

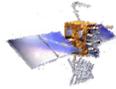
# Research Activities and Education in TUMSAT

2011/09/07 @ ICG-6

Akio Yasuda

Tokyo University of Marine Science &  
Technology

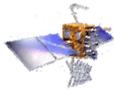
# Content



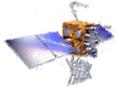
- Etchujima Campus of Tokyo University of Marine Science and Technology
- Stuffs and Researches at Lab. of Satellite Navigation
- GPS/GNSS Symposium in Japan
- Introduction of Institute of PNT of Japan
- Introduction of Multi-GNSS Asia (MGA)
- The 3<sup>rd</sup> AOR-WS
- Introduction of G-Spatial Expo 2012
- Summary

# TUMSAT, Etchujima Campus

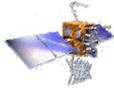
(Faculty of Marine Technology)



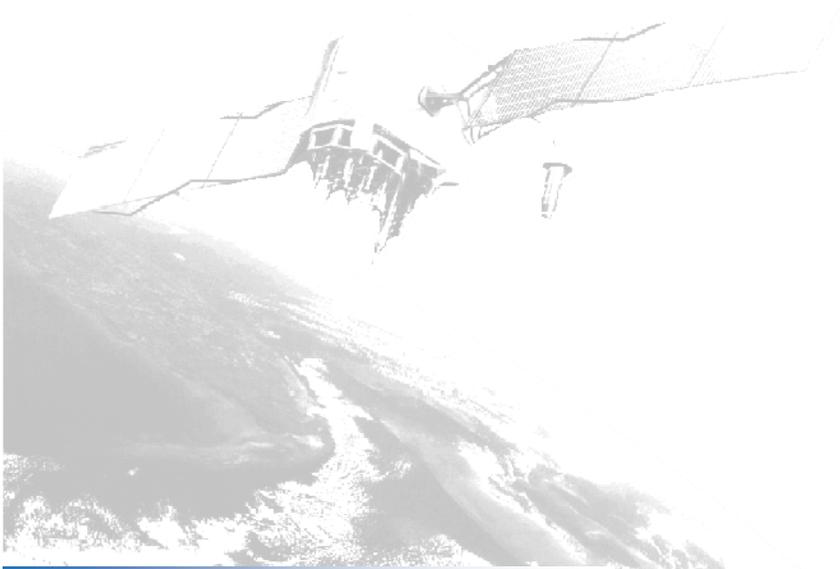
# Laboratory Building



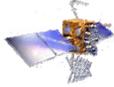
Laboratory of Satellite Navigation Engineering



# Staffs and Research Activities in our Laboratory

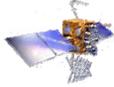


# Research Staffs and Students



- Professor Akio Yasuda
- Professor Harumasa Hojo
- Associate Professor Nobuaki Kubo
- Assistant Professor Chunming Fan
- Research Fellow **Tomoji Takasu**
- Research Fellow Takuji Ebinuma
- D3 2 D2 1 D1 0 M2 7 M1 4
- Research Student 1
- Under Graduate Student 5

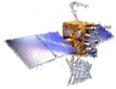
# Research subjects 1/3



- Precise Orbit/Clock Estimation Tool for Multi-GNSS Network  
(JAXA)
- Precise Point Positioning with QZS-LEX signal  
(JAXA)
- GPS+QZS+IMES Integrated Positioning  
(JAXA)
- Development of Multi-GNSS High Accuracy Positioning Tool for GSI Reference Stations  
(GSI)

Inside the Red Bracket : Sponsor

# RTKLIB

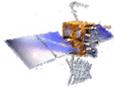


- **Open source program package for RTK-GPS**
  - Has been developed by Mr. Takasu since 2006
  - Latest version: 2.4.1
- **Portable C library + several positioning APs**
  - GUI APs on Windows
  - Console APs on Linux etc...

<http://gpspp.sakura.ne.jp/rtklib/rtklib.htm>



# Application Programs (APs)



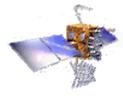
- RTKNAVI** : Real-time positioning
- RTKPOST** : Post-processing baseline analysis
- RTKPLOT** : Plot raw observation data and solutions
- RTKCONV** : RINEX converter for raw receiver log

...

The screenshot displays the RTKLIB software interface with several windows open:

- STRSVR ver.2.2.0**: Network connection settings for the STRSVR client.
- RTKCONV ver.2.2.0**: RINEX converter settings, showing input and output file paths.
- Ntrip Source Table Browser**: A table listing various Ntrip sources with columns for Namepoint, ID, Format, Format-Details, and Cn.
- RTKNAVI ver.2.2.0**: Real-time positioning window showing a 3D plot of a boat's trajectory on the water. The plot shows a boat moving in a curved path. The solution is SBAS, with coordinates: N: 35° 52' 22.7186", E: 138° 23' 22.7875", H: 961.418 m.
- RTKPOST ver.2.2.0**: Post-processing baseline analysis window, showing observation data and navigation messages.
- RTKPLOT**: Plot raw observation data and solutions window, showing a 2D plot of the boat's trajectory on the water.

# GNSS Availability for 24 hours @Tokyo 2011/02/06



EL>15°

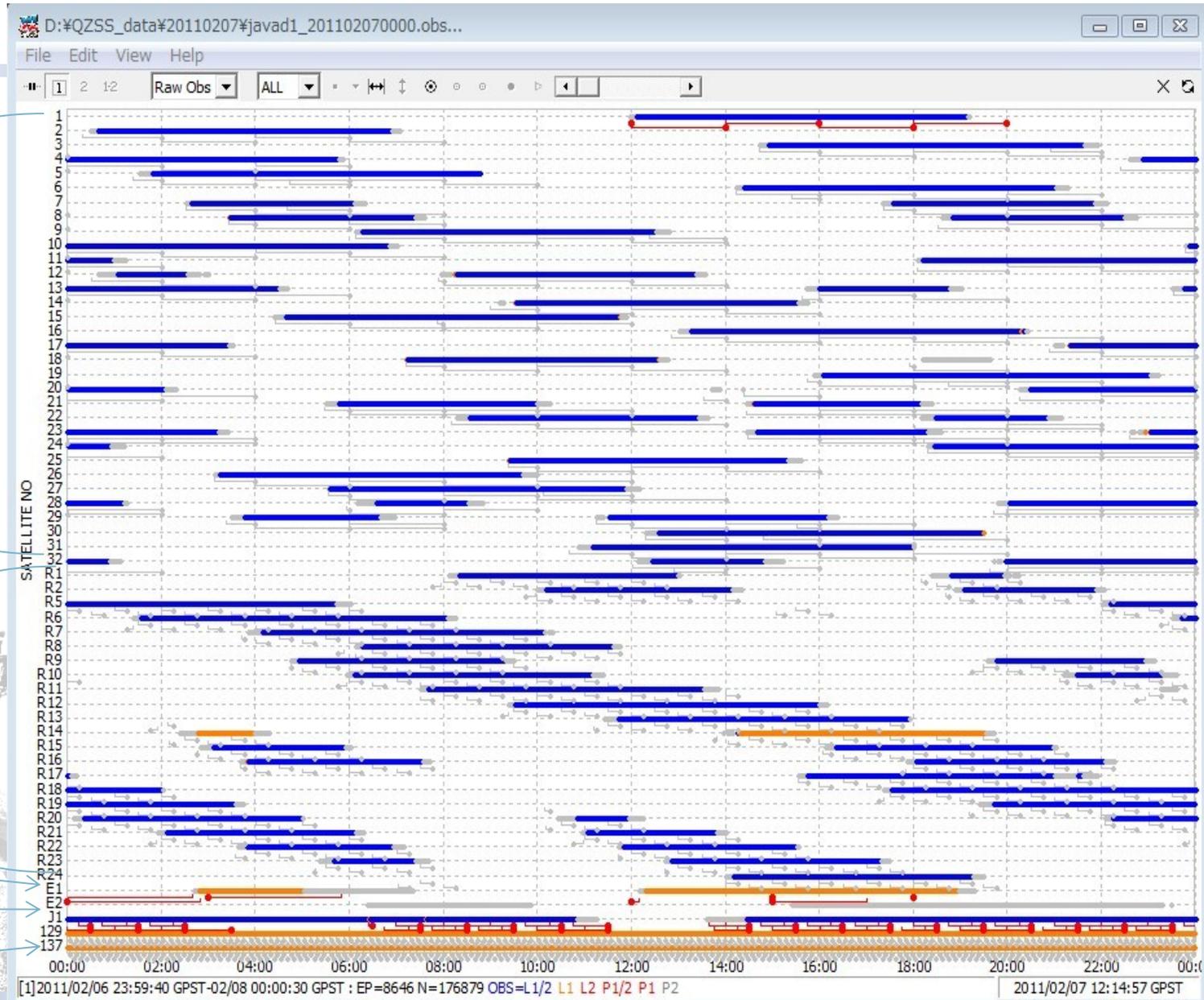
GPS

GLONASS

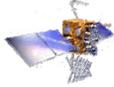
GALILEO

QZSS

MSAS

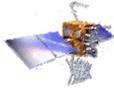


# RTKPOST: Post Processing Analysis



- Input : standard RINEX OBS/NAV files
- Positioning mode:
  - Kinematic/Static/Moving-Baseline
- Smoother solution
- High-rate analysis with GEONET 30s free data
- long baseline analysis (<1000 km)
  - Ionosphere/troposphere estimation
  - Support precise ephemeris (SP3)

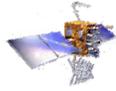
## Research subjects 2/3



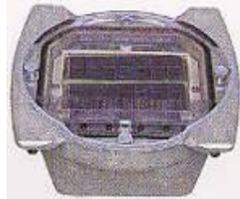
- Long-Term Predicted Ephemeris for GPS Satellite  
(Japan Radio Co. Ltd.)
- Improvement of Positioning Dependability by Multi-GNSS for Train Control  
(Railway Technical Research Institute)
- QZSS synchronized Road marker and Timing applications  
(Ministry of Education)



# QZSS synchronized Road marker and applications



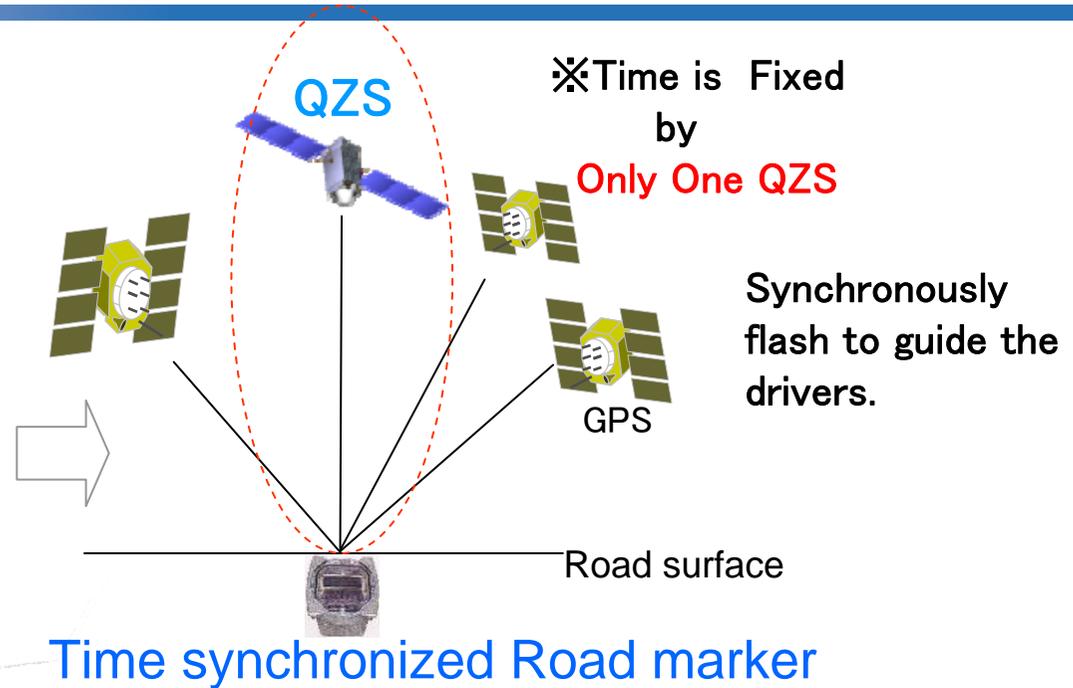
## Road marker



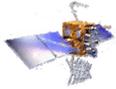
Road stud with solar battery (existing)

+

Precise synchronization device by QZSS

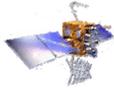


## Research subjects 3/3



- Evaluation of Correction data from MSAS and L1-SAIF of QZSS  
(Satellite Positioning Research and Application Center)
- Application of GPS positioning to ubiquitous sensor network
- Remote Sensing by GNSS Positioning and Signals
- Development of Software Defined Receiver to resolve the new GNSS signals
- Mitigation of Multipath

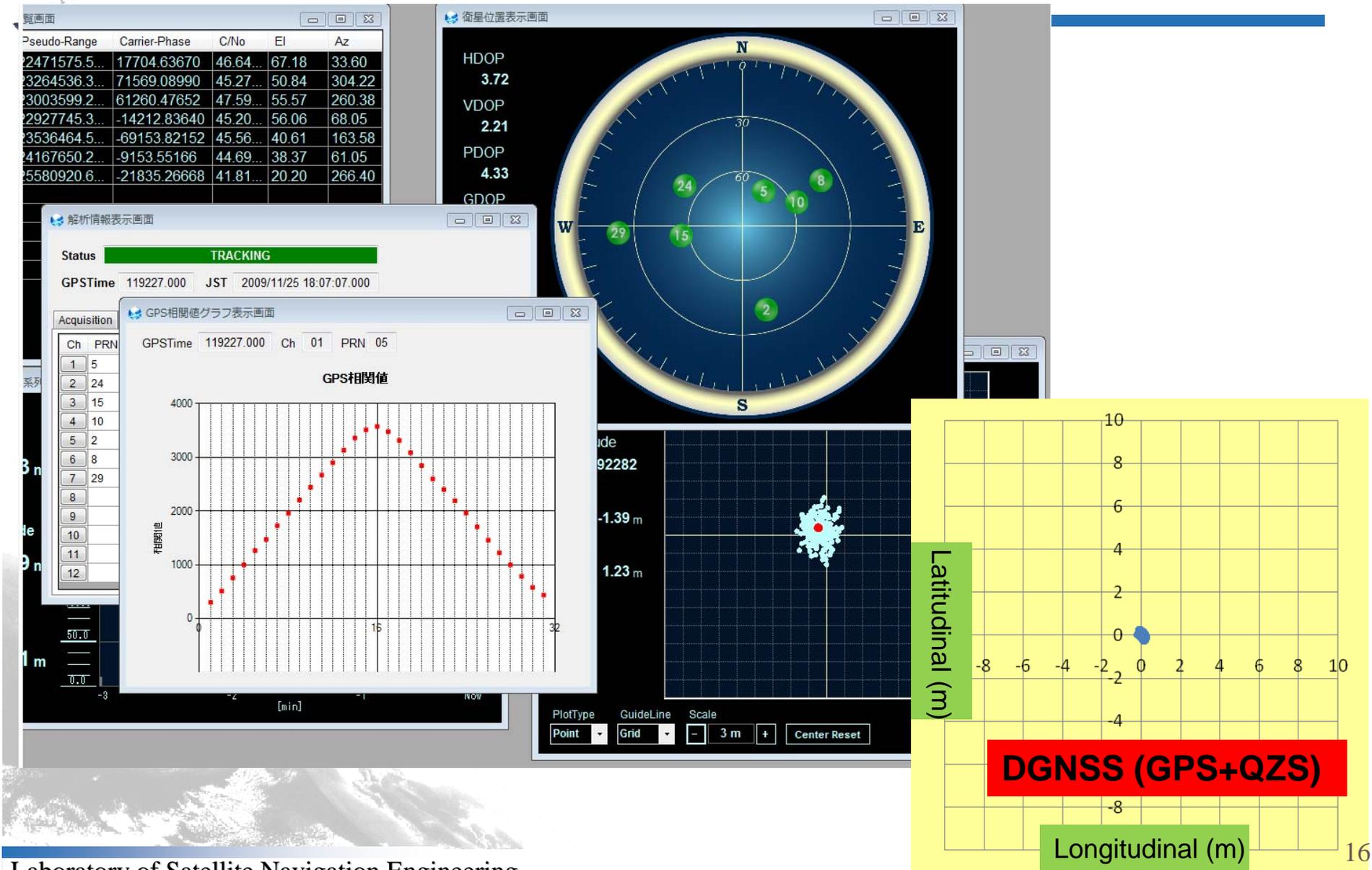
# Software GNSS Receiver



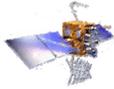
- Our laboratory has developed software GNSS receiver since 2008.
- Software receiver is capable as a platform for the development of a future GNSS receiver. It is useful both for education and research.
- At present, we have finished development of single-frequency GPS + QZSS post-processed software receiver .



# GUI Example of DGNSS



# Ongoing Projects



- We are developing two types of receiver as a platform of GNSS receiver.

## High-Sensitivity Positioning (single-frequency)

Research and education in the field of high-sensitivity area

Car navigation use  
Mobile phone use

Frontend  
(IF=4MHz SF=16MHz  
Bw=4MHz)

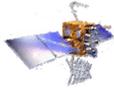
## Precise Positioning (multi-frequency)

Research and education in the field of high accuracy area

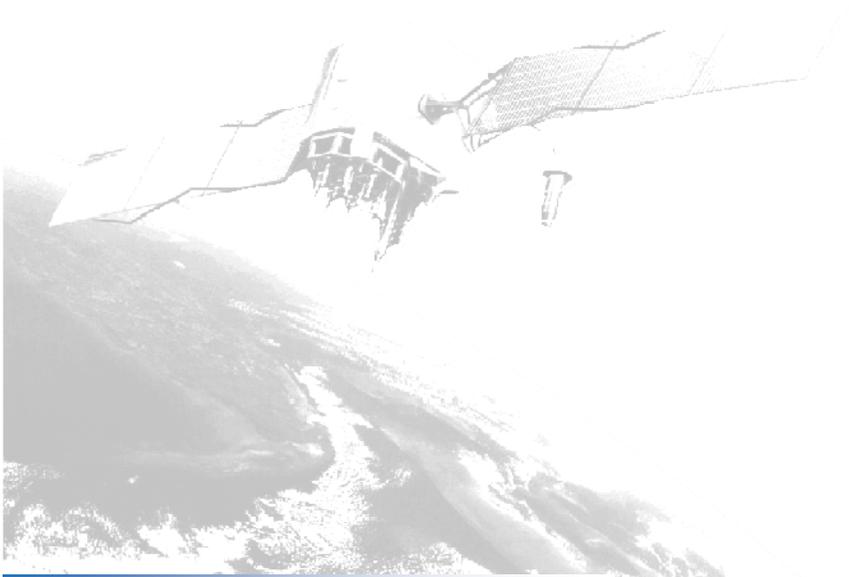
Geodetic use  
RTK use

Frontend  
(IF=12MHz SF=40MHz  
Bw=13MHz)

Both of them will be quite useful for the research and education in GNSS.



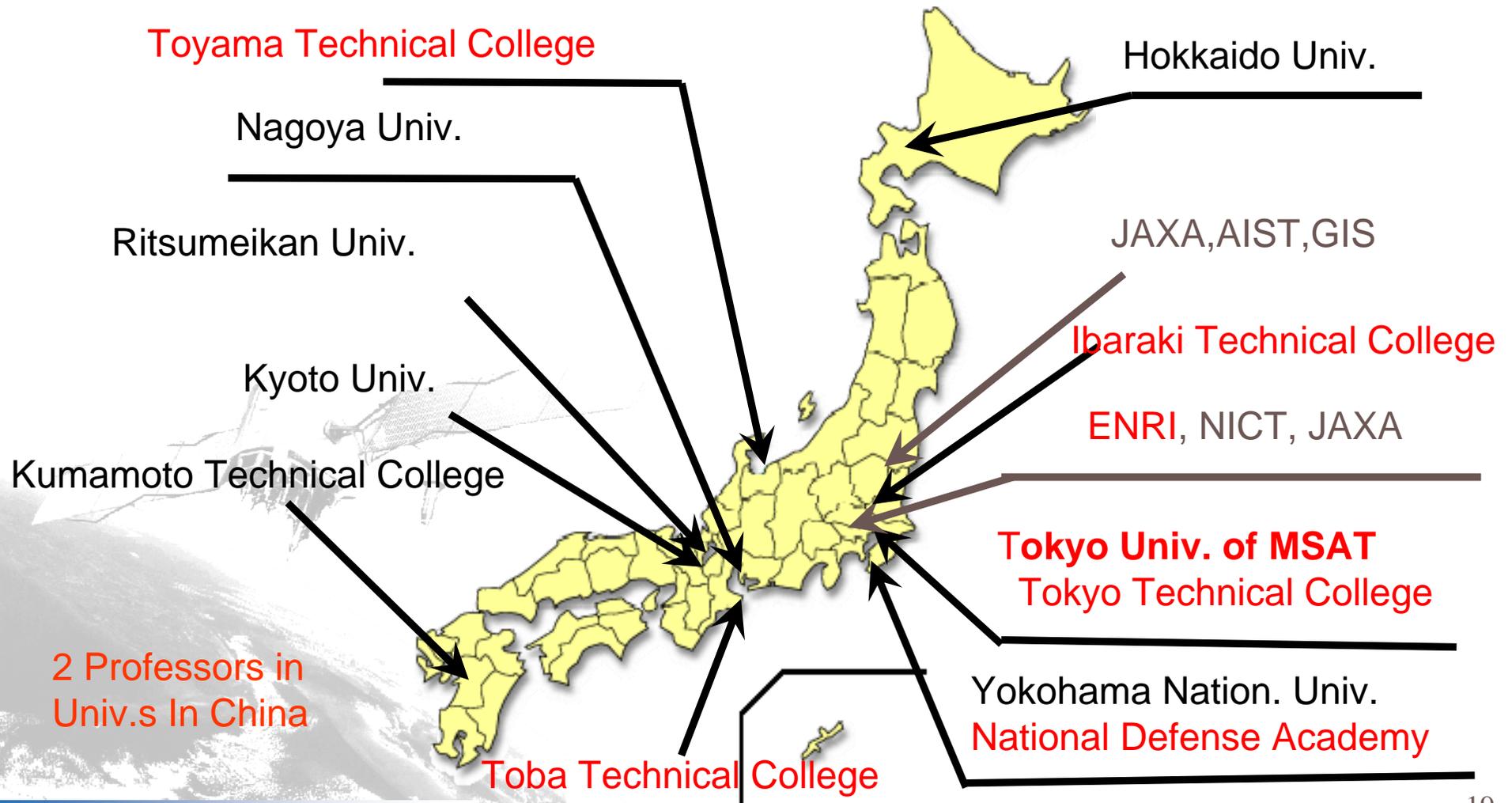
# Graduates studying in GMSSS Fields

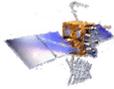




# GNSS Research and Education Institutes

There is a graduate from our Lab. at TUMSAT in red letter institute

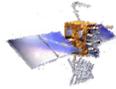




# Social Contributions National and International



# History of Our GPS/GNSS Symposium



## \*International Symposium

Participants from

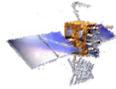
China, Korea, Taiwan, Australia, India, Malaysia, Thailand, Singapore, Turkey, Brazil, US, UK, EC countries, etc

**Will be held 14-17, Nov. this year in Sydney**

<http://ignss.org/Home/tabid/56/Default.aspx>

**No. of Participant    Date**

- 1.    320    28/11/1996
- 2.    310    13-14/11/1997
- 3.    380    26-27/11/1998
- 4.    400    24-26/11/1999
- 5.    410    15-17/11/2000
- 6.    410    14-16/11/2001
- 7.    350    11-13/11/2002
- **8.\*    440    15-18/11/2003**
- 9.    350    17-19/11/2004
- 10.   320    16-18/11/2005
- 11.   350    15-17/11/2006
- 12.   300    21-23/11/2007
- **13.\*   420    11-14/11/2008**
- 14.   380    30/11-01/12/2009
- 15.   280    04-06/11/2010
- 16.        26-28/10/2011

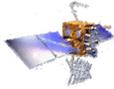


## Institute of PNT of Japan

- Established in November 2009
- Newsletter Quarterly, On-line Transaction
- Annual meeting in April and Symposium in fall are main events.
- 300 members presently
- President is Akio Yasuda

<http://www.gnss-pnt.org/>

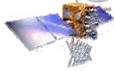
# Multi-GNSS Asia (MGA)



- MGA
  - Is the organization to operate Asia Oceania Multi-GNSS Demonstration Campaign
  - Was established on 4<sup>th</sup> Sep, 2011 in Tokyo
  - Will open its “Call for participation” with adopted “Terms of Reference” very soon
- MGA website : [www.multignss.asia](http://www.multignss.asia)
- As MGA’s recommended activity, JAXA will start “Call for Multi-GNSS Joint Experiment”



# Asia Oceania Multi-GNSS Demonstration Campaign



- The campaign consists of Three main activities

## Multi-GNSS Monitoring Network



## Application Demonstration

### Disaster Mitigation



### Precise Positioning



### ITS



### LBS



### Other, ionospheric observation etc

## Regional Workshop

1<sup>st</sup> Asia Oceania Regional Workshop on GNSS, 25,26 JAN, 2010, @ Bangkok, Thailand



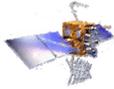
195 Participants, 18 Countries, 95 Organizations

2<sup>nd</sup> Workshop, 21,22 Nov. 2010 @ Melbourne, Australia



3<sup>rd</sup> Workshop, 1-3<sup>rd</sup> Nov. 2011 @ Jeju Island, Korea:

# 3<sup>rd</sup> Asia Oceania Regional Workshop on GNSS



- Date
    - Pre-workshop event (Discussion Session): Nov. 1<sup>st</sup>, 2011
    - 3<sup>rd</sup> AORWS: Nov. 2<sup>nd</sup> and 3<sup>rd</sup>, 2011
  - Venue
    - PHOENIX ISLAND, Jeju, Korea
  - Hosted by
    - GNSS Technology Council (GTC), Korea Aerospace Research Institute (KARI), Japan Aerospace Exploration Agency (JAXA), Satellite Positioning Research and Application Center (SPAC)
  - Supported by
    - International Committee on GNSS (ICG) and International GNSS Service (IGS)
- MGA website : [www.multignss.asia](http://www.multignss.asia)



# G-spatial EXPO 2012

"When & Where" - Information Changes Our Lives, Now and in the Future

is decided to be held from June 21 to 23,  
2012@Pacifico.Yokohama

**G-Spatial EXPO 2010 /09/19 - 09/21** <http://www.g-expo.jp/en/index.html>

189 exhibitors

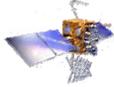
36,819 visitors

36 Lectures, Symposiums and Seminars (3 days)

Participants 3,838



# Summary



- Introduce the research activities in TUMSAT
- Many subjects related to QZSS development
- RTK-LIB for software study for GNSS positioning
- SDR for hardware study for tracking and acquiring GNSS
- Enough potential to teach high level GNSS technology
- Promoting International Contribution by accepting more foreign students is the next step.