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A Brief Overview about RTCM in Brazil: Some Developments and Standard Services

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1. Introduction

The Radio Technical Commission for Maritime services (RTCM) Subcommittee 104 (SC-104) formats are used by Global Navigation Satellite Systems (GNSS) users when they need to perform a real-time positioning more accurate than absolute positioning. In some countries, the RTCM is used in conjunction with other protocols. For example, with the data transmission Radio Data System (RDS), with which some formats and services were developed for DGPS positioning (although nowadays the use of RDS for this application seems to be discontinued): the Radio Aided Satellite Navigation Technique (RASANT), developed in Germany, the DCI and ACCQPOINT, developed in the U.S.A., and DGPSBRDS, developed in Brazil. In this country (Brazil), in general, the technical details of RTCM (and RDS) formats (or protocols) are poorly known. Even among researchers, the RTCM is almost used in its original standard form, that is, without being decoded, processed and encoded in another format (for example, for transmission by RDS), and recoded again in RTCM format to apply in GPS receivers. The exception was the work of doctoral thesis in Geodetic Sciences of this author, who worked on developing a format for the transmission of differential correction data via RDS. To do so, he had to understand their decoding and encoding to write algorithms (software) that make the development of the DGPSBRDS (Brazilian DGPS by RDS) possible. It will be presented: a brief overview of the DGPSBRDS development; a brief overview of the Brazilian GNSS active network and use of RTCM in standard data broadcasting service; some other work results using RTCM.

2. DGPSBRDS: development of a Brazilian DGPS format/service for transmission by RDS

In the author's doctoral thesis work (Development and experimentation of a format for transmitting DGPS corrections by RDS in Brazil), he developed a format called DGPSBRDS which allows differential corrections transmission through RDS (data transmission by the subcarrier broadcasting signal of a Frequency Modulated radio broadcaster). This required understanding the RTCM 2.x. He developed routines for: message type 1 (differential corrections) real-time decoding; encoding for DGPSBRDS format, designed for transmission through the RDS; and, recoding again in RTCM format to be applied in GSP user receiver. Because each RDS ODA (Open Data Applications) group message have only 37 usable data bits, the development of DGPSBRDS required the exclusion of any redundant information within RTCM type 1 message, to reduce the number of bits to a value possible to be transmitted by the RDS. Figure 1 illustrates some RTCM type 1 frames, correspondent decoded binary form, and recoding corresponding to the DGPSBRDS format (Saatkamp, 2003).

Fig. 1

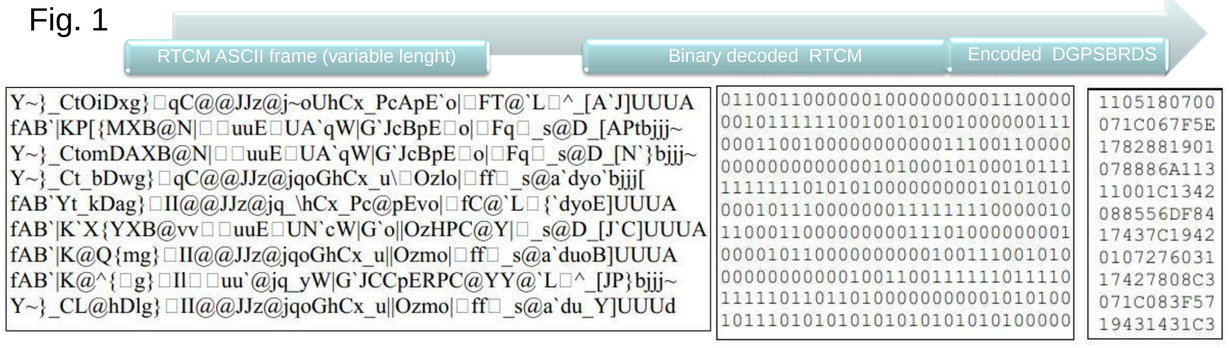

Figure 2 illustrates the above first RTCM binary frame decoded with correspondent signified and values.

Fig. 2

```
No. de bits: 330              Stid:  1      MZcount:  917.4

Sat:  25      UDRE:  0      IOD:  5      PRC:   0.56     RRC:  0.000
Sat:  20      UDRE:  0      IOD:  23     PRC:  -6.88     RRC:  0.004
Sat:  1       UDRE:  0      IOD:  232    PRC:  -6.28     RRC:  0.000
Sat:  11      UDRE:  0      IOD:  19     PRC:   0.78     RRC:  0.000
Sat:  31      UDRE:  1      IOD:  186    PRC: -23.52     RRC:  0.002
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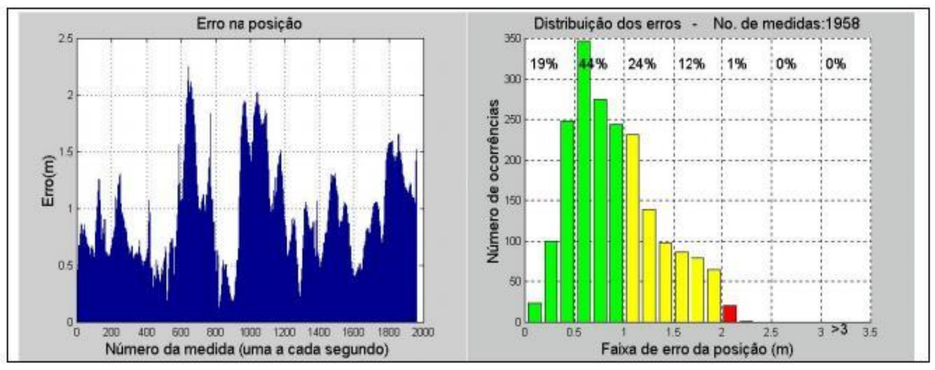
The DGPSBRDS were implemented at end year 2002 on a broadcasting station and tested for one week, with DGPS statics and kinematic positioning in Curitiba, Paraná. Figure 3 shows a typical DGPSBRDS static positioning result (accuracy behavior) during about 32 minutes, with one measurement made each second.

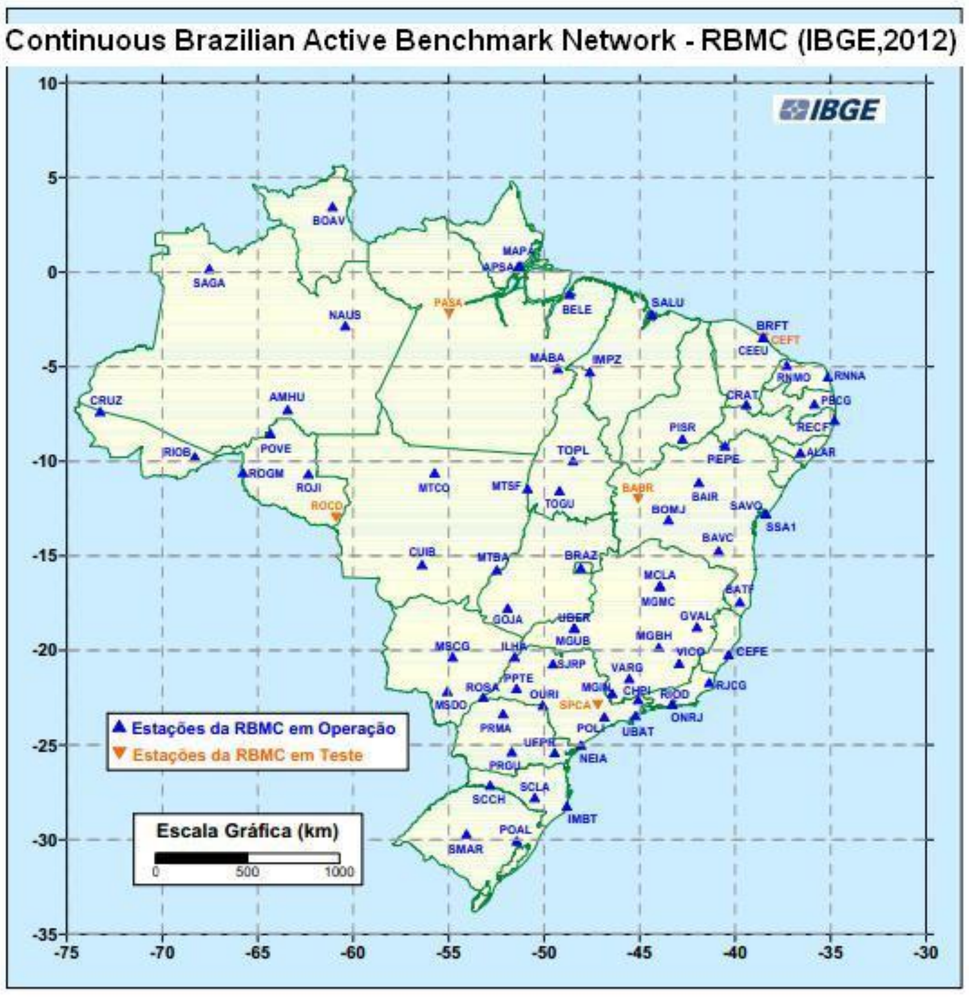
Fig. 3
(Saatkamp,2003,pg. 95)



3. Brazilian GPS Active Network and Services

Brazil has a great territorial extension with about 8.5 milion km² (almost 24 times of Germany's extension). It's Geodetic reference network is composed by active (fig. 4) and by passive benchmarks. On active benchmarks there are L1/L2 GPS or L1/L2 GPS and Glonass receivers. They acts as a public reference network named *Rede Brasileira de Monitoramento Contínuo* (RBMC), and the tracked data can be costless obtained by user on a internet site, for post-processing. Most of them can be too obtained on near real time by Networked Transport of RTCM via Internet Protocol (NTRIP), for GNSS "real-time" positioning. The official federal Brasilian Geodetic Institution, and that offers these public GNSS tracked data service, is named *Instituto Brasileiro de Geografia e Estatística* (IBGE). 21 of the active benchmarks in Brazil are a subframe of the *Sistema de Referência Geocêntrico para as Américas (SIRGAS2000*), the geocentric reference system for South and part of Central America. SIRGAS2000 is also a ITRF frame. Because of the wide Brazilian extension, however, the average distance between active stations is from about 250 km or more (in north/northwest, sometimes greater than 500 km). Therefore, there are some regional implemented network too, to densify the active benchmars. A example is the São Paulo state, that have some more stations with NTRIP service.

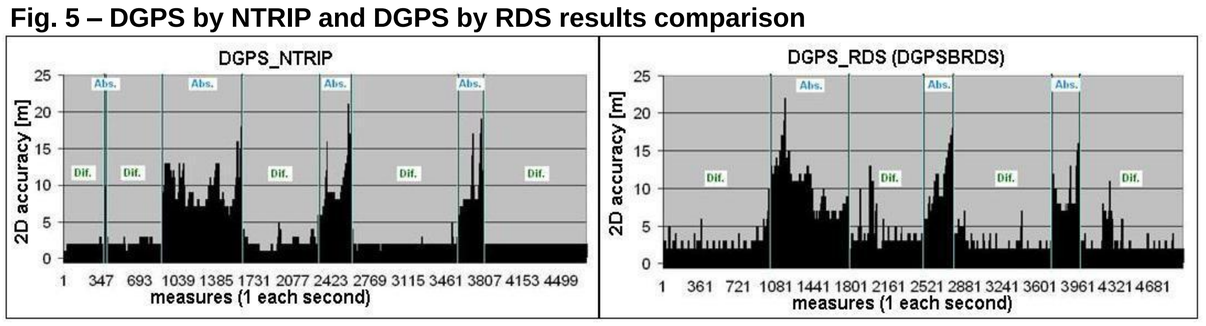
Fig. 4 – Brazilian active benchmarks



4. Some other work results using RTCM

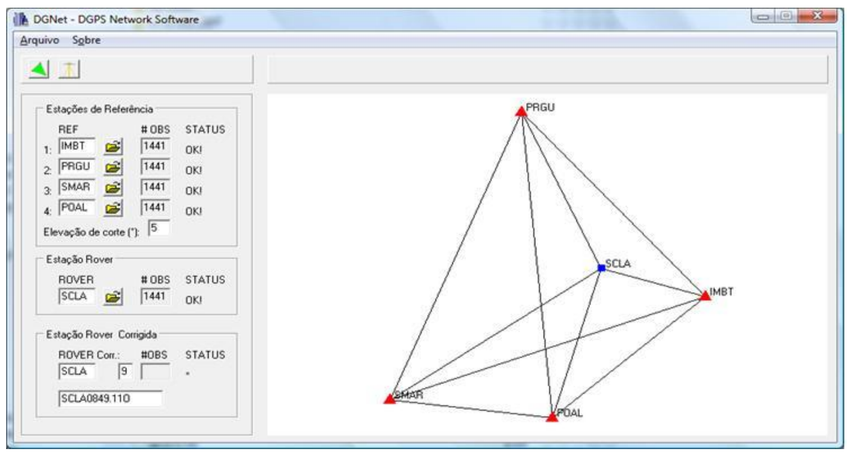
The DGPSBRDS where implemented at Federal University of Santa Maria, south Brazil, and positioning results were investigated using this differential corrections broadcasting system and the NTRIP broadcasting system, both using the same RTCM 2.3 differential corrections (type 1 message) of a RBMC benchmark as reference station (Silvane, 2009). A sample of results is shown on figure 5. DGPS by NTRIP showed a accuracy 15% better than DGPSBRDS (DGPS by RDS).

Fig. 5 – DGPS by NTRIP and DGPS by RDS results comparison



In a other work, interpolation in a network with four IBGE benchmarks as reference stations were implemented, as shown in figure 6. Results are shown in next frame for two test stations (Saatkamp, 2011).

Fig. 6



Test Station	Statistic	Single DGPS	Network DGPS	Improvement
SCCH	Accuracy	1.61 m	0.27 m	6 times
	Standard deviation	0.68 m	0.34 m	2 times
SCLA	Accuracy	0.57 m	0.29 m	2 times
	Standard deviation	0.61 m	0.37 m	1.6 times

5. Concluding Remarks

There is little research on RTCM protocol for GNSS data broadcasting services developments in Brazil. It is often used in their standard form, or in conjunction with international standards developments, such as NTRIP. A exception was the thesis work of this author, but the developed DGPSBRDS format were not implemented as a wide service in Brazil. However, as we see nowadays, it seems that NTRIP has a "brighter" future than RDS. Anyway, internationally cooperation is important to develop ever better systems. Furthermore, even for only international standards protocols users, it is important to know details on the new developments, protocols and systems. Both are our purposes: knowledge and development cooperation.

6. References

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