

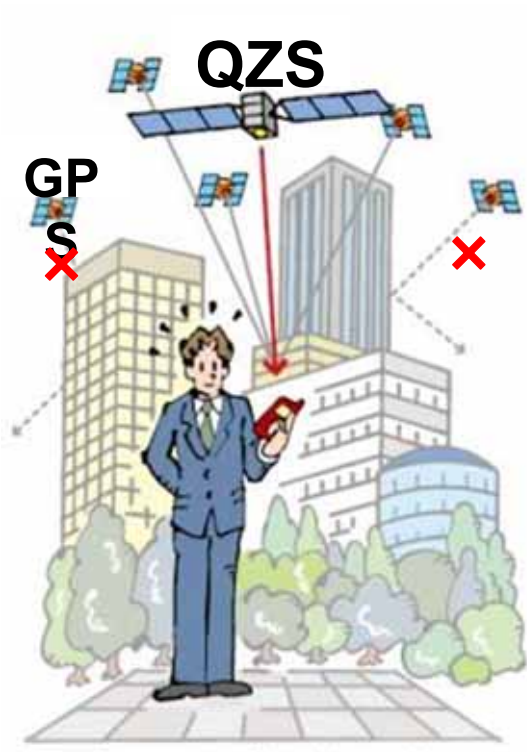
# **High Precision Navigation Capabilities(L1-SAIF) and Applications Using Japanese Quasi-Zenith Satellite System (QZSS)**

**ICG WG-B Application SG Meeting  
Munich, Germany  
March 12, 2012**

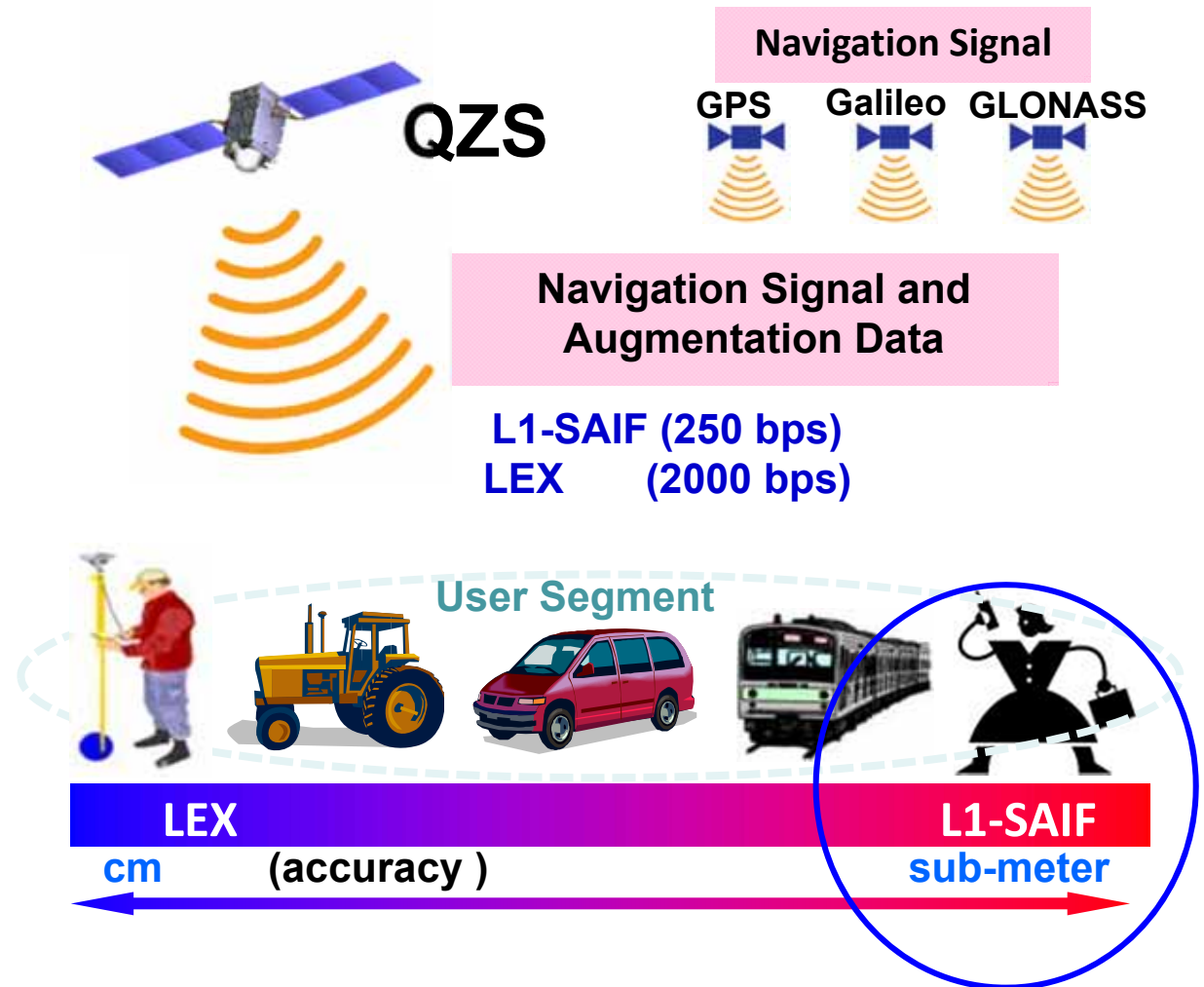
**Satellite Positioning Research and Application Center  
(SPAC)**

# Functions of QZSS

## ■ Increasing Coverage & Availability



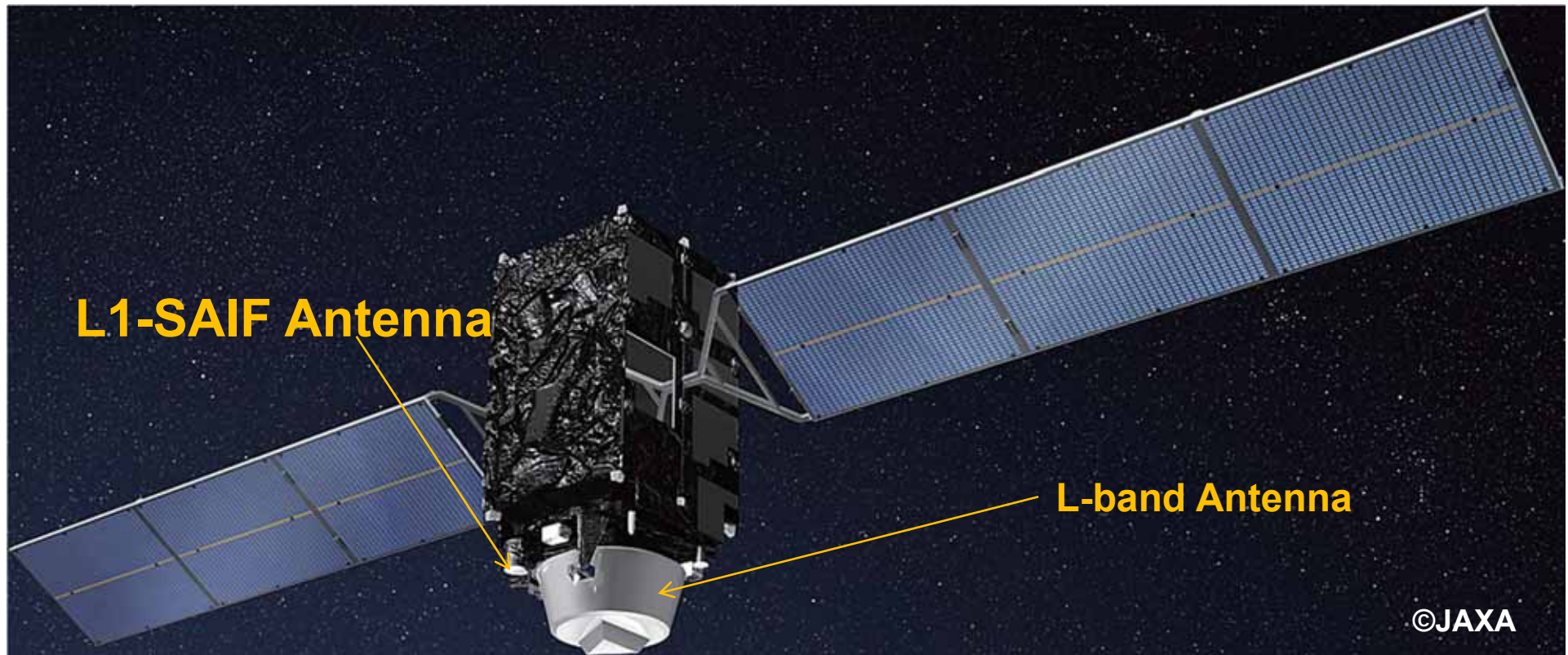
## ■ Enhance GPS Performance



# Functions of QZSS

## ■ QZSS Satellite Overview

Mass	Around 4ton
Power	Around 5kw
Design Life	10 years
Launch Date	September 11, 2010



©JAXA

# Functions of QZSS

## ■ QZSS Navigation Signals

Signal	Channel	Frequency	Interoperability
L1C	L1CD	1575.42 MHz	GPS-like supplemental signals with minimum modifications from GPS signals
	L1CP		
L1-C/A		1227.6 MHz	
L2C			
L5	L5I	1176.45 MHz	
	L5Q		
L1-SAIF		1575.42 MHz	SBAS-like augmentation signal (250bps)
LEX		1278.75 MHz	QZSS-specific augmentation signal (2kbps)

©JAXA IS-QZSS(Interface Specification for QZSS)

# QZSS L1-SAIF Signal

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## ■ L1-SAIF (Submeter-class Augmentation with Integrity Function)

- Development : by ENRI
- Utilization and Demonstrated : by SPAC

## ■ Functions

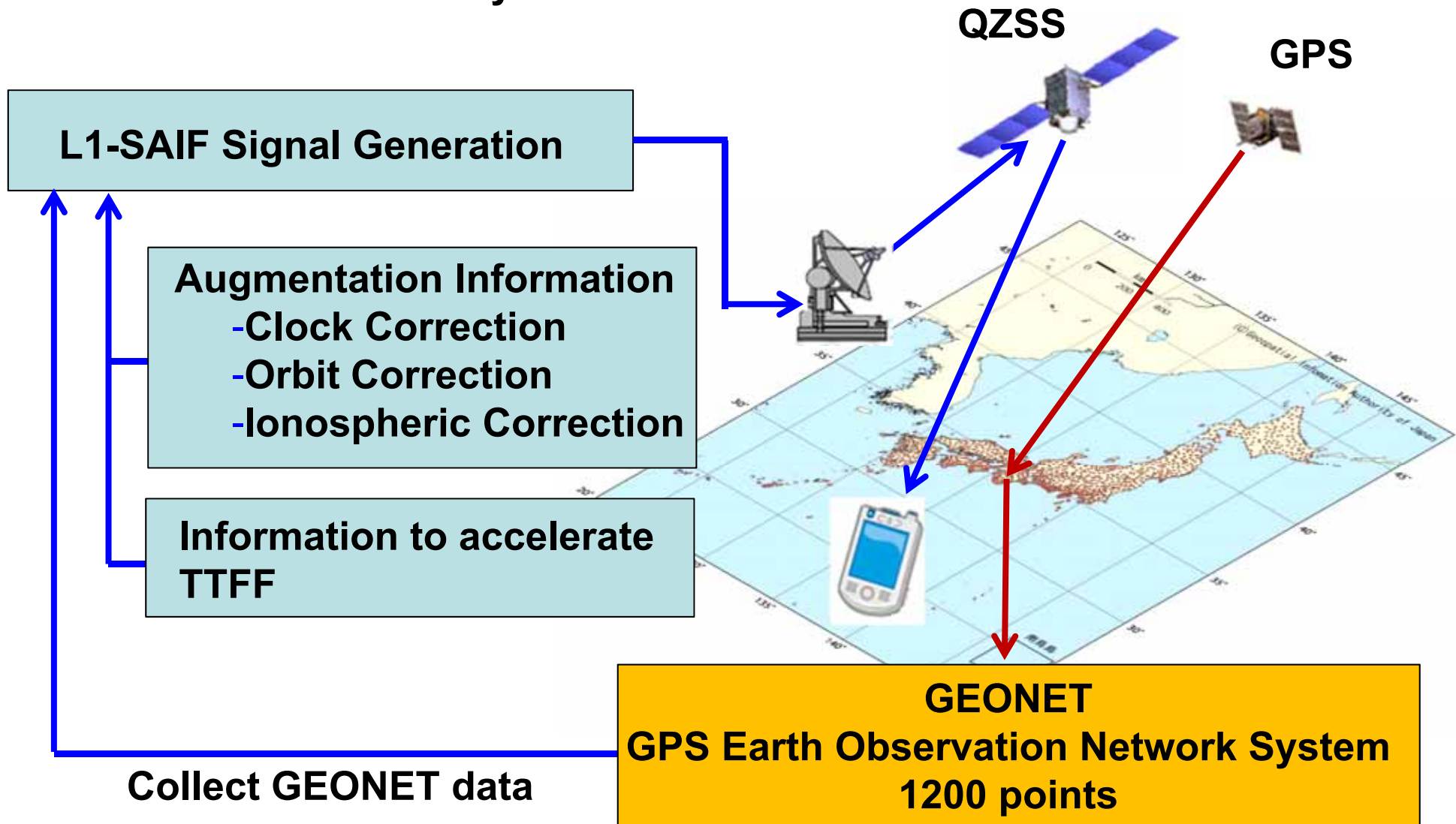
- Ranging
- Error Correction
  - Wide-area differential correction
  - Target accuracy : 1m(horizontal)
- Integrity

## ■ Interoperability and compatibility

- Interoperable with GPS L1C/A
- Fully compatible with SBAS
- Additional messages are included in L1-SAIF signal

# QZSS L1-SAIF Signal

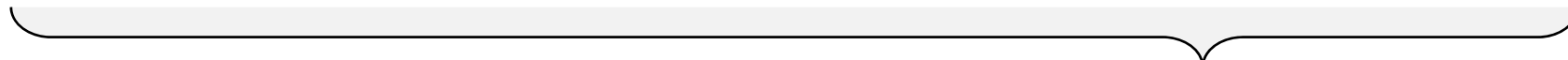
## ■ Structure of L1-SAIF system



# QZSS L1-SAIF Signal

## ■ Structure of L1-SAIF message

Preamble 8 bits	Message Type 6 bits	Data Field 212 bits	CRC Parity 24 bits
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**L1-SAIF Message**

1 message = 250 bits broadcast every second

**SBAS compatible message**  
Type ID : 0-7, 10, 18, 24-26, 28, 62-63

**SBAS non compatible message**  
Type ID : 52-60

**QZSS unique message(for civil utilization demonstration)**  
Type ID : 40-51

# QZSS L1-SAIF Signal

## ■ Structure of L1-SAIF message

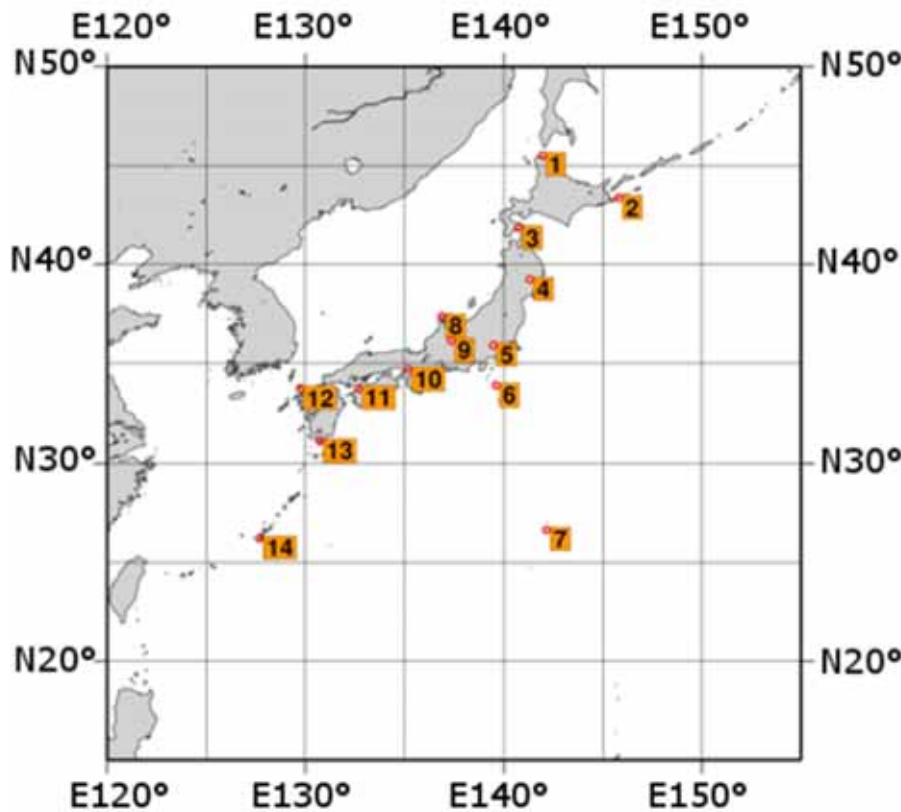
Message Type	Contents	Used by	Status
29 to 51 (40-51)	Undefined (QZSS)	— (L1-SAIF)	— (Tentative)
52	TGP mask	L1-SAIF	Tentative
53	Tropospheric delay	L1-SAIF	Tentative
54 to 55	Advanced Ionospheric delay	L1-SAIF	TBD
56	Intersignal biases	L1-SAIF	Tentative
57	Ephemeris-related parameter	L1-SAIF	TBD
58	QZS ephemeris	L1-SAIF	Tentative
59	QZS almanac	L1-SAIF	TBD
60	Regional information	L1-SAIF	TBD

“Ranging Quality of QZSS L1-SAIF Signal”, IONITM 2012, Newport Beach, 2012  
Electronic Navigation Research Institute

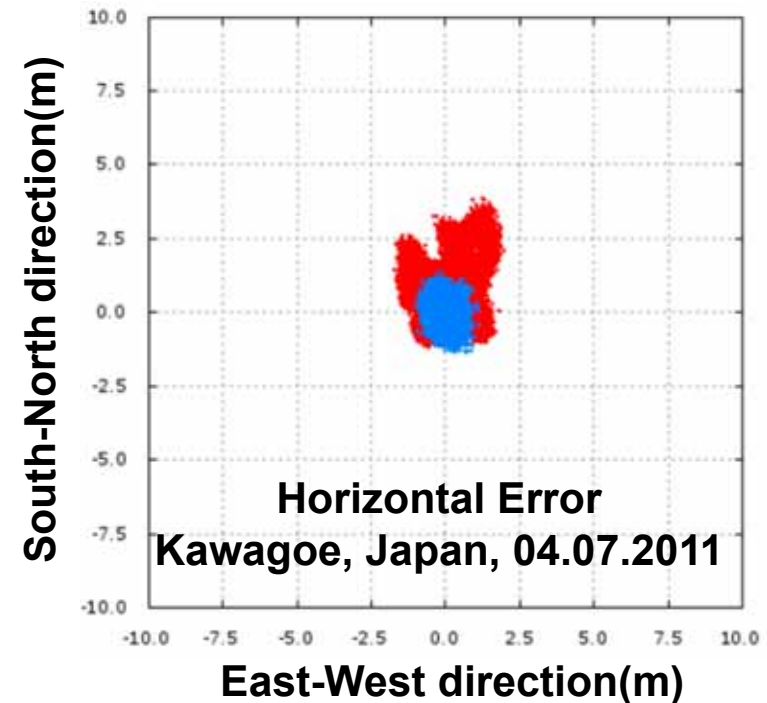


# Demonstration of L1-SAIF Capability

- Following 14 points have been selected from GEONET to generate L1-SAIF augmentation information
- L1-SAIF capability has been evaluated



Vertical(GPS only)	1.83(m)
Horizontal(GPS only)	1.30(m)
Vertical(GPS+L1-SAIF)	0.59(m)
Horizontal(GPS+L1-SAIF)	0.38(m)

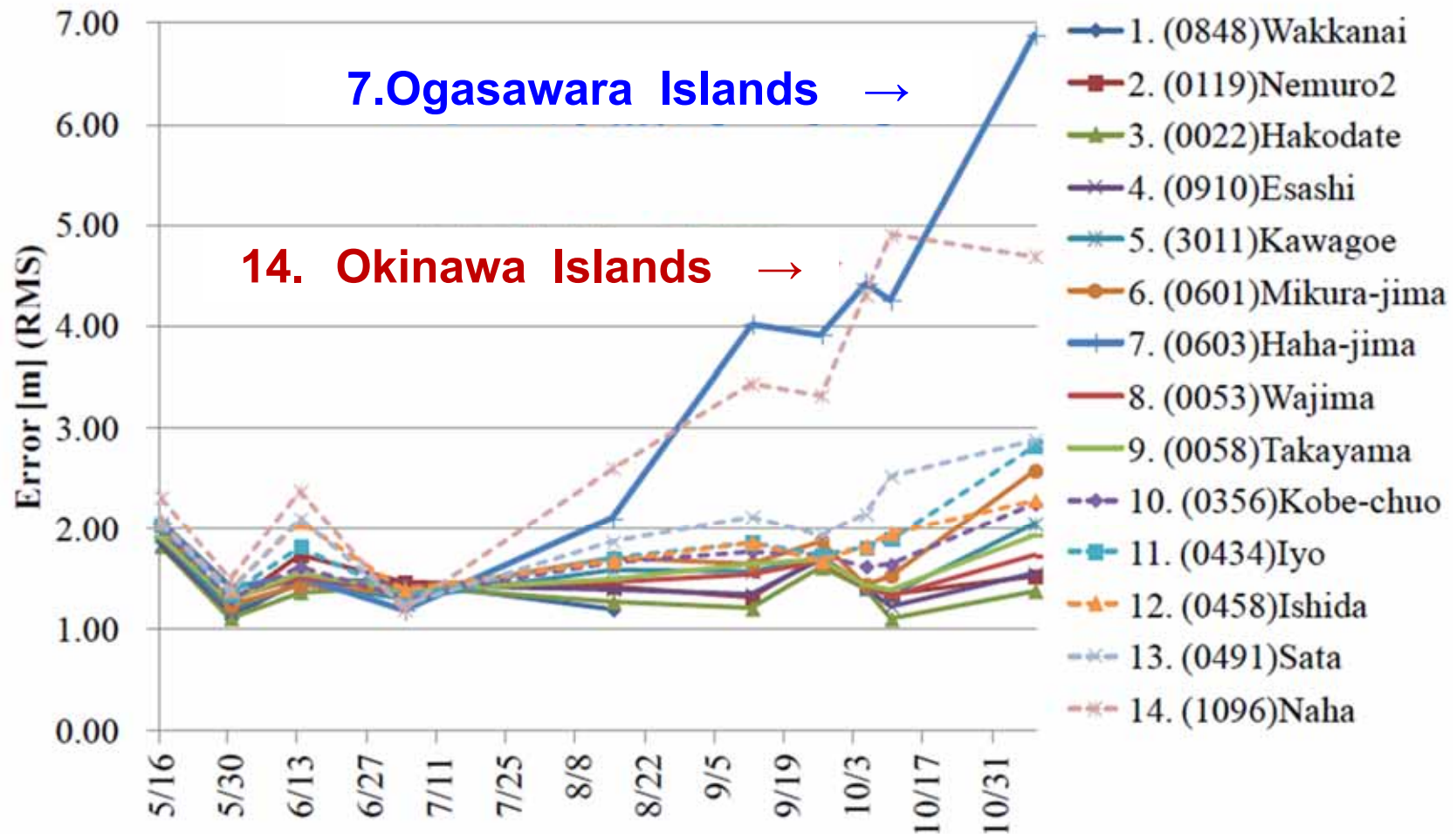


“Activities for QZS application demonstration in private sector”,  
SPAC Symposium 2011, Tokyo, 2011, SPAC

# Demonstration of L1-SAIF Capability

## ■ Effects of L1-SAIF(1/2)

### GPS only: Horizontal Error(RMS)

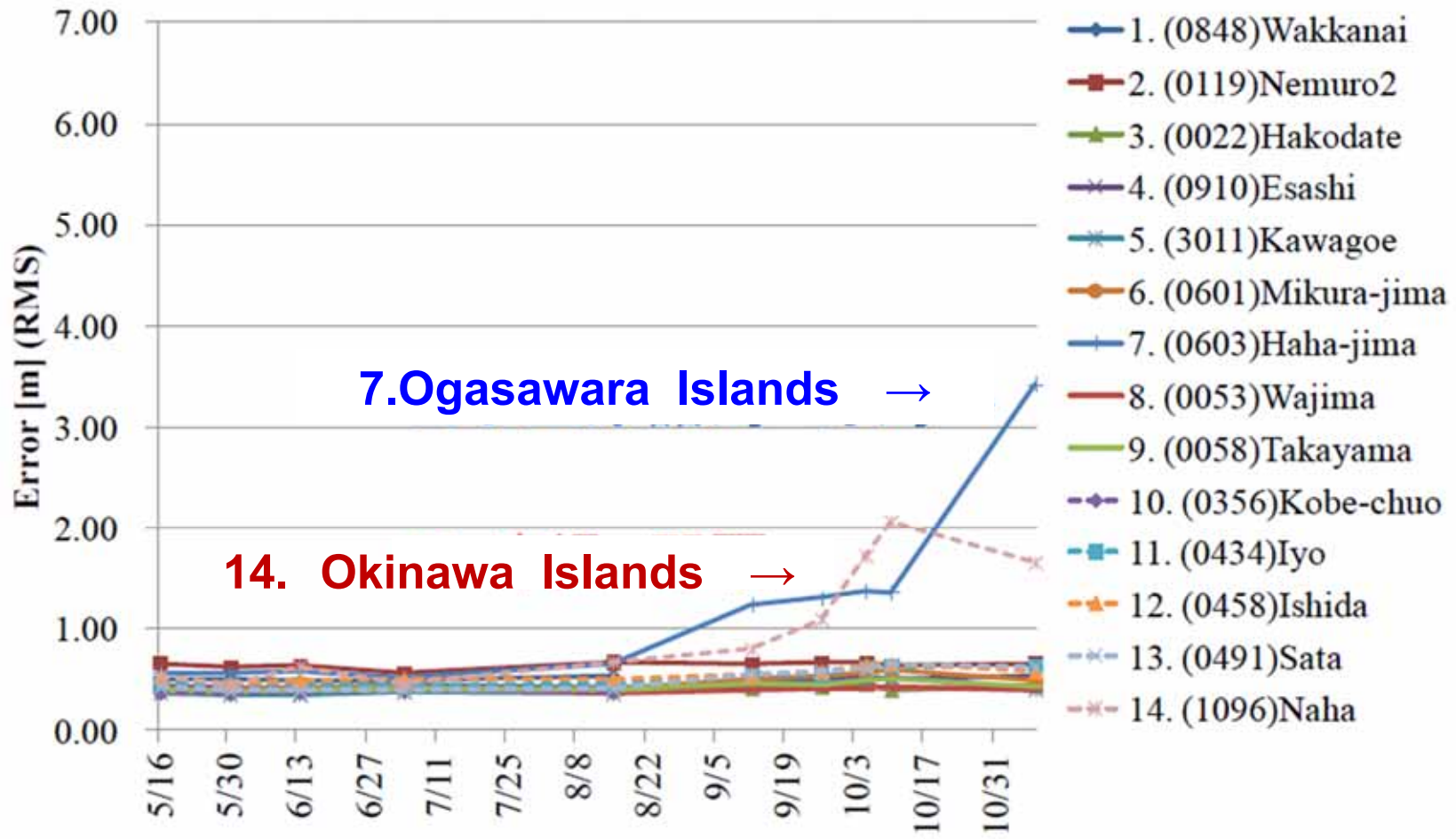


“Activities for QZS application demonstration in private sector”,  
SPAC Symposium 2011, Tokyo, 2011, SPAC

# Overview of L1-SAIF Capability

## ■ Effects of L1-SAIF(2/2)

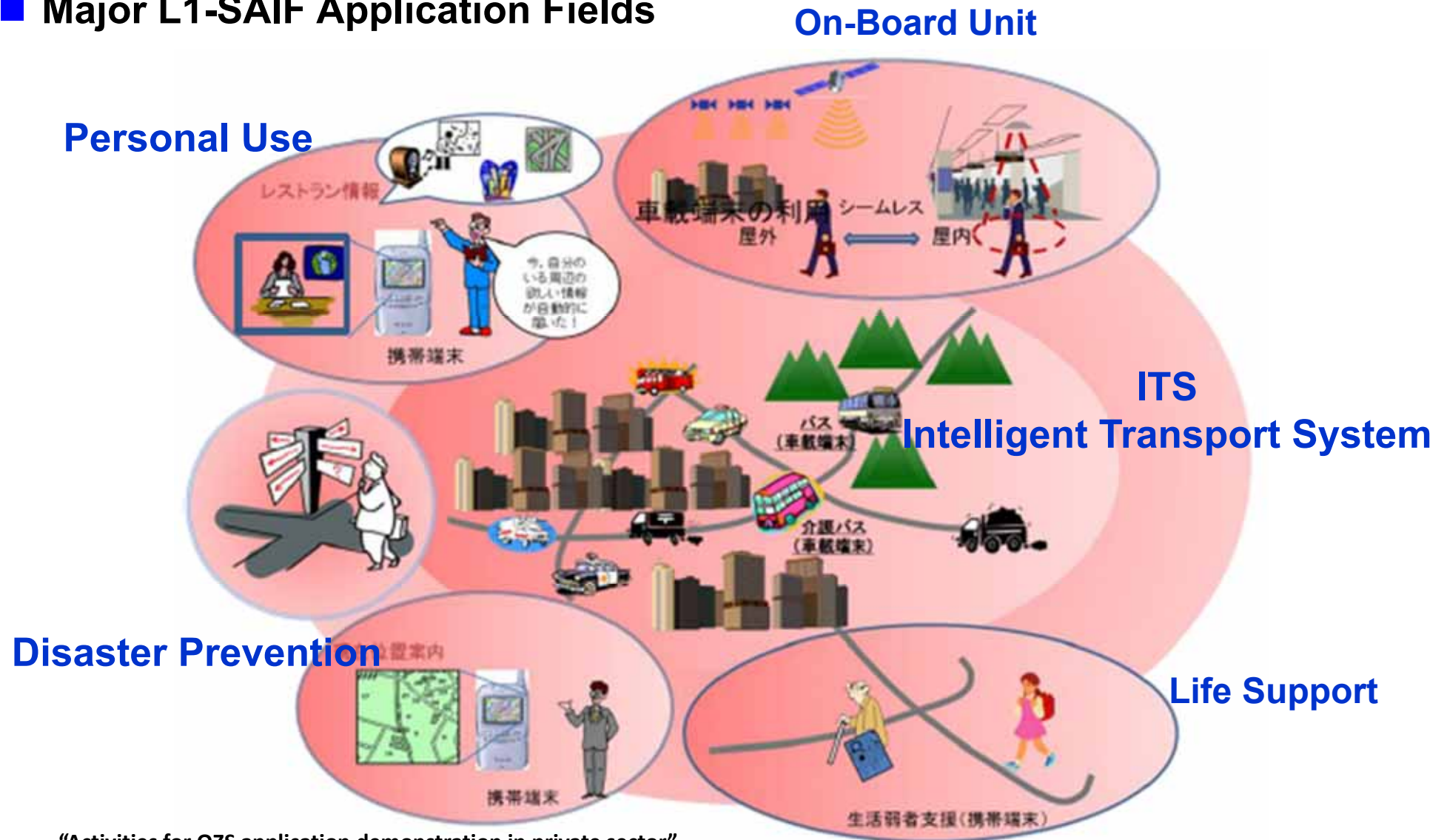
### L1-SAIF: Horizontal Error(RMS)



“Activities for QZS application demonstration in private sector”,  
 SPAC Symposium 2011, Tokyo, 2011, SPAC

# L1-SAIF Application Fields

## Major L1-SAIF Application Fields



“Activities for QZS application demonstration in private sector”,  
 SPAC Symposium 2011, Tokyo, 2011, SPAC

# L1-SAIF Application Fields

- Application for ITS
  - Enhancement of GPS navigation results has been confirmed by the demonstration.
  - By using L1-SAIF signal, cruising lane of each car can be identified.



mode1 : GPS

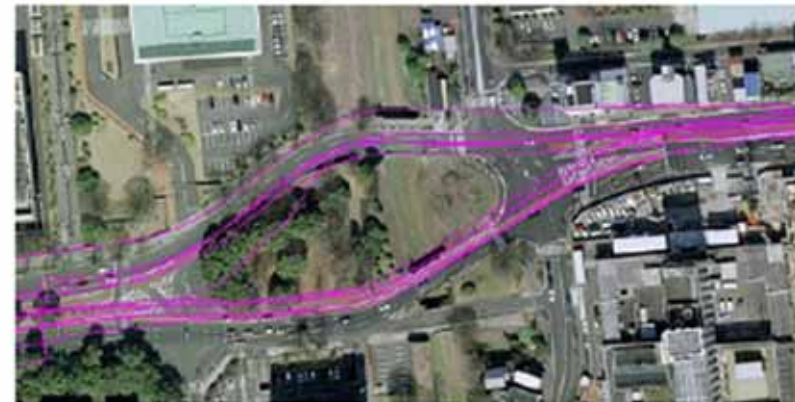


mode2 : GPS + QZS(L1 C/A )

**Date : 2011.10.17&2011.11.17**

**Place : Nagoya-city**

**Remark : 7 times round trip data are superimposed**



mode3 : GPS + QZS( L1-SAIF )

“Activities for QZS application demonstration: ITS”,  
 SPAC Symposium 2011, Tokyo, 2011, AISAN Technology Company LTD.

# L1-SAIF Application Fields

- Application for Personal Use

- “Sekai Camera” is new **AR application** to provide millions of Air Tags (by Tonchidot Corporation)

- L1-SAIF provides capability to show Air Tags at the precise position to each place.

## Examples of Air Tags



“The world of SekaiCamera”, 9<sup>th</sup> Satellite Positioning and Geospatial Information Form 2011, Tokyo, 2011, Tonchidot Corporation

# L1-SAIF Application Fields

- AR application

- AR : Augmented Reality

- Technology to display additional information to the real world by using computer assist

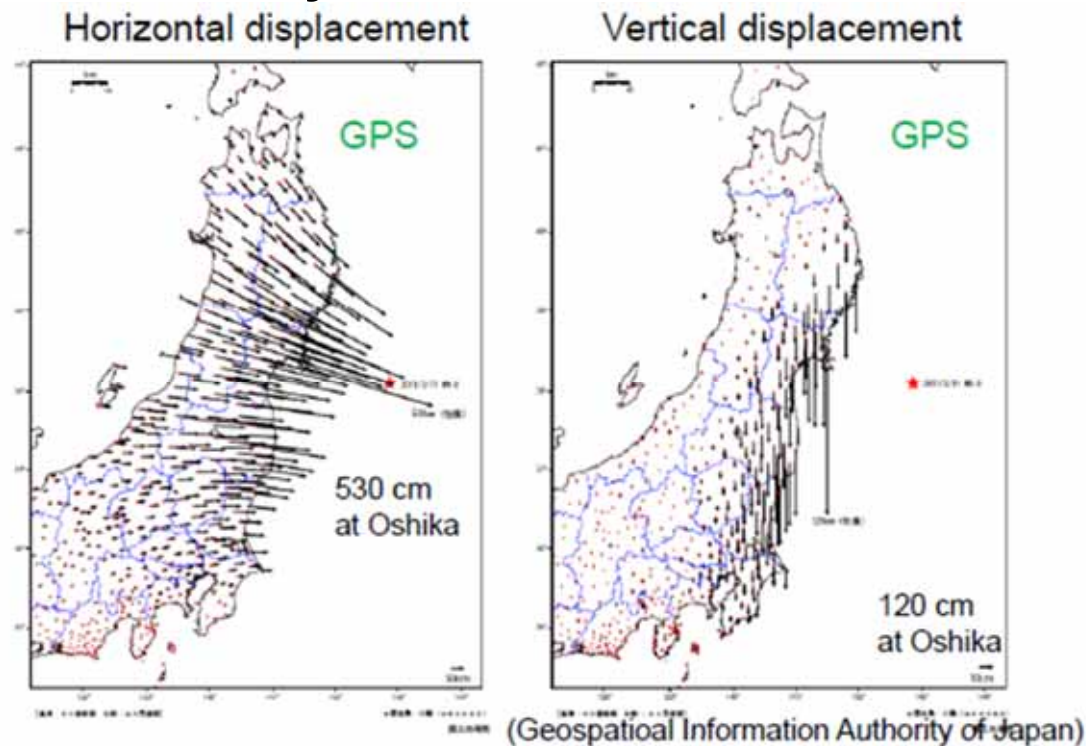
- Based on geographical information obtained from L1-SAIF signal, it is possible to provide facility information around the area and recommended route information by overlaying these digital information on the reality space in Map and Camera Screens.



Omotenabi : <http://omotenabi.jp/en/about/index.html>

# L1-SAIF Application Fields

- Application for Disaster management (Earth Quake)
  - Horizontal and vertical displacement due to coseismic slip can be detected by GPS.
  - Following figure shows GPS observation by the Geospatial Information Authority of Japan. By using L1-SAIF signals, the movement can be detected more accurately

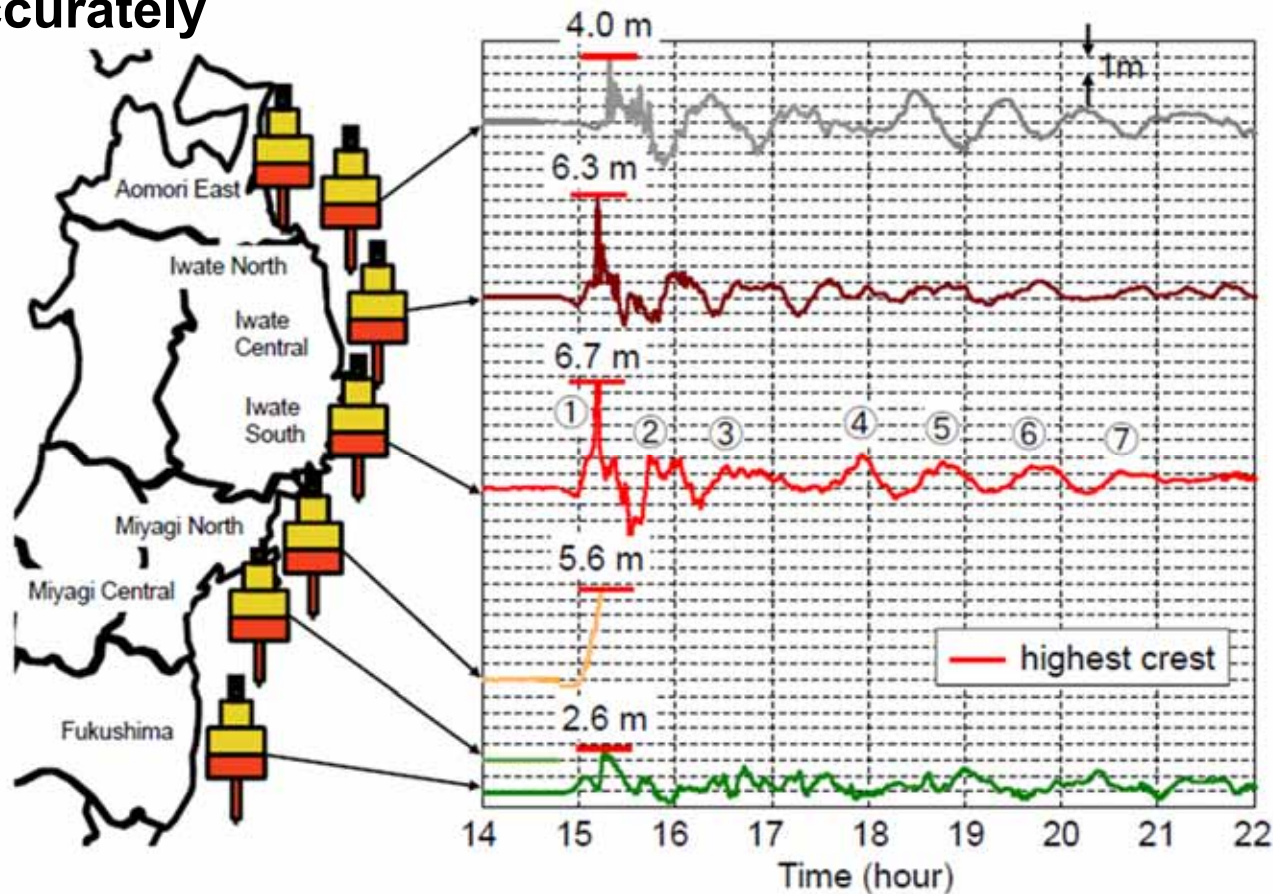


“Tsunami Impacting Eastern Japan and Preparedness for Extraordinary Natural Disaster”,  
 Port and Airport Research Institute, Japan



# L1-SAIF Application Fields

- Application for Disaster management (Tsunami)
  - Tsunami height was measured with GPS buoy as shown bellow.
  - By using L1-SAIF signals, the movement can be detected more accurately



GPS buoy

“Tsunami Impacting Eastern Japan and Preparedness for Extraordinary Natural Disaster”,  
 Port and Airport Research Institute, Japan

# Summary

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- “Augmentation” is characteristic feature of the QZSS.
- Demonstration of L1-SAIF signal has been conducted by SPAC and improvement by L1-SAIF augmentation has been confirmed.
- Signal characteristics of L1-SAIF has been already issued by IS-QZSS  
<http://qzss.jaxa.jp/is-qzss/index.html>  
IS-QZSS : Interface Specifications for QZSS
- L1-SAIF provides efficient augmentation information for “High Precision Navigation Market”