



EPN real-time analysis status report

Wolfgang Söhne

Federal Agency for Cartography and Geodesy



- **History**
- **Status of real-time network**
- **Real-time analysis**
 - **Clocks and orbits**
 - **Precise point positioning**
- **Next steps**



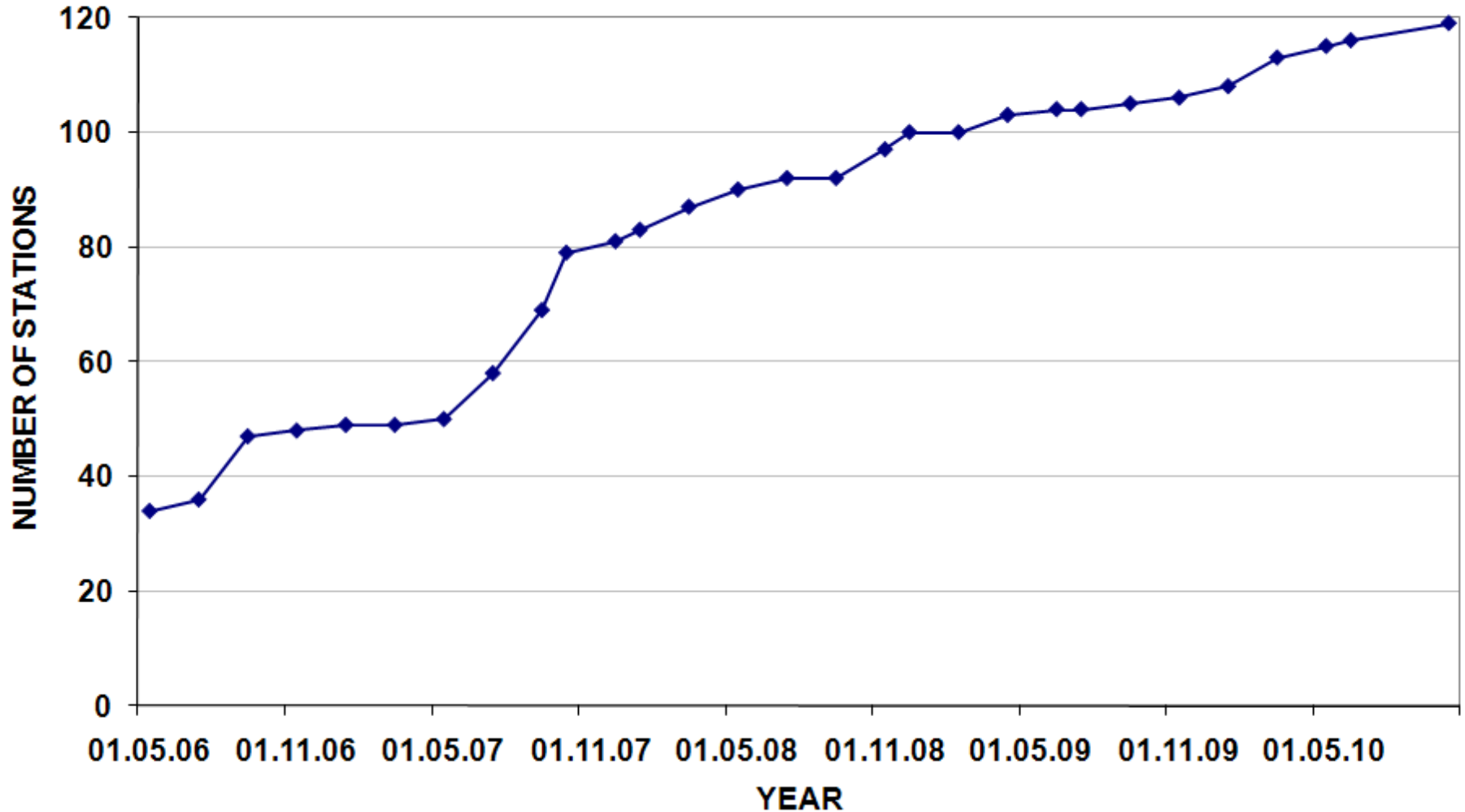
- **EPN real-time activities started in 2002**
- **Pilot project EUREF-IP was created**
- **Moved to operational end of 2007**
- **Necessity for continuation identified**
- **Resolution no. 3 at EUREF symposium 2008**
- **New Special Project „EPN Real-time analysis“ launched in 2008**



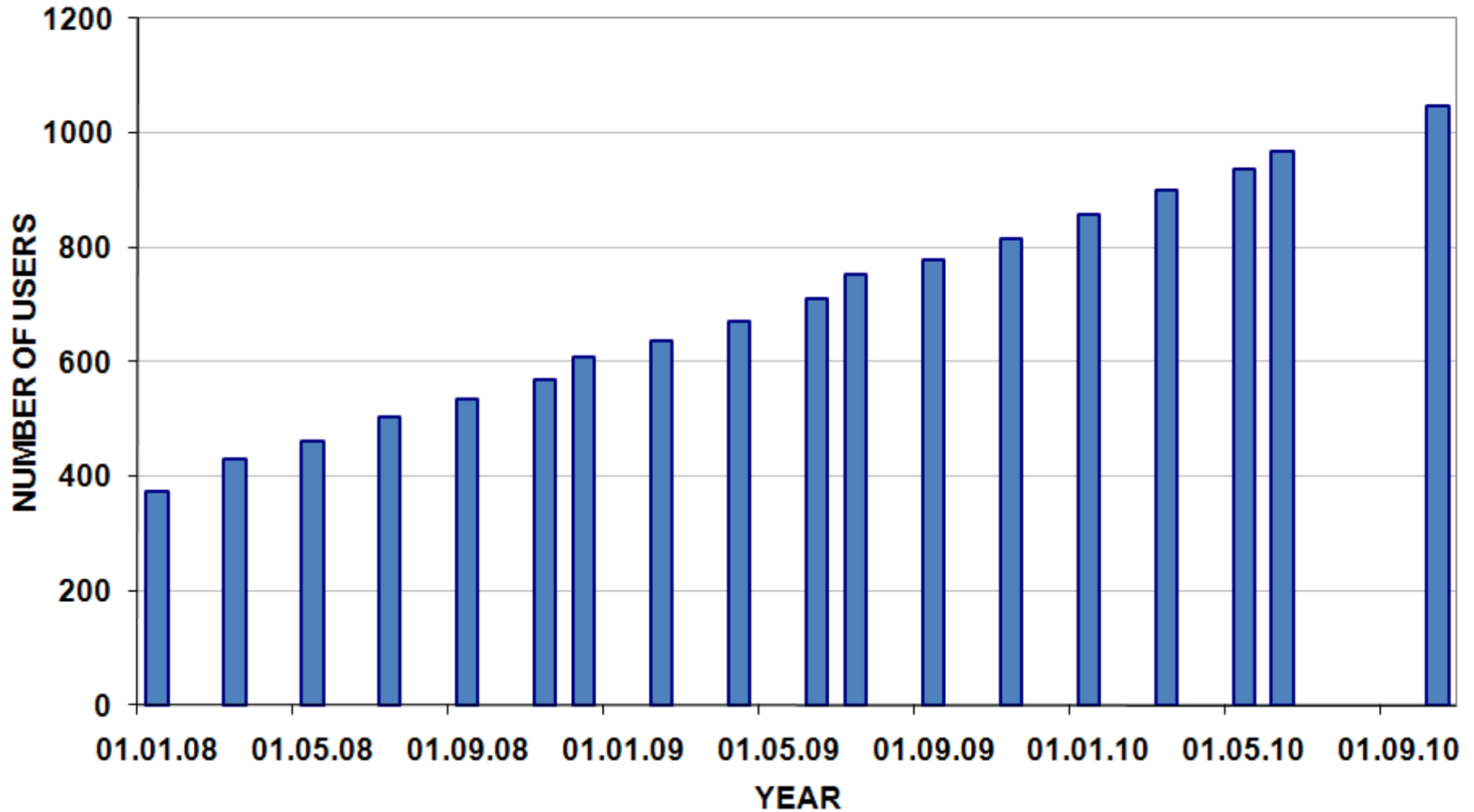
- **119 of 244 EPN stations delivering RT data (status: Oct, 28, 2010)**
- **65 coming from local or national broadcasters (~14)**
- **54 are streaming to euref-ip.net**
- **Concept of distributed EPN broadcasters**
- **Started in 2009**
- **Located at ROB (<http://www.euref-ip.be>) and e-GEOS ASI/CGS (<http://192.106.234.7>) (→ Söhne et al., 2010)**



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



Number of registered users at broadcaster euref-ip.net





- **~ 60-70 globally distributed stations regularly used by the analysis centres**
- **~ 7 Analysis centers**
 - Each with individual software
 - Some with two different solutions
- **Clock & orbit combination in post-processing as well as in real-time**
- **New product-related Ntrip broadcaster set up: products.igs-ip.net**



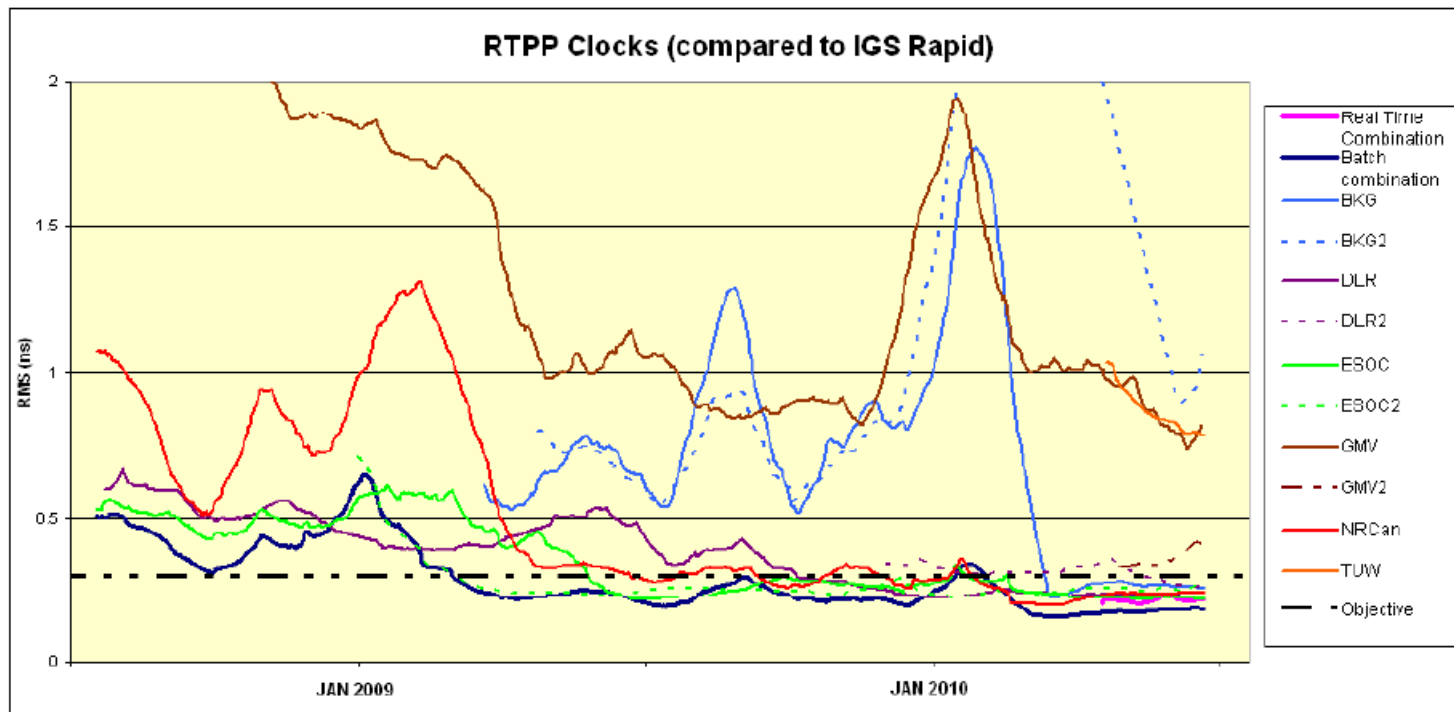
Sourcetable

- CAS;products.igs-ip.net;2101;IGS-IP;BKG;0;DEU;50.12;8.69;http://products.igs-ip.net/home
- CAS;rtcm-ntrip.org;2101;NtripInfoCaster;BKG;0;DEU;50.12;8.69;http://www.rtcm-ntrip.org/home
- NET;Misc;BKG;B;N;http://igs.bkg.bund.de/root_fip/NTRIP/streams/streamlist_igs-ip.htm;http://igs.bkg.bund.de/index_ntrip_reg.htm;none
- STR;CLK00;BRDC_CoM_ITRF;RTCM 3.0;1059(5),1060(5);0;GPS;Misc;DEU;50.00;10.00;0;1;RTNet;none;B;N;1800;BKG
- STR;CLK01;BRDC_CoM_ITRF;RTCM 3.0;1059(5),1060(5),1065(5),1066(5);0;GPS+GLO;Misc;DEU;50.00;10.00;0;1;RTNet;none;B;N;1800;BKG
- STR;CLK10;BRDC_APC_ITRF;RTCM 3.0;1059(5),1060(5);0;GPS;Misc;DEU;50.00;10.00;0;1;RTNet;none;B;N;1800;BKG
- STR;CLK11;BRDC_APC_ITRF;RTCM 3.0;1059(5),1060(5),1065(5),1066(5);0;GPS+GLO;Misc;DEU;50.00;10.00;0;1;RTNet;none;B;N;1800;BKG
- STR;CLK20;BRDC_APC_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RETICLE;none;B;N;1800;gnss.gsoc.dlr.de:2101/CLKA1(1)
- STR;CLK30;BRDC_CoM_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RETINA;none;B;N;1800;IGS Combination
- STR;CLK31;BRDC_APC_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RETINA;none;B;N;1800;IGS Combination
- STR;CLK42;BRDC_APC_NAD83;RTCM 3.0;1059(5),1060(5),1065(5),1066(5);0;GPS+GLO;Misc;DEU;50.00;10.00;0;1;RTNet;none;N;N;1800;BKG
- STR;CLK43;BRDC_APC_GDA94;RTCM 3.0;1059(5),1060(5),1065(5),1066(5);0;GPS+GLO;Misc;DEU;50.00;10.00;0;1;RTNet;none;N;N;1800;BKG
- STR;CLK44;BRDC_APC_SIRGAS2000;RTCM 3.0;1059(5),1060(5),1065(5),1066(5);0;GPS+GLO;Misc;DEU;50.00;10.00;0;1;RTNet;none;N;N;1800;BKG
- STR;CLK45;BRDC_APC_SIRGAS95;RTCM 3.0;1059(5),1060(5),1065(5),1066(5);0;GPS+GLO;Misc;DEU;50.00;10.00;0;1;RTNet;none;N;N;1800;BKG
- STR;CLK50;BRDC_CoM_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RETINA;none;B;N;1800;ESA/ESOC
- STR;CLK51;BRDC_APC_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RETINA;none;B;N;1800;ESA/ESOC
- STR;CLK52;BRDC_CoM_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RETINA;none;B;N;1800;ESA/ESOC2
- STR;CLK53;BRDC_APC_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RETINA;none;B;N;1800;ESA/ESOC2
- STR;CLK60;BRDC_CoM_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RTIGSMR;none;B;N;1800;TUW
- STR;CLK61;BRDC_APC_ITRF;RTCM 3.0;1059(10),1060(10);0;GPS;Misc;DEU;50.00;10.00;0;1;RTIGSMR;none;B;N;1800;TUW
- STR;CLK70;BRDC_CoM_ITRF;RTCM 3.0;1060(10);0;GPS;Misc;DEU;53.00;13.00;0;1;EPOS-RT;none;N;N;4800;GFZ GPS ZD solution
- STR;CLK71;BRDC_APC_ITRF;RTCM 3.0;1060(10);0;GPS;Misc;DEU;53.00;13.00;0;1;EPOS-RT;none;N;N;4800;GFZ GPS ZD solution
- STR;CLK72;BRDC_CoM_ITRF;RTCM 3.0;1060(10);0;GPS;Misc;DEU;53.00;13.00;0;1;EPOS-RT;none;N;N;4800;GFZ GPS ED solution
- STR;CLK73;BRDC_APC_ITRF;RTCM 3.0;1060(10);0;GPS;Misc;DEU;53.00;13.00;0;1;EPOS-RT;none;N;N;4800;GFZ GPS ED solution
- STR;CLK80;BRDC_APC_ITRF;RTCM 3.0;1059(5),1060(5);0;GPS;Misc;ESP;-15.68;128.76;0;1;magicGNSS;none;B;N;520;igs-ip.gmv.com:2101/GMVAPC(1)
- STR;CLK81;BRDC_CoM_ITRF;RTCM 3.0;1059(5),1060(5);0;GPS;Misc;ESP;-15.68;128.76;0;1;magicGNSS;none;B;N;520;igs-ip.gmv.com:2101/GMVCOM(1)
- STR;RTCM3EPH;Assisted-GNSS;RTCM 3;1019(1),1020(1);0;GPS+GLO;Misc;DEU;50.09;8.66;0;1;BNS;none;B;N;2200;BKG

→ **ETRS89-related correction stream on www.euref-ip.net (CLK41)**



Clock Performance



Agrotis, 2010



Real Time Clock Report - Week 1609 - Day 2 - (Nov 9, 2010)

Prepared by ESOC RTPP group - Contacts:

John Dow john.dow (at) esa.int
Loukis Agrotis loukis (at) symban.co.uk
Pedro Alfaro pedro.alfaro (at) esa.int

Results of the Real Time Analysis Centre comparisons against the IGS rapid solution:

This report (igt16092.sum.Z) and combination clock product (igt16092.clk.Z) are available in directory:

<ftp://cddis.nasa.gov/gps/products/rtp/1609>

Summary Table

AC	PFX	nSats	OrbRMS(mm)	nSatClk	nUsed	SatRMS(ns)	SatSig(ns)	nStaClk	nUsed	StaRMS(ns)	StaSig(ns)
comb	igt	31	0.0	8890	8884	0.53	0.10	0	0	0.00	0.00
rtcomb	igc	31	63.7	8928	8922	0.67	0.14	0	0	0.00	0.00
bkg	rtn	31	61.5	8928	8922	0.73	0.12	0	0	0.00	0.00
bkg2	rt2	50	192.4	8556	8553	0.84	0.31	0	0	0.00	0.00
dlr	dlt	31	59.2	8928	8922	0.60	0.13	0	0	0.00	0.00
dlr2	d2t	31	59.2	8928	8922	0.50	0.14	0	0	0.00	0.00
esoc	est	31	59.2	8866	8860	0.37	0.17	8856	8638	3.15	0.37
esoc2	e2t	31	61.5	8928	8922	0.63	0.13	8048	7768	4.24	0.42
nrc	emt	30	45.2	8639	8633	0.32	0.14	8846	8618	0.89	0.29
gmw	gmt	31	55.9	8899	8893	0.62	0.14	0	0	0.00	0.00
gfz	gft	30	84.1	8061	8055	1.25	0.41	0	0	0.00	0.00
tuw	TUW	31	55.0	8863	8857	0.79	0.56	9257	8801	16023.51	6456.07



- **Stations / network**
 - Each station hosted at 2 or more casters
- **Distribution / broadcasters**
 - Each RDC should have onsite and off site caster
- **Analysis centers**
 - Each AC should implement data acquisition plan
 - Computational redundancy
- **Combination**
 - 2 or more combination centres
 - 2 or more correction distribution points
- ...



- **SSR three steps approach**
 - Precise orbits and clocks
 - Global ionospheric messages
 - Troposphere, system biases, carrier phase ambiguities
- **Sequential approach corresponds to**
 - Different levels of networks (global, regional, local)
 - Different levels of accuracy
- **To be formulated in terms of RTCMv3 messages**
- **New working group „ambiguity fixing“ established (chair: M. Ge, GFZ)**
 - Select suitable approaches of the various real-time (zero difference) ambiguity fixing methods developed and implemented so far for PPP within the IGS-RT PP



- **BKG Ntrip Client (BNC)**
 - **Current version 2.4**
 - **PPP option**
 - **GPS and GLONASS**
 - **Estimate troposphere parameter**
 - **Static and kinematic mode**
 - **Smoothing (averaging) option (coordinates and troposphere)**
 - **„Quickstart“ function (useful for kinematic mode)**
 - **Visualisation included**



RT analysis – BNC PPP variants for KARL1

	Static	EstTropo	GLONASS
Var. A	+	+	+
Var. B	+	+	-
Var. C	+	-	+
Var. D	+	-	-
Var. E	-	-	-



BKG Ntrip Client (BNC) Version 2.4

File Help

Proxy General RINEX Observations RINEX Ephemeris Broadcast Corrections Feed Engine Serial Output Outages Miscellaneous **PPP Client**

Mountpoint: KARL1 PPP

Options: Static Use phase obs Estimate tropo Use GLONASS

Options cont'd: Sigma code 5 Averaging

Origin: Plot - X Y Z X: 4146524.3013 Y: 613138.1698 Z: 4791517.2449

NMEA File (full path): D:/soehne/Realtime/Programme/BNC24/Daten/KARL1.dat Port:

Coordinates from Precise Point Positioning (PPP).

Streams:	resource loader / mountpoint	decoder	lat	long	nmea	ntrip	bytes
1	products.igs-ip.net:2101/CLK11	RTCM_3,0	50.00	10.00	no	1	33.473 kB
2	products.igs-ip.net:2101/RTCM3EPH	RTCM_3	50.09	8.66	no	1	148.962 kB
3	www.euref-ip.net:2101/KARL1	RTCM_3,0	49.01	8.41	no	1	94.492 kB

Log Throughput Latency **PPP Plot**

3.30 m NEU Start 11:57:02

0.00 m

-3.30 m

11:58 11:59 12:00 12:01

Add Stream Delete Stream Start Stop Help ?=Shift+F1



BKG Ntrip Client (BNC) Version 2.4

File Help

Proxy General RINEX Observations RINEX Ephemeris Broadcast Corrections Feed Engine Serial Output Outages Miscellaneous **PPP Client**

Mountpoint: KARL1 PPP

Options: Static Use phase obs Estimate tropo Use GLONASS

Options cont'd: Sigma code 5 Averaging

Origin: Plot - X Y Z X: 4146524.3013 Y: 613138.1698 Z: 4791517.2449

NMEA File (full path): D:/soehne/Realtime/Programme/BNC24/Daten/KARL1.dat Port:

Coordinates from Precise Point Positioning (PPP).

Streams:	resource loader / mountpoint	decoder	lat	long	nmea	ntrip	bytes
1	products.igs-ip.net:2101/CLK11	RTCM_3.0	50.00	10.00	no	1	227.33 kB
2	products.igs-ip.net:2101/RTCM3EPH	RTCM_3	50.09	8.66	no	1	1.01186 MB
3	www.euref-ip.net:2101/KARL1	RTCM_3.0	49.01	8.41	no	1	639.892 kB

Log Throughput Latency **PPP Plot**

Add Stream Delete Stream Start Stop Help ?=Shift+F1



BKG Ntrip Client (BNC) Version 2.4

File Help

Proxy General RINEX Observations RINEX Ephemeris Broadcast Corrections Feed Engine Serial Output Outages Miscellaneous **PPP Client**

Mountpoint: KARL1 PPP

Options: Static Use phase obs Estimate tropo Use GLONASS

Options cont'd: Sigma code 5 Averaging

Origin: QuickStart - Static X 4146524.3013 Y 613138.1698 Z 4791517.2449

NMEA File (full path): D:/soehne/Realtime/Programme/BNC24/Daten/KARL1.dat Port:

Coordinates from Precise Point Positioning (PPP).

Streams:	resource loader / mountpoint	decoder	lat	long	nmea	ntrip	bytes
1	products.igs-ip.net:2101/CLK11	RTCM_3,0	50.00	10.00	no	1	33.473 kB
2	products.igs-ip.net:2101/RTCM3EPH	RTCM_3	50.09	8.66	no	1	134.471 kB
3	www.euref-ip.net:2101/KARL1	RTCM_3,0	49.01	8.41	no	1	93.928 kB

Log Throughput Latency **PPP Plot**

Start 11:15:02

NEU

0.10 m

0.00 m

-0.10 m

11:16 11:17 11:18 11:19

Add Stream Delete Stream Start Stop Help ?=Shift+F1



BKG Ntrip Client (BNC) Version 2.4

File Help

Proxy General RINEX Observations RINEX Ephemeris Broadcast Corrections Feed Engine Serial Output Outages Miscellaneous **PPP Client**

Mountpoint: KARL1 PPP

Options: Static Use phase obs Estimate tropo Use GLONASS

Options cont'd: Sigma code 5 Averaging

Origin: Plot - X Y Z X: 4146524.3013 Y: 613138.1698 Z: 4791517.2449

NMEA File (full path): D:/soehne/Realtime/Programme/BNC24/Daten/KARL1.dat Port:

Coordinates from Precise Point Positioning (PPP).

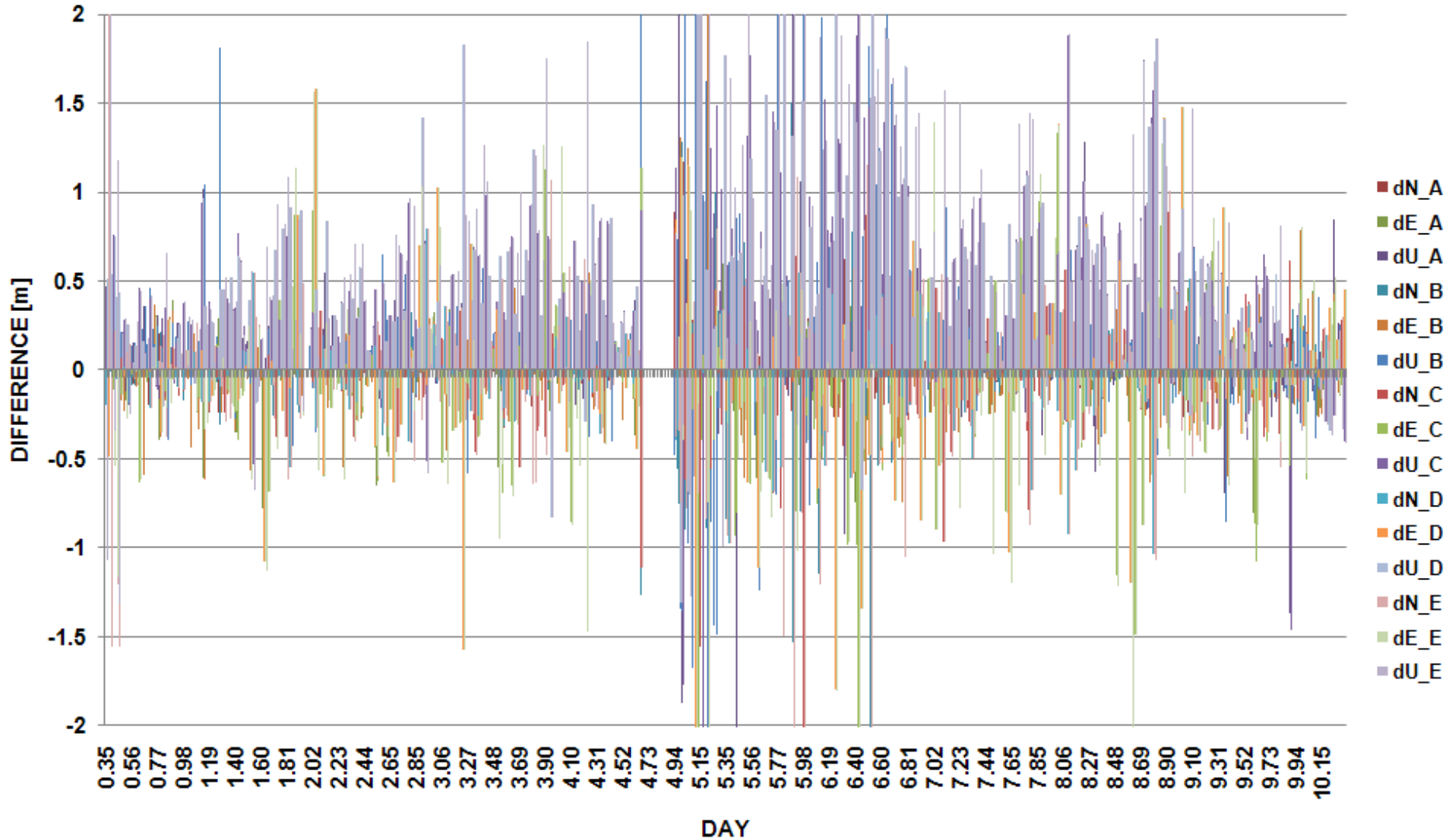
Streams:	resource loader / mountpoint	decoder	lat	long	nmea	ntrip	bytes
1	products.igs-ip.net:2101/CLK11	RTCM_3.0	50.00	10.00	no	1	227.33 kB
2	products.igs-ip.net:2101/RTCM3EPH	RTCM_3	50.09	8.66	no	1	1.01186 MB
3	www.euref-ip.net:2101/KARL1	RTCM_3.0	49.01	8.41	no	1	639.892 kB

Log Throughput Latency **PPP Plot**

Add Stream Delete Stream Start Stop Help ?=Shift+F1



PPP: differences in NEU with CLK11 corrections after 30 minutes using different BNC options, mountpoint KARL1



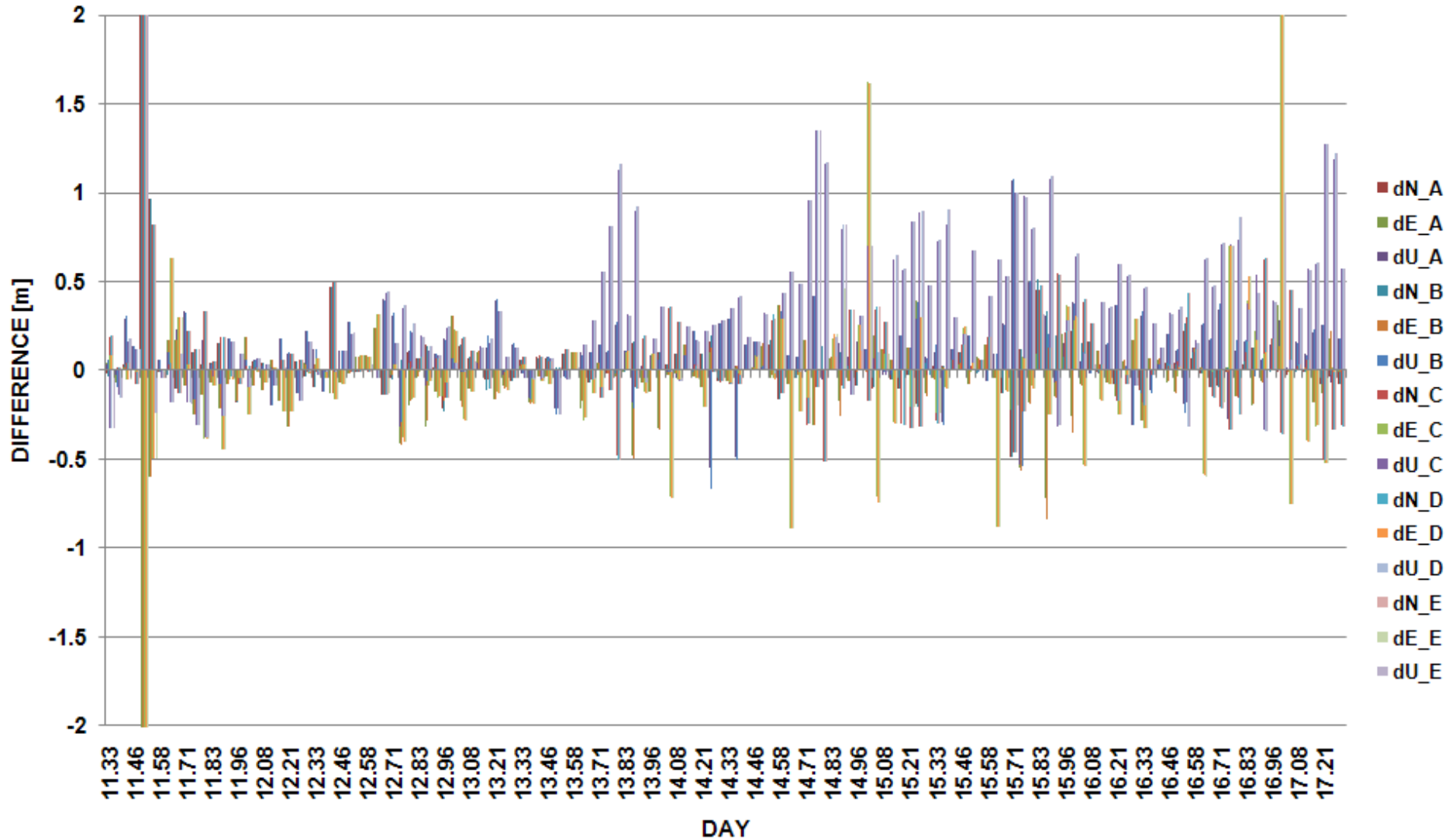


RT analysis – PPP statistics for KARL1, 30 minutes

			RAW				AVE					
	North		East		Up		North		East		Up	
Var. A	-0.01	0.10	-0.01	0.22	0.13	0.21	-0.02	0.12	-0.03	0.25	0.15	0.26
Var. B	-0.01	0.12	-0.01	0.24	0.13	0.25	-0.01	0.13	-0.03	0.26	0.13	0.28
Var. C	-0.03	0.23	-0.03	0.40	0.38	0.36	-0.04	0.24	-0.05	0.39	0.39	0.37
Var. D	-0.04	0.25	-0.01	0.43	0.39	0.39	-0.04	0.27	-0.04	0.43	0.40	0.42
Var. E	-0.04	0.37	-0.01	0.45	0.38	0.44	-0.04	0.28	-0.03	0.43	0.38	0.43



PPP: differences in NEU with CLK11 corrections after 60 minutes using different BNC options, mountpoint KARL1





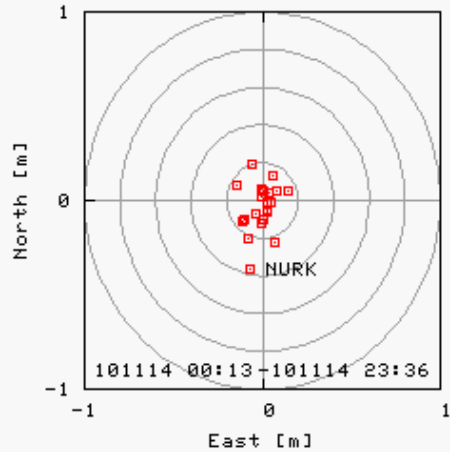
RT analysis – PPP statistics for KARL1, 60 minutes

			RAW				AVE					
	North		East		Up		North		East		Up	
Var. A	0.02	0.11	-0.03	0.16	0.08	0.19						
Var. B	0.02	0.11	-0.03	0.17	0.08	0.20						
Var. C	0.01	0.19	-0.01	0.36	0.30	0.36						
Var. D	0.01	0.20	-0.01	0.36	0.30	0.37						
Var. E	0.01	0.20	-0.01	0.36	0.30	0.37						

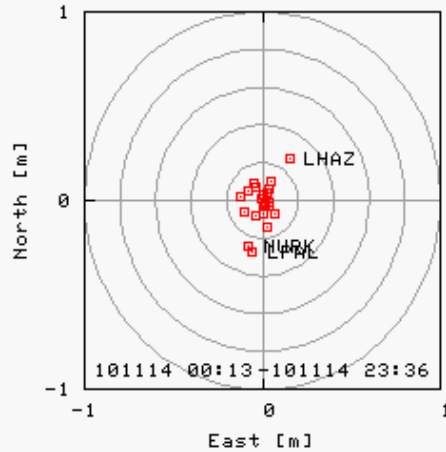


RT analysis – PPP performance

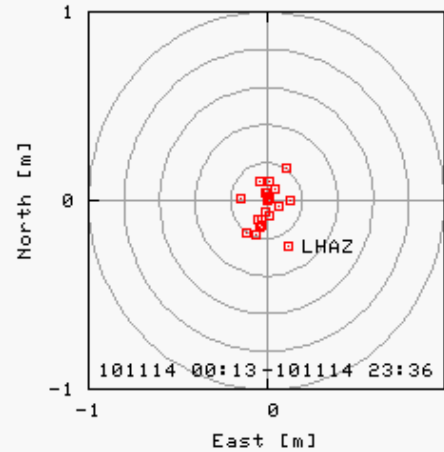
CLK31 COMBI 60min $\pm 0.36m$ n=22



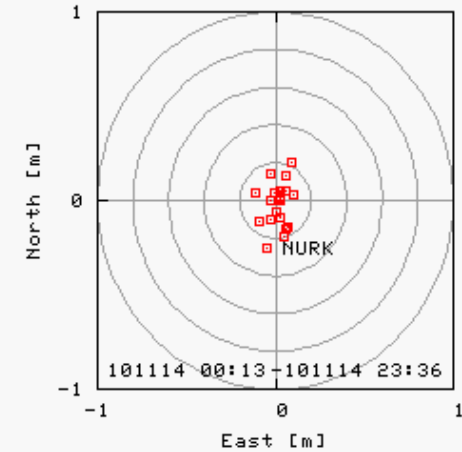
CLK10 BKG 60min $\pm 0.41m$ n=22



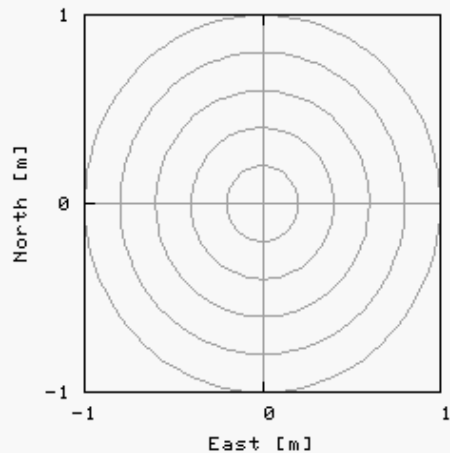
CLK20 DLR 60min $\pm 0.33m$ n=22



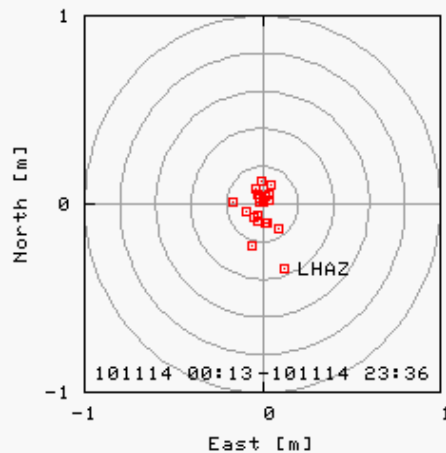
CLK51 ESA 60min $\pm 0.34m$ n=21



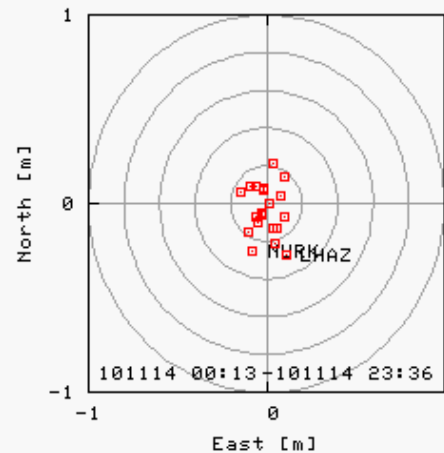
RTCMSSR GEOPP 60min n=0



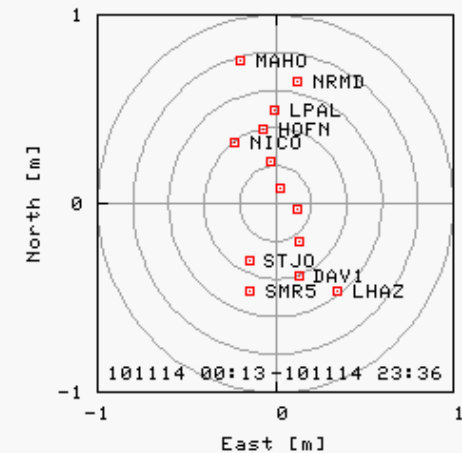
CLK71 GFZ 60min $\pm 0.52m$ n=22



CLK80 GMV 60min $\pm 0.33m$ n=22



CLK61 TUW 60min $\pm 0.86m$ n=16





- **RT data streams: users take advantage of distributed broadcaster concept**
- **RT PPP: horizontal (2D) accuracy < 2 dm after 1 hour, after 30 min under good conditions**
- **State space representation concept will need regional or national densification**