GNSS Data Processing for High-Accuracy Positioning using Low-Cost Receiver Systems

GNSS Education Activities of CSIS

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Overview

- GNSS Trainings, Workshops and Seminars
  - Basically in Asian countries
    - Indonesia, India, Laos, Malaysia, Myanmar, Nepal, Thailand, The Philippines, Singapore, Vietnam
    - Bangladesh (planned in 2020), Egypt (FEB 2020)
  - Also, Some African Countries
    - Mozambique, Rwanda
- Webinars
  - Conduct webinars under MGA (Multi-GNSS Asia)
  - Global Access, Anybody can attend and free
    - Up to 100 participants online webinar at a time
    - Please register at http://gnss.peatix.com
- Joint Research and Pilot Projects
  - Low-Cost High-Accuracy GNSS Systems
  - Traffic Congestion Management
  - Traffic Monitoring
  - GNSS Signal Authentication
  - Supply-Chain Value Analysis
  - Illegal Fishing Monitoring
  - Any GNSS-based Application of your interest
- Installation of GNSS CORS
  - Install GNSS CORS in the Universities around the world for joint research, GNSS technology promotion and capacity building
- RPD (Rapid Prototype Development) Challenge during MGA (Multi-GNSS Asia)
  - Encourage students and researchers to bring solutions and business values by solving real-life problems
    - The 1st RPD Challenge was done during MGA 2018 in Melbourne, Australia on 24th OCT 2018
    - The 2nd RPD Challenge was done during MGA 2019 in Bangkok, Thailand on 27 – 29 AUG 2019
    - The 3st RPD Challenge will be held during MGA 2020 in Bangkok, Thailand AUG 2020
- Develop Low-Cost High-Accuracy Positioning Systems (L-CHAPS)
  - Integrate low-cost receivers for RTK, PPK or PPP processing
    - Android or Raspberry Pi versions
    - Based on QZSS MADOCA Signals
  - RTKDROID : An android APP for RTK with external GNSS receiver

Global Navigation Satellite System (GNSS) Training, Course T-151

6 – 10 JAN 2020, AIT Conference Center, AIT, Thailand

CSiS

ICG International Committee on Global Navigation Satellite Systems

AIT GIC Geoinformatics Center

GNSS Training, Course T-151 and GNSS for Policy and Decision Makers, Course T-131

14 – 18 January 2019

AIT Conference Center, AIT, Thailand

GNSS Training at GIC/AIT, Thailand, 23 – 26 JAN 2018

Afghanistan, Australia, Austria, Bangladesh, Bhutan, Cambodia, India, Indonesia, Japan, Maldives, Mongolia, Nepal, The Philippines, Sri Lanka, Tajikistan, Thailand, The United States of America, Vietnam

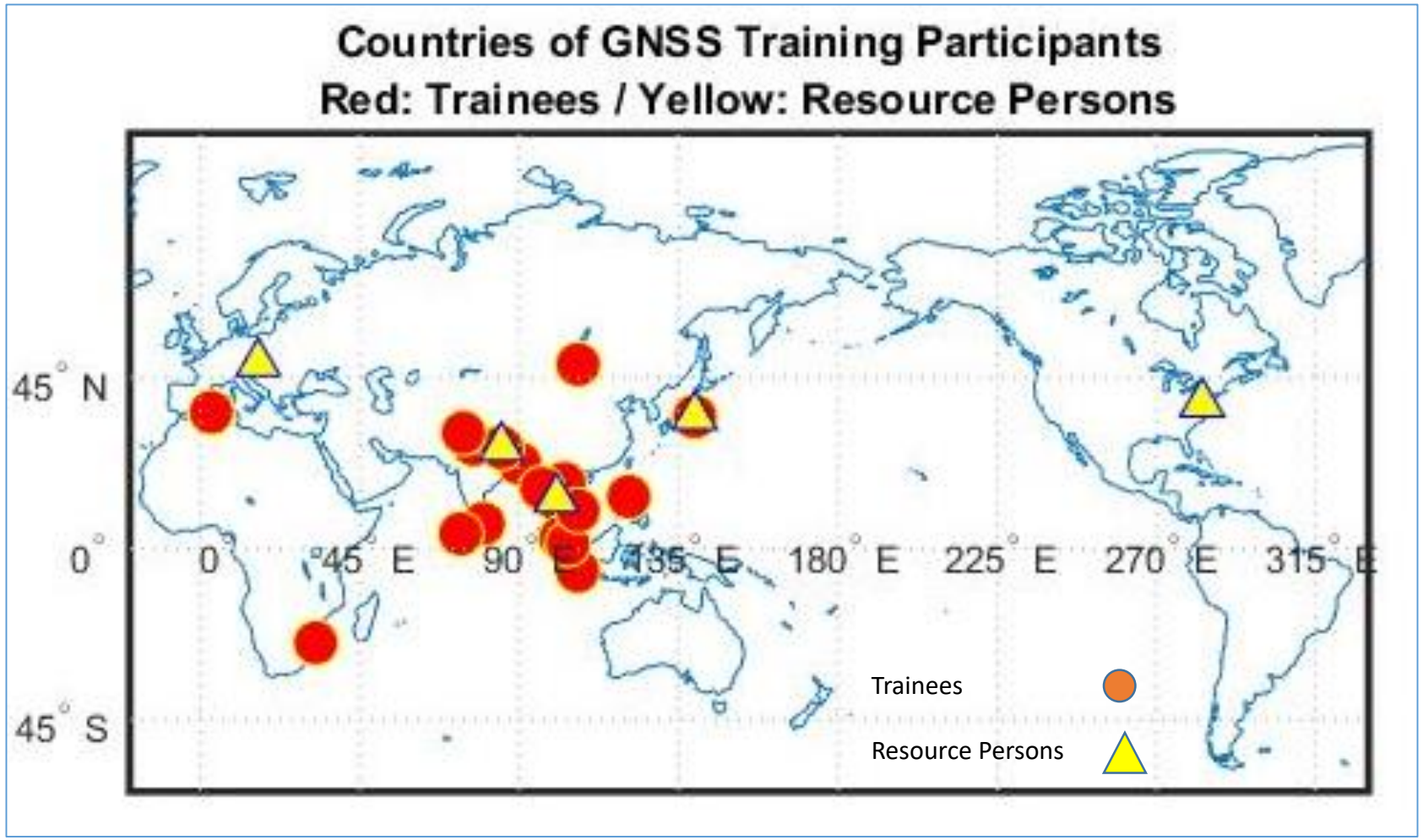
64 Participants from 15 Countries

GNSS Training 2020 : Participants Statistics

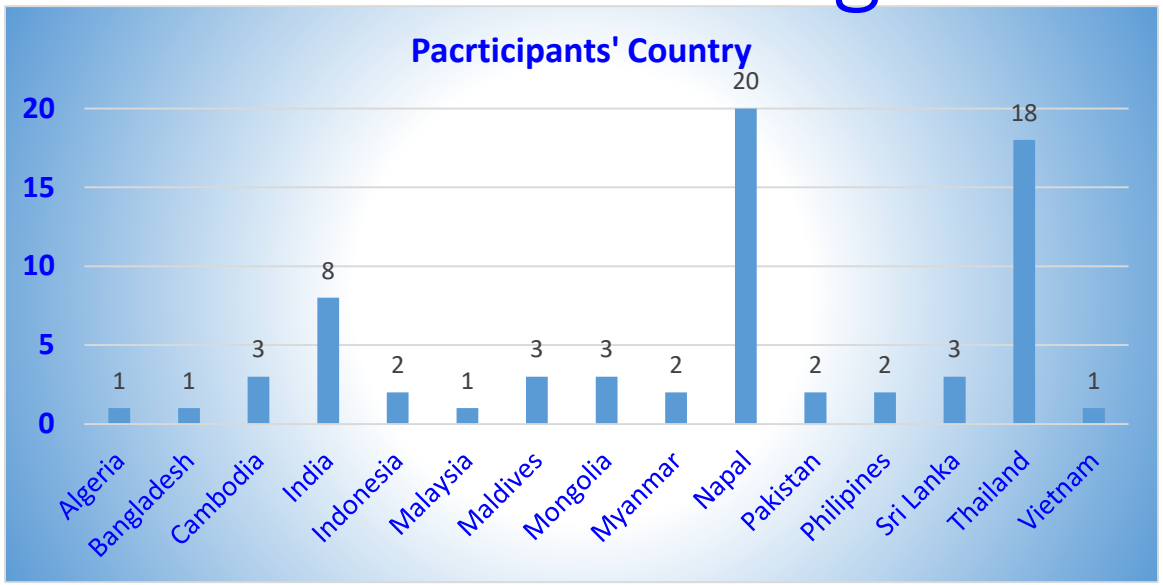
Number of Participants	JAN 2021	JAN 2021	JAN 2020	JAN 2019	JAN 2018
	19 – 21 JAN	28 JAN	T-151	T-151/T-131	T-141
(A) ICG Funded International (travel only)	NA	NA	19	23	14
(B) Other Funding (travel only)	NA	NA	X	4[E]	X
(C) Self Funded International	NA	NA	34	40	11
(D) Self-Funded Thailand	NA	NA	18	27	42 (24 + 18)
Total (A + B + C + D)	270	160 tbc	71	94	67
Applicants	360	Tbc	160+	180+	80+
Number of Resource Persons	15	6	16 7 (Int) + 9 (GIC)	20 11 (Int) + 9 (GIC)	13 7 (Int) + 6 (GIC)
Number of Countries	70+	60+ tbc	15	15	15
Resource Persons Countries	4	3	4	7	4

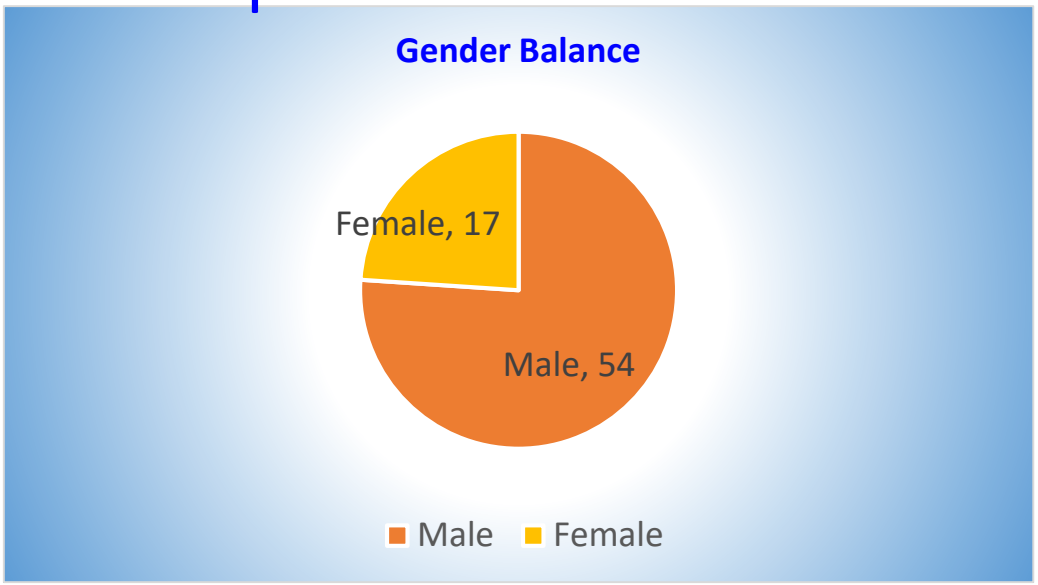
E : Funded by ESCAP

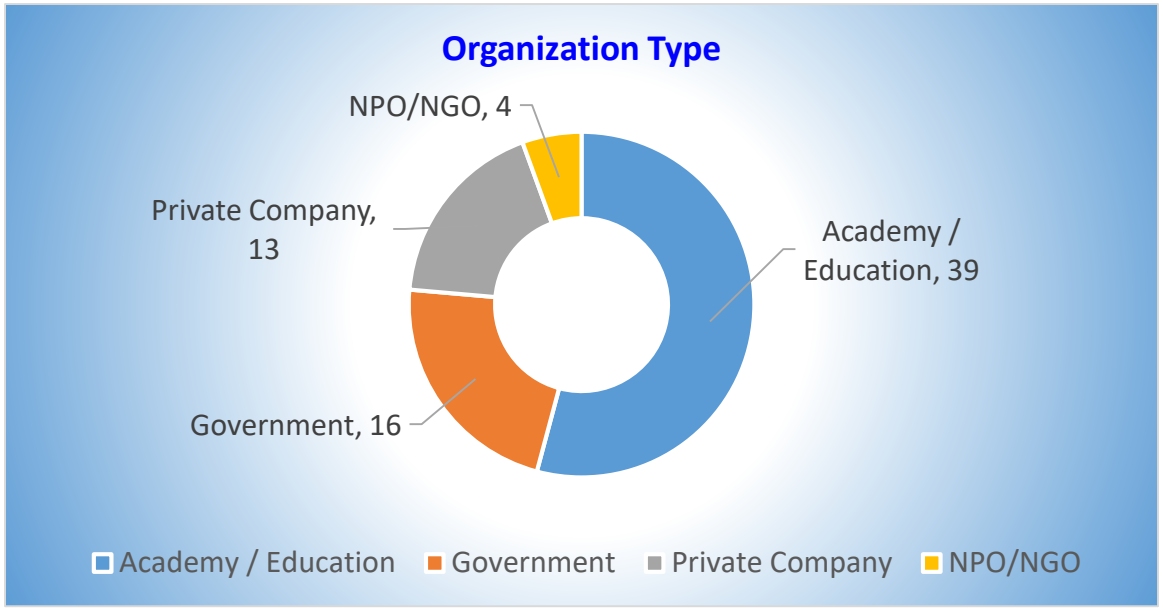
GNSS Training 2020 : Participants Statistics

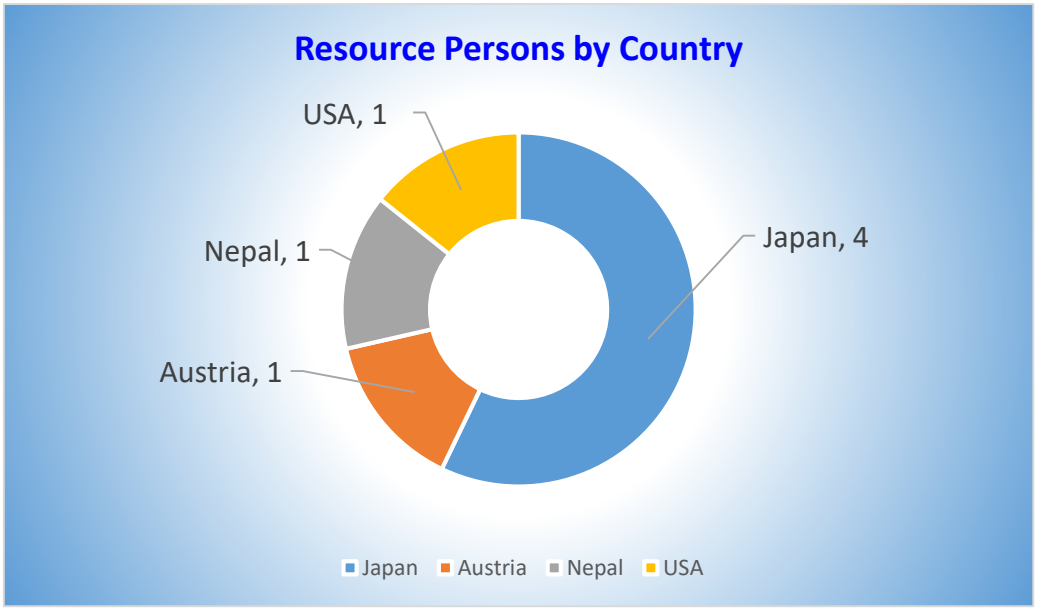


GNSS Training 2020 : Participants Statistics







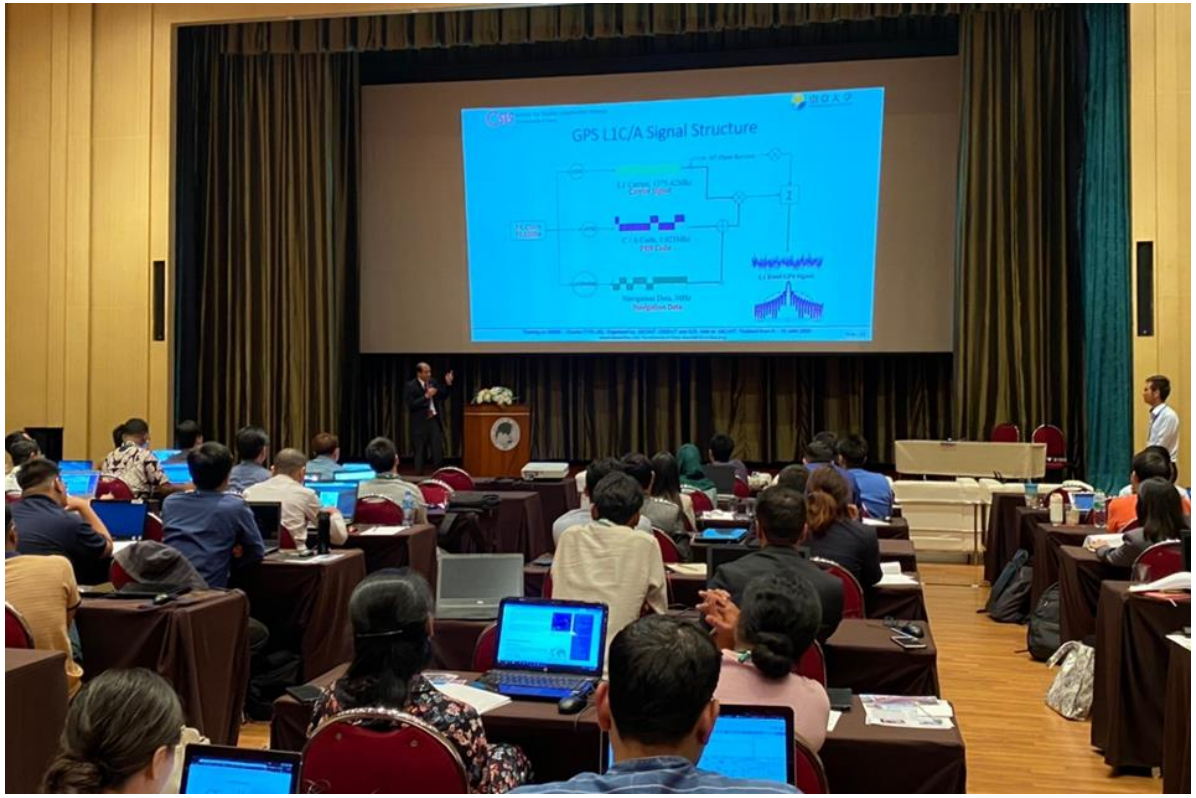


GNSS Training 2020 : Participants Statistics

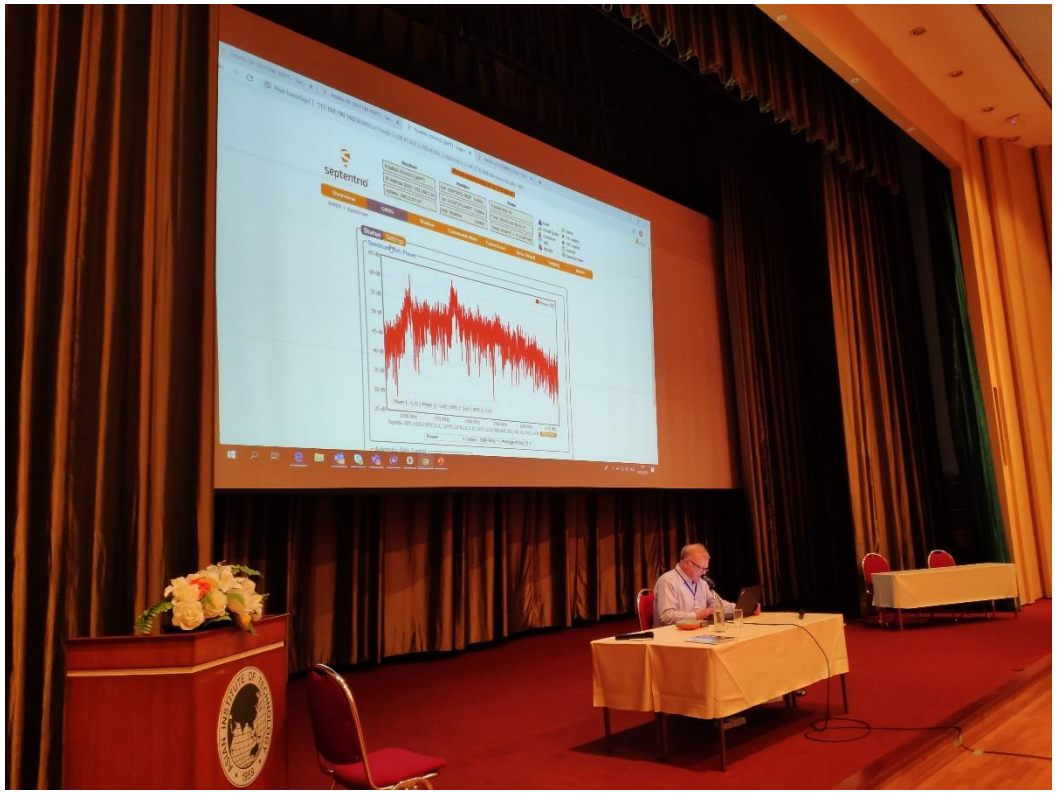
Number of Participants	JAN 2020	JAN 2019	JAN 2018
	T-151	T-151/T-131	T-141
(A) ICG Funded International (travel only)	18 (22)	23	14
(B) ESCAP Funded International (travel only)	x	4	x
(C) Self Funded International	40	40	11
(D) Self-Funded Thailand	20	27	42 (24 + 18)
Total (A + B + C + D)	81	94	67
Applicants	160+	180+	80+
Number of Resource Persons	17 (16) 7 (Int) + 10 (GIC)	20 11 (Int) + 9 (GIC)	13 7 (Int) + 6 (GIC)
Number of Countries	18	15	15
Resource Persons Countries	5	7	4


EXIT
EXIT

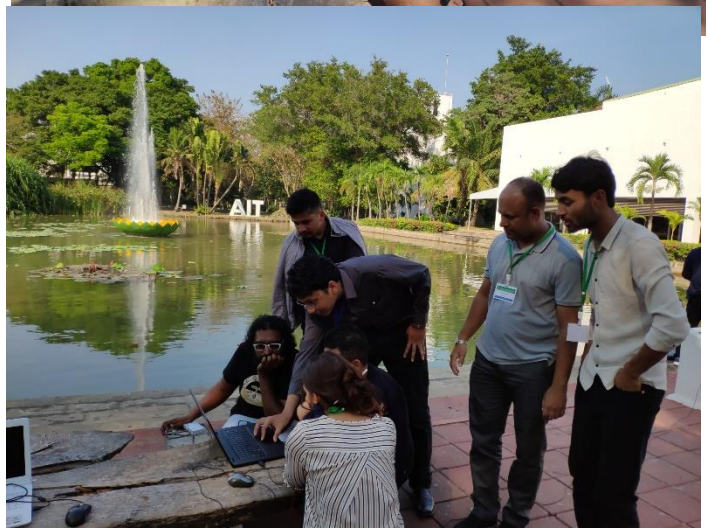
GNSS Training Lectures : 2020



Sponsor Lecture and Demo : 2020



GNSS Field Survey : 2020



GNSS Data Processing : 2020

GNSS Field Survey and Data Processing, 2019






GNSS Field Survey and Data Processing, 2019



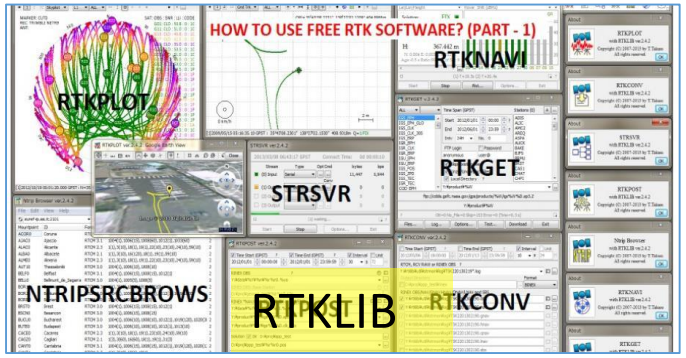


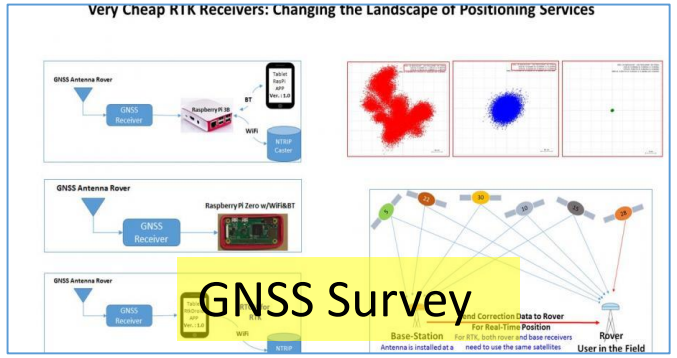
GNSS Training at GIC/AIT, Thailand, 23 – 26 JAN 2018

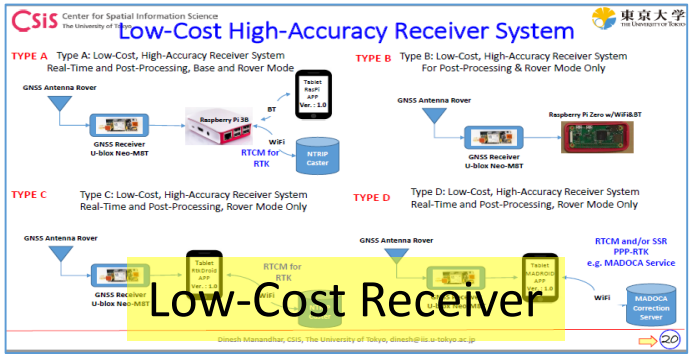
Day 1: Online Presentation
GPS Introduction : David Turner, State Dept. of the USA
GPS Signal Structure : Tom Stansell, Stansell Consulting, USA

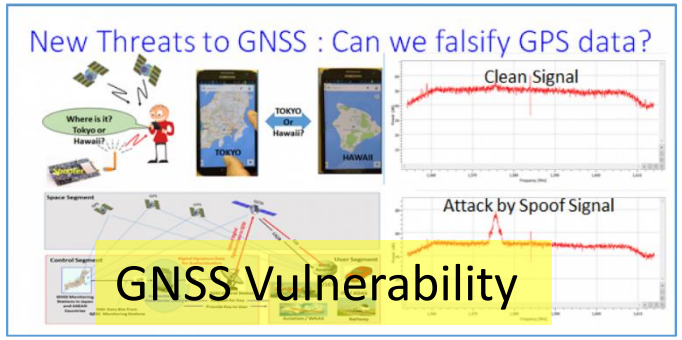
1. Sharafat Gadimova, UNOOSA/ICG, Austria
2. Dinesh Manandhar, Associate Professor, The University of Tokyo, Japan
3. Yuichi Hayakawa, Associate Professor, The University of Tokyo, Japan
4. Nobuaki Kubo, Associate Professor, TUMST, Japan
5. Suelynn Choy, Associate Professor, RMIT University, Australia
6. David Turner, State Department, USA (online lecture)
7. Thomas Stansell, Stansell Consulting, USA (online lecture)
8. GIC/AIT resource persons and staffs

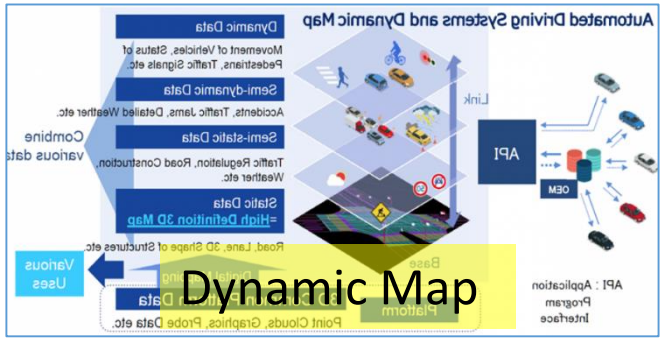
MGA GNSS Webinar

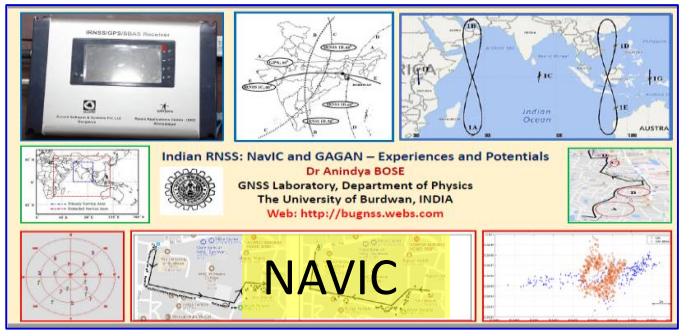












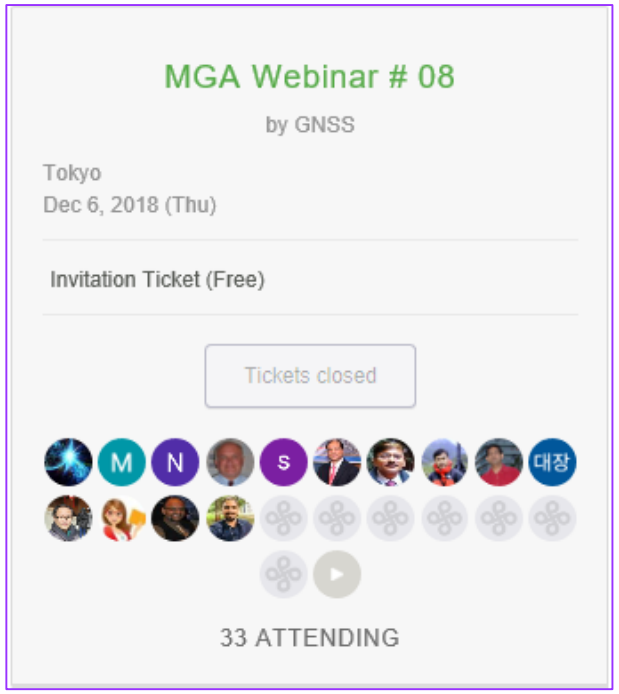
Upcoming Webinars: (1) RTK from Android GNSS Raw Data (2) Early Warning System (3) GNSS Signal Authentication (4) PNT from Micro/Cube Satellites and many more……

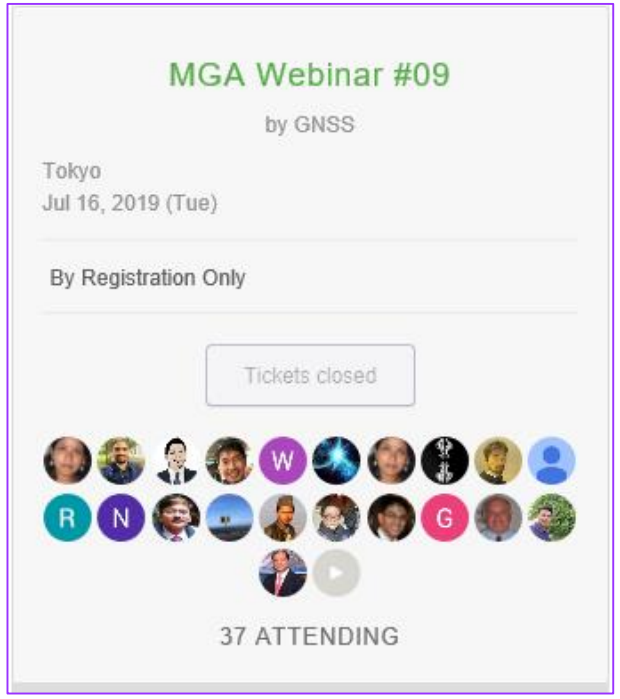
Webinar Registration : http://gnss.peatix.com

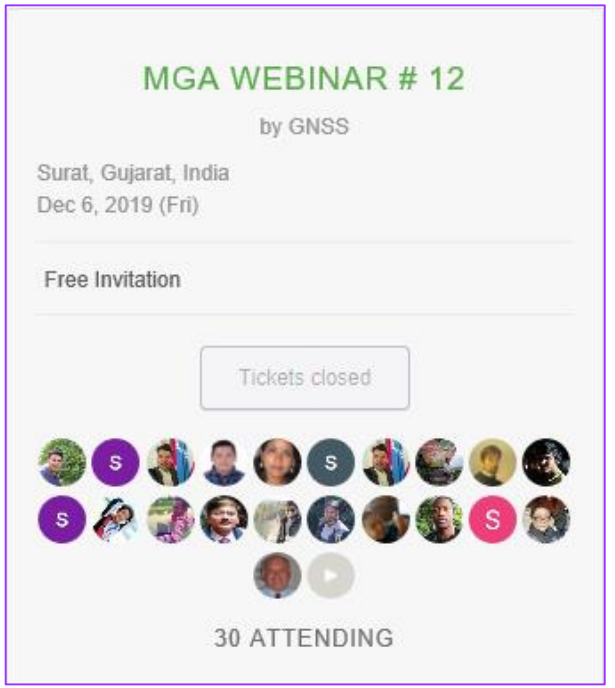
Past Webinar Reference: https://home.csis.u-tokyo.ac.jp/~dinesh/WEBINAR.htm

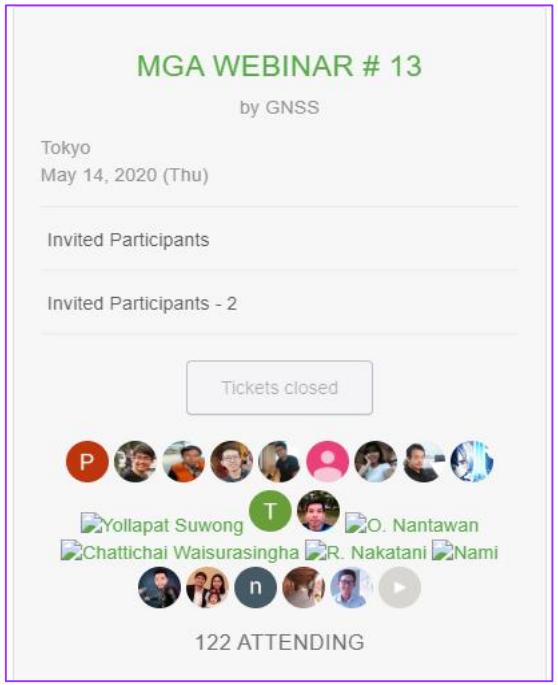
We need YOU as a Resource Person. Please contact us…..

MGA Webinars









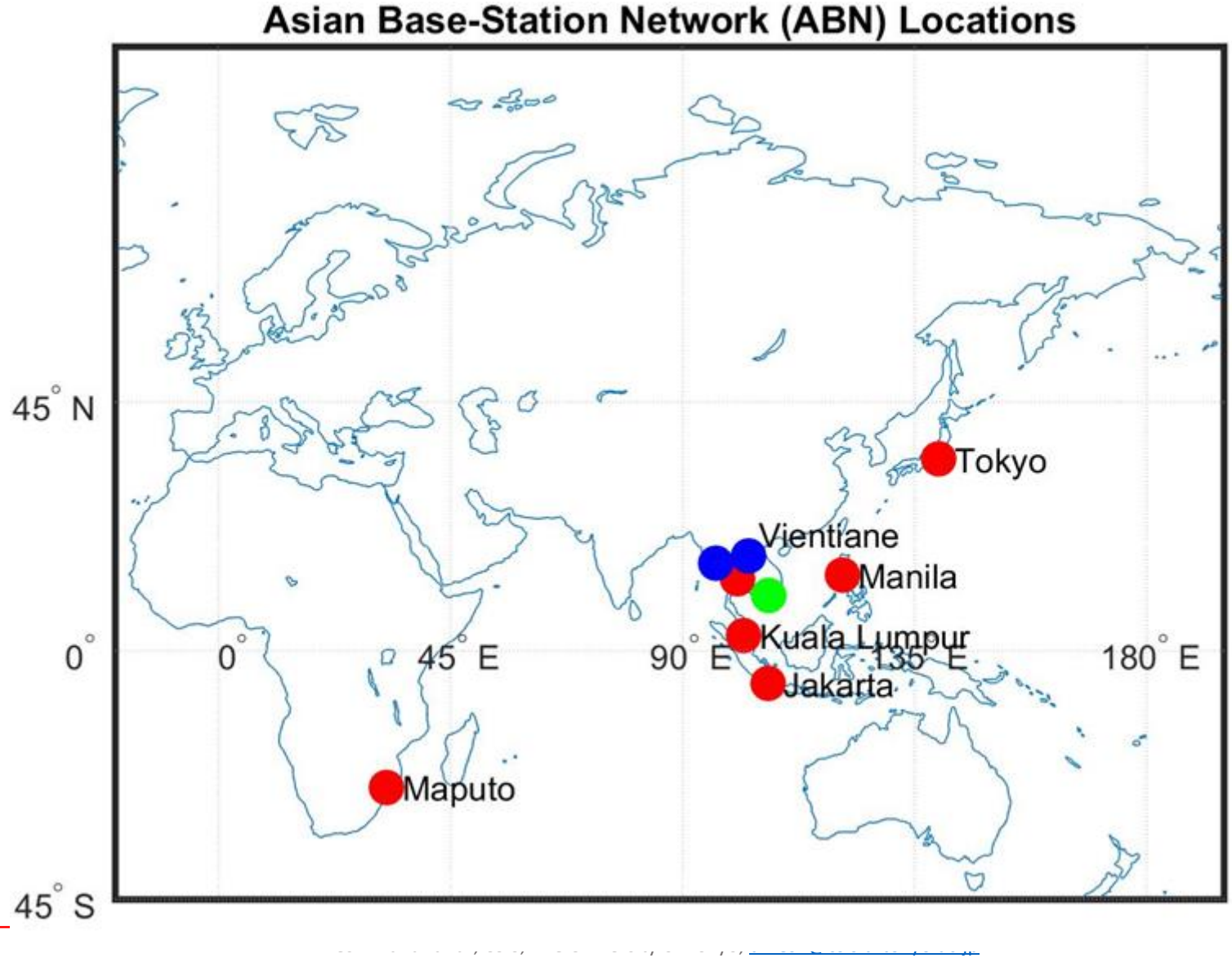
Please Refer the following sites for details (Past presentation files, video files and data are available):

https://gnss.peatix.com/

https://home.csis.u-tokyo.ac.jp/~dinesh/WEBINAR.htm

Asian Base-Station Network

Installation of Base-Stations in Universities for Capacity Building



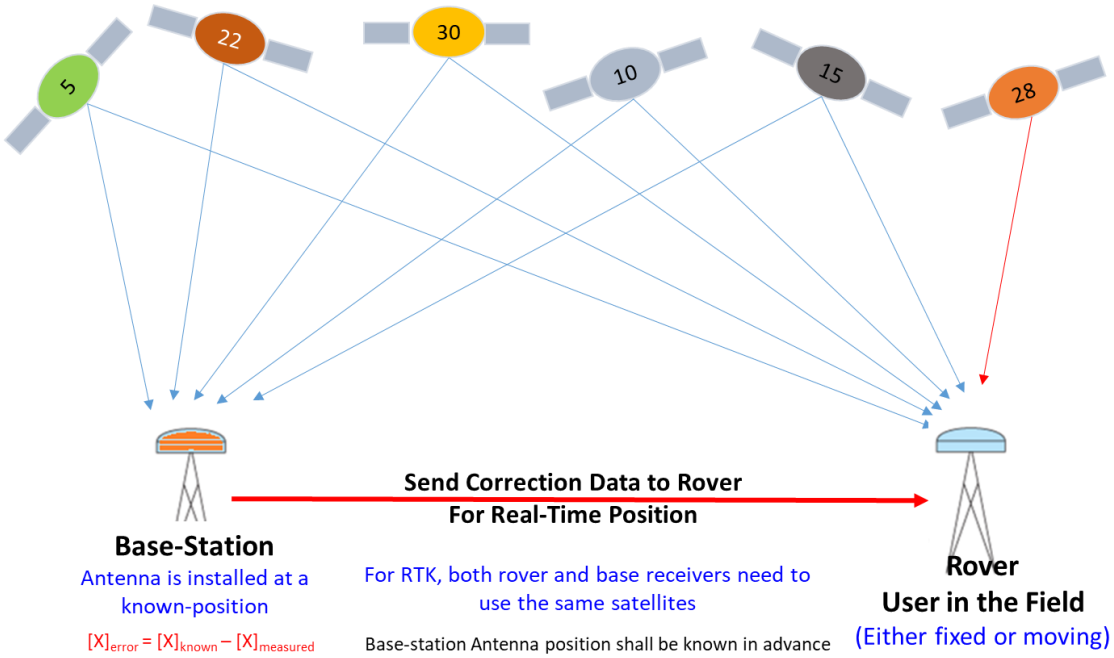
Installation of Base-Stations in Universities for Capacity Building

Country	Place	University	Receiver Type
Indonesia	Jakarta	University of Indonesia	GNSS (1) / GNSS + MADOCA (1)
Japan	Tokyo-A	The University of Tokyo	GNSS (1) / GNSS + MADOCA (1)
Japan	Tokyo-B	Tokyo University of Marine Science & Tech.	GNSS (1) / GNSS + MADOCA (1)
Japan	Tokyo-C	KEIO University	GNSS (1)
Laos*	Vientiane	National University of Laos	GNSS (1)*
Malaysia	Kuala Lumpur	Malaysia Japan International Institute of Tech.	GNSS (1) / GNSS + MADOCA (1)
Myanmar*	Yangon	Yangon Technological University	GNSS (1)*
Thailand	Bangkok	Chulalongkorn University	GNSS (1) / GNSS + MADOCA (1)
Thailand	Pathumthani	Asian Institute of Technology	GNSS(1)
Philippines	Manila	University of the Philippines	GNSS (1) / GNSS + MADOCA (1)
Vietnam	Ho Chi Minh City	International University Vietnam National University	GNSS (1) GNSS + MADOCA (Sep 2020)
Mozambique*	Maputo	Universidade Eduardo Mondlane	GNSS (1)*
Singapore	Singapore	Singapore Land Authority	**GNSS + MADOCA (Sep 2020)**
Australia	Perth	Curtin University	**GNSS + MADOCA (1)**

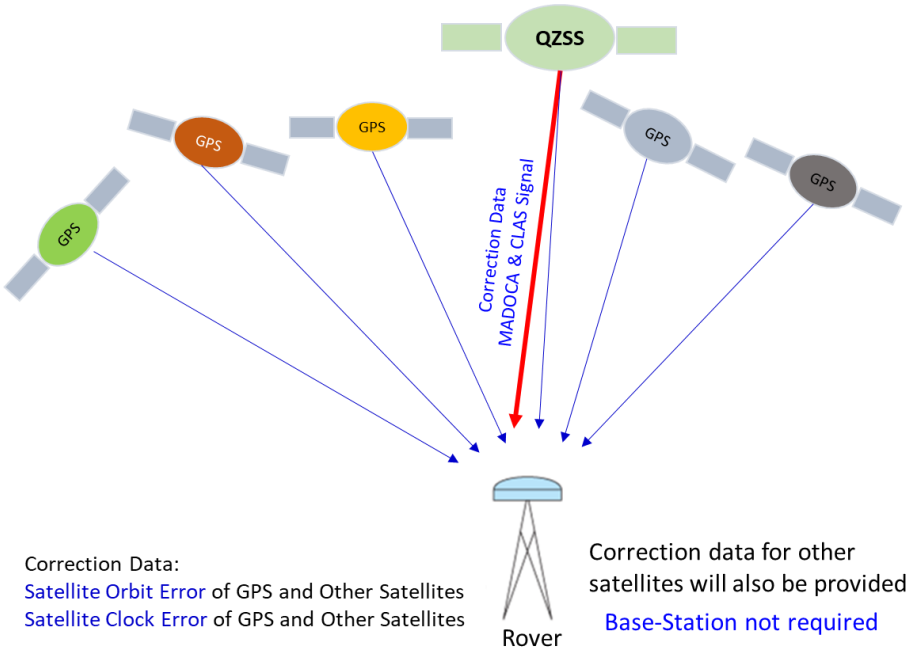
Low-Cost High-Accuracy Receiver System Development

Low-Cost High-Accuracy Receiver System Development

- Based on RTK/PPK
  - Requires Base-Station
  - Accuracy: few cm to 20cm



- Based on QZSS MADOCA PPP
  - Does not require Base-Station
  - Accuracy: 10 – 20cm



Note: QZSS CLAS service provides few cm accuracy
But, this service is only for Japan

Our Definition of Low-Cost Receiver

- Price : $100 or less
- Accuracy : Better than 100cm
- Weight : 100g or less

(Without Battery)

100^3

$100 x 100cm x 100g

Will it be possible?

Current Status:

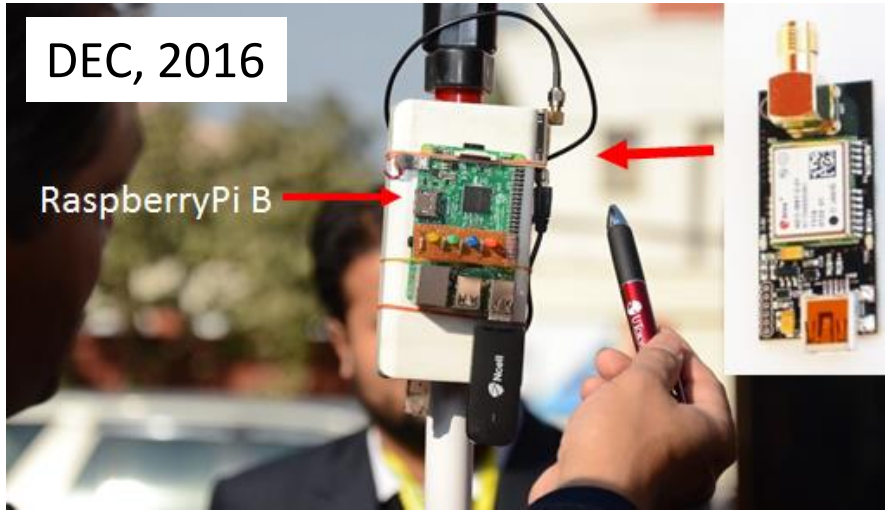
Price: $200 - $ 500 / **Accuracy: 10 – 70cm** / Weight: 100 – 500gm

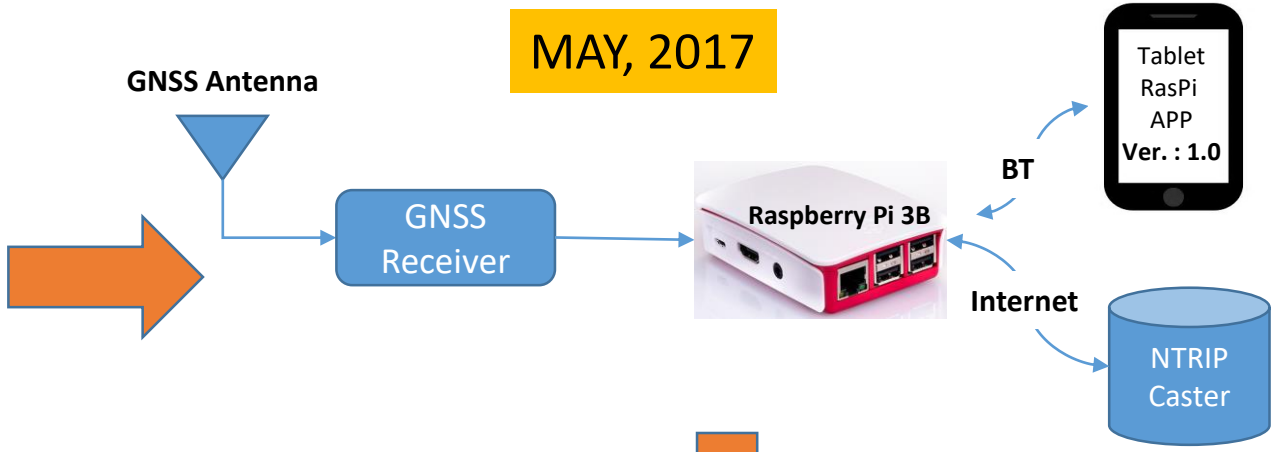
How to Reduce Cost? Improve Accuracy?

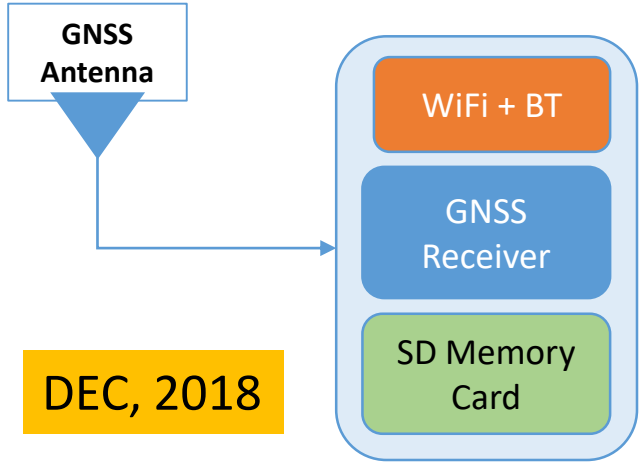
- Bulk Purchase / Manufacturing in Volume
- Find Good Quality Antenna
- System Design as per End-User Requirement:
  - Bsse-Design + Top-On Systems : Design System Required by End-User Applications

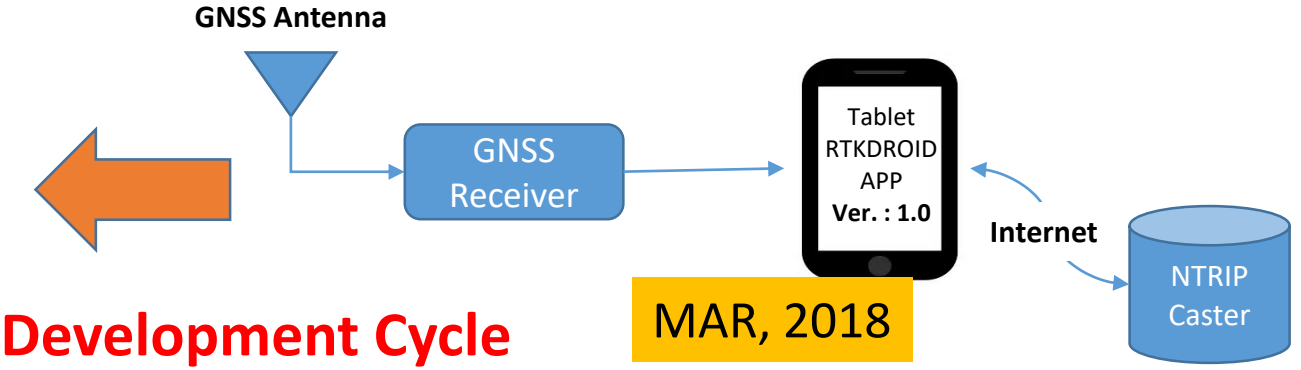
Low-Cost High-Accuracy Positioning System (L-CHAPS)

Our Definition of Low-Cost : $100 x 100cm x 100gm





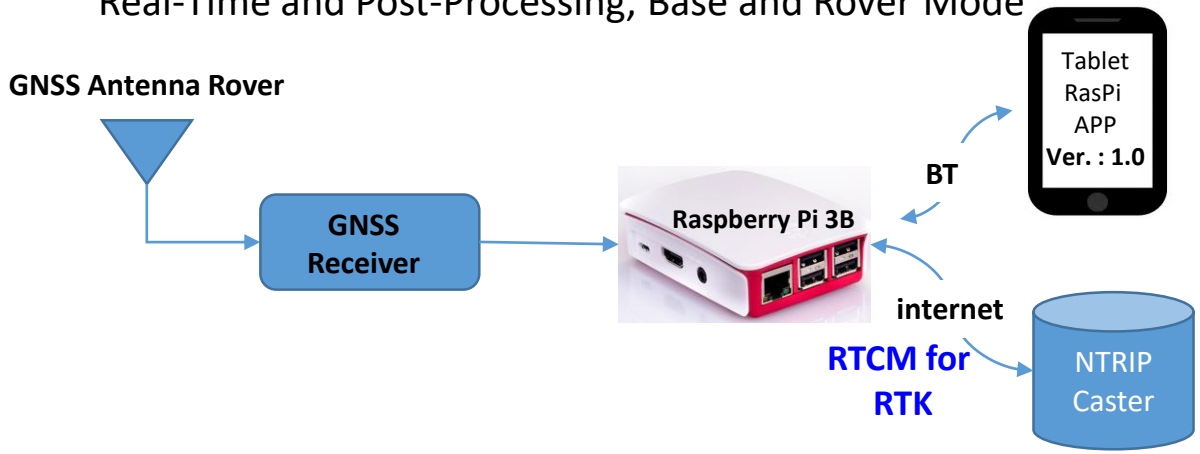




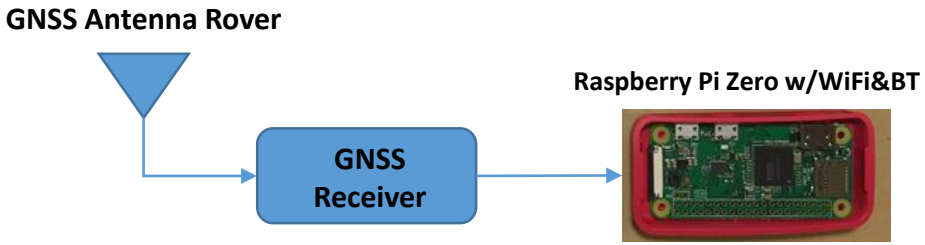
L-CHAPS, Development Cycle

Low-Cost High-Accuracy Receiver System (RTK/PPK)

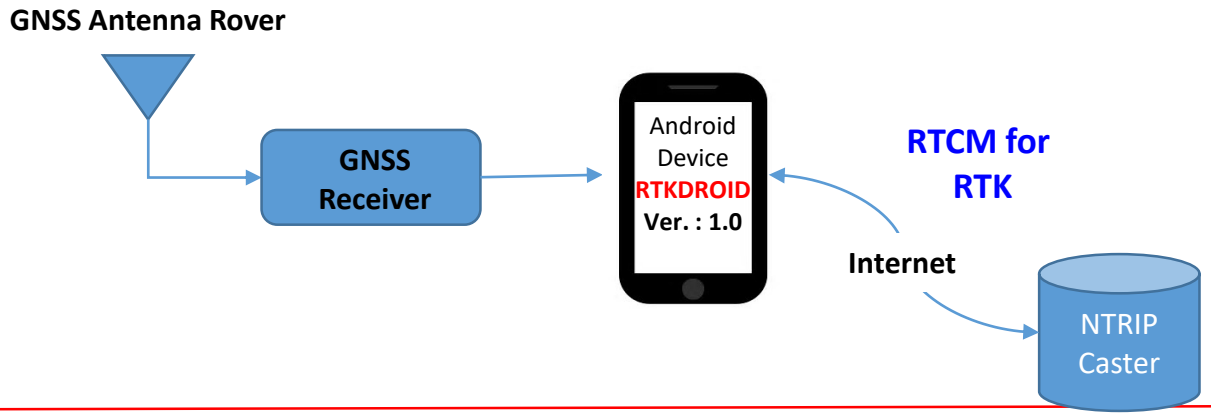
TYPE R1 Type A: Low-Cost, High-Accuracy Receiver System
Real-Time and Post-Processing, Base and Rover Mode



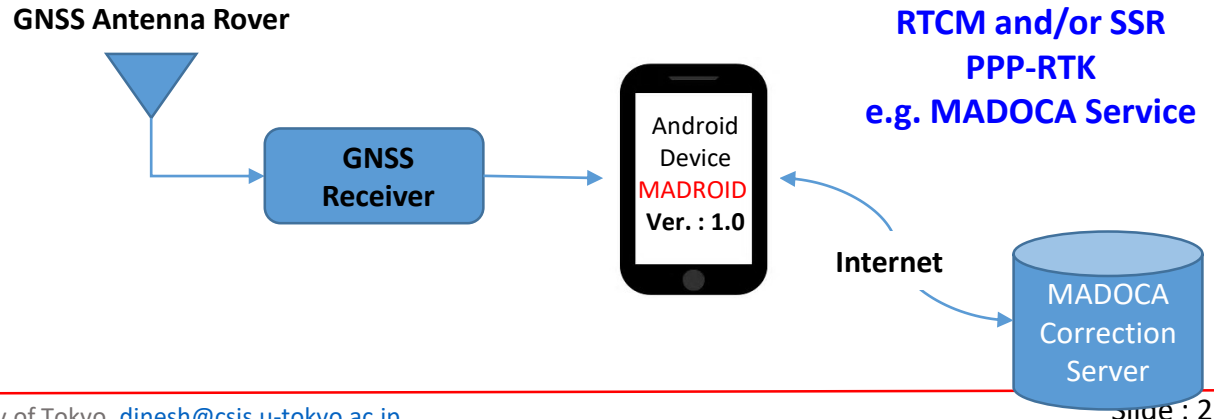
TYPE R2 Type B: Low-Cost, High-Accuracy Receiver System
For Post-Processing & Rover Mode Only



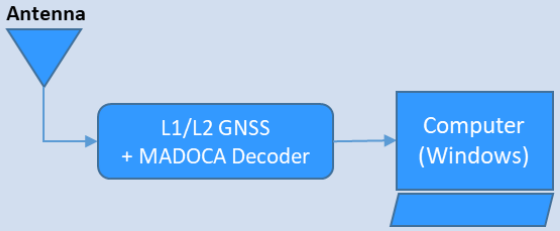
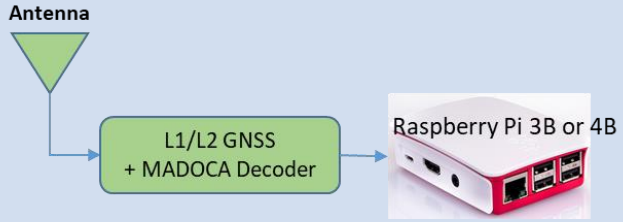
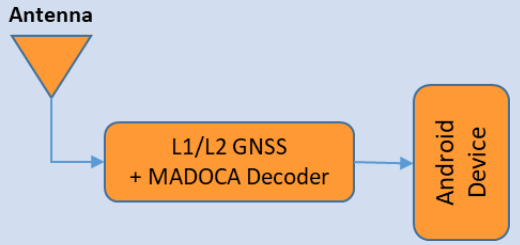
TYPE A1 Type C: Low-Cost, High-Accuracy Receiver System
Real-Time and Post-Processing, Rover Mode Only



TYPE MA Type D: Low-Cost, High-Accuracy Receiver System
Real-Time and Post-Processing, Rover Mode Only

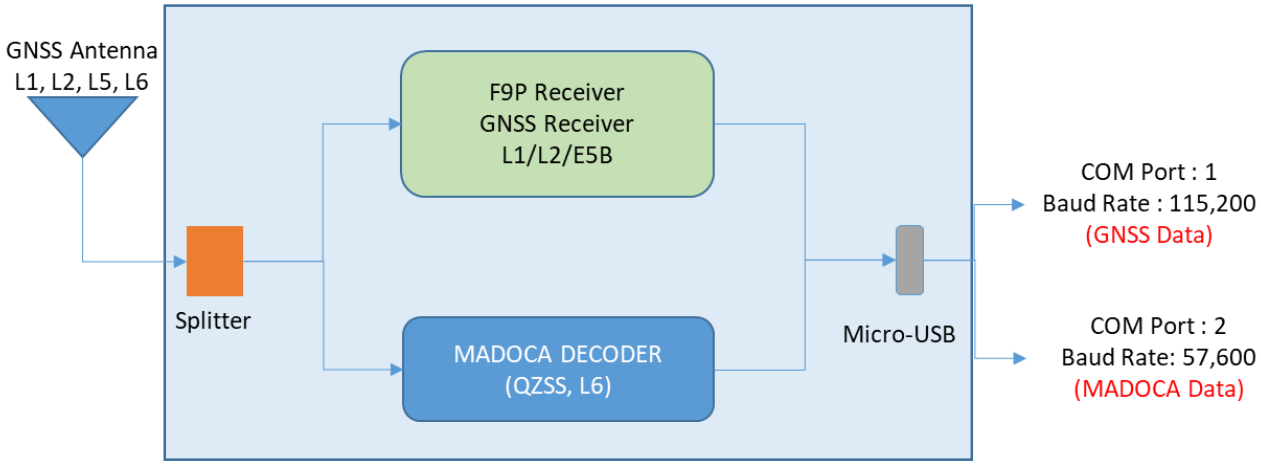


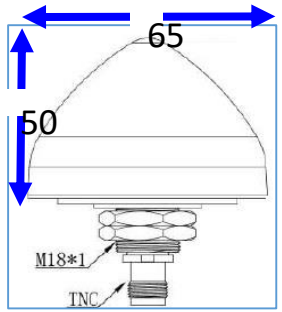
Low-Cost High-Accuracy Receiver System (MADOCA-PPP)

	MAD-WIN	MAD-π	MADROID
Platform / OS	Windows	RaspberryPi 3B or 4B	Android Device
GNSS Receiver	Default : u-blox F9P Other: Any dual-frequency Receiver	Default : u-blox F9P only	Default : u-blox F9P Other: Any dual-frequency Receiver
MADOCA Receiver	U-blox D9 only	U-blox D9 only	NA (MADOCA Online Correction Data only)
GNSS Receiver Data Format	UBX, SBF, RTCM3	UBX SBF, RTCM3 (For online GNSS data)	UBX
MADOCA Correction Data Format (Satellite)	UBX only	UBX only	NA
MADOCA Correction Data Format (Online)	Online Services from GPAS, UTokyo (Test Level) UBX or RTCM3	Online Services from GPAS, UTokyo (Test Level) Online Services UBX or RTCM3	GPAS Services, RTCM3 UTokyo Online Service in the next release
System Architecture			

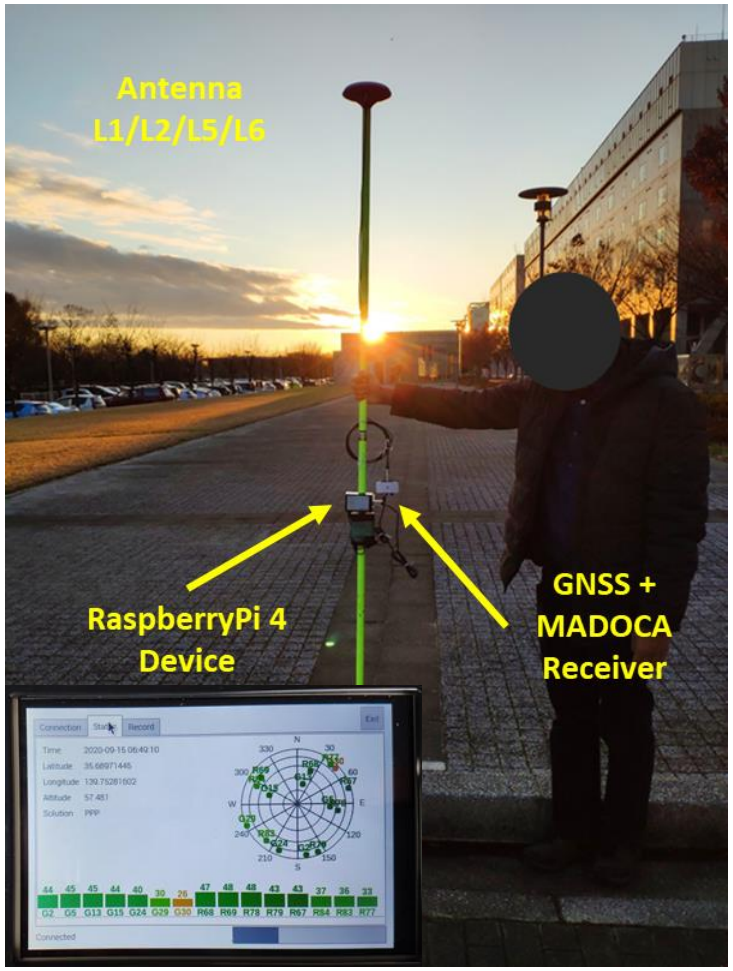
Low-Cost High-Accuracy Receiver System Development

- **低コストのMADOCA受信機システム**

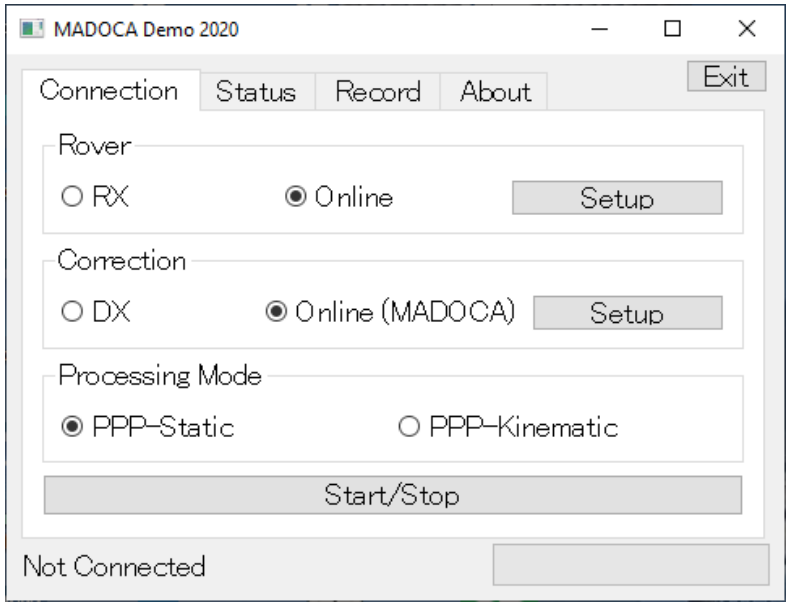




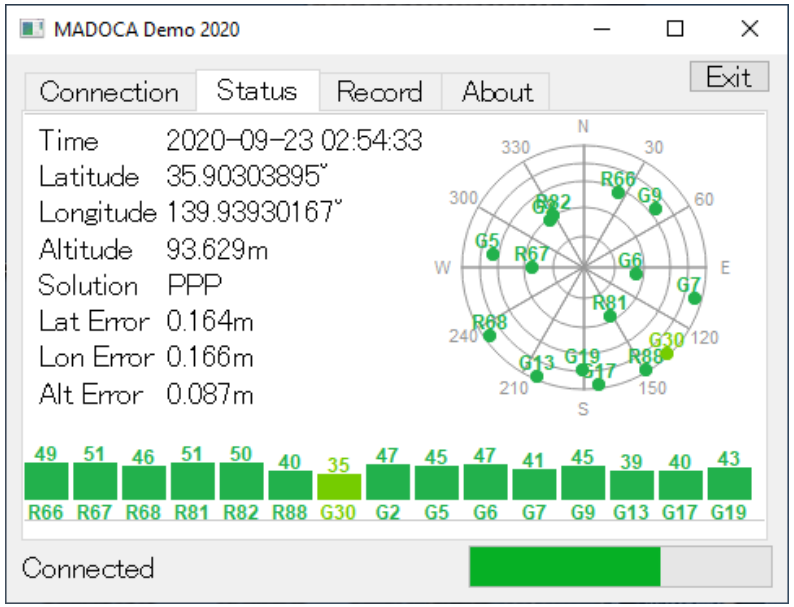
GNSS Antenna



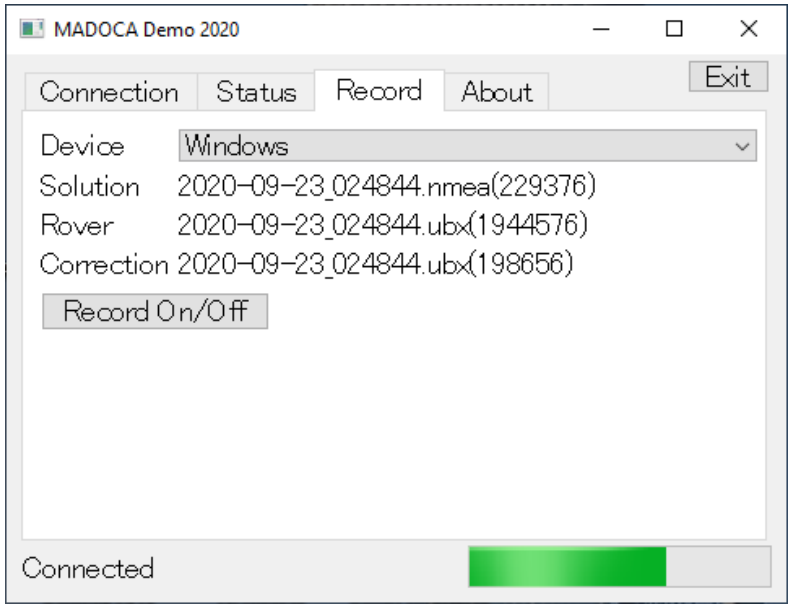
MAD-WIN and MAD-π Screen Shots



Receiver and MADOCA Correction Data Setup Menu



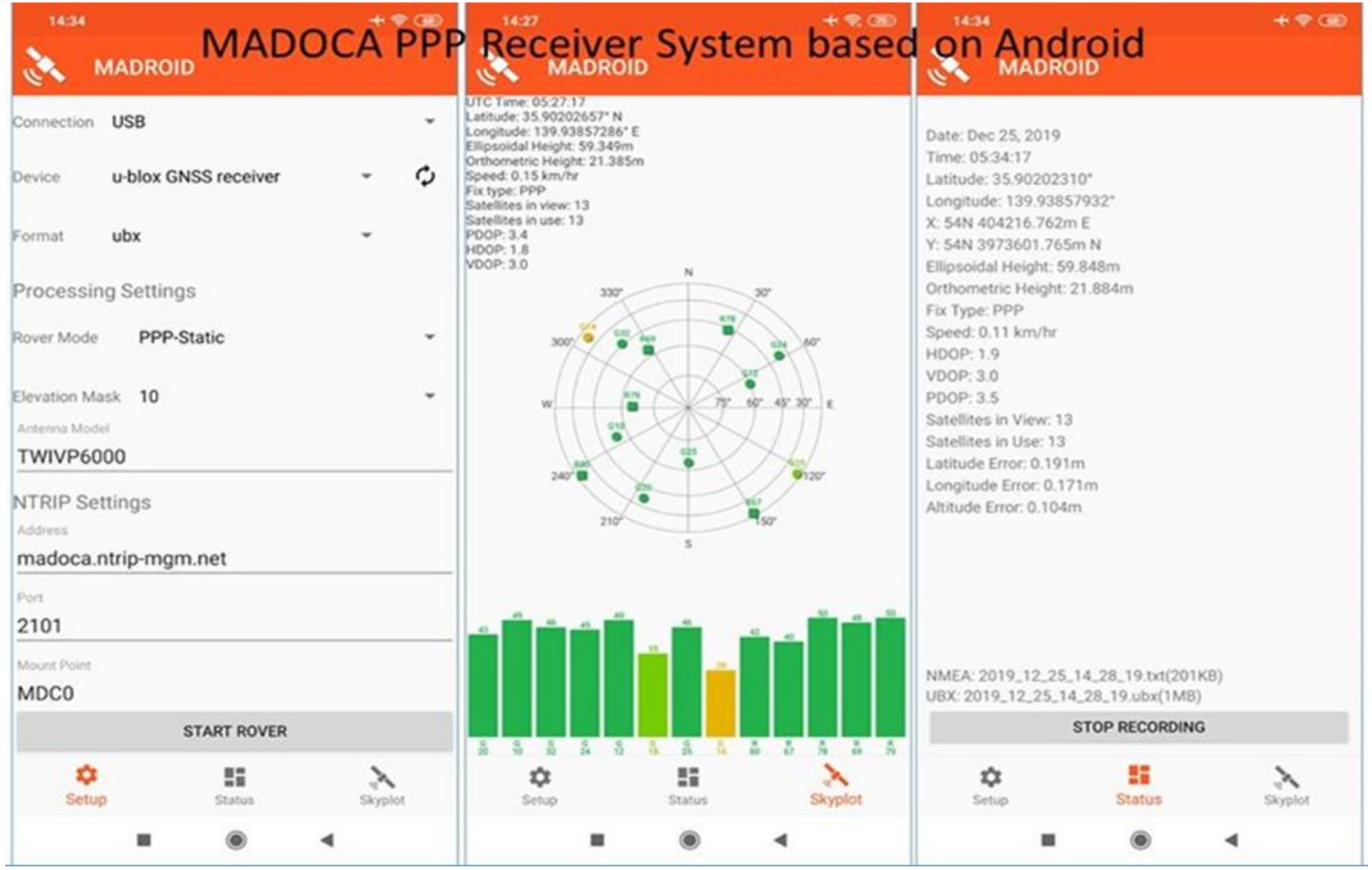
MADOCA PPP Output Display



Log of MADOCA PPP Solution, Receiver Raw Data and MADOCA Correction Data

MADROID Screenshots

MADOCA PPP based on Android Dual Frequency Receiver + Online MADOCA Data



GNSS Reference Station and Data at UT, Kashiwa

- A reference station is set at UT, Kashiwa, General Research Building rooftop
- CSIS can provide GNSS data and GNSS services for high-accuracy positioning for research purpose
  - Based on RTK
    - Real-Time and Post-Processing
  - Based on MADOCA
    - Real-Time and Post-Processing
    - Even Global Service is possible where QZSS is not visible
  - NTRIP Server is set at Kashiwa campus
- Different types of receivers, antenna, signal generating devices and test equipment are available
  - Receivers
    - Trimble NetR9
    - Septentrio PolaRx5, M2a, MOSAIC
    - u-blox M8T, M8U, M9N, F9P, D9
    - ASTRA Receiver for Scintillation and Space Weather Monitoring
  - Signal generators
    - Blade-RF SDR device
  - Spectrum Analyzer
    - Tektronix RSA306
  - Oscilloscope
    - Tektronix TBS1064
  - Please feel free to use

GPS Antenna on the roof top of General Research Building

Link for Reference Materials

- Lab Home Page
  - https://home.csis.u-tokyo.ac.jp/~dinesh/
- Facebook : https://www.facebook.com/gnss.lab (GNSS Related)
- Contact : dinesh@csis.u-tokyo.ac.jp