Impact of a possible redefinition of Coordinated Universal Time on GNSS interoperability

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Outline of presentation

- Relation between UTC and GNSS time scales
  - GPS time
  - Glonass time
  - Galileo system time
  - BeiDou system time
- UTC dissemination by GNSS
- Quality of disseminated time scales
- Possible improvement of GNSS interoperability after stopping leap seconds
- Events related to a possible redefinition of UTC
Multiple GNSS use

- Users need:
  - Interoperability
  - Interchangability

- A number of recommendations related to UTC definition by:
  - ICG
  - CCTF
  - CIPM
  - CGPM
System times

• GPS time: steered to UTC(USNO) modulo 1s
  ✓ [TAI – GPS time] = 19 s + C₀
  ✓ [UTC -GPS time] = -16 s + C₀
  ✓ C₀ ≤ 20 ns
  ✓ Tolerance is 1 µs

• GLONASS time: steered to UTC(SU) with leap second
  ✓ [TAI – GLONASS time] = 35 s + C₁
  ✓ [UTC – GLONASS time] = C₁
  ✓ C₁ ~ some 100 ns
  ✓ Tolerance is 1 ms

• Galileo time: steered to a set of EU UTC(k); using GPS time seconds, GGTO
  ✓ [TAI – Galileo time] = 19 s + C₂
  ✓ [UTC - Galileo time] = -16 s + C₂
  ✓ Tolerance is 50 ns

• COMPASS time: will be steered to set of Chinese UTC(k)
  ✓ [TAI – COMPASS time] = 33 s + C₃
  ✓ [UTC - COMPASS time] = -2 s + C₃
  ✓ Tolerance is 100 ns
GNSS time dissemination

GNSS broadcast:

- **System time** *(internal technical parameter)*
- **Prediction of UTC**
<table>
<thead>
<tr>
<th>2013</th>
<th>GPS time</th>
<th>UTC(USNO)</th>
<th>GLONASS</th>
<th>UTC(SU)</th>
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<td></td>
<td>+15 s</td>
<td>by GPS</td>
<td>time</td>
<td>by GLONASS</td>
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<td>/ns</td>
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**Stand. dev.** 1.1 1.2 6.3 6.3

**Uncert. uB** 10.0 10.0 500.0 500.0

Bureau International des Poids et Mesures
Summary on quality of broadcast time scales

• GPS is broadcasting its two time scales with an uncertainty of a few ns, fulfilling needs of most demanding users.

• GLONASS is broadcasting its two time scales with an uncertainty of some microseconds, which does not meet requirements of professional users.
Summary on safety of life issues

- GNSS providers choose always flat system times to avoid a risk of any disruption

- Only GLONASS is taking a risk of stepping its system time
Summary on impact of removing leap second

- Stopping proliferation of alternative time scales
- Accomodating needs of modern infrastructure as telecoms
- Improving interoperability and interchangeability of GNSS
- Improving safety of life
Related events

• Sept 2013 - ITU/BIPM Workshop on redefinition of UTC in Geneva

• Jan 2015 - World Radio Conference expected change of the definition of UTC
Possible compromises

- As some administrations are opposing change or are reluctant, compromises are considered
  - Suspending application of leap second
  - Replacing leap second by a leap hour
  - ........
  - Introducing a second official time scale is not acceptable
THANK YOU!