Bernese GPS Software: Recent Developments and Plans

R. Dach, H. Bock, A. Jäggi, S. Lutz, M. Meindl, L. Ostini, L. Prange, S. Schaer\textsuperscript{a}, A. Steinbach, D. Thaller, P. Walser, G. Beutler

rolf.dach@aiub.unibe.ch
bernese@aiub.unibe.ch

Astronomisches Institut, Universität Bern, Sidlerstrasse 5, CH-3012 Bern

\textsuperscript{a} Bundesamt für Landestopographie swisstopo, Seftigenstrasse 264, CH-3084 Wabern

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The Bernese GPS Software is used all over the world.
Bernese GPS Software: recent developments and plans

- Bernese GPS Software, Version 5.0 is distributed since May 2004.
- User manual was completed in January 2007.
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Current developments:
- New GNSS are expected in the near future. There are plans to modernize the existing GNSS.
- Reprocessing efforts are ongoing at many places.
- Many model developments have been carried out in the last years.
Introduction

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What does this mean for the Bernese GPS Software?
Bernese GPS Software:
A multi–GNSS analysis software

- The software has been started as a GPS analysis tool.
- It is capable to process GLONASS data already for a long time.
- The measurements from both systems can be processed together on the observation level.
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Extensions to the announced new/modernized GNSS:
- extension from two to $n$ frequencies for each GNSS
- each GNSS may have different set of observation types
Flexible handling of observation types is necessary:
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- All observations types from RINEX3 are kept together in one Bernese observation file per station and session.

- A complex set of modern F90 modules guarantees a flexible access to the measurements with individual linear combinations for each GNSS.

- The use of these modules simplifies the observation handling within the processing programs.

- New linear combinations may be easily implemented at one place for the entire software package.

⇒ M. Meindl et al., Developing a Generic Multi–GNSS Software Package, IGS Workshop, Miami, June 2008.
New file formats are necessary:

- Bernese observations files
  (may contain all types of observations in one (common) file)

- Bernese residual files
  (considering the new linear combinations)

- Differential code biases
  (many new DCBs have to be expected with the new signal types)

- Receiver information file
  (which receiver type is capable to receive which signal and
  priority lists for the observation selection)

- Antenna phase center corrections
  (GNSS-dependent receiver antenna PCV information)
Other necessary developments to get a multi–GNSS software:

- increase the number of satellites that can be processed together
  \((32 \text{ GPS} + 30 \text{ GLONASS} + 36 \text{ Galileo} \approx 100 \text{ satellites})\)

- correct input and output codes for each GNSS for all external files
  (e.g., precise orbit file, clock RINEX file, . . . )

- GNSS dependent parameter setup
  (e.g., receiver antenna phase center offsets/variations, Earth rotation parameters, . . . )

- requires the dynamic allocation of several arrays in many of the processing programs
Other necessary developments to get a multi–GNSS software:

GPSEST 1.4: Define array dimensions

SPECIFY THE DIMENSIONS OF THE MAIN ARRAYS IN GPSEST

- blank: Compute size, limit size by built-in default settings
- (use these options for special test applications only)
  - MAXLOC: Maximum number of parameters to be processed
  - MAXFIL: Maximum number of files to be processed
  - MAXSTA: Maximum number of stations involved
  - MAXSAT: Maximum number of satellites involved
  - MAXAMB: Maximum number of ambiguities in an observation file
  - MAXPAR: Maximum number of parameters simultaneously processed
  - MAXFLS: Maximum number of files simultaneously processed
  - MAXSAS: Maximum number of satellites simultaneously processed
  - MAXAMP: Maximum number of ambiguities simultaneously processed
  - MAXSNG: Maximum number of non-zero elements in one line

of first design matrix
Other necessary developments to get a multi–GNSS software:

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- requires the dynamic allocation of several arrays in many of the processing programs

⇒ Version 5.1 will be declared as “Galileo–ready”.
To improve the reprocessing capability

1. a new coordinate/velocity file containing time intervals

IGS05 COORDINATES EXTRACTED FROM IGS05.SNX 09-MAY-2008

FORMAT:  1
DATUM : IGS05

TYPE 001: STATION COORDINATES

<table>
<thead>
<tr>
<th>STATION NAME</th>
<th>X (M)</th>
<th>Y (M)</th>
<th>Z (M)</th>
<th>FLG</th>
<th>EPOCH</th>
<th>VALIDITY INTERVAL (FROM -&gt; TO)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>*****</td>
<td>*****</td>
<td>*****</td>
<td>*****</td>
<td>YYYY MM DD HH MM SS YYYY MM DD HH MM SS YYYY MM DD HH MM SS YYYY MM DD...</td>
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<td>PPP</td>
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<td>2004 12 23...</td>
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<tr>
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TYPE 002: STATION VELOCITIES

<table>
<thead>
<tr>
<th>STATION NAME</th>
<th>VX (M/Y)</th>
<th>VY (M/Y)</th>
<th>VZ (M/Y)</th>
<th>FLG</th>
<th>VALIDITY INTERVAL (FROM -&gt; TO)</th>
<th>RMS VX</th>
</tr>
</thead>
</table>
|              | *****    | *****    | *****    | ***** | YYYY MM DD HH MM SS YYYY MM DD HH MM SS YYYY MM DD HH MM SS YYYY MM DD... | ...
| ABPO 33302M001 | -0.01100 | 0.01790 | 0.01660 | NUVEL | ... |
| ADE1 50109S001 | -0.04600 | 0.00570 | 0.04170 | NUVEL | ... |
| ADIS 31502M001 | -0.01850 | 0.01840 | 0.01870 | NUVEL | ... |
| AJAC 10077M005 | -0.01460 | 0.00370 | -0.00530 | IGS05 | ... |
To improve the reprocessing capability

1. a new coordinate/velocity file containing time intervals

2. a section on local ties is added to the station information file

<table>
<thead>
<tr>
<th>TYPE 001: RENAMING OF STATIONS</th>
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<table>
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<tr>
<th>TYPE 002: STATION INFORMATION</th>
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<th>TYPE 003: HANDLING OF STATION PROBLEMS</th>
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<tr>
<th>TYPE 004: STATION EVENTS AND ECCENTRICITIES (INCLUDING TROPOSPHERE)</th>
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<table>
<thead>
<tr>
<th>LOCAL TIE (2 MINUS 1) (M)</th>
<th>CONSTRAINTS (M)</th>
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<table>
<thead>
<tr>
<th>CORRELATIONS</th>
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<th>STATION NAME 2</th>
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<th>EPOCH</th>
<th>SYS</th>
<th>DN/DX</th>
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<th>DU/DZ</th>
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<td>001</td>
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<td>08 00 00 00</td>
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<table>
<thead>
<tr>
<th>TYPE 005: HANDLING STATION TYPES</th>
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</table>
To improve the reprocessing capability

1. a new coordinate/velocity file containing time intervals
   (“station ABC” no longer necessary)

2. a section on local ties is added to the station information file
   (discontinuities and local ties may be specified considering an uncertainty)

3. FODITS: Find Outliers and Discontinuities in Time Series
   (presented by L. Ostini et al. at the EUREF Symposium in Brussels, June 2008)

4. improved SINEX support
   (e.g., several equipment setup per coordinate interval,
    GNSS–dependent antenna corrections directly from the NEQ)

5. derive periodic functions for parameters in ADDNEQ2
   (under development, not sure whether this feature will be a part of version 5.1)
Other new features/models of a version 5.1*: 


Other new features/models of a version 5.1*: 

* The final list of features and models provided with the delivery of version 5.1 to the user community will be defined later.
Other Highlights from our Development

Other new features/models of a version 5.1*: selection with a potential relevance for EPN–processing

- GLONASS ambiguity resolution (not for all strategies)
- ADDNEQ2 supports SINEX containing NEQ (instead of COV).
- Support of individually calibrated antennas in ANTEX in an automated processing scheme
  (Keywords: RINEX, SINEX)
- Troposphere modelling: GMF/GPT, VMF1
- Ionosphere modelling: higher order ionosphere correction
- ADDNEQ2: refined support for regional networks
  (e.g., repeatability computation with Transformation parameters)
- ORBGEN: Stochastic pulses for orbit fitting
- Introducing corrections for atmospheric pressure loading
Time Line to Deliver Version 5.1

- The main developments shall be finished in 2009.
- Define a list of further implementations to finalize a deliverable version.
- Review of the on-line help.
- Update the processing examples.
- Develop and test the installation procedure.
- Update the initial “README”-files.
- Update and complete the user manual.
THANK YOU!