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Results and Operation Parameters of the real time precise positioning service REGME-IP based on NTRIP protocol

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1. Introduction

REGME-IP is the Ecuadorian real-time positioning service based on the NTRIP protocol operating since October 2020, establish by 31 CORS stations and two caster servers, the principal and a backup with a connection capacity of 2000 simultaneous users and 100 CORS stations. The service is free to access and administrated by Instituto Geográfico Militar (IGM), which through the official website assigns the credentials to each user to enable the connection in the rover devices. This work presents the results and statistics of the REGME-IP service after one year of operation based on the analysis of the web registration information, as well as the own log files generated by the main caster server, which confirms that the service is stable and available 24/7.

2. REGME-IP

The REGME-IP project is the result of the collaboration and transfer of knowledge between the IGM and the Escuela Superior Politécnica de Chimborazo (ESPOCH). It begins in 2016 with the implementation of the experimental caster with a single CORS GNSS station, in 2017 the workshop realized by the SIRGAS suggests configuration improvements, in 2019 a local caster is implemented in the IGM with all the CORS GNSS stations operating nationwide and under tests for 18 months. In October 2020, the service is formalized and released nationwide with a principal caster server and a backup that concentrates the CORS GNSS streams in the RTCM 2.X and RTCM 3.X format, correction by the pseudo range and by phase respectively, and it relays them to the users that in 2021 it has 576 active users from public and private institutions and academia.

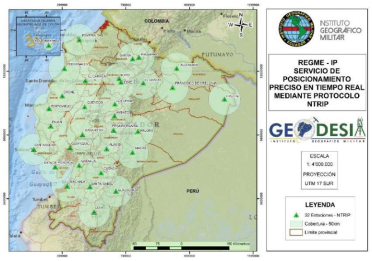

Figure 1. REGME-IP CORS GNSS Stations
Source: http://www.geoportaligm.gob.ec/

The address domain of each caster server is:

- **Principal Caster Server:** regme-ip.igm.gob.ec:2101
- **Backup Caster Server:** regme-ip.espoch.edu.ec:2101

Figure 2. Web Interface Principal Caster
Source: Principal Caster Server. Instituto Geográfico Militar

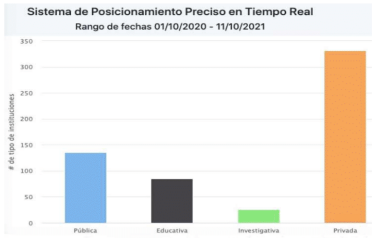

Figure 3. Service requests by institutions
Source: REGME-IP's register web statistics. Instituto Geográfico Militar

3. Operation parameters

From the period of testing and operation of the caster servers some limitations have been identified. NTRIP protocol is part of the TCP / IP protocol stack, depending exclusively on the availability and internet connection characteristics of CORS stations, caster servers and rovers. The RTCM format according to the version, generates a packet size in Kbytes according to the number of available satellites visible on the CORS GNSS station. Table 1 mention the maximum number of satellites the data received in RTCM 2.3 format is 7000 bits/sec and in RTCM 3.0 is 3550 bits/sec, considering a basic internet connection of technologies such as dial-up with a speed of 56 kbps (Kilobit per second) and ADSL (broadband) at 125 Kbps supply this requirement for CORS and caster servers. In the case of the rover, the connection limitations depend on the Advanced Mobile Services (AMS) of each country, coverage, and technology implemented if 2G technology is considered, the transmission speed is 64kbps, 3G is 2000 kbps and 4G is 100,000 kbps. Despite this, the lower speed caters to the connection required to the rover.

Table 1. Data transmission speed by RTCM format [bits/sec]
Source: EUSKADI, Conexión a la red GNSS a través de Internet. 2012. http://www.gps2.euskadi.net/internet.php.

	6 SATELLITE	9 SATELLITE	12 SATELLITE
RTCM 2.3	3900	5400	7000
RTCM 3.0	2500	3000	3550
CMR	1400	1800	2100

The CORS GNSS station operates 24 hours, therefore it generates 75.6 Mbytes and 38.34 Mbytes of information per day according to the format. This information can be stored in the caster server using third-party applications such as RTKlib, reaching maximum annual storage of 27.59 Gbytes and 13.99 Gbytes per format. Considering that the current capacity of storage devices or hard disks reaches up to 1 terabyte or 1024 Gbytes. The REGME-IP service provides 99.99% annual service availability, so the maximum service interruption time is 43.20 minutes, thanks to the bandwidth at IGM and the backup server in ESPOCH which is a mirror of the main caster.

Latency

Ping is a diagnostic utility between two devices that establish a point-to-point connection and allows checking the communication status, it consists of sending a request and response packet to check the status, speed, and quality of the communication link. The caster servers are in the central area of the country (IGM - Quito) and the response time between them, and the furthest station is checked thought this tool. The furthest stations from the location of the caster are described in Table 2:

Table 2. CORS GNSS Station and caster server distance

CORS GNSS STATION	DISTANCE (KM)	ORIENTATION
SAN CRISTÓBAL	1239	INSULAR REGION (ISLAS GALÁPAGOS)
TIPUTINI	333.76	NOR EAST LIMIT WITH PERÚ
LOJA	426.86	SOUTH LIMIT WITH PERÚ

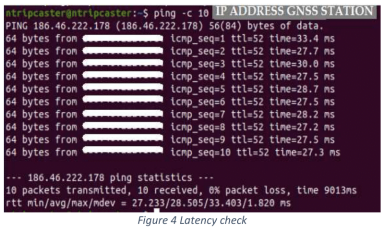

Figure 4 Latency check

According to the ITU-T Rec. G.114 (05/2003) recommendation, it establishes that the minimum latency that a communication system must experience for effective data transmission between two points must be less than 400 ms (milliseconds). The latency between the Tiputini station and the main caster server is verified (see Figure 3), it is on average 27,233 ms and zero packets lost. This demonstrates the effectiveness of the transmission of correction information from the caster to the station, minimizing the response time and processing of the corrections received in the rover positioning process even with low-cost devices.

4. Collecting observation

The scenario, see Table 3, is 150-point sample survey in Sucre Canton (Bahía de Caráquez); the results show an acceptable level of accuracy between the Static Post-Process Differential and Real-Time NTRIP method. In some cases, the horizontal component's difference reaches to millimeters order considering that the Differential Static Positioning had a positioning duration of 30 minutes, instead of with Real-Time technique using NTRIP, the positioning has the only duration of 60 seconds with POLARIS S100 Low-Cost Rover. Both methods show a similar accuracy level. The horizontal component (N, E) has less error than the vertical component (ellipsoidal height h). Table 4 show some results obtained by comparing the two static Post-Process Differential vs Real-Time NTRIP methods taken in Bahia de Caráquez city.

Table 3. Scenario in Bahía de Caráquez

ROVER DEVICE	LOW-COST GNSS L1/L2 MULTICONSTELLATION GPS+GLONASS+GALILEO+BEIDOU
COORDINATES UTM 17 SOUTH ITRF 08, EPOCH 2016.4	
Server caster NTRIP	REGME-IP
Mountpoint used as base station	CHONE - ONEC
Distance	38 [KM]
RTCM version	RTCM 3.0
Register time by point	60 SEC

Table 4. Difference between Post-Process vs Real Time

	DN	DE	Dh
MED	0.011	0.011	0.029
MAX	0.036	0.033	0.055
MIN	0.001	0.000	0.001
DESV	0.010	0.009	0.016

5. Future work

Increase CORS GNSS station to caster server and implement PPP Service.

6. Acknowledge

This research has been supported by Instituto Geográfico Militar and Escuela Superior Politécnica de Chimborazo.