Experiences of Leap Second Adjustment Operations and Questionnaires in Japan

Yasuhiro Koyama, Tsukasa Iwama, Yuko Hanado, and Mizuhiko Hosokawa
National Institute of Information and Communications Technology, Japan
NICT = National Institute of Information and Communications Technology

1952~1988 ⇔ RRL (Radio Research Laboratory)
1988~2004 ⇔ CRL (Communications Research Laboratory)
2004~Present ⇔ NICT

- Telecommunications, Radio-wave Applications
- Frequency Standard, Emission of Standard Signal
- Space Communications
**Time and Frequency Standard and Related Services**

- **Primary Frequency Standard (time accuracy)**
- **Japan Standard Time (JST)**
  - Cesium atomic clocks (18 sets)
  - Hydrogen masers (4 sets)
- **Time comparison using GPS and TWSTFT**
  - BIPM and other organizations of time and frequency standard.

- **Time and Frequency Transmission/radio controlled watch**
- **Telephone JJY**
- **NTP service**
- **Time business service**
- **Calibration service of frequency standard**

- **Analog Telephone Line**
  - Users
  - Broadcast
- **Internet**
  - Units
  - BIPM and other organizations of time and frequency standard.

- **Japan Standard Time (JST)**
  - Reliable time stamp for users
  - Time Authentication (TA)
  - Time Stamp Authentication (TSA)

- **Time comparison using GPS and TWSTFT**
  - Calibration
  - Secondary Frequency Standard
  - Frequency for radio stations
Contents

• Generation, Maintenance and Dissemination of JST
• Leap Second Adjustment in 2009
• Leap Second Adjustment in 2012
• Questionnaires Conducted in Japan
Dissemination of JST : LF radio

- 40kHz (1999~) and 60kHz (2001~) LF radio signals are emitted from two radio stations to cover the country of Japan.
- More than 50 million radio controlled clocks/watches have been sold.
Dissemination of JST : Public NTP

- Stratum 1 Network Time Protocol (NTP) service since 2005.
- Specially designed, powerful (up to 1 million access per second), secure, reliable, and standalone servers in operation at `<ntp.nict.jp>`.
Dissemination of JST : Telephone JJY

- Interactive server accessible by acoustic modem over public telephone line.
- Accurate (~200μsec) and reliable service.
- Train operators, broadcasting stations, etc.
Leap Second Adjustments in 2006 and 2009

• No problem in the JST Dissemination Services from NICT.

• Carefully prepared the operations and hold a lecture to improve the awareness of the leap second insertion.

• Time Stamp Authorities determined to stop operations for about two hours.
Leap Second Adjustment in 2012

- No problem in the JST Dissemination Services from NICT.
- Carefully prepared the operations and hold a lecture to improve the awareness of the leap second insertion.
- Time Stamp Authorities determined to stop operations for about two hours.
- It was found that there is a bug in certain versions of Linux kernels. It caused malfunction of computer systems. Because of this malfunction, a well-known Social Network System service and Internet Service Providers reported delays or failures in their services.
Leap Second Adjustment in 2012
Questionnaire 2001
Conducted by Communications Research Laboratory (former NICT).

(1) Does the present UTC determination method cause any inconveniences?

- Yes 21.3%
- No 78.7%

(2) Do you think the determination method of UTC should be changed?

- Undecided 2.5%
- Yes 23.8%
- No opinion 32.5%
- No 41.3%

(2-1) If “yes”, which solution do you prefer?

- Smooth over leap second 20%
- Increase tolerance 25%
- No leap second 55%

(2-2) Reasons for not changing the determination method of UTC

- Present situation showed no problem 49%
- Present method is satisfactory 21%
- May cause confusion and increase cost and time 27%
- No opinion 3%
**Questionnaire 2007**
Conducted by Ministry of Internal Affairs and Communications.

<table>
<thead>
<tr>
<th>Field</th>
<th>Effect of past leap second adjustment</th>
<th>Effect of future change to UTC</th>
<th>Agree or disagree with future change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcasting carriers</td>
<td>None</td>
<td>None (Find the merit in disappearing in an irregular leap second adjustment)</td>
<td>Agree</td>
</tr>
<tr>
<td>Telecommunications carriers</td>
<td>None</td>
<td>None (Find the merit in disappearing in an irregular leap second adjustment)</td>
<td>Agree</td>
</tr>
<tr>
<td>Time stamp authorities</td>
<td>Operation stopped</td>
<td>None</td>
<td>Agree</td>
</tr>
<tr>
<td>GPS receiver manufacturers</td>
<td>None (Problem with bit length of the navigation message of the GPS in the future)</td>
<td>None in near future (New adjustment method may involve the possibility of significant problems)</td>
<td>Both agree and disagree</td>
</tr>
<tr>
<td>Geographical Survey Institute</td>
<td>None (Manual adjustment)</td>
<td>Need to adopt some changes to the control programs</td>
<td>-</td>
</tr>
<tr>
<td>Satellite launching enterprise</td>
<td>Made some changes to the control programs</td>
<td>Need to adopt some changes to the control programs</td>
<td>-</td>
</tr>
</tbody>
</table>
Summary

• Leap second adjustment operations at a dissemination institute may not be very difficult tasks, but they require careful preparations and repeated announcements to users.
• It is becoming difficult to expect ALL services by ALL providers are not suffered by leap second adjustment.
• There are strong demands for eliminating leap seconds from time stamp authorities.