Federal Agency for Cartography and Geodesy

EUREF-IP – from pilot project to operational status

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History

Resolution No.3 of the EUREF symposium in Ponta Delgada, June 5 - 8, 2002:

The IAG Subcommission for Europe (EUREF)

noting

- the growing need for European-wide improved real-time positioning and navigation

- the recent developments in the interconnection of mobile communication and the Internet

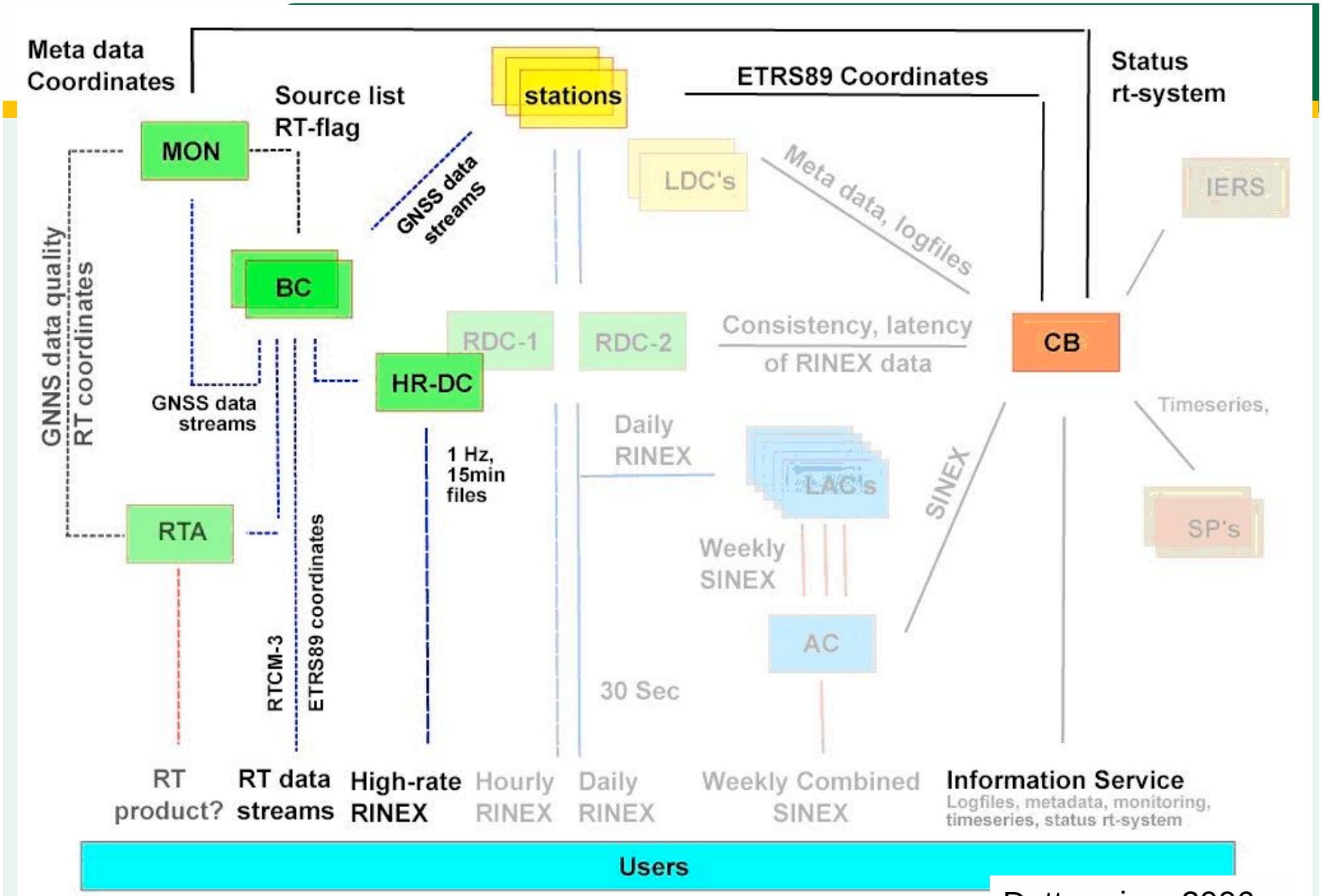
considering

that the EUREF Permanent Network (EPN) infrastructure is capable of providing reliable and standardised real-time data following current efforts within the International Association of Geodesy (IAG) towards real-time data dissemination

asks

- the EUREF Technical Working Group to set up and maintain a differential GNSS infra-structure based on selected EPN stations through the Internet

- the member countries to support this new activity by the necessary upgrade of the respective EPN stations



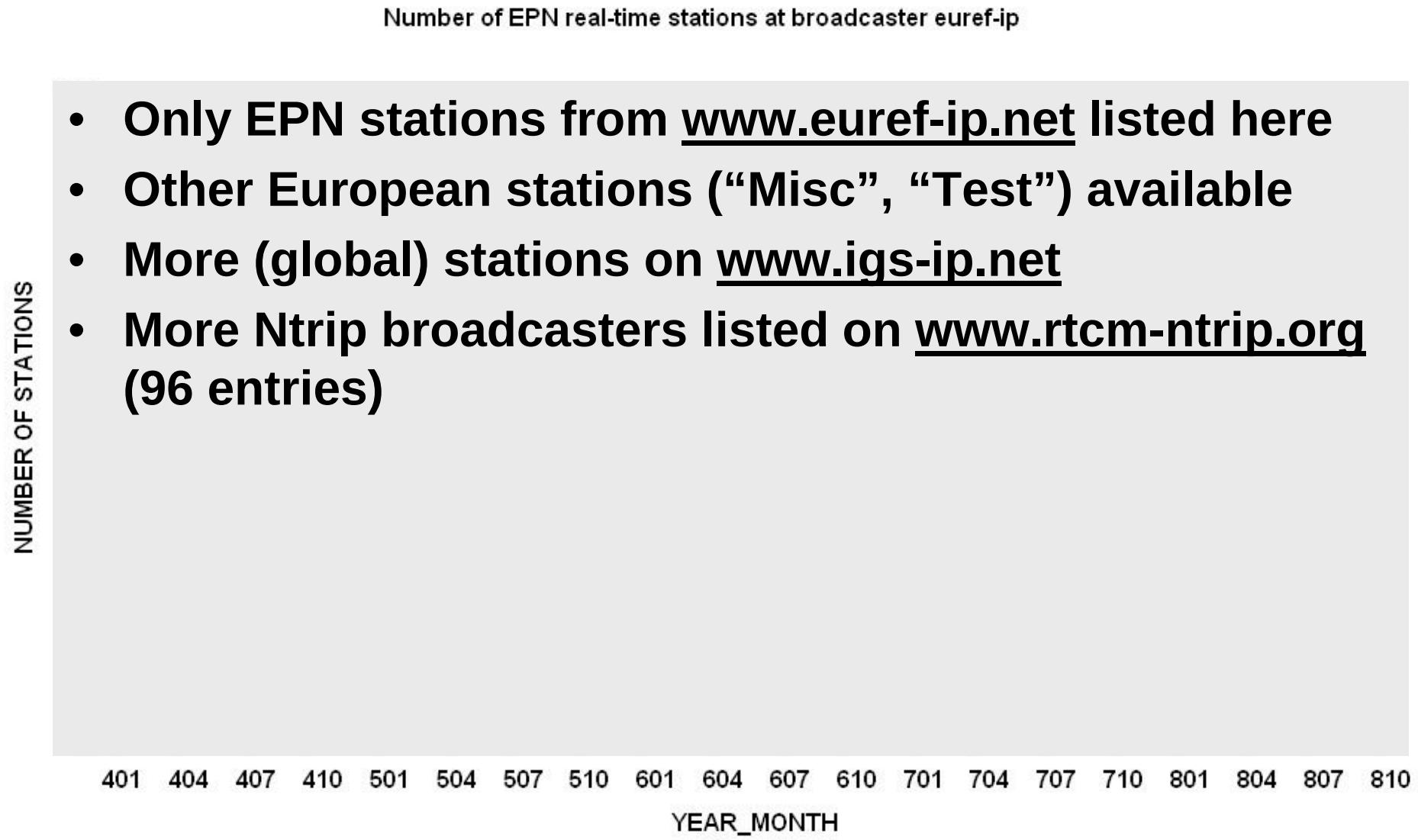
Dettmering, 2006

History

➢ EUREF-IP

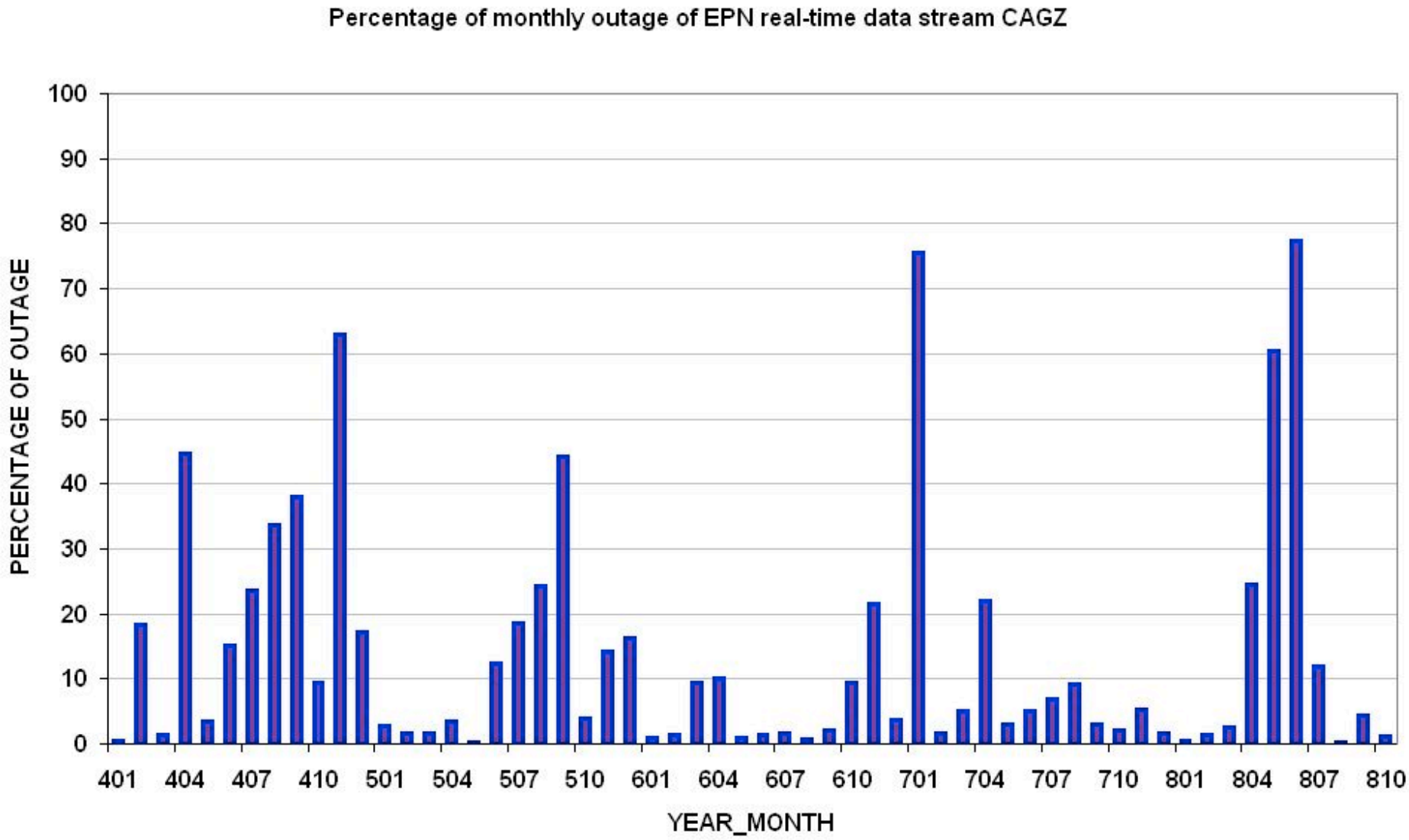
- **Pilot Project started in 2002 (resolution #3, 2002)**
- **White paper "Real-time GNSS in Routine EPN Operations" by EPN RT WG in Dec 2006**
- **Meanwhile, about 90 of the EPN stations with real-time data streaming capability**
- **Decision to close the EUREF-IP Pilot Project at the 45th TWG in November 2007**
- **Real-time data streaming within the EPN on a routine basis now**
  PP EUREF-IP moved towards EPN routine operations at the end of 2007

Stations

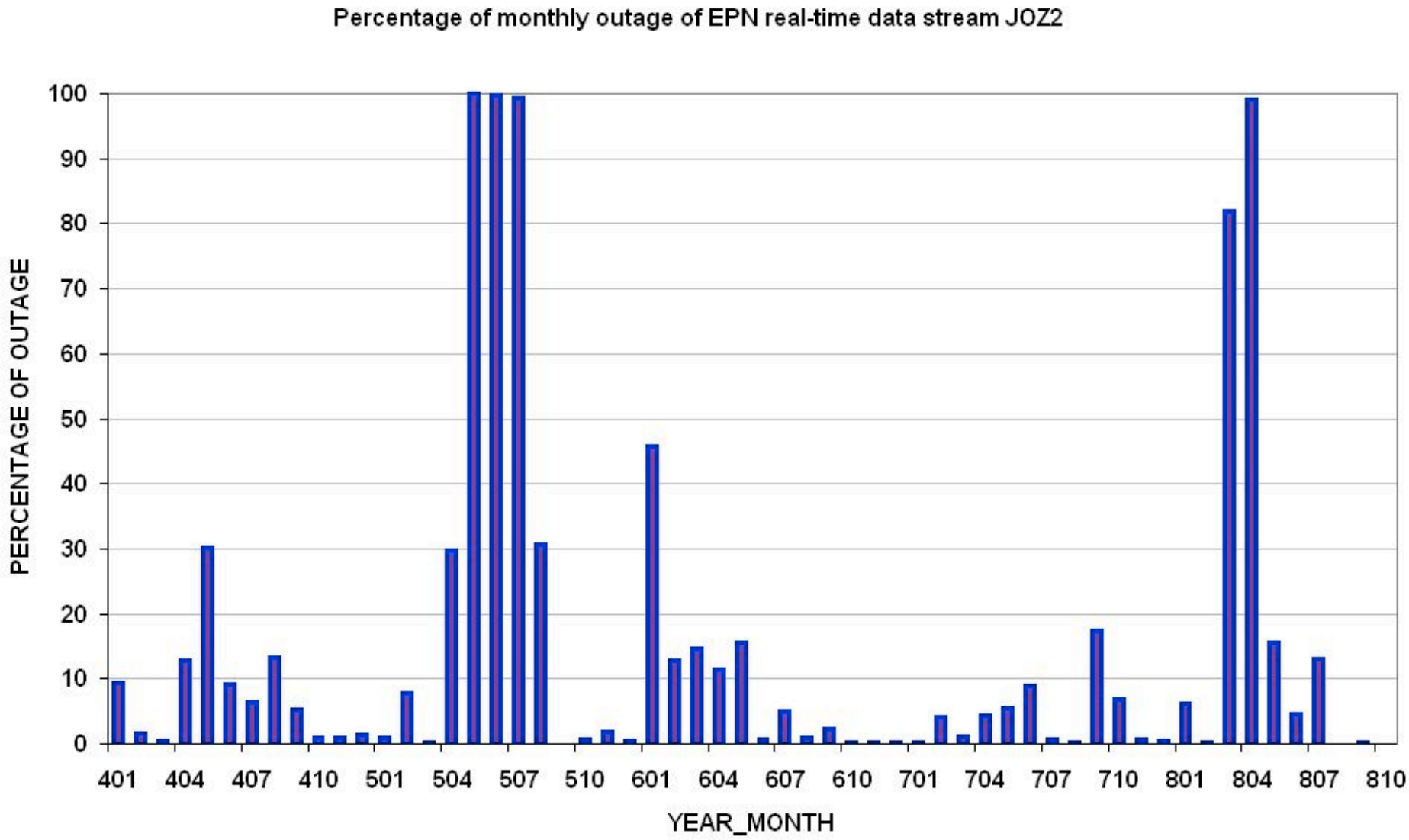


- **Only EPN stations from www.euref-ip.net listed here**
- **Other European stations (“Misc”, “Test”) available**
- **More (global) stations on www.igs-ip.net**
- **More Ntrip broadcasters listed on www.rtcm-ntrip.org (96 entries)**

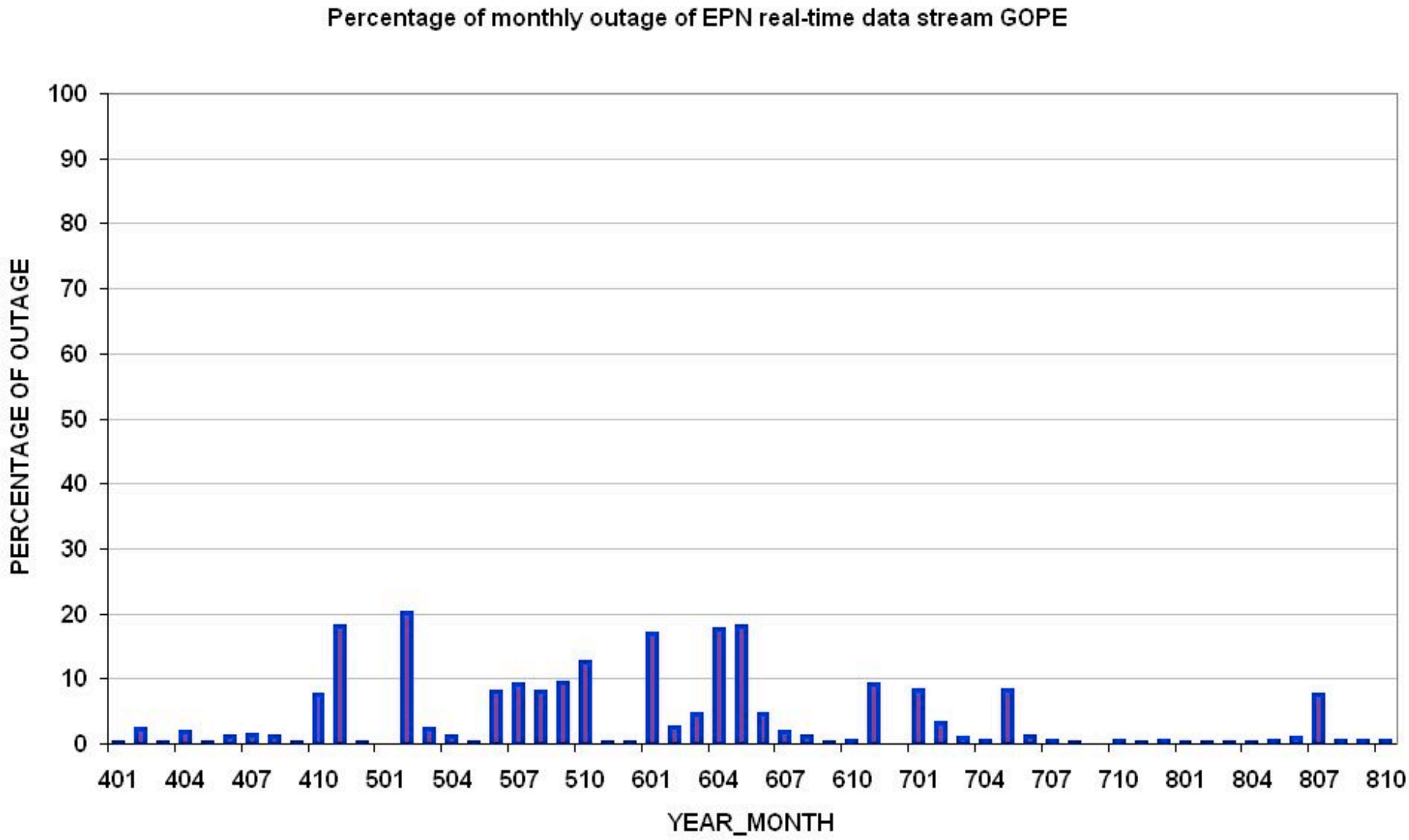
Stations


Percentage of monthly outage of EPN real-time data stream CAGZ
PERCENTAGE OF OUTAGE
100
90
80
70
60
50
40
30
20
10
0
401
404
407
410
501
504
507
510
601
604
607
610
701
704
707
710
801
804
807
810
YEAR_MONTH

Stations


Percentage of monthly outage of EPN real-time data stream JOZ2
PERCENTAGE OF OUTAGE
100
90
80
70
60
50
40
30
20
10
0
401
404
407
410
501
504
507
510
601
604
607
610
701
704
707
710
801
804
807
810
YEAR_MONTH

Stations


Percentage of monthly outage of EPN real-time data stream GOPE
PERCENTAGE OF OUTAGE
100
90
80
70
60
50
40
30
20
10
0
401
404
407
410
501
504
507
510
601
604
607
610
701
704
707
710
801
804
807
810
YEAR_MONTH

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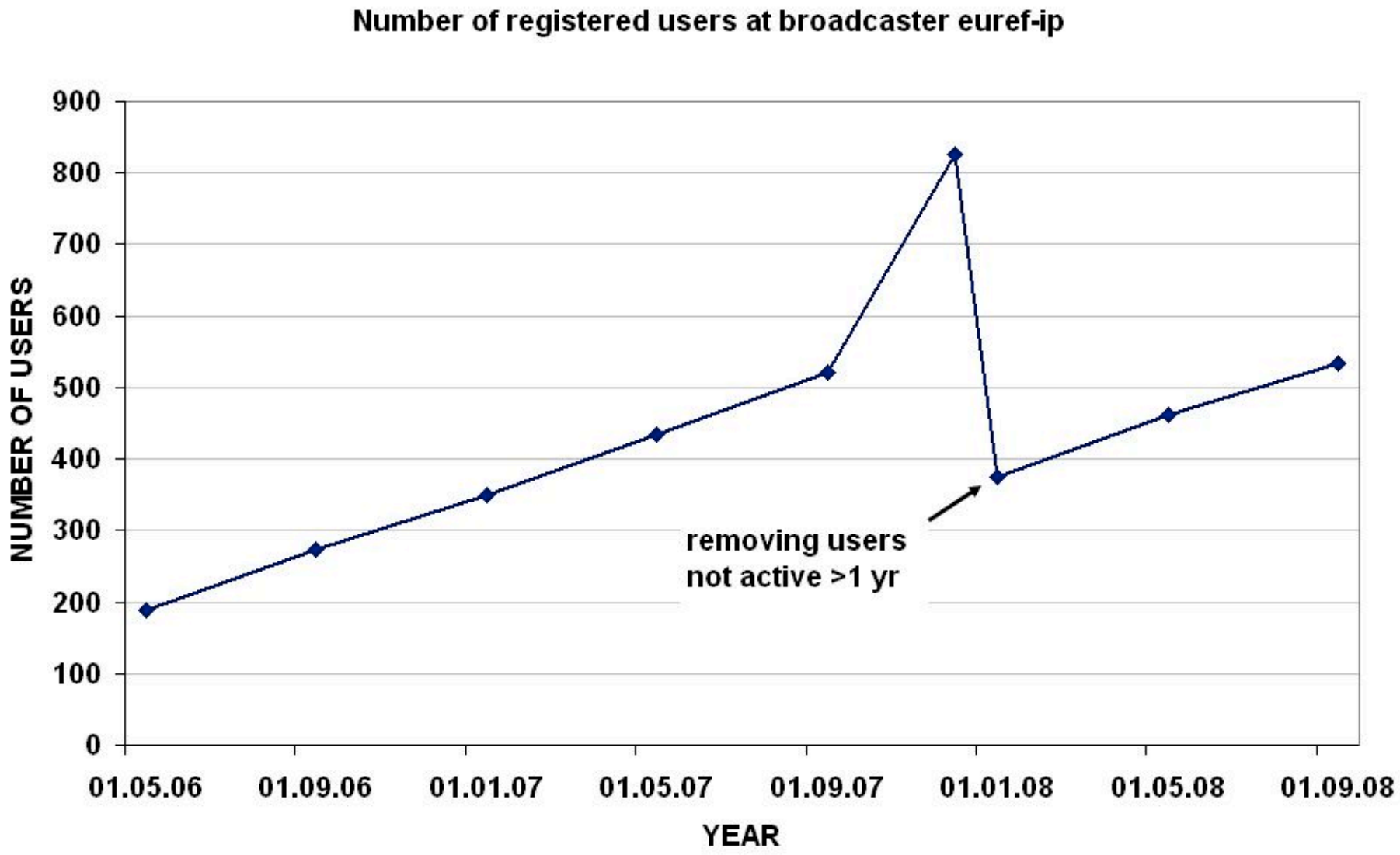
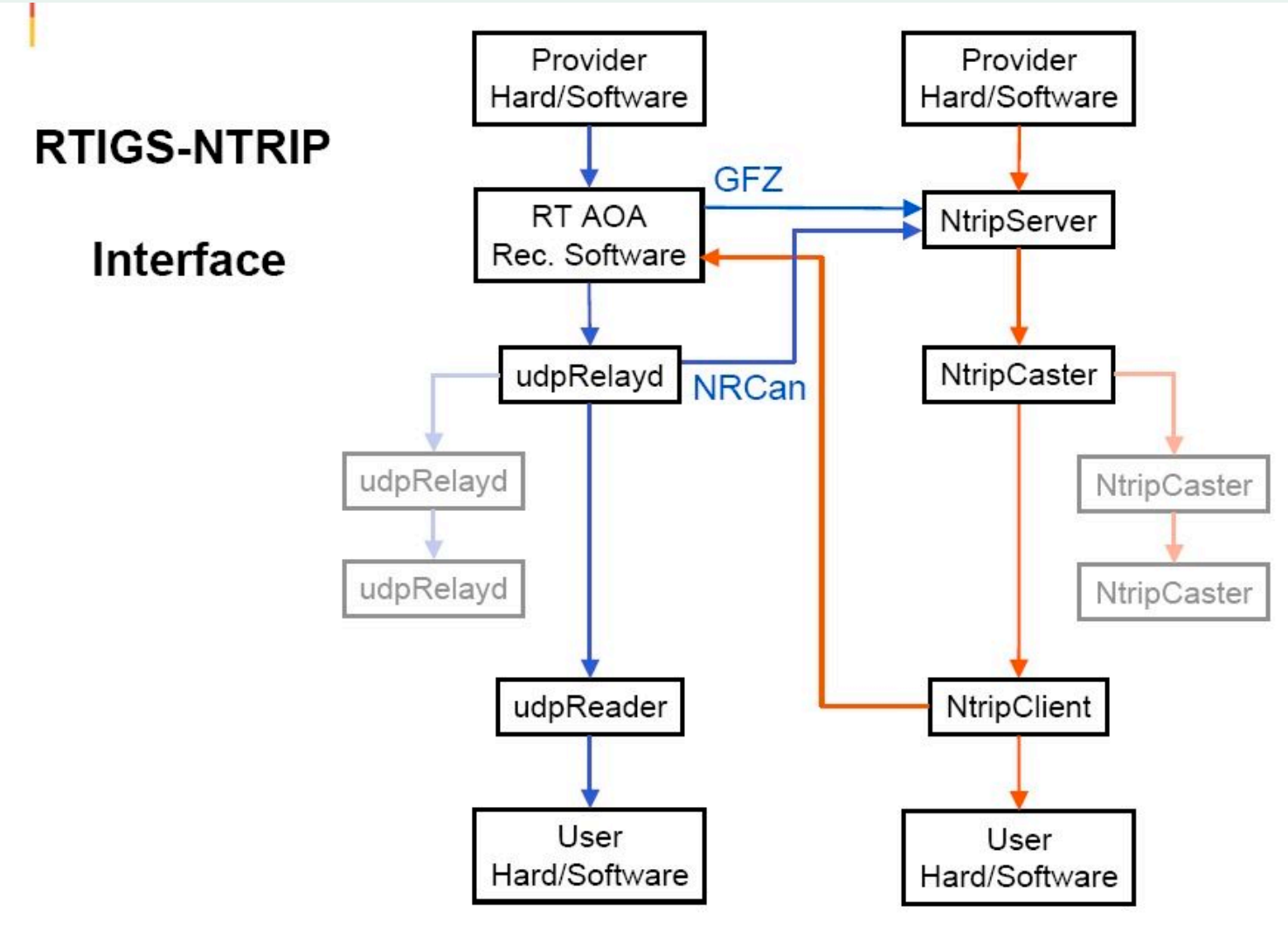
Users


Number of registered users at broadcaster euref-ip
NUMBER OF USERS
900
800
700
600
500
400
300
200
100
0
01.05.06
01.09.06
01.01.07
01.05.07
01.09.07
01.01.08
01.05.08
01.09.08
YEAR
removing users
not active >1 yr

Formats



Weber, 2006

Formats

- **EUREF-IP**
  - **Protocol is Ntrip (Networked Transport of RTCM via Internet Protocol)**
    - **Based on HTTP**
    - **Using TCP/IP**
    - **Official RTCM standard since 2004 (RTCM 10410.0)**
  - **Format is RTCM (The Radio Technical Commission for Maritime Services)**
    - **Special Committee (SC) 104 for Differential Global Navigation Satellite Services (DGNSS)**
    - **Any kind of differential correction data**
    - **GPS+GLONASS**
    - **4 observables**
  - **Software, e.g.**
    - **BNC (BKG Ntrip Client), for LINUX and Windows**
    - **Various Client and Server software for LINUX and Windows**

Formats

- **RTIGS (www.rtigs.net)**
  - **Protocol (transport layer) is UDP (User Datagram Protocol)**
    - **Adopted following IGS Workshop 2002**
    - **Well suited for 1 Hz observations**
    - **Station, observation, ephemeris messages**
  - **Format is SOC (Socket)**
    - **Developed by JPL 1999/2000**
    - **High compression possible (17+21 bytes per sat and epoch)**
    - **Only GPS**
    - **5 observables**
  - **Software, e.g.**
    - **RTGNSSR (Real-Time GNSS Reader), for LINUX**
    - **RTIGSUDPR (RTIGS UDP Relay)**
    - **RTIGSMR (RTIGS Multicast Receive Software)**

Stations

Number of EPN real-time stations at broadcaster euref-ip

- From the 92 EPN stations on euref-ip are streaming
  - 86 RTCM 2.x and 3.x format,
  - 3 RTIGS (BRUS, IENG, WSRT) format, and
  - 3 RAW (BUCU, DARE, INVE) format.
- Within the RTIGS network (on www.rtigs.net)
  - Stations from Europe are KIRU, MAS1, VILL, FFMJ, WTZJ, BRUS, DLFT, IENG, and WSRT,
  - 57 active stations are listed.

IGS RT-PP

- **Status of IGS RT-PP**
  - **CfP in June 2007 (IGS mail 5616)**
  - **Key objectives**
    - **RT network**
    - **Generation of RT products**
    - **Enhancement of (existing) IGS products**
    - **Investigation on standards and formats**
  - **7 individual categories**
    - **RT tracking stations**
    - **RT data and product centre (file and real-time)**
    - **RT analysis centre**
    - **RT associate analysis centre**
    - **RT analysis centre coordinator**
    - **RT network management and monitoring**
    - **RT users**

IGS RT-PP

➢ Status of IGS RT-PP

- 25 proposals (17 from Europe) until Oct 2007
- „Kickoff“ March 2008
- Currently 34 contributions
- Start of orbit & clock product delivery (SP3c (5 min) and clock RINEX (30 sec) files) to be mid of June
- Currently 4 contributions: DLR, ESOC, NRC; BKG
- Combination of orbits and clocks by analysis coordinator Loukis Agrotis (ESOC) in post-processing

➢ Status of IGS RT-PP

- **IGS workshop 2-6 June 2008**
  - **Three real-time related sessions**
  - **Recommendations for RT issues**
    - **Support of dissemination of the PP RT products by both, Ntrip and UDPRelay**
    - **Requirements definition phase for formats of all RT products that are within the scope of the PP**
    - **Development of prototype format for orbits and clocks**
    - **IGS to become a member of RTCM SC 104 – RT PP will play an active role in the definition of formats**
    - **RINEX 3.0 as a basis to define RTIGS requirements for streamed data content and observation resolution**
    - **SP3c and Clock RINEX as a basis to define RTIGS requirements for streamed content and resolution for state space orbits and clocks**
    - **SOC format will no longer be supported**
    - **Existing IGS stations to become real-time station without any additional proposal**

Highrate

- **Highrate RINEX files**
  - **Observational and ephemeris data; products**
  - **“Traditional” way – generation at the station (“locally stored”) – has highest priority**
  - **15 minutes files, 1 Hz sampling rate**
  - **Data volume (> 500 GByte / year)**
  - **Limitations (all observation types; resolution)**
  - **Completeness (epochs, satellites, obs. types, etc.)**
  - **Policy aspects (Derivation of RINEX files from real-time streams possible for everyone)**
  - **(→ Söhne et al., 2008)**
- **Currently RINEX OBS and NAV file generation and storing at BKG; upload to CDDIS; monitoring at EPNCB and BKG**

EUREF Permanent GNSS Network > Data & Products > Data Access - Windows Internet Explorer

http://www.epncb.oma.be/_dataproducts/data_access/

Datei Bearbeiten Ansicht Favoriten Extras ?

EUREF Permanent GNSS Network > Data & Products ...

EUREF HOME

EUREF Permanent Network

EPN CB HOME

ORGANISATION
Creation, Management, Structure, Relation to IGS, Projects, Guidelines, FAQ

TRACKING NETWORK
Maps, Stations, Equipment and calibration, Station coordinates, Site log submission & test

DATA & PRODUCTS
Data access, Analysis centres, Products, Time series, IGS products

NEWS & MAILS
News, Mails, Calendar, Papers, Workshops, Web site history

FTP & WEB ACCESS
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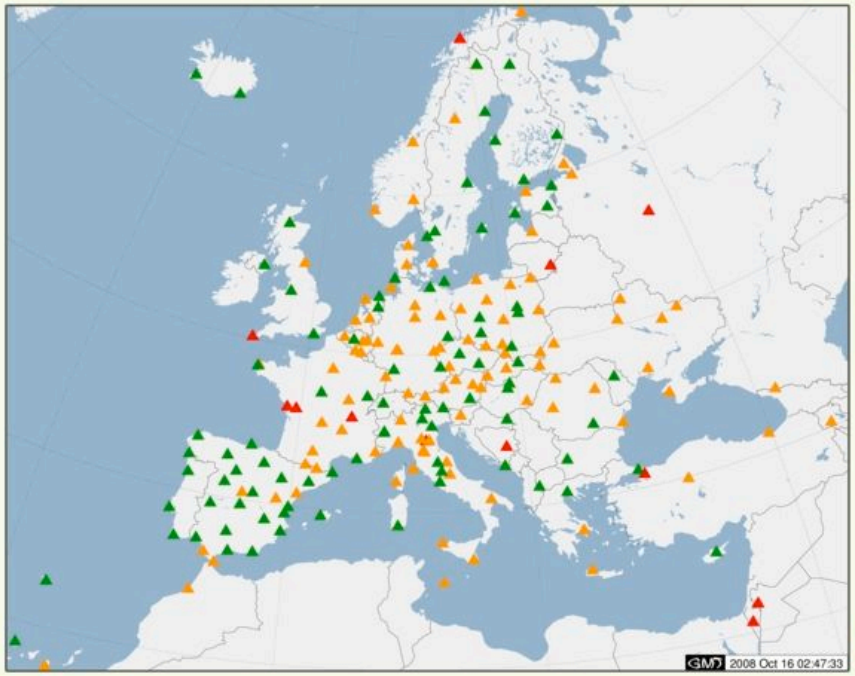
DATA & PRODUCTS > DATA ACCESS

DATA ACCESS



The GNSS data from the EPN stations are freely available through the internet. Depending on the station data policy, daily (mandatory), hourly RINEX (92.2% of the EPN stations), 15min high-rate RINEX (from real-time streams) and real-time (42.2% of the EPN stations) data are made available (see map).

The two Regional Data Centres (RDC), located at BKG (Federal Office of Cartography and Geodesy, Germany) and at OLG (Austrian Academy of Sciences) provide access to the daily and hourly data from all the EPN stations.
The regional EUREF broadcaster www.euref-ip.net makes available the EPN real-time data streams.

green: stations delivering real-time data
orange: stations delivering hourly data
red: stations delivering daily data

Internet

EUREF Permanent GNSS Network > Data & Products > Data Access > Real-time - Windows Internet Explorer

http://www.epncb.oma.be/_dataproducts/data_access/real_time/

Datei Bearbeiten Ansicht Favoriten Extras ?

EUREF Permanent GNSS Network > Data & Products ...

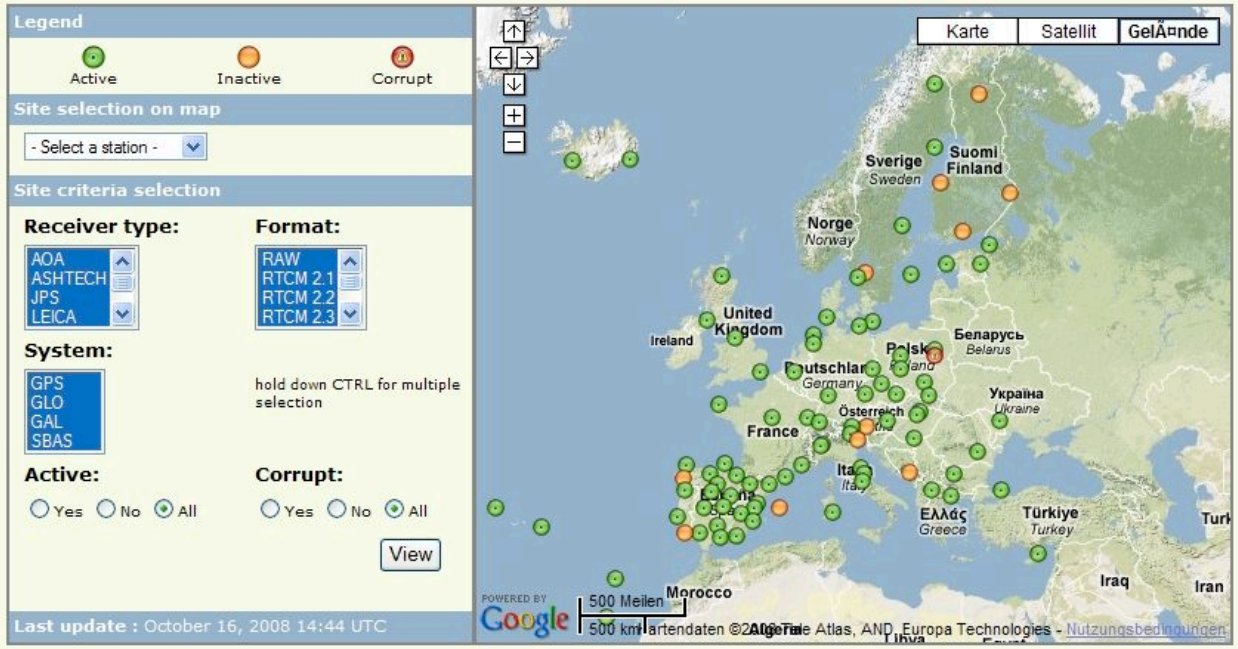
Below you can find details on the **EPN stations providing GNSS data** through the Internet following an open data policy. For more details on the EPN real-time activities, please consult the White Paper on Real-Time GNSS in Routine EPN Operations.

Participating GNSS Stations

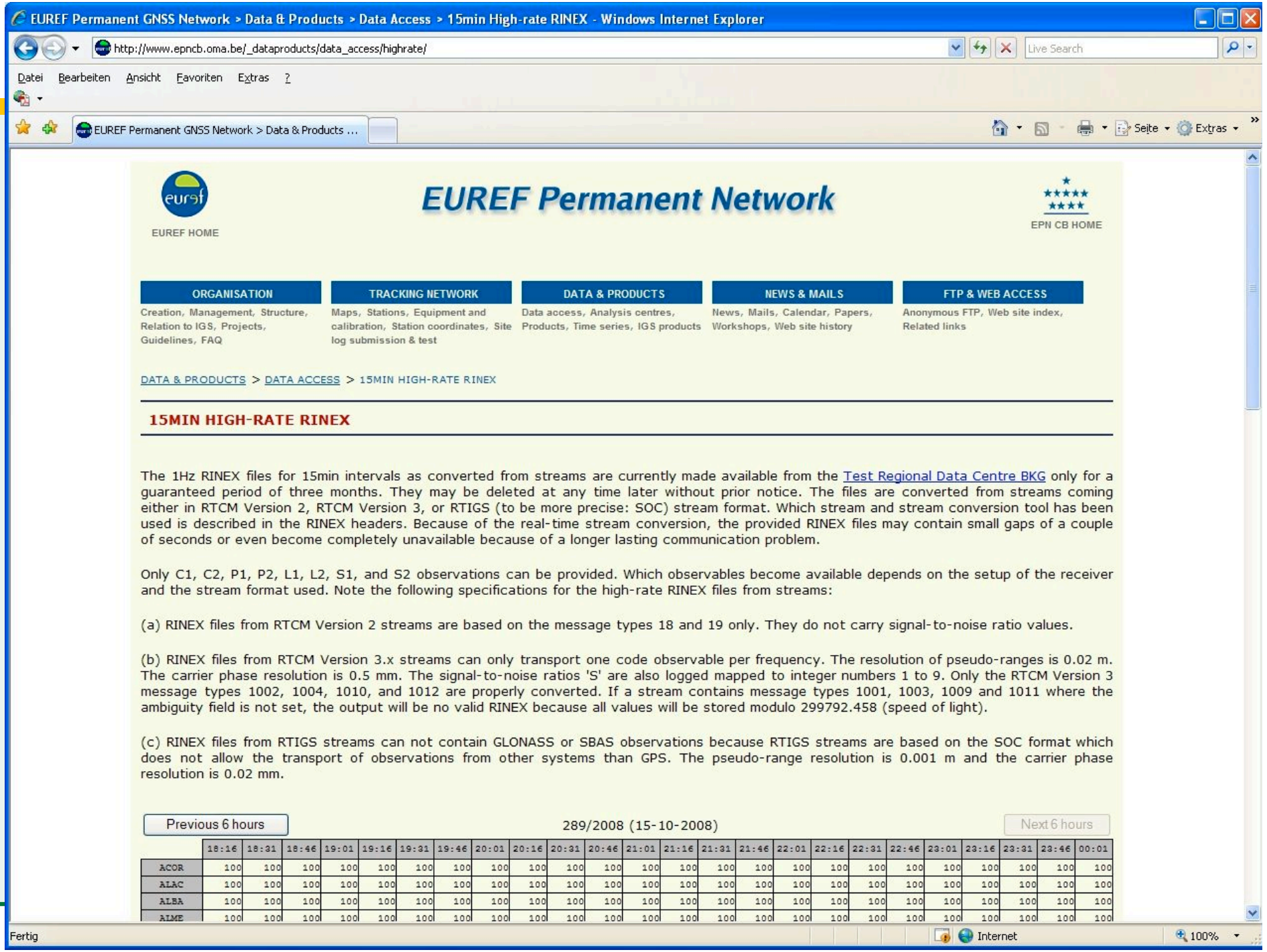
All EPN stations streaming real-time data should follow guidelines specified in Guidelines for EPN Stations and Operational Centres. Depending on the station, the data are made available in different formats: RTCM, SOC or the receiver priopriety format (RPF or RAW). **Operation details for each station are available from here.**
Stations wishing to join the EUREF-IP network should apply to become an EPN station, follow the Procedure for Becoming an EPN Station and register through http://igs.bkg.bund.de/index_ntrip_prov.htm.

Users

To receive the EPN real-time GNSS data streams, free Ntrip client software (available for several platforms) can be downloaded from here after completing the user registration. Authorization (user-ID and password) will be provided by BKG which operates the main (regional) EPN (or EUREF-IP) Broadcaster.



EPN Central Bureau - Royal Observatory of Belgium Disclaimer and Copyright May 30, 2008


EUREF Permanent GNSS Network > Data & Products > Data Access > 15min High-rate RINEX - Windows Internet Explorer
http://www.epncb.oma.be/_dataproducts/data_access/highrate/
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Anonymous FTP, Web site index, Related links
DATA & PRODUCTS > DATA ACCESS > 15MIN HIGH-RATE RINEX
15MIN HIGH-RATE RINEX
The 1Hz RINEX files for 15min intervals as converted from streams are currently made available from the Test Regional Data Centre BKG only for a guaranteed period of three months. They may be deleted at any time later without prior notice. The files are converted from streams coming either in RTCM Version 2, RTCM Version 3, or RTIGS (to be more precise: SOC) stream format. Which stream and stream conversion tool has been used is described in the RINEX headers. Because of the real-time stream conversion, the provided RINEX files may contain small gaps of a couple of seconds or even become completely unavailable because of a longer lasting communication problem.
Only C1, C2, P1, P2, L1, L2, S1, and S2 observations can be provided. Which observables become available depends on the setup of the receiver and the stream format used. Note the following specifications for the high-rate RINEX files from streams:
(a) RINEX files from RTCM Version 2 streams are based on the message types 18 and 19 only. They do not carry signal-to-noise ratio values.
(b) RINEX files from RTCM Version 3.x streams can only transport one code observable per frequency. The resolution of pseudo-ranges is 0.02 m. The carrier phase resolution is 0.5 mm. The signal-to-noise ratios 'S' are also logged mapped to integer numbers 1 to 9. Only the RTCM Version 3 message types 1002, 1004, 1010, and 1012 are properly converted. If a stream contains message types 1001, 1003, 1009 and 1011 where the ambiguity field is not set, the output will be no valid RINEX because all values will be stored modulo 299792.458 (speed of light).
(c) RINEX files from RTIGS streams can not contain GLONASS or SBAS observations because RTIGS streams are based on the SOC format which does not allow the transport of observations from other systems than GPS. The pseudo-range resolution is 0.001 m and the carrier phase resolution is 0.02 mm.
Previous 6 hours
289/2008 (15-10-2008)
Next 6 hours
18:16 18:31 18:46 19:01 19:16 19:31 19:46 20:01 20:16 20:31 20:46 21:01 21:16 21:31 21:46 22:01 22:16 22:31 22:46 23:01 23:16 23:31 23:46 00:01
ACOR 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100
ALAC 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100
ALBA 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100
ALME 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100
Fertig
Internet
100%

(c) RINEX files from RTIGS streams can not contain GLONASS or SBAS observations because RTIGS streams are based on the SOC format which does not allow the transport of observations from other systems than GPS. The pseudo-range resolution is 0.001 m and the carrier phase resolution is 0.02 mm.

The following is a table providing information on the **completeness of 15min high-rate RINEX files** as converted from streams. Each cell covers information concerning 4 consecutive files. Hence it covers the period of one hour with a total number of 3600 epochs. Two numbers are provided per table cell. The first stands for missing epochs, the second for the number of gaps resulting from the missing epochs. Some examples:

- "OK" would mean that non of the 3600 epochs is missing and hence the RINEX files which fall into that 1 hour period do not show any gap.
- "98 5" would mean that observations for 98 epochs are missing, forming a total of 5 gaps.

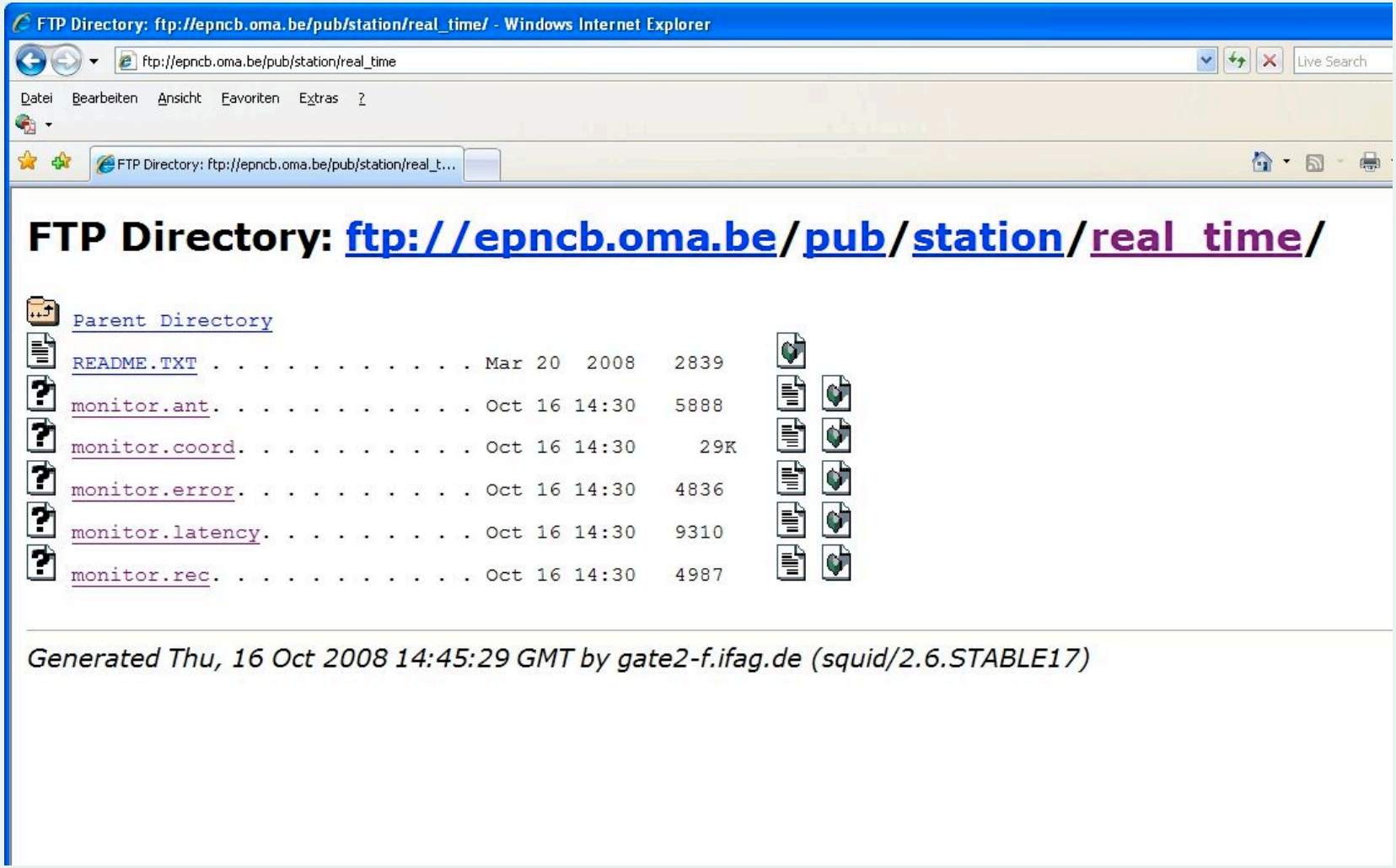
Note the difference between a typical outage situation showing up i.e. as "438 1" and a bottleneck situation resulting from a weak communication link with higher numbers for the missing epochs AND the gaps, i.e. "347 201". Knowing the pattern of missing epochs may be important for operators of post-processing GNSS engines.

Previous 24 hours

Next 24 hours

	289/2008 (15-10-2008)									290/2008 (16-10-2008)														
	15h	16h	17h	18h	19h	20h	21h	22h	23h	00h	01h	02h	03h	04h	05h	06h	07h	08h	09h	10h	11h	12h	13h	14h
ACOR	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	73 1	OK	OK	OK	OK	-	-	1474 1	OK
ALAC	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	-	-	-	-	-	-	-	-	-	-	-	1388 1	OK
ALBA	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	66 1	OK	OK	OK	OK	-	1443 2	OK	OK
ALME	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	56 1	OK	OK	OK	OK	-	-	1300 1	OK
AUT1	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	79 2	539 1	OK	OK	OK	OK
BELF	OK	OK	OK	OK	OK	OK	84 2	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	79 1
BELL	2 1	2 1	OK	2 1	OK	2 1	OK	OK	OK	2 1	OK	OK	OK	8 4	2 1	OK	OK	3 1	2 1	11 3	OK	3 1	4 2	2 1
BOGI	459 459	435 433	385 386	53 53	87 87	83 83	1 1	OK	191 191	35 35	289 289	484 484	505 504	487 486	593 592	159 159	OK	OK	OK	OK	OK	217 216	335 319	223 223
BOR1	OK	OK	OK	149 1	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
BORJ	OK	OK	47 1	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	1 1	OK	-	-	1522 1	OK	OK	OK	OK	OK	OK
BORR	OK	OK	1 1	OK	OK	1 1	OK	OK	OK	OK	OK	OK	OK	OK	OK	54 1	OK	OK	OK	OK	-	-	1297 1	OK
BRST	246 2	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
BRUS	22 22	15 14	37 37	22 22	27 26	16 15	22 22	33 15	17 17	18 18	23 23	20 20	10 10	23 23	38 36	17 17	14 14	13 13	17 17	12 12	14 14	55 42	23 22	19 19
BSCN	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
BUCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUTE	8 1	31 2	25 3	11 2	76 3	9 1	16 2	19 2	8 1	29 1	11 2	30 1	12 2	12 3	18 3	9 3	61 3	11 2	17 2	16 2	OK	OK	13 2	22 2
BZRG	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	218 1	OK	OK
CACE	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	64 1	OK	OK	OK	OK	-	734 1	OK	OK
CAGZ	OK	OK	OK	OK	OK	OK	OK	OK	179 1	OK	OK	OK	OK	OK	OK	OK	OK	1 1	OK	OK	OK	OK	OK	OK
CANT	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	68 1	OK	OK	OK	137 1	-	-	1356 1	OK
CASC	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
COBA	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	47 1	OK	OK	OK	OK	-	822 1	OK	OK
CREU	6 2	2 1	OK	OK	8 4	OK	OK	2 1	6 3	OK	OK	OK	2 1	4 2	3 1	OK	OK	2 1	6 2	10 3	OK	4 2	6 3	OK
DARE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Monitoring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ftp://epncb.oma.be/pub/station/real_time
Live Search
Datei Bearbeiten Ansicht Favoriten Extras ?
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FTP Directory: ftp://epncb.oma.be/pub/station/real_time/
Parent Directory
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monitor.coord. . . . . Oct 16 14:30 29K
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monitor.latency. . . . . Oct 16 14:30 9310
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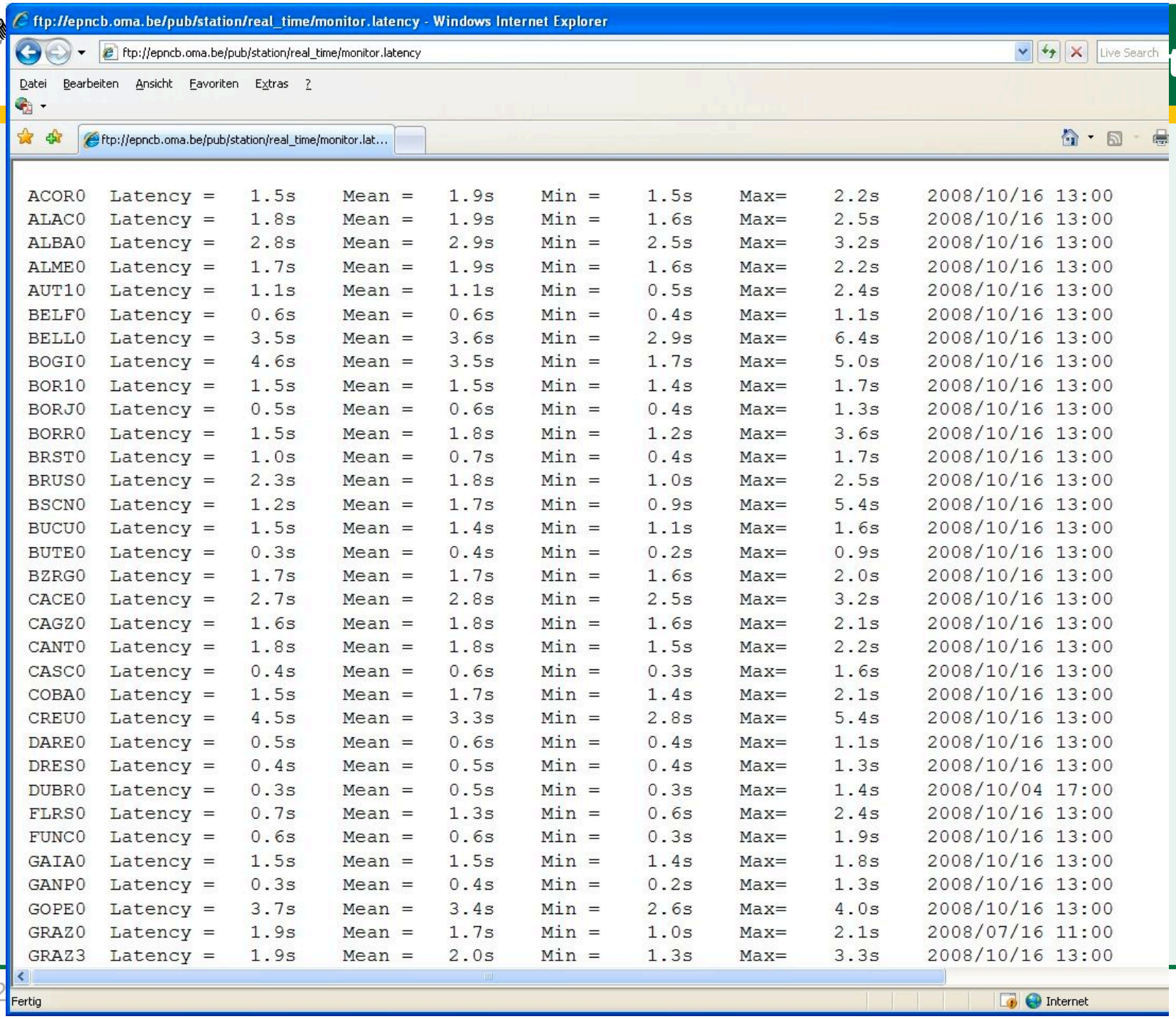
ftp://epncb.oma.be/pub/station/real_time/monitor.latency - Windows Internet Explorer
ftp://epncb.oma.be/pub/station/real_time/monitor.latency
Live Search
Datei Bearbeiten Ansicht Favoriten Extras ?
ftp://epncb.oma.be/pub/station/real_time/monitor.lat...
ACOR0 Latency = 1.5s Mean = 1.9s Min = 1.5s Max= 2.2s 2008/10/16 13:00
ALAC0 Latency = 1.8s Mean = 1.9s Min = 1.6s Max= 2.5s 2008/10/16 13:00
ALBA0 Latency = 2.8s Mean = 2.9s Min = 2.5s Max= 3.2s 2008/10/16 13:00
ALME0 Latency = 1.7s Mean = 1.9s Min = 1.6s Max= 2.2s 2008/10/16 13:00
AUT10 Latency = 1.1s Mean = 1.1s Min = 0.5s Max= 2.4s 2008/10/16 13:00
BELF0 Latency = 0.6s Mean = 0.6s Min = 0.4s Max= 1.1s 2008/10/16 13:00
BELL0 Latency = 3.5s Mean = 3.6s Min = 2.9s Max= 6.4s 2008/10/16 13:00
BOGI0 Latency = 4.6s Mean = 3.5s Min = 1.7s Max= 5.0s 2008/10/16 13:00
BOR10 Latency = 1.5s Mean = 1.5s Min = 1.4s Max= 1.7s 2008/10/16 13:00
BORJ0 Latency = 0.5s Mean = 0.6s Min = 0.4s Max= 1.3s 2008/10/16 13:00
BORR0 Latency = 1.5s Mean = 1.8s Min = 1.2s Max= 3.6s 2008/10/16 13:00
BRST0 Latency = 1.0s Mean = 0.7s Min = 0.4s Max= 1.7s 2008/10/16 13:00
BRUS0 Latency = 2.3s Mean = 1.8s Min = 1.0s Max= 2.5s 2008/10/16 13:00
BSCN0 Latency = 1.2s Mean = 1.7s Min = 0.9s Max= 5.4s 2008/10/16 13:00
BUCU0 Latency = 1.5s Mean = 1.4s Min = 1.1s Max= 1.6s 2008/10/16 13:00
BUTE0 Latency = 0.3s Mean = 0.4s Min = 0.2s Max= 0.9s 2008/10/16 13:00
BZRG0 Latency = 1.7s Mean = 1.7s Min = 1.6s Max= 2.0s 2008/10/16 13:00
CACE0 Latency = 2.7s Mean = 2.8s Min = 2.5s Max= 3.2s 2008/10/16 13:00
CAGZ0 Latency = 1.6s Mean = 1.8s Min = 1.6s Max= 2.1s 2008/10/16 13:00
CANT0 Latency = 1.8s Mean = 1.8s Min = 1.5s Max= 2.2s 2008/10/16 13:00
CASC0 Latency = 0.4s Mean = 0.6s Min = 0.3s Max= 1.6s 2008/10/16 13:00
COBA0 Latency = 1.5s Mean = 1.7s Min = 1.4s Max= 2.1s 2008/10/16 13:00
CREU0 Latency = 4.5s Mean = 3.3s Min = 2.8s Max= 5.4s 2008/10/16 13:00
DARE0 Latency = 0.5s Mean = 0.6s Min = 0.4s Max= 1.1s 2008/10/16 13:00
DRES0 Latency = 0.4s Mean = 0.5s Min = 0.4s Max= 1.3s 2008/10/16 13:00
DUBR0 Latency = 0.3s Mean = 0.5s Min = 0.3s Max= 1.4s 2008/10/04 17:00
FLRS0 Latency = 0.7s Mean = 1.3s Min = 0.6s Max= 2.4s 2008/10/16 13:00
FUNC0 Latency = 0.6s Mean = 0.6s Min = 0.3s Max= 1.9s 2008/10/16 13:00
GAIA0 Latency = 1.5s Mean = 1.5s Min = 1.4s Max= 1.8s 2008/10/16 13:00
GANP0 Latency = 0.3s Mean = 0.4s Min = 0.2s Max= 1.3s 2008/10/16 13:00
GOPE0 Latency = 3.7s Mean = 3.4s Min = 2.6s Max= 4.0s 2008/10/16 13:00
GRAZ0 Latency = 1.9s Mean = 1.7s Min = 1.0s Max= 2.1s 2008/07/16 11:00
GRAZ3 Latency = 1.9s Mean = 2.0s Min = 1.3s Max= 3.3s 2008/10/16 13:00
Fertig
Internet

To do

- Motivate remaining EPN station managers to participate, preferably with carrier phase data (EUREF resolution #4, 2005)
- Setup other euref-ip broadcasters
- Continue with real-time analysis activities, e.g., by the establishment of a new EPN Special Project