Space and Missile Systems Center

Civil Navigation Signal Status

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29 Apr 15
Civil Navigation (CNAV) History

SMC/GPEV
SUMMER 2013 CNAV LIVE-SKY TEST EVENT

NOV 2013
AFSPC/CC DIRECTS CONTINUOUS CNAV BROADCAST PRIOR TO OCX

SOFTWARE DEV & INTEGRATION
TRANSITION A TEST TOOL INTO AN OPS CAPABILITY

MGUE LIVE-SKY TESTING
SUPPORT MGUE DEVELOPMENT

MODNAV TOOL VERIFICATION
CLOSED-LOOP END-TO-END SIGNAL VERIFICATION

SMC/GPEV

OPS INTEGRATION
TRAINING MATERIALS AND UPDATED TECH ORDERS

DIRECT CONNECT OF MODNAV LAPTOP

SMC/GPEV

25 APR 14
AFSPC/A3 AUTHORIZATION FOR CNAV BROADCAST

CRAWL: APR 2014
2 UPLOADS PER WEEK

WALK: JUN 2014
3 UPLOADS PER WEEK

RUN: DEC 2014
DAILY UPLOADS

DIRECT CONNECT OF MODNAV LAPTOP

DEC 2014
MODNAV SOFTWARE INTEGRATED INTO AEP
Civil Navigation (CNAV) Broadcast Status

• CNAV Message Types 10, 11, 30, 33 currently transmitted on seven GPS IIR-M (L2C) & eight GPS IIF SVs (L2C & L5)
  – MODNAV Tool integrated w/AEP providing CNAV message generation
  – Daily CNAV uploads as of 31 Dec 14

• Signal Performance
  – CNAV performing on par with Legacy during daily uploads
  – Total RMS URE from 31 Mar – 7 Apr 15
    • Legacy: 0.517 m (URE for this week aided by additional LNAV uploads)
    • Modernized: 0.584 m
  – Best week: 22 Mar - 29 Mar 15
    • Modernized: 0.397 m

• GPS IIF Launch & Constellation Upgrade
  – SVN 68 & SVN 69 Ops Accepted to users for Legacy Signals
    • CNAV message broadcast as of 23 Feb 15
  – SVN 71 successful launch 25 Mar 15
  – SVN 72 Launch scheduled for Jul 2015
    • CNAV message broadcast for SVN 71 & SVN 72 expected Aug 2015
CNAV Performance

L2C Performance: 28 Apr to 28 Feb 14

Daily uploads of pre-operational CNAV performance within expectations
CNAV Performance

- L2C Performance starting with Daily Uploads: 1 Jan 15 to Present day

LNAV slightly better than CNAV due to addition LNAV uploads
CNAV Development

• Live-sky event summer of 2013
  – Test & Verification of 8/15 defined CNAV Message Types
  – Led to pre-operational use beginning 28 Apr 14

• Planned live-sky event fall of 2015
  – Incorporate Midi Almanac (MT37)
    • GPS IIF SV require only MODNAV Tool software updates
    • GPS IIR-M SVs require MODNAV Tool & SV software updates as well as changes to ICDs
  – Exercise functionality of GNSS off-set parameters (MT35)
    • Integration efforts in progress with NGA and USNO for direct feed of GGTO, UTC and ISC values into AEP

• Future development TBD
  – Software development and test of differential corrections & text messaging require additional knowledge on CONOPs and/or intended use
    • MT13 (Clock Differential)
    • MT14 (Ephemeris Differential)
    • MT15 (Text)
    • MT34 (Clock & Differential)
    • MT36 (Clock & Text)
  – Broadcast of reduced almanac (MT 12 & MT 31) is unlikely; pending further direction
## CNAV Development

### 15 Defined Message Types

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

- **15 Defined Message Types**
  - Tested & verified summer of 2013
  - Development planned for fall test event 2015
  - Conops/direction required for development & test
CNAV Monitoring

- Operational monitoring of civil modernized signals
  - Joint Propulsion Lab (JPL) world-wide monitoring stations
    - Initial capability and procedures delivered to 2SOPS Dec 2014
    - Capability upgrade scheduled for Feb 2016
- SMC/GP MODNAV Database & Website
  - SMC/GP & MITRE CONUS CNAV website data bits (L2C & L5) updated every 15 min or less @ https://gps-modnavdb.mitre.org
  - NGA global CNAV data bits (L2C only) updated daily
  - Expansion of NGA L5 Signal Monitoring by 3Q 2015
    - L2C and L5 updated every 15 min or less
- Legacy signals remain the priority during CNAV pre-operational broadcast
  - If URE or AOD limits are exceeded, the path forward will not affect the broadcast of legacy signals
  - Collaboration with GPE, GPL and FFRDC teams to include the GPE/MITRE MODNAV database & website will occur to determine the best course of action if the URE or AOD limits are exceeded
Questions