# Real-Time PPP based on CONGO and RTCM's Multiple Signal Messages

Georg Weber (1), André Hauschild (2), Dirk Stöcker (3), Leos Mervart (4),
Oliver Montenbruck (2), Peter Steigenberger (5)

(1) Bundesamt für Kartographie und Geodäsie, Frankfurt, Germany
(2) Deutsches Zentrum für Luft und Raumfahrt, Oberpfaffenhofen, Germany
(3) Alberding GmbH, Wildau, Germany
(4) Institute of Advanced Geodesy, Technical University Prague, Czech Republic
(5) Institut für Astronomische und Physikalische Geodäsie, Techn. Univ. München





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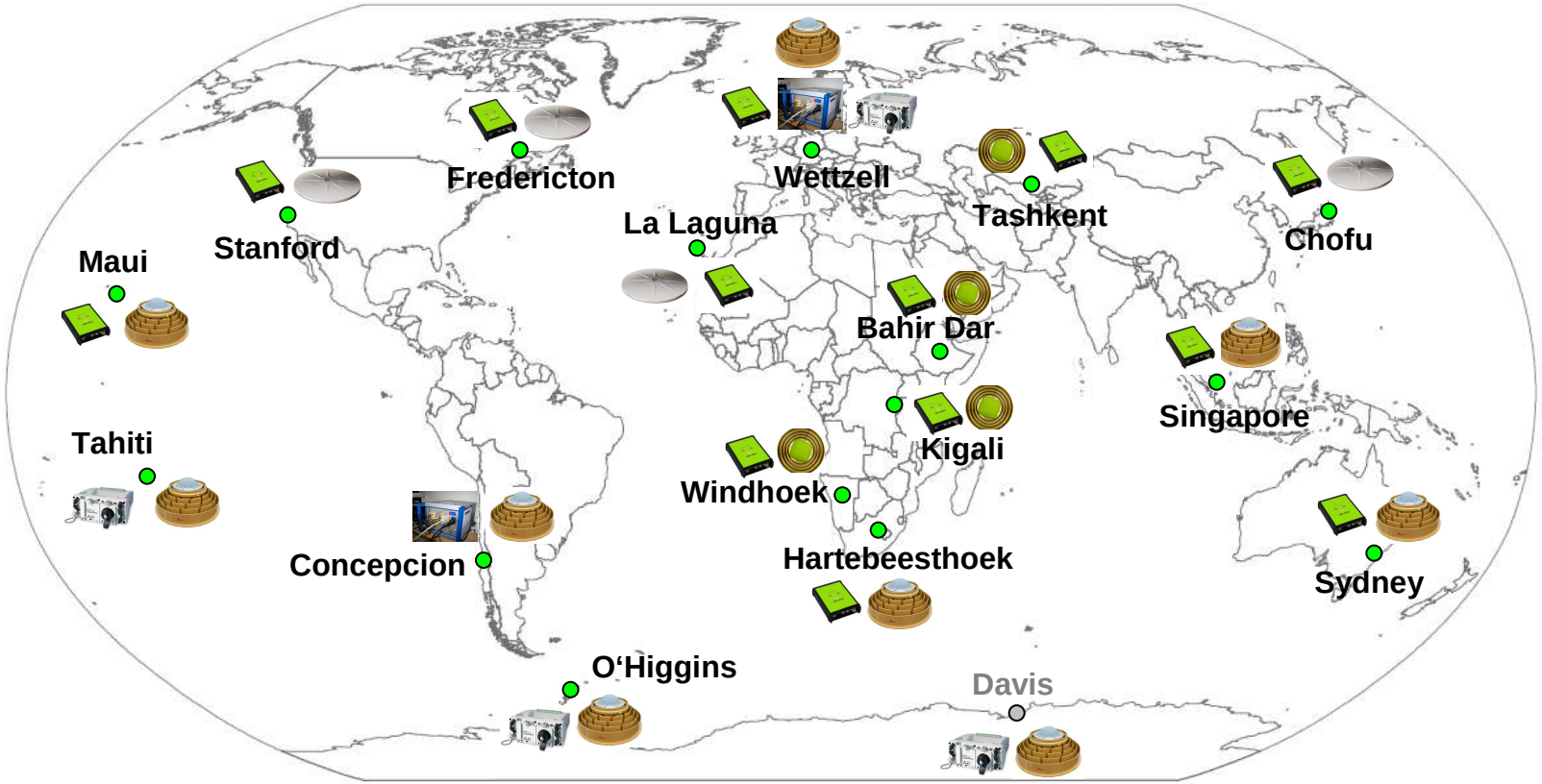
# Outline

- COoperative Network for GIOVE Observation
- GIOVE Orbits and Real-time clocks
- RTCM3 „Multiple Signal Messages
- Encoder & Decoder
- Real-time Point Positioning with GPS + GLONASS + GIOVE
- Plans

# **Co**operative **N**etwork for **G**IOVE **O**bservation




DLR bkg GFZ Helmholtz-Zentrum Potsdam cnes Centre National d'Études Spatiale

**Poster XY252: Orbit and attitude determination of the first QZSS satellite**

# CONGO-Network GIOVE Tracking Monitor

A service of DLR IKN in cooperation with DLR GSOC and BKG

Source: CONGO network
ntrip://euref-ip.bkg.bund.de

DLR

Last Information [UTC] 2011-03-16 13:26:00

Legend: tracked | untracked | not in view | transmission outage

## GIOVE-A1

launched at 28th Dec. 2005, 5:19 UTC
ID: COSPAR/WWAS Int Id: 2005-051A

In View


E1 E5a E5b E5 E6

2011-03-16 13:26:00 Last message received [UTC]

E1-BOC(1,1) & E6 ESA status information Signal Transmission

## GIOVE-B

launched at 26th Apr. 2008, 22:16 UTC
ID: COSPAR/WWAS Int Id: 2008-020A

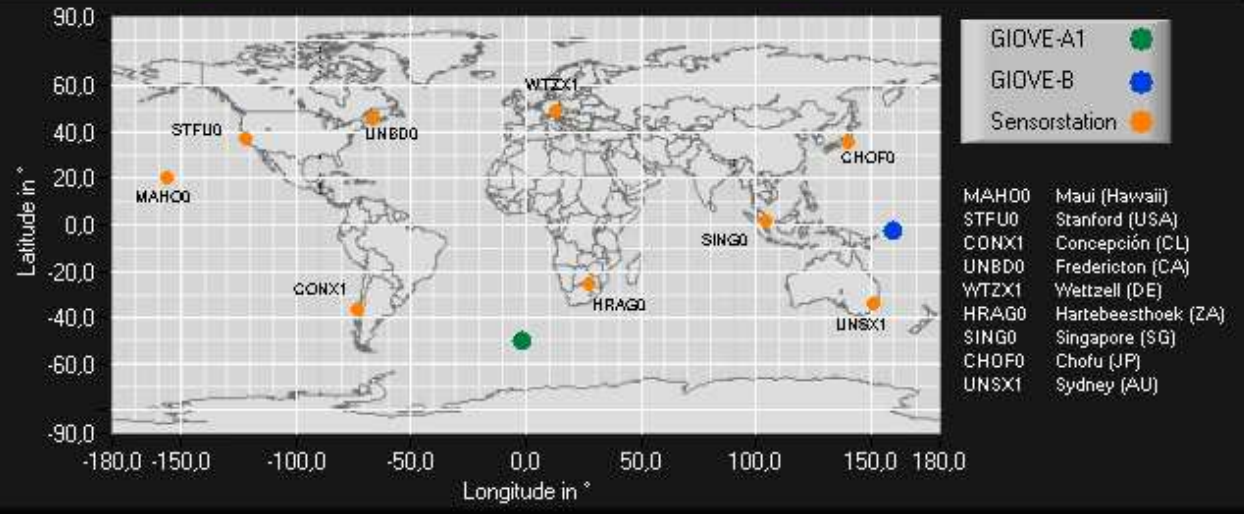
In View


E1 E5a E5b E5 E6

2011-03-16 13:26:00 Last message received [UTC]

E1-CBOC & E5 ESA status information Signal Transmission

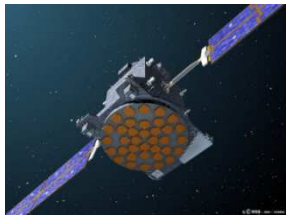
| Station ID | MAHO0 | STFU0 | CONX1 | UNBD0 | WTZX1 | HRAG0 | SING0 | CHOF0 | UNSX1 |
|---|---|---|---|---|---|---|---|---|---|
| GIOVE A1 | | | ■ | | | ■ | | | |
| GIOVE B | ■ | | | | | | | ■ | |



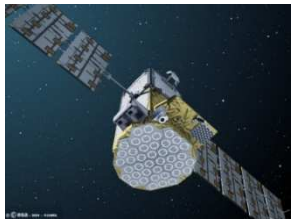

| | |
|---|---|
| MAHO0 | Maui (Hawaii) |
| STFU0 | Stanford (USA) |
| CONX1 | Concepción (CL) |
| UNBD0 | Fredericton (CA) |
| WTZX1 | Wettzell (DE) |
| HRAG0 | Hartebeesthoek (ZA) |
| SING0 | Singapore (SG) |
| CHOF0 | Chofu (JP) |
| UNSX1 | Sydney (AU) |

# Availability of Code and Phase Observations on E1/E5

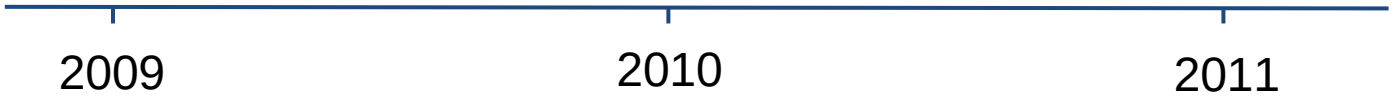
| | |
|---|---|
| Javad TRE-G3TH: | C1X C5X L1X L5X |
| Leica GRX1200+GNSS: | C1X C5X L1X L5X |
| Septentrio GeNeRx1: | C1B C5Q L1B L5Q |



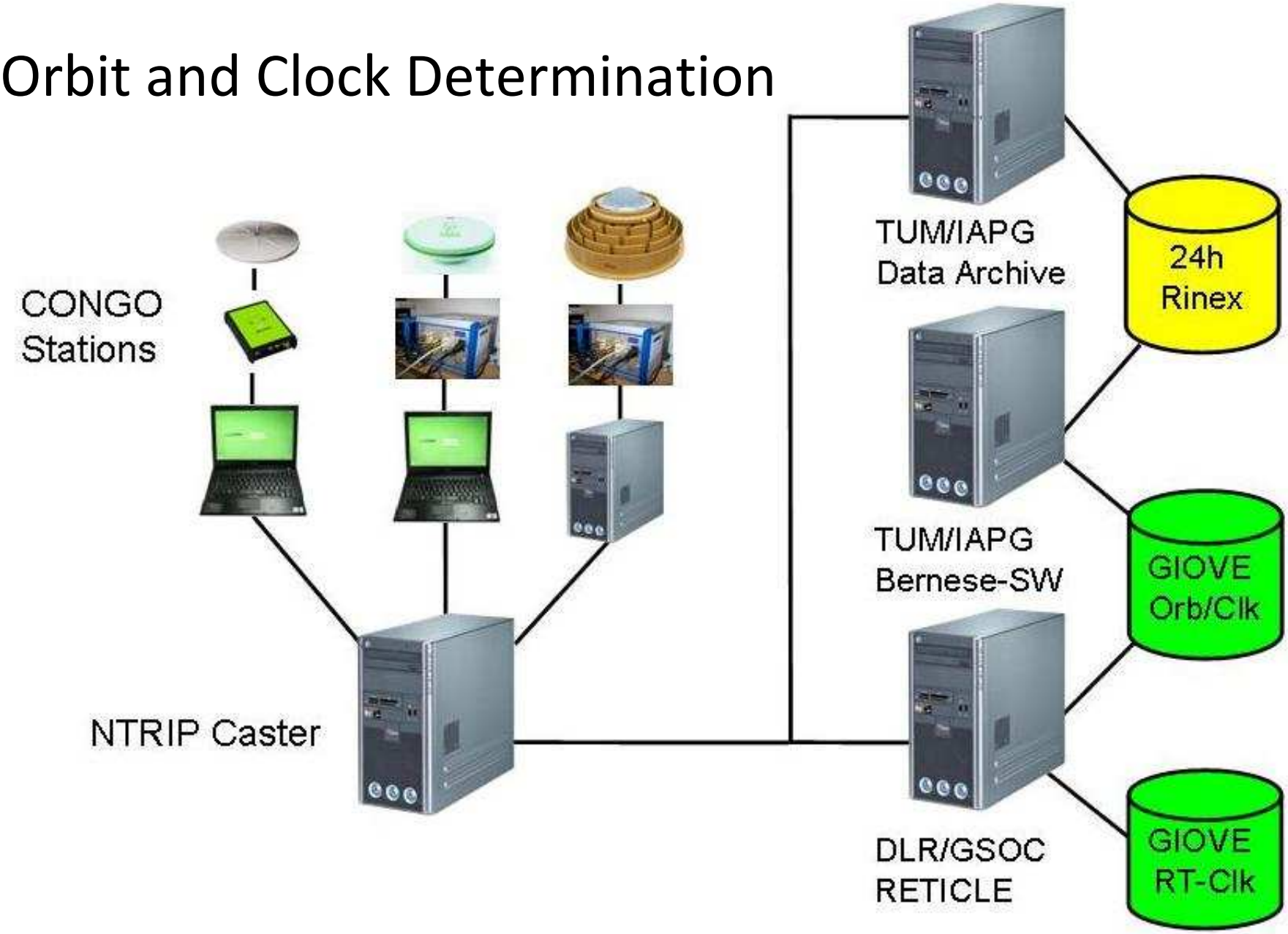
GIOVE-A



GIOVE-B



# Orbit and Clock Determination



# CONGO Processing at TUM


Ntrip Decoder

24 h files RINEX 3.00

GPS-only PPP

CODE orbits and clocks

Coordi-nates

Tropo-sphere

Receiver clocks

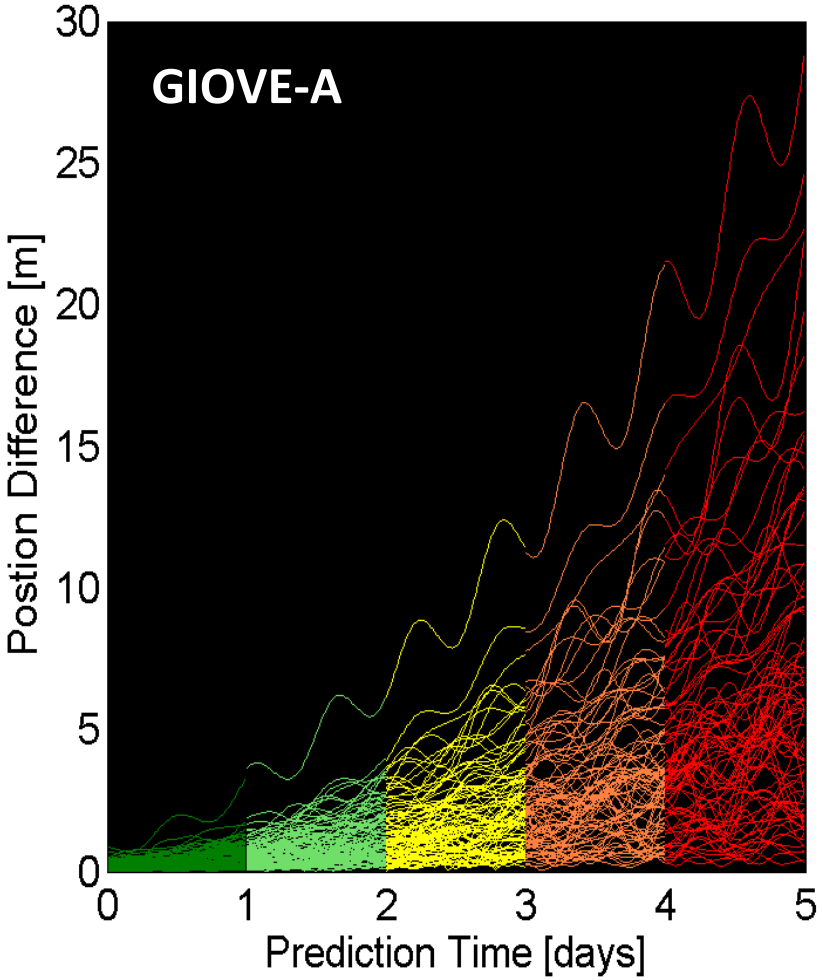
GIOVE orbit and clock determination

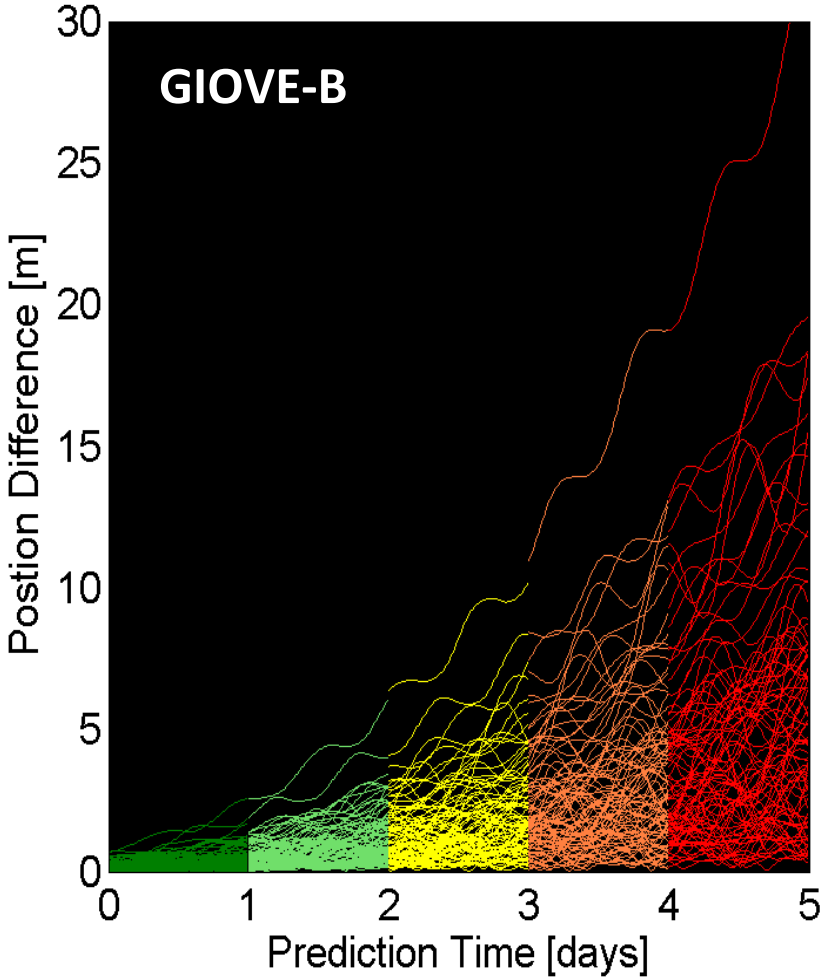
NEQ

5-day long-arc orbit + 2-day prediction

# GIOVE Orbit Predictions

Differences of predicted GIOVE orbits w.r.t. last observed day
Each line represents a 5 days example comparison



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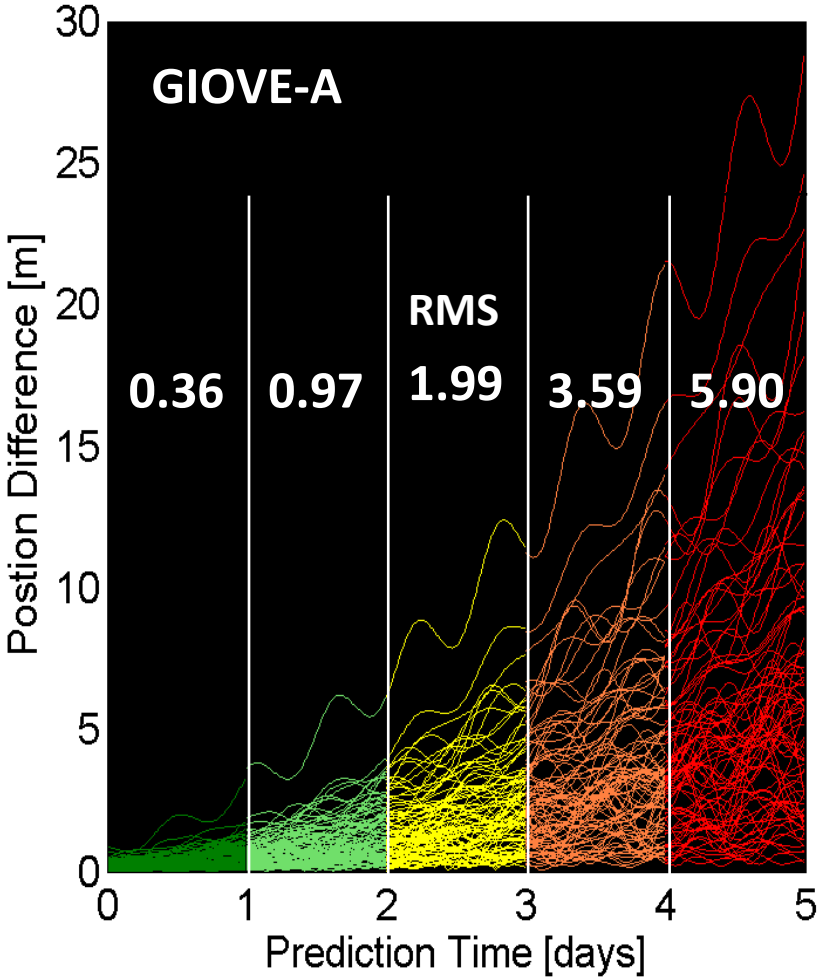
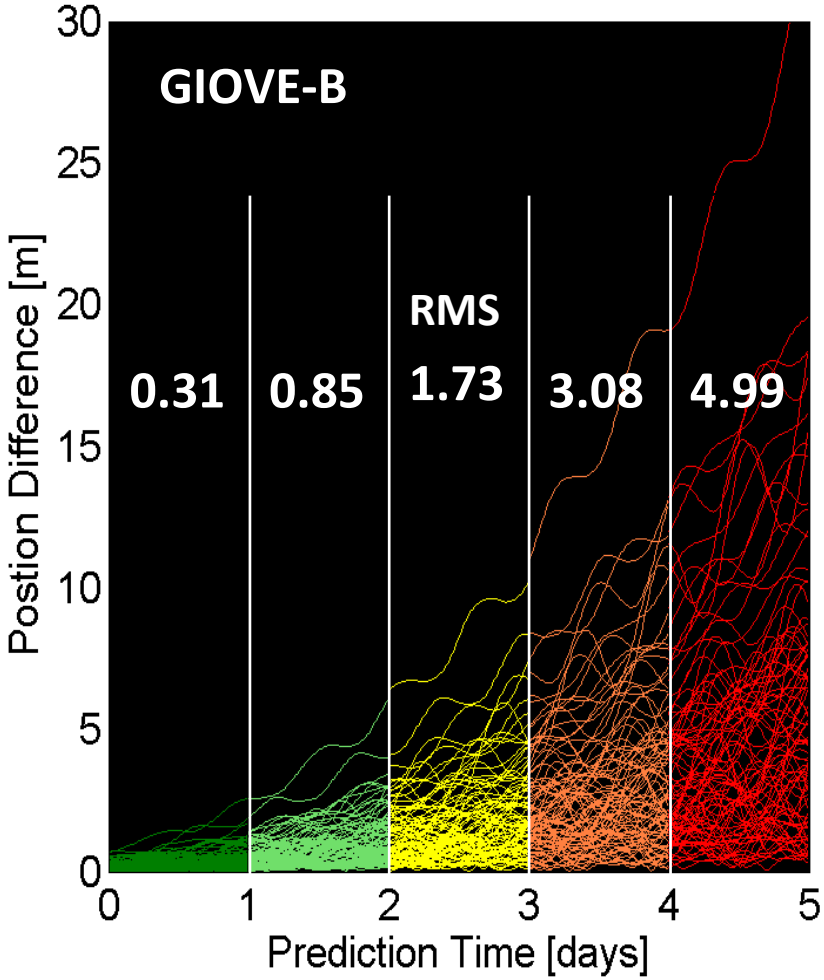


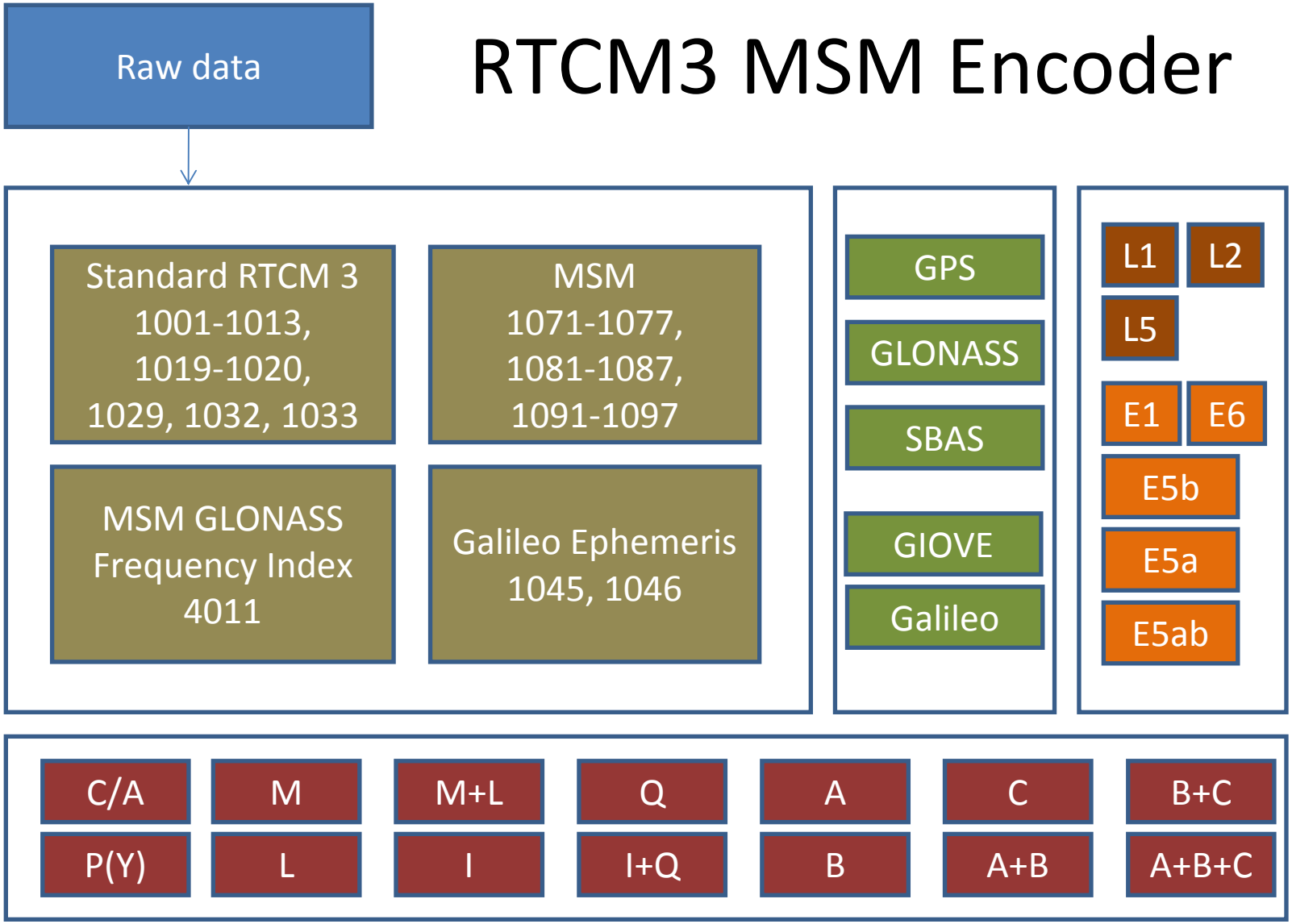
# Why RTCM3 Multi-Signal-Messages (MSM) ?

| | **Heritage Messages** | **MSM** |
|---|---|---|
| **Constellations** | GPS, GLONASS, (SBAS) | GPS, GLONASS, GALILEO, ... |
| **Signals** | 1 signal per frequency<br>(either C/A or P(Y) on L1/L2) | Multiple signals per frequency,<br>all Rinex3 signals |
| **Observation types** | Pseudorange, Carrier-Phase<br>C/N0 | Pseudorange, Carrier-Phase,<br>Doppler, C/N0 |
| **Resolution** | Pseudorange: 20 mm<br>Carrier-Phase: 0.5 mm<br>C/N0: 0.25 dB-Hz | Pseudorange: ~0.6 mm<br>Carrier-Phase: ~0.14 mm<br>C/N0: 0.1 dB-Hz<br>Doppler: 0.1 mm/s |

- MSMs support all signals defined in current Rinex v3 standard for GPS, GLONASS and GALILEO

- MSMs are extendable for new navigation systems and future signals

# RTCM3 MSM Encoder




Alberding

# RTCM3 MSM Decoder for RINEX3

```
GPS          20
C1C L1C D1C S1C C2X L2X D2X S2X C1W L1W D1W S1W
C2W L2W D2W S2W C5X L5X D5X S5X

GLONASS   16
C1C L1C D1C S1C C2C L2C D2C S2C C1P L1P D1P S1P
C2P L2P D2P S2P

GIOVE        8
C1X L1X D1X S1X C5X L5X D5X S5X

SBAS         8
C1C L1C D1C S1C C5X L5X D5X S5X
```

# RTCM3 MSM Data Flow

. . .

Input
Raw data

Output
RTCM3

Output
RINEX

NtripS05/EuroRef


Ntrip Caster

Alberding

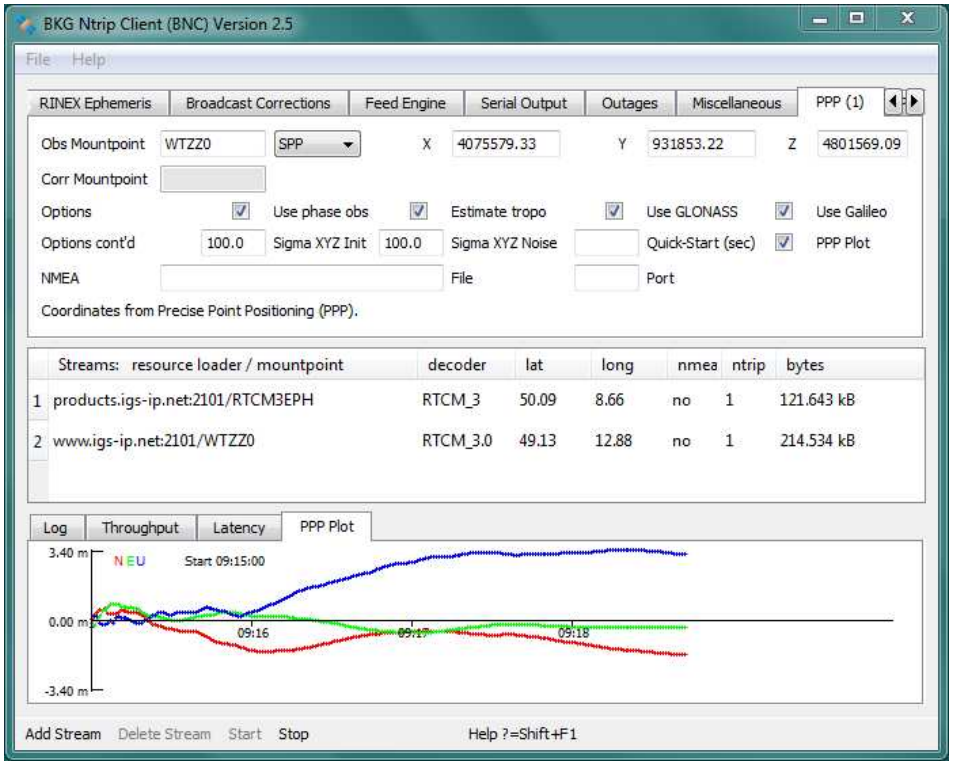
# Wettzell (WTZZ) supporting RTCM3 MSM

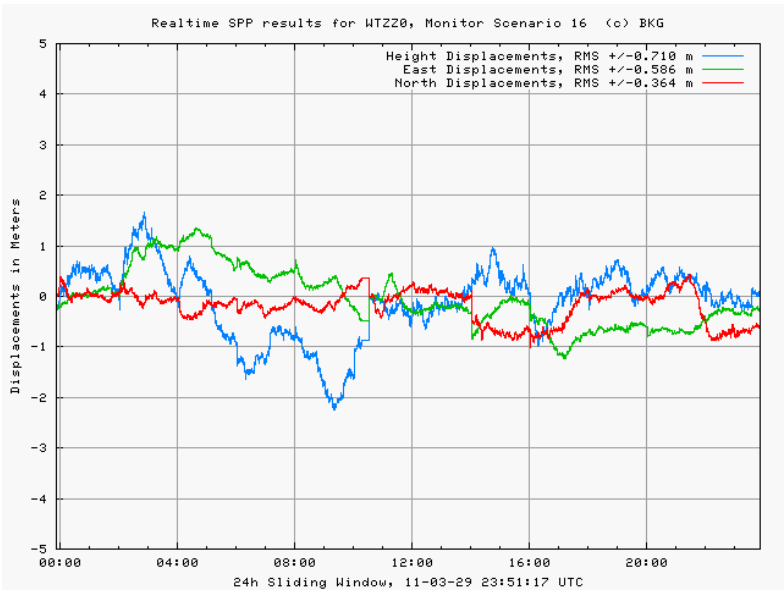
GPS + GLONASS + GALILEO

RTCM3 MSM Decoder

SSR Encoder & Decoder

PPP Engine




BNC Subversion Repository http://software.rtcm-ntrip.org

# Summary

- MSM soon becoming RTCM Recommended Standard
- Encoding/decoding/processing in place for IOV in CONGO

# Plans

- Convert all CONGO raw streams to RTCM3 MSM
- Implement Galileo SSR messages
- Estimate and disseminate Galileo orbit/clock corrections in real-time for PPP

# Real-Time Clock Estimation (RETICLE) System

- Combined GPS+GIOVE clock estimation based on Kalman-filter
- Data from global NTRIP-network in real-time
- Ionosphere-free dual-frequency PR and CP
- Estimation parameters:
  - Sat. clock offset & drift
  - Station clock offset
  - Trop. zenith delay
  - carrier-phase biases