



TEQC and the RINEX Connection:  
Past, Present, and Possible Future

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What is teqc?

software developed and supported at UNAVCO for  
“translation, editing, quality check” of GNSS data

Why is teqc important to the IGS (at this time)?

- 80-90% of all RINEX handled by the IGS use teqc in some way:  
translation, metadata editing, splicing, time-windowing, ...
- counting GNSS qc: about 100% of IGS sites

What does the IGS need to know now about teqc?

- C-code that became teqc started in Jan 1996:
  - replace UNAVCO's Fortran-code "QC" program(s)
  - editing capability for RINEX header metadata
  - was supposed to a 4-6 month project to "make life better"
- early 1996: new RINEX 2.xx elements were under consideration:
  - GLONASS observables and navigation messages
  - sampling intervals < 1 second
  - signal-to-noise "S1" and "S2"
  - new observables to RINEX Met
- All likely features for the code design
  - start of in-depth dialogs with Werner Gurtner about RINEX

- Binary reading capability added for high-rate TurboBinary:
  - GPSMet, launched 3 Apr 1995
  - Data output as RINEX “2”/2.xx
- Binary reading capability added for Trimble binary stream format:
  - early 1996 Yellowstone permanent stations with VSAT via USGS
  - format being used by some NGS/CORS Trimble sites
  - Similar to Trimble’s .dat format (so, add that too ...)
- Then translation floodgates opened ...
  - JPL/AOA ConanBinary and normal TurboBinary formats
  - TI-4100 (ROM, GESAR, BEPP/CORE) formats
  - ARGO .dat and .orb formats
  - Leica DS fileset format
  - ... and so on

- clear that translation and outputting standardized RINEX was going to be an important function
- UNAVCO archive group:
  - extraction of metadata from raw data files for database archiving
  - minimize reliance on various RINEX translators
- requirement to run on in-house SunOS and Solaris Sparc, HP-UX, MS DOS, and MS Windows
- first “teqc” version release 17 Mar 1997

- Expansion to the following differing endianness formats:
  - AOA/JPL TurboBinary and ConanBinary
  - Ashtech B/E/S/D fileset format, MBEN/DBEN/PBEN stream, Z-12 R-file format, mirco-Z BINEX, micro-Z CGRS U-file format
  - Leica LB2 format, MDB format, and DS fileset format
  - Trimble RT17 and RT27 in .dat/.tgd fileset & stream formats
  - Septentrio Binary Format (SBF)
  - Topcon TPS
  - Javad JPS
  - Navcom binary format
  - JPL SOC format
  - IGS RTigs format
  - Texas Instrument TI-4000 ROM, GESAR, and BEPP/CORE formats
  - .... plus others (mainly L1-only formats)

- teqc compiled for following OSs (of differing endianness):
  - SunOS, Solaris Sparc, Solaris x86 (native and gcc)
  - HP-UX (native and gcc)
  - Mac OSX (gcc)
  - RH Linux (gcc, 32- and 64-bit)
  - Viper/ARM (PC-104) Linux-ARM (gcc)
  - Microsoft DOS and Windows 95/98/NT/2000/XP/... (Borland)
  - others in the past: IBM AIX, IRIX, DEC OSF1
- qc: support for GPS, GLONASS, SBAS, Galileo, and related modifications for RINEX “2.xx”-style GNSS data

## Number one priority of teqc:

Provide translation, editing, and quality check capability for (mainly GPS) data coming into and out of UNAVCO

Primary considerations  
for future evolution of teqc:

1. teqc is a **“many-to-one” filter** with a design **tightly coupled to RINEX 2.xx**
2. significant design and code changes needed to go further

## The problem ...

- now used nearly everywhere (e.g. by the IGS)
- now expected to evolve *ad infinitum* with formats, OSs, RINEX, GNSS, signals
- Sisyphean task of one person developing and supporting teqc for 14+ years
- source code cannot be released: proprietary info, NDAs, etc.
- internal design tied to RINEX 2 – 2.11 specs

- RINEX 1 & 2.xx: one observable list
  - 3.xx: different observable list for each constellation
- RINEX 2.xx: SNRs are in free-form units
  - 3.xx: CNo SNRs must be in dB-Hz
- RINEX 2.xx: different RINEX Nav file for each constellation
  - 3.xx: can have all constellation messages in one file
- RINEX 1 & 2.xx: some signal granularity (probably not enough)
  - 3.xx: full signal granularity (maybe too much)

- RINEX 2.xx (2-char observable IDs)
  - L2 – sufficed when just L2P(Y) signal ...  
... but insufficient with additional L2C signal
- RINEX 3.xx (3-char observable IDs)
  - L2P – phase of L2P
  - L2Y – phase of L2Y
  - L2W – phase for Z-tracking or similar of L2Y
  - L2D – semi-codeless phase tracking;  $L1C/A+(P2+P1)$
  - L2M – phase of L2 M(ilitary)-code
  - L2S – phase of L2C C(ivilian) M(edium) code
  - L2L – phase of L2C C(ivilian) L(ong) code
  - L2X – phase of L2C (CM + CL)
  - L2C – phase of L2C/A
  - L2N – codeless L2 tracking

- RINEX 3.01 (and 2.12):
  - Requires phase offset normalization ...
  - ... but **no** information to do this in manufacturers' native formats
  - i.e. RINEX 3.01 (or 2.12) not coming from teqc
- If the IGS requires phase offset normalization:
  - Require that receivers in IGS network directly output 3.01, or
  - Require that manufacturers supply translators to 3.01 for all formats on all platforms used by the IGS SOs (i.e. not just on Windows), or
  - Require a switch to a common binary exchange (e.g. high-precision RTCM messages) and someone develops translator to 3.01 for all platforms used by the IGS SOs, or
  - Require that manufacturers **agree on standardized phase offset normalization** and that this is done prior to **any** data output by IGS receivers ... and then back to normalized RINEX 3.00 (or 2.11)

- IGS requires phase offset alignment done in receivers (like GPS L1C/A and L1P(Y) has been for years)
  - then all data is the same (RTCM, RINEX, native, ...)
  - no need for RINEX 3.01 (or 2.12)
- design interim RINEX 2.xx that gives more granularity than 2.11, e.g. phase, SNR, doppler differentiation of:
  - GPS L2P(Y) vs. L2C
  - GPS L1P(Y) vs. L1C/A vs. (future Block III) L1C
  - GLONASS L1C/A vs. L1P and L2C/A vs. L2P
  - other?and include Galileo RINEX nav definition for interim RINEX 2.xx
- easier to adapt 2.xx-capable software to new 2.xx than to 3.xx

- Simultaneously with teqc:
  - continue to keep up with currently supported manufacturers' formats
  - translation could be upgraded to handle new interim RINEX 2.xx, but would require teqc to be rebuilt as a "many-to-many" filter
  - quality check could be upgraded for new interim RINEX 2.xx
  - improvements for using non-GPS orbits: GLONASS, SBAS, Galileo, SP3
  - point-positioning improvements
- All this would give the IGS time to proceed with:
  - switching over all IGS sites and data flow using new HP RTCM (or ??)
  - getting rid of current "native format - RINEX - Hatanaka-compress - UNIX compress - UNIX decompress - Hatanaka-decompress - RINEX" data flow
  - eventually only using teqc for qc functionality ... which is where we'd like to concentrate more effort in teqc anyway