FACT SHEET
GNSS CORS Networks Principles

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GNSS CORS DEFINITIONS

GNSS is an abbreviation for Global Navigation Satellite System (GNSS). The most known GNSS is the Global Positioning System (GPS) developed and operated by the USA Departments of Defence and Transportation. Competing and complementary systems are GLONASS and in the future, among others, the European Galileo and the Chinese Compass.
For all GNSS measurements of geodetic accuracy you will need at least two simultaneously measuring receivers. In general, the one on a site with known co-ordinates is called the 'reference' station. The one located on the site with unknown co-ordinates is called the 'rover'.

The development of GNSS, especially of GPS, has lead to the operation of continuous operating reference stations (CORS) that acquire GPS signals without any interruption. Additionally these CORS have the task to store the data and in some circumstances process the data and then transmit this data to rover receivers. These CORS help the users by economizing one GPS receiver as the operation of the reference station is performed by the service provider of the CORS network.

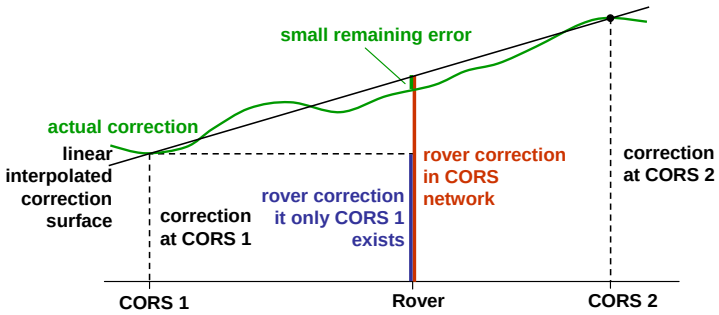
In general a service provider owns or operates a network of CORS that is capable of estimating or resolving the 'ambiguities' of all CORS as one homogeneous model in real time. This is often referred to as a 'network solution' within a GNSS CORS network.

ERROR SOURCES IN GNSS SURVEYING

Most of you may know the general error sources of GNSS. Generally spoken they may be separated into satellite-related, receiver-related and propagation media related. This classification scheme however is not suited for the network approach of CORS as the error sources need to be divided into station dependent and baseline length dependent. The first are not influenced by a network solution. For the latter a network solution improves the result; in other words the errors decrease explicitly. The error sources depending on the baseline length are-

- satellite orbit and clock error as well as
- tropospheric and ionospheric influences.

The most important error source of these is the ionospheric one. The remaining errors are not reduced by the network approach. The following figure shows the improvement by a network solution in a simplified way for the two-dimensional case (two CORS).



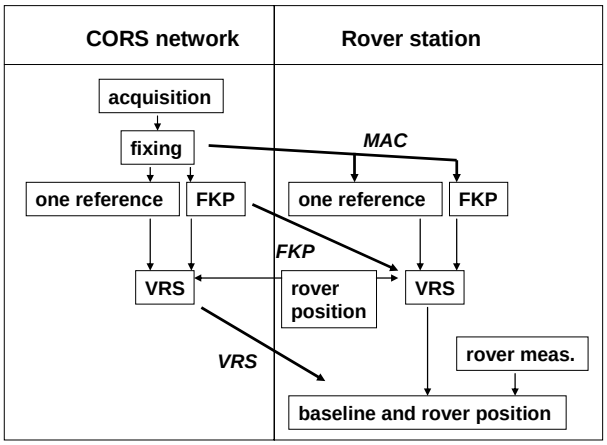
ADVANTAGES OF GNSS CORS NETWORKS

The two main advantages of GNSS networks are the reduction of baseline dependent errors and the automatic referencing of the GNSS measurements to the reference frame and datum needed for the results (Note - for further detail refer to Fact Sheet "GNSS CORS Networks and Linking to the ITRF").
Additionally the user economizes the money for a GNSS receiver on the reference station and the time to install it. They are independent of the local possibilities and issues for a reference site.

DIFFERENT CORS NETWORK PRINCIPLES

As written before the CORS network is mainly driven to eliminate baseline length dependent errors. There exists different methods to transmit this information to the rover. For this we have to deal with some new abbreviations FKP (area correction parameters), VRS (virtual reference station) and MAC (master – auxiliary concept). The three concepts only differ by the steps that are realized at the rover respectively within the CORS network. All these abbreviations, more or less, stand for the same procedure

- ***Acquisition*** of all measurements within the network,
- ***Fixing*** of the ambiguities within the network,
- Determination of area correction parameters (***FKP***),
- Generation of measurements for ***one reference*** station,
- Estimation of the measurements for a virtual reference station (***VRS***) by the use of the approximate position of the rover,
- Determination of the ***baselines*** and finally the ***rover position*** using the ***rover measurements***.



CORS NETWORKS INFRASTRUCTURE

Every CORS network consists of several GNSS station interconnected by reliable communications to enable real time computations and control. Each station, as a minimum, requires a receiver, an antenna, communications and a power supply. In most cases a computer is installed additionally for data transmission and control. In ideal cases a supplementary configuration is used for reliability or 'back up' reasons. Additionally a user interface is required to configure and maintain the network. This may be realized remotely e.g. by radio communication or by mobile phones or via internet connection. If we are talking about an offline network that provides the information to the user for post-processing, the stored data files use 'RINEX' format. For online networks real time kinematic (RTK) is the application and the 'RTCM' format is normally used for data transmission.

CORS NETWORKS EXAMPLES

In general one has to distinguish between CORS networks for post-processing applications and real time applications. The latter are more wide-spread in densely populated countries like e.g. Hong Kong (SatRef) or Germany; the latter country having competing services (SAPOS and ASCOS). The post-processing variant is appreciated in countries that have less inhabitants per square meter e.g. Sweden (SWEPOS) and Australia (ARGN and AUSPOS). The following web pages will help you to get information about the CORS networks addressed in the text. There much more of these service spread all over the world.
SatRef: http://www.geodetic.gov.hk/smo/gsi/programs/en/satref.htm
SAPOS: http://www.zentrale-stelle-sapos.de/
ASCOS:
http://ascos.eon-ruhrgas.com/cps/rde/xchg/er-ascos
SWEPOS: http://swepos.lmv.lm.se/english/index.htm
ARGN, AUSPOS: http://www.ga.gov.au/geodesy/argn/ and http://www.ga.gov.au/geodesy/sgc/wwwgps/

MORE INFORMATION

The following web pages will provide more information on this topic and on special topics related this fact sheet:

- GNSS basics and generalities as well as CORS networks:
  e.g. Seeber: Satellite Geodesy (2003)
- RTCM: http://www.rtcm.org/
- RINEX: ftp://igscb.jpl.nasa.gov/pub/data/format/

BIOGRAPHICAL NOTES

1983 – 1989	Study of Geodesy in Hannover
1989	Dipl.-Ing. in Geodesy (University Hannover)
1998	Dr.-Ing. in Geodesy (University Hannover)
2003	Head of Department "Metrology" at Institute for Applications of Geodesy to Engineering, University Stuttgart
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