

Status and Performance of the EUREF Permanent Tracking Network

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*EPN Central Bureau
Royal Observatory of Belgium*

OUTLINE

- EPN Tracking Network
- Antenna Calibrations
- Requirements for new EPN Stations
- Summary & Future Plans

210 permanent GNSS stations

32 % GPS+GLONASS,

91 % hourly,

42 % real-time,

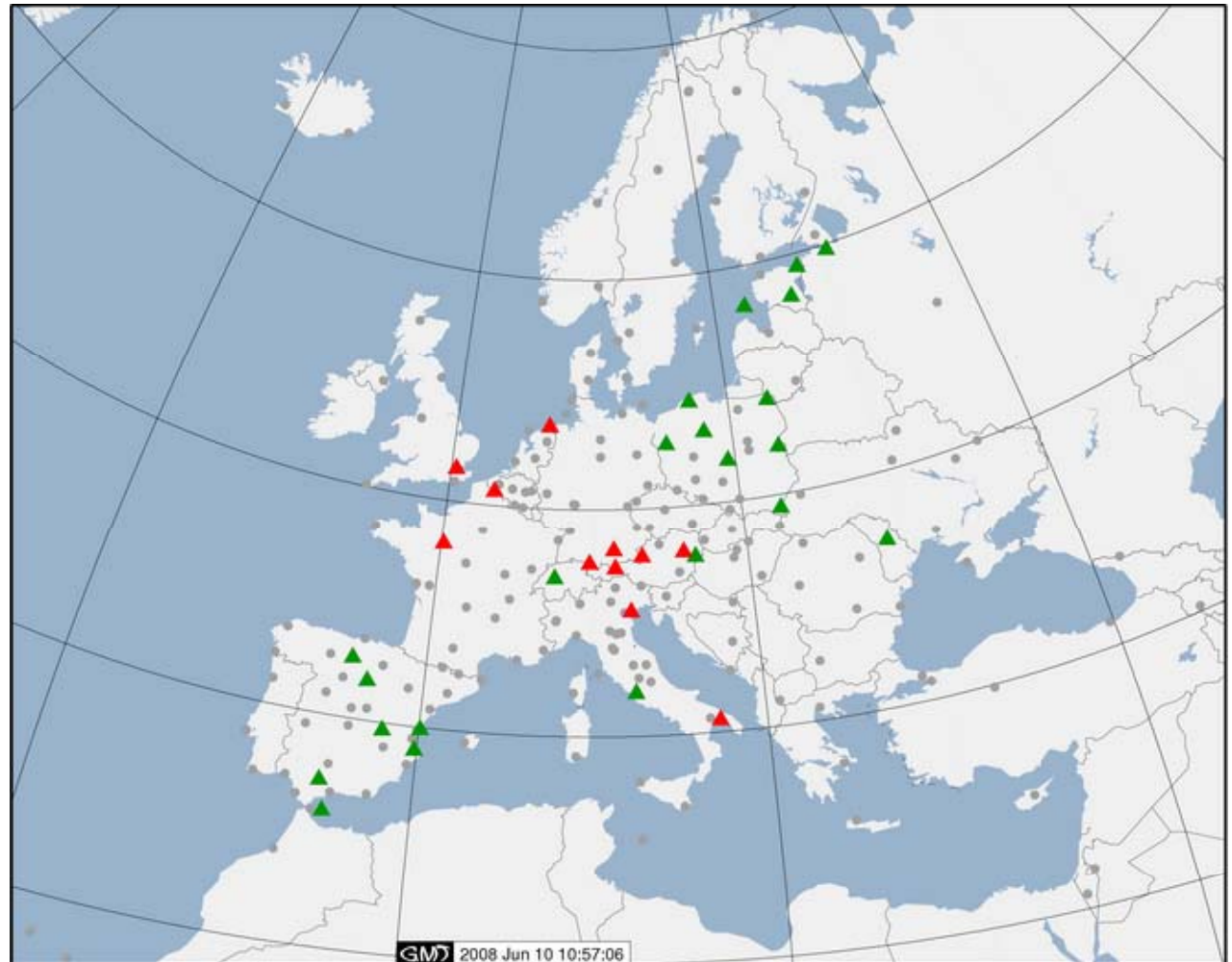
39 % IGS

38 countries

Since June 2007:

22 new EPN stations

11 stations removed
from network



NEW EPN STATIONS

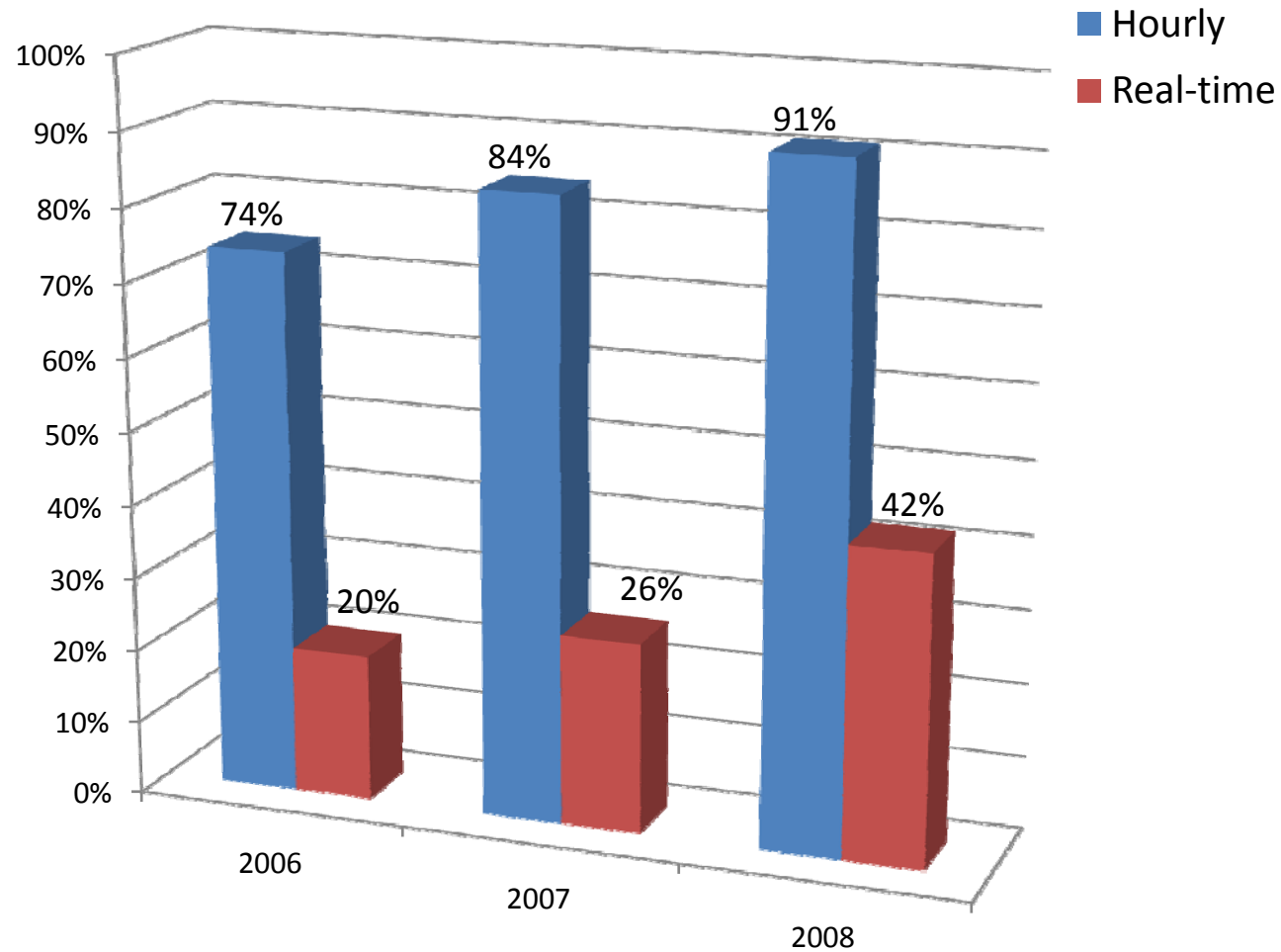
MOSE	Roma, Italy	RT	Type	01/07/2007
SPRN	Sopron, Hungary		Type	22/07/2007
ZIM2	Zimmerwald, Switzerland	RT GLO	Indiv	16/12/2007
IGEO	Chisinau, Republic of Moldova	RT	Type	05/08/2007
ALBA	Albacete, Spain	RT	Type	09/09/2007
HUEL	Huelva, Spain	RT	Type	09/09/2007
LEON	Leon, Spain	RT	Type	09/09/2007
SONS	Sonseca, Spain	RT	Type	09/09/2007
BORR	Borriana, Spain	RT	Type	21/10/2007
CEU1	Ceuta, Spain		Type	09/03/2008
VALA	Valladolid, Spain	RT GLO	Type	20/04/2008
KURE	Kuressaare, Estonia	RT	Type	27/04/2008
TOIL	Toila, Estonia	RT GLO	Type	27/04/2008
TORA	Tõravere, Estonia	RT GLO	Type	27/04/2008
PULK	St.Petersburg, Russia		Type	18/05/2008
BPDL	Biala Podlaska, Poland	GLO	Indiv.	08/06/2008
BYDG	Bydgoszcz, Poland	GLO	Indiv.	08/06/2008
GWWL	Gorzow Wielkopolski, Poland	GLO	Indiv.	08/06/2008
LODZ	Lodz, Poland	GLO	Indiv	08/06/2008
REDZ	Redzikowo, Poland	GLO	Indiv.	08/06/2008
SWKI	Suwalki, Poland	GLO	Indiv.	08/06/2008
USDL	Ustrzyki Dolne, Poland	GLO	Indiv.	08/06/2008

EPN STATIONS REMOVED FROM NETWORK

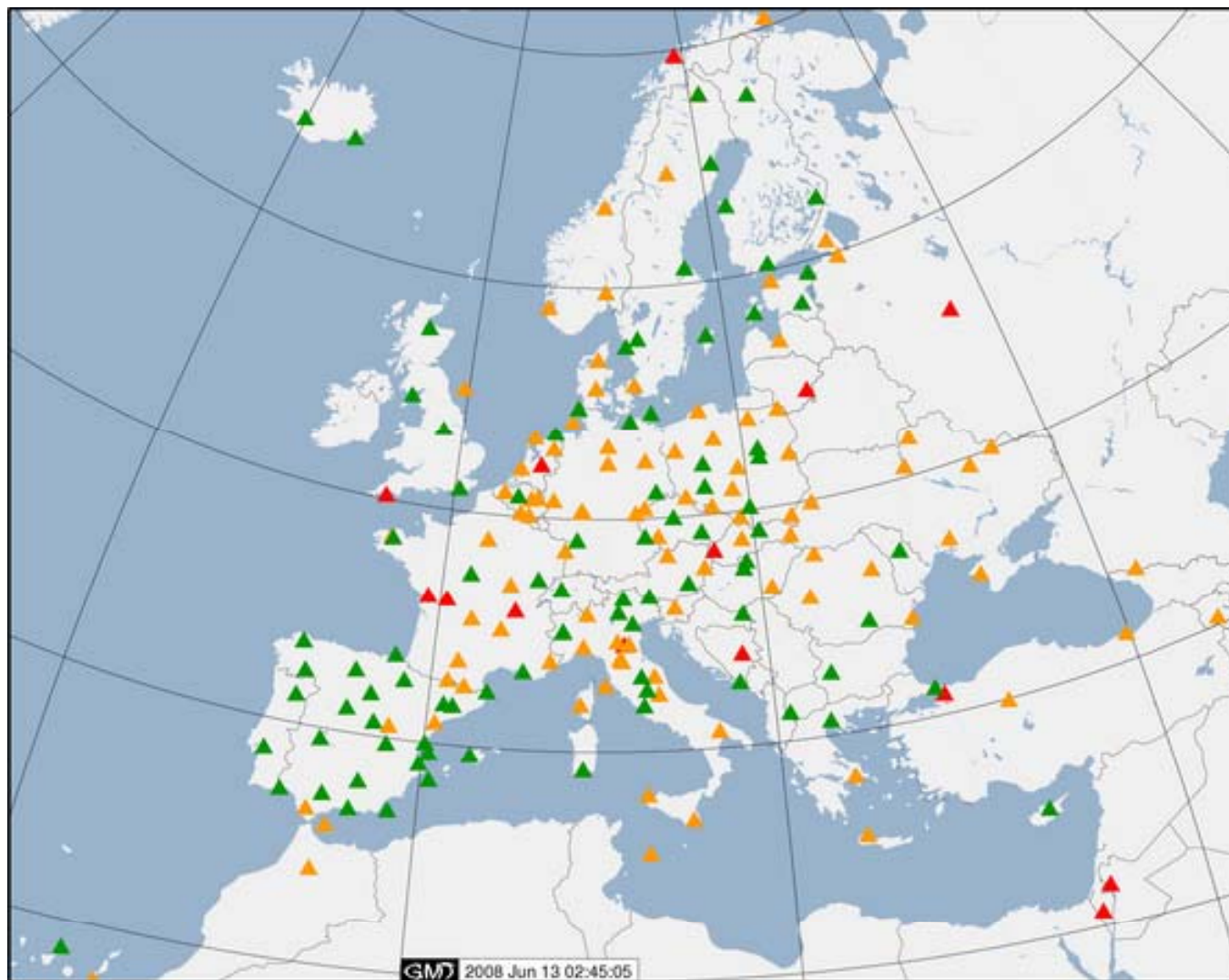
BORK	Borkum, Germany	June 6, 2007
LILL	Villeneuve d'Ascq, France	June 30, 2007
HFLK	Hafelekar, Austria	July 7, 2007
VE NE	Venezia, Italy	July 28, 2007
PFAN	Pfänder, Austria	Dec. 1, 2007
MANS	Le Mans, France	Jan. 26, 2008
NPLD	Teddington, United Kingdom	Feb 2, 2008
SBGZ	Salzburg, Austria	Feb 2, 2008
TRFB	Pernitz, Austria	Feb 2, 2008
OBE2	Oberpfaffenhofen, Germany	Feb 9, 2008
FATA	Taranto, Italy	Feb 23, 2008

Monument: instability, destruction,

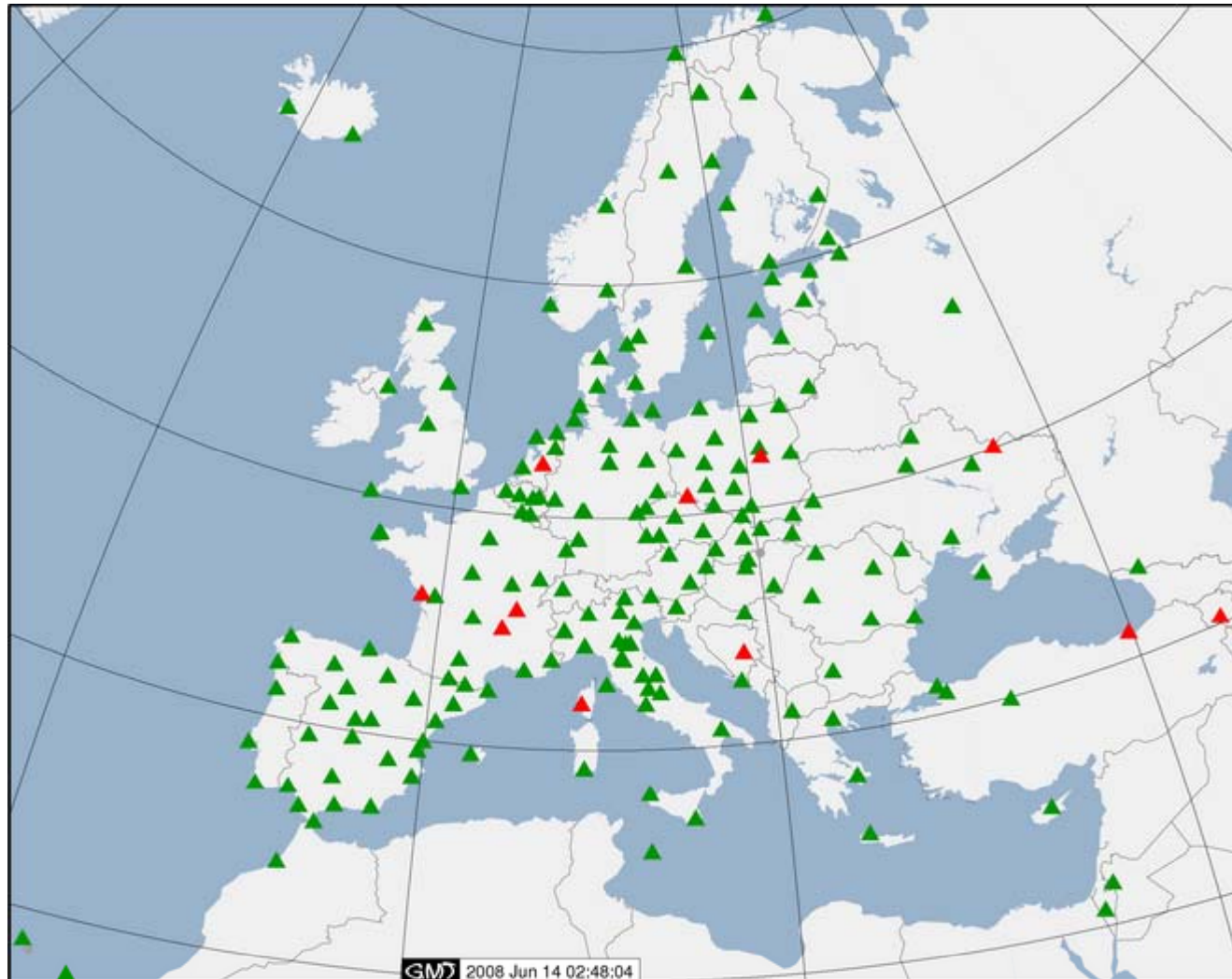
EPN STATIONS PROVIDING HOURLY OR REAL-TIME DATA



Real-time (42%)
Hourly (91%)
Daily
(99% at BKG 95% at OLG)



AVAILABILITY OF DAILY RINEX DATA



Availability of daily
RINEX data
Last 14 days

90% < ??

80% < ?? < 90%

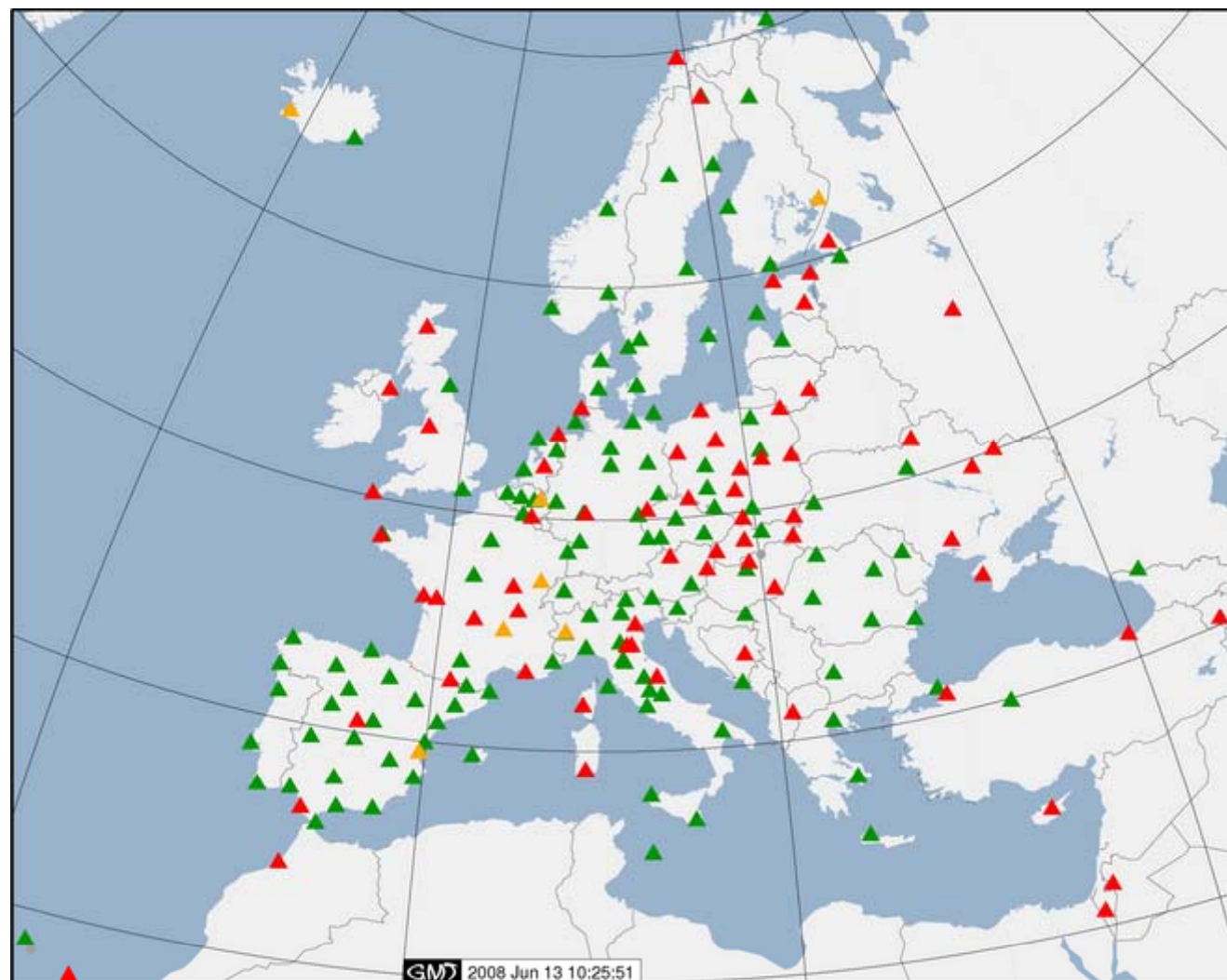
?? < 80%

Hourly data latency
Below 10 min.

90% < ??

80% < ?? < 90%

?? < 80%



ORGANISATION	TRACKING NETWORK	DATA & PRODUCTS	NEWS & MAILS	FTP & WEB ACCESS
Creation, Management, Structure, Relation to IGS, Projects, Guidelines, FAQ	Maps, Stations, Equipment and calibration, Station coordinates, Site log submission & test	Data access, Analysis centres, Products, Time series, IGS products	News, Mails, Calendar, Papers, Workshops, Web site history	Anonymous FTP, Web site index, Related links

WELCOME !

EUREF Symposium 2008: Brussels / Belgium - June 18-21

The [European Terrestrial Reference System 89](#) (ETRS89) is used as the standard precise GPS coordinate system throughout Europe. Supported by [EuroGeographics](#) and endorsed by the EU, this reference system forms the backbone for all geographic and geodynamic projects on the European territory both on a national as on an international level.



The ETRS89 is maintained by the IAG sub-commission [EUREF](#) and it is accessed through the EUREF Permanent Network (EPN), a science-driven network of continuously operating GPS reference stations with precisely known coordinates in the ETRS89.

All contributions to the EPN are voluntary, with more than 100 European agencies/universities involved, and the reliability of the network is based on redundancy and extensive guidelines guaranteeing the quality of the raw GPS data to the resulting station positions. Next to its key role in the maintenance of the ETRS89, the EPN data are also used for a wide range of scientific applications such as the monitoring of ground deformations, sea level, space weather and numerical weather prediction.

This web site is part of the EPN Central Bureau Information System, providing both EPN member organizations and the public with information about the EPN organization, the EPN network of stations, and EPN data & products.

Whenever your use of EPN data or products results in a publication, please include a [citation](#).

The Central Bureau is sponsored by the [Belgian Federal Science Policy](#) and managed by the [Royal Observatory of Belgium](#).

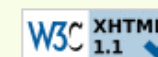
[EPN Central Bureau](#)
Royal Observatory of Belgium
Avenue Circulaire, 3
B-1180 Brussels, Belgium

Phone :
Fax :
E-mail : epncb@oma.be

[Download EPN flyer](#)

Quick link to site information :

(select a station)



GNSS Data (RINEX, RTCM, ...)

DAILY

FORMAT : RINEX, 30 sec, Hatanaka compressed
ACCESS : free

DOWNLOAD DATA

June 2008							
Wk No	Sun	Mon	Tue	Wed	Thu	Fri	Sat
1482	01 (153)	02 (154)	03 (155)	04 (156)	05 (157)	06 (158)	07 (159)
1483	08 (160)	09 (161)	10 (162)	11 (163)	12 (164)	13 (165)	14 (166)
1484	15 (167)	16 (168)	17 (169)	18 (170)	19 (171)	20 (172)	21 (173)
1485	22 (174)	23 (175)	24 (176)	25 (177)	26 (178)	27 (179)	28 (180)
1486	29 (181)	30 (182)					

META DATA ERRORS

Header of the RINEX observation files

DATA CENTRES STATUS

BKGI (primary)	Online.
CDDIS	Online. No data detected for REYK since 2005/069 (1191 days).
IGNI	Online. No data detected for REYK since 2005/100 (1160 days).
OLG (secondary)	Online.

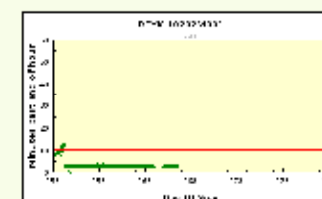
HOURLY

FORMAT : RINEX, 30 sec, Hatanaka compressed
ACCESS : free

DOWNLOAD DATA

BKGI
CDDIS
GOP
IGNI
OLG

DATA LATENCY



REAL-TIME

STREAM : REYK0
FORMAT : RTCM 3.0 - 1004(1),1006(10),1007(10),1012(1),1019,1020
ACCESS : free
DOWNLOAD : available from www.euref-ip.net:2101

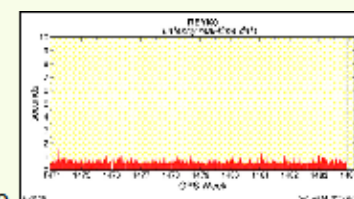
STREAM CONTENT WARNINGS :

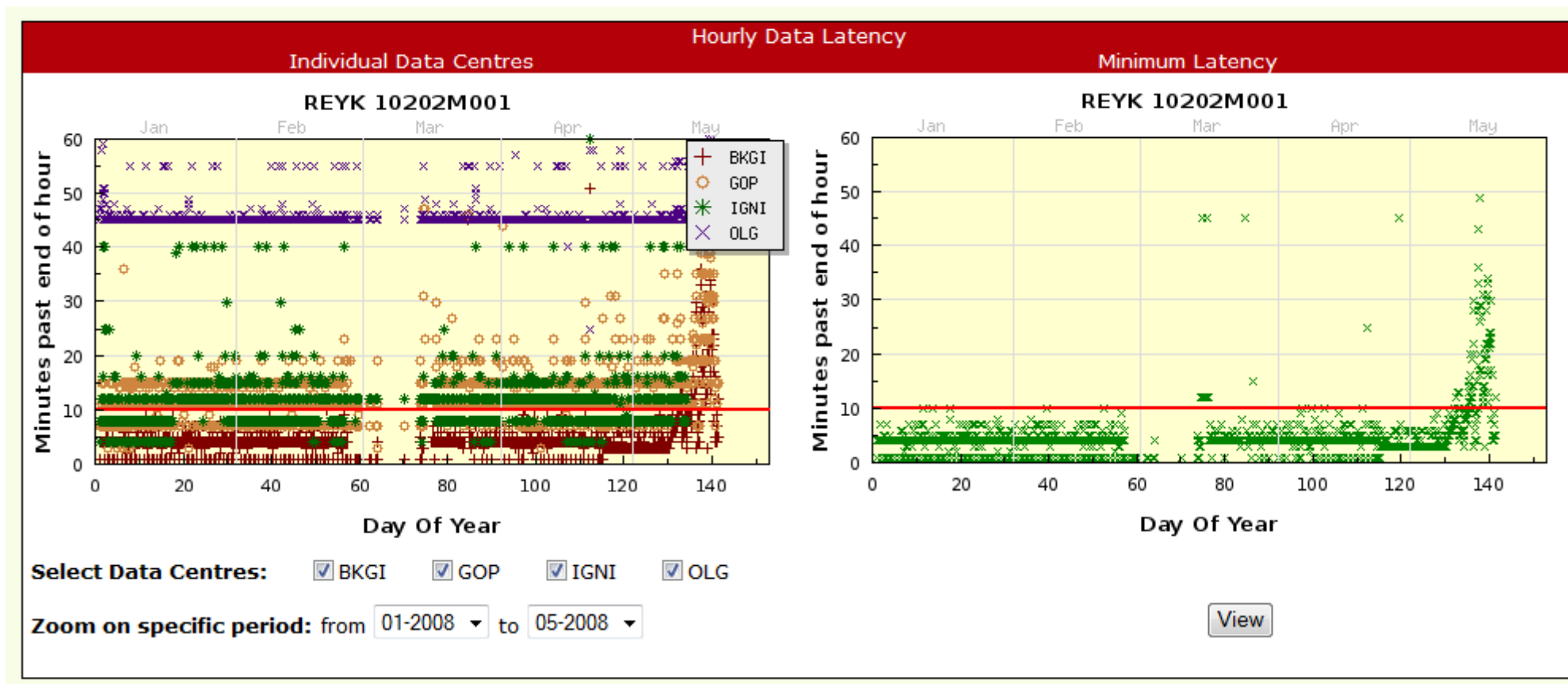
- Message Type 1006: Coordinate difference with ETRS89 (0.2417m) exceeds threshold
- Message Type 1007: Incorrect Antenna/Radome type (TPSCR.G3 TPS) compared to site log (TPSCR.G3 TPSPH)

Download [software](#).

Full list of EPN stations providing real-time data available

DATA LATENCY







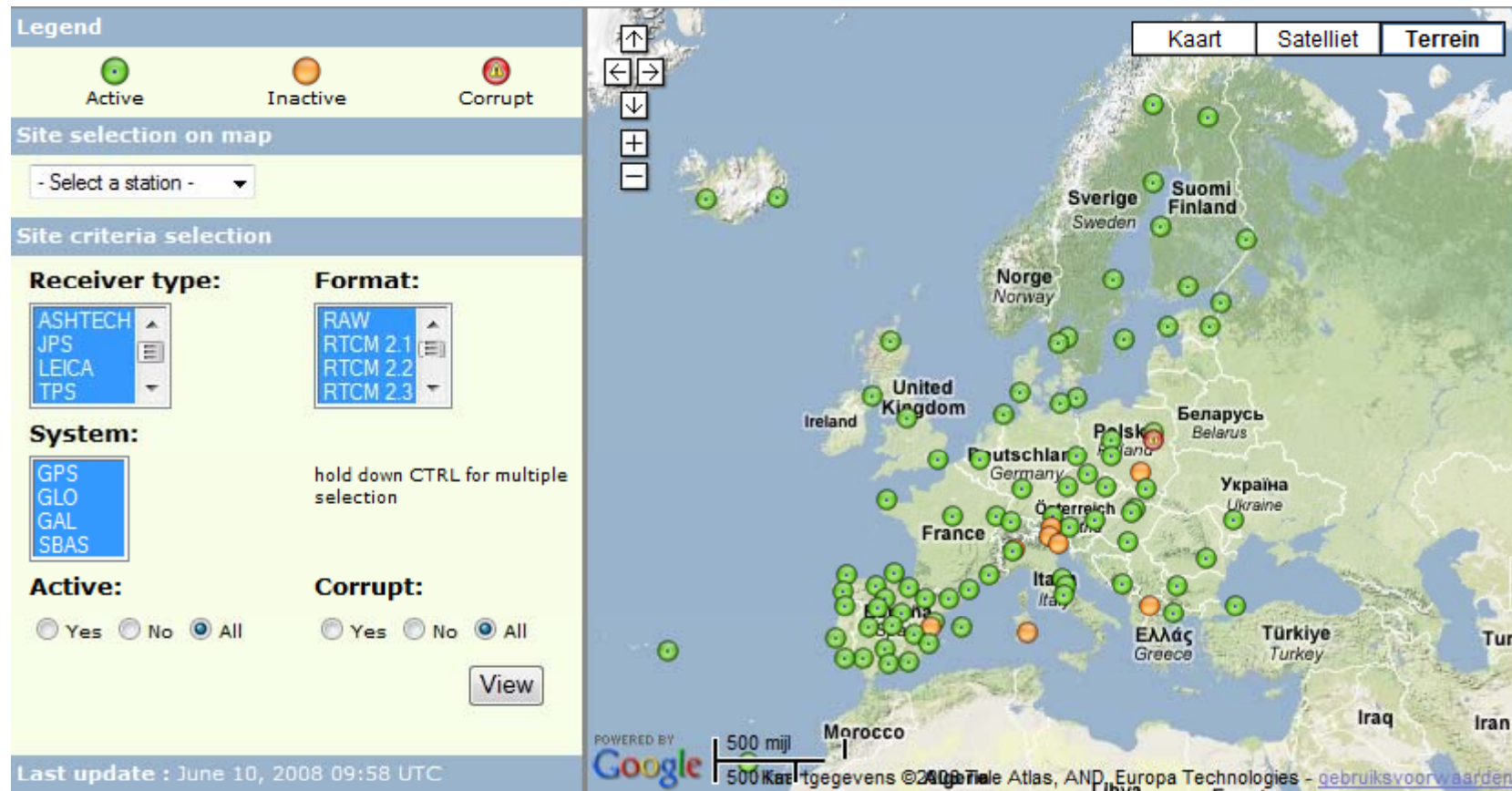
REAL-TIME EPN DATA STREAMS

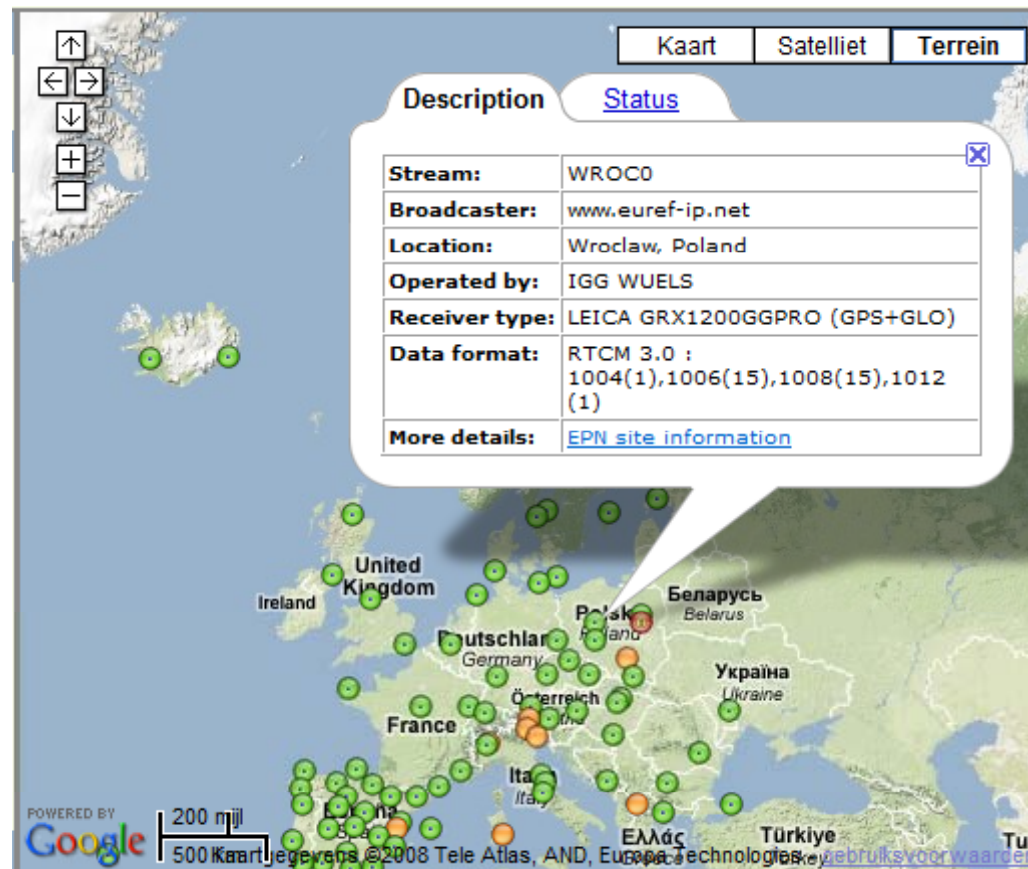


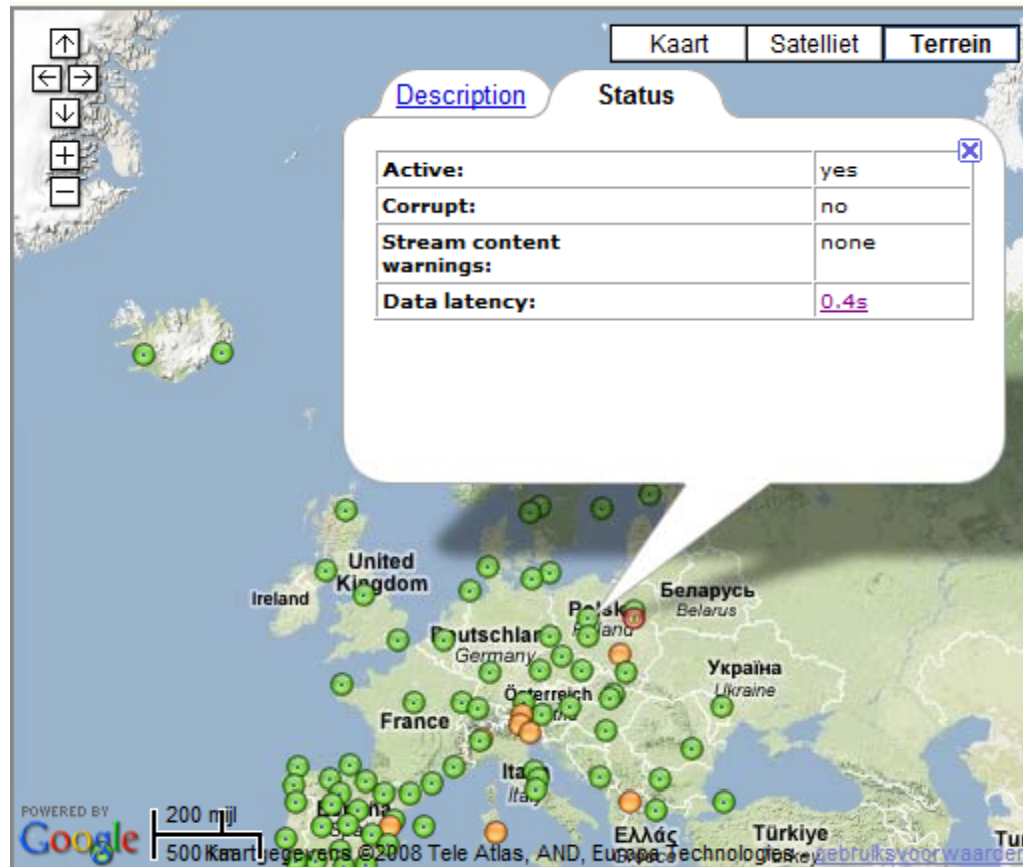
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Creation, Management, Structure, Relation to IGS, Projects, Guidelines, FAQ	Maps, Stations, Equipment and calibration, Station coordinates, Site log submission & test	Data access, Analysis centres, Products, Time series, IGS products	News, Mails, Calendar, Papers, Workshops, Web site history	Anonymous FTP, Web site index, Related links

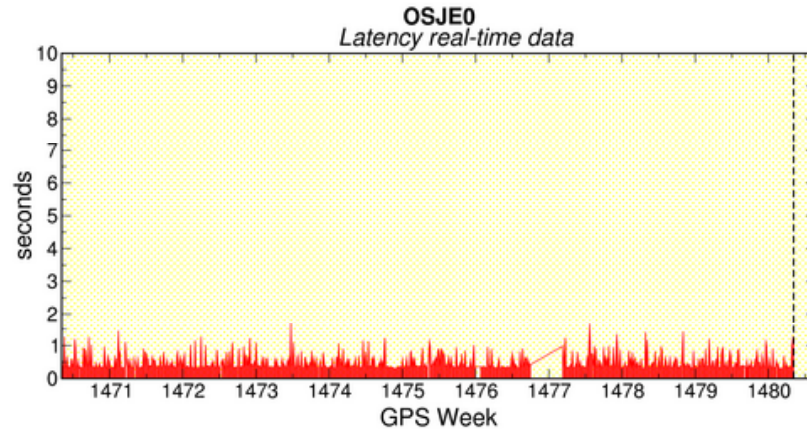
EUREF-IP Pilot Project (2002-2007)

Real-time data streams : now part of routine EPN operations.

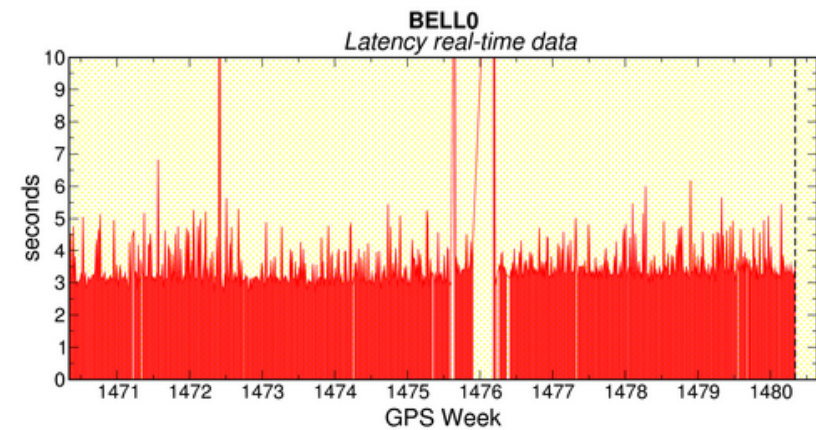
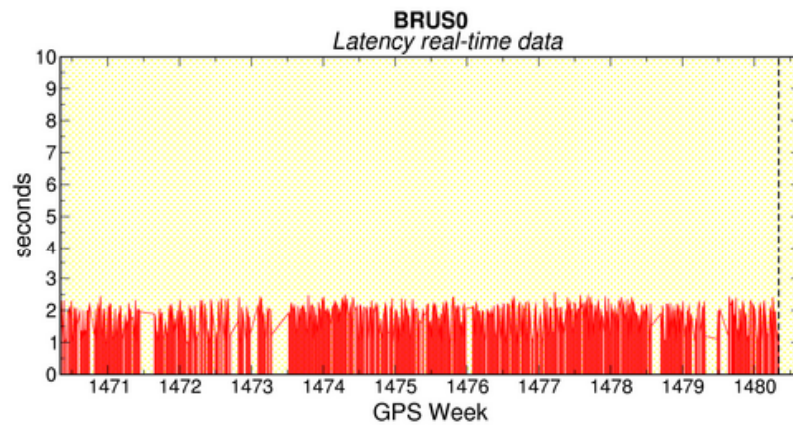








OSJE (Croatia)	RTCM3.0	0.5 s
BRUS (Belgium)	RTIGS	1.8 s
BELL (Spain)	RTCM3.0	3.5 s



REAL-TIME EPN DATA STREAMS

Stream ▲	City	Country	Format	Receiver	Latency	Operator	Bitrate	System
ACOR0	A Coruna	Spain	RTCM 2.3 1(1),2(60),3(10),18(1),19(1),22(10),23(10),24(10)	LEICA GRX1200PRO	<u>1.6s</u>	IGN-E	3000	GPS
ALAC0	Alicante	Spain	RTCM 2.3 1(1),3(10),18(1),19(1),22(10),23(10),24(10),59(10)	TRIMBLE NETRS	<u>1.7s</u>	IGN-E	5000	GPS
ALBA0	Albacete	Spain	RTCM 2.1 1(1),3(10),16(30),18(1),19(1),59(5)	TRIMBLE 4000SSI	<u>2.8s</u>	IGN-E	5000	GPS
ALME0	Almeria	Spain	RTCM 2.3 1(1),3(10),18(1),19(1),22(10),23(10),24(10),59(10)	TRIMBLE NETRS	<u>1.9s</u>	IGN-E	4000	GPS
AUT10	Thessaloniki	Greece	RTCM 3.0 1004(1),1006(10),1008(10)	LEICA GRX1200PRO	<u>1.1s</u>	DGS	1500	GPS
BELF0	Belfast	United Kingdom	RTCM 3.1 1004(1),1006(15),1008(15),1012(1)	LEICA GRX1200GGPRO	<u>0.7s</u>	OSNI	2900	GPS+GLO
BELLO	Bellmunt de Segarra	Spain	RTCM 3.0 1004(1),1005(5),1008(5)	TRIMBLE NETRS	<u>3.5s</u>	ICC	6000	GPS
BOGI0	Borowa Gora	Poland	RTCM 2.1 3(10),18(1),19(1),22(10)	JPS E_GGD	<u>1.8s</u>	IGIK	4000	GPS+GLO
BOR10	Borowiec	Poland	RTCM 2.3 1(1),3(10),18(1),19(1),22(10)	TRIMBLE NETRS	<u>1.4s</u>	SRC PAS	2400	GPS
BORJ0	Borkum (Island of Borkum)	Germany	RTCM 3.0 1004(1),1006(10),1007(10),1012(1),1019,1020	JPS LEGACY	<u>0.5s</u>	BKG	2400	GPS+GLO
BORR0	Borriana	Spain	RTCM 3.0 1004(1),1005(5),1008(5)	TRIMBLE R7	<u>1.9s</u>	ICV	6000	GPS
BRST0	Brest	France	RTCM 3.0 1004(1),1006(15),1008(15)	LEICA GRX1200PRO	<u>2.9s</u>	IGN	2000	GPS
BRUS0	Brussels	Belgium	RTIGS SOC(1)	ASHTech Z- XII3T	<u>1.4s</u>	ROB	1300	GPS
BSCN0	Besançon	France	RTCM 3.0 1004(1),1006(15),1008(15)	LEICA RS500	<u>1.2s</u>	IGN-SGN	2000	GPS
BUCU0	Bucuresti	Romania	RAW MBEN(1)	ASHTech Z-XII3	<u>1.3s</u>	BKG	6300	GPS
BUTE0	Budapest	Hungary	RTCM 3.0 1004(1),1006(10),1008(10),1012(1),1013(10)	TRIMBLE NETR5	<u>0.8s</u>	DGS BUTE	3000	GPS+GLO
BZRG0	Bolzano - Bozen	Italy	RTCM 2.3 3(15),18(1),19(1),22(15),23(15),24(15)	LEICA GRX1200GGPRO	<u>23.0s</u>	GpsBZ	3600	GPS+GLO
CACE0	Caceres	Spain	RTCM 2.1 1(1),3(10),16,18(1),19(1)	TRIMBLE 4000SSI	<u>2.5s</u>	IGN-E	5000	GPS
CAGZ0	Capoterra	Italy	RTCM 2.1 1(3),3(60),16(60),18(1),19(1),31(3)	TPS E_GGD	<u>1.7s</u>	DIST-Cagliari	3900	GPS+GLO
CANT0	Santander	Spain	RTCM 2.3 1(1),3(10),18(1),19(1),22(10),23(10),24(10),59(10)	TRIMBLE NETRS	<u>1.7s</u>	IGN-E	5000	GPS
CASC0	Cascais	Portugal	RTCM 3.0 1004(1),1006(60),1008(60),1012(1)	LEICA GRX1200GGPRO	<u>0.4s</u>	IGP	3000	GPS+GLO
COBA0	Cordoba	Spain	RTCM 2.3 1(1),2(60),3(10),18(1),19(1),22(10),23(10),24(10)	LEICA GRX1200PRO	<u>1.7s</u>	IGN-E	5000	GPS
CREU0	Cadaques	Spain	RTCM 3.0 1004(1),1005(5),1008(5)	TRIMBLE NETRS	<u>3.0s</u>	ICC	700	GPS
DARE0	Daresbury	United Kingdom	RAW LB2(1)	LEICA RS500	<u>0.6s</u>	OS	4000	GPS
DRES0	Dresden	Germany	RTCM 3.0 1004(1),1006(10),1007(10),1012(1),1019,1020	JPS LEGACY	<u>0.7s</u>	BKG	2400	GPS+GLO

New EPN guidelines (Dec 2006):

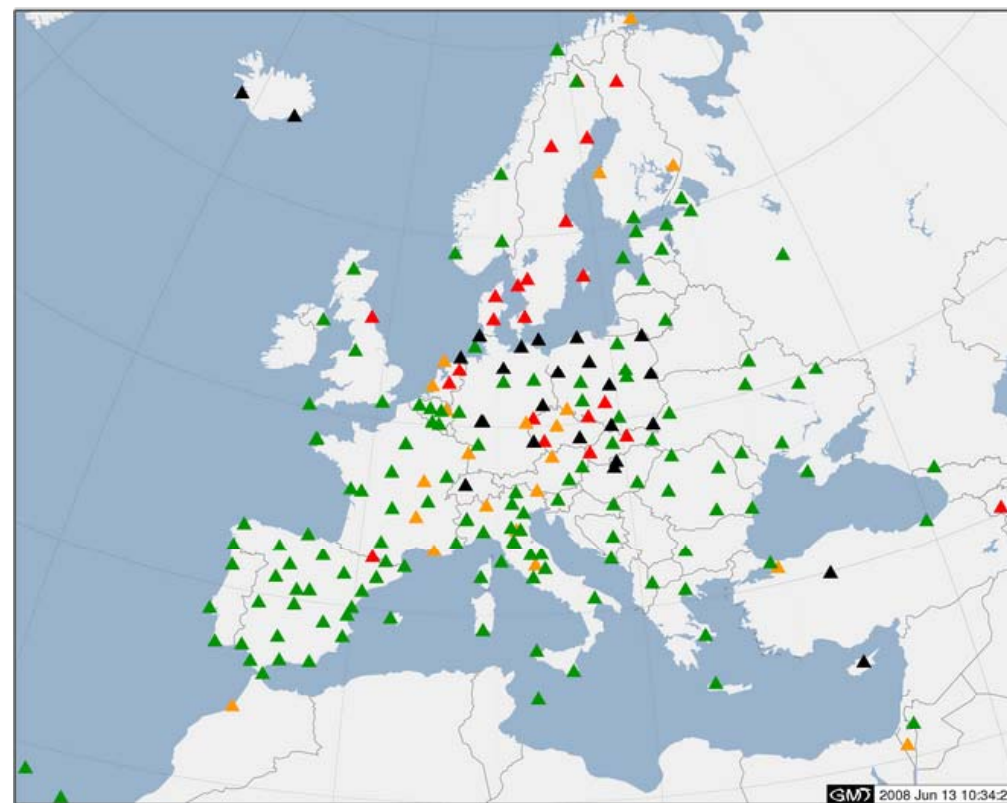
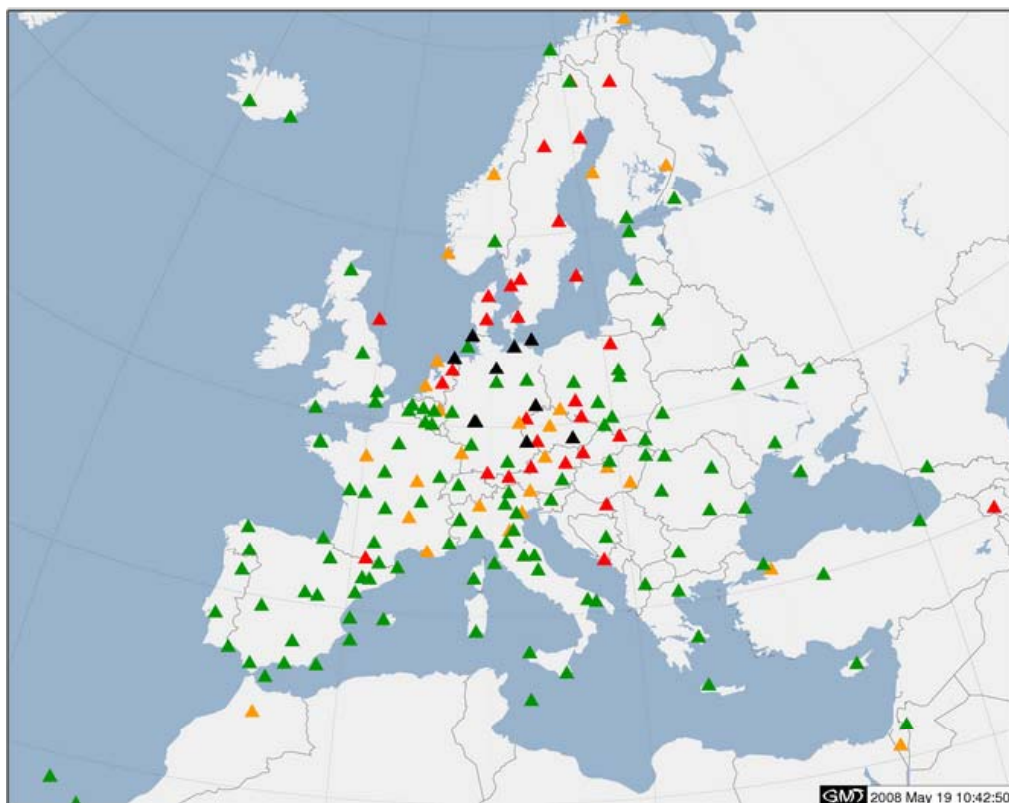
- All antenna/radome combinations introduced within EPN station after Dec 5, 2006 must have TRUE absolute calibrations (taking radome into account).
- Use IGS ATX complemented with absolute individual antenna/radome calibrations for EPN stations

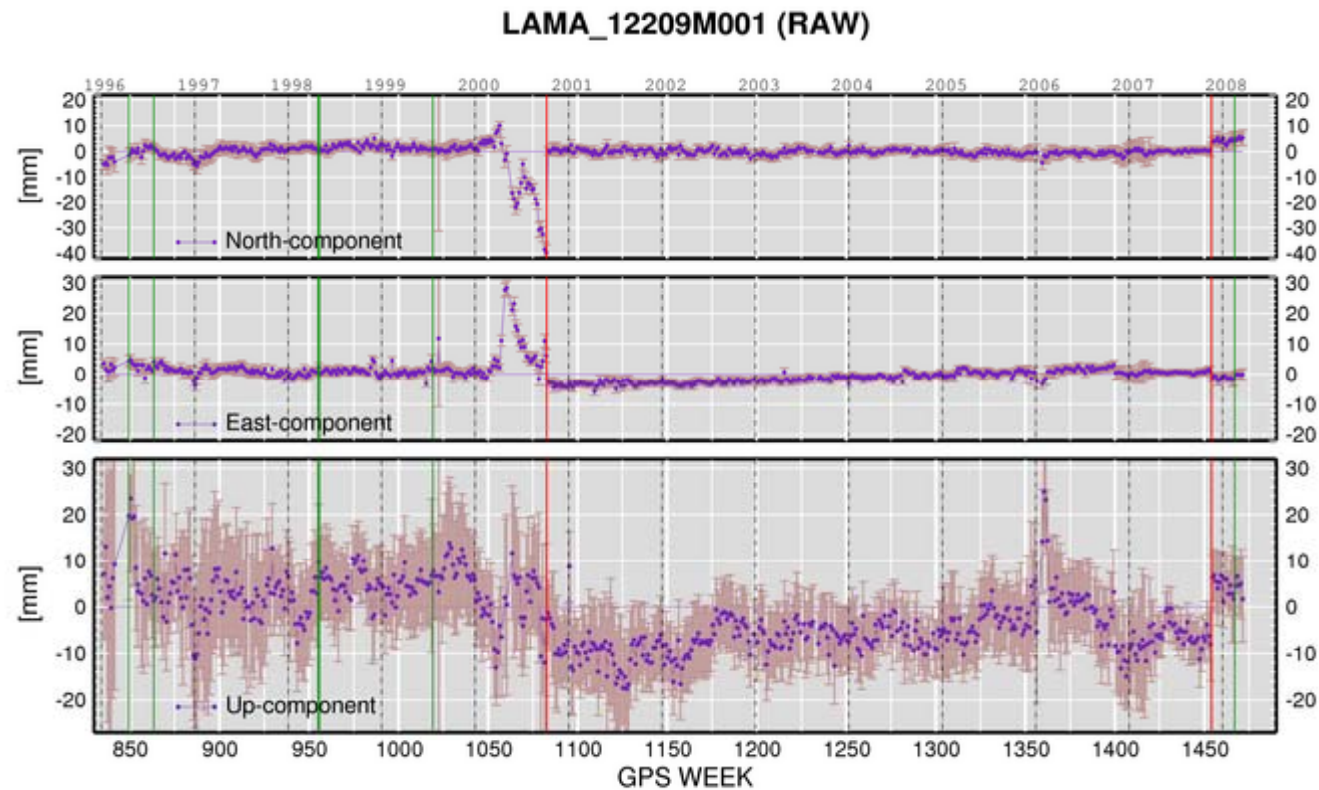
Dec. 2006

Indiv. abs. calib.	5%	
True abs.calib	64%	69%
Calib. from field	14%	
No calib.	17%	

June 2008

Indiv. abs. calib	12%	
True abs. calib	66 %	78%
Calib. from field	11%	
No calib.	11%	





Miami, June 6, 2008

At IGS stations, it should no longer be allowed to install antenna types or antenna/radome combinations that are not absolutely calibrated. If a new station is set up or an old antenna is replaced, station operators are asked to choose an antenna type that shows a robot calibration (or the consistent results of a different calibration procedure of comparable quality) within the IGS antenna calibration file or to provide an absolute calibration.

EPN CB Verifications

	Daily	Hourly	Real-time
Availability	x	x	x
Latency	x	x	x
Meta-data	x		x
Quality	x		

Daily & hourly metrics

90% availability requested in 2 RDC
90% below 10 min. latency (hourly)
Last 7 days

Real-time metrics

90% availability at regional broadcaster
Latency: Simulate user and download stream
using 2-hour samples

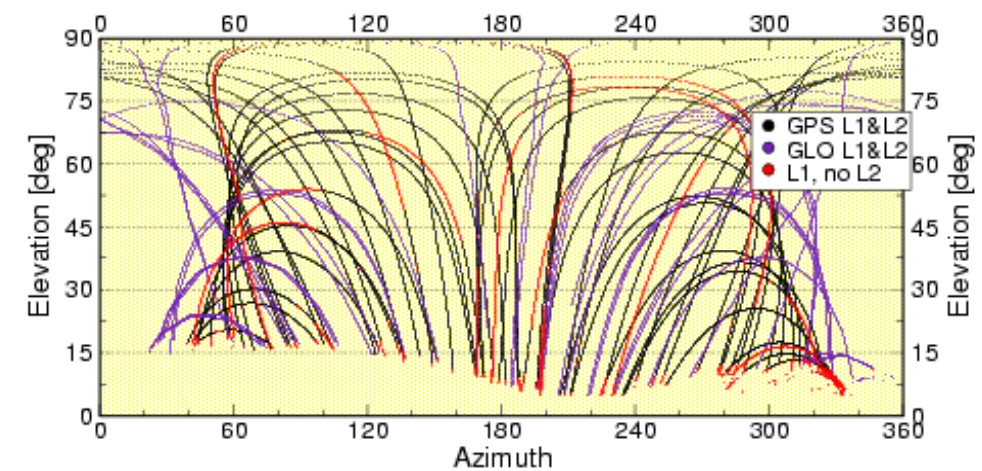
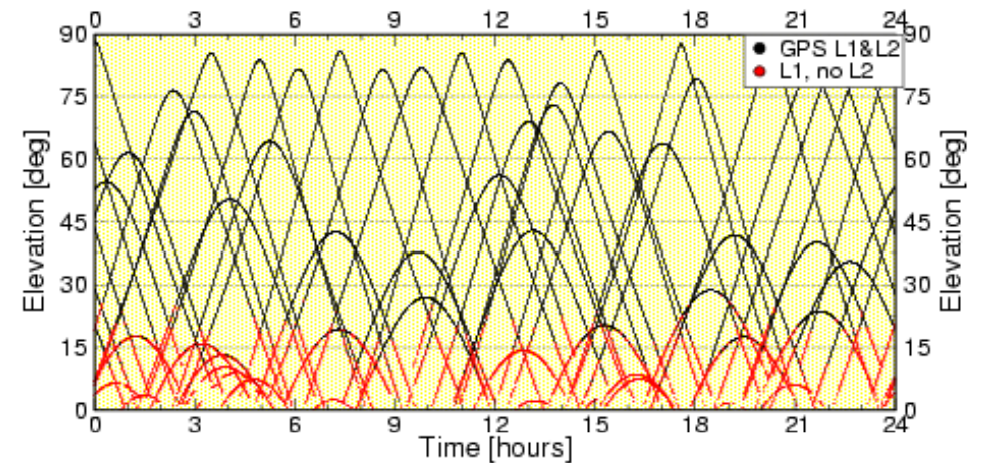
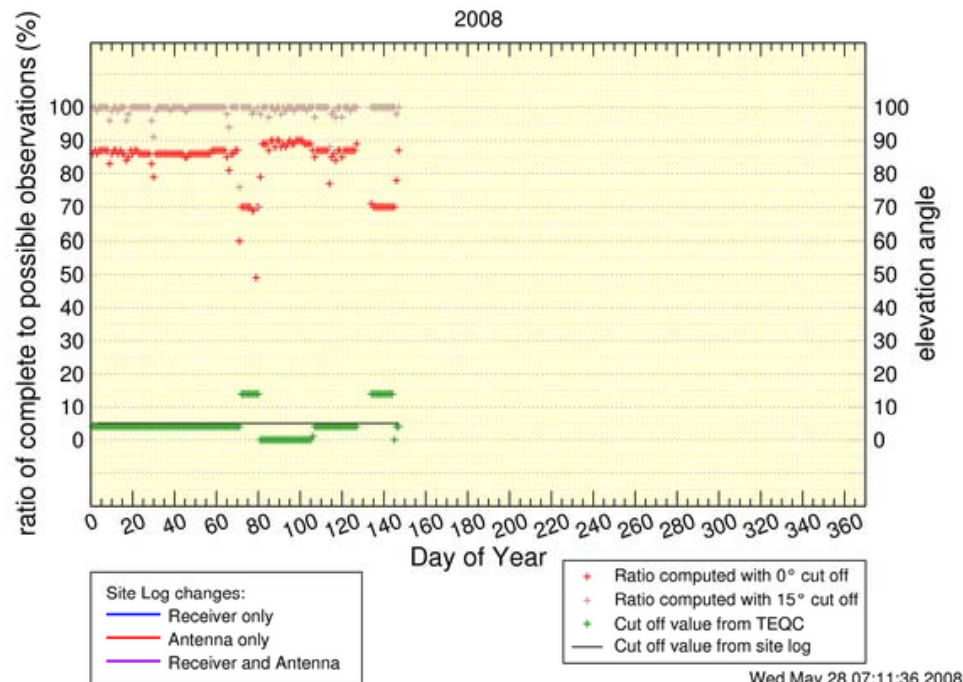
EPN CB Verifications

	Daily	Hourly	Real-time
Availability	x	x	x
Latency	x	x	x
Meta-data	x		x
Quality	x		

Data quality verification : - Teqc-based
- Tracking plots

Tracking at low elevations:

- Elevation cut off angle
- L2
- Obstructions



REQUIEREMENTS FOR NEW EPN STATIONS

Site	Location	Proposed at	Documentation			Availability (%)					Latency			DQ (%)		Meta-data		Data		Rel.	Interested analysis centres
			CL	SL	SP	Daily		Hourly		RT	Hourly (%)		RT (s)	0°	15°	Daily	RT	AC	DQ		
						BKG	OLG	BKG	OLG		BKG	OLG									
FLOR		21/04/2008	✓	✗	✓	0	0	0	0	—	0	0	—	0	0	✗	—	✗	✗		?, ?, ?
FUNC	Funchal, Portugal	03/09/2007	✓	✓	✓	100	100	100	100	—	100	99	0.6	83	99	✓	✗	T	✓	G	IGE, BEK, BKG
HFL2	Innsbruck, Austria	19/03/2008	✓	✓	✗	100	100	100	100	—	100	98	—	93	100	✓	—	I	✓		BKG, OLG, LPT
MAN2	Le Mans, France	03/04/2008	✓	✓	✓	0	0	0	0	—	0	0	—	84	87	✓	—	T	✓	G	ROB, IGN, LPT, IGE
MOP2	Modra-Piesok, Slovak Republic	06/02/2008	✓	✓	✓	29	29	67	67	—	64	63	—	78	99	✓	—	I	✓	G, C	WUT, OLG, LPT, SUT
OBE3	Oberpfaffenhofen, Germany	22/02/2008	✓	✓	✗	100	0	99	0	—	99	0	—	65	93	✓	—	T	✗		BKG, ROB, ?
PFA2	Bregenz, Austria	19/03/2008	✓	✓	✗	100	100	96	96	—	96	91	—	87	98	✓	—	I	✗	G	BKG, OLG, LPT
SBG2	Salzburg, Austria	19/03/2008	✓	✓	✗	14	43	0	0	—	0	0	—	0	0	✓	—	T	✗	G	BKG, OLG, LPT
SCOR	Scoresbysund/Ittoqqoormiit, Greenland	28/02/2006	✓	✓	✓	100	0	100	0	—	98	0	—	84	97	✓	—	✗	✓	D	NKG, IGE, ?
TERU	Teruel, Spain	19/05/2008	✓	✓	✓	100	93	100	100	—	99	87	—	90	100	✓	—	T	✓	G	IGE, ?, ?
TRF2	Pernitz, Austria	19/03/2008	✓	✓	✗	64	64	7	7	—	7	5	—	69	92	✓	—	I	✗	G	BKG, OLG, LPT

Stations are not included in EPN as long as all criteria are not fulfilled

Site	Location	Availability (%)					RT	Latency		RT (s)	DQ (%)	
		Daily		Hourly		Hourly (%)		0°	15°			
		BKG	OLG	BKG	OLG						BKG	OLG
ACOR	A Coruna, Spain	100	93	99	99	100	99	96	1.8	90	99	x
AJAC	Ajaccio, France	57	0	50	49	—	1	1	—	0	0	
ALAC	Alicante, Spain	100	100	100	89	100	99	88	1.8	91	100	
ALBA	Albacete, Spain	100	100	100	100	100	99	96	2.9	88	99	x
ALME	Almeria, Spain	100	100	100	93	99	98	90	1.8	89	100	x
ANKR	Ankara, Turkey	100	100	100	100	—	100	0	—	94	99	
AQUI	L'Aquila, Italy	100	100	100	100	—	99	96	—	84	100	x
AUT1	Thessaloniki, Greece	100	100	100	100	99	99	99	1.2	88	100	x
AUTN	Autun, France	100	86	99	96	—	79	63	—	83	97	
BACA	Bacau, Romania	100	100	100	100	—	100	96	—	87	100	x
BADH	Bad Homburg, Germany	100	100	99	99	—	99	0	—	77	97	
BAIA	Baia Mare, Romania	100	100	100	100	—	95	73	—	85	100	x
BBYS	Banska Bystrica, Slovak Republic	93	71	78	78	—	78	77	—	76	88	
BELF	Belfast, United Kingdom	100	79	100	100	—	52	75	0.8	87	100	
BELL	Bellmunt de Segarra, Spain	64	100	99	95	88	99	78	3.6	80	96	
BISK	Zlate Hory, Czech Republic	100	93	94	94	—	91	35	—	69	86	
BOGI	Borowa Gora, Poland	86	100	100	100	—	100	96	1.8	80	99	
BOGO	Borowa Gora, Poland	100	100	100	100	—	100	96	—	81	100	x
BOLG	Bologna, Italy	100	93	0	0	—	0	0	—	84	99	
BOR1	Borowiec, Poland	100	100	100	100	—	100	0	1.5	83	100	
BORJ	Borkum (Island of Borkum), Germany	100	0	99	0	100	0	0	0.6	92	98	
BORR	Borriana, Spain	100	93	100	100	100	100	96	1.9	86	100	x
BPDL	Biala Podlaska, Poland	93	64	71	71	—	70	67	—	96	99	
BRST	Brest, France	100	0	76	94	—	76	76	1.6	86	100	
BRUS	Brussels, Belgium	100	100	100	100	—	100	96	1.9	80	99	x
BSCN	Besançon, France	100	0	93	89	9	86	69	1.5	69	93	
BUCU	Bucuresti, Romania	93	93	98	98	—	98	0	1.4	81	97	
BUDP	Kobenhavn, Denmark	100	100	100	100	—	100	96	—	90	98	x
BUTE	Budapest, Hungary	100	57	100	99	99	100	96	0.4	91	100	
BVDC	Budapest, Hungary	100	70	71	71	—	70	67	—	83	87	

New statistics under development

basis for:

- weekly/monthly reports distributed through EUREF mail
- new web-pages

- ☐ EPN tracking network is continuously improving (data flow, antenna calibrations, extension towards eastern Europe)
- ☐ Antenna replacements continue to be a problem
- ☐ Real-time data streams are part of routine EPN operations
- ☐ Detailed station statistics are under development
- ☐ Need for more statistics on GLONASS tracking