Note on RTK and CORS

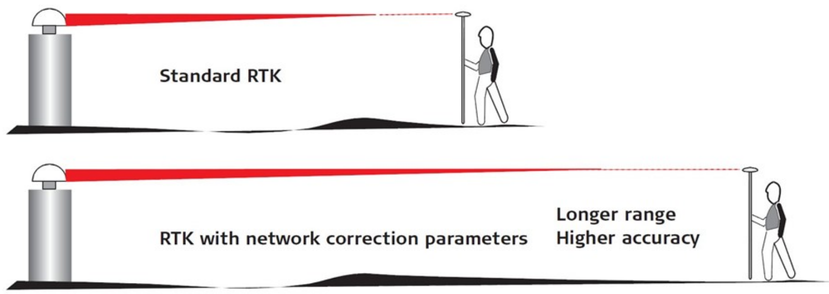
Real-time kinematic (RTK)

Real-time kinematic (RTK) positioning is a satellite navigation technique used to enhance the precision of position data derived from satellite-based positioning systems (global navigation satellite systems, GNSS) such as GPS, BeiDou, GLONASS, Galileo and NavIC.

Traditional RTK systems use a base-station receiver and a number of rover units. The base station re-broadcasts the phase of the carrier that it observes, and the rover units compare their own phase measurements with the one received from the base station. There are several ways to transmit a correction signal from base station to rover station. Till now the most popular way is to use a radio modem, typically in the UHF Band. This communication mode usually restrict application of RTK survey and its range, as radio transmission has its own limitations, pertaining to line of sight and limitations over long range radio communications. Another popular method is to send corrections over the internet. The NTRIP protocol (Networked Transport of RTCM via Internet Protocol) enables the mobile RTK GPS receiver (rover) to access data from the RTK base station over the internet. RTK provides accuracy enhancements up to about 20 km from the base station and allows the units to calculate their relative position to within millimeters, although their absolute position is accurate only to the same accuracy as the computed position of the base station. However, the accuracy, availability and reliability of positioning data when using a single base station for real time positioning is still limited by the distance between the base station and the rover units. As with increased distance, clock errors, satellite orbit errors and atmospheric signal delays are greater. These result in deviations to the accuracy of positioning beyond acceptable limits.

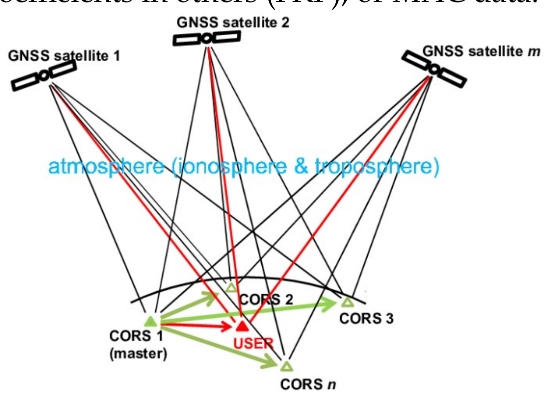
Network RTK by CORS

As discussed above the classic RTK method using a single reference station the rover needs to work within a short range from the reference station due to distance-dependent errors induced by the ionosphere, troposphere and orbital errors. The operating range of RTK positioning is thus dependent on the existing atmospheric conditions and is usually limited to a distance of up to 10-20 km. In addition, no redundancy of the reference stations is usually available if the reference station experiences any malfunctioning. The constraint of the limited reference-to-rover range in RTK can be removed by using a method known as Network RTK (NRTK), whereby a network of Continuously Operating Reference Stations (CORS) is established, 60-70 km distance apart from each other.



The aim of network RTK is to minimize the influence of the distance dependant errors on the computed position of a rover within the bounds of the network.

In principle, the RTK network approach consists of four basic segments: data collection at the reference stations; manipulation of the data and generation of corrections at the network processing centre; broadcasting the corrections, and finally positioning at the rover utilizing information from the NRTK. In the first segment, multiple CORS stations simultaneously collect GNSS satellite observations and send them to the control centre, where a main computer directly controls all the reference stations, mostly via the Internet. In all CORS stations geodetic-grade multi-frequency GNSS receivers are used. The incoming GNSS observation data from all operating CORS stations are screened for blunders and their ambiguities are fixed. The control computer uses these data in processing a networking solution, and the data are archived for post-processing use. The software performs several tasks including: quality check of data, apply antenna phase centre corrections, ambiguity fixing, modelling and estimation of systematic errors, interpolation of errors (corrections) in some techniques (e.g. VRS, PRS) and generation of virtual observations, model coefficients in others (FKP), or MAC data.



This correction information is then broadcast to users over web. The correction information depends on the processing algorithm and may include any of the following:

- observations from one reference station (physical or virtual),
- coefficients for interpolation of corrections within the coverage area,
- Observation corrections at a group of reference stations.

With CORS Network, distance between a GNSS rover and the corresponding base station is no longer an issue. CORS Network also liberate users to setup their own base station and communication system between base and rover units.

Users can subscribe to CORS network on daily, weekly, monthly or yearly basis to receive NRTK corrections with their rover instead of having to set up their own base station.

The CORS network transmits correction over web which are available 24 hours per day and 365 days a year. These corrections are transmitted in non-proprietary RTCM 2.4, RTCM 3.2 protocols, so that any make and model GNSS instrument can use this correction service.

To liberate users from setting of their own reference station each time they wish to undertake GNSS measurement, Survey of India has established a network of Continuously Operating Reference Stations (CORS), which not only capable of providing Real Time Positioning Service through RTK/NRTK with an accuracy of ±3cm, but also host an array of different positioning services targeted to cater requirements for different segments of Geospatial and scientific Community.

CORS Services provided by Survey of India can be accessed from **www.cors.surveyofindia.gov.in**

Benefits of the CORS over classical RTK:

Accuracy Positional accuracy: is improved as the distance-dependent component (ppm) is reduced significantly through network processing, providing more homogenous positioning accuracy at different distances from the stations.

Reliability: The reliability of ambiguity fixed RTK rover positions is improved, even when operating at long ranges and under difficult ionospheric conditions. Permanent stations, fixed communication lines, and redundant server architecture ensure near 100% uptime 24/7. Conversely, local bases are subject to communication outages and have no redundancy in case of failure.

Availability: The proportion of time a system is in a functioning condition, such as providing continuous and reliable RTK corrections and data services to all users. The network software is designed for distributed server architecture, with automatic data archival and hardware redundancy.

Stability: Networks are monitored continuously for station movements, thus ensuring that they truly define the correct reference datum.

Scalability: The ability for the technology to accept increased workload without impacting performance Supporting GPS & GLONASS, and future systems such as GALILEO and COMPASS.

Flexibility: Centralised RTN software can support multiple users and applications simultaneously, including conventional RTK & DGPS, and networked services – nRTK & nDGPS, as well as new applications.

Compatibility: The most powerful network software system incorporates data from legacy base stations, as well as providing standardised RTCM correction information at various rates in various formats. Supports various communication protocols such as cellular (including GMS/GPRS, CDMA & HSPA), radio (UHF & VHF), TCP/IP (NTRIP).

Advantages of Network RTK:

Establishment of CORS Network will enable precise positioning in real time. The benefits of precise positioning in are estimated to be in accord with the following

a) Quick and accurate acquisition of position, enable mapping/surveying and measurement activities faster, resulting in faster survey and mapping.
b) Enables fast accurate staking for layout of civil works
c) Measurement of executed works, monitoring and tracking progress of work.
d) Reduction of cost through automation
e) Auto driving/ auto navigation result in Reduction in fuel consumption, Increase in driver productivity from improved logistics management
f) Improved Logistics/supply chain management, Minimizes idle time to ensure continuity of operations. Improved fleet efficiency (identifying areas of underperformance)
g) More efficient time management and route optimization
h) Lower total heavy vehicle operating costs for a given freight task
i) Improvements in road safety from having fewer, more productive vehicles on the road
j) Avoided cost of road wear from more efficient use of the existing road network
k) Changes in vehicle operating costs from switching to larger, more productive vehicles, partially offset by potential increases in kilometers travelled by such vehicles
l) Safety benefits from the use of in-vehicle technology, resulting in lower crash costs and reduced injuries and
m) Improved environmental outcomes from more intelligent management of road networks.
n) Better enforcement of traffic rule and enhance Road safety by behavioral change in driving.
o) Automatic crash notification and may-day services
p) Electronic toll collection.