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GPS data from receiver to processing input

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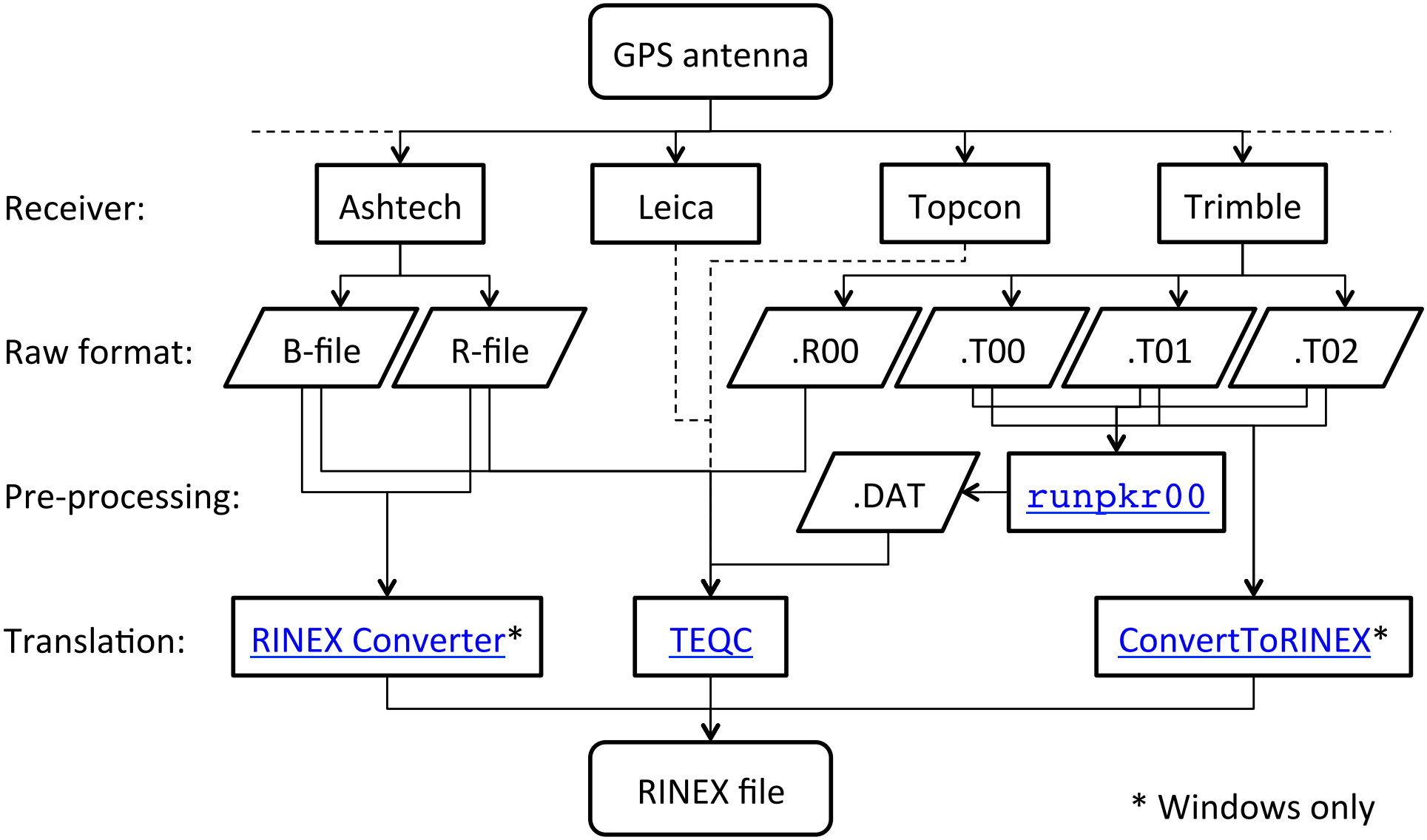
Raw data formats



Motivation for Receiver INdependent EXchange (RINEX) format

- All manufacturers have developed their own proprietary file formats for data storage specific to their receivers and processing software
  - Problems occur when processing data from another manufacturer's receiver
- RINEX developed by the Astronomical Institute of the University of Berne to allow easy and universal exchange of raw GPS data
  - Principal driver was the large European GPS campaign EUREF 89 - involved more than 60 GPS receivers of 4 different manufacturers.

RINEX formats

- RINEX 2
  - Short file names (explained in proceeding slides)
- RINEX 3
  - Long file names (explained in proceeding slides)
- GAMIT currently works with the RINEX 2 format and GPS observables only
- Support for RINEX 3 and GNSS (e.g. GLONASS) observables are under development

RINEX (2) data format

- Includes text file formats for:
  - observation (“o”)
  - navigation (“n”)
  - meteorological (“m”)
  - ionospheric data (“i”)

  } most important for most users
- Latest definition at ftp://ftp.igs.org/pub/data/format/rinex211.txt
- Each file type consists of a header section and a data section
- Header section contains global information for the entire file and is placed at the beginning of the file.
  - Contains header labels in columns 61-80 for each line contained in the header section
  - These labels are mandatory and must appear exactly as per format description
- RINEX 2 filename convention:
  - For site SSSS, on day-of-year DDD, session T and year YY:
    - SSSSDDDT.YYo (RINEX observation file ie the site’s GPS data)
    - SSSSDDDT.YYn (RINEX navigation file ie the broadcast ephem)
  - E.g., hers1270.03o is observation data for Herstmonceux, day 127, session 0, year 2003.
- All the dates and times in GPST

An example of RINEX (2) observation data

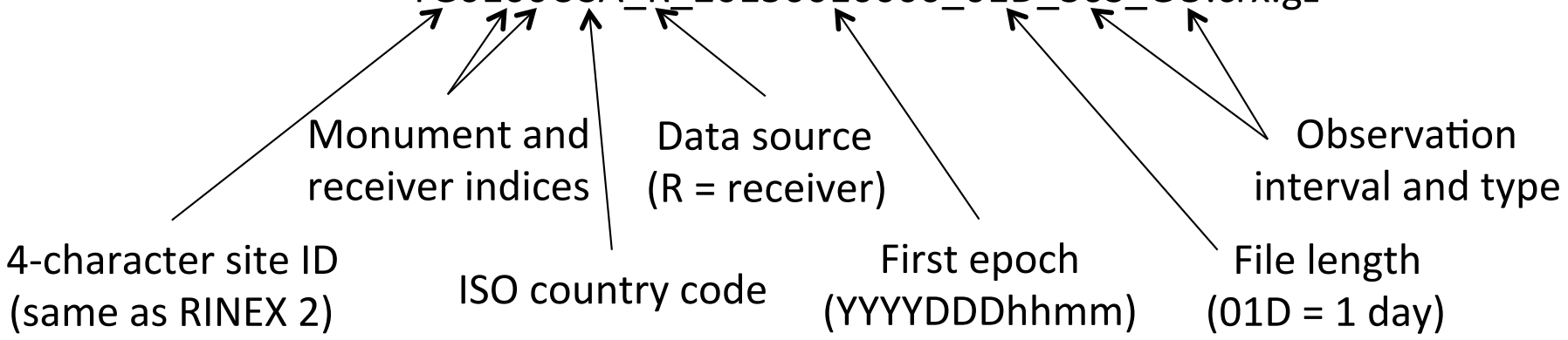
```
     2              OBSERVATION DATA                         RINEX VERSION / TYPE
National GPS Network Ordnance Survey    Oct  3 01:25:41 2002PGM / RUN BY / DATE
Active Station at Ordnance Survey Office Taunton            COMMENT
TAUN                                                        MARKER NAME
TAUN                                                        MARKER NUMBER
National GPS Network Ordnance Survey                        OBSERVER / AGENCY
0080148             LEICA RS500         0080148             REC # / TYPE / VERS
348                 LEIAT504        LEIS                    ANT # / TYPE
The following coordinates are NOT APPROXIMATE               COMMENT
Approx coords replaced by official precise ETRS89 values    COMMENT
  4015122.7250  -217716.1877  4934473.1877                  APPROX POSITION XYZ
        0.0000        0.0000        0.0000                  ANTENNA: DELTA H/E/N
     1     1                                                WAVELENGTH FACT L1/2
     4    L1    C1    L2    P2                             # / TYPES OF OBSERV
  2002    10     3     0     0   15.000000                  TIME OF FIRST OBS
  2002    10     3     1     0    0.000000                  TIME OF LAST OBS
                                                            END OF HEADER

02 10  3 00 00 15.0000000  0  9  2  3  8 15 17 18 22 27 31
PRN02 114956814.47149  21875546.363    89576741.90649  21875544.933
PRN03 106012532.74649  20173505.537    82607201.93949  20173503.535
PRN08 125711842.56047  23922167.349    97957288.14148  23922165.931
PRN15 119238856.33248  22690389.725    92913413.33748  22690387.811
PRN17 126647445.65347  24100198.242    98686357.86547  24100196.537
PRN18 115864289.86249  22048234.526    90283862.18149  22048231.774
PRN22 121423791.97248  23106173.809    94615957.45149  23106172.539
PRN27 126265507.08247  24027524.736    98388709.67748  24027522.683
PRN31 109327695.42149  20804367.862    85190428.66449  20804365.462
02 10  3 00 00 30.0000000  0  9  2  3  8 15 17 18 22 27 31
...
```

RINEX (3) data format

- Must be able to accommodate increased number and complexity of observations from multi-GNSS observations (GPS, GLONASS, Galileo, etc.)
- Latest definition at ftp://ftp.igs.org/pub/data/format/rinex303.pdf
- Each file type consists of a header section and a data section
- Header section contains global information for the entire file and is placed at the beginning of the file.
  - Contains header labels in columns 61-80 for each line contained in the header section
  - These labels are mandatory and must appear exactly as per format description
- RINEX 3 filename convention is longer and more complicated than for RINEX 2, e.g.

TG0100USA_R_20150010000_01D_30S_GO.crx.gz



Compressing/Uncompressing RINEX

- File compression
  - "*.zip" files
    - Uncompress using "unzip", "pkzip" or "WinZip"
    - See http://www.pkware.com/ or http://www.winzip.com/ , or http://www.7-zip.org/
  - "*.??o.Z" (RINEX 2) and "*.rnx.gz" (RINEX 3) files (UNIX `compress` or `gzip`)
    - e.g., hers0010.02o.Z, TG0100USA_R_20150010000_01D_30S_GO.rnx.gz
    - Uncompress using "`uncompress`", "`gunzip`", "7zip", "WinZip" or similar
  - "*.??d.Z" (RINEX 2) and "*.crx.gz" (RINEX 3) files (Hatanaka compression)
    - e.g., hers0010.02d.Z, TG0100USA_R_20150010000_01D_30S_GO.crx.gz
    - Need to uncompress as above to get *.??d and *.crx files
    - Then need to 'unHatanaka' using `CRX2RNX` from http://sopac.ucsd.edu/dataArchive/hatanaka.html
  - Leica Geo Office uncompresses files automatically when using "Internet Download" tool. For manual import you need to uncompress the files manually

runpkr00 (Trimble raw to dat)

- Proprietary software from Trimble
- Maintained by UNAVCO nowadays
  - http://facility.unavco.org/kb/questions/744/
- `runpkr00 -g -adeimv <raw file> [dat-file root]`
- Converts raw data from Trimble receiver to teqc-compatible input “dat”-file
- Always use “-g” option separately from other options

Pre-processing data

- Some level of data quality control may be performed prior to any data processing
- Utilities are available to perform simple but valuable tests
  - The most common example is TEQC (pronounced “tek”)
    - **T**ranslate, **E**dit, **Q**uality **C**heck
    - Translates common binary formats to RINEX format
    - Header editing, windowing, splicing of RINEX data
    - Quality check in ‘lite’ mode (no navigation file) or ‘full’ mode (navigation file available)
    - Download for *free* from

http://www.unavco.org/facility/software/teqc/teqc.html#executables

Using teqc

- Be sure to use correct raw format
  - `teqc -tr d <Trimble .dat file>`
  - `teqc -ash d <Ashtech B-file, etc.>`
- Ability to control observations using "-O.obs"
  - `teqc -O.obs L1L2C1P2 -tr d <Trimble .dat file>`
- Ability to control header information with other "-O.xxx" options
  - `teqc -O.o "M. Floyd" -O.obs L1L2C1P2 -tr d <Trimble .dat file>`
- May create and use a teqc configuration file for consistent information
  - `teqc -config teqc.cfg -tr d <Trimble .dat file>`
- Use a script or command line loop to create RINEX files in batch

TEQC

- Quality Control (QC)
  - In ‘lite’ mode, teqc doesn’t know anything about the satellite positions
    - `teqc +qc site1891.02o > teqc.out`
    - 7 files generated; use the -plots switch to prevent all but the summary (‘S’) file being generated
  - In ‘full’ mode, additional information is available based on the satellite positions
    - `teqc +qc –nav site1891.02n site1891.02o > teqc.out`
    - 9 files generated (elevation and azimuth of satellites)
  - Full solution if navigation file matches observation file, e.g. site1891.02o and site1891.02n,
    - `teqc +qc site1891.02o > teqc.out`

Approximate position

Accurate a priori coordinates necessary for good GPS processing

1. Run teqc to create RINEX observation and (broadcast) navigation files, e.g.

```
teqc +nav abcd3650.14n +obs abcd3650.14o -tr d 12343650.dat
```

2. Run teqc in qc-mode on observation file with navigation file to get pseudorange-derived estimate of approximate coordinate, e.g.

```
teqc +qc -nav abcd3650.14n abcd3650.14o
```

May also be done using GG's `sh_rx2apr`