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RINEX Version 2.10 Modifications

July, 6, 1999

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The call for comments to the proposed modifications of RINEX Version 2 (to become Version 2.10) brought up two requests that we decided to handle with the next version (2.20?) only:

1)

More precise definition of the signal-to-noise "observables" S1, S2, if possible a receiver-independent definition, provided the necessary conversion algorithms exist to convert the receiver-generated values in the raw data stream to some agreed-upon definition, as e.g., the carrier-to-noise density ratio C/No.

2)

Definition of additional observables to deal with smoothed pseudorange observables (to be able to report either sampled and smoothed values or sampled values plus corrections) or to distinguish e.g., between C/A code based and P code based L1 phase data.

A possibility to cover both requests would be to extend the RINEX observation type names "to the left" (e.g., CNS1 for carrier-to-noise density ratio, or PL1, ZL1, CL1 for the various L1 carrier phase recovering techniques), so that those readers not bothering with details would just read the original names (e.g., S1 or L1).

However, we believe that the definition of such additional observables, together with the necessary algorithms, will need some time, and we don't want to further delay the introduction of the other, unquestioned features.
We invite everybody interested in the above extensions to start the discussion anytime.

Introduction Date

Modifications for RINEX reader software necessary to handle RINEX Version 2.10 files should be implemented before January 1st, 2000.

RINEX Version 2.10 files containing new features should not be publicly distributed before January 1st, 2000!

Documentation
****

The revised RINEX Version 2 document will be available at

ftp://ubeclu.unibe.ch/aiub$ftp/rinex/rinex210.txt

as well as at the IGS Central Bureau Information System

ftp://igscb.jpl.nasa.gov/igscb/date/format/rinex210.txt

Till end of July 1999

ftp://ubeclu.unibe.ch/aiub$ftp/rinex/rinex210.txt

will contain a draft version. Comments are welcome.

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Fractional Version Number (All RINEX file types)
****

The RINEX version number in the first header line will be a non-integer value for all rinex file types, as already introduced for the GLONASS navigation message file.

RINEX VERSION / TYPE	- Format version (2.10)	F9.2,11X,
	- File type ('O' for Observation Data)	A1,19X,
	- Satellite System: blank or 'G': GPS	A1,19X
	'R': GLONASS	
	'T': NNSS Transit	
	'M': Mixed	

Example:

```
     2.10           OBSERVATION DATA    M (MIXED)           RINEX VERSION / TYPE
```

Pad Two-digit Year Fields With a Zero (All files)
****

All 2-digit year fields for the years 2000-2009 are recommended to be padded with a zero for easier human readability.

Examples:

Obs:

```
 00  2  6 12 13 10.0000000  0 12G23G07G02G05G26G09G21R20R19R12R02R11
```

Nav:

```
 3 00  2  6 12 15  0.0 0.163525342941D-03 0.363797880709D-11 0.108000000000D+05
```

Met:

```
 00  2  6 12 15  0  987.1   10.6   89.5
```

Ambiguities in the Date of Met Data and GLONASS Nav Message Records
****

Clarification:

RINEX version 2 stores the years of data records with two digits only. The header of observation files contains a TIME OF FIRST OBS record with the full four-digit year, the GPS nav messages contain the GPS week numbers.

A hundred-year ambiguity occurs in the met data and GLONASS and GEO nav messages: Instead of introducing a new TIME OF FIRST OBS header line it is safe to stipulate that any two-digit years in RINEX Version 1 and Version 2 files are understood to represent

```
               80-99:  1980-1999
               00-79:  2000-2079
```

Full 4-digit year fields could then be defined by a future RINEX version.

Increase Field Length of TIME OF FIRST and LAST OBS (Observation files)
****

In order to have the same granularity of the seconds field in the TIME OF FIRST OBS and TIME OF LAST OBS header record as the one in the OBS RECORDS we propose to increase the field length for the seconds from F12.6,6X to F13.7,5X:

	TIME OF FIRST OBS	- Time of first observation record (4-digit-year, month,day,hour,min,sec) - Time system: GPS (=GPS time system) GLO (=UTC time system) Compulsory in mixed GPS/GLONASS files Defaults: GPS for pure GPS files GLO for pure GLONASS files	5I6,F13.7, 5X,A3
*	TIME OF LAST OBS	- Time of last observation record (4-digit-year, month,day,hour,min,sec) - Time system: GPS (=GPS time system) GLO (=UTC time system) Compulsory in mixed GPS/GLONASS files Defaults: GPS for pure GPS files GLO for pure GLONASS files	5I6,F13.7, 5X,A3

Example:

```
  1999     1     5    12    33   30.0490000     GPS         TIME OF FIRST OBS
  1999     1     5    22    25    0.0550000     GPS         TIME OF LAST OBS
```

Non-Integer Sampling Rates (Observation files)

****

The format of the observation interval in the INTERVAL header record is modified in order to allow for fractional parts of seconds (e.g. 0.5 second sampling)

*	INTERVAL	Observation interval in seconds (Old format for integer values only: I6)	F10.3	*

Example:

```
     0.100                                                  INTERVAL
```

Such a record will still conform to RINEX version 1 and 2 for

- integer intervals
- fractional intervals smaller than one second (read as zero = undefined)

Non-integer intervals larger than one second would be read as INT(interval).

Header Records After Event Flags (Obs files)

****

All event flags 2-5 may immediately be followed by header records (the restriction for event flags 2 and 5 shall be removed, especially to allow for COMMENT lines to follow).

EPOCH/SAT or EVENT FLAG	- Epoch : year (2 digits, padded with 0 if necessary) month,day,hour,min, sec	1X,I2.2, 4(1X,I2), F11.7,
	- Epoch flag 0: OK 1: power failure between previous and current epoch >1: Event flag .... If EVENT FLAG record (epoch flag > 2-5): Event flag: 2: start moving antenna .... 5: external event (epoch is significant, same time frame as observation time tags) .... - "Number of satellites" contains number of special records to follow It's recommended to write this value even if it is zero.	I3, I3

Example:

```
 99  1 24 13 13  1.2345678  5  2
     *** AN EVENT FLAG WITH SIGNIFICANT EPOCH ***           COMMENT
    *** DIRECTLY FOLLOWED BY TWO COMMENT LINES  ***         COMMENT
```

Default Wavelength Factor Header Line (Obs files)
****

The default wavelength factor RINEX header line is a required line.

WAVELENGTH FACT L1/2	- Wavelength factors for L1 and L2 1: Full cycle ambiguities 2: Half cycle ambiguities (squaring) 0 (in L2): Single frequency instrument	2I6,
	- zero or blank	I6
	The default wavelength factor line is required and must preceed satellite-specific lines.	

Optional satellite specific wavelength factor RINEX header lines may follow, which should identify a state different from the default values:

WAVELENGTH FACT L1/2	- Wavelength factors for L1 and L2 1: Full cycle ambiguities 2: Half cycle ambiguities (squaring) 0 (in L2): Single frequency instrument	2I6,
	- Number of satellites to follow in list for which these factors are valid.	I6,
	- List of PRNs (satellite numbers with system identifier)	7(3X,A1,I2)
	Repeat record if necessary.	

Additional Observation Type: S1, S2 (Obs files)
****

To allow the exchange of signal strength or signal-to-noise values with the full resolution two new observation types S1 and S2 are defined: They are the original values output by the receiver for L1 and L2 tracking.

	The following observation types are defined in RINEX Version 2: ... ... S1, S2: Raw signal strengths or SNR values as given by the receiver for the L1,L2 phase observations Units : ... SNR etc : receiver-dependent	

A receiver-independent definition of such a value should be introduced in the next RINEX format revision!

Application of Receiver Clock Offsets to the Data and Time Tag (Obs files)
****

RINEX Version 2 defined a field in the epoch/satellite records for the real-time determined clock offsets but asked that the observables code, phase and time tag had to be corrected by these offsets.

The new RINEX Version 2.10 will allow for either way, a new header record has been defined to indicate if the data has been corrected by the reported clock offset or not.

	RCV CLOCK OFFS APPL	Epoch, code, and phase are corrected by applying the realtime-derived receiver clock offset: 1=yes, 0=no; default: 0=no Record required if clock offsets are reported in the EPOCH/SAT records	I6

Example:

```
     1                                                    RCV CLOCK OFFS APPL
```

Curve Fit Interval (Navigation message file)
****

Bit 17 in word 10 of subframe 2 is a "fit interval" flag which indicates the curve-fit interval used by the GPS Control Segment in determining the ephemeris parameters, as follows (see ICD-GPS-200, 20.3.3.4.3.1):

0 = 4 hours
1 = greater than 4 hours.

Together with the IODC values and Table 20-XII the actual fit interval can be determined.

The second value in the last record of each message shall contain the fit interval in hours determined using IODC, fit flag, and Table 20-XII, according to the Interface Document ICD-GPS-200.

BROADCAST ORBIT - 7	- Msg transmit time (sec of GPS week) (derived e.g. from Z-count in Hand Over Word HOW) - Fit interval (hours) (see ICD-GPS-200, 20.3.4.4) Zero if not known - spare - spare	3X,4D19.12

SV Health (Navigation message file)
****

The health of the signal components (bits 18 to 22 of word three in subframe one) are now included into the health value reported in the second field of the sixth nav mess records:

BROADCAST ORBIT - 6	- SV accuracy	(meters)	3X,4D19.12
	- SV health	(bits 17-22 w 3 sf 1)	
	- TGD	(seconds)	
	- IODC	Issue of Data, Clock	

A program reading RINEX files could easily decide if bit 17 only or all bits have been written:

RINEX Value: 0 Health OK
RINEX Value: 1 Health not OK (bits 18-22 not stored)
RINEX Value: >32 Health not OK (bits 18-22 stored)

Transmission Time of Message (Navigation message file)
****

The transmission time of message can be shortly before midnight Saturday/Sunday, the TOE and TOC of the message already in the next week. As the reported week in the nav message (BROADCAST ORBIT - 5 record) goes with ToE, the transmission time of message should be reduced by 604800 (i.e., will become negative) to also refer to the same week.

BROADCAST ORBIT - 7	- Transmission time of message *)		3X,4D19.12
	(sec of GPS week, derived e.g.		
	from Z-count in Hand Over Word (HOW)		
	- Fit interval	(hours)	
	(see ICD-GPS-200, 20.3.4.4)		
	Zero if not known		
	- spare		
	- spare		

*) Adjust the Transmission time of message by -604800 to refer to the reported week, if necessary

Additional Observation Types (Met data files)
****

The following two additional met data observation types have been defined:

ZD : Dry component of zenith path delay
ZT : Total zenith path delay

ZT could be used to distribute the zenith path delays estimated for permanently operated GPS sites using their GPS observables.

RINEX Extensions for Geostationary Satellites (GPS Signal Payloads)
****

With the implementation of GNSS programs, GPS-like ranging measurements can be performed on geostationary navigation payloads.

RINEX Version 2.10 defines the necessary extensions to handle such data in RINEX files for data exchange and postprocessing purposes.

RINEX Observation Files for GEO Satellites

A new satellite system identifier has been defined for the geostationary GPS signal payloads: "S"

RINEX VERSION / TYPE	- Format version (2.10)	F9.2,11X,
	- File type ('O' for Observation Data)	A1,19X,
	- Satellite System: blank or 'G': GPS	A1,19X
	'R': GLONASS	
	'S': Geostationary signal payload	
	'T': NNSS Transit	
	'M': Mixed	

The satellite identifier 'snn' in the observation files consists of the two parts:

's' : Satellite system identifier ("S")
'nn' : Satellite number, being the designated PRN of the GEO satellite minus 100,

e.g.: PRN = 120 --> 'snn' = "S20"

In mixed dual frequency GPS satellite / single frequency GEO payload observation files the fields for the second frequency observations of GEO satellites remain blank or are set to zero values.

RINEX Navigation Message Files for GEO Satellites

As the GEO broadcast orbit format differs from the GPS message a special GEO navigation message file format has been defined which is nearly identical with the GLONASS nav mess file format.

Proposed naming conventions:

System	GEO Nav Files	Compressed GEO Nav Files
UNIX	ssssdddf.yyH	ssssdddf.yyH.Z
VMS	ssssdddf.yyH	ssssdddf.yyH_Z
DOS	ssssdddf.yyH	ssssdddf.yyU

The header section contains informations about the generating program, comments, and the difference between the GEO system time and UTC.

The first data record contains the epoch and satellite clock information, the following records contain the satellite position, velocity and acceleration and auxiliary information such as health, age of the data, etc.

The time tags in the GEO navigation files are given in the GPS time frame, i.e. not UTC.

The corrections of the satellite time to UTC are as follows:

GEO : Tutc = Tsv - aGf0 - aGf1 *(Tsv-Toe) - W0 - leap_sec

W0 being the correction to transform the GEO system time to UTC. Toe, aGf0, aGf1 see below.

TABLE A15

GEOSTATIONARY NAVIGATION MESSAGE FILE - HEADER SECTION DESCRIPTION

	HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT
	RINEX VERSION / TYPE	- Format version (2.10) - File type ('H' = GEO nav mess data)	F9.2,11X, A1,39X
	PGM / RUN BY / DATE	- Name of program creating current file - Name of agency creating current file - Date of file creation (dd-mmm-yy hh:mm)	A20, A20, A20
*	COMMENT	Comment line(s)	A60
*	CORR TO SYSTEM TIME	- Time of reference for system time corr (year, month, day) - Correction to transform the GEO system time to UTC (W0)	3I6, 3X,D19.12
*	LEAP SECONDS	Number of leap seconds since 6-Jan-1980	I6
	END OF HEADER	Last record in the header section.	60X

Records marked with * are optional

TABLE A16

GEOSTATIONARY NAVIGATION MESSAGE FILE - DATA RECORD DESCRIPTION

OBS. RECORD	DESCRIPTION	FORMAT
PRN / EPOCH / SV CLK	- Satellite number (PRN - 100) - Epoch of ephemerides (GPS) (Toe) - year (2 digits, padded with 0 if necessary) - month,day,hour,minute, - second - SV clock bias (sec) (aGf0) - SV relative frequency bias (aGf1) - message frame time (sec of day GPS)	I2, 1X,I2.2, 4(1X,I2), F5.1, D19.12, D19.12, D19.12
BROADCAST ORBIT - 1	- Satellite position X (km) - velocity X dot (km/sec) - X acceleration (km/sec2) - health (0=OK)	3X,4D19.12
BROADCAST ORBIT - 2	- Satellite position Y (km) - velocity Y dot (km/sec) - Y acceleration (km/sec2) - Accuracy code (URA)	3X,4D19.12
BROADCAST ORBIT - 3	- Satellite position Z (km) - velocity Z dot (km/sec) - Z acceleration (km/sec2) - spare	3X,4D19.12

References for the definition of the accuracy and health codes still have to
be defined. Help is needed here by colleagues working with such GEO data!