

Quality Control and Quality Management of Failproof High Accuracy GNSS Positioning Services

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SUMMARY

GNSS Positioning services are usual for different applications of positioning. The provider of such services is responsible for all effects of the service whatever the reason of a failure is. The reliability of the different sectors is explained. Actions and their documentation are described.

GNSS-Dienste haben sich für verschiedenste Anwendungen im Bereich Positionierung bewährt. Der Dienstbetreiber ist für alle Bereiche des Dienstes verantwortlich, was immer auch die Ursache für einen Ausfall ist. Die Ausfallsicherheit der Teilbereiche wird erläutert. Maßnahmen und Dokumentation werden dargestellt.

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1. INTRODUCTION

GNSS positioning services are no longer negligible in our societies. Many users of different ranges of application can no longer operate optimally without these services.

Let me now introduce our German positioning service SAPOS[®]. It's a high accuracy service which guarantees 1-2 centimetres horizontal position and 2-4 centimetres in height and is offered since 2002. Because Germany is a Federal Republic of 16 federal states, surveying is a matter of each of these 16 states. SAPOS[®] is a service all these 16 states provide in a similar standard. Our service is very comfortable and that is why we have a yearly augmentation of 20 %.

SAPOS is a substitution of a dense field of markers. Up to now users of these markers had to check the correct position of the marker. In connection with SAPOS[®] many users relay blindly on the calculated coordinates presented on the display.

Let me now point out a few very important appliances:

- Aviation
- Precise Farming
- Acquisition of Accident Data
- Line Documentation of Water, Electricity,
- Documentation of Property Boundaries
- ...

Positioning services are very often used by non professionals. They do not think about all the individual problems of these services, but only look upon the results. Many users claim customer fulfilment, but they have not the faintest idea how to realize it. If the service does not work, they do not make the effort to fathom out the reasons. The provider of such a positioning service is therefore also responsible for the problems outside of its service, including the challenges which the user himself poses. If positioning services are out of order financial losses follow in some cases. That is the reason why a documentation of availability of all the different parts of these services is absolute necessary.

Let me list these services:

- GNSS-Satellites
- GNSS-Reference Stations
- GNSS-Rovers
- Data lines
- GNSS Network Software
- Space Weather

2. SPACE WEATHER

Ionosphere

The ionosphere is influence able by no means. It is an incalculable phantom. We have the possibility to model its influence, but sometimes there are local events, which cannot be found with a wide range network of Reference Stations. On the other side the ionospheric activity can be so large, that it has severe consequences on the environment. 1989 for example 6 Million Canadian people had no electricity and in January 2005 United Airlines had to reroute 26 flights as a result of ionospheric exceptional circumstances. Such cosmic hurricanes must be recognised and tracked by worldwide operating institutions and an early warning system has to be established. The normal ionospheric influence is shown hourly on the internet by our service SAPOS-Bavaria. The normal ionospheric activities with a cycle of about 10-11 years has additional influence on the distance of our reference stations.

3. GNSS-SATELLITES

Orbit data (broadcast orbits – predicted orbits – final orbits)
Availability

Positioning service operators have normally no influence in this facts. To minimize failures, its good to use not only one satellite system, but as many as available. In our days these are GPS and GLONASS and in some years will be GALILEO. Besides the Broadcast orbits sent by the satellites itself, you can use predicted ultra rapid orbits, which are available on the Internet. They are provided by research facilities. These facilities also calculate precise orbits, which are available about two weeks later and can be used for precise post processing purposes. Satellites are not always available. Reasons are software updates or orbit corrections. In these times satellites usually are switched off. Such operations often are announced, but not at all times. The sources of these information are provided to our customers.

4. REFERENCE STATION NETWORK

Receivers, Antennas, Network software

Depending on the demanded accuracy the distance between the reference stations is variable. A high density of the reference station network causes a high accuracy of coordinates and a short time to fix. A very important part of a positioning service is the quality of the reference station antennas. Some antenna types are very sensitive to the antenna near field. Deviations in the height component up several centimetres are not seldom. Every change of an antenna has to be documented. Before any change of an antenna we make a short range and a wide range control measurement of the old and of the new antenna coordinates. After the check of the results the new antenna is implemented in our service network. Every user of our positioning service SAPOS[®] can see what had happened to each of the reference stations in

our internet pages. Additionally each change of equipment is announced several days before. The whole history of a reference station is even available for every user of SAPOS[®]. Additionally we take care of the failure of single reference stations. The distance of our reference station network is optimised.

5. DATA LINES

Centre – Reference station, Centre – Customer

Positioning services require very fast data connections. Some official data lines have slow firewalls, so that they could not be used for these purposes. SAPOS[®], for example has its own firewall and can provide the data in time. Also private service providers can use our data without loss of service quality.

An important point is the reliability of the data lines. Usually data lines have a reliability of 98,5 %. To rise it up to 99,9 % is very expensive. If customers are willing to pay for this high reliability, we are able and happy to provide this high quality service. But unfortunately they are not willing to pay.

What can be the solution? Using a second data line provider causes a redundancy except the last miles.

6. POSITIONING SERVICE CENTRE

The centre of a GNSS positioning service is the heart of our service. Here the data of the whole network are being processed, it is the connection point for all customers and it is where the service staff is located.

A blackout of the centre can have several reasons:

- Software break down
- Electricity blackout
- Data line failure

Software and electricity blackouts can be handled with redundant equipment. A blackout of the data connection cannot be compensated easily, because on the last mile all data providers usually use the same lines.

A solution is a second not near by permanent operable service centre. Customers have the possibility to connect with the second centre, if there is no answer from the first centre. In normal mode the second centre is controlled by the first. In the case of a blackout of the first centre, the second must run some time alone until staff is available there or the problem on the first centre has been solved.

SAPOS Bavaria uses two data line providers to get the data from the reference station to the centre. A second centre will be established or a cooperation with other German countries is possible provided that both have the same high level of reliability.

The availability of real time service data is documented in the internet for our users.

7. RELIABILITY OF POSTPROCESSING DATA

Users in the photogrammetric and laser scanning domain or universities often use RINEX data for post processing. They are not amused if there are gaps in the data provided. It is possible to close these gaps automatically. But not all Reference receivers can be used for this purpose. Manufacturers of service software have no priority to make this automatic service available for all receivers. SAPOS[®] Bavaria has the possibility to store one week of data at the reference station. If the demand of RINEX data is reclaimed in time, we can close the existing data gaps.

8. CUSTOMER AND HIS EQUIPMENT

Quality of receiver and antenna, location (shadowing effects), software, settings in the receiver, source of interferences

Users of positioning services are often non professionals. They do not have much knowledge concerning surveying. Very often they no idea why the service brings no result on their monitor. Although the instruction sheet contains all necessary information, many users are not able or willing to search the mistake. For these clients we have a hotline during the usual working hours. Our service staff can in most cases help our customers in the field to solve their problems. Therefore our service staff has information of the popular GNSS rover equipments and the actual software release. If necessary we can look up in our centre which satellites our customer tracks, what is his DOP and other details. We also can show his position on a large scale map in order to recognize shadowing effects of satellites. We have very much information to help our customers and give them a tip how to get the demanded solution. All data of the connection are stored and we can answer questions of our users concerning the near past.

To have a better understanding of our customers we run two test rovers in SAPOS-Bavaria. One is located in the southern and the other one in the northern part of Bavaria. These rovers work 24-7. They are located in maximum distance to reference stations. Permanently they try to get a fixed solution and then automatically are switched off and start all over again. The results are shown on our internet page of SAPOS[®]-Bavaria. The Quality of the solution depends on the accuracy and the time to fix of the test station. Every hour a mean value is displayed in the colours deep green, light green yellow and orange. Even old data can be displayed.

One point is left. The existence of further sources of interference is a matter of fact. It is hard to identify them. Often interferences are caused by military equipment or other wireless applications. To figure these out is not always possible. If a user has locally some very strange results, we have the possibility to meet our customer in situ and make test with his and our receivers and antennas. We are planning to provide our customers a list where all these sources are mentioned. This work is still in process.

9. CONCLUSION

Customers want to have only one contact relating to a service like SAPOS[®]. All informations have to be made available by the service provider. Causes of failures must comprehensively documented. Individual support is necessary in addition

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