Improving the GPS L1 Signal

GPS III Offers the Opportunity

Tom Stansell
Tom@Stansell.com
IGS Symposium, Bern
3 March 2004
Introducing L1C Project Leadership

Dr. Ken Hudnut
Co-Chair, USGS

2Lt. Jason Taylor

1Lt. Bryan Titus
Co-Chair, JPO

Tom Stansell
An Invitation: Contact Information

E-mail: L1C_GPS@USGS.gov
FAX: 626-583-7827
Mail: L1C GPS
Attn: Ken Hudnut
525 South Wilson Ave.
Pasadena, CA 91106-3212
Historic Changes and New Initiative

- GPS has had only 3 navigation signals
  - L1 C/A, L1 P/Y, L2 P/Y
- GPS modernization will add at least 4 more
  - L1 M, L2 M, L2C, and L5
- All were designed without asking preferences
  - Even L5, designed by an RTCA committee

**Historic initiative:**
- The IGEB has funded the L1C Project to seek input on the best approach for a new L1 civil signal
GPS III offers an opportunity to improve the L1 Civil signal

How?

- Triple Minimum C/A Power
- Add New Modernized Signal

C/A also is Retained
Constrained to Fit Between M & C/A

P(Y) is the “old” military signal

So, fitting between C/A and M codes is the focus

Note change in frequency scale

Offset from 1575.42 MHz Center Frequency (MHz)
Such As BOC(1,1) (OK for M and for C/A)

BOC(1,1) Spectral Separation Coefficient (SSC)

For C/A = -67.8 dB/Hz

For M = -82.4 dB/Hz
News: Galileo Signal Decision
http://europa.eu.int/rapid/start/cgi/guestfr.ksh?p_action.gettxt=gt&doc=IP/04/264|0|RAPID&lg=EN&display=

Loyola de Palacio welcomes the outcome of EU/US discussions on GALILEO

The United States and the European Commission, joined by the European Union Member States, held a successful round of negotiations in Brussels on 24-25 February 2004. The delegations built upon progress made in The Hague and in Washington and were able to reach agreement on most of the overall principles of GPS/Galileo cooperation.

• Adoption of a common baseline signal structure for their respective open services (the future GPS intends to use a BOC 1,1 signal whereas the Galileo open service intends to use a fully compatible optimized version of the same signal which guarantees an high-level of performance).
GPS III Power Control Thinking

Total C/A + L1C
(-151.2 dBW Max)

L1C (-153 dBW Max)

Current C/A Measurements

Future C/A
(-158.5 dBW Min at 5 degrees El.)
First L1C Modernization Question

GPS III offers an opportunity to improve the L1 Civil signal

How?

- Triple Minimum C/A Power
- Add New Modernized Signal

C/A also is Retained
Next L1C Modernization Questions

Add New Modernized Signal at Double the Minimum C/A Power

**Modulation**
- BOC(1,1)
- BOC(5,1)

**Bit Rate**
- 25 bps
- 50 bps
- 100 bps or higher

Demodulation Threshold Compared to C/A at 50 bps:
- 100 bps is $+5 - 3 - 3 = -1$ dB
- 50 bps is $+5 - 3 = +2$ dB
- 25 bps is $+5 - 3 + 3 = +5$ dB

Presume Equal Power Split between Data and Data-less (pilot carrier) components as in all modern GNSS signals

What New Messages?
Choose One After Each Diamond

What is best for your applications?

- Add Modern Signal at 2X Minimum C/A Power
- Triple Minimum C/A Power
- BOC(5,1)
- BOC(1,1)
- 100 bps or faster
- 50 bps
- 25 bps

What New Messages?
L1C Questionnaire

Name: ___________________________ Date: ____________
Title/Position: ___________________________
Organization: ___________________________
Address: __________________________________
Phone: ___________________________ E-Mail: ___________________________

Circle Preferences:

What new messages:

Comments:
### Application Specific Questions

<table>
<thead>
<tr>
<th>Name:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title/Position:</td>
<td></td>
</tr>
<tr>
<td>Organization:</td>
<td></td>
</tr>
</tbody>
</table>

#### Your Primary Expertise

<table>
<thead>
<tr>
<th>Professional &amp; Scientific</th>
<th>Commercial</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Expected Number of Users in 2005

<table>
<thead>
<tr>
<th>Professional &amp; Scientific</th>
<th>Commercial</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Expected Number of Users in 2020

<table>
<thead>
<tr>
<th>Professional &amp; Scientific</th>
<th>Commercial</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Importance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Best Desired</th>
<th>Worst Acceptable</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIEF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robustness</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Schedule a Web-Based Interview

E-mail:  L1C_GPS@USGS.gov
FAX:  626-583-7827
Mail:  L1C GPS
       Attn: Ken Hudnut
       525 South Wilson Ave.
       Pasadena, CA  91106-3212
See Tom Stansell at the L1C Poster
       Tom@Stansell.com