Real-Time GNSS
EUREF-IP ~~Pilot~~ Project

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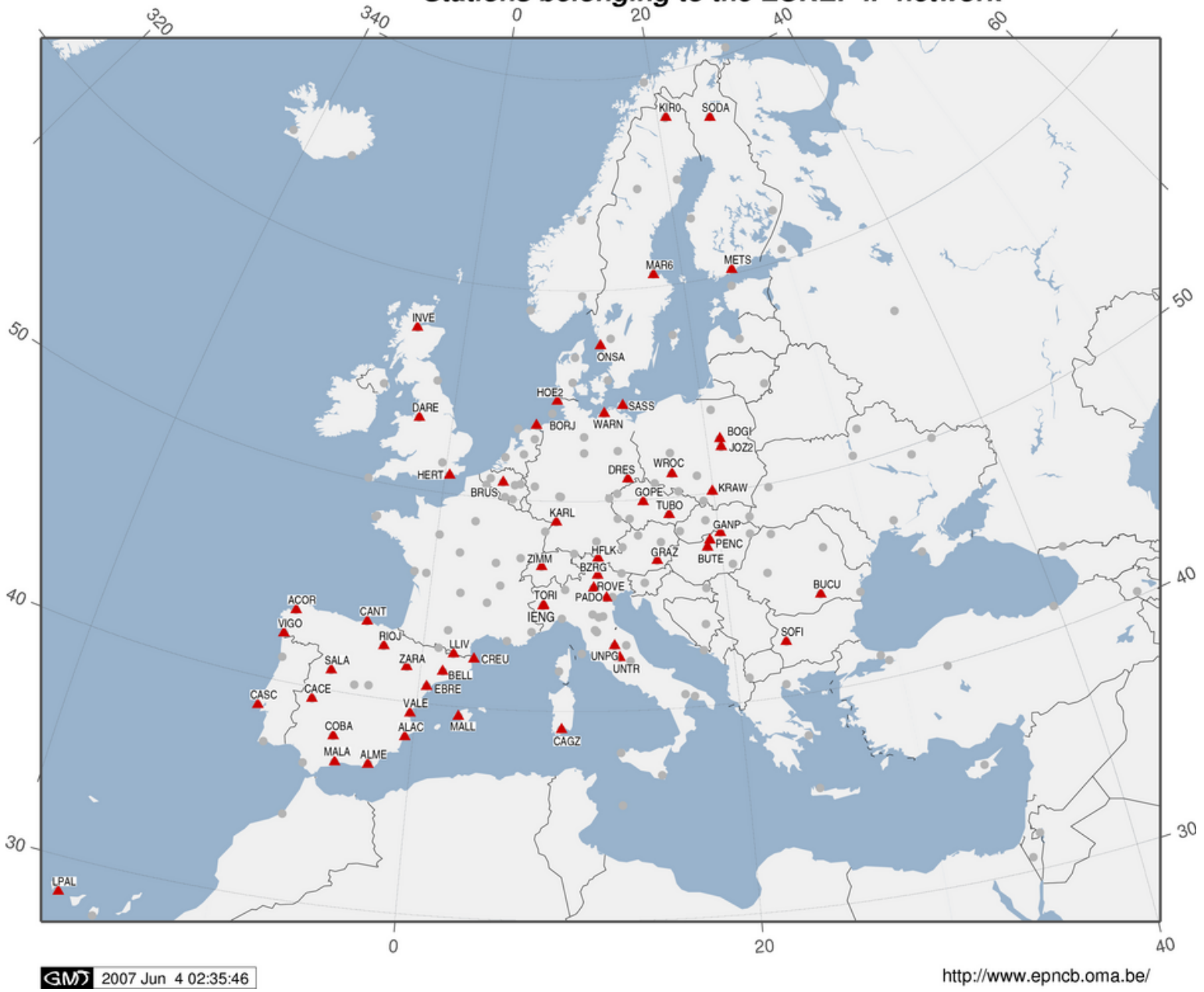
1. Status: Network, coverage, contributors
2. White Paper: Real-time GNSS in Routine EPN Operations
3. Real-time GNSS tools: BNC, client for Windows Mobile
4. Products: RTNET, Real-time orbits & clocks
5. Real-time IGS: Call for Participation
6. The way ahead: Tools & Standardization

EUREF Permanent Tracking Network

Stations belonging to the EUREF-IP network



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Total: 94 Streams

Real-time GNSS in Routine EPN Operations

- White Paper available from: http://www.epncb.oma.be/_organisation/guidelines/EPNRT_WhitePaper.pdf
- Turn EUREF-IP Pilot Project into a routine service
- Guidelines developed for
  - Reference stations
  - NTRIP Broadcasters
  - High-rate RINEX Data Centers
  - Real-time Analysis Centers
  - Role of EPN Central Bureau

Reasons for EUREF-IP

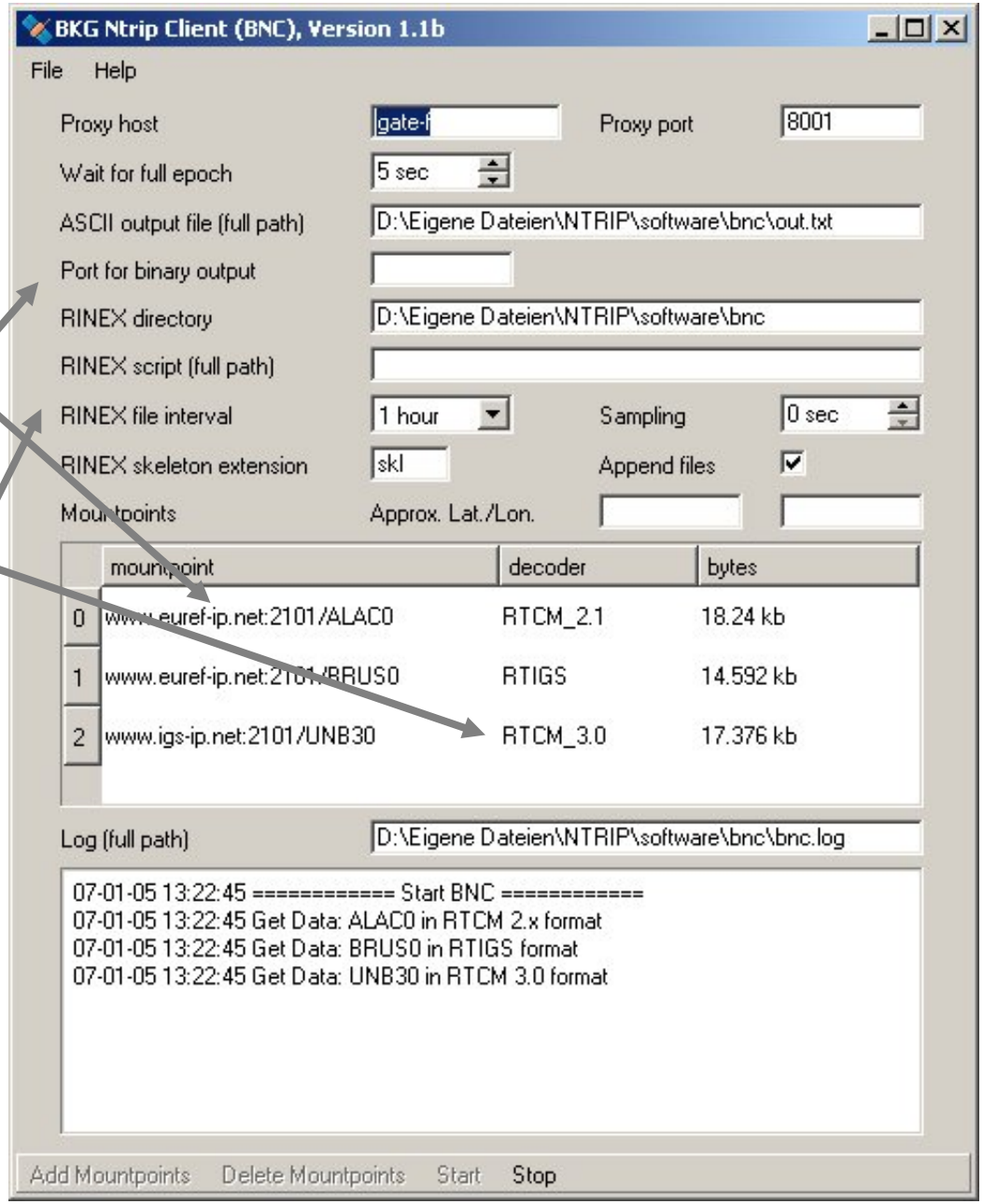
- Integrate Real-time EPN stations in regional DGPS/RTK networks because
  - They are the best real-time monitored long-term available reference stations on the continent.
  - This allows easy real-time data exchange and saves costs.
  - It enables EUREF to support dm-level positioning European-wide, consistently referred to ETRS89.

Streams from different casters

Supports different formats

Synchronised stream output

High-rate RINEX



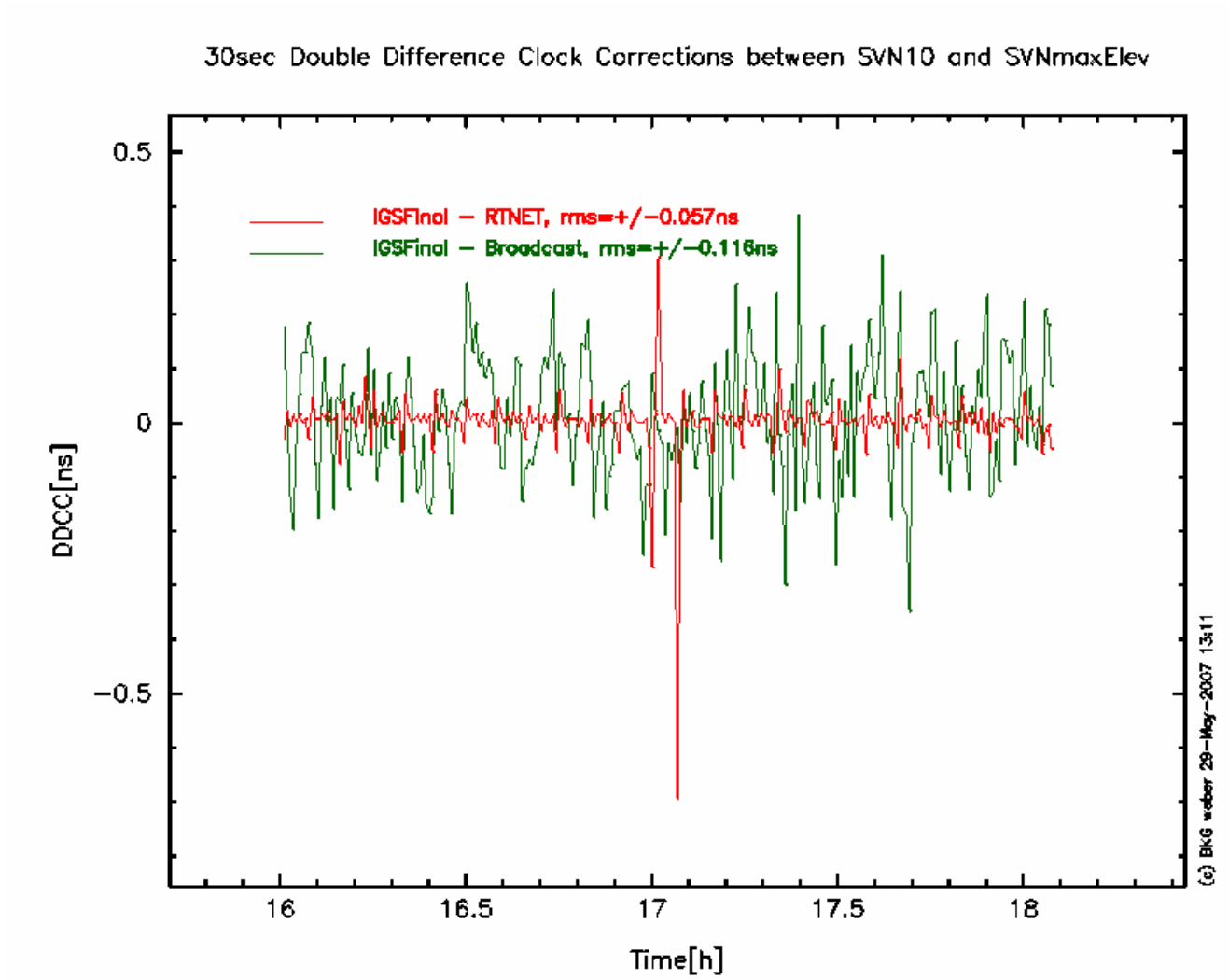
RMS of Discrepancies between Double Difference Clock Corrections:

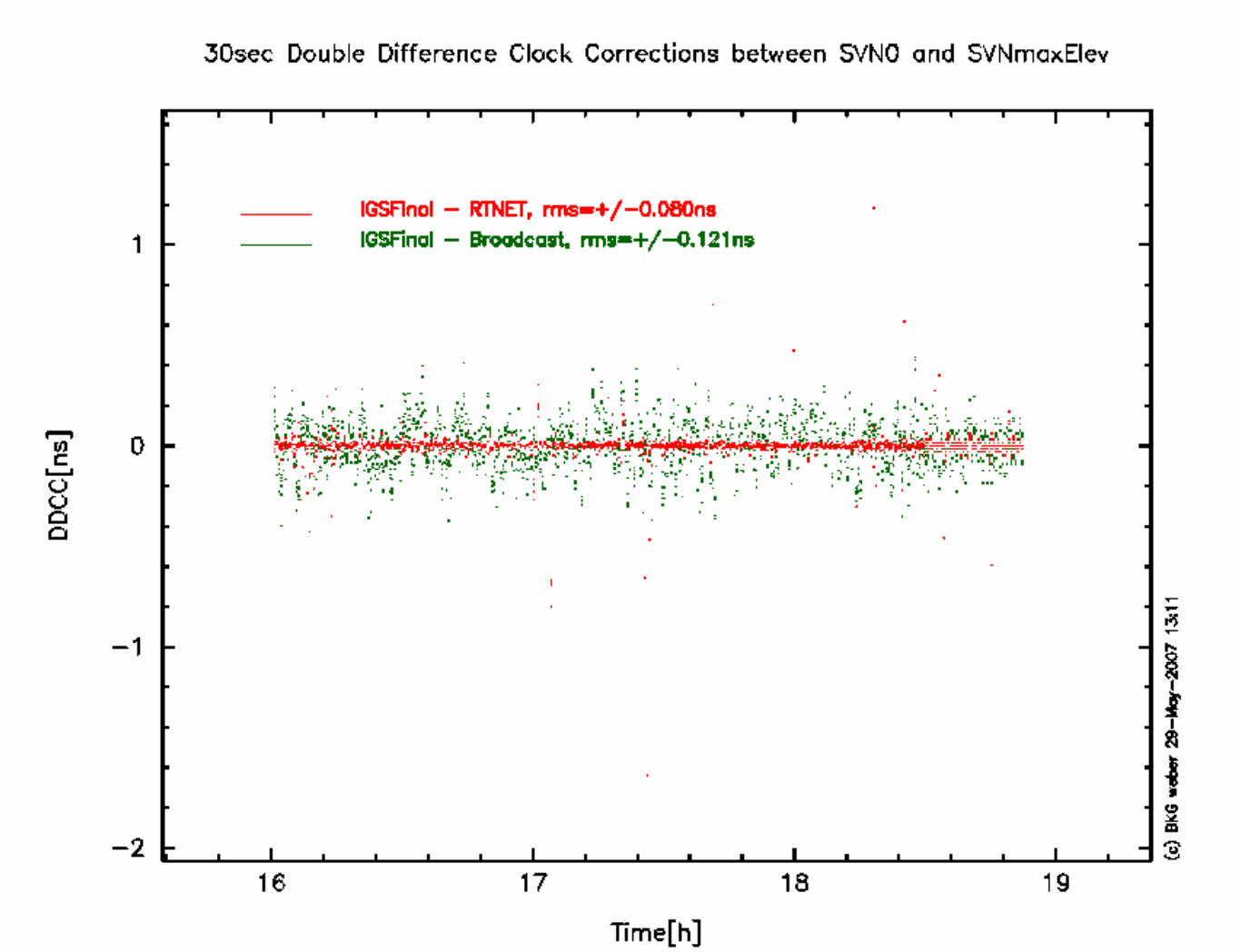
IGS Final Clocks vs. Broadcast or RTNET Clocks

$$\mathbf{RMS} = \pm \sqrt{\frac{\sum_{k=1}^{m-1} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \left[\{ (c_k(t_j) - c_k(t_i)) - (c_{mE}(t_j) - c_{mE}(t_i)) \}_{SOURCE\_1} - \{ (c_k(t_j) - c_k(t_i)) - (c_{mE}(t_j) - c_{mE}(t_i)) \}_{SOURCE\_2} \right]^2}{(m-1) * n * (n-1) / 2}}$$

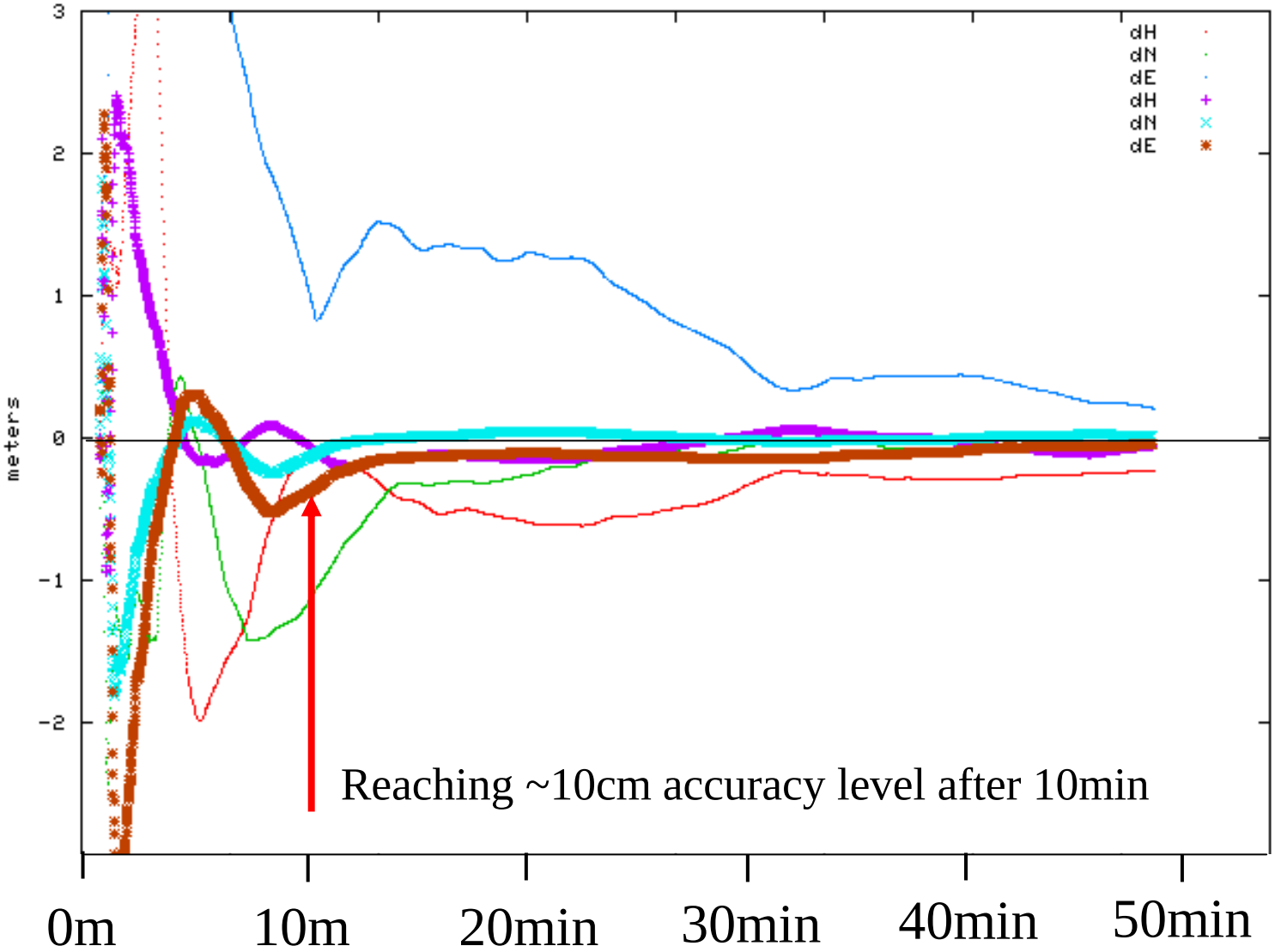
c = Satellite clock correction
t = Epoch
i,j = Index for epochs
k = Index for satellites
mE = Index for satellite with max. elevation
m = Number of satellites
n = Number of epochs

SOURCE = Source of clocks

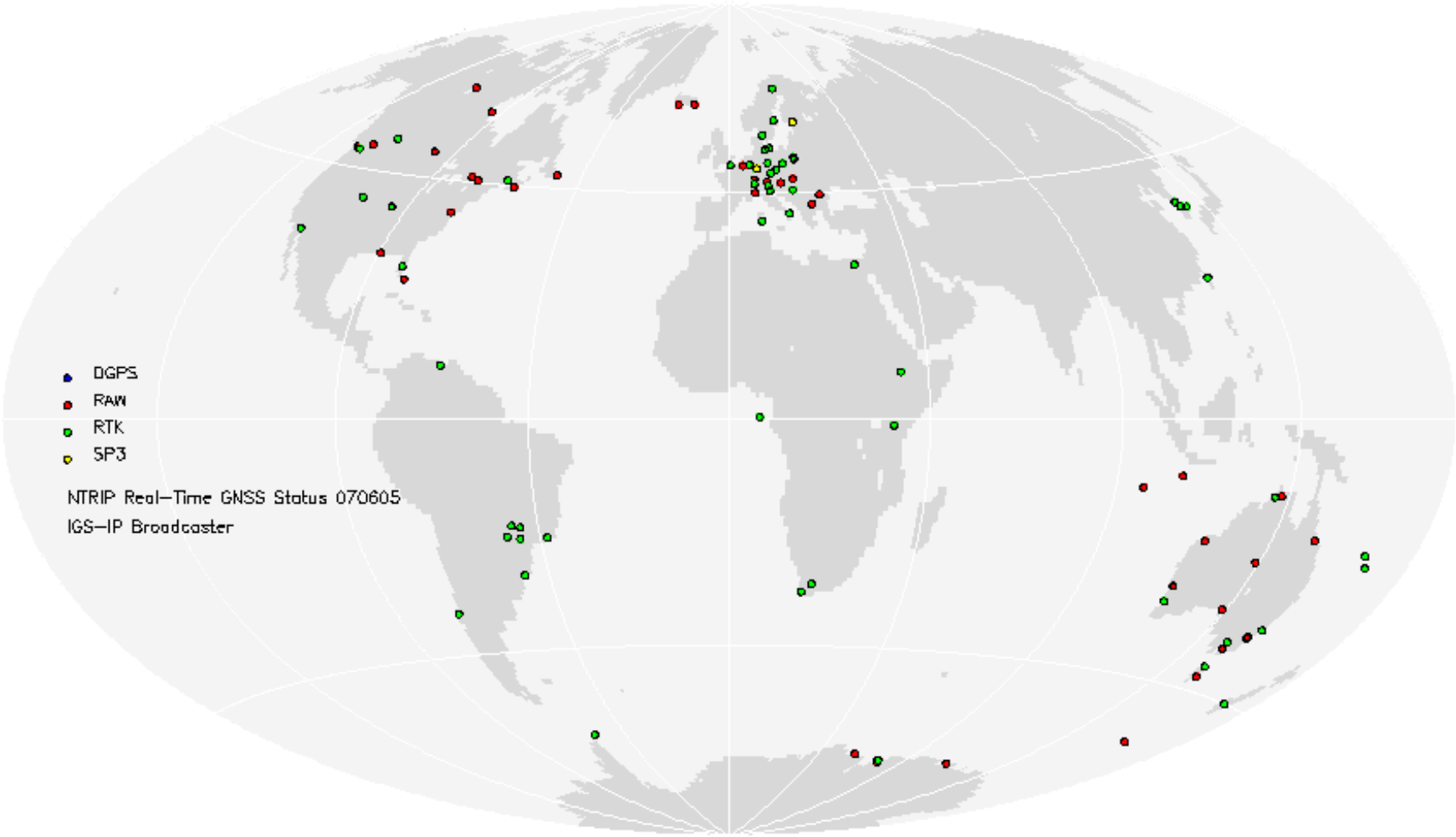

30sec Double Difference Clock Corrections between SVN10 and SVNmaxElev
IGSFinal – RTNET, rms=+/–0.057ns
IGSFinal – Broadcast, rms=+/–0.116ns
DDCC[ns]
0.5
0
–0.5
16
16.5
17
17.5
18
Time[h]
(c) BKG weber 29–May–2007 13:11


30sec Double Difference Clock Corrections between SVN0 and SVNmaxElev
IGSFinal – RTNET, rms=+/–0.080ns
IGSFinal – Broadcast, rms=+/–0.121ns
DDCC[ns]
1
0
–1
–2
16
17
18
19
Time[h]
(c) BKG weber 29–May–2007 13:11

Thin lines: Broadcast clocks
Thick lines: EUREF Real-time clock estimates



Current Real-time IGS Resources



IGS: „SOC/UDP“ vs. EURF: „RTCM/NTRIP“

- Handling GLONASS and GALILEO should be a must for both approaches. Consequently, extending the “SOC/UDP” approach when switching to GPS+GLO would be a necessity. However, all modern Internet-ready receivers already support the “RTCM/NTRIP” approach.
- How can station operators be persuaded to run an extra Linux PC on the site to support “SOC/UPD” if all what’s needed is already integrated in the receiver?
- The suggestion is to closely cooperate with RTCM to develop RTCM v3 and NTRIP v2 in a way that it fully satisfies our needs. This could save us quite some work.

RTCM Working Group: State Space
Chaired by G. Wuebbena

- Final goal: Concepts and Messages for all types of accuracy
- Step 1: Dual frequency Real-time PPP
  - Message(s) for precise orbits and satellite clocks
- Step 2: Single frequency Real-time PPP
  - Development of VTEC ionospheric messages
- Step 3: RTK-PPP
  - STEC, troposphere, delays, carrier phase ambiguity (maintain integer nature)

New RTCM Working Group: Extension of RTCM v3 to...

- Overcome the current limitation of handling only one code per frequency
  - Current problem: L2C
  - Future problems: L5 and GALILEO
- Develop new RTCM v3 format which allows to transport any observation becoming available