CGGTTS-Version 2E: Integration of BDS-3

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Abstract

This paper is a complement to the [1]. It details the signal and naming conventions, in the Common GNSS Generic Time Transfer Standard (CGGTTS) Version 2E, associated with the new generation of the BeiDou System: BDS-3.

1. Introduction

The standard CGGTTS version 2E has been presented in [1], covering clock solutions obtained with GPS, GLONASS, Galileo and BeiDou (also called BDS for BeiDou System). For this latter, only satellites from the second generation BDS-2 were however available at that time. Since then, the BeiDou constellation has been upgraded, with a new generation called BDS-3, containing more satellites and using new signals and frequencies. In particular, while BDS-2 was mainly dedicated to regional applications over Asia, BDS-3 proposes, as of 2024, about 25 satellites in Medium Earth Orbit, hence visible from all regions of the world.

This paper details the convention for reporting the clock solutions obtained from BDS-3 measurements in the CGGTTS standard. This convention was first agreed by the CCTF working group on GNSS time transfer in 2023. The standard computation algorithm and data format are not modified. A new naming convention is defined for BDS-3 clock results, in such a way that a full compatibility is ensured with the previous conventions used for BDS-2 clock results in the CGGTTS Version 2E.

2. Clock solutions to be reported in CGGTTS for BeiDou-3

The new generation BDS-3 does not broadcast any more the signal B2I previously used for the ionosphere-free combination. The signal B1I is still broadcast, but an additional signal is transmitted, B1C, on the same frequency as GPS L1 and Galileo E1. As a consequence, the pseudorange measurements to be used for BDS-3 are B1C for the single frequency solutions, and combined with the signal B2a (same frequency as GPS L5 and Galileo E5a) for the ionosphere-free combination.

The computation of clock solutions in BeiDou requires Total Group Delays, that are broadcasted by the satellites in the navigation message. These TGDs depend on the frequencies and signals used, and are therefore different for BDS-2 and BDS-3. If the CGGTTS is computed from a R2CGGTTS software, navigation files in format RINEX 4.0 or later should be used. The TGDs for BDS-3 are indeed not available in the previous RINEX versions. The software tool named R2CGGTTS and developed at the Royal Observatory of Belgium, in its version 8.7 allows managing RINEX 4.0 and creating CGGTTS files following the CGGTTS Version 2E described in [Metrologia 2015 52 G1] for BDS-2 satellites and here below for BDS-3 satellites. This software tool is made available on the BIPM server (ftp://tai.bipm.org/temp).

3. Format for reporting BeiDou-3 solutions in the CGGTTS

3.1 File name

As detailed in [Metrologia 2015 52 G1], the CGGTTS file names should be on the form: XFLLmodd.ddd. We remind here the definition of each character, including the BDS-3 system:

• X is the code character indicating the constellation, using the same convention as in the RINEX standard:

"G" for a GPS,

"R" for a GLONASS (R stands for Russia),

"E" for Galileo (Europe),

"C" for BDS-2 (China),

"B" for BDS-3 (China),

"J" for QZSS (Japan),

• F is the code character indicating the frequencies and channels:

"S" a Single-frequency single-channel observation file

- "M" for a single-frequency multi-channel observation file
- "Z" for a dual frequency observation file (always multi-channel)
- LL is the two alphabetical character code for the laboratory
- m is the receiver identification first character (to be chosen by the laboratory), it can be "_" if not applicable or "0 to 9"
- o is the receiver identification second character (to be chosen by the laboratory), it can be "_" if not applicable or "0 to 9"
- dd.ddd is the MJD of the first observation in the file

For BeiDou results, the files under the form CMLLmodd.ddd will therefore contain clock results computed from the pseudoranges measured on the frequency B1I. As both BDS-2 and BDS-3 satellites transmit this signal, the files CMLLmodd.ddd will contain clock solutions obtained from both satellite generations. Files under the form BMLLmodd.ddd will however contain only clock solutions from the BDS-3 satellites, computed from pseudoranges measured in B1C.

Files under the form CZLLmodd.ddd will contain dual-frequency solutions from only BDS-2 satellites and files under the form BZLLmodd.ddd will contain dual-frequency solution only from BDS-3 satellites.

3.2 Code names

Table 1 Of the [Metrologia 2015 52 G1] is upgraded as follows:

RINEX	Detail	Header	Column FRC
convention		INTDLY/SYSDLY/TOTDLY	
(RINEX 3.0x and		, ,	
RINEX 4.0x)			
C1C	GPS/GLONASS/QZSS/SBAS L1	C1	L1C
	С/А,		
C1P	GPS/GLONASS L1P	P1	L1P
C1x*	GALILEO E1	E1	_E1
	QZSS L1C	C1	L1C
	BEIDOU B1i (RINEX 3.02)	B1i	B1i
	BEIDOU B1C (RINEX ≥ 3.03)	B1C	B1C
C2C	GLONASS L2 C/A	C2	
C2P	GPS/GLONASS L2P	P2	
C2x*	GPS/QZSS L2C	C2	
	BEIDOU B1i		
C5x*	GALILEO E5a	E5a	
C7x*	BEIDOU B2i	B2	
Dual-Frequency Combinations			
GPS	C1 or P1 & C2 or P2		L3P
Galileo	E1 & E5a		L3E
BDS-2	B1i & B2i		L3B
BDS-3	B1C & B2a		L3B
GLONASS	C1 or P1 & C2 or P2		L3P
QZSS	C1 & C5		L3Q

Table 1. Code denomination to be used in CGGTTS V2E

*where x is the channel attribute.

4. Conclusion

This document presented the signal and naming conventions for BDS-3 signals in the Common GNSS Generic Time Transfer Standard (CGGTTS) Version 2E. The compatibility has been assured so that both BDS-2 can still be used in the format defined previously.

References

[1] Petit, G., Defraigne, P., CGGTTS-Version 2E: an extended standard for GNSS Time Transfer, Metrologia 2015 52 G1