IS-GPS-800 ICWG
MEETING MINUTES

Minutes Date: 05-Oct-2009

Minutes By: Gopal/Kogus/Buckley

Meeting Date: 30 -Sep-2009

Meeting Time: 0800 - 1600

Location: Los Angeles Airport Doubletree Hotel

Chairs: Capt Neal Roach, USAF
Vimal Gopal, SE&I

Discussions:

At this ICWG, the ICC went page-by-page through the last CCB'ed version of the document. All changes in the document that were made after the last ICWG were reviewed. The following is a list of the sections that were reviewed as well as any discussions that took place and any changes that were made to the document as a result.

- Section 3.2.1.3 – Carrier Phase Noise
  - Bud Bakeman presented his updated language (to make the reqt more verifiable)
    - The phase noise spectral density of the unmodulated carrier shall not exceed the magnitude of a straight line (on a log-log plot) between -30 dBc/Hz at 1 Hz and -60 dBc/Hz at 10 Hz, and another straight line between -60 dBc/Hz at 10 Hz and -90 dBc/Hz at 10 KHz. (The spectrum between 1 and 10 KHz, when integrated as linear values, multiplied by two and square rooted, is equal to .034 radians rms.) Also, the spurs shall not exceed -40 dBc.
  - LM recommended updates (based on the way they test the requirement):
    - The phase noise spectral density of the unmodulated carrier shall not exceed the magnitude of a straight line (on a log-log plot) between -30 dBc/Hz at 1 Hz and -60 dBc/Hz at 10 Hz, and another straight line between -60 dBc/Hz at 10 Hz and -80 dBc/Hz at 1 kHz. The phase noise between 1 kHz and 100 kHz shall be such that the integrated phase noise between 10 Hz and 100 kHz is less than 0.01 radians.
  - The compromised position that the ICWG members agreed to was:
    - The phase noise spectral density of the unmodulated carrier shall not exceed the magnitude of a straight line (on a log-log plot) between -30 dBc/Hz at 1 Hz and -60 dBc/Hz at 10 Hz, and another straight line between -60 dBc/Hz at 10 Hz and -80 dBc/Hz at 10 kHz. Spurs in the phase noise spectral density of the unmodulated carrier between 10 Hz and 10 kHz shall not exceed -40 dBc.
  - Chris Hegarty performed a study and validated that the integrated values for the all of the above options were OK. This study was discussed on day 3 of the ICWG (during the 705 discussion)
- Section 3.2.1.5 Correlation Loss
  - Bud Bakeman presented his updated language (to make the reqt more verifiable):
    - The vehicle payload correlation loss considered here is the total allowable, associated with the L1 30.69 MHz bandwidth RF signal transmitted by the payload, for L1Cp and L1Cd, due to filtering in the payload (e.g., multiplexers), plus a limited allowance (approximately 0.2 dB) for any loss due to unexpected signal distortion caused by other

1

payload electronics. This correlation loss can be demonstrated by comparing the code correlation powers from the payload signal with those from a linear unfiltered signal generator which emulates the payload signal formation and is free if correlation loss that is not an expected result of signal combining. This comparison requires equal RF power in a 30.69 MHz bandwidth from both the payload and waveform generator, and the use of a correlating receiver with an approximate ideal filter. The difference in correlation power from this comparison is the defined payload correlation loss. The total allowable vehicle payload correlation loss, which is a function of the receiver bandwidth as well as the signal, shall be:

For L1Cp & L1Cd: 0.3 dB (With a 30.69 MHz BW Rcvr)

0.2 dB (With a 24 MHz BW Rcvr)

- o The ICWG members discussed Bud's updates and believed the language made the requirement more confusing, and that the original requirement was more clear. They were also perplexed about stating values for a 24 MHz receiver. Bud stated that the receiver manufacturers tested this reqt with a 24 MHz receiver, therefore we needed to specify allowable values. The ICWG members did not agree. The ICWG memebers agreed to use the original language.

- Section 3.2.1.6.1 Phase Relationships
  - o See Day 1 meeting minutes for overall synopsis
  - o Removed language referencing pre-operational use section 6.3, as Ann Cignar opposed that language because it discouraged the use of L1C. Added language referencing the IS-GPS-200 for phase relationships to other L1 signals.
- Section 3.2.1.6.2 Phase Continuity
  - o See Day 1 meeting minutes for overall synopsis
  - o LM opposed language, as they believed it could be interpreted to violate their SV design (combing operation in particular).
  - o LM took the action to develop new language which the ICWG members and Ann Cignar agreed upon:
    - ▪ While a satellite is broadcasting standard L1CP code and standard L1CD code signals with data which indicates L1C signal health is OK, the CS/SS will not command an operation causing an intentional phase discontinuity. This does not apply to phase discontinuities caused by signal modulation.
- Section 3.2.1.7.1 Signal Coherence
  - o Karl Kovach recommended inserting the following sentence to the end of the requirement to be consistent with IS-GPS-200:
    - ▪ Corrections for the bias components of the time difference are provided to the US in the CNAV-2 message using parameters designated as ISCs (reference paragraph 3.5.3.9.1).
  - o Updated document to be consistent with IS-GPS-200 (95% probability)
- Section 3.2.1.8.1 Group Delay Uncertainty
  - o LM took exception to the 1.0 ns requirement, stating that it violated their SV design. They requested it be changed to 1.5 ns.
  - o GPC initially non-concurred, then they talked to their Nasa representatives and decided to override their concern. Final ICWG decision: change requirement to 1.5 ns.
  - o The last sentence in this section was deleted for consistency between all documents. The stakeholders also believed that the provided range was too large to have any value.
- Section 3.2.1.8.2 Group Delay Differential
  - o The verbiage "Not Applicable" was placed into this section and then pointers to the Signal Coherence and inter-signal group delay sections. This section was deleted because this document only pertains to one signal, the L1C.
- Section 3.2.1.8.3 SSV Group Delay Differential
  - o The verbiage "Not Applicable" was placed into this section and then pointers to the Signal Coherence and inter-signal group delay sections. This section was deleted because this document only pertains to one signal, the L1C.

- Section 3.2.1.9 Signal Power Levels
  - Chen-shu. Chiu felt that the 2nd sentence in the paragraph referencing combining loss was unclear. The sentence was then changed to accommodate his concern. Specifically, we inserted language to tell the user that any signal combining techniques used would be transparent to the user. This language was agreed to by the ICWG:
    - Any combining operation done by the SV and associated loss is compensated by an increase in SV transmitted power and thus transparent to the user segment.
  - Updated language to "(i.e. 0 dB axial ratio)" for consistency with IS-GPS-200.
  - Discussed creating a table similar to the IS-GPS-200. After deliberation, decided it was unnecessary since the IS-GPS-800 only covers the L1C frequency.
  - To maintain consistency with IS-GPS-200, added the following note to the orbital users in Table 3.2-1:
    - * Over 99.5% of the solid angle inside a cone with a 23.5 degree half-angle with its apex at the SV and measured from 0 degrees at the center of the Earth.
- Table 3.2-3
  - Chris Hegarty recommended a change from $m_{i,j}$ to m_{ij} for clarification purposes.
  - ICWG agreed to proposed changes in the notes section
- Section 3.5.3.10 Integrity Assurance
  - Add clarification of "enhanced" level of integrity and "1" at end of sentence.
- Section 6.2.1.1 Integrity Assured URA
  - Added a "1" to the definition for clarification purposes.
- General
  - Update IS-GPS-800 with "95% probability" instead of "2 sigma" to be consistent with IS-GPS-200.

Supporting Materials:

❑ IS-GPS-800_CRM_Post_29SeptICWG.xls	❑	
❑ IS-GPS-800_Post_29SeptICWG.doc	❑	
❑ IS-GPS-800_WAS-IS_Post_29SeptICWG.xls	❑	
❑	❑	

Attendees:

Name	Company / Organization
Abayon, Annabelle	GPSW/SE&I
Bakeman, Bud	Aerospace
Brown, Steven	LM GPS III
Chiu, Chen-shu	Aerospace
Ciganer, Ann	Trimble/USGIC
Dobyne, John	Arinc/GPC
Frey, Chuck	LM Space
Getto, Luke	ITT SSD
Grundman, Ron	GPS III SE&I
Hegarty, Chris	MITRE
Hietzke, Wolf	SAIC/SE&I
Jeffris, Mike	MITRE

Jelmeland, Tom	Boeing
Kascak, Matt	GPS SE&I
Kawakami, Todd	NGA
Kovach, Karl	Aerospace
Liegeois, Rick	L-3 Interstate Electronic Corp.
Lin, Victor	Aerospace
Mullikin, Tom	Raytheon/OCX
Munoz, Mike	GPSW/SE&I
Naick, Purvis	GPSW, GPC
Notley, William	GPSW, GPC
O'Laughlin, Daniel	MITRE
Phillips, Sarah	LM (NG OCX)
Ranney, Scott	LM Space
Reigh, Dan	LM Space
Renfro, Brent	ARL: Univ of Texas
Tucker, Jack	GPSW/GPV (SAIC)
Van Dierendonck, AJ	AJ Systems/FAA/NASA
Yucis, Mike	ITT SSD

Action Items from this ICWG (Sep 09):

No	Due date	Actionee	Item	Resolution
1	07-Oct-09	Ben Kogus	Create a table in section 3.2.1.5 (correlation loss) to be consistent with the IS-200.	Comment OBE. Subsequent ICWG discussions revealed that a table was unnecessary since the IS-GPS-800 only pertains to the 30.69 MHz bandwidth.
2	07-Oct-09	Ben Kogus	3.2.1.7.1: finalize in the paragraph callout in this section (x.x.x.x) there is another section with the same concern.	Closed.
3	30-Sep-09	Bill Notley	NASA must come back with a response to LM's study of why they need 1.5 ns max group delay uncertainty.	Closed. GPC concurs with the 1.5ns (Bill Notley and Purvis Naick discussed with Nasa on the telephone during the ICWG and decided to override their non-concur).
4	01-Oct-09	C. Hegarty	Provide an analysis on the carrier phase noise and determine whether the more relaxed mask is appropriate. A comparative analysis will ensue for the verbiage from yesterday vs. today.	Closed. Chris Hegarty presented at ICWG day 3 session and ICWG members agreed upon verbiage for Carrier Phase Noise section.

Action Items from last ICWG (Nov 08):

No	Due date	Actionee	Item	Resolution
1	01-Jul-08	Mike Deelo	3.2.1.7: Look at wording in IS GPS 200 and see if it clarifies the req. spec. for L1CP & L1CD, signal coherence.	Closed. No additional clarity from 200. Wording is essentially the same; slight difference in wording adds nothing.
2	30-May-08	Mike Deelo	3.2.1.5: Ensure CRM comment 126 and document changes are the same.	Proposed resolution to be presented by Bakeman at ICWG. Closed with ICWG approval of new language. Closed. At ICWG on 29 Sep 09 - 01 Oct 09, Chris Hegarty, AJ VD and others agreed that the proposed language by Bud Bakeman's working group added confusion to the requirement and all agreed (not including Bud) to keep the original language.
3	01-Jul-08	Soon Yi	3.2.1.5: Set up meeting w/ Aero & Mitre to review current correlation loss for verifiability.	Action completed pending approval of new language. Proposed resolution to be presented by Bakeman at ICWG. Closed. At ICWG on 29 Sep 09 - 01 Oct 09, Chris Hegarty, AJ VD and others agreed that the proposed language by Bud Bakeman's working group added confusion to the requirement and all agreed (not including Bud) to keep the original language.
4	Barring results of #6	Mike Deelo	3.2.1.3: To harmonize phase noise spec. across all signals in space documents.	Closed with closure of action 6.
5	Barring results of #6	Soon Yi	3.2.1.3: Provide analysis to show how the phase lock loop requirements and phase noise mask are related.	Closed with closure of action 6.
6	01-Aug-08	Mike Deelo	3.2.1.3: Set up working group to discuss and resolve re-wording of carrier phase noise language.	Proposed resolution to be presented by Bakeman at ICWG. Closed with ICWG approval of new language. Closed. Compormise reached between LM, Bud Bakeman, and Chris Hegarty on updated language for carrier phase

No	Due date	Actionee	Item	Resolution
				noise.
7	01-Jul-08	Soon Yi/Mike Deelo	3.2.1.8.1: Look at IIF/IIRM data and analyze to see if 1 nanosecond is sufficient, justify the need for 1 nanosecond.	Closed. LM stated it could not meet 1 ns reqt, spec changed to 1.5 ns with GPC concurrence despite Nasa disagreeing with the change.
8	Barring results of # 7	Mike Deelo	3.2.1.8.1, 3.2.1.8.2: Add GPS III req. of 1 nanosecond to legacy interface documents (200 & 705)	Not going to be done, impacts legacy systems as per TIM on 13 Nov 08. 11/18: Requires further discussion Closed. LM stated it could not meet 1 ns reqt, spec changed to 1.5 ns with GPC concurrence despite Nasa disagreeing with the change.
9	01-Jul-08	Soon Yi	3.2.1.9: Text added by Space IPT needs review by Aerospace and Mitre	Closed. Aerospace and Mitre revierwed during ICWG review cycle 29 Sept 09. Language updated to properly reflect signal combining.
10	Next ICWG	Thomas Davis/AJ	Setup a meeting to ensure ICD wording is consistent in all docs & add applicable requirements from 800 to 705 and 200, clearly identify which requirements apply to each block, including symmetry requirements.	Ongoing effort. Part of DOORS conversion.
11	Next ICWG	Thomas Davis	Evaluate removal of PRN code assignments from 800, 200, & 705 documents.	Reject. Evaluated removal of PRN codes, but decidedagaianst it because the Wing wants to control PRNs that are not even used by GPS, and there are not better documents available to do so.
12	15-Jun-08	Thomas Davis	Renumber paragraphs because of duplicate paragraph #s	Completed
13	01-Aug-08	Mike Munoz	Create a working group to discuss the integrity status flag further.	Separate working group not needed, PSICA took lead on documenting integrity CONOPS. Closed. Integrity language incorporated.

6

No	Due date	Actionee	Item	Resolution
14	31-Jan-09	Mike Deelo	Form WG to discuss Correlation Loss language (CRM comment 139; 3.2.1.5 Correlation Loss)	Closed. WG created, language discussed at ICWG, ICWG members decided existing language was sufficient.
15	05-Dec-08	Thomas Davis / Bud Bakeman	Include new Phase Noise Language in ICWG minutes (CRM comment 138; 3.2.1.3 Carrier Phase Noise)	12/16/08: Wording still in work and will not be included in minutes. Will be brought to next ICWG15., Closed. Updated phase noise language agreed to in 29 Sept 09 ICWG.
16	31-Jan-09	Mike Munoz	Provide language for PRN sequences to be incorporated in all three public documents (CRM comment 226; 6.3.1).	Comment deferred. To be addressed after DOORS conversion.
17	31-Jan-09	Mike Munoz	Determine language for off-axis power gain (antenna gain vs. EIRP) (CRM comment 223; 3.2.1.9)	Closed. Updated language incorporated.
18	1/31/2009 (need input from PSICA WG - AI #19)	Thomas Davis	Move Integrity Status Flag information to appropriate section (potentially 3.5.3.5) (CRM comment 196; 3.5.3.5)	Closed. Created section 3.5.3.10 - Integrity Assurance.
19	05-Dec-08	Karl Kovach	Coordinate Integrity Status Flag information with PSICA WG (CRM comment 196; 3.5.3.5)	Closed. Language in 3.5.3.10 is from PSICA WG.
20	31-Jan-09	Tom Stansell / LM	Follow up on phase options for fixed phase requirement. LM to provide language on implementation of phase relation. (CRM comment 148; 3.2.1.6)	Closed. Updated language incorporated.
21	31-Jan-09	GPC	Follow up on comment on specifying power at receiver antennas (space user) (CRM comment 248; 3.2.1.9)	Closed. Updated language incorporated.
22	31-Jan-09	GPC / Mike Munoz	Determine appropriate location of PR equations and parameters (SSV group delay bias and values) (CRM comment 246; 3.5.3.9.3)	Open. Currently a TBD in the IS-GPS-800.
23	05-Dec-08	Thomas Davis / Steve Brown	Remove equations and SSV information from IS-GPS-800 and provide reference/pointer to TBD location. Steve Brown to verify removal. (CRM comment 246; 3.5.3.9.3)	Closed. Reference statement (add to 3.2.1.8.3 - keep first sentence): "The details are provided in TBD." Delete remainder of this section. Partial changes made in real time during ICWG for reference/pointer statement.
24	31-Jan-09	GPC	Provide more rationale for proposed change to chip transition of two modulating signals (CRM comment 231; 3.2.1.7.1)	Closed. Updated rationale provided by originator and captured in CRM.

No	Due date	Actionee	Item	Resolution
25	31-Jan-09	Karl Kovach and Chris Hegarty	Determine appropriate location for ISCs for L1C/A, L2C, L5I5, and L5Q5. (CRM comment 191; Figure 3.5-1)	Closed. Incorporated Chris Hegarty's recommended locations.
26	31-Jan-09	Mike Munoz	Create table similar to IS-GPS-200 Table 30-XII (CRM comment 188; 3.2.3.1)	Open. Comment deferred until next revision.
27	05-Dec-08	GPC	Follow up and provide clarification or withdraw comment on Figure 3.2-2 (CRM comment 183)	Closed. Clarifications added for S1 Polynomial Tables and Figures. GPC concurs.
28	31-Jan-09	PSICA WG	Spec should provide a value for the duration that the clock parameters from a previous data set will remain valid after the transmission of a new data set. (Comment 192, 3.5.3)	Closed. Added further clarification to requirment stating that parameters remain applicable, but their accuracy degrades over time.
29	31-Jan-09	PSICA WG	Clarify how the overall URA should be computed from the individual clock and ephemeris and whether the URA terms account for errors in the inter-signal group delay differential corrections. (Comments 199 & 200, 3.5.3.8)	Closed. Added clarifications in section 3.5.3.8 on clock URA considerations. Also added clarifications in section 3.5.3.10 defining URA as the RSS of URAoc and URAoe.
30	31-Jan-09	PSICA WG	Determine if UDRA and UDRA-dot are to be integrity assured (Comment 205, 3.5.4.4.4)	Closed. Responded to orginator that UDRA and UDRA-dot are not integrity assured. Also, added a defintion of UDRA. PSICA WG and ICWG memebers did not feel like it was necessary to directly state that UDRA and UDRA-dot are not integrity assured in the spec.
31	31-Jan-09	PSICA WG	Provide clarification on how the overall URA should be computed from the individual clock and ephemeris URAs	Closed. See comment 29.
32	31-Jan-09	PSICA WG	Make clear whether the URA terms account for errors in the inter-signal group delay differential corrections	Closed. See comment 29.
33	31-Jan-09	PSICA WG	Determine a value for the duration that the clock parameters from a previous data set will remain valid after the transmission of a new data set.	Closed. See comment 28.

Next Scheduled Meeting:

The next ICWG is scheduled for <u>November 10th, 2009 from 0800 to 1600</u>. We will ONLY be discussing the Preliminary PIRN (PPIRN) on constellation expansion. Please click the link below for this PPIRN:

2009-07-02 PPIRN
for 200 for PRN 38-6:

This ICWG will be a telecon. Dial-in information is as follows:

Phone: 1-800-FON-SAIC
Code: 4511074

There are limited number of lines that will be available on a first-come-first-serve basis. Participants are encouraged to share lines if possible. Please send any comments or further questions to:
 Vimal Gopal
vimal.gopal.ctr@losangeles.af.mil
1-310-416-8476

or

Captain Neal Roach
neal.roach@losangeles.af.mil
1–310–653-3771