

Real-Time GNSS - EUREF-IP

Georg Weber, BKG

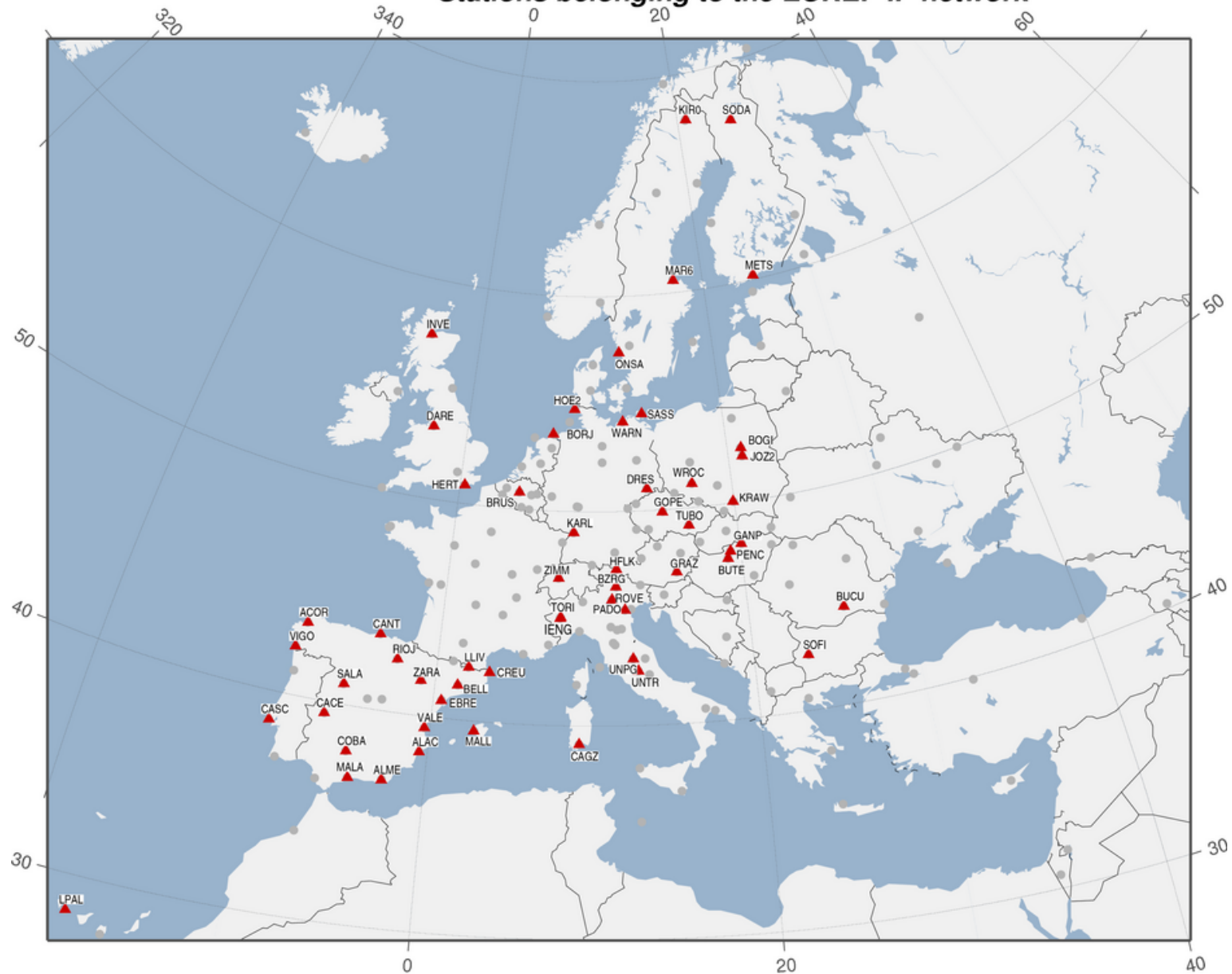
<u>Status</u>	Network, coverage, contributors
<u>White Paper</u>	Real-time GNSS in routine EPN operations
<u>Tools</u>	BNC, Windows Mobile client
<u>Products</u>	RTNET, real-time orbits & clocks
<u>Real-time IGS</u>	Call for Participation
<u>Next</u>	Standardization & Tools

Priorities

- Upgrade EPN stations to real-time
- Integrate them into DGPS/RTK networks
 - They are the best real-time monitored long-term available reference stations.
 - This ensures real-time access to a consistent ETRS89 realization European-wide.
 - It allows an easy real-time data exchange between adjacent networks for offering seamless services.
 - It enables the generation of new products like real-time clock and ionospheric corrections supporting PPP.

EUREF Permanent Tracking Network

Stations belonging to the EUREF-IP network



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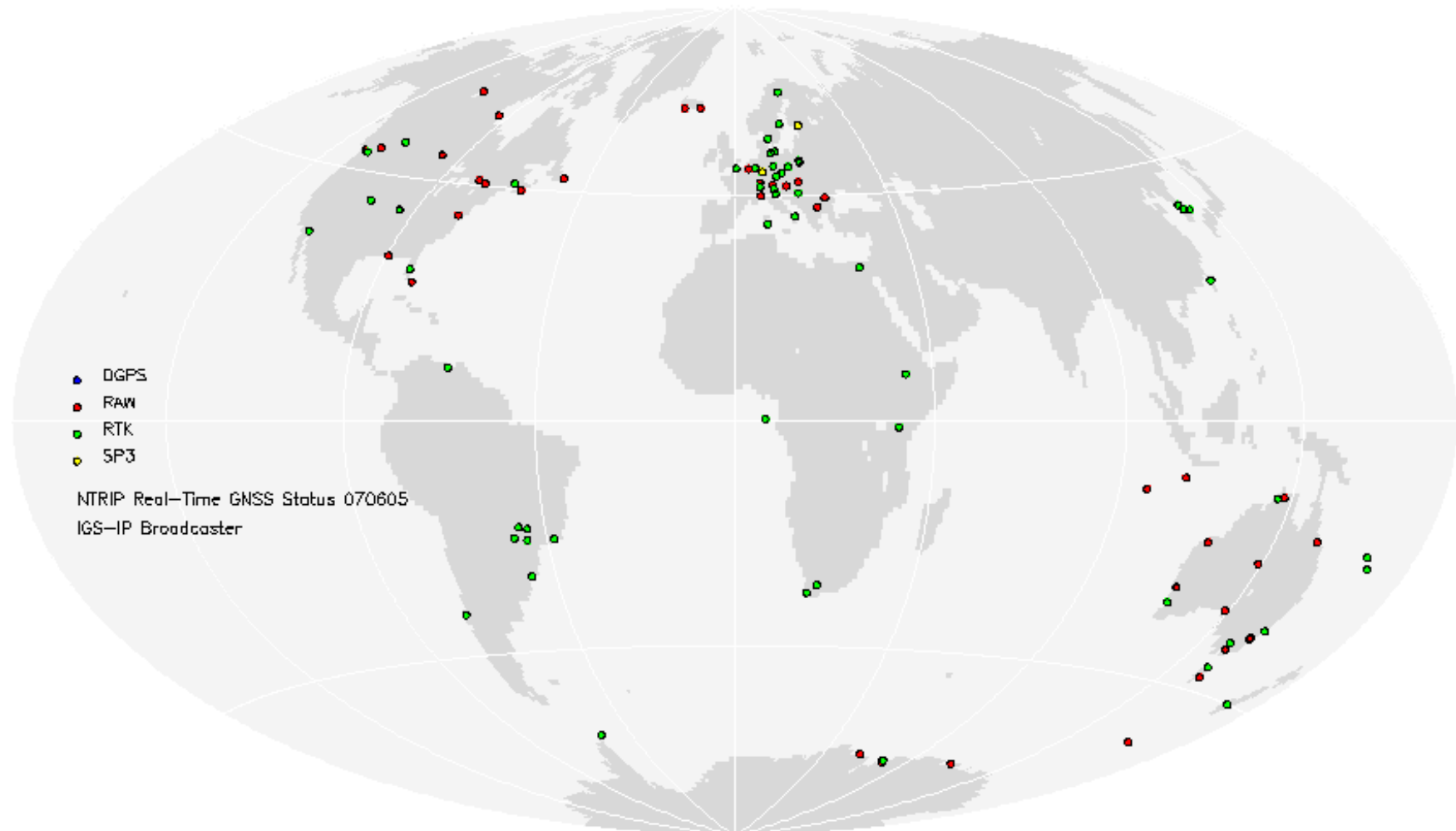
Total: 94 Streams

Contributors to www.igs-ip.net

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 44. Universidade da Baira Interior UBI/CGUL/IDL - Portugal (1)
 45. University New South Wales - Australia (1)
 46. University Padova - Italy (2)
 47. University of New Brunswick - Canada (2)
-

Total: 116 Streams

Real-time IGS



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 routine service
- Guidelines developed for
 - Reference stations
 - NTRIP Broadcasters
 - High-rate RINEX Data Centers
 - Role of EPN Central Bureau

Tools: BNC

Streams from
different casters

Supports
different formats

Synchronised
stream output

High-rate Rinex

BKG Ntrip Client (BNC), Version 1.3

File Help

Proxy host: gate-f Proxy port: 8001

Wait for full epoch: 2 sec

ASCII output file (full path): C:\temp\output\ascii.txt

Port for binary output: 2101

RINEX directory: C:\temp\rinex

RINEX script (full path): C:\temp\rinex\upload

RINEX file interval: 15 min Sampling: 0 sec

RINEX skeleton extension: skl Append files: ☒

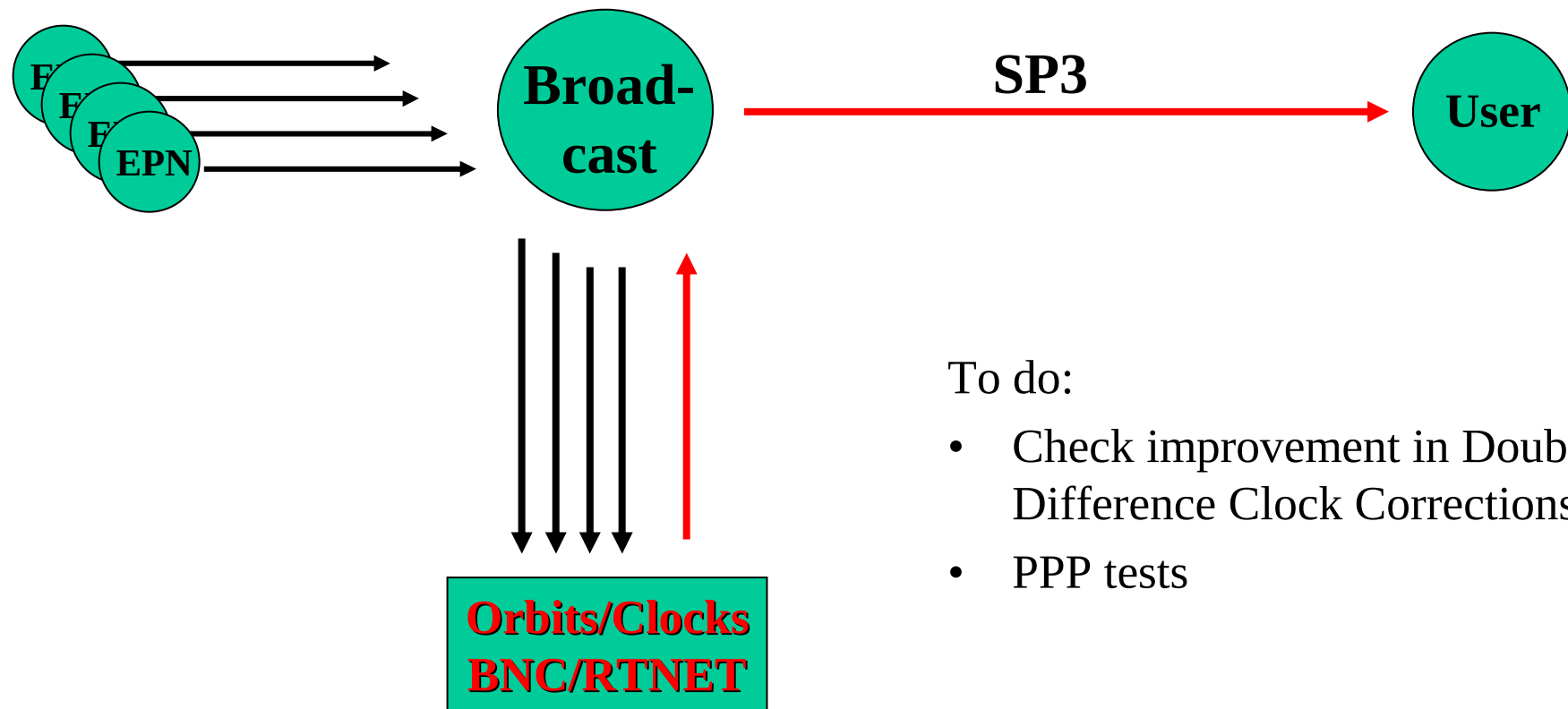
Mountpoints

	mountpoint	decoder	lat	long	nmea	bytes
1	www.euref-ip.net:2101/BRUS0	RTIGS	50.80	4.36	no	0 byte(s)
2	www.euref-ip.net:2101/PADOU	RTCM_2.3	45.41	11.90	no	0 byte(s)
3	www.igs-ip.net:2101/RCMNO	RTCM_3.0	-1.22	36.88	no	0 byte(s)

Log (full path):

Add Mountpoints Delete Mountpoints Start Stop Help=Shift+F1

Real-time orbits from IGS plus clocks from EPN



Double Difference Clock Corrections: Discrepancies

IGS Final Clocks vs. Broadcast and RTNET Clocks

$$\text{RMS} = \pm \sqrt{\frac{\sum_{k=1}^{m-1} \sum_{i=1}^{n-1} \sum_{j=i+1}^n [\{ (\mathbf{c}_k(t_j) - \mathbf{c}_k(t_i)) - (\mathbf{c}_{mE}(t_j) - \mathbf{c}_{mE}(t_i)) \}_{\text{SOURCE_1}} - \{ (\mathbf{c}_k(t_j) - \mathbf{c}_k(t_i)) - (\mathbf{c}_{mE}(t_j) - \mathbf{c}_{mE}(t_i)) \}_{\text{SOURCE_2}}]^2}{(m-1) * n * (n-1) / 2}}$$

c = Satellite clock correction

t = Epoch

i,j = Index for epochs

k = Index for satellites

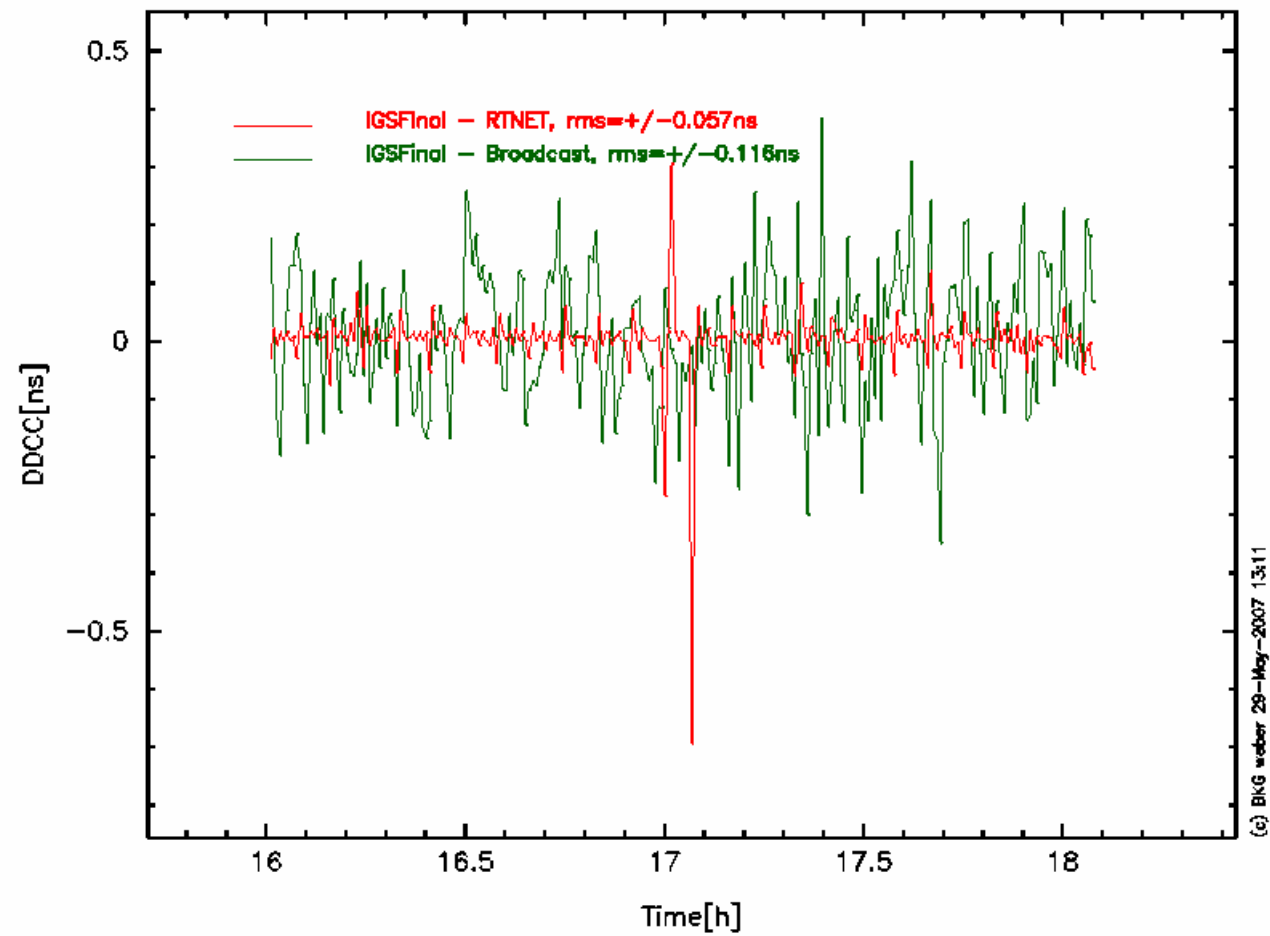
mE = Index for satellite with max. elevation

m = Number of satellites

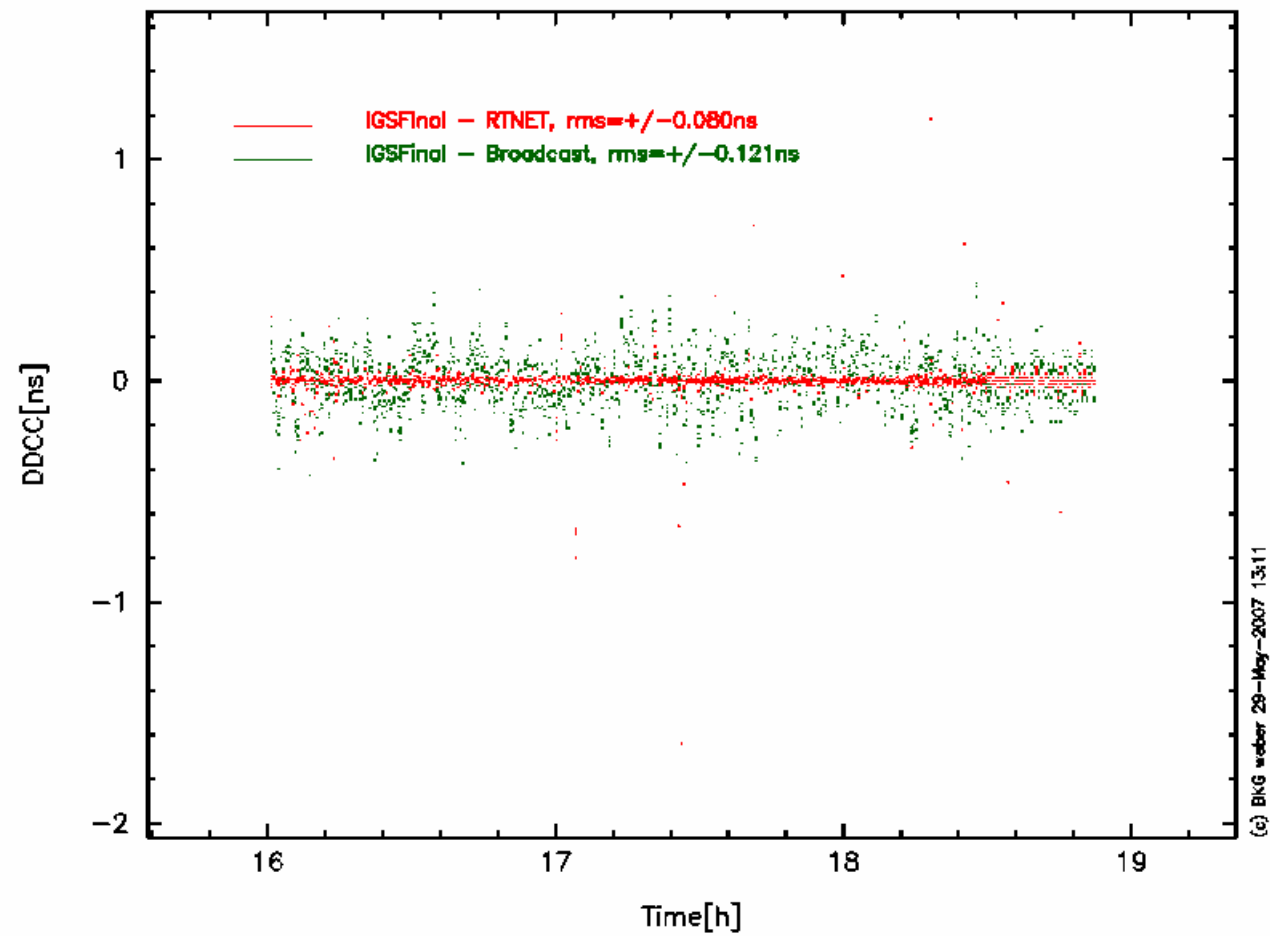
n = Number of epochs

SOURCE = Source of clocks

30sec Double Difference Clock Corrections between SVN10 and SVNmaxElev



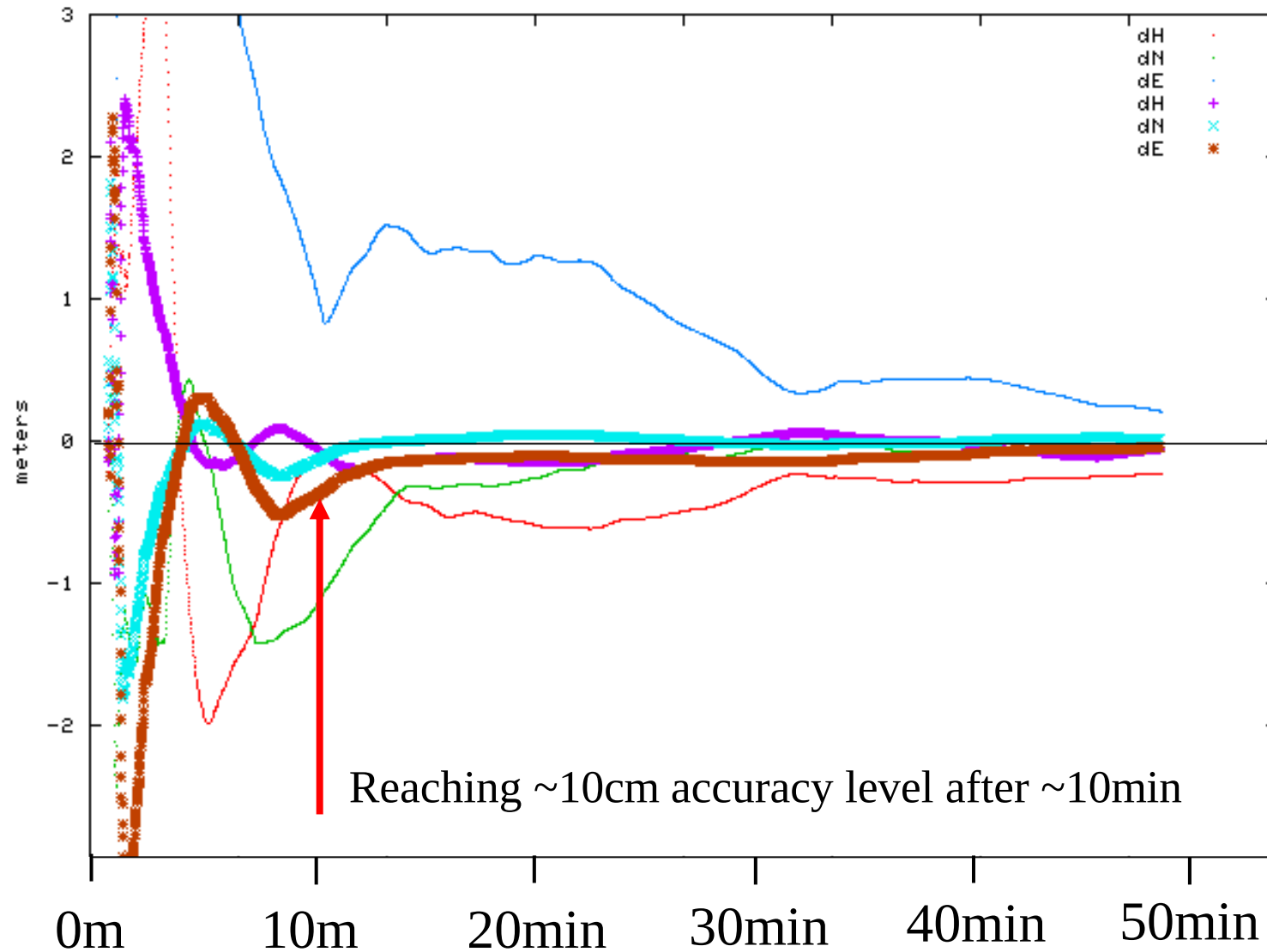
30sec Double Difference Clock Corrections between SVN0 and SVNmaxElev



PPP Test

Thin lines: Broadcast clocks

Thick lines: Real-time clocks



1. Real-time IGS Pilot Project

- 1.1 Background
- 1.2 Goals and Objectives
- 1.3 Organizational Aspects
- 1.4 Project Committee

2. Call for Participation

- 2.1 Real-time Tracking Stations
- 2.2 Real-time Data Centers
- 2.3 Real-time Analysis Centers
- 2.4 Real-time Associate Analysis Centers
- 2.5 Real-time Analysis Center Coordinator
- 2.6 Real-time Network Management and Monitoring
- 2.7 Real-time Users

3. Instructions for Submitting Proposals

- 3.1 Proposal Form

IGS: „SOC/UDP“ vs. EUREF: „RTCM/NTRIP“

- Handling GLONASS and GALILEO should be a must. Consequently, extending today's pure GPS “SOC/UDP” solution would be a necessity.
- However, all modern GPS+GLO Internet-ready receivers already support “RTCM/NTRIP”. How can station operators be convinced to run an extra “SOC/UDP” Linux PC on the site if what's needed is already integrated in the receiver?
- Suggestion: closely cooperate with RTCM to develop RTCM v3 and NTRIP v2 in a way that it fully satisfies our needs.

New RTCM Working Group: State Space

Chaired by G. Wuebbena

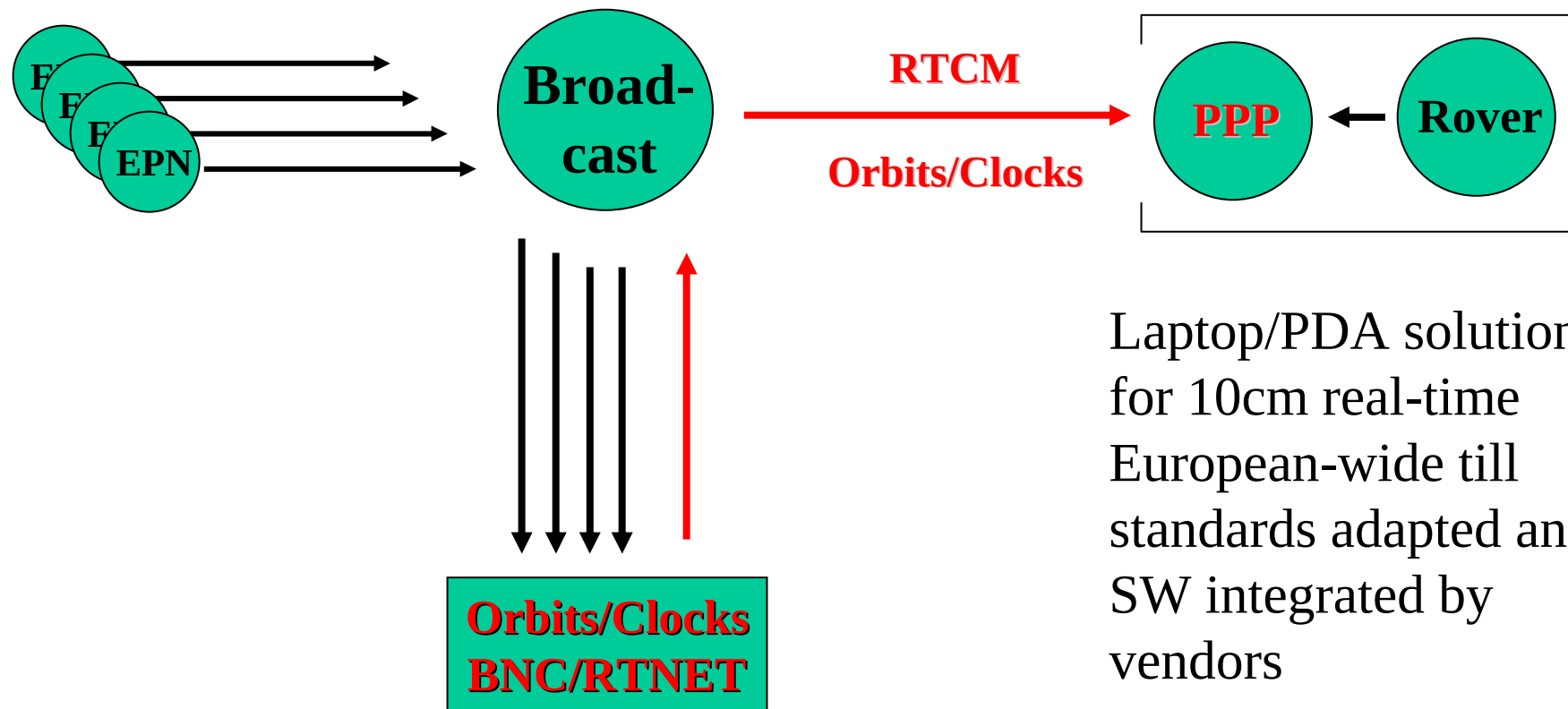
- Final goal: Concepts and Messages for all types of accuracy
- Step 1: Dual frequency Real-time PPP
 - Message(s) for precise orbits and satellite clocks
- Step 2: Single frequency Real-time PPP
 - Development of VTEC ionospheric messages
- Step 3: RTK-PPP
 - STEC, troposphere, delays, carrier phase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

Plans: Precise Point Positioning



Potential Topics for Discussion

- Data policy, stream providers & users
- Protecting commercial interests
- Standardization, formats and protocols
- Limited resources, availability & reliability
- Software tools, Open Source
- Etc.