GLOBAL POSITIONING SYSTEM
MODERNIZED CIVIL NAVIGATION (CNAV)
LIVE-SKY BROADCAST TEST PLAN

30 May 2013

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Executive Summary

The GPS Directorate (SMC/GP) will implement a CNAV (Civil Navigation) Test Program to conduct Live-Sky CNAV testing prior to deployment of the Next Generation Operational Control System (OCX). CNAV is a capability to be provided by Civil Navigation message types for the purpose of improved GPS navigation through the use of signals L2C and L5. Fifteen CNAV message types are defined in the current Interface Specification (IS-GPS-200F and ICD-GPS-705B). CNAV message types will be tested in an incremental fashion in accordance with SMC/GP's program baseline plans. The full operational L2C CNAV capability will be included in the initial OCX delivery which is scheduled for deployment in mid-2016. The purpose of the testing is to ensure enterprise-level readiness to operate, broadcast and receive the modernized civil navigation messages on L2C and L5.

SMC/GP CNAV Live-Sky testing program will span several years and will evolve to support GPS Enterprise and modernized civil navigation performance objectives. This initial CNAV Live-Sky Broadcast is tentatively scheduled for the 15-29 June 2013. The SMC/GP CNAV Test Program is focused on achieving the following two objectives:
  (1) Verify and validate the CNAV requirements specified IS-GPS-200F and IS-GPS-705B.
  (2) Facilitate the development of robust IS-compliant L2C and L5 Civil receivers.

The flexibility of the CNAV messaging system warrants extensive testing of the different message types, message content, and message delivery intervals to verify the requirements defined in IS-GPS-200F and IS-GPS-705B. To support this endeavor, SMC/GP will utilize an engineering developmental test tool (i.e., the MODNAV Engineering Tool Suite) to generate CNAV message content and uploads for the GPS IIR-M and IIF SVs. This process leverages the Kalman filter data elements from the Architecture Evolution Plan (AEP) system. The CNAV messages types and broadcast sequence will vary based on GPS satellite block type (i.e. the IIR-M and IIF) capabilities and will vary over time. Live-sky broadcasts will exercise the CNAV messaging capabilities of the GPS IIR-M and IIF Satellite Vehicles (SVs) in support of CNAV message verification and validation. The CNAV Signal-In-Space (SIS) will facilitate the development of robust GPS L2C and L5 receivers.

All CNAV Live-Sky broadcasts will be orchestrated from the GPS Master Control Station (MCS) located at Schriever Air Force Base (SAFB), Colorado. SMC/GP will generate compliant CNAV message content and uploads for each IIR-M and IIF SV. 2 SOPS will transmit the CNAV uploads to the GPS IIR-M and IIF SVs on a daily basis during the test period. SV contact scheduling will be performed by 2 SOPS and coordinated with SMC/GPEV. Execution of the content specified in this test plan will not adversely affect Legacy receiver navigation performance.

A key metric of the CNAV Test Program's success is the performance evaluation and utility assessment of the L2C and L5 navigation signals by the civil community. As such, SMC/GP is inviting civil users and receiver developers to participate in the test planning process.

Document Revision History

Date	Description
20 Mar 13	A - Original Draft.
27 Mar 13	B - Included comment resolutions from civil review.
17 Apr 13	C - Introduced concept of CNAV Master Frame, remapped frames to test scenarios, clarified scenario #9, added final CNAV master "default" frame, defined CNAV message reserved bit fields for each message type.
25 Apr 13	D - Moved master frame information into section 1 and added upload activation table in section 3.
4 May 13	E - Changed upload activation times from 1500Z to 1800Z.
22 May 13	F - Administrative improvements.

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SECTION I – INTRODUCTION

1.   GPS Directorate CNAV Test Program

1.1   **Overview**

The GPS Directorate (SMC/GP) will implement a CNAV Test Program to conduct Live-Sky CNAV testing prior to deployment of OCX. CNAV is a capability to be provided by Civil Navigation message types for the purpose of improved GPS navigation through the use of signals L2C and L5. Fifteen CNAV message types are defined in the current Interface Specification (IS-GPS-200F and ICD-GPS-705). CNAV message types will be tested in an incremental fashion in accordance with SMC/GP's program baseline plans. The full operational L2C CNAV capability will be included in the initial OCX delivery which is scheduled for deployment in mid-2016. The purpose of the testing is to ensure enterprise-level readiness to operate, broadcast and receive the modernized civil navigation messages on L2C and L5.

This CNAV Test Program is focused on achieving the following two objectives:
    (1) Verify and validate the CNAV requirements specified IS-GPS-200F and IS-GPS-705B.
    (2) Facilitate the development of robust IS-compliant L2C and L5 Civil receivers.

To support these objectives, the GPS Directorate's Engineering Division (SMC/GPE) has developed a set of offline software applications to generate the CNAV message content; this collection of applications is referred to as the MODNAV Engineering Test Tool. SMC/GPEV (Test and Verification Branch) has successfully utilized the MODNAV Tool to generate CNAV message content for the GPS IIR-M and IIF satellites. These CNAV uploads have been exercised with the GPS IIR-M and IIF satellite simulators.

The MODNAV Engineering Test Tool works within the Architecture Evolution Plan (AEP) environment and takes advantage of the Tracking, Telemetry, and Commanding (TT&C) subsystem to transmit the CNAV uploads to the GPS IIR-M and IIF satellites. It also takes advantage of the Clock, Ephemeris and Almanac information from the AEP Kalman filter data tables to construct the higher accuracy CNAV message data during the CNAV generation process. The AEP system does not have the capability to generate CNAV navigation data.   The CNAV upload process utilizes standard 2 SOPS procedures to transmit the CNAV uploads to the GPS IIR-M and IIF satellites.

This GPS Directorate CNAV Test Program implements an incremental CNAV message verification and Position, Navigation, and Timing (PNT) capability approach. This initial CNAV Live-Sky broadcast will focus on basic PNT functionality, so only the indicated CNAV message types will be broadcast. However, CNAV message types 10, 11, and 3x will always be broadcast during each CNAV Live-Sky broadcast to support CNAV PNT functionality. Subsequent CNAV Live-Sky broadcasts will focus on enhanced PNT functionality and requirements verification. CNAV Live-Sky broadcasts will be conducted approximately every six months and will incrementally add new message types and increasing broadcast complexity. This CNAV message buildup supports an incremental CNAV development approach which enables civil receiver developer inputs prior to the next CNAV test event. This incremental approach will also ensure each message type is thoroughly exercised and supports the interaction with the civil community to resolve any message content issues and help to devise test scenarios for future test events.

The CNAV messages types and broadcast sequence will vary based on GPS satellite block type (i.e. IIR-M and IIF) capabilities and will vary over time. Reserved bit fields identified in the CNAV message types will be varied over the test period. The GPS Directorate will convey contents of reserved bit fields prior to the test event. CNAV message contents will always comply with the IS requirements; however, undefined message types will be defined in the test plan and will be broadcast during the course of the CNAV Test Program to evaluate new CNAV message types.

Civil feedback on the CNAV message utility, Time-to-First Fix (TTFF) performance and navigation performance versus message broadcast intervals is critical to the success of the CNAV Test Program. Periodic broadcasts with gradual introduction of new message types will also remind signal users that the flexible data message will change over time, mitigating risks to signal users by encouraging robust developer compliance with the Interface Specifications. The tentative CNAV developmental test program schedule is shown in Figure 1-1. The initial CNAV Live-Sky broadcast will occur in June 2013 and will span approximately 14 days. As indicated in the proposed CNAV event schedule, CNAV messages will be incrementally added as the specified CNAV message functionality is incorporated into MODNAV Engineering Test Tool. While the CNAV Test Program supports the development of new CNAV message types, any changes to the operational message set would be vetted through the ICWG process and documented in the applicable IS.
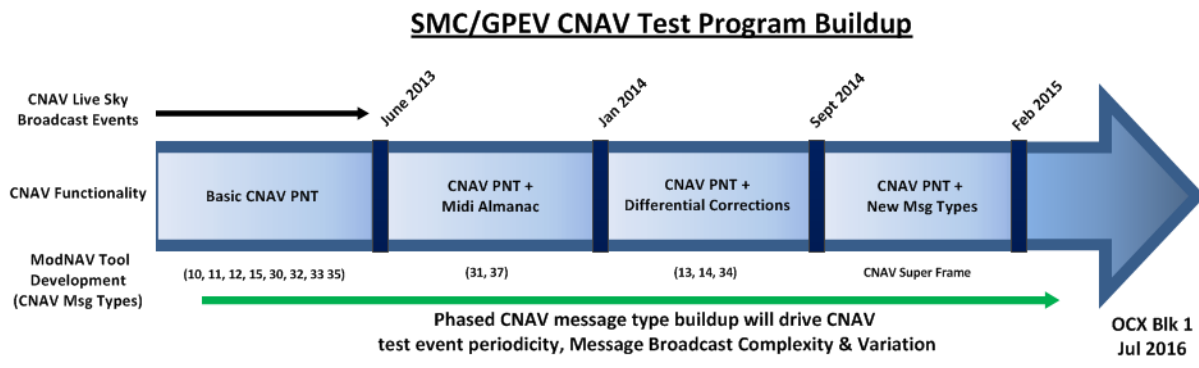
Figure 1-1: CNAV Test Program Overview

1.2   **Modernized Civil Navigation Signal Background**

Section 1.2 provides a brief description of the modernized civil signals to help the reader comprehend the modernized civil signal attributes. Complete details on the generation of the Civil PRN ranging codes and CNAV message definitions are provided in IS-GPS-200F and IS-GPS-705B; these GPS Interface Specifications (ISs) can be downloaded from the United States Coast Guard NAVCEN Website: http://www.navcen.uscg.gov

1.2.1   Modernized Civil PRN Ranging Codes

The two new civil navigation signals, L2C and L5, are designed to enhance civil navigation performance and utility. The L2C PRN ranging code is composed of the chip-by-chip time multiplexed combination of two sub-codes, CM and CL. The L2 CM PRN code is 20 milliseconds in length at a chipping rate of 511.5 Kbps and the L2 CL is 1.5 seconds in length at a chipping rate of 511.5 Kbps. For L2C, the CNAV data stream is modulo-2 added to the L2 CM PRN ranging code before being chip-by-chip time multiplexed with the L2 CL PRN ranging code. The composite L2C PRN ranging code is transmitted at a 1.023MHz chipping rate. The L2C PRN ranging code is Bi-Phased Shift Key (BPSK) modulated onto the L2 carrier (1227.6 MHz). The L5 PRN ranging code is composed of two PRN ranging codes; an in-phase component (L5 I5) and a quadrature component (L5 Q5). For L5, the CNAV data stream is modulo-2 added to the L5 I5 PRN ranging code. Both L5 PRN ranging codes are transmitted at a 10.23MHz chipping rate. The L5 PRN ranging codes are BPSK modulated onto the L5 carrier (1176.45 MHz). The generation of the L2C and L5 PRN ranging codes on the GPS IIR-M and IIF SVs is implemented by hardware structures, so the generation of the PRN sequences (phase offsets) for each satellites PRN is easily verified. The GPS IIR-M satellites broadcast only the L2 PRN ranging code while the GPS IIF satellites broadcast both the L2 and L5 PRN ranging codes.

1.2.2 CNAV Message Structure

The CNAV message types (i.e., Almanac, Clock, Ephemeris, and other SV parameters) contain higher precision representations of the quasi-Keplerian parameters than those contained in the Legacy navigation message. CNAV contains more accurate SV position estimates. Figure 1-2 provides a graphical illustration of the data fields that constitute the CNAV Message structure. The L2 CNAV message utilizes a 300-bit message packet which spans twelve seconds (50sps); L5 CNAV utilizes the same 300-bit message types and packet structure but spans only six seconds (100sps). The message header consists of 38-bits which define multiple fields that convey specific SV information. The MCS is responsible for uploading the CNAV message data block (i.e., the 238-bit message data payload) to each SV to implement the desired CNAV message sequence. Since the AEP system does not inherently generate CNAV content, SV parameter data (i.e. Almanac, Clock, Ephemeris, and User Range Accuracy (URA)) utilized to construct several of the CNAV message types will be derived from data extracted from the AEP Kalman filter data tables. Each message contains a Cyclic Redundancy Check (CRC) parity block consisting of 24 bits covering the entire 300-bit message packet; the parity algorithm utilized by CNAV data stream is different than the Legacy navigation data stream. Table 1-1 provides a breakdown of the CNAV message fields and data source.

300 Bit CNAV Message Format
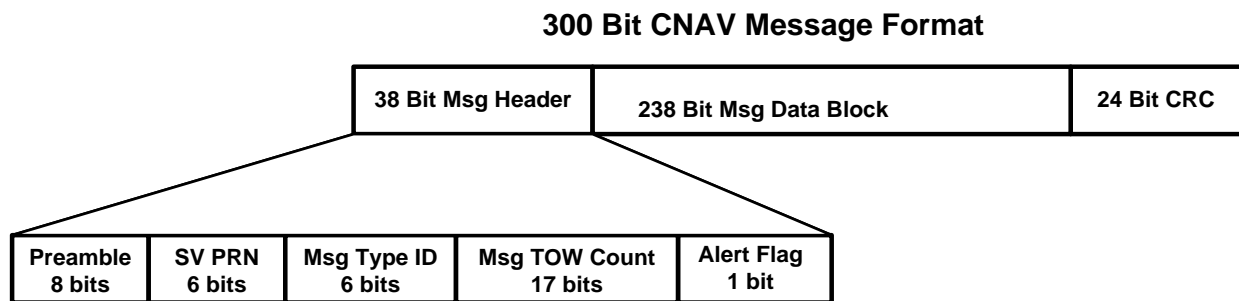
Figure 1-2: CNAV Message Format

Table 1-1: CNAV Message Field Definition and Source

Message Field Definition	Source and Bit Values

CNAV Message Header (38 bits)
  Bits 1 - 8 comprise the fixed Preamble
  Bits 9-14 comprise the SV PRN
  Bits 15-20 comprise the Message Type ID
  Bits 21-37 comprise the Message TOW
  Bit 38 is the SV URA Alert Flag
	Generated by SV's onboard navigation processor (bits 1 – 38):
	  8 Bit fixed Preamble "$8b_{16}$"
	  6 Bit PRN "xx_{16} "
	  6 Bits "xx_{16} " - extracted from NDTE
	  17 Bits "$xxxx_{16}$"
	  1 Bit

CNAV Message Data Block (238 bits)	Uploaded from MCS
Message Checksum (24 bits)	Generated by SV's onboard navigation processor: Bits 277 -300 comprise the CRC

1.2.3   CNAV Message Types

Table 1-2 lists the currently defined CNAV messages which are defined in APPENDIX III of IS-GPS-200F (GPS Navigation Data Structure for CNAV Data) and APPENDIX II of IS-GPS-705B (GPS Navigation Data Structure for L5 CNAV Data).

Table 1-2: CNAV Message Types

Msg Type	CNAV Message Title	Function/Purpose
0	Default	Default message (transmitted when no msg data is available)
10	Ephemeris 1	SV position parameters for the transmitting SV
11	Ephemeris 2	SV position parameters for the transmitting SV
12	Reduced Almanac	Reduced almanac data packets for 7 SVs
13	Clock Differential Correction	SV Clock differential correction parameters
14	Ephemeris Differential Correction	SV Ephemeris differential correction parameters
15	Text	Text, 29 eight-bit ASCII characters
30	Clock, IONO & Group Delay	SV Clock Correction Parameters, Ionospheric and Group Delay correction parameters (Inter-Signal Correction parameters)
31	Clock & Reduced Almanac	SV Clock Correction Parameters, Reduced almanac data packets for 4 SVs
32	Clock & EOP	SV Clock Correction Parameters, earth orientation parameters; ECEF-to-ECI coordinate transformation
33	Clock & UTC	SV Clock Correction Parameters, Coordinated Universal Time (UTC) Parameters
34	Clock & Differential Correction	SV Clock Correction Parameters, SV clock and Ephemeris differential correction parameters
35	Clock & GGTO	SV Clock Correction Parameters, GPS to GNSS Time Offset parameters.
36	Clock & Text	SV Clock Correction Parameters, Text, 18 eight-bit ASCII characters
37	Clock & Midi Almanac	SV Clock Correction Parameters, Midi Almanac parameters

1.2.4   L2C and L5 CNAV Messages Broadcast Intervals

Table 1-3 lists the L2C CNAV message broadcast intervals as stated in IS-GPS-200F. The L5 CNAV message broadcast intervals are as specified in IS-GPS-705B and require half the time specified in Table 1-3 since the broadcast data rate is 2x that of L2C. An examination of the message broadcast intervals indicates the cyclic timing requirements for specific CNAV message types which are required to support receiver Time-To-First-Fix (TTFF) performance. Based on these cyclic timing requirements, a nominal CNAV message sequence or "Super-Frame" can be constructed. However, the CNAV capability supported and/or implemented by each GPS satellite Block type will determine the message types and the message sequence which can be broadcast over a specified time interval.

Table 1-3: L2C CNAV Message Broadcast Intervals

Table 30-XII. Message Broadcast Intervals		
Message Data	**Message Type Number**	**Maximum Broadcast Intervals** [†]
Ephemeris	10 & 11	48 sec
Clock	Type 30's	48 sec
ISC, IONO	30 *	288 sec
Reduced Almanac	31* or 12	20 min**
Midi Almanac	37	120 min**
EOP	32*	30 min
UTC	33*	288 sec
Diff Correction	34* or 13 & 14	30 min***
GGTO	35*	288 sec
Text	36* or 15	As needed

* Also contains SV clock correction parameters.
** Complete set of SVs in the constellation.
*** When Differential Corrections are available.

[†] The intervals specified are maximum. As such, the broadcast intervals may be shorter than the specified value.

1.3 CNAV Test Program Purpose and Objectives

1.3.1 Test Program Purpose

The primary purpose of this CNAV Test Program is to verify and validate the CNAV message requirements defined in IS-GPS-200F and IS-GPS-705B. The GPS IIR-M L2C PRN ranging codes (CM & CL) generation as well as the GPS IIF L2C and L5 (I5 & Q5) PRN ranging codes generation have been validated during SV contractor requirement verification testing and On-orbit signal testing performed by the GPS Directorate. The CNAV data bits (fixed patterns) have been uploaded and broadcast by the GPS IIR-M and IIF SVs during limited on-orbit test intervals so the basic CNAV capabilities of the GPS IIR-M and IIF SVs have already been demonstrated. However, an underlying focus of this test program is to extensively exercise and assess the CNAV capabilities of the GPS IIR-M and IIF SVs in conjunction with the CNAV message verification and validation process.

A salient aspect of the CNAV Test Program is to facilitate the development of robust modernized civil receivers which take full advantage of the L2C and L5 CNAV message attributes. The L2 and L5 CNAV SIS will support evaluation of civil navigation performance sensitivities to the CNAV message broadcast intervals and support the development of potential new CNAV message types. The CNAV test events will support the development and verification of CNAV message processing functionality implemented by the civil receiver developers.

1.3.2   Test Program Objective and Success Criteria

As previously stated, the primary government objective of the CNAV Test Program is to verify and validate the CNAV requirements specified IS-GPS-200F and IS-GPS-705B.

CNAV Test Program Objectives and Success Criteria

Government Objective #1:
    Verify and validate the CNAV message requirements specified in IS-GPS-200F and IS-GPS-705B.
 	
Government Objective #2:
    Assess the PNT utility of the L2C CNAV messages
 	
Verification Approach:
• Broadcast IS-GPS-200F and IS-GPS-705B compliant CNAV messages from the IIR-M and IIF SVs. The intent of this CNAV Test Program is: (1) Broadcast all currently defined CNAV message types, (2) Comply with the message broadcast intervals defined in the aforementioned specifications and, (3) Support development of an initial CNAV message sequence IAW cyclic timing requirements specified in the IS documents
• Section 1.5 outlines the test strategy that will be employed to generate and verify the CNAV messages.
 	
Success Criteria:
    Verified and Validated (V&V) Government test assets (Table 2-2) successfully acquire and track the L2C and L5 PRN ranging codes and all signal quality metrics comply with the specifications defined in Section 3 of IS-GPS-200F and IS-GPS-705B.
  1) Signal quality metrics for each GPS satellite have already been recorded and assessed against the specifications. Also, quarterly State-of-Health (SoH) L-Band signal quality measurements are recorded and assessed for each GPS satellite by the GPS Directorate.
  2) For each CNAV Live-Sky Broadcast, signal quality metrics will be recorded from each GPS IIR-M and IIF satellite since it is an integral part of the signal acquisition and tracking process.
 	
    V&V Government test assets have verified that the broadcast CNAV message sequence and contents for each GPS IIR-M and IIF satellite for each CNAV test scenario comply with the ISs.
  1) CNAV data bits are successfully demodulated and Viterbi-decoded from the L2C CM and L5 I5 PRN ranging codes: Bit Error Rate (BER) will be the statistical success criteria metric
  2) CNAV message parsing successfully verifies the CNAV message Header and CRC: Message Error Rate (MER) will be the statistical success criteria metric.
  3) The recorded CNAV message from each GPS IIR-M and IIF satellite successfully compares with the CNAV content uploaded to the satellite.
  4) L2C-only (PRN ranging and CNAV) PNT performance will be evaluated when the four in-view condition is satisfied; due to the limited numbers of L2C CNAV capable satellites, the four in view condition occurs in small blocks of time and the Geometric Dilution of Precision (GDOP) will not be optimal.
  5) L5-only CNAV PNT evaluation will not be considered due to the small number of IIF satellites; however the L5 pseudorange measurements in combination with the L2C pseudorange measurements, L1C/A pseudorange measurements, and CNAV will be evaluated in hybrid dual-frequency and triple-frequency PNT solutions which are then compared against the corresponding L5, L2C, L1C/A, LNAV hybrid dual-frequency and triple-frequency PNT solutions. Since the only difference between the corresponding hybrid dual-frequency and triple-frequency PNT solutions is the use of CNAV message data versus the use of LNAV message data, a positive CNAV benefit to accuracy can be quantified. The hybrid PNT solution is the mixed utilization of the different GPS PRN code pseudorange measurements.
  6) Sufficient CNAV message data is collected to assess CNAV message utility

Achieving the success criteria is reliant on the following three capabilities: (1) The ability to generate the CNAV content for the GPS IIR-M and IIF satellites using the MODNAV Tool; (2) the ability of the AEP

system to process the CNAV upload files, generate S-Band uploads, and transmit them to the specified SVs and; (3) the ability of the GPS IIR-M and IIF satellites to process and transmit the CNAV messages and (4) the ability of the receivers to process the L2C and L5 signals to produce a PNT solution.

1.3.3   Civil Receiver Development Goals

A key outcome of the CNAV Test Program's success is the performance evaluation and utility assessment of the L2C and L5 signals by the civil community. A goal of the GPS Directorate is to promote participation and CNAV performance feedback from the civil receiver developers. Compliance with the ISs is purely voluntary since the modernized GPS civil signals are open source signals.

CNAV Test Program Civil Goals

Modernized Civil Receiver Goal:
    Facilitate the development of robust GPS L2C and L5 Civil receivers by the civil receiver developers to comply with the ISs.
    • Identify civil performance sensitivities to message delivery intervals and message types
    • Support CNAV CONOPS development
 	
Success Criteria:
    Civil L2C and L5-capable receivers successfully demonstrate CNAV signal processing:
    1) Acquire and track the L2C and L5 PRN ranging codes
    2) Demodulate and Viterbi-decode the L2 and/or L5 CNAV data bits
    3) Correctly parse and verify the CNAV message Header and CRC
    4) Correctly process the broadcast CNAV messages from all IIR-M and IIF satellites
    5) Accurately generate a CNAV-based PNT solution
    6) Record sufficient CNAV message data to assess CNAV message utility

1.4   **CNAV Test Strategy**

The GPS Directorate's CNAV test strategy leverages the TT&C subsystem and Kalman filter data elements of the current AEP system to support generation of the CNAV messages by the MODNAV Tool. The key elements of this strategy are shown in Figure 1-3. This test process flow will occur daily and starts with the extraction of the clock, ephemeris and almanac information from the AEP system's Kalman filter database to construct accurate CNAV message content for each IIR-M and IIF SV. This information is transferred to the MODNAV Engineering Test Tool where the specified CNAV messages and SV unique structures are generated for the GPS IIR-M and IIF SVs. The CNAV upload file for each SV is transferred/loaded onto the AEP system where 2 SOPS will utilize the AEP TT&C subsystem to transmit the CNAV uploads to the GPS IIR-M and IIF SVs. At the upload activation time, the CNAV message content will be modulo-2 added to the L2C CM ranging code and the L5 I5 ranging code.

CNAV Message Generation Process:
   1) Generate clock, ephemeris, and almanac data
   2) Construct CNAV message types, message content, NAV Data Table Elements (NDTE) structures, Master Frame structures
   3) Construct IIR-M CEs and IIR-M and IIF CNAV uploads
   4) Format CNAV uploads into ICD-GPS-401 (IIR-M) and ICD-GPS-601 (IIF) Uploads

CNAV Message Validation:
L-Band signal processing by the GPS Directorate test assets [i.e. the Modernized Signal Test Asset (MSTA), the Modernized Receiver Test Asset (MRTA), the [Advanced Global Navigation Simulator (AGNS)] AGNS Test Station (ATS), GPS Navigation Analysis Tool (GNAT), and the MAGNET; see Table 2-2] will support the validation of the broadcast CNAV message content as compared with the CNAV upload file for each GPS IIR-M and IIF satellite.
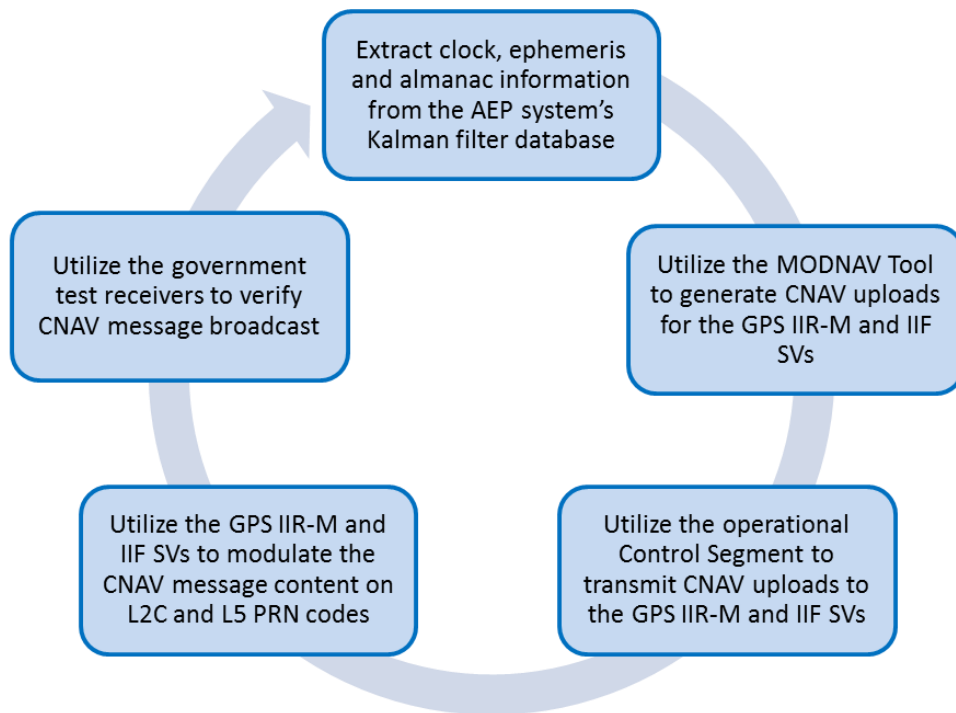
Figure 1-3: CNAV Test Process Flow

1.5 GPS Reference Documents

Table 1-4 provides a list of the pertinent GPS Space to User Segment specifications for the civil community.

Table 1-4: GPS Reference Documents

Document Number	Title	Date	Originator
IS-GPS-200F	Navstar GPS Space Segment / Navigation User Segment Interfaces	21 Sep 2011	GPS Directorate (SMC/GP) Space & Missile Systems Center (SMC)
IS-GPS-705B	Navstar GPS Space Segment / User Segment L5 Interfaces	21 Sep 2011	GPS Directorate (SMC/GP) Space & Missile Systems Center (SMC)

1.6 CNAV Test Event Conditions and Constraints

1.6.1 CNAV Test Event Conditions

Table 1-5 provides the SVN to PRN mapping for the current GPS IIR-M and IIF satellites; the PRN assignments are not expected to change but PRN re-assignments are possible so the users should confirm the PRN assignments prior to each test event. Also, the number of SVs listed in Table 1-5 will change as new IIF SVs are launched or when SVs are retired.

Table 1-5: SVN to PRN Mapping

GPS Block Type	SVN #	PRN #
IIR-M	48	07
IIR-M	50	05
IIR-M	52	31
IIR-M	53	17
IIR-M	55	15
IIR-M	57	29
IIR-M	58	12
IIF	62	25
IIF	63	01
IIF	65	24

1.6.2 CNAV Messages

The CNAV message types containing Almanac, Clock, Ephemeris, and other SV parameters deliver higher precision representations of the quasi-Keplerian parameters than those contained in the Legacy navigation message. CNAV provides a more accurate SV position estimate. Modernized civil signal users are advised not to mix the CNAV message data with the Legacy navigation message data in any receiver algorithm or application. Per IS-GPS-200 30.3.1, comingling or cross-utilization of the CNAV and Legacy data is not recommended.

IS-GPS-200F and IS-GPS-705B identifies undefined and unused CNAV message types to be reserved for future use but does not indicate or specify what the receiver should do if they receive an undefined or unused message type. Operationally, the MCS will never intentionally command an SV to broadcast an undefined CNAV message; however, the potential exists that outdated CNAV-capable receivers may encounter this condition as new CNAV message types are defined. Therefore it is recommended that all modernized civil receivers should be able to successfully process the 38-bit CNAV message Header and 24-bit CRC of the undefined or unused messages without impacting receiver navigation performance or message processing functionality. The contents of the 238-bit message data block of the undefined or unused messages should be discarded or sent to the receiver output port with an associated error status indicator. Also, the reserved bit fields specified in the CNAV message types will be filled with non-zero random values; these values will change over time.

Message types 10, 11, and 12 will convey Almanac, Clock, Ephemeris, and URE information. The data utilized to construct message types 10, 11, and 12 will be derived from the Kalman filter data tables which reside on the current AEP System in the MCS. The data will be fitted to provide the higher precision representations and accuracy required to meet the IS requirements.

Message type 30 will convey the ionospheric and the *new* Inter-Signal Correction (ISC) values to the single and dual frequency users. The broadcast group delay differential correction values will support receiver pseudorange processing validation. During one of the CNAV test scenarios, the bit string "1000000000000" will replace the ISC values to indicate that the group delay values are not available.

Table 1-6 provides *example* measured values for the Inter-Signal Correction (ISC) parameters for the current GPS IIR-M and IIF SVs; these values will be updated prior to each CNAV broadcast. Also, the ionospheric parameters broadcast in the message type 30 are identical to the values broadcast in the Legacy message; these values will be extracted from the AEP system for utilization in message type 30.

Table 1-6: Example Inter-Signal Correction (ISC) Values

SV Type	SVN	L1C/A	L2 P(Y)*	L2C**	L5 I5**	L5 Q5**
IIR-M	48	0	6.9	7.3		
	50	0.8	5.7	4.7		
	52	0.5	8	8.6		
	53	-0.1	6.6	6.8		
	55	0.5	6.1	4.8		
	57	0	5.4	4.8		
	58	0	7.5	7.3		
IIF	62	-0.6	-3.3	-2.6	-0.8	0.3
	63	-1.2	-5.4	-7.0	-2.1	-2.5
	65	1.2	-2.7	-1.0	1.6	3.0

Notes:
(1) All ISC values are referenced to L1 P(Y), * Directly from SV Tgd value, ** Based on SV Tgd value
(2) Accuracy index for all codes for a specific SV will be consistently the same
(3) SVN49 is not included

Message type 32 will convey the EOP data needed to construct the ECEF-to-ECI coordinate transformation.

Message type 33 will convey the required parameters needed to relate GPS Time to UTC (USNO), and notice to the user regarding the scheduled future or recent past (relative to Nav message upload) value of the delta time due to leap seconds (DtLSF), together with the week number (WNLSF) and the day number (DN) at the end of which the leap second becomes effective.

Message type 15 will convey the following text message: "THIS IS A GPS TEST MESSAGE**"**

Message Type 35 provides the parameters related to correlating GPS time with other GNSS time. If available, SMC/GP will acquire the GPS/GNSS Time Offset parameters from the United States Naval Observatory (USNO); otherwise Bits 155 through 157 will be set to zero; indicating no data is available.

1.6.3   CNAV Status Flags

During this CNAV Test Program, the L-Band Channel Health Status bits in message type 10, as shown in Figure 1-4 for L2 and L5, may differ from the L1Channel Health Status bit. However, the L1 status bit will always correspond to the SV Health bit indicated in the Legacy NAV message (i.e., Subframe #1 and #5). The L-Band Channel Health status bits should be processed independently by the receiver. The initial broadcast (24 hours) of message type 10 will have the L2 and L5 channel health status bits set to zero; civil feedback will be evaluated prior to setting the L2 and L5 channel health status to one. Also, SV health status given in messages type 12 (Almanac) during CNAV testing may differ from that shown in other messages of the transmitting SV and/or other SVs since the latter may be updated at a different time.

The Alert Flag will correspond to the setting broadcast in the Legacy navigation message. As stated in the IS requirements when the Alert Flag is set to a logical one ("1"), it will indicate to the Standard Positioning Service (SPS) users that the signal URA may be worse than indicated: users shall use the SV at their own risk. The URA index value broadcast in the L2C and L5 CNAV is independent from the Legacy NAV message; however, the URA index broadcast in message type 10 will be derived from NAV performance

data extracted from the AEP system so it will accurately reflect the URA for the broadcast data set.

The Integrity Status Flag will be set to zero since the MODNAV Tool will be utilized to generate the CNAV messages; stale data may be broadcast due to latencies in the CNAV upload intervals. However, the Integrity Status Flag may be set to one if requested by the civil community during future CNAV test events. The L2 Phasing Flag will be set to zero for all CNAV testing; carrier phase reassignment of any of the L2 codes will not be performed. L2C will remain in phase quadrature to P(Y) code. A logical zero indicates phase quadrature, with the L2C lagging the L2 P(Y) by 90 degrees, and logical one indicates that L2C and L2 P(Y) are in-phase.
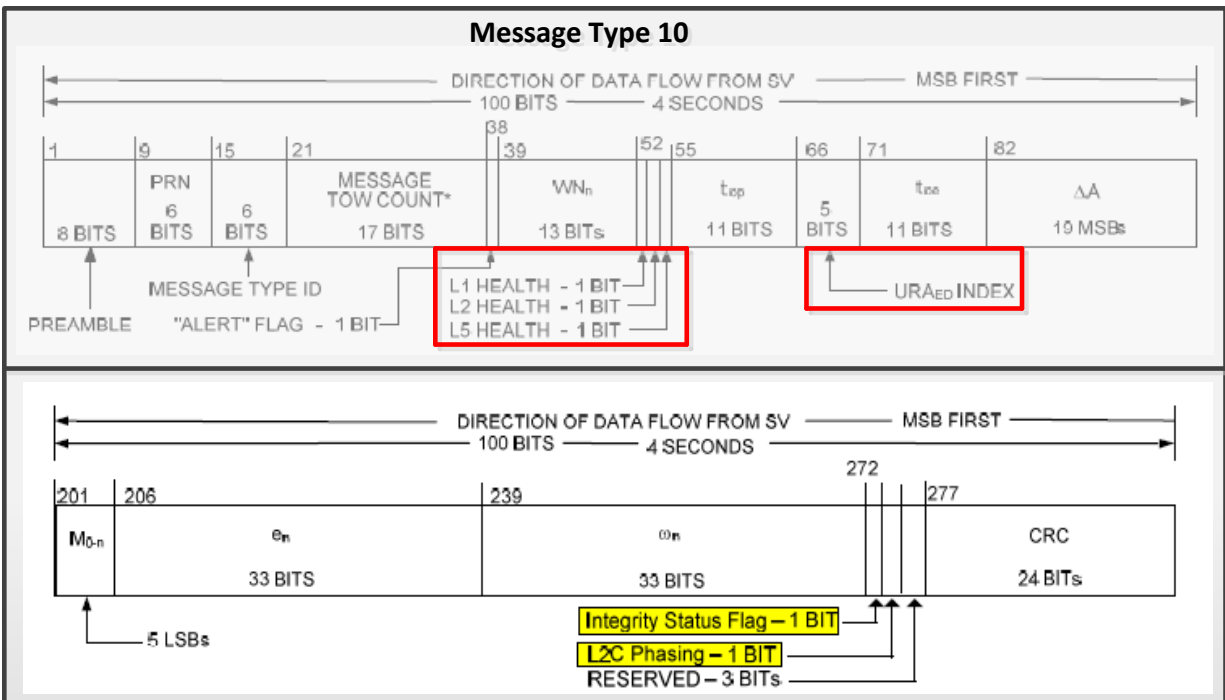
Figure 1-4: CNAV Status Flags

1.6.4   IIR-M and IIF CNAV Implementations

CNAV implementations on the GPS IIR-M and IIF SVs are completely different; therefore the message sequence and message broadcast intervals will be unique to each GPS SV Block Type.

GPS IIR-M CNAV Implementation:
The GPS IIR-M CNAV message sequence is implemented using a 4 x15 array structure; 4 message slots by 15 minor frames to construct a single CNAV master frame. Figure 1-5 illustrates the (slot/ minor frame) master frame concept. The implementation uses three logical pages of memory (slots 1 & 2 are combined on one logical page and slots 3 and 4 use one logical page each) to implement the CNAV Master Frame. Message types 10 and 11 (Ephemeris) will always be broadcast in message slots 1 and 2 in all 15 minor frames. Slots 3 and 4 can contain up to 48 CNAV messages each. The 4x15 structure and the limited number of logical pages of memory imposes a constraint on the CNAV message types which can be broadcast over specific time interval; only a single master frame sequence can be broadcast without consuming more logical pages of memory. Therefore, it is envisioned that the CNAV message sequence broadcast from the GPS IIR-M will be different from that broadcast by the GPS IIF.

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IIR-M CNAV Message Structure

Msg Type 10	Msg Type 11	Msg Type X	Msg Type X

Slot #1 and #2 — Slot #3 — Slot #4

30 Datasets — 48 Msgs/Dataset

Minor Frame

CNAV Message Array Single Master Frame

	Minor Frame #1	Minor Frame #2		Minor Frame #15
Slot #1	Msg Type 10	Msg Type 10	. . . .	Msg Type 10
Slot #2	Msg Type 11	Msg Type 11	. . . .	Msg Type 11
Slot #3	Msg Type X	Msg Type X	. . . .	Msg Type X
Slot #4	Msg Type X	Msg Type X	. . . .	Msg Type X

Figure 1-5: IIR-M CNAV Implementation

GPS IIF CNAV Implementation:

The GPS IIF CNAV message sequence is implemented using a 1x420 flexible message index array which can implement a unique CNAV master frame size or mimic the 4x15 CNAV master frame implemented by the GPS IIR-M SVs. The IIF SVs can implement up to seven 4x15 CNAV master frames all of which can have different message types and message sequences defined. Multiple master frames can be implemented in a single MNAV upload (i.e. alternating master frame) Figure 1-6 illustrates the flexible message repeat cycle which can be implemented by the IIF SVs.

1x420 Flexible CNAV Message Array

CNAV Msg # 1	Msg Type X
CNAV Msg # 2	Msg Type X
CNAV Msg # 59	Msg Type X
CNAV Msg # 60	Msg Type X
CNAV Msg # 419	Msg Type X
CNAV Msg # 420	Msg Type X

Mimic 4x15 Master Frame

Seven 4x15 Master Frames

Figure 1-6: IIF CNAV Implementation

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In the event of a message generation failure, the GPS IIR-M and IIF navigation data units will broadcast message type 0 (Default message) for the specified message interval; CNAV message type zero consists of alternating ones and zeroes with valid message header and CRC. Message type 0 will also be broadcast if no CNAV data and/or control elements have been uploaded to the SVs.

1.6.5   CNAV Master Frame Concept

Section 1.6.4 provided a brief summary of the CNAV messaging structures implemented by the GPS IIR-M and GPS IIF SVs. As illustrated in Figure 1-6, the GPS IIR-M SVs implemented a fixed 4x15 CNAV message structure. This 4x15 structure defines the CNAV Master Frame supported by the GPS IIR-M SVs. The GPS IIR-M SVs support one (i.e. a single) active master frame at any given point in time. More than one CNAV Master Frame can be implemented at the cost of increased SV memory consumption, which increases required CNAV upload frequency for the Control Segment. Figure 1-5 illustrates the basic CNAV Master Frame concept for the GPS IIR-M SVs.

As illustrated in Figure 1-6, the GPS IIF SVs can support multiple 4x15 CNAV Master Frames or any variable CNAV Master Frame structure by mapping the 1x420 message array to mimic multiple 4x15 structures; up to seven unique CNAV Master Frames can be active at a given time. Therefore an alternating or sequential series of master frames can be implemented; however the 1x60, 1x120.... 1x420 message sequences must conform to the CNAV message broadcast intervals defined in Table 1-3Table 1-6.

CNAV Master Frame Message Structure															
	Minor Frames														
Slot#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Slot 1	X.x	X.x	→												X.x
Slot 2	↓	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x
Slot 3		X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x
Slot 4	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x	X.x

Figure 1-7: L2C and L5 CNAV Master Frame Structure

The CNAV Master Frame structure supported by this test program will conform to the 4x15 Master Frame structure shown in Figure 1-7. During this test program, the GPS IIF SVs will be uploaded with CNAV structures which implement multiples (1, 2, 3.... 7) of this CNAV Master Frame structure. The 4x15 CNAV Message broadcast sequence is as follows: the CNAV message contained in Slot 1/Minor 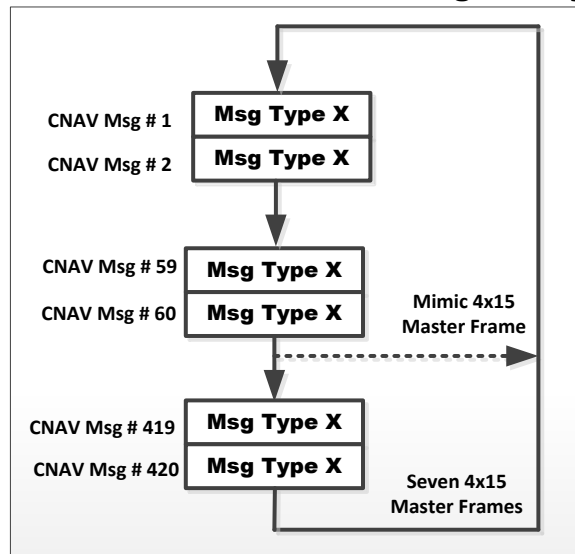Frame 1 is broadcast first and is followed by Slots 2, 3, and 4. The CNAV message contained in Slot 1/ of Minor Frame 2 is broadcast after all CNAV messages identified in Minor Frame 1 have been broadcast. This sequence will continue through Slot 4 of Minor Frame 15 after which the process will be repeated.

1.7   **System Constraints**

1.7.1   SV Visibility Constraints

The SV type and orbits, coupled with the user's location, determine the number CNAV-capable SVs that are visible at a specific location and time. This condition will persist until the constellation is fully populated with L2C and L5 capable SVs. SV visibility plots of the current GPS IIR-M and IIF SVs illustrates how the current IIR-M and IIF SV geometry determines the four in-view condition. The limited number of IIR-M and IIF SVs broadcasting CNAV will impact receiver PNT performance evaluation:
- Limited four in-view time frames; currently ten L2C CNAV SVs and three L5 CNAV SVs
- Non-optimal Geometric Dilution of Precision (GDOP) during visibility window

1.7.2   Operational Control System (OCS) Constraints

The following OCS constraints have been identified and will require collaboration and coordination within the US Air Force to support CNAV Live-Sky testing. SMC/GP has developed and implemented methods to work around the identified constraints and has successfully demonstrated these methods during previous Live Sky testing.

1.7.3   MCS (AEP System) Constraints

(1) CNAV Upload Generation Constraints:
The AEP System does not fully support the modernized functionality of the GPS IIR-M and IIF SVs (i.e. CNAV and M-Code); the generation of CNAV message data and uploads. AEP does support the capability to format and transmit the CNAV uploads to the IIR-M and IIF SVs using the AEP TT&C Subsystem. SMC/GP developed the MODNAV Tool to construct the required data elements and generate the CNAV message uploads.

(2) OCS Monitor Stations (MS):
The current Monitor Station Receiver Element (MSREs) located at the MSs do not have the capability to process the L2C and L5 PRN ranging codes (signal acquisition and tracking process). Operationally, the MSs only actively monitor the L1 and L2 P(Y)-Code signals. Therefore, the AEP Kalman filter is only providing P(Y)-Code pseudorange measurements. Accordingly, non-crew personnel from SMC/GP utilize modernized signal test assets to observe and record the CNAV messages from the IIR-M and IIF SVs. Government analysis teams will compare the CNAV uploads with the recorded CNAV data streams broadcast by each IIR-M and IIF SV.

(3) CNAV Data Dependency :
AEP Kalman filter data elements (i.e. clock, ephemeris and almanac data) will be used to generate the CNAV message content for message types (10, 11, 12, 13, 14, 30, 31, 32, 33, 34, and 37). A MODNAV Tool application which resides on the AEP system, will extract all the necessary data from the Kalman filter data tables to support generation of the aforementioned CNAV message types. Transferring data from/to the AEP system and the MODNAV Tool laptop will be via CD media. SMC/GP is working to replace this manual process with a more automated process to support future CNAV testing.

(4) Satellite Command and Upload Latency:
Time is required for AEP to initiate contacts while waiting for a given satellite to come into view of a ground antenna. For this reason, it will take up to 4 hours (depending on SV visibility) to activate Test Scenarios #3 through #7 (time is required to go up on a contact for each of the ten satellites used in these scenarios) and hours to deactivate them. In the event of an integrity anomaly affecting all CNAV signals, it could be hours before all uploaded SVs are commanded back to the default configuration, broadcasting only message type 0.

1.8   **Operational Environment**

1.8.1   CNAV Test Notification

SMC/GP has announced, through the Federal Register, intent to conduct CNAV Live-Sky Broadcast and provided 45 days for public review of the test plan. The test plan is available on the Federal Register on the U.S. Coast Guard Navigation Center (NAVCEN) webpage. Additionally, CNAV Test Bit Files will be posted to support CNAV message processing development.

1.8.2   Test Support Concept

2 SOPS has responsibility and accountability for the health, safety and performance of the GPS IIR-M and IIF SVs during the execution of CNAV test activities. 2 SOPS will retain Satellite Control Authority (SCA) during all CNAV test activities.   All operational assets supporting the CNAV activities are under the orders of 2 SOPS Commander (2 SOPS/CC), 2 SOPS Director of Operations (2 SOPS/DO) or under the designated Mission Director explicitly delegated that authority. The nominal day-to-day operations of the GPS constellation remain under the orders of the 2 SOPS/CC, 2 SOPS/DO. The 2 SOPS/DO or designated representative shall have the power and flexibility to suspend or terminate the CNAV testing based on current operations in progress. Any SV or AEP anomaly may result in the suspension or termination of CNAV testing.

Without exception, the Legacy mission takes precedence over any CNAV testing. If 2 SOPS is required to perform a Mission Ops Transfer (MOX) to the Alternative Master Control Station (AMCS), or if an SV anomaly occurs or an operational event requires the termination of CNAV testing; all CNAV test activities will be terminated and 2SOPS will configure the GPS IIR-M and IIF SVs back to the nominal L-Band configuration as defined in Table 3-1. This will require contacting each GPS IIR-M and IIF SV and deleting the CNAV logical pages.

1.8.3   Test Event Conduct

All CNAV commanding will be performed from the MCS operations floor and will run concurrently with normal MCS operations. The required CNAV uploads for GPS IIR-M and IIF SV will be provided by SMC/GPEV with support from the GPS IIR-M and IIF SV contractors. SMC/GPEV will provide technical support for each CNAV test event and verification of the L-Band signals. The GPS IIR-M SVs (except SVN49) and IIF SVs, will remain healthy during all CNAV test activities. CNAV upload activities will be performed during the normal SV contact flow when possible. Schedule Requests (SRs) may be initiated to support CNAV testing. 2 SOPS will assign an Operations Test Director (OTD) who will be responsible for directing and coordinating the operational support for all CNAV test activities. Test conduct review meetings will be held daily or periodically, at the discretion of the OTD and the Test Director (TD). This will occur during the course of each test event to review testing progress, to assess test direction, to identify issues, assign actions, and to discuss planning for the next day's activities. Test status reviews will be conducted at the beginning and/or end of each test day to disseminate information.

1.8.3.1   Mission Integrity and Safety

The number one priority is to ensure the integrity and safety of the current GPS mission (i.e. Legacy signal PNT performance), the space and control segment systems, and personnel while conducting all CNAV test and evaluation activities which use operational assets. All space and control assets will be under the direct control and authority of 2 SOPS during all phases of CNAV testing. The GPS Operations Center (GPSOC) will report any indication from users that Legacy PNT performance is being disrupted or degraded due to the CNAV testing.

1.8.3.2   L-Band Signal Monitoring (Legacy Signals)

The 2 SOPS Crew Commander will actively poll his/her crew for any conditions or anomalous events during nominal operations. The test and operational crews will actively monitor all satellite contacts and ground systems (i.e. MSs, MCS, etc.) for any anomalous conditions. The 2 SOPS Crew Commander will notify the 2 SOPS Mission Director of any condition which may lead to a test termination decision.

1.8.3.3   CNAV Test Termination

During the live-sky broadcast, 2 SOPS has the discretion to standup a test termination net. This is similar to a "Cease Buzzer" operation, however since CNAV is already being broadcast by the IIR-M and IIF SVs and the Legacy receiver equipment has no capability to process the CNAV signals the "Go/No Go" criteria is not applicable. Only the agencies identified in 4.4.4 may make a request to terminate the CNAV test. At any time during the test, if an agency identified in 4.4.4 identifies a negative impact attributed to CNAV operations, the representative for that agency can call for a "Test Termination". To request a test termination net, call the 2 SOPS Mission Commander at (719) 567-3219, DSN 560-3219. A test termination net will then be set up at (719) 567-1536, DSN 560-1536.

If a "Test Termination" call is directed by the Mission Director / Test Director, 2 SOPS will take immediate action to delete the CNAV uploads from the SVs; no L-Band configuration changes are required. Once all satellites have been returned to a normal operating mode, all representative entities will be notified. Additionally, an email report will be sent to leadership and supporting agencies.

1.8.3.4   CNAV Test Suspension/Resumption Criteria

During testing, if the following appears to impact the Legacy mission, the identified SV will be immediately set unhealthy until the root-cause can be determined:

(1) User reports of degraded constellation PNT performance.
(2) The identified GPS IIR-M or IIF SV Estimated Range Deviations (ERDs) is above specified thresholds (as specified by 2 SOPS).
(3) GPS IIR-M or IIF SV L-Band SIS is not compliant with the expected CNAV structure

If the anomaly is specific to the modernized civil signals then it does not mean the affected SV needs to be set unhealthy. The cause may be easily corrected without setting the SV unhealthy. A Situation Assessment and Recovery Team (SART) will be formed at Schriever AFB to determine root cause. If root cause is determined to be linked to CNAV commanding, then this will constitute a suspension of the testing.

1.8.4   CNAV Test Termination Criteria

Test event execution will be terminated, if an unscheduled event occurs during the test:

1) Any participating government agency (4.4.4) who determines that the GPS service, whether provided by legacy or CNAV signals, poses a risk to safety of life or safety of flight, may request a CNAV Test Termination.
2) Any participating government agency (4.4.4) reporting a Priority 1 or 2 GPS outage will justify an immediate termination of CNAV testing:
    • Priority 1 is defined as an on-going outage affecting multiple, independent sites/users and
    • Priority 2 is defined as an outage that has ceased, but affected multiple, independent sites/users and was a Critical infrastructure
3) Any participating government agency (4.4.4) reporting a Priority 3-5 GPS outage will be evaluated by SMC/GP before forwarding the request to 2 SOPS for termination of CNAV testing:
    • Priority 3 is defined as an on-going outage affecting multiple, independent sites/user, but is not a critical infrastructure.
    • Priority 4 is defined as an outage that has ceased, but affected multiple, independent sites/users, but was not a critical infrastructure.

- Priority 5 is all other reports. These other reported outages will be evaluated to determine if the reported location falls within the footprint of an active CNAV satellite and the time of report falls within the time of CNAV operations. Although a single reported outage (other than "Safety of Life" or "Safety of Flight") will not constitute a test termination, multiple correlated outages may result in test termination.

4) If 2 SOPS determines CNAV testing impedes or prevents their ability to upload the GPS satellite constellation, it shall terminate the CNAV Test.
5) If 2 SOPS determines one of the IIR-M or IIF SVs incurs an anomaly which degrades Legacy PNT performance, 2 SOPS may terminate the CNAV Test.
6) If 2 SOPS is directed by chain of command to support a real world operation, 2 SOPS may terminate the CNAV Test.
7) If 2 SOPS performs a mission Ops Transfer to the AMCS, 2 SOPS shall terminate the CNAV Test.
8) If 2 SOPS determines the OCS fails to track Y-Code from any IIR-M or IIF SV by multiple OCS MSREs with co-visibility, 2 SOPS may terminate the CNAV Test.
9) If 2 SOPS determines the OCS fails to track C/A-Code and/or Y-Code from any IIR-M or IIF SV by multiple National Geospatial-Intelligence Agency (NGA) MSs with co-visibility, 2 SOPS may terminate the CNAV Test.
10) If 2 SOPS determines there are any indications from SV telemetry that SVs are experiencing out-of-tolerance condition, the 2 SOPS may terminate the CNAV Test.

External Test Termination Requests (4.4.4):
All requests for test termination shall contain the following information:
1) Requestor identification (i.e. name, unit/organization, unit/organization location)
2) Reason for test termination (e.g. safety-of-life, safety-of-flight, OPSEC, operational mission)
3) Telephone contact information
4) Type of receiver platform or facility
5) Summary of indications (total loss of GPS track, …)

1.8.5   Contingency Actions

The contingency recovery actions and associated recall time is dependent on the SV anomaly type and severity. If required, the GPS IIR-M and IIF SVs can be commanded back to the Legacy configuration once the SV contact has been established; recall time is dependent on the time required to establish an SV contact. Once contact is established, SV commanding to the Legacy L-Band configuration is on the order of minutes. If the anomaly is constrained to the CNAV content, the CNAV Team will generate a new CNAV upload and 2 SOPS will transmit the upload at their convenience since the old upload will be superseded.

In the event of CNAV Asynchronicity, 2 SOPS will set the SV unhealthy and the CNAV upload will be deleted and replaced with CNAV Msg Type 0 until the issue is resolved to avoid excessively stale CNAV data from being broadcast. Asynchronicity refers to potential differences between LNAV and CNAV uploads. Generating uploads from different K-points can result in asynchronous behavior due to differences in pseudorange measurements received from the OCS monitor stations and/or NGA. There is no guarantee that we will be uploading CNAV to each SV for each day during the test period; this will be dictated by real world conditions but may not necessitate a test termination.
1) IIR-M or IIF SV Recovery Method:
   - Delete the CNAV logical pages contained in MDU (IIR-M) or NDU (IIF) memory
   - Upload CNAV Msg Type 0 content into MDU (IIR-M) or NDU (IIF) memory

SECTION II – TEST SUPPORT RESOURCES and DATA Collection

2.   Test Support Resources

2.1   Government GPS Operational Resources

The following Government operational resources will be used to support CNAV Live-Sky Broadcasts:
- Control Segment Resources:
    1) The MCS (Mod 11), located at Schriever AFB
    2) All remote Ground Antenna (GA) resources
    3) NGA L-Band signal monitoring resources
    4) GPS Operations Center (GPSOC)
    5) Lockheed Martin Space Systems Company Operational Support System (OSS); IIR-M telemetry processing
    6) Boeing Integrated Mission Operations Support Center (IMOSC); IIF telemetry processing
- Space Segment Resources:
    1) Seven IIR-M SVs (SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58)
    2) All IIF SVs (currently available On-orbit IIF SVs: SVN62, SVN63, SVN65)

2.2 SMC/GP Test Support Resources

2.2.1   CNAV Upload Generation Tool

Table 2-1 lists the functions performed by the Modernized Navigation (MODNAV) Engineering Test Tool.

Table 2-1: SMC/GP CNAV Upload Generation Tool

Hardware/Software	Qty	Purpose	Location	POC
MODNAV Tool Laptop/ Application Suite	1	CNAV Message Generation Application 1) Generate clock, ephemeris, and almanac data 2) Construct CNAV message types, message content, NDTE structures, Master Frame structures 3) Construct IIR-M CEs and IIR-M and IIF CNAV uploads 4) Format CNAV uploads into ICD-GPS-401 (IIR-M) and ICD-GPS-601 (IIF) Uploads	SAFB/ MCS	SMC/ GPEV MODNAV Team

2.2.2   CNAV Upload Generation and Archival

The MODNAV Laptop Tool will store each modernized upload generated for each GPS IIR-M and IIF SV for each test scenario. These SV unique upload files will be used to verify that the broadcast CNAV data from each IIR-M and IIF SV was in compliance with the uploaded CNAV message content for the specified time.

The CNAV bit streams recorded by the SMC/GP test assets will be utilized to construct the CNAV Bit Files defined in Annex B. These validated CNAV Bit Files will act as truth sources for the specified CNAV test scenario. The CNAV bit file record size will be variable and constrained by the visibility window of the geographical location of the SMC/GP test asset.

2.2.3   Government CNAV Data Collection Plan

L2C and L5 CNAV data collection and verification is an integral part of SMC/GP's L-Band SIS validation activities. To support this performance assessment the GPS Directorate will utilize the test assets listed in Table 2-2.

Monitoring of the L-Band signals during CNAV commanding is a critical element to verifying the CNAV uploads activated at the specified times. The MSTAs, MRTAs and ATS will be used to verify the L-Band configuration of each GPS IIR-M and IIF SVs during each scheduled CNAV T&E event. Both MSTA and MRTA receivers will be operated in continuous track mode during testing to provide real-time verification of CNAV message verification of the GPS IIR-M and IIF SVs. The MSTAs and/or MRTAs will be used to satisfy the data collection requirements which are required to meet the success criteria. The CNAV data bits will be collected for each GPS IIR-M and IIF SV during their visible pass for the duration of each test event.

Table 2-2: SMC/GP Data Collection Resources

System/Receiver	Qty	Purpose	Location	POC
MSTA Systems	2	System (10ft reflector antenna) – Verifies the L-Band signal structures for each GPS SV; one SV at a time. Records all NAV data streams (Legacy, CNAV and CNAV)	SRI	SRI
MRTA Systems	2	PVT Mode: Tracks four GPS SVs at a time; Records all NAV data streams (Legacy, CNAV and CNAV)	CCAFS	Draper
MRTA II	2	Tracks eight SVs at a time, Records all NAV data streams (Legacy, CNAV and MNAV); pseudorange measurements	CCAFS	Draper/ MITRE
ATS	1	Provides raw measurement data in real time; complete pseudorange measurement results and all navigation data bits	SPAWAR	SPAWAR
" "	2	Modernized civil GPS Receiver	SPAWAR	SPAWAR
" "	2	Modernized civil GPS Receiver	SPAWAR	SPAWAR
MAGNET	1	Developmental Software Defined GPS Receiver	Aerospace	Aerospace

2.2.4   Civil CNAV Data Collection and Analysis

The following organizations will be involved in the CNAV Test data collection and analysis process. Although none of this data is used for real-time operations by the 2 SOPS, the data will be used to provide SMC/GP with valuable information both during and after the test.

2.2.4.1   FAA CNAV Data Collection and Analysis

The FAA will operate several receivers for data collection and monitoring. The primary data collection site is at the FAA Technical Center near Atlantic City, New Jersey. The WAAS Test Team has the capability to monitor WAAS and GPS performance continuously, throughout the WAAS coverage area.

Two sites have receivers which can track the L2C and L5 signals, and CNAV. These are Mauna Loa, HI, and Atlantic City, NJ. The Mauna Loa site has a single Trimble NetR5 receiver. At Atlantic City, a Trimble NetR5, a Javad Delta, and several NovAtel receivers make up the receiver suite. All of these receivers can process L2C, L5 and CNAV. Observable measurements are recorded at a one-hertz rate, and all CNAV messages from L2 and L5 are recorded.

In the Fall of 2013, a small network of twelve NovAtel G-3 receivers at six sites will be added to the WAAS network for evaluation. This receiver type will become the standard WAAS receiver in the future, and will eventually replace all the existing G-2 receivers. The G-3 can track L1 C/A, L1C, L2C, and L5, and provide data through a dedicated network to the Tech Center. This will improve the FAA coverage area for CNAV, using a more robust architecture than the initial test network.

For backward compatibility, WAAS will be monitored to identify any anomaly of legacy services. WAAS operates a network of 35 sites in North America to provide signal corrections and assure integrity levels for flight operations. WAAS uses L1 C/A and L2 P semi-codeless signal tracking, but does not yet have any L2C or L5 receiving capability. The WAAS coverage area includes all of North America, and typically has twelve to fifteen GPS SVs in view at any time.

The WAAS Test Team processes data to support performance analysis of GPS signals. The new signals and messages will be added to the analysis to evaluate CNAV and the associated PNT performance. CNAV bits will be recorded and analyzed, and receiver measurements will be used in various combinations to evaluate PNT performance. PNT will be evaluated for single-frequency and dual-frequency solutions, and possibly some hybrid solutions. In the case of L5, it is unlikely that sufficient SVs will be in view to compute a solution. L5 range analysis will be performed to estimate range error of the new signal. Note that no performance standards apply to any of these except for the L1 C/A-only case. Results will merely estimate future performance which may be attained when a full constellation of L5 SVs is achieved.

After accounting for network delay, each data sample is recorded and processed in real-time by the WAAS Test Team. Local terminals provide real-time status and results, and these can be replicated on a web site with a three-minute update rate. The results available will include decoded CNAV parameters, message types, and estimated position or range errors, and orbit accuracy.

2.2.4.2   NGA CNAV Data Collection and Analysis

NGA currently records the L2C CNAV bit streams from their monitor stations. Post-processing of the CNAV bit streams will be implemented in the future.

SECTION III – CNAV TEST AND EVALUATION METHODOLOGY

3. Test and Evaluation Methodology

3.1 CNAV Commanding Approach

All CNAV commanding will be performed from the GPS Master Control Station (MCS), located at Schriever AFB, and will run concurrently with normal MCS operations and CNAV test periods. The CNAV message sequence broadcast from each GPS IIR-M and IIF SV will be controlled by the GPS Directorate and will be tailored to support specific CNAV test scenarios defined in the test plan. The required CNAV uploads for GPS IIR-M and IIF SV will be provided by SMC/GPEV with support from the GPS IIR-M and IIF SV contractors. The GPS IIR-M SVs (except SVN49) and IIF SVs, will remain healthy (i.e., not set unhealthy) during all CNAV test activities. CNAV commanding and upload activities will be performed during the normal SV contact flow when possible. Schedule Requests (SRs) will be initiated to support CNAV testing. No mode changes (power states) will be commanded as part of CNAV testing.

The CNAV message types and message sequences broadcast during each test event will be varied; CNAV is a flexible navigation messaging system. During initial phases of the GPS Directorate's CNAV Test Program, only designated CNAV message types will be broadcast. This incremental approach will ensure each message type is thoroughly exercised and supports the interaction with the civil community to resolve any message content issues. Also, the various configuration flag settings and reserved bit fields in the messages will be changed to ensure CNAV message processing functionality implemented by the civil receiver developers conforms to the IS requirements. Ultimately, all defined CNAV message types will be broadcast during the final phase of the GPS Directorate CNAV Test Program. A goal of the CNAV Test Program is to identify a standardized CNAV message sequence or "Super-Frame" that would be nominally broadcast by the CNAV capable SVs. This standardized Super-Frame will differ based on the CNAV capabilities of the specific GPS SV Block Types (IIR-M, IIF, or GPS III).

During each CNAV test event, all CNAV uploads for the GPS IIR-M and IIF satellites will be generated using the GMS/GP's MODNAV Tool and uploaded to the GPS IIR-M and IIF satellites on a daily basis by 2 SOPS. The SV contractors and SMC/GP will provide technical support to 2 SOPS. The data utilized to construct CNAV message types 10, 11, 12 and 30 (Almanac, Clock, Ephemeris and URA) will be derived from the Kalman filter data tables of the current AEP System in the MCS.

3.2 Nominal L2C and L5 Configuration

The nominal L-Band signal structures for the GPS IIR-M and IIF satellites are shown in Table 3-1. The replacement of CNAV message type 0 with valid CNAV message types and data does not represent a change to the L-Band signal structures.

Table 3-1: Nominal L-Band Signal Structure

Signal Type	L-Band Carrier			
	L1	**L2**	**L5** (*IIF only*)	**NAV Message**
Legacy PRN Codes	C/A and P(Y)	P(Y)		Legacy (50bps)
Modernized Civil PRN Codes		L2C (CM & CL)	L5 (L5 I5& L5 Q5)	L2C CNAV (50sps) L5 CNAV (100sps) Msg Type 0

3.3   CNAV Message Types for the Initial CNAV Broadcast

Table 3-2 outlines all of the currently defined CNAV message types. The light-blue shaded rows of Table 3-2 indicate the CNAV message types which will be broadcast during this initial CNAV test event. This CNAV message subset supports SV position determination and SV clock correction which are required to support a PNT solution.

Table 3-2: CNAV Message Types

Msg Type	CNAV Message Title	Function/Purpose
0	Default	Default message (transmitted when no msg data is available)
10	Ephemeris 1	SV position parameters for the transmitting SV
11	Ephemeris 2	SV position parameters for the transmitting SV
12	Reduced Almanac	Reduced almanac data packets for 7 SVs
13	Clock Differential Correction	SV Clock differential correction parameters
14	Ephemeris Differential Correction	SV Ephemeris differential correction parameters
15	Text	Text, 29 eight-bit ASCII characters
30	Clock, IONO & Group Delay	SV Clock Correction Parameters, Ionospheric and Group Delay correction parameters (Inter-Signal Correction parameters)
31	Clock & Reduced Almanac	SV Clock Correction Parameters, Reduced almanac data packets for 4 SVs
32	Clock & EOP	SV Clock Correction Parameters, earth orientation parameters; ECEF-to-ECI coordinate transformation
33	Clock & UTC	SV Clock Correction Parameters, Coordinated Universal Time (UTC) Parameters
34	Clock & Differential Correction	SV Clock Correction Parameters, SV clock and Ephemeris differential correction parameters
35	Clock & GGTO	SV Clock Correction Parameters, GPS to GNSS Time Offset parameters.
36	Clock & Text	SV Clock Correction Parameters, Text, 18 eight-bit ASCII characters
37	Clock & Midi Almanac	SV Clock Correction Parameters, Midi Almanac parameters

3.4   CNAV Message Broadcast Sequences

Table 3-3 lists the L2 and L5 CNAV message sequences that will be broadcast by the IIR-M and IIF SVs during this test. Test Scenarios 1 and 2 are startup configurations which upload to one IIR-M SV and one IIF SV, begin with L2C and L5 set to unhealthy, and then transition to L2C and L5 set to healthy, serving as a risk mitigation measure to evaluate modernized civil receiver response to the broadcast CNAV messages.

Table 3-3: CNAV Message Sequences

Test Scenario	SV Block Type	Message Types/ Sequence	Message Purpose/Description
#1	IIR-M SVN58	10, 11, 30, 15	Minimum CNAV Message Subset to Support SV Position Determination - CNAV Channel status unhealthy
	IIF SVN65	10, 11, 30, 15	Minimum CNAV Message Subset to Support SV Position Determination - CNAV Channel status unhealthy
#2	IIR-M SVN58	10, 11, 30, 15	Minimum CNAV Message Subset to Support SV Position Determination - CNAV Channel status healthy
	IIF SVN65	10, 11, 30, 15	Minimum CNAV Message Subset to Support SV Position Determination - CNAV Channel status healthy
#3	IIR-M (All)	10, 11, 30, 15	Minimum CNAV Message Subset to Support SV Position Determination - CNAV Channel status healthy
	IIF (All)	10, 11, 30, 15	Minimum CNAV Message Subset to Support SV Position Determination - CNAV Channel status healthy
#4	IIR-M (All)	10, 11, 12, 30	Basic CNAV Message Subset includes Reduced Almanac CNAV Channel status healthy
	IIF (All)	10, 11, 12, 30	Basic CNAV Message Subset includes Reduced Almanac CNAV Channel status healthy
#5	IIR-M (All)	10, 11, 12, 30	Basic CNAV Message Subset includes Reduced Almanac CNAV Channel status healthy
	IIF (All)	12, 30, 10, 11	Basic CNAV Message Subset includes Reduced Almanac CNAV Channel status healthy
#6	IIR-M (All)	10, 11, 12, 30	Basic CNAV Message Subset includes Reduced Almanac CNAV Channel status healthy
	IIF (All)	10, 11, 12, 30, 32, 33	Expanded CNAV Message Subset, includes Earth Orientation Parameters and GPS Time to UTC (USNO)
#7	IIR-M (All)	10, 11, 12, 30, 32, 33	Expanded CNAV Message Subset, includes Earth Orientation Parameters and GPS Time to UTC (USNO)
	IIF (All)	10, 11, 12, 30, 32, 33	Expanded CNAV Message Subset, includes Earth Orientation Parameters and GPS Time to UTC (USNO)
#8	IIR-M (All)	10, 11, 12, 30, 32, 33	Expanded CNAV Message Subset, includes Earth Orientation Parameters and GPS Time to UTC (USNO) No ISC values broadcast
	IIF (All)	10, 11, 12, 30, 32, 33	Expanded CNAV Message Subset, includes Earth Orientation Parameters and GPS Time to UTC (USNO) No ISC values broadcast
#9	IIR-M (All)	10, 11, 12, 15, 30, 32, 33, 35	Expanded CNAV Message Subset, includes GGTO message; GGTO values not available "000"
	IIF (All)	10, 11, 12, 15, 30, 32, 33, 35	Expanded CNAV Message Subset, includes GGTO message; GGTO values not available "000"

3.5 CNAV Test Schedule

Figure 3-1 shows the flow of test scenarios for each day in the test broadcast.

15 June	16 June	17 & 18 June	19 June	20 & 21 June
Test Scenario #1 **IIR-M SVs** CNAV Msg Sequence #1 SVN58 CNAV Unhealthy **IIF SVs** CNAV Msg Sequence #1 SVN65 CNAV Unhealthy	**Test Scenario #2** **IIR-M SVs** CNAV Msg Sequence #2 SVN58 CNAV Healthy **IIF SVs** CNAV Msg Sequence #2 SVN65 CNAV Healthy	**Test Scenario #3** **All IIR-M and IIF SVs** CNAV Msg Sequence #3 CNAV Healthy	**Test Scenario #4** **All IIR-M and IIF SVs** CNAV Msg Sequence #4 CNAV Healthy	**Test Scenario #5** **All IIR-M and IIF SVs** CNAV Msg Sequence #5 CNAV Healthy

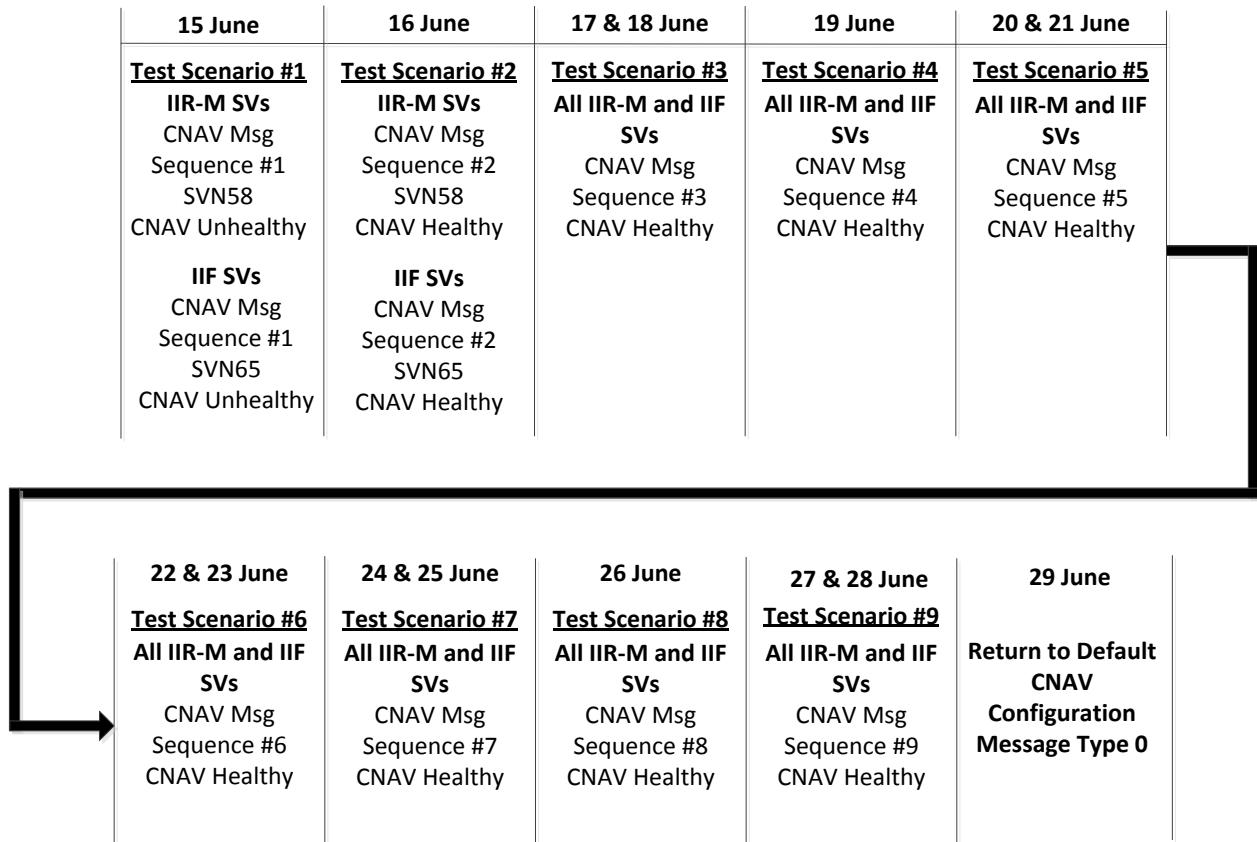| 22 & 23 June	24 & 25 June	26 June	27 & 28 June	29 June
Test Scenario #6 **All IIR-M and IIF SVs** CNAV Msg Sequence #6 CNAV Healthy	**Test Scenario #7** **All IIR-M and IIF SVs** CNAV Msg Sequence #7 CNAV Healthy	**Test Scenario #8** **All IIR-M and IIF SVs** CNAV Msg Sequence #8 CNAV Healthy	**Test Scenario #9** **All IIR-M and IIF SVs** CNAV Msg Sequence #9 CNAV Healthy	**Return to Default CNAV Configuration Message Type 0**

Figure 3-1: CNAV Test Schedule

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3.6   CNAV Test Scenario Activation Times

Table 3-4 provides the mapping of the test scenario, CNAV upload activation time and CNAV status flag configuration. As indicated, for this test event the CNAV upload activation time for all SVs will be at 1500Z each day; however for future CNAV test events the CNAV upload activation time may be varied, therefore the test scenario start time may be SV dependent, SV group dependent or based on SV block type dependent. During the initial test days of this test event when the SVs are first being uploaded with their initial CNAV content, the broadcast start time will be dependent on the SV contact schedule. As previously stated, Test Scenarios 1 and 2 are designed as risk mitigation and as such are only utilizing one IIR-M SV and one IIF SV. The consequence of the SV contact schedule will be especially true for test scenario #3 when the remaining IIR-M and IIF SVs are uploaded with their initial CNAV content. The CNAV messages broadcast start time will be dependent on the SV contact schedule. Since the CNAV uploads generated by the MODNAV Tool contains CNAV data for approximately 36 hours the succeeding test scenarios (4 - 9) will activate at the specified time for each SV; the CNAV upload is designed to overlap in time so the previous CNAV upload will contain data for the next test scenario.

CNAV status flags:
As indicated in Table 3-4, the L1 Channel Health Status will always reflect the health status of the legacy codes broadcast on L1. However if there is a change in the L1 channel health status the CNAV uploads will be deleted from SV memory when that status change occurs. As previously stated, since SMC/GP is utilizing the MODNAV Tool to construct the CNAV uploads, the integrity status flag will always be set to zero. Also, the L5 channel health status (shaded in grey) for all IIR-M SVs will always be set to zero since the IIR-M SVs do not have an L5 channel.
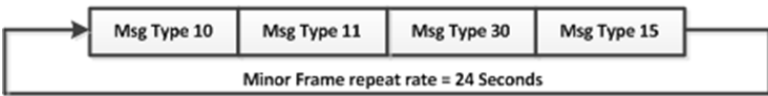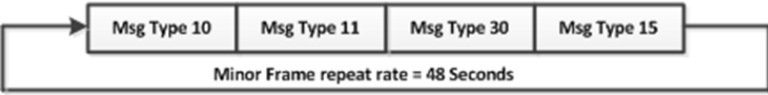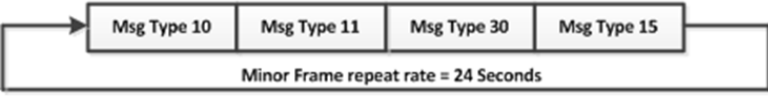
Table 3-4: CNAV Test

Test Scenario #	CNAV Upload Activation Time			CNAV Status Flags								CNAV Master Frame #	
				Channel Health Status									
				IIR-M			IIF						
	Year	Jday	HH:MM:SS	L1	L2C	L5	L1	L2C	L5	Integrity Flag	L2 Phasing	IR-M SVs	IIF SVs
1	2013	166	18:00:00	1	0	0	1	0	0	0	0	1	1
2	2013	167	18:00:00	1	1	0	1	1	1	0	0	1	1
3	2013	168	18:00:00	1	1	0	1	1	1	0	0	1	1
3	2013	169	18:00:00	1	1	0	1	1	1	0	0	1	1
4	2013	170	18:00:00	1	1	0	1	1	1	0	0	2	2
5	2013	171	18:00:00	1	1	0	1	1	1	0	0	2	3
5	2013	172	18:00:00	1	1	0	1	1	1	0	0	2	3
6	2013	173	18:00:00	1	1	0	1	1	1	0	0	2	4
6	2013	174	18:00:00	1	1	0	1	1	1	0	0	2	4
7	2013	175	18:00:00	1	1	0	1	1	1	0	0	4	4
7	2013	176	18:00:00	1	1	0	1	1	1	0	0	4	4
8	2013	177	18:00:00	1	1	0	1	1	1	0	0	4	4
9	2013	178	18:00:00	1	1	0	1	1	1	0	0	5	5
9	2013	179	18:00:00	1	1	0	1	1	1	0	0	5	5
N/A	2013	180	18:00:00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0

3.7   CNAV Test Scenarios

Table 3-5 lists the CNAV Test Scenarios for this initial CNAV Live-Sky Broadcast.

Table 3-5: CNAV Test Scenarios

Test Day 1

Test Scenario #1 Parameters and Attributes:

SV Resources: SVN58 and SVN65 (**two SVs only**)

- L-Band Channel Health Status Bits:
    - IIR-M: L1 = one (Healthy), [L2 = zero (**un-Healthy**)]
    - IIF: L1 = one (Healthy), [L2 and L5 = zero (**un-Healthy**)]
- Valid ISC values broadcast by SVN58 and SVN65
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

CNAV message sequence: Identical on SVN58 and SVN65

Test Day 2

Test Scenario #2 Parameters and Attributes:

SV Resources: SVN58 and SVN65 (**two SVs only**)

- L-Band Channel Health Status Bits:
    - IIR-M: L1 = one (Healthy), [L2 = one (Healthy), L5 = zero (fixed un-Healthy)]
    - IIF: L1 = one (Healthy), [L2 = one (Healthy), L5 = one (Healthy)]
- Valid ISC values broadcast by SVN58 and SVN65
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

CNAV message sequence: Identical on SVN58 and SVN65

Test Days 3 and 4

Test Scenario #3 Parameters and Attributes:

SV Resources: SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58, SVN62, SVN63 and SVN65

- L-Band Channel Health Status Bits:
  - All IIR-M SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = zero (fixed un-Healthy)]
  - All IIF SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = one (Healthy)]
- Valid ISC values broadcast by all SVs
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

CNAV message sequence: Identical on all IIR-M and IIF SVs

IIR-M and IIF L2C CNAV Message Sequence

Msg Type 10	Msg Type 11	Msg Type 30	Msg Type 15

Minor Frame repeat rate = 48 Seconds

IIF L5 CNAV Message Sequence

Msg Type 10	Msg Type 11	Msg Type 30	Msg Type 15

Minor Frame repeat rate = 24 Seconds

CNAV Master Frame Mapping

CNAV Master Frame	Minor Frame
Slot 1	CNAV Msg 10
Slot 2	CNAV Msg 11
Slot 3	CNAV Msg 30
Slot 4	CNAV Msg 15

Repeat

Sequence through 15 Minor Frames

Test Day 5

Test Scenario #4 Parameters and Attributes:

SV Resources: SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58, SVN62, SVN63 and SVN65

- L-Band Channel Health Status Bits:
  - All IIR-M SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = zero (fixed un-Healthy)]
  - All IIF SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = one (Healthy)]
- Valid ISC values broadcast by all SVs
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

CNAV message sequence: Identical on all IIR-M and IIF SVs

IIR-M and IIF L2C CNAV Message Sequence

Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 30

Minor Frame repeat rate = 48 Seconds

IIF L5 CNAV Message Sequence

Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 30

Minor Frame repeat rate = 24 Seconds

CNAV Master Frame Mapping

CNAV Master Frame	Minor Frame
Slot 1	CNAV Msg 10
Slot 2	CNAV Msg 11
Slot 3	CNAV Msg 12
Slot 4	CNAV Msg 30

Repeat

Sequence through 15 Minor Frames

Test Days 6 and 7

Test Scenario #5 Parameters and Attributes:
SV Resources: SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58, SVN62, SVN63 and SVN65
- L-Band Channel Health Status Bits:
  - All IIR-M SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = zero (fixed un-Healthy)]
  - All IIF SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = one (Healthy)]
- Valid ISC values broadcast by all SVs
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

CNAV message sequence is based on SV block type:

IIR-M CNAV Master Frame Mapping

IIR-M L2C CNAV Message Sequence

| Msg Type 10 | Msg Type 11 | Msg Type 12 | Msg Type 30 |

Minor Frame repeat rate = 48 Seconds

CNAV Master Frame	
	Minor Frame
Slot 1	CNAV Msg 10
Slot 2	CNAV Msg 11
Slot 3	CNAV Msg 12
Slot 4	CNAV Msg 30

Repeat

Sequence through 15 Minor Frames

IIF CNAV Master Frame Mapping

IIF L2C and L5 CNAV Message Sequence

| Msg Type 12 | Msg Type 30 | Msg Type 10 | Msg Type 11 |

Minor Frame repeat rate: L2C CNAV = 48 Seconds / L5 CNAV = 24 Seconds

CNAV Master Frame	
	Minor Frame
Slot 1	CNAV Msg 12
Slot 2	CNAV Msg 30
Slot 3	CNAV Msg 10
Slot 4	CNAV Msg 11

Repeat

Sequence through 15 Minor Frames

Test Days 8 and 9

Test Scenario #6 Parameters and Attributes:

SV Resources: SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58, SVN62, SVN63 and SVN65

- L-Band Channel Health Status Bits:
    - All IIR-M SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = zero (fixed un-Healthy)]
    - All IIF SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = one (Healthy)]
- Valid ISC values broadcast by all SVs
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

CNAV message sequence is based on SV block type:

IIR-M CNAV Master Frame Mapping

IIR-M L2C CNAV Message Sequence

Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 30

Minor Frame repeat rate = 48 Seconds

CNAV Master Frame	
	Minor Frame
Slot 1	CNAV Msg 10
Slot 2	CNAV Msg 11
Slot 3	CNAV Msg 12
Slot 4	CNAV Msg 30

Repeat

Sequence through 15 Minor Frames

IIF 2C and L5 CNAV Message Sequence

Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 30
Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 32
Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 33

Time

IIF CNAV Master Frame Mapping

	Minor Frames		
Slot 1	10	10	10
Slot 2	11	11	11
Slot 3	12.x	12.x	12.x
Slot 4	30	32	33

Msg 12.x (12.1 – 12.5)

Message Sequence repeats 5 times for each Master Frame

CNAV Message Sequence repeat rate: L2C CNAV = 144 Seconds / L5 CNAV = 72 Seconds
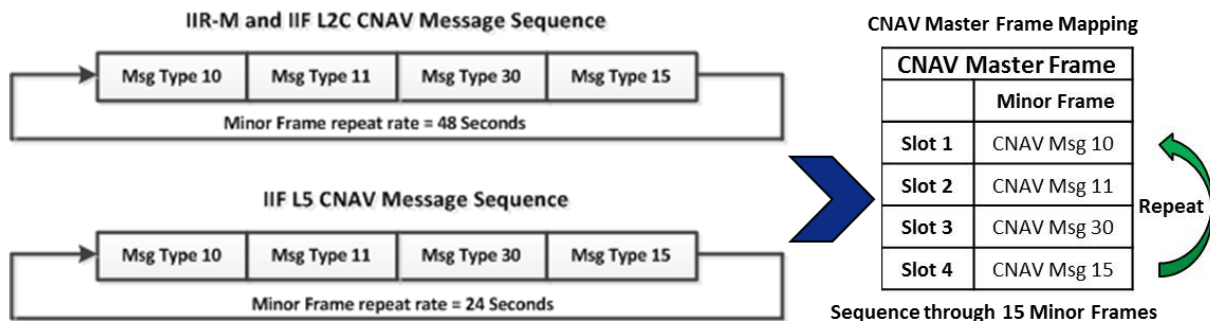
Test Days 10 and 11

Test Scenario #7 Parameters and Attributes:

SV Resources: SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58, SVN62, SVN63 and SVN65

- L-Band Channel Health Status Bits:
  - All IIR-M SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = zero (fixed un-Healthy)]
  - All IIF SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = one (Healthy)]
- Valid ISC values broadcast by all SVs
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

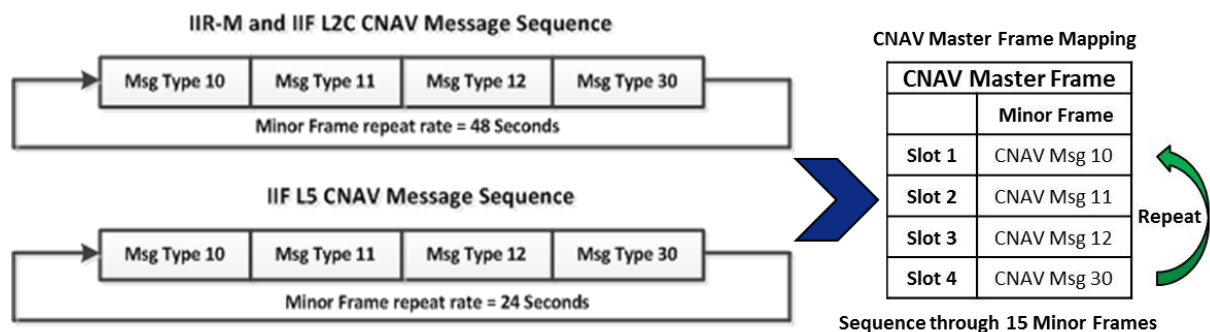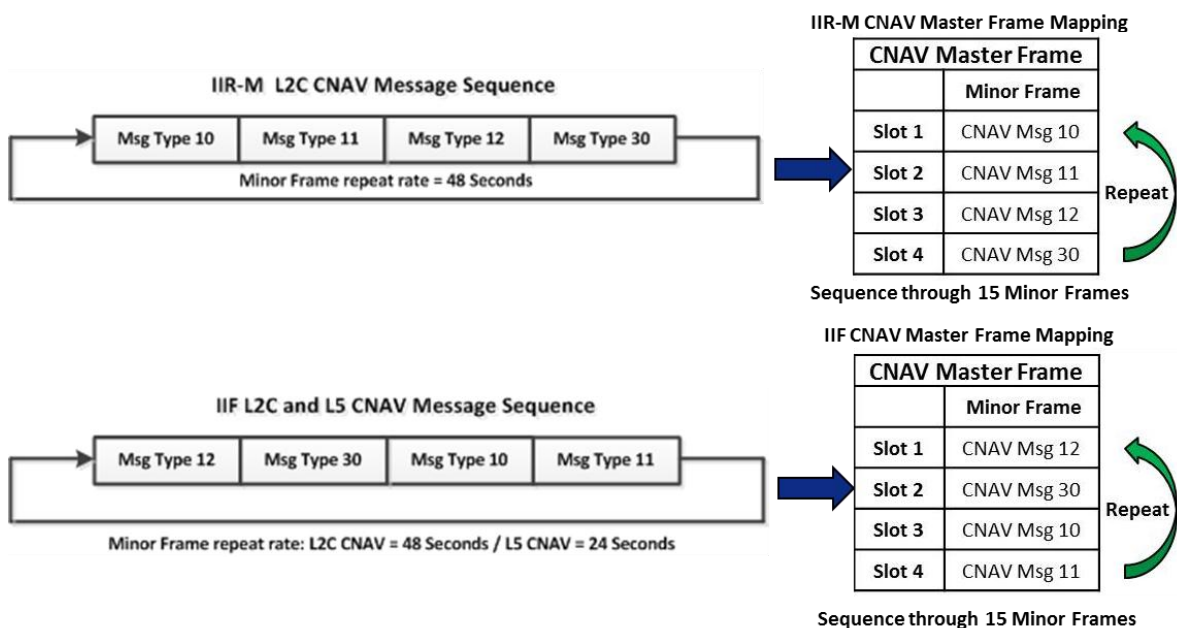CNAV message sequence: Identical on all IIR-M and IIF SVs

IIR-M, IIF L2C and IIF L5 CNAV Message Sequence

Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 30
Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 32
Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 33

Time

CNAV Message Sequence repeat rate: L2C CNAV = 144 Seconds / L5 CNAV = 72 Seconds

IIF CNAV Master Frame Mapping

	Minor Frames		
Slot 1	10	10	10
Slot 2	11	11	11
Slot 3	12.x	12.x	12.x
Slot 4	30	32	33

Msg 12.x (12.1 – 12.5)

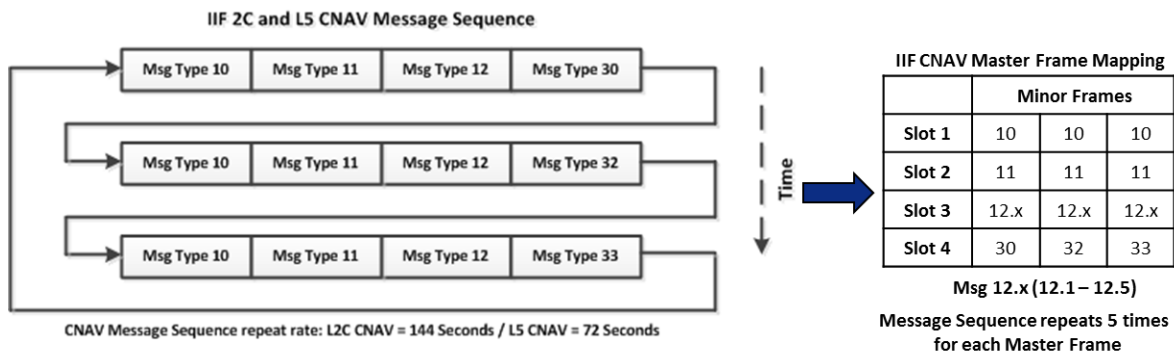**Message Sequence repeats 5 times for each Master Frame**

Test Day 12

Test Scenario #8 Parameters and Attributes:

SV Resources: SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58, SVN62, SVN63 and SVN65

- L-Band Channel Health Status Bits:
  - All IIR-M SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = zero (fixed un-Healthy)]
  - All IIF SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = one (Healthy)]
- **No ISC values available on all SVs**
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

CNAV message sequence: Identical on all IIR-M and IIF SVs

IIR-M, IIF L2C and IIF L5 CNAV Message Sequence

Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 30
Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 32
Msg Type 10	Msg Type 11	Msg Type 12	Msg Type 33

Time

CNAV Message Sequence repeat rate: L2C CNAV = 144 Seconds / L5 CNAV = 72 Seconds

IIF CNAV Master Frame Mapping

	Minor Frames		
Slot 1	10	10	10
Slot 2	11	11	11
Slot 3	12.x	12.x	12.x
Slot 4	30	32	33

Msg 12.x (12.1 – 12.5)

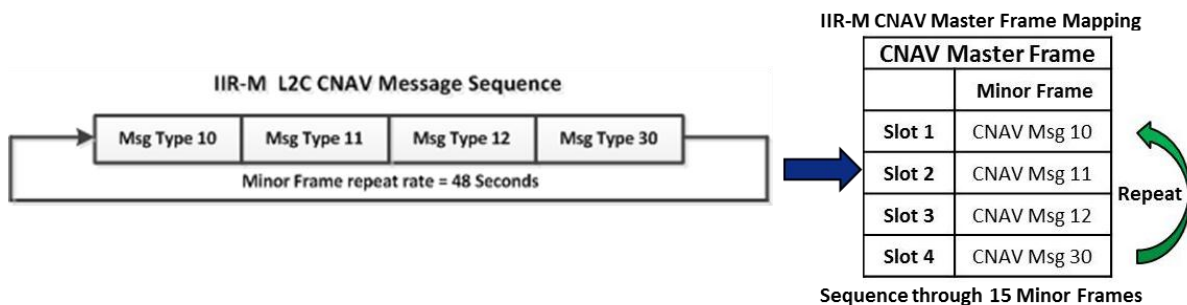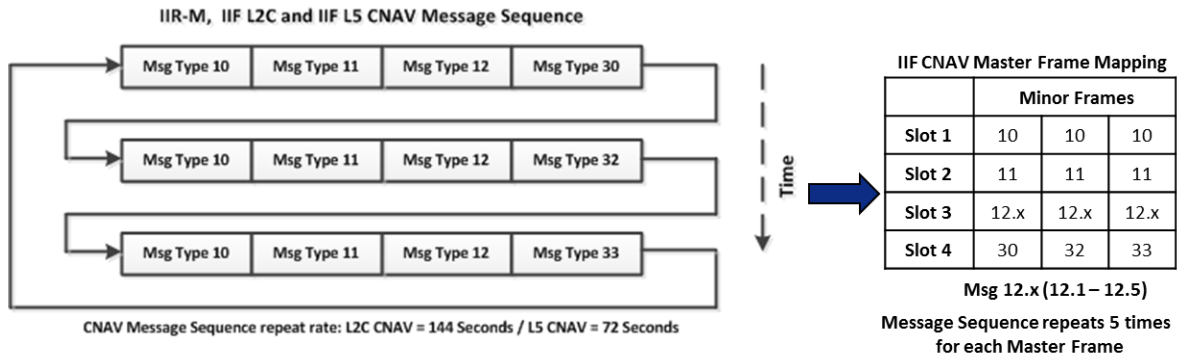**Message Sequence repeats 5 times for each Master Frame**

Test Days 13 and 14

Test Scenario #9 Parameters and Attributes:

SV Resources: SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58, SVN62, SVN63 and SVN65

- L-Band Channel Health Status Bits:
  - All IIR-M SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = zero (fixed un-Healthy)]
  - All IIF SVs: L1 = one (Healthy), [L2 = one (Healthy), L5 = one (Healthy)]
- Valid ISC values broadcast by all SVs
- Integrity Status Flag = zero (Legacy assurance level)
- L2 Phasing Flag = zero (Quadrature)
- Message reserved bit fields: see Table 3-6 for contents

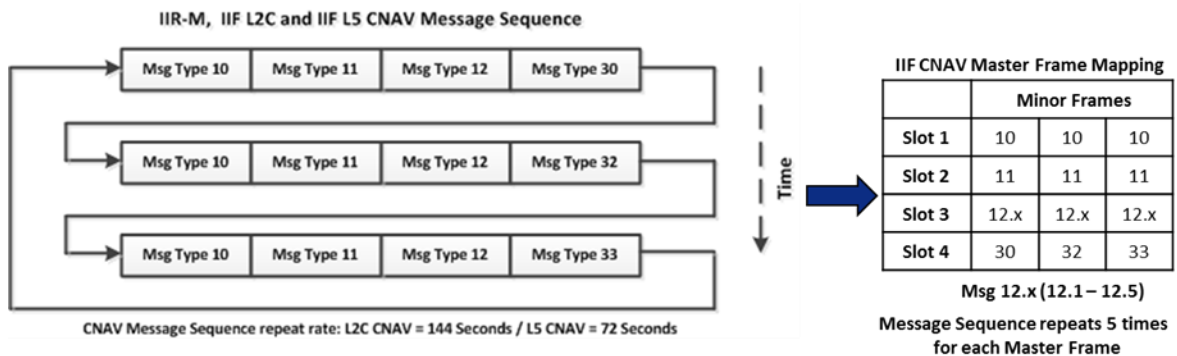CNAV message sequence: Identical on all IIR-M and IIF SVs

IIR-M and IIF L2C and L5 CNAV Master Frame															
	Minor Frames														
Slot#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Slot 1	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Slot 2	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Slot 3	32	12.1	12.2	12.3	12.4	12.5	15	32	12.1	12.2	12.3	12.4	12.5	32	15
Slot 4	30	33	35	30	33	35	30	33	35	30	33	35	30	33	35

Msg 12.x (12.1 – 12.5)
Master Frame Sequence Repeats

Test Day 15

Command Default CNAV Configuration:

SV Resources: SVN48, SVN50, SVN52, SVN53, SVN55, SVN57, SVN58, SVN62, SVN63 and SVN65

CNAV broadcast sequence: Identical on IIR-M and IIF SVs - CNAV Message Type 0 to all IIR-M and IIF SVs:

IIR-M and IIF L2C and L5 CNAV Master Frame															
	Minor Frames														
Slot#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Slot 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slot 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slot 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slot 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Master Frame Sequence Repeats

Table 3-6: CNAV Message Reserved Bit Field Values (Hex)

Test Scenario	Msg 10 (3bits)	Msg 11 (7bits)	Msg 30 (12bits)	Msg 32 (11bits)	Msg 33 (51bits)	Msg 35 (81bits)
1	0_{16}	00_{16}	000_{16}			
2	0_{16}	00_{16}	000_{16}			
3	7_{16}	$6B_{16}$	$C3F_{16}$			
4	5_{16}	24_{16}	239_{16}			
5	0_{16}	77_{16}	220_{16}			
6	1_{16}	67_{16}	182_{16}	$5F8_{16}$	$76DF771439F88_{16}$	
7	2_{16}	74_{16}	$E18_{16}$	$79C_{16}$	$250196712E8E4_{16}$	
8	0_{16}	$7D_{16}$	$F68_{16}$	$2AE_{16}$	$24E3846F63A84_{16}$	
9	6_{16}	27_{16}	925_{16}	$4E5_{16}$	3494844666138_{16}	$0506A4AE0C9094C860096_{16}$

SECTION IV – TEST MANAGEMENT, RISK ASSESSMENT, AND REPORTING

4. TEST MANAGEMENT, RISK ASSESSMENT AND REPORTING

4.1 Test Management

4.1.1 Configuration Control and Management

The validity of the test results depends on configuration control and management of the CS and SS during each test. SMC/GPEV must have prior notification of any modifications to the OCS or SS during execution of any testing. Any configuration changes to the CS or SS must be submitted to the 2 SOPS Director of Operations (DO) and 2 SOPS Maintenance (MA) in advance to ensure potential impacts are adequately assessed. 2 SOPS has final approval authority on any changes, especially if they pose an increased risk to the OCS, the GPS constellation, or any other operational component of the GPS architecture. Specific changes may not impact the Legacy mission; however, they may impact the ability to execute testing. Software configuration audits and lockdowns should conform to requirements specified by 2 SOPS/MA and remain in place during the test; emergency changes may be approved with 2 SOPS/CC or 2 SOPS/DO approval.

The GPS Directorate has assigned overall test management to the CNAV Team which is responsible for coordinating participation, maintaining the overall schedule, and coordinating resources and test assets. The test team will be responsible to ensure all safety, risk management, environmental impact, security, and transportation procedures and policies are followed.

4.2 Test Execution Scheduling and Logistics

4.2.1 Notice Advisory to Navstar Users (NANU)

A Notice Advisory to Navstar Users (NANU) will be issued in advance of each CNAV test event to inform civil users that CNAV data will be broadcast from the IIR-M and IIF SVs. The contents of the NANU will be developed in collaboration with the designated civil authorities and Air Force Space Command (AFSPC). SMC/GPE, JFCCSPACE and USSTRATCOM will provide technical support.

4.2.2 CNAV Test Event Readiness Review

A Test Readiness Review (TRR) will be conducted two weeks prior to each CNAV test event to ensure all participating organizations have been notified and the required GPS system resources and support organizations are ready to support test execution. A critical part of this review is to evaluate the Legacy mission PNT performance risks over the test period. The readiness will be conducted by AFSPC with participation from the designated civil representatives, the GPS Directorate and 2 SOPS.

4.2.3 GPS System Maintenance Concept

There are no maintenance concepts or activities required to support execution of CNAV broadcast activities. All operational maintenance activities either scheduled or un-scheduled will take precedence over CNAV testing. Scheduled GPS system maintenance activities will be de-conflicted in advance of planned CNAV test events. For emergency maintenance activities which occur during the test period, test execution will be suspended or terminated if the condition affects the ability of the Control, Segment to upload the GPS satellite constellation, if one of the IIR-M or IIF SVs incurs an anomaly.

4.2.4 Test Director (TD)

The government Test Director (TD), with contractor support, has responsibility for the execution and management of CNAV test events. The TD has the authority to terminate all CNAV commanding activities and Modernized NAV upload activities if the team reports problems with the CNAV message content. The TD has the responsibility to ensure that the GPS IIR-M and IIF SVs are configured into their nominal operational configuration at the conclusion of each CNAV test event. The TD will coordinate all CNAV test activities with the OTD to ensure all resources are scheduled and available to support test execution.

The TD will coordinate and prioritize test activities among the respective test organizations, and coordinate required government test resources. The TD will be responsible for coordinating the general sequence of CNAV activities with the OTD prior to and during test execution. The TD and the OTD will evaluate the Legacy PNT performance, as provided by the GPSOC and FAA, and feedback from the support organizations to determine whether to continue or terminate testing. The primary mission is to ensure the Legacy PNT performance is not degraded during execution of the CNAV test events.

4.2.5 Test Execution Support Staff

The primary purpose of the CNAV team is to review the test procedures in their areas of expertise, monitor test execution to ensure SV safety, and to provide analysis of PNT performance as requested. Primary functions include but not limited to: CNAV Control Element (CE) generation and verification, CNAV upload generation and verification, SV telemetry verification, assistance to 2 SOPS crew personnel. The SMC CNAV team consists of the following organizations: SMC/GPEV, Aerospace, Infinity Systems Engineering, MITRE, Lockheed Martin, Boeing, Hughes Design, Draper, SPAWAR and SRI.

4.3 **Safety and Risk Management**

4.3.1 Safety

The number one priority is to ensure the integrity and safety of the Legacy mission, space and control segment resources, and personnel while using operational assets when conducting CNAV testing. The OTD and TD have the principal responsibility for test conduct, but all participants share responsibility for ensuring the integrity and safety of the GPS system resources. Any participant who feels the safety and/or integrity of the mission, operational resources, or personnel is in jeopardy will notify the OTD or the DO. Only the DO, in coordination with the operational crew commander, has the authority to restart test activities after assurance is reached the safety and/or integrity issue has been adequately resolved. Once the restart has been approved, the TD can resume test execution activities.

The TD and OTD have the responsibility to ensure all test activities are conducted IAW applicable safety directives. The TD and OTD will ensure all safety hazards identified during testing are reported IAW Air Force Instruction (AFI) 91-202, The United States Air Force (USAF) Mishap Prevention Program.

4.3.2 Risk Assessment, Mitigation and Management

SMC/GPEV has executed several ground test events using the MTS (IIR-M) and STS (IIF) SV simulators as risk mitigation measures and to evaluate compatibility of the modernized NAV (i.e. CNAV) uploads with the Legacy navigation uploads. The GPS IIR-M and IIF SV contractors have performed a software analysis of the navigation data unit's program and memory use to determine the software dependencies between the Legacy NAV message capabilities and the modernized NAV message capabilities.

SMC/GPEV and the SV contractors have evaluated the potential risks of performing CNAV upload

activities to the operational GPS IIR-M and IIF SVs and determined that CNAV test activities can be conducted in parallel without impacting the operational mission. An extensive program of operational procedure validation, training, and checks and balances have been implemented in the GPS system to provide positive control of operations at all times with monitoring of the legacy performance to assure mission integrity and mission support.

Table 4-1 lists the identified risks or hazards which analysis has identified as potentially occurring due to the broadcast of CNAV. The table provides the mitigation measures which have been implemented to mitigate the hazard.

Table 4-1: Risk Identification and Quantification

Risk Description	Mishap Severity Category	Mishap Probability	Mishap Risk Category
(1) CNAV broadcast results in an unanticipated receiver operation	Negligible	Remote	Low

Mitigation Measures:

The CNAV message structure and message content broadcast from the IIR-M and IIF SVs will comply with IS-GPS-200F and IS-GPS-705B CNAV specifications; receivers that are non-compliant with specifications are not the responsibility of the US government. This initial CNAV broadcast implementation plan is an incremental approach with only two SVs (one IIR-M and one IIF) uploaded with CNAV on day #1; this is defined in test scenario #1. The incremental approach outlined in Table 3-5 will allow users to identify and report problems before the next phase (test scenario) is executed.

If receivers experience misleading signal information (MSI) that plausibly raises a concern about potential broadcast CNAV message non-compliance with the CNAV specifications, users are strongly encouraged to report their concerns as soon as possible (in accordance with Section 4.4.4) to facilitate immediate anomaly investigations and any necessary remedial actions.

Risk Description	Mishap Severity Category	Mishap Probability	Mishap Risk Category
(2) Nuisance reports of negligible effects during CNAV testing	Negligible	Remote	Low

Mitigation Measures:

Nuisance reports received by the GPSOC or Navigation Center (NAVCEN) will be investigated by the GPS Directorate's CNAV Team. 2 SOPS will investigate all Legacy navigation performance issues.

Extensive SV testing performed by the SV contractors and the CNAV Team have not indicated any cross-dependency or reliance between the modernized messages (i.e. CNAV) and the Legacy NAV message by the GPS IIR-M or IIF navigation data unit's software.

Risk Description	Mishap Severity Category	Mishap Probability	Mishap Risk Category
(3) Delayed ability to reconfigure SVs to default status	Negligible	Remote	Low

Mitigation Measures:

Ensure no negative feedback from representatives in 4.4.1 during and following Scenario #2 (only two satellites broadcasting CNAV) prior to proceeding to Scenario #3 (ten SVs broadcasting CNAV). This may result in delaying Scenario #3, but reduces required SV contacts from ten to two, thus minimizing time required to command SVs back to default configuration.

Risk Description	Mishap Severity Category	Mishap Probability	Mishap Risk Category
(4) Inability to continuously monitor CNAV signals during test	Negligible	Remote	Low

Mitigation Measures:

Test Termination Criteria given in Section 1.8.4 and Anomaly Resolution and Reporting Procedures in 4.4.4 ensure that observed anomalies are reported as quickly and as clearly as possible. SMC/GP personnel and CNAV Team members will be available 24 hours a day throughout the Test to assist in analysis and decision determination, per the CNAV Test Termination Criteria given in Section 1.8.4.

4.3.3   Impact to Legacy User Equipment

Adverse impact to Legacy GPS receivers which are not designed to process the L2C or L5 signals is improbable since the Legacy NAV message contents will not be altered during this CNAV Test Program. Also, extensive ground testing using the SV simulators and a small set of Legacy receivers demonstrated the CNAV signals did not degrade Legacy signal tracking performance.

Adverse impact to modernized civil GPS L2C and L5 receivers is unlikely since the majority of the currently deployed receivers only utilizes the L2C and L5 PRN codes for ionospheric correction and do not process the CNAV message data. Also, the CNAV message structure and message content broadcast from the IIR-M and IIF SVs will comply with IS-GPS-200F and IS-GPS-705B CNAV specifications. However, the CNAV message broadcast will be implemented in an incremental approach; as defined in Table 3-4.

4.4 TEST REPORTING

4.4.1 Government Test Report

A government test report will document the CNAV message types broadcast by the space segment. The GPS Directorate is responsible for producing this test report. A post-test briefing based on available data will be provided by SMC/GPEV seven days after test conclusion. All test results, analysis and reports will be placed on the NAVCEN website:

http://www.navcen.uscg.gov/ SMC_GP_CNAV_Test_Program/

Sub-Directories:
CNAV_Event_#x
CNAV_ Test_ Report_xx_xxx_xxxx.pdf
(xx_xxx_xxxx = day_month_year)

4.4.2 Test Deficiency Reports (DR)

Any operational problems discovered by the 2 SOPS crew or reported to the GPSOC will be reported to the MD and documented following standard 2 SOPS DR procedures. Any CNAV discrepancies (i.e. upload versus transmitted CNAV disparities) will be deferred to the GPS Directorate's modernized navigation signal development team.

4.4.3 Government Modernized Signal Observation and Reporting

The GPS Directorate will perform modernized signal observation by using their MSTA and MRTA systems and will provide 2 SOPS a signal status report, as requested, for the modernized signals for the duration of the test.

4.4.4 Anomaly Resolution and Reporting

For Control Segment or Space Segment anomalies, the 2 SOPS SART process will be followed in the event of an anomaly which impacts the integrity of the Legacy mission. Signal anomalies which are constrained to the modernized civil signals (i.e. L2C and L5) as a result of an executed CNAV upload will follow the same 2 SOPS SART process. The GPS Directorate will handle CNAV message anomalies just like any other SV anomaly and will utilize the 2 SOPS SART process to determine the root cause and anomaly resolution activities.

4.4.4.1 Anomaly Reporting–Military Users

Any DoD user will report GPS outages or anomalies to the GPS Operations Center (GPSOC).
Commercial: (719) 567-2541
FAX: (719) 567-2671
DSN: 560-2541
NIPR: gps_support@schriever.af.mil
SIPR: gpsvs@afspc.af.smil.mil

4.4.4.2 Anomaly Reporting: Civil Surface Users

Current civil procedures for reporting GPS outages will be followed in accordance with U.S. Government Policy, all requests for information or anomaly reports from individuals or agencies not associated with the DoD must be submitted to the United States Coast Guard (USCG) Navigation Center (NAVCEN).

Homepage: http://www.navcen.uscg.gov/gps/
Anomaly Reporting: http://www.navcen.uscg.gov/gps/gpsuserinput.htm
Contact Information : http://www.navcen.uscg.gov/misc/contact.htm
Commercial: (703) 313-5900 (24-hour)
FAX: (703) 313-5920

4.4.4.3   Anomaly Reporting: Civil Aviation Users

Civil Aviation Users will follow the same procedures for reporting GPS outages. When using Instrument Flight Rules with certified equipment, Civil Aviation Users will report GPS outages to any air traffic control facility in accordance with the Aeronautical Information Manual (AIM).

Webpage: http://www2.faa.gov/ATpubs/AIM/

Coast Guard NAVCEN
The NAVCEN is the point of contact for all domestic non-aviation, non-DoD surface and maritime commercial GPS users. The NAVCEN is the point of contact for all international civil GPS users
Commercial: (703) 313-5900
NIPR: tis-pf-nisws@uscg.mil

Federal Aviation Administration National Operations Control Center (NOCC)
The NOCC is the GPS support node for all domestic civil/commercial aviation users, National Air Space users and those concerned with safety of flight
Commercial: (703) 904-4488
NIPR: 7-awa-nocc@faa.gov

Federal Communications Commission (FCC) OpCen
Manages and leads the FCC's All Hazards emergency preparedness and response activities
Commercial: (202) 418-1122
NIPR: FCCOPCenter@fcc.gov

Department of Homeland Security National Coordination Center for Telecommunications (NCC)
Telecommunications industry and Federal Government; assists in the initiation, coordination, restoration, and reconstitution of national security and emergency preparedness (NS/EP) telecommunications services and facilities.
Commercial: (703) 235-5080
STE: (703) 235-5097
NIPR: ncs@dhs.gov

Department of Transportation Crisis Management Center
Commercial: (202) 366-1863
NIPR: cmc-01@dot.gov

Appendix A - Acronyms

2 SOPS/CC	2nd Space Operations Squadron, Commander
2 SOPS/DO	2nd Space Operations Squadron, Director of Operations
AGNS	Advanced Global Navigation Simulator
AMCS	Alternate Master Control Station
ATS	Advanced Global Navigation Simulator Test Station
C/A	Course Acquisition
CE	Control Element
CL	Civilian Long
CM	Civil Moderate
CNAV	Civil Navigation
CRC	Cyclic Redundancy Check
DAPP	Data Analysis Processing Package
dB	Decibel
DOP	Dilution of Precision
DOT	Department of Transportation
DPSSF	Data Processing and Simulation Software Facility
DtLSF	Delta Time Due to Leap Seconds
DTP	Detailed Test Procedure
EGI	Embedded GPS/INS
EOP	Earth Orientation Parameters
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FOM	Figure of Merit
Freq	Frequency
GGTO	GLONASS GALILEO Time Offset
GLONASS	Global Orbiting Navigation Satellite System
GPS	Global Positioning System
GPSOC	GPS Operations Center
GNSS	Global Navigation Satellite System
GPEV	GPS Directorate System Engineering Test and Verification Branch
Hz	Hertz
I5	In-Phase Code
IA	Information Assurance
ICD	Interface Control Document
ICWG	Interface Control Working Group
IMOSC	Integrated Mission Operations Support Center
IMU	Inertial Measuring Unit
INS	Inertial Navigation System
INU	Inertial Navigation Unit

IS	Interface Specifications
ISC	Intrasignal Corrections
IONO	Ionospheric
JDRS	Joint Deficiency Reporting System
kg	Kilograms
kHz	Kilohertz
km	Kilometers
lat	Latitude
LOS	Line of Sight
MCS	Master Control Station
MDU	Mission Data Unit (IIR/IIR-M)
MHz	Megahertz
MNAV	Military Navigation
MODNAV	Modernized Navigation
MRTA	Modernized Receiver Test Asset
MS&A	Modeling, Simulation, and Analysis
MSI	Misleading Signal Information
MSTA	Modernized Signal Test Asset
N	North
N/A	Not Applicable
NANU	Notice to all Navstar Users
NDTE	NAV Data Table Elements
NDU	Navigation Data Unit (IIF)
NGA	National Geospatial-Intelligence Agency
NM	Nautical Mile
NMEA	National Marine Electronics Association
NPEF	National PNT Engineering Forum
OCS	Operational Control System
OCX	Next Generation Operational Control System
OTD	Operations Test Director
PNT	Positioning, Navigation, and Timing
PRN	Pseudo-Random Noise
Q5	Quadrature-phase code
RAID	Redundant Array of Independent Disks
RF	Radio Frequency
RINEX	Receiver Independent Exchange Format
SAFB	Schriever Air Force Base
SART	Situation Assessment and Recovery Team
SIS	Signal-In-Space
SMC	Space and Missile Systems Center
SMC/GP	Space and Missile Systems Center, Global Positioning Systems Directorate
SMC/GPE	GPS Directorate's Engineering Division
SMC/GPEV	GPS Directorate's Test and Verification Branch

SNR	Signal-to-Noise Ratio
SOPS	Space Operations Squadron
SV	Satellite Vehicle
SVN	Satellite Vehicle Number
TBD	To Be Determined
TD	Test Director
TOW	Time of Week
TRD	Technical Requirements Document
TRR	Test Readiness Review
TT&C	Tracking, Telemetry, and Commanding
TTFF	Time to First Fix
UE	User Equipment
USNO	United States Naval Observatory
URA	User Range Accuracy
UNAVCO	University NAVSTAR Consortium
UTC	Universal Time Coordinated
W	West
WNLSF	Week Number portion of the Leap Second Count Reference

Appendix B – CNAV Bit Files

B.1 CNAV Bit Files

To promote CNAV message processing development, SMC/GP will provide the CNAV Bit Files recorded by their test assets during ground testing with the GPS IIR-M and IIF SV simulators. The CNAV Bit Files recorded during ground testing with the GPS IIR-M and IIF SV simulators will mimic the CNAV messages that will be broadcast during each CNAV Live Sky Broadcast. Also, validated CNAV Bit Files recorded during each CNAV Live Sky test scenario will be posted; these CNAV Bit Files will act as truth sources for comparison for the receiver developers.

The CNAV Bit Files will be posted to the United States Coast Guard NAVCEN Website: http://www.navcen.uscg.gov/ SMC_GP_CNAV_Test_Program/:

Sub-Directories:
 CNAV_Event_#x
  SVNxx_L2C_ CNAV_ Bit_File_ xx_xxx_xxxx.txt
  SVNxx_ L5_ CNAV_ Bit_File_ xx_xxx_xxxx.txt

(xx_xxx_xxxx = day_month_year)