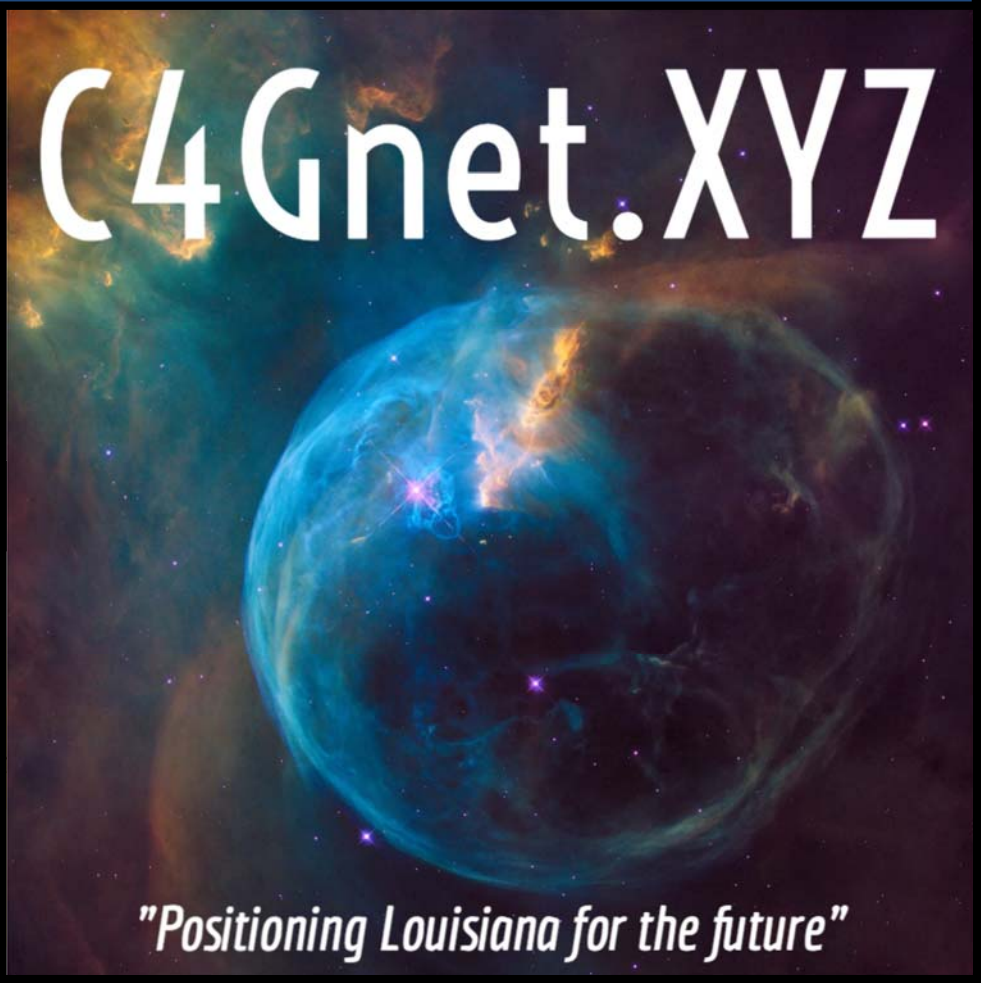
RTN Information

& User Guide

C 4 G

CENTER FOR GEOINFORMATICS
LOUISIANA STATE UNIVERSITY

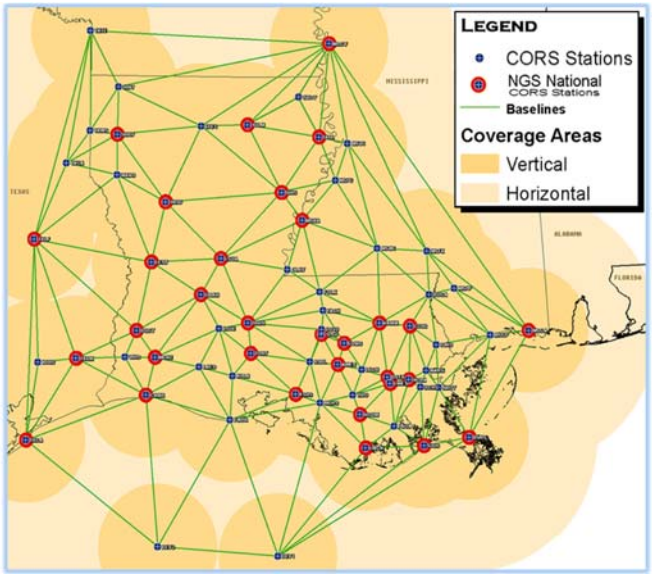


What is a CORS?

Most people are now familiar with the use of Global Navigation Satellite Systems (GNSS) like the ones used for in-car and handheld navigation. They calculate position using signals from GNSS, such as the United States' Global Positioning System (GPS), and have an accuracy of somewhere between a few and several tens of meters. This is the result of minute errors in the satellite orbits, the clocks installed in the satellites and receivers, as well as the tendency for the earth's atmosphere to bend or delay the GNSS radio signal. There are, however, GNSS receivers used by surveyors and researchers which can be used to accurately calculate position at the centimeter level. To obtain this accuracy these receivers and associated software *need to be able to* include sophisticated error corrections in their position calculations.

A Continuously Operating Reference Station "**CORS**" is a high precision GNSS antenna/receiver set on a stable monument. Logging position data continuously, the CORS are used to generate the information needed by high precision GNSS receivers for error corrections in real-time or post processing.

How GULFNet became C4Gnet



C4Gnet Stations at roll-out December 2011

LSU Center for GeoInformatics was created by founding director Dr. Roy K. Dokka & LSU's CoE in 2001, C4G became the home of Louisiana Spatial Reference Center (LSRC), in 2002 through a partnership with NGS-NOAA to create a CORS infrastructure across the state of Louisiana. These CORS provided the positional infrastructure needed for a state-of-the-art active control network that C4G used to re-establish the National Spatial Reference System (NSRS) within the state as defined and managed by the National Geodetic Survey (NGS). In 2007 C4G launched a Real-Time Network utilizing LSRC's state-wide active control networks' GPS CORS infrastructure and called it GULFNet. GULFNet was based on a constrained adjustment of a prior NGS reference frame NAD 83 (CORS96) Position (Epoch 2002.0) which was the basis for the NAD 83(2007) adjustment. NGS stopped supporting this reference frame on July 15th, 2012. In anticipation of the reference frame change C4G launched a second RTN named C4Gnet, running on a newer infrastructure software and a constrained adjustment to the coming NGS reference frame. This allowed users to work in either reference frame by logging into GULFNet or C4Gnet. Once NGS stopped support for the prior (CORS96) reference frame, C4G took the GULFNet RTN offline and reconfigured equipment to become redundant servers for the C4Gnet RTN and all GULFNet RTN clients were switched over to the C4Gnet RTN on or before July 15th, 2012. C4Gnet RTN data are always based on the current NGS CORS reference frame coordinates which are presently NAD 83(2011) Position (Epoch 2010.00) adjustment. The C4Gnet RTN currently runs on Trimble's Pivot Platform which supports multiple reference frames within the infrastructure software making transitions to future reference frames simple and painless for everyone.

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Surveying Application of C4Gnet RTN

New Background Features in C4Gnet

The following features are new in the software that runs the C4Gnet RTN, the features fall into two categories, those that work for you in the *background* and those in the *foreground* that you will see and interact with.

New Background Features:

RTX Technology
RTXNet Processor

If you are interested in how the technology used to deliver C4Gnet's new services actually work, please read the following information on the new features running in the background.

RTX Technology

The RTX Technology infrastructure is a unified framework for estimating satellite parameters for any GNSS satellite. Trimble RTX Technology is revolutionizing global access to high accuracy positioning by creating a system using a worldwide GNSS network to estimate centimeter level real-time satellite orbit and clock corrections and deliver them to any point on earth via satellite broadcast or the Internet. Using multiple network operations centers and redundant communication links, RTX Technology infrastructure ensures the availability of corrections to users across the globe. GNSS field receivers use advanced Precise Point Positioning (PPP) processing algorithms to combine RTX corrections with local measurements and produce cm level accurate absolute positions. RTX corrections are used in a variety of real-time and post-processed positioning applications. RTX based precise absolute positioning is especially useful in remote regions or for coordinate monitoring in locations subject to seismic or subsidence activity.

RTXNet Processor

RTX Technology enables the RTXNet Processor to develop corrections for a full range of satellite systems and delivers Network-RTK corrections for GPS, GLONASS, BeiDou, Galileo, and QZSS. Complete GNSS Network-RTK corrections are available in the industry standard RTCM 3.2 format, Trimble's CMRx format, or the CMR format. Trimble's RTX Technology also improves robustness when working with weak satellite signal transmission or reception and reduces the time to identify and respond to satellite system or signal integrity issues, allowing the delivery of the most complete, reliable, and accurate corrections possible to users. The RTXNet Processor enables real-time network operators to manage stable, highly reliable networks of virtually any size with full multiGNSS support now and in the future.

The RTXNet Processor uses satellite corrections to perform independent processing of reference station data. During processing, additional corrections are applied to measurements, including satellite code bias calibrations, corrections for the yaw angle of the satellite antenna, phase wind-up in the signal path, and the effect of the pole tide. Geometric and ionospheric error models used in Network-RTK corrections are derived from processed observation residuals. This new processing architecture significantly reduces server CPU loading. The RTXNet processing technique also results in increased tolerance for varying station spacing. This allows data from regions with dense station spacing to be processed with data from regions with wider spacing and even allows a single network processor to handle two or more separate

networks. The ability to process very large or mixed geometry networks in Network-RTK mode on a single server and deliver full range real-time GNSS network modeled RTK corrections is unmatched in the industry. This allows very large networks or a combination of networks to be processed by a single module on one server with full GNSS correction support.

The RTXNet Processor incorporates RTX Technology as the core of a Network-RTK solution that supports the expanding range of GNSS systems and signals while at the same time reducing the network processing CPU load. Our new RTXNet Processors deliver the next generation of real-time GNSS network modeling taking full use of all available GNSS signals, ie GPS, GLONASS, Galileo, Beidou and QZSS. Rovers connected to mountpoints using RTXNet based processors are sent corrections based on advanced Precise Point Positioning (PPP) processing algorithms to combine RTX corrections with local measurements and produce cm level accurate absolute positions.

VRSNet Processor

Station Name	Station	Tracke	Processed	Solved
1NSU, Natchitoches, LA	1NSU	18	16	16
AMER, Amerada Pass, LA	AMER	16	16	16
AWES, Donaldsonville, LA	AWES	16	16	16
BCHS, Belle Chasse, LA	BCHS	16	16	16
BSRL, Bayou Sorrel, LA	BSRL	16	16	16
CALC, Calcasieu Pass, LA	CALC	16	16	16
COVG, Covington, LA	COVG	16	16	16
CYPR, Cypremort Point, LA	CYPR	16	16	16
DOTD, Baton Rouge, LA	DOTD	16	16	16
DQCY, Dequincy, LA	DQCY	16	16	16
DSTR, Destrehan, LA	DSTR	16	16	16

RTXNet Processor

Station Name	Station	Tracked	Processed	Solved
BCHS, Belle Chasse, LA	BCHS	23	21	21
DOTD, Baton Rouge, LA	DOTD	24	21	21
FOLK, Jackson, LA	FOLK	24	22	21
GRIS, Grand Isle, LA	GRIS	23	21	21
LSUE, Eunice, LA	LSUE	24	22	21
THHR, Opelousas, LA	THHR	24	22	21
ZACH, Zachary, LA	ZACH	24	21	21
AWES, Donaldsonville, LA	AWES	23	21	20
BSRL, Bayou Sorrel, LA	BSRL	23	21	20
COVG, Covington, LA	COVG	23	21	20
DQCY, Dequincy, LA	DQCY	23	21	20

As illustrated above our RTXNet Processors currently deliver additional satellites form Galileo in solutions sent to rovers connecting to our new PPP mountpoints in the formats of CMRx or RTCM 3.2 Multi-Signal Message (MSM), rovers wishing to take advantage of these additional SV's need to connect to a PPP mountpoint that delivers corrections in CMRx or RTCM 3.2 Multi-Signal Message (MSM) format.

Using a PPP mountpoint also gives your rover a second real-time processing method to collect data. By taking a point with a PPP mountpoint and then with a VRS mountpoint, you can compare these positions as a way to check data collected with in real-time! If data collected with both PPP and RTK agree, you have a very high confidence that the data collected is accurate.

Please Note: VRS RTK mountpoints only support GPS and GLONASS constellations currently, only our PPP mountpoints in CMRx or RTCM 3.2 MSM formats currently have the ability to support GPS, GLONASS, Galileo, Beidou and QZSS satellite constellations.

New Foreground Features in C4Gnet

C4Gnet is introducing new *foreground* features that give our clients new tools to interact with.

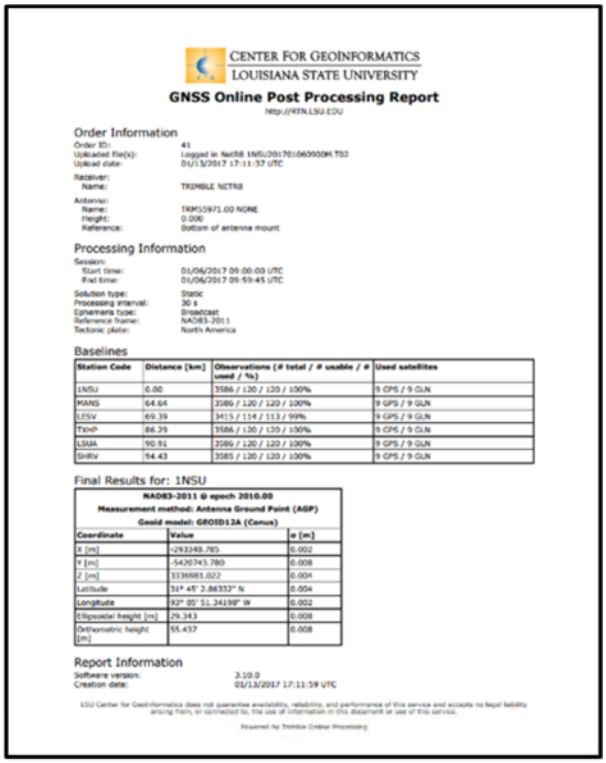
New Positioning Tools:

GNSS Online Post Processing (OPP)
VRS iScope and iScope Live!
Real Time RTXnet Processor using Precise Point Positioning (PPP)
New PPP Mountpoints and a new mountpoint naming convention

New Foreground Features

Online Post Processing (OPP)

C4Gnet GNSS Online Post Processing is an OPUS-like online post processing service that allows you to upload raw static GNSS observation data and receive absolute positioning calculations based on reference stations in the C4Gnet network. Note that the C4Gnet GNSS Online Processing service ***uses GPS, GLONASS and Galileo satellite data*** and has access to all of the LSRC CORS network of over 100 reference stations in the OPP solutions whereas the NGS OPUS tool is limited to only 31 LSRC CORS reference stations.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GNSS Online Post Processing Report

Order Information

Processing Information

Baselines

Station Code	Distance [km]	Observations (# total / # usable / % used / %)	Used satellites
1NSU	0.00	3586 / 120 / 120 / 100%	9 GPS / 9 GLN
MANS	64.64	3586 / 120 / 120 / 100%	9 GPS / 9 GLN
LISV	69.39	3415 / 114 / 113 / 99%	9 GPS / 9 GLN
TXHP	86.29	3586 / 120 / 120 / 100%	9 GPS / 9 GLN
LSUA	90.91	3586 / 120 / 120 / 100%	9 GPS / 9 GLN
SHRV	94.43	3585 / 120 / 120 / 100%	9 GPS / 9 GLN

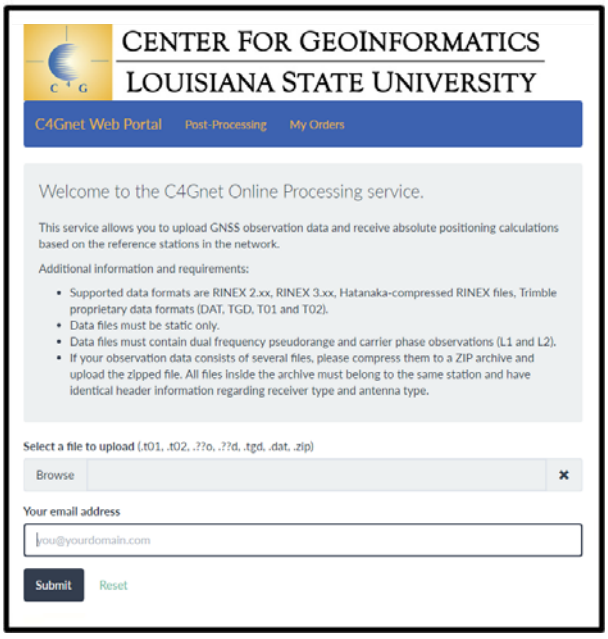
Final Results for: 1NSU

NAD83-2011 @ epoch 2010.00
Measurement method: Antenna Ground Point (AGP)
Geoid model: GEOID12A (Conus)

Coordinate	Value	σ [m]
X [m]	-293348.785	0.002
Y [m]	-5420743.780	0.008
Z [m]	3336681.022	0.004
Latitude	31° 45' 2.86333" N	0.004
Longitude	93° 05' 51.24198" W	0.002
Ellipsoidal height [m]	29.343	0.008
Orthometric height [m]	55.437	0.008

Report Information

Software version: 3.10.0
Creation date: 01/13/2017 17:11:59 UTC



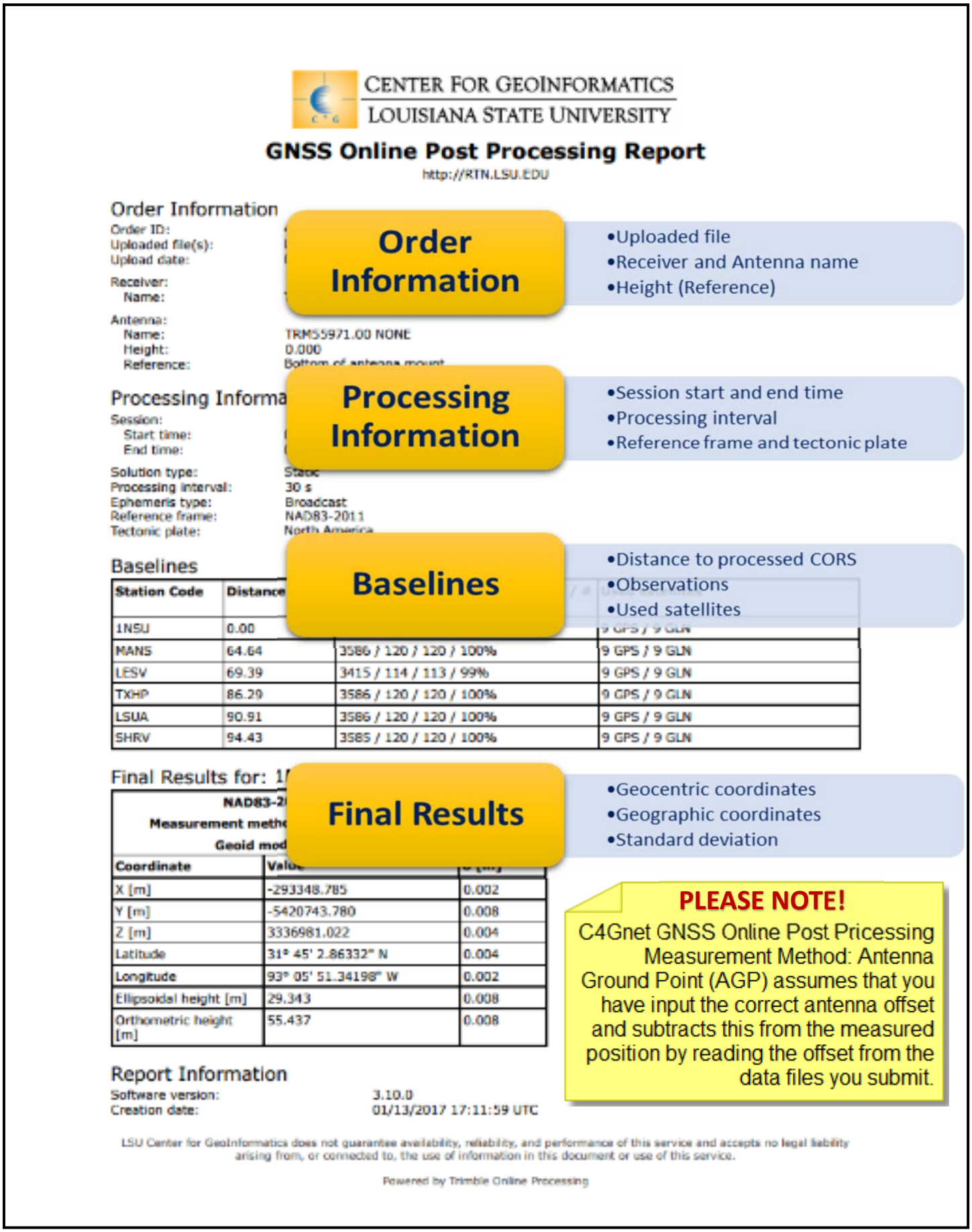
Supported data formats are RINEX 2.xx, RINEX 3.xx, Hatanaka-compressed RINEX files and Trimble proprietary data formats (DAT, TGD, T01 and T02). Data files must be a minimum of 10 minutes of static only (no kinematic) and data files must contain dual frequency pseudorange and carrier phase observations (L1 and L2).

If your observation data consists of several files from the same station, please compress them to a ZIP archive and upload the zipped file. All files inside the archive must belong to the same station and have identical header information regarding receiver type and antenna type as these are read from your file and entered automatically and will appear in the order solution report.

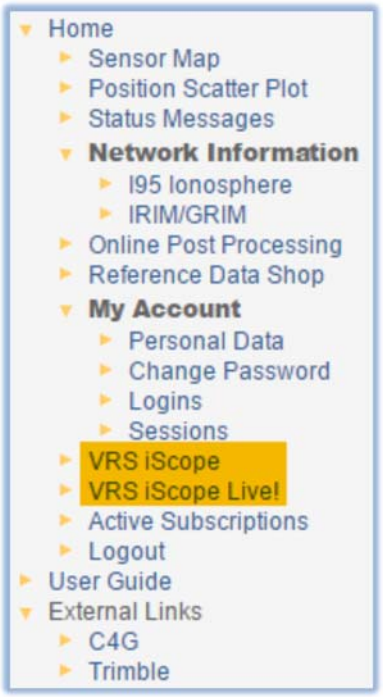
The user interface is quite simple, just hit the Browse button and select a file to upload, enter your email address and hit Submit. If you hit the My Orders link in the header menu you will find a list of your Orders in Progress and Processed Orders. The C4Gnet GNSS OPP system automatically sends notices with links to the solutions to the email you entered when submitting the order but links to the XDF and PDF copies of the reports can be found under your My Orders listings.

Solution datums are NAD83-2011 @ epoch 2010.00 and include Ellipsoidal and Orthometric heights, X, Y, Z and Lat/Lon. NAVD88 and GEOID12B are used for the Orthometric heights.

GNSS Online Post Processing Report Layout

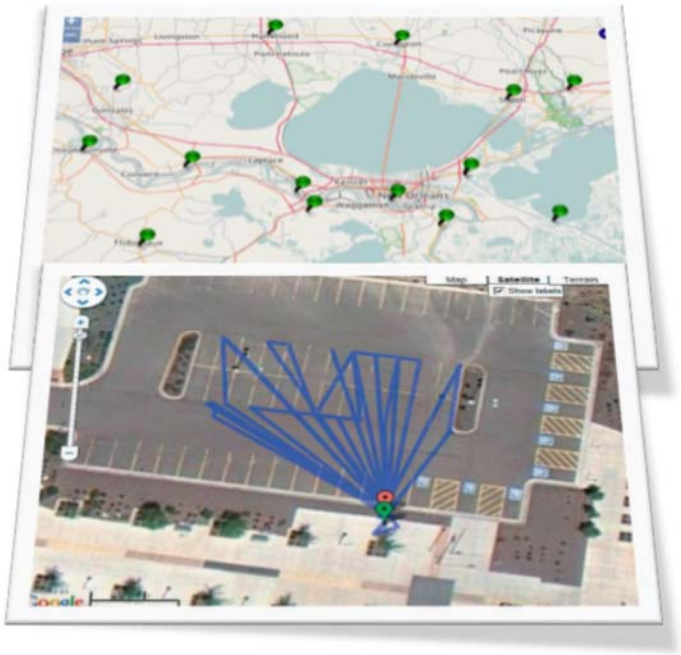


VRS iScope and iScope Live!



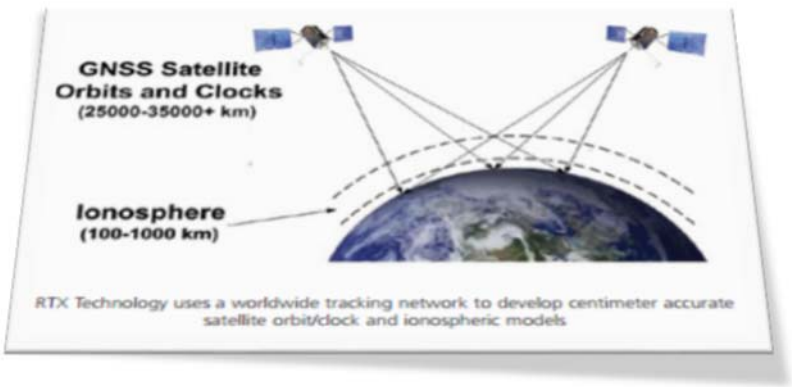
If you manage multiple field crew rover accounts the new VRS iScope Live! service provides an interactive map that can be used to view the location of your rovers that are currently logged into the RTN and receiving corrections.

VRS iScope service provides a remotely accessible interactive map that shows recent rover sessions for each rover account and the current activity or the trajectory of recent sessions, making it easy for field crew managers to schedule, track, and manage projects more efficiently. These iScope tools are a great way for managers in the office to keep up with their connected rovers in the field and review previous survey sessions for each rover account.



If you would like VRS iScope and iScope Live! added to your account, contact C4G by email and we will setup your accounts to access these rover monitoring tools.

New Real Time RTXnet Processor using Precise Point Positioning (PPP)



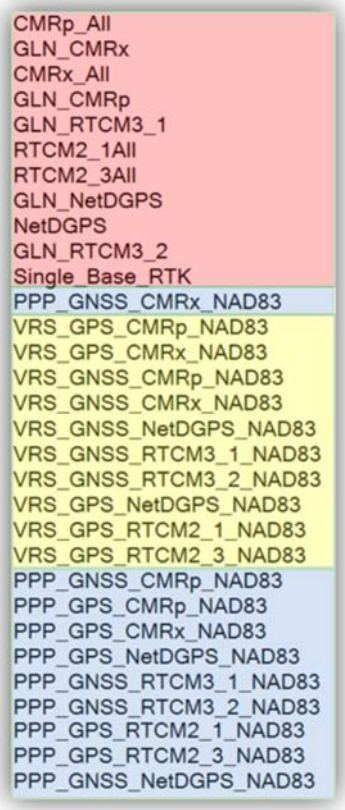
Rovers can access the New RTXnet processors for their real-time data solutions using one of our New PPP mountpoints. These PPP mountpoints give rovers a second real-time method to collect data and/or use as a real-time method of checking data collected with a real-time VRS RTK mountpoints. If data collected with both PPP and VRS agree, you will have a very high confidence that the data collected is accurate. Also while VRS mountpoints currently only support GPS and GLONASS constellations, C4Gnet's PPP CMRx and RTCM3.2 mountpoints currently support GPS, GLONASS and Galileo satellite constellations and are ready for other constellations if or when they are available in our coverage area. The additional constellations help with quicker initialization times and add additional satellites when rovers are in urban canyons or under canopy.

Note: *Check with your GPS dealer to see if your rover is Galileo ready in order for you to take full advantage of these additional Galileo satellites.*

New PPP Mountpoints and Mountpoint Naming Convention for the C4G RTN

In order to differentiate between traditional VRS RTK solutions and new VRS RTX solutions we have added additional mount points to our RTN. To avoid confusion, we have maintained the same mount points (pink in graphic) that you have used in the past but added a duplicate of each (yellow in graphic) with a new naming structure that makes it easier to decode the features used to create the mount point. We also have new mount points (blue in graphic) that use the same naming structure but use a new method to provide positions known as Precise Point Positioning (PPP). The RTN only used VRS network RTK positioning prior to this software release and those are the mount points you will recognize with the same names they have always had.

The new naming convention is broken into four groupings:
TYPE_SATS_FORMAT_REFERENCE



- The first set of characters is the **SOLUTION TYPE**; **VRS** or **PPP** then there is an under bar to separate the next group of characters.
- The next set of characters point out the **SATS or SATELLITES USED** in the solution; **GPS** or **GNSS**. GPS uses GPS satellite vehicles only and GNSS has both GPS and GLONASS SV's in the solutions.
- **Note: CMRx** and **RTCM3_2** mountpoints using **PPP** also include **Galileo SV's**.
- The next set of characters define the **MESSAGE FORMAT**; **CMR+**, **CMRx**, **RTCM2.x** or **RTCM3.x**, etc.
- The last group of characters is the **REFERENCE FRAME**. We are currently only using **NAD83** but the new software can support different reference frames on a mount point by mount point basis so we are calling out the reference frame so that if or when we get requests for additional reference frames or when a new datum is published by NGS, we are able to add them to the available mountpoints and tell them apart simply by looking at the mountpoint names.

C4Gnet RTN Rover Users Guide

Using C4Gnet RTN in Real-time

Live station status, coordinates & the current network solution coverage area are available on the C4Gnet web portal by selecting the Sensor Map link from the left hand menu located at **C4Gnet.XYZ** or by directing your browser directly to the URL **http://C4Gnet.XYZ/Map/SensorMap.aspx.**

You can also manage your real-time rover login passwords, get rover session details and update your personal data when logged into the C4Gnet RTN Web Portal. All of these options are located under the ***My Account*** *menu item*.

Real-time rover logins are in the format of ***username*** and ***password*** while web portal logins require ***organization, username*** and ***password.*** The number of real-time logins will depend on the number of subscriptions licensed by you. The passwords will be the same for both the rover accounts and the web portal unless changed in the web portal by the user.

In order to connect to C4Gnet RTN in real-time you will also need to enter the following information into your equipment.

Host Address: **C4Gnet.XYZ**

(if your rover will not accept the DNS C4Gnet.XYZ for the host address, use IP: 69.2.38.106, however using the DNS is preferable.)

Port: **9000**

Like with all Global Navigation Satellite System-based positioning, C4Gnet RTN is related to orthometric datums like NAVD88 by way of a geoid model or through a local network adjustment; the latter is accomplished by including and holding fixed several NGS benchmarks with valid coordinates. C4Gnet RTN data are based on coordinates in IGS08 epoch 2005.00 and NAD 83 (2011) Position (Epoch 2010.00) adjustment.

Network Real-time Solutions

GNSS Network solutions are available throughout the state of Louisiana and the network density will continue to increase as C4G/LSRC rolls out new CORS across the state and replaces current GPS only CORS with Multi-Constellation CORS. For those who have not used a network solution before, they will look and feel, in a practical sense, like single base solutions. Field procedures should remain the same, particularly in relation to performing site calibrations (localizations).

GPS is based on an Earth Centered Earth Fixed 3-D reference frame, so local vertical is not a product of GPS. Therefore, C4Gnet RTN corrections are not directly connected to NAVD 88. The user must determine the appropriate adjustment to local vertical datums, including NAVD 88. Most often this is accomplished by means of a recent geoid model, the current one being GEOID12B. The GEOID12B model is intended to transform between NAD 83 (2011) and the respective vertical datum for NAVD88. (GEOID12B is identical in the lower 48 to GEOID 12A.)

In areas tested to date, network solutions perform as well or better than single base solutions. It is important to ensure that your equipment settings match the particular mount point you intend to use.

Mountpoints

A mountpoint defines the type of processor used, what satellite constellations are supported, the format of the correction messages and the reference frame that relates to a real-time data stream. When connecting to C4Gnet RTN in real-time, a mountpoint list is generated for a user to select from or the desired mountpoint can be hard coded by the user in their rover setup. The following format options are available when using C4Gnet:

CMRx *This is the latest Trimble proprietary format for Network RTK mountpoints (eg CMRx_All and GLN_CMRx):* CMRx allows Real-Time Kinematic (RTK) users to utilize more satellite constellations and signals as they become available, with faster initializations and improved performance near obstructions and under canopies. It offers significant compression (around 40%) over the already compact CMR/CMR+ format to help users receive corrections within less bandwidth. Trimble rovers that support CMRx should use it exclusively.

RTCM 3.2 Carrier and Code Differential Corrections for High-Precision RTK, Network RTK, and PPP-type applications. Recently modernized with, so-called Multiple Signals Messages (MSM), for generic inclusion of new constellations and signals. MSM Currently supports GPS, GLONASS, Galileo, QZSS, BeiDou, SBAS.

CMRp *Network RTK mount point (eg CMRp_All):* This is intended for legacy equipment in industry groups where CMR plus has been used as a quasi-standard format (such as precision agriculture). CMR plus is a Trimble format so non Trimble users are advised to use the RTCM 3.x format unless you are sure your device fully supports CMR+.

RTCM 3.1 *Network RTK mount point (eg GLN_RTCM3_1):* This format support both GPS and GLONASS SV's and will provide a network RTK data stream optimized for the user's location.

DGPS *Virtual Base mount point (eg NetDGPS)*: This will provide a sub-meter differential solution optimized for the user's location.

Legacy Mountpoints use the following naming convention

CMRp_All, RTCM2_3All, CMRx_All provide GPS only solutions.

GLN_CMRp, GLN_RTCM3_1, GLN_CMRx and NetDGPS provide both GPS and GLONASS solutions.

New Mountpoints use this naming structure: **TYPE_SATS_FORMAT_REFERENCE**

(See the details covered on page 9)

Antenna Setting in C4Gnet

Please be advised that the Trimble Infrastructure software being used by C4Gnet RTN will adjust ***real-time data*** so that all CORS antennas are uniformly described as a null antenna (ADVNULLANTENNA). As such, no base station antenna model needs to be applied to adjust CORS observations from the ***Antenna Phase Centre*** to the ***Antenna Reference Point***. Users will still need to apply the appropriate absolute antenna model for their rover.

Absolute antenna modeling, instead of relative antenna modeling, is used in the infrastructure management software used by C4Gnet RTN. These should be the absolute antenna models derived by the ***International GNSS Service (IGS)*** and users are advised to contact their local GNSS supplier for the required information. Users should also use absolute antenna models when post processing for both the user and CORS antennas. Any mix of absolute and relative antenna modeling will introduce significant systematic errors.

All post process RINEX files and post process files in other formats will continue to hold raw data to the ***Antenna Phase Centre*** in line with international standards.

Always Check Your Work

Precision is dependent upon equipment and procedures. Accuracy should be checked relative to a known or assumed standard. C4G constrains its RTN to the currently published NGS NSRS reference frame.

Rovers wanting to check RTN data collected with C4Gnet, typically compare RTN RTK (VRS) positions to static GPS positions in a Post Processing tool like (OPUS) or **C4G's New *GNSS Online Post Processing*** service. While this method works well, it takes some time to do these post processed checks. C4G now offers an entirely new method of doing real-time data collection using RTXnet processors producing Precise Point Positioning (PPP) solutions. These PPP solutions give rovers a second real-time method to collect data and/or use as a real-time method of checking data collected using real-time VRS RTK processed solutions. If data collected with both PPP and VRS agree, you have a very high confidence that the data collected is accurate. For the highest level of confidence, all accuracy assessments should also include connections to realizations of local coordinate systems and datums.

Best Practice Procedures:

I. **Be In The Box:** Users should be aware of the Network Boundaries. Best results will be achieved when you work inside the Network Boundaries.

II. **Planning:** Be aware of satellite geometry as it will have an effect on performance. Well distributed satellites in your sky plot work better than tight groupings of satellites.

III. **Observing Control:** A minimum of one hundred eighty (180) epochs is recommended with a starting rms <30. For best results a second set of measurements should be taken no sooner than 45 minutes later. This gap in time is important for the establishment of a different satellite constellation. The measurements need to be made with different satellite geometries. The difference between the two measurements is double the probable error. If it exceeds project requirements, re-observe after a three hour change in satellite geometry. Repeat this method until accuracy meets project requirements. (If repeat measurements are made one after the other you must re-initialize the receiver between measurements.)

IV. **Observing Topo:** One five (5) second measurement with an rms <30. If initialization is lost due to high rms, measurements within that initialization should be checked.

V. **Site Calibration:** A site calibration fits the measurements to local control. Errors in the control will change the observed values. In most cases the reported values will provide the best fit to local control.

The messages used in each mountpoint can be found by directing your browser to C4Gnet.XYZ:9000 where you will see a source table like the following:

MOUNTPOINT SOURCE TABLE

CMRp_All;CMRp_All;RAW;1004(1),1005/1007(5),PBS(10);2;GPS;C4Gnet
GLN_CMRx;GLN_CMRx;CMRx;1004(1),1005/1007(5),PBS(10);2;GPS+GLONASS;C4Gnet
CMRx_All;CMRx_All;CMRx;1(1),3(10),18(1),19(1);2;GPS;C4Gnet
GLN_CMRp;GLN_CMRp;CMR+;1004(1),1005/1007(5),PBS(10);2;GPS+GLONASS;C4Gnet
GLN_RTCM3_1;GLN_RTCM3_1;RTCM 3.1;1004(1),1005/1007(5),PBS(10);2;GPS+GLONASS;C4Gnet
RTCM2_1All;RTCM2_1All;RTCM 2.1;1004(1),1005/1007(5),PBS(10);2;GPS;C4Gnet
RTCM2_3All;RTCM2_3All;RTCM 2.3;1004(1),1005/1007(5),PBS(10);2;GPS;C4Gnet
GLN_NetDGPS;GLN_NetDGPS;RTCM 3.1;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS+GLONASS;C4Gnet
NetDGPS;NetDGPS;RTCM 2.3;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS;C4Gnet
GLN_RTCM3_2;GLN_RTCM3_2;RTCM 3.2;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS+GLONASS;C4Gnet
Single_Base_RTK;Single_Base_RTK;RTCM 3.1;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS+GLONASS;C4GNet
PPP_GNSS_CMRx_NAD83;PPP_GNSS_CMRx_NAD83;CMRx;1004(1),1005/1007(5),PBS(10);2;GPS+GLONASS;C4GNet
VRS_GPS_CMRp_NAD83;VRS_GPS_CMRp_NAD83;RTCM 2.3;1(1),3(10),18(1),19(1);2;GPS;C4GNet
VRS_GPS_CMRx_NAD83;VRS_GPS_CMRx_NAD83;CMRx;1(1),3(10),18(1),19(1);2;GPS;C4GNet
VRS_GNSS_CMRp_NAD83;VRS_GNSS_CMRp_NAD83;CMR+;1004(1),1005/1007(5),PBS(10);2;GPS+GLONASS;C4GNet
VRS_GNSS_CMRx_NAD83;VRS_GNSS_CMRx_NAD83;CMRx;1004(1),1005/1007(5),PBS(10);2;GPS+GLONASS;C4GNet
VRS_GNSS_NetDGPS_NAD83;VRS_GNSS_NetDGPS_NAD83;RTCM 3.1;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS+GLONASS;C4GNet
VRS_GNSS_RTCM3_1_NAD83;VRS_GNSS_RTCM3_1_NAD83;RTCM 3.1;1004(1),1005/1007(5),PBS(10);2;GPS+GLONASS;C4GNet
VRS_GNSS_RTCM3_2_NAD83;VRS_GNSS_RTCM3_2_NAD83;RTCM 3.2;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS+GLONASS;C4GNet
VRS_GPS_NetDGPS_NAD83;VRS_GPS_NetDGPS_NAD83;RTCM 2.3;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS;C4GNet
VRS_GPS_RTCM2_1_NAD83;VRS_GPS_RTCM2_1_NAD83;RTCM 2.1;1004(1),1005/1007(5),PBS(10);2;GPS;C4GNet
VRS_GPS_RTCM2_3_NAD83;VRS_GPS_RTCM2_3_NAD83;RTCM 2.3;1004(1),1005/1007(5),PBS(10);2;GPS;C4GNet
PPP_GNSS_CMRp_NAD83;PPP_GNSS_CMRp_NAD83;CMR+;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS+GLONASS;C4GNet
PPP_GPS_CMRp_NAD83;PPP_GPS_CMRp_NAD83;CMR+;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS;C4GNet
PPP_GPS_CMRx_NAD83;PPP_GPS_CMRx_NAD83;CMRx;1004(1),1005/1007(5),PBS(10);2;GPS;C4GNet
PPP_GPS_NetDGPS_NAD83;PPP_GPS_NetDGPS_NAD83;RTCM 2.3;1(1),3(10),18(1),19(1);2;GPS;C4GNet
PPP_GNSS_RTCM3_1_NAD83;PPP_GNSS_RTCM3_1_NAD83;RTCM 3.1;1004(1),1005/1007(5),PBS(10);2;GPS+GLONASS;C4GNet
PPP_GNSS_RTCM3_2_NAD83;PPP_GNSS_RTCM3_2_NAD83;RTCM 3.2;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS+GLONASS;C4GNet
PPP_GPS_RTCM2_1_NAD83;PPP_GPS_RTCM2_1_NAD83;RTCM 2.1;1004(1),1005/1007(5),PBS(10);2;GPS;C4GNet
PPP_GPS_RTCM2_3_NAD83;PPP_GPS_RTCM2_3_NAD83;RTCM 2.3;1004(1),1005/1007(5),PBS(10);2;GPS;C4GNet
PPP_GNSS_NetDGPS_NAD83;PPP_GNSS_NetDGPS_NAD83;RTCM 3.1;1004(1),1005/1007(5),1014(1, 1 msgs),1015(1, all msgs),1016(1, all msgs);2;GPS+GLONASS;C4GNet

ENDSOURCETABLE

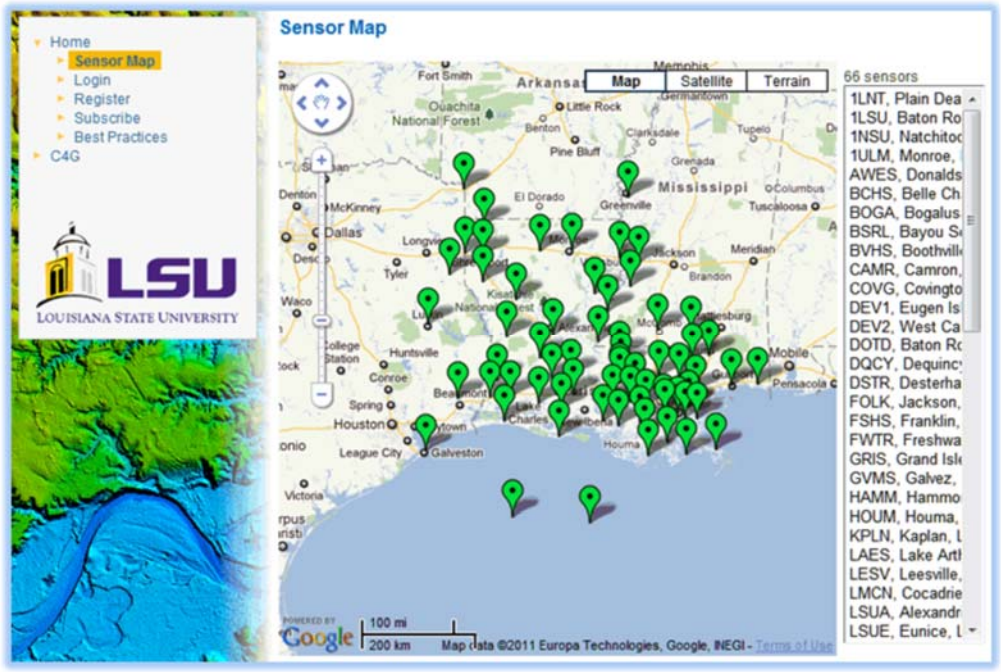
C4Gnet RTN Web Portal Instructions

The webpage for C4Gnet RTN is available at the following URL: **http://C4Gnet.XYZ**

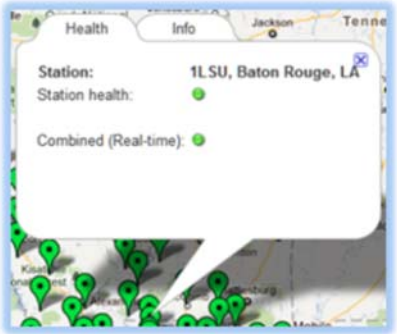
Logged Out Environment

Sensor Map

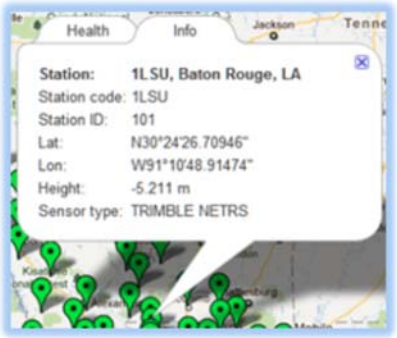
The Sensor Map link takes you to a dynamic map of all C4Gnet RTN CORS stations. You can come here to check on the status of the network.



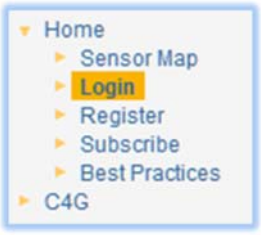
The public map is interactive and by clicking a station, you will get a popup bubble that lets anyone see station information such as station health, RTN health, station name, location, code, ID, Lat, Lon, height and type of receiver.



Additional information will also be available to subscribers once they have successfully logged into the C4Gnet Web Portal.

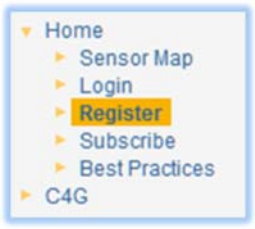


Login



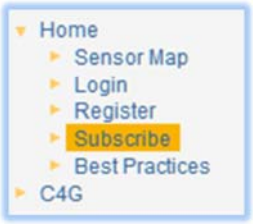
To login to C4Gnet RTN you are required to enter your **Organization** name, **User Name** and **Password**. When an account is created for you, this information will be provided through an automated email.

Register



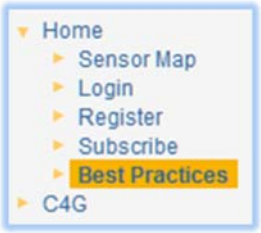
The Register link takes you to a form to create a new account. Once you have registered the network administrator will be notified by email and once your account is approved you will receive notification sent to the email address submitted in your registration request.

Subscribe



The Subscribe link takes you to the C4G web store and provides product and subscription information as well as pricing for all C4Gnet RTN products.

Best Practices



This link is where technical support information can be found on many topics important to users about GPS/GNSS technology for precision positioning. Videos, Podcasts and PowerPoint presentations from the 2011 National Static and Real-Time Network GPS/GNSS Best Practices Seminar in June of 2011 held in New Orleans can be found here.

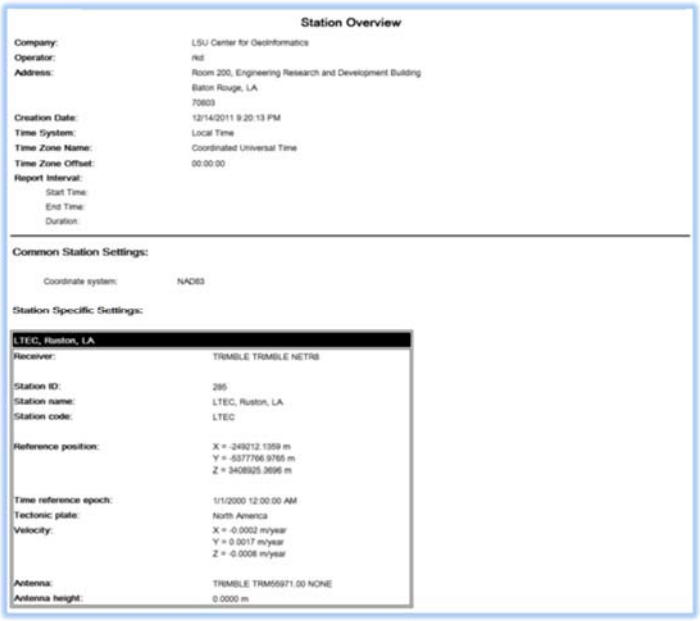
C4G

This link takes you to the LSU Center for GeoInformatics website. This is the official website for C4G and the Louisiana Spatial Reference Center (LSRC), GULFNet and C4Gnet RTN's.

Logged In Environment

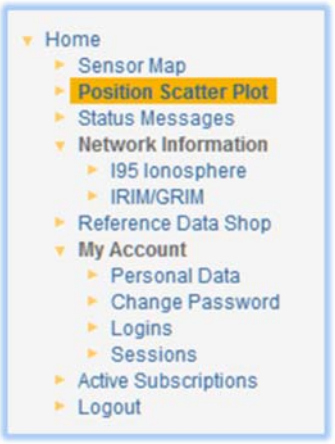
Sensor Map

The Sensor Map link takes you to a dynamic map of all C4Gnet RTN CORS stations. You can come here to check on the status of the network. The sensor map uses the Google Maps application to visualize the location and health status of the sensors (GNSS Receivers) to users.

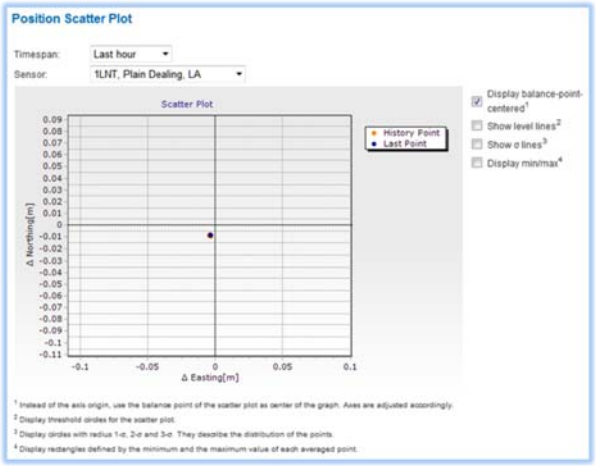


C4Gnet subscribers can click on the sensor symbols to see more information such as Station Overviews and other detailed reporting.

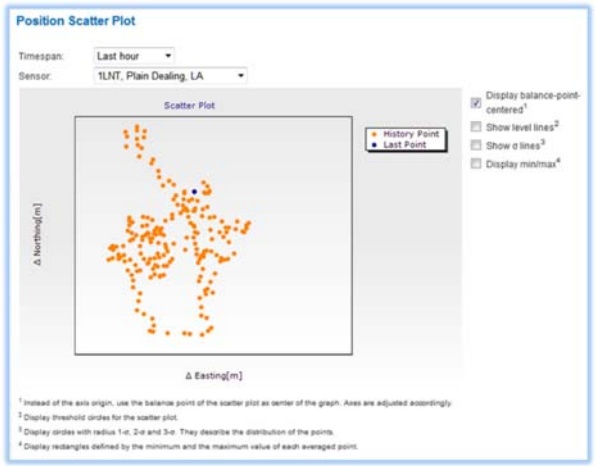
Position Scatter Plot



The Position Scatter Plot link takes you to a dynamic scatter plot of the station selected. This interactive tool lets you check in the 2D position of a station over a period of time that you set.

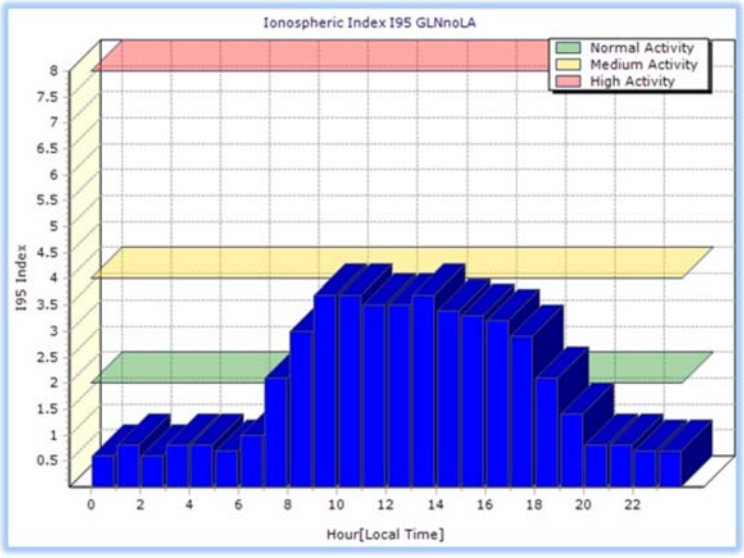


To zoom in and out you just drag a binding box around the area you want to see. Start Top Left to Bottom right to Zoom In and Bottom right to Top Left to Zoom Out

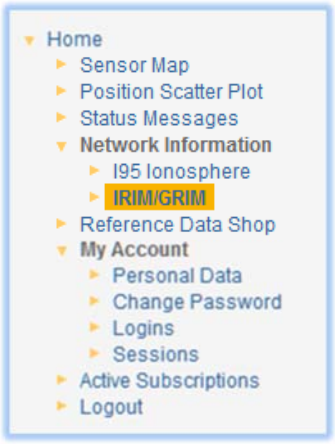


I95 Ionosphere

The I95 Ionosphere link takes you to the Index 95 charts that reflect the intensity of ionospheric activity, i.e., the expected influences onto the relative GPS positions. Both current and historical I95 activity are available.

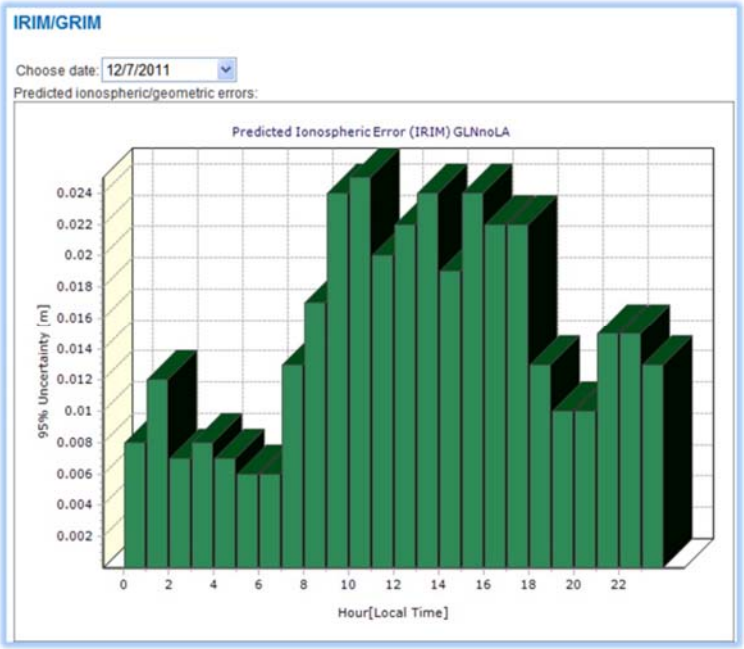


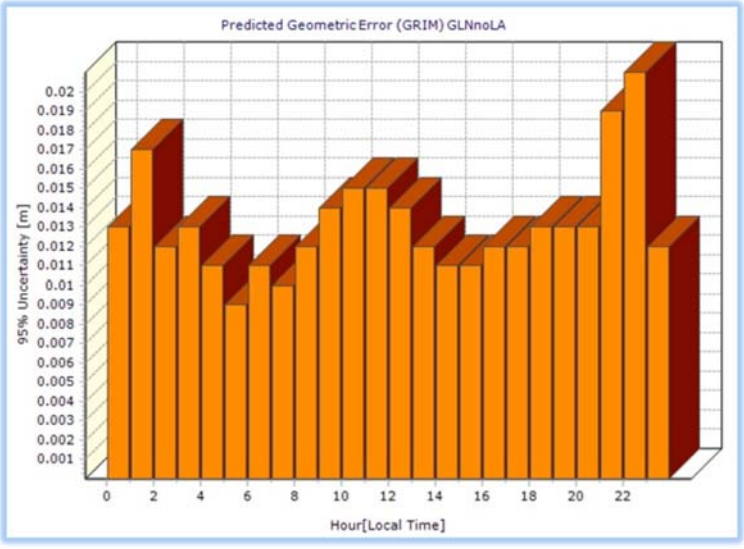
IRIM/GRIM 95



The IRIM/GRIM link takes you to charts of the current predicted and historical ionospheric and geometric errors.

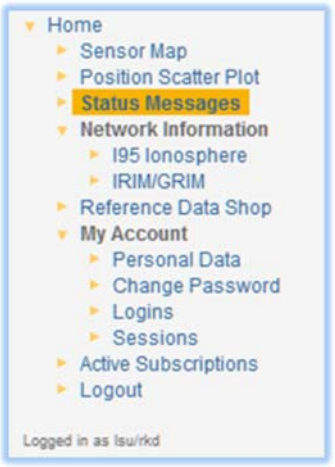
IRIM is Ionospheric Residual Integrity Monitoring, GRIM is Geometric Residual Integrity Monitoring.





Under disturbed ionospheric condition, ionospheric residuals can not be considered as linear. The Network Processor module also describes the potential non-linear residual errors in the generated data stream transmitted to the user. This can also be considered as integrity monitoring for residual interpolation and ambiguity resolution in the network. It is a very useful tool to predict the rover performance. The C4Gnet Web Portal is the best way to find the current and historical predicted ionospheric and geometric errors. C4Gnet removes the linear parts of these effects by applying ionospheric and geometric corrections to the raw data.

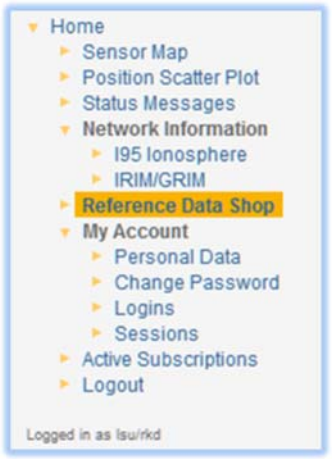
Status Messages



Status messages are used to inform users of important information about C4Gnet RTN. Three levels of messages exist: ***Info***, ***Warning*** and ***Alert***. These will be highlighted green, yellow and red respectively to indicate the severity of the message. ***Info*** messages will be used to inform users of general news and tips for using C4Gnet RTN. ***Warning*** messages will be used to inform users of planned maintenance and any issues associated with C4Gnet RTN. ***Alert*** messages will be used for major issues and unplanned outages of service.

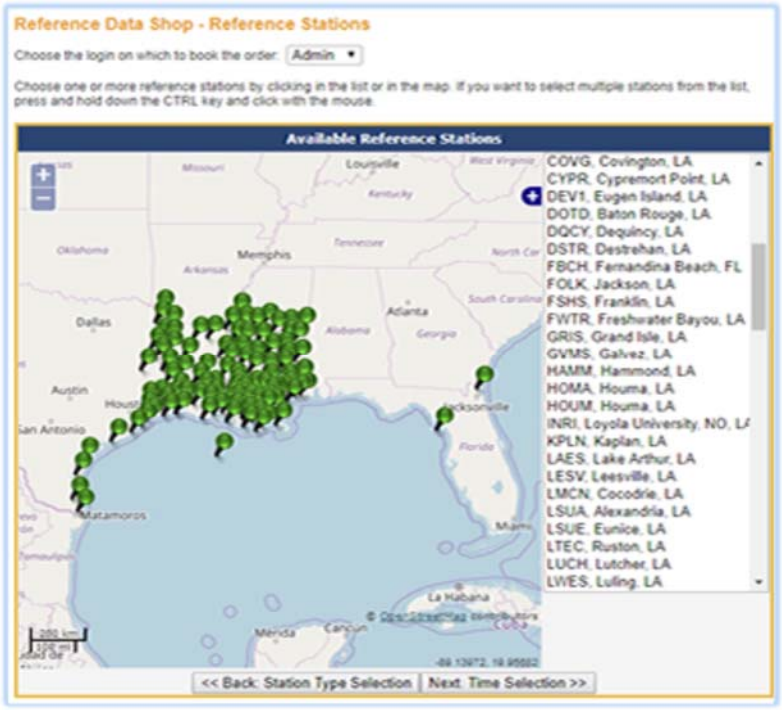
Users are advised to subscribe to the RSS feed to ensure that they keep up to date with the latest information available. This feed can be accessed by some mobile phones in the field.

Reference Data Shop



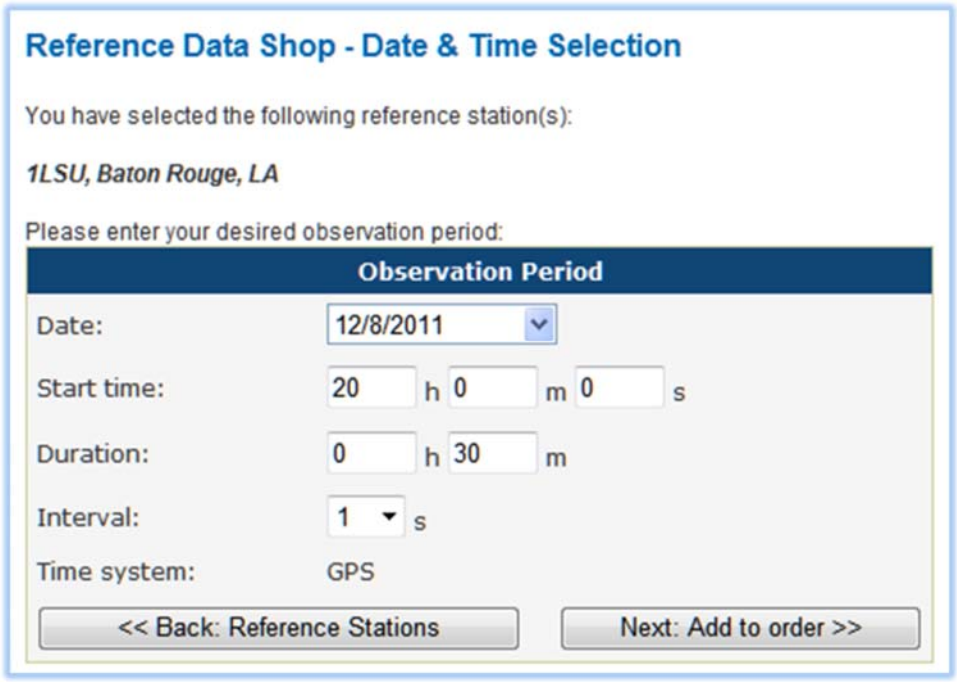
This is where you can access archived GNSS data as RINEX files or alternatively in a number of other formats in whatever durations and interval you desire.

The first time you access the ***Reference Data Shop*** you will be asked to start a new order. After that you will be given the options of choosing to ***View/submit order***, ***Add order items*** or ***Cancel*** order. You can also view a list of orders not yet downloaded and already downloaded orders. When ordering data you are given the option of ordering ***Continuously Operating Reference Station (CORS)*** data or ***Virtual Reference Station (VRS)*** data. CORS data is the data observed at the CORS sites while VRS data is virtual data generated for a user specified location.



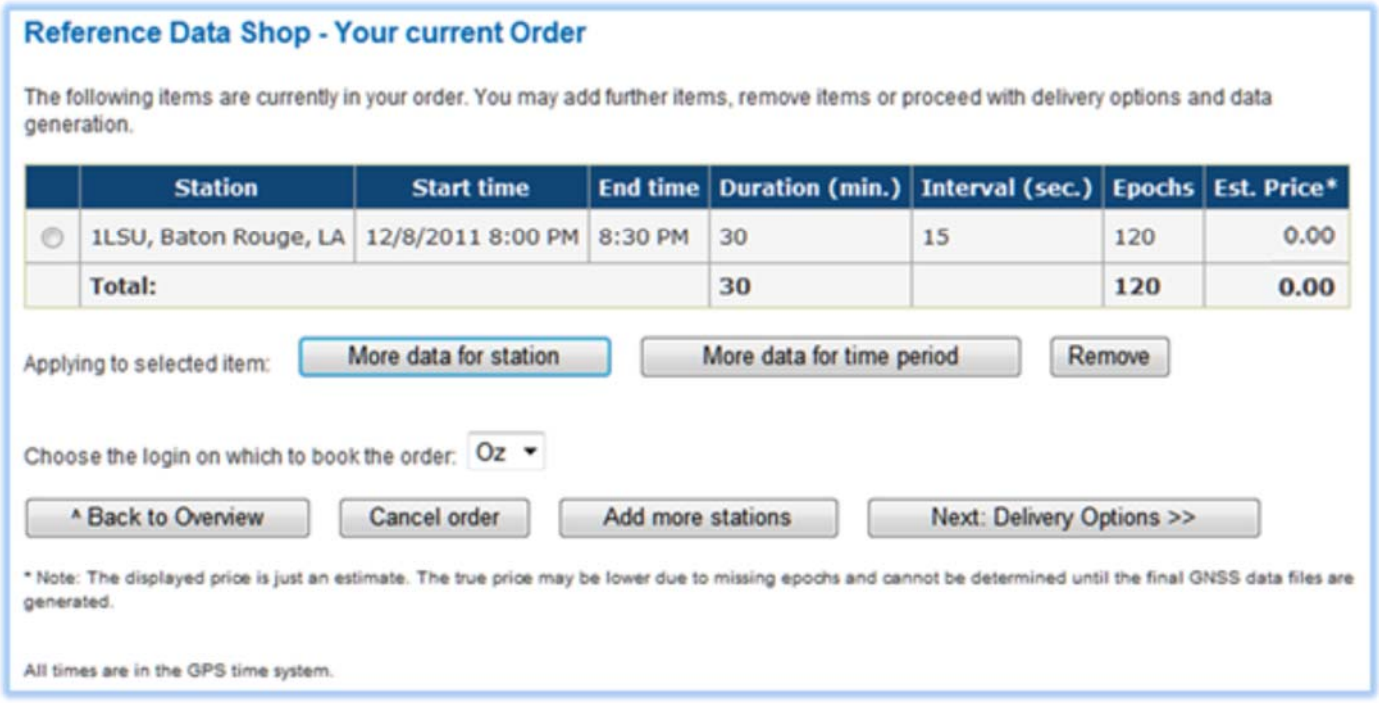
When selecting the ***Reference Stations*** for which you would like to download data, you can either select one or many stations from the list or select them by clicking on the map.

Once your selection is complete, click ***Next: Time Selection >>***



Select the date, start time, duration and interval. Please note that the time system used is GPS time and not a standard zone such as Central Standard Time. You will need to add 6 hours to Central Standard Time (or five hours to Daylight Savings Time) to determine the appropriate GPS time.

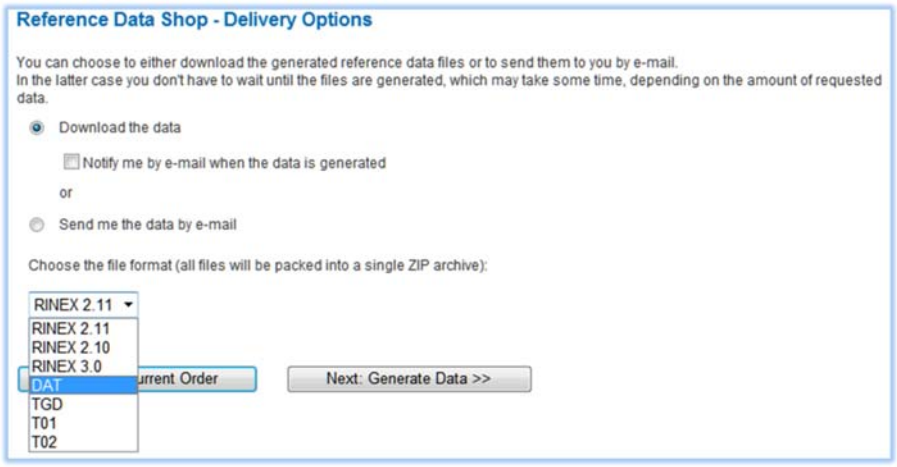
Once your ***Time Selection*** details are complete click ***Next: Add to order >>***.



Here you can either select to add additional order items through a number of options. Ensure you book the order under your primary login as real-time logins do not have access to ***Reference Data Shop*** data. **Note data is Unlimited, so no additional fees apply.**

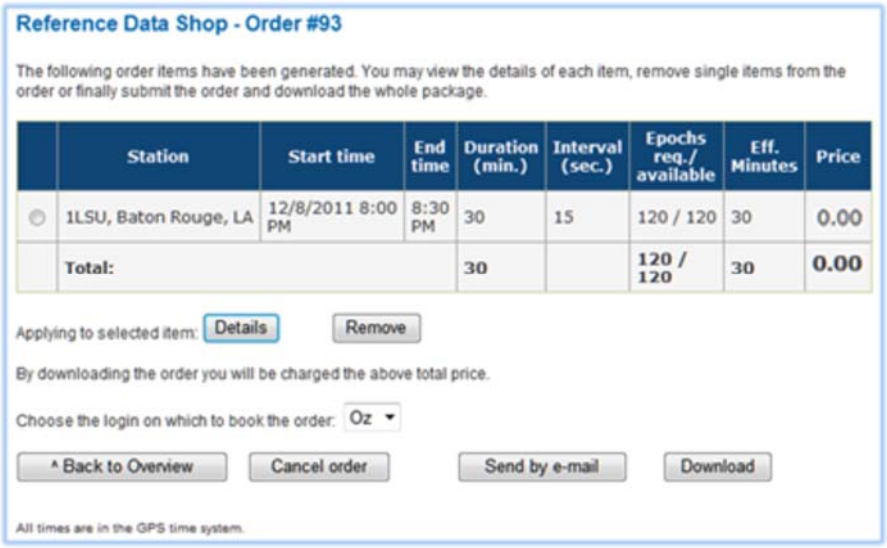
Once your order is complete, click ***Next: Delivery Options >>***.

Here you can chose to download the data or send it via email. Please be aware that the data files are quite large and may be blocked by email systems. You also have the choice of downloading the data in a number of formats. These are RINEX 2.11, RINEX 3.0, DAT, TGD, T01 and T02. While the RINEX formats should be recognized by most software packages, the last four options are not international standards but may be of use to some users. When your delivery options selection is complete click ***Next: Generate Data >>***.



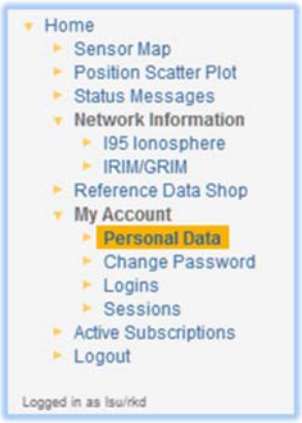
A table indicating the ***Processing Status*** of the order will appear. You can close this screen and the data generation will still continue. For large orders it may be preferable to return at a later time to retrieve the data once this generation is completed. Once the data generation is complete, click on ***Next: Order Details >>***.

Here you will see a summary of the order including the completeness of the data. Select an order item and click on ***Details*** to see further information. Click on ***Remove*** to delete an order item from the list. Click on ***Download*** or ***Email*** to retrieve the data.



The data will be delivered in a compressed zip file. Within the zip file you will find three RINEX files: the observation file, GPS navigation file and the GLONASS navigation file for each station-session chosen. You will also find a text file which summarizes the data ordered including the completeness of the data.

My Account: Personal Data

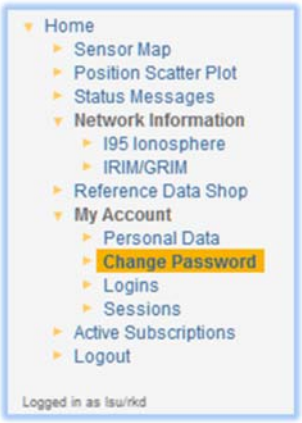


This link allows you to change your personal data for your primary login. Please keep your Personal Data and Profile up to data so we can communicate with you when needed.

My Account: Sessions

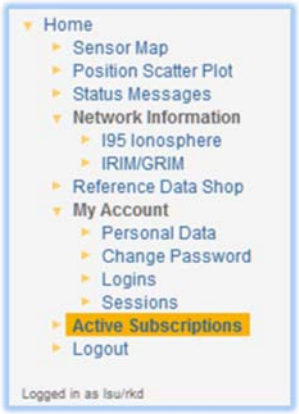
This link allows you to view your C4Gnet RTN usage history over various periods of time. Usage history is summarized in terms of total organization usage, total login usage and total resource usage (e.g. RINEX or real-time).

My Account: Change Password



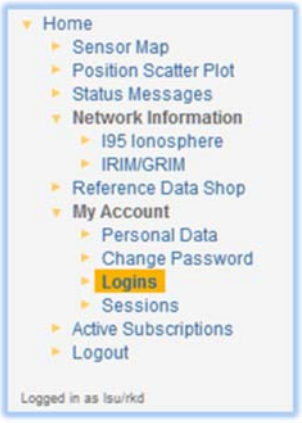
This link allows you to change the password for your primary login. It is advisable to regularly change your password to maintain security.

Active Subscriptions



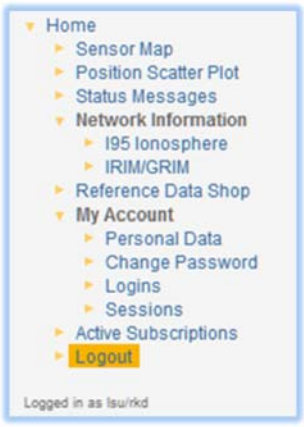
Click on this link to view your current valid subscriptions. Click on ***Details*** to view further information.

My Account: Logins



Here you are able to view your primary login and supplementary real-time logins. By clicking on one of the logins you are able to change its password. It is advisable to regularly change your password to maintain security.

Logout



This link will take you back to the logged out environment home page. Click on ***Logout*** once you have completed accessing C4Gnet RTN data and information.

Glossary of Terms

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>CMR</td><td>Compact Measurement Record - A Trimble proprietary format for real-time data streaming, designed for RTK applications and radio transmissions with low bandwidth. Published in 1996 it holds messages for observations, position, antenna and Primary Base Stations.</td></tr>
<tr><td>CMRp</td><td>Compact Measurement Record plus - A Trimble proprietary format for real-time data streaming, position is trickled over 10 epochs for further bandwidth savings. Commonly used in agricultural and construction applications.</td></tr>
<tr><td>CMRx</td><td>Completely new, strictly Trimble proprietary format - Published in 2009 is for real-time data streaming using orbit information to highly compress data on encoding and decoding position, antenna, PBS and VRS residuals are trickled over several epochs (8 per default) Designed for current and future GNSS systems and applications
<table>
<tr><th>Format</th><th>Bytes</th></tr>
<tr><td>RTCM</td><td>32000</td></tr>
<tr><td>RTCM 3.x</td><td>12600</td></tr>
<tr><td>CMR (CMR+)</td><td>12000</td></tr>
<tr><td>CMRx</td><td>5500</td></tr>
</table>
Compression levels in C4Gnet
1 minute of data, Single Station (no PBS, no VRS residuals)
11 satellites
Position and antenna every 8 epochs (or trickled over 8 epochs)</td></tr>
<tr><td>CORS</td><td>Continuously Operating Reference Station - An installation that is precisely located and continuously observing GNSS data. Arrays of CORS are often linked together as part of a network to deliver precise positioning solutions over large areas.</td></tr>
<tr><td>DGNSS</td><td>Differential GNSS - A basic method of processing GNSS data to achieve sub-meter level accuracies (often referred to as DGPS).</td></tr>
<tr><td>DGPS</td><td>Differential GPS - A basic method of processing GNSS data to achieve sub-meter level accuracies.</td></tr>
<tr><td>DSC</td><td>Dynamic Station Coordinates uses Trimble RTX technology to compute the so-called “Dynamic Station Coordinates” for each reference station. These coordinates are dynamically re-computed and updated to best fit the reference stations’ position.</td></tr>
<tr><td>C4Gnet</td><td>The CORS system offered in Louisiana since December 1, 2011.</td></tr>
<tr><td>GLONASS</td><td>(GLObal'naya NAvigatsionnaya Sputnikovaya Sistema) – This is the name of the satellite-navigation network maintained by the Russian government. The English translation of this name is “GLObal NAvigation Satellite System,” or more commonly named “GLONASS.”</td></tr>
</table>

Glossary of Terms

Term	Definition
GNSS	*Global Navigation Satellite System* - A satellite navigation or SAT NAV system is a system of satellites that provide autonomous geo-spatial positioning with global coverage. As of October 2011, the United States NAVSTAR Global Positioning System (GPS) and the Russian GLONASS are fully globally operational GNSSs.
GRIM	Geometric Residual Integrity Monitoring
IRIM	Ionospheric Residual Integrity Monitoring
GULFNet	The CORS system offered in Louisiana prior to December 1, 2011.
LSRC	*Louisiana Spatial Reference Center* - Founded in 2002 by C4G with a grant from NOAA to establish a network of high precision GPS reference stations throughout Louisiana.
Machine Guidance	A system which utilizes positioning information to guide or auto- steer machinery along a specified path.
NRTK	*Network RTK* - An enhancement of RTK which utilizes data from multiple CORS to provide a uniform level of accuracy across the network.
NTRIP	*Networked Transport of RTCM via Internet Protocol* - A method for streaming RTCM messages over the internet.
PPP	Precise Point Positioning (PPP) is a GNSS positioning method to calculate very precise positions using a single (GNSS) receiver. PPP approach combines precise clocks and orbits calculated from a global network to calculate a precise position with a single receiver.
RINEX	*Receiver Independent Exchange* - An international standard for the storage of GNSS data.
RTCM	*The Radio Technical Commission for Maritime Services* - An international standard for real-time data streaming of GNSS data.
RTK	*Real Time Kinematic* - A sophisticated method of processing GNSS data to achieve centimeter level accuracies.
RTX	RTX Technology infrastructure is a unified framework for estimating satellite parameters for any GNSS satellite.
RTXNet	Is a processor that uses PPP in real-time to provide comprehensive GNSS solutions using GPS, GLONASS Galileo, Beidou and QZSS
VRS	*Virtual Reference Station* - A method of processing Network RTK which generates virtual data from data collected at nearby CORS for a specified location.

Contact Details

For more information or assistance please contact C4Gnet RTN Customer Support at:

Office:	**225-578-4609**
Cell:	**225-328-8976**
Email:	**rosbor1@lsu.edu**
RTN Web Portal:	**C4Gnet.XYZ**
C4G Website:	**C4G.LSU.EDU**

LSU C4G Best Practice Videos are available on YouTube

youtube.com/user/LSUC4G

Topics you will find include the following and much more...

Determining Elevations with GNSS

- **Coastal Issues Facing Southeast Coastal Louisiana What to Do?**
  (Tim Osborn, NOAA)
- **Subsidence in the Gulf Coast**
  (Dr. R. Dokka, LSU)
- **Vertical geodetic control in southern Louisiana: Providing the National Spatial Reference System in dynamic regions**
  (Ms. R. Shields, NGS)
- **Introduction to GNSS** (Mr. C. Mugnier, LSU)
- **Guidelines for establishing GPS-derived ellipsoid heights: NGS Technical Publication 58**
  (Mr. D. Zilkoski, Director-Emeritus, NGS)
- **Guidelines for establishing GPS-derived orthometric heights: NGS Technical Publication 59**
  (Mr. D. Zilkoski, Director-Emeritus, NGS)
- **Improvements to the Geoid model**
  (Dr. G. Mader, NGS)
- **OPUS products**
  (Dr. M. Schenewerk, NGS)

Real-time Kinematic Surveying and Best Practices

- **RTK best practices** (Mr. W. Henning, NGS)
- **Introduction to Real-time GNSS networks** (Dr. R. Dokka, LSU)
- **NGS support for Real-time networks** (Mr. W. Henning, NGS)