Quasi-Zenith Satellite System

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QZSS Project Team

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System Description
System architecture

**Navigation Signals**
- L1: 1575.42 MHz
- L2: 1227.60 MHz
- L5: 1176.45 MHz
- LEX: 1278.75 MHz

**TWSTFT**
- Up: 14.43453GHz
- Down: 12.30669GHz

**System Description**

**System architecture**

- **SLR Site**
- **Monitor Station NW**
- **Time Management Station**
- **TT&C・NAV Message Uplink Station**
- **User Receiver**
- **Master Control Station (MCS)**

Function distributed in each institute:
Timing management, WDGPS correction, etc.

**S** (Up: 2025-2110, Down: 2200-2290MHz) band for LEOP
and **C** (Up:5000-5010, Down:5010-5030MHz) band for Nominal Operation

SLR: Satellite Laser Ranging, TWSTFT: Two Way Satellite Time and Frequency Transfer
QZSS is designed that at least one satellite out of three satellites can be observed more than 60 degrees of elevation angle in Japan.

Three IGSO satellites are in different orbital planes to pass over the same ground track.

\[(a=42,164\text{km}, \ e=0.099, \ i=45\text{deg}, \ \Omega=120\text{deg apart})\]
System Description
Space Segment- Orbit characteristics

- Each satellite orbit has slight eccentricity so that can keep appropriate separation between GSO. The vector of eccentricity will be maintained separation more than 50 km during operational phase.

- After whole mission life, satellite will be injected into “Disposal Orbit”, which defined as orbit with 1000 km higher perigee altitude of GSO.
System Description
Space Segment - QZS-1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>Approx. 1,800kg (dry)</td>
</tr>
<tr>
<td></td>
<td>(NAV Payload: Approx. 320kg)</td>
</tr>
<tr>
<td>Power</td>
<td>Approx. 5.3 kW (EOL)</td>
</tr>
<tr>
<td></td>
<td>(NAV Payload: Approx. 1.9kW)</td>
</tr>
<tr>
<td>Design Life</td>
<td>10 years</td>
</tr>
</tbody>
</table>

Satellite Configuration on Orbit
Okinawa is primary TT&C station for nominal. The number and locations of secondary sites are still being investigated.
# System Description

## Planned Signals

### Planned Signal List for QZSS

<table>
<thead>
<tr>
<th>Generic Signal Name</th>
<th>Center Frequency</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1-C/A</td>
<td>1575.42MHz</td>
<td>-</td>
</tr>
<tr>
<td>L1C</td>
<td>1227.6MHz</td>
<td>-</td>
</tr>
<tr>
<td>L5</td>
<td>1176.45MHz</td>
<td>-</td>
</tr>
<tr>
<td>L1-SAIF*</td>
<td>1575.42MHz</td>
<td>-</td>
</tr>
<tr>
<td>LEX</td>
<td>1278.75MHz</td>
<td>-</td>
</tr>
</tbody>
</table>

- **L1-SAIF: L1-Submeter-class Augmentation with Integrity Function**

**Notes:**

- GPS interoperable signals
- Compatibility and interoperability with existing and future modernized GPS signals
- Compatibility with GPS-SBAS
- WDGPS
- Experimental Signal with higher data rate message (2Kbps)
- Compatibility with Galileo E6 signal
System Description
Performance - Service Area

Minimum Elevation Angle and Ground Track

Ground track of a QZS

Minimum Elevation Contour for 3 QZS over 24 hours

* for maximum elevation of visible satellites
System Description
Performance

- User positioning Accuracy
  - define as positioning accuracy combined GPS L1_C/A and QZSS L1_C/A for single frequency user, L1-L2 for dual frequency user.

<table>
<thead>
<tr>
<th></th>
<th>Specification</th>
<th>Simulation result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single frequency user</td>
<td>21.9m(95%)</td>
<td>7.02m(95%)</td>
</tr>
<tr>
<td>Dual frequency user</td>
<td>7.5m(95%)</td>
<td>6.11m(95%)</td>
</tr>
</tbody>
</table>

- L1-SAIF signal can provide WDGPS correction data, its positioning accuracy is 1m (1 sigma rms) except in cases of large multipath error and large ionospheric disturbance.
System Description
IS-QZSS

- IS-QZSS describes;
  - System architecture of whole QZSS
  - Signal structure and specifications
  - Service properties
- First draft of IS-QZSS (ver. 0.0) was released January 22, 2007.
- Second draft, IS-QZSS ver. 0.1 was released June 8, 2007 on following web site.
  :http://qzss.jaxa.jp/is-qzss/index_e.html
Perspective on Compatibility and Interoperability

- **GPS**
  - GPS-QZSS Technical Working Group (TWG) established to achieve compatibility and technical interoperability between QZSS and current and future configurations of GPS in 2002.
  - QZSS and GPS success in designing “common” signals
    - Five of six QZSS signals use same signal structures, frequencies, spreading code families, data message formats as GPS or SBAS signals
  - US-Japan Joint Statement, 27 January 2006:
    - The Technical Working Group concluded that GPS and QZSS are designed to be fully interoperable and compatible.

- **Galileo**
  - JAXA-EU Galileo signal task force have had six coordination meetings to secure RF compatibility between QZSS and Galileo.
  - QZSS and Galileo have same spectrum of L5–E5a, LEX-E6, and almost close in L1C-E1OS.

- **COMPASS**
  - RF compatibility coordination between QZSS and COMPASS has just started since July 30, 2007.

- **Other RNSS systems**
  - There is no overlapping in QZSS signal with other RNSS systems currently.
GNSS Spectrum Protection Activities

- National-level RNSS spectrum regulation/management procedures
  - No specific regulation/management procedure for national-level RNSS spectrum as of now.

- Views on ITU RNSS spectrum issues or WRC Agenda items
  - As for Agenda item 1.6 WRC07, Japan support NOC position, which protects RNSS 5 GHz band.
  - Japan contribute to ITU-R WP8D activities related to RNSS issues in collaboration with other GNSS providers.

- RNSS interference detection and mitigation plans and procedure
  - No specific plans and procedure for RNSS interference detection and mitigation as of now.
"The Fundamental Act of Promotion for Utilization of Geographical Spatial Information" stipulates the importance of contacts with operators of global satellite based positioning systems.

Japan will participate in ICG to contribute to the cooperation in the compatibility and interoperability among GNSS systems.