Contents

- Introduction
  - QZSS program
  - Concept of QZSS
  - User Benefits of QZSS
- System description
  - Space Segment
  - Ground Segment
  - Navigation Payload on QZS-1
  - Planned Signals
  - QZSS orbit and Clock estimation analyses
- Current Development Status
  - Space Segment
  - Ground Segment
  - Site survey for MS
  - Development Schedule
- Summary
Japan is promoting research and development of the Quasi-Zenith Satellite System (QZSS), which is a regional satellite navigation system aiming at the GPS compliment and augmentation over Japan.

The Japanese government decided to promote the QZSS program on the following step by step approach. (March 31, 2006)

- Single mission: Navigation
- Step by step development:
  - First step; Only one satellite will be launched in summer 2010
    - Technical validation and application demonstration
  - Second Step; 2\textsuperscript{nd} and 3\textsuperscript{rd} satellites launch in several years after 1\textsuperscript{st} satellite launch
    - System operation will be demonstrated.

Some national institutes of Japan participate in the QZSS project for the 1\textsuperscript{st} satellite. JAXA is taking charge of development of satellite bus system, navigation payload, ground system and operation for 1\textsuperscript{st} satellite.
Three satellites are in **elliptical and inclined orbits in different orbital planes** to pass over the same ground track.

QZSS is designed so that **at least one satellite out of three satellites exists near zenith** over Japan.

\[
\begin{align*}
a &= 42,164\,\text{km}, \\
e &= 0.06-0.09, \\
i &= 39-47\,\text{deg}, \\
\Omega &= 120\,\text{deg} \text{ apart}
\end{align*}
\]
Introduction

Concept of the QZSS

Ground track of a QZS

Minimum Elevation Contour for 3 QZS over 24 hours

* for maximum elevation of visible satellites
Introduction

User Benefits of QZSS (1/2)

- QZSS can provide a seamless service from high elevation angle.
- Increasing the availability of PNT services in downtown and mountainous areas.
Introduction

User Benefits of QZSS (2/2)

Availability Analysis in Urban Areas using 3D Simulation

Legend.

- ■ 0-20, ■ 20-40, ■ 40-60, ■ 60-80, ■ 80-90, ■ 90-100 %

The time percentage of positioning availability in Ginza

- Positioning availability is greatly improved by adding QZSS.
**System Description**

**Space Segment**  
- QZS-1 -

| Mass          | Approx. 1,800kg (dry)  
               | (NAV Payload: Approx. 320kg) |
|---------------|------------------------|
| Power         | Approx. 5.3 kW (EOL)   
               | (NAV Payload: Approx. 1.9kW) |
| Design Life   | 10 years               |

**Satellite Configuration on Orbit**

- L-band Helical Array Antenna
- L1-SAIF Antenna
- C-band TTC Antenna
- Laser Reflector
- Radiation Cooled TWT
- TWSTFT Antenna

25.3m
System Description

Navigation Payload on QZS-1

Navigation Payload

- Rb Atomic Clock
- Time Keeping Unit
- Synthesizer
- Navigation Onboard Computer
- Modulator
- Amplifier
- MUX
- TT&C Subsystem
- Time Comparison Unit
- Time Transfer System RF portion
- L1-SAIF-Ant
- L-Ant
- Laser Reflector
- Ku-Ant

JAXA
NICT
(previously: CRL)

Navigation Signal
Sine Wave
Baseband Signal (Navigation Message + PRN Code)
Signal of Two Way Satellite Time and Frequency Transfer

Uploaded Data (including Remote Synchronization Signal (by AIST))

Control
Phase Error

Navigation Message, CMD

TLM
## Planned Signal List for QZSS

<table>
<thead>
<tr>
<th>Generic Signal Name</th>
<th>Center Frequency</th>
<th>Notes</th>
</tr>
</thead>
</table>
| L1-C/A              | 1575.42MHz       | ■ GPS interoperable signals
|                     |                  | ■ Compatibility and interoperability with existing and future modernized GPS signals |
| L1C                 |                  |       |
| L2C                 | 1227.6MHz        |       |
| L5                  | 1176.45MHz       |       |
| L1-SAIF*            | 1575.42MHz       | ■ Compatibility with GPS-SBAS
|                     |                  | ■ WDGPS |
| LEX                 | 1278.75MHz       | ■ Experimental Signal with higher data rate message (2Kbps)
|                     |                  | ■ Compatibility with Galileo E6 signal |

**L1-SAIF: L1-Submeter-class Augmentation with Integrity Function**
Analyses were performed on the current conditions of QZSS dynamic models and monitor station locations and so on.

Accuracy of SIS-URE (orbit + Clock) is expected 30cm (1-sigma) so that high positioning accuracy will be achieved using GPS + QZS.
Current Development status - Space segment -

L-band Antenna Pattern Test
Proto-Flight Model (July 2008)

NAV Payload PFM TVT
(Jan 2009)

Satellite System (Aug 2009)
Current Development status - Ground segment -

@Sarobetsu (Sep 2009) @Guam (Aug 2009)
QZSS Monitoring Station

TT&C-NAV Message Uplink Station (July 2009)
@Okinawa, Japan
Current Development status - Site Survey for MS -

The site surveys for Monitoring Station completed, and Installation construction starts.

- Canberra
  - Geoscience Australia (GA)
- Hawaii
  - Kokee Park Geophysical Observatory (KPGO)
- Guam
  - National Weather Service Forecast Office (WFO)
- Bangkok
  - Asian Institute of Technology (AIT)
- Bangalore
  - ISRO Telemetry, Tracking and Command Network (ISTRAC)

@Mt.Stromlo August 28-30, 2007
3 months later from the launch:
In Orbit Validation

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### Development Schedule

<table>
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<tr>
<th>Milestone</th>
<th>Jun-09</th>
<th>Jul-09</th>
<th>Aug-09</th>
<th>Sep-09</th>
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### Milestone

- System PQR
- Launch Slot
- Launch Campaign
- Pre Launch Validation

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- E to E Test
- Pre Launch Validation by using GPS
Summary

- **QZSS Outline**
  - QZSS is a Japanese regional space-based navigation system
    - Enhance GPS capability
    - High level interoperability with GPS
  - 1st satellite will be launched in Summer of 2010

- **Development Status of the QZSS**
  - Manufacturing the space system and the ground system is completed, and an integrated test is being executed now.
  - Site surveys for Monitoring stations have been completed, and an installation construction starts.