



# A pilot GNSS timing station in Thailand geodetic network

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# Outline

- Introduction
- NIMT timing activities
- 2017 Plans
- Conclusion



# Introduction

GNSS Continuously Operating Reference Stations (CORS) are planned to be built throughout the countries for NRTK, PPP and LBS services.

## Plans for GNSS CORS in Thailand by 2018

Organisation	1. Department of Lands (DoL) 2. Department of Public Works and Town and Country Planning (DPT) 3. Department of Disaster Prevention and Mitigation (DDPM), Hydro and Agro Informatics Institute (HAI) and NIMT
Number of CORS	142
Baseline	30 km to 50 km
Observed satellite constellations	GPS+GLONASS+Galileo+BDS+(QZSS+SBAS)



# NIMT timing activities

- **keeping time-link** with International Bureau of Standards (BIPM) to maintain **the national timescale of UTC(NIMT)**.
- **remote frequency calibration** from:
  - GPS pseudorange observations by **GPS common-view method**.
  - GPS ephemeris is from the broadcast **navigation message**.
  - **ITRF2000** (or WGS84) is applied.



# NIMT timing activities

GPS timing observation	Accuracy (s/s)	Stability (per day)
UTC-UTC(NIMT)	$2.51 \times 10^{-13}$	$3.46 \times 10^{-14}$
UTC-GPST	$-3.06 \times 10^{-14}$	$4.07 \times 10^{-14}$
GPST-UTC(NIMT)	$2.81 \times 10^{-13}$	$5.03 \times 10^{-14}$
UTC-UTC(USNO)	$2.35 \times 10^{-14}$	$3.26 \times 10^{-15}$

NIMT results are based on:

- GPS pseudorange observations only.
- GPS ephemeris is obtained from the broadcast navigation message.



# NIMT timing applications

Application	Output	Customer
Frequency reference	Frequency is traceable to UTC(NIMT) to $\pm 2.1 \times 10^{-13}$ baseline is $< 1,000$ km	Calibration laboratories
Time server	NTP time traceable to $2 \mu\text{s}$	Telecommunications, government, financial markets



# 2017 Plans: establish timing station

## Set up two GNSS timing stations

- Equipment and software are:
  - geodetic receiver (Topcon NetG5)
  - choke-ring antenna (Topcon CR-G5)
  - high performance tube caesium frequency standard (5071A-001)
  - Bernese software
- This work is under HAll, DDPM and NIMT collaborations.

## Include Active Hydrogen MASER (AHM)

- Improve the short term stability of UTC(NIMT)
- Ensemble clocks of 1 AHM and 3 high performance caesium frequency standards.



# 2017 Plans: join IGS timing station

## Join IGS as a GNSS timing station

- This is to obtain GNSS obtain the computed precise satellite ephemeris, clock offsets, atmospheric delay, station coordinates and clock offsets in ITRF.
- Purposes are for :
  - time comparisons
  - Precise Point Positioning (PPP) determination
  - quality measure improvements



# 2017 Plans: improve quality measures

## Improve NIMT timing quality measures

- Plans to improve the quality are in 3 parts:
  - **stability** of the timescale by including an active hydrogen maser to the timescales.
  - timing **accuracy** by determine the error parameters (i.e. receiver internal delay).
  - national time-link **accuracy** by applying GNSS observations.

## Determine integrity of the GNSS timing signals by

- Estimate or model other GNSS observations such as troposphere and ionosphere delay.
- Analyse the reliability (internal and external) of the estimated parameters.



# 2017 Plans: part of CORS network

NIMT GNSS CORS is part of the GNSS CORS network of six stations under collaborations between ministry of interior and ministry of science.

## GNSS CORS by DDPM, HAI and NIMT

Number of stations	6
Main purpose	Water and disaster management
GNSS CORS locations	Flood risk areas along Chaopraya River in central Thailand
Data centre location	HAI, Bangkok
Data observation rates	1 second and 30 seconds
Services	Real-Time Kinematic network and post processing services
Service format	Corrections and observation archives





# Conclusion

- The GNSS CORS at NIMT is the only station in Thailand that is connected to the **external frequency standard**. Hence the clock offset is **well-defined in terms of accuracy and stability**. It is **traceable to UTC** timescale.
- The accredited frequency measurement towards UTC(NIMT) is at  $\pm 2.1 \times 10^{-13}$  using GPS code observations and baseline is  $< 1,000$  km.
- NIMT has plans to
  - Set up an GNSS timing station
  - Improve the quality of the national time scale.
  - Join IGS
  - Improve the quality measures at the receiver clock using GNSS signals
  - Define the integrity of GNSS signals at NIMT
  - Be part of Thailand geodetic network for positioning services



# Thank you for your kind attentions!

