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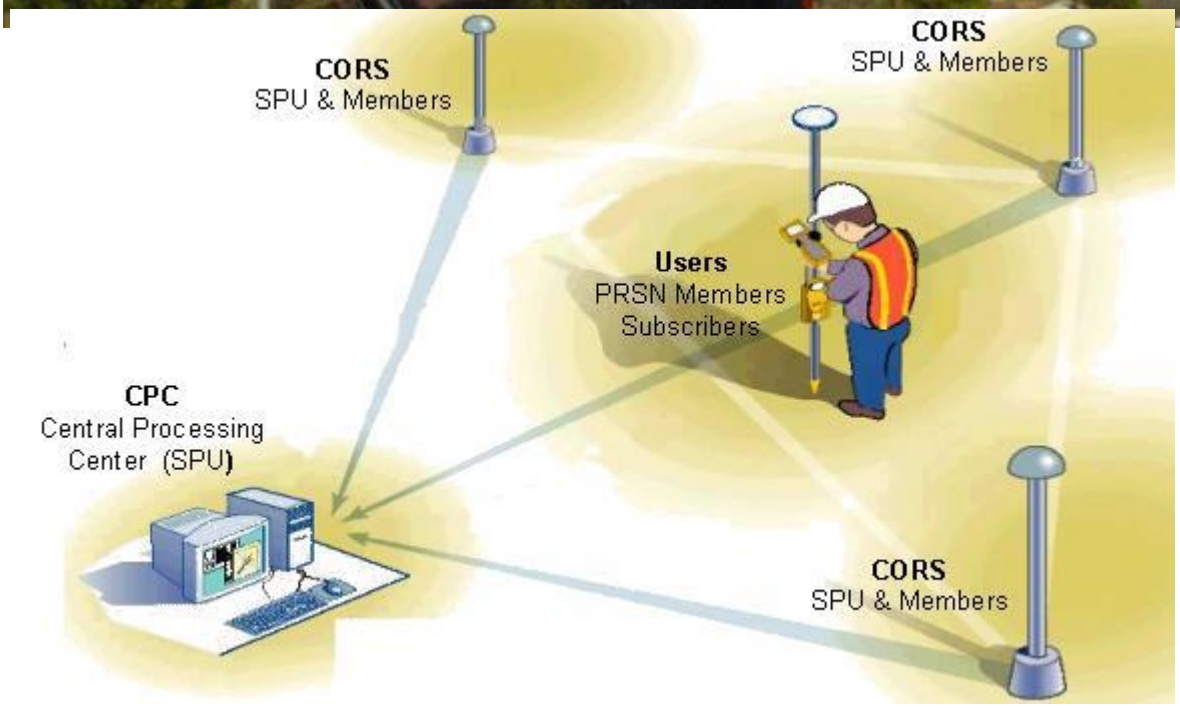

Continuously Operating Reference Stations (CORS), Survey of India
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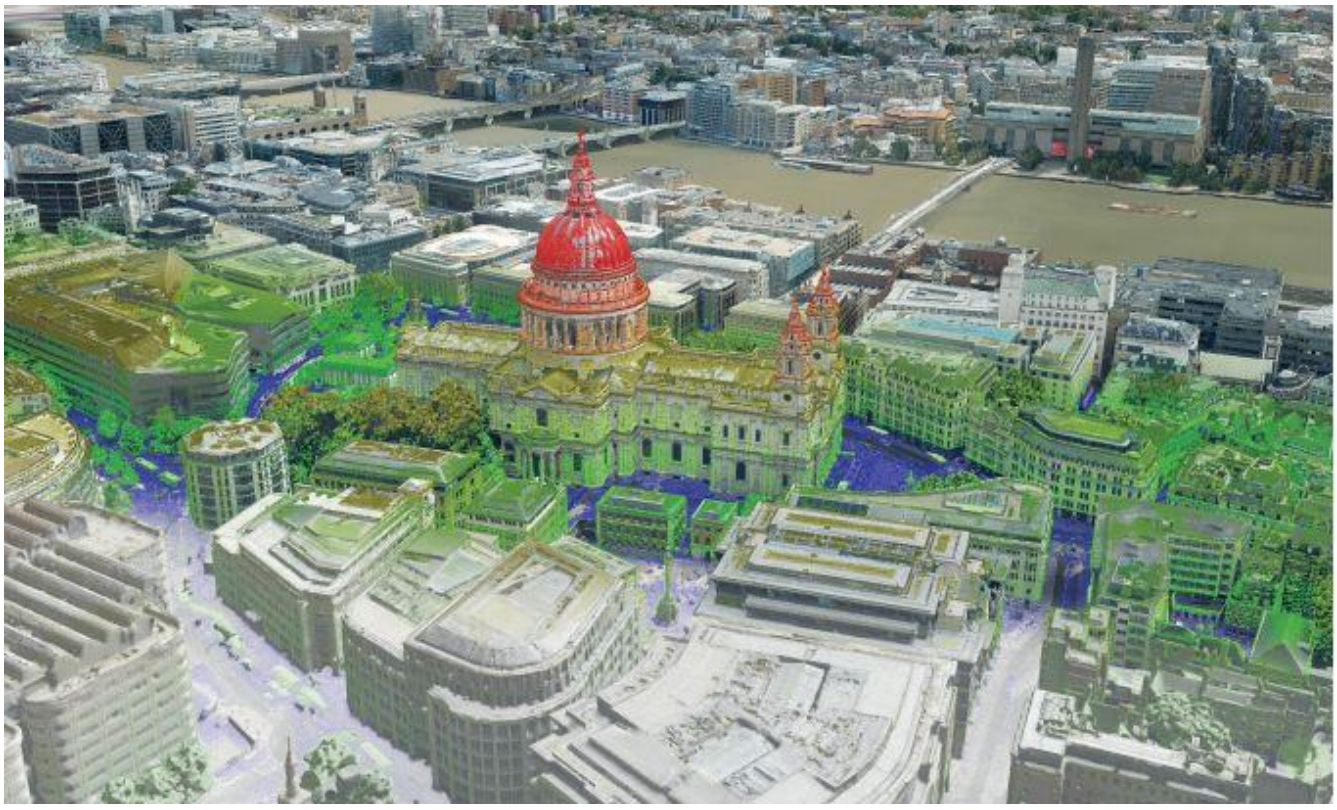

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Content

Editorial

Highlight of this issue is the Government's declaration of New Map Policy that allows ordinary citizens to create, collect, publish, and keep maps (both physical and digital) without asking the government for permission or getting security approvals. This is a welcome step that should have been taken decades ago. GeoMap Society (GEMS) is holding webinar on this on 28 February 2021, National Science Day. Report on this will be in the next issue.

Another highlight of this issue is the research article on Continuously Operating Reference Stations (CORS).

With technological changes, choices are growing. Platforms can be ground, Drone, Air or Space. Spatial data capturing system can be chosen based on platform, extent and type of area and cost/time, etc .

2021 is witnessing opportunities never before, thus paving the way for

New Map Policy 2021

Extracts from various published sources about historic change in Map Policy in India

https://www.surveyofindia.gov.in

https://www.geospatialworld.net/policy-document

Key features of new Policy

Indian Entities, whether in Government or outside, will be free to acquire, collect, generate, prepare, disseminate, store, share, publish, distribute, update, digitize and/or create Geospatial Data, including Maps, of any spatial accuracy within the territory of India including underwater within its territorial waters by using any Geospatial Technology, subject to regulations on attributes in the negative lists.

Ground truthing/verification, access to Indian ground stations and augmentation services for real time positioning (Continuously Operating Reference Stations (CORS), etc) and their data shall be made available without any restrictions and with the ease of access to Indian Entities only.

Maps/Geospatial Data of spatial accuracy/value finer than the threshold value can only be created and/or owned by Indian Entities and must be stored and processed in India.

The government's decision to liberalise its geospatial data policy has been welcomed by academics and entrepreneurs alike as this would bring immense value to general public, help enterprises develop innovative products and make governance more transparent and hassle-free.

"Surveying and mapping is so critical to decision-making, planning, infrastructure, logistics and to services with 80 per cent of all data having some geospatial component. Hence it is important to have ease of doing business in surveying and mapping," said Ashutosh Sharma, Secretary, Department of Science and Technology (DST).

……..map making was a state monopoly under the British rule as it suited their purpose of extraction and control of India.

Surveying and mapping has been freed of all pre-approvals as also vetting of data. Data has been democratised with whatever produced using taxpayer money in public domain, except those required for security purposes and collected by security agencies. It is also for empowering both public sector private sector in the country, Sharma said.

Clearing grey areas

Sanjiv Sanyal, Principal Economic Adviser in the Finance Ministry, said map making was a state monopoly under the British rule as it suited their purpose of extraction and control of India. Subsequently, cartography became a free-wheeling thing in other parts of the world, while India continued to have this colonial approach to cartography. Though technology allowed the use of Goole Earth and satellite pictures quite possible, legally it remained a grey area, Sanyal said. "This is what the government has now changed," he said.

K VijayaRaghavan, Principal Scientific Adviser to the government, said government agencies collect so much of data. "This data is useless, unless it is converted into information and this information into knowledge and this knowledge is used for understanding and decision-making," he said.

Putting data to use

But this collected data is meaningless unless it is put to use rapidly and in the context of space and time. The idea behind the reforms in this sector is actually to make this possible.

Rajkumar Khatri, Additional Chief Secretary to the government of Karnataka who is in charge of Labour Department, said the State is proposing to use the realtime geospatial data on construction activities to monitor labour cess made to Construction Labourer's Welfare Fund. He said he was confident that

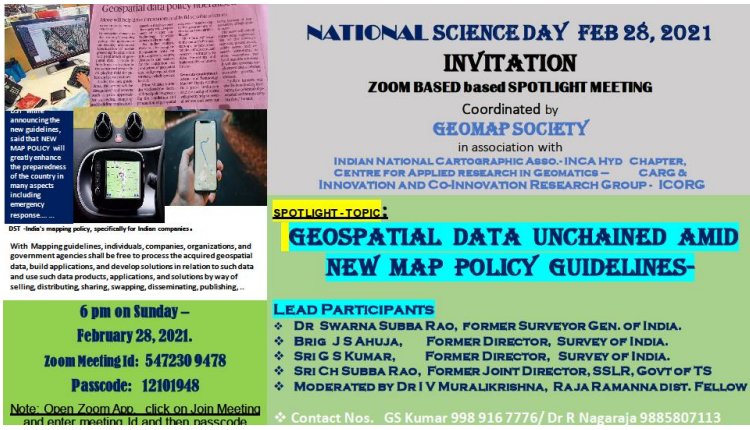
the State would be able to mop up an additional ₹100 crore a month to the fund by doing this.
Lalitesh Katragadda, former Google Country Manager known for developing Google Map Maker group map-making tool that allow people map the world around them, said marking out accurate land boundaries around every piece of land and giving necessary policy infrastructure to trade land freely and mapmakers marking GPS boundaries around the land, would help farmers and others to mortgage their land at much cheaper rates to raise necessary funds. Currently they are all paying much higher interest rates for no fault of theirs, he said.

Digital address

Welcoming the rule change, Rohan Verma, CEO of MapmyIndia, said his firm has been working on this area for a quarter of century and has developed a number of geospatial products which can now be rolled out. One of them, he said, is eLOC, which is capable of any dwelling in the country a digital address that contains six alphanumerical characters. “A person doesn’t need to write his full address, these six characters are good enough for reaching anything at his or her doorsteps, whether they live in a palace or a hut,” Verma said.

Opinions

Webinar invitation on 28 Feb 2021 on New Map Policy 2021



Earlier this week, the Department of Science and Technology (DST) issued a new set of guidelines under the National Map Policy 2005. For the first time, the government has made it clear that ordinary citizens can create, collect, publish, and keep maps (both physical and digital) without asking the government for permission or getting security approvals. This is a welcome step that should have been taken decades ago.

It stands in stark contrast to the draconian Draft Geospatial Information Regulation Bill, 2016, which effectively banned the acquisition of geospatial data (i.e., mapping information) without a government licence. Had it passed, it would effectively have rendered all unlicensed maps (or even collecting of underlying data for a map) illegal, and in its plain reading would have penalized students drawing inaccurate maps during their geography lesson. Thankfully, that proposed Bill never materialized into an Act.

The new guidelines emphasize mapping data as an asset to be used for India’s benefit. With the new guidelines, high resolution mapping by private citizens, which in some cases was already being undertaken in a gray zone of legal uncertainty, will become clearly legal. “Street view” maps, which show photographs

superimposed onto maps to create a virtual reality experience, are also legalized. Importantly, all existing geospatial data produced by any central government entity using public funds is required to be publicly shared—free of charge with other government departments, and at a "fair and transparent" fee for others.

Given how guarded departments have been of their data, this is quite revolutionary. However, as with the National Data Sharing and Accessibility Policy, the National Open Standards Policy, and the RTI Act, revolutionary policies and laws are only as revolutionary as their implementation would allow them to be. There is some room for improvement: non-commercial use of the data should be exempted from fees. Citizens should not be made to pay for non-commercial usage of data that they've themselves funded with their taxes.

These guidelines are welcome news to India's burgeoning community of open-source mapping. The largest such volunteer-driven mapping effort, OpenStreetMap (OSM), powers everything from the maps used by taxi aggregators to those used by the United Nations for disaster relief missions. India has unique addressing and navigation challenges that can only be solved through localized research and standardization.

In a city like Bengaluru, streets can be one-way one day and one-way in the reverse direction the next, and often directions are used instead of addresses. Such bureaucratic caprice and mapping realities can only be reflected in a digital map with some amount of accuracy by decentralized volunteer-driven projects, which have the potential to be both faster and more detailed. Further, if you go to remote parts of India, such as the hinterlands of Himachal Pradesh, you will find that commercial maps such as Google Maps do not provide nearly the same amount of detail as volunteer-driven OSM, to which anyone can contribute.

NEED COLLABORATION, NOT PROTECTIONISM

While the new guidelines bring much-necessary liberalization, they come along with some protectionist measures as well. They prevent non-Indian entities from enjoying the new licence-free regime. They also require that maps with spatial accuracy greater than 1 metre horizontally or 3 metres vertically be created by an Indian entity and stored on Indian servers. This could potentially jeopardize open mapping—while it is predominantly Indians who contribute to efforts like OSM, there's no restriction placed in such a volunteer-driven effort. Further, OSM servers are located all over the globe, and it is unclear why an India-located server is better. Lastly, it is also unclear whether these regulations are in line with India's obligations under the WTO's GATS (General Agreement on Trade in Services) framework. A better way to promote Atmanirbhar Bharat in this sector would be to stop depending on foreign companies by requiring government entities to use only maps generated by Indian entities, which are openly licenced, and put no burden on the exchequer.

We have seen the government collaborate with mapping communities in the past. For instance, Mapathon

Keralam was launched in 2019 by the Kerala State IT Mission and volunteers to map critical assets in the state for emergency and rescue operations, and was found to be very useful by the Kerala government. We need more such collaborations to improve everything, from disaster management to bus schedules and routing. To enable this, administration at all levels—central, state, municipal, and taluk—need to work with civic hackers, and ways and means must be found to encourage public-spirited technologists as well as the commercial mapping industry.

As the guidelines recognize, the government also needs to bring other policies, such as those covering remote-sensing and the national spatial data infrastructure, in line with the new guidelines, and streamline the flow of data within the government. Importantly, stakeholders should be publicly consulted before the formulation of further guidelines and policies, since they can advise the government on how to unlock the full potential of mapping through the usage of open standards and APIs (for technical interoperability), open licences (for legal interoperability), and open metadata and vocabularies (for semantic interoperability), along with insights into civic and developmental issues to tackle with technology.

The DST has shown great sagacity through this commitment to removing the yoke of superfluous regulations that has held India back: now we must move forward to translate this into results on the ground.

Continuously Operating Reference Stations (CORS) GNSS network challenges and benefits in Indian context

Dr. S. K. SINGH & Deepak KUMAR, INDIA

Key words: Benefits, Challenges, CORS, GNSS, IGRF, ITRF, APREF, GCP, NRTK, IRNSS, Methodology

SUMMARY

A Continuously Operating Reference Stations (CORS) GNSS Network is essential to provide a regional positioning service that can provide fit-for-purpose positioning. In CORS Infrastructure, the corrections are instantly sent to the rover receiver (user end) from control centre which helps to find very accurate positioning of rover in real time. CORS plays a major role in achieving centimeter accuracy positioning in many applications, for example, cadastral mapping, land information management, large scale mapping, fleet management, tracking and navigation etc. To achieve this at a regional level, a CORS network need to have an integrated national setup. Survey of India is in process of establishing the Continuously Operated Receiver Station (CORS) network in India for the first time at the national level. In the first phase five Indian states namely Uttar Pradesh, Uttarakhand, Haryana, Maharashtra and Karnataka will have CORS network in place with its control and analysis centre at Dehradun, Uttarakhand.

CORS technology is rapidly becoming the preferred method for accurate 3D positioning across the world and forms the basis for any smart city agenda. It is in great demand among industries like surveying, navigation, construction, mining, precision agriculture and scientific research that require greater positional accuracy, as well as continuity of data. Geophysicists, Meteorologists, Atmospheric and Ionospheric Scientists also leverage CORS data for a wide

variety of applications. Other popular user groups include Surveyors, GIS users, Administrators, Planners and Engineers. In this paper, we will explore benefits from a CORS GNSS Network, and shed light on the methodology adopted for CORS GNSS network at the national level.

Continuously Operating Reference Stations (CORS) GNSS Network Challenges and Benefits in the Indian Context (9921) S. K. Singh and Deepak Kumar (India) FIG Working Week 2019 Geospatial information for a smarter life and environmental resilience Hanoi, Vietnam, April 22–26, 2019 2 | 15

Continuously Operating Reference Stations (CORS) GNSS network challenges and benefits in Indian context

Dr. S. K. SINGH & Deepak KUMAR, INDIA

1. INTRODUCTION

Network-based Real Time Kinematic (NRTK) GPS positioning is considered to be a superior solution compared to the conventional single reference station based Real Time Kinematic (RTK) GPS positioning technique whose accuracy is highly affected by the distance dependent errors such as satellite orbital and atmospheric biases. NRTK GPS positioning uses raw measurements gathered from a network of Continuously Operating Reference Stations (CORS) in order to generate more reliable error models that can mitigate the distance dependent errors within the area covered by the CORS.

The corrections calculated by the CORS network are provided in real-time to any number of GNSS users via internet within the network to correct their positioning accuracy up to centimetre level

This technique has been developed and tested considerably during recent years and the overall performance in terms of achievable accuracies, reliability and mobility is as good as or even better than can be achieved using the conventional RTK GPS positioning technique. The project envisages to establish a Continuously Operating Reference Station (CORS) network to model and correct the distance-dependent errors that reduces the accuracy of conventional GNSS (IRNSS, GPS, GLONASS, Galileo, BeiDou, etc.) positioning.

The corrections calculated by the CORS network are provided in real-time to any number of GNSS users via internet within the network to correct their positioning accuracy up to centimetre level.

The justification for the establishment of CORS networks was initially in support of geodesy and other geoscientific applications, at the global and regional level. However, the GPS CORS network infrastructure could be used as a platform for real-time centimetre-level accuracy services, carrier phase-based modes of operation generally referred to as GPS-RTK (Real-Time Kinematic).

2. INDIAN GEODETIC REFERENCE FRAME (IGRF) & CORS NETWORK:

GPS in the 1980s was almost exclusively used for geodetic control surveys. The inter-receiver distances were at first several tens of kilometres, being the average distance between first order geodetic control groundmarks. The task was to establish new geodetic ground marks using differential carrier phase-based GPS techniques. However, at about this time GPS was also proving itself to be an effective space geodesy technique for measuring crustal motion and for establishing the global reference frame. Hence progressively the distances between GPS receivers increased to hundreds and then thousands of kilometres, while simultaneously the relative accuracies increased, ensuring cm-level relative accuracy within GPS receiver networks even as inter-receiver

distances grew significantly. GPS is now the premier tool for modern geodesy, and relative accuracies at the few parts per billion (ppb) level are routinely achieved (IGS 2006). These GPS geodetic stations inevitably became permanent reference stations for: Continuously Operating Reference Stations (CORS) GNSS Network Challenges and Benefits in the Indian Context (9921) S. K. Singh and Deepak Kumar (India) FIG Working Week 2019 Geospatial information for a smarter life and environmental resilience Hanoi, Vietnam, April 22–26, 2019 3 | 15

(a) the monitoring of the station motion itself (due to horizontal and vertical crustal motion)

(b) realising or defining "modernised" geocentric geodetic datums at the national level, and

(c) the densification of the geodetic control (groundmark) networks using GPS techniques

However, as GPS was becoming an indispensable geodetic tool, government agencies looked for ways to replace traditional geodetic control networks initially with groundmarks surveyed using GPS technology, and then increasingly with networks of CORS receivers. This trend from groundmarks surveyed using carrier phase-based GPS techniques – commencing in the 1980s – to today's networks of GPS receivers supporting high accuracy positioning, anytime and increasingly in real-time, has been generally justified on the basis of improved efficiency. India has followed the same trend and the Indian geodetic reference frame (IGRF) was established through a set of "passive" network of ground marks during the period from 2006 to 2014. The current Indian horizontal reference frame is linked to the *International Terrestrial Reference Frame* (ITRF) epoch 2005. The IGRF was realized through a network of about 260 well spread high precision Ground Control Points (GCPs) at a spacing of 250-300 km apart across the country. This network was observed and adjusted in combination with few IGS stations surrounding the Indian territory.The network was further densified with 2260 precision Ground Control Points at a spacing of 30 to 40 km apart withhin the framework of IGRF . The current horizontal reference framework of nearly 2520 ground control points serves the basis of all the mapping and surveying requirements of the country. Due to it's various inherent inconcistencies the IGRF is only suited for relative positioning, primarily for mapping applications .With relative positioning, it is possible to determine coordinates that can be kept fixed within certain accuracy limits over a long time, depending on how stable a given area is. However, relative positioning requires parallel measurements in both the new points for which coordinates are to be determined and one or more reference points.

Survey of India is in process of establishing the Continuously Operated Receiver Station (CORS) network in India for the first time at the national level. In the first phase five Indian states namely Uttar Pradesh, Uttarakhand, Haryana, Maharashtra and Karnataka will have CORS network in place with its control and analysis centre at Dehradun, Uttarakhand . The CORS network will

fulfil the long standing demand of various user agencies to carry out their surveying and mapping tasks in an effective & faster manner. In addition, it will provide valuable data to Indian scientific community for research and development work.

The proposed CORS network is expected to operate and deliver within the framework of current IGRF till the time the IGRF is redefined following the accepted standards.The proposed CORS network is expected to replace the present network of groundmarks in a phased manner due to obivious advantages. One of the reasons cited by government agencies for replacing “passive” networks of groundmarks with “active” networks of CORS receivers is the lowered maintenance of the network (there are typically far less GPS stations than ground marks – and even if they need to be re-established using the permanent GPS receiver network, such a re-survey task is very cost efficient). Another is that the national geodetic datum can be propagated to all other GPS surveys using reference network data.

3. ISSUES OF CORS OPERATION:

Once a GNSS CORS is established there are several issues the operator must address and monitor for the purpose of site operation and maintenance. The guidelines address the issues of coordination, stability monitoring, data formatting, data access, and metadata requirements. When claiming to operate within the national reference frame, the coordinates of the site need to be calculated in a traceable manner. The guidelines recommend that GNSS CORS operators submit a substantial time series of Receiver INdependent EXchange (RINEX) data (either by providing months of recorded data, or ongoing data streams) for processing and analysis. If all GNSS CORS stations were to be coordinated in this manner then all services from GNSS CORS could be said to be on a unified realisation of the national reference frame. GNSS CORS operators should also be continually monitoring the stability of their GNSS CORS antenna reference point. This may be undertaken through discrete campaigns analysing the movement of the reference point relative to local ground marks, by submitting ongoing data streams for analysis and monitoring, or through the software used to manage a GNSS CORS network.

It is recommended that GNSS CORS sites archive data in the RINEX format to ensure compatibility for post-processed applications with the greatest range of equipment and processing software available. GNSS CORS operators may also choose to archive the raw data from the GNSS CORS equipment in a proprietary format which provides additional functionality but may restrict its use for users with equipment from a different brand of GNSS manufacturer. The GNSS CORS operator should keep a comprehensive metadata set that includes all relevant information for the site including metadata on the:

- • Site
- • Receiver
- • Antenna
- • Monument
- • Coordinate deviation
- • Power
- • Communications
- • Data Formats
- • Reliability of service
- • Stability
- • Additional Site Sensors
- • Data Access

This information should include, as relevant, key contacts, agreements, tenure, equipment vendors, models, serial numbers, firmware versions, equipment warranties, purchase dates, photographs of the site, repairs and upgrades. The metadata should be kept current, with changes logged as soon as they are made, and historical logs maintained to ensure that an understanding of the site conditions at any given moment is available. A subset of this metadata should be provided to all users of data from the GNSS CORS site, with sufficient information for the user to make an informed choice on whether data from the GNSS CORS site will be suitable for their intended application.

METHODOLOGY ADOPTED FOR CORS NETWORK ESTABLISHMENT

This paper adopt the model shown in Fig. 3, which breaks up the process into five discrete roles that need to played in order to achieve a CORS network of desired capability. The establishment, operation and maintenance of the all the CORS components will be done on contract basis exept the site for base station and othe supportive infrastructure will be provided by the Survey of India. An overview of CORS architecture has been given in Fig.4. In the following sections, each of these roles is described in more detail by outlining the types of activities performed under each role.

4.1 Role: Specify System

In this role the underlying characteristics of the reference station network is specified, such as:

Target Density – e.g. current network RTK software typically requires stations to be no more than 70km apart;

Target Coverage – e.g. to cover specific state or to achieve National Coverage;

Target Accuracy – e.g. 2cm horizontal positional uncertainty and 4cm vertical uncertainty at 95% confidence;

Target Reliability – e.g. deliver ambiguity resolution performance to all user receivers such that 95% of initializations are achieved in less than 3 minutes;

Target Availability – e.g. data from all stations 99% available (equivalent to less than 10 minutes of outage per day) and 99% availability of communications for all user receivers;

Site Quality – e.g. antenna mounted with a completely clear view of the sky above 10 degrees elevation and with antenna stability better than 2mm, tested from daily repeatability over a significant time series of measurements;

Equipment Quality – e.g. dual frequency receiver tracking GPS, GLONASS and IRNSS signals through antenna with high resistance to multipath;

Geodetic Reference Frame – connected to current IGRF with an absolute positional uncertainty better than 1cm;

Data Services Produced – supporting:

- • dual frequency receivers with capability to receive GPS, GLONASS and IRNSS signals;
- • dual frequency RTK GPS;
- • Submetre accuracy, differential, single frequency GPS psuedorange users for both post processed and real time.

Data Access Policy – covering:

- • post processed data at 30 second epochs for the establishment, densification and maintenance of the Indian Geodetic Reference Frame;
- • single station real time data stream for scientific users;
- • post processed data at 1 second epochs subject to a fee for commercial users;
- • dual frequency real time GPS, GLONASS and IRNSS corrections subject to a fee for commercial users.

4.2 Role: Own Stations

In this role all the reference stations will be established and mantained as per the operation and maintanance contract between the buyer and the vendor:

Site Selection - selecting sites that meets the criteria;

Site Construction - according to the specifications specified by the buyer;

Equipment Purchasing - according to equipment quality and other specifications;

Station Data Communications - This primarily means the connection of the

station to the chosen method for sending the data to the network control centre;
Site Maintenance - This requires maintaining the site itself to be free of obstructions, and be secure but could also extend to responsibility for being the first port of call when the reference station is experiencing problems such as when a receiver needs to be rebooted or arranging repairs to unreliable data communications;
Equipment Replacement Cycle - This requires funding of the depreciation of the receiver so it can be replaced at the end of its life.

4.3 Role: Network the Data

This role is at the core of the reference network business and is responsible for issues such as:
Data Communications from Network Stations – This involves overseeing and being responsible for retrieving the data from all of the individual reference stations and bringing it together in the Network Control Centre.
Control Centre – This involves running the Network Control Centre, which is responsible for receiving, monitoring and storing the data from all of the reference stations. It will involve extensive quality control of the reference station data including issues like data completeness, analysis of multipath at stations, data latency etc;
Quality Control of Data – This involves a level of pre-processing of the data to check factors such as completeness for number of signals tracked (e.g. L1 and L2 code and phase data), and data frequency and coverage (e.g. data every 1 second in a 1 hour file or every 30 seconds in a 24 hour file), and for factors such as signal quality and multi-path;
Data Archive – Given the value of long term permanent reference stations for the geodetic infrastructure and for other purposes such as earth and atmospheric science and legal issues like traceability and liability, it is important to have in place clear policies and procedures for archiving the reference station data itself and perhaps other information about data quality.

4.4 Role: Process Network

This role is also at the core of the reference network business and is responsible for issues such as:
Copy of Network - This involves taking a copy of the data streams from the organisation with the Network the Data role and then value adding;
Data Processing – This value adding activity is where the data streams from the various individual reference stations are brought together and the network corrections are computed.
Production of Correction Data Streams – Based on the correction models derived above the software can then derive correction data streams for the users. For example in the case of the Virtual Reference Station process, this involves receiving the user's point position and generating correction data as though there is a reference station at the user's position.
Distribution of Correction Data Streams – Once the corrections are derived they are then delivered to the user over what ever communication medium has been decided is best for that user. Often this will be delivery of an NTRIP data stream over a mobile internet connection. However, it may also require hybrid methods in agriculture, construction and mining such as delivering the corrections to a central point like a farmhouse or site office (via the Internet) and then sending the corrections on to field staff, vehicles and equipment via means ranging from a radio broadcast to a meshed wireless LAN.

4.5 Role: Deliver Service

This role is typically providing the CORS corrections as a service to the end users of the reference network data.
Retail Sale of Data Products – This would involve selling the various GNSS corrections offered by the network. The corrections will be disseminated after

proper authentication and payment realization;
Marketing –Since this is an revenue generating activity, it requires marketing and advertising activities and these may need to be tailored to different user groups after accessing their needs;

5. THE BENEFITS OF CORS NETWORK

5.1 Time and cost savings

A significant benefit of a CORS networks is that a single survey grade GNSS receiver with access to the internet can receive CORS correction data and compute centimeter accuracy positions. Furthermore, additional time and costs are saved by not requiring the set-up of the local base station (including the coordination of the base station position), and the time required to move the base station to ensure line-of-sight of the radio wave correction data is avoided. The benefit of reducing the costs for individual users to take advantage of CORS correction data, and hence centimeter positioning, is particularly interesting in emerging countries where users don't have the ability to finance multiple survey grade GNSS receivers.

5.2 Ease of use

Accurate positioning with a CORS network is also very easy to achieve. With minimal training and the correct equipment, professionals and non-professionals, can easily use GNSS to derive centimeter coordinates.

5.3 Coordinate accuracy and homogeneity

A CORS GNSS Network provides the significant benefit that coordinate accuracy is maintained throughout the network, even over large distances between the reference stations and (Network Real Time Kinematic) NRTK rover. With all NRTK rovers using the same CORS network which utilize the same coordinate system, then all coordinates derived will be more homogeneous and consistent, and the source of many possible mistakes made by rover operators are minimized.

5.4 International Terrestrial Reference Frame (ITRF)

A further benefit of CORS GNSS Networks is that they are essential to provide the framework for a unified geodetic reference network that provides a consistent and homogenous 3D coordinate system that can be traced to the International Terrestrial Reference Frame (ITRF) The network will also be utilized to establish the linkage between Asia-Pacific Reference Frame (APREF) and IGRF, monitoring the variations and changes in geopotential and support scientific research related to both intra-plate and inter-plate movement in Asia-Pacific region.

5.5 Traceability of coordinates

With a bi-directional communication channel between the CORS network and the NRTK rovers, it is possible for the network to store the positions and accuracy of the rovers. This would provide the benefit of controlling that positioning is performed within the regulations, but equally, it represents a challenge that regulations would need to be adapted to include such quality/traceability checks

6. THE CHALLENGES OF CORS NETWORK

6.1 Cable/Mobile Internet Coverage

For a CORS network to operate in real-time, the data collected at the CORS stations needs to be transferred in real-time to a central location for processing. These corrections are then made available on the internet for processing to correct the position of NRTK rovers to centimeter accuracy. This requirement means that all CORS stations have an internet connection. When the CORS station is in a built-up area, then this is generally not a problem, but when the CORS station is located at a remote location, then this can be challenging. The same applies for the NRTK rovers conducting their centimeter positioning tasks, they require at least a 3G mobile internet connection.

6.2 Power Supply

Operating 24/7, CORS stations need to be continuously supplied with power. Photovoltaic panels and batteries are needed to accompany the CORS station and associated communication devices

(modem/router) to ensure continuous operation, either as a primary source of power, or as a back-up of unstable power networks. Finally, the complete system needs to be protected from a poor quality or fluctuating power supply that can often cause power surges, spikes and voltage fluctuations.

6.3 Security

The costs of establishing a CORS station are not insignificant, and hence the investment needs to be protected against vandalism, theft and exposure to environmental elements. In the case of a stable ground set-up, the GNSS antenna, receiver, modem/router and the photovoltaic panels and batteries should be located behind a security fence and be mounted high enough to be free from floods, and mounted secure enough to withstand severe winds.

6.4 Maintenance

Although a CORS network brings many benefits over many years, the continuous maintenance of the network needs to be ensured. The CORS stations need to be routinely visited to check for damage and replace and clean components to ensure their continued performance. In addition, the computer network that hosts the software that runs the CORS network, needs to be continually maintained to implement operating system and application software updates to benefit from the latest security and performance enhancements.

6.5 Future proof

Mostly, a CORS network is never static and is continually being expanded and enhanced to adopt to changes and growth in the user base and their locations. This requires that the number of CORS stations in the network is continually expanding. Care should be taken when selecting the software for a CORS network that any receiver type can be added to the network irrespective of the brand of the receiver and without any additional charges being incurred for a brand that is not the same as the software. Failure to ensure this at the outset of the CORS network can significantly increase the total costs of owning and operating a network.

7. USAGE OF CORS NETWORK IN INDIA:

CORS network installation will be used as an infrastructure for disseminating the correction service to various users. CORS technology is rapidly becoming the preferred method for accurate 3D positioning across the world, and forms the basis for any smart city agenda. It is in great demand among industries like surveying, navigation, construction, mining, precision agriculture and scientific research that require greater positional accuracy, as well as continuity of data. Geophysicists, meteorologists, atmospheric and ionospheric scientists also leverage CORS data for a wide variety of applications. Other popular user groups include surveyors, GIS users, and engineers. And with continuously evolving GPS technology, CORS facilities will have an even greater role to play in the future. This subscription based service will be used for numerous activities some of them are mentioned below:

Large Scale Mapping, Cadastral Survey, Flood Plain Mapping, Fleet Management, DEM Generation, Crustal Deformation and Plate Tectonics Study, Land Subsidence and Vertical Ground Motion Study, Dam Deformation Study and Structural Health Monitoring etc.

8. CONCLUSION

This paper has highlighted the many benefits and challenges associated with CORS GNSS networks. To minimize the impacts of the challenges associated with establishing a CORS network, and to avoid any surprises once implementing, this paper recommends that a thorough feasibility study is conducted prior to beginning a CORS project. The feasibility study should include:

i i. Analysis of the cable/mobile internet coverage within the network and at proposed CORS stations.
ii ii. Careful design and examination of the location of each CORS station to ensure that sufficient coverage, accessibility and security can be ensured.
iii iii. Esurance that the system is completely future proof, and that the CORS network can be expanded without discrimination of GNSS receiver brands.
(For references and full paper please visit website)

Survey of India and the land records department decided to implement CORS

Published December 29, 2019

CORS will not only help with the land measurement activity, but also with land acquisition, alignment of roads and other related activities in a swift, transparent and accurate manner," said Milind Chavan, deputy director, land records.

The Survey of India and the land records department have decided to implement continuous operating reference stations (CORS) using which land measurement can be accomplished in minutes along with producing an accurate map of the land.

Once the map is ready and other technicalities are completed, it can be given to the applicant — at the earliest — within three days. The officer said that of the 12 CORS, four will come up in Nashik district. The CORS will provide signals to surveyors within a radius of 35 to 50km. They need not be manned but will need security infrastructure around and hence will ideally have to operate out of government offices — like a tehsildar or district collectorate office.

"The system has tremendous potential. Carrying out activities such as identifying alignment of the road, rail, canals, planning development work and land acquisition will benefit from such a system. Besides, the Survey of India will also be able to carry out its own programmes," Chavan added.

Simultaneous Capturing of Lidar and Imagery - 05/02/2020

How Major Cities May Benefit from a Hybrid Sensor System

Mathias Lemmens

Aerial surveys conducted in the UK and Ireland demonstrate the potential of a combination of nadir camera, oblique cameras and a Lidar unit in one to meet the need for accurate, detailed and up-to-date 3D city models.

Simultaneous Capturing of Lidar and Imagery - Bing

REPL appointed for providing GIS based plans Haldwani Uttrakhand Project

REPL will prepare the master plan of the city for the horizon year 2041 that includes demand assessment, identification of issues.

February 18, 2021 1:32 IST | India Infoline News Service

State Mission Directorate of Uttrakhand has appointed Delhi-based Infrasturcture Consultancy firm Rudhabhishek Enterprises (REPL) to prepare GIS- based master plan of Haldwani under AMRUT scheme with design standards of National Urban Information System (NUIS).

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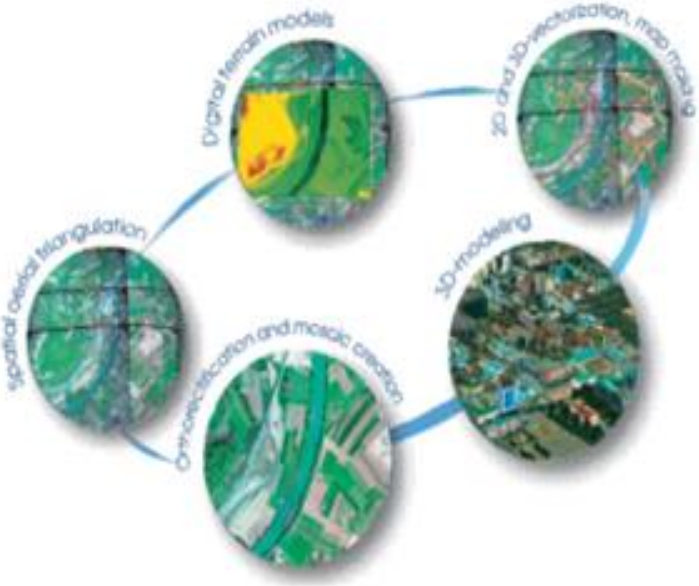
REPL will prepare the master ppan of the city for the horizon year 2041 that includes demand assessment, identification of issues, projected requirements, development strategy and draft proposals on the GIS base map and sector-wise data analysis. The preparation of the master plan will also include aspects of employment generating activities, industries, retails and malls, educational facilities, medical facilities and several other community facilities.

Overview

PHOTOMOD®



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