CORSnet-NSW Reaches 150 CORS Milestone

Volker Janssen, Land and Property Information

CORSnet-NSW is Australia's largest owner-operated Global Navigation Satellite System (GNSS) Continuously Operating Reference Station (CORS) network. It is built, owned and operated by Land and Property Information (LPI), a division of the Office of Finance and Services, NSW Treasury. LPI's first CORS was installed in 1992 in Bathurst, using in-house developed programming to support internal survey and aerial photography operations. In 2004, a pilot-project network of seven CORS was installed in the Sydney metropolitan area and made available to the public one year later under the name SydNET.

A renewed effort of expansion to extend the coverage of CORS throughout NSW commenced in 2009 as part of a 5-year, multimillion-dollar Survey Infrastructure Improvement Project, which corresponded with the rebranding of the network as CORSnet-NSW. In only four-and-a-half years, the network has grown from 27 stations in late 2009 to 150 CORS in July 2014... and it still keeps on growing. Trimble ranks CORSnet-NSW in its top 10 CORS networks in the world. This article provides a brief overview of the current status of CORSnet-NSW and indicates what's in store for the near future.

CURRENT STATUS

Today, CORSnet-NSW (http://www.corsnet.com.au/) is a state-wide network of GNSS CORS providing fundamental positioning infrastructure for New South Wales (and the Australian Capital Territory) that is accurate, reliable and easy to use. It supports the spatial community and provides stimulus for innovative spatial applications and research using satellite positioning technology. CORSnet-NSW subscriptions are currently available through two premium authorised resellers (SmartNetAus and AllDayRTK) and 16 authorised resellers servicing a wide range of applications.

As of August 2014, CORSnet-NSW consists of 152 reference stations across the state. Figure 1 illustrates the CORS network coverage, showing stations that are operational (indicated by small triangles) as well as some planned stations (indicated by small circles). A 50 km radius around active stations is shown to illustrate the maximum recommended coverage area for single-base Real Time Kinematic (RTK) operation, while Network RTK (NRTK) coverage is shown as a striped, pink polygon in areas that have sufficient station density to support this technique.

Currently, 68% of the area of NSW (and 99.8% of the population) is covered by the single-base RTK service, while NRTK is available to 55% of the area of NSW (and 98.4% of the population). The sub-metre Differential GNSS (DGNSS) service is provided across the entire state. Other services include the provision of RINEX and Virtual RINEX data for post-processing applications.

Figure 2 illustrates CORSnet-NSW station redundancy, i.e. the area concurrently covered by two or more CORS. In practice, this means that if the primary CORS should not be available for any reason, an alternative nearby CORS should ensure nearly the same user experience in regards to accuracy, time-to-fix, reliability of ambiguities, etc. Currently, such backup coverage is available to 35% of the state's area for RTK, and 85% for DGNSS.

Eleven CORSnet-NSW stations were built to (inter)national geodetic specifications with joint state/federal funding as part of the scientific, national (Tier 2) AuScope CORS network (http://www.auscope.org.au/). Other CORS were built specifically to augment long-term tide gauges located along the NSW coast. Following cross-border arrangements, CORSnet-NSW also incorporates a number of interstate CORS in order to adequately cover areas in the ACT and along the Queensland and Victorian borders. Most stations in NSW are hosted by local councils, and two by private industry. In total, 86% of CORSnet-NSW stations are hosted by LPI's partners.

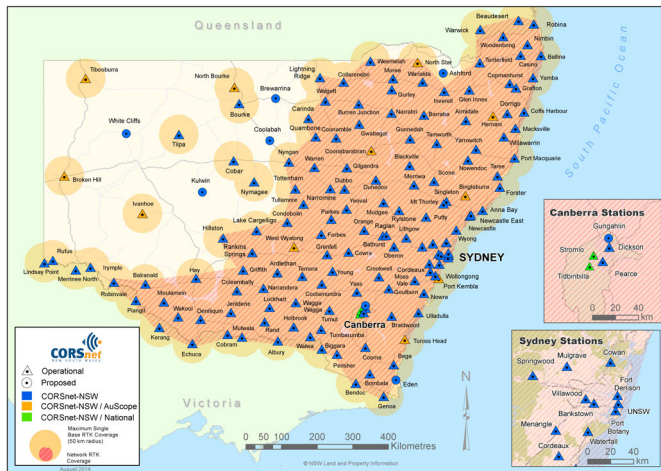In order to provide a legally traceable survey monument that allows the GNSS antenna to be oriented to True North without the need to introduce an antenna height, the CORSnet-NSW Adjustable Antenna Mount (CAAM) was developed and patented by LPI specifically for use within CORSnet-NSW. All Tier 3 CORSnet-NSW CORS installations since March 2011 use the CAAM, which has proven to be very effective.

All CORSnet-NSW stations track both GPS and GLONASS satellites. More than half are hardware-ready for (or at least capable of) tracking additional constellations such as Galileo and Beidou in the future. This functionality will be activated by CORSnet-NSW when each system officially reaches its Initial Operational Capability (IOC), system reliability has been proven and there is sufficient user demand. Where applicable, all CORS feature dual communications (main and backup, e.g. ADSL and Next G) to ensure the highest possible standard in regards to data availability and data completeness.

This is complemented by two Network Control Centres (NCCs) with full redundancy located in Bathurst and Sydney. The system architecture allows for immediate failover between the two NCCs. The data centres use server virtualisation technology to maximise hardware utilisation and at the same time minimise power consumption, space requirements and carbon footprint.

The CORS network is monitored by LPI staff in real-time using Trimble's Pivot CORS network management software. In addition, long-term, multi-year station stability monitoring based on daily 24-hour RINEX files is performed in-house using the scientific Bernese V5.0 software. Station coordinates are calculated with millimetre-level precision, and the resulting time series are made available on the CORSnet-NSW website (see Figure 3 for an example). System performance and station stability are also independently monitored by third parties, including premium resellers and the APREF analysis centres (see below).

All CORSnet-NSW stations contribute to regional geodesy via the Asia-Pacific Reference Frame (APREF, http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/asia-pacific-reference-frame). In addition, all LPI-owned CORSnet-NSW stations support national and local positioning applications via inclusion in Geoscience Australia's free online GPS processing service (AUSPOS, http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/auspos), resulting in better performance for users in and around NSW. The coordinates of each CORS are determined via the national Regulation 13 process (http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/regulation-13-certificates), providing consistent
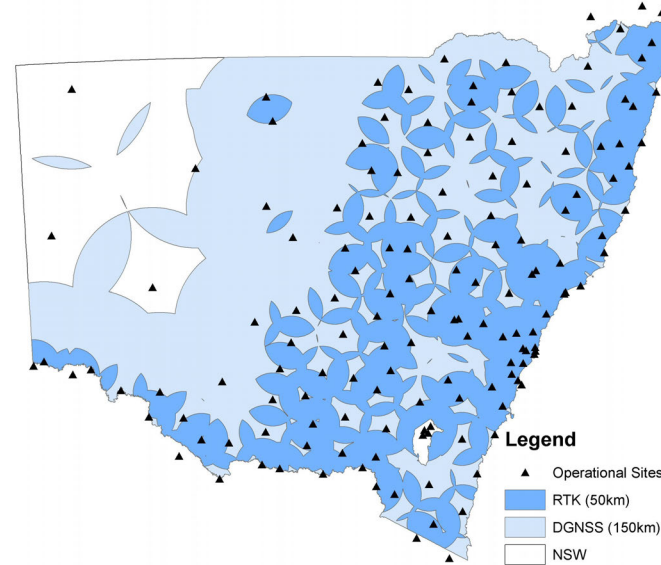

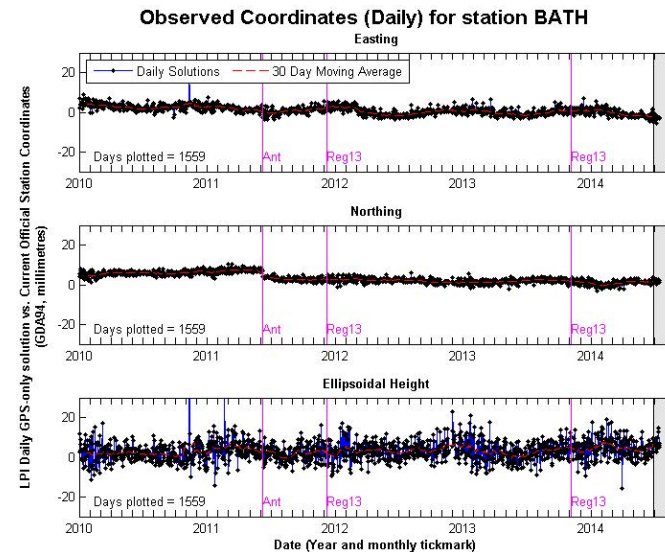Figure 2: CORSnet-NSW backup redundancy map as of August 2014.

Figure 3: Bernese-derived coordinate time series for BATH as of July 2014.

Figure 1: CORSnet-NSW network map as of August 2014.

Cumberland Group Land Development Seminar

and a wealth of ongoing maintenance knowledge. Interestingly Simon noted that Light Rail lines cost $40m-$50m per kilometre with the major costs being the relocation of services. So with the State Government allocating funds in the State Budget to progress the proposal further, the future looks bright for the Western Sydney Light Rail.

NSW SSSI Chair, Gaby Van Wyk, was our final speaker for the morning session, providing an interesting presentation on the implementation of SUI (Subsurface Utility Engineering) from a "Spatial" perspective. Gaby's presentation was very topical given the current program by ICSM (Intergovernmental Committee on Surveying & Mapping) to develop a resources package to assist in the interpretation and application of the new Australian Standard AS5488.

Our Technical and other Exhibitors have always provided great support for the Cumberland Group's annual one day seminars. This year was no exception and once again delegates reaped the benefits of having a number of exhibitors all in the one space. Each exhibitor was provided

time before or after lunch to address the delegates and outline their latest wares. Most took advantage of this opportunity. The Cumberland Group would like to thank the following exhibitors for their support of this Seminar.

• UPG Solutions
• Total Survey Systems
• Position Partners
• Marc Computing Services (Landmark Software)
• CR Kennedy Surveying Solutions
• Civil Survey Solutions
• McMullen Nolan Group
• Mortgage Choice in Sydney Hills District
• Institution of Surveyors NSW

Following the usual hearty lunch at the Liverpool Catholic Club delegates returned to the Seminar room to continue learning and discussion. Our first presenter after lunch was John Hudson, Director ePlanning, Department of Planning and Environment. ePlanning is the use of technology in the delivery and planning and development services, such as online lodgement and tracking of development applications, viewing

planning information on a web based interactive map and providing new ways for stakeholders to engage with the planning process. John explained how the Department has been working with stakeholders to develop a range of tools and services that will improve access to planning information and provide the ability to transact with the planning system online from anywhere anytime. Over the next year more tools and services will be added to those already available. John showed us several examples from the beta version website as developed so far. Release 2 will be launched in early 2015 incorporating the planning portal foundation, the infrastructure platform, updates for functionality and the strategy for 3D visualisation. Release 3 is anticipated to be launched in early 2016 with planning portal enhancements. All surveyors are encouraged to take a look at the work so far at www.planning.nsw.gov.au/eplanning

Vladimir Shopov, Senior Project Manager, Roads and Maritime Services, delivered the next presentation on the Western Sydney Infrastructure Plan

particularly looking at future road projects in connection with the Western Sydney Airport. Vladimir told us that the RMS had formed a dedicated project team based in Parramatta to deliver the new road infrastructure. Highlights of the plan include 55km of new or upgraded roads, Moorebank Freight Terminal and improved movement of freight, a Western Sydney Airport Motorway to the M7, Mamre Road upgrade and $200m allocated to Councils for local roads.

Anthony Mitchell, Director StrataSurv, was next up to the stage to deliver his presentation tiled Homebush – 21 Stage Strata and 1000 lots. The development is located in Homebush West and contains 6.9 hectares of land which was previously the old Hastings Deering Ford factory. Anthony explained how the proposal was to build the first 4 buildings of 18 main buildings in total along a 1 kilometre private road. As the first 4 buildings were not going to change in quantity of units, shape or size and the developer was contracted to deliver a pool and gym within the first 4 stages, all these components were created as "warranted development". Anthony delivered an entertaining presentation with several anecdotes from the construction period. He also warned surveyors to ensure that the development lot and stage boundaries are defined correctly for all future stages of a development as these boundaries are locked in upon registration of Stage 1

and cannot be altered without subsequent approvals and consents. More information on this development can be found in the May *Azimuth*.

The final session of the day was dedicated to Land and Property Information and BOSSI issues. First up was Bob Lock, LPI Surveyor, who took us through the improvements to survey infrastructure through the last 40 years particularly in relation to EDM baselines. Bob is extremely knowledgeable in this area and coloured his talk throughout with a wonderful array of historic and recent photographs.

David Job and Peter Nedelkovski from LPI explained the Audit Process and then presented another array of examples to test the cadastral qualities of the delegates present. Mark Gordon, BOSSI member then completed the day's technical sessions to advise us about BOSSI's interpretation of "Supervision" and its expectations of supervising surveyors.

So with the sun beginning to set the final thanks were delivered and the delegates reassembled at the bar for the usual Cumberland Group Happy Hour. A responsible drink or two later and it was off home to digest the enormous amount of information that one picks up at the annual Cumberland Group Land Development Seminar. I can't wait for next year.

Warren Thomas
Publicity Officer
Cumberland Group of Surveyors

positioning infrastructure that is compatible with other (public and private) CORS operators across the country and provides legal traceability.

FUTURE PLANS

Construction and installs are currently well underway to further expand the network to 160 stations by the end of 2014, in particular to support the agricultural sector, increase station density in the western division of the state and ideally connect the Eden tide gauge to GNSS CORS. Additional stations may be built on a needs and opportunity basis. One such initiative is the national Australian Geophysical Observing System (AGOS) *GPS in Schools* project, which will deliver the integration of two CORS in the ACT, both built with LPI technical support. In NSW, this project may result in up to another five CORS being added to the network, boosting the network to 165 CORS.

Efforts will also be directed towards the inclusion of GPS

modernisation, new emerging GNSS constellations, increased backup redundancy, increased national integration and a larger number of premium resellers. Looking a little further ahead, CORSnet-NSW will provide the backbone of Australia's next-generation datum across NSW, which will result in significant improvements for the surveying and spatial information community.

By reaching its 150 CORS milestone, CORSnet-NSW has matured into a world-class, state-of-the-art, state-wide, multifunction CORS network that balances commercial and public-good mandates. It continues to expand in order to further improve positioning infrastructure across the state, ensuring that NSW is very well positioned for the future.

Dr Volker Janssen <Volker.Janssen@lpi.nsw.gov.au> is with the Survey Infrastructure and Geodesy branch of NSW Land and Property Information, which operates CORSnet-NSW. ∎