

# Federal Agency for Cartography and Geodesy

# BKG Ntrip Client (BNC) Version 2.7 – Recent Developments and Results

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#### Abstract

The BKG Ntrip Client (BNC) was originally designed for collecting, synchronising and streaming real-time GNSS data from real-time broadcasters to real-time users. During the last years, BNC evolved to a very efficient tool in the real-time world, mainly because of its Precise Point Positioning (PPP) module. Being open source software, important features already implemented or under development are: multi GNSS encoding/decoding, real-time GNSS orbit & clock combination, post-processing capability, editing and quality control elements, especially for RINEX 3.

### Orbit & clock correction monitoring with PPP

One method of orbit & clock correction validation is using them for real-time PPP. At BKG, 20 globally distributed reference stations are processed consecutively for one hour each day. The differences to the reference coordinates after 60 minutes are visualized and summarized in a table.

| BKG CLK10 60min +/-0.12m n=20 | CNES CLK91 60min +/-0.19m n=20 | DLR CLK20 60min +/-0,14m n=20 | ESA CLK51 60min +/-0.11m n=20 |
|-------------------------------|--------------------------------|-------------------------------|-------------------------------|
| 1                             | 1                              | 1                             | 1                             |

This poster presentation is reviewing the basic tags and tools of BNC and is highlighting several of the new features. Current results using the PPP module, e.g. from BKG's monitoring webpage, are completing the presentation.

# BNC features at a glance

The following options of BNC have been implemented or improved in the latest version:

- Quality control and editing features, e.g. concatenation of hourly files, multipath visualisation (see poster Habrich et al.)
- Post processing capability using RINEX files (beside the already existing option of using files in an internal raw data format (amount of approx. 2.5GB each day storing ~70 streams, top right)
- Provision of multi GNSS observations (GPS, GLONASS, Galileo, COMPASS, SBAS), either as RTCM3 stream or in RINEX3 file format (top left)
- Precise Point Positioning, e.g. tuning filter parameter via configuration file
- Real-time orbit and clock combination, either with Kalman filter approach or with least square adjustment (bottom left and right)



RMS of N/E/U 2D/3D displacements (m) from 60 min PPP tests:

Source Correctors N-RMS E-RMS U-RMS 2D-RMS 3D-RMS r

| BKG   | CLK10 | 0.04 | 0.12 | 0.10 | 0.12 | 0.16 | 20 |
|-------|-------|------|------|------|------|------|----|
| CNES  | CLK91 | 0.06 | 0.18 | 0.10 | 0.19 | 0.22 | 20 |
| DLR   | CLK20 | 0.06 | 0.12 | 0.11 | 0.14 | 0.18 | 20 |
| ESA   | CLK51 | 0.04 | 0.10 | 0.08 | 0.11 | 0.14 | 20 |
| GFZ   | CLK71 | 0.08 | 0.19 | 0.23 | 0.21 | 0.31 | 20 |
| GMV   | CLK80 | 0.07 | 0.16 | 0.09 | 0.17 | 0.20 | 20 |
| NRCAN | CLK22 | 0.09 | 0.22 | 0.11 | 0.24 | 0.27 | 20 |
| WUHAN | CLK16 | 0.08 | 0.14 | 0.21 | 0.16 | 0.26 | 20 |
| CMB1  | IGS01 | 0.07 | 0.17 | 0.11 | 0.19 | 0.22 | 20 |
| CMB2  | IGS02 | 0.04 | 0.10 | 0.11 | 0.11 | 0.15 | 20 |
| CMB3  | CLK35 | 0.04 | 0.13 | 0.10 | 0.14 | 0.17 | 20 |
| CMB4  | IGS03 | 0.06 | 0.10 | 0.10 | 0.12 | 0.15 | 20 |
|       |       |      |      |      |      |      |    |

The most recent results of scenario 15 and the other monitoring scenes can be found at http://igs.bkg.bund.de/nt

rip/ppp



Several example configuration files are provided with each release

| BKC Ntrin (lient (BNC) Version 2.7   |  |
|--|--|
|  | BKG Ntrip Clent (BNC) Version 2.7  |
| Network   General   RINEX Observations   RINEX Ephemeris   RINEX Editing & QC   Broadcast Corrections   Feed Engine   Serial Output   Outages   Miscellaneous   PPP (1)     Log latencies or scan RTCM streams for numbers of message types and antenna information.   Miscellaneous   PPP (1)   Image: Correction information   | Eile   Help     IEX Ephemeris   RINEX Editing & QC   Broadcast Corrections   Feed Engine   Serial Output   Outages   Miscellaneous   PPP (1)   PPP (2)   Image: Precise Point Positioning, Page 1.   |
| Log latency 1 min V<br>Scan RTCM V   | Mode & mountpoints   Post-Processing   Obs.   Corr.     Marker coordinates   4115014.0696   X   -4550641.5960   Y   -1741443.8604   Z     Antenna excentricity   0.000   dN   0.000   dE   0.008   dU     NMEA & plot output   NMEA File   NMEA Port   PPP Plot     Post-processing   C27/Input/BP.071700.120   Obs   me/BNC27/Input/BP.0C1700   Nav   |
|  | Poscprocessing C2//Inpud/BRA21/90.120 Obs ne/bric2//Inpud/BRDC1/9d Nav   |
| 1 mgex.igs-ip.net;2101/CUT07 RTCM_3.0 -32.00 115.89 no 1 27.753 k8   | 227/Input/CLK111790.12C    Corr   put/bnc_postproc_179.txt   Log (full path)     Streams: resource loader / mountpoint   decoder   lat   long   nmea   ntrip   bytes     Image: postproc_179106 05.tal   WordPad   Image: postproc_179106 05.tal   WordPad   Image: postproc_179106 05.tal   Image: postproc_179106 05.tal<  |
| Log Throughput Latency PPP Plot<br>12-07-16 14:00:22 CUTOT: Get data in RTCM 3.x format<br>12-07-16 14:00:22 CUTOT: Get data in RTCM 3.x format<br>12-07-16 14:00:22 CUTOT: Get data in RTCM 3.x format<br>12-07-16 14:00:23 CUTOT: Get data in RTCM 3.x format<br>12-07-16 14:00:23 CUTOT: Received message type 1007<br>12-07-16 14:00:23 CUTOT: Received message type 1107<br>12-07-16 14:00:28 CUTOT: Received message type 1127<br>12-07-16 14:00:28 CUTOT: Received message type 1107<br>12-07-16 14:00:38 CUTOT: Received message type 1 | Log Throughput Latency PPP Plot<br>00132100.0 PES 603 P9 - 1.4104<br>00132100.0 PES 603 P9 - 1.4104<br>00132100.0 PES 603 P3 - 1.4104<br>00132100.0 PES 603 P3 - 1.4104<br>00132100.0 PES 603 P3 - 1.0108<br>00132100.0 PES 603 P3 - 0.019<br>00132100.0 P2 615<br>mab 603 P3 - 0.4164 P3 P5 P5<br>mab 603 P3 P3 P3 P3 P3 P5 P3 P3 P3 P3 P3 P3 P5 P3 |
| Add Stream Delete Stream Start Stop Help?=Shift+F1   |  |

| BKG Ntrip Client (BNC) Version 2.7      |                                  |                |                     |                    | 💘 ВКС       | G Ntrip Client (B   | BNC) V       | ersion 2     | .7        |             |             |                                      |                     |                                    |         |            |             |
|---|----------------------------------|----------------|---------------------|--------------------|-------------|---------------------|--------------|--------------|-----------|-------------|-------------|--------------------------------------|---------------------|------------------------------------|---------|------------|-------------|
| ile Help                                |                                  |                |                     |                    | <u>File</u> | <u>t</u> elp        |              |              |           |             |             |                                      |                     |                                    |         |            |             |
| ast Corrections Feed Engine Serial Outp | ut Outages Miscellaneous PP      | PP (1) PPP (2) | Combine Corrections | Upload Corrections | tast Co     | rrections Feed      | l Engine     | Serial       | Output O  | utages Mise | cellaneous  | PPP (1) P                            | PP (2)              | Combine Corrections                | s Up    | load Corre | ections     |
| Mountpoint AC Name Weight               | ^                                |                |                     |                    | Uploa       | ad RTCMv3 Broadca   | ast Corre    | ections to a | aster.    |             |             |                                      |                     |                                    |         |            |             |
| 1 CLK10 BKG 1.0                         | Combine Broadcast Correction str | eams.          |                     |                    | H           | lost                | Port         | Mount        | Password  | System      | CoM         | SP3 File                             | RN                  | NX File                            | PID     | SID IO     | D byte 📥    |
| 2 CLK91 CNES 1.0                        | Add Row Dele                     | ete            |                     |                    | 1 p         | roducts.igs-ip.net  | 2101         | CLK33        | •••••     | IGS08       | ~           |                                      |                     |                                    | 256     |            | 0<br>by     |
| 3 CIK20 DIR 1.0                         | Method Filte                     | r 🗸            |                     |                    | 2 p         | roducts.igs-ip.net  | 2101         | CLK32        | •••••     | IGS08       | ~ 🗸         | /home/weber/bnc<br>call/bnc_combi/BN | - /ho<br>IC\$ call, | me/weber/bnc-<br>l/bnc_combi/BNC\$ | 256     |            | 0<br>by     |
|   | Maximal Residuum 0,20 Sing       | r<br>le-Epoch  |                     |                    | 3 р         | roducts.igs-ip.net  | 2101         | IGS02        | •••••     | IG508       | ~           |                                      |                     |                                    | 258     | 0 0        | 0<br>by     |
| 4 CLK53 ESA 1.0                         | Sampling                         | 10 sec 🗢       |                     |                    | 4 14        | www.igs.org         | 2101         | IGS02        |           | IG508       | ~           |                                      |                     |                                    | 258     | 0 2        | 0           |
| 5 CLK80 GMV 1.0                         |                                  |                |                     |                    | 5 %         | www.ias.ora         | 2101         | IGC02        |           | IG508       | ~ ~         |                                      |                     |                                    |         |            | 0           |
| 6 CLK22 NRCAN 1.0                       | v                                |                |                     |                    |             | dd Row Del          | Row          | Inter        | val 1 day | Samplin     | a: Orb      | 60 sec 🤹                             | SP3 1 n             | min 😂 RN                           | X 10 se | x 🗯 🖸      | ustom Trafo |
|   |                                  |                |                     |                    |             |                     |              | ,            |           |             | 3 [         |                                      |                     |                                    |         |            |             |
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| 1 products.igs-ip.net:2101/CLK10        | RTCM_3.0 50.00 10                | ).00 no 1      | 0 byte(s)           | ≡                  | 1 pr        | oducts.igs-ip.net:2 | 2101/CLK     | (10          |           | RTCM_3.0    | 50.00       | 10.00 no                             | D 1                 | 0 byte(s)                          |         |            |             |
| 2 products.igs-ip.net:2101/CLK11        | RTCM_3.0 50.00 10                | ).00 no 1      | 0 byte(s)           |                    | 2 pr        | oducts.igs-ip.net:2 | 2101/CLK     | (11          |           | RTCM_3.0    | 50.00       | 10.00 no                             | D 1                 | 0 byte(s)                          |         |            |             |
| 3 products.igs-ip.net:2101/CLK20        | RTCM_3.0 50.00 10                | ).00 no 1      | 0 byte(s)           |                    | 3 pr        | oducts.igs-ip.net:2 | 2101/CLK     | 20           |           | RTCM_3.0    | 50.00       | 10.00 no                             | D 1                 | 0 byte(s)                          |         |            |             |
| 4 products.igs-ip.net;2101/CLK21        | RTCM 3.0 50.00 10                | ).00 no 1      | 0 byte(s)           |                    | 4 pr        | oducts.igs-ip.net:2 | 2101/CLK     | 21           |           | RTCM 3.0    | 50.00       | 10.00 no                             | D 1                 | 0 byte(s)                          |         |            |             |
| 5 products igs-ip pet/2101/CLK22        | <br>PTCM 3.0 10                  | 00 50 1        |                     | ~                  | 5 04        | oducts igs-ip pet/? | ,<br>101/c1v | 22           |           |             | 50.00       | 10.00                                | . 1                 | () byte(c)                         |         |            |             |
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|   |                                  |                |                     |                    | Log         | mioughpuc           | Latent       | y            |           |             |             |                                      |                     |                                    |         |            |             |
|   |                                  |                |                     |                    |             |                     |              |              |           |             |             |                                      |                     |                                    |         |            |             |
|   |                                  |                |                     |                    |             |                     |              |              |           |             |             |                                      |                     |                                    |         |            |             |
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## Permanent position & ZTD monitoring

Permanent monitoring of IGS station ZIM2 using the combined stream EUREF02 (related to ETRS89) is shown below (see http://igs.bkg.bund.de/ntrip/ppp#Scene26). Thanks to swisstopo, ZTD estimates of NRT solution using BSW5.0 and RT solution from Trimble network solution are included showing a good overall agreement.



#### Positioning & ZTD processing

Results of PPP (consecutive runs over 30 minutes convergence time) and ZTD processing over one week for mountpoints in USA and Brasil are shown below. Correction stream CLK11 was used. JPL's PPP solution used as ZTD reference. Positioning results show slightly better results for GPS+GLONASS vs. GPS only (left figure). ZTD estimation for stations in Brasil fits better if a larger variation of the tropospheric effect is allowed than, e.g., for European stations.



#### **Further Information**

http://igs.bkg.bund.de

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