915	Time of Clock Clarification
1000	Break
1015	Probability of Satellite & Constellation Fault
1045	GPS **Off**line Integrity Support Message
1115	GPS **On**line Integrity Support Message
1145	Lunch
1330	GPS Satellite Outage File in Control Segment Output Products
1400	Open Discussion
1545	Break
1600	Action Item Review
1630	Adjourn

Roll Call

2015 PUBLIC FORUM

REVIEW OF 2014 PUBLIC FORUM TOPICS

P. BENNETT

2014 Open Forum Consolidated CRM

CRM – COMBINED STAKEHOLDER/DIRECTORATE REVIEW STATUS				
Disposition/Type	**Critical**	**Substantial**	**Administrative**	**Totals**
Accept	**06**	**15**	**39**	**60**
Accept with Change	**00**	**00**	**01**	**01**
Reject	**00**	**01**	**01**	**02**
Grand Totals:	**06**	**16**	**41**	**63**

2014 CRM

Microsoft Excel Worksheet

CLARIFICATION OF TIME OF CLOCK, EPHEMERIS

S. BROWN

Public IS errors

- **IS800 redlines required for IS800-1036 (LM DOORS Object ID)**
  - 3.5.5.2 Data Sets
    - ~~The t_{oe} shall be equal to the t_{oc} of the same CNAV data set.~~ The following rule~~s~~ governs the transmission of t_{oe} ~~and t_{oc} values~~ in different data sets: ~~(1)~~ The transmitted ~~t_{oc}~~ t_{oe} will be different from any value transmitted by the SV during the preceding seven days~~;~~ ~~(2) The transmitted t_{oe} will be different from any value transmitted by the SV during the preceding six hours~~.
- **Note that t_{oc} does not even exist at all in CNAV2**

Public IS errors

- **IS200 redlines required for IS200-1481 (LM DOORS Object ID)**
  - 30.3.4.4 Data Sets
    - The t_{oe} shall be equal to the t_{oc} of the same CNAV data set. The following rule~~s~~ governs the transmission of t_{oe} and t_{oc} values in different data sets: ~~(1)~~ The transmitted t_{oe} /t_{oc} will be different from any value transmitted by the SV during the preceding seven days~~; (2) The transmitted t_{oe} will be different from any value transmitted by the SV during the preceding six hours~~.
- **IS705 redlines required for IS705-463 (LM DOORS Object ID)**
  - 20.3.4.4 Data Sets
    - The following rule~~s~~ governs the transmission of t_{oe} and t_{oc} values in different data sets: ~~(1)~~ The transmitted t_{oe} /t_{oc} will be different from any value transmitted by the SV during the preceding seven days~~; (2) The transmitted t_{oe} will be different from any value transmitted by the SV during the preceding six hours~~.
- **Since $t_{oe} = t_{oc}$ the six hour rule is pointless and is just a copy error from LNAV**

BREAK

PROBABILITY OF SATELLITE & CONSTELLATION FAULT

K. KOVACH

Probability of Satellite Fault (P_{sat}) & Probability of Constellation Fault (P_{const})

Karl Kovach, SMC/GPE(Aero)
Calvin Miles, FAA

27 October 2015
US-EU WG-C, ARAIM TSG

Caveat

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GPS Positioning Signal Integrity and Continuity Assurance (PSICA) Team Study

- **Scope of effort**
  - *Quantify threats and estimate P_{sat} for GPS*
    - *Propose mitigations needed to achieve **$P_{sat} \leq$ 1e-5/hr***
  - *Quantify threats and estimate P_{const} for GPS*
    - *Propose mitigations needed to achieve **$P_{const} \leq$ 1e-8/hr***
  - *Consider P_{sat} & P_{const} for an Integrity Support Message (ISM)*
    - *Baseline concept is ISM as proposed by WG-C*

$P_{sat} \leq$ 1e-5/hr

- **Already an Official GPS Performance Commitment**
  - *Standard Positioning Service Performance Standard (SPS PS)*
  - *Precise Positioning Service Performance Standard (PPS PS)*
  - *No mitigations needed*
    - Satisfied with sufficient margin*
  - *Done* ✓

* PSICA Team needs to remain vigilant. Current analysis may not necessarily apply to future Control Segment evolution (e.g., concurrent uploads done routinely).

$P_{const} \leq$ 1e-8/hr

- **GPS PSICA Team has found very few threats**
  - *Slow pace of NAV data uploads very beneficial*
- **Current shortfall: $P_{const} \approx$ 1e-7/hr**
  - *Driven by one insufficiently mitigated fault chain*
- **Recommend inserting a fault detection check**
  - *Might be a minor change under AEP Sustainment Contract*
- **If check inserted, add $P_{const} \leq$ 1e-8/hr to SPS/PPS PSs**
  - *Become a GPS performance commitment*
  - *Baseline to be maintained in perpetuity*

Considering P_{sat} & P_{const} for ISM

- **Good idea for new ISM message in CNAV & MNAV**
  - *Easy enough to do*
  - *Implement P_{sat} & P_{const} as database parameters*
    - Precisely the same numbers specified in SPS/PPS PSs
      - *Won't change any more often than SPS/PPS PSs change*
      - *No additional risk – SPS/PPS PS performance commitments*
- **Recommend same approach for other GNSSs**
  - *P_{sat} & P_{const} cannot be externally substantiated by monitoring*
    - 1e-8/hr number would require 1e+9 hours monitoring (> 1e+5 years)
  - *Other GNSS to specify P_{sat} & P_{const} in their performance standards*
    - Use those numbers in our ISM broadcast

GPS OFFLINE ISM

ISM - Integrity Support Message

K. KOVACH

GPS – Offline ISM

Karl Kovach, SMC/GPE(Aero)

27 October 2015
US-EU WG-C, ARAIM TSG

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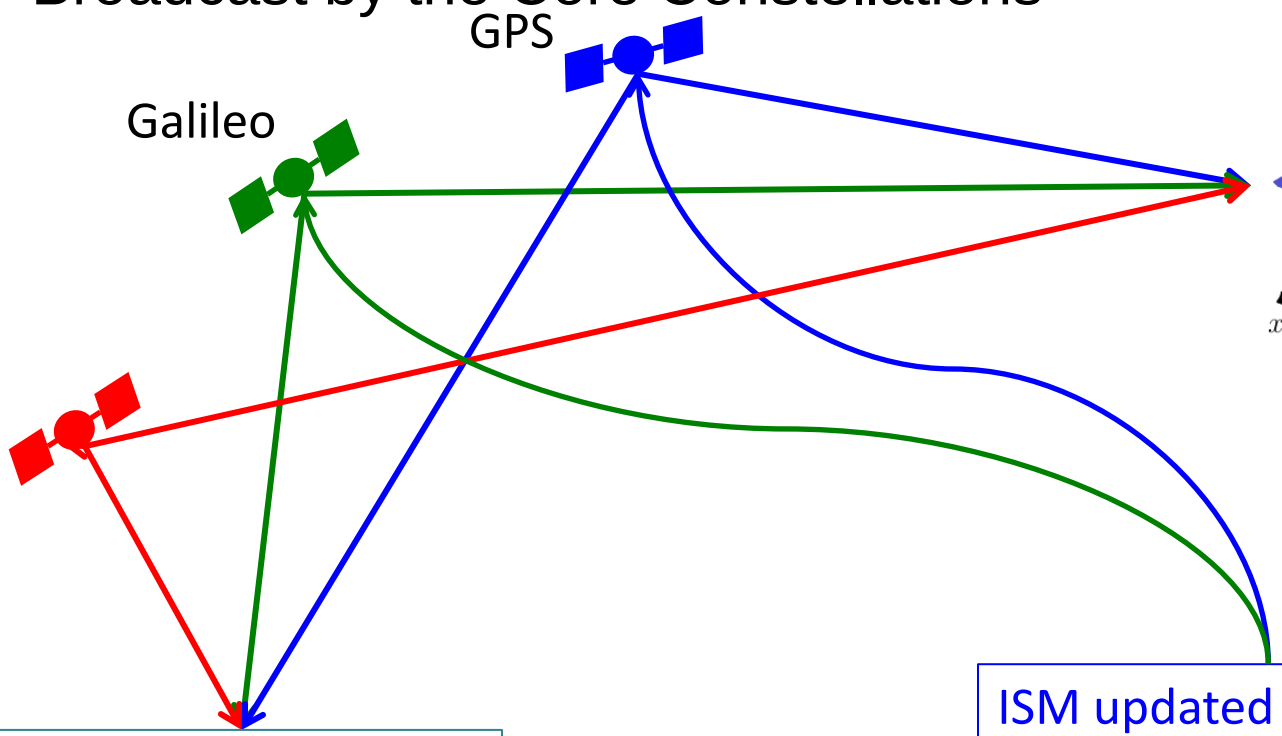
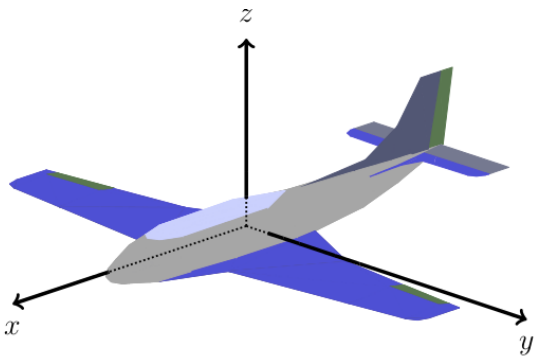
Offline ARAIM is Based on the Ephemeris & Clock Data (ECD) Broadcast by the Core Constellations





URA, P_{sat} & P_{const}
URA, P_{sat} & P_{const}
URA, P_{sat} & P_{const}

Reference Stations
- 100 to 300 globally
- SBAS reuse or
- Not dedicated
- e.g. NASA's GDGPS

→

Offline monitoring
URA < 1 m
$P_{const} < 10^{-8}$

→

ISM updated monthly:
- range accuracy
- P_{sat} & P_{const}
- provide ISM using databases or
- GNSS with 1 bps (15 min. TTFF)

Message for Offline (Galileo)

	Parameter	Description	Value	Size (bits)
Data Header	ISM_WN	ISM Week Number	[0, 1, … 1023]	10
	ISM_TOW	ISM Time of Week (hours)	[0, 1, … 167]	8
	ANSP ID	Service Provider Identification	[0, 1, … 255]	8
	Criticality	Usable for Precise/Vertical?	[0, 1]	1
	Total Header = 27 bits			
Per Constellation Parameters	$Mask_i$	32 bits indicating whether an SV is valid for ARAIM (1) or not (0)	$[m_1, m_2, \ldots m_{32}]$	32
	$P_{const,i}$	Probability of constellation fault at a given time	$[10^{-8}, 10^{-5}, 10^{-4}, 10^{-3}]$	2
	$P_{sat,j}$	Probability of satellite fault at a given time	$[10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}]$	2
	$\alpha_{URA,j}$	Multiplier of the URA for integrity	[1, 1.25, 1.5, 2, 2.5, 3, 5, 10]	3
	$\alpha_{URE,j}$	Multiplier of the URA for continuity & accuracy	[0.25, 0.5, 0.75, 1, 1.25, 1.5, 2, 4]	3
	$b_{nom,j}$	Nominal bias term in meters	[0.0:0.25: 2.5,, 3, 4, 5, 7.5, 10]	4
	Total Core = 46 bits x 4 Constellations = 184 bits			

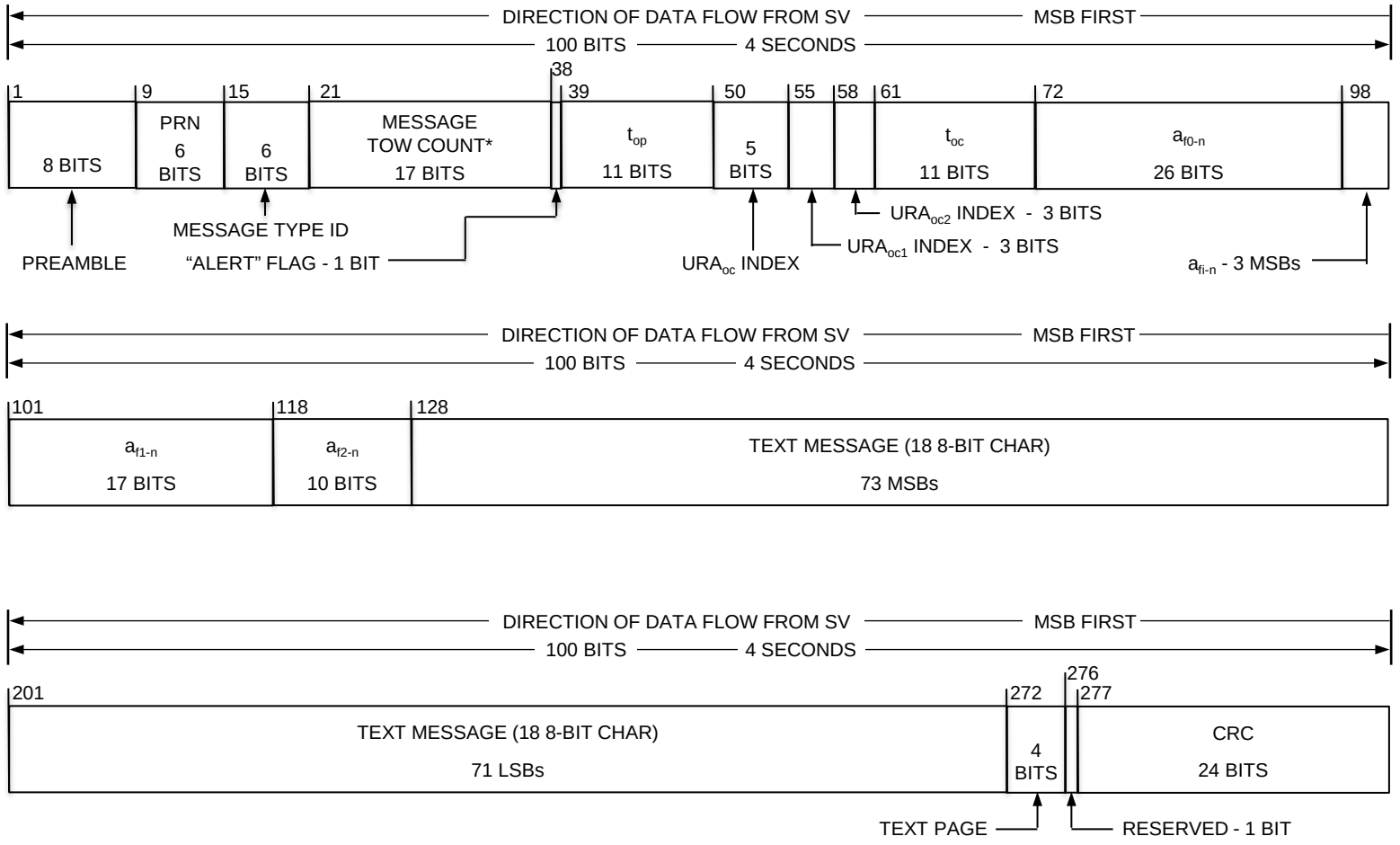
Would fit in one SBAS message (250 bits)

Message for Offline (GPS CNAV)

	Parameter	Description	Value	Size (bits)
Data Header	ISM_WN	ISM Week Number	[0, 1, … 8191]	13
	ISM_TOW	ISM Time of Week (seconds)	[0, 1, … 604500]	11
	GNSS ID	Constellation Identification	[GPS, Galileo, BeiDou, …]	3
	Criticality	Usable for Precise/Vertical?	[0, 1]	1
Per Constellation Parameters	$Mask_i$	63 bits indicating whether an SV is valid for ARAIM (1) or not (0)	$[m_1, m_2, \ldots m_{32}]$	63
	P_{const}	Probability of constellation fault at a given time	$[10^{-9}, 10^{-8}, \ldots, 10^{-4}, 10^{-3}$, NA]	3
	P_{sat}	Probability of satellite fault at a given time	$[10^{-9}, 10^{-8}, \ldots, 10^{-4}, 10^{-3}$, NA]	3
	T_{correl}	Correlation time constant at a given time (minutes)	[15, 30, 60, …, 240, 720, 1440]	3
	α_{URA}	Multiplier of the URA for integrity	[1, 1.25, 1.5, 2, 2.5, 3, 5, 10]	3
	α_{URE}	Multiplier of the URA for accuracy	[0.25, 0.5, 0.75, 1, 1.25, 1.5, 2, 4]	3
	b_{nom}	Nominal bias term in meters	[0.0:0.25: 2.5,, 3, 4, 5, 7.5, 10]	4
	Total = 107 bits			

Would fit in one CNAV message (300 bits)

Current CNAV Message (e.g., MT-36)



* MESSAGE TOW COUNT = 17 MSB OF ACTUAL TOW COUNT AT START OF NEXT 12-SECOND MESSAGE

Figure 30-9. Message Type 36 - Clock & Text

“Offline ISM” CNAV Message (“MT-38”)

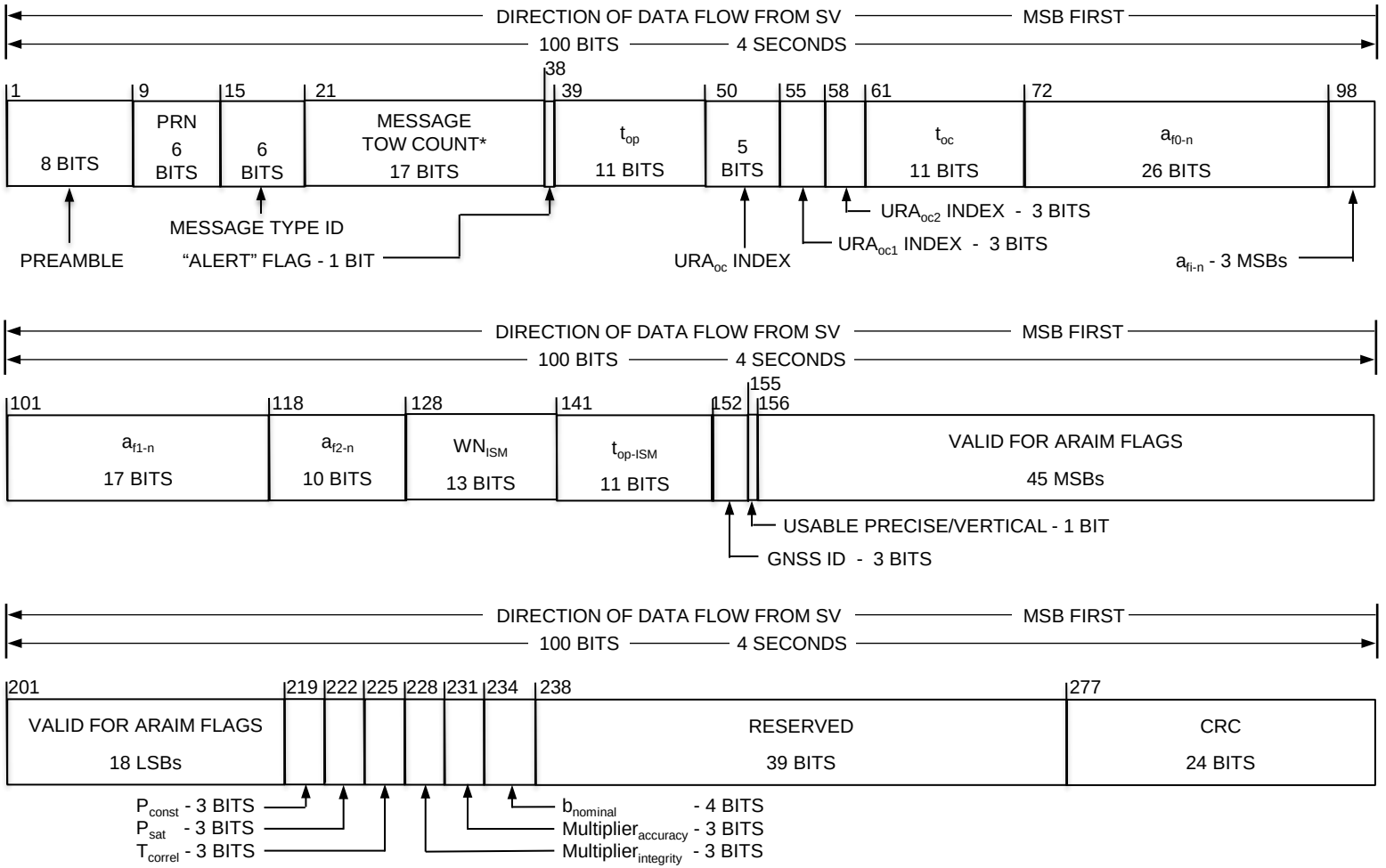


Figure 30-x. Message Type 38 - Clock & Offline ISM

Offline ISM Similarities/Differences

- **Galileo:** one to four 300 bit messages every 5 min to guarantee TTFF, does not need to be refreshed daily. P_{const} & P_{sat} per ANSP monitor estimates*.

- **GPS:** one to four 300 bit messages every 5 min to guarantee TTFF, does not need to be refreshed daily. P_{const} & P_{sat} per GNSS service provider's Performance Standard.

* Monitoring for P_{const} of 10^{-8}/hr requires 10^{+9} hr (~114,000 years)

GPS ONLINE ISM

ISM - Integrity Support Message

K. KOVACH

GPS – Online ISM

Karl Kovach, SMC/GPE(Aero)

27 October 2015
US-EU WG-C, ARAIM TSG

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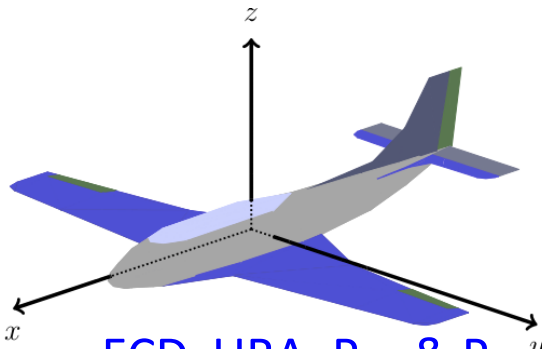
Online ARAIM "Replaces" the Ephemeris & Clock Data (ECD) Generated by the Core Constellations



ECD, URA, P_{sat} & P_{const}
ECD, URA, P_{sat} & P_{const}
ECD, URA, P_{sat} & P_{const}

Reference Stations
- 15-20 globally
- SBAS reuse
- 3 rcvrs/station

Offline monitoring

Ephemeris Overlay correct GNSS ECD & reduce sensitivity to GNSS commitments

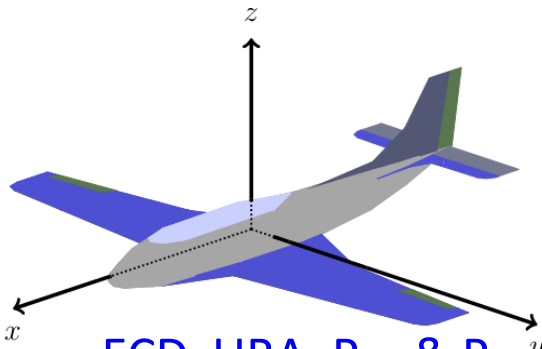
Online monitoring

ISM updated hourly:
- ephemeris + clock
- provide ISM using GNSS with 6 bps (15 m TTFF)

Wide Area GPS/GNSS Enhancement (WAGE)

- **WAGE is like a "poor man's SBAS"**
  - *Satellites uploaded with differential corrections (DCs)*
    - DCs for every other satellite in the constellation
    - Not fast enough to satisfy time-to-alert (TTA) for integrity
    - No ionospheric corrections, dual-frequency assumed
- **WAGE-1 (1995) from GPS, only for PPS users**
- **WAGE-2 (2004) from GPS, both PPS & SPS users**
- **WAGE-2^{+} (2013) from GPS, multi-constellation**
- **WAGE-3^{+} (2015) from Galileo, multi-constellation**

WAGE-2⁺ Improves Accuracy, But Not Level B Process



ECD, URA, P_{sat} & P_{const}
ECD, URA, P_{sat} & P_{const}
ECD, URA, P_{sat} & P_{const}

Reference Stations
- 15-20 globally
- ~~SBAS reuse~~
- ~~3 rcvrs/station~~

~~Offline monitoring (FAA)~~

WAGE-2⁺ corrections correct GPS ECD & reduce URA

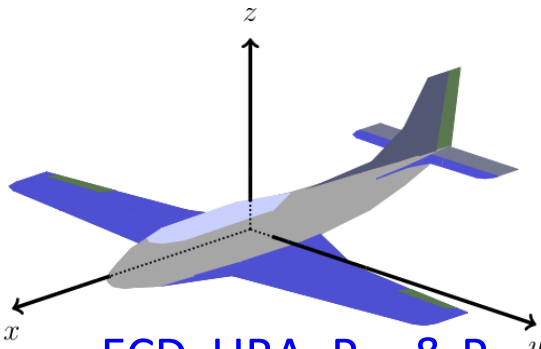
Online monitoring

WAGE-2⁺ updated 24 min:
- ephemeris + clock

Timely Warning

- **The ‘timely warning’ comes from ARAIM on aircraft**
  - *Usually at same rate as PVT solution*
    - 1 Hz, 5 Hz, 10 Hz, etcetera
- **Integrity is dominated by P_{sat}**
  - *If a satellite fails 1 minute after ISM* updated
    - Don’t care where prior assurance came from
    - Real-time detection is only provided by ARAIM
- **ARAIM benefits from tighter detection thresholds**
  - Comes from knowing exactly what errors to expect
  - Detect differences between expectation and measurements

WAGE-2^{+} Improves ARAIM Detection



ECD, URA, P_{sat} & P_{const}
ECD, URA, P_{sat} & P_{const}
ECD, URA, P_{sat} & P_{const}

Reference Stations
- 15-20 globally
- SBAS reuse (?)
- ~~3 rcvrs/station~~

~~Offline monitoring (FAA)~~

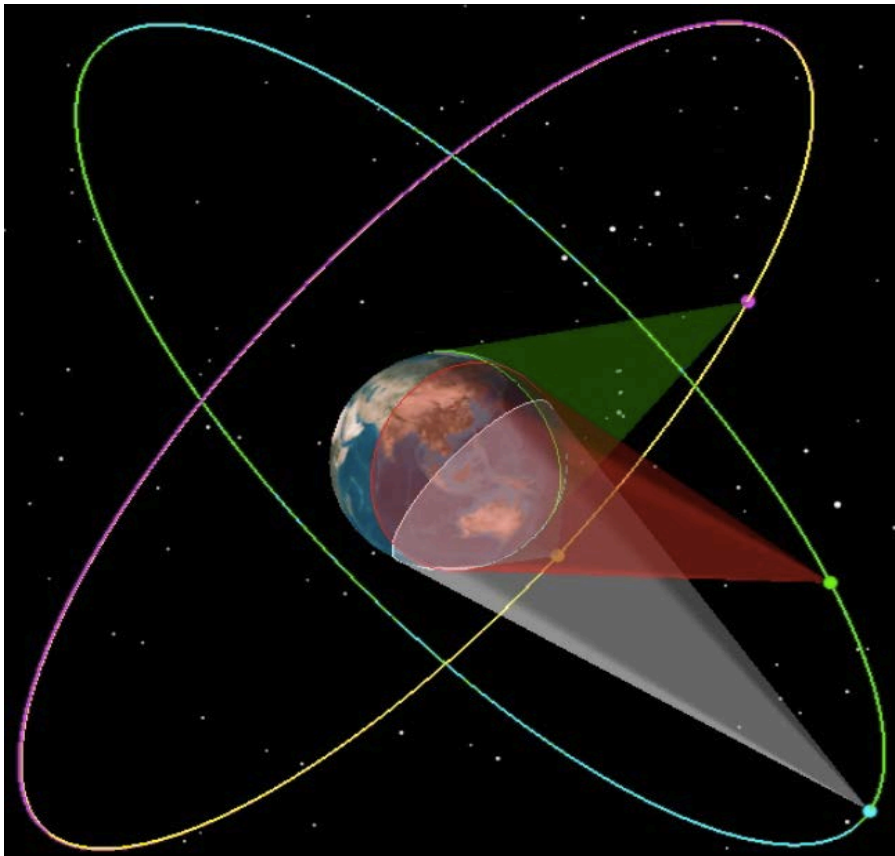
WAGE-2^{+} error estimates
Tighten ARAIM detection thresholds

Online monitoring

ISM updated 24 min:
- ephemeris + clock
- Provide online ISM using WAGE-2^{+} messaging over CNAV

WAGE-2^{+} Updates One SV at a Time

- Newest corrections visible to ~1/3 of users
- Older corrections for users outside of updated footprint
- Availability depends on SV update sequence
- Need to characterize WAGE-2^{+} performance for all valid ages of data
- WAGE-2^{+} provides receivers with recent time history of AT/CT/R/CLK errors for all satellites in constellation
  – *Spread over past 12 hours*



Online ISM Similarities/Differences

- **Galileo:** In current ISM proposed structure, WAGE-3+ corrections to be *refreshed** every 12 min (more frequent than in proposed GPS operations)

- **GPS:** In current ISM proposed structure, WAGE-2+ corrections to be *updated* every 24 min (more frequent than in proposed Galileo operations**)

* Not entirely clear what “refreshed” means in Galileo WAGE-3+ proposal

** Galileo “SIS Operational Status Definition” document says 100 minute updates

LUNCH

PUBLIC RELEASE OF SATELLITE OUTAGE FILE

USCG

NON-ICWG COMMENTS

R. ANDERSON

ICWG - Interface Control Working Group

Comments

Comment Originator(s)	Advanced Research Corp
Resolution	Discuss
Impacted Docs	All

Comment	WAS	IS	GPS Directorate Response
This is a comment on process, not on the document itself. The means for presenting the WAS/IS changes is ineffective and wasteful. The approach used is to present a series of text as WAS, followed by revised text as IS, without identifying the change made. This is tantamount to forcing the reader to find the "needle in a haystack", by reading through all the text carefully until locating the change or changes. The result is significant time spent in looking for the change, rather than simply evaluating the change. This approach consumes unnecessary time and is a waste to the U.S. taxpayer. When presenting the WAS and IS text, please mark the changed text, so that the reviewer may quickly identify the change made, and spend time in evaluating the change.	N/A	N/A	Concur

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
6.2.3 “There is no requirement for extended operations on L5". What is the expected behavior on L5 signals and CNAV message when the satellite transitions to extended operations? Can it be detected based on CNAV processing only? (in L5 single-frequency mode)."	N/A	N/A	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.3.1.1 "Users not employing the ideal correlation receiver with E-L discriminator having a correlator spacing of 97.75 ns are invited to account for the ""potential inapplicability of the group delay differential correction terms"". Since no user equipment will be strictly compliant with this ideal receiver, what is the actual recommendation? Should the computed URA be increased to take into account the inadequacy of the group delay differential correction terms? If so, the document should give a conservative bound.	N/A	N/A	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.3.2.4 Clarify the URANED0 role for single-frequency L5 users.	URANED0 accounts for zeroth order SIS contributions to user range error which include, but are not limited to, the following: LSB representation/truncation error; the net effect of clock correction polynomial error and code phase error in the transmitted signal for single-frequency L1C/A or single-frequency L2C users who correct the code phase as described in Section 20.3.3.3.1.1.1; [...]	URANED0 accounts for zeroth order SIS contributions to user range error which include, but are not limited to, the following: LSB representation/truncation error; the net effect of clock correction polynomial error and code phase error in the transmitted signal for single-frequency L1C/A ~~or single-frequency L2C~~ users who correct the code phase as described in Section 20.3.3.3.1.1.1 or for single-frequency L5 users who correct the code phase as described in Section 20.3.3.3.1.2.1; [...]	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.3.2.4 Clarify to which users the IURANED is applicable.	The following equations together with the broadcast URANED0 Index, URANED1 Index, and URANED2 Index shall give the clock-related user range accuracy of IAURANED over the current clock/ephemeris fit interval	The following equations together with the broadcast URANED0 Index, URANED1 Index, and URANED2 Index shall give the clock-related user range accuracy of IAURANED over the current clock/ephemeris fit interval for single-frequency L1 C/A users who correct the code phase as described in section 20.3.3.3.1.1.1, for single-frequency L5 users who correct the code phase as described in section 20.3.3.3.1.2.1 and for dual-frequency L1/L5 users who correct the group delay and ionospheric effects as described in Section 20.3.3.3.1.1.2.	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.3.3 There is no date of validity or interval of validity associated with the group delay differential parameters detailed in Table 20-IV. Please clarify whether or not the user equipment can store in memory these parameters and re-use them at power-on without waiting for the decoding of a new message type 30.	N/A	N/A	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.3.3.1.3 If the CS is unable to upload the SVs, the ionospheric data transmitted by the SVs may not be accurate. Clarify how this can be detected based on CNAV-only processing.	N/A	N/A	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.3.3.1.3 The document should clarify the use of iono parameters whi are said "updated by the CS at least once every six days", but without any reference date to identify the end of the validity period.	N/A	N/A	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.3.3.1.3 Autonav mode is mentioned in this section but nowhere else in the document. Can the document clarify the Autonav mode functioning with L5 signals?	N/A	N/A	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.3.6.2 It would be helpful if the ICD could clarify if there is a commitment from the CS on the number of weeks in advance the leap second is announced. This way, the receiver is able to decide at power-up whether the UTC parameters stored in memory can be used to update the leap second and provide UTC time, or whether it has to decode a new message type 33 before providing UTC time.	N/A	N/A	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.4.4 The toe shall be equal to the toc of the same CNAV data set. The following rules govern the transmission of toe and toc values in different data sets: (1) The transmitted toc will be different from any value transmitted by the SV during the preceding seven days; (2) The transmitted toe will be different from any value transmitted by the SV during the preceding six hours. Since toe and toc should be equal, it means that the toe will also be different from any value transmitted by the SV during the preceding seven days (and not only during the preceding 6 hours). Can you confirm?	N/A	N/A	Discuss

Comments

Comment Originator(s)	Thales
Resolution	Discuss
Impacted Docs	IS-GPS-705

Comment	WAS	IS	GPS Directorate Response
20.3.4.5 Reference time information is referred to paragraph 30.3.4.5 in IS-GPS-200. The 144 h transmission interval for UTC in table 30-XIII is in contradiction with what is explained in paragraph 20.3.3.6.1 of IS-GPS-705 (namely a transmission interval of 72 hours max). Please clarify.	N/A	N/A	Discuss

Open Discussion

Action Item Review

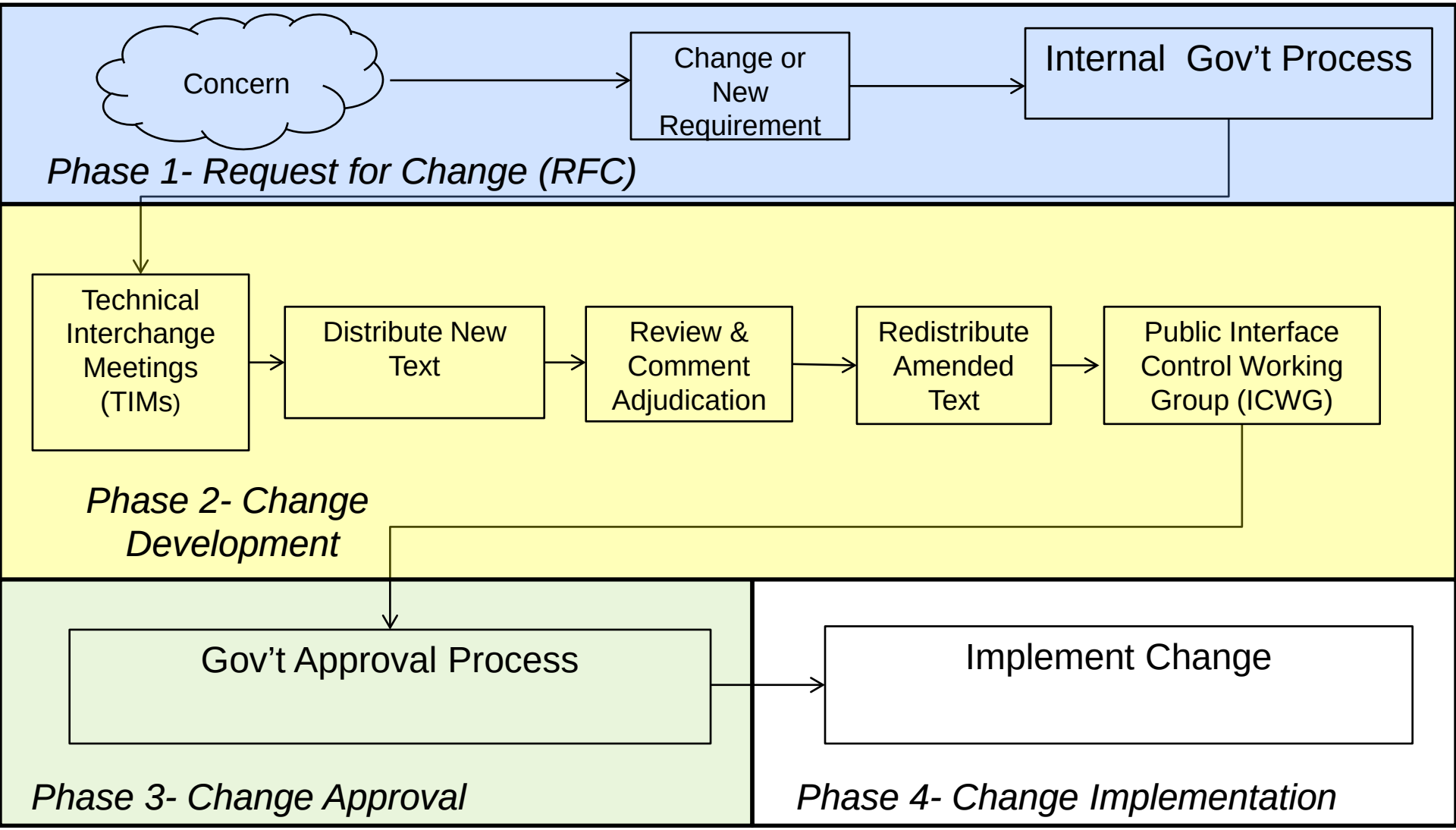
James Horejsi

Chief Engineer, Global Positioning Systems (GPS) Directorate Space and Missile Systems Center

Closing Comments

- 2016 meetings for the GPS public documents will resume September schedule
- Direct any follow-up communication related to this meeting to smcgper@us.af.mil
- Way forward

Change Management High Level Process Flow



Thank You